MEMORANDUM

SUBJECT: EPA Comments on "Assessment of Dam Safety of Coal Combustion Surface Impoundments: City of San Antonio, JT Deely Power Plant, San Antonio, TX

DATE: December 3, 2013

1. Sections 1.3.2.4 and 1.3.2.5 are both discussing surveillance and monitoring (subject heading for 1.3.2.5). Maintenance is also discussed in section 1.3.2.5, however, that is the subject heading for section 1.3.2.4. Please correct.
2. In Appendix B, checklist sheets for both North Bottom Ash Pond and South Bottom Ash Pond, names and materials changed from Bottom Ash to Fly Ash. Please explain or correct.
3. In Section 6, "H/H Safety" it may be advantageous to provide additional detail regarding any observed contributory areas to the units, if known. If not known, as much should be stated.
4. On page 7-3, Section 7.1.4, second paragraph, what concern exists with a factor of safety of 1.4 for long-term, steady – state normal pool conditions?

DATE: June 3, 2014

1. Please reconsider the hazard potential classification for the North and South Bottom Ash Ponds. It is currently rated as High and should be reduced if the loss of life for plant personnel is the only rationale for this rating. The facility where there is not a 24/7 operation is not on par with homes/schools/hospitals in which at any point in time, loss of life could occur.
2. With a change in the hazard potential classification for the North and South Bottom Ash Ponds, and the Low hazard rating for the Evaporation Pond, please conduct a back of the envelope H&H calculation that may in fact have influence a change in condition rating.
3. **Section 1.1, Introduction**, second paragraph: "In summary, the North and South Bottom Ash Ponds and Evaporation Basin's embankments are classified as **FAIR** based on static and seismic engineering studies following the best professional engineering practice to support acceptable safety factors under normal loading conditions (static, hydrologic, seismic)…" Section 7.3, concludes that under all conditions, each impoundment met minimum FOS for stability analyses. If, "FAIR," then provide an appropriate rationale, if not, revise the condition rating.
4. **Section 1.3.1.1, Conclusions Regarding Structural Soundness of the CCW Impoundments,** needs to include a statement indicating that (1) the May 2014 is included in this report in Appendix A; (2) the May 2014 replaces the 2012 report that was included in the draft report as Appendix A (If this is true, there are several instances in the report that refer to the 2012 report that need to be corrected. If this is not so, then both reports need to be included as an appendix). Also, please include a statement in this section that indicates the minimum factors of safety for all loading conditions was met or exceeded for each impoundment.
5. On page 1-4, revise statement **in Section 1.3.2.1** of "As required by FEMA" to "as recommended by FEMA." FEMA only issues guidance, not regulations, of IDF selection.
6. **Section 1.4.2** rates the units as FAIR, please provide appropriate rationale or change rating.
7. **Section 1.4.2,** first paragraph, last sentence: remove "may".
8. **Section 2.1.2** indicates that included in Appendix A is the 2012 report. It is now the 2014 report. Please correct.
9. **Section 2.2 and Section 4.1.1 (second paragraph)** each references the 2012 report.

10. **In Section 6.1**, again, remove references to "Requirements" by FEMA. These are guidelines and therefore recommendations.
11. Remove references to % of PMP. These are no longer relevant per FEMA Federal Guidelines for Dame Safety: Selection of Inflow Design Flood, August 2013.
12. **Section 7, Tables 7-1 and 7-4:** Minimum required FOS for Seismic is 1.0, not 1.1. Please correct.
13. **Section 7.1,** first paragraph: this paragraph should include information regarding both the 2012 and the 2014 reports. There needs to be some kind of statement that indicates that the draft report included information and deficiencies regarding the 2012 report and that subsequent to the draft report, the 2014 analyses was conducted and results were relayed to EPA which are now included in the final report.
14. **Section 7.1.4,** second paragraph, sixth line, remove the added period.
15. **Section 9.1** indicates that there are no surveillance procedures for the Evaporation Pond. Section 9.2 indicates that Water levels are not monitored in the Evaporation Pond. Section 9.3.1 indicates that the Inspection programs do not exist for the Evaporation Pond and are inadequate. Although Section 9.1 indicates no surveillance procedures for the Evaporation Pond, Section 9.3.2 indicates the surveillance program is considered adequate. Please reconcile.

From:	Mustafa, Golam
To:	Englander, Jana
Cc:	Kelley, Willie; Vargo, Steve; Kelly, PatrickM; Hoffman, Stephen; Dufficy, Craig; wsamuels@tceq.state.tx.us
Subject:	RE: Comment Request on Coal Ash Site Assessment Round 12 Draft Reports – City of San Antonio - JK Spruce and JT Deely Power Plants
Date:	Wednesday, December 04, 2013 1:50:57 PM

Jana,

I have a comment on these two reports as below.

City of San Antonio - JK Spruce Power Plant

Section 1.3.2.6, Recommendations Regarding Continued Safe and Reliable Operation – third paragraph should be rewritten as below.

The above recommendations should be implemented to maintain continued safe and reliable operation of the CCW impoundments.

Please Delete – "None of the conditions observe require immediate attention or remediation, however, the"

City of San Antonio - JT Deely Power Plant

Section 1.3.2.6, Recommendations Regarding Continued Safe and Reliable Operation – third paragraph should be rewritten as below.

The above recommendations should be implemented to maintain continued safe and reliable operation of the CCW impoundments.

Please Delete – "None of the conditions observe require immediate attention or remediation, however, the"

Thanks
Golam

From: Englander, Jana
Sent: Tuesday, December 03, 2013 9:26 AM
To: Mustafa, Golam; Vargo, Steve; wsamuels@tceq.state.tx.us
Cc: Hoffman, Stephen; Dufficy, Craig; Kelly, PatrickM; Englander, Jana
Subject: FW: Comment Request on Coal Ash Site Assessment Round 12 Draft Reports – City of San Antonio - JK Spruce and JT Deely Power Plants

Dear All,

We would like to offer Texas and EPA Region 6 an opportunity to comment on the Draft Assessment Reports on the Coal Combustion Residual Impoundments located at the facilities below. Please let me know if you intend to comment or have any questions. Comments would be appreciated within 30 calendar days of receipt of this email. Thank

you!
Regards,

Jana

Jana Englander
Office of Resource Conservation and Recovery,
Materials Recovery Waste Management Division
Energy Recovery and Waste Disposal Branch
U.S. Environmental Protection Agency
703-308-8711

From: Englander, Jana
Sent: Tuesday, December 03, 2013 10:20 AM
To: fajames@cpsenergy.com; mmmalone@cpsenergy.com; grtieken@cpsenergy.com
Cc: Hoffman, Stephen; Dufficy, Craig; Englander, Jana; Kelly, PatrickM
Subject: Comment Request on Coal Ash Site Assessment Round 12 Draft Reports – City of San Antonio - JK Spruce and JT Deely Power Plants

Dear Mr. James,

The draft assessment reports for City of San Antonio - JK Spruce and JT Deely Power Plants are ready for review. EPA would appreciate it if you would review and submit your comments on these reports to us within 30 calendar days of receipt of this email. **Please confirm receipt of this email and send your comments to:**

Mr. Stephen Hoffman
US Environmental Protection Agency (5304P)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

If you are using overnight of hand delivery mail, please use the following address:

Mr. Stephen Hoffman
US Environmental Protection Agency
Two Potomac Yard
2733 South Crystal Drive
5th Floor, N-5237
Arlington, VA 22202-2733

You may also provide your comments by e-mail to hoffman.stephen@epa.gov and englander.jana@epa.gov.

You may assert a business confidentiality claim covering all or part of the information requested, in the manner described by 40 C. F. R. Part 2, Subpart B. Information covered by such a claim will be disclosed by EPA only to the extent and only by means of the procedures set forth in 40 C.F.R. Part 2, Subpart B. If no such claim accompanies the information when EPA receives it, the information may be made available to the public by EPA without further notice to you. If you wish EPA to treat any of your response as “confidential” you must so advise EPA when you submit your response.

The draft reports can be accessed at the secured link below. The secured link will expire on January 31, 2014.

Here is the link for the report:

http://www.hightail.com/download/OGhmUWVqMGM4aU5jR01UQw

Please let me know if you have trouble accessing the reports or have any questions/requests.

Respectfully,

Jana Englander

Jana Englander
Office of Resource Conservation and Recovery,
Materials Recovery Waste Management Division
Energy Recovery and Waste Disposal Branch
U.S. Environmental Protection Agency
703-308-8711

From:	Warren Samuelson
To:	Englander, Jana
Subject:	RE: Comment Request on Coal Ash Site Assessment Round 12 Draft Reports – Luminant Generation Co., LLC – Big Brown Steam Electric Station
Date:	Wednesday, January 08, 2014 9:44:18 AM

No.

From: Englander, Jana [mailto:Englander.Jana@epa.gov]
Sent: Wednesday, January 08, 2014 8:29 AM
To: Warren Samuelson
Subject: RE: Comment Request on Coal Ash Site Assessment Round 12 Draft Reports – Luminant Generation Co., LLC – Big Brown Steam Electric Station

Warren,

Will you have any comments on the two reports that I sent on December 3, 2013 – City of San Antonio JK Spruce and JT Deely?

Thanks,

Jana

Jana Englander
Office of Resource Conservation and Recovery,
Materials Recovery Waste Management Division
Energy Recovery and Waste Disposal Branch
U.S. Environmental Protection Agency
703-308-8711

From: Warren Samuelson [mailto:warren.samuelson@tceq.texas.gov]
Sent: Wednesday, January 08, 2014 9:11 AM
To: Englander, Jana; Mustafa, Golam; Vargo, Steve
Cc: Hoffman, Stephen; Kelly, PatrickM; Dufficy, Craig
Subject: RE: Comment Request on Coal Ash Site Assessment Round 12 Draft Reports – Luminant Generation Co., LLC – Big Brown Steam Electric Station

Jana:

The Texas Dam Safety Program has no comments. This structure is not covered by the Texas Dam Safety Program.

Warren D. Samuelson, P. E.
Manager, Dam Safety Section
TCEQ
512/239-5195

From: Englander, Jana [mailto:Englander.Jana@epa.gov]
Sent: Wednesday, January 08, 2014 8:02 AM

To: Mustafa, Golam; Vargo, Steve; Warren Samuelson
Cc: Hoffman, Stephen; Kelly, PatrickM; Dufficy, Craig; Englander, Jana
Subject: FW: Comment Request on Coal Ash Site Assessment Round 12 Draft Reports – Luminant Generation Co., LLC – Big Brown Steam Electric Station

Dear All,

We would like to offer Texas and EPA Region 6 an opportunity to comment on the Draft Assessment Report on the Coal Combustion Residual Impoundment located at the facility below. Please let me know if you intend to comment or have any questions. Comments would be appreciated within 30 calendar days of receipt of this email. Thank you!
Regards,

Jana

Jana Englander
Office of Resource Conservation and Recovery,
Materials Recovery Waste Management Division
Energy Recovery and Waste Disposal Branch
U.S. Environmental Protection Agency
703-308-8711

From: Englander, Jana
Sent: Wednesday, January 08, 2014 8:57 AM
To: Gary.Spicer@luminant.com; Kimberly.Mireles@luminant.com
Cc: Hoffman, Stephen; Dufficy, Craig; Kelly, PatrickM; Englander, Jana
Subject: Comment Request on Coal Ash Site Assessment Round 12 Draft Reports – Luminant Generation Co., LLC – Big Brown Steam Electric Station

Dear Ms. Mireles,

The draft assessment report for Luminant Generation Co., LLC – Big Brown Steam Electric Station is ready for review. EPA would appreciate it if you would review and submit your comments on this report to us within 30 calendar days of receipt of this email. **Please confirm receipt of this email and send your comments to:**

Mr. Stephen Hoffman
US Environmental Protection Agency (5304P)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

If you are using overnight of hand delivery mail, please use the following address:

Mr. Stephen Hoffman
US Environmental Protection Agency
Two Potomac Yard
2733 South Crystal Drive
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You may also provide your comments by e-mail to hoffman.stephen@epa.gov and englander.jana@epa.gov.

You may assert a business confidentiality claim covering all or part of the information requested, in the manner described by 40 C. F. R. Part 2, Subpart B. Information covered by such a claim will be disclosed by EPA only to the extent and only by means of the procedures set forth in 40 C.F.R. Part 2, Subpart B. If no such claim accompanies the information when EPA receives it, the information may be made available to the public by EPA without further notice to you. If you wish EPA to treat any of your response as "confidential" you must so advise EPA when you submit your response.

The draft report can be accessed at the secured link below. The secured link will expire on February 28, 2014.

Here is the link for the report:
http://www.hightail.com/download/elNMV280WlRBNkVPd3NUQw

Please let me know if you have trouble accessing the report or have any questions/requests.

Respectfully,

Jana Englander

Jana Englander
Office of Resource Conservation and Recovery,
Materials Recovery Waste Management Division
Energy Recovery and Waste Disposal Branch
U.S. Environmental Protection Agency
703-308-8711

December 19, 2013

Mr. Stephen Hoffman
US Environmental Protection Agency (5304P)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Re: Deely Assessment of Dam Safety of Coal Combustion Surface Impoundment Revised Draft Report & Spruce Assessment of Dam Safety of Coal Combustion Surface Impoundments Revised Draft Report

Dear Mr. Hoffman:

This letter is in response to the above referenced draft reports provided to us by email on December 3, 2013. We have reviewed the documents and do not have objections to your comments or recommendations. CPS Energy will provide your draft assessment to our geotechnical consultant and request a proposal to complete the supplemental information you requested. CPS Energy will also incorporate the suggested operational and maintenance improvements.

Once we have received and discussed the proposal with our consultant and management, we will provide you with an update and may request clarification regarding the information you are requesting. We will also provide you a status update with regards to incorporating the recommendation into our plant operation's O&M procedures.

If you have any questions or need any information in the interim, please let me know.

Sincerely,

Michael M. Malone, P.E.
Environmental Engineer
Environmental Management

GEOTECHNICAL ENGINEERING STUDY

FOR

ASH POND BERMS - CALAVERAS LAKE POWER PLANT
SAN ANTONIO, TEXAS

RABA KISTNER CONSULTANTS

Raba Kistner Consultants, Inc.
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San Antonio, TX 78249
P.O. Box 690287
San Antonio, TX 78269
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TBPE Firm F-3257

Project No. ASA12-098-00
November 12, 2012

Mr. Eric R. Olson
CPS Energy
c/o Mr. Steven Dean, P.E.
Pape-Dawson Engineers, Inc.
555 East Ramsey
San Antonio, Texas 78216

RE: Geotechnical Engineering Study
Ash Pond Berms – Calaveras Lake Power Plant
San Antonio, Texas

Dear Mr. Dean:

Raba Kistner Consultants Inc. (RKCI) is pleased to submit the report of our Geotechnical Engineering Study for the above-referenced project. This study was performed in accordance with **RKCI** Proposal No. PSA12-168-00 (3rd Revision), dated October 4, 2012. The purpose of this study was to drill borings within the existing ash pond berms, to perform laboratory testing to classify and characterize subsurface conditions, and to prepare an engineering report presenting slope stability analyses for the existing berms.

We appreciate the opportunity to be of service to you on this project. Should you have any questions about the information presented in this report, or if we may be of additional assistance with value engineering or on the materials testing-quality control program during construction, please call.

Very truly yours,

RABA KISTNER CONSULTANTS, INC.

R. Blake Wright

R. Blake Wright, E.I.T.
Graduate Engineer

John A. Focht III, P.E.
Chief Geotechnical Engineer

STATE OF TEXAS
John A. Focht, III
60313
LICENSED
PROFESSIONAL ENGINEER
11/12/2012

RBW/JAF/mem

Attachments

Copies Submitted: Above (4)

GEOTECHNICAL ENGINEERING STUDY

For

ASH POND BERMS – CALAVERAS LAKE POWER PLANT
SAN ANTONIO, TEXAS

Prepared for

PAPE-DAWSON ENGINEERS, INC.
San Antonio, Texas

Prepared by

RABA KISTNER CONSULTANTS, INC.
San Antonio, Texas

PROJECT NO. ASA12-098-00

November 12, 2012

RABA KISTNER

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ATTACHMENTS

INTRODUCTION

Raba Kistner Consultants Inc. (RKCI) has completed the authorized subsurface exploration and slope stability analyses for the existing ash pond berms at the Calaveras Lake Power Plant in San Antonio, Texas. This report briefly describes the procedures utilized during this study and presents our findings along with our recommendations for maintaining the existing ash pond berms.

PROJECT DESCRIPTION

The structures being considered in this study include the existing ash pond berms located at the Calaveras Lake Power Plant, which is operated by CPS Energy. Specifically, three ponds were studied and are denoted on the Boring Location Map, Figure 1. Our understanding of the slope profile at each berm, as well as the existing site topography, is based on several drawings provided to us on September 14, and November 1, 2012, by Mr. Steven Dean, P.E., with Pape-Dawson Engineers, Inc.

RISK

The geotechnical engineering recommendations contained in this memorandum are intended to provide Pape-Dawson Engineers, Inc; CPS Energy; and the U.S. Environmental Protection Agency with information pertaining to the stability of the existing ash pond berms at the Calaveras Lake Power Plant.

The geotechnical properties of the soils encountered in this study involve variability. This variability includes some spatial variability; however, the spatial variability appears to occur over relatively short distances. It is important to note that berms differ from other types of structures, such as drilled piers or driven piles, in that the performance of the berm involves local, not average, soil conditions.[1] The selection of analysis parameters for this project was based on a review of the available geotechnical data, our knowledge of the project area, and design calculations using select surveyed geometries. The results of our analyses were then reviewed with respect to important trends and general concepts, keeping these conditions and limitations in mind. Our conceptual recommendations are based on a conservative approach as is warranted for all slope stability analyses. We believe that the combination of observed conditions and probable failure modes justifies this approach.

LIMITATIONS

This engineering report has been prepared in accordance with accepted Geotechnical Engineering practices in the region of south/central Texas and for the use of Pape-Dawson Engineers, Inc. (CLIENT) and its representatives for design purposes. This report may not contain sufficient information for purposes of other parties or other uses. This report is not intended for use in determining construction means and methods.

The recommendations submitted in this report are based on the data obtained from 14 borings drilled at this site and our understanding of the project information provided to us. If the project information

[1] Focht, J.A. Jr. and Focht, J.A. III, "Factor of Safety and Reliability in Geotechnical Engineering, Discussion and Closure", ASCE JGGE Vol. 127 No. 8, pp.700-721, August 2001.

described in this report is incorrect, is altered, or if new information is available, we should be retained to review and modify our recommendations.

This report may not reflect the actual variations of the subsurface conditions across the site. However, it is important to note that a significant portion of the apparent site variability is due to variation in the proportions of sand and clay in the native soils. These variations cause the soil classification to change between borings, while our experience indicates the behavior of these soils varies within a relatively narrow range.

The scope of our Geotechnical Engineering Study does not include an environmental assessment of the air, soil, rock, or water conditions either on or adjacent to the site. No environmental opinions are presented in this report.

BORINGS AND LABORATORY TESTS

Subsurface conditions at the site were evaluated by 14 borings drilled at the locations shown on the Boring Location Map, Figure A-1. These locations are approximate and distances were measured using a recreational-grade, hand-held GPS locator; tape; angles; pacing; etc. Ground surface elevations were estimated from the topography depicted on the above-referenced drawings provided by Mr. Dean. The estimated ground surface elevation at each of the boring locations is listed in the table below as well as the approximate bottom elevation of each boring.

Boring No.	Ground Surface Elevation (ft, MSL)	Boring Bottom Elevation (ft, MSL)
B-1	522	472
B-2	523	473
B-3	522	472
B-4	523	473
B-5	501	461
B-6	500	460
B-7	500	470
B-8	501	461
B-9	499	469
B-10	496	456
B-11	496	466
B-12	500	470
B-13	496	456
B-14	501	461

The borings were drilled using a truck-mounted drilling rig. During drilling operations, the following samples were collected:

Type of Sample	Number Collected
Split-Spoon (with Standard Penetration Test)	126
Undisturbed Shelby Tube	28

Each sample was visually classified in the laboratory by a member of our Geotechnical Engineering staff. The geotechnical engineering properties of the strata were evaluated by the following tests:

Type of Test	Number Conducted
Natural Moisture Content	151
Atterberg Limits	29
Percent Passing a No. 200 Sieve	33
Direct Shear	2
Consolidated-Undrained (CU) Triaxial	10
Unconfined Compression	17
Dry Unit Weight	17

With the exception of the CU triaxial and direct shear tests, the results of the field and laboratory tests are presented in graphical or numerical form on the boring logs illustrated on Figures A-2 through A-15. A key to classification terms and symbols used on the logs is presented on Figure A-16. The results of the laboratory and field testing are also tabulated on Figure B-1 for ease of reference.

Standard penetration test results are noted as “blows per ft” on the boring logs and Figure B-1, where “blows per ft” refers to the number of blows by a falling hammer required for 1 ft of penetration into the soil/weak rock. Where hard or dense materials were encountered, the tests were terminated at 50 blows even if one foot of penetration had not been achieved. When all 50 blows fall within the first 6 in. (seating blows), refusal “ref” for 6 in. or less will be noted on the boring logs and on Figure B-1.

Samples will be retained in our laboratory for 30 days after submittal of this report. Other arrangements may be provided at the request of the Client.

pH TESTING

Seepage from the ash ponds would most likely result in an increase pH in the embankment soils. As a part of our laboratory study, we evaluated the collected soil samples using a phenolphthalein solution. We customarily screen for pH in order to prevent chemical burns to our laboratory staff, who typically work with the samples bare-handed.

No reaction to the phenolphthalein solution was noted in any of the samples tested. This would indicate that all samples tested had a pH value of less than 8.

CU TESTS

Multi-stage CU tests were used to measure both total and effective soil strength parameters of harvested samples from the project site. During CU testing, each stage was subjected to a range of effective consolidation pressure.

The following table presents the results of our multi-stage CU tests:

		Effective		Total	
Boring No.	Depth (ft)*	Friction Angle, ϕ' (degrees)	Cohesion, c' (ksf)	Friction Angle, ϕ (degrees)	Cohesion, c (ksf)
B-2	13-15	11.6	1.94	11.7	2.02
B-3	18-20	21.7	1.13	22.7	1.22
B-5	8-10	25.4	0.93	24.5	1.36
B-7	8-10	34.3	0.63	51.8	0.82
B-9	8-10	33.6	0.00	36.8	0.00
B-12	8-10	31.8	0.57	39.7	0.60

*Depth below the top of berm surface elevation existing at the time of our field study.

DIRECT SHEAR TESTS

Direct shear tests were performed on two samples collected during drilling operations. The results of these tests are presented in the table below:

Boring No.	Depth (ft)	Apparent Cohesion (psf)	Phi (degrees)
B-3	28.5 - 30	62	27
B-5	38.5 – 40	72	34

GENERAL SITE CONDITIONS

SITE DESCRIPTION

The project site is a tract of developed land located at the Calaveras Lake Power Plant, which is operated by CPS Energy. The ash ponds considered in this study are located east and northeast of the existing main power plant facility. The entire facility is bounded to the west, south, and east by Calaveras Lake. The topography generally slopes downward toward Calaveras Lake. CPS maintains the level at a target pool elevation of Elevation 485 feet with periodic fluctuations of plus or minus one foot. Levels above the target pool elevation are usually due to rainfall in the Calaveras Creek, Hondo

Creek and Chupaderas Creek watersheds, and typically return to the target pool elevation within a few days of the rain event.

GEOLOGY

A review of the *Geologic Atlas of Texas, San Antonio Sheet*, indicates that this site is naturally underlain with the soils/rocks of the Wilcox Group, which is composed of mudstone with varying amounts of sandstone and lignite. The Wilcox Group may weather to yellowish-brown clay, sandy clay, clayey sands, and sands.

The Wilcox Group grades downward into the Midway Group, which is composed of clay, silt, and sand, with some pebbles near its base. Glauconite is often encountered in these soils. Key engineering considerations for development supported on the soils/rock of this formation typically include the presence of possible water-bearing layers, very hard mudstone/sandstone layers, and the expansive nature of the highly plasticity clays that can be present in this formation.

STRATIGRAPHY

The subsurface stratigraphy at this site varies from pond to pond, and berm to berm. However, the embankment fill soils typically consist of sandy clay or clayey sand. It is difficult to distinguish between these two soil types in the berms because the percent passing a No. 200 sieve ranges within about 10 percentage points higher and lower than 50%. The subgrade stratigraphy is also generally composed of interbedded sandy clay and clayey sand. There were also isolated tan and gray clay seams encountered in our borings. Each stratum has been designated by grouping soils that possess similar physical and engineering characteristics. The boring logs should be consulted for more specific stratigraphic information. The lines designating the interfaces between strata on the boring logs represent approximate boundaries. Transitions between strata may be gradual, which vary within a relatively narrow combined range of Plasticity Index and -200 values.

GROUNDWATER

The depth to groundwater was measured in all borings except Boring B-1. The groundwater level in Boring B-1 could not be measured due to the introduction of drilling fluids in this boring.

Upon completion of the drilling operations, groundwater levels ranged from 11 to 17 ft below the existing ground surface in the borings drilled for Ponds 1 and 2. Groundwater levels ranged from 40 to 42 ft below the existing ground surface in the borings drilled for Pond 3 (with the exception of Boring B-1).

As mentioned previously, this site is bounded to the west, south, and east by Calaveras Lake. The groundwater levels encountered at this site are most likely dominated by the surface water elevation of Calaveras Lake. Fluctuations in groundwater levels are possible due to variations in rainfall and surface water run-off.

EARTHEN BERMS

DESIGN CONSIDERATIONS

The existing berms should meet three important criteria: they should be resistant to the forces of erosion, should exhibit a suitable slope stability design allowable factor of safety with respect to long-term, short-term, and sudden drawdown conditions, as well as performance type scenarios such as underseepage. The levee structure must meet these criteria so that the calculated risk of failure is consistent with criteria established by the USACE guidelines.

Probable failure modes

Our review of the site and expected conditions for the Calaveras Power Plant ash ponds indicates that the following major modes of failure could affect the berms:

- Slope stability
- Underseepage
- Embankment Seepage

The following sections address each of these failure modes, as well as slope erosion and liquefaction.

Slope Stability Based on our review of available data and our visual observations during drilling, the existing embankments exhibit slopes ranging from about 3:1 (horizontal:vertical) or flatter, while a few limited areas exhibit slopes of about 2.5:1.

In general, slopes flatter than 3:1 would be expected to exhibit the required factors of safety for a normal (non-flood) seepage condition with the area water table near Elevation 485 feet.

Underseepage We generally consider underseepage to be a very low risk for the existing berms. Underseepage consists of water flowing beneath the embankment as a result of water seeping out of the ash ponds. The principal failure mechanism related to underseepage occurs when the upward force of the water equals or exceeds the buoyant weight of the soil. This does not appear likely to occur at this project site.

Berm Seepage Embankment seepage consists of water flowing through the berm as a result of seepage through the berm. The principal failure mechanism related to embankment seepage occurs when the horizontal force of the water equals or exceeds the effective shear strength of the soil. This mode of failure is not expected to occur at this project site.

Slope Erosion The existing embankments are generally composed of cohesive soils, while the underlying soils are generally composed of cohesive soils with layers semi-cohesive soils. It appears that the existing embankments were constructed using the soils available at the project site. These materials are generally considered acceptable to good materials to use when constructing levees, dams and slopes.

In addition, the berms are not expected to be exposed to flowing water, other than rain that falls on the berm crest and berm slopes. The risk of berm failure due to erosion is considered to be very low.

Liquefaction Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded, and fine-grained sands. Empirical evidence indicates that loose silty sands are also potentially liquefiable. When seismic ground shaking occurs, the soil is subjected to cyclic shear stresses that can cause excess hydrostatic pressures to develop. If excess hydrostatic pressures reach the effective confining stress from the overlying soil, the sand may undergo deformations. If the sand undergoes virtually unlimited deformation without developing significant resistance, it is said to have liquefied, and if the sand consolidates or vents to the surface during and following liquefaction, ground settlement may occur.

The soils contain significant quantities of clay, and are relatively dense. Even when groundwater is present, the berms have a very low potential for liquefaction during earthquake events, particularly since the USGS online resources indicate there is less than 0.1 percent chance of experiencing a magnitude 5.0 or greater earthquake at this site during a 50 year period. In addition, calculations performed using the Seed and Idriss method indicate the most susceptible tested sample must experience a ground acceleration in excess of 0.44g before liquefaction will occur. Based on these findings, RKCI believes the soils beneath the existing berms have a very low risk of experiencing liquefaction due to an earthquake.

SLOPE STABILITY

This section presents our slope stability analyses performed for this study. In general, the procedures described in USACE EM 1110-2-1902 *Slope Stability* were followed. As such, our analysis focused on embankment stability, settlement, interior drainage, and slope protection.

The slope configurations analyzed, method of analysis, loading conditions, and soil properties used in the analyses are discussed in the following paragraphs.

Minimum Factor of Safety

For a given slope configuration, the forces that “drive” slope failure (including gravity, groundwater seepage pressure, and possible excess pore water pressures from external loading conditions) are compared to the slope’s resistance to failure, which is a function of dewatering controls and internal shear strength (cohesion and internal angle of friction) of both the foundation soils and the fill soils utilized for construction of the embankment.

The USACE has specified minimum safety factors against slope failure with respect to loading conditions. The minimum acceptable factors of safety for levees, provided in Table 3-1 on Page 3-2 of EM 1110-2-1902, are listed in the following table.

Condition	Required Factor of Safety
End of Construction	1.3
Sudden Drawdown	1.1 to 1.3
Long Term (Steady Seepage)	1.4

We consider a significant slope failure to involve a volume of slope material that is large enough to substantially impair the serviceability or operation of the berm or that could imperil human life. Shallow, sloughing slope failures that involve relatively little material or that can be repaired locally without substantially impacting the ash pond operations are considered to be minor slope failures and do not control the conclusions of our stability analyses.

Slope Configurations

At the time this technical report was prepared, field surveys drawings of the existing berms had been performed by Pape Dawson Engineers, Inc. As a part of their work, we understand that Pape Dawson spot-checked the existing berms, and only provided surveyed cross-sections where the existing condition did not closely resemble the original drawings. As such, we have provided the original design geometry for the purposes of our study for the select berms. Figure C-1 shows the profiles that were surveyed and those that are based on the design drawings.

We recognized four general soil conditions along the length of the alignment that may be considered as worst-case boundary conditions. As such, four cases were analyzed based on these boundary conditions.

Method of Analysis

The slope stability analyses for this study were conducted with the aid of a computer using the program SLIDE developed by RocScience. The SLIDE computer program randomly generates trial failure surfaces and evaluates the factor of safety for each trial surface. The program allows a large number of potential shear surfaces to be investigated to determine the critical failure surface for each of the analyzed slope configurations.

The portions of the program used in this study employed both the Morgenstern-Price and Spencer computational methods. These methods were used to make calculations of the stability of slopes where non-circular failure surfaces were permitted. In each case, the computed factor of safety is the ratio of the forces resisting movement to the driving forces. A factor of safety of 1.0 or less implies the slope is unstable, while a factor of safety greater than 1.0 implies the slope is stable.

Loading Conditions

For satisfactory performance, an earth embankment should have an acceptable factor of safety during construction and throughout its projected service lifetime. Stability analyses should include variations in stress conditions brought on by construction practices and sequencing, external loadings, and any anticipated changes in hydraulic conditions. The following paragraphs discuss each stability condition analyzed in our study.

External Loads External loads for the roadways along the levee crest have also been modeled. A traffic loading of HS20 (modeled as an equivalent uniform surcharge of 100 psf) was applied to the crest of the levee.

End of Construction The short-term (undrained) loading condition models the slope immediately following construction. For this loading condition, the pore pressures developed during construction have not had the opportunity to dissipate. We did not analyze this condition since the berms have been in place for many years.

Steady State Seepage The long term (drained), steady-state seepage loading condition was analyzed. This loading condition models the ash pond completely full condition and assumes that the berm soils are fully saturated and a condition of steady state seepage occurs through the embankment. For this loading condition, effective stress soil parameters were used in the analysis.

Sudden Drawdown from Design Flood Stage This condition represents the situation when the water within the pond is drained at such a rapid rate that the saturated levee soils do not have time to drain. Consequently, excess pore water pressures result in the soil. We did not model this condition since it would pose no risk of environmental contamination, because the pond must be empty for this condition to occur.

SOIL PARAMETERS

Drained soil parameters (drained cohesion and drained friction angle) were selected for each soil stratum based on the laboratory and field test data collected during our study as well as correlations published by Stark and Hussain (2010)[2]. We assumed that soil behavior was represented by the fully softened soil condition. We did not employ the residual strength soil properties since we found no evidence of pre-existing failure surfaces, and are unaware of any prior slope failures in the berm slopes. For purposes of our slope stability analyses, we have assigned the material properties presented in the following table.

[2] Stark, T.D. and M. Hussain, "Shear Strength in Pre-existing Landslides," *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE, 136(7), July, 2010, pp. 957-962.

Drained Fully Softened Shear Stresses from Equations Developed by Stark and Hussain (2010)

Pond 1	Clay Fraction %	Assumed Liquid Limit	Normal Stress, psf			
			0	**1,044**	**2,089**	**8,354**
Embankment Soil (CL)	47	42	0	647	1,158	4,075
Sandy Clay (CL)	52	52	0	561	972	3,281
Clayey Sand (ML)	36	33	0	669	1,197	4,240

Pond 2	Clay Fraction %	Assumed Liquid Limit	Normal Stress, psf			
			0	**1,044**	**2,089**	**8,354**
Embankment Soil (CL)	45	35	0	664	1,188	4,202
Sandy Clay (CL)	61	51	0	563	976	3,298
Clayey Sand (ML)	43	33	0	669	1,197	4,240

Pond 3	Clay Fraction %	Assumed Liquid Limit	Normal Stress, psf			
			0	**1,044**	**2,089**	**8,354**
Embankment Soil (CL)	45	45	0	640	1,145	4,023
Sandy Clay (CL)	50	54	0	557	963	3,247
Clayey Sand (ML)	34	55	0	618	1,105	3,859

Results of Analyses

The following table contains a summary of the results from our slope stability analyses for each loading condition and slope configuration. In general, the point where a potential slide surface was permitted to intersect was not allowed to occur within 3 ft of the relevant top of slope. This limitation was intended to reduce the occurrence of "non-critical" failure surfaces from resulting from the analyses. A graphical presentation of the most critical failure surface from our SLIDE iterations for each berm profile studied can be found at the end of this memorandum in Appendix C. The "a" series figures show the critical failure surface on the "dry side" of each berm, while the "b" series figures show the critical failure surface on the "pond side" of each berm.

Computed Factors of Safety for Pond 1					
Slope Profile	End of Construction	Steady State on Pond Side	Steady State on Dry Side	Sudden Drawdown – Riverside	Sudden Drawdown – Landside
J	N/A	> 2	> 2	N/A	N/A
K	N/A	> 2	> 2	N/A	N/A
L	N/A	> 2	> 2	N/A	N/A
M	N/A	> 2	> 2	N/A	N/A

Computed Factors of Safety for Pond 2					
Slope Profile	End of Construction	Steady State on Pond Side	Steady State on Dry Side	Sudden Drawdown – Riverside	Sudden Drawdown – Landside
E	N/A	> 2	> 2	N/A	N/A
F	N/A	> 2	> 2	N/A	N/A
G	N/A	> 2	1.3	N/A	N/A
H	N/A	> 2	> 2	N/A	N/A
I	N/A	> 2	1.8	N/A	N/A

Computed Factors of Safety for Pond 3					
Slope Profile	End of Construction	Steady State on Pond Side	Steady State on Dry Side	Sudden Drawdown – Riverside	Sudden Drawdown – Landside
A	N/A	> 2	> 2	N/A	N/A
B	N/A	> 2	> 2	N/A	N/A
C	N/A	> 2	1.5	N/A	N/A
D	N/A	> 2	1.9	N/A	N/A

SEEPAGE ANALYSIS

We performed a steady-state seepage analysis for each slope geometry using the finite element groundwater module within SLIDE. Our seepage analyses were performed assuming that the soil properties observed in our borings exhibited a 5:1 ratio of permeability (horizontal:vertical) with the assumed permeability values presented in the following table.

Soil	Assumed Permeability, cm/second	
	Horizontal	Vertical
Clay	$1x10^{-7}$	$2x10^{-8}$
Sandy Clay	$1x10^{-6}$	$2x10^{-7}$
Clayey Sand	$1x10^{-4}$	$2x10^{-5}$

Other Approaches

Other seepage cutoffs could be used to improve the overall stability of the levees, such as cement or chemical grout curtains and soil-cement jet-grouted walls. In general, we consider these options to be less desirable due to their probable costs and relatively high risk of failure.

RESULTS

In general, the global stability analyses resulted in calculated factors of safety in excess of 2. Three sections exhibited calculated factors of safety of less than 2, and one section ("G") exhibited a calculated factor of safety of 1.2 for the "dry" slope. Review of Figure C-8a revealed that the critical failure surface for this analysis was relatively thin and did not appear to threaten the ash pond reservoir. A second analysis of this section was then performed, with the top of the assumed surfaces limited to intersecting the ground surface at the top of slope of the "wet" slope or farther from the "dry" slope. Surfaces in this portion of the berm would threaten containment of the ash pond's contents. The results of this analysis are presented on Figure C-8c, and indicate the calculated factor of safety for this analysis was 1.4.

CONCLUSIONS

The existing berms were constructed of lean sandy clays and/or clayey sands over competent sandy clays and clayey sands. Liquefaction is considered a very low risk issue at this site. The results of our seepage analyses indicate that no significant risk of an erosion or piping-type failure beneath the embankments exists.

The end-of-construction condition was not evaluated due to the age of the ash ponds, and both rapid drawdown and erosion failures are considered to be of very low risk due to the berm toe elevations (above EL 490 feet) with respect to the target pool elevation (EL 485 feet). We do not consider embankment seepage or underseepage to pose a significant risk to the berm based on both the long-term performance of the berms and the results of the seepage analyses, which was indirectly confirmed by the pH testing performed on all of the harvested soil samples. The results of our slope stability analyses indicate that all of the berm slopes meet or exceed both USEPA and USACE criteria for stability under steady state (long term) conditions.

* * * * * * * * * * * * * * * * * *

The following appendices are attached and complete this report:

Field Data	Appendix A
Laboratory Test Results	Appendix B
Slope Stability Analyses	Appendix C

ATTACHMENTS

APPENDIX A

FIELD DATA

RABA KISTNER CONSULTANTS
Raba Kistner Consultants, Inc.
12821 West Golden Lane
San Antonio, Texas 78249
P 210 :: 699 :: 9090
F 210 :: 699 :: 6426
www.rkci.com
TBPE Firm Number 3257

SOURCE: 2011 Aerial Photograph Provided by the City of San Antonio (COSA)

BORING & MONITORING WELL LOCATION MAP

ASH POND BERMS - CALAVERAS LAKE POWER PLANT
SAN ANTONIO, TEXAS

REVISIONS:

No.	DATE	DESCRIPTION

PROJECT No.:	ASA12-098-00
ISSUE DATE:	10/10/2012
DRAWN BY:	CCL
CHECKED BY:	RBW
REVIEWED BY:	GLB

FIGURE

A-1

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

LOG OF BORING NO. B-1

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32477; W 98.31464

SURFACE ELEVATION: 522 ft

SHEAR STRENGTH, TONS/FT^2: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	BASE MATERIAL (6 in.)				
	FILL MATERIAL: SAND, Medium Dense, Tan	11			
	FILL MATERIAL: CLAY, Sandy, Firm, Reddish-Tan, with gray mottling	7			50
5			106	16	
			110		
	SAND, Clayey, Medium Dense to Very Dense, Tan to Gray		112		40
10					
	-with a tan and gray clay seam from 13 to 15 ft	16		37	
15	-switched to mud rotary at 15 ft				
20		22			
25		50/11"			
30		50/11"			43
35		49			
		50/11"			

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 49.7 ft
DATE DRILLED: 10/15/2012
DEPTH TO WATER: N/A
DATE MEASURED: 10/15/2012
PROJ. No.: ASA12-098-00
FIGURE: A-2a

LOG OF BORING NO. B-1

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32477; W 98.31464

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT^2 (0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0) / PLASTIC LIMIT, WATER CONTENT, LIQUID LIMIT (10 20 30 40 50 60 70 80)	PLASTICITY INDEX	% -200
			SURFACE ELEVATION: 522 ft					
			SAND, Clayey, Medium Dense to Very Dense, Tan to Gray *(continued)*					
45				50/9"		●		
50				50/8"		●		
55								
60								
65								
70								
75								

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	49.7 ft	**DEPTH TO WATER:**	N/A	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/15/2012	**DATE MEASURED:**	10/15/2012	**FIGURE:**	A-2b

LOG OF BORING NO. B-2

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32378; W 98.31541

SURFACE ELEVATION: 523 ft

SHEAR STRENGTH, TONS/FT^2: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	CLAY, Sandy, Stiff, Brown	11			
	SAND, Clayey, Brown and Tan		119		38
5			104	15	
			102		
	CLAY, Sandy, Very Stiff, Tan and Gray		110		
10					
				36	
15					
			101		
20	SAND, Clayey, Dense to Very Dense, Gray				
		50/11"			24
25					
		50/10"			
30					
		38			
35					
		50			

DEPTH DRILLED: 49.8 ft
DATE DRILLED: 10/16/2012
DEPTH TO WATER: 40 ft
DATE MEASURED: 10/16/2012
PROJ. No.: ASA12-098-00
FIGURE: A-3a

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-2

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32378; W 98.31541

SHEAR STRENGTH, TONS/FT^2: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0
PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

SURFACE ELEVATION: 523 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	WATER CONTENT	PLASTICITY INDEX	% -200
40–49.8	SAND, Clayey, Dense to Very Dense, Gray *(continued)* -DRILLER'S NOTE: WATER encountered at 40 ft					
~44		50/8"				
~49		50/9"				

Depth scale: 45, 50, 55, 60, 65, 70, 75

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	49.8 ft	**DEPTH TO WATER:**	40 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/16/2012	**DATE MEASURED:**	10/16/2012	**FIGURE:**	A-3b

LOG OF BORING NO. B-3

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32401; W 98.31406

SURFACE ELEVATION: 522 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–2	FILL MATERIAL: SAND, Medium Dense, Brown, with gravel (road material)	24			
2–8	FILL MATERIAL: SAND, Clayey, Medium Dense, Tan	12			
		11		19	
		19			41
8–23	CLAY, Sandy, Stiff to Very Stiff, Tan and Gray	14			
			112	30	
23–40	SAND, Clayey, Dense to Very Dense, Tan to Gray	46			47
		50			
		50/11"			
	-DRILLER'S NOTE: WATER encountered at 39 ft	50/11"			33

SHEAR STRENGTH, TONS/FT²: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

DEPTH DRILLED: 49.8 ft	**DEPTH TO WATER:** 40 ft	**PROJ. No.:** ASA12-098-00	
DATE DRILLED: 10/15/2012	**DATE MEASURED:** 10/15/2012	**FIGURE:** A-4a	

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-3

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32401; W 98.31406

SURFACE ELEVATION: 522 ft

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT	PLASTICITY INDEX	% -200
			SAND, Clayey, Dense to Very Dense, Tan to Gray *(continued)*					
			-with a tan and gray clay seam from 43 to 45 ft	38				
45								
				50/10"				
50								
55								
60								
65								
70								
75								

Shear strength scale: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0
Water content scale: 10, 20, 30, 40, 50, 60, 70, 80

DEPTH DRILLED:	49.8 ft	**DEPTH TO WATER:**	40 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/15/2012	**DATE MEASURED:**	10/15/2012	**FIGURE:**	A-4b

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-4

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

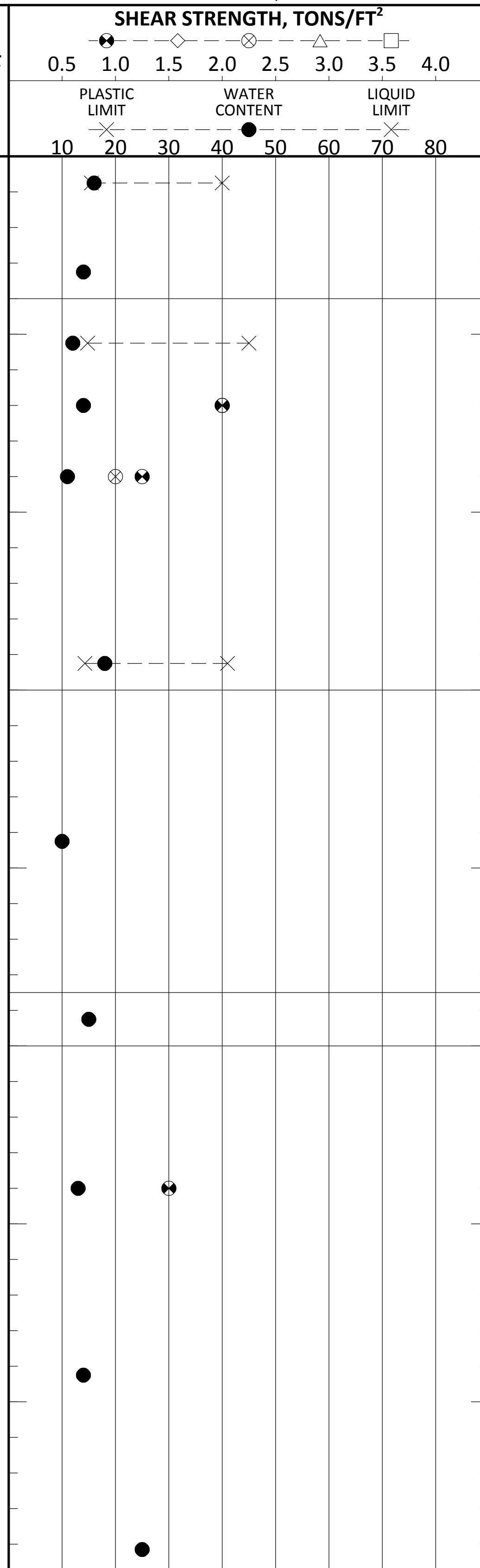
DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32322; W 98.31478

SURFACE ELEVATION: 523 ft

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
FILL MATERIAL: CLAY, Sandy, Firm, Brown	7		25	
	5			54
CLAY, Sandy, Stiff to Very Stiff, Tan and Brown	14		30	
		113		
		110		
	26		27	
SAND, Clayey, Dense, Brown				
	49			
CLAY, Very Stiff, Reddish-Tan	24			
SAND, Clayey, Dense to Very Dense, Tan and Gray, with intermittent clay seams				
		97		32
	50			
	50/10"			

DEPTH, FT: 5, 10, 15, 20, 25, 30, 35



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	49.8 ft	**DEPTH TO WATER:**	42 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/16/2012	**DATE MEASURED:**	10/16/2012	**FIGURE:**	A-5a

LOG OF BORING NO. B-4

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32322; W 98.31478

SURFACE ELEVATION: 523 ft

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT	PLASTICITY INDEX	% -200
			SAND, Clayey, Dense to Very Dense, Tan and Gray, with intermittent clay seams *(continued)* -DRILLER'S NOTE: WATER encountered at 42 ft					
45				50				
50				50/9"				23
55								
60								
65								
70								
75								

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	49.8 ft	**DEPTH TO WATER:**	42 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/16/2012	**DATE MEASURED:**	10/16/2012	**FIGURE:**	A-5b

LOG OF BORING NO. B-5

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

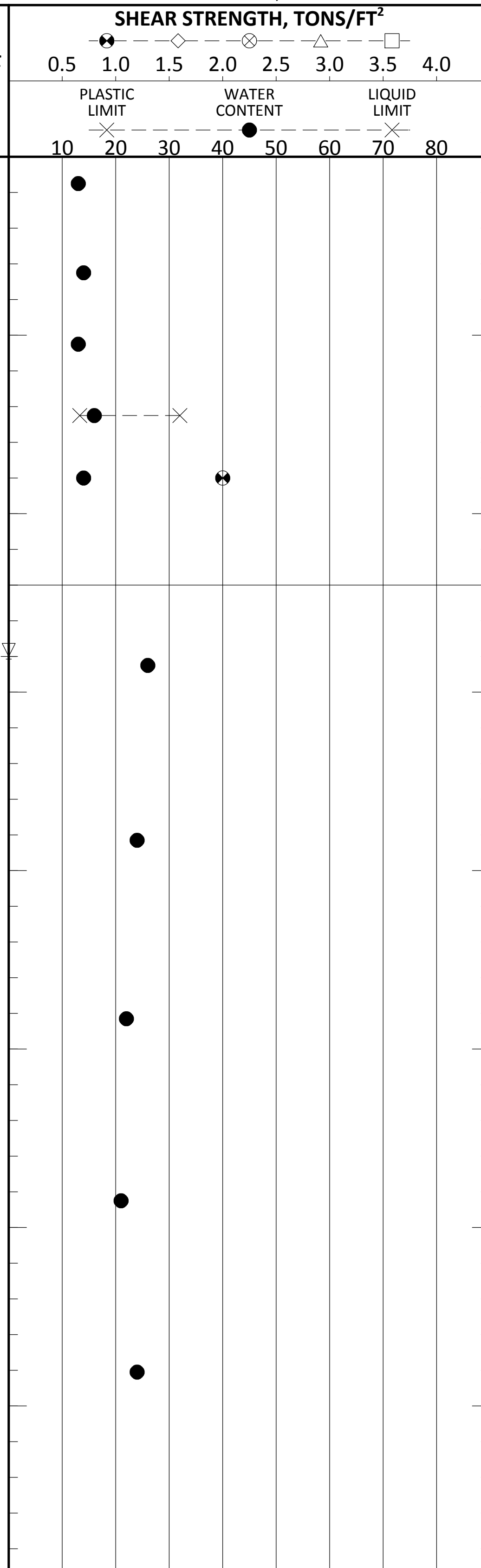
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30947; W 98.31590

SURFACE ELEVATION: 501 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	FILL MATERIAL: SAND, Clayey, Medium Dense, Tan				
		17			
		21			
5		24			
		20		19	
					46
10					
12	SAND, Clayey, Medium Dense to Very Dense, Gray				
		33			46
15					
20		50/10"			
25		50/9"			
	-with a clay seam from 28-1/2 to 30 ft	24			
30					
		50/7"			31
35					
		50/8"			



DEPTH DRILLED: 39.7 ft
DATE DRILLED: 10/17/2012
DEPTH TO WATER: 14 ft
DATE MEASURED: 10/17/2012
PROJ. No.: ASA12-098-00
FIGURE: A-6

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-6

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

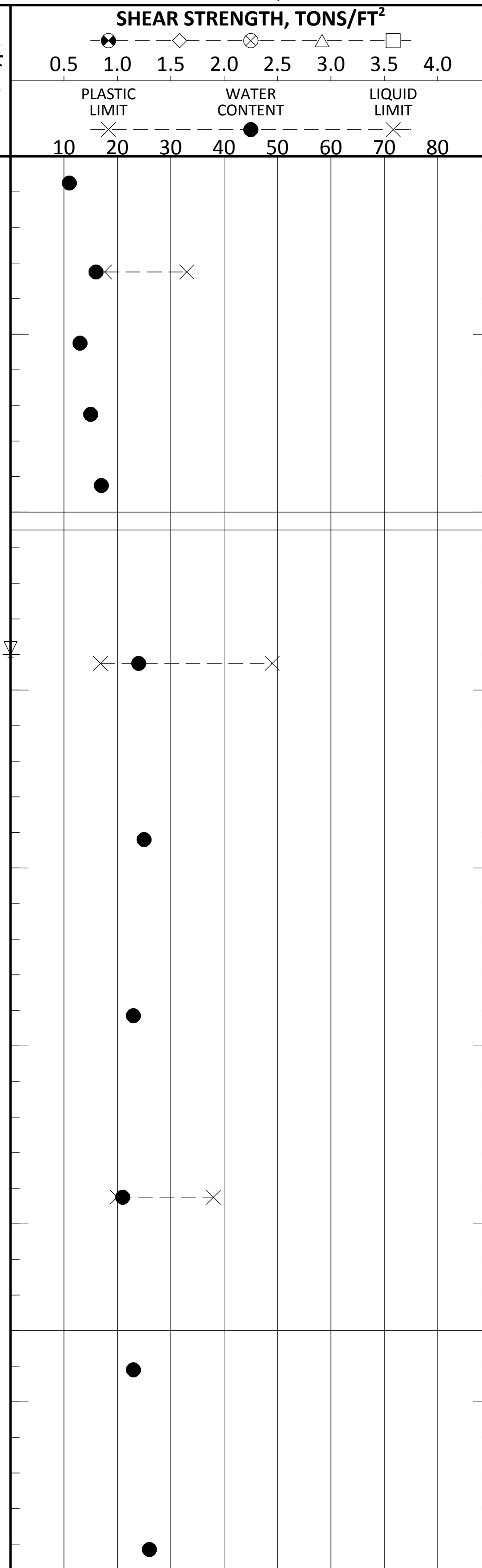
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30837; W 98.31790

SURFACE ELEVATION: 500 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	FILL MATERIAL: CLAY, Sandy, Stiff to Very Stiff, Tan	15			
		14		15	
5		24			50
		19			
		21			
10	GRAVEL, Tan				
	CLAY, Sandy, Firm to Hard, Tan and Gray				
15	-DRILLER'S NOTE: WATER encountered at 14 ft	7		32	
20		50/11"			51
25		50/10"			
30		38		18	
35	SAND, Clayey, Very Dense, Gray	50/8"			
		50/10"			29



DEPTH DRILLED: 39.8 ft	**DEPTH TO WATER:** 14 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED: 10/18/2012	**DATE MEASURED:** 10/18/2012	**FIGURE:**	A-7

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-7

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

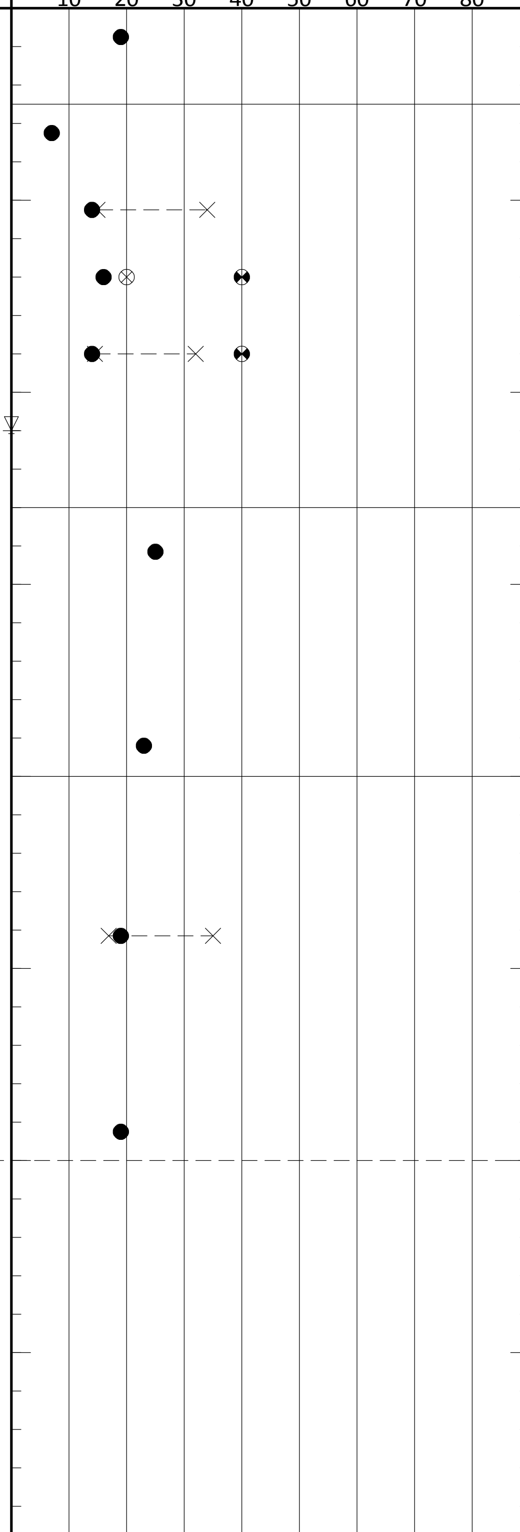
LOCATION: N 29.30899; W 98.31660

SURFACE ELEVATION: 500 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–2.5	FILL MATERIAL: SAND, Clayey, Medium Dense, Brown	10			
2.5–13	FILL MATERIAL: CLAY, Sandy, Very Stiff, Tan and Gray	29			
		22		19	
			115		
				17	
	-DRILLER'S NOTE: WATER encountered at 11 ft				
13–20	SAND, Clayey, Very Dense, Tan and Gray	50/9"			47
		50/11"			
20–30	CLAY, Sandy, Hard, Tan and Gray	50/9"		18	
		47			

SHEAR STRENGTH, TONS/FT²: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	30.0 ft	**DEPTH TO WATER:**	11 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/16/2012	**DATE MEASURED:**	10/16/2012	**FIGURE:**	A-8

LOG OF BORING NO. B-8

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30884; W 98.31510

SURFACE ELEVATION: 501 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–12	FILL MATERIAL: SAND, Clayey, Loose to Medium Dense, Brown and Tan	25			
		14		NP	
5		7			39
	-with a tan and gray clay seam from 6 to 8 ft		113		
10					
12–16	CLAY, Sandy, Very Stiff, Tan and Gray		111		
15					
16–39.7	SAND, Clayey, Medium Dense to Dense, Tan and Gray -DRILLER'S NOTE: WATER encountered at 16 ft				
20		25			47
25		10		18	
30		25			
35	-with a tan and gray clay seam from 33 to 35 ft	38			52
		50/8"		9	

SHEAR STRENGTH, TONS/FT^2: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

DEPTH DRILLED: 39.7 ft	**DEPTH TO WATER:** 16 ft	**PROJ. No.:** ASA12-098-00	
DATE DRILLED: 10/19/2012	**DATE MEASURED:** 10/19/2012	**FIGURE:** A-9	

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-9

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30802; W 98.31601

SURFACE ELEVATION: 499 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–1.5	FILL MATERIAL: SAND, Medium Dense, Brown and Tan	11			
1.5–10	CLAY, Stiff to Very Stiff, Tan	14			
		16		21	
		11			
10–28	SAND, Clayey, Loose to Very Dense, Tan and Gray	9			49
	-DRILLER'S NOTE: WATER encountered at 16 ft				
		50/11"			
		ref/1"			
28–29.9	CLAY, Sandy, Hard, Tan and Gray	50/11"			62

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	29.9 ft	**DEPTH TO WATER:**	16 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/17/2012	**DATE MEASURED:**	10/17/2012	**FIGURE:**	A-10

LOG OF BORING NO. B-10

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

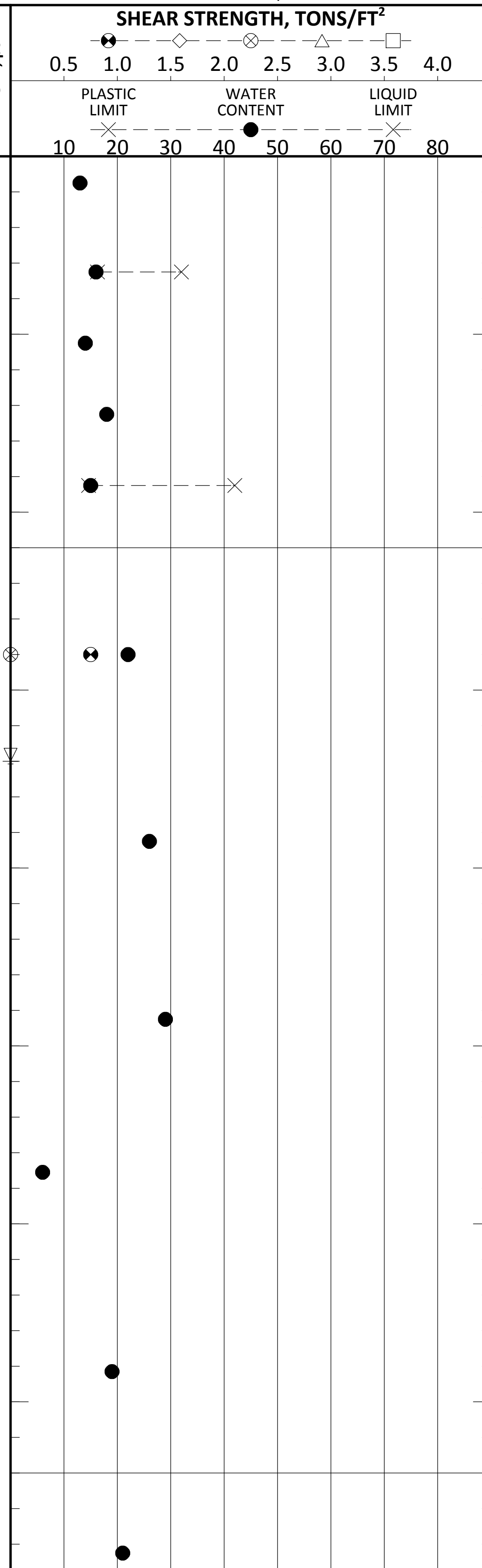
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30769; W 98.31855

SURFACE ELEVATION: 496 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	FILL MATERIAL: CLAY, Sandy, Very Stiff, Tan	16			
		16		16	
5		19			
		24			
		19		27	
11	SAND, Clayey, Medum Dense to Very Dense, Tan and Gray, with intermittent clay seams				
			97		41
	-DRILLER'S NOTE: WATER encountered at 17 ft				
		38			
		17			
		ref/1"			
		50/9"			42
37	CLAY, Very Stiff, Dark Gray				
		26			



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	40.0 ft	**DEPTH TO WATER:**	17 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/17/2012	**DATE MEASURED:**	10/17/2012	**FIGURE:**	A-11

LOG OF BORING NO. B-11

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30737; W 98.31744

SURFACE ELEVATION: 496 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–12	FILL MATERIAL: CLAY, Sandy, Stiff to Very Stiff, Tan to Brown	15		16	
		11			
	-with a tan sand seam from 4 to 6 ft	12			49
		18			
12–30	SAND, Clayey, Medium Dense to Dense, Tan and Gray, with intermittent clay seams	18			
	-DRILLER'S NOTE: WATER encountered at 16 ft				
		18			
		49			34
		42			

SHEAR STRENGTH, TONS/FT^2: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

Depth scale: 5, 10, 15, 20, 25, 30, 35

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	30.0 ft	**DEPTH TO WATER:**	16 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/18/2012	**DATE MEASURED:**	10/18/2012	**FIGURE:**	A-12

LOG OF BORING NO. B-12

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30757; W 98.31509

SURFACE ELEVATION: 500 ft

SHEAR STRENGTH, TONS/FT²: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT, WATER CONTENT, LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–4.5	FILL MATERIAL: SAND, Clayey, Loose to Medium Dense, Brown, with gravel	23			46
		6			
4.5–25	CLAY, Sandy, Firm to Hard, Tan to Brown	8		18	
		27			
				21	
		18			
	-DRILLER'S NOTE: WATER encountered at 16 ft				
		24			
		50/11"			51
25–26	SANDSTONE, Hard, Gray				
26–30	SAND, Clayey, Medium Dense, Tan and Gray	11			

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	30.0 ft	**DEPTH TO WATER:**	16 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/17/2012	**DATE MEASURED:**	10/17/2012	**FIGURE:**	A-13

LOG OF BORING NO. B-13

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30715; W 98.31792

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

SURFACE ELEVATION: 496 ft

DESCRIPTION OF MATERIAL

0 – 13 ft: FILL MATERIAL: CLAY, Sandy, Very Stiff to Hard, Tan to Brown

-with a tan sand seam from 4 to 6 ft

13 – 40 ft: CLAY, Sandy, Very Stiff to Hard, Tan and Gray

-DRILLER'S NOTE: WATER encountered at 16 ft

BLOWS PER FT	PLASTICITY INDEX	% -200
23		
27	16	
34		43
16		
18		
19		53
41		
34	33	
41		
39		

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 40.0 ft	**DEPTH TO WATER:** 16 ft	**PROJ. No.:** ASA12-098-00	
DATE DRILLED: 10/18/2012	**DATE MEASURED:** 10/18/2012	**FIGURE:** A-14	

LOG OF BORING NO. B-14

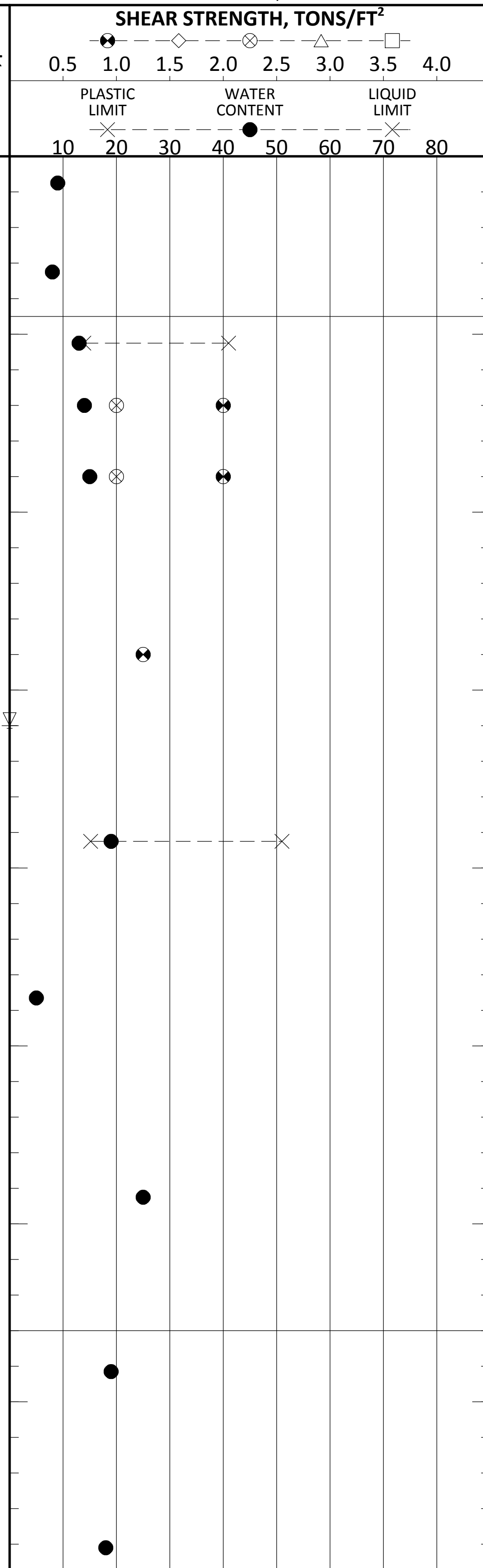
Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger **LOCATION:** N 29.30684; W 98.31590

SURFACE ELEVATION: 501 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–4.5	FILL MATERIAL: SAND, Clayey, Loose to Dense, Brown and Tan	9			
		30			46
4.5–33	CLAY, Sandy, Very Stiff to Hard, Tan to Tan and Gray	18		27	
			118		
			117		
	-DRILLER'S NOTE: WATER encountered at 16 ft				
		15		36	
		ref/3"			
		32			72
33–39.7	SAND, Clayey, Very Dense, Tan and Gray	50/9"			
		50/8"			



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 39.7 ft	**DEPTH TO WATER:** 16 ft	**PROJ. No.:** ASA12-098-00
DATE DRILLED: 10/19/2012	**DATE MEASURED:** 10/19/2012	**FIGURE:** A-15

KEY TO TERMS AND SYMBOLS

MATERIAL TYPES

SOIL TERMS

- CALCAREOUS
- CALICHE
- CLAY
- CLAYEY
- GRAVEL
- GRAVELLY
- PEAT
- SAND
- SANDY
- SILT
- SILTY
- FILL

ROCK TERMS

- CHALK
- CLAYSTONE
- CLAY-SHALE
- CONGLOMERATE
- DOLOMITE
- IGNEOUS
- LIMESTONE
- MARL
- METAMORPHIC
- SANDSTONE
- SHALE
- SILTSTONE

OTHER

- ASPHALT
- BASE
- CONCRETE/CEMENT
- BRICKS / PAVERS
- WASTE
- NO INFORMATION

WELL CONSTRUCTION AND PLUGGING MATERIALS

- BLANK PIPE
- SCREEN
- BENTONITE
- CEMENT GROUT
- BENTONITE & CUTTINGS
- CONCRETE/CEMENT
- CUTTINGS
- GRAVEL
- SAND
- VOLCLAY

SAMPLE TYPES

- AIR ROTARY
- GRAB SAMPLE
- CORE
- GEOPROBE SAMPLER
- ROTOSONIC -DAMAGED
- MUD ROTARY
- NO RECOVERY
- NX CORE
- PITCHER
- ROTOSONIC -INTACT
- SHELBY TUBE
- SPLIT BARREL
- SPLIT SPOON
- TEXAS CONE PENETROMETER
- DISTURBED

STRENGTH TEST TYPES

- POCKET PENETROMETER
- TORVANE
- UNCONFINED COMPRESSION
- TRIAXIAL COMPRESSION UNCONSOLIDATED-UNDRAINED
- TRIAXIAL COMPRESSION CONSOLIDATED-UNDRAINED

NOTE: VALUES SYMBOLIZED ON BORING LOGS REPRESENT SHEAR STRENGTHS UNLESS OTHERWISE NOTED

PROJECT NO. ASA12-098-00

RABAKISTNER

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

Terms used in this report to describe soils with regard to their consistency or conditions are in general accordance with the discussion presented in Article 45 of SOILS MECHANICS IN ENGINEERING PRACTICE, Terzaghi and Peck, John Wiley & Sons, Inc., 1967, using the most reliable information available from the field and laboratory investigations. Terms used for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in American Society for Testing and Materials D2487-06 and D2488-00, Volume 04.08, Soil and Rock; Dimension Stone; Geosynthetics; 2005.

The depths shown on the boring logs are not exact, and have been estimated to the nearest half-foot. Depth measurements may be presented in a manner that implies greater precision in depth measurement, i.e 6.71 meters. The reader should understand and interpret this information only within the stated half-foot tolerance on depth measurements.

RELATIVE DENSITY

Penetration Resistance Blows per ft	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
> 50	Very Dense

COHESIVE STRENGTH

Resistance Blows per ft	Consistency	Cohesion TSF
0 - 2	Very Soft	0 - 0.125
2 - 4	Soft	0.125 - 0.25
4 - 8	Firm	0.25 - 0.5
8 - 15	Stiff	0.5 - 1.0
15 - 30	Very Stiff	1.0 - 2.0
> 30	Hard	> 2.0

PLASTICITY

Plasticity Index	Degree of Plasticity
0 - 5	None
5 - 10	Low
10 - 20	Moderate
20 - 40	Plastic
> 40	Highly Plastic

ABBREVIATIONS

B = Benzene
T = Toluene
E = Ethylbenzene
X = Total Xylenes
BTEX = Total BTEX
TPH = Total Petroleum Hydrocarbons
ND = Not Detected
NA = Not Analyzed
NR = Not Recorded/No Recovery
OVA = Organic Vapor Analyzer
ppm = Parts Per Million

Qam, Qas, Qal = Quaternary Alluvium
Qat = Low Terrace Deposits
Qbc = Beaumont Formation
Qt = Fluviatile Terrace Deposits
Qao = Seymour Formation
Qle = Leona Formation
Q-Tu = Uvalde Gravel
Ewi = Wilcox Formation
Emi = Midway Group
Mc = Catahoula Formation
El = Laredo Formation
Kknm = Navarro Group and Marlbrook Marl
Kpg = Pecan Gap Chalk
Kau = Austin Chalk

Kef = Eagle Ford Shale
Kbu = Buda Limestone
Kdr = Del Rio Clay
Kft = Fort Terrett Member
Kgt = Georgetown Formation
Kep = Person Formation
Kek = Kainer Formation
Kes = Escondido Formation
Kew = Walnut Formation
Kgr = Glen Rose Formation
Kgru = Upper Glen Rose Formation
Kgrl = Lower Glen Rose Formation
Kh = Hensell Sand

PROJECT NO. ASA12-098-00

RABA KISTNER

REVISED 04/2012

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.
Carbonate	Having more than 50% carbonate content.

SAMPLING METHODS

RELATIVELY UNDISTURBED SAMPLING

Cohesive soil samples are to be collected using three-inch thin-walled tubes in general accordance with the Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587) and granular soil samples are to be collected using two-inch split-barrel samplers in general accordance with the Standard Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). Cohesive soil samples may be extruded on-site when appropriate handling and storage techniques maintain sample integrity and moisture content.

STANDARD PENETRATION TEST (SPT)

A 2-in.-OD, 1-3/8-in.-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

NOTE: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

APPENDIX B

LABORATORY TESTING SUMMARY

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

FILE NAME: ASA12-098-00.GPJ 11/8/2012

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-1	0.0 to 1.5	11	15								
	2.5 to 4.0	7	23						50		
	4.0 to 6.0		18	31	15	16	CL	106		0.27	UC
	6.0 to 8.0		15					110		1.09	UC
	8.0 to 10.0		13					112	40	0.39	UC
	13.5 to 15.0	16	21	55	18	37	CH				
	18.5 to 20.0	22	18								
	23.5 to 24.9	50/11"	14								
	28.5 to 29.9	50/11"	11						43		
	33.5 to 35.0	49	20								
	38.5 to 39.9	50/11"	20								
	43.5 to 44.8	50/9"	19								
	48.5 to 49.7	50/8"	19								
B-2	0.0 to 1.5	11	18								
	2.0 to 4.0		11					119	38	2.59	UC
	4.0 to 6.0		17	33	18	15	CL	104		0.79	UC
	6.0 to 8.0		19					102		0.28	UC
	8.0 to 10.0		17					110		0.98	UC
	13.0 to 15.0		18	54	18	36	CH			2.00	PP
	18.0 to 20.0		13					101		0.65	UC
	23.5 to 24.9	50/11"	12						24		
	28.5 to 29.8	50/10"	20								
	33.5 to 35.0	38	12								
	38.5 to 40.0	50	20								
	43.5 to 44.7	50/8"	18								
	48.5 to 49.8	50/9"	20								
B-3	0.0 to 1.5	24	13								
	2.5 to 4.0	12	15								
	4.5 to 6.0	11	17	34	15	19	CL				
	6.5 to 8.0	19	17						41		
	8.5 to 10.0	14	17								
	13.0 to 15.0		18	42	12	30	CL	112		0.73	UC
	18.0 to 20.0		15							2.00	PP
	23.5 to 25.0	46	11						47		
	28.5 to 30.0	50									
	33.5 to 34.9	50/11"	13								
	38.5 to 39.9	50/11"	18						33		
	43.5 to 45.0	38	27								
	48.5 to 49.8	50/10"	22								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ASA12-098-00

RABA KISTNER

FIGURE B-1a

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

FILE NAME: ASA12-098-00.GPJ 11/8/2012

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-4	0.0 to 1.5	7	16	40	15	25	CL				
	2.5 to 4.0	5	14						54		
	4.5 to 6.0	14	12	45	15	30	CL				
	6.0 to 8.0		14					113		1.96	UC
	8.0 to 10.0		11					110		0.71	UC
	13.5 to 15.0	26	18	41	14	27	CL				
	18.5 to 20.0	49	10								
	23.5 to 25.0	24	15								
	28.0 to 30.0		13					97	32	1.50	PP
	33.5 to 35.0	50	14								
	38.5 to 39.8	50/10"	25								
	43.5 to 45.0	50	24								
	48.5 to 49.8	50/9"	19						23		
B-5	0.0 to 1.5	17	13								
	2.5 to 4.0	21	14								
	4.5 to 6.0	24	13								
	6.5 to 8.0	20	16	32	13	19	CL				
	8.0 to 10.0		14						46	2.00	PP
	13.5 to 15.0	33	26						46		
	18.5 to 19.8	50/10"	24								
	23.5 to 24.8	50/9"	22								
	28.5 to 30.0	24	21								
	33.5 to 34.6	50/7"	24						31		
	38.5 to 39.7	50/8"									
B-6	0.0 to 1.5	15	11								
	2.5 to 4.0	14	16	33	18	15	CL				
	4.5 to 6.0	24	13						50		
	6.5 to 8.0	19	15								
	8.5 to 10.0	21	17								
	13.5 to 15.0	7	24	49	17	32	CL				
	18.5 to 19.9	50/11"	25						51		
	23.5 to 24.8	50/10"	23								
	28.5 to 30.0	38	21	38	20	18	CL				
	33.5 to 34.7	50/8"	23								
	38.5 to 39.8	50/10"	26						29		
B-7	0.0 to 1.5	10	19								
	2.5 to 4.0	29	7								
	4.5 to 6.0	22	14	34	15	19	CL				
	6.0 to 8.0		16					115		1.37	UC

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ASA12-098-00

RABA KISTNER

FIGURE B-1b

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

FILE NAME: ASA12-098-00.GPJ 11/8/2012

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-7	8.0 to 10.0		14	32	15	17	CL			2.00	PP
	13.5 to 14.8	50/9"	25						47		
	18.5 to 19.9	50/11"	23								
	23.5 to 24.8	50/9"	19	35	17	18	CL				
	28.5 to 30.0	47	19								
B-8	0.0 to 1.5	25	16								
	2.5 to 4.0	14	39			NP					
	4.5 to 6.0	7	16						39		
	6.0 to 8.0		15					113		0.78	UC
	8.0 to 10.0									2.00	PP
	13.0 to 15.0		18					111		0.39	UC
	18.5 to 20.0	25	23						47		
	23.5 to 25.0	10	20	33	15	18	CL				
	28.5 to 30.0	25	22								
	33.5 to 35.0	38	19						52		
	38.5 to 39.7	50/8"	24	29	20	9	CL				
B-9	0.0 to 1.5	11	13								
	2.5 to 4.0	14	16								
	4.5 to 6.0	16	15	35	14	21	CL				
	6.5 to 8.0	11	20								
	8.0 to 10.0		21							1.50	PP
	13.5 to 15.0	9	23						49		
	18.5 to 19.9	50/11"	24								
	23.5 to 23.6	ref/1"	26								
	28.5 to 29.9	50/11"	20						62		
B-10	0.0 to 1.5	16	13								
	2.5 to 4.0	16	16	32	16	16	CL				
	4.5 to 6.0	19	14								
	6.5 to 8.0	24	18								
	8.5 to 10.0	19	15	42	15	27	CL				
	13.0 to 15.0		22					97	41	0.23	UC
	18.5 to 20.0	38	26								
	23.5 to 25.0	17	29								
	28.5 to 28.6	ref/1"	6								
	33.5 to 34.8	50/9"	19						42		
	38.5 to 40.0	26	21								
B-11	0.0 to 1.5	15	14	32	16	16	CL				
	2.5 to 4.0	11	15								
	4.5 to 6.0	12	17						49		

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ASA12-098-00

RABAKISTNER

FIGURE B-1c

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

FILE NAME: ASA12-098-00.GPJ 11/8/2012

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-11	6.5 to 8.0	18	13								
	8.0 to 10.0									2.00	PP
	13.5 to 15.0	18	18								
	18.5 to 20.0	18	26								
	23.5 to 25.0	49	23						34		
	28.5 to 30.0	42	24								
B-12	0.0 to 1.5	23	28						46		
	2.5 to 4.0	6	38								
	4.5 to 6.0	8	16	32	14	18	CL				
	6.5 to 8.0	27	14								
	8.0 to 10.0		15	34	13	21	CL			2.00	PP
	13.5 to 15.0	18	18								
	18.5 to 20.0	24	28								
	23.5 to 24.9	50/11"	23						51		
	28.5 to 30.0	11	28								
B-13	0.0 to 1.5	23	13								
	2.5 to 4.0	27	14	33	17	16	CL				
	4.5 to 6.0	34	14						43		
	6.5 to 8.0	16	15								
	8.0 to 10.0									2.00	PP
	13.5 to 15.0	18	19								
	18.5 to 20.0	19	24						53		
	23.5 to 25.0	41	25								
	28.5 to 30.0	34	26	52	19	33	CH				
	33.5 to 35.0	41	21								
	38.5 to 40.0	39	20								
B-14	0.0 to 1.5	9	9								
	2.5 to 4.0	30	8						46		
	4.5 to 6.0	18	13	41	14	27	CL				
	6.0 to 8.0		14					118		1.10	UC
	8.0 to 10.0		15					117		1.15	UC
	13.0 to 15.0									1.25	PP
	18.5 to 20.0	15	19	51	15	36	CH				
	23.5 to 23.8	ref/3"	5								
	28.5 to 30.0	32	25						72		
	33.5 to 34.8	50/9"	19								
	38.5 to 39.7	50/8"	18								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ASA12-098-00

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FIGURE B-1d

US EPA ARCHIVE DOCUMENT

PROJECT NO. ASA12-098-00

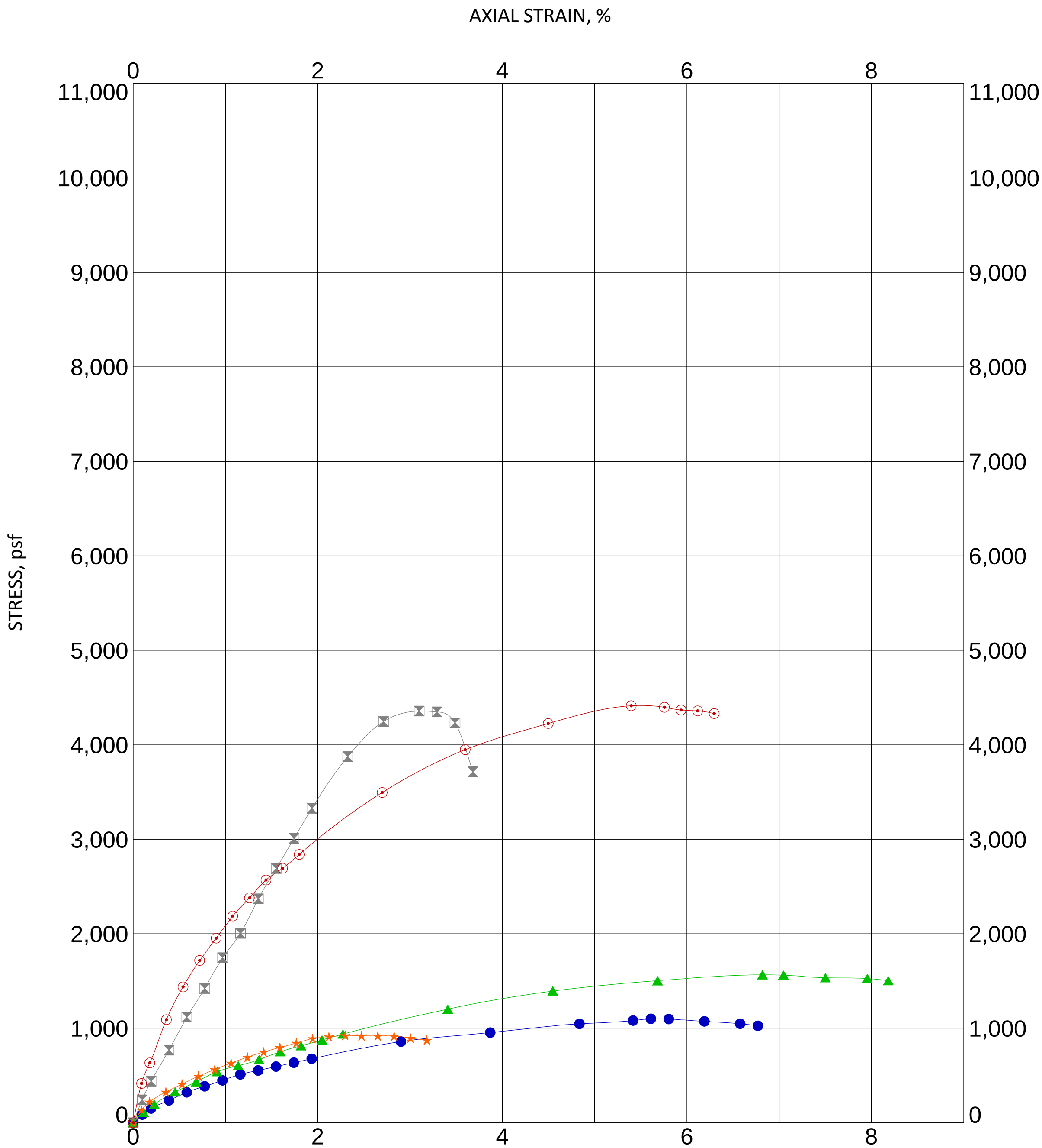

FIGURE B-2

Specimen Identification		Classification	Shear Str. (tsf)	Failure Strain (%)	PI	Dry Unit Weight (pcf)	w (%)
● B-1	4 ft		0.3	5.6	16	106.0	17.7
⧗ B-1	6 ft		1.1	3.1		109.9	15.4
▲ B-1	8 ft		0.4	6.8		111.8	13.2
★ B-10	13 ft		0.2	2.3		97.4	24.5
⊙ B-14	6 ft		1.1	5.4		117.9	13.6

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www.rkci.com

UNCONFINED COMPRESSION

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

PROJECT NO. ASA12-098-00

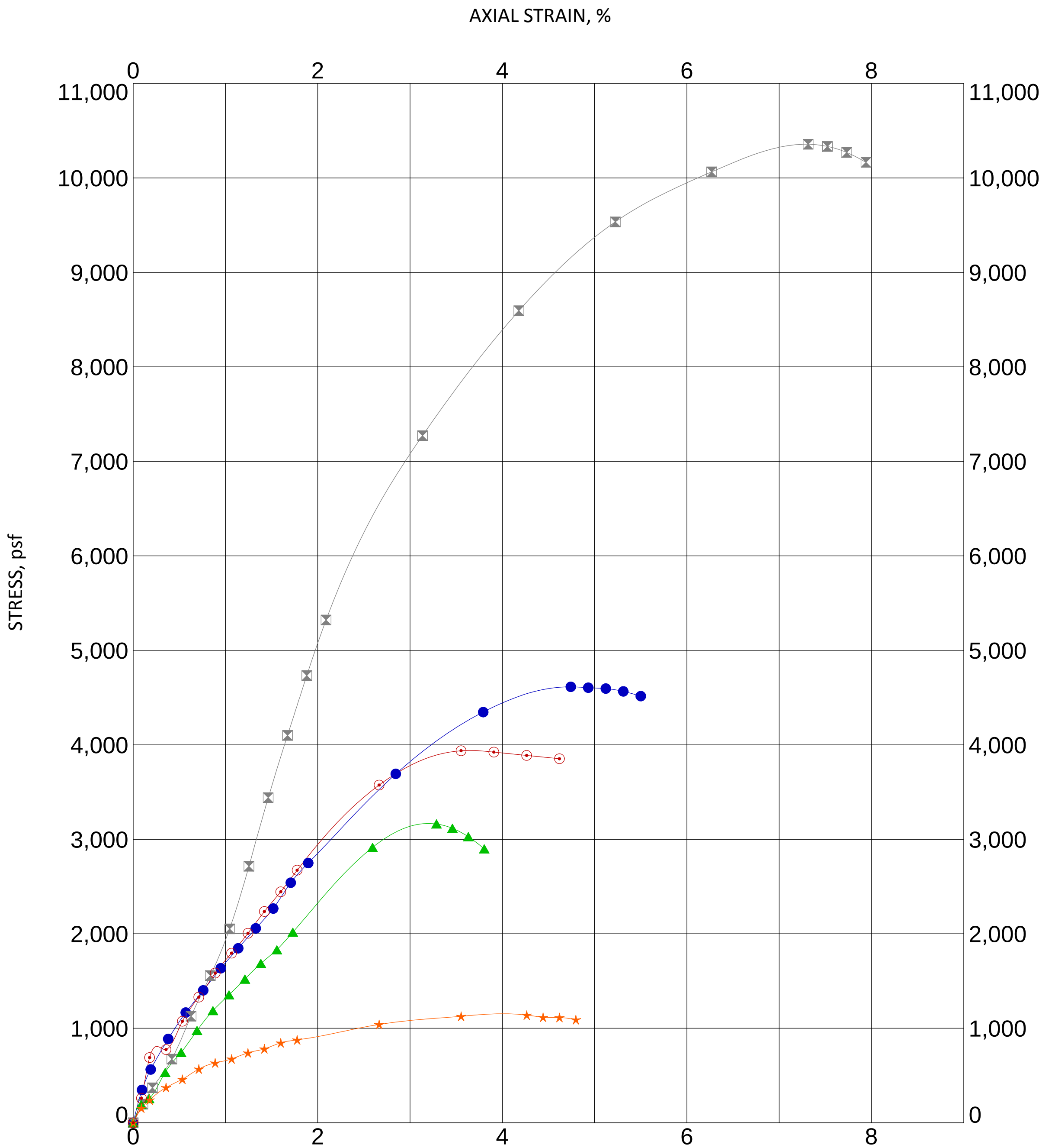

FIGURE B-3

Specimen Identification		Classification	Shear Str. (tsf)	Failure Strain (%)	PI	Dry Unit Weight (pcf)	w (%)
● B-14	8 ft		1.2	4.7		116.9	14.7
⧗ B-2	2 ft		2.6	7.3		119.3	10.9
▲ B-2	4 ft		0.8	3.3	15	104.0	16.6
★ B-2	6 ft		0.3	4.3		102.1	19.0
⊙ B-2	8 ft		1.0	3.6		110.3	16.9

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UNCONFINED COMPRESSION

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

R-K UNCONFINED COMPRESSION ASA12-098-00.GPJ RKCI.GDT 11/8/12

US EPA ARCHIVE DOCUMENT

PROJECT NO. ASA12-098-00

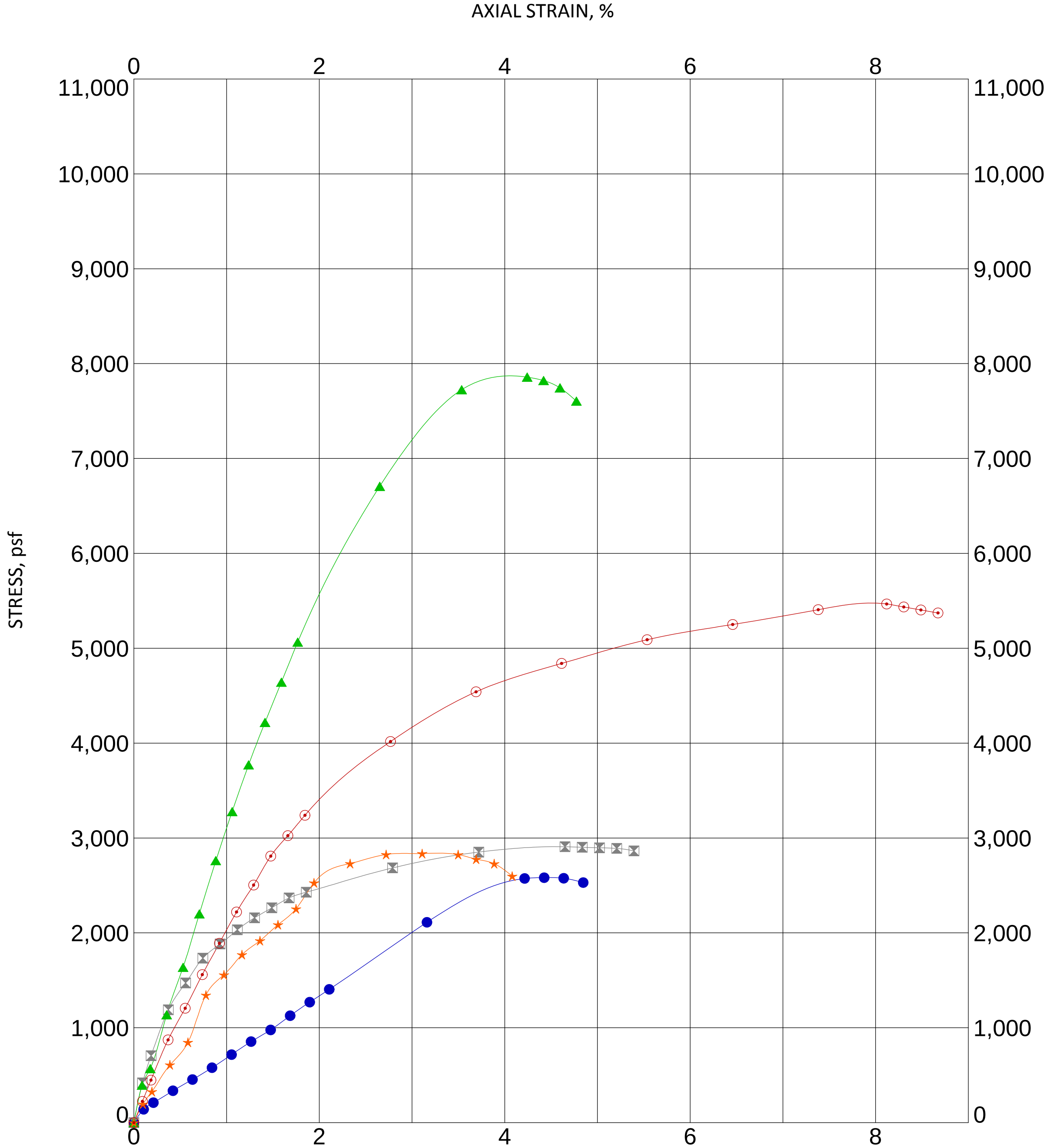

FIGURE B-4

Specimen Identification		Classification	Shear Str. (tsf)	Failure Strain (%)	PI	Dry Unit Weight (pcf)	w (%)
● B-2	18 ft		0.6	4.4		100.8	13.0
⧗ B-3	13 ft		0.7	4.7	30	112.2	17.6
▲ B-4	6 ft		2.0	4.2		113.1	14.3
★ B-4	8 ft		0.7	3.1		109.8	10.6
⊙ B-7	6 ft		1.4	8.1		115.1	15.7

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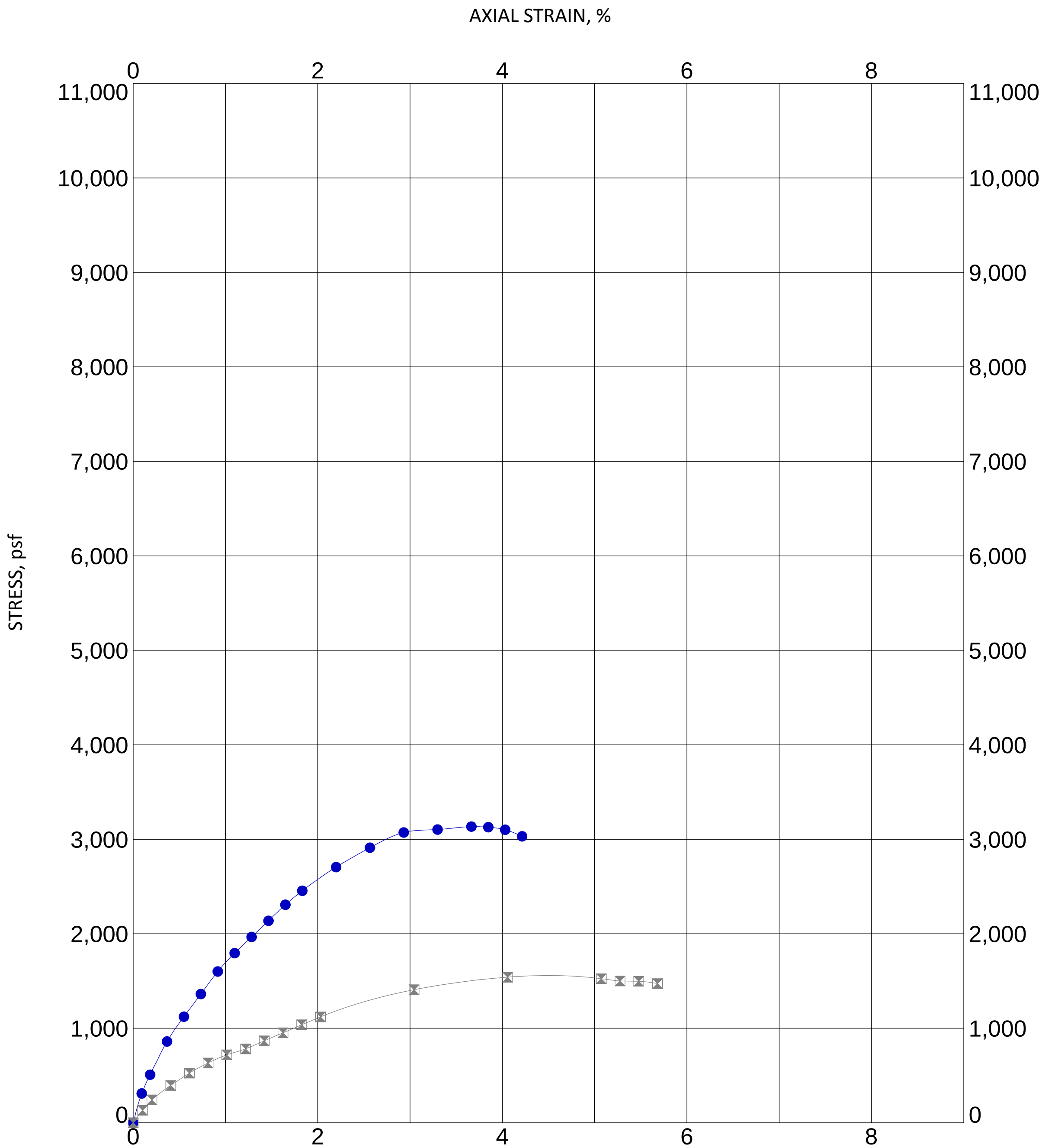

FIGURE B-5

Specimen Identification		Classification	Shear Str. (tsf)	Failure Strain (%)	PI	Dry Unit Weight (pcf)	w (%)
● B-8	6 ft		0.8	3.7		112.6	15.1
⧗ B-8	13 ft		0.4	4.1		110.8	18.1

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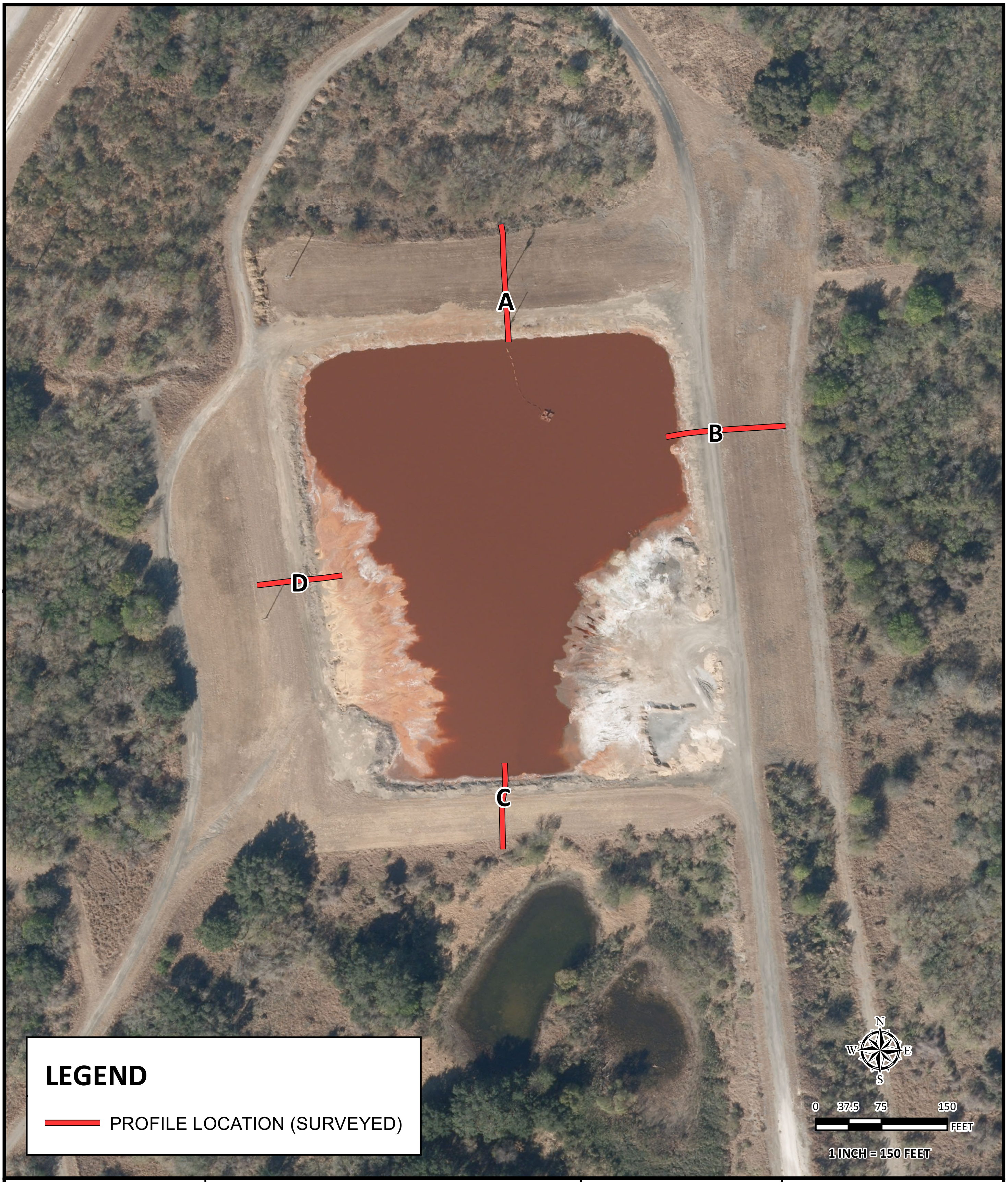
UNCONFINED COMPRESSION

Ash Pond Berms - Calaveras Lake Power Plant
San Antonio, Texas

APPENDIX C

RESULTS OF GEOTECHNICAL ANALYSES



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TBPE Firm Number 3257

SOURCE: 2011 Aerial Photograph Provided by the City of San Antonio (COSA)

SLOPE PROFILE LOCATION MAP

ASH POND BERMS - CALAVERAS LAKE POWER PLANT
SAN ANTONIO, TEXAS

REVISIONS:

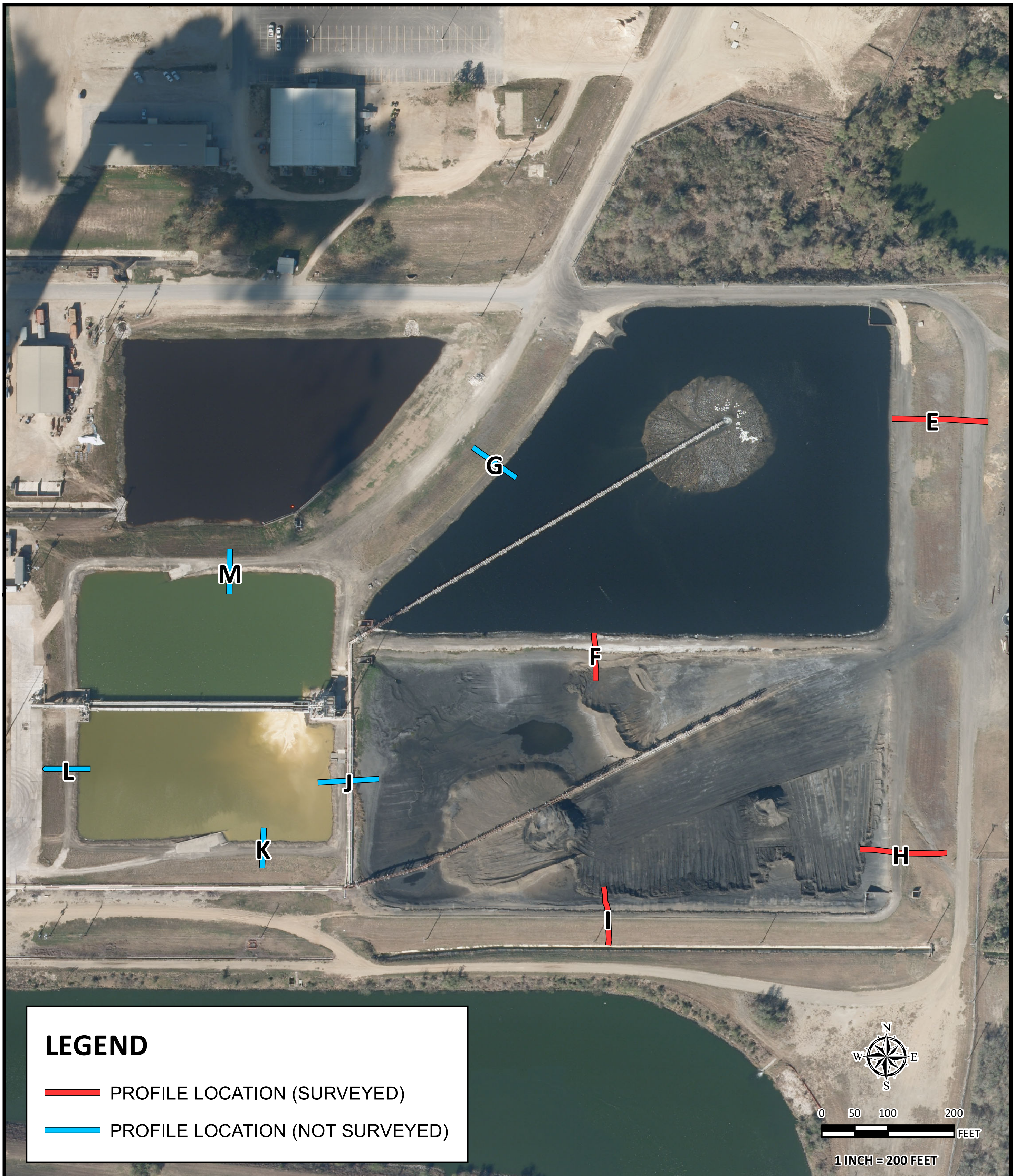
No.	DATE	DESCRIPTION

PROJECT No.:	ASA12-098-00
ISSUE DATE:	11/08/2012
DRAWN BY:	CCL
CHECKED BY:	RBW
REVIEWED BY:	GLB

FIGURE

C-1a

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes



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TBPE Firm Number 3257

SOURCE: 2011 Aerial Photograph Provided by the City of San Antonio (COSA)

SLOPE PROFILE LOCATION MAP

ASH POND BERMS - CALAVERAS LAKE POWER PLANT
SAN ANTONIO, TEXAS

REVISIONS:

No.	DATE	DESCRIPTION

PROJECT No.:	ASA12-098-00
ISSUE DATE:	11/08/2012
DRAWN BY:	CCL
CHECKED BY:	RBW
REVIEWED BY:	GLB

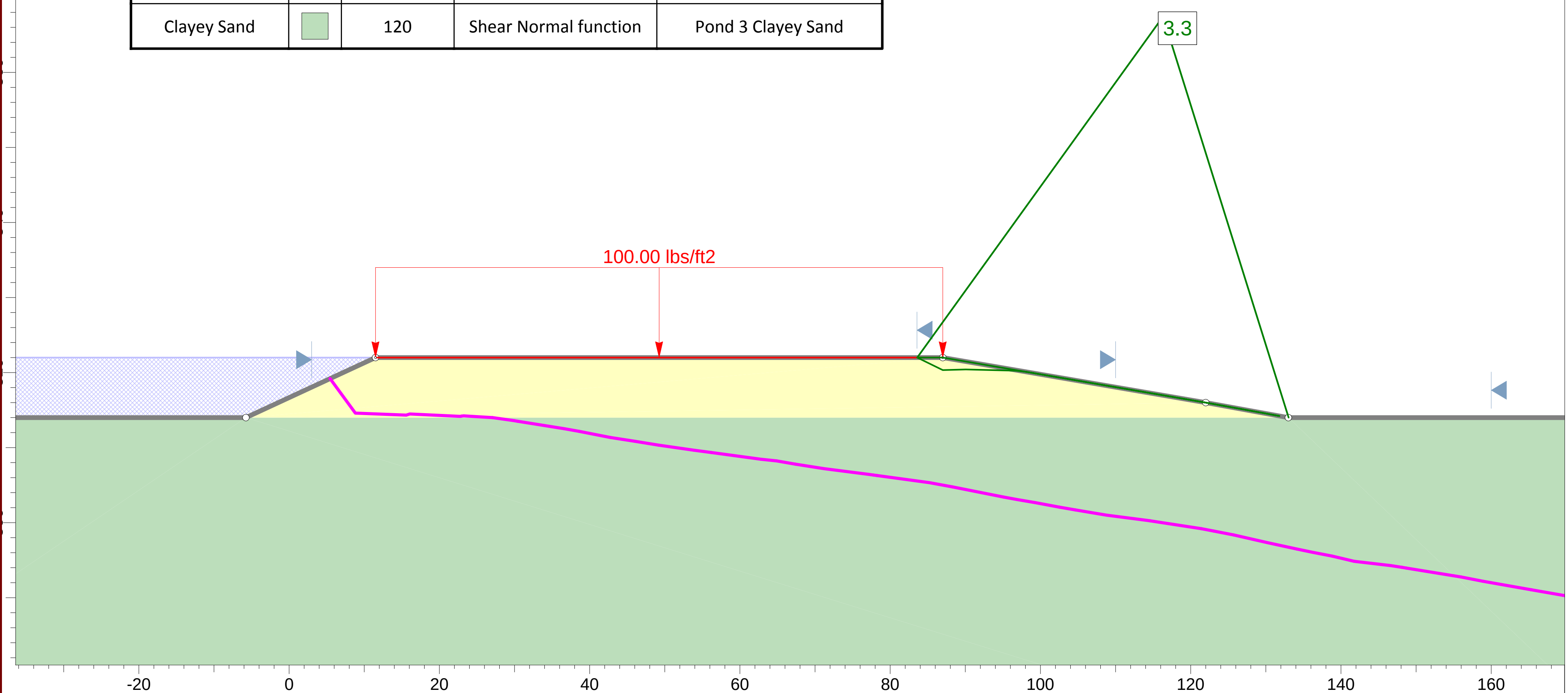
FIGURE

C-1b

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "A"
Ash Pond Berms - Calaveras Lake Power Plant

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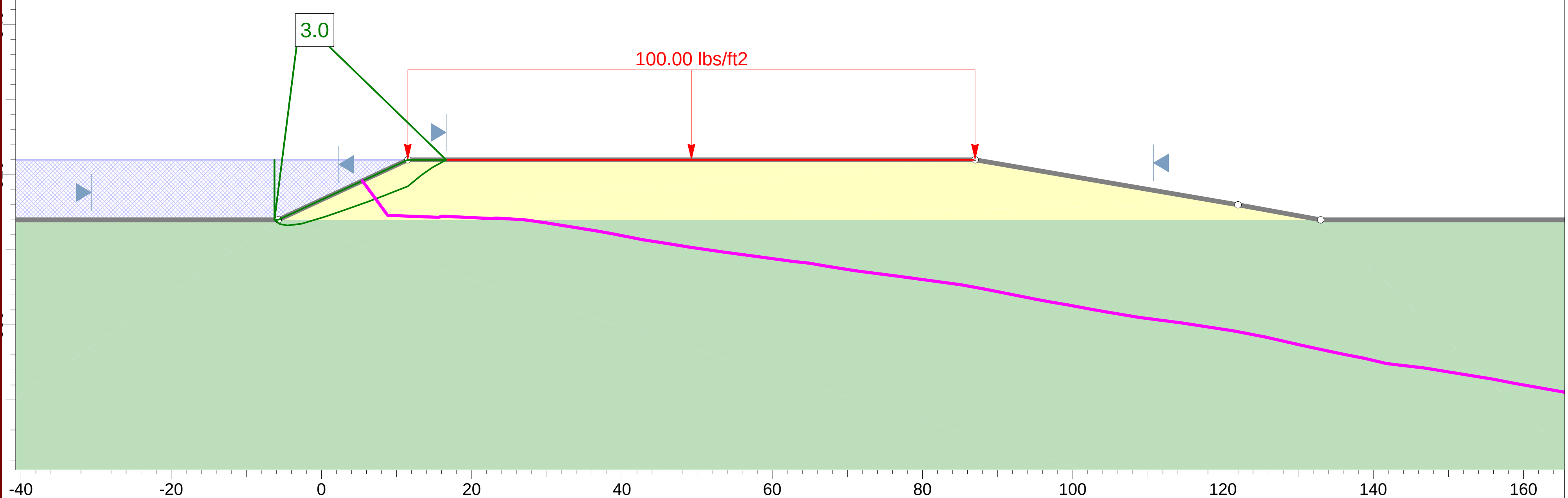
Figure C-2a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "A"
Ash Pond Berms - Calaveras Lake Power Plant

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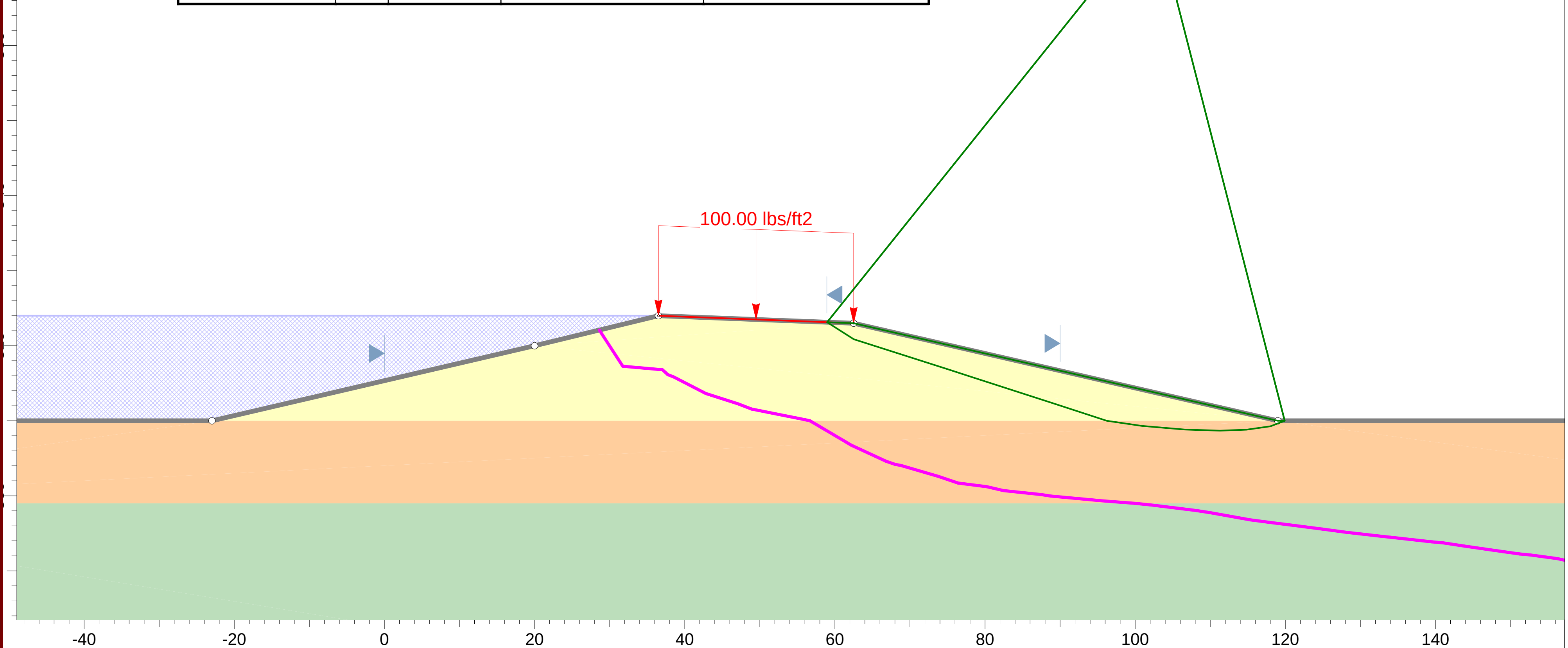
Figure C-2b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



Profile "B"
Ash Pond Berms - Calaveras Lake Power Plant

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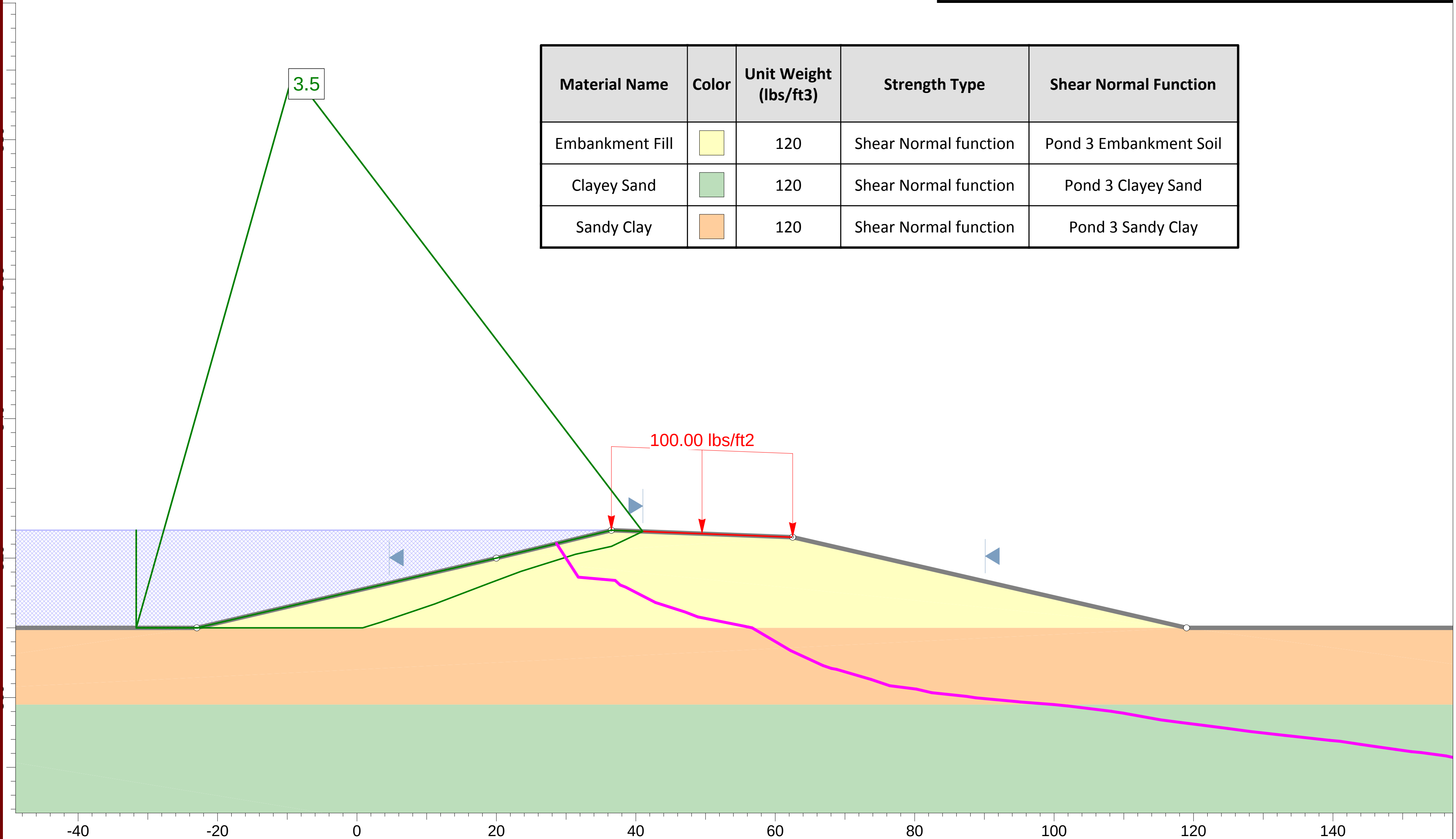
Figure C-3a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



Profile "B"
Ash Pond Berms - Calaveras Lake Power Plant

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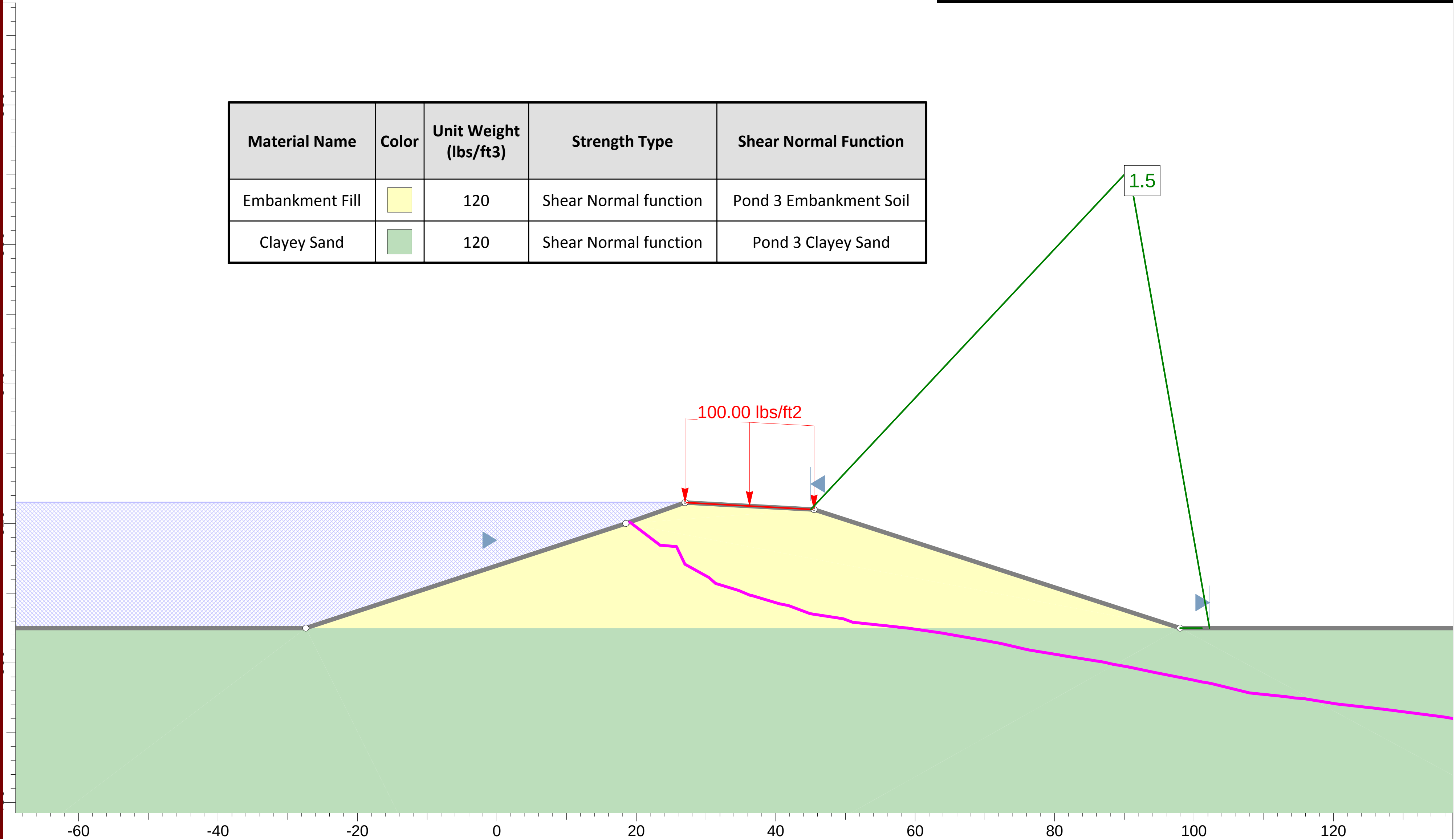
Figure C-3b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "C"
Ash Pond Berms - Calaveras Lake Power Plant

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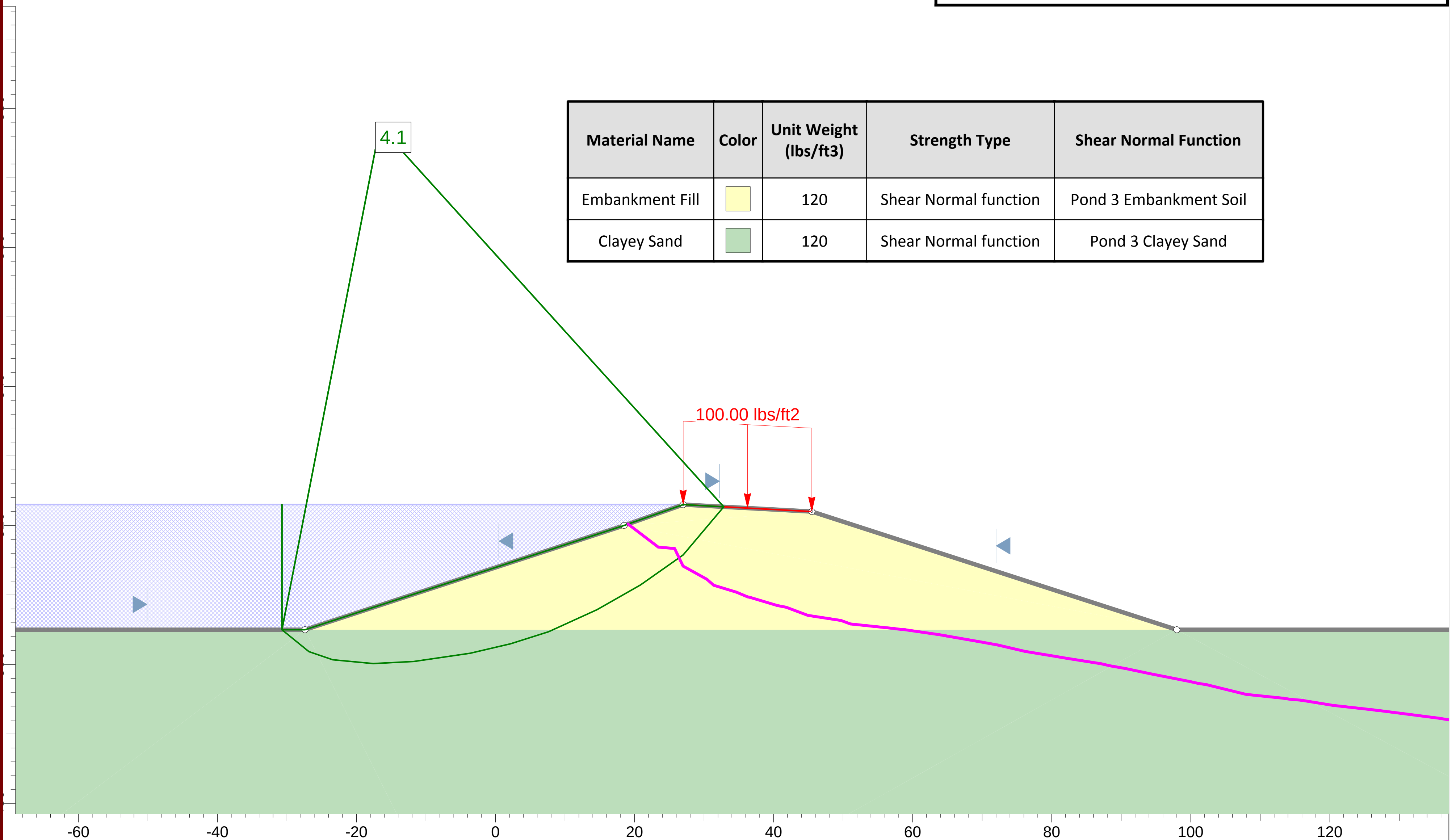
Figure C-4a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "C"
Ash Pond Berms - Calaveras Lake Power Plant

Raba Kistner Consultants, Inc.
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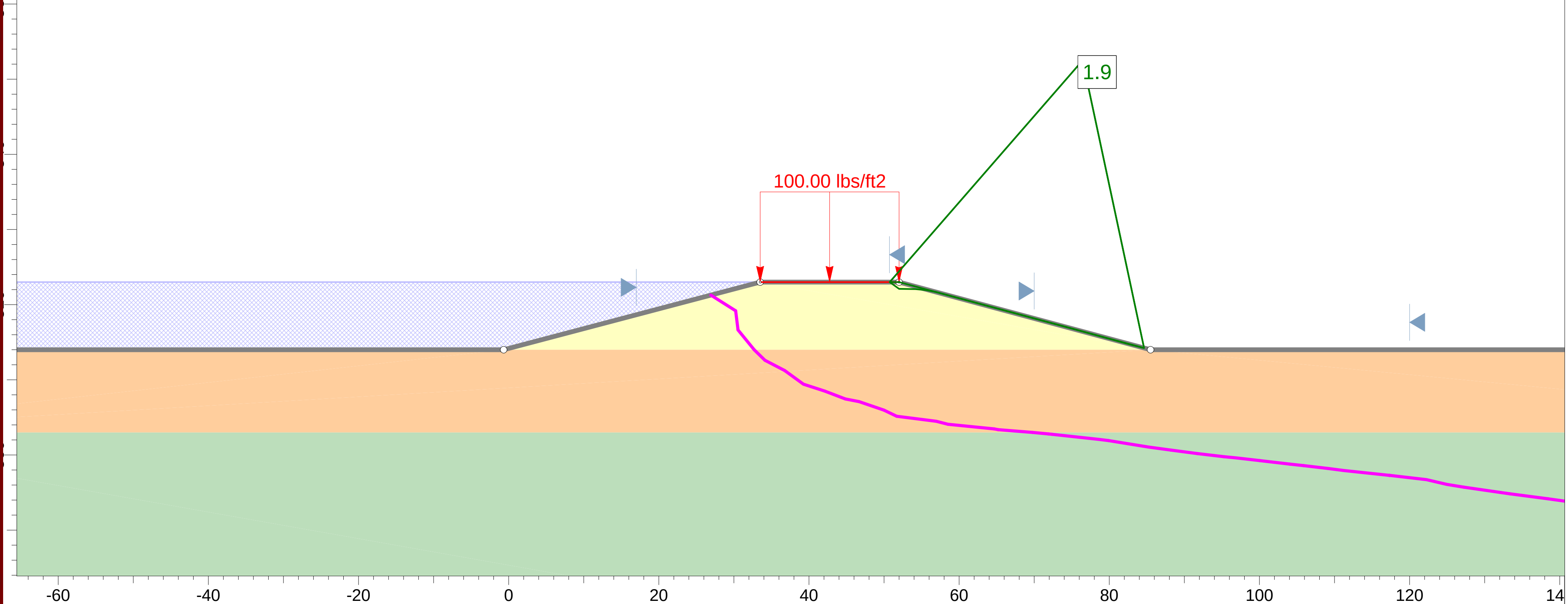
Figure C-4b

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



Profile "D"
Ash Pond Berms - Calaveras Lake

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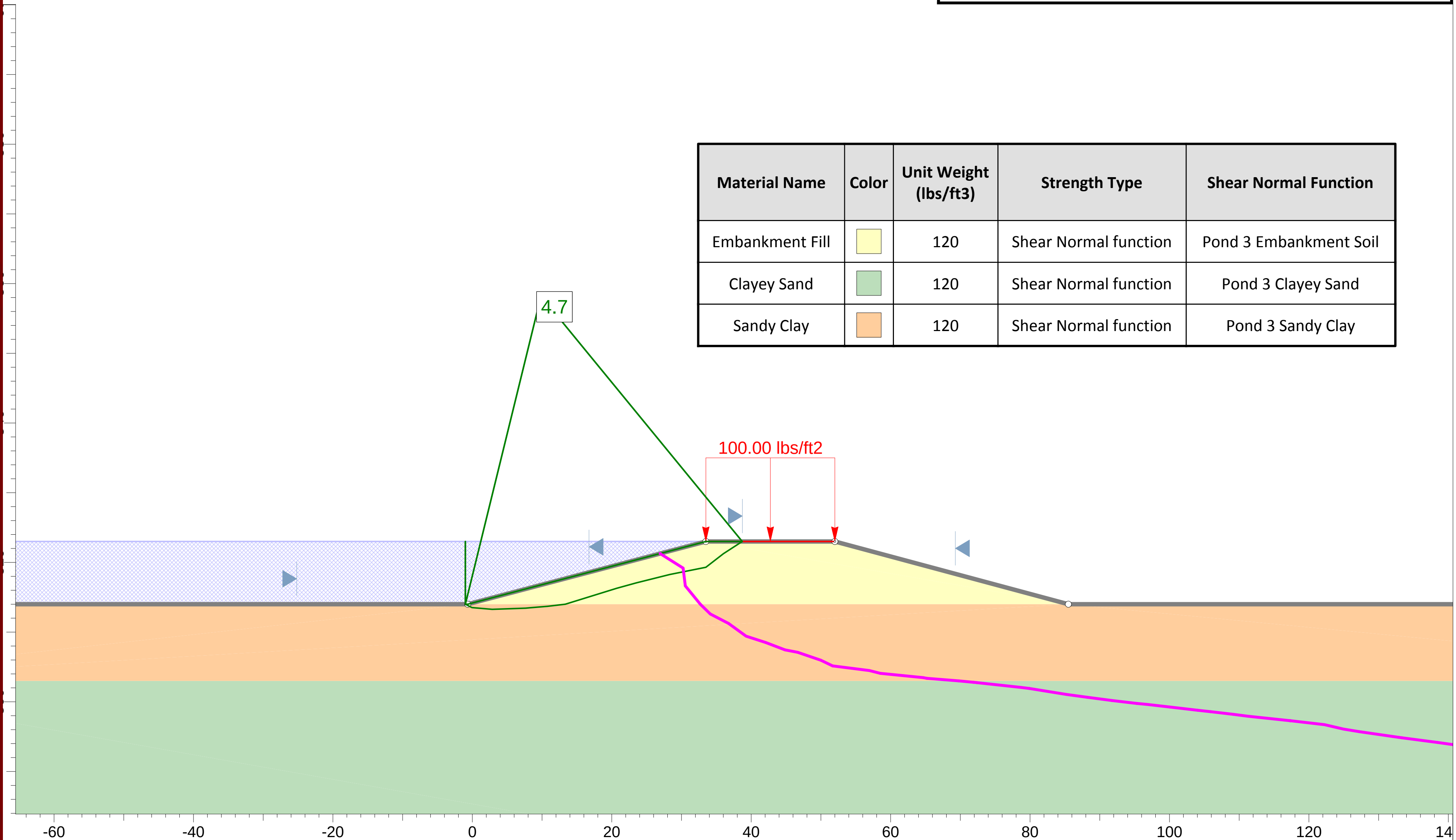
Figure C-5a

RABA KISTNER CONSULTANTS

Global Stability Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay

Profile "D"
Ash Pond Berms - Calaveras Lake

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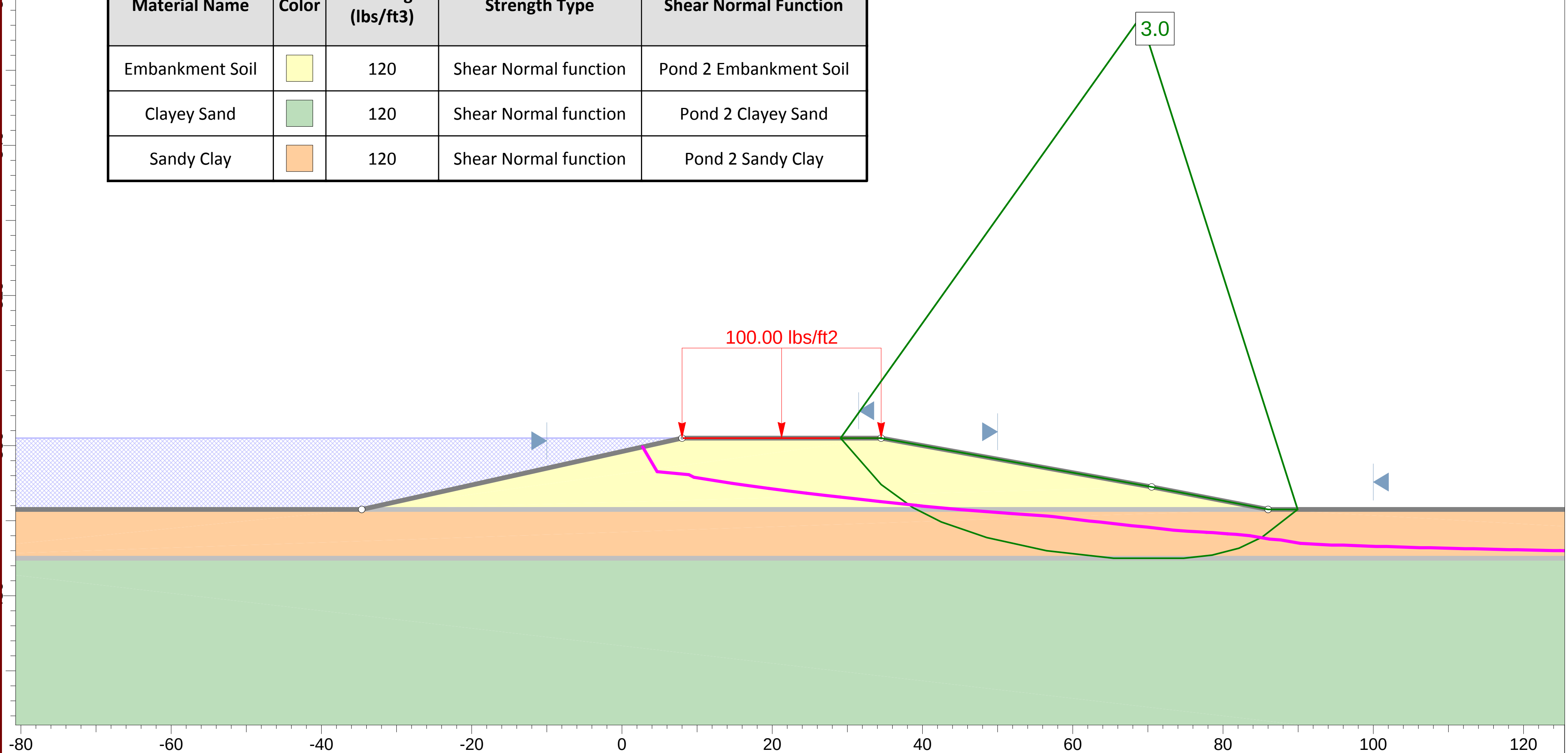
Figure C-5b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Soil		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "E"
Ash Pond Berms - Calaveras Lake Power Plant

Raba Kistner Consultants, Inc.
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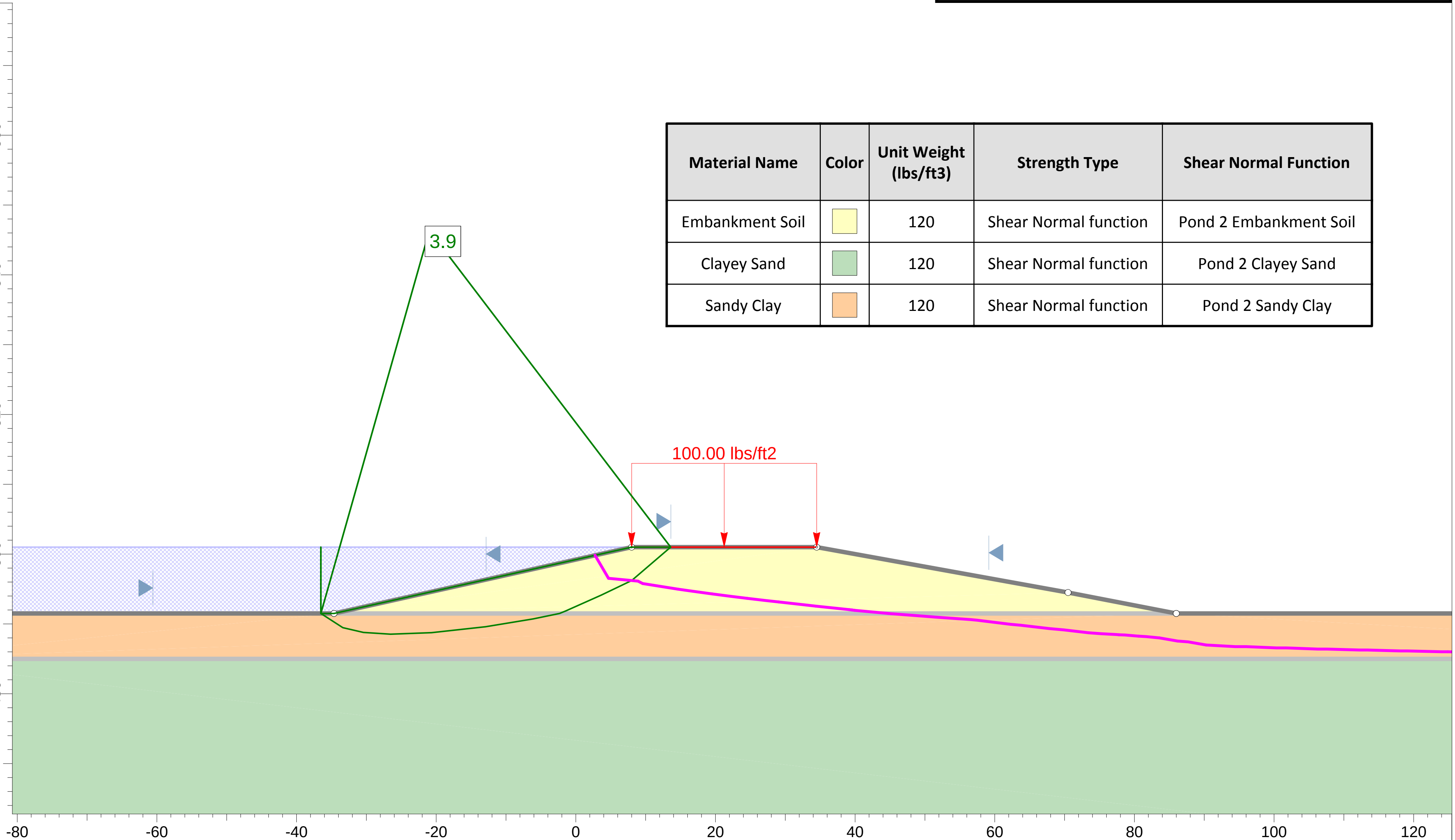
Figure C-6a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Soil		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "E"
Ash Pond Berms - Calaveras Lake Power Plant

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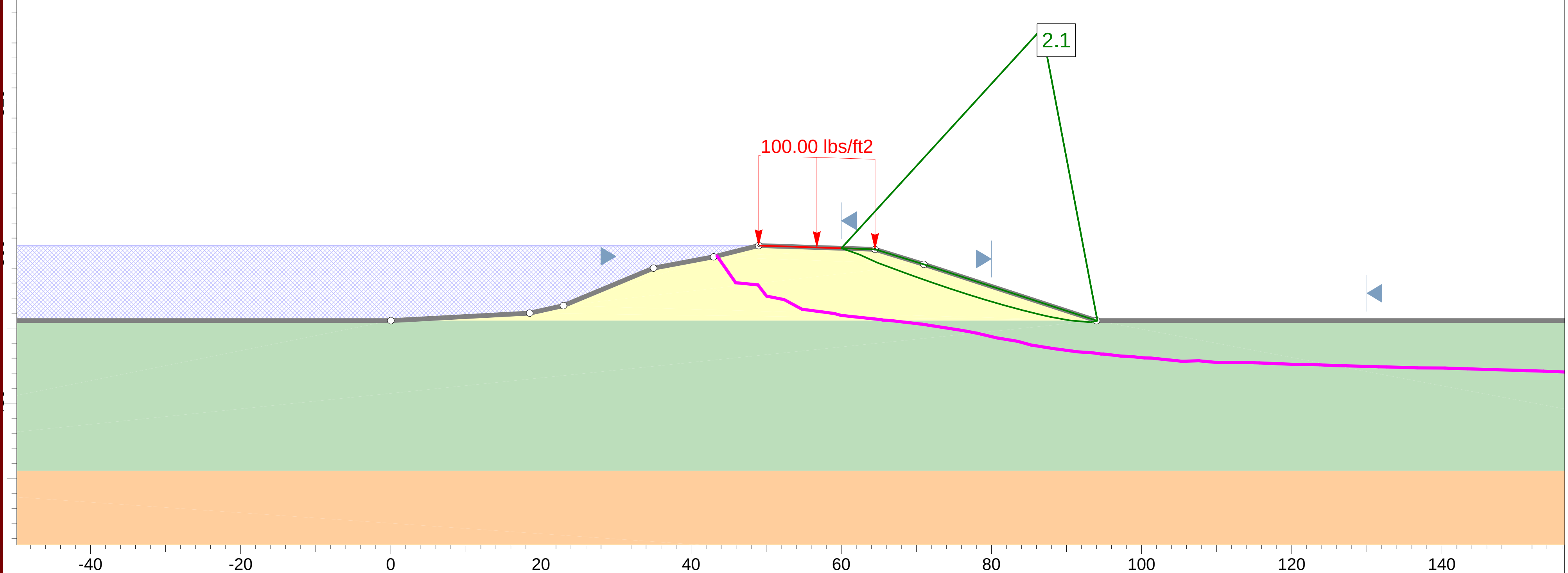
Figure C-6b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



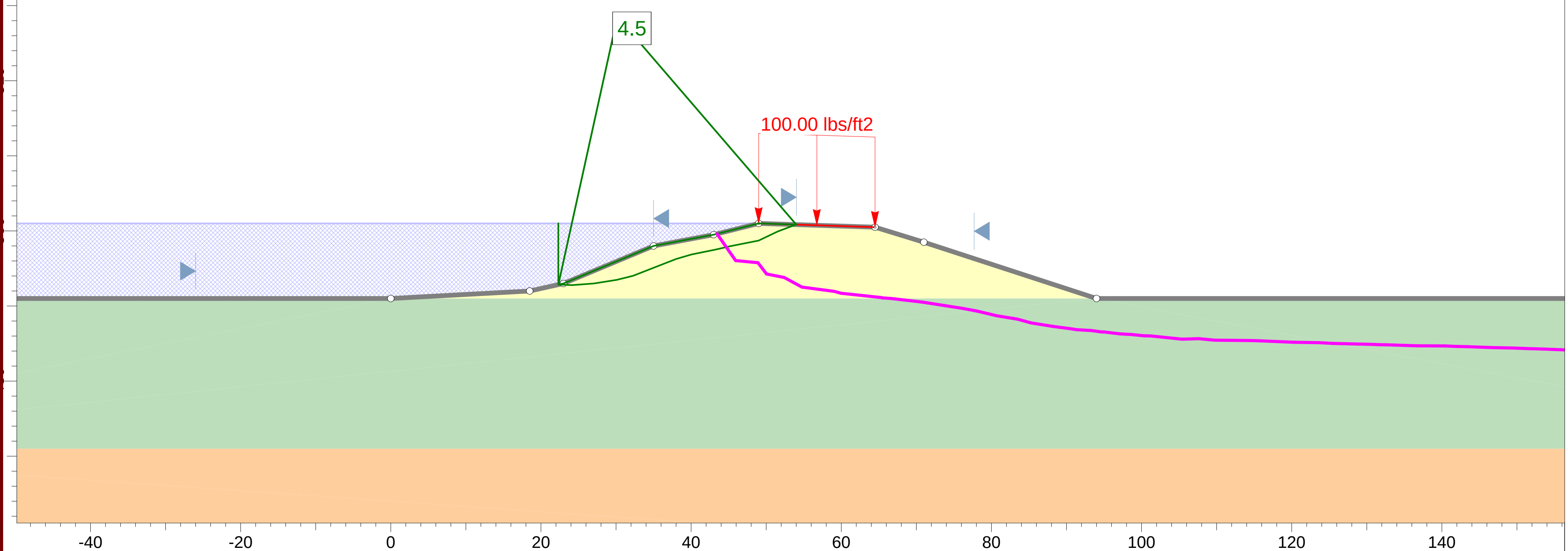
Profile "F"
Ash Pond Berms - Calaveras Lake Power Plant

Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-7a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "F"
Ash Pond Berms - Calaveras Lake Power Plant

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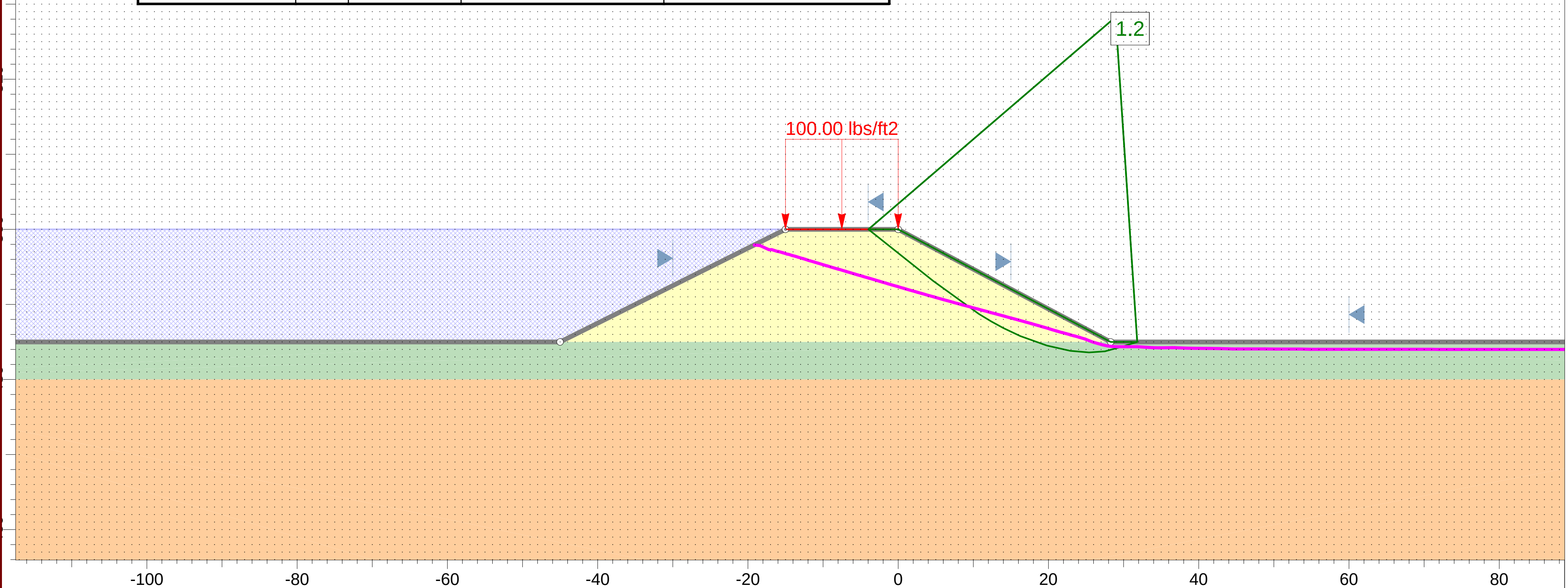
ASA12-098-00

Figure C-7b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "G"
Ash Pond Berms - Calaveras Lake Power Plant

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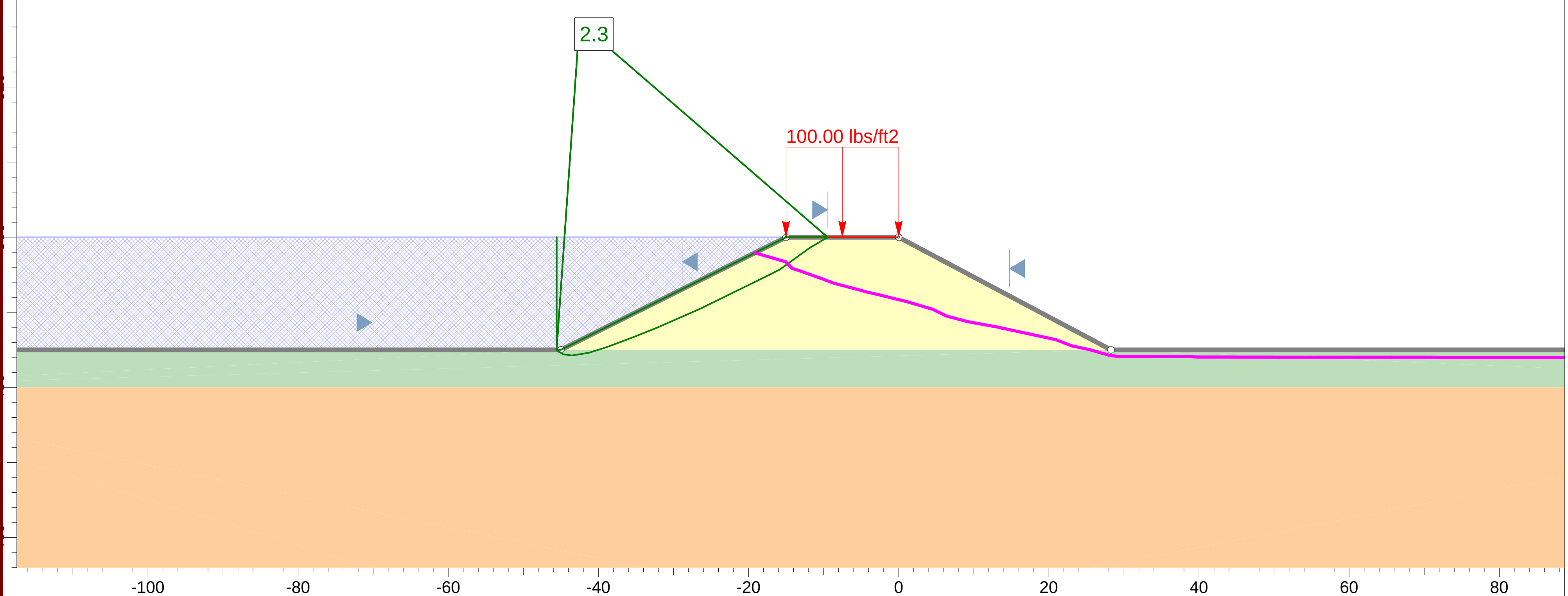
ASA12-098-00

Figure C-8a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "G"
Ash Pond Berms - Calaveras Lake Power Plant

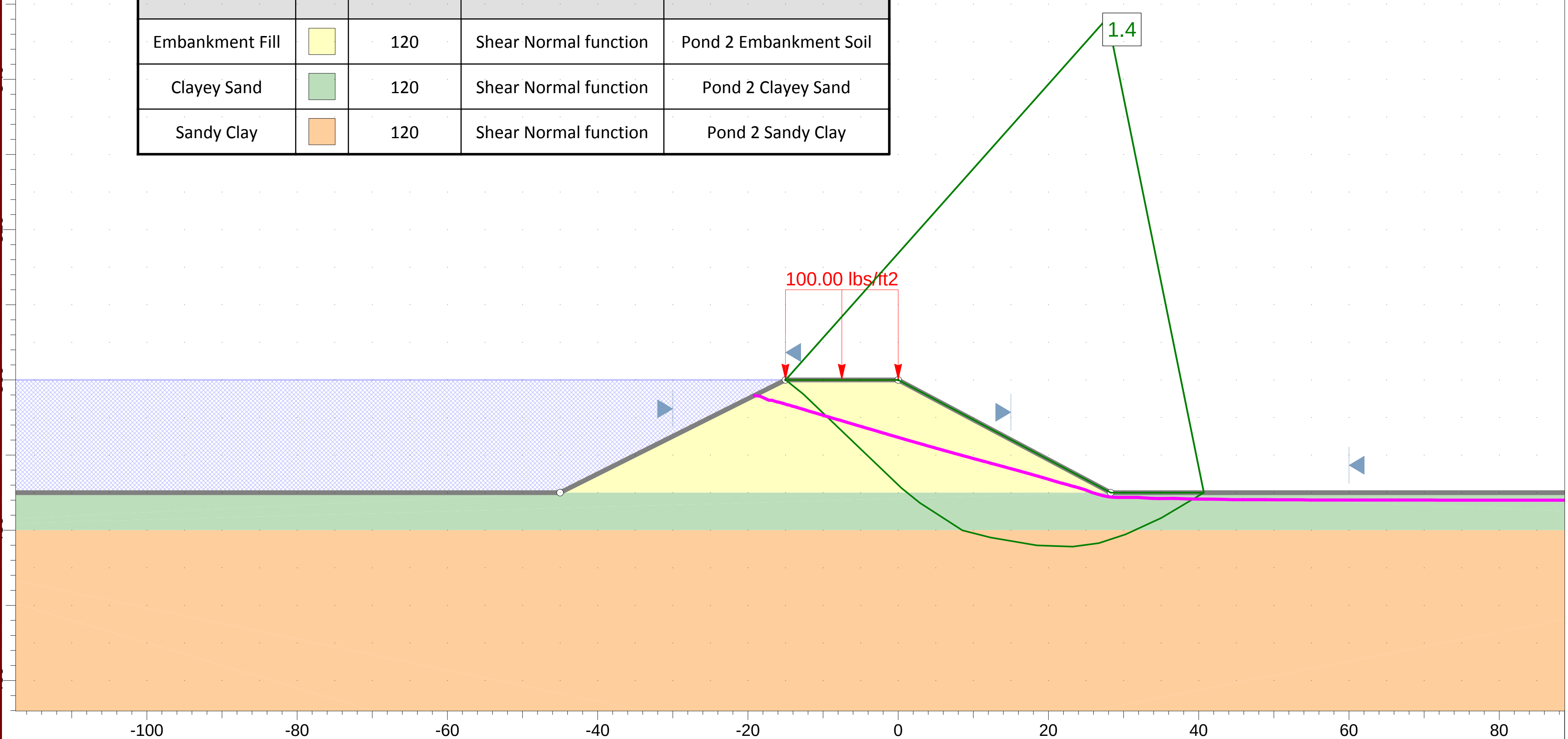
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-8b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "G"
Ash Pond Berms - Calaveras Lake Power Plant

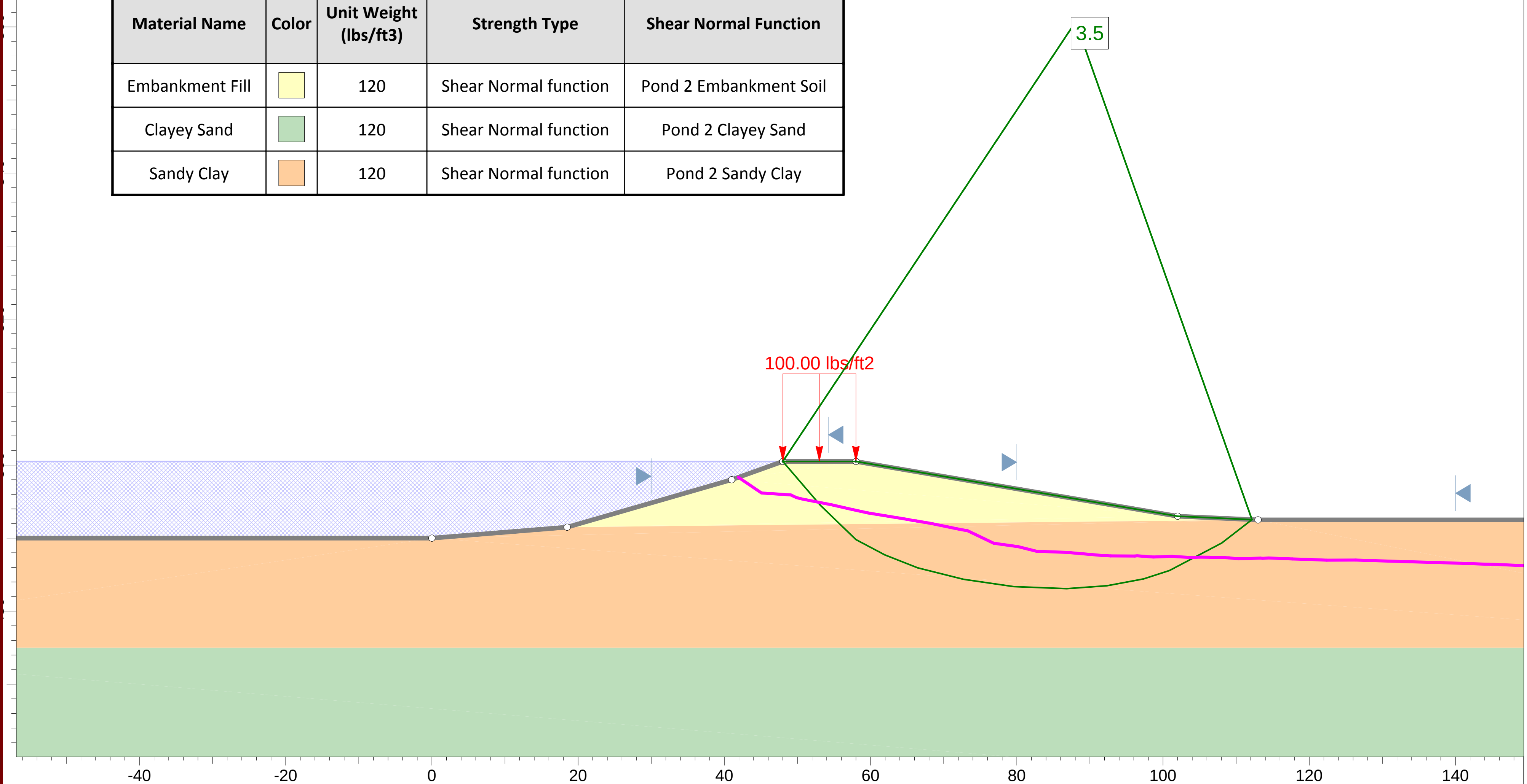
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-8c

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "H"
Ash Pond Berms - Calaveras Lake Power Plant

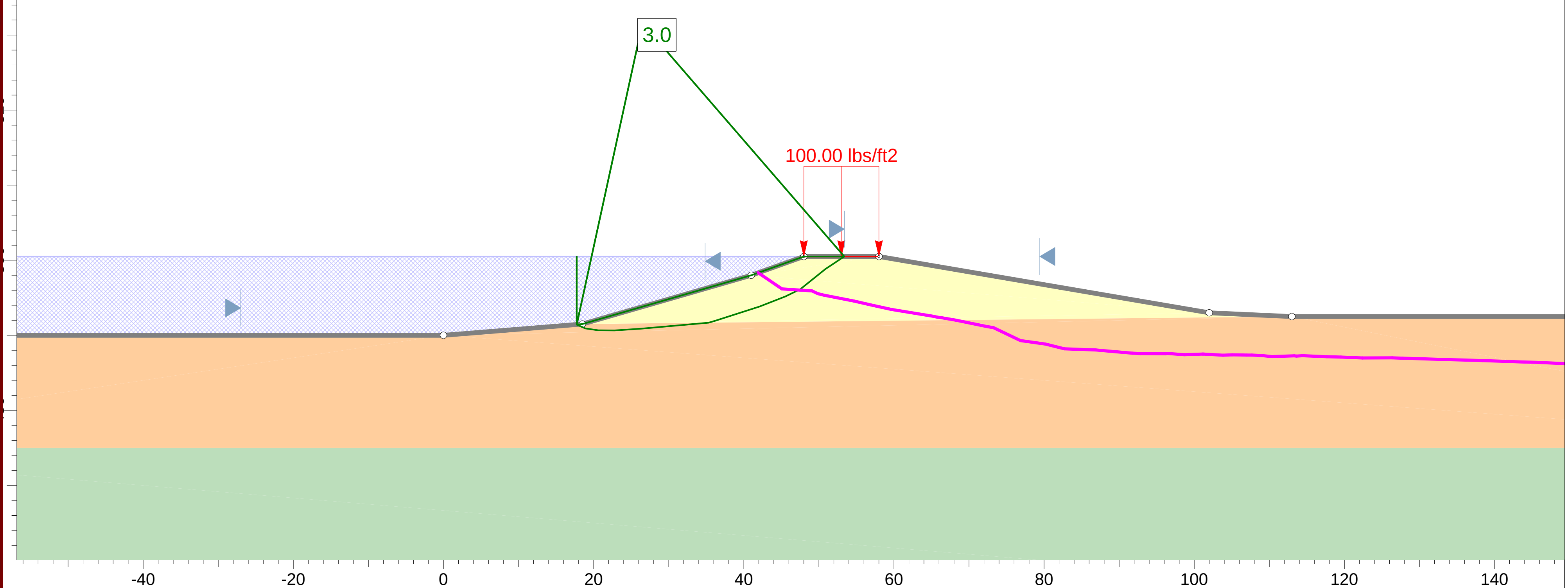
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-9a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "H"
Ash Pond Berms - Calaveras Lake Power Plant

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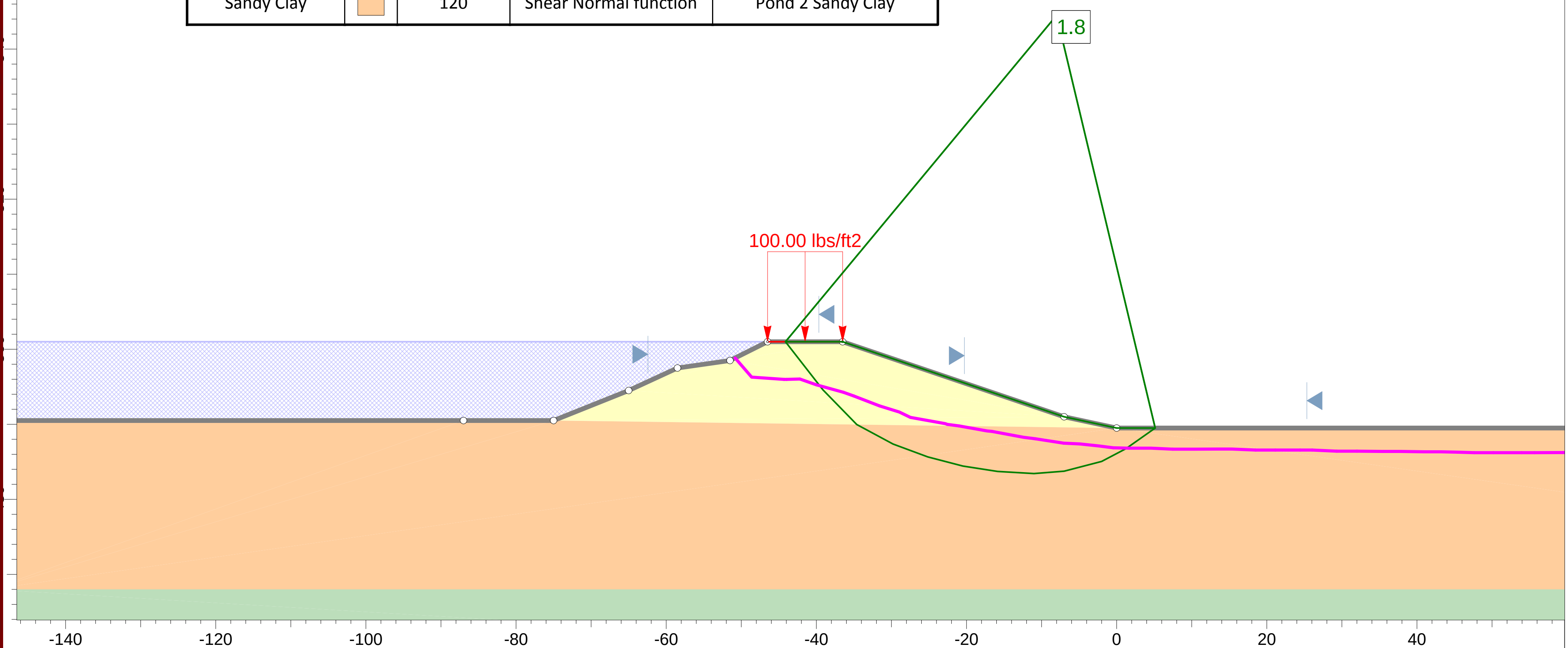
ASA12-098-00

Figure C-9b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "I"
Ash Pond Berms - Calaveras Lake Power Plant

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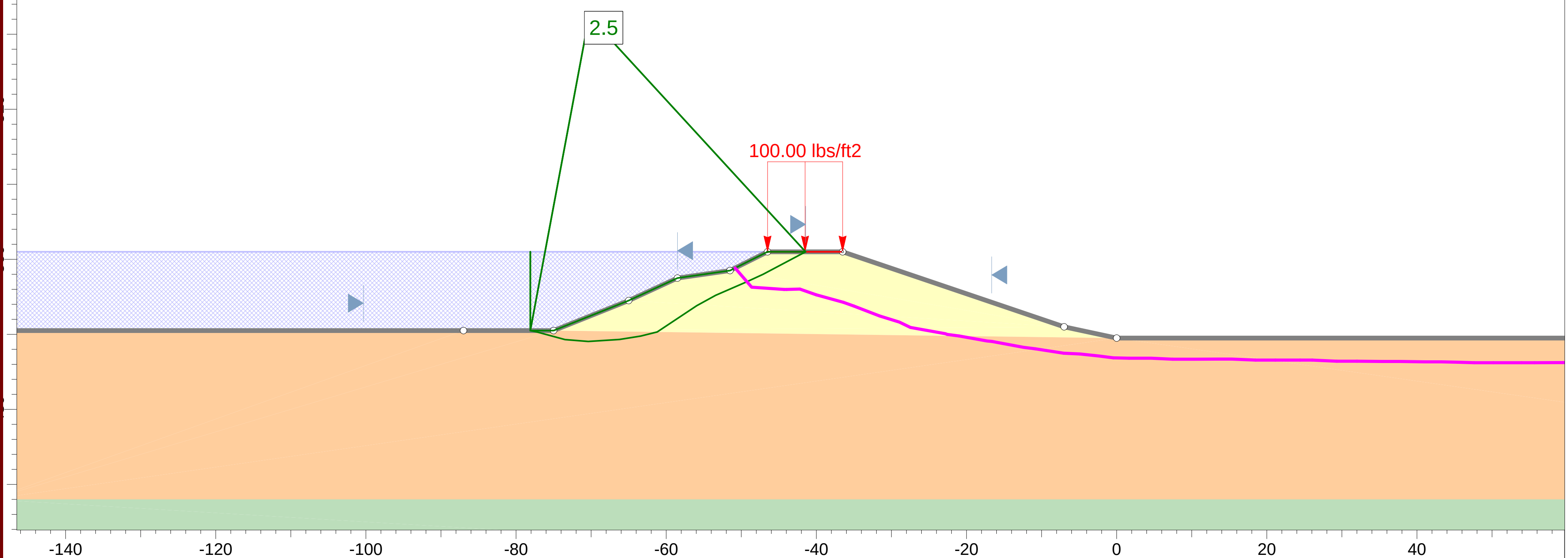
ASA12-098-00

Figure C-10a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "I"
Ash Pond Berms - Calaveras Lake Power Plant

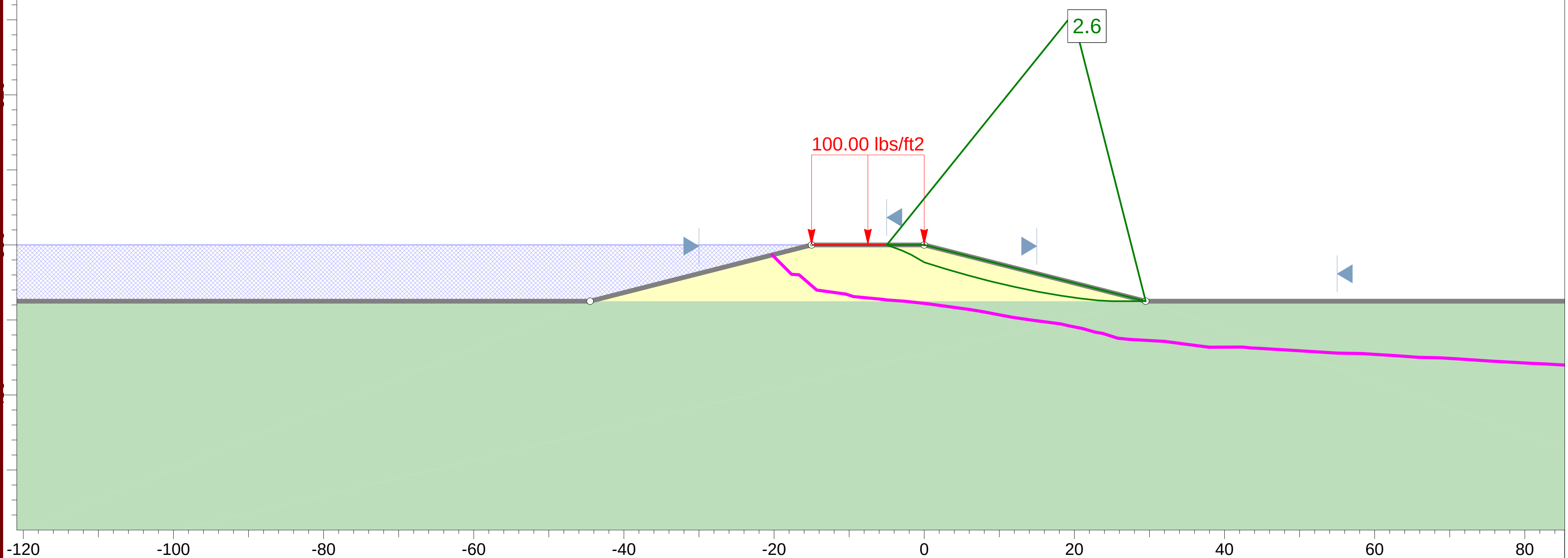
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-10b

RABA KISTNER CONSULTANTS

Global Stability Analysis

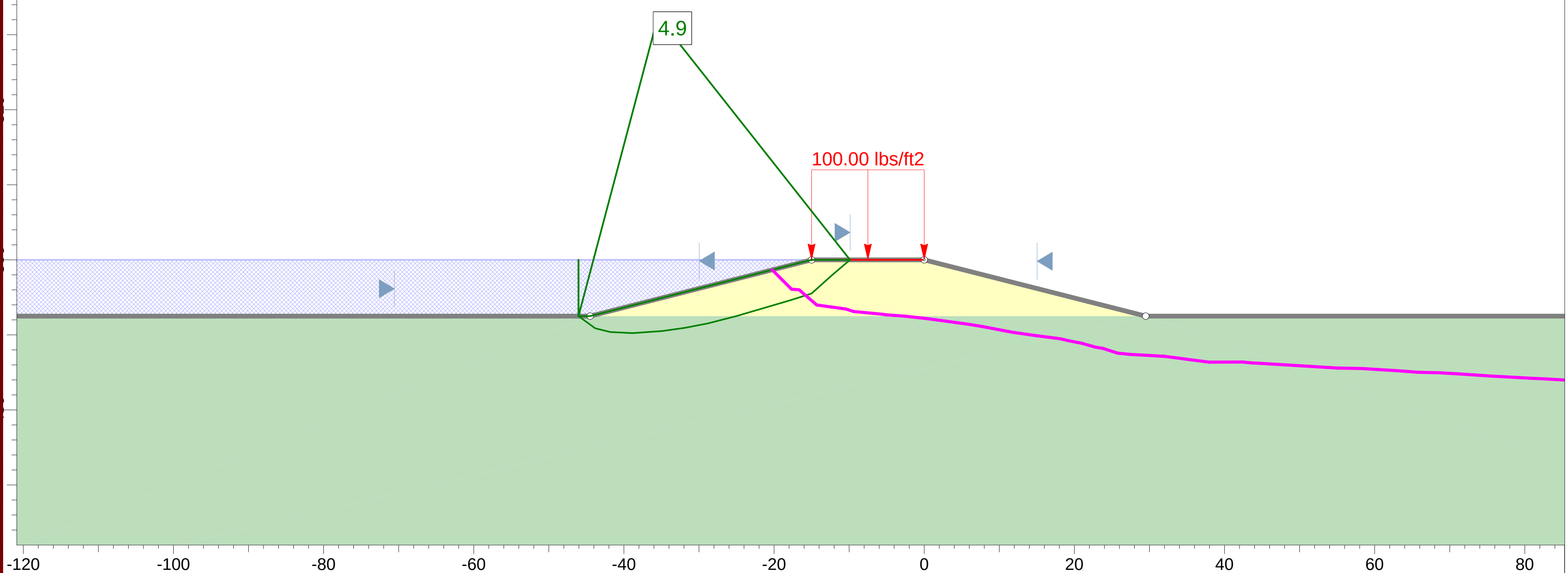
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand



Profile "J" Ash Pond Berms - Calaveras Lake Power Plant	Raba Kistner Consultants, Inc. ASA12-098-00	Figure C-11a RABA KISTNER CONSULTANTS

Global Stability Analysis

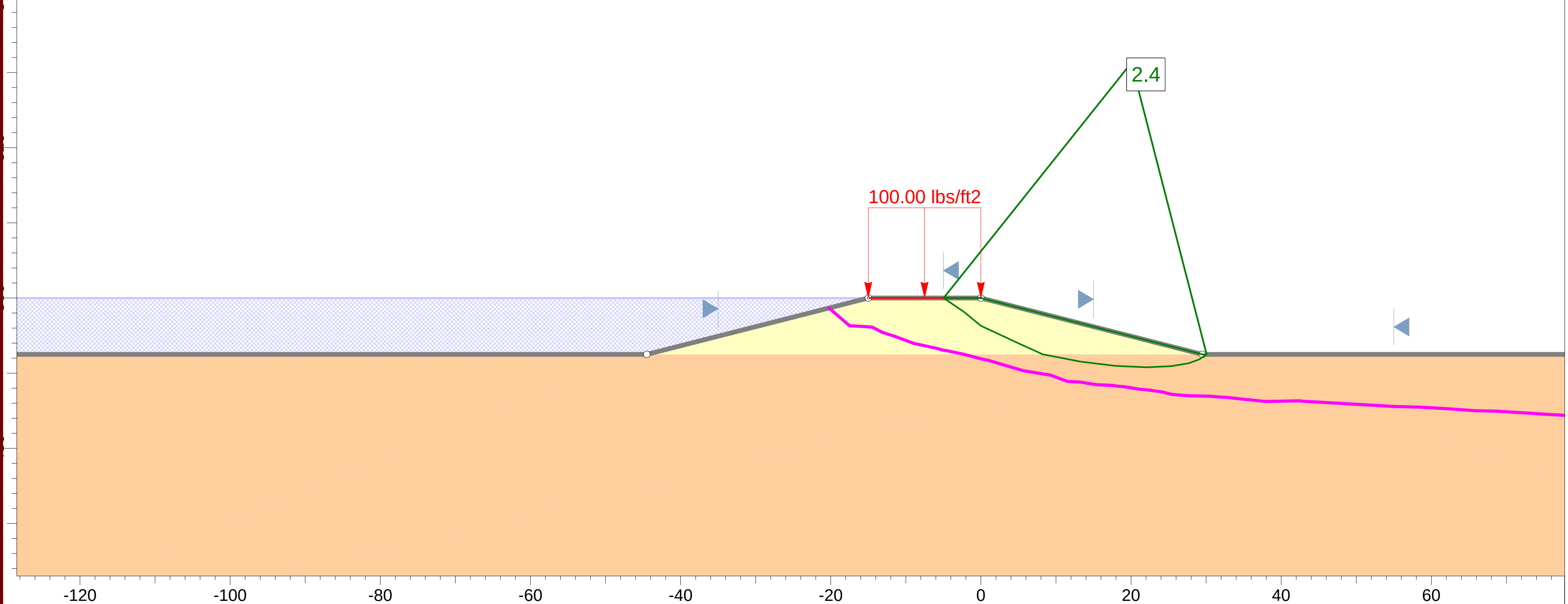
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill	(yellow)	120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand	(green)	120	Shear Normal function	Pond 1 Clayey Sand



Profile "J" Ash Pond Berms - Calaveras Lake Power Plant	Raba Kistner Consultants, Inc. ASA12-098-00	Figure C-11b RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



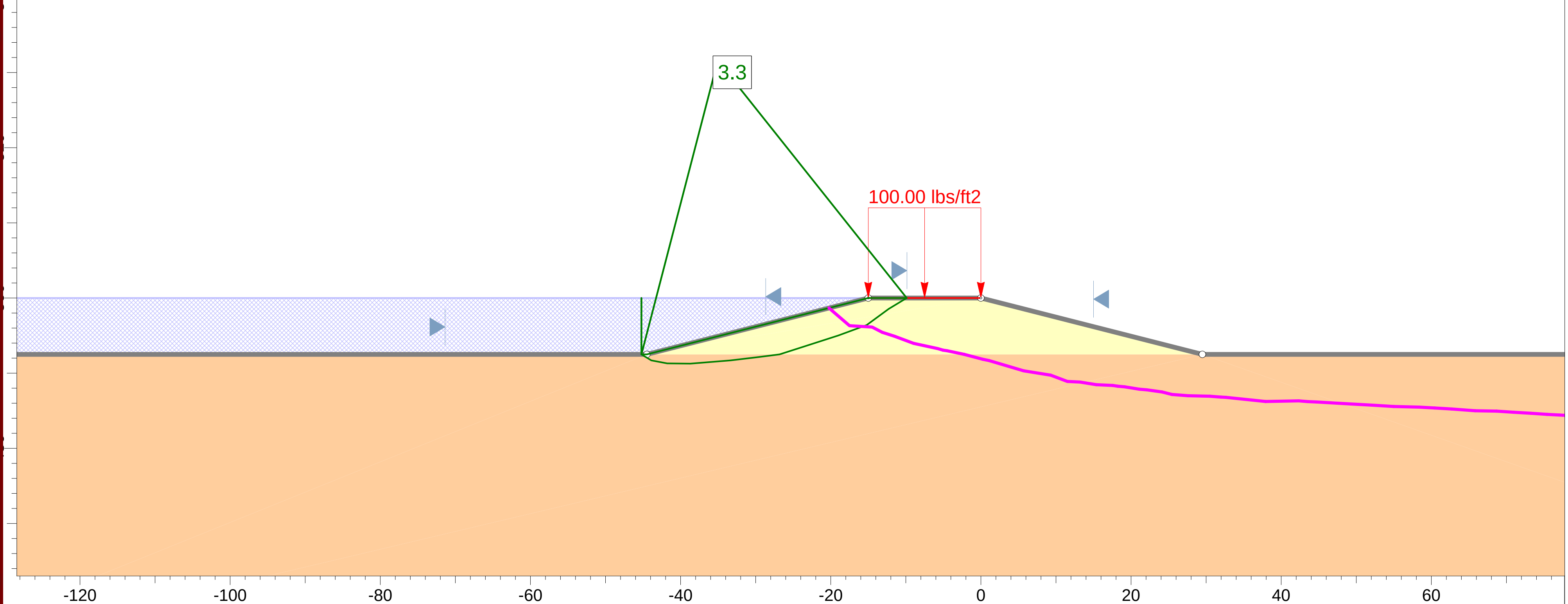
Profile "K"
Ash Pond Berms - Calaveras Lake Power Plant

Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-12a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "K"
Ash Pond Berms - Calaveras Lake Power Plant

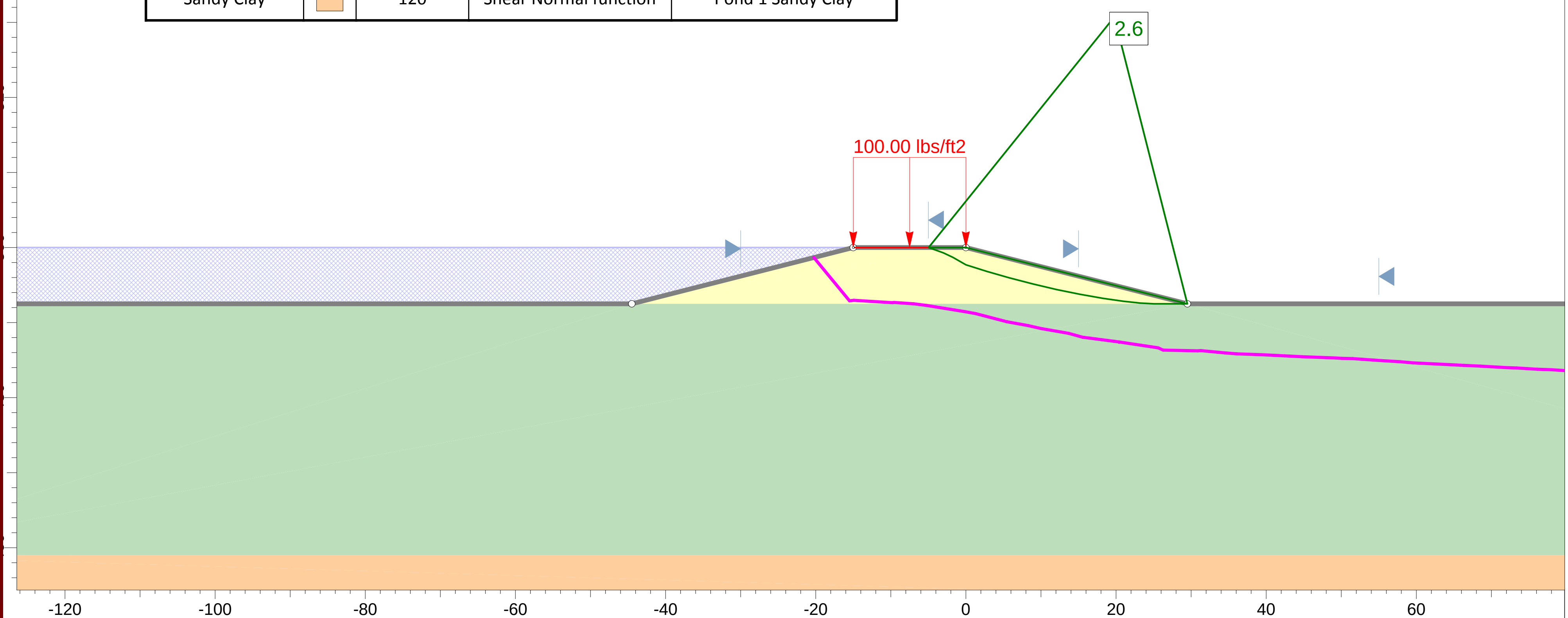
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-12b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "L"
Ash Pond Berms - Calaveras Lake Power Plant

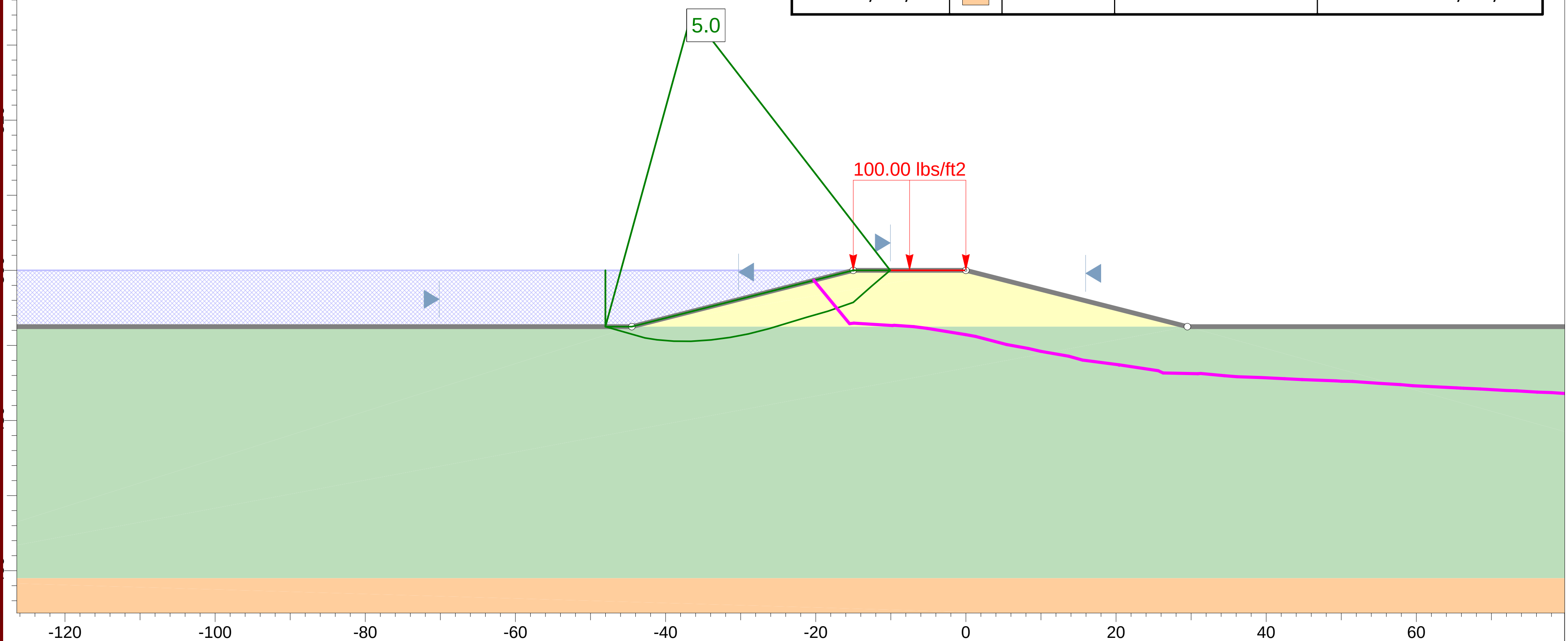
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-13a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "L"
Ash Pond Berms - Calaveras Lake Power Plant

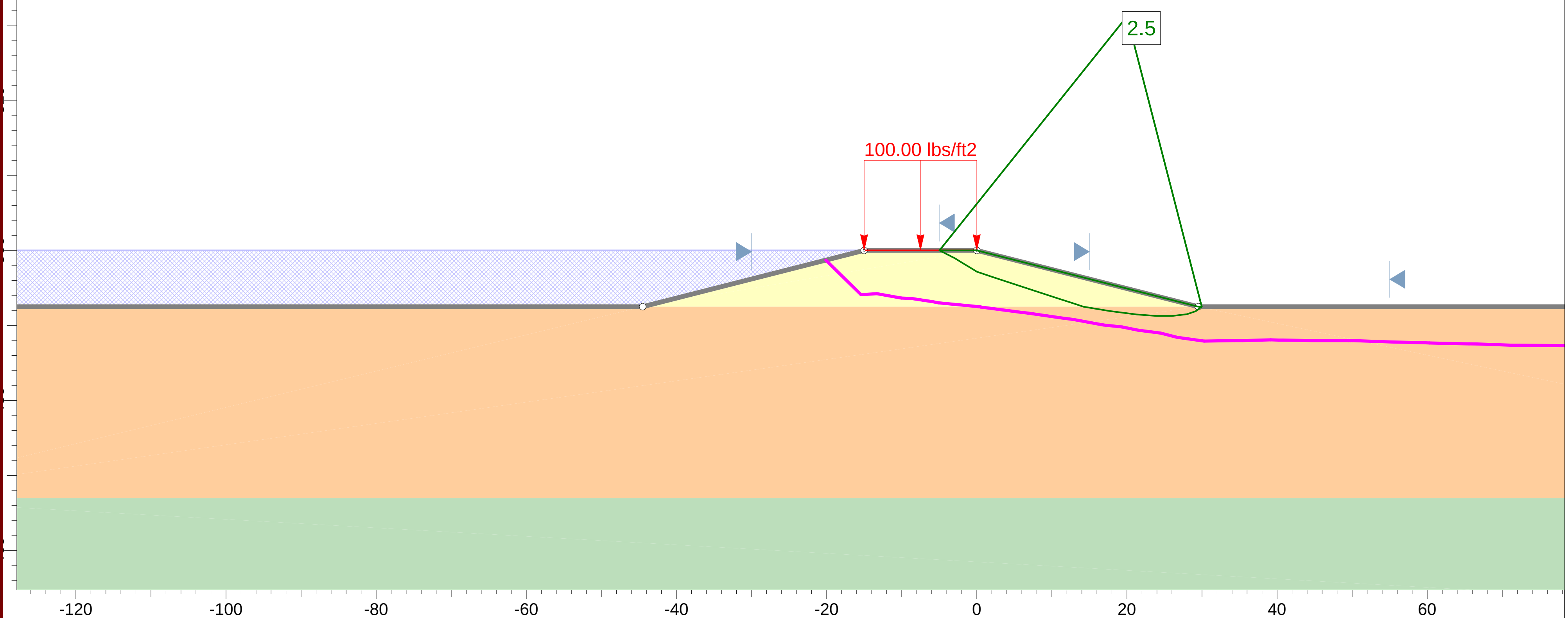
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-13b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "M"
Ash Pond Berms - Calaveras Lake Power Plant

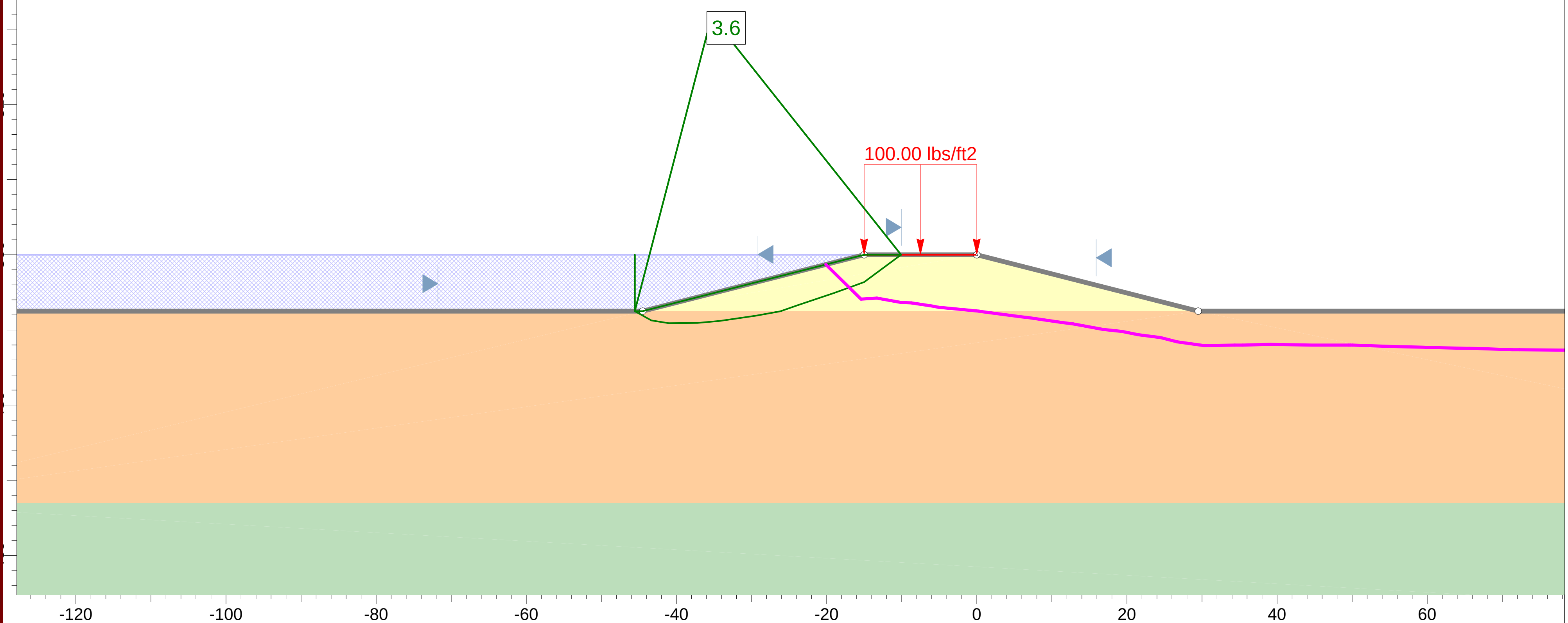
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-14a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "M"
Ash Pond Berms - Calaveras Lake Power Plant

Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-14b

RABA KISTNER CONSULTANTS

RABA KISTNER

GEOTECHNICAL ENGINEERING STUDY

FOR

ASH POND BERMS - SPRUCE/DEELY GENERATION UNITS
SAN ANTONIO, TEXAS

RABA KISTNER CONSULTANTS

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TBPE Firm F-3257

Project No. ASA12-098-00
November 20, 2012

Mr. Eric R. Olson
CPS Energy
c/o Mr. Steven Dean, P.E.
Pape-Dawson Engineers, Inc.
555 East Ramsey
San Antonio, Texas 78216

RE: Geotechnical Engineering Study
Ash Pond Berms – Spruce/Deely Generation Units
San Antonio, Texas

Dear Mr. Dean:

Raba Kistner Consultants Inc. (RKCI) is pleased to submit the report of our Geotechnical Engineering Study for the above-referenced project. This study was performed in accordance with **RKCI** Proposal No. PSA12-168-00 (3rd Revision), dated October 4, 2012. The purpose of this study was to drill borings within the existing ash pond berms, to perform laboratory testing to classify and characterize subsurface conditions, and to prepare an engineering report presenting slope stability analyses for the existing berms.

We appreciate the opportunity to be of service to you on this project. Should you have any questions about the information presented in this report, or if we may be of additional assistance with value engineering or on the materials testing-quality control program during construction, please call.

Very truly yours,

RABA KISTNER CONSULTANTS, INC.

R. Blake Wright

R. Blake Wright, E.I.T.
Graduate Engineer

STATE OF TEXAS
John A. Focht, III
60313
LICENSED
PROFESSIONAL ENGINEER

John A. Focht III, P.E.
Chief Geotechnical Engineer

RBW/JAF/mem

Attachments

Copies Submitted: Above (4)

GEOTECHNICAL ENGINEERING STUDY

For

ASH POND BERMS – SPRUCE/DEELY GENERATION UNITS
SAN ANTONIO, TEXAS

Prepared for

PAPE-DAWSON ENGINEERS, INC.
San Antonio, Texas

Prepared by

RABA KISTNER CONSULTANTS, INC.
San Antonio, Texas

PROJECT NO. ASA12-098-00

November 20, 2012

RABAKISTNER

TABLE OF CONTENTS

TABLE OF CONTENTS

ATTACHMENTS

INTRODUCTION

Raba Kistner Consultants Inc. (RKCI) has completed the authorized subsurface exploration and slope stability analyses for the existing ash pond berms at the Spruce/Deely Generation Units in San Antonio, Texas. This report briefly describes the procedures utilized during this study and presents our findings along with our recommendations for maintaining the existing ash pond berms.

PROJECT DESCRIPTION

The structures being considered in this study include the existing ash pond berms located at the Spruce/Deely Generation Units , which is operated by CPS Energy. Specifically, three ponds were studied and are denoted on the Boring Location Map, Figure 1. Our understanding of the slope profile at each berm, as well as the existing site topography, is based on several drawings provided to us on September 14, and November 1, 2012, by Mr. Steven Dean, P.E., with Pape-Dawson Engineers, Inc.

RISK

The geotechnical engineering recommendations contained in this memorandum are intended to provide Pape-Dawson Engineers, Inc; CPS Energy; and the U.S. Environmental Protection Agency with information pertaining to the stability of the existing ash pond berms at the Spruce/Deely Generation Units .

The geotechnical properties of the soils encountered in this study involve variability. This variability includes some spatial variability; however, the spatial variability appears to occur over relatively short distances. It is important to note that berms differ from other types of structures, such as drilled piers or driven piles, in that the performance of the berm involves local, not average, soil conditions.[1] The selection of analysis parameters for this project was based on a review of the available geotechnical data, our knowledge of the project area, and design calculations using select surveyed geometries. The results of our analyses were then reviewed with respect to important trends and general concepts, keeping these conditions and limitations in mind. Our conceptual recommendations are based on a conservative approach as is warranted for all slope stability analyses. We believe that the combination of observed conditions and probable failure modes justifies this approach.

LIMITATIONS

This engineering report has been prepared in accordance with accepted Geotechnical Engineering practices in the region of south/central Texas and for the use of Pape-Dawson Engineers, Inc. (CLIENT) and its representatives for design purposes. This report may not contain sufficient information for purposes of other parties or other uses. This report is not intended for use in determining construction means and methods.

The recommendations submitted in this report are based on the data obtained from 14 borings drilled at this site and our understanding of the project information provided to us. If the project information

[1] Focht, J.A. Jr. and Focht, J.A. III, "Factor of Safety and Reliability in Geotechnical Engineering, Discussion and Closure", ASCE JGGE Vol. 127 No. 8, pp.700-721, August 2001.

described in this report is incorrect, is altered, or if new information is available, we should be retained to review and modify our recommendations.

This report may not reflect the actual variations of the subsurface conditions across the site. However, it is important to note that a significant portion of the apparent site variability is due to variation in the proportions of sand and clay in the native soils. These variations cause the soil classification to change between borings, while our experience indicates the behavior of these soils varies within a relatively narrow range.

The scope of our Geotechnical Engineering Study does not include an environmental assessment of the air, soil, rock, or water conditions either on or adjacent to the site. No environmental opinions are presented in this report.

BORINGS AND LABORATORY TESTS

Subsurface conditions at the site were evaluated by 14 borings drilled at the locations shown on the Boring Location Map, Figure A-1. These locations are approximate and distances were measured using a recreational-grade, hand-held GPS locator; tape; angles; pacing; etc. Ground surface elevations were estimated from the topography depicted on the above-referenced drawings provided by Mr. Dean. The estimated ground surface elevation at each of the boring locations is listed in the table below as well as the approximate bottom elevation of each boring.

Boring No.	Ground Surface Elevation (ft, MSL)	Boring Bottom Elevation (ft, MSL)
B-1	522	472
B-2	523	473
B-3	522	472
B-4	523	473
B-5	501	461
B-6	500	460
B-7	500	470
B-8	501	461
B-9	499	469
B-10	496	456
B-11	496	466
B-12	500	470
B-13	496	456
B-14	501	461

The borings were drilled using a truck-mounted drilling rig. During drilling operations, the following samples were collected:

Type of Sample	Number Collected
Split-Spoon (with Standard Penetration Test)	126
Undisturbed Shelby Tube	28

Each sample was visually classified in the laboratory by a member of our Geotechnical Engineering staff. The geotechnical engineering properties of the strata were evaluated by the following tests:

Type of Test	Number Conducted
Natural Moisture Content	151
Atterberg Limits	29
Percent Passing a No. 200 Sieve	33
Direct Shear	2
Consolidated-Undrained ($\overline{CU}$) Triaxial	10
Unconfined Compression	17
Dry Unit Weight	17

With the exception of the $\overline{CU}$ triaxial and direct shear tests, the results of the field and laboratory tests are presented in graphical or numerical form on the boring logs illustrated on Figures A-2 through A-15. A key to classification terms and symbols used on the logs is presented on Figure A-16. The results of the laboratory and field testing are also tabulated on Figure B-1 for ease of reference.

Standard penetration test results are noted as “blows per ft” on the boring logs and Figure B-1, where “blows per ft” refers to the number of blows by a falling hammer required for 1 ft of penetration into the soil/weak rock. Where hard or dense materials were encountered, the tests were terminated at 50 blows even if one foot of penetration had not been achieved. When all 50 blows fall within the first 6 in. (seating blows), refusal “ref” for 6 in. or less will be noted on the boring logs and on Figure B-1.

Samples will be retained in our laboratory for 30 days after submittal of this report. Other arrangements may be provided at the request of the Client.

pH TESTING

Seepage from the ash ponds would most likely result in an increase pH in the embankment soils. As a part of our laboratory study, we evaluated the collected soil samples using a phenolphthalein solution. We customarily screen for pH in order to prevent chemical burns to our laboratory staff, who typically work with the samples bare-handed.

No reaction to the phenolphthalein solution was noted in any of the samples tested. This would indicate that all samples tested had a pH value of less than 8.

$\overline{CU}$ TESTS

Multi-stage $\overline{CU}$ tests were used to measure both total and effective soil strength parameters of harvested samples from the project site. During $\overline{CU}$ testing, each stage was subjected to a range of effective consolidation pressure.

The following table presents the results of our multi-stage $\overline{CU}$ tests:

Boring No.	Depth (ft)*	Effective		Total		Stress Path	
		Friction Angle, ϕ' (degrees)	Cohesion, c' (psf)	Friction Angle, ϕ (degrees)	Cohesion, c' (psf)	Friction Angle, ϕ (degrees)	Cohesion, c' (psf)
B-2	13-15	18.6	1,350	20.2	1,390	19.1	1,310
B-3	18-20	21.7	1,130	22.7	1,220	25.9	1,060
B-5	8-10	28.0	730	30.0	1,020	29.5	720
B-7	8-10	28.3	2,040	-	-	36.2	560
B-9	8-10	33.6	0.0	38.6	0.0	24.0	1,070
B-12	8-10	27.2	1,160	34.9	1,090	31.3	860

*Depth below the top of berm surface elevation existing at the time of our field study.

DIRECT SHEAR TESTS

Direct shear tests were performed on two samples collected during drilling operations. The results of these tests are presented in the table below:

Boring No.	Depth (ft)	Apparent Cohesion (psf)	Phi (degrees)
B-3	28.5 - 30	62	27
B-5	38.5 – 40	72	34

GENERAL SITE CONDITIONS

SITE DESCRIPTION

The project site is a tract of developed land located at the Spruce/Deely Generation Units , which is operated by CPS Energy. The ash ponds considered in this study are located east and northeast of the existing main power plant facility. The entire facility is bounded to the west, south, and east by Calaveras Lake. The topography generally slopes downward toward Calaveras Lake. CPS maintains the level at a target pool elevation of Elevation 485 feet with periodic fluctuations of plus or minus one foot. Levels above the target pool elevation are usually due to rainfall in the Calaveras Creek, Hondo Creek and Chupaderas Creek watersheds, and typically return to the target pool elevation within a few days of the rain event.

GEOLOGY

A review of the *Geologic Atlas of Texas, San Antonio Sheet*, indicates that this site is naturally underlain with the soils/rocks of the Wilcox Group, which is composed of mudstone with varying amounts of sandstone and lignite. The Wilcox Group may weather to yellowish-brown clay, sandy clay, clayey sands, and sands.

The Wilcox Group grades downward into the Midway Group, which is composed of clay, silt, and sand, with some pebbles near its base. Glauconite is often encountered in these soils. Key engineering considerations for development supported on the soils/rock of this formation typically include the presence of possible water-bearing layers, very hard mudstone/sandstone layers, and the expansive nature of the highly plasticity clays that can be present in this formation.

STRATIGRAPHY

The subsurface stratigraphy at this site varies from pond to pond, and berm to berm. However, the embankment fill soils typically consist of sandy clay or clayey sand. It is difficult to distinguish between these two soil types in the berms because the percent passing a No. 200 sieve ranges within about 10 percentage points higher and lower than 50%. The subgrade stratigraphy is also generally composed of interbedded sandy clay and clayey sand. There were also isolated tan and gray clay seams encountered in our borings. Each stratum has been designated by grouping soils that possess similar physical and engineering characteristics. The boring logs should be consulted for more specific stratigraphic information. The lines designating the interfaces between strata on the boring logs represent approximate boundaries. Transitions between strata may be gradual, which vary within a relatively narrow combined range of Plasticity Index and -200 values.

GROUNDWATER

The depth to groundwater was measured in all borings except Boring B-1. The groundwater level in Boring B-1 could not be measured due to the introduction of drilling fluids in this boring.

Upon completion of the drilling operations, groundwater levels ranged from 11 to 17 ft below the existing ground surface in the borings drilled for Ponds 1 and 2. Groundwater levels ranged from 40 to 42 ft below the existing ground surface in the borings drilled for Pond 3 (with the exception of Boring B-1).

As mentioned previously, this site is bounded to the west, south, and east by Calaveras Lake. The groundwater levels encountered at this site are most likely dominated by the surface water elevation of Calaveras Lake. Fluctuations in groundwater levels are possible due to variations in rainfall and surface water run-off.

EARTHEN BERMS

DESIGN CONSIDERATIONS

The existing berms should meet three important criteria: they should be resistant to the forces of erosion, should exhibit a suitable slope stability design allowable factor of safety with respect to long-term, short-term, and sudden drawdown conditions, as well as performance type scenarios such as underseepage. The levee structure must meet these criteria so that the calculated risk of failure is consistent with criteria established by the USACE guidelines.

Probable failure modes

Our review of the site and expected conditions for the Calaveras Power Plant ash ponds indicates that the following major modes of failure could affect the berms:

- Slope stability
- Underseepage
- Embankment Seepage

The following sections address each of these failure modes, as well as slope erosion and liquefaction.

Slope Stability Based on our review of available data and our visual observations during drilling, the existing embankments exhibit slopes ranging from about 3:1 (horizontal:vertical) or flatter, while a few limited areas exhibit slopes of about 2.5:1.

In general, slopes flatter than 3:1 would be expected to exhibit the required factors of safety for a normal (non-flood) seepage condition with the area water table near Elevation 485 feet.

Underseepage We generally consider underseepage to be a very low risk for the existing berms. Underseepage consists of water flowing beneath the embankment as a result of water seeping out of the ash ponds. The principal failure mechanism related to underseepage occurs when the upward force of the water equals or exceeds the buoyant weight of the soil. This does not appear likely to occur at this project site.

Berm Seepage Embankment seepage consists of water flowing through the berm as a result of seepage through the berm. The principal failure mechanism related to embankment seepage occurs when the horizontal force of the water equals or exceeds the effective shear strength of the soil. This mode of failure is not expected to occur at this project site.

Slope Erosion The existing embankments are generally composed of cohesive soils, while the underlying soils are generally composed of cohesive soils with layers semi-cohesive soils. It appears that the existing embankments were constructed using the soils available at the project site. These materials are generally considered acceptable to good materials to use when constructing levees, dams and slopes. In addition, the berms are not expected to be exposed to flowing water, other than rain that falls on the berm crest and berm slopes. The risk of berm failure due to erosion is considered to be very low.

Liquefaction Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded, and fine-grained sands. Empirical evidence indicates that loose silty sands are also potentially liquefiable. When seismic ground shaking occurs, the soil is subjected to cyclic shear stresses that can cause excess hydrostatic pressures to develop. If excess hydrostatic pressures reach the effective confining stress from the overlying soil, the sand may undergo deformations. If the sand undergoes virtually unlimited deformation without developing significant resistance, it is said to have liquefied, and if the sand consolidates or vents to the surface during and following liquefaction, ground settlement may occur.

The soils contain significant quantities of clay, and are relatively dense. Even when groundwater is present, the berms have a very low potential for liquefaction during earthquake events, particularly since the USGS online resources indicate there is less than 0.1 percent chance of experiencing a magnitude 5.0 or greater earthquake at this site during a 50 year period. In addition, calculations performed using the Seed and Idriss method indicate the most susceptible tested sample must experience a ground acceleration in excess of 0.44g before liquefaction will occur. Based on these findings, RKCI believes the soils beneath the existing berms have a very low risk of experiencing liquefaction due to an earthquake.

SLOPE STABILITY

This section presents our slope stability analyses performed for this study. In general, the procedures described in USACE EM 1110-2-1902 *Slope Stability* were followed. As such, our analysis focused on embankment stability, settlement, interior drainage, and slope protection.

The slope configurations analyzed, method of analysis, loading conditions, and soil properties used in the analyses are discussed in the following paragraphs.

Minimum Factor of Safety

For a given slope configuration, the forces that “drive” slope failure (including gravity, groundwater seepage pressure, and possible excess pore water pressures from external loading conditions) are compared to the slope’s resistance to failure, which is a function of dewatering controls and internal shear strength (cohesion and internal angle of friction) of both the foundation soils and the fill soils utilized for construction of the embankment.

The USACE has specified minimum safety factors against slope failure with respect to loading conditions. The minimum acceptable factors of safety for levees at end of construction, rapid drawdown, and steady state conditions, provided in Table 3-1 on Page 3-2 of EM 1110-2-1902, are listed in the following table. The minimum safety factor against slope failure during an earthquake is customarily assumed to be a calculated value greater than 1.0 where the risk of loss of life is low and the structure is not deemed critical in nature (hospitals, emergency services, etc.)

Condition	Required Factor of Safety
End of Construction	1.3
Sudden Drawdown	1.1 to 1.3
Long Term (Steady Seepage)	1.4
Earthquake	Greater than 1.0

We consider a significant slope failure to involve a volume of slope material that is large enough to substantially impair the serviceability or operation of the berm or that could imperil human life. Shallow, sloughing slope failures that involve relatively little material or that can be repaired locally without substantially impacting the ash pond operations are considered to be minor slope failures and do not control the conclusions of our stability analyses.

Slope Configurations

At the time this technical report was prepared, field surveys drawings of the existing berms had been performed by Pape Dawson Engineers, Inc. As a part of their work, we understand that Pape Dawson spot-checked the existing berms, and only provided surveyed cross-sections where the existing condition did not closely resemble the original drawings. As such, we have provided the original design geometry for the purposes of our study for the select berms. Figure C-1 shows the profiles that were surveyed and those that are based on the design drawings.

We recognized four general soil conditions along the length of the alignment that may be considered as worst-case boundary conditions. As such, four cases were analyzed based on these boundary conditions.

Method of Analysis

The slope stability analyses for this study were conducted with the aid of a computer using the program SLIDE developed by RocScience. The SLIDE computer program randomly generates trial failure surfaces and evaluates the factor of safety for each trial surface. The program allows a large number of potential shear surfaces to be investigated to determine the critical failure surface for each of the analyzed slope configurations.

The portions of the program used in this study employed both the Morgenstern-Price and Spencer computational methods. These methods were used to make calculations of the stability of slopes where non-circular failure surfaces were permitted. In each case, the computed factor of safety is the ratio of the forces resisting movement to the driving forces. A factor of safety of 1.0 or less implies the slope is unstable, while a factor of safety greater than 1.0 implies the slope is stable.

Loading Conditions

For satisfactory performance, an earth embankment should have an acceptable factor of safety during construction and throughout its projected service lifetime. Stability analyses should include variations in stress conditions brought on by construction practices and sequencing, external loadings, and any anticipated changes in hydraulic conditions. The following paragraphs discuss each stability condition analyzed in our study.

External Loads External loads for the roadways along the levee crest have also been modeled. A traffic loading of HS20 (modeled as an equivalent uniform surcharge of 100 psf) was applied to the crest of the levee.

End of Construction The short-term (undrained) loading condition models the slope immediately following construction. For this loading condition, the pore pressures developed during construction have not had the opportunity to dissipate. We did not analyze this condition since the berms have been in place for many years.

Steady State Seepage The long term (drained), steady-state seepage loading condition was analyzed. This loading condition models the ash pond completely full condition and assumes that the berm soils are fully saturated and a condition of steady state seepage occurs through the embankment. For this loading condition, effective stress soil parameters were used in the analysis.

Sudden Drawdown from Design Flood Stage This condition represents the situation when the water within the pond is drained at such a rapid rate that the saturated levee soils do not have time to drain. Consequently, excess pore water pressures result in the soil. We did not model this condition since it would pose no risk of environmental contamination, because the pond must be empty for this condition to occur.

SOIL PARAMETERS

Drained soil parameters (drained cohesion and drained friction angle) were selected for each soil stratum based on the laboratory and field test data collected during our study as well as correlations published by Stark and Hussain (2010)[2]. The fully softened soil strength envelopes were compared to the stress path strength envelopes developed from the $\overline{CU}$ tests performed for this study. With the possible exception of the multi-stage $\overline{CU}$ test performed on a sandy clay sample harvested from boring B-2 at 13 to 15 feet, all of the stress path strength envelopes developed from the $\overline{CU}$ tests exceeded the Stark and Hussain fully softened soil strength envelopes. We assumed that soil behavior was represented by the fully softened soil condition, and also evaluated Profile D using both the relevant fully softened soil strength envelope and the stress path strength envelope developed from the referenced $\overline{CU}$ test. We did not employ the residual strength soil properties since we found no evidence of pre-existing failure surfaces, and are unaware of any prior slope failures in the berm slopes. For

[2] Stark, T.D. and M. Hussain, "Shear Strength in Pre-existing Landslides," *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE, 136(7), July, 2010, pp. 957-962.

purposes of our slope stability analyses, we have assigned the material properties presented in the following table.

Drained Fully Softened Shear Stresses from Equations Developed by Stark and Hussain (2010)

Pond 1	Clay Fraction %	Assumed Liquid Limit	Normal Stress, psf			
			0	1,044	2,089	8,354
Embankment Soil (CL)	47	42	0	647	1,158	4,075
Sandy Clay (CL)	52	52	0	561	972	3,281
Clayey Sand (ML)	36	33	0	669	1,197	4,240

Pond 2	Clay Fraction %	Assumed Liquid Limit	Normal Stress, psf			
			0	1,044	2,089	8,354
Embankment Soil (CL)	45	35	0	664	1,188	4,202
Sandy Clay (CL)	61	51	0	563	976	3,298
Clayey Sand (ML)	43	33	0	669	1,197	4,240

Pond 3	Clay Fraction %	Assumed Liquid Limit	Normal Stress, psf			
			0	1,044	2,089	8,354
Embankment Soil (CL)	45	45	0	640	1,145	4,023
Sandy Clay (CL)	50	54	0	557	963	3,247
Clayey Sand (ML)	34	55	0	618	1,105	3,859

Results of Analyses

The following table contains a summary of the results from our slope stability analyses for each loading condition and slope configuration. In general, the point where a potential slide surface was permitted to intersect was not allowed to occur within 3 ft of the relevant top of slope. This limitation was intended to reduce the occurrence of "non-critical" failure surfaces from resulting from the analyses. A graphical presentation of the most critical failure surface from our SLIDE iterations for each berm profile studied can be found at the end of this memorandum in Appendix C. The "a" series figures show the critical failure surface on the "dry side" of each berm, while the "b" series figures show the critical failure surface on the "pond side" of each berm.

Computed Factors of Safety for Pond 1					
Slope Profile	End of Construction	Steady State on Pond Side	Steady State on Dry Side	Sudden Drawdown – Riverside	Sudden Drawdown – Landside
J	N/A	> 2	> 2	N/A	N/A
K	N/A	> 2	> 2	N/A	N/A
L	N/A	> 2	> 2	N/A	N/A
M	N/A	> 2	> 2	N/A	N/A

Computed Factors of Safety for Pond 2					
Slope Profile	End of Construction	Steady State on Pond Side	Steady State on Dry Side	Sudden Drawdown – Riverside	Sudden Drawdown – Landside
E	N/A	> 2	> 2	N/A	N/A
F	N/A	> 2	> 2	N/A	N/A
G	N/A	> 2	1.3	N/A	N/A
H	N/A	> 2	> 2	N/A	N/A
I	N/A	> 2	1.8	N/A	N/A
N	N/A	> 2	1.6	N/A	N/A

Computed Factors of Safety for Pond 3					
Slope Profile	End of Construction	Steady State on Pond Side	Steady State on Dry Side	Sudden Drawdown – Riverside	Sudden Drawdown – Landside
A	N/A	> 2	> 2	N/A	N/A
B	N/A	> 2	> 2	N/A	N/A
C	N/A	> 2	1.5	N/A	N/A
D	N/A	> 2	1.9	N/A	N/A

Profile D was also analyzed using the stress path strength envelope (cohesion intercept of 1,310 psf and angle of internal friction of 19.1°) developed from of the multi-stage $\overline{CU}$ test performed on a sandy clay sample harvested from boring B-2 at 13 to 15 feet. This analysis resulted in a calculated factor of safety of 2.0, while the Stark and Hussain fully softened soil strength envelope resulted in a calculated factor of safety of 1.9. Both failure surfaces were relatively thin, and would not be considered to pose a risk to the pond's overall stability.

SEEPAGE ANALYSIS

We performed steady-state seepage analyses for each slope profile using the finite element groundwater module within SLIDE. Our seepage analyses were performed assuming that the soil properties observed in our borings exhibited a 5:1 ratio of permeability (horizontal:vertical) with the assumed permeability values presented in the following table.

Soil	Assumed Permeability, cm/second	
	Horizontal	Vertical
Clay	$1x10^{-7}$	$2x10^{-8}$
Sandy Clay	$1x10^{-6}$	$2x10^{-7}$
Clayey Sand	$1x10^{-4}$	$2x10^{-5}$

EARTHQUAKE ANALYSES

Each berm profile was also evaluated for earthquake conditions utilizing a design spectral acceleration of 0.098g. The assumed seismic force was calculated using the USGS web site calculator; in general, these analyses are considered to be very conservative since the nearest documented active fault is roughly 385 miles from the project site. A probabilistic assessment of the likelihood of the project site experiencing a magnitude 5 or larger earthquake within a 50 year period was also performed. This assessment indicated that the probability of occurrence was only 4 to 6 percent, which is considerably less than the 10 percent required by USEPA regulations. Graphical representations of these analyses are presented in Appendix D. The “a” series figures show the critical failure surface on the “dry side” of each berm, while the “b” series figures show the critical failure surface on the “pond side” of each berm.

Quasi-static analyses were performed, with soil behavior modeled using total stress soil strength values. The assumed values of shear strength used in our models consisted of both a cohesion intercept and angle of internal friction, with the cohesion intercept values chosen based on the unconfined compressive strength testing performed for this study as well as prior area experience. The strength values chosen are considered lower bound for the soils encountered at the project site.

The soil properties utilized for these analyses are presented in the table below:

Material	Unit Weight (pcf)	Cohesion (psf)	Phi (degrees)
Embankment Fill	120	350	20
Clayey Sand	120	400	20
Clayey Sand Below Water Table	57.6	400	20
Sandy Clay	120	500	20
Sandy Clay Below Water Table	57.6	500	20

Results of Analyses

Global stability analyses were also performed for each slope analyzed for steady state conditions. The results of our analyses are summarized below and are graphically presented in Appendix D at the end of this report.

Computed Factors of Safety for Pond 1		
Slope Profile	**Pond Side**	**Dry Side**
J	> 2	> 2
K	> 2	> 2
L	> 2	> 2
M	> 2	> 2

Computed Factors of Safety for Pond 2		
Slope Profile	**Pond Side**	**Dry Side**
E	> 2	> 2
F	> 2	> 2
G	> 2	1.9
H	> 2	> 2
I	> 2	> 2
N	> 2	> 2

Computed Factors of Safety for Pond 3		
Slope Profile	**Pond Side**	**Dry Side**
A	> 2	> 2
B	> 2	> 2

Computed Factors of Safety for Pond 3		
Slope Profile	**Pond Side**	**Dry Side**
C	> 2	> 2
D	> 2	> 2

RESULTS

In general, the global stability analyses for steady state conditions resulted in calculated factors of safety in excess of 2 for both long term and earthquake conditions. Three sections exhibited calculated factors of safety of less than 2, and one section ("G") exhibited a calculated factor of safety of 1.2 for the "dry" slope. Review of Figure C-8a revealed that the critical failure surface for this analysis was relatively thin and did not appear to threaten the ash pond reservoir. A second analysis of this section was then performed, with the top of the assumed surfaces limited to intersecting the ground surface at the top of slope of the "wet" slope or farther from the "dry" slope. Surfaces in this portion of the berm would not threaten containment of the ash pond's contents. The results of this analysis are presented on Figure C-8c, and indicate the calculated factor of safety for this analysis was 1.4.

Global stability analyses for the assumed earthquake conditions resulted in calculated factors of safety that exceeded 1.9 in all cases. These results indicate that pond failures due to seismic forces do not pose a significant threat to the ash ponds at this site.

CONCLUSIONS

The existing berms were constructed of lean sandy clays and/or clayey sands over competent sandy clays and clayey sands. Liquefaction is considered a very low risk issue at this site. The results of our seepage analyses indicate that no significant risk of an erosion or piping-type failure beneath the ash pond embankments exists. The results of our earthquake analyses indicate that that no significant risk of embankment failure due to seismic forces exists at this site. Global stability analyses of steady state conditions indicate that acceptable calculated factors of safety were obtained for reasonable failure surfaces through the embankments at this site, even though the analyses were performed using fully softened soil strength envelopes that were lower than $\overline{CU}$ tests indicate are available at the project site.

The end-of-construction condition was not evaluated due to the age of the ash ponds, and both rapid drawdown and erosion failures are considered to be of very low risk due to the embankment toe elevations (above EL 490 feet) with respect to the target pool elevation (EL 485 feet). We do not consider embankment seepage or underseepage to pose a significant risk to the berm based on both the long-term performance of the berms and the results of the seepage analyses, which was indirectly confirmed by the pH testing performed on all of the harvested soil samples. The results of our slope stability analyses indicate that all of the berm slopes meet or exceed both USEPA and USACE criteria for stability under steady state (long term) and seismic (earthquake) conditions.

* * * * * * * * * * * * * * * * * *

The following appendices are attached and complete this report:

Field Data	Appendix A
Laboratory Test Results	Appendix B
Slope Stability Analyses	Appendix C
Seismic Analyses	Appendix D

ATTACHMENTS

APPENDIX A

FIELD DATA

RABA KISTNER CONSULTANTS
Raba Kistner Consultants, Inc.
12821 West Golden Lane
San Antonio, Texas 78249
P 210 :: 699 :: 9090
F 210 :: 699 :: 6426
www.rkci.com
TBPE Firm Number 3257

SOURCE: 2011 Aerial Photograph Provided by the City of San Antonio (COSA)

BORING & MONITORING WELL LOCATION MAP

ASH POND BERMS - SPRUCE/DEELY GENERATION UNITS
SAN ANTONIO, TEXAS

REVISIONS:

No.	DATE	DESCRIPTION

PROJECT No.: ASA12-098-00

ISSUE DATE:	10/10/2012
DRAWN BY:	CCL
CHECKED BY:	RBW
REVIEWED BY:	GLB

FIGURE

A-1

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

LOG OF BORING NO. B-1

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

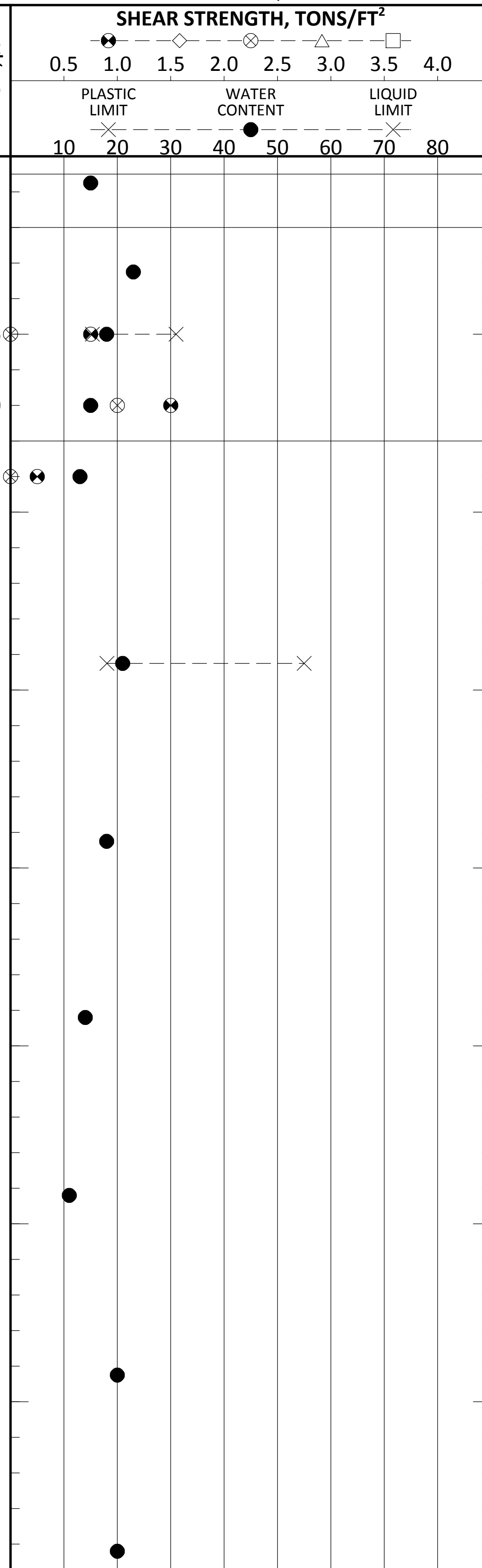
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32477; W 98.31464

SURFACE ELEVATION: 522 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	BASE MATERIAL (6 in.)				
	FILL MATERIAL: SAND, Medium Dense, Tan	11			
	FILL MATERIAL: CLAY, Sandy, Firm, Reddish-Tan, with gray mottling	7			50
5			106	16	
			110		
	SAND, Clayey, Medium Dense to Very Dense, Tan to Gray		112		40
10					
	-with a tan and gray clay seam from 13 to 15 ft	16		37	
15	-switched to mud rotary at 15 ft				
20		22			
25		50/11"			
30		50/11"			43
35		49			
		50/11"			



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	49.7 ft	**DEPTH TO WATER:**	N/A	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/15/2012	**DATE MEASURED:**	10/15/2012	**FIGURE:**	A-2a

LOG OF BORING NO. B-1

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32477; W 98.31464

SURFACE ELEVATION: 522 ft

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT	PLASTICITY INDEX	% -200
			SAND, Clayey, Medium Dense to Very Dense, Tan to Gray *(continued)*					
45		X		50/9"		● (water content ~19)		
		X		50/8"		● (water content ~19)		
50								
55								
60								
65								
70								
75								

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 49.7 ft
DATE DRILLED: 10/15/2012
DEPTH TO WATER: N/A
DATE MEASURED: 10/15/2012
PROJ. No.: ASA12-098-00
FIGURE: A-2b

LOG OF BORING NO. B-2

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

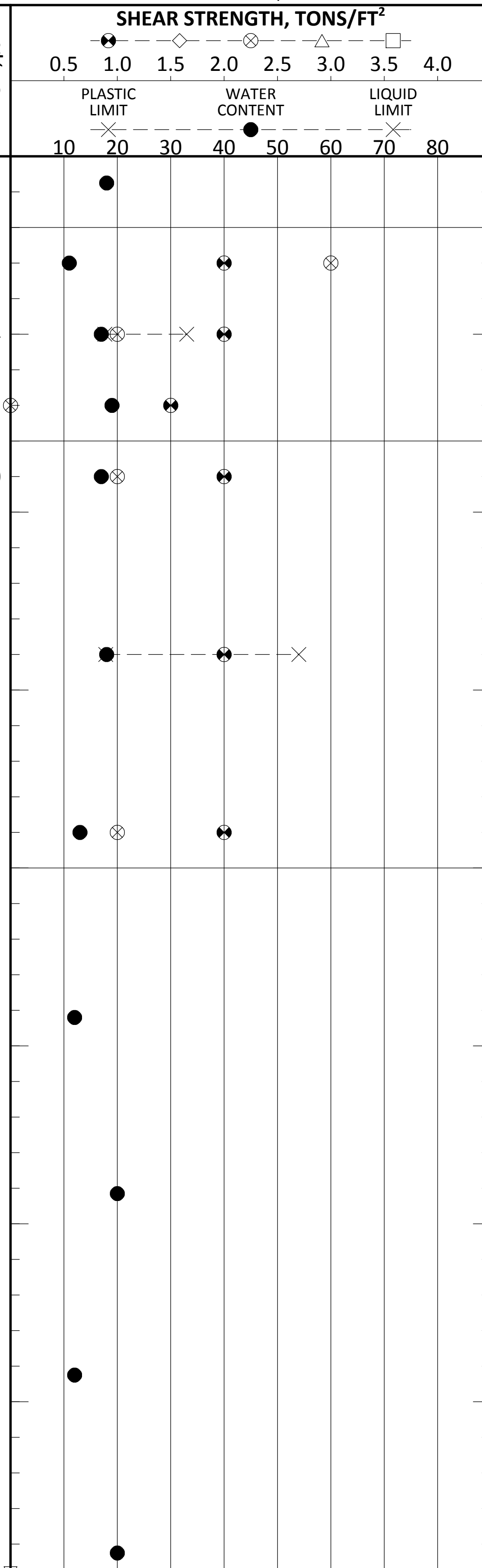
DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32378; W 98.31541

SURFACE ELEVATION: 523 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	FILL MATERIAL: CLAY, Sandy, Stiff, Brown	11			
2	FILL MATERIAL: SAND, Clayey, Brown and Tan		119		38
5			104	15	
			102		
8	CLAY, Sandy, Very Stiff, Tan and Gray		110		
10					
				36	
15					
			101		
20	SAND, Clayey, Dense to Very Dense, Gray				
		50/11"			24
25					
		50/10"			
30					
		38			
35					
		50			

SHEAR STRENGTH, TONS/FT^2



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	49.8 ft	**DEPTH TO WATER:**	40 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/16/2012	**DATE MEASURED:**	10/16/2012	**FIGURE:**	A-3a

LOG OF BORING NO. B-2

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32378; W 98.31541

SHEAR STRENGTH, TONS/FT²: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

SURFACE ELEVATION: 523 ft

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
			SAND, Clayey, Dense to Very Dense, Gray *(continued)* -DRILLER'S NOTE: WATER encountered at 40 ft				
45		X		50/8"			
50		X		50/9"			
55							
60							
65							
70							
75							

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	49.8 ft	**DEPTH TO WATER:**	40 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/16/2012	**DATE MEASURED:**	10/16/2012	**FIGURE:**	A-3b

LOG OF BORING NO. B-3

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32401; W 98.31406

SURFACE ELEVATION: 522 ft

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–2	FILL MATERIAL: SAND, Medium Dense, Brown, with gravel (road material)	24			
2–8	FILL MATERIAL: SAND, Clayey, Medium Dense, Tan	12			
5		11		19	
		19			41
8–23	CLAY, Sandy, Stiff to Very Stiff, Tan and Gray	14			
10					
15			112	30	
20					
23–40	SAND, Clayey, Dense to Very Dense, Tan to Gray	46			47
25					
30		50			
35		50/11"			
	-DRILLER'S NOTE: WATER encountered at 39 ft	50/11"			33

DEPTH DRILLED: 49.8 ft	**DEPTH TO WATER:** 40 ft	**PROJ. No.:** ASA12-098-00	
DATE DRILLED: 10/15/2012	**DATE MEASURED:** 10/15/2012	**FIGURE:** A-4a	

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-3

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32401; W 98.31406

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

SURFACE ELEVATION: 522 ft

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
			SAND, Clayey, Dense to Very Dense, Tan to Gray *(continued)*				
45		X	-with a tan and gray clay seam from 43 to 45 ft	38			
50		X		50/10"			

Depth scale: 45, 50, 55, 60, 65, 70, 75

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	49.8 ft	**DEPTH TO WATER:**	40 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/15/2012	**DATE MEASURED:**	10/15/2012	**FIGURE:**	A-4b

LOG OF BORING NO. B-4

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

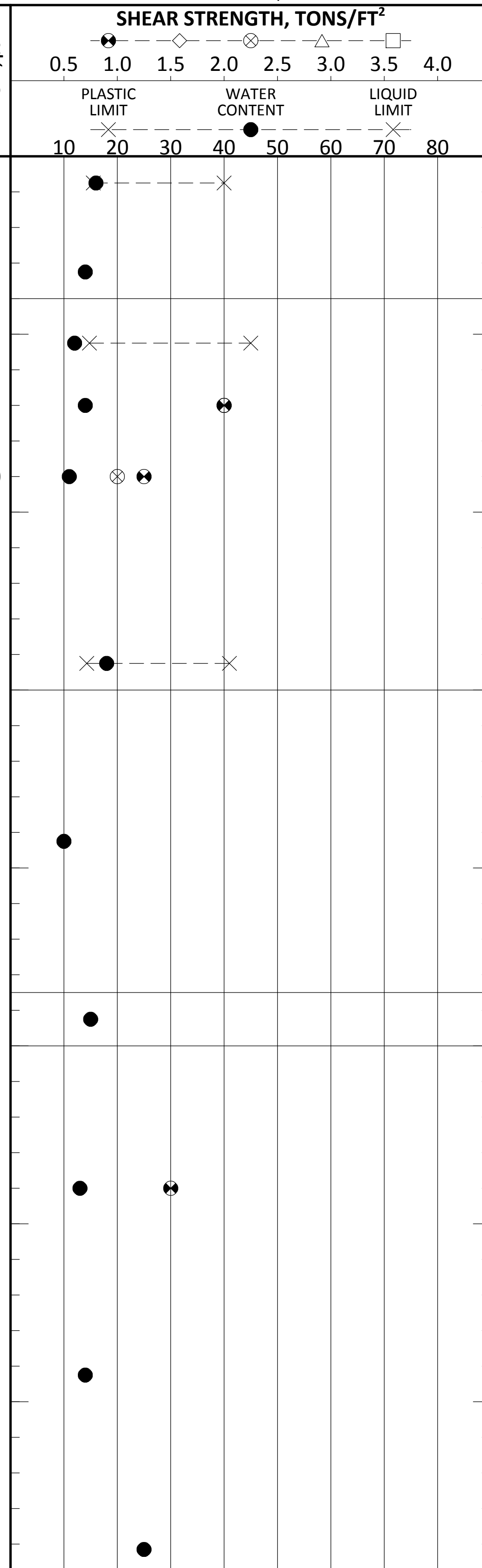
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32322; W 98.31478

SURFACE ELEVATION: 523 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	FILL MATERIAL: CLAY, Sandy, Firm, Brown	7		25	
		5			54
4	FILL MATERIAL: CLAY, Sandy, Stiff to Very Stiff, Tan and Brown	14		30	
			113		
			110		
		26		27	
15	SAND, Clayey, Dense, Brown				
		49			
23.5	CLAY, Very Stiff, Reddish-Tan	24			
25	SAND, Clayey, Dense to Very Dense, Tan and Gray, with intermittent clay seams				
			97		32
		50			
		50/10"			



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 49.8 ft
DATE DRILLED: 10/16/2012
DEPTH TO WATER: 42 ft
DATE MEASURED: 10/16/2012
PROJ. No.: ASA12-098-00
FIGURE: A-5a

LOG OF BORING NO. B-4

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger **LOCATION:** N 29.32322; W 98.31478

SURFACE ELEVATION: 523 ft

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	SAND, Clayey, Dense to Very Dense, Tan and Gray, with intermittent clay seams *(continued)*				
	-DRILLER'S NOTE: WATER encountered at 42 ft				
45		50			
50		50/9"			23
55					
60					
65					
70					
75					

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	49.8 ft	**DEPTH TO WATER:**	42 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/16/2012	**DATE MEASURED:**	10/16/2012	**FIGURE:**	A-5b

LOG OF BORING NO. B-5

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

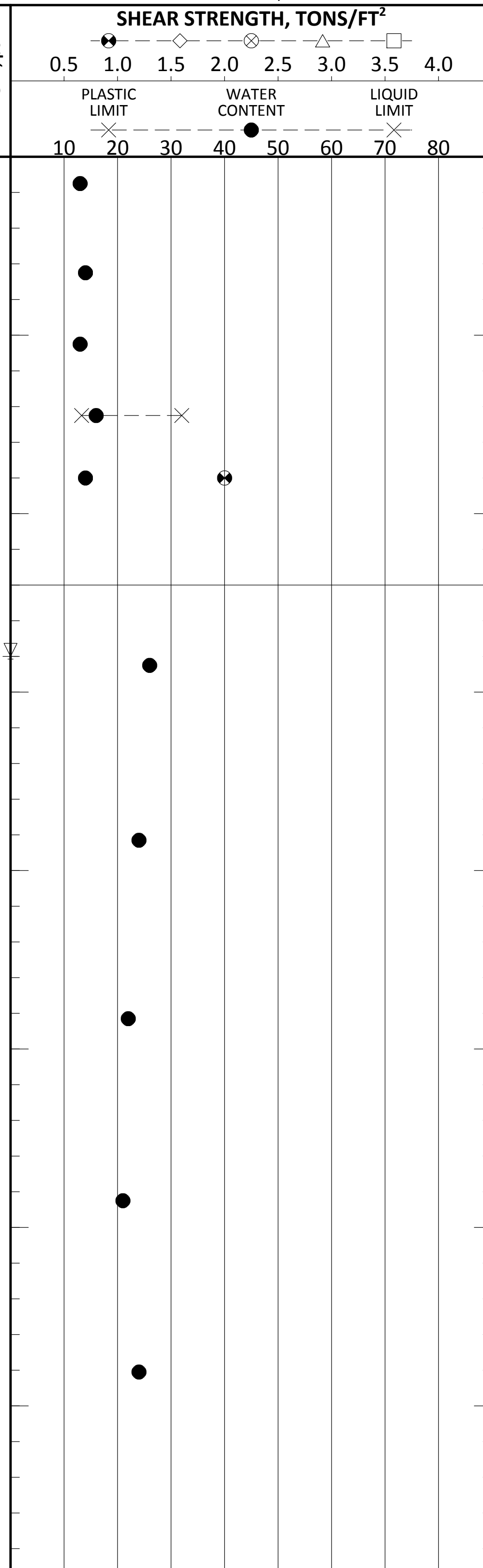
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30947; W 98.31590

SURFACE ELEVATION: 501 ft

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
FILL MATERIAL: SAND, Clayey, Medium Dense, Tan	17			
	21			
	24			
	20		19	
				46
SAND, Clayey, Medium Dense to Very Dense, Gray	33			46
	50/10"			
	50/9"			
-with a clay seam from 28-1/2 to 30 ft	24			
	50/7"			31
	50/8"			



DEPTH, FT: 5, 10, 15, 20, 25, 30, 35

DEPTH DRILLED: 39.7 ft
DATE DRILLED: 10/17/2012
DEPTH TO WATER: 14 ft
DATE MEASURED: 10/17/2012
PROJ. No.: ASA12-098-00
FIGURE: A-6

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-6

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger **LOCATION:** N 29.30837; W 98.31790

SHEAR STRENGTH, TONS/FT²: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

SURFACE ELEVATION: 500 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–10	FILL MATERIAL: CLAY, Sandy, Stiff to Very Stiff, Tan	15			
		14		15	
		24			50
		19			
		21			
10	GRAVEL, Tan				
	CLAY, Sandy, Firm to Hard, Tan and Gray				
	-DRILLER'S NOTE: WATER encountered at 14 ft	7		32	
		50/11"			51
		50/10"			
		38		18	
33	SAND, Clayey, Very Dense, Gray	50/8"			
		50/10"			29

DEPTH DRILLED:	39.8 ft	**DEPTH TO WATER:**	14 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/18/2012	**DATE MEASURED:**	10/18/2012	**FIGURE:**	A-7

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-7

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30899; W 98.31660

SURFACE ELEVATION: 500 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–2.5	FILL MATERIAL: SAND, Clayey, Medium Dense, Brown	10			
2.5–13	FILL MATERIAL: CLAY, Sandy, Very Stiff, Tan and Gray	29			
		22		19	
			115		
				17	
	-DRILLER'S NOTE: WATER encountered at 11 ft				
13–20	SAND, Clayey, Very Dense, Tan and Gray	50/9"			47
		50/11"			
20–30	CLAY, Sandy, Hard, Tan and Gray	50/9"		18	
		47			

SHEAR STRENGTH, TONS/FT²: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	30.0 ft	**DEPTH TO WATER:**	11 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/16/2012	**DATE MEASURED:**	10/16/2012	**FIGURE:**	A-8

LOG OF BORING NO. B-8

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

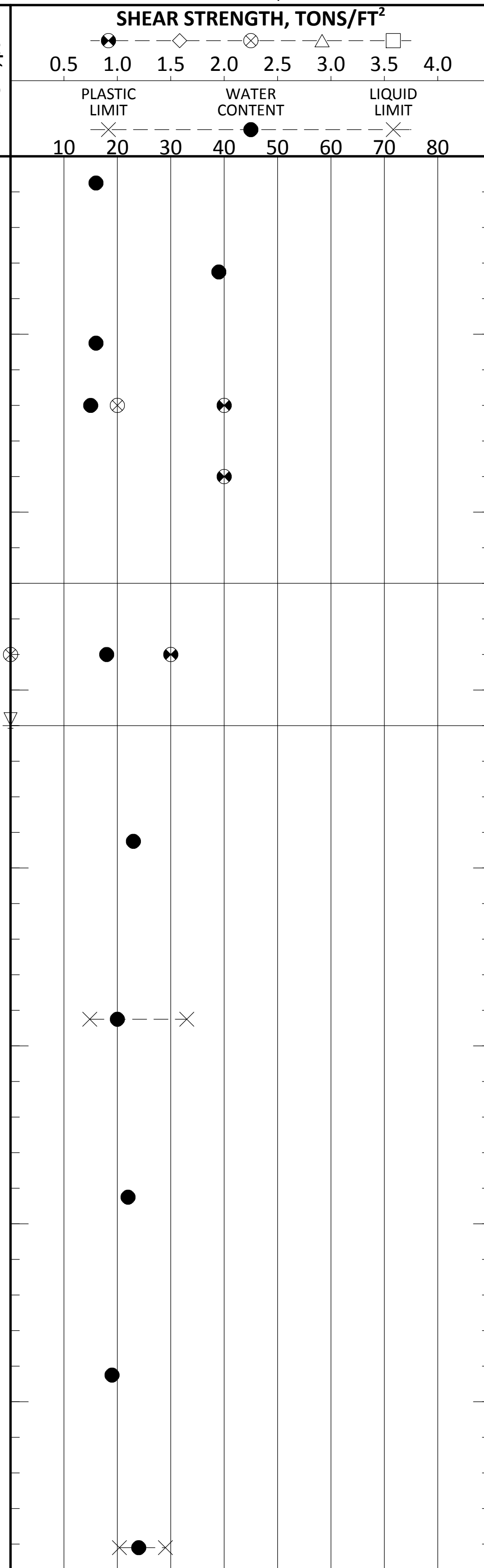
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30884; W 98.31510

SURFACE ELEVATION: 501 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–12	FILL MATERIAL: SAND, Clayey, Loose to Medium Dense, Brown and Tan	25			
		14		NP	
5		7			39
	-with a tan and gray clay seam from 6 to 8 ft		113		
12–16	CLAY, Sandy, Very Stiff, Tan and Gray		111		
16–39.7	SAND, Clayey, Medium Dense to Dense, Tan and Gray -DRILLER'S NOTE: WATER encountered at 16 ft				
20		25			47
25		10		18	
30		25			
35	-with a tan and gray clay seam from 33 to 35 ft	38			52
39.7		50/8"		9	



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	39.7 ft	**DEPTH TO WATER:**	16 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/19/2012	**DATE MEASURED:**	10/19/2012	**FIGURE:**	A-9

LOG OF BORING NO. B-9

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30802; W 98.31601

SURFACE ELEVATION: 499 ft

SHEAR STRENGTH, TONS/FT²: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–1	FILL MATERIAL: SAND, Medium Dense, Brown and Tan	11			
1–10	FILL MATERIAL: CLAY, Stiff to Very Stiff, Tan	14			
		16		21	
		11			
10–28	SAND, Clayey, Loose to Very Dense, Tan and Gray	9			49
	-DRILLER'S NOTE: WATER encountered at 16 ft				
		50/11"			
		ref/1"			
28–29.9	CLAY, Sandy, Hard, Tan and Gray	50/11"			62

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 29.9 ft	**DEPTH TO WATER:** 16 ft	**PROJ. No.:** ASA12-098-00	
DATE DRILLED: 10/17/2012	**DATE MEASURED:** 10/17/2012	**FIGURE:** A-10	

LOG OF BORING NO. B-10

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30769; W 98.31855

SURFACE ELEVATION: 496 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–11	FILL MATERIAL: CLAY, Sandy, Very Stiff, Tan	16			
		16		16	
		19			
		24			
		19		27	
11–37	SAND, Clayey, Medum Dense to Very Dense, Tan and Gray, with intermittent clay seams		97		41
	-DRILLER'S NOTE: WATER encountered at 17 ft				
		38			
		17			
		ref/1"			
		50/9"			42
37–40	CLAY, Very Stiff, Dark Gray	26			

SHEAR STRENGTH, TONS/FT²: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0
PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

DEPTH DRILLED: 40.0 ft
DATE DRILLED: 10/17/2012
DEPTH TO WATER: 17 ft
DATE MEASURED: 10/17/2012
PROJ. No.: ASA12-098-00
FIGURE: A-11

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-11

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30737; W 98.31744

SURFACE ELEVATION: 496 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–12	FILL MATERIAL: CLAY, Sandy, Stiff to Very Stiff, Tan to Brown	15		16	
		11			
	-with a tan sand seam from 4 to 6 ft	12			49
		18			
12–30	SAND, Clayey, Medium Dense to Dense, Tan and Gray, with intermittent clay seams	18			
	-DRILLER'S NOTE: WATER encountered at 16 ft				
		18			
		49			34
		42			

SHEAR STRENGTH, TONS/FT²: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 30.0 ft	**DEPTH TO WATER:** 16 ft	**PROJ. No.:** ASA12-098-00	
DATE DRILLED: 10/18/2012	**DATE MEASURED:** 10/18/2012	**FIGURE:** A-12	

LOG OF BORING NO. B-12

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

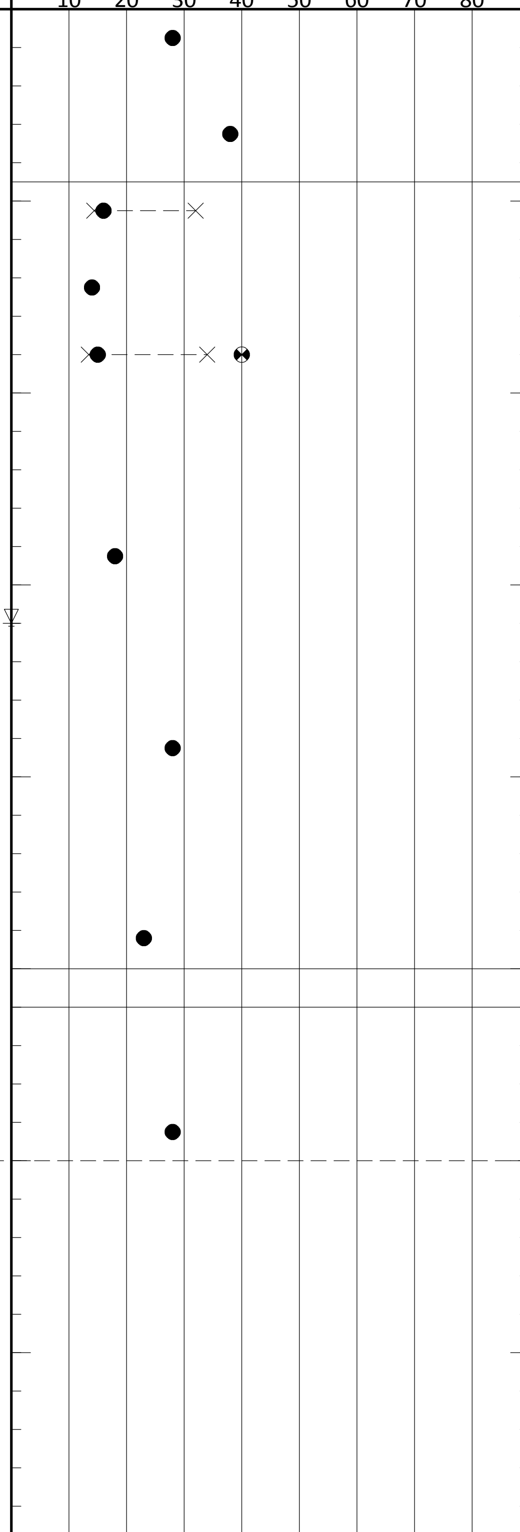
DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30757; W 98.31509

SURFACE ELEVATION: 500 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–4.5	FILL MATERIAL: SAND, Clayey, Loose to Medium Dense, Brown, with gravel	23			46
		6			
4.5–25	CLAY, Sandy, Firm to Hard, Tan to Brown	8		18	
		27			
				21	
		18			
	-DRILLER'S NOTE: WATER encountered at 16 ft				
		24			
		50/11"			51
25–26	SANDSTONE, Hard, Gray				
26–30	SAND, Clayey, Medium Dense, Tan and Gray	11			

SHEAR STRENGTH, TONS/FT^2: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0
PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	30.0 ft	**DEPTH TO WATER:**	16 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/17/2012	**DATE MEASURED:**	10/17/2012	**FIGURE:**	A-13

LOG OF BORING NO. B-13

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

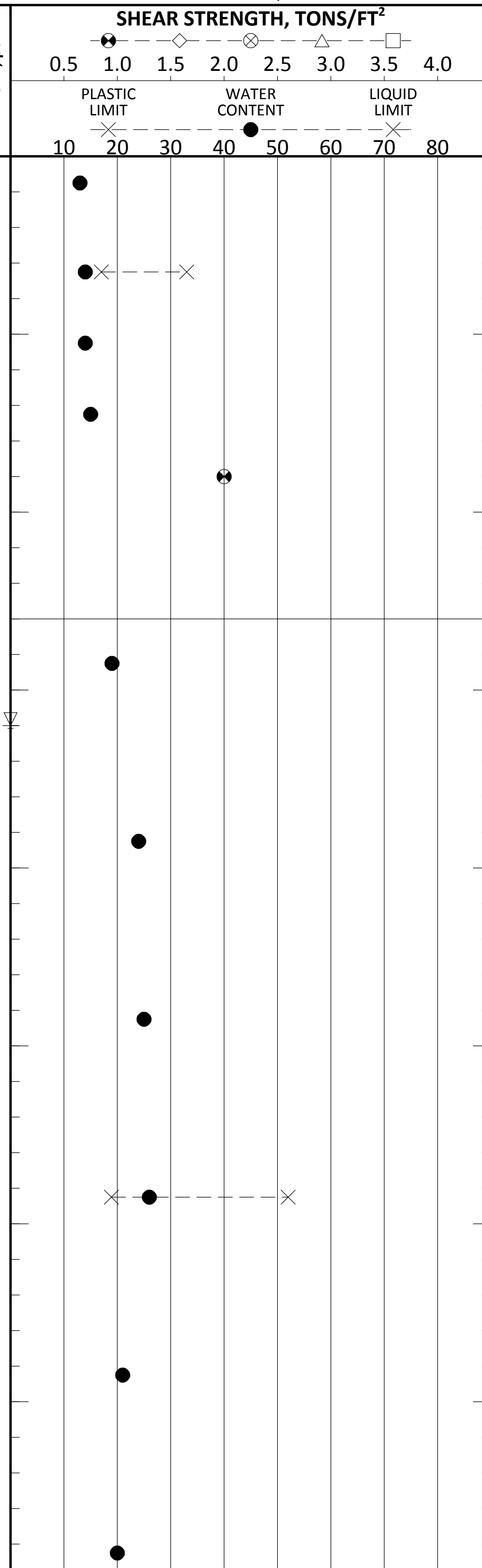
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30715; W 98.31792

SURFACE ELEVATION: 496 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–13	FILL MATERIAL: CLAY, Sandy, Very Stiff to Hard, Tan to Brown	23			
		27		16	
5	-with a tan sand seam from 4 to 6 ft	34			43
		16			
10					
13–40	CLAY, Sandy, Very Stiff to Hard, Tan and Gray	18			
15	-DRILLER'S NOTE: WATER encountered at 16 ft				
20		19			53
25		41			
30		34		33	
35		41			
40		39			



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	40.0 ft	**DEPTH TO WATER:**	16 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/18/2012	**DATE MEASURED:**	10/18/2012	**FIGURE:**	A-14

LOG OF BORING NO. B-14

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

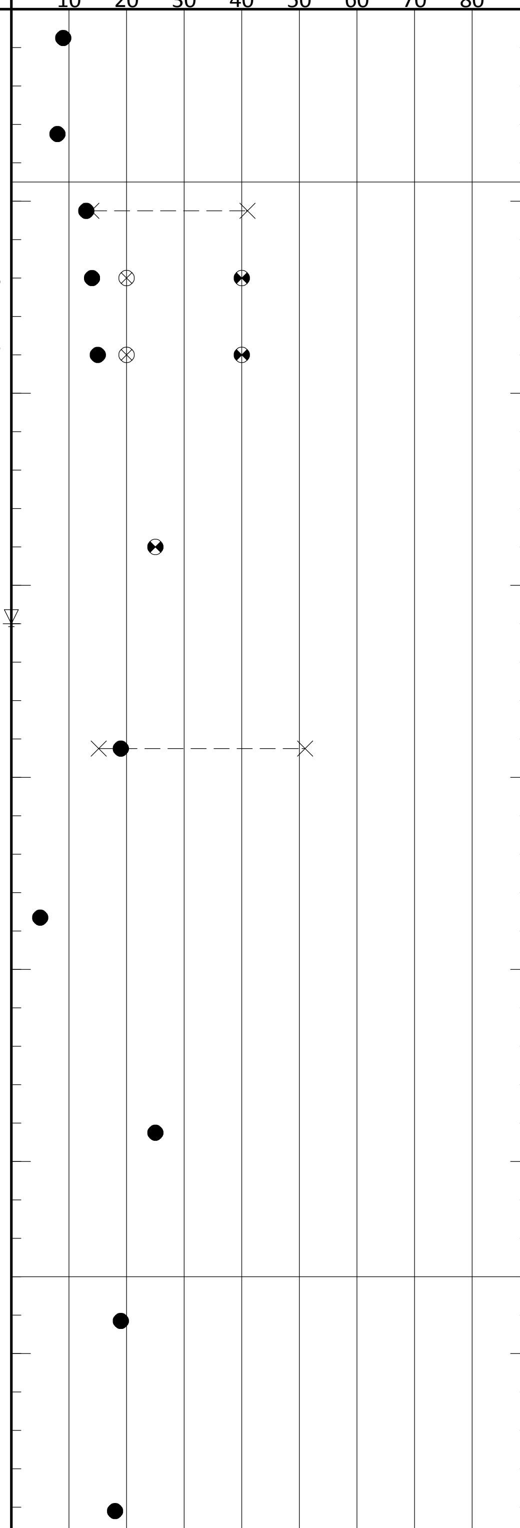
LOCATION: N 29.30684; W 98.31590

SURFACE ELEVATION: 501 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	FILL MATERIAL: SAND, Clayey, Loose to Dense, Brown and Tan	9			
		30			46
5	CLAY, Sandy, Very Stiff to Hard, Tan to Tan and Gray	18		27	
			118		
			117		
16	-DRILLER'S NOTE: WATER encountered at 16 ft				
20		15		36	
		ref/3"			
30		32			72
33	SAND, Clayey, Very Dense, Tan and Gray	50/9"			
		50/8"			

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 39.7 ft
DATE DRILLED: 10/19/2012
DEPTH TO WATER: 16 ft
DATE MEASURED: 10/19/2012
PROJ. No.: ASA12-098-00
FIGURE: A-15

KEY TO TERMS AND SYMBOLS

MATERIAL TYPES

SOIL TERMS

- CALCAREOUS
- CALICHE
- CLAY
- CLAYEY
- GRAVEL
- GRAVELLY
- PEAT
- SAND
- SANDY
- SILT
- SILTY
- FILL

ROCK TERMS

- CHALK
- CLAYSTONE
- CLAY-SHALE
- CONGLOMERATE
- DOLOMITE
- IGNEOUS
- LIMESTONE
- MARL
- METAMORPHIC
- SANDSTONE
- SHALE
- SILTSTONE

OTHER

- ASPHALT
- BASE
- CONCRETE/CEMENT
- BRICKS / PAVERS
- WASTE
- NO INFORMATION

WELL CONSTRUCTION AND PLUGGING MATERIALS

- BLANK PIPE
- BENTONITE
- BENTONITE & CUTTINGS
- CUTTINGS
- SAND
- SCREEN
- CEMENT GROUT
- CONCRETE/CEMENT
- GRAVEL
- VOLCLAY

SAMPLE TYPES

- AIR ROTARY
- MUD ROTARY
- SHELBY TUBE
- GRAB SAMPLE
- NO RECOVERY
- SPLIT BARREL
- CORE
- NX CORE
- SPLIT SPOON
- GEOPROBE SAMPLER
- PITCHER
- TEXAS CONE PENETROMETER
- ROTOSONIC -DAMAGED
- ROTOSONIC -INTACT
- DISTURBED

STRENGTH TEST TYPES

- POCKET PENETROMETER
- TORVANE
- UNCONFINED COMPRESSION
- TRIAXIAL COMPRESSION UNCONSOLIDATED-UNDRAINED
- TRIAXIAL COMPRESSION CONSOLIDATED-UNDRAINED

NOTE: VALUES SYMBOLIZED ON BORING LOGS REPRESENT SHEAR STRENGTHS UNLESS OTHERWISE NOTED

PROJECT NO. ASA12-098-00

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

Terms used in this report to describe soils with regard to their consistency or conditions are in general accordance with the discussion presented in Article 45 of SOILS MECHANICS IN ENGINEERING PRACTICE, Terzaghi and Peck, John Wiley & Sons, Inc., 1967, using the most reliable information available from the field and laboratory investigations. Terms used for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in American Society for Testing and Materials D2487-06 and D2488-00, Volume 04.08, Soil and Rock; Dimension Stone; Geosynthetics; 2005.

The depths shown on the boring logs are not exact, and have been estimated to the nearest half-foot. Depth measurements may be presented in a manner that implies greater precision in depth measurement, i.e 6.71 meters. The reader should understand and interpret this information only within the stated half-foot tolerance on depth measurements.

RELATIVE DENSITY

Penetration Resistance Blows per ft	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
> 50	Very Dense

COHESIVE STRENGTH

Resistance Blows per ft	Consistency	Cohesion TSF
0 - 2	Very Soft	0 - 0.125
2 - 4	Soft	0.125 - 0.25
4 - 8	Firm	0.25 - 0.5
8 - 15	Stiff	0.5 - 1.0
15 - 30	Very Stiff	1.0 - 2.0
> 30	Hard	> 2.0

PLASTICITY

Plasticity Index	Degree of Plasticity
0 - 5	None
5 - 10	Low
10 - 20	Moderate
20 - 40	Plastic
> 40	Highly Plastic

ABBREVIATIONS

B = Benzene
T = Toluene
E = Ethylbenzene
X = Total Xylenes
BTEX = Total BTEX
TPH = Total Petroleum Hydrocarbons
ND = Not Detected
NA = Not Analyzed
NR = Not Recorded/No Recovery
OVA = Organic Vapor Analyzer
ppm = Parts Per Million

Qam, Qas, Qal = Quaternary Alluvium
Qat = Low Terrace Deposits
Qbc = Beaumont Formation
Qt = Fluviatile Terrace Deposits
Qao = Seymour Formation
Qle = Leona Formation
Q-Tu = Uvalde Gravel
Ewi = Wilcox Formation
Emi = Midway Group
Mc = Catahoula Formation
EI = Laredo Formation
Kknm = Navarro Group and Marlbrook Marl
Kpg = Pecan Gap Chalk
Kau = Austin Chalk

Kef = Eagle Ford Shale
Kbu = Buda Limestone
Kdr = Del Rio Clay
Kft = Fort Terrett Member
Kgt = Georgetown Formation
Kep = Person Formation
Kek = Kainer Formation
Kes = Escondido Formation
Kew = Walnut Formation
Kgr = Glen Rose Formation
Kgru = Upper Glen Rose Formation
Kgrl = Lower Glen Rose Formation
Kh = Hensell Sand

PROJECT NO. ASA12-098-00

RABAKISTNER

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.
Carbonate	Having more than 50% carbonate content.

SAMPLING METHODS

RELATIVELY UNDISTURBED SAMPLING

Cohesive soil samples are to be collected using three-inch thin-walled tubes in general accordance with the Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587) and granular soil samples are to be collected using two-inch split-barrel samplers in general accordance with the Standard Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). Cohesive soil samples may be extruded on-site when appropriate handling and storage techniques maintain sample integrity and moisture content.

STANDARD PENETRATION TEST (SPT)

A 2-in.-OD, 1-3/8-in.-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

<u>NOTE:</u> To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

APPENDIX B

LABORATORY TEST RESULTS

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

FILE NAME: ASA12-098-00.GPJ 11/20/2012

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-1	0.0 to 1.5	11	15								
	2.5 to 4.0	7	23						50		
	4.0 to 6.0		18	31	15	16	CL	106		0.27	UC
	6.0 to 8.0		15					110		1.09	UC
	8.0 to 10.0		13					112	40	0.39	UC
	13.5 to 15.0	16	21	55	18	37	CH				
	18.5 to 20.0	22	18								
	23.5 to 24.9	50/11"	14								
	28.5 to 29.9	50/11"	11						43		
	33.5 to 35.0	49	20								
	38.5 to 39.9	50/11"	20								
	43.5 to 44.8	50/9"	19								
	48.5 to 49.7	50/8"	19								
B-2	0.0 to 1.5	11	18								
	2.0 to 4.0		11					119	38	2.59	UC
	4.0 to 6.0		17	33	18	15	CL	104		0.79	UC
	6.0 to 8.0		19					102		0.28	UC
	8.0 to 10.0		17					110		0.98	UC
	13.0 to 15.0		18	54	18	36	CH			2.00	PP
	18.0 to 20.0		13					101		0.65	UC
	23.5 to 24.9	50/11"	12						24		
	28.5 to 29.8	50/10"	20								
	33.5 to 35.0	38	12								
	38.5 to 40.0	50	20								
	43.5 to 44.7	50/8"	18								
	48.5 to 49.8	50/9"	20								
B-3	0.0 to 1.5	24	13								
	2.5 to 4.0	12	15								
	4.5 to 6.0	11	17	34	15	19	CL				
	6.5 to 8.0	19	17						41		
	8.5 to 10.0	14	17								
	13.0 to 15.0		18	42	12	30	CL	112		0.73	UC
	18.0 to 20.0		15							2.00	PP
	23.5 to 25.0	46	11						47		
	28.5 to 30.0	50									
	33.5 to 34.9	50/11"	13								
	38.5 to 39.9	50/11"	18						33		
	43.5 to 45.0	38	27								
	48.5 to 49.8	50/10"	22								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ASA12-098-00

RABA KISTNER

FIGURE B-1a

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

FILE NAME: ASA12-098-00.GPJ 11/20/2012

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-4	0.0 to 1.5	7	16	40	15	25	CL				
	2.5 to 4.0	5	14						54		
	4.5 to 6.0	14	12	45	15	30	CL				
	6.0 to 8.0		14					113		1.96	UC
	8.0 to 10.0		11					110		0.71	UC
	13.5 to 15.0	26	18	41	14	27	CL				
	18.5 to 20.0	49	10								
	23.5 to 25.0	24	15								
	28.0 to 30.0		13					97	32	1.50	PP
	33.5 to 35.0	50	14								
	38.5 to 39.8	50/10"	25								
	43.5 to 45.0	50	24								
	48.5 to 49.8	50/9"	19						23		
B-5	0.0 to 1.5	17	13								
	2.5 to 4.0	21	14								
	4.5 to 6.0	24	13								
	6.5 to 8.0	20	16	32	13	19	CL				
	8.0 to 10.0		14						46	2.00	PP
	13.5 to 15.0	33	26						46		
	18.5 to 19.8	50/10"	24								
	23.5 to 24.8	50/9"	22								
	28.5 to 30.0	24	21								
	33.5 to 34.6	50/7"	24						31		
	38.5 to 39.7	50/8"									
B-6	0.0 to 1.5	15	11								
	2.5 to 4.0	14	16	33	18	15	CL				
	4.5 to 6.0	24	13						50		
	6.5 to 8.0	19	15								
	8.5 to 10.0	21	17								
	13.5 to 15.0	7	24	49	17	32	CL				
	18.5 to 19.9	50/11"	25						51		
	23.5 to 24.8	50/10"	23								
	28.5 to 30.0	38	21	38	20	18	CL				
	33.5 to 34.7	50/8"	23								
	38.5 to 39.8	50/10"	26						29		
B-7	0.0 to 1.5	10	19								
	2.5 to 4.0	29	7								
	4.5 to 6.0	22	14	34	15	19	CL				
	6.0 to 8.0		16					115		1.37	UC

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ASA12-098-00

RABA KISTNER

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

FILE NAME: ASA12-098-00.GPJ 11/20/2012

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-7	8.0 to 10.0		14	32	15	17	CL			2.00	PP
	13.5 to 14.8	50/9"	25						47		
	18.5 to 19.9	50/11"	23								
	23.5 to 24.8	50/9"	19	35	17	18	CL				
	28.5 to 30.0	47	19								
B-8	0.0 to 1.5	25	16								
	2.5 to 4.0	14	39			NP					
	4.5 to 6.0	7	16						39		
	6.0 to 8.0		15					113		0.78	UC
	8.0 to 10.0									2.00	PP
	13.0 to 15.0		18					111		0.39	UC
	18.5 to 20.0	25	23						47		
	23.5 to 25.0	10	20	33	15	18	CL				
	28.5 to 30.0	25	22								
	33.5 to 35.0	38	19						52		
	38.5 to 39.7	50/8"	24	29	20	9	CL				
B-9	0.0 to 1.5	11	13								
	2.5 to 4.0	14	16								
	4.5 to 6.0	16	15	35	14	21	CL				
	6.5 to 8.0	11	20								
	8.0 to 10.0		21							1.50	PP
	13.5 to 15.0	9	23						49		
	18.5 to 19.9	50/11"	24								
	23.5 to 23.6	ref/1"	26								
	28.5 to 29.9	50/11"	20						62		
B-10	0.0 to 1.5	16	13								
	2.5 to 4.0	16	16	32	16	16	CL				
	4.5 to 6.0	19	14								
	6.5 to 8.0	24	18								
	8.5 to 10.0	19	15	42	15	27	CL				
	13.0 to 15.0		22					97	41	0.23	UC
	18.5 to 20.0	38	26								
	23.5 to 25.0	17	29								
	28.5 to 28.6	ref/1"	6								
	33.5 to 34.8	50/9"	19						42		
	38.5 to 40.0	26	21								
B-11	0.0 to 1.5	15	14	32	16	16	CL				
	2.5 to 4.0	11	15								
	4.5 to 6.0	12	17						49		

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ASA12-098-00

RABAKISTNER

FIGURE B-1c

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

FILE NAME: ASA12-098-00.GPJ 11/20/2012

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-11	6.5 to 8.0	18	13								
	8.0 to 10.0									2.00	PP
	13.5 to 15.0	18	18								
	18.5 to 20.0	18	26								
	23.5 to 25.0	49	23						34		
	28.5 to 30.0	42	24								
B-12	0.0 to 1.5	23	28						46		
	2.5 to 4.0	6	38								
	4.5 to 6.0	8	16	32	14	18	CL				
	6.5 to 8.0	27	14								
	8.0 to 10.0		15	34	13	21	CL			2.00	PP
	13.5 to 15.0	18	18								
	18.5 to 20.0	24	28								
	23.5 to 24.9	50/11"	23						51		
	28.5 to 30.0	11	28								
B-13	0.0 to 1.5	23	13								
	2.5 to 4.0	27	14	33	17	16	CL				
	4.5 to 6.0	34	14						43		
	6.5 to 8.0	16	15								
	8.0 to 10.0									2.00	PP
	13.5 to 15.0	18	19								
	18.5 to 20.0	19	24						53		
	23.5 to 25.0	41	25								
	28.5 to 30.0	34	26	52	19	33	CH				
	33.5 to 35.0	41	21								
	38.5 to 40.0	39	20								
B-14	0.0 to 1.5	9	9								
	2.5 to 4.0	30	8						46		
	4.5 to 6.0	18	13	41	14	27	CL				
	6.0 to 8.0		14					118		1.10	UC
	8.0 to 10.0		15					117		1.15	UC
	13.0 to 15.0									1.25	PP
	18.5 to 20.0	15	19	51	15	36	CH				
	23.5 to 23.8	ref/3"	5								
	28.5 to 30.0	32	25						72		
	33.5 to 34.8	50/9"	19								
	38.5 to 39.7	50/8"	18								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ASA12-098-00

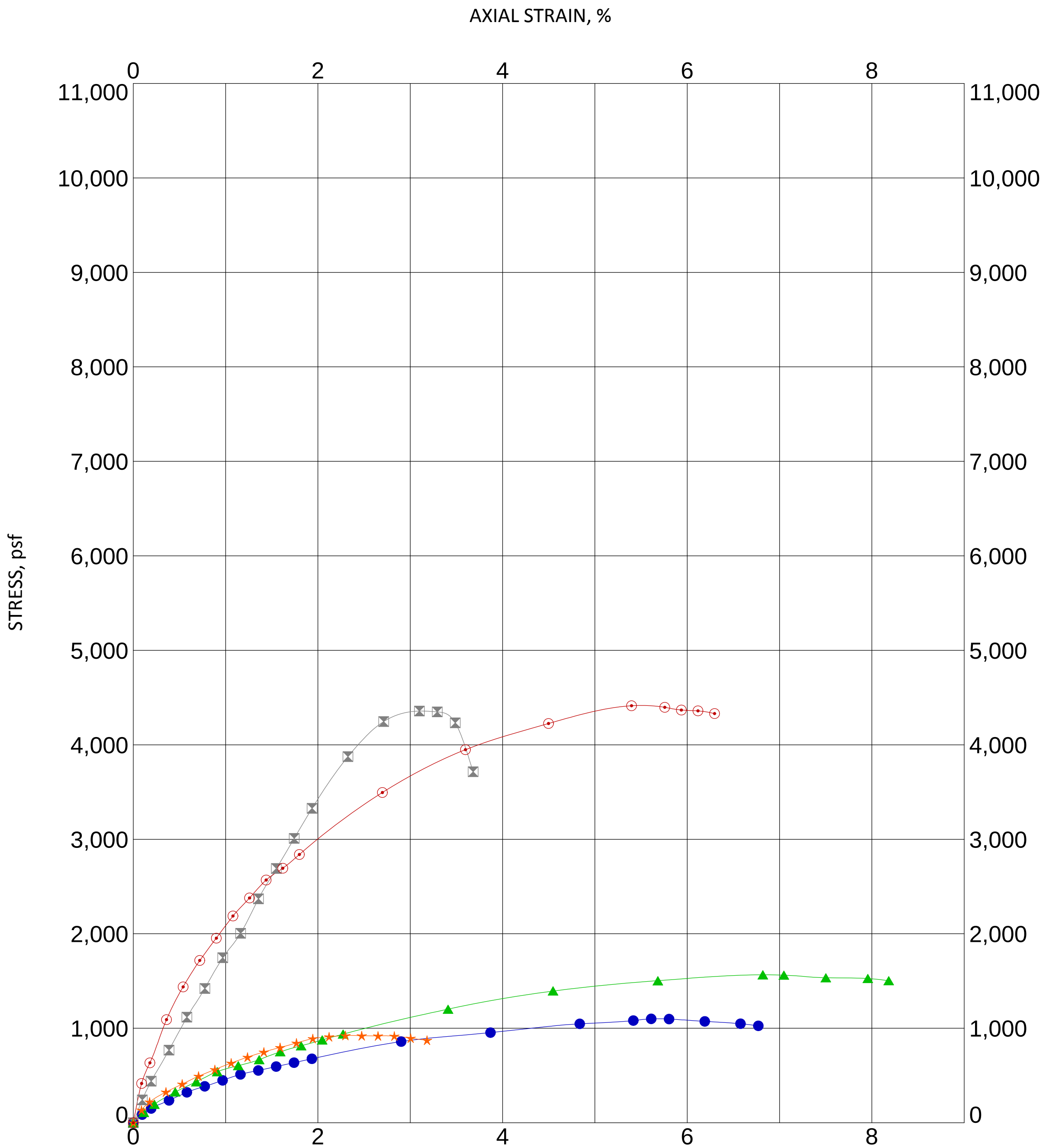


FIGURE B-2

Specimen Identification		Classification	Shear Str. (tsf)	Failure Strain (%)	PI	Dry Unit Weight (pcf)	w (%)
● B-1	4 ft		0.3	5.6	16	106.0	17.7
⧗ B-1	6 ft		1.1	3.1		109.9	15.4
▲ B-1	8 ft		0.4	6.8		111.8	13.2
★ B-10	13 ft		0.2	2.3		97.4	24.5
⊙ B-14	6 ft		1.1	5.4		117.9	13.6

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UNCONFINED COMPRESSION

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

R-K UNCONFINED COMPRESSION ASA12-098-00.GPJ RKCI.GDT 11/20/12

PROJECT NO. ASA12-098-00

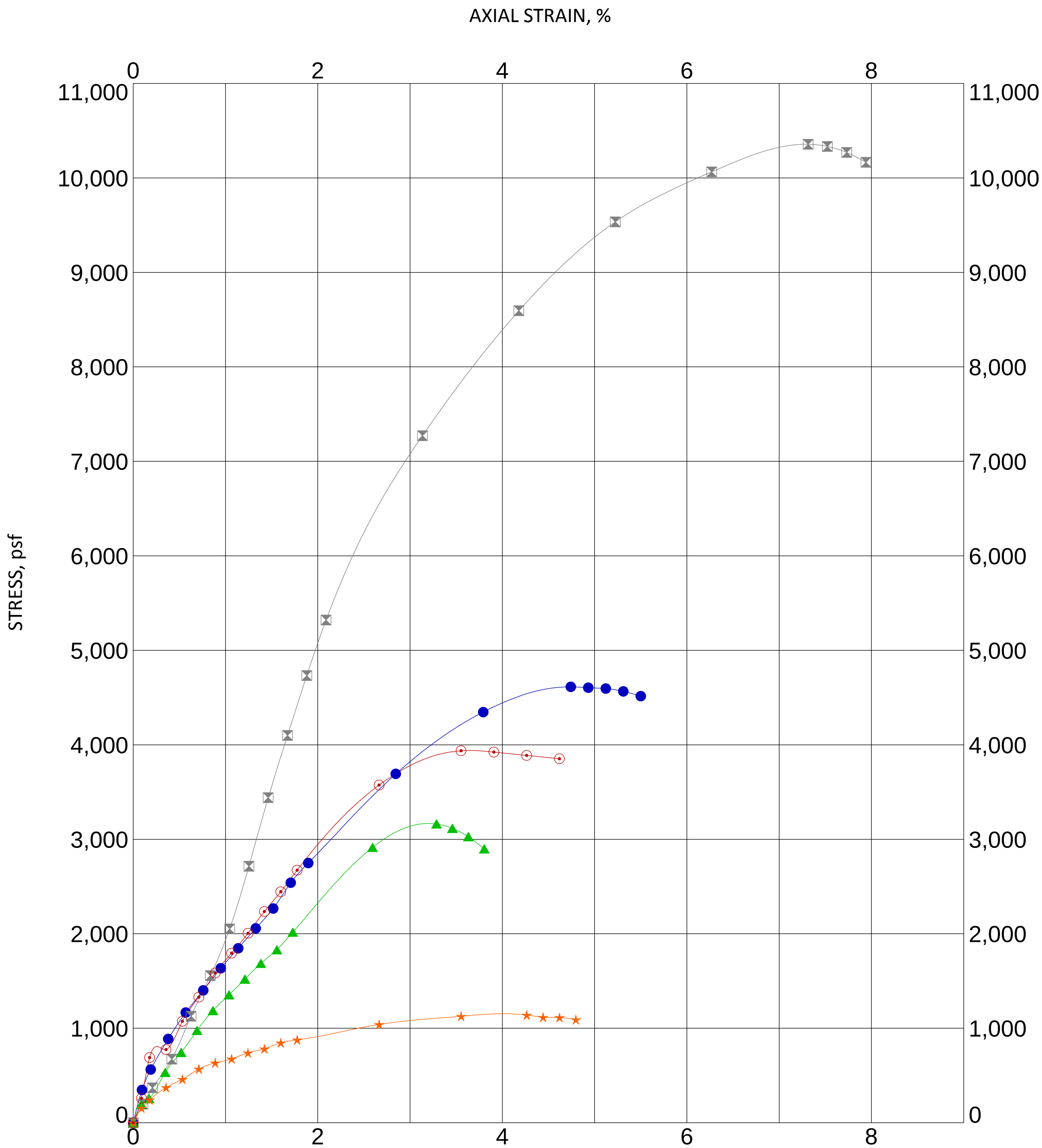

FIGURE B-3

Specimen Identification		Classification	Shear Str. (tsf)	Failure Strain (%)	PI	Dry Unit Weight (pcf)	w (%)
● B-14	8 ft		1.2	4.7		116.9	14.7
⧗ B-2	2 ft		2.6	7.3		119.3	10.9
▲ B-2	4 ft		0.8	3.3	15	104.0	16.6
★ B-2	6 ft		0.3	4.3		102.1	19.0
⊙ B-2	8 ft		1.0	3.6		110.3	16.9

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UNCONFINED COMPRESSION

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R-K UNCONFINED COMPRESSION ASA12-098-00.GPJ RKCI.GDT 11/20/12

PROJECT NO. ASA12-098-00

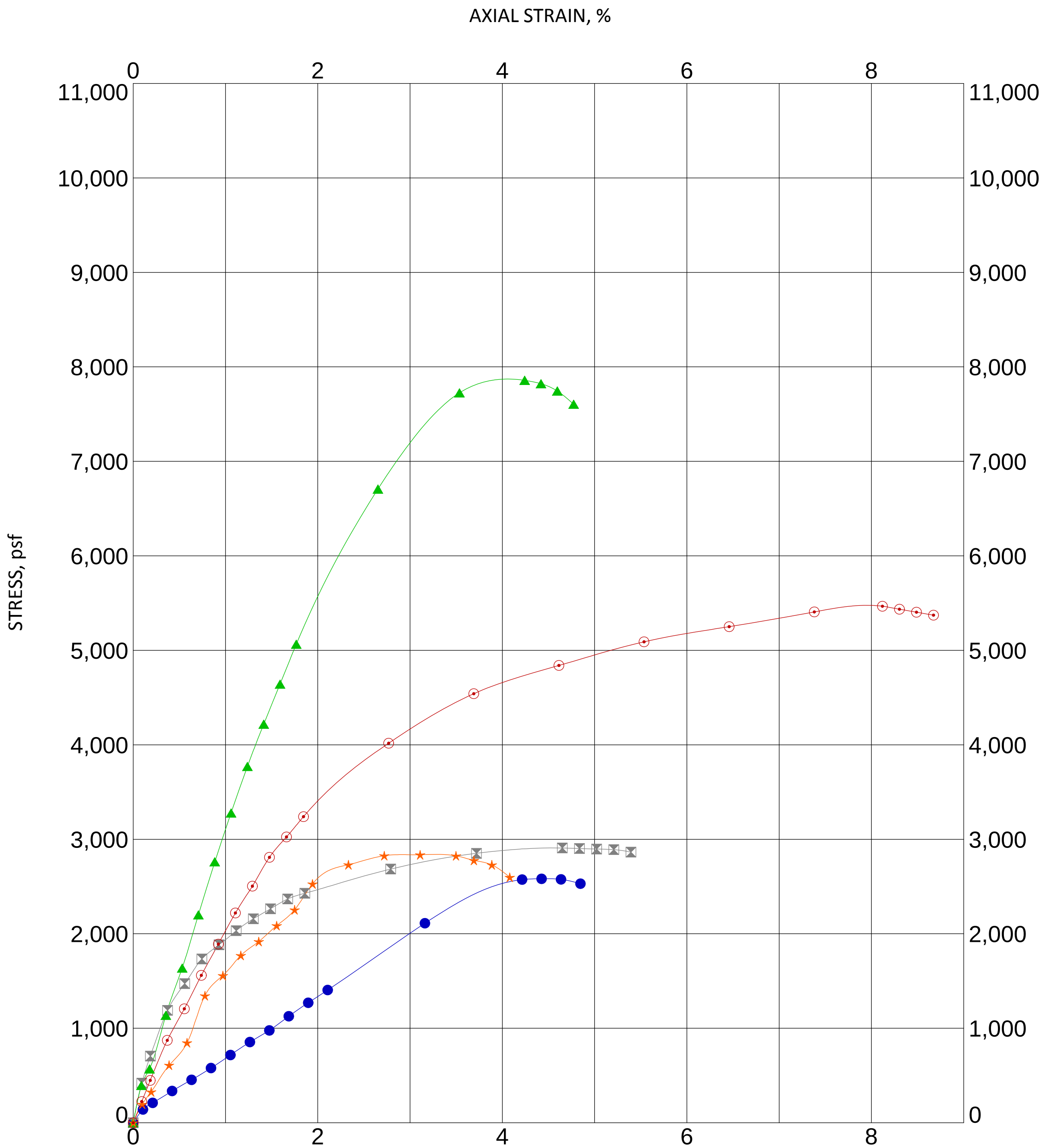

FIGURE B-4

Specimen Identification		Classification	Shear Str. (tsf)	Failure Strain (%)	PI	Dry Unit Weight (pcf)	w (%)
● B-2	18 ft		0.6	4.4		100.8	13.0
⧗ B-3	13 ft		0.7	4.7	30	112.2	17.6
▲ B-4	6 ft		2.0	4.2		113.1	14.3
★ B-4	8 ft		0.7	3.1		109.8	10.6
⊙ B-7	6 ft		1.4	8.1		115.1	15.7

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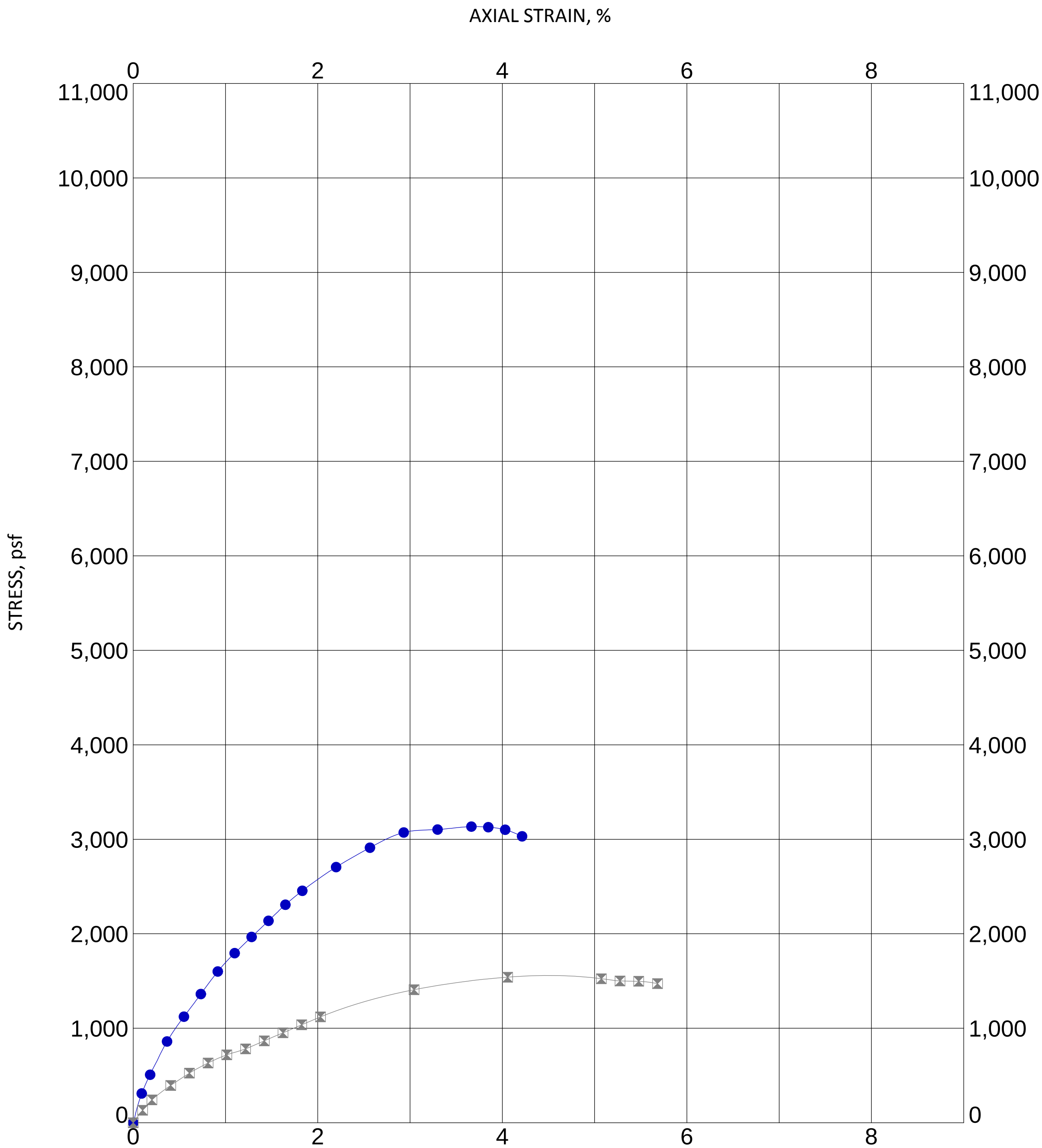

FIGURE B-5

Specimen Identification		Classification	Shear Str. (tsf)	Failure Strain (%)	PI	Dry Unit Weight (pcf)	w (%)
● B-8	6 ft		0.8	3.7		112.6	15.1
⧗ B-8	13 ft		0.4	4.1		110.8	18.1

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UNCONFINED COMPRESSION

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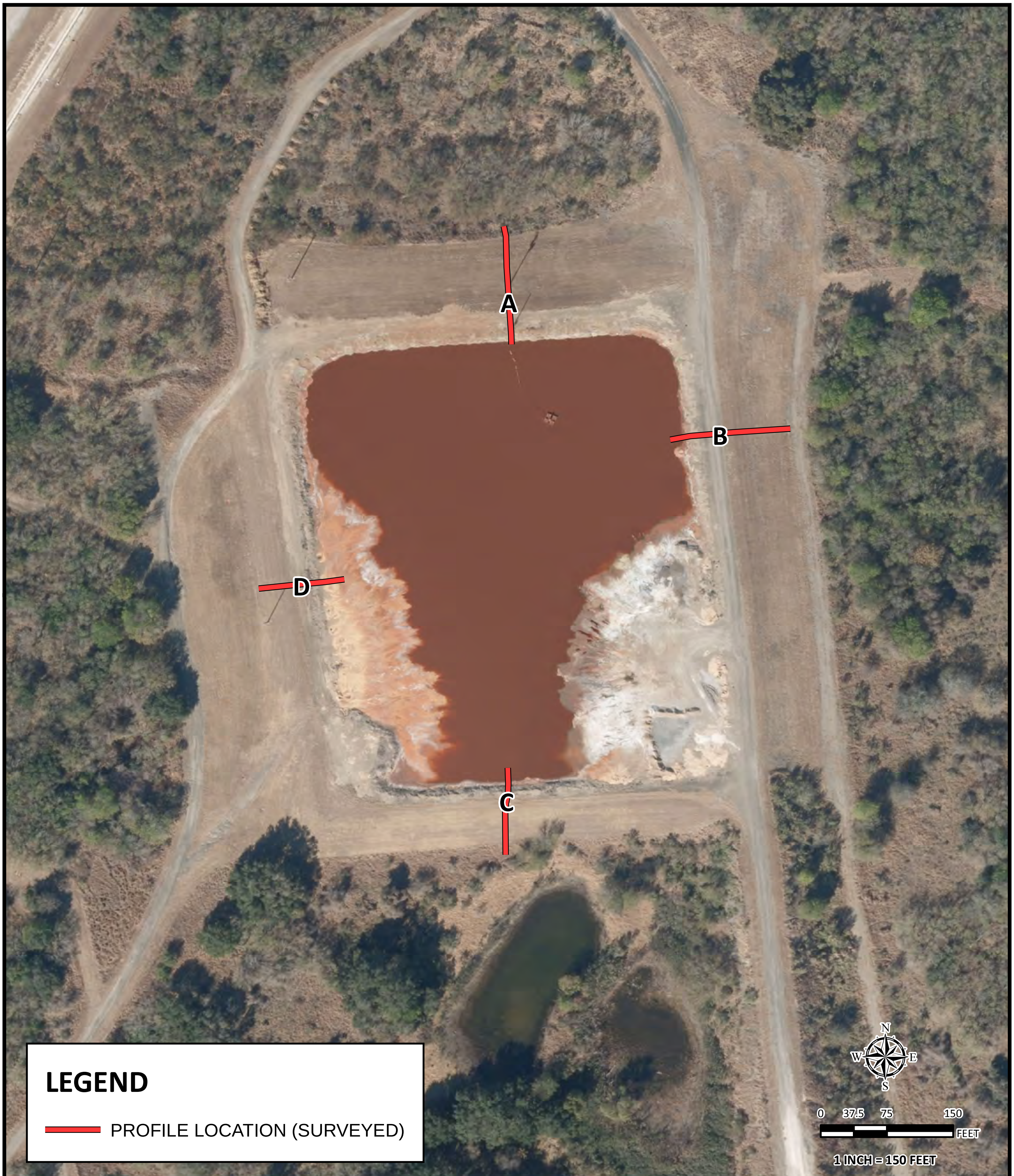
San Antonio, Texas

APPENDIX C

SLOPE STABILITY ANALYSES



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SOURCE: 2011 Aerial Photograph Provided by the City of San Antonio (COSA)

SLOPE PROFILE LOCATION MAP

ASH POND BERMS - SPRUCE/DEELY GENERATION UNITS
SAN ANTONIO, TEXAS

REVISIONS:

No.	DATE	DESCRIPTION

PROJECT No.:	ASA12-098-00
ISSUE DATE:	11/08/2012
DRAWN BY:	CCL
CHECKED BY:	RBW
REVIEWED BY:	GLB

FIGURE

C-1a

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

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TBPE Firm Number 3257

SOURCE: 2011 Aerial Photograph Provided by the City of San Antonio (COSA)

SLOPE PROFILE LOCATION MAP

ASH POND BERMS - SPRUCE/DEELY GENERATION UNITS
SAN ANTONIO, TEXAS

REVISIONS:

No.	DATE	DESCRIPTION

PROJECT No.:	ASA12-098-00
ISSUE DATE:	11/20/2012
DRAWN BY:	CCL
CHECKED BY:	RBW
REVIEWED BY:	GLB

FIGURE

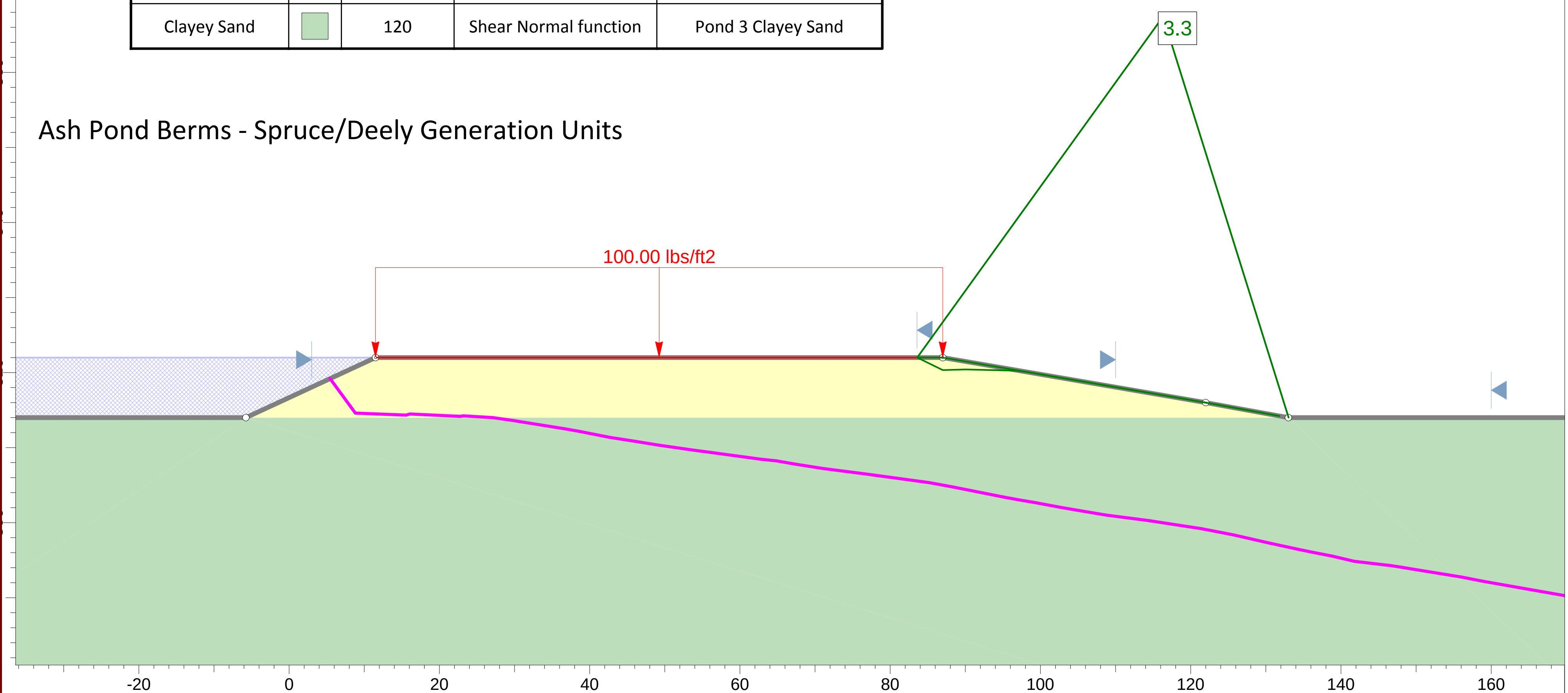
C-1b

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand

Ash Pond Berms - Spruce/Deely Generation Units



Profile "A"
Ash Pond Berms - Spruce/Deely Generation Units

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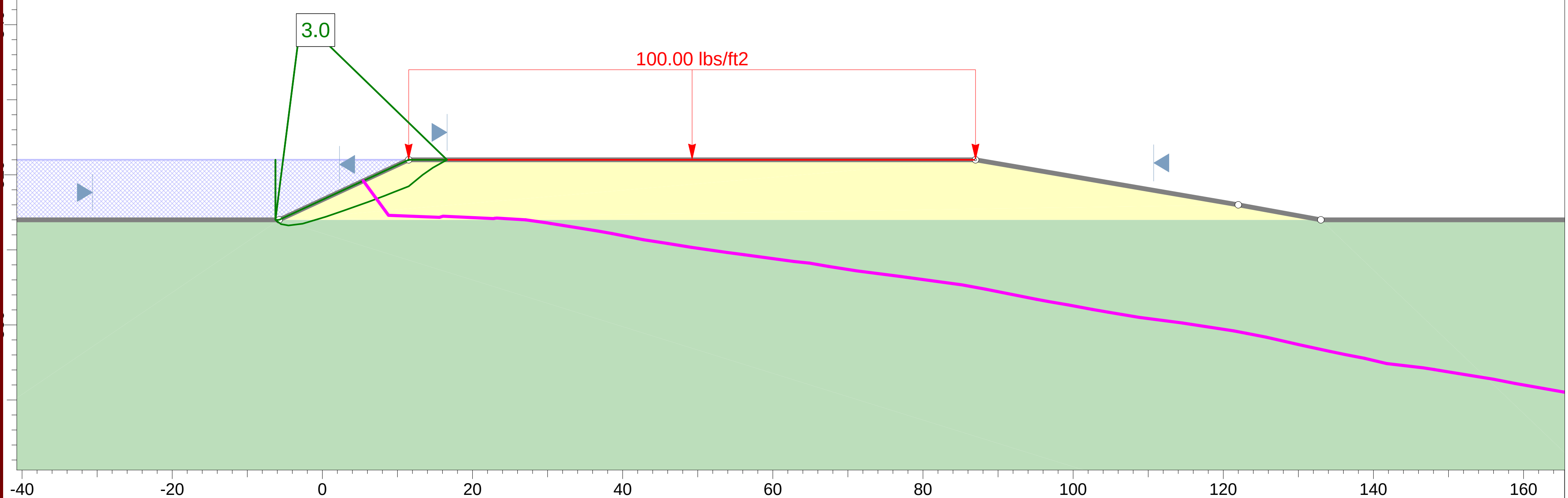
Figure C-2a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "A"
Ash Pond Berms - Spruce/Deely Generation Units

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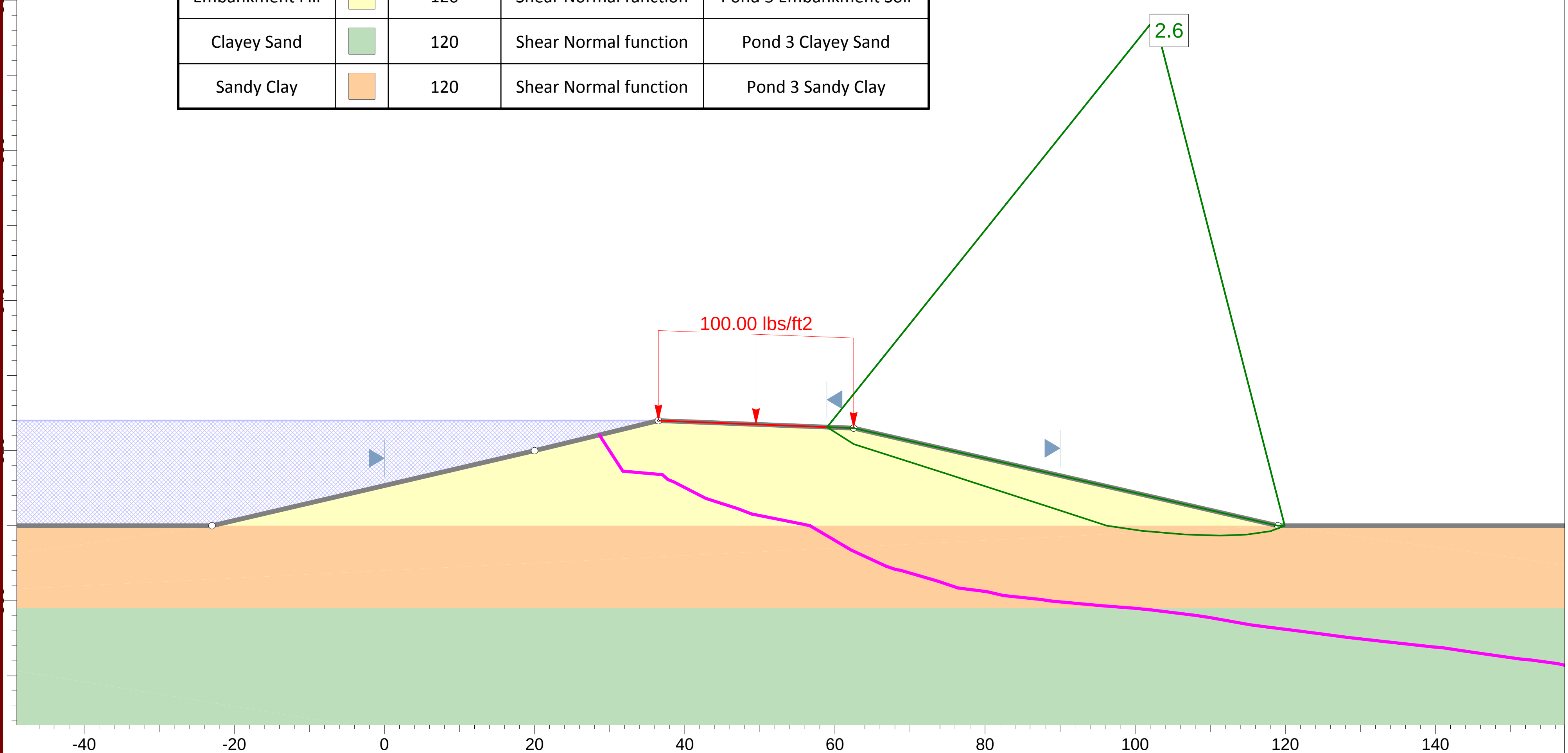
Figure C-2b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



Profile "B"
Ash Pond Berms - Spruce/Deely Generation Units

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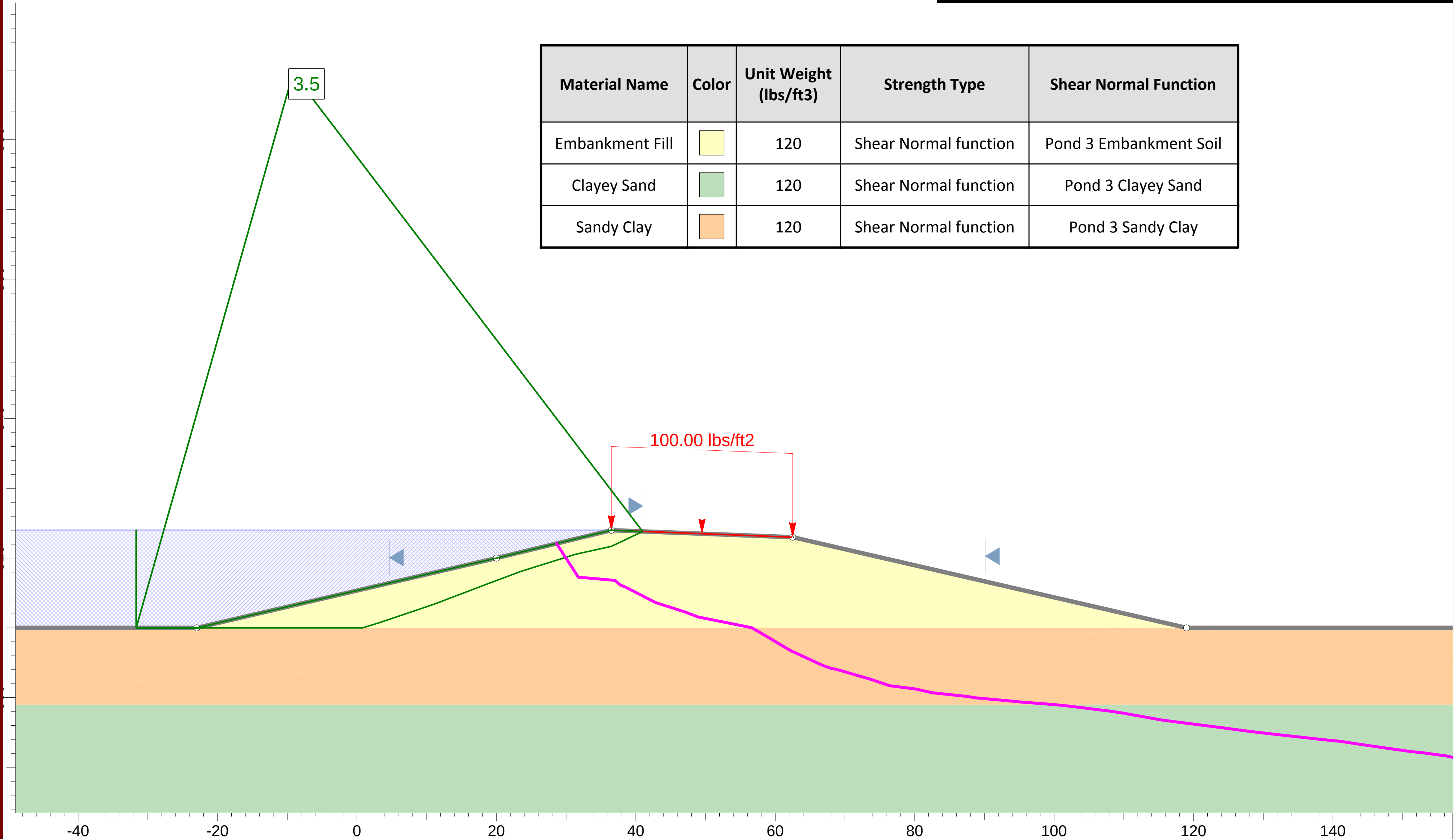
Figure C-3a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



Profile "B"
Ash Pond Berms - Spruce/Deely Generation Units

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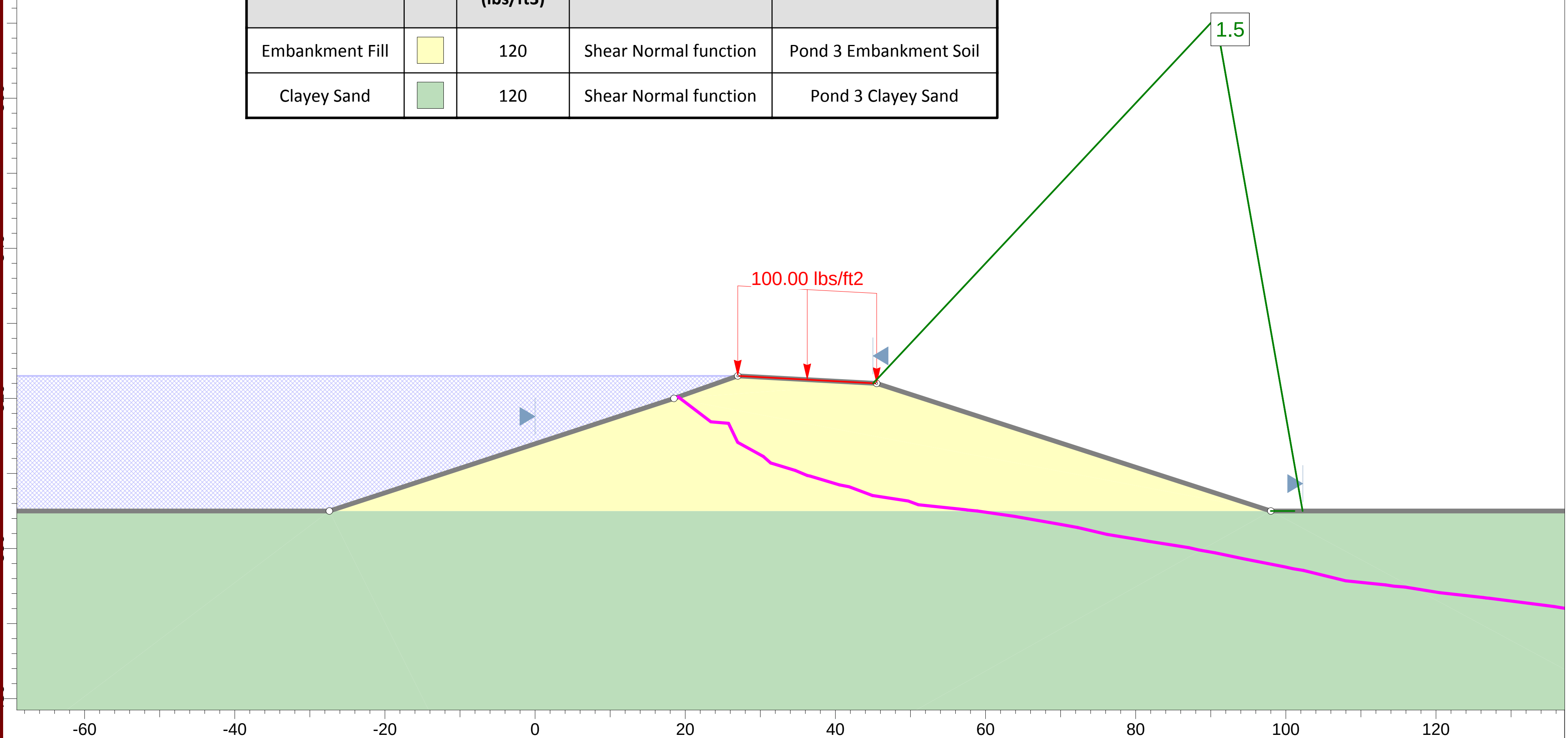
Figure C-3b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "C"
Ash Pond Berms - Spruce/Deely Generation Units

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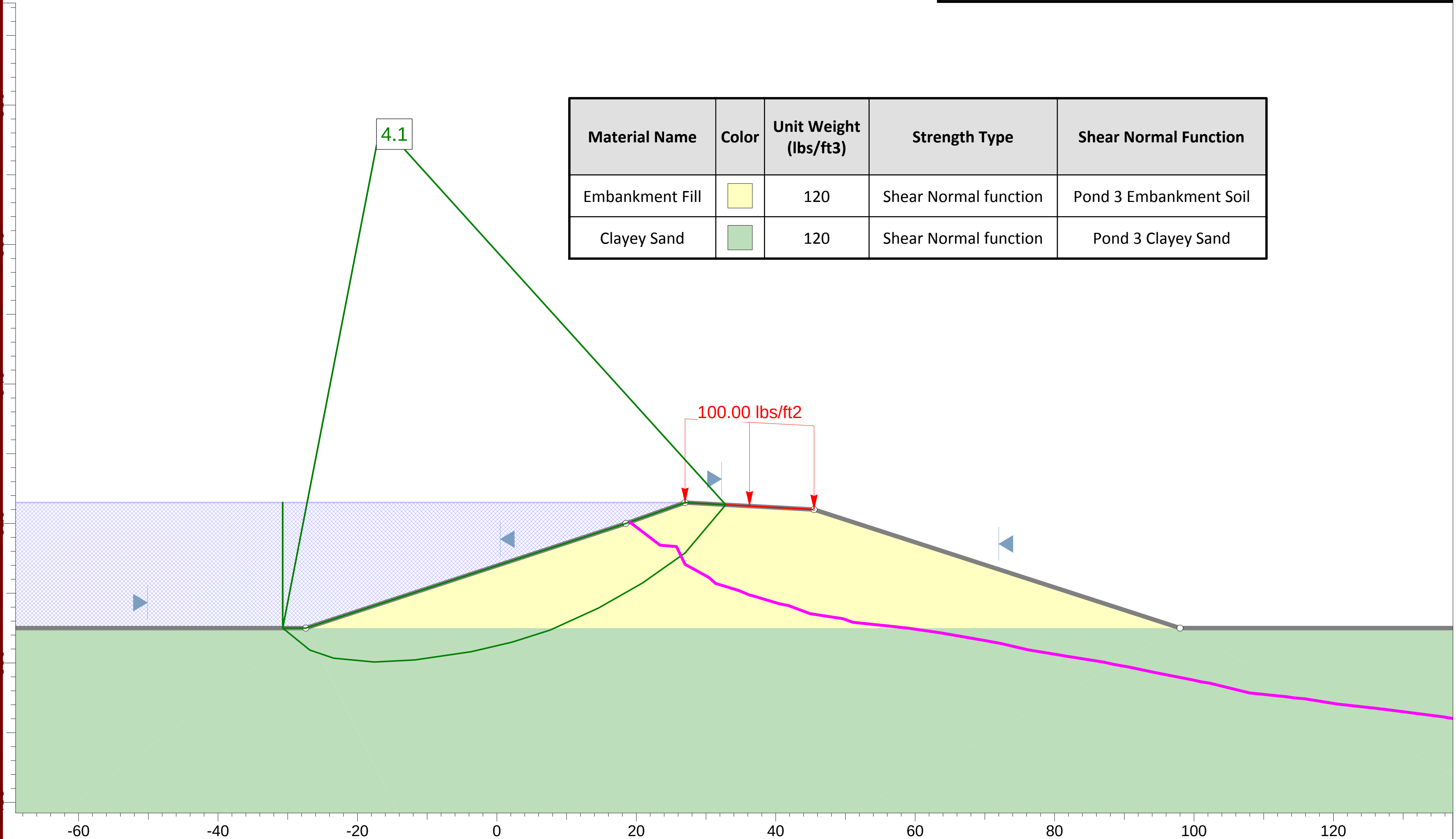
Figure C-4a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "C"
Ash Pond Berms - Spruce/Deely Generation Units

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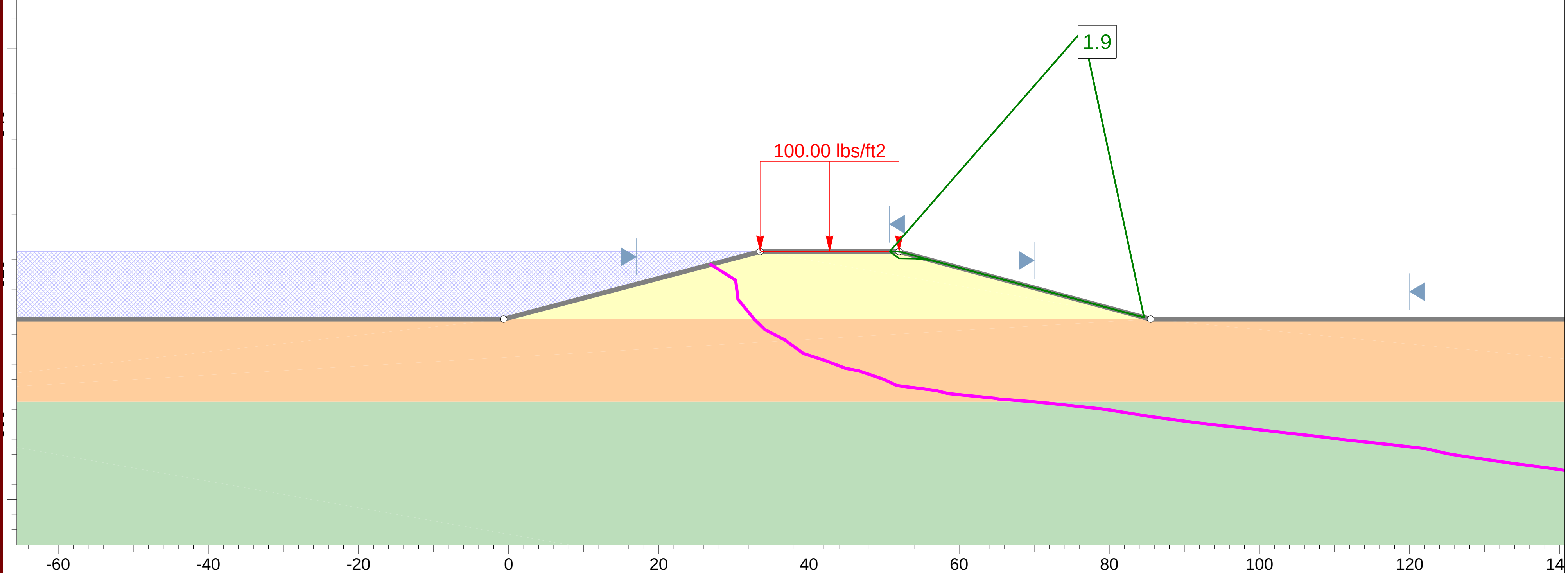
Figure C-4b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



Profile "D"
Ash Pond Berms - Spruce/Deely Generation Units

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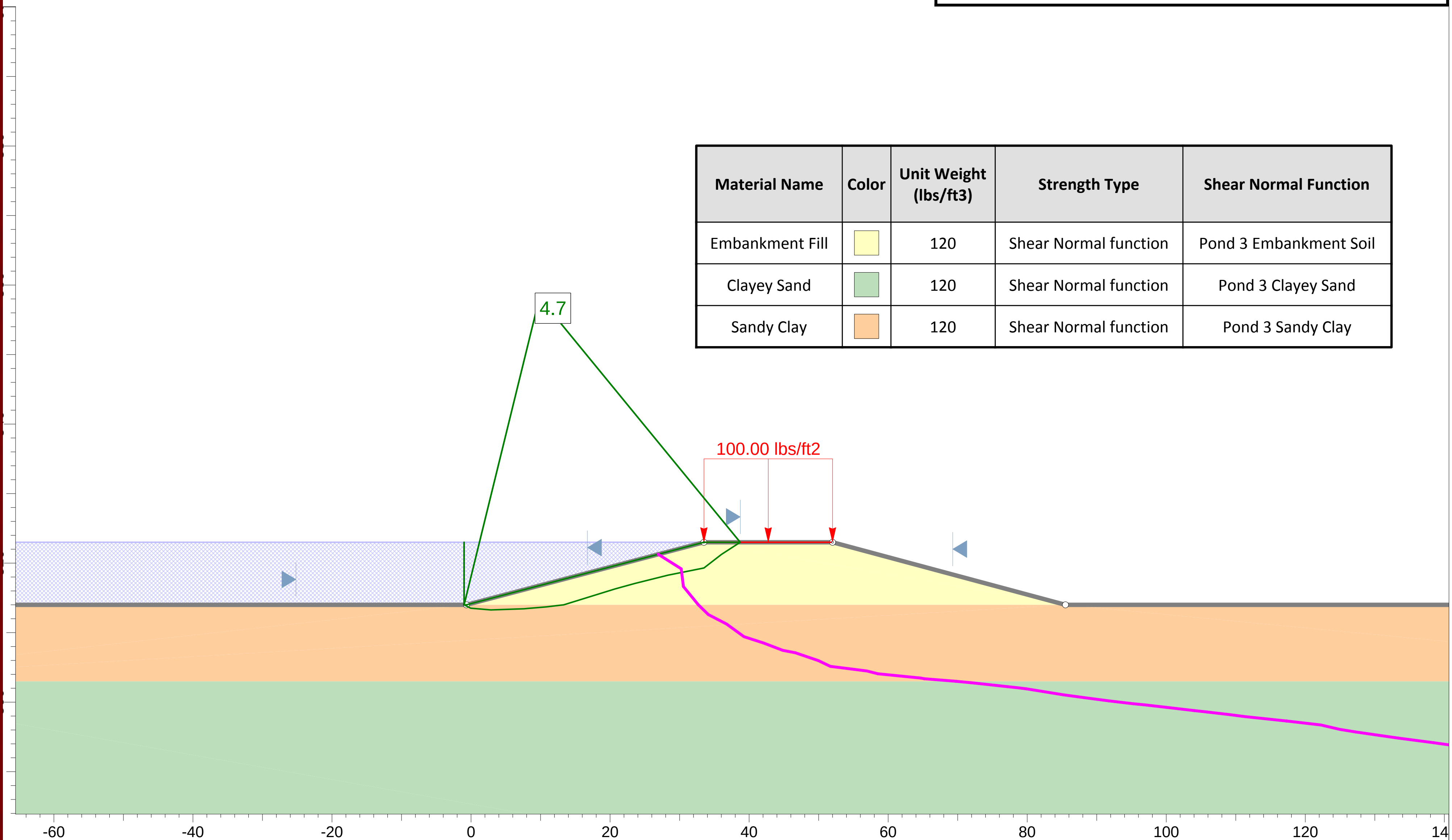
Figure C-5a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



Profile "D"
Ash Pond Berms - Spruce/Deely Generation Units

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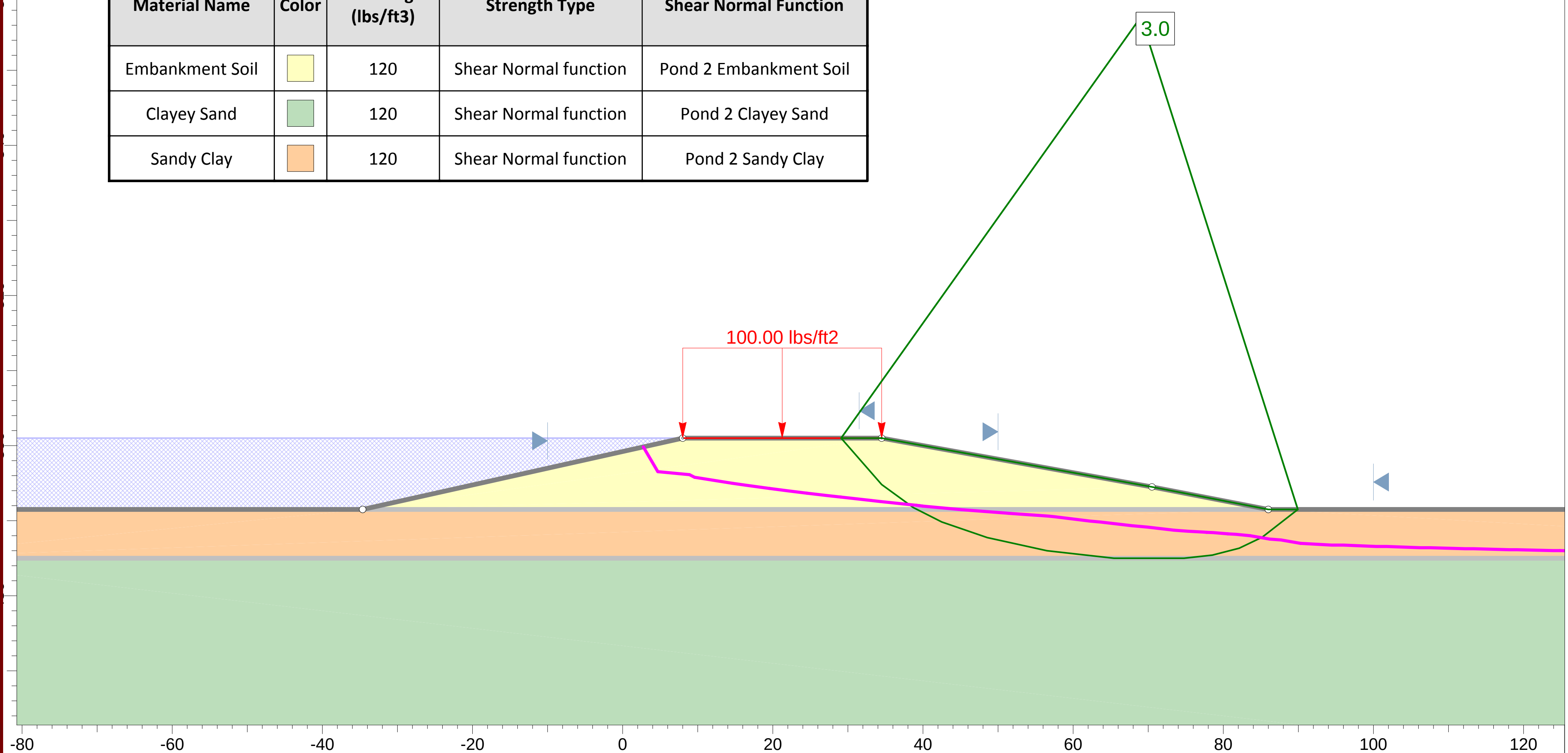
Figure C-5b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Soil		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "E"
Ash Pond Berms - Spruce/Deely Generation Units

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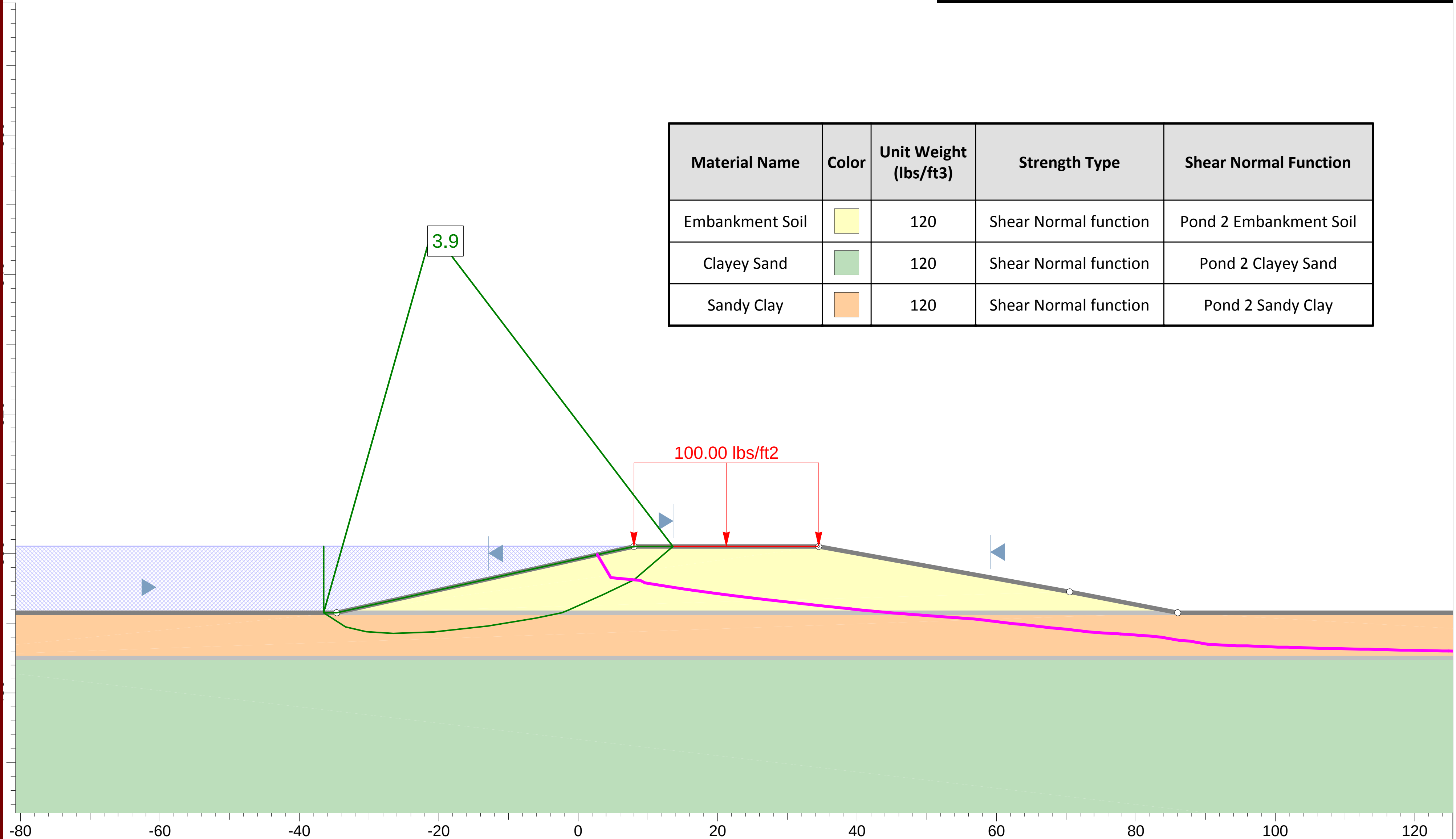
Figure C-6a

Global Stability Analysis

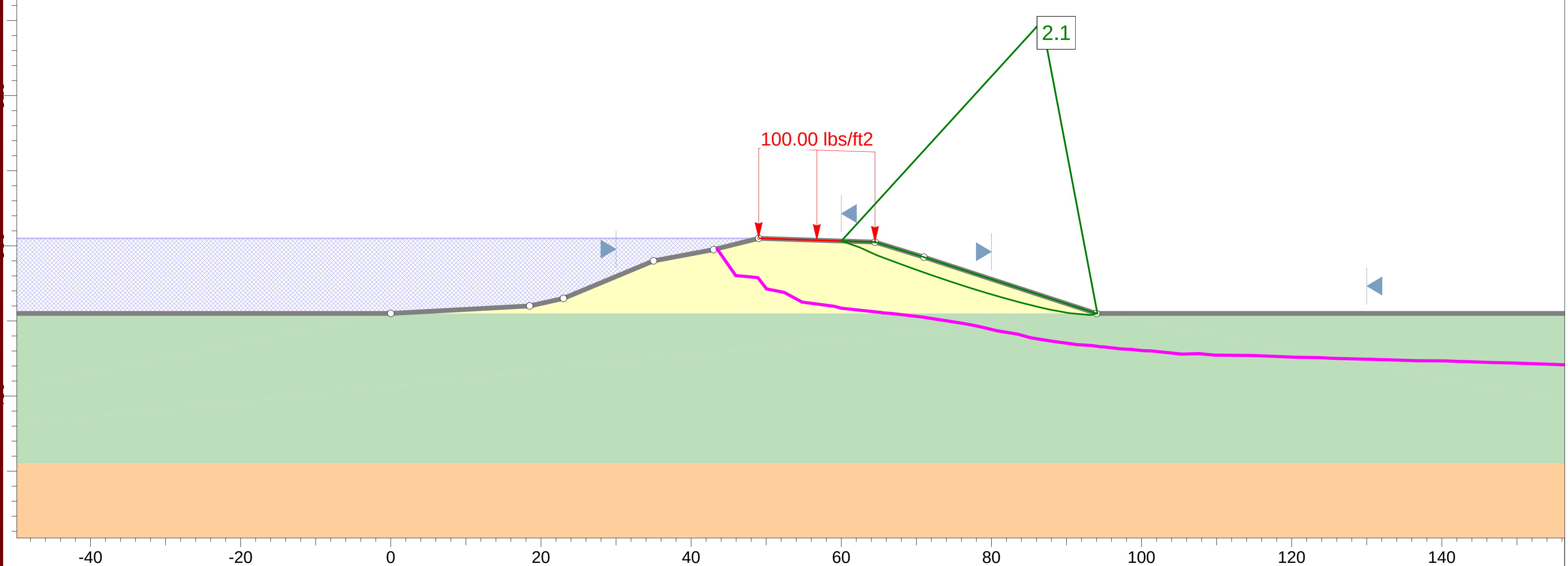


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Soil		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay

Profile "E" Ash Pond Berms - Spruce/Deely Generation Units	Raba Kistner Consultants, Inc. ASA12-098-00	Figure C-6b RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "F"
Ash Pond Berms - Spruce/Deely Generation Units

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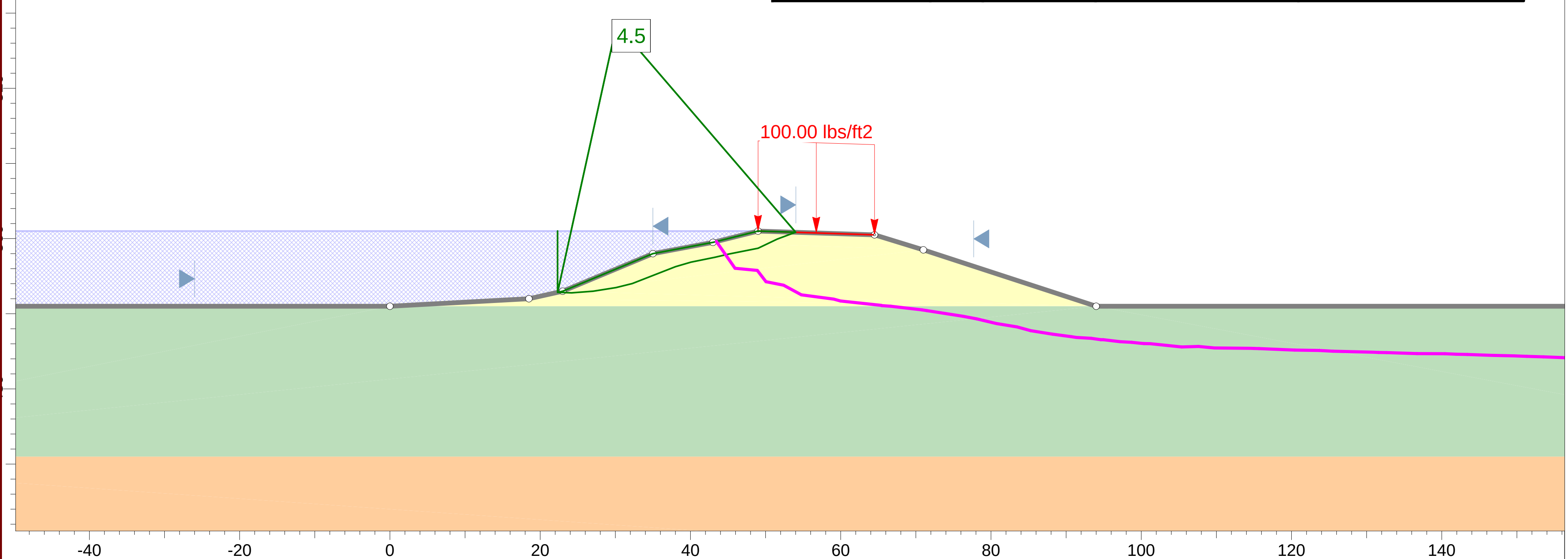
Figure C-7a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "F"
Ash Pond Berms - Spruce/Deely Generation Units

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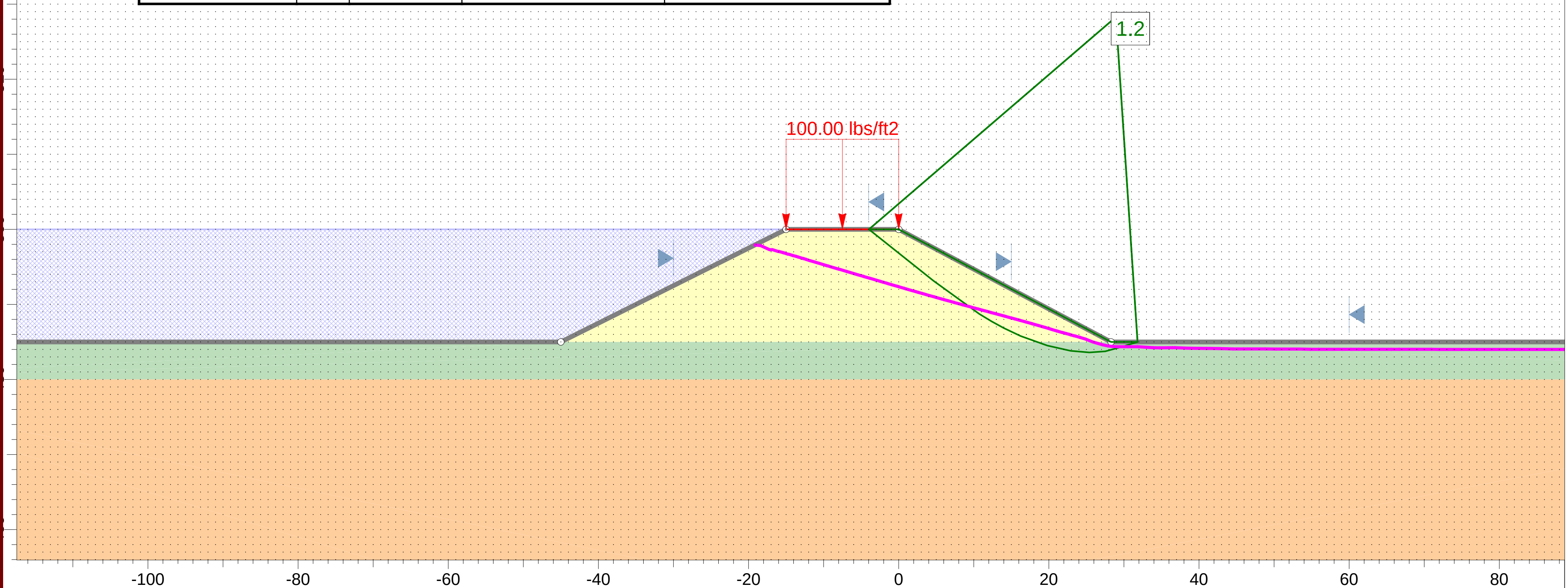
Figure C-7b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "G"
Ash Pond Berms - Spruce/Deely Generation Units

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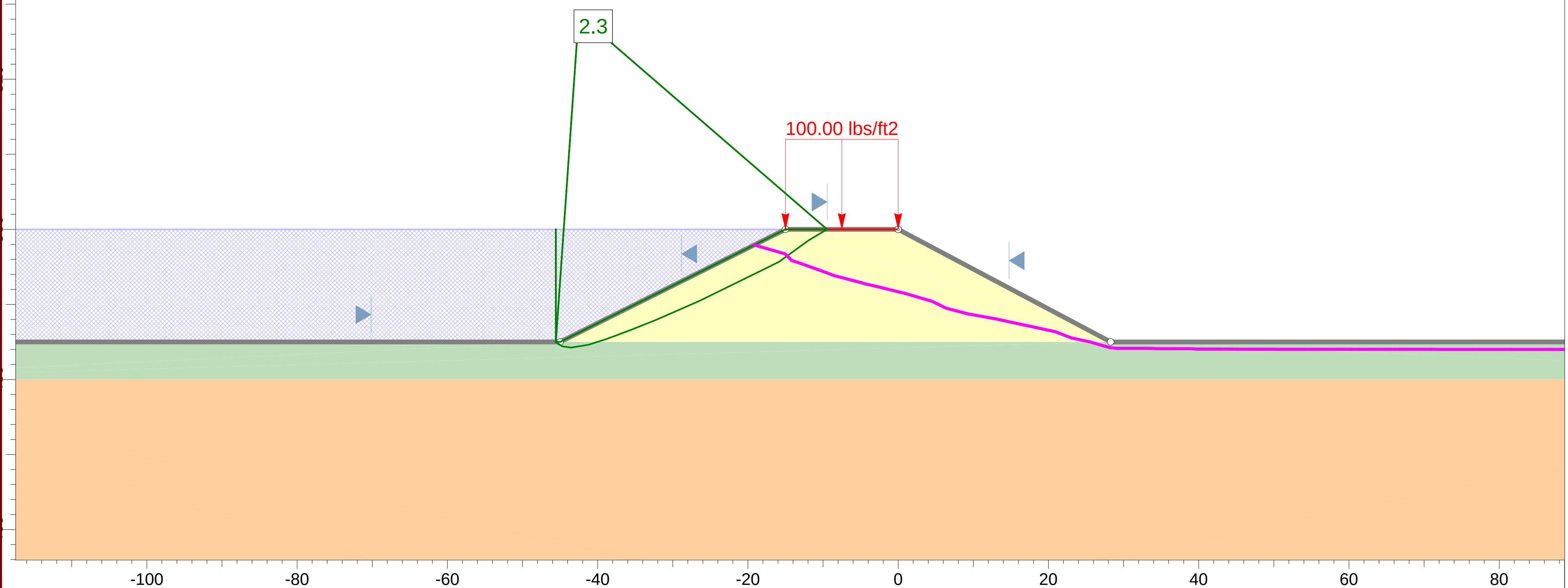
Figure C-8a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "G"
Ash Pond Berms - Spruce/Deely Generation Units

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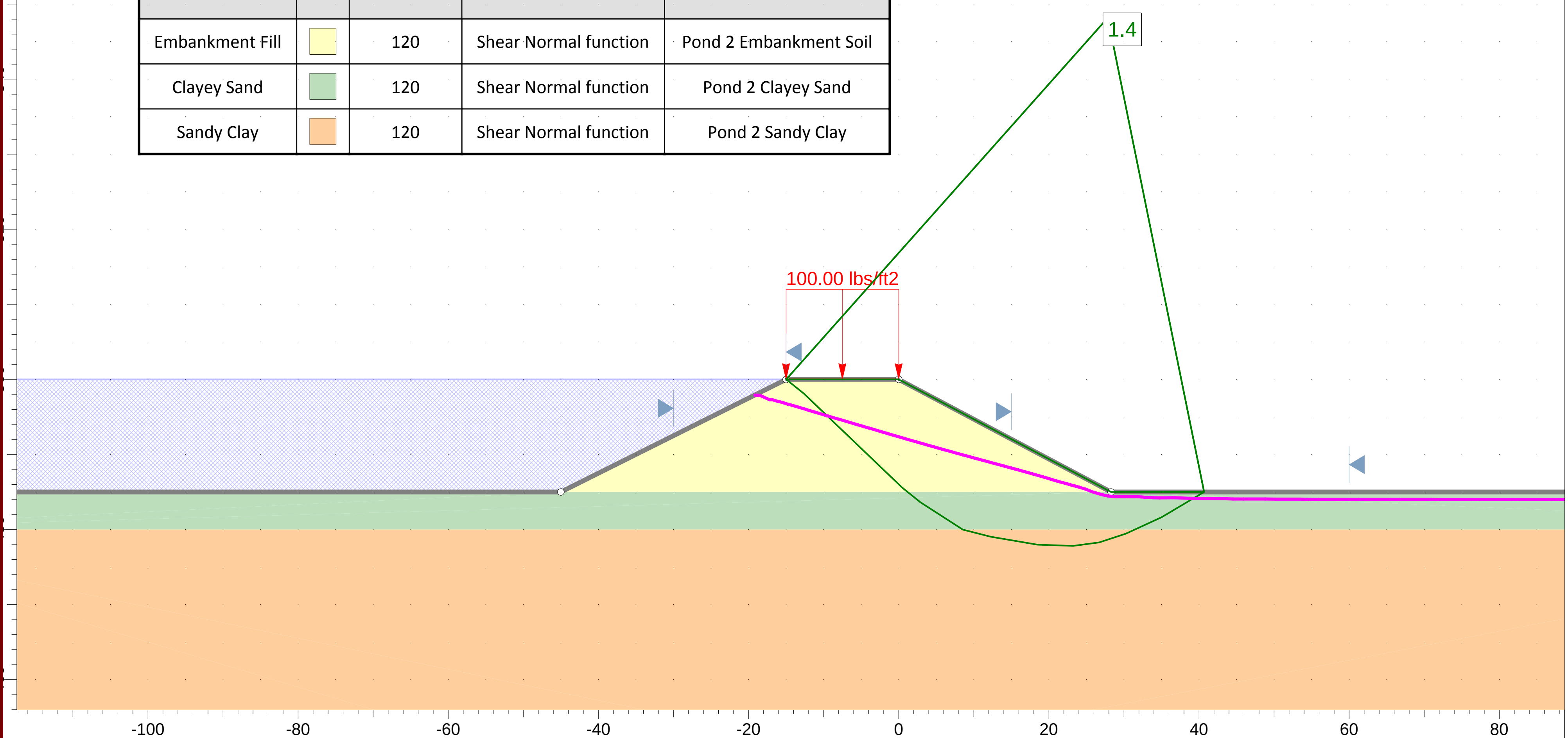
Figure C-8b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "G"
Ash Pond Berms - Spruce/Deely Generation Units

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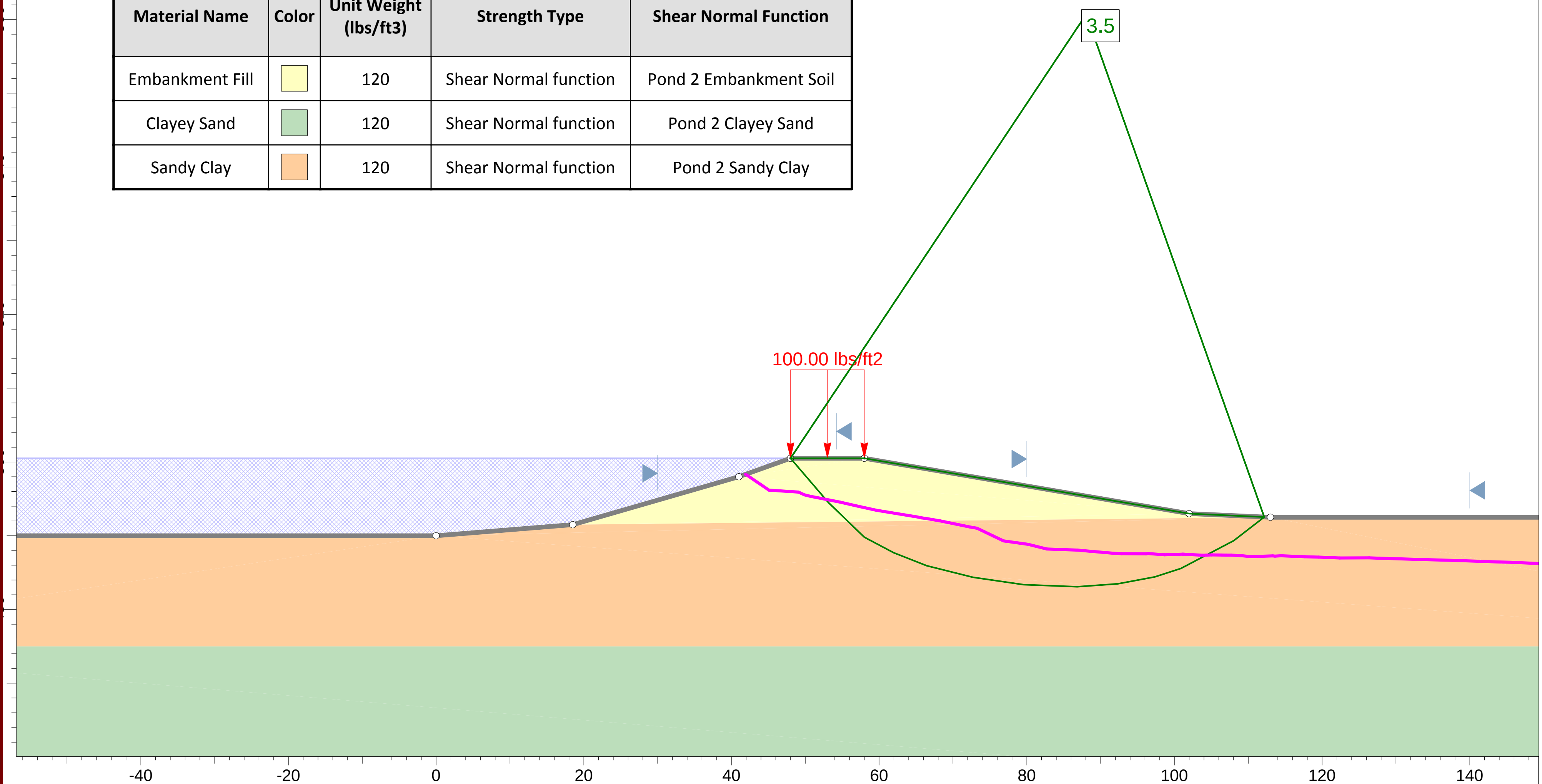
Figure C-8c

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "H"
Ash Pond Berms - Spruce/Deely Generation Units

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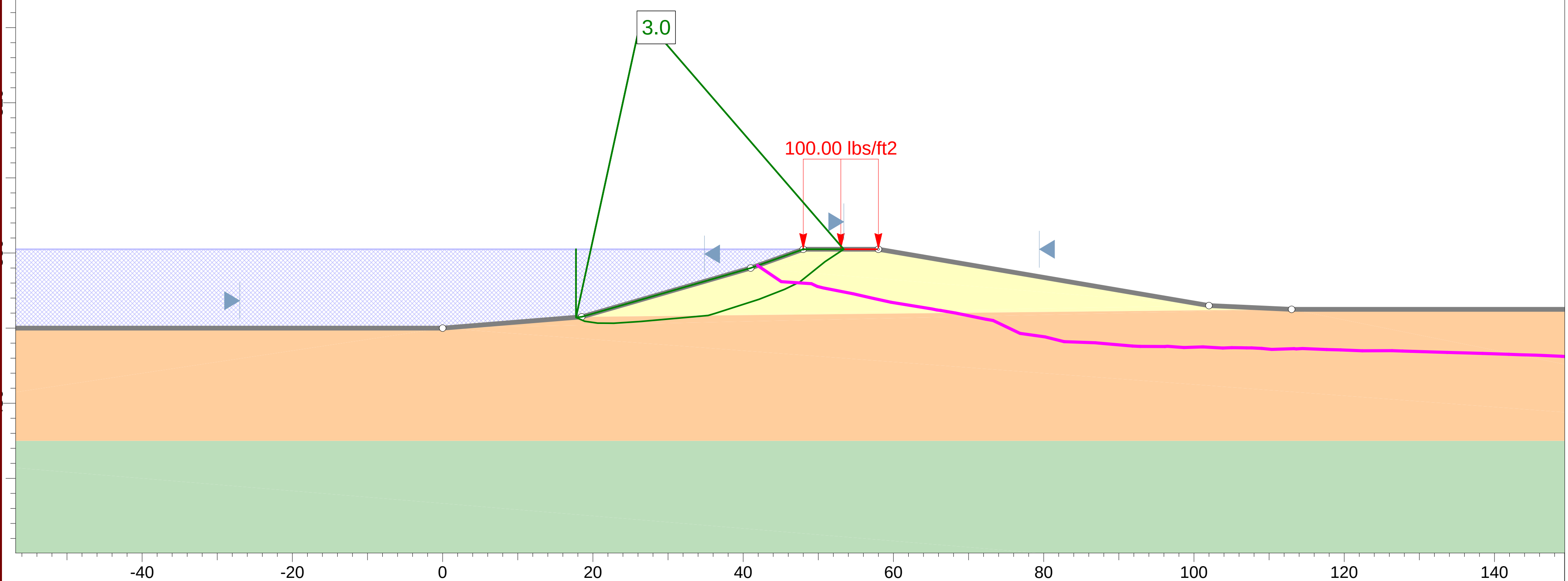
ASA12-098-00

Figure C-9a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "H"
Ash Pond Berms - Spruce/Deely Generation Units

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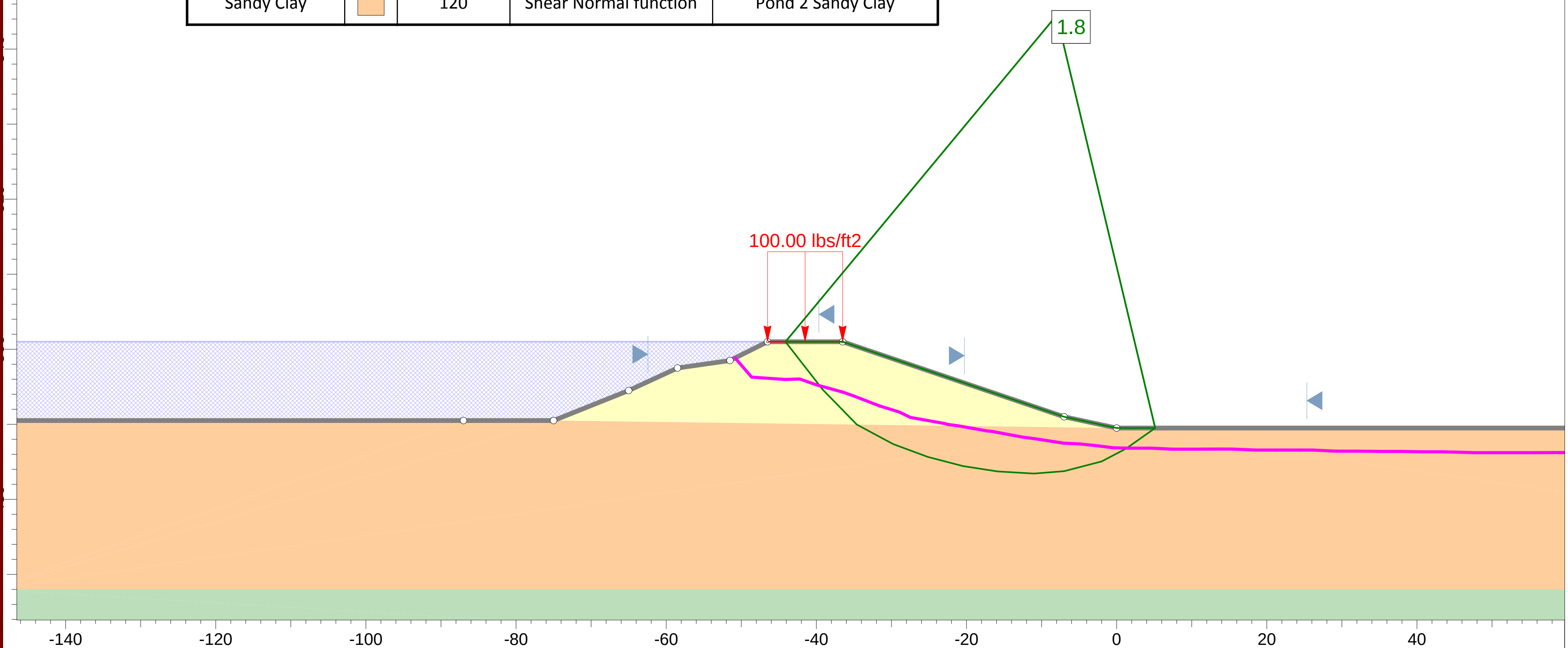
Figure C-9b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "I"
Ash Pond Berms - Spruce/Deely Generation Units

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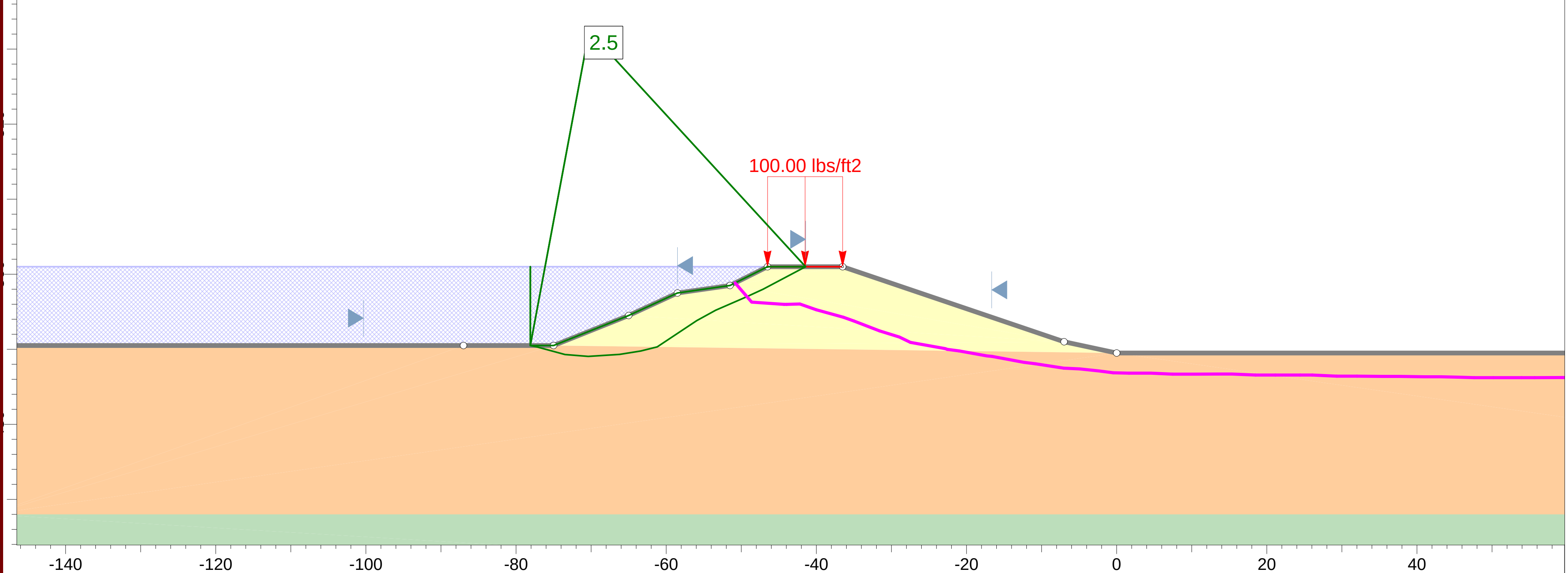
Figure C-10a

RABA KISTNER CONSULTANTS

Global Stability Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay

Profile "I"
Ash Pond Berms - Spruce/Deely Generation Units

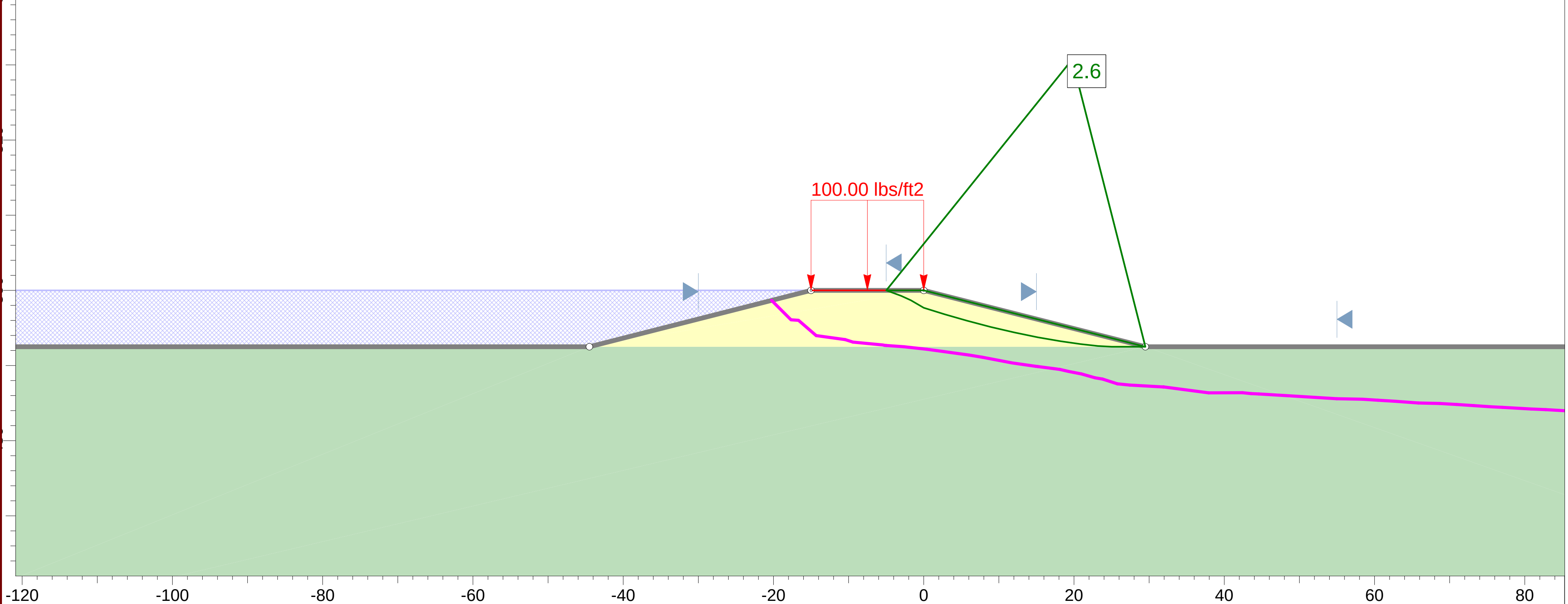
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-10b

RABA KISTNER CONSULTANTS

Global Stability Analysis

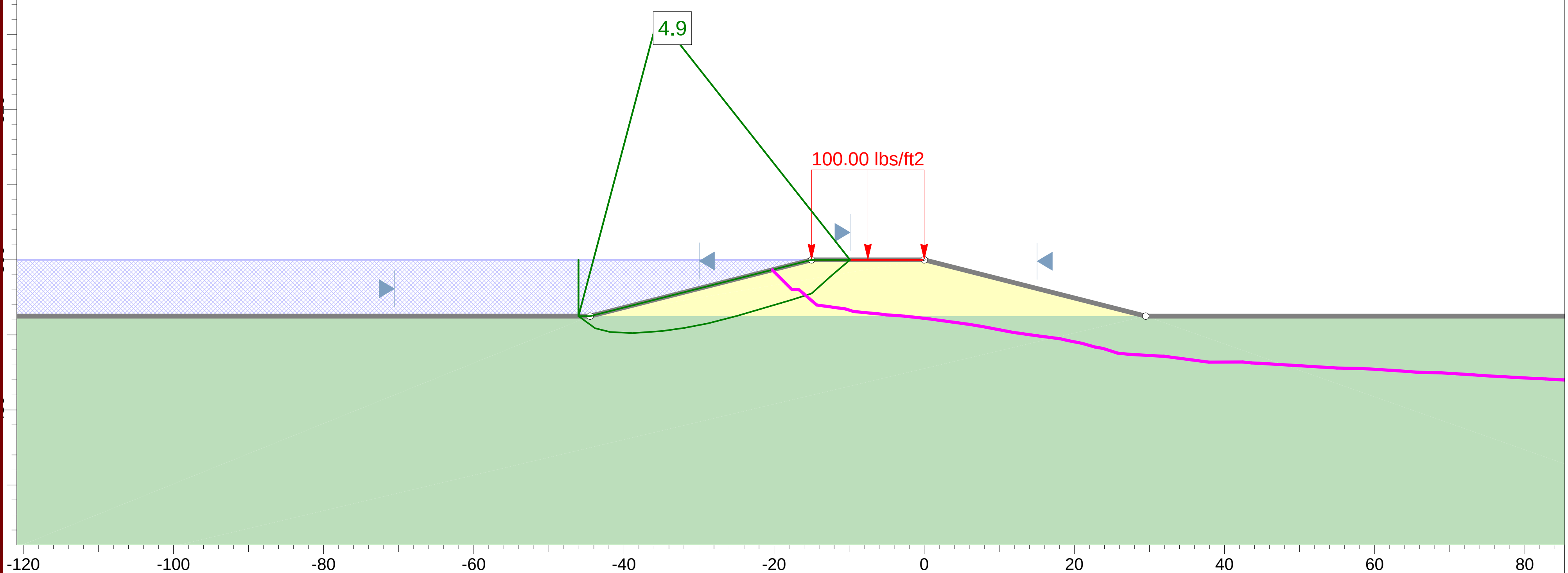
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand



Profile "J" Ash Pond Berms - Spruce/Deely Generation Units	Raba Kistner Consultants, Inc. ASA12-098-00	Figure C-11a RABA KISTNER CONSULTANTS

Global Stability Analysis

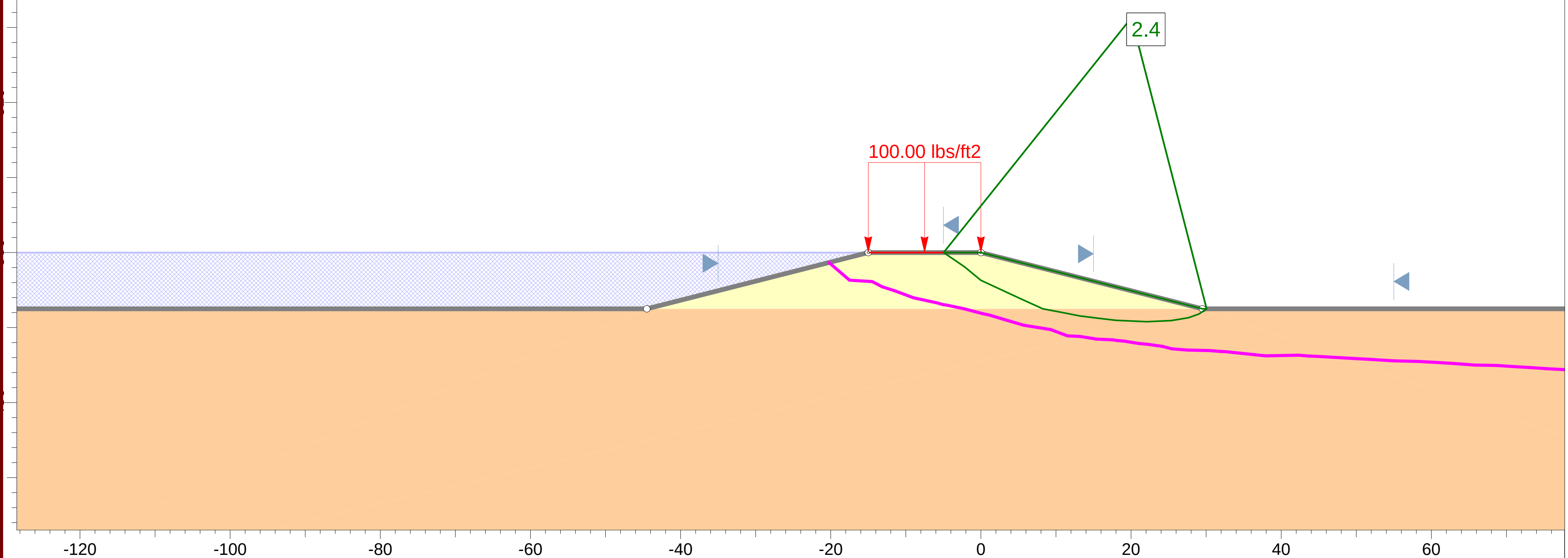
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand



Profile "J" Ash Pond Berms - Spruce/Deely Generation Units	Raba Kistner Consultants, Inc. ASA12-098-00	Figure C-11b RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "K"
Ash Pond Berms - Spruce/Deely Generation Units

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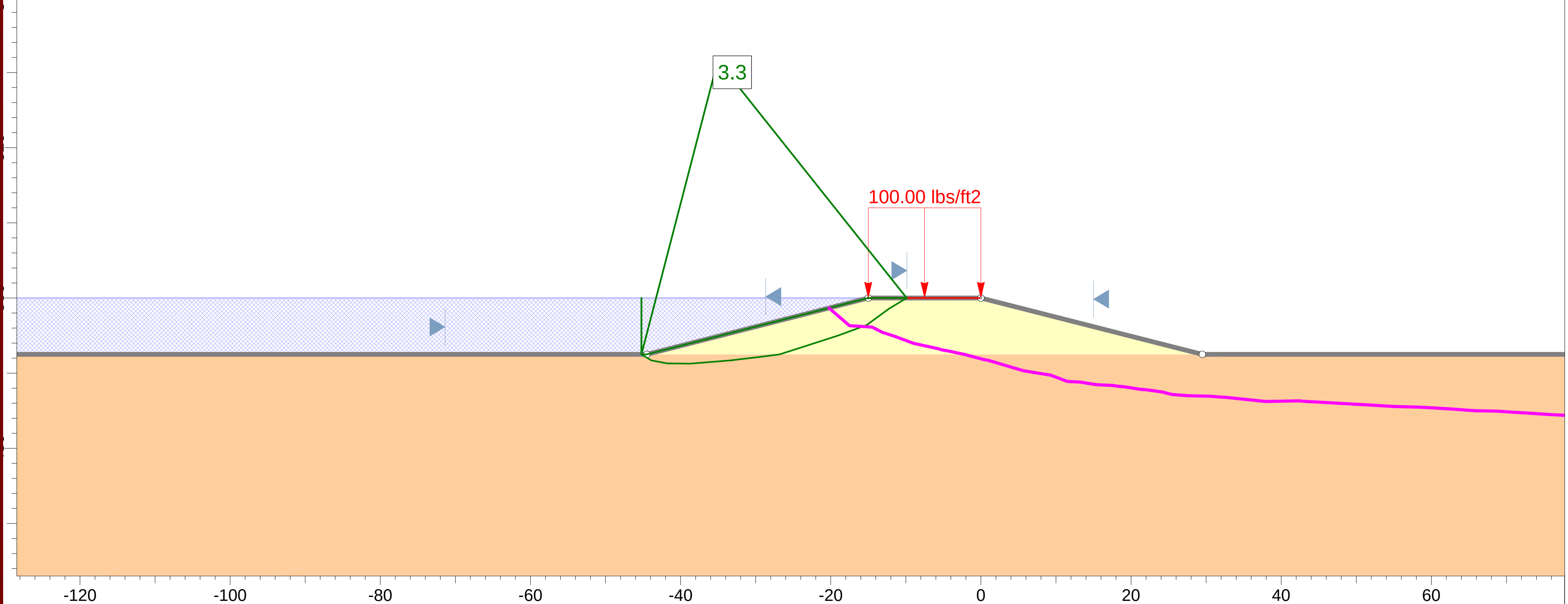
Figure C-12a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "K"
Ash Pond Berms - Spruce/Deely Generation Units

Raba Kistner Consultants, Inc.
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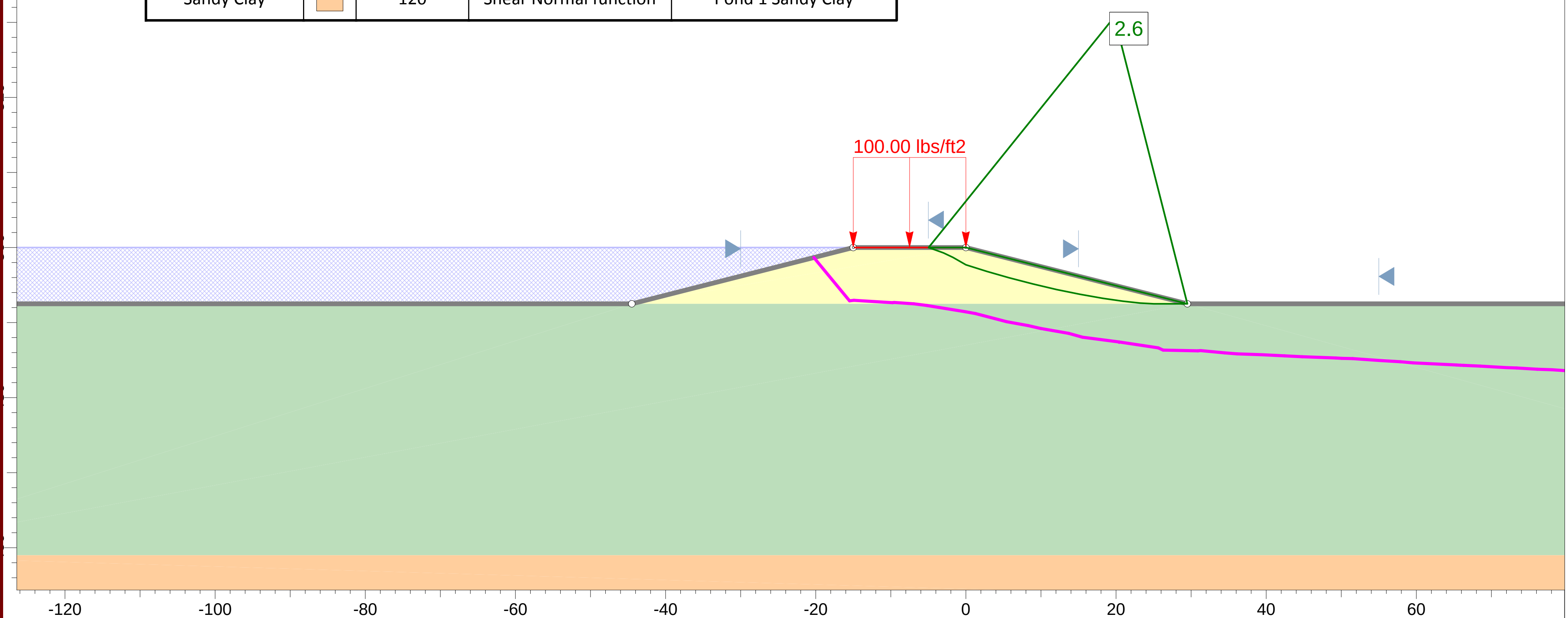
Figure C-12b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "L"
Ash Pond Berms - Spruce/Deely Generation Units

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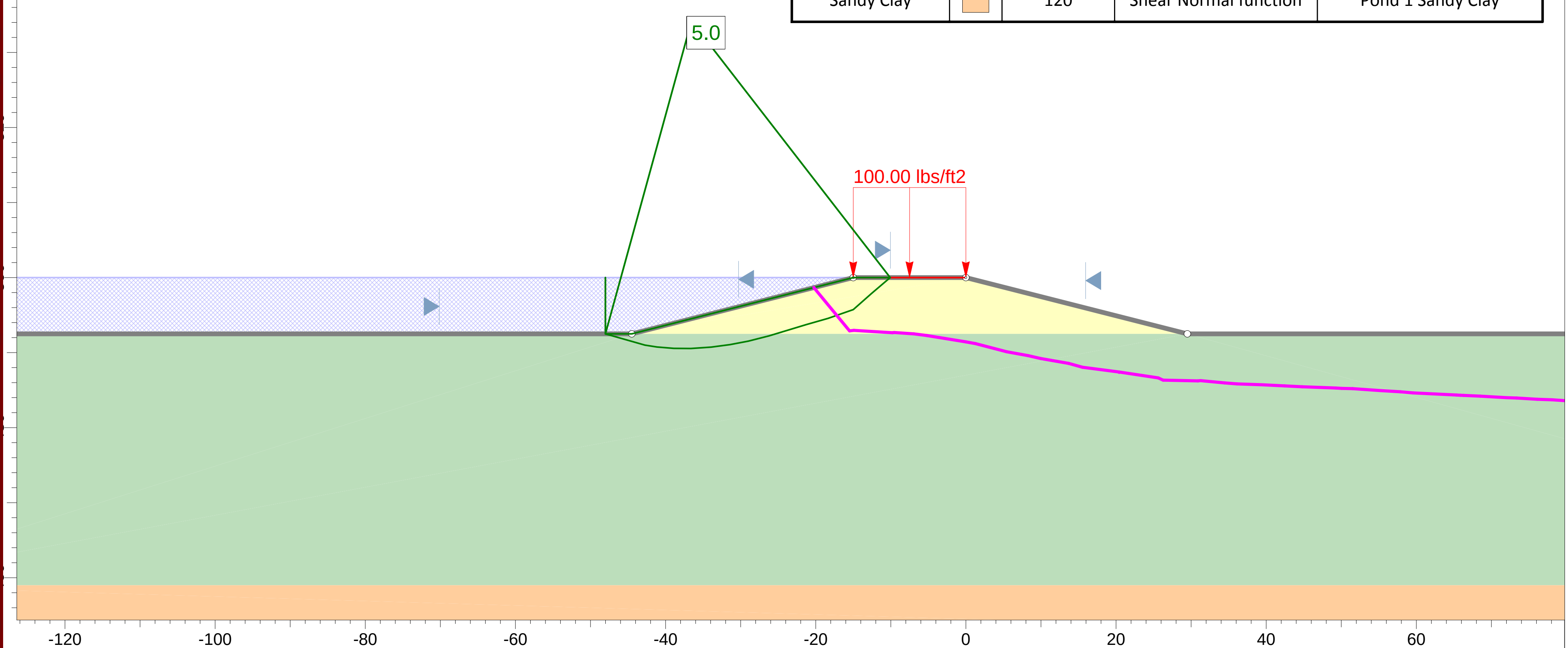
Figure C-13a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "L"
Ash Pond Berms - Spruce/Deely Generation Units

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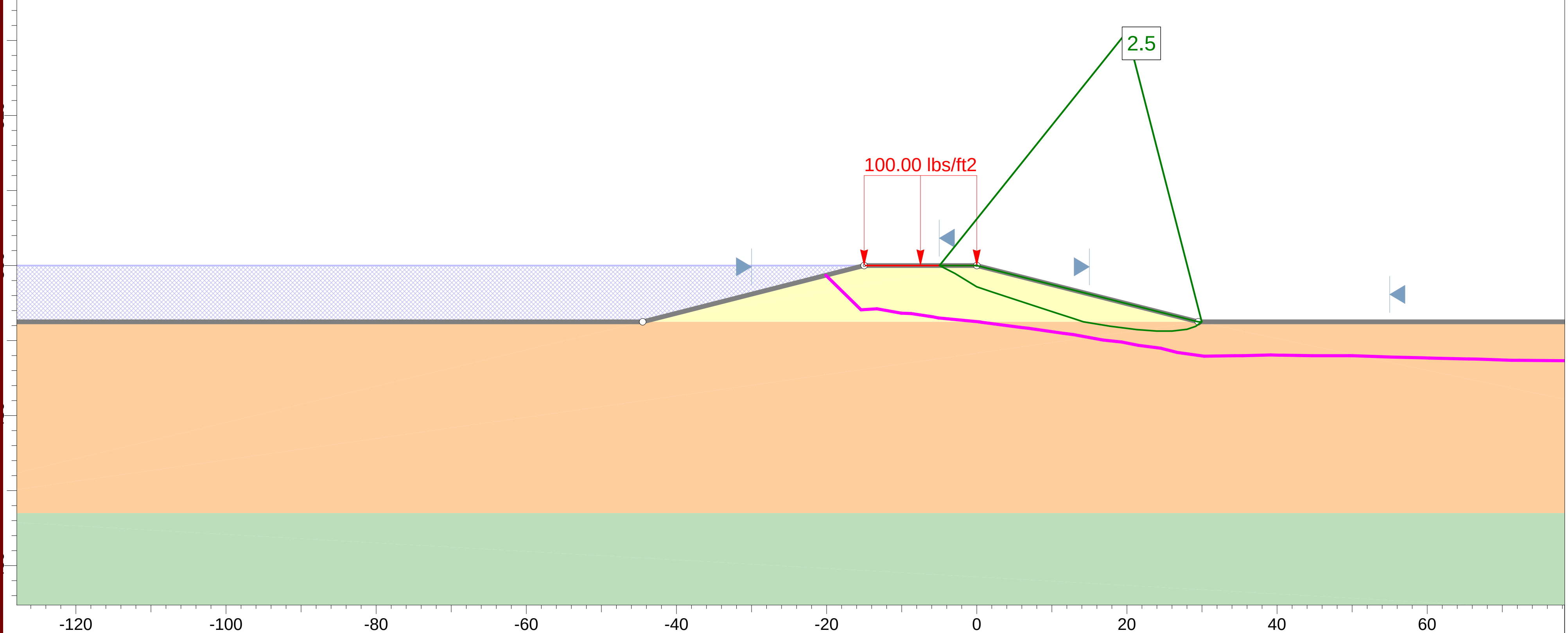
Figure C-13b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "M"
Ash Pond Berms - Spruce/Deely Generation Units

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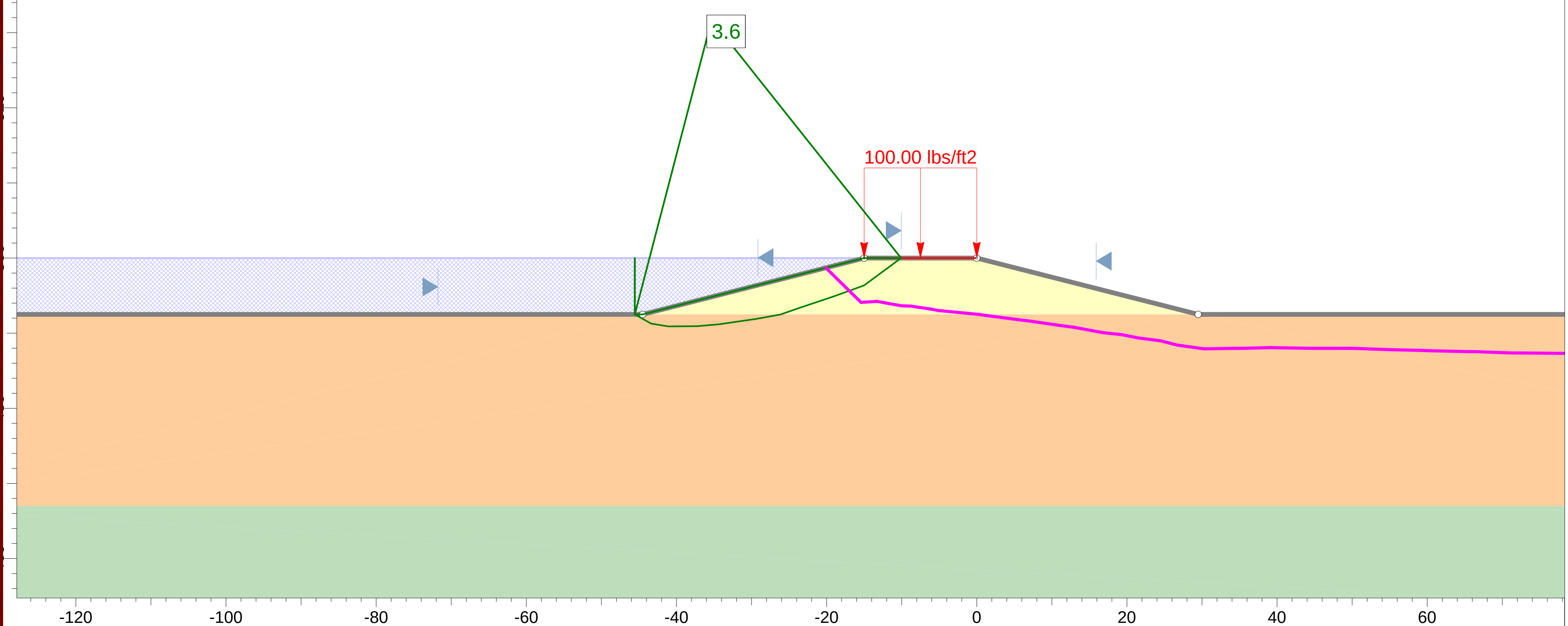
Figure C-14a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "M"
Ash Pond Berms - Spruce/Deely Generation Units

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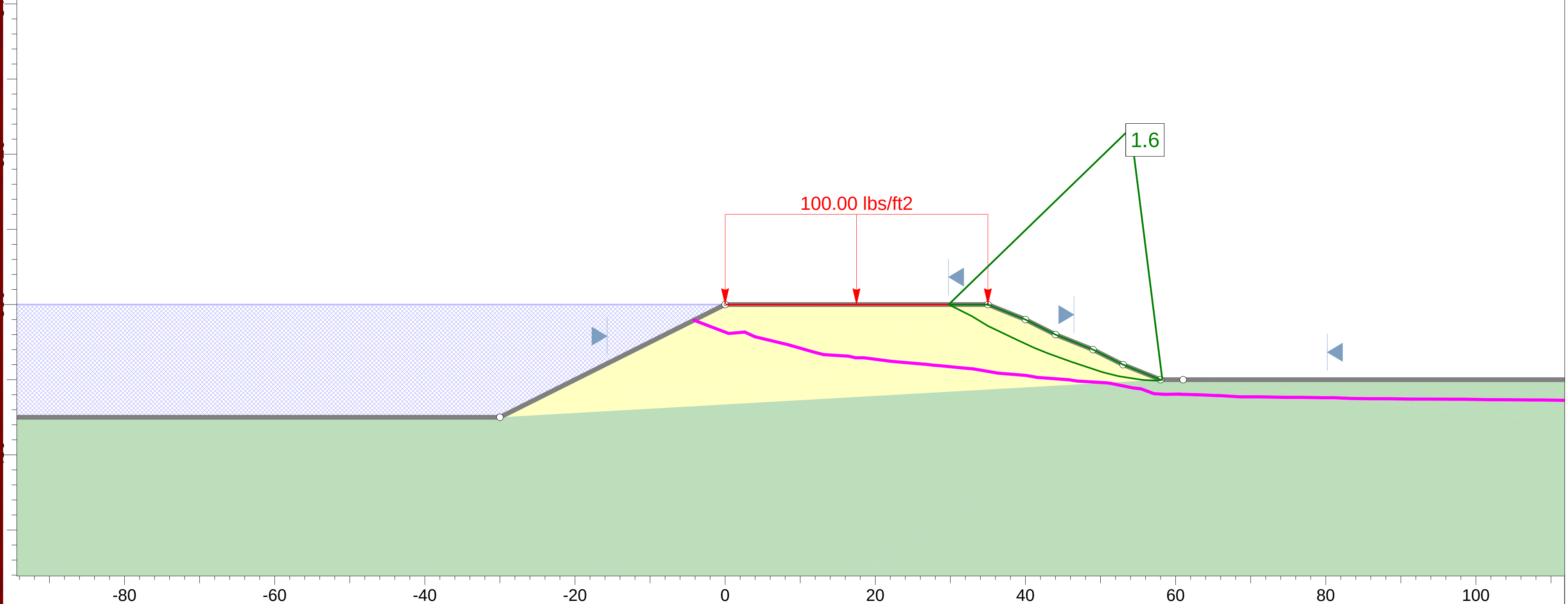
Figure C-14b

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand



Profile "N"
Ash Pond Berms - Spruce/Deely Generation Units

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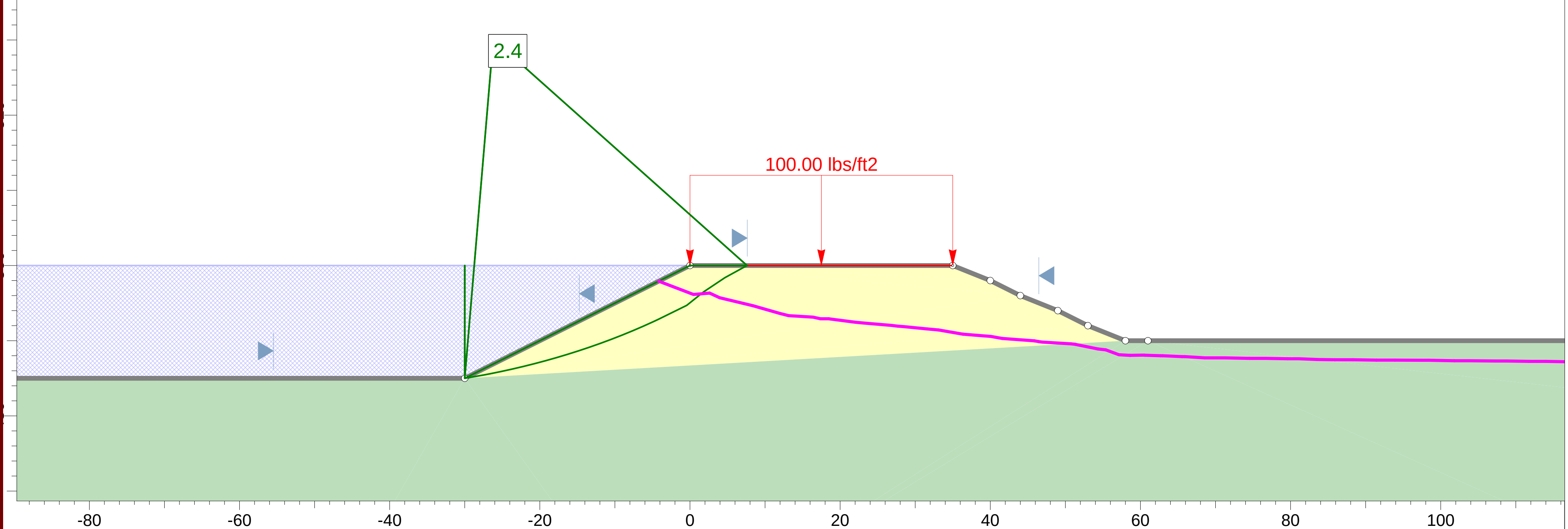
Figure C-15a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand



Profile "N"
Ash Pond Berms - Spruce/Deely Generation Units

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Figure C-15b

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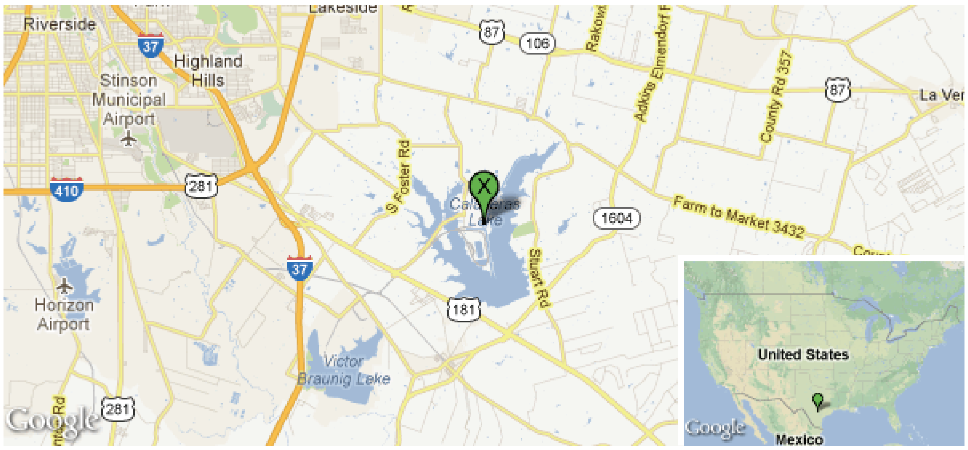
APPENDIX D

SEISMIC ANALYSES

Design Maps Summary Report

User–Specified Input

Building Code Reference Document	2009 NEHRP Recommended Seismic Provisions (which makes use of 2008 USGS hazard data)
Site Coordinates	29.30821°N, 98.3168°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

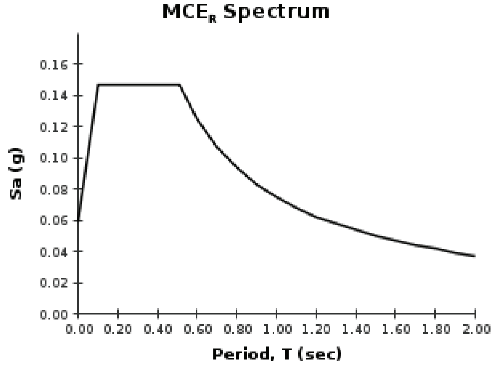


USGS–Provided Output

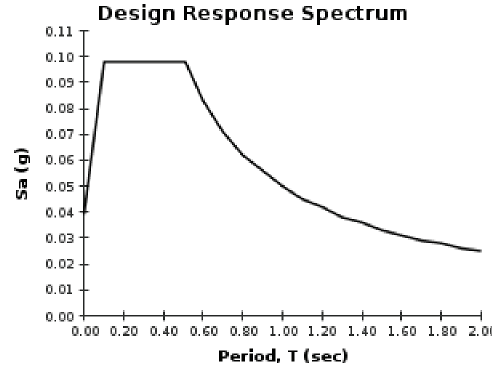
S_S =	0.092 g	S_{MS} =	0.147 g	S_{DS} =	0.098 g
S_1 =	0.031 g	S_{M1} =	0.075 g	S_{D1} =	0.050 g

For information on how the S_S and S_1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please view the detailed report.

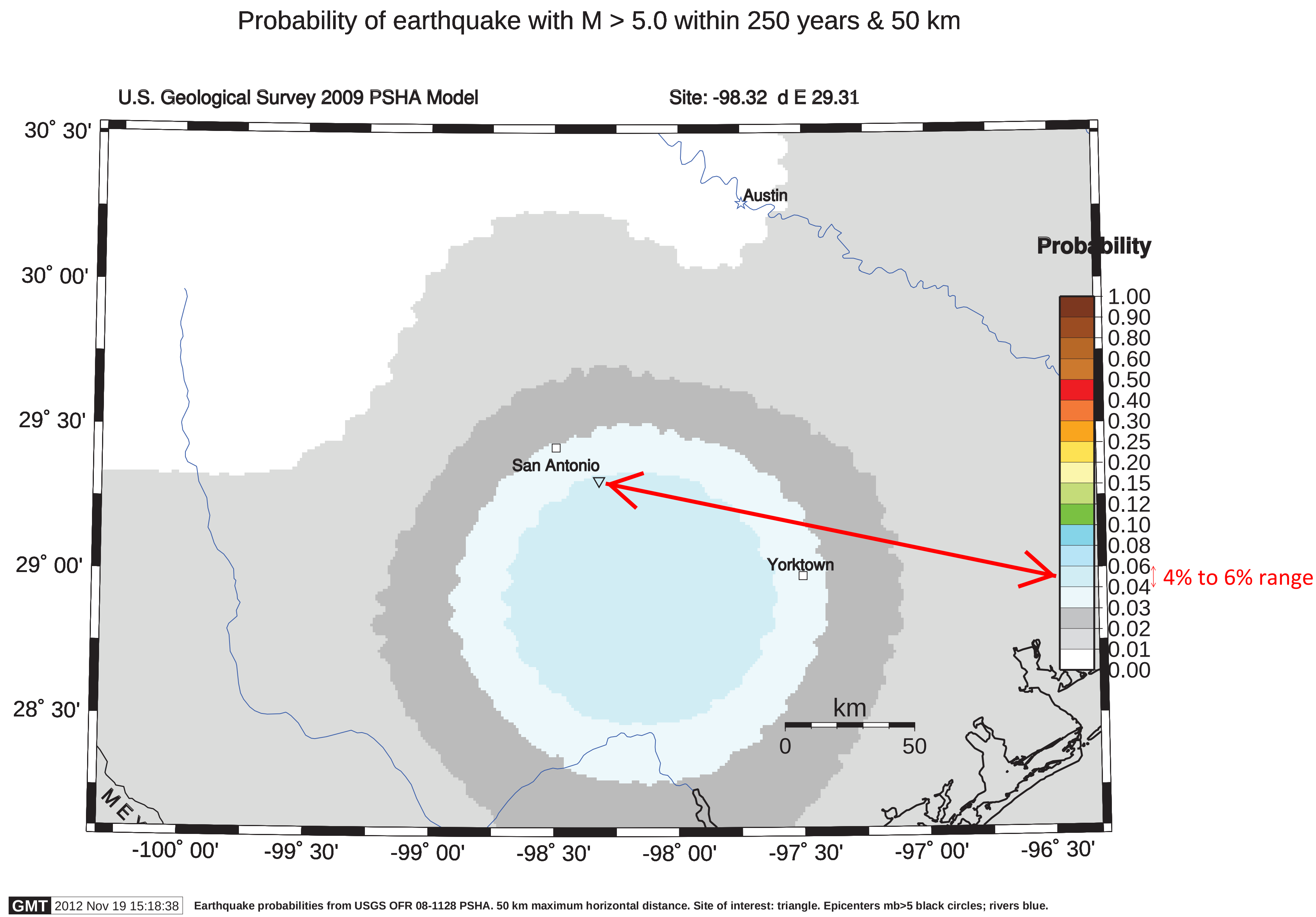
MCE_R Spectrum



Design Response Spectrum



For PGA_M, T_L, C_{RS}, and C_{R1} values, please view the detailed report.



ASA12-098-00
Figure D-2

Design Maps Detailed Report

2009 NEHRP Recommended Seismic Provisions (29.30821°N, 98.3168°W)

Section 11.4.1 — Mapped Acceleration Parameters and Risk Coefficients

Note: Ground motion values contoured on Figures 22-1, 2, 5, & 6 below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_{SUH} and S_{SD}) and 1.3 (to obtain S_{1UH} and S_{1D}). Maps in the 2009 NEHRP Provisions are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

Figure 22–1: Uniform–Hazard (2% in 50–Year) Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

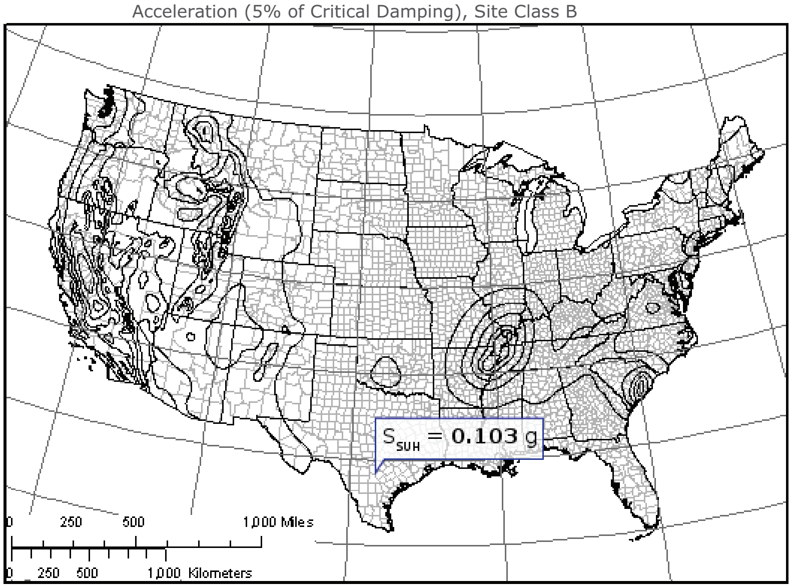
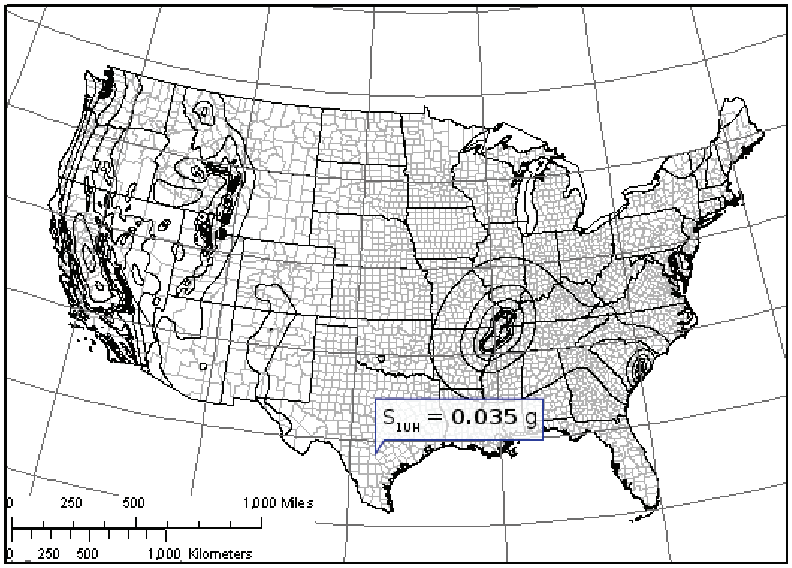


Figure 22–2: Uniform–Hazard (2% in 50–Year) Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B



S_{1UH} = 0.035 g
0 250 500 1,000 Miles
0 250 500 1,000 Kilometers

Figure 22–3: Risk Coefficient at 0.2-Second Spectral Response Period

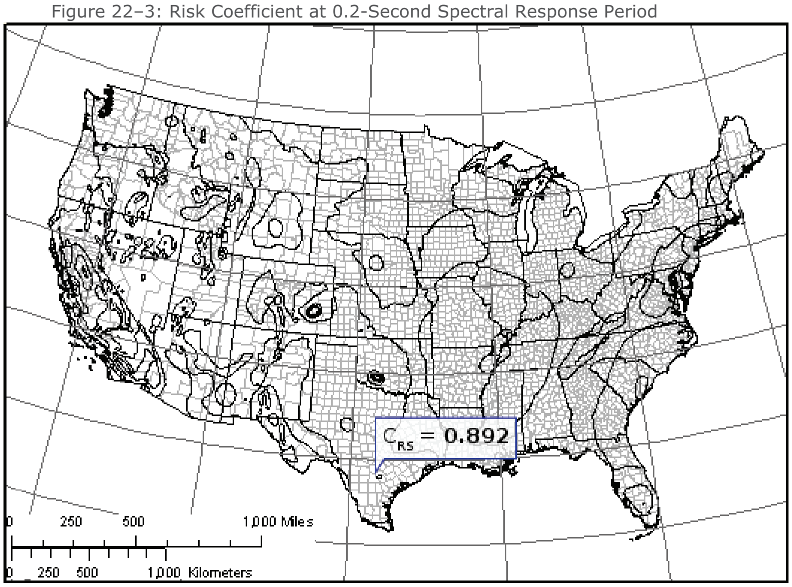


Figure 22–4: Risk Coefficient at 1.0-Second Spectral Response Period

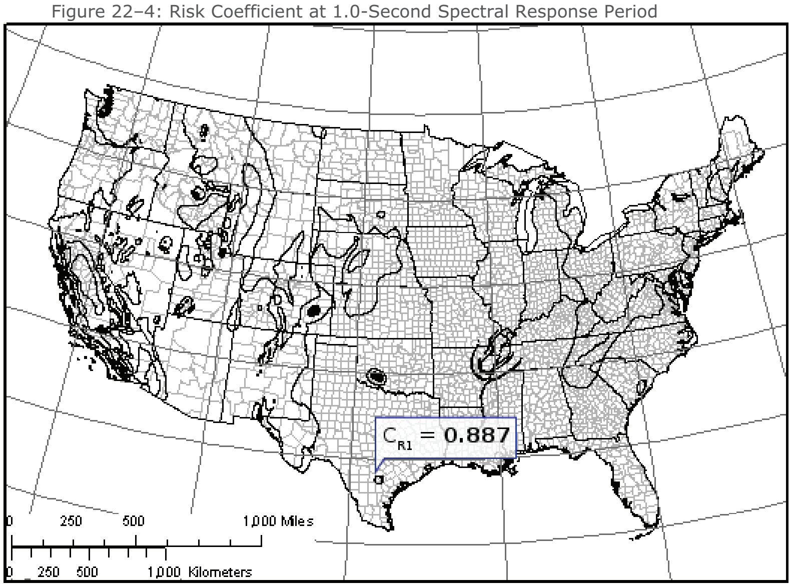


Figure 22–5: Deterministic Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

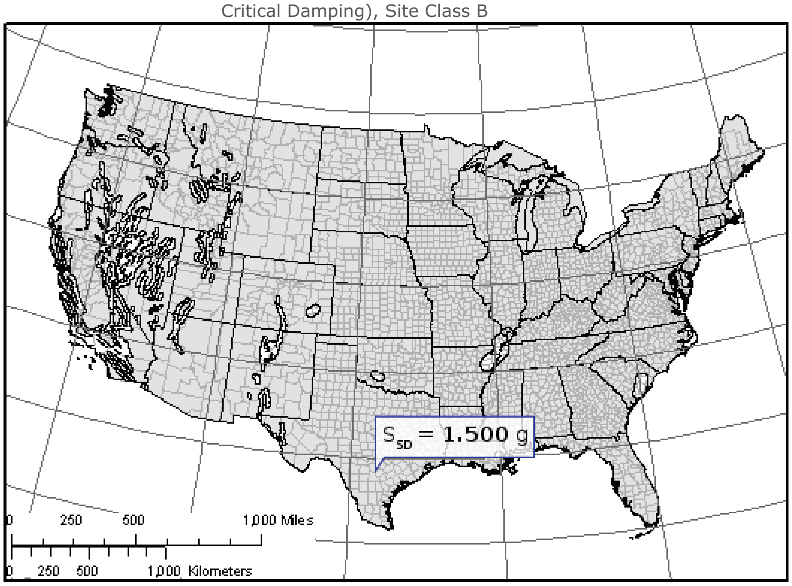
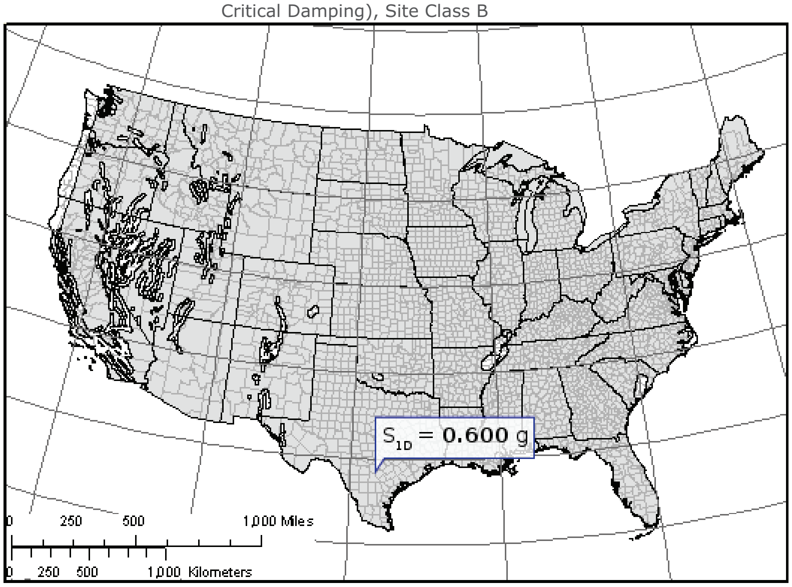


Figure 22–6: Deterministic Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B



Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content *w* ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 11.4.3 — Site Coefficients, Risk Coefficients, and Risk–Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Equation (11.4–1): $C_{RS}S_{SUH}$ = 0.892 x 0.103 = 0.092 g

Equation (11.4–2): S_{SD} = 1.500 g

S_S ≡ "Lesser of values from Equations (11.4–1) and (11.4–2)" = 0.092 g

Equation (11.4–3): $C_{R1}S_{1UH}$ = 0.887 x 0.035 = 0.031 g

Equation (11.4–4): S_{1D} = 0.600 g

S_1 ≡ "Lesser of values from Equations (11.4–3) and (11.4–4)" = 0.031 g

Table 11.4–1: Site Coefficient F_a

Site Class	Spectral Response Acceleration Parameter at Short Period				
	$S_S \le 0.25$	$S_S = 0.5$	$S_S = 0.75$	$S_S = 1$	$S_S \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 0.092 g, F_a = 1.600

Table 11.4–2: Site Coefficient F_v

Site Class	Spectral Response Acceleration Parameter at 1–Second Period				
	$S_1 \le 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \ge 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.031 g, F_v = 2.400

Equation (11.4–5):	$S_{MS} = F_aS_S = 1.600 \times 0.092 = 0.147$ g
Equation (11.4–6):	$S_{M1} = F_vS_1 = 2.400 \times 0.031 = 0.075$ g

Section 11.4.4 — Design Spectral Acceleration Parameters

Equation (11.4–7):	$S_{DS} = ⅔ S_{MS} = ⅔ \times 0.147 = 0.098$ g
Equation (11.4–8):	$S_{D1} = ⅔ S_{M1} = ⅔ \times 0.075 = 0.050$ g

Section 11.4.5 — Design Response Spectrum

Figure 22–7: Long–period Transition Period, T_L (s)

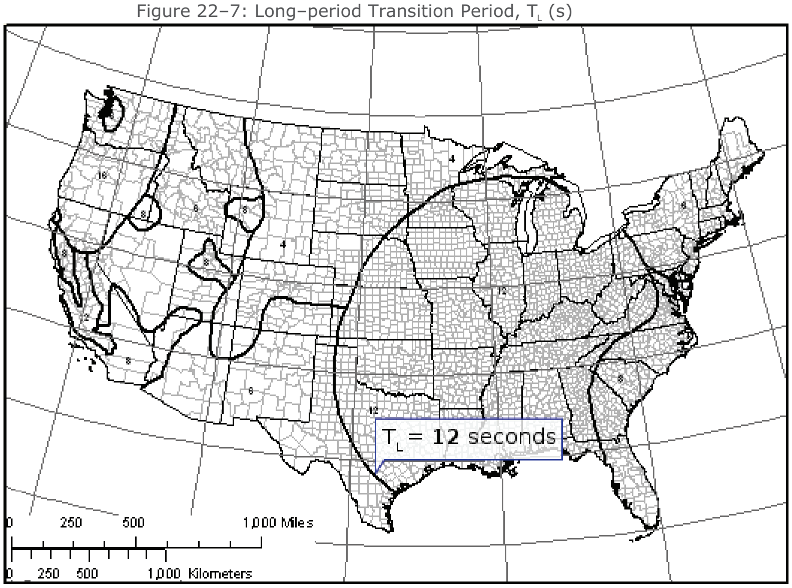
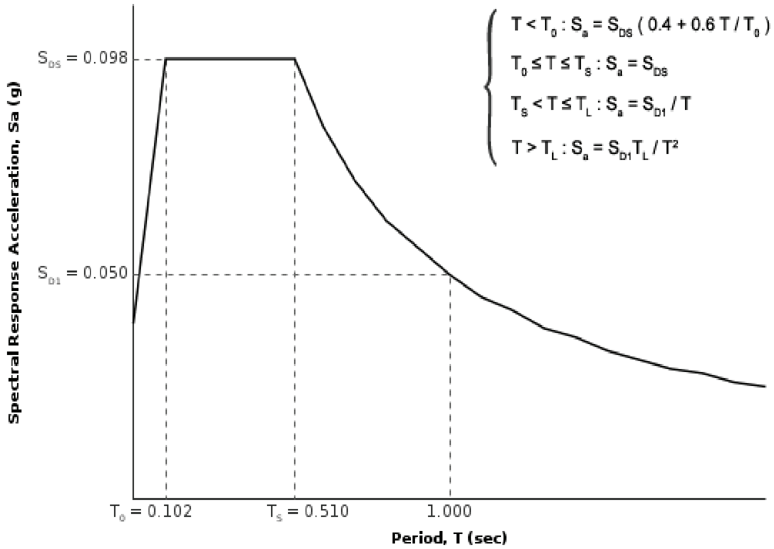
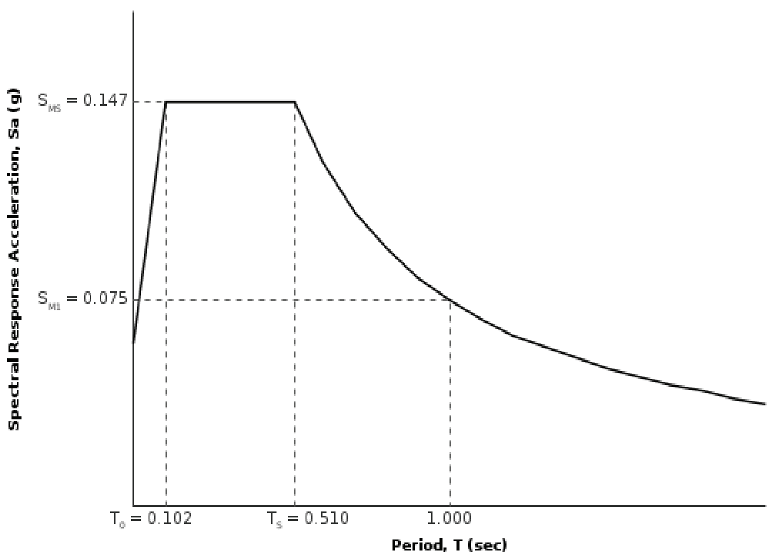


Figure 11.4–1: Design Response Spectrum



Section 11.4.6 — MCE_R Response Spectrum

The MCE_R response spectrum is determined by multiplying the design response spectrum above by 1.5.



ASA12-098-00
Figure D-10

Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

Table 11.8–1: Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.1	PGA = 0.2	PGA = 0.3	PGA = 0.4	PGA ≥ 0.5
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.047 g, F_{PGA} = 1.600

Mapped PGA	PGA = 0.047 g
Equation (11.8–1):	$PGA_M = F_{PGA}PGA$ = 1.600 x 0.047 = 0.075 g

STRUCTURAL COMPONENTS AND SYSTEMS

For the Seismic Retrofit of Tilt-Up Buildings

Seismic Intensity Scales vs Peak Ground Acceleration

Modified Mercalli Scale and PGA	
MMI	**PGA (g)**
IV	0.03 and below
V	0.03 - 0.08
VI	0.08 - 0.15
VII	0.15 - 0.25
VIII	0.25 - 0.45
IX	0.45 - 0.60
X	0.60 - 0.80
XI	0.80 - 0.90
XII	0.90 and above

The above table shows the approximate relationship between Modified Mercalli Intensity and Peak Ground Acceleration (PGA).

Richter Magnitude, PGA, and Duration		
Richter Magnitude	**PGA (g)**	**Duration (seconds)**
5.0	0.09	2
5.5	0.15	6
6.0	0.22	12

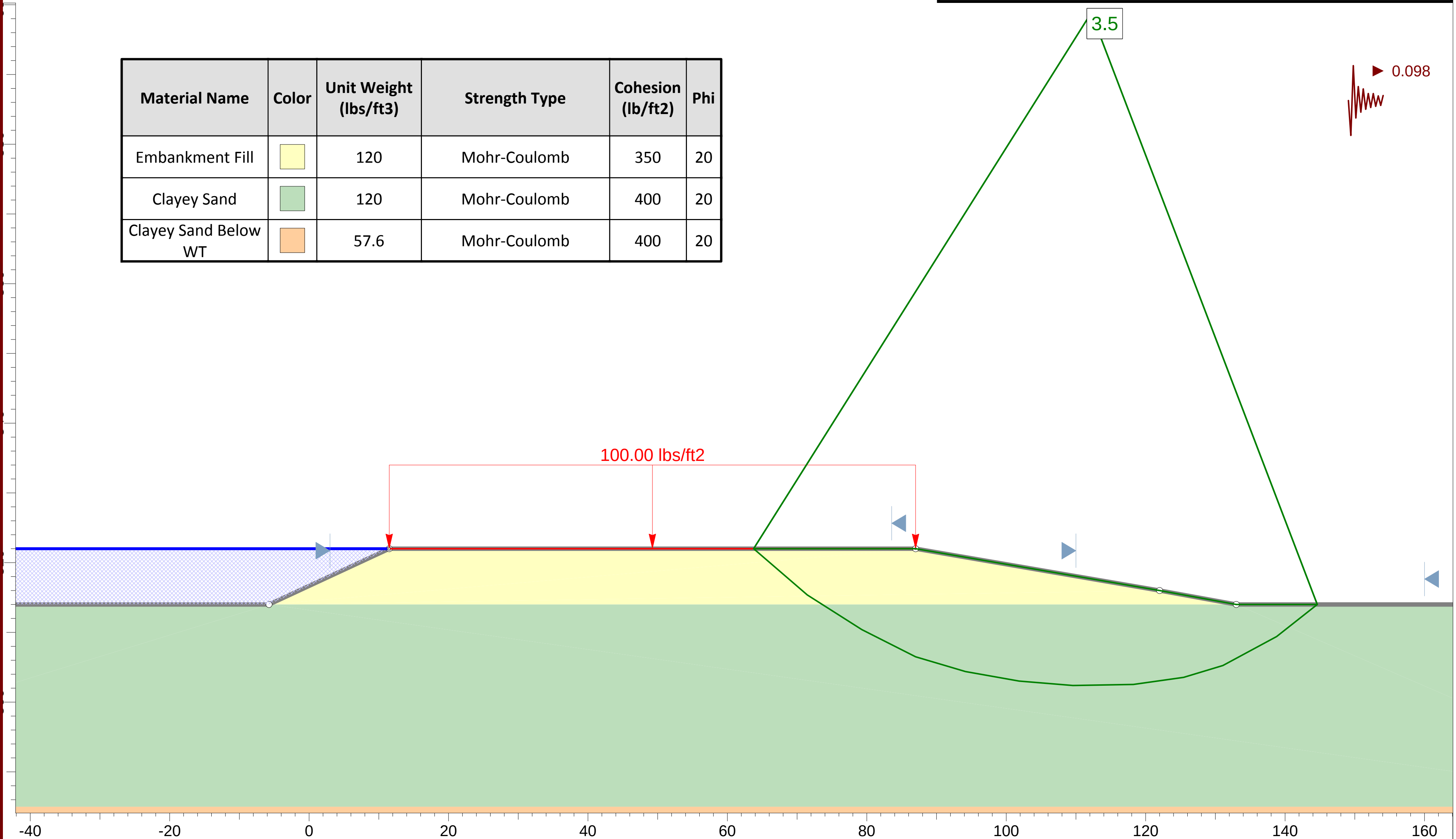
6.5	0.29	18
7.0	0.37	24
7.5	0.45	30
8.0	0.50	34
8.5	0.50	37

The above table shows the approximate relationship between Richter Magnitude, Peak Ground Acceleration (PGA), and duration of strong-phase shaking near the epicenter of earthquakes located in California.

< Prev Next >

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



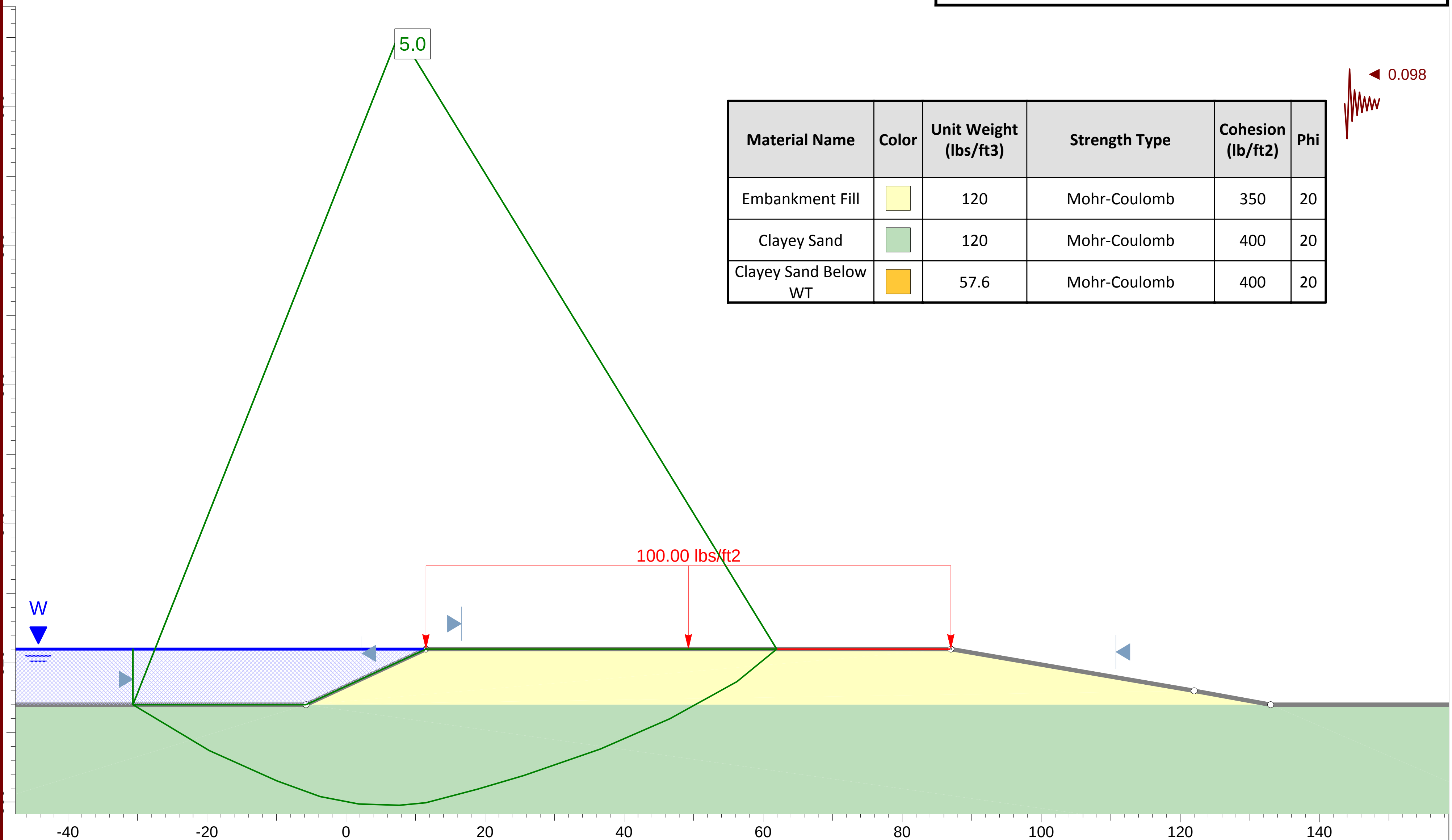
Profile "A"
Ash Pond Berms - Spruce/Deely Generation Units

Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-14a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "A"
Ash Pond Berms - Spruce/Deely Generation Units

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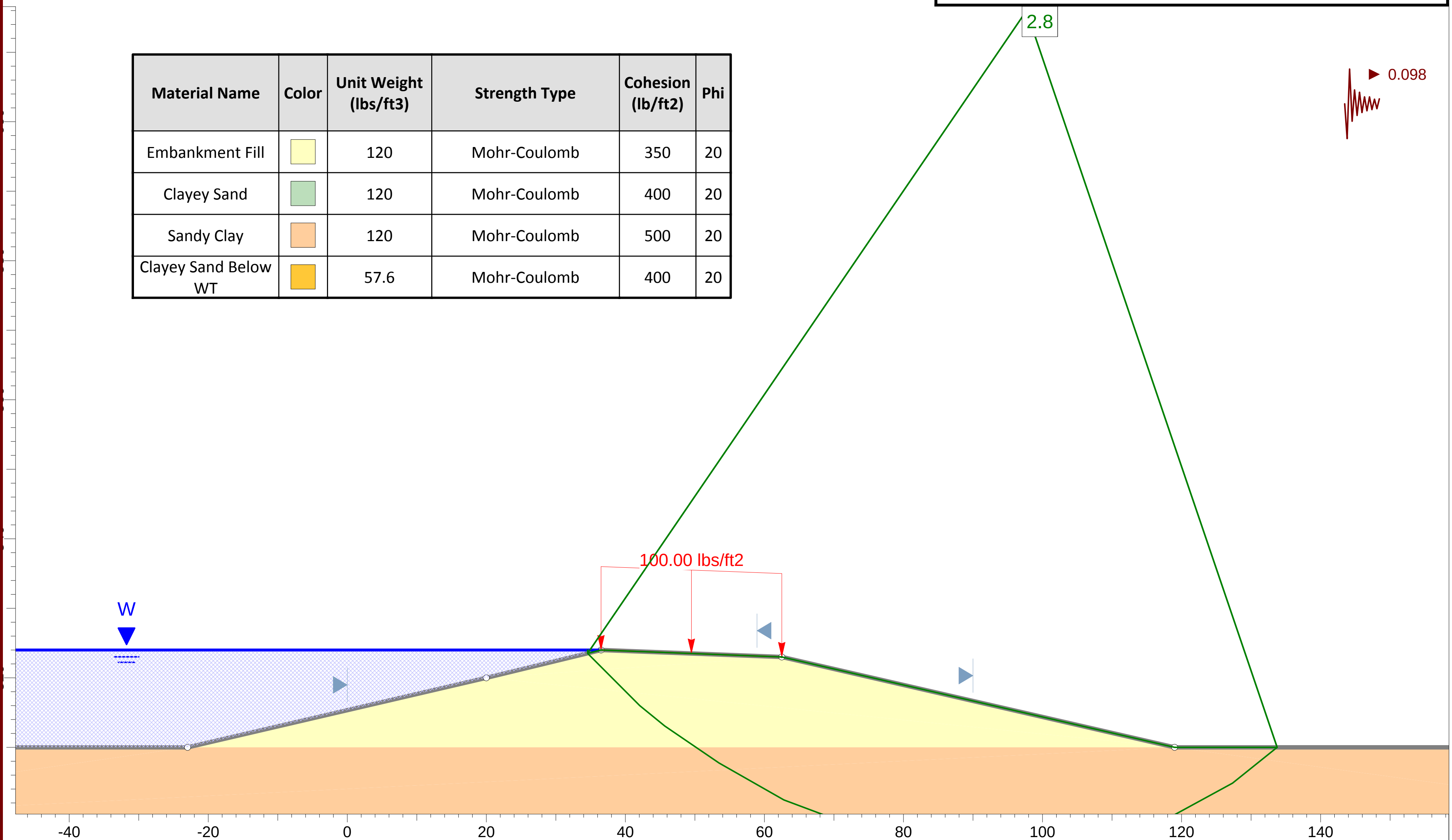
Figure D-14b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "B"
Ash Pond Berms - Spruce/Deely Generation Units

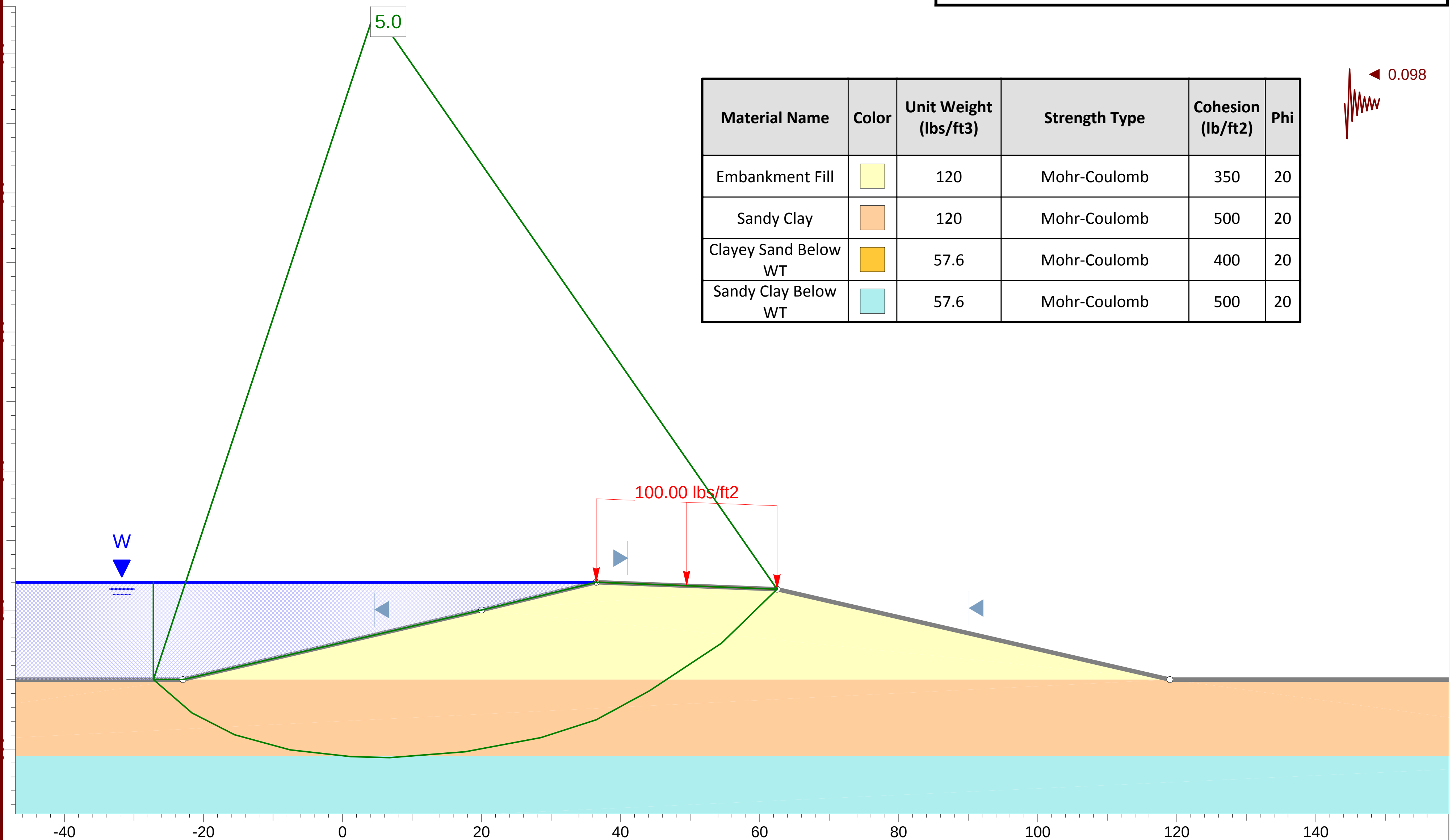
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-15a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "B"
Ash Pond Berms - Spruce/Deely Generation Units

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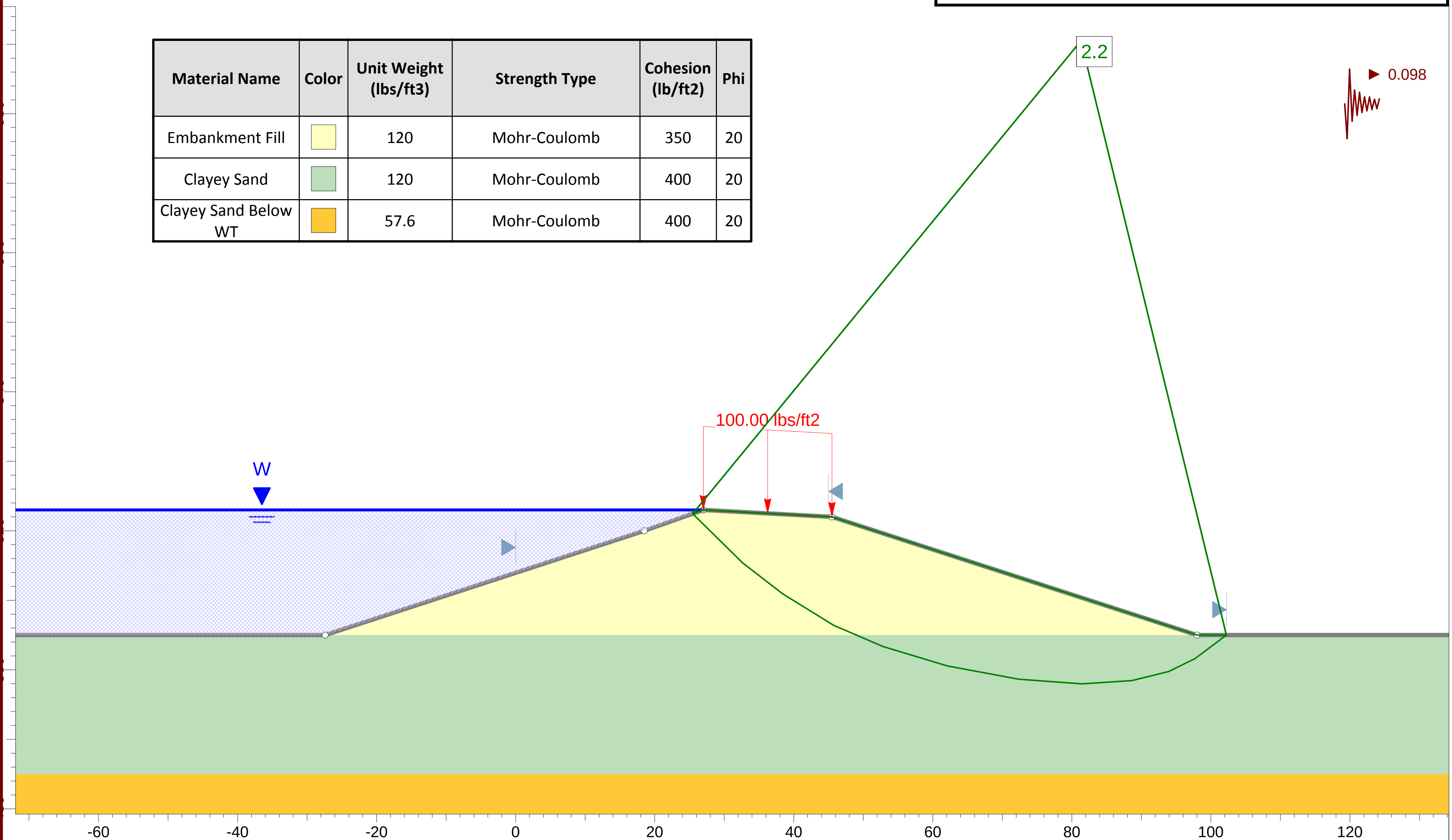
ASA12-098-00

Figure D-15b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "C"
Ash Pond Berms - Spruce/Deely Generation Units

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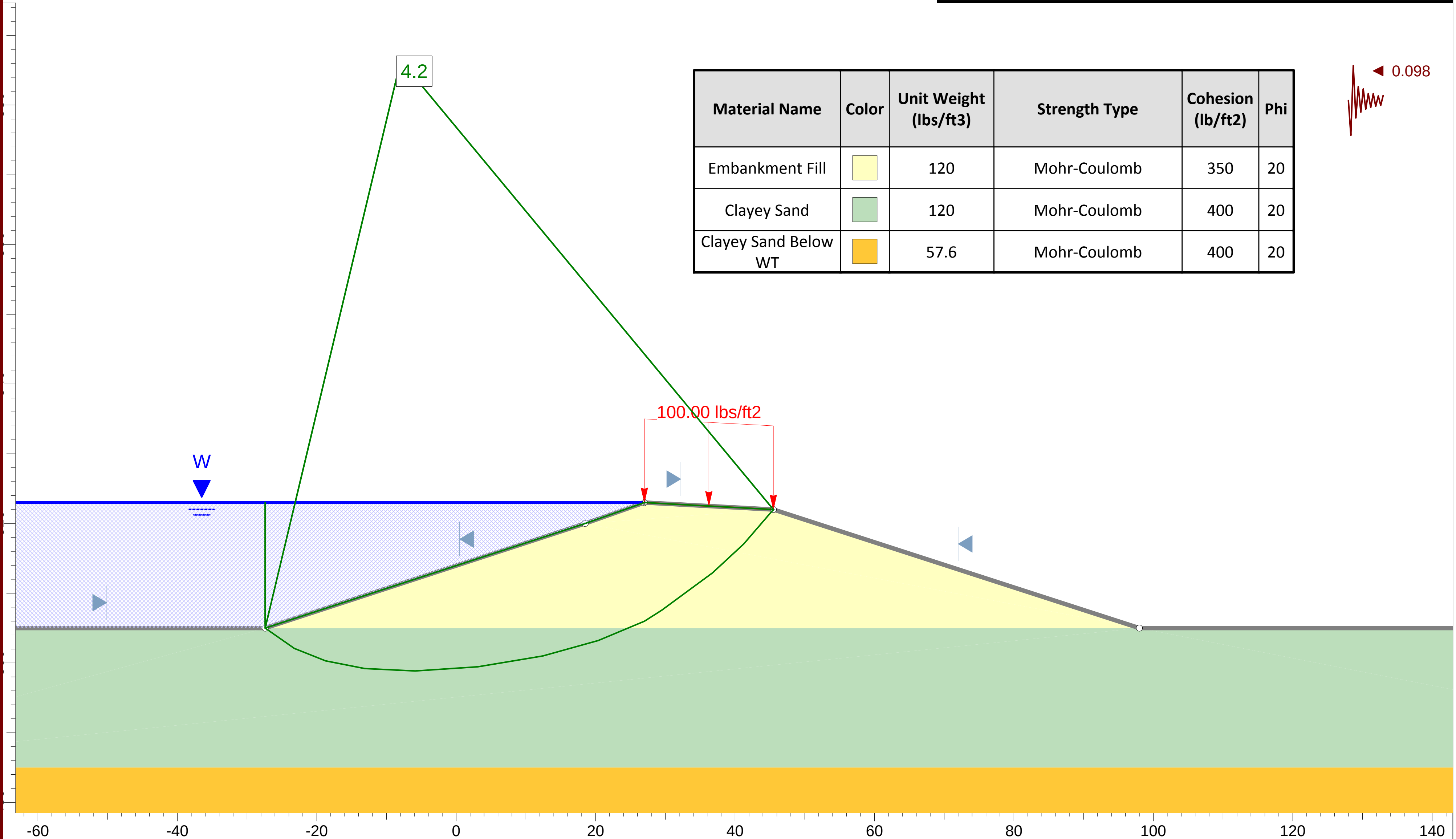
ASA12-098-00

Figure D-16a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "C"
Ash Pond Berms - Spruce/Deely Generation Units

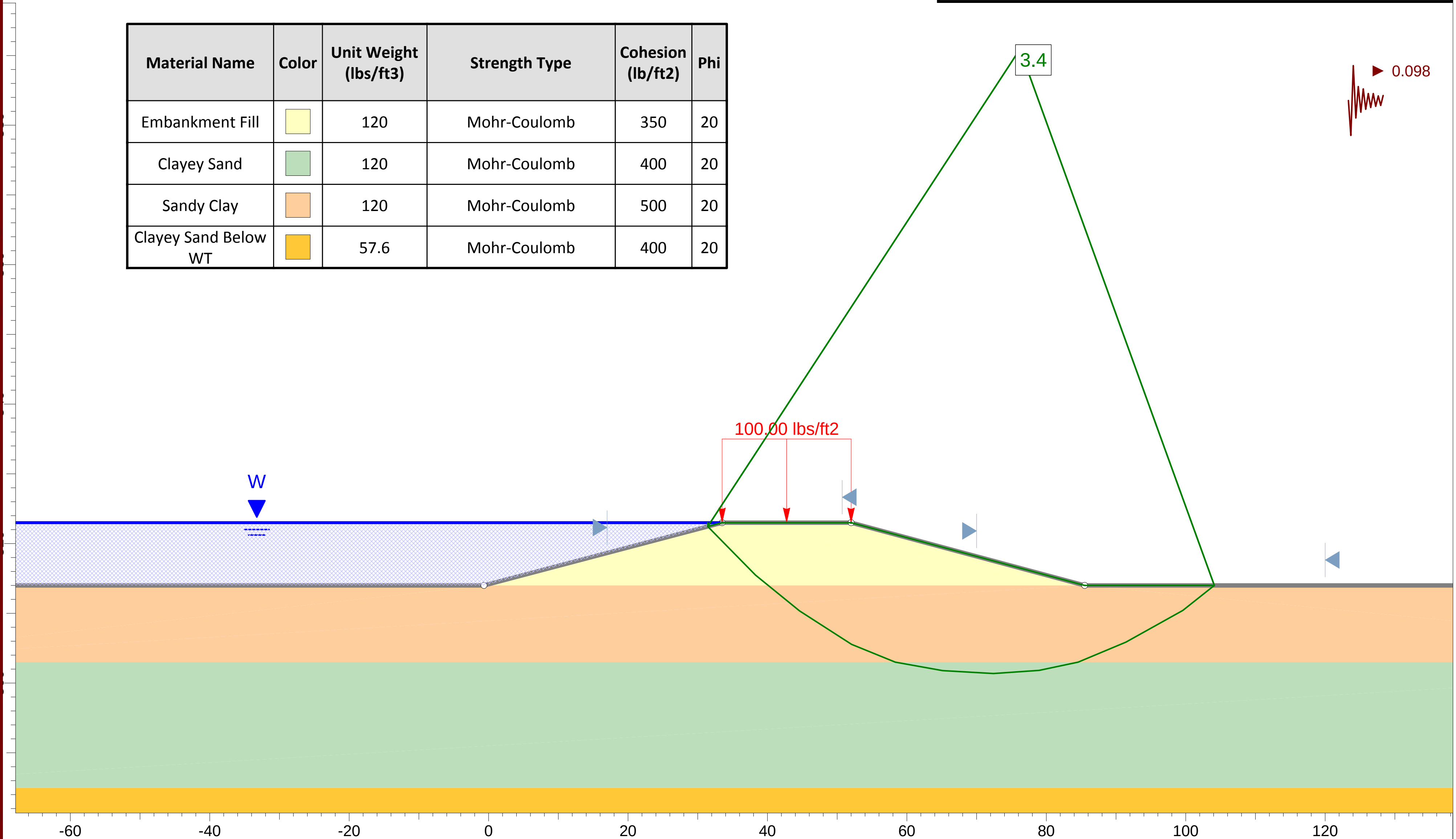
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-16b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "D"
Ash Pond Berms - Spruce/Deely Generation Units

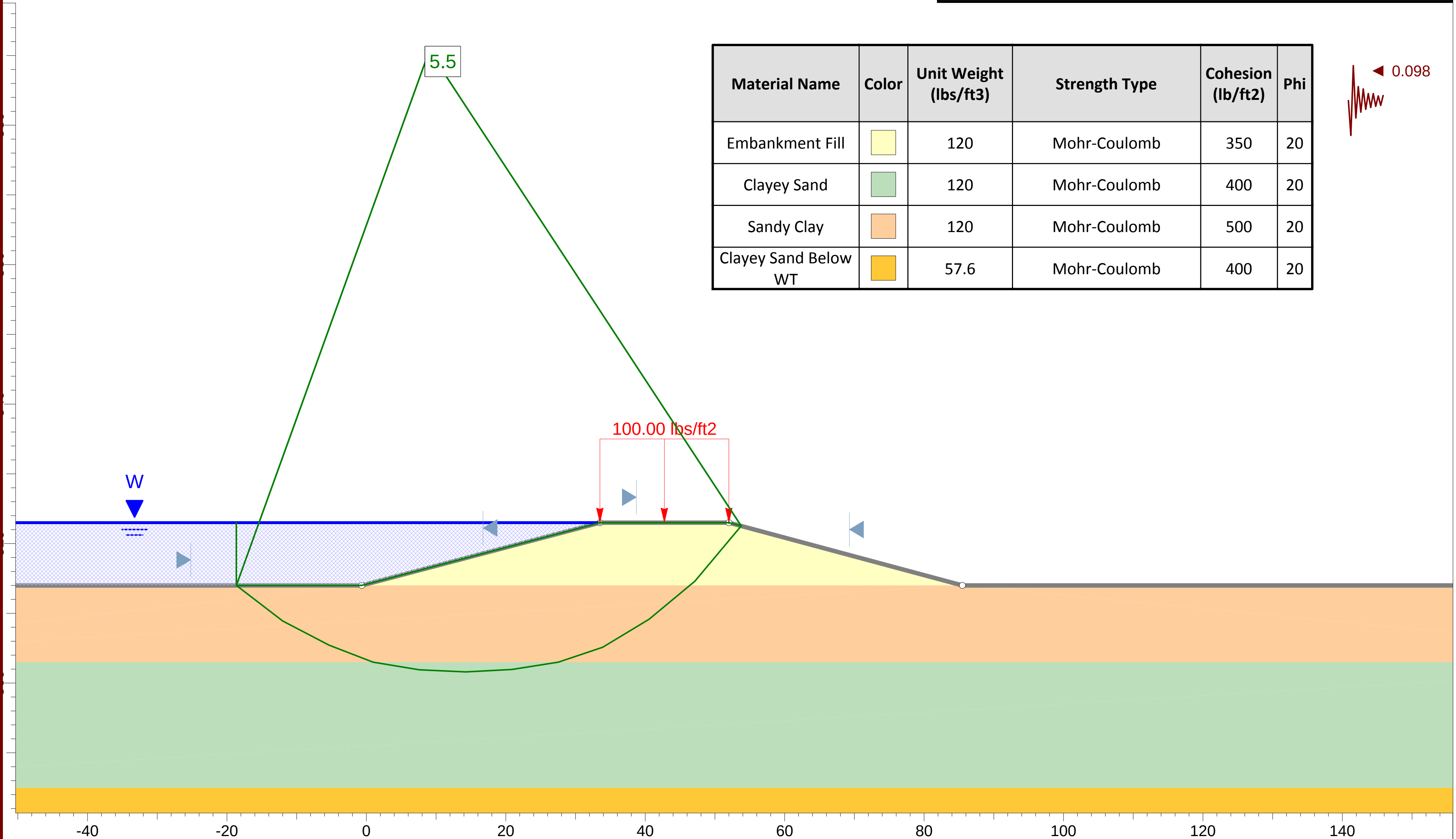
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-17a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "D"
Ash Pond Berms - Spruce/Deely Generation Units

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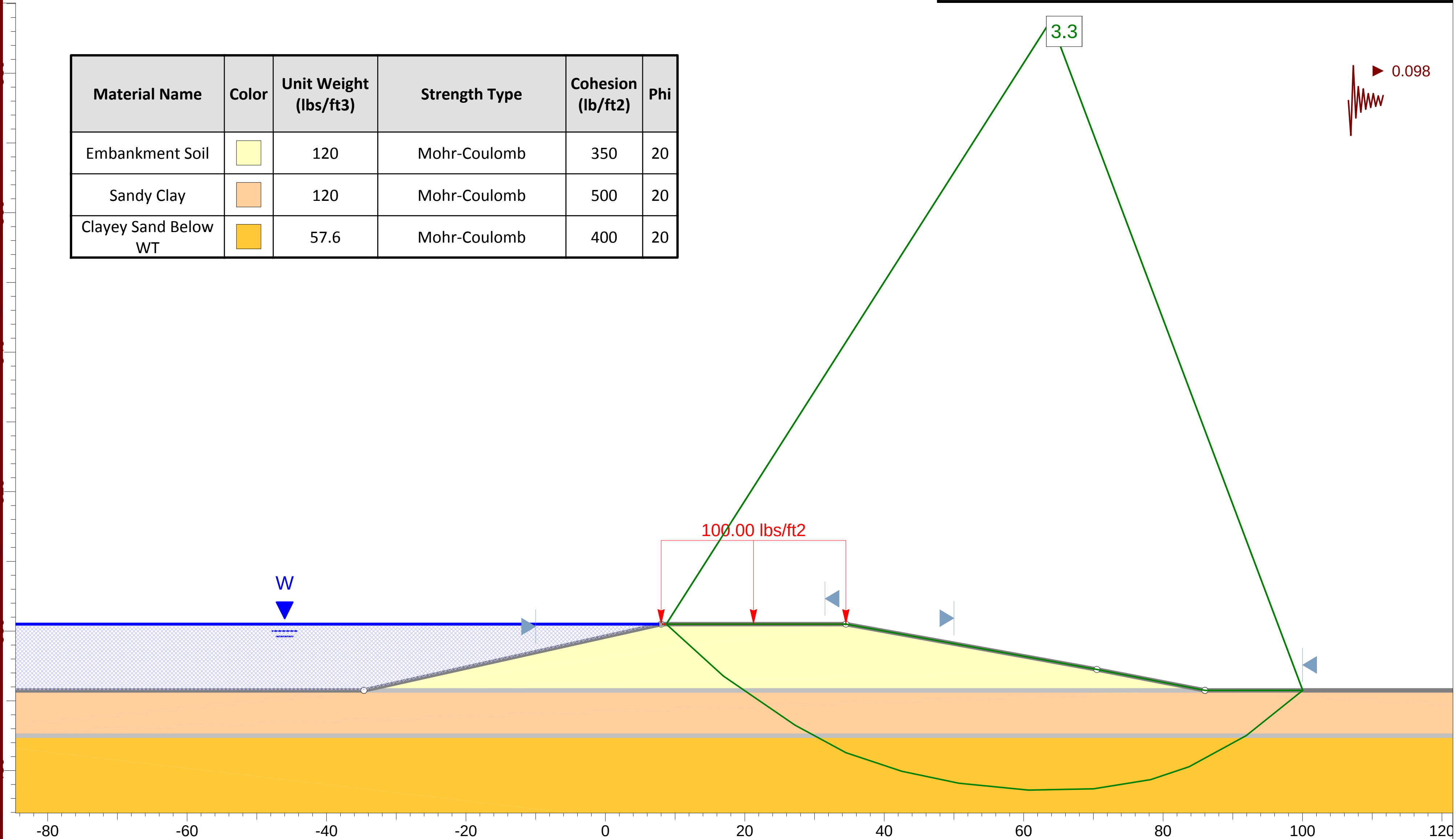
Figure D-17b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Soil		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



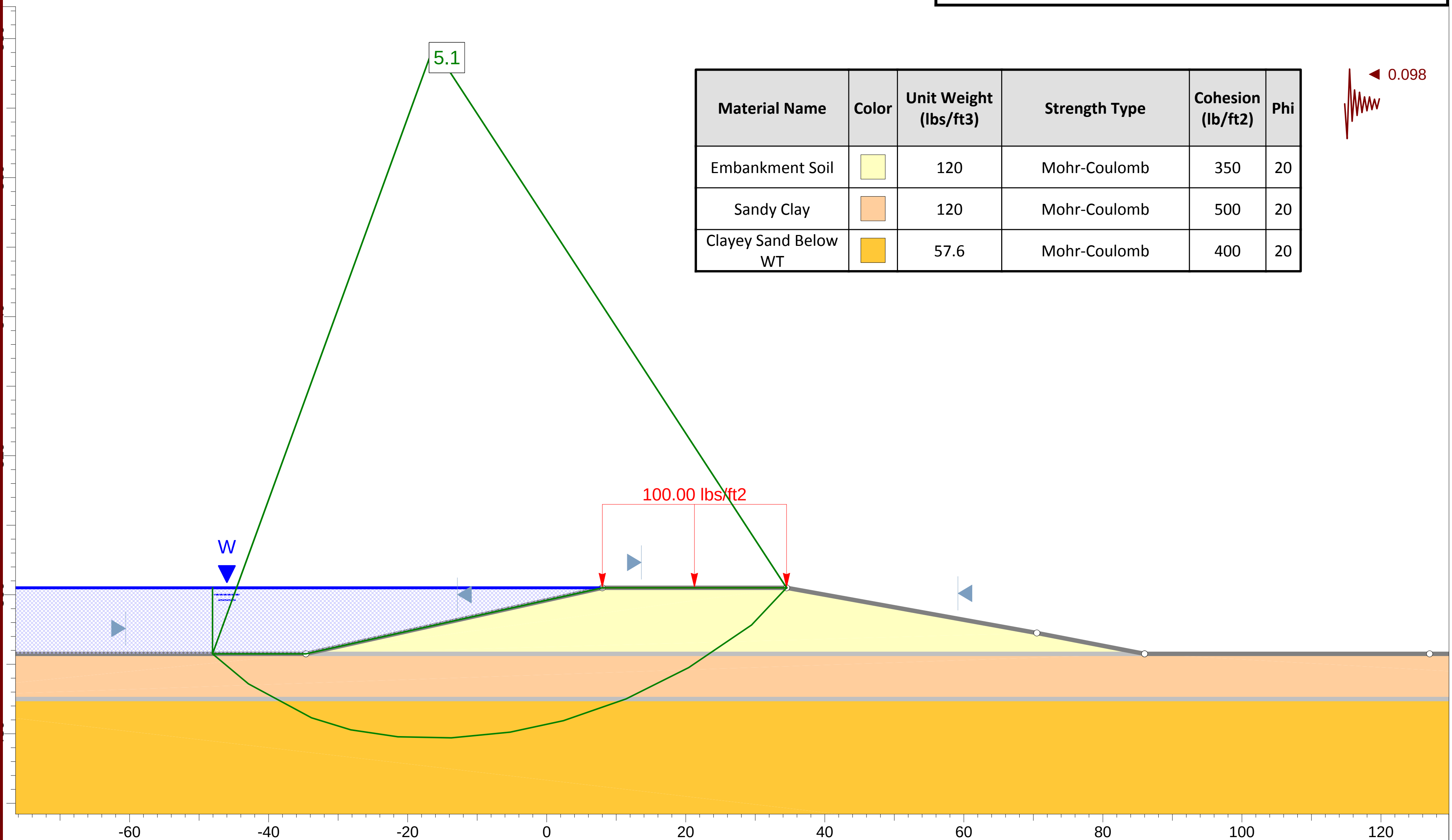
Profile "E"
Ash Pond Berms - Spruce/Deely Generation Units

Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-18a

RABA KISTNER CONSULTANTS

Global Stability Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Soil		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20

Profile "E"
Ash Pond Berms - Spruce/Deely Generation Units

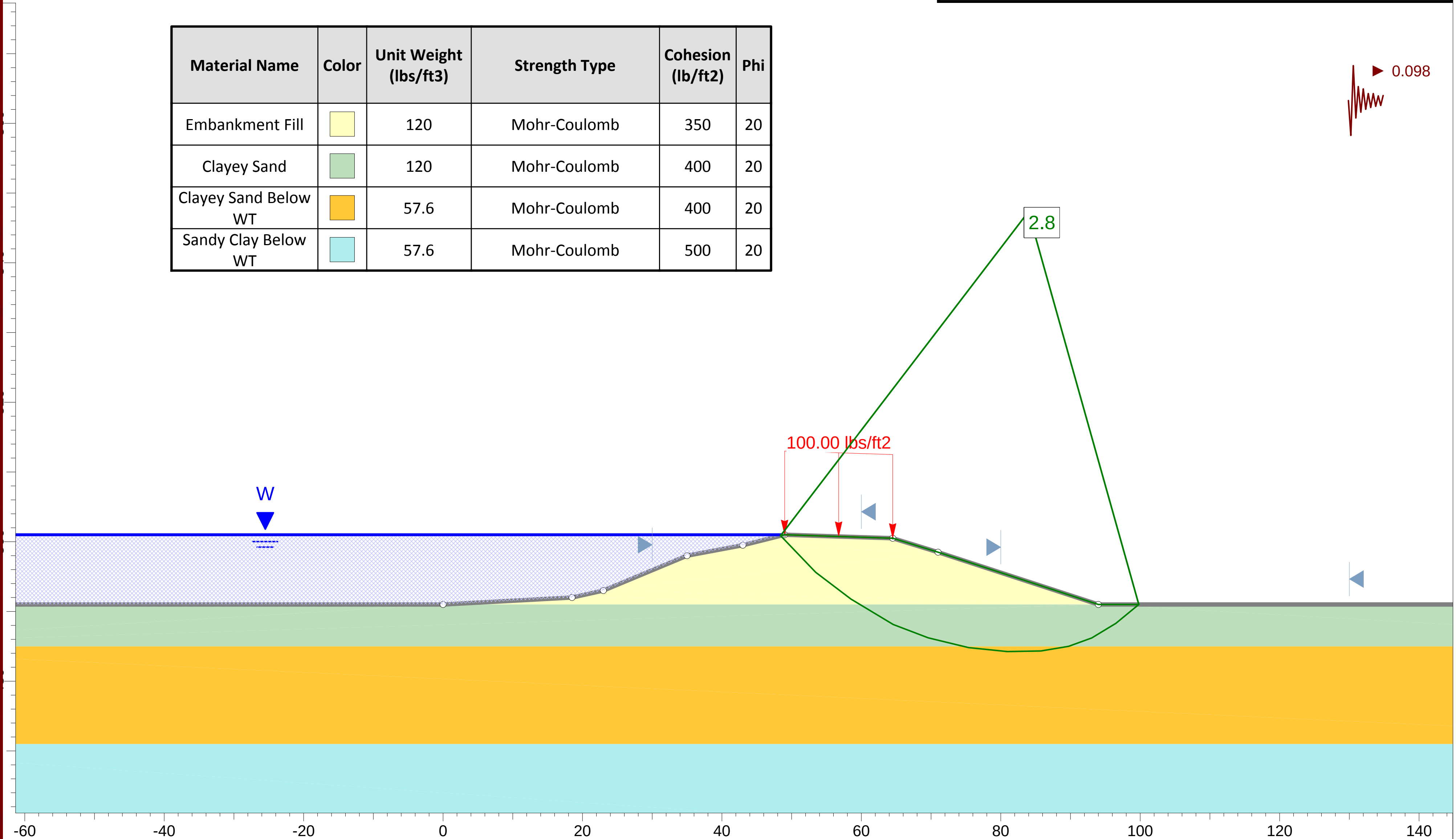
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-18b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "F"
Ash Pond Berms - Spruce/Deely Generation Units

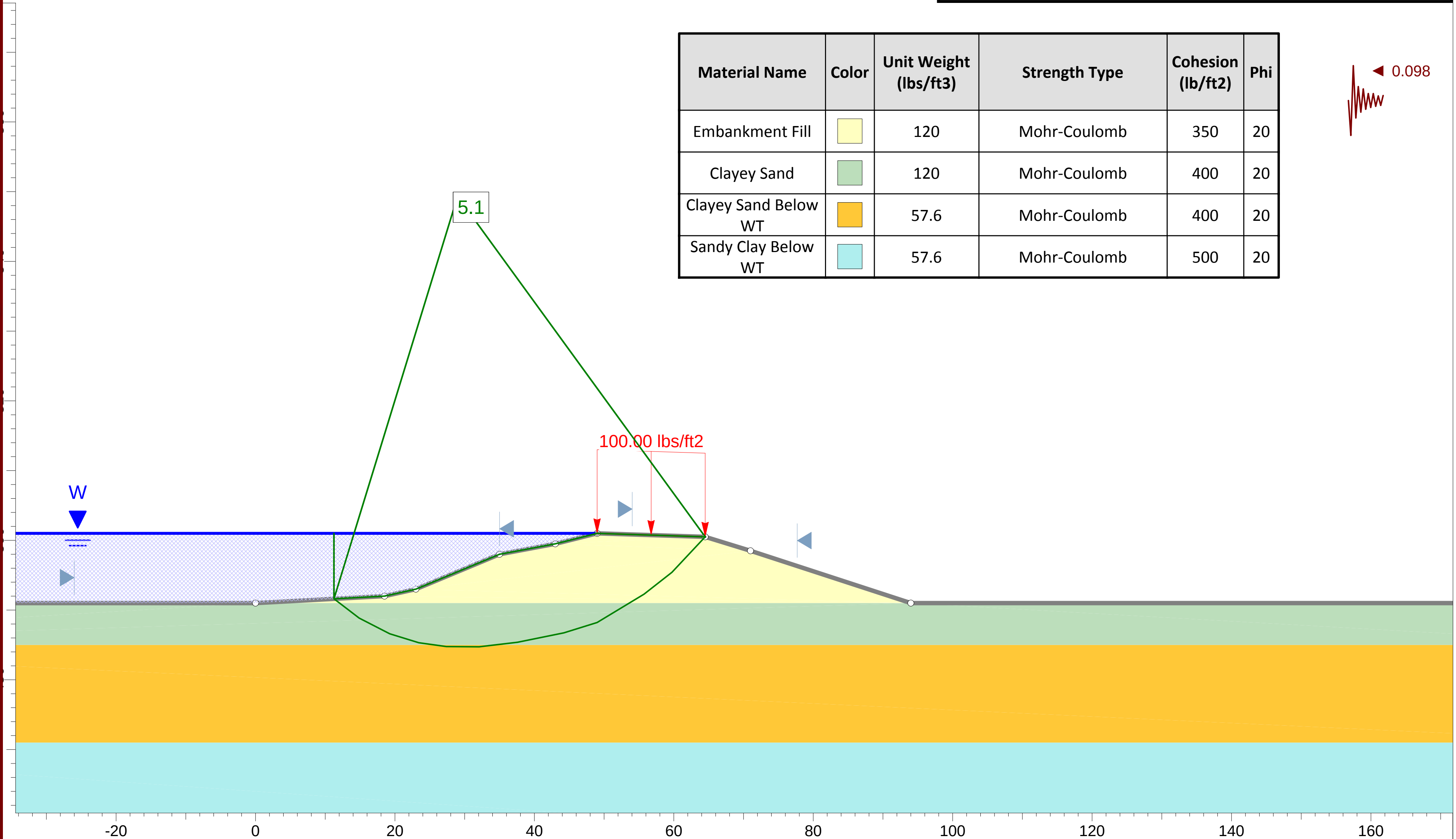
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-19a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "F"
Ash Pond Berms - Spruce/Deely Generation Units

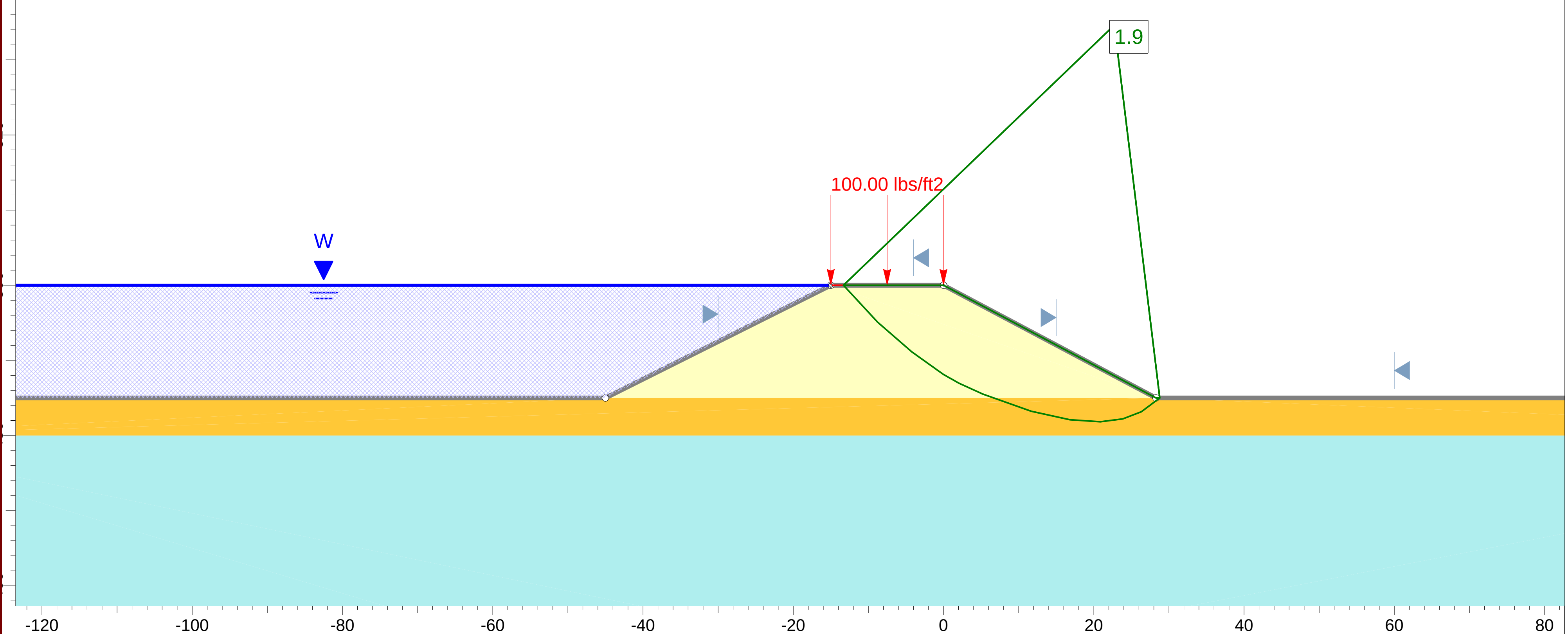
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-19b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "G"
Ash Pond Berms - Spruce/Deely Generation Units

Raba Kistner Consultants, Inc.
ASA12-098-00

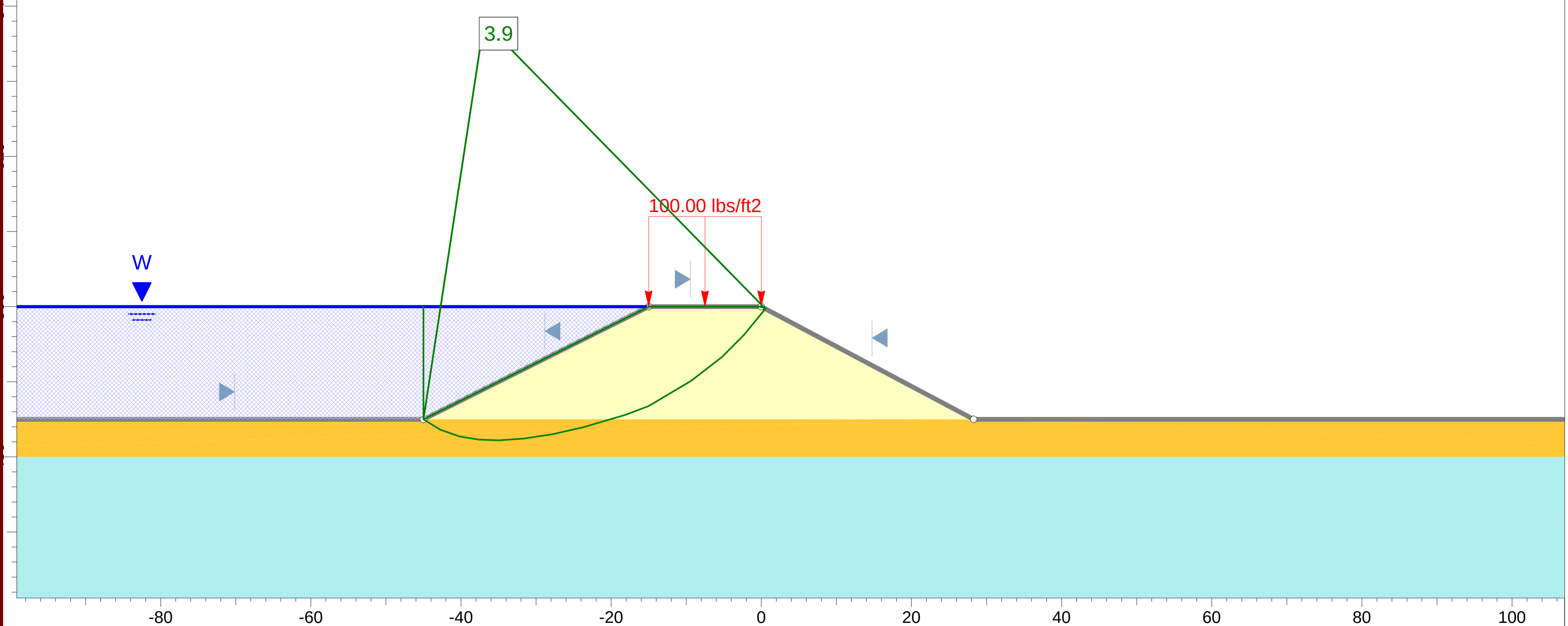
Figure D-20a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20

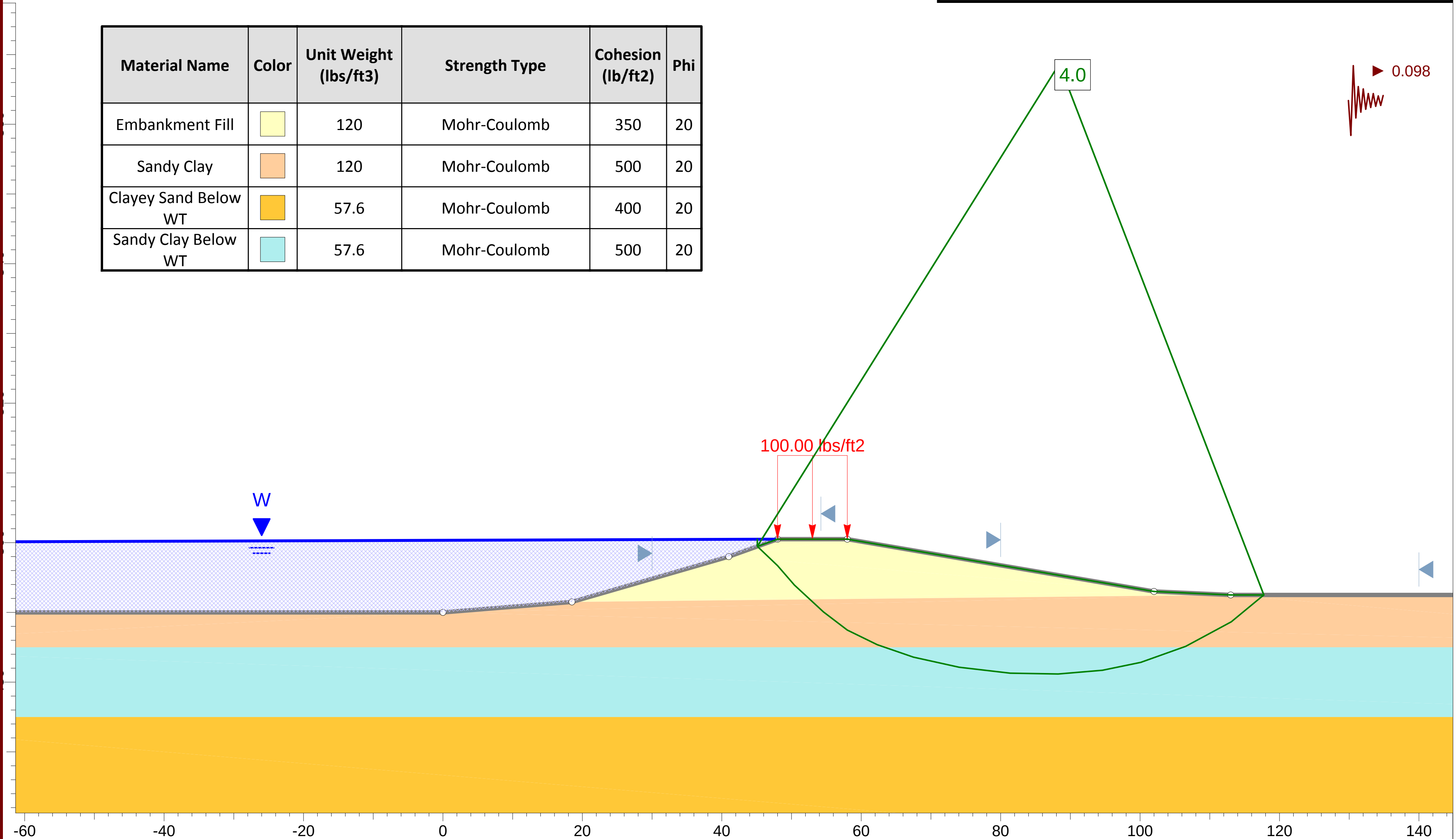
0.098



Profile "G" Ash Pond Berms - Spruce/Deely Generation Units	Raba Kistner Consultants, Inc. ASA12-098-00	Figure D-20b RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



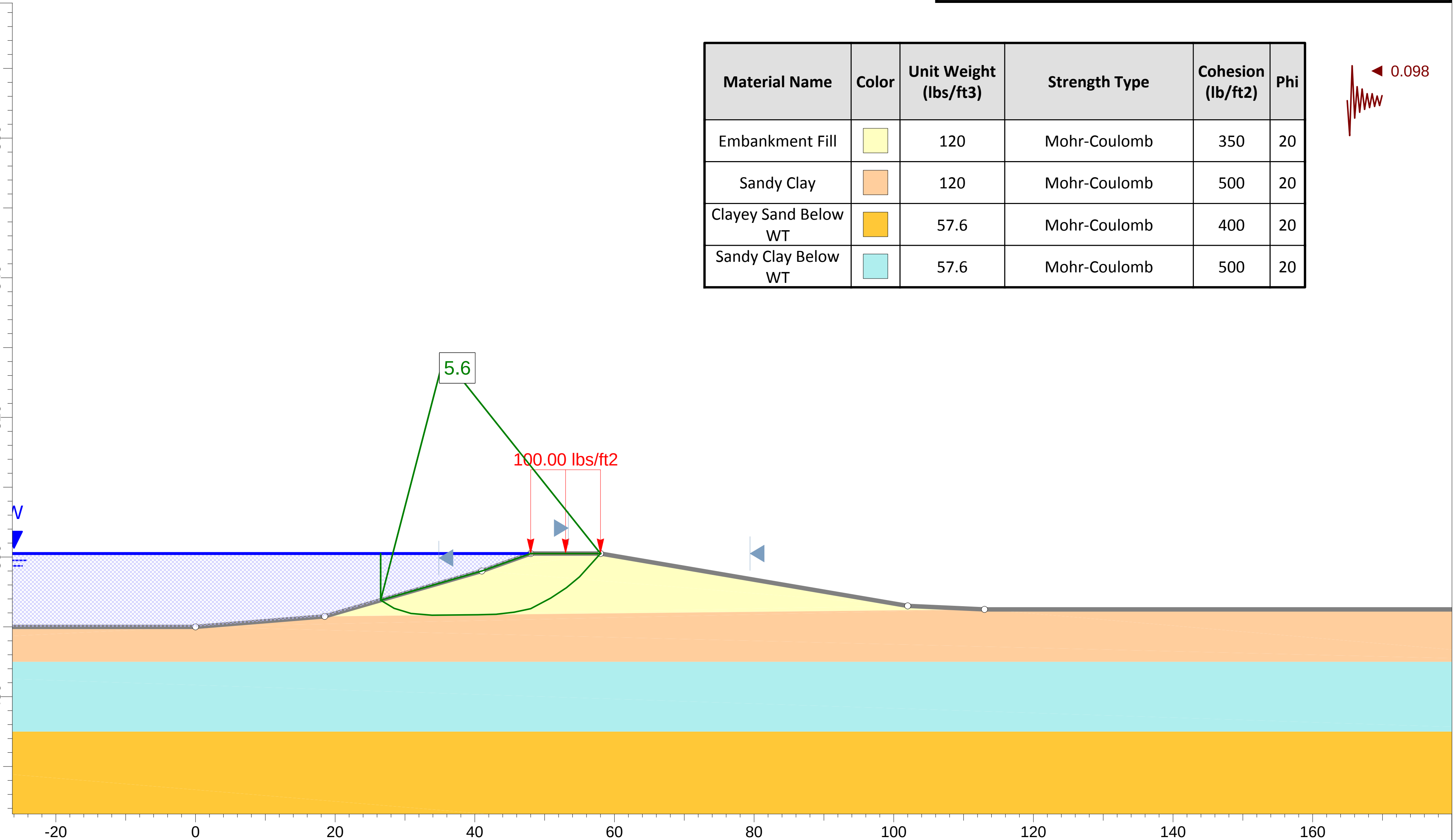
Profile "H"
Ash Pond Berms - Spruce/Deely Generation Units

Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-21a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "H"
Ash Pond Berms - Spruce/Deely Generation Units

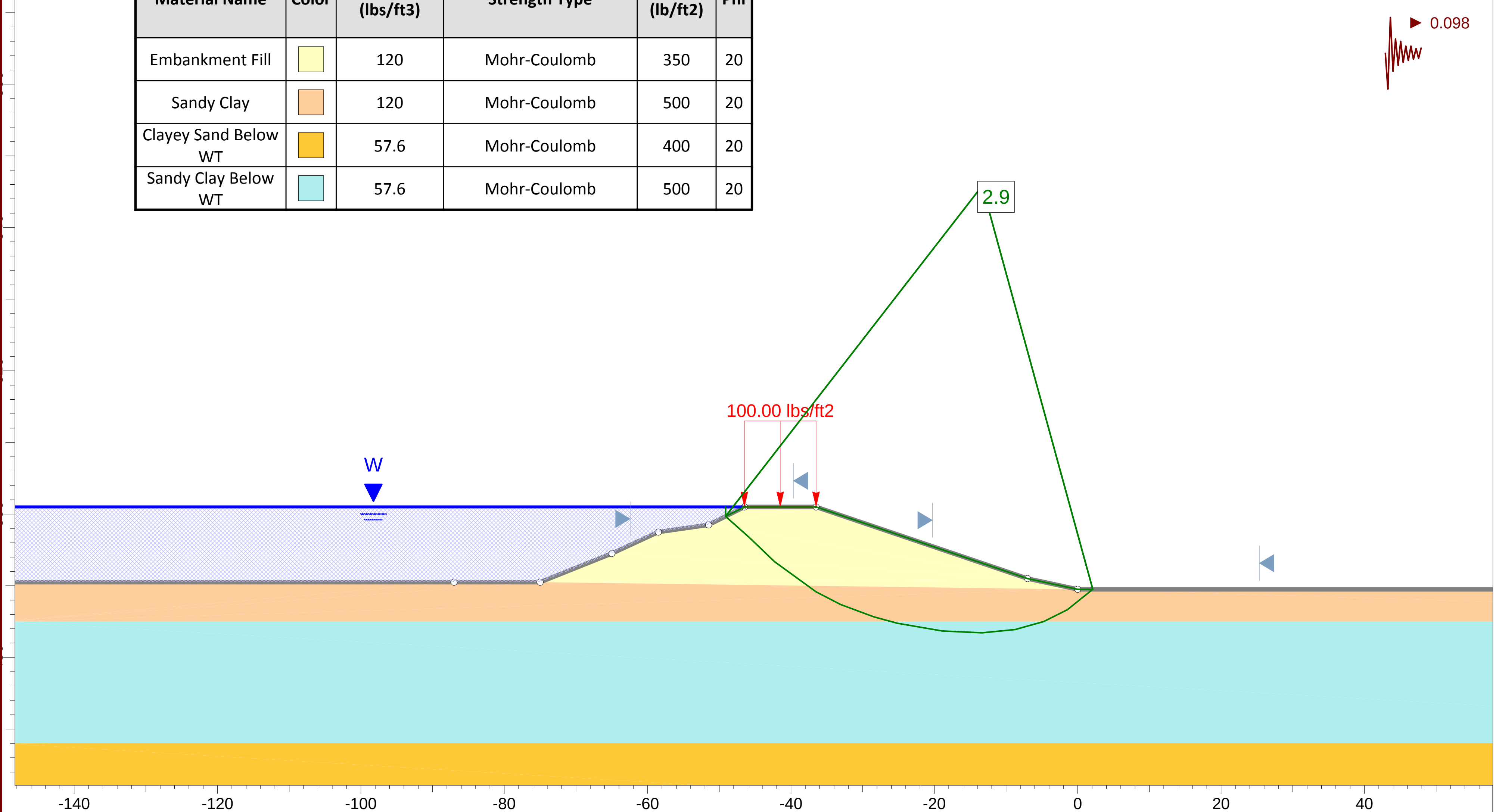
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-21b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "I"
Ash Pond Berms - Spruce/Deely Generation Units

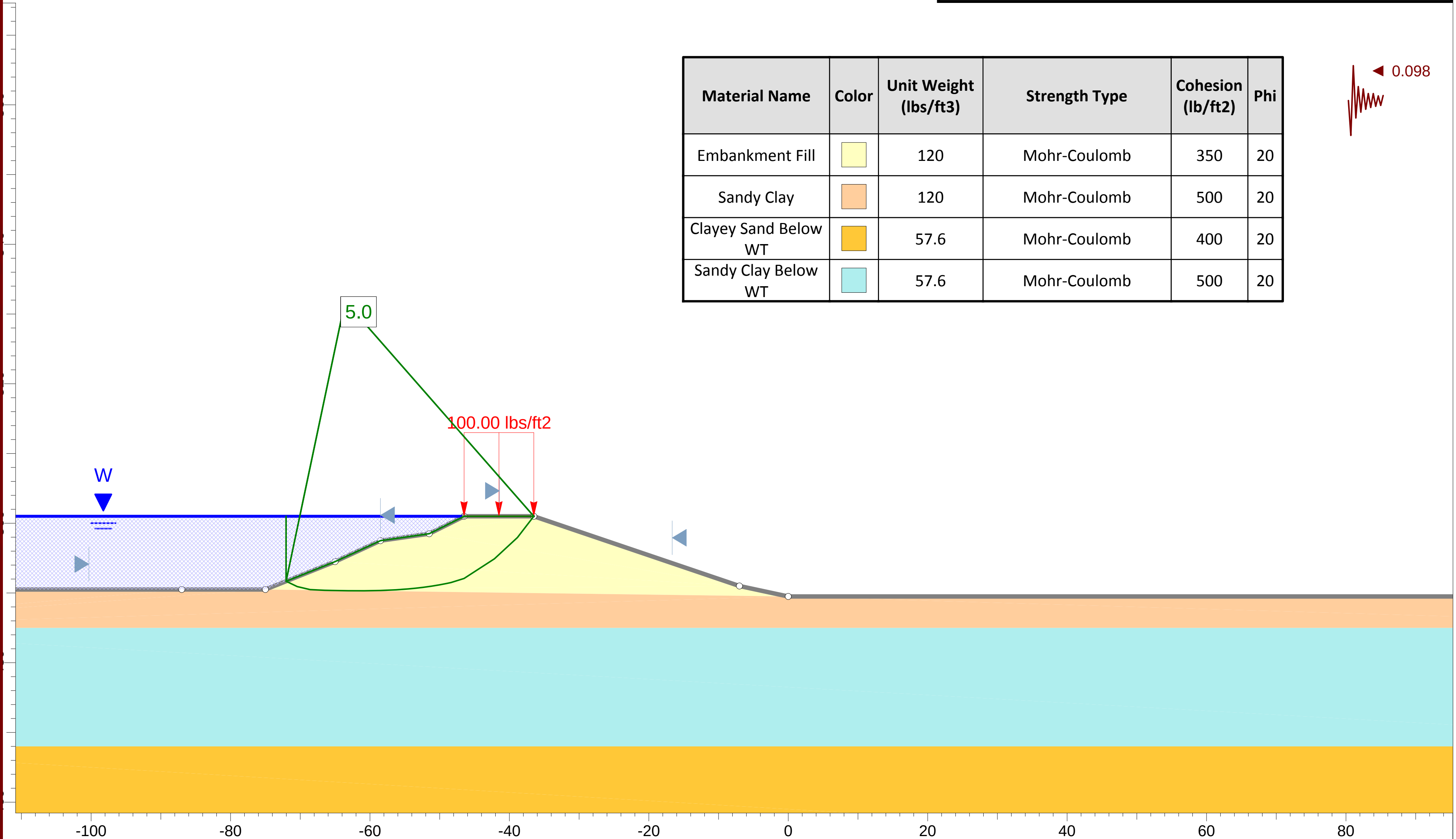
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-22a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "I"
Ash Pond Berms - Spruce/Deely Generation Units

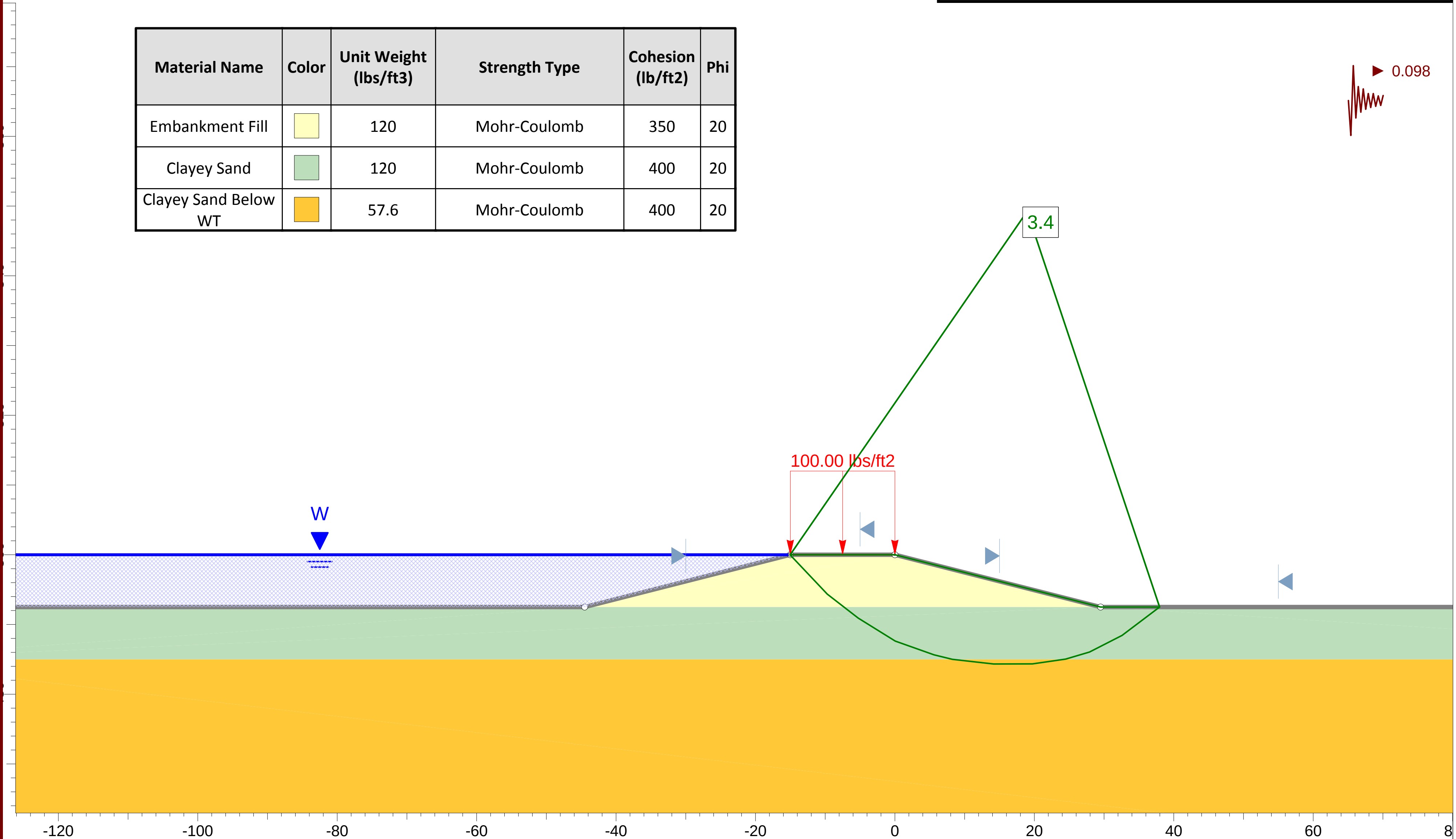
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-22b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "J"
Ash Pond Berms - Spruce/Deely Generation Units

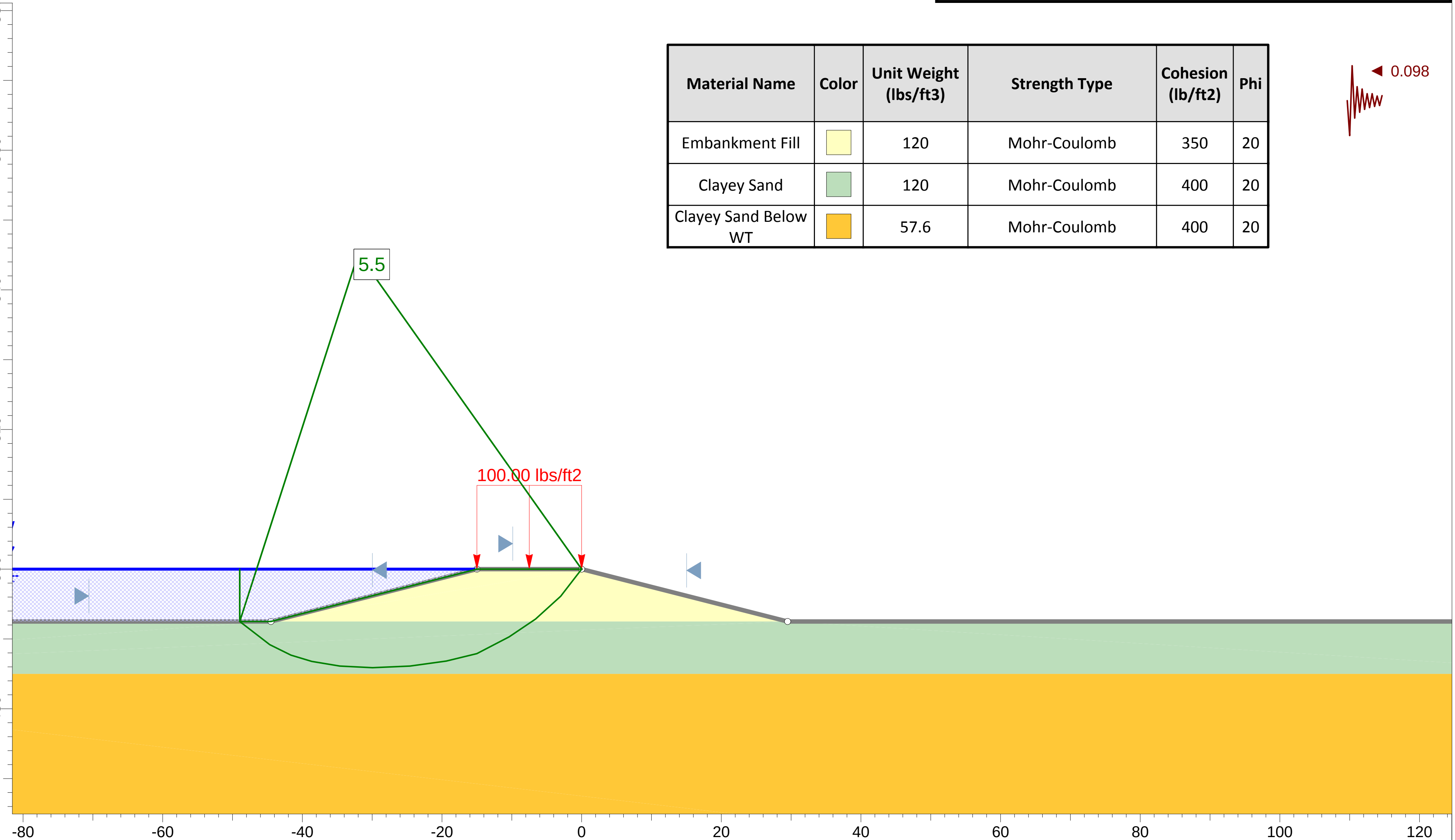
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-23a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "J"
Ash Pond Berms - Spruce/Deely Generation Units

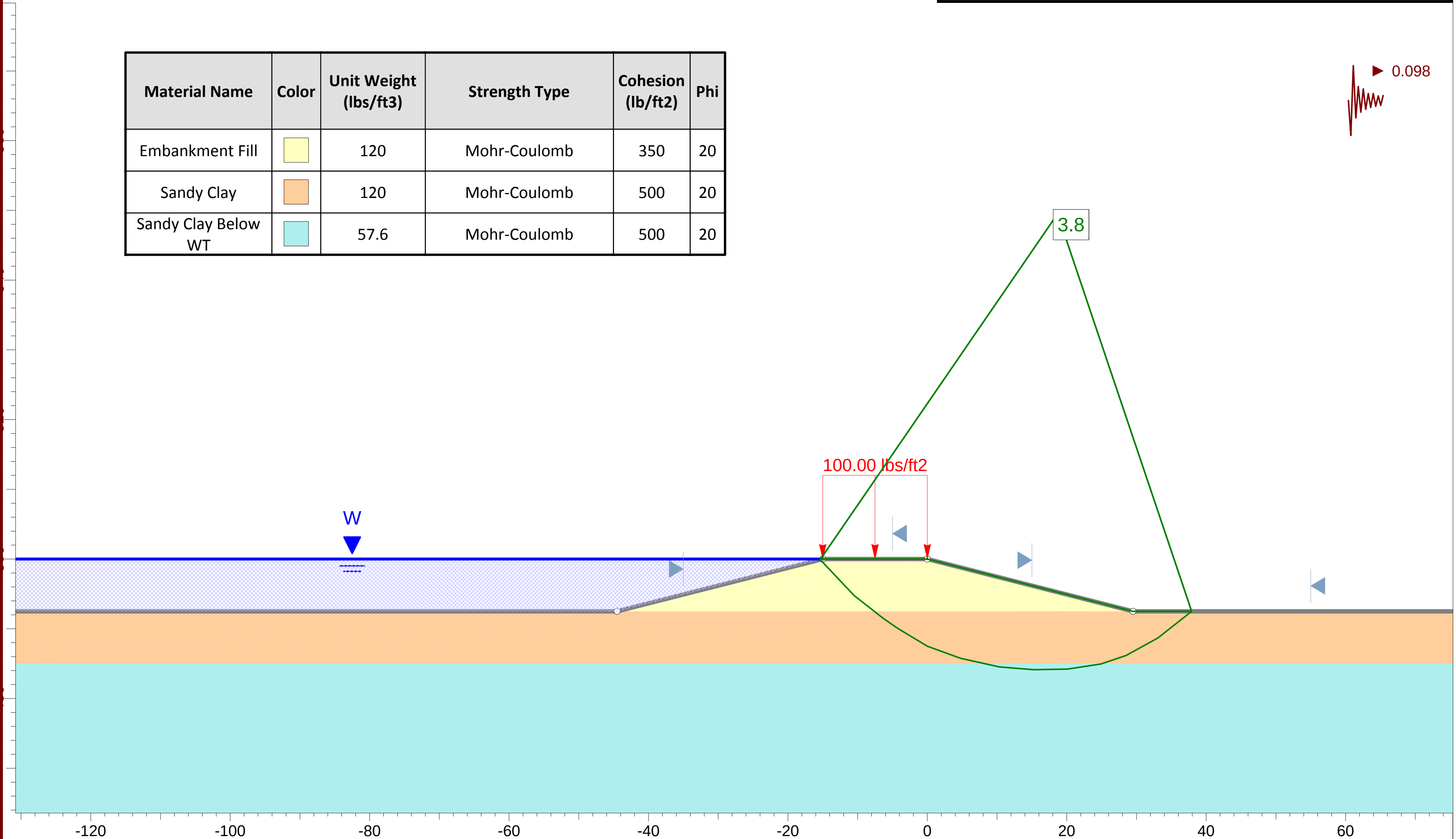
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-23b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "K"
Ash Pond Berms - Spruce/Deely Generation Units

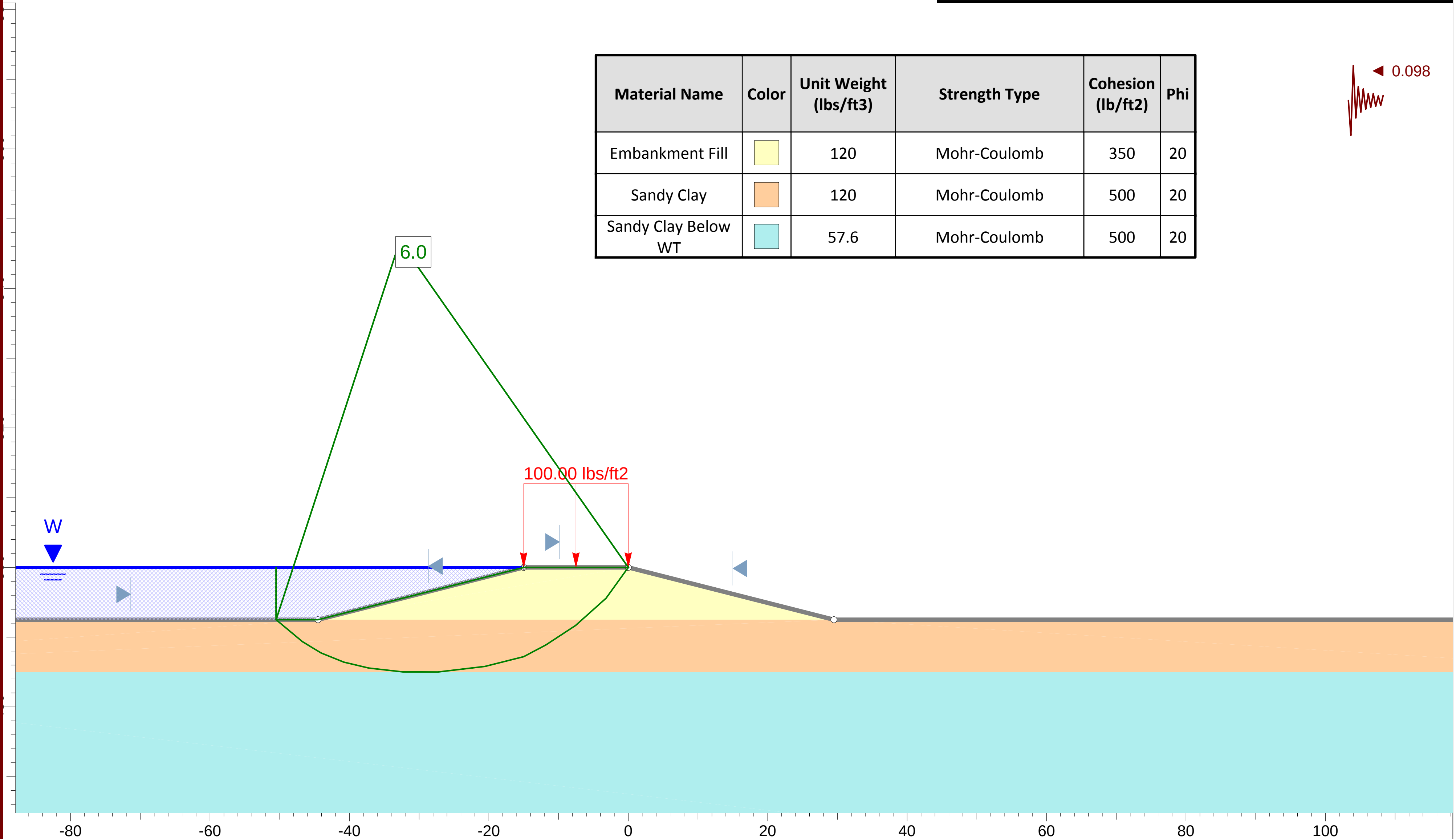
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-24a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "K"
Ash Pond Berms - Spruce/Deely Generation Units

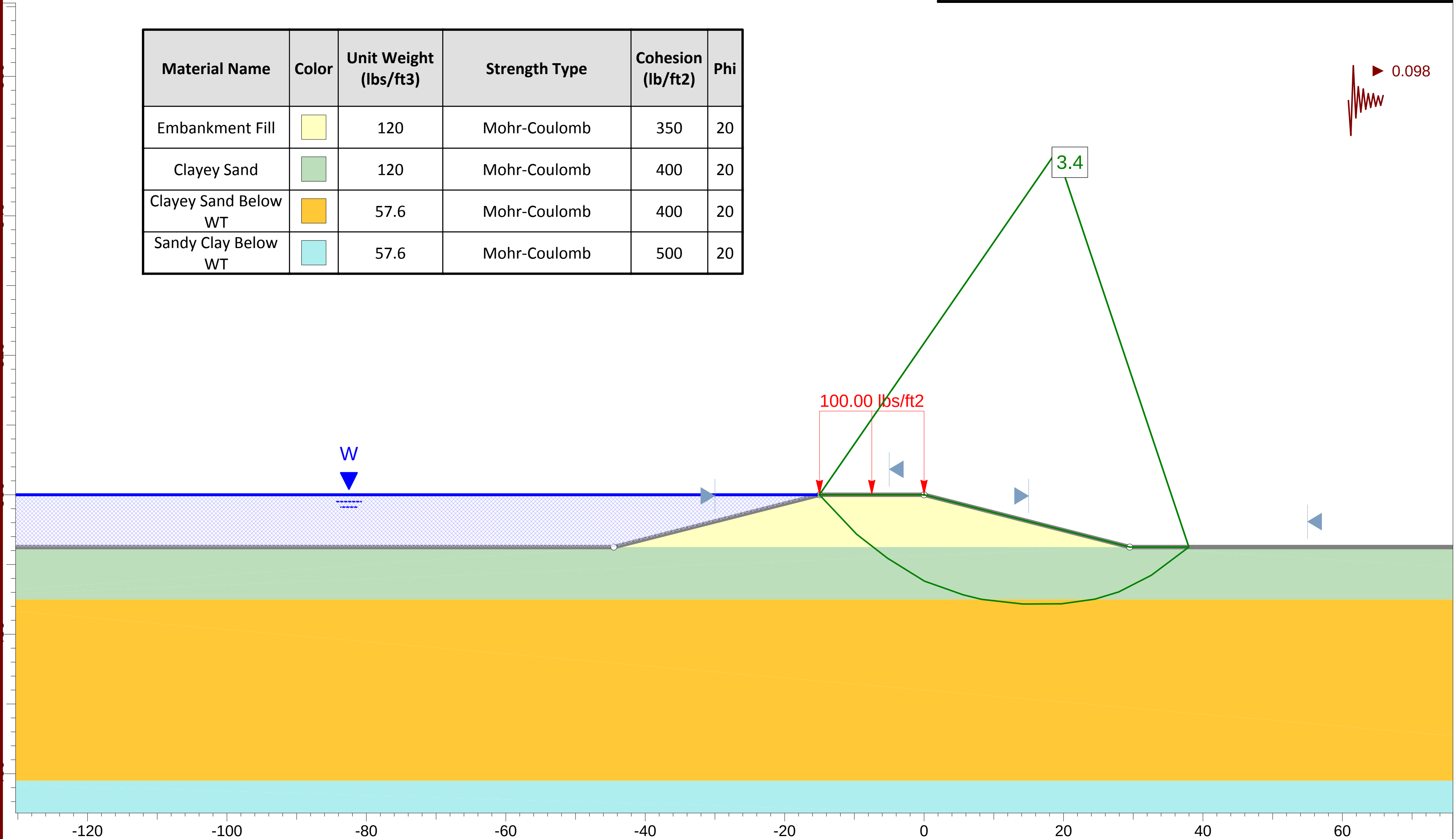
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-24b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "L"
Ash Pond Berms - Spruce/Deely Generation Units

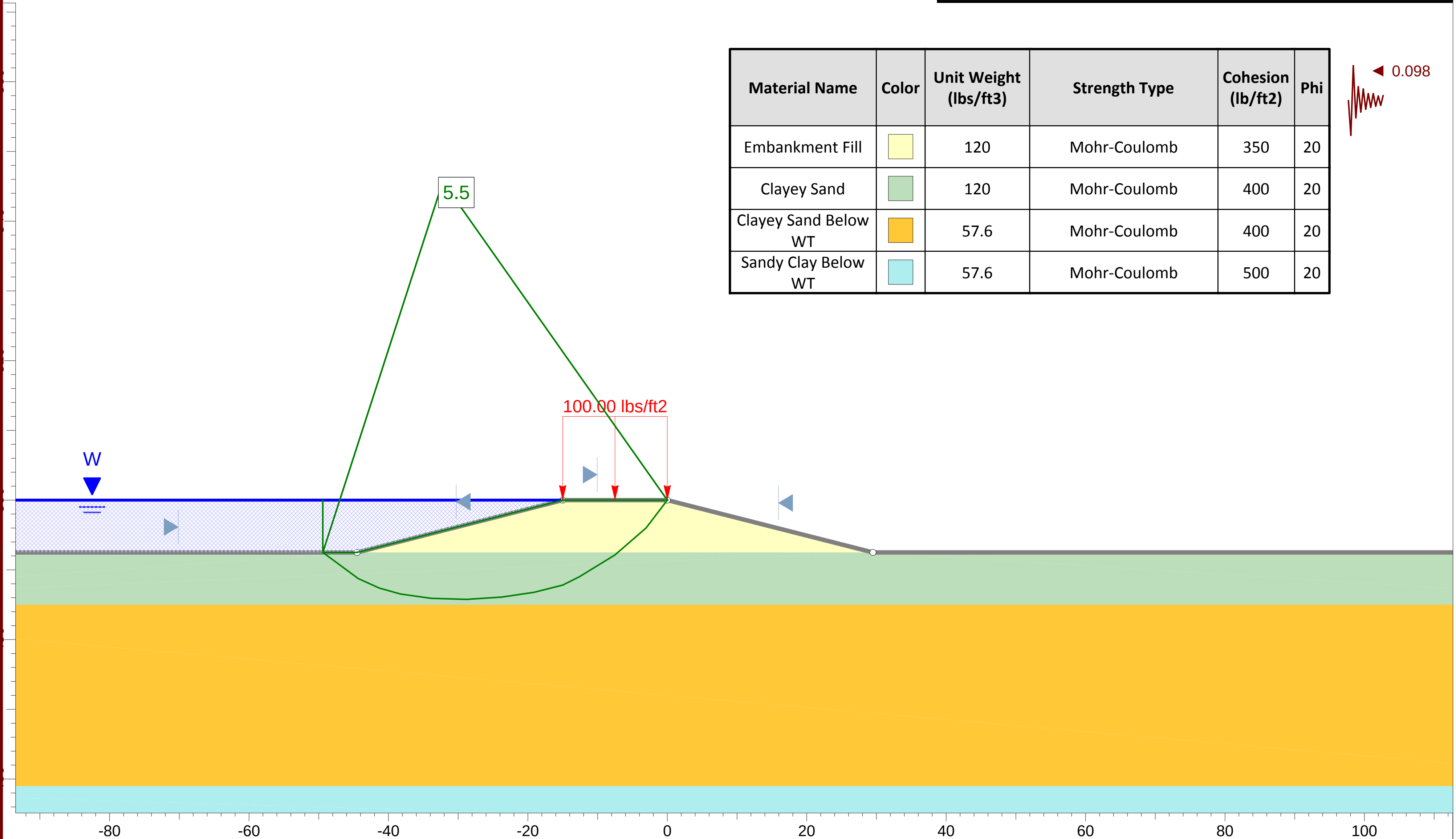
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-25a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "L"
Ash Pond Berms - Spruce/Deely Generation Units

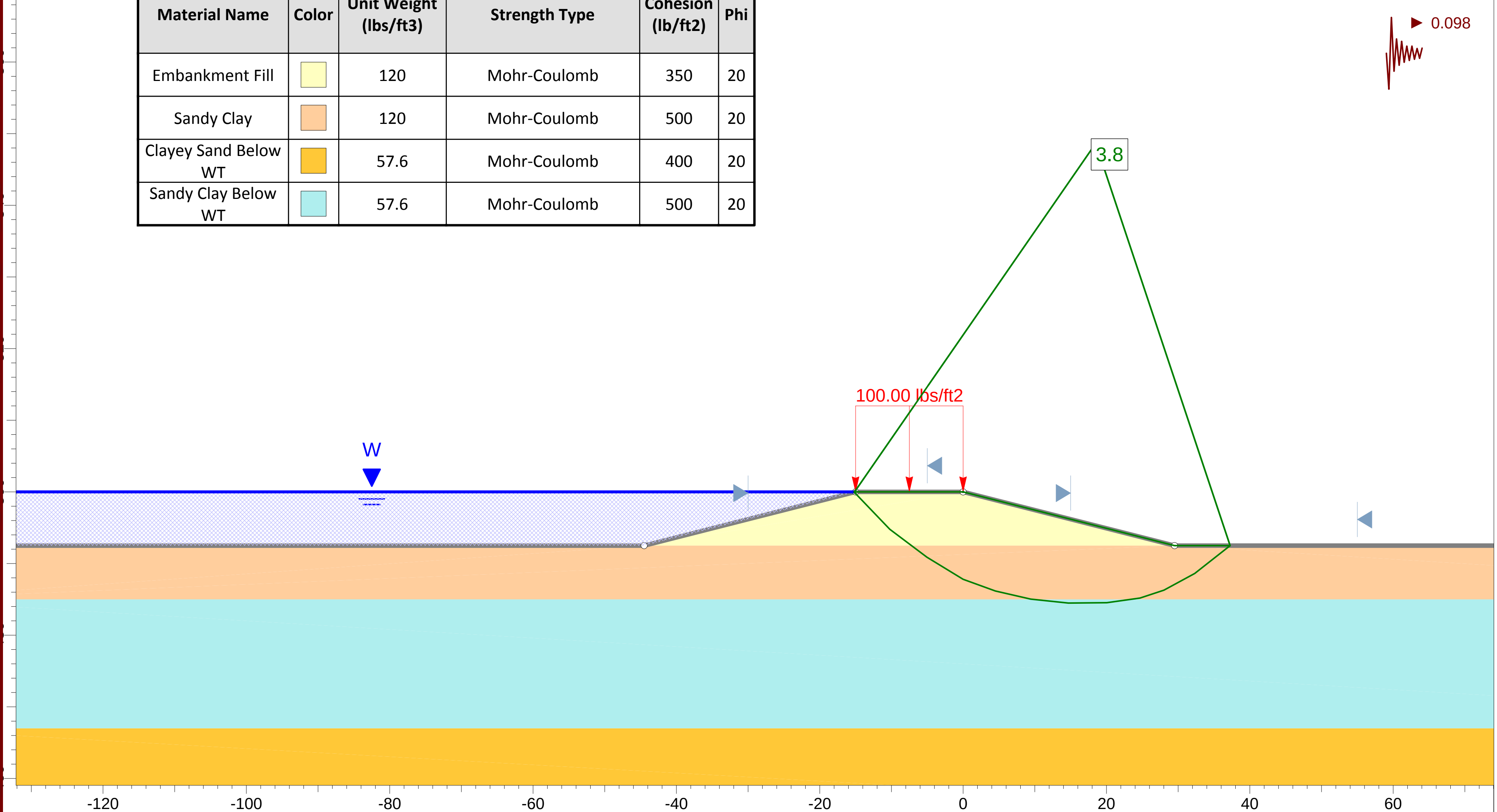
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-25b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20

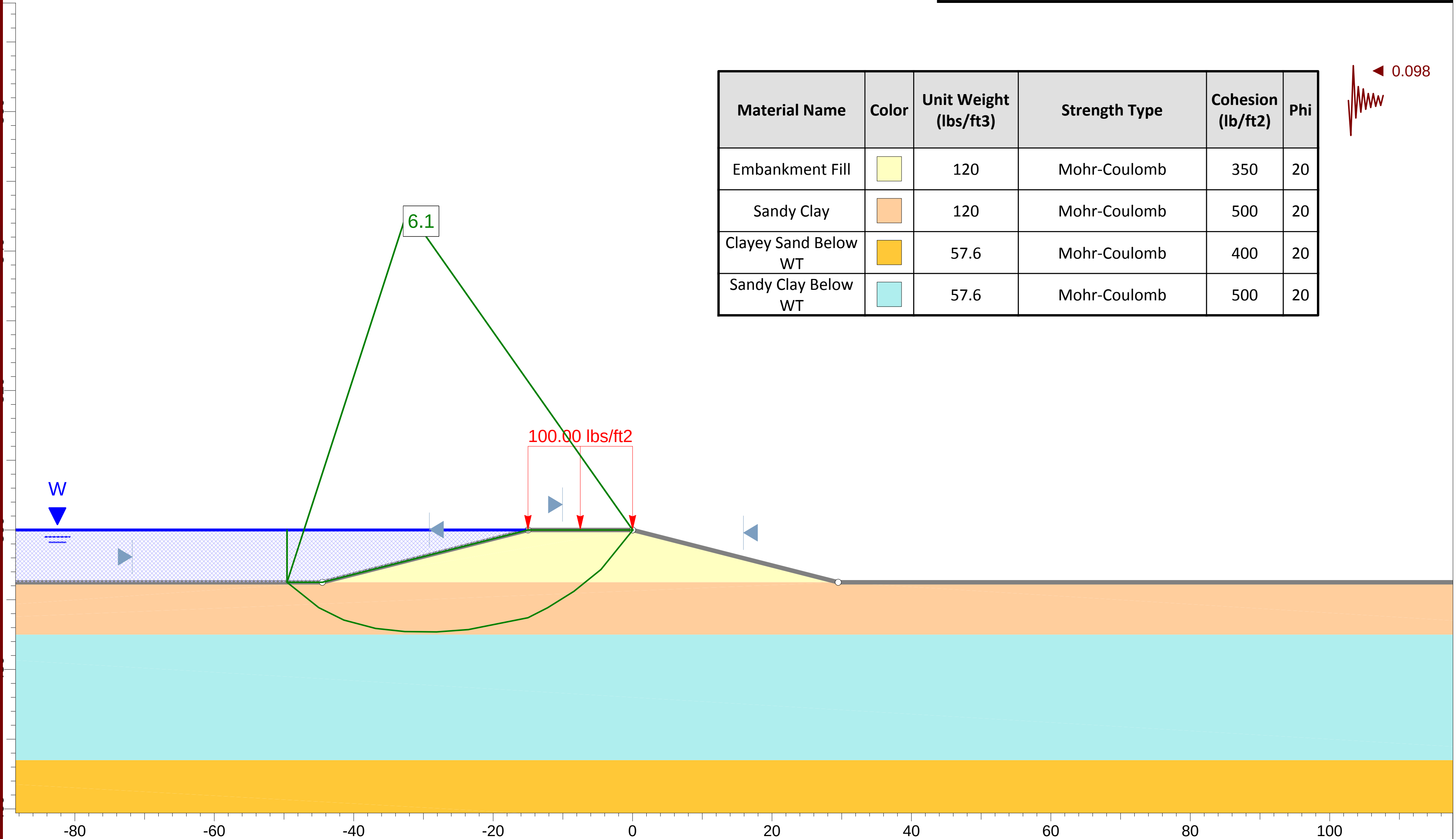


Profile "M"
Ash Pond Berms - Spruce/Deely Generation Units

Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-26a

Global Stability Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20

Profile "M"
Ash Pond Berms - Spruce/Deely Generation Units

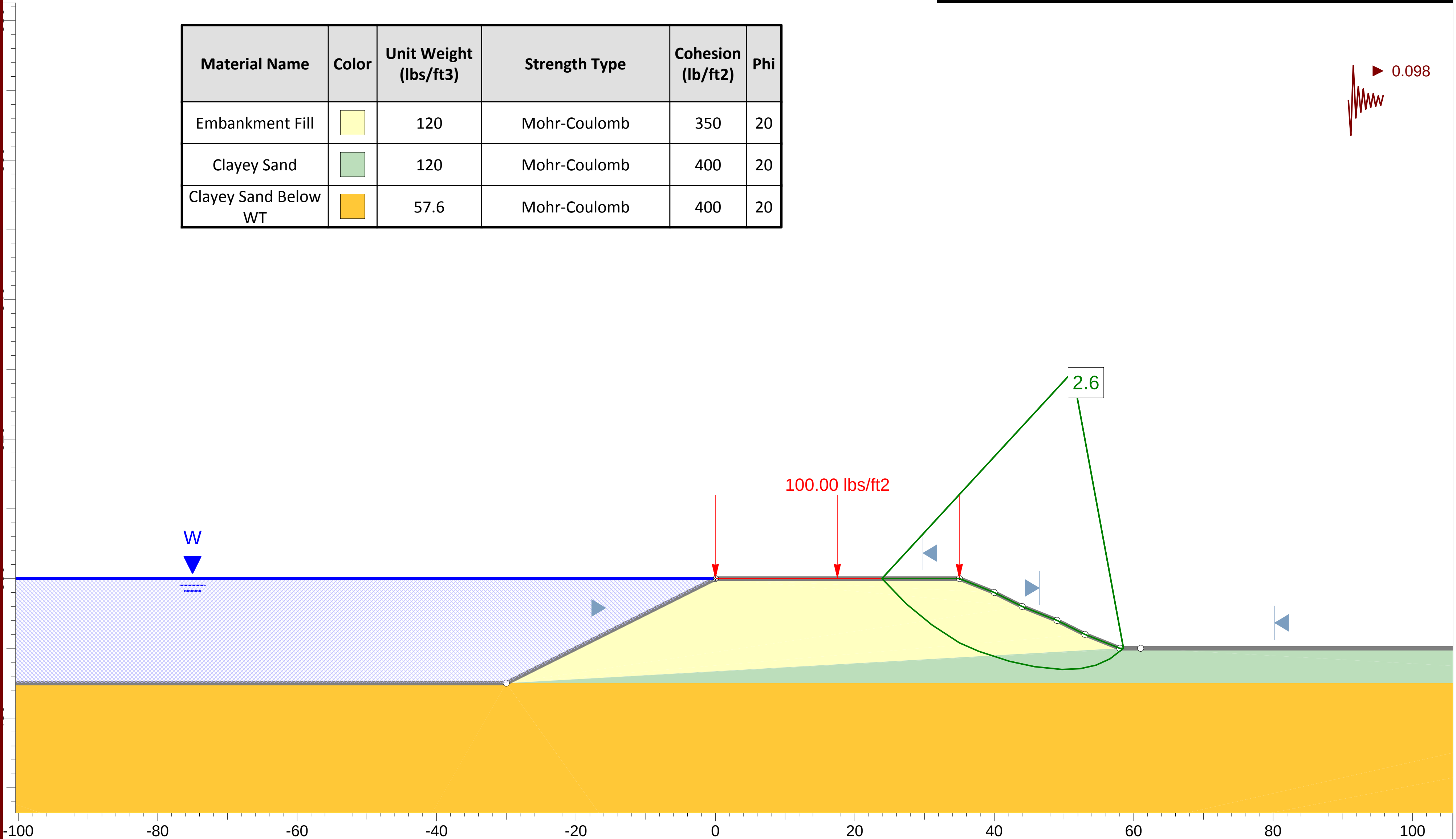
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-26b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "N"
Ash Pond Berms - Spruce/Deely Generation Units

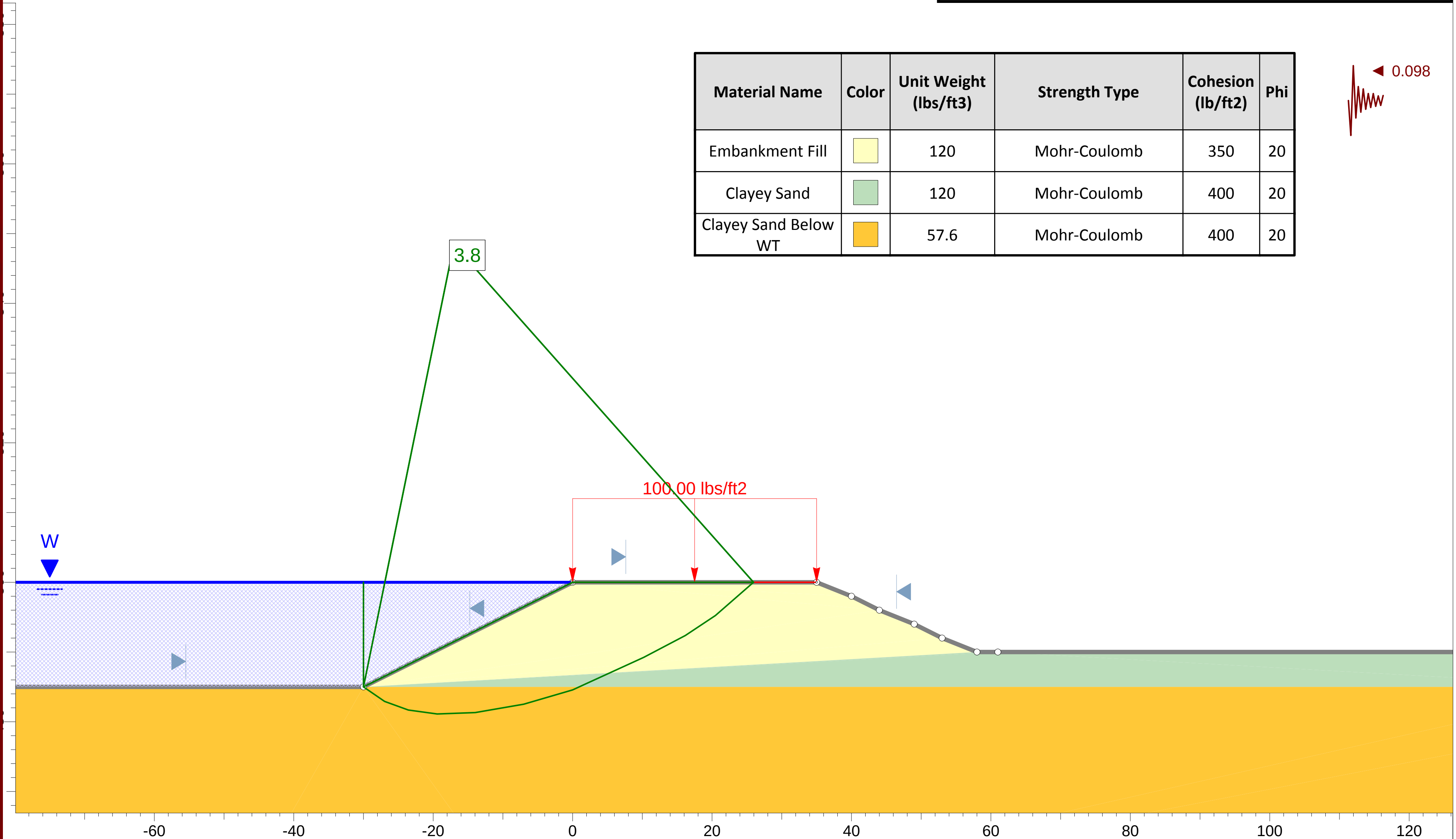
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-27a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "N"
Ash Pond Berms - Spruce/Deely Generation Units

Raba Kistner Consultants, Inc.
ASA12-098-00

Figure D-27b

RABA KISTNER CONSULTANTS

RABA KISTNER

GEOTECHNICAL ENGINEERING STUDY

FOR

ASH POND BERMS - SPRUCE/DEELY GENERATION UNITS
SAN ANTONIO, TEXAS

RABA KISTNER CONSULTANTS

Raba Kistner
Consultants, Inc.
12821 W. Golden Lane
San Antonio, TX 78249
P.O. Box 690287
San Antonio, TX 78269
www.rkci.com

P 210 :: 699 :: 9090
F 210 :: 699 :: 6426
TBPE Firm F-3257

Project No. ASA12-098-00 (Revised)
May 7, 2014

Mr. Eric R. Olson
CPS Energy
c/o Mr. Steven Dean, P.E.
Pape-Dawson Engineers, Inc.
555 East Ramsey
San Antonio, Texas 78216

RE: Geotechnical Engineering Study
Ash Pond Berms – Spruce/Deely Generation Units
San Antonio, Texas

Dear Mr. Dean:

Raba Kistner Consultants Inc. (RKCI) is pleased to submit the revised report of our Geotechnical Engineering Study for the above-referenced project. This study was performed in accordance with RKCI Proposal No. PSA12-168-00 (3rd Revision), dated October 4, 2012, and comments provided in a conference call on April 17, 2014. The purpose of this study was to drill borings within the existing ash pond berms, to perform laboratory testing to classify and characterize subsurface conditions, and to prepare an engineering report presenting slope stability analyses for the existing berms.

We appreciate the opportunity to be of service to you on this project. Should you have any questions about the information presented in this report, or if we may be of additional assistance with value engineering or on the materials testing-quality control program during construction, please call.

Very truly yours,

RABA KISTNER CONSULTANTS, INC.

R. Blake Wright

R. Blake Wright, E.I.T.
Graduate Engineer

STATE OF TEXAS
ERIC J. NEUNER
116311
LICENSED
PROFESSIONAL ENGINEER
5/7/2014

Eric J. Neuner, P.E.
Manager, San Antonio Engineering

RBW/JAF/EJN

Attachments

Copies Submitted: Above (4)

GEOTECHNICAL ENGINEERING STUDY

For

ASH POND BERMS – SPRUCE/DEELY GENERATION UNITS
SAN ANTONIO, TEXAS

Prepared for

PAPE-DAWSON ENGINEERS, INC.
San Antonio, Texas

Prepared by

RABA KISTNER CONSULTANTS, INC.
San Antonio, Texas

PROJECT NO. ASA12-098-00 (Revised)

May 7, 2014

TABLE OF CONTENTS

TABLE OF CONTENTS

ATTACHMENTS

INTRODUCTION

Raba Kistner Consultants Inc. (RKCI) has completed the authorized subsurface exploration and slope stability analyses for the existing ash pond berms at the Spruce/Deely Generation Units in San Antonio, Texas. This report briefly describes the procedures utilized during this study and presents our findings along with our recommendations for maintaining the existing ash pond berms.

PROJECT DESCRIPTION

The structures being considered in this study include the existing ash pond berms located at the Spruce/Deely Generation Units, which is operated by CPS Energy. Specifically, three ponds were studied and are denoted on the Boring Location Map, Figure 1. Our understanding of the slope profile at each berm, as well as the existing site topography, is based on several drawings provided to us on September 14, November 1, 2012, and May 6, 2014 by Mr. Steven Dean, P.E., with Pape-Dawson Engineers, Inc.

RISK

The geotechnical engineering recommendations contained in this memorandum are intended to provide Pape-Dawson Engineers, Inc; CPS Energy; and the U.S. Environmental Protection Agency with information pertaining to the stability of the existing ash pond berms at the Spruce/Deely Generation Units .

The geotechnical properties of the soils encountered in this study involve variability. This variability includes some spatial variability; however, the spatial variability appears to occur over relatively short distances. It is important to note that berms differ from other types of structures, such as drilled piers or driven piles, in that the performance of the berm involves local, not average, soil conditions.[1] The selection of analysis parameters for this project was based on a review of the available geotechnical data, our knowledge of the project area, and design calculations using select surveyed geometries. The results of our analyses were then reviewed with respect to important trends and general concepts, keeping these conditions and limitations in mind. Our conceptual recommendations are based on a conservative approach as is warranted for all slope stability analyses. We believe that the combination of observed conditions and probable failure modes justifies this approach.

LIMITATIONS

This engineering report has been prepared in accordance with accepted Geotechnical Engineering practices in the region of south/central Texas and for the use of Pape-Dawson Engineers, Inc. (CLIENT) and its representatives for design purposes. This report may not contain sufficient information for purposes of other parties or other uses. This report is not intended for use in determining construction means and methods.

[1] Focht, J.A. Jr. and Focht, J.A. III, "Factor of Safety and Reliability in Geotechnical Engineering, Discussion and Closure", ASCE JGGE Vol. 127 No. 8, pp.700-721, August 2001.

The recommendations submitted in this report are based on the data obtained from 14 borings drilled at this site and our understanding of the project information provided to us. If the project information described in this report is incorrect, is altered, or if new information is available, we should be retained to review and modify our recommendations.

This report may not reflect the actual variations of the subsurface conditions across the site. However, it is important to note that a significant portion of the apparent site variability is due to variation in the proportions of sand and clay in the native soils. These variations cause the soil classification to change between borings, while our experience indicates the behavior of these soils varies within a relatively narrow range.

The scope of our Geotechnical Engineering Study does not include an environmental assessment of the air, soil, rock, or water conditions either on or adjacent to the site. No environmental opinions are presented in this report.

BORINGS AND LABORATORY TESTS

Subsurface conditions at the site were evaluated by 14 borings drilled at the locations shown on the Boring Location Map, Figure A-1. These locations are approximate and distances were measured using a recreational-grade, hand-held GPS locator; tape; angles; pacing; etc. Ground surface elevations were estimated from the topography depicted on the above-referenced drawings provided by Mr. Dean. The estimated ground surface elevation at each of the boring locations is listed in the table below as well as the approximate bottom elevation of each boring.

Boring No.	Ground Surface Elevation (ft, MSL)	Boring Bottom Elevation (ft, MSL)
B-1	522	472
B-2	523	473
B-3	522	472
B-4	523	473
B-5	501	461
B-6	500	460
B-7	500	470
B-8	501	461
B-9	499	469
B-10	496	456
B-11	496	466
B-12	500	470
B-13	496	456
B-14	501	461

The borings were drilled using a truck-mounted drilling rig. During drilling operations, the following samples were collected:

Type of Sample	Number Collected
Split-Spoon (with Standard Penetration Test)	126
Undisturbed Shelby Tube	28

Each sample was visually classified in the laboratory by a member of our Geotechnical Engineering staff. The geotechnical engineering properties of the strata were evaluated by the following tests:

Type of Test	Number Conducted
Natural Moisture Content	151
Atterberg Limits	29
Percent Passing a No. 200 Sieve	33
Direct Shear	2
Consolidated-Undrained ($\overline{CU}$) Triaxial	10
Unconfined Compression	17
Dry Unit Weight	17

With the exception of the $\overline{CU}$ triaxial and direct shear tests, the results of the field and laboratory tests are presented in graphical or numerical form on the boring logs illustrated on Figures A-2 through A-15. A key to classification terms and symbols used on the logs is presented on Figure A-16. The results of the laboratory and field testing are also tabulated on Figure B-1 for ease of reference.

Standard penetration test results are noted as “blows per ft” on the boring logs and Figure B-1, where “blows per ft” refers to the number of blows by a falling hammer required for 1 ft of penetration into the soil/weak rock. Where hard or dense materials were encountered, the tests were terminated at 50 blows even if one foot of penetration had not been achieved. When all 50 blows fall within the first 6 in. (seating blows), refusal “ref” for 6 in. or less will be noted on the boring logs and on Figure B-1.

Samples will be retained in our laboratory for 30 days after submittal of this report. Other arrangements may be provided at the request of the Client.

<u>pH TESTING</u>

Seepage from the ash ponds would most likely result in an increase pH in the embankment soils. As a part of our laboratory study, we evaluated the collected soil samples using a phenolphthalein solution. We customarily screen for pH in order to prevent chemical burns to our laboratory staff, who typically work with the samples bare-handed.

No reaction to the phenolphthalein solution was noted in any of the samples tested. This would indicate that all samples tested had a pH value of less than 8.

$\overline{\text{CU}}$ TESTS

Multi-stage $\overline{\text{CU}}$ tests were used to measure both total and effective soil strength parameters of harvested samples from the project site. During $\overline{\text{CU}}$ testing, each stage was subjected to a range of effective consolidation pressure.

The following table presents the results of our multi-stage $\overline{\text{CU}}$ tests:

Boring No.	Depth (ft)*	Effective		Total		Stress Path	
		Friction Angle, ϕ' (degrees)	Cohesion, c' (psf)	Friction Angle, ϕ (degrees)	Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Cohesion, c (psf)
B-2	13-15	18.6	1,350	20.2	1,390	19.1	1,310
B-3	18-20	21.7	1,130	22.7	1,220	25.9	1,060
B-5	8-10	28.0	730	30.0	1,020	29.5	720
B-7	8-10	28.3	2,040	-	-	36.2	560
B-9	8-10	33.6	0.0	38.6	0.0	24.0	1,070
B-12	8-10	27.2	1,160	34.9	1,090	31.3	860

*Depth below the top of berm surface elevation existing at the time of our field study.

DIRECT SHEAR TESTS

Direct shear tests were performed on two samples collected during drilling operations. The results of these tests are presented in the table below:

Boring No.	Depth (ft)	Apparent Cohesion (psf)	Phi (degrees)
B-3	28.5 - 30	62	27
B-5	38.5 – 40	72	34

LIQUID DENSITY TESTS

Three one-gallon liquid samples were collected at the site on April 22, 2014. These samples were collected from the Evaporation Pond, North Bottom Ash Pond, and the North SRH Pond. The densities of these liquids are presented in the following table:

Sample Location	Density (pcf)
Evaporation Pond	61.0
North Bottom Ash Pond	60.6

Sample Location	Density (pcf)
North SRH Pond	60.7

FLY ASH SPECIFIC GRAVITY TESTING

Two samples of fly ash sludge were collected at the site on April 22, 2014 to calculate the specific gravity of the fly ash. The calculated specific gravities are presented in the table below:

Sample Location	Specific Gravity
North Bottom Ash Pond	2.59
South Bottom Ash Pond	2.60

MOISTURE-DENSITY TESTING

The density of the at surface material in the dry portions of the ponds was measured on April 22, 2014 using a nuclear density gauge. The results of these tests are presented in the tables below:

Pond	Sample Location	Wet Density (pcf)	Moisture Content (%)	Dry Density (pcf)
Evaporation Pond	West Edge of Pond	94.2	33.3	70.7
		92.9	40.0	66.4
		92.0	31.1	70.2
		95.2	31.5	72.4
		92.6	35.5	68.4
		94.4	34.5	70.2
North Bottom Ash Pond	East and Southeast Edge of Pond	106.3	18.0	90.1
		111.2	19.0	93.4
		107.3	24.2	86.4
		112.9	17.9	95.8
		110.7	21.5	91.1
		107.6	24.9	86.2
South Bottom Ash Pond	Center of Pond	118.0	18.0	100.0
		122.2	16.3	105.1
		119.5	16.2	102.9
		114.6	19.2	96.2
		106.7	23.6	86.4
		115.5	17.7	98.1

GENERAL SITE CONDITIONS

SITE DESCRIPTION

The project site is a tract of developed land located at the Spruce/Deely Generation Units , which is operated by CPS Energy. The ash ponds considered in this study are located east and northeast of the existing main power plant facility. The entire facility is bounded to the west, south, and east by Calaveras Lake. The topography generally slopes downward toward Calaveras Lake. CPS maintains the Calaveras Lake at a target pool elevation of Elevation 485 feet with periodic fluctuations of plus or minus one foot. Levels above the target pool elevation are usually due to rainfall in the Calaveras Creek, Hondo Creek and Chupaderas Creek watersheds, and typically return to the target pool elevation within a few days of the rain event.

GEOLOGY

A review of the *Geologic Atlas of Texas, San Antonio Sheet*, indicates that this site is naturally underlain with the soils/rocks of the Wilcox Group, which is composed of mudstone with varying amounts of sandstone and lignite. The Wilcox Group may weather to yellowish-brown clay, sandy clay, clayey sands, and sands.

The Wilcox Group grades downward into the Midway Group, which is composed of clay, silt, and sand, with some pebbles near its base. Glauconite is often encountered in these soils. Key engineering considerations for development supported on the soils/rock of this formation typically include the presence of possible water-bearing layers, very hard mudstone/sandstone layers, and the expansive nature of the highly plasticity clays that can be present in this formation.

STRATIGRAPHY

The subsurface stratigraphy at this site varies from pond to pond, and berm to berm. However, the embankment fill soils typically consist of sandy clay or clayey sand. It is difficult to distinguish between these two soil types in the berms because the percent passing a No. 200 sieve ranges within about 10 percentage points higher and lower than 50%. The subgrade stratigraphy is also generally composed of interbedded sandy clay and clayey sand. There were also isolated tan and gray clay seams encountered in our borings. Each stratum has been designated by grouping soils that possess similar physical and engineering characteristics. The boring logs should be consulted for more specific stratigraphic information. The lines designating the interfaces between strata on the boring logs represent approximate boundaries. Transitions between strata may be gradual, which vary within a relatively narrow combined range of Plasticity Index and -200 values.

GROUNDWATER

The depth to groundwater was measured in all borings except Boring B-1. The groundwater level in Boring B-1 could not be measured due to the introduction of drilling fluids in this boring.

Upon completion of the drilling operations, groundwater levels ranged from 11 to 17 ft below the existing ground surface in the borings drilled for Ponds 1 and 2. Groundwater levels ranged from 40 to 42 ft below the existing ground surface in the borings drilled for Pond 3 (with the exception of Boring B-1).

As mentioned previously, this site is bounded to the west, south, and east by Calaveras Lake. The groundwater levels encountered at this site are most likely dominated by the surface water elevation of Calaveras Lake. Fluctuations in groundwater levels are possible due to variations in rainfall and surface water run-off.

EARTHEN BERMS

DESIGN CONSIDERATIONS

The existing berms should meet three important criteria: they should be resistant to the forces of erosion, should exhibit a suitable slope stability design allowable factor of safety with respect to long-term, short-term, and sudden drawdown conditions, as well as performance type scenarios such as underseepage. The berm structure must meet these criteria so that the calculated risk of failure is consistent with criteria established by the USACE guidelines.

Probable failure modes

Our review of the site and expected conditions for the Calaveras Power Plant ash ponds indicates that the following major modes of failure could affect the berms:

- Slope stability
- Underseepage
- Embankment Seepage

The following sections address each of these failure modes, as well as slope erosion and liquefaction.

Slope Stability Based on our review of available data and our visual observations during drilling, the existing embankments exhibit slopes ranging from about 3:1 (horizontal:vertical) or flatter, while a few limited areas exhibit slopes of about 2.5:1.

In general, slopes flatter than 3:1 would be expected to exhibit the required factors of safety for a normal (non-flood) seepage condition with the area water table near Elevation 485 feet.

Underseepage We generally consider underseepage to be a very low risk for the existing berms. Underseepage consists of water flowing beneath the embankment as a result of water seeping out of the ash ponds. The principal failure mechanism related to underseepage occurs when the upward force of the water equals or exceeds the buoyant weight of the soil. This does not appear likely to occur at this project site.

Berm Seepage Embankment seepage consists of water flowing through the berm as a result of seepage through the berm. The principal failure mechanism related to embankment seepage occurs when the horizontal force of the water equals or exceeds the effective shear strength of the soil. This mode of failure is not expected to occur at this project site.

Slope Erosion The existing embankments are generally composed of cohesive soils, while the underlying soils are generally composed of cohesive soils with layers semi-cohesive soils. It appears that the existing embankments were constructed using the soils available at the project site. These materials are generally considered acceptable to good materials to use when constructing berms, dams and slopes. In addition, the berms are not expected to be exposed to flowing water, other than rain that falls on the berm crest and berm slopes. The risk of berm failure due to erosion is considered to be very low.

Liquefaction Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded, and fine-grained sands. Empirical evidence indicates that loose silty sands are also potentially liquefiable. When seismic ground shaking occurs, the soil is subjected to cyclic shear stresses that can cause excess hydrostatic pressures to develop. If excess hydrostatic pressures reach the effective confining stress from the overlying soil, the sand may undergo deformations. If the sand undergoes virtually unlimited deformation without developing significant resistance, it is said to have liquefied, and if the sand consolidates or vents to the surface during and following liquefaction, ground settlement may occur.

The soils contain significant quantities of clay, and are relatively dense. Even when groundwater is present, the berms have a very low potential for liquefaction during earthquake events, particularly since the USGS online resources indicate there is less than 0.1 percent chance of experiencing a magnitude 5.0 or greater earthquake at this site during a 50 year period. In addition, calculations performed using the Seed and Idriss method indicate the most susceptible tested sample must experience a ground acceleration in excess of 0.44g before liquefaction will occur. Based on these findings, RKCI believes the soils beneath the existing berms have a very low risk of experiencing liquefaction due to an earthquake.

SLOPE STABILITY

This section presents our slope stability analyses performed for this study. In general, the procedures described in USACE EM 1110-2-1902 *Slope Stability* were followed. As such, our analysis focused on embankment stability, settlement, interior drainage, and slope protection.

The slope configurations analyzed, method of analysis, loading conditions, and soil properties used in the analyses are discussed in the following paragraphs.

Minimum Factor of Safety

For a given slope configuration, the forces that "drive" slope failure (including gravity, groundwater seepage pressure, and possible excess pore water pressures from external loading conditions) are compared to the slope's resistance to failure, which is a function of dewatering controls and internal shear strength (cohesion and internal angle of friction) of both the foundation soils and the fill soils utilized for construction of the embankment.

The USACE has specified minimum safety factors against slope failure with respect to loading conditions. The minimum acceptable factors of safety for berms at end of construction, rapid drawdown, and steady state conditions, provided in Table 3-1 on Page 3-2 of EM 1110-2-1902, are listed in the following table. The minimum safety factor against slope failure during an earthquake is customarily assumed to be a calculated value greater than 1.0 where the risk of loss of life is low and the structure is not deemed critical in nature (hospitals, emergency services, etc.)

Condition	Required Factor of Safety
End of Construction	1.3
Sudden Drawdown	1.1 to 1.3
Long Term (Steady Seepage)	1.4
Earthquake	Greater than 1.0

We consider a significant slope failure to involve a volume of slope material that is large enough to substantially impair the serviceability or operation of the berm or that could imperil human life. Shallow, sloughing slope failures that involve relatively little material or that can be repaired locally without substantially impacting the ash pond operations are considered to be minor slope failures and do not control the conclusions of our stability analyses.

Slope Configurations

At the time this technical report was prepared, field surveys drawings of the existing berms had been performed by Pape Dawson Engineers, Inc. As a part of their work, we understand that Pape Dawson spot-checked the existing berms, and only provided surveyed cross-sections where the existing condition did not closely resemble the original drawings. As such, we have provided the original design geometry for the purposes of our study for the select berms. Figure C-1 shows the profiles that were surveyed and those that are based on the design drawings.

We recognized four general soil conditions along the length of the alignment that may be considered as worst-case boundary conditions. As such, four cases were analyzed based on these boundary conditions.

Method of Analysis

The slope stability analyses for this study were conducted with the aid of a computer using the program SLIDE developed by RocScience. The SLIDE computer program randomly generates trial failure surfaces and evaluates the factor of safety for each trial surface. The program allows a large number of potential shear surfaces to be investigated to determine the critical failure surface for each of the analyzed slope configurations.

The portions of the program used in this study employed both the Morgenstern-Price and Spencer computational methods. These methods were used to make calculations of the stability of slopes where non-circular failure surfaces were permitted. In each case, the computed factor of safety is the ratio of the forces resisting movement to the driving forces. A factor of safety of 1.0 or less implies the slope is unstable, while a factor of safety greater than 1.0 implies the slope is stable.

Loading Conditions

For satisfactory performance, an earth embankment should have an acceptable factor of safety during construction and throughout its projected service lifetime. Stability analyses should include variations in stress conditions brought on by construction practices and sequencing, external loadings, and any anticipated changes in hydraulic conditions. The following paragraphs discuss each stability condition analyzed in our study.

External Loads External loads for the roadways along the berm crest have also been modeled. A traffic loading of HS20 (modeled as an equivalent uniform surcharge of 100 psf) was applied to the crest of the berm.

Liquid/Sludge Loads Based on the results of the density testing performed on the samples collected on April 22, 2014, we have included additional loads on the analyses conducted for the "dry side" of the berms.

These loads account for the increase in pressure in the bottom of the ponds and along the berm slopes due to weight of the sludge and/or liquid in the ponds. The increase in the pressure due to this material is modeled in our analysis.

These loads were not applied to the "pond side" analyses due to the increase in factors of safety from this loading condition.

End of Construction The short-term (undrained) loading condition models the slope immediately following construction. For this loading condition, the pore pressures developed during construction have not had the opportunity to dissipate. We did not analyze this condition since the berms have been in place for many years.

Steady State Seepage The long term (drained), steady-state seepage loading condition was analyzed. This loading condition models the ash ponds with 2 ft of freeboard along the berm crest and assumes that the berm soils are fully saturated and a condition of steady state seepage occurs through the embankment. For this loading condition, effective stress soil parameters were used in the analysis.

Maximum Pool The analyses for "Maximum Pool" consider those given for "Steady State" but assume that the pond is completely full.

The maximum pool condition represents a more severe condition than an assumed steady state analysis with the pond level 2 ft below the top of the embankment. Provided the analyses meet the relevant criteria for slope stability and seepage, a separate steady state analysis for normal operating conditions is not required.

Sudden Drawdown from Design Flood Stage This condition represents the situation when the water within the pond is drained at such a rapid rate that the saturated berm soils do not have time to drain. Consequently, excess pore water pressures result in the soil. We did not model this condition since it would pose no risk of environmental contamination, because the pond must be empty for this condition to occur.

SOIL PARAMETERS

Drained soil parameters (drained cohesion and drained friction angle) were selected for each soil stratum based on the laboratory and field test data collected during our study as well as correlations published by Stark and Hussain (2010)[2]. The fully softened soil strength envelopes were compared to the stress path strength envelopes developed from the $\overline{CU}$ tests performed for this study. With the possible exception of the multi-stage $\overline{CU}$ test performed on a sandy clay sample harvested from Boring B-2 at 13 to 15 feet, all of the stress path strength envelopes developed from the $\overline{CU}$ tests exceeded the Stark and Hussain fully softened soil strength envelopes. We assumed that soil behavior was represented by the fully softened soil condition, and also evaluated Profile D using both the relevant fully softened soil strength envelope and the stress path strength envelope developed from the referenced $\overline{CU}$ test. We did not employ the residual strength soil properties since we found no evidence of pre-existing failure surfaces, and are unaware of any prior slope failures in the berm slopes. For purposes of our slope stability analyses, we have assigned the material properties presented in the following table.

Drained Fully Softened Shear Stresses from Equations Developed by Stark and Hussain (2010)

North and South SRH Ponds	Clay Fraction %	Assumed Liquid Limit	Normal Stress, psf				Equivalent Upper-Bound Soil Parameters	
			0	1,044	2,089	8,354	c (psf)	Phi (degrees)
Embankment Soil (CL)	47	42	0	647	1,158	4,075	186	25.0
Sandy Clay (CL)	52	52	0	561	972	3,281	202	20.2
Clayey Sand (ML)	36	33	0	669	1,197	4,240	183	25.9

[2] Stark, T.D. and M. Hussain, "Shear Strength in Pre-existing Landslides," *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE, 136(7), July, 2010, pp. 957-962.

North and South Bottom Ash Ponds	Clay Fraction %	Assumed Liquid Limit	Normal Stress, psf				Equivalent Upper-Bound Soil Parameters	
			0	1,044	2,089	8,354	c (psf)	Phi (degrees)
Embankment Soil (CL)	45	35	0	664	1,188	4,202	184	25.7
Sandy Clay (CL)	61	51	0	563	976	3,298	202	20.3
Clayey Sand (ML)	43	33	0	669	1,197	4,240	183	25.9

Evaporation Pond	Clay Fraction %	Assumed Liquid Limit	Normal Stress, psf				Equivalent Upper-Bound Soil Parameters	
			0	1,044	2,089	8,354	c (psf)	Phi (degrees)
Embankment Soil (CL)	45	45	0	640	1,145	4,023	186	24.7
Sandy Clay (CL)	50	54	0	557	963	3,247	202	20.0
Clayey Sand (ML)	34	55	0	618	1,105	3,859	187	23.7

The tables obtained from Stark and Hussain can be used to estimate equivalent c-phi linear shear strength parameters that have been traditionally used in slope stability analyses. These values are also tabulated in the three tables presented above. Please note that the c-phi values tend to overestimate the available soil shear strength at low overburden pressures. The Stark and Hussain values correctly predict the likelihood of shallow surface sloughs for clay soils, but the calculated results for the deeper failures contemplated in this study should be essentially the same using either soil model.

Results of Analyses

The following table contains a summary of the results from our slope stability analyses for each loading condition and slope configuration. In general, the point where a potential slide surface was permitted to intersect was not allowed to occur within 3 ft of the relevant top of slope. This limitation was intended to reduce the occurrence of "non-critical" failure surfaces from resulting from the analyses. A graphical presentation of the most critical failure surface from our SLIDE iterations for each berm profile studied can be found at the end of this memorandum in Appendix C. The "a" series figures show the critical failure surface on the "dry side" of each berm, while the "b" series figures show the critical failure surface on the "pond side" of each berm.

Computed Factors of Safety for North and South SRH Ponds					
Slope Profile	**End of Construction**	**Steady State on Pond Side**	**Steady State on Dry Side**	**Maximum Pool on Pond Side**	**Maximum Pool on Dry Side**
J	N/A	> 2	> 2	> 2	> 2
K	N/A	> 2	> 2	> 2	> 2
L	N/A	> 2	> 2	> 2	> 2
M	N/A	> 2	1.7	> 2	1.6

Computed Factors of Safety for North and South Bottom Ash Ponds					
Slope Profile	**End of Construction**	**Steady State on Pond Side**	**Steady State on Dry Side**	**Maximum Pool on Pond Side**	**Maximum Pool on Dry Side**
E	N/A	> 2	> 2	> 2	> 2
F	N/A	> 2	> 2	> 2	> 2
G	N/A	1.8	1.3	> 2	1.4
H	N/A	> 2	> 2	> 2	> 2
I	N/A	1.8	1.6	> 2	1.5
N	N/A	1.9	1.6	> 2	1.6

Computed Factors of Safety for the Evaporation Pond					
Slope Profile	**End of Construction**	**Steady State on Pond Side**	**Steady State on Dry Side**	**Maximum Pool on Pond Side**	**Maximum Pool on Dry Side**
A	N/A	2	> 2	> 2	> 2
B	N/A	> 2	> 2	> 2	> 2
C	N/A	> 2	1.5	> 2	> 2
D	N/A	> 2	1.9	> 2	> 2

SEEPAGE ANALYSIS

We performed steady-state seepage analyses for each slope profile using the finite element groundwater module within SLIDE. Our seepage analyses were performed assuming that the soil properties observed in our borings exhibited a 5:1 ratio of permeability (horizontal:vertical) with the assumed permeability values presented in the following table.

Soil	Assumed Permeability, cm/second	
	Horizontal	Vertical
Clay	$1x10^{-7}$	$2x10^{-8}$
Sandy Clay	$1x10^{-6}$	$2x10^{-7}$
Clayey Sand	$1x10^{-4}$	$2x10^{-5}$

EARTHQUAKE ANALYSES

Each berm profile was also evaluated for earthquake conditions utilizing a design spectral acceleration of 0.098g. The assumed seismic force was calculated using the USGS web site calculator; in general, these analyses are considered to be very conservative since the nearest documented active fault is roughly 385 miles from the project site. A probabilistic assessment of the likelihood of the project site experiencing a magnitude 5 or larger earthquake within a 50 year period was also performed. This assessment indicated that the probability of occurrence was only 4 to 6 percent, which is considerably less than the 10 percent required by USEPA regulations. Graphical representations of these analyses are presented in Appendix D. The “a” series figures show the critical failure surface on the “dry side” of each berm, while the “b” series figures show the critical failure surface on the “pond side” of each berm.

Quasi-static analyses were performed, with soil behavior modeled using total stress soil strength values. The assumed values of shear strength used in our models consisted of both a cohesion intercept and angle of internal friction, with the cohesion intercept values chosen based on the unconfined compressive strength testing performed for this study as well as prior area experience. The strength values chosen are considered lower bound for the soils encountered at the project site.

The soil properties utilized for these analyses are presented in the following table:

Material	Unit Weight (pcf)	Cohesion (psf)	Phi (degrees)
Embankment Fill	120	350	20
Clayey Sand	120	400	20
Clayey Sand Below Water Table	57.6	400	20
Sandy Clay	120	500	20
Sandy Clay Below Water Table	57.6	500	20

Results of Quasi-Static (Seismic) Analyses

Global stability analyses were also performed for each slope analyzed for steady state conditions. The results of our analyses are summarized below and are graphically presented in Appendix D at the end of this report.

Computed Factors of Safety for North and South SRH Ponds					
Slope Profile	**End of Construction**	**Steady State on Pond Side**	**Steady State on Dry Side**	**Maximum Pool on Pond Side**	**Maximum Pool on Dry Side**
J	N/A	> 2	> 2	> 2	> 2
K	N/A	> 2	> 2	> 2	> 2
L	N/A	> 2	> 2	> 2	> 2
M	N/A	> 2	1.7	> 2	1.6

Computed Factors of Safety for North and South Bottom Ash Ponds					
Slope Profile	**End of Construction**	**Steady State on Pond Side**	**Steady State on Dry Side**	**Maximum Pool on Pond Side**	**Maximum Pool on Dry Side**
E	N/A	> 2	> 2	> 2	> 2
F	N/A	> 2	> 2	> 2	> 2
G	N/A	> 2	1.9	> 2	1.9
H	N/A	> 2	> 2	> 2	> 2
I	N/A	> 2	> 2	> 2	> 2
N	N/A	> 2	> 2	> 2	> 2

Computed Factors of Safety for the Evaporation Pond					
Slope Profile	**End of Construction**	**Steady State on Pond Side**	**Steady State on Dry Side**	**Maximum Pool on Pond Side**	**Maximum Pool on Dry Side**
A	N/A	> 2	> 2	> 2	> 2
B	N/A	> 2	> 2	> 2	> 2
C	N/A	> 2	1.5	> 2	> 2
D	N/A	> 2	1.9	> 2	> 2

RESULTS

In general, the global stability analyses for steady state conditions resulted in calculated factors of safety in excess of 2 for both long term and earthquake conditions. Three sections exhibited calculated factors of safety of less than 2, and one section ("G") exhibited a calculated factor of safety of 1.2 for the "dry" slope. Review of Figure C-8a revealed that the critical failure surface for this analysis was relatively thin and did not appear to threaten the ash pond reservoir. A second analysis of this section was then performed, with the top of the assumed surfaces limited to intersecting the ground surface at the top of slope of the "wet" slope or farther from the "dry" slope. Surfaces in this portion of the berm would not threaten containment of the ash pond's contents. The results of this analysis are presented on Figure C-8c, and indicate the calculated factor of safety for this analysis was 1.4.

Global stability analyses for the assumed earthquake conditions resulted in calculated factors of safety that exceeded 1.5 in the evaluated cases. These results indicate that pond failures due to seismic forces do not pose a significant threat to the ash ponds at this site.

CONCLUSIONS

The existing berms were constructed of lean sandy clays and/or clayey sands over competent sandy clays and clayey sands. Liquefaction is considered a very low risk issue at this site. The results of our seepage analyses indicate that no significant risk of an erosion or piping-type failure beneath the ash pond embankments exists. The results of our earthquake analyses indicate that no significant risk of embankment failure due to seismic forces exists at this site. Global stability analyses of steady state conditions indicate that acceptable calculated factors of safety were obtained for reasonable failure surfaces through the embankments at this site, even though the analyses were performed using fully softened soil strength envelopes that were lower than $\overline{CU}$ tests indicate are available at the project site.

The end-of-construction condition was not evaluated due to the age of the ash ponds, and both rapid drawdown and erosion failures are considered to be of very low risk due to the embankment toe elevations (above EL 490 feet) with respect to the target pool elevation (EL 485 feet). We do not consider embankment seepage or underseepage to pose a significant risk to the berm based on both the long-term performance of the berms and the results of the seepage analyses, which was indirectly confirmed by the pH testing performed on all of the harvested soil samples. The results of our slope stability analyses indicate that all of the berm slopes meet or exceed both USEPA and USACE criteria for stability under steady state (long term) and seismic (earthquake) conditions.

* * * * * * * * * * * * * * * * * *

The following appendices are attached and complete this report:

Field Data	Appendix A
Laboratory Test Results	Appendix B
Slope Stability Analyses	Appendix C
Seismic Analyses	Appendix D

ATTACHMENTS

APPENDIX A

FIELD DATA

RABA KISTNER CONSULTANTS
Raba Kistner Consultants, Inc.
12821 West Golden Lane
San Antonio, Texas 78249
P 210 :: 699 :: 9090
F 210 :: 699 :: 6426
www.rkci.com
TBPE Firm Number 3257

SOURCE: 2011 Aerial Photograph Provided by the City of San Antonio (COSA)

BORING & MONITORING WELL LOCATION MAP

ASH POND BERMS - SPRUCE/DEELY GENERATION UNITS
SAN ANTONIO, TEXAS

REVISIONS:

No.	DATE	DESCRIPTION

PROJECT No.: ASA12-098-00

ISSUE DATE:	10/10/2012
DRAWN BY:	CCL
CHECKED BY:	RBW
REVIEWED BY:	GLB

FIGURE

A-1

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

LOG OF BORING NO. B-1

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32477; W 98.31464

SURFACE ELEVATION: 522 ft

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
BASE MATERIAL (6 in.)				
FILL MATERIAL: SAND, Medium Dense, Tan	11			
FILL MATERIAL: CLAY, Sandy, Firm, Reddish-Tan, with gray mottling	7			50
		106	16	
		110		
SAND, Clayey, Medium Dense to Very Dense, Tan to Gray		112		40
-with a tan and gray clay seam from 13 to 15 ft	16		37	
-switched to mud rotary at 15 ft				
	22			
	50/11"			
	50/11"			43
	49			
	50/11"			

DEPTH, FT: 5, 10, 15, 20, 25, 30, 35

DEPTH DRILLED: 49.7 ft
DATE DRILLED: 10/15/2012
DEPTH TO WATER: N/A
DATE MEASURED: 10/15/2012
PROJ. No.: ASA12-098-00
FIGURE: A-2a

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-1

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32477; W 98.31464

SURFACE ELEVATION: 522 ft

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70 80)	PLASTICITY INDEX	% -200
			SAND, Clayey, Medium Dense to Very Dense, Tan to Gray *(continued)*					
45		X		50/9"		●		
50		X		50/8"		●		
55								
60								
65								
70								
75								

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 49.7 ft
DATE DRILLED: 10/15/2012
DEPTH TO WATER: N/A
DATE MEASURED: 10/15/2012
PROJ. No.: ASA12-098-00
FIGURE: A-2b

LOG OF BORING NO. B-2

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32378; W 98.31541

SURFACE ELEVATION: 523 ft

SHEAR STRENGTH, TONS/FT^2: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	FILL MATERIAL: CLAY, Sandy, Stiff, Brown	11			
	FILL MATERIAL: SAND, Clayey, Brown and Tan		119		38
5			104	15	
			102		
	CLAY, Sandy, Very Stiff, Tan and Gray		110		
10					
15				36	
			101		
20	SAND, Clayey, Dense to Very Dense, Gray				
25		50/11"			24
30		50/10"			
35		38			
		50			

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	49.8 ft	**DEPTH TO WATER:**	40 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/16/2012	**DATE MEASURED:**	10/16/2012	**FIGURE:**	A-3a

LOG OF BORING NO. B-2

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32378; W 98.31541

SURFACE ELEVATION: 523 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	WATER CONTENT (plotted)	PLASTICITY INDEX	% -200
	SAND, Clayey, Dense to Very Dense, Gray *(continued)* -DRILLER'S NOTE: WATER encountered at 40 ft					
~44		50/8"		●		
~49		50/9"		●		

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

Depth scale: 45 50 55 60 65 70 75

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 49.8 ft
DATE DRILLED: 10/16/2012
DEPTH TO WATER: 40 ft
DATE MEASURED: 10/16/2012
PROJ. No.: ASA12-098-00
FIGURE: A-3b

LOG OF BORING NO. B-3

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32401; W 98.31406

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

SURFACE ELEVATION: 522 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	FILL MATERIAL: SAND, Medium Dense, Brown, with gravel (road material)	24			
	FILL MATERIAL: SAND, Clayey, Medium Dense, Tan	12			
5		11		19	
		19			41
10	CLAY, Sandy, Stiff to Very Stiff, Tan and Gray	14			
15			112	30	
20					
25	SAND, Clayey, Dense to Very Dense, Tan to Gray	46			47
30		50			
35		50/11"			
	-DRILLER'S NOTE: WATER encountered at 39 ft	50/11"			33

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	49.8 ft	**DEPTH TO WATER:**	40 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/15/2012	**DATE MEASURED:**	10/15/2012	**FIGURE:**	A-4a

LOG OF BORING NO. B-3

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32401; W 98.31406

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL (SURFACE ELEVATION: 522 ft)	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT	PLASTICITY INDEX	% -200
			SAND, Clayey, Dense to Very Dense, Tan to Gray *(continued)*					
			-with a tan and gray clay seam from 43 to 45 ft	38				
45								
				50/10"				
50								
55								
60								
65								
70								
75								

Shear strength scale: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0
Water content scale: 10, 20, 30, 40, 50, 60, 70, 80

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	49.8 ft	**DEPTH TO WATER:**	40 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/15/2012	**DATE MEASURED:**	10/15/2012	**FIGURE:**	A-4b

LOG OF BORING NO. B-4

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

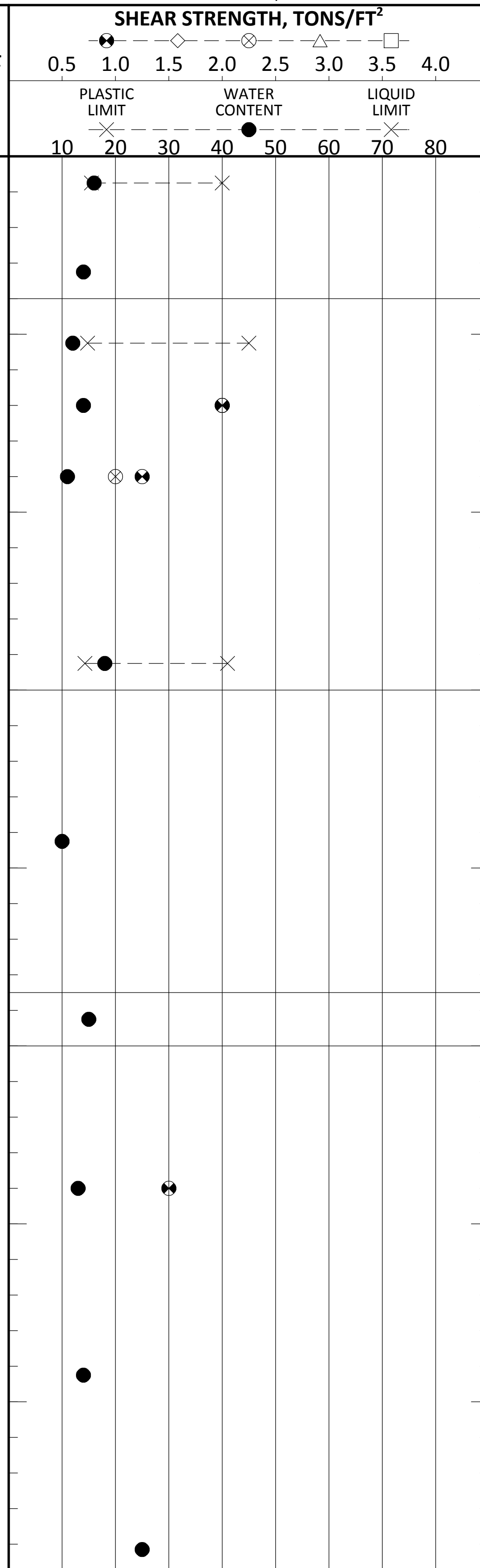
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32322; W 98.31478

SURFACE ELEVATION: 523 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–4	FILL MATERIAL: CLAY, Sandy, Firm, Brown	7		25	
		5			54
4–15	FILL MATERIAL: CLAY, Sandy, Stiff to Very Stiff, Tan and Brown	14		30	
			113		
			110		
		26		27	
15–23.5	SAND, Clayey, Dense, Brown	49			
23.5–25	CLAY, Very Stiff, Reddish-Tan	24			
25–	SAND, Clayey, Dense to Very Dense, Tan and Gray, with intermittent clay seams		97		32
		50			
		50/10"			



DEPTH DRILLED: 49.8 ft	**DEPTH TO WATER:** 42 ft	**PROJ. No.:** ASA12-098-00	
DATE DRILLED: 10/16/2012	**DATE MEASURED:** 10/16/2012	**FIGURE:** A-5a	

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-4

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.32322; W 98.31478

SHEAR STRENGTH, TONS/FT²: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

SURFACE ELEVATION: 523 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	SAND, Clayey, Dense to Very Dense, Tan and Gray, with intermittent clay seams *(continued)*				
	-DRILLER'S NOTE: WATER encountered at 42 ft				
45		50			
50		50/9"			23
55					
60					
65					
70					
75					

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	49.8 ft	**DEPTH TO WATER:**	42 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/16/2012	**DATE MEASURED:**	10/16/2012	**FIGURE:**	A-5b

LOG OF BORING NO. B-5

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

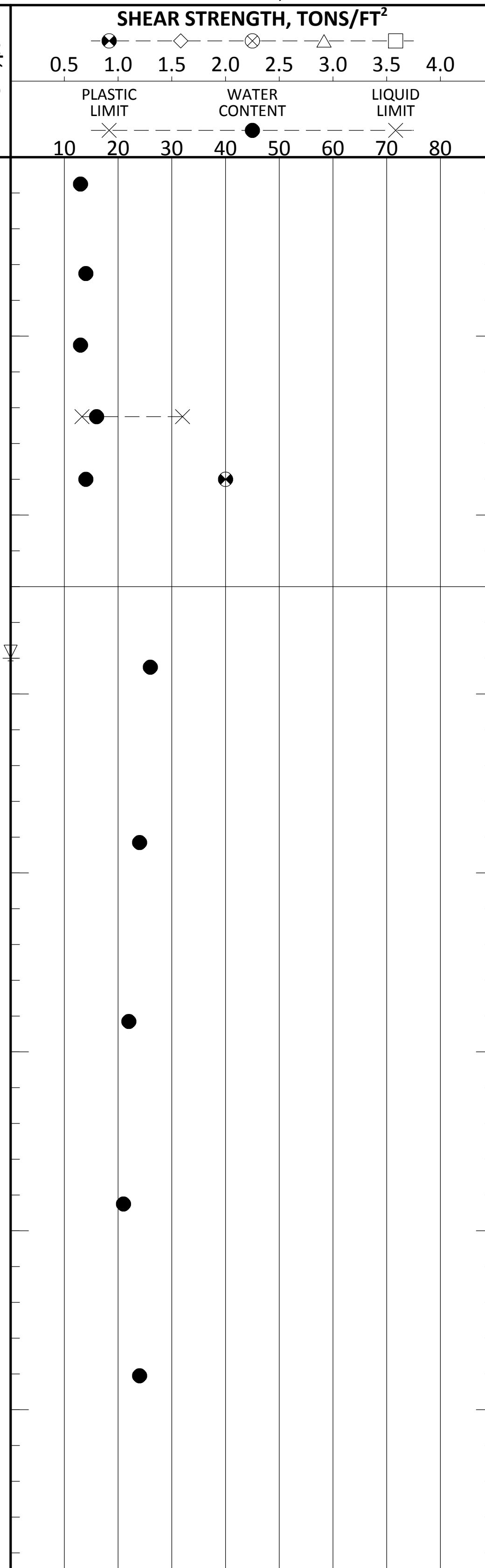
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30947; W 98.31590

SURFACE ELEVATION: 501 ft

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
FILL MATERIAL: SAND, Clayey, Medium Dense, Tan	17			
	21			
	24			
	20		19	
				46
SAND, Clayey, Medium Dense to Very Dense, Gray	33			46
	50/10"			
	50/9"			
-with a clay seam from 28-1/2 to 30 ft	24			
	50/7"			31
	50/8"			



Depth scale (DEPTH, FT): 5, 10, 15, 20, 25, 30, 35

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 39.7 ft	**DEPTH TO WATER:** 14 ft	**PROJ. No.:** ASA12-098-00	
DATE DRILLED: 10/17/2012	**DATE MEASURED:** 10/17/2012	**FIGURE:** A-6	

LOG OF BORING NO. B-6

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

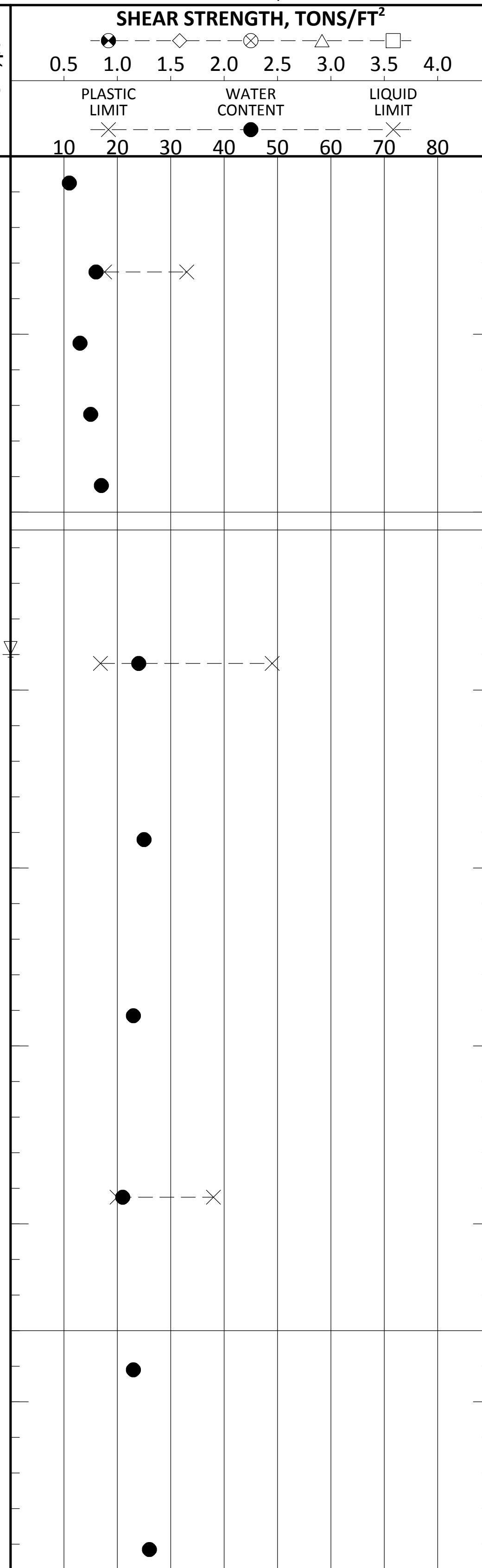
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30837; W 98.31790

SURFACE ELEVATION: 500 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	FILL MATERIAL: CLAY, Sandy, Stiff to Very Stiff, Tan	15			
		14		15	
5		24			50
		19			
		21			
10	GRAVEL, Tan				
	CLAY, Sandy, Firm to Hard, Tan and Gray				
	-DRILLER'S NOTE: WATER encountered at 14 ft	7		32	
15					
20		50/11"			51
25		50/10"			
30		38		18	
	SAND, Clayey, Very Dense, Gray	50/8"			
35					
		50/10"			29



DEPTH DRILLED: 39.8 ft
DATE DRILLED: 10/18/2012
DEPTH TO WATER: 14 ft
DATE MEASURED: 10/18/2012
PROJ. No.: ASA12-098-00
FIGURE: A-7

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-7

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30899; W 98.31660

SURFACE ELEVATION: 500 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–2.5	FILL MATERIAL: SAND, Clayey, Medium Dense, Brown	10			
2.5–13	FILL MATERIAL: CLAY, Sandy, Very Stiff, Tan and Gray	29			
		22		19	
			115		
				17	
	-DRILLER'S NOTE: WATER encountered at 11 ft				
13–20	SAND, Clayey, Very Dense, Tan and Gray	50/9"			47
		50/11"			
20–30	CLAY, Sandy, Hard, Tan and Gray	50/9"		18	
		47			

SHEAR STRENGTH, TONS/FT²: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	30.0 ft	**DEPTH TO WATER:**	11 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/16/2012	**DATE MEASURED:**	10/16/2012	**FIGURE:**	A-8

LOG OF BORING NO. B-8

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

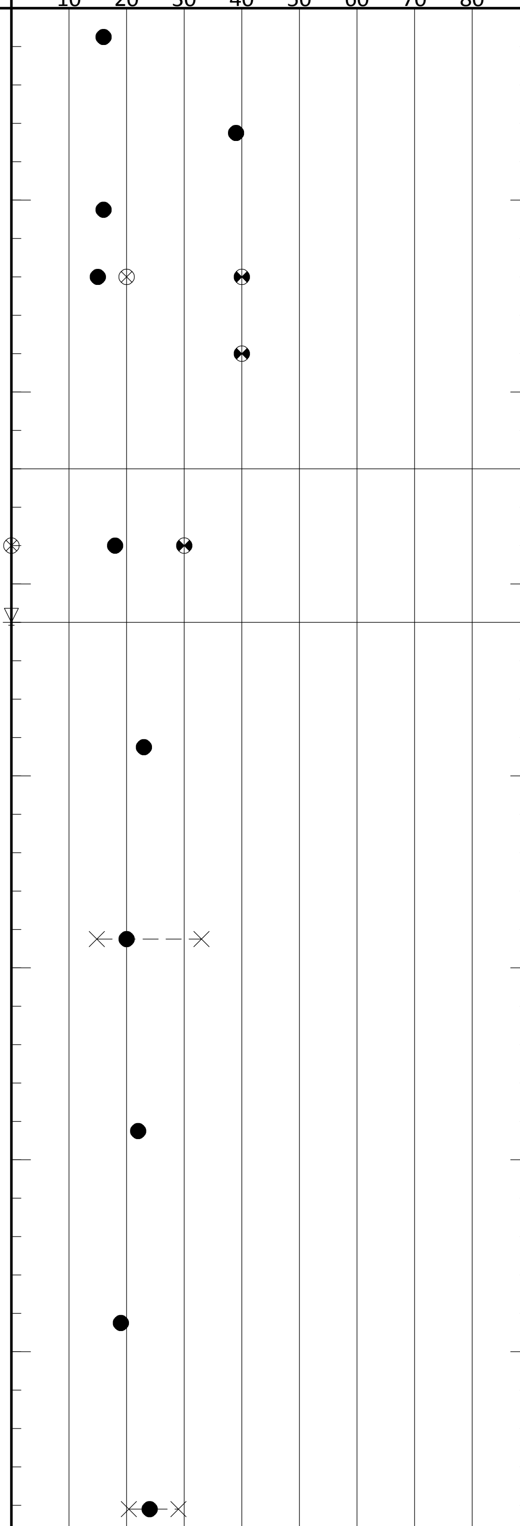
LOCATION: N 29.30884; W 98.31510

SURFACE ELEVATION: 501 ft

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–12	FILL MATERIAL: SAND, Clayey, Loose to Medium Dense, Brown and Tan	25			
		14		NP	
5		7			39
	-with a tan and gray clay seam from 6 to 8 ft		113		
12–16	CLAY, Sandy, Very Stiff, Tan and Gray		111		
16–39.7	SAND, Clayey, Medium Dense to Dense, Tan and Gray -DRILLER'S NOTE: WATER encountered at 16 ft				
20		25			47
25		10		18	
30		25			
35	-with a tan and gray clay seam from 33 to 35 ft	38			52
		50/8"		9	



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 39.7 ft	**DEPTH TO WATER:** 16 ft	**PROJ. No.:** ASA12-098-00	
DATE DRILLED: 10/19/2012	**DATE MEASURED:** 10/19/2012	**FIGURE:** A-9	

LOG OF BORING NO. B-9

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30802; W 98.31601

SURFACE ELEVATION: 499 ft

SHEAR STRENGTH, TONS/FT²: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	FILL MATERIAL: SAND, Medium Dense, Brown and Tan	11			
	FILL MATERIAL: CLAY, Stiff to Very Stiff, Tan	14			
5		16		21	
		11			
10	SAND, Clayey, Loose to Very Dense, Tan and Gray				
15		9			49
	-DRILLER'S NOTE: WATER encountered at 16 ft				
20		50/11"			
		ref/1"			
25					
	CLAY, Sandy, Hard, Tan and Gray	50/11"			62
30					
35					

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	29.9 ft	**DEPTH TO WATER:**	16 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/17/2012	**DATE MEASURED:**	10/17/2012	**FIGURE:**	A-10

LOG OF BORING NO. B-10

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30769; W 98.31855

SHEAR STRENGTH, TONS/FT^2: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

SURFACE ELEVATION: 496 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–11	FILL MATERIAL: CLAY, Sandy, Very Stiff, Tan	16			
		16		16	
5		19			
		24			
10		19		27	
11–37	SAND, Clayey, Medum Dense to Very Dense, Tan and Gray, with intermittent clay seams				
			97		41
15					
	-DRILLER'S NOTE: WATER encountered at 17 ft				
20		38			
25		17			
		ref/1"			
30					
35		50/9"			42
37–40	CLAY, Very Stiff, Dark Gray				
		26			

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	40.0 ft	**DEPTH TO WATER:**	17 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/17/2012	**DATE MEASURED:**	10/17/2012	**FIGURE:**	A-11

LOG OF BORING NO. B-11

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30737; W 98.31744

SURFACE ELEVATION: 496 ft

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–12	FILL MATERIAL: CLAY, Sandy, Stiff to Very Stiff, Tan to Brown	15		16	
		11			
	-with a tan sand seam from 4 to 6 ft	12			49
		18			
12–30	SAND, Clayey, Medium Dense to Dense, Tan and Gray, with intermittent clay seams	18			
	-DRILLER'S NOTE: WATER encountered at 16 ft				
		18			
		49			34
		42			

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	30.0 ft	**DEPTH TO WATER:**	16 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/18/2012	**DATE MEASURED:**	10/18/2012	**FIGURE:**	A-12

LOG OF BORING NO. B-12

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30757; W 98.31509

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

SURFACE ELEVATION: 500 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	FILL MATERIAL: SAND, Clayey, Loose to Medium Dense, Brown, with gravel	23			46
		6			
5	CLAY, Sandy, Firm to Hard, Tan to Brown	8		18	
		27			
				21	
10					
15		18			
	-DRILLER'S NOTE: WATER encountered at 16 ft				
20		24			
		50/11"			51
25	SANDSTONE, Hard, Gray				
	SAND, Clayey, Medium Dense, Tan and Gray	11			
30					
35					

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	30.0 ft	**DEPTH TO WATER:**	16 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/17/2012	**DATE MEASURED:**	10/17/2012	**FIGURE:**	A-13

LOG OF BORING NO. B-13

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

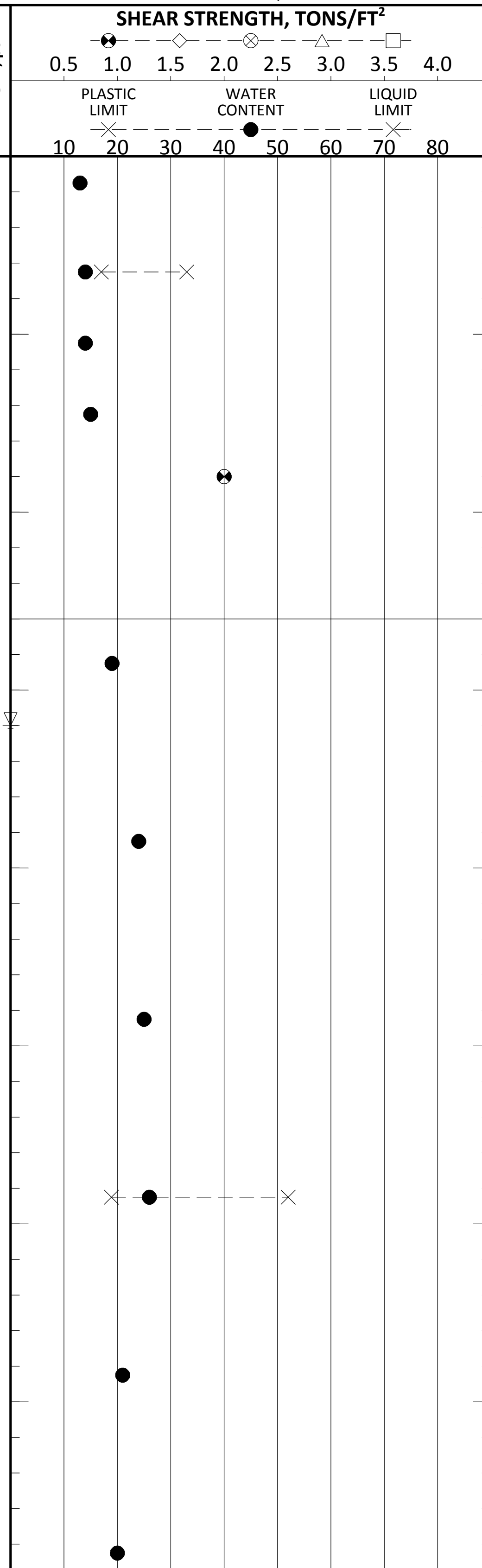
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30715; W 98.31792

SURFACE ELEVATION: 496 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT	PLASTICITY INDEX	% -200
0–13	FILL MATERIAL: CLAY, Sandy, Very Stiff to Hard, Tan to Brown	23				
		27			16	
5	-with a tan sand seam from 4 to 6 ft	34				43
		16				
10						
13–40	CLAY, Sandy, Very Stiff to Hard, Tan and Gray	18				
15	-DRILLER'S NOTE: WATER encountered at 16 ft					
20		19				53
25		41				
30		34			33	
35		41				
40		39				



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	40.0 ft	**DEPTH TO WATER:**	16 ft	**PROJ. No.:**	ASA12-098-00
DATE DRILLED:	10/18/2012	**DATE MEASURED:**	10/18/2012	**FIGURE:**	A-14

LOG OF BORING NO. B-14

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

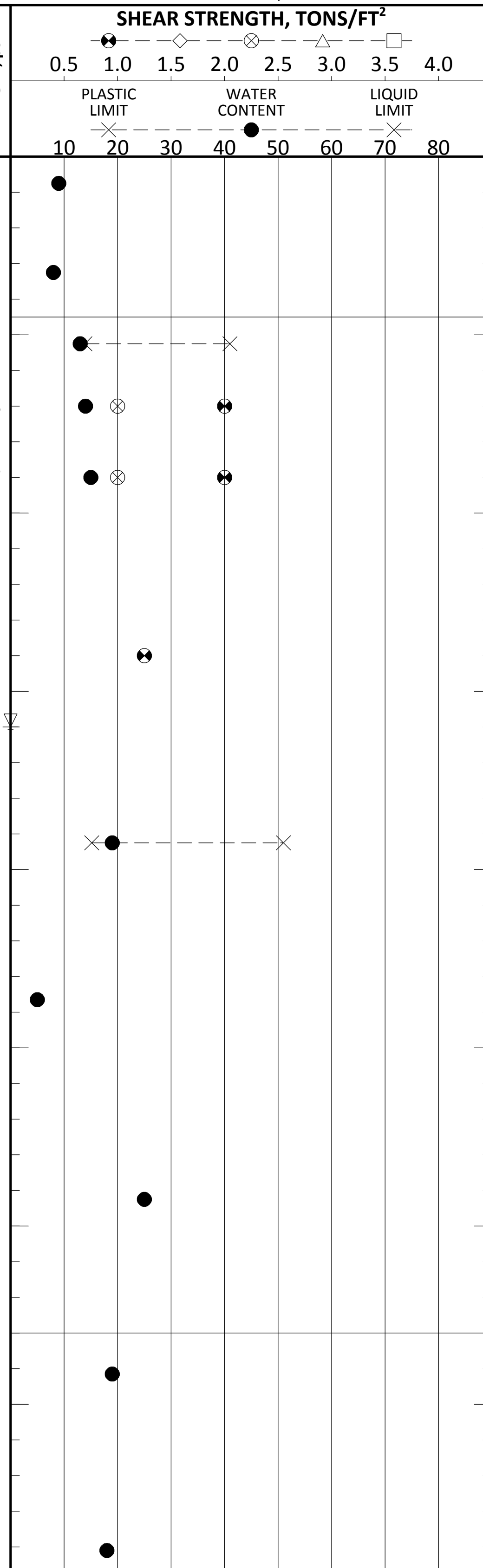
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.30684; W 98.31590

SURFACE ELEVATION: 501 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	FILL MATERIAL: SAND, Clayey, Loose to Dense, Brown and Tan	9			
		30			46
5	CLAY, Sandy, Very Stiff to Hard, Tan to Tan and Gray	18		27	
			118		
			117		
10					
15	-DRILLER'S NOTE: WATER encountered at 16 ft				
		15		36	
20					
		ref/3"			
25					
		32			72
30					
	SAND, Clayey, Very Dense, Tan and Gray	50/9"			
35					
		50/8"			



DEPTH DRILLED: 39.7 ft
DATE DRILLED: 10/19/2012
DEPTH TO WATER: 16 ft
DATE MEASURED: 10/19/2012
PROJ. No.: ASA12-098-00
FIGURE: A-15

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

KEY TO TERMS AND SYMBOLS

MATERIAL TYPES

SOIL TERMS

- CALCAREOUS
- CALICHE
- CLAY
- CLAYEY
- GRAVEL
- GRAVELLY
- PEAT
- SAND
- SANDY
- SILT
- SILTY
- FILL

ROCK TERMS

- CHALK
- CLAYSTONE
- CLAY-SHALE
- CONGLOMERATE
- DOLOMITE
- IGNEOUS
- LIMESTONE
- MARL
- METAMORPHIC
- SANDSTONE
- SHALE
- SILTSTONE

OTHER

- ASPHALT
- BASE
- CONCRETE/CEMENT
- BRICKS / PAVERS
- WASTE
- NO INFORMATION

WELL CONSTRUCTION AND PLUGGING MATERIALS

- BLANK PIPE
- SCREEN
- BENTONITE
- CEMENT GROUT
- BENTONITE & CUTTINGS
- CONCRETE/CEMENT
- CUTTINGS
- GRAVEL
- SAND
- VOLCLAY

SAMPLE TYPES

- AIR ROTARY
- GRAB SAMPLE
- CORE
- GEOPROBE SAMPLER
- ROTOSONIC -DAMAGED
- MUD ROTARY
- NO RECOVERY
- NX CORE
- PITCHER
- ROTOSONIC -INTACT
- SHELBY TUBE
- SPLIT BARREL
- SPLIT SPOON
- TEXAS CONE PENETROMETER
- DISTURBED

STRENGTH TEST TYPES

- POCKET PENETROMETER
- TORVANE
- UNCONFINED COMPRESSION
- TRIAXIAL COMPRESSION UNCONSOLIDATED-UNDRAINED
- TRIAXIAL COMPRESSION CONSOLIDATED-UNDRAINED

NOTE: VALUES SYMBOLIZED ON BORING LOGS REPRESENT SHEAR STRENGTHS UNLESS OTHERWISE NOTED

PROJECT NO. ASA12-098-00

RABAKISTNER

REVISED 04/2012

FIGURE A-16a

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

Terms used in this report to describe soils with regard to their consistency or conditions are in general accordance with the discussion presented in Article 45 of SOILS MECHANICS IN ENGINEERING PRACTICE, Terzaghi and Peck, John Wiley & Sons, Inc., 1967, using the most reliable information available from the field and laboratory investigations. Terms used for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in American Society for Testing and Materials D2487-06 and D2488-00, Volume 04.08, Soil and Rock; Dimension Stone; Geosynthetics; 2005.

The depths shown on the boring logs are not exact, and have been estimated to the nearest half-foot. Depth measurements may be presented in a manner that implies greater precision in depth measurement, i.e 6.71 meters. The reader should understand and interpret this information only within the stated half-foot tolerance on depth measurements.

RELATIVE DENSITY

Penetration Resistance Blows per ft	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
> 50	Very Dense

COHESIVE STRENGTH

Resistance Blows per ft	Consistency	Cohesion TSF
0 - 2	Very Soft	0 - 0.125
2 - 4	Soft	0.125 - 0.25
4 - 8	Firm	0.25 - 0.5
8 - 15	Stiff	0.5 - 1.0
15 - 30	Very Stiff	1.0 - 2.0
> 30	Hard	> 2.0

PLASTICITY

Plasticity Index	Degree of Plasticity
0 - 5	None
5 - 10	Low
10 - 20	Moderate
20 - 40	Plastic
> 40	Highly Plastic

ABBREVIATIONS

B = Benzene
T = Toluene
E = Ethylbenzene
X = Total Xylenes
BTEX = Total BTEX
TPH = Total Petroleum Hydrocarbons
ND = Not Detected
NA = Not Analyzed
NR = Not Recorded/No Recovery
OVA = Organic Vapor Analyzer
ppm = Parts Per Million

Qam, Qas, Qal = Quaternary Alluvium
Qat = Low Terrace Deposits
Qbc = Beaumont Formation
Qt = Fluviatile Terrace Deposits
Qao = Seymour Formation
Qle = Leona Formation
Q-Tu = Uvalde Gravel
Ewi = Wilcox Formation
Emi = Midway Group
Mc = Catahoula Formation
El = Laredo Formation
Kknm = Navarro Group and Marlbrook Marl
Kpg = Pecan Gap Chalk
Kau = Austin Chalk

Kef = Eagle Ford Shale
Kbu = Buda Limestone
Kdr = Del Rio Clay
Kft = Fort Terrett Member
Kgt = Georgetown Formation
Kep = Person Formation
Kek = Kainer Formation
Kes = Escondido Formation
Kew = Walnut Formation
Kgr = Glen Rose Formation
Kgru = Upper Glen Rose Formation
Kgrl = Lower Glen Rose Formation
Kh = Hensell Sand

PROJECT NO. ASA12-098-00

RABA KISTNER

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.
Carbonate	Having more than 50% carbonate content.

SAMPLING METHODS

RELATIVELY UNDISTURBED SAMPLING

Cohesive soil samples are to be collected using three-inch thin-walled tubes in general accordance with the Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587) and granular soil samples are to be collected using two-inch split-barrel samplers in general accordance with the Standard Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). Cohesive soil samples may be extruded on-site when appropriate handling and storage techniques maintain sample integrity and moisture content.

STANDARD PENETRATION TEST (SPT)

A 2-in.-OD, 1-3/8-in.-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

NOTE: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

APPENDIX B

LABORATORY TEST RESULTS

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

FILE NAME: ASA12-098-00.GPJ 11/20/2012

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-1	0.0 to 1.5	11	15								
	2.5 to 4.0	7	23						50		
	4.0 to 6.0		18	31	15	16	CL	106		0.27	UC
	6.0 to 8.0		15					110		1.09	UC
	8.0 to 10.0		13					112	40	0.39	UC
	13.5 to 15.0	16	21	55	18	37	CH				
	18.5 to 20.0	22	18								
	23.5 to 24.9	50/11"	14								
	28.5 to 29.9	50/11"	11						43		
	33.5 to 35.0	49	20								
	38.5 to 39.9	50/11"	20								
	43.5 to 44.8	50/9"	19								
	48.5 to 49.7	50/8"	19								
B-2	0.0 to 1.5	11	18								
	2.0 to 4.0		11					119	38	2.59	UC
	4.0 to 6.0		17	33	18	15	CL	104		0.79	UC
	6.0 to 8.0		19					102		0.28	UC
	8.0 to 10.0		17					110		0.98	UC
	13.0 to 15.0		18	54	18	36	CH			2.00	PP
	18.0 to 20.0		13					101		0.65	UC
	23.5 to 24.9	50/11"	12						24		
	28.5 to 29.8	50/10"	20								
	33.5 to 35.0	38	12								
	38.5 to 40.0	50	20								
	43.5 to 44.7	50/8"	18								
	48.5 to 49.8	50/9"	20								
B-3	0.0 to 1.5	24	13								
	2.5 to 4.0	12	15								
	4.5 to 6.0	11	17	34	15	19	CL				
	6.5 to 8.0	19	17						41		
	8.5 to 10.0	14	17								
	13.0 to 15.0		18	42	12	30	CL	112		0.73	UC
	18.0 to 20.0		15							2.00	PP
	23.5 to 25.0	46	11						47		
	28.5 to 30.0	50									
	33.5 to 34.9	50/11"	13								
	38.5 to 39.9	50/11"	18						33		
	43.5 to 45.0	38	27								
	48.5 to 49.8	50/10"	22								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ASA12-098-00

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FIGURE B-1a

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

FILE NAME: ASA12-098-00.GPJ 11/20/2012

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-4	0.0 to 1.5	7	16	40	15	25	CL				
	2.5 to 4.0	5	14						54		
	4.5 to 6.0	14	12	45	15	30	CL				
	6.0 to 8.0		14					113		1.96	UC
	8.0 to 10.0		11					110		0.71	UC
	13.5 to 15.0	26	18	41	14	27	CL				
	18.5 to 20.0	49	10								
	23.5 to 25.0	24	15								
	28.0 to 30.0		13					97	32	1.50	PP
	33.5 to 35.0	50	14								
	38.5 to 39.8	50/10"	25								
	43.5 to 45.0	50	24								
	48.5 to 49.8	50/9"	19						23		
B-5	0.0 to 1.5	17	13								
	2.5 to 4.0	21	14								
	4.5 to 6.0	24	13								
	6.5 to 8.0	20	16	32	13	19	CL				
	8.0 to 10.0		14						46	2.00	PP
	13.5 to 15.0	33	26						46		
	18.5 to 19.8	50/10"	24								
	23.5 to 24.8	50/9"	22								
	28.5 to 30.0	24	21								
	33.5 to 34.6	50/7"	24						31		
	38.5 to 39.7	50/8"									
B-6	0.0 to 1.5	15	11								
	2.5 to 4.0	14	16	33	18	15	CL				
	4.5 to 6.0	24	13						50		
	6.5 to 8.0	19	15								
	8.5 to 10.0	21	17								
	13.5 to 15.0	7	24	49	17	32	CL				
	18.5 to 19.9	50/11"	25						51		
	23.5 to 24.8	50/10"	23								
	28.5 to 30.0	38	21	38	20	18	CL				
	33.5 to 34.7	50/8"	23								
	38.5 to 39.8	50/10"	26						29		
B-7	0.0 to 1.5	10	19								
	2.5 to 4.0	29	7								
	4.5 to 6.0	22	14	34	15	19	CL				
	6.0 to 8.0		16					115		1.37	UC

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CU = Consolidated Undrained Triaxial

PROJECT NO. ASA12-098-00

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FIGURE B-1b

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

FILE NAME: ASA12-098-00.GPJ 11/20/2012

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-7	8.0 to 10.0		14	32	15	17	CL			2.00	PP
	13.5 to 14.8	50/9"	25						47		
	18.5 to 19.9	50/11"	23								
	23.5 to 24.8	50/9"	19	35	17	18	CL				
	28.5 to 30.0	47	19								
B-8	0.0 to 1.5	25	16								
	2.5 to 4.0	14	39			NP					
	4.5 to 6.0	7	16						39		
	6.0 to 8.0		15					113		0.78	UC
	8.0 to 10.0									2.00	PP
	13.0 to 15.0		18					111		0.39	UC
	18.5 to 20.0	25	23						47		
	23.5 to 25.0	10	20	33	15	18	CL				
	28.5 to 30.0	25	22								
	33.5 to 35.0	38	19						52		
	38.5 to 39.7	50/8"	24	29	20	9	CL				
B-9	0.0 to 1.5	11	13								
	2.5 to 4.0	14	16								
	4.5 to 6.0	16	15	35	14	21	CL				
	6.5 to 8.0	11	20								
	8.0 to 10.0		21							1.50	PP
	13.5 to 15.0	9	23						49		
	18.5 to 19.9	50/11"	24								
	23.5 to 23.6	ref/1"	26								
	28.5 to 29.9	50/11"	20						62		
B-10	0.0 to 1.5	16	13								
	2.5 to 4.0	16	16	32	16	16	CL				
	4.5 to 6.0	19	14								
	6.5 to 8.0	24	18								
	8.5 to 10.0	19	15	42	15	27	CL				
	13.0 to 15.0		22					97	41	0.23	UC
	18.5 to 20.0	38	26								
	23.5 to 25.0	17	29								
	28.5 to 28.6	ref/1"	6								
	33.5 to 34.8	50/9"	19						42		
	38.5 to 40.0	26	21								
B-11	0.0 to 1.5	15	14	32	16	16	CL				
	2.5 to 4.0	11	15								
	4.5 to 6.0	12	17						49		

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CU = Consolidated Undrained Triaxial

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

FILE NAME: ASA12-098-00.GPJ 11/20/2012

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-11	6.5 to 8.0	18	13								
	8.0 to 10.0									2.00	PP
	13.5 to 15.0	18	18								
	18.5 to 20.0	18	26								
	23.5 to 25.0	49	23						34		
	28.5 to 30.0	42	24								
B-12	0.0 to 1.5	23	28						46		
	2.5 to 4.0	6	38								
	4.5 to 6.0	8	16	32	14	18	CL				
	6.5 to 8.0	27	14								
	8.0 to 10.0		15	34	13	21	CL			2.00	PP
	13.5 to 15.0	18	18								
	18.5 to 20.0	24	28								
	23.5 to 24.9	50/11"	23						51		
	28.5 to 30.0	11	28								
B-13	0.0 to 1.5	23	13								
	2.5 to 4.0	27	14	33	17	16	CL				
	4.5 to 6.0	34	14						43		
	6.5 to 8.0	16	15								
	8.0 to 10.0									2.00	PP
	13.5 to 15.0	18	19								
	18.5 to 20.0	19	24						53		
	23.5 to 25.0	41	25								
	28.5 to 30.0	34	26	52	19	33	CH				
	33.5 to 35.0	41	21								
	38.5 to 40.0	39	20								
B-14	0.0 to 1.5	9	9								
	2.5 to 4.0	30	8						46		
	4.5 to 6.0	18	13	41	14	27	CL				
	6.0 to 8.0		14					118		1.10	UC
	8.0 to 10.0		15					117		1.15	UC
	13.0 to 15.0									1.25	PP
	18.5 to 20.0	15	19	51	15	36	CH				
	23.5 to 23.8	ref/3"	5								
	28.5 to 30.0	32	25						72		
	33.5 to 34.8	50/9"	19								
	38.5 to 39.7	50/8"	18								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

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PROJECT NO. ASA12-098-00

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FIGURE B-1d

PROJECT NO. ASA12-098-00

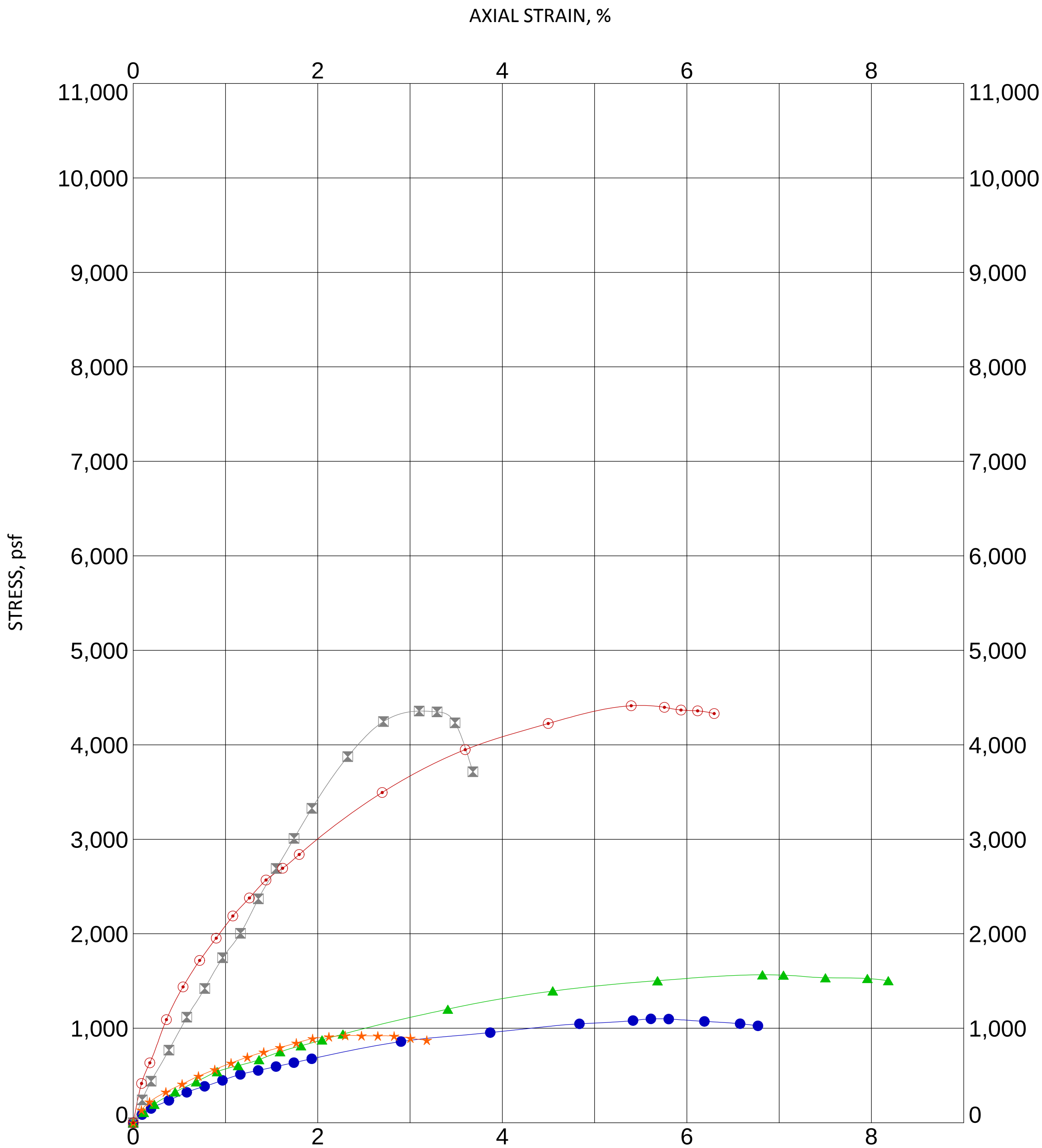

FIGURE B-2

Specimen Identification		Classification	Shear Str. (tsf)	Failure Strain (%)	PI	Dry Unit Weight (pcf)	w (%)
● B-1	4 ft		0.3	5.6	16	106.0	17.7
⧗ B-1	6 ft		1.1	3.1		109.9	15.4
▲ B-1	8 ft		0.4	6.8		111.8	13.2
★ B-10	13 ft		0.2	2.3		97.4	24.5
⊙ B-14	6 ft		1.1	5.4		117.9	13.6

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UNCONFINED COMPRESSION

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

R-K UNCONFINED COMPRESSION ASA12-098-00.GPJ RKCI.GDT 11/20/12

PROJECT NO. ASA12-098-00

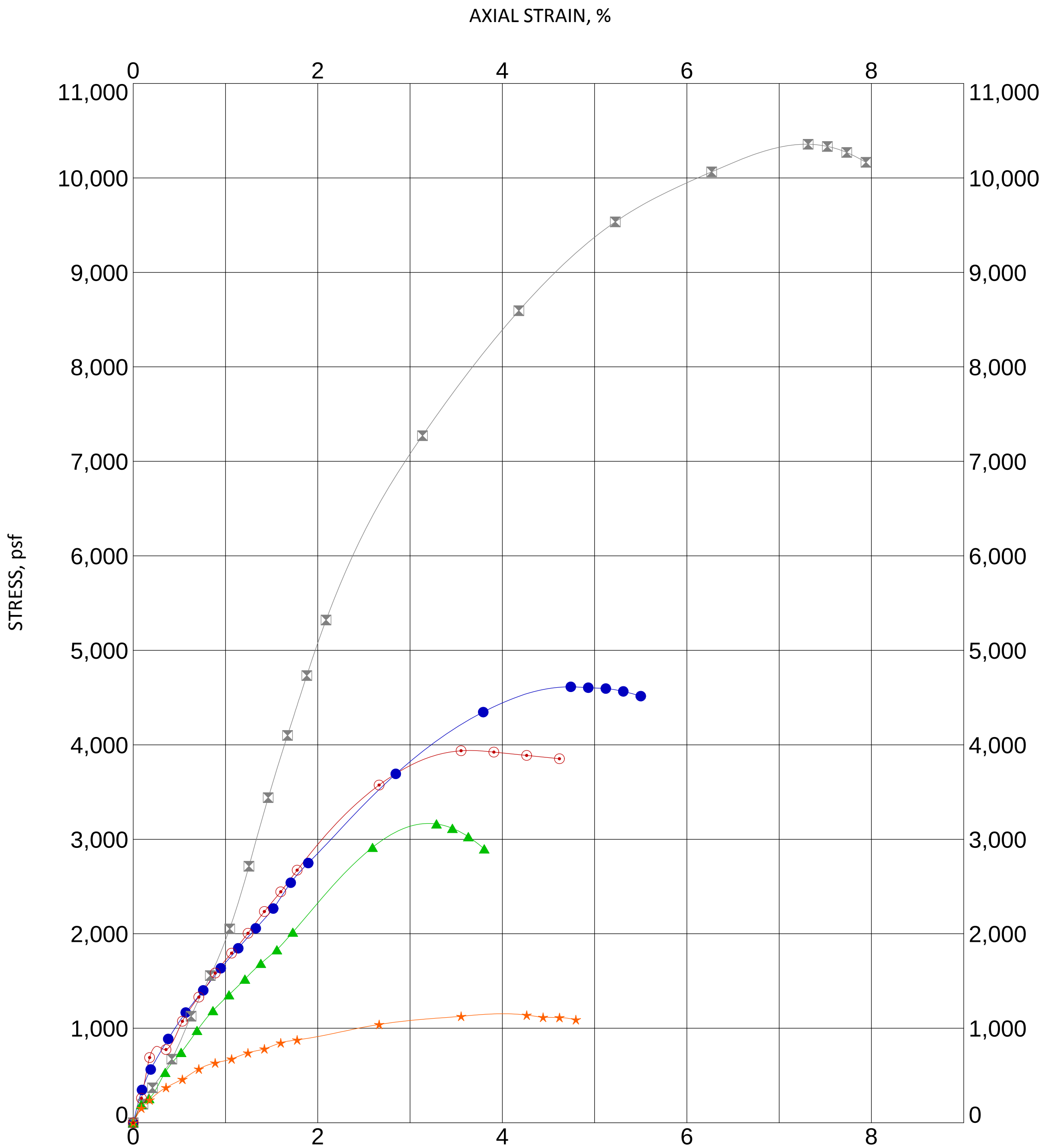

FIGURE B-3

Specimen Identification		Classification	Shear Str. (tsf)	Failure Strain (%)	PI	Dry Unit Weight (pcf)	w (%)
● B-14	8 ft		1.2	4.7		116.9	14.7
⧗ B-2	2 ft		2.6	7.3		119.3	10.9
▲ B-2	4 ft		0.8	3.3	15	104.0	16.6
★ B-2	6 ft		0.3	4.3		102.1	19.0
⊙ B-2	8 ft		1.0	3.6		110.3	16.9

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UNCONFINED COMPRESSION

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

R-K UNCONFINED COMPRESSION ASA12-098-00.GPJ RKCI.GDT 11/20/12

PROJECT NO. ASA12-098-00

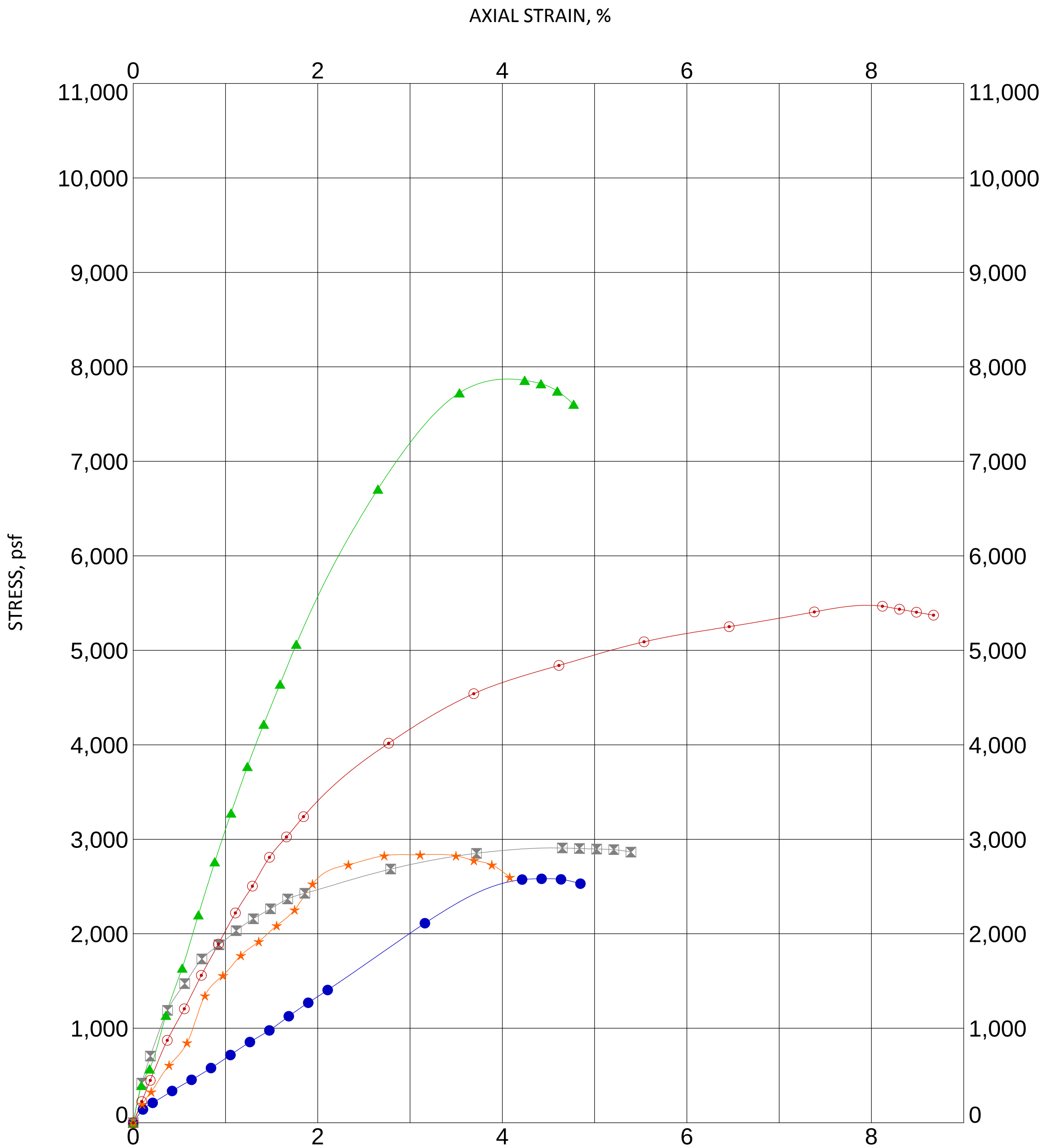

FIGURE B-4

Specimen Identification		Classification	Shear Str. (tsf)	Failure Strain (%)	PI	Dry Unit Weight (pcf)	w (%)
● B-2	18 ft		0.6	4.4		100.8	13.0
⧗ B-3	13 ft		0.7	4.7	30	112.2	17.6
▲ B-4	6 ft		2.0	4.2		113.1	14.3
★ B-4	8 ft		0.7	3.1		109.8	10.6
⊙ B-7	6 ft		1.4	8.1		115.1	15.7

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San Antonio, Texas

PROJECT NO. ASA12-098-00

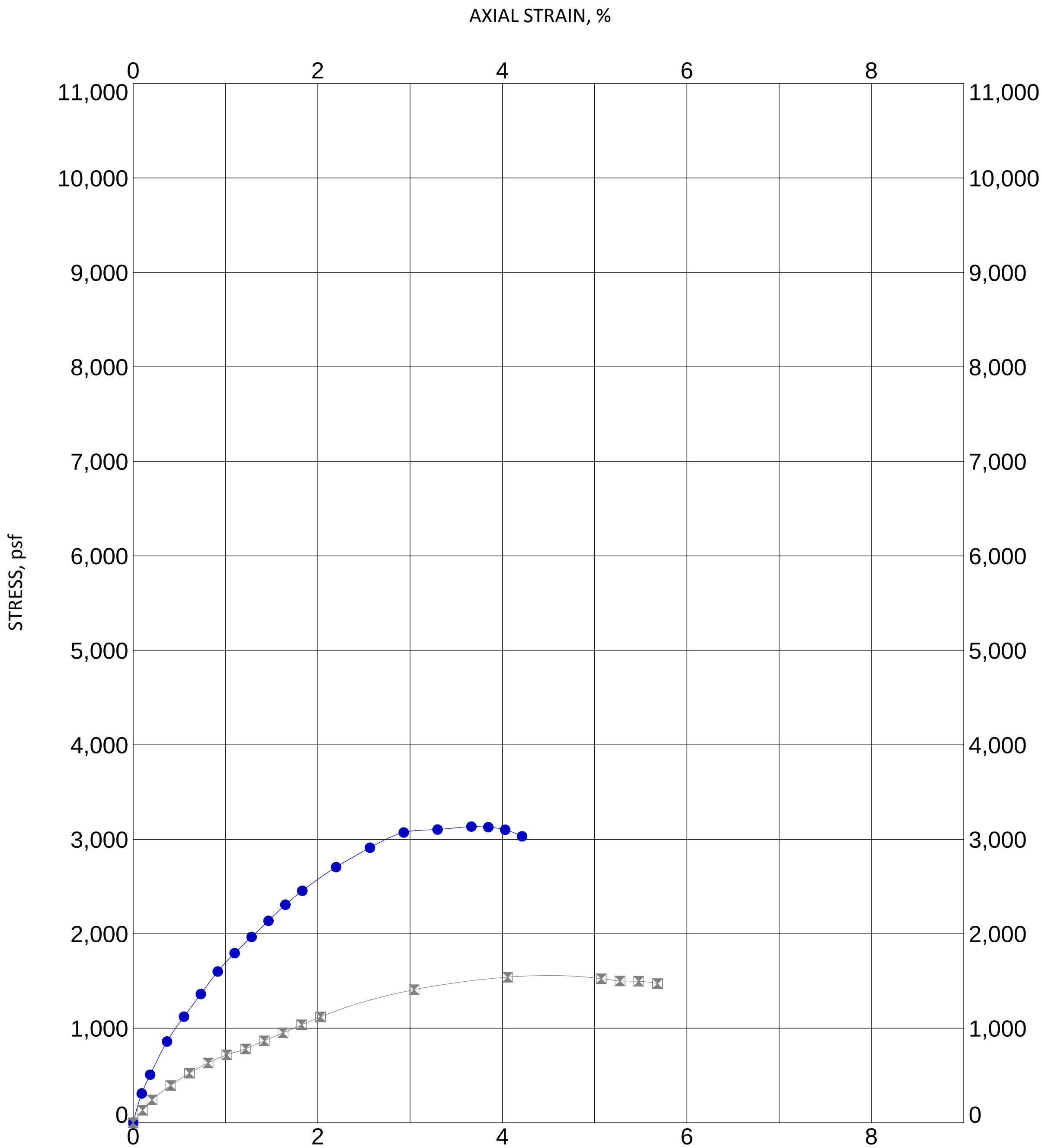

FIGURE B-5

Specimen Identification		Classification	Shear Str. (tsf)	Failure Strain (%)	PI	Dry Unit Weight (pcf)	w (%)
● B-8	6 ft		0.8	3.7		112.6	15.1
⧗ B-8	13 ft		0.4	4.1		110.8	18.1

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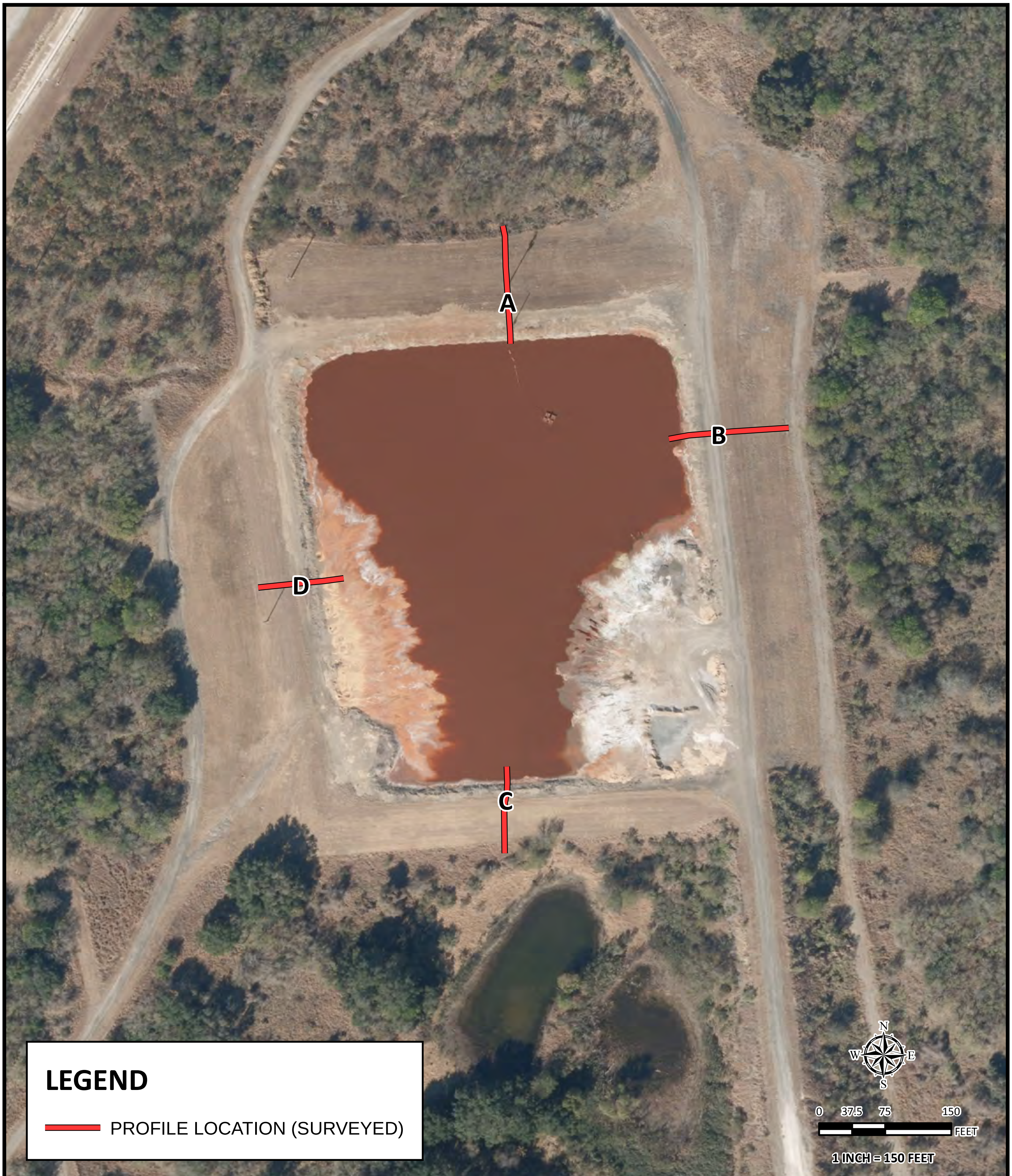
UNCONFINED COMPRESSION

Ash Pond Berms - Spruce/Deely Generation Units
San Antonio, Texas

APPENDIX C

SLOPE STABILITY ANALYSES



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SOURCE: 2011 Aerial Photograph Provided by the City of San Antonio (COSA)

SLOPE PROFILE LOCATION MAP

ASH POND BERMS - SPRUCE/DEELY GENERATION UNITS
SAN ANTONIO, TEXAS

REVISIONS:

No.	DATE	DESCRIPTION

PROJECT No.:	ASA12-098-00
ISSUE DATE:	11/08/2012
DRAWN BY:	CCL
CHECKED BY:	RBW
REVIEWED BY:	GLB

FIGURE

C-1a

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

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SOURCE: 2011 Aerial Photograph Provided by the City of San Antonio (COSA)

SLOPE PROFILE LOCATION MAP

ASH POND BERMS - SPRUCE/DEELY GENERATION UNITS
SAN ANTONIO, TEXAS

REVISIONS:

No.	DATE	DESCRIPTION

PROJECT No.:	ASA12-098-00
ISSUE DATE:	11/20/2012
DRAWN BY:	CCL
CHECKED BY:	RBW
REVIEWED BY:	GLB

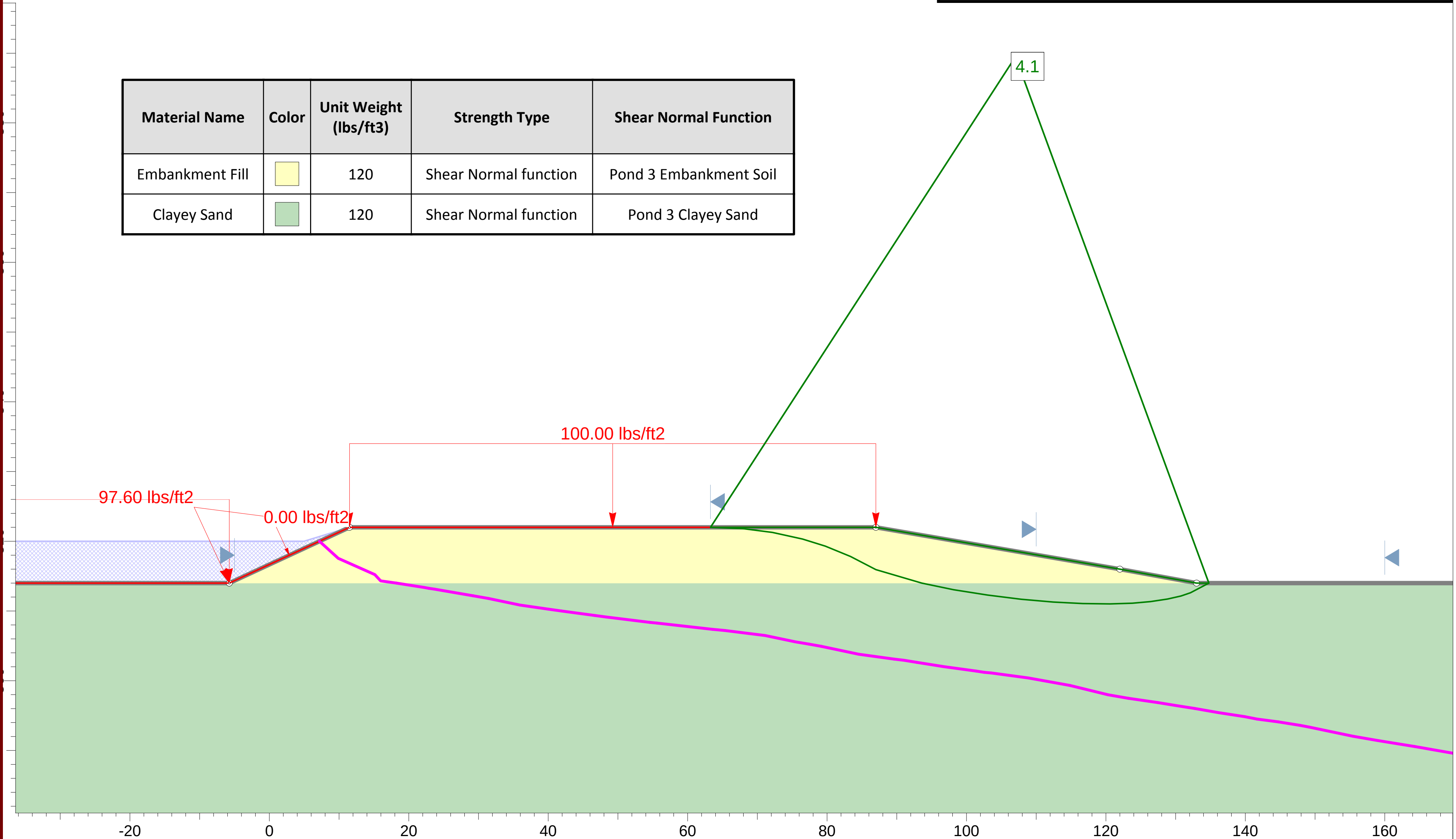
FIGURE

C-1b

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "A" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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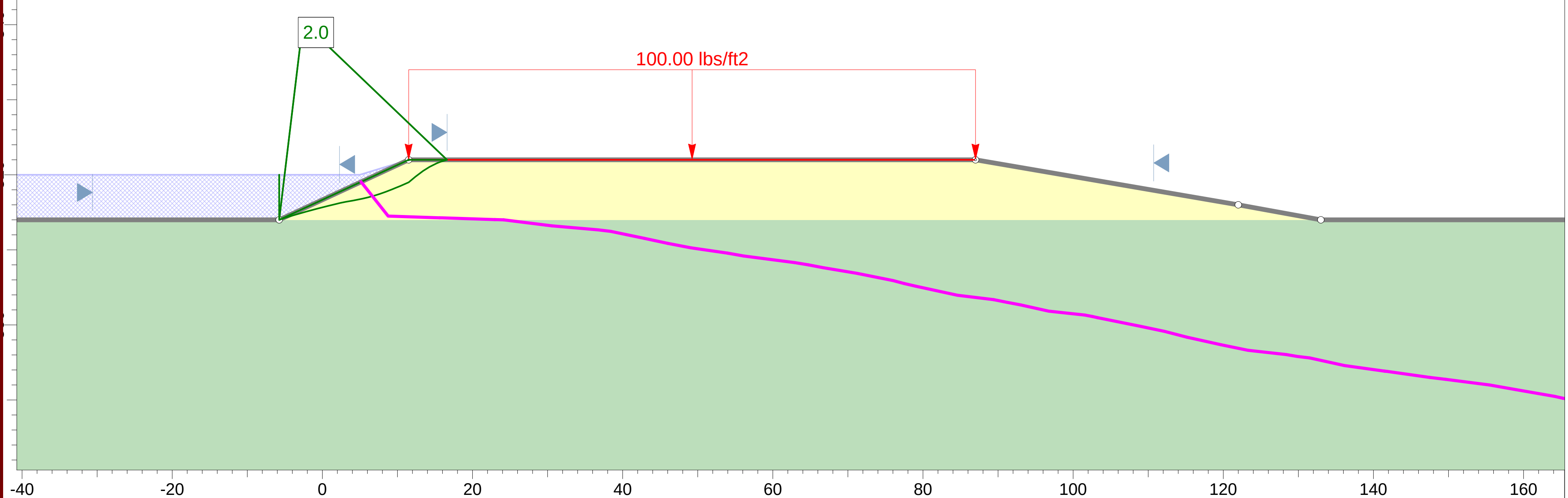
ASA12-098-00

Figure C-2a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "A" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

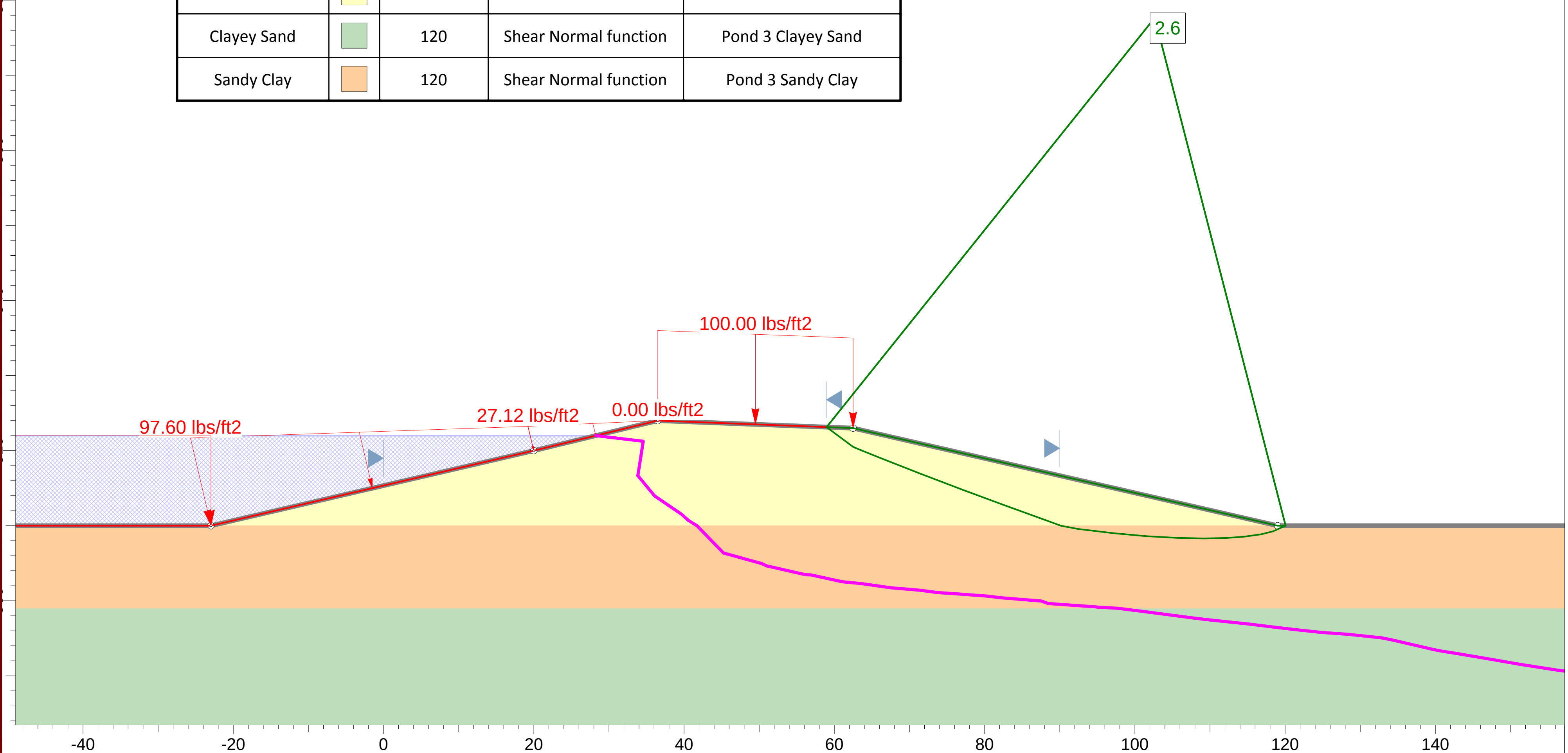
Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-2b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



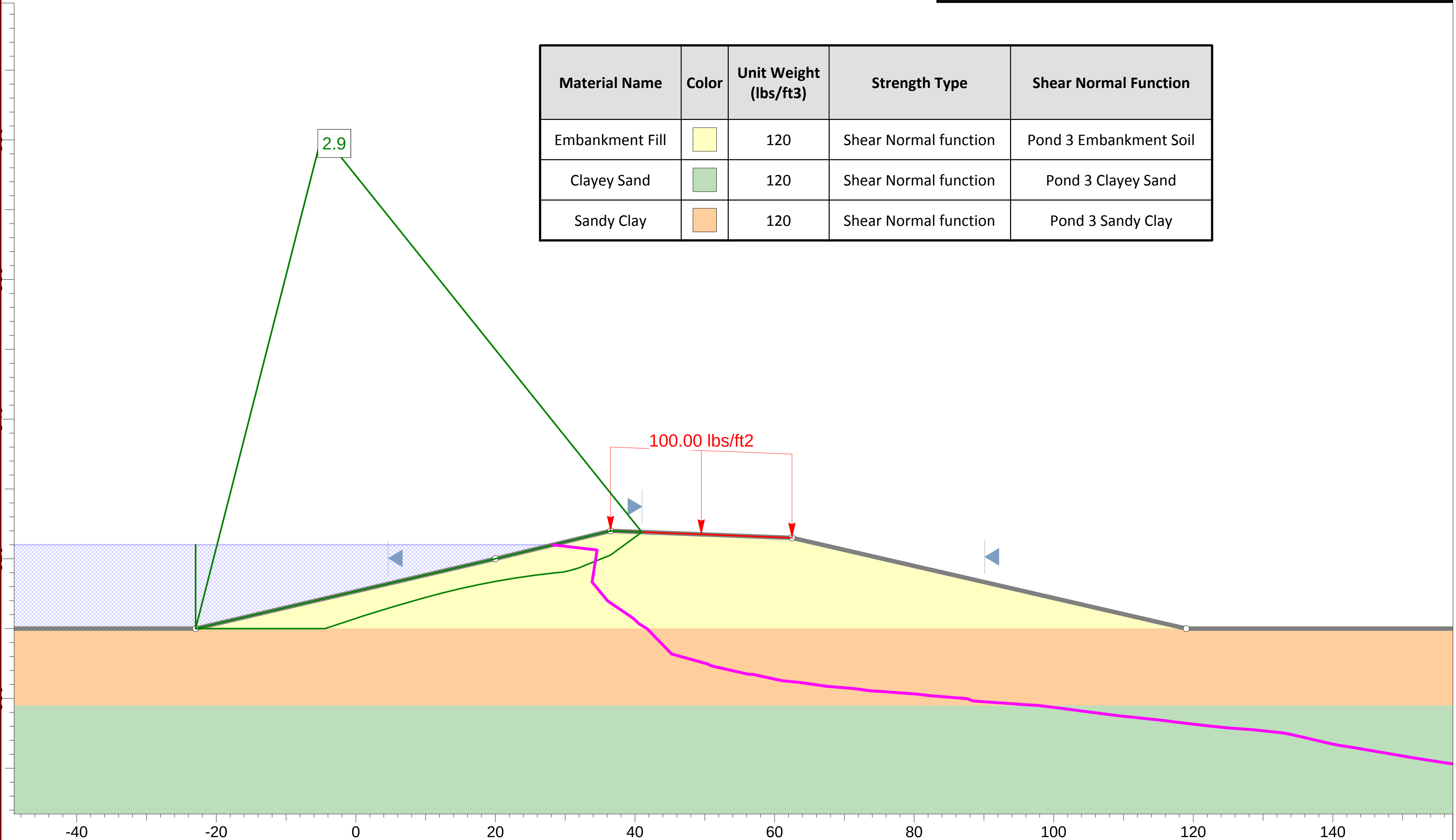
Profile "B" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

Raba Kistner Consultants, Inc.
ASA12-098-00

Figure C-3a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



Profile "B" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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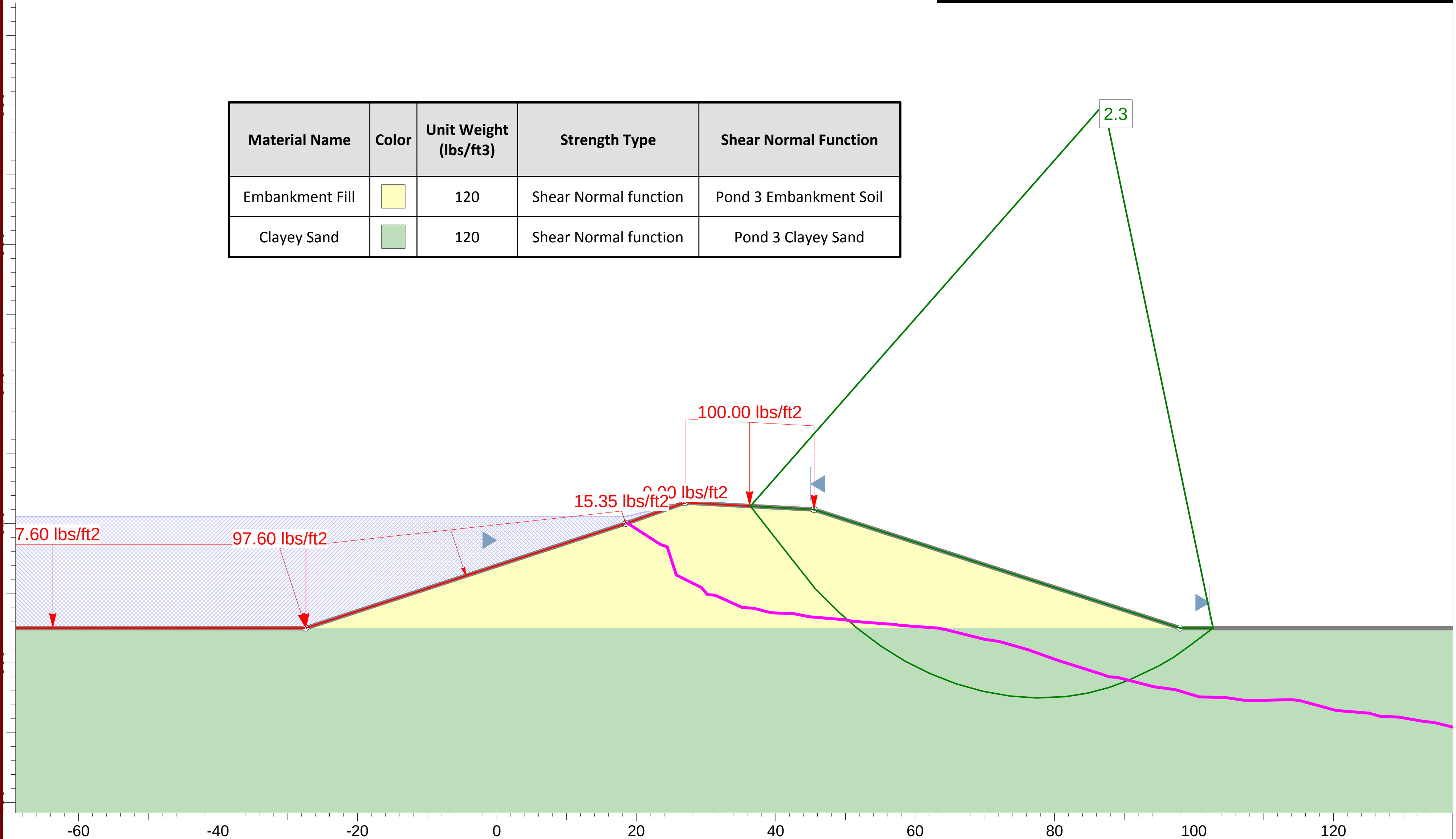
Figure C-3b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand

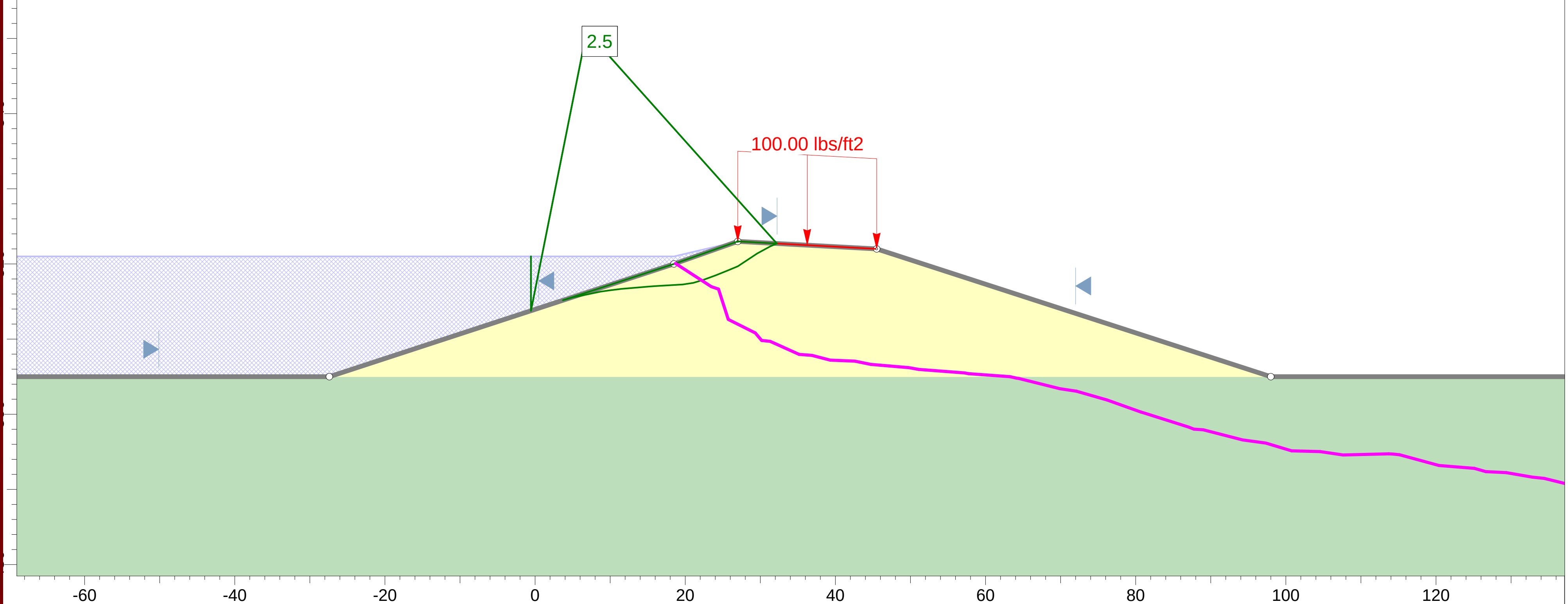


Profile "C" - Steady State Ash Pond Berms - Spruce/Deely Generation Units	Raba Kistner Consultants, Inc. ASA12-098-00	Figure C-4a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "C" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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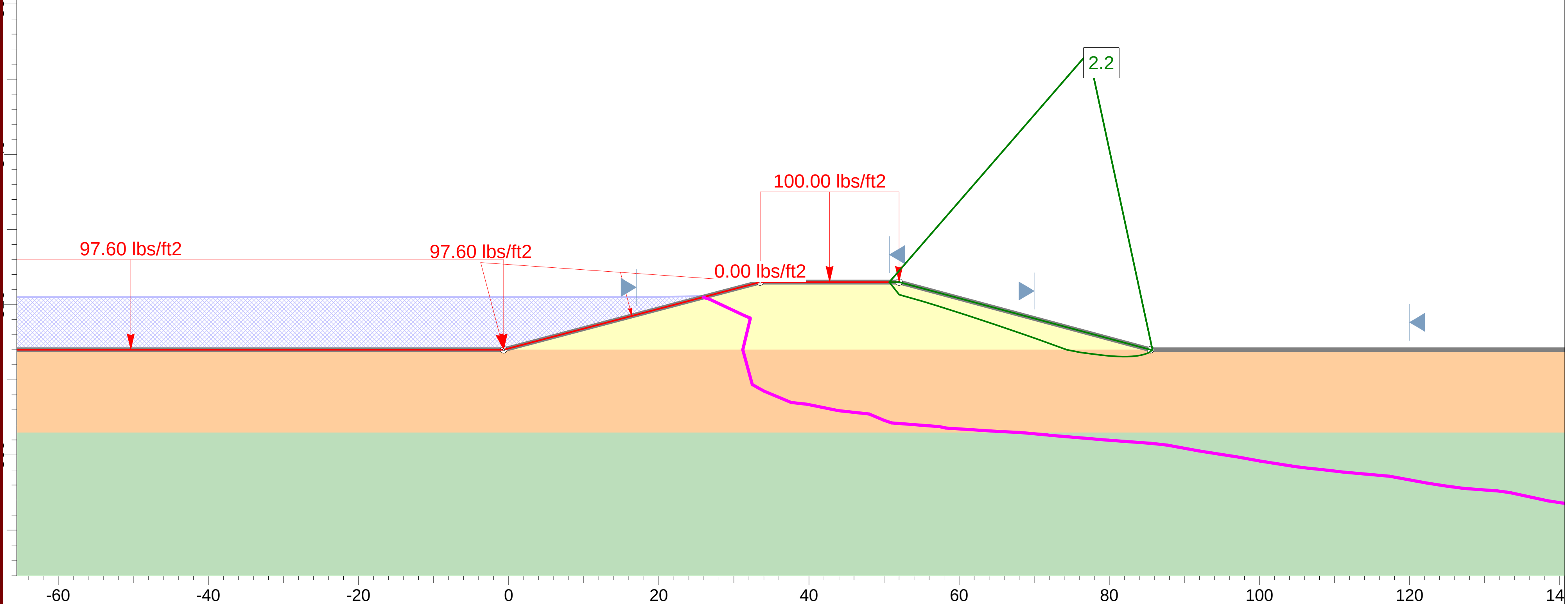
Figure C-4b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



Profile "D" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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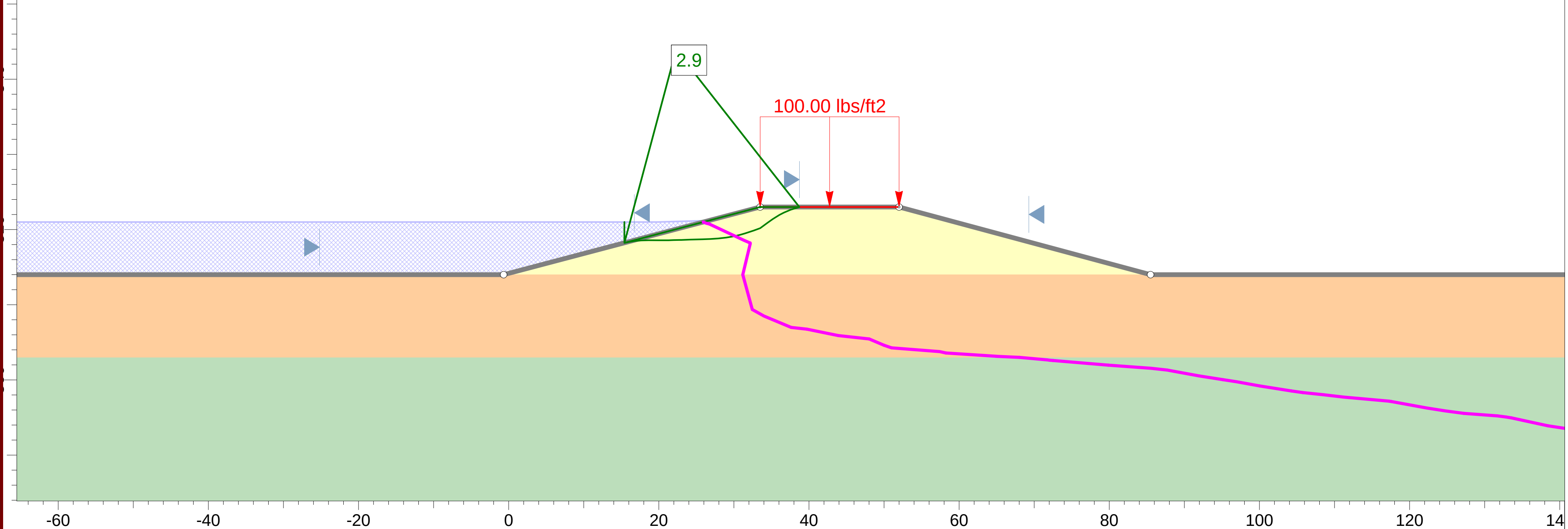
Figure C-5a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



Profile "D" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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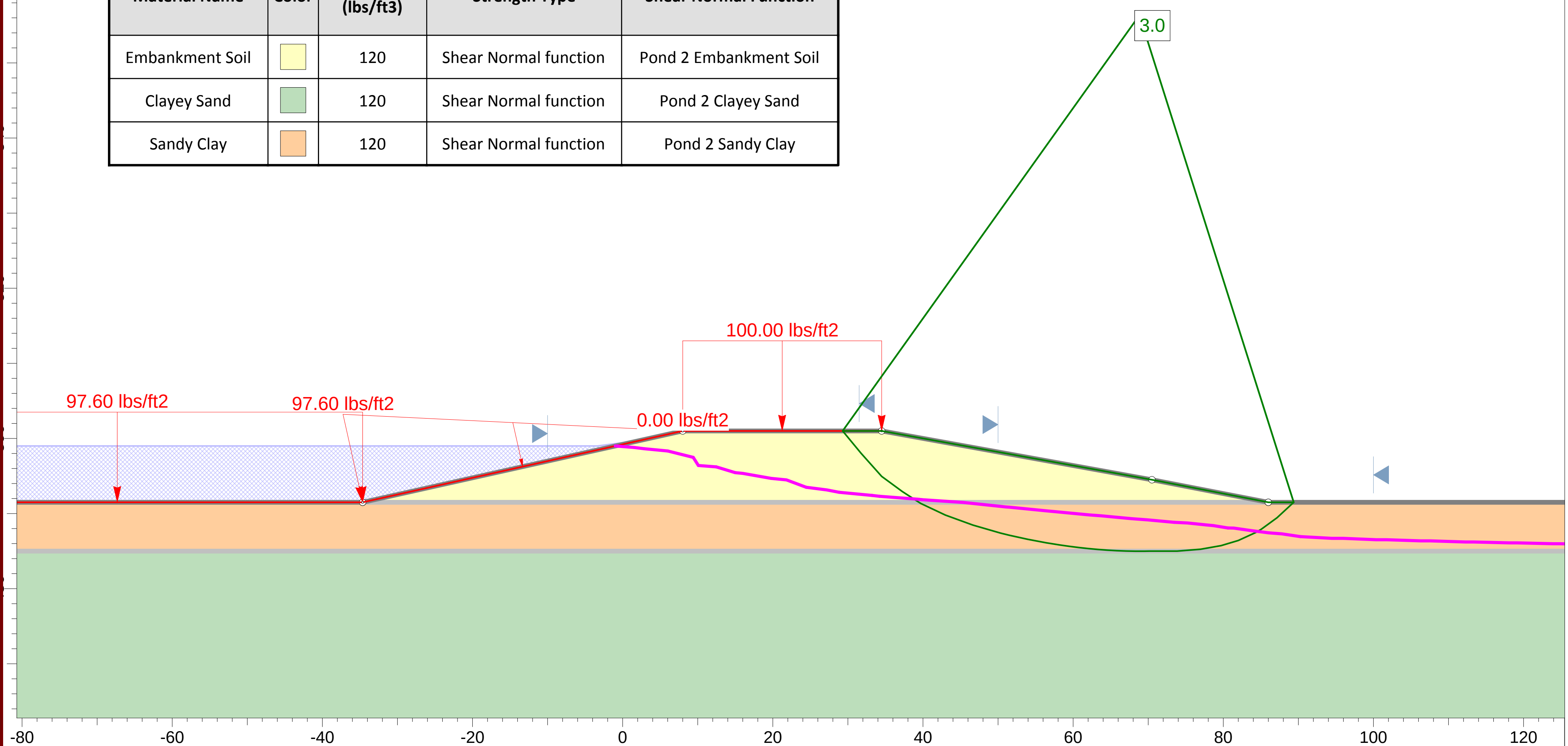
Figure C-5b

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Soil		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "E" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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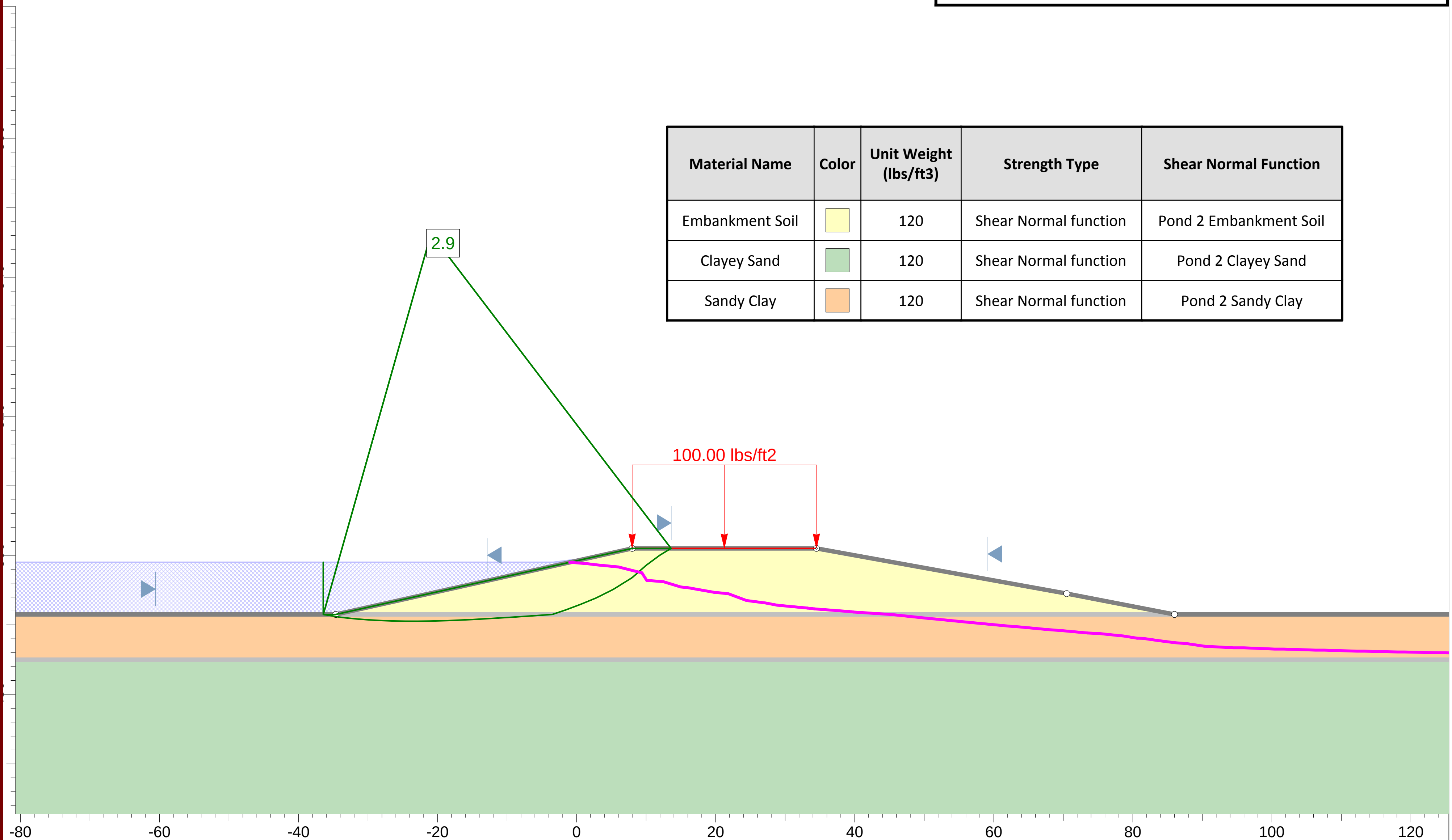
Figure C-6a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Soil		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "E" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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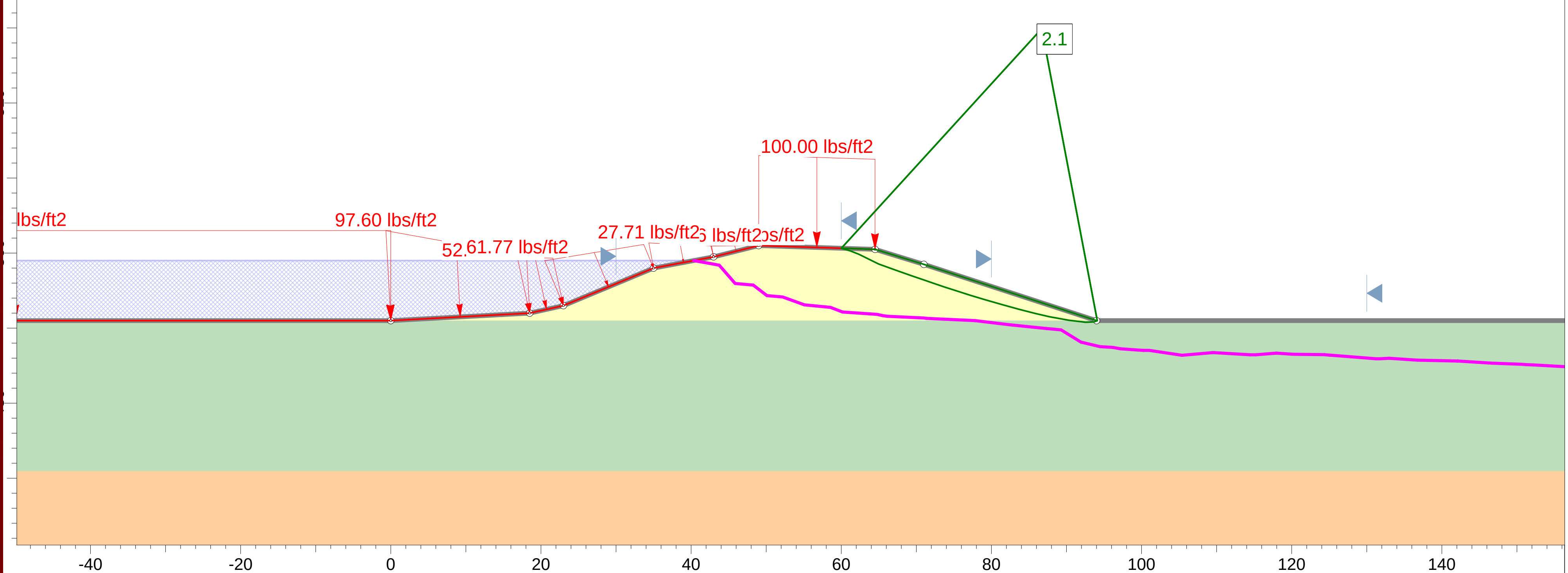
Figure C-6b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "F" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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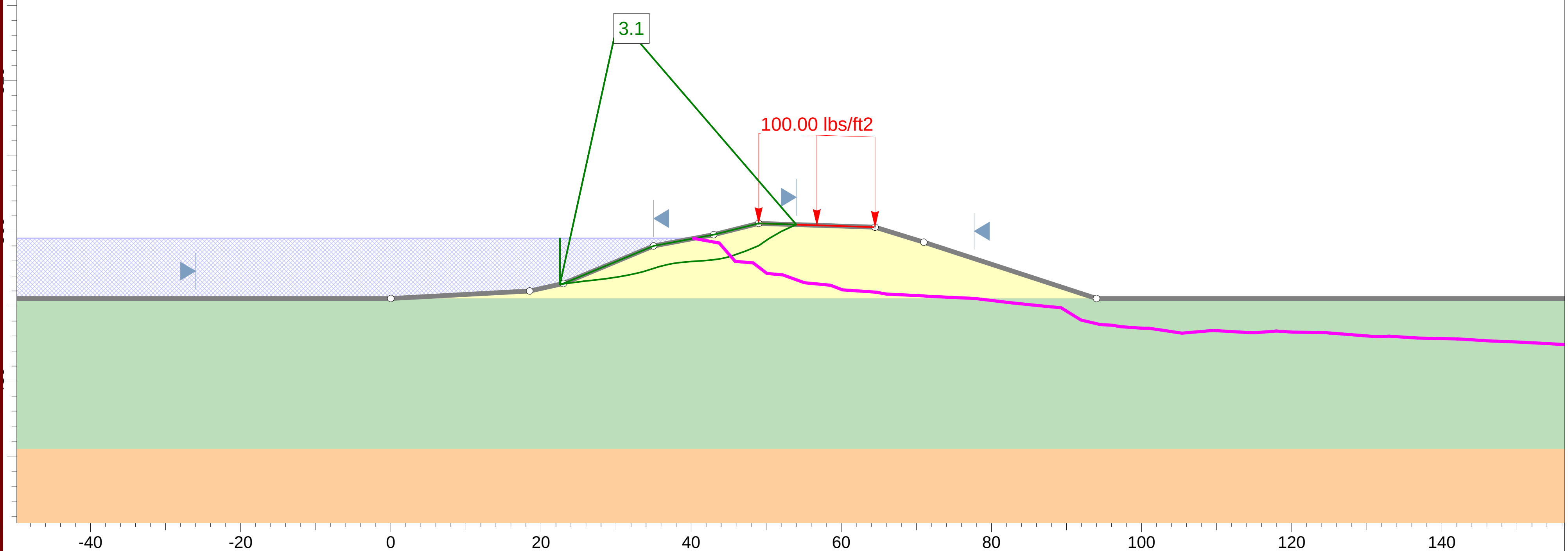
Figure C-7a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "F" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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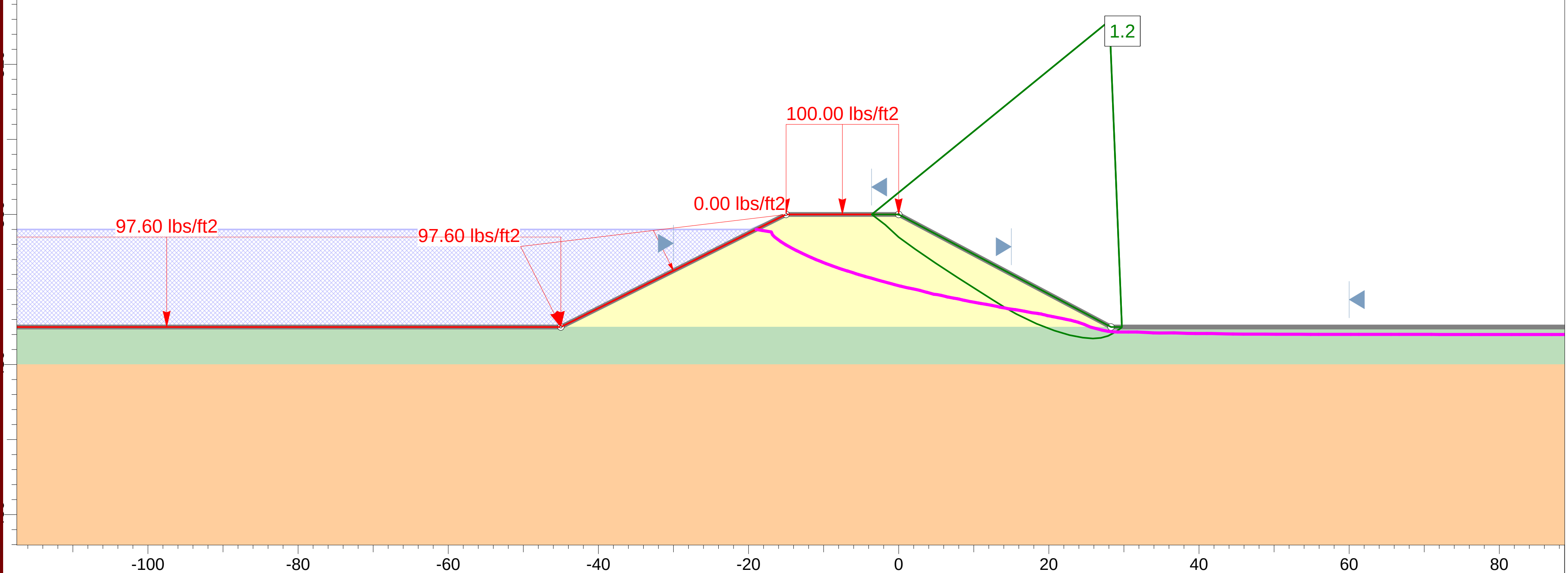
Figure C-7b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "G" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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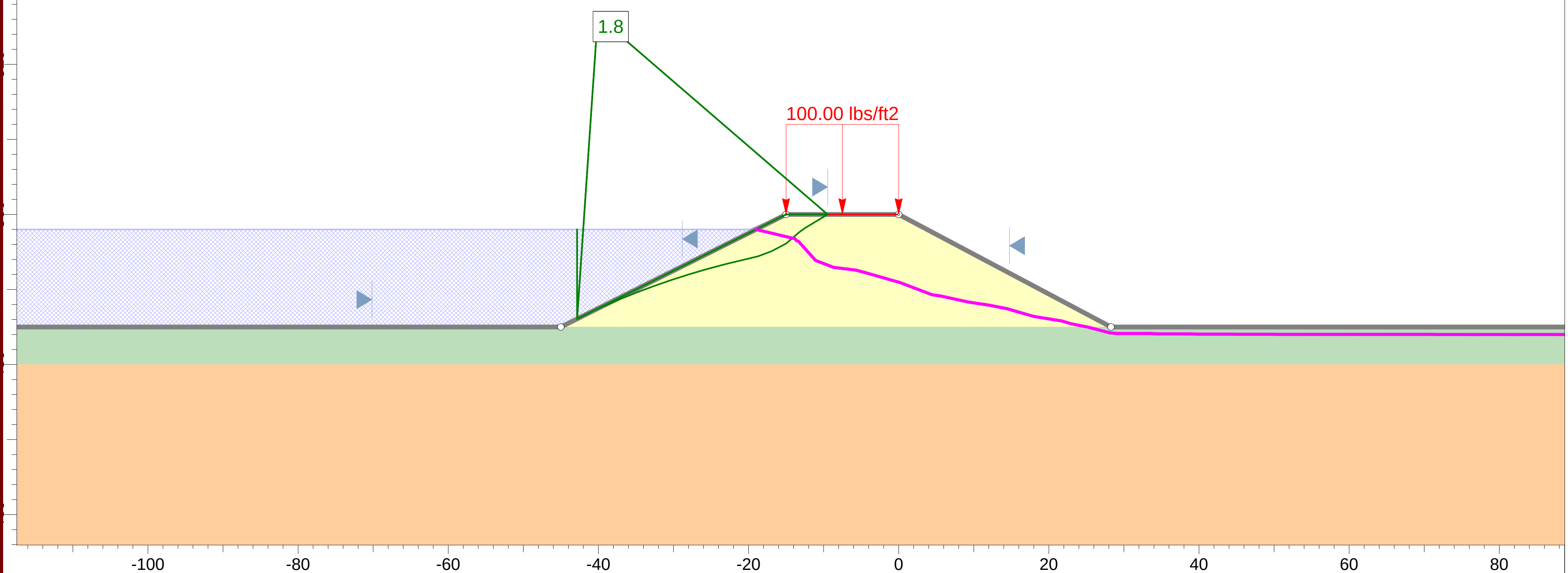
Figure C-8a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "G" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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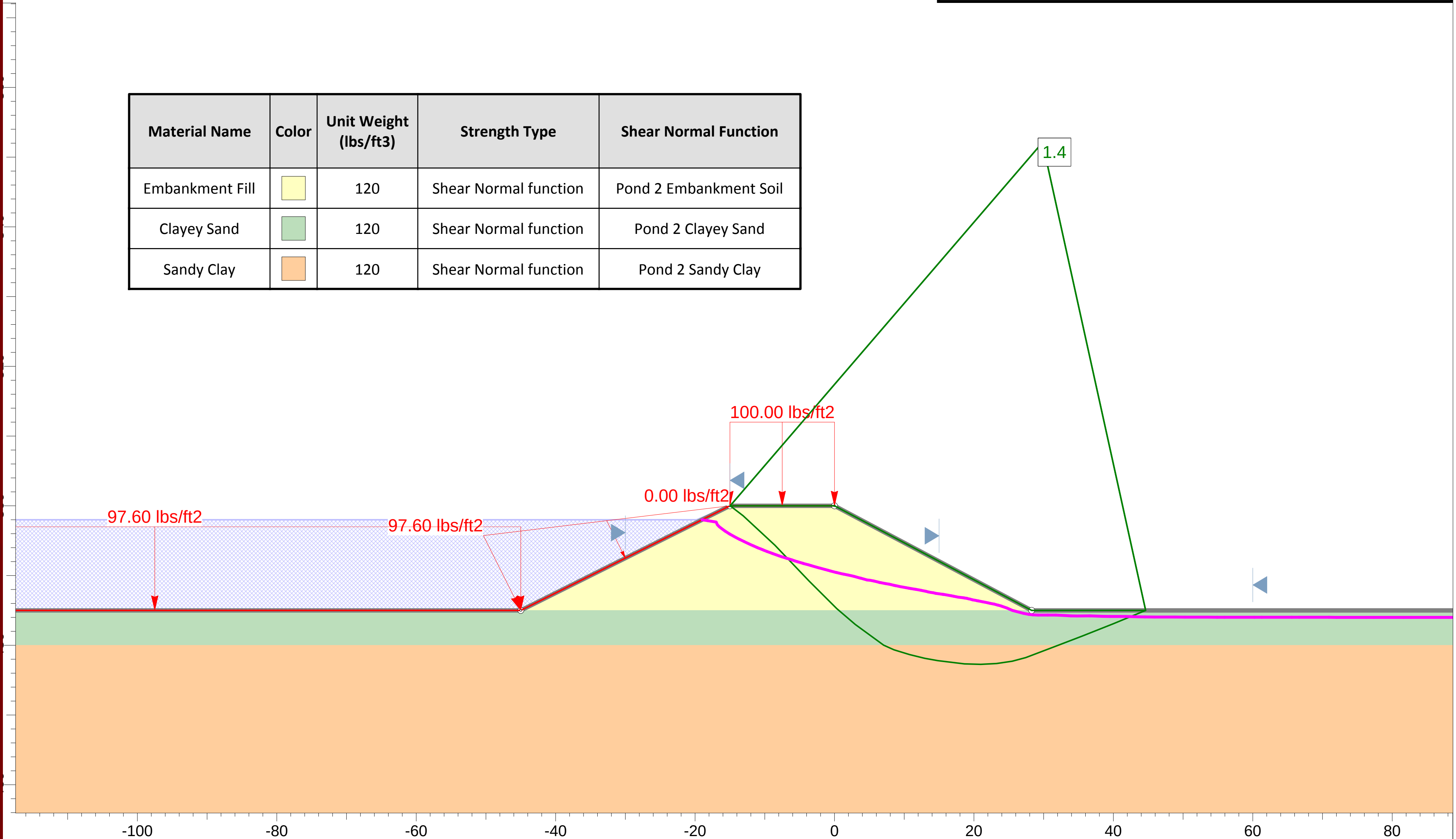
Figure C-8b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "G" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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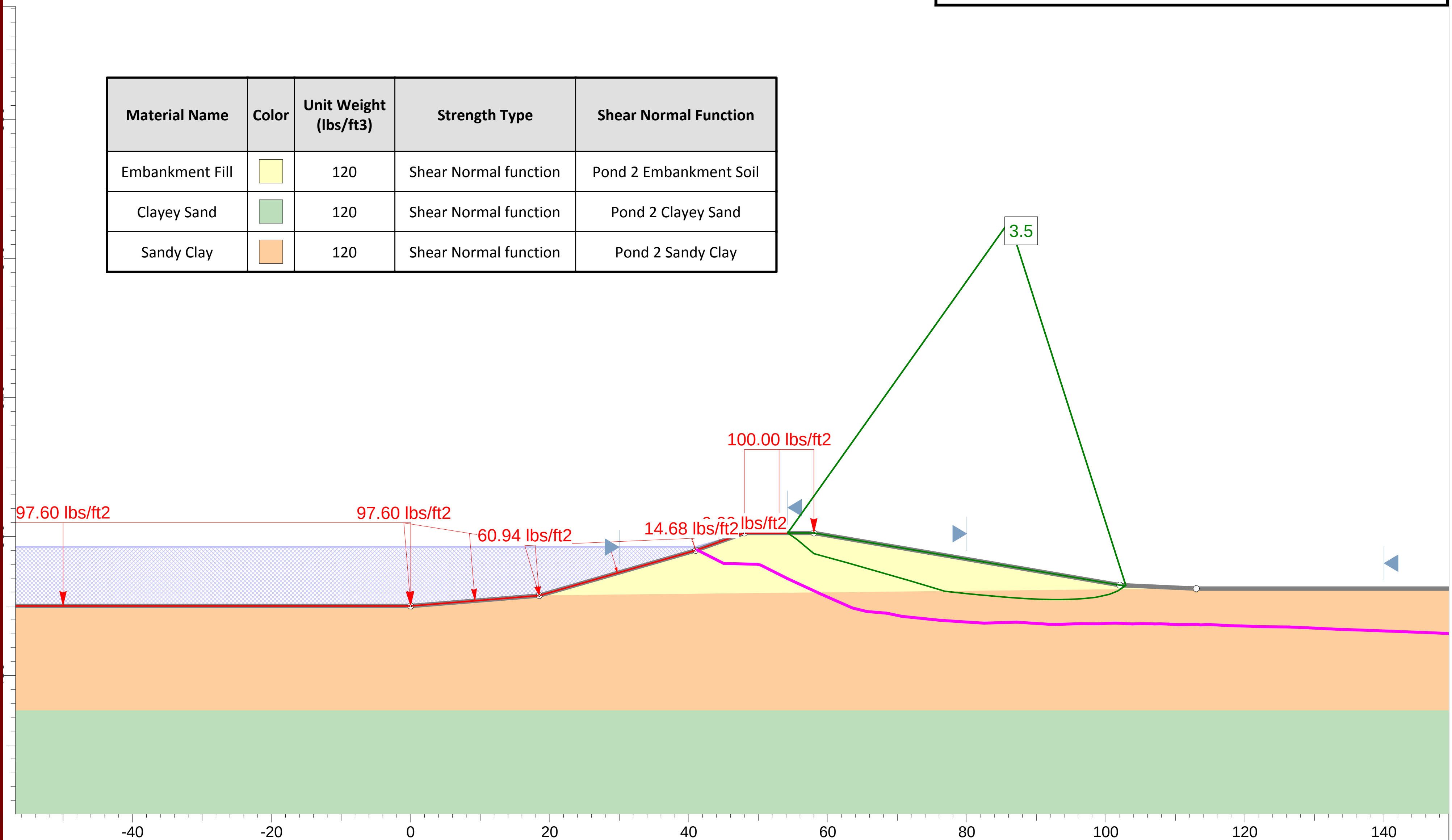
Figure C-8c

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "H" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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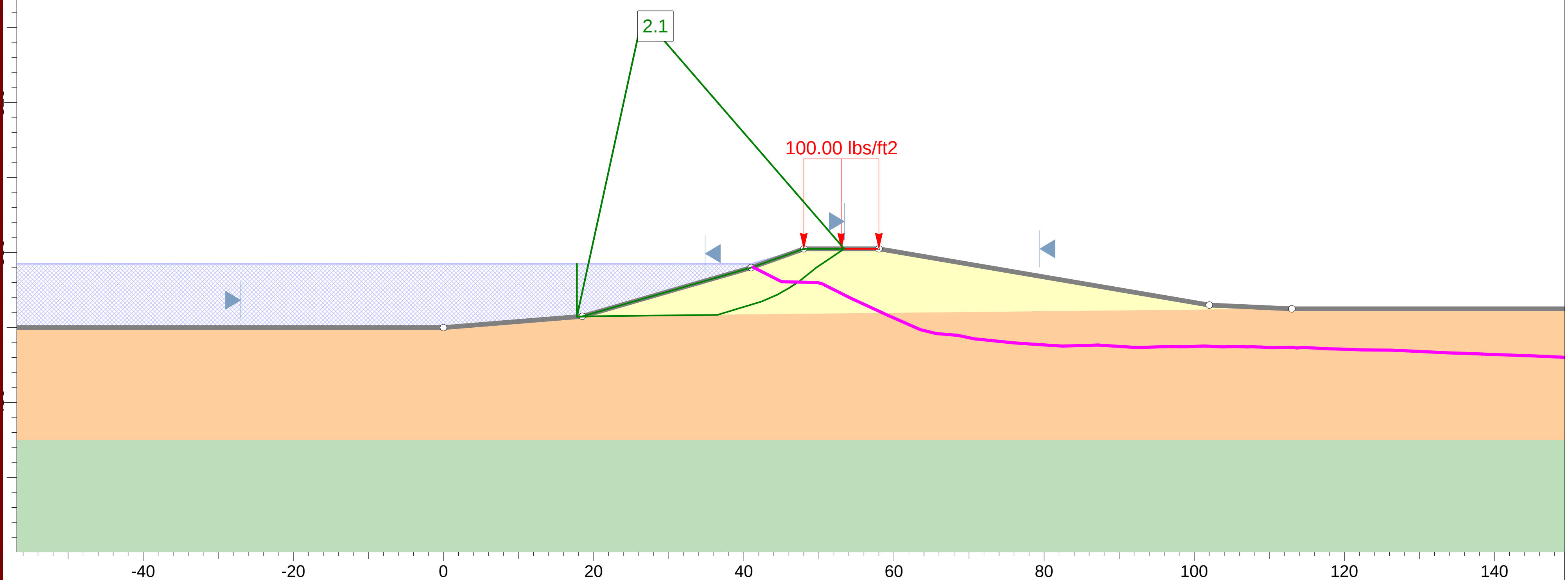
Figure C-9a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "H" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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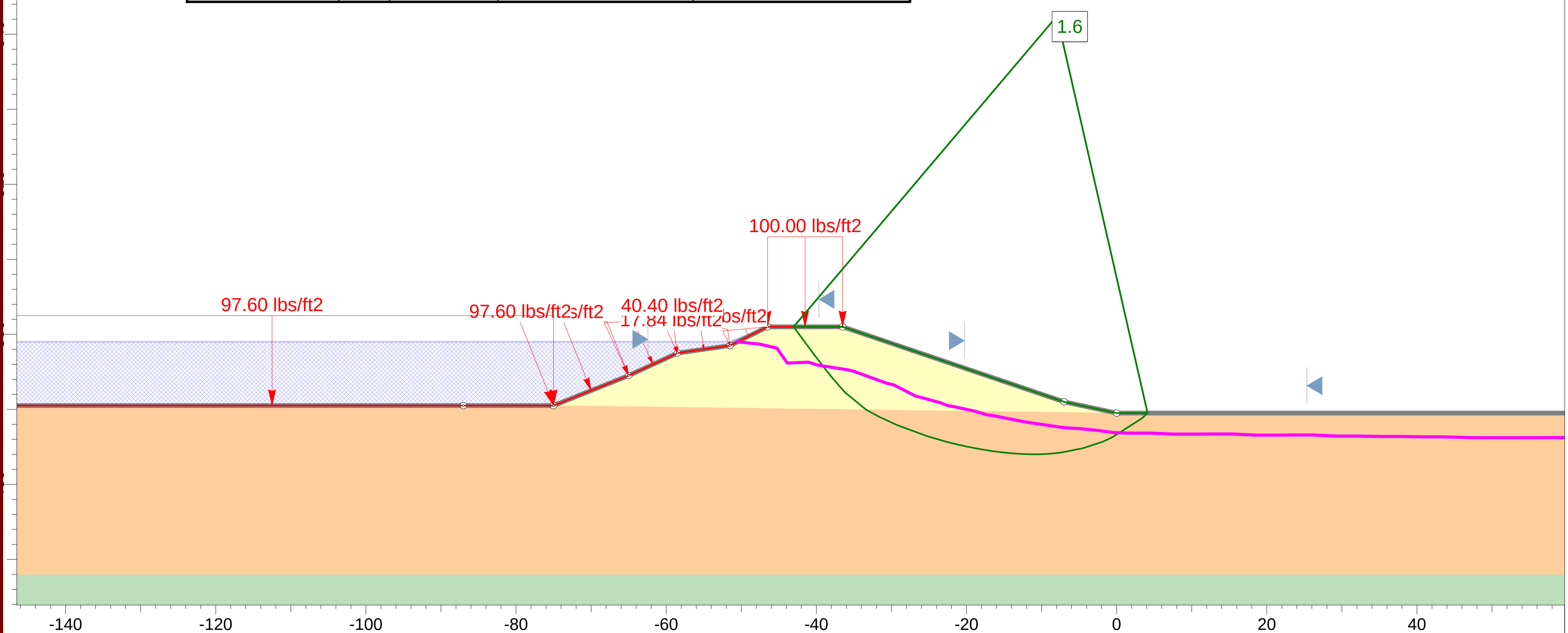
Figure C-9b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "I" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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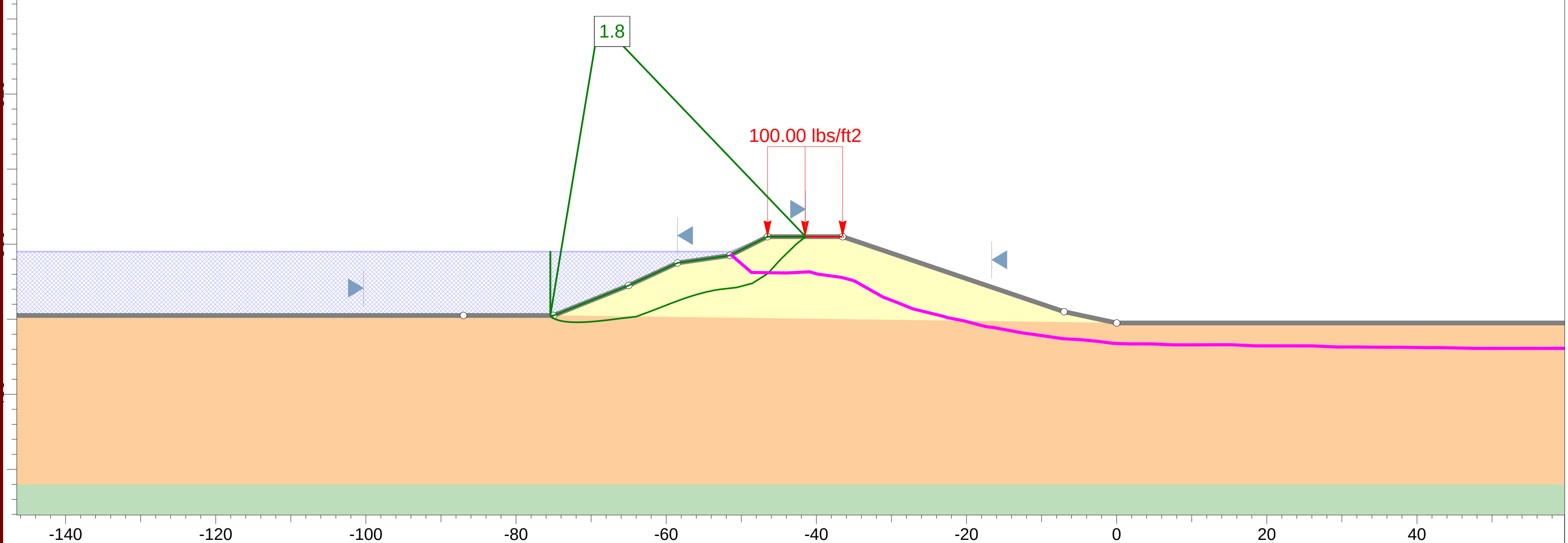
Figure C-10a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "I" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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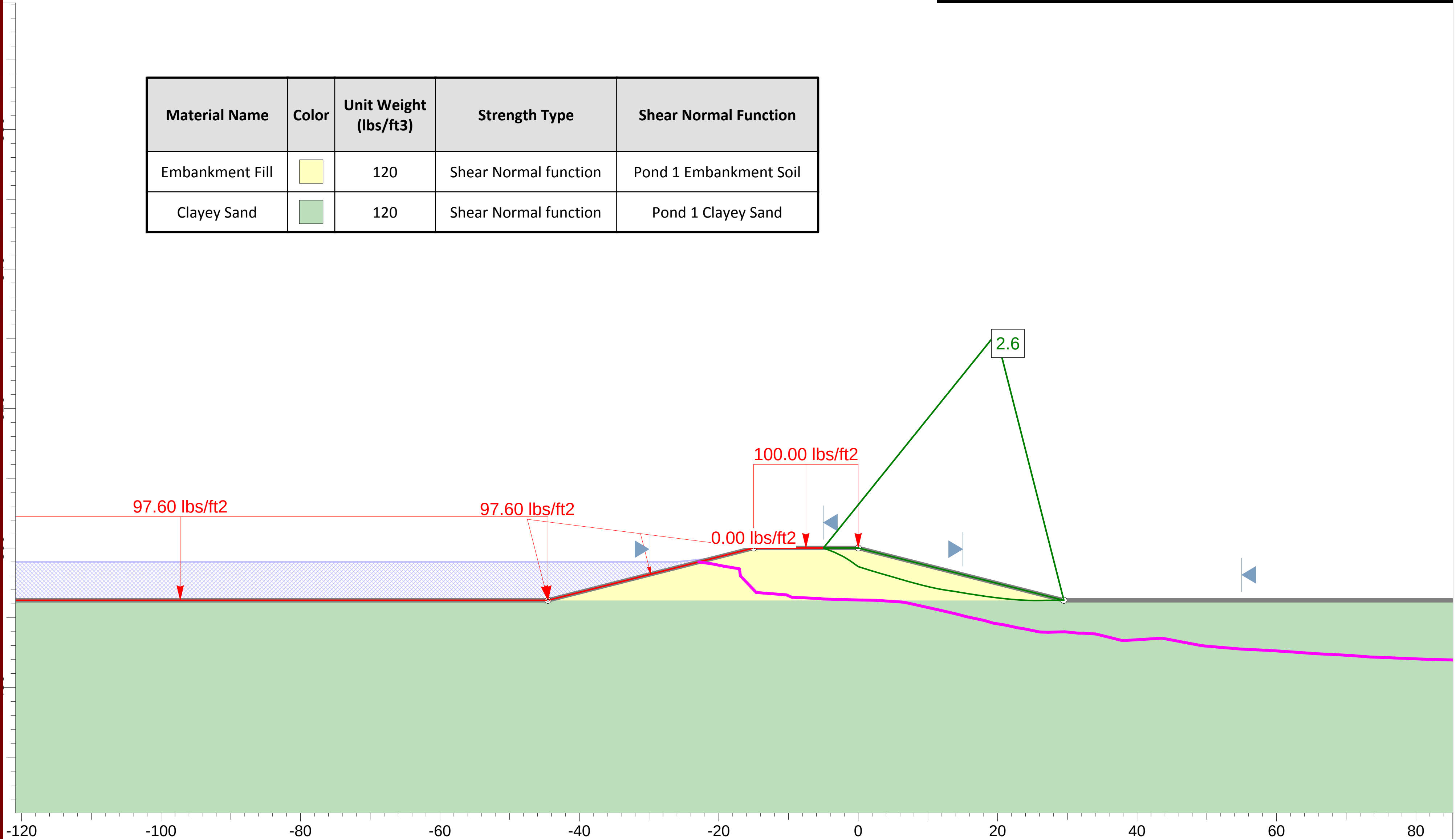
Figure C-10b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand



Profile "J" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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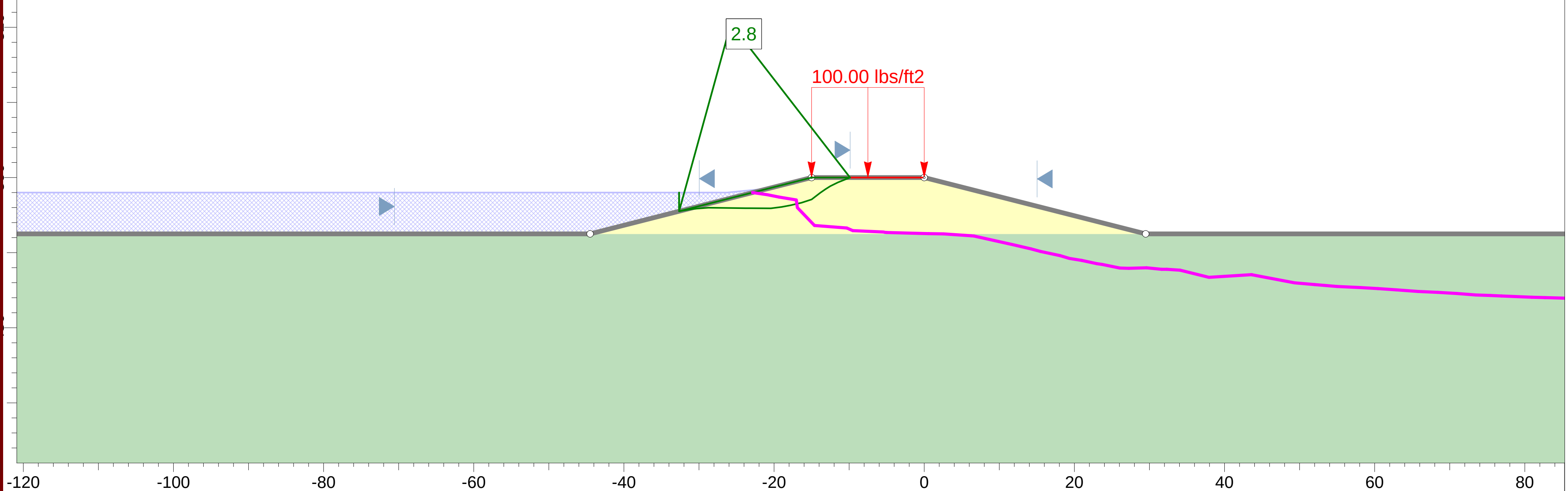
Figure C-11a

RABA KISTNER CONSULTANTS

Global Stability Analysis

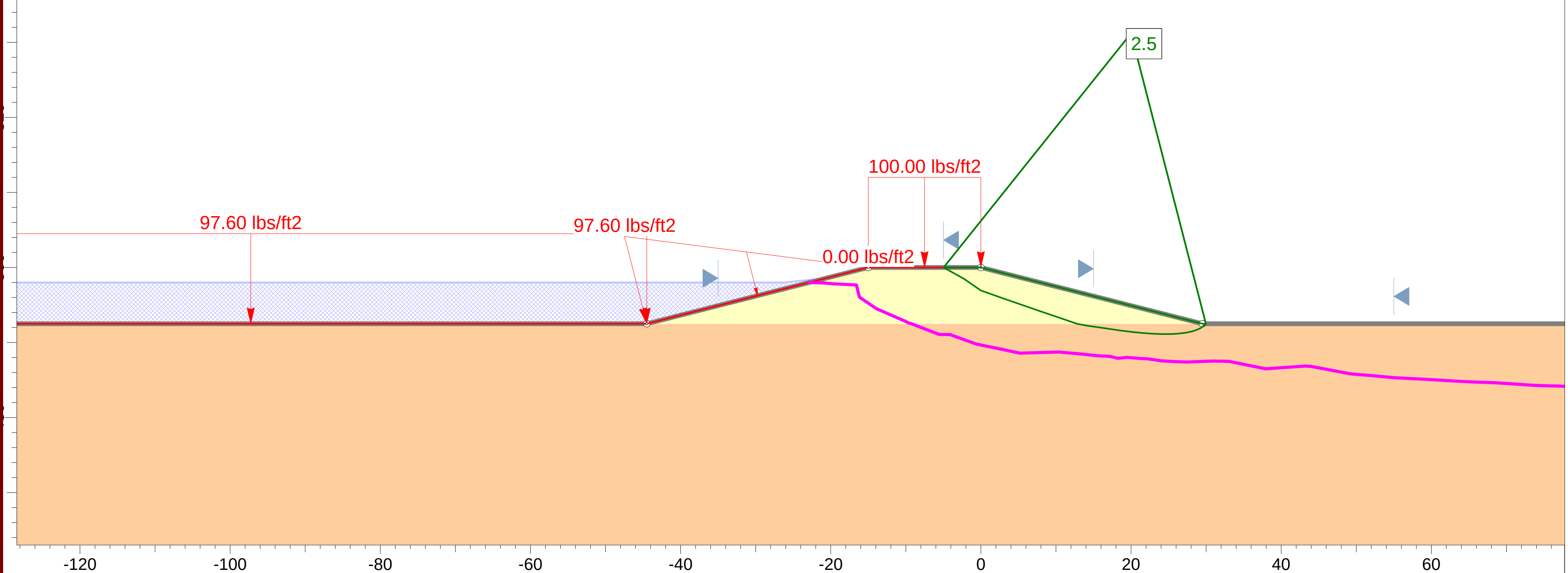
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand



Profile "J" - Steady State Ash Pond Berms - Spruce/Deely Generation Units	Raba Kistner Consultants, Inc. ASA12-098-00	Figure C-11b RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "K" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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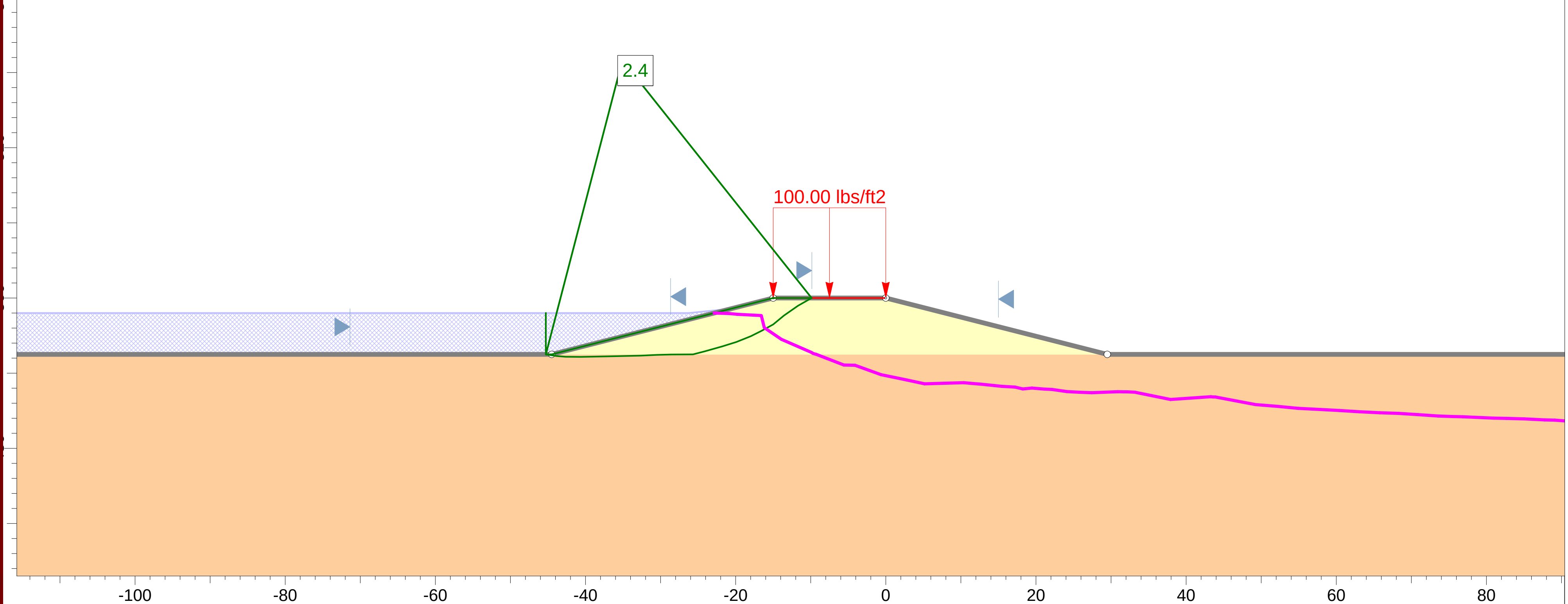
Figure C-12a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "K" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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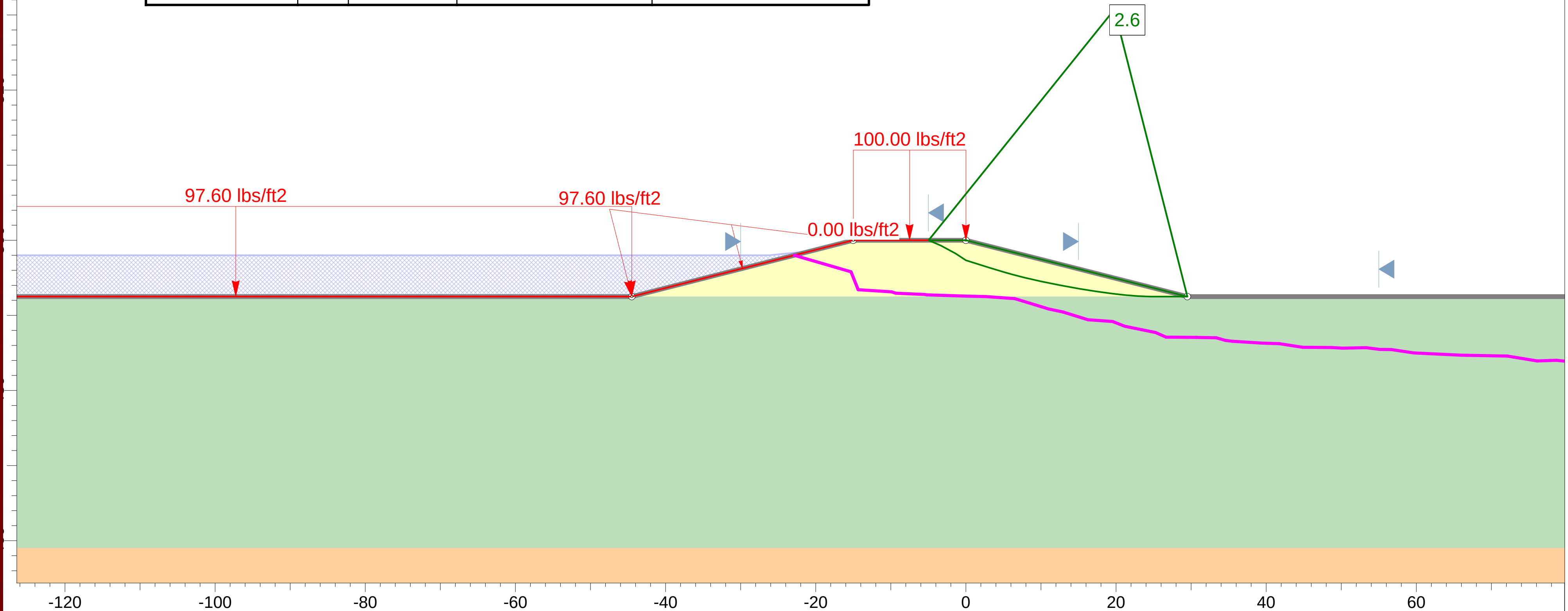
Figure C-12b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "L" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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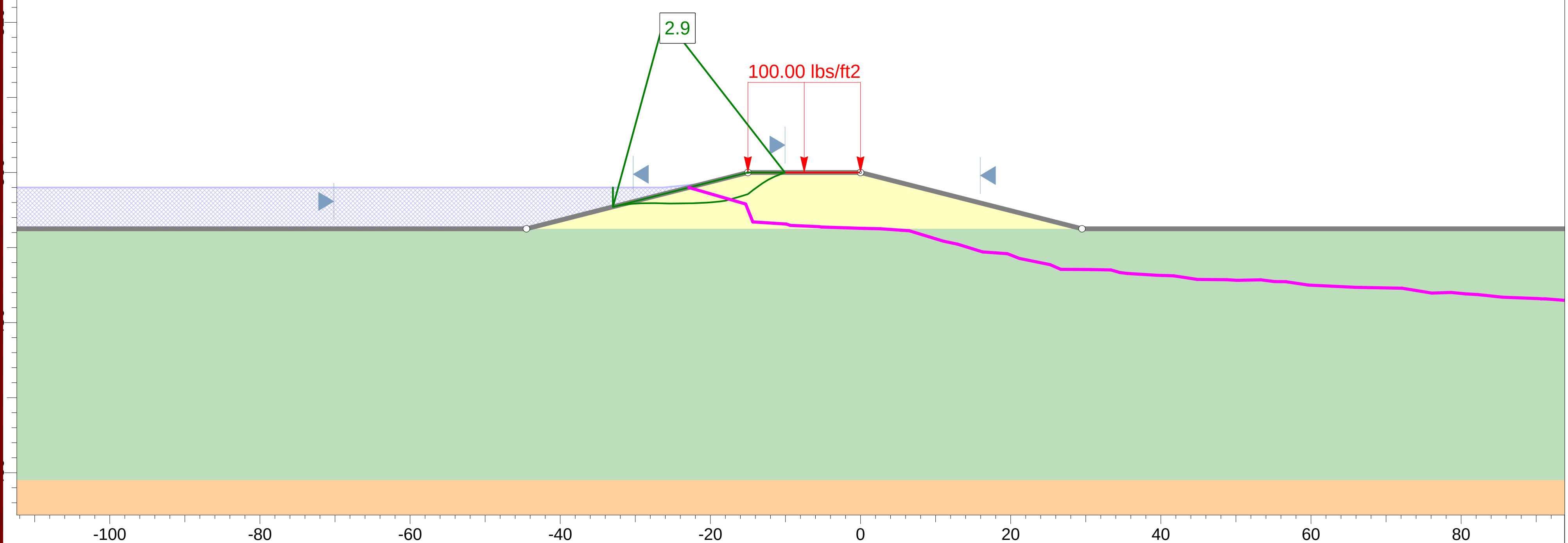
Figure C-13a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "L" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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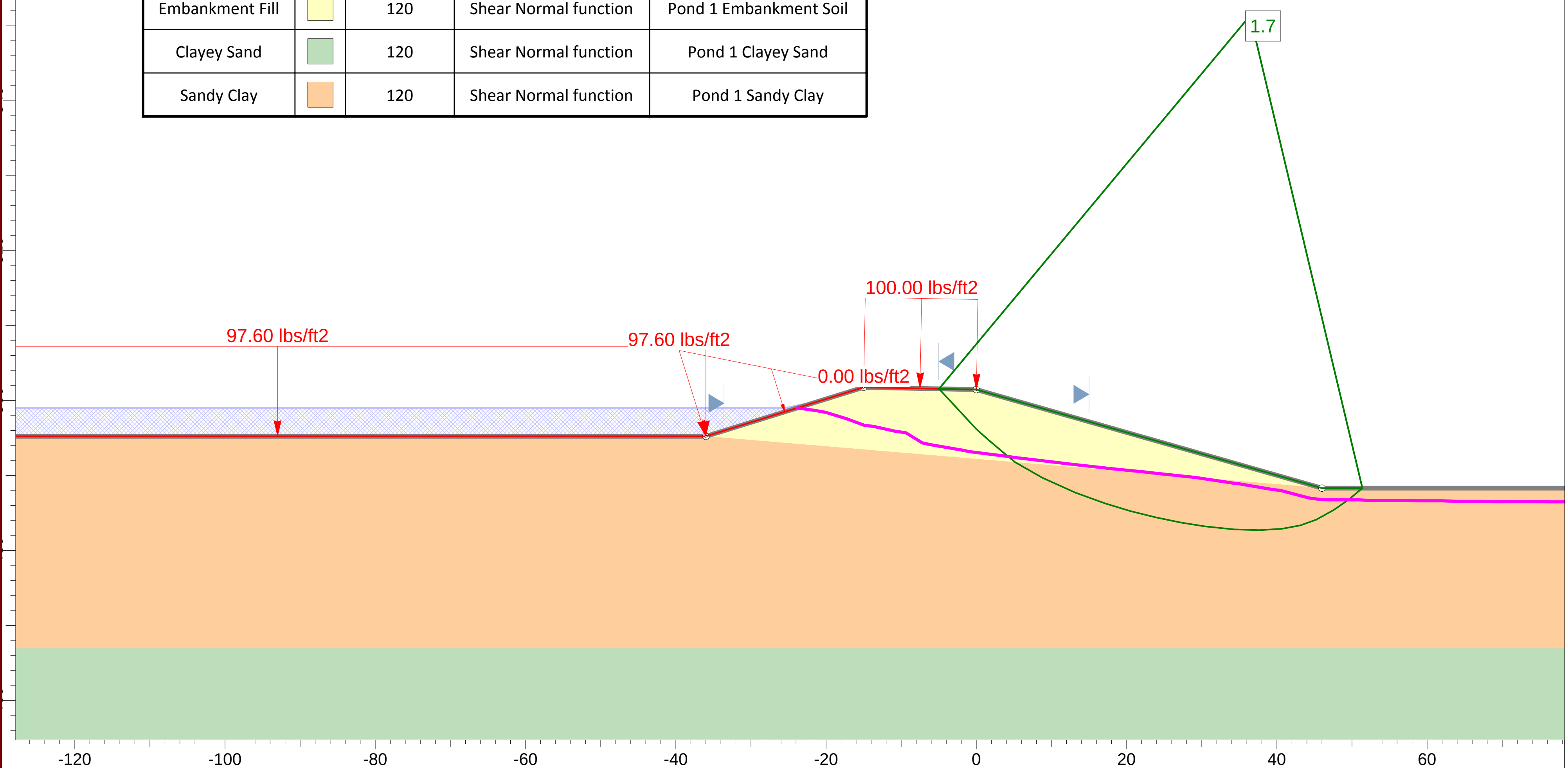
Figure C-13b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "M" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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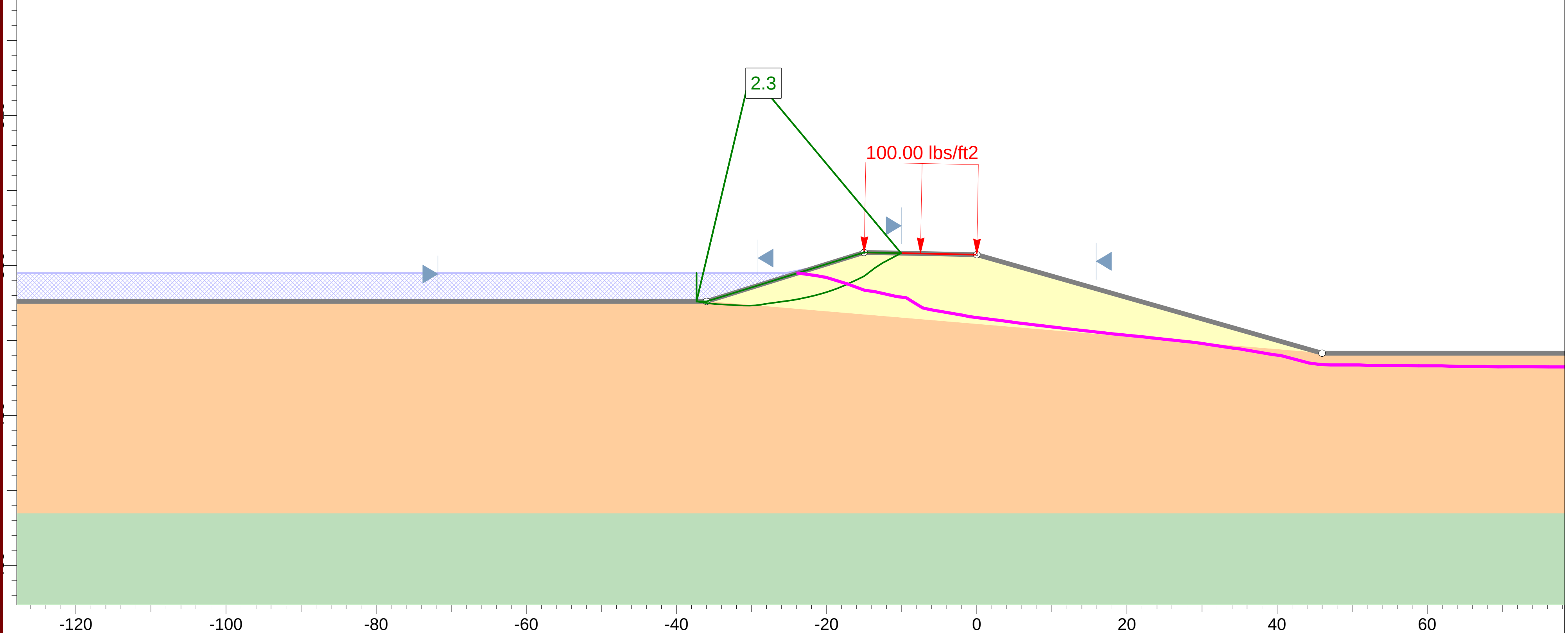
Figure C-14a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "M" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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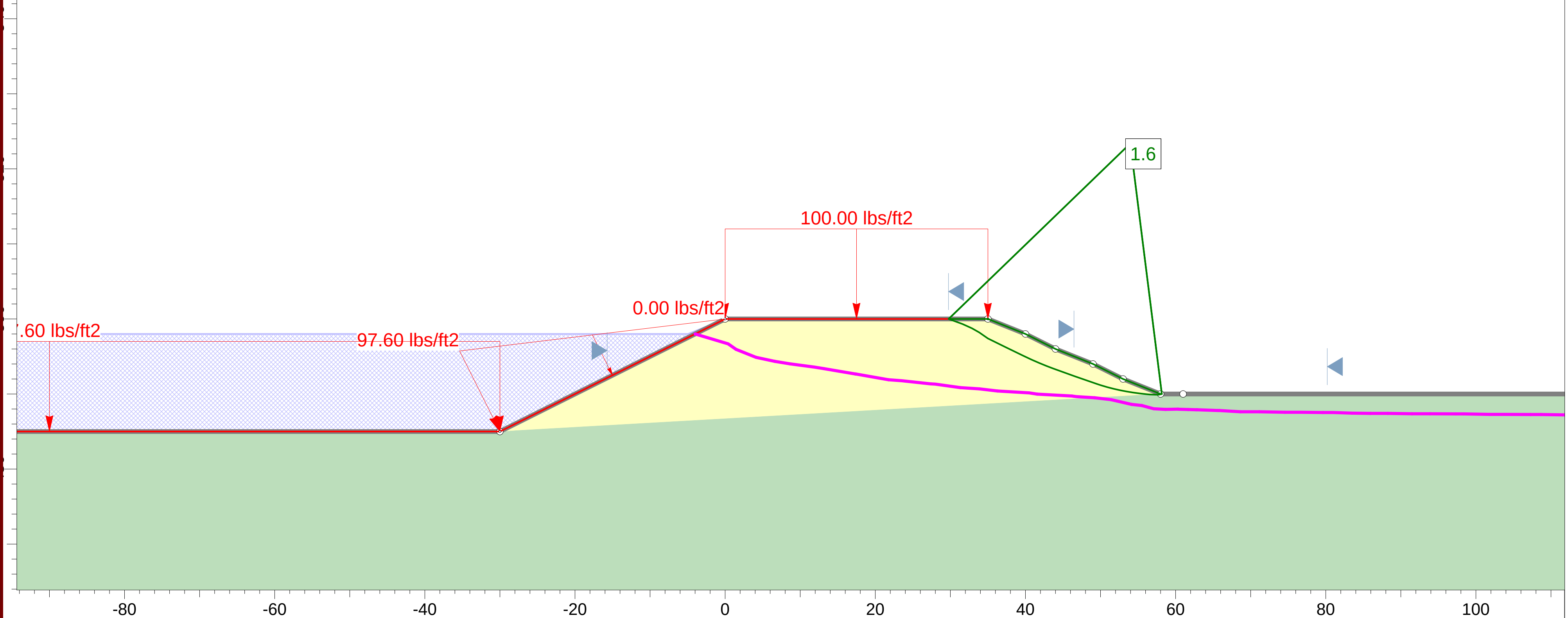
Figure C-14b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand



Profile "N" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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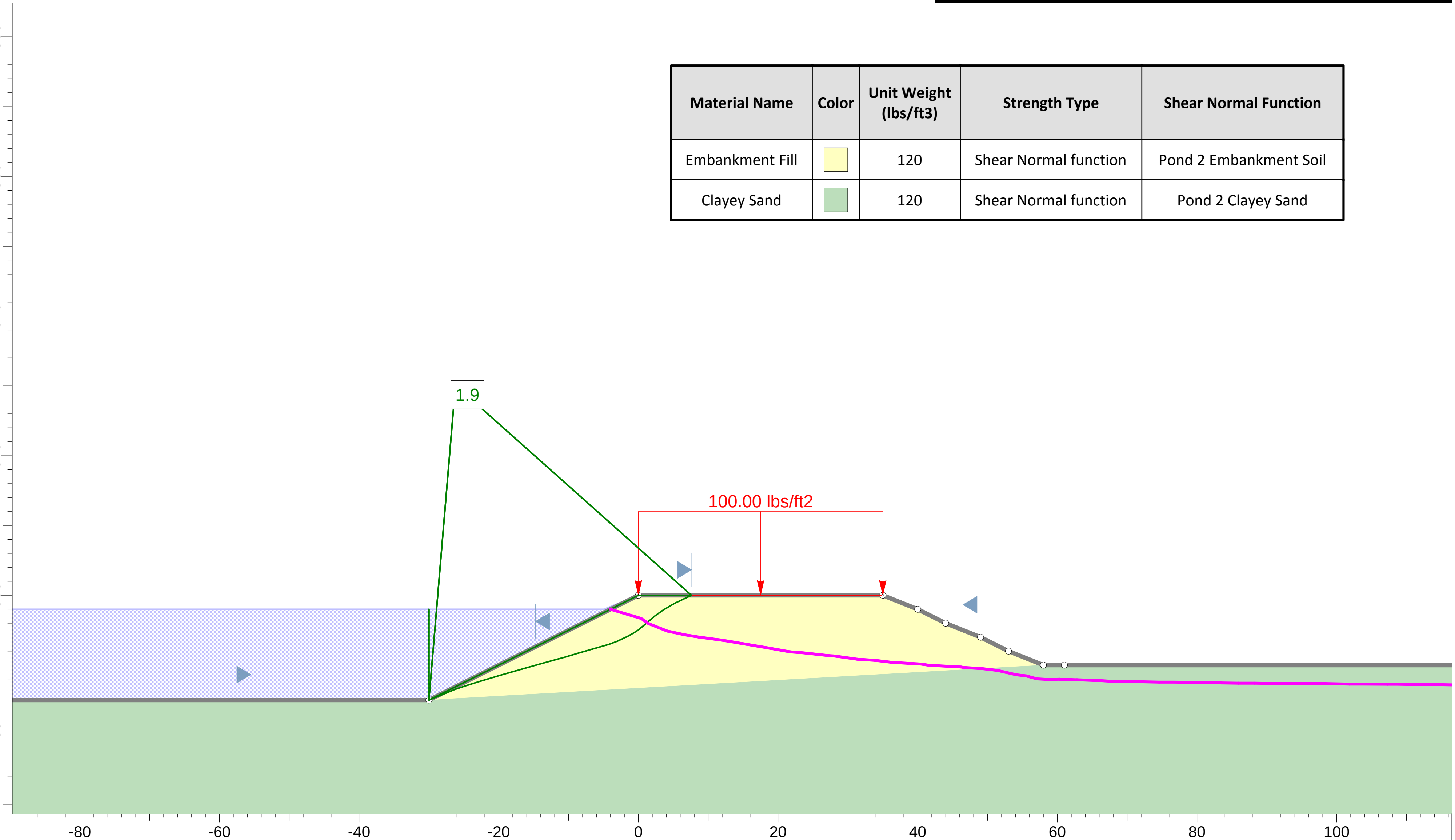
Figure C-15a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand



Profile "N" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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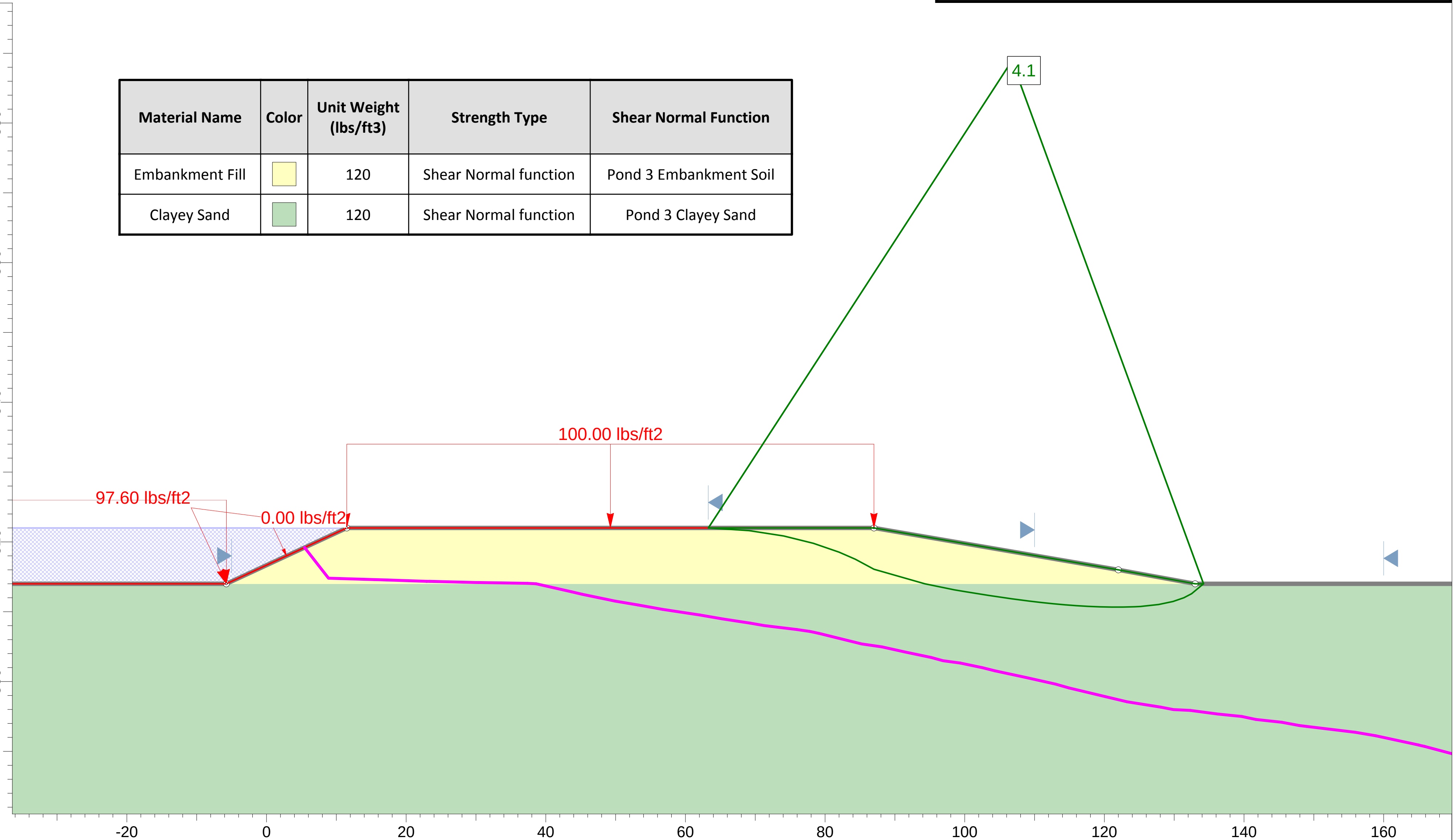
Figure C-15b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "A" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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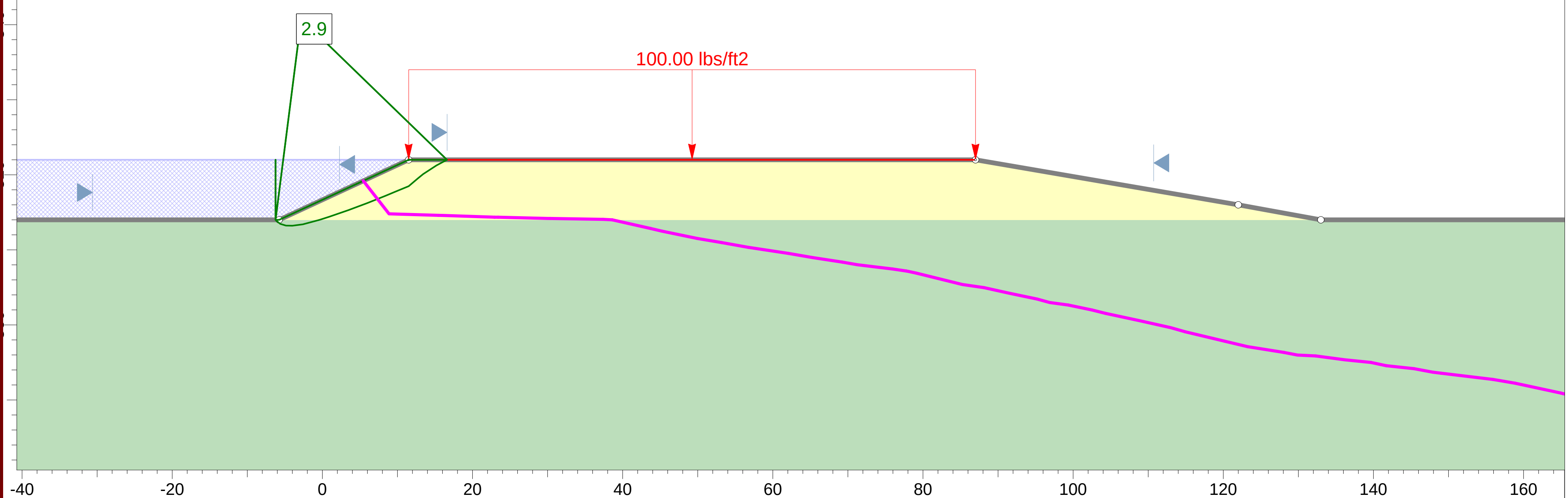
Figure C-16a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "A" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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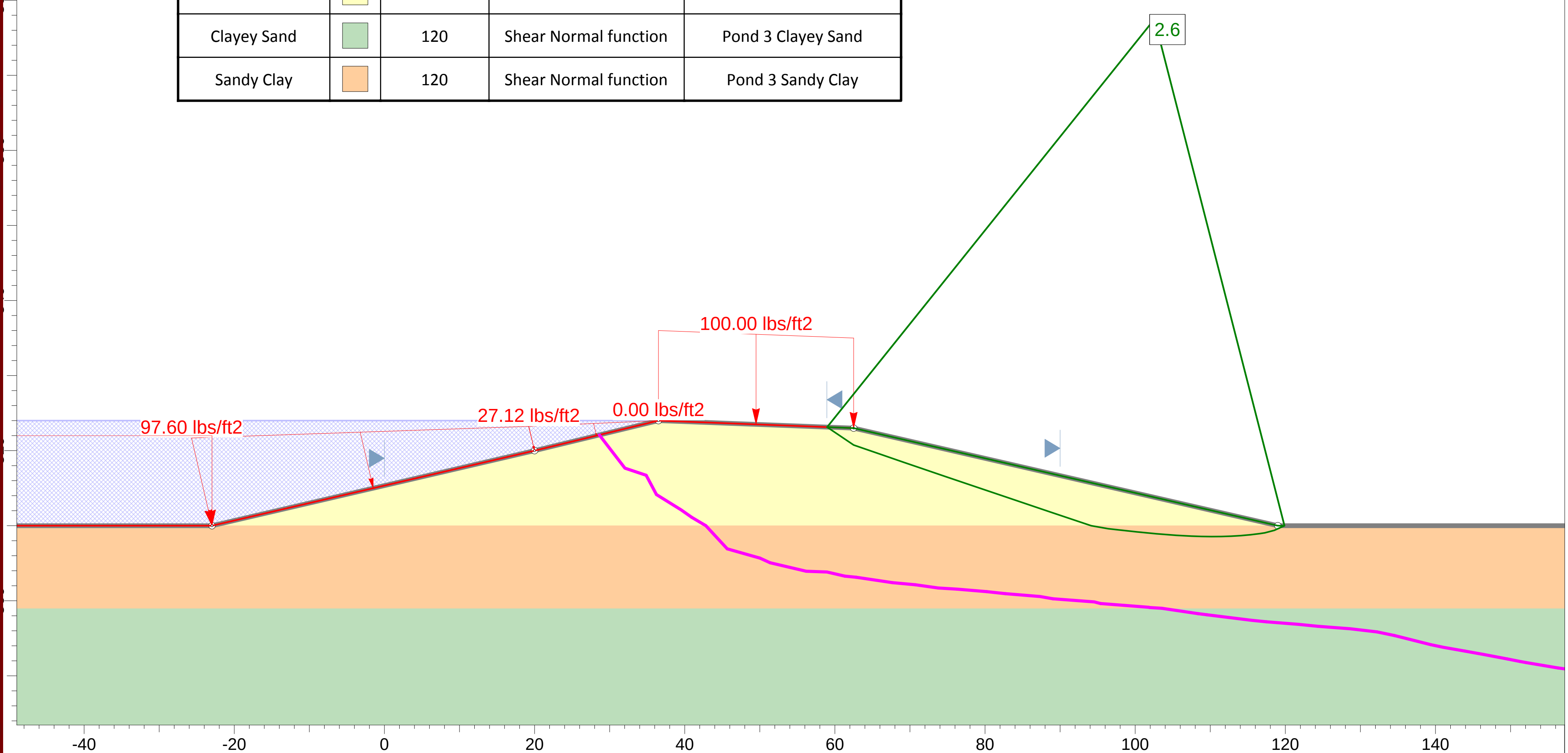
Figure C-16b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



Profile "B" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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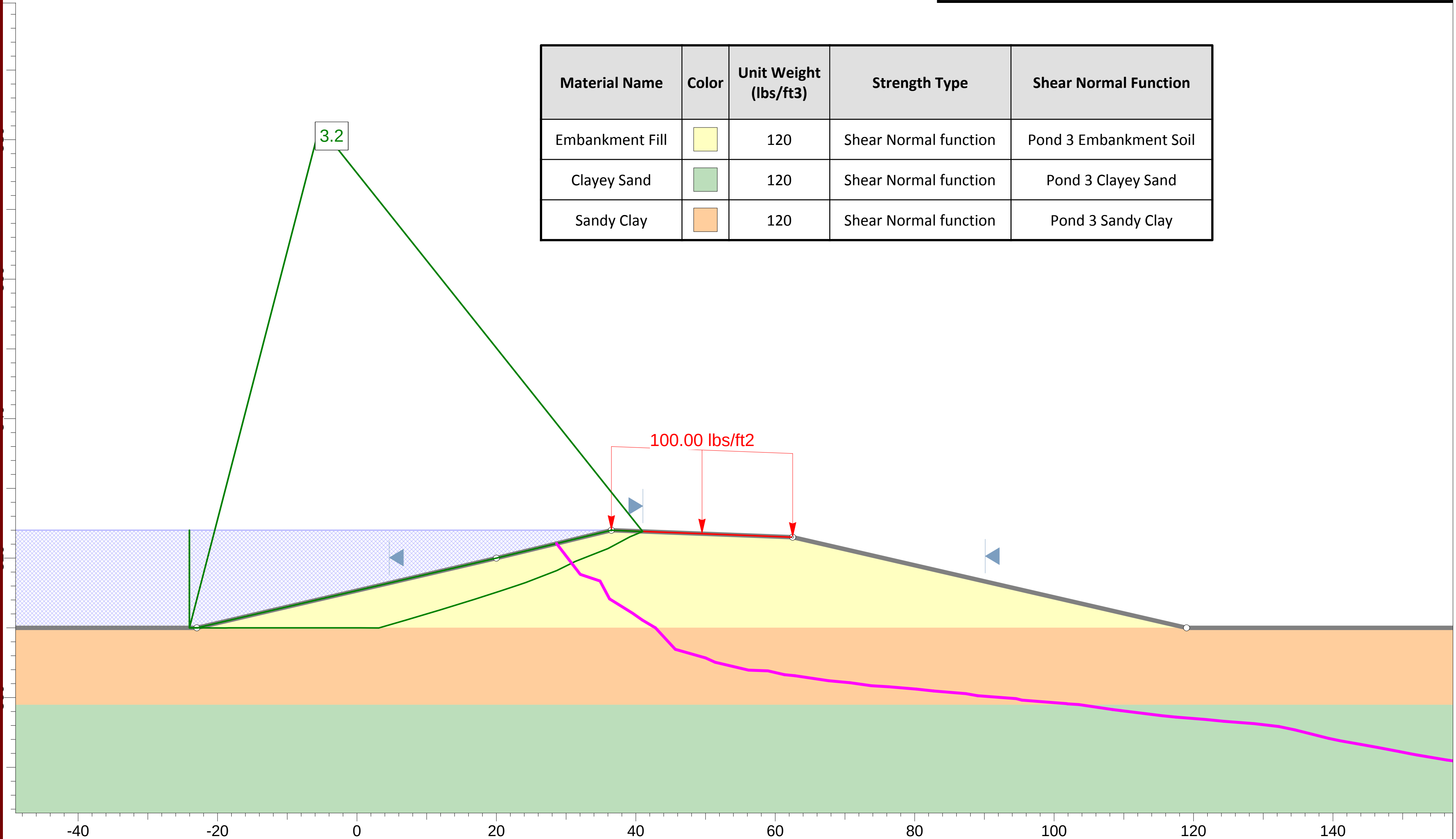
Figure C-17a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



Profile "B" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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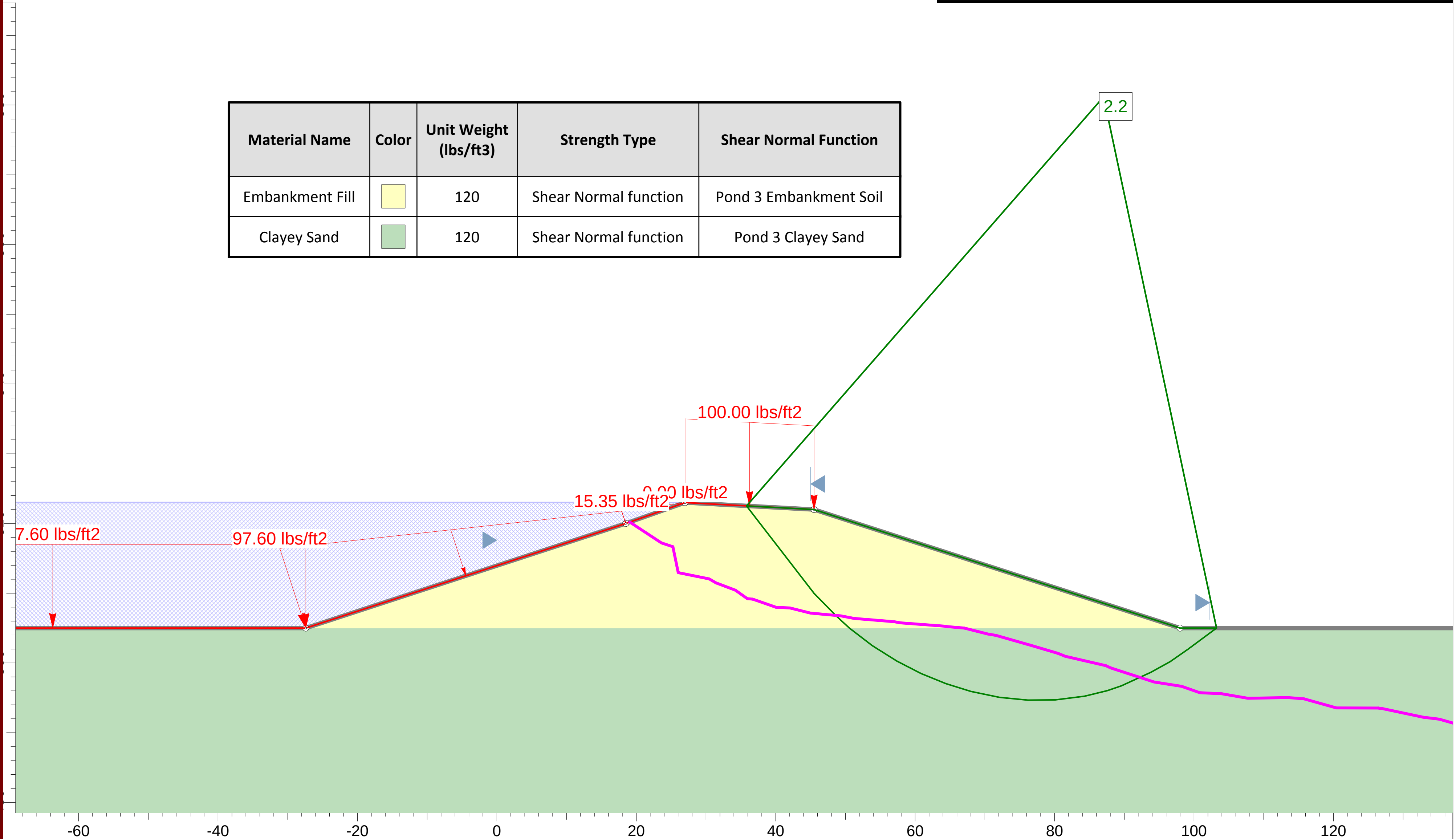
Figure C-17b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "C" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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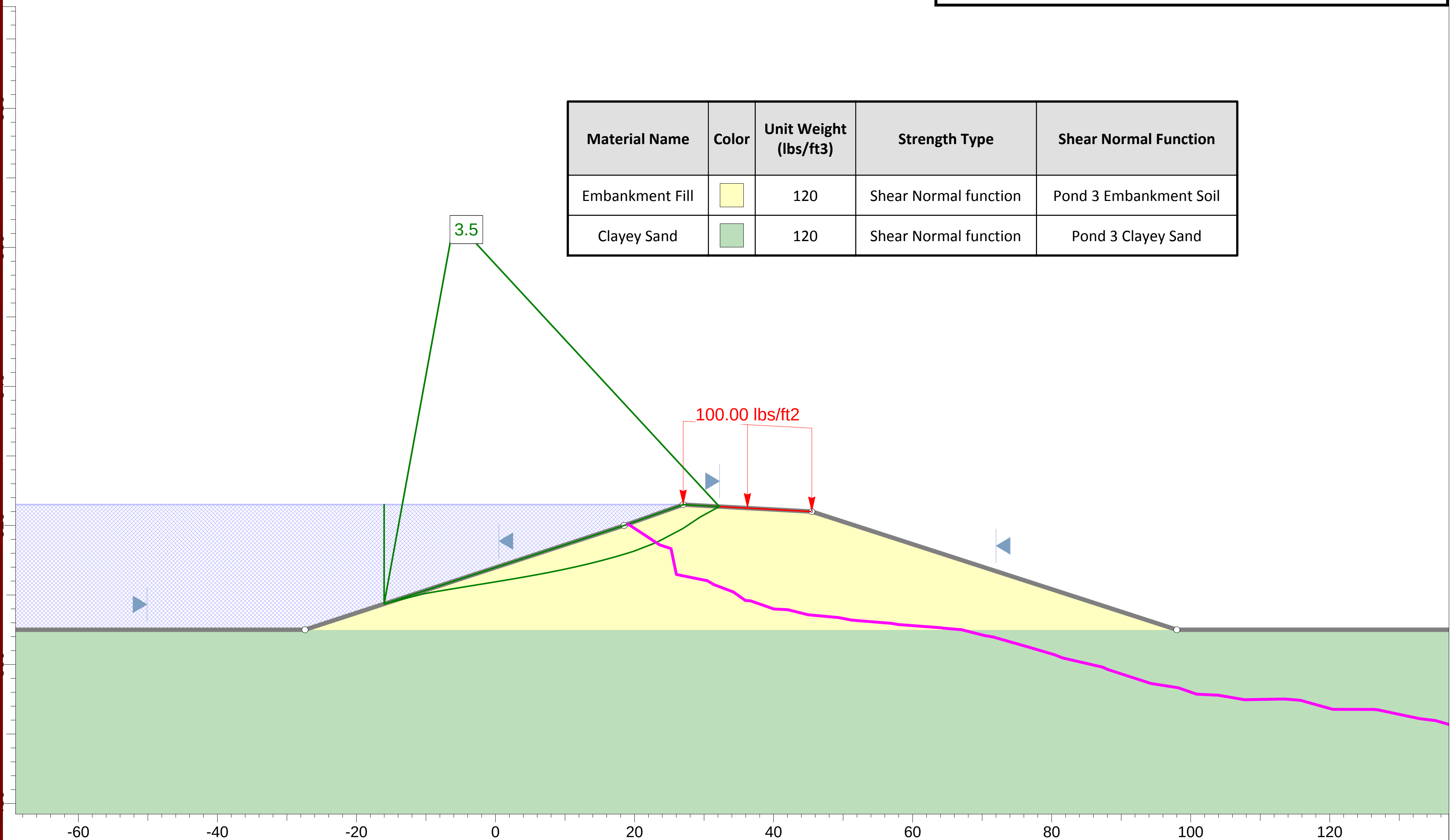
Figure C-18a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand



Profile "C" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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Figure C-18b

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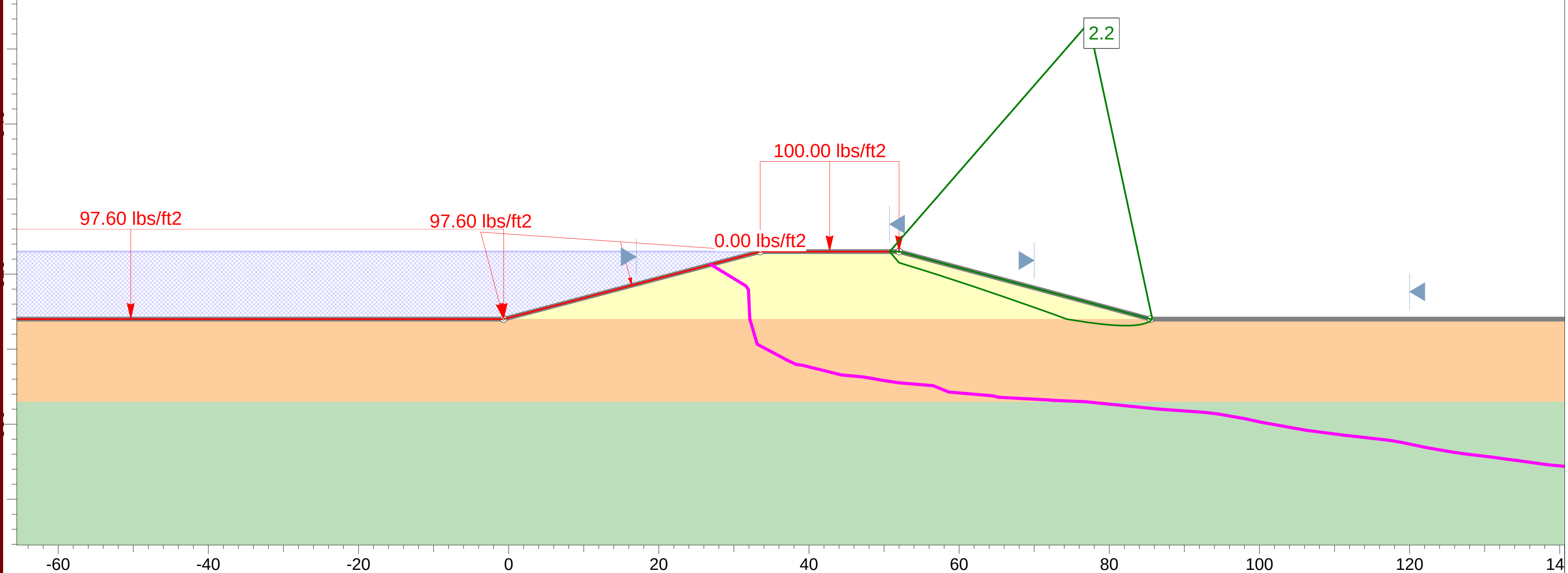
Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay



Profile "D" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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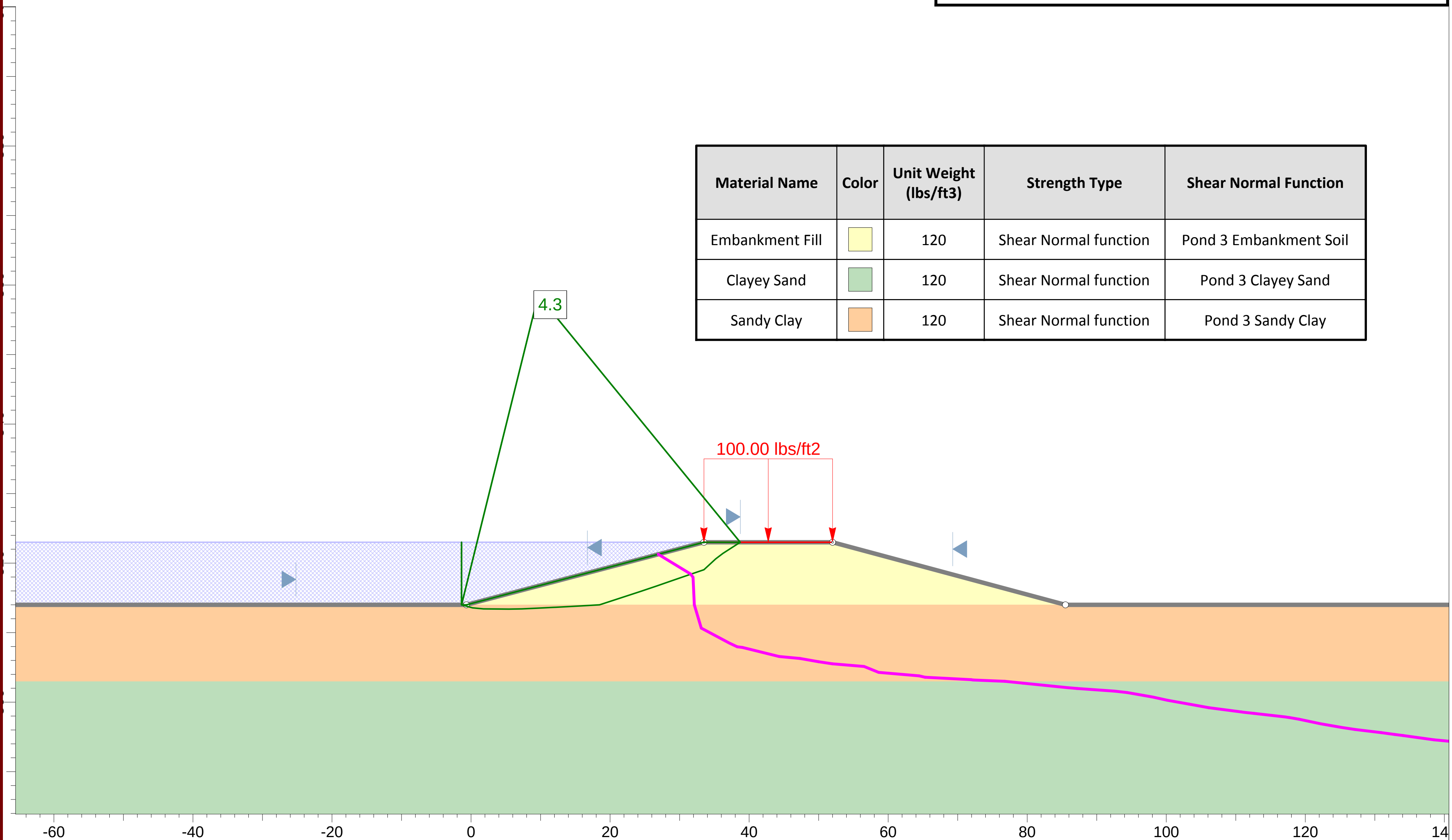
Figure C-19a

RABA KISTNER CONSULTANTS

Global Stability Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 3 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 3 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 3 Sandy Clay

Profile "D" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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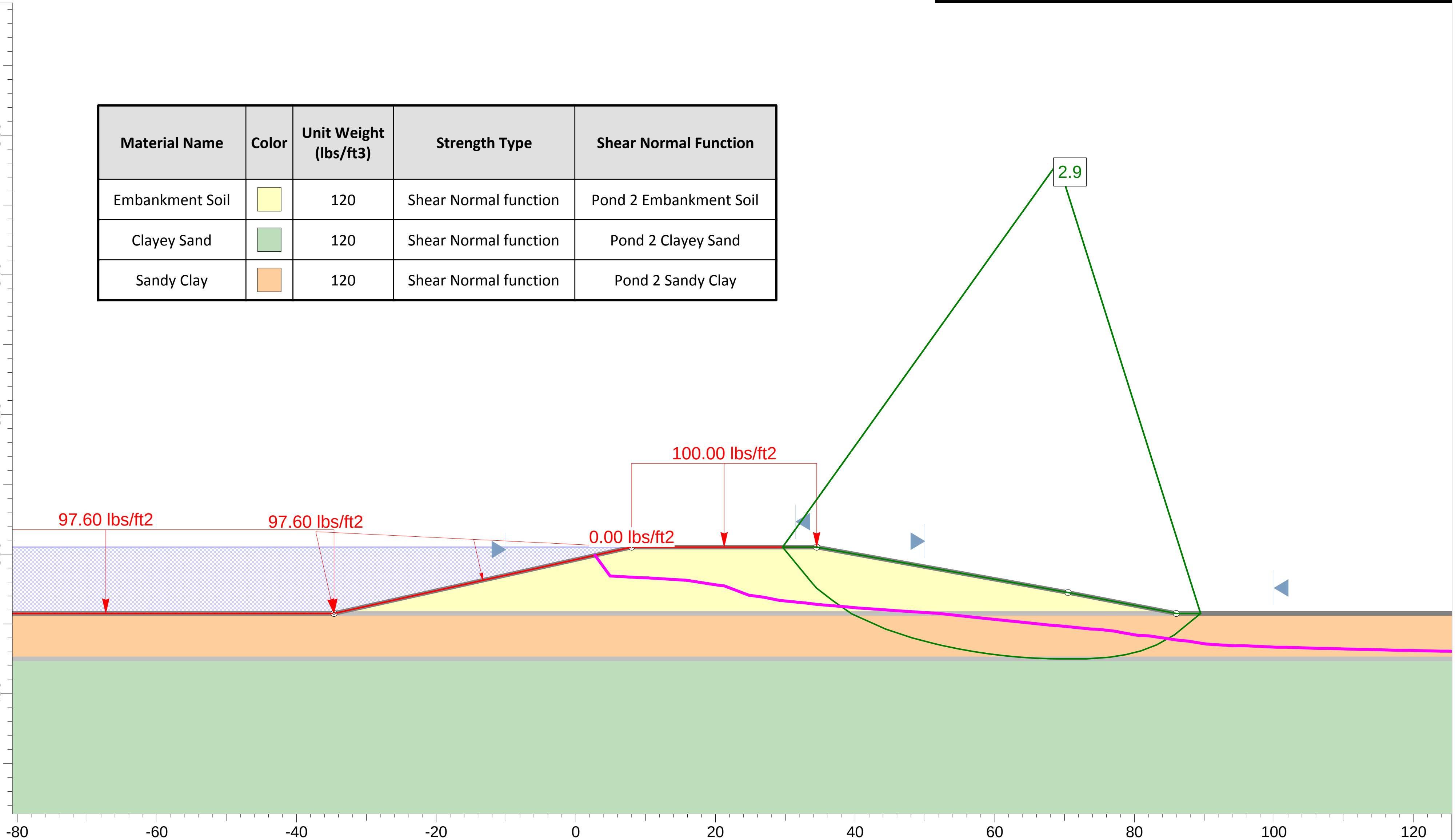
Figure C-19b

RABA KISTNER CONSULTANTS

Global Stability Analysis

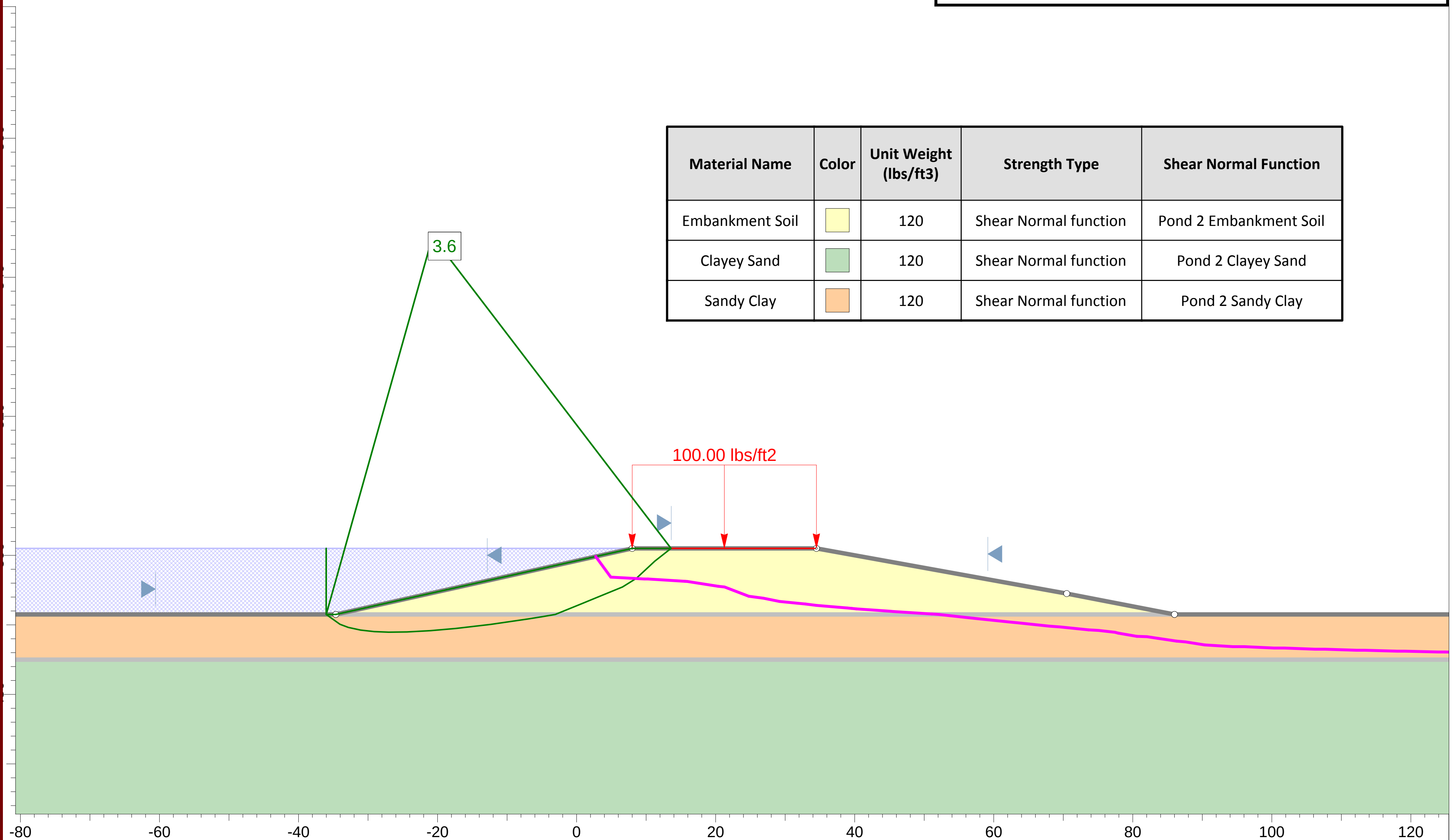
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Soil		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "E" - Maximum Pool Ash Pond Berms - Spruce/Deely Generation Units	Raba Kistner Consultants, Inc. ASA12-098-00	Figure C-20a RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Soil		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "E" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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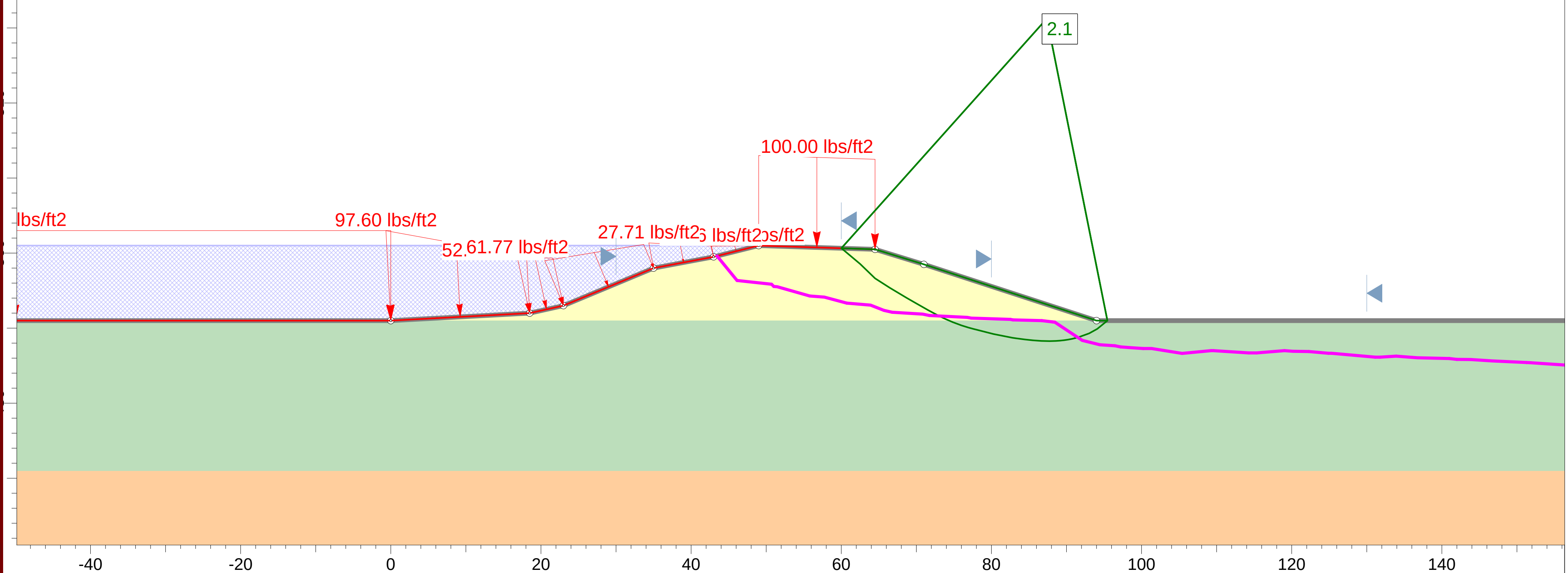
Figure C-20b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "F" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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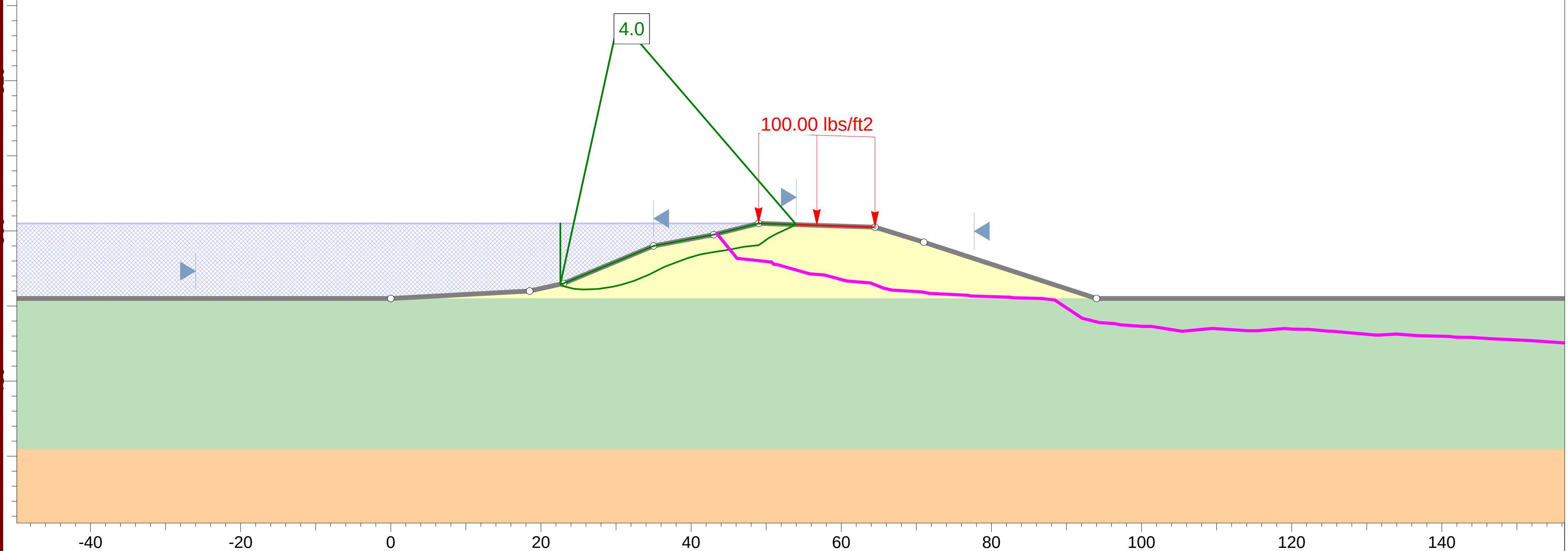
Figure C-21a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "F" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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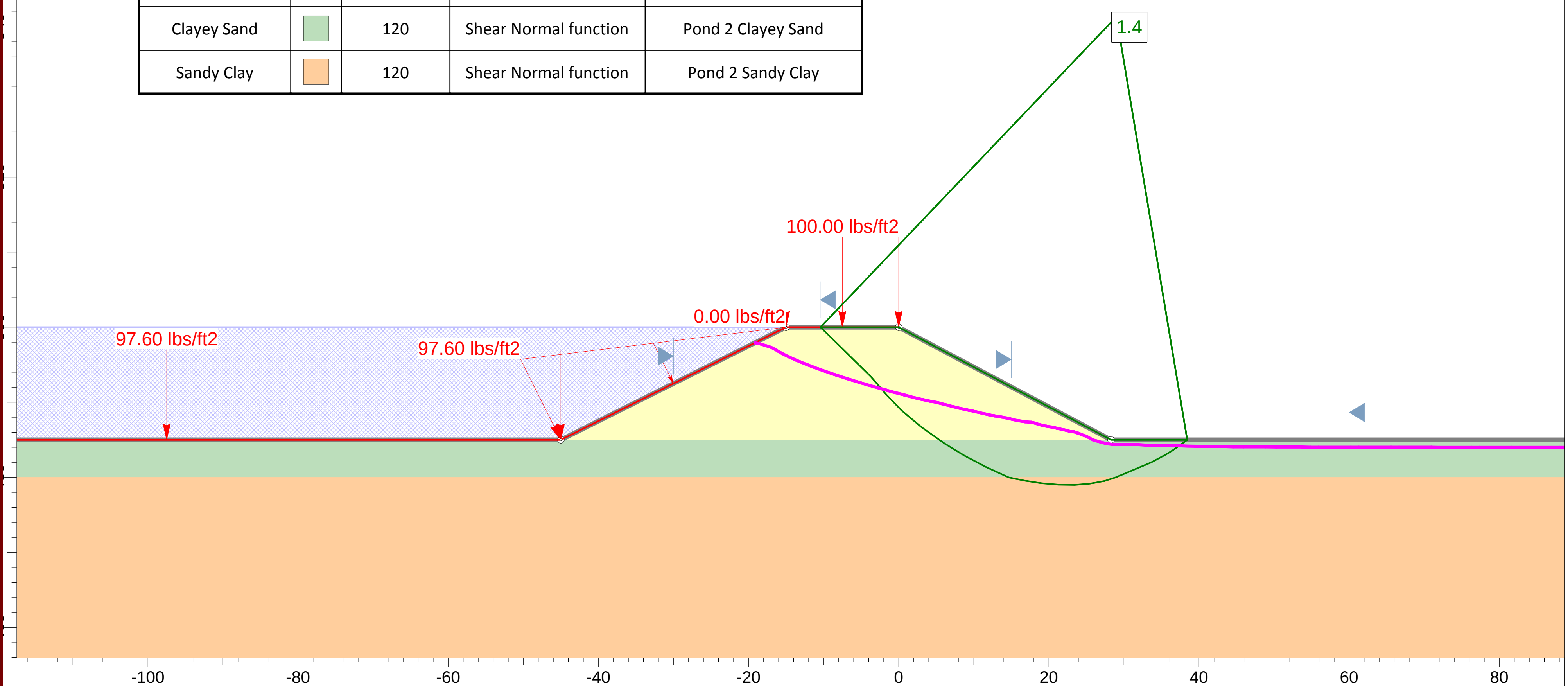
Figure C-21b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "G" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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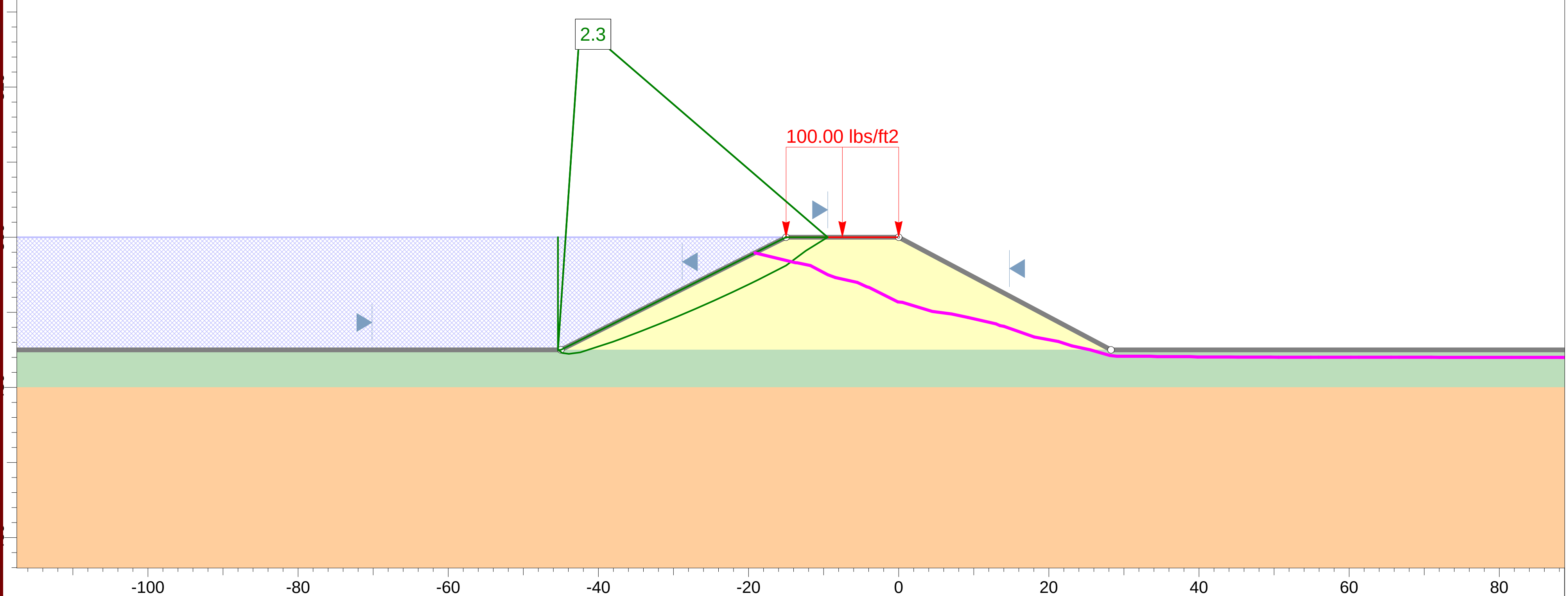
Figure C-22a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "G" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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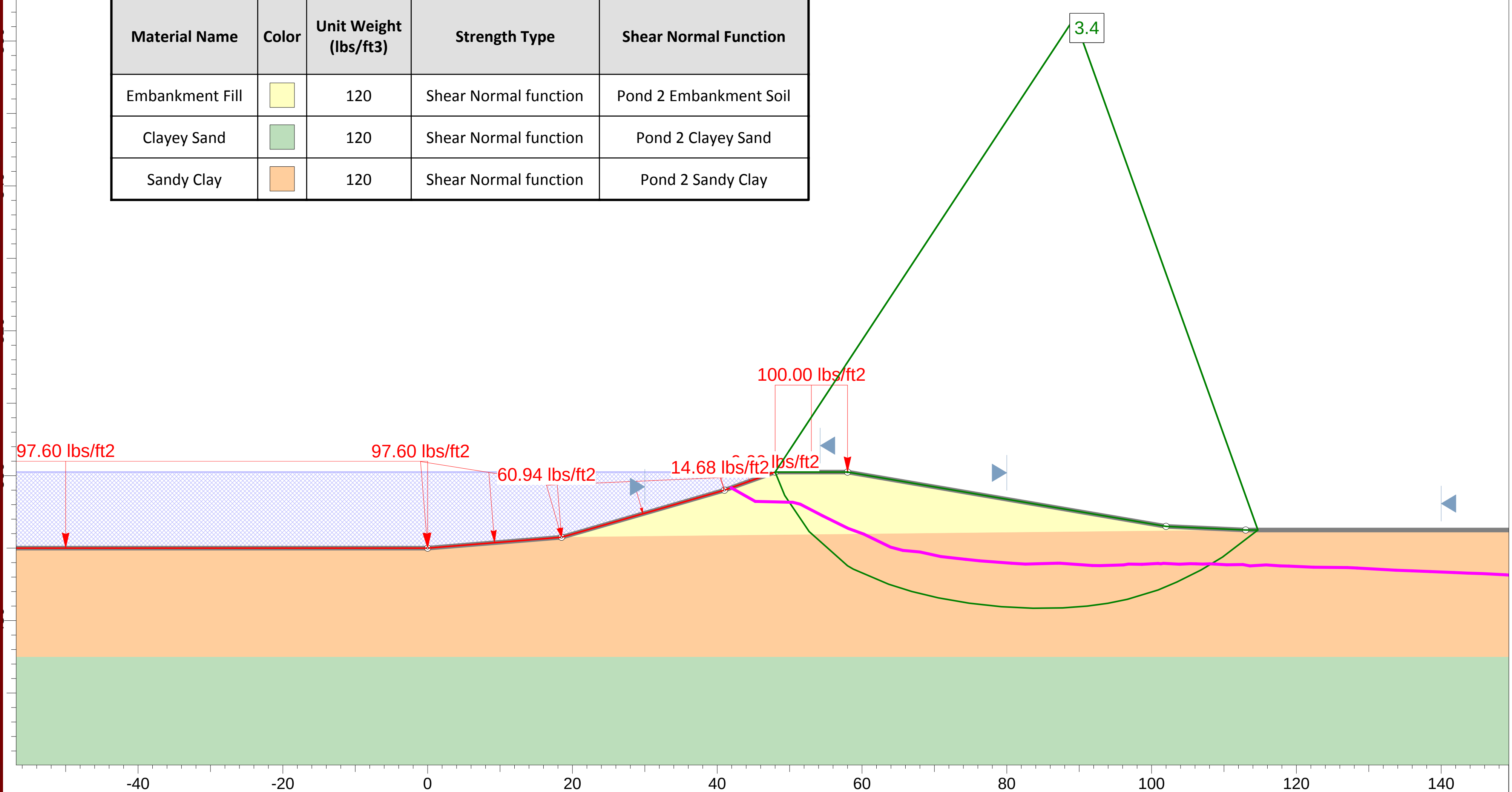
Figure C-22b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "H" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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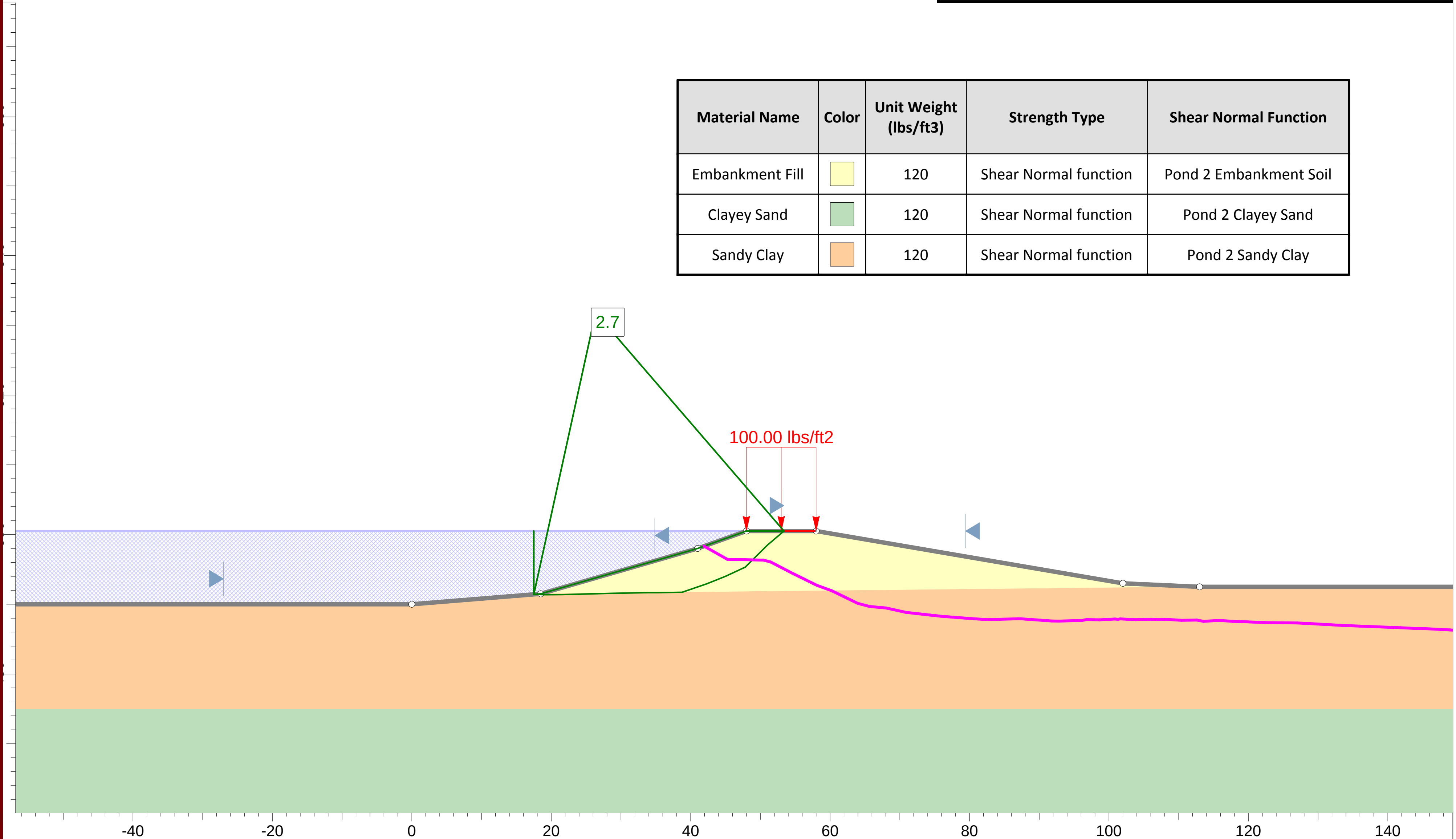
Figure C-23a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "H" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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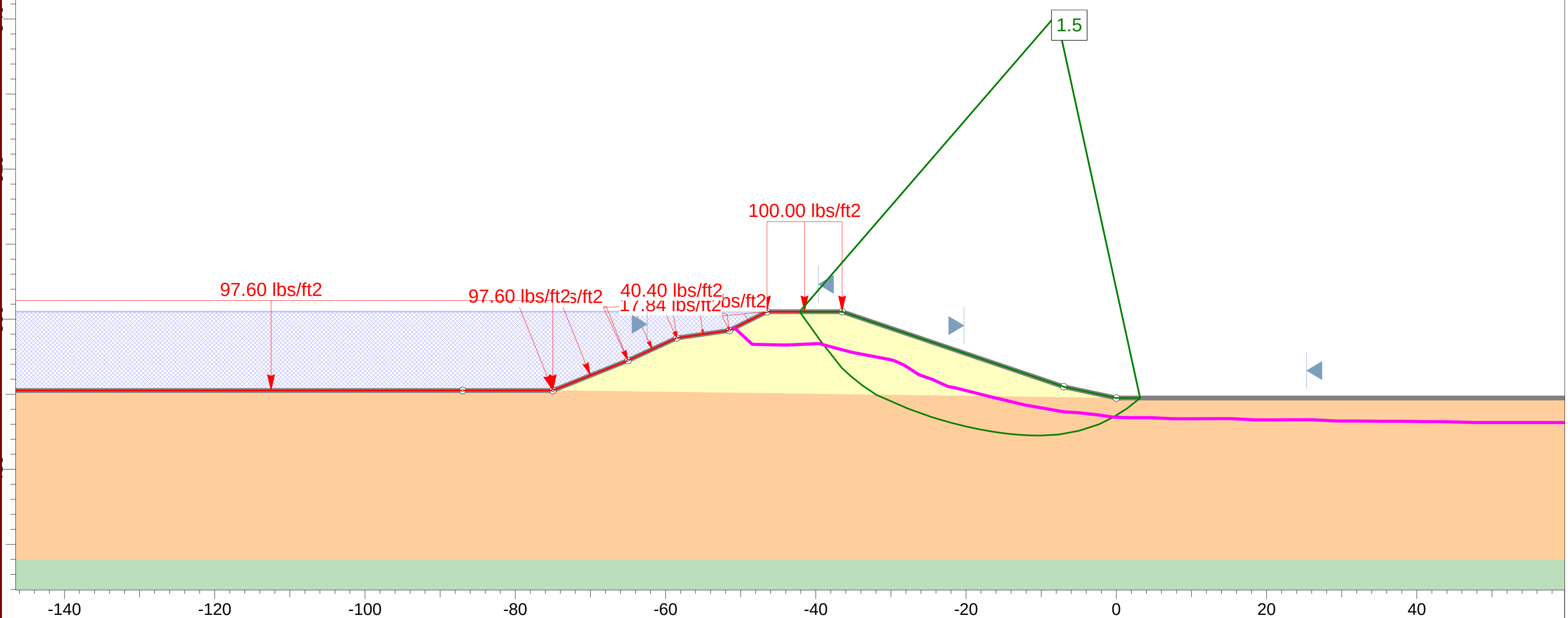
Figure C-23b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "I" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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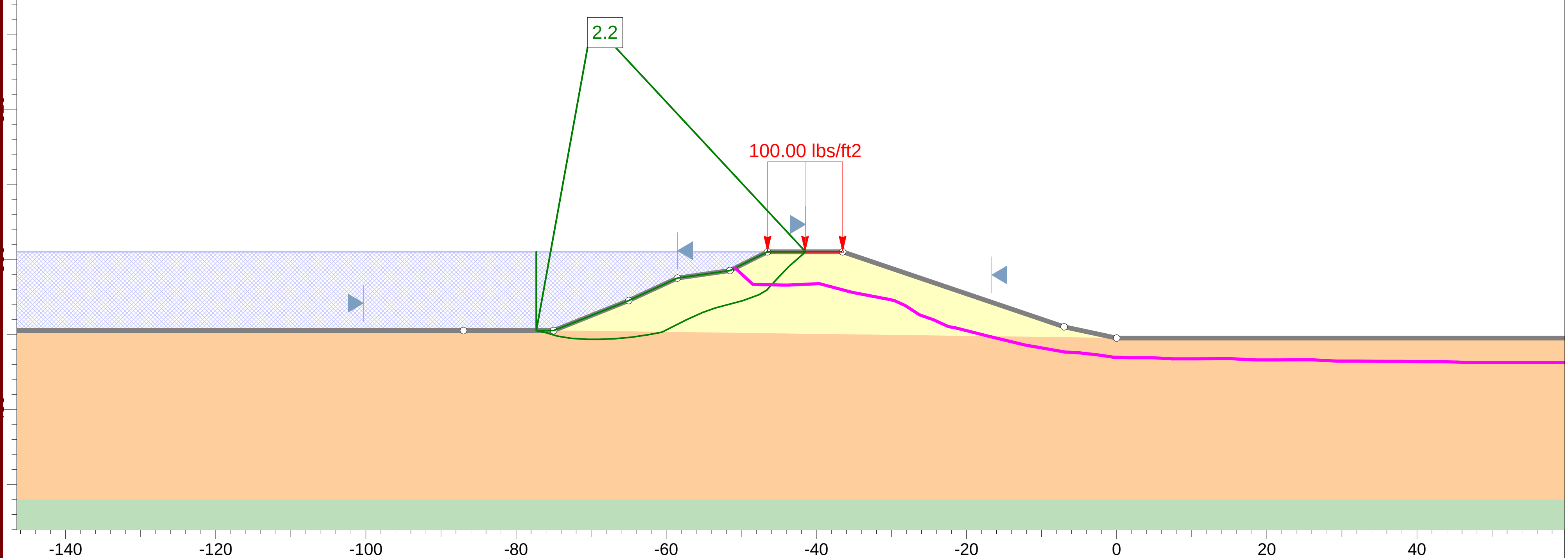
Figure C-24a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 2 Sandy Clay



Profile "I" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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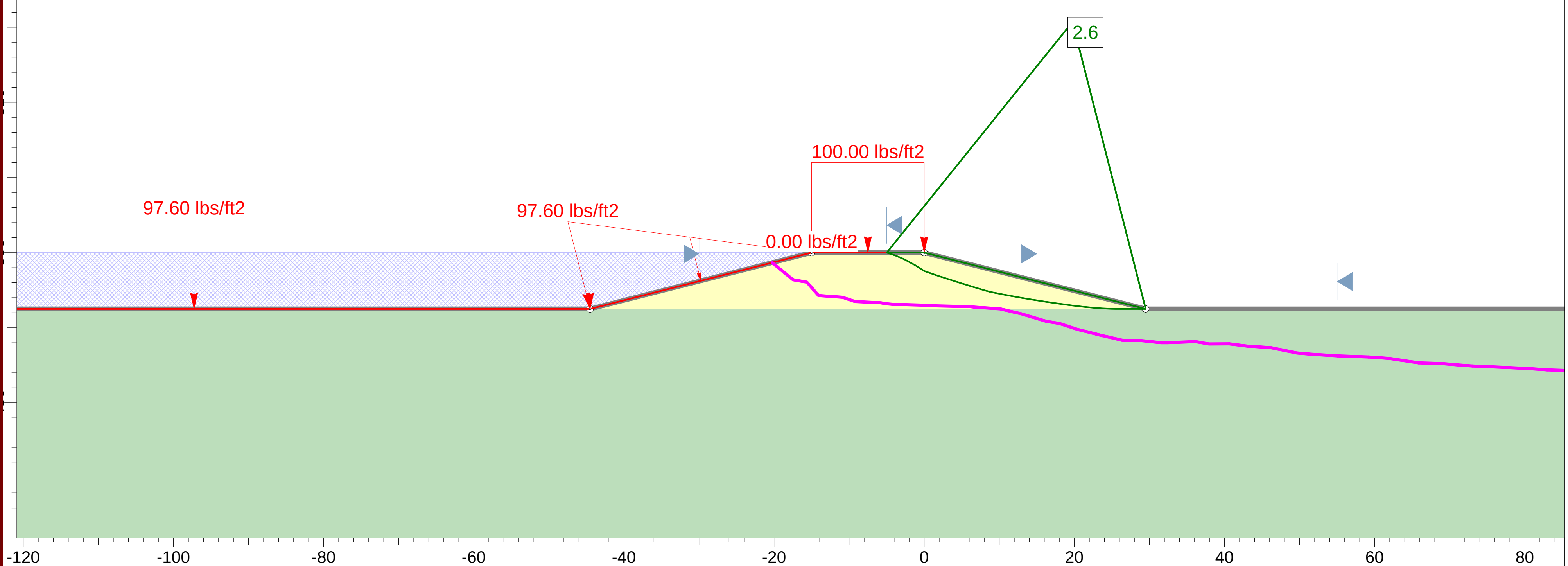
Figure C-24b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand



Profile "J" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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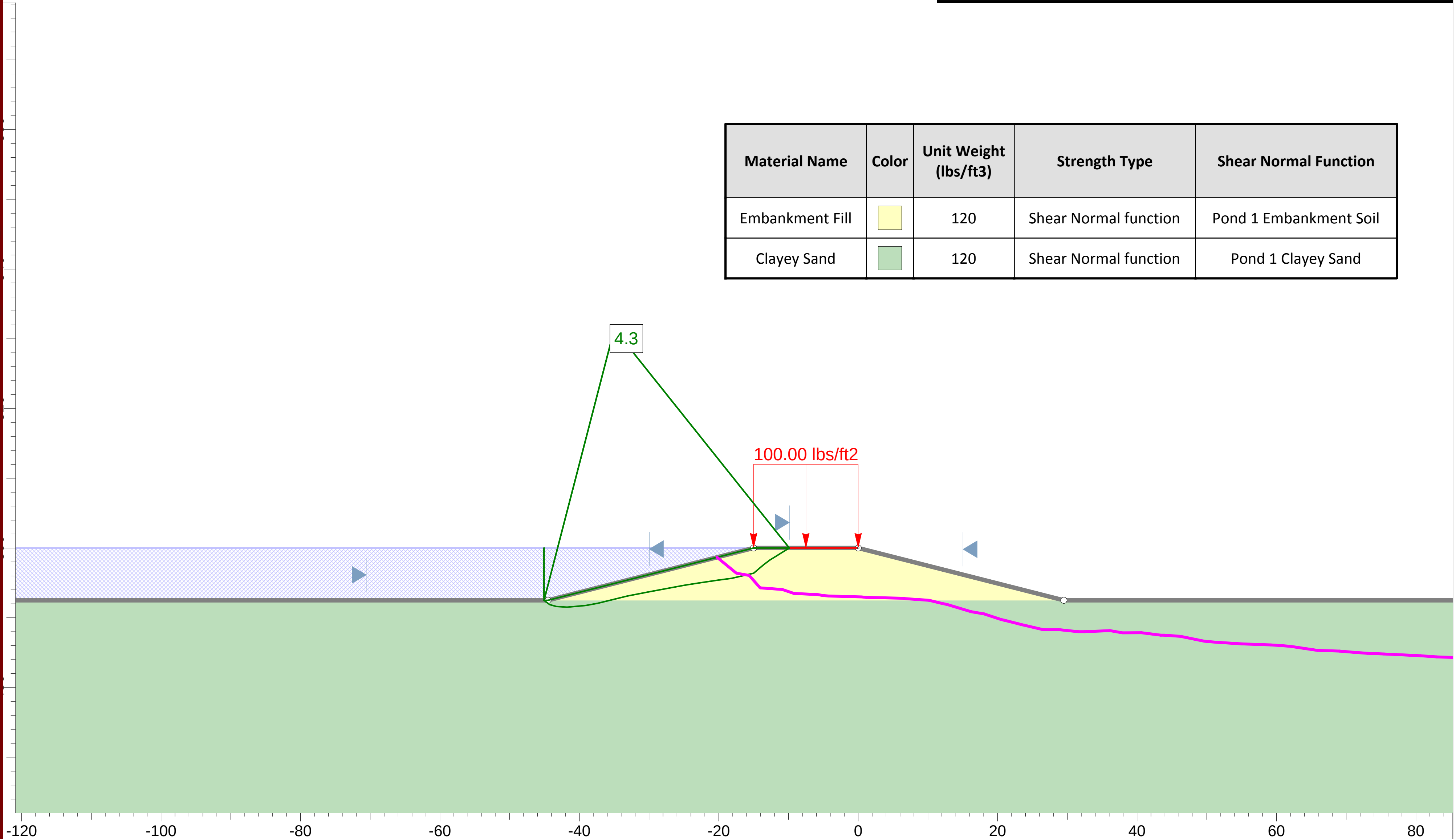
Figure C-25a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand



Profile "J" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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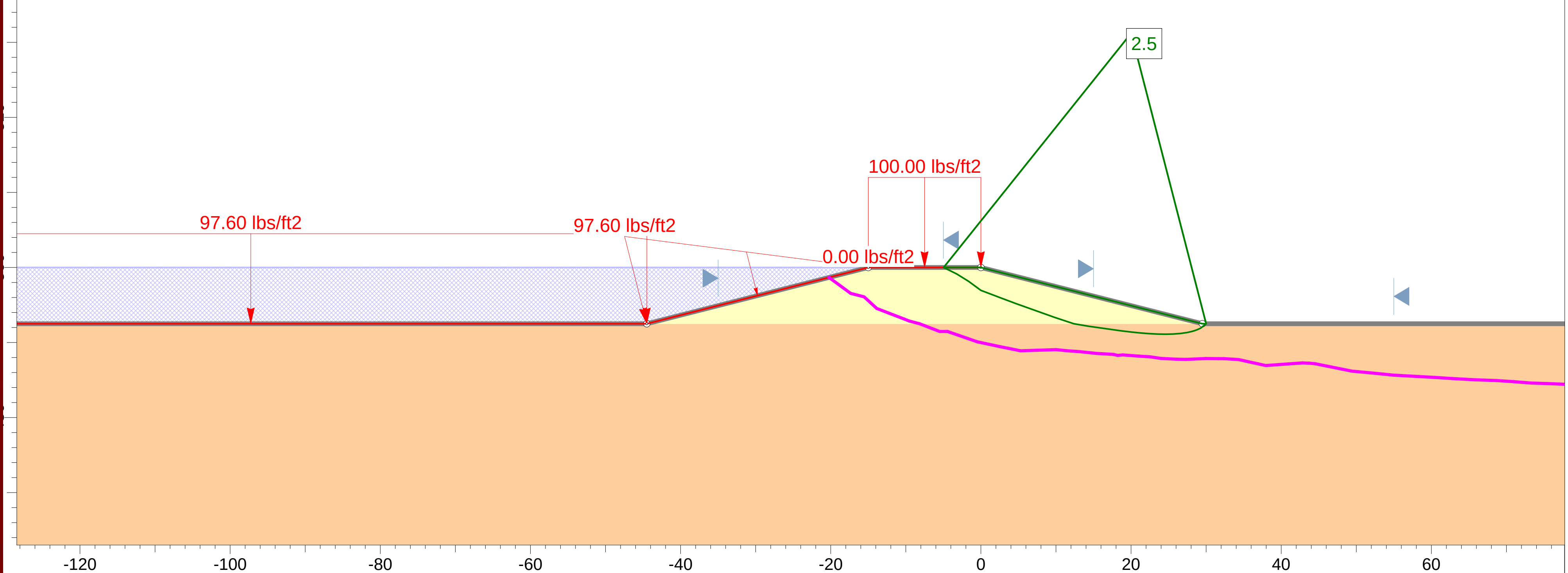
Figure C-25b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "K" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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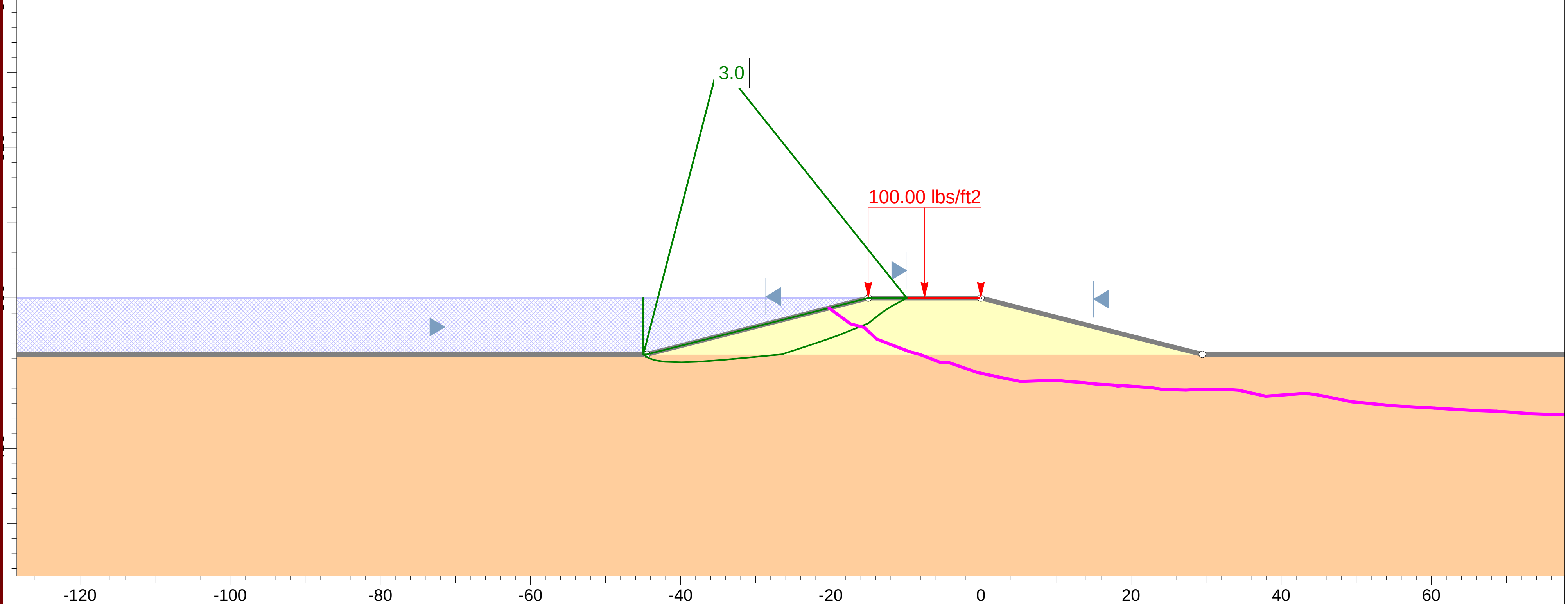
Figure C-26a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "K" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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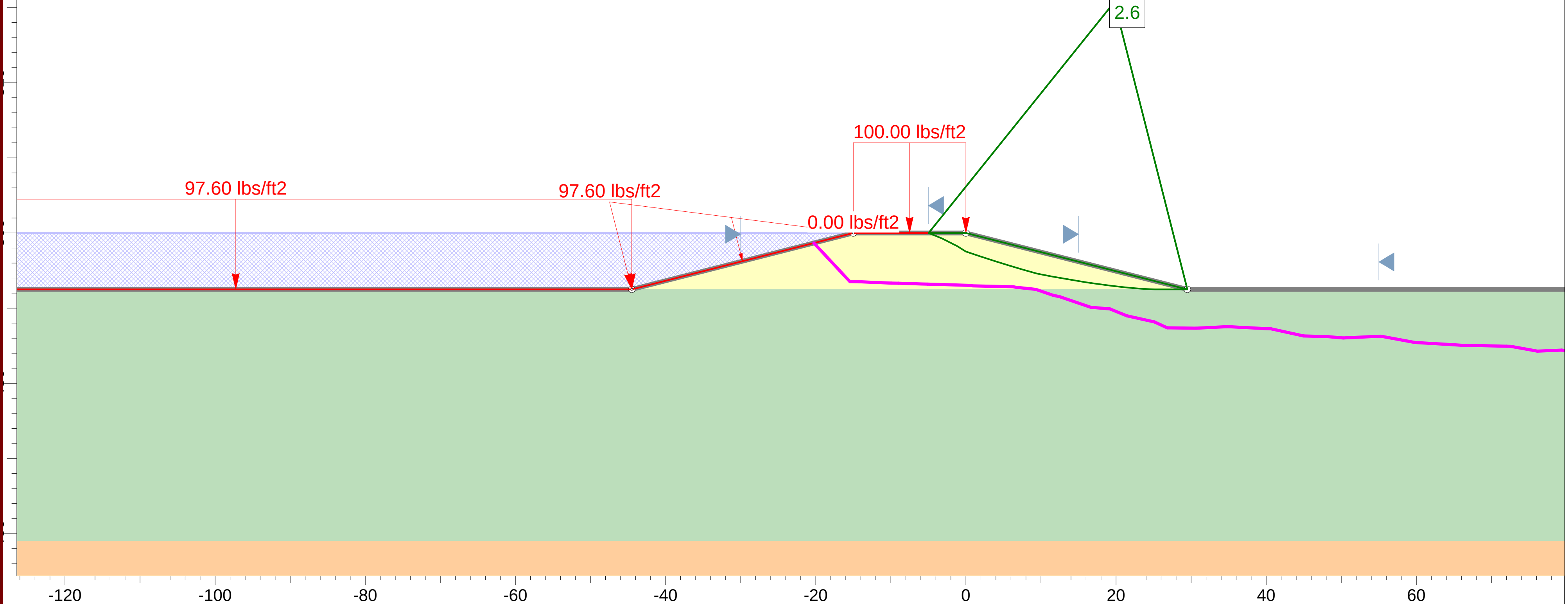
Figure C-26b

US EPA ARCHIVE DOCUMENT

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "L" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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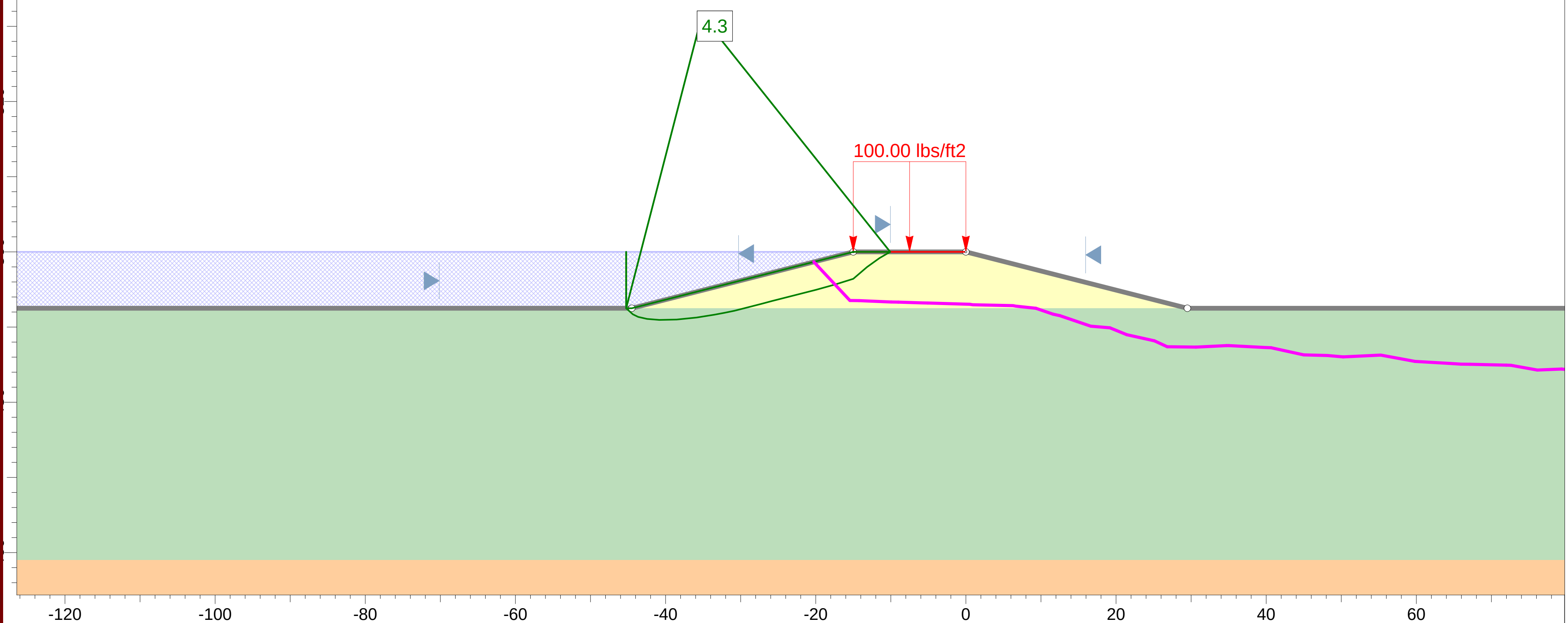
Figure C-27a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "L" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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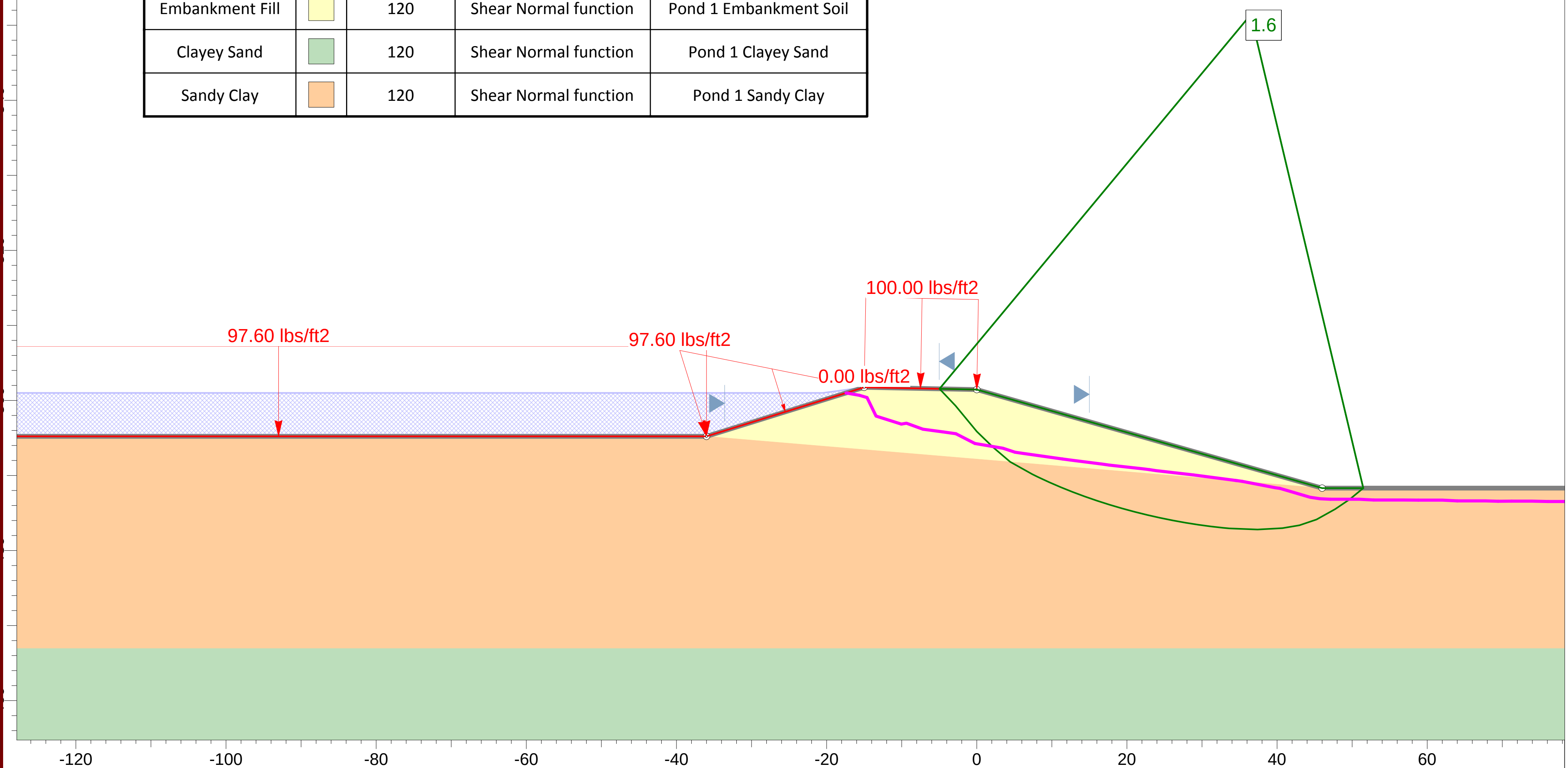
Figure C-27b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "M" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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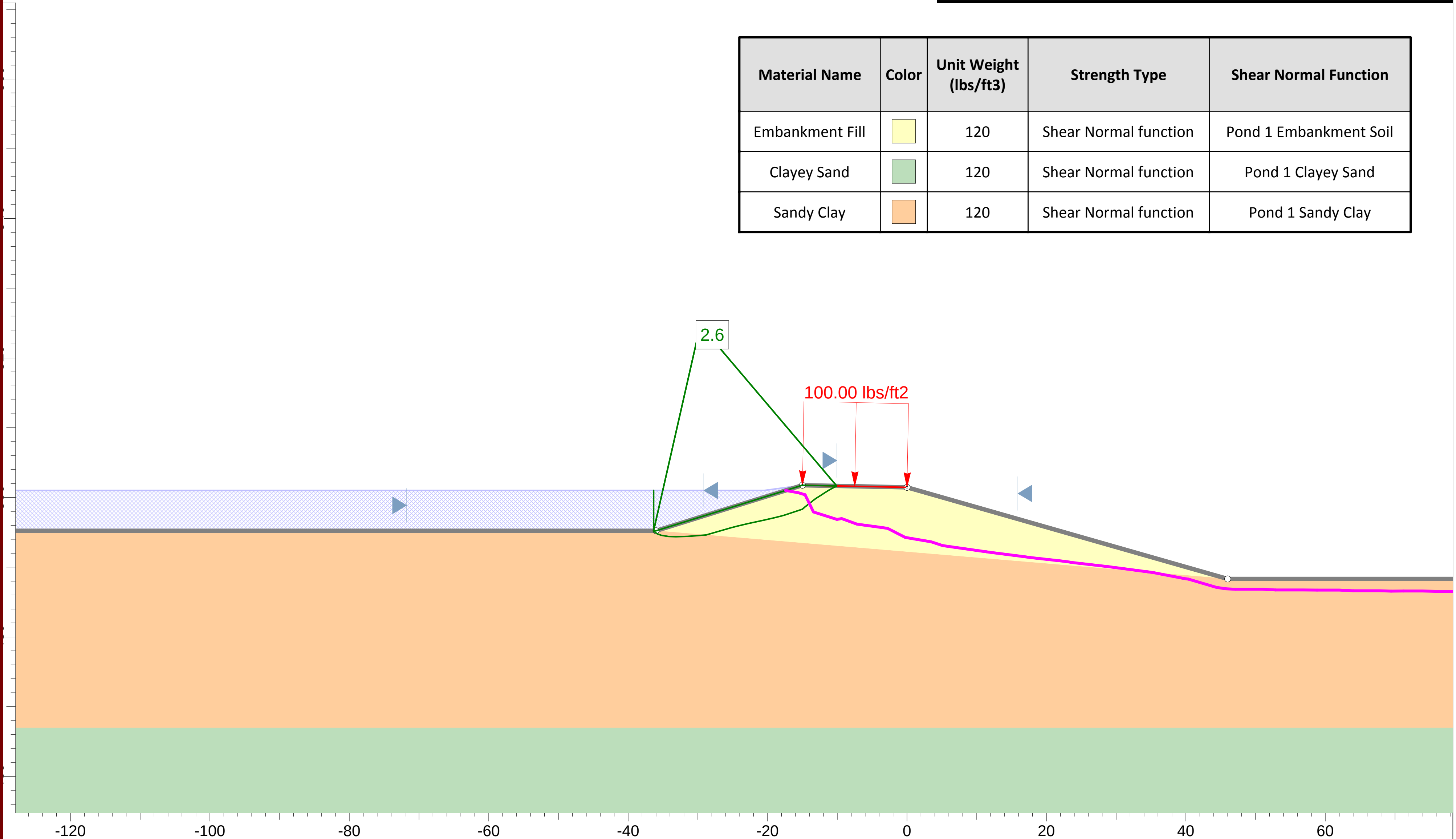
Figure C-28a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 1 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 1 Clayey Sand
Sandy Clay		120	Shear Normal function	Pond 1 Sandy Clay



Profile "M" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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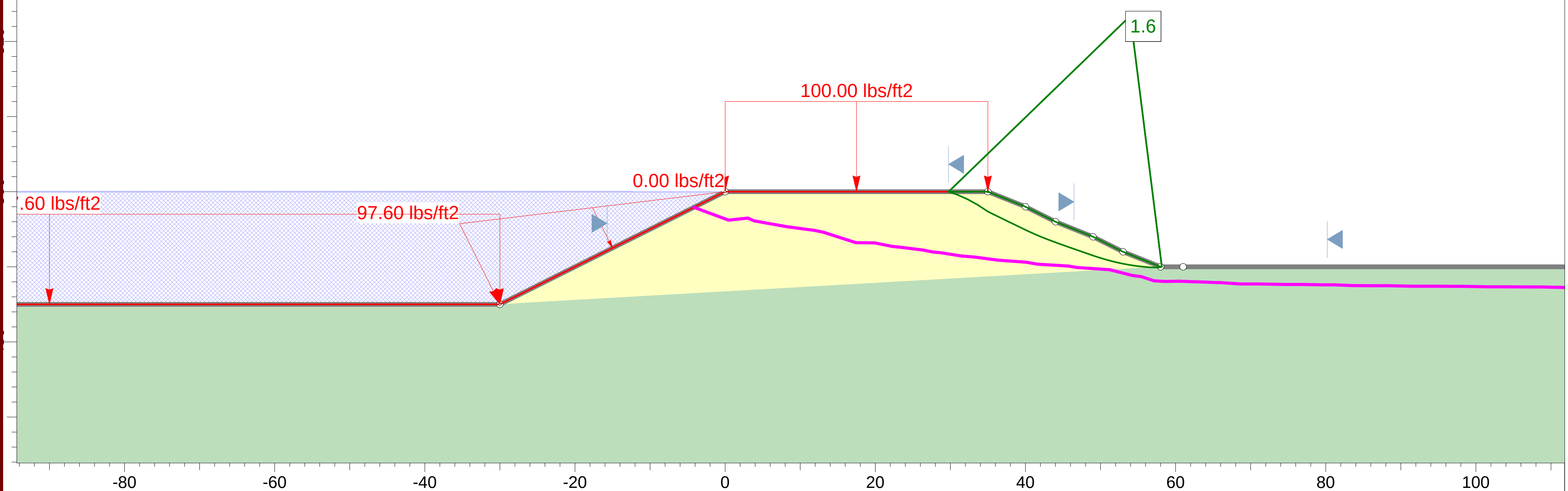
Figure C-28b

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand



Profile "N" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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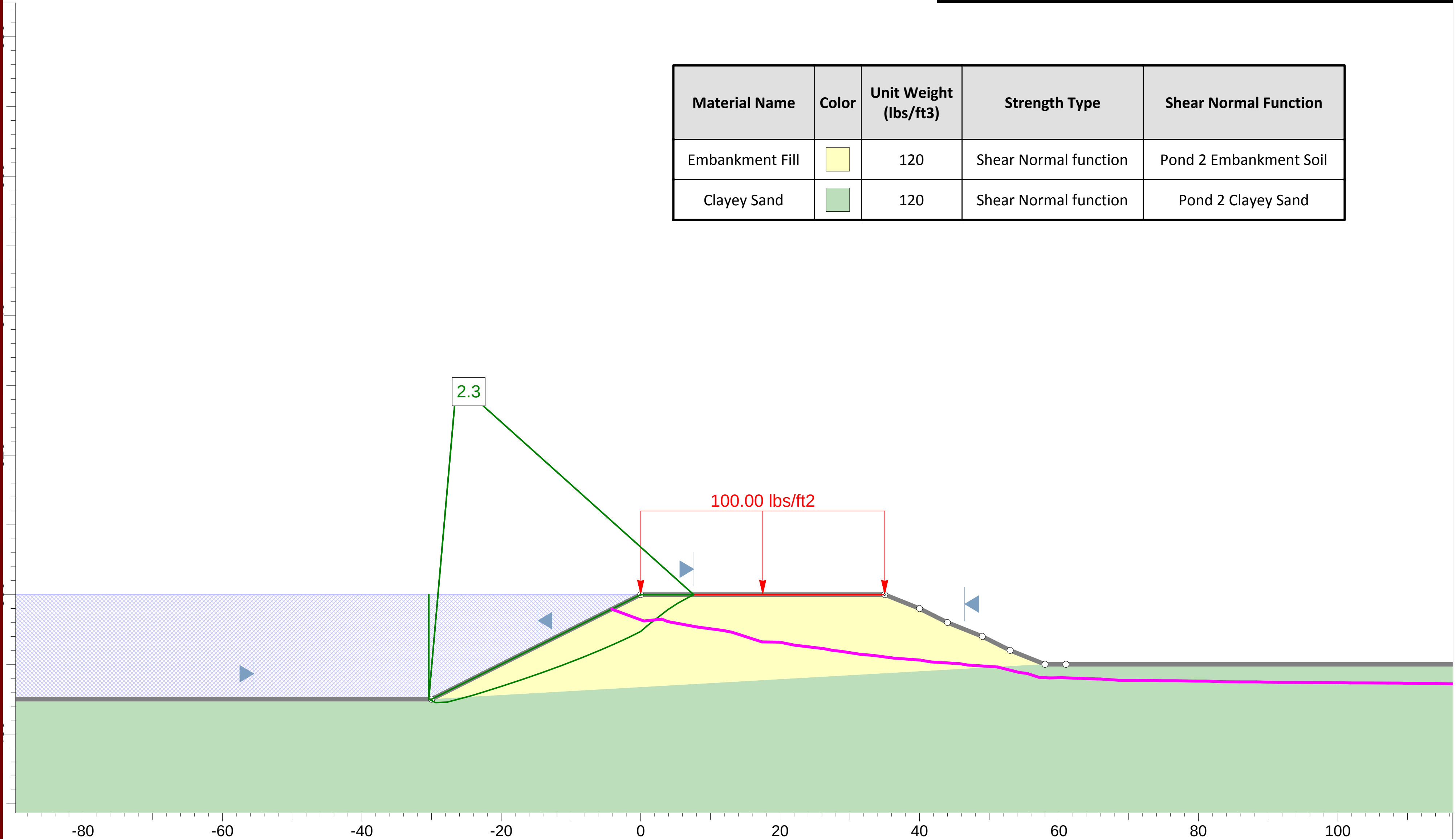
Figure C-29a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Shear Normal Function
Embankment Fill		120	Shear Normal function	Pond 2 Embankment Soil
Clayey Sand		120	Shear Normal function	Pond 2 Clayey Sand



Profile "N" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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Figure C-29b

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APPENDIX D

SEISMIC ANALYSES

USGS Design Maps Summary Report

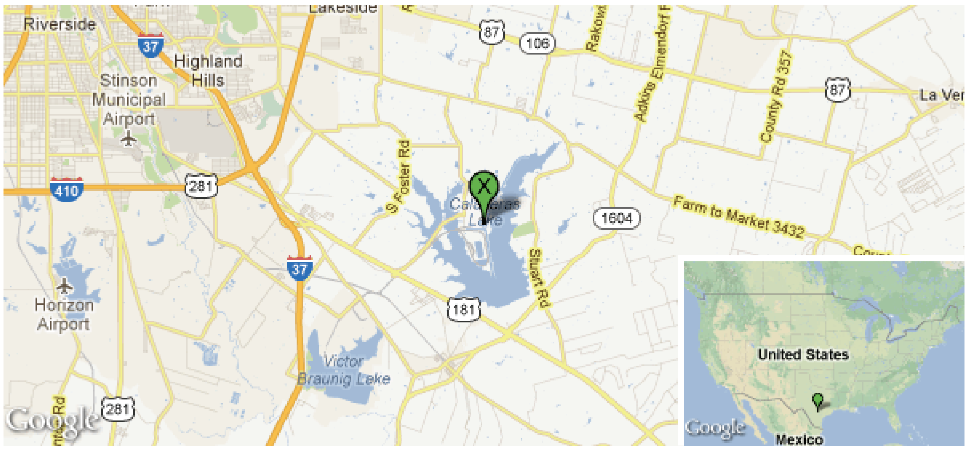
User–Specified Input

Building Code Reference Document 2009 NEHRP Recommended Seismic Provisions
(which makes use of 2008 USGS hazard data)

Site Coordinates 29.30821°N, 98.3168°W

Site Soil Classification Site Class D – "Stiff Soil"

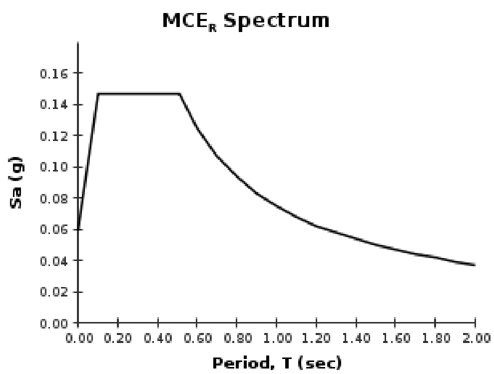
Risk Category I/II/III

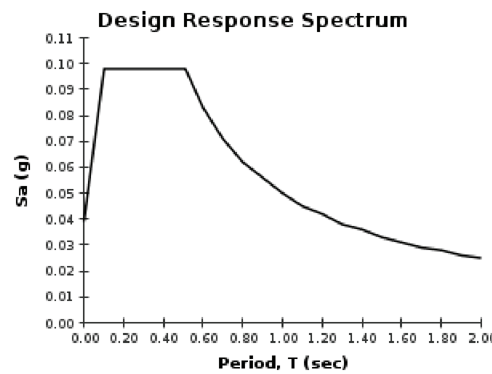


USGS–Provided Output

S_S =	0.092 g	S_{MS} =	0.147 g	S_{DS} =	0.098 g
S_1 =	0.031 g	S_{M1} =	0.075 g	S_{D1} =	0.050 g

For information on how the S_S and S_1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please view the detailed report.



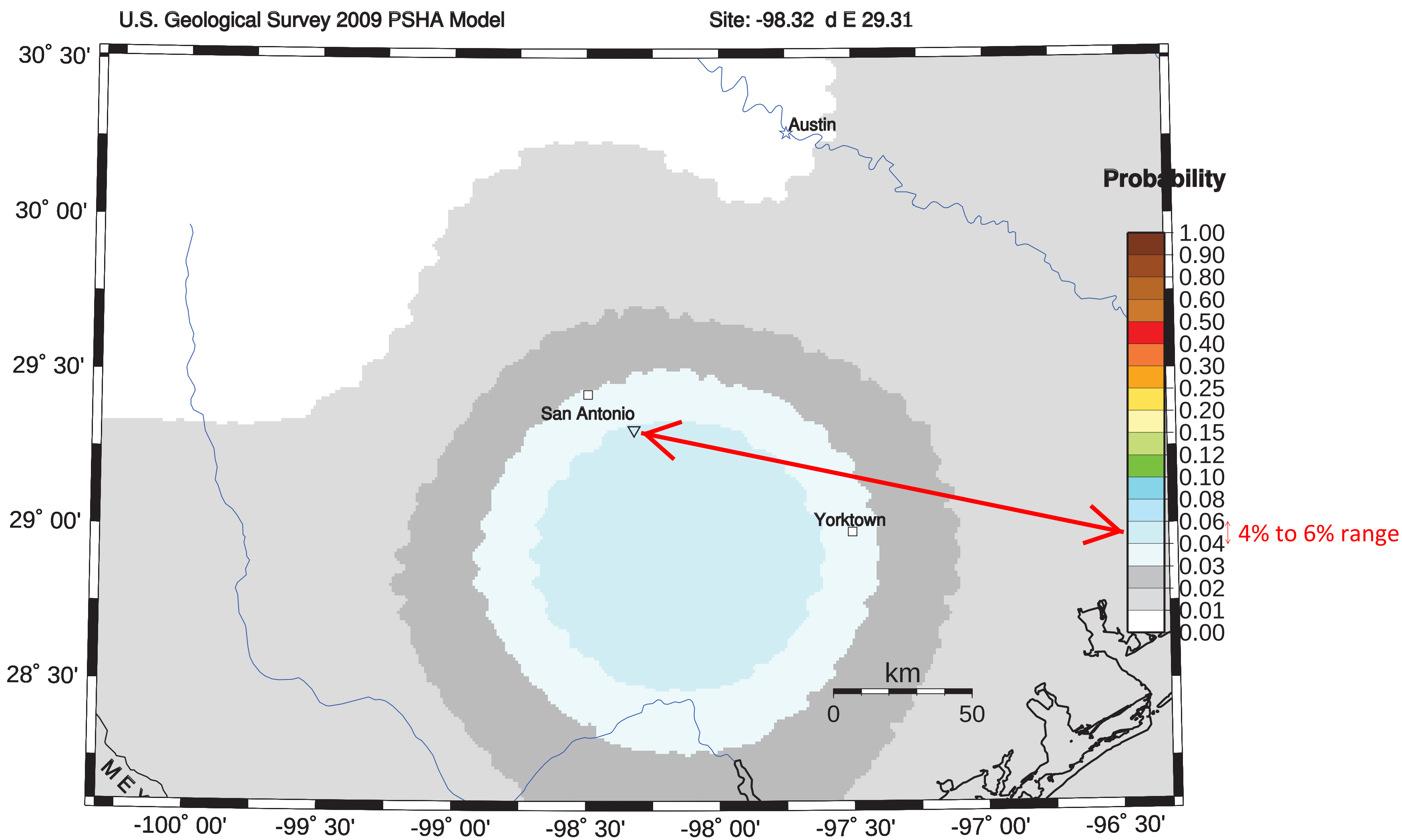


For PGA_M, T_L, C_{RS}, and C_{R1} values, please view the detailed report.

Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

ASA12-098-00
Figure D-1

Probability of earthquake with M > 5.0 within 250 years & 50 km



GMT 2012 Nov 19 15:18:38 Earthquake probabilities from USGS OFR 08-1128 PSHA. 50 km maximum horizontal distance. Site of interest: triangle. Epicenters mb>5 black circles; rivers blue.

Design Maps Detailed Report

2009 NEHRP Recommended Seismic Provisions (29.30821°N, 98.3168°W)

Section 11.4.1 — Mapped Acceleration Parameters and Risk Coefficients

Note: Ground motion values contoured on Figures 22-1, 2, 5, & 6 below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_{SUH} and S_{SD}) and 1.3 (to obtain S_{1UH} and S_{1D}). Maps in the 2009 NEHRP Provisions are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

Figure 22–1: Uniform–Hazard (2% in 50–Year) Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

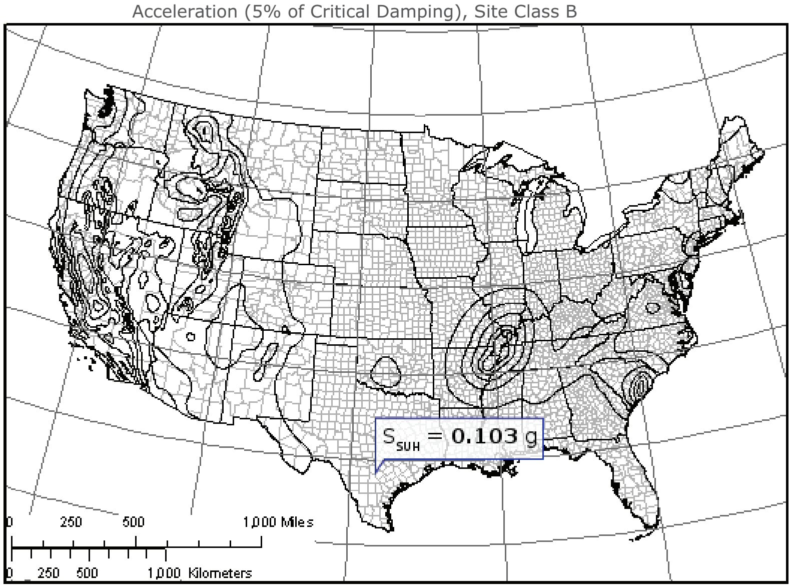


Figure 22–2: Uniform–Hazard (2% in 50–Year) Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

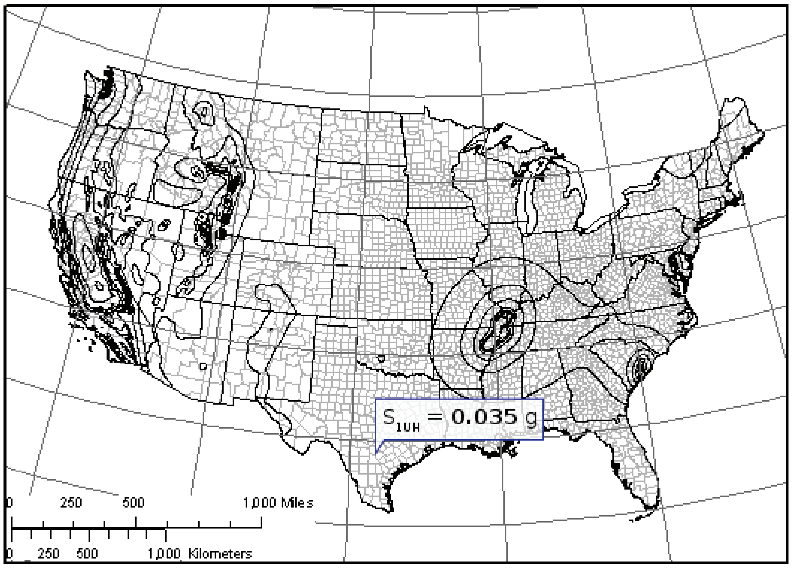

S_{1UH} = 0.035 g
0 250 500 1,000 Miles
0 250 500 1,000 Kilometers

Figure 22–3: Risk Coefficient at 0.2-Second Spectral Response Period

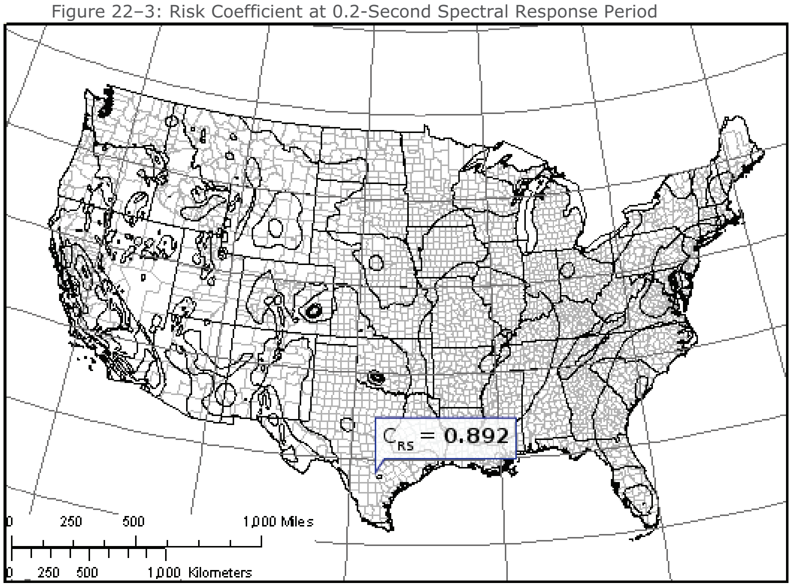


Figure 22–4: Risk Coefficient at 1.0-Second Spectral Response Period

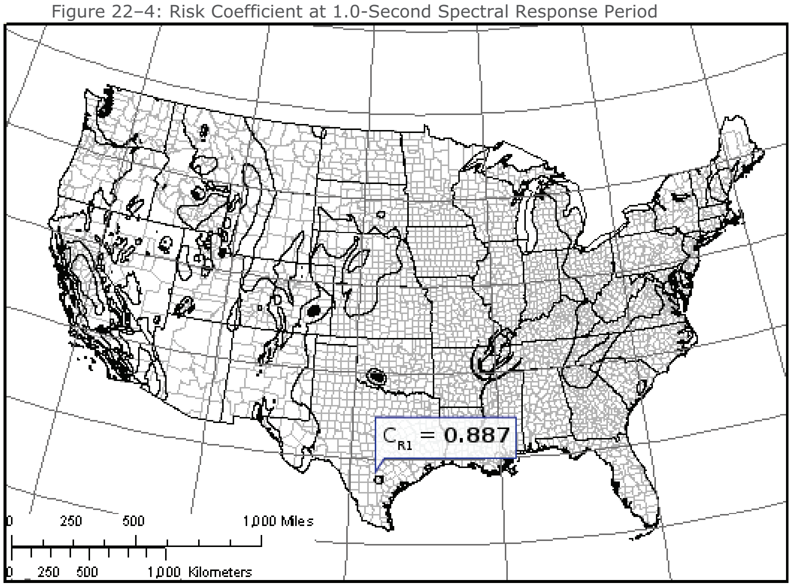


Figure 22–5: Deterministic Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

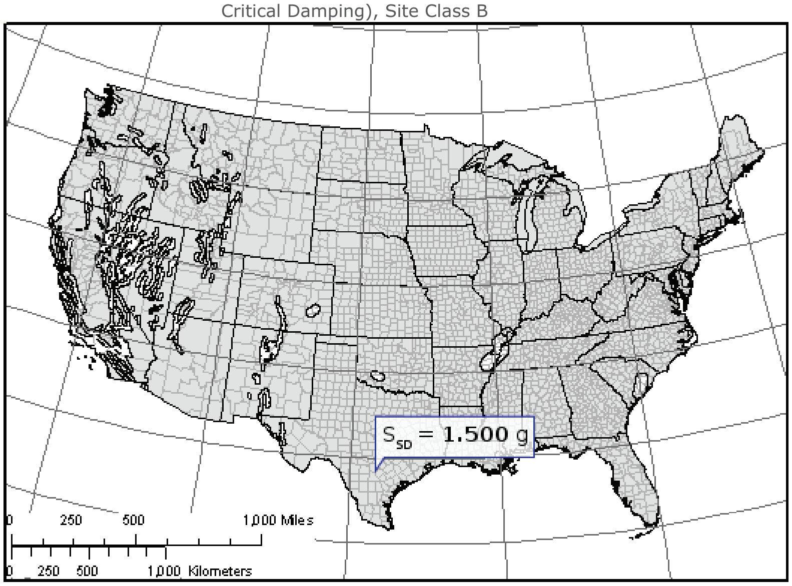
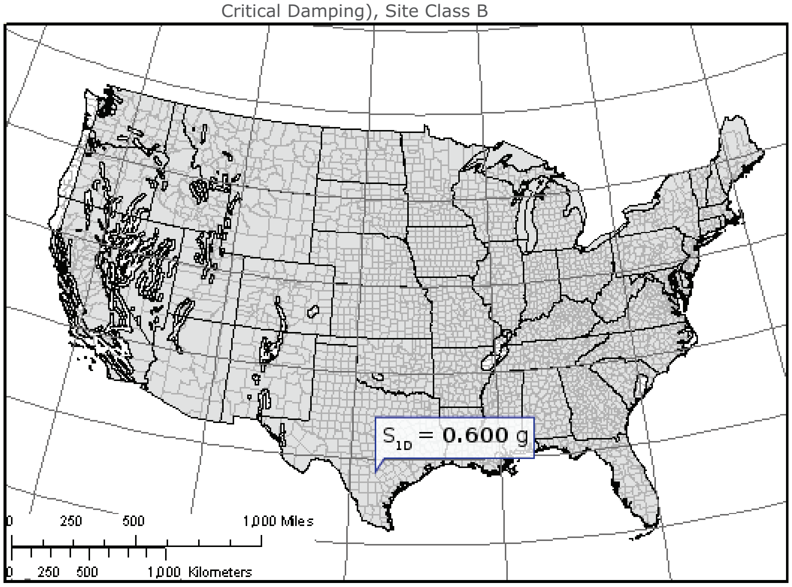


Figure 22–6: Deterministic Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B



Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content *w* ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 11.4.3 — Site Coefficients, Risk Coefficients, and Risk–Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Equation (11.4–1): $C_{RS}S_{SUH}$ = 0.892 x 0.103 = 0.092 g

Equation (11.4–2): S_{SD} = 1.500 g

S_S ≡ "Lesser of values from Equations (11.4–1) and (11.4–2)" = 0.092 g

Equation (11.4–3): $C_{R1}S_{1UH}$ = 0.887 x 0.035 = 0.031 g

Equation (11.4–4): S_{1D} = 0.600 g

S_1 ≡ "Lesser of values from Equations (11.4–3) and (11.4–4)" = 0.031 g

Table 11.4–1: Site Coefficient F_a

Site Class	Spectral Response Acceleration Parameter at Short Period				
	$S_S \le 0.25$	$S_S = 0.5$	$S_S = 0.75$	$S_S = 1$	$S_S \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 0.092 g, F_a = 1.600

Table 11.4–2: Site Coefficient F_v

Site Class	Spectral Response Acceleration Parameter at 1–Second Period				
	$S_1 \le 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \ge 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.031 g, F_v = 2.400

Equation (11.4–5):	$S_{MS} = F_aS_S = 1.600 \times 0.092 = 0.147$ g
Equation (11.4–6):	$S_{M1} = F_vS_1 = 2.400 \times 0.031 = 0.075$ g

Section 11.4.4 — Design Spectral Acceleration Parameters

Equation (11.4–7):	$S_{DS} = ⅔ S_{MS} = ⅔ \times 0.147 = 0.098$ g
Equation (11.4–8):	$S_{D1} = ⅔ S_{M1} = ⅔ \times 0.075 = 0.050$ g

Section 11.4.5 — Design Response Spectrum

Figure 22–7: Long–period Transition Period, T_L (s)

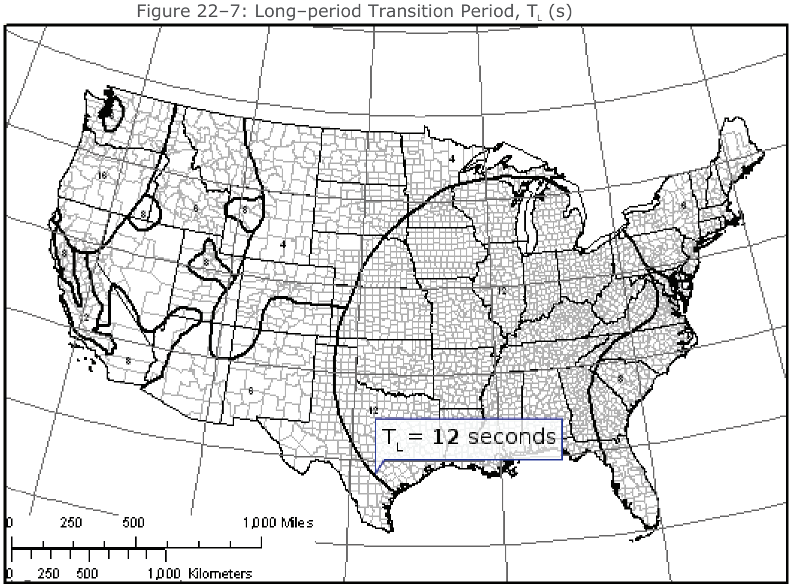
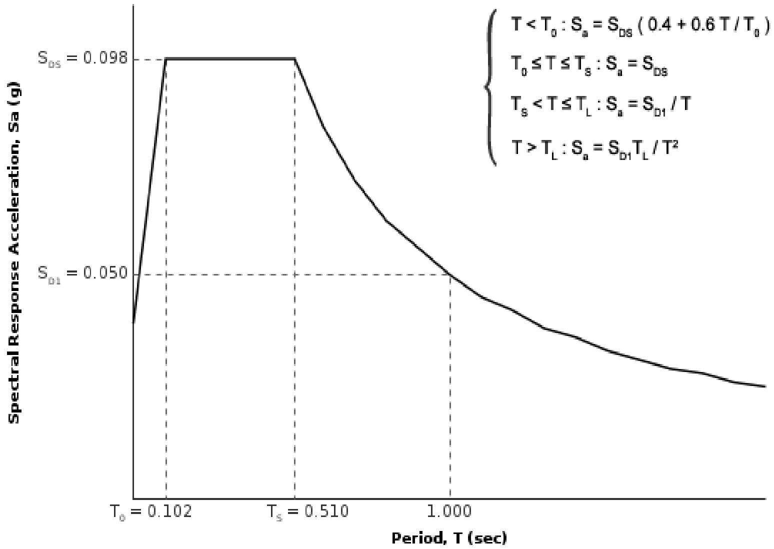


Figure 11.4–1: Design Response Spectrum



Section 11.4.6 — MCE_R Response Spectrum

The MCE_R response spectrum is determined by multiplying the design response spectrum above by 1.5.

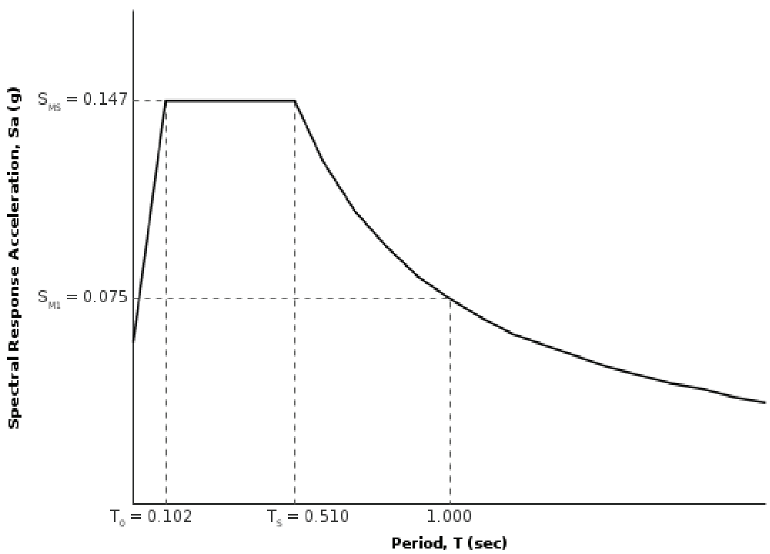


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Figure D-10

Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

Table 11.8–1: Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.1	PGA = 0.2	PGA = 0.3	PGA = 0.4	PGA ≥ 0.5
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.047 g, F_{PGA} = 1.600

Mapped PGA PGA = 0.047 g

Equation (11.8–1): $PGA_M = F_{PGA}PGA = 1.600 \times 0.047 = 0.075$ g

STRUCTURAL COMPONENTS AND SYSTEMS

For the Seismic Retrofit of Tilt-Up Buildings

Seismic Intensity Scales vs Peak Ground Acceleration

Modified Mercalli Scale and PGA	
MMI	**PGA (g)**
IV	0.03 and below
V	0.03 - 0.08
VI	0.08 - 0.15
VII	0.15 - 0.25
VIII	0.25 - 0.45
IX	0.45 - 0.60
X	0.60 - 0.80
XI	0.80 - 0.90
XII	0.90 and above

The above table shows the approximate relationship between Modified Mercalli Intensity and Peak Ground Acceleration (PGA).

Richter Magnitude, PGA, and Duration		
Richter Magnitude	**PGA (g)**	**Duration (seconds)**
5.0	0.09	2
5.5	0.15	6
6.0	0.22	12

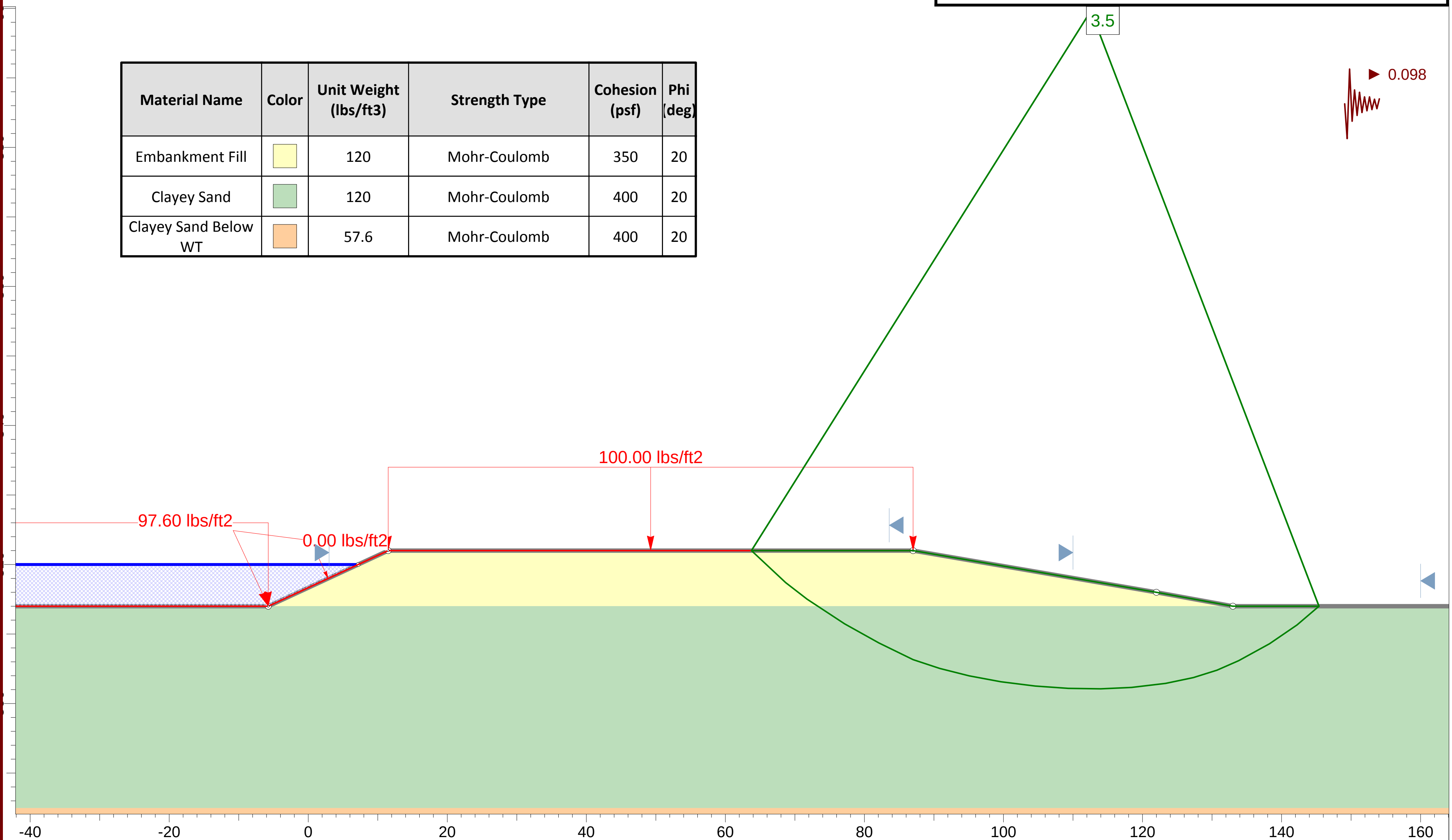
6.5	0.29	18
7.0	0.37	24
7.5	0.45	30
8.0	0.50	34
8.5	0.50	37

The above table shows the approximate relationship between Richter Magnitude, Peak Ground Acceleration (PGA), and duration of strong-phase shaking near the epicenter of earthquakes located in California.

< Prev Next >

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "A" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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Figure D-14a

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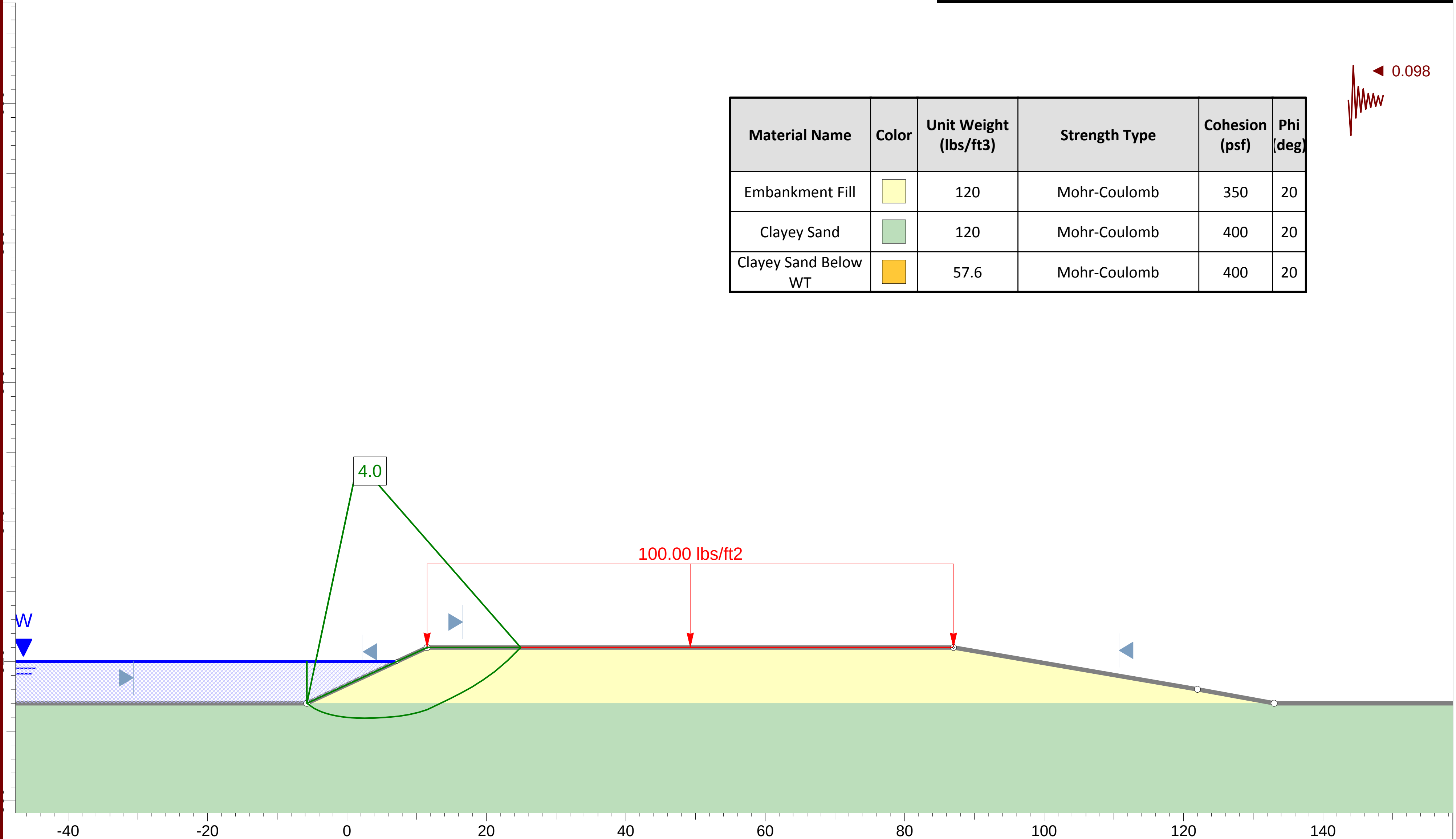
Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "A" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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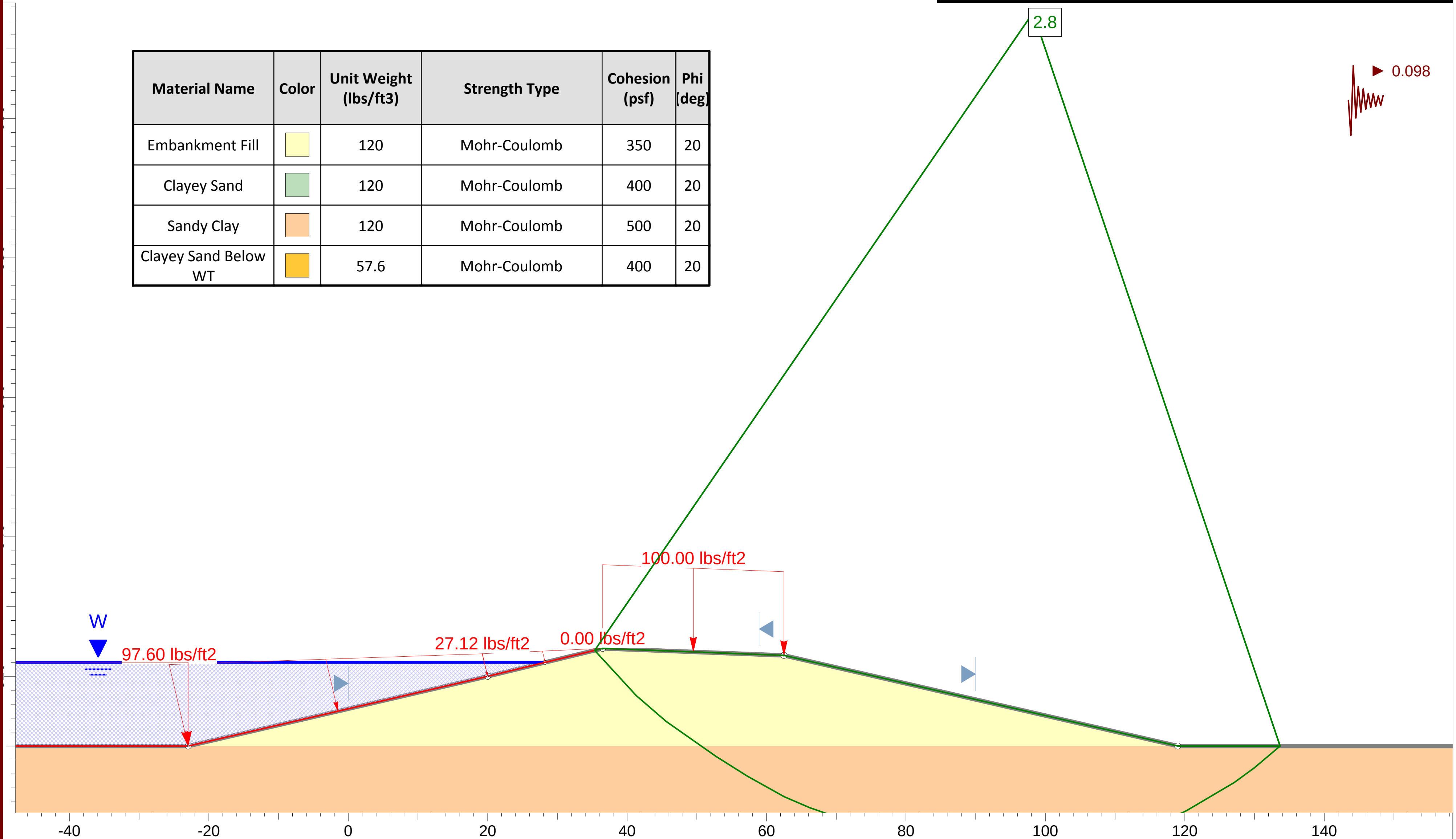
Figure D-14b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "B" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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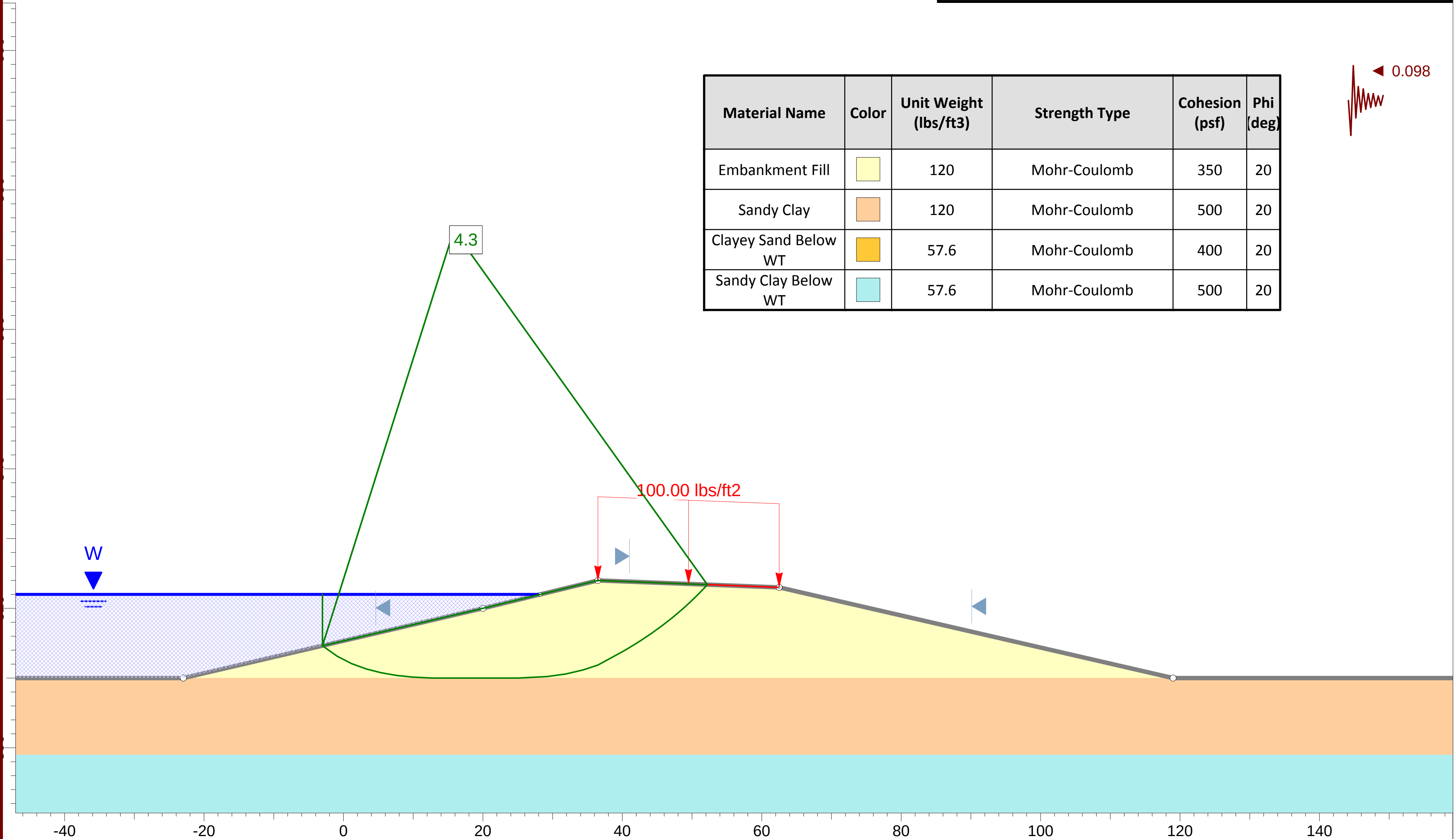
Figure D-15a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "B" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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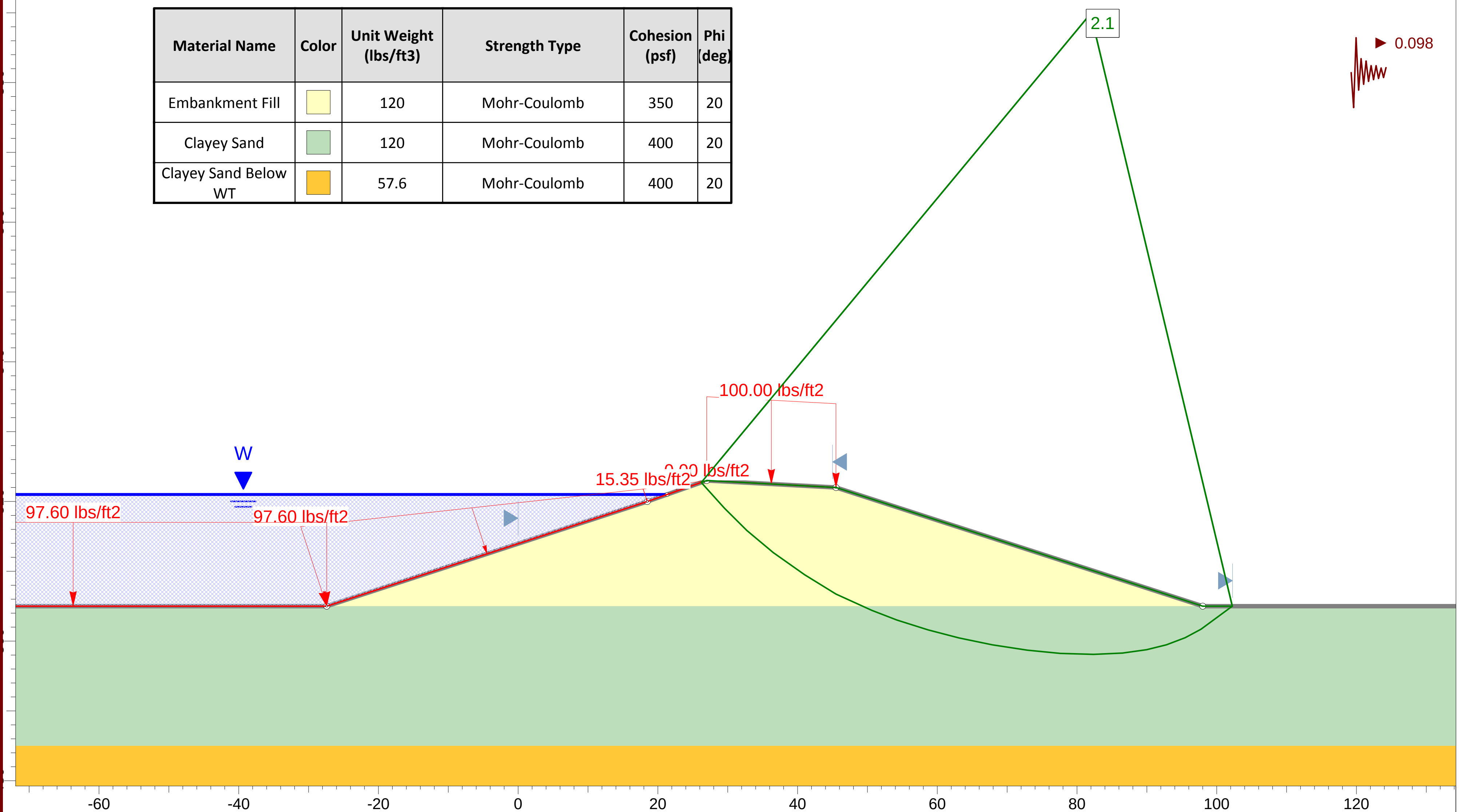
Figure D-15b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "C" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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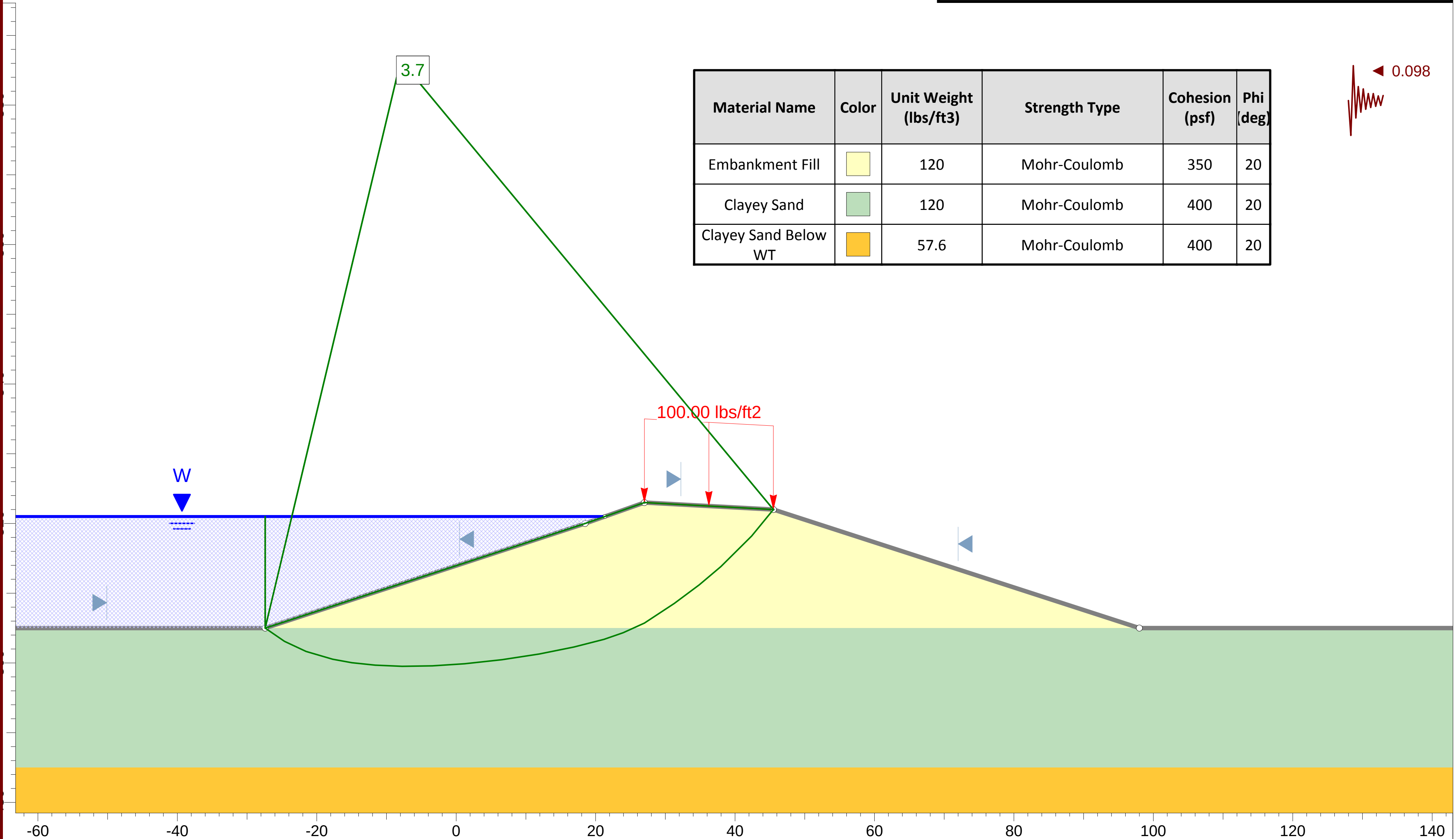
Figure D-16a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "C" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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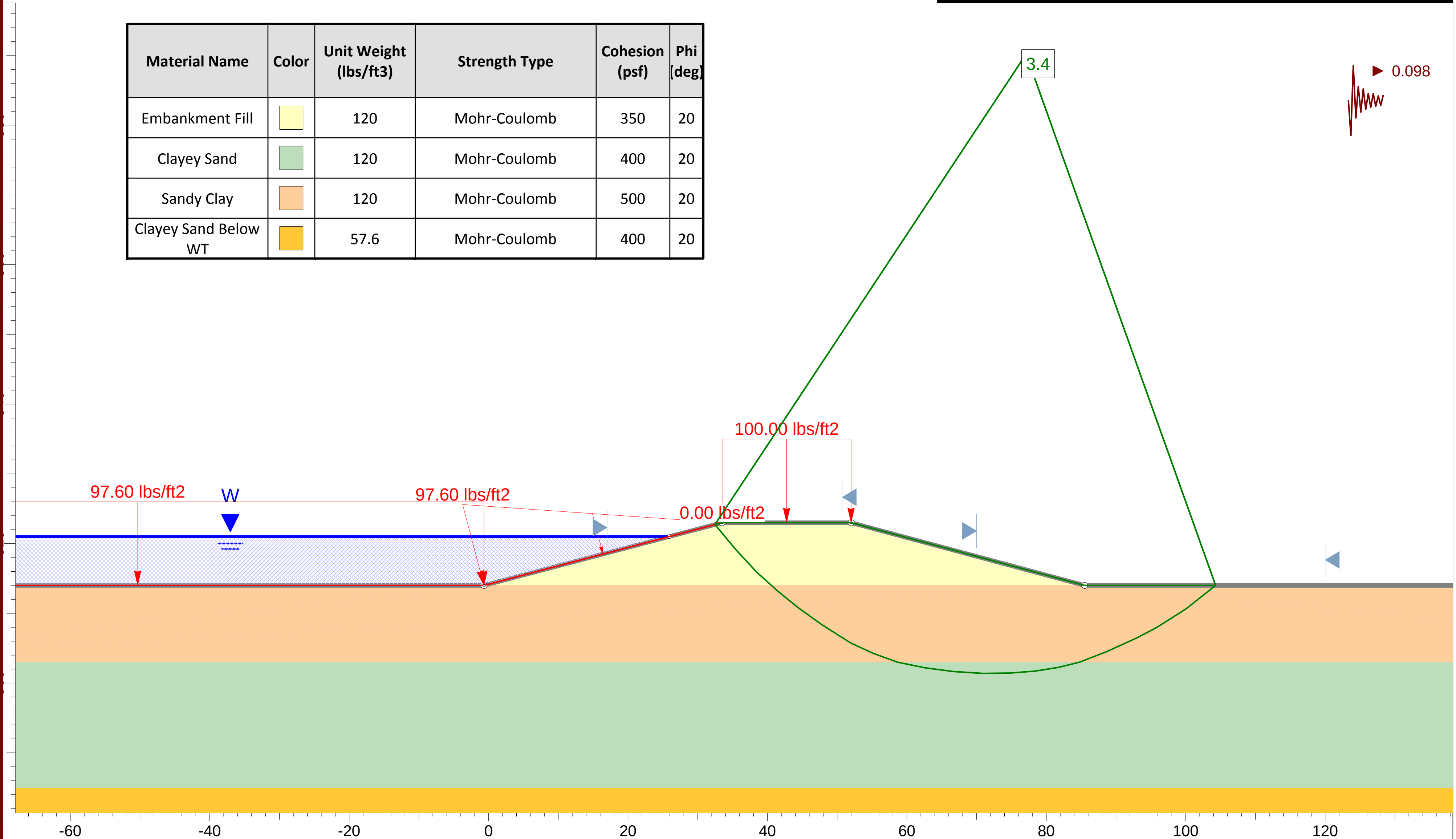
Figure D-16b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "D" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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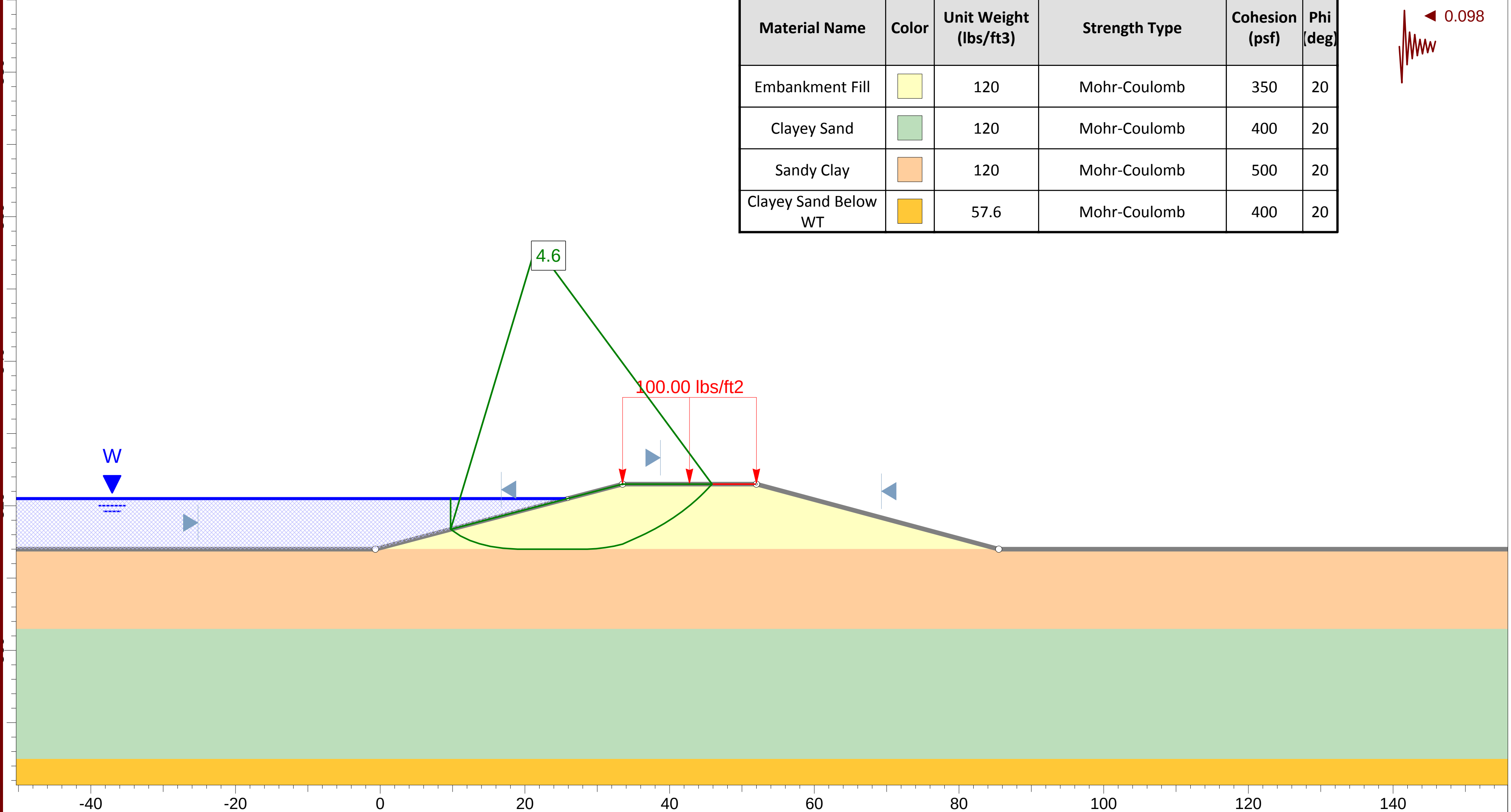
Figure D-17a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "D" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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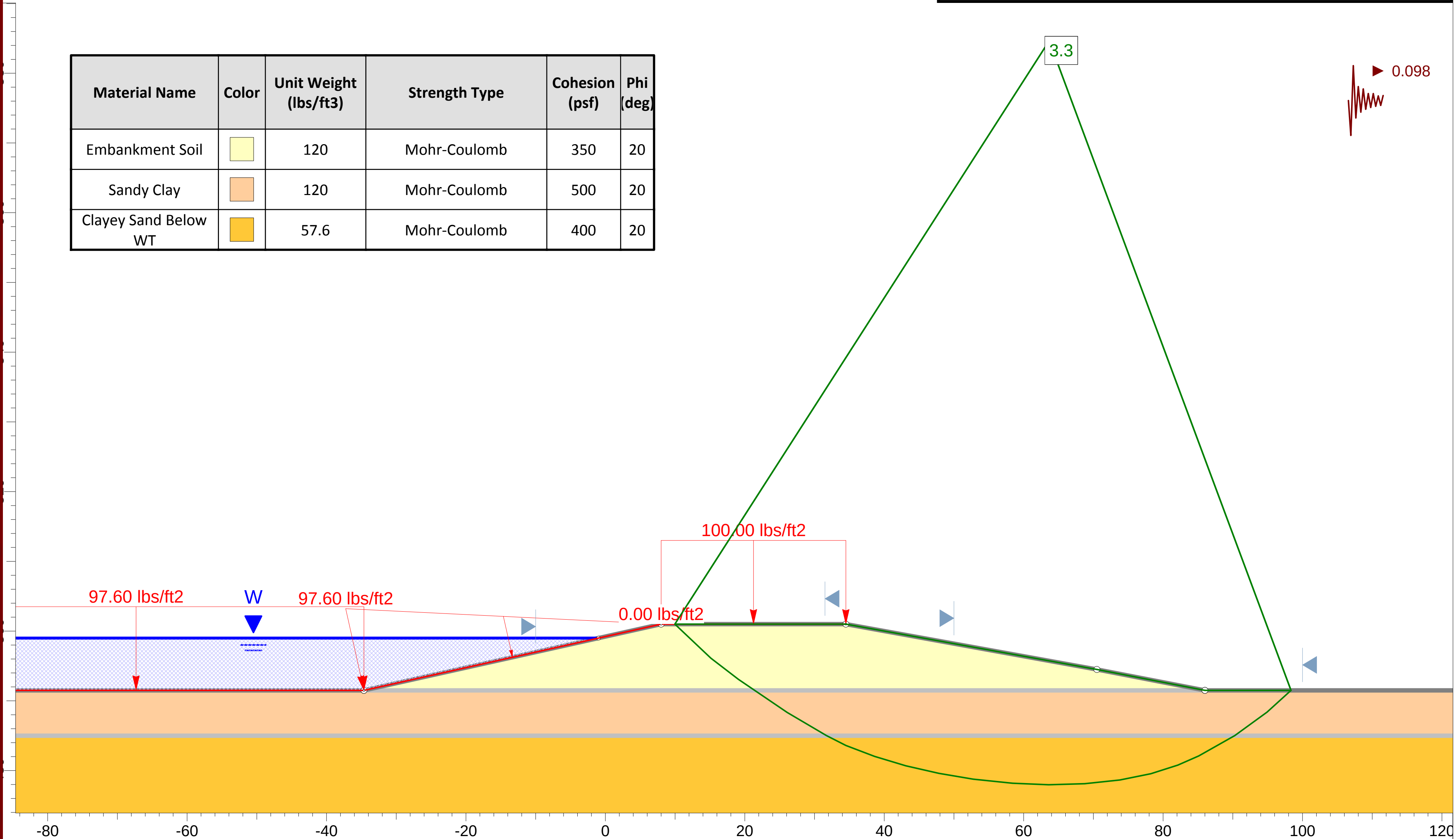
Figure D-17b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Soil		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "E" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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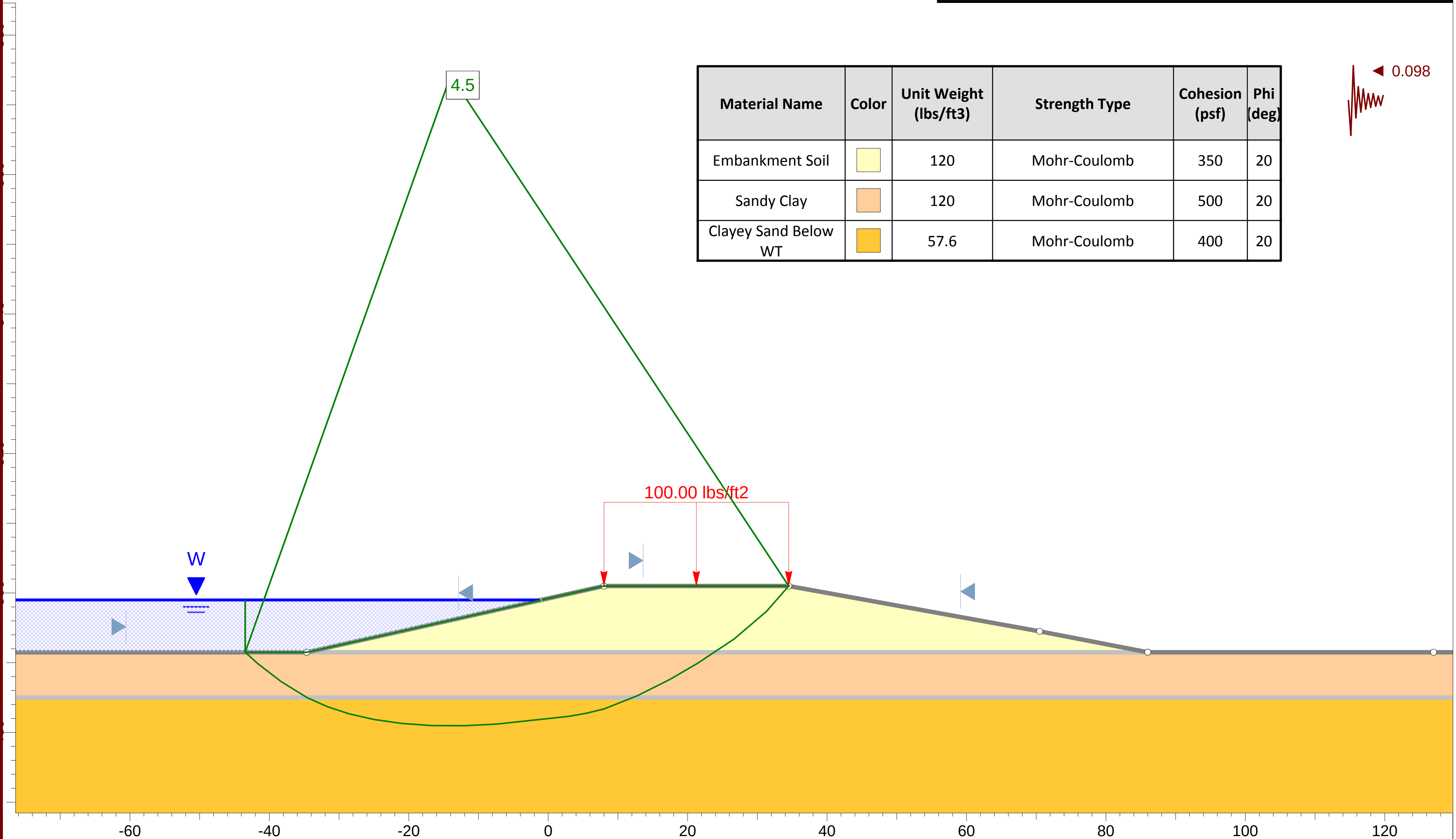
Figure D-18a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Soil		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "E" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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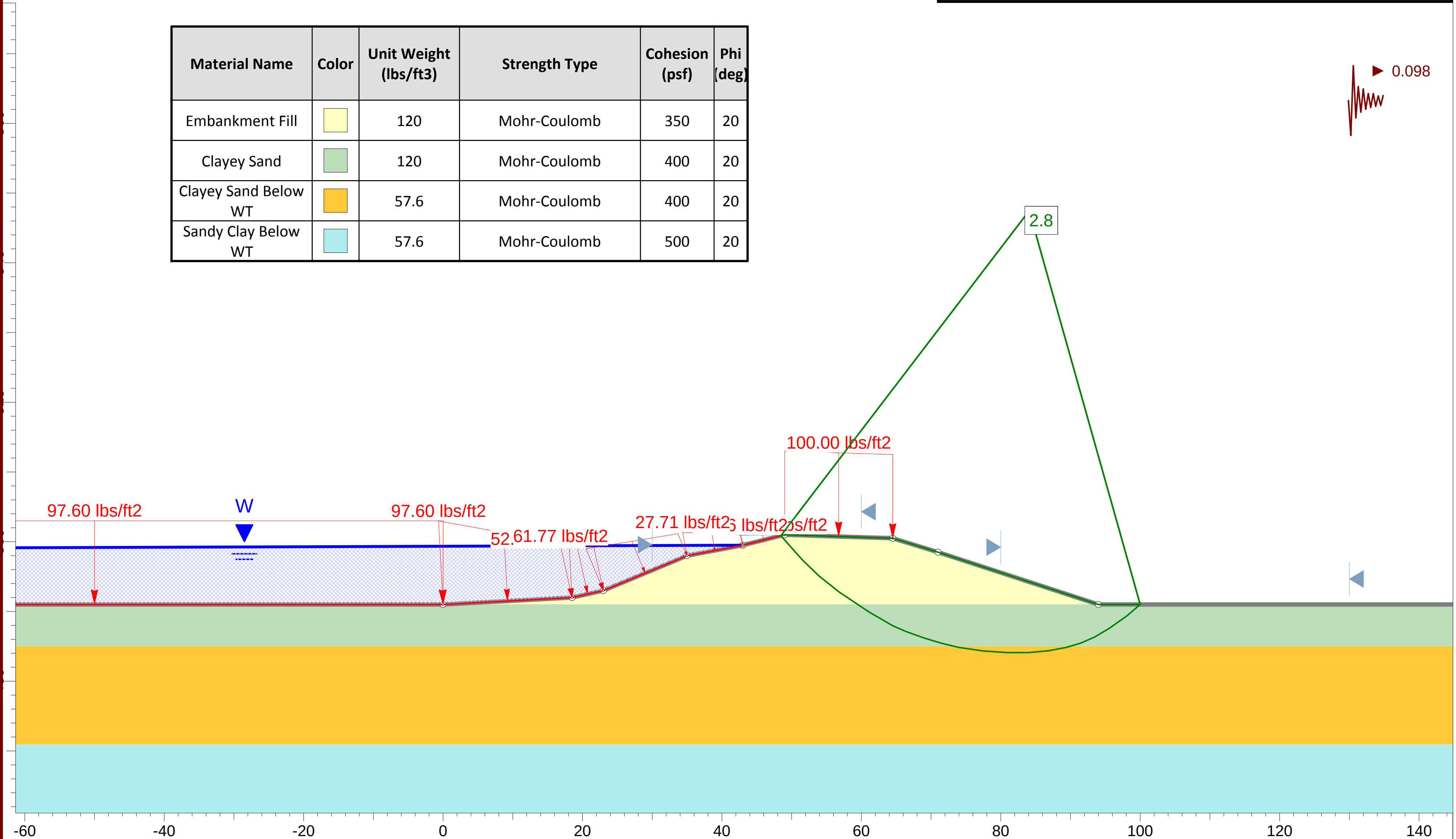
Figure D-18b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "F" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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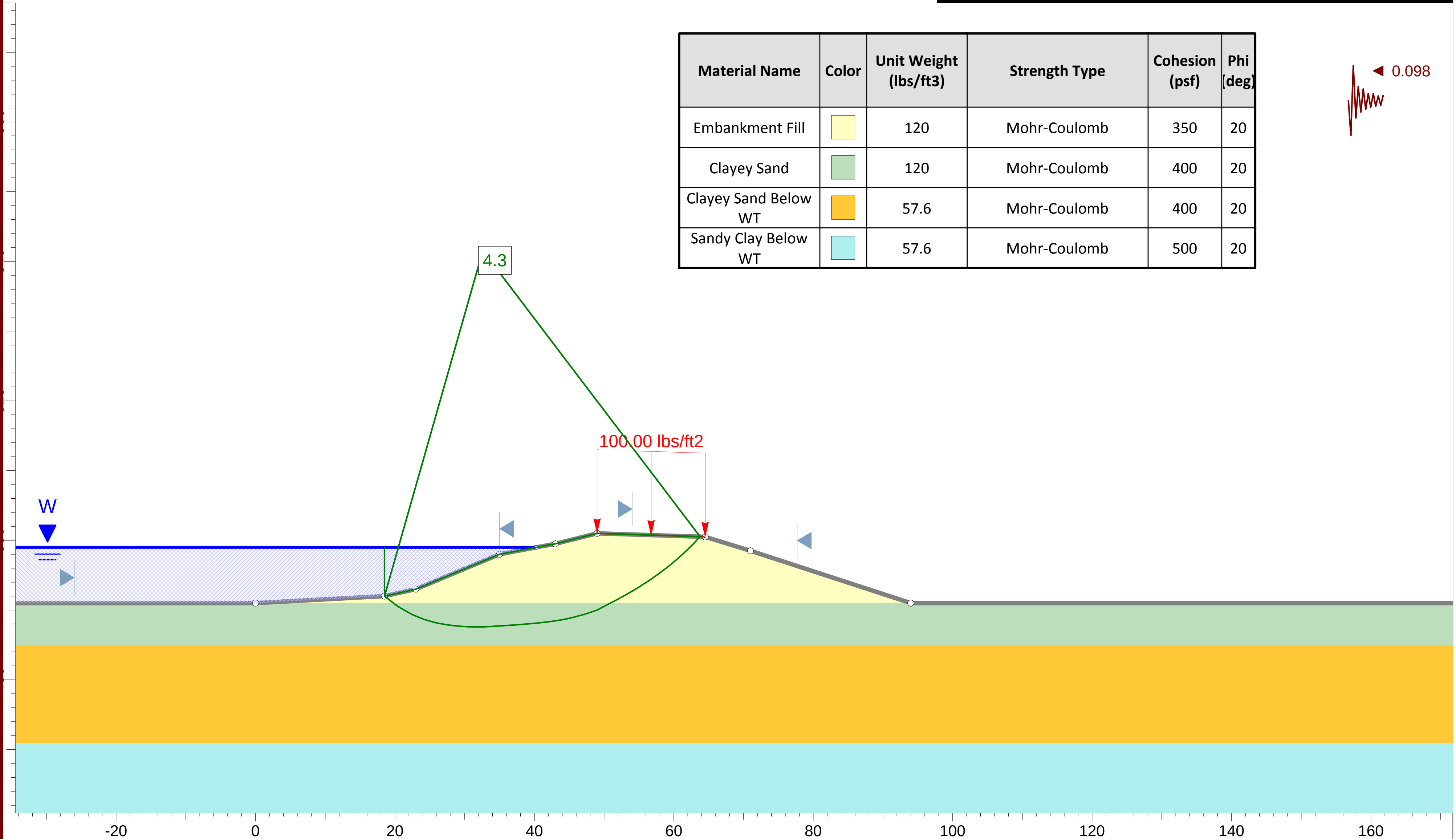
Figure D-19a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "F" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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Figure D-19b

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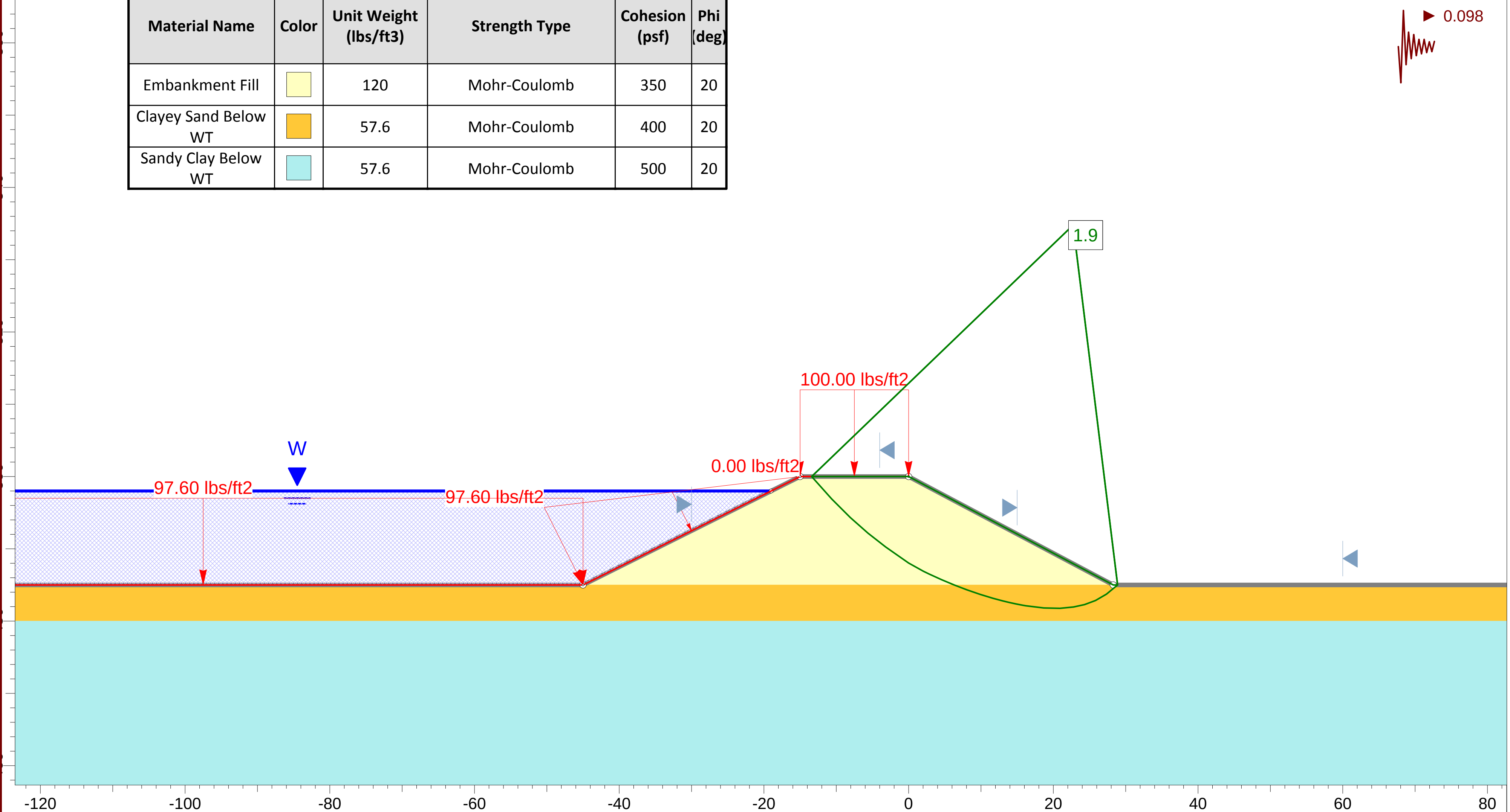
Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "G" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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Figure D-20a

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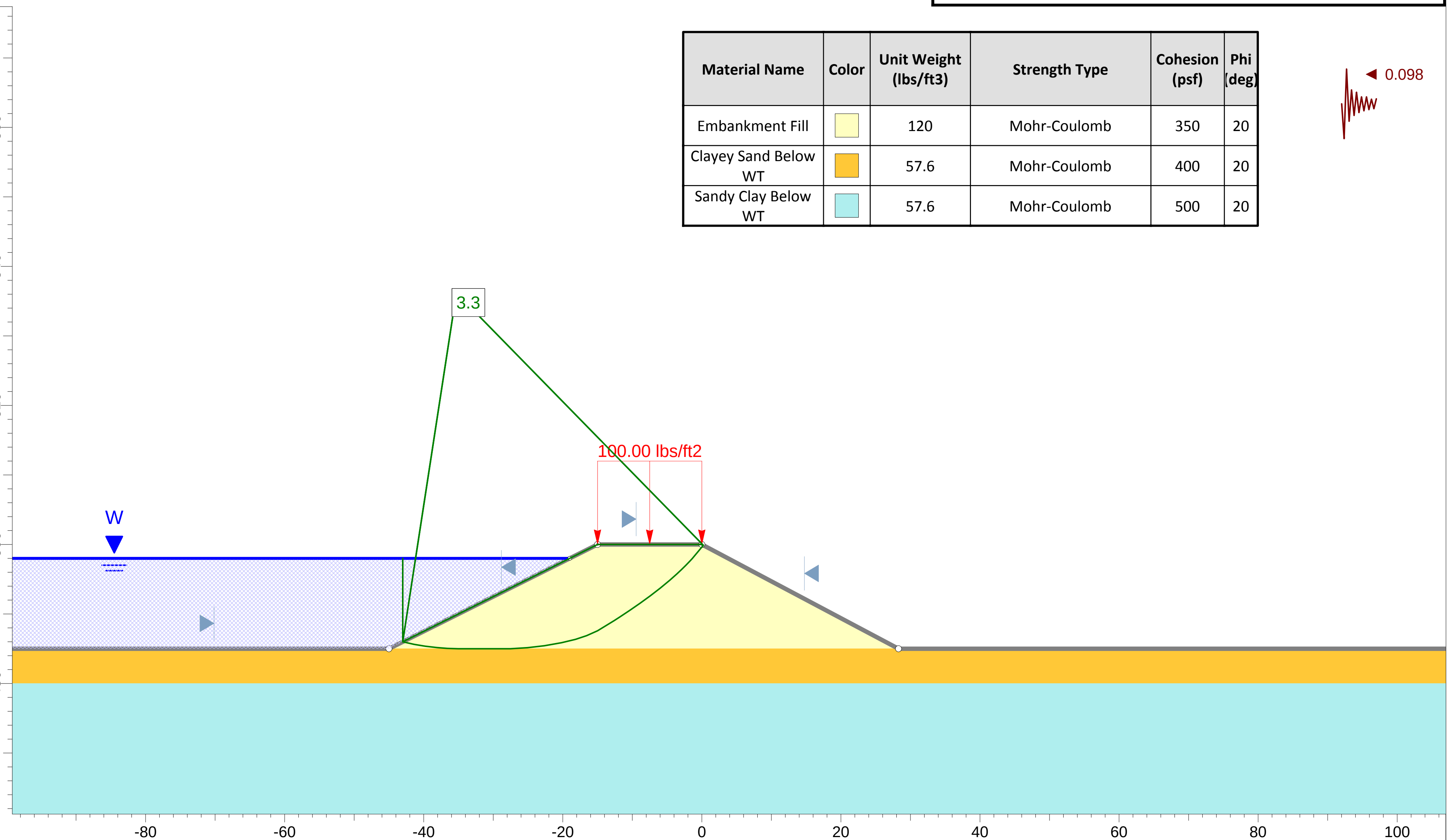
Global Stability Analysis

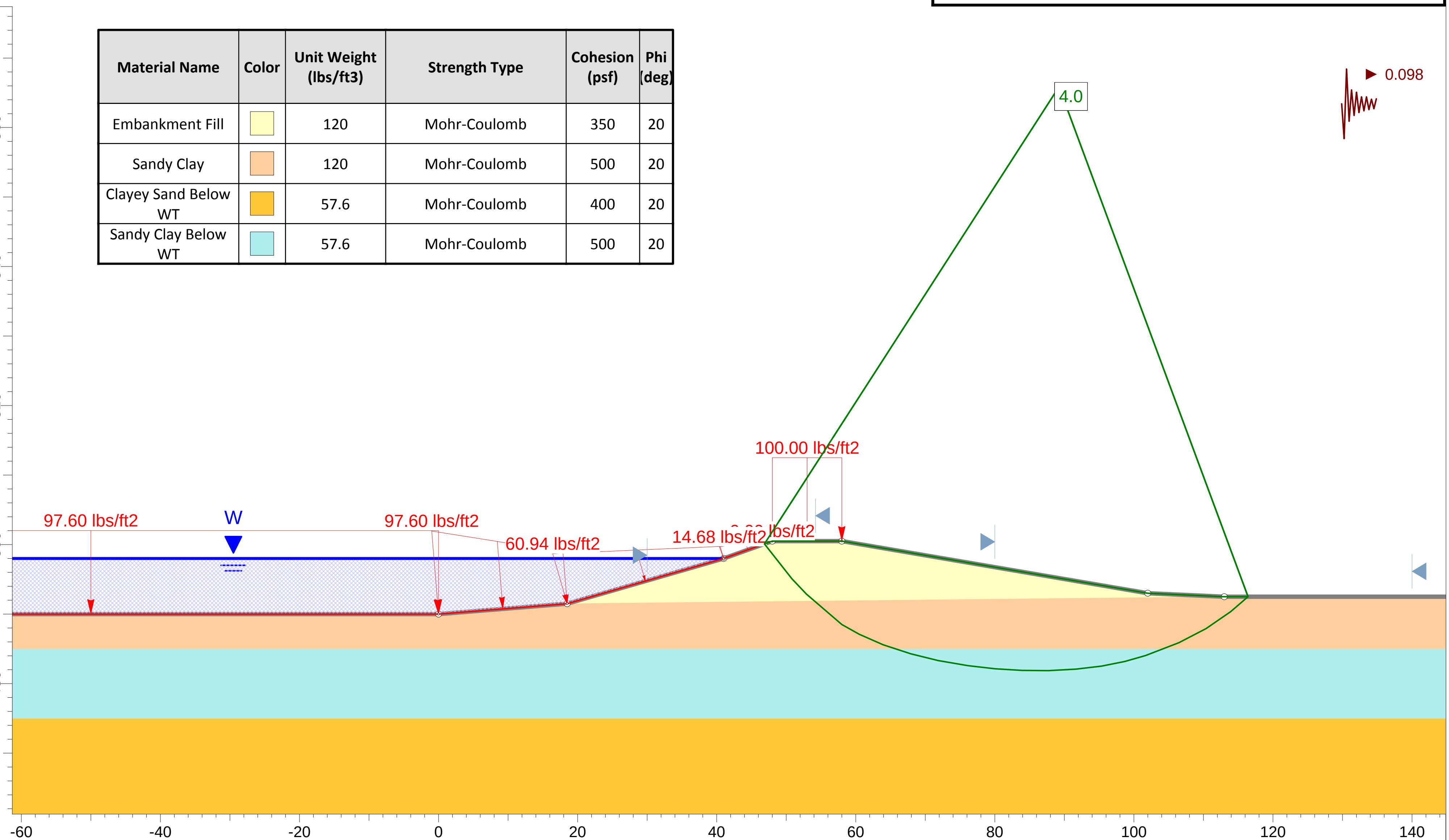
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "G" - Steady State Ash Pond Berms - Spruce/Deely Generation Units	Raba Kistner Consultants, Inc. ASA12-098-00	Figure D-20b RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "H" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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Figure D-21a

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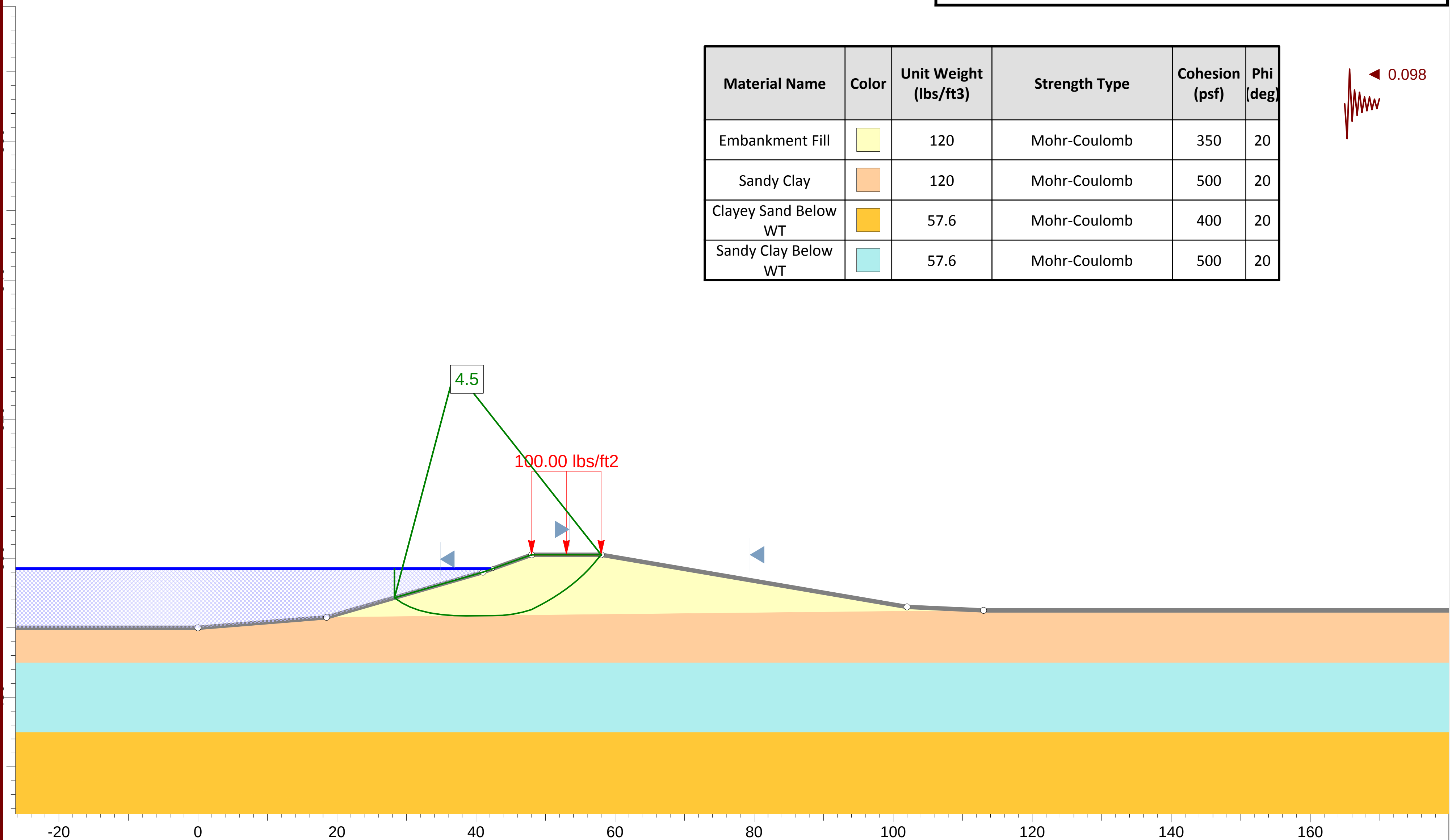
Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "H" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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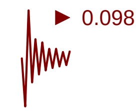
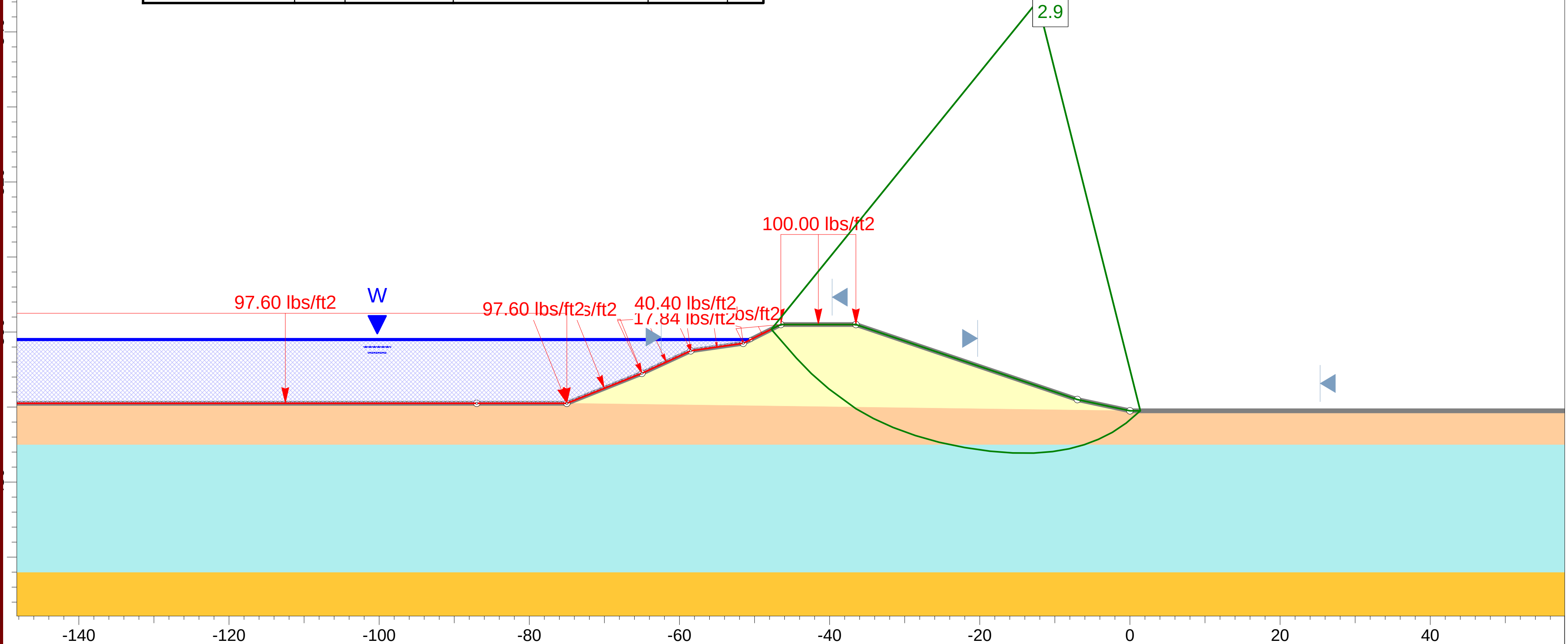
Figure D-21b

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20





Profile "I" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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Figure D-22a

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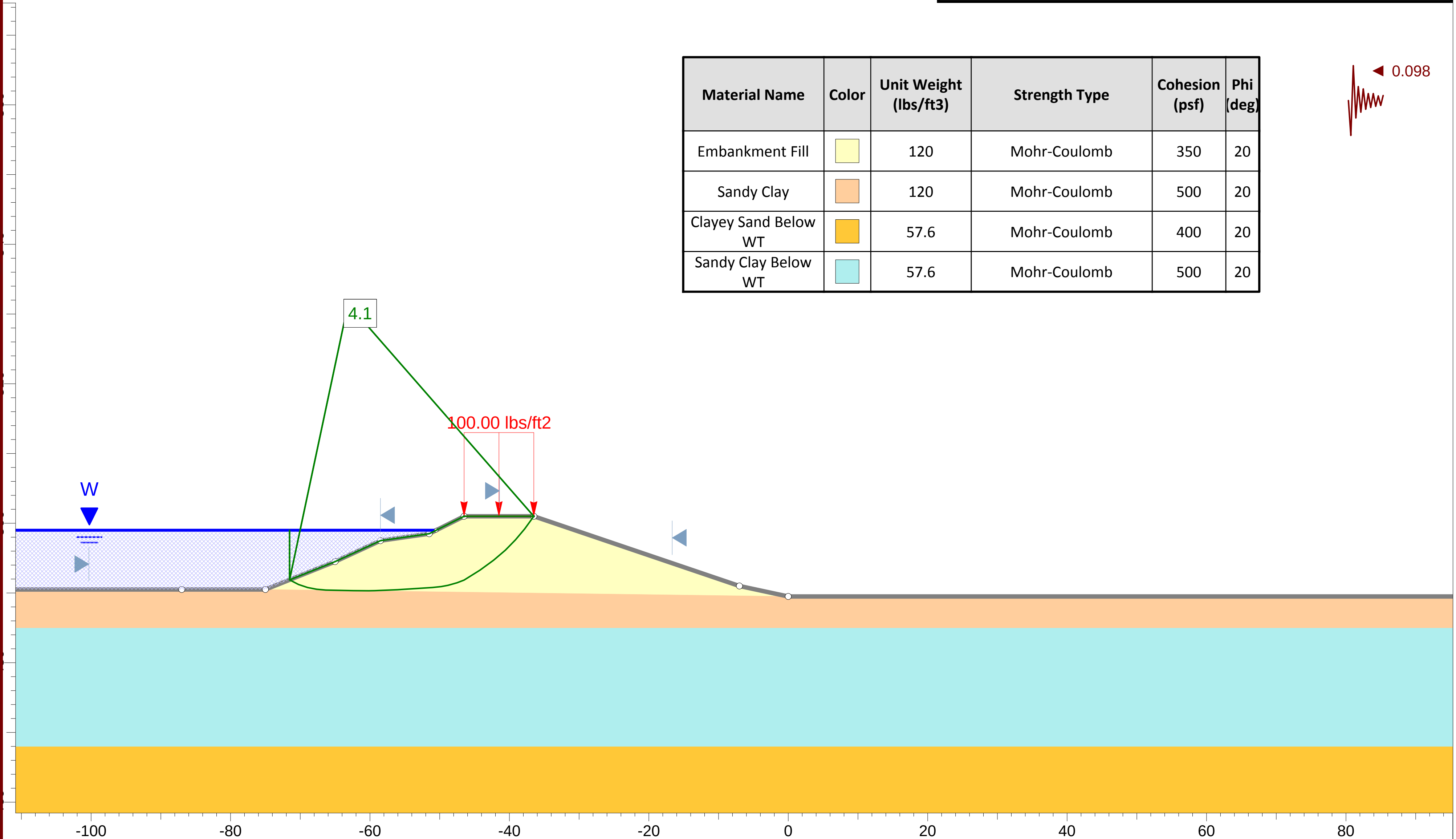
Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "I" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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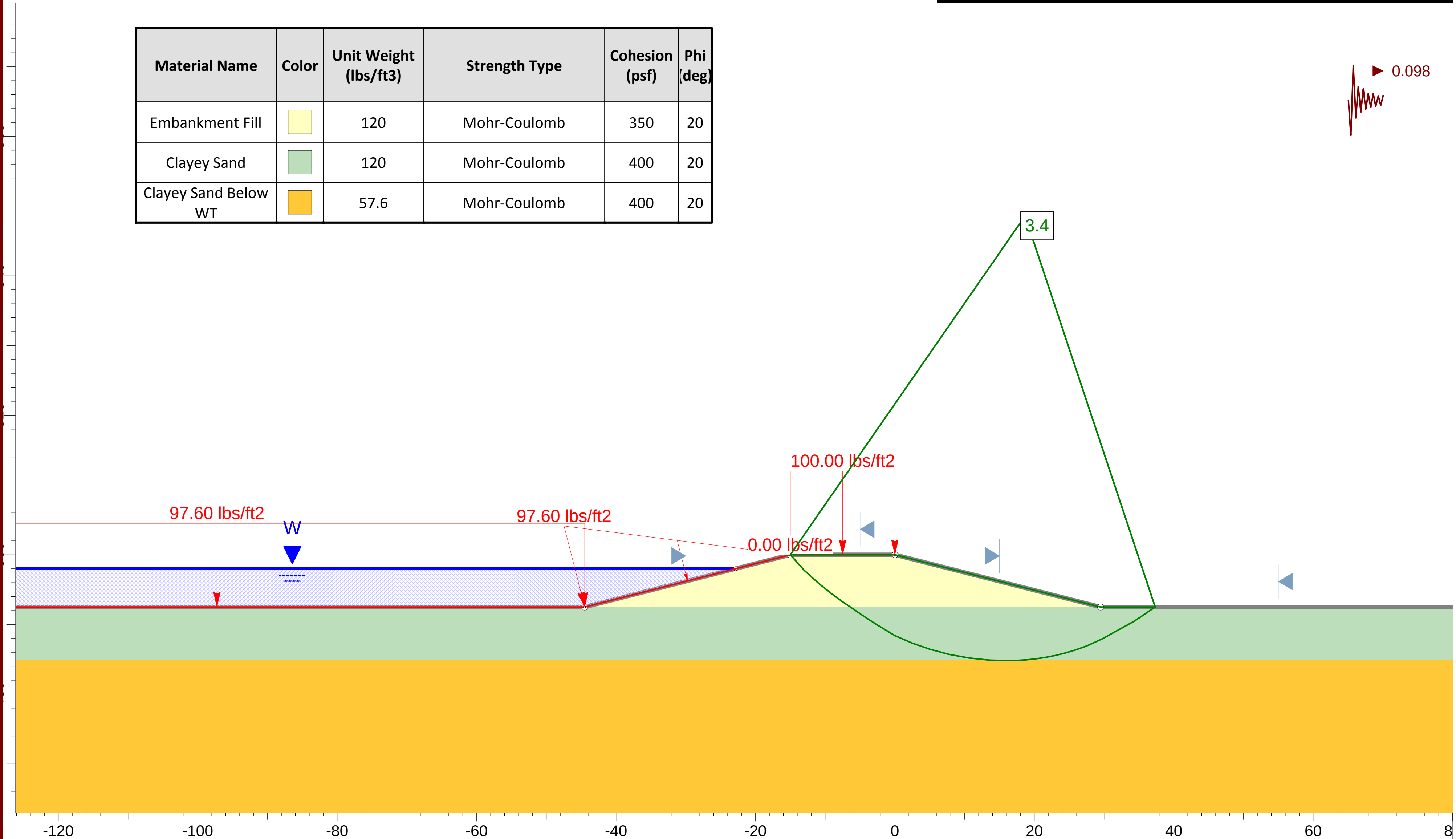
Figure D-22b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "J" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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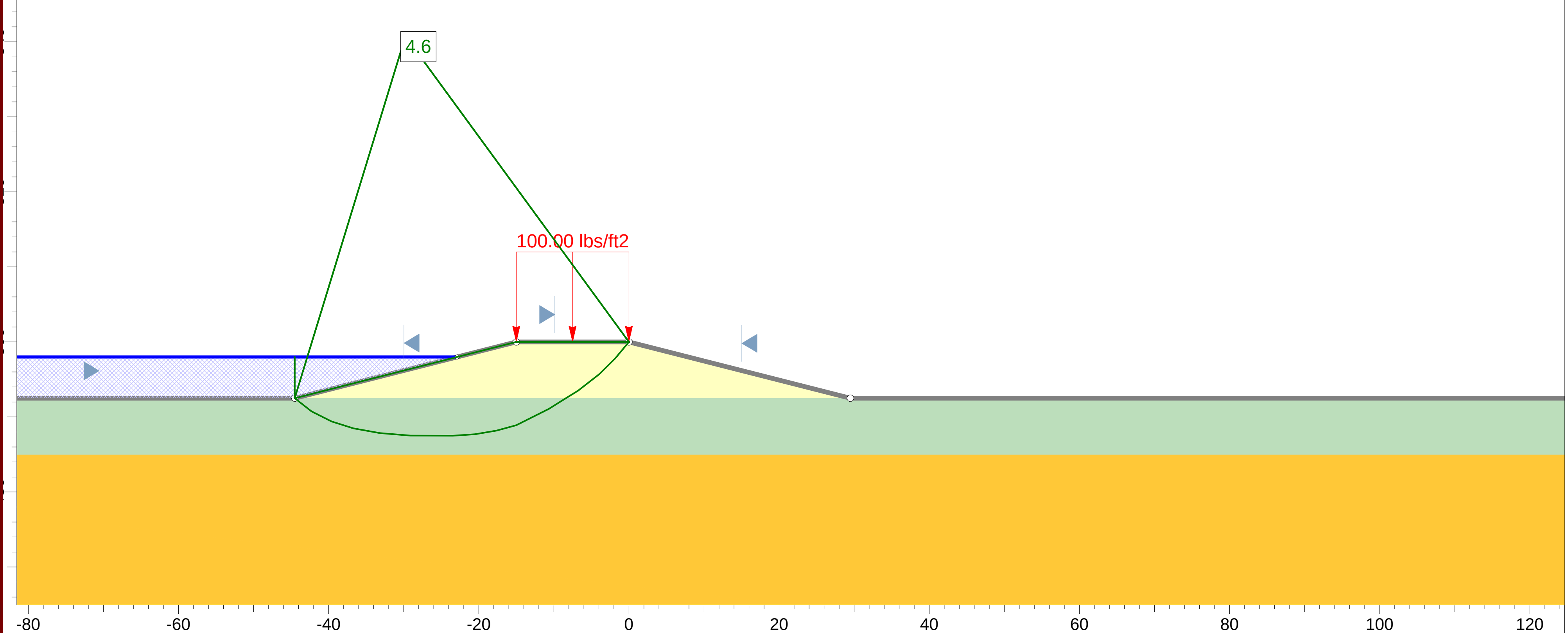
Figure D-23a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "J" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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Figure D-23b

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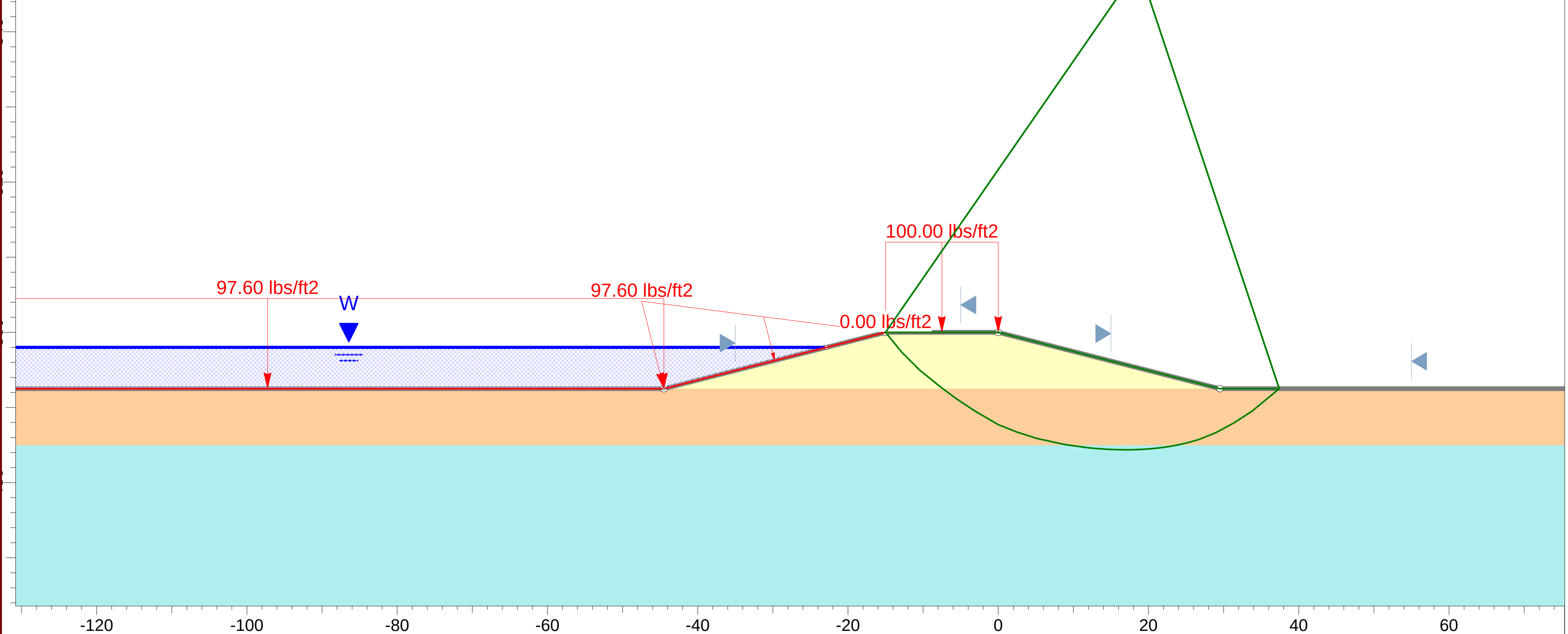
Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "K" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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Figure D-24a

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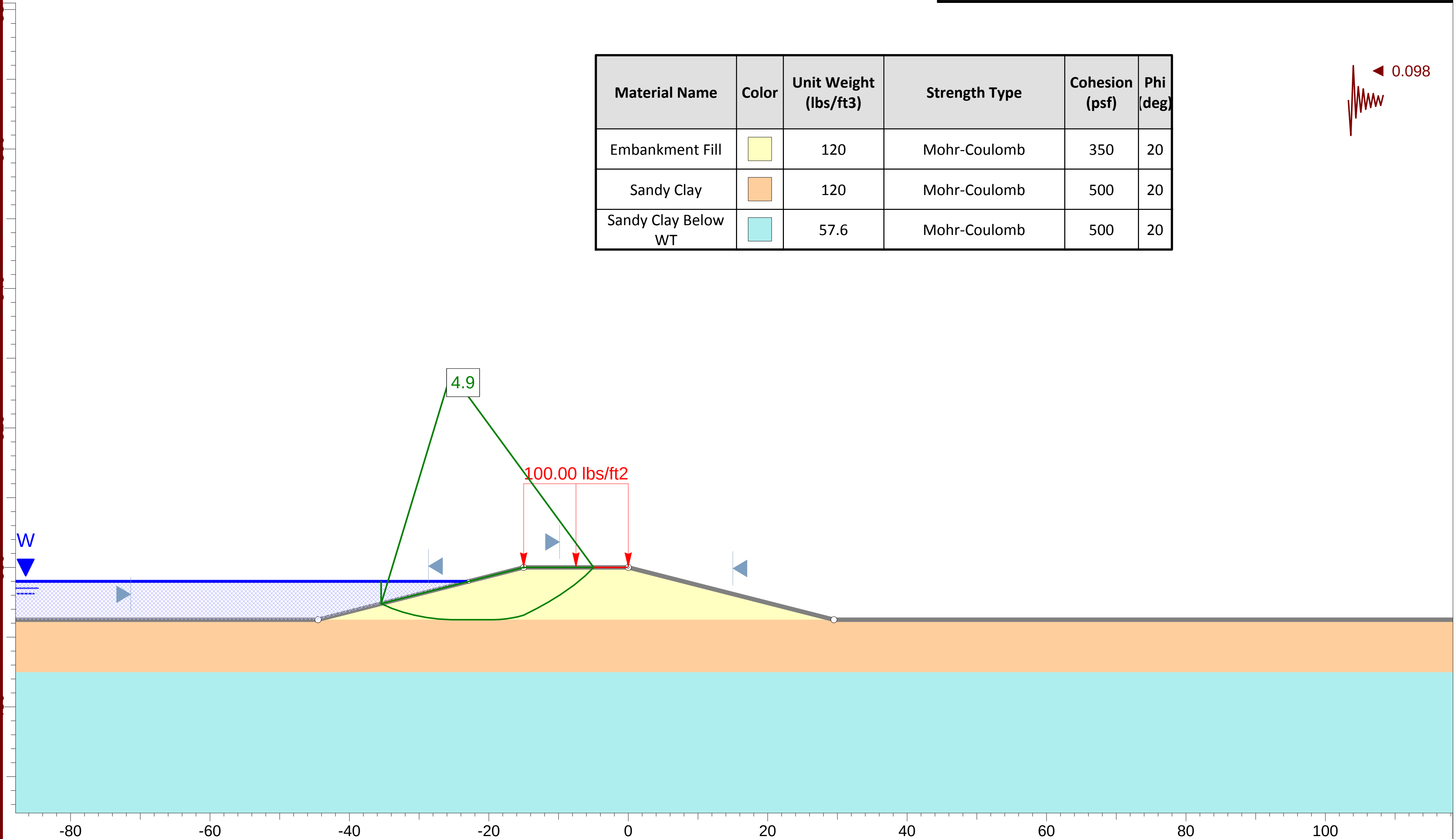
Global Stability Analysis

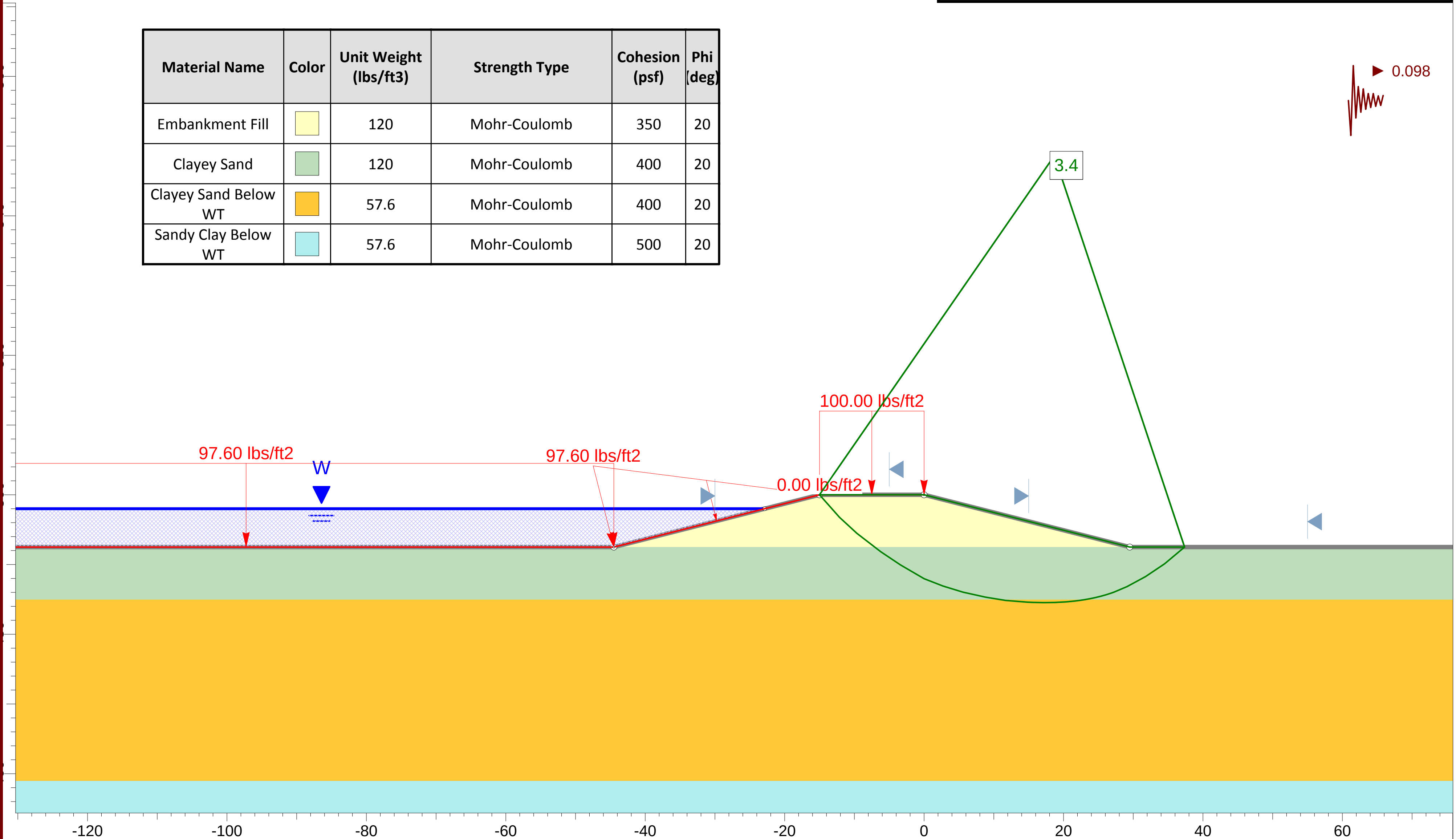
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "K" - Steady State Ash Pond Berms - Spruce/Deely Generation Units	Raba Kistner Consultants, Inc. ASA12-098-00	Figure D-24b RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "L" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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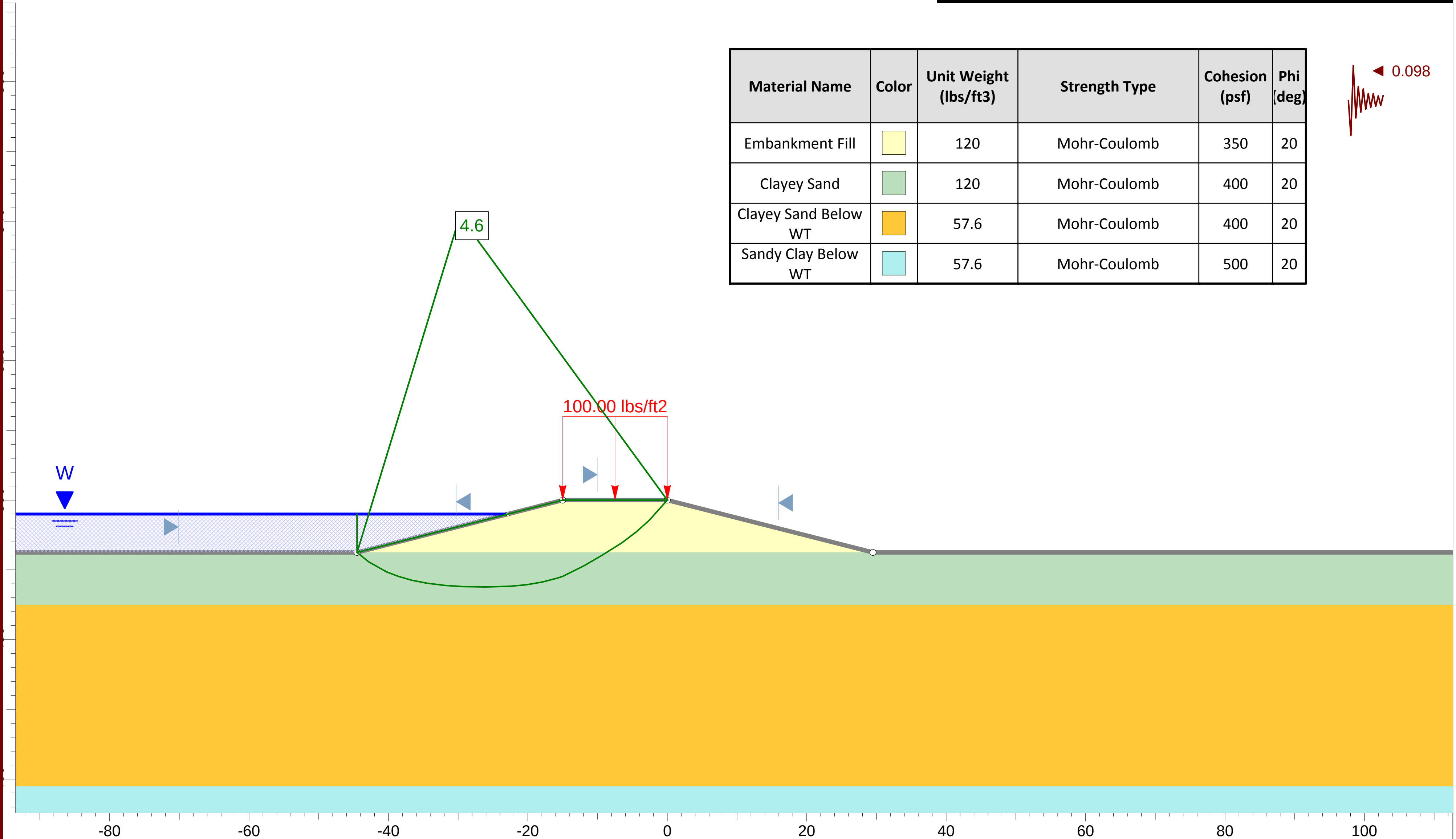
Figure D-25a

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "L" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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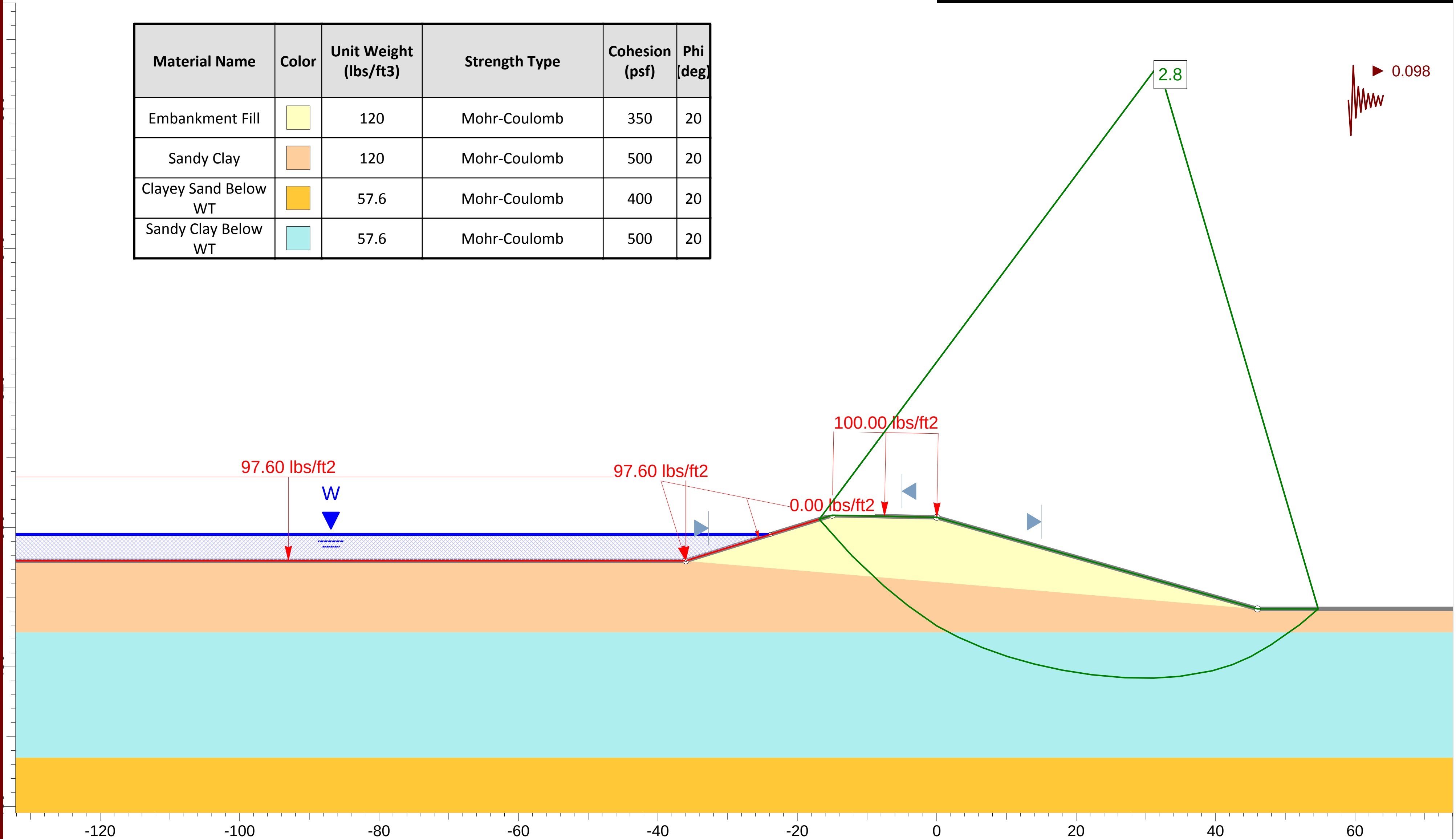
Figure D-25b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "M" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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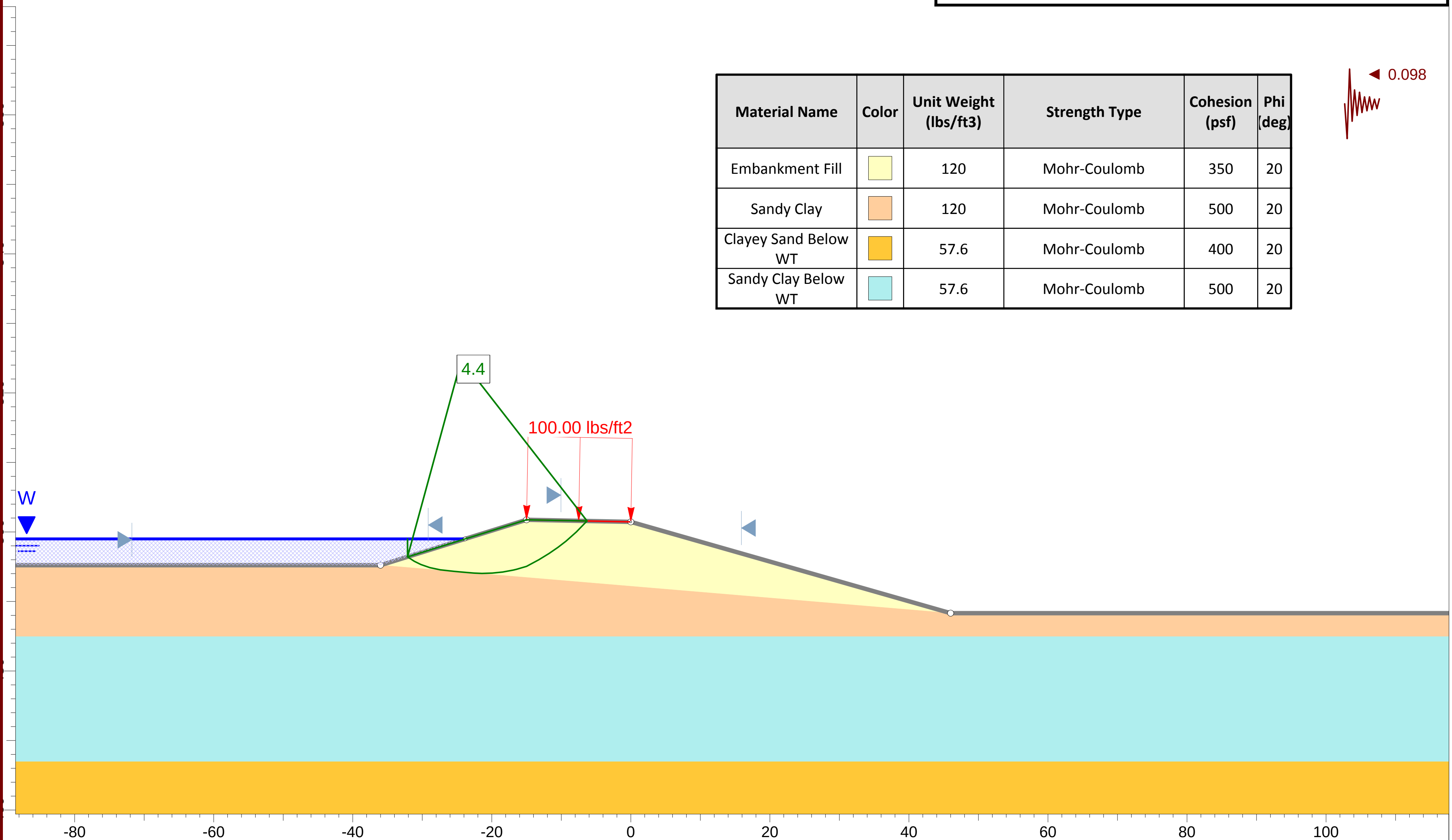
Figure D-26a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "M" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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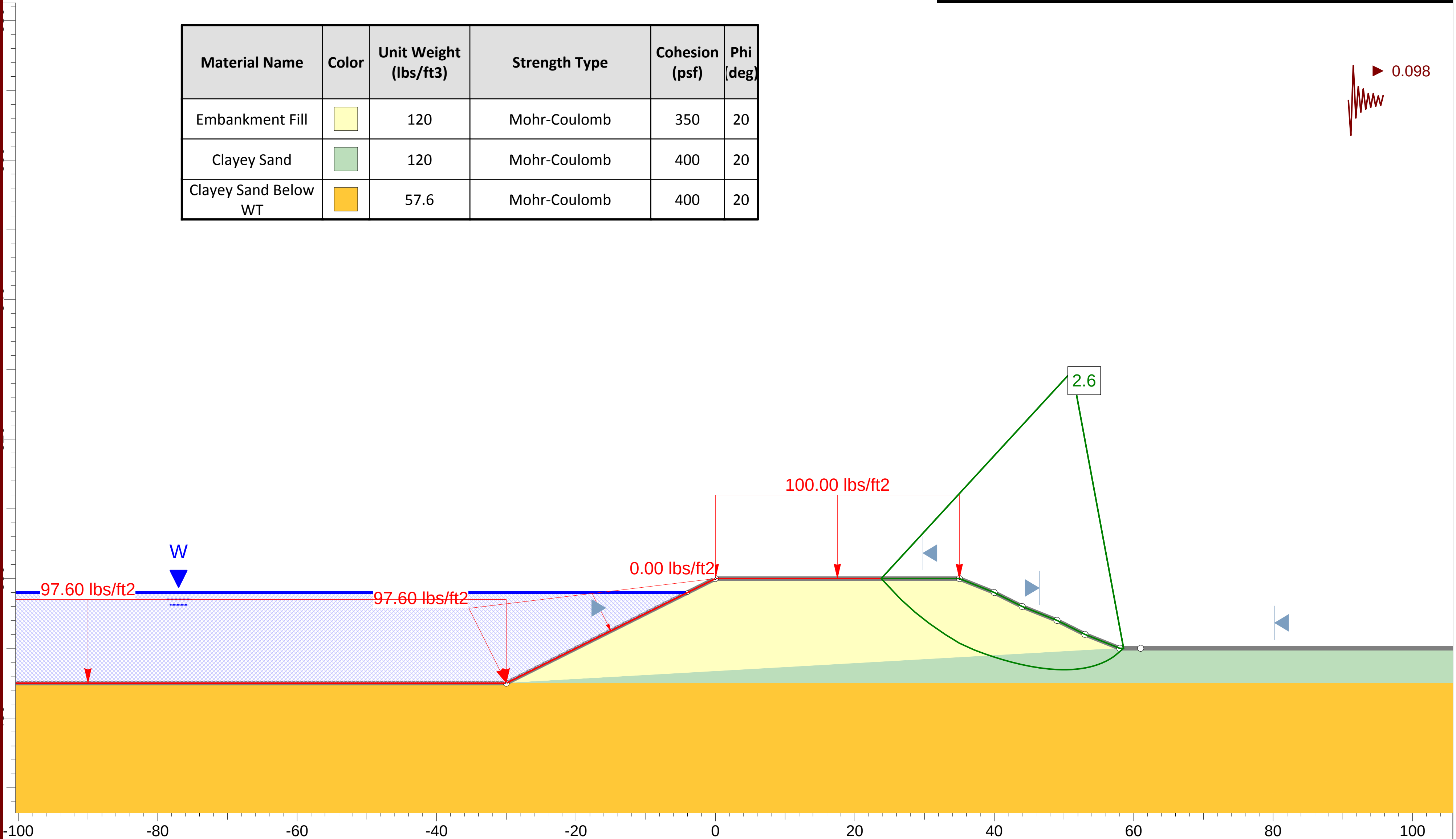
Figure D-26b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "N" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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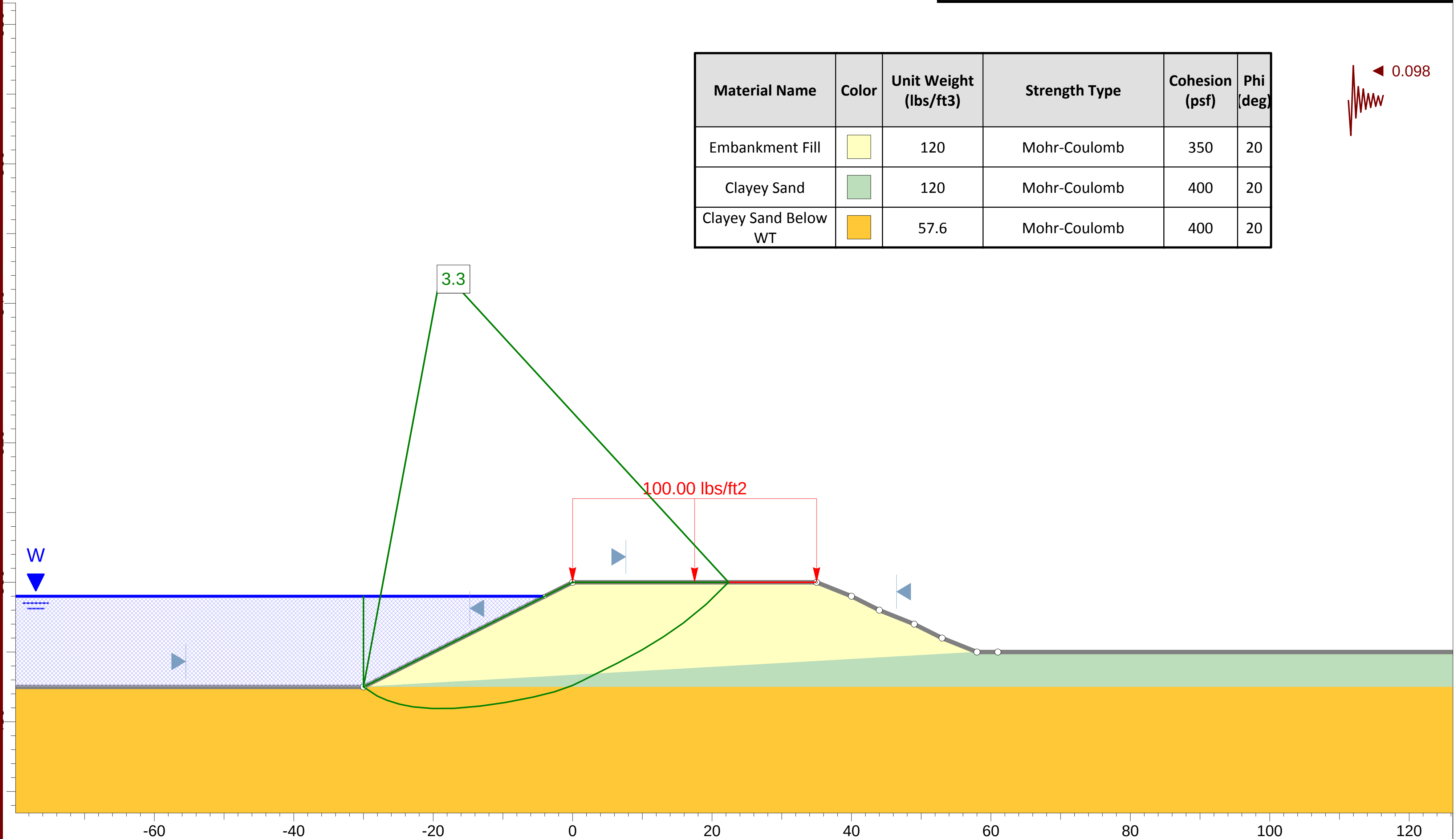
Figure D-27a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "N" - Steady State
Ash Pond Berms - Spruce/Deely Generation Units

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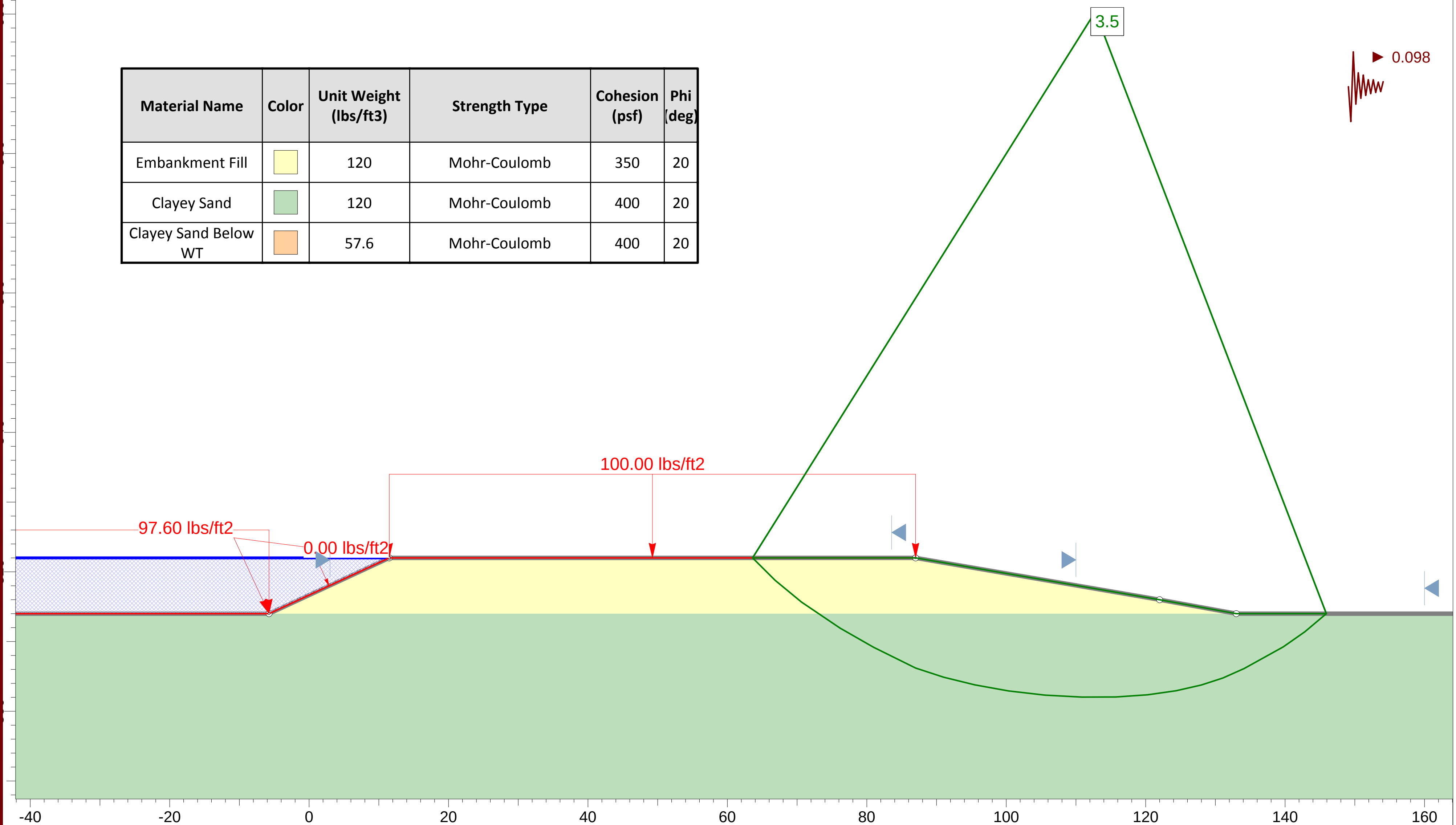
Figure D-27b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "A" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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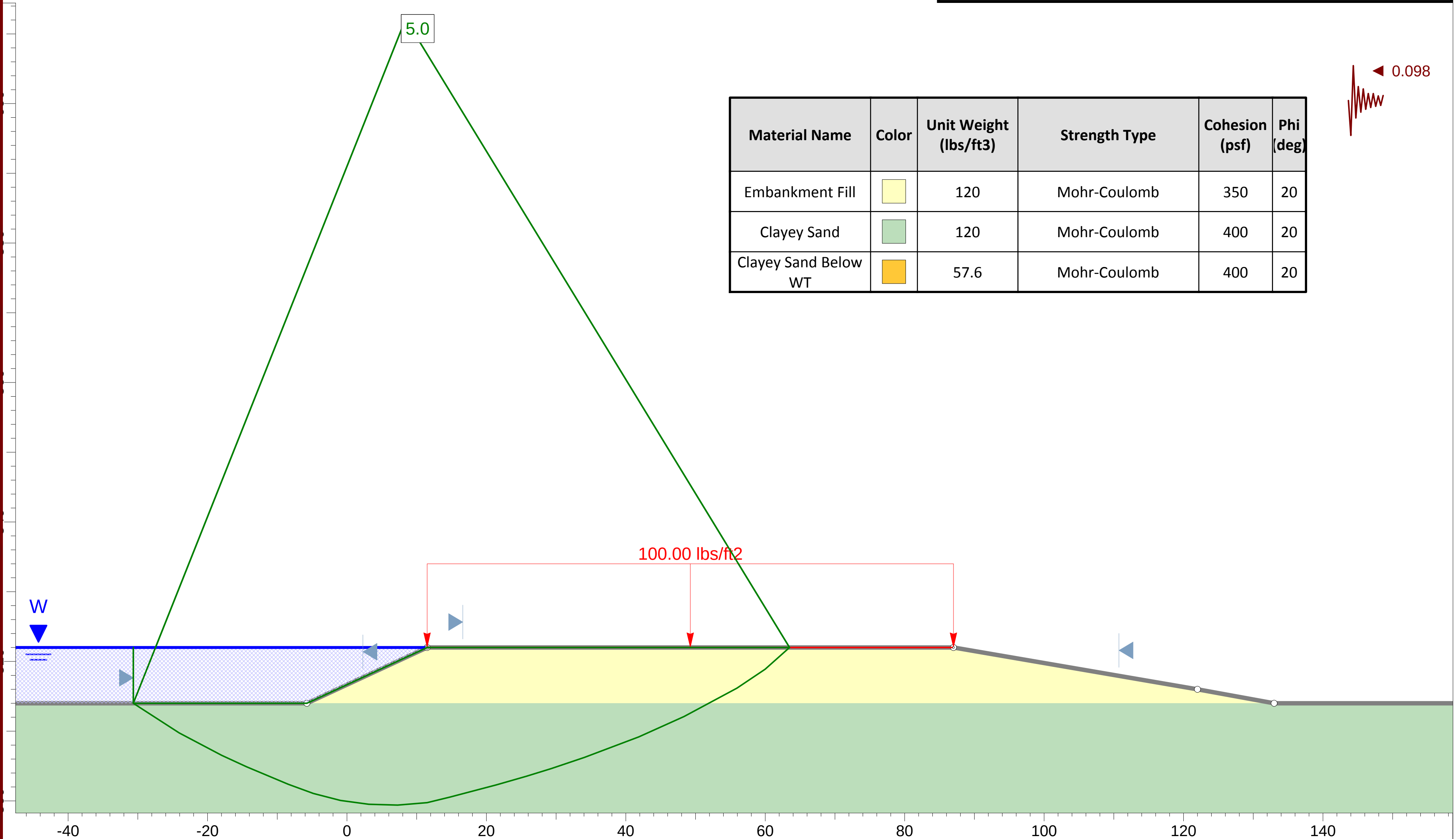
Figure D-28a

RABA KISTNER CONSULTANTS

Global Stability Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20

Profile "A" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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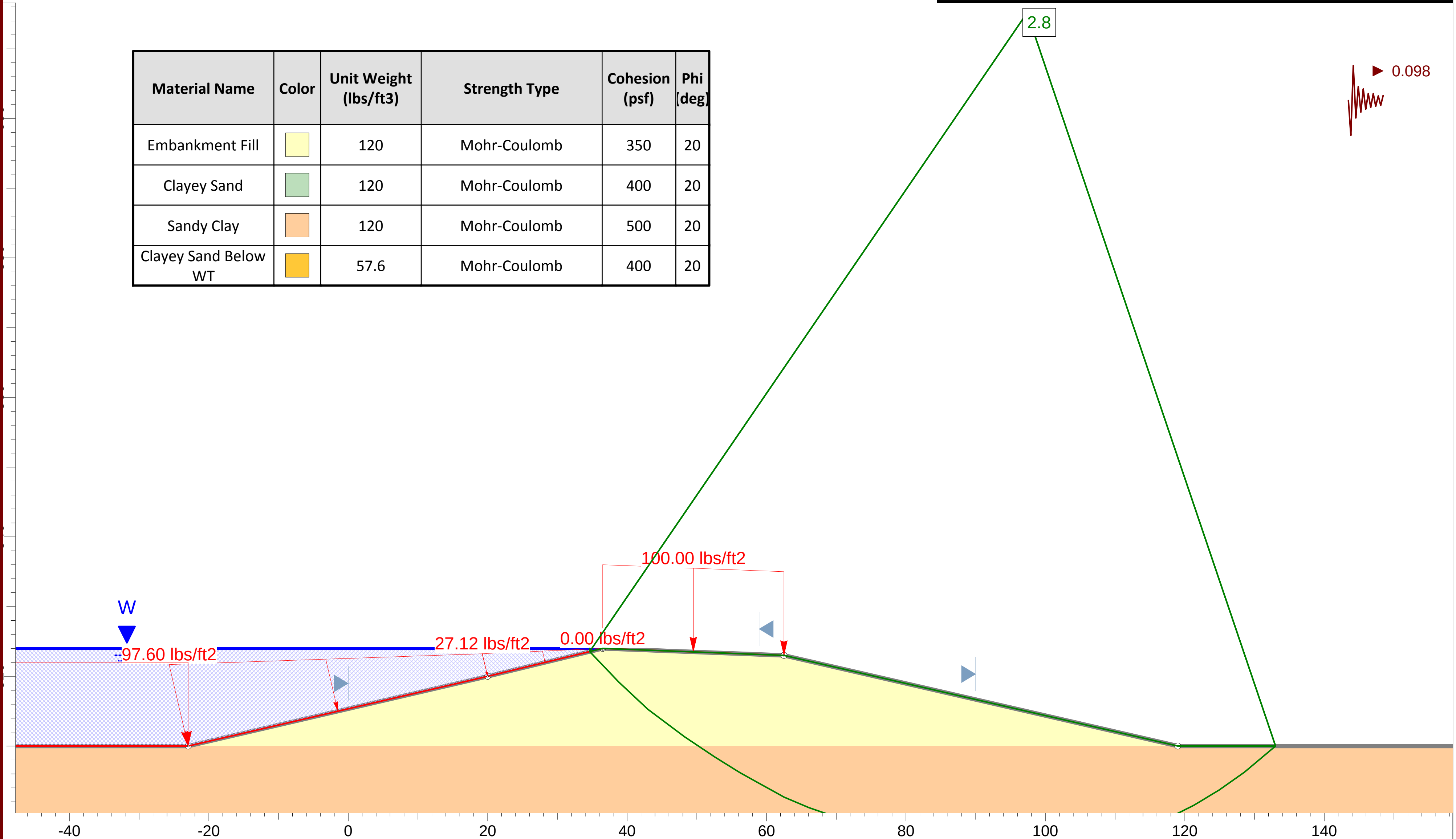
Figure D-28b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "B" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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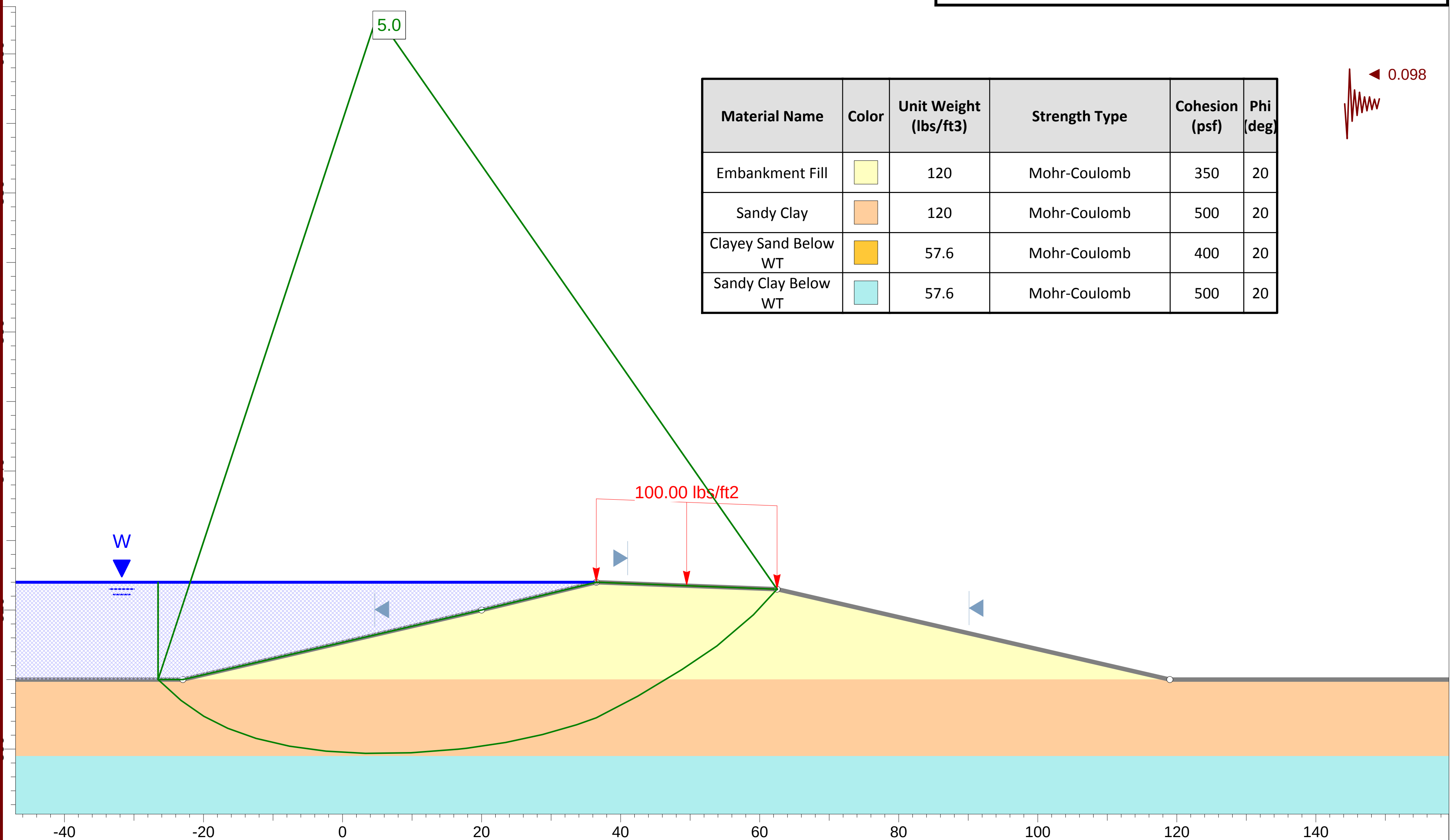
Figure D-29a

RABA KISTNER CONSULTANTS

Global Stability Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20

Profile "B" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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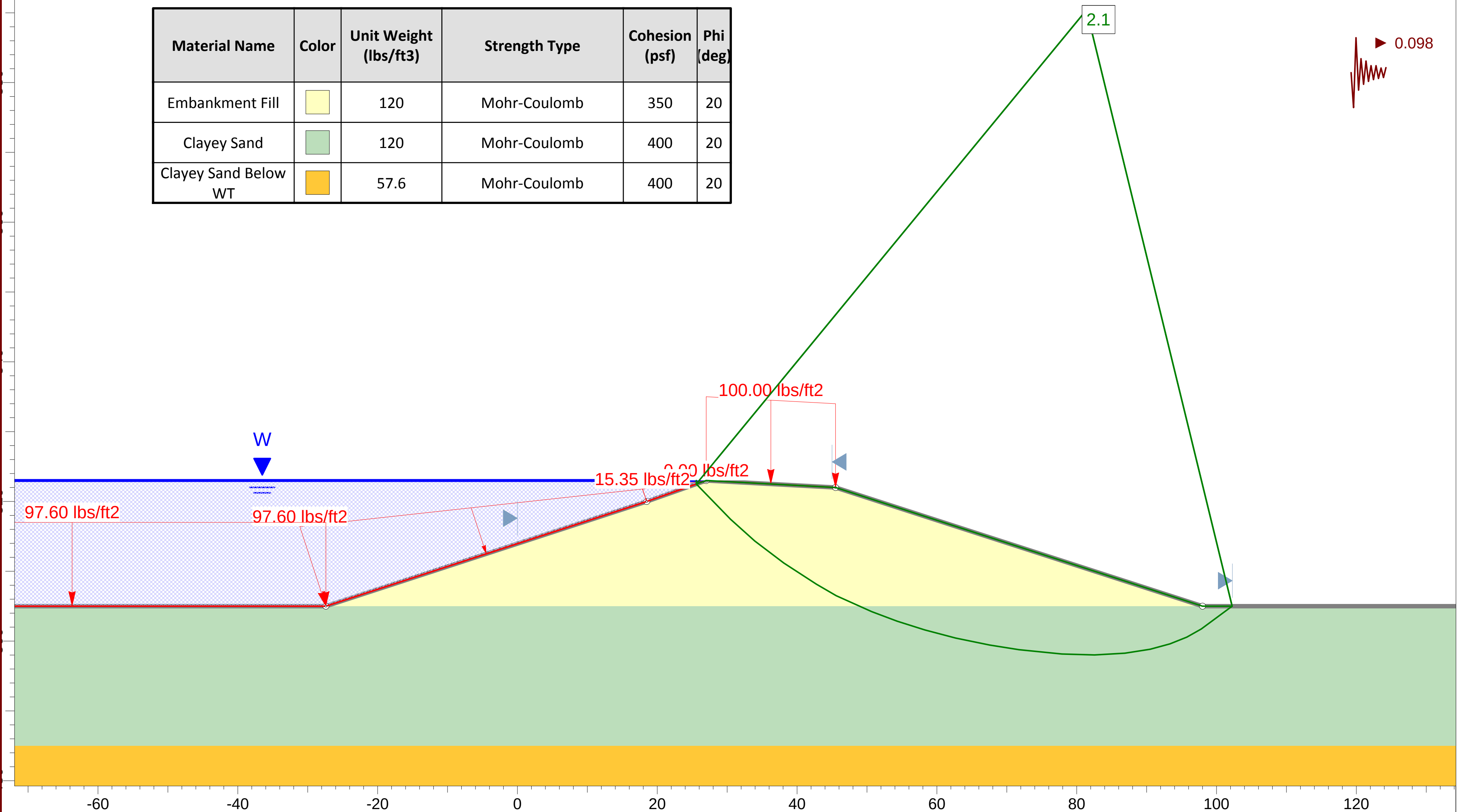
Figure D-29b

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "C" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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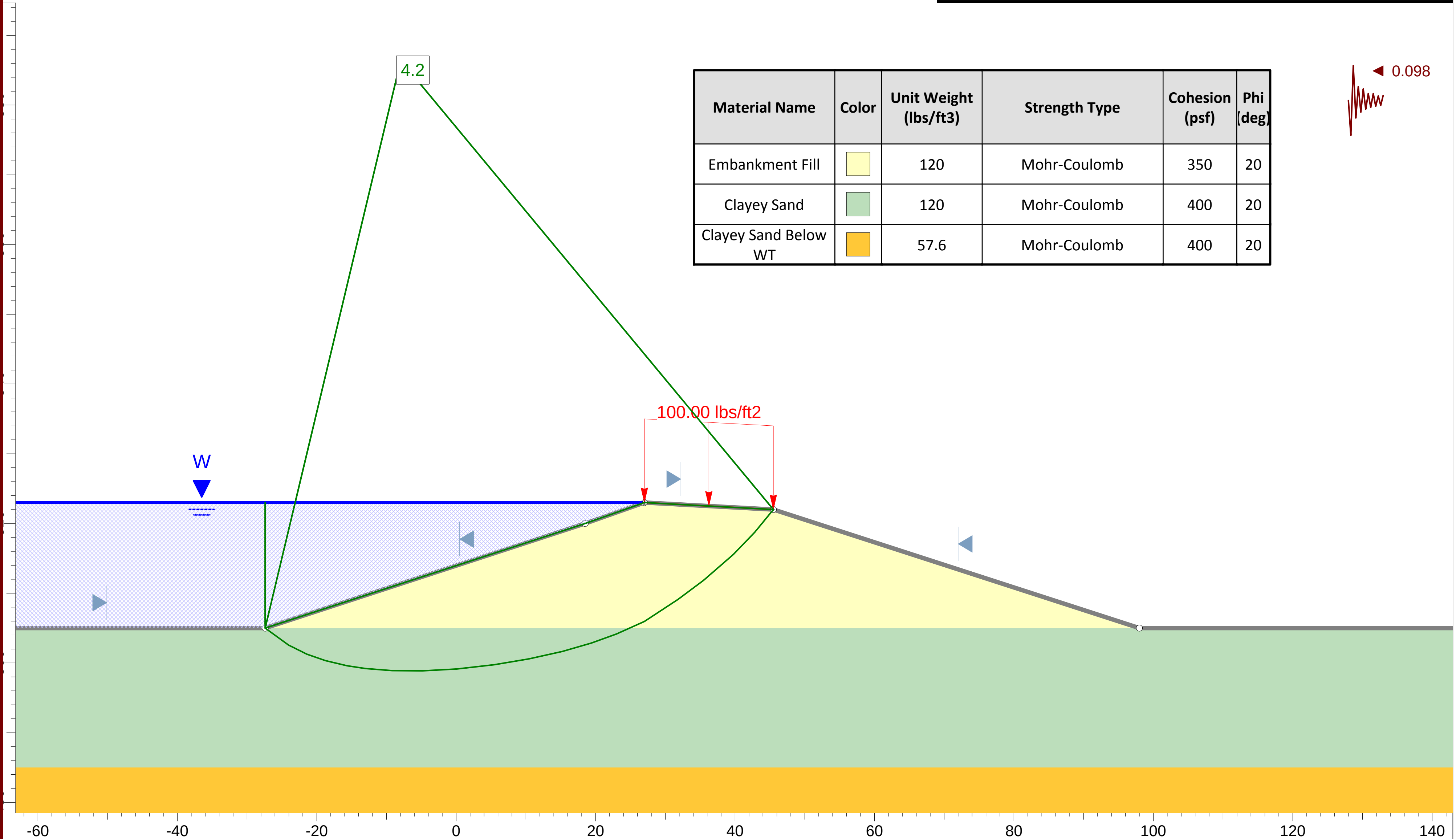
Figure D-30a

RABA KISTNER CONSULTANTS

Global Stability Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20

Profile "C" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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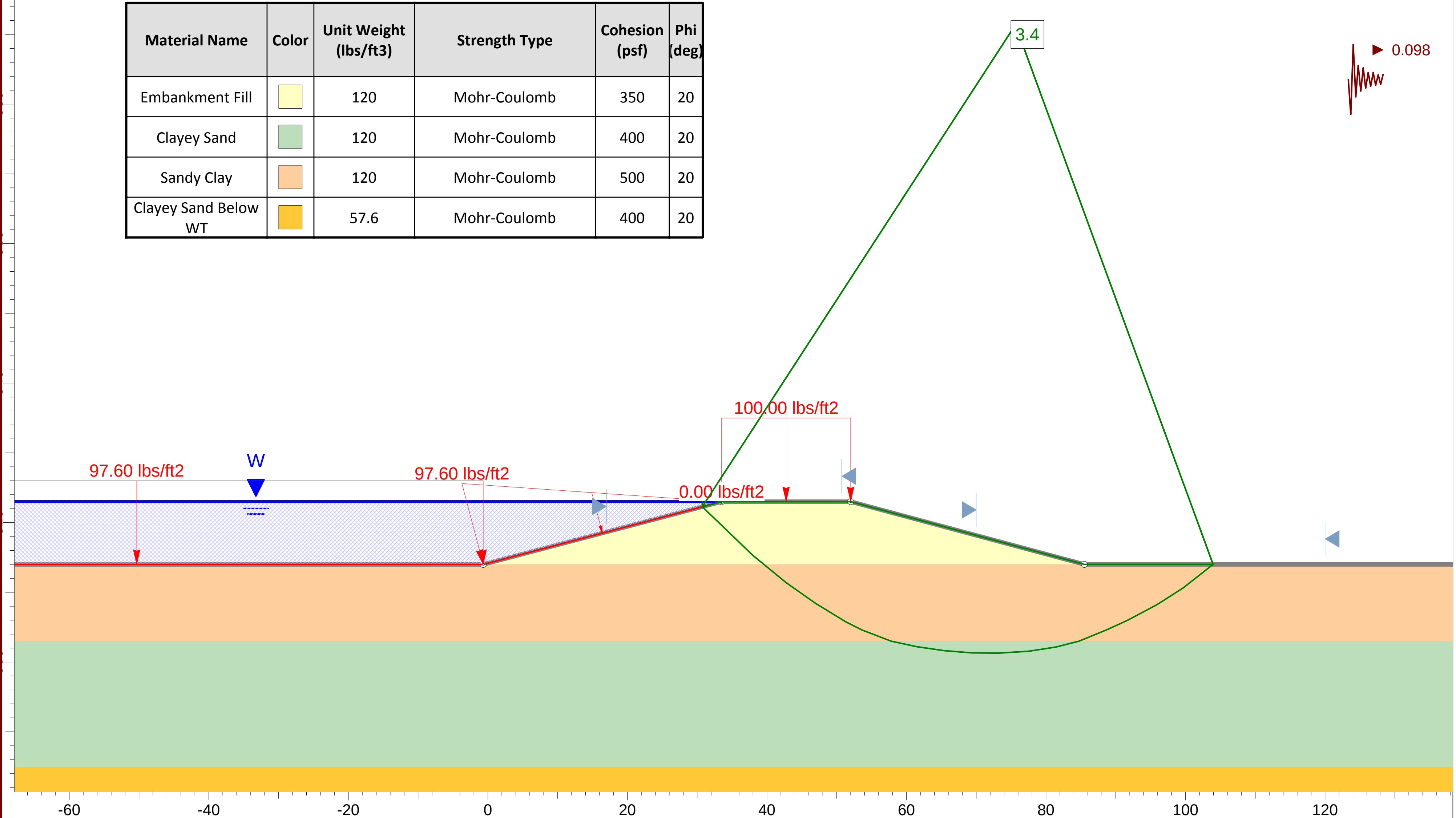
Figure D-30b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "D" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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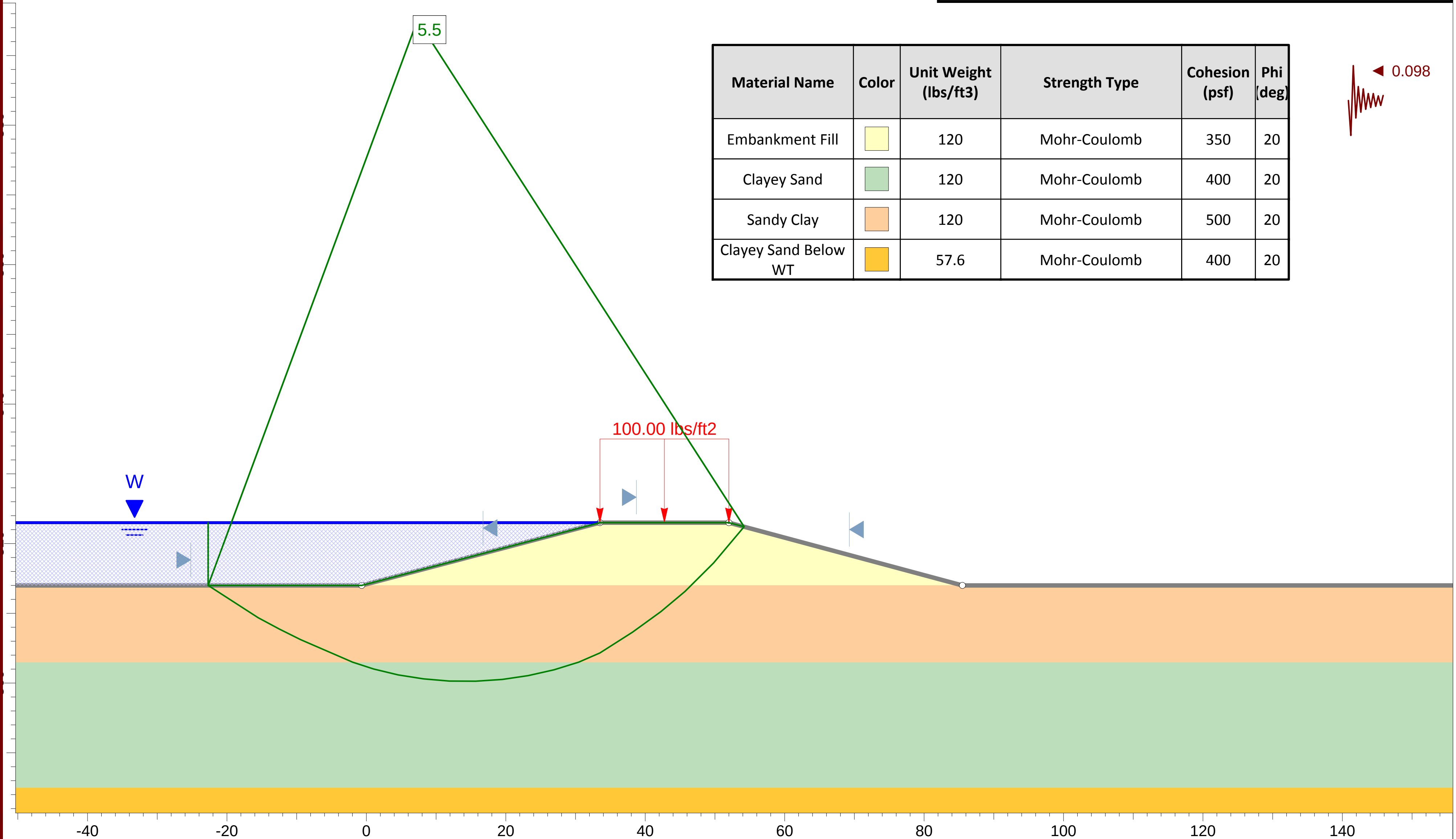
Figure D-31a

RABA KISTNER CONSULTANTS

Global Stability Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20

Profile "D" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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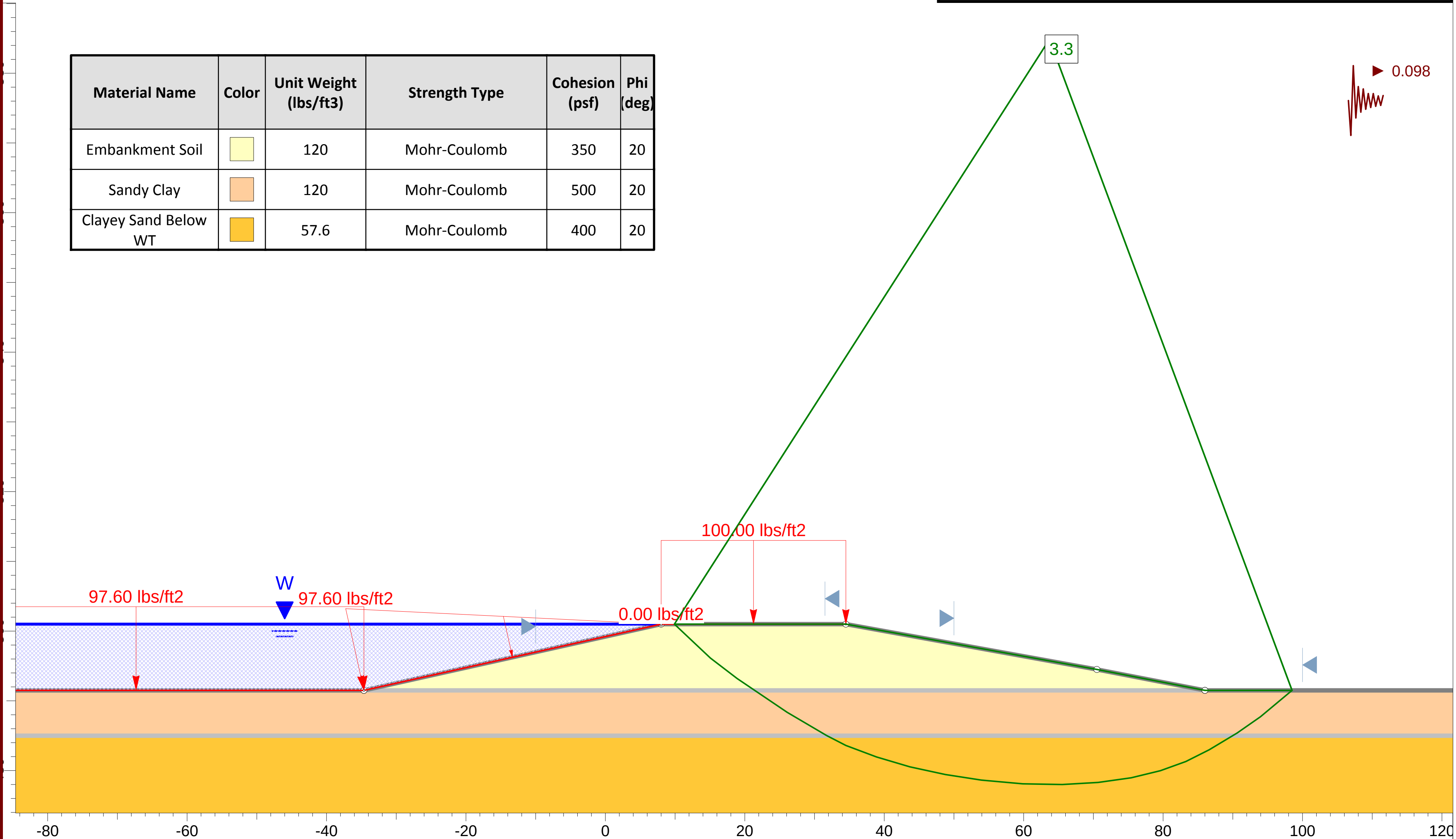
Figure D-31b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Soil		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "E" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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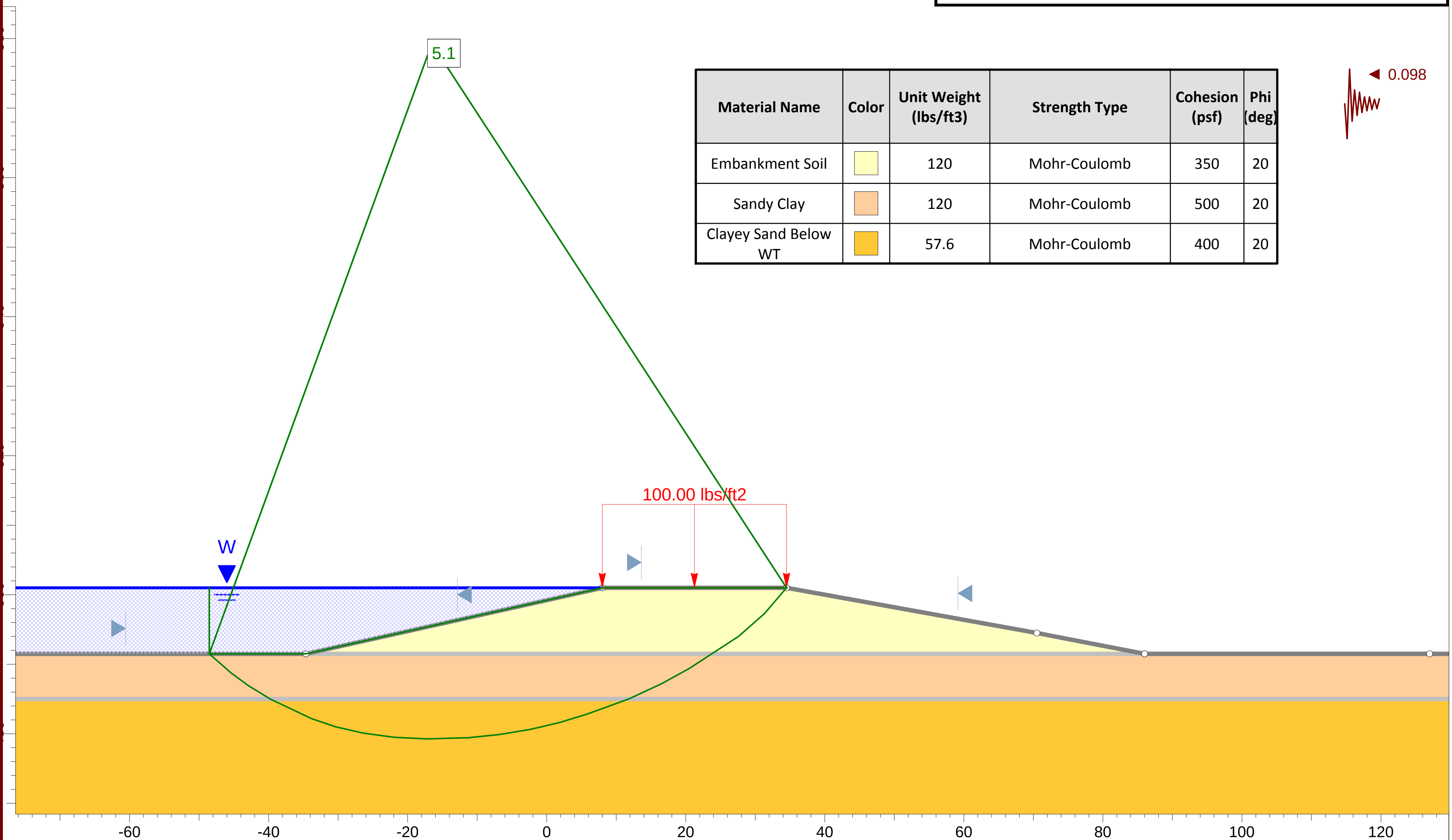
Figure D-32a

RABA KISTNER CONSULTANTS

Global Stability Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Soil		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20

Profile "E" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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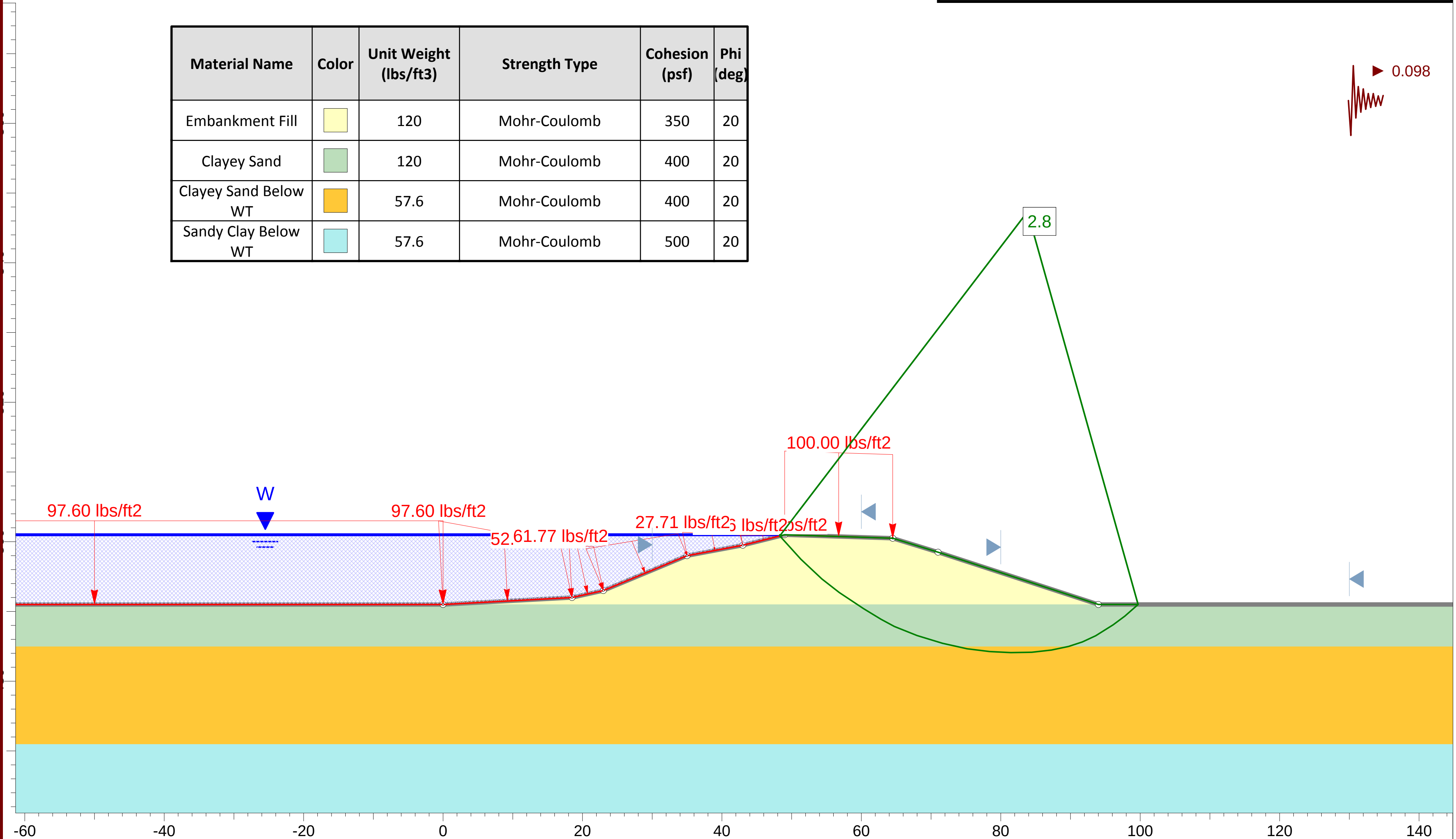
Figure D-32b

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "F" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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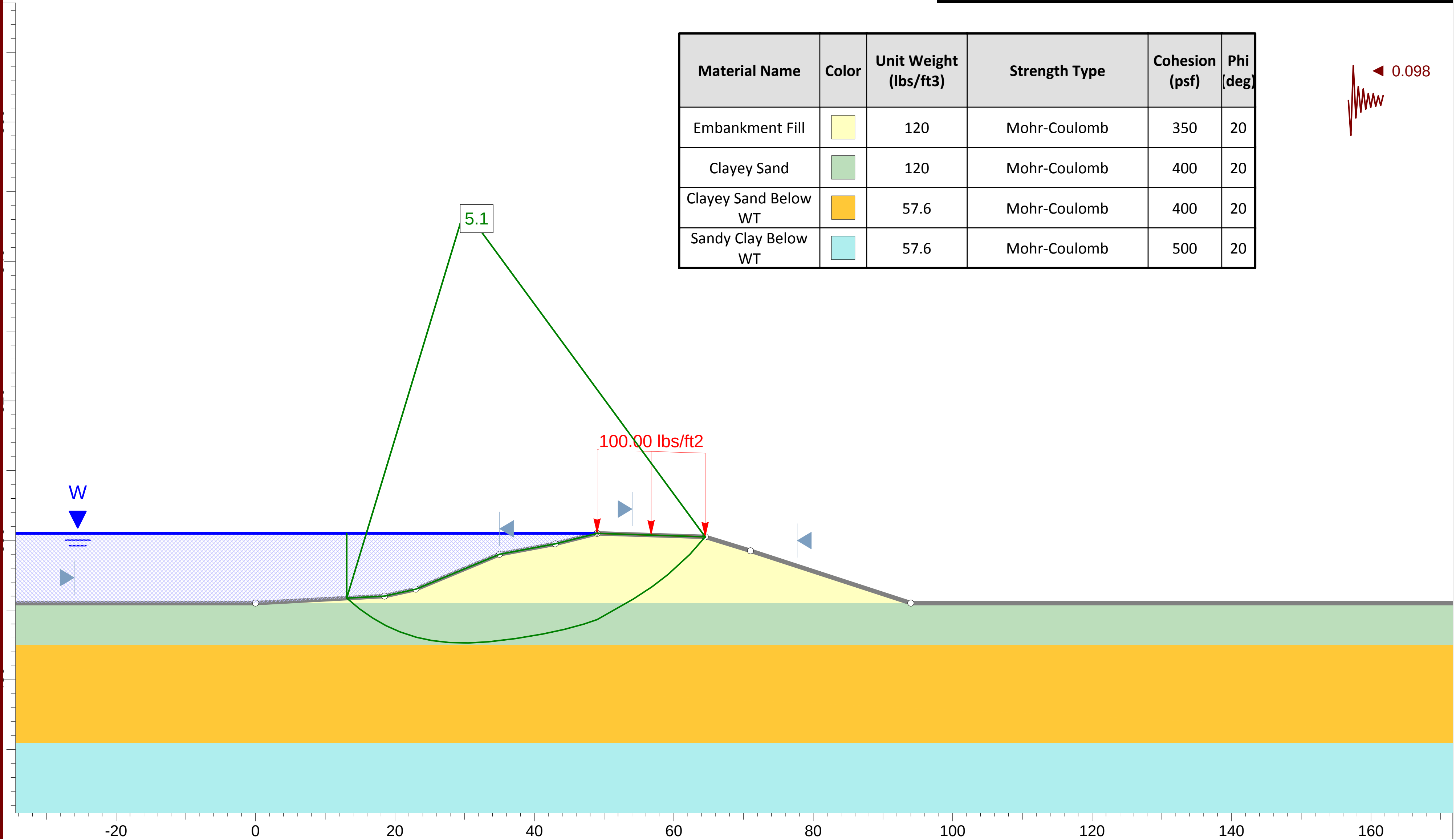
Figure D-33a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "F" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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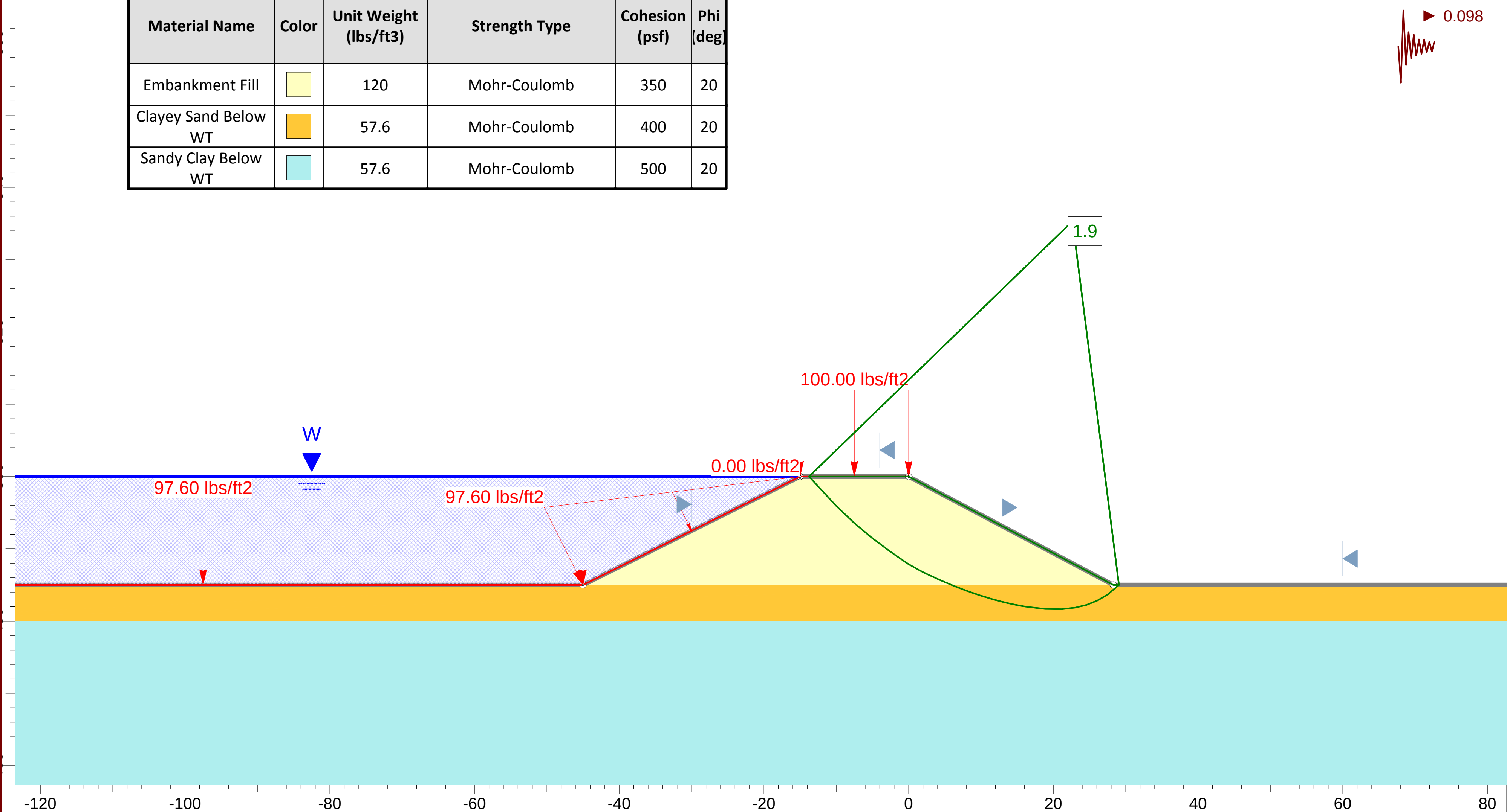
Figure D-33b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "G" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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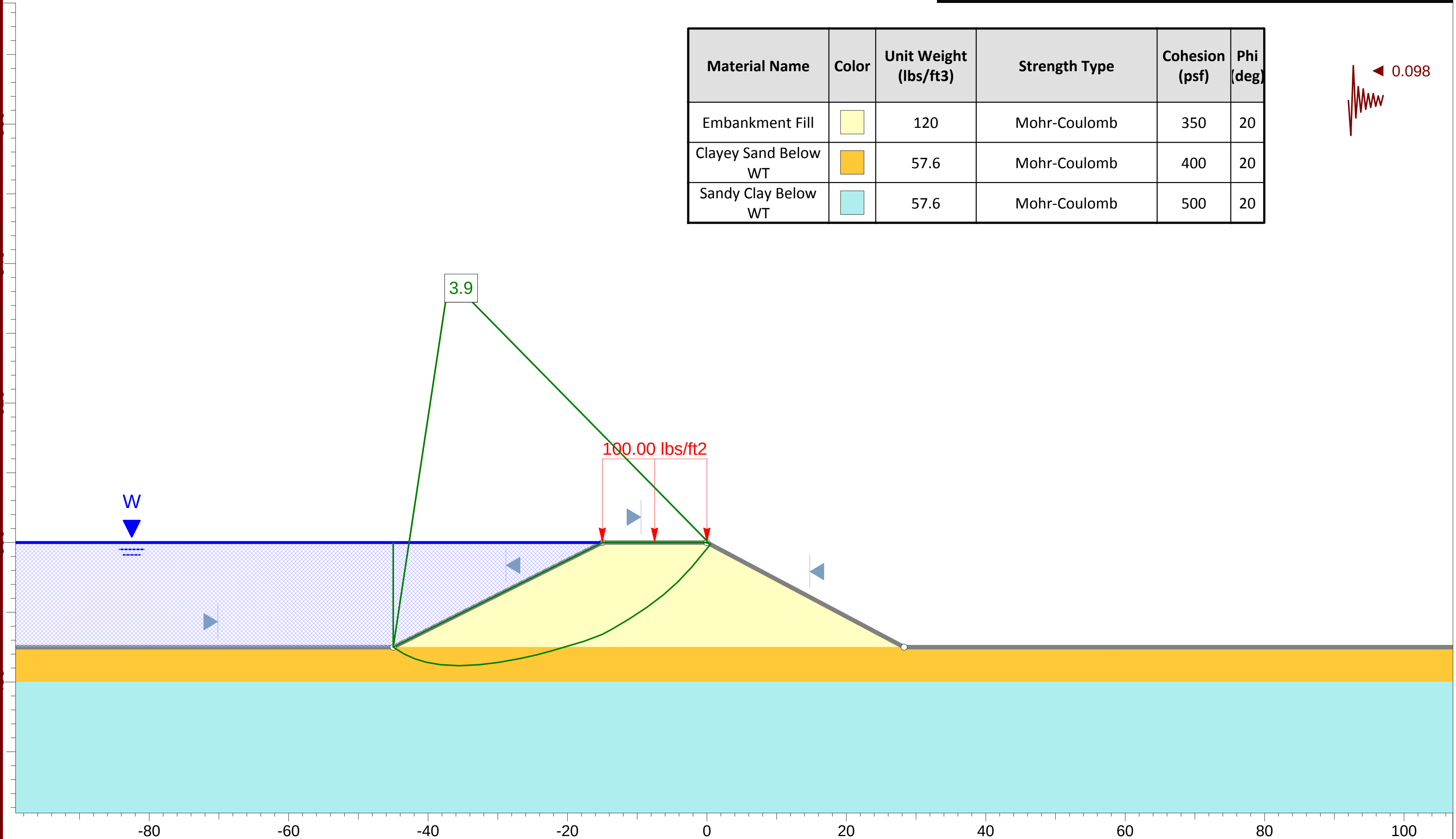
Figure D-34a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "G" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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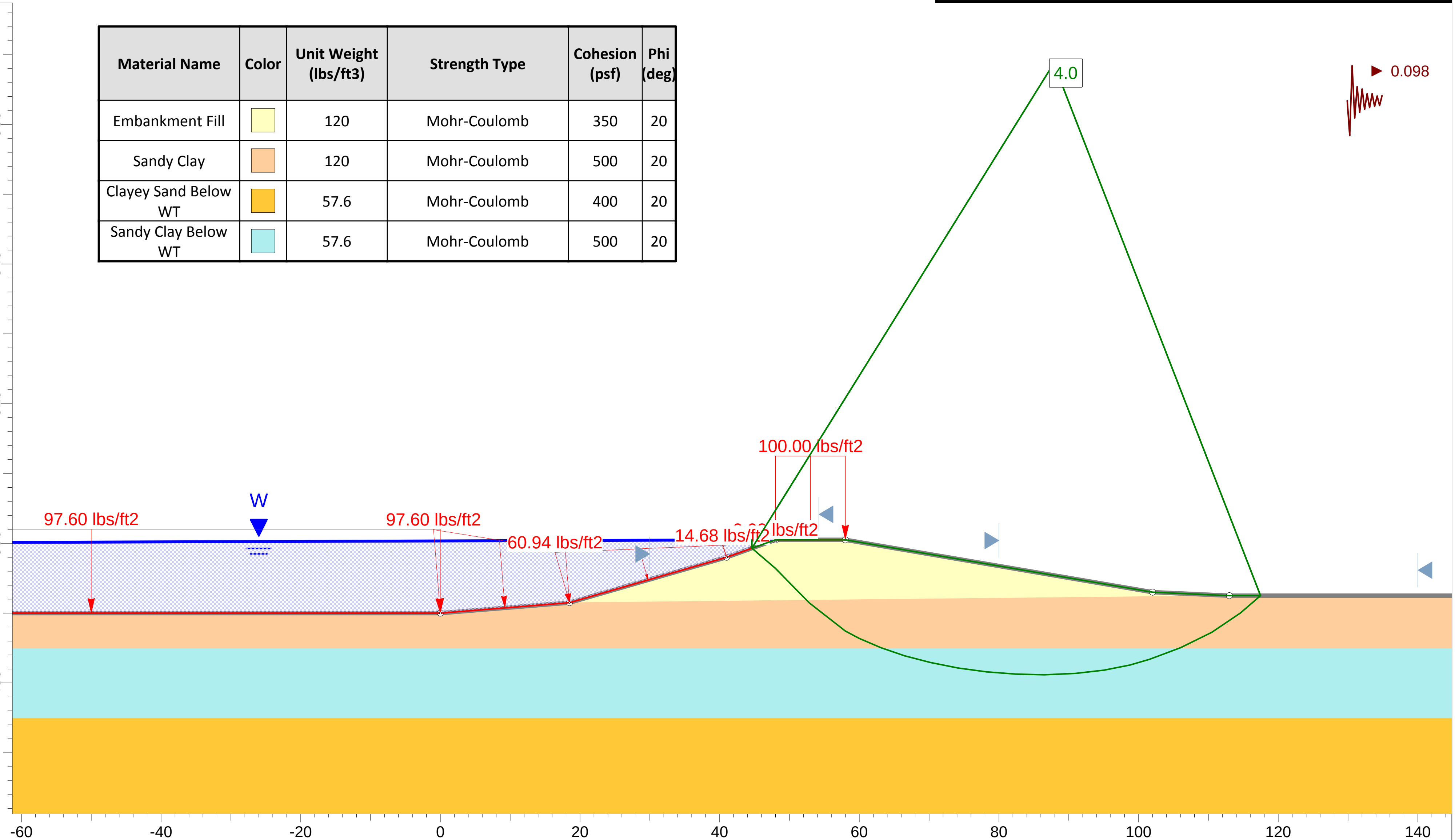
Figure D-34b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "H" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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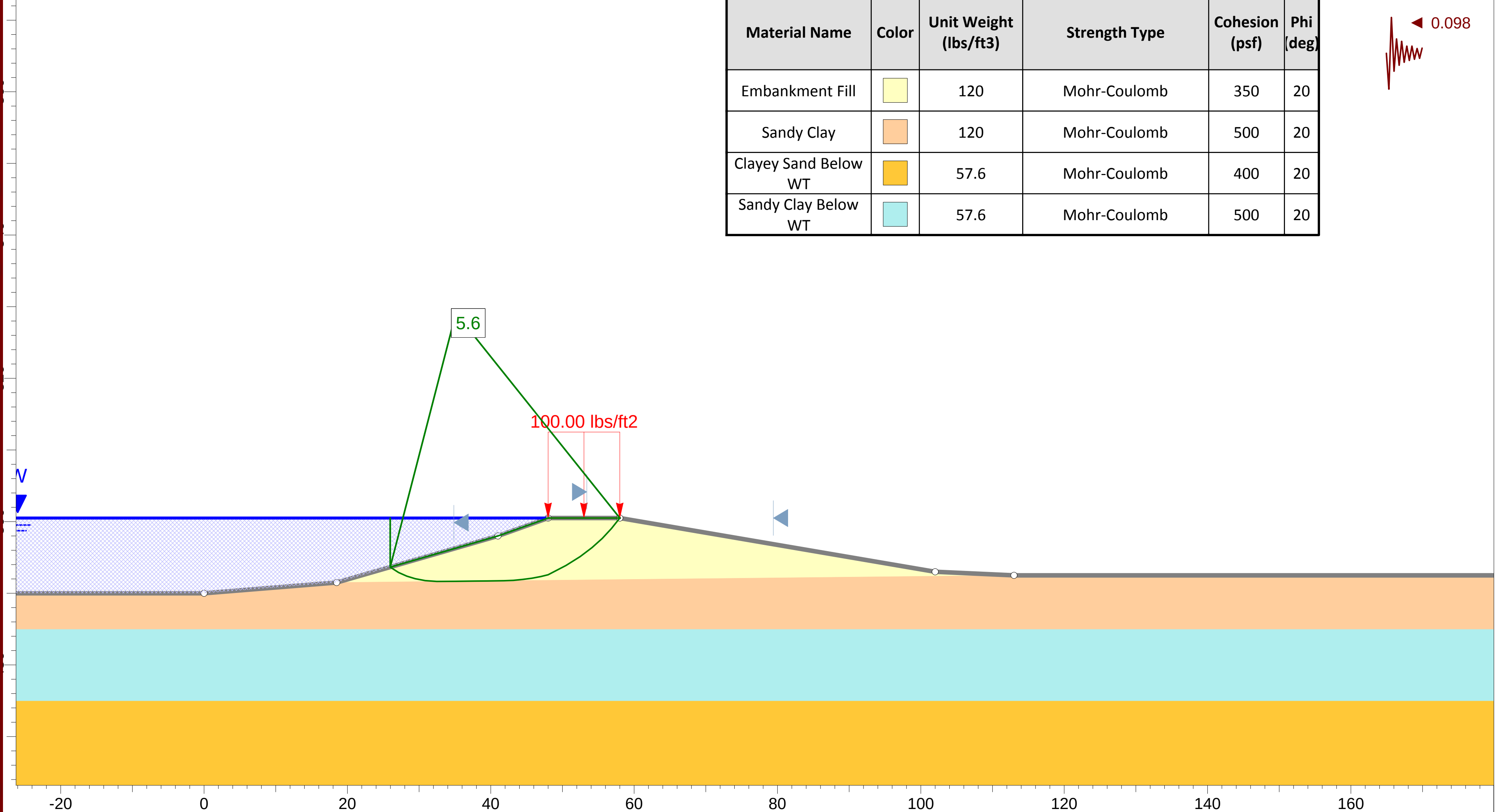
Figure D-35a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "H" - Maximum Pool
Ash Pond Berms - Calaveras Lake Power Plant

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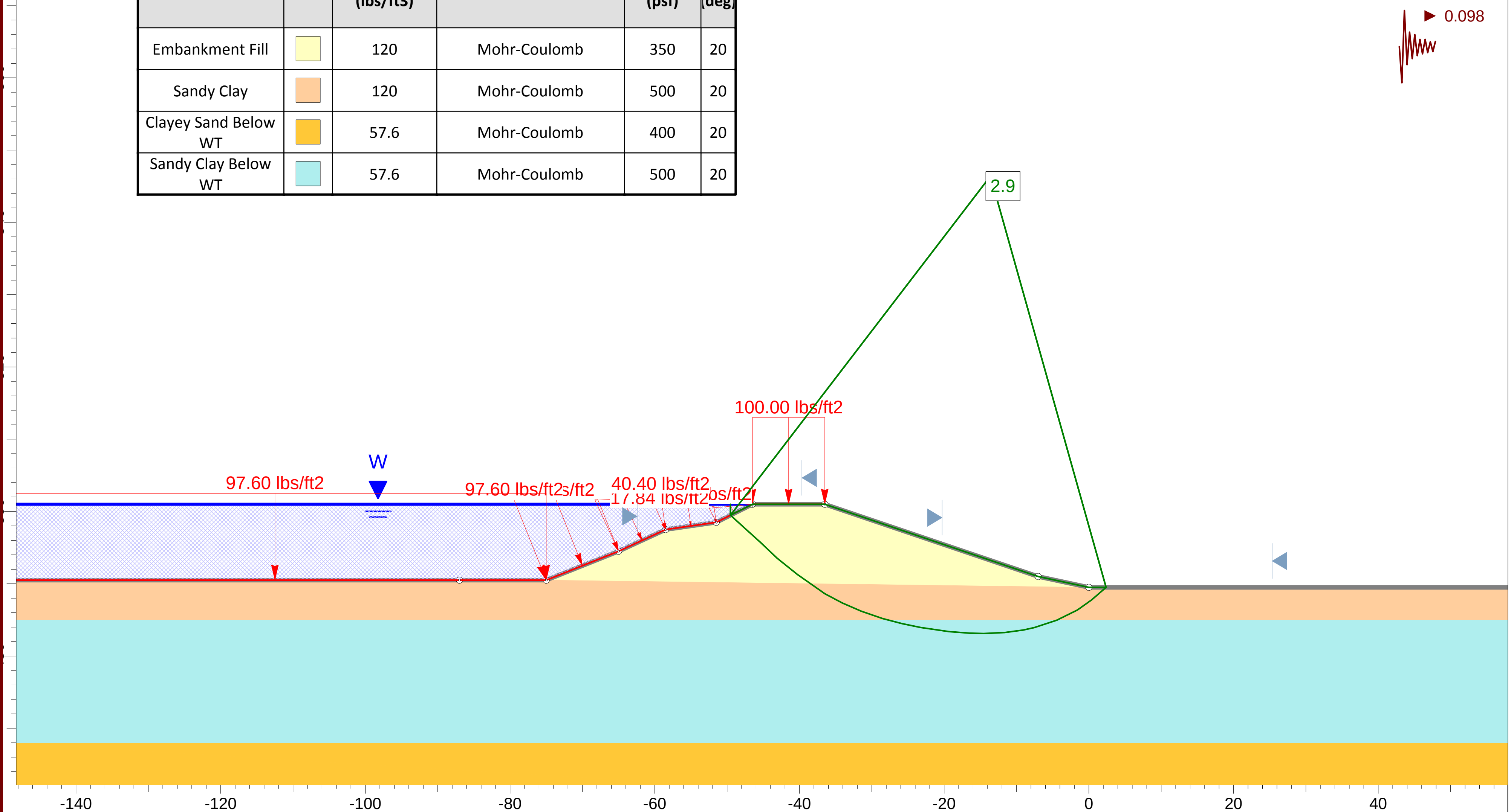
Figure D-35b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "I" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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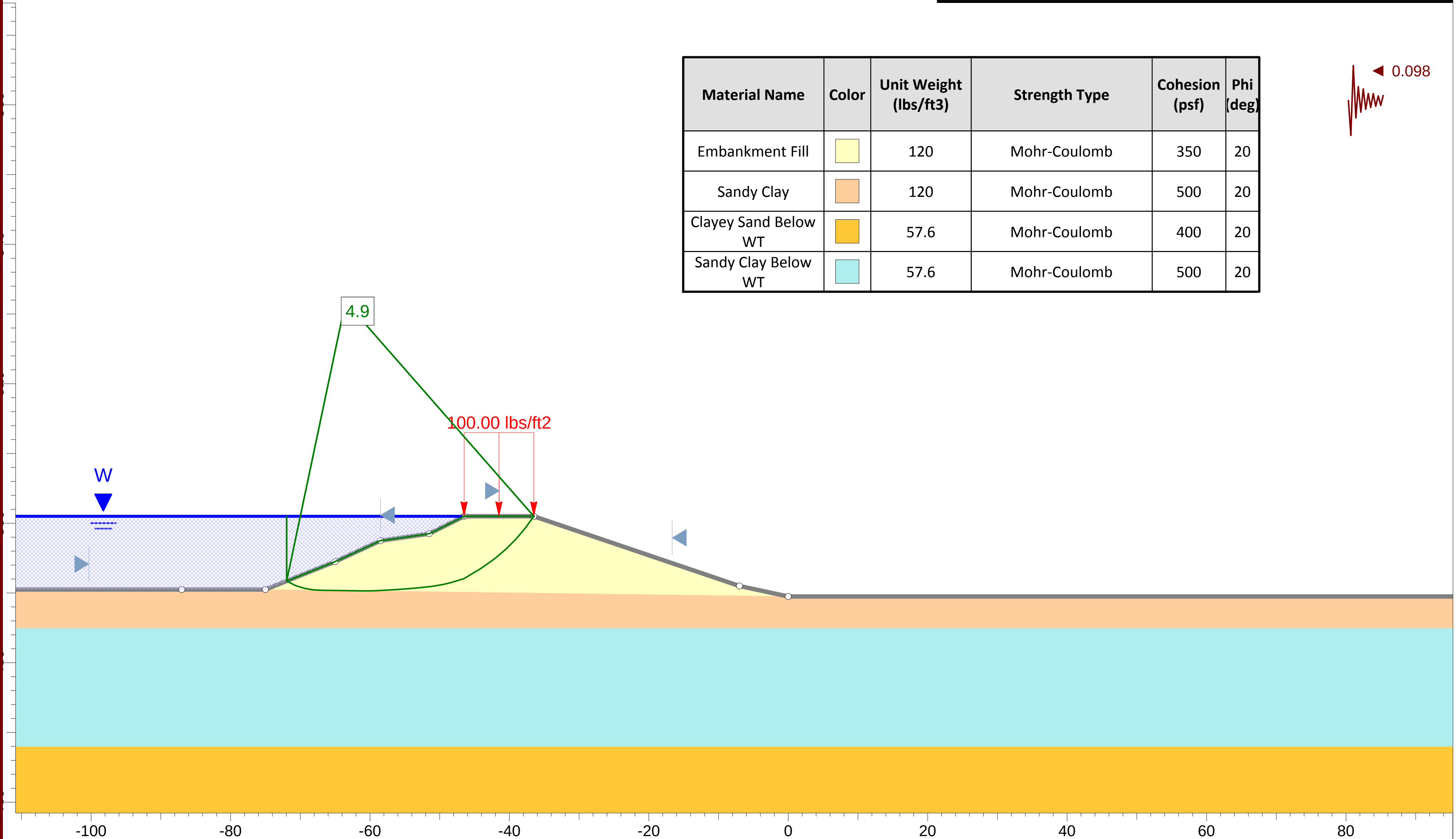
Figure D-36a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "I" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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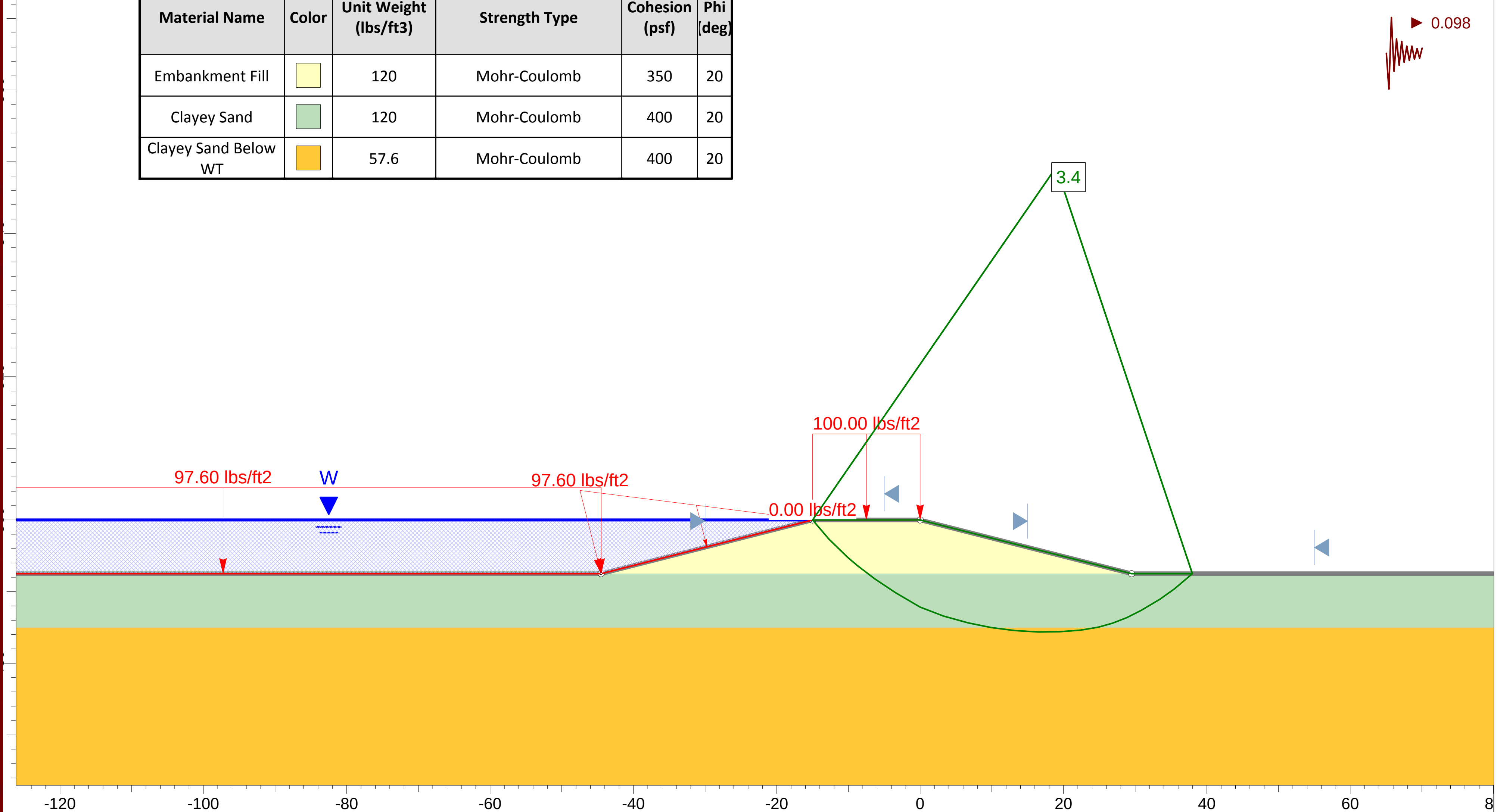
Figure D-36b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "J" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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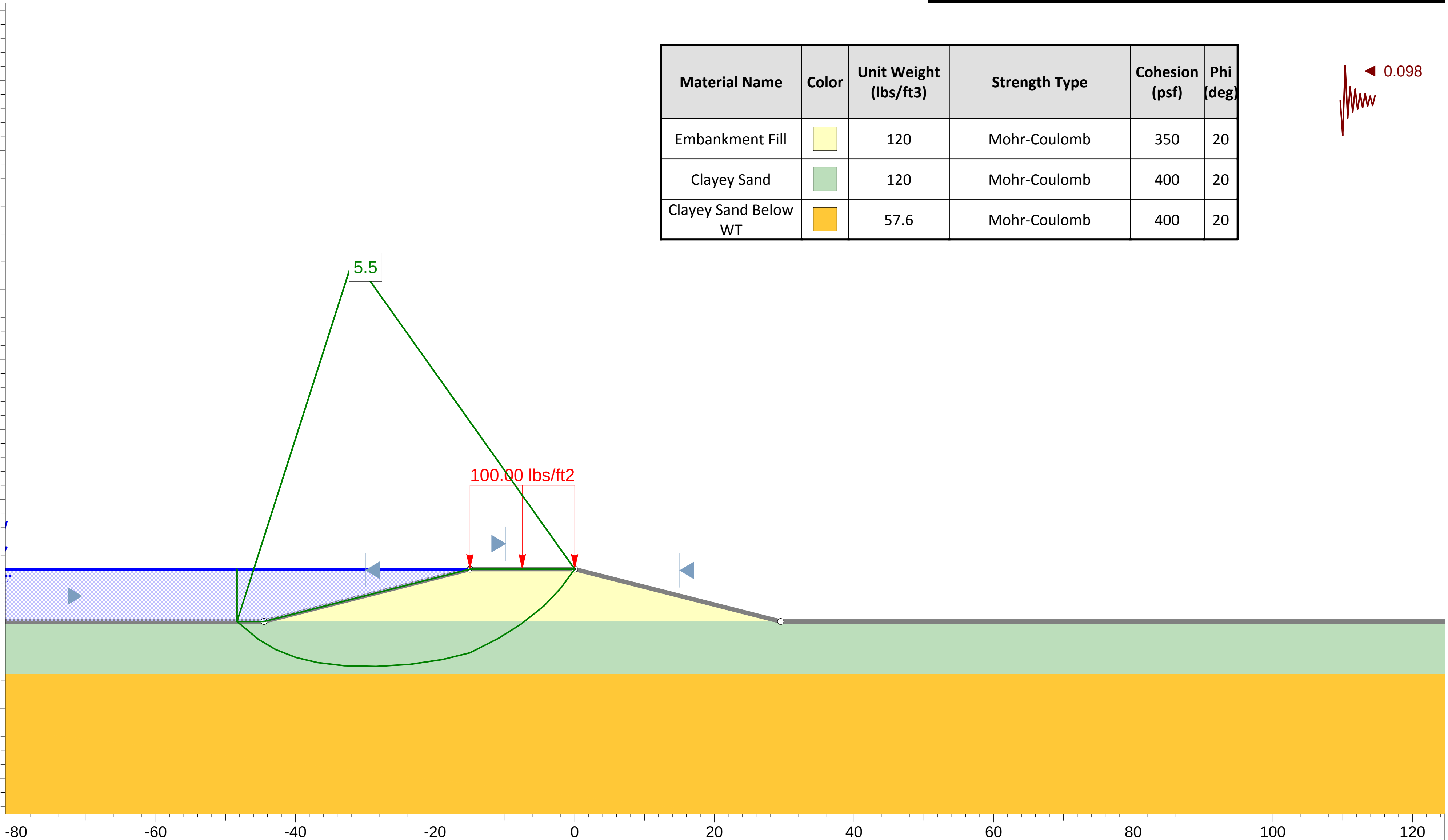
Figure D-37a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "J" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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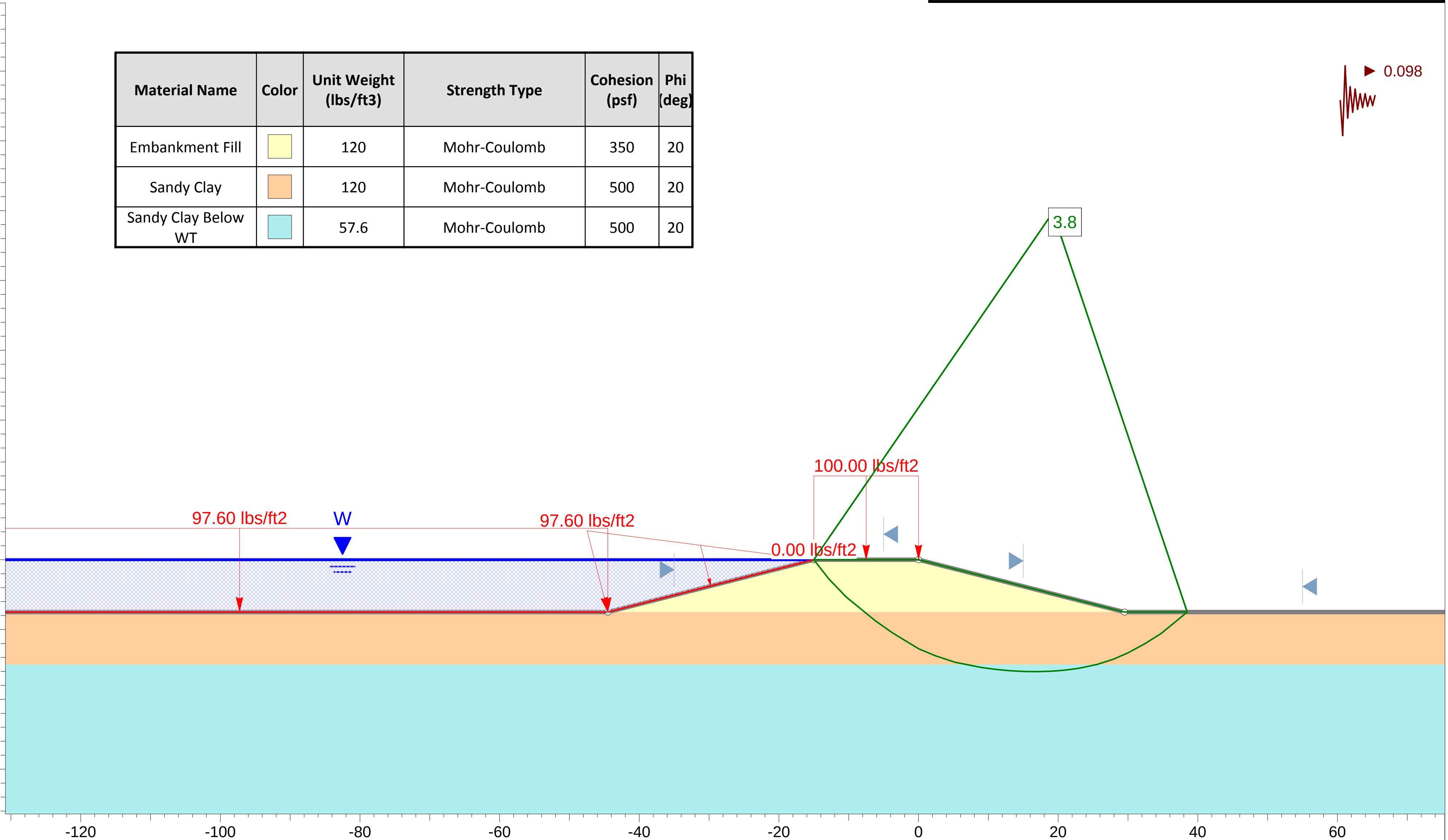
Figure D-37b

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "K" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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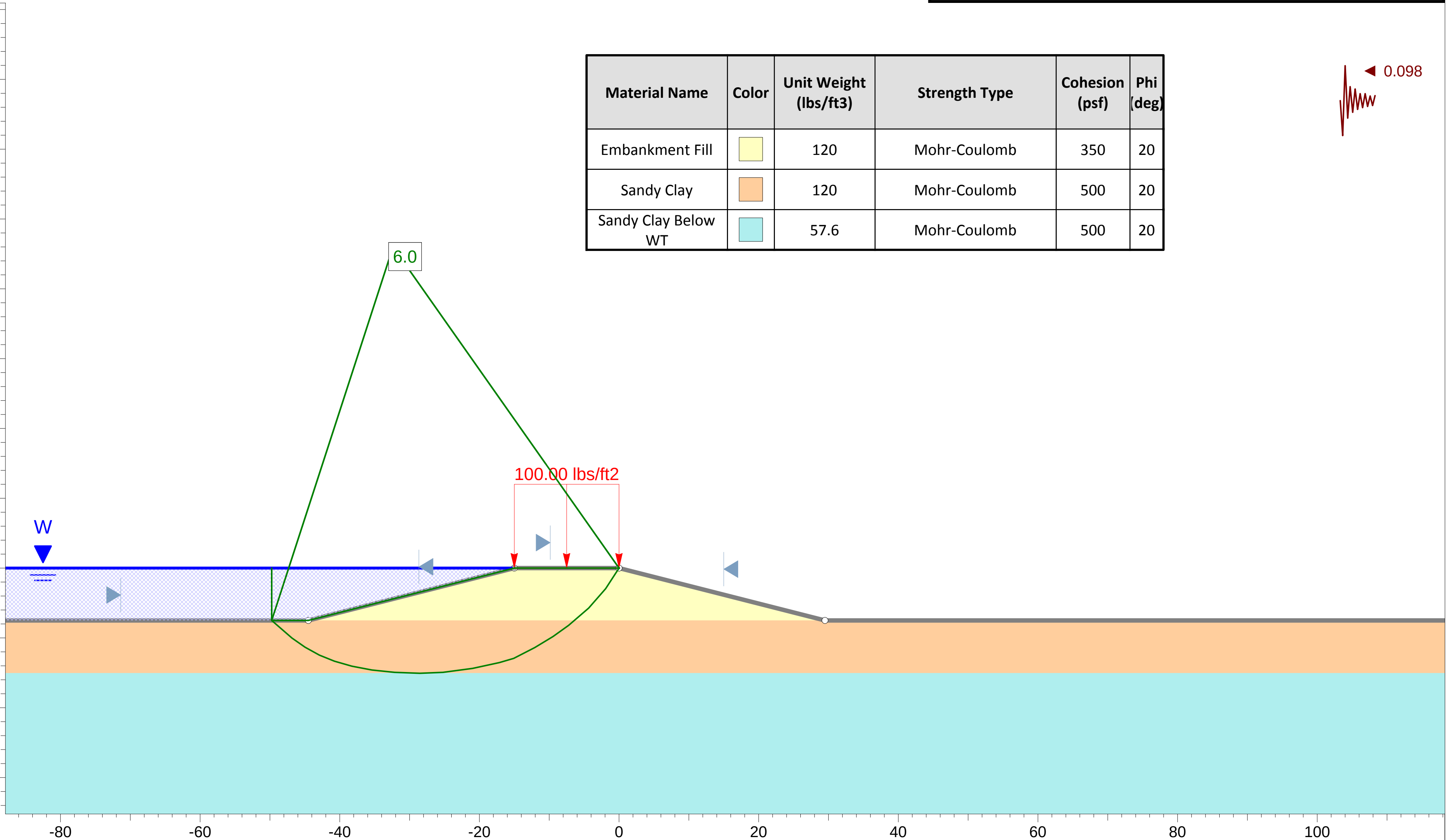
Figure D-38a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "K" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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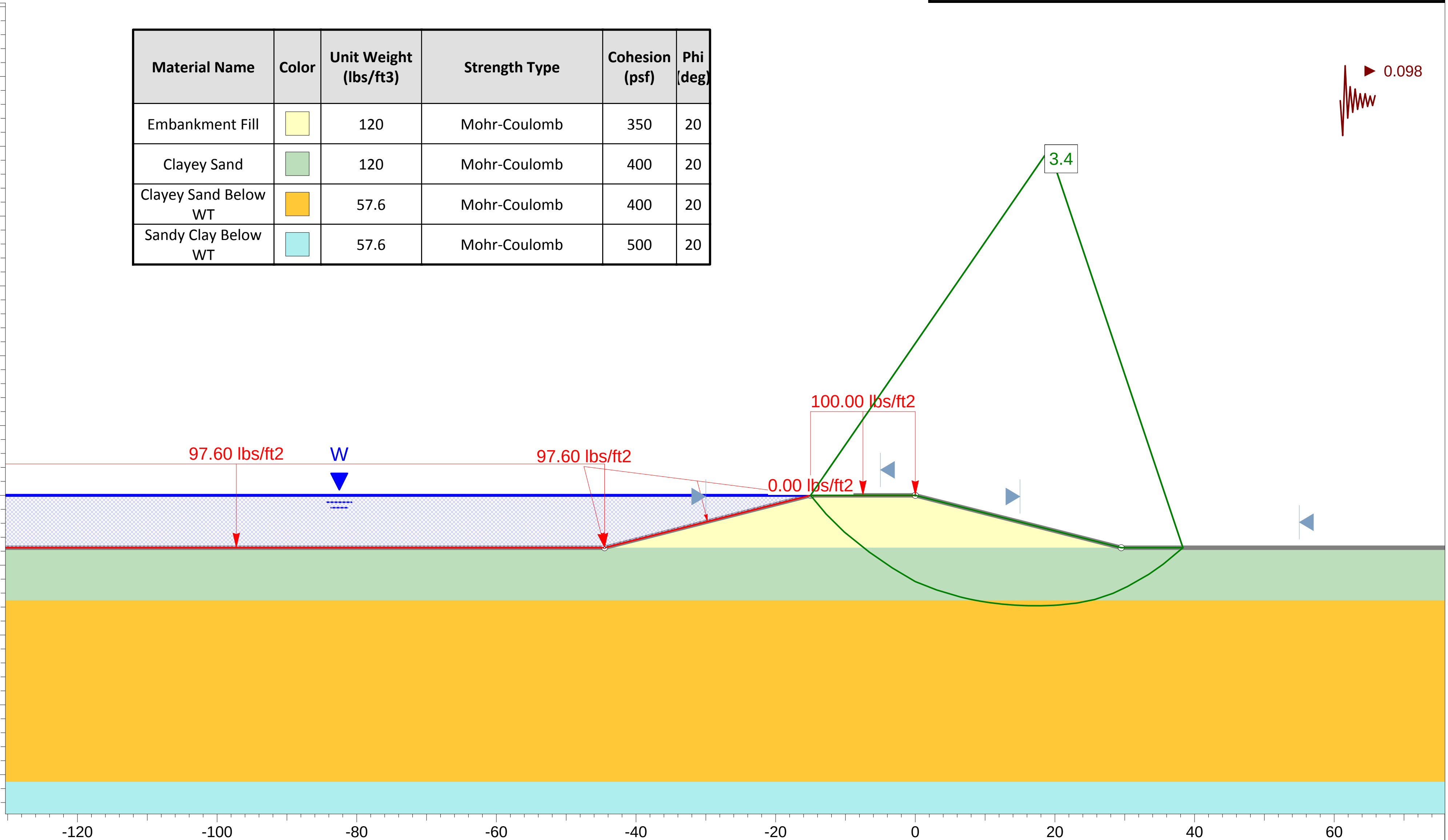
Figure D-38b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "L" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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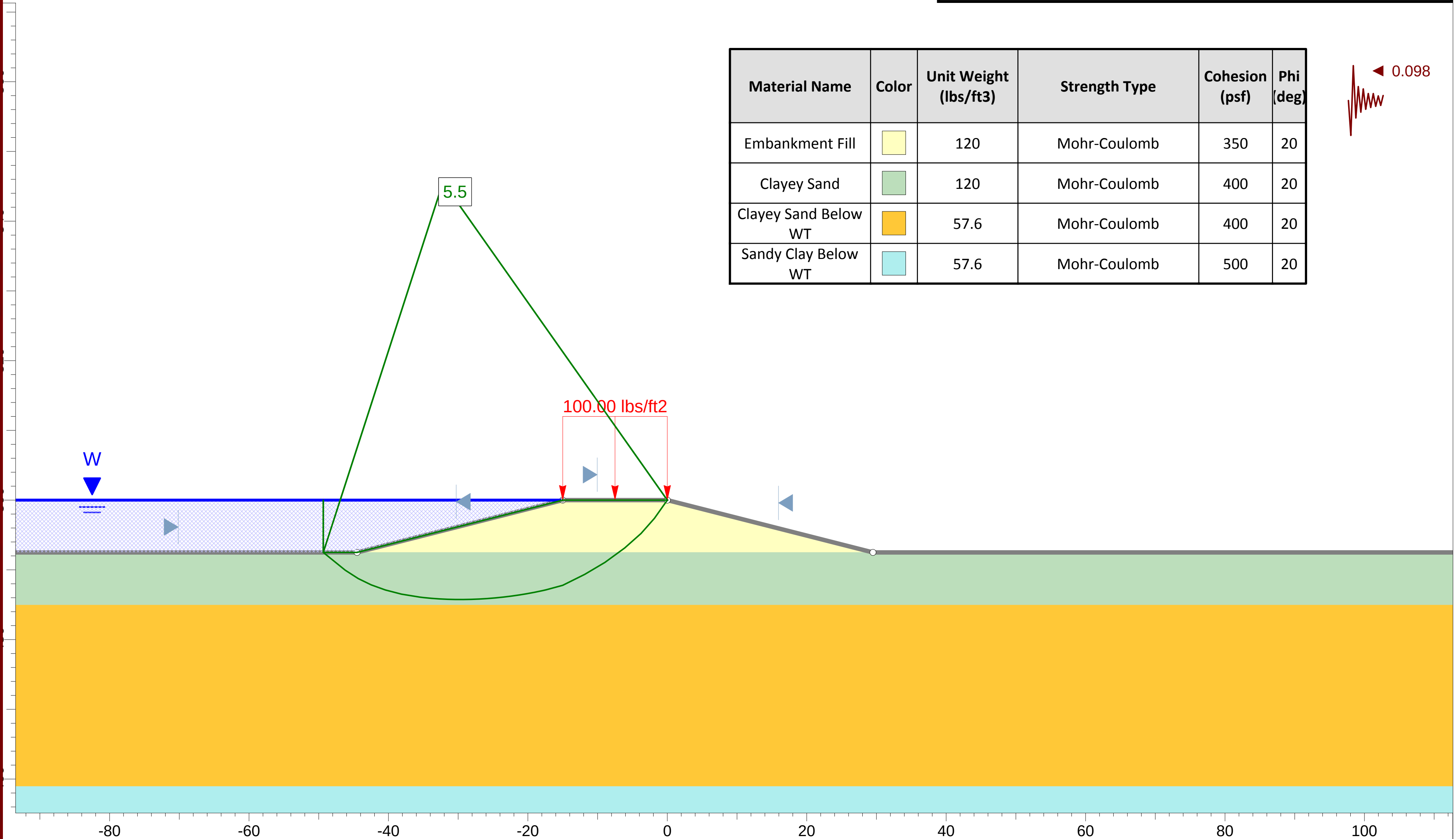
Figure D-39a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "L" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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Figure D-39b

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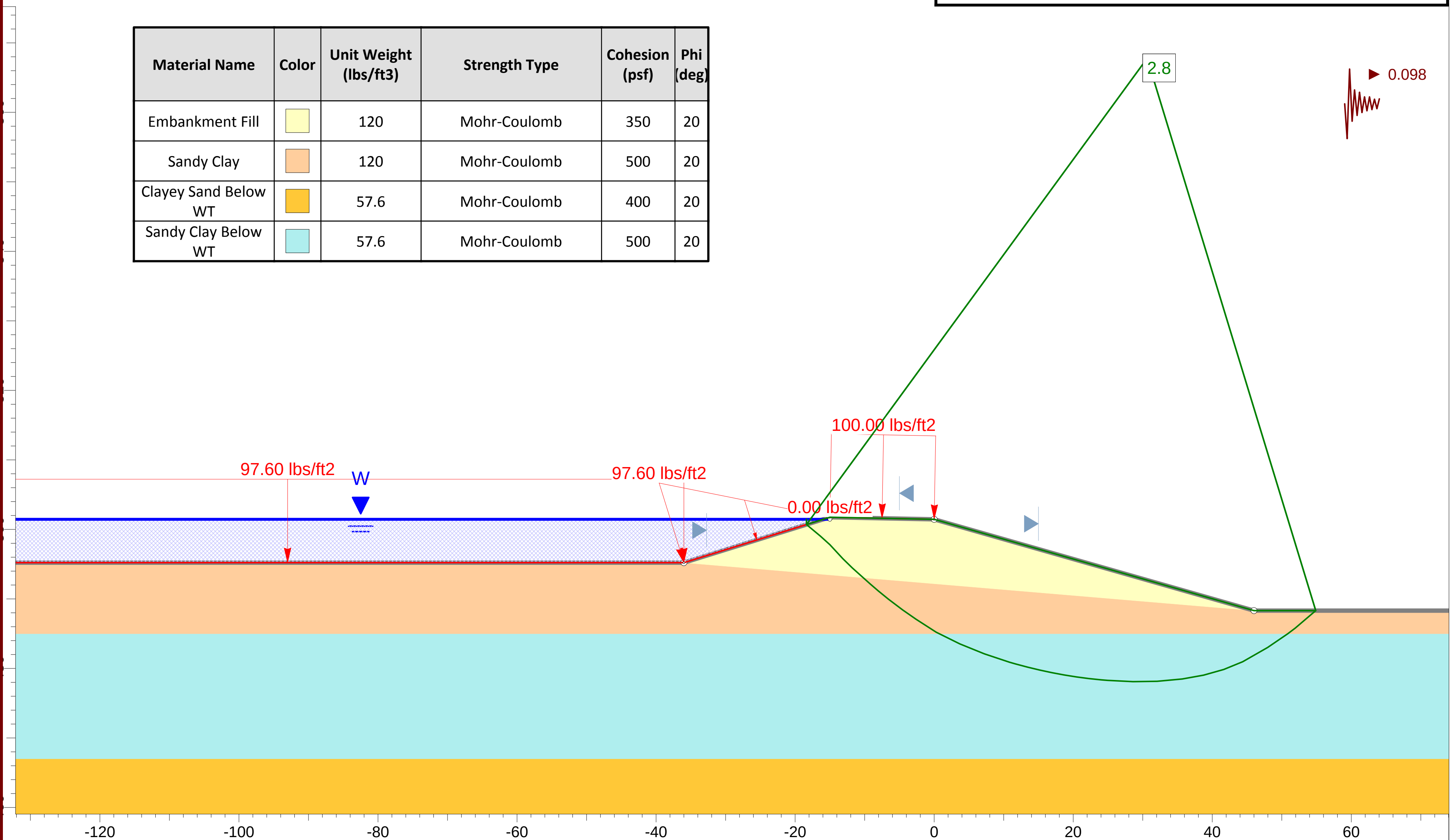
Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "M" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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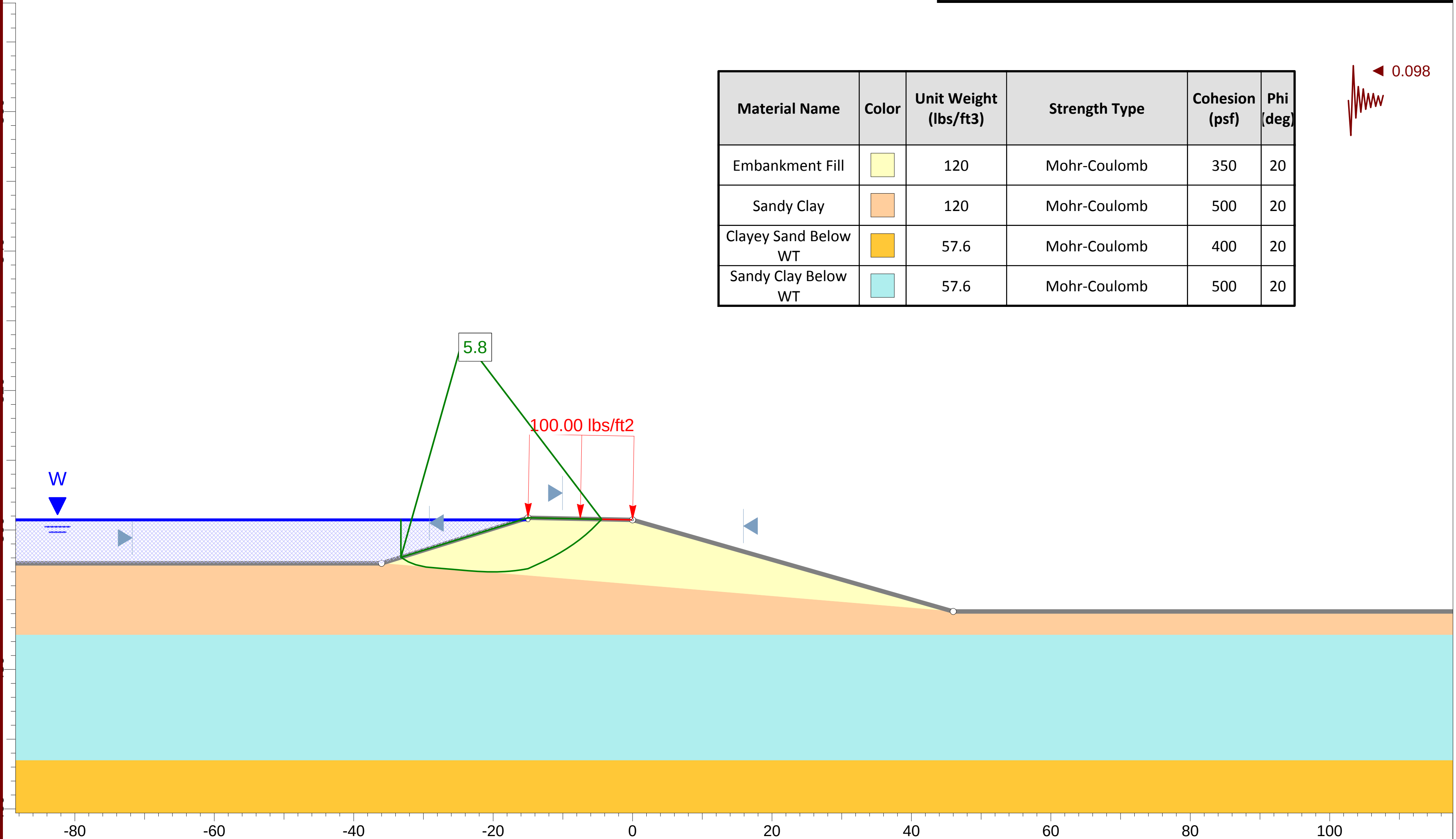
Figure D-40a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Sandy Clay		120	Mohr-Coulomb	500	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20
Sandy Clay Below WT		57.6	Mohr-Coulomb	500	20



Profile "M" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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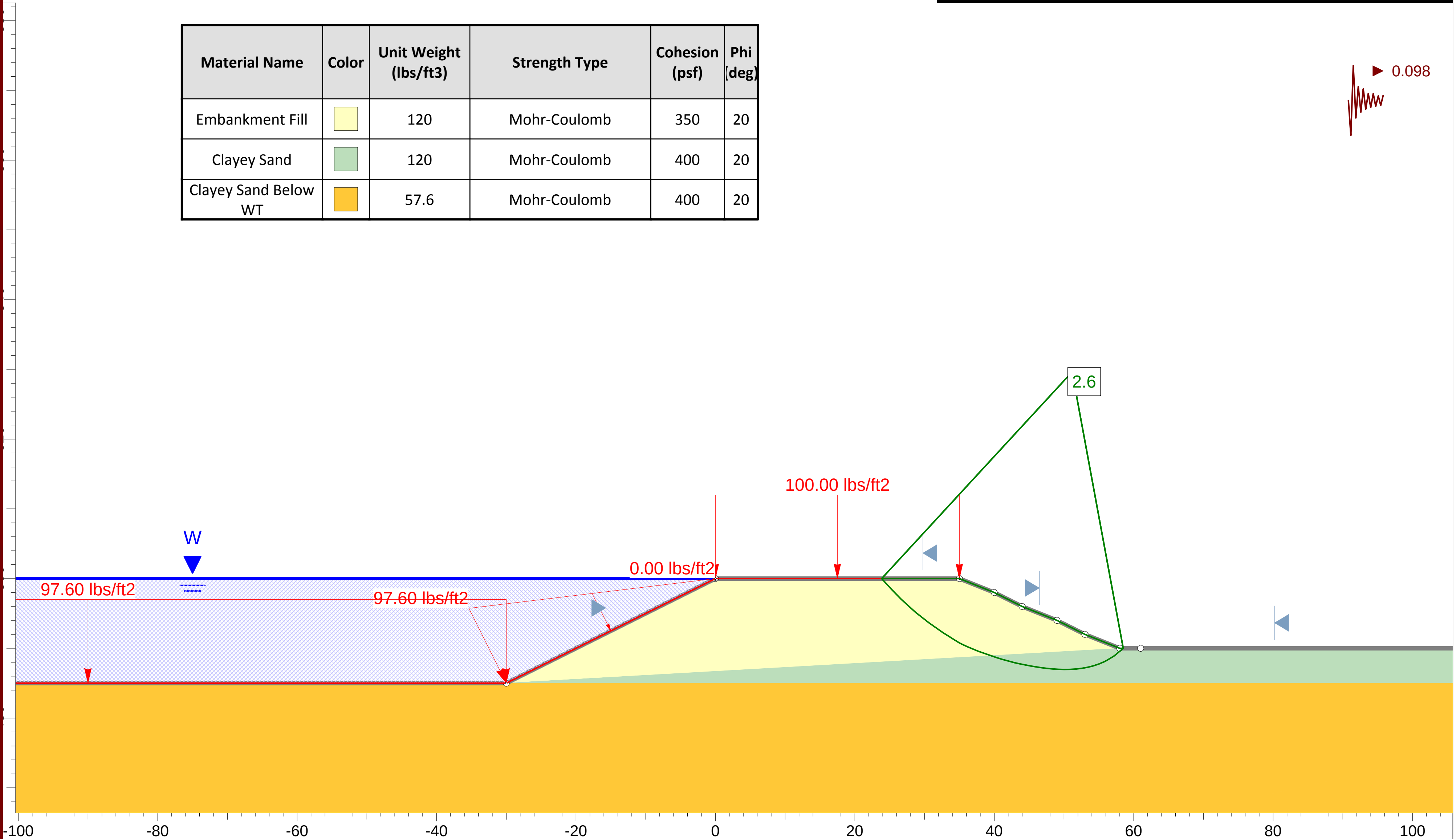
Figure D-40b

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "N" - Maximum Pool
Ash Pond Berms - Spruce/Deely Generation Units

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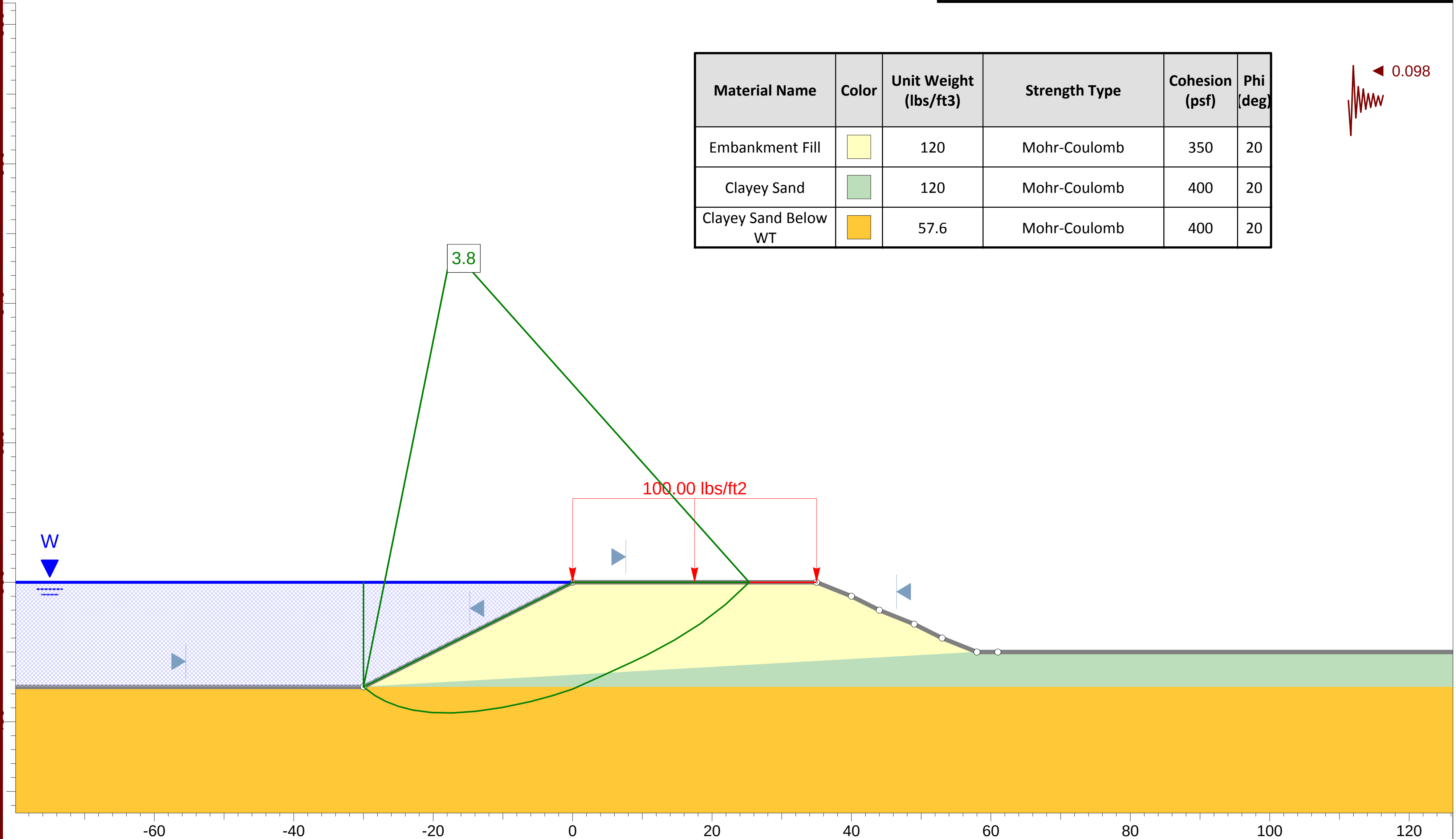
Figure D-41a

RABA KISTNER CONSULTANTS

Global Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		120	Mohr-Coulomb	350	20
Clayey Sand		120	Mohr-Coulomb	400	20
Clayey Sand Below WT		57.6	Mohr-Coulomb	400	20



Profile "N" - Maximum Pool
Ash Pond Berms - Calaveras Lake Power Plant

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Figure D-41b

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