**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

# SEEPAGE AND STABILITY STUDY FOR NORTH END OF EAST DIKE

## PURPOSE

In March 2010, Tennessee Valley Authority (TVA) requested that Geosyntec Consultants (Geosyntec) perform a Seepage and Stability Study for the South End of the East Dike that is located adjacent to the Intake Channel for the TVA Kingston Fossil Plant (KIF). As shown in Figure 1, the East Dike is located on a portion of reclaimed land that is adjacent to the existing Sluice Channel and the Ballfield Site (Site) at the KIF. Geosyntec performed a geotechnical investigation, laboratory investigation and seepage and stability analyses on the South End of the Dike. These analyses were presented to TVA in June 2010 in the letter report titled "Summary of Stability Calculations for East Dike Haul Road Kingston Fossil Plant, Ballfield Site" [Geosyntec, 2010a] and the calculation package titled "Seepage and Stability Study for East Dike and Raised Dike" [Geosyntec, 2010a]. In these analyses, the North End of the East Dike was not considered since no seepage water was observed along the downstream slope of the North End of the East Dike. These previous analyses are collectively referred to as the "South End Study".

At the request of TVA, Geosyntec has performed a follow-up seepage and stability study focused on the North End of the East Dike (referred to as the "North End Study"). It is noted that the Raised Dike and Haul Road are not present in this area. This calculation package presents the results of additional geotechnical investigation, laboratory testing and slope stability analyses for the North End of the East Dike performed during the North End Study.

## BACKGROUND

The KIF is located on the Watts Bar Reservoir, at the confluence of the Emory River and Clinch River in Harriman, Tennessee approximately 35 miles southwest of Knoxville, Tennessee. The East Dike is on the far eastern edge of a portion of land bounded by the Sluice Channel and the Intake Channel as shown on the attached aerial plan included as Figure 1.

The area of the East Dike investigated in the North End Study includes a relatively narrow driveway used for inspection of the perimeter slopes of the KIF Site and is at approximate elevation 746 feet, which is approximately 5 feet above the summer pool elevation (i.e., 741 feet) of Watts Bar Lake.

TVA has not historically reported seepage locations along the North End slopes of the East Dike.

## GEOTECHNICAL INVESTIGATION PROGRAM

As a part of the North End Study, Geosyntec requested that MACTEC advance six Standard Penetration Testing (SPT) borings along two cross section locations (i.e., C-C and D-D) selected by Geosyntec. Due to accessibility issues with the adjacent wetlands, only four SPT borings were drilled by MACTEC as part of the North End Study. Cross sections C-C and D-D were selected based on visual observations of the site. Continuous split-spoon samples were obtained during drilling. The borings were advanced to auger refusal depths to investigate the general engineering characteristics and the subsurface conditions. After the completion of the borings, TVA personnel surveyed the boring locations and the local ground surface elevations adjacent to the borings. The cross-sections derived from these borings are shown on Figure 1. The North End Study boring logs prepared by MACTEC are included in Attachment 1. A summary of the location and depth of the borings is presented in Table 1.

MACTEC also installed six standpipe piezometers near the borings to monitor the water levels. Piezometer construction consisted of two-inch diameter, five-foot long, Schedule 40 PVC well screen at the bottom of the standpipes. A sand filter pack was used to backfill to some distance above the screened section followed by a minimum two-foot thick bentonite seal. Piezometer locations and tip elevations are summarized in Table 2. Water levels at these six locations were obtained on a daily basis. A summary of the water level readings observed as part of the North End Study through 13 October 2010 is shown in Figure 2. It is noted that in the future, the monitoring frequency is expected to be reduced to three times per week.

MACTEC performed laboratory testing on selected split-spoon samples and undisturbed (i.e., Shelby) tube samples. Because the previous South End Study included an extensive laboratory testing matrix, the North End Study testing matrix was intended to determine whether the subsurface materials encountered as part of the North End Study are similar to those previously encountered in the South End Study. The testing matrix for the North End Study has been broken into two phases. Phase I includes a large number of natural moisture content, Atterberg Limits, soil classification, and sieve analysis tests. Phase II uses three Shelby tube samples to perform consolidated-undrained (CU) triaxial tests. The results of these tests are included in Attachment 2. Table 3 summarizes the results of the Phase I tests. Table 4 summarizes the results of the Phase II CU tests.

## SUBSURFACE STRATIGRAPHY & MATERIAL PROPERTIES

Based on Geosyntec's review of the results of the geotechnical investigation program, the subsurface materials along cross section C-C generally exhibit slightly higher blow counts than the subsurface materials along cross section D-D. Therefore, Geosyntec identified cross section

D-D as a more critical cross section and subsequently used the stratigraphy along this cross section in the seepage and static stability analyses. The location of the cross section D-D is shown in Figure 1. The ground surface geometry and the interpreted subsurface stratigraphy used in SLIDE are presented in Figure 3. Previous geotechnical boring B-45 performed by MACTEC in early 2009 was also included in the preparation of the stratigraphy of cross section D-D. The boring locations are shown in Figure 3. The boring logs for these three previous borings are also included in Attachment 1.

Geosyntec reviewed the laboratory test results received as part of the North End Study laboratory testing matrix. The laboratory test results are similar to those received previously from the South End Study, with the exception of the "Upper Dike Fill" layer. Based on Geosyntec's understanding of site conditions and the SPT testing values, it appears that the dike was constructed in two stages. The dike was constructed initially and then a second layer of "Upper Dike Fill" was added on top in the South End of the East Dike to support additional ash disposal behind the East Dike. The North End of the East Dike does not appear to have this additional fill, therefore the entire East Dike section in the North End Study will be considered to be Lower Dike Fill.

Based on the similarity in laboratory test results between the North End Study and the South End Study, Geosyntec has used the same material properties previously assumed as part of the South End Study in the analyses herein. The material properties used in the seepage analyses are summarized in Table 5, and the properties used in the stability analyses are summarized in Table 6.

## SEEPAGE ANALYSES

### Methodology

Based on the interpreted subsurface stratigraphy, a seepage model for the entire cross section D-D was developed based on the interpreted subsurface stratigraphy. Calculations related to seepage were conducted using the computer program SLIDE (version 5.044) [Rocscience, 2010]. SLIDE is distributed by Rocscience of Toronto, Ontario, Canada and includes the capability of performing steady-state, saturated and unsaturated groundwater analysis using the finite element method. The program calculates pore-pressures, piezometric head, and discharge quantities using the site-specific geometry considered for the slope stability analysis. Calculated pore pressures at discrete points are integrated into the slope stability analysis.

Steady state seepage was assumed for these analyses, using static water levels in the rim ditch, the sluice channel, and the intake channel as boundary conditions. The water level in the

rim ditch and sluice channel was assumed to be at elevation 765 feet based on recent topographic plan provided by Jacobs. On the downstream side, the water level in the intake channel was assumed to be at elevation 737 feet, corresponding to a normal winter pool elevation of the adjacent Watts Bar Lake.

Additional relevant boundary conditions for the SLIDE analysis are assumed as follows. Along the vertical upstream edge of the model, the hydraulic head at each node is constant with depth and equal to the rim ditch/sluice channel water level elevation. Along the vertical downstream edge of the model, the hydraulic head at each node is equal to the intake channel water level elevation at the location of the node. Other nodes along the ground surface are treated as potential seepage exit locations. The base of the model is assumed to be located on top of the shale bedrock and is modeled as a seepage barrier, where flow is not allowed to cross these boundary nodes.

Input Parameters

For the analyzed cross section D-D, the representative profile was compiled based on boring logs and available record drawings. The hydraulic conductivity for vertical seepage through saturated materials ($k_v$) was estimated using available laboratory data. Typical values for similar soils were obtained by Geosyntec using various public sources in cases when laboratory data were not available. The ratio of horizontal hydraulic conductivity ($k_h$) to vertical hydraulic conductivity ($k_v$) was estimated based on placement condition of the materials. Given the hydraulic placement condition of the materials, a typical value of $k_h/k_v$=10 was assumed for the ash, the clay dike material, the clayey foundation materials, and the sandy foundation material. It is noted that the input parameters used for the seepage analysis are similar to those previously assumed as part of the South End Study.

Critical Exit Gradient

A critical exit gradient is calculated as the gradient that causes seepage pressures in an upward direction to exceed the downward force of the soil. In this case, the calculated factor of safety (FS) with respect to the escape gradient ($FS_G$) can be defined as:

$$FS_{gradient} = i_c / i \qquad (1)$$

where $i$ is the escape gradient in the soil at the exit point. SLIDE computes values of the escape gradient. The hydraulic gradient associated with escape gradient near an unrestrained soil surface is termed the critical gradient, $i_c$, which can be computed as:

$$i_c = (\gamma - \gamma_w) / \gamma_w \qquad (2)$$

where $\gamma$ is the total unit weight of the soil and $\gamma_w$ is the unit weight of water. For the clayey dike material such as the Upper Dike Fill and Lower Dike Fill, $\gamma$ is approximately 120 pounds per cubic feet (pcf) and the $\gamma_w$ is 62.4 pcf. Therefore, the calculated $i_c$ is ≈0.9.

According Section 1.7.1 of TVA's 7 December 2009 report titled "*Facility Design and Construction Requirements, Volume 2, Rev 1.0*", "*selection of an acceptable minimum $FS_{eg}$ against piping should be on a case by case basis at the discretion of an experienced engineer. Based on the literature, a $FS_{eg}$ greater than or equal to 4 should provide reasonable guidance as an acceptable minimum factor of safety for the piping mode, providing it is used in conjunction with other factors and sound engineering judgment.*"

Other investigators have recommended ranges for $FS_G$ from 1.5 to 15 according to US Army Corps of Engineers (USACE) Engineering Manual 1110-2-1901 [USACE 1986].

Contour plots of the vertical hydraulic gradient and the phreatic surface computed in SLIDE are shown in Figure 4. The negative value indicates the water flows downward and the positive value indicates the water flows upward. Due to the different hydraulic conductivities of different layers, the contour lines are discontinuous at the material boundaries. The results indicate that the calculated vertical hydraulic gradient along the East Dike Fill and the underlain Clayey Foundation Soil, *i*, ranges from 0 to 0.46. The calculated maximum *i* within the East Dike Fill is located at the toe of the East Dike Fill layer. Using Equation (1), the minimum $FS_G$ is calculated as 1.96, which is less than the recommended FS of 4 as presented in the TVA Master Programmatic Document. Further discussion and recommendations are provided in the conclusion session of this calculation package.

## STATIC STABILITY ANALYSES

### Methodology

Static stability analyses were performed using Spencer's method [Spencer 1973], as implemented in SLIDE, the same program used in the previously referenced seepage analysis. Two failure modes were considered in the analyses: (i) rotational failure modes (i.e., circular slip surfaces); and (ii) translational failure modes (i.e., block slip surfaces). The purpose of the stability analyses is to evaluate the calculated factor of safety for these two potential relatively deep-seated failure modes.

Spencer's method is chosen to analyze the rotational failure modes and the translational failure modes. Spencer's method, which satisfies both vertical and horizontal force equilibrium

and moment equilibrium, is considered to be more rigorous than other methods, including the simplified Janbu method [Janbu, 1973] and the simplified Bishop method [Bishop, 1955]. It should be noted that a minimum depth of 3 ft was used in the analysis to avoid calculation of shallow veneer slip (i.e., sloughing), as this slip mode is not considered to be as important as the overall global stability of the dike.

### Input Parameters

Information required for the static stability analyses includes slope geometry, subsurface ash/soil stratigraphy, phreatic surface computed from the seepage analysis, and material properties of the subsurface soils along the selected cross section.

### Target Factors of Safety

Target factor of safety (FS) values for these conditions are identified in Section 1.4.2 of TVA's 7 December 2009 report titled "*Facilities Design and Construction Requirements, Volume 2, Rev 1.0.*" In this document, the TVA requirement for post-closure slopes (i.e., long-term conditions) is 1.5. TVA allows a calculated factor of safety of 1.3 for "interim slopes." Geosyntec believes that the East Dike is a long-term condition and therefore a target FS of 1.5 is appropriate.

### Results

The minimum FS values for the North End of the East Dike were calculated using Cross Section D-D and the results are summarized in Table 7. As shown in this table, the calculated FS values satisfy the target FS of 1.5 long-term loading conditions. The calculated critical failure surface for each potential failure mode is shown graphically in Figures 9 (rotational failure). SLIDE output files are included in Attachment 3.

## SEISMIC STABILITY ANALYSES

### Methodology

Seismic slope stability analyses were performed using a procedure consistent with a guidance document prepared by the U.S. Environmental Protection Agency [USEPA, 1995]. The procedure is as follows:

1. Estimate the peak ground acceleration (PGA) at the site. Estimate the peak horizontal acceleration ($a_{max}$) of the potential critical slip surface based on PGA.

2. Perform pseudo-static slope stability analyses for the potential critical section to evaluate the yield acceleration. The yield acceleration is the horizontal acceleration at which a marginally stable condition is produced (i.e., factor of safety of 1.0) for the potential slip surface. A trial-and-error process was applied to evaluate the yield acceleration.

3. The yield acceleration ($k_y$) was compared to the peak horizontal acceleration ($a_{max}$) of the slide mass due to the design earthquake. If $k_y$ is greater than $a_{max}$, the analysis is concluded, as the landfill will not likely undergo permanent displacement. If $k_y$ is less than $a_{max}$, then the landfill will likely undergo permanent displacement and a displacement analysis is performed to evaluate the magnitude of the permanent displacement.

4. The seismic displacement, corresponding to the computed $k_y/a_{max}$ ratio, is estimated using the results presented by Hynes and Franklin [1984] and the "modified mean + one standard deviation curve" developed by Geosyntec, as presented in Figure 7. The "modified mean + one standard deviation curve" considers data associated with only large earthquakes, and therefore, is more conservative to use. This procedure is consistent with those given in the USEPA guidance document [USEPA, 1995].

According to United States Geological Survey (USGS) seismic hazard map [2008], the PGA with a 2 percent probability of exceedence in 50 years (or 10 percent probability of exceedence in 250 years) is 0.20 g for the KIF site as presented in Figure 8. The peak horizontal acceleration ($a_{max}$) was assumed the same as the PGA because subsurface soil conditions were considered not to have the potential for amplification of the ground motion.

Deformation Performance Criteria

The criterion for seismic stability is based on calculated permanent deformation. According to Table 1.4.2-1 of the TVA's 7 December 2009 report titled "*Facilities Design and Construction Requirements, Volume 2, Rev 1.0.*", the embankment has an allowable calculated displacement of 1 meter.

Analysis Case and Shear Strength Selection

Based on the static slope stability analyses results, both the circular slip mode and the block mode have similar calculated FSs with the circular mode being a little more conservative. Therefore, only the circular mode was analyzed for seismic slope stability analysis.

The seismic slope stability analyses were conducted using both drained and undrained shear strength values, and the smaller yield acceleration ($k_y$) (i.e., more conservative) was used to estimate the deformation.

Results

The minimum yield acceleration ($k_y$) using the undrained shear strength was computed for Section D-D and the results are summarized in Table 8. Per Figure 7, the calculated deformation is approximately 0.4 meter, which is considered as acceptable since it is less than the maximum allowable deformation of 1.0 meter. SLIDE output files are included in Attachment 3.

## CONCLUSIONS

The minimum calculated FS of 1.96 from the seepage model for the slopes of the North End of the East Dike is less than the recommended FS of 4 as presented in the TVA Master Programmatic Document. It is noted that the water pool elevation in the model was conservatively modeled using winter pool elevation at 737 ft. However, the water level observation at well PZ-D1B was conducted during summer/fall season and the summer pool elevation was at approximately 741 ft. An additional seepage analysis was performed using a water pool elevation at 741 ft and the result is presented in Figure 10. According to the result, the maximum calculated vertical hydraulic gradient $i$ = 0.275, therefore, the FS was calculated to be 3.27, which is greater than the previously calculated FS of 1.96. It should be noted that this FS corresponding to the summer pool elevation is still less than the recommended value of 4. If the water level at well PZ-D1B remains the same during winter season when the pool elevation drops to 737 ft, the FS against piping will be calculated as 1.96 again.

Due to the interim condition of the East Dike, Geosyntec recommends regular monitoring of water levels in the piezometers/wells on the North End of East Dike. In addition, one or more slope inclinometers are recommended to be installed on the North End of the East Dike. The purpose of the proposed slope inclinometers is to capture abnormal and sudden dike soil movement and provide early warning to potential piping failure. If a consistent trend of soil lateral movement is observed, remediation measures (such as lowering the water level behind the dike on the landside) shall be taken immediately at that time.

The static stability analysis performed by Geosyntec indicates that the North End of the East Dike has adequate calculated factors of safety against a deep-seated failure mechanism in long term conditions.

The seismic stability analysis performed by Geosyntec indicates that the North End of the East Dike is anticipated to develop deformation during the design earthquake. However, the calculated deformation is less than the maximum allowable deformation, and is thus considered as acceptable.

## REFERENCES

Bishop, A. (1955), *The Use of the Slip Circle in the Stability Analysis of Slopes*, Geotechnique, Volume 5, No. 1, Jan 1955, pp. 7-17.

Geosyntec Consultants (2010), *Summary of Stability Calculations for East Dike Haul Road Kingston Fossil Plant, Ballfield Site*, June 2010.

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USEPA. RCRA Subtitle D (258) *Seismic Design Guidance for Municipal Solid Waste Landfill Facilities*. Document Number EPA600-R-95-051, 1995.

# Tables

## Table 1. Summary of Borings

| Boring No. | Northing | Easting | Ground Elevation (ft) | Boring Termination Depth (ft) | Boring Termination Elevation (ft) |
|---|---|---|---|---|---|
| C-1 | 553672.74 | 2440474.16 | 748.44 | 47.2 | 701.2 |
| C-2 | 553640.67 | 2440489.71 | 743.90 | 43.4 | 700.5 |
| D-1 | 553760.16 | 2440698.96 | 748.70 | 53.7 | 695.0 |
| D-2 | 553727.81 | 2440708.45 | 743.30 | 44.9 | 698.4 |

Notes:

1. The northing, easting, and ground elevation at each boring location was provided by Jacobs.
2. The boring logs provided by MACTEC are included in Attachment 1.

## Table 2. Summary of Piezometers

| Piezometer No. | Piezometer Depths (ft) | Ground Elevation (ft) | Screen Depth (ft) | Layer Screened In |
|---|---|---|---|---|
| PZ-C1A | 15.50 | 748.44 | 10.00 – 15.00 | East Dike Fill |
| PZ-C1B | 30.09 | 748.44 | 24.90 – 29.90 | Sandy Foundation Soil |
| PZ-C2 | 17.50 | 743.90 | 11.93 – 16.93 | Clayey Foundation Soil |
| PZ-D1A | 20.50 | 748.70 | 14.86 – 19.86 | Clayey Foundation Soil |
| PZ-D1B | 39.50 | 748.70 | 34.00 – 39.00 | Sandy Foundation Soil |
| PZ-D2 | 15.32 | 743.30 | 10.07 – 15.07 | Clayey Foundation Soil |

Note:

1. The piezometer depth, ground surface elevation and screen depth at each piezometer location was provided by MACTEC in the piezometer logs.
2. Based on the boring results, the foundation soil layer may potentially be a confined/pressurized layer.

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

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# Table 3. Summary of Phase I Testing (provided by MACTEC)

*East Dike Stability Study, TVA Kingston, Harriman, TN*
*MACTEC Project 3043101038*

*September 24, 2010*

**Table 1**
**Index/Classification Test Summary**

| Boring | Sample Depth (Feet bgs) | Sample Type/Number | Natural Moisture Content, % | Atterberg Limits | | | Grain Size Distribution | | | USCS Classification | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Liquid Limit | Plastic Limit | Plasticity Index | Gravel, % | Sand, % | Fines – Silt & Clay, % | Group Symbol | Group Name |
| C-1 | 8.5-10 | SS-6 | 21.5 | | | | | | | | |
| C-1 | 7-8.5 | SS-5 | | 42 | 26 | 17 | 9.3 | 41.6 | 49.1 | SC | Clayey Sand |
| C-1 | 10-11.5 | SS-7 | 63.6 | | | | | | | | |
| C-1 | 11.5-13 | SS-8 | 23.9 | 44 | 28 | 16 | 12.0 | 54.1 | 33.9 | SM | Silty Sand |
| C-1 | 13-14.5 | SS-9 | 29.6 | | | | | | | | |
| C-1 | 16-17.5 | SS-11 | 25.2 | 31 | 20 | 10 | 0 | 26.8 | 73.2 | CL | Lean Clay with Sand |
| C-1 | 17.5-19 | SS-12 | 22.3 | | | | | | | | |
| C-1 | 19-20.5 | SS-13 | | 33 | 20 | 13 | 2.0 | 24.1 | 73.9 | CL | Lean Clay with Sand |
| C-1 | 20.5-22 | SS-14 | 22.7 | | | | | | | | |
| C-1 | 38.5-40 | SS-26 | 20.5 | | | | | | | | |
| C-1 | 40-41.5 | SS-27 | 16.5 | NP | NP | NP | 0 | 66.9 | 33.1 | SM | Silty Sand |
| C-1 | 41.5-43 | SS-28 | 19.1 | | | | | | | | |
| C-2 | 7.5-9 | SS-5 | 17.0 | 40 | 25 | 14 | 25.4 | 44.5 | 30.1 | SC | Clayey Sand with Gravel |
| C-2 | 10.5-12 | SS-7 | 26.3 | | | | | | | | |
| C-2 | 12-13.5 | SS-8 | 26.6 | 29 | 20 | 10 | 7.2 | 27.8 | 65.0 | CL | Sandy Lean Clay |
| C-2 | 13.5-15 | SS-9 | 22.7 | | | | | | | | |
| C-2 | 25.5-27 | SS-17 | 19.8 | NP | NP | NP | 0.6 | 50.2 | 49.2 | SM | Silty Sand |
| C-2 | 27-28.5 | SS-18 | 16.2 | | | | | | | | |
| C-2 | 28.5-30 | SS-19 | 24.4 | | | | | | | | |
| D-1 | 12-13.5 | SS-9 | | 40 | 23 | 17 | 11.9 | 54.1 | 34.0 | SC | Clayey Sand |
| D-1 | 13.5-15 | SS-10 | 19.4 | | | | | | | | |
| D-1 | 15-16.5 | SS-11 | 21.1 | 34 | 20 | 14 | 1.0 | 16.7 | 82.3 | CL | Lean Clay with Sand |
| D-1 | 16.5-18 | SS-12 | 23.4 | | | | | | | | |
| D-1 | 18-19.5 | SS-13 | 23.3 | | | | | | | | |
| D-2 | 5.5-7 | SS-4 | | | | | | | | | |
| D-2 | 7-8.5 | SS-5 | 14.2 | 40 | 22 | 18 | 12.4 | 49.1 | 38.5 | SC | Clayey Sand |
| D-2 | 8.5-10 | SS-6 | 18.4 | | | | | | | | |
| D-2 | 10-11.5 | SS-7 | 17.4 | 30 | 19 | 11 | 0 | 15.9 | 84.1 | CL | Lean Clay with Sand |
| D-2 | 11.5-13 | SS-8 | | | | | | | | | |

bgs – below ground surface
SS – standard penetration test/split spoon
NP – non-plastic

Prepared by/Date: Tim Lawrence 9/24/2010
Checked by/Date: [illegible] 9/24/2010

Note:

1. These results were provided to Geosyntec by MACTEC.

## Table 4. Summary of Consolidated – Undrained Triaxial Shear Testing

| Boring No. | Sample Interval (ft) | Material Description | Material Zone | CU Triaxial Strength | |
|---|---|---|---|---|---|
| | | | | c' (psf) | ϕ' ($^o$) |
| C-2 [2] | 25.0-27.0 | Silty Clayey Sand | Sandy Foundation Soil | 1260 | 25.8° |
| D-2 | 7.5-9.5 | Clayey Sand with Gravel | East Dike Fill | 80 | 33.4° |
| D-2 | 15.0-17.0 | Sandy Clay | Clayey Foundation Soil | 0 | 33.4° |

Note:

1. Laboratory testing results provided by MACTEC in October 2010 (see Attachment 2).
2. The cohesion value of 1,260 psf for boring C-2 is considered relatively large for a silty clayey sand material. This is likely caused by the large silt and clay percentage in the testing sample (i.e., 49.2% per Table 3). For slope stability analyses presented in this calculation package, the cohesion component will be conservatively ignored.

## Table 5. Material Properties for Seepage Analysis

| Material Layers | Permeability | | Source |
|---|---|---|---|
| | Vertical $k_v$ (cm/s) | $k_h/k_v$ | |
| Crust Layer | $3 \times 10^{-5}$ | 10 | Note 1 |
| East Dike Fill | $1.7 \times 10^{-7}$ | 10 | Note 2 |
| Soft Pond Ash | $5.85 \times 10^{-5}$ | 10 | Note 3 |
| Clayey Foundation Soil | $4.4 \times 10^{-8}$ | 10 | Note 2 |
| Sandy Foundation Soil | $1 \times 10^{-5}$ | 10 | Note 4 |

Notes:

1. Based on *Fly Ash, Bottom Ash and Scrubber Gypsum Study* performed by Law Engineering at KIF site in 1995.
2. Based on laboratory testing results provided by MACTEC during the *South End Study*.
3. Based on average values for Pond Ash presented in the aforementioned 1995 study.
4. Typical values for gravel and sands.

## Table 6. Material Properties for Stability Analysis

| Material Layers | Total Unit Weight (pcf) | Drained Shear Strength | | Undrained Shear Strength |
|---|---|---|---|---|
| | | c' (psf) | ϕ' (°) | |
| Crust Layer | 120 | 500 | 10 | N/A |
| East Dike Fill | 120 | 0 | 30 | $Su/\sigma_v' = 0.78$ [2] |
| Soft Pond Ash | 75 | 0 | 25 | $Su/\sigma_v' = 0.8$ |
| Clayey Foundation Soil | 125 | 0 | 30 | $Su/\sigma_v' = 0.25$ |
| Sandy Foundation Soil | 125 | 0 | 26 [3] | N/A |

Notes:

1. The shear strength values presented in this table are identical to those previously assumed in the South End Study [Geosyntec, 2010] except those discussed in the following notes. The laboratory investigation indicates that the materials encountered as part of the North End Study are similar to those encountered in the South End Study, therefore, the use of the previous material properties is considered acceptable. The "East Dike Fill" layer matches the "Lower Dike Fill" layer from the South End Study, as discussed in the package.
2. The $Su/\sigma_v'$ for the East Dike Fill is derived from the triaxial test results for sample D-2 at depth 7.9' to 9.5'. This triaxial test results are presented in Attachment 2 of this calculation package.
3. As previously discussed in Table 4, sample C-2 is located in the Sandy Foundation Soil layer. For slope stability analyses presented in this calculation package, the cohesion component based on the triaxial test results for C-2 will be conservatively ignored.

**Table 7. Results of Slope Stability Analysis for East Dike and Raised Dike (Long Term Condition)**

| Failure Mode | Analyzed Condition | Calculated FS | Target FS | Is FS OK? | Results Shown in Figure |
|---|---|---|---|---|---|
| Circular Slip | Long Term | 1.80 | 1.50 | Yes | 5 |
| Block Slip | Long Term | 1.83 | 1.50 | Yes | 6 |

Notes:

1. Factors of safety presented in this table were calculated using Spencer's method for both the circular slip mode and the block slip mode.

## Table 8. Results of Seismic Slope Stability Analysis

| Failure Mode | Peak Horizontal Acceleration, $a_{max}$ (g) | Minimum Yield Acceleration ky | Displacement Analysis Necessary? | Displacement (cm.) | Acceptable ? |
|---|---|---|---|---|---|
| Circular Slip | 0.20 | 0.031 | Yes | 40 [2] | Yes |

Notes:

1. The minimum yield acceleration (Ky) calculated for Section D using the drained shear strength values was 0.104g, which was not as critical when compared with the 0.031g obtained using undrained shear strength values.
2. $k_y$ / $a_{max}$ = 0.031 / 0.2 = 0.156, per Figure 7, the displacement corresponding to a $k_y$ / $a_{max}$ ratio of 0.031 is approximately 40 cm (0.4 m, or 15.8 inches)

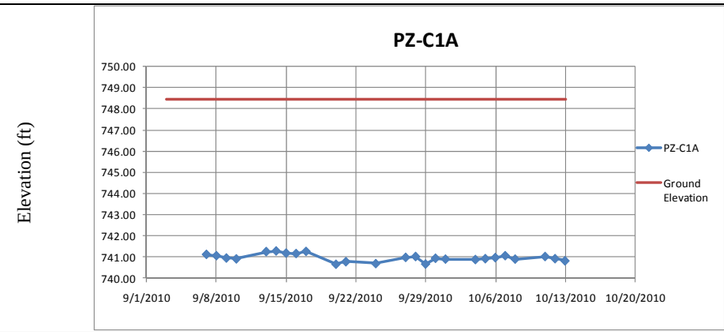
# Figures

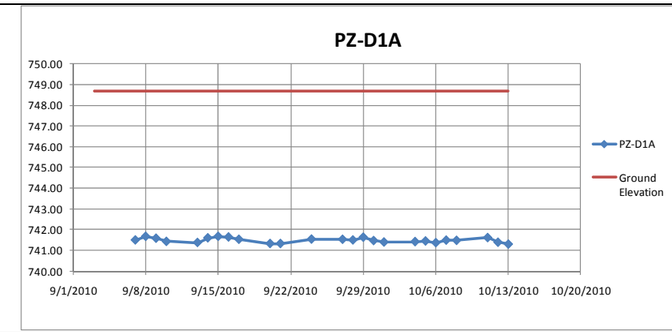

**Figure 1. Site Location**

**Note:** Sections A-A and B-B were previously analyzed as part of the South End Study

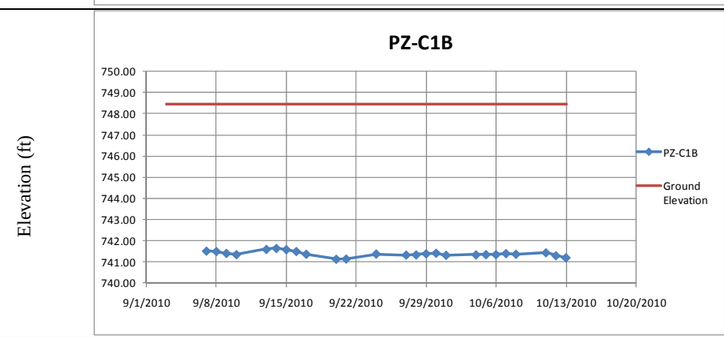
**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

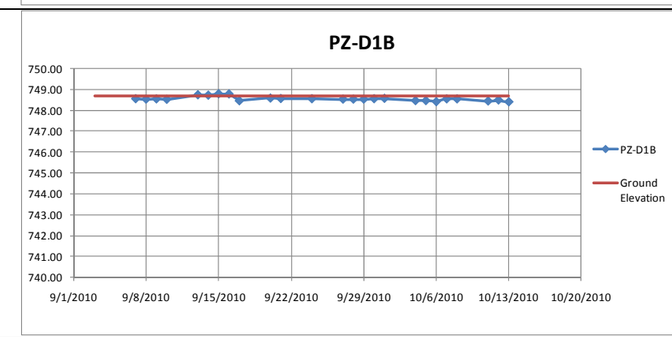
**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

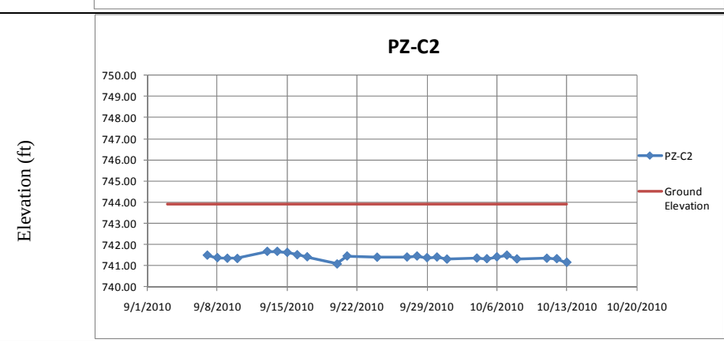



Note: The calculated phreatic surface and the ground elevation line are at the same location.



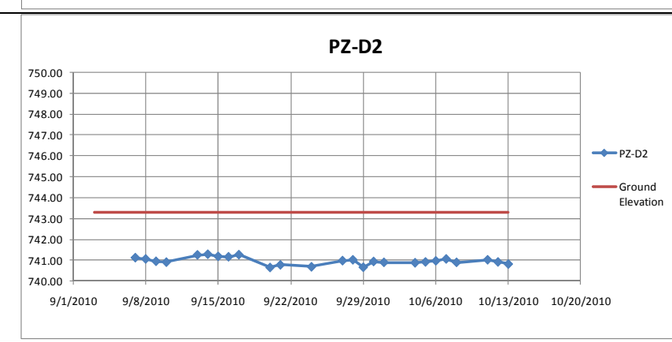




**Figure 2. Summary of Piezometer Readings (updated to 13 October 2010)**

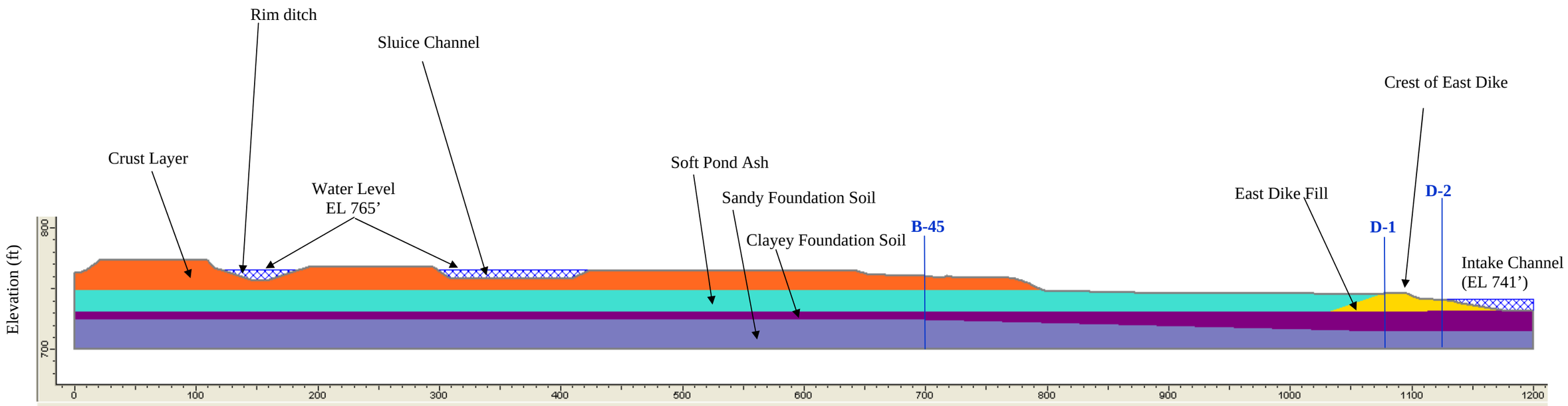



**Figure 3. Surface Geometry and Subsurface Stratigraphy (Cross Section D-D)**

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

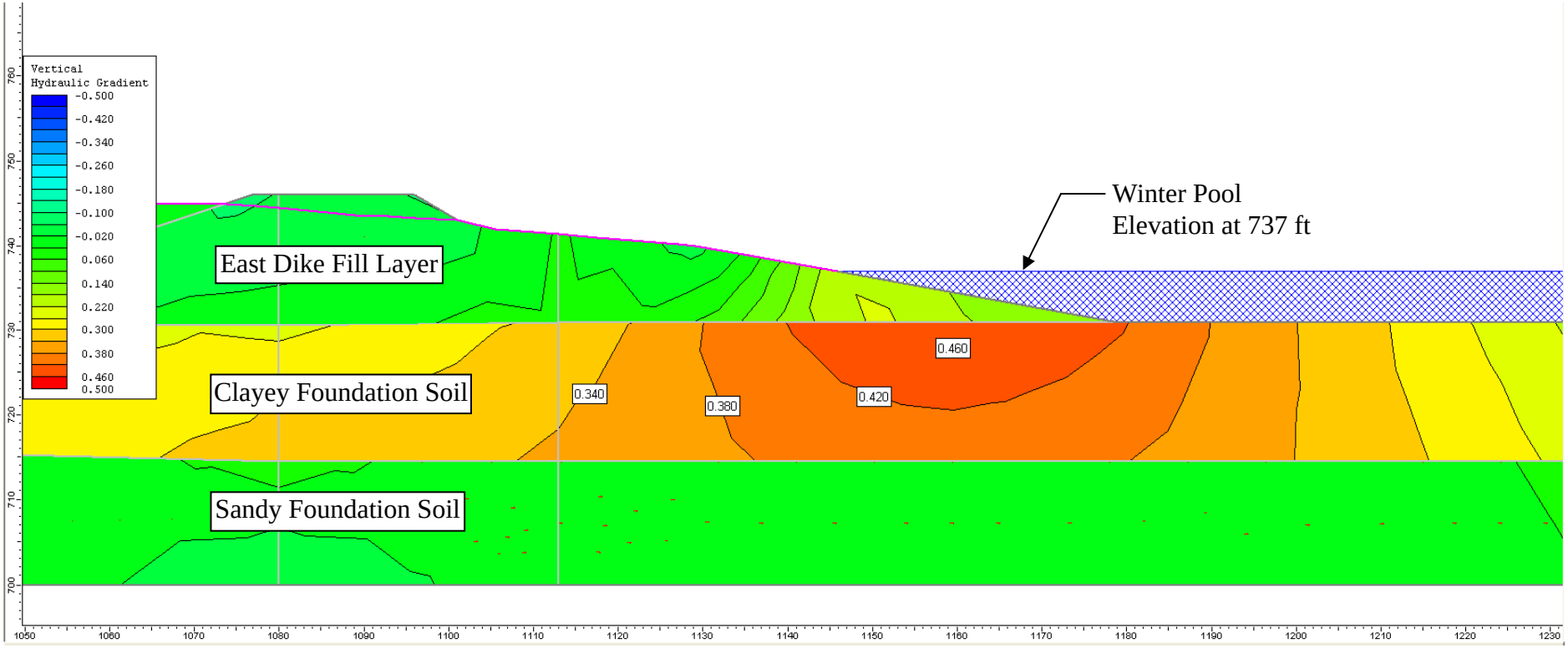



**Figure 4. Calculated Vertical Hydraulic Gradient along Cross Section D-D using Winter Pool Elevation of 737 ft**

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

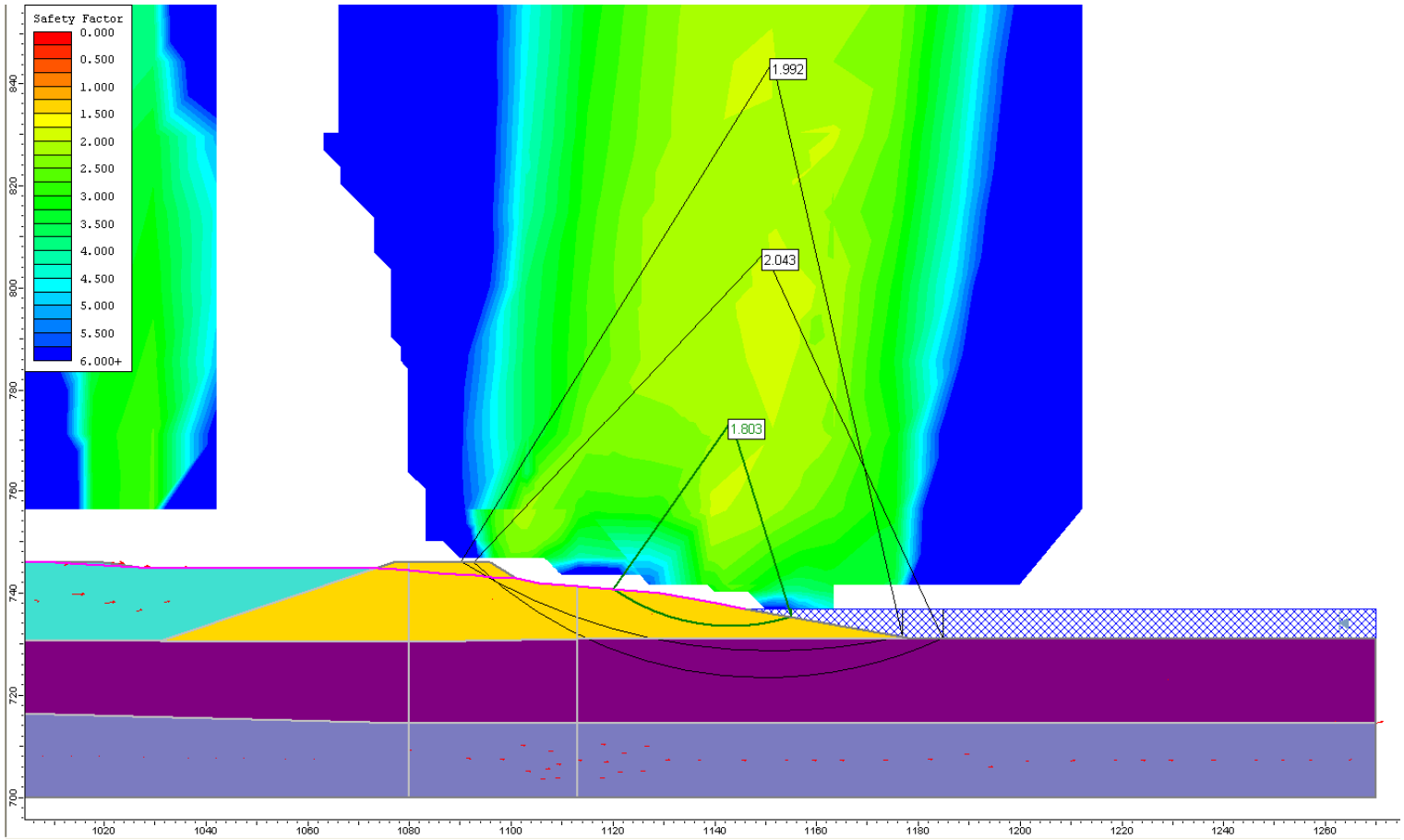



**Figure 5. Slope Stability Result: Rotational Failure Mode**

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

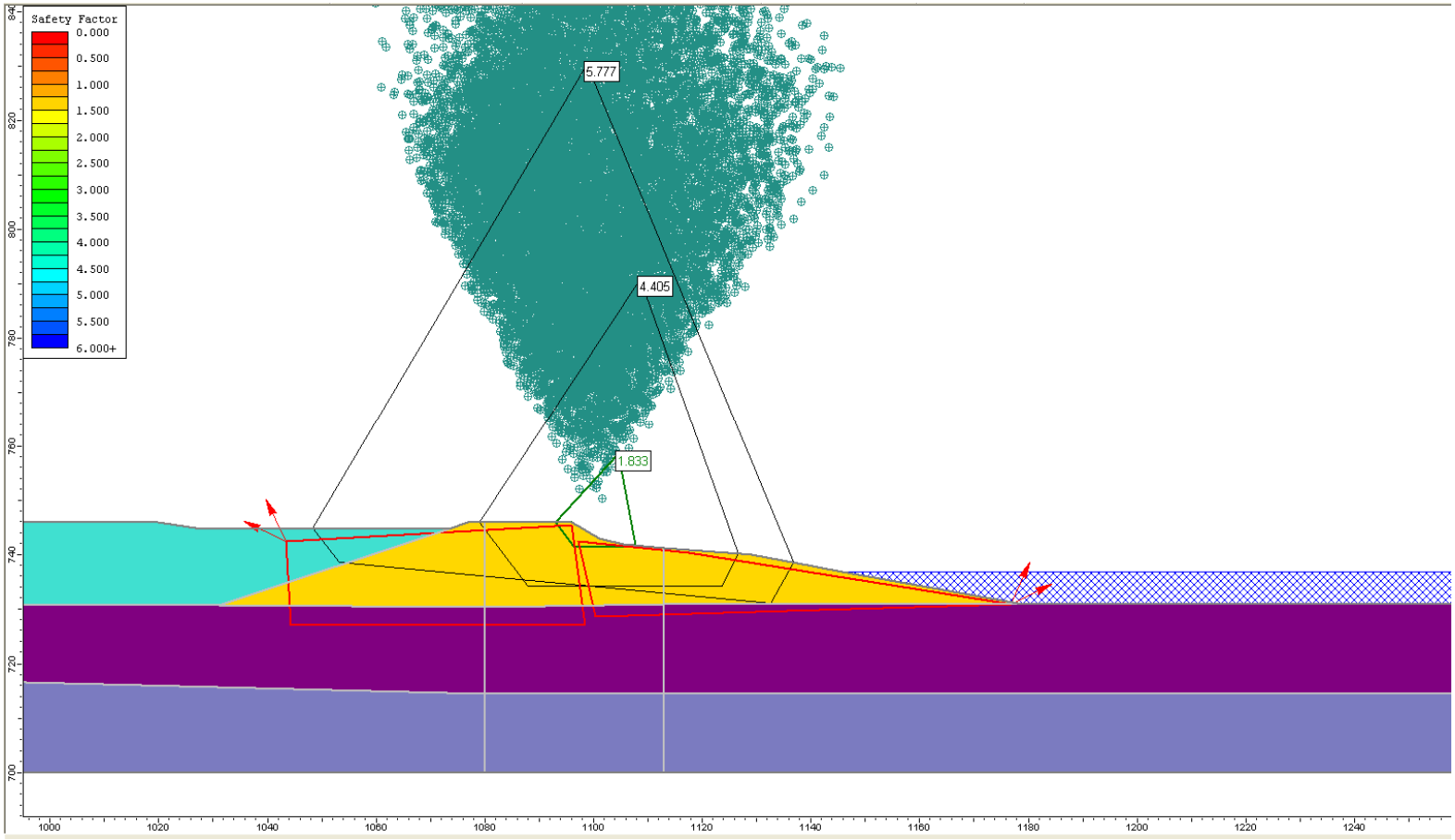



**Figure 6. Slope Stability Result: Translational Failure Mode**

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

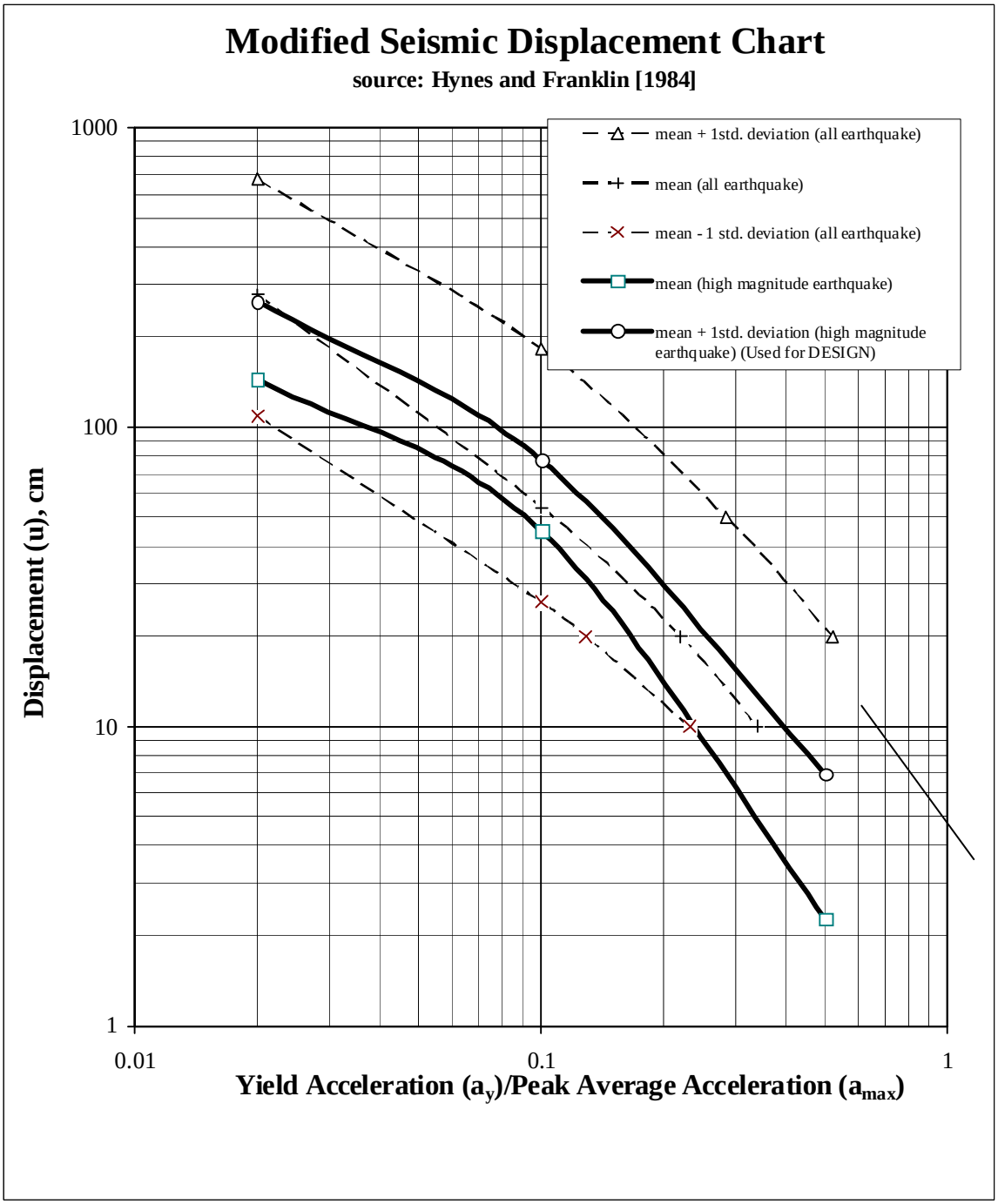
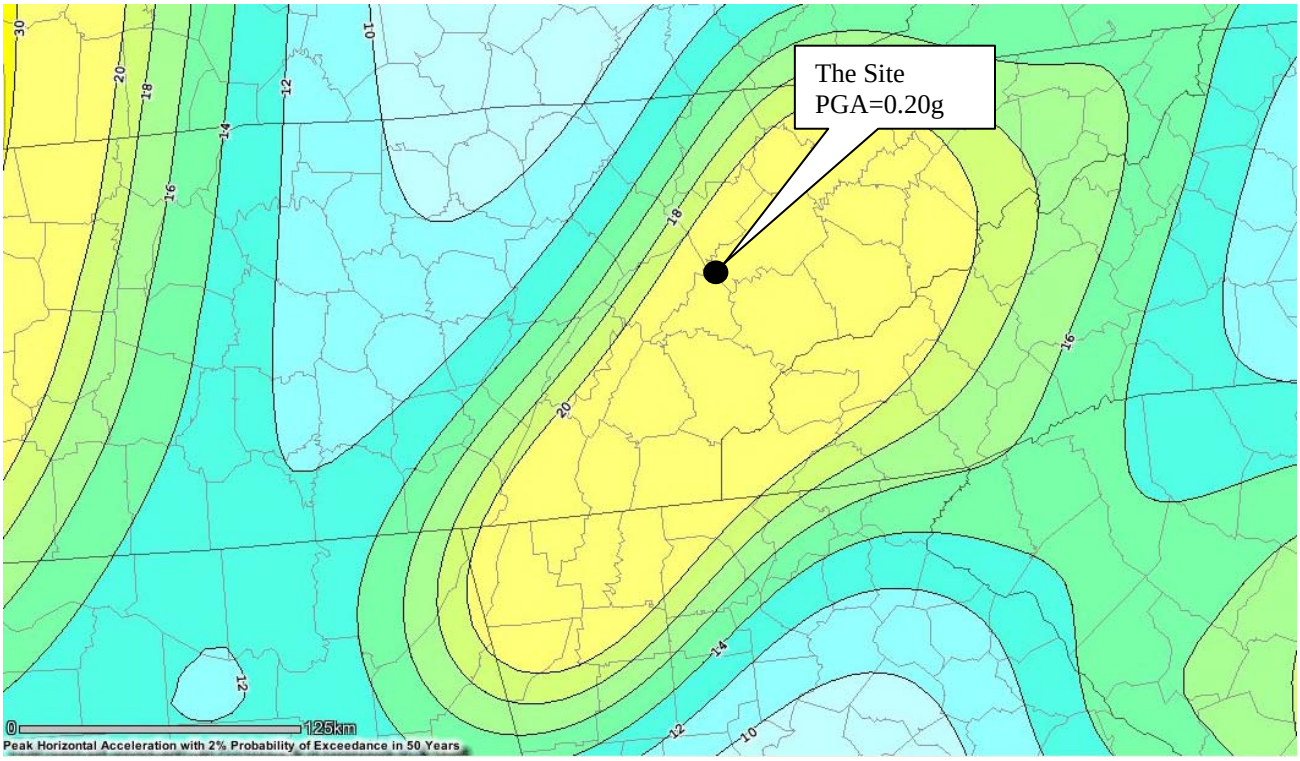



**Figure 7. Selection of Calculated Displacement**




N 35.89472°
W 84.50351°

**Figure 8. The Peak Ground Acceleration (PGA) with a 2 Percent Probability of Exceedence in 50 Years (or 10 Percent Probability of Exceedence in 250 Years) [USGS, 2008]**

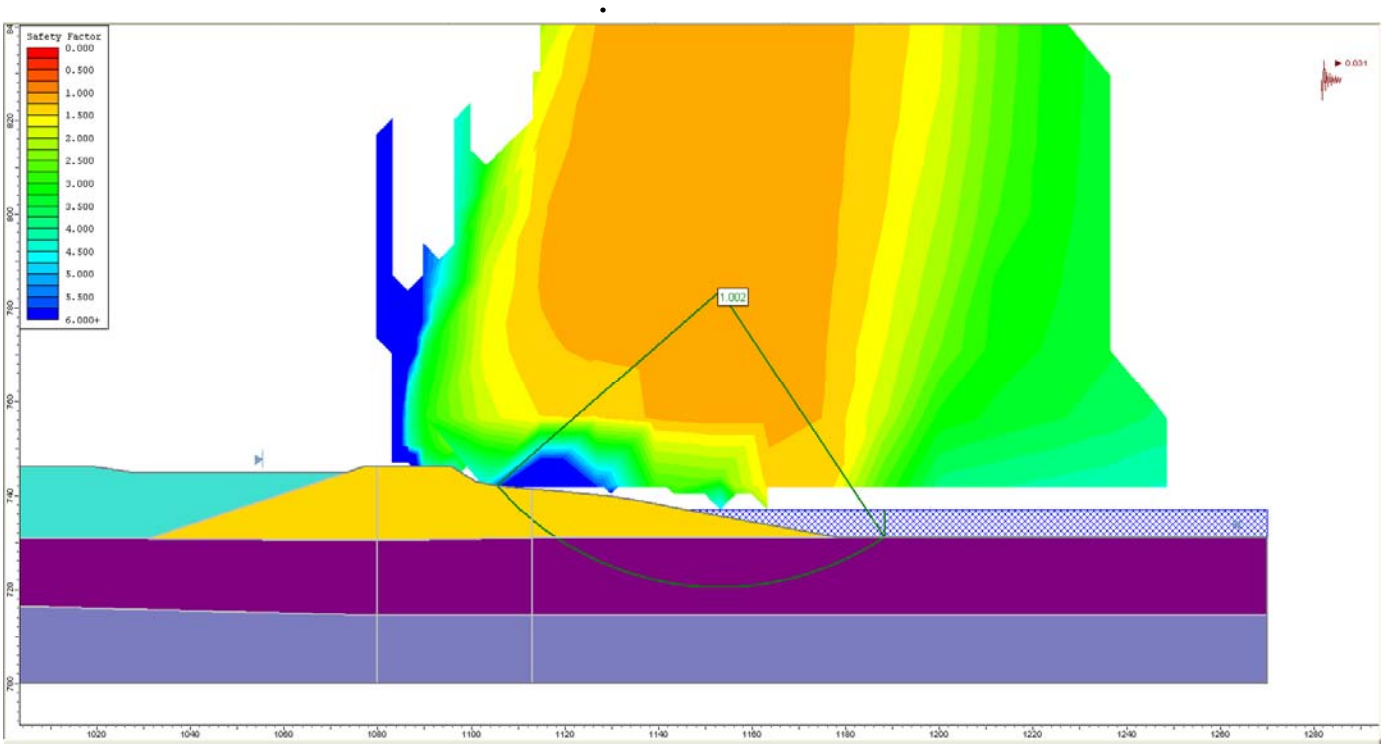



**Figure 9. Seismic Slope Stability Result using Undrained Shear Strength**

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

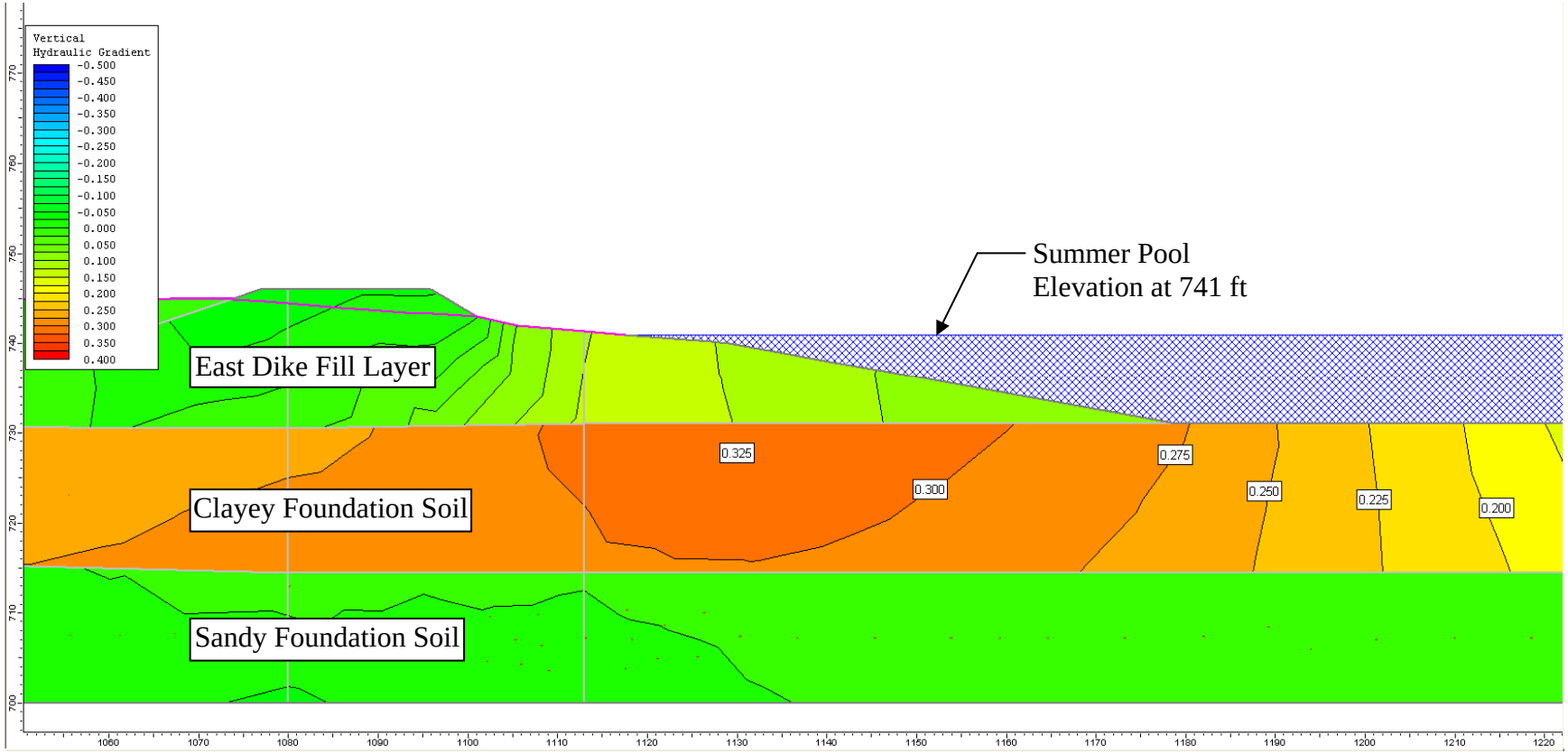



**Figure 10. Calculated Vertical Hydraulic Gradient along Cross Section D-D using Summer Pool Elevation of 741 ft**

## Attachment 1: Boring Logs

- C-1 field boring log
- PZ-C1A piezometer installation record
- PZ-C1B piezometer installation record

- C-2 field boring log
- C-2 UD offset boring log
- PZ-C2 piezometer installation record

- D-1 field boring log
- PZ-D1A piezometer installation record
- PZ-D1B piezometer installation record
- D-1 UD offset boring log

- D-2 field boring log
- D-2 UD offset boring log
- PZ-D2 piezometer installation record

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. C-1 PG. 1 OF 3

RIG TYPE CME-550 ATV HAMMER TYPE AUTO

JOB NO. 3043101038 DRILLER George Akins HOURS DRILLING 7 hours GROUND SURFACE ELEV. 748.44

JOB NAME TVA KINGSTON EAST DIKE LOGGED BY Rodney Clark HOURS MOVING 0.5 hrs DATE: 8/16/10 8/17/10 WEATHER: Cloudy, 90's Rain prior to sea

Boring is West side of East Dike Gravel Road

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Removed appx 1.0 of surfical gravel | |
| 1 | 1.0'-2.5' | WOH | 1 | WOH | | | 0.5' | light reddish brown sandy gravel fat CLAY w/ gravel, angular gravel, FILL MATERIAL very soft | FILL |
| 2 | 2.5'-4.0' | 1 | 1 | 1 | | | 1.3' | same as above | |
| 3 | 4.0'-5.5' | 4 | 6 | 9 | | | 1.2' | dark brown fat CLAY w/ gravel, wet stiff, gravel is angular shale & clay trace organics, FILL MATERIAL | |
| 4 | 5.5'-7.0' | 7 | 9 | 7 | | | 1.0' | dark brown, same as above abundant shale | |
| 5 | 7.0'-8.5' | 2 | 1 | 2 | | | 1.2' | light reddish brown fat CLAY w/ gravel (CH), gravel is angular primarily shale, soft | Begin change auger w/ water prior to SPTs |
| 6 | 8.5'-10.0' | WOH | 2 | 2 | | | 1.3' | same as above except very soft | |
| 7 | 10.0'-11.5' | WOH | WOH | 1 | | | 1.2' | same as above w/ trace organics ~~wood~~ wood | |
| 8 | 11.5'-13.0' | WOH | WOH | 1 | | | 1.5' | very soft & dark grayish brown, same as above | |
| 9 | 13.0'-14.5' | WOH | WOH | WOH | | | 0.8' | same as above | |
| 10 | 14.5'-16.0' | WOH | 7 | 3 | | | 0.4' | same as above, except stiff | |
| 11 | 16.0'-17.5' | WOH | 1 | 1 | | | 0.8' | dark brown fat CLAY w/ sand, soft, wet very soft medium plasticity, low toughness slick | 16.0 Top of Alluvium |
| 12 | 17.5'-19.0' | WOH | 1 | 2 | | | 1.5' | light yellowish brown fat CLAY, CH, high plasticity, medium toughness, moist, soft little mottling | Alluvium |
| 13 | 19.0'-20.5' | WOH | 1 | 2 | | | 1.3' | same as above, some mottling w/ light gray (8/16/10) stop drilling for the day | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED: 47.2'

BORING REFUSAL: 47.2'

WATER TOB DEPTH: 5.89' (tremie pipe) 1.89' bgs (borehole)

WATER 24 HR DEPTH: 4.32' bgs (tremie pipe) 2.25' bgs (borehole)

WATER LOSSES: DAM

CAVE-IN DEPTHS: NA

CASING: SIZE NA LENGTH NA

STANDBY TIME: 1 hr BORING LAYOUT gravel road on East Dike

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | 0.0 TO 47.2 |
| HAND SHOP: W/MUD: W/WATER | TO |
| ROTARY DRILL: W/MUD: W/WATER | TO |
| DIAMOND CORE | TO |
| CORE SIZE | TO |
| UNDISTURBED SAMPLES No. NA SIZE NA | |
| BAG SAMPLES No. NA SIZE NA | |

F102

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. C-1 PG. 2 OF 3

RIG TYPE CME-550 HAMMER TYPE AUTO

JOB NO. 3043101036 DRILLER George Akins HOURS DRILLING GROUND SURFACE ELEV. 748.44

JOB NAME TVA KINGSTON EAST DIKE LOGGED BY Rodney Clark HOURS MOVING 0.5 DATE: 8/16>17/10 WEATHER: 80°F RAIN PRIOR TO SET-UP

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | ← 8/17/10 begin drilling from 20.5' | |
| 14 | 20.5→ 22.0' | 1 | 1 | 3 | | | 1.2' | Morning W.L. = 8.54' bgs; light tan mottled w/ reddish brown fat CLAY w/ sand, wet, soft high plasticity, medium toughness | ← Coring changing augers |
| 15 | 22.0'→ 23.5' | 2 | 2 | 3 | | | 1.5' | reddish brown mottled w/ light gray fat CLAY, moist, firm high plasticity, med. toughness some sand | prior to collecting SPTs |
| 16 | 23.5'→ 25.0 | 1 | 2 | 3 | | | 1.5' | same as above | |
| 17 | 25.0'→ 26.5' | 1 | 1 | 3 | | | 1.5' | same as above except soft & increased sand content | |
| 18 | 26.5'→ 28.0' | 1 | 2 | 2 | | | 1.5' | same as above except reddish brown | |
| 19 | 28.0'→ 29.5' | WOH | WOH | 2 | | | 1.5' | same as above except very soft | |
| 20 | 29.5'→ 31.0' | 1 | 2 | 6 | | | 1.4 | same as above, grades to reddish brown clayey SAND (SC), wet, loose, mostly fine quartz sand w/ clay lensing | |
| 21 | 31.0'→ 32.5' | WOH | 1 | 3 | | | 1.3 | same as above, except very loose | |
| 22 | 32.5'→ 34.0' | 3 | 2 | 1 | | | 1.5' | same as above | |
| 23 | 34.0'→ 35.5' | 1 | 2 | 3 | | | 1.5' | light gray mottled w/ reddish brown clayey SAND (SC) wet loose, trace coarse sand mostly fine | |
| 24 | 35.5'→ 37.0' | 3 | 3 | 1 | | | 1.2' | light reddish brown silty SAND (SM) wet, loose, mostly fine quartz sand | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED:
BORING REFUSAL:
WATER TOB DEPTH: (see page 1)
WATER 24 HR DEPTH:
WATER LOSSES:
CAVE-IN DEPTHS:
CASING: SIZE LENGTH
STANDBY TIME: BORING LAYOUT

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | ___ TO ___ |
| HAND SHOP: W/MUD W/WATER | ___ TO ___ |
| ROTARY DRILL: W/MUD: W/WATER | ___ TO ___ |
| DIAMOND CORE | ___ TO ___ |
| CORE SIZE | ___ TO ___ |
| UNDISTURBED SAMPLES No. ___ SIZE ___ | |
| BAG SAMPLES No. ___ SIZE ___ | |

F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. C-1 PG. 3 OF 3

RIG TYPE CME-550 TRACK HAMMER TYPE AUTO

JOB NO. 3043101038 DRILLER George Akins HOURS DRILLING 2 GROUND SURFACE ELEV. 748.44

JOB NAME TVA KINGSTON EAST DIKE LOGGED BY Rodney Clark HOURS MOVING 0.5 DATE: 8/16→11/10 WEATHER: Cloudy 90°F RAIN 8/16/10 Prior to set up

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 25 | 37.0'→ 38.5' | WOH | WOH | 1 | / | / | 1.8' | light gray, clayey SAND (SC) wet, very loose mostly fine quartz sand some fine s. grades from yellow-brown @ 37.1' | chang auger w/water prior to obtaining SPTs! |
| 26 | 38.5→ 40.0' | WOH | 2 | 2 | / | / | 1.2' | same as above | |
| 27 | 40.0'→ 41.5' | WOH | WOH | WOH | / | / | 1.5' | same as above | |
| 28 | 41.5'→ 43.0' | 2 | 2 | 1 | / | / | 1.2' | light gray-brown, silty SAND (SM) wet, very loose, mostly fine quartz sand | |
| 29 | 43.0'→ 44.5' | 2 | 1 | 3 | / | / | 1.5' | grayish yellowish brown silty SAND (SM) wet, very loose, few coarse sand, trace subrounded gravel (sandstone & shale) | |
| 30 | 44.5→ 46.0 | 15 | 20 | 8 | / | / | 1.3' | @ 44.8 dark gray, weathered SHALE, friable, severely weathered, fissle, platy bedding | |
| 31 | 46.0→ 47.2 | 19 | 32 | 50/0.2' | / | / | 1.2' | same as above. Auger Refusal @ 47.2' Terminate Boring @ 47.2' | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED:
BORING REFUSAL:
WATER TOB DEPTH:
WATER 24 HR DEPTH: (see page 1)
WATER LOSSES:
CAVE-IN DEPTHS:
CASING: SIZE LENGTH
STANDBY TIME: BORING LAYOUT

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | TO |
| HAND SHOP: W/MUD: W/WATER | TO |
| ROTARY DRILL: W/MUD: W/WATER | TO |
| DIAMOND CORE | TO |
| CORE SIZE | TO |
| UNDISTURBED SAMPLES No. SIZE | |
| BAG SAMPLES No. SIZE | |

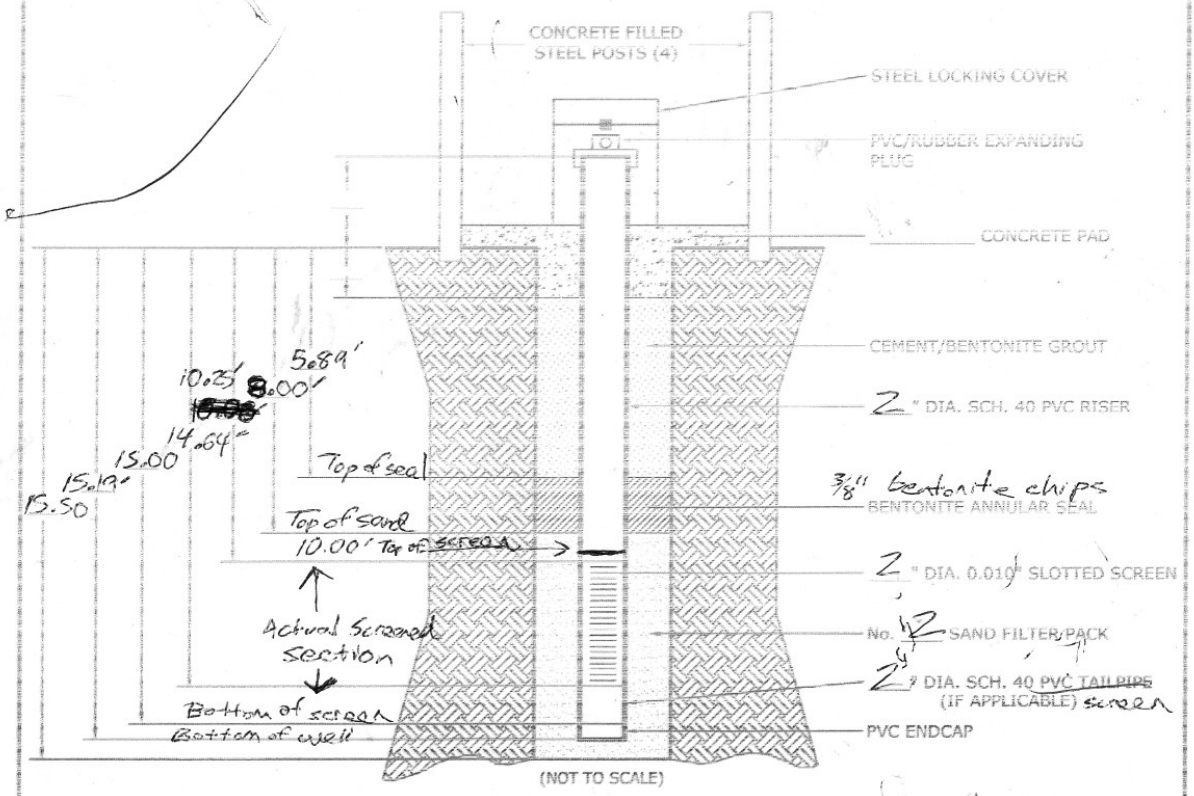
F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

# PIEZOMETER INSTALLATION RECORD

JOB NAME: TVA KINGSTON EAST DIKE
JOB NUMBER: 3043101038
WELL NUMBER: PZ-C1A
INSTALLATION DATE: 8/31/2010
DRILLED BY: TRISTATE (GEORGE AKINS)
BOREHOLE DIAMETER: 8"
RISER/SCREEN
MATERIAL: Schedule 40 PVC
TOTAL DEPTH: 15.5'
DIAMETER: 2"
FIELD REPRESENTATIVE: Rodney Clark
SLOT SIZE: 0.010"




DTW @ time of installation = 6.19' btoc / 3.07' bgs

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. PZ-C1B PG. 1 OF 1

RIG TYPE CME-550 TRACK HAMMER TYPE AUTO

JOB NO. 3043101038 DRILLER Tristate/George A. HOURS DRILLING 5 GROUND SURFACE ELEV. Appx 748.44

JOB NAME TVA Kingston EAST DIKE STABILITY STUDY LOGGED BY Rodney Clark HOURS MOVING 0.25 DATE: 8/27/10 WEATHER: Sunny 80°F

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Begin drilling from 0.0' w/ 3¼" HSA's/Charge augers at 5.0' -Driller indicates obstruction (hard drill) at target test depth/drill appx grind. 0.5' to 5.5' & charge auger | |
| UD-1 | 5.5'-7.5' | NA | NA | NA | / | UD-1 | 1.3' | -Push tube via piston sampler 2.0' -Wait appx 10 minutes prior to pulling tube/Material is brown fat CLAY (CH) w/some gravel | |
| UD-2 | 11.0'-13.0' | NA | NA | NA | / | UD-2 | | -Drill to 11.0'/Charge Augers @ 10.0' -Push tube via piston sampler 2.0' -Wait appx. 10 minutes prior to pulling tube from boring Material is brown fat CLAY w/some gravel | |
| UD-3 | 21.0'-23.0' | NA | NA | NA | / | UD-3 | | -Drill to 21.0'/Charge augers @ 15.0' & 20.0'/push tube via piston sampler 2.0' -Wait appx 10.0' minutes prior to pulling tube from boring -Drill Boring to 30.5' for installation of piezometer/Charge Augers at 25.' & 30' prior to well installation (see piezometer installation record for more details) | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT-BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED: 30.5'

BORING REFUSAL: NA

WATER TOB DEPTH: 2.85' bgs

WATER 24 HR DEPTH:

WATER LOSSES: NA

CAVE-IN DEPTHS: NA

CASING: SIZE NA LENGTH NA

STANDBY TIME: NA BORING LAYOUT Appx 5' North of C-1 boring

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | 0.0 TO 30.5' |
| HAND SHOP: W/MUD: W/WATER | TO |
| ROTARY DRILL: W/MUD: W/WATER | TO |
| DIAMOND CORE | TO |
| CORE SIZE | TO |
| UNDISTURBED SAMPLES No. 3 SIZE 2.5' tube | |
| BAG SAMPLES No. SIZE | |

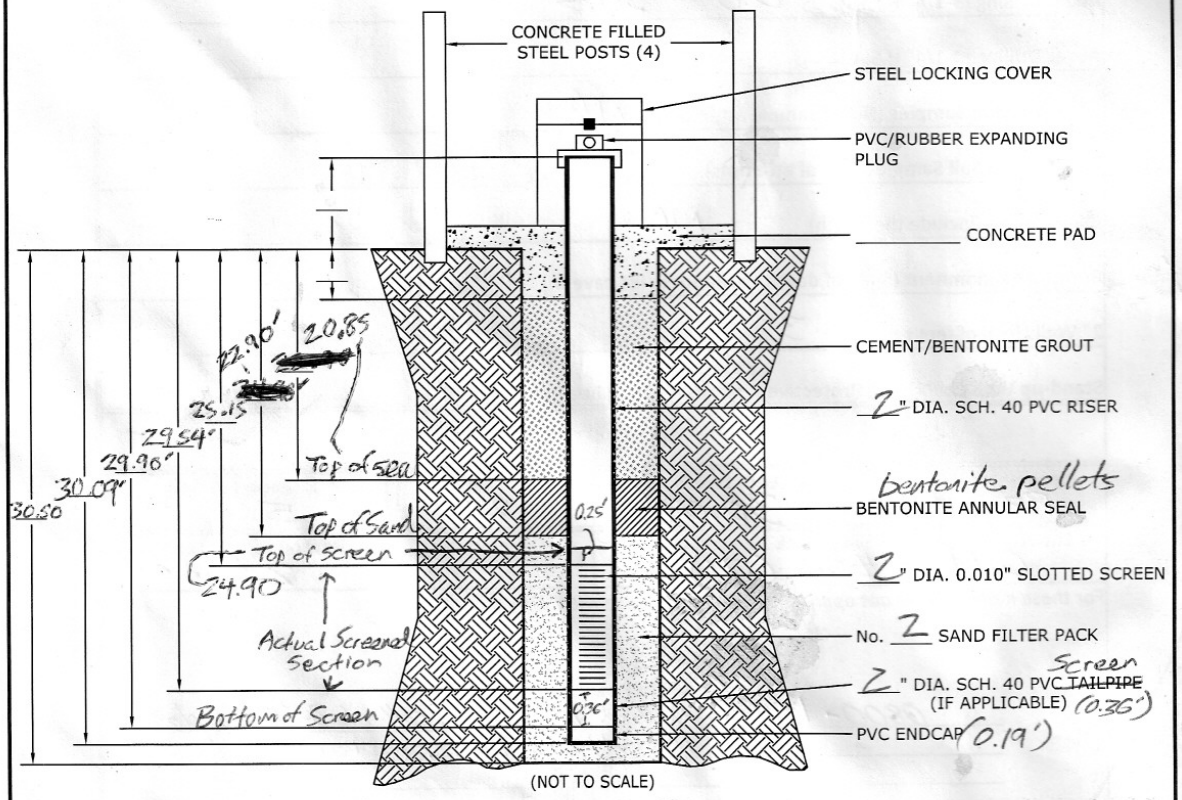
F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

# PIEZOMETER INSTALLATION RECORD

JOB NAME: TVA KINGSTON - EAST DIKE
JOB NUMBER: 3043101038
WELL NUMBER: PZ-C1B
INSTALLATION DATE: 8/27/10
DRILLED BY: TRISTATE (GEORGE AKINS)
BOREHOLE DIAMETER: 8"
RISER/SCREEN MATERIAL: Schedule 40 PVC
TOTAL DEPTH: 30.09'
DIAMETER: 2"
FIELD REPRESENTATIVE: ROONEY CLARK
SLOT SIZE: 0.010"



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**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. C-2 PG. 1 OF 3

RIG TYPE CME-550ATV HAMMER TYPE AUTO

JOB NO. 3043101038 DRILLER George Akins HOURS DRILLING 9 HRS GROUND SURFACE ELEV. 743.9'

JOB NAME TVA KINGSTON EAST DIKE LOGGED BY Rodney Clark HOURS MOVING 1.0 HRS DATE: 8/13-16/10 WEATHER: Sunny 90's some rain on 8/15/10

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| NA | 0.0'-1.5' | | | | | | | 1.5' OF SURFICIAL GRAVEL | |
| 1 | 1.5'-3.0' | 2 | 3 | 4 | / | / | 1.0' | grayish brown fat CLAY w/gravel moist, firm, gravel is angular limestone & shale, large wood stick, FILL MATERIAL | FILL |
| 2 | 3.0'-4.5' | 7 | 6 | 3 | / | / | 1.4' | same as above except stiff, abundant shale fragments | |
| 3 | 4.5'-6.0' | 2 | 2 | 2 | / | / | 1.5' | brown fat CLAY (CH) w/gravel, moist, soft, high plasticity, low toughness, gravel is primarily granule size & shale fragments | ALLUVIUM |
| 4 | 6.0'-7.5' | 1 | 3 | 3 | / | / | 0.8' | same as above except firm | |
| 5 | 7.5'-9.0' | 1 | 1 | 1 | / | / | 1.3' | same as above except very soft & wet | |
| 6 | 9.0'-10.5' | WOR | WOH | 1 | / | / | 0.0' | No recovery, catcher intact | |
| 7 | 10.5'-12.0' | WOR | WOH | 1 | / | / | 1.2' | same as above | |
| 8 | 12.0'-13.5' | WOH | | | / | / | 1.2' | grayish brown elastic SILT w/sand w/some fine sand, wet, very soft | |
| 9 | 13.5'-15.0' | WOH | | | / | / | 1.3 | same as above | |
| 10 | 15.0'-16.5' | 3 | 4 | 6 | / | / | 1.5' | yellowish brown mottled w/ light gray SILT w/sand (ML) wet, stiff, low plasticity | |
| 11 | 16.5'-18.0' | 1 | 3 | 4 | / | / | 1.4' | yellowish brown mottled & gray fat CLAY w/sand (CH) wet, firm, medium plasticity, medium toughness | |
| 12 | 18.0'-19.5' | WOH | 2 | 4 | / | / | 1.5' | same as above | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED: 43.4'

BORING REFUSAL: 43.4'

WATER TOB DEPTH: 3.00' bgs (tremie pipe) 1.63' bgs (borehole)

WATER 24 HR DEPTH: 0.15' bgs (tremie pipe) 1.88' bgs (borehole)

WATER LOSSES: None

CAVE-IN DEPTHS: NA (set tremie pipe)

CASING: SIZE NA LENGTH NA

STANDBY TIME: 8/16/10 1245 RAIN DELAY BORING LAYOUT Gravel pad adjacent to river/East Dike

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | 0.0 TO 43.4' |
| HAND SHOP: W/MUD: W/WATER | ___ TO ___ |
| ROTARY DRILL: W/MUD: W/WATER | ___ TO ___ |
| DIAMOND CORE | ___ TO ___ |
| CORE SIZE | ___ TO ___ |
| UNDISTURBED SAMPLES No. NA SIZE NA | |
| BAG SAMPLES No. NA SIZE NA | |

F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. C-2 PG. 2 OF 3

RIG TYPE CME-550 TRACK HAMMER TYPE AUTO

JOB NO. 3043101038 DRILLER George Akins HOURS DRILLING 9 HRS GROUND SURFACE ELEV. 743.9

JOB NAME TVA KINGSTON EAST DIKE LOGGED BY Rodney Clark HOURS MOVING 1 HRS DATE: 8/13-16/10 WEATHER: Sunny 90°F some rain on 8/16/10

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 13 | 19.5'→ 21.0' | 1 | 3 | 5 | / | / | 1.5' | yellowish reddish brown mottled light gray, fat CLAY w/sand moist-wet, firm, medium plasticity (8-14-10) stop drilling (8/16/10) restart drilling W.L. = appx 12' bgs | All WH |
| 14 | 21.0'→ 22.5' | 1 | 3 | 4 | / | / | 1.5' | reddish brown fat CLAY (CH) w/some sand, moist firm medium plasticity, low toughness (brown fat wet CLAY cuttings begin to surface from augers drilling from 22.0' | |
| 15 | 22.5'→ 24.0' | 1 | 1 | 2 | | | 0.0' | No recovery / No catcher in split spoon | |
| 16 | 24.0'- 25.5' | WOH | 1 | 1 | | | 1.5' | reddish brown, fat CLAY w/some to few fine sand, wet, very soft, high plasticity, low toughness | |
| 17 | 25.5'- 27.0' | WOH | WOH | WOH | | | 1.5' | light yellowish brown, elastic SILT w/sand, wet, very soft, medium plastic, low toughness, sand is very fine | |
| 18 | 27.0 - 28.5' | WOH | WOH | 1 | / | / | 1.25' | same as above | |
| 19 | 28.5'- 30.0' | WOH | WOH | WOH | / | / | 1.5' | light yellowish brown CLAYEY SAND (SC) wet, very loose moist, very fine quartz sand, some fines | |
| 20 | 30.0'→ 31.5' | 2 | 1 | 2 | / | / | 1.0' | same as above | |
| 21 | 31.5'→ 33.0' | 1 | 5 | 6 | / | / | 1.5' | same as above, except firm | |
| 22 | 33.0'- 34.5' | 1 | 2 | 3 | / | / | 1.5' | same as above except loose | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED:
BORING REFUSAL:
WATER TOB DEPTH:
WATER 24 HR DEPTH:
WATER LOSSES:
CAVE-IN DEPTHS:
CASING: SIZE LENGTH
STANDBY TIME: BORING LAYOUT

(see page 1)

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | ___ TO ___ |
| HAND SHOP: W/MUD: W/WATER | ___ TO ___ |
| ROTARY DRILL: W/MUD: W/WATER | ___ TO ___ |
| DIAMOND CORE | ___ TO ___ |
| CORE SIZE | ___ TO ___ |
| UNDISTURBED SAMPLES No. ___ SIZE ___ | |
| BAG SAMPLES No. ___ SIZE ___ | |

F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. C-2 PG. 3 OF 3

RIG TYPE CME-550 TRACK HAMMER TYPE AUTO 743.9'

JOB NO. 3043101038 DRILLER George Akins HOURS DRILLING 9 HRS GROUND SURFACE ELEV. ~~743.9~~

JOB NAME TVA KINGSTON EAST DIKE LOGGED BY Rodney Clark HOURS MOVING 1.0 HRS DATE 8/13-16/10 WEATHER: 90°F + rain

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 23 | 34.5-36.0 | WOH | 2 | 4 | / | / | 1.5' | light grayish brown silty SAND; SM, wet, loose mostly fine quartz sand | |
| 24 | 36.0-37.5 | WOH | 4 | 3 | / | / | 1.5' | same as above w/trace gravel (shale fragments, quartz, limestone) & dark grayish brown | |
| 25 | 37.5-39.0 | 1 | 3 | 4 | | | 1.3' | same as above | |
| 26 | 39.0-40.5 | 29 | 18 | 16 | / | / | 1.0 | light gray, silty SAND (SM) w/some gravel, wet, dense, gravel is subrounded SANDSTONE & weathered shale fragments, mostly fine quartz sand | |
| 27 | 40.5-42.0 | 10 | 5 | 9 | / | / | 1.4' | At 40.7' dark gray, weathered SHALE friable, severely weathered, platy bedding | |
| 28 | 42.0-43.8 | 15 | 28 | 50/0.3' | / | / | 1.5' | same as above Augers Refusal @ 43.4 | Top of SHALE @40.7' ↑ Terminated |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED:
BORING REFUSAL:
WATER TOB DEPTH:
WATER 24 HR DEPTH:
WATER LOSSES:
CAVE-IN DEPTHS:
CASING: SIZE LENGTH
STANDBY TIME: BORING LAYOUT

(See page 1)

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | ___ TO ___ |
| HAND SHOP: W/MUD: W/WATER | ___ TO ___ |
| ROTARY DRILL: W/MUD: W/WATER | ___ TO ___ |
| DIAMOND CORE | ___ TO ___ |
| CORE SIZE | ___ TO ___ |
| UNDISTURBED SAMPLES No. ___ SIZE ___ | |
| BAG SAMPLES No. ___ SIZE ___ | |

F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. C2-UD Offset PG. 1 OF 1

JOB NO. ~~TVA~~ 3043101038 DRILLER TRISTATE GEORGE AKINS RIG TYPE CME-550 TRACK HAMMER TYPE AUTO

JOB NAME TVA KINGSTON LOGGED BY RODNEY CLARK HOURS DRILLING 3 GROUND SURFACE ELEV. 743.9

EAST DIKE STABILITY STUDY HOURS MOVING 0.25 DATE: 8/26/10 WEATHER:

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| UD-1 | 10.0'-12.0' | NA | NA | NA | NA | UD-1 | 1.25' | Drilled from 0.0' to 10.0' w/ 3¼" HSA's / Charged augers w/water at 5' & 10' prior to collection of UD-1 - Pushed UD-1 tube via piston sampler - Wait appx 10 minutes prior to pulling tube from boring - Material is reddish brown fat CLAY (CH) | |
| UD-2 | 25.0'-27.0' | NA | NA | NA | NA | UD-2 | | - Drill to 25.0' / Charge augers at 5' intervals & prior to collecting UD-2 - Push UD-2 2.0' via piston sampler - Wait appx 10 minutes prior to pulling tube from boring | |
| | | | | | | | | Terminate @ 27.0' | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED: 27.0'

BORING REFUSAL: NA

WATER TOB DEPTH: 2.5' bgs

WATER 24 HR DEPTH: DNM

WATER LOSSES: NA

CAVE-IN DEPTHS: NA

CASING: SIZE NA LENGTH NA

STANDBY TIME: NA BORING LAYOUT 5' west of C-2

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | 0.0 TO 25.0' |
| HAND SHOP: W/MUD: W/WATER | ___ TO ___ |
| ROTARY DRILL: W/MUD: W/WATER | ___ TO ___ |
| DIAMOND CORE | ___ TO ___ |
| CORE SIZE | ___ TO ___ |
| UNDISTURBED SAMPLES No. 2 SIZE 2.5" tubes | |
| BAG SAMPLES No. NA SIZE NA | |

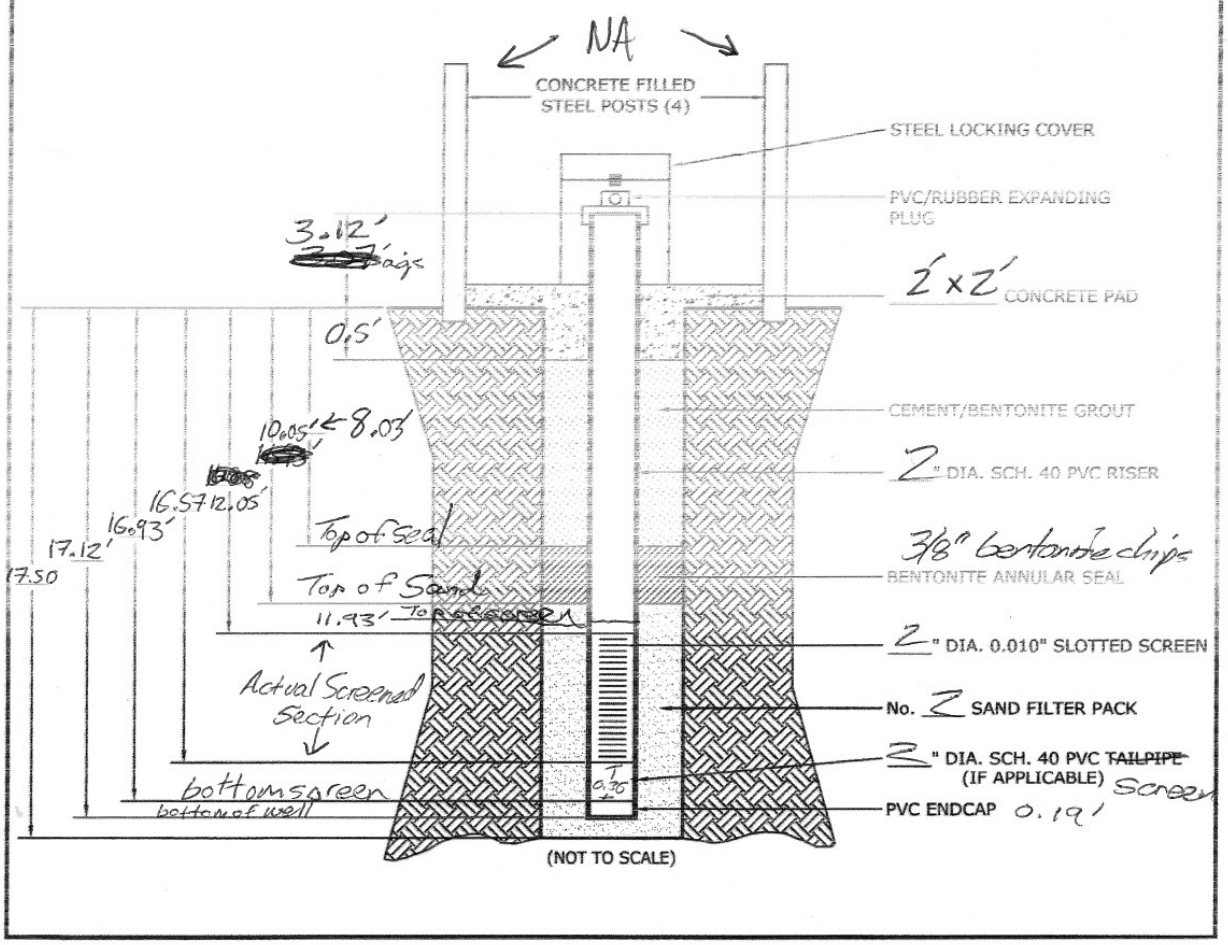
F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

# PIEZOMETER INSTALLATION RECORD

JOB NAME: TVA KINGSTON-EAST DIKE
JOB NUMBER: 3043-10-1038
WELL NUMBER: PZ-C2
INSTALLATION DATE: 8/31/2010
DRILLED BY: TRISTATE
BOREHOLE DIAMETER: 8"
RISER/SCREEN
MATERIAL: Schedule 40 PVC
TOTAL DEPTH: 17.5'
DIAMETER: 2"
FIELD REPRESENTATIVE: Rodney Clark
SLOT SIZE: 0.010"



**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC SOIL TEST BORING FIELD REPORT BORING NO. D-1 PG. 1 OF 3

RIG TYPE CME-550 ATV HAMMER TYPE AUTO

JOB NO. 3043101038 DRILLER George Akins HOURS DRILLING 11.5 HRS GROUND SURFACE ELEV. 748.7

JOB NAME TVA KINGSTON EAST DIKE LOGGED BY Rodney Clark HOURS MOVING 0.5 HRS DATE: 8/12/10 8/13/10 WEATHER: 90°F+ Minimal Rain

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 0.3' OF SURFICAL GRAVEL, BORING IN ROADWAY | 0.3' of gravel |
| 1 | 0.0'-1.5' | 3 | 6 | 10 | | | 1.3' | reddish brown, fat CLAY (CH) w/gravel, moist, very stiff, gravel is angular chert* limestone, FILL MATERIAL | |
| 2 | 1.5'-3.0 | 3 | 4 | 9 | / | / | 1.4' | same as above except stiff instead of very stiff | FILL |
| 3 | 3.0'-4.5 | 2 | 4 | 3 | / | / | 1.2' | same as above except firm instead of very stiff | |
| 4 | 4.5'-6.0' | 1 | 2 | 3 | / | / | 1.0' | same as above, except firm color change @ 5.8' to yellowish | |
| 5 | 6.0'-7.5' | 3 | 8 | 4 | / | / | 1.0' | gray-reddish gray to reddish brown fat CLAY (CH), moist (increased moisture) w/gravel, hard material @6.5' (angular gravel is limestone/chert) -Driller indicated cobble, pushing auger to side | |
| 6 | 7.5'-9.0' | 1 | 2 | 1 | / | / | 1.2' | brown, fat CLAY (CH) w/some angular gravel (chert/limestone) moist, soft, high plasticity, low toughness | FILL |
| 7 | 9.0'-10.5' | 1 | 4 | 3 | / | / | 1.4' | brown to dark brown fat CLAY (CH) w/ some angular gravel - moist to wet, wet zone at appx 10.0'-10.2' bgs high plasticity low toughness | |
| 8 | 10.5'-12.0' | 1 | 1 | 3 | / | / | 1.5' | grayish brown fat CLAY, CH, moist, soft, some angular gravel, shale frag. FILL MATERIAL, high plasticity, low toughness | |
| 9 | 12.0-13.5' | 1 | 2 | 2 | / | / | 0.5' | brown, fat CLAY w/gravel (CH) WET, soft gravel is angular, shale, ~~[illegible]~~ | ▽ WT encountered |
| 10 | 13.5'-15.0' | WOH | 1 | 1 | / | / | 1.5' | same as above except very soft instead of soft | 15.0' Top of shale |
| 11 | 15.0'-16.5' | WOR | WOH | 1 | / | / | 0.9 | light brown fat CLAY (CH) w/some sand, high plasticity, low toughness shale fragments in upper-most portion of sample | Allowed to hole |
| 12 | 16.5'-18.0' | WOH | WOH | WOH | / | / | 1.2' | ~~elastic silt~~ (CH) moist, very soft | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED: 53.7 bgs
BORING REFUSAL: 53.7 bgs
WATER TOB DEPTH: 15.13' bgs
WATER 24 HR DEPTH: 3.03' bgs (tremie pipe) (hole)
WATER LOSSES: None
CAVE-IN DEPTHS: NA (set tremie pipe)
CASING: SIZE NA LENGTH NA
STANDBY TIME: 1 HR 15 MIN BORING LAYOUT On East Dike Gravel Road
RAIN DELAY

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | 0.0 TO 53.7 |
| HAND SHOP: W/MUD: W/WATER | ___ TO ___ |
| ROTARY DRILL: W/MUD: W/WATER | ___ TO ___ |
| DIAMOND CORE | ___ TO ___ |
| CORE SIZE | ___ TO ___ |
| UNDISTURBED SAMPLES No. NA SIZE NA | |
| BAG SAMPLES No. NA SIZE NA | |

*Begin "charging" auger @ 41.5'

F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. D-1 PG. 2 OF 3

RIG TYPE CME-550ATV HAMMER TYPE AUTO

JOB NO. 3043101038 DRILLER George Akins HOURS DRILLING 11.5 HRS GROUND SURFACE ELEV. 748.7

JOB NAME TVA KINGSTON EAST DIKE LOGGED BY Rodney Clark HOURS MOVING 0.5 HRS DATE: 8/12/10 WEATHER: 90°F Minimal Rain

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 13 | 18.0-19.5 | WOH | WOH | WOH | / | / | 1.3' | light yellowish brown, fat, CLAY (CH), moist, very soft, high plasticity, low toughness, little fine sand | Allowed |
| 14 | 19.5-21.0 | 2 | 5 | 6 | | | 1.2' | yellowish brown mottled w/ light gray lean CLAY w/sand, CL, moist, trace angular shale fragments, mottled | |
| 15 | 21.0-22.5 ~~19.5-21.0~~ | 7 | 9 | 11 | | | 1.5' | some very fine sand, stiff yellowish brown mottled w/ light gray lean CLAY w/sand (CL), moist, some fine sand, very stiff | |
| 16 | 22.5-24.0 | 3 | 4 | 5 | / | / | 1.4' | light yellowish brown/slight mottling fat CLAY (CH) w/sand, stiff, high plasticity, medium toughness | |
| 17 | 24.0-25.5 | 2 | 3 | 5 | / | / | 1.5 | same as above except firm | |
| 18 | 25.5-27.0 | 1 | 3 | 5 | / | / | 1.5 | same as above, vertical striations/mottling | |
| 19 | 27.0-28.5 | 3 | 5 | 6 | / | / | 1.4' | grades into clayey SAND (SC) wet, yellowish brown w/trace gravel, small silty SAND (SM) lensing, firm | |
| 20 | 28.5→30.0 | 1 | 4 | 3 | / | / | 1.0' | grades into light gray, silty SAND (SM) wet, loose, mostly fine-very fine sand | |
| 21 | 30.0-31.5 | 1 | 2 | 2 | / | / | 0.0' | No recovery, cutter intact light gray | |
| 22 | 31.5→33.0 | 1 | 0 | 0 | / | / | 1.7' | clayey SAND (SC) wet, very loose, lensing w/ silty sand (SM), trace shale fragments | |
| 23 | 33.0-34.5 | WOR | WOR | WOH | / | / | 1.5' | light grayish brown, lean silt (ML) w/sand, medium to low plasticity, some clay, sand is very fine, very soft | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED: _____

BORING REFUSAL: _____

WATER TOB DEPTH: _____

WATER 24 HR DEPTH: _____

WATER LOSSES: _____

CAVE-IN DEPTHS: _____

CASING: SIZE _____ LENGTH _____

STANDBY TIME: _____ BORING LAYOUT _____

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | ___ TO ___ |
| HAND SHOP: W/MUD: W/WATER | ___ TO ___ |
| ROTARY DRILL: W/MUD: W/WATER | ___ TO ___ |
| DIAMOND CORE | ___ TO ___ |
| CORE SIZE | ___ TO ___ |
| UNDISTURBED SAMPLES No. _____ SIZE _____ | |
| BAG SAMPLES No. _____ SIZE _____ | |

F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. D-1 PG. 3 OF 3

RIG TYPE CME-550ATV HAMMER TYPE AUTO

JOB NO. 3043101038 DRILLER George Akins HOURS DRILLING 11.5 HRS GROUND SURFACE ELEV. 748.7

JOB NAME TVA KINGSTON EAST DIKE LOGGED BY Rodney Clark HOURS MOVING 0.5 HRS DATE: 8/12/10 8/3/10 WEATHER: 90°F

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 24 | 34.5→ 36.0' | WOR | WOH | WOH | / | / | 1.4' | gray, elastic SILT w/sand (MH), wet, very soft, medium plasticity | Alluvium |
| 25 | 36.0'- 37.5' | WOR | WOH | WOH | / | / | 1.4' | ← same as above | |
| 26 | 37.5'→ 39.0' | WOH | WOH | 1 | / | / | 1.5' | gray, silty SAND (SM), wet, very loose, mostly very fine quartz sand | |
| 27 | 39.0'- 41.5 | WOH | WOH | 1 | / | / | 1.3' | ← same as above | |
| 28 | 41.5'-43.0 | WOH | WOH | 1 | / | / | 1.3' | yellowish brown, silty, SAND (SM) wet, very loose, mostly fine quartz sand ALLUVIUM | Alluvium ★NOTE |
| 29 | 43.0-44.5' | 1 | 5 | 6 | / | / | 1.4' | grayish brown grades to yellowish brown, silty, SAND (SM) wet, firm, mostly fine quartz sand ALLUVIUM | |
| 30 | 44.5-46.0' | 5 | 15 | 23 | / | / | 1.5' | dark gray, SILT, ML, WEATHERED SHALE, RESIDUUM, mo[illegible] platy bedding, friable, fissile, hard | TOP OF SHALE @ 44.5 |
| 31 | 46.0'→ 47.5' | 10 | 15 | 19 | / | / | 1.3' | dark gray, weathered SHALE moist, platy bedding, friable fissile | weathered Shale |
| 32 | 47.5'- 49.0' | 7 | 19 | 26 | / | / | 1.0' | same as above | |
| 33 | 49.0'-50.5' | 15 | 23 | 22 | / | / | 1.3' | same as above | |
| 34 | 50.5'-52.0' | 6 | 13 | 9 | / | / | 0.5 | same as above | |
| 35 | 52.0'→ 53.7' | 15 | 30 | 50/0.3' | / | / | | Refusal @ 53.7 bgs | |

★ NOTE: drillers begin adding water @ 41.5' to prevent sand upheaval

STANDARD PENETRATION RESISTANCE (SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED:
BORING REFUSAL:
WATER TOB DEPTH:
WATER 24 HR DEPTH: (See page 1)
WATER LOSSES:
CAVE-IN DEPTHS:
CASING: SIZE ____ LENGTH ____
STANDBY TIME: ____ BORING LAYOUT ____

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | ___ TO ___ |
| HAND SHOP: W/MUD: W/WATER | ___ TO ___ |
| ROTARY DRILL: W/MUD: W/WATER | ___ TO ___ |
| DIAMOND CORE | ___ TO ___ |
| CORE SIZE | ___ TO ___ |
| UNDISTURBED SAMPLES No. ____ SIZE ____ | |
| BAG SAMPLES No. ____ SIZE ____ | |

F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

# PIEZOMETER INSTALLATION RECORD

JOB NAME TVA KINGSTON - EAST DIKE

JOB NUMBER 3043101038

WELL NUMBER PZ-D1A

INSTALLATION DATE 8/25/2010

DRILLED BY TRISTATE - GEORGE AKINS

BOREHOLE DIAMETER 8"

TOTAL DEPTH 20.5' bgs

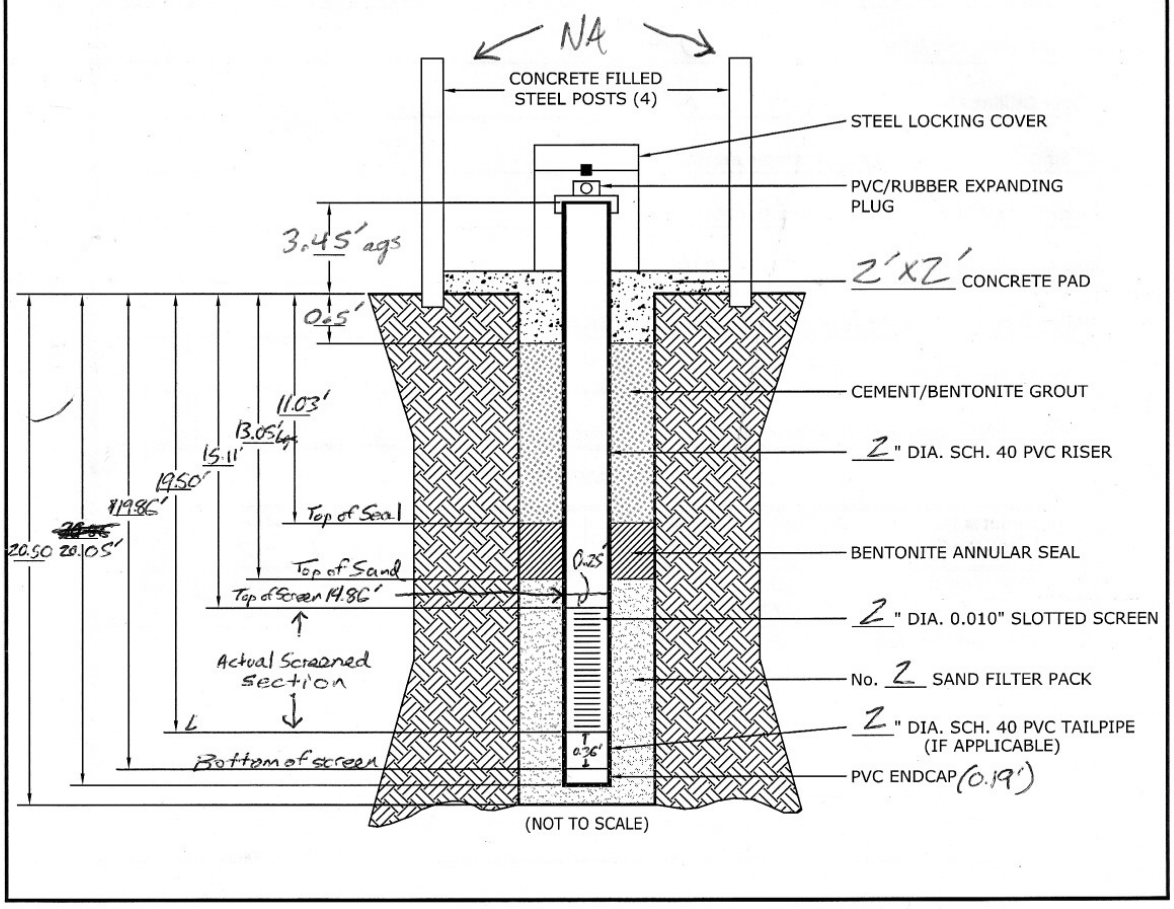
FIELD REPRESENTATIVE Rodney M. Clark

RISER/SCREEN

MATERIAL Schedule 40 PVC

DIAMETER 2"

SLOT SIZE 0.010"



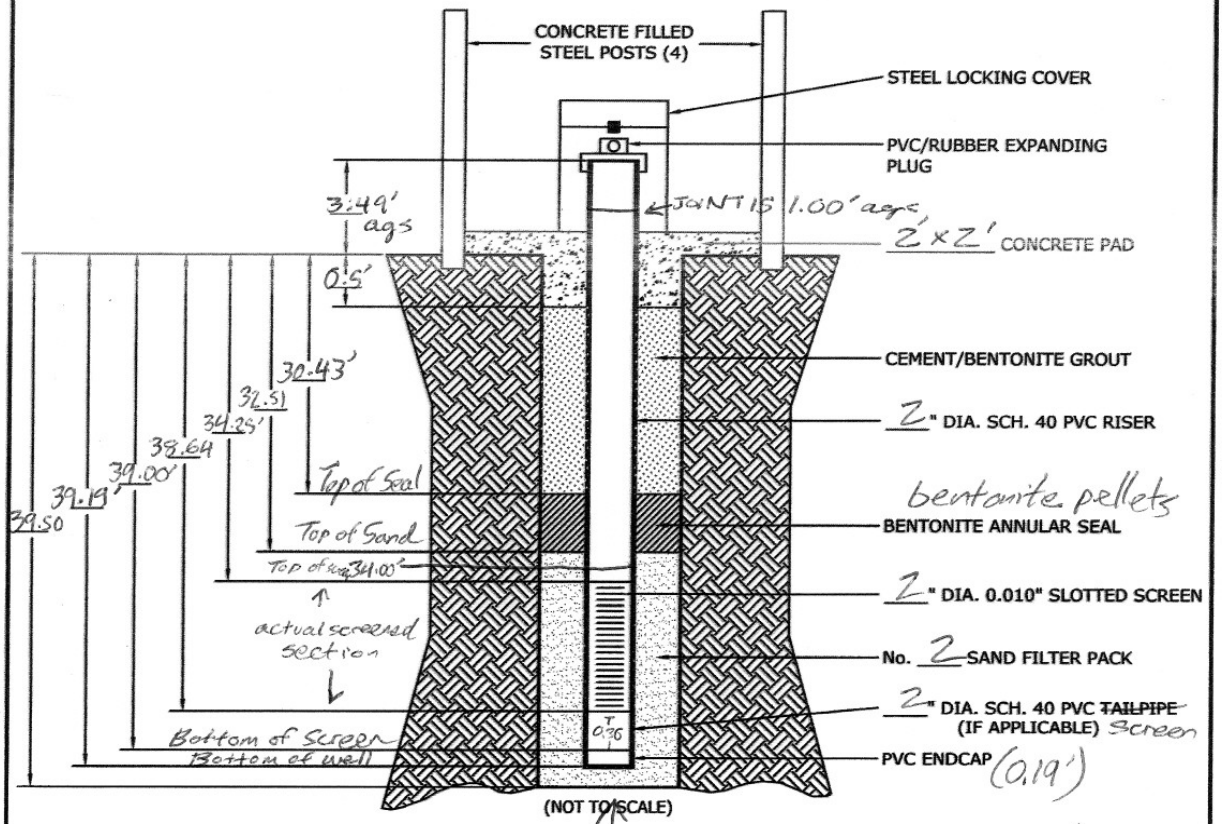
**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

Revision

# PIEZOMETER INSTALLATION RECORD

JOB NAME: TVA KINGSTON EAST DIKE
JOB NUMBER: 3043101038
WELL NUMBER: PZ-D1B Offset
INSTALLATION DATE: 8/26/10
DRILLED BY: Tristate (George Alexis)
BOREHOLE DIAMETER: 8"
RISER/SCREEN MATERIAL: Schedule 40 PVC
TOTAL DEPTH: 39.50
DIAMETER: 2"
FIELD REPRESENTATIVE: Rodney Clark
SLOT SIZE: 0.010"




SAND UPHEAVAL @ 40.5 TO 39.0' IN AUGERS
DRILLED TO 41.5' & CHARGED AUGERS
PRIOR TO INSTALLING WELL

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. Pz-D1B PG. 1 OF 1

RIG TYPE CME 550 TRACK HAMMER TYPE AUTO

JOB NO. 3043101038 DRILLER George Akins HOURS DRILLING 1.0 GROUND SURFACE ELEV. Appx 748.7

JOB NAME TVA KINGSTON LOGGED BY Rodney Clark HOURS MOVING 0.25 DATE: 8/25/10 WEATHER: Sunny 80°

EAST DIKE STABILITY STUDY

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3'-5' | NA | NA | NA | NA | 1 | 1.25' | Drill to 3' w/ 3¼" HSA's, push tube via piston sampler after charging boring w/ water / wait appx 10 minutes prior to pulling tube. Material is reddish brown fat CLAY (CH) w/ some gravel | |
| | | | | | | | | - Charge boring at 5' intervals when adding augers | |
| | | | | | | | | - At 6' bgs encounter obstruction "large cobble" Auger refusal / Offset to new location | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED: 6'

BORING REFUSAL: 6'

WATER TOB DEPTH: 4.5' bgs

WATER 24 HR DEPTH: NA

WATER LOSSES: NA

CAVE-IN DEPTHS: NA

CASING: SIZE NA LENGTH NA

STANDBY TIME: NA BORING LAYOUT 6' South of D-1

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | 0.0 TO 6.0' |
| HAND SHOP: W/MUD: W/WATER | ___ TO ___ |
| ROTARY DRILL: W/MUD: W/WATER | ___ TO ___ |
| DIAMOND CORE | ___ TO ___ |
| CORE SIZE | ___ TO ___ |
| UNDISTURBED SAMPLES No. NA SIZE NA | |
| BAG SAMPLES No. NA SIZE NA | |

F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC SOIL TEST BORING FIELD REPORT BORING NO. D-2 PG. 1 OF 4

RIG TYPE CME 550 TRACK HAMMER TYPE AUTO

JOB NO. 3043101038 DRILLER George Akins HOURS DRILLING 8 GROUND SURFACE ELEV. 743.3

JOB NAME TVA KINGSTON East Dike LOGGED BY Rodney Clark HOURS MOVING 1 DATE: 8/11/10 WEATHER: Sunny

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| ~~1~~ | 0.0-1.0' | NA | NA | NA | NA | NA | NA | -Removed 0.0'-1.0' of wet graded GRAVEL, FILL, dry (very loose to loose) | |
| 1 | 1.0-2.5' | 1 | 1 | 2 | NA | NA | 0.5' | -1.0'-1.5' gravel, FILL, GW 1.5'-2.5' yellowish brown to grayish brown, fat CLAY (CH), soft moist, some gravel-sized shale fragments, trace organics | |
| 2 | 2.5-4.0' | 1 | 2 | 1 | NA | NA | 0.5' | -same as above (fat CLAY) trace mottling | FILL MATERIAL |
| 3 | 4.0-5.5' | 1 | 2 | 3 | NA | NA | 1.3' | - brown, fat CLAY (CH), moist, firm, some granule (gravel) sized angular fragments of shale/weathered shale, slight organic-like odor | |
| ~~4~~ | | | | | | | | | |
| 4 | 5.5'-7.0' | 1 | 3 | 3 | NA | NA | 1.4' | - ~~bro~~ same as above, gravelly, fat CLAY (CH), firm, moist, some granule sized gravel sized, fragments of shale and CHERT, subrounded to angular | |
| ~~5~~ | 7.0'-8.5' | 1 | 2 | 3 | NA | NA | 1.3' | - brown fat CLAY w/gravel (CH), ~~some~~ moist firm (same as above) trace roots | |
| 6 | 8.5'-10.0' | 1 | 1 | 1 | NA | NA | 1.0' | brown to gray, fat CLAY (CH), moist-wet very soft, few angular gravel shale fragments, grades from moist to wet | 10.0' |
| 7 | 10.0-11.5' | WOH | WOH | 1 | NA | NA | 1.2' | light yellowish brown, elastic SILT, (MH), moist, trace to little fine sand; no structure | * Begin Alluvium |
| 8 | 11.5'-13.0' | 1 | 2 | 3 | NA | NA | 1.5' | light yellowish brown mottled w/ reddish brown ~~SILT~~ w/sand (ML), wet, firm, some fine sand, blocky | Alluvium |
| 9 | 13.0'-14.5' | 0 | 2 | 3 | NA | NA | 1.0' | reddish to orangish brown mottled w/ yellowish brown, elastic SILT w/ sand, moist-wet, firm, some mottling, organic-dark streaking | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1.4" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED: 44.9' (add 4' SPT) 1.21 AGS (tremie pipe) = 9.49' bgs (borehole)

BORING REFUSAL: 43.7' WL = 1.21

WATER TOB DEPTH: 6.4' bgs AGS 10

WATER 24 HR DEPTH: ~~8.8 bgs~~ * see note

WATER LOSSES: NA

CAVE-IN DEPTHS: NA / set Tremie Pipe

CASING: SIZE NA LENGTH NA

STANDBY TIME: NA BORING LAYOUT ON GRAVEL PAD

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | 0 TO 43.7 |
| HAND SHOP: W/MUD: W/WATER | TO |
| ROTARY DRILL: W/MUD: W/WATER | TO |
| DIAMOND CORE | TO |
| CORE SIZE | TO |
| UNDISTURBED SAMPLES No. NA SIZE NA | |
| BAG SAMPLES No. NA SIZE NA | |

* Note: 8/12/10 @ 0800 W.L. = 0.4' above ground surface in augers/set tremie pipe to obtain 24 hour W.L.

F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. D7 PG. 2 OF 4

JOB NO. 3043101038 DRILLER George Akins RIG TYPE CME-550 TRACK HAMMER TYPE AUTO HOURS DRILLING 8 GROUND SURFACE ELEV. 743.3

JOB NAME TVA KINGSTON EAST DIKE LOGGED BY RODNEY CLARK HOURS MOVING 1 DATE: 8/17/10 WEATHER: Sunny

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 10 | 14.5-16.0' | 3 | 5 | 6 | NA | NA | 1.5' | light tan mottled w/ orangish brown, elastic SILT w/ sand, moist, some fine to very fine sand, stiff, medium toughness medium plasticity | |
| 11 | 16.0'-17.5' | 1 | 2 | 3 | NA | NA | 1.4' | same as above, except firm instead of stiff. Orangish brown mottled w/ tanish brown to light gray, clayey SAND (SC), wet, loose, laminations and lensing (fat CLAY (CH), mostly very fine sand | |
| 12 | 17.5'-19.0' | 2 | 2 | 3 | NA | NA | 1.4' | orangish brown w/ little mottling light gray, clayey SAND (SC) very fine sand w/ some clay mottling | Alluvium |
| 13 | 19.0'-20.5' | 0 | 2 | 3 | NA | NA | 1.4' | same as above (very wet loose zone @ 19.0'-19.5') | |
| 14 | 20.5'-22.0' WOH | | 1 | 1 | NA | NA | 1.5' | orangish-yellowish brown, clayey SAND, SC, wet, very loose trace mottling, mostly very fine quartz sand (SC) w/ some fines | |
| 15 | 22.0'-23.5' | 0 | 1 | 3 | NA | NA | 1.5' | light yellowish brown grades to orangish brown, clayey SAND (SC) grades to silty SAND (SM) at appx 22.3', very loose, wet, mostly fine quartz sand | |
| 16 | 23.5'-25.0' | 1 | WOH | 1 | NA | NA | 1.5' | sharp contact @ 23.9' bgs / light tannish gray, elastic SILT (MH) w/ sand, wet, very soft, high plasticity, low toughness | |
| 17 | 25.0'-26.5' | WOH | 1 | WOH | NA | NA | 1.4' | light gray-gray, clayey SAND (SC) wet, very soft and quartz sand. | Alluvium |
| 18 | 26.5'-28.0' WOH | | WOH | WOH | NA | NA | 1.6' | Same as above | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED:
BORING REFUSAL:
WATER TOB DEPTH: Seepage
WATER 24 HR DEPTH:
WATER LOSSES:
CAVE-IN DEPTHS:
CASING: SIZE LENGTH
STANDBY TIME: BORING LAYOUT

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | TO |
| HAND SHOP: W/MUD: W/WATER | TO |
| ROTARY DRILL: W/MUD: W/WATER | TO |
| DIAMOND CORE | TO |
| CORE SIZE | TO |
| UNDISTURBED SAMPLES No. SIZE | |
| BAG SAMPLES No. SIZE | |

F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC SOIL TEST BORING FIELD REPORT BORING NO. D-2 PG. 3 OF 4

JOB NO. 3043101036 DRILLER George Mathis HOURS DRILLING 8 GROUND SURFACE ELEV. 743.3

JOB NAME TVA KINGSTON EAST DIKE LOGGED BY Rodney Clark HOURS MOVING 1 DATE: 8/4/10 WEATHER: Hot

RIG TYPE CME 550 TRACK HAMMER TYPE AUTO

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 19 | 29.0-29.5' | WOH | WOH | WOH | NA | NA | 1.5' | gray, elastic SILT w/sand, MH, wet, very soft, w/some sand sized ash | Alluvial SAND |
| 20 | 29.5-31.0' | WOR | WOR | WOR | NA | NA | 0.0' | No recovery, catcher intact | |
| 21 | 31.0'→32.5' | WOH | WOH | 1 | NA | NA | 1.4' | gray, clayey, SAND (SC) wet, very loose, quartz sand | |
| 22 | 32.5-34.0' | WOH | 1 | 1 | NA | NA | 1.4' | grayish dark gray, silt & sand sized, SAND w/ silt, wet, very soft | SILT & SAND |
| 23 | 34.0-35.5' | WOH | 1 | 2 | NA | NA | 1.1' | dark gray, silty SAND SM, wet, very loose | |
| 24 | 35.5'→37.0' | WOH | 1 | 1 | NA | NA | 1.2' | dark gray, silty SAND (SM), wet, very loose, quartz sand lense w/ organics (sticks, wood) 0.1' φ observed at 36.8' ALLUVIAL quartz sand w/ abundant shale gravel from 37.0'-37.5' | Begin weathered SHALE |
| 25 | 37.0'→38.5' | 8 | 6 | 15 | NA | NA | 1.3' | 37.5'-38.5 dark gray, WEATHERED SHALE, fissle, friable moderately severe weathering negative HCl test | |
| 26 | 38.5'→40.0' | 9 | 9 | 9 | NA | NA | 1.4' | 38.5 weathered Shale, dark gray, fissle, laminated bedding planes dipping approx 45° | |
| 27 | 40.0'-41.5' | 9 | 19 | 16 | NA | NA | 1.5' | friable, platy bedding Same as above | |
| 28 | 41.5'→43.0' | ← | 3 | 8 | NA | NA | 1.5' | dark gray grades to greenish brown weathered SHALE, platy bedding fissle, friable, moderately to severely weathered | |
| 29 | 43.0'-44.5' | ← | 41 | 46 | 42 | NA | 1.4' | Same as above 43.7' Auger Refusal | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED:
BORING REFUSAL:
WATER TOB DEPTH:
WATER 24 HR DEPTH: See page 1
WATER LOSSES:
CAVE-IN DEPTHS:
CASING: SIZE LENGTH
STANDBY TIME: BORING LAYOUT

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | TO |
| HAND SHOP: W/MUD: W/WATER | TO |
| ROTARY DRILL: W/MUD: W/WATER | TO |
| DIAMOND CORE | TO |
| CORE SIZE | TO |
| UNDISTURBED SAMPLES No. SIZE | |
| BAG SAMPLES No. SIZE | |

F102

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. D-2 PG. 4 OF 4

RIG TYPE CME-550 TRACK HAMMER TYPE AUTO 7433

JOB NO. 3043101038 DRILLER George Akins HOURS DRILLING 8 GROUND SURFACE ELEV. ~~43~~

JOB NAME TVA KINGSTON LOGGED BY Rodney Clark HOURS MOVING 1 DATE: 8/4/10 WEATHER: Sunny

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 30 | 44.5'-44.9' | 50/0.4' | | | | | 0.2' | Drillers indicated refusal on "very hard material" at 43.7 / Indicate to drill to collect SPT @ 44.5' SS-30 = Weathered SHALE / Same as above | |
| | | | | | | | | Terminate @ 44.9' bgs | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED: _____

BORING REFUSAL: _____

WATER TOB DEPTH: _____

WATER 24 HR DEPTH: See page 1

WATER LOSSES: _____

CAVE-IN DEPTHS: _____

CASING: SIZE _____ LENGTH _____

STANDBY TIME: _____ BORING LAYOUT _____

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | ___ TO ___ |
| HAND SHOP: W/MUD: W/WATER | ___ TO ___ |
| ROTARY DRILL: W/MUD: W/WATER | ___ TO ___ |
| DIAMOND CORE | ___ TO ___ |
| CORE SIZE | ___ TO ___ |
| UNDISTURBED SAMPLES No. _____ SIZE _____ | |
| BAG SAMPLES No. _____ SIZE _____ | |

F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC **SOIL TEST BORING FIELD REPORT** BORING NO. D-2 UD Offset PG. 1 OF

RIG TYPE CME-550 ATV HAMMER TYPE AUTO

JOB NO. 3043101038 DRILLER George Atkins HOURS DRILLING GROUND SURFACE ELEV. 743.3

JOB NAME TVA KINGSTON EAST DIKE LOGGED BY Rodney Clark HOURS MOVING DATE: 8/18/10 WEATHER: Cloudy

| SAMPLING No. | DEPTH | "N" 1ST 6" | 2ND 6" | 3RD 6" | SCALE | UD | REC | SOIL CLASSIFICATION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Hard material encountered at appx 7.0' bgs / intended UD test interval - Instruct drillers to auger past obstruction prior to collecting UD sample | |
| UD-1 | 7.5'→9.5' | NA | NA | NA | | UD-1 | 1.3' | - Auger to 7.5' & charge augers w/ water / push piston sample ~~app~~ 2.0' & wait appx 5 minutes prior to pulling tube from boring / Material is | |
| UD-2 | 15.5-17.0' | NA | NA | NA | | UD-2 | 2.0' | Charge Auger or / Push tube 2.0' via piston sampler Wait appx 5 minutes prior to pulling tube / Material is | |
| ~~UD3 25.0~~ | | | | | | | | | |
| UD3 | 25.0→27.0' | NA | NA | NA | | UD-3 | 2.0' | Charge augers / push tube 2.0' via piston sampler / Wait appx 5 minutes prior to pulling tube / Material is | |

STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED: 27.0'
BORING REFUSAL: NA
WATER TOB DEPTH: NA
WATER 24 HR DEPTH: NA
WATER LOSSES: NA
CAVE-IN DEPTHS: NA
CASING: SIZE ~~3 1/4 HSA~~ LENGTH NA
STANDBY TIME: NA BORING LAYOUT D-2 pads

| METHOD OF ADVANCING BORING | DEPTH |
|---|---|
| POWER AUGER | 0.0 TO 27.0' |
| HAND SHOP: W/MUD: W/WATER | ___ TO ___ |
| ROTARY DRILL: W/MUD: W/WATER | ___ TO ___ |
| DIAMOND CORE | ___ TO ___ |
| CORE SIZE | ___ TO ___ |
| UNDISTURBED SAMPLES No. 3 SIZE 2.5" TUBES | |
| BAG SAMPLES No. NA SIZE NA | |

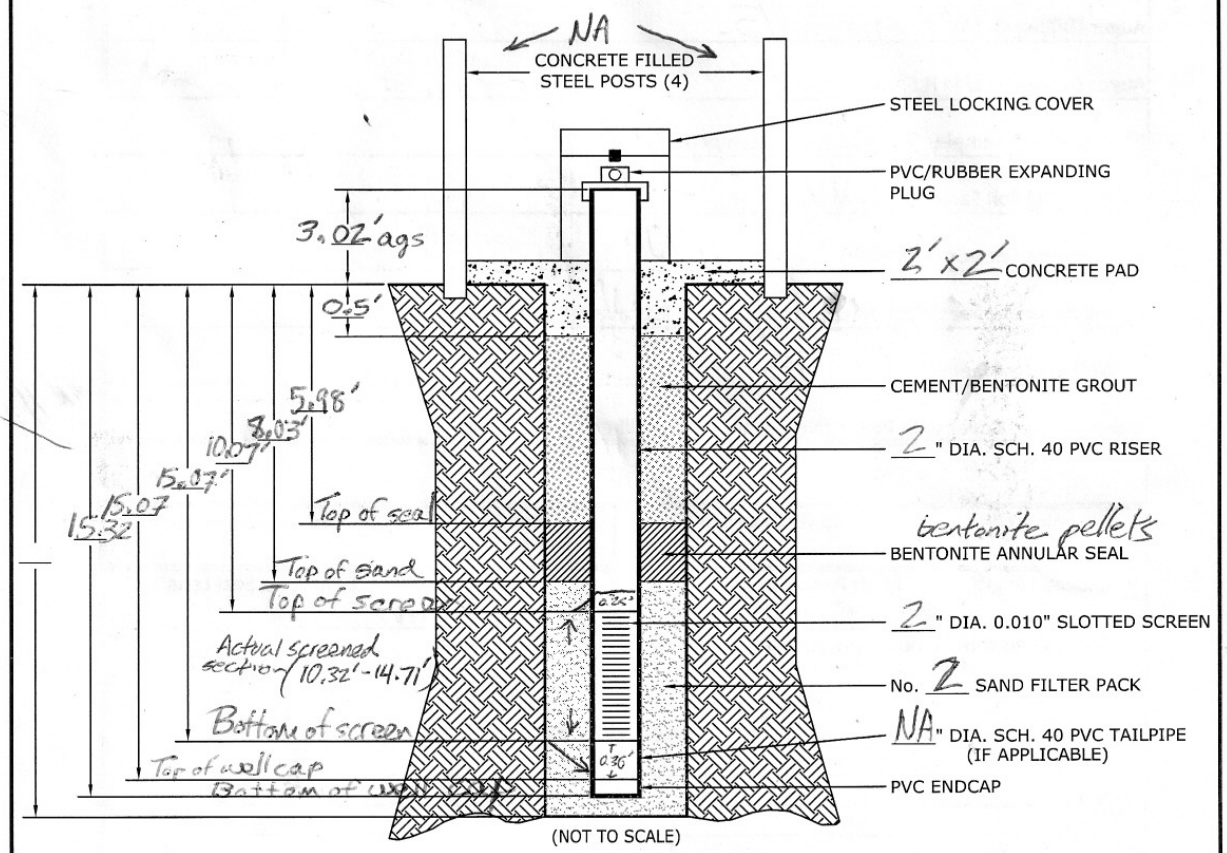
F1024

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

# PIEZOMETER INSTALLATION RECORD

JOB NAME: TVA KINGSTON EAST DIKE
JOB NUMBER: 3043101038
WELL NUMBER: PZ-D-2 ~~piezometer~~
INSTALLATION DATE: 8/18/10
DRILLED BY: TRISTATE / George Akins
BOREHOLE DIAMETER: 8"
RISER/SCREEN MATERIAL: 2" PVC
TOTAL DEPTH: 15.32'
DIAMETER: 2"
FIELD REPRESENTATIVE: RODNEY M. CLARK
SLOT SIZE: 0.010



## Attachment 2: Laboratory Test Results (provided by MACTEC)

# Phase I Test Results

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

*East Dike Stability Study, TVA Kingston, Harriman, TN*
*MACTEC Project 3043101038*

*September 24, 2010*

**Table 1**
**Index/Classification Test Summary**

| Boring | Sample Depth (Feet bgs) | Sample Type/Number | Natural Moisture Content, % | Atterberg Limits | | | Grain Size Distribution | | | USCS Classification | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Liquid Limit | Plastic Limit | Plasticity Index | Gravel, % | Sand, % | Fines – Silt & Clay, % | Group Symbol | Group Name |
| C-1 | 8.5-10 | SS-6 | 21.5 | | | | | | | | |
| C-1 | 7-8.5 | SS-5 | | 42 | 26 | 17 | 9.3 | 41.6 | 49.1 | SC | Clayey Sand |
| C-1 | 10-11.5 | SS-7 | 63.6 | | | | | | | | |
| C-1 | 11.5-13 | SS-8 | 23.9 | 44 | 28 | 16 | 12.0 | 54.1 | 33.9 | SM | Silty Sand |
| C-1 | 13-14.5 | SS-9 | 29.6 | | | | | | | | |
| C-1 | 16-17.5 | SS-11 | 25.2 | 31 | 20 | 10 | 0 | 26.8 | 73.2 | CL | Lean Clay with Sand |
| C-1 | 17.5-19 | SS-12 | 22.3 | | | | | | | | |
| C-1 | 19-20.5 | SS-13 | | 33 | 20 | 13 | 2.0 | 24.1 | 73.9 | CL | Lean Clay with Sand |
| C-1 | 20.5-22 | SS-14 | 22.7 | | | | | | | | |
| C-1 | 38.5-40 | SS-26 | 20.5 | | | | | | | | |
| C-1 | 40-41.5 | SS-27 | 16.5 | NP | NP | NP | 0 | 66.9 | 33.1 | SM | Silty Sand |
| C-1 | 41.5-43 | SS-28 | 19.1 | | | | | | | | |
| C-2 | 7.5-9 | SS-5 | 17.0 | 40 | 25 | 14 | 25.4 | 44.5 | 30.1 | SC | Clayey Sand with Gravel |
| C-2 | 10.5-12 | SS-7 | 26.3 | | | | | | | | |
| C-2 | 12-13.5 | SS-8 | 26.6 | 29 | 20 | 10 | 7.2 | 27.8 | 65.0 | CL | Sandy Lean Clay |
| C-2 | 13.5-15 | SS-9 | 22.7 | | | | | | | | |
| C-2 | 25.5-27 | SS-17 | 19.8 | NP | NP | NP | 0.6 | 50.2 | 49.2 | SM | Silty Sand |
| C-2 | 27-28.5 | SS-18 | 16.2 | | | | | | | | |
| C-2 | 28.5-30 | SS-19 | 24.4 | | | | | | | | |
| D-1 | 12-13.5 | SS-9 | | 40 | 23 | 17 | 11.9 | 54.1 | 34.0 | SC | Clayey Sand |
| D-1 | 13.5-15 | SS-10 | 19.4 | | | | | | | | |
| D-1 | 15-16.5 | SS-11 | 21.1 | 34 | 20 | 14 | 1.0 | 16.7 | 82.3 | CL | Lean Clay with Sand |
| D-1 | 16.5-18 | SS-12 | 23.4 | | | | | | | | |
| D-1 | 18-19.5 | SS-13 | 23.3 | | | | | | | | |
| D-2 | 5.5-7 | SS-4 | | | | | | | | | |
| D-2 | 7-8.5 | SS-5 | 14.2 | 40 | 22 | 18 | 12.4 | 49.1 | 38.5 | SC | Clayey Sand |
| D-2 | 8.5-10 | SS-6 | 18.4 | | | | | | | | |
| D-2 | 10-11.5 | SS-7 | 17.4 | 30 | 19 | 11 | 0 | 15.9 | 84.1 | CL | Lean Clay with Sand |
| D-2 | 11.5-13 | SS-8 | | | | | | | | | |

bgs – below ground surface
SS – standard penetration test/split spoon
NP – non-plastic

Prepared by/Date: Tric Lawrence 9/24/2010
Checked by/Date: 9/24/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

1070 West Main Street Suite
Abingdon, Va. 24210
(276) 676-0426
(276) 676-0761

## Moisture Content, %

**ASTM D-2216-98**

**Project Name:** TVA Kingston East Dike Stability Study
**Project Number:** 3043-10-1038
**Date:** 9/21/2010

| Boring # | C-1 | C-1 | C-1 | C-1 | C-1 | C-1 | C-1 | C-1 |
|---|---|---|---|---|---|---|---|---|
| Sample # | SS-6 | SS-7 | SS-8 | SS-9 | SS-11 | SS-12 | SS-14 | SS-26 |
| Depth | 8.5'-10.0' | 10.0'-11.5' | 11.5'-13.0' | 13.0'-14.5' | 16.0'-17.5' | 17.5'-19.0' | 20.5'-22.0' | 38.5'-40.0' |
| Tare + Wet | 129.59 | 106.63 | 120.58 | 100.53 | 81.98 | 79.25 | 118.55 | 113.11 |
| Tare + Dry | 112.26 | 77.53 | 103.35 | 84.56 | 71.78 | 70.50 | 102.55 | 99.25 |
| Water (w/w) | 17.33 | 29.10 | 17.23 | 15.97 | 10.20 | 8.75 | 16.00 | 13.86 |
| Tare | 31.68 | 31.74 | 31.29 | 30.65 | 31.23 | 31.27 | 31.91 | 31.72 |
| Dry Soil (w/s) | 80.58 | 45.79 | 72.06 | 53.91 | 40.55 | 39.23 | 70.64 | 67.53 |
| **Moisture, %** | **21.5** | **63.6** | **23.9** | **29.6** | **25.2** | **22.3** | **22.7** | **20.5** |

| Boring # | C-1 | C-1 | C-2 | C-2 | C-2 | C-2 | C-2 | C-2 |
|---|---|---|---|---|---|---|---|---|
| Sample # | SS-27 | SS-28 | SS-5 | SS-7 | SS-8 | SS-9 | SS-17 | SS-18 |
| Depth | 40.0'-41.5' | 41.5'-43.0' | 7.5'-9.0' | 10.5'-12.0' | 12.0'-13.5' | 13.5'-15.0' | 25.5'-27.0' | 27.0'-28.5' |
| Tare + Wet | 117.66 | 106.95 | 101.96 | 114.07 | 110.25 | 115.78 | 113.95 | 119.30 |
| Tare + Dry | 105.39 | 94.89 | 91.65 | 96.81 | 93.69 | 100.16 | 100.20 | 107.09 |
| Water (w/w) | 12.27 | 12.06 | 10.31 | 17.26 | 16.56 | 15.62 | 13.75 | 12.21 |
| Tare | 31.19 | 31.72 | 31.18 | 31.21 | 31.51 | 31.48 | 30.85 | 31.58 |
| Dry Soil (w/s) | 74.20 | 63.17 | 60.47 | 65.60 | 62.18 | 68.68 | 69.35 | 75.51 |
| **Moisture, %** | **16.5** | **19.1** | **17.0** | **26.3** | **26.6** | **22.7** | **19.8** | **16.2** |

| Boring # | C-2 | D-1 | D-1 | D-1 | D-1 | D-2 | D-2 | D-2 |
|---|---|---|---|---|---|---|---|---|
| Sample # | SS-19 | SS-10 | SS-11 | SS-12 | SS-13 | SS-5 | SS-6 | SS-7 |
| Depth | 28.5'-30.0' | 13.5'-15.0' | 15.0'-16.5' | 16.5'-18.0' | 18.0'-19.5' | 7.0'-8.5' | 8.5'-10.0' | 10.0'-11.5' |
| Tare + Wet | 157.81 | 101.36 | 97.94 | 117.82 | 125.54 | 106.91 | 98.89 | 95.28 |
| Tare + Dry | 133.08 | 89.97 | 86.29 | 101.46 | 107.71 | 97.45 | 88.37 | 85.90 |
| Water (w/w) | 24.73 | 11.39 | 11.65 | 16.36 | 17.83 | 9.46 | 10.52 | 9.38 |
| Tare | 31.71 | 31.31 | 31.10 | 31.50 | 31.27 | 30.80 | 31.14 | 31.89 |
| Dry Soil (w/s) | 101.37 | 58.66 | 55.19 | 69.96 | 76.44 | 66.65 | 57.23 | 54.01 |
| **Moisture, %** | **24.4** | **19.4** | **21.1** | **23.4** | **23.3** | **14.2** | **18.4** | **17.4** |

| Boring # | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sample # | | | | | | | | |
| Depth | | | | | | | | |
| Tare + Wet | | | | | | | | |
| Tare + Dry | | | | | | | | |
| Water (w/w) | | | | | | | | |
| Tare | | | | | | | | |
| Dry Soil (w/s) | | | | | | | | |
| Moisture, % | | | | | | | | |

Performed By: NCH Checked By RDR 9-21-10

Tim Lawrence 9/21/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

1070 West Main Street Suite 5
Abingdon, Virginia 24210
Telephone: 276-676-0426 ~ Facsimile: 276-676-0761

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/23/10

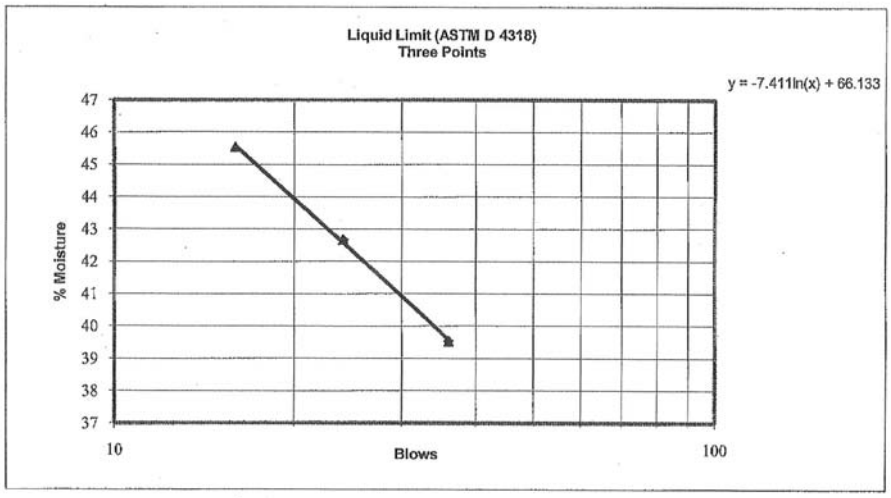
Soil Description: Dark Brown Clayey **SAND (SC)**
(10YR 3/3)

**Atterberg Limits AASHTO T90-00 (2004)**
**(Three Points)**

Sample Number: C-1 SS-5/SS-7
Depth (ft): 7.0'-8.5'/10.0'-11.5'

| Blows | % Moisture |
|---|---|
| 36 | 39.5 |
| 24 | 42.7 |
| 16 | 45.5 |

| Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|
| 42 | 26 | 17 |




Performed by: JCM Checked by: JCM
Tim Lawrence 9/24/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

1070 West Main Street Suite 5
Abingdon, Virginia 24210
Telephone: 276-676-0426 ~ Facsimile: 276-676-0761

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/23/10

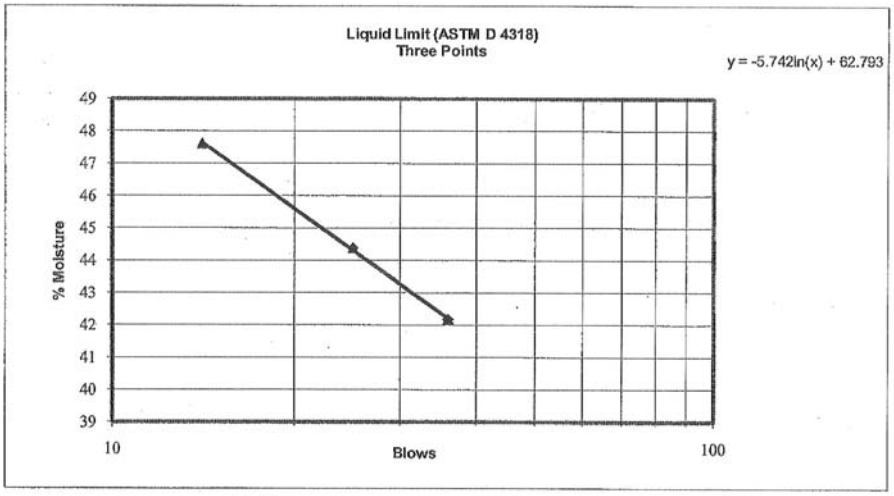
Soil Description: Dark Grayish Brown Silty **SAND** **(SM)** (2.5Y 4/2)

**Atterberg Limits AASHTO T90-00 (2004)**
**(Three Points)**

Sample Number: C-1 SS-8/SS-9
Depth (ft): 11.5'-14.5'

| Blows | % Moisture |
|---|---|
| 36 | 42.2 |
| 25 | 44.4 |
| 14 | 47.6 |

| Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|
| 44 | 28 | 16 |




Performed by: NCA Checked by: GM
Tim Lawrence 9/24/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

1070 West Main Street Suite 5
Abingdon, Virginia 24210
Telephone: 276-676-0426 ~ Facsimile: 276-676-0761

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/23/10

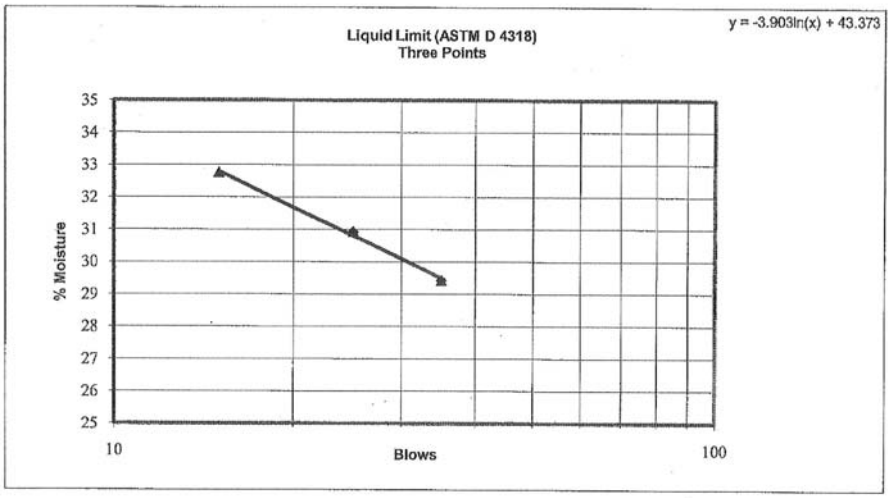
Soil Description: Olive Brown Lean CLAY (CL) with Sand (2.5Y 4/4)

**Atterberg Limits AASHTO T90-00 (2004)**
**(Three Points)**

Sample Number: C-1 SS-11/SS-12
Depth (ft): 16.0'-19.0'

| Blows | % Moisture |
|---|---|
| 35 | 29.4 |
| 25 | 30.9 |
| 15 | 32.8 |

| Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|
| 31 | 20 | 10 |




Performed by: Neff

Checked by: JCM.
Tim Lawrence 9/24/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

1070 West Main Street Suite 5
Abingdon, Virginia 24210
Telephone: 276-676-0426 ~ Facsimile: 276-676-0761

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/23/10

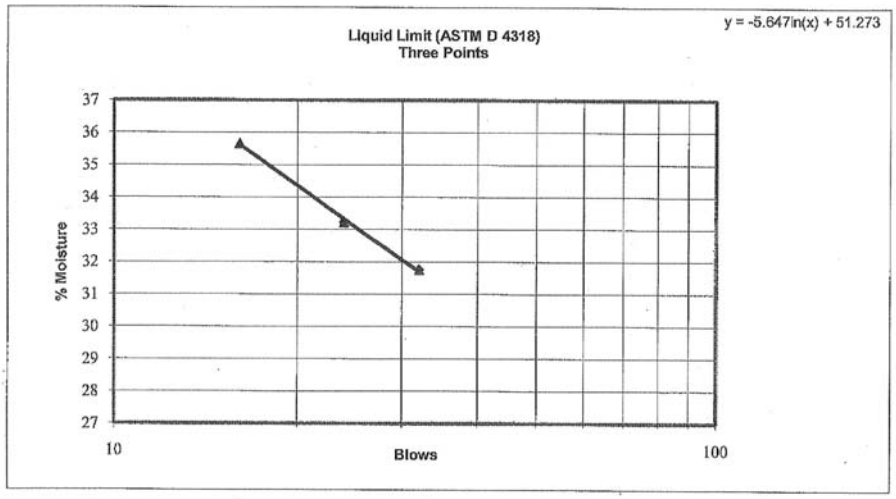
Soil Description:Brownish Yellow Lean **CLAY(CL)** with Sand (10YR 6/6)

**Atterberg Limits AASHTO T90-00 (2004)**
**(Three Points)**

Sample Number: C-1 SS-13/SS-14
Depth (ft): 19.0'-22.0'

| Blows | % Moisture |
|---|---|
| 32 | 31.8 |
| 24 | 33.2 |
| 16 | 35.7 |

| Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|
| 33 | 20 | 13 |




Performed by: NCH Checked by: JCM

Tim Lawrence 9/24/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

1070 West Main Street Suite 5
Abingdon, Virginia 24210
Telephone: 276-676-0426 ~ Facsimile: 276-676-0761

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/23/10

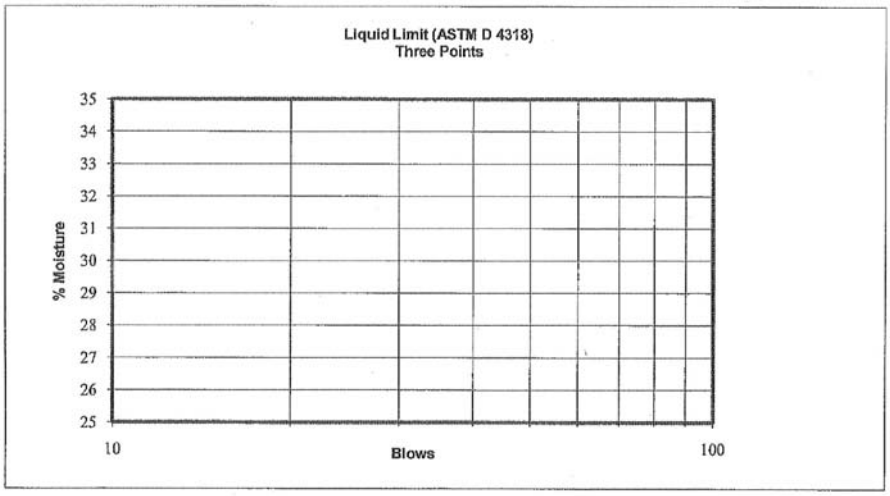
Soil Description: Gray **Silty SAND (SM)** (10YR 5/1)

**Atterberg Limits AASHTO T90-00 (2004)**
**(Three Points)**

Sample Number: C-1 SS-27/SS-28
Depth (ft): 40.0'-43.0'

| Blows | % Moisture |
|---|---|
| 0 | 0.0 |
| 0 | 0.0 |
| 0 | 0.0 |

| Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|
| NP | NP | NP |




Performed by: NCH

Checked by: GCM
Tim Lawrence 9/24/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

1070 West Main Street Suite 5
Abingdon, Virginia 24210
Telephone: 276-676-0426 ~ Facsimile: 276-676-0761

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/23/10

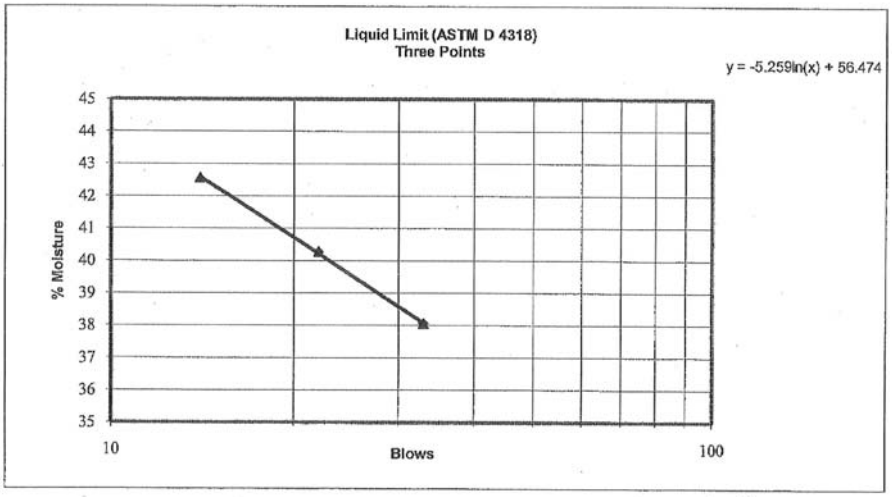
Soil Description:Dark Grayish Brown Clayey **SAND** **(SC)** with Gravel (2.5Y 4/2)

**Atterberg Limits AASHTO T90-00 (2004)**
**(Three Points)**

Sample Number: C-2 SS-5/SS-7
Depth (ft): 7.5'-9.0' / 10.5'-12.0'

| Blows | % Moisture |
|---|---|
| 33 | 38.1 |
| 22 | 40.3 |
| 14 | 42.6 |

| Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|
| 40 | 25 | 14 |




Performed by: NCH

Checked by: [illegible]
Tim Lawrence 9/24/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

1070 West Main Street Suite 5
Abingdon, Virginia 24210
Telephone: 276-676-0426 ~ Facsimile: 276-676-0761

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/23/10

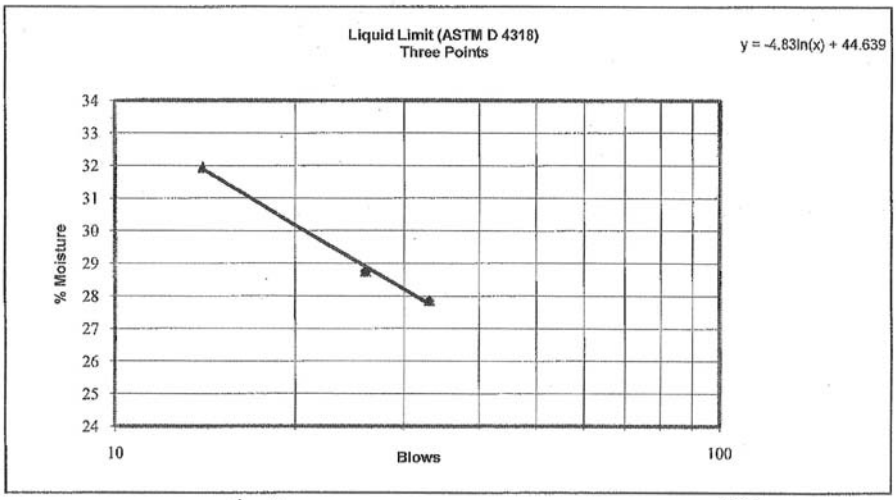
Soil Description: Dark Grayish Brown Sandy Lean **CLAY (CL)** (2.5Y 4/2)

**Atterberg Limits AASHTO T90-00 (2004)**
**(Three Points)**

Sample Number: C-2 SS-8/SS-9
Depth (ft): 12.0'-15.0'

| Blows | % Moisture |
|---|---|
| 33 | 27.9 |
| 26 | 28.8 |
| 14 | 31.9 |

| Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|
| 29 | 20 | 10 |




Performed by: Matt

Checked by: JCM
Tim Lawrence 9/24/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

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1070 West Main Street Suite 5
Abingdon, Virginia 24210
Telephone: 276-676-0426 ~ Facsimile: 276-676-0761

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/23/10

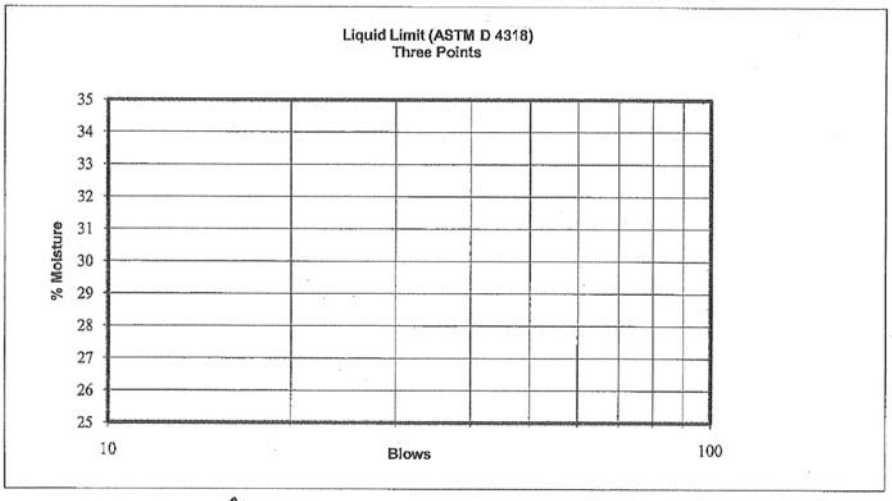
Soil Description: Gray Silty **SAND (SM)** (2.5Y 5/4)

**Atterberg Limits AASHTO T90-00 (2004)**
**(Three Points)**

Sample Number: C-2 SS-17/SS-18
Depth (ft): 25.5'-28.5'

| Blows | % Moisture |
|---|---|
| 0 | 0.0 |
| 0 | 0.0 |
| 0 | 0.0 |

| Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|
| NP | NP | NP |




Performed by: NCH Checked by: grm

Tim Lawrence 9/24/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

1070 West Main Street Suite 5
Abingdon, Virginia 24210
Telephone: 276-676-0426 ~ Facsimile: 276-676-0761

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/23/10

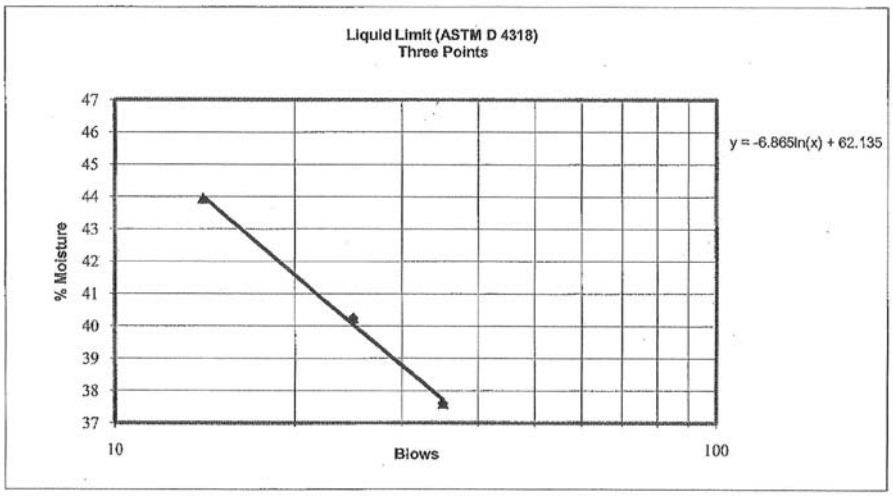
Soil Description: Olive Brown Clayey **SAND (SC)**
(2.5Y 4/4)

**Atterberg Limits AASHTO T90-00 (2004)**
**(Three Points)**

Sample Number: D-1 SS-9/SS-10
Depth (ft): 12.0'-15.0'

| Blows | % Moisture |
|---|---|
| 35 | 37.6 |
| 25 | 40.2 |
| 14 | 43.9 |

| Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|
| 40 | 23 | 17 |




Performed by: NH Checked by: ACM
Tim Lawrence 9/24/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

1070 West Main Street Suite 5
Abingdon, Virginia 24210
Telephone: 276-676-0426 ~ Facsimile: 276-676-0761

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/23/10

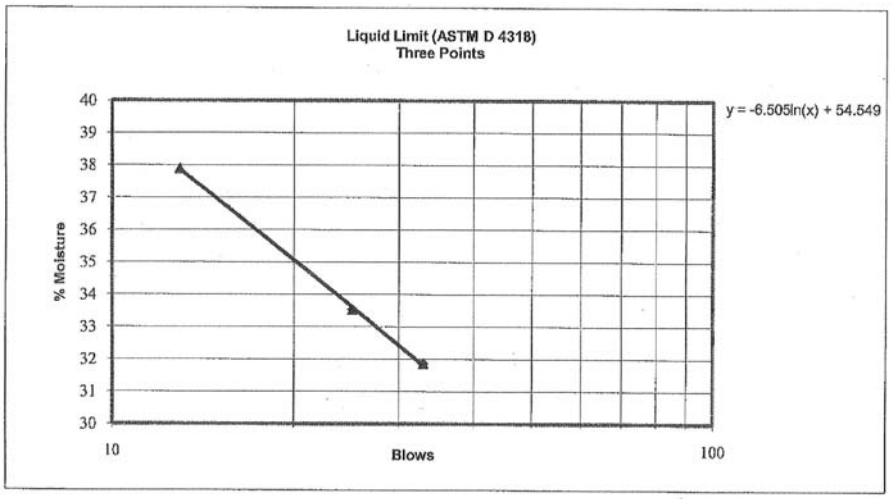
Soil Description: Light Olive Brown Lean **CLAY** **(CL)** with Sand (2.5Y 5/3)

**Atterberg Limits AASHTO T90-00 (2004)**
**(Three Points)**

Sample Number: D-1 SS-11/SS-12/SS-13
Depth (ft): 15.0'-19.5'

| Blows | % Moisture |
|---|---|
| 33 | 31.9 |
| 25 | 33.5 |
| 13 | 37.9 |

| Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|
| 34 | 20 | 14 |




Performed by: NCH Checked by: JCR

Tim Lawrence 9/24/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

1070 West Main Street Suite 5
Abingdon, Virginia 24210
Telephone: 276-676-0426 ~ Facsimile: 276-676-0761

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/23/10

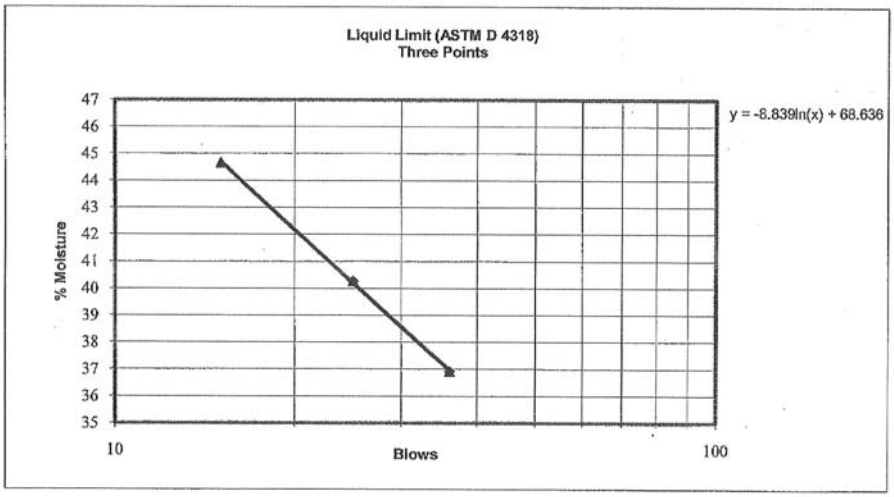
Soil Description:Dark Olive Brown Clayey **SAND(SC)**
(2.5Y 3/3)

**Atterberg Limits AASHTO T90-00 (2004)**
**(Three Points)**

Sample Number: D-2 SS-5/SS-6
Depth (ft): 7.0'-10.0'

| Blows | % Moisture |
|---|---|
| 36 | 36.9 |
| 25 | 40.3 |
| 15 | 44.7 |

| Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|
| 40 | 22 | 18 |




Performed by: Neff

Checked by: JCM
Tim Lawrence 9/24/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

1070 West Main Street Suite 5
Abingdon, Virginia 24210
Telephone: 276-676-0426 ~ Facsimile: 276-676-0761

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/23/10

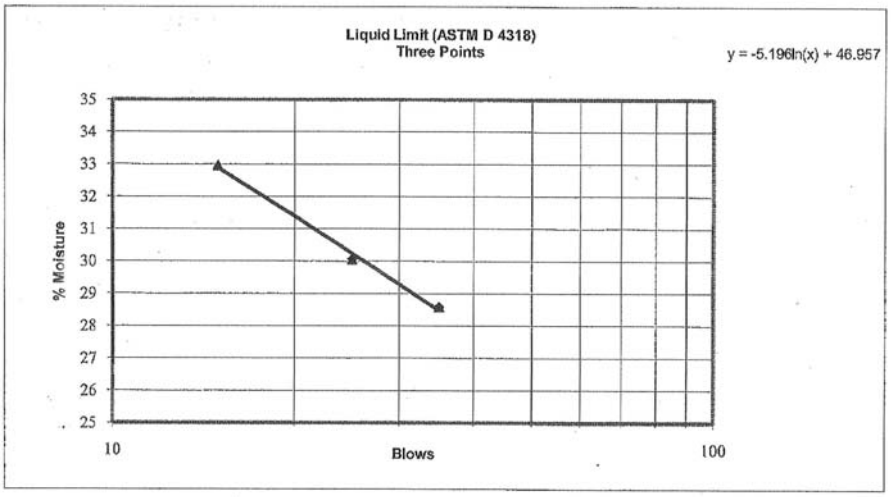
Soil Description: Yellowish Brown Lean **CLAY (CL)** with Sand (10YR 5/8)

**Atterberg Limits AASHTO T90-00 (2004)**
**(Three Points)**

Sample Number: D-2 SS-7/SS-8
Depth (ft): 10.0'-13.0'

| Blows | % Moisture |
|---|---|
| 35 | 28.6 |
| 25 | 30.1 |
| 15 | 33.0 |

| Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|
| 30 | 19 | 11 |




Performed by: Ncdl

Checked by: JCM
Tim Laurence 9/24/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

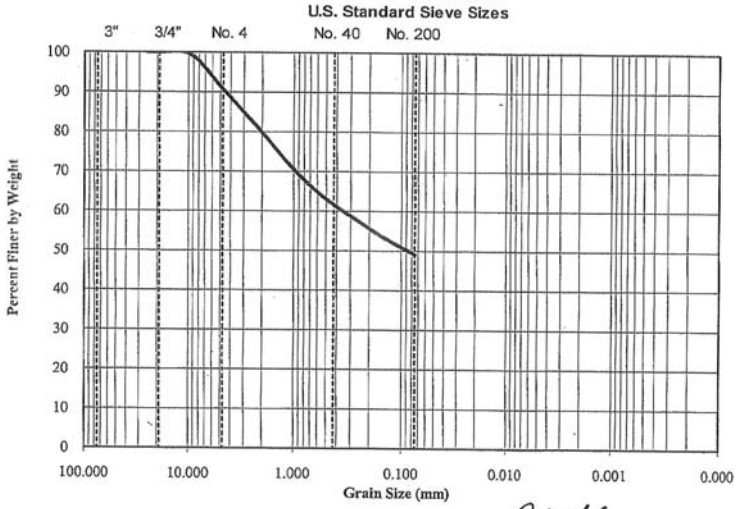
**MACTEC ENGINEERING AND CONSULTING, INC**
**1070 West Main StreetSuite 5**
**Abingdon, Virginia 24210**
**(276) 676-0426**

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/22/10

**Washed Particle Size/Gradation Test Report**
**ASTM D1140/D422**
**Sample Number: SS-5/SS-7** **Location:** C-1
**Depth:** 7.0'-8.5'/10.0'-11.5'
**Percent Finer than No. 200:** 49.1 **% (from washing)**

| Sieve Size | Cumulative (g) | Wt. Retained Each Sieve (g) | Cumulative % Passing | Cumulative % Passing w/ Wash 200 |
|---|---|---|---|---|
| 1 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/4 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/8 in. | 0.80 | 0.80 | 98.8 | 99.4 |
| # 4 | 11.63 | 10.83 | 81.9 | 90.7 |
| # 10 | 25.39 | 13.76 | 60.5 | 79.8 |
| # 20 | 39.60 | 14.21 | 38.4 | 68.5 |
| # 40 | 48.24 | 8.64 | 25.0 | 61.6 |
| # 60 | 53.47 | 5.23 | 16.9 | 57.4 |
| # 100 | 58.39 | 4.92 | 9.2 | 53.5 |
| #200 | 63.93 | 5.54 | 0.6 | 49.1 |
| PAN | 64.33 | 0.40 | | |
| | | | | |
| Wt. of Soil, g | 125.55 | | | |

**Particle Size Analysis**
**U.S. Standard Sieve Sizes**




Performed By: NCD

Checked By: JCM
Tim Lawrence 9/23/2010

C-1 SS-5,SS-7

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

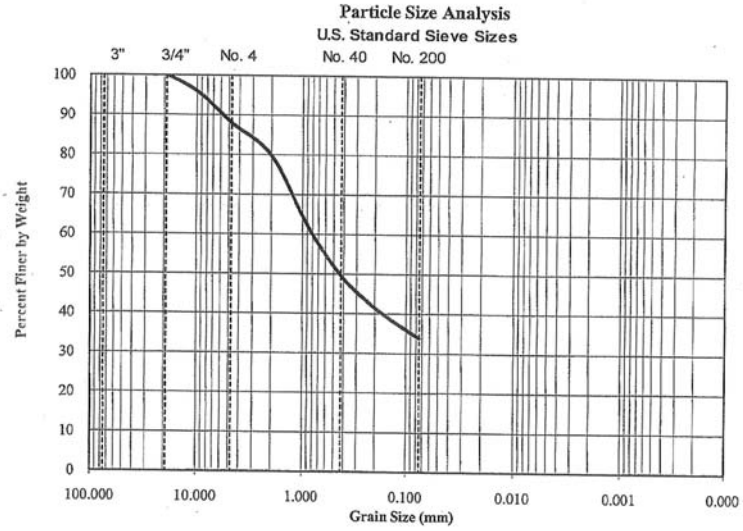
MACTEC ENGINEERING AND CONSULTING, INC
1070 West Main StreetSuite 5
Abingdon, Virginia 24210
(276) 676-0426

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/22/10

**Washed Particle Size/Gradation Test Report**
**ASTM D1140 / D422**
**Sample Number:** SS-8/SS-9 **Location:** C-1
**Depth:** 11.5'-14.5'
**Percent Finer than No. 200:** 33.9 **% (from washing)**

| Sieve Size | Cumulative (g) | Wt. Retained Each Sieve (g) | Cumulative % Passing | Cumulative % Passing w/ Wash 200 |
|---|---|---|---|---|
| 1 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/4 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/8 in. | 5.92 | 5.92 | 93.2 | 95.5 |
| # 4 | 15.60 | 9.68 | 82.1 | 88.0 |
| # 10 | 26.52 | 10.92 | 69.6 | 79.7 |
| # 20 | 50.87 | 24.35 | 41.7 | 61.0 |
| # 40 | 65.75 | 14.88 | 24.7 | 49.6 |
| # 60 | 73.58 | 7.83 | 15.7 | 43.6 |
| # 100 | 79.67 | 6.09 | 8.7 | 39.0 |
| #200 | 86.27 | 6.60 | 1.1 | 33.9 |
| PAN | 87.26 | 0.99 | | |
| | | | | |
| Wt. of Soil, g | 130.52 | | | |

**Particle Size Analysis**
**U.S. Standard Sieve Sizes**




Performed By: NOH

Checked By: ACM
Tim Lawrence 9/23/2010

C-1 SS-8,SS-9

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

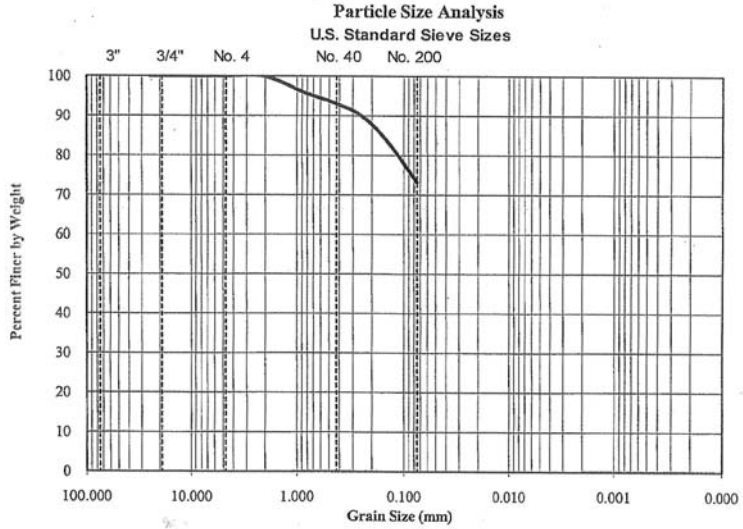
MACTEC ENGINEERING AND CONSULTING, INC
1070 West Main StreetSuite 5
Abingdon, Virginia 24210
(276) 676-0426

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/22/10

**Washed Particle Size/Gradation Test Report**
**ASTM D1140 / D422**
**Sample Number: SS-11/SS-12** **Location:** C-1
**Depth:** 16.0'-19.0'
**Percent Finer than No. 200:** 73.2 **% (from washing)**

| Sieve Size | Cumulative (g) | Wt. Retained Each Sieve (g) | Cumulative % Passing | Cumulative % Passing w/ Wash 200 |
|---|---|---|---|---|
| 1 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/4 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/8 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| # 4 | 0.00 | 0.00 | 100.0 | 100.0 |
| # 10 | 0.10 | 0.10 | 99.7 | 99.9 |
| # 20 | 4.81 | 4.71 | 84.8 | 95.8 |
| # 40 | 8.05 | 3.24 | 74.5 | 93.0 |
| # 60 | 11.55 | 3.50 | 63.5 | 90.0 |
| # 100 | 18.25 | 6.70 | 42.3 | 84.2 |
| #200 | 30.97 | 12.72 | 2.0 | 73.2 |
| PAN | 31.61 | 0.64 | | |
| | | | | |
| Wt. of Soil, g | 115.60 | | | |

**Particle Size Analysis**
**U.S. Standard Sieve Sizes**




Performed By: NCH Checked By: JCM

C-1 SS-11,SS-12

Tim Lawrence 9/23/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

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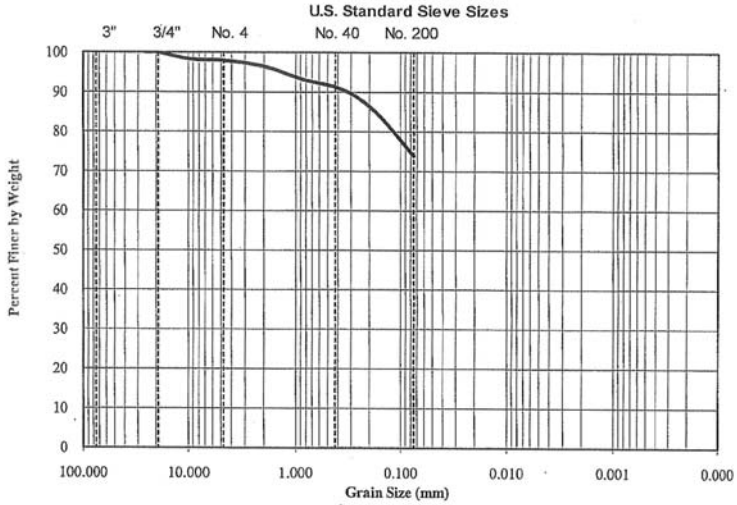
1070 West Main StreetSuite 5
Abingdon, Virginia 24210
(276) 676-0426

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/22/10

**Washed Particle Size/Gradation Test Report**
**ASTM D1140 / D422**
**Sample Number: SS-13/SS-14** **Location:** C-1
**Depth:** 19.0'-22.0'
**Percent Finer than No. 200:** 73.9 **% (from washing)**

| Sieve Size | Cumulative (g) | Wt. Retained Each Sieve (g) | Cumulative % Passing | Cumulative % Passing w/ Wash 200 |
|---|---|---|---|---|
| 1 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/4 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/8 in. | 2.28 | 2.28 | 93.5 | 98.3 |
| # 4 | 2.71 | 0.43 | 92.3 | 98.0 |
| # 10 | 4.66 | 1.95 | 86.7 | 96.5 |
| # 20 | 8.97 | 4.31 | 74.4 | 93.2 |
| # 40 | 11.50 | 2.53 | 67.2 | 91.3 |
| # 60 | 15.34 | 3.84 | 56.3 | 88.4 |
| # 100 | 22.26 | 6.92 | 36.6 | 83.2 |
| #200 | 34.58 | 12.32 | 1.5 | 73.9 |
| PAN | 35.09 | 0.51 | | |
| | | | | |
| Wt. of Soil, g | 132.69 | | | |

**Particle Size Analysis**
**U.S. Standard Sieve Sizes**




Performed By: NCH Checked By: JCM

C-1 SS-13,SS-14

Tim Laurence 9/23/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

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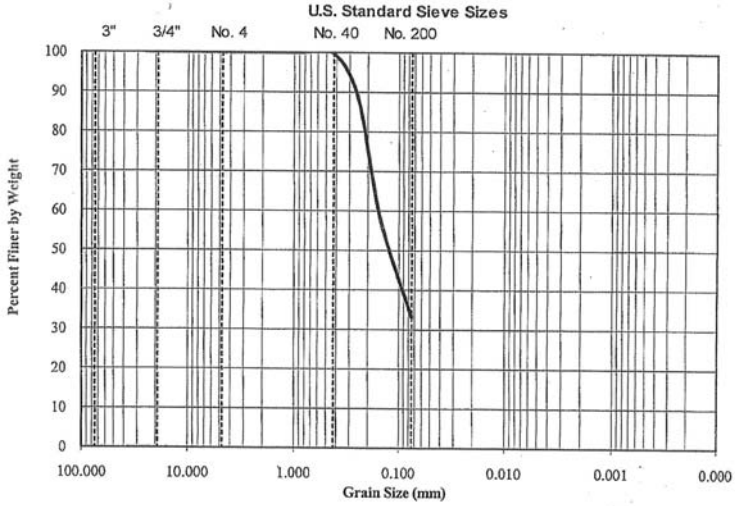
MACTEC ENGINEERING AND CONSULTING, INC
1070 West Main StreetSuite 5
Abingdon, Virginia 24210
(276) 676-0426

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/22/10

**Washed Particle Size/Gradation Test Report**
**ASTM D1140 / D422**
**Sample Number: SS-27/SS-28** **Location:** C-1
**Depth:** 40.0'-43.0'
**Percent Finer than No. 200:** 33.1 **% (from washing)**

| Sieve Size | Cumulative (g) | Wt. Retained Each Sieve (g) | Cumulative % Passing | Cumulative % Passing w/ Wash 200 |
|---|---|---|---|---|
| 1 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/4 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/8 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| # 4 | 0.00 | 0.00 | 100.0 | 100.0 |
| # 10 | 0.00 | 0.00 | 100.0 | 100.0 |
| # 20 | 0.08 | 0.08 | 99.9 | 100.0 |
| # 40 | 0.61 | 0.53 | 99.6 | 99.7 |
| # 60 | 22.72 | 22.11 | 83.4 | 88.6 |
| # 100 | 84.95 | 62.23 | 37.8 | 57.2 |
| #200 | 132.94 | 47.99 | 2.6 | 33.1 |
| PAN | 136.50 | 3.56 | | |
| | | | | |
| Wt. of Soil, g | 198.58 | | | |

**Particle Size Analysis**
**U.S. Standard Sieve Sizes**




Performed By: NCH Checked By: ACM Tim Lawrence 9/23/2010 C-1 SS-27,SS-28

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

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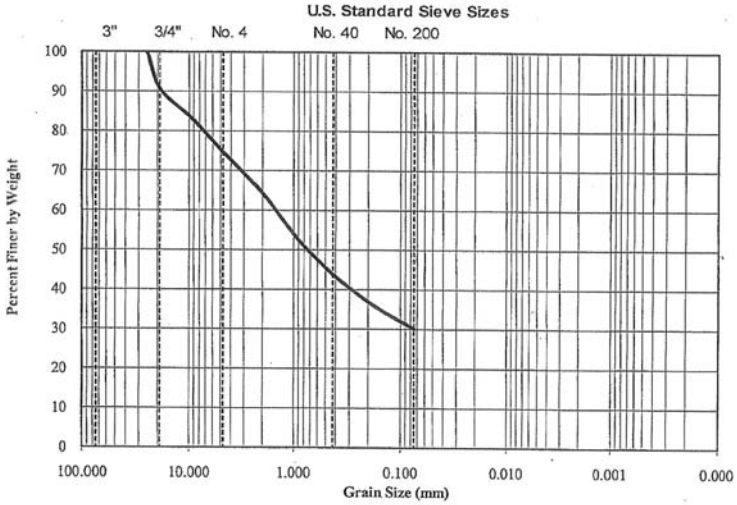
MACTEC ENGINEERING AND CONSULTING, INC
1070 West Main StreetSuite 5
Abingdon, Virginia 24210
(276) 676-0426

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/22/10

**Washed Particle Size/Gradation Test Report**
**ASTM D1140 / D422**
**Sample Number:** SS-5/SS-7 **Location:** C-2
**Depth:** 7.5'-9.0'/10.5'-12.0'
**Percent Finer than No. 200:** 30.1 % (from washing)

| Sieve Size | Cumulative (g) | Wt. Retained Each Sieve (g) | Cumulative % Passing | Cumulative % Passing w/ Wash 200 |
|---|---|---|---|---|
| 1 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/4 in. | 10.19 | 10.19 | 86.8 | 90.7 |
| 3/8 in. | 18.33 | 8.14 | 76.3 | 83.3 |
| # 4 | 27.99 | 9.66 | 63.8 | 74.6 |
| # 10 | 39.29 | 11.30 | 49.3 | 64.3 |
| # 20 | 53.12 | 13.83 | 31.4 | 51.7 |
| # 40 | 61.91 | 8.79 | 20.0 | 43.8 |
| # 60 | 67.32 | 5.41 | 13.0 | 38.8 |
| # 100 | 71.90 | 4.58 | 7.1 | 34.7 |
| #200 | 76.91 | 5.01 | 0.7 | 30.1 |
| PAN | 77.42 | 0.51 | | |
| | | | | |
| Wt. of Soil, g | 110.07 | | | |

**Particle Size Analysis**
**U.S. Standard Sieve Sizes**




Performed By: NCH

Checked By: 4cm
Tim Lawrence 9/23/2010

C-2 SS-5,SS-7

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

MACTEC ENGINEERING AND CONSULTING, INC
1070 West Main StreetSuite 5
Abingdon, Virginia 24210
(276) 676-0426

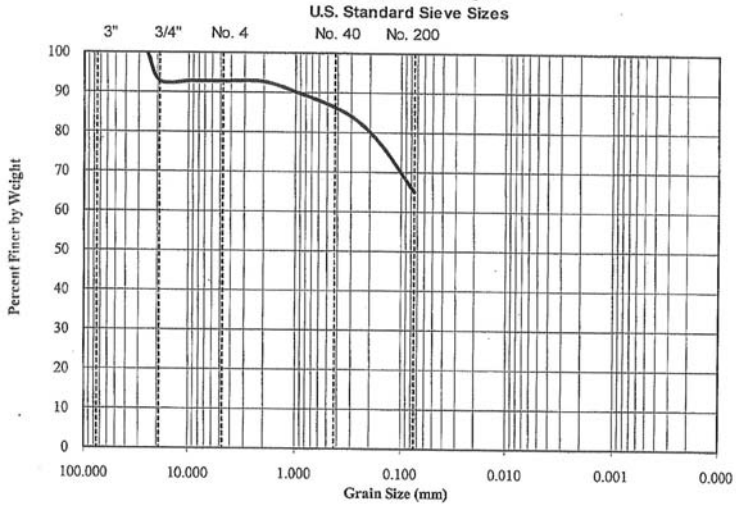
Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/22/10

**Washed Particle Size/Gradation Test Report**
**ASTM D1140 / D422**

**Sample Number:** SS-8/SS-9 **Location:** C-2
**Depth:** 12.0'-15.0'
**Percent Finer than No. 200:** 65.0 **% (from washing)**

| Sieve Size | Cumulative (g) | Wt. Retained Each Sieve (g) | Cumulative % Passing | Cumulative % Passing w/ Wash 200 |
|---|---|---|---|---|
| 1 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/4 in. | 9.10 | 9.10 | 79.8 | 92.8 |
| 3/8 in. | 9.10 | 0.00 | 79.8 | 92.8 |
| # 4 | 9.10 | 0.00 | 79.8 | 92.8 |
| # 10 | 9.26 | 0.16 | 79.4 | 92.7 |
| # 20 | 13.30 | 4.04 | 70.4 | 89.5 |
| # 40 | 17.33 | 4.03 | 61.5 | 86.3 |
| # 60 | 22.15 | 4.82 | 50.8 | 82.5 |
| # 100 | 29.88 | 7.73 | 33.6 | 76.3 |
| #200 | 44.15 | 14.27 | 1.8 | 65.0 |
| PAN | 44.98 | 0.83 | | |
| | | | | |
| Wt. of Soil, g | 126.29 | | | |

**Particle Size Analysis**
**U.S. Standard Sieve Sizes**




Performed By: NCH

Checked By: gcm
Tim Lawrence 9/23/2010

C-2 SS-8,SS-9

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

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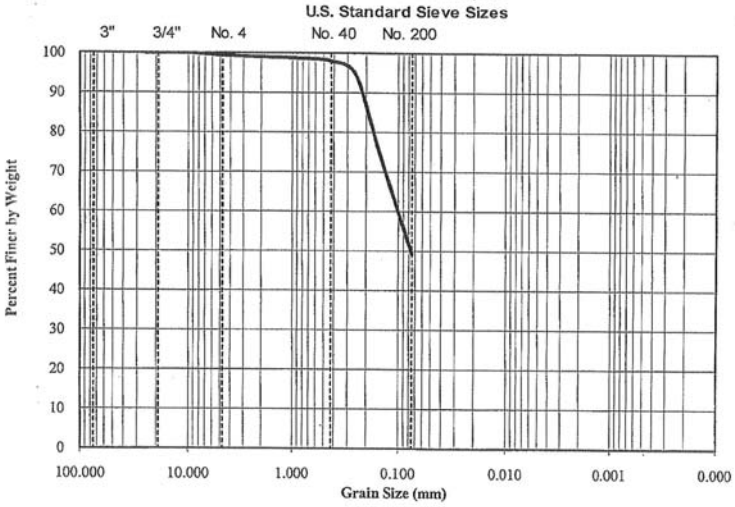
MACTEC ENGINEERING AND CONSULTING, INC
1070 West Main StreetSuite 5
Abingdon, Virginia 24210
(276) 676-0426

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/22/10

**Washed Particle Size/Gradation Test Report**
**ASTM D1140 / D422**
**Sample Number:** SS-17/SS-18 **Location:** C-2
**Depth:** 25.5'-28.5'
**Percent Finer than No. 200:** 49.2 **% (from washing)**

| Sieve Size | Cumulative (g) | Wt. Retained Each Sieve (g) | Cumulative % Passing | Cumulative % Passing w/ Wash 200 |
|---|---|---|---|---|
| 1 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/4 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/8 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| # 4 | 1.02 | 1.02 | 98.8 | 99.4 |
| # 10 | 1.68 | 0.66 | 98.0 | 99.0 |
| # 20 | 2.05 | 0.37 | 97.6 | 98.7 |
| # 40 | 3.15 | 1.10 | 96.2 | 98.0 |
| # 60 | 8.86 | 5.71 | 89.4 | 94.5 |
| # 100 | 41.05 | 32.19 | 51.1 | 74.5 |
| #200 | 81.74 | 40.69 | 2.6 | 49.2 |
| PAN | 83.95 | 2.21 | | |
| | | | | |
| Wt. of Soil, g | 160.81 | | | |

**Particle Size Analysis**
**U.S. Standard Sieve Sizes**




Performed By: NCH Checked By: JCM C-2 SS-17,SS-18
Tim Lawrence 9/23/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

MACTEC

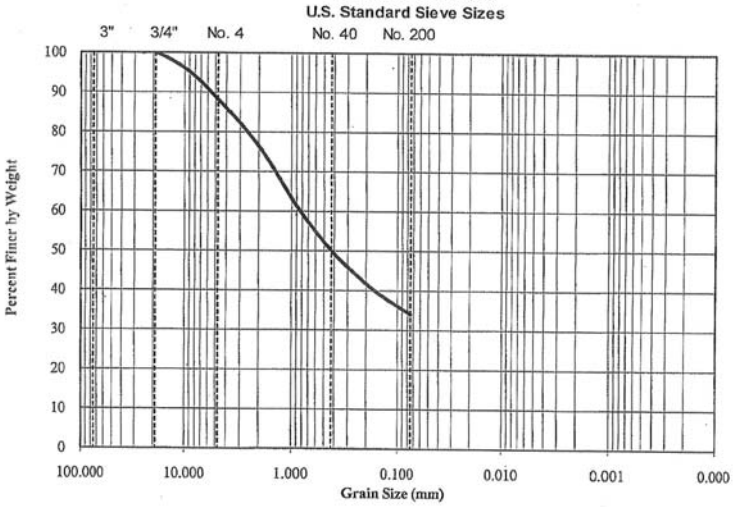
MACTEC ENGINEERING AND CONSULTING, INC
1070 West Main StreetSuite 5
Abingdon, Virginia 24210
(276) 676-0426

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/22/10

**Washed Particle Size/Gradation Test Report**
**ASTM D1140 / D422**
**Sample Number: SS-9/SS-10** **Location: D-1**
**Depth:** 12.0'-15.0'
**Percent Finer than No. 200:** **34.0** **% (from washing)**

| Sieve Size | Cumulative (g) | Wt. Retained Each Sieve (g) | Cumulative % Passing | Cumulative % Passing w/ Wash 200 |
|---|---|---|---|---|
| 1 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/4 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/8 in. | 5.27 | 5.27 | 93.4 | 95.6 |
| # 4 | 14.30 | 9.03 | 82.2 | 88.1 |
| # 10 | 28.62 | 14.32 | 64.3 | 76.3 |
| # 20 | 47.89 | 19.27 | 40.3 | 60.3 |
| # 40 | 60.39 | 12.50 | 24.7 | 50.0 |
| # 60 | 67.59 | 7.20 | 15.7 | 44.0 |
| # 100 | 73.46 | 5.87 | 8.4 | 39.1 |
| #200 | 79.63 | 6.17 | 0.7 | 34.0 |
| PAN | 80.19 | 0.56 | | |
| | | | | |
| Wt. of Soil, g | 120.67 | | | |

**Particle Size Analysis**
**U.S. Standard Sieve Sizes**




Performed By: NCH

Checked By: ACM
Tim Lawrence 9/23/2010

D-1 SS-9,SS-10

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

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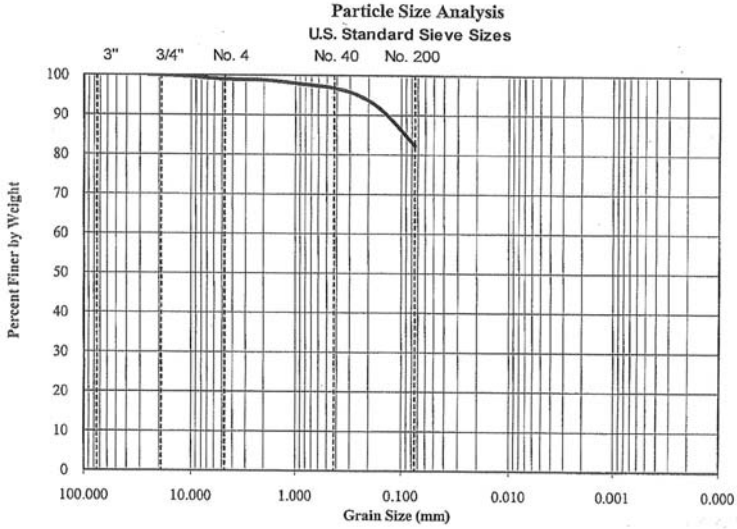
(276) 676-0426

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/22/10

**Washed Particle Size/Gradation Test Report**
**ASTM D1140 / D422**
**Sample Number:** SS-11/SS-12/SS-13 **Location:** D-1
**Depth:** 15.0'-19.5'
**Percent Finer than No. 200:** 82.3 **% (from washing)**

| Sieve Size | Cumulative (g) | Wt. Retained Each Sieve (g) | Cumulative % Passing | Cumulative % Passing w/ Wash 200 |
|---|---|---|---|---|
| 1 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/4 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/8 in. | 1.05 | 1.05 | 97.6 | 99.6 |
| # 4 | 2.47 | 1.42 | 94.3 | 99.0 |
| # 10 | 2.77 | 0.30 | 93.6 | 98.8 |
| # 20 | 5.16 | 2.39 | 88.1 | 97.8 |
| # 40 | 7.69 | 2.53 | 82.2 | 96.8 |
| # 60 | 11.91 | 4.22 | 72.5 | 95.0 |
| # 100 | 21.13 | 9.22 | 51.2 | 91.2 |
| #200 | 42.40 | 21.27 | 2.0 | 82.3 |
| PAN | 43.26 | 0.86 | | |
| | | | | |
| Wt. of Soil, g | 239.88 | | | |

**Particle Size Analysis**
**U.S. Standard Sieve Sizes**




Performed By: NCH

Checked By: GCM D-1 SS-11,SS-12,SS-13
Tim Lawrence 9/23/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

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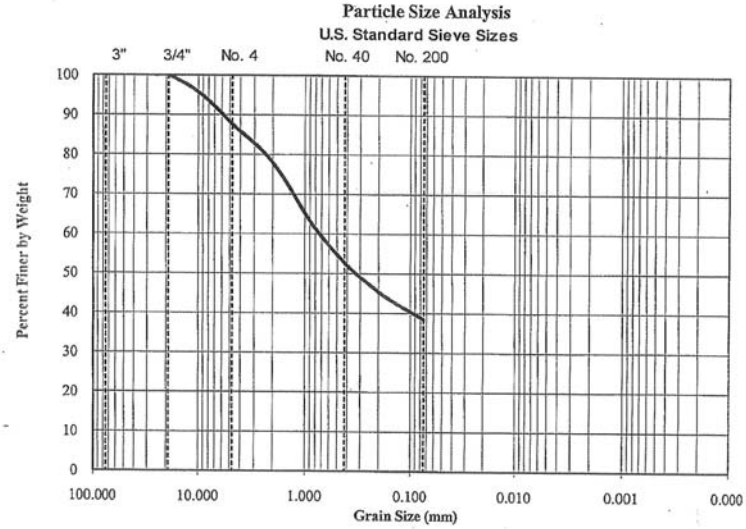
Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/22/10

**Washed Particle Size/Gradation Test Report**
**ASTM D1140 / D422**
**Sample Number: SS-5/SS-6** **Location:** D-2
**Depth:** 7.0'-10.0'
**Percent Finer than No. 200:** 38.5 **% (from washing)**

| Sieve Size | Cumulative (g) | Wt. Retained Each Sieve (g) | Cumulative % Passing | Cumulative % Passing w/ Wash 200 |
|---|---|---|---|---|
| 1 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/4 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/8 in. | 8.14 | 8.14 | 92.5 | 95.3 |
| # 4 | 21.68 | 13.54 | 79.9 | 87.6 |
| # 10 | 38.54 | 16.86 | 64.3 | 77.9 |
| # 20 | 65.85 | 27.31 | 39.1 | 62.3 |
| # 40 | 82.58 | 16.73 | 23.6 | 52.7 |
| # 60 | 91.85 | 9.27 | 15.0 | 47.4 |
| # 100 | 99.50 | 7.65 | 7.9 | 43.1 |
| #200 | 107.45 | 7.95 | 0.6 | 38.5 |
| PAN | 108.06 | 0.61 | | |
| | | | | |
| Wt. of Soil, g | 174.73 | | | |

**Particle Size Analysis**
**U.S. Standard Sieve Sizes**




Performed By: NCH

Checked By: JCM
Tim Lawrence 9/23/2010

D-2 SS-5,SS-6

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

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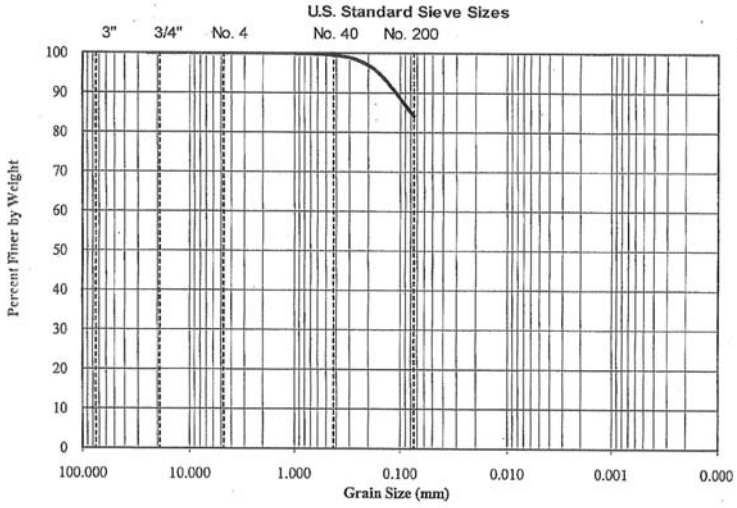
Abingdon, Virginia 24210
(276) 676-0426

Project Name: TVA East Dike Stability Study
Project Number: 3043-10-1038
Report Date: 09/22/10

**Washed Particle Size/Gradation Test Report**
**ASTM D1140 / D422**
**Sample Number:** SS-7/SS-8 **Location:** D-2
**Depth:** 10.0'-13.0'
**Percent Finer than No. 200:** 84.1 **% (from washing)**

| Sieve Size | Cumulative (g) | Wt. Retained Each Sieve (g) | Cumulative % Passing | Cumulative % Passing w/ Wash 200 |
|---|---|---|---|---|
| 1 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/4 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| 3/8 in. | 0.00 | 0.00 | 100.0 | 100.0 |
| # 4 | 0.00 | 0.00 | 100.0 | 100.0 |
| # 10 | 0.00 | 0.00 | 100.0 | 100.0 |
| # 20 | 0.19 | 0.19 | 99.1 | 99.9 |
| # 40 | 0.64 | 0.45 | 97.0 | 99.5 |
| # 60 | 2.29 | 1.65 | 89.3 | 98.2 |
| # 100 | 7.50 | 5.21 | 65.0 | 94.3 |
| #200 | 20.85 | 13.35 | 2.7 | 84.1 |
| PAN | 21.43 | 0.58 | | |
| | | | | |
| Wt. of Soil, g | 130.84 | | | |

**Particle Size Analysis**
**U.S. Standard Sieve Sizes**




Performed By: NCH

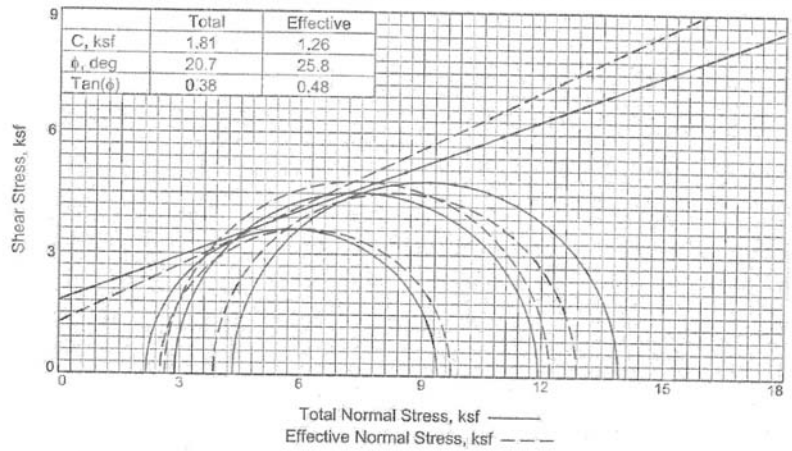
Checked By: TCM
Tim Lawrence 9/23/2010

D-2 SS-7,SS-8

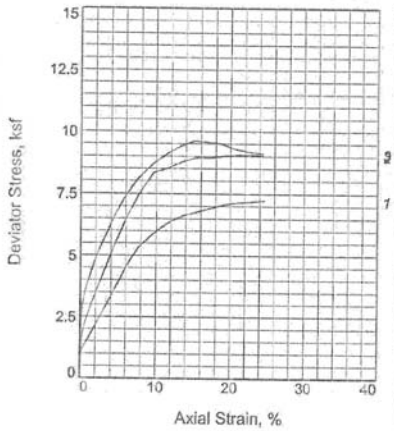
# Phase II Test Results

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105




| | Total | Effective |
|---|---|---|
| C, ksf | 1.81 | 1.26 |
| ϕ, deg | 20.7 | 25.8 |
| Tan(ϕ) | 0.38 | 0.48 |




| Sample No. | | 1 | 2 | 3 |
|---|---|---|---|---|
| Initial | Water Content, % | 23.9 | 22.6 | 22.3 |
| | Dry Density, pcf | 102.1 | 104.7 | 102.7 |
| | Saturation, % | 101.1 | 102.2 | 95.7 |
| | Void Ratio | 0.6301 | 0.5899 | 0.6206 |
| | Diameter, in. | 2.86 | 2.86 | 2.87 |
| | Height, in. | 5.26 | 5.25 | 5.34 |
| At Test | Water Content, % | 23.3 | 21.7 | 22.7 |
| | Dry Density, pcf | 102.7 | 105.5 | 103.7 |
| | Saturation, % | 100.0 | 100.0 | 100.0 |
| | Void Ratio | 0.6208 | 0.5781 | 0.6052 |
| | Diameter, in... | 2.86 | 2.85 | 2.86 |
| | Height, in. | 5.25 | 5.24 | 5.33 |
| Strain rate, in./min. | | 0.01 | 0.01 | 0.01 |
| Back Pressure, psi | | 50.00 | 50.00 | 50.00 |
| Cell Pressure, psi | | 65.00 | 70.00 | 80.00 |
| Fail. Stress, ksf | | 7.2 | 9.0 | 9.6 |
| Total Pore Pr., ksf | | 6.9 | 6.2 | 8.9 |
| Ult. Stress, ksf | | | | |
| Total Pore Pr., ksf | | | | |
| $\bar{\sigma}_1$ Failure, ksf | | 9.7 | 12.9 | 12.2 |
| $\bar{\sigma}_3$ Failure, ksf | | 2.5 | 3.8 | 2.6 |

**Type of Test:**
CU with Pore Pressures
**Sample Type:** UD
**Description:** Gray silty clayey SAND

**Specific Gravity=** 2.666
**Remarks:** Percent passing No. 200 sieve:
Pill A: 48.0
Pill B: 39.3
Pill C: 42.1
**Figure** _____

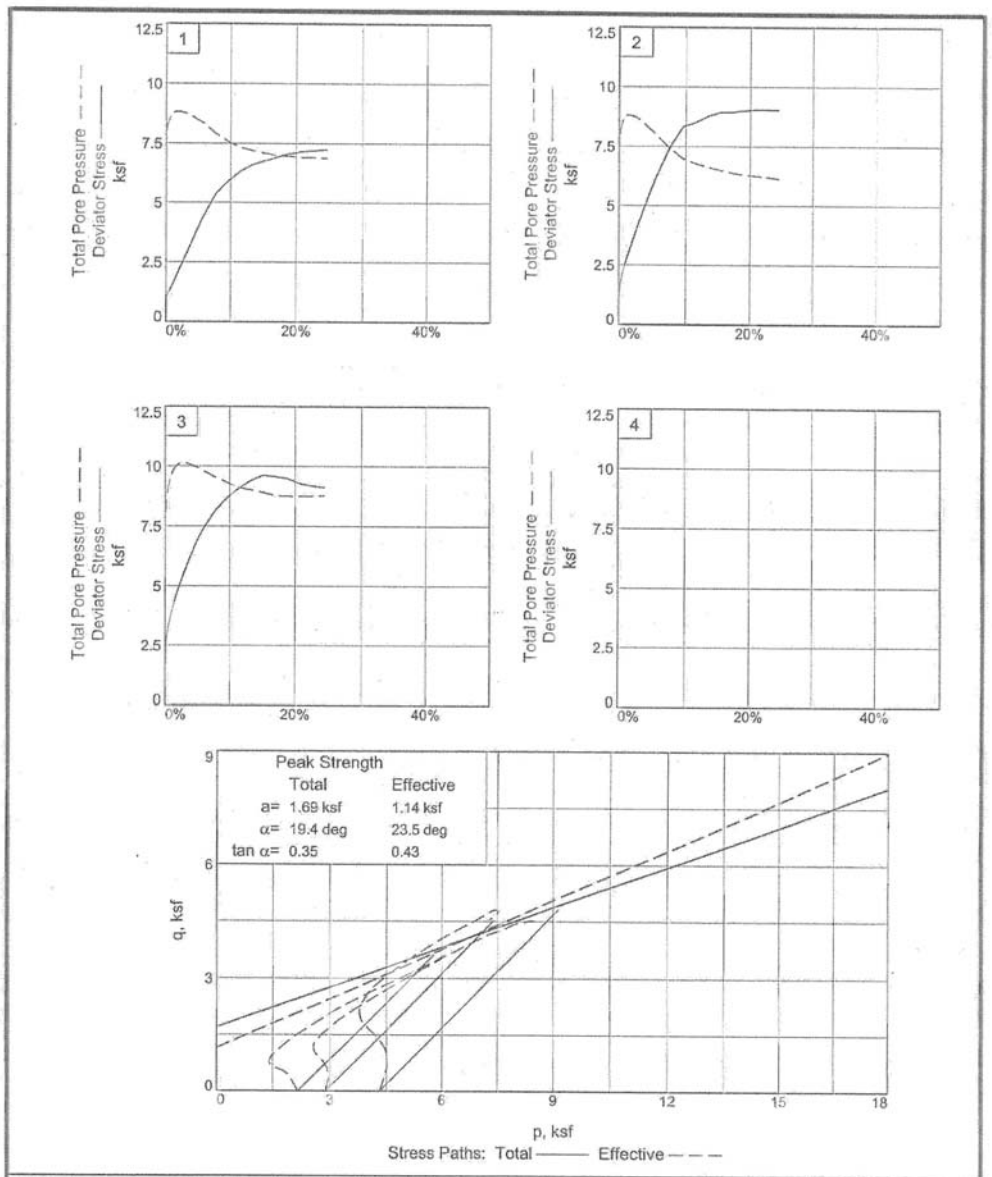
**Client:** Tennessee Valley Authority
**Project:** TVA KIF East Dike Stability Study
**Source of Sample:** Boring C-2 **Depth:** 25.0'-27.0'
**Sample Number:** UD
**Proj. No.:** 3043-10-1038 **Date Sampled:**

TRIAXIAL SHEAR TEST REPORT
MACTEC ENGINEERING AND CONSULTING, INC.

**Tested By:** FB **Checked By:** Kelly Marshall 10/7/10
Tri Lawrence 10/13/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

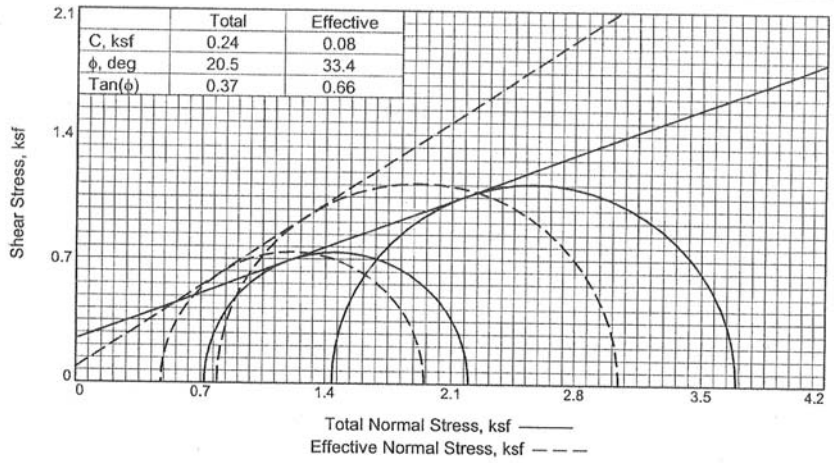



**Client:** Tennessee Valley Authority
**Project:** TVA KIF East Dike Stability Study
**Source of Sample:** Boring C-2 **Depth:** 25.0'-27.0' **Sample Number:** UD
**Project No.:** 3043-10-1038 **Figure** _____ **MACTEC Engineering and Consulting, Inc.**

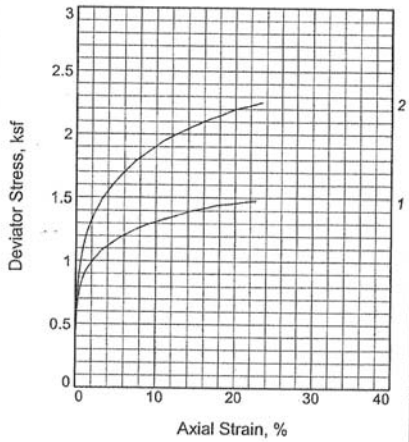
**Tested By:** FB **Checked By:** Kelly Marshall 10/7/10
Tim Laurence 10/13/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105




| | Total | Effective |
|---|---|---|
| C, ksf | 0.24 | 0.08 |
| ϕ, deg | 20.5 | 33.4 |
| Tan(ϕ) | 0.37 | 0.66 |




| | Sample No. | 1 | 2 |
|---|---|---|---|
| Initial | Water Content, % | 18.6 | 19.9 |
| | Dry Density, pcf | 111.5 | 110.9 |
| | Saturation, % | 94.3 | 99.6 |
| | Void Ratio | 0.5442 | 0.5522 |
| | Diameter, in. | 2.82 | 2.87 |
| | Height, in. | 5.68 | 5.56 |
| At Test | Water Content, % | 18.6 | 18.7 |
| | Dry Density, pcf | 113.8 | 113.7 |
| | Saturation, % | 100.0 | 100.0 |
| | Void Ratio | 0.5133 | 0.5148 |
| | Diameter, in. | 2.80 | 2.85 |
| | Height, in. | 5.64 | 5.52 |
| Strain rate, in./min. | | 0.01 | 0.01 |
| Back Pressure, psi | | 60.00 | 60.00 |
| Cell Pressure, psi | | 65.00 | 70.00 |
| Fail. Stress, ksf | | 1.48 | 2.25 |
| Total Pore Pr., ksf | | 8.88 | 9.29 |
| Ult. Stress, ksf | | | |
| Total Pore Pr., ksf | | | |
| $\bar{\sigma}_1$ Failure, ksf | | 1.95 | 3.05 |
| $\bar{\sigma}_3$ Failure, ksf | | 0.48 | 0.79 |

**Type of Test:**
CU with Pore Pressures
**Sample Type:** UD
**Description:** Gray clayey SAND with gravel

**Specific Gravity=** 2.758
**Remarks:** Percent passing No. 200 sieve:
Pill A: 42.5
Pill B: 41.9

**Figure** _____

**Client:** Tennessee Valley Authority

**Project:** TVA KIF East Dike Stability Study

**Source of Sample:** Boring D-2 **Depth:** 7.5'-9.5'

**Proj. No.:** 3043-10-1038 **Date Sampled:**

TRIAXIAL SHEAR TEST REPORT

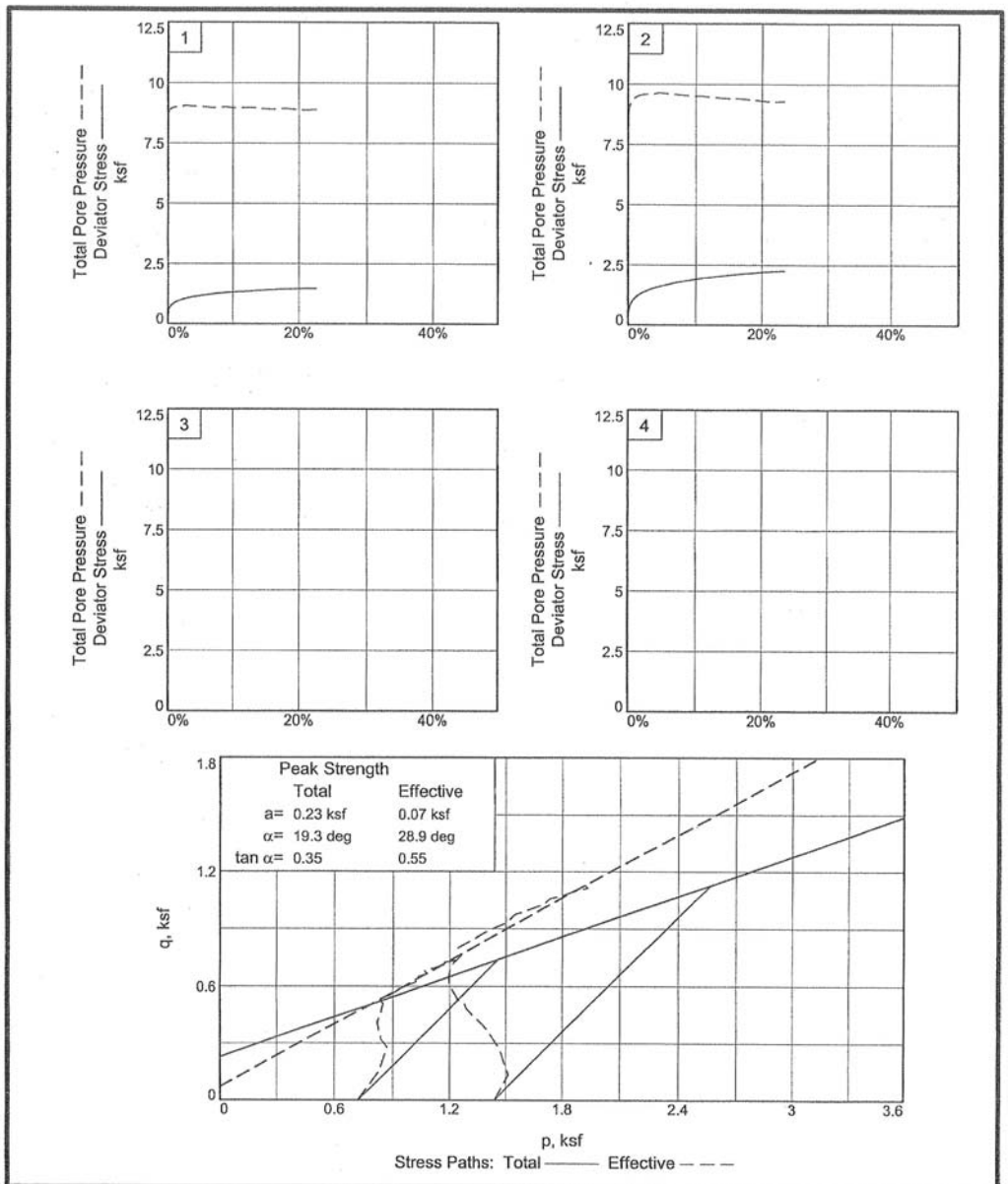
MACTEC ENGINEERING AND CONSULTING, INC.

**Tested By:** FB **Checked By:** Kelly Marshall 10/13/10

Tri Lawrence 10/13/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105




**Client:** Tennessee Valley Authority
**Project:** TVA KIF East Dike Stability Study
**Source of Sample:** Boring D-2 **Depth:** 7.5'-9.5'
**Project No.:** 3043-10-1038 **Figure** _____

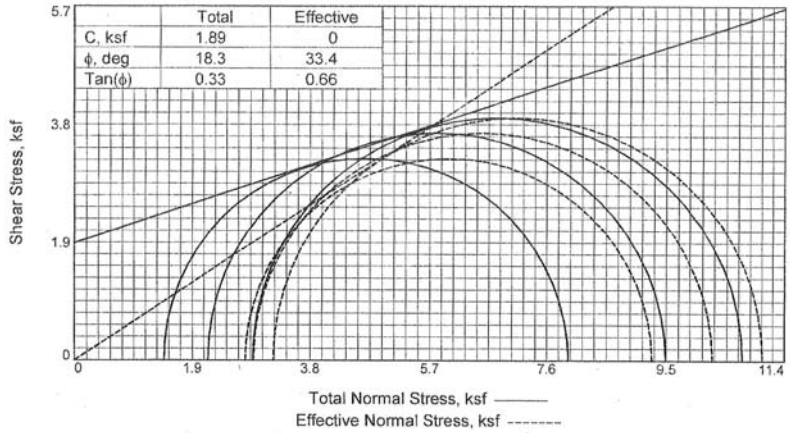
**MACTEC Engineering and Consulting, Inc.**

**Tested By:** FB **Checked By:** Kelly Marshall 10/13/10

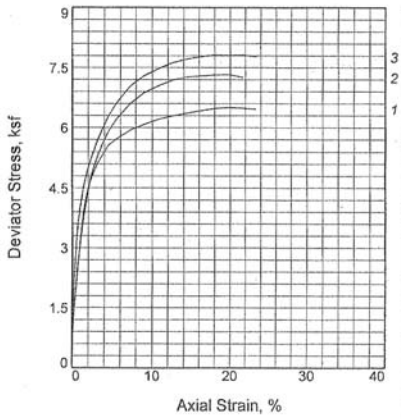
Tim Lawrence 10/13/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105




| | Total | Effective |
|---|---|---|
| C, ksf | 1.89 | 0 |
| ϕ, deg | 18.3 | 33.4 |
| Tan(ϕ) | 0.33 | 0.66 |




| Sample No. | | 1 | 2 | 3 |
|---|---|---|---|---|
| Initial | Water Content, % | 21.9 | 21.6 | 20.2 |
| | Dry Density, pcf | 104.7 | 104.7 | 107.7 |
| | Saturation, % | 97.0 | 95.9 | 99.9 |
| | Void Ratio | 0.6081 | 0.6072 | 0.5366 |
| | Diameter, in. | 2.85 | 2.85 | 2.84 |
| | Height, in. | 5.58 | 5.61 | 5.62 |
| At Test | Water Content, % | 21.7 | 20.7 | 18.4 |
| | Dry Density, pcf | 106.3 | 108.1 | 111.3 |
| | Saturation, % | 100.0 | 100.0 | 100.0 |
| | Void Ratio | 0.5840 | 0.5569 | 0.4869 |
| | Diameter, in. | 2.83 | 2.82 | 2.81 |
| | Height, in. | 5.56 | 5.55 | 5.56 |
| Strain rate, in./min. | | 0.01 | 0.01 | 0.01 |
| Back Pressure, psi | | 50.00 | 50.00 | 50.00 |
| Cell Pressure, psi | | 60.00 | 65.00 | 70.00 |
| Fail. Stress, ksf | | 6.5 | 7.3 | 7.8 |
| Total Pore Pr., ksf | | 5.9 | 6.5 | 6.9 |
| Ult. Stress, ksf | | | | |
| Total Pore Pr., ksf | | | | |
| $\bar{\sigma}_1$ Failure, ksf | | 9.3 | 10.2 | 11.0 |
| $\bar{\sigma}_3$ Failure, ksf | | 2.8 | 2.9 | 3.2 |

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

**Sample Type:** UD

**Description:** Orange-brown and light gray sandy CLAY

**Specific Gravity=** 2.696

**Remarks:** Percent passing No. 200 sieve:
Pill A: 71.0
Pill B: 66.3
Pill C: 68.7

**Figure** _____

**Client:** Tennessee Valley Authority

**Project:** TVA KIF East Dike Stability Study

**Source of Sample:** Boring D-2 **Depth:** 15.0'-17.0'

**Proj. No.:** 3043-10-1038 **Date Sampled:**

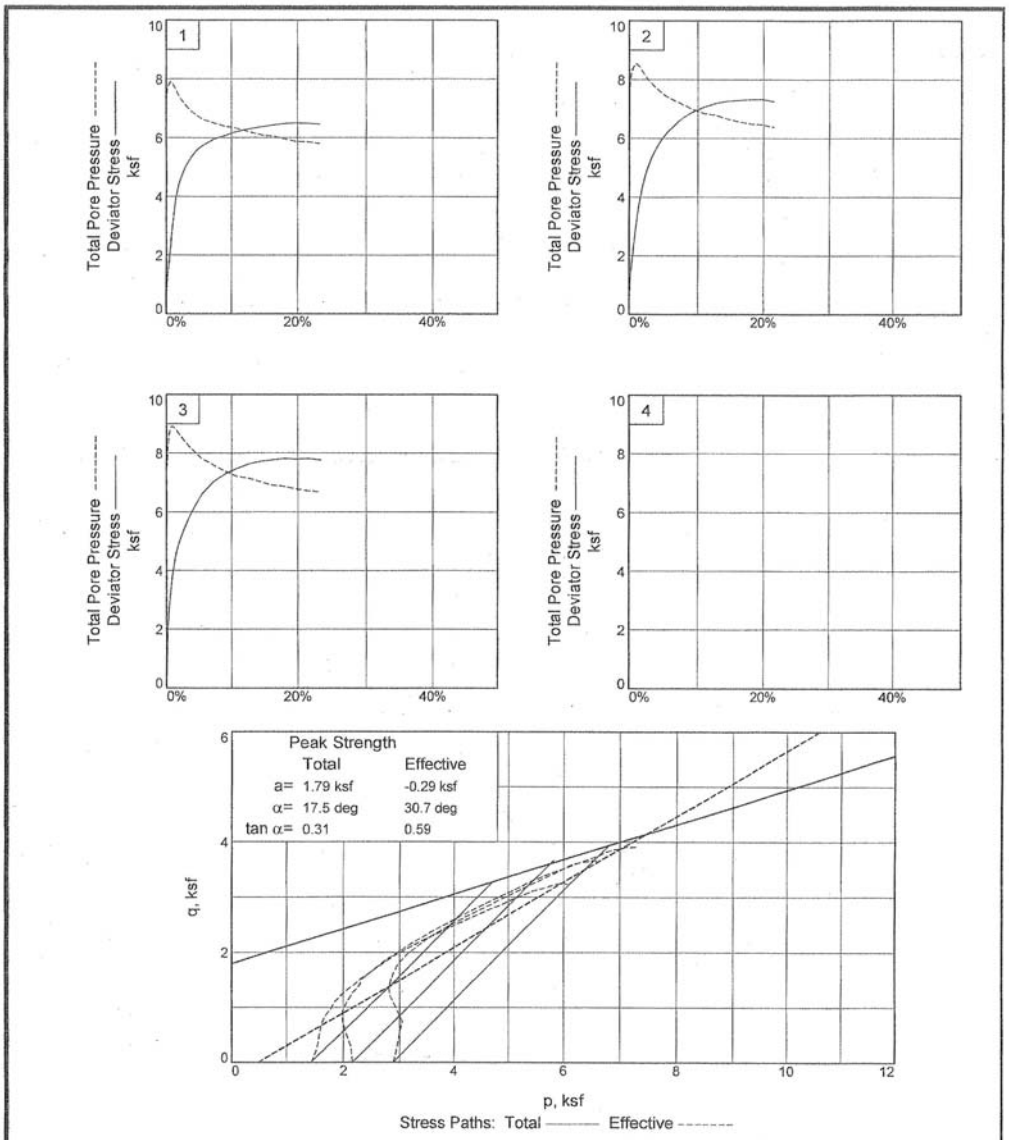
TRIAXIAL SHEAR TEST REPORT

MACTEC ENGINEERING AND CONSULTING, INC.

**Tested By:** FB **Checked By:** Kelly Marshall 10/13/10 10/13/2010

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105




**Client:** Tennessee Valley Authority
**Project:** TVA KIF East Dike Stability Study
**Source of Sample:** Boring D-2 **Depth:** 15.0'-17.0'
**Project No.:** 3043-10-1038 **Figure** _____

**MACTEC Engineering and Consulting, Inc.**

**Tested By:** FB **Checked By:** Kelly Marshall 10/13/10 Tim Lawrence 10/13/2010

## Attachment 3:

## SLIDE Output Files (Static and Seismic)

**Note:** The error messages in the output files are a result of invalid slip surfaces generated by the SLIDE program during the automatic search for the most critical slip surface. The invalid slip surfaces include surfaces that are beyond the defined model boundaries, surfaces that are kinematically not feasible, and surfaces that mathematically do not converge to a solution. The invalid slip surfaces do not affect the valid slip surfaces from which the critical slip surface is identified.

## Circular Mode of Section D-D

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

# *Slide Analysis Information*

## Document Name

File Name: Section D_Circular_Fan.slw

## Project Settings

Project Title: SLIDE - An Interactive Slope Stability Program
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Finite Element Analysis
Tolerance (groundwater): 1e-006
Maximum number of iterations (groundwater): 500
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Analysis Methods

Analysis Methods used:
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: 3

## Groundwater Analysis

Maximum Number of Iterations: 500
Iteration Tolerance: 1e-006
Mesh Element Type: 3 noded triangles
Number of Elements: 2411
Number of Nodes: 1367

## Material Properties

Material: Clayey Foundation Soil
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 30 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 1.4e-009
K2/K1: 10
K Angle: 90

Model: Simple

Material: Sandy Foundation Soil
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 26 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 3.3e-007
K2/K1: 10
K Angle: 90

Model: Simple

Material: Pond Ash
Strength Type: Mohr-Coulomb
Unit Weight: 75 lb/ft3
Cohesion: 0 psf
Friction Angle: 25 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 1.92e-006
K2/K1: 10
K Angle: 90

Model: Simple

Material: Lower Dike Fill
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 0 psf
Friction Angle: 30 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 5.6e-009
K2/K1: 10
K Angle: 90

Model: Simple

Material: Crust Layer
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3

Cohesion: 500 psf
Friction Angle: 10 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 1e-006
K2/K1: 10
K Angle: 90

Model: Simple

## Global Minimums

Method: spencer
FS: 1.802600
Center: 1143.143, 773.742
Radius: 40.242
Left Slip Surface Endpoint: 1120.044, 740.790
Right Slip Surface Endpoint: 1155.101, 735.318
Left Slope Intercept: 1120.044 740.790
Right Slope Intercept: 1155.101 737.000
Resisting Moment=130663 lb-ft
Driving Moment=72485.7 lb-ft
Resisting Horizontal Force=3136.73 lb
Driving Horizontal Force=1740.11 lb

## Valid / Invalid Surfaces

Method: spencer
Number of Valid Surfaces: 6840
Number of Invalid Surfaces: 14302
Error Codes:
Error Code -103 reported for 8799 surfaces
Error Code -107 reported for 1482 surfaces
Error Code -108 reported for 769 surfaces
Error Code -111 reported for 4 surfaces
Error Code -112 reported for 323 surfaces
Error Code -115 reported for 131 surfaces
Error Code -1000 reported for 2794 surfaces

## Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.

-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

-115 = Surface too shallow, below the minimum depth.

-1000 = No valid slip surfaces are generated at a grid center. Unable to draw a surface.

## List of All Coordinates

Material Boundary

| | |
|---|---|
| 1080.000 | 700.000 |
| 1080.000 | 709.200 |
| 1080.000 | 714.500 |
| 1080.000 | 728.200 |
| 1080.000 | 730.500 |
| 1080.000 | 746.000 |

Material Boundary

| | |
|---|---|
| 1113.000 | 700.000 |
| 1113.000 | 714.500 |
| 1113.000 | 727.980 |
| 1113.000 | 731.000 |
| 1113.000 | 741.376 |

Material Boundary

| | |
|---|---|
| 1080.000 | 730.500 |
| 1113.000 | 731.000 |
| 1178.955 | 731.000 |

Material Boundary

| | |
|---|---|
| 1080.000 | 714.500 |
| 1113.000 | 714.500 |

Material Boundary

| | |
|---|---|
| 1113.000 | 714.500 |

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

| | |
|---|---|
| 1270.000 | 714.500 |

Material Boundary

| | |
|---|---|
| 700.000 | 748.000 |
| 797.481 | 748.000 |

Material Boundary

| | |
|---|---|
| 0.000 | 731.094 |
| 700.000 | 730.866 |
| 1031.098 | 730.757 |
| 1080.000 | 730.500 |

Material Boundary

| | |
|---|---|
| 700.000 | 724.000 |
| 1080.000 | 714.500 |

Material Boundary

| | |
|---|---|
| 1031.098 | 730.757 |
| 1073.819 | 744.998 |

Material Boundary

| | |
|---|---|
| 0.000 | 724.000 |
| 700.000 | 724.000 |

Material Boundary

| | |
|---|---|
| 700.000 | 700.000 |
| 700.000 | 724.000 |
| 700.000 | 730.866 |
| 700.000 | 748.000 |
| 700.000 | 759.881 |

Material Boundary

| | |
|---|---|
| 0.000 | 748.000 |
| 700.000 | 748.000 |

External Boundary

| | |
|---|---|
| 1178.955 | 731.000 |
| 1145.812 | 737.000 |
| 1140.289 | 738.000 |
| 1134.765 | 739.000 |
| 1129.123 | 739.995 |
| 1127.112 | 740.202 |
| 1117.516 | 741.000 |
| 1113.000 | 741.376 |
| 1105.491 | 742.000 |
| 1101.027 | 743.000 |
| 1095.938 | 746.000 |
| 1080.000 | 746.000 |
| 1076.826 | 746.000 |
| 1073.819 | 744.998 |
| 1052.469 | 744.887 |
| 1026.854 | 745.000 |
| 1019.909 | 746.000 |
| 877.234 | 746.000 |
| 872.145 | 747.000 |
| 797.481 | 748.000 |
| 790.090 | 751.728 |
| 784.400 | 754.278 |
| 782.532 | 755.000 |
| 779.168 | 756.000 |
| 775.893 | 756.899 |
| 773.335 | 757.857 |
| 768.603 | 758.819 |
| 765.957 | 758.962 |
| 758.332 | 758.654 |
| 754.184 | 758.686 |
| 748.681 | 758.844 |
| 745.296 | 759.000 |
| 733.369 | 759.000 |
| 721.203 | 759.710 |
| 718.106 | 760.000 |
| 717.580 | 760.000 |
| 715.841 | 759.689 |
| 713.704 | 759.000 |
| 710.267 | 759.000 |
| 706.457 | 759.474 |
| 704.026 | 759.670 |
| 700.000 | 759.881 |
| 696.937 | 759.952 |
| 670.822 | 760.000 |
| 667.003 | 761.000 |
| 651.105 | 762.000 |
| 643.719 | 764.000 |
| 423.803 | 765.000 |
| 408.803 | 758.000 |
| 308.803 | 758.000 |
| 298.621 | 765.000 |
| 294.984 | 767.500 |
| 192.090 | 767.500 |
| 187.590 | 766.000 |
| 184.590 | 765.000 |
| 157.590 | 756.000 |
| 147.590 | 756.000 |
| 120.590 | 765.000 |
| 117.590 | 766.000 |
| 115.094 | 767.000 |
| 112.195 | 770.000 |
| 109.647 | 773.000 |
| 65.729 | 773.282 |
| 36.900 | 773.381 |
| 28.534 | 773.062 |
| 20.403 | 772.993 |
| 19.869 | 772.834 |
| 18.940 | 771.904 |
| 12.977 | 767.877 |
| 9.507 | 765.000 |
| 7.712 | 764.000 |
| 5.056 | 763.000 |
| 3.208 | 762.994 |
| 0.000 | 762.759 |

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

| | |
|---|---|
| 0.000 | 748.000 |
| 0.000 | 732.500 |
| 0.000 | 731.094 |
| 0.000 | 724.000 |
| 0.000 | 700.000 |
| 700.000 | 700.000 |
| 1080.000 | 700.000 |
| 1113.000 | 700.000 |
| 1113.019 | 700.000 |
| 1270.000 | 700.000 |
| 1270.000 | 714.500 |
| 1270.000 | 727.190 |
| 1270.000 | 731.000 |

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

## Block Mode of Section D-D

# *Slide Analysis Information*

## Document Name

File Name: Section D_Block_Fan.sli

## Project Settings

Project Title: SLIDE - An Interactive Slope Stability Program
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Finite Element Analysis
Tolerance (groundwater): 1e-006
Maximum number of iterations (groundwater): 500
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Analysis Methods

Analysis Methods used:
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

## Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 16000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 115
Left Projection Angle (End Angle): 155
Right Projection Angle (Start Angle): 25
Right Projection Angle (End Angle): 65
Minimum Elevation: Not Defined
Minimum Depth: 3

## Groundwater Analysis

Maximum Number of Iterations: 500
Iteration Tolerance: 1e-006
Mesh Element Type: 3 noded triangles
Number of Elements: 2411
Number of Nodes: 1367

## Material Properties

Material: Clayey Foundation Soil
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 30 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 1.4e-009
K2/K1: 10
K Angle: 90

Model: Simple

Material: Sandy Foundation Soil
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 26 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 3.3e-007
K2/K1: 10
K Angle: 90

Model: Simple

Material: Pond Ash
Strength Type: Mohr-Coulomb
Unit Weight: 75 lb/ft3
Cohesion: 0 psf
Friction Angle: 25 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 1.92e-006
K2/K1: 10
K Angle: 90

Model: Simple

Material: Lower Dike Fill
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 0 psf
Friction Angle: 30 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 5.6e-007
K2/K1: 10
K Angle: 90

Model: Simple

Material: Crust Layer
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 500 psf
Friction Angle: 10 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 1e-006
K2/K1: 10
K Angle: 90

Model: Simple

## Global Minimums

Method: spencer
FS: 1.833330
Axis Location: 1104.518, 758.715
Left Slip Surface Endpoint: 1092.927, 746.000
Right Slip Surface Endpoint: 1107.735, 741.813
Resisting Moment=24291.1 lb-ft
Driving Moment=13249.8 lb-ft
Resisting Horizontal Force=1248.29 lb
Driving Horizontal Force=680.889 lb

## Valid / Invalid Surfaces

Method: spencer
Number of Valid Surfaces: 9878
Number of Invalid Surfaces: 6122
Error Codes:
Error Code -105 reported for 13 surfaces
Error Code -107 reported for 744 surfaces
Error Code -108 reported for 5181 surfaces
Error Code -111 reported for 172 surfaces
Error Code -112 reported for 12 surfaces

## Error Codes

The following errors were encountered during the computation:

-105 = More than two surface / slope intersections with no valid slip surface.

-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

## List of All Coordinates

Focus/Block Search Window

| | |
|---|---|
| 1044.324 | 727.160 |
| 1098.457 | 727.160 |
| 1096.053 | 745.460 |
| 1043.467 | 742.592 |

Focus/Block Search Window

| | |
|---|---|
| 1100.370 | 728.721 |
| 1176.738 | 731.000 |
| 1117.557 | 740.473 |
| 1097.192 | 742.541 |

Material Boundary

| | |
|---|---|
| 1080.000 | 700.000 |
| 1080.000 | 709.200 |
| 1080.000 | 714.500 |
| 1080.000 | 728.200 |
| 1080.000 | 730.500 |
| 1080.000 | 746.000 |

Material Boundary

| | |
|---|---|
| 1113.000 | 700.000 |
| 1113.000 | 714.500 |
| 1113.000 | 727.980 |
| 1113.000 | 731.000 |
| 1113.000 | 741.376 |

Material Boundary

| | |
|---|---|
| 1080.000 | 730.500 |
| 1113.000 | 731.000 |
| 1178.955 | 731.000 |

Material Boundary

| | |
|---|---|
| 1080.000 | 714.500 |
| 1113.000 | 714.500 |

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

Material Boundary

| | |
|---|---|
| 1113.000 | 714.500 |
| 1270.000 | 714.500 |

Material Boundary

| | |
|---|---|
| 700.000 | 748.000 |
| 797.481 | 748.000 |

Material Boundary

| | |
|---|---|
| 0.000 | 731.094 |
| 700.000 | 730.866 |
| 1031.098 | 730.757 |
| 1080.000 | 730.500 |

Material Boundary

| | |
|---|---|
| 700.000 | 724.000 |
| 1080.000 | 714.500 |

Material Boundary

| | |
|---|---|
| 1031.098 | 730.757 |
| 1073.819 | 744.998 |

Material Boundary

| | |
|---|---|
| 0.000 | 724.000 |
| 700.000 | 724.000 |

Material Boundary

| | |
|---|---|
| 700.000 | 700.000 |
| 700.000 | 724.000 |
| 700.000 | 730.866 |
| 700.000 | 748.000 |
| 700.000 | 759.881 |

Material Boundary

| | |
|---|---|
| 0.000 | 748.000 |
| 700.000 | 748.000 |

External Boundary

| | |
|---|---|
| 1178.955 | 731.000 |
| 1145.812 | 737.000 |
| 1140.289 | 738.000 |
| 1134.765 | 739.000 |
| 1129.123 | 739.995 |
| 1127.112 | 740.202 |
| 1117.516 | 741.000 |
| 1113.000 | 741.376 |
| 1105.491 | 742.000 |
| 1101.027 | 743.000 |
| 1095.938 | 746.000 |
| 1080.000 | 746.000 |
| 1076.826 | 746.000 |
| 1073.819 | 744.998 |
| 1052.469 | 744.887 |
| 1026.854 | 745.000 |
| 1019.909 | 746.000 |
| 877.234 | 746.000 |
| 872.145 | 747.000 |
| 797.481 | 748.000 |
| 790.090 | 751.728 |
| 784.400 | 754.278 |
| 782.532 | 755.000 |
| 779.168 | 756.000 |
| 775.893 | 756.899 |
| 773.335 | 757.857 |
| 768.603 | 758.819 |
| 765.957 | 758.962 |
| 758.332 | 758.654 |
| 754.184 | 758.686 |
| 748.681 | 758.844 |
| 745.296 | 759.000 |
| 733.369 | 759.000 |
| 721.203 | 759.710 |
| 718.106 | 760.000 |
| 717.580 | 760.000 |
| 715.841 | 759.689 |
| 713.704 | 759.000 |
| 710.267 | 759.000 |
| 706.457 | 759.474 |
| 704.026 | 759.670 |
| 700.000 | 759.881 |
| 696.937 | 759.952 |
| 670.822 | 760.000 |
| 667.003 | 761.000 |
| 651.105 | 762.000 |
| 643.719 | 764.000 |
| 423.803 | 765.000 |
| 408.803 | 758.000 |
| 308.803 | 758.000 |
| 298.621 | 765.000 |
| 294.984 | 767.500 |
| 192.090 | 767.500 |
| 187.590 | 766.000 |
| 184.590 | 765.000 |
| 157.590 | 756.000 |
| 147.590 | 756.000 |
| 120.590 | 765.000 |
| 117.590 | 766.000 |
| 115.094 | 767.000 |
| 112.195 | 770.000 |
| 109.647 | 773.000 |
| 65.729 | 773.282 |
| 36.900 | 773.381 |
| 28.534 | 773.062 |
| 20.403 | 772.993 |
| 19.869 | 772.834 |
| 18.940 | 771.904 |
| 12.977 | 767.877 |
| 9.507 | 765.000 |
| 7.712 | 764.000 |
| 5.056 | 763.000 |

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**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

| | |
|---|---|
| 3.208 | 762.994 |
| 0.000 | 762.759 |
| 0.000 | 748.000 |
| 0.000 | 732.500 |
| 0.000 | 731.094 |
| 0.000 | 724.000 |
| 0.000 | 700.000 |
| 700.000 | 700.000 |
| 1080.000 | 700.000 |
| 1113.000 | 700.000 |
| 1113.019 | 700.000 |
| 1270.000 | 700.000 |
| 1270.000 | 714.500 |
| 1270.000 | 727.190 |
| 1270.000 | 731.000 |

## Circular Mode of Section D-D

**Written by:** J. Sura / Y. Cao **Date:** 10/29/10 **Reviewed by:** Neil Davis **Date:** 10/29/10

**Client:** TVA **Project:** Dredge Cells Recovery **Project/ Proposal No.:** GR4327 **Task No.:** 105

# *Slide Analysis Information*

## Document Name

File Name: Section D_Circular_Seis_UD_Fan.sli

## Project Settings

Project Title: SLIDE - An Interactive Slope Stability Program
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Finite Element Analysis
Tolerance (groundwater): 1e-006
Maximum number of iterations (groundwater): 500
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Analysis Methods

Analysis Methods used:
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: 3

## Loading

Seismic Load Coefficient (Horizontal): 0.031

## Groundwater Analysis

Maximum Number of Iterations: 500
Iteration Tolerance: 1e-006
Mesh Element Type: 3 noded triangles
Number of Elements: 2411
Number of Nodes: 1367

## Material Properties

Material: Clayey Foundation Soil
Strength Type: Strength=F(overburden)
Unit Weight: 125 lb/ft3
Tau/Sigma Ratio: 0.25
Minimum Shear Strength: 0 psf
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 1.4e-009
K2/K1: 10
K Angle: 90

Model: Simple

Material: Sandy Foundation Soil
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 26 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 3.3e-007
K2/K1: 10
K Angle: 90

Model: Simple

Material: Pond Ash
Strength Type: Strength=F(overburden)
Unit Weight: 75 lb/ft3
Tau/Sigma Ratio: 0.8
Minimum Shear Strength: 0 psf
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 1.92e-006
K2/K1: 10
K Angle: 90

Model: Simple

Material: Lower Dike Fill
Strength Type: Strength=F(overburden)
Unit Weight: 120 lb/ft3
Tau/Sigma Ratio: 0.78
Minimum Shear Strength: 0 psf
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 5.6e-009
K2/K1: 10
K Angle: 90

Model: Simple

Material: Crust Layer
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 500 psf
Friction Angle: 10 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 1e-006
K2/K1: 10
K Angle: 90

Model: Simple

## Global Minimums

Method: spencer
FS: 1.001620
Center: 1153.143, 783.742
Radius: 63.428
Left Slip Surface Endpoint: 1105.360, 742.029
Right Slip Surface Endpoint: 1188.376, 731.000
Left Slope Intercept: 1105.360 742.029
Right Slope Intercept: 1188.376 737.000
Resisting Moment=833734 lb-ft
Driving Moment=832389 lb-ft
Resisting Horizontal Force=11826 lb
Driving Horizontal Force=11806.9 lb

## Valid / Invalid Surfaces

Method: spencer
Number of Valid Surfaces: 7766
Number of Invalid Surfaces: 13376
Error Codes:
Error Code -103 reported for 1788 surfaces
Error Code -107 reported for 721 surfaces
Error Code -108 reported for 817 surfaces
Error Code -111 reported for 145 surfaces
Error Code -113 reported for 63 surfaces
Error Code -115 reported for 63 surfaces
Error Code -1000 reported for 9779 surfaces

## Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.

-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-113 = Surface intersects outside slope limits.

-115 = Surface too shallow, below the minimum depth.

-1000 = No valid slip surfaces are generated at a grid center. Unable to draw a surface.

## List of All Coordinates

Material Boundary

| | |
|---|---|
| 1080.000 | 700.000 |
| 1080.000 | 709.200 |
| 1080.000 | 714.500 |
| 1080.000 | 728.200 |
| 1080.000 | 730.500 |
| 1080.000 | 746.000 |

Material Boundary

| | |
|---|---|
| 1113.000 | 700.000 |
| 1113.000 | 714.500 |
| 1113.000 | 727.980 |
| 1113.000 | 731.000 |
| 1113.000 | 741.376 |

Material Boundary

| | |
|---|---|
| 1080.000 | 730.500 |
| 1113.000 | 731.000 |
| 1178.955 | 731.000 |

Material Boundary

| | |
|---|---|
| 1080.000 | 714.500 |
| 1113.000 | 714.500 |

Material Boundary

| | |
|---|---|
| 1113.000 | 714.500 |
| 1270.000 | 714.500 |

Material Boundary

| | |
|---|---|
| 700.000 | 748.000 |

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| | |
|---|---|
| 797.481 | 748.000 |

Material Boundary

| | |
|---|---|
| 0.000 | 731.094 |
| 700.000 | 730.866 |
| 1031.098 | 730.757 |
| 1080.000 | 730.500 |

Material Boundary

| | |
|---|---|
| 700.000 | 724.000 |
| 1080.000 | 714.500 |

Material Boundary

| | |
|---|---|
| 1031.098 | 730.757 |
| 1073.819 | 744.998 |

Material Boundary

| | |
|---|---|
| 0.000 | 724.000 |
| 700.000 | 724.000 |

Material Boundary

| | |
|---|---|
| 700.000 | 700.000 |
| 700.000 | 724.000 |
| 700.000 | 730.866 |
| 700.000 | 748.000 |
| 700.000 | 759.881 |

Material Boundary

| | |
|---|---|
| 0.000 | 748.000 |
| 700.000 | 748.000 |

External Boundary

| | |
|---|---|
| 1178.955 | 731.000 |
| 1145.812 | 737.000 |
| 1140.289 | 738.000 |
| 1134.765 | 739.000 |
| 1129.123 | 739.995 |
| 1127.112 | 740.202 |
| 1117.516 | 741.000 |
| 1113.000 | 741.376 |
| 1105.491 | 742.000 |
| 1101.027 | 743.000 |
| 1095.938 | 746.000 |
| 1080.000 | 746.000 |
| 1076.826 | 746.000 |
| 1073.819 | 744.998 |
| 1052.469 | 744.887 |
| 1026.854 | 745.000 |
| 1019.909 | 746.000 |
| 877.234 | 746.000 |
| 872.145 | 747.000 |
| 797.481 | 748.000 |
| 790.090 | 751.728 |
| 784.400 | 754.278 |
| 782.532 | 755.000 |
| 779.168 | 756.000 |
| 775.893 | 756.899 |
| 773.335 | 757.857 |
| 768.603 | 758.819 |
| 765.957 | 758.962 |
| 758.332 | 758.654 |
| 754.184 | 758.686 |
| 748.681 | 758.844 |
| 745.296 | 759.000 |
| 733.369 | 759.000 |
| 721.203 | 759.710 |
| 718.106 | 760.000 |
| 717.580 | 760.000 |
| 715.841 | 759.689 |
| 713.704 | 759.000 |
| 710.267 | 759.000 |
| 706.457 | 759.474 |
| 704.026 | 759.670 |
| 700.000 | 759.881 |
| 696.937 | 759.952 |
| 670.822 | 760.000 |
| 667.003 | 761.000 |
| 651.105 | 762.000 |
| 643.719 | 764.000 |
| 423.803 | 765.000 |
| 408.803 | 758.000 |
| 308.803 | 758.000 |
| 298.621 | 765.000 |
| 294.984 | 767.500 |
| 192.090 | 767.500 |
| 187.590 | 766.000 |
| 184.590 | 765.000 |
| 157.590 | 756.000 |
| 147.590 | 756.000 |
| 120.590 | 765.000 |
| 117.590 | 766.000 |
| 115.094 | 767.000 |
| 112.195 | 770.000 |
| 109.647 | 773.000 |
| 65.729 | 773.282 |
| 36.900 | 773.381 |
| 28.534 | 773.062 |
| 20.403 | 772.993 |
| 19.869 | 772.834 |
| 18.940 | 771.904 |
| 12.977 | 767.877 |
| 9.507 | 765.000 |
| 7.712 | 764.000 |
| 5.056 | 763.000 |
| 3.208 | 762.994 |
| 0.000 | 762.759 |
| 0.000 | 748.000 |
| 0.000 | 732.500 |
| 0.000 | 731.094 |
| 0.000 | 724.000 |

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| | |
|---|---|
| 0.000 | 700.000 |
| 700.000 | 700.000 |
| 1080.000 | 700.000 |
| 1113.000 | 700.000 |
| 1113.019 | 700.000 |
| 1270.000 | 700.000 |
| 1270.000 | 714.500 |
| 1270.000 | 727.190 |
| 1270.000 | 731.000 |