SOUTH CAROLINA ELECTRIC & GAS

LOCATION RESTRICTIONS:
FAULT AREAS,
SEISMIC IMPACT ZONES,
& UNSTABLE AREAS

FOR THE

WATEREE STATION FGD POND

RICHLAND COUNTY, SOUTH CAROLINA

OCTOBER 2018

PURPOSE

The purpose of this report is to demonstrate that the Wateree Station FGD Pond meets the Location Restriction requirements of the CCR Rule…

> *40 CFR Part 257 – Criteria for Classification of Solid Waste Disposal Facilities and Practices, Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments*

APPLICABLE REGULATIONS

§257.62 Fault Areas

(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that an alternative setback distance of less than 60 meters (200 feet) will prevent damage to the structural integrity of the CCR unit.

(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section.

(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of § 257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit.

(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e).

§ 257.63 Seismic Impact Zones

(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in seismic impact zones unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site.

(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section.

(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of § 257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit.

(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e).

§ 257.64 Unstable Areas

(a) An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted.

(b) The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:

(1) On-site or local soil conditions that may result in significant differential settling;

(2) On-site or local geologic or geomorphologic features; and

(3) On-site or local human-made features or events (both surface and subsurface).

(c) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section.

(d) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (d)(1) or (2) of this section.

(1) For an existing CCR landfill or existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment or existing CCR landfill who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (d)(1) of this section is subject to the requirements of § 257.101(b)(1) or (d)(1), respectively.

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit.

(e) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements

FGD POND DESCRIPTION

Wateree Station is a coal-fired electric generation plant located along the Wateree River near Eastover, Richland County, South Carolina. The FGD Pond is used to manage wastewater generated from the flue gas desulfurization scrubber system. The FGD pond was constructed in accordance with construction permit (permit 19263-IW) issued from the South Carolina Department of Health and Environmental Control (SCDHEC) on December 7, 2009, and placed into operation in accordance with an operation approval issued by DHEC on April 10, 2010. Effluent discharge for the FGD Pond is regulated under NPDES Permit #SC0002038.

The FGD Pond includes two forebays (1.1 and 1.15-acres), a primary settling pond, and a secondary settling pond.

DEMONSTRATIONS

A Geotechnical Evaluation was performed at Wateree Station to demonstrate that the FGD Pond meets the criteria of the regulations. The Appendix includes the results of the geotechnical evaluation presenting and certifying that the FGD Pond at Wateree Station…

a) is not located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time,
b) is designed and constructed to resist the maximum horizontal acceleration in lithified earth material for a facility located in a seismic impact zone, and
c) is not located in an unstable area.

CONCLUSION

The Wateree Station FGD Pond meets the requirements of CCR Rule §257.62 *Fault Areas,* §257.63 *Seismic Impact Zones,* and §257.64 *Unstable Areas* as demonstrated in the Appendix - *Geotechnical Evaluation* which is certified by a qualified professional engineer.

APPENDIX

GEOTECHNICAL EVALUATIONS

F&ME CONSULTANTS

October 13 2017

Ms. Amy Breshnahan, P.E.
SCANA Corporation
220 Operation Way
Cayce, South Carolina 29033

Re.: Location Restrictions for CCR Ponds
Wateree Station Power Generation Facility
Richland County, South Carolina
F&ME Project No.: G5739.00

Dear Ms. Breshnahan:

F&ME Consultants Inc. (F&ME) is submitting the enclosed Location Restrictions for CCR Ponds (PowerAdvocate Event 67204 : EA0003(2017)-Location Restrictions for CCR Ponds) demonstration which provides the seismic geotechnical evaluations and analysis of the existing Coal Combustion Residue (CCR) Surface Impoundments (ponds) located at the Wateree Station power generation facility in accordance with (IAW) 40 CFR 257.62, .63 and .64.

We appreciate the opportunity to provide you this requested report. Please contact us if you have any questions or need additional information.

Sincerely,

F&ME Consultants, Inc.

Michael S. Miller, P.E.
Senior Geotechnical Engineer

SOUTH CAROLINA REGISTERED PROFESSIONAL ENGINEER No. 20955 MICHAEL S. MILLER

Zane W. Abernethy, P.E.
President

SOUTH CAROLINA F&ME CONSULTANTS, INC. No. 4891 CERTIFICATE OF AUTHORIZATION

Summary of Findings

The following summarizes the method of investigations, results of our analyses, and conclusions for the Coal Combustion Residue (CCR) ponds designated as FGD #1, FGD#2, and Coal Ash Basin #1 located at the SCE&G Wateree Station power generation facility.

- F&ME performed on-site visual inspections of the CCR ponds and surrounding topography to verify conditions consistent with the provided mapping.
- The CCR ponds subject of this report are located in areas defined as Seismic Impact Zones.
- The CCR ponds subject of this evaluation are not located in Fault Areas.
- The CCR ponds subject of this demonstration are not located in areas defined as Unstable Areas.
- F&ME used soil data from previous field explorations and performed additional field investigations to adequately define subsurface soil conditions for use in seismic slope stability analyses.
- F&ME utilized provided CCR pond as-built/constructed plan sets and provided topographic survey mapping for development of embankment cross-section profiles used in our seismic slope stability models.
- F&ME performed seismic stability analyses utilizing two seismic horizontal ground motion values. One value was based on SCDHEC Regulation 61-107.19 SWM: Solid Waste Landfill. The second ground motion value was based on USGS Seismic Hazard Maps and represents current industry/engineering practice.
- The results of seismic slope stability analyses for the Wateree Station CCR Ponds designated as FGD #1, FGD#2, and Coal Ash Pond #1 meet design requirements when using SCDHEC and current USGS Hazard Map values for selection of seismic maximum horizontal acceleration values.

Introduction

Our scope of work is to provide the requested seismic and static evaluations of the following Coal Combustion Residuals (CCR) surface impoundments (ponds) as listed in the RFP for the Wateree Station power generation facility:

- FGD Pond #1
- FGD Pond #2
- Coal Ash Basin #1

Our proposal included providing SCE&G evaluations of proximity of seismic fault areas, seismic impact zones, seismic stability analysis if CCR units are classified as located in seismic impact zones, and evaluation of any unstable areas, as defined by applicable regulations, in the areas of the above listed ponds. F&ME utilized accepted industry standards, the latest field investigation and the state-of-the-art analytical tools to gather additional field subsurface data and to conduct our stability analysis.

F&ME is in receipt of the documents provided by SCE&G via the Poweradvocate Website. The information in these documents was utilized to initially develop the work plan and was used in our analysis.

Scope of Work

For each CCR pond listed above, F&ME has performed an evaluation of the existing dike containment systems to meet the objectives of 40 CFR Part 257 – Criteria for Classification of Solid Waste Disposal Facilities and Practices – Subpart D - Standards for the disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. The specific CFR subsections addressed in this demonstration are as follows:

1. Subsection 257.62 Fault Areas;
2. Subsection 257.63 Seismic Impact Zones; and,
3. Subsection 257.64 Unstable Areas (Non-seismic related settlements)

In order to accomplish this task, F&ME performed the following:

1. A visual reconnaissance of the subject CCR ponds;
2. Submit a soil test location plan for SCE&G approval;
3. Comparison of observed conditions with provided topographic information;
4. Development of design cross sections based upon the provided data;
5. Performing field investigations and obtaining additional subsurface data;
6. Determining the design earthquake intensity (per SCDHEC & EPA);
7. Analyzing the impact of the design earthquakes on the material strength properties of the embankment and foundation soils;
8. Determining CCR pond embankment global stability factors of safety for the various ponds physical configurations and cross sections for static and seismic loading conditions; and,

9. Comparison of the calculated slope stability safety factors with the requirements of SCDHEC regulations 61-107.19 SWM and EPA/600/R-95/051.

Site Geology

The project site is geographically located near the town of Eastover in Richland County, South Carolina and is situated near the boundary between the Middle and Upper Coastal Plain Physiographic Provinces. The Coastal Plain consists of a wedge of sedimentary deposits, which starts at the Fall Line and becomes progressively thicker moving toward the Coast. The deposits in this area generally consist of sands, silts, and clays, which have eroded from the Piedmont Province. Some of these sedimentary materials have been consolidated/indurated and are expressed as siltstone and mudstone. This wedge of sedimentary materials overlying the crystalline rocks of the Piedmont is approximately 650 feet thick in the project area. The site is also situated north of the confluence of the Wateree and Congaree Rivers. Both rivers have influenced the local geology of the site, and repeated meanderings of the river systems over time have deposited various sedimentary sequences including channel deposits (clean sands and gravels) and flood plain deposits (silt and clay materials).

The site is overlain by the shallow surface Congaree River Valley Terrace Complex (layered fluvial deposits) and underlain by the Sawdust Landing Formation. The Sawdust Landing Formation is generally consolidated sandy clay/clayey sand and functions as an aquitard below the surficial aquifer, preventing/limiting downward flow. The depth to this formation varies across the site, from approximately 25 feet below ground surface along the Wateree River to approximately 50 feet to the southwest of Ash Pond No. 2. This southwest dip of the Sawdust Landing Formation was probably cut down due to the past meandering of the Congaree River.

Site Seismicity

The records for seismic activity in the southeastern United States cover a span of about 300 years and consist mostly of non-instrumented data. The seismic activity in the southeast is also infrequent. Because of the infrequency of southeastern earthquakes and the lack of statistical data, little basis exists for development of typical seismic design response spectrums. Unlike earthquakes of California, southeastern earthquakes have not caused ground surface ruptures, which make it difficult for geologists to predict active fault locations.

The earthquake that occurred in 1886 in the Coastal Plain Physiographic Province near Charleston, South Carolina dominates the seismic history of the southeastern United States. It is the largest historic earthquake in the southeastern United States with an estimated moment magnitude, M_W, of 7.3 (Richter scale). The resulting earthquake damage area with a Modified Mercalli Intensity Scale of X (X being the highest degree of ground shaking and damage to structures on the Mercalli Scale) is an elliptical shape approximately 20 by 30 miles trending northeast between Charleston and Jedburg, South Carolina, including Summerville and roughly centered at Middleton Place. The intraplate (i.e. areas of the earth's crustal tectonic plates not associated with plate-to-plate tectonic boundaries) epicenter of the 1886 Charleston earthquake and its magnitude is not unique in the central and eastern United States. Other intraplate earthquakes include those at Cape Ann, Massachusetts (1755) with a M_W of 5.9, and Madrid, Missouri (1811-1812) with M_W of at least 7.7.

US Geological Survey methodology and mapping were utilized to establish ground accelerations for our analysis. The data utilized in our analysis is discussed further in this report.

Field Exploration

Two (2) Standard Penetration Test (SPT) borings, labeled boring SPT-1 and SPT-2, were conducted on August 24, 2017. The approximate boring locations can be seen on the boring location plan (Figure 2) provided in Attachment 1. The test boring's ground surface elevations and boring locations were measured with Trimble R6 GPS equipment and should be considered approximate.

A CME 45B trailer mounted drill rig was used to perform the soil test borings. SPT drilling was performed using hollow stem auger drilling methods to maintain stable borehole conditions. SPT sampling was performed continuously in the top ten (10) feet and at five-foot intervals throughout the remaining depth of the test boring. The SPT sampling was performed in general accordance with ASTM D1586. Both borings SPT-1 and SPT-2 were drilled to a planned termination depth of fifty (50) feet below existing ground surface.

Soil samples were collected from split-spoon samples during SPT boring. The collected soil samples were visually classified and logged in the field by F&ME personnel and sealed in plastic bags for transport to F&ME's laboratory. The soil samples were visually classified based upon the Unified Soil Classification System (USCS).

Groundwater measurements were made following test boring completion and following 24 hours from boring completion. The bore holes were then cement grout backfilled after performing the 24-hour groundwater measurements.

Soil Stratigraphy

The below soil descriptions, strata depths, and consistencies are generalized and were interpreted by F&ME based on the subsurface conditions as encountered in the test borings SPT-1 and SPT-2 performed during this phase of exploration. We have included the soil test boring logs in Attachment 1 for detailed descriptions of the encountered soil conditions.

Both soil test borings SPT-1 and SPT-2 were located in the gravel access road constructed at the top of the existing CCR pond berms. Following boring penetration of the gravel road (gravel thickness of 6 to 8 inches), both borings encountered existing embankment fill material which was classified as a low plasticity sandy CLAY (CL). Standard Penetration Test values (i.e. N-values) recorded in this clay soil fill material ranged from 4 to 17 blows per foot (bpf). The embankment fill material extended to a depth of approximately 9 feet below the top of the existing embankment crest. The borings then encountered a silty SAND (SM) layer which is also believed to be the basal unit of the existing embankment fill zone. This sandy fill soil layer is approximately 4-1/2 feet thick and exhibited N-values of 4 and 5 bpf.

Below the embankment fill material, the borings encountered natural alluvial sandy CLAY (CL) and clayey SAND (SC) soils. These alluvial clay/sand soils extended to depths of 18.5 feet and 23.5 feet below top of ground surface in SPT-1 and SPT-2, respectively. N-values in these clay/sand soils ranged from 4 to 12 bpf.

Below the clayey soils, the natural soil stratigraphy generally exhibited a decreasing plasticity constituency transitioning into SAND with clay (SP-SC) and silty SAND (SM) to depths ranging from approximately 33.5 to 38.5 feet below existing ground surface. N-values recorded in the sandy soil strata ranged from 8 to 23 bpf.

Prior to the boring terminations at depths of 50 feet below ground surface, boring SPT-1 encountered very high consistency clayey SAND (SC) and silty SAND (SM), with boring SPT-2 encountering sandy SILT (ML) and CLAY (CL). N-values recorded in these high consistency sand, silt and clay layers ranged from 12 to 50 bpf.

We would note that as with any geologic formation, the depth and thickness of the soil strata will vary across the site. Although the test borings designate strata changes at specific depths on the soil test boring logs, transitions between soil strata are generally gradual. Therefore, the above soil stratigraphy description and the outlined subsurface profile shown on the soil test boring logs should only be considered general on-site soil conditions and should not be utilized as an absolute indicator.

<u>Groundwater</u>

At the time of boring, groundwater was encountered in both borings SPT-1 and SPT-2. Groundwater measurements were performed at the time of boring (T.O.B.) and following twenty-hours from completion of the boring. The 24-hour groundwater measurement is considered indicative of stabilized groundwater conditions.

At the time of boring, groundwater was recorded at depths of forty-four point seven (44.7) feet and twenty-four (24.0) feet in test boring SPT-1 and SPT-2, respectively, below existing ground surface. Allowing 24 hours from boring completions, the recorded depth to groundwater was at seventeen (17) feet in test boring SPT-1. In SPT-2 the borehole caved at a depth of sixteen (16) feet below ground surface and water was not present to this cave-in depth.

It should be noted that groundwater levels will naturally fluctuate from season to season and will also be influenced by Wateree River stage.

FAULT AREA EVALUATION

F&ME has performed a regional seismic fault evaluation in accordance with the requirements listed in the regulations and guidance documents for the Wateree Station CCR ponds subject of this demonstration. The fault area location restrictions imposed by CFR Subtitle D (257.62), in part, restrict siting of existing and new CCR surface impoundments, and all lateral extensions of

CCR units must not be located within 200 feet of the outermost damage zone of a fault that has had displacement in Holocene time. The Holocene time period extends to approximately 10,000 to 12,000 years before present time.

Based on our review of seismological studies of seismogenesis east of the Rocky Mountains, the region of capable faults which may result in actual ground surface ruptures is excluded from Eastern United States. The current consensus is that earthquake source zones or hypocenters in the Eastern United States are related to subsurface crustal structures which occur at relatively deep depths such that surface expressions of the faulting cannot or do not result. No surface ruptures or displacements related to earthquake faulting have been identified at or near the Wateree Station CCR ponds vicinities.

SEISMIC IMPACT ZONE EVALUATION

F&ME has performed a seismic impact zone evaluation in accordance with the requirements listed in the regulations and guidance documents for the Wateree Station CCR ponds subject of this report. The seismic impact zones location restrictions imposed by CFR Subtitle D (257.63), in part, restrict siting of existing and new CCR surface impoundments, and all lateral extensions of CCR units must not be located in seismic impact zones unless the owner or operator demonstrates that all structural components are designed to meet the maximum horizontal acceleration in lithified earth material for the site.

The determination as to if the Wateree Station CCR ponds subject of this demonstration is based on earthquake probability maps prepared by the United States Geological Survey (USGS). Seismic impact zones are defined in the regulations as those regions shown on this map as having a peak bedrock acceleration exceeding 0.1g based on a 90% probability of non-exceedance over a 250 year time period (approximately a 2,475-year return period event).

Review of the referenced USGS Impact Zones mapping for determination of site seismic impact zone designation indicates the Wateree Station existing CCR ponds subject of this report are located in a seismic impact zone.

Design Analyses Methodologies

Due to the Wateree Station CCR ponds being located in a region defined as a seismic impact zone, F&ME has performed seismic analyses in accordance with the requirements listed in the following regulations and/or guidance documents:

> SCDHEC Regulation 61-107.19 SWM: Solid Waste Landfills and Structural Fill (May 23, 2008), Part V. Class Three landfills, Subpart D Design Criteria for Class 3 Landfills, 258.40 Design, Subparagraph r; and,
>
> EPA RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Faculties (EPA/600/R-95/051 – April 1995).

Within seismic impact zones, the regulations, in part, require that that the waste containment systems for all existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in seismic impact zones unless the owner or operator demonstrates that all structural components are designed to resist the maximum horizontal acceleration in lithified earth material for the site.

Seismic Design Ground Motions

Each of these regulations and/or guidance documents utilize slightly different methodologies or references in estimating the design peak ground acceleration (PGA) value for use in seismic stability analyses. F&ME has reviewed SCDHEC and EPA recommended guidance sources for estimation of seismic motions at the subject CCR pond locations and are providing the following PGA values (expressed as a percentage of gravity) in Table 1:

Table 1 - Peak Ground Acceleration (PGA) Values

Reference	Recurrence Interval	PGA[1] (g)	Site Coefficient F_{PGA}[2]	Design PGA (g)
SCDHEC – USGS Open-File Report No. 82-1033 - Plate 3 (USGS 1982)	90 Percent Probability of not being Exceeded in 250 Years (1 in ~2,500 Year Event)	0.23	1.202	0.276
F&ME Structural Stability Report (June 22, 2010) – USGS Hazard Maps	2 Percent Probability of being exceeded in 50 Years (1 in ~2,500 Year Event)	0.361	1.15	0.41
USGS Hazard Map – 2015 NEHRP Provisions	2 Percent Probability of being exceeded in 50 Years (1 in ~2,500 Year Event)	0.222	1.378	0.305

[1] Rock Outcrop PGA (i.e. B-C Boundary)
[2] Site Coefficient based on Seismic Site Class D.

The PGA value listed in the above table referenced to F&ME's Structural Stability Report was utilized in our seismic stability analyses for Coal Ash Basin #1 and was based on USGS Hazard Maps at the time that that slope stability analyses and reporting was performed (June, 2010). We note that estimated maximum PGA values recommended to be used in seismic analysis which are based on current USGS Hazard Maps are lower than those used during our 2010 stability analyses for Coal Ash Basin #1. As presented in the following section, results from the Coal Ash Basin #1 seismic stability analyses were determined as having adequate factors of safety using the 2010 greater PGA value.

Slope Stability Evaluations

As referred to in the above demonstration section, F&ME had performed slope stability analyses of the existing Coal Ash Basin #1 embankments at the locations requested by SCE&G under this scope of work. We have attached a copy of this previous report to this as Attachment 3. The following Table 2 and Table 3 summarize the results of our static and seismic slope stability analyses as presented in our slope stability analyses for Coal Ash Basin #1.

Table 2 – Coal Ash Basin #1 Static Slope Stability

Coal Ash Basin #1 - Static Stability Summary Table	
Station	FOS
12+00	2.50
18+00	2.21
33+00	2.89

Table 3 – Coal Ash Basin #1 Seismic Slope Stability

Coal Ash Basin #1 - Seismic Stability Summary Table			
Seismic Input Reference	Design MHA (g)[1]	Station	FOS
F&ME Structural Stability Report (June 22, 2010) – USGS Hazard Maps	0.205	12+00	1.08
		18+00	1.18
		33+00	1.38

[1]MHA = Maximum Horizontal Acceleration = 0.5 x Design PGA

With respect to FGD Ponds #1 and #2, multiple cross sections were developed to analyze CCR pond embankments and the "most critical" cross section/failure plane was determined for FGD Pond #1 and FGD Pond #2. These cross sections were developed utilizing provided topographic and geological data (utilizing both provided and newly developed geotechnical information) at each of the selected locations for each subject CCR pond.

F&ME used the computer software program SLIDE for static and seismic stability analyses of the CCR pond embankments. Given non-lithified soil conditions extending to depths below reasonable failure plane generation, circular failure planes were defined in in evaluating global stability. The Modified Bishops method was used in calculating the factor of safety (FOS) for circular failure surfaces. We have included the SLIDE generated stability analyses output sheets in Attachment 2 of this demonstration which depicts slope/subsurface geometries, soil stratigraphy, and soil unit weights and strength parameters used in our analyses.

For static slope stability analyses of FGD Pond #1 and FGD #2, a uniform live load (LL) of two-hundred fifty (250) pounds per square foot (psf) was modeled as being applied to gravel access roads located at the top of the pond embankments. LL was neglected in seismic slope stability analyses model.

In our seismic slope stability analyses of the CCR embankments the maximum horizontal acceleration (MHA) value used in our analyses was calculated as being one-half the design PGA value as listed in Table 1. This reduction in the maximum PGA value by one half is outlined in RCRA Subtitle D seismic design guidance documents and is based on studies in which a hypothetical yield acceleration (i.e. seismic ground acceleration value resulting in a FOS = 1.0) equal to half the maximum PGA value would experience permanent seismic deformations of less than a foot. Any permanent seismic deformations resulting from the design seismic event with a calculated minimum FOS of 1.0 are considered as being within typical acceptable deformation limits used in practice in the design of geosynthetic liner systems.

Table 4 and Table 5 summarize the results from our static and seismic slope stability analyses of FGD Pond #1 and FGD Pond #2.

Table 4 – FGD Ponds Static Slope Stability

Static Stability FOS	
FGD Pond #1	FGD Pond #2
4.89	4.06

Table 5 – FGD Ponds Seismic Slope Stability

Seismic Input Reference	Design MHA (g)[1]	Seismic Stability FOS	
		FGD Pond #1	FGD Pond #2
SCDHEC – USGS Open-File Report No. 82-1033 - Plate 3 (USGS 1982)	0.138	2.85	2.90
USGS Hazard Map – 2015 NEHRP Provisions[2]	0.153	2.69	2.77

[1]MHA = Maximum Horizontal Acceleration = 0.5 x Design PGA

Current industry standard for minimum acceptable FOS for static slope stability condition is 1.3. Coal Ash Basin #1, FGD Pond #1 and FGD Pond #2 all meet this current static slope stability design criteria.

The industry standard, as well as current minimum criteria FOS as stipulated in CFR 40, Part 257 for seismic slope stability design/analysis, is 1.0. Based on the our seismic slope stability analysis the existing CCR pond embankments subject of this demonstration located at the SCE&G Wateree Station power generating facility meet minimum factors of safety for seismic conditions.

UNSTABLE AREA EVALUATION

F&ME has evaluated subsurface/foundation conditions in accordance with the requirements listed in the regulations and guidance documents for the Wateree Station CCR ponds subject of this report for demonstrating if existing CCR units are located in unstable areas. The unstable area classification restrictions imposed by CFR Subtitle D (257.64), in part, restrict siting of existing and new CCR surface impoundments, and all lateral extensions of CCR units must not be located in an unstable area unless the owner or operator demonstrates that all structural components are designed to ensure the integrity of the structural components of the CCR unit will not be disrupted.

F&ME's evaluation of unstable area classification considered on-site or local soils conditions that may possibly result in significant differential settlement, on-site or local geologic or geomorphological features, and/or on-site or local man-made features or events (both surface and subsurface) that might disrupt existing CCR units.

The Wateree Station CCR units subject of this study are existing structures and any settlements (total and differential) associated with past increased vertical loadings from CCR embankment construction has already occurred. No additional settlements that might impact structural components or disrupt CCR functionality is possible given time span since original CCR pond construction.

In addition to evaluation of settlements imposed by the CCR structure itself, there are no known or documented geomorphological conditions to include karst features such as sinkholes or other subsurface dissolution cavities that would result in any significant future settlements.

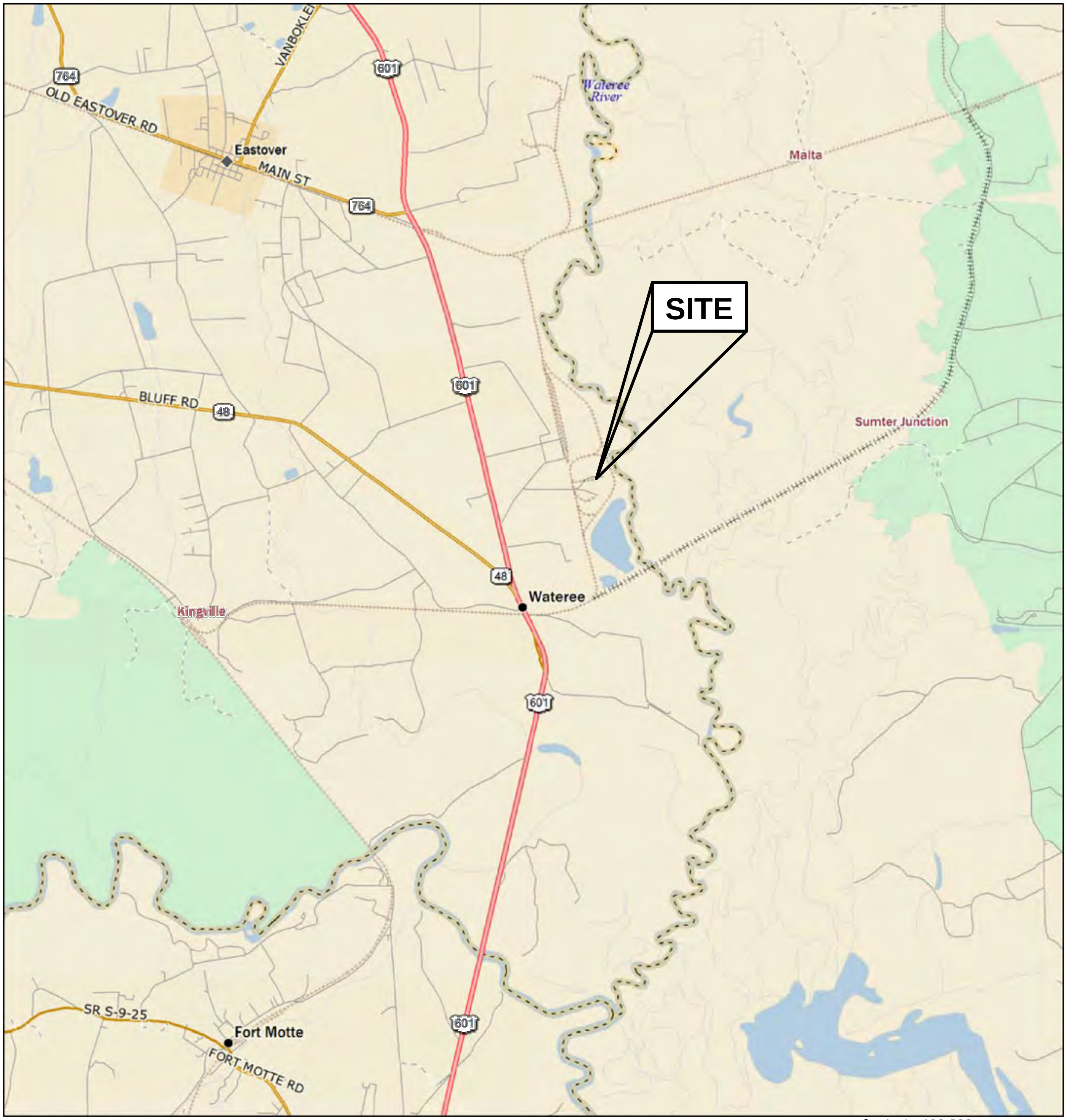
There are no known man-made surface or subsurface features such as mine tunnels (either abandoned or active), quarry pits, etc. located in or below the areas of the existing CCR ponds subject of this study located at the Wateree Station power generation facility which would result in unstable conditions.

Attachment 1

Figure 1 – Site Location Map

Figure 2 – Test Boring Location Plan

Soil Test Boring Logs SPT-1 and SPT-2



TN
MN (7.5°W)

Scale 1 : 100,000
0 ½ 1 1½ 2 mi
0 1 2 3 4 km
1" = 1.58 mi   Data Zoom 11-0

F&ME
CONSULTANTS
GEOTECHNICAL – ENVIRONMENTAL – MATERIALS
COLUMBIA, SOUTH CAROLINA

SCE&G WATEREE STATION
EASTOVER, SC

SITE LOCATION MAP

F&ME JOB NO. G5739

SCALE = As Noted

FIGURE 1

REV.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO.______ DATE ________
DWG. CTC DATE 8/15/2017 GROUP____ – _____
R/W ______ DATE ________

Test No.	Test Type	Northing	Easting	Latitude	Longitude	Elevation (FT-MSL)
SPT-1	STB	724947.086	2113398.952	33.8253041	-80.6265552	136.3
SPT-2	STB	724524.918	2113635.191	33.8241414	-80.6257823	135.2

REV.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1	AMA	8/25	UPDATED COORDINATES

TOPO._____ DATE
DWG. CTC DATE 8/15/2017 GROUP___ – ____
R/W _____ DATE ________

F&ME
CONSULTANTS
GEOTECHNICAL - ENVIRONMENTAL - MATERIALS
COLUMBIA, SOUTH CAROLINA

SCE&G WATEREE STATION
EASTOVER, SC

BORING LOCATION PLAN

F&ME PROJECT NO. G5739.00

SCALE = NOT TO SCALE | FIGURE 2

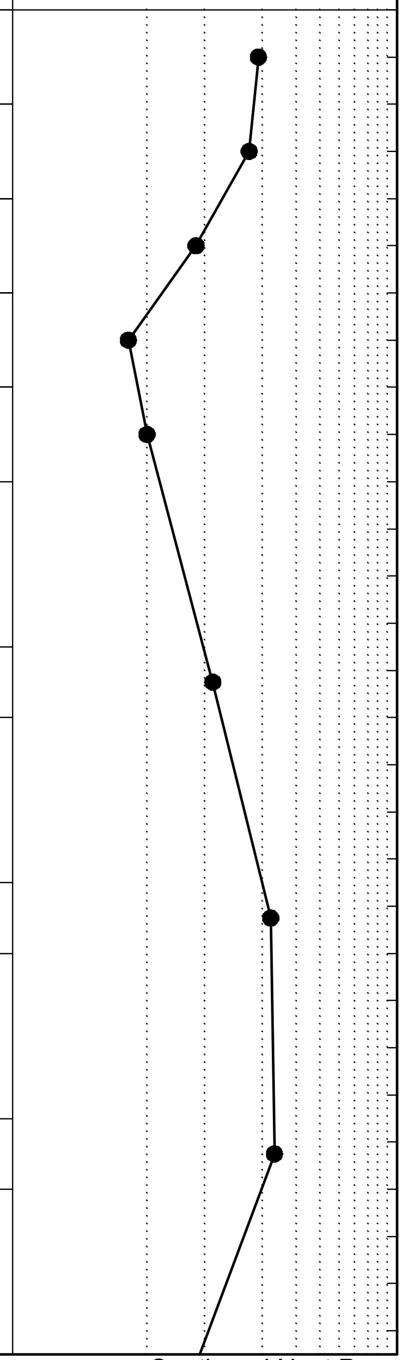
F&ME CONSULTANTS

Wateree Station Eastover, South Carolina G5739	**LOG OF BORING No. SPT-1** Latitude: 33.8253041 Longitude: -80.6265552

Date Drilled: 8/24/2017	Supervisor: C. Piercy	Notes: CME 45B Trailer Mounted Drill Rig
Date Completed: 8/24/2017	Approx. Ground Elevation (ft): 136	
Drill Machine: CME 45B	Drilling Method: Hollow Stem Auger	
Water T.O.B. (ft): 44.7	Water 24 HR (ft): 17 (Cave-In at 17.3-ft)	

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION Gravel Surface	Sample Depth (ft)	Sample Type-No.	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		GRAVEL	0.0						
	0.8	Very Stiff, Dry to Moist, Brown/Red, CLAY (CL)		SS-1	15	15	4	5	19
		=> Moist	2.0	SS-2	6	7	10	10	17
		=> Stiff	4.0						
131.3				SS-3	2	4	5	5	9
		=> Soft to Firm, Brown/Gray/Yellowish Red	6.0	SS-4	2	2	2	2	4
		=> Reddish Brown	8.0						
	8.5	Firm, Moist, Gray/Brown/Reddish Brown, Fine to Medium Sandy CLAY (CL) with Trace of Gravel and Charcoal		SS-5	WOH	3	2	7	5
	9.1	Loose, Moist, Gray, Silty Fine to Medium SAND (SM)							
126.3									
	13.5	Stiff, Moist, Brown/Gray/Red (Mottled), Fine to Medium Sandy CLAY (CL)	13.5	SS-6	3	5	6		11
121.3									
	18.5	Medium Dense, Moist, Gray/Yellow, Clayey Fine to Medium SAND (SC)	18.5	SS-7	7	10	12		22
	19.5	Medium Dense, Moist, Pink/Gray, Fine to Medium SAND (SP-SC) with Clay							
116.3									
	23.5	Medium Dense, Moist to Wet, Light Brown/White, Silty Fine to Coarse SAND (SM) with Trace of Gravel (Quartz)	23.5	SS-8	10	14	9		23
111.3									
			28.5						

STD. PENETRATION TEST DATA (blows/ft)



Continued Next Page

LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	PHD - Percussion Hammer Drill

F&ME CONSULTANTS

Wateree Station
Eastover, South Carolina
G5739

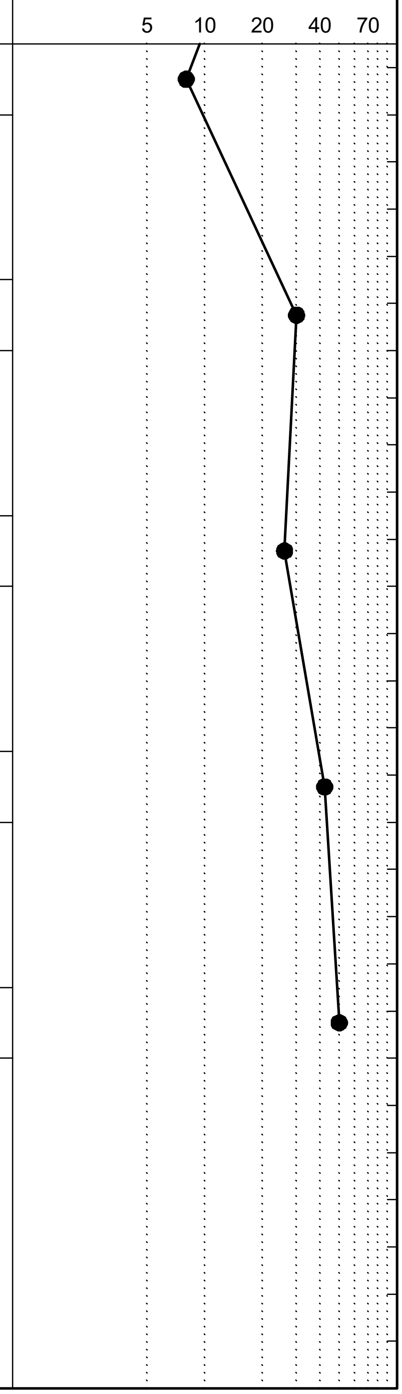
LOG OF BORING No. SPT-1

Latitude: 33.8253041
Longitude: -80.6265552

Date Drilled: 8/24/2017	Supervisor: C. Piercy	Notes: CME 45B Trailer Mounted Drill Rig
Date Completed: 8/24/2017	Approx. Ground Elevation (ft): 136	
Drill Machine: CME 45B	Drilling Method: Hollow Stem Auger	
Water T.O.B. (ft): 44.7	Water 24 HR (ft): 17 (Cave-In at 17.3-ft)	

Elevation (ft)	Depth (ft)	Description	Sample Depth (ft)	Sample Type-No.	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		=> Wet, Light Brownish Yellow, Fine to Medium Sand		SS-9	3	5	3		8
106.3									
	33.5	@SS-10: NO RECOVERY	33.5	SS-10	8	12	18		30
101.3									
	38.5	Medium Dense, wet, Light Gray/Yellow, Clayey Fine to Medium SAND (SC)	38.5	SS-11	7	11	15		26
96.3									
	43.5	Dense, Wet, Light Gray, Silty Fine to Medium SAND (SM)	43.5	SS-12	9	18	24		42
91.3									
		=> Light Gray/Yellow	48.5	SS-13	12	23	27		50
86.3	50.0	Boring Terminated at 50.0 feet							
81.3									

STD. PENETRATION TEST DATA (blows/ft)



LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	PHD - Percussion Hammer Drill

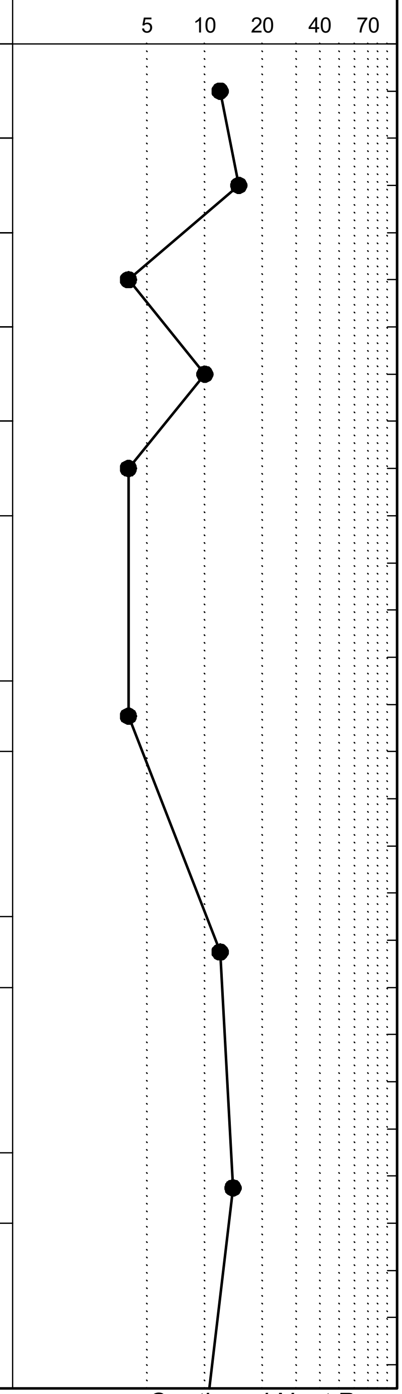
F&ME CONSULTANTS

Wateree Station Eastover, South Carolina G5739	LOG OF BORING No. SPT-2 Latitude: 33.8241414 Longitude: -80.6257823

Date Drilled: 8/24/2017	Supervisor: C. Piercy	Notes: CME 45B Trailer Mounted Drill Rig
Date Completed: 8/24/2017	Approx. Ground Elevation (ft): 135	
Drill Machine: CME 45B	Drilling Method: Hollow Stem Auger	
Water T.O.B. (ft): 24	Water 24 HR (ft): Dry (Cave-In at 16-ft.)	

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION Gravel Surface	Sample Depth (ft)	Sample Type-No.	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		GRAVEL	0.0						
	0.5	Stiff, Dry to Moist, Yellowish Red/Gray, Fine to Medium Sandy CLAY (CL)		SS-1	14	5	7	7	12
	2.0	Stiff, Moist, Brown/Red, CLAY (CL)	2.0	SS-2	6	7	8	10	15
130.2		=> Soft, Brown/Gray	4.0	SS-3	2	2	2	4	4
		Stiff, Red/Brown	6.0	SS-4	4	4	6	7	10
		=> Soft	8.0	SS-5	2	2	2	3	4
	9.3	Soft, Moist, Gray, Fine to Medium Sandy CLAY (CL)							
125.2	9.4	Very Loose, Moist, Gray, Silty Fine to Medium SAND (SM)							
120.2	13.5	Soft, Moist, Gray/Dark Gray, Fine to Medium Sandy CLAY (CL) with Trace of Organics (Wood/Grass)	13.5	SS-6	WOH	1	3		4
115.2	18.5	Medium Dense, Moist, Gray, Clayey Fine to Medium SAND (SC)	18.5	SS-7	2	5	7		12
110.2	23.5	▽ Medium Dense to Loose, Moist, Gray, Silty Fine to Medium SAND (SM), Micaceous	23.5	SS-8	5	6	8		14
			28.5						

STD. PENETRATION TEST DATA (blows/ft)



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LEGEND

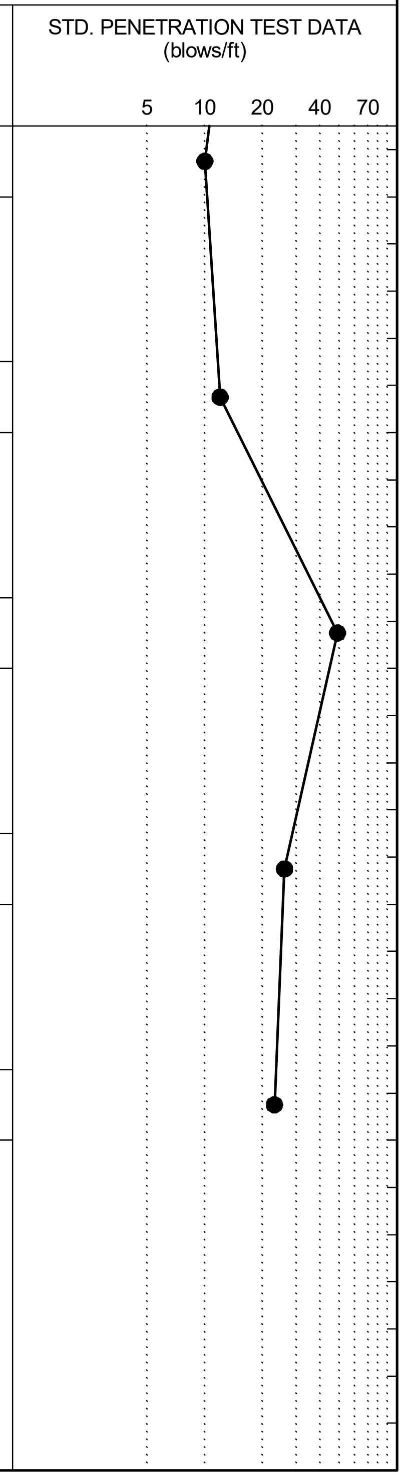
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	PHD - Percussion Hammer Drill

F&ME CONSULTANTS

Wateree Station **Eastover, South Carolina** **G5739**	**LOG OF BORING No. SPT-2** Latitude: 33.8241414 Longitude: -80.6257823

Date Drilled: 8/24/2017	Supervisor: C. Piercy	Notes: CME 45B Trailer Mounted Drill Rig
Date Completed: 8/24/2017	Approx. Ground Elevation (ft): 135	
Drill Machine: CME 45B	Drilling Method: Hollow Stem Auger	
Water T.O.B. (ft): 24	Water 24 HR (ft): Dry (Cave-In at 16-ft.)	

Elevation (ft)	Depth (ft)	Description	Sample Depth (ft)	Sample Type-No.	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		=> Wet		SS-9	1	3	7		10
105.2									
	33.5	Stiff, Wet, Yellow/Light Gray, Fine Sandy SILT (ML), Micaceous	33.5	SS-10	3	5	7		12
100.2									
	38.5	Hard to Very Stifff, Moist, Gray, CLAY (CL) with Fine to Medium Sand, Kaolinic	38.5	SS-11	6	17	32		49
95.2									
		=> Wet, Light Gray	43.5	SS-12	6	11	15		26
90.2									
			48.5	SS-13	6	10	13		23
85.2	50.0	Boring Terminated at 50.0 feet							
80.2									

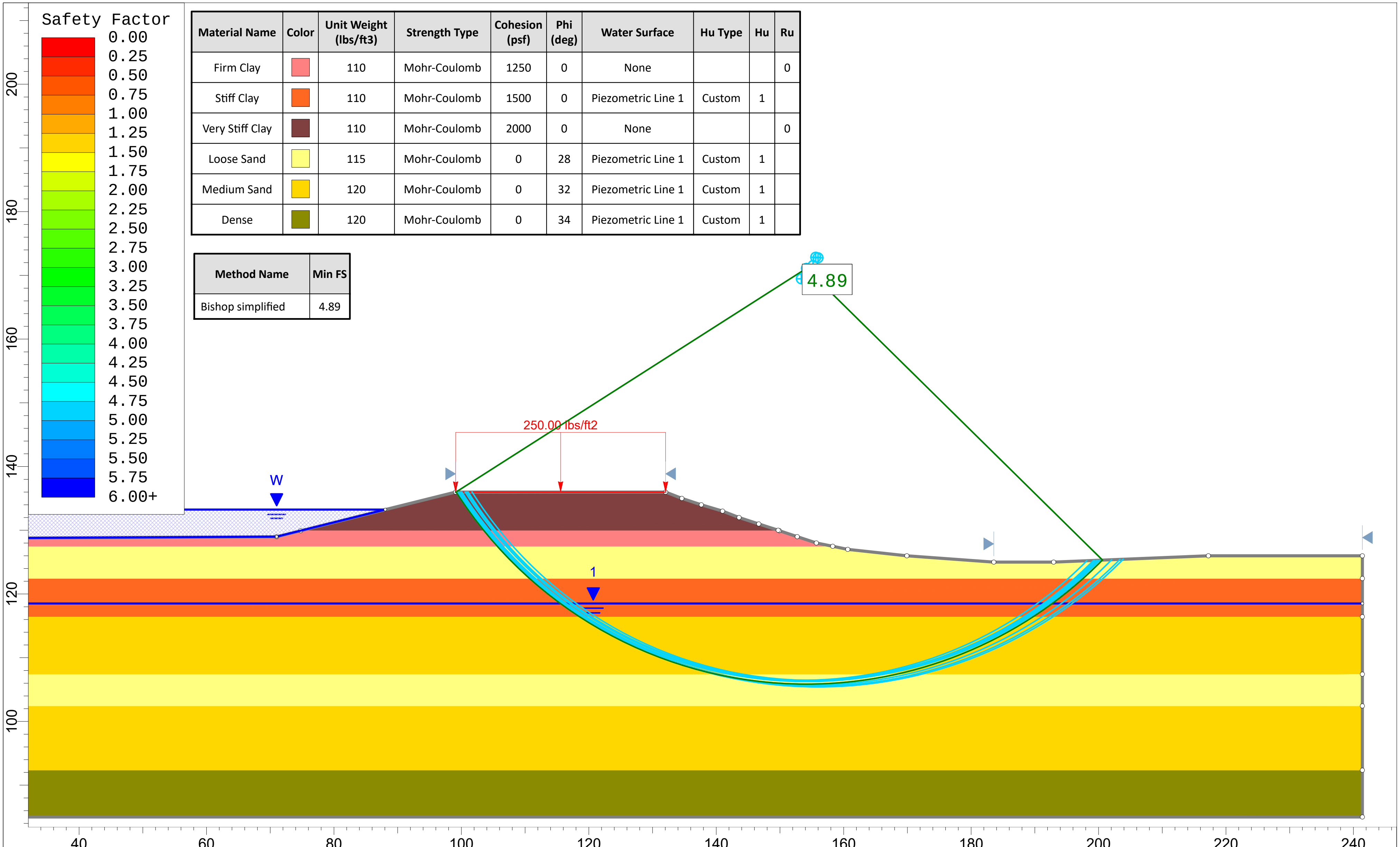


LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	PHD - Percussion Hammer Drill

Attachment 2

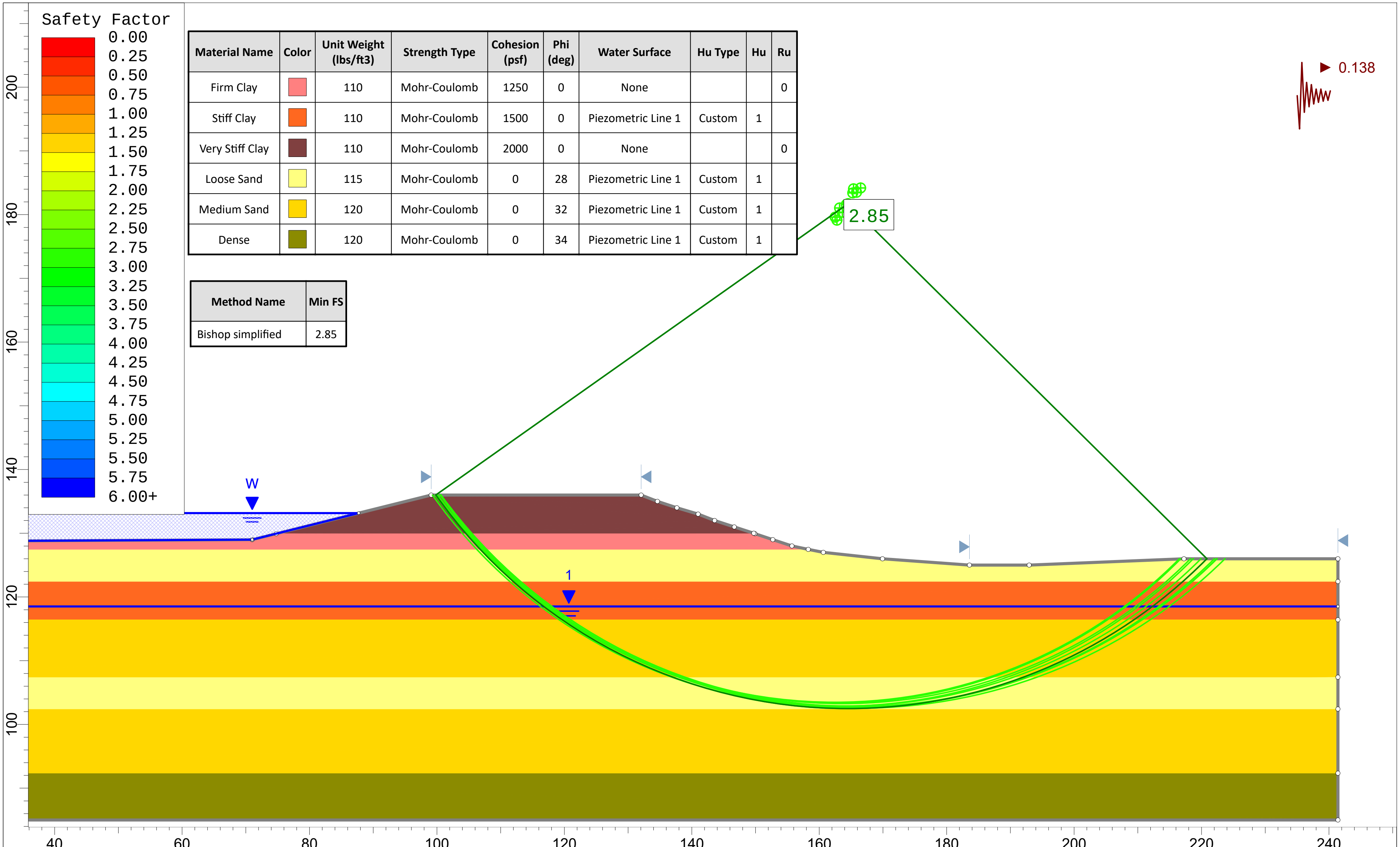
SLIDE Output



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Firm Clay		110	Mohr-Coulomb	1250	0	None			0
Stiff Clay		110	Mohr-Coulomb	1500	0	Piezometric Line 1	Custom	1	
Very Stiff Clay		110	Mohr-Coulomb	2000	0	None			0
Loose Sand		115	Mohr-Coulomb	0	28	Piezometric Line 1	Custom	1	
Medium Sand		120	Mohr-Coulomb	0	32	Piezometric Line 1	Custom	1	
Dense		120	Mohr-Coulomb	0	34	Piezometric Line 1	Custom	1	

Method Name	Min FS
Bishop simplified	4.89

SLIDEINTERPRET 7.026	*Project*	Wateree Station - FGD Pond #1
	Analysis Description	Static Loading
	Drawn By WAP	*Scale* 1:250
	Company	F&ME
	Date 9/19/2017	*File Name* SPT-1 Static Loading.slim

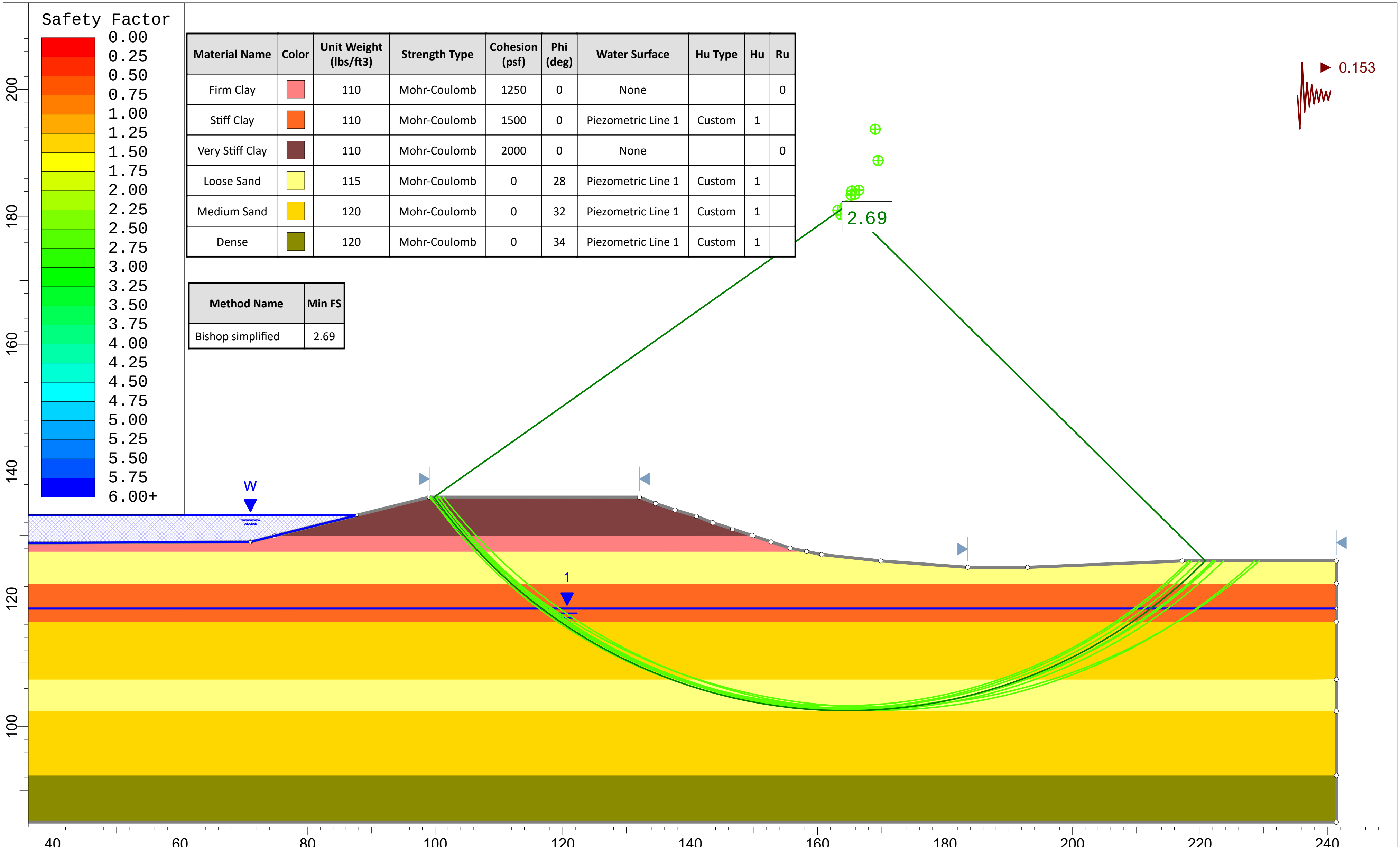


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Firm Clay		110	Mohr-Coulomb	1250	0	None			0
Stiff Clay		110	Mohr-Coulomb	1500	0	Piezometric Line 1	Custom	1	
Very Stiff Clay		110	Mohr-Coulomb	2000	0	None			0
Loose Sand		115	Mohr-Coulomb	0	28	Piezometric Line 1	Custom	1	
Medium Sand		120	Mohr-Coulomb	0	32	Piezometric Line 1	Custom	1	
Dense		120	Mohr-Coulomb	0	34	Piezometric Line 1	Custom	1	

Method Name	Min FS
Bishop simplified	2.85

Project	Wateree Station - FGD Pond #1
Analysis Description	Seismic Loading PGA-0.276 (SCDHEC Method)
Drawn By	WAP
Scale	1:250
Company	F&ME
Date	9/19/2017
File Name	SPT-1 Seismic Loading.slim

SLIDEINTERPRET 7.026



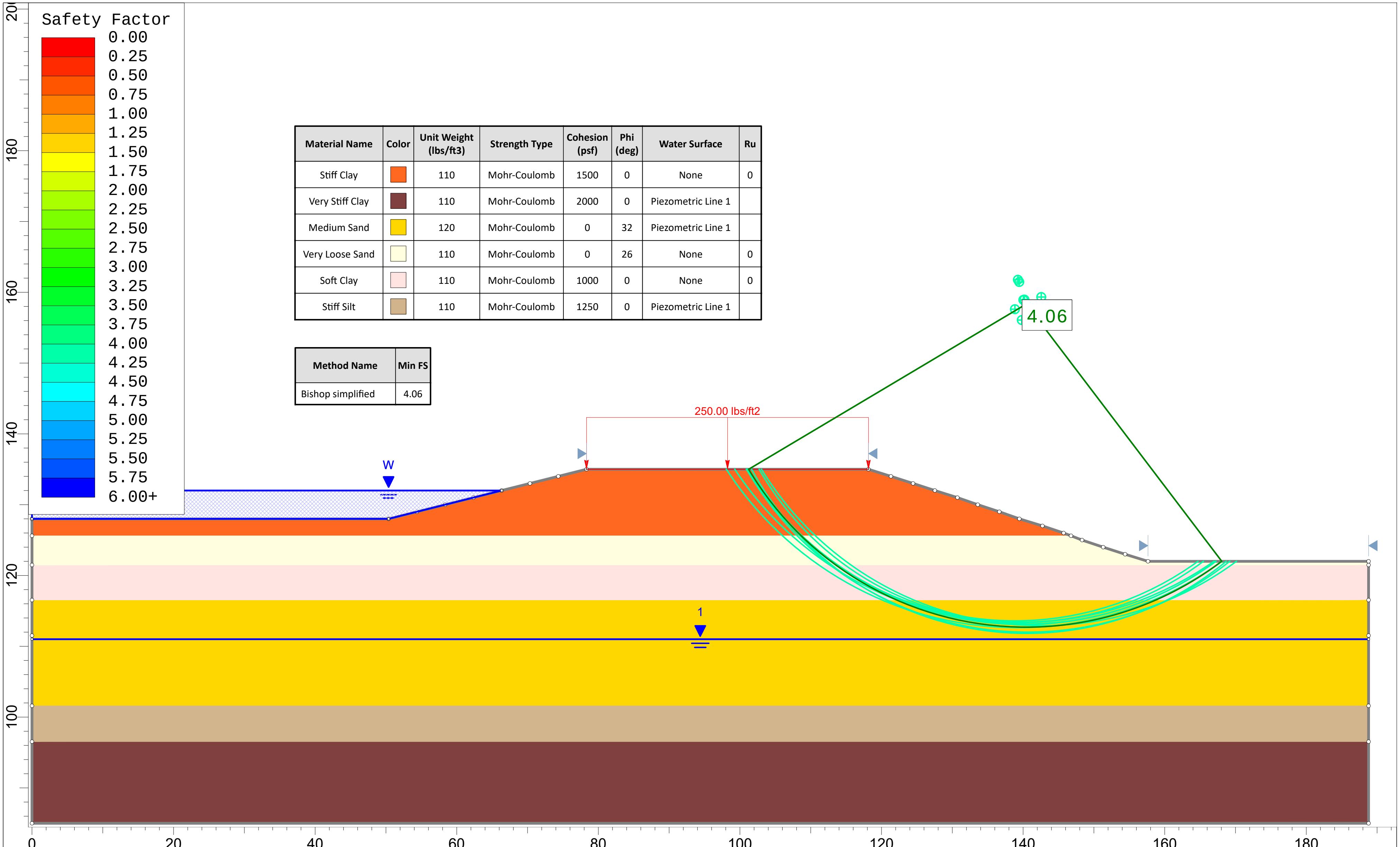
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Firm Clay		110	Mohr-Coulomb	1250	0	None			0
Stiff Clay		110	Mohr-Coulomb	1500	0	Piezometric Line 1	Custom	1	
Very Stiff Clay		110	Mohr-Coulomb	2000	0	None			0
Loose Sand		115	Mohr-Coulomb	0	28	Piezometric Line 1	Custom	1	
Medium Sand		120	Mohr-Coulomb	0	32	Piezometric Line 1	Custom	1	
Dense		120	Mohr-Coulomb	0	34	Piezometric Line 1	Custom	1	

Method Name	Min FS
Bishop simplified	2.69

rocscience

SLIDEINTERPRET 7.026

Project	Wateree Station - FGD Pond #1		
Analysis Description	Seismic Loading PGA-0.305 (EPA Method)		
Drawn By	WAP	*Scale*	1:250
Company	F&ME		
Date	9/19/2017	*File Name*	SPT-1 Seismic Loading.slim

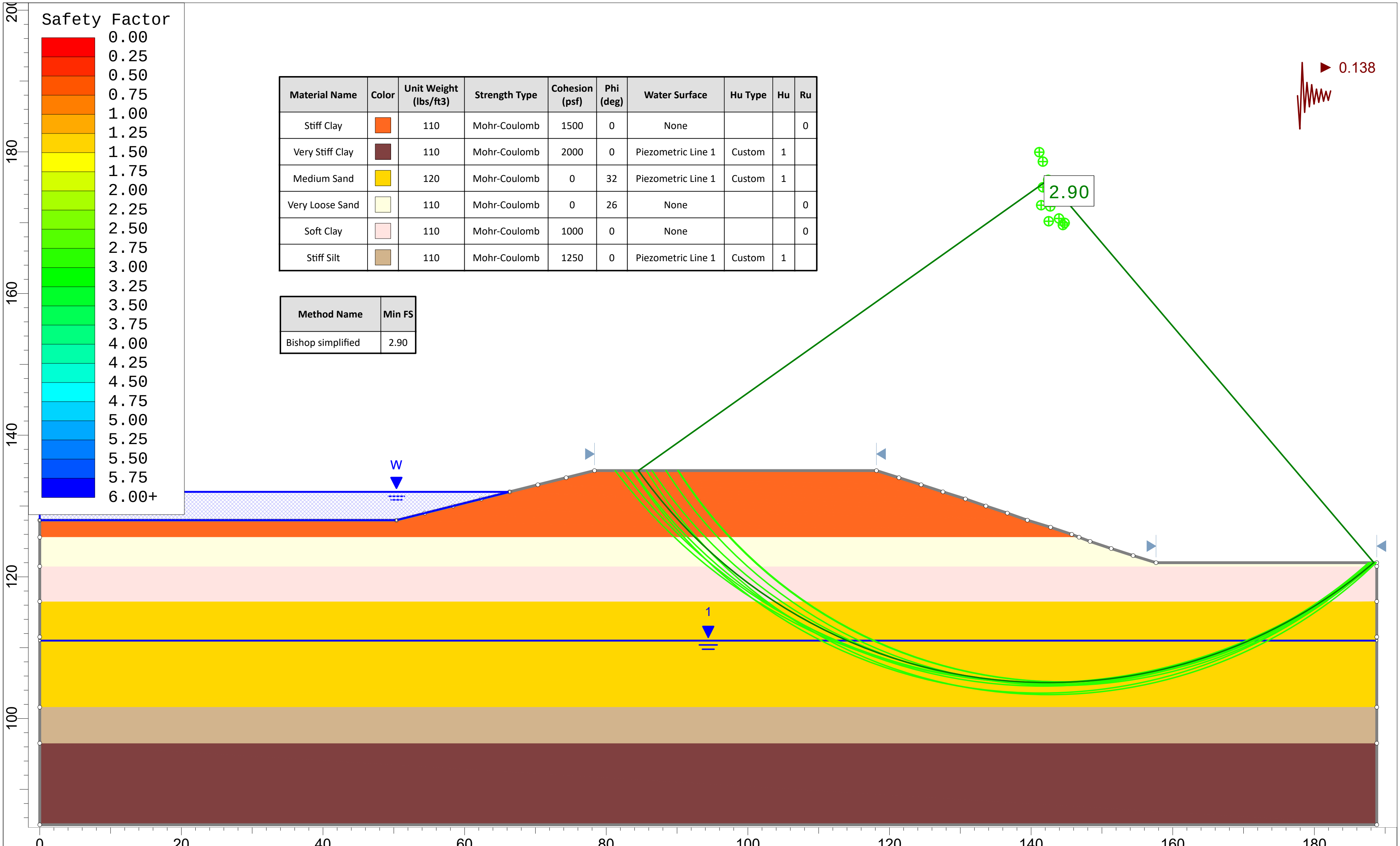


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Stiff Clay		110	Mohr-Coulomb	1500	0	None	0
Very Stiff Clay		110	Mohr-Coulomb	2000	0	Piezometric Line 1	
Medium Sand		120	Mohr-Coulomb	0	32	Piezometric Line 1	
Very Loose Sand		110	Mohr-Coulomb	0	26	None	0
Soft Clay		110	Mohr-Coulomb	1000	0	None	0
Stiff Silt		110	Mohr-Coulomb	1250	0	Piezometric Line 1	

Method Name	Min FS
Bishop simplified	4.06

SLIDEINTERPRET 7.026

Project	Wateree Station - FGD Pond #2
Analysis Description	Static Loading
Drawn By	WAP
Scale	1:225
Company	F&ME
Date	9/19/2017
File Name	SPT-2 Static Loading.slim

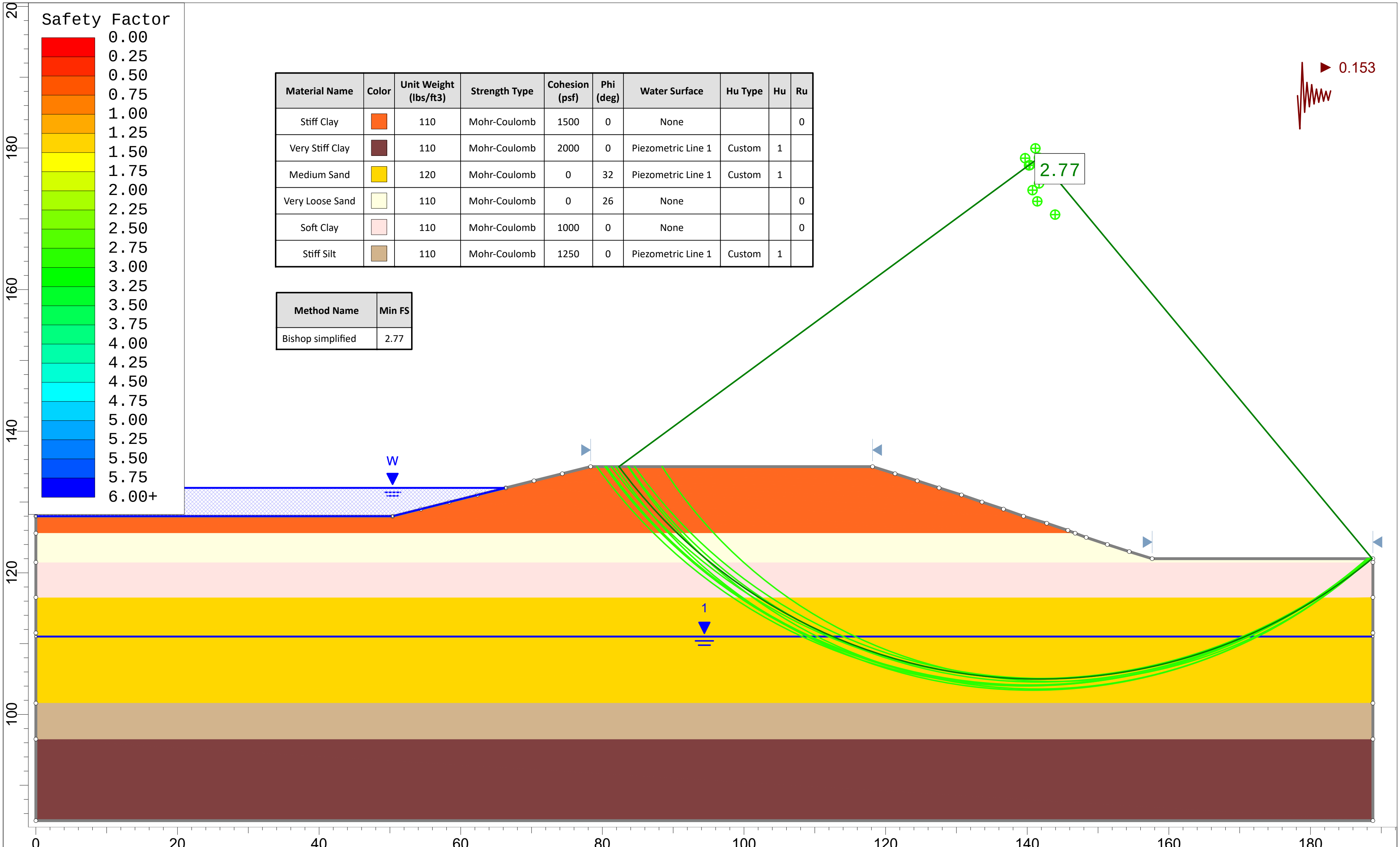


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Stiff Clay		110	Mohr-Coulomb	1500	0	None			0
Very Stiff Clay		110	Mohr-Coulomb	2000	0	Piezometric Line 1	Custom	1	
Medium Sand		120	Mohr-Coulomb	0	32	Piezometric Line 1	Custom	1	
Very Loose Sand		110	Mohr-Coulomb	0	26	None			0
Soft Clay		110	Mohr-Coulomb	1000	0	None			0
Stiff Silt		110	Mohr-Coulomb	1250	0	Piezometric Line 1	Custom	1	

Method Name	Min FS
Bishop simplified	2.90

SLIDEINTERPRET 7.026

Project	Wateree Station - FGD Pond #2
Analysis Description	Seismic Loading PGA-0.276 (SCDHEC Method)
Drawn By	WAP
Scale	1:225
Company	F&ME
Date	9/19/2017
File Name	SPT-2 Seismic Loading.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Stiff Clay		110	Mohr-Coulomb	1500	0	None			0
Very Stiff Clay		110	Mohr-Coulomb	2000	0	Piezometric Line 1	Custom	1	
Medium Sand		120	Mohr-Coulomb	0	32	Piezometric Line 1	Custom	1	
Very Loose Sand		110	Mohr-Coulomb	0	26	None			0
Soft Clay		110	Mohr-Coulomb	1000	0	None			0
Stiff Silt		110	Mohr-Coulomb	1250	0	Piezometric Line 1	Custom	1	

Method Name	Min FS
Bishop simplified	2.77

Project	Wateree Station - FGD Pond #2
Analysis Description	Seismic Loading PGA-0.305 (EPA Method)
Drawn By	WAP
Scale	1:225
Company	F&ME
Date	9/19/2017
File Name	SPT-2 Seismic Loading.slim

SLIDEINTERPRET 7.026