Structural Stability and Safety Factor Assessment Report

# J.H. CAMPBELL GENERATING FACILITY

# BOTTOM ASH POND 3 STRUCTURAL STABILITY AND SAFETY FACTOR ASSESSMENT REPORT

## West Olive, Michigan

## Pursuant to 40 CFR 257.73(d, e)

**Submitted To:** Consumers Energy Company
1945 W. Parnall Road
Jackson, Michigan 49201

**Submitted By:** Golder Associates Inc.
15851 South US 27, Suite 50
Lansing, Michigan 48906

**October 2016** **1654923**

Golder Associates

## CERTIFICATION

### Professional Engineer Certification Statement [40 CFR 257.73(d)(3) & 257.73(e)(2)]

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), I attest that this Structural Stability and 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(d) periodic structural stability assessments and 40 CFR Part 257.73(e) periodic safety factor assessments.

Golder Associates Inc.

Signature

October 14, 2016

Date of Report Certification

Matthew Wachholz, PE

Name

6201047513

Professional Engineer Certification Number

STATE OF MICHIGAN
MATTHEW J. WACHHOLZ
ENGINEER
No.
47513
LICENSED PROFESSIONAL ENGINEER

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# 1.0 INTRODUCTION

## 1.1 Purpose

On April 17, 2015, the United States Environmental Protection Agency (EPA) issued the Coal Combustion Residual (CCR) Resource Conservation and Recovery Act (RCRA) Rule (40 CFR 257 Subpart D) ("CCR RCRA Rule") to regulate the beneficial use and disposal of CCR materials generated at coal-fired electrical power generating complexes. The CCR RCRA Rule requires that existing CCR surface impoundments meeting the requirements of Section 257.73(b) conduct initial and periodic structural stability assessments in accordance with Section 257.73(d) and safety factor assessments in accordance with Section 257.73(e). This report provides the initial structural stability assessment and the safety factor assessment for Bottom Ash Pond 3 surface impoundment (Bottom Ash Pond 3) at the J.H. Campbell Generating Facility (JH Campbell). A hazard potential classification was conducted for Bottom Ash Pond 3 pursuant to Section 257.73, which resulted in a low hazard classification. As a result of the low hazard classification potential, the 100-year flood elevation was used in the models to prepare this report.

## 1.2 Site Description and Background

JH Campbell is a coal-fired power generation facility located near West Olive, Michigan as presented on Figure 1 – Site Location Map. JH Campbell Bottom Ash Pond 3 is a hydraulically active CCR surface impoundment which receives sluiced bottom ash. Bottom Ash Pond 3 consists of one northern pond (Bottom Ash Pond 3 North) and one southern pond (Bottom Ash Pond 3 South) separated by an internal dike. The ponds together are considered one CCR surface impoundment and are located in the northwestern side of the JH Campbell ash disposal area (Figure 2). Topographic and bathymetric surveys were conducted for Bottom Ash Pond 3 in May 2016 by Engineering & Environmental Solutions, LLC (E&ES); which were used to develop the assessments contained herein.

Sluiced ash enters Bottom Ash Pond 3 via an above-ground trestle. Bottom Ash Pond 3 North and Bottom Ash Pond 3 South have one outlet each. The outlet for Bottom Ash Pond 3 North is located in the northeast corner of the pond and consists of an 18-inch diameter high density polyethylene (HDPE) pipe. The outlet for Bottom Ash Pond 3 South is located in the southeast corner and consists of an 18-inch diameter HDPE pipe.

## 1.3 Previous Evaluations

There are no certified records of previous slope stability analyses that have been performed for the Bottom Ash Pond 3 embankments. A Probable Failure Mode Analysis (PFMA) was previously completed for JH Campbell (AECOM 2009a) to identify structural (geotechnical) and environmental risks. Additionally, previous site inspections have been conducted to observe and document the structural conditions of the embankment dikes. A list of reviewed documents pertinent to the structural stability assessment is provided in Table 1.3.1.

**Table 1.3.1 - Previous Evaluations Related to Structural Stability Assessment**

| Document | Date | Author |
|---|---|---|
| J.H. Campbell Bottom Ash Pond 3 Annual RCRA CCR Surface Impoundment Inspection Report – January 2016 | January 2016 | Golder Associates Inc. |
| J.H. Campbell Ash Disposal Area Triennial Ash Dike Risk Assessment Report | December 2014 | Barr Engineering |
| Resource Conservation and Recovery Act Vertical Expansion Feasibility Investigation-2012 | December 2012 | Engineering & Environmental Solutions, LLC |
| J.H. Campbell Ash Disposal Area 2012 Ash Dike Risk Assessment FINAL Inspection Report | July 2012 | AECOM Technical Services, Inc. |
| Inspection Report J.H. Campbell Generating Facility Ash Dike Risk Assessment | November 2009 | AECOM Technical Services, Inc. |
| Potential Failure Mode Analysis (PFMA) Report J.H. Campbell Generating Facility Ash Dike Risk Assessment | November 2009 | AECOM Technical Services, Inc. |

## 2.0 SUBSURFACE CONDITIONS

The site is located near the east shore of Lake Michigan. Quaternary deposits in the area primarily consist of eolian sands extending to depths of approximately 45 to 60 feet below natural ground surface. The sands are underlain by fine-grained silty clay and clayey silt soils which extend down to bedrock. Bedrock of the Coldwater Shale deposits and Marshall Formation consisting of shale, sandstone, limestone, and siltstone exists at depths of approximately 140 feet below natural ground surface (STS 1993).

Soil borings and laboratory testing programs were completed in 2012, 2015, and 2016 around Bottom Ash Pond 3 to develop site specific stratigraphy and engineering material properties. The subsurface investigations and testing identified that the native soil beneath Bottom Ash Pond 3 consists of sand underlain by silty clay; and the embankments consist of sand fill. The May 2016 survey conducted by E&ES was used to develop the slope geometry in the stability analysis.

## 3.0 STRUCTURAL STABILITY ASSESSMENT [40 CFR 257.73(d)(1)(i-vii)]

The CCR RCRA Rule requires an initial and periodic structural stability assessment be conducted by a qualified professional engineer (QPE) to document whether the design, construction, operation, and maintenance are consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater that can be impounded therein. The following sections provide documentation on the initial structural stability assessment and rely mainly on the recent and historic annual inspections performed at the site as well as the weekly field inspections performed by Consumers Energy Company (CEC). The most recent inspection was completed by Golder Associates Inc. (Golder) in May 2016 for the initial structural stability assessment. The summary inspection checklist for the May 2016 site inspection is included in Appendix A.

In accordance with the CCR RCRA Rule, in any calendar year in which both the periodic inspection by a QPE and the quinquennial (occurring every five years) structural stability assessment by a QPE required by Section 257.73(d) are required to be completed, the annual inspection is not required. If the annual inspection is not conducted in a year as provided by this paragraph, the deadline for completing the next annual inspection is one year from the date of completing the quinquennial structural stability assessment. As a result, a certified annual inspection report for Bottom Ash Pond 3 will not be required until October 2017.

### 3.1 Foundations and Abutments [40 CFR 257.73(d)(1)(i)]

Certified issued for construction (IFC) drawings were available on the original design of the Bottom Ash Pond 3 embankments from 1979. As previously noted, the foundation soils consist of native sand soils. There has been no indication of foundational or abutment instability or movement in recent or historic site inspections and; therefore, the foundation soils and abutments are considered stable.

### 3.2 Slope Protection [40 CFR 257.73(d)(1)(ii)]

The downstream slopes of the embankments for Bottom Ash Pond 3 are protected from erosion and deterioration by the establishment of a vegetative cover. Existing slopes are inspected weekly for erosion, signs of seepage, animal burrows, sloughing, and plants that could negatively impact the embankment. The May 2016 inspection did not identify items relating to slope protection that required investigation or repair, and the downstream slopes of Bottom Ash Pond 3 are not subjected to wave or sudden drawdown effects. The existing slope protection measures are considered adequate to provide protection against surface erosion, wave action, and adverse effects of sudden drawdown.

### 3.3 Dikes (Embankment) [40 CFR 257.73(d)(1)(iii)]

Based on the IFC drawings and subsurface investigation information reviewed, it is understood that the perimeter dike was constructed with standard earthwork equipment and consists of sand fill that was compacted to 90 percent of the maximum dry density achieved by the Standard Proctor (ASTM D698), as specified in the embankment construction drawings. Results of the stability analysis detailed in Section 4.0 provide additional details on the stability of the external dike. Based on the relative density of the material encountered during the subsurface investigations, historic inspections, recent observations, and results of the stability analysis; the embankment dikes are considered sufficient to withstand the range or loading conditions in Bottom Ash Pond 3.

### 3.4 Vegetated Slopes [40 CFR 257.73(d)(1)(iv)]

The EPA has vacated the requirement that vegetative cover on surface impoundment dikes be maintained at no more than six inches. A new rule establishing requirements relating to the use of vegetation as slope protection for CCR surface impoundments is still pending.

### 3.5 Spillways [40 CFR 257.73(d)(1)(v)]

There are no spillways on Bottom Ash Pond 3. Flow is conveyed out of Bottom Ash Pond 3 via pipes as described in Section 3.6.

### 3.6 Hydraulic Structures [40 CFR 257.73(d)(1)(v)]

Bottom Ash Pond 3 North and Bottom Ash Pond 3 South have one outlet each. The outlet for Bottom Ash Pond 3 North is located in the northeast corner of the pond and consists of an 18-inch diameter HDPE pipe with an upstream invert of 625.34 feet (NGVD29). Bottom Ash Pond 3 South has an overflow outlet located in the southeast corner that consists of an 18-inch diameter HDPE pipe with an upstream invert of 624.66 feet (NGVD29). As a result, the normal operating level of Bottom Ash Pond 3 has been determined to be at elevation 625.34 feet (NGVD29).

The two outflow pipes were identified as the hydraulic structures that are underlying the base or passing through the external dike of the CCR unit. The Bottom Ash Pond 3 North outflow pipe was reported to be in good to fair condition in the 2014 Triennial Ash Dike Risk Assessment Report (Barr 2014a), which was based on a closed circuit television (CCTV) inspection of the hydraulic structures. No change to the conditions of the pipe that was CCTV inspected in 2014 was noted in the May 2016 inspection by Golder. There is no record of an internal CCTV inspection of the Bottom Ash Pond 3 South outflow pipe; however, inspections of the pipe at the discharge location indicate that the pipe is functioning properly.

Based on review of the Barr Triennial Ash Dike Assessment Report and May 2016 inspection, the hydraulic structures that were inspected are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure.

### 3.7 Downstream Slopes Adjacent to Water Body [40 CFR 257.73(d)(1)(vii)]

The downstream slopes of Bottom Ash Pond 3 are not adjacent to water bodies and; therefore, rapid-drawdown was not considered a potential mechanism for structural instability in the exterior slope.

### 3.8 Structural Stability Deficiencies [40 CFR 257.73(d)(2)]

Based on the 2016 site inspection and structural stability assessment contained herein, no structural stability deficiencies were identified.

## 4.0 SAFETY FACTOR ASSESSMENT [40 CFR 257.73(e)]

According to Section 257.73(e)(1) of the CCR RCRA Rule, periodic safety factor assessments must be conducted for each CCR unit. The safety factor assessment must document the calculated factor of safety for the dike slopes under the following scenarios:

- Maximum Pool Storage - Section 257.73(e)(1)(i) – Defined as the long-term, maximum storage pool (or operating) elevation and equal to the upstream outlet elevation (elevation = 625.3 feet NGVD29) for this facility; static factor of safety must equal or exceed 1.50
- Maximum Pool Surcharge - Section 257.73(e)(1)(ii) – Defined as the temporary raised pond level above the maximum pool storage elevation due to an inflow design flood (626.5 feet NGVD29); static factor of safety must equal or exceed 1.40
- Seismic Loading Conditions - Section 257.73(e)(1)(iii) – Seismic factor of safety must equal or exceed 1.00
- Liquefaction Potential - Section 257.73(e)(1)(iv) – Only necessary for dikes constructed of soils that have susceptibility to liquefaction; factor of safety must equal or exceed 1.20

The following sections provide details on the factor of safety assessment and methods used to calculate the slope factor of safety and results of the analysis.

### 4.1 Slope Stability Analysis

Slope stability analyses were performed to evaluate the slope factor of safety for each of the maximum pool storage, maximum pool surcharge, and seismic loading scenarios. In the Preamble to Sections 257 and 261 of the CCR RCRA Rule *General Safety Factor Assessment Considerations* [VI (E)(3)(b)(ii)(a)], limit equilibrium methods are identified as conventional analysis procedures for calculating the factor of safety and specific common methods are identified, including the Morgenstern and Price method of slices (Abramson et al. 2002), which was used for this stability analysis.

#### *4.1.1 Cross Sections Analyzed*

Critical sections of the exterior dike were determined by using the existing topography (2016) and, considering the interpreted soil profile from the subsurface investigations and observed phreatic surface. The critical cross section is anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions.

The critical section used for the slope stability analysis was located along the western dike of Bottom Ash Pond 3 North and is shown as Section A-A’ in Figure 2.

### 4.1.2 Geotechnical Material Properties

Representative material properties based on the subsurface investigations and laboratory testing were selected for use in the stability analysis for the critical section as follows: 1) embankment fill consisting of sand; 2) upper sand (native foundation soil); and 3) lower sand (native foundation soil).

### 4.1.3 Pond Elevation and Phreatic Surface/Groundwater

The phreatic surface for the stability models was developed based on water level measurements from standpipe piezometers installed within the embankment. Two upstream water boundary conditions were considered in the analyses; the maximum pool storage and the maximum pool surcharge conditions. The maximum pool surcharge scenario considers the temporary rise of the pond water elevation due to rainfall and collection of site stormwater runoff during the design event. Pond water elevations were calculated for the 100-year storm event, resulting in an increase in pond elevations to an elevation of 626.23 feet (NGVD29) for Bottom Ash Pond 3 North and 626.43 feet (NGVD29) for Bottom Ash Pond 3 South, as provided in Golder's J.H. Campbell Generating Facility Bottom Ash Pond 3, Inflow Design Flood Control System Plan (Golder 2016b).

Downstream water boundary condition was set to water elevations observed in the ditch of approximately 602.0 feet (NGVD29). For the maximum pool storage scenario, upstream water boundary condition was set to pond water surface elevation of 625.3 feet (NGVD29) based on the primary outlet upstream invert elevation. For the maximum pool surcharge scenario, upstream water boundary condition was set to pond water surface elevation of 626.5 feet (NGVD29) based on the 100-year storm pond water elevation.

The phreatic surface was estimated inside the embankment by using piezometer water level measurements with known pond elevations to calibrate the model.

### 4.1.4 Vehicle Loading

The crest of the embankments are periodically used by maintenance vehicles as access roads around the ponds and; therefore, a vehicle load was applied to the critical cross section for the maximum pool storage and maximum pool surcharge cases to model the loading effects of vehicle traffic. The vehicle load was applied based on American Association of State Highway and Transportation Officials (AASHTO) recommended loading for truck loads acting perpendicular to traffic (AASHTO 2012).

### 4.1.5 Seismic Loading Conditions

Factors of safety for stability under seismic conditions were calculated using the pseudo-static method. The peak ground acceleration (PGA) based on the 2008 United States Geological Survey (USGS) seismic hazard maps (Peterson et al. 2008) with a two percent probability of exceedance in 50 years (2,475-year return period) is 0.033g; however, the Natural Resources Conservation Service (NRCS) recommends a minimum seismic coefficient of 0.05g for Michigan, so a seismic coefficient of 0.05g was used in seismic analyses.

## 4.2 Stability Analysis Results

Slope stability analyses were performed for long-term static conditions for the critical cross section considered under maximum pool storage and maximum pool surcharge scenarios as well as pseudo-static seismic conditions. The results of the slope stability analyses cases are presented in Table 4.2.1, and critical failure surface result outputs are contained in Appendix B. The results indicate that the calculated factor of safety through the critical cross section in Bottom Ash Pond 3 surface impoundment meet or exceed the minimum values listed in Section 257.73(e)(1)(i)-(iv).

**Table 4.2.1 - Slope Stability Analysis Results**

| Scenarios | Maximum Pool Storage | Maximum Pool Surcharge | Seismic |
|---|---|---|---|
| **Required Safety Factor** | **1.50** | **1.40** | **1.00** |
| **Section** | **Calculated Safety Factor** | | |
| Section A-A’ | 1.51 | 1.48 | 1.33 |

## 4.3 Liquefaction Potential Assessment

Embankment and foundation soils were screened for seismically-induced liquefaction susceptibility using methods recommended by the National Center for Earthquake Research (NCEER), which uses Cone Penetrometer Test (CPT) data (Youd et al. 2001; Robertson and Wride 1998). The calculated factor of safety against seismically-induced liquefaction is shown in Appendix C and was calculated to be greater than 1.20 throughout the depth of the embankments and underlying foundation in the evaluated CPT soundings for the considered earthquake loading. These screening-level results indicate that the embankments and foundation soils for Bottom Ash Pond 3 are not susceptible to seismically-induced liquefaction for the seismic loading considered.

## 5.0 SUMMARY

Based on our review of the information provided by CEC, onsite observations, and the results of the structural stability assessment; no structural stability deficiencies were identified for the Bottom Ash Pond 3 surface impoundment during this assessment. Based on this same information and on our safety factor assessment, the calculated factor of safety through the critical cross section in the Bottom Ash Pond 3 surface impoundment meets or exceeds the minimum values listed in Section 257.73(e)(1)(i-iv).

## 6.0 CLOSING

This report summarizes the results of the structural stability and factor of safety assessment to fulfill the provisions of Title 40 of the Code of Federal Regulations Section 257.73 (40 CFR Part 257.73) for the Bottom Ash Pond 3 at JH Campbell.

**GOLDER ASSOCIATES INC.**

Jeffrey Piaskowski, P.E.
Project Engineer

Jeffrey Schneider, P.E.
Senior Project Engineer

Matt Wachholz, P.E.
Senior Engineer

## 7.0 REFERENCES

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Petersen, Mark D., Arthur D. Frankel, Stephen C. Harmsen, Charles S. Mueller, Kathleen M. Haller, Russell L. Wheeler, Robert L. Wesson, Yuehua Zeng, Oliver S. Boyd, David M. Perkins, Nicolas Luco, Edward H. Field, Chris J. Wills, Kenneth S. Rukstales, (2008). Documentation for the 2008 Update of the United States National Seismic Hazard Maps, Open File Report 2008-1128, U.S. Department of the Interior, U.S. Geological Survey.

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STS, 1993. STS Consultants, Ltd. Design Criteria for the J.H. Campbell Ash Storage Facility Expansion. STS Consultants, Ltd. January 26, 1993.

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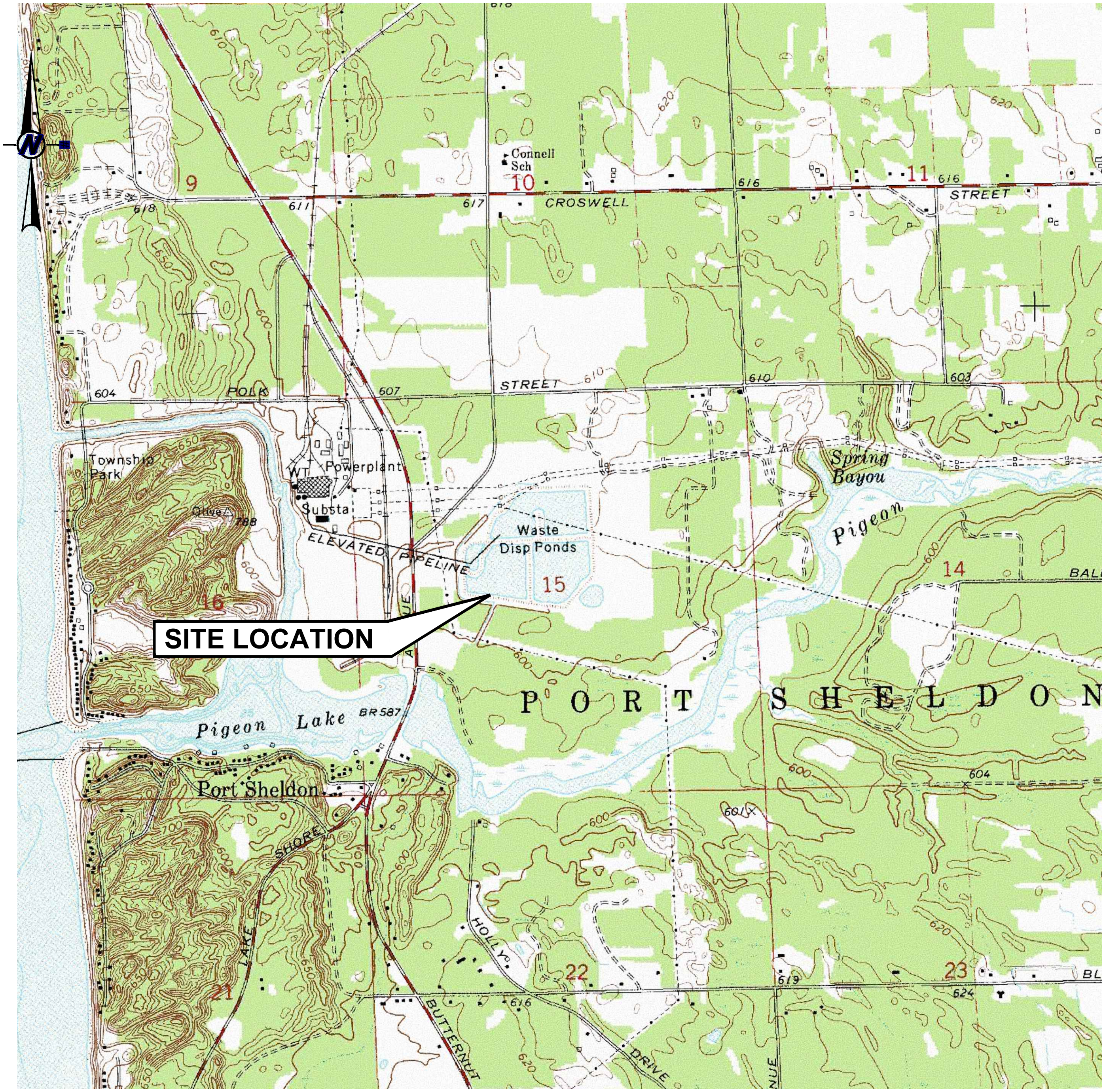
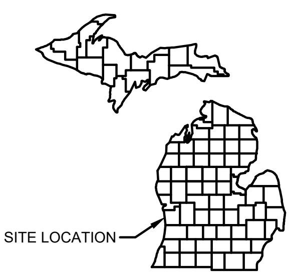
# FIGURES




MICHIGAN COUNTIES

NOT TO SCALE

**REFERENCE(S)**

1. BASE MAP TAKEN FROM 7.5 MINUTE U.S.G.S. QUADRANGLES OF PORT SHELDON MICHIGAN, DOWNLOADED FROM MICHIGAN DNR WEBSITE JUNE 2016.

0 1000 2000

1" = 2000' FEET

CLIENT
CONSUMERS ENERGY COMPANY
17000 CROSWELL ST.
WEST OLIVE, MI 49460

PROJECT
2016 RCRA COMPLIANCE STRUCTURAL STABILITY & SAFETY FACTOR ASSESSMENT

CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2016-06-06 |
| DESIGNED | JS |
| PREPARED | ARM |
| REVIEWED | DJS |
| APPROVED | MAB |

TITLE
**SITE LOCATION MAP**

| PROJECT NO. | REV. | FIGURE |
|---|---|---|
| 1654923 | # | 1 |


**NOTES**

1. CONTOURS SHOWN ARE FROM MAY 2016 GROUND SURVEY.

**LEGEND**

- SOIL BORING (2016)
- HISTORICAL SOIL BORING
- PIEZOMETER
- MONITORING WELL
- CPTS (GOLDER 2016)

| REFERENCE DRAWINGS | REV | DATE | DESCRIPTION | BY | CHK | APP | REV | DATE | DESCRIPTION | BY | CHK | APP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 10/6/2016 | FILED IN OWNER'S OPERATING RECORD | AM | DS | JP |

Consumers Energy

J.H. CAMPBELL ASH STORAGE FACILITY

**2016 RCRA COMPLIANCE FACTOR OF SAFETY ASSESSMENT**

**BOTTOM ASH POND 3 PLAN VIEW**

**BOREHOLE LOCATION AND CROSS SECTION LOCATION MAP**

UNIT#

| SCALE | 1" = 40'/1" = 4' | DRAWING NO. | FIGURE | REV. |
|---|---|---|---|---|
| JOB | 1654923 | ---- | 2 | A |

S:\Projects\094 - Golder Associates\2016 Projects\094-16-004 - JH Campbell RCRA Ash Pond Closure\CAD\094-16-004-UNIT 3 BORINGS.dwg 10/6/2016 7:33 PM

# APPENDIX A
# SUMMARY INSPECTION CHECKLIST

# CCR SURFACE IMPOUNDMENT VISUAL INSPECTION CHECKLIST

***Facility Name: J.H. Campbell Bottom Ash Pond 3***
***Owner: Consumers Energy Company (CEC)***
***Purpose of Facility: Detention and settlement of sluiced bottom ash from Unit 3***
***County, State: Ottawa County, Michigan***
***Inspected By: Tiffany Johnson*** ***Inspection Date: 5/19/2016***
***Weather: Clear, 75-degrees F***

| ITEM | | | Acceptable | Monitor/Maintain | Investigate | Repair | REMARKS |
|---|---|---|---|---|---|---|---|
| 1. | General Conditions | | | | | | |
| | a. | Year Minimum Water Elevation | | | | | Elevation: 604.0 NGVD29 |
| | b. | Year Average Water Elevation | | | | | Elevation: 625.3 NGVD29 |
| | c. | Year Maximum Water Elevation | | | | | Elevation: 625.3 NGVD29 |
| | d. | Current water level | | | | | Elevation: Both ponds are dry at the time of inspection |
| | e. | Current storage capacity | | | | | Volume: ~129,200 CY Pond 3S / ~142,500 CY Pond 3N (See Note 1) |
| | f. | Current volume of impounded water and CCR | | | | | Volume: ~100,900 CY Pond 3S / ~ 111,600 CY Pond 3N (See Note 1) |
| | g. | Alterations | X | | | | |
| | h. | Development of downstream plain | | X | | | Intermittent historical plains observed from historical seeps, maintain water level controls and erosion controls. No active seepage was observed at the time of inspection. See Note 4. |
| | i. | Grass cover | X | | | | |
| | j. | Settlement/misalignment/cracks | | X | | | Continue weekly monitoring in accordance with SMP, no change was observed. See Note 2. |
| | k. | Sudden drops in water level? | | | | | Both ponds are dry. |
| 2. | Inflow Structure | | | | | | |
| | a. | Settlement | X | | | | |
| | b. | Cracking | X | | | | |
| | c. | Corrosion | | X | | | Perform routine maintenance of inflow piping and supports. See Note 4. |
| | d. | Obstacles in inlet | X | | | | |
| | e. | Riprap/erosion control | X | | | | |
| 3. | Outflow Structure | | | | | | |
| | a. | Settlement | | X | | | Minor bend noted in outlet pipe of Pond 3, continue maintenance controls and monitor in accordance with the SMP. See Note 4. |
| | b. | Cracking | X | | | | |
| | c. | Corrosion | X | | | | |
| | d. | Obstacles in outlet | X | | | | |
| | e. | Riprap/erosion control | X | | | | |
| | f. | Seepage | X | | | | |
| 4. | Upstream slope | | | | | | |
| | a. | Erosion | | X | | | Intermittent interior erosion rills observed along eastern slopes, maintain erosion controls in this area. See Note 4. |
| | b. | Rodent burrows | X | | | | |
| | c. | Vegetation | X | | | | |
| | d. | Cracks/settlement | X | | | | |
| | e. | Riprap/other erosion protection | X | | | | |
| | f. | Slide, Slough, Scarp | X | | | | |
| 5. | Crest | | | | | | |
| | a. | Soil condition | X | | | | |
| | b. | Comparable to width from previous inspection | X | | | | |
| | c. | Vegetation | X | | | | |
| | d. | Rodent burrows | X | | | | |
| | e. | Exposed to heavy traffic | X | | | | |
| | f. | Damage from vehicles/machinery | | | | X | Minor rutting observed along crest of Pond 3, maintain road grading controls. See Note 4. |
| 6. | Downstream slope | | | | | | |
| | a. | Erosion | | X | | | Observed areas of minor erosion, maintain erosion controls. See Note 4. |
| | b. | Vegetation | | X | | | Observed areas of sparse vegetation, maintain vegetation controls. See Note 4. |
| | c. | Rodent burrows | X | | | | |
| | d. | Slide, Slough, Scarp | | X | | | See Note 2. |
| | e. | Drain conditions | X | | | | |

| ITEM | Acceptable | Monitor/Maintain | Investigate | Repair | REMARKS |
|---|---|---|---|---|---|
| f. Seepage | X | | | | |
| 7. Toe | | | | | |
| a. Vegetation | X | X | | | |
| b. Rodent burrows | X | | | | |
| c. Settlement | X | | | | See Note 2. |
| d. Drainage conditions | X | | | | See Note 3. |
| e. Seepage | X | | | | See Note 3. |

***Notes:***

1) Current storage capacity is based on an approximate bottom elevation of 600.0 feet NGVD29 and two feet of freeboard measured from a topographic survey collected in May of 2016 (629.8 NGVD29). Volume of impounded water and CCR are based on an approximate bottom elevation of 600.0 feet NGVD29 and pond operating level (625.3 feet NGVD29) based on a topographic survey collected in May of 2016.
2) Evidence of historic sloughing was observed along areas of the western slope of the Bottom Ash Pond. Sloughing appeared unchanged from previous inspection. Golder recommends weekly observations for visual changes in appearance or further movement. This item is not considered a deficiency or release requiring immediate action per 40 CFR 257.83(b)(5).
3) Evidence of active seepage and piping was not observed during this inspection. The Bottom Ash Pond 3 was dry at the time of inspection. Golder recommends CEC visually monitor for seepage on a weekly basis, per the site's SMP, to identify potential for changes in seep flow, sediment transport, or visible piping. This item is not considered a deficiency or release requiring immediate action per 40 CFR 257.83(b)(5).
4) Features observed and documented in this checklist were not considered a deficiency or release as classified under 40 CFR 257.83(b)(5) and required no immediate action beyond periodic inspection in accordance with the SMP and typical maintenance.

PROFESSIONAL ENGINEER SEAL

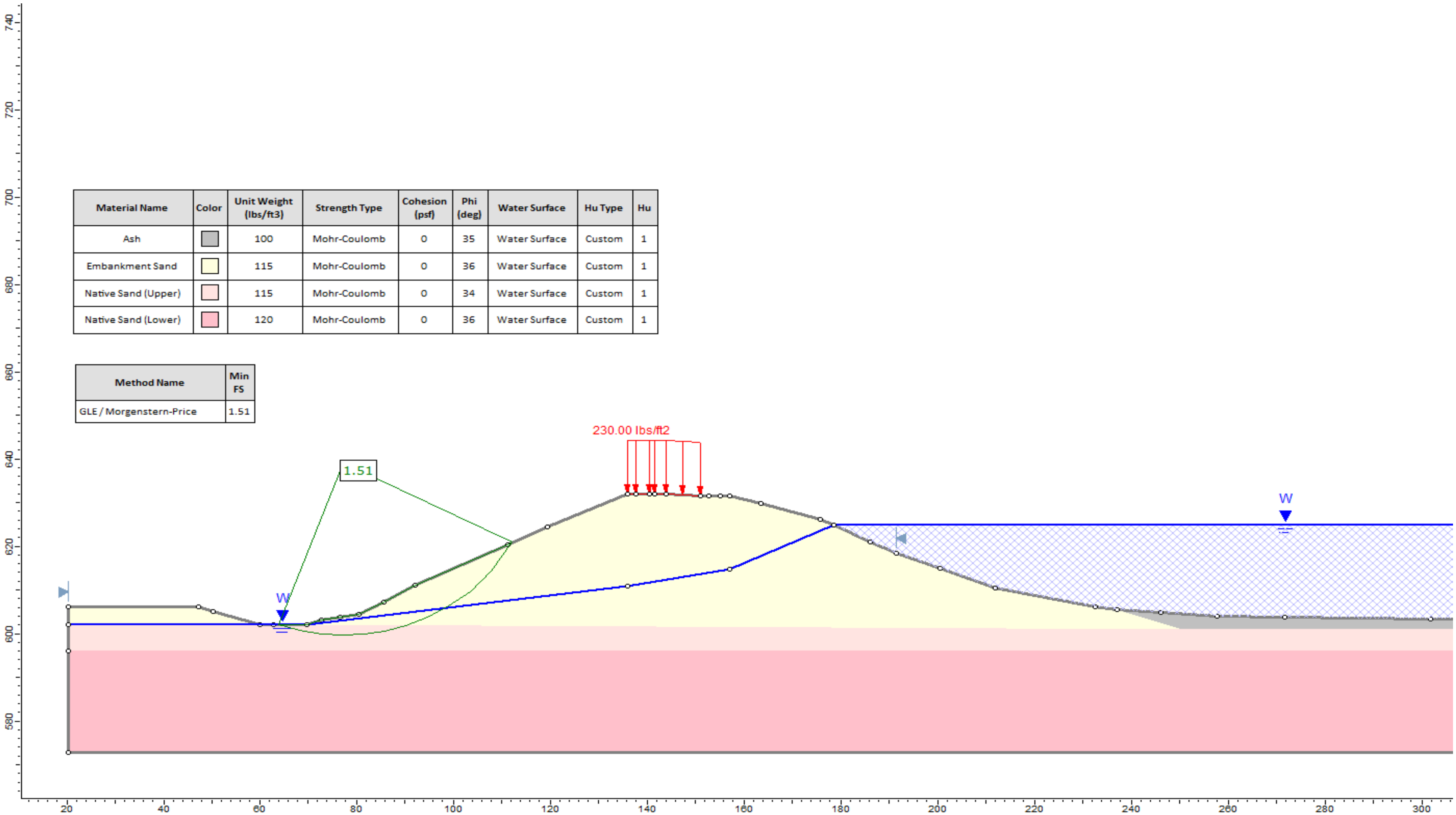
***Name of Engineer: Tiffany Johnson, P.E.***

***Date: 10/14/2016***

***Engineering Firm: Golder Associates Inc.***

***Signature:*** Tiffany Johnson

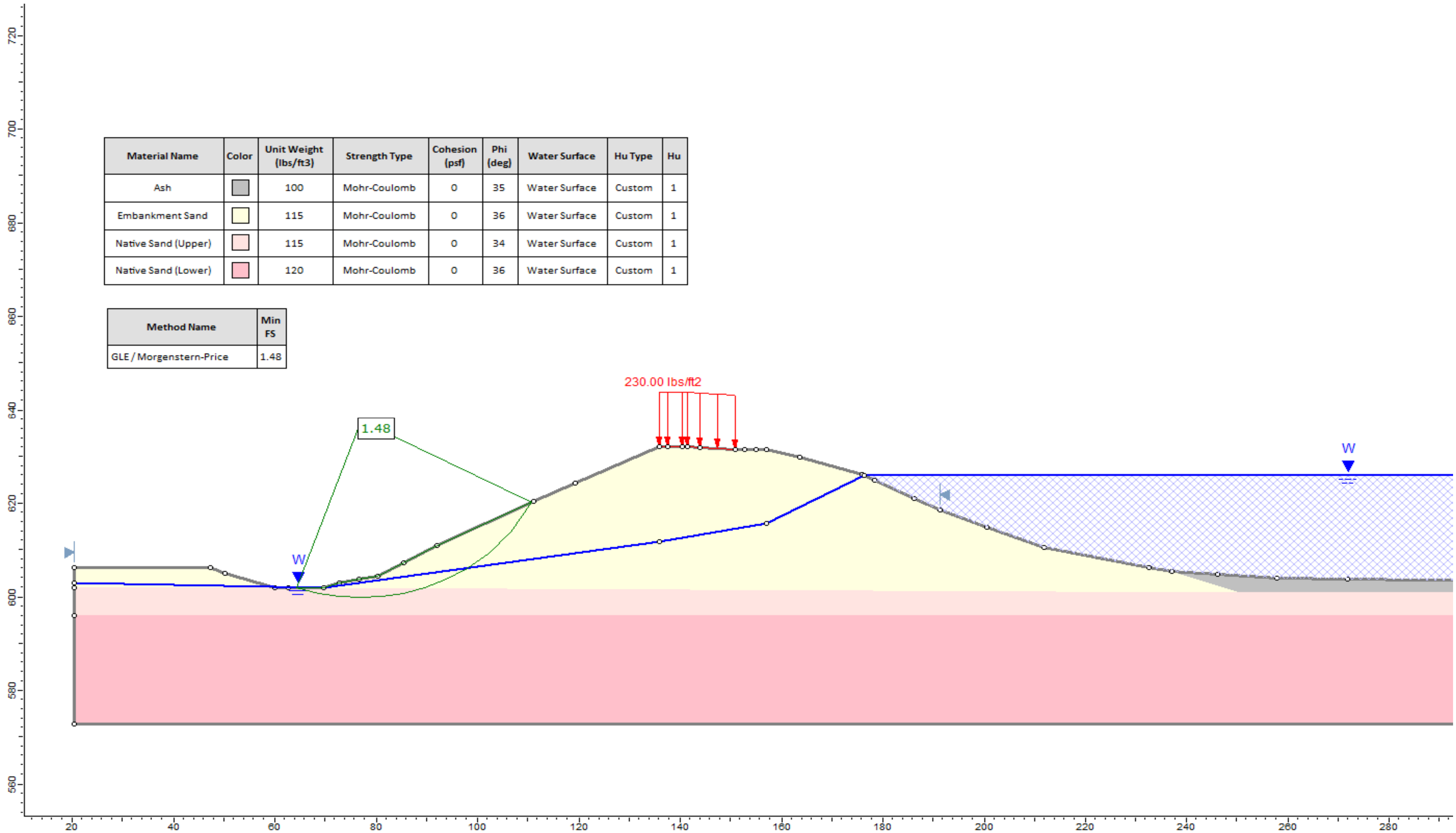
# APPENDIX B
# SLOPE STABILITY ANALYSIS RESULTS




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Ash | | 100 | Mohr-Coulomb | 0 | 35 | Water Surface | Custom | 1 |
| Embankment Sand | | 115 | Mohr-Coulomb | 0 | 36 | Water Surface | Custom | 1 |
| Native Sand (Upper) | | 115 | Mohr-Coulomb | 0 | 34 | Water Surface | Custom | 1 |
| Native Sand (Lower) | | 120 | Mohr-Coulomb | 0 | 36 | Water Surface | Custom | 1 |

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.51 |

| | | | |
|---|---|---|---|
| Golder Associates | SCALE: AS SHOWN | PROJECT | J.H. Campbell Structural Stability Assessments |
| | DATE: Sep 2016 | TITLE | Unit 3 Bottom Ash Pond Section A-A'<br>Slope Factor of Safety<br>Max Pool Storage Scenario |
| | MADE BY: JS | | |
| | CAD: - | | |
| FILE: STABILITY | CHECK: AF | CLIENT | Consumers Energy Company |
| PROJECT No. 1654923 — REV. 0 | REVIEW: MW | FIGURE | B-A1 |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Ash | | 100 | Mohr-Coulomb | 0 | 35 | Water Surface | Custom | 1 |
| Embankment Sand | | 115 | Mohr-Coulomb | 0 | 36 | Water Surface | Custom | 1 |
| Native Sand (Upper) | | 115 | Mohr-Coulomb | 0 | 34 | Water Surface | Custom | 1 |
| Native Sand (Lower) | | 120 | Mohr-Coulomb | 0 | 36 | Water Surface | Custom | 1 |

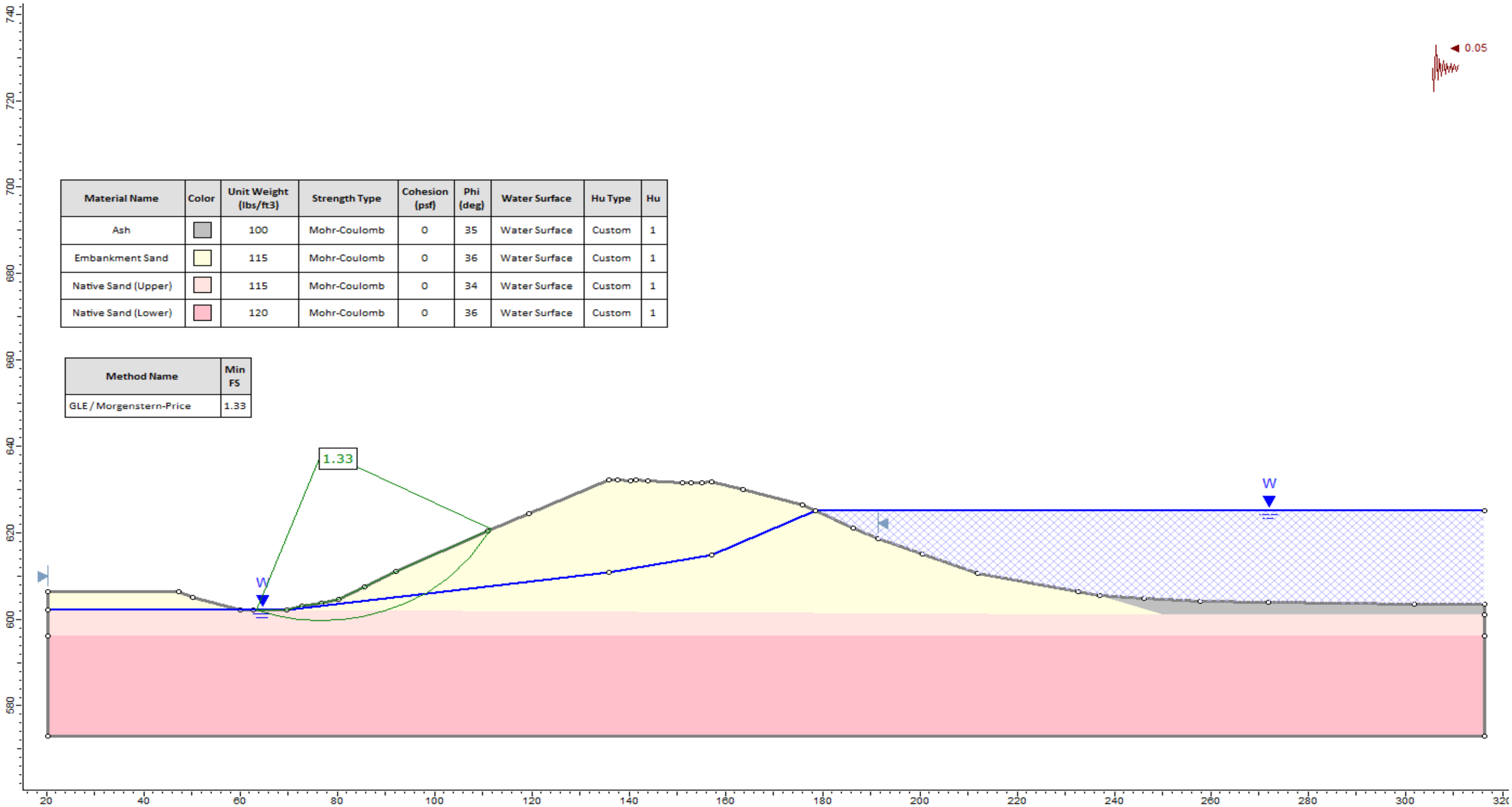
| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.48 |

Golder Associates

| | | | |
|---|---|---|---|
| SCALE | AS SHOWN | PROJECT | J.H. Campbell Structural Stability Assessments |
| DATE | Sep 2016 | TITLE | Unit 3 Bottom Ash Pond Section A-A'<br>Slope Factor of Safety<br>Max Pool Surcharge Scenario |
| MADE BY | JS | | |
| CAD | - | | |
| CHECK | AF | CLIENT | Consumers Energy Company |
| REVIEW | MW | FIGURE | B-A2 |

FILE STABILITY

PROJECT No. 1654923 REV. 0




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Ash | | 100 | Mohr-Coulomb | 0 | 35 | Water Surface | Custom | 1 |
| Embankment Sand | | 115 | Mohr-Coulomb | 0 | 36 | Water Surface | Custom | 1 |
| Native Sand (Upper) | | 115 | Mohr-Coulomb | 0 | 34 | Water Surface | Custom | 1 |
| Native Sand (Lower) | | 120 | Mohr-Coulomb | 0 | 36 | Water Surface | Custom | 1 |

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.33 |

Golder Associates

| | | | |
|---|---|---|---|
| SCALE | AS SHOWN | PROJECT | J.H. Campbell Structural Stability Assessments |
| DATE | Sep 2016 | TITLE | Unit 3 Bottom Ash Pond Section A-A' Slope Factor of Safety Seismic Scenario |
| MADE BY | JS | | |
| CAD | - | | |
| CHECK | AF | CLIENT | Consumers Energy Company |
| REVIEW | MW | FIGURE | B-A3 |

FILE STABILITY

PROJECT No. 1654923 REV. 0

## APPENDIX C
## LIQUIFACTION POTENTIAL ANALYSIS RESULTS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project:** | JH Campbell RCRA | **Test Type:** | CPTU | **Golder Eng:** | AK | **Design EQ 1** | |
| **Location:** | West Olive, MI | **Device:** | 15 $cm^2$, Type 2 filter | **Check** | AF | **Magnitude:** | 6.4 |
| **Client:** | CEC | **Standard:** | ASTM D5778 | **Review:** | JS | | |
| **Proj No.:** | 1654923 | **Push Co.:** | ConeTec | **Max Depth:** | 50.0 ft | | |
| **Area:** | Bottom Ash Pond 3 | **Operator:** | Thomas Carpenter | **Termination:** | Target Depth | | |

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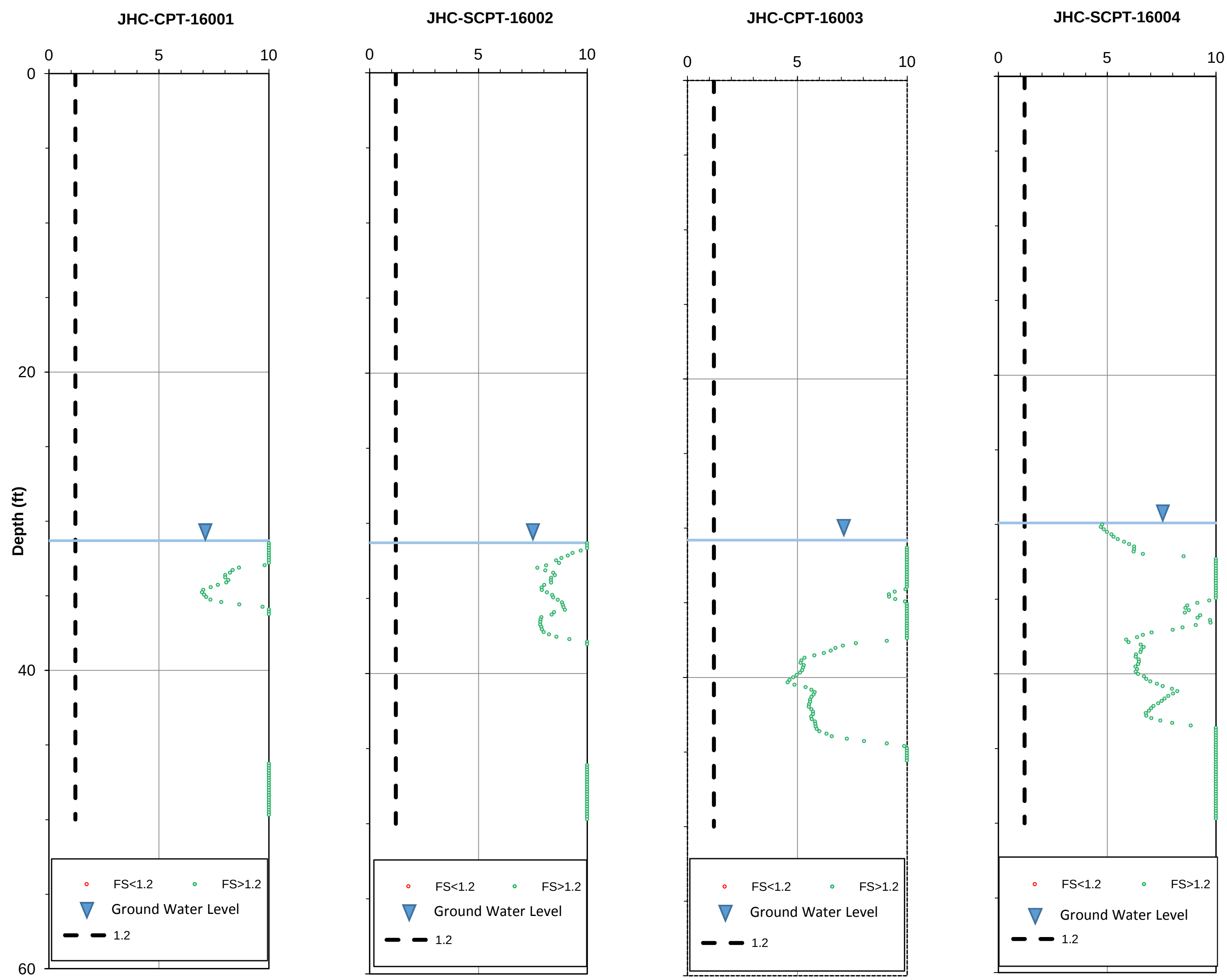
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **CPT ID:** | JHC-CPT-16001 | **CPT ID:** | JHC-SCPT-16002 | **CPT ID:** | JHC-CPT-16003 | **CPT ID:** | JHC-SCPT-16004 |
| **Test Date:** | 5/17/2016 | **Test Date:** | 5/17/2016 | **Test Date:** | 5/17/2016 | **Test Date:** | 5/17/2016 |
| **Northing:** | 520147 | **Northing:** | 520024 | **Northing:** | 519438 | **Northing:** | 519226 |
| **Easting:** | 12634075 | **Easting:** | 12633678 | **Easting:** | 12633627 | **Easting:** | 12633838 |
| **Elevation:** | 633 ft | **Elevation:** | 633 ft | **Elevation:** | 632 ft | **Elevation:** | 632 ft |
| **$a_{max}$:** | 0.05 g | **$a_{max}$:** | 0.05 g | **$a_{max}$:** | 0.05 g | **$a_{max}$:** | 0.05 g |
| **Water Table:** | 31.3 ft | **Water Table:** | 31.3 ft | **Water Table:** | 30.8 ft | **Water Table:** | 29.9 ft |

# FACTOR OF SAFETY AGAINST LIQUEFACTION




Notes: Factors of safety (FS) greater than 10 are shown equal to 10.
NCEER (2001) method was used to calculate factors of safety against liquefaction.
The ground water levels shown here are the interpreted ground water levels at the time of CPT investigation.
No liquefaction assumed to be possible above the water table or if qc1Ncs > 160.

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