AECOM

Submitted to
Southern Indiana
Gas & Electric Company
(SIGECO)
dba CenterPoint Energy
Indiana South (CEIS)
211 Northwest Riverside
Drive, Evansville, IN 47708

Submitted by
AECOM
9400 Amberglen Boulevard
Austin, Texas 78729

October 13, 2021

CCR Certification:
Periodic Safety Factor Assessment
§257.73 (e)

for the

Ash Pond System

at the

A. B. Brown Generating Station

Revision 0

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1 Introduction

The purpose of the Safety Factor Assessment is to document that the requirements specified in 40 Code of Federal Regulations (CFR) §257.73 (e) have been met to support the certification required under each of the applicable regulatory provisions for the A. B. Brown Generating Station Ash Pond System. The Ash Pond is an existing CCR surface impoundment as defined by 40 CFR §257.53. The CCR Rule requires that the specified documentation and assessments for an existing CCR surface impoundment be prepared within five years of the placement of the previous assessment in the facility's operating record. Since the Initial Safety Factor Assessment was placed in the facility's operating record on October 13, 2016, the deadline for completing this 5-year update is October 13, 2021.

An initial safety factor assessment was performed in October 2016. As part of the periodic assessment, an updated analysis has been performed to document that the calculated factors of safety for the Ash Pond System achieve the minimum factors of safety listed in § 257.73(e)(1)(i) through (iv).

2 Periodic Safety Factor Assessment

Regulatory Citation: 40 CFR §257.73 (e); Periodic safety factor assessments. (1) The owner or operator must conduct an initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in paragraphs (e)(1)(i) through (iv) of this section for the critical cross-section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations.

An initial safety factor assessment was performed in October 2016. That assessment included slope stability analyses of multiple cross-sections of the dike structure that were considered to be most critical (i.e. most susceptible), based on rigorous field and laboratory testing and appropriate engineering considerations and calculations.

As part of this periodic assessment, an updated analysis has been performed to document that the calculated factors of safety for the Ash Pond System achieve the minimum factors of safety listed in § 257.73(e)(1)(i) through (iv). The analyses used subsurface information collected from historical subsurface investigations and laboratory testing data and included consideration of any changes to the configuration of the structures that has occurred since the time of the initial assessment. Upon review of the existing configuration (which included data gathered from various site visits and inspections that have occurred since 2016 and on the most recent February 2020 survey data), it is noted that very minor (and mostly beneficial) changes to the Ash Pond System have occurred – Specifically, the storage pool elevation and ash impounded elevation have been lowered. There were no changes to the Ash Pond dike geometry.

Given this, it was concluded that the cross-sections selected for analysis in the 2016 initial safety factor assessment are still pertinent critical locations, and therefore were retained for the current evaluation. The above minor changes were incorporated into the selected cross-sections, and engineering properties for the various material strata were selected based on the results of available field and laboratory data. The results of the safety factor assessment are presented in the continuing subsections.

2.1 Results of Slope Stability Analyses

Regulatory Citation: 40 CFR §257.73 (e)(1);

- *(i) The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.*
- *(ii) The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.*
- *(iii) The calculated seismic factor of safety must equal or exceed 1.00.*
- *(iv) For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.*

Limit equilibrium slope stability analyses were performed for five (5) critical cross-sections (Cross-Section A through Cross-Section E, located as shown in the **Attachment A**) under each of the above loading conditions and using the computer program SLOPE/W. The results of the slope stability analyses for each load case are summarized in

Table 2-1. The Slope/W output figures showing the critical slip surfaces and details of the analyses are included in **Appendix B**.

Table 2-1 – Summary of Minimum Slope Stability Factors of Safety

Load Case	Criteria	Cross-Section A	Cross-Section B	Cross-Section C	Cross-Section D	Cross-Section E
Steady State (Normal Pool)	FS ≥ 1.50	3.01	3.14	2.98	2.93	3.65
Surcharge Pool (Flood Pool)	FS ≥ 1.40	3.02	3.10	2.97	2.91	3.67
Seismic (Pseudo-static)	FS ≥ 1.00	1.49	1.44	1.34	1.50	1.57
Post-liquefaction	FS ≥ 1.20	1.22	1.26	1.32	1.25	1.34

The calculated factors of safety are greater than the minimum values required in §257.73(e)(1)(i) through (iv) and thereby satisfy the regulatory requirement.

3 Conclusions

The calculated factors of safety from the limit equilibrium slope stability analysis satisfy the CCR Rule §257.73 (e) requirements for all the load cases analyzed at the critical analysis section for the embankment that comprises the perimeter of the impoundment. Load cases analyzed for this study included static (steady-state) normal pool, maximum flood surcharge pool, seismic (pseudo-static), and static post-liquefaction.

4 Certification

This Certification Statement documents that the Ash Pond System at the A. B. Brown Generating Station meets the Safety Factor Assessment requirements specified in 40 CFR §257.73 (e). The Ash Pond System is an existing CCR surface impoundment as defined by 40 CFR §257.53. The CCR Rule requires that the specified documentation and assessments for an existing CCR surface impoundment be prepared within five years of the placement of the previous assessment in the facility's operating record. Since the Initial Safety Factor Assessment was placed in the facility's operating record on October 13, 2016, the deadline for completing this 5-year update is October 13, 2021.

CCR Unit: Southern Indiana Gas & Electric Company; A. B. Brown Generating Station; Ash Pond System

I, Jay Mokotoff, being a Registered Professional Engineer in good standing in the State of Indiana, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above referenced CCR Unit, that the Safety Factor Assessment dated October 13, 2021 meets the requirements of 40 CFR §257.73 (e).

Jay Mokotoff

Printed Name

10-13-2021

Date

5 Limitations

Background information, design basis, and other data have been furnished to AECOM by SIGECO. AECOM has used this data in preparing this report. AECOM has relied on this information as furnished, and is not responsible for the accuracy of this information. Our recommendations are based on available information from previous and current investigations. These recommendations may be updated as future investigations are performed.

Borings were performed as part of historical investigations at the Ash Pond (including work performed by AECOM as part of the 2015 and 2016 initial safety factor assessment) and were spaced as closely as economically feasible, but variations in soil properties between borings, that may become evident at a later date, are possible. The conclusions developed in this report are based on the assumption that the subsurface soil, rock, and groundwater conditions do not deviate appreciably from those encountered in the site-specific exploratory borings. If any variations or undesirable conditions are encountered in any future exploration, we should be notified so that additional analyses can be made, if necessary.

The conclusions presented in this report are intended only for the purpose, site location, and project indicated. The recommendations presented in this report should not be used for other projects or purposes. Conclusions or recommendations made from these data by others are their responsibility. The conclusions and recommendations are based on AECOM's understanding of current plant operations, maintenance, stormwater handling, and ash handling procedures at the station, as provided by Client. Changes in any of these operations or procedures may invalidate the findings in this report until AECOM has had the opportunity to review the findings, and revise the report if necessary.

This periodic assessment and all previous related geotechnical investigations and analyses were performed in accordance with the standard of care commonly used as state-of-practice in our profession. Specifically, our services have been performed in accordance with accepted principles and practices of the geological and geotechnical engineering profession. The conclusions presented in this report are professional opinions based on the indicated project criteria and data available at the time this report was prepared. Our services were provided in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation is intended.

Appendix A
Cross-Section Location

EXISTING COAL STOCKPILE

EXISTING RAILROAD

¢ OF EXISTING STREAM

EXISTING EMERGENCY SPILLWAY

SOIL BUTTRESS

6" HDPE

6" HDPE

12" HDPE

36" RCP

STONE ROAD

EXISTING PUMPHOUSE

LOWER ASH POND
NORMAL POOL EL. = 444 FT MSL

B-207
B-208
AECOM-B5/B-215
CPT-5
AECOM-B4/B-205
B-216
B-217
CPT-4
B-206
B-218
CPT-3
AECOM-B3/B-219
B-212
CPT-2
B-203
B-211
AECOM-B2/B-210
B-204
B-209
HAL-1
HAL-2
HAL-3
HAL-4
HAL-5
HAL-6
AECOM B-8
B-202
CPT-1
B-213
B-214
AECOM-B1/B-201

A
A'
B
B'
C
C'
D
D'
E
E'

0+00 1+00 2+00 3+00 4+00 5+00 6+00 7+00 8+00 9+00 10+00 11+00 12+00 13+00 14+00 14+55

0 100 200 Feet

N

LEGEND

- AECOM BORINGS, 2015
- CARDNO ATC BORINGS, 2015
- HLA BORINGS, 1982
- AECOM CPT, 2015
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR

AECOM
1300 E. 9TH STREET
SUITE 500
CLEVELAND, OH
216-622-2300 (PHONE)

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY

A.B. BROWN GENERATING STATION
POSEY COUNTY, IN

ISSUED FOR BIDDING — DATE BY

ISSUED FOR CONSTRUCTION — DATE BY

REVISIONS

NO.	DESCRIPTION	DATE

AECOM PROJECT NO:	60442676
DRAWN BY:	ACI
DESIGNED BY:	ACI
CHECKED BY:	VKG
DATE CREATED:	9/9/2016
PLOT DATE:	9/9/2016
SCALE:	AS SHOWN
ACAD VER:	AUTOCAD CIVIL 3D 2016

SHEET TITLE

FIGURE 3 -
GEOTECHNICAL
CROSS-SECTION PLAN

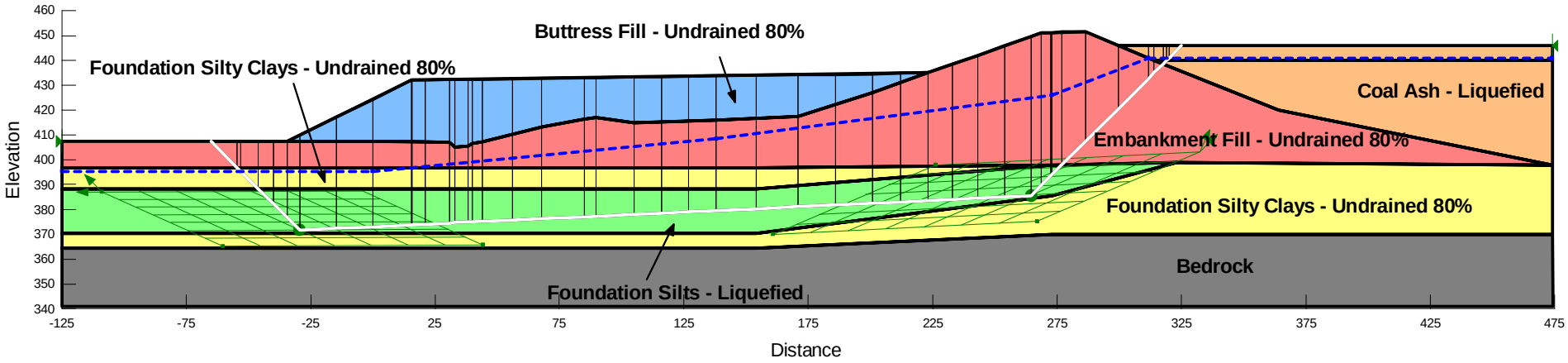
Appendix B
Slope Stability Analysis Calculations

Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Post-Liquefaction - Critical Block Failure Surface Geometry
Cross-Section A
Factor of Safety = 1.22
Date: 10/5/2021

Ash Elev. = 446.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio	Constant Unit Wt. Above Water Table (pcf)	Minimum Strength (psf)
	Bedrock						
	Buttress Fill - Undrained 80%	123	425	16			
	Coal Ash - Liquefied	100			0.12	100	0
	Embankment Fill - Undrained 80%	128	475	18		125	
	Foundation Silts - Liquefied	119			0.1	119	100
	Foundation Silty Clays - Undrained 80%	126	320	19			

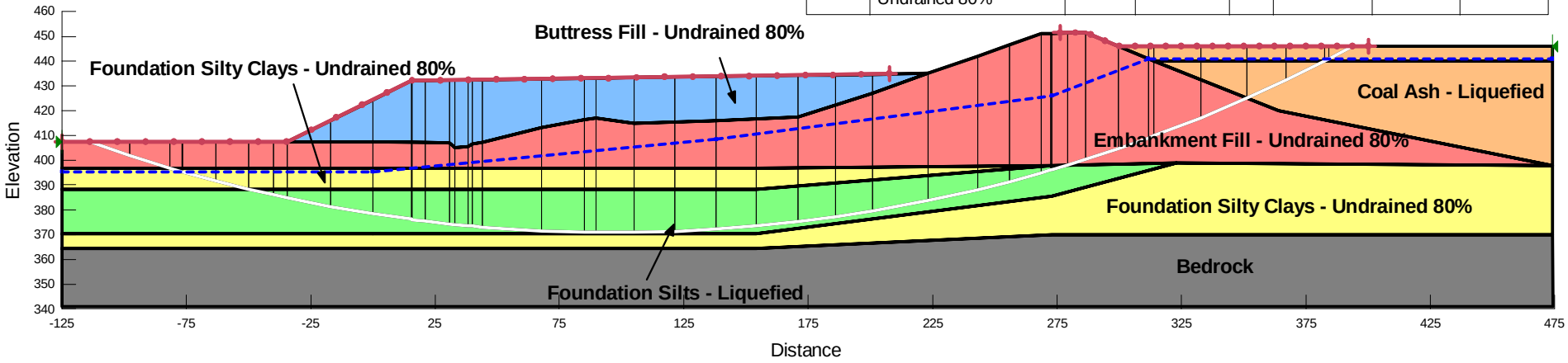


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Post-Liquefaction - Critical Circular Surface Failure Geometry
Cross-Section A
Factor of Safety = 1.58
Date: 10/5/2021

Ash Elev. = 446.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio	Constant Unit Wt. Above Water Table (pcf)	Minimum Strength (psf)
	Bedrock						
	Buttress Fill - Undrained 80%	123	425	16			
	Coal Ash - Liquefied	100			0.12	100	0
	Embankment Fill - Undrained 80%	128	475	18		125	
	Foundation Silts - Liquefied	119			0.1	119	100
	Foundation Silty Clays - Undrained 80%	126	320	19			

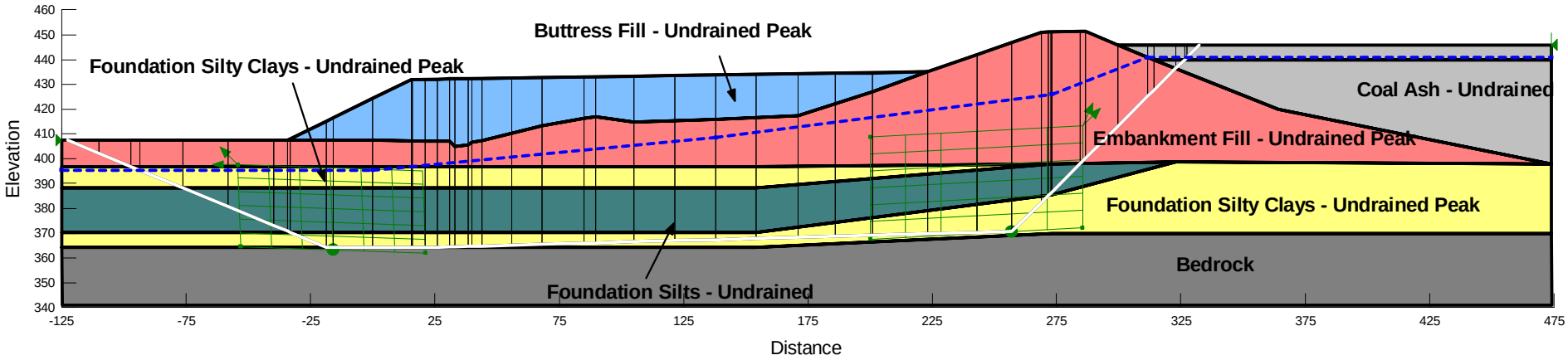


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Seismic - Critical Block Failure Surface Geometry
Cross-Section A
Factor of Safety = 1.58
Date: 10/5/2021

Ash Elev. = 446.0 ft
Static Storage Pool Elev. = 441.0 ft
Horizontal Seismic Load = 0.18 g

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Constant Unit Wt. Above Water Table (pcf)
	Bedrock				
	Buttress Fill - Undrained Peak	123	540	20	
	Coal Ash - Undrained	100	100	12	
	Embankment Fill - Undrained Peak	128	600	22	125
	Foundation Silts - Undrained	119	650	22	
	Foundation Silty Clays - Undrained Peak	126	400	23	

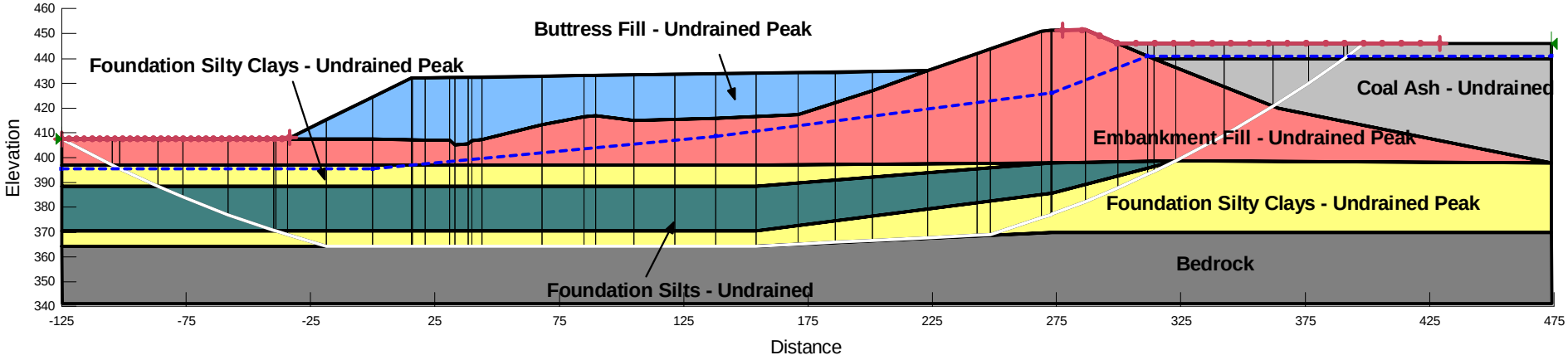


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Seismic - Critical Circular Buttress Failure Geometry
Cross-Section A
Factor of Safety = 1.49
Date: 10/5/2021

Ash Elev. = 446.0 ft
Static Storage Pool Elev. = 441.0 ft
Horizontal Seismic Load = 0.18 g

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Constant Unit Wt. Above Water Table (pcf)
	Bedrock				
	Buttress Fill - Undrained Peak	123	540	20	
	Coal Ash - Undrained	100	100	12	
	Embankment Fill - Undrained Peak	128	600	22	125
	Foundation Silts - Undrained	119	650	22	
	Foundation Silty Clays - Undrained Peak	126	400	23	

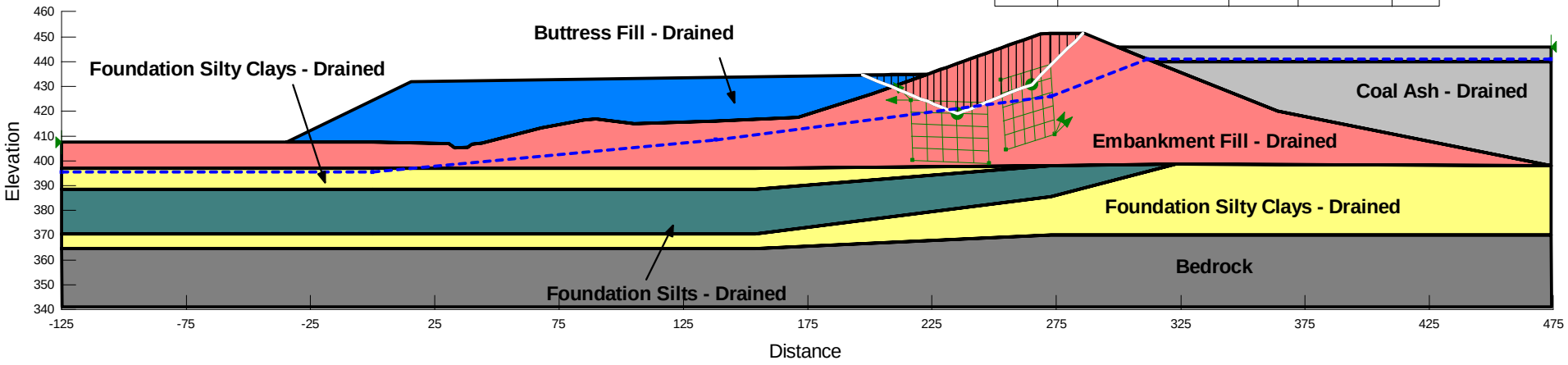


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Static Storage Pool - Critical Block Failure Surface Geometry
Cross-Section A
Factor of Safety = 3.38
Date: 10/5/2021

Ash Elev. = 446.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

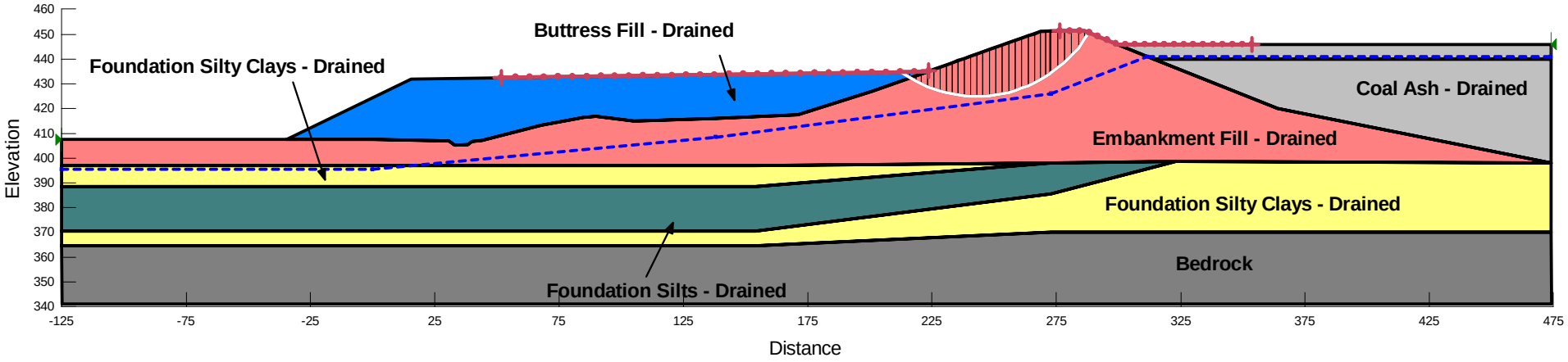


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Static Storage Pool - Critical Circular Surface Failure Geometry
Cross-Section A
Factor of Safety = 3.01
Date: 10/5/2021

Ash Elev. = 446.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

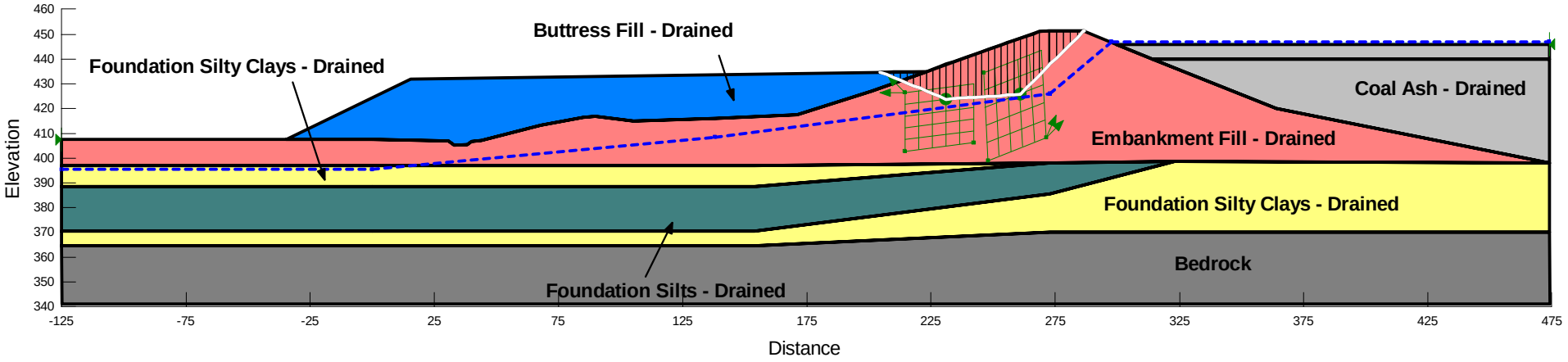


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Static Surcharge Pool - Critical Block Failure Surface Geometry
Cross-Section A
Factor of Safety = 3.25
Date: 10/5/2021

Ash Elev. = 446.0 ft
Static Surcharge Pool Elev. = 446.8 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

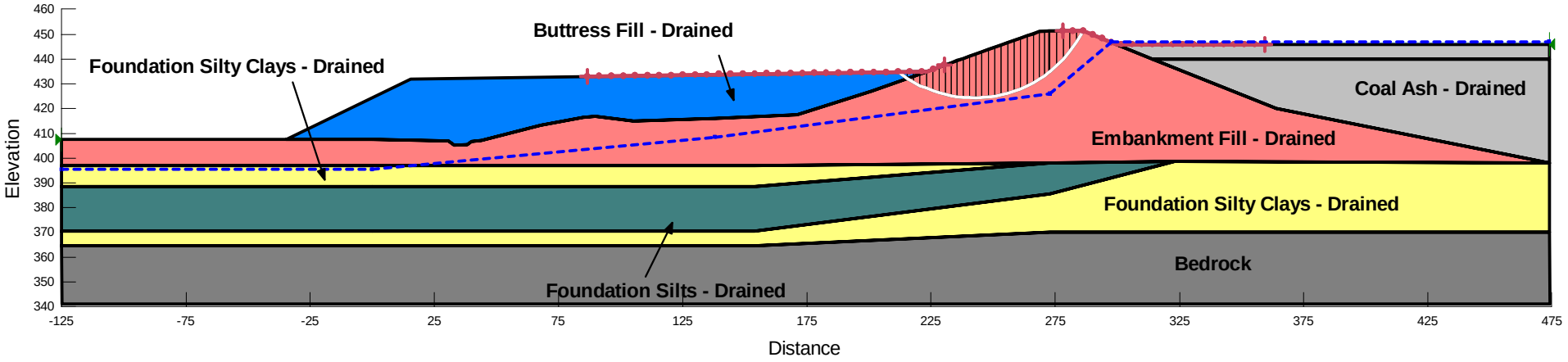


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Static Surcharge Pool - Critical Circular Surface Failure Geometry
Cross-Section A
Factor of Safety = 3.02
Date: 10/5/2021

Ash Elev. = 446.0 ft
Static Surcharge Pool Elev. = 446.8 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

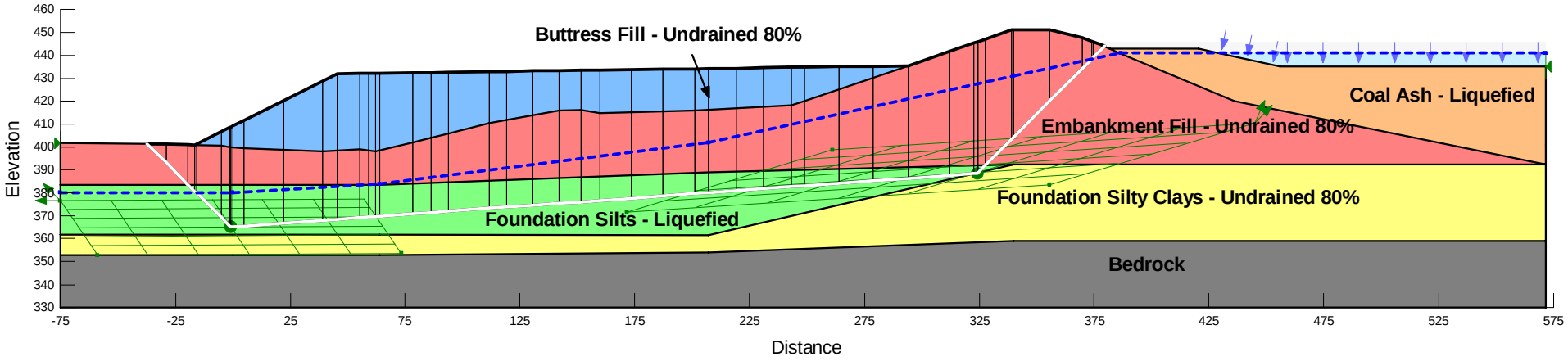


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Post-Liquefaction - Critical Block Failure Surface Geometry
Cross-Section B
Factor of Safety = 1.26
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio	Constant Unit Wt. Above Water Table (pcf)	Minimum Strength (psf)
	Bedrock						
	Buttress Fill - Undrained 80%	123	425	16			
	Coal Ash - Liquefied	100			0.12	100	0
	Embankment Fill - Undrained 80%	128	475	18			
	Foundation Silts - Liquefied	119			0.1	119	100
	Foundation Silty Clays - Undrained 80%	126	320	19			

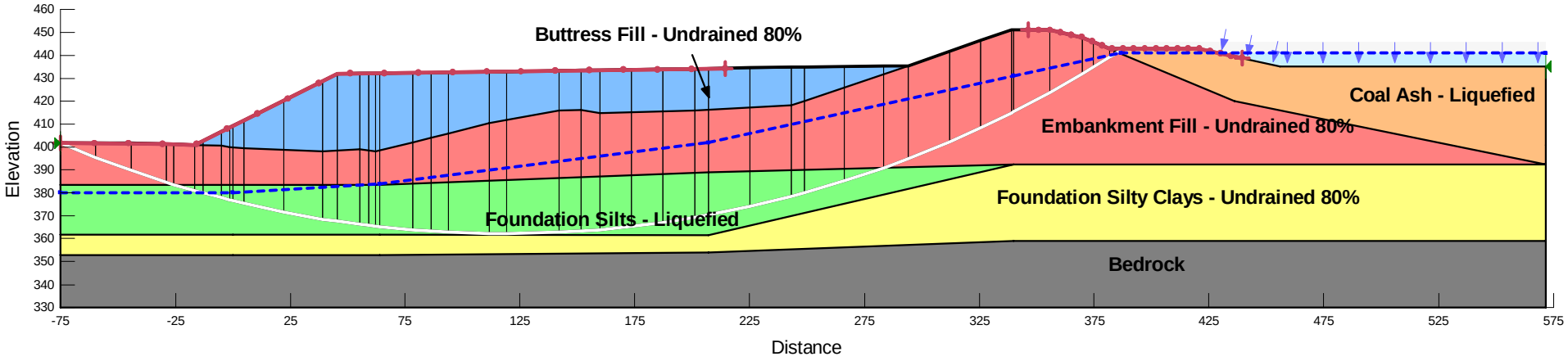


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Post-Liquefaction - Critical Circular Surface Failure Geometry
Cross-Section B
Factor of Safety = 1.61
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio	Constant Unit Wt. Above Water Table (pcf)	Minimum Strength (psf)
	Bedrock						
	Buttress Fill - Undrained 80%	123	425	16			
	Coal Ash - Liquefied	100			0.12	100	0
	Embankment Fill - Undrained 80%	128	475	18			
	Foundation Silts - Liquefied	119			0.1	119	100
	Foundation Silty Clays - Undrained 80%	126	320	19			

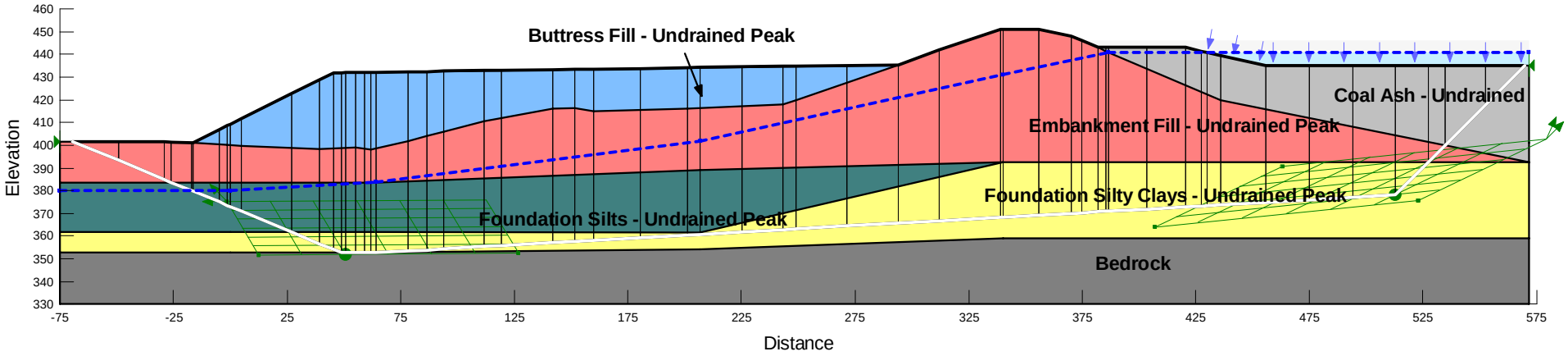


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Seismic - Critical Block Failure Surface Geometry
Cross-Section B
Factor of Safety = 1.44
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 441.0 ft
Horizontal Seismic Load = 0.18 g

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Undrained Peak	123	540	20
	Coal Ash - Undrained	100	100	12
	Embankment Fill - Undrained Peak	128	600	22
	Foundation Silts - Undrained Peak	119	650	22
	Foundation Silty Clays - Undrained Peak	126	400	23

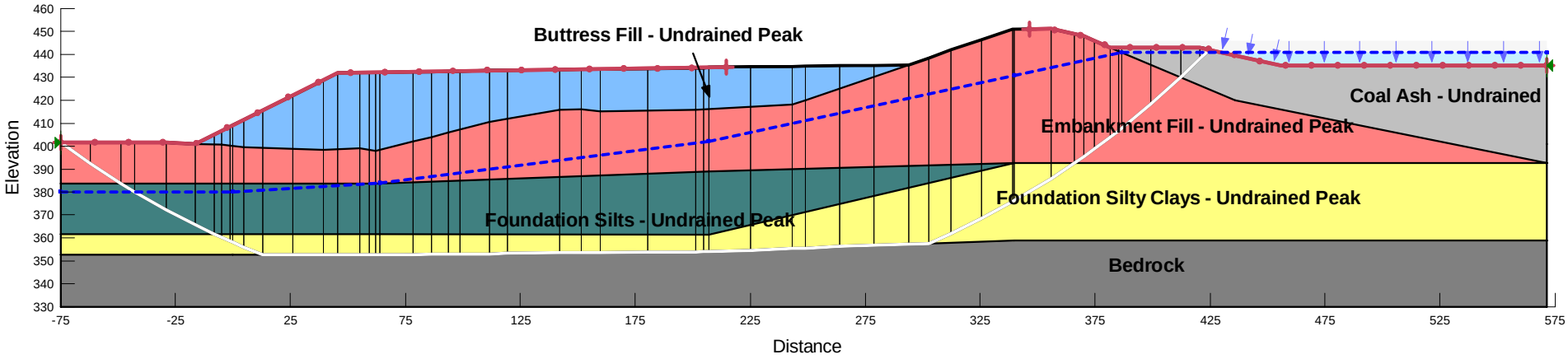


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Seismic - Critical Circular Surface Failure Geometry
Cross-Section B
Factor of Safety = 1.57
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 441.0 ft
Horizontal Seismic Load = 0.18 g

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Undrained Peak	123	540	20
	Coal Ash - Undrained	100	100	12
	Embankment Fill - Undrained Peak	128	600	22
	Foundation Silts - Undrained Peak	119	650	22
	Foundation Silty Clays - Undrained Peak	126	400	23

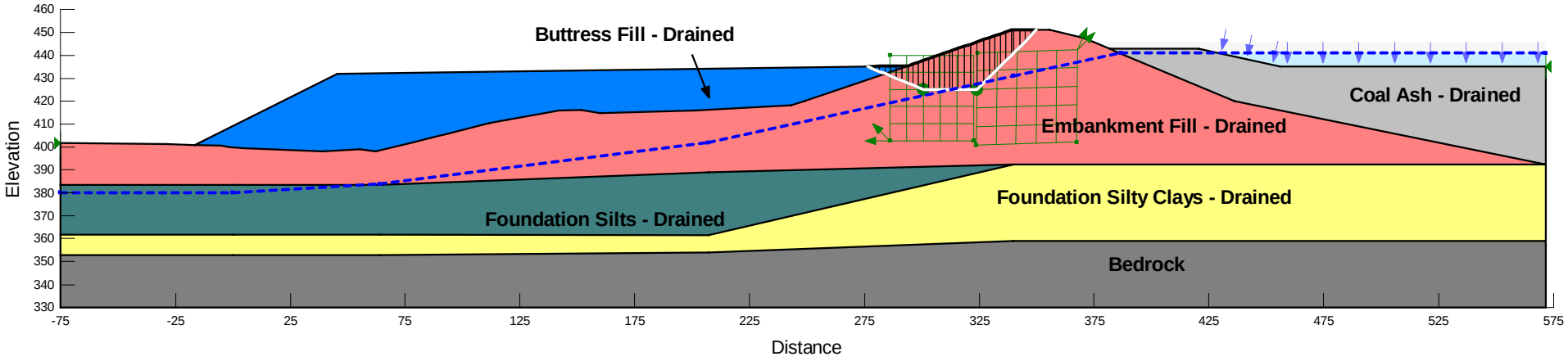


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Static Storage Pool - Critical Block Failure Surface Geometry
Cross-Section B
Factor of Safety = 3.31
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

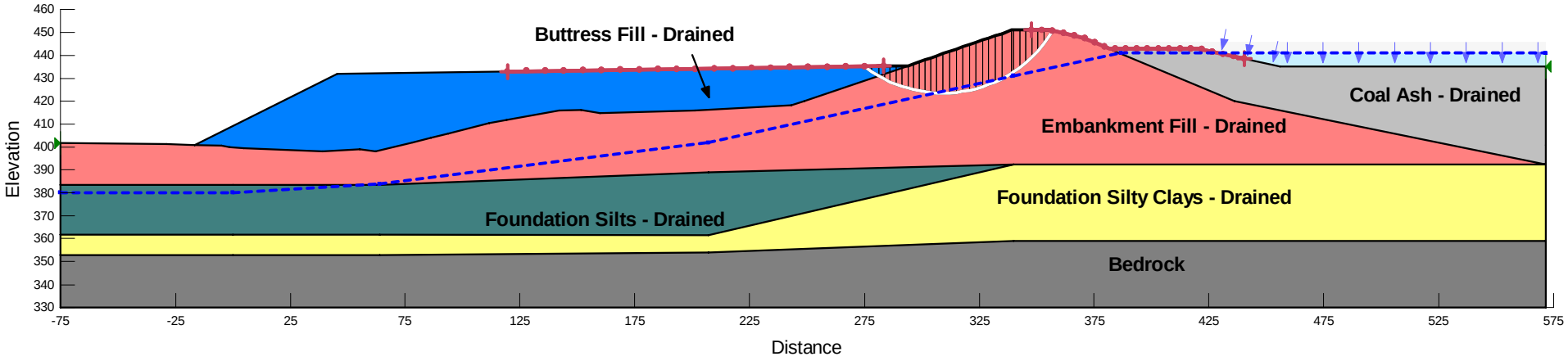


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Static Storage Pool - Critical Circular Surface Failure Geometry
Cross-Section B
Factor of Safety = 3.14
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

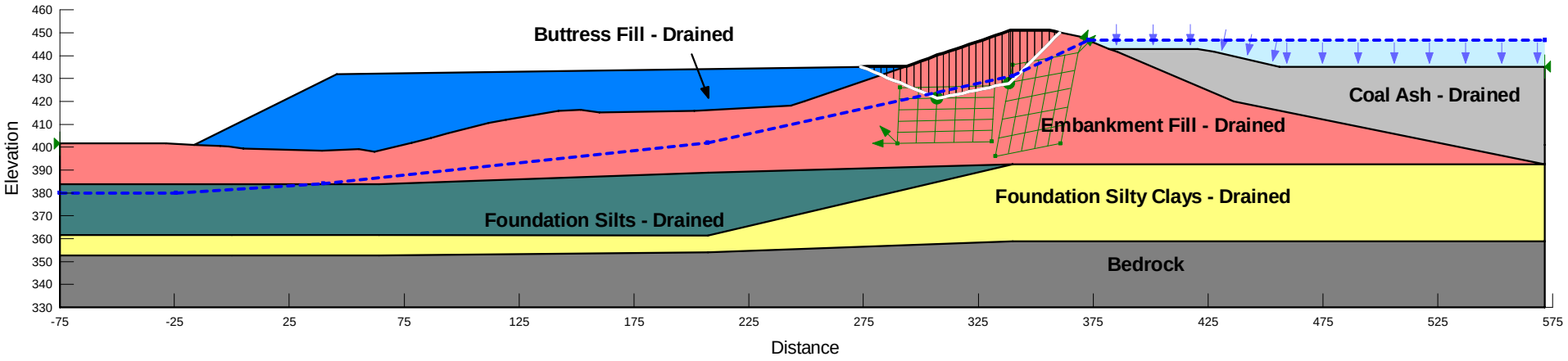


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Static Surcharge Pool - Critical Block Failure Surface Geometry
Cross-Section B
Factor of Safety = 3.43
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 446.8 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

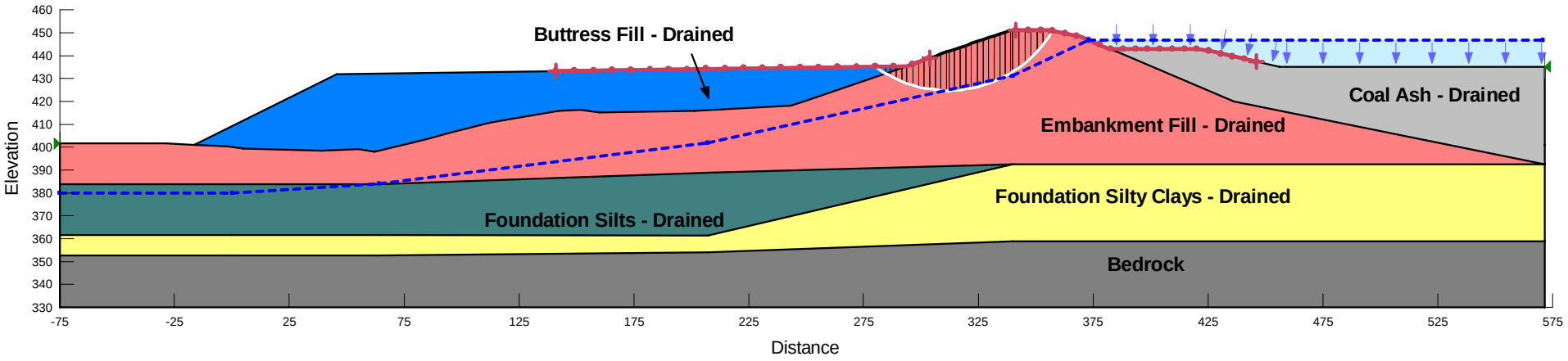


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment - 5-yr Recertification
Static Surcharge Pool - Critical Circular Surface Failure Geometry
Cross-Section B
Factor of Safety = 3.10
Date: 10/5/2021

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 446.8 ft

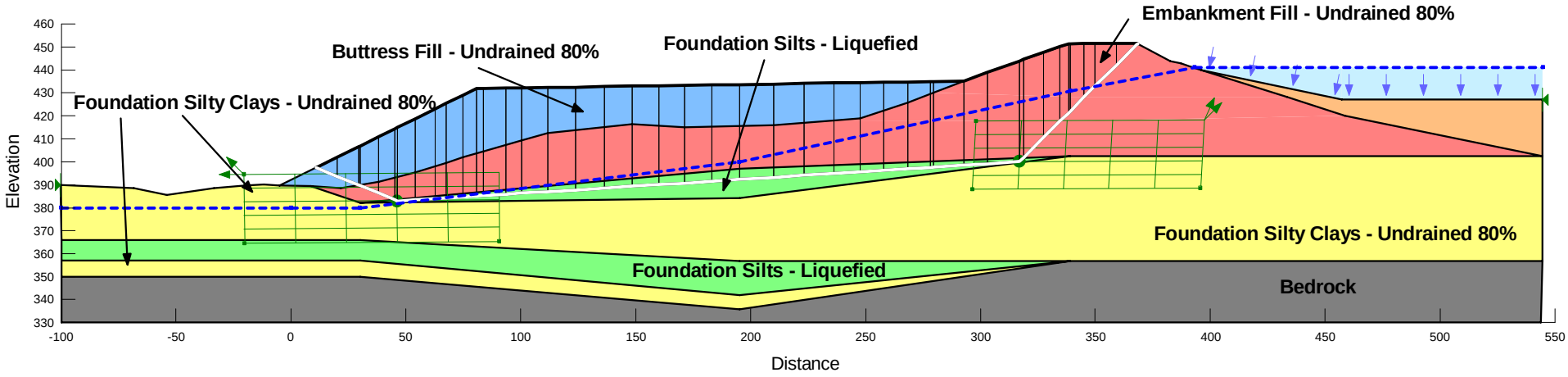


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Post-Liquefaction - Critical Block Failure Surface Geometry
Cross-Section C
Factor of Safety = 1.32
Date: 10/5/2021

Ash Elev. = 440.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio
	Bedrock				
	Buttress Fill - Undrained 80%	123	425	16	
	Coal Ash - Liquefied	100			0.12
	Embankment Fill - Undrained 80%	128	475	18	
	Foundation Silts - Liquefied	119			0.1
	Foundation Silty Clays - Undrained 80%	126	320	19	

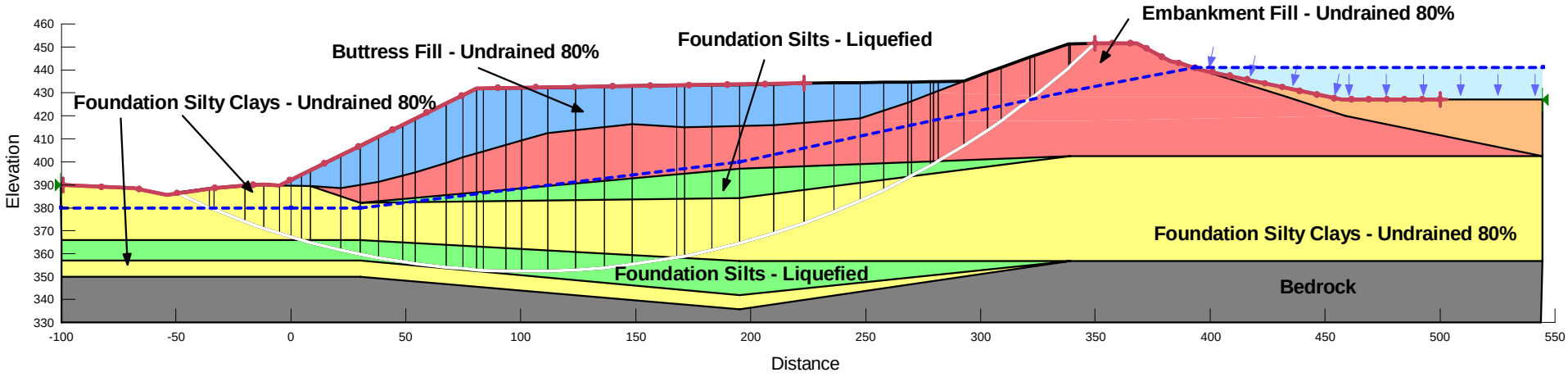


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Post-Liquefaction - Critical Circular Failure Surface Geometry
Cross-Section C
Factor of Safety = 1.54
Date: 10/5/2021

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio
	Bedrock				
	Buttress Fill - Undrained 80%	123	425	16	
	Coal Ash - Liquefied	100			0.12
	Embankment Fill - Undrained 80%	128	475	18	
	Foundation Silts - Liquefied	119			0.1
	Foundation Silty Clays - Undrained 80%	126	320	19	

Ash Elev. = 440.0 ft
Static Storage Pool Elev. = 441.0 ft

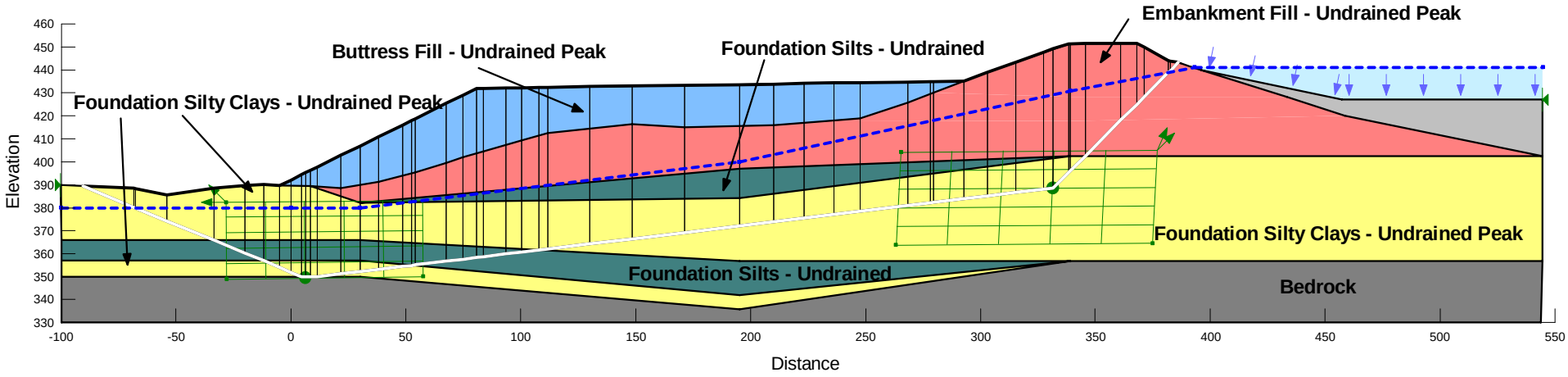


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Seismic - Critical Block Failure Surface Geometry
Cross-Section C
Factor of Safety = 1.36
Date: 10/5/2021

Ash Elev. = 440.0 ft
Static Storage Pool Elev. = 441.0 ft
Horizontal Seismic Load = 0.18 g

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Undrained Peak	123	540	20
	Coal Ash - Undrained	100	100	12
	Embankment Fill - Undrained Peak	128	600	22
	Foundation Silts - Undrained	119	650	22
	Foundation Silty Clays - Undrained Peak	126	400	23

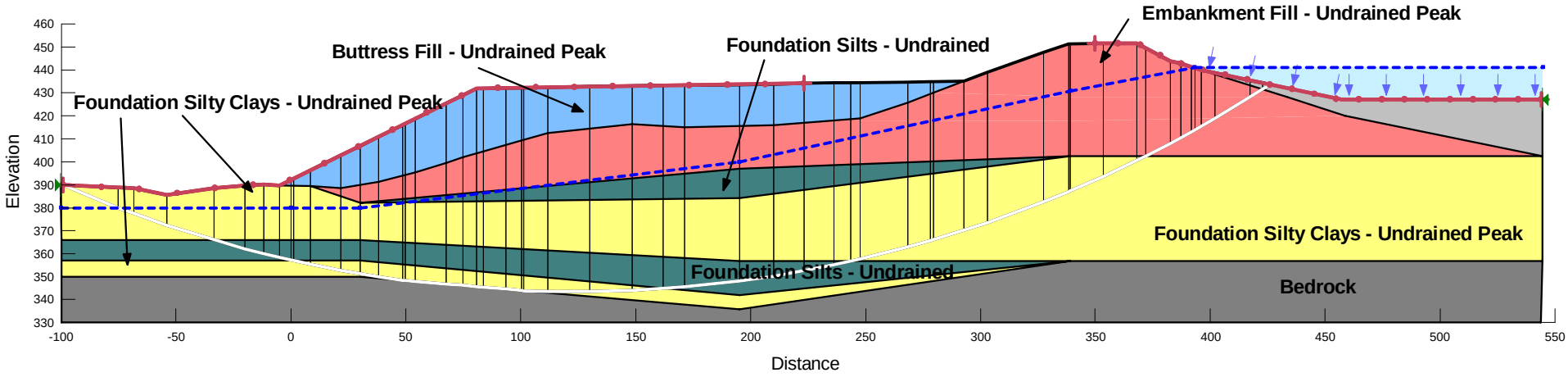


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Seismic - Critical Circular Failure Surface Geometry
Cross-Section C
Factor of Safety = 1.34
Date: 10/5/2021

Ash Elev. = 440.0 ft
Static Storage Pool Elev. = 441.0 ft
Horizontal Seismic Load = 0.18 g

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Undrained Peak	123	540	20
	Coal Ash - Undrained	100	100	12
	Embankment Fill - Undrained Peak	128	600	22
	Foundation Silts - Undrained	119	650	22
	Foundation Silty Clays - Undrained Peak	126	400	23

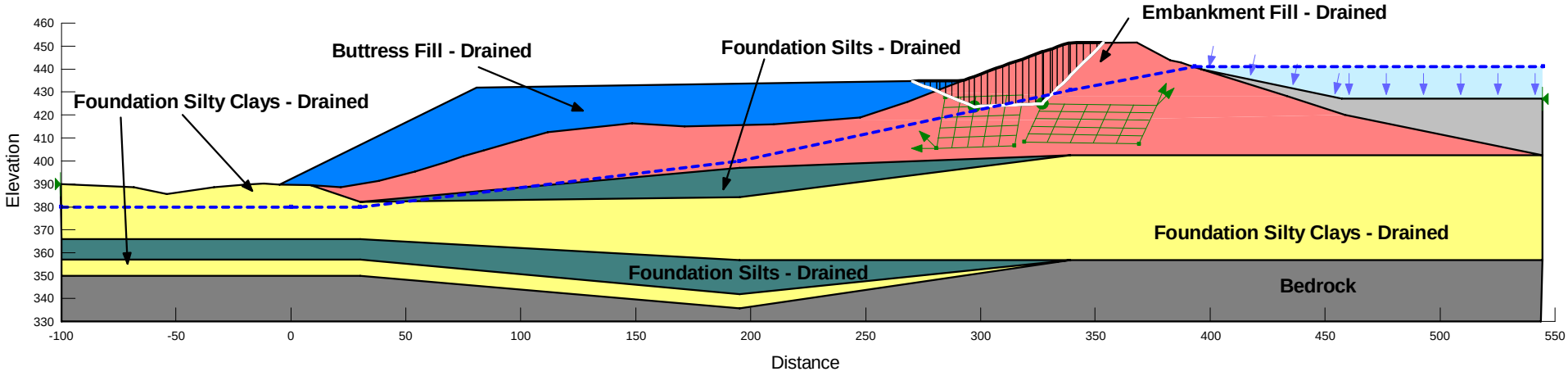


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Static Storage Pool - Critical Block Failure Surface Geometry
Cross-Section C
Factor of Safety = 3.16
Date: 10/5/2021

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

Ash Elev. = 440.0 ft
Static Storage Pool Elev. = 441.0 ft

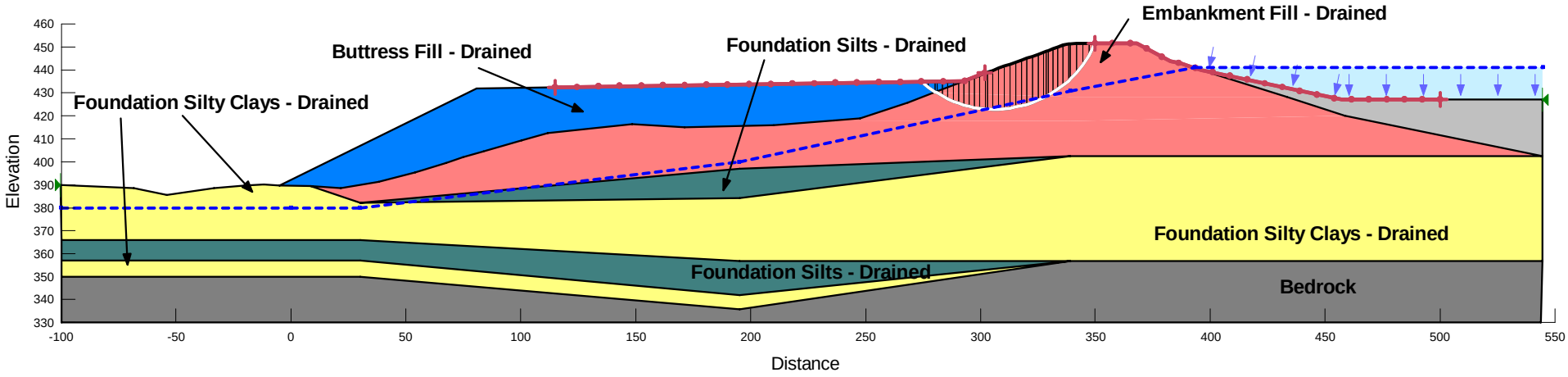


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Static Storage Pool - Critical Circular Failure Surface Geometry
Cross-Section C
Factor of Safety = 2.98
Date: 10/5/2021

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

Ash Elev. = 440.0 ft
Static Storage Pool Elev. = 441.0 ft

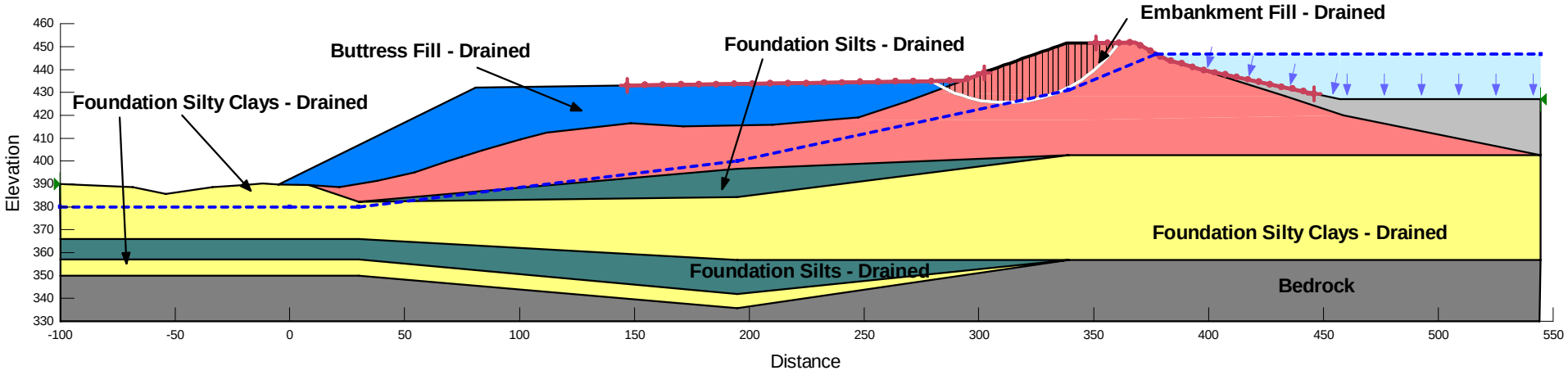


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Static Surcharge Pool - Critical Circular Failure Surface Geometry
Cross-Section C
Factor of Safety = 2.97
Date: 10/5/2021

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

Ash Elev. = 440.0 ft
Static Surcharge Pool Elev. = 446.8 ft

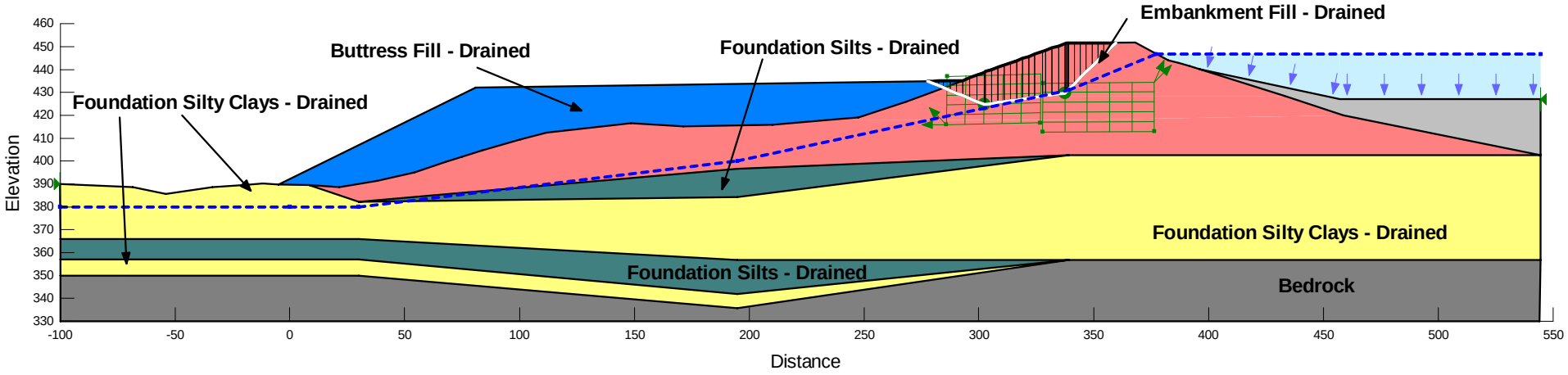


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Static Surcharge Pool - Critical Block Failure Surface Geometry
Cross-Section C
Factor of Safety = 3.16
Date: 10/5/2021

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

Ash Elev. = 440.0 ft
Static Surcharge Pool Elev. = 446.8 ft

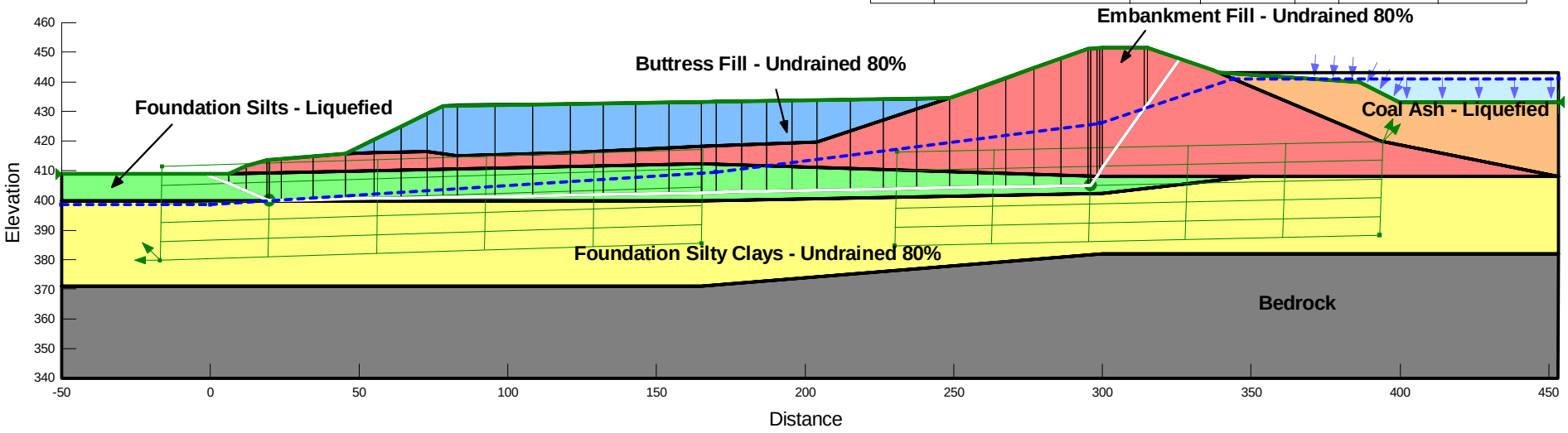


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Post-Liquefaction - Critical Block Failure Surface Geometry
Cross-Section D
Factor of Safety = 1.25
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio	Minimum Strength (psf)
	Bedrock					
	Buttress Fill - Undrained 80%	123	425	16		
	Coal Ash - Liquefied	100			0.12	0
	Embankment Fill - Undrained 80%	128	475	18		
	Foundation Silts - Liquefied	119			0.1	100
	Foundation Silty Clays - Undrained 80%	126	320	19		

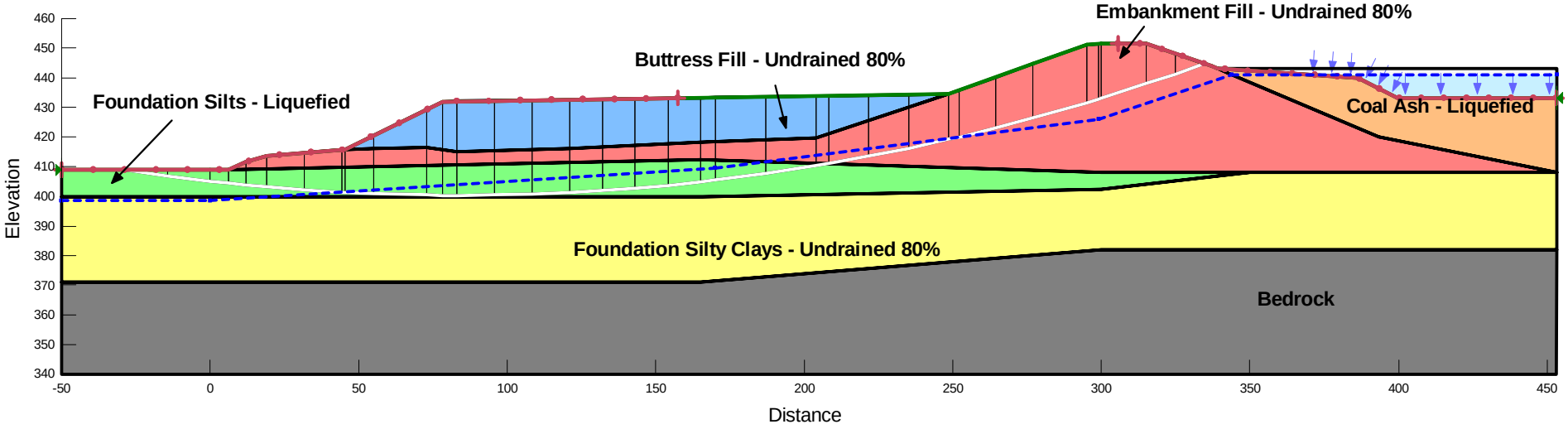


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Post-Liquefaction - Critical Circular Failure Surface Geometry
Cross-Section D
Factor of Safety = 2.19
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio	Minimum Strength (psf)
	Bedrock					
	Buttress Fill - Undrained 80%	123	425	16		
	Coal Ash - Liquefied	100			0.12	0
	Embankment Fill - Undrained 80%	128	475	18		
	Foundation Silts - Liquefied	119			0.1	100
	Foundation Silty Clays - Undrained 80%	126	320	19		

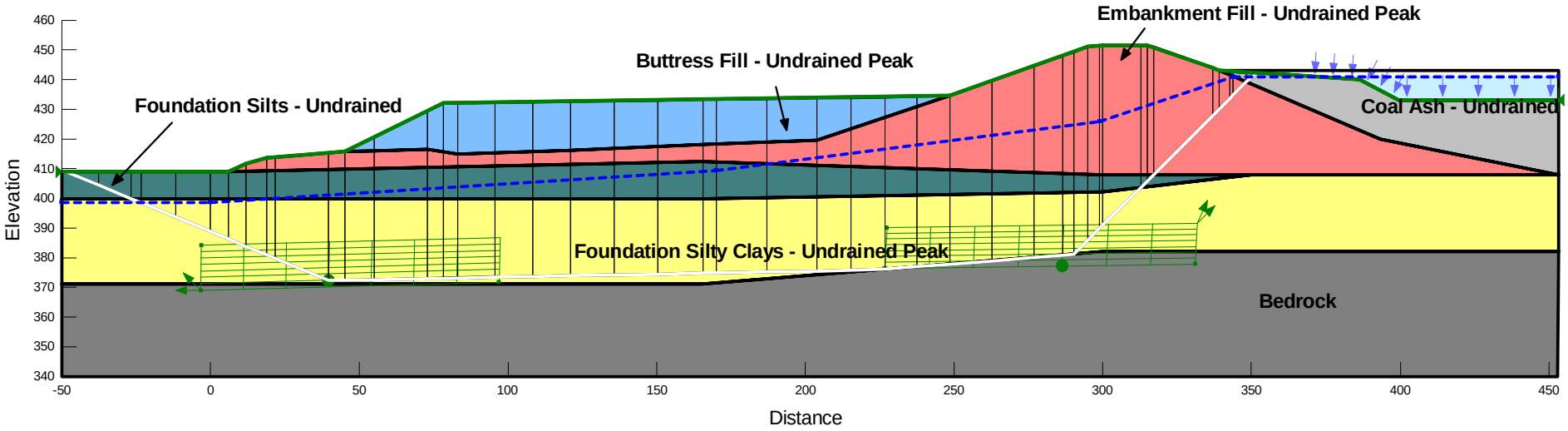


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Seismic - Critical Block Failure Surface Geometry
Cross-Section D
Factor of Safety = 1.56
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 441.0 ft
Horizontal Seismic Load = 0.18 g

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Undrained Peak	123	540	20
	Coal Ash - Undrained	100	100	12
	Embankment Fill - Undrained Peak	128	600	22
	Foundation Silts - Undrained	119	650	22
	Foundation Silty Clays - Undrained Peak	126	400	23

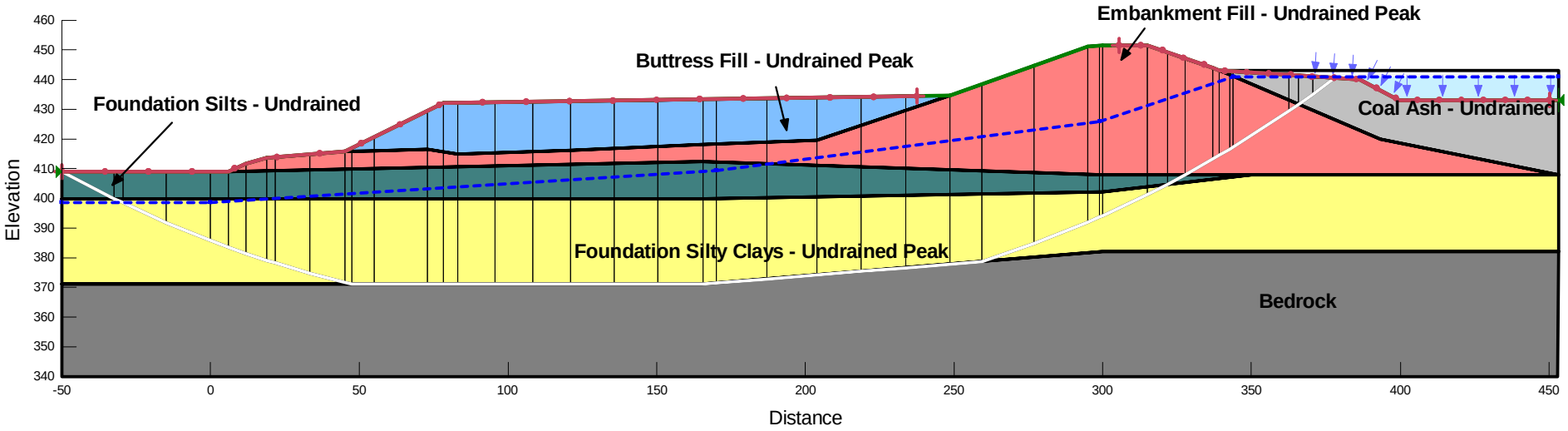


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Seismic - Critical Circular Failure Surface Geometry
Cross-Section D
Factor of Safety = 1.50
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 441.0 ft
Horizontal Seismic Load = 0.18 g

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Undrained Peak	123	540	20
	Coal Ash - Undrained	100	100	12
	Embankment Fill - Undrained Peak	128	600	22
	Foundation Silts - Undrained	119	650	22
	Foundation Silty Clays - Undrained Peak	126	400	23

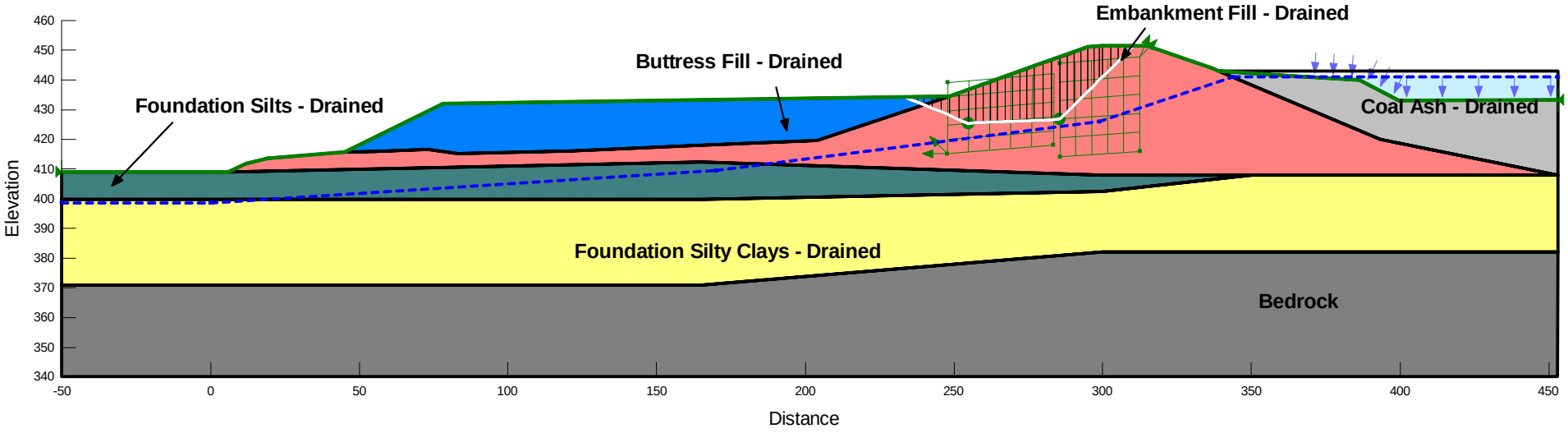


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Static Storage Pool - Critical Block Failure Surface Geometry
Cross-Section D
Factor of Safety = 3.03
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

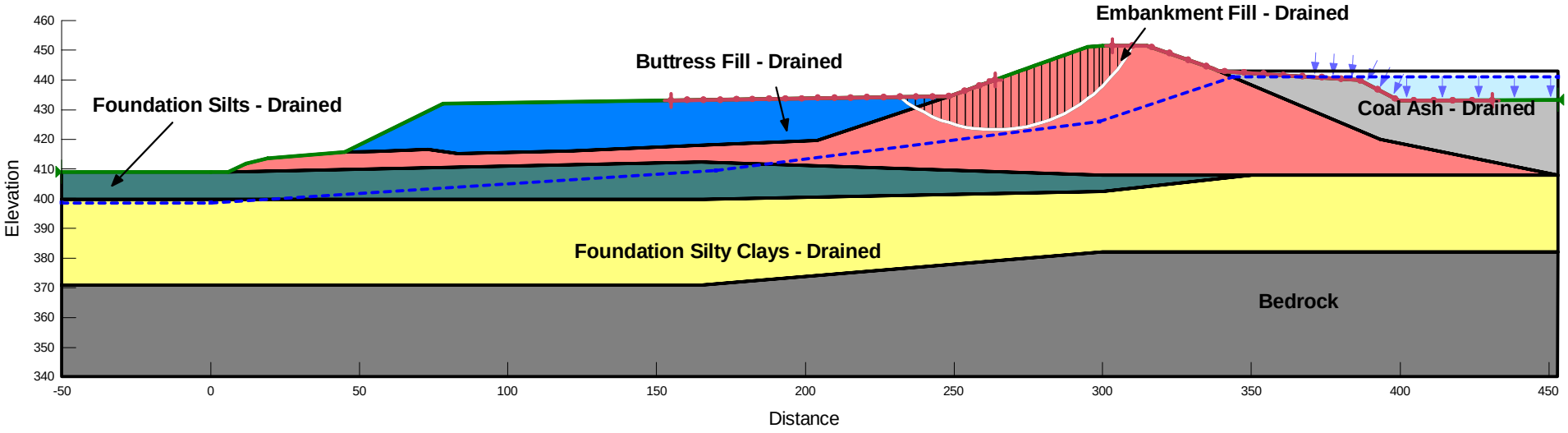


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Static Storage Pool - Critical Circular Failure Surface Geometry
Cross-Section D
Factor of Safety = 2.93
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

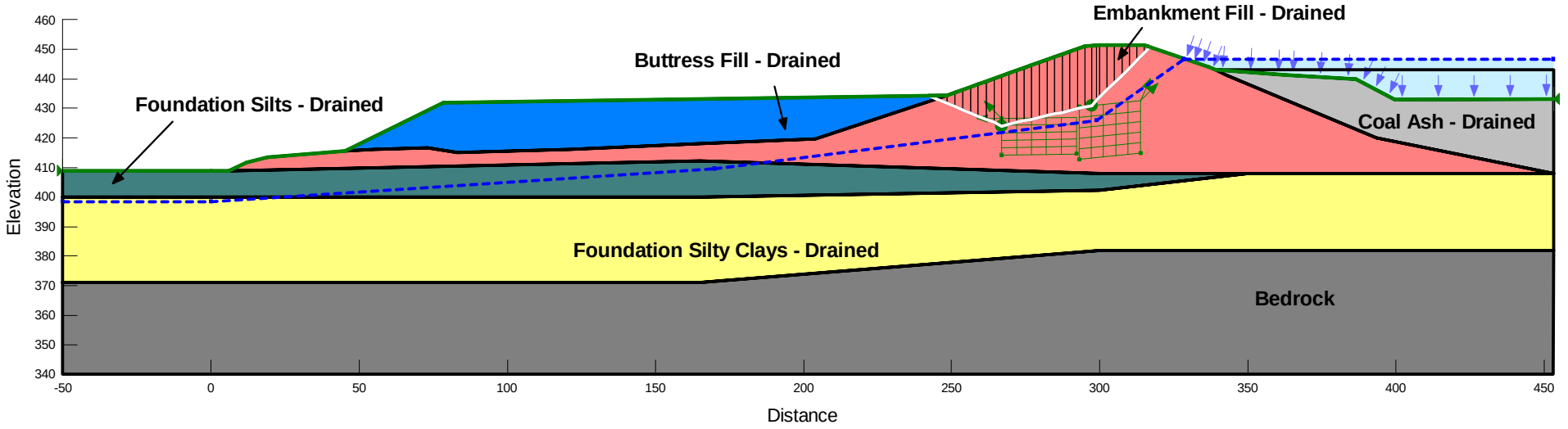


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Static Surcharge Pool - Critical Block Failure Surface Geometry
Cross-Section D
Factor of Safety = 3.22
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Surcharge Pool Elev. = 446.8 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

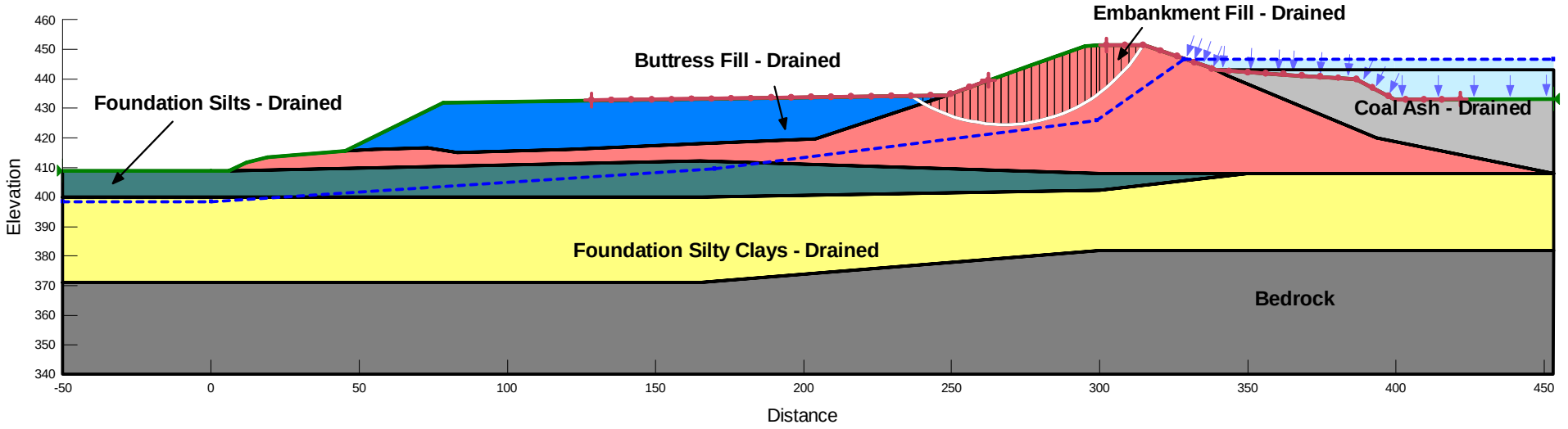


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Static Surcharge Pool - Critical Circular Failure Surface Geometry
Cross-Section D
Factor of Safety = 2.91
Date: 10/5/2021

Ash Elev. = 443.0 ft
Static Surcharge Pool Elev. = 446.8 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silts - Drained	119	0	33
	Foundation Silty Clays - Drained	126	80	31

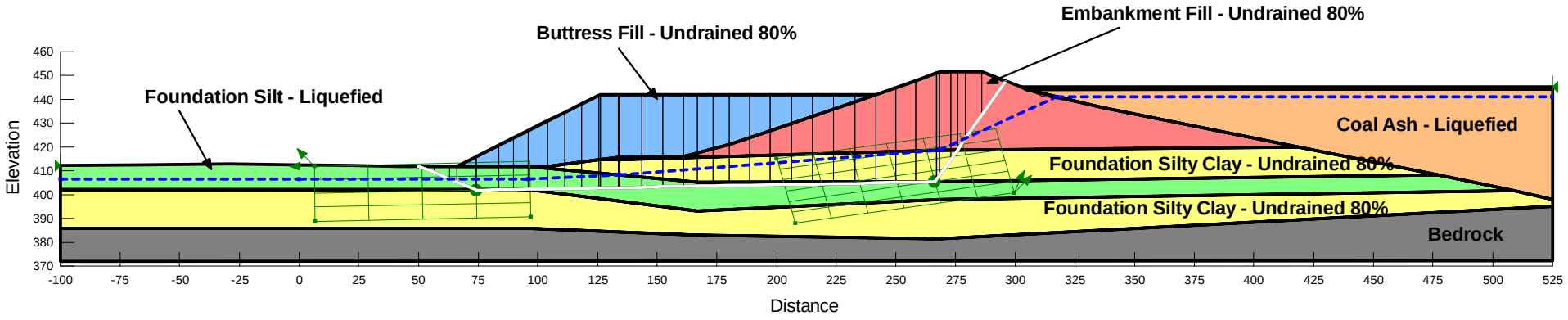


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Post- Liquefaction - Critical Block Failure Surface Geometry
Cross-Section E
Factor of Safety = 1.34
Date: 10/4/2021

Ash Elev. = 445.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio	Minimum Strength (psf)
	Bedrock					
	Buttress Fill - Undrained 80%	123	425	16		
	Coal Ash - Liquefied	100			0.12	0
	Embankment Fill - Undrained 80%	128	475	18		
	Foundation Silt - Liquefied	119			0.1	100
	Foundation Silty Clay - Undrained 80%	126	320	19		

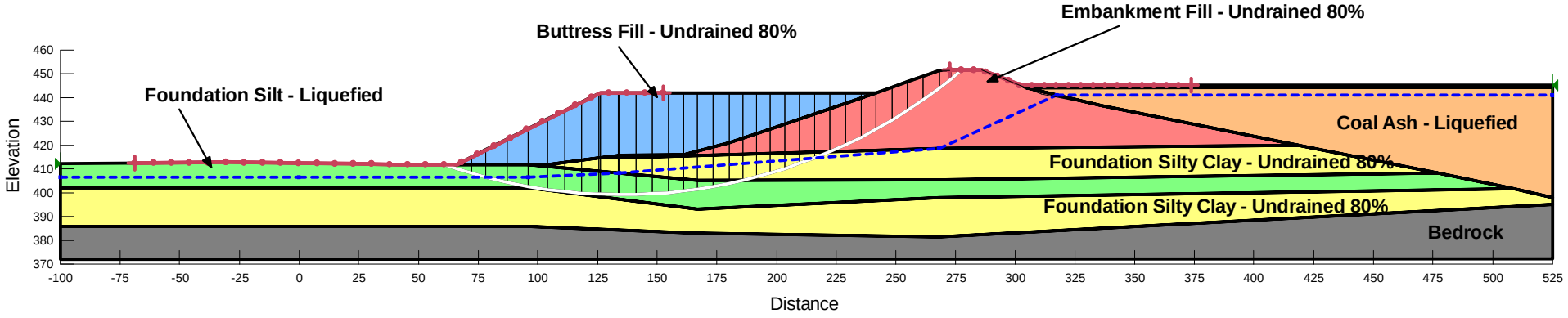


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Post-Liquefaction - Critical Circular Failure Surface Geometry
Cross-Section E
Factor of Safety = 1.69
Date: 10/4/2021

Ash Elev. = 445.0 ft
Static Storage Pool Elev. = 441.0 ft

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio	Minimum Strength (psf)
	Bedrock					
	Buttress Fill - Undrained 80%	123	425	16		
	Coal Ash - Liquefied	100			0.12	0
	Embankment Fill - Undrained 80%	128	475	18		
	Foundation Silt - Liquefied	119			0.1	100
	Foundation Silty Clay - Undrained 80%	126	320	19		

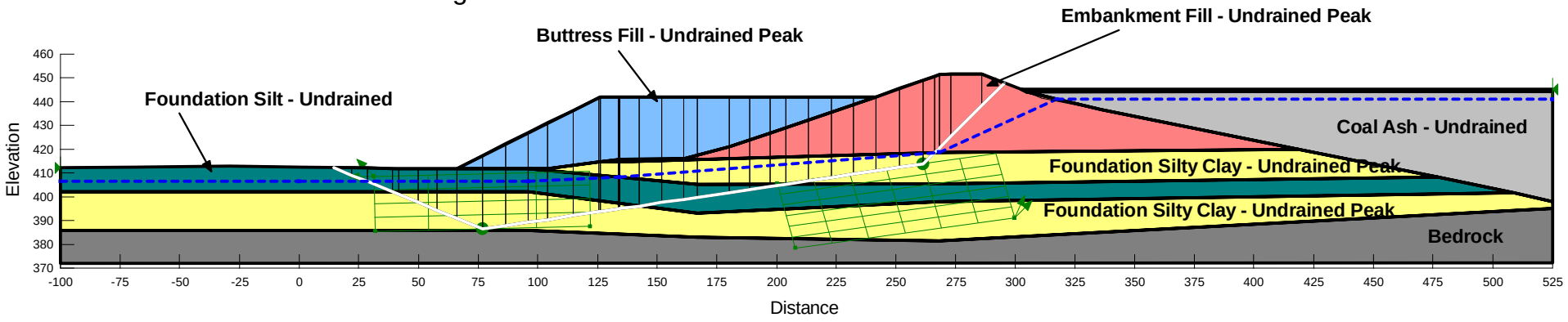


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Seismic - Critical Block Failure Surface Geometry
Cross-Section E
Factor of Safety = 1.66
Date: 10/4/2021

Ash Elev. = 445.0 ft
Static Storage Pool Elev. = 441.0 ft
Horizontal Seismic Load = 0.18 g

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Undrained Peak	123	540	20
	Coal Ash - Undrained	100	100	12
	Embankment Fill - Undrained Peak	128	600	22
	Foundation Silt - Undrained	119	650	22
	Foundation Silty Clay - Undrained Peak	126	400	23

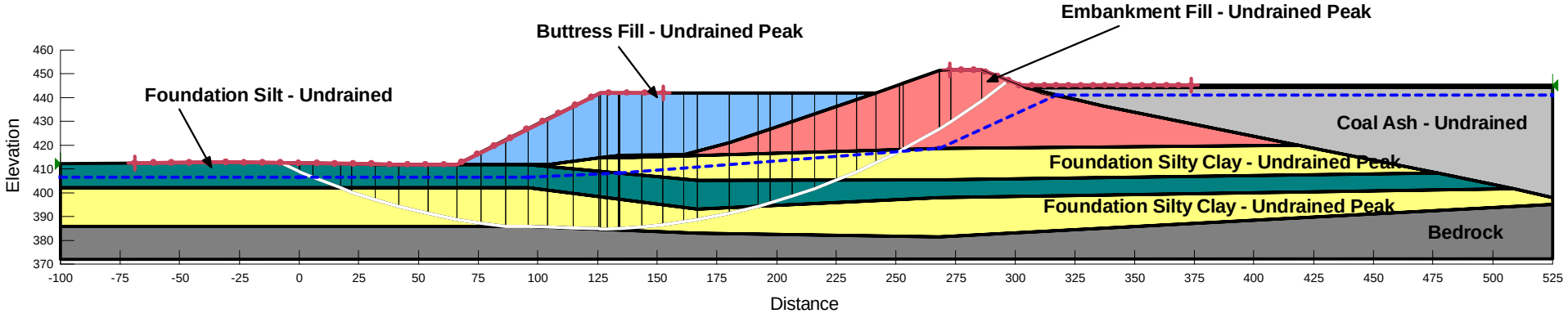


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Seismic - Critical Circular Failure Surface Geometry
Cross-Section E
Factor of Safety = 1.57
Date: 10/4/2021

Ash Elev. = 445.0 ft
Static Storage Pool Elev. = 441.0 ft
Horizontal Seismic Load = 0.18 g

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Undrained Peak	123	540	20
	Coal Ash - Undrained	100	100	12
	Embankment Fill - Undrained Peak	128	600	22
	Foundation Silt - Undrained	119	650	22
	Foundation Silty Clay - Undrained Peak	126	400	23

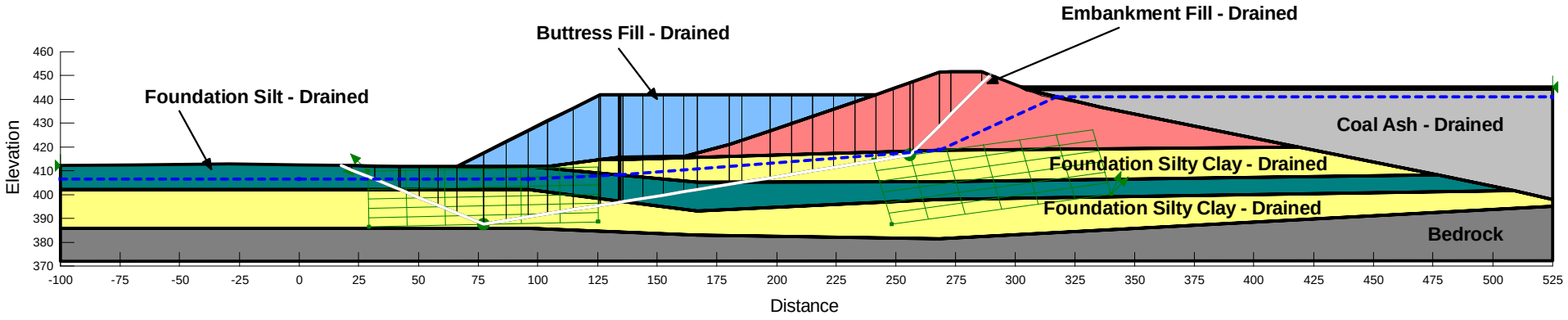


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Static Storage Pool - Critical Block Failure Surface Geometry
Cross-Section E
Factor of Safety = 3.67
Date: 10/4/2021

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silt - Drained	119	0	33
	Foundation Silty Clay - Drained	126	80	31

Ash Elev. = 445.0 ft
Static Storage Pool Elev. = 441.0 ft

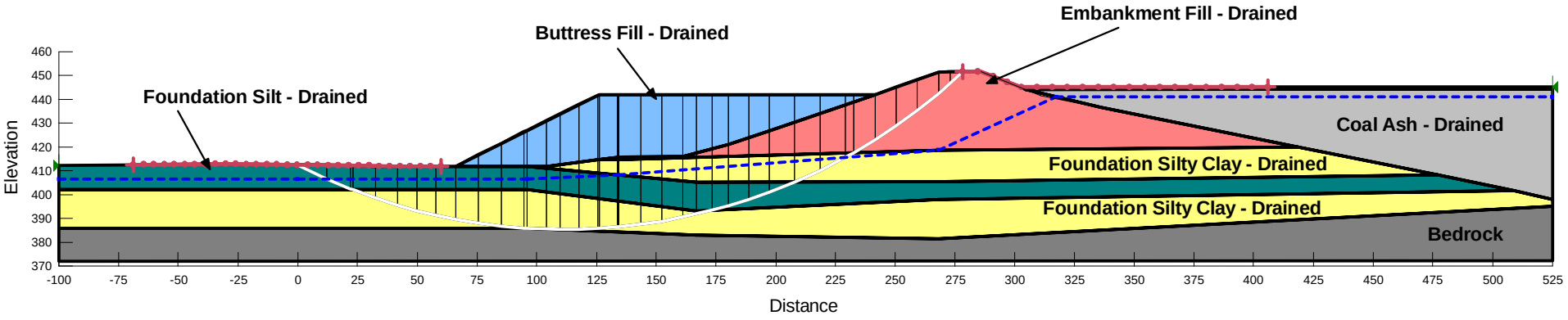


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Static Storage Pool - Critical Circular Failure Surface Geometry
Cross-Section E
Factor of Safety = 3.65
Date: 10/4/2021

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silt - Drained	119	0	33
	Foundation Silty Clay - Drained	126	80	31

Ash Elev. = 445.0 ft
Static Storage Pool Elev. = 441.0 ft

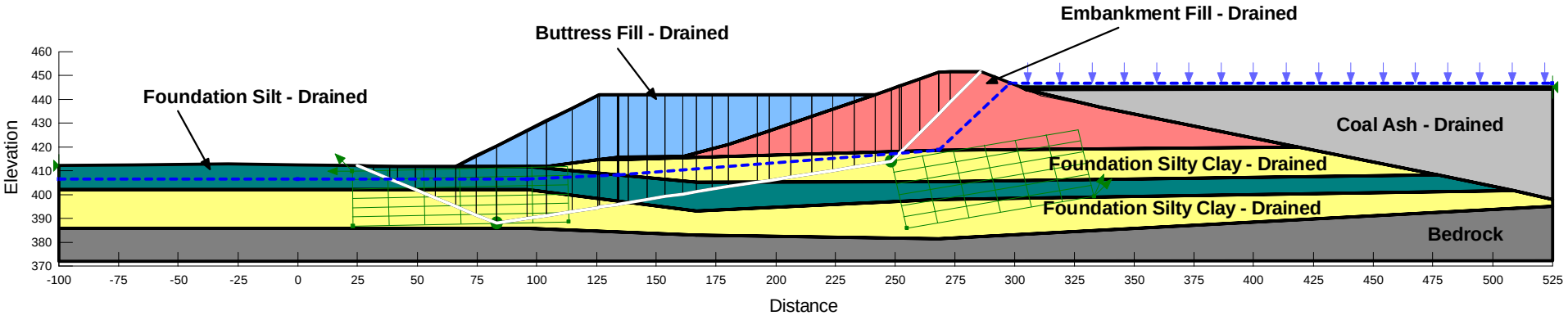


Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Static Surcharge Pool - Critical Block Failure Surface Geometry
Cross-Section E
Factor of Safety = 3.69
Date: 10/4/2021

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
	Buttress Fill - Drained	123	45	27
	Coal Ash - Drained	100	0	32
	Embankment Fill - Drained	128	50	30
	Foundation Silt - Drained	119	0	33
	Foundation Silty Clay - Drained	126	80	31

Ash Elev. = 445.0 ft
Static Surcharge Pool Elev. = 446.7 ft



Ash Pond Lower Dam Buttress Evaluation
Vectren A.B. Brown Station

CCR Rule Safety Factor Assessment
Static Surcharge Pool - Critical Circular Failure Surface Geometry
Cross-Section E
Factor of Safety = 3.67
Date: 10/4/2021

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock			
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