# Periodic Safety Factor Assessment

*Possum Point Power Station CCR Surface Impoundment: Pond D*

Submitted to:

**Possum Point Power Station**

19000 Possum Point Road

Dumfries, VA 22026

Submitted by:

**Golder Associates Inc.**

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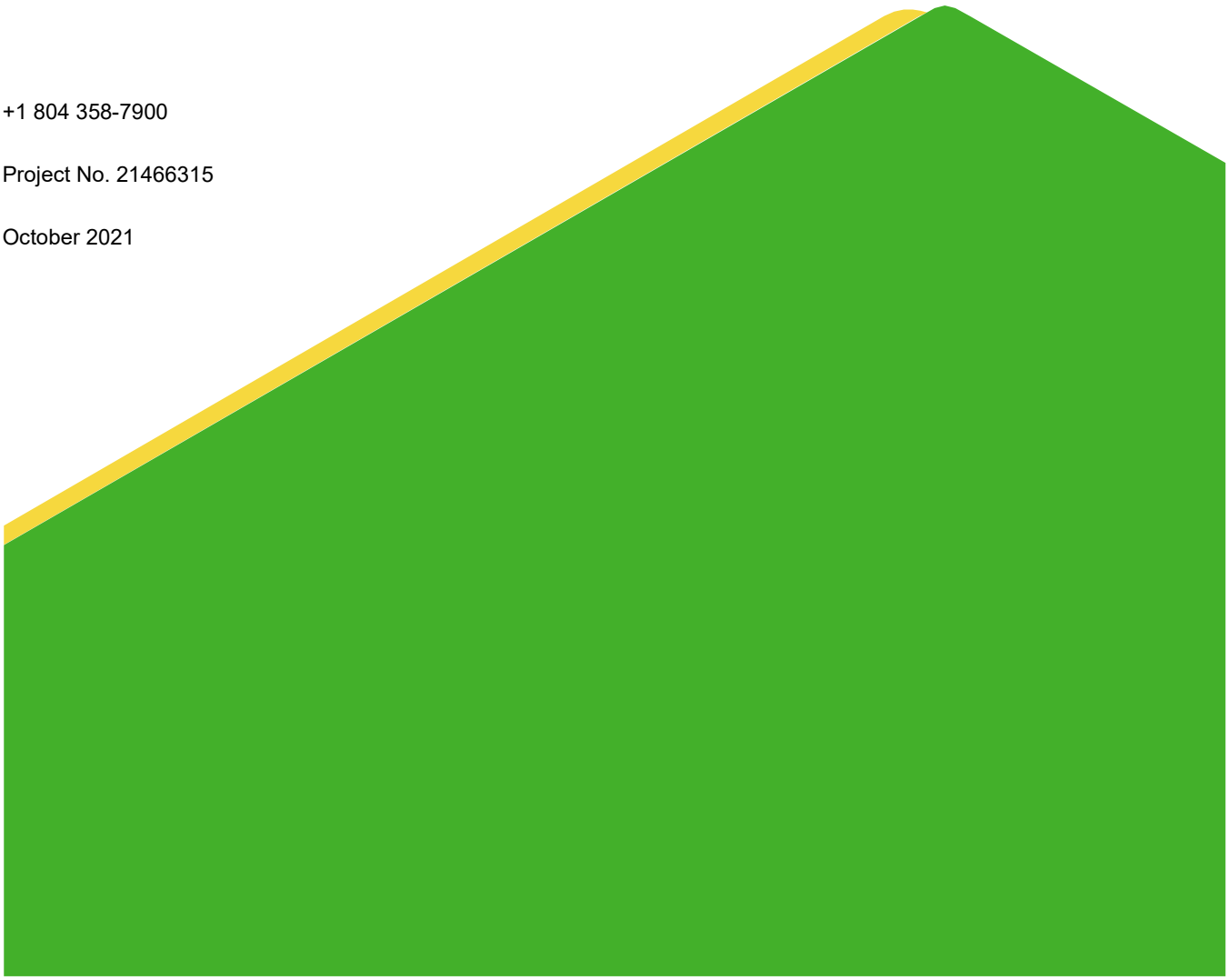
Project No. 21466315

October 2021



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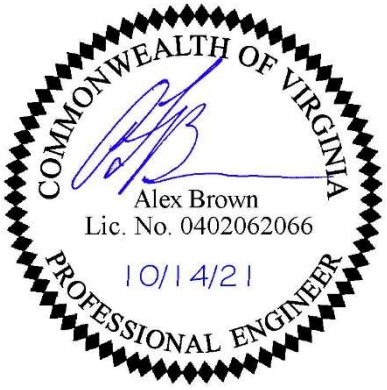
# 1.0 CERTIFICATION

This periodic Safety Factor Assessment for the Possum Point Power Station's Pond D was prepared by Golder Associates Inc. (Golder). The document and Certification/Statement of Professional Opinion are based on and limited to information that Golder has relied on from Dominion and others, but not independently verified, as well as work products produced by Golder.

On the basis of and subject to the foregoing, it is my professional opinion as a Professional Engineer licensed in the Commonwealth of Virginia that this document has been prepared in accordance with good and accepted engineering practices as exercised by other engineers practicing in the same discipline(s), under similar circumstances, at the same time, and in the same locale. It is my professional opinion that the document was prepared consistent with the requirements in §257.73(e) of the United States Environmental Protection Agency's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," published in the Federal Register on April 17, 2015, with an effective date of October 19, 2015 [40 CFR §257.73(e)].

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

| | |
|---|---|
| Alex Brown, PE | Senior Project Geotechnical Engineer |
| Print Name | Title |
|  | |
| Signature | 10/14/2021 |
| | Date |



# 2.0 INTRODUCTION

This periodic Safety Factor Assessment (Assessment) was prepared for the Possum Point Power Station's (Station) existing Coal Combustion Residuals (CCR) surface impoundment known as Pond D. This Safety Factor Assessment was prepared in accordance with 40 CFR Part §257, Subpart D and is consistent with the requirements of 40 CFR §257.73(e).

The Station, owned and operated by Virginia Electric and Power Company d/b/a Dominion Energy Virginia (Dominion), is located in Prince William County, Virginia, at 19000 Possum Point Road, east of I-95 and West of the Potomac River. The Station includes an existing CCR surface impoundment, Pond D, as defined by the Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule (40 CFR §257; the CCR rule). Pond D is also regulated as a dam by the Virginia Department of Conservation and Recreation (DCR) with Inventory Number 153020 (DCR Dam Permit).

# 3.0 PURPOSE

This periodic Assessment is prepared pursuant to § 257.73(e)(1) of the CCR Rule [40 CFR § 257.73(e)(1)]. The initial Safety Factor Assessment was completed on October 17, 2016, and is required to be updated every five (5) years pursuant to 40 CFR 257.73(f)(3).

# 4.0 SAFETY FACTOR ASSESSMENT REQUIREMENTS

In accordance with § 257.73(e)(1), the owner or operator of a CCR surface impoundment must conduct periodic safety factor assessments and document whether the calculated factors of safety achieve the minimum safety factors specified for the critical cross section of the embankment. 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 factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50;
- The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40;
- The calculated seismic factor of safety 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.

# 5.0 SAFETY FACTOR ASSESSMENT

A slope stability analysis of the Pond D embankment was conducted to determine whether the calculated factors of safety for the critical cross section of the embankment meet or exceed the minimum safety factors specified in 40 CFR §257.73(e)(1).

## 5.1 Methodology

Stability safety factors were evaluated using a general limit equilibrium (GLE) method and the computer program SLIDE2 Version 9.008. Specifically, the method developed by Morgenstern and Price (1965) was used in SLIDE to evaluate the stability of potential failure surfaces associated with the critical cross section. For each surface, the method calculates the shear strengths that would be required to maintain equilibrium and then calculates a factor of safety by dividing the available shear strength by the shear strength required to maintain stability. The slip

surface producing the minimum factor of safety is reported as the critical slip surface. Golder evaluated slip surfaces using Rocscience's Cuckoo Search, which is a global optimization method. This method typically yields more conservative safety factors than methods assuming either block or circular failure geometries. Material properties and slope geometry for the Pond D embankment were based on the Final Design Report developed by Virginia Power Engineering and Construction (Virginia Power, 1986). The properties used in this design report were conservatively estimated based on a subsurface investigation discussed in the report and are presented in Table 1 below.

**Table 1: Summary of Geotechnical Strength Properties**

| Material | Total Unit Weight *(pound per cubic foot, pcf)* | Strength Properties[1] | |
|---|---|---|---|
| | | Peak φ' (°) | Cohesion (*pound per square foot, psf*) |
| Vegetative Cover | 120 | 33, *27* | 720, *576* |
| Embankment Soil | 120 | 33, *27* | 0 |
| CCR | 90 | 36, *30* | 0 |
| Drainage Blanket | 125 | 37, *31* | 0 |
| Clay Foundation | 125 | 25, *20* | 0 |

Notes:
1. Seismic strength properties are italicized.

The four loading scenarios required by the CCR rule are discussed in the following sections.

## 5.2 Critical Cross Sections

The Pond D embankment is relatively uniform, thus the critical cross section runs perpendicular to the sideslopes, through the steepest section of the embankment (Figure 1). Since the initial 5-year Safety Factor Assessment was performed, no significant changes have occurred to the slope geometry or materials in the cross-section. However, changes in CCR placed upstream of the embankment have resulted in increased water levels used to determine the long-term maximum storage pool conditions and maximum surcharge pool conditions. The groundwater table (GWT) modeled within the embankment varies for each loading scenario and is modeled as a straight-line phreatic surface between the ponded water level and the interior edge of the blanket drain located in the toe of the embankment.

## 5.3 Long-Term Maximum Storage Pool Conditions

In accordance with the CCR Rules, the long-term maximum storage pool elevation was set equal to the Pond D emergency spillway elevation [144.5 feet above mean sea level (ft amsl)], as the principal spillway, a reinforced concrete riser and 30-inch diameter pipe, has been temporarily plugged and is not included in this analysis.

The emergency spillway, located on the northwest side of the pond, is available for discharge should water accumulate to the crest of the spillway. The existing emergency spillway is a trapezoidal-shape, broad-crested vegetated spillway that is built into the road surface along the top of the Pond D embankment. It has a width of 70 feet, 10:1 side slopes, and a crest elevation of 144.5 ft-amsl. The embankment has an effective depth of 4.5 feet and is surfaced with well-compacted gravel confined by established vegetation. The size and capacity of the emergency spillway are adequate to convey the runoff from the inflow design flood without overtopping the embankment. The analysis of the spillway capacity is included in Appendix A of the Periodic Inflow Design Flood Control System Plan (Golder, 2021).

The calculated static factor of safety is 1.60 for the long-term, maximum storage pool loading condition, therefore meeting the requirement for the long-term, maximum storage pool condition.

## 5.4 Maximum Surcharge Pool Conditions

The maximum surcharge pool elevation was conservatively calculated based on 90% of the probable maximum flood (PMF) in accordance with DCR regulations, Section 4VAC50-20-50 for impounding structures. The evaluation of Pond D's hydraulic performance using the DCR's requirements for a Spillway Design Flood has been used in-lieu of the 1,000-year flood which provides a more conservative approach. The maximum surcharge pool condition corresponds to a water level at elevation 146.3 ft amsl. The analysis of the hydraulic and hydrologic conditions is included in Appendix A of the Periodic Inflow Design Flood Control System Plan (Golder, 2021).

The calculated static factor of safety is 1.58 for the maximum surcharge pool loading condition, therefore meeting the requirement for the maximum surcharge pool condition.

## 5.5 Seismic Loading Conditions

Factors of safety for stability under seismic loading conditions were calculated based on the earthquake hazard corresponding to a probability of exceedance of 2% in 50 years (2,475-year return period). The Hynes-Griffin and Franklin Method (1984) was used. This method applies one-half the Peak Ground Acceleration (PGA) for the 2,475-year return period to the model in addition to reducing the material strengths of the model by 20%.

The calculated seismic factor of safety is 1.12 for the long-term, maximum storage pool loading condition, therefore meeting the requirement for the maximum storage pool loading condition.

## 5.6 Post-Seismic Liquefaction Loading Conditions

GAI Consultants, Inc. (GAI) performed a liquefaction evaluation as part of the 2016 Safety Factor Assessment. Based on the liquefaction evaluations, the foundation and embankment materials of the Pond D embankment were determined to not be susceptible to liquefaction under the design earthquake hazard (GAI, 2016). Because the embankment is not constructed of materials or on foundation materials calculated to be susceptible to liquefaction, no post-liquefaction demonstration is required in the CCR rule.

## 5.7 Results

The table below presents the results of the Safety Factor Assessments for the Pond D analysis cases required in 40 CFR §257.73(e)(1)(i) to (iv) of the CCR rule. For all required conditions evaluated, the calculated factors of safety meet the target factors of safety identified in the CCR rule. Stability analysis figures are included in Appendix A, and the summary of factors of safety are summarized in Table 2 below.

**Table 2: Pond D - Factors of Safety**

| Case | Pool Elevation (ft amsl) | Target Factor of Safety (FS) | FS |
|---|---|---|---|
| Max Storage Pool | 144.5 | 1.5 | 1.60 |
| Max Surcharge Pool | 146.3 | 1.4 | 1.58 |
| Seismic | 144.5 | 1.0 | 1.12 |
| Liquefied Ash | N/A | 1.2 | N/A |

# 6.0 CONCLUSION

Based on known site conditions, information referenced herein, as well as work performed by Golder for this Periodic Safety Factor Assessment, Pond D meets the minimum factors of safety as required by §257.73(e)(1) for each of the conditions analyzed.

# 7.0 REFERENCES

Code of Virginia, 4VAC50-20-50. Performance standards required for impounding structures; effective March 23, 2016.

GAI Consultants. Coal Combustion Residuals – Factor of Safety Assessment, Possum Point Power Station Surface Impoundment D. October 2016.

Golder Associates. Periodic Inflow Design Flood Control System Plan, Possum Point Power Station, Pond D. October 2021.

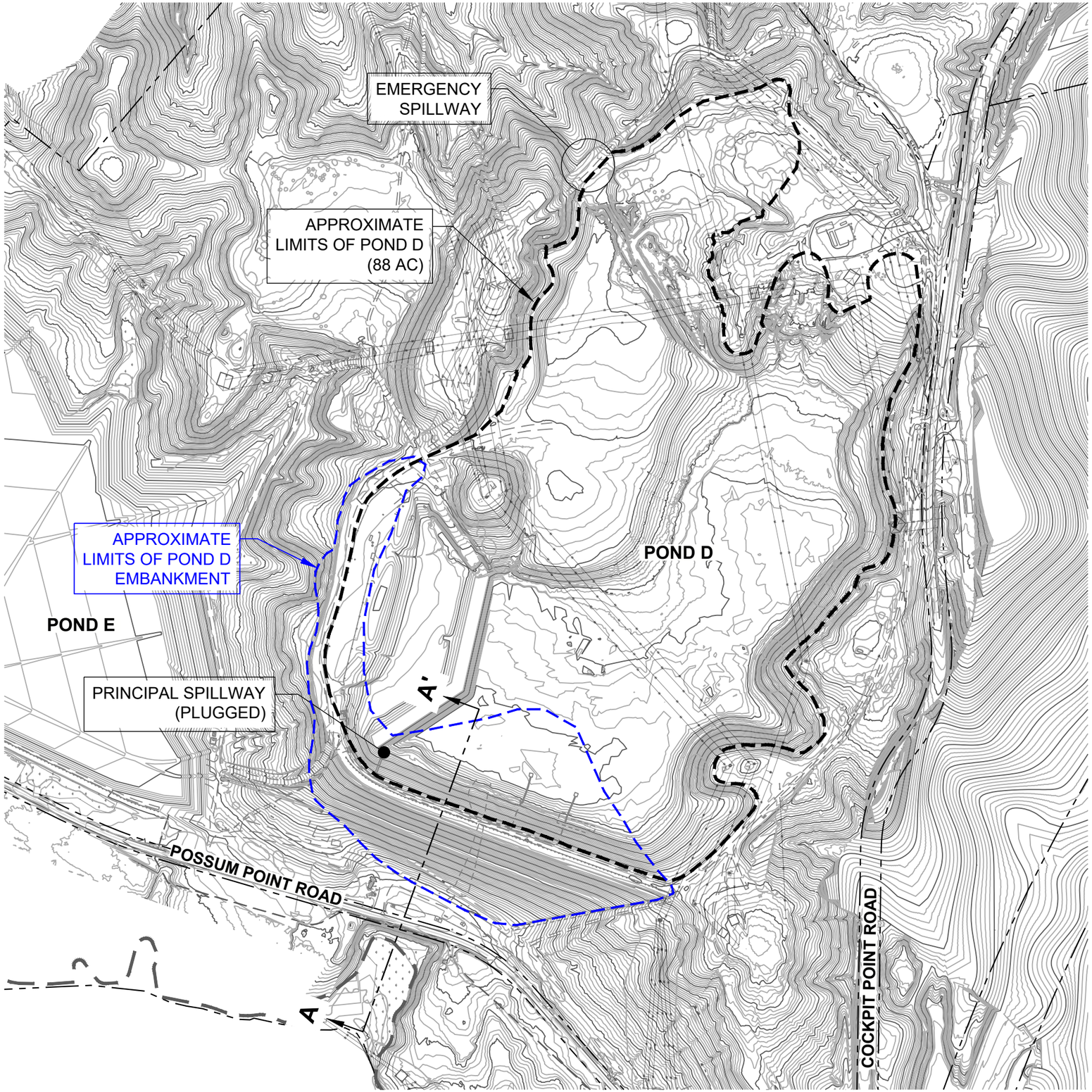
Hynes-Griffin, Mary E. and Franklin, Arley G. (1984). "Rationalizing the Seismic Coefficient Method," Miscellaneous Paper Prepared for the U.S. Army Corps of Engineers. July 1984.

Morgenstern, N. R., and Price, V. E. (1965). "The Analysis of the Stability of General Slip Surfaces," Geotechnique Vol 15 1, p. 79.

RocScience (2021). Slide Version 9.017. Build date: June 2, 2021.

United States Geological Survey (USGS). Unified Hazard Tool. Dynamic: Conterminous U.S. 2014 (update) Edition. PGA with 2% probability of exceedance in 50 years. Available online: https://earthquake.usgs.gov/hazards/interactive/

Virginia Power (Dominion). Final Design Report, Possum Point Power Station, Ash Pond 'D' Dam, DCR Inventory #15320, October 1986.




## LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- EXISTING TOPOGRAPHIC CONTOURS (2' INTERVALS)
- APPROXIMATE LIMITS OF EXISTING ASH PONDS
- LIMITS OF 100-YR FLOOD PLAIN

400 0 400 FEET

SCALE

## NOTES

1. EXISTING CONDITIONS COMPILED BY MCKENZIE SNYDER, INC., USING PHOTOGRAMMETRIC METHODS, FROM AERIAL PHOTOGRAPHY DATED APRIL 28, 2017.

CLIENT
DOMINION ENERGY
POSSUM POINT POWER STATION
PRINCE WILLIAM COUNTY, VIRGINIA

CONSULTANT
GOLDER
MEMBER OF WSP

| | YYYY-MM-DD | 2021-08-16 |
|---|---|---|
| DESIGNED | | ATN |
| PREPARED | | SIB |
| REVIEWED | | JRD |
| APPROVED | | ATN |

PROJECT
PERIODIC SAFETY FACTOR ASSESSMENT
STABILITY ANALYSIS
POND D

TITLE
**STABILITY**
**CROSS SECTION LOCATION**

PROJECT NO.
21-466315

REV.
0

FIGURE
1

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

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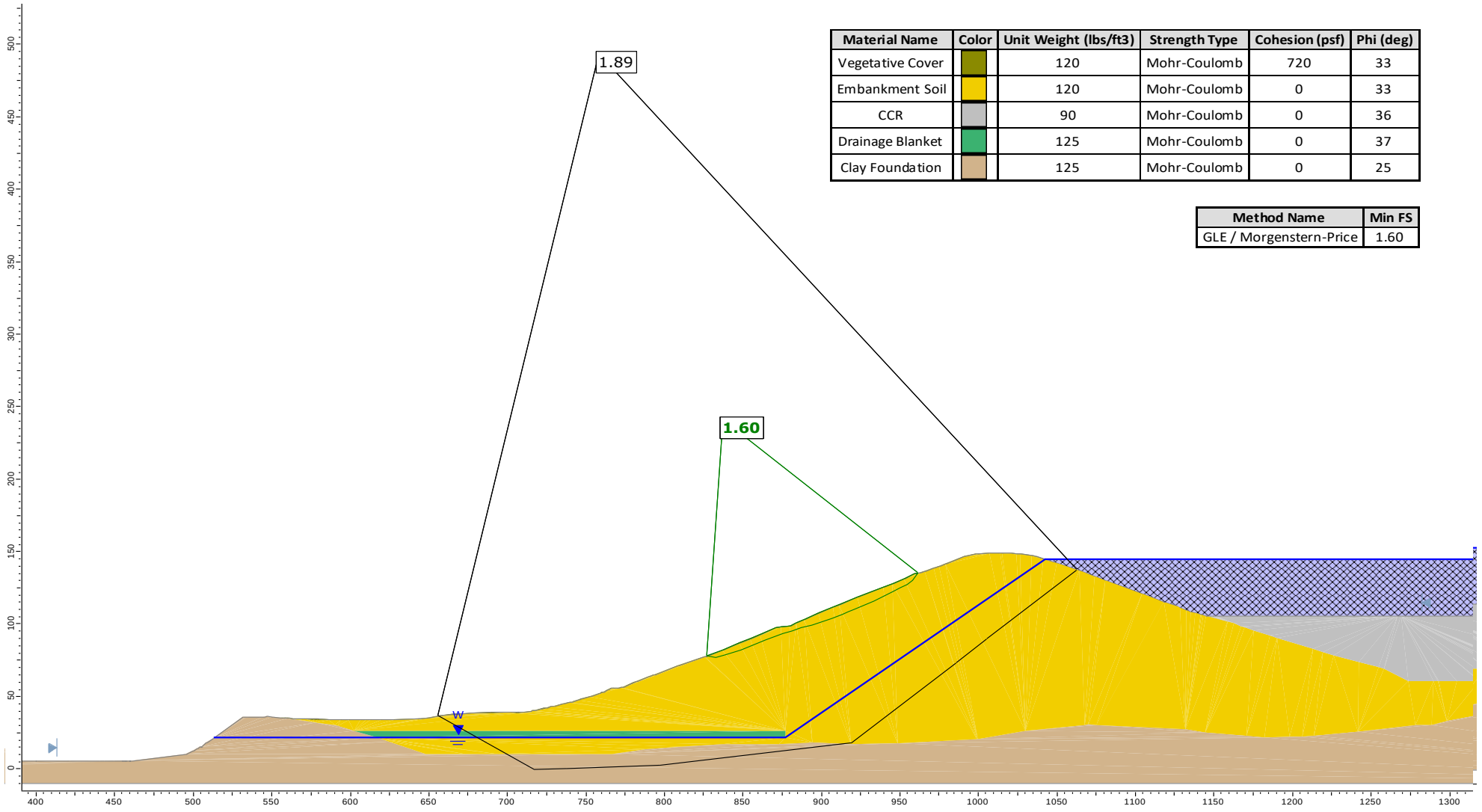
**APPENDIX A**

# Pond D Stability Analysis

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) |
|---|---|---|---|---|---|
| Vegetative Cover | | 120 | Mohr-Coulomb | 720 | 33 |
| Embankment Soil | | 120 | Mohr-Coulomb | 0 | 33 |
| CCR | | 90 | Mohr-Coulomb | 0 | 36 |
| Drainage Blanket | | 125 | Mohr-Coulomb | 0 | 37 |
| Clay Foundation | | 125 | Mohr-Coulomb | 0 | 25 |

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.60 |




Note: GLE/Morgenstern Price method results displayed.

GOLDER
MEMBER OF WSP

| | |
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| SCALE | AS SHOWN |
| DATE | Aug 2021 |
| MADE BY | SDRM |
| CAD | - |
| CHECK | ALB |
| REVIEW | ATN |

PROJECT: **Possum Point Power Station**

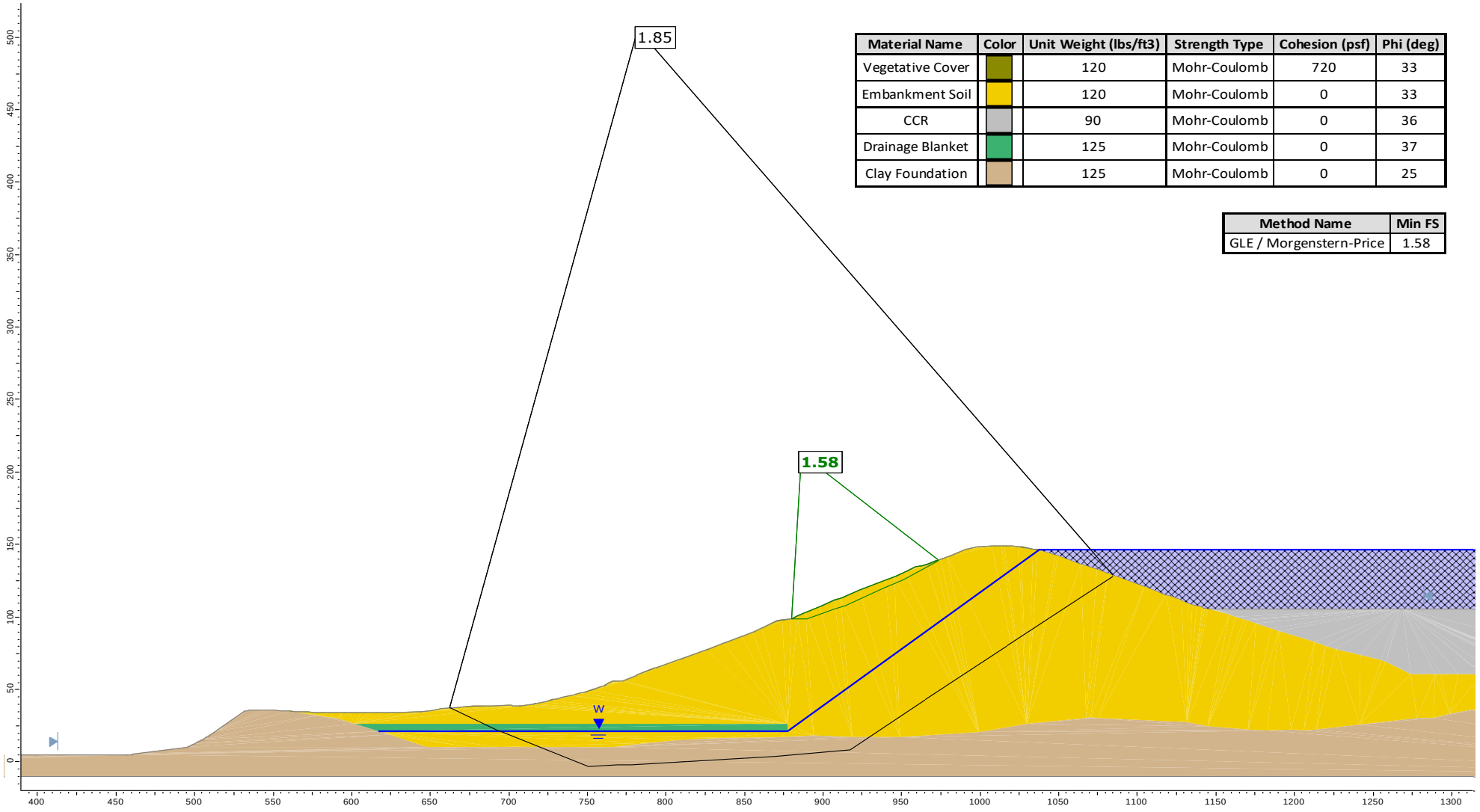
TITLE: **Pond D**
**Maximum Pool Storage**

FILE: SAFETY FACTOR ASSESSMENT

PROJECT No. 21466315 REV. 0

CLIENT: **Dominion Energy**

FIGURE 1




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) |
|---|---|---|---|---|---|
| Vegetative Cover | | 120 | Mohr-Coulomb | 720 | 33 |
| Embankment Soil | | 120 | Mohr-Coulomb | 0 | 33 |
| CCR | | 90 | Mohr-Coulomb | 0 | 36 |
| Drainage Blanket | | 125 | Mohr-Coulomb | 0 | 37 |
| Clay Foundation | | 125 | Mohr-Coulomb | 0 | 25 |

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.58 |

Note: GLE/Morgenstern Price method results displayed.

GOLDER
MEMBER OF WSP

| | |
|---|---|
| SCALE | AS SHOWN |
| DATE | Aug 2021 |
| MADE BY | SDRM |
| CAD | - |
| CHECK | ALB |
| REVIEW | ATN |

PROJECT: **Possum Point Power Station**

TITLE: **Pond D**
**Maximum Pool Surcharge**

FILE: SAFETY FACTOR ASSESSMENT

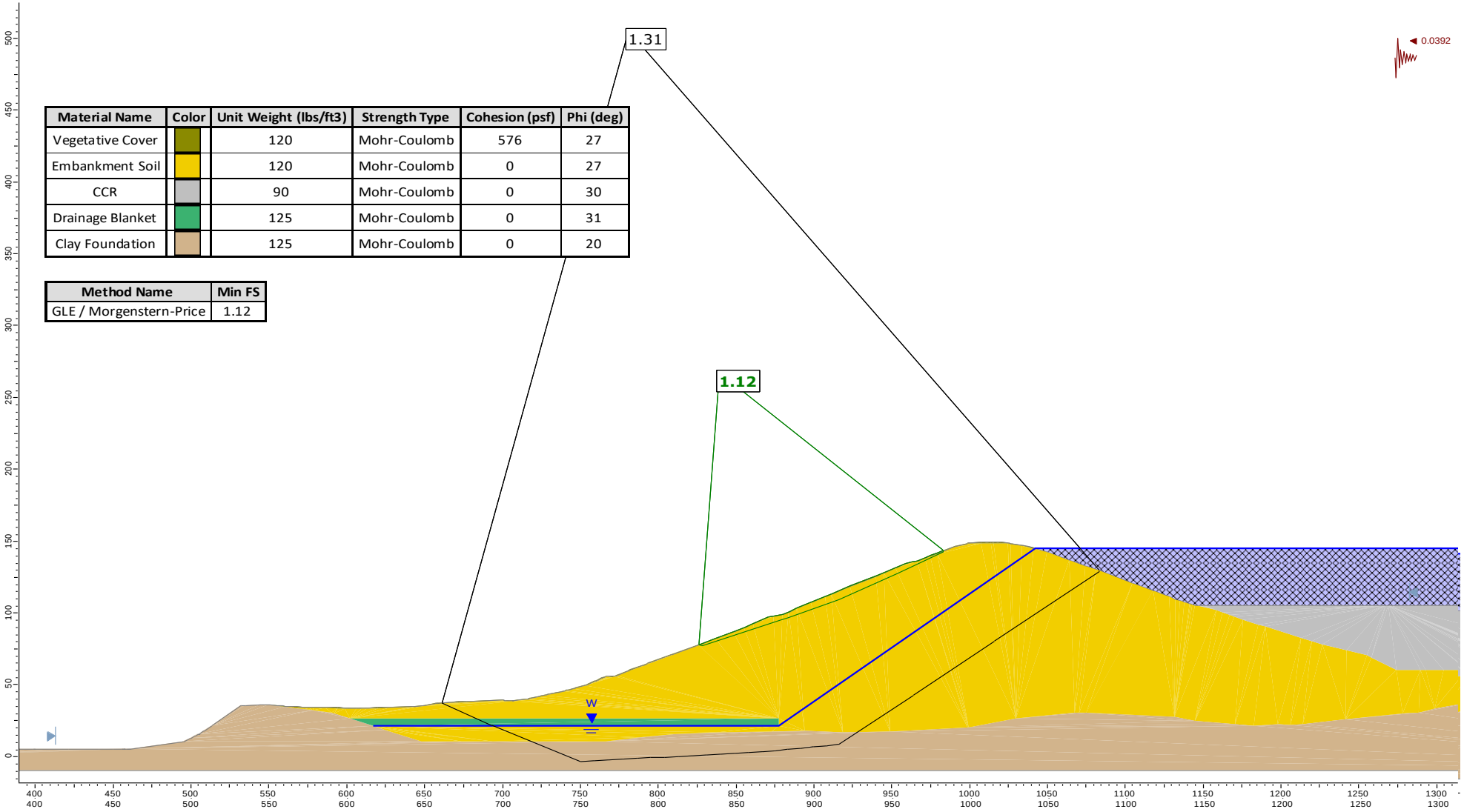
PROJECT No. 21466315 REV. 0

CLIENT: **Dominion Energy**

FIGURE 2

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) |
|---|---|---|---|---|---|
| Vegetative Cover | | 120 | Mohr-Coulomb | 576 | 27 |
| Embankment Soil | | 120 | Mohr-Coulomb | 0 | 27 |
| CCR | | 90 | Mohr-Coulomb | 0 | 30 |
| Drainage Blanket | | 125 | Mohr-Coulomb | 0 | 31 |
| Clay Foundation | | 125 | Mohr-Coulomb | 0 | 20 |

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.12 |




Note: GLE/Morgenstern Price method results displayed.

GOLDER
MEMBER OF WSP

| | |
|---|---|
| SCALE | AS SHOWN |
| DATE | Aug 2021 |
| MADE BY | SDRM |
| CAD | - |
| CHECK | ALB |
| REVIEW | ATN |

PROJECT: **Possum Point Power Station**

TITLE: **Pond D**
**Seismic**

FILE: SAFETY FACTOR ASSESSMENT

PROJECT No. 21466315 REV. 0

CLIENT: **Dominion Energy**

FIGURE 3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