**AMENDED SAFETY FACTOR ASSESSMENT**
**40 C.F.R. PART 257.73**
**PLANT MCMANUS ASH POND (AP-1)**
**GEORGIA POWER COMPANY**

EPA's "Disposal of Coal Combustion Residuals from Electric Utilities" Final Rule (40 C.F.R. Part 257 and Part 261), §257.73(e), requires the owner or operator of an existing CCR surface impoundment to conduct initial and periodic safety factor assessments. The owner or operator of the CCR unit must conduct an assessment and document whether the minimum safety factors outlined in §257.73(e)(1)(i) through (iv) for the critical cross section of the embankment are achieved.

The CCR surface impoundment known as Plant McManus AP-1 is located on Plant McManus property, just west of Brunswick, Georgia. AP-1 was formed by construction of a dike across an upland marsh area north of the plant's main access road. The cross-section of AP-1 is relatively consistent across the embankment over this marsh area. Therefore, a generalized cross section of the dam is deemed to represent the "critical section."

The analyses used to determine the minimum safety factor for the critical section resulted in the following minimum safety factors:

| Loading Condition | Minimum Calculated Safety Factor | Minimum Required Safety Factor |
|---|---|---|
| Long-term Maximum Storage Pool (Static) | 2.27 | 1.5 |
| Maximum Surcharge Pool (Static) | 1.69 | 1.4 |
| Seismic | 1.69 | 1.0 |

The embankments of AP-1 are constructed of silty sands that are not susceptible to liquefaction. An assessment of liquefaction potential was performed using Standard Penetration Test N-values, the soils' percent finer than a No. 200 sieve, a seismic event on the order of 6M to 6.5M and a PGA of approximately 8 percent. Factors of Safety against liquefaction were greater than approximately 1.8.

This assessment is supported by appropriate engineering calculations which are attached.

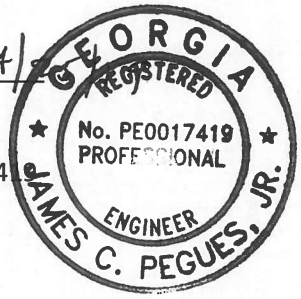
In accordance with 40 C.F.R. 257.73(f)(3) and 40 C.F.R. 257.73(e), the Initial Factor of Safety Assessment will be updated every 5 years until such time the surface impoundment has been closed and no longer meets the definition of a CCR surface impoundment as described in 40 C.F.R. 257.53.

I hereby certify that the safety factor assessment was conducted in accordance with 40 C.F.R. Part 257.73 (e)(1).

4/

James C. Pegues, P.E.

Licensed State of Georgia, PE No. 174



SOUTHERN COMPANY

**Engineering and Construction Services Calculation**

| **Calculation Number:** TV-MM-GPC574555-001 |
|---|

| **Project/Plant:** Plant McManus | **Unit(s):** | **Discipline/Area:** ES&FS |
|---|---|---|
| **Title/Subject:** Factor of Safety Assessment for CCR Rule | | |
| **Purpose/Objective:** Analyze Factor of Safety of the Ash Pond Dike | | |
| **System or Equipment Tag Numbers:** NA | **Originator:** Jacob A. Jordan, P.E. | |

**Contents**



**Revision Record**

| Rev. No. | Description | Originator Initial / Date | Reviewer Initial / Date | Approver Initial / Date |
|---|---|---|---|---|
| 0 | Issued for Information | JAJ/04-16-18 | JCP/04-16-18 | JCP/04-16-18 |
| 1 | Narrative Revisions | JAJ/04-23-19 | JCP/04-23-19 | JCP/04-23-19 |
| | | | | |
| | | | | |

**Notes:**

## Purpose of Calculation

The purpose of this calculation is to evaluate the slope stability of the Plant McManus AP-1 embankment under a variety of loading conditions, including long-term normal pool elevation, surcharge loading (maximum pool) and seismic loading.

Plant McManus's AP-1 was constructed in 1957 by Georgia Power Company by placing a dike embankment across an upland marsh area north of the plant's main access road. The pond was constructed in parallel with Unit 2. Units 1 and 2 were converted to #6 fuel oil in 1971 and 1972, respectively and AP-1 stopped received CCRs. Closure activities for AP-1 began in 2016.

The dike was constructed at a 4(H):1(V) slope with a maximum crest elevation of EL 9-ft located along the east abutment. Most of the embankment crest has a surface elevation of about EL 7-ft. The embankment soils are comprised of fine silty sand, which overlie the soft silty clay and clayey sand foundation soils.

## Methodology

The calculation was performed using the following methods and software:

GeoStudio 2016 (Version 8.16.1, Build 13452), Copyright 1991-2016, GEO-SLOPE International, Ltd.

Morgenstern-Price analytical method was run and reported.

## Criteria and Assumptions

The slope stability models were run using the following assumptions and design criteria:

- Seismic site response was determined using a one-dimensional equivalent linear site response analysis.
- The median surface ground motions were then used to calculate a pseudostatic seismic coefficient for utilization in the stability analysis using the approach suggested by Bray and Tavasarou (2009). The procedure calculates the seismic coefficient for an allowable seismic displacement and a probability exceedance of the displacement. For this analysis, an allowable displacement of 0.5 ft, and a probability of exceedance of 16% were conservatively selected, providing a seismic coefficient of 0.058g for use as a horizontal acceleration in the stability analysis.
- The current required minimum criteria (factors of safety) were taken from the Structural Integrity Criteria for existing CCR surface impoundment from 40 CFR 257.73, published April 17, 2015.
- The soil properties of unit weight, phi angle, and cohesion were obtained from triaxial shear testing performed on UD samples of the fill and foundation soils obtained during drilling in January 2018 and from historical data.

- The COE EM 1110-2-1902, October 2003, allows the use of the phreatic surface established for the maximum storage condition (normal pool) in the analysis for the maximum surcharge loading condition. This is based on the short term duration of the surcharge loading relative to the permeability of the embankment and the foundation materials. This method is used in the analysis for the impoundments at this facility with surcharge loading.

The slope stability model was run using the following assumptions:

- Maximum storage pool is at EL 3-ft.
- Maximum surcharge pool is at EL 7-ft..

**Input Data**

The following soil properties were used in the analyses. This data was generally obtained from laboratory testing performed on UD samples collected in the upper two embankment fill and residual soil layers from the Ash Pond in January 2018. The laboratory testing consisted of classification testing and consolidated undrained triaxial tests. The triaxial tests provide total and effective shear strength parameters of the embankment and foundation soils. The effective stress parameters were used in the analyses. Historical data from the installation of monitor wells were also reviewed to confirm the soil classification and engineering parameters.

| Soil Description | Moist Unit Weight, pcf | Effective Stress Parameters | |
|---|---|---|---|
| | | Cohesion, psf | Phi Angle, degrees |
| Embankment Fill | 113 | 0 | 35 |
| Residual | 100 | 180 | 17.4 |
| Weak Residual | 95 | 0 | 25 |

**Hydrologic Considerations**

The following hydraulic information is based on the calculation package Inflow Design Control System Plan: Hydrologic and Hydraulic Calculation Summary for Plant McManus Ash Pond by Southern Company Services, was used in the analyses. This calculation states that the Ash Pond is capable of handling the 1000-year 24-hour storm event with a maximum surcharge pool elevation of EL 6 ft (EL 7 ft was used in this analysis).

## Summary of Conclusions

The following table lists the factors of safety for various slope stability failure conditions. All conditions are steady state except where noted. Construction cases were not considered. Based on the results of these analyses all structures are stable.

| Load Conditions | Computed Factor of Safety | Required Minimum Factor of Safety |
|---|---|---|
| Long-term Maximum Storage (Static) | 2.3 | 1.5 |
| Maximum Surcharge Pool (Static) | 1.7 | 1.4 |
| Seismic | 1.7 | 1.0 |

The analyses indicate that in all cases the ash pond dike, for Ash Pond 1, the factors of safety are above the required minimums.

## Design Inputs/References

USGS Earthquake Hazards website, http://earthquake.usgs.gov/designmaps/beta/us
Georgia Power Co. Drawing D-302, Plant McManus Unit No. 2, Ash Pond Dike
Bray, J. D. and Travasarou, T., *Pseudostatic Coefficient for Use in Simplified Seismic Slope Stability Evaluation*, Journal of Geotechnical and Environmental Engineering, American Society of Civil Engineers, September 2009
Lidar survey, 1-29-18

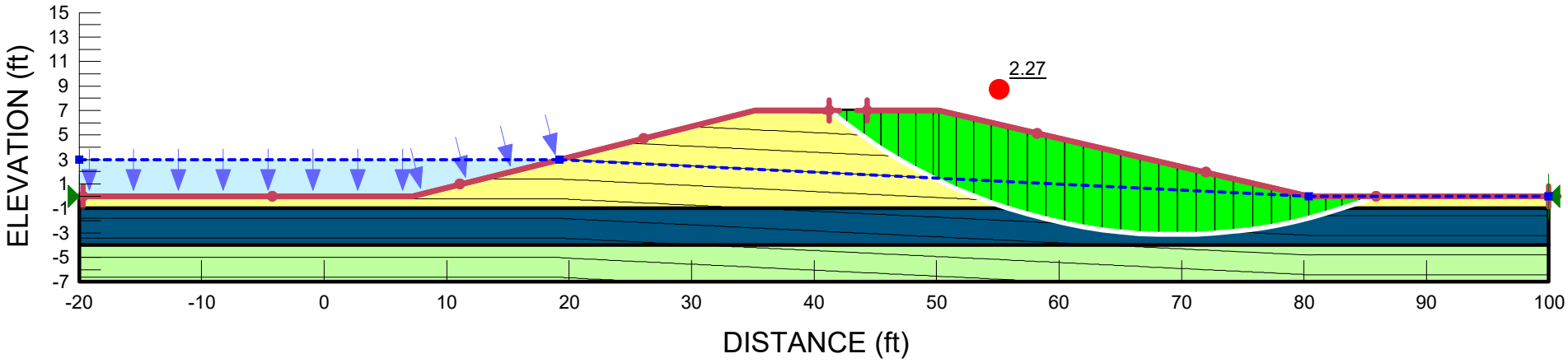
## Body of Calculations

Calculation consists of Slope-W modeling attached.

Plant McManus
Georgia Power Company
Slope Stability Analysis

Steady State - Normal Pool

| Color | Name | Model | Unit Weight (pcf) | Cohesion' (psf) | Phi' (°) |
|---|---|---|---|---|---|
| | SM | Mohr-Coulomb | 113 | 0 | 35 |
| | CH | Mohr-Coulomb | 100 | 180 | 17.4 |
| | Loose SP-SC | Mohr-Coulomb | 95 | 0 | 25 |

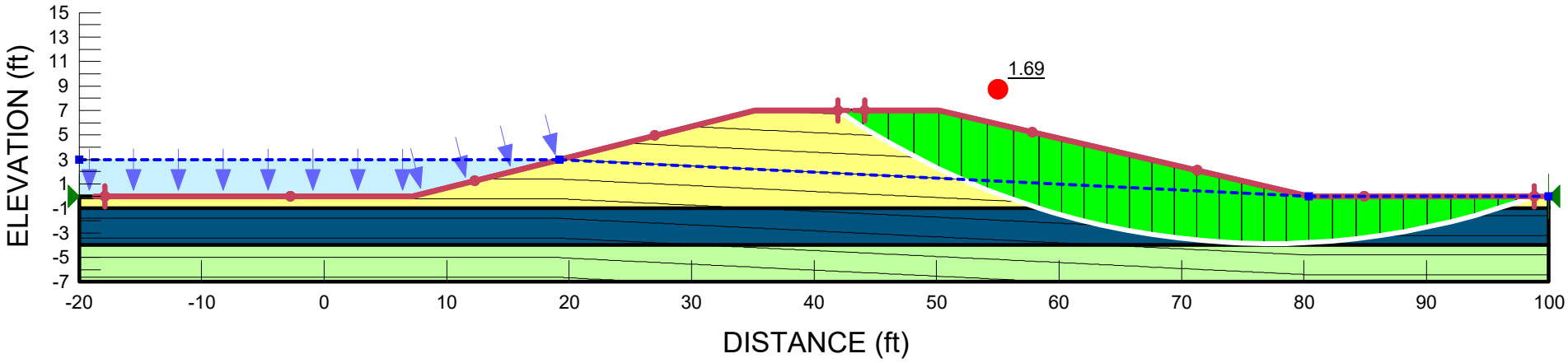



Topographic data based on 1/29/2018 LiDAR Survey
Soil parameters based on 1/31/2018 borings and historical boring data

Plant McManus
Georgia Power Company
Slope Stability Analysis

Seismic Loading
0.058g

| Color | Name | Model | Unit Weight (pcf) | Cohesion' (psf) | Phi' (°) |
|---|---|---|---|---|---|
| | SM | Mohr-Coulomb | 113 | 0 | 35 |
| | CH | Mohr-Coulomb | 100 | 180 | 17.4 |
| | Loose SP-SC | Mohr-Coulomb | 95 | 0 | 25 |

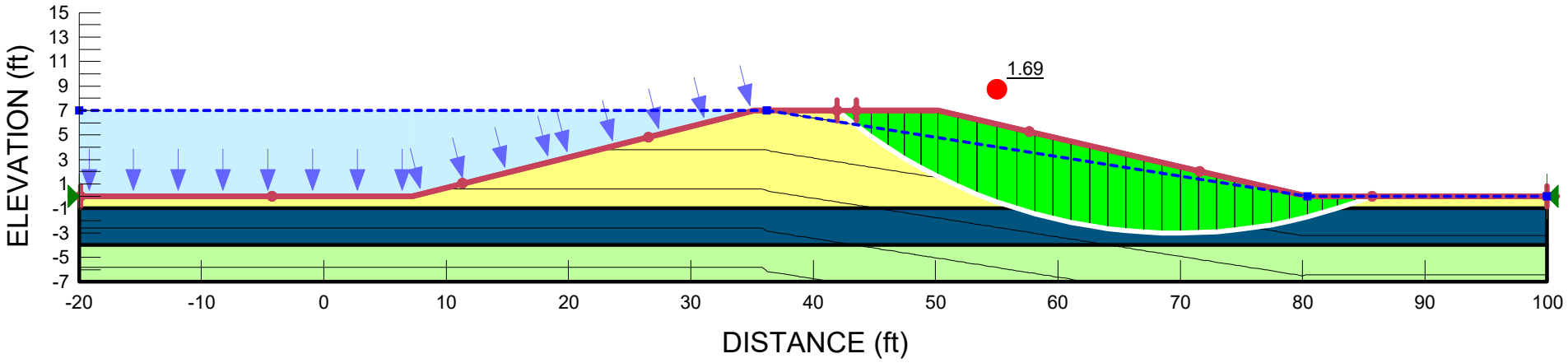



Topographic data based on 1/29/2018 LiDAR Survey
Soil parameters based on 1/31/2018 borings and historical boring data

Plant McManus
Georgia Power Company
Slope Stability Analysis

Maximum Pool Elevation

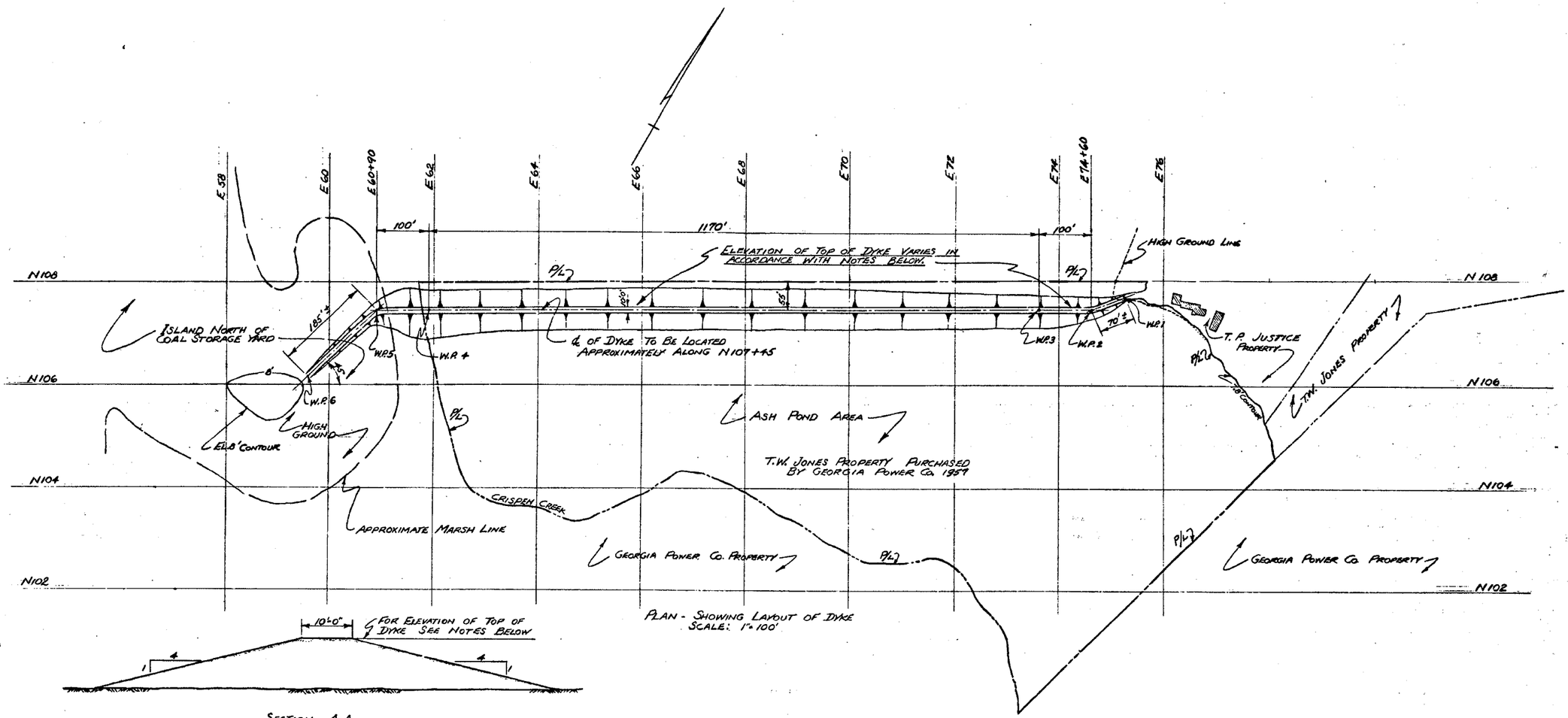
| Color | Name | Model | Unit Weight (pcf) | Cohesion' (psf) | Phi' (°) |
|---|---|---|---|---|---|
| | SM | Mohr-Coulomb | 113 | 0 | 35 |
| | CH | Mohr-Coulomb | 100 | 180 | 17.4 |
| | Loose SP-SC | Mohr-Coulomb | 95 | 0 | 25 |




Topographic data based on 1/29/2018 LiDAR Survey
Soil parameters based on 1/31/2018 borings and historical boring data

# Attachment A

Figure – Site Plan




PLAN - SHOWING LAYOUT OF DYKE
SCALE: 1"=100'




SECTION A-A
TYPICAL CROSS SECTION THRU DYKE
SCALE 1"=10'

REFERENCE DRAWINGS
10-804-H-301- GENERAL LAYOUT OF PLANT SITE

NOTES:
1. ELEVATION OF TOP OF DYKE TO BE AS FOLLOWS:
   (a) W.P.1 TO W.P.2 TO BE LEVEL AT EL. 7.8'.
   (b) SLOPE FROM EL 7.8' AT W.P. 2 TO EL 8.5' AT W.P. 3.
   (c) W.P. 3 TO W.P. 4 TO BE LEVEL AT EL. 8.5'.
   (d) SLOPE FROM EL. 8.5' AT W.P. 4 TO EL. 7.8' AT W.P. 5.
   (e) W.P.5 TO W.P. 6 TO BE LEVEL AT EL. 7.8'.
2. FOR TYPICAL CROSS SECTION OF DYKE, SEE SECTION A-A.
3. W.P.1 TO BE LOCATED IN FIELD.

GEORGIA POWER CO., ATLANTA, GA.
ENGINEERING DEPARTMENT

PLANT MCMANUS UNIT No 2

ASH POND DYKE

| No. | DATE | BY | APPROVALS | REVISIONS |
|---|---|---|---|---|
| | | | E.A. Harrison V.P. & CH. ENG. | |

DBNH TR. CHK. C-SB
SCALE AS SHOWN DATE 4-19-57
DRAWING NUMBER
LOCATION 10-804 SHEET No. D-302

# Attachment B

Soil Test Boring

# UNIVERSAL ENGINEERING SCIENCES
# BORING LOG

| | |
|---|---|
| PROJECT NO.: | 0930.1800026.0000 |
| REPORT NO.: | |
| PAGE: | A-1 |

PROJECT: GEOTECHNICAL EXPLORATION
PLANT MCMANUS AP DIKES
BRUNSWICK, GEORGIA

BORING DESIGNATION: **B-1** SHEET: **1 of 1**
SECTION: TOWNSHIP: RANGE:

CLIENT: Southern Company Services

LOCATION: SEE BORING LOCATION PLAN

REMARKS:

G.S. ELEVATION (ft):
WATER TABLE (ft): 3.9
DATE OF READING: 1/31/18
EST. W.S.W.T. (ft):

DATE STARTED: 1/31/18
DATE FINISHED: 1/31/18
DRILLED BY: P/D
TYPE OF SAMPLING:

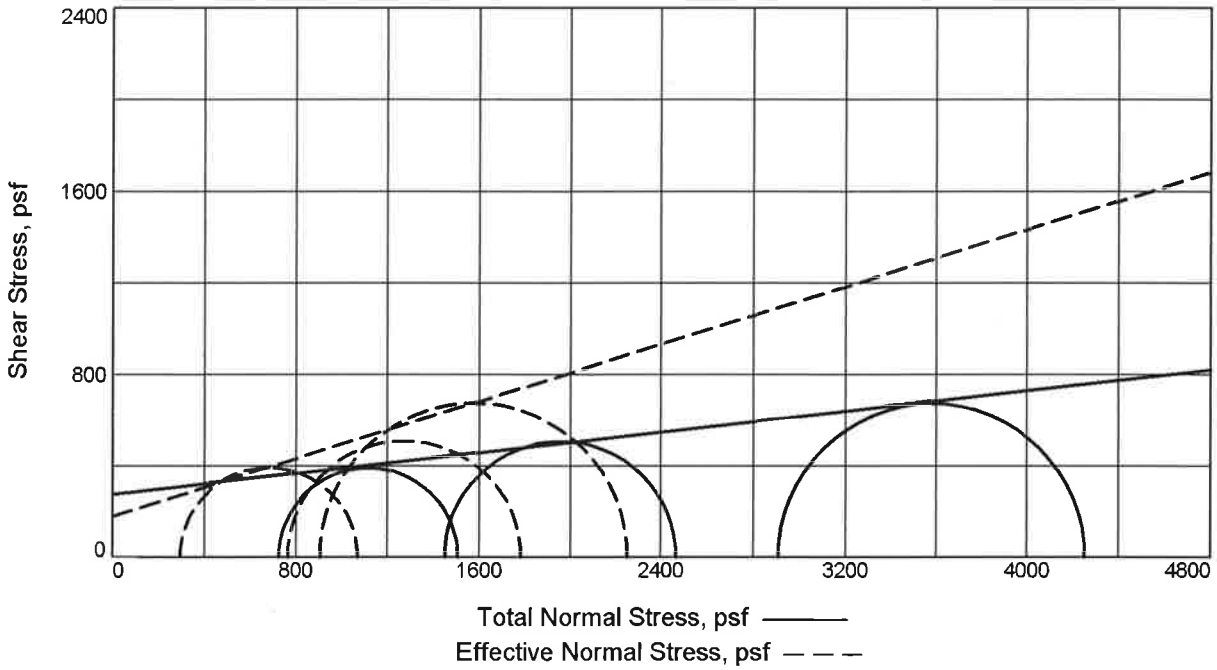
| DEPTH (FT.) | SAMPLE | BLOWS PER 6" INCREMENT | N (BLOWS/ FT.) | W.T. | SYMBOL | DESCRIPTION | -200 (%) | MC (%) | ATTERBERG LIMITS LL | ATTERBERG LIMITS PI | K (FT./ DAY) | ORG. CONT. (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | | |
| | | 1-2-4 | 6 | | | Very loose to loose brown to light brown slightly Clayey fine SAND (SP-SC) | 11.0 | 10.0 | | | | |
| | | 4-5-4 | 9 | | | | 8.3 | 14.4 | | | | |
| | | 3-4-3 | 7 | ▼ | | | 7.5 | 22.3 | | | | |
| 5 | | 1-1/12" | 1/12" | | | | 6.6 | 27.0 | | | | |
| | | WOH | WOH | | | | 6.1 | 27.8 | | | | |
| | | WOH | WOH | | | Very loose light brown and gray slightly Clayey fine SAND with trace small Roots (SP-SC) | 7.8 | 27.8 | | | | |
| 10 | | WOH | WOH | | | | 5.9 | 25.4 | | | | |
| | | WOH | WOH | | | Very soft gray Silty CLAY (CH) | 90.6 | 115.9 | 75 | 35 | | |
| | | WOH | WOH | | | Very loose gray slightly Clayey fine SAND with some Shell fragments (SP-SC) | 10.8 | 33.8 | NP | | | |
| 15 | | 1-1-2 | 3 | | | Very loose gray Clayey fine SAND (SC) | 14.1 | 36.4 | NP | | | |
| | | 4-8-11 | 19 | | | Medium dense gray fine SAND with some Shell fragments (SP) | 4.1 | 23.8 | | | | |
| 20 | | 3-6-7 | 13 | | | Loose to medium dense gray slightly Clayey fine SAND with trace shell fragments (SP-SC) | 6.2 | 26.0 | | | | |
| | | 1-4-9 | 13 | | | | 9.5 | 29.6 | NP | | | |
| 25 | | 3-4-4 | 8 | | | | 5.3 | 25.1 | | | | |
| | | 2-5-6 | 11 | | | Medium dense gray fine SAND with trace Shell fragments (SP) | 4.2 | 26.5 | | | | |
| 30 | | | | | | | | | | | | |

BORING_LOG 0930.1800026.0000-PLANT MCMANUS AP DIKE.GPJ UNIENGSC.GDT 2/21/18

# Attachment C

Laboratory Test Results

# TRIAXIAL SHEAR TEST REPORT




**Type of Test:** CU with Pore Pressures **Sample Type:**

| No. | Fluid Press. psi | | Fail. Stress, psf | | Ult. Stress, psf | | Principal Stresses at Failure psf | |
|---|---|---|---|---|---|---|---|---|
| | Cell | Back | Deviator | Total Pore Pressure | Deviator | Total Pore Pressure | $\bar{\sigma}_1$ | $\bar{\sigma}_3$ |
| 1 | 26.24 | 21.20 | 782 | 3486 | | | 1074 | 292 |
| 2 | 31.27 | 21.20 | 1016 | 3736 | | | 1783 | 767 |
| 3 | 41.39 | 21.20 | 1345 | 5053 | | | 2253 | 907 |
| | | | | | | | | |

| No. | Consolidated Sample Parameters | | | | | | |
|---|---|---|---|---|---|---|---|
| | % Water Content | Dry Dens. pcf | Satur-ation | Void Ratio | Diameter in. | Height in. | Strain Rate %/min. |
| 1 | 99.3 | 45.6 | 100.0% | 2.6517 | 2.84 | 5.60 | -0.0332 |
| 2 | 99.3 | 45.6 | 100.0% | 2.6517 | 2.87 | 5.47 | -0.0398 |
| 3 | 99.3 | 45.6 | 100.0% | 2.6517 | 2.90 | 5.36 | -0.0184 |
| | | | | | | | |

| Mohr-Coulomb Strength Parameters | Total | Effective |
|---|---|---|
| Strength intercept, c= | 276 psf | 180 psf |
| Friction angle, $\phi$ = | 6.5 deg | 17.4 deg |
| Tangent, $\phi$ = | 0.11 | 0.31 |

**Material Description:** Dark Green Gray Silty Clay

**Client:** Southern Company Services

**Project:** McManus AP Dike

**Location:** B-1-A

**Sample Number:** 2 **Depth:** 12'

**Date Sampled:**

**File:** McManus AP Dike

**Remarks:**

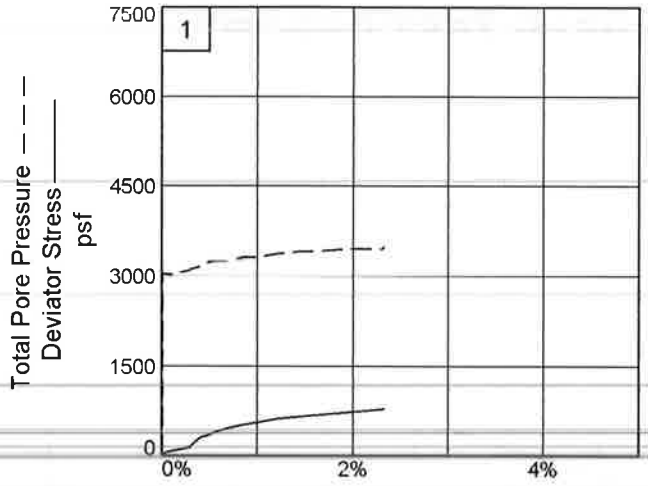
TRIAXIAL SHEAR TEST REPORT

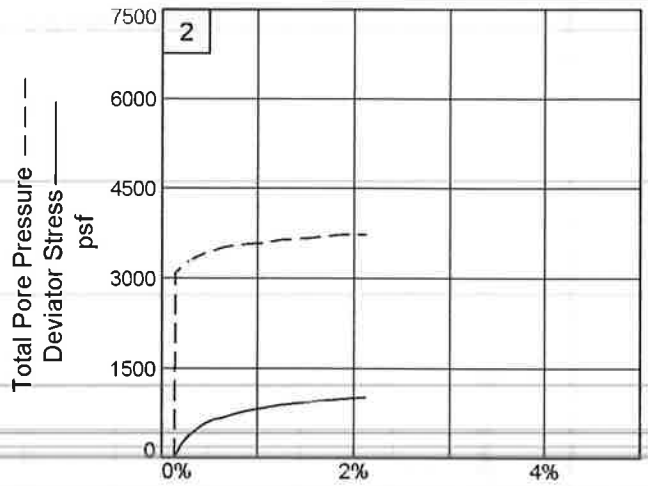
Universal Engineering Sciences

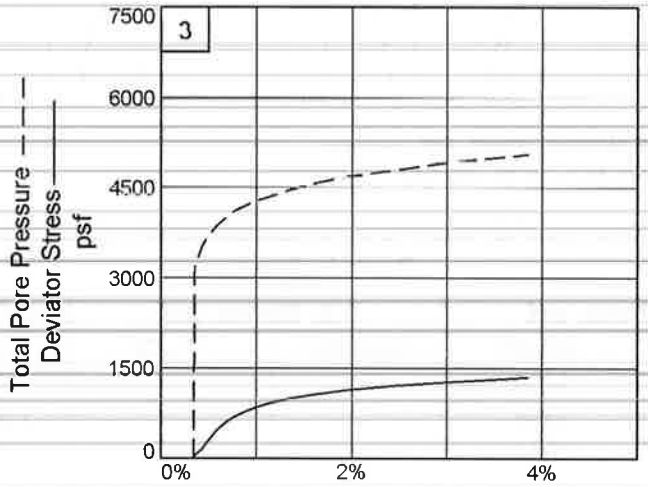
Orlando, Florida

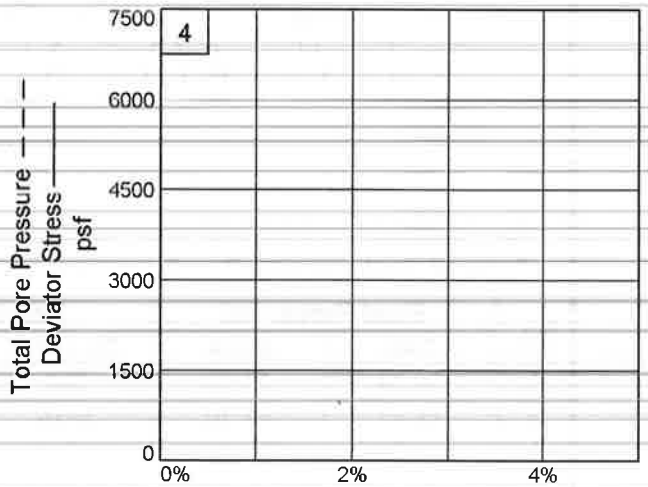
**Proj. No.:** 0930.1800026

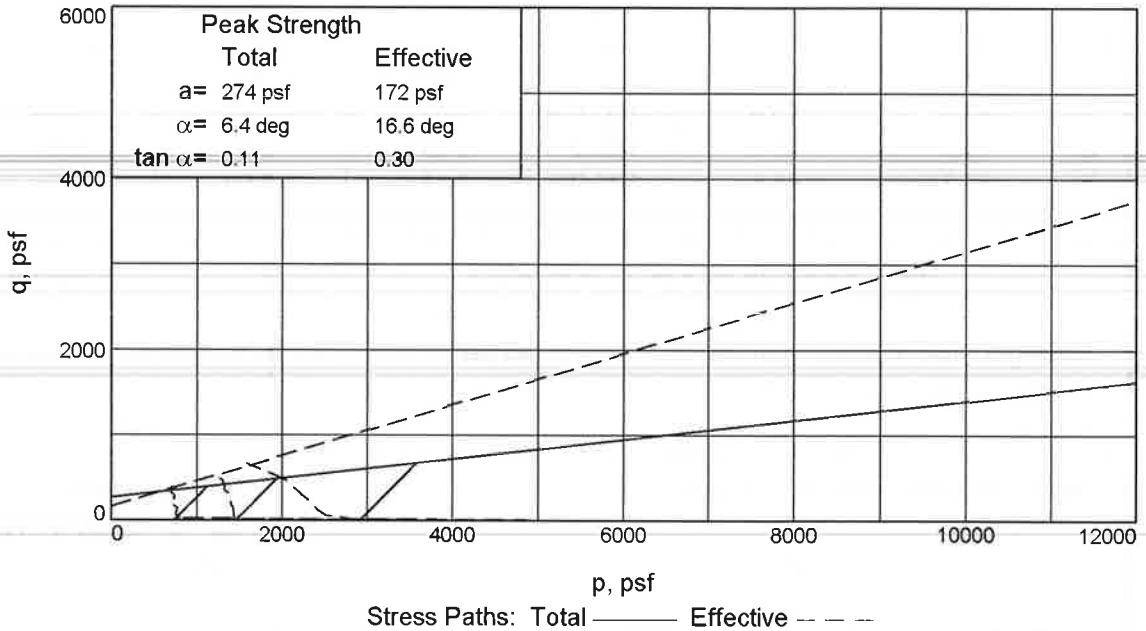
**Figure** _____



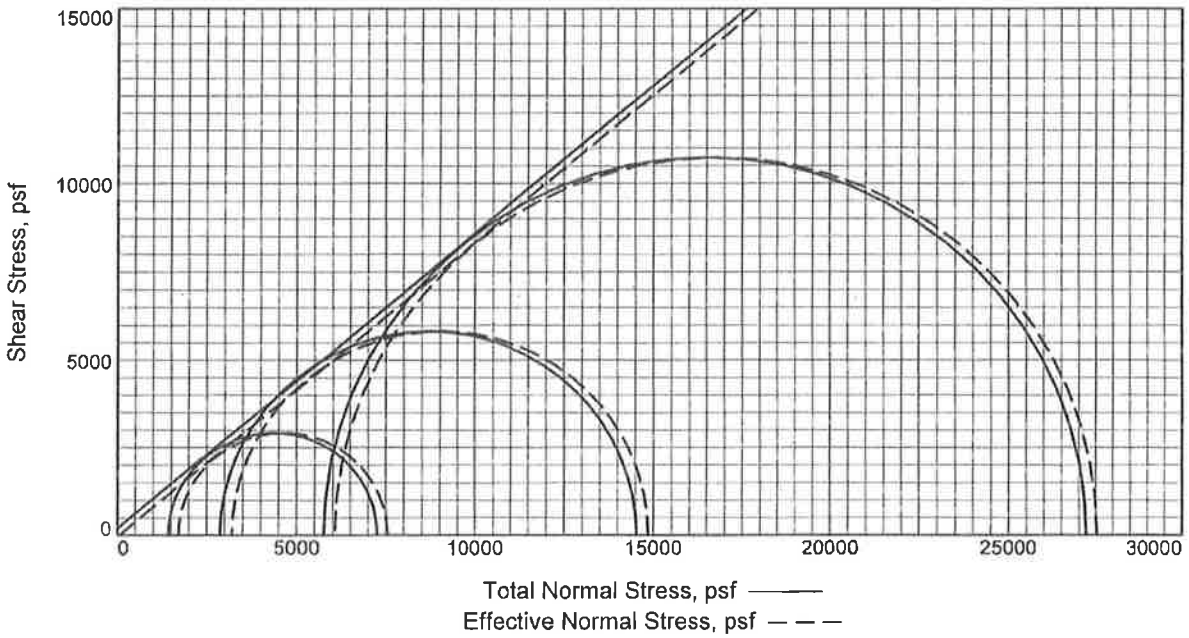




**Client:** Southern Company Services
**Project:** McManus AP Dike
**Location:** B-1-A **Depth:** 12' **Sample Number:** 2
**Project No.:** 0930.1800026 **Figure** _____

**Universal Engineering Sciences**

# TRIAXIAL SHEAR TEST REPORT




**Type of Test:** CU with Pore Pressures **Sample Type:**

| No. | Fluid Press. psi | | Fail. Stress, psf | | Ult. Stress, psf | | Principal Stresses at Failure psf | |
|---|---|---|---|---|---|---|---|---|
| | Cell | Back | Deviator | Total Pore Pressure | Deviator | Total Pore Pressure | $\bar{\sigma}_1$ | $\bar{\sigma}_3$ |
| 1 | 31.35 | 21.40 | 5828 | 2795 | | | 7547 | 1719 |
| 2 | 41.38 | 21.40 | 11653 | 2752 | | | 14859 | 3207 |
| 3 | 61.31 | 21.40 | 21468 | 2772 | | | 27525 | 6057 |
| | | | | | | | | |

| No. | Consolidated Sample Parameters | | | | | | |
|---|---|---|---|---|---|---|---|
| | % Water Content | Dry Dens. pcf | Satur-ation | Void Ratio | Diameter in. | Height in. | Strain Rate %/min. |
| 1 | 24.7 | 100.6 | 100.0% | 0.6632 | 2.75 | 5.59 | -0.0058 |
| 2 | 24.7 | 100.6 | 100.0% | 0.6632 | 2.77 | 5.51 | -0.0556 |
| 3 | 24.7 | 100.6 | 100.0% | 0.6632 | 2.79 | 5.45 | -0.0380 |
| | | | | | | | |

| Mohr-Coulomb Strength Parameters | Total | Effective |
|---|---|---|
| Strength intercept, c= | 213 psf | -35 psf |
| Friction angle, $\phi$ = | 40.0 deg | 39.9 deg |
| Tangent, $\phi$ = | 0.84 | 0.84 |

**Material Description**

Dark Green Gray Silty sand with Clay

**Client:** Southern Company Services

**Project:** McManus AP Dike

**Location:** B-1-A

**Sample Number:** 1 **Depth:** 1

**Date Sampled:**

**File:** McManus AP Dike

**Remarks:**

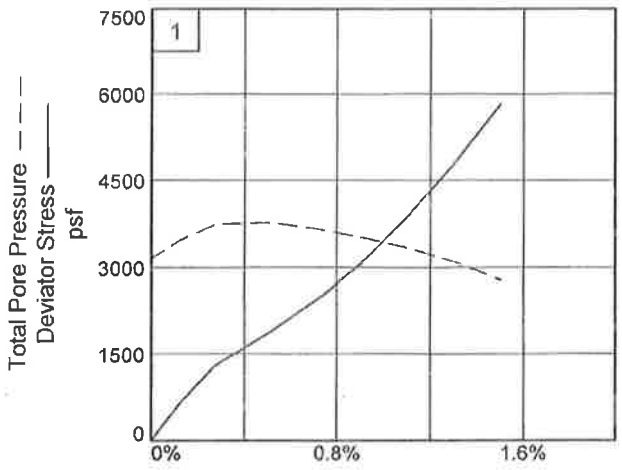
TRIAXIAL SHEAR TEST REPORT

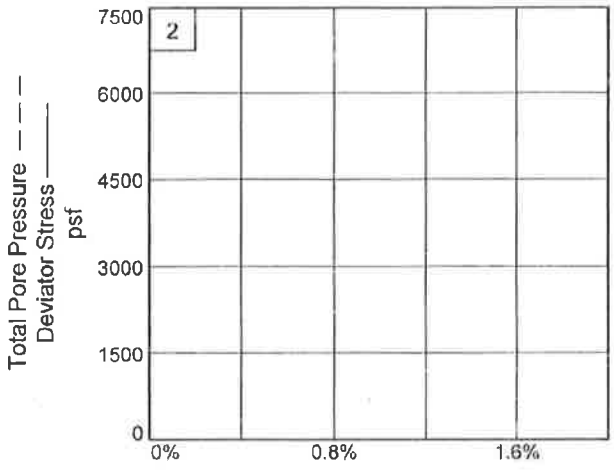
Universal Engineering Sciences

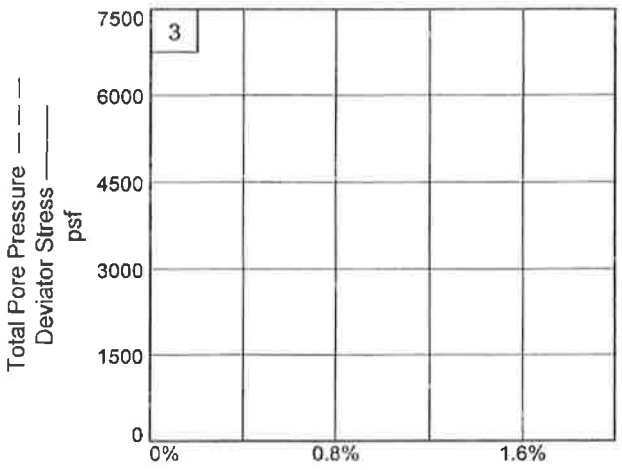
Orlando, Florida

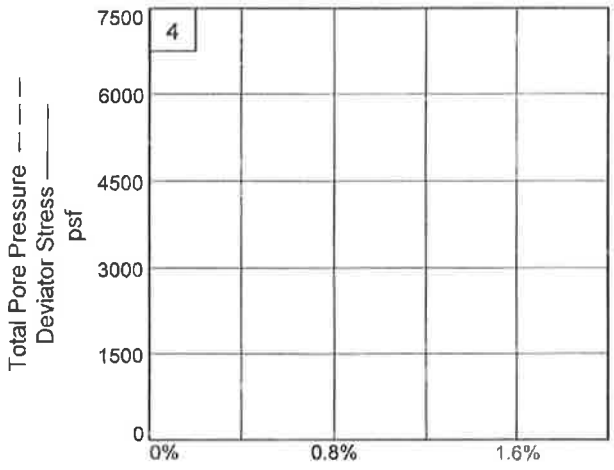
**Proj. No.:** 0930.1800026

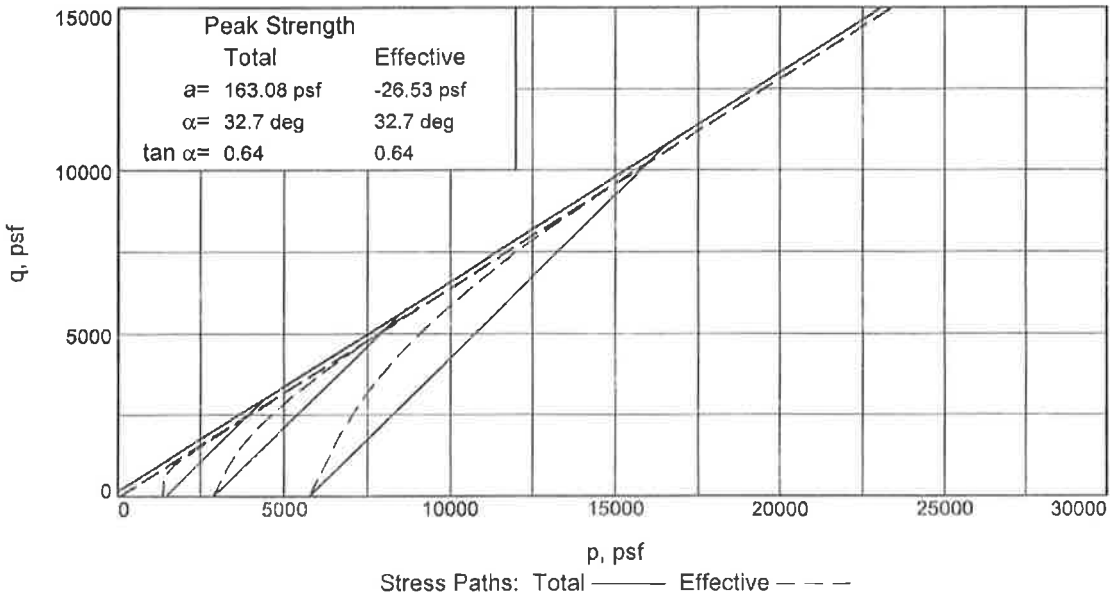
**Figure** _____




**Client:** Southern Company Services
**Project:** McManus AP Dike
**Location:** B-1-A **Depth:** 1 **Sample Number:** 1
**Project No.:** 0930.1800026 **Figure** _____

**Universal Engineering Sciences**