CLOSURE PLAN

POND CLOSURE PLAN

Chesapeake Energy Center CCR Surface Impoundment: Bottom Ash Pond

Submitted To: Chesapeake Energy Center
2701 Vepco Street
Chesapeake, VA 23323

Submitted By: Golder Associates Inc.
2108 W. Laburnum Avenue, Suite 200
Richmond, VA 23227

April 2018 **Project No. 13-00193**

Table of Contents

Tables

Attachments

1.0 PLAN CERTIFICATION

This Closure Plan for the Chesapeake Energy Center's Bottom Ash Pond was prepared by Golder Associates Inc. (Golder). The document and Certification/Statement of Professional Opinion are based on and limited to information that Golder has relied on from Dominion and others, but not independently verified, as well as work products produced by Golder.

On the basis of and subject to the foregoing, it is my professional opinion as a Professional Engineer licensed in the Commonwealth of Virginia that this document has been prepared in accordance with good and accepted engineering practices as exercised by other engineers practicing in the same discipline(s), under similar circumstances, at the same time, and in the same locale. It is my professional opinion that the document was prepared consistent with the requirements in §257.102 of the United States Environmental Protection Agency's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," published in the Federal Register on April 17, 2015, with an effective date of October 19, 2015 [40 CFR §257.73(c)], as well as with the requirements in §257.100 resulting from the EPA's "Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Extension of Compliance Deadlines for Certain Inactive Surface Impoundments; Response to Partial Vacatur" published in the Federal Register on August 5, 2016 with an effective date of October 4, 2016 (40 CFR §257.100).

The use of the word "certification" and/or "certify" in this document shall be interpreted and construed as a Statement of Professional Opinion, and is not and shall not be interpreted or construed as a guarantee, warranty, or legal opinion.

Daniel McGrath	Associate and Senior Consultant
Print Name	Title
Daniel McGrath	4/12/18
Signature	Date

COMMONWEALTH OF VIRGINIA
Daniel McGrath
DANIEL P. McGRATH
Lic. No. 040703
4/12/18
PROFESSIONAL ENGINEER

Golder Associates

2.0 CLOSURE PURPOSE

This Pond Closure Plan (Plan) has been prepared for the Bottom Ash Pond (BAP) at Dominion Energy's Chesapeake Energy Center (CEC), located in Chesapeake, Virginia. The Station, owned and operated by Virginia Electric and Power Company d/b/a Dominion Energy Virginia (Dominion), is located in the City of Chesapeake, Virginia. The Station includes an inactive CCR surface impoundment, the BAP, as defined by the Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule (40 CFR §257; the CCR rule).

2.1 Bottom Ash Pond Information

The current configuration of the bottom ash pond was developed in approximately 1985. The Pond was designed for bottom ash management (separate from the sedimentation pond), and is approximately 4.6 acres in plan area. As built drawings for the current configuration indicate that the Pond is approximately 11 feet deep and has varying interior sideslopes. At its peak, the pond contained approximately 42,000 cubic yards (CY) of CCR. The Pond is not lined.

The Pond received bottom ash sluice from the CEC as part of normal station operations. The sluiced bottom ash entered the Pond on the northeast corner, where it then flowed through a serpentine path to the outlet on the west side. The bottom ash solids dropped out by gravity and the water decanted into the adjacent sedimentation pond for eventual discharge through VPDES Outfall 002. The landfill operations contractor excavated the bottom ash solids periodically and stockpiled them within the bounds of the Pond for further dewatering and then disposal in the landfill or beneficial reuse off-site. As recently as 2017-2018, approximately 8,500 CY of bottom ash was dewatered and beneficially reused off-site.

In 2014, the Station ceased coal-fired electric generating activities, and subsequently ceased placing CCR in the pond. The BAP continues to receive surface water runoff from the adjacent landfill which discharges to the adjacent sedimentation basin.

3.0 CLOSURE PLAN IMPLEMENTATION

3.1 Material Removal and Disposal

Dominion intends to effect closure of the BAP by removal of the CCR. CCR removal will be by common earthworking equipment consisting of excavators, bulldozers, dump trucks, etc. Dewatering of the material, if required, will be accomplished by placing the wet material into windrows and allowing it to drain until a suitable moisture content is reached. This technique was successfully applied at the BAP during its operational period, owing to the relatively free-draining nature of the bottom ash. CCR removed from the BAP will preferentially be used for beneficial reuse projects, subject to market demand and needs. Any CCR that is not identified for beneficial reuse will be taken to an off-site licensed solid waste disposal facility.

CCR will be excavated from the BAP until the original design grades of the pond are reached, or until the sand drainage layer is reached, whichever comes first. Certification of the removal will be provided by a licensed Professional Engineer.

3.2 Post-Excavation Embankment Stability

3.2.1 East, West and South Embankments

Golder evaluated the BAP embankment stability during the anticipated conditions of excavation, immediately after excavation, and after final closure. This evaluation shows that the east, west, and south embankments exhibit satisfactory calculated factors of safety during all phases of excavation and at their final configuration. No special considerations are needed for these embankments during pond closure.

3.2.2 North Embankment

Removing the bottom ash from the toe of the landfill embankment removes the buttressing effect provided by the bottom ash, and lowers the long-term factor of safety below recommended values. Golder's evaluation, presented in Appendix 1, describes the field investigation, evaluation, and recommendations for excavation in the vicinity of the landfill embankment.

The excavation along the toe of the embankment will be made within the "Limits of Buttress" area along the embankment. Once the ash is removed, a 30-foot wide soil buttress will be placed against the embankment to restore an adequate long-term factor of safety. The total time allowed between ash excavation and embankment placement is no more than 90 days. The summary table below outlines the evaluated factors of safety.

Table 1: Excavation Stability Analysis Results

Scenario	Target Factor of Safety	Calculated Factor of Safety
Pre-Excavation Conditions	1.5	1.9
Intermediate Conditions	1.3	1.4
Final Conditions	1.5	1.5

3.3 Groundwater

Groundwater monitoring for the site, including the BAP and landfill, will be conducted in accordance with the facility's Groundwater Monitoring Plan.

3.4 Site Grading and Stabilization

After completing removal of the CCR from the BAP, a geomembrane liner system will be installed to reduce future infiltration in the pond area. The engineered liner system will consist of the following minimum components, listed from top to bottom, and described below:

- 6-inch vegetative support layer;
- Protective cover soil layer of varying thickness, 18-inch minimum;
- 6-oz / yd^2 Orange, nonwoven geotextile warning layer (installed 6" above geomembrane);
- 60-mil High Density Polyethylene (HDPE) geomembrane;
- 8-oz / yd^2 nonwoven cushion geotextile;
- 18-inch liner subgrade soil fill;
- Woven geotextile subgrade reinforcing fabric (where designated);
- Liner subgrade

3.4.1 Liner Subgrade

The liner subgrade will be the surface remaining after CCR removal and verification by a professional engineer. This material is anticipated to be competent sand or embankment fill soil, depending on location. If areas of liner subgrade are found to be unsuitable for normal construction traffic, the contractor and the engineer may elect to remove material and replace with suitable fill. The liner subgrade surface will be graded to a relatively smooth surface free of abrupt grade changes and large (>4") protuberances. The liner subgrade shall be smooth-drum rolled prior to installation of the woven geotextile reinforcing fabric.

3.4.2 Woven Geotextile

A woven geotextile will be placed on the lower portions of the pond bottom to provide structural reinforcement for the liner subgrade. The geotextile will be anchored around the pond edges and sufficient overlap or sewn seams between panels provided. If the excavated liner subgrade is found to be competent to directly support the liner subgrade fill, it can be eliminated with the consent of the engineer and owner.

3.4.3 Liner Subgrade Soil

An 18-inch layer of soil will be placed on top of the liner subgrade to serve as an engineered base for the following geosynthetic layers. If placed on top of the woven geotextile, placement will be monitored to verify the geotextile is not damaged or displaced during soil placement. Liner subgrade soil will likely be placed in one, 18-inch lift and compacted to project specifications.

3.4.4 Nonwoven Geotextile

An 8-oz / yd^2 nonwoven geotextile fabric will be installed to serve the dual purpose of a geomembrane cushion and venting layer. As a cushion layer, the geotextile will protect the overlying geomembrane from puncture from below. Although no gas or liquid generation beneath the geomembrane is anticipated, industry standard design guidance recommends a geotextile layer to serve as a passive venting layer to prevent bubbles from forming under the geomembrane. Vents will be placed at 100-foot intervals around the top perimeter of the pond to relieve gas pressure should it accumulate.

3.4.5 60-mil HDPE Geomembrane

HDPE geomembrane will be installed to serve as the primary barrier layer in the closure system. The geomembrane liner will consist of 60-mil, dual-textured, High Density Polyethylene (HDPE) geomembrane, or equivalent, with a maximum hydraulic conductivity of $1x10^{-12}$ centimeter per second (cm/s). The geomembrane liner will be placed directly on the nonwoven geotextile cushion layer, and will generally be placed parallel to the slope. The liner will be secured over the subgrade with a perimeter anchor trench, and will be seamed using heat-fusion and extrusion welding techniques.

3.4.6 Nonwoven Geotextile Warning Layer

After installation of the initial 6-inches of protective cover soil, an orange colored, nonwoven geotextile will be installed to serve as a warning layer of the underlying geomembrane. This layer will be installed to serve as a visual warning against further excavation and possible geomembrane damage.

3.4.7 Protective Cover Soil

An 18-inch (minimum) protective cover soil layer will be placed over the geomembrane / warning geotextile. The thickness of the cover soil layer will vary throughout the pond as needed to provide positive drainage to the sediment basin. The protective cover soil will consist of soil with an average maximum particle size of 2 inches. No deleterious material will be allowed in the protective cover layer. The protective cover layer will be placed in lifts no greater than 9 inches (compacted depth), and will be wetted or dried as necessary to reach acceptable moisture content. The protective cover layer will be compacted to at least 90% of its maximum dry density.

3.4.8 Vegetative Support Layer

A 6-inch vegetative support layer will be placed over the protective cover layer to promote grass growth and reduce erosion. The vegetative soil layer will consist of soil with an average maximum particle size of 1 inch that is capable of supporting vegetation. Organic material may contribute up to 1.5% of the vegetative support layer (by weight). The vegetative support layer will be seeded, fertilized, and mulched to prevent erosion. Temporary and permanent soil stabilization matting will be used on side slopes to reduce the effects of erosion during final cover stabilization.

Seeding will follow the seeding dates outlined in Section 329219 – “Seeding” of the Technical Specifications. The selected plant species will be native vegetation as described in the Technical Specifications, and include Kentucky 31 Fescue, Annual Ryegrass, and German Millet.

The established vegetation will be maintained through periodic mowing to prevent the growth of large brush or trees that could damage the underlying geosynthetics, and to maintain healthy coverage. Maintenance will be performed as necessary to maintain the covered areas.

3.4.9 Final Grades

The final grades for the Bottom Ash Pond have been developed to control stormwater and erosion, as well as to reduce hydraulic head accumulation on the geomembrane liner. The minimum slope for the final grade is 1.5% to ensure positive drainage of the surface. Integrated into the final grades is a stormwater conveyance channel (SCC-04) that will convey stormwater flows from the connecting perimeter channel to the sediment basin. This channel has a 10-foot minimum bottom width and a longitudinal slope of 1% to convey a sufficient volume of water at relatively low flow velocities to prevent erosion.

4.0 CLOSURE TIMEFRAMES

Bottom ash pond closure construction will be conducted concurrent with the landfill closure construction and upon receipt of all required permits. Closure of the BAP will be completed in accordance with this Plan and is anticipated to take approximately 12 months. If an extension of the closure construction time frame is needed, Dominion will petition the Director of the Virginia DEQ.

Table 2 below outlines the estimated sequence of scheduled closure activities

Table 2: Closure Schedule

Activity	Tentative Date
Receipt of required permits	By December 2018
Commence closure construction	By January 2019
Closure construction complete	By December 2019
Certification of construction completion	By February 2020

CALCULATIONS

Date:	February 21, 2018	**Made by:**	G. Martin
Project No.:	130-0193	**Checked by:**	D. McGrath
Subject:	Bottom Ash Pond Excavation Plan & Stability Analysis	**Reviewed by:**	G. Hebeler
Project:	**CHESAPEAKE ENERGY CENTER – LANDFILL PERMIT MODIFICATION**		

1.0 OBJECTIVE

Dominion Energy plans excavate material from the Bottom Ash Pond (BAP) at their Chesapeake Energy Center (CEC) in Chesapeake, VA. The northern portion of the BAP is bound by dikes impounding the Ash Landfill. This calculation package evaluates the stability of the south slope of the Ash Landfill during the excavation operations and provides recommendations for the excavation plan near the slope.

2.0 METHODOLOGY

Stability safety factors were evaluated for three scenarios along the critical slope (Section A in Figure 1):

- Pre-excavation Conditions
- Intermediate Conditions
- Final Conditions

Pre-excavation conditions model the slope before excavation activities impacting the stability of the slope occur. Intermediate conditions model the slope after BAP excavations are completed, but before a stabilizing buttress is constructed at the toe of the critical slope. Final conditions represent the slope after the stabilizing buttress has been constructed. These scenarios represent short-term conditions.

Factors of safety were calculated using the computer program SLIDE 7.0 Version 7.031 (2018). As required by the EPA rule, a general limit equilibrium (GLE) method (Morgenstern and Price) was used to calculate factors of safety, using the software program SLIDE. The factor of safety is calculated by dividing the resisting forces by the driving forces along the critical slip surface.

Material properties and subsurface conditions were modeled from the following sources:

- Schnabel Engineering's 2010 report titled "Geotechnical Engineering Study, Chesapeake Energy Center, Stability Evaluation of the Bottom Ash Pond and Sedimentation Pond Dikes"
- Schnabel Engineering's 2011 report titled "Geotechnical Engineering Study, Chesapeake Energy Center, Phase 1 Evaluation of Perimeter Dikes of the Columbia Gas Property and Dry Ash Landfill"

- Golder geotechnical explorations completed in 2016 and 2017.

Material properties used in stability analyses are presented in the table below. Since this analysis focuses on the short-term stability, only granular materials were modeled using drained strengths; undrained strengths were used for all other materials.

Table 1: Selected Material Properties for Use in Slope Stability Analysis

Material	Drained Strength		Undrained Strength			Unit Weight (pcf)
	ϕ' (degrees)	c' (psf)	Su/σ'v	Minimum Su (psf)	Su (Constant, psf)	
Dike Fill	26	100	N/A	N/A	1,500	125
Ponded Fill	20	100	0.22	400	N/A	100
Landfilled Ash	33	0	N/A	N/A	N/A	92.4
Soil Buttress	28	0	N/A	N/A	N/A	120
Fine Grained Organic Alluvium	20	100	0.22	400	N/A	115
Upper Sand	32	0	N/A	N/A	N/A	120
Layered Clayey Sand	28	100	0.5	N/A	N/A	120
Silty Sand	30	0	N/A	N/A	N/A	120
Lower Sand	34	0	N/A	N/A	N/A	120
Lower Silty Sand	34	0	N/A	N/A	N/A	120

4.0 RESULTS

The calculated factor of safety for each scenario analyzed is shown in the table below.

Stability Analysis Results		
Scenario	**Target Factor of Safety**	**Calculated Factor of Safety**
Pre-Excavation Conditions (Figure 2)	1.5	1.9
Intermediate Conditions (Figure 3)	1.3	1.4
Final Conditions (Figure 4)	1.5	1.5

5.0 CONCLUSION AND RECOMMENDATIONS

The calculated factors of safety meet target factors of safety for all three scenarios analyzed. The calculated factor of safety (FS) for the intermediate condition meets the target FS generally accepted for short-term conditions (1.3), but does not meet the FS generally accepted for long-term conditions (1.5). Thus, for the excavation of the north side of the BAP, Golder recommends the following:

- The duration of excavation and buttress construction activities within the "Limits of Buttress" area (see Figure 1) shall be minimized. Specifically, the buttress shall be completed within 90 days of beginning excavation activities in this area.
- If the entire buttress area cannot be completed in the 90-day window, it shall be divided into segments such that the work can be completed in the timeframe allotted.
- The water level shall maintained below elevation 7.5-msl under the soil berm and excavated areas.

6.0 ATTACHMENTS

Figure 1 – Stability Sections

Figure 2 – Section A-A' Pre-Excavation Stability Results

Figure 3 – Section A-A' Post-Excavation Stability Results

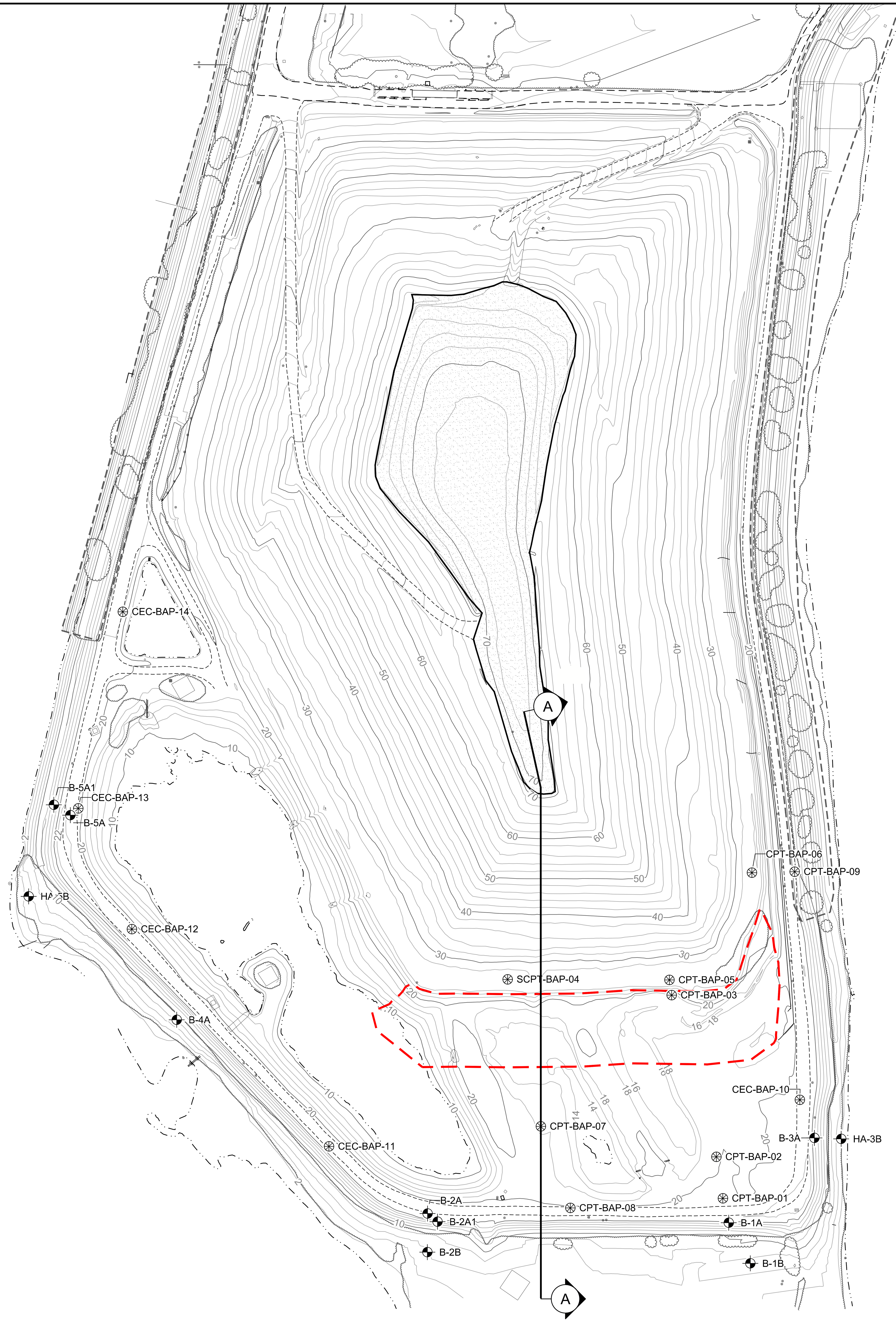
Figure 4 – Section A-A' Final Conditions Stability Results

7.0 REFERENCES

Rocscience (2018), SLIDE Version 7.031.

Schnabel Engineering (2010). "Geotechnical Engineering Study, Chesapeake Energy Center, Stability Evaluation of the Bottom Ash Pond and Sedimentation Pond Dikes." February 5, 2010.

Schnabel Engineering (2011). "Geotechnical Engineering Study, Chesapeake Energy Center, Phase 1 Evaluation of Perimeter Dikes of the Columbia Gas Property and Dry Ash Landfill." July 18, 2011.



0 100 200
1" = 100' FEET

LEGEND

EXISTING CONTOURS
EXISTING UNPAVED ROAD
EXISTING EDGE OF WATER
CP GOLDER CPT
BH SCHNABEL BOREHOLE
07/2014 EXISTING CONTOUR BOUNDARY, SEE REFERENCE 2
LIMITS OF BUTTRESS

NOTE

1. GOLDER CPTS LOCATED WITH HAND-HELD GPS UNITS (+/- 10 FEET).

2. SCHNABEL BOREHOLE LOCATIONS APPROXIMATED FROM "GEOTECHNICAL ENGINEERING STUDY" DOCUMENTS.

REFERENCE

1. SCHNABEL ENGINEERING (2011). "GEOTECHNICAL ENGINEERING STUDY, CHESAPEAKE ENERGY CENTER, PHASE 1 EVALUATION OF PERIMETER DIKES OF THE COLUMBIA GAS PROPERTY AND DRY ASH LANDFILL." JULY 18, 2011.

2. CONSTRUCTED TOPOGRAPHY PROVIDED BY SCHNABEL ENGINEERING ON JULY 16 2014 IN DRAWING TITLED "CHESAPEAKE ENERGY CENTER SHORELINE EROSION REPAIR, PRIORITY AREAS 2 & 3 AND SOUTH DIKE OF BOTTOM ASH POND."

CLIENT
DOMINION ENERGY

CONSULTANT
Golder Associates

YYYY-MM-DD	2018/02/12
DESIGNED	OAE
PREPARED	RMS
REVIEWED	JGM
APPROVED	GLH

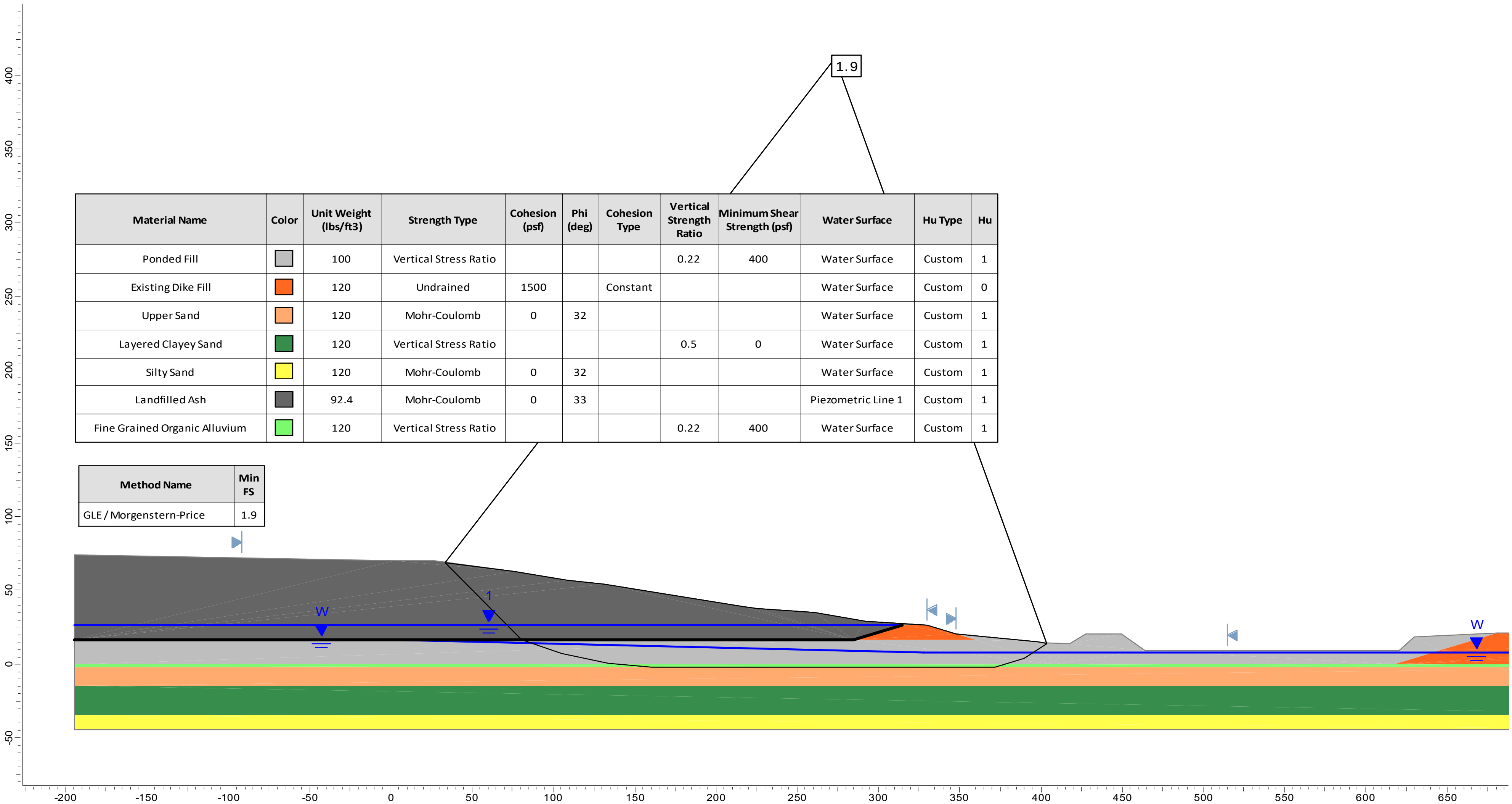
PROJECT
CHESAPEAKE ENERGY CENTER
LANDFILL PERMIT MODIFICATION

TITLE
STABILITY SECTION PLAN

PROJECT NO. 1300193
CONTROL
REV. ----
FIGURE 1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

Path: \\atlanta\Cadd\Dominion\1300193.850 Chesapeake\PRODUCTION\GEOTECHNICAL INVESTIGATION\ | File Name: 1300193.00 GEOTECH INVESTIGATION.dwg



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Vertical Strength Ratio	Minimum Shear Strength (psf)	Water Surface	Hu Type	Hu
Ponded Fill		100	Vertical Stress Ratio				0.22	400	Water Surface	Custom	1
Existing Dike Fill		120	Undrained	1500		Constant			Water Surface	Custom	0
Upper Sand		120	Mohr-Coulomb	0	32				Water Surface	Custom	1
Layered Clayey Sand		120	Vertical Stress Ratio				0.5	0	Water Surface	Custom	1
Silty Sand		120	Mohr-Coulomb	0	32				Water Surface	Custom	1
Landfilled Ash		92.4	Mohr-Coulomb	0	33				Piezometric Line 1	Custom	1
Fine Grained Organic Alluvium		120	Vertical Stress Ratio				0.22	400	Water Surface	Custom	1

Method Name	Min FS
GLE / Morgenstern-Price	1.9

Golder Associates

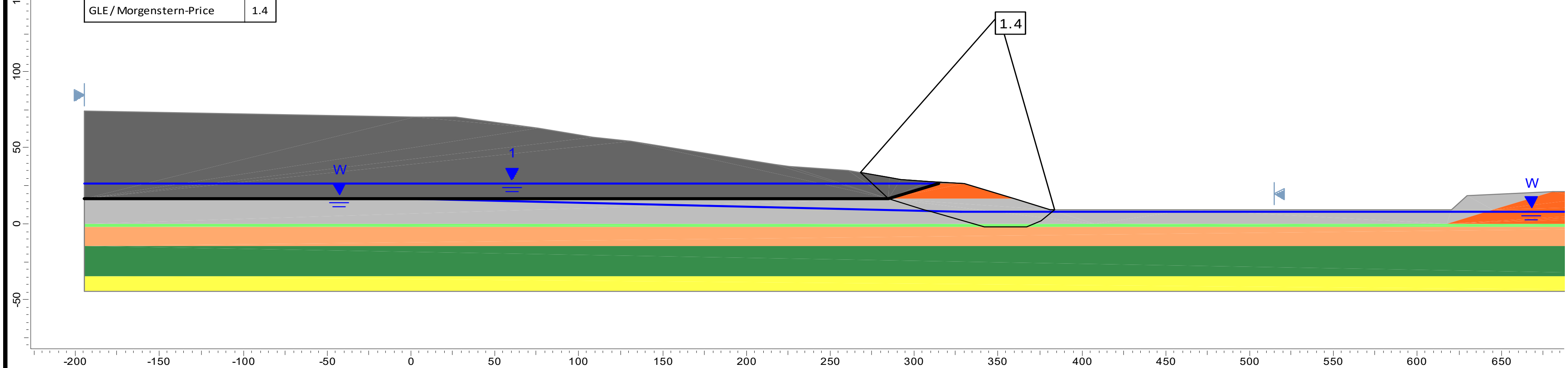
SCALE	AS SHOWN	PROJECT	CEC Landfill Permit Modificiation
DATE	Feb 2018	TITLE	Section A-A' Pre-Excavation Conditions
MADE BY	LJ		
CAD	-		
CHECK	JGM	CLIENT	Dominion Energy
REVIEW	GLH	FIGURE	2

FILE STABILITY

PROJECT No. 13-00193 REV. 0

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Vertical Strength Ratio	Minimum Shear Strength (psf)	Water Surface	Hu Type	Hu
Ponded Fill		100	Vertical Stress Ratio				0.22	400	Water Surface	Custom	1
Existing Dike Fill		120	Undrained	1500		Constant			Water Surface	Custom	0
Upper Sand		120	Mohr-Coulomb	0	32				Water Surface	Custom	1
Layered Clayey Sand		120	Vertical Stress Ratio				0.5	0	Water Surface	Custom	1
Silty Sand		120	Mohr-Coulomb	0	32				Water Surface	Custom	1
Landfilled Ash		92.4	Mohr-Coulomb	0	33				Piezometric Line 1	Custom	1
Fine Grained Organic Alluvium		120	Vertical Stress Ratio				0.22	400	Water Surface	Custom	1

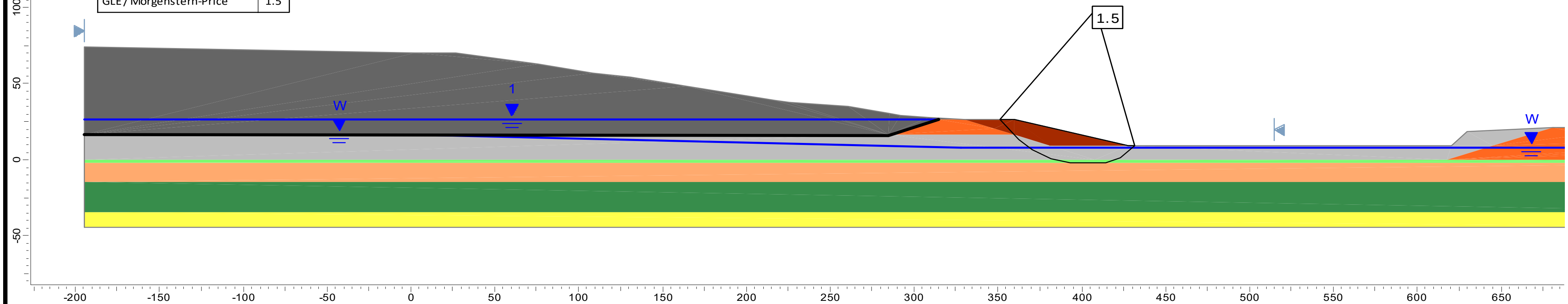
Method Name	Min FS
GLE / Morgenstern-Price	1.4



Golder Associates	SCALE: AS SHOWN	PROJECT	CEC Landfill Permit Modificiation
	DATE: Feb 2018	TITLE	Section A-A' Intermediate Conditions
	MADE BY: LJ		
	CAD: -		
FILE: STABILITY	CHECK: JGM	CLIENT	Dominion Energy
PROJECT No. 13-00193 REV. 0	REVIEW: GLH	FIGURE	3

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Vertical Strength Ratio	Minimum Shear Strength (psf)	Water Surface	Hu Type	Hu
Ponded Fill		100	Vertical Stress Ratio				0.22	400	Water Surface	Custom	1
Existing Dike Fill		120	Undrained	1500		Constant			Water Surface	Custom	0
Upper Sand		120	Mohr-Coulomb	0	32				Water Surface	Custom	1
Layered Clayey Sand		120	Vertical Stress Ratio				0.5	0	Water Surface	Custom	1
Silty Sand		120	Mohr-Coulomb	0	32				Water Surface	Custom	1
Landfilled Ash		92.4	Mohr-Coulomb	0	33				Piezometric Line 1	Custom	1
Fine Grained Organic Alluvium		120	Vertical Stress Ratio				0.22	400	Water Surface	Custom	1
Soil Buttress		120	Mohr-Coulomb	0	28				Water Surface	Custom	1

Method Name	Min FS
GLE / Morgenstern-Price	1.5



Golder Associates

SCALE	AS SHOWN	PROJECT	**CEC Landfill Permit Modificiation**
DATE	Feb 2018	TITLE	**Section A-A'** **Final Conditions**
MADE BY	LJ		
CAD	-		
FILE STABILITY	CHECK JGM	CLIENT	**Dominion Energy**
PROJECT No. 13-00193 REV. 0	REVIEW GLH	FIGURE	**4**

Established in 1960, Golder Associates is a global, employee-owned organization that helps clients find sustainable solutions to the challenges of finite resources, energy and water supply and management, waste management, urbanization, and climate change. We provide a wide range of independent consulting, design, and construction services in our specialist areas of earth, environment, and energy. By building strong relationships and meeting the needs of clients, our people have created one of the most trusted professional services organizations in the world.

Africa	+ 27 11 254 4800
Asia	+ 852 2562 3658
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 56 2 2616 2000

solutions@golder.com
www.golder.com

Golder Associates Inc.
2108 W. Laburnum Avenue, Suite 200
Richmond, VA 23227 USA
Tel: (804) 358-7900
Fax: (804) 358-2900

Golder Associates

Engineering Earth's Development, Preserving Earth's Integrity