INITIAL SAFETY FACTOR ASSESSMENT

40 CFR 257.73 (e)

East Fly Ash Pond

Kanawha River Site

Glasgow, WV

May, 2026

Prepared for: Appalachian Power Company

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

AMERICAN ELECTRIC POWER
BOUNDLESS ENERGY™

Kanawha River Site

East Fly Ash Pond

Initial Safety Factor Assessment

PREPARED BY Dan Murphy DATE ______________

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Dan Murphy, P.E.

REVIEWED BY Blake Arthur, PE DATE ______________

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Blake Arthur, P.E.

APPROVED BY David Anthony Miller DATE **04.23.2026**

David Anthony Miller, P.E.

Director- Ash Management Services

I certify to the best of my knowledge, information, and belief that the information contained in this safety factor assessment meets the requirements of 40 CFR § 257.73(e)

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1.0 OBJECTIVE

The "Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Legacy CCR Surface Impoundments", 89 Fed. Reg. 38950 (May 8, 2024) (amending 40 C.F.R. §257) requires owners and operators of facilities with a legacy coal combustion residual (CCR) surface impoundment to prepare an initial safety factor assessment document for each legacy CCR surface impoundment at the facility.

The East Fly Ash Pond at the Kanawha River Site is subjected to this rule.

2.0 DESCRIPTION OF THE CCR UNIT

The Kanawha River Site is located approximately 0.5 miles southeast of Glasgow, West Virginia. The latitude/longitude of the Bottom Ash Pond Complex is: 38° 12' 33.34"N / 81° 25' 25.52"W. Construction of the Kanawha River Plant began in October of 1950 and the plant reached commercial operation in August of 1953. The Kanawha River Plant ceased operating in May 2015.

The East Fly Ash Pond functioned as a surface impoundment for fly ash storage beginning around 1953. The crest of the dike was originally set to elevation 625 ft-msl. The original design embankment geometry included downstream slopes of 2.5H:1V, 10-foot-wide crest and an interior slope of 1.75 H: 1 V.

Sometime around 1960, the crest of dikes was raised vertically 25 feet to elevation 650 ft-msl to provide additional ash storage capacity. The embankment was raised with fly ash harvested from the pond and the exterior slope of the raised cross section received earth cover. It is believed ash storage ceased in the East Fly Ash Pond in the late 1970s when the facility reached capacity.

The East Fly Ash Pond was capped and closed by November 2017 under West Virginia Class F Industrial Landfill Permit WV0001066. During closure, the perimeter dikes were lowered back down to elevation 625 ft-msl and the site was graded in a configuration that does not retain ponded water. Stormwater structures and spillways were demolished or abandoned in place via grout placement. The cap consists of a 40-mil textured LLDPE geomembrane, geocomposite drainage layer, geotextile cushion layer and 2 feet of protective crushed stone cover.

Two sections of the exterior slope were repaired by construction of a riprap revetment in 2020 and similarly four sections of the exterior slope were repaired by construction of a riprap revetment in 2025.

3.0 SAFETY FACTOR ASSESSMENT 257.73(e)

The Initial Safety Factor Assessment was prepared by WSP USA, Inc. and is included as Attachment A.

The most critical failure surfaces of the perimeter dike of the Kanawha River East Fly Ash Pond did not meet the required FS values. The failure surfaces would not result in a release of CCR and are associated with steepened exterior slopes. The slope stability is considered marginal.

AEP is evaluating options for addressing the slope stability deficiency.

ATTACHMENT A

Initial Safety Factor Assessment Report

REPORT

Initial Safety Factor Assessment

East Fly Ash Pond, Former Kanawha River Power Plant, Glasgow, West Virginia

Submitted to:

Mr. Dan Murphy

American Electric Power Company, Inc.
Project Manager
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Columbus, OH 43215

Submitted by:

WSP USA Inc.

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April 10, 2026

Distribution List

Benjamin J Hackett (bjhackett@aep.com)

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CERTIFICATION

Professional Engineer Certification Statement [40 CFR 257.73(e)]

I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations Section 257.73 (40 CFR Part 257.73(e)), I attest that this Safety Factor Assessment Report is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of 40 CFR Part 257.73(e) - Initial and Periodic Safety Factor Assessments.

WSP USA Inc.

Signature

April 10, 2026

Date of Report Certification

Steven J. Moeller, PE (AL, GA, NC, SC, TN, WV)

Name

27354

Professional Engineering Certification Number

1 INTRODUCTION

WSP USA Inc. (WSP) was retained by Appalachian Power Company, a subsidiary to American Electric Power Company, Inc. (AEP), to perform this initial Safety Factor Assessment for the East Fly Ash (EFA) Pond, an inactive Coal Combustion Residuals (CCR) surface impoundment. This assessment has been prepared in accordance with the requirements of 40 CFR Part §257, Subpart D (CCR Rule), specifically §257.73(e).

1.1 Purpose and Regulatory Basis

The objective of this assessment is to evaluate the stability of the Kanawha River EFA Pond under various loading conditions and confirm compliance with the minimum safety factors required by the CCR Rule. Per 40 CFR §257.73(e), owners and operators of CCR surface impoundments must demonstrate that the unit meets specified safety factors for static, seismic, and liquefaction conditions.

1.2 Site Description and History

The former Kanawha River Power Station (Plant), owned and operated by the Appalachian Power Company, is located along West Virginia State Route 60, adjacent to the Kanawha River (Figure 1). Operations at the Plant began in 1953 and ceased in 2015. The Plant and associated structures remain at the site, and the ash pond was closed in 2017 in compliance with applicable state regulations at that time. The overall facility is approximately 108 acres, and the EFA Pond covers approximately 22 acres and is surrounded by the former Plant, the Kanawha River, mostly undeveloped land, and commercial and residential properties.

1.3 Scope of Assessment

Previous field investigations were performed to characterize the subsurface conditions at the ash pond site. The results of the field programs are presented in the Geotechnical Data Report (GDR) for the Kanawha River Plant (WSP 2026).

This safety assessment report provides:

- Field and laboratory data from the investigations,
- Slope stability analyses under multiple loading conditions, and
- Model outputs and calculated safety factors for critical cross sections of the EFA Pond.

2 BACKGROUND

The former Kanawha River Power Station utilized multiple surface impoundments, the EFA Pond and the Bottom Ash Pond (BAP), to manage sluiced ash. This Safety Factor Assessment evaluates the stability of the EFA Pond. This impoundment is located east of the former Plant and is classified as a legacy CCR impoundment under the United States Environmental Protection Agency's (USEPA) Legacy CCR Final Rule (May 28, 2024), which established regulatory requirements for legacy CCR surface impoundments and CCR management units.

The area of the EFA Pond is approximately 22 acres and is located adjacent to the Kanawha River. The EFA Pond was operated as a surface impoundment from approximately 1953 to sometime prior to 1989. The EFA Pond is an inactive impoundment, which no longer impounds surface water, and is surrounded by an earthen dike with an approximate elevation of 628 feet above mean sea level (feet MSL) based on topographic data presented in Figure 2 and Figure 3. Existing topographic surfaces within the EFA Pond boundary were derived from the aerial LiDAR survey from July 2025 performed by AEP and the areas outside the pond footprint are represented using the 2018 United States Geological Survey (USGS) topographic data. Bathymetric data for the adjacent riverbed was incorporated where available and is based on a survey conducted by AEP in March 2026. As shown in Figure 2 and Figure 3, the contours just below the water line along the perimeter berm slope were interpolated using survey data collected from the LiDAR and bathymetric surveys and reasonable engineering assumptions. Based on 1951 drawings (APPENDIX A), the original ground within the pond area ranged from 605 to 625 feet MSL. The pond area was excavated to an approximate elevation of 605 feet MSL, and the pond bottom was sloped towards an outfall structure located in the southwest corner of the pond. While operating as a fly ash pond, the water elevation was controlled with this outfall structure, which, during periods of high flow, discharged water into the Kanawha River.

Historical records indicate that during the 1960s, the perimeter dikes surrounding the EFA Pond were raised to an elevation of approximately 650 feet MSL using fly ash with a soil cover. In 1989, AEP submitted a permit to construct a landfill overlying the former EFA Pond, which was not constructed. A revised landfill permit was submitted to the State of West Virginia in 2017 that included a proposed Closure Plan for the facility, and subsequently the landfill was capped and closed. As part of closure activities completed in 2017, the dikes were regraded and lowered to their current crest elevation of approximately 628 feet MSL.

According to the Ash Pond Closure drawings dated July 2015, the closure cover constructed on the in-place ash material consists of a textured high-density polyethylene (HDPE) geomembrane and drainage composite overlain by 24 inches of general fill and vegetative soil. However, based upon our site visit and discussions with AEP, the general fill and vegetative soil was replaced with surge stone above the geosynthetics.

The thickness of the ash within the bermed area ranges between approximately 9 and 67 feet. The available EFA closure design drawings are presented in APPENDIX A.

3 SAFETY FACTOR ASSESSMENT REQUIREMENTS

In accordance with § 257.73(e)(1), the owner or operator of a CCR surface impoundment must conduct initial and periodic safety factor assessments and document whether the calculated factors of safety (FoS) achieve the minimum safety factors specified 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. The minimum safety factors specified in §257.73(e)(1)(i) through(iv) include:

- The calculated static FoS under the long-term, maximum storage pool loading condition must equal or exceed 1.50;
- The calculated static FoS under the maximum surcharge pool loading condition must equal or exceed 1.40;
- The calculated seismic FoS must equal or exceed 1.00; and
- For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the initial assessment specified in §257.73(e)(1) meets the requirements of this section.

4 SAFETY FACTOR ASSESSMENT

Slope stability analyses of the EFA Pond were conducted to determine whether the calculated FoS for the critical cross-sections of the perimeter dike meet or exceed the minimum safety factors specified in Section 3.

4.1 Methodology

The stability assessment was conducted using the General Limit Equilibrium (GLE) method implemented in the computer program SLIDE2 (Version 9.026). Specifically, the Morgenstern-Price method (1965) was applied to evaluate potential failure surfaces associated with the selected cross-sections. The FoS is calculated by dividing the resisting forces by the driving forces along the critical slip surface.

The stability analyses were performed for two cross-sections (Section A-A and Section B-B) of the ash pond dike, as shown in Figure 2 and APPENDIX A. These cross sections were selected as the most susceptible to structural failure based on appropriate engineering considerations, including loading conditions. Material properties and slope geometry for the ash pond dike were taken from the GDR, and the recent topographic survey performed in 2025 and 2026 for the EFA Pond (Figure 2 and Table 1). Previous subsurface investigations, analyses, and reports included in the GDR were used to determine the material strength properties, presented in Table 1, for the subsurface stratum at the EFA Pond. The calculation package presenting the selection of geotechnical material strength properties for the slope stability analyses is provided as APPENDIX B.

The existing dike primarily consists of recompacted Earthfill and sandy and silty alluvial soils. The exterior slopes of the dike are generally uniform across the site based on an average slope from the top of slope to the toe, with the slopes of the more critical sections at approximately 1.7 horizontal (H):1 vertical (V). A map showing the slope gradients is presented in Figure 3, which shows the slope varying significantly from the top of slope to the toe due to localized erosion and sloughing of the slope. The maximum height of the dike is approximately 38 feet. The four loading scenarios required by the CCR rule are discussed in the following section.

4.2 Loading Scenarios

In accordance with 40 CFR §257.73(e), slope stability analyses were performed for the following four loading conditions required by the CCR Rule:

1) Long-Term Maximum Storage Pool Condition: Represents the steady-state condition under the maximum water level historically maintained in the impoundment.

2) Maximum Surcharge Pool Condition: Simulates the temporary rise in water level due to short-term events such as storm inflow or operational surcharging.

3) Seismic Condition: Evaluates stability under earthquake loading using the site-specific peak ground acceleration (PGA) in accordance with regulatory requirements.

4) Liquefaction Condition: Assesses the potential for loss of strength in susceptible soils under seismic loading, considering effective stress and cyclic resistance.

4.2.1 Long-Term Maximum Storage Pool Condition

The EFA Pond is an inactive impoundment that no longer impounds surface water; therefore, a maximum surcharge pool loading condition is not applicable. However, the ash pond is located adjacent to the Kanawha River with a normal pool elevation of 590 feet MSL and an ordinary high-water mark (OHWM) at elevation 594 feet MSL.

AEP has installed monitoring wells at the EFA Pond and has been collecting quarterly groundwater measurements. Based on the available data (Table 3), the water levels range between approximately 589 and 593 feet MSL. The water elevations in all monitoring wells were observed to be the highest in March 2024.

For the long-term maximum pool loading condition, WSP used a phreatic surface across for both cross sections as 592 feet MSL, calculated as average of the March 2024 water surface elevations.

4.2.2 Maximum Surcharge Pool Condition

As noted in Section 4.2.1, the EFA Pond is an inactive impoundment and no longer retains surface water. Consequently, a maximum surcharge pool loading condition, which typically represents a temporary increase in water level due to storm inflow or operational surcharging, is not applicable for this site.

4.2.3 Seismic Condition (Pseudo-static Stability Analysis)

The pseudo-static slope stability analysis was performed using the Hynes-Griffin and Franklin (1984) procedure, which recommends applying a horizontal seismic coefficient equal to 50% of the expected Peak Ground Acceleration (PGA). This approach accounts for the fact that the full PGA is not sustained during an earthquake and provides a conservative estimate of seismic loading for stability evaluations.

For this site, the design earthquake PGA was determined to be 0.153 g based on the site-specific seismic hazard analysis. Applying the Hynes-Griffin and Franklin recommendation:

$$k_h = 0.5 \times PGA = 0.5 \times 0.153\ g = 0.765 \approx 0.077\ g$$

Thus, the pseudo-static condition was modelled using a $k_h$of 0.077g, representing half the PGA. This value is consistent with industry practice and regulatory guidance for CCR impoundments and provides a reasonable balance between conservatism and realistic seismic demand.

4.2.4 Liquefaction Condition (Post-Earthquake Liquefaction)

Liquefaction susceptibility of the dike materials was evaluated using the procedure outlined by Youd et al. (2001), based on Standard Penetration Test (SPT) data obtained during previous geotechnical exploration programs. FoS against liquefaction were calculated for all borings. The analysis incorporated earthquake magnitude and peak horizontal acceleration as input parameters to characterize the intensity and duration of ground shaking.

The applicable ground motion parameter, peak horizontal acceleration at bedrock, was taken as a_{max} = 0.153g, consistent with the pseudo-static stability assessment. The earthquake magnitude was determined using the Unified Hazard Tool provided by the USGS Earthquake Hazards Program (USGS, 2023). An event with a moment magnitude of Mw = 5.96, corresponding to a 2% probability of exceedance in 50 years (2,475-year return period), was selected for the liquefaction assessment. Details of the calculated Cyclic Stress Ratio (CSR) and Cyclic Resistance Ratio (CRR) values are provided in APPENDIX C.

Based on the evaluation, the dike materials are not susceptible to liquefaction under the design seismic conditions. Consequently, post-liquefaction stability analyses were not required and were not performed.

5 SLOPE STABILITY ASSESSMENT RESULTS

Table 2 summarizes the results of the slope stability analyses for the dike sections evaluated in accordance with 40 CFR §257.73(e)(1)(i)–(iv) of the CCR Rule, and detailed stability figures are provided in APPENDIX D.

For the analyzed cases, the calculated FoS under the long-term static condition does not meet the CCR Rule threshold of FoS ≥ 1.50 for both local and global failure surfaces for both Sections A-A and B-B. Under pseudo-static seismic loading, both Sections A-A and B-B fall below the CCR Rule threshold of FoS ≥ 1.00 for both local and global failure surfaces.

Review of the Sections A-A and B-B indicate that the lower FoS values are associated with the steep exterior slopes of the perimeter dike as shown in Figure 4.

6 REFERENCES

Hynes-Griffin, M. E., & Franklin, A. G. (1984). Rationalizing the seismic coefficient method. U.S. Army Corps of Engineers, Waterways Experiment Station.

Morgenstern, N. R., & Price, V. E. (1965). The analysis of the stability of general slip surfaces. Géotechnique, 15(1), 79–93.

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WSP USA Inc. (WSP). (2026). Geotechnical Data Report. Kanawha River Ash Ponds (BAP and EFA), Former Kanawha River Power Plant, Glasgow, West Virginia. January 28, 2026

Youd, T. L., Idriss, I. M., Andrus, R. D., et al. (2001). Liquefaction resistance of soils: Summary report from the 1996 NCEER and 1998 NCEER/NSF workshops on evaluation of liquefaction resistance of soils. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833.

Signature Page

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https://wsponlinenam.sharepoint.com/sites/us-aep-efa-kanawha-r/shared documents/5 technical work/safety factor assessment_efa/sfa_kanawha_eastflyashpond_ccr_engsupport.docx

Tables

Table 1: Summary of Geotechnical Material Properties

Material	Unit Weight (pcf)	Drained Strength		Undrained Strength	
		Effective Internal Friction φ' (°)	Effective Cohesion c' (psf)	Total Internal Friction φ' (°)	Total Cohesion c' (psf)
Embankment Materials					
Earthfill	125	32	100	-	-
Coal Combustion Residuals					
CCR-Impounded	100	28	0	-	-
Alluvium					
Alluvium-1	120	32	100	0	26
Alluvium-2	115	32	0	0	26

Table 2: Summary of Slope Stability Assessment Results

Slope Failure	Section	Long-term static (CCR Rule Threshold FoS ≥1.50)[3]	Pseudo-static seismic loading (CCR Rule Threshold FoS ≥1.00)[3]
Local[1]	A-A	**1.28**	**0.90**
Global[2]	A-A	**1.28**	**0.90**
Local[1]	B-B	**1.40**	**0.97**
Global[2]	B-B	**1.40**	**0.97**

Notes:

1. For Local Slope Failure Surfaces, the minimum depth is set to 5 feet to capture shallow failures near the crest or slope face without including very thin surface slides.

2. For Global Slope Failure Surfaces, the minimum depth is set to 15 feet to focus on deeper, more critical failure mechanisms that could impact overall embankment stability

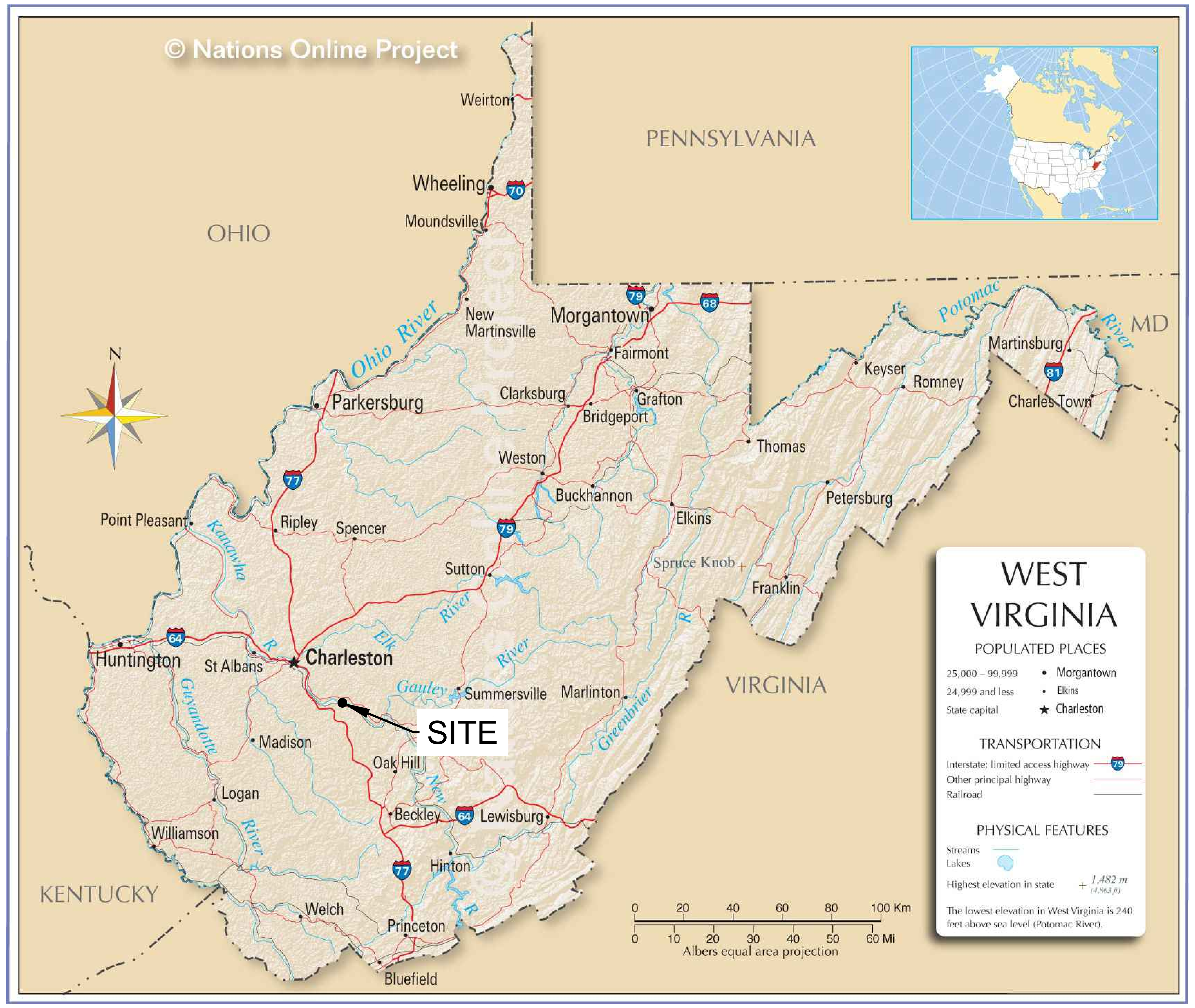
3. Results shown in bold do not meet the minimum Factor of Safety (FoS) requirement per CCR Rule.

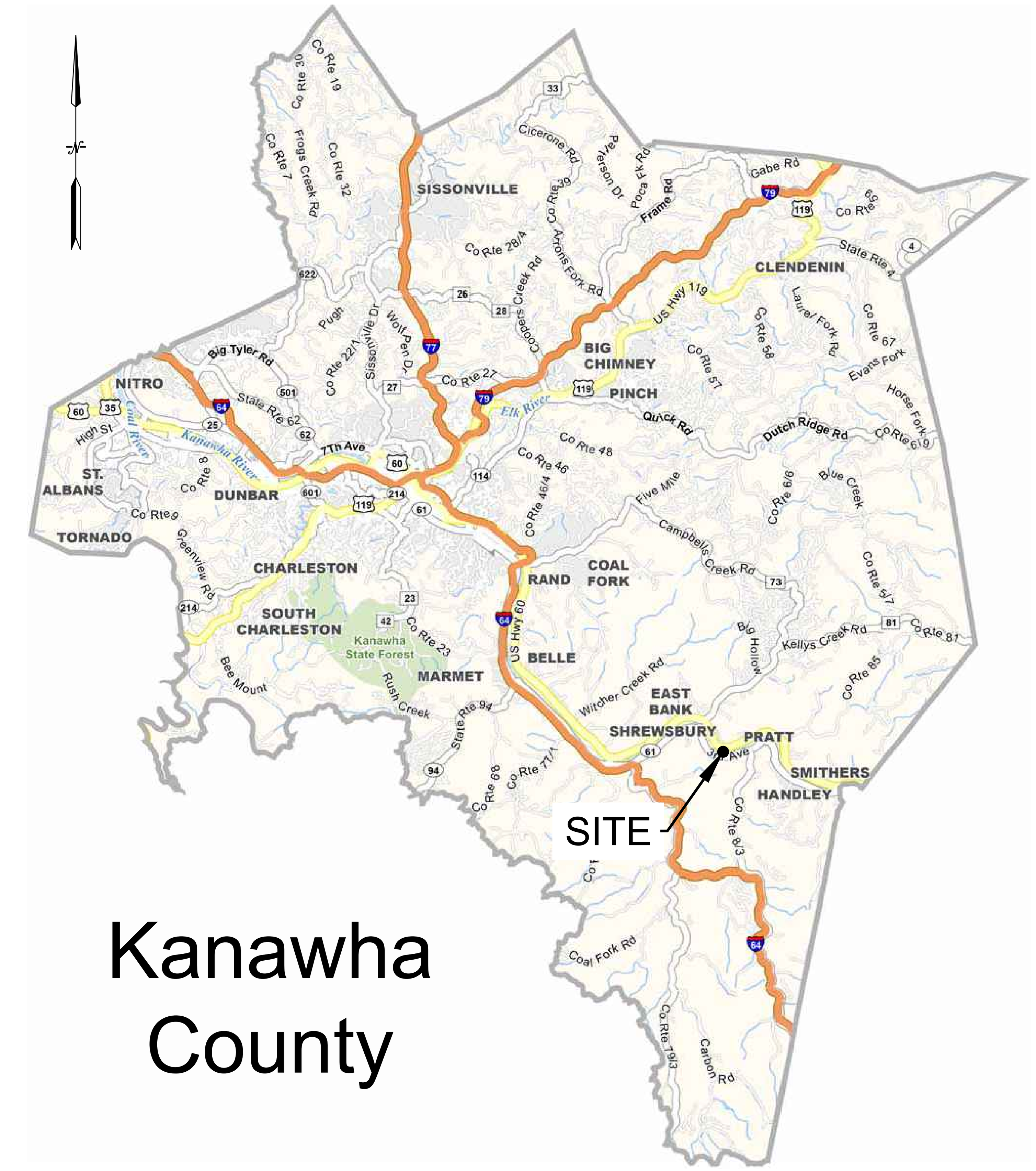
Table 3: Summary of Groundwater Elevations in EFA Monitoring Wells

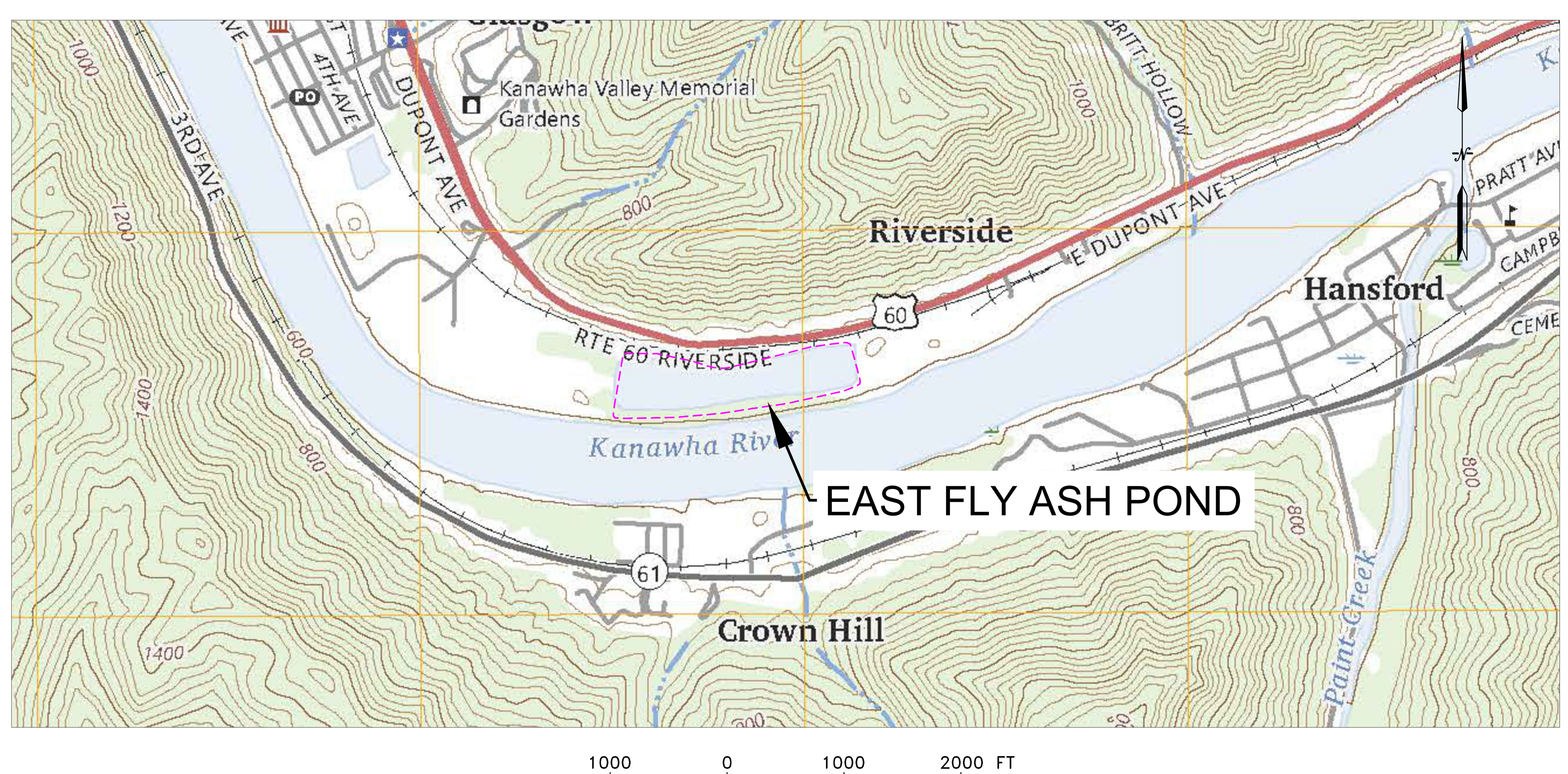
Monitoting Well ID	TOC[1] Elevation (ft-MSL)	Sept 2021		Mar 2022		Sep 2022		Mar 2023		Sep 2023		Mar 2024		Sep 2024		May 2025		Sep 2025	
		DTW[2] below TOC (feet)	GWE[3] (ft-MSL)	DTW below TOC (feet)	GWE (ft-MSL)	DTW below TOC (feet)	GWE (ft-MSL)	DTW below TOC (feet)	GWE (ft-MSL)	DTW below TOC (feet)	GWE (ft-MSL)	DTW below TOC (feet)	GWE (ft-MSL)	DTW below TOC (feet)	GWE (ft-MSL)	DTW below TOC (feet)	GWE (ft-MSL)	DTW below TOC (feet)	GWE (ft-MSL)
MW-1601	631.02	41.22	589.80	40.62	590.40	41.20	589.82	40.16	590.86	41.20	589.82	38.98	592.04	41.23	589.79	40.81	590.21	41.29	589.73
MW-1602	630.78	41.36	589.42	40.87	589.91	41.42	589.36	40.26	590.52	41.32	589.46	39.06	591.72	41.21	589.57	41.10	589.68	41.22	589.56
MW-1603	631.17	41.41	589.76	41.06	590.11	41.46	589.71	40.50	590.67	41.60	589.57	38.47	592.70	41.40	589.77	41.30	589.87	41.35	589.82
MW-1604	631.18	40.22	590.96	39.74	591.44	40.14	591.04	39.29	591.89	40.51	590.67	38.25	592.93	40.53	590.65	40.00	591.18	40.35	590.83
MW-1605	631.26	41.40	589.86	40.87	590.39	41.52	589.74	40.41	590.85	41.71	589.55	39.63	591.63	41.62	589.64	41.35	589.91	41.45	589.81

Notes:
1. Top of the Casing Elevation in feet above mean seal level (MSL)
2. Depth to Water below the Top of Casing
3. Ground Water Elevation in feet above mean seal level (MSL)

Figures







REFERENCES:
USGS 7.5 MINUTE QUADRANGLE; CEDAR GROVE, 2023.

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DATE	NO.	DESCRIPTION	APPD.

REVISIONS

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APPALACHIAN POWER COMPANY

EAST FLY ASH POND
FORMER KANAWHA RIVER POWER PLANT

GLASGOW WEST VIRGINIA

SITE LOCATION PLAN

UNIT: FEET | DRAWING NUMBER: 1 OF 4 | REV: --

SCALE:
DR: CCP
CH: NG
SUP: NG
ENG: SJM
DATE: 4/10/2026
APPROVED BY

STEVEN J. MOELLER REGISTERED 27354 STATE OF WEST VIRGINIA PROFESSIONAL ENGINEER

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APPALACHIAN POWER COMPANY

EAST FLY ASH POND
FORMER KANAWHA RIVER POWER PLANT

GLASGOW — WEST VIRGINIA

SLOPE STABILITY SECTION LOCATION PLAN (WITH AERIAL)

NOTES

1. SOME OF THE MONITORING WELLS (FROM 1988/1989/1995) MAY HAVE BEEN ABANDONED.

REFERENCES

1. EXISTING TOPOGRAPHIC SURFACES WITHIN THE EFA POND BOUNDARY WERE DERIVED FROM THE AERIAL LIDAR SURVEY PROVIDED BY AEP (JULY 2025).
2. THE AREAS OUTSIDE THE POND FOOTPRINT ARE REPRESENTED USING THE 2018 (USGS) TOPOGRAPHIC DATA.
3. BATHYMETRIC DATA FOR THE ADJACENT RIVERBED IS BASED ON SURVEY CONDUCTED BY AEP IN MARCH 2026.
4. AREAS BETWEEN LIMITS OF AERIAL LIDAR AND BATHYMETRIC DATA WERE INTERPOLATED USING SURVEY DATA IN THE SURROUNDING AREAS AND REASONABLE ENGINEERING ASSUMPTIONS CONSISTENT WITH AVAILABLE SITE DATA.
5. SITE BOUNDARY IS APPROXIMATE.

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UNIT: FEET	DRAWING NUMBER: 2 OF 4	REV: --
SCALE: 1" = 100'		
DR: CCP	APPROVED BY	STEVEN J. MOELLER REGISTERED 27354 STATE OF WEST VIRGINIA PROFESSIONAL ENGINEER
CH: NG		
SUP: NG		
ENG: SJM		
DATE: 4/10/2026		

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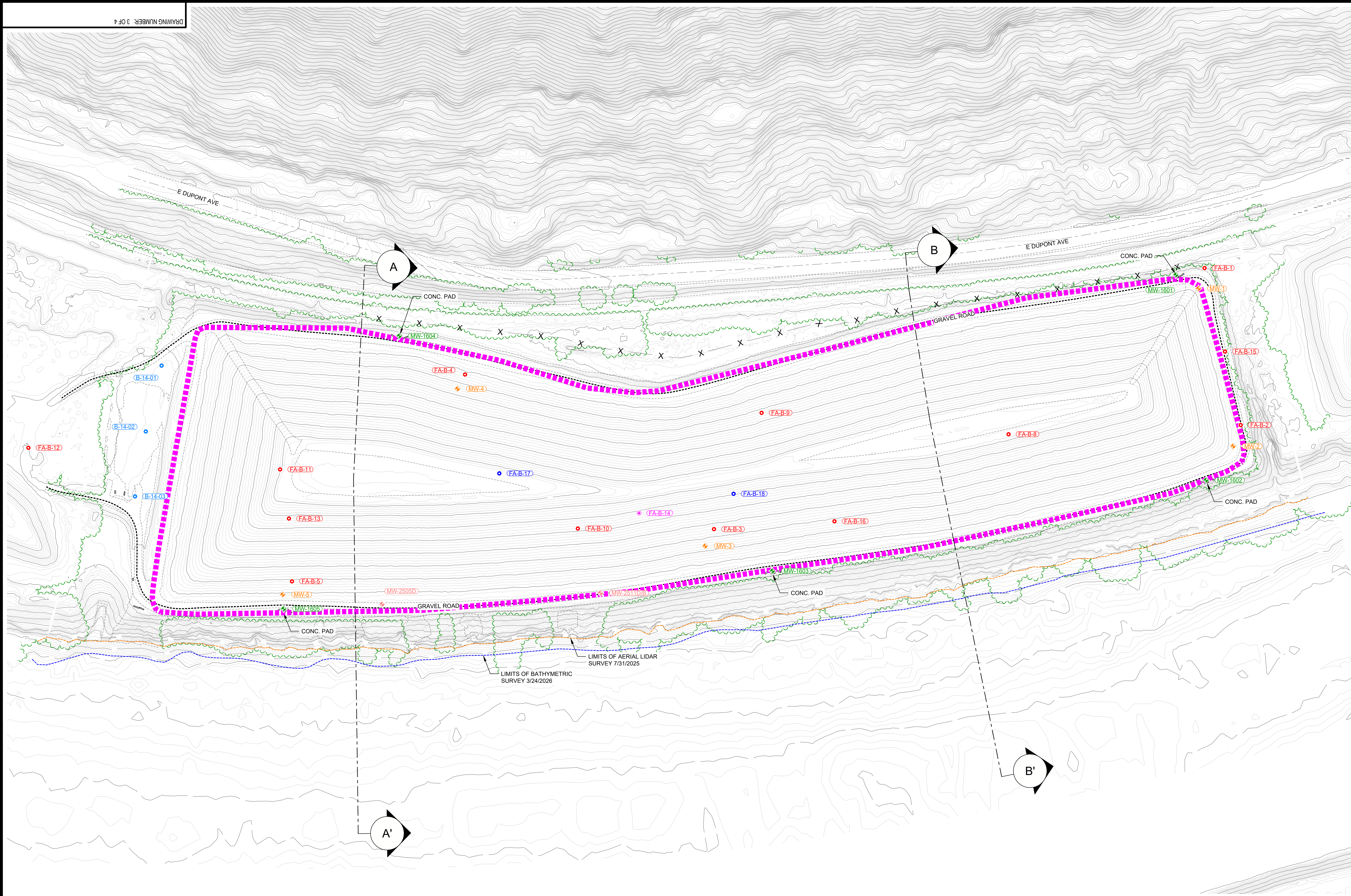

LEGEND

- EXISTING CONTOURS
- EXISTING ROADS
- EXISTING TREE LINE
- APPROXIMATE EAST FLY ASH POND BOUNDARY
- AEP MONITORING WELL (MW-XX), 1988,1989,1995
- AEP MONITORING WELL (MW-16XX), 2016
- EHS MONITORING WELL (MW-25XX), 2025
- AEP BORING (FA-B-XX), 1988/1989
- AEP BORING (FA-B-XX), 2005
- AEP BORING (B-14-XX), 2014
- AEP CPT SOUNDING (FA-B-14), 2014

100 0 100 200 FT

NOTES

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APPALACHIAN POWER COMPANY

EAST FLY ASH POND
FORMER KANAWHA RIVER POWER PLANT

GLASGOW WEST VIRGINIA

SLOPE STABILITY SECTION LOCATION PLAN

UNIT: FEET
DRAWING NUMBER: 3 OF 4
REV: –

SCALE: 1" = 100'
DR: CCP
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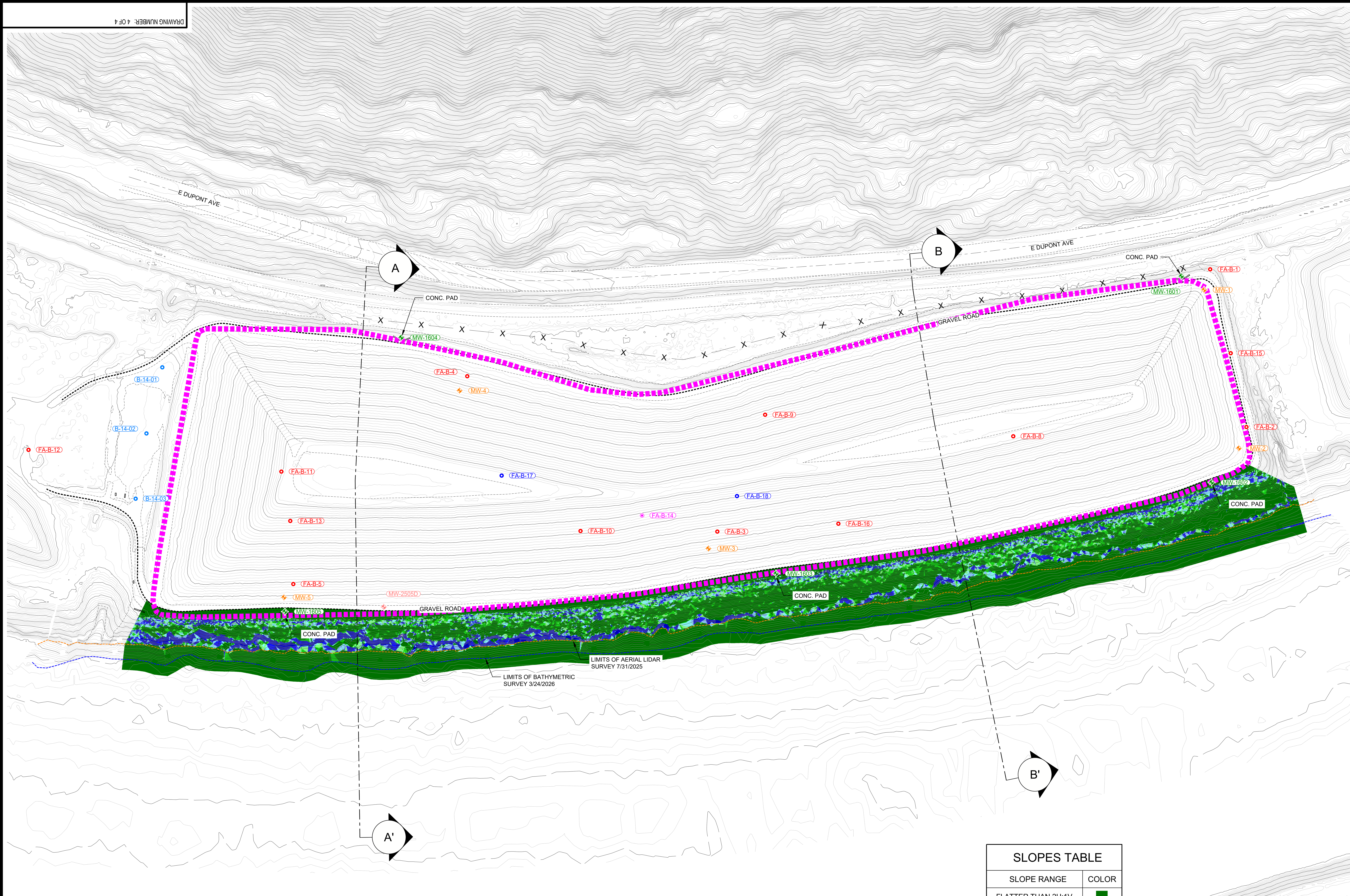
Suite 1100
Atlanta, GA 30326

AEP AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215



LEGEND

- EXISTING CONTOURS
- EXISTING ROADS
- EXISTING TREE LINE
- APPROXIMATE EAST FLY ASH POND BOUNDARY
- AEP MONITORING WELL (MW-XX), 1988,1989,1995
- AEP MONITORING WELL (MW-16XX), 2016
- EHS MONITORING WELL (MW-25XX), 2025
- AEP BORING (FA-B-XX), 1988/1989
- AEP BORING (FA-B-XX), 2005
- AEP BORING (B-14-XX), 2014
- AEP CPT SOUNDING (FA-B-14), 2014

100 0 100 200 FT

DATE	NO.	DESCRIPTION	APPD.

REVISIONS

THIS DRAWING IS CLASSIFIED AS:

REFERENCE AEP's CORPORATE INFORMATION SECURITY POLICY

APPALACHIAN POWER COMPANY

EAST FLY ASH POND
FORMER KANAWHA RIVER POWER PLANT

GLASGOW WEST VIRGINIA

SLOPE GRADIENTS

UNIT: FEET | DRAWING NUMBER: 4 OF 4 | REV: –

SCALE: 1" = 100'
DR: CCP
CH: NG
SUP: NG
ENG: SJM
DATE: 4/10/2026

APPROVED BY

STEVEN J. MOELLER REGISTERED 27354 STATE OF WEST VIRGINIA PROFESSIONAL ENGINEER

SLOPES TABLE

SLOPE RANGE	COLOR
FLATTER THAN 2H:1V	
2H:1V to 1.875H:1V	
1.875H:1V to 1.75H:1V	
1.75H:1V to 1.625H:1V	
1.625H:1V to 1.5H:1V	
1.5H:1V to 1.375H:1V	
1.375H:1V to 1.25H:1V	
STEEPER THAN 1.25H:1V	

NOTES

1. SOME OF THE MONITORING WELLS (FROM 1988/1989/1995) MAY HAVE BEEN ABANDONED.

REFERENCES

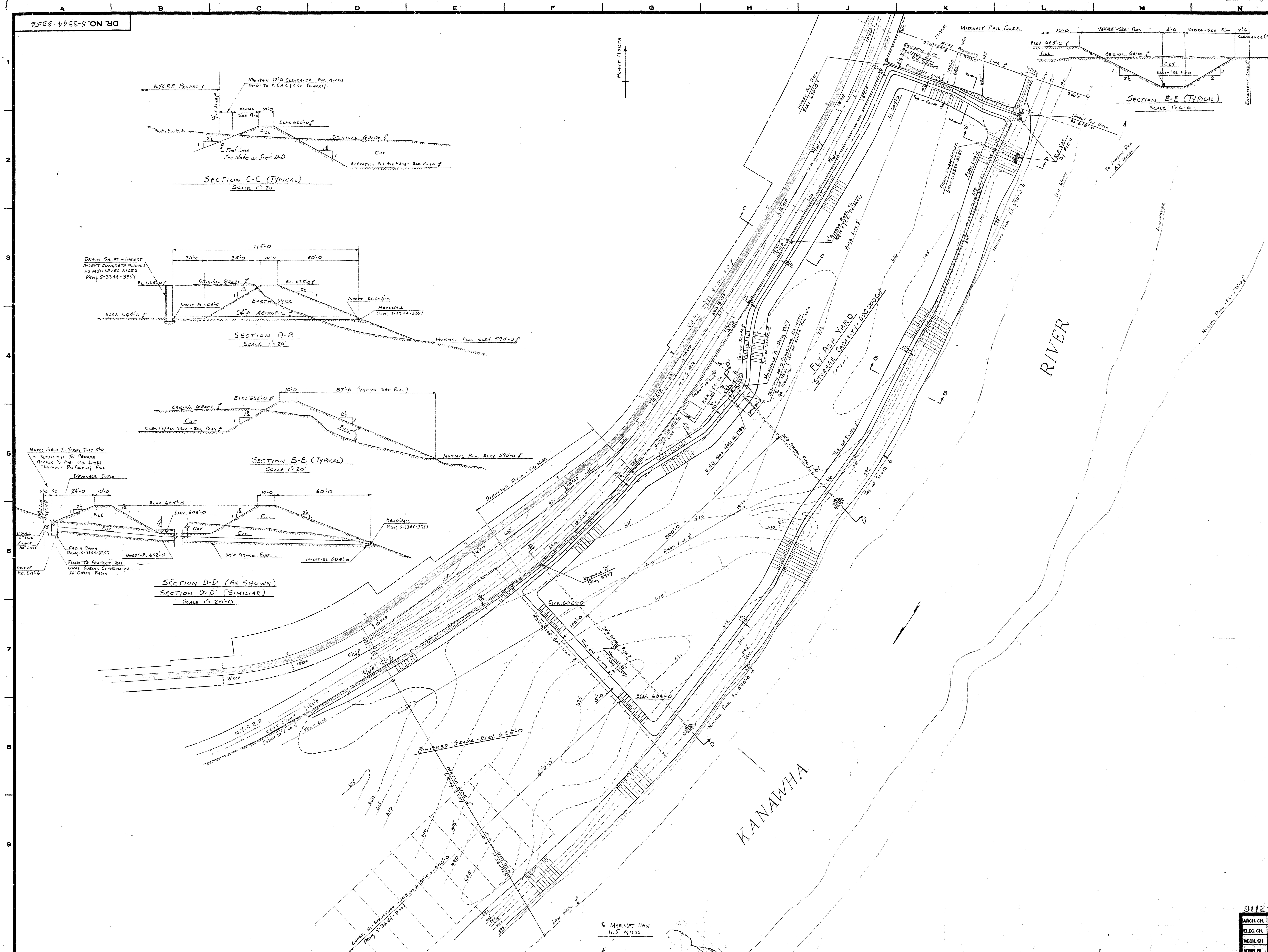
1. EXISTING TOPOGRAPHIC SURFACES WITHIN THE EFA POND BOUNDARY WERE DERIVED FROM THE AERIAL LIDAR SURVEY PROVIDED BY AEP (JULY 2025).
2. THE AREAS OUTSIDE THE POND FOOTPRINT ARE REPRESENTED USING THE 2018 (USGS) TOPOGRAPHIC DATA.
3. BATHYMETRIC DATA FOR THE ADJACENT RIVERBED IS BASED ON SURVEY CONDUCTED BY AEP IN MARCH 2026.
4. AREAS BETWEEN LIMITS OF AERIAL LIDAR AND BATHYMETRIC DATA WERE INTERPOLATED USING SURVEY DATA IN THE SURROUNDING AREAS AND REASONABLE ENGINEERING ASSUMPTIONS CONSISTENT WITH AVAILABLE SITE DATA.
5. SITE BOUNDARY IS APPROXIMATE.

wsp
3348 Peachtree Road NE
Suite 1100
Atlanta, GA 30326

AEP AMERICAN ELECTRIC POWER
AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

APPENDIX A

Historical Drawings



GENERAL NOTES

THIS DRWG NOT TO BE SCALED

QUANTITIES:

EXCAVATION: 410000 C.Y.
FILL (INCLUDING 15% COMPACTION): 308000 C.Y.

NOTE:
THE ABOVE QUANTIES ARE FOR THE AREA EAST OF THE MATCH-LINE, QUANTITIES OF EARTHWORK, WEST OF THE MATCH LINE, ARE SHOWN ON DRAWING S-3344-3007. THE AMOUNT OF CUT WILL BALANCE THE AMOUNT OF FILL BY ADDING THE QUANTITIES SHOWN ON THIS DRWG. & DRWG S-3344-3007

EARTHWORK & DRAINAGE BY: BOSO & RITCHIE

MATERIALS:

125 L.F. 24" Ø ARMCO PIPE BY: FIELD
1200 L.F. 30" Ø ARMCO PIPE BY: FIELD

REFERENCE DRAWINGS

S-3344-3007 EXCAVATION & GRADING PLAN
3001 PLOT PLAN
3357 ASH YARD - MISC. STRUCTURES

DATE	NO.	DESCRIPTION	APPD.
4/17/51	1	RELEASED FOR CONSTRUCT.	G.R.

REVISIONS

AMERICAN GAS & ELECTRIC SERVICE CORPORATION
30 CHURCH STREET NEW YORK

FLY ASH YARD
PLAN AND SECTIONS

APPALACHIAN ELECTRIC P[illegible]
KANAWHA RIVER PL[illegible]
GLASGOW, WEST VIR[illegible]

9112-A

SCALE 1"=100' DATE 4/1951

ARCH. CH.		DR. BY M E	APPROVED [signature]
ELEC. CH.		TR. BY	
MECH. CH.		CH. BY	
STRUCT. CH.			

DR. No. S-3344-3356-1

°4-4 2

APPENDIX B

Geotechnical Strength Selection

APPENDIX B: GEOTECHNICAL STRENGTH SELECTION

DATE April, 2026 **Project No.** US0041868.3860
TO AEP
FROM WSP

1 INTRODUCTION

The following calculation package provides an assessment of the soil strength data collected for the former Kanawha River Power Plant to assess the strength of the soil materials to be evaluated in the factor of safety assessment. Coal Combustion Residuals (CCRs), underlying alluvial soils, and embankment fill material were evaluated in this analysis. A discussion of the available data is provided along with the proposed selected material strength properties for each stratum.

2 INVESTIGATIONS AND LABORATORY TESTING

Subsurface investigations at the EFA Pond and BAP sites have been conducted over multiple phases to characterize site conditions and support closure planning. The Geotechnical Data Report (GDR) discusses the historic explorations and lab testing conducted for each site. Laboratory testing performed on relatively undisturbed samples collected with Shelby tubes included Consolidated-Undrained (CU with pore pressures) Triaxial Compression Tests (ASTM D4767), Unit Weight (ASTM D7263), Natural Moisture Content (ASTM D2216), and Atterberg Limits (ASTM D4318). Additionally, limited direct shear analyses were performed (ASTM D3080).

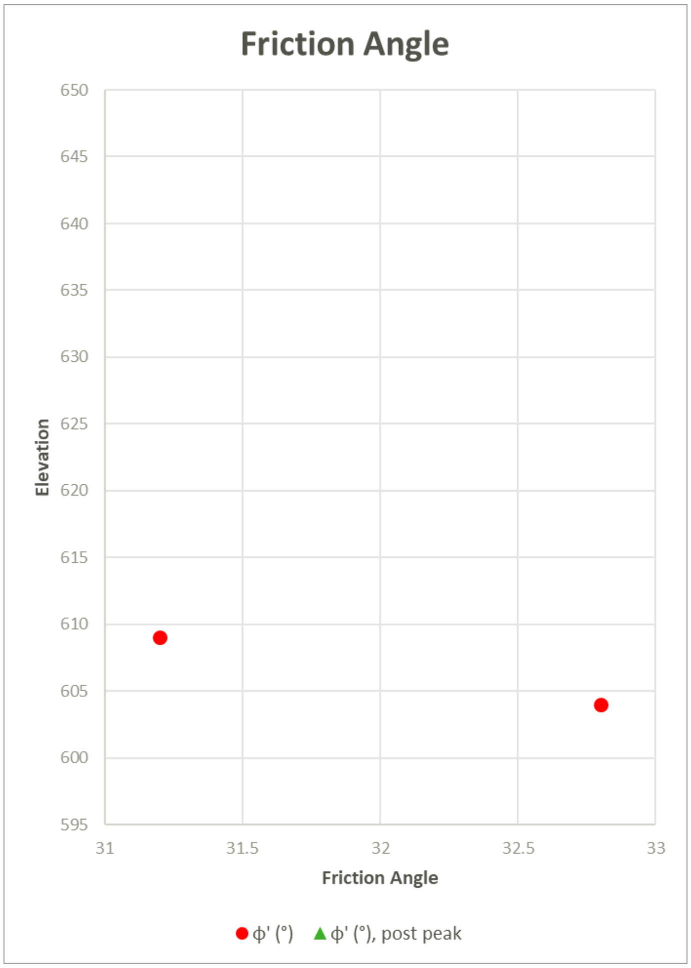
3 STRENGTH PARAMETER SELECTION

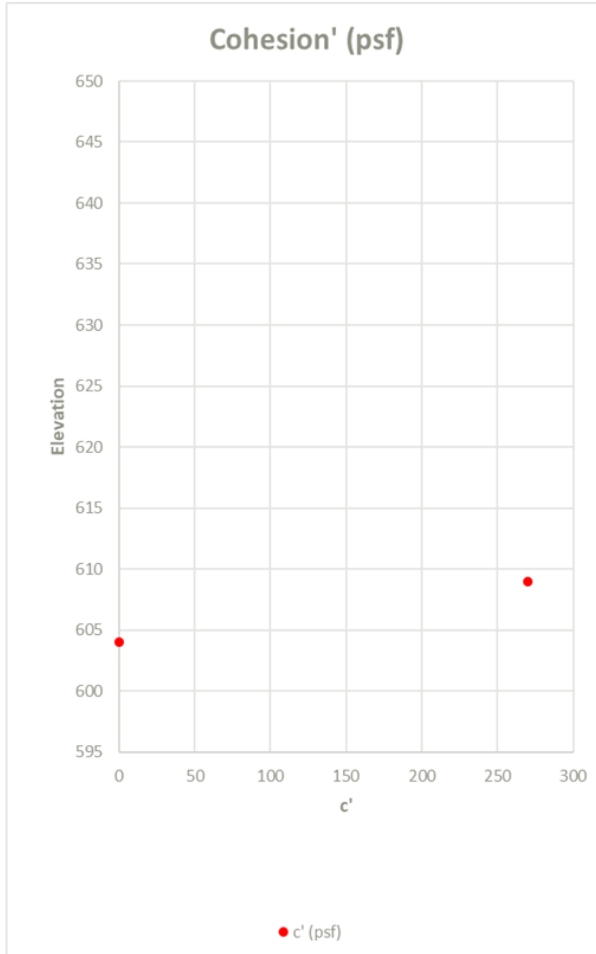
The data collected in the field program for the various soil strata were plotted and evaluated to determine representative strength properties for each soil material type. The following data were used in the analysis. Laboratory Strength Parameters: Data from laboratory testing were used to estimate cohesion (c) and friction angle (φ) for each material type.

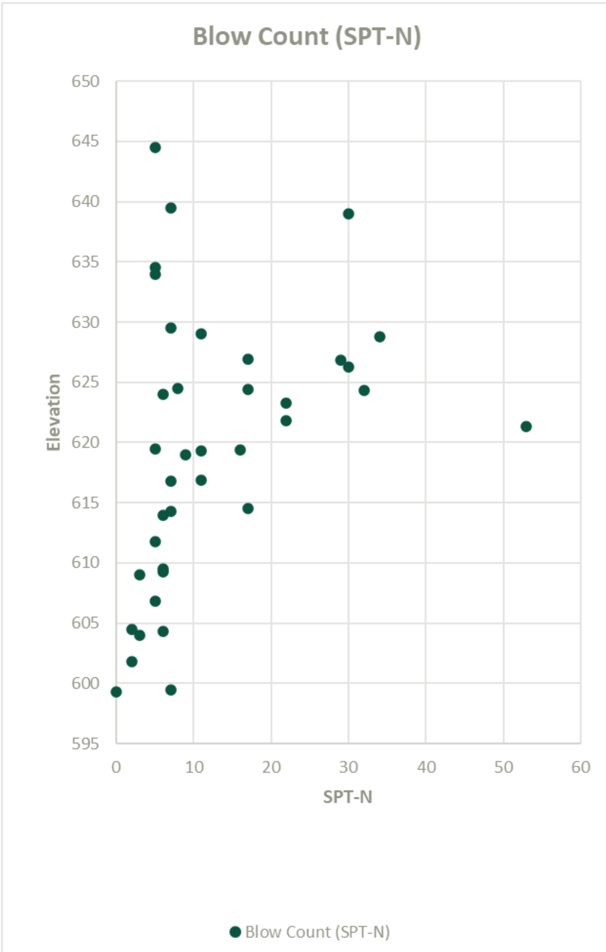
SPT Correlation and Strength Parameters: SPT values were correlated with shear strength parameters using established empirical relationships commonly applied in geotechnical engineering practice. These correlations consider soil type, relative density, and consistency, and were used to estimate cohesion (c) and friction angle (φ). The calculations followed procedures outlined in ASTM D1586 and supplemented by published correlations (Peck, Hanson & Thornburn, 1974).

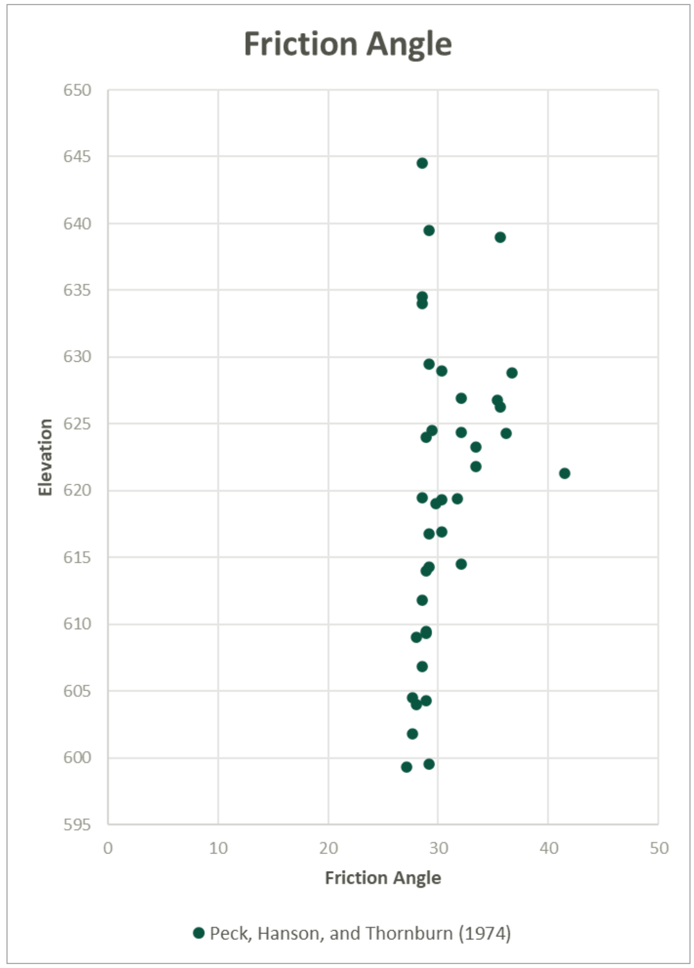
3.1 STRENGTH PARAMETERS - CCR IMPOUNDMENT MATERIALS

From previous analysis at the site, the triaxial compression tests performed on the samples of fly ash yielded effective shear strengths with φ ranging from 30.5° to 32.8° and apparent cohesions ranging from 0 to 270 psf. Previous slope stability calculations had used a φ angle of 31 degrees and an apparent cohesion of 0 psf. The following plots show the laboratory strength data and the correlated strength data from SPT values.


Friction Angle
Elevation
650
645
640
635
630
625
620
615
610
605
600
595
31
31.5
32
32.5
33
Friction Angle
ϕ' (°)
ϕ' (°), post peak


Cohesion' (psf)
Elevation
650
645
640
635
630
625
620
615
610
605
600
595
0
50
100
150
200
250
300
c'
c' (psf)

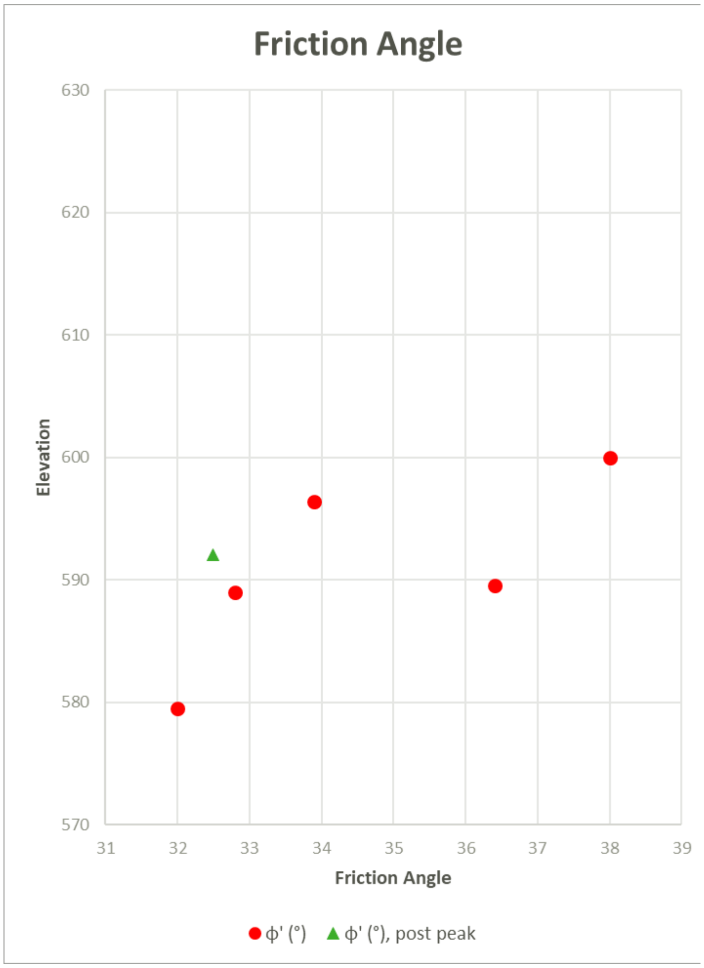


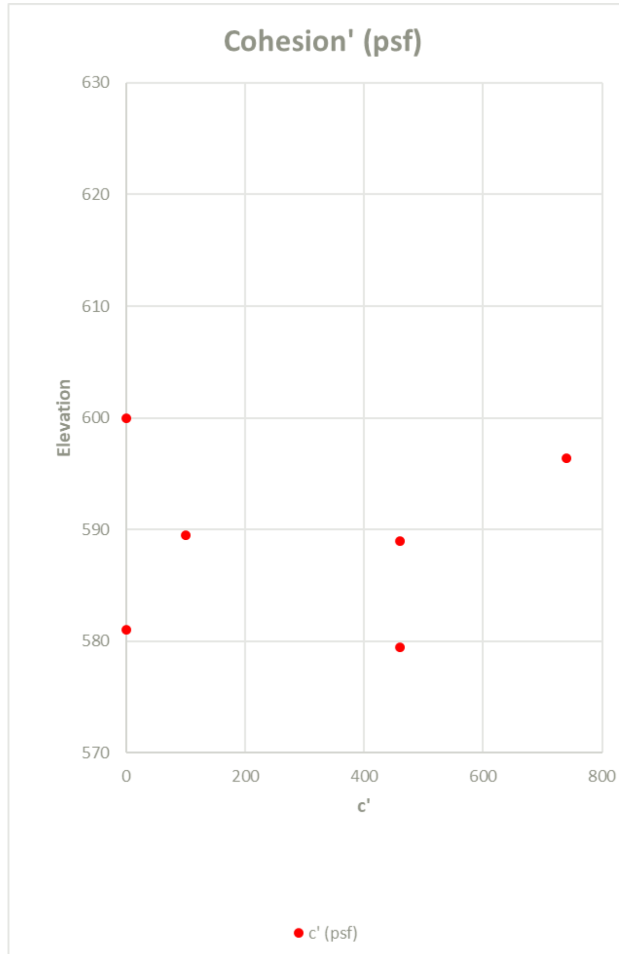


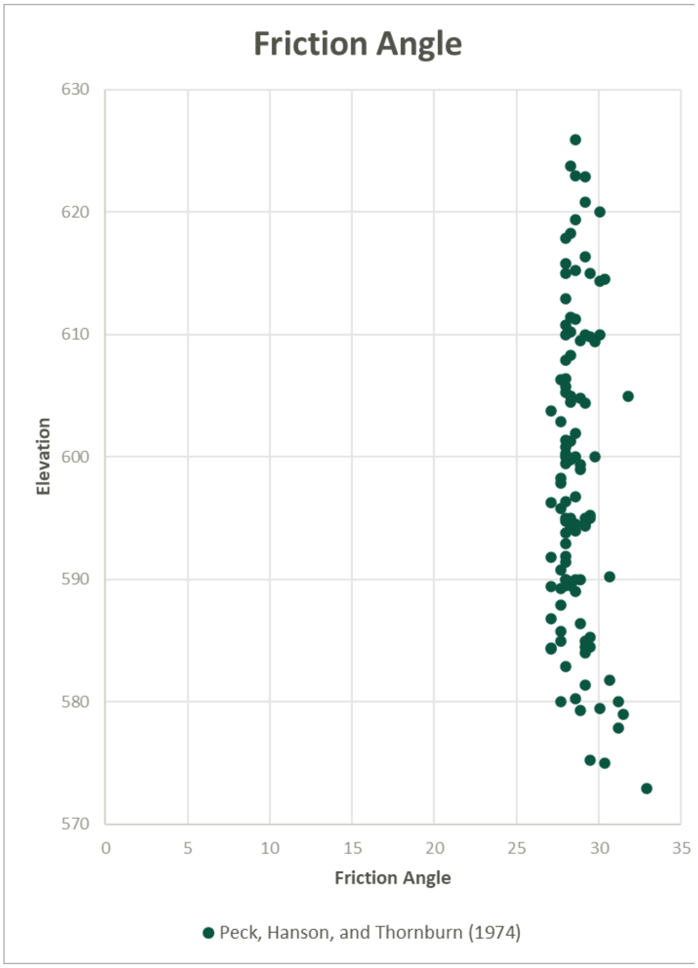
Based on an evaluation of the data, WSP's experience at other sites, and a comparison of data for dry, previously sluiced CCR materials, WSP selected representative strength parameters for the CCR materials: φ angle of 28 degrees and apparent cohesion of 0 psf.

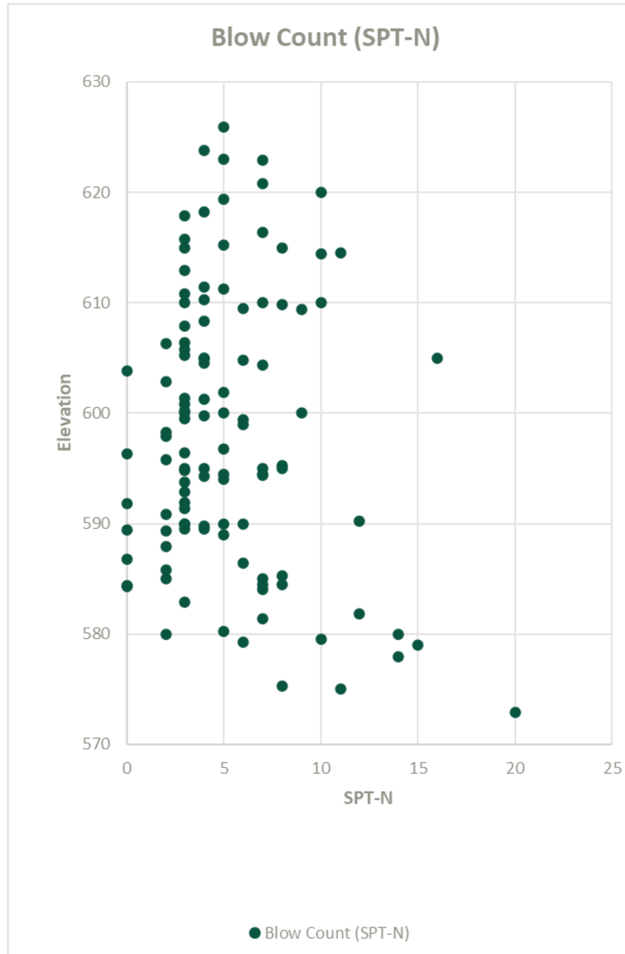
3.2 STRENGTH PARAMETERS - ALLUVIUM 1

From previous analysis at the site, the triaxial compression tests performed on the samples of alluvial soils from 2005 yielded effective shear strengths with φ ranging from 32° to 36.4° and apparent cohesions ranging from 100 to 460 psf. Previous slope stability calculations had used a φ angle of 30 degrees and an apparent cohesion of 0 psf. The following plots show laboratory strength data and correlated SPT-based strength data.


Friction Angle
630
620
610
600
590
580
570
Elevation
31
32
33
34
35
36
37
38
39
Friction Angle
ϕ' (°)
ϕ' (°), post peak


Cohesion' (psf)
630
620
610
600
590
580
570
Elevation
0
200
400
600
800
c'
c' (psf)

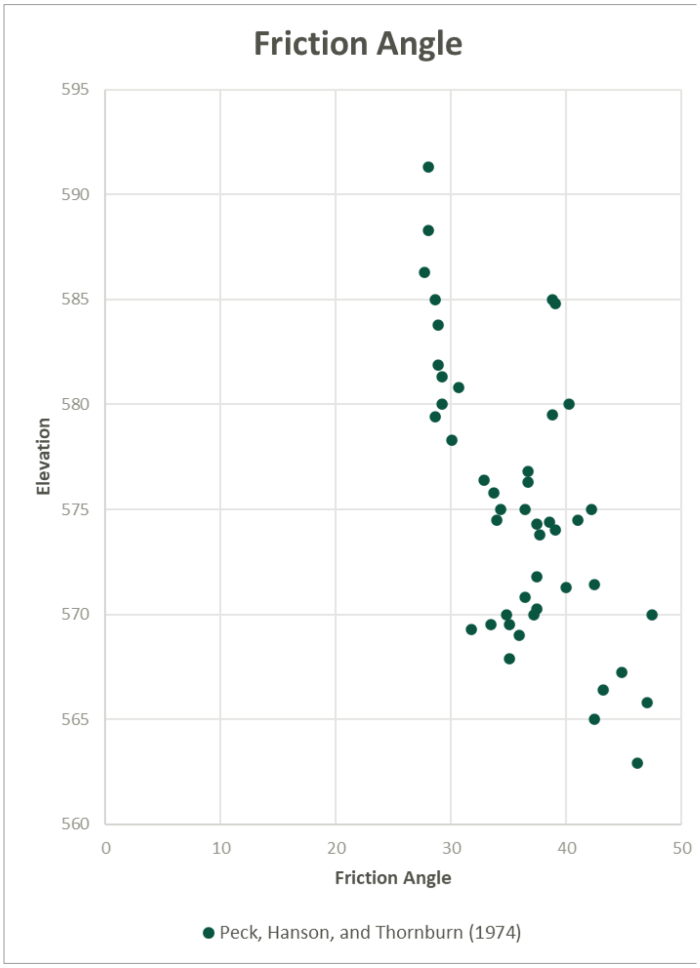


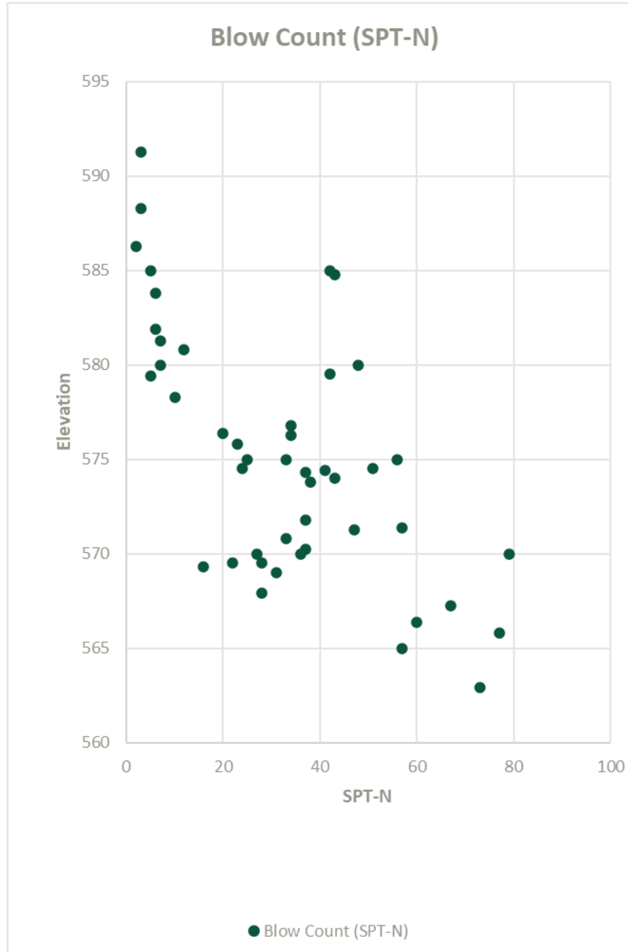


Based on an evaluation of the data and WSP's experience at other sites, WSP selected representative strength parameters for the Alluvial 1 material of: φ angle of 32 degrees and apparent cohesion of 100 psf.

3.3 STRENGTH PARAMETERS - ALLUVIUM 2

From previous analysis at the site, the triaxial compression tests performed on the samples of alluvial soils from 2005 yielded effective shear strengths with φ ranging from 32° to 36.4° and apparent cohesions ranging from 100 to 460 psf. Previous slope stability calculations had used a φ angle of 30 degrees and an apparent cohesion of 0 psf. The following plots show the correlated strength data from SPT values.

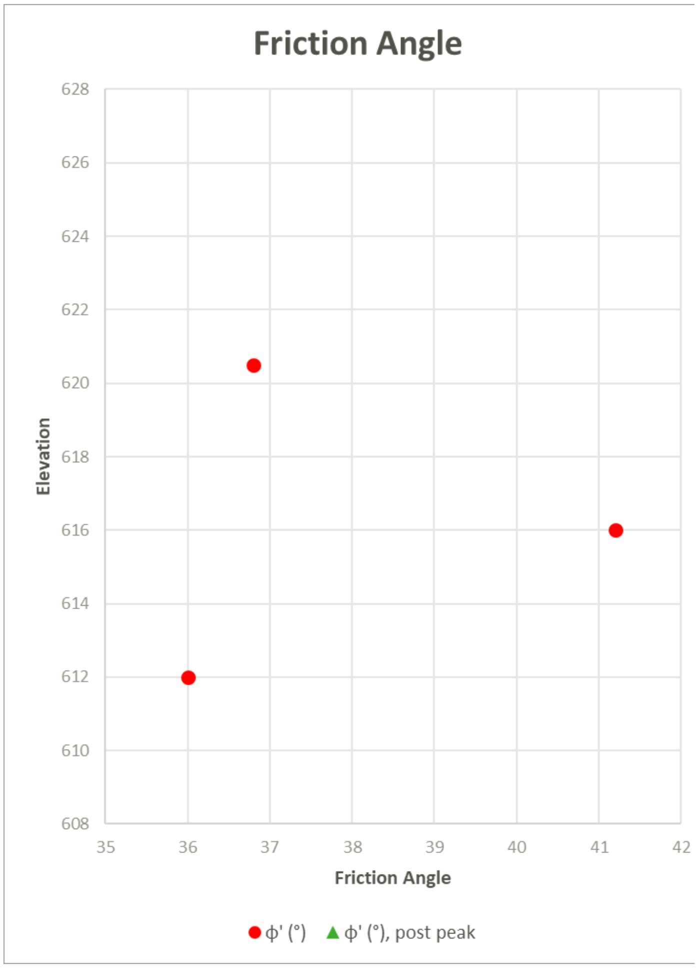


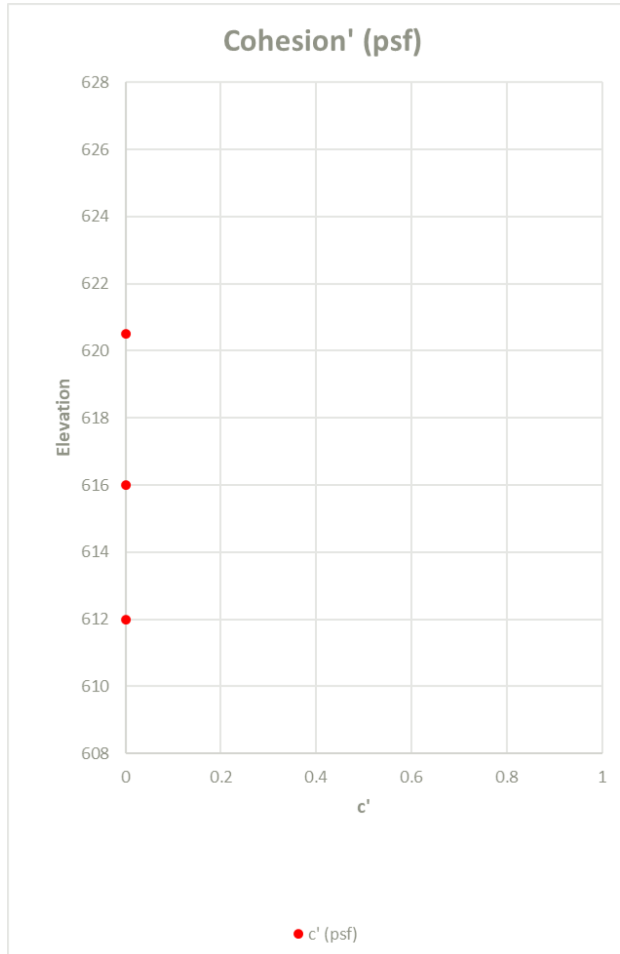


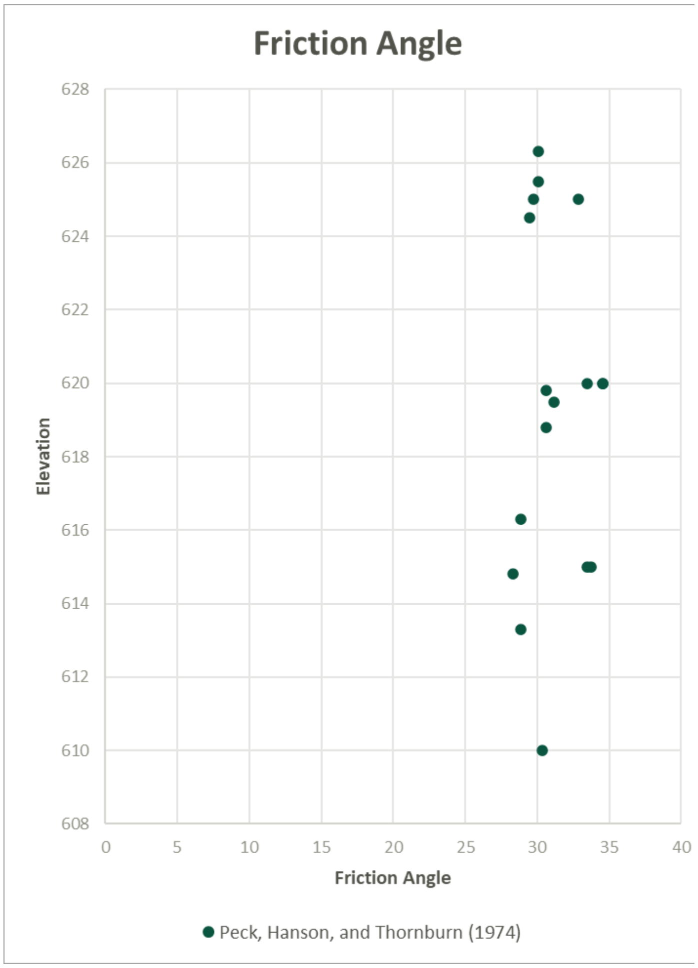
Based on an evaluation of the data and WSP's experience at other sites, WSP selected representative strength parameters for the Alluvial 2 materials of: φ angle of 32 degrees and apparent cohesion of 0 psf. The underlying alluvial materials are more granular (less cohesive) than the upper alluvium and are expected to have less apparent cohesion.

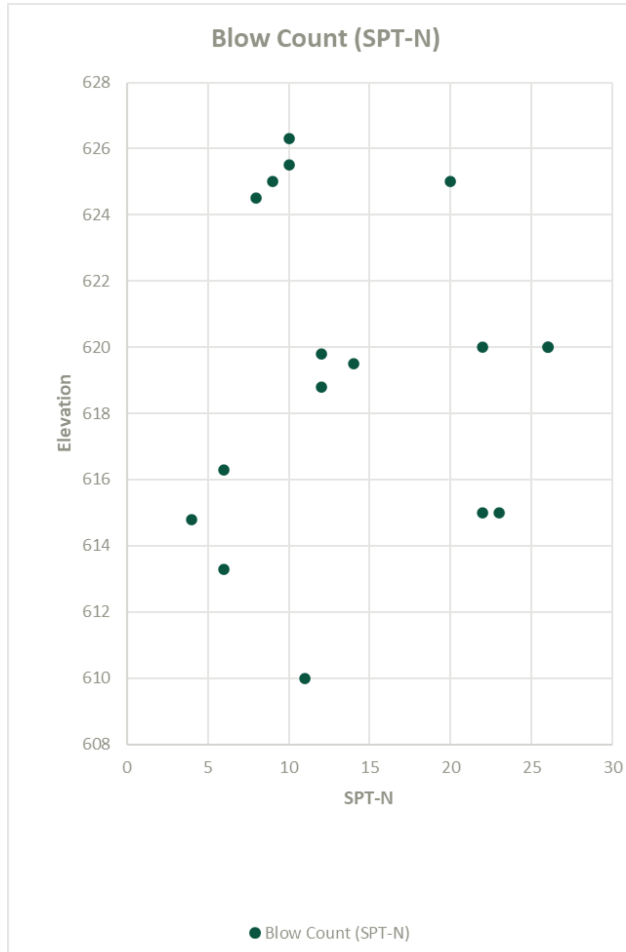
3.4 STRENGTH PARAMETERS - EMBANKMENT MATERIALS

From previous analysis at the site, the shear strength properties for the embankment materials were estimated based on the results of the tests performed on the site's native subsoil (alluvial material), with some minor modification to account for the soil being compacted during placement. Previous slope stability calculations had used a φ angle of 30 degrees and an apparent cohesion of 125 psf. The following plots show laboratory strength data and correlated SPT-based strength data.


Friction Angle
628
626
624
622
620
618
616
614
612
610
608
Elevation
35
36
37
38
39
40
41
42
Friction Angle
ϕ' (°)
ϕ' (°), post peak


Cohesion' (psf)
628
626
624
622
620
618
616
614
612
610
608
Elevation
0
0.2
0.4
0.6
0.8
1
c'
c' (psf)





Based on an evaluation of the data and WSP's experience at other sites, WSP selected representative strength parameters for the embankment materials of: φ angle of 32 degrees and apparent cohesion of 100 psf.

4 SUMMARY OF STRENGTH PARAMETERS

Strength parameters based on the geotechnical information provided in the GDR

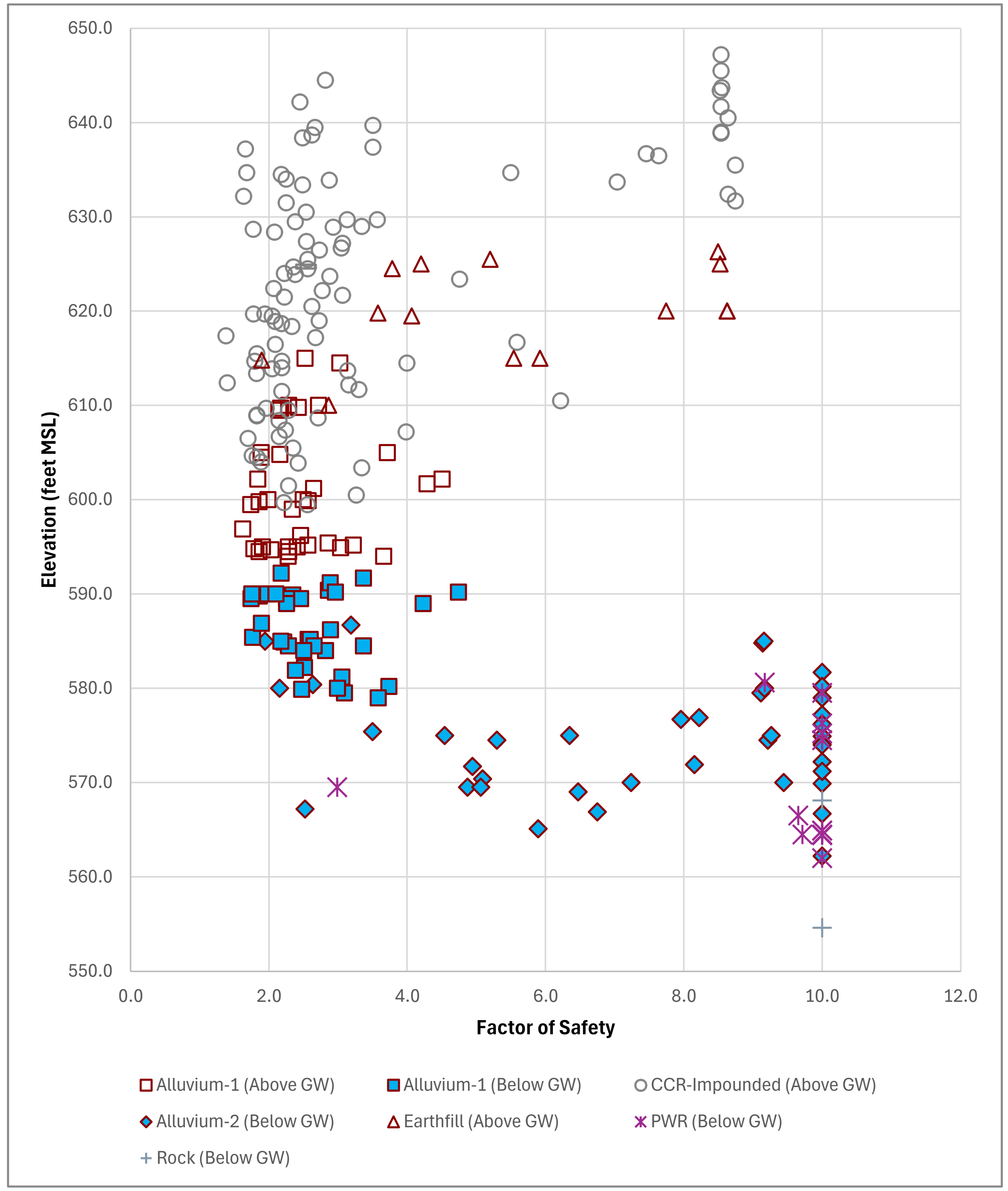
Table 1: Summary of Geotechnical Material Properties

Material	Unit Weight (pcf)	Drained Strength		Undrained Strength	
		Effective Internal Friction φ' (°)	Effective Cohesion c' (psf)	Total Internal Friction φ' (°)	Total Cohesion c' (psf)
Embankment Materials					
Earthfill	125	32	100	-	-
Coal Combustion Residuals					
CCR-Impounded	100	28	0	-	-
Alluvium					
Alluvium-1	120	32	100	0	26
Alluvium-2	115	32	0	0	26

APPENDIX C

Liquefaction Assessment

APPENDIX C - LIQUEFACTION ASSESSMENT RESULTS
Kanawha River Ash Pond (EFA), Former Kanawha River Power Plant, Glasgow, WV
Initial Safety Factor Assessment 2025



Note(s)

1. Reported Factor of Safety is an average value obtained from consecutive SPT records of a same material.
2. Calculated Factor of Safety is for comparison only. Liquefaction would not occur in unsaturated dike materials.

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID FA-B-1

Groundwater Elevation=	594	feet
Ground Surface Elevation=	640.9	feet
Depth to Water=	46.9	feet - below ground surface
M_w=	5.96	*Moment magnitude of earthquake at the Site*
MSF=	1.80	*Magnitude Scaling Factor*
a_{max}=	0.153	*peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N=	see each cell	*Overburden*
C_E=	0.8	*Energy Ratio*
C_B=	1.05	*Borehole Diameter*
C_R=	see each cell	*Rod Length*
C_S=	1	*Sampling Method*
Pa=	2116.2	*Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
CCR-Impounded	100	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%
PWR	140	≤5%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
637.4	3.5	1.07	CCR-Impounded	100	350	350	0.99	0.099	7	11	≥35%	2.5	0.75	18	0.192	0.346	3.50
632.4	8.5	2.59	CCR-Impounded	100	850	850	0.98	0.097	27	27	≥35%	1.6	0.75	30	0.468	0.842	8.64
627.4	13.5	4.12	CCR-Impounded	100	1350	1350	0.97	0.096	7	6	≥35%	1.3	0.85	13	0.136	0.245	2.54
622.4	18.5	5.64	CCR-Impounded	100	1850	1850	0.96	0.095	5	4	≥35%	1.1	0.85	10	0.109	0.197	2.07
617.4	23.5	7.16	CCR-Impounded	100	2350	2350	0.95	0.094	0	0	≥35%	0.9	0.95	5	0.072	0.130	1.38
612.4	28.5	8.69	CCR-Impounded	100	2850	2850	0.93	0.093	0	0	≥35%	0.9	0.95	5	0.072	0.130	1.40
607.4	33.5	10.21	CCR-Impounded	100	3350	3350	0.90	0.090	6	4	≥35%	0.8	1.00	10	0.111	0.201	2.24
599.9	41.0	12.50	Alluvium-1	120	4250	4250	0.84	0.084	8	5	≥35%	0.7	1.00	11	0.119	0.215	2.57
594.9	46.0	14.02	Alluvium-1	120	4850	4850	0.80	0.080	11	6	≥35%	0.7	1.00	12	0.134	0.242	3.04
589.9	51.0	15.55	Alluvium-1	120	5450	5194	0.76	0.079	6	3	≥35%	0.6	1.00	9	0.103	0.186	2.35
584.9	56.0	17.07	Alluvium-1	120	6050	5482	0.72	0.079	5	3	≥35%	0.6	1.00	8	0.097	0.175	2.22
579.9	61.0	18.60	Alluvium-1	120	6650	5770	0.68	0.078	7	4	≥35%	0.6	1.00	9	0.107	0.192	2.48
574.9	66.0	20.12	Alluvium-2	115	7225	6033	0.64	0.076	58	29	≥35%	0.6	1.00	30	0.468	0.842	10.00
569.9	71.0	21.65	Alluvium-2	115	7800	6296	0.60	0.073	76	37	≥35%	0.6	1.00	30	0.468	0.842	10.00
564.9	76.0	23.17	PWR	140	8500	6684	0.56	0.071	100	47	≤5%	0.6	1.00	30	0.468	0.842	10.00

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)
1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID FA-B-2

Groundwater Elevation=	594	feet
Ground Surface Elevation=	638.2	feet
Depth to Water=	44.2	feet - below ground surface
M_w=	5.96	*Moment magnitude of earthquake at the Site*
MSF=	1.80	*Magnitude Scaling Factor*
a_{max}=	0.153	*peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N=	see each cell	*Overburden*
C_E=	0.8	*Energy Ratio*
C_B=	1.05	*Borehole Diameter*
C_R=	see each cell	*Rod Length*
C_S=	1	*Sampling Method*
Pa=	2116.2	*Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
CCR-Impounded	100	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%
PWR	140	≤5%
Rock	140	≤5%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
634.7	3.5	1.07	CCR-Impounded	100	350	350	0.99	0.099	11	17	≥35%	2.5	0.75	25	0.301	0.542	5.49
629.7	8.5	2.59	CCR-Impounded	100	850	850	0.98	0.097	11	11	≥35%	1.6	0.75	18	0.193	0.348	3.57
624.7	13.5	4.12	CCR-Impounded	100	1350	1350	0.97	0.096	6	5	≥35%	1.3	0.85	11	0.126	0.227	2.36
619.7	18.5	5.64	CCR-Impounded	100	1850	1850	0.96	0.095	3	2	≥35%	1.1	0.85	8	0.094	0.169	1.78
614.7	23.5	7.16	CCR-Impounded	100	2350	2350	0.95	0.094	3	2	≥35%	0.9	0.95	8	0.094	0.169	1.79
609.7	28.5	8.69	Alluvium-1	120	2950	2950	0.93	0.093	6	4	≥35%	0.8	0.95	10	0.112	0.202	2.17
602.2	36.0	10.98	Alluvium-1	120	3850	3850	0.88	0.088	3	2	≥35%	0.7	1.00	7	0.090	0.161	1.84
592.2	46.0	14.02	Alluvium-1	120	5050	4938	0.80	0.081	5	3	≥35%	0.7	1.00	8	0.098	0.177	2.18
582.2	56.0	17.07	Alluvium-1	120	6250	5514	0.72	0.081	8	4	≥35%	0.6	1.00	10	0.113	0.204	2.51
577.2	61.0	18.60	Alluvium-2	115	6825	5777	0.68	0.080	50	25	≥35%	0.6	1.00	30	0.468	0.842	10.00
572.2	66.0	20.12	Alluvium-2	115	7400	6040	0.64	0.078	100	50	≥35%	0.6	1.00	30	0.468	0.842	10.00
567.2	71.0	21.65	Alluvium-2	115	7975	6303	0.60	0.075	7	3	≥35%	0.6	1.00	9	0.105	0.189	2.52
562.2	76.0	23.17	Alluvium-2	115	8550	6566	0.56	0.073	66	31	≥35%	0.6	1.00	30	0.468	0.842	10.00
562.0	76.2	23.23	PWR	140	8578	6581	0.56	0.073	100	48	≤5%	0.6	1.00	30	0.468	0.842	10.00
550.1	88.1	26.86	Rock	140	11594	8855	0.56	0.073	100	41	≤5%	0.5	1.00	30	0.468	0.842	10.00

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)
1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID FA-B-3

Groundwater Elevation= 594 feet
Ground Surface Elevation= 643.2 feet
Depth to Water= 49.2 feet - below ground surface
M_w= 5.96 *Moment magnitude of earthquake at the Site*
MSF= 1.80 *Magnitude Scaling Factor*
a_{max}= 0.153 *peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N= see each cell *Overburden*
C_E= 0.8 *Energy Ratio*
C_B= 1.05 *Borehole Diameter*
C_R= see each cell *Rod Length*
C_S= 1 *Sampling Method*

Pa= 2116.2 *Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
CCR-Impounded	100	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%
PWR	140	≤5%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value,$(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
639.7	3.5	1.07	CCR-Impounded	100	350	350	0.99	0.099	7	11	≥35%	2.5	0.75	18	0.192	0.346	3.50
634.7	8.5	2.59	CCR-Impounded	100	850	850	0.98	0.097	2	2	≥35%	1.6	0.75	7	0.091	0.164	1.68
629.7	13.5	4.12	CCR-Impounded	100	1350	1350	0.97	0.096	10	9	≥35%	1.3	0.85	16	0.167	0.301	3.13
624.7	18.5	5.64	CCR-Impounded	100	1850	1850	0.96	0.095	8	6	≥35%	1.1	0.85	12	0.134	0.242	2.54
619.7	23.5	7.16	CCR-Impounded	100	2350	2350	0.95	0.094	4	3	≥35%	0.9	0.95	9	0.101	0.182	1.94
614.7	28.5	8.69	CCR-Impounded	100	2850	2850	0.93	0.093	6	4	≥35%	0.9	0.95	10	0.113	0.203	2.19
609.7	33.5	10.21	CCR-Impounded	100	3350	3350	0.90	0.090	4	3	≥35%	0.8	1.00	8	0.098	0.176	1.96
604.7	38.5	11.74	CCR-Impounded	100	3850	3850	0.86	0.086	2	1	≥35%	0.7	1.00	6	0.084	0.151	1.76
599.7	43.5	13.26	CCR-Impounded	100	4350	4350	0.82	0.082	5	3	≥35%	0.7	1.00	9	0.100	0.181	2.21
594.7	48.5	14.79	Alluvium-1	120	4950	4950	0.78	0.077	3	2	≥35%	0.7	1.00	7	0.087	0.158	2.03
591.7	51.5	15.70	Alluvium-1	120	5310	5166	0.75	0.077	13	7	≥35%	0.6	1.00	13	0.144	0.260	3.37
586.7	56.5	17.23	Alluvium-2	115	5885	5429	0.71	0.077	12	6	≥35%	0.6	1.00	13	0.136	0.245	3.19
581.7	61.5	18.75	Alluvium-2	115	6460	5692	0.67	0.076	100	51	≥35%	0.6	1.00	30	0.468	0.842	10.00
576.7	66.5	20.27	Alluvium-2	115	7035	5955	0.63	0.074	36	18	≥35%	0.6	1.00	27	0.328	0.591	7.96
571.7	71.5	21.80	Alluvium-2	115	7610	6218	0.59	0.072	23	11	≥35%	0.6	1.00	19	0.198	0.356	4.94
566.7	76.5	23.32	Alluvium-2	115	8185	6481	0.56	0.070	56	27	≥35%	0.6	1.00	30	0.468	0.842	10.00
564.4	78.8	24.02	PWR	140	8507	6660	0.56	0.071	100	47	≤5%	0.6	1.00	30	0.468	0.842	10.00

Note(s)

1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)

1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)

2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID FA-B-4

Groundwater Elevation=	594	feet
Ground Surface Elevation=	646.4	feet
Depth to Water=	52.4	feet - below ground surface
M_w=	5.96	*Moment magnitude of earthquake at the Site*
MSF=	1.80	*Magnitude Scaling Factor*
a_{max}=	0.153	*peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N=	see each cell	*Overburden*
C_E=	0.8	*Energy Ratio*
C_B=	1.05	*Borehole Diameter*
C_R=	see each cell	*Rod Length*
C_S=	1	*Sampling Method*
Pa=	2116.2	*Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
CCR-Impounded	100	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
643.4	3.0	0.91	CCR-Impounded	100	300	300	0.99	0.099	30	50	≥35%	2.7	0.75	30	0.468	0.842	8.53
638.4	8.0	2.44	CCR-Impounded	100	800	800	0.98	0.098	6	6	≥35%	1.6	0.75	12	0.135	0.242	2.48
633.4	13.0	3.96	CCR-Impounded	100	1300	1300	0.97	0.096	7	6	≥35%	1.3	0.80	12	0.133	0.240	2.48
628.4	18.0	5.49	CCR-Impounded	100	1800	1800	0.96	0.095	5	4	≥35%	1.1	0.85	10	0.110	0.198	2.08
623.4	23.0	7.01	CCR-Impounded	100	2300	2300	0.95	0.094	19	15	≥35%	1.0	0.95	22	0.249	0.448	4.76
618.4	28.0	8.54	CCR-Impounded	100	2800	2800	0.93	0.093	7	5	≥35%	0.9	0.95	11	0.120	0.217	2.33
613.4	33.0	10.06	CCR-Impounded	100	3300	3300	0.91	0.090	3	2	≥35%	0.8	1.00	7	0.091	0.164	1.82
608.4	38.0	11.59	CCR-Impounded	100	3800	3800	0.86	0.086	5	3	≥35%	0.7	1.00	9	0.102	0.184	2.14
603.4	43.0	13.11	CCR-Impounded	100	4300	4300	0.82	0.082	13	8	≥35%	0.7	1.00	14	0.152	0.274	3.34
595.4	51.0	15.55	Alluvium-1	120	5260	5260	0.76	0.075	9	5	≥35%	0.6	1.00	11	0.120	0.216	2.86
590.4	56.0	17.07	Alluvium-1	120	5860	5635	0.72	0.074	9	5	≥35%	0.6	1.00	11	0.118	0.213	2.86
585.4	61.0	18.60	Alluvium-1	120	6460	5923	0.68	0.073	0	0	≥35%	0.6	1.00	5	0.072	0.130	1.77
580.4	66.0	20.12	Alluvium-2	115	7035	6186	0.64	0.072	7	3	≥35%	0.6	1.00	9	0.106	0.190	2.64
575.4	71.0	21.65	Alluvium-2	115	7610	6449	0.60	0.070	13	6	≥35%	0.6	1.00	13	0.136	0.245	3.50
570.4	76.0	23.17	Alluvium-2	115	8185	6712	0.56	0.068	23	11	≥35%	0.6	1.00	18	0.192	0.346	5.09
565.1	81.3	24.79	Alluvium-2	115	8794.5	6991	0.56	0.070	29	13	≥35%	0.6	1.00	21	0.229	0.413	5.90

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)
1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID FA-B-5

Groundwater Elevation=	594	feet
Ground Surface Elevation=	647.7	feet
Depth to Water=	53.7	feet - below ground surface
M_w=	5.96	*Moment magnitude of earthquake at the Site*
MSF=	1.80	*Magnitude Scaling Factor*
a_{max}=	0.153	*peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N=	see each cell	*Overburden*
C_E=	0.8	*Energy Ratio*
C_B=	1.05	*Borehole Diameter*
C_R=	see each cell	*Rod Length*
C_S=	1	*Sampling Method*
Pa=	2116.2	*Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
CCR-Impounded	100	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
643.7	4.0	1.22	CCR-Impounded	100	400	400	0.99	0.099	18	26	≥35%	2.3	0.75	30	0.468	0.842	8.55
638.7	9.0	2.74	CCR-Impounded	100	900	900	0.98	0.097	7	7	≥35%	1.5	0.75	13	0.142	0.255	2.62
633.7	14.0	4.27	CCR-Impounded	100	1400	1400	0.97	0.096	22	19	≥35%	1.2	0.85	28	0.376	0.677	7.03
628.7	19.0	5.79	CCR-Impounded	100	1900	1900	0.96	0.095	3	2	≥35%	1.1	0.85	8	0.094	0.168	1.77
623.7	24.0	7.32	CCR-Impounded	100	2400	2400	0.94	0.094	10	7	≥35%	0.9	0.95	14	0.150	0.270	2.88
618.7	29.0	8.84	CCR-Impounded	100	2900	2900	0.93	0.093	6	4	≥35%	0.9	0.95	10	0.112	0.202	2.18
613.7	34.0	10.37	CCR-Impounded	100	3400	3400	0.90	0.089	12	8	≥35%	0.8	1.00	15	0.155	0.280	3.14
608.7	39.0	11.89	CCR-Impounded	100	3900	3900	0.86	0.085	9	6	≥35%	0.7	1.00	12	0.128	0.231	2.71
601.2	46.5	14.18	Alluvium-1	120	4800	4800	0.80	0.079	8	4	≥35%	0.7	1.00	10	0.116	0.209	2.65
596.2	51.5	15.70	Alluvium-1	120	5400	5400	0.75	0.075	6	3	≥35%	0.6	1.00	9	0.103	0.185	2.46
591.2	56.5	17.23	Alluvium-1	120	6000	5825	0.71	0.073	9	5	≥35%	0.6	1.00	10	0.117	0.211	2.89
586.2	61.5	18.75	Alluvium-1	120	6600	6113	0.67	0.072	9	4	≥35%	0.6	1.00	10	0.116	0.209	2.89
581.2	66.5	20.27	Alluvium-1	120	7200	6401	0.63	0.071	10	5	≥35%	0.6	1.00	11	0.120	0.216	3.06
576.2	71.5	21.80	Alluvium-2	115	7775	6664	0.59	0.069	52	25	≥35%	0.6	1.00	30	0.468	0.842	10.00
571.2	76.5	23.32	Alluvium-2	115	8350	6927	0.56	0.067	51	24	≥35%	0.6	1.00	30	0.468	0.842	10.00

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)
1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID FA-B-8

Groundwater Elevation=	594	feet
Ground Surface Elevation=	640.0	feet
Depth to Water=	46.0	feet - below ground surface
M_w=	5.96	*Moment magnitude of earthquake at the Site*
MSF=	1.80	*Magnitude Scaling Factor*
a_{max}=	0.153	*peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N=	see each cell	*Overburden*
C_E=	0.8	*Energy Ratio*
C_B=	1.05	*Borehole Diameter*
C_R=	see each cell	*Rod Length*
C_S=	1	*Sampling Method*
Pa=	2116.2	*Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
CCR-Impounded	100	≥35%
Alluvium-1	120	≥35%
PWR	140	≤5%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
636.5	3.5	1.07	CCR-Impounded	100	350	350	0.99	0.099	13	20	≥35%	2.5	0.75	29	0.418	0.753	7.64
631.5	8.5	2.59	CCR-Impounded	100	850	850	0.98	0.097	5	5	≥35%	1.6	0.75	11	0.122	0.219	2.25
626.5	13.5	4.12	CCR-Impounded	100	1350	1350	0.97	0.096	8	7	≥35%	1.3	0.85	14	0.146	0.263	2.73
621.5	18.5	5.64	CCR-Impounded	100	1850	1850	0.96	0.095	6	5	≥35%	1.1	0.85	10	0.118	0.212	2.22
616.5	23.5	7.16	CCR-Impounded	100	2350	2350	0.95	0.094	5	4	≥35%	0.9	0.95	10	0.109	0.196	2.09
611.5	28.5	8.69	CCR-Impounded	100	2850	2850	0.93	0.093	6	4	≥35%	0.9	0.95	10	0.113	0.203	2.19
606.5	33.5	10.21	CCR-Impounded	100	3350	3350	0.90	0.090	2	1	≥35%	0.8	1.00	7	0.084	0.152	1.70
601.5	38.5	11.74	CCR-Impounded	100	3850	3850	0.86	0.086	6	4	≥35%	0.7	1.00	9	0.109	0.196	2.28
594.5	45.5	13.87	Alluvium-1	120	4690	4690	0.80	0.080	2	1	≥35%	0.7	1.00	6	0.082	0.149	1.86
589.5	50.5	15.40	Alluvium-1	120	5290	5009	0.76	0.080	7	4	≥35%	0.6	1.00	10	0.109	0.197	2.46
584.5	55.5	16.92	Alluvium-1	120	5890	5297	0.72	0.080	14	7	≥35%	0.6	1.00	14	0.149	0.269	3.37
579.5	60.5	18.45	PWR	140	6590	5685	0.68	0.079	100	51	≤5%	0.6	1.00	30	0.468	0.842	10.00
574.5	65.5	19.97	PWR	140	7290	6073	0.64	0.076	100	50	≤5%	0.6	1.00	30	0.468	0.842	10.00
569.5	70.5	21.49	PWR	140	7990	6461	0.60	0.074	23	11	≤5%	0.6	1.00	11	0.123	0.221	2.99
564.5	75.5	23.02	PWR	140	8690	6849	0.56	0.071	100	47	≤5%	0.6	1.00	30	0.468	0.842	10.00

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)
1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID	FA-B-9
Groundwater Elevation=	594 feet
Ground Surface Elevation=	642.4 feet
Depth to Water=	48.4 feet - below ground surface
M_w=	5.96 *Moment magnitude of earthquake at the Site*
MSF=	1.80 *Magnitude Scaling Factor*
a_{max}=	0.153 *peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)			
10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT		
C_N=	see each cell	*Overburden*
C_E=	0.8	*Energy Ratio*
C_B=	1.05	*Borehole Diameter*
C_R=	see each cell	*Rod Length*
C_S=	1	*Sampling Method*
Pa=	2116.2	*Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
CCR-Impounded	100	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%
Rock	140	≤5%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
638.9	3.5	1.07	CCR-Impounded	100	350	350	0.99	0.099	16	25	≥35%	2.5	0.75	30	0.468	0.842	8.54
633.9	8.5	2.59	CCR-Impounded	100	850	850	0.98	0.097	8	8	≥35%	1.6	0.75	15	0.155	0.280	2.87
628.9	13.5	4.12	CCR-Impounded	100	1350	1350	0.97	0.096	9	8	≥35%	1.3	0.85	15	0.157	0.282	2.93
623.9	18.5	5.64	CCR-Impounded	100	1850	1850	0.96	0.095	7	5	≥35%	1.1	0.85	11	0.126	0.226	2.38
618.9	23.5	7.16	CCR-Impounded	100	2350	2350	0.95	0.094	5	4	≥35%	0.9	0.95	10	0.109	0.196	2.09
613.9	28.5	8.69	CCR-Impounded	100	2850	2850	0.93	0.093	5	3	≥35%	0.9	0.95	9	0.105	0.190	2.05
608.9	33.5	10.21	CCR-Impounded	100	3350	3350	0.90	0.090	3	2	≥35%	0.8	1.00	7	0.091	0.164	1.83
603.9	38.5	11.74	CCR-Impounded	100	3850	3850	0.86	0.086	7	4	≥35%	0.7	1.00	10	0.115	0.207	2.42
596.9	45.5	13.87	Alluvium-1	120	4690	4690	0.80	0.080	0	0	≥35%	0.7	1.00	5	0.072	0.130	1.62
586.9	55.5	16.92	Alluvium-1	120	5890	5447	0.72	0.078	2	1	≥35%	0.6	1.00	6	0.082	0.147	1.89
581.9	60.5	18.45	Alluvium-1	120	6490	5735	0.68	0.077	6	3	≥35%	0.6	1.00	9	0.102	0.183	2.39
576.9	65.5	19.97	Alluvium-2	115	7065	5998	0.64	0.075	37	18	≥35%	0.6	1.00	27	0.343	0.617	8.22
571.9	70.5	21.49	Alluvium-2	115	7640	6261	0.60	0.073	37	18	≥35%	0.6	1.00	27	0.330	0.594	8.15
566.9	75.5	23.02	Alluvium-2	115	8215	6524	0.56	0.070	32	15	≥35%	0.6	1.00	23	0.263	0.473	6.75
554.6	87.8	26.77	Rock	140	9937	7478	0.56	0.074	100	45	≤5%	0.5	1.00	30	0.468	0.842	10.00

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)
1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID FA-B-10

Groundwater Elevation= 594 feet
Ground Surface Elevation= 645.2 feet
Depth to Water= 51.2 feet - below ground surface
M_w= 5.96 *Moment magnitude of earthquake at the Site*
MSF= 1.80 *Magnitude Scaling Factor*
a_{max}= 0.153 *peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N= see each cell *Overburden*
C_E= 0.8 *Energy Ratio*
C_B= 1.05 *Borehole Diameter*
C_R= see each cell *Rod Length*
C_S= 1 *Sampling Method*

Pa= 2116.2 *Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
CCR-Impounded	100	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%
PWR	140	≤5%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
641.7	3.5	1.07	CCR-Impounded	100	350	350	0.99	0.099	18	28	≥35%	2.5	0.75	30	0.468	0.842	8.54
636.7	8.5	2.59	CCR-Impounded	100	850	850	0.98	0.097	20	20	≥35%	1.6	0.75	29	0.404	0.727	7.46
631.7	13.5	4.12	CCR-Impounded	100	1350	1350	0.97	0.096	33	30	≥35%	1.3	0.85	30	0.468	0.842	8.74
626.7	18.5	5.64	CCR-Impounded	100	1850	1850	0.96	0.095	11	8	≥35%	1.1	0.85	15	0.161	0.290	3.04
621.7	23.5	7.16	CCR-Impounded	100	2350	2350	0.95	0.094	11	8	≥35%	0.9	0.95	15	0.160	0.288	3.06
616.7	28.5	8.69	CCR-Impounded	100	2850	2850	0.93	0.093	24	17	≥35%	0.9	0.95	25	0.288	0.519	5.59
611.7	33.5	10.21	CCR-Impounded	100	3350	3350	0.90	0.090	13	9	≥35%	0.8	1.00	15	0.164	0.296	3.30
606.7	38.5	11.74	CCR-Impounded	100	3850	3850	0.86	0.086	5	3	≥35%	0.7	1.00	9	0.102	0.184	2.15
601.7	43.5	13.26	Alluvium-1	120	4450	4450	0.82	0.082	19	11	≥35%	0.7	1.00	18	0.194	0.350	4.29
595.2	50.0	15.24	Alluvium-1	120	5230	5230	0.77	0.076	7	4	≥35%	0.6	1.00	9	0.109	0.196	2.56
590.2	55.0	16.77	Alluvium-1	120	5830	5593	0.73	0.075	10	5	≥35%	0.6	1.00	11	0.124	0.223	2.96
585.2	60.0	18.29	Alluvium-1	120	6430	5881	0.69	0.075	7	4	≥35%	0.6	1.00	9	0.106	0.192	2.57
580.2	65.0	19.82	Alluvium-2	115	7005	6144	0.64	0.073	79	39	≥35%	0.6	1.00	30	0.468	0.842	10.00
575.2	70.0	21.34	PWR	140	7705	6532	0.60	0.071	100	48	≤5%	0.6	1.00	30	0.468	0.842	10.00

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)

1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID	FA-B-11	
Groundwater Elevation=	594	feet
Ground Surface Elevation=	650.7	feet
Depth to Water=	56.7	feet - below ground surface
M_w=	5.96	*Moment magnitude of earthquake at the Site*
MSF=	1.80	*Magnitude Scaling Factor*
a_{max}=	0.153	*peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N=	see each cell	*Overburden*
C_E=	0.8	*Energy Ratio*
C_B=	1.05	*Borehole Diameter*
C_R=	see each cell	*Rod Length*
C_S=	1	*Sampling Method*
Pa=	2116.2	*Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
CCR-Impounded	100	≥35%
Alluvium-1	120	≥35%
PWR	140	≤5%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value,$(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
647.2	3.5	1.07	CCR-Impounded	100	350	350	0.99	0.099	26	40	≥35%	2.5	0.75	30	0.468	0.842	8.54
642.2	8.5	2.59	CCR-Impounded	100	850	850	0.98	0.097	6	6	≥35%	1.6	0.75	12	0.133	0.239	2.45
637.2	13.5	4.12	CCR-Impounded	100	1350	1350	0.97	0.096	2	2	≥35%	1.3	0.85	7	0.089	0.160	1.66
632.2	18.5	5.64	CCR-Impounded	100	1850	1850	0.96	0.095	2	2	≥35%	1.1	0.85	7	0.086	0.155	1.63
627.2	23.5	7.16	CCR-Impounded	100	2350	2350	0.95	0.094	11	8	≥35%	0.9	0.95	15	0.160	0.288	3.06
622.2	28.5	8.69	CCR-Impounded	100	2850	2850	0.93	0.093	10	7	≥35%	0.9	0.95	13	0.143	0.257	2.77
617.2	33.5	10.21	CCR-Impounded	100	3350	3350	0.90	0.090	9	6	≥35%	0.8	1.00	12	0.133	0.240	2.67
612.2	38.5	11.74	CCR-Impounded	100	3850	3850	0.86	0.086	12	7	≥35%	0.7	1.00	14	0.150	0.270	3.15
607.2	43.5	13.26	CCR-Impounded	100	4350	4350	0.82	0.082	17	10	≥35%	0.7	1.00	17	0.180	0.325	3.98
602.2	48.5	14.79	Alluvium-1	120	4950	4950	0.78	0.077	20	11	≥35%	0.7	1.00	18	0.194	0.349	4.50
595.2	55.5	16.92	Alluvium-1	120	5790	5790	0.72	0.072	11	6	≥35%	0.6	1.00	12	0.128	0.231	3.22
590.2	60.5	18.45	Alluvium-1	120	6390	6153	0.68	0.070	21	10	≥35%	0.6	1.00	17	0.185	0.334	4.74
585.2	65.5	19.97	Alluvium-1	120	6990	6441	0.64	0.069	6	3	≥35%	0.6	1.00	8	0.100	0.180	2.60
580.2	70.5	21.49	Alluvium-1	120	7590	6729	0.60	0.067	14	7	≥35%	0.6	1.00	13	0.140	0.252	3.74
576.3	74.4	22.68	PWR	140	8136	7032	0.57	0.065	100	46	≤5%	0.5	1.00	30	0.468	0.842	10.00

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)
1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID FA-B-13

Groundwater Elevation= 594 feet
Ground Surface Elevation= 649.0 feet
Depth to Water= 55.0 feet - below ground surface
M_w= 5.96 *Moment magnitude of earthquake at the Site*
MSF= 1.80 *Magnitude Scaling Factor*
a_{max}= 0.153 *peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N= see each cell *Overburden*
C_E= 0.8 *Energy Ratio*
C_B= 1.05 *Borehole Diameter*
C_R= see each cell *Rod Length*
C_S= 1 *Sampling Method*

Pa= 2116.2 *Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
CCR-Impounded	100	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value,$(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
645.5	3.5	1.07	CCR-Impounded	100	350	350	0.99	0.099	27	42	≥35%	2.5	0.75	30	0.468	0.842	8.54
640.5	8.5	2.59	CCR-Impounded	100	850	850	0.98	0.097	28	28	≥35%	1.6	0.75	30	0.468	0.842	8.64
635.5	13.5	4.12	CCR-Impounded	100	1350	1350	0.97	0.096	36	32	≥35%	1.3	0.85	30	0.468	0.842	8.74
630.5	18.5	5.64	CCR-Impounded	100	1850	1850	0.96	0.095	8	6	≥35%	1.1	0.85	12	0.134	0.242	2.54
625.5	23.5	7.16	CCR-Impounded	100	2350	2350	0.95	0.094	8	6	≥35%	0.9	0.95	12	0.134	0.241	2.56
620.5	28.5	8.69	CCR-Impounded	100	2850	2850	0.93	0.093	9	6	≥35%	0.9	0.95	12	0.135	0.243	2.62
615.5	33.5	10.21	CCR-Impounded	100	3350	3350	0.90	0.090	3	2	≥35%	0.8	1.00	7	0.091	0.164	1.83
610.5	38.5	11.74	CCR-Impounded	100	3850	3850	0.86	0.086	27	17	≥35%	0.7	1.00	25	0.295	0.532	6.21
605.5	43.5	13.26	CCR-Impounded	100	4350	4350	0.82	0.082	6	4	≥35%	0.7	1.00	9	0.106	0.191	2.35
600.5	48.5	14.79	CCR-Impounded	100	4850	4850	0.78	0.077	12	7	≥35%	0.7	1.00	13	0.140	0.253	3.26
594.0	55.0	16.77	Alluvium-1	120	5630	5630	0.73	0.072	14	7	≥35%	0.6	1.00	14	0.147	0.264	3.66
589.0	60.0	18.29	Alluvium-1	120	6230	5918	0.69	0.072	18	9	≥35%	0.6	1.00	16	0.169	0.304	4.23
584.0	65.0	19.82	Alluvium-1	120	6830	6206	0.64	0.071	8	4	≥35%	0.6	1.00	10	0.111	0.199	2.82
579.0	70.0	21.34	Alluvium-2	115	7405	6469	0.60	0.069	88	42	≥35%	0.6	1.00	30	0.468	0.842	10.00
574.2	74.8	22.80	Alluvium-2	115	7957	6721	0.57	0.067	81	38	≥35%	0.6	1.00	30	0.468	0.842	10.00

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)
1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID	FA-B-17		a_{max} (USGS Hazard tool)				Corrections to SPT		
Groundwater Elevation=	594	feet	10% in 50 yrs	0.053	Lat	38.2045	C_N=	see each cell	*Overburden*
Ground Surface Elevation=	647.9	feet	5% in 50 yrs	0.085	Long	-81.4132	C_E=	0.8	*Energy Ratio*
Depth to Water=	53.9	feet - below ground surface	2% in 50 yrs	0.153			C_B=	1.05	*Borehole Diameter*
M_w=	5.96	*Moment magnitude of earthquake at the Site*					C_R=	see each cell	*Rod Length*
MSF=	1.80	*Magnitude Scaling Factor*					C_S=	1	*Sampling Method*
a_{max}=	0.153	*peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*					Pa=	2116.2	*Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
CCR-Impounded	100	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%
Rock	140	≤5%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
644.5	3.4	1.04	CCR-Impounded	100	340	340	0.99	0.099	5	8	≥35%	2.5	0.75	14	0.154	0.278	2.82
639.5	8.4	2.56	CCR-Impounded	100	840	840	0.98	0.098	7	7	≥35%	1.6	0.75	13	0.144	0.260	2.67
634.5	13.4	4.09	CCR-Impounded	100	1340	1340	0.97	0.096	5	4	≥35%	1.3	0.85	10	0.117	0.210	2.18
629.5	18.4	5.61	CCR-Impounded	100	1840	1840	0.96	0.095	7	5	≥35%	1.1	0.85	11	0.126	0.227	2.38
624.5	23.4	7.13	CCR-Impounded	100	2340	2340	0.95	0.094	8	6	≥35%	1.0	0.95	12	0.134	0.241	2.56
619.5	28.4	8.66	CCR-Impounded	100	2840	2840	0.93	0.093	5	3	≥35%	0.9	0.95	9	0.106	0.190	2.05
614.5	33.4	10.18	CCR-Impounded	100	3340	3340	0.90	0.090	17	11	≥35%	0.8	1.00	19	0.199	0.358	4.00
609.5	38.4	11.71	CCR-Impounded	100	3840	3840	0.86	0.086	6	4	≥35%	0.7	1.00	9	0.109	0.196	2.28
604.5	43.4	13.23	CCR-Impounded	100	4340	4340	0.82	0.082	2	1	≥35%	0.7	1.00	6	0.083	0.149	1.83
599.5	48.4	14.76	CCR-Impounded	100	4840	4840	0.78	0.078	7	4	≥35%	0.7	1.00	10	0.110	0.198	2.56
594.5	53.4	16.28	Alluvium-1	120	5440	5440	0.74	0.074	5	3	≥35%	0.6	1.00	8	0.097	0.175	2.38
589.5	58.4	17.80	Alluvium-1	120	6040	5759	0.70	0.073	4	2	≥35%	0.6	1.00	7	0.091	0.164	2.26
584.5	63.4	19.33	Alluvium-1	120	6640	6047	0.66	0.072	7	3	≥35%	0.6	1.00	9	0.106	0.191	2.65
579.5	68.4	20.85	Alluvium-1	120	7240	6335	0.62	0.070	10	5	≥35%	0.6	1.00	11	0.120	0.217	3.09
574.5	73.4	22.38	Alluvium-2	115	7815	6598	0.58	0.068	24	11	≥35%	0.6	1.00	19	0.200	0.360	5.30
569.5	78.4	23.90	Alluvium-2	115	8390	6861	0.56	0.068	22	10	≥35%	0.6	1.00	17	0.184	0.332	4.87
568.1	79.8	24.33	Rock	140	10036	8420	0.56	0.066	100	42	≤5%	0.5	1.00	30	0.468	0.842	10.00

Note(s)

1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)

1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID FA-B-18

Groundwater Elevation=	594	feet
Ground Surface Elevation=	642.5	feet
Depth to Water=	48.5	feet - below ground surface
M_w=	5.96	*Moment magnitude of earthquake at the Site*
MSF=	1.80	*Magnitude Scaling Factor*
a_{max}=	0.153	*peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N=	see each cell	*Overburden*
C_E=	0.8	*Energy Ratio*
C_B=	1.05	*Borehole Diameter*
C_R=	see each cell	*Rod Length*
C_S=	1	*Sampling Method*
Pa=	2116.2	*Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
CCR-Impounded	100	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%
PWR	140	≤5%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
639.0	3.5	1.07	CCR-Impounded	100	350	350	0.99	0.099	30	46	≥35%	2.5	0.75	30	0.468	0.842	8.54
634.0	8.5	2.59	CCR-Impounded	100	850	850	0.98	0.097	5	5	≥35%	1.6	0.75	11	0.122	0.219	2.25
629.0	13.5	4.12	CCR-Impounded	100	1350	1350	0.97	0.096	11	10	≥35%	1.3	0.85	17	0.179	0.322	3.34
624.0	18.5	5.64	CCR-Impounded	100	1850	1850	0.96	0.095	6	5	≥35%	1.1	0.85	10	0.118	0.212	2.22
619.0	23.5	7.16	CCR-Impounded	100	2350	2350	0.95	0.094	9	7	≥35%	0.9	0.95	13	0.142	0.256	2.72
614.0	28.5	8.69	CCR-Impounded	100	2850	2850	0.93	0.093	6	4	≥35%	0.9	0.95	10	0.113	0.203	2.19
609.0	33.5	10.21	CCR-Impounded	100	3350	3350	0.90	0.090	3	2	≥35%	0.8	1.00	7	0.091	0.164	1.83
604.0	38.5	11.74	CCR-Impounded	100	3850	3850	0.86	0.086	3	2	≥35%	0.7	1.00	7	0.090	0.161	1.89
599.0	43.5	13.26	Alluvium-1	120	4450	4450	0.82	0.082	6	3	≥35%	0.7	1.00	9	0.106	0.191	2.34
594.0	48.5	14.79	Alluvium-1	120	5050	5050	0.78	0.077	5	3	≥35%	0.6	1.00	8	0.098	0.177	2.28
589.0	53.5	16.31	Alluvium-1	120	5650	5338	0.74	0.078	5	3	≥35%	0.6	1.00	8	0.097	0.175	2.26
584.0	58.5	17.84	Alluvium-1	120	6250	5626	0.70	0.077	7	4	≥35%	0.6	1.00	9	0.107	0.193	2.50
579.0	63.5	19.36	Alluvium-1	120	6850	5914	0.66	0.076	15	8	≥35%	0.6	1.00	14	0.151	0.271	3.58
574.0	68.5	20.88	Alluvium-2	115	7425	6177	0.62	0.074	43	21	≥35%	0.6	1.00	30	0.468	0.842	10.00
569.0	73.5	22.41	Alluvium-2	115	8000	6440	0.58	0.071	31	15	≥35%	0.6	1.00	23	0.256	0.460	6.47
564.9	77.6	23.66	PWR	140	8574	6758	0.56	0.071	100	47	≤5%	0.6	1.00	30	0.468	0.842	10.00

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)

1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID MW-1601

Groundwater Elevation=	594	feet
Ground Surface Elevation=	627.8	feet
Depth to Water=	33.8	feet - below ground surface
M_w=	5.96	*Moment magnitude of earthquake at the Site*
MSF=	1.80	*Magnitude Scaling Factor*
a_{max}=	0.153	*peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N=	see each cell	*Overburden*
C_E=	0.8	*Energy Ratio*
C_B=	1.05	*Borehole Diameter*
C_R=	see each cell	*Rod Length*
C_S=	1	*Sampling Method*
Pa=	2116.2	*Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
Earthfill	125	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%
PWR	140	≤5%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
626.3	1.5	0.46	Earthfill	125	187.5	188	1.00	0.099	10	21	≥35%	3.4	0.75	30	0.468	0.842	8.50
619.8	8.0	2.44	Earthfill	125	1000	1000	0.98	0.098	12	11	≥35%	1.5	0.75	18	0.194	0.349	3.58
614.8	13.0	3.96	Earthfill	125	1625	1625	0.97	0.096	4	3	≥35%	1.1	0.80	9	0.102	0.183	1.90
609.8	18.0	5.49	Alluvium-1	120	2225	2225	0.96	0.095	8	6	≥35%	1.0	0.85	12	0.128	0.231	2.42
604.8	23.0	7.01	Alluvium-1	120	2825	2825	0.95	0.094	6	4	≥35%	0.9	0.95	10	0.113	0.203	2.16
599.8	28.0	8.54	Alluvium-1	120	3425	3425	0.93	0.093	4	3	≥35%	0.8	0.95	8	0.096	0.173	1.86
594.8	33.0	10.06	Alluvium-1	120	4025	4025	0.91	0.090	3	2	≥35%	0.7	1.00	7	0.089	0.161	1.78
589.8	38.0	11.59	Alluvium-1	120	4625	4363	0.86	0.091	4	2	≥35%	0.7	1.00	8	0.094	0.170	1.86
584.8	43.0	13.11	Alluvium-2	115	5200	4626	0.82	0.092	43	24	≥35%	0.7	1.00	30	0.468	0.842	9.14
580.6	47.2	14.39	PWR	140	5788	4952	0.79	0.092	100	55	≤5%	0.7	1.00	30	0.468	0.842	9.17

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)
1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID MW-1602

Groundwater Elevation=	594	feet
Ground Surface Elevation=	627.5	feet
Depth to Water=	33.5	feet - below ground surface
M_w=	5.96	*Moment magnitude of earthquake at the Site*
MSF=	1.80	*Magnitude Scaling Factor*
a_{max}=	0.153	*peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N=	see each cell	*Overburden*
C_E=	0.8	*Energy Ratio*
C_B=	1.05	*Borehole Diameter*
C_R=	see each cell	*Rod Length*
C_S=	1	*Sampling Method*
Pa=	2116.2	*Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
Earthfill	125	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%
PWR	140	≤5%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
624.5	3.0	0.91	Earthfill	125	375	375	0.99	0.099	8	12	≥35%	2.4	0.75	19	0.208	0.374	3.79
619.5	8.0	2.44	Earthfill	125	1000	1000	0.98	0.098	14	13	≥35%	1.5	0.75	20	0.220	0.397	4.07
614.5	13.0	3.96	Alluvium-1	120	1600	1600	0.97	0.096	11	9	≥35%	1.2	0.80	15	0.162	0.292	3.03
609.5	18.0	5.49	Alluvium-1	120	2200	2200	0.96	0.095	6	4	≥35%	1.0	0.85	10	0.113	0.204	2.14
604.5	23.0	7.01	Alluvium-1	120	2800	2800	0.95	0.094	4	3	≥35%	0.9	0.95	8	0.099	0.178	1.89
599.5	28.0	8.54	Alluvium-1	120	3400	3400	0.93	0.093	3	2	≥35%	0.8	0.95	7	0.090	0.162	1.74
594.5	33.0	10.06	Alluvium-1	120	4000	4000	0.91	0.090	7	4	≥35%	0.7	1.00	10	0.114	0.206	2.29
589.5	38.0	11.59	Alluvium-1	120	4600	4319	0.86	0.092	3	2	≥35%	0.7	1.00	7	0.089	0.160	1.74
584.5	43.0	13.11	Alluvium-1	120	5200	4607	0.82	0.092	8	5	≥35%	0.7	1.00	10	0.117	0.211	2.28
579.5	48.0	14.63	Alluvium-2	115	5775	4870	0.78	0.092	42	23	≥35%	0.7	1.00	30	0.468	0.842	9.12
574.5	53.0	16.16	Alluvium-2	115	6350	5133	0.74	0.091	51	28	≥35%	0.6	1.00	30	0.468	0.842	9.22
569.5	58.0	17.68	Alluvium-2	115	6925	5396	0.70	0.090	28	15	≥35%	0.6	1.00	23	0.252	0.454	5.06
564.5	63.0	19.21	PWR	140	7625	5784	0.66	0.087	100	51	≤5%	0.6	1.00	30	0.468	0.842	9.71

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)

1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID MW-1603

Groundwater Elevation= 594 feet
Ground Surface Elevation= 628.0 feet
Depth to Water= 34.0 feet - below ground surface
M_w= 5.96 *Moment magnitude of earthquake at the Site*
MSF= 1.80 *Magnitude Scaling Factor*
a_{max}= 0.153 *peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N= see each cell *Overburden*
C_E= 0.8 *Energy Ratio*
C_B= 1.05 *Borehole Diameter*
C_R= see each cell *Rod Length*
C_S= 1 *Sampling Method*

Pa= 2116.2 *Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
Earthfill	125	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
625.0	3.0	0.91	Earthfill	125	375	375	0.99	0.099	20	30	≥35%	2.4	0.75	30	0.468	0.842	8.53
620.0	8.0	2.44	Earthfill	125	1000	1000	0.98	0.098	26	24	≥35%	1.5	0.75	30	0.468	0.842	8.63
615.0	13.0	3.96	Earthfill	125	1625	1625	0.97	0.096	23	18	≥35%	1.1	0.80	26	0.317	0.571	5.92
610.0	18.0	5.49	Alluvium-1	120	2225	2225	0.96	0.095	10	7	≥35%	1.0	0.85	13	0.144	0.259	2.72
595.0	33.0	10.06	Alluvium-1	120	4025	4025	0.91	0.090	7	4	≥35%	0.7	1.00	10	0.114	0.206	2.28
590.0	38.0	11.59	Alluvium-1	120	4625	4375	0.86	0.091	5	3	≥35%	0.7	1.00	9	0.100	0.180	1.98
585.0	43.0	13.11	Alluvium-2	115	5200	4638	0.82	0.092	5	3	≥35%	0.7	1.00	8	0.099	0.179	1.95
580.0	48.0	14.63	Alluvium-2	115	5775	4901	0.78	0.092	7	4	≥35%	0.7	1.00	10	0.110	0.198	2.16
575.0	53.0	16.16	Alluvium-2	115	6350	5164	0.74	0.091	33	18	≥35%	0.6	1.00	26	0.320	0.576	6.35
570.0	58.0	17.68	Alluvium-2	115	6925	5427	0.70	0.089	36	19	≥35%	0.6	1.00	28	0.358	0.645	7.24

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)
1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID MW-1604

Groundwater Elevation= 594 feet
Ground Surface Elevation= 628.0 feet
Depth to Water= 34.0 feet - below ground surface
M_w= 5.96 *Moment magnitude of earthquake at the Site*
MSF= 1.80 *Magnitude Scaling Factor*
a_{max}= 0.153 *peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N=	see each cell	*Overburden*
C_E=	0.8	*Energy Ratio*
C_B=	1.05	*Borehole Diameter*
C_R=	see each cell	*Rod Length*
C_S=	1	*Sampling Method*
Pa=	2116.2	*Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
Earthfill	125	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%
PWR	140	≤5%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
625.5	2.5	0.76	Earthfill	125	312.5	313	0.99	0.099	10	16	≥35%	2.6	0.75	25	0.286	0.514	5.20
620.0	8.0	2.44	Earthfill	125	1000	1000	0.98	0.098	26	24	≥35%	1.5	0.75	30	0.468	0.842	8.63
615.0	13.0	3.96	Alluvium-1	120	1600	1600	0.97	0.096	8	6	≥35%	1.2	0.80	12	0.135	0.243	2.52
610.0	18.0	5.49	Alluvium-1	120	2200	2200	0.96	0.095	7	5	≥35%	1.0	0.85	11	0.121	0.218	2.29
605.0	23.0	7.01	Alluvium-1	120	2800	2800	0.95	0.094	4	3	≥35%	0.9	0.95	8	0.099	0.178	1.89
600.0	28.0	8.54	Alluvium-1	120	3400	3400	0.93	0.093	5	3	≥35%	0.8	0.95	9	0.103	0.185	1.99
595.0	33.0	10.06	Alluvium-1	120	4000	4000	0.91	0.090	4	2	≥35%	0.7	1.00	8	0.095	0.172	1.91
590.0	38.0	11.59	Alluvium-1	120	4600	4350	0.86	0.091	6	4	≥35%	0.7	1.00	9	0.106	0.191	2.10
585.0	43.0	13.11	Alluvium-2	115	5175	4613	0.82	0.092	42	24	≥35%	0.7	1.00	30	0.468	0.842	9.16
580.0	48.0	14.63	Alluvium-2	115	5750	4876	0.78	0.092	48	27	≥35%	0.7	1.00	30	0.468	0.842	9.17
575.0	53.0	16.16	Alluvium-2	115	6325	5139	0.74	0.091	56	30	≥35%	0.6	1.00	30	0.468	0.842	9.26
570.0	58.0	17.68	Alluvium-2	115	6900	5402	0.70	0.089	79	42	≥35%	0.6	1.00	30	0.468	0.842	9.44
566.5	61.5	18.75	PWR	140	7390	5674	0.67	0.087	100	51	≤5%	0.6	1.00	30	0.468	0.842	9.65

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

Reference(s)

1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

LIQUEFACTION RESISTANCE CALCULATION

Borehole ID	MW-1605		
Groundwater Elevation=	594	feet	
Ground Surface Elevation=	628.0	feet	
Depth to Water=	34.0	feet - below ground surface	
M_w=	5.96	*Moment magnitude of earthquake at the Site*	
MSF=	1.80	*Magnitude Scaling Factor*	
a_{max}=	0.153	*peak horizontal acceleration at the ground surface based on USGS Unified Hazard Tool*	

a_{max} (USGS Hazard tool)

10% in 50 yrs	0.053	Lat	38.2045
5% in 50 yrs	0.085	Long	-81.4132
2% in 50 yrs	0.153		

Corrections to SPT

C_N=	see each cell	*Overburden*
C_E=	0.8	*Energy Ratio*
C_B=	1.05	*Borehole Diameter*
C_R=	see each cell	*Rod Length*
C_S=	1	*Sampling Method*
Pa=	2116.2	*Atmospheric Pressure, psf*

Material Type	Unit Weight (pcf)	Avg % Fines
Earthfill	125	≥35%
Alluvium-1	120	≥35%
Alluvium-2	115	≥35%

Groundwater (Approximate)
(GW is assumed to be at elevation 594 feet according to the OHWM)

Bottom Elevation (feet)	Bottom Depth (feet)	Depth (m)	Predominant Material Type	Unit Weight, γ_b (pcf)	Total Stress, σ_v (psf)	Effective Stress, σ'_v (psf)	Stress Reduction Coefficient, r_d	Cyclic Stress Ratio, CSR	SPT-N[1] (bpf)	Corrected SPT-N, $(N_1)_{60}$ (bpf)	Fine Content (based on lab results or visual classification)	Correction to SPT, Overburden Factor, C_N	Correction to SPT-Rod Length, C_R	$(N_1)_{60}$ adjusted to equivalent clean-sand value, $(N_1)_{60cs}$ (bpf)	Cyclic Resistance Ratio (CRR) for earthquakes for M_w= 7.5, $CRR_{7.5}$	CRR for Mw (5.96) at the Site, CRR	Factor of Safety, FS
625.0	3.0	0.91	Earthfill	125	375	375	0.99	0.099	9	13	≥35%	2.4	0.75	21	0.230	0.415	4.20
620.0	8.0	2.44	Earthfill	125	1000	1000	0.98	0.098	22	20	≥35%	1.5	0.75	29	0.420	0.756	7.74
615.0	13.0	3.96	Earthfill	125	1625	1625	0.97	0.096	22	17	≥35%	1.1	0.80	25	0.297	0.534	5.54
610.0	18.0	5.49	Earthfill	125	2250	2250	0.96	0.095	11	8	≥35%	1.0	0.85	14	0.152	0.273	2.86
605.0	23.0	7.01	Alluvium-1	120	2850	2850	0.95	0.094	16	11	≥35%	0.9	0.95	18	0.194	0.349	3.71
600.0	28.0	8.54	Alluvium-1	120	3450	3450	0.93	0.093	9	6	≥35%	0.8	0.95	12	0.129	0.232	2.50
595.0	33.0	10.06	Alluvium-1	120	4050	4050	0.91	0.090	8	5	≥35%	0.7	1.00	11	0.121	0.217	2.41
590.0	38.0	11.59	Alluvium-1	120	4650	4400	0.86	0.091	3	2	≥35%	0.7	1.00	7	0.088	0.159	1.75
585.0	43.0	13.11	Alluvium-1	120	5250	4688	0.82	0.092	7	4	≥35%	0.7	1.00	10	0.111	0.200	2.17
580.0	48.0	14.63	Alluvium-1	120	5850	4976	0.78	0.092	14	8	≥35%	0.7	1.00	14	0.152	0.274	2.99
575.0	53.0	16.16	Alluvium-2	115	6425	5239	0.74	0.091	25	13	≥35%	0.6	1.00	21	0.228	0.411	4.54

Note(s)
1. Measured resistance from Standard Penetration Test (SPT), blow count (N)
2. m=meter; ft-msl= feet above mean sea level; pcf= pounds per cubic foot; psf= pounds per square foot; bpf= blows per foot; yrs= years; USGS=United States Geological Survey
3. Average % Fines of the material type were used for (N1)60cs correction when lab results were not available for a given depth

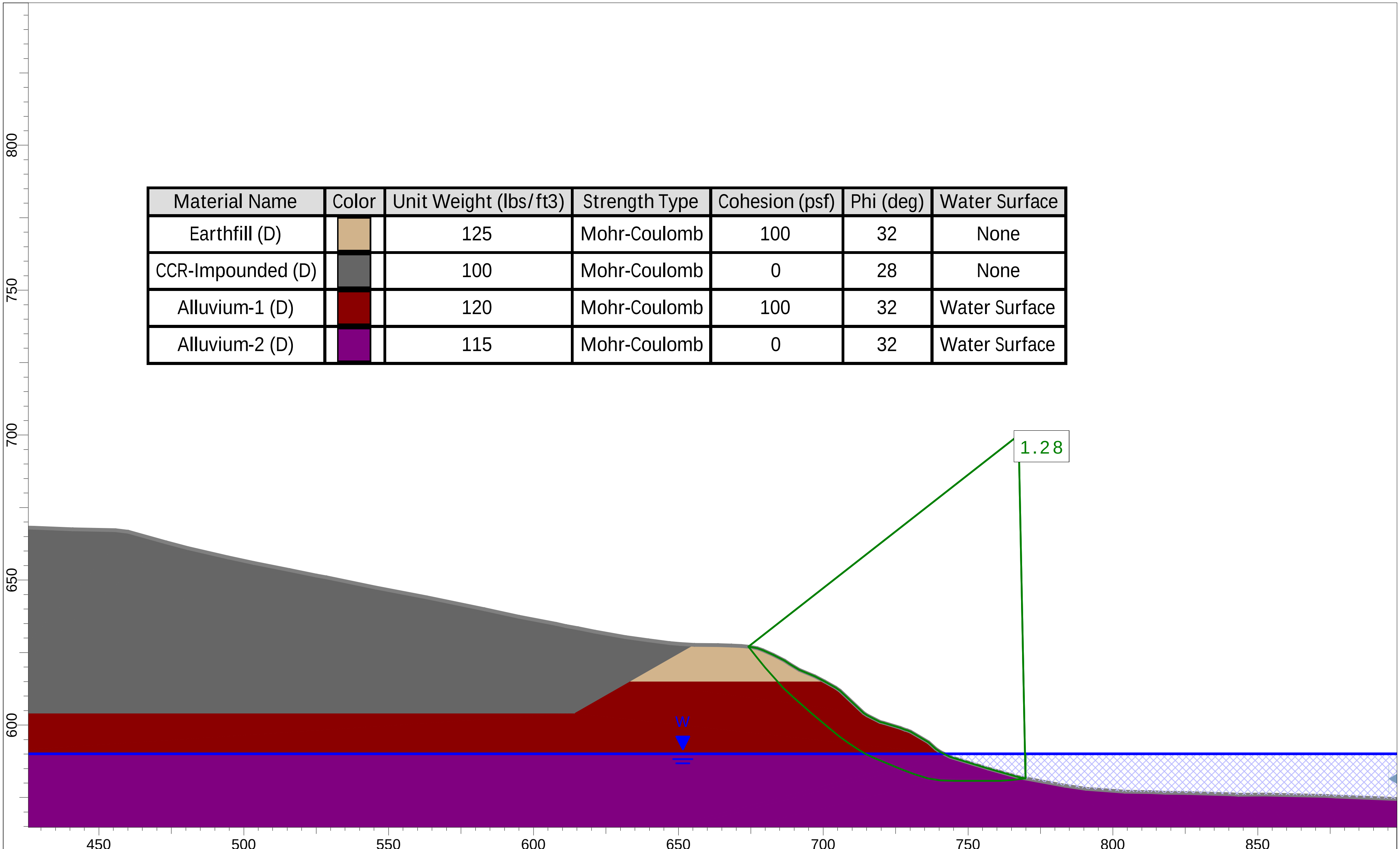
Reference(s)
1. Youd, B. T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christian, J. T., Dobry, R., Finn, W. D. L., Jr, L. F. H., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Iii, W. F. M., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Ii, K. H. S. (2001). Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER / NSF Workshops on Evaluation. Journal of Geotechnical and Geoenvironmental Engineering, 127(10), 817–833. https://doi.org/10.1061/(ASCE)1090-0241(2001)127:10(817)
2. USGS Earthquake Hazard Toolbox (usgs.gov)

Prepared by: MN Date: 12/04/2025
Checked by: SM Date: 12/19/2025

APPENDIX D

Slope Stability Analyses Outputs

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Earthfill (D)		125	Mohr-Coulomb	100	32	None
CCR-Impounded (D)		100	Mohr-Coulomb	0	28	None
Alluvium-1 (D)		120	Mohr-Coulomb	100	32	Water Surface
Alluvium-2 (D)		115	Mohr-Coulomb	0	32	Water Surface



Project: East Fly Ash Pond - Slope Stability Analyses

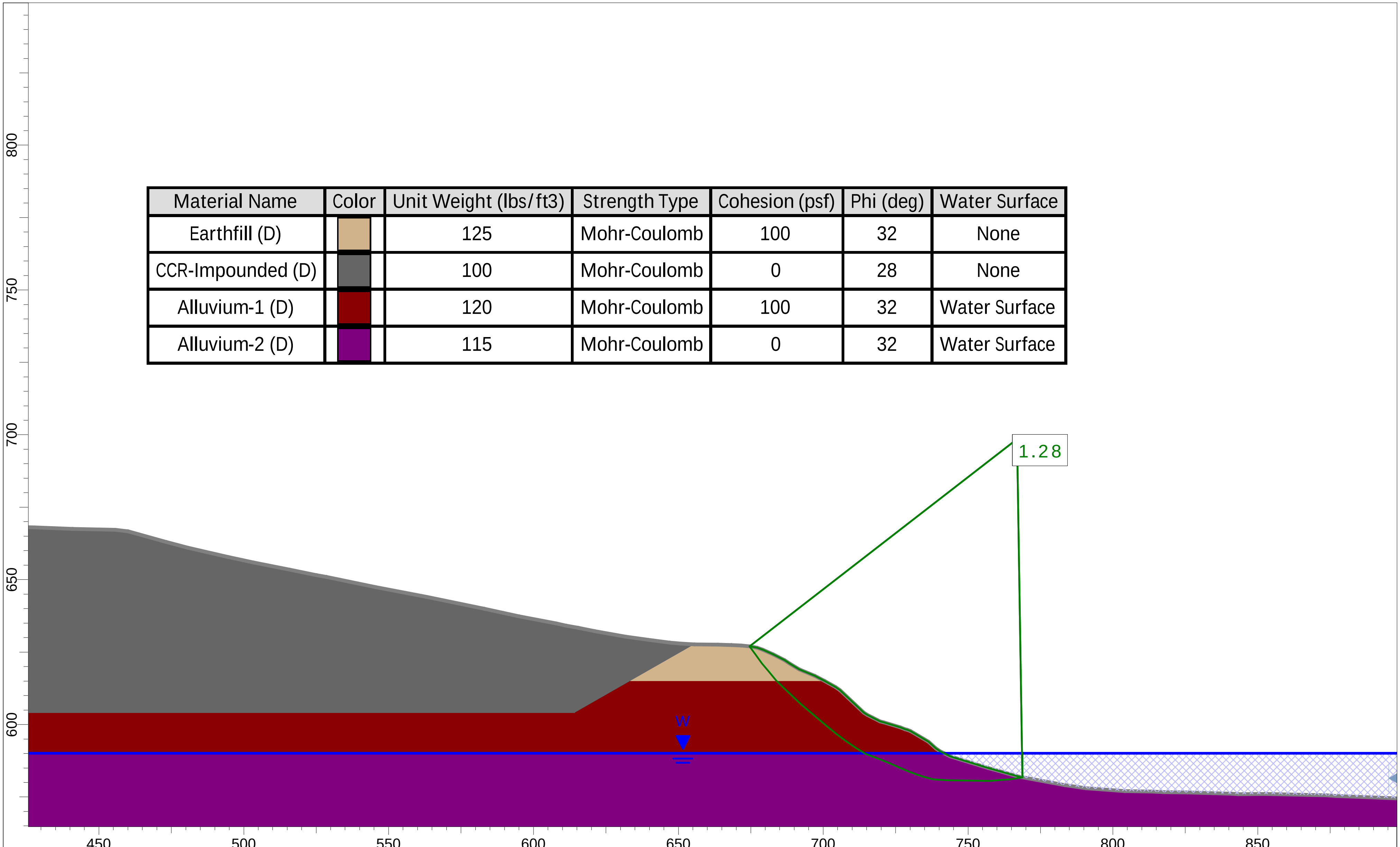
Description: AEP Sec A-A (Existing Conditions, Long-term Static) - Local Stability Analyses

Drawn by:	Checked by:	Reviewed by:	Scale:	Client:	Figure:
NG	SM	SM	1:550	AEP	A-1

Date: 4/10/2026

SLIDEINTERPRET 9.026

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Earthfill (D)		125	Mohr-Coulomb	100	32	None
CCR-Impounded (D)		100	Mohr-Coulomb	0	28	None
Alluvium-1 (D)		120	Mohr-Coulomb	100	32	Water Surface
Alluvium-2 (D)		115	Mohr-Coulomb	0	32	Water Surface

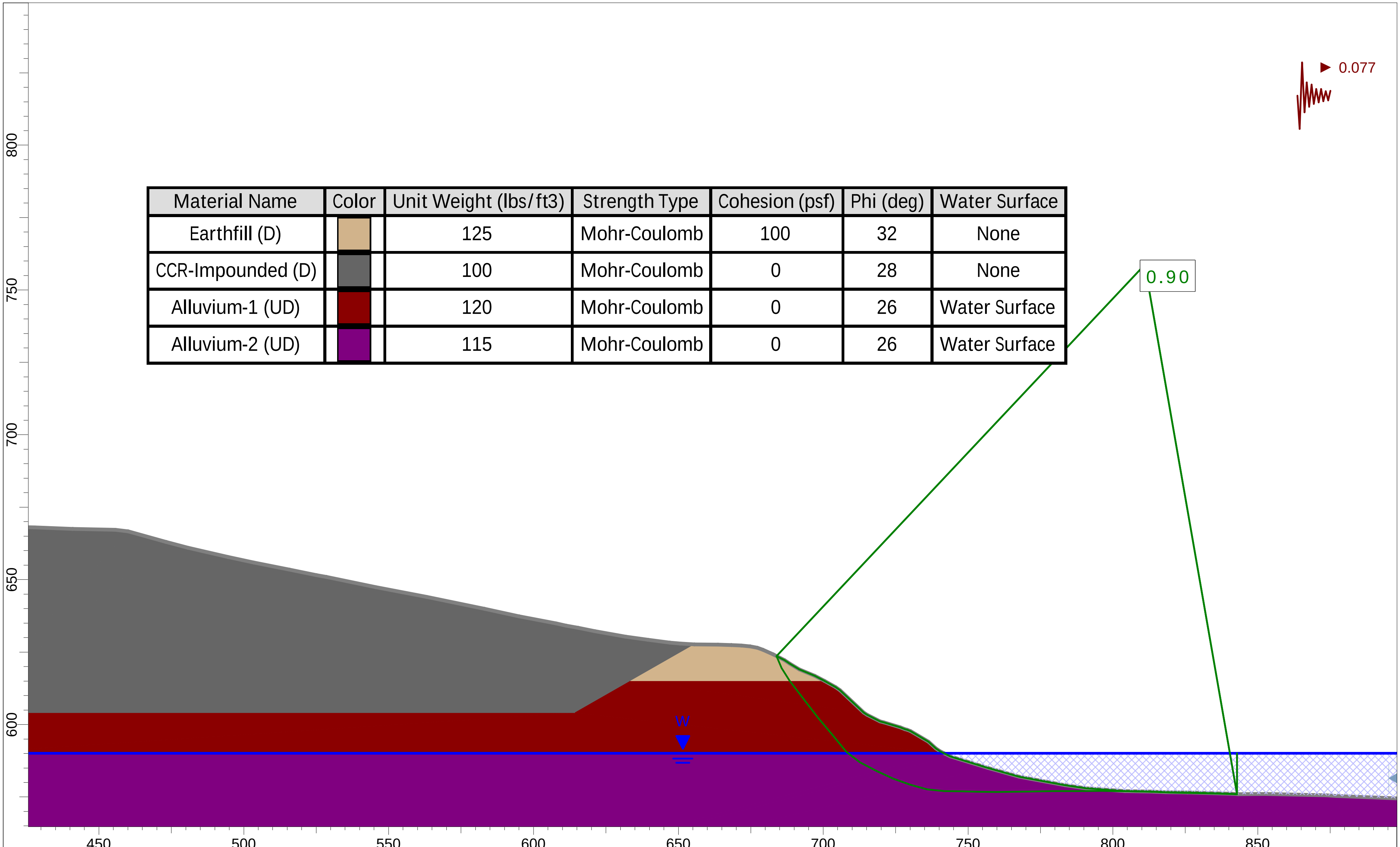


Project: East Fly Ash Pond - Slope Stability Analyses

Description: AEP Sec A-A (Existing Conditions, Long-term Static) - Global Stability Analyses

Drawn by: NG	Checked by: SM	Reviewed by: SM	Scale: 1:550	Client: AEP	Figure: A-2
Date: 4/10/2026					

SLIDEINTERPRET 9.026



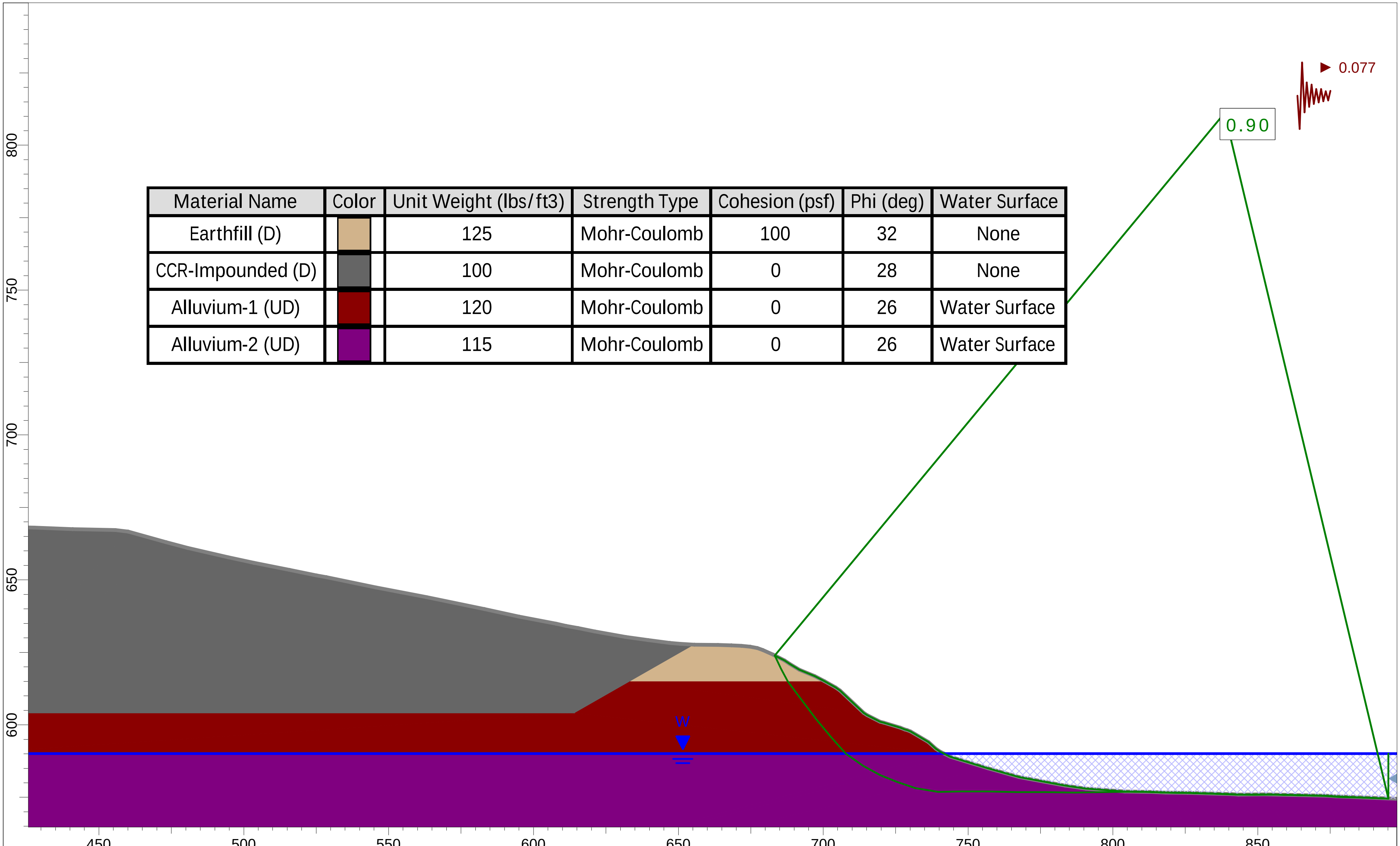
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Earthfill (D)		125	Mohr-Coulomb	100	32	None
CCR-Impounded (D)		100	Mohr-Coulomb	0	28	None
Alluvium-1 (UD)		120	Mohr-Coulomb	0	26	Water Surface
Alluvium-2 (UD)		115	Mohr-Coulomb	0	26	Water Surface

SLIDEINTERPRET 9.026

Project: East Fly Ash Pond - Slope Stability Analyses

Description: AEP Sec A-A (Existing Conditions, Pseudo-static) - Local Stability Analyses

Drawn by: NG	Checked by: SM	Reviewed by: SM	Scale: 1:550	Client: AEP	Figure: A-3
Date: 4/10/2026					



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Earthfill (D)		125	Mohr-Coulomb	100	32	None
CCR-Impounded (D)		100	Mohr-Coulomb	0	28	None
Alluvium-1 (UD)		120	Mohr-Coulomb	0	26	Water Surface
Alluvium-2 (UD)		115	Mohr-Coulomb	0	26	Water Surface

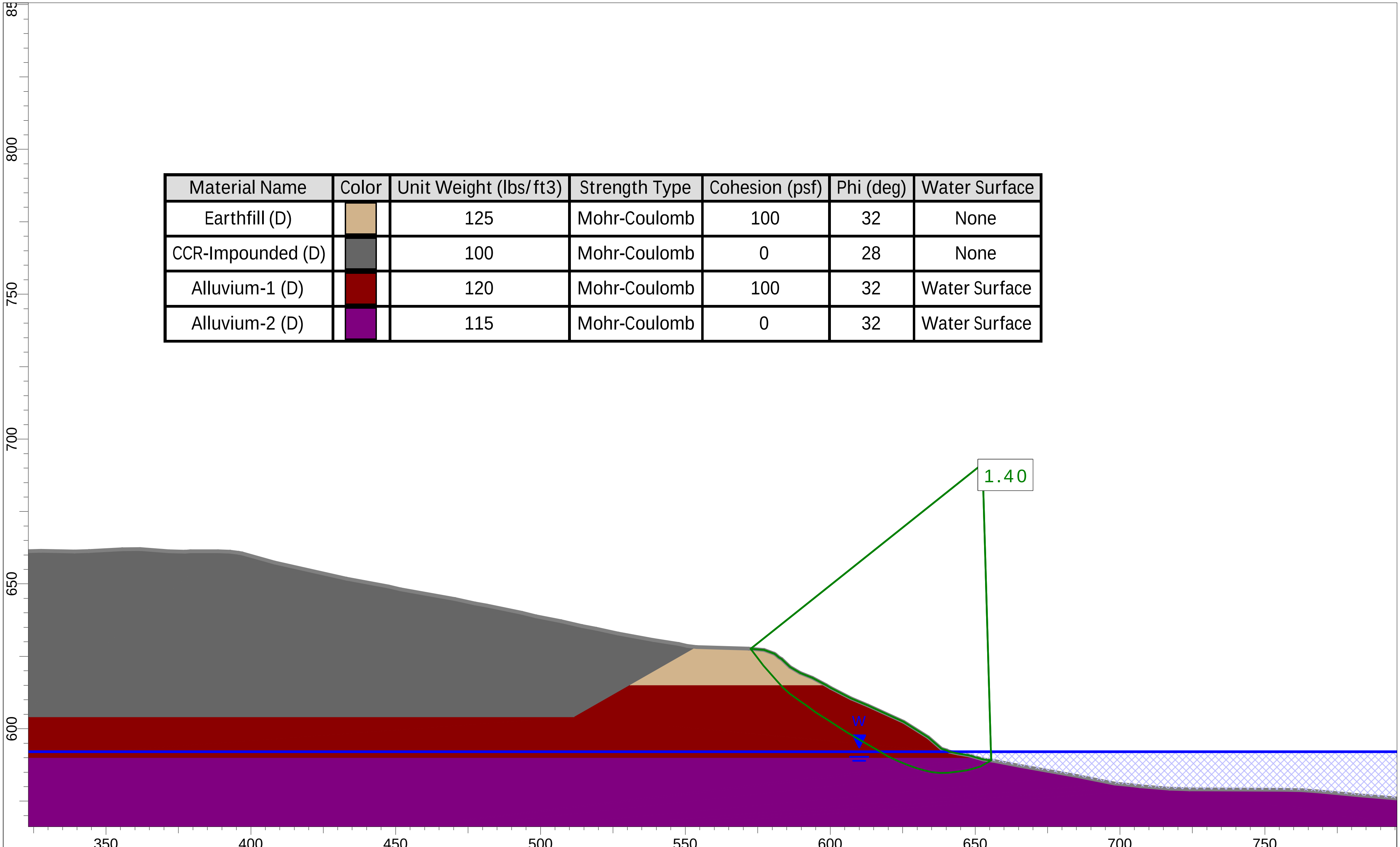
SLIDEINTERPRET 9.026

Project
East Fly Ash Pond - Slope Stability Analyses

Description:
AEP Sec A-A (Existing Conditions, Pseudo-static) - Global Stability Analyses

Drawn by: NG
Checked by: SM
Reviewed by: SM
Scale: 1:550
Client: AEP
Figure: A-4
Date: 4/10/2026

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Earthfill (D)		125	Mohr-Coulomb	100	32	None
CCR-Impounded (D)		100	Mohr-Coulomb	0	28	None
Alluvium-1 (D)		120	Mohr-Coulomb	100	32	Water Surface
Alluvium-2 (D)		115	Mohr-Coulomb	0	32	Water Surface



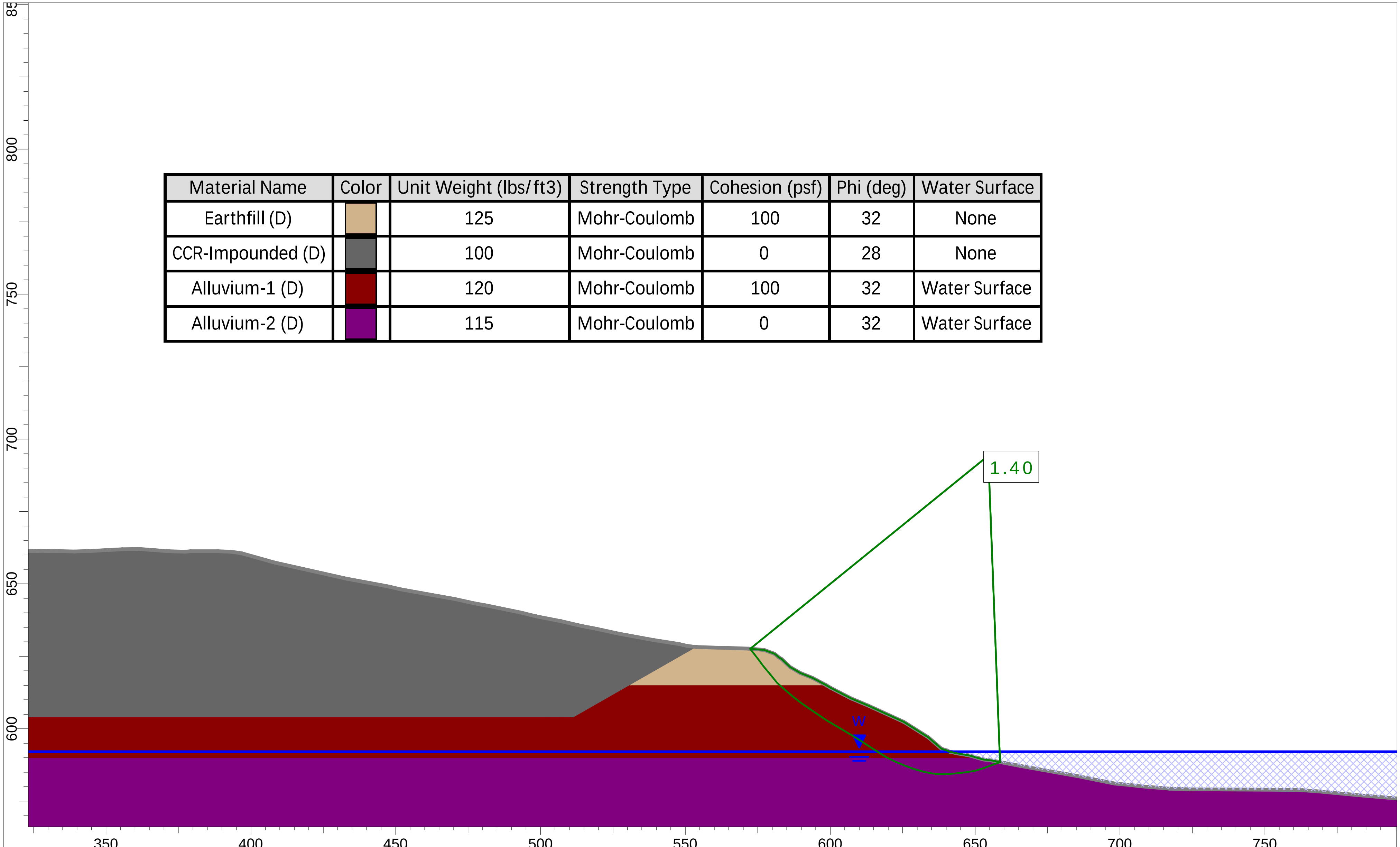
Project: East Fly Ash Pond - Slope Stability Analyses

Description: AEP Sec B-B (Existing Conditions, Long-term Static) - Local Stability Analyses

Drawn by: NG	Checked by: SM	Reviewed by: SM	Scale: 1:550	Client: AEP	Figure: B-1
Date: 4/10/2026					

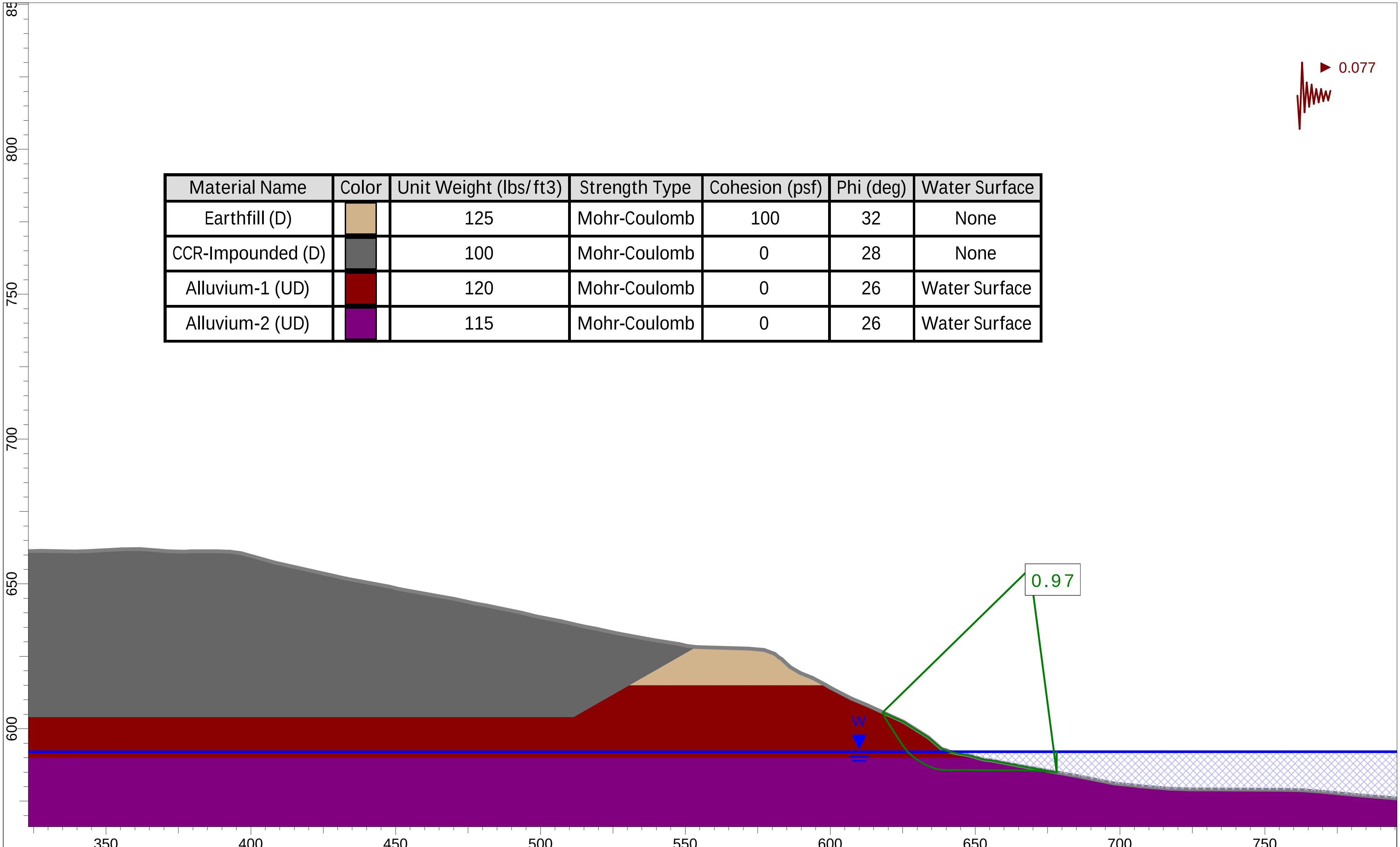
SLIDEINTERPRET 9.026

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Earthfill (D)		125	Mohr-Coulomb	100	32	None
CCR-Impounded (D)		100	Mohr-Coulomb	0	28	None
Alluvium-1 (D)		120	Mohr-Coulomb	100	32	Water Surface
Alluvium-2 (D)		115	Mohr-Coulomb	0	32	Water Surface



SLIDEINTERPRET 9.026

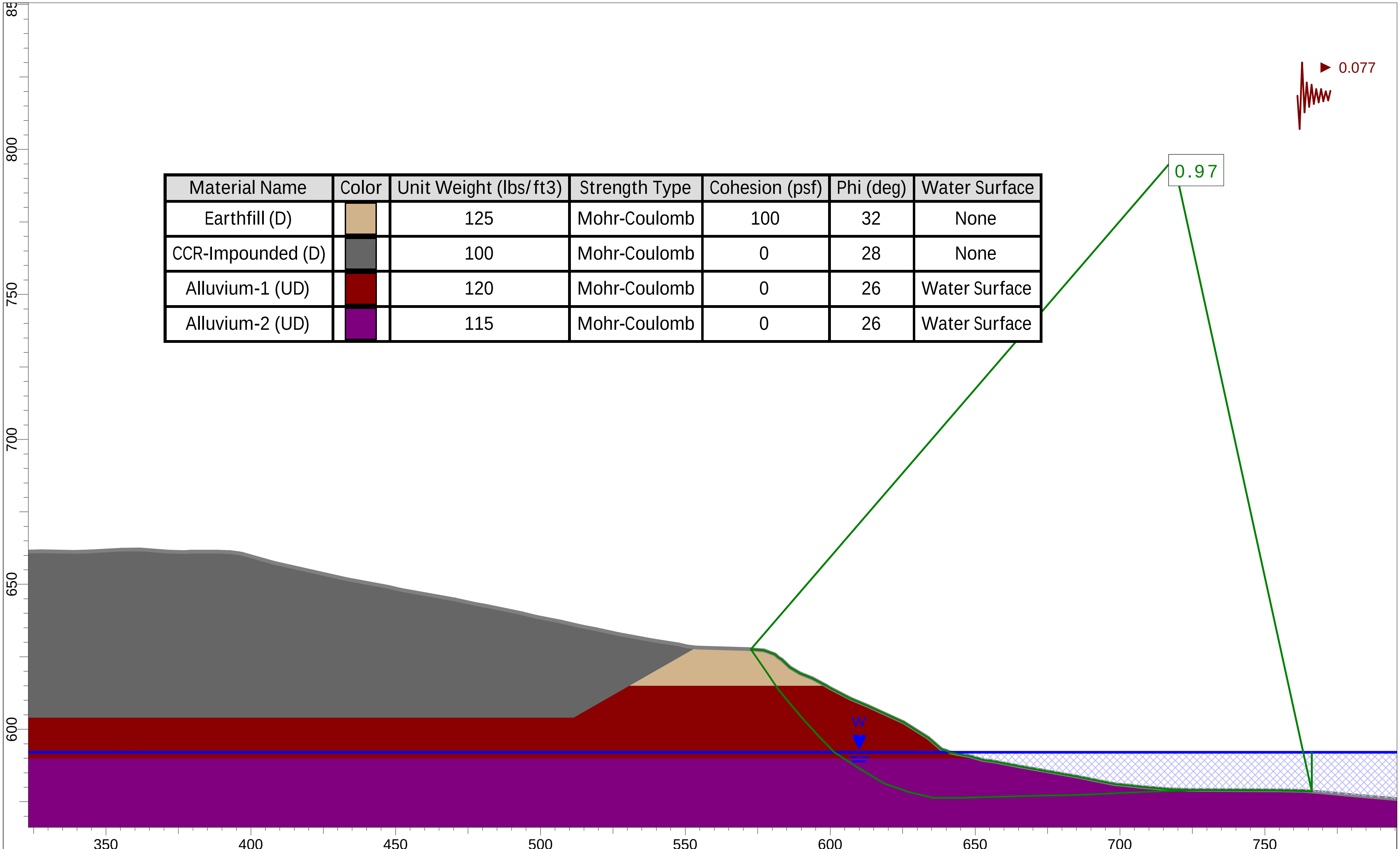
Project	East Fly Ash Pond - Slope Stability Analyses
Description:	AEP Sec B-B (Existing Conditions, Long-term Static) - Global Stability Analyses
Drawn by: NG	*Checked by:* SM
Reviewed by: SM	*Scale:* 1:550
Date: 4/10/2026	
Client: AEP	*Figure:* B-2



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Earthfill (D)		125	Mohr-Coulomb	100	32	None
CCR-Impounded (D)		100	Mohr-Coulomb	0	28	None
Alluvium-1 (UD)		120	Mohr-Coulomb	0	26	Water Surface
Alluvium-2 (UD)		115	Mohr-Coulomb	0	26	Water Surface

Project East Fly Ash Pond - Slope Stability Analyses					
Description: AEP Sec B-B (Existing Conditions, Pseudo-static) - Local Stability Analyses					
Drawn by: NG	*Checked by:* SM	*Reviewed by:* SM	*Scale:* 1:550	*Client:* AEP	*Figure:* B-3
Date: 4/10/2026					

SLIDEINTERPRET 9.026



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Earthfill (D)		125	Mohr-Coulomb	100	32	None
CCR-Impounded (D)		100	Mohr-Coulomb	0	28	None
Alluvium-1 (UD)		120	Mohr-Coulomb	0	26	Water Surface
Alluvium-2 (UD)		115	Mohr-Coulomb	0	26	Water Surface

Project	East Fly Ash Pond - Slope Stability Analyses
Description:	AEP Sec B-B (Existing Conditions, Pseudo-static) - Global Stability Analyses
Drawn by: NG	Checked by: SM
Reviewed by: SM	Scale: 1:550
Client:	AEP
Figure:	B-4
Date:	4/10/2026

SLIDEINTERPRET 9.026

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