DRAFT

Coal Combustion Residue Impoundment
Round 11 - Dam Assessment Report

Cumberland Fossil Plant

Dry Ash Storage/ Ash Pond
TVA
Cumberland City, Tennessee

Prepared for:

United States Environmental Protection Agency
Office of Resource Conservation and Recovery

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INTRODUCTION, SUMMARY CONCLUSIONS AND RECOMMENDATIONS

The release of over five million cubic yards of coal combustion residue from the Tennessee Valley Authority (TVA) Kingston, Tennessee facility in December 2008, which flooded more than 300 acres of land, damaging homes and property, is a wake-up call for diligence on coal combustion residue disposal units. We must marshal our best efforts to prevent such catastrophic failure and damage. A first step toward this goal is to assess the stability and functionality of the ash impoundments and other units, then quickly take any needed corrective measures.

This assessment of the stability and functionality of the Cumberland Fossil Plant coal combustion residue (CCR) management facilities is based on a review of available documents and on the site assessment conducted by Dewberry personnel on September 7, 2011. We found the supporting technical documentation to be inadequate in some important respects (Section 1.1.3). As detailed in Section 1.2, there are recommendations based on field observations and documentation reviews that may help to maintain a safe and trouble-free operation.

The original power plant's ash pond has been modified over time, due to operational changes in the plant. The current configuration includes the Ash Pond, which is used to settle out remaining bottom ash and serve as a storm water detention basin for the storm water runoff for the Dry Fly Ash Stack and the Gypsum Disposal Area. The rest of the original pond was split into two dry storage areas - the Dry Fly Ash Stack and the Gypsum Disposal Area - and a small incised pond (Bottom Ash Pond) located at the north end of the divider dike between the Dry Fly Ash Stack and the Gypsum Disposal Area. The incised pond receives sluiced bottom ash directly from the plant and is used to capture the bulk of the bottom ash, which is excavated and processed into dry material. Since the small Bottom Ash Pond is incised, it was not separately assessed and not rated. The Ash Pond, Dry Fly Ash Stack, and the Gypsum Disposal Area were all three separately assessed and rated, since failure of their containment dikes could release significant amounts of CCR off site into Wells Creek and to the Cumberland River.

In summary, the Cumberland Ash Pond is **FAIR,** and the Dry Fly Ash Stack and the Gypsum Disposal Area are **POOR** for continued safe and reliable operation. The rating for the Ash Pond is influenced by the need to implement remedial measures to improve safety against potential piping failure. The ratings for the Dry Fly Ash Stack and the Gypsum Disposal Area are influenced by lack of documentation showing satisfactory performance of their containment dikes under the design seismic event; available documentation infers that the dikes may not have adequate seismic stability. Performance of the dikes under potential liquefaction scenarios is unknown, as no liquefaction potential analyses have been provided. In addition, there is some uncertainty regarding piping potential at the critical section of Gypsum Disposal Area containment dike. There are no other recognized existing or potential management unit safety deficiencies.

PURPOSE AND SCOPE

The U.S. Environmental Protection Agency (EPA) is embarking on an initiative to investigate the potential for catastrophic failure of Coal Combustion Surface Impoundments (i.e., management unit) from occurring at electric utilities in an effort to protect lives and property from the consequences of a dam failure or the improper release of impounded slurry. The EPA initiative is intended to identify conditions that may adversely affect the structural stability and functionality of a management unit and its appurtenant structures (if present); to note the extent of deterioration (if present), status of maintenance and/or a need for immediate repair; to evaluate conformity with current design and construction practices; and to determine the hazard potential classification for units not currently classified by the management unit owner or by a state or federal agency. The initiative will address management units that are classified as having a Less-than-Low, Low, Significant or High Hazard Potential ranking. (For Classification, see pp. 3-8 of the 2004 Federal Guidelines for Dam Safety)

In February 2009, the EPA sent letters to coal-fired electric utilities seeking information on the safety of surface impoundments and similar facilities that receive liquid-borne material that store or dispose of coal combustion residue. This letter was issued under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 104(e), to assist the Agency in assessing the structural stability and functionality of such management units, including which facilities should be visited to perform a safety assessment of the berms, dikes, and dams used in the construction of these impoundments.

EPA requested that utility companies identify all management units including surface impoundments or similar diked or bermed management units or management units designated as landfills that receive liquid-borne material used for the storage or disposal of residuals or by-products from the combustion of coal, including, but not limited to, fly ash, bottom ash, boiler slag, or flue gas emission control residuals. Utility companies provided information on the size, design, age and the amount of material placed in the units. The EPA used the information received from the utilities to determine preliminarily which management units had or potentially could have High Hazard Potential ranking.

The purpose of this report is **to evaluate the condition and potential of residue release from management units and to determine the hazard potential classification**. This evaluation included a site visit. Prior to conducting the site visit, a two-person team reviewed the information submitted to EPA, reviewed any relevant publicly available information from state or federal agencies regarding the unit hazard potential classification (if any) and accepted information provided via telephone communication with the management unit owner. Also, after the field visit, additional information was received by Dewberry & Davis LLC about the Cumberland CCR management units that was reviewed and used in the preparation of this report.

Factors considered in determining the hazard potential classification of the management units(s) included the age and size of the impoundment, the quantity of coal combustion residuals or by-products that were stored or disposed of in these impoundments, its past operating history, and its geographic location relative to down gradient population centers and/or sensitive environmental systems.

This report presents the opinion of the assessment team as to the potential of catastrophic failure and reports on the condition of the management unit(s).

LIMITATIONS

The assessment of dam safety reported herein is based on field observations and review of readily available information provided by the owner/operator of the subject coal combustion residue management unit(s). Qualified Dewberry engineering personnel performed the field observations and review and made the assessment in conformance with the required scope of work and in accordance with reasonable and acceptable engineering practices. No other warranty, either written or implied, is made with regard to our assessment of dam safety.

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1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

Conclusions are based on visual observations from a one-day site visit on September 7, 2011, and review of technical documentation provided by the Tennessee Valley Authority (TVA).

1.1.1 Conclusions Regarding the Structural Soundness of the Management Unit(s)

The overall structural stability of the Ash Pond containment dike and outlet works appears to be satisfactory in most respects. An issue is that the factor of safety against a potential piping failure is below the acceptable minimum. There appears to be no immediate threat of a piping failure. However, until remedial measures recommended by Stantec are implemented, the overall structural stability of the Ash Pond dike is considered fair.

The static stability of the dikes containing the Dry Fly Ash Stack appear to be satisfactory. The static stability of the dikes containing the Gypsum Disposal Area appear to be generally satisfactory, except for marginally low factors of safety against potential piping at the critical section. There appears to be no immediate threat of a piping failure, but until this issue is resolved, the static stability of the Gypsum Disposal Area dike is considered fair.

The furnished documentation of pseudostatic[1] stability analyses of the critical sections of the Dry Fly Ash Stack and the Gypsum Disposal Area containment dikes under the 500-year seismic event yielded FS = 1.0, the acceptance criterion. Thus, it appears by inspection that for the stronger, 2,500-year seismic event required by the USEPA, a FS < 1.0 would result. Therefore, by inference using the available pseudostatic analysis results, the Dry Fly Ash Stack and the Gypsum Disposal Area containment dikes do not have adequate seismic stability to meet the USEPA criterion. Furthermore, the potential for liquefaction and the consequences of potential liquefaction failure of the dike raise embankments of these containment dikes, which are largely founded on sluiced fly ash, are

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[1] See footnote 1 at bottom of page 7-1.

unknown. Until the seismic stability and liquefaction issues have been suitably addressed and resolved, the overall stability of the Dry Fly Ash Stack and the Gypsum Disposal Area containment dikes is considered poor.

1.1.2 Conclusions Regarding the Hydrologic/Hydraulic Safety of the Management Unit(s)

On the basis of furnished hydrologic/hydraulic documentation, the Ash Pond (CCR Complex) currently meets accepted standards for hydrologic/hydraulic safety.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

The documentation of hydrologic/hydraulic analyses for the Ash Pond (CCR Complex) appears overall to be adequate. Documentation of static slope stability, seepage analysis, and piping potential (where appropriate) of the CCR Complex containment dikes is adequate. The documentation of performance of the Ash Pond containment dike under seismic loading is adequate. The documentation of performance of the Dry Ash Stack and the Gypsum Disposal Area containment dikes under seismic loading is inadequate, because no evaluation of potential liquefaction has been provided and seismic stability analyses are incomplete or do not demonstrate acceptable safety under the design seismic event required by the USEPA.

1.1.4 Conclusions Regarding the Description of the Management Unit(s)

The descriptions of the management units provided by the owner were accurate representations of what Dewberry observed in the field.

1.1.5 Conclusions Regarding the Field Observations

Dewberry staff was provided access to all areas in the vicinity of the management unit required to conduct a thorough filed observation. The visible parts of the embankment dikes and outlet structure were observed to have no signs of overstress, significant settlement, shear failure, or other signs of instability although visual observations were hampered by the presence of thick vegetation in some areas. Embankments appear structurally sound. There are no visible indications of unsafe conditions or conditions needing immediate remedial action.

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation

The current maintenance and methods of operation appear to be adequate for the CCR management units. There was no evidence of significant unexplained embankment repairs or prior releases observed during the field assessment.

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

The surveillance program appears to be adequate. The management unit dikes are instrumented with piezometers and slope inclinometers.

1.1.8 Classification Regarding Suitability for Continued Safe and Reliable Operation

The Ash Pond is rated <u>FAIR</u> for continued safe and reliable operation. The rating is influenced by the need to implement remedial measures to improve safety against potential piping failure.

The Dry Fly Ash Stack and the Gypsum Disposal Area are rated <u>POOR</u> for continued safe and reliable operation. The ratings are influenced by lack of documentation showing satisfactory performance of their containment dikes under the design seismic event. Available documentation infers that the dikes may not have adequate seismic stability. Performance of the dikes under potential liquefaction scenarios is unknown, as no liquefaction potential analyses have been provided. In addition, there is some uncertainty regarding piping potential at the critical section of Gypsum Disposal Area containment dike.

No other existing or potential management unit safety deficiencies are recognized in the field assessment and review of furnished operations, maintenance, surveillance, and monitoring information. Except as noted above with respect to piping potential, acceptable performance is expected under applicable static loading conditions and hydrologic conditions in accordance with the applicable criteria. The ratings are influenced by the deficiencies and circumstances noted above. Implementation of recommendations as presented below would help improve the ratings.

1.2 RECOMMENDATIONS

1.2.1 Recommendations Regarding the Structural Stability

1) Install Stantec's recommended remedial measures for increasing the factor of safety against piping failure to the acceptable margin. If the driven sheet-pile wall is selected as the remedial measure, close attention should be paid to sheet-wall alignment location and depth to achieve maximum benefit in lengthening the seepage path to reduce exit gradients; the sheet-wall alignment should generally be at or upstream of the centerline of the dike crest.

2) Install the planned lined ponds in the Gypsum Disposal Area as soon as possible for receiving and settling the gypsum slurry that must be sluiced to the Gypsum Disposal Area whenever the dewatering facility has an outage. Revaluate the piping potential factor of safety after the lined ponds have been in place for about a year, to check whether or not the elimination of sluice water in the gypsum stack reduces the seepage exit gradients sufficiently to result in acceptable factors of safety against piping. Closely monitor the seepage conditions at the critical section in the interim. If the seepage exit gradients have not sufficiently abated, develop and implement a remedial measure to lower the exit gradients and achieve acceptable factor of safety against piping failure.

3) Depending on the results of additional seismic stability analyses and of liquefaction potential analyses recommended in Subsection 1.2.3, develop and implement measures to ensure adequate performance of the Dry Fly Ash Stack and the Gypsum Disposal Area containment dikes under the 2,500-year seismic event.

1.2.2 Recommendations Regarding the Hydrologic/Hydraulic Safety

No recommendations for physical or operational modifications to enhance hydrologic/hydraulic capacity appear warranted at this time.

1.2.3 Recommendations Regarding the Supporting Technical Documentation

1) Perform a quantitative liquefaction analysis of embankment sections overlying very loose/ loose saturated fly ash at the Dry Fly Ash Stack and the Gypsum Disposal Area; evaluate the impact of liquefaction on

the containment dikes, if liquefaction is indicated; and evaluate the consequences of liquefaction failure of the containment dikes

2) If it is determined that liquefaction will not occur, review/investigate any soft or very soft clays in the lower part of the dike embankments and in the alluvial foundation beneath the embankments. If significant soft/very soft clay deposits are indicated (e.g., 10 feet or more in thickness and continuous for 100 feet or more), analyze their deformation potential during the design earthquake, and assess the impact of any such deformations on the stability of the embankments.

3) Review the basis and reasoning for the “design” seismic coefficient used in the pseudostatic slope stability analysis, rerun the analysis if a modification appears appropriate, or perform a higher level of analysis that uses more sophisticated methods. (Note: If a deformation analysis is done, there may be no need for the pseudostatic analysis. However, a post-earthquake static slope stability analysis using reduced shear strengths would be appropriate.)

1.2.4 Recommendations Regarding the Field Observations

No significant problems were observed in the field assessment that would require special attention outside of routine maintenance. The minor issues observed, mostly small eroded areas or areas of seepage and poor drainage, should be addressed by TVA’s routine maintenance activities. These include:

1) Repair minor erosion at various locations.

2) Continue to mow/ maintain vegetation along slopes.

3) Continue to monitor and document known seepage per seepage action plan.

4) Provide positive slope to promote drainage into perimeter ditch.

1.2.5 Recommendations Regarding Continued Safe and Reliable Operation

No additional recommendations are warranted at this time.

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants

Dana Williams, TVA CCP
Shane Harris, TVA RHO&M
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Griffin Lifsey, TVA
John Dizer, TVA
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Michael McLaren, Dewberry
Pamela Stanford, Dewberry

1.3.2 Acknowledgement and Signature

We acknowledge that the management unit referenced herein has been assessed on September 7, 2011.

Pamela Stanford, P.E. Tennessee License #104977

Michael McLaren, P.E.

2.0 DESCRIPTION OF THE COAL COMBUSTION RESIDUE MANAGEMENT UNIT(S)

2.1 LOCATION AND GENERAL DESCRIPTION

The Cumberland Fossil Plant is located in western Tennessee west-southwest of Clarksville, Tennessee on the south shore of Lake Barkley. The plant is operated by the TVA. The Coal Combustion Residuals (CCR) Complex encompasses approximately 330 acres and consists of the Ash Pond (50 acres), Dry Fly Ash Stack (110 acres) (also known as Dry Ash Stack), and Gypsum Disposal Area (170 acres). A project location map is provided in Appendix A – Doc 1. An aerial photograph of the CCR Complex is provided in Appendix A – Doc 2. Initial information provided by the TVA about the CCR Complex is included in Appendix A – Doc 3. The general layout of the CCR management units is shown in Appendix A – Doc 6, Figure 3.

The entire CCR disposal area was originally constructed in 1969 as one large ash pond. The gypsum disposal area was constructed during 1995-96. It was built over the original ash pond. Additional detail is provided in Section 4.1.2.

Currently, dewatered gypsum is either conveyed directly for use in an adjacent dry wall production facility (Temple Inland Wall Board Plant) or stockpiled and later hauled by truck to the gypsum disposal area. Gypsum can be diverted into the wall board plant at a valve station operated by Synthetic Materials (SynMat). SynMat dewaters the gypsum slurry using vacuum filter presses and the filtrate is returned to the gypsum disposal area where any fines can settle. The gypsum currently is sluiced into the gypsum disposal area only during emergency events when the dewatering facility is not operational. The filtrate or sluice water, as well as surface runoff, drain to a perimeter ditch system and ultimately to the ash pond; a significant body of water is not impounded in the gypsum disposal area.

Fly ash is collected in a dry state, conditioned with moisture and then spread and compacted in the dry fly ash stack. Bottom ash is sluiced to a processing area, reclaimed, and then placed on the dry fly ash stack. The bottom ash processing area includes a small incised pond located at the north end of the divider dike that separates the dry fly ash stack area from the gypsum disposal area (see area marked “Bottom Ash” on Figure 3 in Appendix A – Doc 6.)

Water flows to the ash pond from the bottom ash processing area, which receives slurry directly from the plant. The water decanted from the bottom ash processing area is conveyed to the 37.4-acre retention pond by a 72-inch diameter pipe spillway. Surface runoff from the gypsum disposal area and from the dry fly ash stack perimeter ditch, as well as filtrate from dewatering or any sluice water from the gypsum disposal area, is also conveyed to the ash pond via 36-inch diameter pipes at two locations through the dike between the ash pond and the dry fly ash stack. One 36-inch pipe is through the west end of the divider dike and a pair of 36-inch pipes is through the east end of the dike.

Water in the ash pond flows generally to the northwest and exits to the stilling basin portion of the ash pond through a 100-foot wide opening in the dike separating the ash retention pond from the stilling basin. A floating boom spans the opening and aids in settlement of very fine solids.

Decanted water discharges from the stilling basin through four 36-inch pipe spillways. Each spillway has a 48-inch concrete riser with a 120-inch diameter corrugated steel pipe skimmer. The spillways empty clean water into a concrete discharge channel that leads to the main plant channel and Lake Barkley.

Table 2.1: Summary of Dam Dimensions and Size	
	Dry Fly Ash Stack
Dam Height (ft)	35
Crest Width (ft)	20
Length (ft)	internal
Side Slopes (upstream) H:V	3:1
Side Slopes (downstream) H:V	3:1
Table 2.1a: Summary of Dam Dimensions and Size	
	Ash Pond
Dam Height (ft)	35
Crest Width (ft)	19 divider , 20 perimeter , 31 dry stack divider
Length (ft)	5600
Side Slopes (upstream) H:V	1.8:1 to 2.5:1
Side Slopes (downstream) H:V	2.2:1 to 2.5:1
Table 2.1b: Summary of Dam Dimensions and Size	
	Gypsum Disposal Area
Dam Height (ft)	50
Crest Width (ft)	20
Length (ft)	internal
Side Slopes (upstream) H:V	1:5 to 3:1
Side Slopes (downstream) H:V	3:1

2.2 COAL COMBUSTION RESIDUE HANDLING

Questions and answers concerning CCR generation and handling are presented in tabular form in Appendix A – Doc 12. The handling of each type of coal combustion residue is briefly described in the following subsections.

2.2.1 Fly Ash

Fly ash CCR is handled through SCR Hoppers, Precipitator Hoppers, and Surge Bins; collected in silos; then trucked to the dry fly ash stack for filling in compacted lifts after adjusting to proper moisture content for compaction.

2.2.2 Bottom Ash

Bottom ash CCR is collected in the Economizer Hoppers using Hydroveyors, and in the bottom ash hoppers using jet pumps. Bottom ash is piped (sluiced) to the bottom ash processing area, where it is reclaimed with excavators, dried, and placed in the dry fly ash stack in the same manner as the fly ash.

2.2.3 Boiler Slag

No information was provided.

2.2.4 Flue Gas Desulfurization Sludge

FGD sludge from the limestone scrubbers is piped directly to the dewatering plant; then conveyed for use in the wallboard plant or trucked for disposal in the gypsum disposal area; sluiced directly to the gypsum disposal area during dewatering plant outages.

2.3 SIZE AND HAZARD CLASSIFICATION

The classification for the Ash Pond, based on height of the dam is “small” and, based on storage capacity, is “intermediate” in accordance with U.S. Army Corps of Engineers (USACE) “Recommended Guidelines for Safety Inspections of Dams” (ER 1110-2-106); the criteria are summarized in Table 2.3a. The classification for the Dry Ash Stack, based on height of the dam is “small” and, based on storage capacity, is “intermediate.” The classification for the gypsum storage area, based on height of the dam is “intermediate” and, based on storage capacity, is “intermediate.” (Note: The size classification probably is overstated or even has little meaning, if the stored material is not “flowable.”)

Table 2.3a: USACE ER 1110-2-106
Size Classification

	Impoundment	
Category	**Storage (Ac-ft)**	**Height (ft)**
Small	50 and < 1,000	25 and < 40
Intermediate	1,000 and < 50,000	40 and < 100
Large	> 50,000	> 100

The facilities are not in the National Inventory of Dams; therefore these dikes do not have hazard classifications established by the USACE. The TVA provided preliminary hazard classifications to the USEPA on July 16, 2009, and amended the hazard classifications on October 22, 2010, after a more detailed assessment was performed by their consultant, Stantec Consulting Services, Inc (Stantec). The classification was made based on the 2004 Federal Guidelines for Dam Safety classifications system (shown in Table 2.3b).

Table 2.3b: FEMA Federal Guidelines for Dam Safety
Hazard Classification

	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None Expected	Low and generally limited to owner
Significant	None Expected	Yes
High	Probable. One or more expected	Yes (but not necessary for classification)

TVA's current hazard classifications for the CCR facilities at the Cumberland Fossil Plant are as follows:

Ash Pond	High (Due to impact on highway bridge)
Dry Ash Stack	Not Rated (Not an impoundment)
Gypsum Storage Area	Significant

Stantec recommended that the preliminary hazard classification of "High" for the Ash Pond remain in place until it is confirmed that riprap scour protection has been placed around the piers of a threatened bridge on Cumberland City Road over Wells Creek, after which the hazard classification could be reduced to "Significant."

Loss of human life is not probable in the event of a failure of the Ash Pond dikes, but a failure of these dikes is expected to have potential for environmental damage to Lake Barkley, and economic loss to the adjacent road and bridge. Stantec's recommendation of "High" hazard classification seems excessively conservative, since human life does not appear to be at significant risk in case of failure of the Ash Pond dikes. Stantec's own dam breach analysis of the Ash Pond dikes shows that the bridge would be overtopped even before the dike failed (see Appendix A – Doc 14). Thus, the bridge would likely be closed so that there would be no traffic on the road and bridge just before a postulated breach of the Ash Pond dikes. Also, there are no habitable dwellings within the impact area. Therefore, Dewberry's opinion is that the Ash Pond should currently have a **"Significant"** hazard potential classification.

Dewberry concurs with TVA's current **"Significant"** hazard potential classification for the Gypsum Disposal Area on the basis of Stantec's dam breach analysis of the Gypsum Disposal Area dikes (see Appendix A – Doc 13). Although the Gypsum Disposal Area is currently operated primarily as a dry disposal facility, its dikes have the capability of accumulating and containing a significant body of water generated by runoff from the design storm, which was taken as the Probable Maximum Precipitation (PMP) in Stantec's analysis.

Dewberry recognizes that a significant body of water cannot be contained on the Dry Ash Stack. However, runoff from the stack is drained via perimeter ditches leading to drainage structures that discharge through the north divider dike to the Ash Pond. Design storm runoff could potentially collect along the divider dike faster than it can drain to the Ash Pond, causing the buildup of a small body of water that would be contained by relatively short segments of the Dry Ash Stack perimeter dike near the east and west ends of the divider dike. A breach through either segment would at the least have an environmental impact to waterways and drainage ways leading to Lake Barkley. Therefore, Dewberry's opinion is that the Dry Ash Stack area be rated with a **"Significant"** hazard potential classification.

2.4 AMOUNT AND TYPE OF RESIDUALS CURRENTLY CONTAINED IN THE UNIT(S) AND MAXIMUM CAPACITY

The data reviewed by Dewberry did not include the volume of the residuals stored in the ponds at the time of inspection. Volume information provided in Table 2.4, 2.4a, 2.4b was measured by TVA in 2006.

Table 2.4: Maximum Capacity of Unit	
Dry Fly Ash Stack	
Surface Area (acre)[1]	110
Current Storage Capacity (cubic yards)[1]	4,781,000
Current Storage Capacity (acre-feet)	2,963.4
Total Storage Capacity (cubic yards)[1]	12,600,00
Total Storage Capacity (acre-feet)	7,809.9
Perimeter Dike Crest Elevation (feet)	395
Normal Pond Level (feet)	N/A

Table 2.4a: Maximum Capacity of Unit	
Ash Pond	
Surface Area (acre)[1]	50
Current Storage Capacity (cubic yards)[1]	1,305,000
Current Storage Capacity (acre-feet)	808.9
Total Storage Capacity (cubic yards)[1]	2,000,000
Total Storage Capacity (acre-feet)	1,239.7
Perimeter Dike Crest Elevation (feet)	395
Normal Pond Level (feet)	384

Table 2.4b: Maximum Capacity of Unit	
Gypsum Disposal Area	
Surface Area (acre)1	**170**
Current Storage Capacity (cubic yards)1	**1,826,000**
Current Storage Capacity (acre-feet)	**1,131.8**
Total Storage Capacity (cubic yards)1	**20,000,000**
Total Storage Capacity (acre-feet)	**12,396.7**
Perimeter Dike Crest Elevation (feet)	**395**
Normal Pond Level (feet)	**N/A**

[1] 2006 data provided by TVA

2.5 PRINCIPAL PROJECT STRUCTURES

2.5.1 Earth Embankment

The entire CCR disposal area was originally constructed in 1969 as one large ash pond encompassed by a perimeter dike constructed to a crest elevation of 380 feet. A divider dikes was added to separate the Ash Pond from the Dry Fly Ash Stack, and the perimeter dike was later raised to current elevation 395 feet; another dike was constructed to separate the Gypsum Disposal Area.

2.5.2 Outlet Structures

Decanted water discharges from the stilling basin through four 36-inch diameter pipe spillways. Each spillway has a 48-inch diameter concrete riser with a 120-inch diameter corrugated steel pipe skimmer. The spillways release treated water into a concrete discharge channel that leads to the main plant channel and Lake Barkley. An emergency spillway has recently been constructed; completed since the date of the site visit (see Appendix A – Doc 17). The spillway is constructed of concrete and is 36 feet wide with a control elevation of 390 feet. A siphon spillway was under construction at the time of the site visit.

2.6 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

Critical infrastructure inventory data was not provided to Dewberry for review.

Based on the available area topographic maps, surface drainage in the area of the ponds are from the southeast to the northwest through the Ash Pond stilling pond to Lake Barkley. Releases from the impoundments would not impact the water level of Lake Barkley significantly; however, damage may occur to the adjacent bridge and highway to the north. If the dikes failed on the south side, releases from the impoundments would not impact the water level of Wells Creek significantly. A release on the north east side of the gypsum stack could result in damage to the adjacent dewatering facility and potentially the wall board plant.

3.0 SUMMARY OF RELEVANT REPORTS, PERMITS, AND INCIDENTS

3.1 SUMMARY OF REPORTS ON THE SAFETY OF THE MANAGEMENT UNIT

TVA provided internal inspection of CCR management units for 2011. The reports included various inspections that were performed daily, weekly, monthly, and quarterly. TVA also provided the 2011 Annual Inspection of CCP Facilities and Ponds, performed by Stantec dated July 19, 2011(see Appendix A – Docs 10, 11).

The reports concluded that the structures appeared to be performing adequately with only minor maintenance items that needed to be addressed. No conditions were observed that would affect the continued safe operation of the impoundments.

Stantec also prepared a “Seepage Action Plan (SAP)” dated June 25, 2010 that provides guidelines for controlling different levels of seepage, should they be observed in routine inspections (see Appendix A – Doc 9).

3.2 SUMMARY OF LOCAL, STATE, AND FEDERAL ENVIRONMENTAL PERMITS

Discharge from the Ash Pond is regulated by the Tennessee Department of Environmental and Conservation, Division of Water Pollution Control, and the impoundment has been issued a National Pollutant Discharge Elimination System Permit. Permit No. TN0005789 was issued November 30, 2007 (See Appendix A – Doc 4).

3.3 SUMMARY OF SPILL/RELEASE INCIDENTS

On February 2, 1997 a bypass of the Cumberland Ash Pond Discharge (outfall 001) occurred when between one-half to one million gallons of gypsum wastewater spilled into Wells Creek. Heavy rainfall contributed to the failure of the internal gypsum dike, allowing a brief surge of wastewater to pass over the exterior dike in the gypsum dewatering area and enter the creek. The bypass lasted no longer than ten minutes.

4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

The Cumberland Fossil Plant was constructed between 1968 and 1973, with operation beginning in 1972. The entire CCR disposal area was originally constructed in 1969 as one large ash pond.

4.1.2 Significant Changes/Modifications in Design since Original Construction

In 1977, the divider dike for the ash pond to the north (interior divider dike) was constructed. In 1979, the dikes around the Ash Pond were raised to elevation 395 feet with clay. In 1986, approximately 300 feet of the west portion of the divider dike between the Ash Pond and the Dry Fly Ash Stack was constructed (exterior divider dike) to form the current configuration. In 1996, stacking within the Dry Fly Ash Stack began.

The Gypsum Disposal Area was constructed during 1995-96. It was built over the original ash pond. The Gypsum Disposal Area was constructed in several stages beginning with construction of a rock drainage blanket to collect and divert water away from the base. It is surrounded by a lower earth dike capped with bottom ash and an upper gypsum dike. Due to concerns about elevated piezometeric levels in the gypsum stack and the surrounding dikes, TVA elected to cease regular pumping of gypsum slurry to the gypsum stack in May, 2009. Dewatered gypsum is either conveyed to Temple Inland, adjacent to the plant property, for use in dry wall production or stockpiled and later hauled by truck to the gypsum disposal area.

4.1.3 Significant Repairs/Rehabilitation since Original Construction

A small landslide occurred on the facility in 2005 and temporary stabilization measures were implemented by TVA. Stantec has developed construction documents for permanent repair.

4.2 SUMMARY OF OPERATIONAL PROCEDURES

4.2.1 Original Operational Procedures

The impoundment was designed and operated for ash sedimentation and control. The pond receives plant process waste water, and coal combustion waste slurry. Treated (via sedimentation) process water is discharged through an overflow outlet structure.

4.2.2 Significant Changes in Operational Procedures and Original Startup

Sulfur dioxide scrubbers were installed for both coal fired generating units. Dry fly ash silos were constructed during the dry fly ash conversion project.

4.2.3 Current Operational Procedures

No documents were provided to indicate any operational procedures have changed.

4.2.4 Other Notable Events since Original Startup

As previously noted, TVA was constructing a siphon spillway at the time of the site visit to allow lowering of the pool elevation; a 35-foot wide concrete emergency spillway has also been constructed. The spillway improvements also include lowering the four risers by 6 feet for permanent lowering of the pool elevation. The lowering of the permanent pool and installation of the emergency spillway were done to prevent overtopping of the Ash Pond dike during the design flood.

5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry personnel Pamela Sanford, P.E. and Michael McLaren, P.E., performed a site visit on Wednesday, September 7, 2011 in company with the participants listed in Section 1.3.

The site visit began at 9:00 AM. The weather was cool and cloudy. Photographs were taken of conditions observed. Please refer to the Dam Inspection Checklist in Appendix B for additional information. Selected photographs are included here for ease of visual reference. All pictures were taken by Dewberry personnel during the site visit.

The overall assessment of the dam was that it was in fair condition and no significant findings were noted.

5.2 DRY GYPSUM DISPOSAL

5.2.1 Crest

The dike divides the gypsum disposal area and Wells Creek. The crest had no signs of depressions, tension cracks, or other indications of settlement or shear failure, and appeared to be in satisfactory condition.

Figure 5.2.1-1 Photo showing Crest, East Dike

Figure 5.2.1-2 Photo showing Crest, South Dike

5.2.2 Upstream/Inside Slope

There were no observed scarps, sloughs, bulging, cracks, or depressions or other indications of slope instabilities or signs of erosion. Figures 5.2.2-1 and 5.2.2-2 show the general condition of the inside slope. Vegetation should be installed to help minimize erosion in bare areas and maintained to allow for inspection of the slopes.

Figure 5.2.2-1 Photo showing inside slope, East Dike

Figure 5.2.2-2 Photo showing inside slope, South Dike

5.2.3 Downstream/Outside Slope and Toe

There were no observed scarps, sloughs, bulging, cracks, or depressions or other indications of slope instabilities or signs of erosion. Figures 5.2.3-1, 5.2.3-2 and 5.2.3-3 show general conditions of the outside slope. Vegetation should be installed to help minimize erosion in bare areas and maintained to allow for inspection of the slopes.

Figure 5.2.3-1 Photo showing outside slope, South Dike

Figure 5.2.3-2 Photo showing outside slope, North Dike. Incised Bottom Ash Pond is on left side of the photo

Figure 5.2.3-3 Photo showing outside slope, East Dike

5.3 DRY FLY ASH STORAGE

5.3.1 Crest

The dike divides the ash storage area and Wells Creek. The crest had no signs of depressions, tension cracks, or other indications of settlement or shear failure, and appeared to be in satisfactory condition.

Figure 5.3.1-1 Photo showing crest, West Dike

Figure 5.3.1-2 Photo showing crest, South/West Dike

5.3.2 Upstream/Inside Slope

There were no observed scarps, sloughs, bulging, cracks, or depressions or other indications of slope instabilities or signs of erosion. The three pictures below show the general condition of the inside slope. Vegetation should be installed to help minimize erosion in bare areas and maintained to allow for inspection of the slopes.

Figure 5.3.2-1 Photo showing inside slope, North Dike

Figure 5.3.2-2 Photo showing inside slope, West Dike

Figure 5.3.2-3 Photo showing inside slope, South/West Dike

5.3.3 Downstream/Outside Slope and Toe

There were no observed scarps, sloughs, bulging, cracks, or depressions or other indications of slope instabilities or signs of erosion. Figures 5.3.3-1 and 5.3.3-2 show the general condition of outside slope. Vegetation should be installed to help minimize erosion in bare areas and maintained to allow for inspection of the slopes.

Figure 5.3.3-1 Photo showing outside slope, West Dike

Figure 5.3.3-2 Photo showing outside slope, South/West Dike

5.4 ASH POND

5.4.1 Crest

The dike divides the Ash Pond and Wells Creek on the south and Lake Barkley to the north. The crest had no signs of depressions, tension cracks, or other indications of settlement or shear failure, and appeared to be in satisfactory condition.

Figure 5.4.1-1 Photo showing crest, North Dike

Figure 5.4.1-2 Photo showing crest, West Dike

Figure 5.4.1-3 Photo showing crest, South Dike

5.4.2 Upstream/Inside Slope

There were no observed scarps, sloughs, bulging, cracks, or depressions or other indications of slope instabilities or signs of erosion. The photo below shows the general condition of the inside slope. Vegetation should be installed to help minimize erosion in bare areas and maintained to allow for inspection of the slopes.

Figure 5.4.2-1 Photo showing inside slope, North Dike

5.4.3 Outside Slope and Toe

There were no observed scarps, sloughs, bulging, cracks, or depressions or other indications of slope instabilities or signs of erosion. Figures 5.4.3-1, 5.4.3-2 and 5.4.3-3 show the general condition of outside slope. Vegetation should be installed to help minimize erosion in bare areas and maintained to allow for inspection of slopes.

Figure 5.4.3-1 Photo showing outside slope, North Dike

DRAFT

Figure 5.4.3-2 Photo showing outside slope, West Dike

Figure 5.4.3-3 Photo showing outside slope, South Dike

5.5 OUTLET STRUCTURES

5.5.1 Overflow Structure

The outfall of the Ash Pond is located on the north end of the pond and consists of four 48-inch RCP risers/weirs with 120- inch diameter corrugated steel pipe skimmers that discharge through four 36-inch concrete pipes that empty treated water into a concrete discharge channel that leads to the main plant channel and Lake Barkley.

The primary overflow structures were observed to be working properly, discharging flow from the ash pond. The outlet structure visually appeared to be in satisfactory condition. There were no signs of clogging.

Figure 5.5.1-1 Photo showing Outlet Structures

5.5.2 Outlet Conduit

The outlet pipes appeared to be operating normally with no signs of clogging and the water exiting the outlets was flowing clear.

Figure 5.5.2 -1 Photo showing Outlet Conduits

5.5.3 Emergency Spillway

No emergency spillway was present at the time of the site visit. TVA completed constructing an emergency spillway in March 2012 (see Appendix A – Doc 17 for letter noting completion of the emergency spillway).

5.5.4 Low Level Outlet

No low level outlet was present; TVA was installing a siphon spillway at the time of the site visit.

6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Flood of Record

No documentation has been provided about the historic maximum water surface elevations in the CCR management units. All the CCR management units (CCR Complex) are contained within a perimeter dike and do not receive off-site natural drainage. Therefore, they do not receive flood inflows from off-site. The Ash Pond within the complex serves as a storm water retention basin. The source of water into the Ash Pond, aside from sluicing water, pumped plant drainage, and pumped Coal Yard drainage, is precipitation that falls directly into the CCR Complex. The Ash Pond collects runoff from the Gypsum Disposal Area and the Dry Ash Stack, as well as rain that falls directly into it.

Historic climate data available on-line from the National Weather Service (NWS) indicate that record rainfall was experienced in middle Tennessee in the two-day period of May 1-2, 2010. A precipitation contour map developed by the NWS shows that the Cumberland Fossil Plant was on the north side of the heaviest precipitation, but the rainfall amount for the 48-hour period was still on the order of 9 inches. According to an “Average Recurrence Intervals Map for 48-Hour Duration,” prepared by the Hydrometeological Design Studies Center, the plant is in a location that experienced rainfall having an average recurrence interval on the order of 200 years. At the town of Dover, approximately 10 miles northwest of the plant, the all-time record rainfall was 7.6 inches on August 31, 1982.

6.1.2 Inflow Design Flood

For a conservatively assigned “intermediate” size classification for the three disposal areas comprising the CCR Complex and “significant” hazard potential classification for the entire complex, the USACE hydrologic evaluation guidelines (ER-1110-2-106 26 Sept 1979 “Recommended Guidelines for the Safety Inspection of Dams”) recommend a spillway design flood (SDF) of 1/2 Probable Maximum Flood (1/2 PMF) to PMF, where the magnitude selected most closely relates to the involved risk. For comparison, the Tennessee Dam Safety Laws and Regulations (2007) require (for existing dams) use of a

Freeboard Design Storm of 1/3 Probable Maximum Precipitation (1/3 PMP) (6-hour duration) to develop the design flood.

Stantec performed a hydrologic and hydraulic (H & H) analysis of the Ash Pond, which is the hydraulic control for the entire CCR Complex. The analysis is summarized in their memo titled "Hydrologic and Hydraulic Calculations Summary" (H & H memo) dated September 28, 2010 (see Appendix A - Doc 05 for reference). Stantec's analysis evaluated the performance of the CCR Complex for the PMP (6-hour duration), which is the design criterion adopted by the TVA. Stantec used the Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) Version 3.4 computer program to develop the inflow hydrograph. The results of the analysis are summarized in the following Table 6.1:

Table 6.1: Summary of 6-Hour PMP Routing

	Pre-Design Conditions	**Post-Design Conditions**[1]
Drainage Area (ac)	460	460
Dam Crest El (ft)	394[2]	394[2]
Normal Pool El (ft)	384.2	378.2
Normal Freeboard (ft)	9.8	15.8
Design Storm Max Pool El (ft)	Overtops	393.9
Min Freeboard During Design Storm (ft)	None	0.1[2]

[1] *Conditions that now exist after remedial spillway improvements.*

[2] *The crest elevation according to historical information is 395 feet in which case the freeboard during the design storm would be 1.1 feet. The actual crest elevation appears to vary from 394.1 feet, to greater than 395 feet, based on furnished topographic information.*

As shown by the above results, with implementation of the spillway improvements the Ash Pond (i.e., CCR Complex) meets TVA's adopted design criterion for spillway design flood.

6.1.3 Spillway Rating

Stantec's H & H memo (Appendix A-Doc 5) indicates that standard hydraulic equations were used to develop a rating curve for the existing spillways (for the pre-design analysis) and level pool routing methodology was used to route the design storm through the outlets. Although not stated in the memo, a rating curve presumably was also developed for the new emergency spillway and the modified old spillways with lowered risers (for the post-design analysis).

6.1.4 Downstream Flood Analysis

Downstream flood analysis was performed by Stantec in their Dam Breach Analysis for the Ash Pond (see Appendix A – Doc 14) and for the Gypsum Disposal Area (see Appendix A – Doc 13). These analyses were performed to determine the limit of impact in case of breach failure of the dikes and to assist in assessing hazard potential classifications. Of particular interest were potential impacts on downstream bridges in case of failure of the Ash Pond perimeter dike and potential impacts on the SynMat Dewatering Facility and Temple Inland Wall Board Plant in case of failure of the Gypsum Disposal Area perimeter dike. A dam breach analysis was not performed for the Dry Ash Stack, since such analysis does not appear to be warranted for this predominantly dry disposal area that is not capable of retaining much water in the majority of its area. A breach of one of the short segments of the perimeter dike that could potentially contain a small body of water in the northern part of the area next to the divider dike, would by inspection have much less impact than a breach of the perimeter dike around the Ash Pond.

Stantec performed the dam breach analyses with the aid of the HEC-HMS Version 3.4 computer program. The analyses examined both a “Sunny Day” breach and a “PMP Event” breach. The assumptions and details of the analyses are presented in some detail in the appended reports (see Appendix A – Doc 13 & Doc 14). The “Sunny Day” breaches were assumed to occur as a result of a piping failure during normal operations. For the Gypsum Disposal Area, wet operations (when needed) were assumed to be limited to lined ponds in a water quality cell along the northern edge of the Gypsum Disposal Area, in accordance with TVA’s proposed plans. The “Sunny Day” breach was assumed through the northeast dike, which is near the dewatering facility. The “PMP Event” breach at the Ash Pond was assumed to occur as a result of overtopping of the perimeter dike (pre-spillway improvement possibility). The “PMP Event” breach at the Gypsum Disposal Area was assumed to be initiated by a piping failure of an interior (presumably unlined) dike on the southwest side of the water quality cell during a PMP event, whose failure would release water that causes overtopping failure of the lower, southeast part of the perimeter dike, which is near the wall board plant. Stantec judged that a piping breach through the northeast dike during a PMP event “was not a concern because a failure through the liner would have an extremely low likelihood of coinciding with the peak PMP event.”

(Overtopping was not a concern apparently due to substantial freeboard to contain PMP runoff in the water quality cell.) It is important to note that the analyses are of "postulated" breaches, not predicted breaches, to see what the impacts would be if failures occurred as assumed in the analyses.

The results of the Dam Breach Analysis for the Ash Pond show that the most significant impact is to the Cumberland City Road Bridge over Wells Creek due to a postulated PMP Breach, which would cause the water surface elevation to rise 0.4 feet above the bridge deck elevation, although the bridge would be overtopped before a PMP Breach of the Ash Pond dike. It is indicated that the base 100-year flood elevation provided by the USACE is at the bridge deck elevation. Thus, Stantec concluded that "This small rise in the water surface elevation caused by the breach event is unlikely to result in additional risk of loss of life at the bridge." Stantec's model results also show that pier and contraction scour at the bridge could extend to a depth of 22.3 feet within the channel, which would extend 1.3 feet below the base of the pile cap supporting a bridge pier. Stantec concluded that the scour "could undermine the piers, potentially causing bridge failure." As previously mentioned, Stantec recommended that the hazard potential classification for the Ash Pond remain "High Hazard until confirmation of existing scour protection or action is taken to protect the bridge." TVA has implemented plans to place scour protection at the bridge piers and plans for Ash Pond spillway improvements that meet TVA's 6-hour PMP design requirement.

The results of the Dam Breach Analysis for the Gypsum Disposal Area show that the most significant impact is to the dewatering facility during the "Sunny Day" breach. The results indicate maximum inundation depths of approximately 1.3 feet, which Stantec indicated "based on a review of dam safety literature regarding life loss estimation..., would not likely present a probable threat to human life." Neither the wall board plant nor the dewatering facility is shown to be impacted by the PMP breach through the southeast dike. Stantec recommended that the hazard potential classification be lowered from the preliminary "high" hazard to "significant" hazard.

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Although the furnished information is not detailed or complete in some respects (e.g., missing attachments and appendices), there is sufficient information to ascertain that valid hydrologic/hydraulic analysis was performed. Therefore the documentation for the Ash Pond (CCR Complex) appears overall to be adequate.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

Calculations provided in the hydrologic analysis report (See Appendix A-Doc 5) show under the outflow configuration at the time of the site visit that the Ash Pond, which controls flow from the entire CCR Complex, would be unable to pass the 6-hour PMP event without overtopping the embankment. The report anticipated CCR releases to the environment if overtopping occurred. As a result of the above findings, TVA re-configured the spillways and added an emergency spillway to prevent overtopping during the maximum rainfall event. The USEPA was notified by TVA in April 2012 that the spillway improvements were completed and in service in March 2012 (see Appendix A – Doc 17 for Stantec’s notification letter regarding the in-service date for the spillway improvements). Therefore, on the basis of furnished hydrologic/hydraulic documentation, the Ash Pond (CCR Complex) currently meets accepted standards for hydrologic/hydraulic safety.

7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

Stantec has performed extensive studies of stability of the CCR Complex dikes, including: a slope stability evaluation of the Ash Pond in March 2010; a detailed geotechnical exploration and stability evaluation of the Dry Ash and Gypsum Storage facilities in June 2010; initial seismic slope stability analysis in September 2011, using ground motions of a 500-year return period seismic event; and additional pseudostatic[1] slope stability analysis in February 2012, using ground motions of a 2,500-year return period seismic event, as requested by the USEPA. In addition, analyses of seepage, pore-water pressures, and piping potential were also performed. (See Appendix A – Docs 6, 7, 8, and 16 for selected sections of the various reports.)

The stability analyses used the computer program SLOPE/W (from GEO-SLOPE International, Inc.). The program is capable of calculating the potential failure surfaces using the Spencer's procedure. Seepage analyses used SEEP/W. Stability under undrained loading conditions, such as may be created by placing in a relatively short time frame a thick lift of CCR material over saturated ash where strength reduction may occur, was analyzed using UTEXAS4 software.

Conditions assessed were:

- Long term steady state conditions based on groundwater and pore water pressures obtained from the SEEP/W model.
- Undrained loading conditions, where appropriate.
- Static analysis under rapid drawdown conditions, where appropriate.

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[1] The pseudostatic method is a simplified method for determining seismic slope stability that is based on the same approach (i.e., limit equilibrium) used in analyzing static slope stability. In current practice, the pseudostatic method of analysis is used primarily as a screening tool to help assess whether an embankment dam or slope requires a more detailed seismic slope analysis. The pseudostatic method ignores cyclic loading of the earthquake, but accounts for the seismic force by applying an equivalent static force on the slope. In the limit equilibrium approach the stress-strain relationship of the soil is not considered, so the method should not be used for sensitive clays and other materials that lose shear strength during an earthquake or loose soils located below the groundwater table subject to liquefaction.

- Potential failure due to piping (internal erosion).
- Seismic loading applied with steady state loading w/ horiz seismic coef = 0.083 (500-year return period) and horiz seismic coef = 0.096 (2,500-year return period).

7.1.2 Design Parameters and Dam Materials

The Stantec reports on Geotechnical Exploration and Slope Stability Evaluation, Seismic Stability Report, and the Geotechnical Exploration of the Dry Ash and Gypsum Storage Report provided to Dewberry for review contained sufficient information on design parameters and materials of construction (see Appendix A – Docs 6, 7, 8, and 16).

The dike embankment soils consist of predominantly clay for the original dikes and dike raises. The dike raise embankments were largely founded on sluiced ash. A relatively deposit of alluvial underlies the dikes and extends down to refusal material (presumed bedrock). The alluvial deposit typically consist of a layer of clay overlying a granular layer, although there are sections under the Ash Pond perimeter dike where only clay alluvium is present under the original dike and granular alluvium is largely present under the dike raise embankment. Based on laboratory shear strength testing and correlations with standard penetration test data from the borings, design properties and parameters were developed for use in stability analyses. The design properties and parameters used in stability analyses of the Ash Pond dikes are as shown in the following Table 7.1:

Table 7.1: Ash Pond Dikes - Design Properties and Parameters of Materials used in the Stability Analyses

Material	**Unit Wt. (pcf)**	**Effective Stress Parameters (Drained)**		**Total Stress Parameters (Undrained)**	
		C´ (psf)	**Ø´ (deg)**	**C (psf)**	**Ø (deg)**
Clay Dike 1 – Lean Clay	123	200	22	800	20
Clay Dike 1 – Fat Clay	119	200	22	-	-
Clay Dike 2 – Lean Clay	123	200	32	500	21
Clay Dike 2 – Fat Clay	119	200	29	-	-
Fly Ash – Sluiced	100	0	22	140	11
Alluvial – Clay	124	200	33	450	20
Alluvial – Granular	130	0	32	100	20
Bedrock – Very Strong	-	-	-	-	-

Ref: Docs 6, 7, 8, and 16 in Appendix A.

Design properties and parameters used in the slope stability analyses of the dikes containing the Dry Ash Stack and Gypsum Disposal Area are as shown in the following Table 7.2:

Table 7.2: Dry Ash Stack and Gypsum Disposal Area Dikes - Design Properties and Parameters of Materials used in the Stability Analyses

Material	Unit Wt. (pcf)	Effective Stress Parameters (Drained)		Total Stress Parameters (Undrained)	
		C´ (psf)	Ø´ (deg)	C (psf)	Ø (deg)
Clay Dike 1	124	100	25	800	20
Clay Dike 2 – Lean Clay	128	100	28	500	21
Clay Dike 2 – Fat Clay	127	200	19	200	18
Clay Dike 3	126	50	30	1000	25
Fly Ash – Stacked	100	0	32	0	32
Fly Ash – Stacked (Sat.)	100	-	-	140	11
Fly Ash – Sluiced	100	-	-	280	11
Bottom Ash - Stacked	105	0	35	-	-
Bot. Ash/Fly Ash – Sluiced	100	0	22	140	11
Bottom Ash – Regraded	105	0	32	0	32
Gypsum	105	0	38	0	33
Alluvial – Clay	121	200	30	450	20
Alluvial – Granular	130	0	32	100	20
Matrix (Gvl., Clay, Bould.)	130	0	35	0	35
Riprap	150	0	38	0	38
Bedrock – Boundary	-	-	-	-	-

Ref: Docs 6, 7, 8, and 16 in Appendix A.

Table 7.2 covers the soil parameters in most stability analyses associated with the Dry Ash Stack and the Gypsum Disposal Area. However, somewhat different strength parameters were used in the pseudostatic stability analysis of the divider dike (Section A) between the Dry Ash Stack and the Ash Pond and are presented in the following Table 7.3:

Table 7.3: Dry Ash Stack/Ash Pond Divider Dike - Design Properties and Parameters of Materials used in the Pseudostatic Stability Analysis (2,500-year Return Period Only)

		Effective Stress Parameters (Drained)		Total Stress Parameters (Undrained)	
Material	**Unit Wt. (pcf)**	**C´ (psf)**	**Ø´ (deg)**	**C (psf)**	**Ø (deg)**
Alluvial – Clay	121	-	-	450	21
Alluvial – Granular	130	-	-	0	32
Fly Ash – Stacked	100	-	-	0	32
Fly Ash – Sluiced	100	-	-	280	11
Fly Ash/Bot. Ash – Sluiced	100	-	-	0	25
Regraded Bottom Ash	105	-	-	0	32
Divider Dike	130	-	-	0	38
Old Wells Creek Material	130	-	-	100	20

Ref: Doc 16 in Appendix A.

7.1.3 Uplift and/or Phreatic Surface Assumptions

The Stantec reports referenced above included an embankment investigation and evaluation of the phreatic surface elevations based on piezometer data and modeling, where appropriate (Ash Pond dikes), using the SEEP/W program (see Appendix A – Docs 6, 7). The phreatic surfaces determined from the evaluation were used in the embankment slope stability analyses. The phreatic surfaces varied but were generally within the embankment sections below the embankment surface at varying depths with entry at pool or ditch water level on the interior side and exit at the waterway or drainage way along the exterior toe. However, in one area (Section H) of the perimeter dike on the southwest side of the Gypsum Disposal Area, the phreatic surface was found under the original active wet disposal (sluicing) operating assumption to be very shallow under the outside slope of the highest dike raise (Dike 3), to crop out at ditch level behind the lower dike raise (Dike 2), and to continue at relatively shallow depth through Dike 2 and into the original dike embankment (Dike 1). In the interior dikes the phreatic surface was assumed to extend linearly from ditch water level on one side to pool or ditch water level on the other side.

7.1.4 Factors of Safety and Base Stresses

Stantec analyzed eight representative sections (Sections P, Q, R, S, T, U, V, W) of the Ash Pond perimeter dike under long term steady state (SS) loading conditions. The most critical section (P), having lowest SS factor of safety (FS), was analyzed for two earthquake events (500-year and 2,500-year return period events) using the pseudosatic method. The respective peak ground accelerations (PGA) of 0.083g and 0.217g were determined and used for the seismic coefficients (k = PGA/g). The computed factors of safety for the critical sections of the Ash Pond perimeter dike are presented in the following Table 7.4:

Table 7.4 Factors of Safety for Ash Pond

Critical Sections	Loading Condition	Computed Minimum Factor of Safety (FS)		Required FS (USACE)
		Global (Deep-Seated Pot. Failure)	Non-Global (Very Shallow Pot. Failure)	
P (Exterior Slope – W. Side of Ret. Pond)	Steady State (SS)	1.7	-	1.5
	SS w/ Seismic – 500-Yr Return (k = 0.083)	1.2	-	1.0
	SS w/ Seismic – 2,500-Yr Return (k = 0.217)	1.0	-	
U (Interior Slope – NE Side of Stilling Pond)	SS	2.1	-	1.5

Ref: Doc 6 in Appendix A

Stantec analyzed seven representative sections (Sections A, B, C, D, E, F, G) of the Dry Ash Stack dikes under long term SS loading conditions. Four of the sections (C, D, E, F) are along the perimeter dike; two of the sections (A, B) are along the divider dike between the Dry Ash Stack and the Ash Pond; one (G) is through the interior dike between the Dry Ash Stack and the Gypsum Disposal area. The most critical section (F) was analyzed for the 500-year return period earthquake event but not for the 2,500-year event, apparently because it could be determined by inspection, based on the results for the 500-year event, that the pseudostatic analysis would yield a FS < 1.0. The divider dike (Section A) was instead analyzed for the 2,500-year event. The divider dike (Section A) was also analyzed for rapid drawdown loading conditions. The computed factors of safety for the critical sections are presented in the following Table 7.5:

Table 7.5 Factors of Safety for Dry Ash Stack

Critical Sections	Loading Condition	Computed Minimum Factor of Safety (FS)		Required FS (USACE)
		Global (Deep- Seated Pot. Failure)	Non-Global (Very Shallow Pot. Failure)	
F (Perimeter Dike – SW Corner)	Steady State (SS)	1.4	-	1.5
	SS w/ Seismic – 500-Yr Return (PGA = 0.083g)	1.0 (Failure Beneath Perim. Dike) 0.8 (Failure Inside Perim. Dike)	-	1.0
	SS w/ Seismic – 2,500-Yr Return (PGA = 0.217g)	Not Analyzed (Presumed < 1.0, based on above results)	-	
A (Divider Dike – N. Side, E. Part)	SS	2.6 (2.8 After Repair)	1.0 (1.6 After Repair)	1.5
	Rapid Draw Down Ash Pond Side	1.7	-	1.2*
	SS w/ Seismic – 2,500-Yr Return (PGA = 0.217g)	1.1 (Failure Through Dike) 1.0 (Failure Through Stack and Under Dike)	-	1.0
B (Divider Dike – N. Side, W. Part)	SS	2.8 (Est. >2.8 After Repair, based on Sect. A Analysis)	1.3 (Est. >1.6 After Repair, based on Sect. A Analysis)	1.5

*Ref: Doc 7 in Appendix A   *1.5 if drawdown rate and pore pressures developed from flow nets.*

Stantec analyzed eight representative sections (Sections H, I, J, K, L, M, N, O) of the Gypsum Disposal Area dikes under long term SS loading conditions. All of the sections except one (O) are along the perimeter dike; Section O is through the divider dike between the Gypsum Disposal

Area and the incised Bottom Ash Pond (dredge pit). The most critical section (H) was analyzed for the 500-year return period earthquake event but not for the 2,500-year event, as noted above for Section F, apparently because it could be determined by inspection that the pseudostatic analysis would yield a FS < 1.0, and no other Gypsum Disposal Area dike section has currently been analyzed for the 2,500-year event. The computed factors of safety for the critical sections are presented in the following Table 7.6:

Table 7.6 Factors of Safety for Gypsum Disposal Area

Critical Sections	Loading Condition	Computed Minimum Factor of Safety (FS)		Required FS (USACE)
		Global (Deep-Seated Pot. Failure)	Non-Global (Very Shallow Pot. Failure)	
H (Perimeter Dike – SW. Corner)	Steady State (SS)	1.4 (1.8 After Repair)	-	1.5
	SS w/ Seismic – 500-Yr Return (PGA = 0.083g)	1.0 (Failure Beneath Perim. Dike) 0.8 (Failure Inside Perim. Dike)	-	1.0
	SS w/ Seismic – 2,500-Yr Return (PGA = 0.217g)	Not Analyzed (Presumed < 1.0, based on above results)	-	
J (Perimeter Dike – S. Side)	SS	1.7 (1.8 After Repair)	1.3(1.6 After Repair)	1.5
K (Perimeter Dike – SE Corner)	SS	2.0 (Est. >1.8 After Repair, based on Sect. J Analysis)	1.2 (Est. >1.6 After Repair, based on Sect. J Analysis)	1.5
L (Perimeter Dike – SE Side)	SS	2.0 (Est. >1.8 After Repair, based on Sect. J Analysis)	1.3 (Est. >1.6 After Repair, based on Sect. M Analysis)	1.5
M (Perimeter Dike – NE Side)	SS	2.5 (2.8 After Repair)	1.2 (1.6 After Repair)	1.5

Ref: Doc 7 in Appendix A

Undrained analyses were performed for the Dry Ash Stack, using Sections C and F, and for the Gypsum Stack, using Sections J and M, for use in determining additional loading that could be safely placed quickly ("instantaneously"). The objective was to determine the maximum lift thicknesses that could be placed quickly without inducing excessive shear strains that would produce sharp loss of shear strength in the underlying saturated sluiced ash materials. The above sections were selected because they had the lowest drained factors of safety and generally had the thickest layers of saturated ash. A sudden loss of shear strength in the underlying saturated ash originally sluiced into the areas now used for dry disposal of ash and gypsum could potentially precipitate massive failure of the stacks and the raised dike sections that are founded on sluiced ash. It appears that the maximum build-out of the stacks is planned to be around elevation 600 feet for the dry ash stack (approximately 205 feet above the existing raised perimeter dike) and around 590 feet (approximately 180 feet above the existing raised perimeter dike) for the gypsum stack. Therefore, the rate of filling is critical. The results showed for the Dry Ash Stack that the maximum lift thickness placed quickly should be limited to 12.5 feet at Section C and 20.0 feet at Section F. Based on one-dimensional consolidation calculations, Stantec calculated that if the maximum lift thickness was placed "instantaneously" in an area, no additional fill should be placed in that area for 2.5 years. For the Gypsum Disposal Area Sections J and M, "full buildout" was indicated, meaning there was no limitation on lift thickness at these locations.

For all the analysis sections for the Ash Pond perimeter dike, piping potential was evaluated. This was done by computing seepage exit gradients and comparing with the critical gradient (0.97 to 1.00, depending on location) to calculate a factor of safety against piping ($FS_{piping} = i_{crit}/i$). The minimum computed $FS_{piping} > 4.0$ for most of the analysis sections. For Sections P, Q, and R, the minimum computed FS_{piping} = 1.3, 2.4, and 2.6, respectively. Stantec adopted a target minimum factor of safety criterion of 4.0 against piping. This exceeds the factor of safety criterion of 2.5-3.0 proposed in 1977 by Cedergren and noted in USACE's EM 1110-2-1901. Therefore, the analysis Sections P, Q, and R, which represent the west side of the retention pond, do not meet Stantec's criterion and generally do not meet the Cedergren criterion. Stantec provided two alternatives for increasing the factor of safety against piping. One would be to construct a toe berm along the west side of the perimeter dike, along Wells Creek, but this would require 404 and 401 permitting. The other alternative, which was recommended, would be to install a driven sheet-pile wall; the wall would not require environmental permitting. However, Stantec recommended that design of the sheet-pile wall be delayed until studies underway at the time concerning potential spillway modifications and hazard status were completed.

Only the Ash Pond in the CCR Complex represents a surface impoundment. Since the Dry Ash Stack only stores dry products, it is not considered an impoundment, since it does not retain standing water. The only water is storm water runoff that drains to the Ash Pond. Therefore, piping potential evaluation of the Dry Ash Stack dikes was not needed.

Although the Gypsum Disposal Area currently is operated as a dry disposal facility, it does on occasion receive sluiced (pumped) gypsum slurry whenever the dewatering facility is down for maintenance or repairs or power outage. In addition, infiltrated water from past sluicing operations is still slowly draining through the relatively massive gypsum stack and may be responsible for the high phreatic surface that was encountered at the most critical analysis section (Section H). In order to evaluate the effects of seepage on slope stability and piping potential at the critical Section H, Stantec performed a detailed seepage analysis to determine the water conditions for use in slope stability analysis and seepage gradients for using in computing the factor of safety against piping.

For the existing conditions (prevailing at the time of the study) and assuming active sluicing to the Gypsum Stack, the slope stability analysis at Section H incorporating the seepage results yields a computed static slope stability FS = 0.7. For the proposed repair, which included a gravel trench drain extending down below the crest of Dike 2 and riprap toe buttress into foundation soil at the toe of Dike 1 (original dike) with riprap blanket extending up slope to the crest of Dike 2, the computed FS = 1.6.

The factor of safety against piping was computed at a number of potential exit points on the outer side of the Section H perimeter dikes assuming active sluicing: for existing conditions the computed FS_{piping} = 0.68-1.05 and for the repaired conditions the computed FS_{piping} = 1.35-1.39. The factor of safety against piping was also computed assuming no active sluicing and no active stack dewatering: for existing conditions the computed FS_{piping} = 1.04-1.70 and for the repaired conditions the computed FS_{piping} = 2.26-3.59. None of these results meet the adopted FS criterion of 4.0, although the repaired conditions with no active sluicing and no active stack dewatering comes close to meeting the Cedergren FS criterion of 2.5 to 3.0. Stantec suggested that active dewatering by pumping from wells may need to be considered and that pump tests would be needed for evaluation and design of pumping wells. Stantec recommended active sluicing be discontinued, but indicated that sluicing to small lined ponds on the Gypsum Stack would be feasible. Stantec further recommended that the proposed repairs be implemented as soon as possible.

On the basis of the results of the static stability analyses, Stantec recommended repairs in four areas of the Dry Ash Stack/ Gypsum Disposal Area, as follows:

1. Constructing toe buttress of compacted clay with surface layer of rock along the so-called “bottom ash road dike” on the perimeter of the Gypsum Disposal Area, including Sections H, J, K, L, M, and N, to improve stability to acceptable factor of safety against Non-global (shallow) potential failures.

2. Repair of “original and raised” dikes at Section H at the Gypsum Disposal Area, consisting of a gravel trench drain extending down below the crest of Dike 2 and riprap toe buttress into foundation soil at the toe of Dike 1 (original dike) with riprap blanket extending up slope to the crest of Dike 2, to improve stability to acceptable factors of safety against Global (deep-seated) potential failures and against potential piping failures.

3. Regrading of somewhat over-steepened Stacked Fly Ash slope at Section F to maximum slope of 3H to 1V, to improve Global stability to an acceptable level.

4. Regrading of over-steepened slope at Sections A and B on the Ash Pond side of divider dike to maximum slope of 3H to 1V, to improve Non-global stability to an acceptable level.

The repairs have been implemented, and Stantec has re-performed static stability analyses of as-built conditions to verify conformance with the minimum FS criterion.

7.1.5 Liquefaction Potential

There was no documentation provided to Dewberry that included an evaluation of potential liquefaction. It is understood from TVA that liquefaction potential will be addressed as part of a comprehensive risk/consequences-based evaluation of seismic failure risks being conducted in closure design. TVA's approach is described in a "Seismic Risk Assessment White Paper" provided in Stantec's report dated September 22, 2011 (see Appendix A – Doc 8). It is understood that Phase A of the seismic risk assessment study includes analysis/evaluation for liquefaction potential using Phase 2 geotechnical data. It is further understood that the results are being used to assess seismic failure risks for probable closure geometries.

Dewberry has performed an independent qualitative assessment of the Cumberland Ash Pond and determined a qualitative rating of "No Concern" about potential liquefaction under the Ash Pond dikes (see Appendix B – Doc 21).

Stantec's test borings indicate that dike embankments are generally firm and compacted. However, the upper dike raise embankments at the Dry Ash Stack and Gypsum Disposal Area are largely founded on sluiced fly ash, some of which is very loose, according to a number of Stantec's test borings. Thus, there appears to be a potential for liquefaction to occur during strong seismic shaking. Evaluation of these conditions will require a quantitative evaluation to determine the amount of potential deformation and its effects on the integrity and stability of the dike embankments, as well the stacks themselves. Based on currently available information, it is concluded that liquefaction potential at the Dry Ash Stack and Gypsum Disposal Area containment dikes under seismic loading is unknown.

7.1.6 Critical Geological Conditions

From Stantec's "Report of Geotechnical Exploration and Slope Stability Evaluation" dated March 2010 (Appendix A – Doc 6), the geologic map of the Cumberland City Quadrangle (USGS 1968, revised 1986) shows the site of the CCR Complex is predominantly underlain by bedrock belonging to the Mannie Shale, Fernvale Limestone, Hermitage, Carters, Lebanon, Ridley, Pierce, and Murfreesboro Limestone formations, in general order of descending lithology. The limestone layers may be generally described as thin to thick bedded, greenish-gray to gray, coarse to crystalline grained, argillaceous and hard. There is a large variation in the contour of the bedrock due to an ancient meteorite impact crater below the site.

The CCR Complex is founded on alluvial soils consisting of predominantly clay and granular soils. The clay typically occurs in a layer above the granular alluvium. The clay is generally lean clay containing varying amounts of silt and sand. The consistency of the clay ranges from soft to very stiff. The granular alluvium generally consists of silty sand with gravel and has relative densities ranging from very loose to compact.

The main hazard associated with the geology of the area is the presence of some very loose granular soils and soft clays and potentially very soft clays that may behave unsatisfactorily under certain cases of loading, particularly seismic loading. Although Stantec's test borings penetrated such very loose and soft alluvial soils under the dike embankments, they appeared to occur in relatively thin layers or zones, rather than as thick deposits. The saturated fly ash that generally occurs under the dike raise embankments presents the greatest hazard.

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Structural stability and related documentation, including analyses for static slope stability, seismic (pseudostatic) slope stability, seepage, and piping potential, for the Ash Pond containment dike is adequate. Static slope stability documentation for both the Dry Ash Stack and the Gypsum Disposal Area containment dikes is adequate, as is documentation of seepage and piping potential at the critical section of the Gypsum Disposal Area containment dike. However, the documentation of performance of the Dry Ash Stack and the Gypsum Disposal Area containment dikes under seismic loading is inadequate, because no evaluation of potential liquefaction has been provided and seismic stability analyses are incomplete or do not demonstrate acceptable safety under the design seismic event required by the USEPA.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

The structural stability of the Ash Pond containment dike and outlet works appears to be satisfactory in most respects, based on the following:

- The containment dike crests appeared free of depressions and no significant vertical or horizontal alignment variations were observed.
- There was no indication of major scarps, sloughs or bulging along the dike.
- Boils, sinks or major uncontrolled seepage was not observed along the slopes or toes of the dike.
- The static loading slope stability factors of safety are generally well above the minimum required value.

- The seismic (pseudostatic) slope stability analyses, performed for ground motions with a return period of 2,500 years (2% probability of exceedence in 50 years), shows the dike meets the minimum factor of safety.
- There appears to be “No Concern” for liquefaction potential, based on Dewberry’s qualitative evaluation.
- The outflow structures appeared to be in satisfactory condition and stable.

An issue is that, for the perimeter dike along the west side of the retention part of the Ash Pond, the factor of safety against a potential piping failure is below the acceptable minimum. Stantec has provided recommendations to improve the factor of safety against potential piping to an acceptable level. There appears to be no immediate danger of a piping failure, and TVA’s surveillance program and seepage action plan appear sufficient to timely identify an emerging active piping problem and take corrective actions before an emerging condition worsens. Until the recommended remedial measures are implemented, the overall structural stability of the Ash Pond dike is considered fair.

Based on the field observations and results of static slope stability documentation and considering that repairs have been made in the four potential problem areas identified in Stantec’s geotechnical investigation, the static stability of the dikes containing the Dry Fly Ash Stack appear to be satisfactory. The static stability of the dikes containing the Gypsum Disposal Area appear to be generally satisfactory, except for marginally low factors of safety against potential piping at the critical section (H), even after recommended repair and ceasing regular active sluicing of gypsum slurry into the facility. The seepage exit gradients causing the lower-than-desired piping factors of safety may eventually subside when the current infrequent sluicing, necessitated during dewatering plant outages, is to the lined ponds planned for the Gypsum Disposal Area. However, infiltration of rainfall runoff will continue to recharge the groundwater system in the gypsum stack, and the ultimate seepage gradients will depend on the long-term water balance. Stantec’s suggestion of pumping from wells may need to be considered. Until this issue is resolved, the static stability of the Gypsum Disposal Area dike is considered fair.

Suitable documentation demonstrating adequate seismic stability of the critical sections of the dikes containing the Dry Fly Ash Stack and the Gypsum Disposal Area has not been provided for the design earthquake acceptable to the USEPA, i.e., a seismic event with 2,500-year return period. The documentation which provides pseudostatic stability analysis of the divider dike (Section A) between the Dry Fly Ash Stack and the Ash Pond under the 2,500-year seismic event shows adequate stability, but this section is not representative of the critical section (F) of the Dry Fly Ash Stack containment dike. In addition, no documentation has been provided for seismic stability analysis of the critical section (H) of the Gypsum Disposal Area containment dike under the 2,500-year seismic event. The furnished documentation of pseudostatic stability analyses of the critical sections of the Dry Fly Ash Stack and the Gypsum Disposal Area containment dikes under the 500-year seismic event yielded FS = 1.0, the acceptance criterion. Thus, it appears by inspection that for the stronger, 2,500-year seismic event, a FS < 1.0 would result. Therefore, by inference using the available pseudostatic analysis results, the Dry Fly Ash Stack and the Gypsum Disposal Area containment dikes do not have adequate seismic stability to meet the USEPA criterion. Furthermore, no documentation of liquefaction potential analysis has been provided for the Dry Fly Ash Stack and the Gypsum Disposal Area containment dikes. Since the dike raise embankments are largely founded on sluiced fly ash, this is a critical issue that should be quantitatively evaluated to determine the consequences of dike failure as a result of liquefaction. Until the seismic stability and liquefaction issues have been suitably addressed and resolved, the overall stability of the Dry Fly Ash Stack and the Gypsum Disposal Area containment dikes is considered poor.

8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATING PROCEDURES

The Ash Pond is operated for settling and storage of ash deposits. The Dry Fly Ash Stack is used to store the dry fly ash produced by the plant. The Gypsum Disposal Area is used to store the dry gypsum that the drywall plant is unable to use. The Ash Pond receives effluent from the Bottom Ash pond and runoff from the perimeter ditch that surrounds the Gypsum Disposal Area. Water flows from the ash retention area of the Ash Pond to the stilling basin area through a 100-foot opening in an interior dike. The stilling basin serves as a polishing step. Treated coal combustion process waste water is discharged through four overflow risers into the main plant discharge channel and Lake Barkley.

8.2 MAINTENANCE OF THE DAM AND PROJECT FACILITIES

Plant personnel perform daily, weekly, monthly, and quarterly inspections, and hire a third party engineering firm to perform an annual inspection. All the inspections address required maintenance. It appears the maintenance procedures are adequate (see Appendix A – Docs 10, 11).

8.3 ASSESSMENT OF MAINTENANCE AND METHODS OF OPERATIONS

8.3.1 Adequacy of Operating Procedures

Based on the assessments of this report, operating procedures appear to be adequate

8.3.2 Adequacy of Maintenance

Based on the assessments of the inspection reports and visual observations during the site visit, maintenance activities appear to be adequate.

9.0 ADEQUACY OF SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

Daily inspections are conducted by plant personnel. Inspection reports are submitted for review by TVA management. The appropriate corrective actions are performed as required.

9.2 INSTRUMENTATION MONITORING

The Cumberland CCR management dikes have piezometers to monitor ground water levels (see Appendix A – Doc 15) and slope inclinometers to monitor the slope movement of the dikes.

9.3 ASSESSMENT OF SURVEILLANCE AND MONITORING PROGRAM

9.3.1 Adequacy of Inspection Program

Based on the data reviewed by Dewberry, including observations during the site visit, the inspection program is adequate.

9.3.2 Adequacy of Instrumentation Monitoring Program

Based on the data reviewed by Dewberry, including observations during the site visit, the instrumentation program is adequate.

APPENDIX A

Document 1

Project Location Map


Cumberland Fossil Plant
Cumberland City
Lake Barkley
River Bend Recreation Area
Guices Creek Recreation Area
Cumberland City Rd
State Hwy 149 Bus
46
233
149

APPENDIX A

Document 2

Aerial Photography


Cumberland City Rd
233
Ash Pond
Dry Fly Ash Stack
Gypsum Disposal Area

APPENDIX A

Document 3

Steam Electric Questions and Answers

TVA

Tennessee Valley Authority
400 West Summit Hill Drive
Knoxville, Tennessee 37902-1401

Anda A. Ray
Senior Vice President
Office of Environment and Research

March 25, 2009

Mr. Richard Kinch
U.S. Environmental Protection Agency
Two Potomac Yard
2733 South Crystal Drive
5th Floor: N-5783
Arlington, Virginia 22202-2733

Dear Mr. Kinch:

Enclosed is the Tennessee Valley Authority's (TVA) response to your requests for information about coal-combustion by-product management impoundments and our signed authorized certification. Your requests were received at TVA's plant sites on March 12 and March 13. Enclosed is the consolidated response from TVA for all of our fossil plants. We have also included in our response two plants (Watts Bar Fossil Plant, inactive and Cumberland Fossil Plant) for which we did not receive a request for information.

Sincerely,

Anda A Ray

Anda A. Ray

Enclosures: 2007-2008 Annual Inspection Reports of Waste Disposal Areas for all TVA fossil plants.
TVA Responses to EPA Information Request.
Ash Storage Summary.
Certification Form.

EPA believes that the information requested is essential to an evaluation of the threat of releases of pollutants or contaminants from these units. The provisions of Section 104 of CERCLA authorize EPA to pursue penalties for failure to comply with or respond adequately to an information request under Section 104(e). In addition, providing false, fictitious or fraudulent statements or representations may subject you to criminal penalties under 18 U.S.C. 1001.

Your response must include the following certification signed and dated by an authorized representative of Tennessee Valley Authority.

> I certify that the information contained in this response to EPA's request for information and the accompanying documents is true, accurate, and complete. As to the identified portions of this response for which I cannot personally verify their accuracy, I certify under penalty of law that this response and all attachments were prepared in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Signature:
Name: John C. Kammeyer
Title: VP, Engineering

This request has been reviewed and approved by the Office of Management and Budget pursuant to the Paperwork Reduction Act, 44 U.S.C., 3501-3520.

Please send your reply to:

Mr. Richard Kinch
US Environmental Protection Agency (5306P)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

If you are using overnight or hand delivery mail, please use the following address:

Mr. Richard Kinch
US Environmental Protection Agency
Two Potomac Yard
2733 S. Crystal Dr.
5th Floor; N-5783
Arlington, VA 22202 2733

Tennessee Valley Authority Response to Environmental Protection Agency Request for Information

1. **Relative to the National Inventory of Dams criteria for High, Significant, Low, or Less-than-Low, please provide the potential hazard rating for each management unit and indicate who established the rating, what the basis of the rating is, and what federal or state agency regulates the unit(s). If unit(s) does not have a rating, please note that fact.**

   The dam safety hazard potential rating for each management unit is identified on the attached table. The current hazard potential ratings were assigned by TVA using the National Inventory of Dams criteria as a guideline. Hazard classifications have not been assigned to dry disposal management units. The list is updated by TVA every 2 years. No other agencies, federal or state, regulate these facilities from a dam safety perspective.

   Currently, TVA has secured the services of a third party consultant to review the conditions at our coal combustion storage facilities and provide opinions relative to hazard potential. These opinions will be based on the National Inventory of Dams criteria, as well as dam safety regulations of the states in which each unit is located.

2. **What year was each management unit commissioned and expanded?**

   The year each management unit was commissioned and expanded is identified in the attached table.

3. **What materials are temporarily or permanently contained in the unit? Use the following categories to respond to the question: (1) fly ash; (2) bottom ash; (3) boiler slag; (4) flue gas emission control residuals; (5) other. If the management unit contains more than one type of material, please identify all that apply. Also, if you identify "other", please specify, the other types of materials that are temporarily or permanently contained in the unit(s)**

   The coal-combustion byproduct materials contained in each unit are identified in the attached table. Impoundments at units are also routinely used to combine and treat a variety of runoff and low volume water wastes prior to discharge.

4. **Was the management unit(s) designed by a Professional Engineer? Is or was the construction of the waste management unit(s) under the supervision of a Professional Engineer? Is inspection and monitoring of the safety of the waste management unit(s) under the supervision of a Professional Engineer?**

   Permitted solid waste landfill design documents were prepared under the supervision of a registered professional engineer, with design documents stamped by the responsible engineer. In general, for non-permitted management units, the design and construction, along with the inspection and monitoring of all management units, were performed under the supervision of professional engineers.

   TVA is currently revising our program to ensure that the supervision of all design, construction, and monitoring elements for all management units will be performed by professional engineers properly licensed in the states where the project is located and that have specific experience in dam design and operation.

5. **When did the company last assess or evaluate the safety (i.e., structural integrity) of the management unit(s)? Briefly describe the credentials of those conducting the structural integrity assessments/evaluations. Identify actions taken or planned by facility personnel as a result of these assessments or evaluations. If corrective actions were taken, briefly describe the credentials of those performing the corrective actions, whether they were company employees or contractors. If the company plans an assessment or evaluation in the future, when is it expected to occur?**

   Dates of the most recent facility inspection performed by the company or its consultant are listed in the attached table. These inspections were limited to surface observations. No intrusive sampling or testing, or engineering analyses were involved. Enclosed are the 2007-2008 inspection reports which were performed by TVA staff. All 2009 inspection reports are currently under review. These 2009 inspections were performed by TVA staff (who are experienced, degreed Civil Engineers, under the supervision of a registered professional engineer), with the exception of Cumberland, Shawnee, and Watts Bar (inactive) Fossil Plants, which were performed by Stantec.

   The most recent reviews at the Cumberland and Shawnee Fossil Plants were performed by Stantec. Stan Harris, PE, led those reviews. Mr. Harris has over 25 years experience in dam design, construction, and monitoring. In addition, Mr. Harris has experience leading dam safety training initiatives for the United States Army Corps of Engineers.

   Recommended corrective actions resulting from these evaluations are listed in the attached table. The corrective actions have been assigned to TVA staff or contractors experienced in general earth work construction and operation/construction of coal combustion disposal facilities.

TVA has retained the services of a third party consultant, Stantec, to assess each coal combustion byproducts storage facility at the eleven (11) active and one (1) inactive fossil plant. The assessments include field reconnaissance and records review for each facility. Reports will include recommendations and a priority list for additional geotechnical and engineering evaluations, if necessary. The study is on-going with results expected by the end of April 2009.

As a part of this study, TVA has initiated geotechnical explorations of the gypsum stack at our Paradise Fossil Plant, the ash pond at our Johnsonville Fossil Plant, the gypsum stack and ash dredge cell at our Widows Creek Fossil Plant, the ash disposal facility at our John Sevier Fossil Plant, and the gypsum stack and ash stack at our Cumberland Fossil Plant.

6. **When did a State or Federal regulatory official inspect or evaluate the safety (structural integrity) of the management unit(s)? If you are aware of a planned state or federal inspection or evaluation in the future, when is it expected to occur? Please identify the Federal or State regulatory agency or department which conducted or is planning the inspection or evaluation. Please provide a copy of the most recent official inspection report or evaluation.**

TVA facilities are subject to regulation by state agencies responsible for permitting solid waste disposal and discharging of process or storm water flows. These state agencies do perform field reviews; however TVA facilities are not subject to regulation by state agencies relative to dam safety permitting and have not been subject to review or inspections by any federal regulatory agency. Copies of the most recent issued inspection report are enclosed for the 2007-2008 time period.

7. **Have assessments or evaluations, or inspections conducted by Federal regulatory officials conducted within the past year uncovered a safety issue(s) with the management unit(s), and, if so, describe the actions that have been or are being taken to deal with the issue or issues. Please provide any documentation that you have for these actions.**

TVA facilities are subject to regulation by state agencies responsible for permitting solid waste disposal and discharging of process or storm water flows. These state agencies do perform field reviews however; TVA facilities are not subject to regulation by state or federal regulatory agencies relative to dam safety permitting and have not been subject to review or inspections. Copies of the most recent issued inspection report are enclosed for the 2007-2008 time period.

Primarily maintenance issues were identified *during the most recent inspections. A summary of items identified are provided in the attached table. TVA is currently preparing work orders to address these items. The work will be performed by TVA staff or contractors experienced in earth work and the operation of coal combustion product disposal facilities.*

8. **What is the surface area (acres) and total storage capacity of each of the management units? What is the volume of materials currently stored in each of the management unit(s)? Please provide the date that the volume measurement(s) was taken. Please provide the maximum height of the management unit(s). The basis for determining maximum height is explained later in this Enclosure.**

   The surface area, total storage capacity, volume of materials currently stored, and date of last volume measurement for each management unit are provided in the attached table. Data based on 2006 long-range plans of the projected remaining capacities ending at Fiscal Year 2008.

9. **Please provide a brief history of known spills or unpermitted releases from the unit within the last ten years, whether or not these were reported to State or federal regulatory agencies. For purposes of this question, please include only releases to surface water or to the land (do not include releases to groundwater).**

   A history of known spills or unpermitted releases from each unit within the last ten (10) years, if applicable, is listed in the attached table. All spills and unpermitted releases were reported to the appropriate state or federal agencies as required by regulation or law.

10. **Please identify all current legal owner(s) and operator(s) at the facility.**

    The United States is the owner of TVA facilities, and TVA is the operator of each facility listed in the attached table.

PLANT	FACILITY	HAZARD POTENTIAL CLASSIFICATION See footnote #1	Hazard Rating Performed By	YR MGT UNIT COMMISSIONED See footnote #2	YR MGT UNIT EXPANDED	MATERIALS CONTAINED IN UNIT	LAST TVA ASSESSMENT	NEXT SCHEDULED TVA ANNUAL INSPECTION	ACTIONS TAKEN OR PLANNED RESULTING FROM LAST ANNUAL INSPECTION	ISSUES REPORTED BY STATE OR FEDERAL ASSESSMENTS AND ACTIONS TAKEN See footnote #3	SURFACE AREA (ACRES)	TOTAL STORAGE CAPACITY (Cubic Yards)	CURRENT VOLUME OF MATERIAL (Cubic Yards)	REMAINING CAPACITY (Cubic Yards)	DATE VOLUME TAKEN	CURRENT HEIGHT (FT)	FUTURE MAX. HEIGHT (FT)	KNOWN SPILLS OR UNPERMITTED RELEASES (SURFACE WATER/LAND) See footnote #4	CURRENT LEGAL OWNER(S)) & OPERATOR(S)) AT FACILITY
Allen Fossil Plant	EAST ASH DISPOSAL	LOW	TVA	1967	1978	FLY ASH	Nov-08	2009	Maintenance concerns such as rutting, erosion, vegetation, etc., were noted; a seep was noted north of the plant - TVA has an independent consultant evaluating the seep.	NR	70	1,775,000	1,029,000	746,000	2006	20	20	NR	Owner - United States, Operator - TVA
	EAST ASH STILLING POND	Not Rated		1978	Not Expanded	Fly ash, bottom ash					23	290,000	INCLUDED IN EAST ASH DISPOSAL AREA	INCLUDED IN EAST ASH DISPOSAL AREA	2006	20	20		
Bull Run Fossil Plant	DRY FLY ASH DISPOSAL AREA	Not Rated		1982 - Phase 1	1990 - Phase II	FLY ASH	Nov-08	2009	(1) Work order written to regrade top of Bottom Ash Stack, (2) work order for regrading and placement of rip rap below drainage pipe erosion on east side of Bottom Ash Stack, (3) work orders written for numerous animal paths and burrows noted around Bottom Ash Stack and Active Fly Ash Pond Area 2, (4) work order for repair of erosion areas along the bank of Bull Run Creek on south side of Active Fly Ash Pond Area 2, (5) removal of fallen trees on west side of Area 2 Stilling Pond and north side of Gypsum Disposal Area 2A, (6) work order written to repair eroded area on south slope of Gypsum Disposal Area 2A.	NR	17 (Phase II)	4,800,000.00	3,903,000	897000	2006	60	84	NR	Owner - United States, Operator - TVA
	FLY ASH POND AND STILLING BASIN AREA 2	LOW	TVA	1967	1976 - divider dike constructed to form Stilling Pond 1981 - dike constructed to form Pond 2A	Fly ash, bottom ash					49	2,700,000	2,332,600	367,400	2006	20	20		
	BOTTOM ASH DISPOSAL AREA 1	Not Rated		1967	1980 - Dike constructed to form stacking area within former pond	BOTTOM ASH (flows to Fly Ash Pond)					32	876,500	627,000	250,000	2006	52	65		
	GYPSUM DISPOSAL AREA 2A	Not Rated		1981 (originally fly ash settlement pond) 2008 (Gypsum Disposal Area)	Not Expanded	FLUE GAS EMISSION CONTROL RESIDUALS (Flows to fly ash pond)					42	2,743,000	896,000	1,847,000	2006	45	165		
rt Fossil Plant	DISPOSAL AREA 5	LOW	TVA	1983	1990 - converted to dry ash operation	FLY ASH, potentially ammoniated.	Mar-08	2009	Disposal Area 5 - reported annual maintenance items include: cover and vegetate stack slopes semi-annually, repair erosion as needed, regrade perimeter ditch as needed. Ash Pond 4 - joint sealant applied to RCP spillway riser joints annually, semi-annual mowing of dike slopes, reportedly applied tree killer substance to sparse tress on west side of pond last year (trees not yet removed though), weekly monitoring of seepage areas.	NR	75	8,800,000	6,765,000	2,035,000	2006	120	135	NR	Owner - United States, Operator - TVA
	ASH POND 4	LOW	TVA	1972	1984	Bottom ash, fly ash (historical)					45	2,200,000	1,159,000	1,041,000	2006	40	40		
	DISPOSAL AREA 5 BASIN	Not Rated		1983	N/A	Fly Ash					12	600,000	150,000	450,000	2006	17	17		
berland Fossil Plant	DRY ASH STACK	Not Rated		1969	Dry Ash stacking began in mid- 1990s over old pond	FLY ASH/BOTTOM ASH	Feb-09	2009	Maintenance activities needed include repairs for erosion, monitoring seepage, tree removal, clearing and cleaning inner slopes and perimeter ditches, repair of animal burrows, establishing vegetation in exposed areas, and recommendations for construction of the current gypsum dikes.	NR	110	12,600,000	4,781,000	7,819,000	2006	35	200	NR	Owner - United States, Operator - TVA
	ASH POND	LOW	TVA	1969	Dikes raised in 1979	Bottom ash, fly ash (historical)					50	2,000,000	1,305,000	695,000	2006	35	35		
	GYPSUM STORAGE AREA	LOW	TVA	1969	Gypsum area constructed over old pond in mid 1990s	FLUE GAS EMISSION CONTROL RESIDUALS					170	20,000,000	1,826,000	18,174,000	2006	60	140		
in Fossil Plant	FLY ASH POND E	LOW	TVA	1970	1986 - Divider Dike Constructed Forming Ponds A and E; 2006 - Pond E Expanded	FLY ASH, bottom ash. E flows to C.	2008	2009	Annual maintenance items reported by GAF include: annual seeding of new dikes for Pond E, mow along Pond E dike slopes beneath power lines along river.	NR	157	7,100,000	4,968,000	2,132,000	2006	30	35	NR	Owner - United States, Operator - TVA
	BOTTOM ASH POND A	LOW	TVA	1970	1986 - Divider Dike Constructed Forming Ponds A and E; 1994 - Divider dike raised	BOTTOM ASH; A flows to B					269	7,083,000	4,951,409	2,131,591	2006	25	25		
	STILLING POND B, C & D	Not Rated		1970	1986 - Ponds B and C formed when divider dike constructed to form Ash Ponds A and E	FLY ASH & BOTTOM ASH and other listed in E.					55	600,000	400,000	200,000	2006	10	10		
Sevier Fossil Plant	DRY ASH STACK	Not Rated		1955 (former ash ponds)	1979 - all sluicing stopped, designated for dry ash disposal	FLY ASH	Nov-07	2009	(A) to monitor the exterior dikes slopes and toe areas of all disposal areas for surface sloughs, new seepage area, changes in existing seeps, or movements; (B) continuation of mowing program and prevention of tree growth on dikes; (C) cover exposed slopes with earth, seed, fertilize and mulch as described in the operations manual; (D) removal of sediment from Coal Yard Drainage basin; (E) reclaim animal burrows.	NR	84	3,800,000	2,098,000	1,702,000	2006	101	143	NR	Owner - United States, Operator - TVA
	BOTTOM ASH POND	LOW	TVA	1979	Not Expanded	BOTTOM ASH, FLY ASH					26 (pond area only) 41 (total area)	1,200,000	1,035,293	165,000	2006	25	25		

PLANT	FACILITY	HAZARD POTENTIAL CLASSIFICATION See footnote #1	Hazard Rating Performed By	YR MGT UNIT COMMISSIONED See footnote #2	YR MGT UNIT EXPANDED	MATERIALS CONTAINED IN UNIT	LAST TVA ASSESSMENT	NEXT SCHEDULED TVA ANNUAL INSPECTION	ACTIONS TAKEN OR PLANNED RESULTING FROM LAST ANNUAL INSPECTION	ISSUES REPORTED BY STATE OR FEDERAL ASSESSMENTS AND ACTIONS TAKEN See footnote #3	SURFACE AREA (ACRES)	TOTAL STORAGE CAPACITY (Cubic Yards)	CURRENT VOLUME OF MATERIAL (Cubic Yards)	REMAINING CAPACITY (Cubic Yards)	DATE VOLUME TAKEN	CURRENT HEIGHT (FT)	FUTURE MAX. HEIGHT (FT)	KNOWN SPILLS OR UNPERMITTED RELEASES (SURFACE WATER/LAND) See footnote #4	CURRENT LEGAL OWNER(S)) & OPERATOR(S)) AT FACILITY
Johnsonville Fossil Plant	**ASH DISPOSAL AREA 2**	LOW	TVA	1970	1978	FLY ASH & BOTTOM ASH	Nov-07	2009	Recommendations include maintenance activities: filling animal burrows, repairing erosion, filling in depressed areas, clearing heavy vegetation, and tree removal. Additionally, also monitoring seepage.	NR	87	4,360,000	4,164,000	199000	2006	30	30	Reported release of small quantity of ceneospheres on March 27, 2004 when discharge structure was disturbed during maintenance.	Owner - United States, Operator - TVA
Kingston Fossil Plant	**MAIN ASH POND**	LOW	TVA	1951	1968 - raised dike	FLY ASH & BOTTOM ASH	Oct-08	2009	Standard recommendations were to repair all erosion ditches, repair wheel ruts, remove floating ash from the pond to prevent a permit violation, remove trees from dikes and mow the dikes regularly to control the growth of vegetation. Repair broken monitoring wells along Swan Pond Road, monitor seeps and under drains.	NR	92	14,370,000	UNKNOWN	UNKNOWN	NA	50	UNKNOWN	November 7, 2003 and November 1, 2006, an ash release occurred to land from a slough in the Dredge Cell embankment. A release into the Emory River occurred on December 22, 2008 from the Dredge Cell embankment failure. No reports found of releases from the Main Ash Pond or Stilling Basin.	Owner - United States, Operator - TVA
	STILLING POND	LOW See footnote 1	TVA	1978	Not Expanded	Materials from main ash pond					29	468,000	260,000	208,000	2006	50	50		
Paradise Fossil Plant	**SCRUBBER SLUDGE COMPLEX (Gypsum Stack and Scrubber Sludge Stilling Pond)**	LOW	TVA	1986	Not Expanded	FLY ASH, FLUE GAS EMISSION CONTROL RESIDUALS	Oct-08	2009	With respect to dam safety, primarily minor concerns (rutting, erosion, vegetation, etc.) were identified in the report. The under drain ditch at the Gypsum Stack needs to be cleaned out to prevent flow over the road. Several seeps were noted at the Daniel Run Pond 3, but were not flowing. Recommended removal of fines from the Coal Yard Runoff Ponds and all of the Red Water Ponds.	NR	255	858,000	11,783,000	35,074,000	2006	62	270	NR	Owner - United States, Operator - TVA
	FLY ASH EXTENSION AREA POND (Peabody Ash and Stilling Pond and Jacob's Creek Fly Ash and Stilling Pond)	LOW	TVA	1971	1997	FLY ASH					203	6,348,000	2,956,000	3,392,000	2006	34	34		
	SLAG AREAS 2A & 2B	LOW	TVA	1967	1970	BOTTOM ASH. A portion of the flow is routed to the fly ash extension area pond.					27	968,000	752,000	216,000	2006	24	24		
Shawnee Fossil Plant	**CONSOLIDATED WASTE DRY STACK**			1984	Horizontal expansion design prepared in 2000	FLY ASH/BOTTOM ASH. Drains to ash pond	Feb-09	2009	Maintenance activities needed include repairs for erosion, monitoring seepage, tree removal, clearing and cleaning inner slopes, repair of animal burrows, establishing vegetation in exposed areas, monitoring animal paths, repairing leaking raw water line, removing sediment build-up, and recommendations for regrading intake channel dredge cell.	NR	200	33,194,000	22,811,000	10,382,000	2006	100	270	NR	Owner - United States, Operator - TVA
	ASH POND	LOW	TVA	1952	Area 2 was constructed in 1971 and the dikes were raised in 1979	FLY ASH/BOTTOM ASH					180	5,000,000	4,712,000	287,000	2006	25	25		
Widows Creek Fossil Plant	**ASH POND (Complex consists of Bottom Ash Stack, Iron Pond, Cooper Pond, Old Scrubber Sludge Pond (Dredge Cell), Asbestos Waste Disposal Area, Pump Pond, Upper and Lower Stilling Ponds)**	LOW	TVA	1950	During 2005, a dredge cell was constructed over the old scrubber sludge pond area. During 2007 dredging ceased.	FLUE GAS EMISSION CONTROL RESIDUALS, FLY ASH & BOTTOM ASH	Oct-08	2009	Review with the Constructor the Gypsum Stack operations manual and drawings to ensure the operations continue in accordance with the current stacking plan, monitor the wet area along the southern lower perimeter dike, rework a portion of the west slope next to the Stilling Pond, install sub drains on the west slope adjacent to the Gypsum Stilling Pond, uncover the slope drains on the 650/655 bench and grade per design drawings. In regards to the Wet Gypsum Stacking Stilling Pond, the planned actions are to consider and alternate skimmer design on TVA drawing 10W235-19. In regards to the Pump Pond, the planned actions are to monitor the seep in the dike between the Stilling Pond and the Pump Pond. In regards to the Active Ash Pond, the planned actions are to monitor the seepage along the south Perimeter dike next to the stilling pond.	NR	310	18,890,000	1,856,000	17,034,000	2006	50	115	Reported release of small quantity of ceneosperes from the Ash Pond which occurred on December 10, 2004 due to intense precipitation. Reported release of small quantity of ceneospheres from the Ash Pond which occurred on January 30, 2008. An abandoned decant weir in Pond 2B of the Gypsum Stack failed on January 9, 2009.	Owner - United States, Operator - TVA
	GYPSUM STACK (Wet Stacking Area)	LOW	TVA	1986	Phase I vertical expansion occurred from 1986 to 1992. Phase II horizontal expansion began in 1992.	FLUE GAS EMISSION CONTROL RESIDUALS, FLY ASH & BOTTOM ASH					110	17,683,000	7,892,000	9,791,000	2006	75	150		
Watts Bar Fossil Plant (Inactive)	**ASH POND and STILLING BASIN**	LOW	TVA	1974	1977	Previous fly ash, bottom ash	Feb-09	2009	Complete Closure Plan - currently construction is approximately 95 percent complete.	NR	14	230,000	150000	80,000	2006	30	30	NR	Owner - United States, Operator - TVA

Notes: 1. Hazard Potential listed for those facilities previously rated by TVA, all facilities are currently under evaluation. Based on hindsight at Kingston Fossil Plant, the ranking did not adequately represent the actual risk experienced on 12/22/2008.
2. Year Management Unit Commissioned approximated from available reports, drawings, or permit documents.
3. NR - None Reported
4. Does not include NPDES permit exceedences

APPENDIX A

Document 4

NPDES Permit

Document Type: NPDES Permits/Applications

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
401 CHURCH STREET
L & C ANNEX 6TH FLOOR
NASHVILLE TN 37243-1534

November 30, 2007

Mr. Gordon G Park
Manager of Environmental Affairs
Tennessee Valley Authority
5D Lookout Place
1101 Market Street
Chattanooga, TN 37402

Subject: **Modified 316(b) Requirements for NPDES Permit No. TN0005789**
TVA - Cumberland Fossil Plant
Cumberland City, Stewart County, Tennessee

Dear Mr. Park:

In accordance with the provisions of the Tennessee Water Quality Control Act, Tennessee Code Annotated, Sections 69-3-101 through 69-3-120, the Division of Water Pollution Control hereby issues the enclosed modified NPDES Permit. The continuance and/or reissuance of this NPDES Permit is contingent upon your meeting the conditions and requirements as stated therein.

This modification is subject only to those provisions as detailed in the Addendum to Rationale found in the permit. Specifically, this modification removes the reporting requirement of the January 7, 2008 Comprehesive Demonstration Study (CDS) that was previously required by the now suspended federal rule known as 316(b). However, some remaining and additional requirements and details of this modification are found in the addendum. The previously issued permit (30, November 2005) should be archived and this modified permit document placed into service effective January 1, 2008

Please be advised that you have the right to appeal any of the provisions established in this NPDES Permit, in accordance with Tennessee Code Annotated, Section 69-3-105(i), and the General Regulations of the Tennessee Water Quality Control Board. If you elect to appeal, you should file a petition within thirty (30) days of the receipt of this permit.

If you have questions, please contact the Division of Water Pollution Control at your local Field Office at 1-888-891-TDEC or, at this office, please contact Ms. Pamala Myers at (615) 532-0654 or by E-mail at *Pamala.Myers@state.tn.us*.

Sincerely,

Wade D. Murphy

Wade D. Murphy
Acting Manager, Permit Section
Division of Water Pollution Control

WDM:pm:wlo

Enclosure

STATE OF TENNESSEE

NPDES PERMIT

No. TN0005789

MODIFICATION: November 30, 2007

Authorization to discharge under the
National Pollutant Discharge Elimination System (NPDES)

Issued By

Tennessee Department of Environment and Conservation
Division of Water Pollution Control
401 Church Street
6th Floor, L & C Annex
Nashville, Tennessee 37243-1534

Under authority of the Tennessee Water Quality Control Act of 1977 (T.C.A. 69-3-101 et seq.) and the delegation of authority from the United States Environmental Protection Agency under the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977 (33 U.S.C. 1251, et seq.)

Discharger: **TVA - Cumberland Fossil Plant**

is authorized to discharge: **ash transport water, treated chemical and nonchemical metal cleaning wastewaters, coal pile runoff, low volume wastes, and storm water runoff through Outfall 001, once through condenser cooling water, miscellaneous equipment cooling and lubricating water, and storm water through Outfall 002, intake screen backwash water through Outfall 004, and chemical and nonchemical metal cleaning wastewaters through Outfall 007**

from a facility located: **in Cumberland City, Stewart County, Tennessee**

to receiving waters named: **Cumberland River at mile 103**

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit shall become effective on: **January 1, 2008**

This permit shall expire on: **May 31, 2010**

Issuance date: **November 30, 2007**

Wade P. Murphy / for
Paul E. Davis, Director
Division of Water Pollution Control

RDAs 2352 and 2366

APPENDIX A

Document 5

Hydrologic & Hydraulic Analysis, Stantec, September 28, 2010

Memo

Stantec

To: Scott Turnbow
Chattanooga, TN
Job: 175008014

From: Matthew [illegible], PE
St. Louis, MO
Date: September 28, 2010

Reference: Hydrologic and Hydraulic Calculations Summary
Spillway Improvement Project
Cumberland Fossil Plant (CUF)
Main Ash Pond

The purpose of this memorandum is to summarize the hydrologic and hydraulic calculations supporting design of spillway improvements at the CUF Main Ash Pond. Detailed design calculations and descriptions will be provided with the final spillway design report and calculation package. Preliminary design drawings will be submitted to TVA on 10/4/2010.

BACKGROUND

A hydrologic and hydraulic analysis was performed for the Cumberland Fossil Plant (CUF) Ash Pond Complex in support of the spillway improvement project. The pond complex consists of the Ash Pond and the Ash Stilling Pond. These ponds act as settling basins for the ash slurry that is discharged from the plant, as well as stormwater detention for runoff from the Gypsum Storage Area, Dry Ash Stack and pumped runoff from the Coal Yard. The existing spillway risers are located in the Ash Stilling Pond and direct flow from the Ash Stilling Pond to the spillway discharge channel, which flows to the Cumberland River.

WATERSHED & PROCESS FLOW

[illegible]

PROJECT DESCRIPTION

[illegible]

Reference: Hydrologic and Hydraulic Calculations Summary
Spillway Improvement Project
Cumberland Fossil Plant (CUF)
Main Ash Pond

FREEBOARD

TVA's Master Programmatic Document requires 5 ft of operating freeboard for ash pond facilities. The perimeter dike crest elevation is 394 ft and the Ash Pond water surface elevation is currently maintained at 384.2 ft, resulting in an operating freeboard of 9.8 ft. The facility currently meets freeboard requirements.

METHODOLOGY SUMMARY

The 6-hour PMP rainfall depth of 35.4 inches for Stewart County, Tennessee, was determined and the SCS 6-hour rainfall distribution was applied to this depth. This depth was estimated from a map on page 45 of *Hydrometeorological Report No. 56 Probable Maximum and TVA Precipitation Estimates With Areal Distribution for Tennessee River Drainages Less Than 3,000 Mi² in Area* by US Department of Commerce. The 24-hour Type II SCS distribution was applied to a 100-yr, 24-hr rainfall depth of 7.6 inches obtained from *Technical Paper No. 40 Rainfall Frequency Atlas of the United States* by US Department of Commerce. The SCS curve number method was used to convert the rainfall into runoff. Composite curve numbers ranging from 84 to 93 were assigned to subbasins within the watershed based on land use and soil characterization. Lag time assumptions were based on topographic mapping and ranged from 3 minutes to 10 minutes. Stage-storage relationships for the main ash pond storage were developed using available contour data and a hydrographic survey provided by TVA. This data was input into a US Army Corps of Engineers Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) version 3.4 model of the watershed to develop the inflow hydrograph to the ash pond [illegible]

[illegible]

[illegible]

Reference: Hydrologic and Hydraulic Calculations Summary
Spillway Improvement Project
[illegible]
[illegible] Pond

Table 1 – Freeboard and Routing Summary

	Pre-design Conditions	Post-design Conditions
Drainage Area (ac)	480	480
Crest of Dam (ft)	[illegible]	394
Normal Pool Elevation (ft)	[illegible]	[illegible]
Normal Operating Freeboard (ft)	9.8	15.9
Normal Operation Flow (cfs)	[illegible]	[illegible]
100-yr, 24-hr Storm Precipitation Depth (in)	7.83	7.83
100-yr 24-hr max. water surface elevation (ft)	386.7	380.8
Design Storm	6-hr PMP	6-hr PMP
Design Storm max. water surface elevation (ft)	Overtopped	[illegible]

FUTURE MODIFICATIONS

Because the existing spillway system is not capable of passing the 6-hr PMP design storm, a spillway improvement project is currently under design [illegible] unsupported structures and [illegible] with a 35-ft wide [illegible] emergency spillway at elevation 38[illegible] ft. Siphon spillways will be installed to lower the [illegible] spillways. If the structures are found to be in adequate structural condition, the top [illegible] of the riser will be cut and removed to allow for permanent lowering of the pool [illegible]

STANTEC CONSULTING SERVICES INC.

[illegible]

[illegible]

APPENDIX A

Document 6

Slope Stability Evaluation – Ash Pond, Stantec, March 2010

Report of Geotechnical Exploration and Slope Stability Evaluation

Ash Pond
Cumberland Fossil Plant
Stewart County, Tennessee

Stantec Consulting Services Inc.
One Team. Infinite Solutions
11687 Lebanon Road
Cincinnati, Ohio 45241-20026
Tel: (513) 842-4200 • Fax: (513) 842-8250
www.stantec.com

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

March, 2010

Stantec

Stantec Consulting Services Inc.
1409 North Forbes Road
Lexington KY 40511-2050
Tel: (859) 422-3000
Fax: (859) 422-3100

March 29, 2010
File: 175539016R01

Mr. Barry S. Snider, PE
Tennessee Valley Authority
1101 Market Street
LP2N
Chattanooga, Tennessee 37402

Re: Report of Geotechnical Exploration and Slope Stability Evaluation
Ash Pond
Cumberland Fossil Plant
Stewart County, Tennessee

Dear Mr. Snider:

Stantec Consulting Services Inc. (Stantec) has completed a geotechnical exploration of the Ash Pond at the Coal Combustion Product Disposal Complex at the Cumberland Fossil Plant. Our final report includes discussions of general site conditions, scope of work performed, subsurface conditions, and results of laboratory testing and our engineering analyses.

The report also includes a review of historical documentation provided by TVA, and our conclusions and recommendations relative to future use of the facility. These services were performed under Engineering Service Request ESR/TAO 894 in accordance with the terms and provisions established in our System-Wide Services Agreement dated December 22, 2008.

Stantec appreciates the opportunity to provide engineering services for this project. If you have any questions, or if we may be of further assistance, please contact our office.

Sincerely,

STANTEC CONSULTING SERVICES INC.

Daniel B. Rogers

Daniel B. Rogers, PE
Project Engineer

Stan A. Harris

Stan A. Harris, PE
Principal

Report of Geotechnical Exploration and Slope Stability Evaluation

Ash Pond
Cumberland Fossil Plant
Stewart County, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

March, 2010

Report of Geotechnical Exploration

Ash Pond
Cumberland Fossil Plant
Stewart County, Tennessee

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Appendix

Executive Summary

Stantec Consulting Services Inc. (Stantec) has completed a Geotechnical Exploration and Slope Stability Evaluation of the Ash Pond Complex at the Cumberland Fossil Plant. This study was performed to evaluate slope stability and seepage for existing conditions at the Ash Pond.

Background Information

The Ash Pond Complex is approximately 50 acres in area. It consists of the Retention Pond and the Stilling Basin, contiguous structures located on the north end of the larger coal combustion product (CCP) waste disposal complex. The Ash Pond receives effluent from the Bottom Ash Pond and also receives runoff from the perimeter ditch system which surrounds the Gypsum Disposal Area Complex. With a total length of approximately 4,200 feet, the dike system that surrounds the Ash Pond has a maximum height of about 36 feet above Wells Creek. The dike system was constructed with approximately 3H:1V slopes, but isolated areas are slightly steeper (2.8:1V).

Water in the Retention Pond generally flows to the northwest and exits to the Stilling Basin through a 100-foot wide opening in the dike separating the two structures. A floating boom spans the opening and aids in removal of floating solids. Decanted water discharges from the Stilling Basin through four 36-inch pipe spillways. Each spillway has a 48-inch concrete riser with a 120-inch diameter corrugated steel pipe skimmer. The spillways drain into a concrete discharge channel that leads to the main plant discharge channel and Lake Barkley.

TVA has classified the Ash Pond Complex as a “high hazard” facility due to the potential for damage to the downstream state highway and bridge should a failure of the impoundment occur. Currently, Stantec and TVA are in the early stages of performing a detailed study to more accurately determine the downstream impacts resulting from a failure. Stantec is also in the process of studying modifications and/or replacements of the existing Ash Pond spillways. One of the outcomes of these efforts may be lowering the pool elevation by several feet.

According to historical documents provided by TVA, a seep was noted in 1974 through the dike along the western side of the Retention Pond. A repair was performed consisting of placing a 40-foot wide clay seal on the interior of the dike. The area is monitored annually and no further seepage has been noted. There are no other reported cases of seepage or slope instability.

Scope of Geotechnical Exploration

This study began with a review of TVA-provided historical information along with site inspections. A geotechnical exploration program was then developed and executed. The exploration consisted of drilling 30 soil test/sample borings at 16 locations. Piezometers were installed at 7 locations and slope inclinometer casings at three locations. Drilling locations were positioned along eight cross sections around the Retention Pond and the Stilling Basin. Laboratory testing performed included moisture content, classification, permeability and shear strength testing to establish key index properties and strength parameters.

Results of Exploration and Engineering Analyses

Eleven primary soil horizons were identified from the field and laboratory program. These primary horizons generally fall into one of three categories: 1) natural foundation soils which included alluvial clay and alluvial sands and gravels, 2) dikes constructed with natural clays and varying amounts of gravel, and 3) coal combustion byproducts including fly ash and bottom ash.

Following the drilling and laboratory testing program, seepage and slope stability analyses were performed to quantify factors of safety for current conditions. The dikes were assessed under static, long-term steady state conditions since the dikes have been in their current configuration for a long time. Analyses were performed on eight sections.

Phreatic surfaces predicted by the seepage analyses were generally in good agreement with levels measured in piezometers installed as part of this study. At three locations, Sections P, Q and R, the calculated factor of safety against piping was found to be less than the recommended acceptable minimum value of 4. Results of the slope stability analyses indicates factors of safety against long-term slope stability failure are greater than the target value of 1.5. If the pond water level or top of dike elevations are lowered in the future, the factors of safety would tend to increase.

Two alternatives have been proposed to increase the factor of safety against piping at Sections P, Q and R. The first is to construct a toe berm along the banks of Wells Creek. This method would likely require obtaining 401/404 permits. A second alternative would be installing a sheet pile cutoff wall along the interior side of the dike system. It is recommended that a final decision on the mitigation option to follow not be made until Stantec's breaching spillway studies are completed. Changes resulting from those studies, such as the operating pond level, would have an impact on the design of remedial measures.

Report of Geotechnical Exploration

Ash Pond
Cumberland Fossil Plant
Stewart County, Tennessee

1. Introduction

1.1. General

Tennessee Valley Authority (TVA) retained Stantec Consulting Services Inc. (Stantec) to perform facility assessments at eleven (11) active and one closed electricity-generating fossil plants. Specifically, Stantec was requested to assess the coal combustion product (CCP) disposal facilities at these generating plants. In general, the facilities consisted of ash ponds, scrubber sludge (gypsum) ponds, wet ash dredge cells, dry ash stacks and gypsum stacks. A number of facilities were abandoned (having completed their design life), while a majority of them were actively receiving combustion products at the time of this project.

1.2. Facilities Assessment Project

Stantec's scope of work for the facilities assessment project is divided into four main phases, with Phase 1 divided into two sub-phases, 1A and 1B. Brief descriptions of Stantec's scope of work for each phase are presented in the following paragraphs.

- Phase 1A – Review most recent TVA inspection reports, observe critical disposal features while accompanied by TVA personnel, develop a list of primary concerns and recommend immediate action or engineering assessment as considered necessary.

- Phase 1B – Review available historical documentation, re-visit sites for more detailed observations and measurements, complete dam safety checklists adapted from standard dam safety protocols, recommend immediate action as judged necessary and recommend sites/features that should undergo further evaluation.

- Phase 2 – Evaluate TVA facilities based on current dam safety criteria adopted by the state in which the plant is located, conduct geotechnical explorations and engineering analyses at sites recommended in Phase 1B, and complete conceptual and final repair designs and budget level cost estimates.

- Phase 3 – Design repairs for sites recommended in Phase 2 and prepare construction plans and specifications as well as permit/planning documents.

- Phase 4 – Provide dam safety training for TVA staff and update operation manuals.

At the time of this report, Phase 1 of the assessment is complete. Phase 2 is being implemented at several facilities located within the different plants. The Phase 1 report recommended that Phase 2 evaluations include geotechnical explorations and hydraulic/hydrologic assessments. This document reports the results of a geotechnical exploration of the dikes surrounding the Retention and Stilling Ponds within the Cumberland Fossil Plant. The exploration was performed to evaluate dike slope stability and seepage for the existing conditions.

2. Cumberland Fossil Plant

2.1. Location

The Cumberland Fossil Plant (CUF) is located in western Tennessee west-southwest of Clarksville, Tennessee on the south shore of Lake Barkley, as shown in Figure 1. The plant is adjacent to the town of Cumberland City, Tennessee. The plant can be accessed by state Highway 233, which connects to TVA-owned roads.

Figure 1. Portions of 7 ½-minute U.S.G.S. topographic maps (Cumberland City and Clarksville quadrangles) showing the vicinity of the Cumberland Fossil Plant near Cumberland City and Clarksville, Tennessee.

2.2. Power Generation

Cumberland Fossil Plant (CUF) has two coal-fired generating units and produces more power than any other plant in the TVA system. The plant was constructed between 1968 and 1973. The winter net dependable generating capacity is about 2,530 megawatts. The plant consumes approximately 20,000 tons of coal a day and produces roughly 750,000 tons of combustion products in the forms of fly ash and bottom ash each year.

Sulfur dioxide scrubbers for both coal-fired generating units were installed in 1994. The process generates a synthetic gypsum byproduct. Approximately 1,000,000 tons of gypsum is produced each year, depending upon the actual amount of coal burned. The gypsum is marketed as a building material.

3. Ash Pond

3.1. General

The ash pond complex is comprised of the retention pond and the stilling basin. These structures are contiguous structures on the north end of the larger coal combustion product (CCP) waste disposal complex (Shown in Figures 2 and 3). Each structure was formed by construction of divider dikes in order to create areas for a two-staged, gravity, water clarification process. The ash pond processes the effluent from the bottom ash pond and the drainage and runoff from the entire waste disposal complex. With a total length of approximately 4,200 feet, the dike system that surrounds the ash pond has a maximum height of 36 feet above the pool of Wells Creek. The dike system was constructed with slopes of approximately 3H:1V, but isolated areas are slightly steeper (2.8H:1V).

Water flows to the ash pond from the bottom ash pond which receives slurry directly from the generating plant. The water decanted from the bottom ash pond is conveyed to the 37.4-acre retention pond by a 72-inch diameter pipe spillway. Water from the disposal area perimeter ditch (see Stantec's 2009 Report for perimeter ditch details) is also conveyed to the retention pond via 36-inch diameter pipes at two locations through the dike between the pond and the dry fly ash stack. One 36-inch pipe is on the west end of the divider dike and a pair of 36-inch pipes are near the east end of the dike.

Water in the retention pond flows generally to the northwest and exits to the stilling basin through a 100-foot wide opening in the dike separating the two structures. A floating boom spans the opening and aids in settlement of very fine solids.

Decanted water discharges from the stilling basin through four 36-inch pipe spillways. Each spillway has a 48-inch concrete riser with 120-inch diameter corrugated steel pipe skimmer. The spillways empty clean water into a concrete discharge channel that leads to the main plant discharge channel and Lake Barkley.

3.2. Dry Fly Ash Stack and Gypsum Disposal Complex

Stantec submitted a Draft Report of Geotechnical Exploration for the Cumberland Dry Fly Ash Stack and Gypsum Disposal Complex on December 16, 2009. This report references historical data and laboratory test results presented in that report.

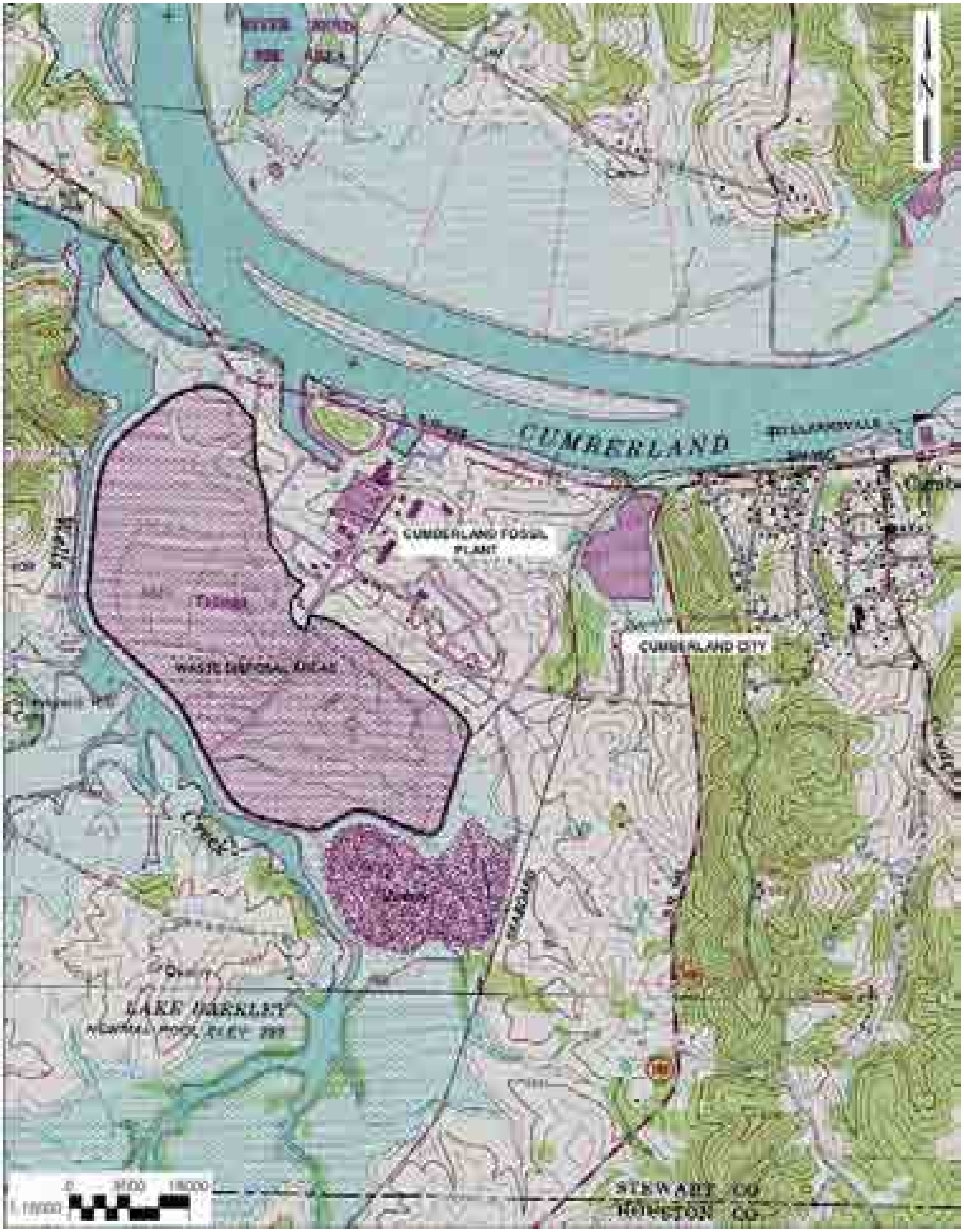


Figure 2. Portion of 7 ½-minute U.S.G.S. topographic map (Cumberland City quadrangle) showing Cumberland Fossil Plant.

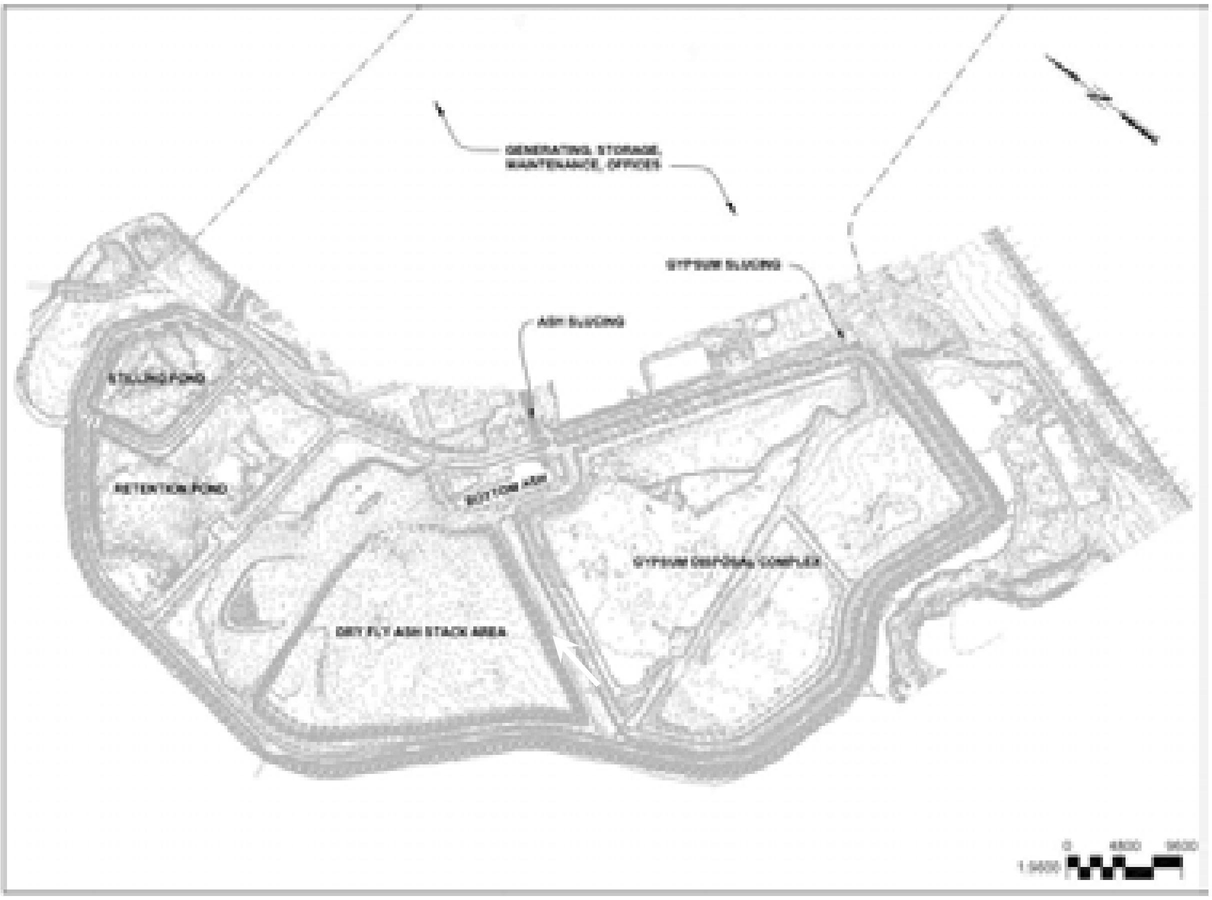


Figure 3. General layout of the Cumberland Fossil Plant showing the components of the coal combustion by-product disposal complex

4. Scope of Work

The scope of the geotechnical exploration was divided into the following tasks.

a. Review of Available Information

b. Review of General Site Geology

c. Subsurface Exploration

d. Field Instrumentation and Monitoring

e. Surveying

f. Laboratory Testing

g. Engineering Analyses

h. Conceptual Design of Repairs

The work performed as part of these tasks is described in the following sections.

5. Review of Available Information

5.1. General

As part of the facilities assessment (Phase 1) project, Stantec reviewed documents provided by TVA pertaining to the waste disposal area. The Phase 1 Coal Combustion Product Facility Summary is included in Appendix A.

5.2. Reviewed Documents

Below is a summary of the documents reviewed for the geotechnical exploration.

Table 1. List of Documents Reviewed for Geotechnical Exploration

Reference No.	Document Name	Type of Document	Dated	Agency	TVA Reference No.
1	Ash Dike Raising, Borrow Areas B & D	Memo	June 16, 1981	TVA	CDB 81 0619 005
2	Ash Pond Pressure Grouting Records	Grouting Records	3/1991 – 8/1991	TVA	N/A
3	Ash Pond Dikes - Chronological Events	Memo	January 17, 1992	TVA	N/A
4	Operations Manual	Manual	September, 2003	TVA	IDL811020082
5	Wastewater Flow Schematic – NPDES Permit No. TN0005789	Schematic	May, 2005	TVA	N/A
6	2009 Annual Inspection of Waste Disposal Areas	Report	February 11, 2009	TVA	N/A
7	Reports of Annual Waste Area Inspections	Reports	1972 - 2008	TVA	Various

Selected historical documents were presented in the Draft Report of Geotechnical Exploration for the Dry Fly Ash Stack and the Gypsum Disposal Complex. They are not included with this report. A short summary of each item in Table 1 appears below.

Item No. 1 Ash Dike Raising, Borrow Areas B & D – This memo from the chief of the Construction Services Branch reports borrow area soil boring and laboratory soil testing results for soil used in raising the original perimeter dike of the ash disposal area.

Item No. 2 Ash Pond Pressure Grouting Records – Daily records of the pressure grouting of over 5,000 feet of the foundation of the ash pond dike in 1991.

Item No. 3 Ash Pond Dikes – Chronological Events – A brief history is given by K.W. Burnett, manager, Civil Section One, Fossil Engineering, of the ash pond dikes from construction in 1969 to the October, 1991 pressure grouting of the dike foundation in a memo to Gary Nuyt.

Item No. 4 Operations Manual, Dry Ash and Gypsum Stacking Facility – The manual contains sections on site information, description of the solid waste, general site preparation, daily operations, surface water management and geologic buffer system. It also contains sections on the gas control system, groundwater monitoring, environmental protection, closure and post closure and quality assurance/quality control. Appendices contain specifications, calculations, studies, regulations, policies, and miscellaneous information.

Item No. 5 Wastewater Flow Schematic for NPDES Permit No. TN0-005789 – This one-page schematic flow diagram shows amounts and sources of drainage and process water flows in millions of gallons per day. The schematic shows intake of 2096.877 MGD gallons with 2097.062 MGD flowing out to the Cumberland River.

Item No. 6 2009 Annual Inspection of Waste Disposal Areas – Prepared by Stantec, the report contains the results of an annual inspection of the waste disposal areas at Cumberland Fossil Plant. The pages contain descriptions, observations and recommendations for the Coal Yard Drainage Basin, Chemical Treatment Pond, Active Ash Pond, Dry Ash Stack, Wet Gypsum Stacking Area and the slough beside Highway 233, including associated ditches, dikes, roads and effluent points.

Item No. 7 Reports of Annual Waste Area Inspections, 1972-2008 – These annual reports were prepared by various persons within TVA. The reports contain the results of an annual inspection of the waste disposal areas (as they existed at the time of the inspection) at Cumberland Fossil (or Steam) Plant. Also included are the 2007 (performed 2006) Annual Ash Pond Dike Stability Report and Quarterly Red Water Seep Inspections as well as the 2008 (performed 2007) Quarterly Red Water Seep Inspections. A copy of the Dredge Report for the Coal Yard Runoff Pond is also included in the binder.

First noted in 1974, there was a seep that was present through the dike in the area that is now the ash pond. According to the 1974 annual report, in February of the same year the seep appeared at the location of the “northernmost dike crossing of the abandoned Wells Creek channel.” A repair was affected immediately by placing a 40-foot wide clay seal on the interior of the dike. The area was monitored specifically for a period of 4 years and is now monitored during the course of the annual inspections. No additional incidence of seepage in this area has been recorded.

5.3. Design Drawings

A set of reduced-sized drawings approved as part of TDEC permit No. IDL 811020082 was obtained from TVA. The drawings for the FGD Retrofit Project for Units 1 and 2 were originally produced by United Engineers and Constructors. They were issued for permit on August 20, 1993 and updated December 21, 1993, according to the title block. Other markings on the first sheet of the drawings indicate a modification to the permit dated July 11,1994.

The set contains Drawing Nos. 10W302-1 through 10W302-27 and shows 8 stages of construction progressing towards the waste disposal area configuration present today. The drawings also show the construction of the Retention Pond out of Area 2 with no modification of the Stilling Pond, which has remained unchanged.

Copies of a few of the original construction drawings of the waste disposal area were found with miscellaneous memorandums and with a few of the annual reports. Sheets 10N212 through -214, 10N218, 10N224 and 10N225 were used to show particular aspects of the facilities. No drawings marked “As-Built” or similar were found.

6. Site Geology

6.1. General

The Physiographic Regions of Tennessee Map (Tennessee Department of Environment and Conservation (TDEC)) indicates that the project site is located in the Western Highland Rim of Middle Tennessee. Underlying bedrock of the region is chiefly Mississippian limestone, chert, shale, and sandstone with exposures of Devonian, Silurian, Ordovician, and Cambrian limestone, chert, and shale. In the northern part of the Western Highland Rim, caves and other karst features may be present. The ground surface elevation in the vicinity of the project ranges from approximately 360 feet to 650 feet above mean sea level.

The Generalized Geologic Map of Tennessee (Tennessee Department of Environment and Conservation, 2009) indicates that the areas surrounding the project site are underlain by rock of Mississippian age. In the immediate vicinity of the project site, rock of Ordovician age predominates.

6.2. Soils

The soil survey (Web Soil Survey of Stewart County, Tennessee, United States Department of Agriculture (USDA), 2009) indicates that the soils surrounding the Cumberland Fossil Plant are Silt-Loams or Silty Clay-Loams of the Nolen, Sengtown, Bodine, Egam, Maury, Lindside, Melvinville, Byler and Wolftever Associations. These soils are described as moderately deep to deep, moderately well to well drained, moderately sloped soils that formed from the weathering of interbedded sedimentary rock. These soils generally range from silt loam to clay loam in texture. Typical USCS soil classifications of these soil types are CL, CL-ML, SM, GC and GM.

6.3. Bedrock Geology

The Cumberland Fossil Plant is underlain by bedrock primarily of Ordovician age, with smaller amounts of Silurian and Devonian aged rock. The plant is situated in an ancient meteorite impact crater just north of the impact zone. This event has produced a large variation in the contour of the bedrock below the facility as well as several mapped faults (Shown in Figure 4).

According to the Geologic Map of the Cumberland City Quadrangle (USGS 1968, revised 1986), the complex site is predominantly underlain by bedrock belonging to the Mannie Shale, Fernvale Limestone, Hermitage, Carters, Lebanon, Ridley, Pierce and Murfreesboro Limestone Formations, in general order of descending lithology. Each of these formations is of Ordovician age and is comprised of limestones which may be described as thin to thick bedded, greenish-gray to gray, coarse to crystalline grained, argillaceous and hard. The Hermitage Formation also contains thin bedded to laminated gray sandy shale and the Mannie Shale Formation contains shale and limestone interbedded.

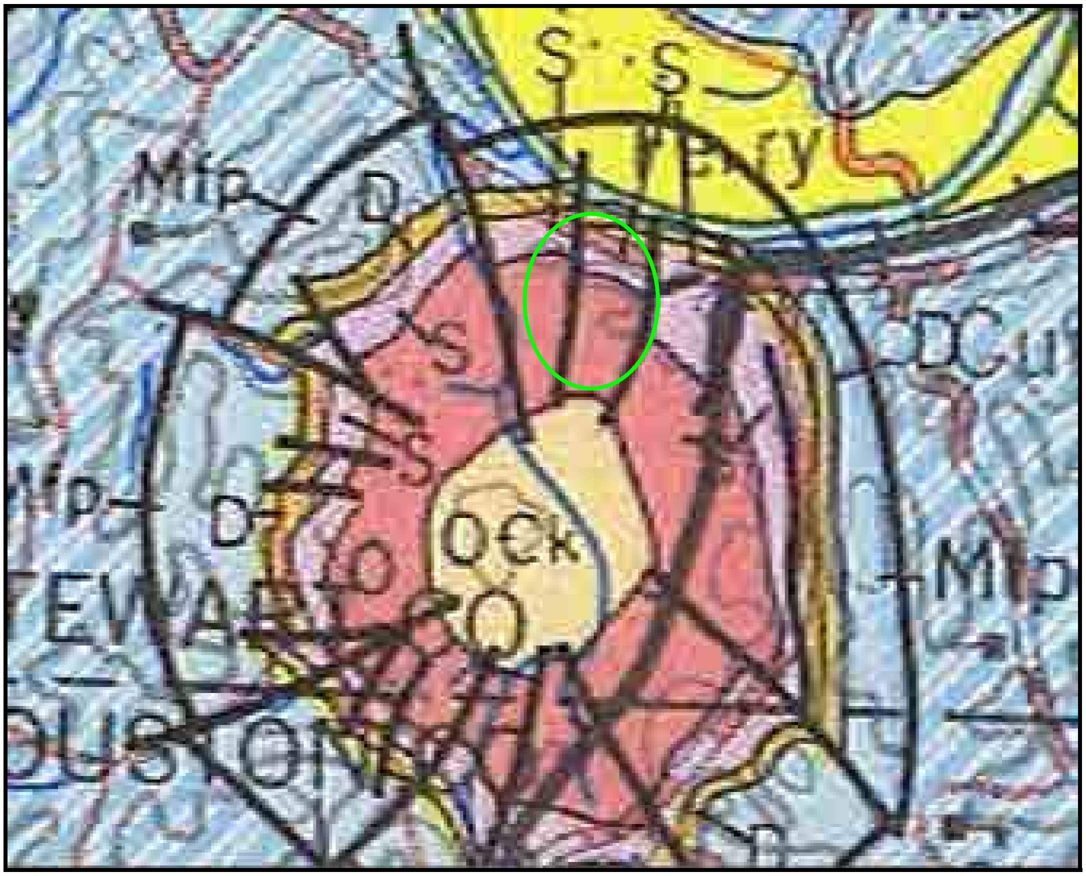


Figure 4. Portion of Geologic Map With Approximate Location of Cumberland Fossil Plant Indicated (USGS Geologic Map of the Cumberland City Quadrangle (1966, revised 1986).

6.4. Hydrology and Hydrogeology

Surface water migrates along natural drainage swales and diversions along local hillsides. The Cumberland River and Wells Creek, which bound the project area, together with their respective tributaries collect the surface water and drain the groundwater from this area. These rivers flow generally northward and are part of the Lake Barkley watershed.

Groundwater migrates through both primary and secondary porosity at the site. Groundwater seeps into the alluvium, residual soils and/or unconsolidated material within the project area. Some of that water migrates along the top of bedrock, saturating the interface between the top of bedrock and unconsolidated material, until the groundwater seeps into the bedrock or finds a fracture or joint to follow. Below top of bedrock, the water migrates through the fractures, joints, bedding planes and other voids in the bedrock. The groundwater eventually intercepts the existing groundwater in the area and/or eventually flows to the surface at a lower elevation.

7. Subsurface Exploration

7.1. General

Stantec performed the fieldwork for the geotechnical exploration from July 21 through August 14, 2009. The exploration consisted of test borings, sampling, rock coring, instrumentation and backfilling. The work was performed around and on the Retention Pond and Stilling Basin dikes. Stantec drilled 30 soil test borings mainly on top and along the downstream toe of the pond dikes. The locations were chosen by Stantec to be along pre-determined cross-section alignments. The boring locations were surveyed by TVA after drilling. The locations are shown on the boring layout in Appendix B.

The borings were drilled using both 3¼- and 4¼-inch inside diameter hollow-stemmed augers powered by a truck-mounted drill rig or an ATV-mounted drill rig.

In the soil test borings, continuous standard penetration tests (SPT's) were performed in accordance with ASTM D1586 until original (foundation) soils were encountered, after which SPTs were continued at 2.5-foot intervals. The results of SPT testing are presented on the boring logs included in Appendix C.

After soil borings with SPT samples were drilled and an understanding of the subsurface profile at a particular location was obtained, offset borings were advanced, if required. The offset borings were used to obtain undisturbed, thin-walled (Shelby) tube samples in particular materials at specific depths. Thin-walled (Shelby) tube samples were obtained in accordance with ASTM D 1587. Sample depths and percent of recovery are presented on the boring logs.

In addition to the samples described above, disturbed bag samples of soils, typically consisting of auger cuttings obtained from the borehole during the drilling process, were also taken for laboratory testing.

A Stantec geotechnical engineer or geologist directed the drill crews, logged the subsurface materials encountered during the exploration and collected soil samples. During field logging particular attention was given to the material's color, texture, moisture content and consistency or relative density.

Rock coring was performed in selected borings using NQ2-size (2-inch diameter) wire-line coring equipment. Core runs began at top of weathered rock and were either 5 or 10 feet in length. Upon retrieval, the core was extracted and sequentially placed in a core storage box and labeled.

The onsite representative then logged the core noting its physical appearance, integrity and bedding characteristics. The amount of core recovered from the operation was also noted and expressed in the log as a percentage recovered. The Rock Quality Designation (RQD) value, a simple, quantitative indication of rock competency, was determined for each coring run by adding the length of all naturally occurring pieces in a run greater than 4 inches and dividing by the length of the total run. The resultant is expressed as a percentage.

Upon completion of drilling, the boreholes without instrumentation were backfilled using a mixture of Portland cement and bentonite clay. Boreholes with piezometers received a quartz sand filter pack around the piezometer, a bentonite seal above the sand then backfill with the cement and bentonite mixture. Boreholes with slope inclinometers were backfilled with high-solids cement-bentonite grout placed by tremie pipe to displace cuttings and drilling fluid. Soil auger cuttings were disposed of by plant personnel.

Following the field exploration, the SPT samples, Shelby tubes and bag samples were transported to Stantec's (or approved vendor's) laboratory for testing. The remnant samples will be available for review up to thirty (30) days following testing and the submittal of the final version of this report, at which time the samples will be discarded unless prior arrangements have been made with Stantec.

7.2. Summary of Borings

A boring layout drawing is presented on a drawing included in Appendix B. Typed boring logs are presented in Appendix C. A summary of boring information is presented in Table 2, where all measurements are expressed in feet.

Table 2. Summary of Borings

Boring No.(1)	Top of Hole (Elevation)	Northing(2)	Easting(2)	Bottom of Hole (Feet)	Bottom of Hole (Elevation)
STN-47	380.0	732324.14	1509428.51	40.5	339.5
STN-48	395.0	732333.24	1509489.49	55	340
STN-48 A	395.0	732333.24	1509489.49	15	380
STN-49	379.2	732928.84	1509696.68	64.1	315.1
STN-50	394.5	732872.44	1509725.55	38	356.5
STN-50 A	394.5	732869.56	1509722.77	91	303.5
STN-50 B	394.5	732875.32	1509728.33	39	355.5
STN-51	378.8	733191.78	1510006.75	66.5	312.3
STN-52	394.9	733149.40	1510045.62	84	310.9
STN-52 A	394.9	733149.4	1510045.62	10	384.9
STN-53	376.0	733453.67	1510310.59	27	349
STN-53 A	376.0	733456.66	1510307.93	96	280
STN-53 B	376.0	733450.68	1510313.25	43	333
STN-54	395.0	733419.93	1510374.67	100.3	294.7
STN-54 A	395.0	733417.3	1510371.66	52.5	342.5
STN-55	379.5	733614.54	1510849.80	75	304.5
STN-56	395.0	733560.12	1510902.86	76.2	318.8
STN-56 A	395.0	733560.12	1510902.86	10	385
STN-57	381.5	733365.74	1511360.12	56.5	325
STN-57 A	381.5	733368.89	1511362.59	21	360.5
STN-57 B	381.5	733365.74	1511360.12	66.5	315
STN-58	395.0	733305.89	1511314.36	62.9	332.1
STN-58 A	394.8	733308.7	1511311.51	47	347.8
STN-59	383.0	732780.76	1511517.22	35	348
STN-59 A	383.0	732780.76	1511517.22	38	345
STN-59 B	383.0	732780.76	1511517.22	46.3	336.7
STN-60	395.1	732791.74	1511426.11	43.6	351.5
STN-61	387.2	732271.84	1511477.99	22.5	364.7
STN-62	394.8	732274.04	1511365.06	32	362.8
STN-62 A	394.8	732274.04	1511365.06	10	384.8

7.3. Subsurface Soil Conditions

Eleven primary soil horizons have been identified using soil boring results and available historical documents from TVA archives. Below are brief descriptions of the horizons. Two-letter classification codes (CL, SM, SP, etc.) in the descriptions refer to the Unified Soil Classification System (USCS).

Coal Combustion Products:

- Fly Ash – Classifies as silt (ML) or silt with sand/silty sand. Light gray to black or gray brown, silt to clay-sized grains, dry to wet, soft to very stiff. Lenses of bottom ash or lean clay may be present.

    - Fly Ash (Sluiced) or Fly Ash/Bottom Ash (Sluiced) – Saturated fly ash, bottom ash, or a laminated zone of both that is wet to saturated, hydraulically placed, very soft to medium stiff. Fly ash alone classifies as silt (ML). The fly ash/bottom ash (sluiced) was visually classified as silty sand with gravel (SP), silty sand (SM), and sandy lean clay (CL). For purposes of slope stability analyses, a distinction was not drawn between sluiced fly ash and a combination material of sluiced fly ash and bottom ash. Definite zones were unclear. Sluiced fly ash properties were conservatively assumed for both materials. This material was not encountered during the field exploration of this project. The presence of this material was inferred due to the purpose of the pond.

- Bottom Ash – Segregated and placed bottom ash. Classifies as a silty sand with gravel (SP) or silty sand (SM). Dark gray to black, coarse grained, damp to wet, very loose to very dense with occasional interbedded layers of fly ash and clay. Medium sand to gravel-sized grains with some fines. This material may be present on the site as a construction material, however it was not encountered in any of Stantec's borings during this exploration.

Natural Soils Used In Dike Construction:

- Dike 1 – The original perimeter dike. A lean clay (CL), red brown to gray brown, moist to wet, very soft to very stiff. Occasional gray mottling, with areas of sand or gravel, chert fragments, few organics and manganese concretions. Approximate top of dike elevation is 380 feet. In a limited area, the material was classified as a fat clay (CH).

  Stantec identified this zone in most borings surrounding the Retention and Stilling Ponds just above natural ground.

- Dike 2 – The raised dike uphill of the original perimeter dike. It has a crushed stone covered crest between 0.5 and 1.0 feet deep. Dike 2 was identified by Stantec along the outside perimeter of the Retention and Stilling Ponds. It is not found in the divider dike between the Dry Fly Ash Stack and Retention Pond. The approximate top of dike elevation is 395 feet. The raised dike has two distinct soil horizons:

    - Dike 2 (Lean Clay) – Lean clay (CL) to lean clay with gravel, some cobbles, light brown to brown, some gray mottling, moist to wet, soft to very stiff.

  - Dike 2 (Fat Clay) – Fat clay (CH) to fat clay with gravel, dark brown to reddish brown, damp to wet, firm to very stiff. This layer is typically near the top of Dike 2 or may compose the complete Dike 2 zone.

Natural Foundation Soils:

- Alluvial (Clay) – Lean clay (CL), silty grading to sandy, manganese concretions, reddish brown to light gray, some gray mottling, soft to very stiff, moist to wet, with rock fragments. Few organics and wood fragments, but typically has a faint organic odor near the suspected natural ground interface.

- Alluvial (Granular) – Varying between silty sand with gravel (SM), yellowish brown to light gray, moist to wet, very loose to compact, medium to coarse grained, poorly sorted with increasing gravel size and gravel with clay to silt and sand (GP-GC or GM), gray, wet, angular, loose to very dense. Some wood fragments with a slight organic odor near the suspected natural ground interface.

Bedrock:

- Interbedded Limestone and Shale – Limestone is light gray, hard, and thick bedded. Shale is light gray, calcareous, moderately hard and laminated. Core recovery ranged from 94 to 100 percent. RQD ranged from 56 to 100 percent. When core was obtained, limestone comprised approximately 50 to 90 percent of the recovery.

7.4. Subsurface Water

Subsurface water was encountered in most of the borings advanced during this exploration. A water level reading was taken after the boring had been drilled but before the installation of instrumentation. Typically, subsurface water was not found in borings advanced purposely to a shallow depth to obtain undisturbed samples. The depths to water noted immediately after drilling are shown on the boring logs presented in Appendix C. Additional water level readings were and are being obtained from piezometers installed in some of the borings, as discussed in the following section of this report.

8. Field Instrumentation and Monitoring

8.1. General

Stantec's exploration included the installation and monitoring of geotechnical instrumentation. Piezometers and slope inclinometer casings were installed in some of the boreholes to provide data relative to existing conditions and to provide a baseline for future monitoring efforts. Initial or baseline readings preceded a regular and ongoing instrumentation monitoring program.

8.2. Instrumentation

Two types of instruments were installed as part of the geotechnical exploration. These include standpipe piezometers (PZ) and slope inclinometer (SI) casings.

Standpipe piezometers, installed in a borehole, consist of a screened interval of pipe (generally 10-ft) joined to a 1-inch diameter riser pipe. The screened interval was placed in a sand pack and a bentonite seal was placed above the sand to isolate the target pore water pressure reading zone. The annular space between the riser pipe and the borehole was backfilled to the surface with bentonite grout to prevent vertical migration of water. The riser pipe was terminated above ground and protected with either a lockable metal cover or a flush-mounted 6" diameter manhole.

Slope inclinometer casings consist of 2.75-inch outside diameter PVC casing with interior vertical grooves also installed in a borehole. The annular space between the casing and borehole was backfilled to the surface with cement-bentonite grout. The casing was terminated above ground and protected with either a lockable metal cover or a flush-mounted 6" diameter manhole. Lockable covers used in typical installation are shown in Figure 5. Table 3 provides a summary of the instruments installed. Appendix D presents the PZ and SI instrumentation logs.

Figure 5. Typical Instrumentation (Slope Inclinometers, Piezometers) Installation

Table 3. Summary of Instrumentation

Boring No.	Instrument	Surface Elevation	Tip Elevation
STN-49	PZ	379.18	322.2
STN-50A	SI	394.47	309.5
STN-50B	PZ	394.47	355.5
STN-53A	PZ	376.01	311.0
STN-53B	PZ	376.01	333.0
STN-54	SI	394.95	295.0
STN-54A	PZ	394.95	344.0
STN-57A	PZ	381.52	361.5
STN-58	SI	394.79	333.3
STN-58A	PZ	394.79	349.3

8.3. Monitoring of Dike Slope Conditions

Stantec is monitoring the instruments installed during the exploration. Water level readings (from PZs) and slope movement data (from SIs) are obtained on a monthly basis and the results to date are included in Appendix E. PZ readings are taken using a water level indicator and SI readings are obtained using a portable traversing inclinometer designed for this purpose. The first SI survey established the initial profile of the casing and subsequent surveys measure changes in the profile of the casing if movement of the slope has occurred.

Instrumentation readings are currently obtained on a monthly schedule. Future reading schedules may be modified in response to detection of any significant variation in readings. Depending on factors such as the magnitude, location and circumstances of the reading variation, the schedule may be adjusted to read the instruments more often, say, weekly or daily.

Generally, water levels across the site have fallen nearly one foot since the initial readings and varied by just a few tenths of a foot between monthly readings. The piezometers on the west side of the Retention Pond (PZ-49 and PZ-50) show water levels approximately 10 to 12 feet below the ground surface. The water levels of the remaining instruments around the ponds show water levels varying between 13 to 20 feet below the ground surface.

Slope Inclinometers have been installed around the perimeter of the site and are being monitored for slope movement. No significant lateral movements have been detected to date.

9. Surveying

9.1. General

Topographic mapping of the disposal facility was developed from aerial photography provided by TVA. Contour mapping of the bottom of the stilling and retention ponds was developed from a hydrographic field survey, also provided by TVA.

9.2. Aerial Survey

Topographic mapping and aerial photogrammetry were created by Tuck Mapping Solutions Inc., Big Stone Gap, Virginia. The project site was flown April 17, 2009. The base mapping was completed May 19, 2009. Horizontal datum is NAD27 and vertical datum is NGVD29. The coordinate system is Tennessee State Plane and the contour interval of the mapping is one foot. The limits of the topographic mapping as well as control points referenced to the State Plane Coordinates system were established by TVA. The results of aerial survey can be seen on the boring layout presented in Appendix B.

9.3. Topographic Survey

Topographic surveying was performed by TVA to locate the soil borings. Field cross sections were also taken to provide a check on the aerial mapping.

9.4. Hydrographic Survey

TVA performed a hydrographic survey of the retention and stilling ponds in September of 2008. The results (contour lines) of the hydrographic survey of the ponds are shown on the boring layout Appendix B.

10. Laboratory Testing

10.1. General

Soil and rock samples from the field exploration were returned to a Stantec (or certified vendor's) materials laboratory for inventory and testing. The laboratory tests were performed in accordance with ASTM standard testing procedures. Detailed results of laboratory testing are presented in Appendix F.

10.2. Laboratory Tests Performed

Each soil sample was visually classified and tested for natural moisture content. Engineering classification tests were performed on samples reflecting the main soil horizons. The represented horizons are: "raised" dike, "original" dike and foundation soils. A summary of laboratory tests and the corresponding testing standard are presented in Table 4. Not all tests were performed on all samples.

Table 4. Laboratory Tests

Test	Standard
Natural Moisture Content	ASTM D 2216
Particle Size Analysis	ASTM D 422
Dry Density	ASTM D 2166
Shear Strength	ASTM D 4767
Permeability	ASTM D 5084
Atterberg Limits	ASTM D 4318
Specific Gravity	ASTM D 422
Particle Size Analysis	ASTM D 854
Standard Proctor	ASTM D 698

10.3. Natural Moisture Content

Natural moisture content tests were performed on all SPT, bag and Shelby tube samples. The results of moisture content determinations are presented in Appendix F.

10.4. Particle Size Analyses, Atterberg Limits and Specific Gravity, Classification

Particle size analyses and Atterberg limits tests were performed on 7 samples of Dike 2, 7 of Dike 1, 6 samples of Alluvial Granular and 4 samples of Alluvial Clay.

Many of the test samples were composite SPT samples. Composite SPT samples consist of materials from different depths but of the same material, as determined through visual classification.

The particle size analyses were performed in accordance with ASTM D-422, “Particle Size Analysis of Soils,” using sieve analysis for the soil fraction greater than 0.074mm (No. 200 sieve size) and hydrometer analysis for the fraction smaller than 0.074mm. The individual grain size distribution curves generated from these tests are presented in Appendix F.

Atterberg limits tests were conducted in accordance with ASTM D 4318 Method A. The liquid limit, plastic limit and plasticity index are reported in Appendix F. The samples were also tested for specific gravity in accordance with ASTM D 854. The results of particle size analyses and Atterberg limits tests were used to classify the soil samples.

The samples were classified in accordance with the Unified Soil Classification Soil System (USCS) and the American Association of State Highway and Transportation Officials (AASHTO) method. The results of the classification testing are contained in Appendix F. Table 5 summarizes the classification testing results.

Table 5. Summary of Classification Testing Results

Material Type		w_0 (%)	G_s	LL	PL	PI	Gravel *(3"- 4.75 mm) (>No. 4)*	Sand *(4.75-2 mm) (No. 4-No. 200)*	Silt *(0.075-0.005 mm) (<No. 200)*	Clay *(<0.005 mm)*	USCS
Dike 1	*max*	43.5	2.70	72	27	47	23	29	46	65	CH
	min	18.8	2.65	34	17	13	1	9	13	28	CL
	average	26.8	2.67	49	21	28	9	18	33	40	CL-CH
Dike 2	*max*	29.3	2.76	68	23	45	44	32	37	57	CH
	min	20.9	2.68	46	16	29	0	18	11	21	CL
	average	22.9	2.71	55	19	36	11	26	23	40	CH-CL
Alluvial Clay	*max*	29.7	2.71	68	23	45	13	20	65	62	CH
	min	22.8	2.62	30	16	10	0	7	26	27	CL
	average	26.3	2.67	48	19	29	4	11	41	44	CL
Alluvial Granular	*max*	37.4	2.73	68	36	34	59	49	27	28	GP
	min	21.5	2.65	41	23	13	18	18	7	5	SM
	average	28.9	2.68	53	28	25	35	31	15	18	GP-GM

10.5. Unit Weight and Moisture-Density (Proctor) Testing

Once the Shelby tube samples were extruded, suitable portions representative of selected soil horizons were trimmed for testing. The natural moisture content and both the unit weight wet and unit weight dry was determined for each sample. The test results are presented in

Appendix F. Table 6 summarizes the unit weight test results. Also shown in Table 6 are the results of moisture-density (Standard Proctor) tests performed on samples of dike and borrow area materials. Three samples of dike material and one borrow area sample were tested in accordance with ASTM D 698, Method ‘A’.

Table 6. Summary of Unit Weight Test Results

Boring Location	Sample Depth Interval (feet)	Material	Unit Weight Dry (pcf)	Moisture Content (%)	Maximum Dry Density (pcf)	Percent Maximum Dry Density (%)	Optimum Moisture Content (%)	Moisture Content Variation (%)
STN-50B	15.6-16.3	Dike 2 (Lean)	91.9	25	105.6	87	18.9	+6.1
STN-50B	16.3-16.9	Dike 2 (Lean)	95.4	31	105.6	90	18.9	+12.1
STN-53A	43.0-43.8	Alluvial (Clay)	93.5	26	--	--	--	--
STN-53A	43.8-44.4	Alluvial (Clay)	98.7	26	--	--	--	--
STN-53A	44.4-45.0	Alluvial (Clay)	98.9	24	--	--	--	--
STN-54A	6.6-7.2	Dike 2 (Fat)	90.7	27	103.1	88	20.2	+6.8
STN-54A	7.3-8.0	Dike 2 (Fat)	105.3	21	103.1	102	20.2	+0.8
STN-54A	8.4-8.9	Dike 2 (Fat)	101.5	22	103.1	98	20.2	+1.8
STN-54A	30.0-30.6	Dike 2 (Lean)	97.8	26	102.1	96	21.9	+4.1
STN-54A	30.6-31.8	Dike 2 (Lean)	110	20	102.1	108	21.9	-1.9
STN-54A	45.2-45.8	Alluvial (Clay)	99.2	25	--	--	--	--
STN-54A	45.8-46.4	Alluvial (Clay)	102.6	24	--	--	--	--
STN-54A	46.3-47.0	Alluvial (Clay)	101.7	24	--	--	--	--
STN-57A	5.3-5.8	Dike 1 (Lean)	92.9	29	--	--	--	--
STN-58A	25.4-26.0	Dike 1 (Lean)	92.13	28	--	--	--	--
STN-58A	25.4-26.0	Dike 1 (Lean)	98.88	26	--	--	--	--
STN-58A	26.0-26.5	Dike 1 (Lean)	93	27	--	--	--	--
STN-58A	26.5-27	Dike 1 (Lean)	98.2	28	--	--	--	--
STN-58A	35.3-35.8	Alluvial (Clay)	71.4	60	--	--	--	--
STN-58A	35.8-36.4	Alluvial (Clay)	80.1	40	--	--	--	--
STN-58A	36.4-37.0	Alluvial (Clay)	87.5	30	--	--	--	--
STN-58A	46.5-47.0	Alluvial (Clay)	59.6	69	--	--	--	--

-- Proctor test not conducted on this material

The in-situ unit weights were compared to the unit weights of the Shelby tube samples that were obtained in the same vicinity from where the proctor samples were taken. In Dike 2, the unit weights of the samples ranged from as low as 87 percent to as high as 108 percent of maximum standard proctor. It should be noted that the proctor unit weights are lower than expected due to using test method A to conduct the proctor tests. Test method A excludes the gravel fraction for the compacted specimen. According to the US Army Corps of Engineers, soil placed for dams and levees should be compacted to at least 95 percent standard proctor (EM 1110-2-1911, Chapter 5).

10.6. Shear Strength Testing

Consolidated undrained triaxial compression tests were performed on the trimmed samples. All shear strength tests were conducted in accordance with ASTM D 4767. The test results are presented in Appendix F. Table 7 summarizes the consolidated undrained triaxial compression test results.

Table 7. Summary of Consolidated Undrained Triaxial Testing

Boring	Depth (ft)	Material Type	γ_{w0} (pcf)	w_0 (%)	c' (psf)	ϕ' (deg)
STN-54A	30.6-31.2	Dike 2 (Lean Clay)	132.3	20.3	220.3	32.1
STN-54A	31.2-31.8		130.6	19.4		
STN-58A	26.0-26.5	Dike 1 (Lean Clay)	117.8	27.9	220.3	22.3
STN-58A	26.5-27.0		124.3	25.7		
STN-54A	45.2-45.8	Alluvial Clay	124.9	24.9	220.3	33.3
STN-54A	45.8-46.4		125.8	23.2		
Dike 2 (Lean Clay) Bulk (STN-48A)			121.2	21.0	220.3	29.5
			120.9	20.9		
			121.0	20.6		
Dike 2 (Lean Clay) Bulk (STN-52A)			119.7	23.6	97.2	29.8
			119.1	23.4		
			119.3	23.4		
Dike 2 (Fat Clay) Bulk (STN-58)			120.3	23.5	254.9	29.4
			121.9	23.4		
			122.0	23.6		

10.7. Permeability Testing

Falling Head Permeability (FHP) tests were performed on additional trimmed samples. All permeability tests were conducted in accordance with ASTM D 5084. The test results are presented in Appendix F. Table 8 summarizes the permeability test results.

Table 8. Summary of Permeability Testing

Boring	Depth (ft)	Material Type	Permeability (cm/sec)
STN-48A	5-15 (Bulk)	Dike 2 – Lean Clay	2.8e-8
STN-52A	5-10 (Bulk)	Dike 2 – Lean Clay	3.5e-8
STN-54A	30.0-30.6	Dike 2 – Lean Clay	6.5e-8
STN-58	10-20 (Bulk)	Dike 2 – Fat Clay	2.7e-8
STN-48A	26.0-26.5	Dike 1 – Lean Clay	6.3e-8
STN-53A	43.8-43.2	Alluvial Clay	7.4e-8

11. Engineering Analyses

11.1. General

Engineering analyses of the dikes surrounding the Retention and Stilling Ponds consists of examining slope stability and seepage of ground water through in-situ materials. The analyses were performed using available historic information, results of the geotechnical field exploration and the results of the laboratory testing. Multiple cross-sections were analyzed for slope stability and also for seepage.

Cross-section locations and extents to use for analyses were chosen according to several factors. The cross-sections were selected because they are representative of the facilities as a whole, are along the most critical slopes and are at regular intervals along the dike alignment. The cross-sections are named using letters ‘P’ through ‘W’. Figure 6 shows the cross-section locations and orientations for the project area.

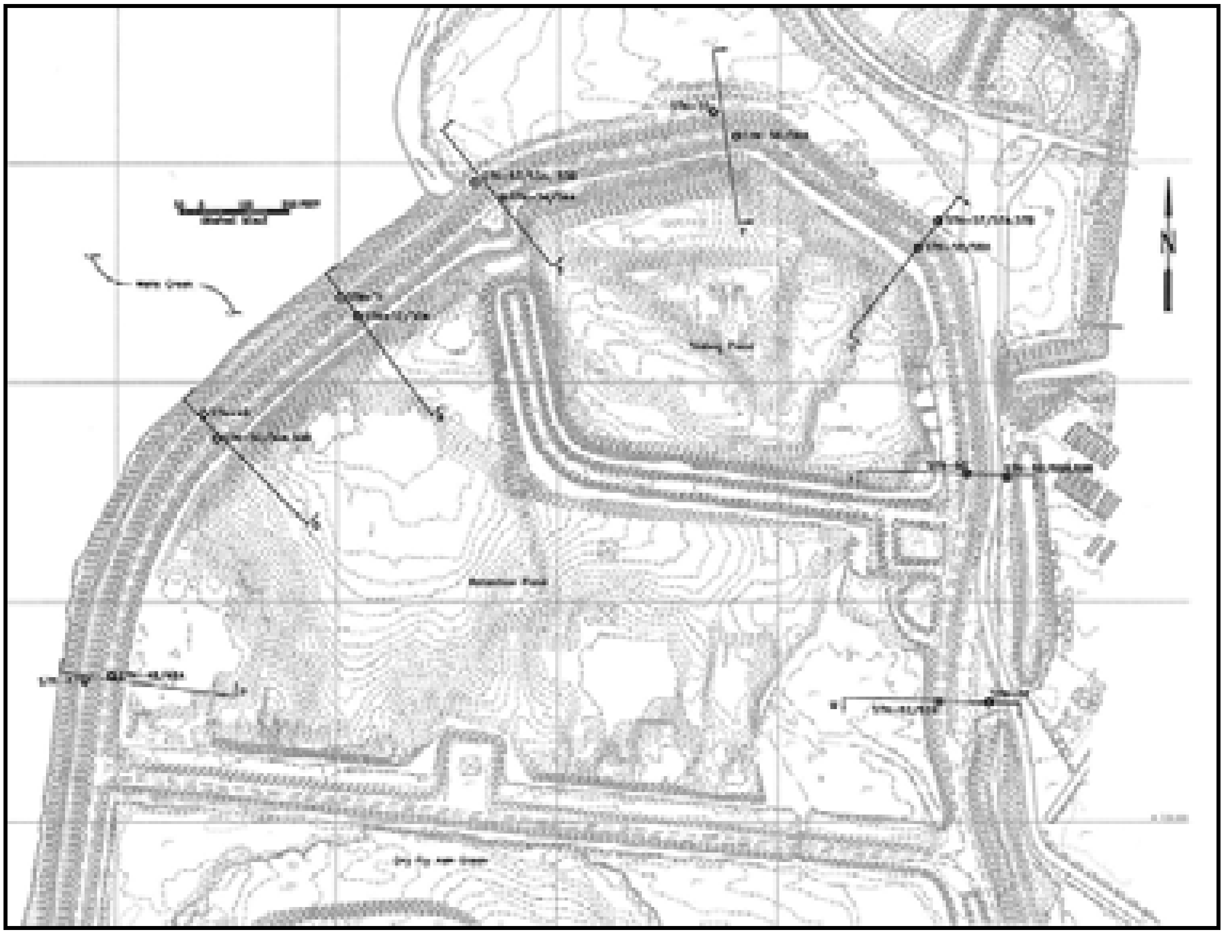


Figure 6. Plan View of the Retention and Stilling Ponds with the Locations of the Stability Cross-Sections Indicated.

11.2. Seepage Analysis

11.2.1. Background

The objective of this seepage analysis was to estimate the magnitude of seepage gradients (for the evaluation of potential piping) and pore water pressures within the soils (for the evaluation of slope stability). Seepage was examined in terms of total head (and pore water pressure) distribution within a given cross section of the dike assuming steady-state seepage conditions were achieved.

The numerical seepage models were developed using SEEP/W 2007 (Version 7.14), a finite element code tailored for modeling groundwater seepage in soil and rock. SEEP/W is distributed by GEO-SLOPE International, Ltd, of Calgary, Alberta, Canada (www.geo-slope.com). SEEP/W uses soil properties, geometry, and boundary conditions provided by the user to compute the total hydraulic head at nodal points within the modeled cross-sections. Among other features, SEEP/W includes a graphical user interface, semi-automated mesh generation routines, iterative algorithms for solving unconfined flow problems, specialized boundary conditions (seepage faces, etc.), capabilities for steady-state or transient analyses, and features for visualizing model predictions. The code also includes material models that allow tracking both saturated and unsaturated flow, including the transition in seepage characteristics for soils that become saturated or unsaturated during the problem simulation.

11.2.2. Boundary Conditions

Boundary conditions for the SEEP/W analysis were assumed as follows. Steady-state seepage was assumed for the analysis, with the static pool levels placed at approximate El. 384.23 feet for the Retention and Stilling Ponds. For the left side of Sections P through U, the pool level for Wells Creek/Cumberland River was set at El. 359.5 feet. For Sections V and W the outer boundary condition was assumed to be the invert of a surface ditch that leads to the outlet channel. This elevation was determined to be approximately El. 375 feet. Along the vertical, interior edge of the model, the hydraulic head at each node was constant with depth and equal to the pool elevations of the ash ponds (El. 384.23 feet). A total head equal to the pool levels was also applied to all submerged nodes along the ground surface of the interior side. Other nodes along the ground surface were treated as potential seepage exits. At various steps in the computer analysis, if the software determines that water flows from the mesh at these nodes along the ground surface, SEEP/W assigned a head equal to the elevation of the node. This routine effectively models the seepage exit to the ground surface. The horizontal boundary at the base of the model (located within the bedrock) was modeled as a seepage barrier, with no vertical flow across the boundary nodes. Steady state seepage was assumed for the analysis.

11.2.3. Seepage Properties

For each modeled cross-section, a representative subsurface profile was compiled based on boring logs, known project history and available historical mapping. Material properties were estimated based on available laboratory data, correlations with classification data, and on typical values for similar materials. In some cases, the laboratory data used referenced previous work that Stantec had completed around the coal combustion products disposal facility. Material properties used in the seepage analysis are summarized in Table 9.

Table 9. Material Properties for SEEP/W Analysis

Soil Horizon	Saturated k_v (cm/s)	Ratio k_h / k_v	Specific Gravity G_s	Void Ratio e	Volumetric Water Content		Basis
					Residual	Saturated	
Clay Dike 1 - Lean Clay	6.50E-07	10	2.67	0.704	0.06	0.413	Available Laboratory Data and Correlation w/ Typical Values
Clay Dike 1 - Fat Clay	2.70E-08	10	2.67	0.709	0.09	0.415	Available Laboratory Data and Correlation w/ Typical Values
Clay Dike 2 - Lean Clay	4.27E-08	10	2.71	0.540	0.08	0.351	Available Laboratory Data and Correlation w/ Typical Values
Clay Dike 2 - Fat Clay	2.70E-08	10	2.71	0.540	0.09	0.351	Available Laboratory Data and Correlation w/ Typical Values
Fly Ash - Sluiced	8.41E-05	50	2.50	0.550	0.015	0.3548	Available Laboratory Data and Correlation w/ Typical Values
Alluvial – Clay	7.41E-08	20	2.67	0.667	0.07	0.401	Available Laboratory Data and Correlation w/ Typical Values
Alluvial – Granular	1.00E-04	20	2.68	0.370	0.02	0.27	Correlation w/ Typical Values
Bedrock	3.05E-11	10	N/A	N/A	0	0.05	Correlation w/ Typical Values

Note: SEEP/W requires input parameters k_h and ratio of k_v/k_h

For this table, the variables referenced are:

- K_v is the vertical hydraulic conductivity,
- K_h is the horizontal hydraulic conductivity,
- G_s is the specific gravity of solids,
- *e* is the void ratio,

Horizontal Hydraulic Conductivity (K_h): The K_h values for the in-situ materials (with the exception of bedrock) were estimated based on permeability test results on Shelby tube samples. Cone Penetrometer Test (CPT) dissipation results from the Dry Fly Ash Stack/Gypsum Disposal Complex report were also used for fly ash. These estimates were compared to typical values from similar TVA projects, similar facility types, and technical literature. A tabular summary of the hydraulic conductivity information is included in Appendix G, Material Property Calculation.

The K_v values for gravel and rip rap were assumed based on typical values. A very low K_v value was assigned to bedrock assuming some fractures would be present in the shale and limestone, allowing minimal flow.

Vertical Hydraulic Conductivity (K_v): The ratio of K_v to K_h was estimated based on permeability test results on Shelby tube samples and CPT dissipation results (fly ash only). These estimates were compared to typical values from similar TVA projects, similar facility types, and technical literature. This ratio was used to calculation the K_v.

Specific Gravity of Solids (G_s): Specific gravity is a dimensionless unit defined as the ratio of density of the material to the density of water.

Saturated Volumetric Water Content: These values were estimated based on general material type using the article, "Estimation of Soil Water Properties" (Rawls et al. 1982).

Residual Water Content: These values of all materials were estimated based on general material type using the article, "Estimation of Soil Water Properties" (Rawls et al. 1982).

Significant engineering judgment is needed to select appropriate hydraulic properties for earth/soil materials. Unlike other key properties, hydraulic conductivity can vary over several orders of magnitude for a range of soils, often with substantial anisotropy for seepage in horizontal versus vertical directions. Laboratory test samples often do not represent important variations within a larger soil deposit. For this analysis, an iterative process of parametric variation was used to arrive at final estimates of the seepage properties. Results from trial simulations were compared to field data (measured piezometric levels) and the material parameters were then varied until the solutions reasonably matched the field data. The final set of parameters are presented in Table 9.

The ratio of horizontal hydraulic conductivity (kh) to vertical hydraulic conductivity (kv) was estimated based on placement, depositional characteristics, and origin of the materials. An isotropic material would have kh/kv = 1, while deposits of horizontally layered soils will have much higher values. For this analysis, higher ranges of ratios were used for sluiced ash and native materials, whereas a lower range of ratios was assumed for compacted dike materials.

The governing equations in SEEP/W are formulated to consider seepage through unsaturated soils. In the simulations for this study, this formulation is used to locate the phreatic surface for unconfined seepage through the dike cross-sections. To represent the change in hydraulic conductivity due to de-saturation of each soil, SEEP/W implements a model based on two curves, a hydraulic conductivity function and a volumetric water content function. Three parameters are needed to define this behavior: the saturated hydraulic conductivity, saturated water content, and residual water content (water content of air dried soil). Of these, only the residual water contents were not previously estimated for each material. Values were estimated based on typical values for similar soils. The simulation results show very low sensitivity to the selection of these values.

11.2.4. Comparison to Field Observations

After the initial seepage parameters were estimated, results from the SEEP/W model were compared to pore water pressures actually measured in the 7 piezometers installed within the CUF Retention and Stilling pond perimeter dikes. Nodes were placed in the model at the same location as the actual piezometer tips so that the total head predicted at the node could be compared to the corresponding piezometer reading. The material properties in each modeled cross-section were then varied until a reasonable match was obtained between the seepage predictions and field data. Specifically, the saturated hydraulic conductivity and the kh/kv ratios were adjusted (while still maintaining the parameters within expected ranges) to give model predictions as consistent as possible with field measurements and observations.

The comparison between the field piezometer measurements and final SEEP/W predictions show the predicted groundwater table ranging from about 1.5 feet below to 3 feet above the readings obtained in the piezometers. Most differences are between about 1-foot below to 2 feet above the actual readings. In one section (Section U) the SEEP/W results predict water levels to be as much as 10 feet higher that actual piezometer readings. These differences are judged to be acceptable given the limited information available and unknown conditions between the modeled cross-sections and borings. For Section U, it is unknown if the actual stratigraphy differs from how it is currently modeled. In sections P, Q and R, the models indicate some amount of seepage emanating from the toe of Dike 1. This is consistent with historic reports in the area of Section Q, although no seepage has been reported in recent years. In summary, the seepage models appear to give a reasonable prediction of the phreatic surface location when compared to field observations and piezometer measurements.

11.2.5. Critical Exit Gradients

Seepage forces, resulting from hydrodynamic drag on the soil particles, can destabilize earthen structures. Excessive hydraulic gradients near the ground surface can lead to the initiation of soil erosion and piping, which has caused numerous dam failures in the past. Hydraulic gradients (computed where seepage exits at the ground surface) can be evaluated to understand the potential severity of this problem.

Where upward seepage through a uniform soil exits the ground surface, the factor of safety with respect to soil piping (FSpiping) is as defined below.

$$FS_{piping} = \frac{i_{crit}}{i}$$

Eqn. 11.1

Where “i” is the vertical gradient in the soil at the exit point. The critical gradient (icrit) is related to the submerged unit weight of the soil, and can be computed as:

$$i_{crit} = \frac{\gamma_{sub}}{\gamma_w} = \frac{G_s - 1}{1 + e}$$

Eqn. 11.2

where γsub is the submerged unit weight of the soil, γw is the unit weight of water, Gs is the specific gravity of the soil particles, and e is the void ratio. For nearly all soils, the critical gradient is between about 0.6 and 1.4, with a typical value near 1.

When FSpiping = 1, the effective stress is zero and the near-surface soils are subject to piping or heaving, but only for vertical seepage that actually exits to the ground surface. If the phreatic surface is buried, then the FSpiping will be greater than 1 even when i=icrit.

11.2.6. Results of Seepage Analysis

Plots from the SEEP/W analyses of the eight cross-sections through the CUF pond dikes are presented in Appendix H. The plots show the finite element mesh, material zones, and boundary conditions used in each analysis. The results are depicted in contour plots of seepage gradients and include a phreatic line as well.

On each modeled cross-section, examination of the output (predicted phreatic surface and vertical gradients) can be used to search for areas where the potential for excessive vertical gradients might exist that could possibly initiate the erosion or piping of material. In general, areas of potential concern are where water seeps laterally out onto a sloping ground surface, or where vertical, upward seepage occurs at the ground surface. The potential for piping was evaluated using the factor of safety equation as defined in Section 11.2.5. First, contour plots of vertical gradient were examined to determine the general location of the maximum vertical exit gradient. On the modeled cross-sections, the maximum upward gradient occurs near or beyond the exterior toe of the dikes. For the factor of safety calculations, vertical gradients from these locations were then used along with the critical gradients determined from the soil properties.

The calculated factors of safety against piping are summarized in Table 10. They range from 1.3 to 49, with two values being even greater (Sections T and W) because a critical exit point was not predicted by the model. Stantec recommends a target factor of safety against piping of 4, based on information contained in United States Army Corps of Engineers (USACE) manual EM 1110-2-1901. Hence, on five of the eight cross sections modeled, the recommended target factor of safety for piping at the critical seepage exit points is met or exceeded.

Table 10. Summary of Computed Exit Gradients and Minimum Factors of Safety Against Piping

Cross Section*	Vertical Gradient (i_y) at Critical Exit Point	Location of Critical Exit Point	Material	Critical Gradient (i_{crit})	FS_{piping}
P	0.75	Toe of Dike 1	Alluvial Clay	1.00	1.3
Q	0.42	Toe of Dike 1	Alluvial Clay	1.00	2.4
R	0.38	Toe of Dike 1	Alluvial Clay	1.00	2.6
S	0.02	Toe of Dike 2	Dike 1 – Lean Clay	0.98	49.0
T	Critical Exit Location Not Identified	N/A	Dike 1 – Lean Clay	0.98	>4.0
U	0.06	Toe of Dike 2	Dike 1 – Lean Clay	0.98	16.3
V	0.18	Ditch in Dike 1	Dike 1 – Fat Clay	0.97	5.4
W	Critical Exit Location Not Identified	N/A	Dike 1 – Fat Clay	0.97	>4.0

*Refer to Appendix B for locations of cross-sections.

11.2.7. Remedial Improvements

A review of the seepage analysis results indicate less than acceptable factors of safety against piping for Sections P, Q and R. These areas represent the western dike of the Retention Pond. Factors of safey against piping can be improved by the addition of a toe berm or by construction of a barrier wall Alternatives are proposed to increase the resistance to piping to meet USACE design criteria. The conceptual improvements are shown in Appendix B.

To raise the minimum factor of safety to 4.0 or greater, two options were considered and modeled. Option 1 is a seepage berm that extends approximately 40 feet from the toe of Dike 1. Conceptually, the seepage berm would include the installation of a graded filter consisting of sand, bedding stone (TDOT No. 2 stone) and rip-rap (Class A). The seepage berm would be embedded approximately 5 feet into the creek bed and maintain a minimum thickness of 5 feet up the slope to approximately EL. 370 feet. The exit gradient would be significantly reduced, thereby increasing the factor of safety against piping well above the desired minimum of 4.

Option 2 consists of installing a sheet pile cutoff wall through the upstream side of the dikes. As modeled, the sheet piling would be installed to approximate depths of 45 to 55 feet. The sheet piling should be of an interlocking design such as to minimize the flow of water through the joints and of sufficient material thickness to withstand driving through expected subsurface materials. Installed properly, the sheet pile wall would serve to increase the length of the drainage path and thereby reduce the exit gradient.

Seepage analyses were performed on Section P for these repair scenarios and the results are presented in Table 11.

Table 11. Summary of Seepage Analyses – Mitigation Option

Cross Section*	Repair Mitigation Option	Vertical Gradient (i_y) at Critical Exit Point	Location of Critical Exit Point	Material	Critical Gradient (i_{crit})	FS_{piping}
P	Seepage Berm	0.11	Toe of Dike 1	Alluvial Clay	1.00	9.1
P	Cutoff Wall	Critical Exit Location Not Identified	N/A	Alluvial Clay	1.00	>4.0

*Refer to Appendix B for locations of cross-sections.

11.3. Slope Stability Analysis

11.3.1. SLOPE/W Model

The stability of the Ash Pond dike slopes was analyzed using limit equilibrium methods. Analyses were performed for static, long-term conditions with steady-state seepage conditions. The slopes were analyzed using SLOPE/W software, which is available from GEO-SLOPE International, Ltd., of Calgary, Alberta, Canada (www.geo-slope.com). SLOPE/W is a special-purpose computer program designed to analyze the stability of earth slopes using two-dimensional, limit equilibrium methods. With SLOPE/W, the distribution of pore water pressures within the earth mass can be determined using a defined piezometric line or it can be mapped directly from a SEEP/W solution.

In this study, steady-state pore pressures were obtained from the SEEP/W seepage analysis program. As previously stated, the phreatic line determined by SEEP/W was initially established by using the borehole water levels observed at the time of drilling, piezometer readings, the normal pool level of Wells Creek and visual observations of free water in surface ditches. The unit weight and shear strength properties used in the stability analyses are summarized in Tables 7 and 8.

11.3.2. Limit Equilibrium Methods in SLOPE/W

The limit equilibrium method for analyzing slope stability evaluates the static equilibrium of a soil mass above a potential failure surface. For conventional, two-dimensional methods of analysis, the slide mass above an assumed failure surface is split into vertical slices and stresses are evaluated along the sides and base of each slice. The factor of safety against a slope failure (FS_{slope}) is defined as:

$$FS_{slope} = \frac{\text{shear strength of soil}}{\text{shear stress required for equilibrium}} \qquad \textbf{Eqn. 3}$$

where the strengths and stresses are computed along a defined failure surface, on the base of the vertical slices. The shearing resistance at locations along the potential slip surface are computed, with appropriate Mohr-Coulomb strength parameters, as a function of the total or effective normal stress.

Spencer's solution procedure (Spencer 1967; USACE 2003; Duncan and Wright 2005), which satisfies all of the conditions of equilibrium for each slice, was used in this study. Spencer's procedure computes FS_{slope} for an assumed failure surface. A search must be made to find the critical slip surface corresponding to the lowest FS_{slope}. Both curved and noncircular potential failure surfaces can be evaluated.

11.3.3. Slope Stability of the Dikes Surrounding the Retention and Stilling Ponds

The outslope of each dike cross-section was analyzed for slope stability using SLOPE/W 2007. SLOPE/W incorporates various search routines to locate the critical slip surface. For the analyses presented here, the "Entrance and Exit" method was employed. Once the potential failure surface with the lowest factor of safety was identified, the optimization routine was run.

Optimization allows the failure surface geometry to be modified based on the properties of the material through which the surface penetrates. The minimum and maximum range for the entrance and exit points of the failure surface was parametrically varied over a wide range to determine the likely solution region for the critical surface. In subsequent runs, the search was refined by narrowing the range and spacing for the candidate points. In addition, the entrance and exit ranges were also specified so that each "structure" was investigated individually. This allows for a comparison of the factors of safety of each portion of the slope within the cross-section.

Where the surface slope is composed of cohesionless (c' = 0) materials, an infinite slope failure (shallow sliding parallel to the surface) will be critical. While solutions were initially obtained for this case, these shallow sloughs were deemed to be minor and would be able to be repaired before any additional instabilities occurred. Suction pressures in unsaturated surface soils will often create enough apparent cohesion to prevent this type of failure. If shallow sliding does occur, the resulting deformations are unlikely to threaten the integrity of the dike. Neglecting the repair of the "minor slides" can lead to larger, more serious failures. To force the search routine to evaluate deeper failure mechanisms, a minimum failure depth of at least 10 feet was specified for each section.

11.3.4. Slope Stability Parameters

Table 12 summarizes the parameters selected for each of the soil horizons used in the analyses. Specifics of how the parameters were selected are provided in Appendix G (Material Property Calculation).

Table 12. Slope Stability Shear Strength Parameters

Material Type	Unit Weight, g' (pcf)	Effective Stress	
		Cohesion, c' (psf)	Friction Angle, φ' (deg)
Clay Dike 1 – Lean Clay	123	200	22
Clay Dike 1 – Fat Clay	119	200	22
Clay Dike 2 - Lean Clay	123	200	32
Clay Dike 2 - Fat Clay	119	200	29
Fly Ash – Sluiced	100	0	22
Alluvial – Clay	124	200	33
Alluvial – Granular	130	0	32
Bedrock	Impenetrable		

11.3.5. Results of Slope Stability Analysis

Using the strength parameters (c' and ϕ') listed in Table 10, the existing dike configuration was analyzed at each of the eight cross sections. Geo-Slope's Slope/W computer program was used for the analyses with pore pressures calculated from the imported seepage analysis. Long term (effective stress), steady state seepage conditions were analyzed using Spencer's method. For the Spencer's method analyses, curved failure surfaces with optimization were analyzed. Minor details of the geometry, such as various small gravel surface zones and bottom ash cover, were not represented in the stability model.

The stability analyses focused on the potential for failure of both the interior and exterior dike slopes. SLOPE/W failure surfaces from these analyses are presented on the drawings in Appendix B. The results are summarized in Table 13.

Table 13. Summary of Computed Factors of Safety for Slope Stability

Section*	Minimum Exterior	Minimum Interior
P	1.7	3.0
Q	1.9	3.0
R	2.0	2.9
S	2.5	3.2
T	2.9	2.9
U	2.6	2.1
V	2.8	2.9
W	7.2	2.7

*Refer to Figure 6 for plan view of site with section locations

The Tennessee Department of Environment and Conservation (TDEC) "Rules and Regulations Applied to the Safe Dams Act of 1973" provides guidance and standards with regards to existing dams. The standards do not specifically address target factors of safety for slope stability, but instead merely indicate that the dam shall be "stable". Based on discussions with TVA and to be in accordance with current prevailing practice, a minimum factor of safety of 1.5 was adopted for long term slope stability conditions using the guidelines presented in USACE Manual EM 1110-2-1902 "Slope Stability".

The results of the slope stability analyses demonstrate that the factors of safety against long term steady state seepage slope instability range from 1.7 to 7.2 with most results falling between 2 and 3. Hence the resulting factors of safety are greater than the target of 1.5 for each cross section. For each cross section, the minimum factor of safety was generally associated with the minimum 10-foot deep slip surface. In each case, deeper failure surfaces resulted in higher factors of safety. The slip surfaces are shown on the cross sections that are included in Appendix B. Appendix I includes the program output from SLOPE/W.

There was no indication in the slope stability analyses that a translational (noncircular) failure surface would give a factor of safety lower than obtained for optimized curved surfaces. Overall, the geometry of the dike cross sections and the foundation stratigraphy do not appear to be susceptible to sliding along a planar surface. The results in Table 12 and Appendix B represent factors of safety computed from the optimized, curved slip surface routine.

12. Conclusions and Recommendations

12.1. The conclusions and recommendations that follow are based upon Stantec's understanding of the facility as outlined in this report, and in TVA's plans for future operations. This understanding of the facility developed from reviews of historical information provided by TVA, discussions with TVA personnel throughout the course of this work and results of the geotechnical exploration and stability analysis.

12.2. Stantec performed a preliminary hazard assessment of the Cumberland Ash Pond in the summer of 2009, based primarily on USGS topographic mapping. The Ash Pond is currently considered to be a high hazard facility, due to the potential for downstream damage to the existing State highway and bridge should the impoundment fail. Stantec and TVA are currently undertaking a detailed study to more accurately determine the downstream impacts resulting from a failure. Stantec is also in the process of studying modifications and/or replacement of the existing Ash Pond spillways. One of the outcomes of these efforts may be lowering the pool elevation by several feet. Currently, there are no plans in place to permanently close the facility.

12.3. The results of the seepage analyses were reviewed to identify conditions where seepage and possible piping may occur. Seepage outbreaks along the slopes can create the potential for the initiation of soil piping if excessive vertical gradients exist. The seepage analyses showed that maximum vertical exit gradients typically occur near or beyond the exterior toe of the dikes. At three locations, Sections P, Q and R, the calculated factor of safety against piping was found to be less than the recommended acceptable minimum value of 4.

12.4. Review of historic documents, including Annual Inspections performed by TVA personnel, indicate a history of seepage along the banks of Wells Creek, near Sections P and Q. Remediation efforts in 1974 included the placement of a clay blanket on the interior of the Ash Pond dikes in that vicinity. Seepage reportedly ceased within months and has not been reported since that time.

12.5. Two alternatives have been proposed to increase the factor of safety against piping at Sections P, Q and R. The first is to construct a toe berm along the banks of Wells Creek. This method would likely cost less than the second alternative, however significant permitting challenges exist. To construct the toe berm below the ordinary water level of Wells Creek would require both a 404 and 401 permit. For this reason, it is recommended that a driven sheet pile wall be considered. No environmental permitting would be required. It is recommended that design of the sheet pile wall not be performed until the current studies on the pond spillways and hazard status are complete. If the pool level is to be lowered significantly, it will have an impact on the sheet pile wall design. Also, construction of the sheet pile wall should be coordinated with other construction projects that may take place such as modification of the spillways or lowering of the dikes.

12.6. Results of the slope stability analyses indicate factors of safety against long-term slope stability failure are greater than the target value of 1.5. If the pond water level or top of dike elevations are lowered in the future, the factors of safety would tend to increase.

12.7. The inspection program at CUF should include regular inspections of the bank of Wells Creek in the vicinity of Sections P, Q and R. Any noted seeps should be located on a map and observed at regular intervals. An accurate approximation of flow should be recorded along with photographs of the seep area. The seep area should be kept clear of vegetation in order to facilitate visual observation. Any rapid changes in the seep should be reported to the appropriate personnel.

13. Closure and Limitations of Study

13.1. The scope of this evaluation was limited to consider only the potential risks of dike failure under long-term, steady-state seepage loading conditions. This assessment did not consider potential failure modes related to spillway capacity and overtopping or seepage along penetrations through the embankments (including the buried spillway pipes).

13.2. The recommendations presented herein are based on information gathered (from various sources) using that degree of care and skill ordinarily exercised under similar circumstances by competent members of the engineering profession. Subsurface profiles are generally based on straight-line interpolation between borings and no warranties can be made regarding the continuity of subsurface conditions between the borings.

13.3. The boring logs and related information presented in this report depict approximate subsurface conditions only at the specific boring locations noted and at the time of drilling. Conditions at other locations may differ from those occurring at the boring locations. Also, the passage of time may result in a change in the subsurface conditions at the boring locations.

Appendix A

Phase 1 Coal Combustion Product Facility Summaries, 2009

Stantec

TVA Disposal Facility Assessment
Phase 1 Coal Combustion Product Disposal Facility Summary
Cumberland Fossil Plant (CUF)
Ash Pond (AP-1)

1. General Facility Information

Facility Status:	Active	NID Identification:	TN16109
Surface Area (inside dikes)	50 acres (estimated)	Maximum Height (toe to top of dike):	35 feet (estimated)
Free Water Volume:	1,296,069 CY (9/2008)	Maximum Water Storage:	2,165,158 CY (9/2008)
Estimated CCB Storage:	1,305,346 CY	Dike Length:	5,600 feet (estimated)
Plant Discharge to Facility:	Not provided by TVA	Current Pool Elevation:	384 feet (estimated)

2. Site Visit Information

Stantec Assessment Team:	Stephen Bickel, PE, Nathan Bader, PE, Stan Harris, PE and Matthew Hoy, EIT
TVA Staff Present:	Stuart Harris and Carrie McCarty
Field Assessment Dates:	January 14, 2009 and February 3 - 4, 2009
Weather/Site Conditions:	Mid-30 degrees F, sunny, moist ground both days.

3. History/Description of Usage

History and Operation:

This disposal area was constructed in 1969. As part of this construction, Wells Creek was relocated in order to construct what was initially known as Disposal Area 1. As a result, portions of the current Active Ash Pond and Dry Stack were constructed over the original location of Wells Creek. Area 1 was located within the perimeter dikes that now include the current ash and gypsum disposal areas. In 1977, the divider dike for the stilling pool to the north (interior divider dike) was constructed. In 1979, the dikes around the Ash Pond were raised to elevation 395 feet with clay. In 1986, approximately 300 feet of the west portion of the divider dike between the Ash Pond and the Dry Ash Stack was constructed. In 1995-96, the current divider dike between the Ash Pond and Dry Stack was constructed (exterior divider dike) to

	form the current configuration. Approximately 135,000 dry tons of bottom ash is wet sluiced to the Ash Pond annually. Dewatered bottom ash is reclaimed and stacked in the Dry Stack area. Outlet for the Ash Pond is through four 48-inch RCP riser pipe/weirs that discharge through four 36-inch RCP sections into an adjacent discharge channel.
Past Failures/Releases:	No failures or releases reported.

4. Owner's Operations, Maintenance and Inspection Information

Emergency Action Plan:	No EAP has been prepared for this facility.
Operations Manual:	"Operations Manual: Dry Ash and Gypsum Stacking Facility", prepared by Tennessee Valley Authority, October 10, 2003.
TVA Maintenance:	Exterior slopes are mowed every two years.
TVA Inspections:	TVA Engineering performs annual dike inspections and prepares reports. Plant personnel recently started making daily observations, with documented inspections made weekly.
Problems Previously Identified During Past TVA Inspections:	Sloughed areas on interior divider dike, tree growth on dikes, animal burrows.

5. Documents Reviewed

See attached Document Log for complete list of documents provided by TVA for review. In particular, the following provided pertinent information for the assessment of this facility:

TVA Design Drawings:	10N212, 213, 214, 218, 224, 225, 10W287-1, 287-2, 6314-W-C110200 through 222
TVA As-Built Drawings:	None available.
TVA Construction Testing Records:	None available.
TVA Annual Inspection Reports:	TVA Annual Inspection Reports 1972-1984, 1986-1990, 1994-1995, 1997-2004, 2006-2008.

Geotechnical Data:	"Cumberland Steam Plant - Ash Dike Raising - Borrow Area B Expansion and Proposed Borrow Area D", Memorandum from Frank Van Meter to G.L. Buchanan, June 16, 1981. "Cumberland Fossil Plant - Ash Disposal Area No. 1A", Power Engineering & Construction Calculations, K.W. Burnett, December 19, 1990. "Ash Pond Dike - Recommended Engineering Properties for Slope Stability Analyses", Tennessee Valley Authority, December 12, 1986. "Recommendations for Stability Improvement, Ash Pond Dike System, Cumberland Fossil Plant, Cumberland City, Tennessee", Law Engineering, March 13, 1992. "Report of Site Investigation - Cumberland Fossil Plant Soils Investigation for Ash Pond Dike and Borrow Areas", Hall, Blake, and Associates, Inc., October 3, 1986.

6. Stantec Field Observations

See attached Concerns/Photo Log, Photos, and Site Plan Drawing.

6.1. Interior Slopes

Vegetation:	Phragmites and brush, dense coverage.
Trees:	Sparse small trees were noted in various areas on the majority of dikes.
Wave Wash Protection:	The interior divider dike separating the Stilling Pond from the Ash Pond has riprap protection. None observed on other interior slopes.
Erosion:	Erosion observed along divider dike to Dry Ash Stack around 36 inch HDPE pipe. The pipe is located at the west end of the divider dike; rill/gullies noted in various areas along this divider dike.
Instabilities:	None observed.
Animal Burrows:	None observed.

Freeboard:
Measured: 10.9 feet at Section 2
Design: Not available on drawings provided.

Encroachments: None observed.

Slope:
Measured: 1.8H:1V along divider dike at Section 1, 2.5H:1V along inner perimeter dike slope (Estimated), 2.2H:1V along Dry Stack divider dike at Section 3.
Design: 2H:1V on interior divider dike (from Drawing 10N224), 2.5H:1V on perimeter dike (from Drawing 10N213).

6.2. Crest

Crest Cover and Slope: Gravel-covered road on perimeter dike, crest appears relatively flat. Bottom ash and gravel-covered road on interior stilling pond divider dike, crest appears relatively flat. Bottom ash-covered road on divider dike between Dry Ash Stack and Ash Pond, crest appears relatively flat.

Erosion: Minor erosion rill/gullies on divider dike to Dry Ash Stack.

Alignment: Alignment appeared to agree with design drawings.

Settlement/Cracking: None observed.

Bare Spots/Rutting: None observed.

Width:
Measured: 19 feet on divider dike at Section 1; 20 feet on perimeter dike at Section 2; 31 feet on Dry Stack divider dike at Section 3.
Design: 16 feet on interior divider dike and perimeter dike (from Drawings 10N224 and 10N213). No information available for Dry Stack divider dike.

6.3. Exterior Slopes

Vegetation: Maintained grass, adequate coverage.

Trees: None observed.

Erosion: None observed.

Instabilities:	None observed.
Uniform Appearance:	Good.
Seepage:	Standing water was observed along north portion of perimeter dike.
Benches:	None observed.
Foundations, Drains, Relief Wells, Instrumentation:	No provisions for drainage/seepage control, or instrumentation were observed.
Animal Burrows:	One burrow on exterior dike was observed.
Slope:	**Measured:** 2.7H:1V at Section 2. **Design:** 3H:1V (from Drawing 10N213).
Height:	**Measured:** 15 feet at Section 2 **Design:** 35 feet at outlet area (from Drawing 10N214).

6.4. Spillway Weirs/Riser Inlets

Number:	Four, located at the east end of the stilling pond.
Size, Type and Material:	48-inch RCP push-together riser sections with standard TVA steel skimmers.
Height of Riser Inlets:	23 feet (est. from Drawing 10N214)
Access:	All spillways accessible via steel catwalks.
Joints:	Unable to observe below inlet any joint leakage or sealant.
Mis-Alignment:	None reported or observed.
Closed/Abandoned Conduits:	None reported or observed.

6.5. Outlet Pipes

Number:	Four
Size, Type and Material:	36-inch RCP
Headwall:	None observed.

Joint Separations:	Unknown, unable to observe.
Mis-Alignment:	Unknown, unable to observe.
Closed/Abandoned Conduits:	None reported or observed.

7. Notable Observations and Concerns

- The absence of an Emergency Action Plan, Operation and Maintenance Plan, as-built drawings and construction testing records is a concern.
- One animal burrow was noted along the perimeter dike.
- Standing water attributed to poor drainage was noted along the toe of the north perimeter dike.
- RCP push-together riser spillways are a concern.
- Some minor erosion was noted along the outslope of the perimeter roadway just east of the sluicing channel.
- A few small trees were noted along the stilling pond divider dike.
- Erosion was noted along the new 36-inch HDPE drain pipe along the west end of the Ash Pond-Dry Stack divider dike. Several other areas of minor erosion along this divider dike were also noted.
- Some erosion was noted along the north outslope of the bottom ash area.
- The steel angles within the standard skimmers were observed to be corroded and in poor condition. Walkways that are supported by the skimmers are putting eccentric loading on the structure.

8. Recommendations

8.1. Phase 2 Engineering and Programmatic Recommendations

- It is recommended that the perimeter dikes for the Ash Pond undergo further engineering study to evaluate slope stability and seepage. It is also recommended that a hydraulic and hydrologic analysis be performed to check freeboard and pond outlet adequacy relative to process flow and stormwater.
- Based on the findings of Phase 2 and designs from Phase 3, if performed, Stantec recommends that the existing O&M Manual be reviewed and updated. These updates may include sections on routine monitoring and facility maintenance.
- It is recommended that a program be established to develop as-built drawings and

construction records for future maintenance and construction activities.

8.2. Maintenance Recommendations

- Remove trees from noted locations.
- Repair animal burrows where noted.
- Cut and maintain heavy/tall phragmite growth on slopes of ponds to allow better observation. Establish mowing program of ponds and disposal areas.
- Regrade and repair erosion areas where noted.
- The RCP riser spillway outlet system may ultimately be modified or replaced, pending Stantec-TVA assessment of replacement system. Monitor the spillway systems until that time.
- Monitor standing water along toe of perimeter dike. Regrade adjacent drainage ditch if conditions worsen.
- Continue annual inspection program and execute recommendations.
- Evaluate the structural condition of the skimmers and the way walkways are supported, and modify or replace as necessary.

Drawing Mark AP-1-1 Crest and inside slopes of the perimeter dikes around the Ash Pond.

Drawing Mark AP-1-2 Animal burrow along north perimeter dike of Ash Pond.

Drawing Mark AP-1-3 Standing water along toe of north perimeter Ash Pond dike.

Drawing Mark AP-1-4 Spillways at northeast side of Stilling Pond.

Drawing Mark AP-1-5 Spillway discharge and channel.

Drawing Mark AP-1-6 Trees on stilling pond divider dike.

Drawing Mark AP-1-7 Erosion around 36” HDPE drain pipe along the west end of the divider dike.

Drawing Mark AP-1-8 Erosion along north outslope of Bottom Ash Area.

Drawing Mark AP-1-9 Erosion along divider dike between Dry Ash Stack and Ash Pond.

Concerns/Photo Log

Drawing Mark	Comments	Photo/GPS ID
AP-1-1	Crest and inside slopes of the perimeter dikes around the Ash Pond.	Photo 26B
AP-1-2	Animal burrow along north perimeter dike of Ash Pond.	Photo 21B
AP-1-3	Standing water along toe of north perimeter Ash Pond dike.	Photo 23B
AP-1-4	Spillways at northeast side of Stilling Pond.	Photo 25B
AP-1-5	Spillway discharge and channel.	Photo 24B
AP-1-6	Trees on stilling pond divider dike.	Photo 48B
AP-1-7	Erosion around 36” HDPE drain pipe along the west end of the divider dike.	Photo 38B
AP-1-8	Erosion along north outslope of Bottom Ash Area.	Photo 14B
AP-1-9	Erosion along divider dike between Dry Ash Stack and Ash Pond.	Photo 41B

Appendix E

Instrumentation Monitoring Results

PIEZOMETER
CUF: Main Ashpond
815 Cumberland City Rd
Cumberland City,TN
175539016

	8/19/2009				9/15/2009				10/20/2009			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**
49	379.2	0.0	11.9	367.3	379.2	0.0	13.1	366.1	379.2	0.0	11.8	367.4
50B	394.5	0.0	14.3	380.2	394.5	0.0	17.7	376.9	394.5	0.0	14.4	380.1
53A	376.0	2.5	13.2	365.3	376.0	2.5	14.1	364.4	376.0	2.5	13.5	365.0
53B	376.0	3.0	14.0	365.0	376.0	3.0	14.8	364.2	376.0	3.0	15.0	364.0
54A	395.0	0.0	21.3	373.7	395.0	0.0	22.0	373.0	395.0	0.0	22.5	372.5
57A	381.5	0.0	12.0	369.5	381.5	0.0	11.0	370.5	381.5	0.0	10.4	371.1
58A	394.8	0.0	24.1	370.7	394.8	0.0	23.9	370.9	394.8	0.0	23.4	371.4

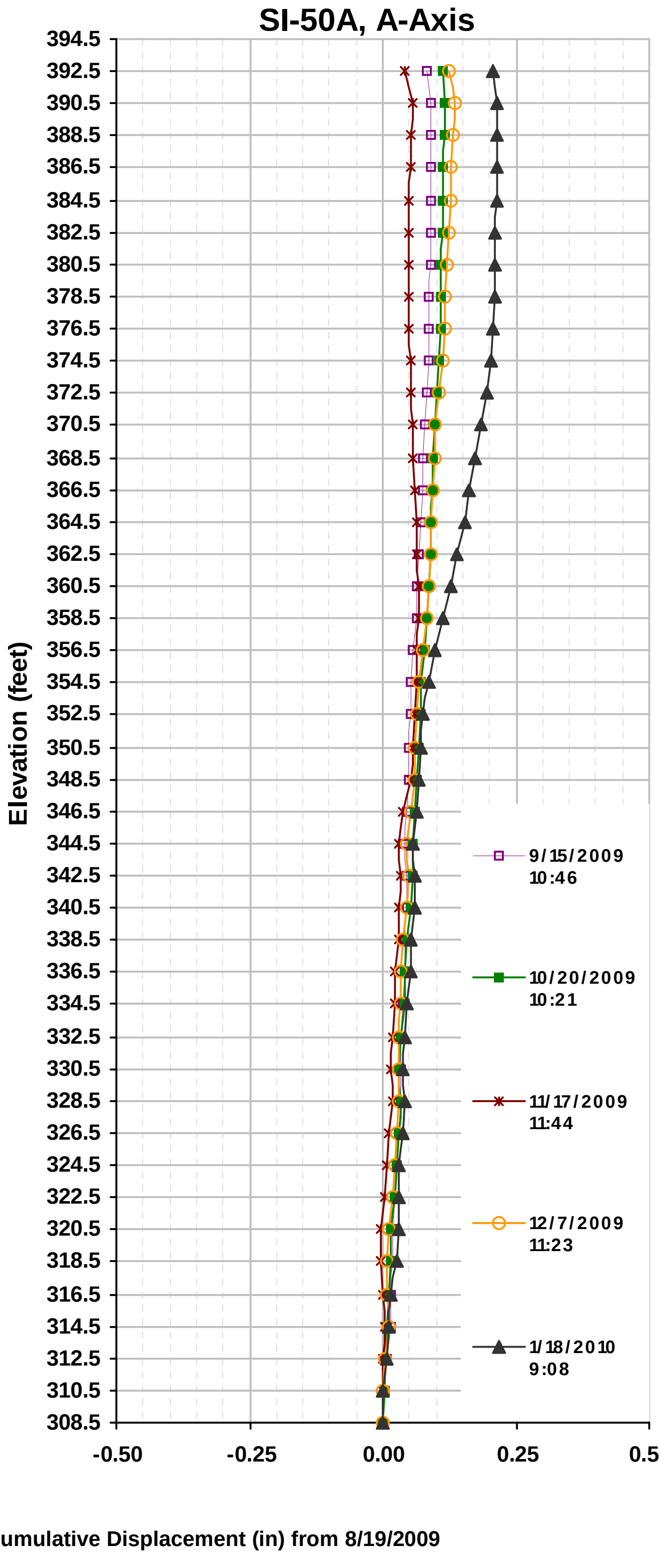
▨ * Change from previous reading

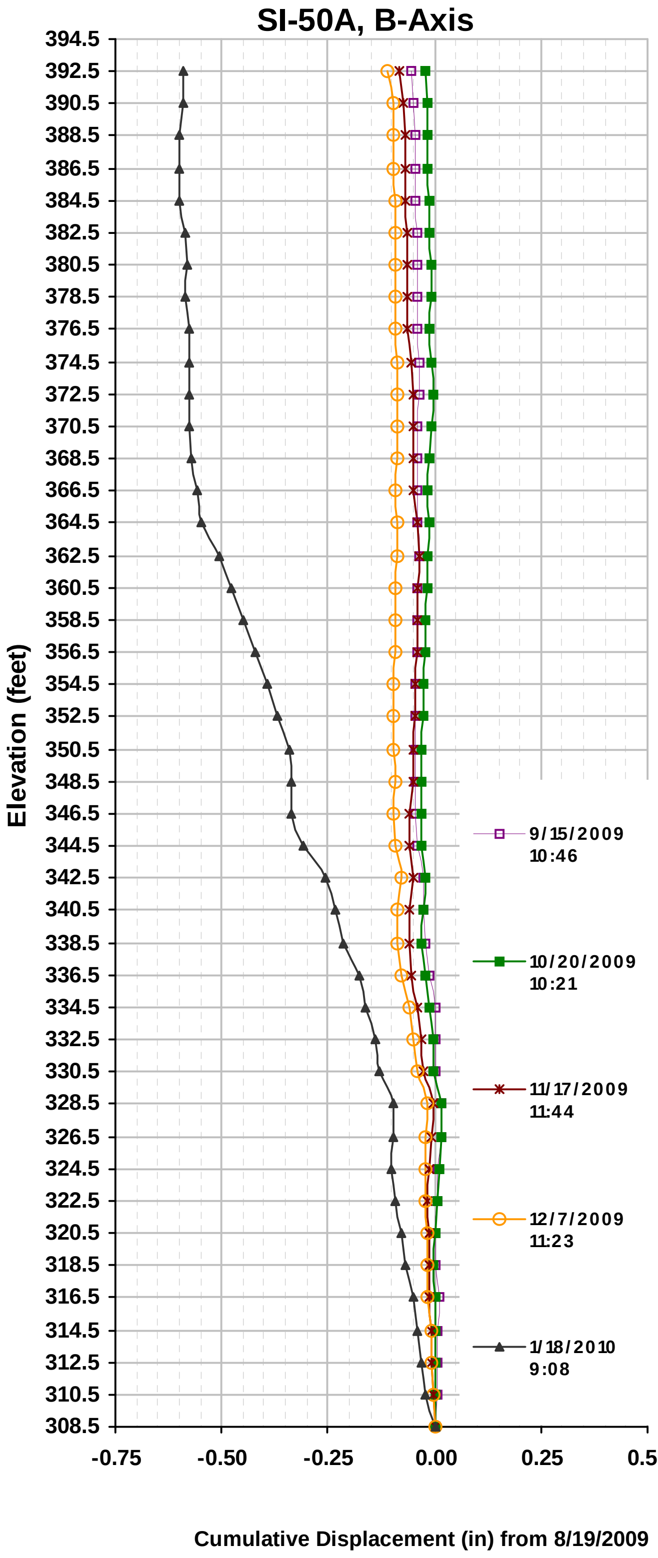
Stantec

PIEZOMETER
CUF: Main Ashpond
815 Cumberland City Rd
Cumberland City,TN
175539016

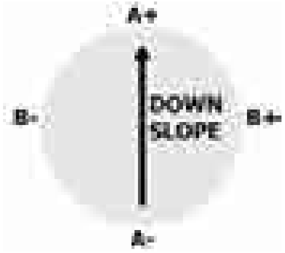
	11/17/2009				**12/7/2009**				**1/18/2010**			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**
49	379.2	0.0	12.4	366.8	379.2	0.0	12.9	366.3	379.2	0.0	13.1	366.1
50B	394.5	0.0	14.5	380.0	394.5	0.0	15.0	379.5	394.5	0.0	15.1	379.4
53A	376.0	2.5	14.3	364.2	376.0	2.5	14.9	363.6	376.0	2.5	15.0	363.5
53B	376.0	3.0	13.9	365.1	376.0	3.0	15.3	363.7	376.0	3.0	15.4	363.6
54A	395.0	0.0	21.9	373.1	395.0	0.0	22.4	372.6	395.0	0.0	21.1	373.9
57A	381.5	0.0	10.7	370.8	381.5	0.0	11.5	370.0	381.5	0.0	11.8	369.7
58A	394.8	0.0	24.1	370.7	394.8	0.0	24.6	370.2	394.8	0.0	24.9	369.9

*** Change from previous reading**





Stantec



Cumberland Fossil Plant

Cumberland City, TN
175539016
1/18/2010

SITE	CUFTVA
INSTALLATION	SI-50A
DESCRIPTION	

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INITIAL SURVEY	8/19/2009	11:00:39 AM
DATE PRINTED	1/18/2010	2:14:44 PM

Data Reduction for A Axis:

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Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-109	115	-0.1344	-117	119	-0.1416	-0.0072	0.0840
4	-55	60	-0.0690	-57	59	-0.0696	-0.0006	0.0912
6	9	-5	0.0084	8	-6	0.0084	0.0000	0.0918
8	142	-134	0.1656	142	-137	0.1674	0.0018	0.0918
10	298	-297	0.3570	298	-299	0.3582	0.0012	0.0900
12	511	-506	0.6102	509	-508	0.6102	0.0000	0.0888
14	704	-699	0.8418	703	-702	0.8430	0.0012	0.0888
16	867	-864	1.0386	865	-865	1.0380	-0.0006	0.0876
18	1154	-1152	1.3836	1153	-1154	1.3842	0.0006	0.0882
20	1551	-1551	1.8612	1553	-1556	1.8654	0.0042	0.0876
22	1962	-1962	2.3544	1966	-1966	2.3592	0.0048	0.0834
24	2332	-2330	2.7972	2334	-2334	2.8008	0.0036	0.0786
26	2694	-2693	3.2322	2695	-2694	3.2334	0.0012	0.0750
28	3029	-3023	3.6312	3028	-3026	3.6324	0.0012	0.0738
30	3291	-3290	3.9486	3293	-3294	3.9522	0.0036	0.0726
32	3512	-3514	4.2156	3515	-3517	4.2192	0.0036	0.0690
34	3692	-3691	4.4298	3694	-3694	4.4328	0.0030	0.0654
36	3857	-3855	4.6272	3861	-3859	4.6320	0.0048	0.0624
38	3973	-3972	4.7670	3976	-3975	4.7706	0.0036	0.0576
40	4004	-4004	4.8048	4006	-4007	4.8078	0.0030	0.0540
42	3954	-3952	4.7436	3955	-3953	4.7448	0.0012	0.0510
44	3805	-3800	4.5630	3805	-3802	4.5642	0.0012	0.0498
46	3504	-3505	4.2054	3507	-3506	4.2078	0.0024	0.0486
48	3279	-3274	3.9318	3281	-3277	3.9348	0.0030	0.0462
50	3239	-3243	3.8892	3239	-3239	3.8868	-0.0024	0.0432
52	3245	-3247	3.8952	3247	-3247	3.8964	0.0012	0.0456
54	3286	-3283	3.9414	3287	-3286	3.9438	0.0024	0.0444
56	3282	-3288	3.9420	3285	-3289	3.9444	0.0024	0.0420
58	3300	-3301	3.9606	3299	-3303	3.9612	0.0006	0.0396
60	3314	-3317	3.9786	3317	-3323	3.9840	0.0054	0.0390
62	3287	-3290	3.9462	3288	-3291	3.9474	0.0012	0.0336
64	3191	-3198	3.8334	3192	-3197	3.8334	0.0000	0.0324
66	3089	-3095	3.7104	3093	-3094	3.7122	0.0018	0.0324
68	3055	-3051	3.6636	3058	-3055	3.6678	0.0042	0.0306
70	3020	-3026	3.6276	3022	-3029	3.6306	0.0030	0.0264
72	2934	-2941	3.5250	2937	-2943	3.5280	0.0030	0.0234
74	2849	-2858	3.4242	2850	-2860	3.4260	0.0018	0.0204
76	3027	-3033	3.6360	3031	-3034	3.6390	0.0030	0.0186
78	3081	-3082	3.6978	3083	-3084	3.7002	0.0024	0.0156

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 9/15/2009 10:46:55 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:44 PM

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80	3177	-3173	3.8100	3182	-3176	3.8148	0.0048	0.0132
82	3235	-3242	3.8862	3238	-3245	3.8898	0.0036	0.0084
84	3274	-3275	3.9294	3278	-3279	3.9342	0.0048	0.0048
86	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

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INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:44 PM

Data Reduction for A Axis:

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2	-109	115	-0.1344	-110	122	-0.1392	-0.0048	0.1134
4	-55	60	-0.0690	-51	62	-0.0678	0.0012	0.1182
6	9	-5	0.0084	14	-4	0.0108	0.0024	0.1170
8	142	-134	0.1656	147	-133	0.1680	0.0024	0.1146
10	298	-297	0.3570	303	-293	0.3576	0.0006	0.1122
12	511	-506	0.6102	515	-504	0.6114	0.0012	0.1116
14	704	-699	0.8418	710	-697	0.8442	0.0024	0.1104
16	867	-864	1.0386	873	-859	1.0392	0.0006	0.1080
18	1154	-1152	1.3836	1161	-1147	1.3848	0.0012	0.1074
20	1551	-1551	1.8612	1558	-1550	1.8648	0.0036	0.1062
22	1962	-1962	2.3544	1971	-1959	2.3580	0.0036	0.1026
24	2332	-2330	2.7972	2339	-2330	2.8014	0.0042	0.0990
26	2694	-2693	3.2322	2699	-2690	3.2334	0.0012	0.0948
28	3029	-3023	3.6312	3034	-3021	3.6330	0.0018	0.0936
30	3291	-3290	3.9486	3296	-3288	3.9504	0.0018	0.0918
32	3512	-3514	4.2156	3521	-3512	4.2198	0.0042	0.0900
34	3692	-3691	4.4298	3698	-3691	4.4334	0.0036	0.0858
36	3857	-3855	4.6272	3866	-3854	4.6320	0.0048	0.0822
38	3973	-3972	4.7670	3982	-3970	4.7712	0.0042	0.0774
40	4004	-4004	4.8048	4011	-4003	4.8084	0.0036	0.0732
42	3954	-3952	4.7436	3962	-3950	4.7472	0.0036	0.0696
44	3805	-3800	4.5630	3811	-3797	4.5648	0.0018	0.0660
46	3504	-3505	4.2054	3510	-3505	4.2090	0.0036	0.0642
48	3279	-3274	3.9318	3289	-3274	3.9378	0.0060	0.0606
50	3239	-3243	3.8892	3245	-3235	3.8880	-0.0012	0.0546
52	3245	-3247	3.8952	3255	-3243	3.8988	0.0036	0.0558
54	3286	-3283	3.9414	3297	-3283	3.9480	0.0066	0.0522
56	3282	-3288	3.9420	3291	-3284	3.9450	0.0030	0.0456
58	3300	-3301	3.9606	3309	-3296	3.9630	0.0024	0.0426
60	3314	-3317	3.9786	3323	-3319	3.9852	0.0066	0.0402
62	3287	-3290	3.9462	3297	-3283	3.9480	0.0018	0.0336
64	3191	-3198	3.8334	3199	-3188	3.8322	-0.0012	0.0318
66	3089	-3095	3.7104	3099	-3093	3.7152	0.0048	0.0330
68	3055	-3051	3.6636	3063	-3047	3.6660	0.0024	0.0282
70	3020	-3026	3.6276	3027	-3025	3.6312	0.0036	0.0258
72	2934	-2941	3.5250	2943	-2941	3.5304	0.0054	0.0222
74	2849	-2858	3.4242	2855	-2857	3.4272	0.0030	0.0168
76	3027	-3033	3.6360	3037	-3029	3.6396	0.0036	0.0138
78	3081	-3082	3.6978	3089	-3076	3.6990	0.0012	0.0102

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 10/20/2009 10:21:38 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:45 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	3177	-3173	3.8100	3186	-3170	3.8136	0.0036	0.0090
82	3235	-3242	3.8862	3243	-3239	3.8892	0.0030	0.0054
84	3274	-3275	3.9294	3282	-3271	3.9318	0.0024	0.0024
86	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 11/17/2009 11:44:50 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:45 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-109	115	-0.1344	-118	125	-0.1458	-0.0114	0.0432
4	-55	60	-0.0690	-54	60	-0.0684	0.0006	0.0546
6	9	-5	0.0084	10	-6	0.0096	0.0012	0.0540
8	142	-134	0.1656	145	-135	0.1680	0.0024	0.0528
10	298	-297	0.3570	300	-297	0.3582	0.0012	0.0504
12	511	-506	0.6102	511	-506	0.6102	0.0000	0.0492
14	704	-699	0.8418	706	-699	0.8430	0.0012	0.0492
16	867	-864	1.0386	867	-862	1.0374	-0.0012	0.0480
18	1154	-1152	1.3836	1154	-1145	1.3794	-0.0042	0.0492
20	1551	-1551	1.8612	1553	-1549	1.8612	0.0000	0.0534
22	1962	-1962	2.3544	1964	-1958	2.3532	-0.0012	0.0534
24	2332	-2330	2.7972	2333	-2327	2.7960	-0.0012	0.0546
26	2694	-2693	3.2322	2693	-2687	3.2280	-0.0042	0.0558
28	3029	-3023	3.6312	3027	-3019	3.6276	-0.0036	0.0600
30	3291	-3290	3.9486	3291	-3287	3.9468	-0.0018	0.0636
32	3512	-3514	4.2156	3514	-3510	4.2144	-0.0012	0.0654
34	3692	-3691	4.4298	3693	-3690	4.4298	0.0000	0.0666
36	3857	-3855	4.6272	3859	-3855	4.6284	0.0012	0.0666
38	3973	-3972	4.7670	3976	-3972	4.7688	0.0018	0.0654
40	4004	-4004	4.8048	4010	-4006	4.8096	0.0048	0.0636
42	3954	-3952	4.7436	3959	-3951	4.7460	0.0024	0.0588
44	3805	-3800	4.5630	3810	-3803	4.5678	0.0048	0.0564
46	3504	-3505	4.2054	3515	-3518	4.2198	0.0144	0.0516
48	3279	-3274	3.9318	3286	-3278	3.9384	0.0066	0.0372
50	3239	-3243	3.8892	3242	-3237	3.8874	-0.0018	0.0306
52	3245	-3247	3.8952	3250	-3244	3.8964	0.0012	0.0324
54	3286	-3283	3.9414	3291	-3283	3.9444	0.0030	0.0312
56	3282	-3288	3.9420	3292	-3287	3.9474	0.0054	0.0282
58	3300	-3301	3.9606	3303	-3297	3.9600	-0.0006	0.0228
60	3314	-3317	3.9786	3319	-3317	3.9816	0.0030	0.0234
62	3287	-3290	3.9462	3294	-3289	3.9498	0.0036	0.0204
64	3191	-3198	3.8334	3198	-3190	3.8328	-0.0006	0.0168
66	3089	-3095	3.7104	3099	-3098	3.7182	0.0078	0.0174
68	3055	-3051	3.6636	3058	-3049	3.6642	0.0006	0.0096
70	3020	-3026	3.6276	3026	-3028	3.6324	0.0048	0.0090
72	2934	-2941	3.5250	2942	-2945	3.5322	0.0072	0.0042
74	2849	-2858	3.4242	2850	-2858	3.4248	0.0006	-0.0030
76	3027	-3033	3.6360	3028	-3029	3.6342	-0.0018	-0.0036
78	3081	-3082	3.6978	3081	-3074	3.6930	-0.0048	-0.0018

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 11/17/2009 11:44:50 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:45 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	3177	-3173	3.8100	3181	-3173	3.8124	0.0024	0.0030
82	3235	-3242	3.8862	3238	-3239	3.8862	0.0000	0.0006
84	3274	-3275	3.9294	3277	-3273	3.9300	0.0006	0.0006
86	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 12/7/2009 11:23:30 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:45 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-109	115	-0.1344	-118	124	-0.1452	-0.0108	0.1230
4	-55	60	-0.0690	-53	58	-0.0666	0.0024	0.1338
6	9	-5	0.0084	11	-6	0.0102	0.0018	0.1314
8	142	-134	0.1656	146	-136	0.1692	0.0036	0.1296
10	298	-297	0.3570	301	-299	0.3600	0.0030	0.1260
12	511	-506	0.6102	515	-507	0.6132	0.0030	0.1230
14	704	-699	0.8418	709	-701	0.8460	0.0042	0.1200
16	867	-864	1.0386	870	-862	1.0392	0.0006	0.1158
18	1154	-1152	1.3836	1157	-1151	1.3848	0.0012	0.1152
20	1551	-1551	1.8612	1560	-1556	1.8696	0.0084	0.1140
22	1962	-1962	2.3544	1970	-1965	2.3610	0.0066	0.1056
24	2332	-2330	2.7972	2337	-2330	2.8002	0.0030	0.0990
26	2694	-2693	3.2322	2700	-2692	3.2352	0.0030	0.0960
28	3029	-3023	3.6312	3034	-3021	3.6330	0.0018	0.0930
30	3291	-3290	3.9486	3295	-3290	3.9510	0.0024	0.0912
32	3512	-3514	4.2156	3520	-3513	4.2198	0.0042	0.0888
34	3692	-3691	4.4298	3698	-3691	4.4334	0.0036	0.0846
36	3857	-3855	4.6272	3865	-3857	4.6332	0.0060	0.0810
38	3973	-3972	4.7670	3982	-3973	4.7730	0.0060	0.0750
40	4004	-4004	4.8048	4010	-4006	4.8096	0.0048	0.0690
42	3954	-3952	4.7436	3959	-3952	4.7466	0.0030	0.0642
44	3805	-3800	4.5630	3810	-3799	4.5654	0.0024	0.0612
46	3504	-3505	4.2054	3510	-3510	4.2120	0.0066	0.0588
48	3279	-3274	3.9318	3287	-3277	3.9384	0.0066	0.0522
50	3239	-3243	3.8892	3243	-3236	3.8874	-0.0018	0.0456
52	3245	-3247	3.8952	3253	-3243	3.8976	0.0024	0.0474
54	3286	-3283	3.9414	3296	-3283	3.9474	0.0060	0.0450
56	3282	-3288	3.9420	3290	-3287	3.9462	0.0042	0.0390
58	3300	-3301	3.9606	3304	-3298	3.9612	0.0006	0.0348
60	3314	-3317	3.9786	3321	-3317	3.9828	0.0042	0.0342
62	3287	-3290	3.9462	3294	-3284	3.9468	0.0006	0.0300
64	3191	-3198	3.8334	3197	-3189	3.8316	-0.0018	0.0294
66	3089	-3095	3.7104	3097	-3097	3.7164	0.0060	0.0312
68	3055	-3051	3.6636	3060	-3049	3.6654	0.0018	0.0252
70	3020	-3026	3.6276	3026	-3028	3.6324	0.0048	0.0234
72	2934	-2941	3.5250	2942	-2945	3.5322	0.0072	0.0186
74	2849	-2858	3.4242	2853	-2858	3.4266	0.0024	0.0114
76	3027	-3033	3.6360	3033	-3027	3.6360	0.0000	0.0090
78	3081	-3082	3.6978	3087	-3075	3.6972	-0.0006	0.0090

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 12/7/2009 11:23:30 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:45 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	3177	-3173	3.8100	3185	-3173	3.8148	0.0048	0.0096
82	3235	-3242	3.8862	3242	-3241	3.8898	0.0036	0.0048
84	3274	-3275	3.9294	3277	-3274	3.9306	0.0012	0.0012
86	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 1/18/2010 9:08:14 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:45 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-109	115	-0.1344	-119	121	-0.1440	-0.0096	0.2064
4	-55	60	-0.0690	-56	59	-0.0690	0.0000	0.2160
6	9	-5	0.0084	10	-7	0.0102	0.0018	0.2160
8	142	-134	0.1656	141	-137	0.1668	0.0012	0.2142
10	298	-297	0.3570	300	-298	0.3588	0.0018	0.2130
12	511	-506	0.6102	511	-506	0.6102	0.0000	0.2112
14	704	-699	0.8418	705	-701	0.8436	0.0018	0.2112
16	867	-864	1.0386	870	-865	1.0410	0.0024	0.2094
18	1154	-1152	1.3836	1159	-1153	1.3872	0.0036	0.2070
20	1551	-1551	1.8612	1560	-1558	1.8708	0.0096	0.2034
22	1962	-1962	2.3544	1973	-1969	2.3652	0.0108	0.1938
24	2332	-2330	2.7972	2341	-2337	2.8068	0.0096	0.1830
26	2694	-2693	3.2322	2705	-2700	3.2430	0.0108	0.1734
28	3029	-3023	3.6312	3036	-3030	3.6396	0.0084	0.1626
30	3291	-3290	3.9486	3305	-3301	3.9636	0.0150	0.1542
32	3512	-3514	4.2156	3526	-3522	4.2288	0.0132	0.1392
34	3692	-3691	4.4298	3706	-3699	4.4430	0.0132	0.1260
36	3857	-3855	4.6272	3871	-3865	4.6416	0.0144	0.1128
38	3973	-3972	4.7670	3987	-3980	4.7802	0.0132	0.0984
40	4004	-4004	4.8048	4014	-4011	4.8150	0.0102	0.0852
42	3954	-3952	4.7436	3958	-3956	4.7484	0.0048	0.0750
44	3805	-3800	4.5630	3806	-3806	4.5672	0.0042	0.0702
46	3504	-3505	4.2054	3508	-3505	4.2078	0.0024	0.0660
48	3279	-3274	3.9318	3282	-3281	3.9378	0.0060	0.0636
50	3239	-3243	3.8892	3240	-3238	3.8868	-0.0024	0.0576
52	3245	-3247	3.8952	3247	-3246	3.8958	0.0006	0.0600
54	3286	-3283	3.9414	3291	-3292	3.9498	0.0084	0.0594
56	3282	-3288	3.9420	3285	-3285	3.9420	0.0000	0.0510
58	3300	-3301	3.9606	3306	-3305	3.9666	0.0060	0.0510
60	3314	-3317	3.9786	3318	-3320	3.9828	0.0042	0.0450
62	3287	-3290	3.9462	3291	-3293	3.9504	0.0042	0.0408
64	3191	-3198	3.8334	3191	-3190	3.8286	-0.0048	0.0366
66	3089	-3095	3.7104	3097	-3095	3.7152	0.0048	0.0414
68	3055	-3051	3.6636	3059	-3057	3.6696	0.0060	0.0366
70	3020	-3026	3.6276	3022	-3023	3.6270	-0.0006	0.0306
72	2934	-2941	3.5250	2940	-2938	3.5268	0.0018	0.0312
74	2849	-2858	3.4242	2857	-2855	3.4272	0.0030	0.0294
76	3027	-3033	3.6360	3037	-3039	3.6456	0.0096	0.0264
78	3081	-3082	3.6978	3086	-3084	3.7020	0.0042	0.0168

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 1/18/2010 9:08:14 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:45 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	3177	-3173	3.8100	3182	-3178	3.8160	0.0060	0.0126
82	3235	-3242	3.8862	3246	-3240	3.8916	0.0054	0.0066
84	3274	-3275	3.9294	3276	-3275	3.9306	0.0012	0.0012
86	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-50A
DESCRIPTION

CURRENT SURVEY 9/15/2009 10:46:55 AM
INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:53 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	3	49	-0.0276	-2	57	-0.0354	-0.0078	-0.0564
4	9	50	-0.0246	9	54	-0.0270	-0.0024	-0.0486
6	41	14	0.0162	42	15	0.0162	0.0000	-0.0462
8	23	30	-0.0042	23	33	-0.0060	-0.0018	-0.0462
10	-18	61	-0.0474	-18	65	-0.0498	-0.0024	-0.0444
12	-55	107	-0.0972	-53	111	-0.0984	-0.0012	-0.0420
14	-109	163	-0.1632	-108	167	-0.1650	-0.0018	-0.0408
16	-102	146	-0.1488	-101	146	-0.1482	0.0006	-0.0390
18	-115	161	-0.1656	-115	166	-0.1686	-0.0030	-0.0396
20	-38	70	-0.0648	-35	72	-0.0642	0.0006	-0.0366
22	118	-78	0.1176	121	-77	0.1188	0.0012	-0.0372
24	238	-205	0.2658	241	-204	0.2670	0.0012	-0.0384
26	341	-303	0.3864	344	-301	0.3870	0.0006	-0.0396
28	413	-368	0.4686	412	-366	0.4668	-0.0018	-0.0402
30	429	-384	0.4878	430	-382	0.4872	-0.0006	-0.0384
32	411	-342	0.4518	416	-341	0.4542	0.0024	-0.0378
34	335	-262	0.3582	342	-258	0.3600	0.0018	-0.0402
36	255	-223	0.2868	257	-218	0.2850	-0.0018	-0.0420
38	143	-75	0.1308	149	-78	0.1362	0.0054	-0.0402
40	6	40	-0.0204	10	47	-0.0222	-0.0018	-0.0456
42	-122	190	-0.1872	-122	190	-0.1872	0.0000	-0.0438
44	-301	368	-0.4014	-305	359	-0.3984	0.0030	-0.0438
46	-511	527	-0.6228	-511	529	-0.6240	-0.0012	-0.0468
48	-658	722	-0.8280	-662	730	-0.8352	-0.0072	-0.0456
50	-793	841	-0.9804	-797	854	-0.9906	-0.0102	-0.0384
52	-909	968	-1.1262	-905	974	-1.1274	-0.0012	-0.0282
54	-1005	1075	-1.2480	-1006	1083	-1.2534	-0.0054	-0.0270
56	-1088	1107	-1.3170	-1087	1125	-1.3272	-0.0102	-0.0216
58	-1131	1180	-1.3866	-1140	1195	-1.4010	-0.0144	-0.0114
60	-1175	1225	-1.4400	-1175	1226	-1.4406	-0.0006	0.0030
62	-1208	1273	-1.4886	-1209	1273	-1.4892	-0.0006	0.0036
64	-1238	1265	-1.5018	-1241	1281	-1.5132	-0.0114	0.0042
66	-1271	1298	-1.5414	-1272	1300	-1.5432	-0.0018	0.0156
68	-1290	1363	-1.5918	-1290	1346	-1.5816	0.0102	0.0174
70	-1298	1344	-1.5852	-1296	1342	-1.5828	0.0024	0.0072
72	-1221	1253	-1.4844	-1221	1252	-1.4838	0.0006	0.0048
74	-1090	1122	-1.3272	-1089	1123	-1.3272	0.0000	0.0042
76	-1062	1093	-1.2930	-1065	1099	-1.2984	-0.0054	0.0042
78	-1165	1220	-1.4310	-1164	1218	-1.4292	0.0018	0.0096

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 9/15/2009 10:46:55 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:53 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-1138	1189	-1.3962	-1137	1189	-1.3956	0.0006	0.0078
82	-1095	1139	-1.3404	-1095	1136	-1.3386	0.0018	0.0072
84	-1039	1087	-1.2756	-1027	1090	-1.2702	0.0054	0.0054
86	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 10/20/2009 10:21:38 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:53 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	3	49	-0.0276	-4	54	-0.0348	-0.0072	-0.0234
4	9	50	-0.0246	8	51	-0.0258	-0.0012	-0.0162
6	41	14	0.0162	41	14	0.0162	0.0000	-0.0150
8	23	30	-0.0042	21	31	-0.0060	-0.0018	-0.0150
10	-18	61	-0.0474	-20	62	-0.0492	-0.0018	-0.0132
12	-55	107	-0.0972	-55	110	-0.0990	-0.0018	-0.0114
14	-109	163	-0.1632	-108	164	-0.1632	0.0000	-0.0096
16	-102	146	-0.1488	-102	144	-0.1476	0.0012	-0.0096
18	-115	161	-0.1656	-117	167	-0.1704	-0.0048	-0.0108
20	-38	70	-0.0648	-37	73	-0.0660	-0.0012	-0.0060
22	118	-78	0.1176	122	-78	0.1200	0.0024	-0.0048
24	238	-205	0.2658	241	-207	0.2688	0.0030	-0.0072
26	341	-303	0.3864	349	-305	0.3924	0.0060	-0.0102
28	413	-368	0.4686	410	-367	0.4662	-0.0024	-0.0162
30	429	-384	0.4878	430	-385	0.4890	0.0012	-0.0138
32	411	-342	0.4518	415	-341	0.4536	0.0018	-0.0150
34	335	-262	0.3582	341	-264	0.3630	0.0048	-0.0168
36	255	-223	0.2868	259	-217	0.2856	-0.0012	-0.0216
38	143	-75	0.1308	151	-78	0.1374	0.0066	-0.0204
40	6	40	-0.0204	11	43	-0.0192	0.0012	-0.0270
42	-122	190	-0.1872	-122	186	-0.1848	0.0024	-0.0282
44	-301	368	-0.4014	-305	367	-0.4032	-0.0018	-0.0306
46	-511	527	-0.6228	-511	523	-0.6204	0.0024	-0.0288
48	-658	722	-0.8280	-655	726	-0.8286	-0.0006	-0.0312
50	-793	841	-0.9804	-795	854	-0.9894	-0.0090	-0.0306
52	-909	968	-1.1262	-898	969	-1.1202	0.0060	-0.0216
54	-1005	1075	-1.2480	-1001	1077	-1.2468	0.0012	-0.0276
56	-1088	1107	-1.3170	-1085	1122	-1.3242	-0.0072	-0.0288
58	-1131	1180	-1.3866	-1131	1198	-1.3974	-0.0108	-0.0216
60	-1175	1225	-1.4400	-1177	1235	-1.4472	-0.0072	-0.0108
62	-1208	1273	-1.4886	-1206	1277	-1.4898	-0.0012	-0.0036
64	-1238	1265	-1.5018	-1239	1298	-1.5222	-0.0204	-0.0024
66	-1271	1298	-1.5414	-1270	1292	-1.5372	0.0042	0.0180
68	-1290	1363	-1.5918	-1286	1359	-1.5870	0.0048	0.0138
70	-1298	1344	-1.5852	-1297	1338	-1.5810	0.0042	0.0090
72	-1221	1253	-1.4844	-1222	1249	-1.4826	0.0018	0.0048
74	-1090	1122	-1.3272	-1090	1116	-1.3236	0.0036	0.0030
76	-1062	1093	-1.2930	-1063	1095	-1.2948	-0.0018	-0.0006
78	-1165	1220	-1.4310	-1166	1223	-1.4334	-0.0024	0.0012

SITE	CUFTVA
INSTALLATION	SI-50A
DESCRIPTION	

CURRENT SURVEY	10/20/2009	10:21:38 AM
INITIAL SURVEY	8/19/2009	11:00:39 AM
DATE PRINTED	1/18/2010	2:14:53 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-1138	1189	-1.3962	-1136	1187	-1.3938	0.0024	0.0036
82	-1095	1139	-1.3404	-1098	1139	-1.3422	-0.0018	0.0012
84	-1039	1087	-1.2756	-1029	1092	-1.2726	0.0030	0.0030
86	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-50A
DESCRIPTION

CURRENT SURVEY 11/17/2009 11:44:50 AM
INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:53 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	3	49	-0.0276	-2	62	-0.0384	-0.0108	-0.0840
4	9	50	-0.0246	10	57	-0.0282	-0.0036	-0.0732
6	41	14	0.0162	43	19	0.0144	-0.0018	-0.0696
8	23	30	-0.0042	26	33	-0.0042	0.0000	-0.0678
10	-18	61	-0.0474	-16	67	-0.0498	-0.0024	-0.0678
12	-55	107	-0.0972	-51	114	-0.0990	-0.0018	-0.0654
14	-109	163	-0.1632	-103	169	-0.1632	0.0000	-0.0636
16	-102	146	-0.1488	-98	150	-0.1488	0.0000	-0.0636
18	-115	161	-0.1656	-118	174	-0.1752	-0.0096	-0.0636
20	-38	70	-0.0648	-37	79	-0.0696	-0.0048	-0.0540
22	118	-78	0.1176	123	-73	0.1176	0.0000	-0.0492
24	238	-205	0.2658	241	-200	0.2646	-0.0012	-0.0492
26	341	-303	0.3864	347	-299	0.3876	0.0012	-0.0480
28	413	-368	0.4686	407	-356	0.4578	-0.0108	-0.0492
30	429	-384	0.4878	434	-378	0.4872	-0.0006	-0.0384
32	411	-342	0.4518	417	-338	0.4530	0.0012	-0.0378
34	335	-262	0.3582	342	-258	0.3600	0.0018	-0.0390
36	255	-223	0.2868	261	-214	0.2850	-0.0018	-0.0408
38	143	-75	0.1308	155	-73	0.1368	0.0060	-0.0390
40	6	40	-0.0204	18	48	-0.0180	0.0024	-0.0450
42	-122	190	-0.1872	-120	188	-0.1848	0.0024	-0.0474
44	-301	368	-0.4014	-299	371	-0.4020	-0.0006	-0.0498
46	-511	527	-0.6228	-499	522	-0.6126	0.0102	-0.0492
48	-658	722	-0.8280	-651	727	-0.8268	0.0012	-0.0594
50	-793	841	-0.9804	-790	862	-0.9912	-0.0108	-0.0606
52	-909	968	-1.1262	-892	973	-1.1190	0.0072	-0.0498
54	-1005	1075	-1.2480	-995	1078	-1.2438	0.0042	-0.0570
56	-1088	1107	-1.3170	-1082	1128	-1.3260	-0.0090	-0.0612
58	-1131	1180	-1.3866	-1127	1205	-1.3992	-0.0126	-0.0522
60	-1175	1225	-1.4400	-1175	1241	-1.4496	-0.0096	-0.0396
62	-1208	1273	-1.4886	-1203	1283	-1.4916	-0.0030	-0.0300
64	-1238	1265	-1.5018	-1236	1306	-1.5252	-0.0234	-0.0270
66	-1271	1298	-1.5414	-1265	1295	-1.5360	0.0054	-0.0036
68	-1290	1363	-1.5918	-1286	1362	-1.5888	0.0030	-0.0090
70	-1298	1344	-1.5852	-1293	1343	-1.5816	0.0036	-0.0120
72	-1221	1253	-1.4844	-1221	1255	-1.4856	-0.0012	-0.0156
74	-1090	1122	-1.3272	-1090	1123	-1.3278	-0.0006	-0.0144
76	-1062	1093	-1.2930	-1055	1099	-1.2924	0.0006	-0.0138
78	-1165	1220	-1.4310	-1161	1235	-1.4376	-0.0066	-0.0144

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 11/17/2009 11:44:50 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:53 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-1138	1189	-1.3962	-1134	1194	-1.3968	-0.0006	-0.0078
82	-1095	1139	-1.3404	-1095	1149	-1.3464	-0.0060	-0.0072
84	-1039	1087	-1.2756	-1031	1097	-1.2768	-0.0012	-0.0012
86	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 12/7/2009 11:23:30 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:53 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	3	49	-0.0276	-3	62	-0.0390	-0.0114	-0.1092
4	9	50	-0.0246	11	56	-0.0270	-0.0024	-0.0978
6	41	14	0.0162	44	18	0.0156	-0.0006	-0.0954
8	23	30	-0.0042	25	33	-0.0048	-0.0006	-0.0948
10	-18	61	-0.0474	-17	64	-0.0486	-0.0012	-0.0942
12	-55	107	-0.0972	-51	114	-0.0990	-0.0018	-0.0930
14	-109	163	-0.1632	-105	167	-0.1632	0.0000	-0.0912
16	-102	146	-0.1488	-97	147	-0.1464	0.0024	-0.0912
18	-115	161	-0.1656	-115	173	-0.1728	-0.0072	-0.0936
20	-38	70	-0.0648	-34	76	-0.0660	-0.0012	-0.0864
22	118	-78	0.1176	123	-77	0.1200	0.0024	-0.0852
24	238	-205	0.2658	242	-203	0.2670	0.0012	-0.0876
26	341	-303	0.3864	352	-300	0.3912	0.0048	-0.0888
28	413	-368	0.4686	412	-362	0.4644	-0.0042	-0.0936
30	429	-384	0.4878	432	-381	0.4878	0.0000	-0.0894
32	411	-342	0.4518	416	-339	0.4530	0.0012	-0.0894
34	335	-262	0.3582	341	-259	0.3600	0.0018	-0.0906
36	255	-223	0.2868	262	-213	0.2850	-0.0018	-0.0924
38	143	-75	0.1308	152	-73	0.1350	0.0042	-0.0906
40	6	40	-0.0204	15	49	-0.0204	0.0000	-0.0948
42	-122	190	-0.1872	-121	191	-0.1872	0.0000	-0.0948
44	-301	368	-0.4014	-299	374	-0.4038	-0.0024	-0.0948
46	-511	527	-0.6228	-507	525	-0.6192	0.0036	-0.0924
48	-658	722	-0.8280	-654	730	-0.8304	-0.0024	-0.0960
50	-793	841	-0.9804	-795	865	-0.9960	-0.0156	-0.0936
52	-909	968	-1.1262	-890	975	-1.1190	0.0072	-0.0780
54	-1005	1075	-1.2480	-995	1083	-1.2468	0.0012	-0.0852
56	-1088	1107	-1.3170	-1083	1129	-1.3272	-0.0102	-0.0864
58	-1131	1180	-1.3866	-1133	1205	-1.4028	-0.0162	-0.0762
60	-1175	1225	-1.4400	-1176	1243	-1.4514	-0.0114	-0.0600
62	-1208	1273	-1.4886	-1208	1285	-1.4958	-0.0072	-0.0486
64	-1238	1265	-1.5018	-1238	1305	-1.5258	-0.0240	-0.0414
66	-1271	1298	-1.5414	-1269	1296	-1.5390	0.0024	-0.0174
68	-1290	1363	-1.5918	-1289	1362	-1.5906	0.0012	-0.0198
70	-1298	1344	-1.5852	-1297	1343	-1.5840	0.0012	-0.0210
72	-1221	1253	-1.4844	-1221	1259	-1.4880	-0.0036	-0.0222
74	-1090	1122	-1.3272	-1089	1122	-1.3266	0.0006	-0.0186
76	-1062	1093	-1.2930	-1061	1100	-1.2966	-0.0036	-0.0192
78	-1165	1220	-1.4310	-1162	1235	-1.4382	-0.0072	-0.0156

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 12/7/2009 11:23:30 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:53 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-1138	1189	-1.3962	-1137	1193	-1.3980	-0.0018	-0.0084
82	-1095	1139	-1.3404	-1096	1146	-1.3452	-0.0048	-0.0066
84	-1039	1087	-1.2756	-1034	1095	-1.2774	-0.0018	-0.0018
86	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

CURRENT SURVEY 1/18/2010 9:08:14 AM

INITIAL SURVEY 8/19/2009 11:00:39 AM

DATE PRINTED 1/18/2010 2:14:53 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	3	49	-0.0276	-41	11	-0.0312	-0.0036	-0.5916
4	9	50	-0.0246	-25	-2	-0.0138	0.0108	-0.5880
6	41	14	0.0162	-5	-33	0.0168	0.0006	-0.5988
8	23	30	-0.0042	-19	-9	-0.0060	-0.0018	-0.5994
10	-18	61	-0.0474	-54	42	-0.0576	-0.0102	-0.5976
12	-55	107	-0.0972	-99	77	-0.1056	-0.0084	-0.5874
14	-109	163	-0.1632	-145	115	-0.1560	0.0072	-0.5790
16	-102	146	-0.1488	-147	118	-0.1590	-0.0102	-0.5862
18	-115	161	-0.1656	-148	124	-0.1632	0.0024	-0.5760
20	-38	70	-0.0648	-55	55	-0.0660	-0.0012	-0.5784
22	118	-78	0.1176	92	-100	0.1152	-0.0024	-0.5772
24	238	-205	0.2658	210	-224	0.2604	-0.0054	-0.5748
26	341	-303	0.3864	306	-321	0.3762	-0.0102	-0.5694
28	413	-368	0.4686	362	-400	0.4572	-0.0114	-0.5592
30	429	-384	0.4878	366	-374	0.4440	-0.0438	-0.5478
32	411	-342	0.4518	350	-358	0.4248	-0.0270	-0.5040
34	335	-262	0.3582	264	-287	0.3306	-0.0276	-0.4770
36	255	-223	0.2868	201	-227	0.2568	-0.0300	-0.4494
38	143	-75	0.1308	77	-99	0.1056	-0.0252	-0.4194
40	6	40	-0.0204	-50	28	-0.0468	-0.0264	-0.3942
42	-122	190	-0.1872	-185	171	-0.2136	-0.0264	-0.3678
44	-301	368	-0.4014	-355	326	-0.4086	-0.0072	-0.3414
46	-511	527	-0.6228	-517	516	-0.6198	0.0030	-0.3342
48	-658	722	-0.8280	-720	712	-0.8592	-0.0312	-0.3372
50	-793	841	-0.9804	-861	857	-1.0308	-0.0504	-0.3060
52	-909	968	-1.1262	-958	955	-1.1478	-0.0216	-0.2556
54	-1005	1075	-1.2480	-1072	1041	-1.2678	-0.0198	-0.2340
56	-1088	1107	-1.3170	-1140	1114	-1.3524	-0.0354	-0.2142
58	-1131	1180	-1.3866	-1194	1147	-1.4046	-0.0180	-0.1788
60	-1175	1225	-1.4400	-1240	1199	-1.4634	-0.0234	-0.1608
62	-1208	1273	-1.4886	-1267	1225	-1.4952	-0.0066	-0.1374
64	-1238	1265	-1.5018	-1299	1260	-1.5354	-0.0336	-0.1308
66	-1271	1298	-1.5414	-1286	1284	-1.5420	-0.0006	-0.0972
68	-1290	1363	-1.5918	-1340	1307	-1.5882	0.0036	-0.0966
70	-1298	1344	-1.5852	-1340	1315	-1.5930	-0.0078	-0.1002
72	-1221	1253	-1.4844	-1257	1242	-1.4994	-0.0150	-0.0924
74	-1090	1122	-1.3272	-1122	1105	-1.3362	-0.0090	-0.0774
76	-1062	1093	-1.2930	-1094	1094	-1.3128	-0.0198	-0.0684
78	-1165	1220	-1.4310	-1219	1183	-1.4412	-0.0102	-0.0486

SITE CUFTVA

INSTALLATION SI-50A

DESCRIPTION

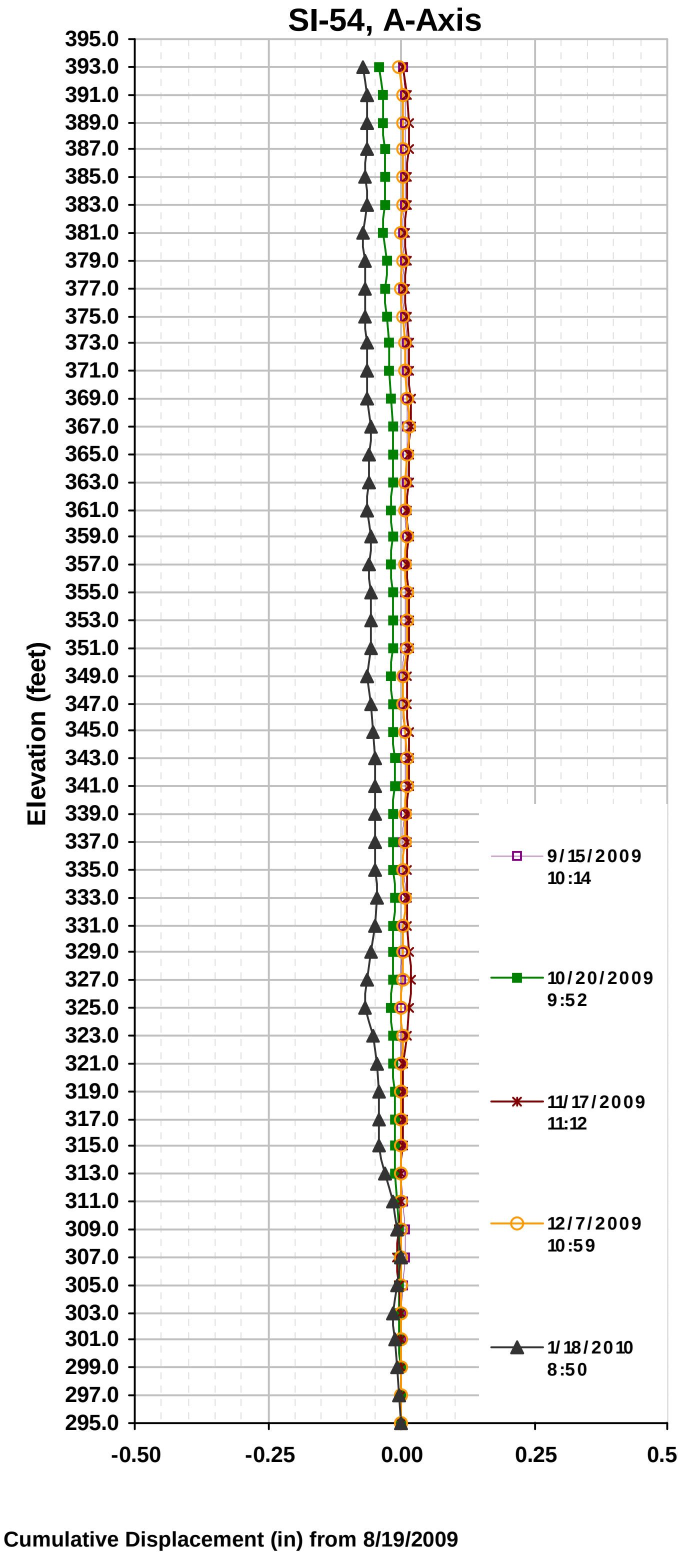
CURRENT SURVEY 1/18/2010 9:08:14 AM

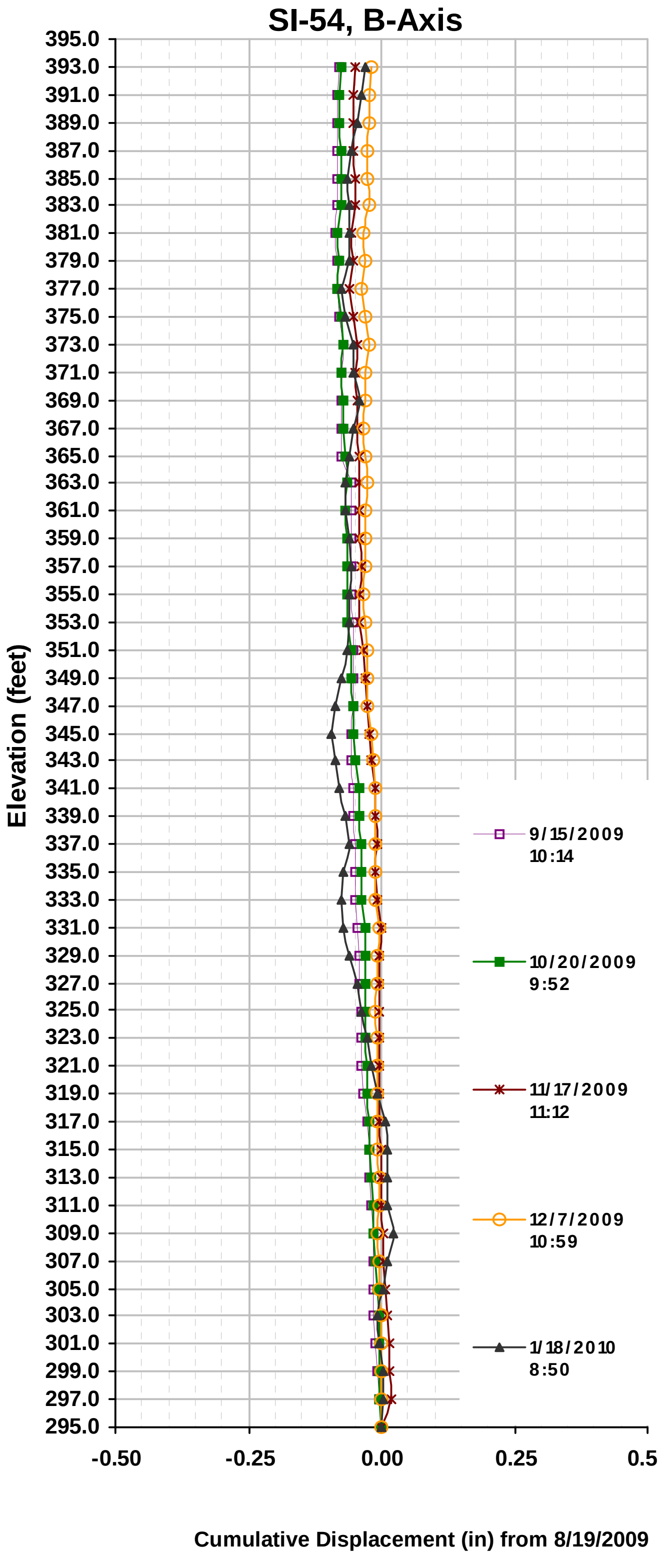
INITIAL SURVEY 8/19/2009 11:00:39 AM

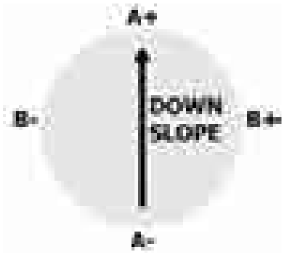
DATE PRINTED 1/18/2010 2:14:53 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-1138	1189	-1.3962	-1186	1155	-1.4046	-0.0084	-0.0384
82	-1095	1139	-1.3404	-1133	1113	-1.3476	-0.0072	-0.0300
84	-1039	1087	-1.2756	-1082	1082	-1.2984	-0.0228	-0.0228
86	0	0	0.0000	0	0	0.0000	0.0000	0.0000







Cumberland Fossil Plant

Cumberland City, TN
175539016
1/18/2010

SITE CUFTVA

INSTALLATION SI-54

DESCRIPTION

CURRENT SURVEY 9/15/2009 10:14:38 AM

INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:20:43 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	74	-64	0.0828	69	-62	0.0786	-0.0042	0.0048
4	56	-47	0.0618	54	-49	0.0618	0.0000	0.0090
6	2	8	-0.0036	1	5	-0.0024	0.0012	0.0090
8	-46	54	-0.0600	-47	51	-0.0588	0.0012	0.0078
10	-82	94	-0.1056	-85	92	-0.1062	-0.0006	0.0066
12	-81	91	-0.1032	-81	85	-0.0996	0.0036	0.0072
14	-91	100	-0.1146	-95	100	-0.1170	-0.0024	0.0036
16	-69	77	-0.0876	-70	74	-0.0864	0.0012	0.0060
18	-3	12	-0.0090	-6	11	-0.0102	-0.0012	0.0048
20	21	-12	0.0198	14	-10	0.0144	-0.0054	0.0060
22	37	-28	0.0390	36	-31	0.0402	0.0012	0.0114
24	10	0	0.0060	9	-2	0.0066	0.0006	0.0102
26	-29	38	-0.0402	-33	38	-0.0426	-0.0024	0.0096
28	-209	217	-0.2556	-210	214	-0.2544	0.0012	0.0120
30	-273	284	-0.3342	-275	281	-0.3336	0.0006	0.0108
32	-214	221	-0.2610	-212	218	-0.2580	0.0030	0.0102
34	-174	183	-0.2142	-178	184	-0.2172	-0.0030	0.0072
36	-242	253	-0.2970	-243	249	-0.2952	0.0018	0.0102
38	-262	269	-0.3186	-263	268	-0.3186	0.0000	0.0084
40	-224	237	-0.2766	-226	234	-0.2760	0.0006	0.0084
42	-209	216	-0.2550	-211	215	-0.2556	-0.0006	0.0078
44	-157	166	-0.1938	-155	161	-0.1896	0.0042	0.0084
46	-216	224	-0.2640	-219	223	-0.2652	-0.0012	0.0042
48	-243	252	-0.2970	-247	251	-0.2988	-0.0018	0.0054
50	-293	303	-0.3576	-295	302	-0.3582	-0.0006	0.0072
52	-305	313	-0.3708	-307	311	-0.3708	0.0000	0.0078
54	-339	350	-0.4134	-341	346	-0.4122	0.0012	0.0078
56	-393	402	-0.4770	-394	399	-0.4758	0.0012	0.0066
58	-410	418	-0.4968	-411	415	-0.4956	0.0012	0.0054
60	-481	491	-0.5832	-485	490	-0.5850	-0.0018	0.0042
62	-413	420	-0.4998	-413	417	-0.4980	0.0018	0.0060
64	-224	233	-0.2742	-223	231	-0.2724	0.0018	0.0042
66	-13	21	-0.0204	-13	18	-0.0186	0.0018	0.0024
68	133	-123	0.1536	133	-127	0.1560	0.0024	0.0006
70	-34	46	-0.0480	-39	46	-0.0510	-0.0030	-0.0018
72	-326	333	-0.3954	-328	331	-0.3954	0.0000	0.0012
74	-453	464	-0.5502	-455	462	-0.5502	0.0000	0.0012
76	-467	479	-0.5676	-468	477	-0.5670	0.0006	0.0012
78	-414	426	-0.5040	-415	422	-0.5022	0.0018	0.0006

SITE CUFTVA

INSTALLATION SI-54

DESCRIPTION

CURRENT SURVEY 9/15/2009 10:14:38 AM

INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:20:43 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-475	488	-0.5778	-477	488	-0.5790	-0.0012	-0.0012
82	-674	685	-0.8154	-679	685	-0.8184	-0.0030	0.0000
84	-905	915	-1.0920	-909	916	-1.0950	-0.0030	0.0030
86	-1082	1094	-1.3056	-1086	1094	-1.3080	-0.0024	0.0060
88	-1042	1045	-1.2522	-1040	1040	-1.2480	0.0042	0.0084
90	-871	882	-1.0518	-871	877	-1.0488	0.0030	0.0042
92	-773	779	-0.9312	-774	777	-0.9306	0.0006	0.0012
94	-746	759	-0.9030	-748	758	-0.9036	-0.0006	0.0006
96	-769	781	-0.9300	-772	779	-0.9306	-0.0006	0.0012
98	-844	849	-1.0158	-842	848	-1.0140	0.0018	0.0018
100	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-54

DESCRIPTION

CURRENT SURVEY 10/20/2009 9:52:54 AM

INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:20:43 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	74	-64	0.0828	65	-60	0.0750	-0.0078	-0.0426
4	56	-47	0.0618	52	-47	0.0594	-0.0024	-0.0348
6	2	8	-0.0036	-1	6	-0.0042	-0.0006	-0.0324
8	-46	54	-0.0600	-47	53	-0.0600	0.0000	-0.0318
10	-82	94	-0.1056	-86	94	-0.1080	-0.0024	-0.0318
12	-81	91	-0.1032	-81	85	-0.0996	0.0036	-0.0294
14	-91	100	-0.1146	-97	103	-0.1200	-0.0054	-0.0330
16	-69	77	-0.0876	-69	73	-0.0852	0.0024	-0.0276
18	-3	12	-0.0090	-7	13	-0.0120	-0.0030	-0.0300
20	21	-12	0.0198	15	-10	0.0150	-0.0048	-0.0270
22	37	-28	0.0390	34	-30	0.0384	-0.0006	-0.0222
24	10	0	0.0060	5	2	0.0018	-0.0042	-0.0216
26	-29	38	-0.0402	-33	39	-0.0432	-0.0030	-0.0174
28	-209	217	-0.2556	-209	214	-0.2538	0.0018	-0.0144
30	-273	284	-0.3342	-275	281	-0.3336	0.0006	-0.0162
32	-214	221	-0.2610	-212	218	-0.2580	0.0030	-0.0168
34	-174	183	-0.2142	-179	185	-0.2184	-0.0042	-0.0198
36	-242	253	-0.2970	-243	249	-0.2952	0.0018	-0.0156
38	-262	269	-0.3186	-265	269	-0.3204	-0.0018	-0.0174
40	-224	237	-0.2766	-227	235	-0.2772	-0.0006	-0.0156
42	-209	216	-0.2550	-212	214	-0.2556	-0.0006	-0.0150
44	-157	166	-0.1938	-155	159	-0.1884	0.0054	-0.0144
46	-216	224	-0.2640	-221	224	-0.2670	-0.0030	-0.0198
48	-243	252	-0.2970	-248	253	-0.3006	-0.0036	-0.0168
50	-293	303	-0.3576	-296	303	-0.3594	-0.0018	-0.0132
52	-305	313	-0.3708	-308	310	-0.3708	0.0000	-0.0114
54	-339	350	-0.4134	-340	346	-0.4116	0.0018	-0.0114
56	-393	402	-0.4770	-395	400	-0.4770	0.0000	-0.0132
58	-410	418	-0.4968	-410	415	-0.4950	0.0018	-0.0132
60	-481	491	-0.5832	-485	491	-0.5856	-0.0024	-0.0150
62	-413	420	-0.4998	-414	416	-0.4980	0.0018	-0.0126
64	-224	233	-0.2742	-225	231	-0.2736	0.0006	-0.0144
66	-13	21	-0.0204	-14	19	-0.0198	0.0006	-0.0150
68	133	-123	0.1536	132	-127	0.1554	0.0018	-0.0156
70	-34	46	-0.0480	-39	47	-0.0516	-0.0036	-0.0174
72	-326	333	-0.3954	-327	333	-0.3960	-0.0006	-0.0138
74	-453	464	-0.5502	-456	463	-0.5514	-0.0012	-0.0132
76	-467	479	-0.5676	-470	477	-0.5682	-0.0006	-0.0120
78	-414	426	-0.5040	-417	424	-0.5046	-0.0006	-0.0114

SITE	CUFTVA
INSTALLATION	SI-54
DESCRIPTION	

CURRENT SURVEY	10/20/2009	9:52:54 AM
INITIAL SURVEY	8/19/2009	10:24:47 AM
DATE PRINTED	1/18/2010	2:20:43 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-475	488	-0.5778	-477	487	-0.5784	-0.0006	-0.0108
82	-674	685	-0.8154	-681	684	-0.8190	-0.0036	-0.0102
84	-905	915	-1.0920	-909	915	-1.0944	-0.0024	-0.0066
86	-1082	1094	-1.3056	-1086	1093	-1.3074	-0.0018	-0.0042
88	-1042	1045	-1.2522	-1042	1043	-1.2510	0.0012	-0.0024
90	-871	882	-1.0518	-873	879	-1.0512	0.0006	-0.0036
92	-773	779	-0.9312	-776	778	-0.9324	-0.0012	-0.0042
94	-746	759	-0.9030	-750	759	-0.9054	-0.0024	-0.0030
96	-769	781	-0.9300	-773	778	-0.9306	-0.0006	-0.0006
98	-844	849	-1.0158	-843	850	-1.0158	0.0000	0.0000
100	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-54
DESCRIPTION

CURRENT SURVEY 11/17/2009 11:12:58 AM
INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:20:43 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	74	-64	0.0828	66	-58	0.0744	-0.0084	0.0030
4	56	-47	0.0618	54	-46	0.0600	-0.0018	0.0114
6	2	8	-0.0036	1	7	-0.0036	0.0000	0.0132
8	-46	54	-0.0600	-45	52	-0.0582	0.0018	0.0132
10	-82	94	-0.1056	-83	94	-0.1062	-0.0006	0.0114
12	-81	91	-0.1032	-77	85	-0.0972	0.0060	0.0120
14	-91	100	-0.1146	-95	103	-0.1188	-0.0042	0.0060
16	-69	77	-0.0876	-69	75	-0.0864	0.0012	0.0102
18	-3	12	-0.0090	-6	12	-0.0108	-0.0018	0.0090
20	21	-12	0.0198	16	-7	0.0138	-0.0060	0.0108
22	37	-28	0.0390	36	-30	0.0396	0.0006	0.0168
24	10	0	0.0060	7	2	0.0030	-0.0030	0.0162
26	-29	38	-0.0402	-30	39	-0.0414	-0.0012	0.0192
28	-209	217	-0.2556	-205	212	-0.2502	0.0054	0.0204
30	-273	284	-0.3342	-273	282	-0.3330	0.0012	0.0150
32	-214	221	-0.2610	-213	219	-0.2592	0.0018	0.0138
34	-174	183	-0.2142	-177	187	-0.2184	-0.0042	0.0120
36	-242	253	-0.2970	-240	249	-0.2934	0.0036	0.0162
38	-262	269	-0.3186	-265	271	-0.3216	-0.0030	0.0126
40	-224	237	-0.2766	-226	237	-0.2778	-0.0012	0.0156
42	-209	216	-0.2550	-210	215	-0.2550	0.0000	0.0168
44	-157	166	-0.1938	-153	162	-0.1890	0.0048	0.0168
46	-216	224	-0.2640	-216	223	-0.2634	0.0006	0.0120
48	-243	252	-0.2970	-247	255	-0.3012	-0.0042	0.0114
50	-293	303	-0.3576	-293	301	-0.3564	0.0012	0.0156
52	-305	313	-0.3708	-308	313	-0.3726	-0.0018	0.0144
54	-339	350	-0.4134	-337	346	-0.4098	0.0036	0.0162
56	-393	402	-0.4770	-392	401	-0.4758	0.0012	0.0126
58	-410	418	-0.4968	-410	417	-0.4962	0.0006	0.0114
60	-481	491	-0.5832	-482	490	-0.5832	0.0000	0.0108
62	-413	420	-0.4998	-416	420	-0.5016	-0.0018	0.0108
64	-224	233	-0.2742	-226	234	-0.2760	-0.0018	0.0126
66	-13	21	-0.0204	-16	23	-0.0234	-0.0030	0.0144
68	133	-123	0.1536	133	-125	0.1548	0.0012	0.0174
70	-34	46	-0.0480	-31	38	-0.0414	0.0066	0.0162
72	-326	333	-0.3954	-322	328	-0.3900	0.0054	0.0096
74	-453	464	-0.5502	-452	463	-0.5490	0.0012	0.0042
76	-467	479	-0.5676	-469	479	-0.5688	-0.0012	0.0030
78	-414	426	-0.5040	-416	426	-0.5052	-0.0012	0.0042

SITE CUFTVA
INSTALLATION SI-54
DESCRIPTION

CURRENT SURVEY 11/17/2009 11:12:58 AM

INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:20:44 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-475	488	-0.5778	-471	484	-0.5730	0.0048	0.0054
82	-674	685	-0.8154	-673	682	-0.8130	0.0024	0.0006
84	-905	915	-1.0920	-903	913	-1.0896	0.0024	-0.0018
86	-1082	1094	-1.3056	-1082	1090	-1.3032	0.0024	-0.0042
88	-1042	1045	-1.2522	-1043	1048	-1.2546	-0.0024	-0.0066
90	-871	882	-1.0518	-874	883	-1.0542	-0.0024	-0.0042
92	-773	779	-0.9312	-775	780	-0.9330	-0.0018	-0.0018
94	-746	759	-0.9030	-747	759	-0.9036	-0.0006	0.0000
96	-769	781	-0.9300	-770	778	-0.9288	0.0012	0.0006
98	-844	849	-1.0158	-842	852	-1.0164	-0.0006	-0.0006
100	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-54
DESCRIPTION

CURRENT SURVEY 12/7/2009 10:59:23 AM
INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:20:44 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	74	-64	0.0828	70	-57	0.0762	-0.0066	-0.0030
4	56	-47	0.0618	57	-44	0.0606	-0.0012	0.0036
6	2	8	-0.0036	3	10	-0.0042	-0.0006	0.0048
8	-46	54	-0.0600	-42	54	-0.0576	0.0024	0.0054
10	-82	94	-0.1056	-81	97	-0.1068	-0.0012	0.0030
12	-81	91	-0.1032	-75	88	-0.0978	0.0054	0.0042
14	-91	100	-0.1146	-93	106	-0.1194	-0.0048	-0.0012
16	-69	77	-0.0876	-65	77	-0.0852	0.0024	0.0036
18	-3	12	-0.0090	-2	15	-0.0102	-0.0012	0.0012
20	21	-12	0.0198	18	-5	0.0138	-0.0060	0.0024
22	37	-28	0.0390	38	-27	0.0390	0.0000	0.0084
24	10	0	0.0060	10	5	0.0030	-0.0030	0.0084
26	-29	38	-0.0402	-27	43	-0.0420	-0.0018	0.0114
28	-209	217	-0.2556	-204	217	-0.2526	0.0030	0.0132
30	-273	284	-0.3342	-270	285	-0.3330	0.0012	0.0102
32	-214	221	-0.2610	-209	221	-0.2580	0.0030	0.0090
34	-174	183	-0.2142	-175	190	-0.2190	-0.0048	0.0060
36	-242	253	-0.2970	-237	252	-0.2934	0.0036	0.0108
38	-262	269	-0.3186	-262	274	-0.3216	-0.0030	0.0072
40	-224	237	-0.2766	-222	239	-0.2766	0.0000	0.0102
42	-209	216	-0.2550	-206	218	-0.2544	0.0006	0.0102
44	-157	166	-0.1938	-150	163	-0.1878	0.0060	0.0096
46	-216	224	-0.2640	-215	228	-0.2658	-0.0018	0.0036
48	-243	252	-0.2970	-243	256	-0.2994	-0.0024	0.0054
50	-293	303	-0.3576	-293	308	-0.3606	-0.0030	0.0078
52	-305	313	-0.3708	-304	315	-0.3714	-0.0006	0.0108
54	-339	350	-0.4134	-335	349	-0.4104	0.0030	0.0114
56	-393	402	-0.4770	-390	404	-0.4764	0.0006	0.0084
58	-410	418	-0.4968	-406	418	-0.4944	0.0024	0.0078
60	-481	491	-0.5832	-479	494	-0.5838	-0.0006	0.0054
62	-413	420	-0.4998	-411	420	-0.4986	0.0012	0.0060
64	-224	233	-0.2742	-221	234	-0.2730	0.0012	0.0048
66	-13	21	-0.0204	-11	25	-0.0216	-0.0012	0.0036
68	133	-123	0.1536	137	-124	0.1566	0.0030	0.0048
70	-34	46	-0.0480	-34	48	-0.0492	-0.0012	0.0018
72	-326	333	-0.3954	-321	333	-0.3924	0.0030	0.0030
74	-453	464	-0.5502	-451	466	-0.5502	0.0000	0.0000
76	-467	479	-0.5676	-465	481	-0.5676	0.0000	0.0000
78	-414	426	-0.5040	-412	428	-0.5040	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-54

DESCRIPTION

CURRENT SURVEY 12/7/2009 10:59:23 AM

INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:20:44 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-475	488	-0.5778	-472	490	-0.5772	0.0006	0.0000
82	-674	685	-0.8154	-674	686	-0.8160	-0.0006	-0.0006
84	-905	915	-1.0920	-903	918	-1.0926	-0.0006	0.0000
86	-1082	1094	-1.3056	-1080	1094	-1.3044	0.0012	0.0006
88	-1042	1045	-1.2522	-1038	1047	-1.2510	0.0012	-0.0006
90	-871	882	-1.0518	-869	884	-1.0518	0.0000	-0.0018
92	-773	779	-0.9312	-771	783	-0.9324	-0.0012	-0.0018
94	-746	759	-0.9030	-745	762	-0.9042	-0.0012	-0.0006
96	-769	781	-0.9300	-767	782	-0.9294	0.0006	0.0006
98	-844	849	-1.0158	-838	855	-1.0158	0.0000	0.0000
100	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-54
DESCRIPTION

CURRENT SURVEY 1/18/2010 8:50:35 AM
INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:20:44 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	74	-64	0.0828	66	-63	0.0774	-0.0054	-0.0696
4	56	-47	0.0618	51	-51	0.0612	-0.0006	-0.0642
6	2	8	-0.0036	-1	4	-0.0030	0.0006	-0.0636
8	-46	54	-0.0600	-49	48	-0.0582	0.0018	-0.0642
10	-82	94	-0.1056	-88	89	-0.1062	-0.0006	-0.0660
12	-81	91	-0.1032	-79	81	-0.0960	0.0072	-0.0654
14	-91	100	-0.1146	-99	100	-0.1194	-0.0048	-0.0726
16	-69	77	-0.0876	-72	72	-0.0864	0.0012	-0.0678
18	-3	12	-0.0090	-7	8	-0.0090	0.0000	-0.0690
20	21	-12	0.0198	14	-12	0.0156	-0.0042	-0.0690
22	37	-28	0.0390	34	-32	0.0396	0.0006	-0.0648
24	10	0	0.0060	4	-3	0.0042	-0.0018	-0.0654
26	-29	38	-0.0402	-37	39	-0.0456	-0.0054	-0.0636
28	-209	217	-0.2556	-212	213	-0.2550	0.0006	-0.0582
30	-273	284	-0.3342	-277	278	-0.3330	0.0012	-0.0588
32	-214	221	-0.2610	-213	214	-0.2562	0.0048	-0.0600
34	-174	183	-0.2142	-184	184	-0.2208	-0.0066	-0.0648
36	-242	253	-0.2970	-246	247	-0.2958	0.0012	-0.0582
38	-262	269	-0.3186	-267	268	-0.3210	-0.0024	-0.0594
40	-224	237	-0.2766	-230	231	-0.2766	0.0000	-0.0570
42	-209	216	-0.2550	-214	213	-0.2562	-0.0012	-0.0570
44	-157	166	-0.1938	-156	156	-0.1872	0.0066	-0.0558
46	-216	224	-0.2640	-225	225	-0.2700	-0.0060	-0.0624
48	-243	252	-0.2970	-249	250	-0.2994	-0.0024	-0.0564
50	-293	303	-0.3576	-303	304	-0.3642	-0.0066	-0.0540
52	-305	313	-0.3708	-308	310	-0.3708	0.0000	-0.0474
54	-339	350	-0.4134	-344	345	-0.4134	0.0000	-0.0474
56	-393	402	-0.4770	-397	398	-0.4770	0.0000	-0.0474
58	-410	418	-0.4968	-412	413	-0.4950	0.0018	-0.0474
60	-481	491	-0.5832	-490	491	-0.5886	-0.0054	-0.0492
62	-413	420	-0.4998	-409	413	-0.4932	0.0066	-0.0438
64	-224	233	-0.2742	-222	223	-0.2670	0.0072	-0.0504
66	-13	21	-0.0204	-10	12	-0.0132	0.0072	-0.0576
68	133	-123	0.1536	132	-131	0.1578	0.0042	-0.0648
70	-34	46	-0.0480	-53	52	-0.0630	-0.0150	-0.0690
72	-326	333	-0.3954	-336	336	-0.4032	-0.0078	-0.0540
74	-453	464	-0.5502	-461	462	-0.5538	-0.0036	-0.0462
76	-467	479	-0.5676	-472	475	-0.5682	-0.0006	-0.0426
78	-414	426	-0.5040	-421	421	-0.5052	-0.0012	-0.0420

SITE CUFTVA

INSTALLATION SI-54

DESCRIPTION

CURRENT SURVEY 1/18/2010 8:50:35 AM

INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:20:44 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-475	488	-0.5778	-490	489	-0.5874	-0.0096	-0.0408
82	-674	685	-0.8154	-693	696	-0.8334	-0.0180	-0.0312
84	-905	915	-1.0920	-916	915	-1.0986	-0.0066	-0.0132
86	-1082	1094	-1.3056	-1093	1093	-1.3116	-0.0060	-0.0066
88	-1042	1045	-1.2522	-1036	1039	-1.2450	0.0072	-0.0006
90	-871	882	-1.0518	-870	874	-1.0464	0.0054	-0.0078
92	-773	779	-0.9312	-776	779	-0.9330	-0.0018	-0.0132
94	-746	759	-0.9030	-754	759	-0.9078	-0.0048	-0.0114
96	-769	781	-0.9300	-777	779	-0.9336	-0.0036	-0.0066
98	-844	849	-1.0158	-849	849	-1.0188	-0.0030	-0.0030
100	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-54

DESCRIPTION

CURRENT SURVEY 9/15/2009 10:14:38 AM

INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:21:35 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	108	-53	0.0966	111	-54	0.0990	0.0024	-0.0786
4	128	-64	0.1152	127	-65	0.1152	0.0000	-0.0810
6	163	-102	0.1590	165	-102	0.1602	0.0012	-0.0810
8	247	-189	0.2616	248	-188	0.2616	0.0000	-0.0822
10	314	-261	0.3450	314	-260	0.3444	-0.0006	-0.0822
12	338	-283	0.3726	344	-283	0.3762	0.0036	-0.0816
14	262	-198	0.2760	261	-195	0.2736	-0.0024	-0.0852
16	239	-178	0.2502	241	-175	0.2496	-0.0006	-0.0828
18	283	-226	0.3054	281	-221	0.3012	-0.0042	-0.0822
20	255	-212	0.2802	253	-203	0.2736	-0.0066	-0.0780
22	157	-120	0.1662	163	-123	0.1716	0.0054	-0.0714
24	34	26	0.0048	33	30	0.0018	-0.0030	-0.0768
26	-44	102	-0.0876	-42	103	-0.0870	0.0006	-0.0738
28	-26	80	-0.0636	-26	80	-0.0636	0.0000	-0.0744
30	15	39	-0.0144	-14	39	-0.0318	-0.0174	-0.0744
32	9	31	-0.0132	11	32	-0.0126	0.0006	-0.0570
34	-123	186	-0.1854	-124	188	-0.1872	-0.0018	-0.0576
36	-179	243	-0.2532	-178	246	-0.2544	-0.0012	-0.0558
38	-199	261	-0.2760	-196	259	-0.2730	0.0030	-0.0546
40	-265	317	-0.3492	-267	321	-0.3528	-0.0036	-0.0576
42	-265	323	-0.3528	-266	327	-0.3558	-0.0030	-0.0540
44	-233	296	-0.3174	-231	297	-0.3168	0.0006	-0.0510
46	-167	225	-0.2352	-165	223	-0.2328	0.0024	-0.0516
48	-57	103	-0.0960	-53	103	-0.0936	0.0024	-0.0540
50	41	10	0.0186	42	13	0.0174	-0.0012	-0.0564
52	62	-5	0.0402	62	-1	0.0378	-0.0024	-0.0552
54	43	23	0.0120	43	25	0.0108	-0.0012	-0.0528
56	-29	89	-0.0708	-29	94	-0.0738	-0.0030	-0.0516
58	-71	131	-0.1212	-68	134	-0.1212	0.0000	-0.0486
60	-20	69	-0.0534	-18	70	-0.0528	0.0006	-0.0486
62	46	11	0.0210	46	17	0.0174	-0.0036	-0.0492
64	30	31	-0.0006	29	34	-0.0030	-0.0024	-0.0456
66	-68	129	-0.1182	-67	134	-0.1206	-0.0024	-0.0432
68	-119	180	-0.1794	-118	184	-0.1812	-0.0018	-0.0408
70	-205	253	-0.2748	-204	258	-0.2772	-0.0024	-0.0390
72	-278	331	-0.3654	-275	335	-0.3660	-0.0006	-0.0366
74	-344	399	-0.4458	-346	402	-0.4488	-0.0030	-0.0360
76	-455	504	-0.5754	-458	510	-0.5808	-0.0054	-0.0330
78	-564	616	-0.7080	-565	621	-0.7116	-0.0036	-0.0276

SITE CUFTVA

INSTALLATION SI-54

DESCRIPTION

CURRENT SURVEY 9/15/2009 10:14:38 AM

INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:21:35 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-665	709	-0.8244	-665	714	-0.8274	-0.0030	-0.0240
82	-691	740	-0.8586	-691	746	-0.8622	-0.0036	-0.0210
84	-698	763	-0.8766	-697	767	-0.8784	-0.0018	-0.0174
86	-746	805	-0.9306	-743	809	-0.9312	-0.0006	-0.0156
88	-678	734	-0.8472	-675	736	-0.8466	0.0006	-0.0150
90	-615	661	-0.7656	-614	665	-0.7674	-0.0018	-0.0156
92	-534	588	-0.6732	-533	593	-0.6756	-0.0024	-0.0138
94	-576	628	-0.7224	-575	634	-0.7254	-0.0030	-0.0114
96	-646	703	-0.8094	-647	708	-0.8130	-0.0036	-0.0084
98	-708	746	-0.8724	-711	751	-0.8772	-0.0048	-0.0048
100	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-54
DESCRIPTION

CURRENT SURVEY 10/20/2009 9:52:54 AM
INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:21:35 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	108	-53	0.0966	109	-57	0.0996	0.0030	-0.0756
4	128	-64	0.1152	127	-64	0.1146	-0.0006	-0.0786
6	163	-102	0.1590	162	-101	0.1578	-0.0012	-0.0780
8	247	-189	0.2616	245	-189	0.2604	-0.0012	-0.0768
10	314	-261	0.3450	314	-261	0.3450	0.0000	-0.0756
12	338	-283	0.3726	345	-287	0.3792	0.0066	-0.0756
14	262	-198	0.2760	258	-194	0.2712	-0.0048	-0.0822
16	239	-178	0.2502	245	-182	0.2562	0.0060	-0.0774
18	283	-226	0.3054	274	-219	0.2958	-0.0096	-0.0834
20	255	-212	0.2802	253	-207	0.2760	-0.0042	-0.0738
22	157	-120	0.1662	164	-123	0.1722	0.0060	-0.0696
24	34	26	0.0048	27	28	-0.0006	-0.0054	-0.0756
26	-44	102	-0.0876	-43	103	-0.0876	0.0000	-0.0702
28	-26	80	-0.0636	-30	81	-0.0666	-0.0030	-0.0702
30	15	39	-0.0144	11	39	-0.0168	-0.0024	-0.0672
32	9	31	-0.0132	11	29	-0.0108	0.0024	-0.0648
34	-123	186	-0.1854	-126	187	-0.1878	-0.0024	-0.0672
36	-179	243	-0.2532	-181	245	-0.2556	-0.0024	-0.0648
38	-199	261	-0.2760	-197	258	-0.2730	0.0030	-0.0624
40	-265	317	-0.3492	-266	319	-0.3510	-0.0018	-0.0654
42	-265	323	-0.3528	-270	329	-0.3594	-0.0066	-0.0636
44	-233	296	-0.3174	-233	297	-0.3180	-0.0006	-0.0570
46	-167	225	-0.2352	-171	225	-0.2376	-0.0024	-0.0564
48	-57	103	-0.0960	-61	104	-0.0990	-0.0030	-0.0540
50	41	10	0.0186	38	13	0.0150	-0.0036	-0.0510
52	62	-5	0.0402	58	-2	0.0360	-0.0042	-0.0474
54	43	23	0.0120	42	23	0.0114	-0.0006	-0.0432
56	-29	89	-0.0708	-33	92	-0.0750	-0.0042	-0.0426
58	-71	131	-0.1212	-72	131	-0.1218	-0.0006	-0.0384
60	-20	69	-0.0534	-23	68	-0.0546	-0.0012	-0.0378
62	46	11	0.0210	41	16	0.0150	-0.0060	-0.0366
64	30	31	-0.0006	31	31	0.0000	0.0006	-0.0306
66	-68	129	-0.1182	-69	130	-0.1194	-0.0012	-0.0312
68	-119	180	-0.1794	-119	180	-0.1794	0.0000	-0.0300
70	-205	253	-0.2748	-205	255	-0.2760	-0.0012	-0.0300
72	-278	331	-0.3654	-279	333	-0.3672	-0.0018	-0.0288
74	-344	399	-0.4458	-343	401	-0.4464	-0.0006	-0.0270
76	-455	504	-0.5754	-457	506	-0.5778	-0.0024	-0.0264
78	-564	616	-0.7080	-566	617	-0.7098	-0.0018	-0.0240

SITE CUFTVA

INSTALLATION SI-54

DESCRIPTION

CURRENT SURVEY 10/20/2009 9:52:54 AM

INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:21:35 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-665	709	-0.8244	-667	711	-0.8268	-0.0024	-0.0222
82	-691	740	-0.8586	-697	742	-0.8634	-0.0048	-0.0198
84	-698	763	-0.8766	-701	763	-0.8784	-0.0018	-0.0150
86	-746	805	-0.9306	-749	807	-0.9336	-0.0030	-0.0132
88	-678	734	-0.8472	-681	735	-0.8496	-0.0024	-0.0102
90	-615	661	-0.7656	-617	663	-0.7680	-0.0024	-0.0078
92	-534	588	-0.6732	-535	588	-0.6738	-0.0006	-0.0054
94	-576	628	-0.7224	-576	627	-0.7218	0.0006	-0.0048
96	-646	703	-0.8094	-648	706	-0.8124	-0.0030	-0.0054
98	-708	746	-0.8724	-712	746	-0.8748	-0.0024	-0.0024
100	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-54

DESCRIPTION

CURRENT SURVEY 11/17/2009 11:12:58 AM

INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:21:35 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	108	-53	0.0966	112	-53	0.0990	0.0024	-0.0492
4	128	-64	0.1152	131	-61	0.1152	0.0000	-0.0516
6	163	-102	0.1590	165	-100	0.1590	0.0000	-0.0516
8	247	-189	0.2616	249	-185	0.2604	-0.0012	-0.0516
10	314	-261	0.3450	317	-257	0.3444	-0.0006	-0.0504
12	338	-283	0.3726	350	-285	0.3810	0.0084	-0.0498
14	262	-198	0.2760	259	-190	0.2694	-0.0066	-0.0582
16	239	-178	0.2502	249	-181	0.2580	0.0078	-0.0516
18	283	-226	0.3054	281	-217	0.2988	-0.0066	-0.0594
20	255	-212	0.2802	253	-201	0.2724	-0.0078	-0.0528
22	157	-120	0.1662	162	-119	0.1686	0.0024	-0.0450
24	34	26	0.0048	34	31	0.0018	-0.0030	-0.0474
26	-44	102	-0.0876	-39	106	-0.0870	0.0006	-0.0444
28	-26	80	-0.0636	-26	85	-0.0666	-0.0030	-0.0450
30	15	39	-0.0144	17	45	-0.0168	-0.0024	-0.0420
32	9	31	-0.0132	13	33	-0.0120	0.0012	-0.0396
34	-123	186	-0.1854	-121	189	-0.1860	-0.0006	-0.0408
36	-179	243	-0.2532	-177	247	-0.2544	-0.0012	-0.0402
38	-199	261	-0.2760	-193	261	-0.2724	0.0036	-0.0390
40	-265	317	-0.3492	-260	322	-0.3492	0.0000	-0.0426
42	-265	323	-0.3528	-269	335	-0.3624	-0.0096	-0.0426
44	-233	296	-0.3174	-233	299	-0.3192	-0.0018	-0.0330
46	-167	225	-0.2352	-169	230	-0.2394	-0.0042	-0.0312
48	-57	103	-0.0960	-56	112	-0.1008	-0.0048	-0.0270
50	41	10	0.0186	41	18	0.0138	-0.0048	-0.0222
52	62	-5	0.0402	62	4	0.0348	-0.0054	-0.0174
54	43	23	0.0120	46	27	0.0114	-0.0006	-0.0120
56	-29	89	-0.0708	-26	96	-0.0732	-0.0024	-0.0114
58	-71	131	-0.1212	-66	133	-0.1194	0.0018	-0.0090
60	-20	69	-0.0534	-17	75	-0.0552	-0.0018	-0.0108
62	46	11	0.0210	43	22	0.0126	-0.0084	-0.0090
64	30	31	-0.0006	35	33	0.0012	0.0018	-0.0006
66	-68	129	-0.1182	-63	134	-0.1182	0.0000	-0.0024
68	-119	180	-0.1794	-114	183	-0.1782	0.0012	-0.0024
70	-205	253	-0.2748	-200	257	-0.2742	0.0006	-0.0036
72	-278	331	-0.3654	-276	335	-0.3666	-0.0012	-0.0042
74	-344	399	-0.4458	-339	403	-0.4452	0.0006	-0.0030
76	-455	504	-0.5754	-451	509	-0.5760	-0.0006	-0.0036
78	-564	616	-0.7080	-561	621	-0.7092	-0.0012	-0.0030

SITE CUFTVA

INSTALLATION SI-54

DESCRIPTION

CURRENT SURVEY 11/17/2009 11:12:58 AM

INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:21:35 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-665	709	-0.8244	-662	714	-0.8256	-0.0012	-0.0018
82	-691	740	-0.8586	-689	746	-0.8610	-0.0024	-0.0006
84	-698	763	-0.8766	-695	768	-0.8778	-0.0012	0.0018
86	-746	805	-0.9306	-743	810	-0.9318	-0.0012	0.0030
88	-678	734	-0.8472	-676	741	-0.8502	-0.0030	0.0042
90	-615	661	-0.7656	-614	669	-0.7698	-0.0042	0.0072
92	-534	588	-0.6732	-532	596	-0.6768	-0.0036	0.0114
94	-576	628	-0.7224	-572	632	-0.7224	0.0000	0.0150
96	-646	703	-0.8094	-646	710	-0.8136	-0.0042	0.0150
98	-708	746	-0.8724	-704	718	-0.8532	0.0192	0.0192
100	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-54

DESCRIPTION

CURRENT SURVEY 12/7/2009 10:59:23 AM

INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:21:35 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	108	-53	0.0966	115	-55	0.1020	0.0054	-0.0186
4	128	-64	0.1152	130	-62	0.1152	0.0000	-0.0240
6	163	-102	0.1590	166	-100	0.1596	0.0006	-0.0240
8	247	-189	0.2616	250	-186	0.2616	0.0000	-0.0246
10	314	-261	0.3450	316	-258	0.3444	-0.0006	-0.0246
12	338	-283	0.3726	347	-290	0.3822	0.0096	-0.0240
14	262	-198	0.2760	259	-194	0.2718	-0.0042	-0.0336
16	239	-178	0.2502	250	-182	0.2592	0.0090	-0.0294
18	283	-226	0.3054	278	-216	0.2964	-0.0090	-0.0384
20	255	-212	0.2802	255	-203	0.2748	-0.0054	-0.0294
22	157	-120	0.1662	166	-123	0.1734	0.0072	-0.0240
24	34	26	0.0048	34	27	0.0042	-0.0006	-0.0312
26	-44	102	-0.0876	-39	103	-0.0852	0.0024	-0.0306
28	-26	80	-0.0636	-26	83	-0.0654	-0.0018	-0.0330
30	15	39	-0.0144	11	43	-0.0192	-0.0048	-0.0312
32	9	31	-0.0132	16	32	-0.0096	0.0036	-0.0264
34	-123	186	-0.1854	-123	186	-0.1854	0.0000	-0.0300
36	-179	243	-0.2532	-178	245	-0.2538	-0.0006	-0.0300
38	-199	261	-0.2760	-194	259	-0.2718	0.0042	-0.0294
40	-265	317	-0.3492	-264	321	-0.3510	-0.0018	-0.0336
42	-265	323	-0.3528	-267	332	-0.3594	-0.0066	-0.0318
44	-233	296	-0.3174	-230	298	-0.3168	0.0006	-0.0252
46	-167	225	-0.2352	-165	228	-0.2358	-0.0006	-0.0258
48	-57	103	-0.0960	-61	107	-0.1008	-0.0048	-0.0252
50	41	10	0.0186	39	16	0.0138	-0.0048	-0.0204
52	62	-5	0.0402	62	1	0.0366	-0.0036	-0.0156
54	43	23	0.0120	46	25	0.0126	0.0006	-0.0120
56	-29	89	-0.0708	-29	91	-0.0720	-0.0012	-0.0126
58	-71	131	-0.1212	-68	132	-0.1200	0.0012	-0.0114
60	-20	69	-0.0534	-20	72	-0.0552	-0.0018	-0.0126
62	46	11	0.0210	42	20	0.0132	-0.0078	-0.0108
64	30	31	-0.0006	36	30	0.0036	0.0042	-0.0030
66	-68	129	-0.1182	-65	129	-0.1164	0.0018	-0.0072
68	-119	180	-0.1794	-115	182	-0.1782	0.0012	-0.0090
70	-205	253	-0.2748	-203	257	-0.2760	-0.0012	-0.0102
72	-278	331	-0.3654	-276	335	-0.3666	-0.0012	-0.0090
74	-344	399	-0.4458	-341	402	-0.4458	0.0000	-0.0078
76	-455	504	-0.5754	-452	510	-0.5772	-0.0018	-0.0078
78	-564	616	-0.7080	-562	618	-0.7080	0.0000	-0.0060

SITE CUFTVA
INSTALLATION SI-54
DESCRIPTION

CURRENT SURVEY 12/7/2009 10:59:23 AM
INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:21:35 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-665	709	-0.8244	-663	713	-0.8256	-0.0012	-0.0060
82	-691	740	-0.8586	-686	744	-0.8580	0.0006	-0.0048
84	-698	763	-0.8766	-696	763	-0.8754	0.0012	-0.0054
86	-746	805	-0.9306	-745	810	-0.9330	-0.0024	-0.0066
88	-678	734	-0.8472	-676	738	-0.8484	-0.0012	-0.0042
90	-615	661	-0.7656	-614	667	-0.7686	-0.0030	-0.0030
92	-534	588	-0.6732	-530	593	-0.6738	-0.0006	0.0000
94	-576	628	-0.7224	-571	633	-0.7224	0.0000	0.0006
96	-646	703	-0.8094	-643	707	-0.8100	-0.0006	0.0006
98	-708	746	-0.8724	-710	742	-0.8712	0.0012	0.0012
100	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-54

DESCRIPTION

CURRENT SURVEY 1/18/2010 8:50:35 AM

INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:21:35 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	108	-53	0.0966	73	-99	0.1032	0.0066	-0.0306
4	128	-64	0.1152	88	-118	0.1236	0.0084	-0.0372
6	163	-102	0.1590	133	-152	0.1710	0.0120	-0.0456
8	247	-189	0.2616	211	-234	0.2670	0.0054	-0.0576
10	314	-261	0.3450	272	-300	0.3432	-0.0018	-0.0630
12	338	-283	0.3726	301	-321	0.3732	0.0006	-0.0612
14	262	-198	0.2760	211	-246	0.2742	-0.0018	-0.0618
16	239	-178	0.2502	206	-234	0.2640	0.0138	-0.0600
18	283	-226	0.3054	235	-263	0.2988	-0.0066	-0.0738
20	255	-212	0.2802	215	-227	0.2652	-0.0150	-0.0672
22	157	-120	0.1662	135	-143	0.1668	0.0006	-0.0522
24	34	26	0.0048	-14	-6	-0.0048	-0.0096	-0.0528
26	-44	102	-0.0876	-78	52	-0.0780	0.0096	-0.0432
28	-26	80	-0.0636	-54	38	-0.0552	0.0084	-0.0528
30	15	39	-0.0144	-22	-7	-0.0090	0.0054	-0.0612
32	9	31	-0.0132	-17	2	-0.0114	0.0018	-0.0666
34	-123	186	-0.1854	-174	150	-0.1944	-0.0090	-0.0684
36	-179	243	-0.2532	-232	193	-0.2550	-0.0018	-0.0594
38	-199	261	-0.2760	-242	216	-0.2748	0.0012	-0.0576
40	-265	317	-0.3492	-304	277	-0.3486	0.0006	-0.0588
42	-265	323	-0.3528	-300	282	-0.3492	0.0036	-0.0594
44	-233	296	-0.3174	-264	243	-0.3042	0.0132	-0.0630
46	-167	225	-0.2352	-194	179	-0.2238	0.0114	-0.0762
48	-57	103	-0.0960	-83	68	-0.0906	0.0054	-0.0876
50	41	10	0.0186	-5	-28	0.0138	-0.0048	-0.0930
52	62	-5	0.0402	11	-39	0.0300	-0.0102	-0.0882
54	43	23	0.0120	-13	-13	0.0000	-0.0120	-0.0780
56	-29	89	-0.0708	-82	48	-0.0780	-0.0072	-0.0660
58	-71	131	-0.1212	-104	77	-0.1086	0.0126	-0.0588
60	-20	69	-0.0534	-49	31	-0.0480	0.0054	-0.0714
62	46	11	0.0210	-3	-26	0.0138	-0.0072	-0.0768
64	30	31	-0.0006	-20	-1	-0.0114	-0.0108	-0.0696
66	-68	129	-0.1182	-121	99	-0.1320	-0.0138	-0.0588
68	-119	180	-0.1794	-169	143	-0.1872	-0.0078	-0.0450
70	-205	253	-0.2748	-244	233	-0.2862	-0.0114	-0.0372
72	-278	331	-0.3654	-322	300	-0.3732	-0.0078	-0.0258
74	-344	399	-0.4458	-392	370	-0.4572	-0.0114	-0.0180
76	-455	504	-0.5754	-500	483	-0.5898	-0.0144	-0.0066
78	-564	616	-0.7080	-606	582	-0.7128	-0.0048	0.0078

SITE CUFTVA

INSTALLATION SI-54

DESCRIPTION

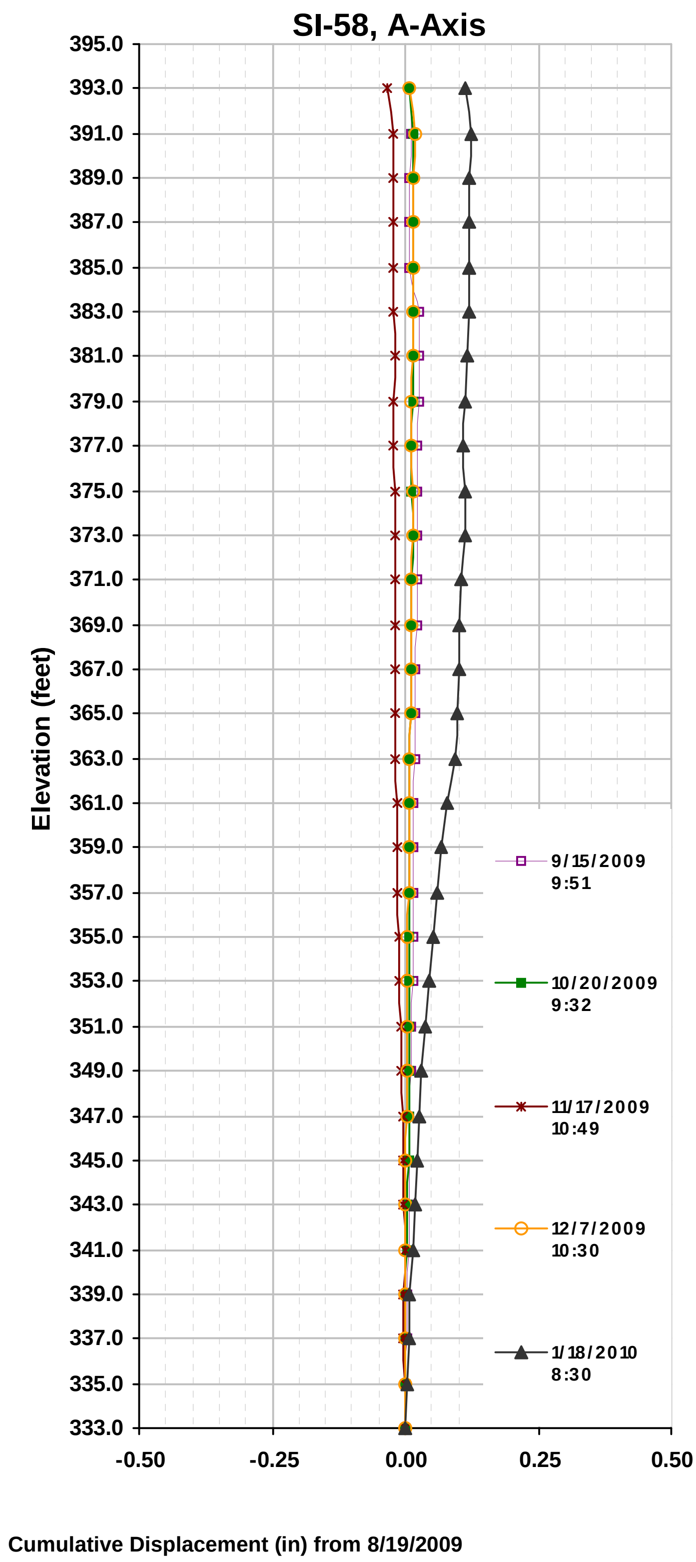
CURRENT SURVEY 1/18/2010 8:50:35 AM

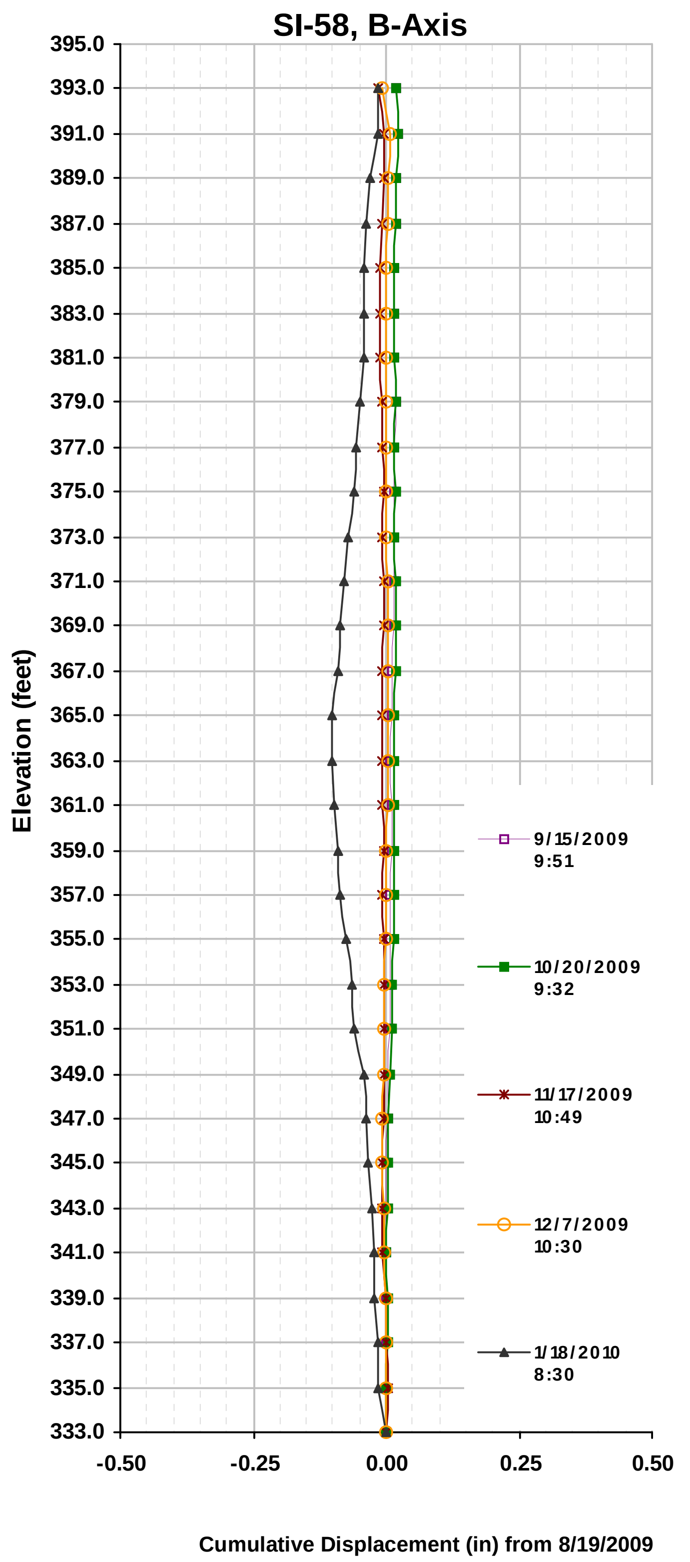
INITIAL SURVEY 8/19/2009 10:24:47 AM

DATE PRINTED 1/18/2010 2:21:35 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-665	709	-0.8244	-700	671	-0.8226	0.0018	0.0126
82	-691	740	-0.8586	-733	700	-0.8598	-0.0012	0.0108
84	-698	763	-0.8766	-757	723	-0.8880	-0.0114	0.0120
86	-746	805	-0.9306	-776	755	-0.9186	0.0120	0.0234
88	-678	734	-0.8472	-712	687	-0.8394	0.0078	0.0114
90	-615	661	-0.7656	-639	620	-0.7554	0.0102	0.0036
92	-534	588	-0.6732	-579	546	-0.6750	-0.0018	-0.0066
94	-576	628	-0.7224	-622	597	-0.7314	-0.0090	-0.0048
96	-646	703	-0.8094	-688	663	-0.8106	-0.0012	0.0042
98	-708	746	-0.8724	-719	726	-0.8670	0.0054	0.0054
100	0	0	0.0000	0	0	0.0000	0.0000	0.0000





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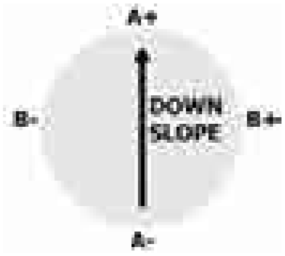


Cumberland Fossil Plant

Cumberland City, TN
175539016
1/18/2010

SITE CUFTVA

INSTALLATION SI-58

DESCRIPTION

CURRENT SURVEY 9/15/2009 9:51:58 AM

INITIAL SURVEY 8/19/2009 9:45:12 AM

DATE PRINTED 1/18/2010 2:22:15 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-547	550	-0.6582	-551	553	-0.6624	-0.0042	0.0060
4	-613	618	-0.7386	-613	614	-0.7362	0.0024	0.0102
6	-536	542	-0.6468	-538	541	-0.6474	-0.0006	0.0078
8	-260	267	-0.3162	-256	268	-0.3144	0.0018	0.0084
10	109	-104	0.1278	107	-73	0.1080	-0.0198	0.0066
12	253	-248	0.3006	251	-249	0.3000	-0.0006	0.0264
14	181	-175	0.2136	181	-179	0.2160	0.0024	0.0270
16	153	-146	0.1794	153	-150	0.1818	0.0024	0.0246
18	109	-100	0.1254	107	-102	0.1254	0.0000	0.0222
20	93	-89	0.1092	92	-90	0.1092	0.0000	0.0222
22	118	-109	0.1362	118	-111	0.1374	0.0012	0.0222
24	99	-91	0.1140	97	-93	0.1140	0.0000	0.0210
26	63	-56	0.0714	62	-59	0.0726	0.0012	0.0210
28	-66	78	-0.0864	-67	75	-0.0852	0.0012	0.0198
30	-164	170	-0.2004	-165	167	-0.1992	0.0012	0.0186
32	-11	11	-0.0132	-11	10	-0.0126	0.0006	0.0174
34	200	-202	0.2412	200	-203	0.2418	0.0006	0.0168
36	401	-403	0.4824	400	-405	0.4830	0.0006	0.0162
38	514	-511	0.6150	514	-513	0.6162	0.0012	0.0156
40	593	-593	0.7116	593	-594	0.7122	0.0006	0.0144
42	741	-736	0.8862	742	-737	0.8874	0.0012	0.0138
44	860	-859	1.0314	861	-861	1.0332	0.0018	0.0126
46	913	-910	1.0938	913	-913	1.0956	0.0018	0.0108
48	983	-978	1.1766	984	-978	1.1772	0.0006	0.0090
50	987	-984	1.1826	987	-986	1.1838	0.0012	0.0084
52	966	-962	1.1568	966	-963	1.1574	0.0006	0.0072
54	1062	-1058	1.2720	1063	-1062	1.2750	0.0030	0.0066
56	1025	-1022	1.2282	1025	-1024	1.2294	0.0012	0.0036
58	1054	-1049	1.2618	1054	-1051	1.2630	0.0012	0.0024
60	1085	-1082	1.3002	1085	-1084	1.3014	0.0012	0.0012
62	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-58

DESCRIPTION

CURRENT SURVEY 10/20/2009 9:32:05 AM

INITIAL SURVEY 8/19/2009 9:45:12 AM

DATE PRINTED 1/18/2010 2:22:15 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-547	550	-0.6582	-550	560	-0.6660	-0.0078	0.0084
4	-613	618	-0.7386	-609	618	-0.7362	0.0024	0.0162
6	-536	542	-0.6468	-534	545	-0.6474	-0.0006	0.0138
8	-260	267	-0.3162	-258	272	-0.3180	-0.0018	0.0144
10	109	-104	0.1278	113	-99	0.1272	-0.0006	0.0162
12	253	-248	0.3006	256	-245	0.3006	0.0000	0.0168
14	181	-175	0.2136	186	-175	0.2166	0.0030	0.0168
16	153	-146	0.1794	157	-146	0.1818	0.0024	0.0138
18	109	-100	0.1254	111	-96	0.1242	-0.0012	0.0114
20	93	-89	0.1092	96	-85	0.1086	-0.0006	0.0126
22	118	-109	0.1362	123	-107	0.1380	0.0018	0.0132
24	99	-91	0.1140	102	-87	0.1134	-0.0006	0.0114
26	63	-56	0.0714	67	-54	0.0726	0.0012	0.0120
28	-66	78	-0.0864	-63	79	-0.0852	0.0012	0.0108
30	-164	170	-0.2004	-159	173	-0.1992	0.0012	0.0096
32	-11	11	-0.0132	-6	16	-0.0132	0.0000	0.0084
34	200	-202	0.2412	206	-199	0.2430	0.0018	0.0084
36	401	-403	0.4824	404	-399	0.4818	-0.0006	0.0066
38	514	-511	0.6150	518	-508	0.6156	0.0006	0.0072
40	593	-593	0.7116	596	-590	0.7116	0.0000	0.0066
42	741	-736	0.8862	743	-731	0.8844	-0.0018	0.0066
44	860	-859	1.0314	864	-855	1.0314	0.0000	0.0084
46	913	-910	1.0938	918	-908	1.0956	0.0018	0.0084
48	983	-978	1.1766	987	-975	1.1772	0.0006	0.0066
50	987	-984	1.1826	991	-982	1.1838	0.0012	0.0060
52	966	-962	1.1568	970	-959	1.1574	0.0006	0.0048
54	1062	-1058	1.2720	1067	-1057	1.2744	0.0024	0.0042
56	1025	-1022	1.2282	1029	-1019	1.2288	0.0006	0.0018
58	1054	-1049	1.2618	1058	-1047	1.2630	0.0012	0.0012
60	1085	-1082	1.3002	1088	-1079	1.3002	0.0000	0.0000
62	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-58
DESCRIPTION

CURRENT SURVEY 11/17/2009 10:49:52 AM
INITIAL SURVEY 8/19/2009 9:45:12 AM

DATE PRINTED 1/18/2010 2:22:15 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-547	550	-0.6582	-555	558	-0.6678	-0.0096	-0.0330
4	-613	618	-0.7386	-613	617	-0.7380	0.0006	-0.0234
6	-536	542	-0.6468	-537	542	-0.6474	-0.0006	-0.0240
8	-260	267	-0.3162	-262	266	-0.3168	-0.0006	-0.0234
10	109	-104	0.1278	108	-103	0.1266	-0.0012	-0.0228
12	253	-248	0.3006	251	-247	0.2988	-0.0018	-0.0216
14	181	-175	0.2136	182	-177	0.2154	0.0018	-0.0198
16	153	-146	0.1794	153	-147	0.1800	0.0006	-0.0216
18	109	-100	0.1254	107	-98	0.1230	-0.0024	-0.0222
20	93	-89	0.1092	92	-87	0.1074	-0.0018	-0.0198
22	118	-109	0.1362	120	-110	0.1380	0.0018	-0.0180
24	99	-91	0.1140	98	-89	0.1122	-0.0018	-0.0198
26	63	-56	0.0714	64	-56	0.0720	0.0006	-0.0180
28	-66	78	-0.0864	-67	78	-0.0870	-0.0006	-0.0186
30	-164	170	-0.2004	-163	170	-0.1998	0.0006	-0.0180
32	-11	11	-0.0132	-11	14	-0.0150	-0.0018	-0.0186
34	200	-202	0.2412	199	-200	0.2394	-0.0018	-0.0168
36	401	-403	0.4824	399	-402	0.4806	-0.0018	-0.0150
38	514	-511	0.6150	513	-510	0.6138	-0.0012	-0.0132
40	593	-593	0.7116	591	-591	0.7092	-0.0024	-0.0120
42	741	-736	0.8862	740	-733	0.8838	-0.0024	-0.0096
44	860	-859	1.0314	859	-858	1.0302	-0.0012	-0.0072
46	913	-910	1.0938	913	-909	1.0932	-0.0006	-0.0060
48	983	-978	1.1766	982	-976	1.1748	-0.0018	-0.0054
50	987	-984	1.1826	987	-983	1.1820	-0.0006	-0.0036
52	966	-962	1.1568	966	-960	1.1556	-0.0012	-0.0030
54	1062	-1058	1.2720	1063	-1059	1.2732	0.0012	-0.0018
56	1025	-1022	1.2282	1025	-1021	1.2276	-0.0006	-0.0030
58	1054	-1049	1.2618	1053	-1049	1.2612	-0.0006	-0.0024
60	1085	-1082	1.3002	1084	-1080	1.2984	-0.0018	-0.0018
62	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-58

DESCRIPTION

CURRENT SURVEY 12/7/2009 10:30:39 AM

INITIAL SURVEY 8/19/2009 9:45:12 AM

DATE PRINTED 1/18/2010 2:22:15 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-547	550	-0.6582	-554	558	-0.6672	-0.0090	0.0090
4	-613	618	-0.7386	-611	615	-0.7356	0.0030	0.0180
6	-536	542	-0.6468	-535	541	-0.6456	0.0012	0.0150
8	-260	267	-0.3162	-261	265	-0.3156	0.0006	0.0138
10	109	-104	0.1278	109	-102	0.1266	-0.0012	0.0132
12	253	-248	0.3006	254	-246	0.3000	-0.0006	0.0144
14	181	-175	0.2136	183	-177	0.2160	0.0024	0.0150
16	153	-146	0.1794	154	-147	0.1806	0.0012	0.0126
18	109	-100	0.1254	108	-97	0.1230	-0.0024	0.0114
20	93	-89	0.1092	94	-87	0.1086	-0.0006	0.0138
22	118	-109	0.1362	122	-109	0.1386	0.0024	0.0144
24	99	-91	0.1140	100	-89	0.1134	-0.0006	0.0120
26	63	-56	0.0714	65	-56	0.0726	0.0012	0.0126
28	-66	78	-0.0864	-66	77	-0.0858	0.0006	0.0114
30	-164	170	-0.2004	-162	169	-0.1986	0.0018	0.0108
32	-11	11	-0.0132	-9	11	-0.0120	0.0012	0.0090
34	200	-202	0.2412	203	-201	0.2424	0.0012	0.0078
36	401	-403	0.4824	402	-403	0.4830	0.0006	0.0066
38	514	-511	0.6150	516	-511	0.6162	0.0012	0.0060
40	593	-593	0.7116	593	-593	0.7116	0.0000	0.0048
42	741	-736	0.8862	743	-736	0.8874	0.0012	0.0048
44	860	-859	1.0314	861	-858	1.0314	0.0000	0.0036
46	913	-910	1.0938	915	-910	1.0950	0.0012	0.0036
48	983	-978	1.1766	985	-977	1.1772	0.0006	0.0024
50	987	-984	1.1826	989	-982	1.1826	0.0000	0.0018
52	966	-962	1.1568	968	-961	1.1574	0.0006	0.0018
54	1062	-1058	1.2720	1065	-1059	1.2744	0.0024	0.0012
56	1025	-1022	1.2282	1026	-1021	1.2282	0.0000	-0.0012
58	1054	-1049	1.2618	1054	-1049	1.2618	0.0000	-0.0012
60	1085	-1082	1.3002	1086	-1079	1.2990	-0.0012	-0.0012
62	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-58

DESCRIPTION

CURRENT SURVEY 1/18/2010 8:30:01 AM

INITIAL SURVEY 8/19/2009 9:45:12 AM

DATE PRINTED 1/18/2010 2:22:15 PM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-547	550	-0.6582	-555	558	-0.6678	-0.0096	0.1128
4	-613	618	-0.7386	-612	617	-0.7374	0.0012	0.1224
6	-536	542	-0.6468	-537	540	-0.6462	0.0006	0.1212
8	-260	267	-0.3162	-262	266	-0.3168	-0.0006	0.1206
10	109	-104	0.1278	109	-106	0.1290	0.0012	0.1212
12	253	-248	0.3006	256	-252	0.3048	0.0042	0.1200
14	181	-175	0.2136	185	-178	0.2178	0.0042	0.1158
16	153	-146	0.1794	152	-149	0.1806	0.0012	0.1116
18	109	-100	0.1254	104	-102	0.1236	-0.0018	0.1104
20	93	-89	0.1092	94	-88	0.1092	0.0000	0.1122
22	118	-109	0.1362	123	-115	0.1428	0.0066	0.1122
24	99	-91	0.1140	99	-96	0.1170	0.0030	0.1056
26	63	-56	0.0714	63	-60	0.0738	0.0024	0.1026
28	-66	78	-0.0864	-70	72	-0.0852	0.0012	0.1002
30	-164	170	-0.2004	-161	162	-0.1938	0.0066	0.0990
32	-11	11	-0.0132	0	2	0.0000	0.0132	0.0924
34	200	-202	0.2412	214	-208	0.2532	0.0120	0.0792
36	401	-403	0.4824	410	-408	0.4908	0.0084	0.0672
38	514	-511	0.6150	519	-514	0.6198	0.0048	0.0588
40	593	-593	0.7116	602	-597	0.7194	0.0078	0.0540
42	741	-736	0.8862	750	-743	0.8958	0.0096	0.0462
44	860	-859	1.0314	868	-864	1.0392	0.0078	0.0366
46	913	-910	1.0938	917	-913	1.0980	0.0042	0.0288
48	983	-978	1.1766	985	-981	1.1796	0.0030	0.0246
50	987	-984	1.1826	990	-985	1.1850	0.0024	0.0216
52	966	-962	1.1568	970	-966	1.1616	0.0048	0.0192
54	1062	-1058	1.2720	1068	-1061	1.2774	0.0054	0.0144
56	1025	-1022	1.2282	1028	-1023	1.2306	0.0024	0.0090
58	1054	-1049	1.2618	1057	-1051	1.2648	0.0030	0.0066
60	1085	-1082	1.3002	1089	-1084	1.3038	0.0036	0.0036
62	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-58

DESCRIPTION

CURRENT SURVEY 9/15/2009 9:51:58 AM

INITIAL SURVEY 8/19/2009 9:45:12 AM

DATE PRINTED 1/18/2010 2:22:33 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	216	-172	0.2328	212	-173	0.2310	-0.0018	0.0198
4	229	-181	0.2460	231	-181	0.2472	0.0012	0.0216
6	245	-203	0.2688	248	-203	0.2706	0.0018	0.0204
8	355	-322	0.4062	360	-323	0.4098	0.0036	0.0186
10	530	-481	0.6066	532	-478	0.6060	-0.0006	0.0150
12	586	-543	0.6774	588	-542	0.6780	0.0006	0.0156
14	567	-525	0.6552	569	-519	0.6528	-0.0024	0.0150
16	611	-567	0.7068	613	-566	0.7074	0.0006	0.0174
18	674	-629	0.7818	677	-627	0.7824	0.0006	0.0168
20	729	-681	0.8460	732	-681	0.8478	0.0018	0.0162
22	785	-737	0.9132	787	-734	0.9126	-0.0006	0.0144
24	890	-843	1.0398	892	-842	1.0404	0.0006	0.0150
26	987	-945	1.1592	993	-944	1.1622	0.0030	0.0144
28	1082	-1036	1.2708	1085	-1036	1.2726	0.0018	0.0114
30	1179	-1130	1.3854	1183	-1129	1.3872	0.0018	0.0096
32	1148	-1110	1.3548	1147	-1107	1.3524	-0.0024	0.0078
34	1022	-970	1.1952	1024	-969	1.1958	0.0006	0.0102
36	942	-894	1.1016	945	-893	1.1028	0.0012	0.0096
38	839	-793	0.9792	841	-791	0.9792	0.0000	0.0084
40	706	-655	0.8166	709	-656	0.8190	0.0024	0.0084
42	602	-563	0.6990	603	-562	0.6990	0.0000	0.0060
44	538	-483	0.6126	539	-483	0.6132	0.0006	0.0060
46	400	-365	0.4590	403	-366	0.4614	0.0024	0.0054
48	185	-153	0.2028	186	-154	0.2040	0.0012	0.0030
50	25	-4	0.0174	27	-2	0.0174	0.0000	0.0018
52	213	-164	0.2262	216	-166	0.2292	0.0030	0.0018
54	218	-177	0.2370	217	-173	0.2340	-0.0030	-0.0012
56	253	-202	0.2730	254	-201	0.2730	0.0000	0.0018
58	203	-153	0.2136	205	-152	0.2142	0.0006	0.0018
60	171	-125	0.1776	174	-124	0.1788	0.0012	0.0012
62	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-58

DESCRIPTION

CURRENT SURVEY 10/20/2009 9:32:05 AM

INITIAL SURVEY 8/19/2009 9:45:12 AM

DATE PRINTED 1/18/2010 2:22:33 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	216	-172	0.2328	211	-170	0.2286	-0.0042	0.0174
4	229	-181	0.2460	230	-183	0.2478	0.0018	0.0216
6	245	-203	0.2688	247	-203	0.2700	0.0012	0.0198
8	355	-322	0.4062	357	-325	0.4092	0.0030	0.0186
10	530	-481	0.6066	530	-479	0.6054	-0.0012	0.0156
12	586	-543	0.6774	587	-545	0.6792	0.0018	0.0168
14	567	-525	0.6552	568	-520	0.6528	-0.0024	0.0150
16	611	-567	0.7068	612	-567	0.7074	0.0006	0.0174
18	674	-629	0.7818	673	-628	0.7806	-0.0012	0.0168
20	729	-681	0.8460	731	-682	0.8478	0.0018	0.0180
22	785	-737	0.9132	784	-735	0.9114	-0.0018	0.0162
24	890	-843	1.0398	889	-842	1.0386	-0.0012	0.0180
26	987	-945	1.1592	989	-946	1.1610	0.0018	0.0192
28	1082	-1036	1.2708	1083	-1037	1.2720	0.0012	0.0174
30	1179	-1130	1.3854	1181	-1131	1.3872	0.0018	0.0162
32	1148	-1110	1.3548	1147	-1110	1.3542	-0.0006	0.0144
34	1022	-970	1.1952	1021	-971	1.1952	0.0000	0.0150
36	942	-894	1.1016	943	-894	1.1022	0.0006	0.0150
38	839	-793	0.9792	839	-794	0.9798	0.0006	0.0144
40	706	-655	0.8166	708	-656	0.8184	0.0018	0.0138
42	602	-563	0.6990	603	-566	0.7014	0.0024	0.0120
44	538	-483	0.6126	538	-485	0.6138	0.0012	0.0096
46	400	-365	0.4590	403	-367	0.4620	0.0030	0.0084
48	185	-153	0.2028	186	-154	0.2040	0.0012	0.0054
50	25	-4	0.0174	25	-5	0.0180	0.0006	0.0042
52	213	-164	0.2262	213	-169	0.2292	0.0030	0.0036
54	218	-177	0.2370	215	-175	0.2340	-0.0030	0.0006
56	253	-202	0.2730	254	-203	0.2742	0.0012	0.0036
58	203	-153	0.2136	202	-155	0.2142	0.0006	0.0024
60	171	-125	0.1776	172	-127	0.1794	0.0018	0.0018
62	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-58

DESCRIPTION

CURRENT SURVEY 11/17/2009 10:49:52 AM

INITIAL SURVEY 8/19/2009 9:45:12 AM

DATE PRINTED 1/18/2010 2:22:33 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	216	-172	0.2328	211	-162	0.2238	-0.0090	-0.0144
4	229	-181	0.2460	233	-176	0.2454	-0.0006	-0.0054
6	245	-203	0.2688	251	-203	0.2724	0.0036	-0.0048
8	355	-322	0.4062	361	-323	0.4104	0.0042	-0.0084
10	530	-481	0.6066	533	-476	0.6054	-0.0012	-0.0126
12	586	-543	0.6774	588	-538	0.6756	-0.0018	-0.0114
14	567	-525	0.6552	570	-517	0.6522	-0.0030	-0.0096
16	611	-567	0.7068	616	-564	0.7080	0.0012	-0.0066
18	674	-629	0.7818	674	-625	0.7794	-0.0024	-0.0078
20	729	-681	0.8460	735	-678	0.8478	0.0018	-0.0054
22	785	-737	0.9132	787	-730	0.9102	-0.0030	-0.0072
24	890	-843	1.0398	893	-839	1.0392	-0.0006	-0.0042
26	987	-945	1.1592	993	-943	1.1616	0.0024	-0.0036
28	1082	-1036	1.2708	1086	-1034	1.2720	0.0012	-0.0060
30	1179	-1130	1.3854	1183	-1128	1.3866	0.0012	-0.0072
32	1148	-1110	1.3548	1148	-1106	1.3524	-0.0024	-0.0084
34	1022	-970	1.1952	1025	-966	1.1946	-0.0006	-0.0060
36	942	-894	1.1016	947	-890	1.1022	0.0006	-0.0054
38	839	-793	0.9792	841	-788	0.9774	-0.0018	-0.0060
40	706	-655	0.8166	710	-651	0.8166	0.0000	-0.0042
42	602	-563	0.6990	606	-561	0.7002	0.0012	-0.0042
44	538	-483	0.6126	539	-480	0.6114	-0.0012	-0.0054
46	400	-365	0.4590	405	-362	0.4602	0.0012	-0.0042
48	185	-153	0.2028	190	-153	0.2058	0.0030	-0.0054
50	25	-4	0.0174	27	1	0.0156	-0.0018	-0.0084
52	213	-164	0.2262	214	-162	0.2256	-0.0006	-0.0066
54	218	-177	0.2370	219	-169	0.2328	-0.0042	-0.0060
56	253	-202	0.2730	257	-195	0.2712	-0.0018	-0.0018
58	203	-153	0.2136	206	-146	0.2112	-0.0024	0.0000
60	171	-125	0.1776	174	-126	0.1800	0.0024	0.0024
62	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-58
DESCRIPTION

CURRENT SURVEY 12/7/2009 10:30:39 AM
INITIAL SURVEY 8/19/2009 9:45:12 AM

DATE PRINTED 1/18/2010 2:22:33 PM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	216	-172	0.2328	205	-163	0.2208	-0.0120	-0.0060
4	229	-181	0.2460	232	-179	0.2466	0.0006	0.0060
6	245	-203	0.2688	250	-202	0.2712	0.0024	0.0054
8	355	-322	0.4062	359	-321	0.4080	0.0018	0.0030
10	530	-481	0.6066	533	-477	0.6060	-0.0006	0.0012
12	586	-543	0.6774	589	-542	0.6786	0.0012	0.0018
14	567	-525	0.6552	572	-518	0.6540	-0.0012	0.0006
16	611	-567	0.7068	614	-568	0.7092	0.0024	0.0018
18	674	-629	0.7818	673	-626	0.7794	-0.0024	-0.0006
20	729	-681	0.8460	731	-680	0.8466	0.0006	0.0018
22	785	-737	0.9132	786	-733	0.9114	-0.0018	0.0012
24	890	-843	1.0398	890	-840	1.0380	-0.0018	0.0030
26	987	-945	1.1592	991	-944	1.1610	0.0018	0.0048
28	1082	-1036	1.2708	1083	-1034	1.2702	-0.0006	0.0030
30	1179	-1130	1.3854	1182	-1129	1.3866	0.0012	0.0036
32	1148	-1110	1.3548	1151	-1106	1.3542	-0.0006	0.0024
34	1022	-970	1.1952	1026	-968	1.1964	0.0012	0.0030
36	942	-894	1.1016	946	-892	1.1028	0.0012	0.0018
38	839	-793	0.9792	843	-791	0.9804	0.0012	0.0006
40	706	-655	0.8166	711	-655	0.8196	0.0030	-0.0006
42	602	-563	0.6990	605	-561	0.6996	0.0006	-0.0036
44	538	-483	0.6126	541	-481	0.6132	0.0006	-0.0042
46	400	-365	0.4590	405	-363	0.4608	0.0018	-0.0048
48	185	-153	0.2028	188	-151	0.2034	0.0006	-0.0066
50	25	-4	0.0174	25	-1	0.0156	-0.0018	-0.0072
52	213	-164	0.2262	209	-165	0.2244	-0.0018	-0.0054
54	218	-177	0.2370	218	-171	0.2334	-0.0036	-0.0036
56	253	-202	0.2730	256	-198	0.2724	-0.0006	0.0000
58	203	-153	0.2136	204	-150	0.2124	-0.0012	0.0006
60	171	-125	0.1776	175	-124	0.1794	0.0018	0.0018
62	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-58

DESCRIPTION

CURRENT SURVEY 1/18/2010 8:30:01 AM

INITIAL SURVEY 8/19/2009 9:45:12 AM

DATE PRINTED 1/18/2010 2:22:33 PM

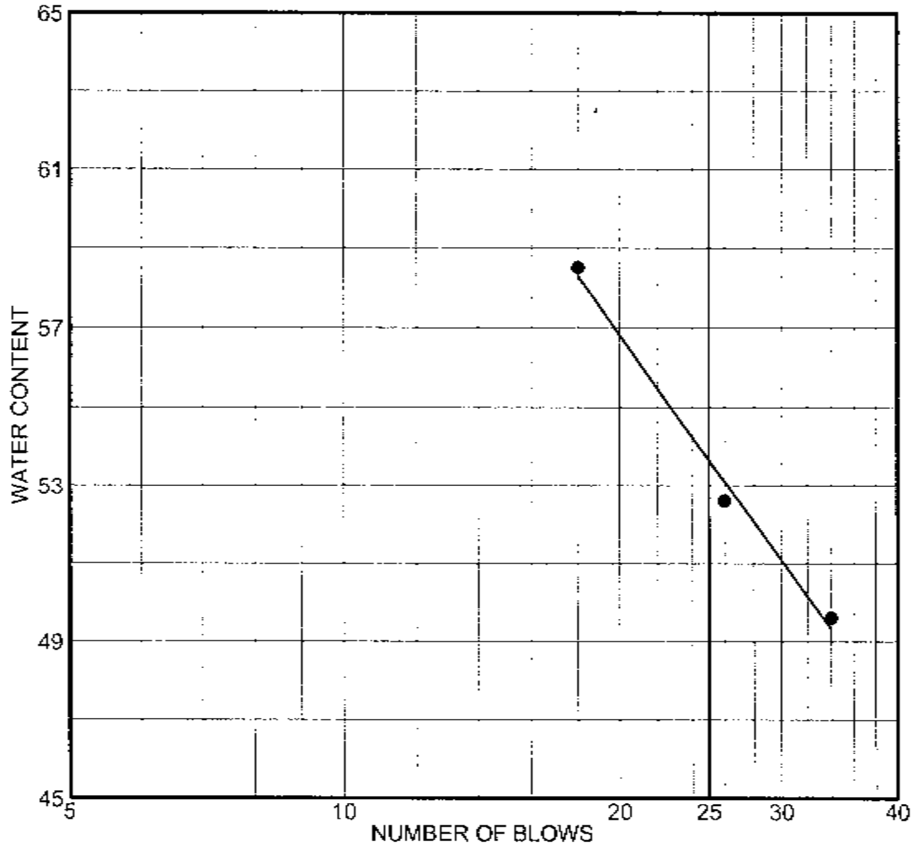
Data Reduction for B Axis:

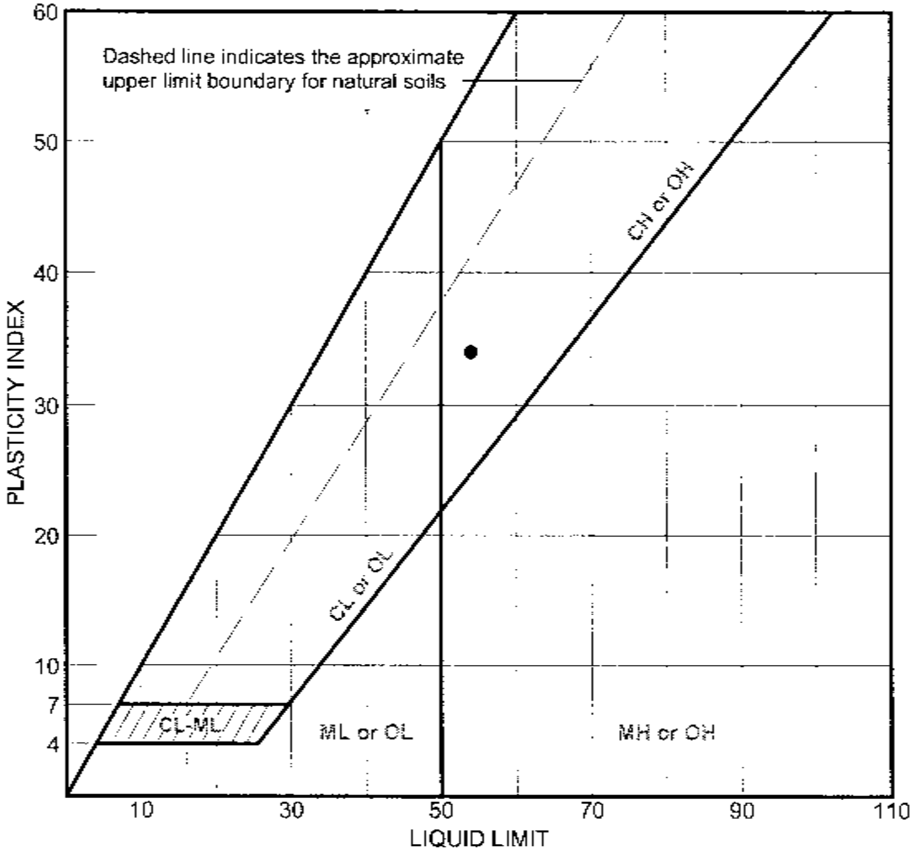
	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	216	-172	0.2328	184	-202	0.2316	-0.0012	-0.0144
4	229	-181	0.2460	207	-230	0.2622	0.0162	-0.0132
6	245	-203	0.2688	222	-242	0.2784	0.0096	-0.0294
8	355	-322	0.4062	342	-340	0.4092	0.0030	-0.0390
10	530	-481	0.6066	500	-512	0.6072	0.0006	-0.0420
12	586	-543	0.6774	550	-575	0.6750	-0.0024	-0.0426
14	567	-525	0.6552	542	-566	0.6648	0.0096	-0.0402
16	611	-567	0.7068	584	-606	0.7140	0.0072	-0.0498
18	674	-629	0.7818	646	-665	0.7866	0.0048	-0.0570
20	729	-681	0.8460	703	-724	0.8562	0.0102	-0.0618
22	785	-737	0.9132	759	-773	0.9192	0.0060	-0.0720
24	890	-843	1.0398	862	-883	1.0470	0.0072	-0.0780
26	987	-945	1.1592	964	-979	1.1658	0.0066	-0.0852
28	1082	-1036	1.2708	1063	-1074	1.2822	0.0114	-0.0918
30	1179	-1130	1.3854	1140	-1166	1.3836	-0.0018	-0.1032
32	1148	-1110	1.3548	1122	-1128	1.3500	-0.0048	-0.1014
34	1022	-970	1.1952	984	-999	1.1898	-0.0054	-0.0966
36	942	-894	1.1016	905	-920	1.0950	-0.0066	-0.0912
38	839	-793	0.9792	806	-810	0.9696	-0.0096	-0.0846
40	706	-655	0.8166	668	-676	0.8064	-0.0102	-0.0750
42	602	-563	0.6990	566	-589	0.6930	-0.0060	-0.0648
44	538	-483	0.6126	492	-501	0.5958	-0.0168	-0.0588
46	400	-365	0.4590	377	-378	0.4530	-0.0060	-0.0420
48	185	-153	0.2028	169	-167	0.2016	-0.0012	-0.0360
50	25	-4	0.0174	-4	-21	0.0102	-0.0072	-0.0348
52	213	-164	0.2262	173	-193	0.2196	-0.0066	-0.0276
54	218	-177	0.2370	185	-213	0.2388	0.0018	-0.0210
56	253	-202	0.2730	208	-237	0.2670	-0.0060	-0.0228
58	203	-153	0.2136	162	-190	0.2112	-0.0024	-0.0168
60	171	-125	0.1776	128	-144	0.1632	-0.0144	-0.0144
62	0	0	0.0000	0	0	0.0000	0.0000	0.0000

Appendix F

Results of Laboratory Testing

LIQUID AND PLASTIC LIMITS TEST REPORT





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●		B-48A	5-15ft	10/1/09	CH	Brown fat clay with sand	29.3	54	34

Client Stantec

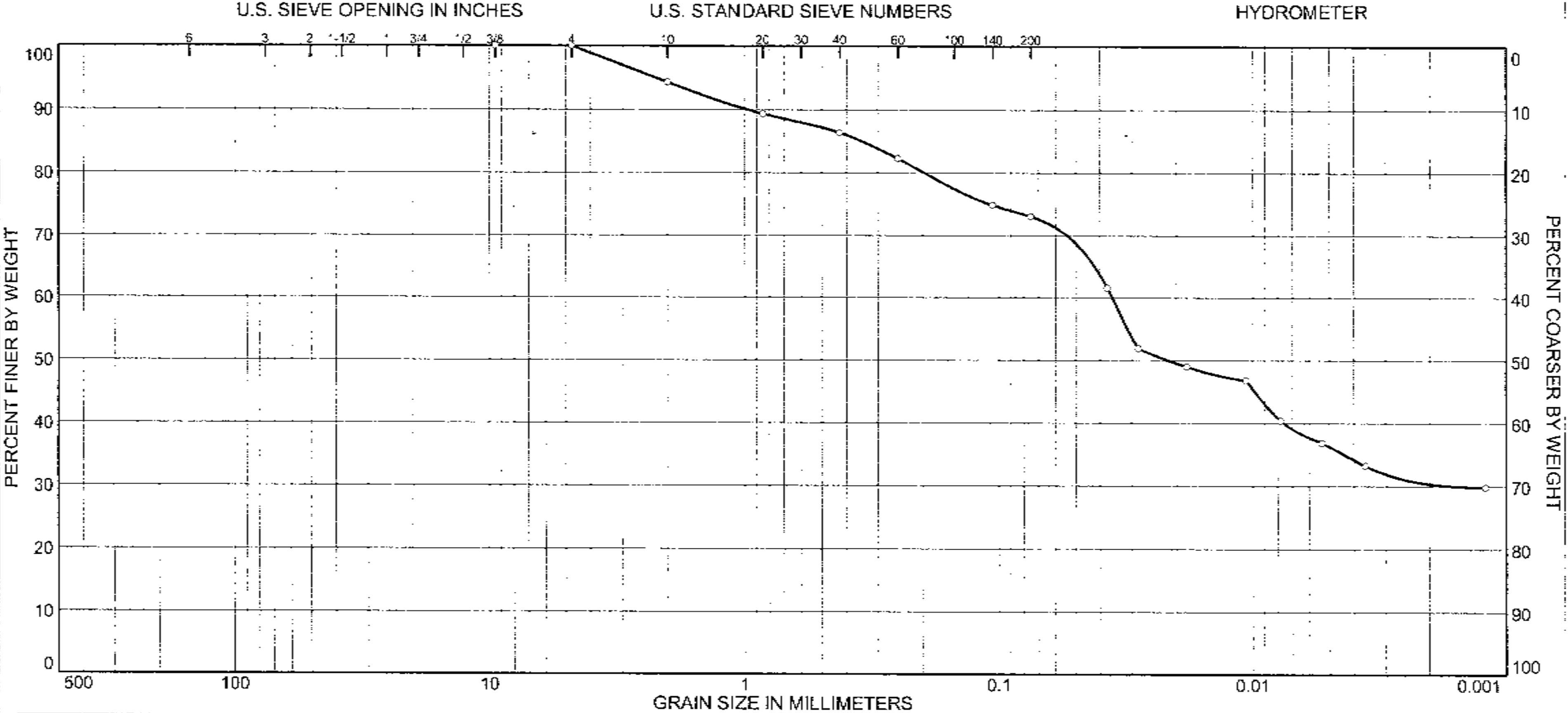
Project Cumberland Fossil Plant

Project No. GTX-1493 Lab no.

GeoTesting Express Inc.

● Moisture Content taken from bag as recieved, natural moisture content may be different

Particle Size Distribution Report ASTM D422



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	26.9	36.9	36.2

	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
○		B-48A	5-15ft	10/1/09	CH	Brown fat clay with sand	29.3	54	20

Client Stantec

Project Cumberland Fossil Plant

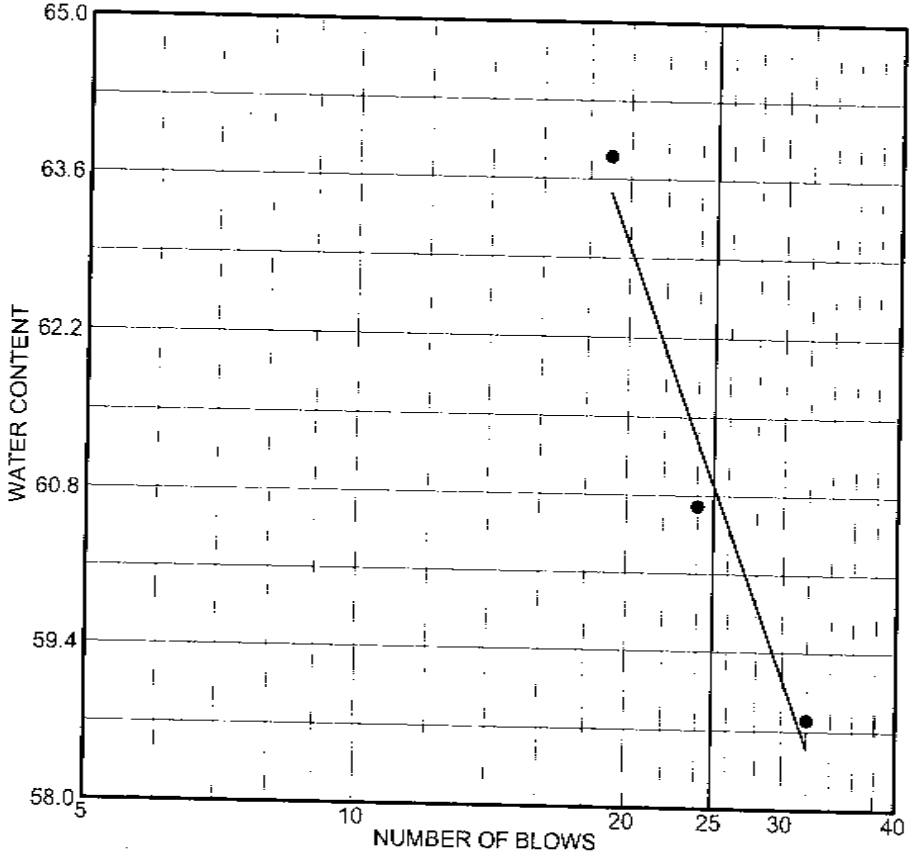
Project No. GTX-1493

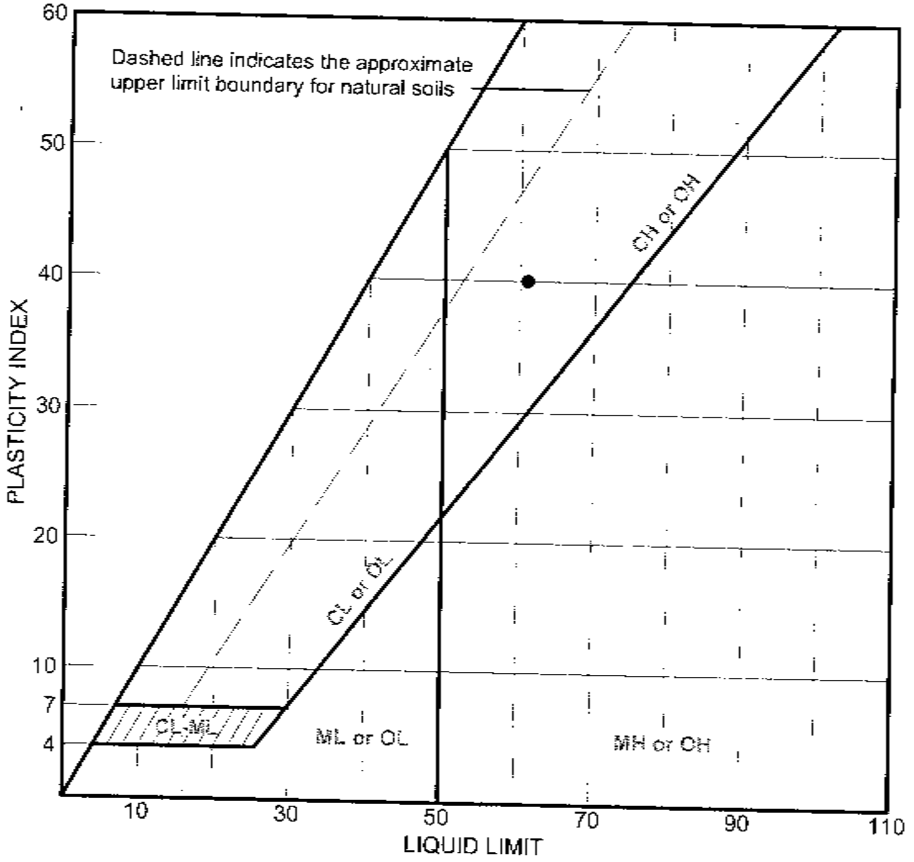
Lab no.

GeoTesting Express Inc.

○ Moisture Content was taken from bag as recieved, natural moisture content may be different

LIQUID AND PLASTIC LIMITS TEST REPORT





SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●	B-52	5-10 ft	10/07/09	CH	Sandy fat clay		61	40

Client Stantec

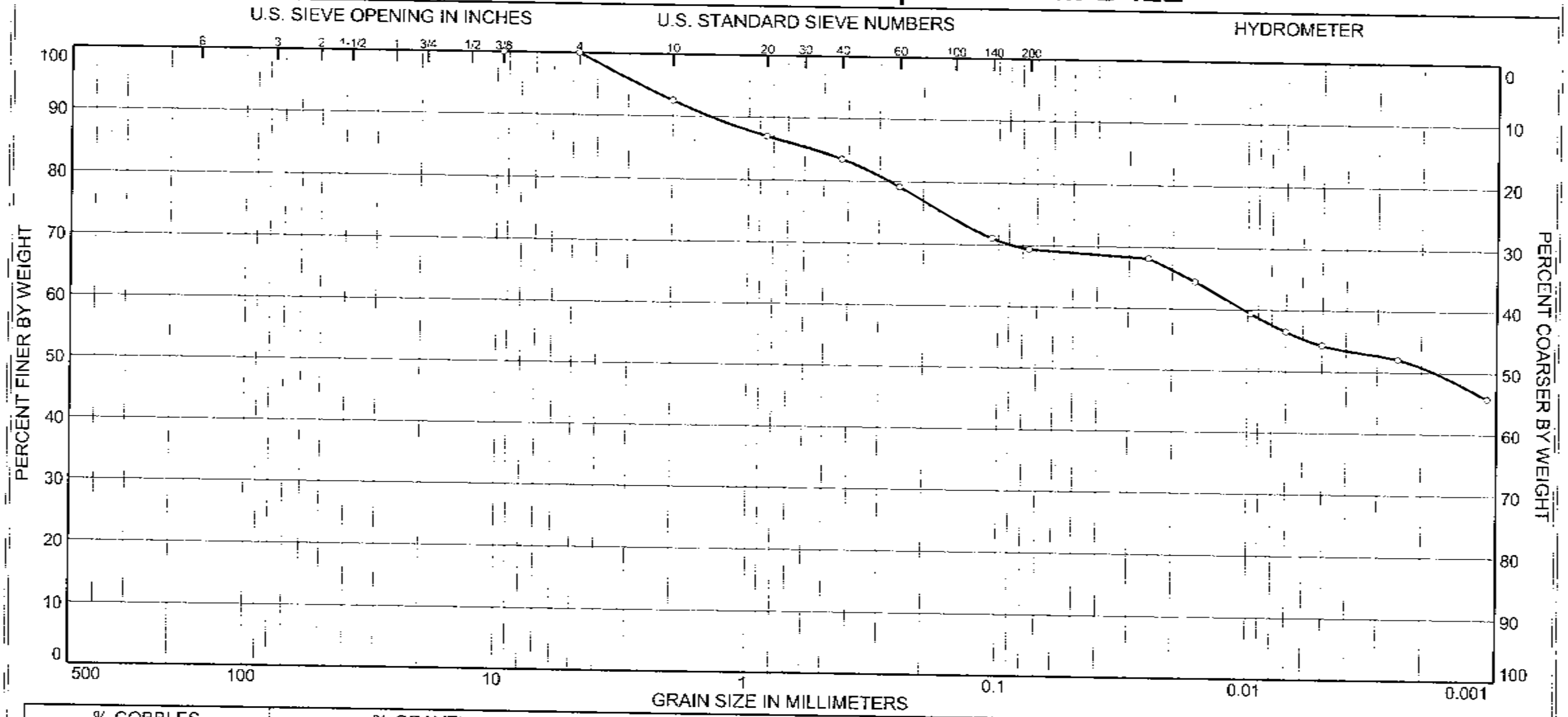
Project Cumberland Fossil Plant

Project No. 175539016 Lab no.

GeoTesting Express Inc.

●

Particle Size Distribution Report ASTM D422



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	30.6	15.1	54.3

SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
	B-52	5-10 ft	10/07/09	CH	Sandy fat clay		61	21

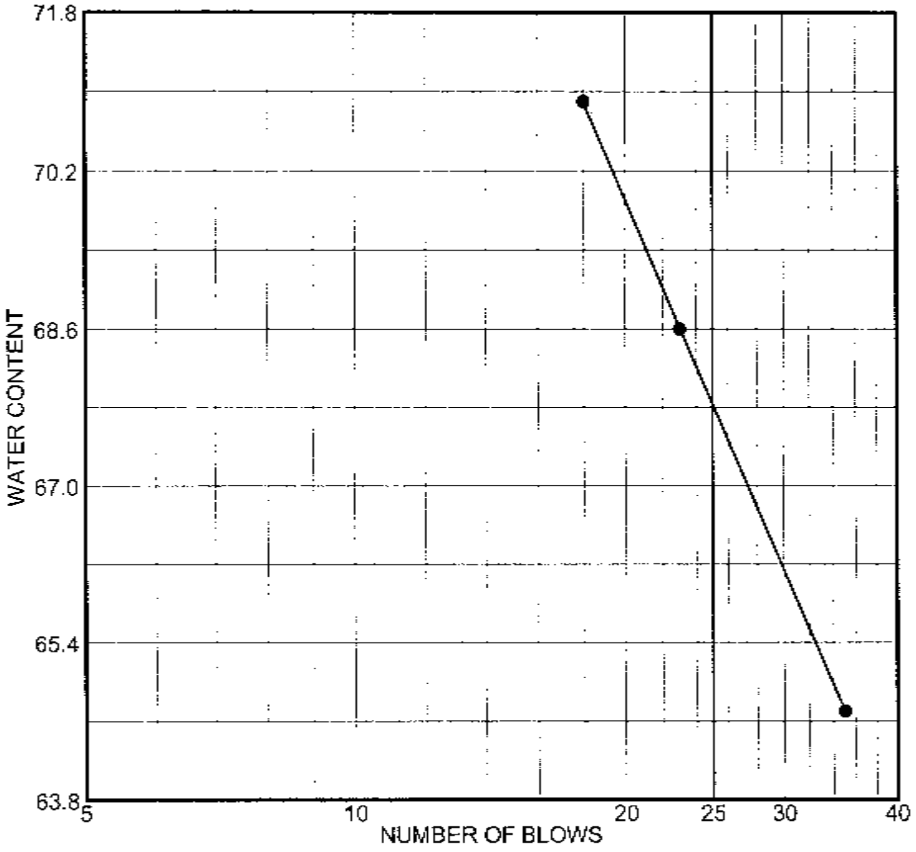
Client Stantec

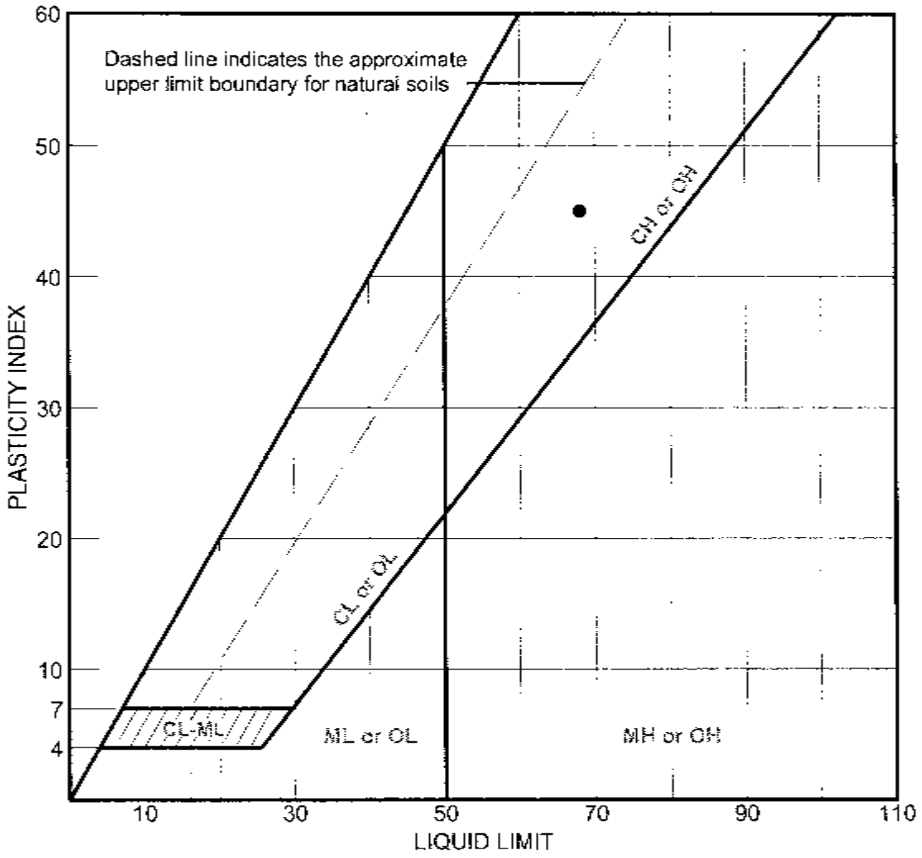
Project Cumberland Fossil Plant

Project No. 175539016 Lab no.

GeoTesting Express Inc.

LIQUID AND PLASTIC LIMITS TEST REPORT




Dashed line indicates the approximate upper limit boundary for natural soils

	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●		B-58	10-20 ft	10/07/09	CH	Sandy fat clay		68	45

Client Stantec

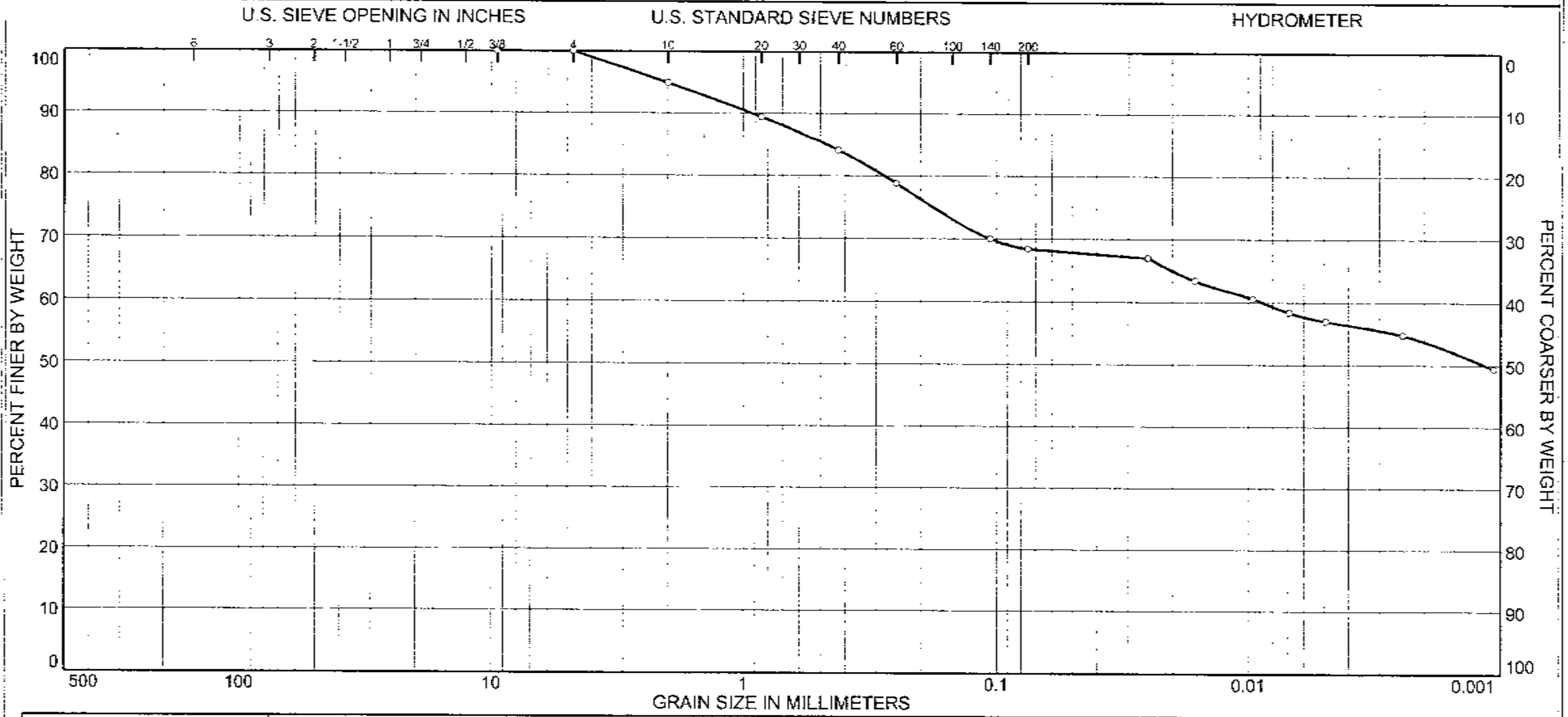
Project Cumberland Fossil Plant

Project No. 175539016 Lab no.

GeoTesting Express Inc.

●

Particle Size Distribution Report ASTM D422



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	31.6	11.3	57.1

	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
○		B-58	10-20 ft	10/07/09	CH	Sandy fat clay		68	23

Client Stantec

Project Cumberland Fossil Plant

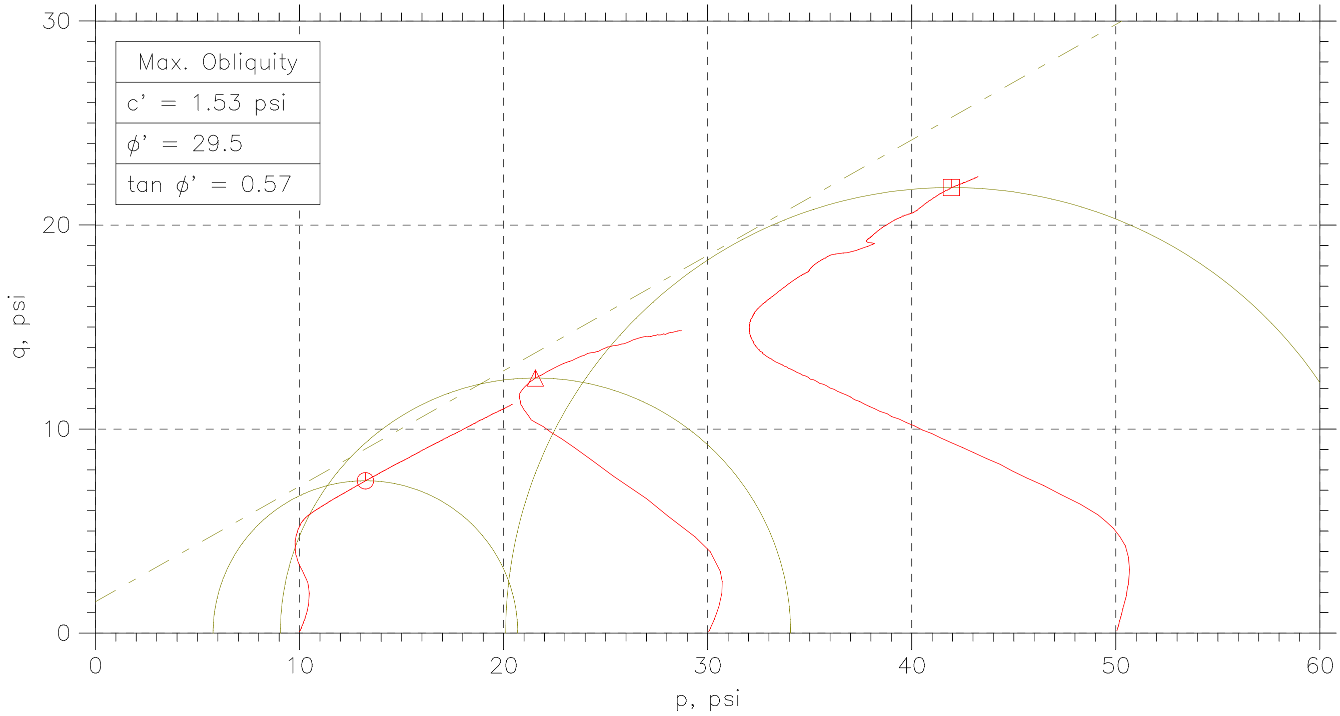
Project No. 175539016

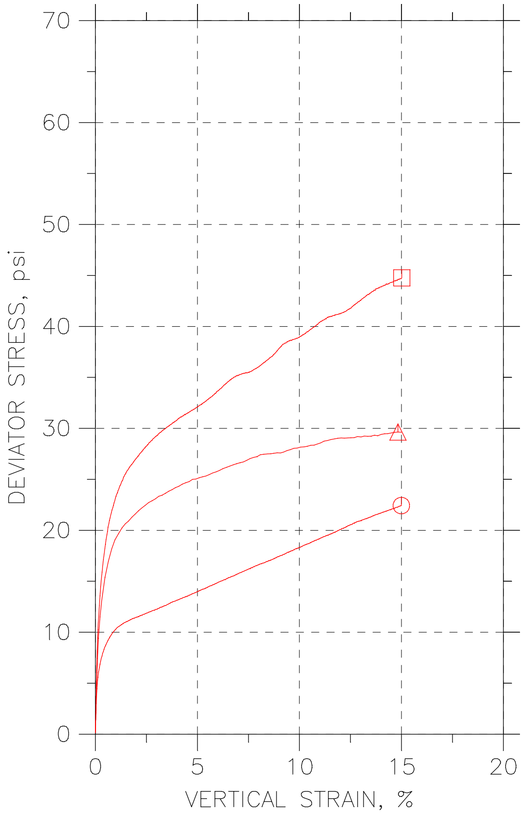
Lab no.

GeoTesting Express Inc.

○

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





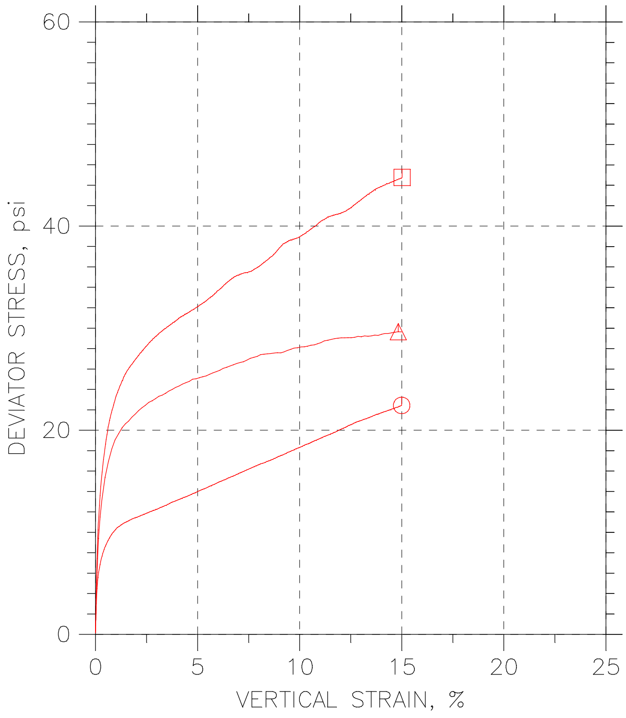
Symbol		○	△	□	
Sample No.		---	---	---	
Test No.		BA48A-1.1	B48A-1.2	B48A-1.3	
Depth		5-15'	5-15 ft	5-15'	
Initial	Diameter, in	2.863	2.859	2.849	
	Height, in	5.998	5.896	5.992	
	Water Content, %	21.0	20.9	20.6	
	Dry Density, pcf	100.2	100.	100.3	
	Saturation, %	83.0	82.1	81.5	
	Void Ratio	0.682	0.686	0.681	
Before Shear	Water Content, %	22.4	21.2	20.3	
	Dry Density, pcf	105.	107.2	108.9	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.606	0.572	0.548	
	Back Press., psi	98.44	119	97.92	
Ver. Eff. Cons. Stress, psi		9.939	29.99	49.94	
Shear Strength, psi		11.21	14.82	22.38	
Strain at Failure, %		15	14.8	15	
Strain Rate, %/min		0.016	0.016	0.016	
B-Value		0.96	0.95	0.95	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		54	54	54	
Plastic Limit		20	20	20	

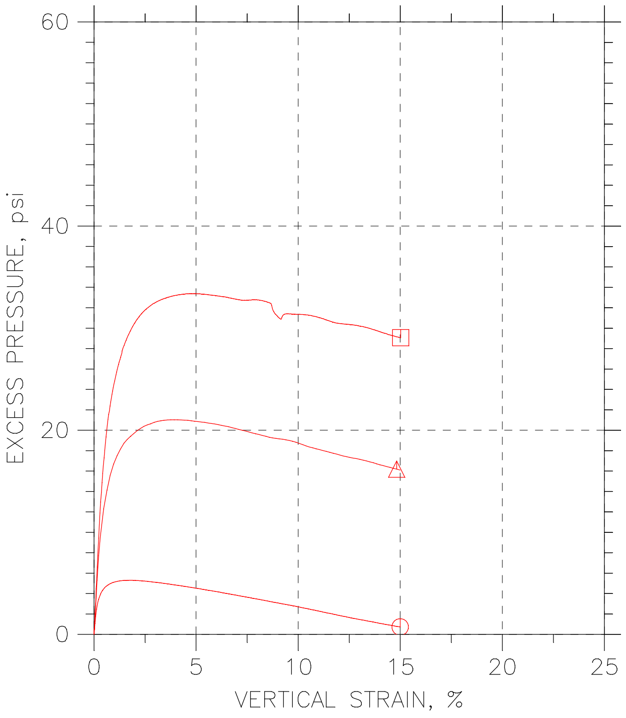
GeoTesting express

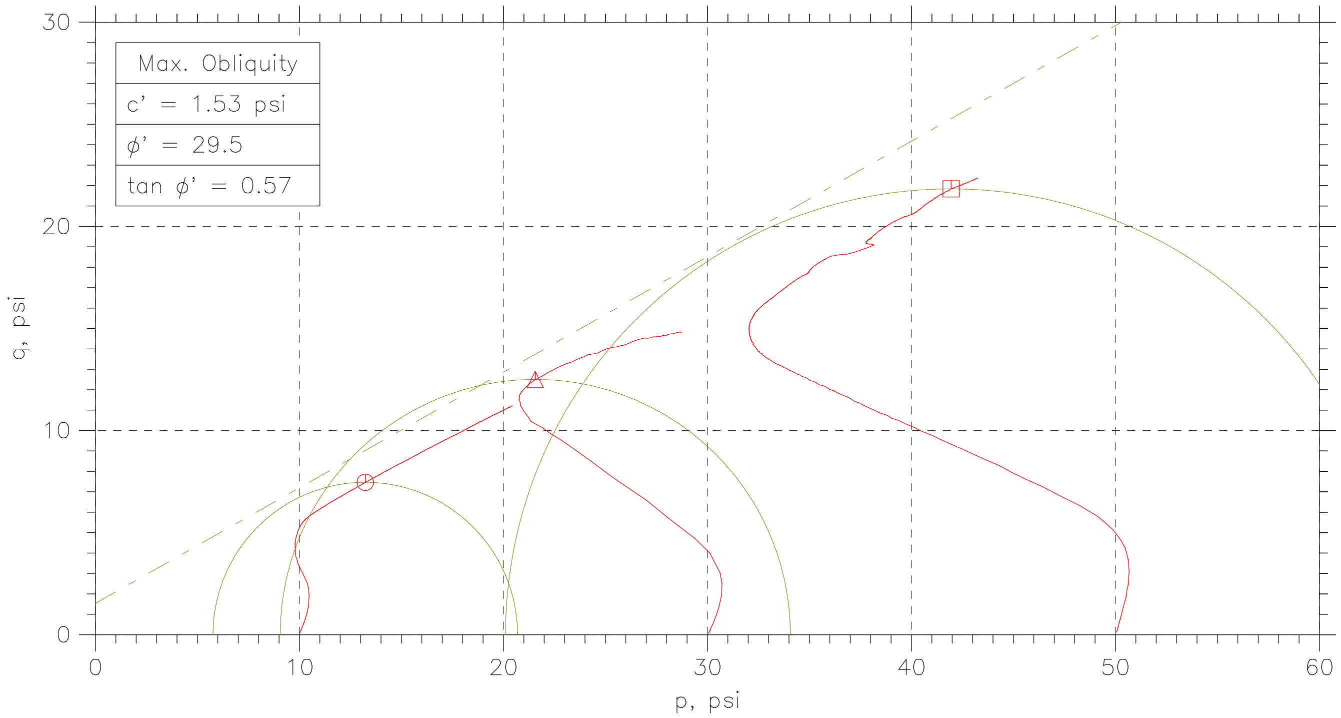
Project: Cumberland Fossil Plant
Location: ---
Project No.: GTX-1493
Boring No.: B-48A
Sample Type: Remolded
Description: Moist, brown fat clay with sand
Remarks: Compact test specimens to 95% max. density

Thu, 01-OCT-2009 09:23:15

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	BA48A-1.1	5-15'	MM	9/26/09	GT		1493-B48A-1.1.dat
△	---	B48A-1.2	5-15 ft	MM	9/26/09	GT		1493-B48A-1.2.dat
□	---	B48A-1.3	5-15'	MM	9/26/09	GT		1493-B48A-1.3.dat

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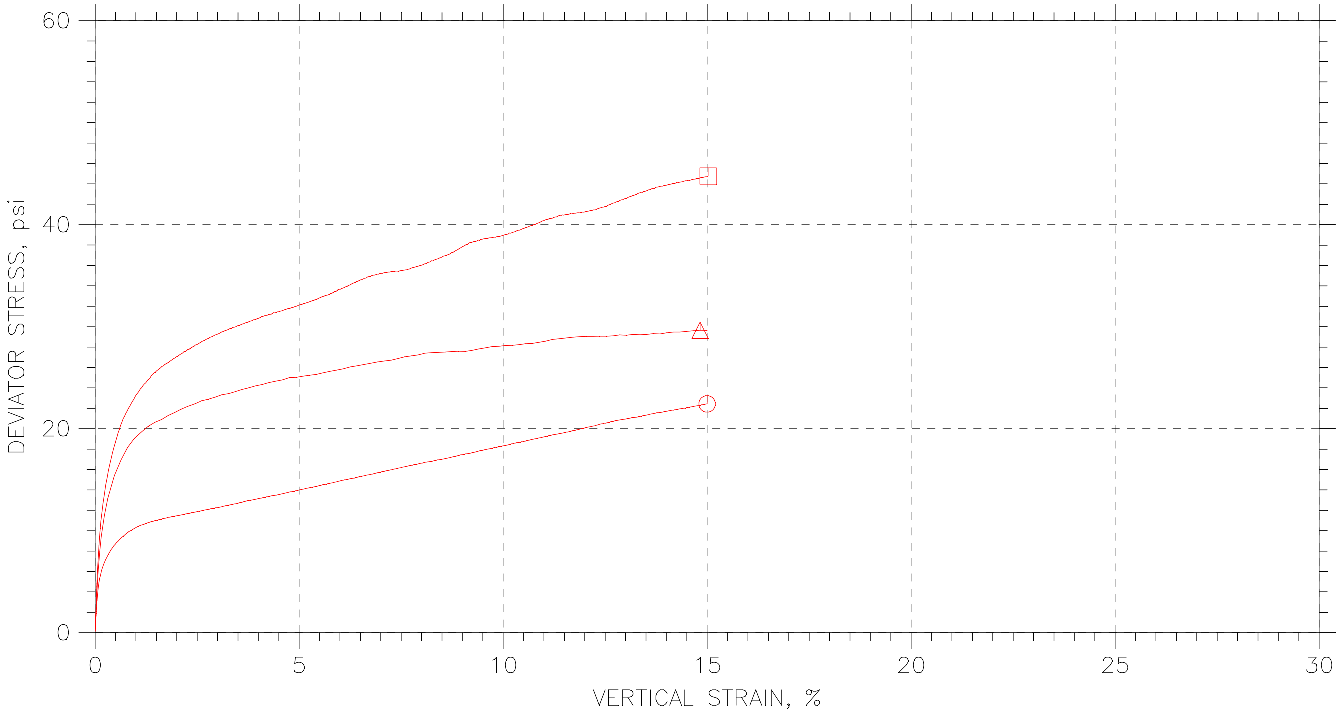
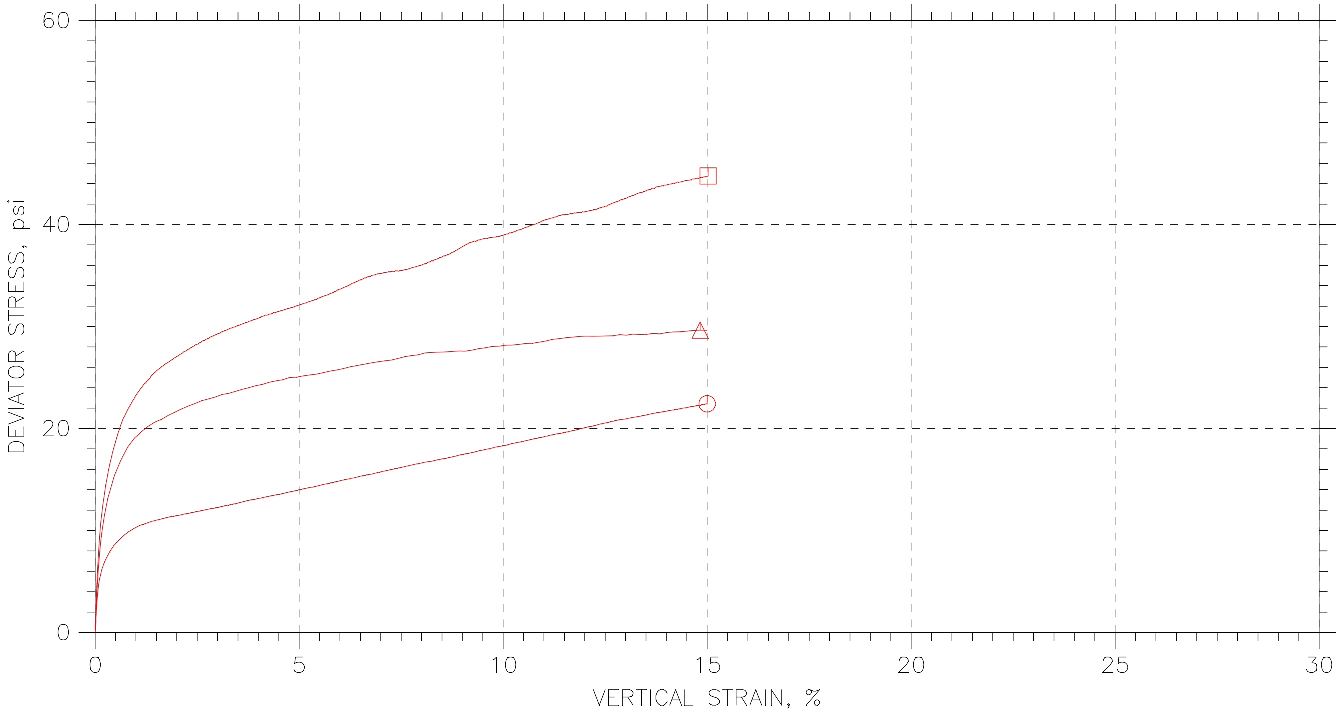
Project: Cumberland Fossil Plant	Location: ---	Project No.: GTX-1493
Boring No.: B-48A	Sample Type: Remolded	
Description: Moist, brown fat clay with sand		
Remarks: Compact test specimens to 95% max. density		

Thu, 01-OCT-2009 09:23:17

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	BA48A-1.1	5-15'	MM	9/26/09	GT		1493-B48A-1.1.dat
△	---	B48A-1.2	5-15 ft	MM	9/26/09	GT		1493-B48A-1.2.dat
□	---	B48A-1.3	5-15'	MM	9/26/09	GT		1493-B48A-1.3.dat

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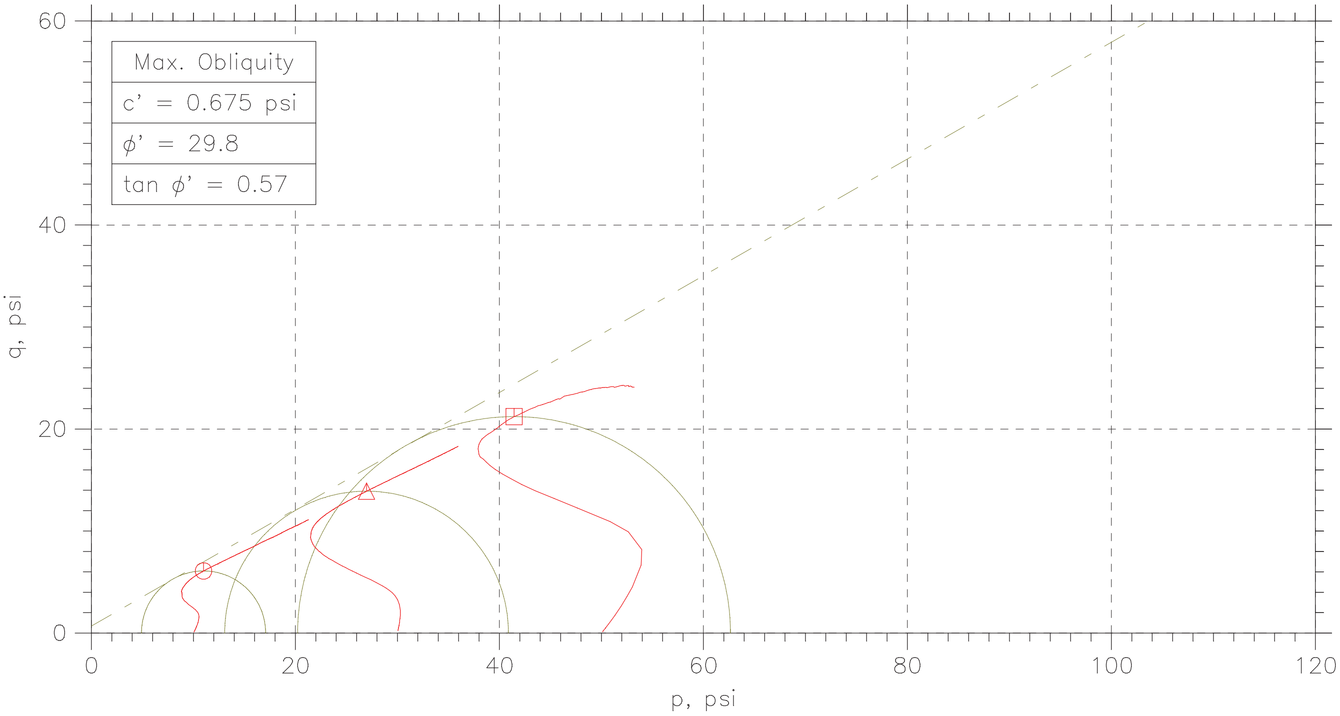
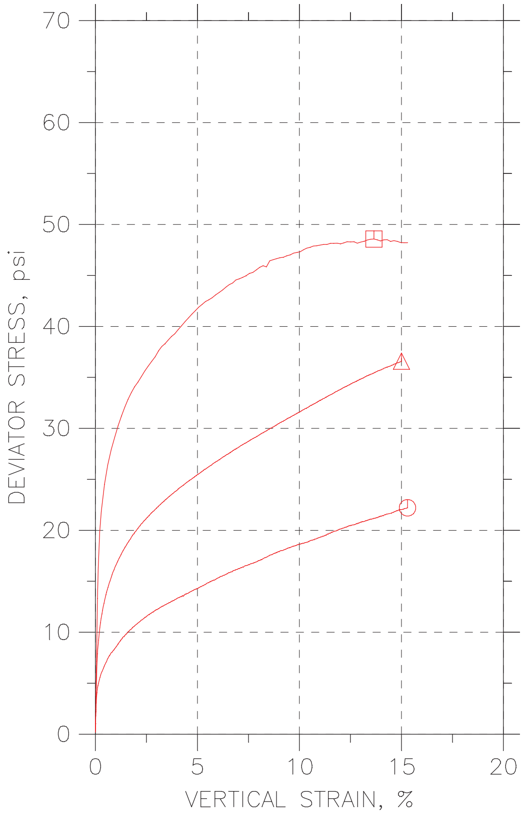
Project: Cumberland Fossil Plant	Location: ---	Project No.: GTX-1493
Boring No.: B-48A	Sample Type: Remolded	
Description: Moist, brown fat clay with sand		
Remarks: Compact test specimens to 95% max. density		

Thu, 01-OCT-2009 09:23:18

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		---	---	---	
Test No.		11.1	11.2	11.3	
Depth		5-10 ft	5-10 '	5-10 ft	
Initial	Diameter, in	2.879	2.878	2.879	
	Height, in	5.89	5.951	5.977	
	Water Content, %	23.6	23.4	23.4	
	Dry Density, pcf	96.87	96.48	96.68	
	Saturation, %	86.1	84.5	84.8	
	Void Ratio	0.74	0.747	0.744	
Before Shear	Water Content, %	23.2	21.9	20.0	
	Dry Density, pcf	103.6	105.9	109.4	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.627	0.592	0.541	
	Back Press., psi	140	119.2	101	
Ver. Eff. Cons. Stress, psi		9.972	29.82	49.99	
Shear Strength, psi		11.1	18.29	24.29	
Strain at Failure, %		15.3	15	13.7	
Strain Rate, %/min		0.016	0.016	0.016	
B-Value		0.96	0.95	0.95	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		61	61	61	
Plastic Limit		21	21	21	

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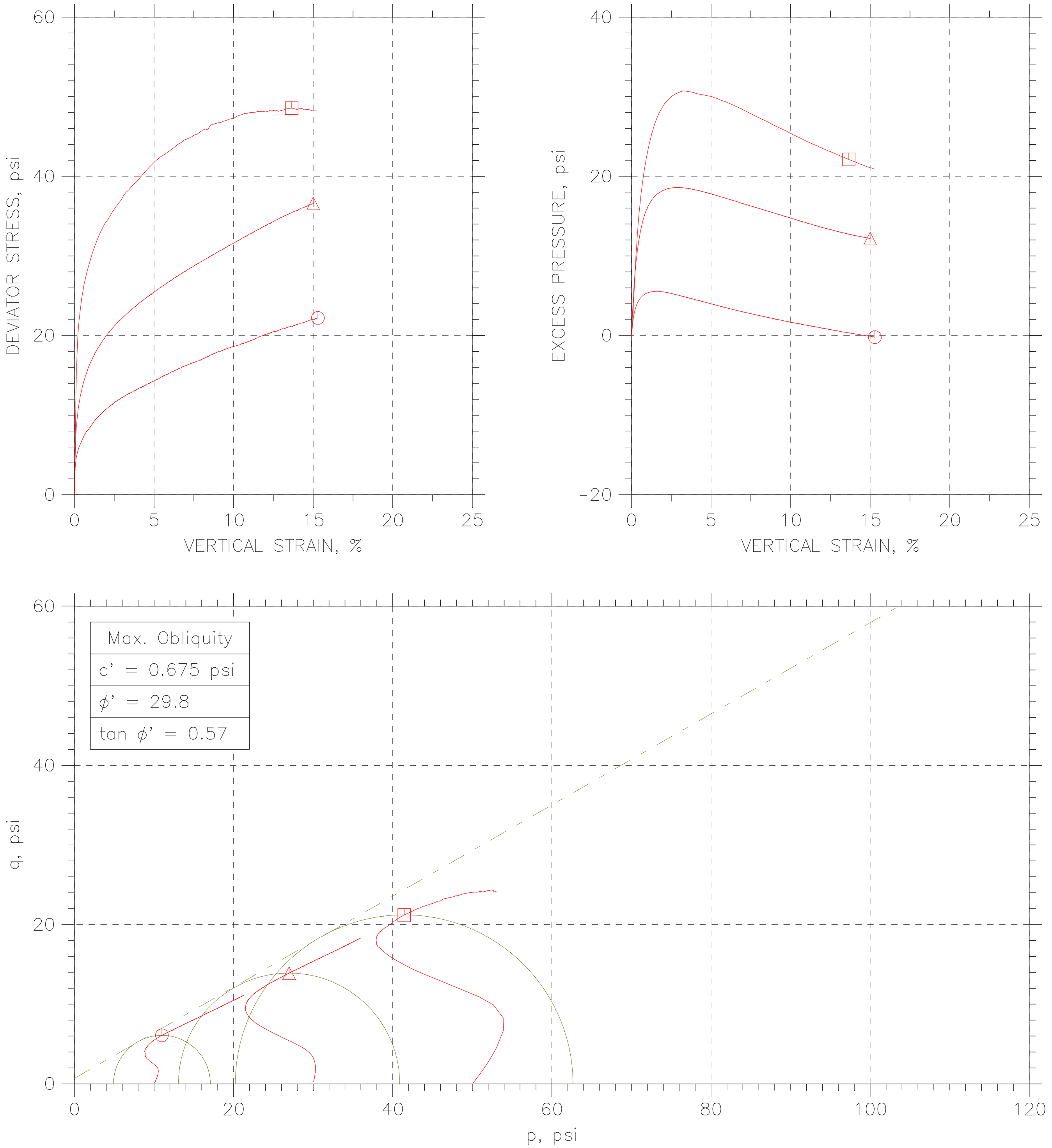
Project: Cumberland Fossil Plant
Location: ---
Project No.: GTX-1493
Boring No.: B-52A
Sample Type: Remolded
Description: Brown Sandy fat clay
Remarks: System 1057

Thu, 22-OCT-2009 17:06:19

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	11.1	5-10 ft	MM	10/5/09	GT		1493-11.1.dat
△	---	11.2	5-10 '	MM	10/03/09	GT		1493 -11.2.dat
□	---	11.3	5-10 ft	MM	10/2/09	GT		1493-11.3.dat

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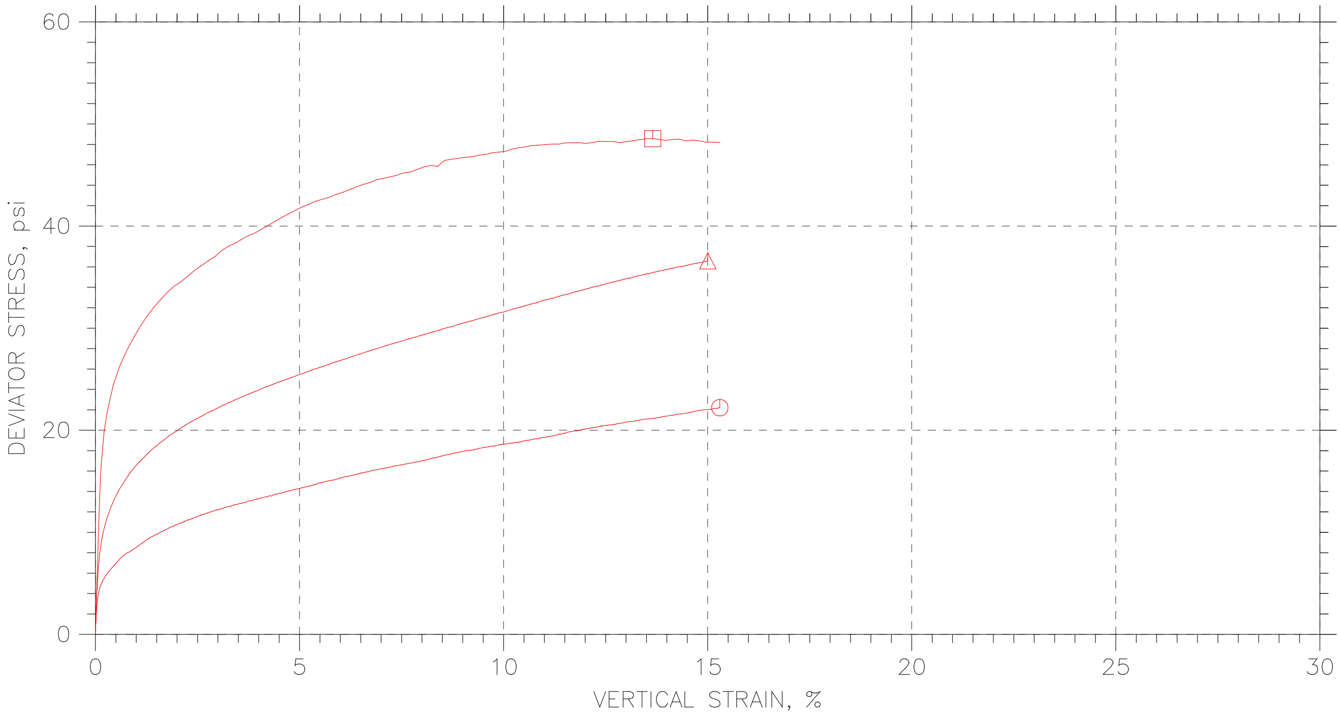
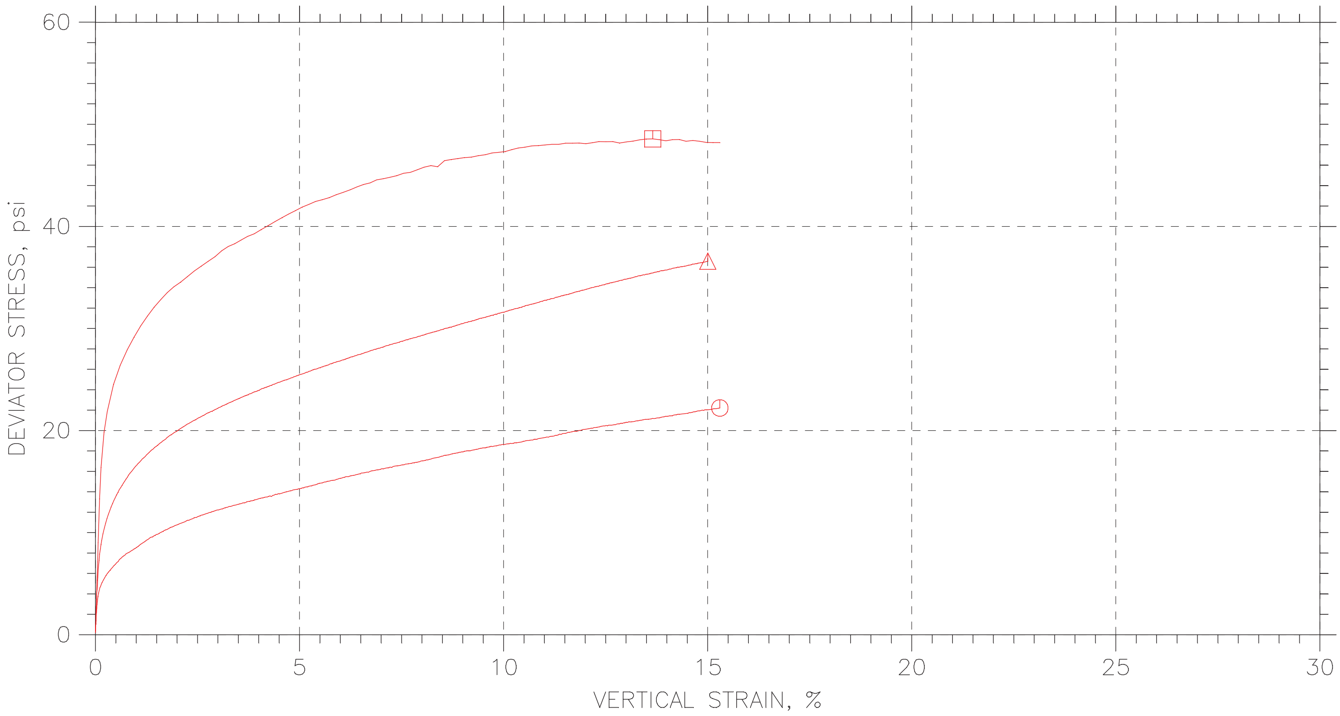
Project: Cumberland Fossil Plant	Location: ---	Project No.: GTX-1493
Boring No.: B-52A	Sample Type: Remolded	
Description: Brown Sandy fat clay		
Remarks: System 1057		

Thu, 22-OCT-2009 17:06:20

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	11.1	5-10 ft	MM	10/5/09	GT		1493-11.1.dat
△	---	11.2	5-10 '	MM	10/03/09	GT		1493 -11.2.dat
□	---	11.3	5-10 ft	MM	10/2/09	GT		1493-11.3.dat

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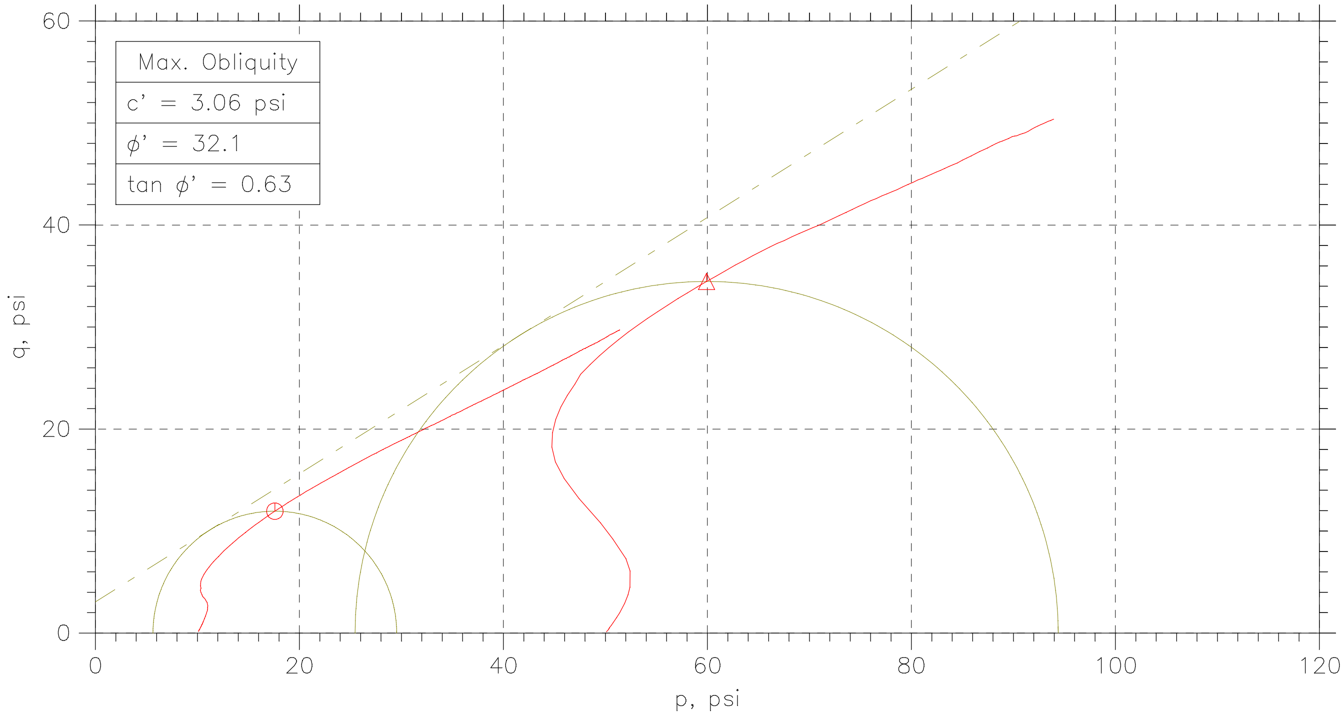
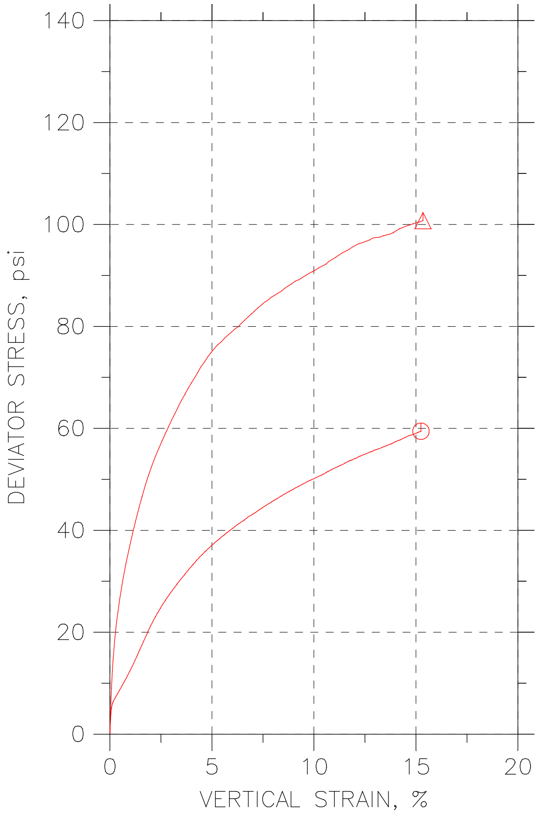
Project: Cumberland Fossil Plant	Location: ---	Project No.: GTX-1493
Boring No.: B-52A	Sample Type: Remolded	
Description: Brown Sandy fat clay		
Remarks: System 1057		

Thu, 22-OCT-2009 17:06:21

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





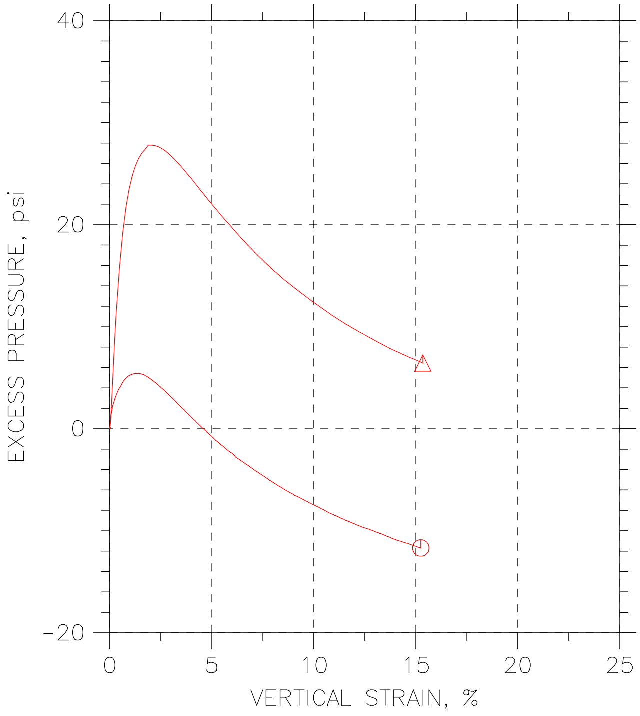
Symbol		○	△		
Sample No.		---	---		
Test No.		2.1	2.2		
Depth		30.6-31.2	31.3-31.8'		
Initial	Diameter, in	2.824	2.849		
	Height, in	6.028	6.063		
	Water Content, %	20.3	19.4		
	Dry Density, pcf	110.	109.4		
	Saturation, %	102.7	96.9		
	Void Ratio	0.533	0.541		
Before Shear	Water Content, %	20.2	18.6		
	Dry Density, pcf	109.	112.1		
	Saturation*, %	100.0	100.0		
	Void Ratio	0.546	0.503		
	Back Press., psi	140	101		
Ver. Eff. Cons. Stress, psi		9.972	49.99		
Shear Strength, psi		29.72	50.37		
Strain at Failure, %		15.2	15.3		
Strain Rate, %/min		0.03	0.016		
B-Value		0.95	0.95		
Estimated Specific Gravity		2.7	2.7		
Liquid Limit		---	---		
Plastic Limit		---	---		

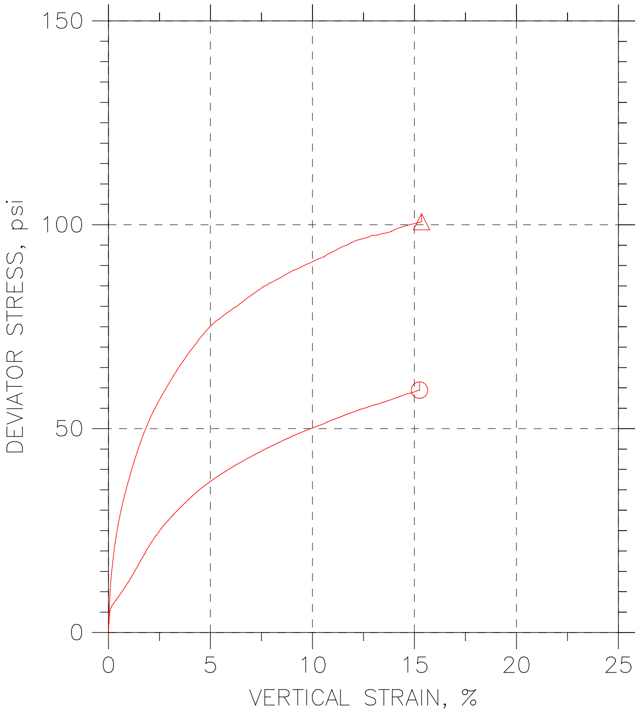
GeoTesting express

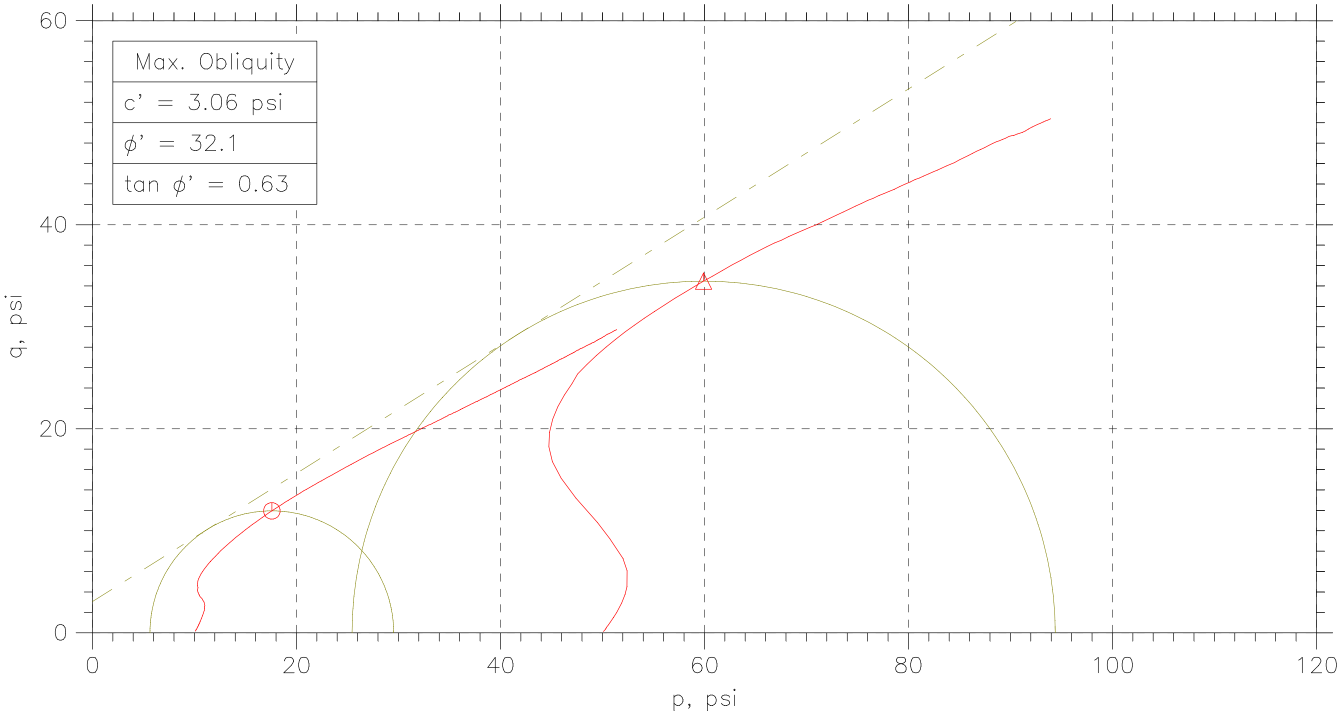
Project: Cumberland Fossil Plant
Location: ---
Project No.: GTX-1493
Boring No.: 54A
Sample Type: Remolded
Description: Brown Silty lean clay with sand
Remarks: System 1057

Wed, 07-OCT-2009 16:53:24

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	2.1	30.6-31.2	MM	9/29/09	GT		1493-2.1.dat
△	---	2.2	31.3-31.8'	MM	9/29/09	GT		1493-2.2.dat

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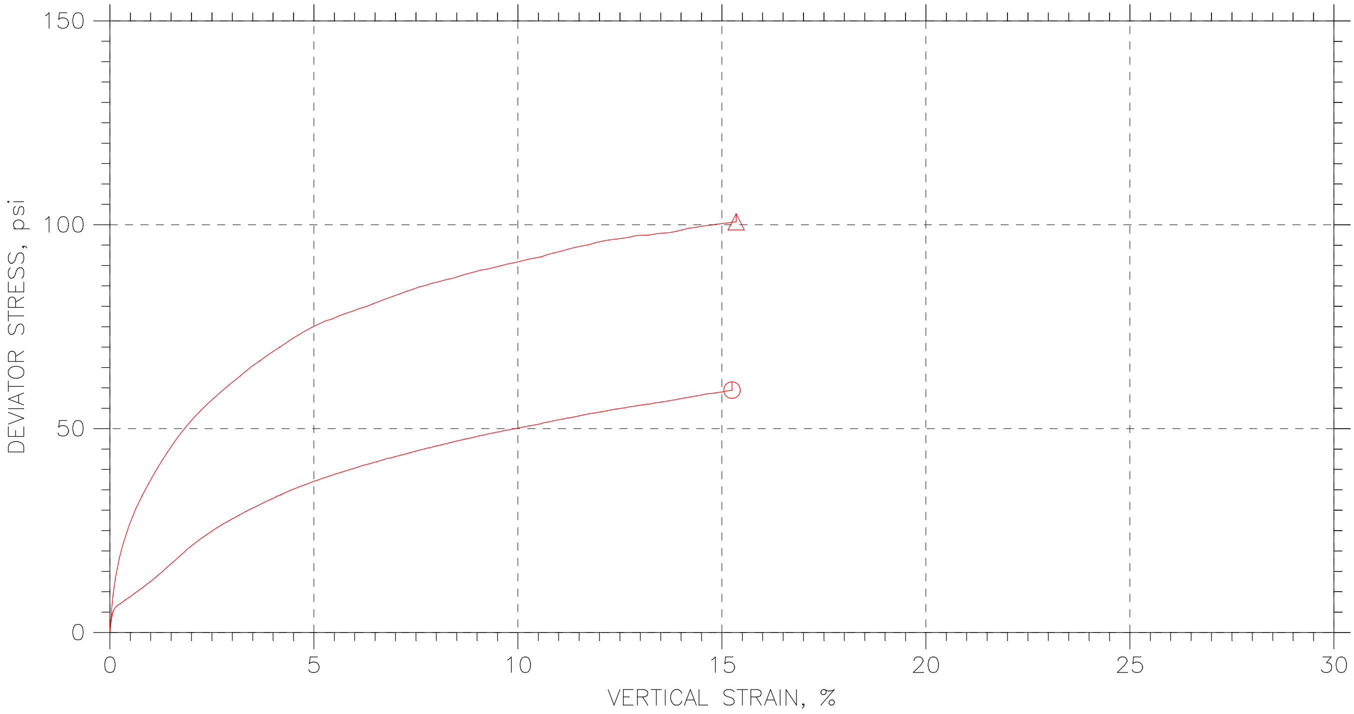
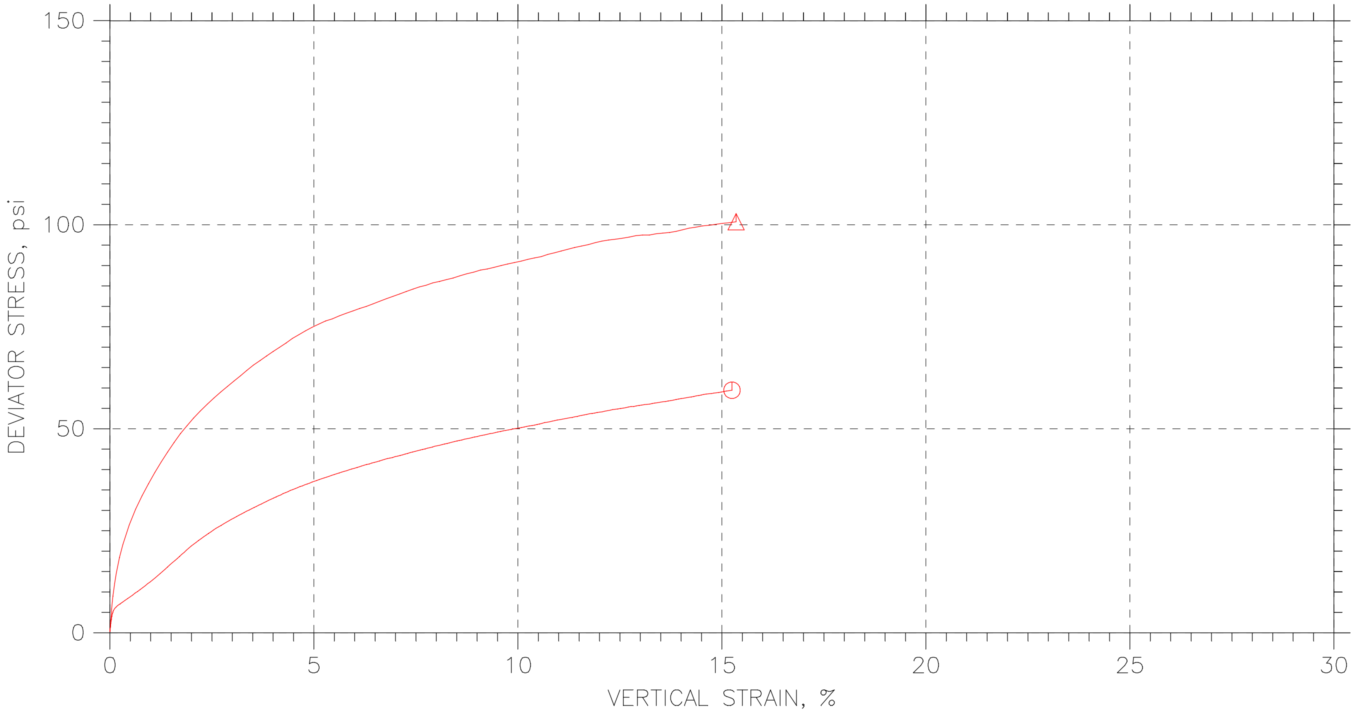
Project: Cumberland Fossil Plant	Location: ---	Project No.: GTX-1493
Boring No.: 54A	Sample Type: Remolded	
Description: Brown Silty lean clay with sand		
Remarks: System 1057		

Wed, 07-OCT-2009 16:53:25

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	2.1	30.6-31.2	MM	9/29/09	GT		1493-2.1.dat
△	---	2.2	31.3-31.8'	MM	9/29/09	GT		1493-2.2.dat

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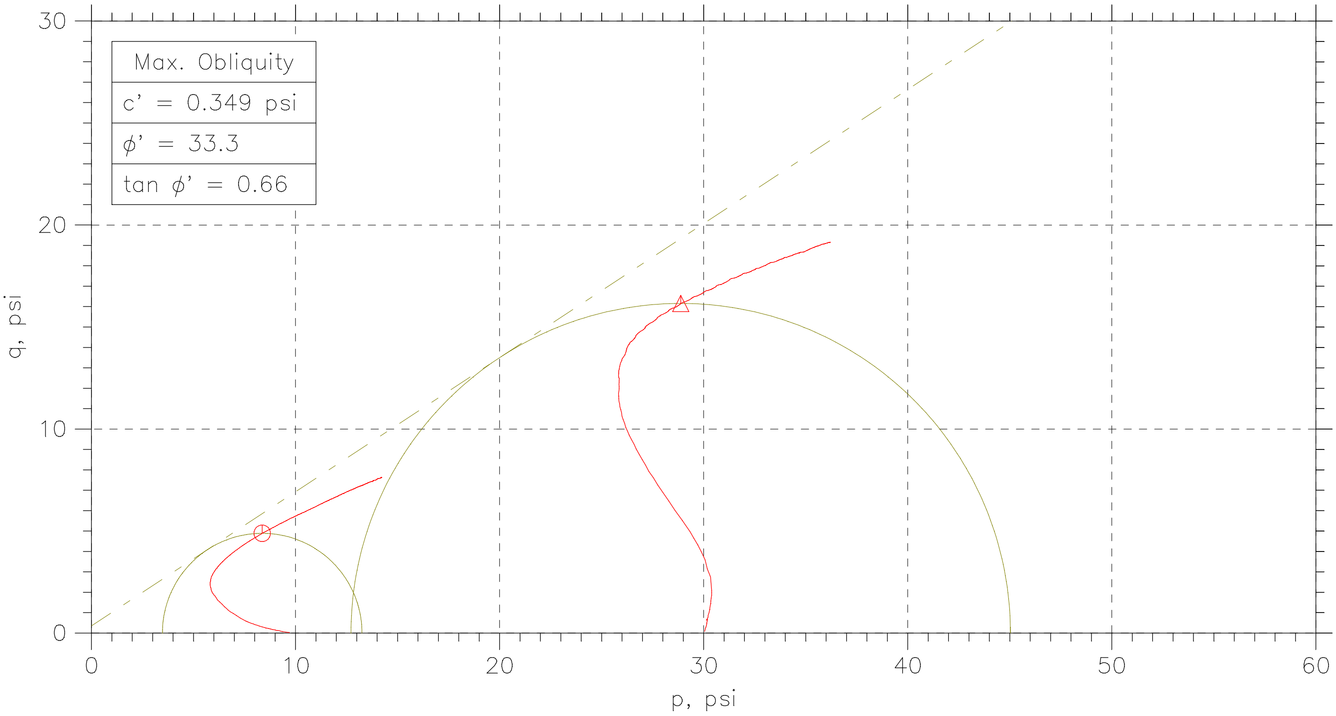
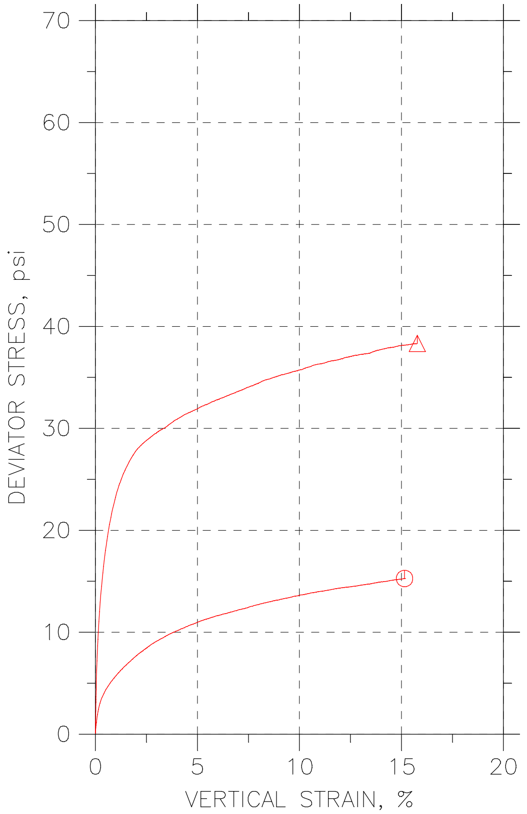
Project: Cumberland Fossil Plant	Location: ---	Project No.: GTX-1493
Boring No.: 54A	Sample Type: Remolded	
Description: Brown Silty lean clay with sand		
Remarks: System 1057		

Wed, 07-OCT-2009 16:53:26

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





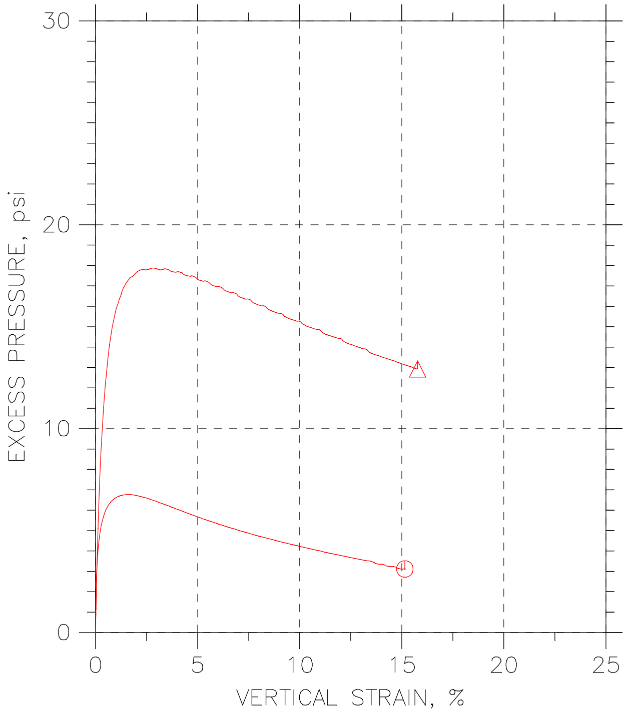
Symbol		○	△		
Sample No.		---	---		
Test No.		3.1	3.2		
Depth		45.2-45.8	45.8-46.4		
Initial	Diameter, in	2.848	2.834		
	Height, in	6.099	6.001		
	Water Content, %	24.9	23.2		
	Dry Density, pcf	99.97	102.1		
	Saturation, %	98.1	96.3		
	Void Ratio	0.686	0.651		
Before Shear	Water Content, %	25.2	23.1		
	Dry Density, pcf	100.3	103.8		
	Saturation*, %	100.0	100.0		
	Void Ratio	0.68	0.624		
	Back Press., psi	71.61	80.29		
Ver. Eff. Cons. Stress, psi		9.687	29.97		
Shear Strength, psi		7.635	19.17		
Strain at Failure, %		15.2	15.8		
Strain Rate, %/min		0.016	0.016		
B-Value		0.95	0.95		
Estimated Specific Gravity		2.7	2.7		
Liquid Limit		---	---		
Plastic Limit		---	---		

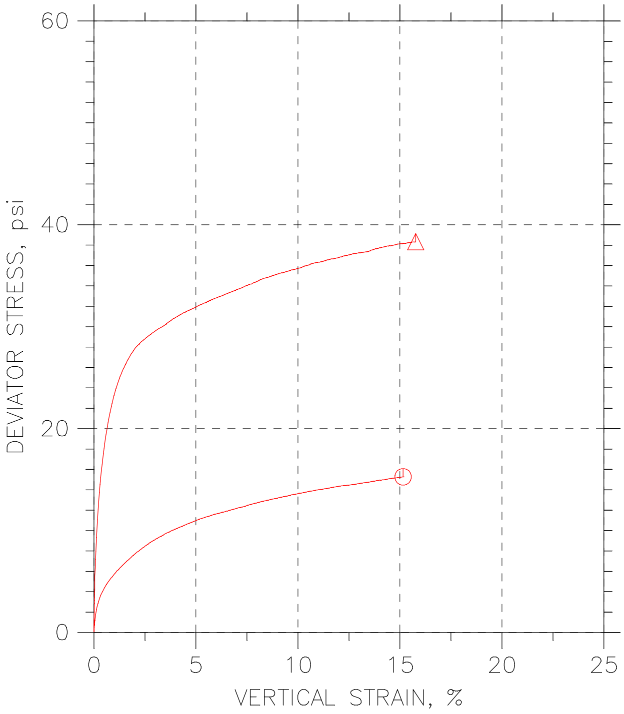
GeoTesting express

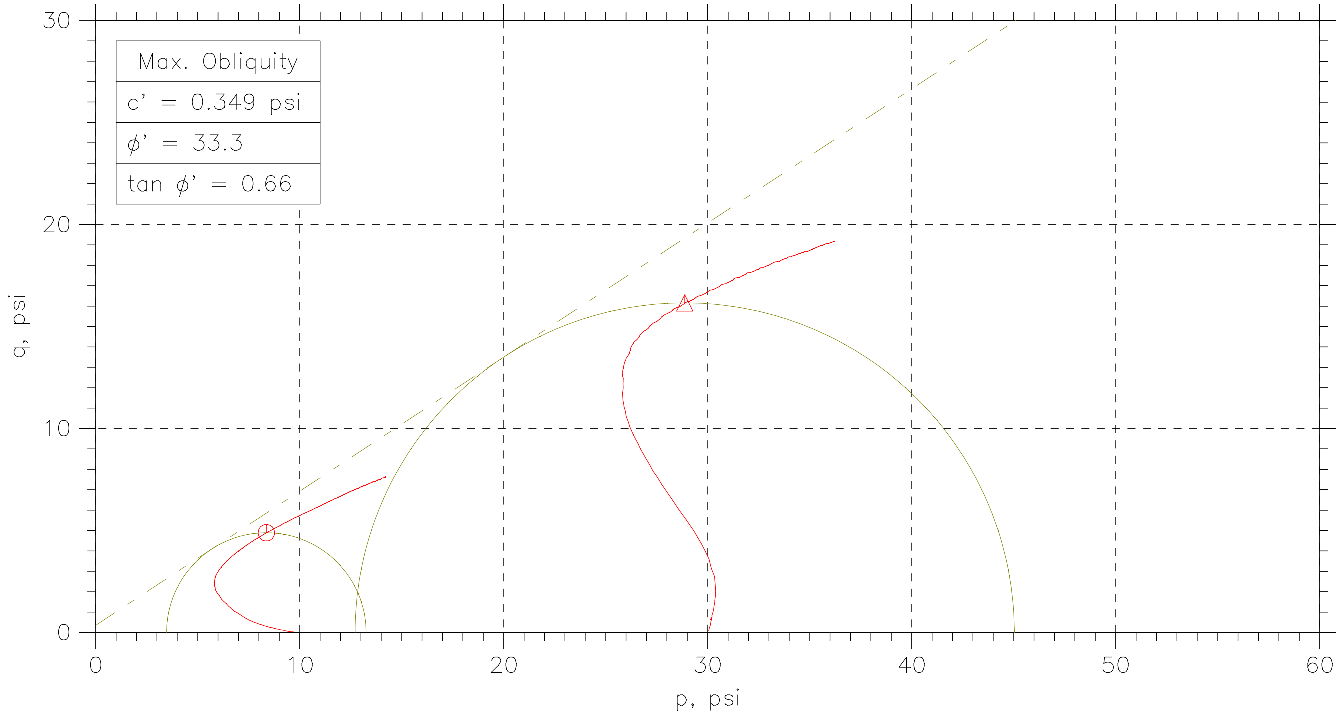
Project: Cumberland Fossil Plant
Location: ---
Project No.: GTX-1493
Boring No.: 54A
Sample Type: Remolded
Description: Brown Lean clay
Remarks: 2054

Thu, 08-OCT-2009 09:51:44

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







Max. Obliquity
c' = 0.349 psi
ϕ' = 33.3
tan ϕ' = 0.66

	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	3.1	45.2-45.8	MM	10/01/09	GT		1493 -3.1.dat
△	---	3.2	45.8-46.4	MM	10/02/09	GT		1493 -3.2.dat

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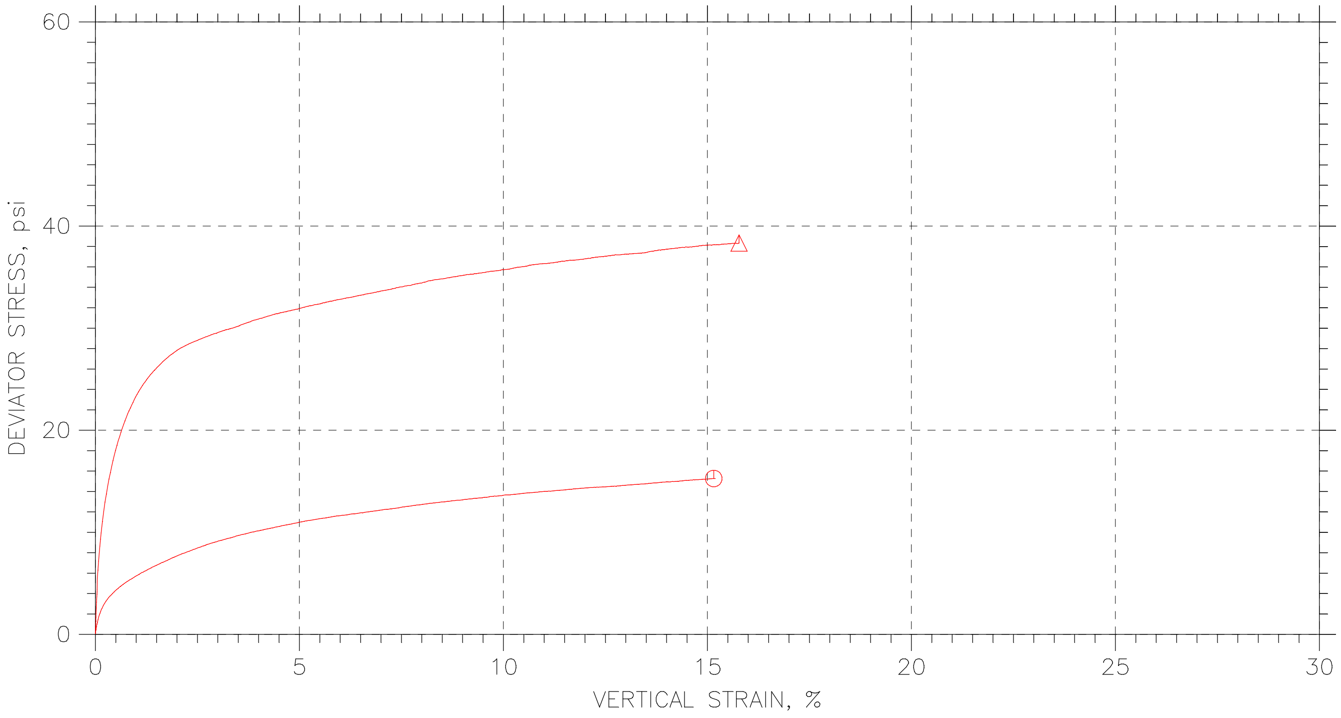
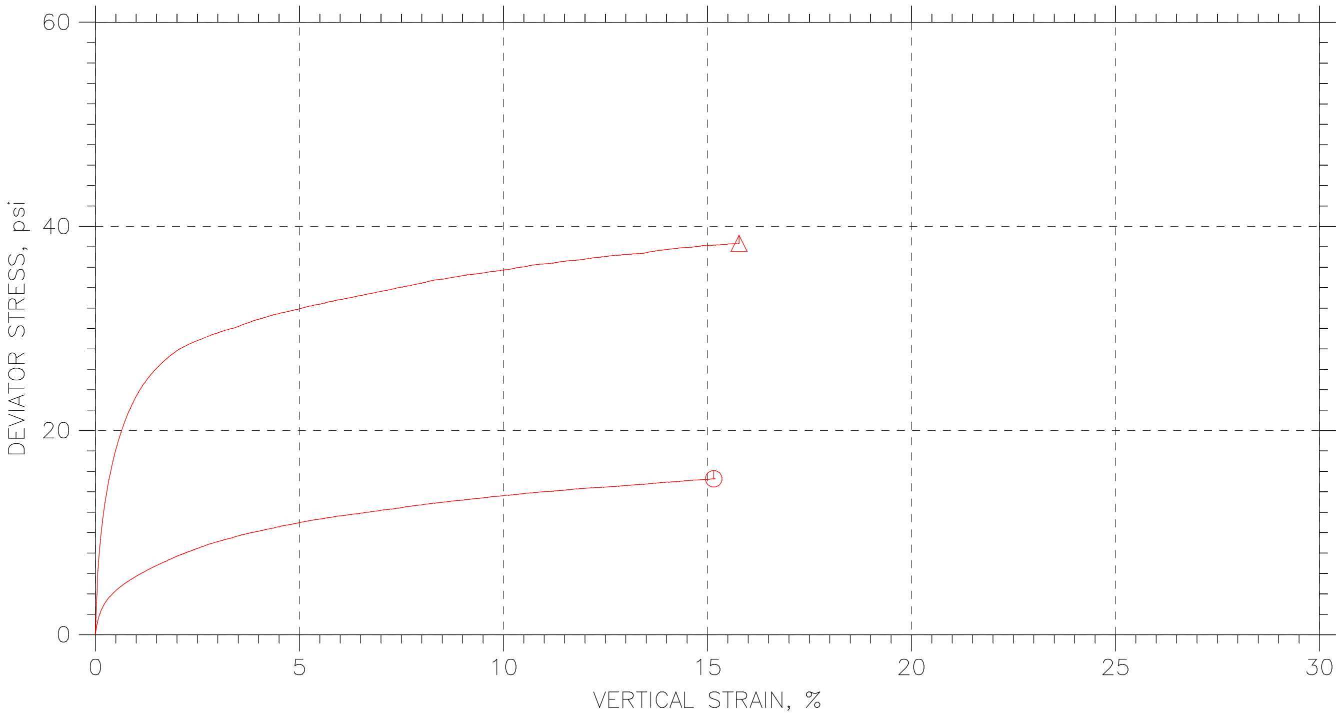
Project: Cumberland Fossil Plant	Location: ---	Project No.: GTX-1493
Boring No.: 54A	Sample Type: Remolded	
Description: Brown Lean clay		
Remarks: 2054		

Thu, 08-OCT-2009 09:51:45

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	3.1	45.2-45.8	MM	10/01/09	GT		1493 -3.1.dat
△	---	3.2	45.8-46.4	MM	10/02/09	GT		1493 -3.2.dat

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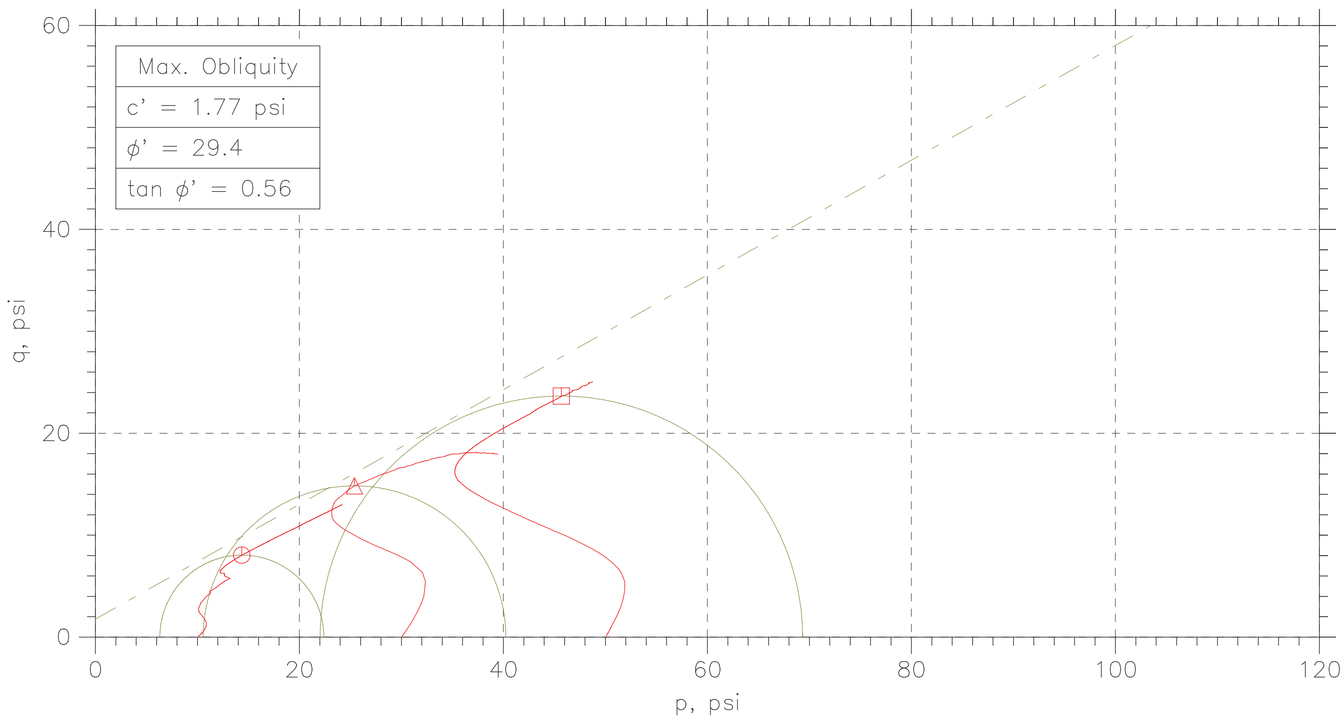
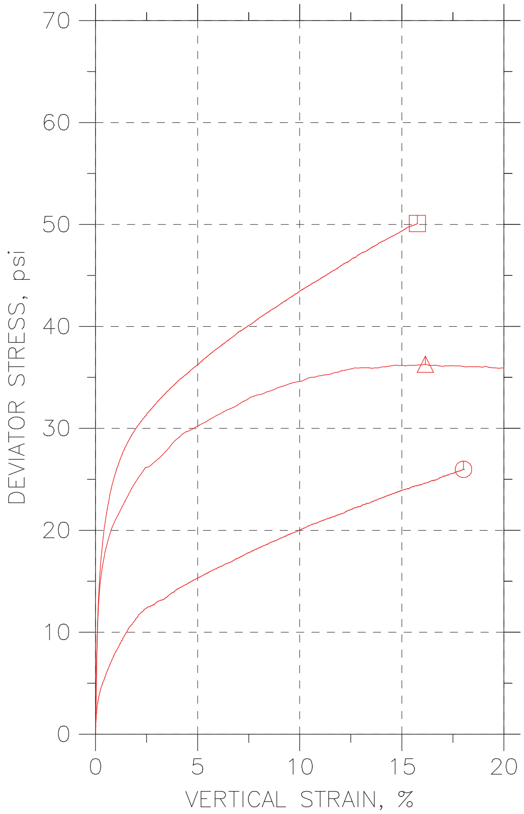
Project: Cumberland Fossil Plant	Location: ---	Project No.: GTX-1493
Boring No.: 54A	Sample Type: Remolded	
Description: Brown Lean clay		
Remarks: 2054		

Thu, 08-OCT-2009 09:51:47

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Symbol	○	△	□	
	Sample No.	---	---	---	
	Test No.	9.1	9.2	9.3	
	Depth	10-20 ft	10-20 ft	10-20 ft	
Initial	Diameter, in	2.848	2.846	2.834	
	Height, in	6.019	5.946	6.021	
	Water Content, %	23.5	23.4	23.6	
	Dry Density, pcf	97.37	98.75	98.72	
	Saturation, %	86.7	89.3	90.1	
	Void Ratio	0.731	0.707	0.707	
Before Shear	Water Content, %	24.9	24.2	22.8	
	Dry Density, pcf	100.9	101.9	104.4	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.671	0.654	0.615	
	Back Press., psi	139.6	119	74.23	
	Ver. Eff. Cons. Stress, psi	10.01	29.99	49.98	
	Shear Strength, psi	12.99	18.15	25.05	
	Strain at Failure, %	18	16.2	15.8	
	Strain Rate, %/min	0.016	0.016	0.016	
	B-Value	0.95	0.95	0.95	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	68	68	68	
	Plastic Limit	23	23	23	

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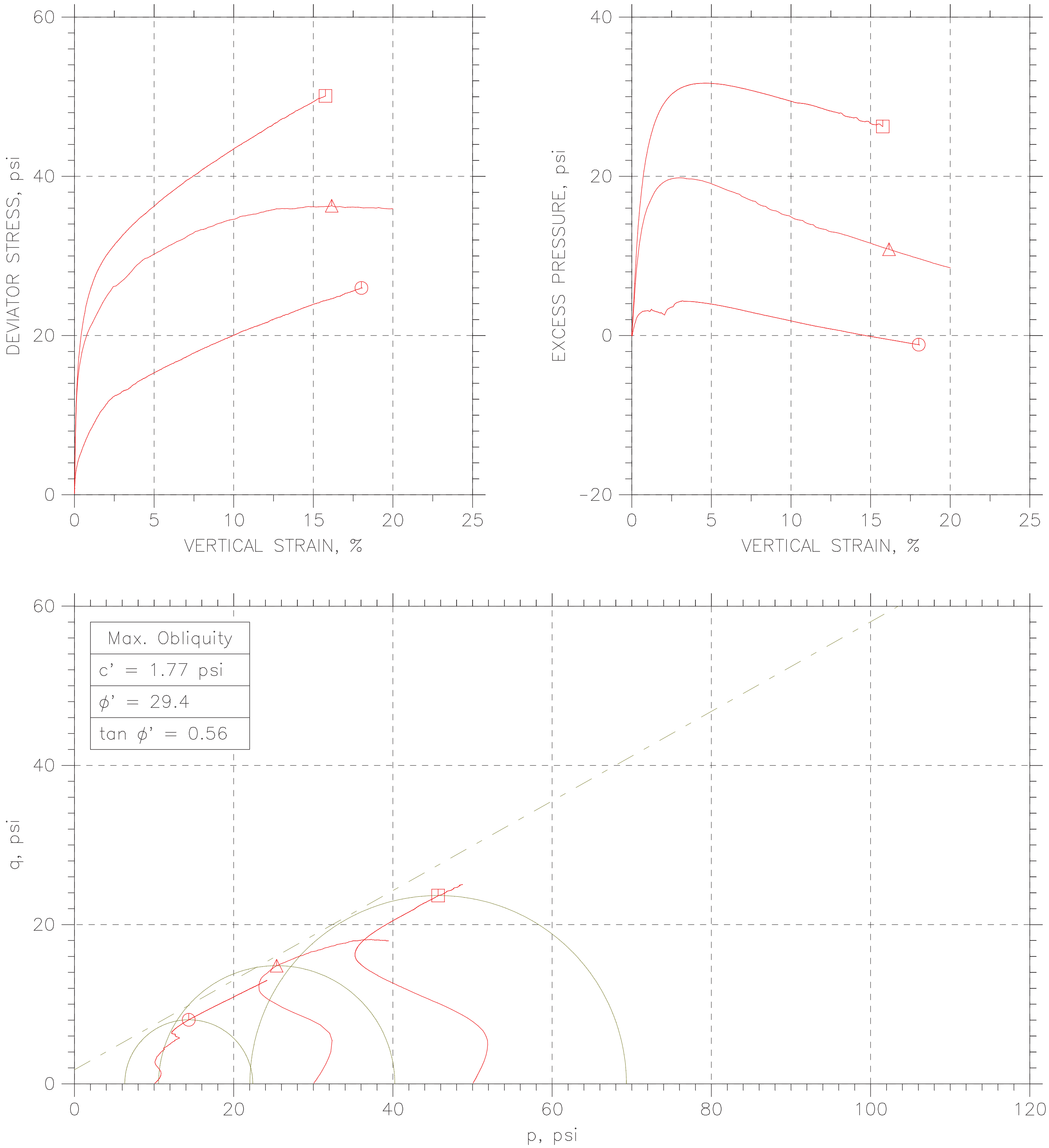
Project: Cumberland Fossil Plant
Location: ---
Project No.: GTX-1493
Boring No.: B-58
Sample Type: Remolded
Description: Brown Sandy fat clay
Remarks: System 1057

Thu, 22-OCT-2009 16:37:00

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	9.1	10-20 ft	MM	10/6/09	GT		1493-9.1.dat
△	---	9.2	10-20 ft	MM	10/05/09	GT		1493-9.2.dat
□	---	9.3	10-20 ft	MM	10/05/09	GT		1493 -9.3.dat

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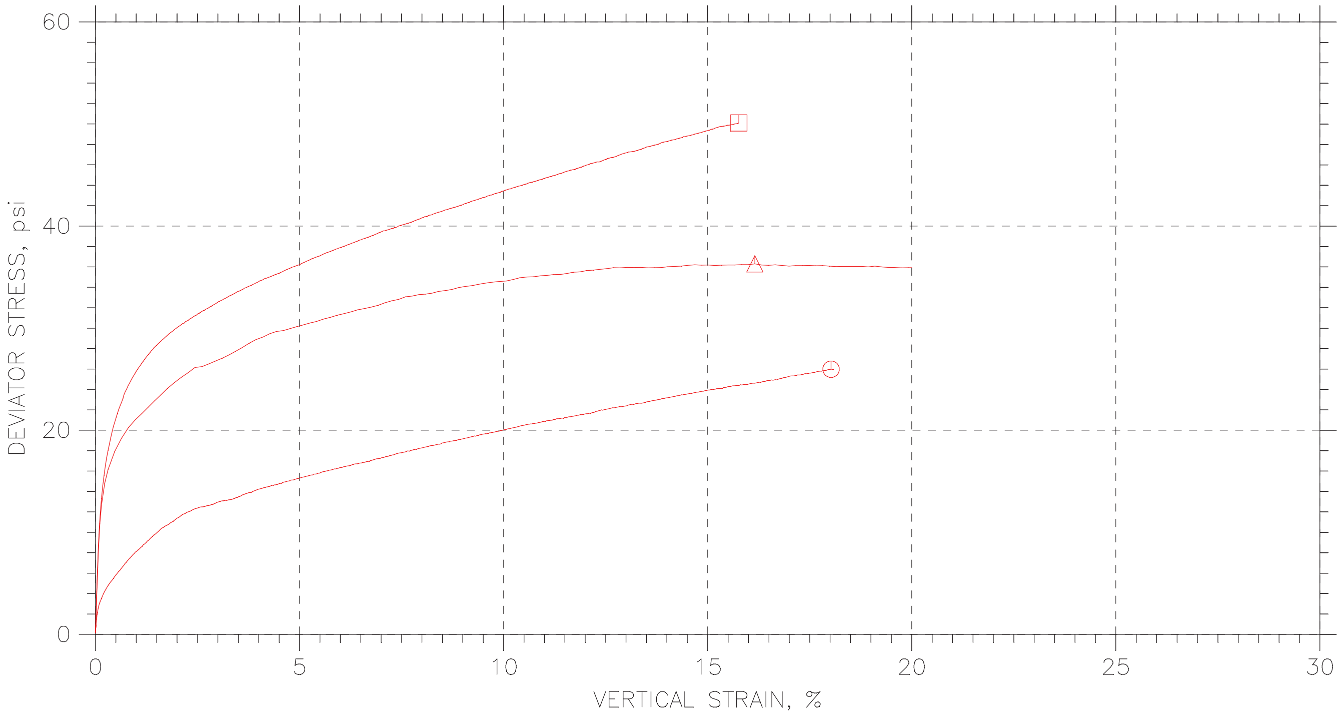
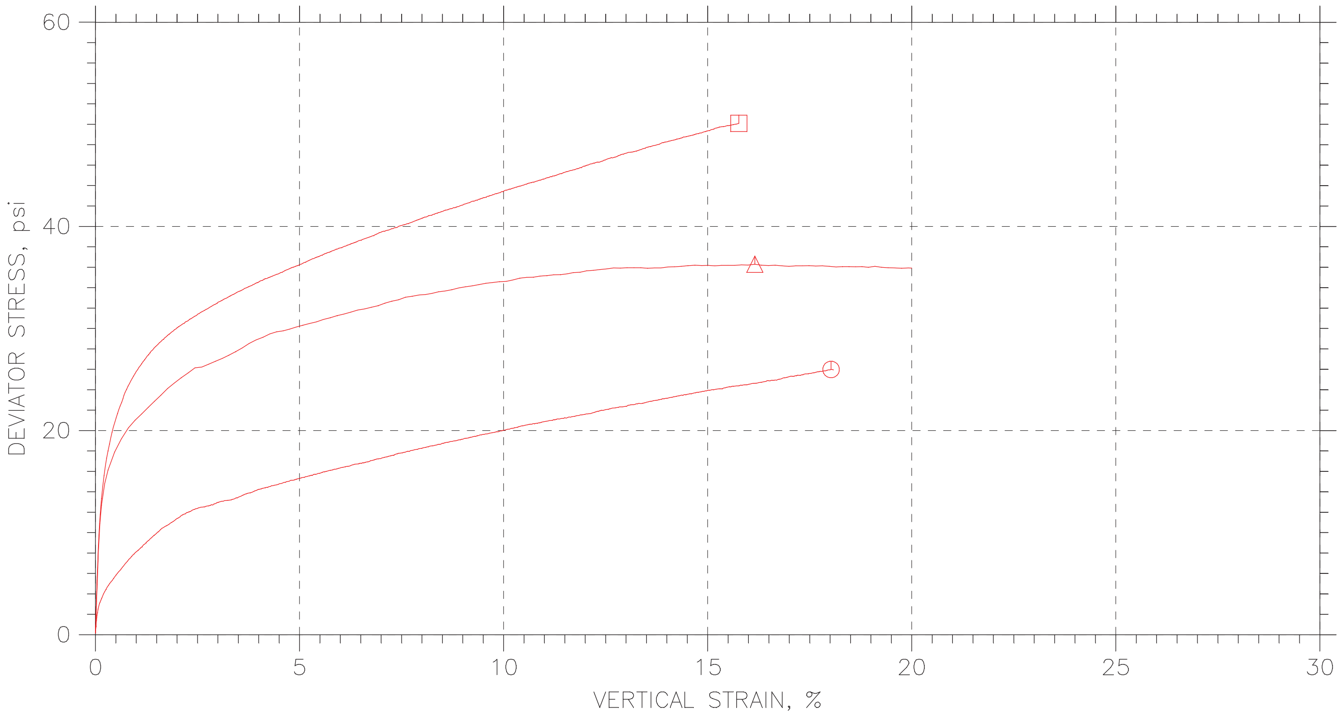
Project: Cumberland Fossil Plant	Location: ---	Project No.: GTX-1493
Boring No.: B-58	Sample Type: Remolded	
Description: Brown Sandy fat clay		
Remarks: System 1057		

Thu, 22-OCT-2009 16:37:01

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	9.1	10-20 ft	MM	10/6/09	GT		1493-9.1.dat
△	---	9.2	10-20 ft	MM	10/05/09	GT		1493-9.2.dat
□	---	9.3	10-20 ft	MM	10/05/09	GT		1493 -9.3.dat

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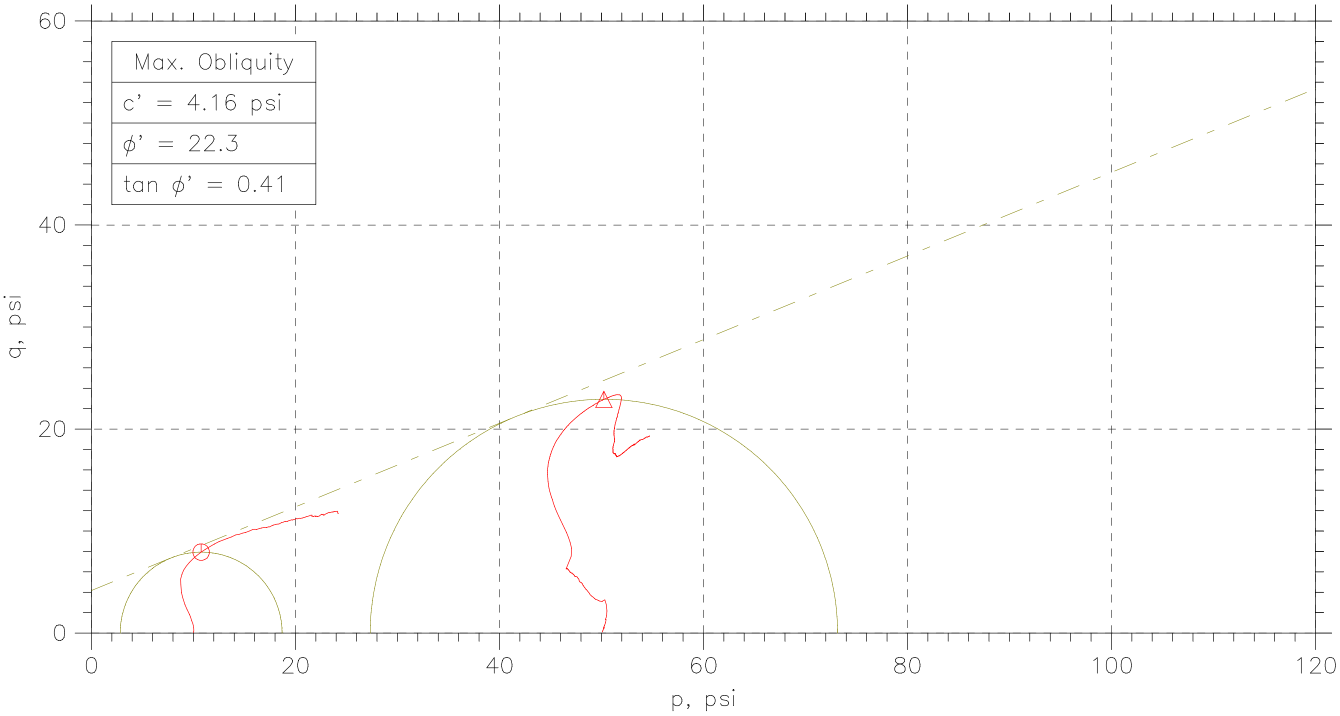
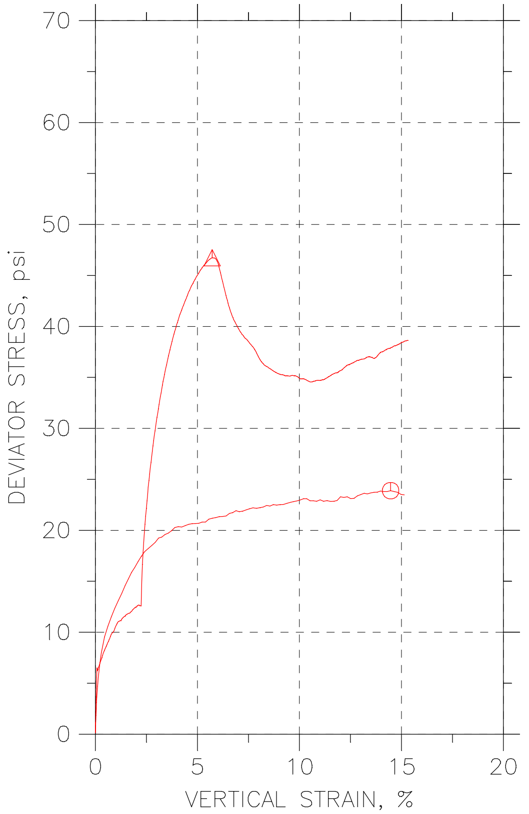
Project: Cumberland Fossil Plant	Location: ---	Project No.: GTX-1493
Boring No.: B-58	Sample Type: Remolded	
Description: Brown Sandy fat clay		
Remarks: System 1057		

Thu, 22-OCT-2009 16:37:02

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





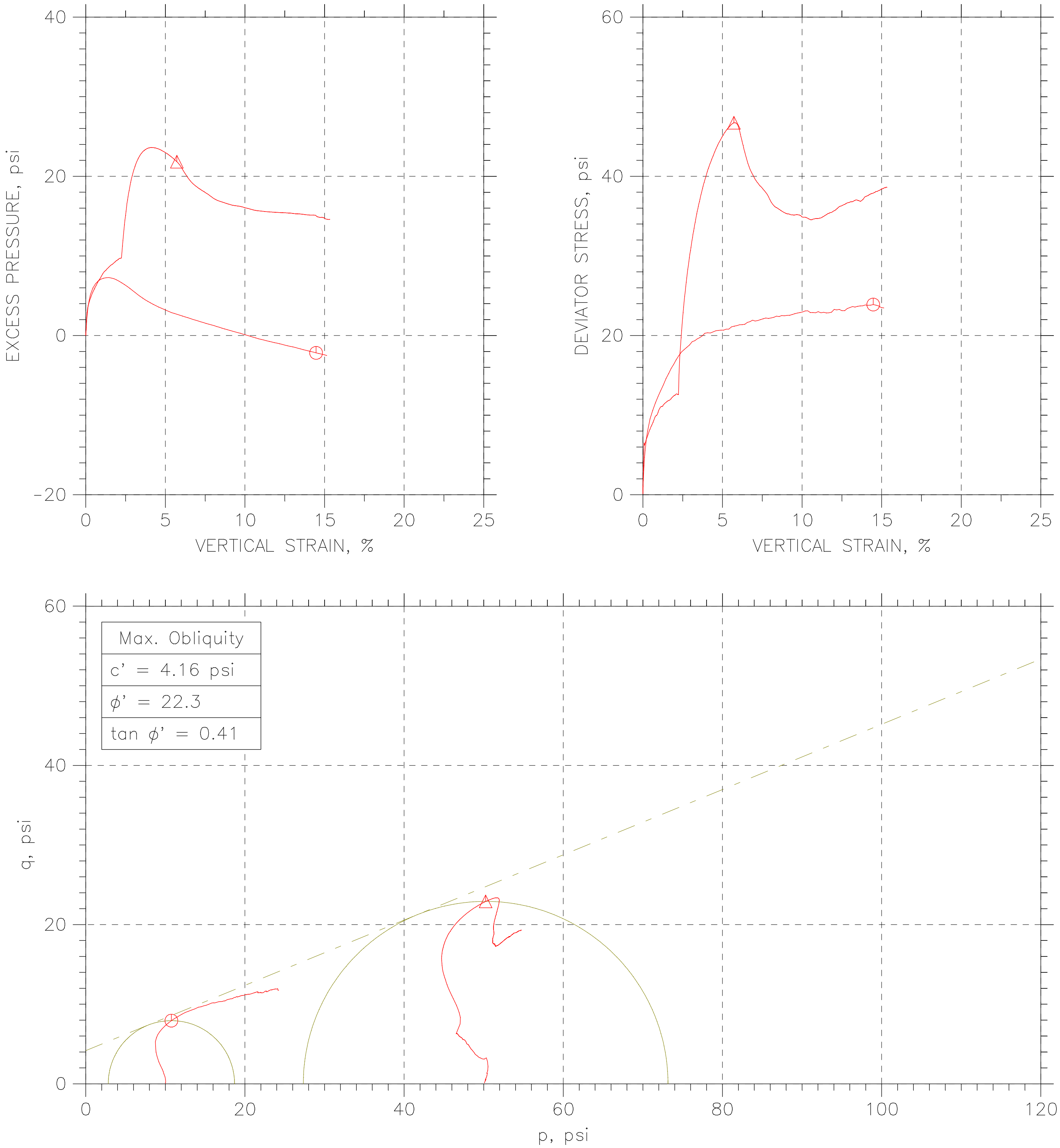
Symbol		○	△		
Sample No.		---	---		
Test No.		6.1	6.2		
Depth		26.0-26.5	26.5-27.0		
Initial	Diameter, in	2.875	2.853		
	Height, in	5.83	6		
	Water Content, %	27.9	25.7		
	Dry Density, pcf	92.13	98.88		
	Saturation, %	90.7	98.6		
	Void Ratio	0.83	0.705		
Before Shear	Water Content, %	30.1	25.8		
	Dry Density, pcf	92.94	99.32		
	Saturation*, %	100.0	100.0		
	Void Ratio	0.814	0.697		
	Back Press., psi	140	89.42		
Ver. Eff. Cons. Stress, psi		9.96	49.98		
Shear Strength, psi		11.95	23.36		
Strain at Failure, %		14.5	5.72		
Strain Rate, %/min		0.016	0.016		
B-Value		0.96	0.95		
Estimated Specific Gravity		2.7	2.7		
Liquid Limit		---	---		
Plastic Limit		---	---		

GeoTesting express

Project: Cumberland Fossil Plant
Location: ---
Project No.: GTX-1493
Boring No.: 58A
Sample Type: UD
Description: Gray Brown lean clay
Remarks: System 1062

Thu, 08-OCT-2009 11:03:02

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	6.1	26.0-26.5	MM	9/30/09	GT		1493-6.1.dat
△	---	6.2	26.5-27.0	MM	9/30/09	GT		1493 - 6.2.dat

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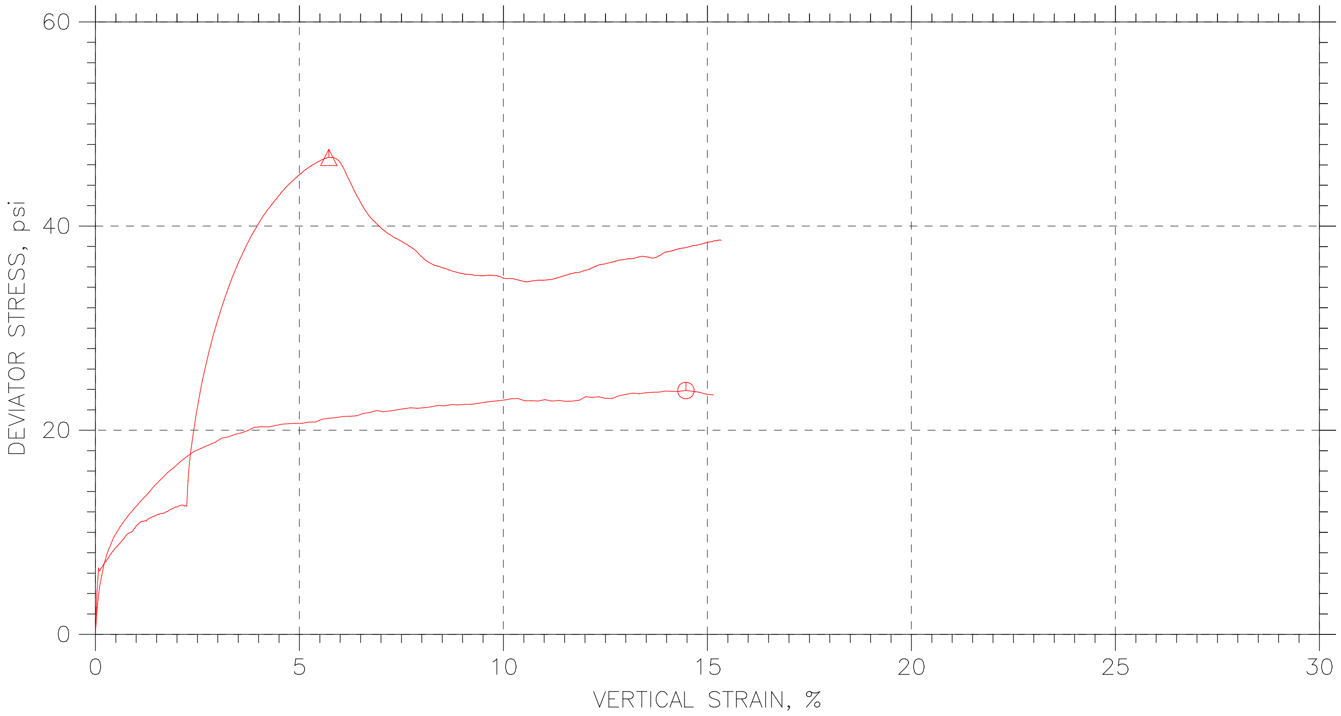
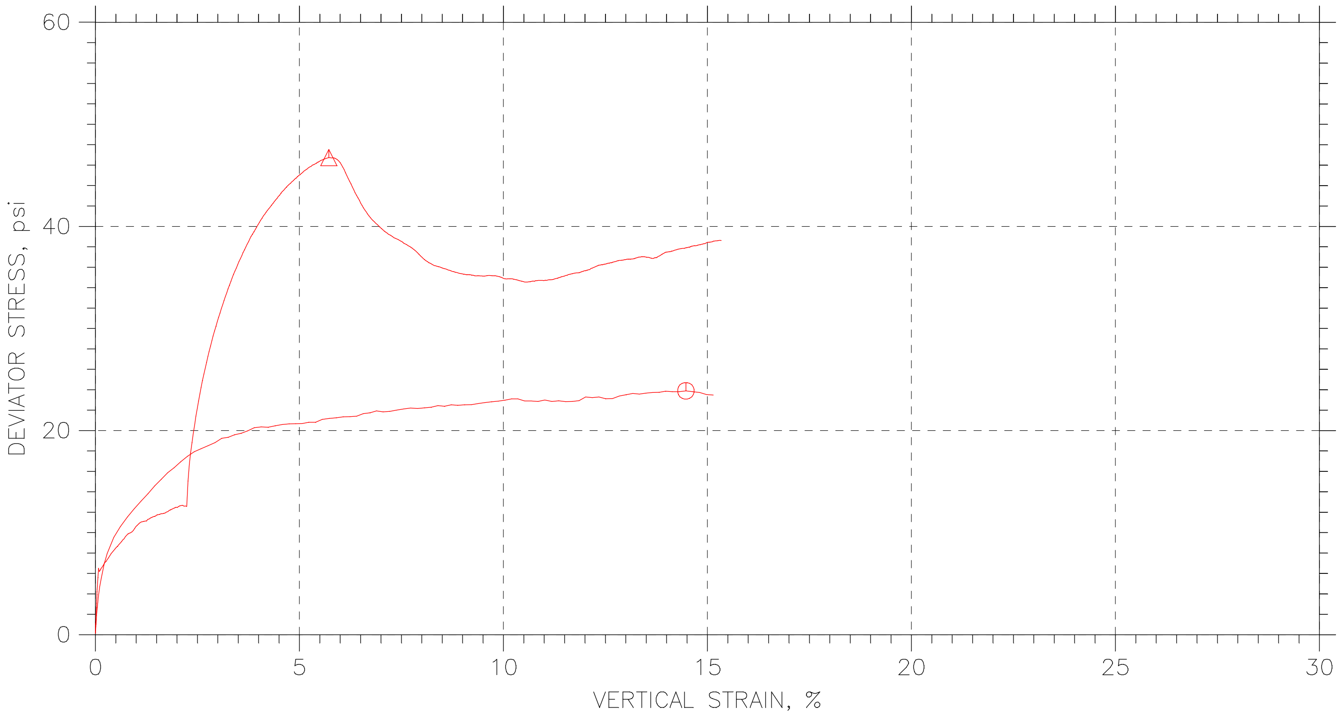
Project: Cumberland Fossil Plant	Location: ---	Project No.: GTX-1493
Boring No.: 58A	Sample Type: UD	
Description: Gray Brown lean clay		
Remarks: System 1062		

Thu, 08-OCT-2009 11:03:03

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	6.1	26.0-26.5	MM	9/30/09	GT		1493-6.1.dat
△	---	6.2	26.5-27.0	MM	9/30/09	GT		1493 - 6.2.dat

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Project: Cumberland Fossil Plant
Location: ---
Project No.: GTX-1493
Boring No.: 58A
Sample Type: UD
Description: Gray Brown lean clay
Remarks: System 1062

Thu, 08-OCT-2009 11:03:05

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HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1493*	Tested By	*JM*
Project Name	*Cumberland Fossil Plant*	Test Date	*9/30/2009*
Boring No.	*48A*	Reviewed By	*MM*
Sample No.	*----*	Review Date	*10/4/2009*
Sample Depth	*5-15 ft*	Lab No.	*---*
Sample Description	*Brown Sandy fat clay*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*Remolded*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*22.1*
Wet Unit Weight, pcf:	*122.2*
Dry Unit Weight, pcf:	*100.1*
Compaction, %:	*94.8*
Hydraulic Conductivity, cm/sec. @20 °C	***2.8E-08***

Remarks:

GeoTesting express

HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1493*	Tested By	*JM*
Project Name	*Cumberland Fossil Plant*	Test Date	*10/5/2009*
Boring No.	*52A*	Reviewed By	*MM*
Sample No.	*----*	Review Date	*10/9/2009*
Sample Depth	*5-10 ft*	Lab No.	*---*
Sample Description	*Brown Sandy fat clay*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*Remolded*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*24.5*
Wet Unit Weight, pcf:	*120.6*
Dry Unit Weight, pcf:	*96.8*
Compaction, %:	*94.8*
Hydraulic Conductivity, cm/sec. @20 °C	***3.5E-08***

Remarks:

GeoTesting express

HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1493*	Tested By	*JM*
Project Name	*Cumberland Fossil Plant*	Test Date	*9/24/2009*
Boring No.	*53A*	Reviewed By	*MM*
Sample No.	*----*	Review Date	*9/29/2009*
Sample Depth	*43.8-44.2*	Lab No.	*---*
Sample Description	*Gray-Brown sandy lean clay*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*27.2*
Wet Unit Weight, pcf:	*120.6*
Dry Unit Weight, pcf:	*94.9*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***7.4E-08***

Remarks: ______________________________

GeoTesting Express

HYDRAULIC CONDUCTIVITY

Project No.	*GTX 1493*	Tested By	*JM*
Project Name	*Cumberland Fossil Plant CUF*	Test Date	*9/23/2009*
Boring No.	*54A*	Reviewed By	*mm*
Sample No.	*---*	Review Date	*10/2/2009*
Sample Depth	*30-30.6 ft*		
Sample Description	*Gray brown lean clay*		

ASTM D5084 - Falling Head

Sample Type:	*Ud*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*31.1*
Wet Unit Weight, pcf:	*127.4*
Dry Unit Weight, pcf:	*97.1*
Compaction, %:	*N/A*
Effective Confining Pressure, psi	*5.0*
Hydraulic Conductivity, cm/sec. @20 °C	***6.5E-08***

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HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1493*	Tested By	*JM*
Project Name	*Cumberland Fossil Plant*	Test Date	*10/5/2009*
Boring No.	*58*	Reviewed By	*MM*
Sample No.	*----*	Review Date	*10/9/2009*
Sample Depth	*10-20 ft*	Lab No.	*---*
Sample Description	*Brown Sandy fat clay*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*Remolded*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*23.1*
Wet Unit Weight, pcf:	*121.1*
Dry Unit Weight, pcf:	*98.4*
Compaction, %:	*95.4*
Hydraulic Conductivity, cm/sec. @20 °C	***2.7E-08***

Remarks:

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HYDRAULIC CONDUCTIVITY

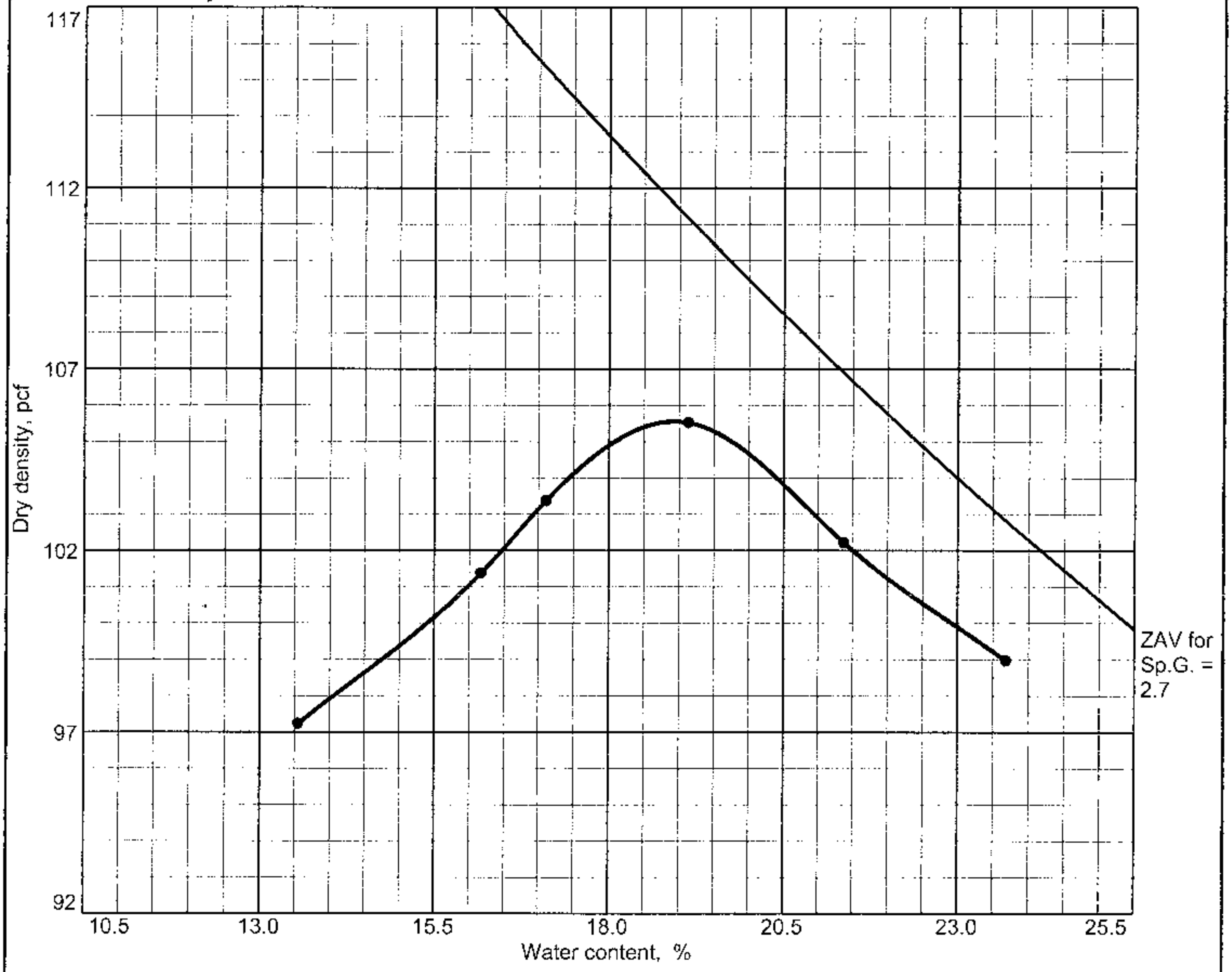
Project No.	*GTX-1493*	Tested By	*JM*
Project Name	*Cumberland Fossil Plant*	Test Date	*9/22/2009*
Boring No.	*58A*	Reviewed By	*MM*
Sample No.	*----*	Review Date	*9/27/2009*
Sample Depth	*25.4-26.0 ft*	Lab No.	*---*
Sample Description	*Gray-Brown sandy lean clay*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*30.8*
Wet Unit Weight, pcf:	*127.5*
Dry Unit Weight, pcf:	*97.4*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***6.3E-08***

Remarks: ______________________

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
5-15ft	CII	A-7-6(24)	29.3	2.7	54	34	0.0	73.1

TEST RESULTS

Maximum dry density = 105.6 pcf

Optimum moisture = 18.9 %

MATERIAL DESCRIPTION

Brown fat clay with sand

Project No. GTX-1493 **Client:** Stantec

Project: Cumberland Fossil Plant

● **Source:** **Sample No.:** B-48A **Elev./Depth:** 5-15ft

Remarks:

Moisture Content was take from bag as recieved, natural moisture content may be different

COMPACTION TEST REPORT

GeoTesting Express Inc.

Lab no.

COMPACTION TEST REPORT

Test specification: ASTM D 698-78 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
5-10 ft	CH	A-7-6(27)		2.7	61	40	0.0	69.4

TEST RESULTS

Maximum dry density = 102.1 pcf

Optimum moisture = 21.9 %

MATERIAL DESCRIPTION

Sandy fat clay

Project No. 175539016 **Client:** Stantec

Project: Cumberland Fossil Plant

● **Source:** **Sample No.:** B-52 **Elev./Depth:** 5-10 ft

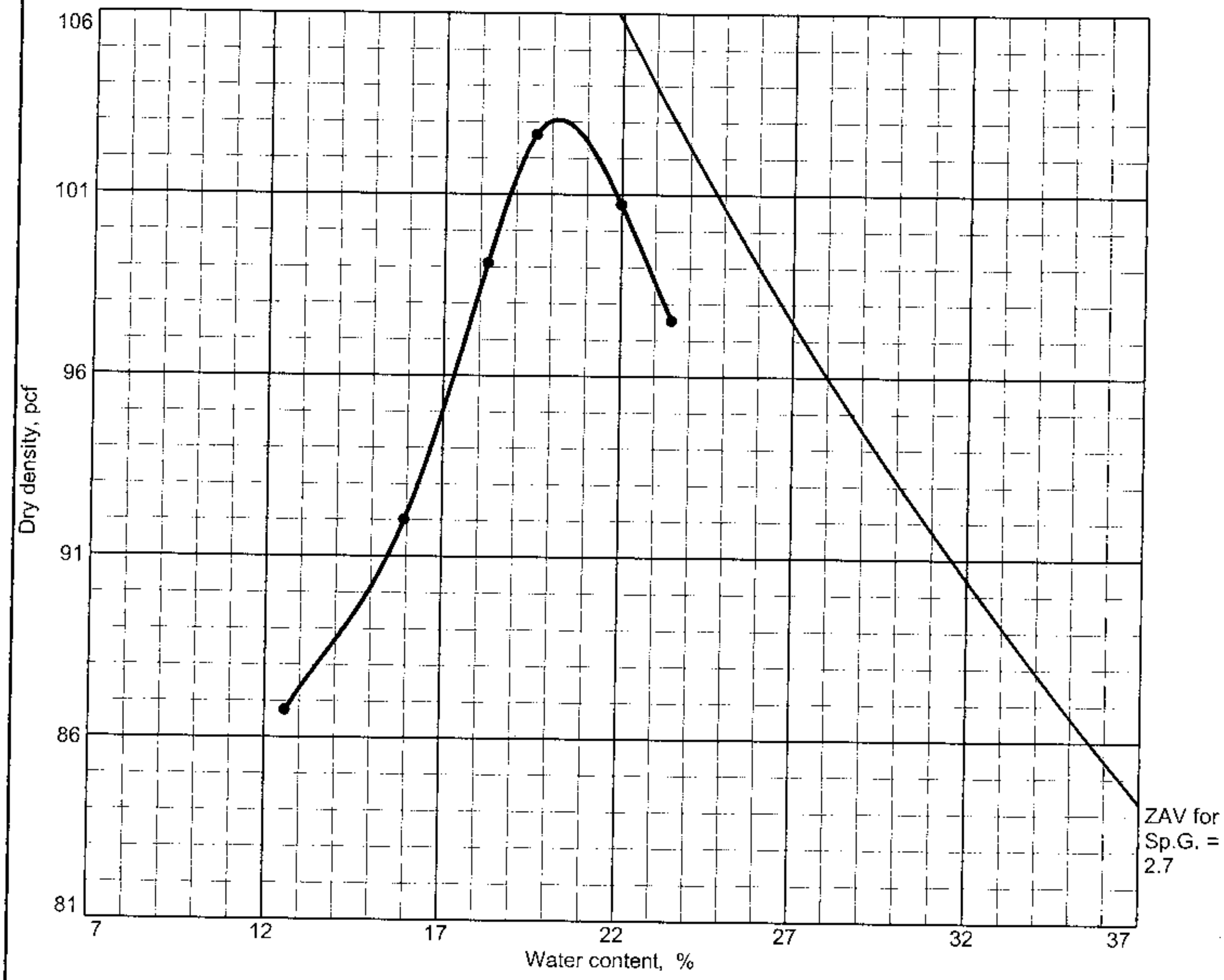
Remarks:

COMPACTION TEST REPORT

GeoTesting Express Inc.

Lab no.

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
10-20 ft	CH	A-7-6(30)		2.7	68	45	0.0	68.4

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 103.1 pcf Optimum moisture = 20.2 %	Sandy fat clay

Project No. 175539016 **Client:** Stantec

Project: Cumberland Fossil Plant

● **Source:** **Sample No.:** B-58 **Elev./Depth:** 10-20 ft

Remarks:

COMPACTION TEST REPORT

GeoTesting Express Inc.

Lab no.

Stantec

Moisture Content of Soil
ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
47, 0.0'-1.5'	1	8/4/09	Hom	3/4"			No	21.90	132.49	113.88	20.2
47, 1.5'-3.0'	3	8/4/09	Hom	3/8"			No	25.85	173.32	153.64	15.4
47, 3.0'-4.5'	4	8/4/09	Hom	3/8"			No	26.01	183.44	160.18	17.3
47, 4.5'-6.0'	5	8/4/09	Hom	3/8"			No	26.05	151.59	132.37	18.1
47, 6.0'-7.5'	6	8/4/09	Hom	3/8"			No	21.79	122.09	105.99	19.1
47, 7.5'-9.0'	7	8/4/09	Hom	No. 4			Yes	21.61	146.45	124.47	21.4
47, 9.0'-10.5'	8	8/4/09	Hom	No. 4			Yes	26.05	243.65	203.58	22.6
47, 10.5'-12.0'	9	8/4/09	Hom	No. 4			No	21.67	130.70	105.96	29.4
47, 12.0'-13.5'	10	8/4/09	Hom	3/8"			No	25.93	212.46	172.00	27.7
47, 13.5'-15.0'	11	8/4/09	Hom	3/8"			No	22.09	187.39	155.61	23.8
47, 15.0'-16.5'	12	8/4/09	Hom	3/8"			No	21.82	175.57	145.35	24.5
47, 16.5'-18.0'	14	8/4/09	Hom	No. 4			Yes	25.99	184.88	157.84	20.5
47, 18.0'-19.5'	15	8/4/09	Hom	No. 4			Yes	21.44	154.91	127.66	25.7
47, 19.5'-21.0'	16	8/4/09	Hom	No. 4			Yes	26.07	219.52	184.07	22.4
47, 21.0'-22.5'	17	8/4/09	Len	No. 4			Yes	25.69	162.62	135.22	25.0
47, 22.5'-24.0'	18	8/4/09	Hom	No. 4			Yes	25.86	178.72	150.21	22.9
47, 24.0'-25.5'	19	8/4/09	Hom	No. 4			Yes	25.74	170.34	144.14	22.1
47, 25.5'-27.0'	20	8/4/09	Hom	3/4"			No	25.73	171.63	141.49	26.0
47, 27.0'-28.5'	21	8/4/09	Hom	No. 4			Yes	26.13	179.47	143.46	30.7
47, 28.5'-30.0'	22	8/4/09	Hom	No. 4			Yes	26.03	162.03	132.06	28.3
47, 31.0'-32.5'	23	8/4/09	Hom	3/8"			No	25.84	168.88	136.92	28.8
47, 33.5'-35.0'	24	8/4/09	Hom	No. 4			Yes	25.82	181.33	139.50	36.8
47, 36.0'-37.5'	25	8/4/09	Hom	No. 4			Yes	26.09	172.72	136.66	32.6
47, 38.5'-40.0'	26	8/4/09	Hom	3/8"			No	25.96	167.17	131.24	34.1
47, 40.4'-40.5'	27	8/4/09	Hom	3/4"			No	25.75	46.98	46.44	2.6
48, 0.0'-1.5'	28	8/4/09	Hom	3/4"			No	25.56	155.93	142.38	11.6
48, 1.5'-3.0'	29	8/4/09	Hom	3/4"			No	21.84	141.79	121.15	20.8
48, 3.0'-4.5'	31	8/4/09	Hom	3/4"			No	26.19	145.27	122.55	23.6

Stantec

Moisture Content of Soil
ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016
Tested By
Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
48, 4.5'-6.0'	32	8/4/09	Hom	3/4"			No	26.01	157.79	136.93	18.8
48, 6.0'-7.5'	33	8/4/09	Hom	3/4"			No	26.28	158.49	137.99	18.4
48, 7.5'-9.0'	34	8/4/09	Hom	No. 4			No	25.59	67.46	61.81	15.6
48, 9.0'-10.5'	35	8/4/09	Hom	3/4"			No	26.20	183.67	157.24	20.2
48, 10.5'-12.0'	36	8/4/09	Hom	3/8"			No	26.13	173.74	145.25	23.9
48, 12.0'-13.5'	37	8/4/09	Hom	3/4"			No	26.23	185.32	158.84	20.0
48, 13.5'-15.0'	38	8/4/09	Hom	3/8"			No	25.75	170.48	144.31	22.1
48, 15.0'-16.5'	39	8/4/09	Hom	3/4"			No	25.59	191.60	158.29	25.1
48, 16.5'-18.0'	40	8/4/09	Hom	3/4"			No	26.17	175.05	151.76	18.5
48, 18.0'-19.5'	42	8/5/09	Hom	No. 4			No	25.58	98.46	85.12	22.4
48, 19.5'-21.0'	43	8/5/09	Hom	No. 4			No	26.16	129.63	109.70	23.9
48, 21.0'-22.5'	44	8/5/09	Hom	3/4"			No	25.75	157.14	145.63	9.6
48, 22.5'-24.0'	45	8/5/09	Hom	3/8"			No	26.00	166.82	140.08	23.4
48, 24.0'-25.5'	46	8/5/09	Hom	3/8"			No	26.22	216.18	187.36	17.9
48, 25.5'-27.0'	47	8/5/09	Hom	3/8"			No	26.26	186.97	158.55	21.5
48, 27.0'-27.9'	48	8/5/09	Hom	3/4"			No	26.11	140.72	123.29	17.9
48, 28.5'-28.8' NO RECOVERY	49	8/5/09									
48, 31.0'-32.5'	50	8/5/09	Hom	3/8"			No	26.14	152.28	130.56	20.8
48, 33.5'-33.7'	51	8/5/09	Hom	3/8"			No	25.60	125.14	99.59	34.5
48, 36.0'-37.5'	52	8/5/09	Hom	No. 4			Yes	26.00	160.39	133.80	24.7
48, 38.5'-40.0'	53	8/5/09	Hom	No. 4			No	26.18	135.74	112.77	26.5
48, 41.0'-42.5'	54	8/5/09	Hom	No. 4			Yes	26.07	156.62	128.43	27.5
48, 43.5'-45.0'	55	8/5/09	Hom	No. 4			Yes	26.08	183.72	153.22	24.0
48, 46.0'-47.5'	56	8/5/09	Hom	No. 4			No	25.87	141.81	115.67	29.1
48, 48.5'-49.9'	57	8/5/09	Hom	3/8"			No	25.86	163.25	140.46	19.9
48, 51.0'-52.5'	58	8/5/09	Hom	No. 4			No	25.72	128.74	106.79	27.1
48, 53.5'-54.8'	59	8/5/09	Hom	No. 4			Yes	25.71	173.68	143.03	26.1
49, 0.0'-1.5'	60	8/6/09	Lam	3/4"			No	21.90	122.36	102.71	24.3
49, 1.5'-3.0'	61	8/6/09	Hom	3/4"			No	26.12	148.84	122.17	27.8
49, 3.0'-4.5'	62	8/6/09	Hom	3/8"			No	25.72	148.32	126.50	21.7
49, 4.5'-6.0'	63	8/6/09	Hom	No. 10			Yes	21.58	126.92	109.46	19.9

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: <u>Str</u>atified, <u>Lam</u>inated, <u>Len</u>sed, <u>Hom</u>ogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
49, 6.0'-7.5'	64	8/6/09	Hom	No. 10			Yes	21.58	123.72	106.72	20.0
49, 7.5'-9.0'	65	8/6/09	Hom	No. 10			Yes	22.11	132.83	112.16	23.0
49, 9.0'-10.5'	66	8/6/09	Hom	No. 10			Yes	21.82	98.06	84.49	21.7
49, 10.5'-12.0'	67	8/6/09	Hom	No. 4			No	25.98	135.34	112.04	27.1
49, 12.0'-13.5'	68	8/6/09	Hom	No. 4			No	25.55	134.08	110.87	27.2
49, 13.5'-15.0'	69	8/6/09	Hom	No. 4			No	25.73	139.14	117.50	23.6
49, 15.0'-16.5'	70	8/6/09	Hom	No. 4			No	26.08	154.16	124.07	30.7
49, 16.5'-18.0'	71	8/6/09	Hom	No. 4			No	25.85	152.16	122.39	30.8
49, 18.0'-19.5'	72	8/6/09	Hom	No. 4			No	21.62	116.54	94.97	29.4
49, 19.5'-21.0'	73	8/6/09	Hom	No. 4			No	21.64	148.40	118.37	31.0
49, 21.0'-22.5'	74	8/6/09	Hom	No. 10			Yes	21.81	116.32	94.86	29.4
49, 22.5'-24.0'	75	8/6/09	Hom	No. 4			Yes	25.59	160.31	127.77	31.8
49, 24.0'-25.5'	76	8/6/09	Hom	No. 4			Yes	26.06	170.57	134.78	32.9
49, 26.0'-27.5'	77	8/6/09	Hom	No. 4			No	25.97	153.96	123.70	31.0
49, 28.5'-30.0'	78	8/6/09	Hom	No. 4			No	26.04	151.76	121.46	31.8
49, 31.0'-32.5'	79	8/6/09	Hom	No. 4			Yes	25.99	158.99	127.16	31.5
49, 33.5'-35.0'	80	8/6/09	Hom	No. 4			No	25.86	155.30	123.72	32.3
49, 36.0'-37.5'	81	8/6/09	Hom	No. 10			Yes	21.90	106.15	87.83	27.8
49, 38.5'-40.0'	82	8/6/09	Hom	No. 10			Yes	30.84	140.74	114.36	31.6
49, 41.0'-42.5'	83	8/6/09	Hom	No. 10			Yes	26.42	154.04	128.15	25.4
49, 43.5'-45.0'	84	8/6/09	Len	No. 10			Yes	25.96	185.90	152.14	26.8
49, 46.0'-47.5'	85	8/6/09	Hom	No. 10			Yes	25.72	228.10	174.00	36.5
49, 48.5'-50.0'	86	8/6/09	Hom	3/8"			No	26.29	234.50	190.41	26.9
49, 51.0'-52.5'	87	8/6/09	Hom	3/8"			No	26.15	210.99	161.87	36.2
49, 53.5'-55.0'	88	8/6/09	Hom	No. 10			Yes	25.63	224.47	181.00	28.0
49, 56.0'-57.5'	89	8/6/09	Hom	3/8"			No	26.11	218.06	178.40	26.0
49, 58.5'-60.0'	90	8/6/09	Hom	3/8"			No	26.02	215.47	182.65	21.0
49, 61.0'-62.5'	91	8/6/09	Hom	3/4"			No	26.03	205.53	175.15	20.4
49, 63.5'-64.1'	92	8/6/09	Hom	3/4"			No	25.88	240.22	219.08	10.9
50, 0.0'-1.5'	93	8/6/09	Hom	No. 4			Yes	21.91	140.19	123.17	16.8
50, 1.5'-3.0'	94	8/6/09	Hom	3/4"			No	26.12	170.30	151.27	15.2

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded		Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
					Amount	Size					
50, 3.0'-4.5'	95	8/6/09	Hom	3/8"			No	21.80	142.59	119.11	24.1
50, 4.5'-6.0'	96	8/6/09	Hom	3/8"			No	21.02	131.16	111.28	22.0
50, 6.0'-7.5'	97	8/6/09	Hom	No. 4			Yes	26.55	151.52	127.72	23.5
50, 7.5'-9.0'	98	8/6/09	Hom	3/8"			No	21.12	130.92	109.98	23.6
50, 9.0'-10.5'	99	8/6/09	Hom	No. 4			No	21.79	142.82	118.82	24.7
50, 10.5'-12.0'	100	8/6/09	Hom	No. 4			No	21.70	136.32	116.88	20.4
50, 12.0'-13.5'	101	8/6/09	Hom	No. 4			Yes	25.98	146.97	126.19	20.7
50, 13.5'-15.0'	102	8/6/09	Hom	No. 4			Yes	26.34	165.40	139.87	22.5
50, 15.0'-16.5'	103	8/6/09	Hom	No. 4			Yes	21.53	144.51	122.04	22.4
50, 16.5'-18.0'	104	8/6/09	Hom	3/8"			No	21.43	113.15	98.03	19.7
50, 18.0'-19.5'	105	8/6/09	Hom	3/8"			No	20.97	129.09	111.77	19.1
50, 19.5'-21.0'	106	8/6/09	Hom	3/8"			No	26.17	216.81	184.72	20.2
50, 21.0'-22.5'	107	8/6/09	Hom	3/4"			No	21.91	187.79	174.54	8.7
50, 22.5'-24.0'	108	8/6/09	Hom	3/4"			No	26.38	184.63	157.99	20.2
50, 24.0'-25.5'	109	8/6/09	Hom	3/8"			No	21.79	163.74	139.52	20.6
50, 25.5'-27.0'	110	8/6/09	Hom	3/8"			No	21.33	147.53	117.40	31.4
50, 27.0'-28.5'	111	8/6/09	Hom	No. 4			No	21.87	141.25	115.11	28.0
50, 28.5'-30.0'	112	8/6/09	Hom	No. 4			No	21.38	90.33	70.58	40.1
50, 31.0'-32.5'	113	8/6/09	Hom	No. 4			No	21.76	138.57	106.10	38.5
50, 33.5'-35.0' NO RECOVERY	114	8/6/09									
50, 36.0'-37.3' NO RECOVERY	115	8/6/09									
51, 0.0'-1.5'	116	8/6/09	Hom	No. 4			Yes	25.87	168.36	144.32	20.3
51, 1.5'-3.0'	118	8/6/09	Hom	No. 4			Yes	21.05	159.02	144.32	11.9
51, 3.0'-4.5'	119	8/6/09	Hom	No. 4			Yes	25.88	178.67	153.61	19.6
51, 4.5'-6.0'	120	8/6/09	Hom	No. 4			Yes	20.98	149.89	129.58	18.7
51, 6.0'-7.5'	121	8/6/09	Hom	No. 4			Yes	25.90	188.47	161.02	20.3
51, 7.5'-9.0'	122	8/6/09	Hom	No. 4			Yes	21.40	153.70	134.41	17.1
51, 9.0'-10.5'	123	8/6/09	Hom	No. 4			Yes	25.60	170.94	147.62	19.1
51, 10.5'-12.0'	124	8/6/09	Hom	No. 4			Yes	26.24	168.51	143.53	21.3
51, 12.0'-13.5'	125	8/6/09	Hom	No. 4			Yes	26.37	166.97	143.34	20.2
51, 13.5'-15.0'	126	8/6/09	Hom	No. 4			No	20.99	136.39	117.58	19.5

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
51, 15.0'-16.5'	127	8/6/09	Hom	No. 4			Yes	25.96	176.59	152.38	19.2
51, 16.5'-18.0'	128	8/6/09	Hom	No. 4			Yes	21.60	150.60	129.49	19.6
51, 18.0'-19.5'	129	8/6/09	Hom	No. 4			No	21.38	139.53	119.87	20.0
51, 19.5'-21.0'	130	8/6/09	Hom	No. 4			Yes	21.34	159.48	135.76	20.7
51, 21.0'-22.5'	131	8/6/09	Hom	No. 4			No	21.80	130.96	112.06	20.9
51, 23.5'-25.0'	132	8/6/09	Hom	3/8"			No	25.93	177.59	152.14	20.2
51, 26.0'-27.5'	133	8/6/09	Hom	3/8"			No	26.08	170.50	142.09	24.5
51, 28.5'-30.0'	134	8/6/09	Hom	No. 4			No	21.53	137.41	113.15	26.5
51, 31.0'-31.3'	136	8/6/09	Hom	3/4"			No	21.50	141.66	118.39	24.0
51, 33.5'-35.0'	137	8/6/09	Hom	No. 4			Yes	22.15	157.97	129.31	26.7
51, 36.0'-37.5'	138	8/6/09	Hom	No. 4			Yes	21.87	160.33	129.65	28.5
51, 38.5'-40.0'	139	8/6/09	Hom	No. 4			Yes	21.50	162.82	130.99	29.1
51, 41.0'-42.5'	140	8/6/09	Len	No. 4			Yes	21.40	182.74	149.22	26.2
51, 43.5'-45.0'	141	8/6/09	Len	No. 4			Yes	22.01	154.64	126.88	26.5
51, 46.0'-47.5'	142	8/6/09	Hom	No. 4			Yes	21.67	175.25	143.17	26.4
51, 48.5'-50.0'	143	8/6/09	Hom	No. 4			Yes	21.66	160.58	126.91	32.0
51, 51.0'-52.5'	144	8/6/09	Hom	3/8"			No	21.12	194.70	159.13	25.8
51, 53.5'-55.0'	146	8/6/09	Hom	3/8"			No	21.95	206.38	169.89	24.7
51, 56.0'-57.5'	147	8/6/09	Hom	3/8"			No	25.64	244.87	206.67	21.1
51, 58.5'-60.0'	148	8/6/09	Hom	3/4"			No	21.73	219.50	184.23	21.7
51, 61.0'-62.5'	149	8/6/09	Hom	3/8"			No	25.43	224.22	192.41	19.1
51, 63.5'-65.0'	150	8/6/09	Hom	3/8"			No	21.21	162.19	139.03	19.7
51, 66.0'-66.4'	151	8/6/09	Len	3/8"			No	21.55	155.77	138.76	14.5
52, 0.0'-1.5'	152	8/6/09	Hom	3/8"			No	21.29	152.82	133.37	17.4
52, 1.5'-3.0'	153	8/6/09	Hom	No. 4			No	22.12	140.31	118.24	23.0
52, 3.0'-4.5'	155	8/6/09	Hom	No. 4			No	25.31	151.64	124.80	27.0
52, 4.5'-6.0'	156	8/6/09	Hom	No. 4			No	22.12	134.82	113.76	23.0
52, 6.0'-7.5'	157	8/18/09	Hom	3/8"			No	25.17	165.88	141.53	20.9
52, 7.5'-9.0'	158	8/18/09	Hom	3/8"			No	26.14	166.42	140.93	22.2
52, 9.0'-10.5'	159	8/18/09	Hom	3/8"			No	21.05	136.79	112.22	26.9
52, 10.5'-12.0'	160	8/18/09	Hom	3/8"			No	26.21	158.70	135.74	21.0

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
52, 12.0'-13.5'	161	8/18/09	Hom	3/8"			No	26.08	159.87	134.21	23.7
52, 13.5'-15.0'	162	8/18/09	Hom	3/8"			No	26.02	168.00	144.69	19.6
52, 15.0'-16.5'	163	8/18/09	Hom	No. 4			Yes	26.10	151.20	127.58	23.3
52, 16.5'-18.0'	164	8/18/09	Hom	3/8"			No	25.72	178.82	157.62	16.1
52, 18.0'-18.9'	165	8/18/09	Hom	3/8"			No	22.10	156.27	135.67	18.1
52, 19.5'-21.0'	166	8/18/09	Hom	No. 4			Yes	26.25	208.32	194.88	8.0
52, 21.0'-22.5'	167	8/18/09	Hom	3/8"			No	21.41	151.02	130.90	18.4
52, 22.5'-24.0'	169	8/18/09	Hom	3/8"			No	21.62	151.42	121.96	29.4
52, 24.0'-25.5'	170	8/18/09	Hom	3/8"			No	21.75	166.48	130.06	33.6
52, 25.5'-27.0'	171	8/18/09	Hom	3/8"			No	20.91	126.09	107.79	21.1
52, 27.0'-28.5'	172	8/18/09	Hom	3/8"			No	21.51	138.34	115.94	23.7
52, 28.5'-30.0'	173	8/18/09	Hom	3/8"			No	20.99	120.06	110.43	10.8
52, 31.0'-32.5'	174	8/18/09	Hom	3/8"			No	25.95	180.05	149.92	24.3
52, 33.5'-35.0'	175	8/18/09	Hom	3/8"			No	26.52	199.73	167.91	22.5
52, 36.0'-37.5'	176	8/18/09	Hom	3/4"			No	25.91	110.37	100.23	13.6
52, 38.5'-40.0'	177	8/18/09	Hom	3/8"			No	26.05	197.88	169.84	19.5
52, 41.0'-42.5'	178	8/18/09	Len	No. 4			Yes	26.24	182.50	147.00	29.4
52, 43.5'-45.0'	179	8/18/09	Hom	No. 4			Yes	21.68	150.08	123.78	25.8
52, 46.0'-47.5'	180	8/18/09	Hom	No. 10			Yes	21.48	151.37	125.47	24.9
52, 48.5'-50.0'	181	8/18/09	Hom	No. 10			Yes	26.32	161.83	134.37	25.4
52, 51.0'-52.5'	182	8/18/09	Hom	No. 10			Yes	25.96	200.28	162.91	27.3
52, 53.5'-55.0'	183	8/18/09	Hom	No. 10			Yes	25.89	196.89	159.70	27.8
52, 56.0'-57.5'	184	8/18/09	Hom	No. 10			Yes	21.10	184.11	147.71	28.7
52, 58.5'-60.0'	185	8/18/09	Hom	No. 10			Yes	21.96	158.42	128.91	27.6
52, 61.0'-62.5'	186	8/18/09	Len	No. 10			Yes	26.23	211.62	171.83	27.3
52, 63.5'-65.0'	187	8/18/09	Hom	3/8"			No	25.94	232.72	177.54	36.4
52, 66.0'-67.5'	188	8/18/09	Hom	3/8"			No	21.29	184.71	150.10	26.9
52, 68.5'-70.0'	190	8/18/09	Hom	3/8"			No	21.80	119.97	99.54	26.3
52, 71.0'-72.5'	191	8/18/09	Hom	3/4"			No	21.05	143.42	124.47	18.3
52, 73.5'-75.0'	192	8/18/09	Hom	3/4"			No	21.87	169.14	139.87	24.8
52, 76.0'-77.5'	193	8/18/09	Hom	3/8"			No	20.96	135.45	115.06	21.7

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: <u>Str</u>atified, <u>Lam</u>inated, <u>Len</u>sed, <u>Hom</u>ogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
52, 78.5'-80.0'	194	8/18/09	Hom	3/8"			No	22.07	79.18	71.20	16.2
52, 81.0'-81.8'	195	8/18/09	Hom	3/4"			No	25.70	211.84	187.39	15.1
52, 83.5'-83.7'	196	8/18/09	Hom	3/8"			No	21.38	117.22	107.51	11.3
53, 0.0'-1.5'	197	8/18/09	Hom	3/8"			No	25.94	168.52	142.74	22.1
53, 1.5'-3.0'	198	8/18/09	Hom	3/8"			No	25.65	196.04	169.70	18.3
53, 3.0'-4.5'	199	8/18/09	Hom	3/8"			No	26.10	184.05	150.50	27.0
53, 4.5'-6.0'	200	8/18/09	Hom	3/8"			No	25.86	176.09	144.61	26.5
53, 6.0'-7.5'	201	8/18/09	Hom	3/8"			No	21.89	170.57	148.95	17.0
53, 7.5'-9.0'	202	8/18/09	Hom	3/8"			No	26.40	179.91	151.15	23.1
53, 9.0'-10.5'	203	8/18/09	Hom	3/8"			No	20.98	139.82	114.36	27.3
53, 10.5'-12.0'	204	8/18/09	Hom	3/8"			No	21.41	135.69	116.26	20.5
53, 12.0'-13.5'	205	8/18/09	Hom	3/8"			No	26.06	182.96	155.24	21.5
53, 13.5'-15.0'	206	8/18/09	Hom	3/8"			No	26.24	178.43	150.61	22.4
53, 15.0'-16.5'	207	8/18/09	Hom	No. 4			Yes	21.01	166.43	141.94	20.3
53, 16.5'-18.0'	208	8/18/09	Hom	No. 4			No	21.70	79.21	68.35	23.3
53, 18.0'-19.5'	209	8/18/09	Hom	No. 4			Yes	26.12	200.19	172.97	18.5
53, 19.5'-21.0'	210	8/18/09	Hom	No. 4			No	21.52	120.31	105.21	18.0
53, 21.0'-22.5'	211	8/18/09	Hom	3/8"			No	26.35	165.95	136.53	26.7
53, 22.5'-24.0'	212	8/18/09	Hom	3/8"			No	21.73	141.64	115.53	27.8
53, 24.0'-25.5'	213	8/18/09	Hom	3/8"			No	22.35	134.48	111.27	26.1
53, 25.5'-27.0' NO RECOVERY	214	8/18/09									
54, 0.0'-1.5'	215	8/18/09	Hom	3/8"			No	21.51	137.38	116.31	22.2
54, 1.5'-3.0'	216	8/18/09	Hom	3/8"			No	21.30	143.33	122.75	20.3
54, 3.0'-4.5'	217	8/18/09	Hom	3/8"			No	25.85	160.61	131.44	27.6
54, 4.5'-6.0'	218	8/18/09	Hom	3/8"			No	25.48	208.63	170.72	26.1
54, 6.0'-7.5'	219	8/18/09	Hom	3/8"			No	21.48	130.51	111.46	21.2
54, 7.5'-9.0'	220	8/18/09	Hom	3/8"			No	21.25	168.17	141.45	22.2
54, 9.0'-10.5'	221	8/18/09	Hom	3/8"			No	22.06	157.06	132.51	22.2
54, 10.5'-12.0'	222	8/18/09	Hom	3/8"			No	21.66	156.18	131.28	22.7
54, 12.0'-13.5'	223	8/18/09	Hom	3/8"			No	21.56	165.47	142.21	19.3
54, 13.5'-15.0'	224	8/18/09	Hom	3/8"			No	25.16	179.36	152.45	21.1

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded		Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
					Amount	Size					
54, 15.0'-16.5'	225	8/18/09	Hom	3/8"			No	21.26	190.47	156.70	24.9
54, 16.5'-18.0'	226	8/18/09	Hom	3/8"			No	25.60	197.70	164.00	24.3
54, 18.0'-19.5'	227	8/18/09	Hom	3/8"			No	21.73	162.84	145.86	13.7
54, 19.5'-21.0'	228	8/18/09	Hom	3/8"			No	25.29	169.62	147.73	17.9
54, 21.0'-22.5'	229	8/18/09	Hom	3/8"			No	21.34	173.02	148.43	19.3
54, 22.5'-24.0'	230	8/18/09	Hom	No. 4			Yes	21.38	171.49	149.14	17.5
54, 24.0'-25.5'	231	8/18/09	Hom	No. 4			Yes	21.48	195.47	171.37	16.1
54, 25.5'-27.0'	232	8/18/09	Hom	3/4"			No	22.14	110.21	99.97	13.2
54, 27.0'-28.5'	233	8/18/09	Hom	No. 4			Yes	22.04	170.83	147.87	18.2
54, 28.5'-30.0'	234	8/18/09	Hom	No. 4			Yes	21.99	176.52	149.59	21.1
54, 30.0'-31.5'	235	8/18/09	Len	No. 4			Yes	21.70	190.88	163.23	19.5
54, 31.5'-33.0'	236	8/18/09	Len	No. 4			Yes	21.16	166.96	139.51	23.2
54, 33.0'-34.5'	237	8/18/09	Len	No. 4			Yes	25.96	209.68	176.29	22.2
54, 34.5'-36.0'	238	8/18/09	Hom	No. 4			Yes	22.11	162.26	139.34	19.6
54, 36.0'-37.5'	239	8/18/09	Hom	No. 4			Yes	21.69	170.73	143.55	22.3
54, 37.5'-39.0'	240	8/18/09	Hom	No. 4			Yes	21.21	170.22	144.38	21.0
54, 39.0'-40.5'	241	8/18/09	Hom	No. 4			Yes	21.11	165.49	140.47	21.0
54, 40.5'-42.0'	242	8/18/09	Hom	No. 4			Yes	20.96	178.46	149.97	22.1
54, 42.0'-43.5'	243	8/18/09	Hom	No. 4			Yes	22.57	175.13	150.06	19.7
54, 43.5'-45.0'	244	8/18/09	Len	No. 4			Yes	26.17	201.96	170.41	21.9
54, 45.0'-46.5'	245	8/18/09	Len	No. 4			Yes	20.95	158.94	132.40	23.8
54, 47.5'-49.0'	246	8/18/09	Len	No. 4			Yes	21.19	171.05	141.31	24.8
54, 50.0'-51.5'	247	8/18/09	Hom	3/8"			No	25.98	199.67	166.41	23.7
54, 52.5'-54.0'	248	8/18/09	Hom	No. 4			Yes	21.80	173.58	142.55	25.7
54, 55.0'-56.5'	249	8/18/09	Hom	No. 4			Yes	25.91	206.95	167.07	28.3
54, 57.5'-59.0'	250	8/18/09	Hom	No. 4			No	21.29	144.97	111.65	36.9
54, 60.0'-61.5'	251	8/18/09	Len	No. 4			Yes	26.13	203.27	163.68	28.8
54, 62.5'-64.0'	252	8/18/09	Len	No. 4			Yes	25.96	221.90	183.32	24.5
54, 65.0'-66.5'	253	8/18/09	Len	No. 4			Yes	20.88	180.68	146.98	26.7
54, 67.5'-69.0'	254	8/18/09	Hom	3/8"			No	26.11	225.72	177.73	31.7
54, 70.0'-71.5'	255	8/18/09	Hom	3/8"			No	26.01	215.18	176.84	25.4

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
54, 72.5'-74.0'	256	8/18/09	Hom	3/8"			No	21.62	160.09	129.86	27.9
54, 75.0'-76.5'	257	8/18/09	Hom	3/4"			No	26.07	215.95	179.33	23.9
54, 77.5'-79.0'	258	8/18/09	Hom	3/4"			No	21.26	198.09	170.18	18.7
54, 80.0'-81.5'	259	8/18/09	Hom	3/4"			No	25.57	233.43	204.62	16.1
54, 82.5'-84.0'	260	8/18/09	Hom	No. 4			Yes	20.93	178.64	150.00	22.2
54, 85.0'-86.5'	261	8/18/09	Hom	3/4"			No	25.32	211.78	186.62	15.6
54, 87.5'-89.0'	262	8/18/09	Hom	3/4"			No	21.33	205.60	179.94	16.2
54, 90.0'-90.1' NO RECOVERY	263	8/18/09									
55, 0.0'-1.5'	265	8/7/09	Hom	3/8"			No	21.54	101.08	87.17	21.2
55, 1.5'-3.0'	266	8/7/09	Hom	3/8"			No	21.74	84.67	76.83	14.2
55, 3.0'-4.5'	267	8/7/09	Hom	3/8"			No	21.47	112.58	97.59	19.7
55, 4.5'-6.0'	268	8/7/09	Hom	3/8"			No	21.89	92.18	79.60	21.8
55, 6.0'-7.5'	269	8/7/09	Hom	3/8"			No	22.09	90.10	77.62	22.5
55, 7.5'-9.0'	270	8/7/09	Hom	No. 4			No	25.93	119.16	101.50	23.4
55, 9.0'-10.5'	272	8/7/09	Hom	No. 4			No	21.51	69.76	61.62	20.3
55, 10.5'-12.0'	273	8/7/09	Hom	No. 4			No	25.91	95.84	83.03	22.4
55, 12.0'-13.5'	274	8/7/09	Hom	No. 4			No	21.13	86.02	73.38	24.2
55, 13.5'-15.0'	275	8/7/09	Hom	3/4"			No	26.59	92.21	80.99	20.6
55, 15.0'-16.5'	276	8/7/09	Hom	3/4"			No	21.79	74.89	66.06	19.9
55, 16.5'-18.0'	277	8/7/09	Hom	3/4"			No	21.05	94.72	80.60	23.7
55, 18.0'-19.5'	278	8/7/09	Hom	No. 4			No	26.40	109.17	94.39	21.7
55, 19.5'-21.0'	279	8/7/09	Hom	No. 4			Yes	21.00	151.78	126.72	23.7
55, 21.0'-22.5'	280	8/7/09	Hom	3/4"			No	26.01	128.97	113.24	18.0
55, 22.5'-24.0'	281	8/7/09	Hom	3/4"			No	21.78	111.59	97.17	19.1
55, 24.0'-25.5'	283	8/7/09	Hom	3/4"			No	21.09	89.52	79.22	17.7
55, 25.5'-28.5'	284	8/7/09	Hom	3/4"			No	32.04	129.79	109.90	25.5
55, 28.5'-31.0'	285	8/7/09	Hom	3/4"			No	21.55	99.96	80.22	33.6
55, 31.0'-33.5'	286	8/7/09	Hom	3/4"			No	30.94	67.18	60.10	24.3
55, 33.5'-36.0'	287	8/7/09	Hom	3/4"			No	21.05	110.04	93.14	23.4
55, 36.0'-38.5' LITTLE RECOVERY	288	8/7/09	Hom	1 1/2"							
55, 38.5'-41.0'	289	8/7/09	Hom	3/4"			No	21.38	91.49	77.42	25.1

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: <u>Str</u>atified, <u>Lam</u>inated, <u>Len</u>sed, <u>Hom</u>ogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
55, 41.0'-43.5'	290	8/7/09	Hom	3/4"			No	26.12	147.29	121.12	27.5
55, 43.5'-46.0'	291	8/7/09	Hom	No. 4			No	21.91	92.81	65.04	64.4
55, 46.0'-48.5'	292	8/7/09	Hom	3/4"			No	30.88	161.56	131.76	29.5
55, 48.5'-51.0'	293	8/7/09	Hom	3/4"			No	21.31	139.82	114.49	27.2
55, 51.0'-53.5'	294	8/7/09	Hom	3/4"			No	31.85	156.34	139.22	15.9
55, 53.5'-56.0'	295	8/7/09	Hom	3/4"			No	32.29	170.85	132.89	37.7
55, 56.0'-58.5'	296	8/7/09	Hom	3/4"			No	21.92	112.76	86.21	41.3
55, 58.5'-61.0'	297	8/7/09	Hom	3/4"			No	32.12	151.34	116.05	42.0
55, 61.0'-63.5'	298	8/7/09	Hom	3/4"			No	31.66	188.78	143.56	40.4
55, 63.5'-66.0'	299	8/7/09	Hom	3/8"			No	32.33	185.53	126.30	63.0
55, 66.0'-68.5'	300	8/7/09	Hom	3/8"			No	32.12	180.91	123.35	63.1
55, 68.5'-71.0'	301	8/7/09	Hom	3/8"			No	30.97	181.99	139.30	39.4
55, 71.0'-73.5'	302	8/7/09	Hom	3/8"			No	20.86	207.54	128.05	74.2
55, 73.5'-75.0'	303	8/7/09	Hom	3/8"			No	31.09	188.60	146.29	36.7
55, 75.0'-75.1'	304	8/7/09	Hom	1 1/2"			No	25.90	52.57	47.76	22.0
58, 0.0'-1.5'	305	8/7/09	Hom	3/4"			No	25.96	174.09	154.25	15.5
58, 1.5'-3.0'	307	8/7/09	Hom	3/4"			No	32.17	115.23	100.81	21.0
58, 3.0'-4.5'	308	8/7/09	Hom	3/8"			No	26.42	159.07	135.24	21.9
58, 4.5'-6.0'	309	8/7/09	Hom	3/8"			No	21.03	151.14	126.01	23.9
58, 6.0'-7.5'	310	8/7/09	Hom	3/8"			No	31.94	134.16	113.41	25.5
58, 7.5'-9.0'	311	8/7/09	Hom	3/4"			No	21.49	101.57	90.61	15.9
58, 9.0'-10.5'	312	8/7/09	Hom	3/8"			No	32.54	142.11	116.87	29.9
58, 10.5'-12.0'	313	8/7/09	Hom	3/8"			No	20.89	84.96	76.07	16.1
58, 12.0'-13.5'	314	8/7/09	Hom	3/4"			No	32.53	86.58	79.10	16.1
58, 13.5'-15.0'	315	8/7/09	Hom	3/4"			No	30.70	118.45	101.85	23.3
58, 15.0'-16.5'	316	8/7/09	Hom	3/4"			No	31.98	132.08	115.52	19.8
58, 16.5'-18.0'	317	8/7/09	Hom	3/8"			No	32.29	147.11	128.03	19.9
58, 18.0'-19.5'	318	8/7/09	Hom	3/8"			No	32.20	107.81	95.29	19.8
58, 19.5'-21.0'	319	8/7/09	Hom	3/8"			No	22.52	134.18	109.16	28.9
58, 21.0'-22.5'	320	8/7/09	Hom	3/8"			No	21.42	129.30	104.56	29.8
58, 22.5'-24.0'	321	8/7/09	Hom	No. 4			No	32.38	92.53	79.28	28.3

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
58, 24.0'-25.5'	322	8/7/09	Hom	No. 4			No	26.09	146.22	121.46	26.0
58, 25.5'-27.0'	323	8/7/09	Hom	3/8"			No	26.08	186.61	159.22	20.6
58, 27.0'-28.5'	324	8/7/09	Hom	No. 4			No	26.20	147.53	117.37	33.1
58, 28.5'-30.0'	325	8/7/09	Hom	3/8"			No	21.48	116.96	89.32	40.7
58, 30.0'-31.5'	326	8/7/09	Hom	3/8"			No	32.23	171.86	114.24	70.3
58, 32.5'-34.0'	328	8/7/09	Hom	3/8"			No	26.28	124.28	94.77	43.1
58, 35.0'-36.5'	329	8/7/09	Hom	3/8"			No	32.05	135.92	101.83	48.9
58, 37.5'-39.0'	330	8/7/09	Hom	3/4"			No	26.07	157.23	135.06	20.3
58, 40.0'-41.5'	331	8/7/09	Hom	3/4"			No	21.17	121.87	88.84	48.8
58, 42.5'-44.0'	333	8/7/09	Hom	3/4"			No	25.16	135.59	106.69	35.4
58, 45.0'-46.5'	334	8/7/09	Hom	3/4"			No	21.47	110.38	88.00	33.6
58, 47.5'-49.0'	335	8/7/09	Hom	3/4"			No	26.16	182.07	141.24	35.5
58, 50.0'-51.5'	336	8/7/09	Hom	3/4"			No	21.30	179.65	157.08	16.6
58, 52.5'-54.0'	337	8/7/09	Hom	3/4"			No	25.97	187.19	139.98	41.4
58, 55.0'-56.5'	338	8/7/09	Hom	3/4"			No	26.33	186.96	167.18	14.0
58, 57.5'-58.1'	339	8/7/09	Hom	3/4"			No	21.36	152.62	137.07	13.4
58, 60.0'-60.2'	340	8/7/09	Hom	3/4"			No	22.16	109.71	104.20	6.7
59, 0.0'-1.5'	341	8/7/09	Hom	3/4"			No	25.32	191.95	168.57	16.3
59, 1.5'-3.0'	342	8/7/09	Hom	1 1/2"			No	25.65	158.83	123.16	36.6
59, 3.0'-4.5'	343	8/7/09	Hom	1 1/2"			No	21.71	97.75	74.74	43.4
59, 4.5'-6.0'	345	8/7/09	Hom	3/4"			No	25.59	105.33	80.59	45.0
59, 6.0'-7.5'	346	8/7/09	Hom	3/4"			No	21.54	104.04	83.40	33.4
59, 7.5'-9.0'	347	8/7/09	Hom	3/4"			No	21.12	106.87	87.19	29.8
59, 9.0'-10.5'	348	8/7/09	Hom	3/4"			No	25.38	99.40	79.78	36.1
59, 10.5'-12.0'	349	8/7/09	Hom	1 1/2"			No	21.03	81.11	64.97	36.7
59, 12.0'-13.5'	350	8/7/09	Hom	3/8"			No	26.34	119.92	87.97	51.8
59, 13.5'-15.0'	351	8/7/09	Hom	3/8"			No	25.86	151.48	108.71	51.6
59, 15.0'-16.5'	352	8/7/09	Hom	3/8"			No	26.16	141.02	105.08	45.5
59, 16.5'-18.0'	353	8/7/09	Hom	No. 4			No	26.19	150.74	103.46	61.2
59, 18.0'-19.5'	354	8/19/09	Hom	3/8"			No	21.17	149.47	109.79	44.8
59, 19.5'-21.0'	355	8/19/09	Hom	3/8"			No	21.06	138.62	98.75	51.3

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded		Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
					Amount	Size					
59, 21.0'-23.5'	356	8/19/09	Hom	3/8"			No	25.36	154.51	111.84	49.3
59, 23.5'-26.0'	357	8/19/09	Hom	No. 4			Yes	26.07	160.05	128.53	30.8
59, 26.0'-28.5'	358	8/19/09	Hom	No. 4			Yes	26.07	182.20	144.38	32.0
59, 28.5'-31.0'	359	8/19/09	Hom	3/8"			No	25.65	176.64	142.14	29.6
59, 31.0'-33.5'	360	8/19/09	Hom	No. 4			Yes	25.96	156.99	128.15	28.2
59, 33.5'-35.0' NO RECOVERY	361	8/19/09									
60, 0.0'-1.5'	362	8/19/09	Hom	3/8"			No	26.27	192.94	169.07	16.7
60, 1.5'-3.0'	364	8/19/09	Hom	3/8"			No	25.90	141.91	128.59	13.0
60, 3.0'-4.5'	365	8/19/09	Hom	No. 4			No	21.29	92.45	79.87	21.5
60, 4.5'-6.0'	366	8/19/09	Hom	3/8"			No	20.82	169.83	143.34	21.6
60, 6.0'-7.5'	367	8/19/09	Hom	3/8"			No	21.39	157.74	130.00	25.5
60, 7.5'-9.0'	368	8/19/09	Hom	3/8"			No	26.13	156.45	130.76	24.6
60, 9.0'-10.5'	369	8/19/09	Hom	3/8"			No	26.35	160.98	133.62	25.5
60, 10.5'-12.0'	370	8/19/09	Hom	3/8"			No	21.49	163.65	136.48	23.6
60, 12.0'-13.5'	371	8/19/09	Hom	No. 4			Yes	22.45	156.99	133.11	21.6
60, 13.5'-15.0'	372	8/19/09	Hom	3/8"			No	26.45	172.04	143.59	24.3
60, 15.0'-16.5'	373	8/19/09	Hom	3/8"			No	21.07	169.95	134.42	31.3
60, 16.5'-18.0'	374	8/19/09	Hom	No. 4			Yes	25.75	194.17	149.95	35.6
60, 18.0'-19.5'	376	8/19/09	Hom	No. 4			No	26.05	155.21	122.87	33.4
60, 19.5'-21.0'	377	8/19/09	Hom	3/4"			No	26.15	166.89	135.89	28.2
60, 21.0'-22.5'	378	8/19/09	Hom	No. 4			No	25.96	151.53	120.81	32.4
60, 22.5'-24.0'	379	8/19/09	Hom	No. 4			No	26.19	163.59	123.06	41.8
60, 24.0'-25.5'	380	8/19/09	Hom	No. 4			Yes	25.58	174.17	133.67	37.5
60, 25.5'-27.0'	381	8/19/09	Hom	No. 10			Yes	25.68	147.14	112.28	40.3
60, 27.0'-28.5'	382	8/19/09	Hom	No. 4			Yes	26.32	171.43	129.32	40.9
60, 28.5'-30.0'	383	8/19/09	Hom	No. 10			Yes	25.84	182.46	137.97	39.7
60, 30.0'-31.5'	384	8/19/09	Hom	No. 4			Yes	26.23	185.99	146.22	33.1
60, 31.5'-33.0'	385	8/19/09	Hom	No. 4			Yes	25.69	181.75	138.31	38.6
60, 33.0'-34.5'	387	8/19/09	Hom	3/8"			No	26.08	146.48	111.41	41.1
60, 34.5'-36.0'	388	8/19/09	Hom	No. 4			No	26.00	159.73	125.58	34.3
60, 36.0'-37.5'	389	8/19/09	Hom	No. 4			Yes	25.69	185.65	154.79	23.9

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded		Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
					Amount	Size					
60, 37.5'-39.0'	390	8/19/09	Hom	No. 10			Yes	26.10	211.28	176.64	23.0
60, 39.0'-40.5'	391	8/19/09	Hom	No. 4			Yes	21.87	183.82	146.55	29.9
60, 40.5'-42.0'	392	8/19/09	Hom	No. 4			Yes	25.85	171.33	141.56	25.7
60, 42.0'-43.5'	393	8/19/09	Hom	No. 10			Yes	25.97	187.36	151.69	28.4
60, 43.5'-43.6'	394	8/19/09	Hom	3/4"			No	22.02	75.40	74.03	2.6
61, 4.5'-6.0'	395	8/19/09	Hom	3/4"			No	21.53	190.67	187.37	2.0
61, 6.0'-7.5'	396	8/19/09	Hom	3/8"			No	25.96	175.39	147.87	22.6
61, 7.5'-9.0' NO RECOVERY	397	8/19/09									
61, 9.0'-10.5'	398	8/19/09	Hom	No. 4			Yes	26.07	179.44	149.83	23.9
61, 10.5'-12.0'	399	8/19/09	Hom	3/8"			No	25.71	175.32	146.73	23.6
61, 12.0'-13.5'	400	8/19/09	Hom	No. 4			Yes	26.10	202.17	168.99	23.2
61, 13.5'-15.0'	401	8/19/09	Hom	No. 4			No	26.20	164.48	126.10	38.4
61, 15.0'-16.5'	402	8/19/09	Hom	No. 4			Yes	26.56	213.60	178.63	23.0
61, 16.5'-18.0'	403	8/19/09	Hom	No. 4			Yes	26.09	203.95	165.99	27.1
61, 18.0'-19.5'	404	8/19/09	Hom	No. 4			Yes	26.03	181.07	141.73	34.0
61, 19.5'-21.0'	405	8/19/09	Hom	No. 4			Yes	25.90	166.34	130.39	34.4
61, 21.0'-22.5'	406	8/19/09	Hom	3/4"			No	25.93	192.11	160.94	23.1
61, 22.5'	407	8/19/09	Hom	No. 4			No	21.93	123.50	99.16	31.5
62, 0.0'-1.5'	408	8/5/09	Hom	3/8"			No	25.97	129.53	111.59	21.0
62, 1.5'-3.0'	409	8/5/09	Hom	3/8"			No	25.86	154.90	136.35	16.8
62, 3.0'-4.5'	410	8/5/09	Hom	3/4"			No	20.85	103.64	89.41	20.8
62, 4.5'-6.0'	411	8/5/09	Hom	3/4"			No	26.42	139.48	121.50	18.9
62, 6.0'-7.5'	412	8/5/09	Hom	3/4"			No	22.64	125.90	107.15	22.2
62, 7.5'-9.0'	413	8/5/09	Hom	3/8"			No	21.46	77.79	67.07	23.5
62, 9.0'-10.5'	414	8/5/09	Hom	3/8"			No	21.36	113.80	97.27	21.8
62, 10.5'-12.0'	415	8/5/09	Hom	3/8"			No	20.99	113.54	99.47	17.9
62, 12.0'-13.5'	416	8/5/09	Hom	3/8"			No	31.99	117.24	100.46	24.5
62, 13.5'-15.0' NO RECOVERY	417	8/5/09									
62, 15.0'-16.5'	418	8/5/09	Hom	3/8"			No	32.00	100.18	86.77	24.5
62, 16.5'-18.0'	419	8/5/09	Hom	3/8"			No	32.30	145.96	128.75	17.8
62, 18.0'-19.5'	420	8/5/09	Hom	3/4"			No	21.58	131.69	117.08	15.3

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded		Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
					Amount	Size					
62, 19.5'-19.9'	421	8/5/09	Hom	3/4"			No	32.36	177.20	163.09	10.8
62, 21.0'-21.4'	422	8/5/09	Hom	3/4"			No	32.25	204.81	183.37	14.2
62, 22.5'-23.8'	423	8/5/09	Hom	3/8"			No	32.86	140.55	108.78	41.8
50 A, 33.5'-35.0'	424	8/5/09	Hom	3/8"			No	32.08	135.37	109.73	33.0
50 A, 36.0' NO RECOVERY	425	8/5/09									
50 A, 43.5'-45.0' NO RECOVERY	426	8/5/09									
50 A, 46.0'-47.3'	427	8/5/09	Hom	3/4"			No	30.91	93.70	83.30	19.9
50 A, 48.5'-50.0'	428	8/5/09	Hom	3/4"			No	25.94	160.24	127.89	31.7
50 A, 51.0'-52.5'	429	8/5/09	Hom	3/8"			No	31.62	130.31	103.98	36.4
50 A, 54.0' NO RECOVERY	430	8/5/09									
50 A, 56.0'-57.5'	431	8/5/09	Hom	3/8"			No	21.38	113.98	93.14	29.0
50 A, 58.5'-60.0'	432	8/5/09	Hom	3/8"			No	32.10	139.93	116.24	28.2
50 A, 61.0'-62.5'	433	8/5/09	Hom	No. 4			Yes	30.94	205.81	163.90	31.5
50 A, 63.5'-65.0'	434	8/5/09	Hom	3/8"			No	21.70	196.25	159.80	26.4
50 A, 66.0'-67.5'	435	8/5/09	Hom	3/8"			No	21.02	151.41	123.87	26.8
50 A, 68.5'-70.0'	436	8/5/09	Hom	No. 4			No	26.12	145.50	118.62	29.1
50 A, 71.0'-72.5'	437	8/5/09	Hom	No. 4			Yes	30.91	175.65	140.37	32.2
50 A, 73.5'-75.0'	438	8/5/09	Hom	3/4"			No	21.07	124.12	107.60	19.1
50 A, 76.0'-77.5'	439	8/5/09	Hom	1 1/2"			No	21.88	103.77	83.13	33.7
50 A, 78.5'-80.0'	440	8/5/09	Hom	3/4"			No	21.67	106.83	88.66	27.1
50 A, 81.0'-82.5'	441	8/5/09	Hom	3/4"			No	21.00	97.80	77.47	36.0
50 A, 83.5'-85.0'	442	8/5/09	Hom	3/4"			No	32.02	101.81	85.70	30.0
50 A, 86.0'-87.5'	443	8/5/09	Hom	1 1/2"			No	31.75	129.44	107.22	29.4
50 A, 88.5'-90.0'	444	8/5/09	Hom	3/4"			No	32.28	132.21	111.77	25.7
53 A, 29.5'-31.0'	445	8/5/09	Hom	3/4"			No	21.32	105.25	88.05	25.8
53 A, 31.0'-33.5'	446	8/5/09	Hom	No. 4			Yes	30.96	163.98	139.70	22.3
53 A, 33.5'-38.5'	447	8/5/09	Hom	No. 4			Yes	26.07	176.49	143.75	27.8
53 A, 38.5'-41.0'	448	8/5/09	Hom	No. 4			No	32.46	136.41	114.46	26.8
53 A, 41.0'-46.0'	449	8/5/09	Hom	No. 4			No	31.94	124.53	105.97	25.1
53 A, 46.0'-48.5'	450	8/5/09	Hom	No. 4			No	26.22	69.04	60.25	25.8
53 A, 48.5'-51.0'	451	8/5/09	Hom	No. 4			No	21.52	131.49	102.55	35.7

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Ash pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
53 A, 51.0'-53.5'	452	8/5/09	Hom	3/8"			No	21.56	149.12	117.80	32.5
53 A, 53.5'-56.0'	453	8/5/09	Hom	3/8"			No	21.83	167.11	142.77	20.1
53 A, 56.0'-58.5'	454	8/5/09	Hom	3/8"			No	21.47	148.34	125.37	22.1
53 A, 58.5'-61.0'	455	8/5/09	Hom	No. 4			No	20.98	108.43	92.75	21.8
53 A, 61.0'-63.5'	456	8/5/09	Hom	3/4"			No	21.47	79.45	66.29	29.4
53 A, 63.5'-66.0'	457	8/5/09	Hom	3/4"			No	26.12	85.91	73.67	25.7
53 A, 66.0'-68.5'	458	8/5/09	Hom	1 1/2"			No	25.61	195.09	167.61	19.4
53 A, 68.5'-71.0'	459	8/5/09	Hom	1 1/2"			No	25.89	263.29	224.75	19.4
53 A, 71.0'-73.5'	460	8/5/09	Hom	3/4"			No	21.31	78.22	64.84	30.7
53 A, 73.5'-76.0'	461	8/5/09	Hom	3/4"			No	21.50	133.62	111.53	24.5
53 A, 76.0'-78.5'	462	8/5/09	Hom	3/4"			No	21.24	166.39	137.71	24.6
53 A, 78.5'-81.0'	463	8/5/09	Hom	3/4"			No	21.91	144.09	112.27	35.2
53 A, 81.0'-83.5'	464	8/5/09	Hom	3/4"			No	25.27	168.62	136.78	28.6
53 A, 83.5'-86.0'	465	8/5/09	Hom	3/4"			No	25.93	192.54	148.49	35.9
53 A, 86.0'-88.5'	466	8/5/09	Hom	3/4"			No	30.86	162.16	122.32	43.6
53 A, 88.5'-91.0'	467	8/5/09	Hom	3/4"			No	32.25	204.56	152.27	43.6
53 A, 91.0'-93.5'	468	8/5/09	Hom	3/4"			No	21.89	151.59	112.39	43.3
53 A, 93.5'-95.0'	469	8/5/09	Hom	3/4"			No	21.09	185.07	126.67	55.3
54 A, 6.0'-8.0' NO RECOVERY	470	8/19/09									
54 A, 8.0'-9.4' NO RECOVERY	471	8/19/09									
54 A, 22.0'-24.0' NO RECOVERY	472	8/19/09									
54 A, 30.0'-32.0' NO RECOVERY	473	8/19/09									
54 A, 45.0'-47.0' NO RECOVERY	474	8/19/09									
59 A, 38.0' NO RECOVERY	475	8/19/09									

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Fossil Plant - Ash Pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
56, 0.0'-1.5'	477	8/20/09	Hom	No. 4			Yes	26.32	154.09	139.90	12.5
56, 1.5'-3.0'	478	8/20/09	Hom	No. 4			Yes	25.63	156.73	136.06	18.7
56, 3.0'-4.5'	479	8/20/09	Hom	No. 4			Yes	25.70	149.41	126.43	22.8
56, 4.5'-6.0'	480	8/20/09	Hom	No. 4			No	25.58	137.67	117.72	21.7
56, 6.0'-7.5'	481	8/20/09	Hom	No. 4			Yes	25.69	156.93	132.50	22.9
56, 7.5'-9.0'	482	8/20/09	Hom	No. 4			Yes	25.89	172.30	141.56	26.6
56, 9.0'-10.5'	483	8/20/09	Hom	3/8"			No	26.06	147.54	125.19	22.5
56, 10.5'-12.0'	484	8/20/09	Hom	No. 4			No	26.08	143.52	123.19	20.9
56, 12.0'-13.5'	485	8/20/09	Hom	No. 4			Yes	26.07	162.43	136.70	23.3
56, 13.5'-15.0'	486	8/20/09	Hom	3/8"			No	26.02	181.87	152.03	23.7
56, 15.0'-16.5'	487	8/20/09	Hom	3/8"			No	26.10	151.31	127.73	23.2
56, 16.5'-18.0'	488	8/20/09	Hom	No. 4			Yes	25.66	164.71	138.81	22.9
56, 18.0'-19.5'	489	8/20/09	Hom	No. 4			No	25.94	64.49	57.53	22.0
56, 19.5'-21.0'	490	8/20/09	Hom	No. 4			No	26.12	102.91	89.15	21.8
56, 21.0'-22.5'	491	8/20/09	Hom	No. 4			No	25.81	100.63	84.99	26.4
56, 22.5'-24.0'	492	8/20/09	Hom	No. 4			Yes	26.28	155.19	135.88	17.6
56, 24.0'-25.5'	493	8/20/09	Hom	No. 4			Yes	25.95	161.19	140.79	17.8
56, 25.5'-27.0'	494	8/20/09	Hom	No. 10			Yes	25.67	144.45	126.49	17.8
56, 27.0'-28.5'	495	8/20/09	Hom	No. 4			Yes	26.28	145.50	126.85	18.5
56, 28.5'-30.0'	496	8/20/09	Hom	3/8"			No	26.08	134.95	108.87	31.5
56, 30.0'-31.5'	497	8/20/09	Hom	3/8"			No	25.92	135.36	112.87	25.9
56, 31.5'-33.0'	498	8/20/09	Hom	3/8"			No	26.21	158.38	140.30	15.8
56, 33.0'-34.5'	499	8/20/09	Hom	3/8"			No	25.98	133.95	102.37	41.3
56, 34.5'-36.0'	501	8/20/09	Hom	No. 4			No	26.17	145.42	107.30	47.0
56, 36.0'-37.5'	502	8/20/09	Hom	3/8"			No	25.89	137.17	114.40	25.7
56, 37.5'-39.0'	503	8/20/09	Hom	3/8"			No	26.19	122.59	97.99	34.3
56, 39.0'-40.5'	504	8/20/09	Hom	3/8"			No	26.52	173.99	141.52	28.2
56, 40.5'-42.0'	505	8/20/09	Hom	3/8"			No	25.96	157.99	128.07	29.3

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Fossil Plant - Ash Pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
56, 42.0'-43.5'	506	8/21/09	Hom	3/4"			No	21.36	164.14	131.53	29.6
56, 43.5'-45.0'	507	8/21/09	Hom	No. 4			Yes	20.83	187.76	129.04	54.3
56, 45.0'-46.5'	508	8/21/09	Hom	3/4"			No	21.63	163.38	111.41	57.9
56, 46.5'-48.0'	509	8/21/09	Hom	3/8"			No	21.46	160.48	125.14	34.1
56, 48.0'-49.5'	510	8/21/09	Hom	3/8"			No	21.23	153.69	110.61	48.2
56, 49.5'-51.0'	511	8/21/09	Hom	3/8"			No	21.11	160.07	105.13	65.4
56, 52.5'-54.0'	512	8/21/09	Hom	3/4"			No	26.05	217.99	178.28	26.1
56, 55.0'-56.5'	513	8/21/09	Hom	No. 4			No	26.08	176.43	119.56	60.8
56, 57.5'-59.0'	514	8/21/09	Hom	3/8"			No	26.05	229.74	164.35	47.3
56, 60.0'-61.5'	515	8/21/09	Hom	3/8"			No	22.50	174.82	134.73	35.7
56, 62.5'-64.0'	516	8/21/09	Hom	3/4"			No	25.94	208.88	169.04	27.8
56, 65.0'-66.5'	517	8/21/09	Hom	3/4"			No	25.70	248.14	203.43	25.2
56, 67.5'-69.0'	518	8/21/09	Hom	3/8"			No	21.61	188.57	137.80	43.7
56, 70.0'-71.5'	519	8/21/09	Hom	3/8"			No	20.99	171.31	134.79	32.1
56, 72.5'-74.0'	520	8/21/09	Hom	3/4"			No	26.33	257.60	206.33	28.5
56, 75.0'-75.7'	521	8/21/09	Hom	3/4"			No	20.96	146.30	141.80	3.7
57, 0.0'-1.5'	522	8/21/09	Hom	3/4"			No	21.97	183.86	172.32	7.7
57, 1.5'-2.3'	523	8/21/09	Hom	3/4"			No	26.29	225.91	208.00	9.9
57, 3.0'-4.5'	524	8/21/09	Hom	3/8"			No	26.08	170.68	147.18	19.4
57, 4.5'-6.0'	525	8/21/09	Hom	3/8"			No	26.02	167.01	138.55	25.3
57, 6.0'-7.5'	526	8/21/09	Hom	No. 4			Yes	25.84	188.72	153.40	27.7
57, 7.5'-9.0'	528	8/21/09	Hom	No. 4			No	21.50	146.64	118.84	28.6
57, 9.0'-10.5'	529	8/21/09	Hom	No. 4			Yes	21.53	159.79	132.04	25.1
57, 10.5'-12.0'	530	8/21/09	Hom	3/8"			No	22.14	157.02	131.16	23.7
57, 12.0'-13.5'	531	8/21/09	Hom	3/8"			No	21.47	153.35	127.56	24.3
57, 13.5'-15.0'	532	8/21/09	Hom	No. 4			No	21.91	136.09	111.44	27.5
57, 15.0'-16.5'	533	8/21/09	Hom	No. 4			Yes	21.46	151.91	126.16	24.6
57, 16.5'-18.0'	534	8/21/09	Hom	No. 4			Yes	21.78	147.14	122.12	24.9
57, 18.0'-19.5'	535	8/21/09	Hom	No. 4			No	26.22	165.40	122.12	45.1
57, 19.5'-21.0'	536	8/21/09	Hom	3/8"			No	26.08	210.05	172.80	25.4
57, 21.0'-22.5'	537	8/21/09	Hom	No. 4			Yes	25.92	196.73	161.04	26.4

Stantec

Moisture Content of Soil
ASTM D 2216

Project Name Cumberland Fossil Plant - Ash Pond

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
57, 22.5'-24.0'	538	8/21/09	Hom	No. 4			No	21.46	136.24	106.22	35.4
57, 24.0'-25.5'	539	8/21/09	Hom	No. 4			Yes	21.89	152.10	125.61	25.5
57, 25.5'-27.0'	540	8/21/09	Hom	No. 4			Yes	21.36	154.51	122.14	32.1
57, 27.0'-28.5'	541	8/21/09	Hom	No. 4			No	21.12	160.74	112.37	53.0
57, 28.5'-30.0'	542	8/21/09	Hom	No. 4			Yes	25.40	170.33	136.61	30.3
57, 30.0'-30.7'	543	8/21/09	Hom	No. 4			Yes	22.22	166.82	136.68	26.3
57, 32.5'-34.0'	544	8/21/09	Hom	3/8"			No	25.33	201.82	157.04	34.0
57, 35.0'-36.5'	545	8/21/09	Hom	No. 4			Yes	21.20	205.36	145.19	48.5
57, 37.5'-39.0'	546	8/21/09	Hom	3/4"			No	26.13	227.25	195.18	19.0
57, 40.0'-41.5'	547	8/21/09	Hom	3/8"			No	25.59	223.76	175.67	32.0
57, 42.5'-44.0'	548	8/21/09	Hom	3/8"			No	26.10	210.79	148.41	51.0
57, 45.0'-46.5'	549	8/21/09	Hom	3/8"			No	20.95	175.41	141.71	27.9
57, 47.5'-49.0'	550	8/21/09	Hom	3/8"			No	21.40	180.02	120.95	59.3
57, 50.0'-50.9'	551	8/21/09	Hom	3/4"			No	21.29	197.32	154.14	32.5
57, 52.5'-54.0'	552	8/21/09	Hom	3/8"			No	21.09	189.28	133.02	50.3
57, 55.0'-56.5'	553	8/21/09	Hom	3/8"			No	20.91	160.91	111.70	54.2
57B, 57.5'-59.0'	554	8/21/09	Hom	3/8"			No	26.04	199.44	151.55	38.2
57B, 60.0'-61.5'	555	8/21/09	Hom	3/8"			No	25.94	187.77	140.39	41.4
57B, 62.5'-64.0'	556	8/21/09	Hom	3/8"			No	25.94	209.13	160.90	35.7
57B, 65.0'-66.5'	557	8/21/09	Hom	3/8"			No	26.13	121.57	92.53	43.7

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Fossil Plant - Ash and Gypsum Stacks

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded		Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
					Amount	Size					
23, 0.0'-1.5'	558	8/25/09	Hom	No. 10			Yes	25.88	164.51	153.43	8.7
23, 1.5'-3.0'	559	8/25/09	Hom	No. 10			Yes	26.25	187.90	173.78	9.6
23, 3.0'-4.5'	560	8/25/09	Hom	No. 10			Yes	26.26	181.51	164.46	12.3
23, 4.5'-6.0'	561	8/25/09	Hom	No. 10			Yes	25.93	171.90	158.15	10.4
23, 6.0'-7.5'	562	8/25/09	Hom	No. 10			Yes	26.15	185.01	166.70	13.0
23, 7.5'-9.0'	563	8/25/09	Hom	No. 10			Yes	26.66	181.76	162.12	14.5
23, 9.0'-10.5'	564	8/25/09	Hom	No. 10			Yes	25.81	196.56	177.32	12.7
23, 10.5'-12.0'	565	8/25/09	Hom	No. 10			Yes	25.94	178.51	159.61	14.1
23, 12.0'-13.5'	566	8/25/09	Hom	No. 10			Yes	26.00	204.00	179.07	16.3
23, 13.5'-15.0'	567	8/25/09	Hom	No. 10			Yes	26.07	203.52	172.36	21.3
23, 15.0'-16.5'	568	8/25/09	Hom	No. 10			Yes	25.66	196.47	167.21	20.7
23, 16.5'-18.0'	569	8/25/09	Hom	No. 10			Yes	25.70	195.90	162.65	24.3
23, 18.0'-19.5'	570	8/25/09	Hom	No. 10			Yes	26.22	203.05	169.46	23.5
23, 19.5'-21.0'	571	8/25/09	Hom	3/4"			No	25.91	236.49	232.24	2.1
23, 21.0'-22.5'	572	8/25/09	Hom	No. 10			Yes	25.98	183.15	142.03	35.4
23, 22.5'-24.0'	573	8/25/09	Hom	No. 10			Yes	26.09	193.83	150.00	35.4
23, 24.0'-25.5'	574	8/25/09	Hom	No. 10			Yes	26.02	182.02	140.67	36.1
23, 25.5'-27.0'	575	8/25/09	Hom	No. 10			Yes	26.10	194.68	155.09	30.7
23, 27.0'-28.5'	576	8/25/09	Hom	No. 10			Yes	26.26	188.57	145.32	36.3
23, 28.5'-30.0'	577	8/25/09	Hom	No. 10			Yes	25.95	194.46	157.30	28.3
23, 30.0'-31.5'	578	8/25/09	Hom	No. 10			Yes	25.91	184.65	139.84	39.3
23, 31.5'-33.0'	579	8/25/09	Hom	No. 10			Yes	26.04	204.37	160.96	32.2
23, 33.0'-34.5'	580	8/25/09	Hom	No. 10			Yes	25.69	185.92	141.26	38.6
23, 34.5'-36.0'	581	8/25/09	Hom	No. 10			Yes	25.58	224.36	174.88	33.1
23, 36.0'-37.5'	582	8/25/09	Hom	No. 10			Yes	25.63	187.02	137.67	44.0
23, 37.5'-39.0'	583	8/25/09	Hom	No. 10			Yes	25.69	190.09	131.71	55.1
23, 39.0'-40.5'	584	8/25/09	Hom	No. 10			Yes	26.29	175.64	127.98	46.9
23, 40.5'-42.0'	585	8/25/09	Hom	No. 10			Yes	26.06	235.10	178.95	36.7

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Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Fossil Plant - Ash and Gypsum Stacks

Project Number 175539016

Tested By

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Test Method ASTM

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded		Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
					Amount	Size					
23, 42.0'-43.5'	586	8/25/09	Hom	No. 10			Yes	32.08	187.17	147.70	34.1
23, 43.5'-45.0'	587	8/25/09	Hom	No. 10			Yes	30.87	163.92	128.14	36.8
23, 45.0'-46.5'	588	8/25/09	Hom	No. 10			Yes	32.31	121.25	92.96	46.6
23, 46.5'-48.0'	589	8/25/09	Hom	No. 10			Yes	30.72	113.99	86.59	49.0
23, 48.0'-49.5'	590	8/25/09	Hom	No. 10			Yes	31.76	103.28	78.82	52.0
23, 49.5'-51.0'	591	8/25/09	Hom	No. 10			Yes	32.07	117.90	88.59	51.9
23, 51.0'-52.5'	592	8/25/09	Hom	No. 10			Yes	32.29	107.35	82.48	49.6
23, 52.5'-54.0'	593	8/25/09	Hom	No. 10			Yes	30.94	111.02	84.89	48.4
23, 54.0'-55.5'	594	8/25/09	Hom	No. 10			Yes	30.73	160.67	114.83	54.5
23, 55.5'-57.0'	595	8/25/09	Hom	No. 10			Yes	31.01	164.45	115.65	57.7
23, 57.0'-58.5'	596	8/25/09	Hom	No. 10			Yes	32.30	117.46	89.80	48.1
23, 58.5'-60.0'	597	8/25/09	Hom	No. 10			Yes	32.12	140.84	107.81	43.6
23, 60.0'-61.5'	598	8/25/09	Hom	No. 10			Yes	31.81	113.62	89.20	42.6
23, 61.5'-63.0'	599	8/25/09	Hom	No. 10			Yes	30.91	109.44	80.06	59.8
23, 63.0'-64.5'	600	8/25/09	Hom	No. 10			Yes	32.23	120.78	91.87	48.5
23, 64.5'-66.0'	601	8/25/09	Hom	No. 10			Yes	32.14	116.00	86.55	54.1
23, 66.0'-67.5'	602	8/25/09	Hom	No. 10			Yes	31.04	126.04	106.86	25.3
23, 67.5'-69.0'	603	8/25/09	Hom	No. 10			Yes	32.09	107.01	92.77	23.5
23, 69.0'-70.5'	604	8/25/09	Hom	No. 10			Yes	31.92	114.39	97.59	25.6
23, 70.5'-72.0'	605	8/25/09	Hom	No. 10			Yes	32.47	118.68	101.75	24.4
23, 72.0'-73.5'	606	8/25/09	Hom	No. 10			Yes	30.71	146.47	123.11	25.3
23, 75.0'-76.5'	607	8/25/09	Hom	No. 10			Yes	32.14	112.19	95.65	26.0
23, 77.5'-79.0'	608	8/25/09	Hom	No. 4			Yes	30.66	153.78	131.66	21.9
23, 80.0'-81.5'	609	8/25/09	Hom	No. 4			No	31.94	150.34	128.18	23.0
23, 82.5'-84.0'	610	8/25/09	Hom	3/8"			No	31.92	154.79	133.02	21.5
23, 85.0'-86.5'	611	8/25/09	Hom	3/8"			No	32.47	176.65	147.85	25.0
23, 87.5'-89.0'	612	8/25/09	Hom	3/8"			No	31.77	160.95	141.21	18.0
23, 90.0'-91.5'	613	8/25/09	Hom	3/8"			No	30.56	176.61	149.36	22.9
23, 92.5'-94.0'	614	8/25/09	Hom	3/8"			No	32.12	161.58	142.02	17.8
23, 95.0'-96.5'	615	8/25/09	Hom	3/8"			No	32.23	159.90	132.61	27.2
23, 97.5'-98.8'	616	8/25/09	Hom	3/8"			No	30.99	169.86	148.62	18.1

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Fossil Plant - Ash and Gypsum Stacks

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded		Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
					Amount	Size					
23, 99.4'-99.5'	617	8/25/09	Hom	3/8"			No	32.32	72.67	69.58	8.3
31, 0.0'-1.5'	618	8/25/09	Hom	No. 4			No	31.92	130.65	121.67	10.0
31, 1.5'-3.0'	619	8/25/09	Hom	No. 4			No	32.31	119.83	114.70	6.2
31, 3.0'-4.5'	620	8/25/09	Hom	No. 4			No	31.67	111.84	106.39	7.3
31, 4.5'-6.0'	621	8/25/09	Hom	No. 4			No	30.64	133.39	125.38	8.5
31, 6.0'-7.5'	622	8/25/09	Hom	No. 4			No	91.82	130.98	124.84	18.6
31, 7.5'-9.0'	623	8/25/09	Hom	No. 4			Yes	30.97	138.75	131.61	7.1
31, 9.0'-10.5'	624	8/25/09	Hom	No. 4			Yes	25.95	143.37	133.80	8.9
31, 10.5'-11.8'	625	8/25/09	Hom	No. 4			No	21.38	124.32	111.64	14.0
31, 12.0'-13.5'	626	8/25/09	Hom	No. 4			No	21.73	108.92	100.54	10.6
31, 13.5'-14.7'	627	8/25/09	Hom	No. 4			No	21.35	125.20	113.16	13.1
31, 15.0'-16.2'	628	8/25/09	Hom	No. 4			No	21.20	138.62	118.58	20.6
31, 16.5'-17.8'	629	8/25/09	Hom	No. 4			No	20.90	103.68	90.16	19.5
31, 18.0'-19.5'	630	8/25/09	Hom	No. 4			No	22.31	124.73	107.27	20.6
31, 19.5'-21.0'	631	8/25/09	Hom	3/8"			No	22.04	98.32	94.81	4.8
31, 21.0'-22.5'	632	8/25/09	Hom	No. 10			Yes	21.19	100.85	94.28	9.0
31, 22.5'-24.0'	633	8/25/09	Hom	No. 10			Yes	21.66	133.35	119.39	14.3
31, 24.0'-25.5'	634	8/25/09	Hom	No. 4			Yes	26.17	169.12	150.28	15.2
31, 25.5'-27.0'	635	8/25/09	Hom	3/4"			No	21.15	153.50	135.13	16.1
31, 27.0'-28.5'	636	8/25/09	Hom	3/8"			No	20.93	185.83	167.89	12.2
31, 28.5'-30.0'	637	8/25/09	Hom	No. 4			Yes	21.19	149.44	133.86	13.8
31, 30.0'-31.5'	638	8/25/09	Hom	3/8"			No	21.63	156.30	134.56	19.3
31, 31.5'-33.0'	639	8/25/09	Hom	No. 4			No	21.62	141.02	110.58	34.2
31, 33.0'-34.5'	640	8/25/09	Hom	No. 4			No	75.93	156.16	124.81	64.1
31, 34.5'-36.0'	641	8/25/09	Hom	No. 4			No	21.38	113.01	86.12	41.5
31, 36.0'-37.5'	642	8/25/09	Hom	3/8"			No	25.70	174.95	145.40	24.7
31, 37.5'-39.0'	643	8/25/09	Hom	3/8"			No	21.55	161.50	129.26	29.9
31, 39.0'-40.5'	644	8/25/09	Hom	No. 4			Yes	25.75	180.62	140.84	34.6
31, 40.5'-42.0'	645	8/25/09	Hom	No. 4			Yes	25.56	187.93	143.84	37.3
31, 42.0'-43.5'	646	8/25/09	Hom	No. 10			Yes	22.14	107.33	83.49	38.9
31, 43.5'-45.0'	647	8/25/09	Hom	No. 10			Yes	21.42	126.57	98.90	35.7

Stantec

Moisture Content of Soil

ASTM D 2216

Project Name Cumberland Fossil Plant - Ash and Gypsum Stacks

Project Number 175539016

Tested By

Test Method ASTM

Maximum Particle Size in Sample	No. 10	No. 4	3/8"	3/4"	1 1/2"	3"
Recommended Minimum Mass (g)	20	100	500	2,500	10,000	50,000

Material Type: Stratified, Laminated, Lensed, Homogeneous

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
31, 45.0'-46.5'	648	8/25/09	Hom	No. 10			Yes	21.32	76.83	61.35	38.7
31, 46.5'-48.0'	649	8/25/09	Hom	No. 10			Yes	21.50	108.53	78.83	51.8
31, 48.0'-49.5'	650	8/25/09	Hom	No. 10			Yes	21.83	107.29	80.15	46.5
31, 49.5'-51.0'	651	8/25/09	Hom	No. 10			Yes	21.44	103.95	77.65	46.8
31, 51.0'-52.5'	652	8/25/09	Hom	No. 10			Yes	21.61	109.04	78.10	54.8
31, 52.5'-54.0'	653	8/25/09	Hom	No. 10			Yes	21.23	80.10	60.87	48.5
31, 54.0'-55.5'	654	8/25/09	Hom	No. 10			Yes	21.55	107.74	82.08	42.4
31, 55.5'-57.0'	655	8/25/09	Hom	No. 10			Yes	21.21	107.24	84.76	35.4
31, 57.0'-58.5'	656	8/25/09	Hom	No. 10			Yes	25.58	140.73	107.62	40.4
31, 58.5'-60.0'	657	8/25/09	Hom	No. 10			Yes	25.33	108.34	85.66	37.6
31, 60.0'-61.5'	658	8/25/09	Hom	No. 10			Yes	25.25	139.87	100.95	51.4
31, 61.5'-63.0'	659	8/25/09	Hom	No. 10			Yes	21.50	100.36	76.51	43.4
31, 63.0'-64.5'	660	8/25/09	Len	No. 10			Yes	21.42	108.30	87.70	31.1
31, 64.5'-66.0'	661	8/25/09	Hom	No. 10			Yes	26.07	111.56	95.03	24.0
31, 66.0'-67.5'	662	8/25/09	Hom	No. 10			Yes	21.22	126.42	107.94	21.3
31, 67.5'-69.0'	663	8/25/09	Hom	No. 10			Yes	20.94	118.76	101.23	21.8
31, 69.0'-69.8'	664	8/25/09	Hom	No. 4			Yes	26.33	192.45	156.27	27.8

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Preparation Date: 2-2008
Revision Date: 4-2008

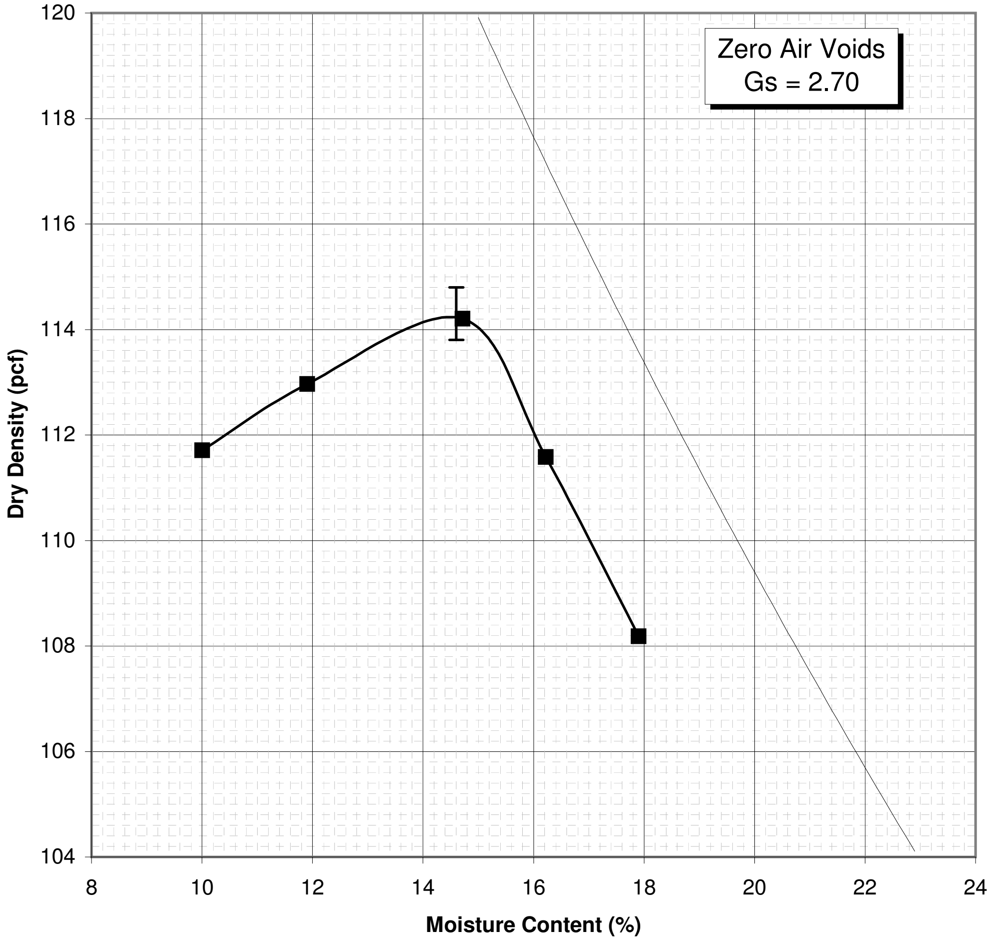
Stantec Consulting Services Inc.

Laboratory Document
Prepared by : JW
Approved by : TLK

Moisture-Density Data Sheet

Project: Cumberland Fossil Plant- Gypsum and Ash stacks
Project No.: 175539016
Source: Fill Soil
Sample No.: 476
Sample Description: lean clay with gravel, brown, moist
Nmc: 14.2 %
Visual Notes: N/A
Test Method: ASTM D 698 - Method A
Prepared: Dry
Oversized Fraction: < 5 %
Rammer: Mechanical
Gs - Fines: Assumed

Mold Weight 4125 grams		Moisture Determination				
Wet Weight plus Mold (grams)	Wet Weight minus Mold (grams)	Wet Soil and Can Weight (grams)	Dry Soil and Can Weight (grams)	Can Weight (grams)	Water Content (%)	Dry Density (pcf)
5970	1845	401.26	371.27	71.49	10.0	111.7
6023	1898	373.49	341.26	70.61	11.9	113.0
6092	1967	432.80	386.96	75.46	14.7	114.2
6072	1947	419.10	368.16	54.13	16.2	111.6
6040	1915	385.63	338.11	72.69	17.9	108.2



Maximum Dry Density 114.3 PCF
Optimum Moisture Content 14.6 %

Stantec

Summary of Soil Tests

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 47, 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.
Lab ID: 2

County: Stewart
Date Received: 8-4-09
Sample Type: SPT Comp
Date Reported: 8-21-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 21.4

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	100.0
3/8"	9.5	98.1
No. 4	4.75	97.7
No. 10	2	97.4
No. 40	0.425	93.3
No. 200	0.075	88.6
	0.02	72.3
	0.005	44.7
	0.002	38.7
estimated	0.001	29.8

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	2.3	2.6
Coarse Sand	0.3	4.1
Medium Sand	4.1	---
Fine Sand	4.7	4.7
Silt	43.9	49.9
Clay	44.7	38.7

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: 40
Plastic Limit: 21
Plasticity Index: 19
Activity Index: 0.49

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: CL
Group Name: Lean clay

AASHTO Classification: A-6 (17)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Cumberland Ash pond	Project Number	175539016
Source	47, 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13	Lab ID	2

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-05-2009
Date Received 08-04-2009

Maximum Particle size: 3/4" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	100.0
3/8"	98.1
No. 4	97.7
No. 10	97.4

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.7

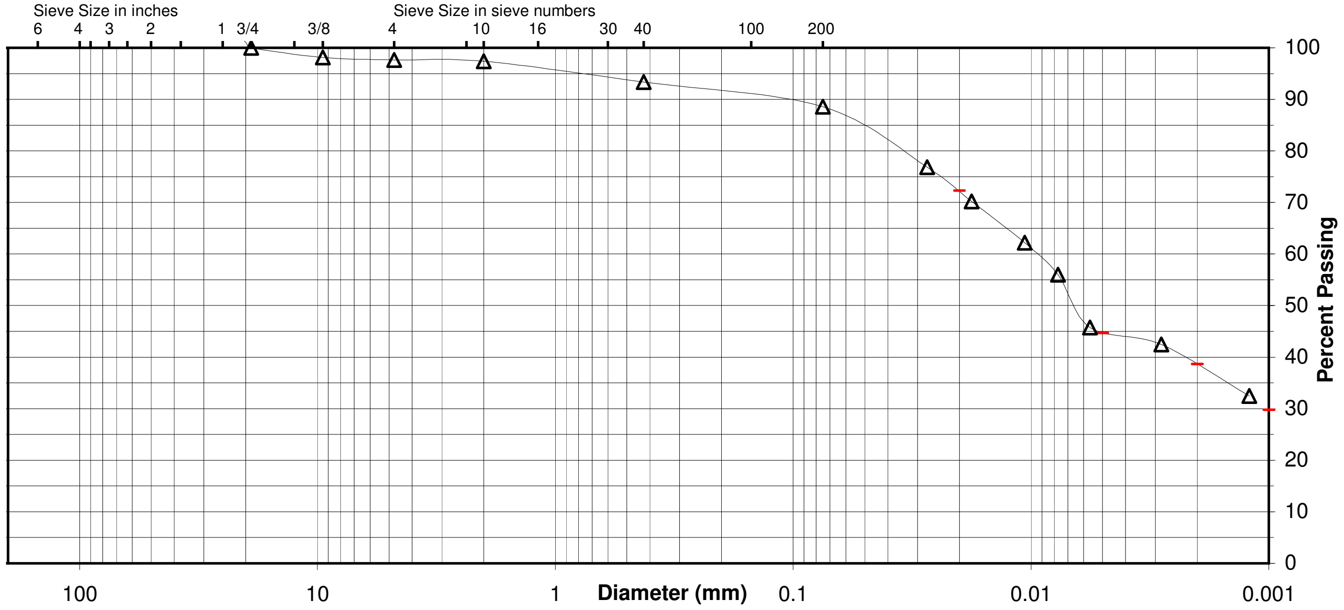
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	93.3
No. 200	88.6
0.02 mm	72.3
0.005 mm	44.7
0.002 mm	38.7
0.001 mm	29.8

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	2.3	0.3	4.1	4.7	43.9	44.7

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	2.6	4.1	4.7	49.9	38.7



Comments

Reviewed By

File: frm_175539016_sum_2 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

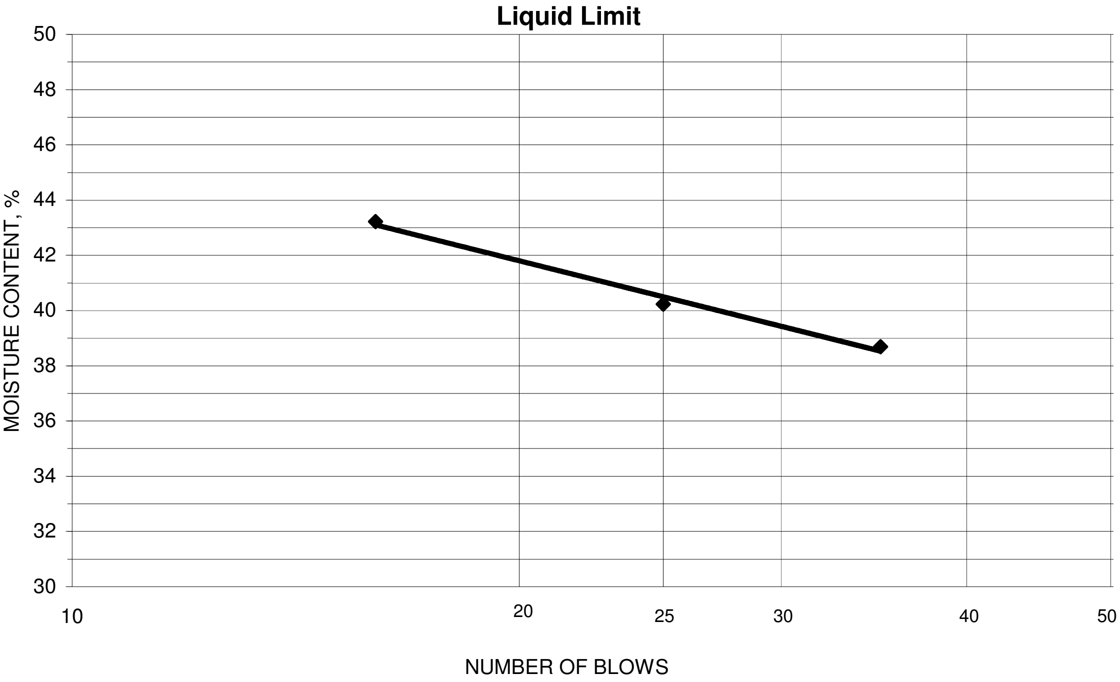
Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

ATTERBERG LIMITS

Project	Cumberland Ash pond	Project No.	175539016
Source	47, 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0',	Lab ID	2
		% + No. 40	7
Tested By	BB	Date Received	08-04-2009
Test Method	ASTM D 4318 Method A		
Test Date	08-07-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
27.27	23.97	15.44	35	38.7	40
23.42	19.88	11.08	25	40.2	
22.87	19.14	10.51	16	43.2	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
22.67	20.57	10.57	21.0	21	19
21.91	19.96	10.58	20.8		

Remarks: ____________________

Reviewed By ____________________

Stantec

Summary of Soil Tests

Project Name Cumberland Ash pond
Project Number 175539016
Source 47, 16.5'-18.0', 18.0'-19.5', 19.5'-21.0', 21.0'-22.5', 22.5'-24.0', 2
Lab ID 13

County Stewart
Sample Type SPT Comp
Date Received 8-4-09
Date Reported 8-19-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 25.2

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	100.0
3/8"	9.5	99.1
No. 4	4.75	98.7
No. 10	2	98.6
No. 40	0.425	95.2
No. 200	0.075	89.6
	0.02	63.7
	0.005	45.4
	0.002	37.1
estimated	0.001	30.7

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	1.3	1.4
Coarse Sand	0.1	3.4
Medium Sand	3.4	---
Fine Sand	5.6	5.6
Silt	44.2	52.5
Clay	45.4	37.1

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: 45
Plastic Limit: 18
Plasticity Index: 27
Activity Index: 0.73

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.67

Classification

Unified Group Symbol: CL
Group Name: Lean clay

AASHTO Classification: A-7-6 (25)

Comments:

Particle-Size Analysis of Soils
ASTM D 422

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 47, 16.5'-18.0', 18.0'-19.5', 19.5'-21.0', 21.0'-22.5', 22.5'-24.0', 24.0'-25.5', 25.5'-
Lab ID: 13

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-05-2009
Date Received 08-04-2009

Maximum Particle size: 3/4" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	100.0
3/8"	99.1
No. 4	98.7
No. 10	98.6

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.67

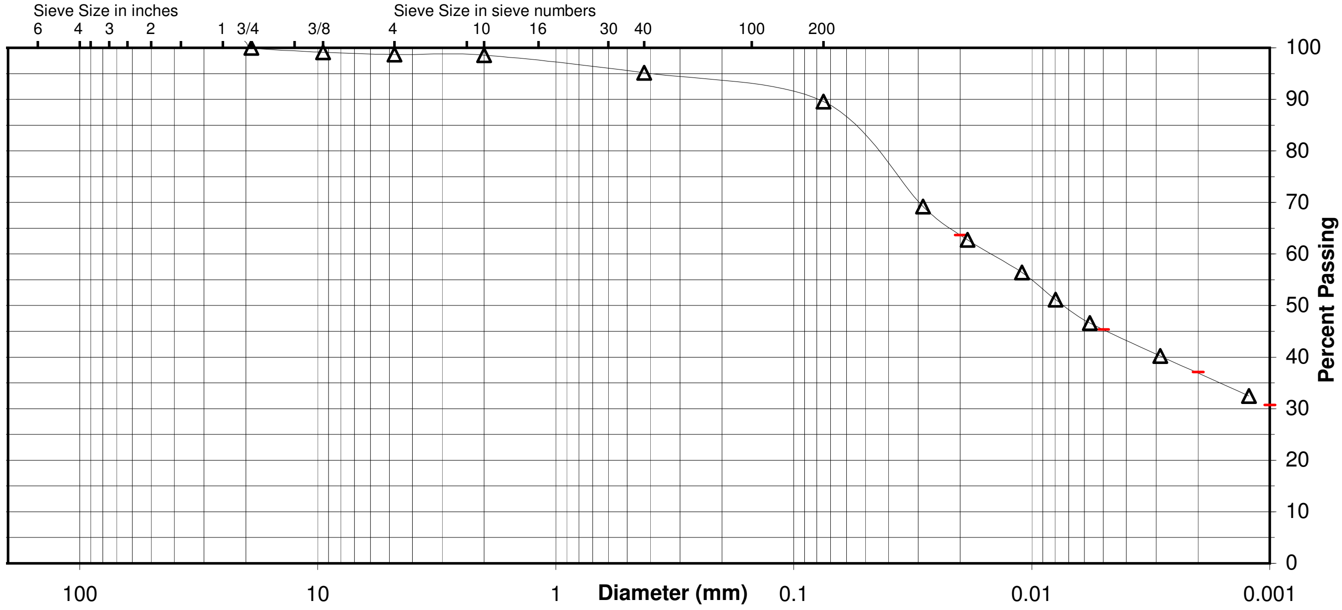
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	95.2
No. 200	89.6
0.02 mm	63.7
0.005 mm	45.4
0.002 mm	37.1
0.001 mm	30.7

Particle Size Distribution

	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
ASTM	0.0	1.3	0.1	3.4	5.6	44.2	45.4

	Gravel	Coarse Sand	Fine Sand	Silt	Clay
AASHTO	1.4	3.4	5.6	52.5	37.1



Comments

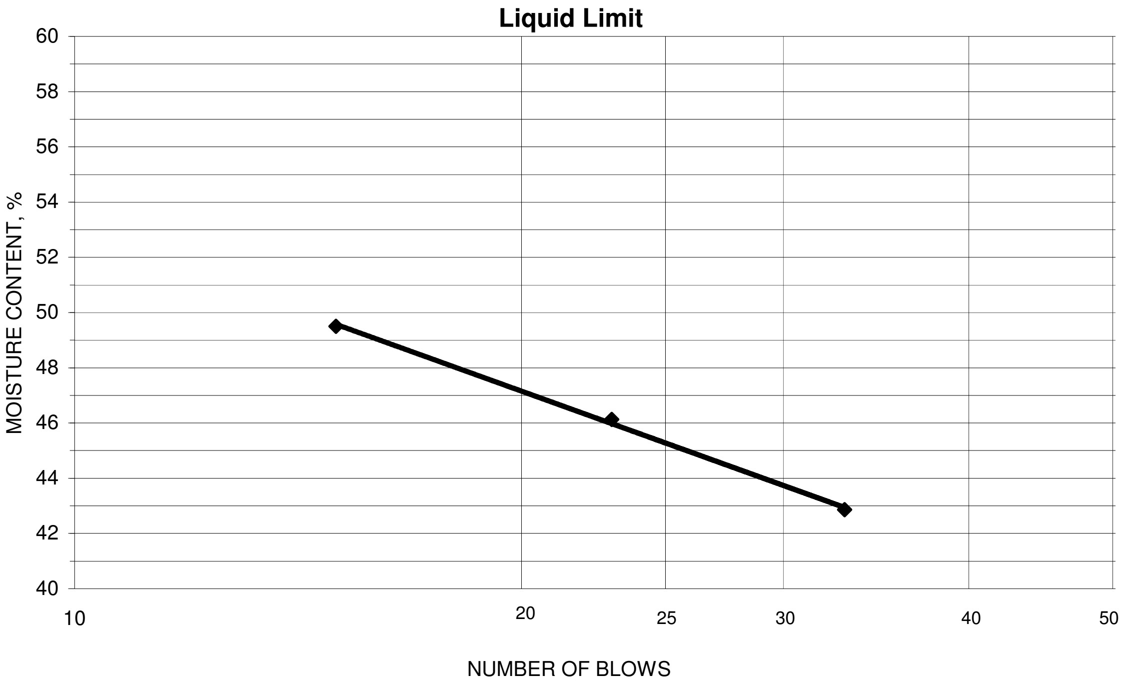
Reviewed By

Stantec

ATTERBERG LIMITS

Project Cumberland Ash pond
Source 47, 16.5'-18.0', 18.0'-19.5', 19.5'-21.0', 21.0'-22.5', 22.5'-24.0', 24.0'-25.
Project No. 175539016
Lab ID 13
% + No. 40 5
Tested By BB
Test Method ASTM D 4318 Method A
Date Received 08-04-2009
Test Date 08-12-2009
Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
21.69	18.39	10.69	33	42.9	45
21.75	18.23	10.60	23	46.1	
24.15	19.69	10.68	15	49.5	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
24.38	22.28	10.88	18.4	18	27
23.57	21.59	10.66	18.1		

Remarks:

Reviewed By

Stantec

Summary of Soil Tests

Project Name	Cumberland Ash pond	Project Number	175539016
Source	48, 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0',	Lab ID	30
County	Stewart	Date Received	8-4-09
Sample Type	SPT Comp	Date Reported	8-19-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 20.9

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	100.0
3/4"	19	96.6
3/8"	9.5	89.5
No. 4	4.75	83.5
No. 10	2	81.6
No. 40	0.425	74.5
No. 200	0.075	65.3
	0.02	49.7
	0.005	35.2
	0.002	30.3
estimated	0.001	27.8

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	16.5	18.4
Coarse Sand	1.9	7.1
Medium Sand	7.1	---
Fine Sand	9.2	9.2
Silt	30.1	35.0
Clay	35.2	30.3

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 49

Plastic Limit: 17

Plasticity Index: 32

Activity Index: 1.07

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.76

Classification

Unified Group Symbol: CL/CH

Group Name: Sandy lean clay with gravel

AASHTO Classification: A-7-6 (18)

Comments:

Particle-Size Analysis of Soils
ASTM D 422

Project Name Cumberland Ash pond
Project Number 175539016
Source 48, 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13.5', 13.5'-
Lab ID 30

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-05-2009
Date Received 08-04-2009

Maximum Particle size: 1" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	100.0
3/4"	96.6
3/8"	89.5
No. 4	83.5
No. 10	81.6

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.76

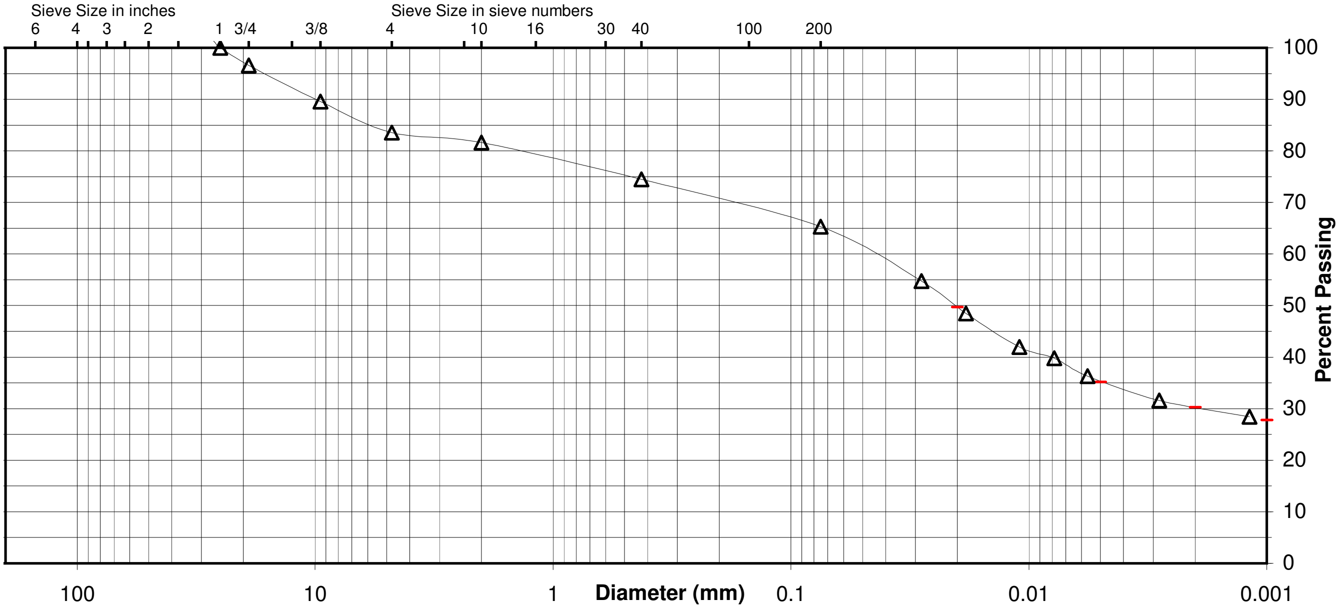
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	74.5
No. 200	65.3
0.02 mm	49.7
0.005 mm	35.2
0.002 mm	30.3
0.001 mm	27.8

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	3.4	13.1	1.9	7.1	9.2	30.1	35.2

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	18.4	7.1	9.2	35.0	30.3



Comments

Reviewed By

File: frm_175539016_sum_30 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

ATTERBERG LIMITS

Project Cumberland Ash pond

Source 48, 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13.

Project No. 175539016

Lab ID 30

% + No. 40 26

Tested By BB

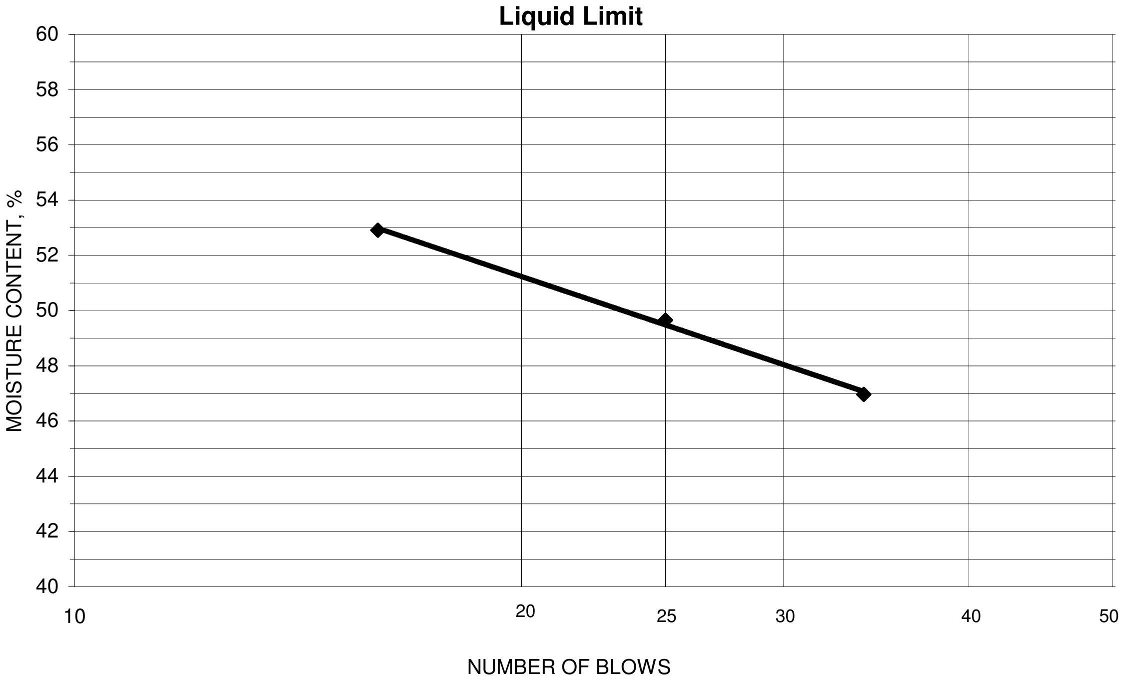
Test Method ASTM D 4318 Method A

Date Received 08-04-2009

Test Date 08-12-2009

Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
21.60	18.12	10.71	34	47.0	49
21.54	17.94	10.69	25	49.7	
23.16	18.98	11.08	16	52.9	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
22.11	20.52	11.06	16.8	17	32
22.93	21.19	11.02	17.1		

Remarks:

Reviewed By

Stantec

Summary of Soil Tests

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 48, 18.0'-19.5', 19.5'-21.0', 21.0'-22.5', 22.5'-24.0', 24.0'-25.5', 2
Lab ID: 41

County: Stewart
Date Received: 8-4-09
Sample Type: SPT Comp
Date Reported: 8-19-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 21.3

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	100.0
1"	25	90.9
3/4"	19	75.6
3/8"	9.5	66.5
No. 4	4.75	56.3
No. 10	2	48.4
No. 40	0.425	34.2
No. 200	0.075	32.2
	0.02	28.9
	0.005	20.6
	0.002	17.7
estimated	0.001	16.1

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	43.7	51.6
Coarse Sand	7.9	14.2
Medium Sand	14.2	---
Fine Sand	2.0	2.0
Silt	11.6	14.5
Clay	20.6	17.7

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: 52
Plastic Limit: 18
Plasticity Index: 34
Activity Index: 1.89

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: GC
Group Name: Clayey gravel with sand
AASHTO Classification: A-2-7 (4)

Comments:

Stantec

Particle-Size Analysis of Soils

ASTM D 422

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 48, 18.0'-19.5', 19.5'-21.0', 21.0'-22.5', 22.5'-24.0', 24.0'-25.5', 25.5'-27.0', 27.0'-
Lab ID: 41

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-05-2009
Date Received 08-04-2009

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	100.0
1"	90.9
3/4"	75.6
3/8"	66.5
No. 4	56.3
No. 10	48.4

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.7

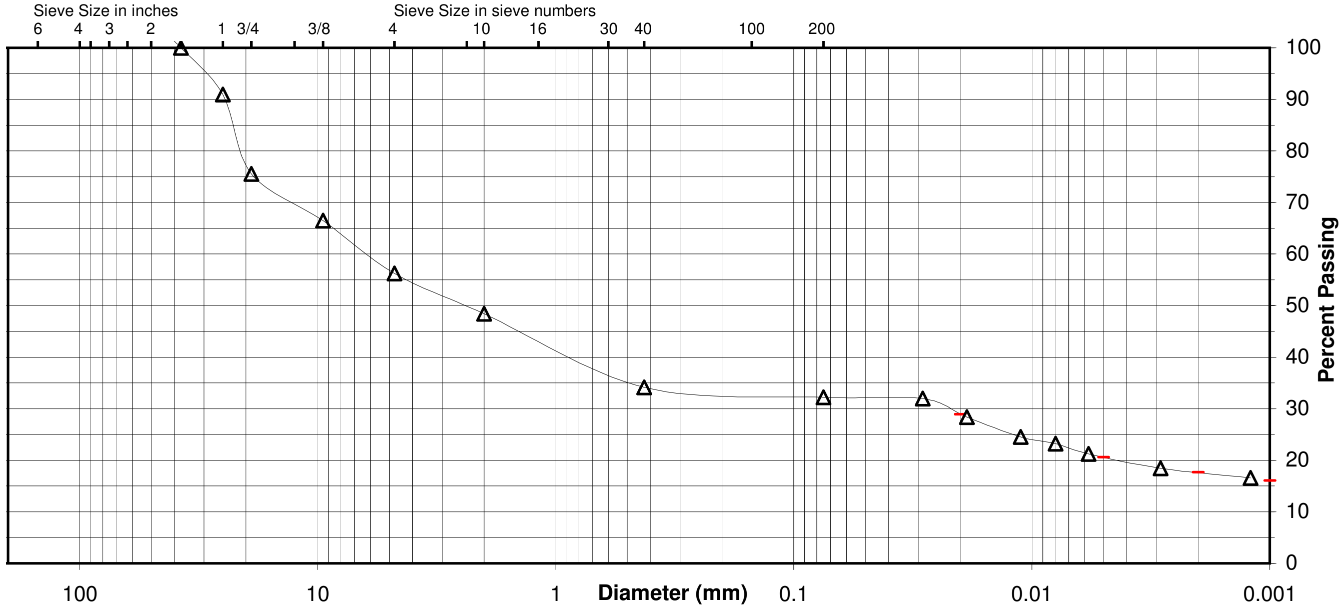
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	34.2
No. 200	32.2
0.02 mm	28.9
0.005 mm	20.6
0.002 mm	17.7
0.001 mm	16.1

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	24.4	19.3	7.9	14.2	2.0	11.6	20.6

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	51.6	14.2	2.0	14.5	17.7



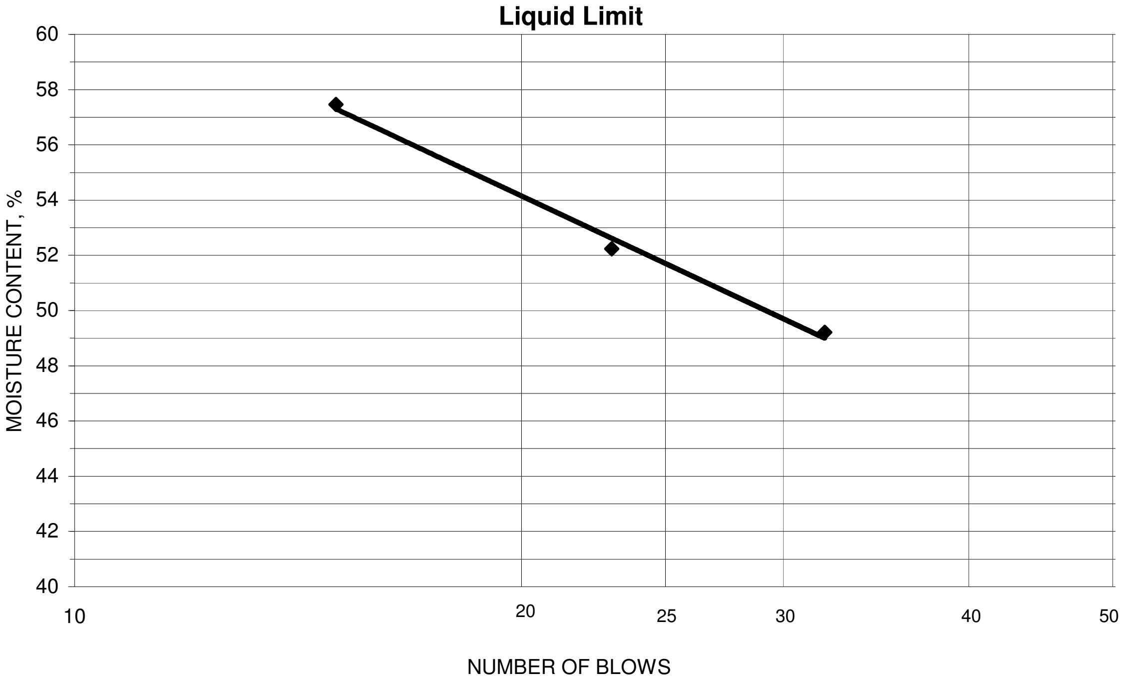
Comments

Reviewed By

ATTERBERG LIMITS

Project	Cumberland Ash pond	Project No.	175539016
Source	48, 18.0'-19.5', 19.5'-21.0', 21.0'-22.5', 22.5'-24.0', 24.0'-25.5', 25.5'-27.	Lab ID	41
		% + No. 40	66
Tested By	BB	Test Method	ASTM D 4318 Method A
Date Received	08-04-2009		
Test Date	08-10-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
22.48	18.73	11.11	32	49.2	52
26.53	22.80	15.66	23	52.2	
20.91	17.33	11.10	15	57.5	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
21.33	19.74	10.90	18.0	18	34
20.63	19.10	10.68	18.2		

Remarks:

Reviewed By

Stantec

Summary of Soil Tests

Project Name	Cumberland Ash pond	Project Number	175539016
Source	51, 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.	Lab ID	117
County	Stewart	Date Received	8-4-09
Sample Type	SPT Comp	Date Reported	8-21-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 18.8

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	100.0
3/8"	9.5	99.3
No. 4	4.75	99.0
No. 10	2	99.0
No. 40	0.425	95.9
No. 200	0.075	80.8
	0.02	56.7
	0.005	35.1
	0.002	28.8
estimated	0.001	24.4

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	1.0	1.0
Coarse Sand	0.0	3.1
Medium Sand	3.1	---
Fine Sand	15.1	15.1
Silt	45.7	52.0
Clay	35.1	28.8

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 35

Plastic Limit: 18

Plasticity Index: 17

Activity Index: 0.59

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.67

Classification

Unified Group Symbol: CL

Group Name: Lean clay with sand

AASHTO Classification: A-6 (13)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 51, 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13
Lab ID: 117

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-06-2009
Date Received 08-04-2009

Maximum Particle size: 3/4" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	100.0
3/8"	99.3
No. 4	99.0
No. 10	99.0

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.67

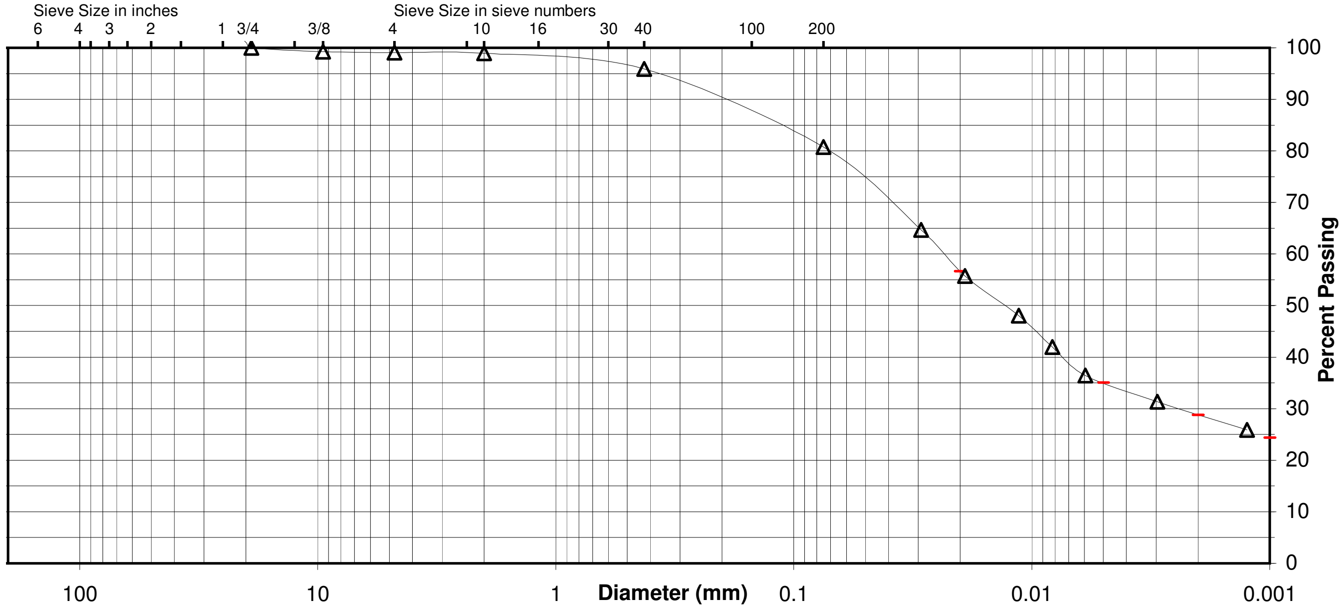
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	95.9
No. 200	80.8
0.02 mm	56.7
0.005 mm	35.1
0.002 mm	28.8
0.001 mm	24.4

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	1.0	0.0	3.1	15.1	45.7	35.1

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	1.0	3.1	15.1	52.0	28.8



Comments

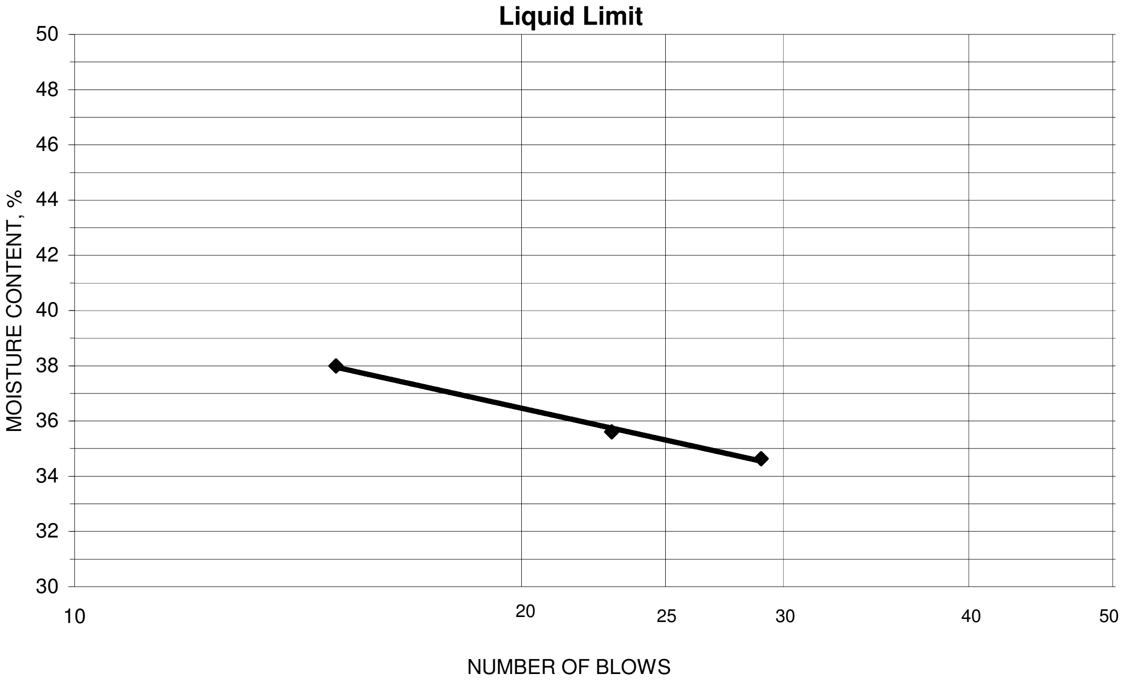
Reviewed By

ATTERBERG LIMITS

Project	Cumberland Ash pond	Project No.	175539016
Source	51, 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0',	Lab ID	117
		% + No. 40	4

Tested By	BB	Test Method	ASTM D 4318 Method A	Date Received	08-04-2009
Test Date	08-11-2009	Prepared	Dry		

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
22.33	19.32	10.63	29	34.6	35
23.40	20.16	11.06	23	35.6	
22.29	19.22	11.14	15	38.0	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
22.53	20.72	10.58	17.9	18	17
26.05	23.80	11.04	17.6		

Remarks: ____________________

Reviewed By ____________

Summary of Soil Tests

Project Name Cumberland Ash pond
Project Number 175539016
Source 51, 31.0'-31.3', 33.5'-35.0', 36.0'-37.5', 38.5'-40.0', 41.0'-42.5', 4
Lab ID 135

County Stewart
Sample Type SPT Comp
Date Received 8-4-09
Date Reported 8-21-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 27.4

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	
3/8"	9.5	100.0
No. 4	4.75	99.8
No. 10	2	99.8
No. 40	0.425	98.9
No. 200	0.075	91.5
	0.02	57.4
	0.005	26.7
	0.002	20.9
estimated	0.001	16.6

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	0.2	0.2
Coarse Sand	0.0	0.9
Medium Sand	0.9	---
Fine Sand	7.4	7.4
Silt	64.8	70.6
Clay	26.7	20.9

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: 30
Plastic Limit: 20
Plasticity Index: 10
Activity Index: 0.48

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.62

Classification

Unified Group Symbol: CL
Group Name: Lean clay

AASHTO Classification: A-4 (9)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name Cumberland Ash pond
Project Number 175539016
Source 51, 31.0'-31.3', 33.5'-35.0', 36.0'-37.5', 38.5'-40.0', 41.0'-42.5', 43.5'-45.0', 46.0'-
Lab ID 135

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Soft

Tested By: KAF
Test Date: 08-06-2009
Date Received 08-04-2009

Maximum Particle size: 3/8" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	
3/8"	100.0
No. 4	99.8
No. 10	99.8

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.62

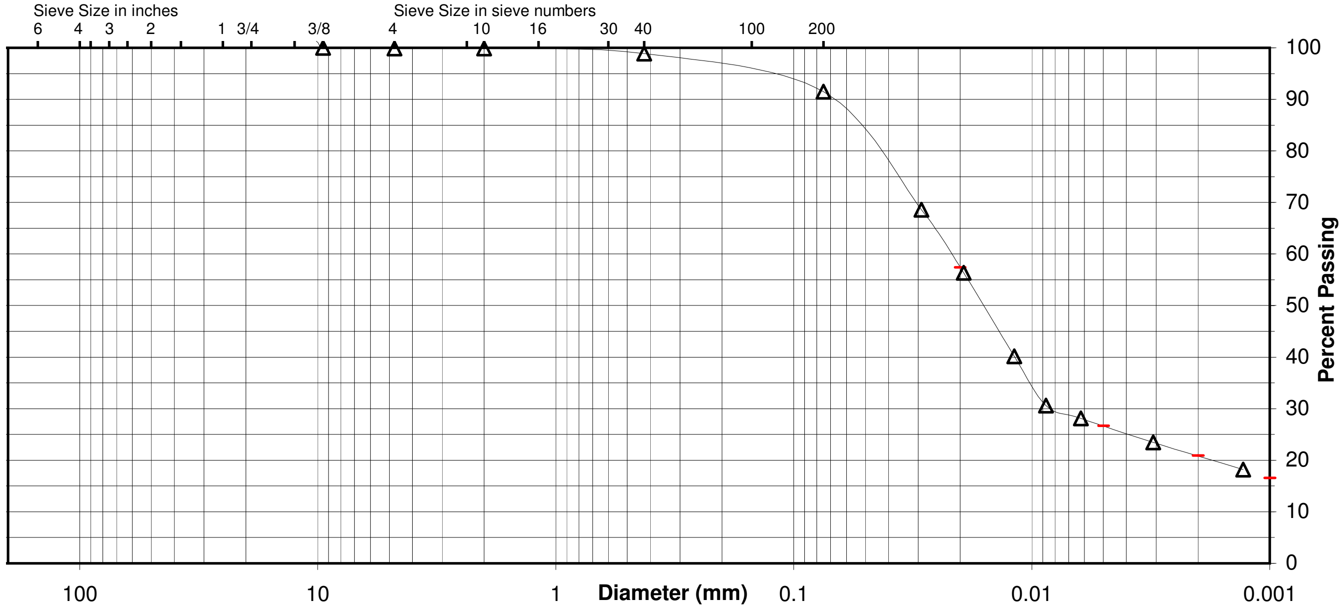
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	98.9
No. 200	91.5
0.02 mm	57.4
0.005 mm	26.7
0.002 mm	20.9
0.001 mm	16.6

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.2	0.0	0.9	7.4	64.8	26.7

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	0.2	0.9	7.4	70.6	20.9



Comments

Reviewed By

File: frm_175539016_sum_135 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

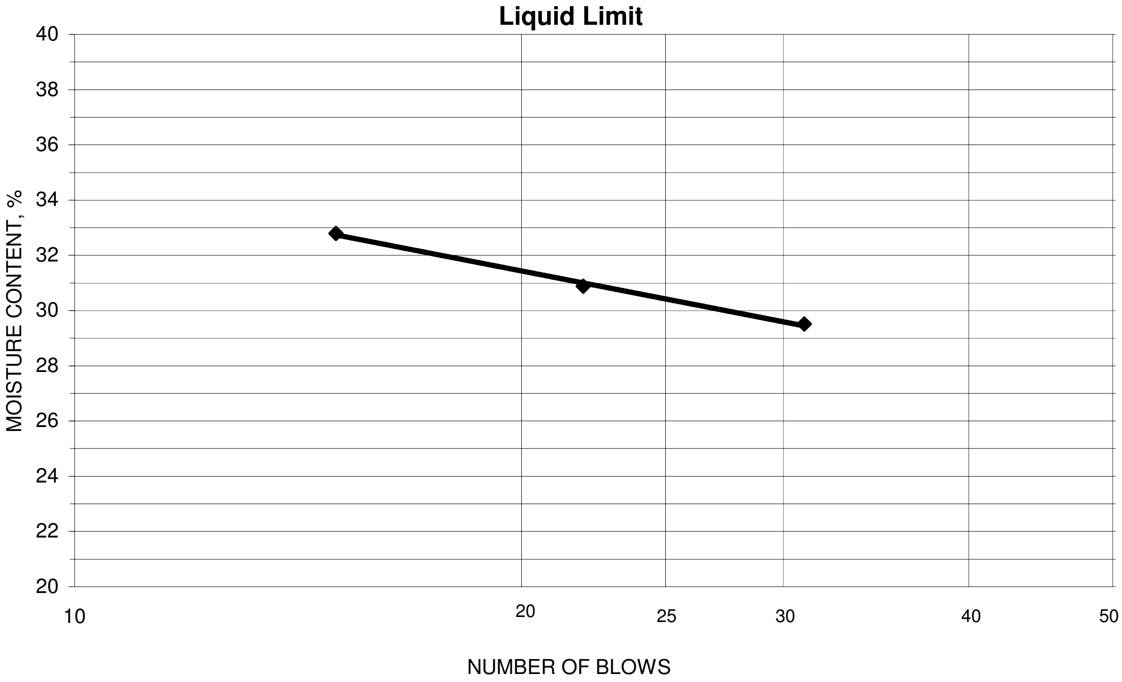
Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

ATTERBERG LIMITS

Project	Cumberland Ash pond	Project No.	175539016
Source	51, 31.0'-31.3', 33.5'-35.0', 36.0'-37.5', 38.5'-40.0', 41.0'-42.5', 43.5'-45.	Lab ID	135
		% + No. 40	1
Tested By	BB	Test Method	ASTM D 4318 Method A
Date Received	08-04-2009		
Test Date	08-11-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
23.95	20.89	10.52	31	29.5	30
22.62	19.78	11.12	15	32.8	
21.77	19.25	11.09	22	30.9	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
27.13	24.29	10.51	20.6	20	10
24.76	22.44	11.03	20.3		

Remarks:

Reviewed By

Stantec

Summary of Soil Tests

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 51, 53.5'-55.0', 56.0'-57.5', 58.5'-60.0', 61.0'-62.5'
Lab ID: 145

County: Stewart
Date Received: 8-4-09
Sample Type: SPT Comp
Date Reported: 8-19-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 21.7

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	100.0
3/4"	19	96.9
3/8"	9.5	80.8
No. 4	4.75	67.0
No. 10	2	54.2
No. 40	0.425	29.4
No. 200	0.075	18.3
	0.02	11.8
	0.005	7.3
	0.002	6.0
estimated	0.001	4.6

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	33.0	45.8
Coarse Sand	12.8	24.8
Medium Sand	24.8	---
Fine Sand	11.1	11.1
Silt	11.0	12.3
Clay	7.3	6.0

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: ---
Plastic Limit: Non Plastic
Plasticity Index: ---
Activity Index: N/A

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.66

Classification

Unified Group Symbol: SM
Group Name: Silty sand with gravel

AASHTO Classification: A-1-b (0)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name Cumberland Ash pond
Source 51, 53.5'-55.0', 56.0'-57.5', 58.5'-60.0', 61.0'-62.5'

Project Number 175539016
Lab ID 145

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-06-2009
Date Received 08-04-2009

Maximum Particle size: 1" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	100.0
3/4"	96.9
3/8"	80.8
No. 4	67.0
No. 10	54.2

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.66

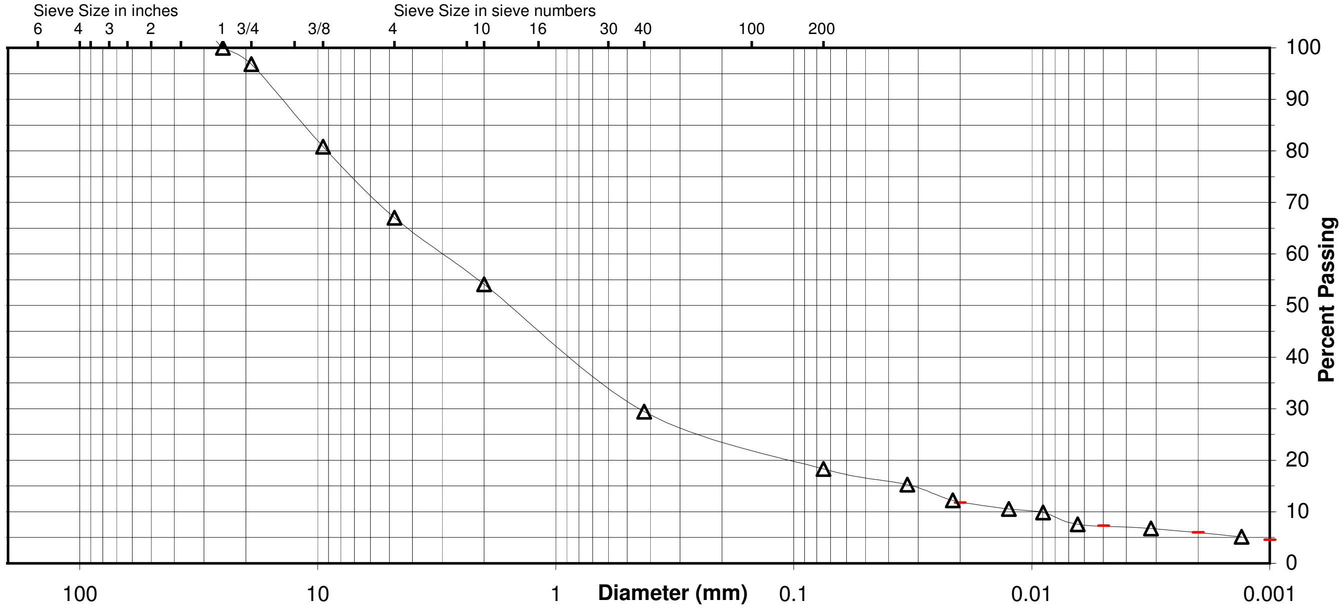
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	29.4
No. 200	18.3
0.02 mm	11.8
0.005 mm	7.3
0.002 mm	6.0
0.001 mm	4.6

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	3.1	29.9	12.8	24.8	11.1	11.0	7.3

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	45.8	24.8	11.1	12.3	6.0



Comments

Reviewed By

File: frm_175539016_sum_145 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

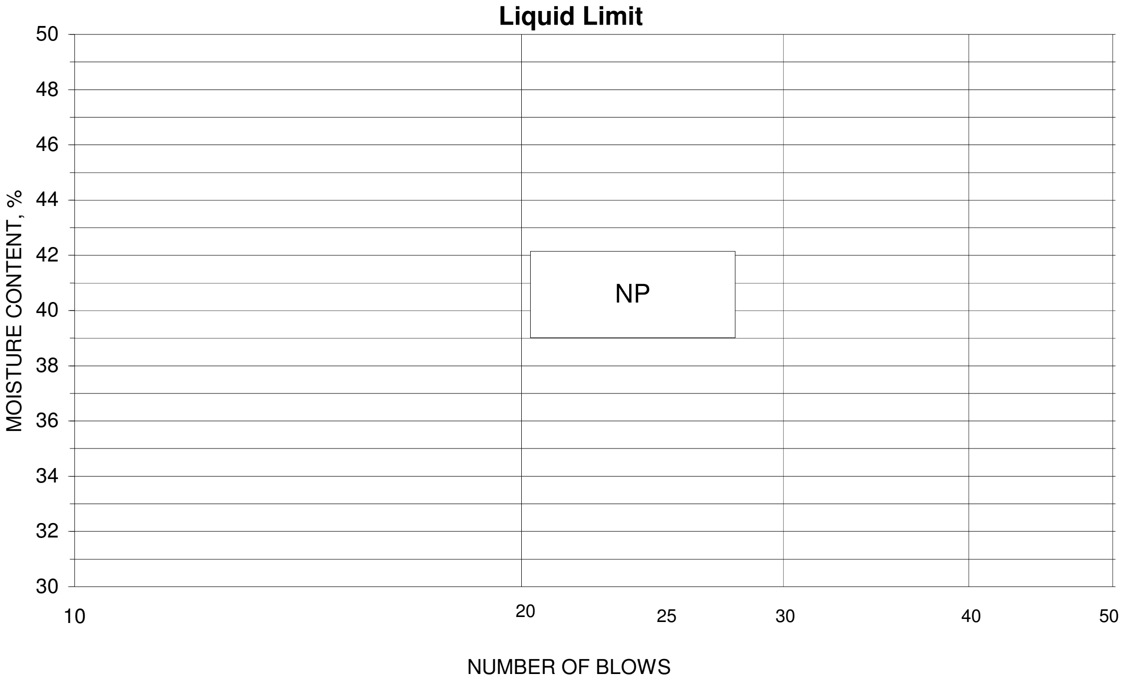
Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

ATTERBERG LIMITS

Project Cumberland Ash pond
Source 51, 53.5'-55.0', 56.0'-57.5', 58.5'-60.0', 61.0'-62.5'
Project No. 175539016
Lab ID 145
% + No. 40 71
Tested By BB
Test Method ASTM D 4318 Method A
Date Received 08-04-2009
Test Date 08-07-2009
Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks:

Reviewed By

Stantec

Summary of Soil Tests

Project Name	Cumberland Ash pond	Project Number	175539016
Source	52, 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0',	Lab ID	154
County	Stewart	Date Received	8-4-09
Sample Type	SPT Comp	Date Reported	8-19-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 22.4

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	100.0
1"	25	95.0
3/4"	19	95.0
3/8"	9.5	90.1
No. 4	4.75	85.3
No. 10	2	81.6
No. 40	0.425	72.2
No. 200	0.075	60.5
	0.02	46.4
	0.005	32.9
	0.002	29.5
estimated	0.001	26.9

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	14.7	18.4
Coarse Sand	3.7	9.4
Medium Sand	9.4	---
Fine Sand	11.7	11.7
Silt	27.6	31.0
Clay	32.9	29.5

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry

Liquid Limit: 46
Plastic Limit: 17
Plasticity Index: 29
Activity Index: 0.97

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.74

Classification

Unified Group Symbol: CL
Group Name: Sandy lean clay

AASHTO Classification: A-7-6 (15)

Comments:

File: frm_175539016_sum_154 Sheet: Summary
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 52, 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13.5', 13.5'-
Lab ID: 154

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-06-2009
Date Received 08-04-2009

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	100.0
1"	95.0
3/4"	95.0
3/8"	90.1
No. 4	85.3
No. 10	81.6

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.74

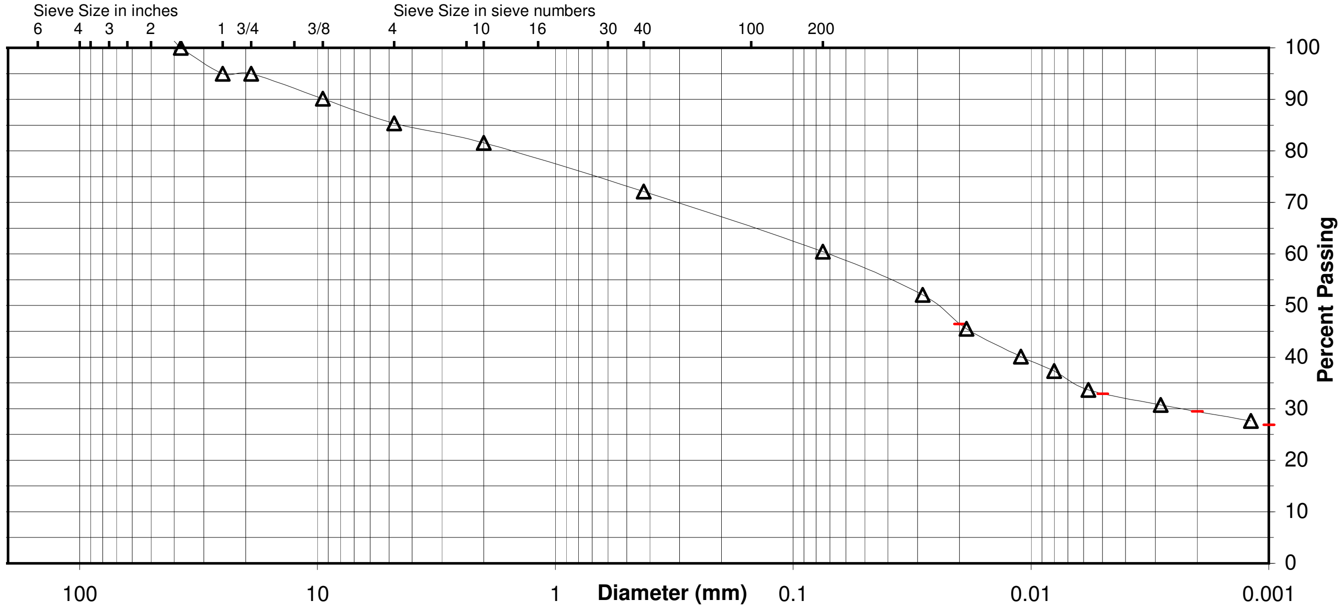
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	72.2
No. 200	60.5
0.02 mm	46.4
0.005 mm	32.9
0.002 mm	29.5
0.001 mm	26.9

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	5.0	9.7	3.7	9.4	11.7	27.6	32.9

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	18.4	9.4	11.7	31.0	29.5



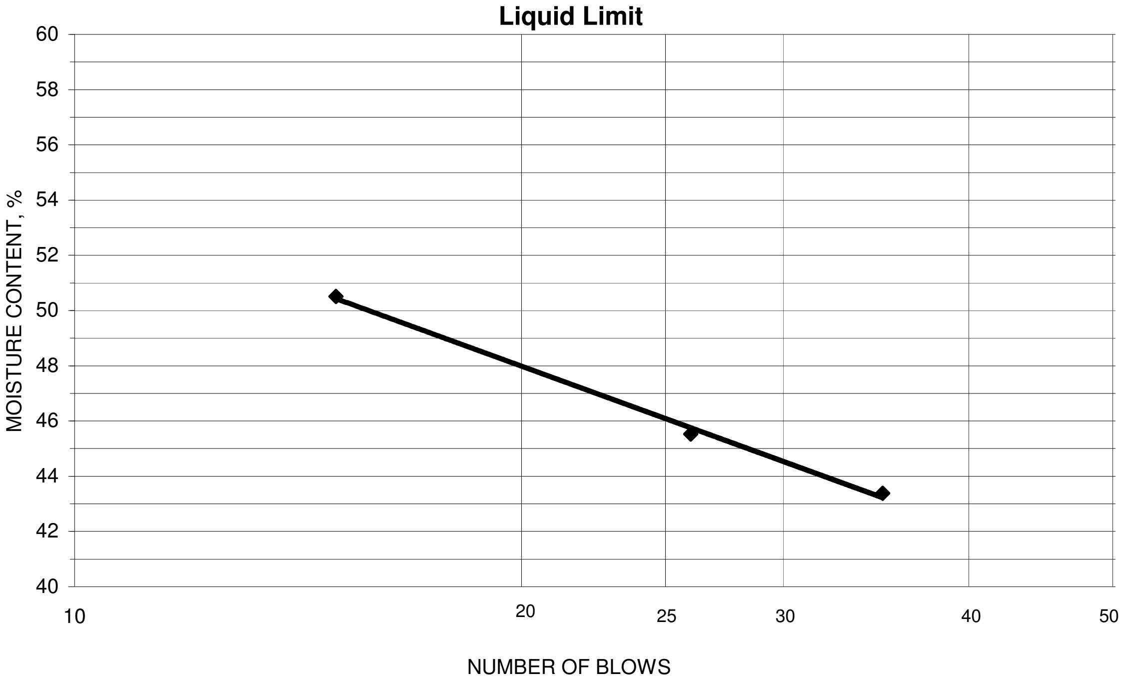
Comments

Reviewed By

ATTERBERG LIMITS

Project	Cumberland Ash pond	Project No.	175539016
Source	52, 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13.	Lab ID	154
		% + No. 40	28
Tested By	BB	Date Received	08-04-2009
Test Method	ASTM D 4318 Method A		
Test Date	08-07-2009		
Prepared	Dry		

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
22.46	18.51	10.69	15	50.5	46
22.18	18.57	10.64	26	45.5	
22.86	19.29	11.06	35	43.4	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
27.90	25.42	10.51	16.6	17	29
29.31	26.68	11.04	16.8		

Remarks:

Reviewed By

Stantec

Summary of Soil Tests

Project Name	Cumberland Ash pond	Project Number	175539016
Source	52, 22.5'-24.0', 24.0'-25.5', 25.5'-27.0', 27.0'-28.5', 28.5'-30.0', 3	Lab ID	168
County	Stewart	Date Received	8-4-09
Sample Type	SPT Comp	Date Reported	8-19-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 22.8

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	100.0
3/8"	9.5	93.7
No. 4	4.75	86.8
No. 10	2	82.9
No. 40	0.425	73.8
No. 200	0.075	67.1
	0.02	54.6
	0.005	41.1
	0.002	34.8
estimated	0.001	31.2

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	13.2	17.1
Coarse Sand	3.9	9.1
Medium Sand	9.1	---
Fine Sand	6.7	6.7
Silt	26.0	32.3
Clay	41.1	34.8

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry

Liquid Limit: 48
Plastic Limit: 16
Plasticity Index: 32
Activity Index: 0.91

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.71

Classification

Unified Group Symbol: CL
Group Name: Sandy lean clay

AASHTO Classification: A-7-6 (19)

Comments:

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Cumberland Ash pond	Project Number	175539016
Source	52, 22.5'-24.0', 24.0'-25.5', 25.5'-27.0', 27.0'-28.5', 28.5'-30.0', 31.0'-32.5', 33.5'-	Lab ID	168

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-06-2009
Date Received 08-04-2009

Maximum Particle size: 3/4" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	100.0
3/8"	93.7
No. 4	86.8
No. 10	82.9

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.71

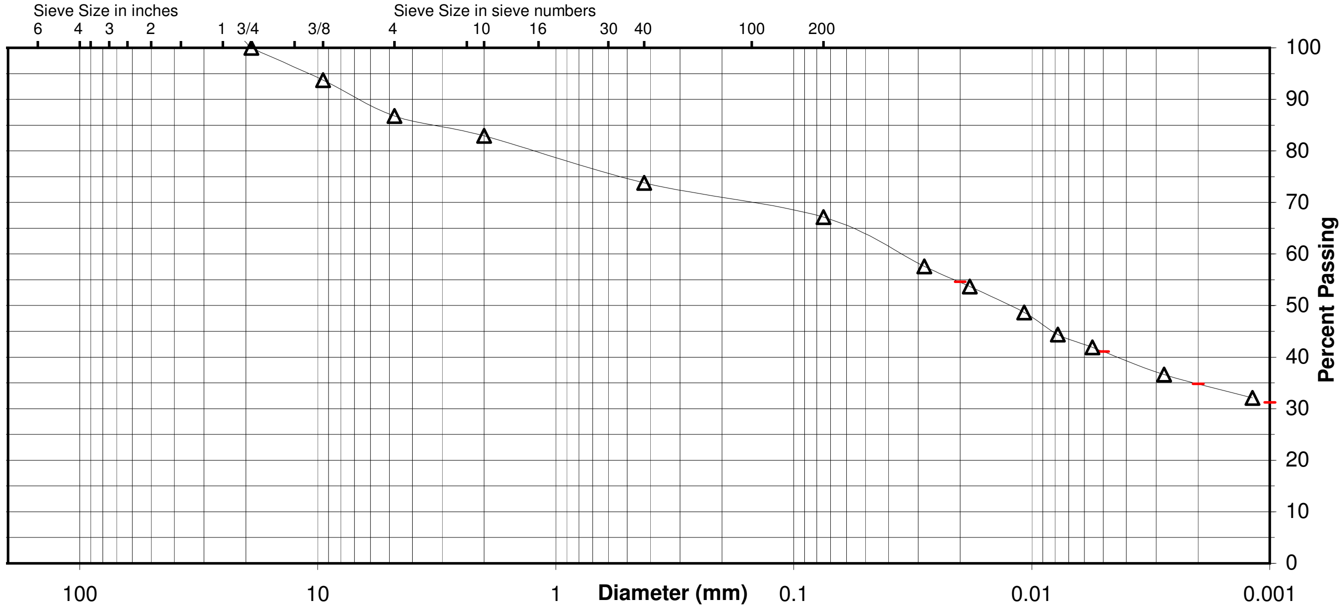
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	73.8
No. 200	67.1
0.02 mm	54.6
0.005 mm	41.1
0.002 mm	34.8
0.001 mm	31.2

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	13.2	3.9	9.1	6.7	26.0	41.1

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	17.1	9.1	6.7	32.3	34.8



Comments

Reviewed By

Stantec

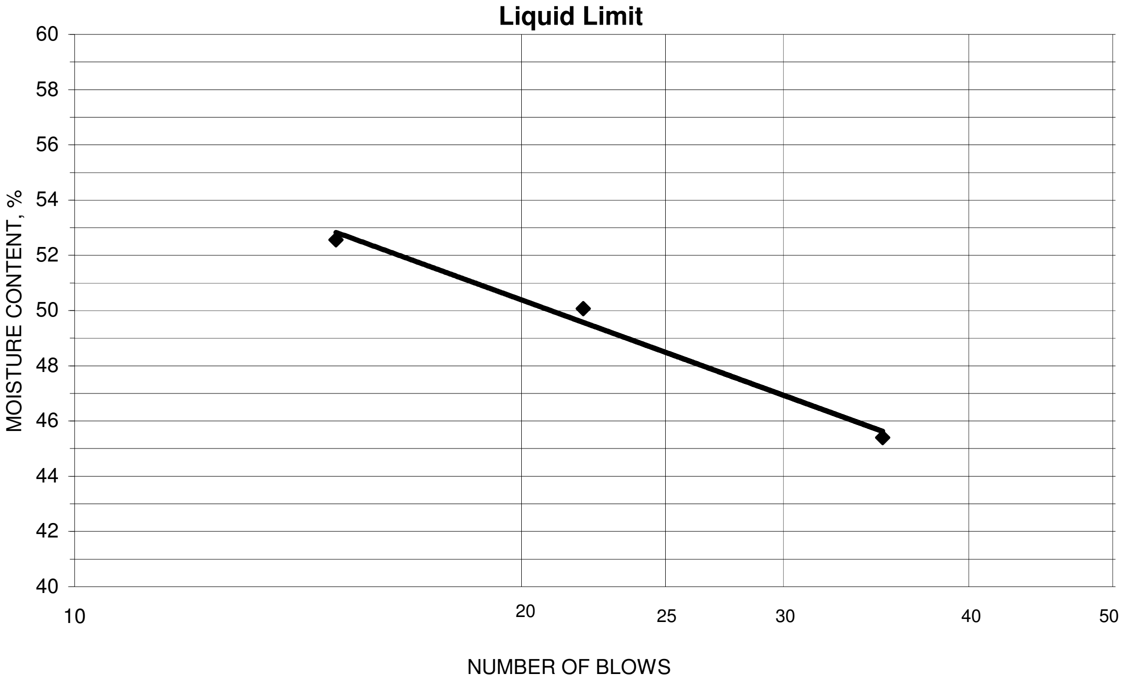
ATTERBERG LIMITS

Project	Cumberland Ash pond	Project No.	175539016
Source	52, 22.5'-24.0', 24.0'-25.5', 25.5'-27.0', 27.0'-28.5', 28.5'-30.0', 31.0'-32.	Lab ID	168
		% + No. 40	26
Tested By	BB	Date Received	08-04-2009
Test Date	08-11-2009		

Test Method ASTM D 4318 Method A

Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
21.74	18.43	11.14	35	45.4	48
22.27	18.54	11.09	22	50.1	
21.23	17.74	11.10	15	52.6	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
26.83	24.71	10.82	15.3	16	32
25.80	23.73	11.03	16.3		

Remarks:

Reviewed By

File: frm_175539016_sum_168 Sheet: Limit-Report
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

Summary of Soil Tests

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 52, 68.5'-70.0', 71.0'-72.5', 73.5'-75.0', 76.0'-77.5', 78.5'-80.0'
Lab ID: 189

County: Stewart
Date Received: 8-4-09
Sample Type: SPT Comp
Date Reported: 8-19-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 21.5

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	100.0
1"	25	95.7
3/4"	19	88.5
3/8"	9.5	55.4
No. 4	4.75	41.2
No. 10	2	31.3
No. 40	0.425	19.0
No. 200	0.075	11.9
	0.02	8.0
	0.005	5.1
	0.002	4.0
estimated	0.001	3.1

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	58.8	68.7
Coarse Sand	9.9	12.3
Medium Sand	12.3	---
Fine Sand	7.1	7.1
Silt	6.8	7.9
Clay	5.1	4.0

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: ---
Plastic Limit: Non Plastic
Plasticity Index: ---
Activity Index: N/A

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.66

Classification

Unified Group Symbol: GP-GM
Group Name: Poorly graded gravel with silt and sand

AASHTO Classification: A-1-a (0)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Cumberland Ash pond	Project Number	175539016
Source	52, 68.5'-70.0', 71.0'-72.5', 73.5'-75.0', 76.0'-77.5', 78.5'-80.0'	Lab ID	189

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-06-2009
Date Received 08-04-2009

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	100.0
1"	95.7
3/4"	88.5
3/8"	55.4
No. 4	41.2
No. 10	31.3

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.66

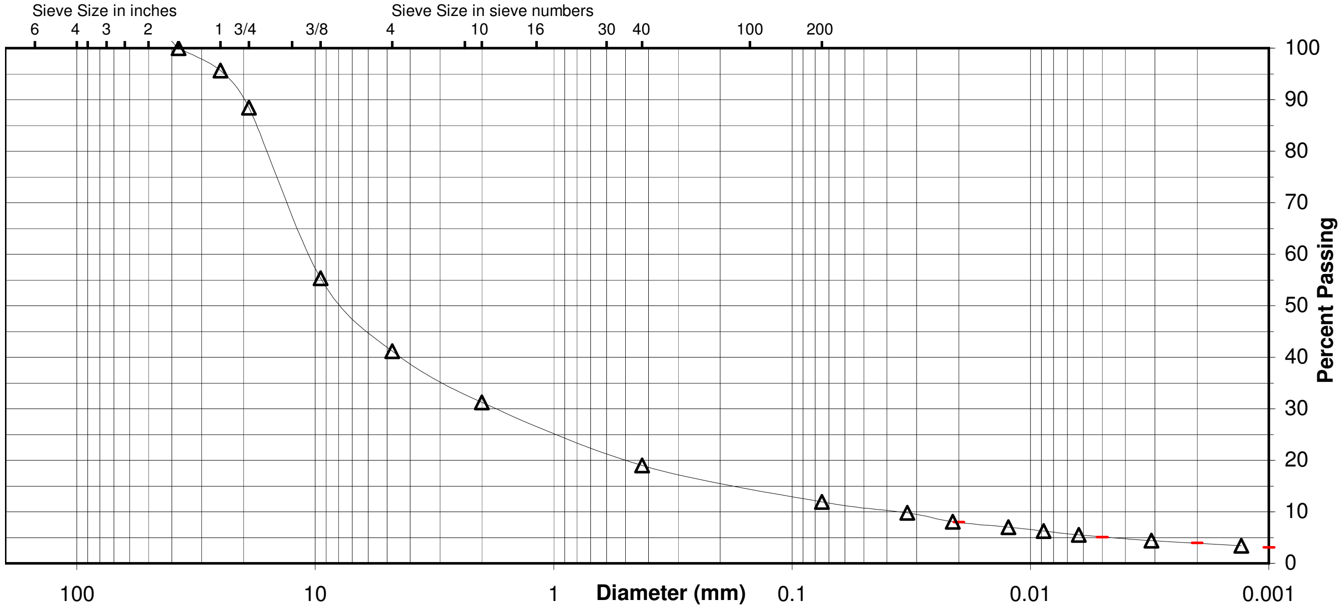
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	19.0
No. 200	11.9
0.02 mm	8.0
0.005 mm	5.1
0.002 mm	4.0
0.001 mm	3.1

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	11.5	47.3	9.9	12.3	7.1	6.8	5.1

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	68.7	12.3	7.1	7.9	4.0



Comments

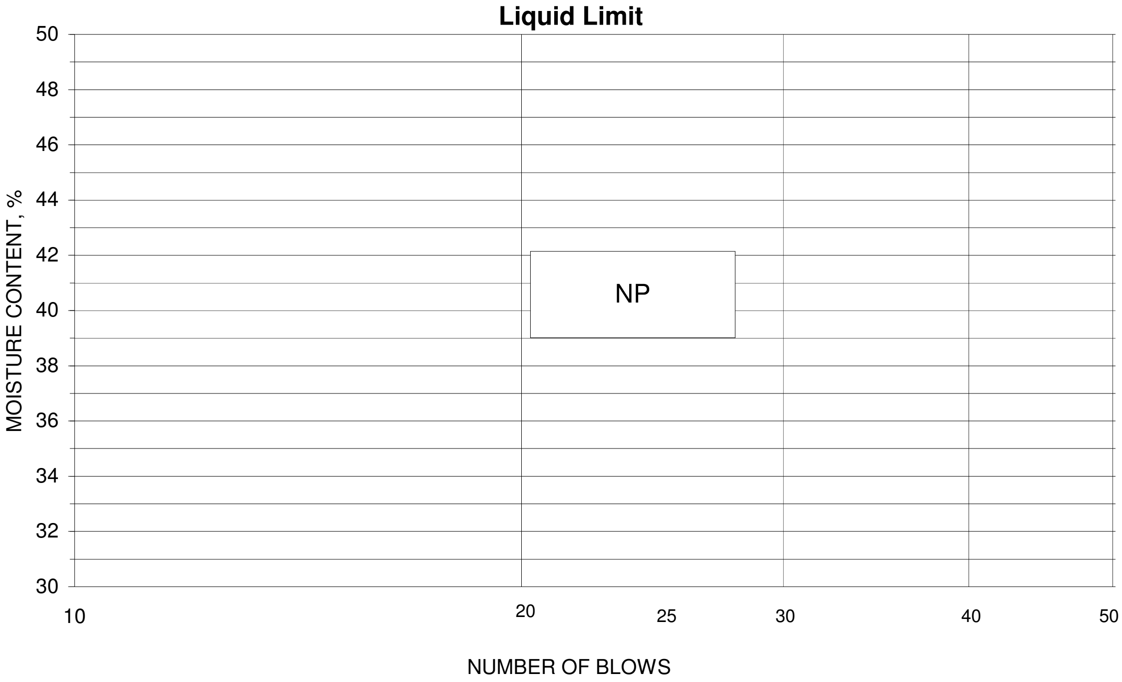
Reviewed By

Stantec

ATTERBERG LIMITS

Project Cumberland Ash pond
Source 52, 68.5'-70.0', 71.0'-72.5', 73.5'-75.0', 76.0'-77.5', 78.5'-80.0'
Project No. 175539016
Lab ID 189
% + No. 40 81
Tested By BB
Test Method ASTM D 4318 Method A
Date Received 08-04-2009
Test Date 08-11-2009
Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks:

Reviewed By

Stantec

Summary of Soil Tests

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 55, 0.0'-1.5', 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5'
Lab ID: 264

County: Stewart
Date Received: 8-4-09
Sample Type: SPT Comp
Date Reported: 8-19-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 19.9

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	100.0
3/4"	19	94.9
3/8"	9.5	82.7
No. 4	4.75	77.0
No. 10	2	74.4
No. 40	0.425	68.0
No. 200	0.075	59.6
	0.02	47.6
	0.005	34.6
	0.002	30.0
estimated	0.001	26.2

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	23.0	25.6
Coarse Sand	2.6	6.4
Medium Sand	6.4	---
Fine Sand	8.4	8.4
Silt	25.0	29.6
Clay	34.6	30.0

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: 52
Plastic Limit: 20
Plasticity Index: 32
Activity Index: 1.07

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.65

Classification

Unified Group Symbol: CH
Group Name: Gravelly fat clay with sand

AASHTO Classification: A-7-6 (16)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name Cumberland Ash pond
Source 55, 0.0'-1.5', 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5'

Project Number 175539016
Lab ID 264

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-06-2009
Date Received 08-04-2009

Maximum Particle size: 1" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	100.0
3/4"	94.9
3/8"	82.7
No. 4	77.0
No. 10	74.4

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.65

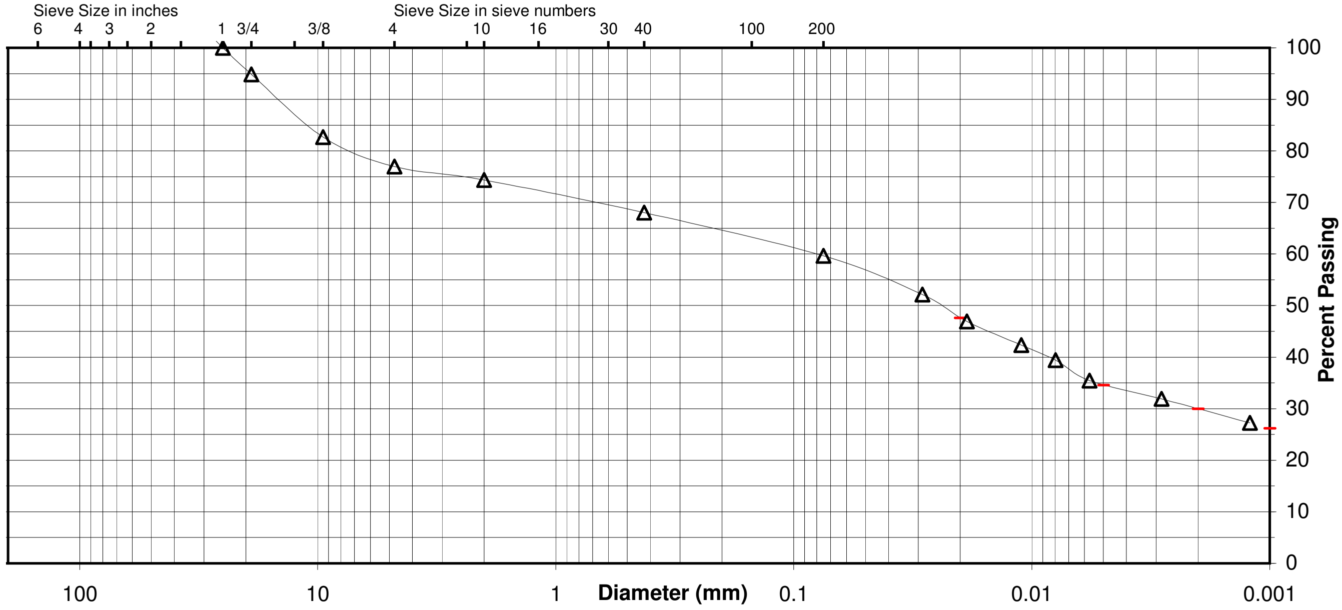
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	68.0
No. 200	59.6
0.02 mm	47.6
0.005 mm	34.6
0.002 mm	30.0
0.001 mm	26.2

Particle Size Distribution

	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
ASTM	5.1	17.9	2.6	6.4	8.4	25.0	34.6

	Gravel	Coarse Sand	Fine Sand	Silt	Clay
AASHTO	25.6	6.4	8.4	29.6	30.0



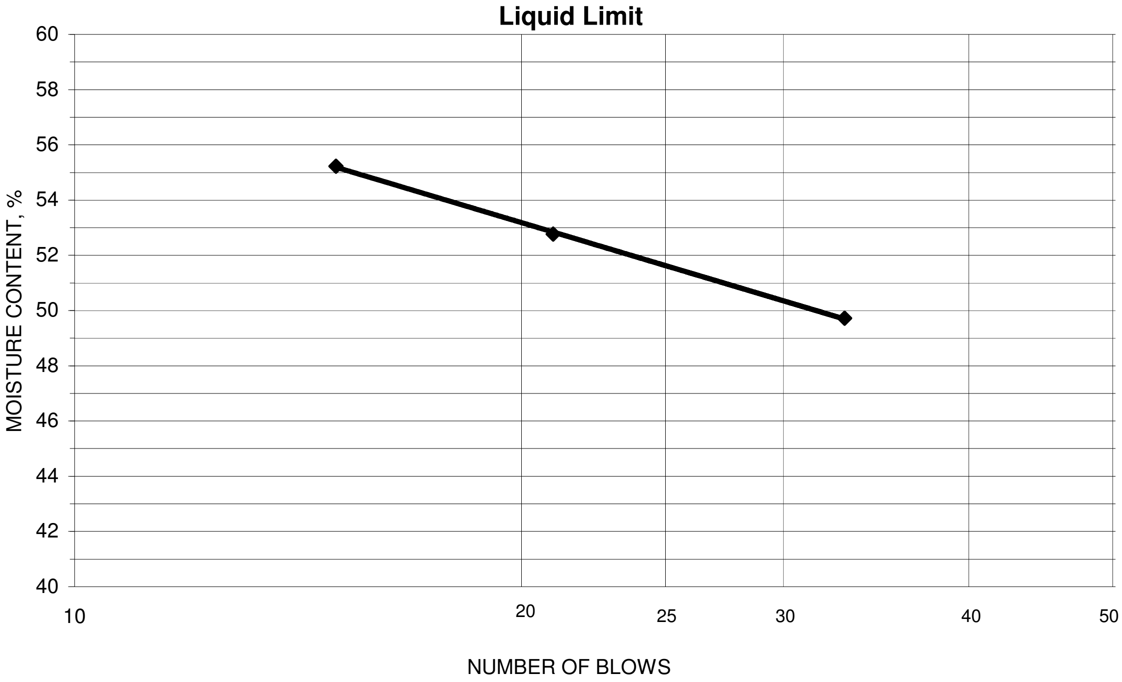
Comments

Reviewed By

ATTERBERG LIMITS

Project Cumberland Ash pond
Source 55, 0.0'-1.5', 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5'
Project No. 175539016
Lab ID 264
% + No. 40 32
Tested By BB
Test Method ASTM D 4318 Method A
Date Received 08-04-2009
Test Date 08-10-2009
Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
21.87	18.30	11.12	33	49.7	52
22.58	18.49	10.74	21	52.8	
22.21	18.09	10.63	15	55.2	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
21.66	19.86	11.03	20.4	20	32
20.30	18.65	10.55	20.4		

Remarks:

Reviewed By

Summary of Soil Tests

Project Name	Cumberland Ash pond	Project Number	175539016
Source	55, 9.0'-10.5', 10.5'-12.0', 12.0'-13.5', 13.5'-15.0', 15.0'-16.5', 1	Lab ID	271
County	Stewart	Date Received	8-4-09
Sample Type	SPT Comp	Date Reported	8-21-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 21.8

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	100.0
3/8"	9.5	94.9
No. 4	4.75	92.4
No. 10	2	91.0
No. 40	0.425	85.5
No. 200	0.075	75.5
	0.02	56.9
	0.005	37.4
	0.002	30.1
estimated	0.001	24.8

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	7.6	9.0
Coarse Sand	1.4	5.5
Medium Sand	5.5	---
Fine Sand	10.0	10.0
Silt	38.1	45.4
Clay	37.4	30.1

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 42

Plastic Limit: 17

Plasticity Index: 25

Activity Index: 0.83

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.65

Classification

Unified Group Symbol: CL

Group Name: Lean clay with sand

AASHTO Classification: A-7-6 (18)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 55, 9.0'-10.5', 10.5'-12.0', 12.0'-13.5', 13.5'-15.0', 15.0'-16.5', 16.5'-18.0', 18.0'-1
Lab ID: 271

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-10-2009
Date Received 08-04-2009

Maximum Particle size: 3/4" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	100.0
3/8"	94.9
No. 4	92.4
No. 10	91.0

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.65

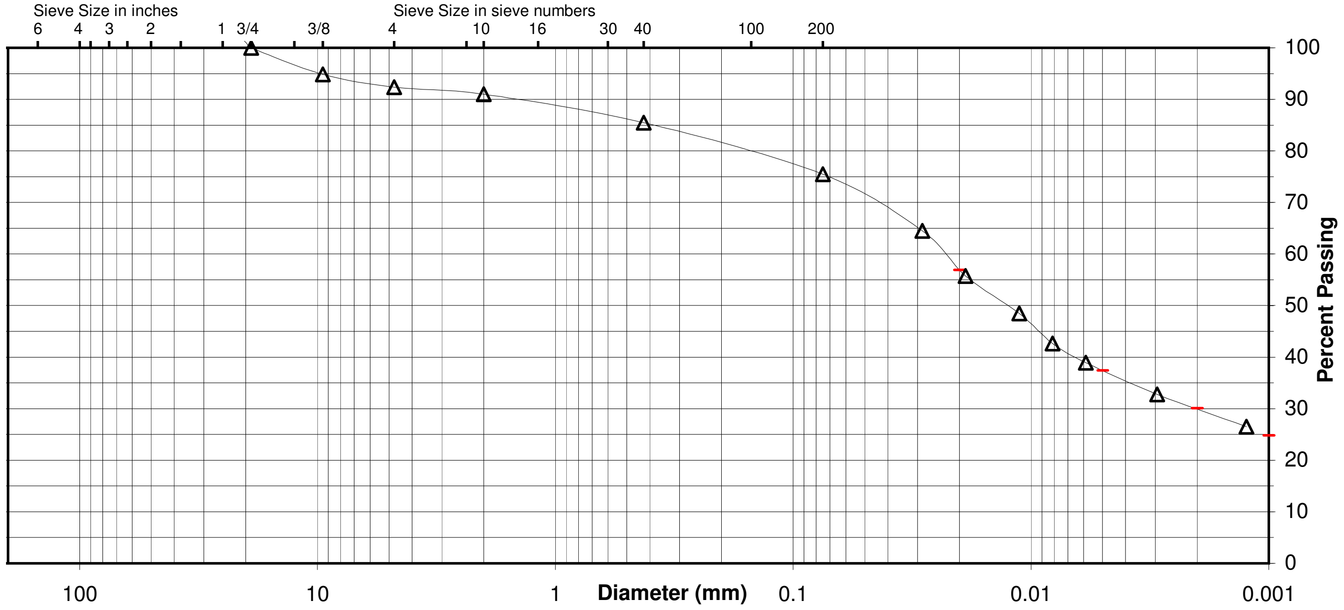
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	85.5
No. 200	75.5
0.02 mm	56.9
0.005 mm	37.4
0.002 mm	30.1
0.001 mm	24.8

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	7.6	1.4	5.5	10.0	38.1	37.4

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	9.0	5.5	10.0	45.4	30.1



Comments

Reviewed By

File: frm_175539016_sum_271 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

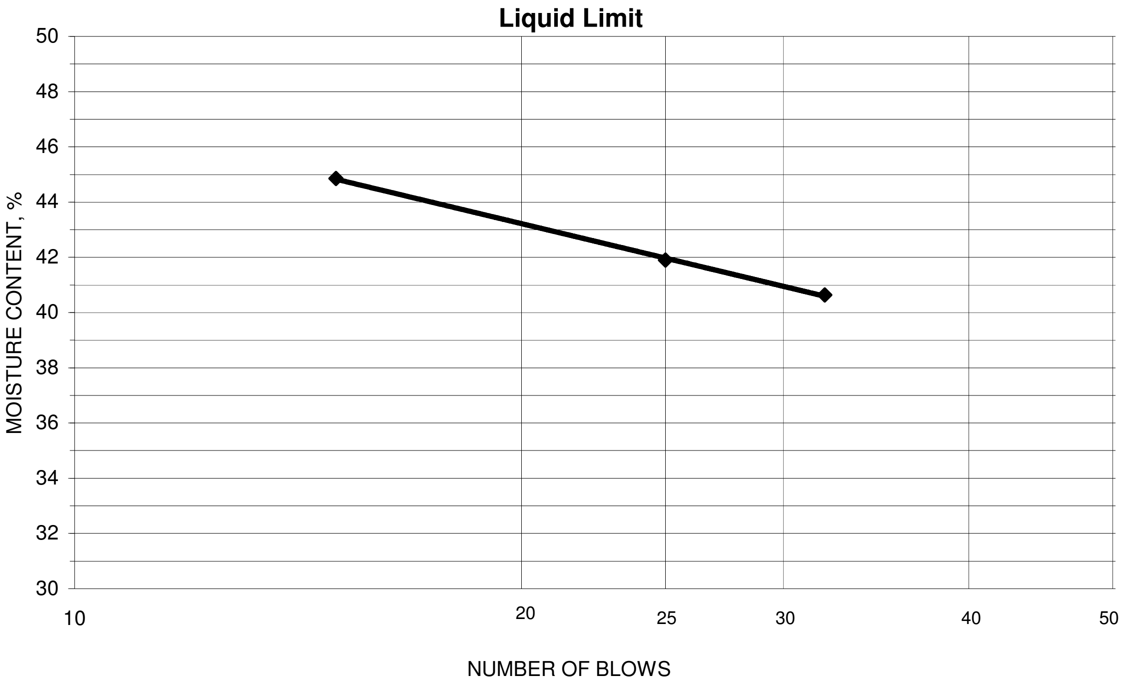
Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

ATTERBERG LIMITS

Project	Cumberland Ash pond	Project No.	175539016
Source	55, 9.0'-10.5', 10.5'-12.0', 12.0'-13.5', 13.5'-15.0', 15.0'-16.5', 16.5'-18.0'	Lab ID	271
		% + No. 40	14
Tested By	KAF	Test Method	ASTM D 4318 Method A
Date Received	08-04-2009		
Test Date	08-14-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
37.96	29.64	11.09	15	44.9	42
39.98	31.45	11.09	25	41.9	
36.52	29.18	11.12	32	40.6	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
26.58	24.27	10.62	16.9	17	25
25.72	23.58	11.01	17.0		

Remarks: ________________

Reviewed By ________________

Stantec

Summary of Soil Tests

Project Name	Cumberland Ash pond	Project Number	175539016
Source	55, 24.0'-25.5', 25.5'-28.5', 28.5'-31.0', 31.0'-33.5', 33.5'-36.0', 3	Lab ID	282
County	Stewart	Date Received	8-4-09
Sample Type	SPT Comp	Date Reported	8-21-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 30.1

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	100.0
1"	25	95.0
3/4"	19	77.7
3/8"	9.5	64.1
No. 4	4.75	53.7
No. 10	2	46.5
No. 40	0.425	38.8
No. 200	0.075	35.3
	0.02	28.5
	0.005	19.4
	0.002	15.9
estimated	0.001	13.2

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	46.3	53.5
Coarse Sand	7.2	7.7
Medium Sand	7.7	---
Fine Sand	3.5	3.5
Silt	15.9	19.4
Clay	19.4	15.9

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 45

Plastic Limit: 25

Plasticity Index: 20

Activity Index: 1.25

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.65

Classification

Unified Group Symbol: GC

Group Name: Clayey gravel with sand

AASHTO Classification: A-2-7 (2)

Comments:

Particle-Size Analysis of Soils
ASTM D 422

Project Name Cumberland Ash pond
Project Number 175539016
Source 55, 24.0'-25.5', 25.5'-28.5', 28.5'-31.0', 31.0'-33.5', 33.5'-36.0', 36.0'-38.5', 38.5'-
Lab ID 282

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-10-2009
Date Received 08-04-2009

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	100.0
1"	95.0
3/4"	77.7
3/8"	64.1
No. 4	53.7
No. 10	46.5

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.65

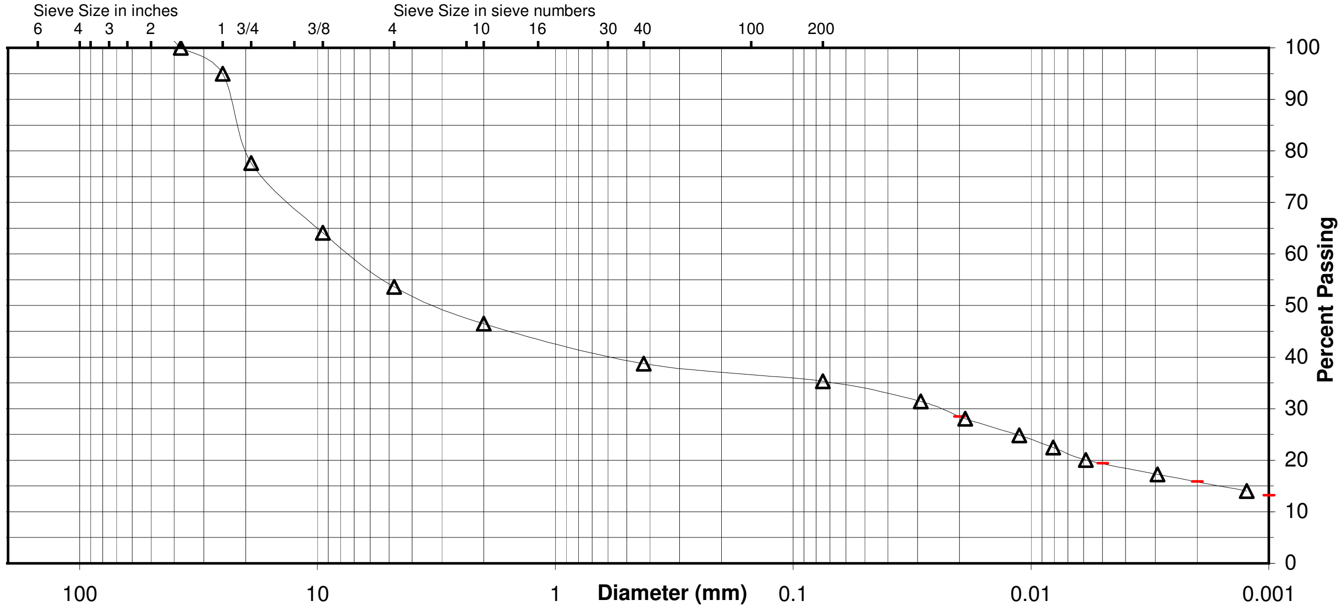
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	38.8
No. 200	35.3
0.02 mm	28.5
0.005 mm	19.4
0.002 mm	15.9
0.001 mm	13.2

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	22.3	24.0	7.2	7.7	3.5	15.9	19.4

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	53.5	7.7	3.5	19.4	15.9



Comments

Reviewed By

File: frm_175539016_sum_282 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

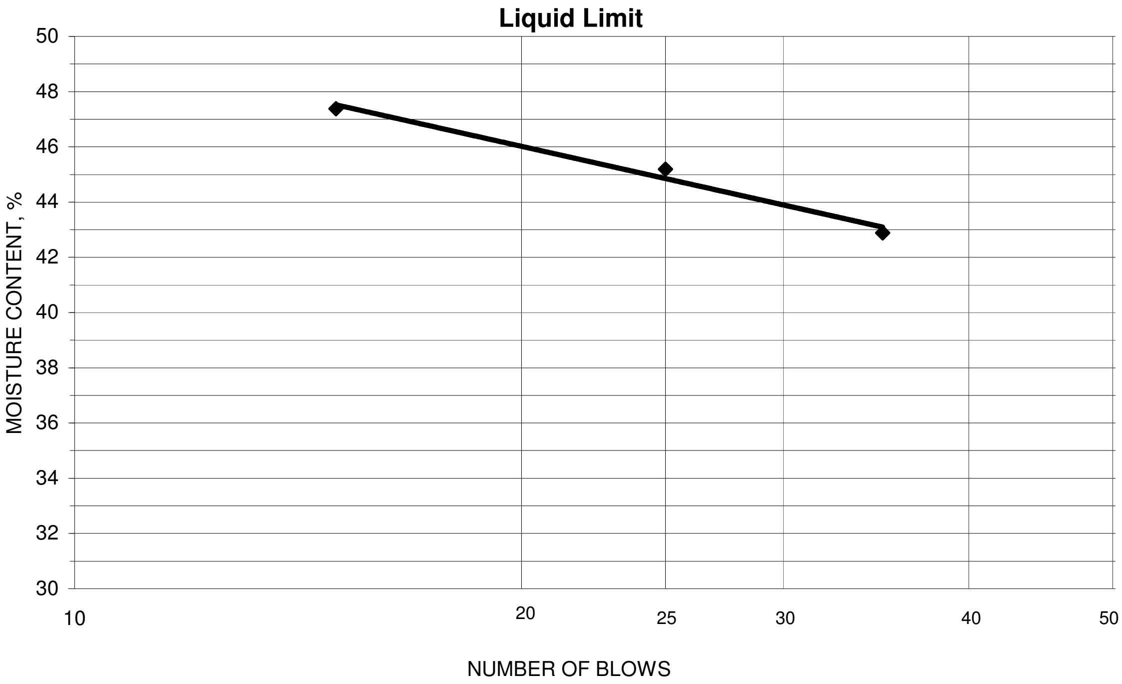
Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

ATTERBERG LIMITS

Project	Cumberland Ash pond	Project No.	175539016
Source	55, 24.0'-25.5', 25.5'-28.5', 28.5'-31.0', 31.0'-33.5', 33.5'-36.0', 36.0'-38.	Lab ID	282
		% + No. 40	61
Tested By	KAF	Test Method	ASTM D 4318 Method A
Date Received	08-04-2009		
Test Date	08-13-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
33.48	26.14	10.65	15	47.4	45
35.41	27.84	11.09	25	45.2	
37.83	29.78	11.01	35	42.9	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
22.73	20.27	10.53	25.3	25	20
21.80	19.63	11.02	25.2		

Remarks: ________________

Reviewed By ________________

Stantec

Summary of Soil Tests

Project Name	Cumberland Fossil Plant - Ash Pond	Project Number	175539016
Source	56, 34.5'-36.0', 36.0'-37.5', 37.5'-39.0'	Lab ID	500
County	Stewart	Date Received	8-21-09
Sample Type	SPT Comp	Date Reported	9-1-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 35.7

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	100.0
1"	25	95.7
3/4"	19	91.6
3/8"	9.5	78.6
No. 4	4.75	69.2
No. 10	2	62.8
No. 40	0.425	54.0
No. 200	0.075	49.2
	0.02	37.5
	0.005	22.7
	0.002	16.8
estimated	0.001	14.0

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	30.8	37.2
Coarse Sand	6.4	8.8
Medium Sand	8.8	---
Fine Sand	4.8	4.8
Silt	26.5	32.4
Clay	22.7	16.8

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 41

Plastic Limit: 28

Plasticity Index: 13

Activity Index: 0.76

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.73

Classification

Unified Group Symbol: GM

Group Name: Silty gravel with sand

AASHTO Classification: A-7-6 (4)

Comments:

File: frm_175539016_sum_500 Sheet: Summary
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

Particle-Size Analysis of Soils

ASTM D 422

Project Name: Cumberland Fossil Plant - Ash Pond
Source: 56, 34.5'-36.0', 36.0'-37.5', 37.5'-39.0'
Project Number: 175539016
Lab ID: 500

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-26-2009
Date Received 08-21-2009

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	100.0
1"	95.7
3/4"	91.6
3/8"	78.6
No. 4	69.2
No. 10	62.8

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.73

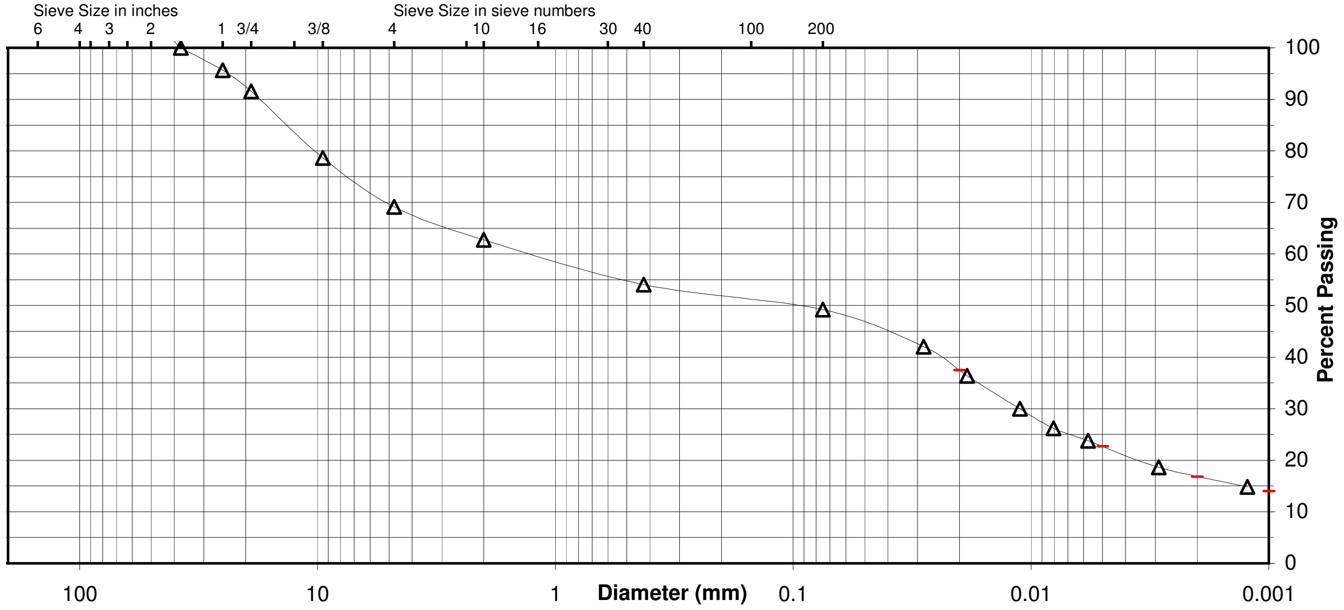
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	54.0
No. 200	49.2
0.02 mm	37.5
0.005 mm	22.7
0.002 mm	16.8
0.001 mm	14.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	8.4	22.4	6.4	8.8	4.8	26.5	22.7

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	37.2	8.8	4.8	32.4	16.8



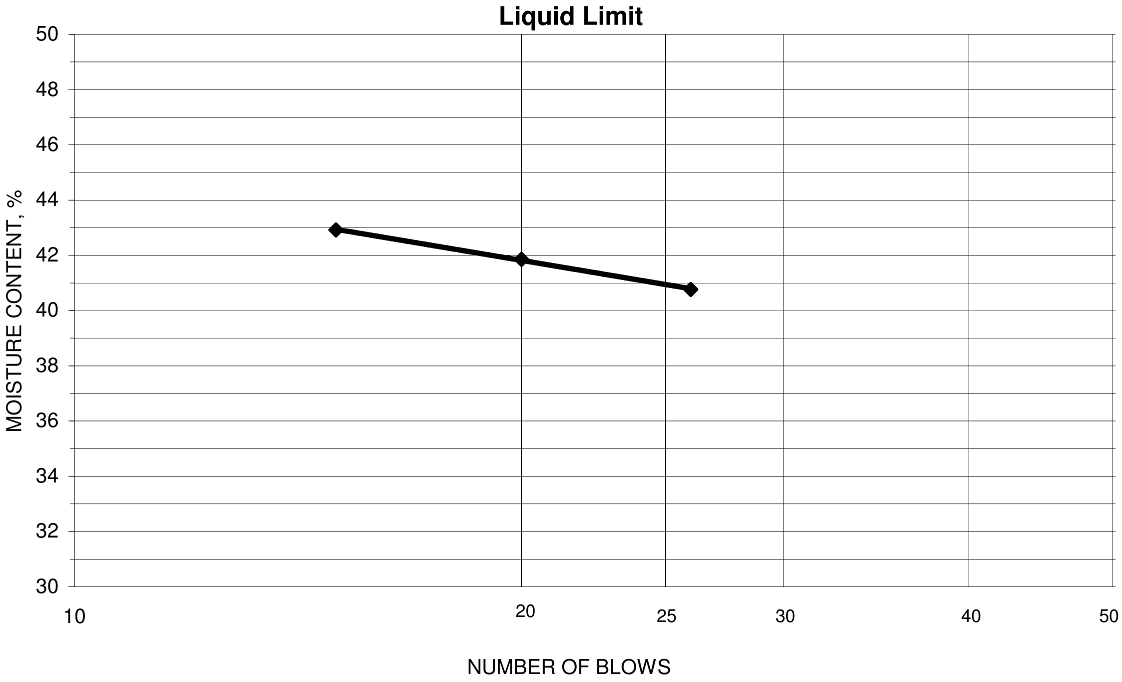
Comments

Reviewed By

ATTERBERG LIMITS

Project	Cumberland Fossil Plant - Ash Pond	Project No.	175539016
Source	56, 34.5'-36.0', 36.0'-37.5', 37.5'-39.0'	Lab ID	500
		% + No. 40	46
Tested By	BB	Test Method	ASTM D 4318 Method A
Date Received	08-21-2009		
Test Date	09-01-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
26.10	22.94	15.39	20	41.9	41
23.30	19.63	11.08	15	42.9	
23.09	19.49	10.66	26	40.8	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
22.26	19.82	11.05	27.8	28	13
25.30	23.12	15.21	27.6		

Remarks: ______________________________

Reviewed By ______________

Stantec

Summary of Soil Tests

Project Name	Cumberland Fossil Plant - Ash Pond	Project Number	175539016
Source	57, 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13.5', 13.5'-15.0', 15.0'	Lab ID	527
County	Stewart	Date Received	8-21-09
Sample Type	SPT Comp	Date Reported	9-1-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 25.5

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size Sieve Size	(mm)	% Passing
3"	75	
2"	50	
1 1/2"	37.5	100.0
1"	25	98.4
3/4"	19	96.4
3/8"	9.5	95.7
No. 4	4.75	95.3
No. 10	2	95.2
No. 40	0.425	87.0
No. 200	0.075	66.3
	0.02	45.0
	0.005	27.6
	0.002	18.6
estimated	0.001	13.4

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	4.7	4.8
Coarse Sand	0.1	8.2
Medium Sand	8.2	---
Fine Sand	20.7	20.7
Silt	38.7	47.7
Clay	27.6	18.6

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 34

Plastic Limit: 21

Plasticity Index: 13

Activity Index: 0.68

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.69

Classification

Unified Group Symbol: CL

Group Name: Sandy lean clay

AASHTO Classification: A-6 (7)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name: Cumberland Fossil Plant - Ash Pond
Project Number: 175539016
Source: 57, 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13.5', 13.5'-15.0', 15.0'-16.5', 16.5'-18.0
Lab ID: 527

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-26-2009
Date Received: 08-21-2009

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	100.0
1"	98.4
3/4"	96.4
3/8"	95.7
No. 4	95.3
No. 10	95.2

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity: 2.69

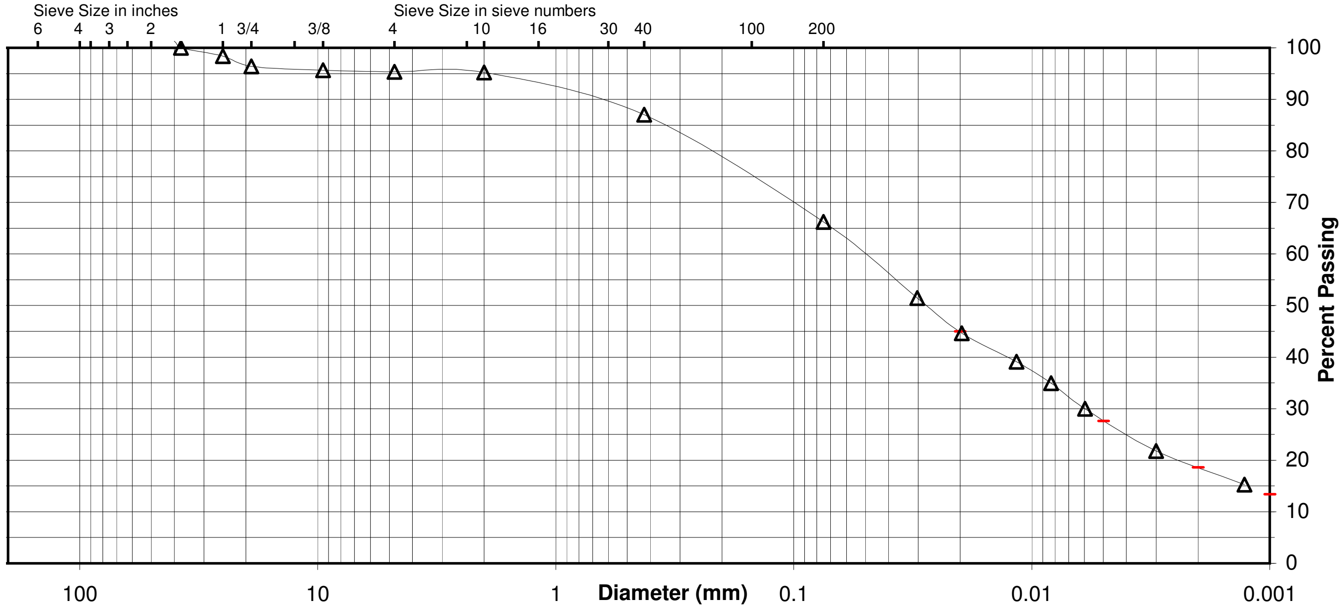
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	87.0
No. 200	66.3
0.02 mm	45.0
0.005 mm	27.6
0.002 mm	18.6
0.001 mm	13.4

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	3.6	1.1	0.1	8.2	20.7	38.7	27.6

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	4.8	8.2	20.7	47.7	18.6



Comments ____________________

Reviewed By ____________________

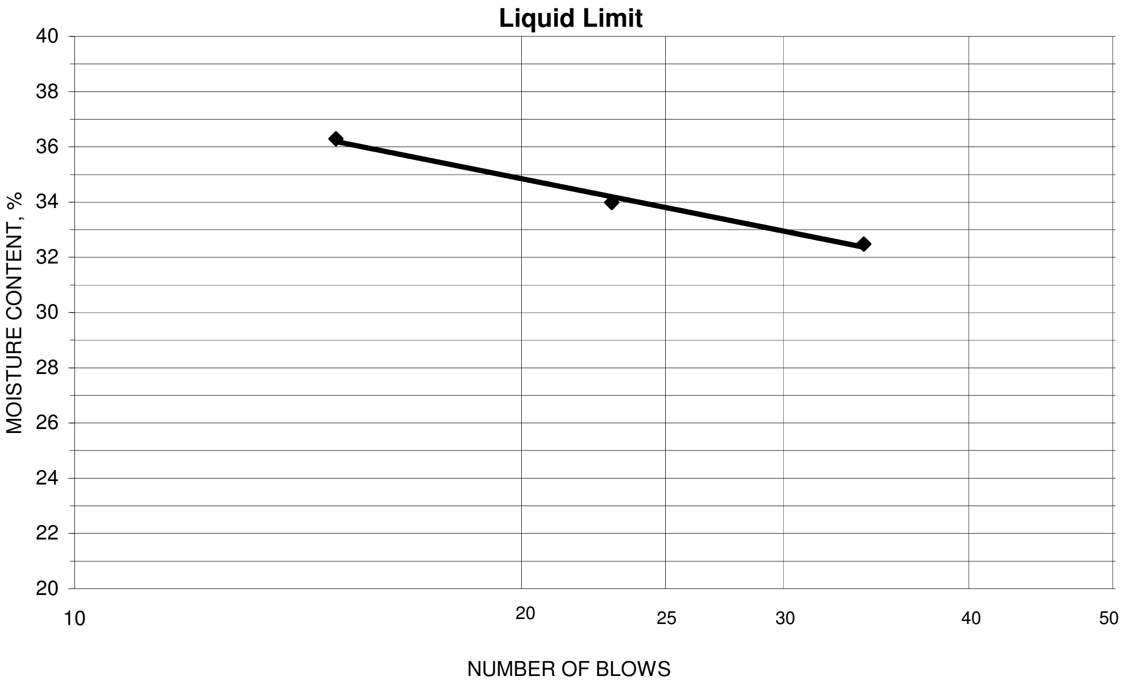
ATTERBERG LIMITS

Project	Cumberland Fossil Plant - Ash Pond	Project No.	175539016
Source	57, 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13.5', 13.5'-15.0', 15.0'-16.5', 1	Lab ID	527
		% + No. 40	13

Tested By BB Test Method ASTM D 4318 Method A Date Received 08-21-2009

Test Date 08-27-2009 Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
22.43	19.32	10.75	15	36.3	34
23.32	20.21	11.06	23	34.0	
23.46	20.43	11.10	34	32.5	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
28.17	25.14	10.57	20.8	21	13
27.74	24.78	10.61	20.9		

Remarks:

Reviewed By

Stantec

Summary of Soil Tests

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 58, 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.
Lab ID: 306

County: Stewart
Date Received: 8-4-09
Sample Type: SPT Comp
Date Reported: 8-19-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 21.3

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	100.0
3/4"	19	98.7
3/8"	9.5	95.4
No. 4	4.75	92.5
No. 10	2	88.6
No. 40	0.425	79.9
No. 200	0.075	64.2
	0.02	52.8
	0.005	41.9
	0.002	37.9
estimated	0.001	34.6

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	7.5	11.4
Coarse Sand	3.9	8.7
Medium Sand	8.7	---
Fine Sand	15.7	15.7
Silt	22.3	26.3
Clay	41.9	37.9

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: 54
Plastic Limit: 18
Plasticity Index: 36
Activity Index: 0.95

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.68

Classification

Unified Group Symbol: CH
Group Name: Sandy fat clay

AASHTO Classification: A-7-6 (21)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 58, 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13
Lab ID: 306

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-11-2009
Date Received 08-04-2009

Maximum Particle size: 1" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	100.0
3/4"	98.7
3/8"	95.4
No. 4	92.5
No. 10	88.6

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.68

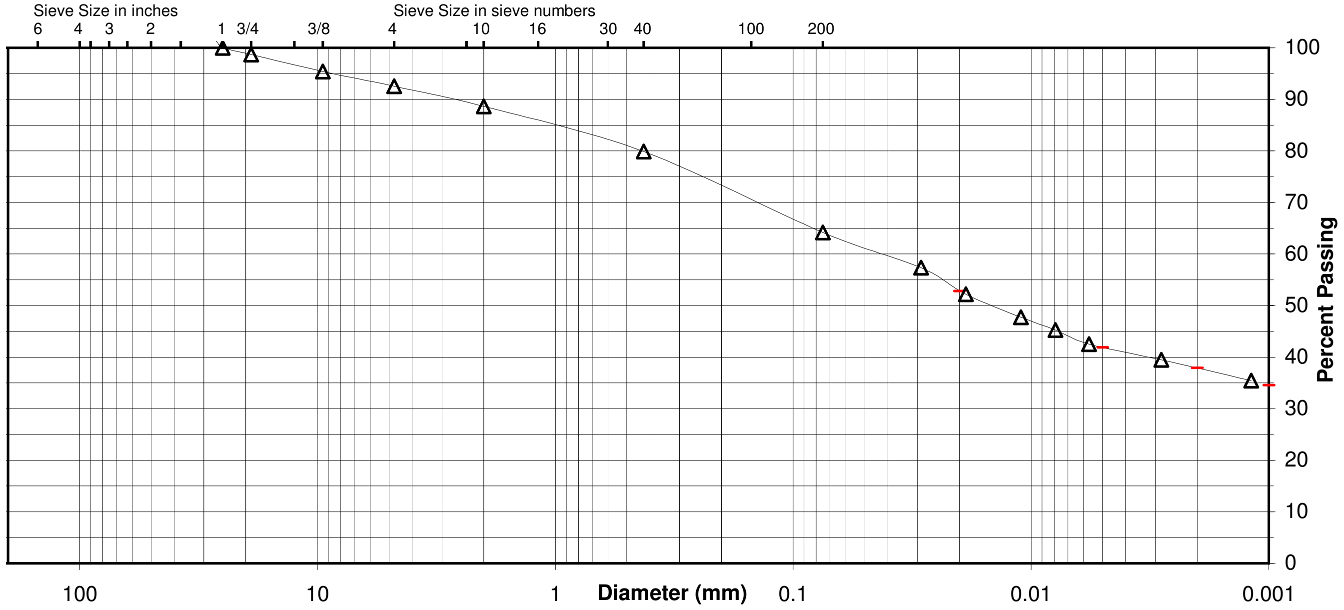
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	79.9
No. 200	64.2
0.02 mm	52.8
0.005 mm	41.9
0.002 mm	37.9
0.001 mm	34.6

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	1.3	6.2	3.9	8.7	15.7	22.3	41.9

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	11.4	8.7	15.7	26.3	37.9



Comments

Reviewed By

File: frm_175539016_sum_306 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

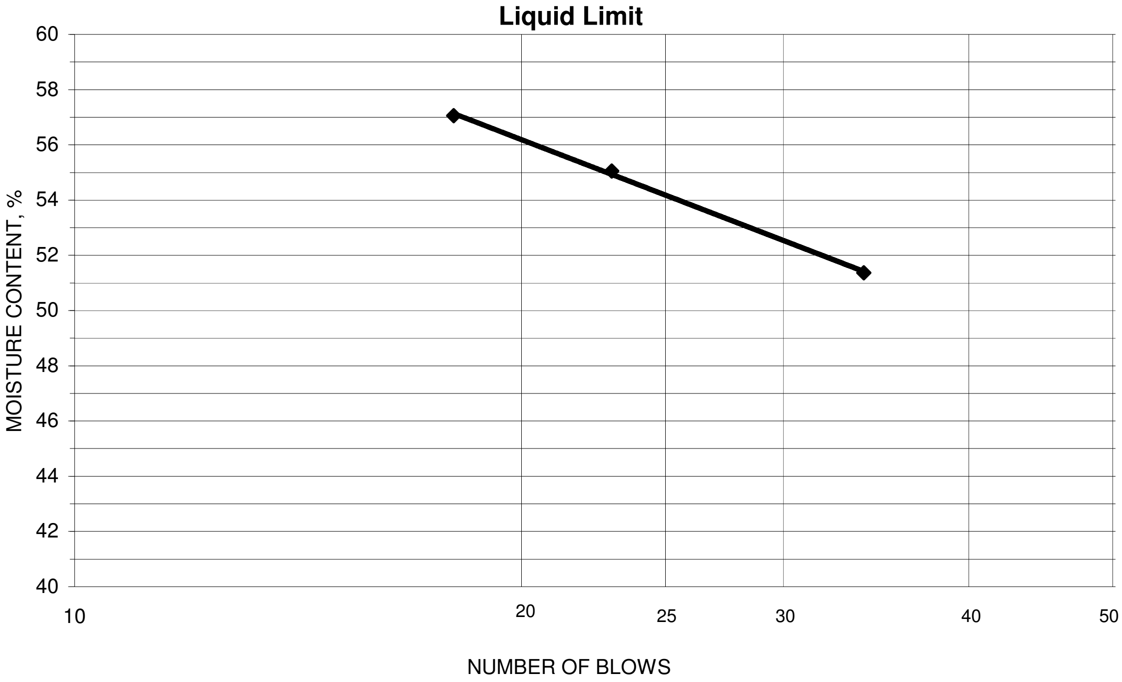
Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

ATTERBERG LIMITS

Project	Cumberland Ash pond	Project No.	175539016
Source	58, 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0',	Lab ID	306
		% + No. 40	20
Tested By	KAF	Test Method	ASTM D 4318 Method A
Date Received	08-04-2009		
Test Date	08-13-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
34.86	26.05	10.61	18	57.1	54
34.97	26.47	11.03	23	55.1	
35.36	27.11	11.05	34	51.4	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
27.44	24.92	11.01	18.1	18	36
25.61	23.41	11.03	17.8		

Remarks: ______________________

Reviewed By ______________

Stantec

Summary of Soil Tests

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 58, 32.5'-34.0', 35.0'-36.5', 37.5'-39.0'
Lab ID: 327

County: Stewart
Date Received: 8-4-09
Sample Type: SPT Comp
Date Reported: 8-19-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 37.4

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	100.0
3/4"	19	95.7
3/8"	9.5	91.6
No. 4	4.75	82.2
No. 10	2	73.5
No. 40	0.425	55.4
No. 200	0.075	42.1
	0.02	36.3
	0.005	27.0
	0.002	23.5
estimated	0.001	21.3

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	17.8	26.5
Coarse Sand	8.7	18.1
Medium Sand	18.1	---
Fine Sand	13.3	13.3
Silt	15.1	18.6
Clay	27.0	23.5

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: 68
Plastic Limit: 36
Plasticity Index: 32
Activity Index: 1.33

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.68

Classification

Unified Group Symbol: SM
Group Name: Silty sand with gravel

AASHTO Classification: A-7-5 (8)

Comments:

Stantec

Particle-Size Analysis of Soils

ASTM D 422

Project Name Cumberland Ash pond

Source 58, 32.5'-34.0', 35.0'-36.5', 37.5'-39.0'

Project Number 175539016

Lab ID 327

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422

Prepared using: ASTM D 421

Particle Shape: Angular

Particle Hardness: Hard and Durable

Tested By: KAF

Test Date: 08-11-2009

Date Received 08-04-2009

Maximum Particle size: 1" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	100.0
3/4"	95.7
3/8"	91.6
No. 4	82.2
No. 10	73.5

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.68

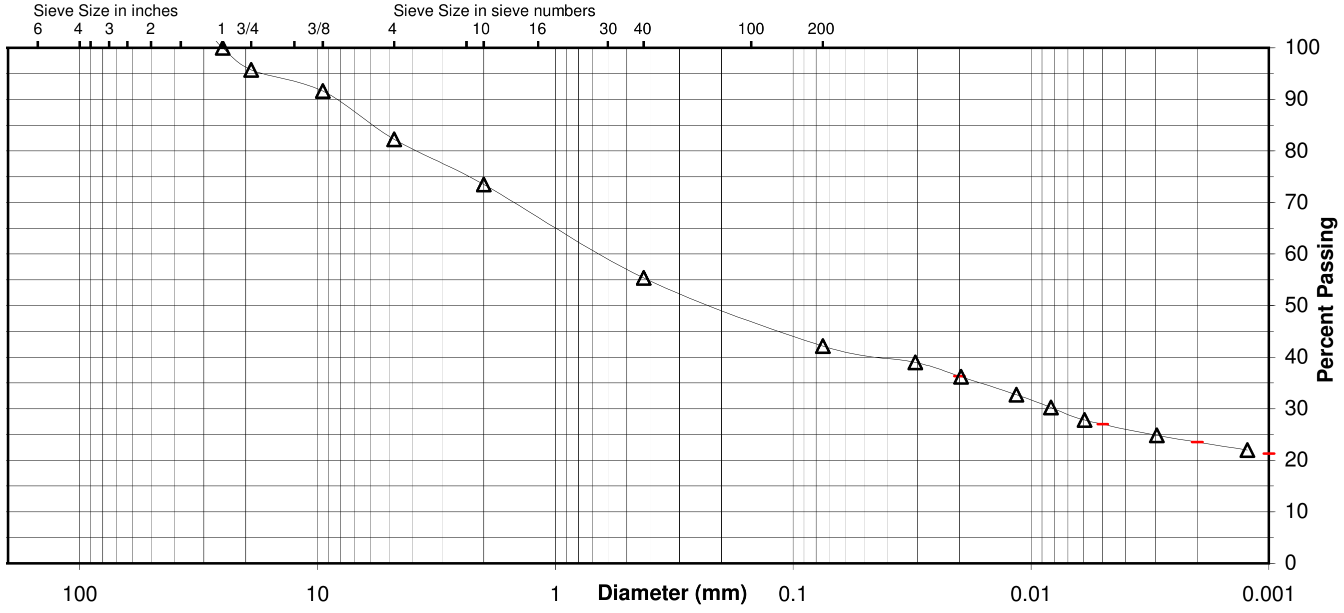
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	55.4
No. 200	42.1
0.02 mm	36.3
0.005 mm	27.0
0.002 mm	23.5
0.001 mm	21.3

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	4.3	13.5	8.7	18.1	13.3	15.1	27.0

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	26.5	18.1	13.3	18.6	23.5



Comments

Reviewed By

File: frm_175539016_sum_327 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

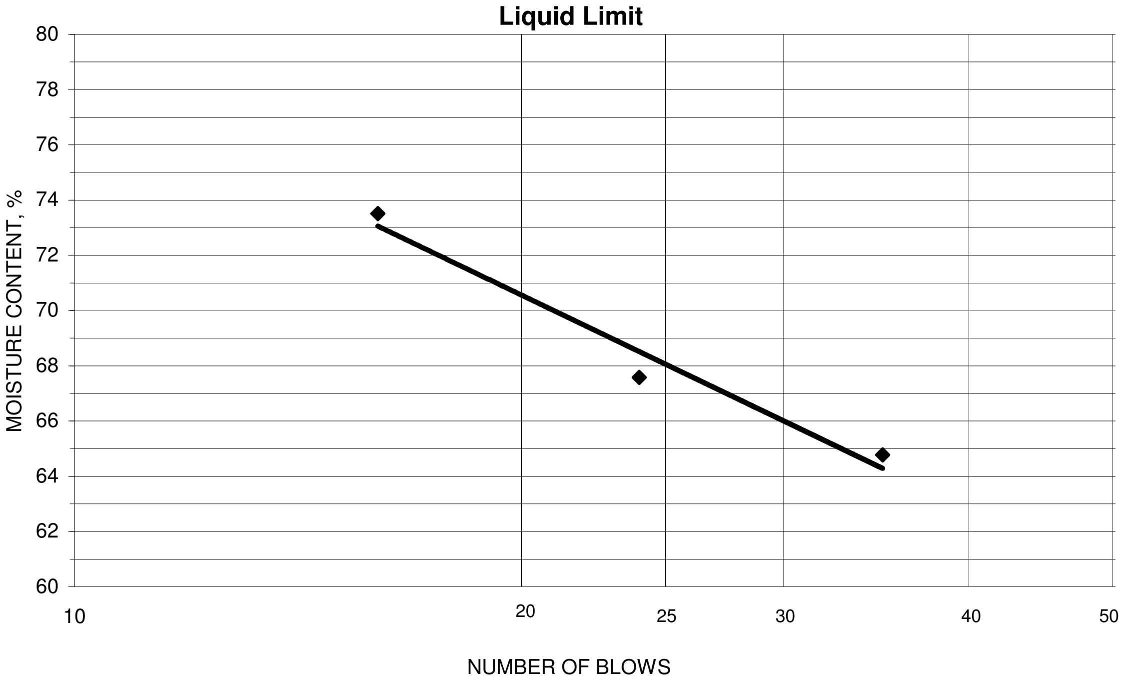
Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

ATTERBERG LIMITS

Project	Cumberland Ash pond	Project No.	175539016
Source	58, 32.5'-34.0', 35.0'-36.5', 37.5'-39.0'	Lab ID	327
		% + No. 40	45
Tested By	KAF	Test Method	ASTM D 4318 Method A
Date Received	08-04-2009		
Test Date	08-14-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
32.17	23.04	10.62	16	73.5	68
33.19	24.29	11.12	24	67.6	
34.32	25.20	11.12	35	64.8	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
28.92	24.19	11.06	36.0	36	32
26.58	22.48	11.04	35.8		

Remarks: ______________________

Reviewed By ______________

Stantec

Summary of Soil Tests

Project Name	Cumberland Ash pond	Project Number	175539016
Source	58, 42.5'-44.0', 45.0'-46.5', 47.5'-49.0', 50.0'-51.5', 52.5'-54.0', 5	Lab ID	332
County	Stewart	Date Received	8-4-09
Sample Type	SPT Comp	Date Reported	8-19-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 27.1

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	100.0
1"	25	98.1
3/4"	19	94.4
3/8"	9.5	82.5
No. 4	4.75	74.3
No. 10	2	68.3
No. 40	0.425	55.9
No. 200	0.075	45.5
	0.02	39.6
	0.005	28.2
	0.002	24.1
estimated	0.001	20.9

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	25.7	31.7
Coarse Sand	6.0	12.4
Medium Sand	12.4	---
Fine Sand	10.4	10.4
Silt	17.3	21.4
Clay	28.2	24.1

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 57

Plastic Limit: 23

Plasticity Index: 34

Activity Index: 1.42

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.67

Classification

Unified Group Symbol: SC

Group Name: Clayey sand with gravel

AASHTO Classification: A-7-6 (11)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Cumberland Ash pond	Project Number	175539016
Source	58, 42.5'-44.0', 45.0'-46.5', 47.5'-49.0', 50.0'-51.5', 52.5'-54.0', 55.0'-56.5', 57.5'-	Lab ID	332

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-11-2009
Date Received 08-04-2009

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	100.0
1"	98.1
3/4"	94.4
3/8"	82.5
No. 4	74.3
No. 10	68.3

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.67

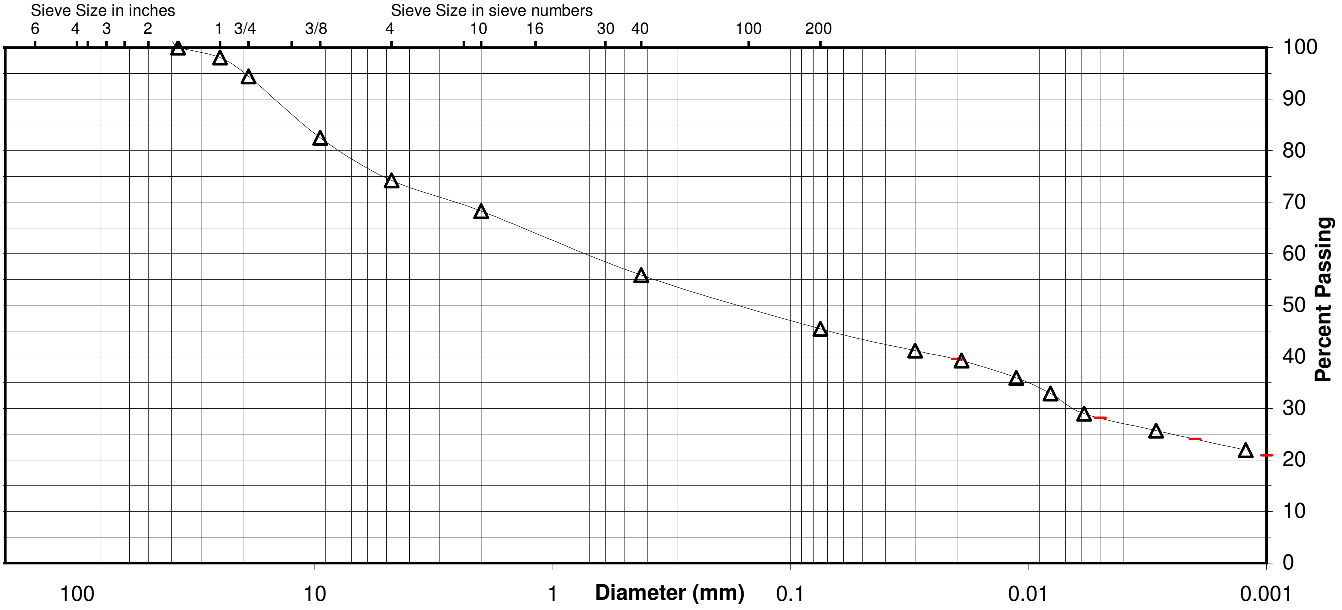
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	55.9
No. 200	45.5
0.02 mm	39.6
0.005 mm	28.2
0.002 mm	24.1
0.001 mm	20.9

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	5.6	20.1	6.0	12.4	10.4	17.3	28.2

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	31.7	12.4	10.4	21.4	24.1



Comments

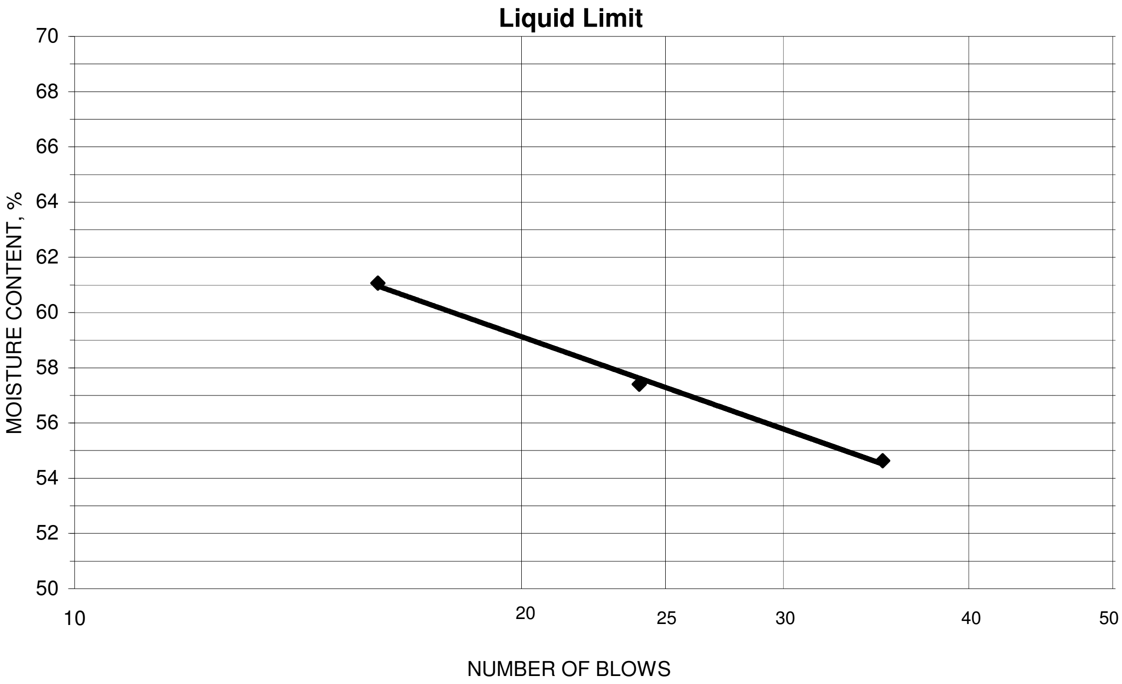
Reviewed By

Stantec

ATTERBERG LIMITS

Project: Cumberland Ash pond
Source: 58, 42.5'-44.0', 45.0'-46.5', 47.5'-49.0', 50.0'-51.5', 52.5'-54.0', 55.0'-56.
Project No. 175539016
Lab ID 332
% + No. 40 44
Tested By: KAF
Test Method: ASTM D 4318 Method A
Date Received: 08-04-2009
Test Date: 08-14-2009
Prepared: Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
34.18	25.27	10.68	16	61.1	57
36.78	27.24	10.62	24	57.4	
39.42	29.40	11.06	35	54.6	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
25.59	22.79	10.51	22.8	23	34
25.66	22.92	11.05	23.1		

Remarks:

Reviewed By

Stantec

Summary of Soil Tests

Project Name: Cumberland Ash pond
Project Number: 175539016
Source: 59, 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13.5
Lab ID: 344

County: Stewart
Date Received: 8-4-09
Sample Type: SPT Comp
Date Reported: 8-20-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 43.5

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	100.0
1"	25	93.6
3/4"	19	92.7
3/8"	9.5	86.1
No. 4	4.75	78.0
No. 10	2	69.9
No. 40	0.425	57.4
No. 200	0.075	50.3
	0.02	43.9
	0.005	37.8
	0.002	34.4
estimated	0.001	32.2

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	22.0	30.1
Coarse Sand	8.1	12.5
Medium Sand	12.5	---
Fine Sand	7.1	7.1
Silt	12.5	15.9
Clay	37.8	34.4

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: 72
Plastic Limit: 25
Plasticity Index: 47
Activity Index: 1.38

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.67

Classification

Unified Group Symbol: CH
Group Name: Sandy fat clay with gravel
AASHTO Classification: A-7-6 (18)

Comments:

Stantec

Particle-Size Analysis of Soils

ASTM D 422

Project Name	Cumberland Ash pond	Project Number	175539016
Source	59, 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13.5', 13.5'-15.0', 15.	Lab ID	344

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-11-2009
Date Received 08-04-2009

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	100.0
1"	93.6
3/4"	92.7
3/8"	86.1
No. 4	78.0
No. 10	69.9

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.67

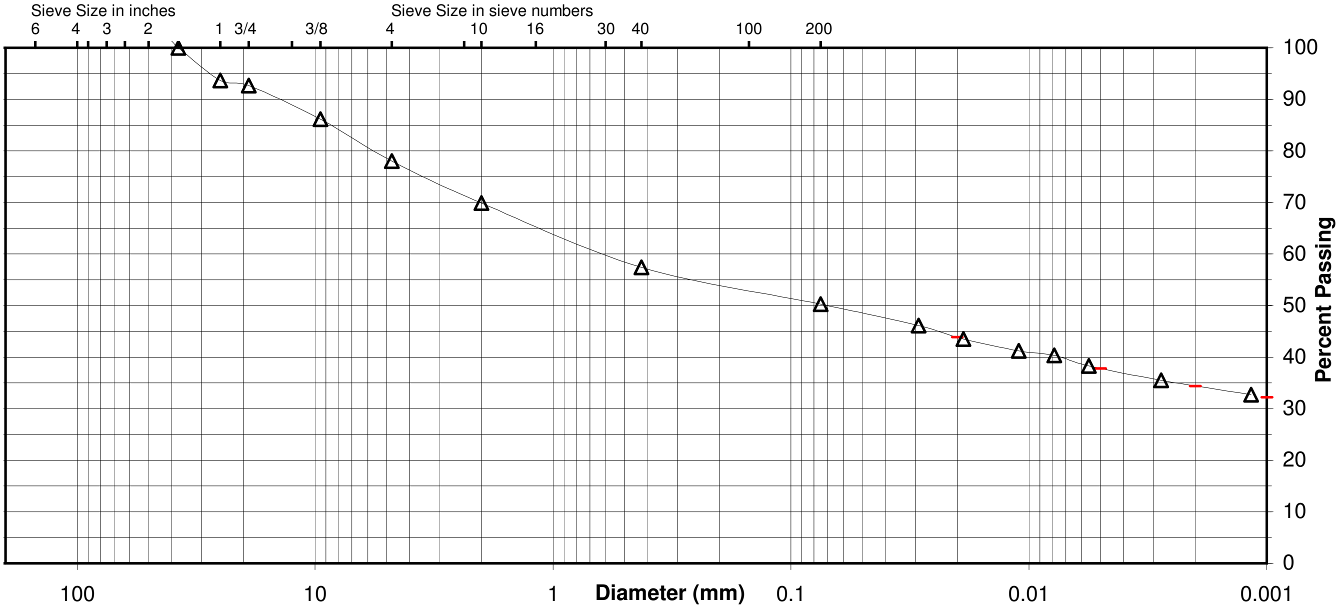
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	57.4
No. 200	50.3
0.02 mm	43.9
0.005 mm	37.8
0.002 mm	34.4
0.001 mm	32.2

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	7.3	14.7	8.1	12.5	7.1	12.5	37.8

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	30.1	12.5	7.1	15.9	34.4



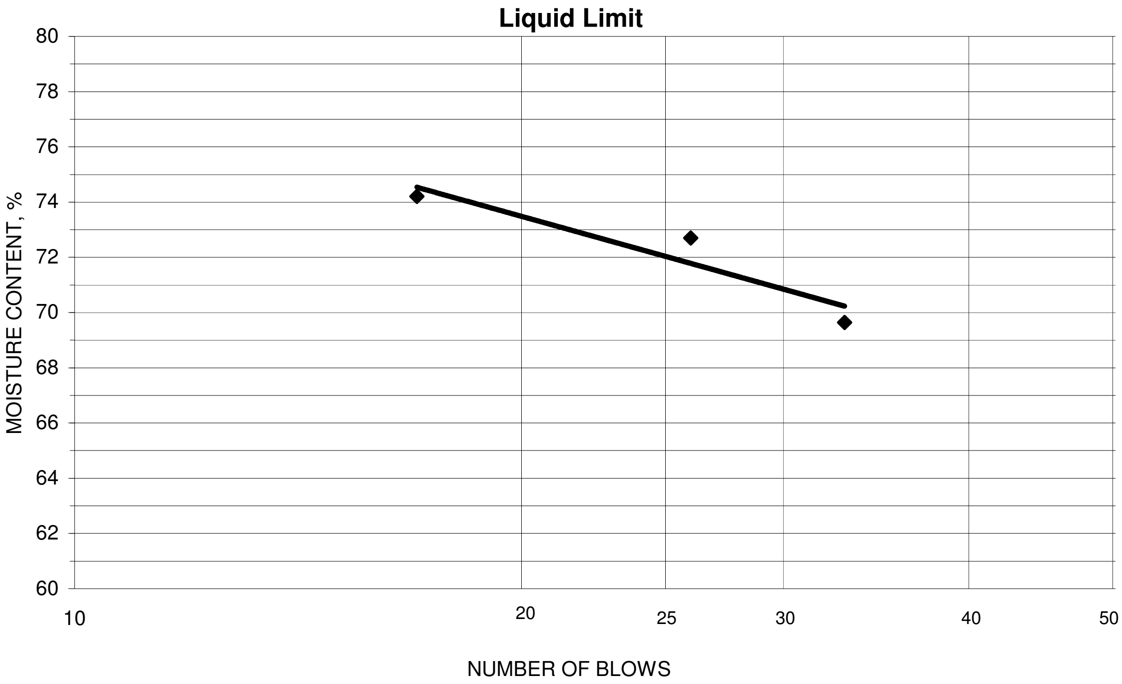
Comments

Reviewed By

ATTERBERG LIMITS

Project	Cumberland Ash pond	Project No.	175539016
Source	59, 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13.5', 13.5'-1	Lab ID	344
		% + No. 40	43
Tested By	KAF	Test Method	ASTM D 4318 Method A
Date Received	08-04-2009		
Test Date	08-13-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
35.97	25.21	10.71	17	74.2	72
35.11	24.99	11.07	26	72.7	
34.27	24.75	11.08	33	69.6	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
26.91	23.60	10.59	25.4	25	47
27.12	23.82	10.88	25.5		

Remarks: ________

Reviewed By ________

Stantec

Summary of Soil Tests

Project Name Cumberland Ash pond
Project Number 175539016
Source 60, 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.
Lab ID 363

County Stewart
Sample Type SPT Comp
Date Received 8-4-09
Date Reported 8-19-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 22.4

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	100.0
3/4"	19	97.9
3/8"	9.5	96.4
No. 4	4.75	93.5
No. 10	2	91.1
No. 40	0.425	83.9
No. 200	0.075	66.5
	0.02	51.5
	0.005	40.5
	0.002	35.7
estimated	0.001	32.3

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	6.5	8.9
Coarse Sand	2.4	7.2
Medium Sand	7.2	---
Fine Sand	17.4	17.4
Silt	26.0	30.8
Clay	40.5	35.7

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: 52
Plastic Limit: 16
Plasticity Index: 36
Activity Index: 1.00

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: CH
Group Name: Sandy fat clay

AASHTO Classification: A-7-6 (22)

Comments:

Stantec

Particle-Size Analysis of Soils

ASTM D 422

Project Name Cumberland Ash pond
Project Number 175539016
Source 60, 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0', 12.0'-13
Lab ID 363

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-11-2009
Date Received 08-04-2009

Maximum Particle size: 1" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	100.0
3/4"	97.9
3/8"	96.4
No. 4	93.5
No. 10	91.1

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.7

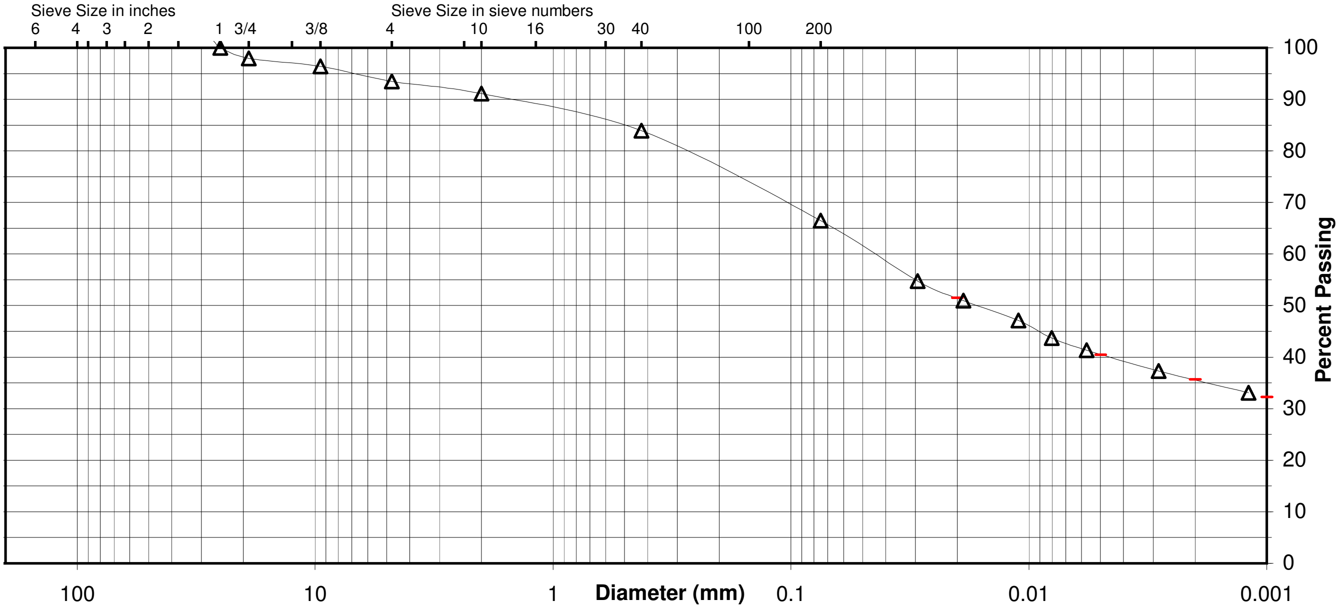
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	83.9
No. 200	66.5
0.02 mm	51.5
0.005 mm	40.5
0.002 mm	35.7
0.001 mm	32.3

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	2.1	4.4	2.4	7.2	17.4	26.0	40.5

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	8.9	7.2	17.4	30.8	35.7



Comments

Reviewed By

File: frm_175539016_sum_363 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

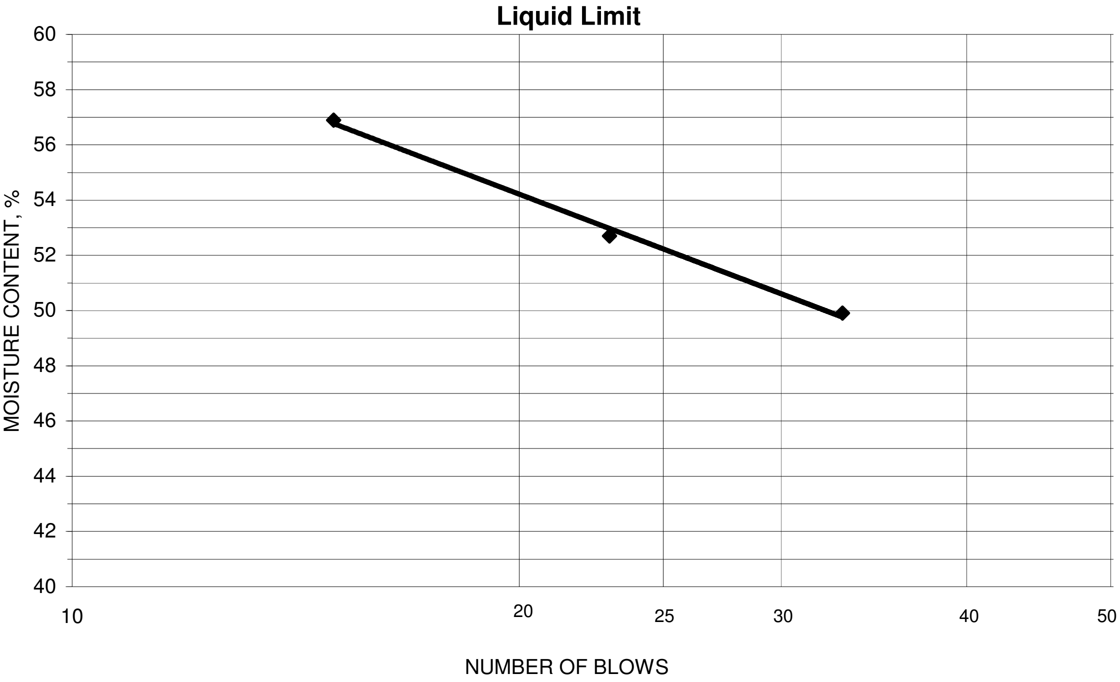
Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

ATTERBERG LIMITS

Project	Cumberland Ash pond	Project No.	175539016
Source	60, 1.5'-3.0', 3.0'-4.5', 4.5'-6.0', 6.0'-7.5', 7.5'-9.0', 9.0'-10.5', 10.5'-12.0',	Lab ID	363
		% + No. 40	16
Tested By	KAF	Test Method	ASTM D 4318 Method A
Date Received	08-04-2009		
Test Date	08-13-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
32.97	24.88	10.66	15	56.9	52
35.74	27.06	10.59	23	52.7	
36.24	27.87	11.10	33	49.9	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
25.05	23.09	11.12	16.4	16	36
25.19	23.19	11.07	16.5		

Remarks: ______

Reviewed By ______

Stantec

Summary of Soil Tests

Project Name	Cumberland Ash pond	Project Number	175539016
Source	60, 18.0'-19.5', 19.5'-21.0', 21.0'-22.5', 22.5'-24.0', 24.0'-25.5', 2	Lab ID	375
County	Stewart	Date Received	8-4-09
Sample Type	SPT Comp	Date Reported	8-20-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 36.4

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	100.0
3/8"	9.5	99.4
No. 4	4.75	98.9
No. 10	2	98.2
No. 40	0.425	93.5
No. 200	0.075	89.9
	0.02	74.3
	0.005	65.0
	0.002	60.3
estimated	0.001	56.8

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	1.1	1.8
Coarse Sand	0.7	4.7
Medium Sand	4.7	---
Fine Sand	3.6	3.6
Silt	24.9	29.6
Clay	65.0	60.3

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 69

Plastic Limit: 27

Plasticity Index: 42

Activity Index: 0.70

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.66

Classification

Unified Group Symbol: CH

Group Name: Fat clay

AASHTO Classification: A-7-6 (43)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Cumberland Ash pond	Project Number	175539016
Source	60, 18.0'-19.5', 19.5'-21.0', 21.0'-22.5', 22.5'-24.0', 24.0'-25.5', 25.5'-27.0', 27.0'-	Lab ID	375

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-11-2009
Date Received 08-04-2009

Maximum Particle size: 3/4" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	100.0
3/8"	99.4
No. 4	98.9
No. 10	98.2

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.66

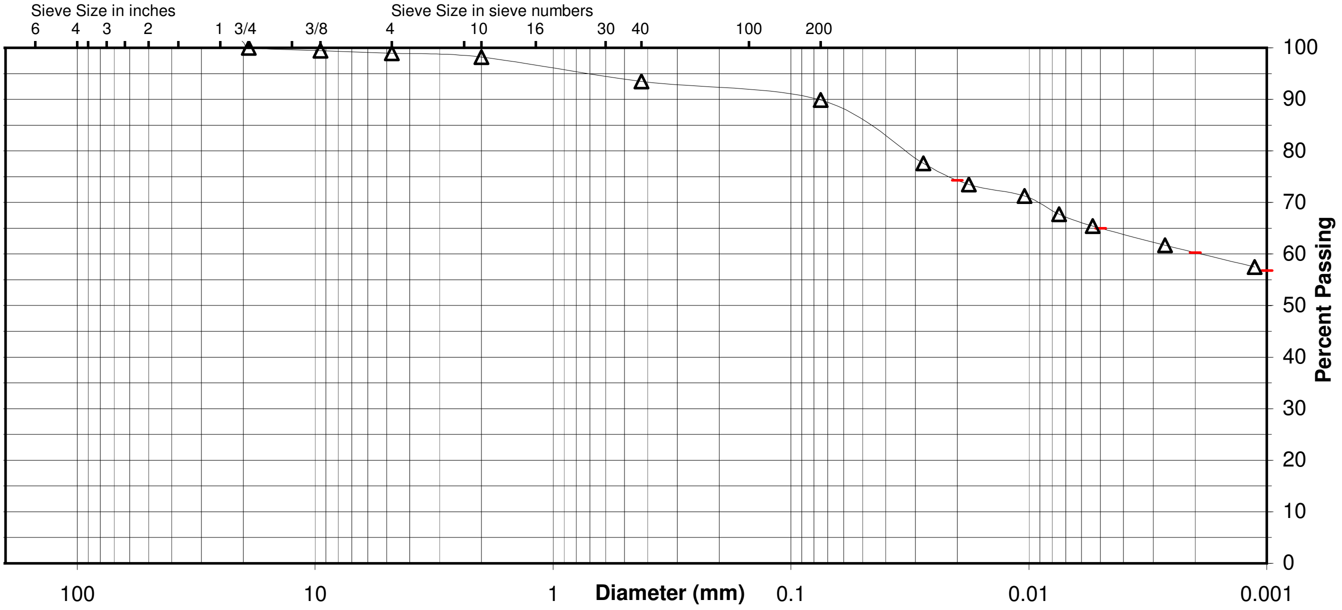
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	93.5
No. 200	89.9
0.02 mm	74.3
0.005 mm	65.0
0.002 mm	60.3
0.001 mm	56.8

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	1.1	0.7	4.7	3.6	24.9	65.0

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	1.8	4.7	3.6	29.6	60.3



Comments

Reviewed By

File: frm_175539016_sum_375 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

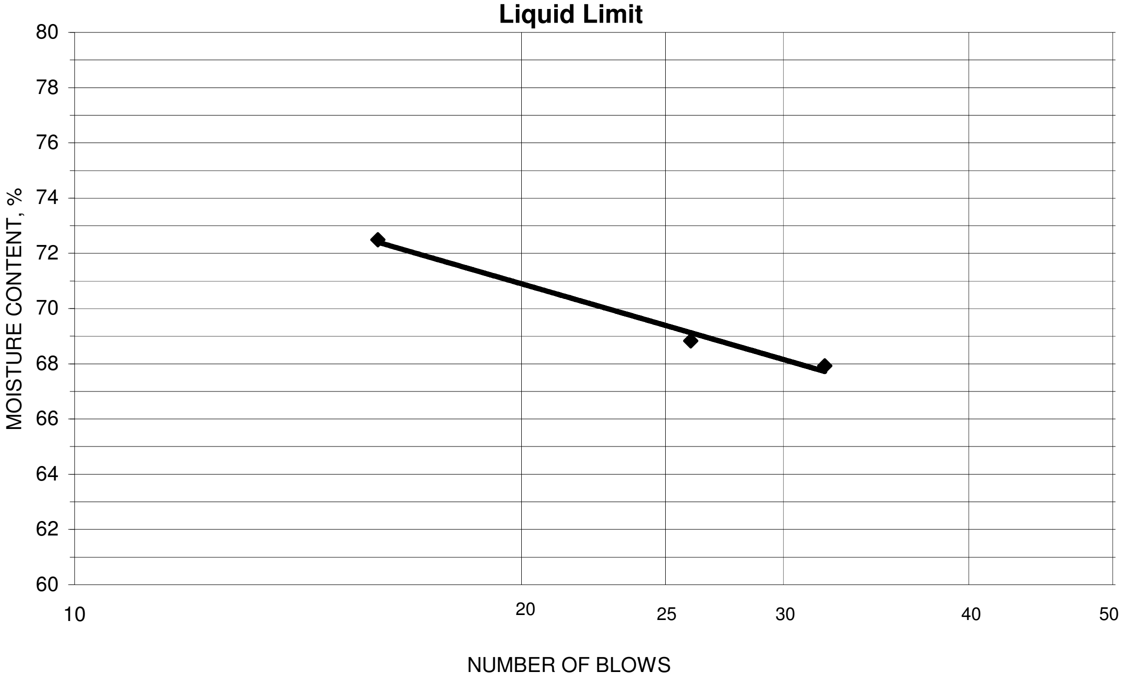
ATTERBERG LIMITS

Project	Cumberland Ash pond	Project No.	175539016
Source	60, 18.0'-19.5', 19.5'-21.0', 21.0'-22.5', 22.5'-24.0', 24.0'-25.5', 25.5'-27.	Lab ID	375
		% + No. 40	7

Tested By	KAF	Test Method	ASTM D 4318 Method A	Date Received	08-04-2009
Test Date	08-17-2009	Prepared	Dry		

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
33.90	24.15	10.70	16	72.5	69
35.79	25.72	11.09	26	68.8	
33.68	24.53	11.06	32	67.9	

Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
23.52	20.81	10.60	26.5	27	42
25.72	22.64	11.01	26.5		

Remarks: ____________________

Reviewed By ____________

Stantec

Summary of Soil Tests

Project Name	Cumberland Ash pond	Project Number	175539016
Source	60, 33.0'-34.5', 34.5'-36.0', 36.0'-37.5', 37.5'-39.0', 39.0'-40.5', 4	Lab ID	386
County	Stewart	Date Received	8-4-09
Sample Type	SPT Comp	Date Reported	8-20-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 29.7

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	100.0
3/8"	9.5	98.8
No. 4	4.75	98.1
No. 10	2	97.8
No. 40	0.425	93.8
No. 200	0.075	90.7
	0.02	75.9
	0.005	62.0
	0.002	53.9
estimated	0.001	47.5

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	1.9	2.2
Coarse Sand	0.3	4.0
Medium Sand	4.0	---
Fine Sand	3.1	3.1
Silt	28.7	36.8
Clay	62.0	53.9

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 68

Plastic Limit: 23

Plasticity Index: 45

Activity Index: 0.83

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.68

Classification

Unified Group Symbol: CH

Group Name: Fat clay

AASHTO Classification: A-7-6 (46)

Comments:

Stantec

Particle-Size Analysis of Soils

ASTM D 422

Project Name Cumberland Ash pond
Project Number 175539016
Source 60, 33.0'-34.5', 34.5'-36.0', 36.0'-37.5', 37.5'-39.0', 39.0'-40.5', 40.5'-42.0'
Lab ID 386

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KAF
Test Date: 08-11-2009
Date Received 08-04-2009

Maximum Particle size: 3/4" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	100.0
3/8"	98.8
No. 4	98.1
No. 10	97.8

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.68

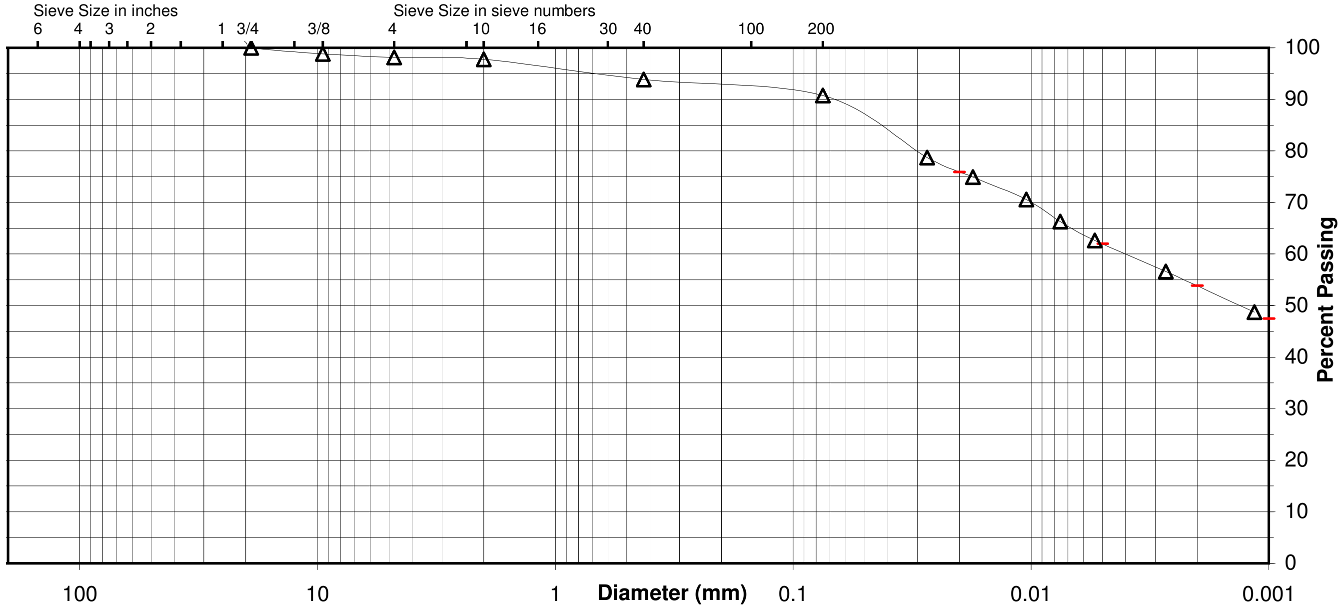
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	93.8
No. 200	90.7
0.02 mm	75.9
0.005 mm	62.0
0.002 mm	53.9
0.001 mm	47.5

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	1.9	0.3	4.0	3.1	28.7	62.0

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	2.2	4.0	3.1	36.8	53.9



Comments

Reviewed By

Stantec

ATTERBERG LIMITS

Project: Cumberland Ash pond

Source: 60, 33.0'-34.5', 34.5'-36.0', 36.0'-37.5', 37.5'-39.0', 39.0'-40.5', 40.5'-42.

Project No. 175539016

Lab ID 386

% + No. 40 6

Tested By KAF

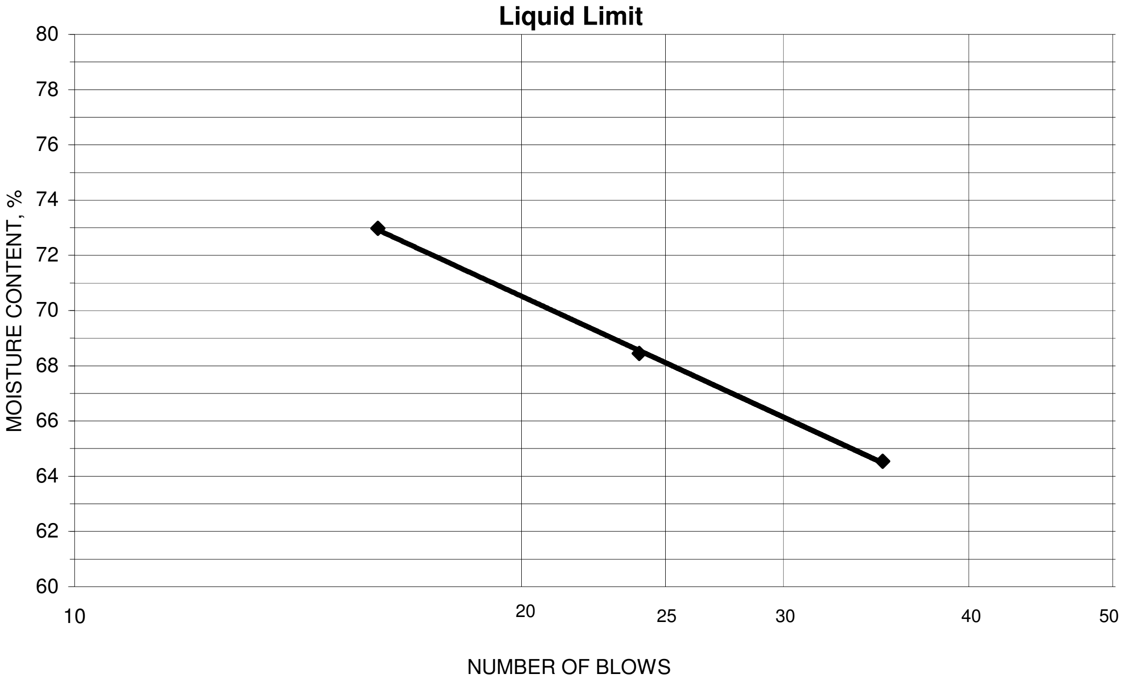
Test Method ASTM D 4318 Method A

Date Received 08-04-2009

Test Date 08-13-2009

Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
33.45	24.00	11.05	16	73.0	68
33.43	24.34	11.06	24	68.4	
35.59	25.98	11.09	35	64.5	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
23.06	20.72	10.60	23.1	23	45
23.29	20.97	10.96	23.2		

Remarks: ______________________

Reviewed By ______________

Stantec

Summary of Soil Tests

Project Name	Cumberland Fossil Plant- Gypsum and Ash stacks	Project Number	175539016
Source	Fill Soil	Lab ID	665
County	Stewart	Date Received	9-1-09
Sample Type	Bag	Date Reported	9-9-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 14.2

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	100.0
1 1/2"	37.5	95.5
1"	25	88.6
3/4"	19	85.9
3/8"	9.5	80.0
No. 4	4.75	75.3
No. 10	2	70.6
No. 40	0.425	63.0
No. 200	0.075	53.2
	0.02	39.4
	0.005	27.3
	0.002	23.2
estimated	0.001	21.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	24.7	29.4
Coarse Sand	4.7	7.6
Medium Sand	7.6	---
Fine Sand	9.8	9.8
Silt	25.9	30.0
Clay	27.3	23.2

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 33

Plastic Limit: 18

Plasticity Index: 15

Activity Index: 0.65

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.68

Classification

Unified Group Symbol: CL

Group Name: Gravelly lean clay with sand

AASHTO Classification: A-6 (5)

Comments:

Stantec

Particle-Size Analysis of Soils

ASTM D 422

Project Name	Cumberland Fossil Plant- Gypsum and Ash stacks	Project Number	175539016
Source	Fill Soil	Lab ID	665

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: BB
Test Date: 09-03-2009
Date Received 09-01-2009

Maximum Particle size: 2" Sieve

Sieve Size	% Passing
3"	
2"	100.0
1 1/2"	95.5
1"	88.6
3/4"	85.9
3/8"	80.0
No. 4	75.3
No. 10	70.6

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.68

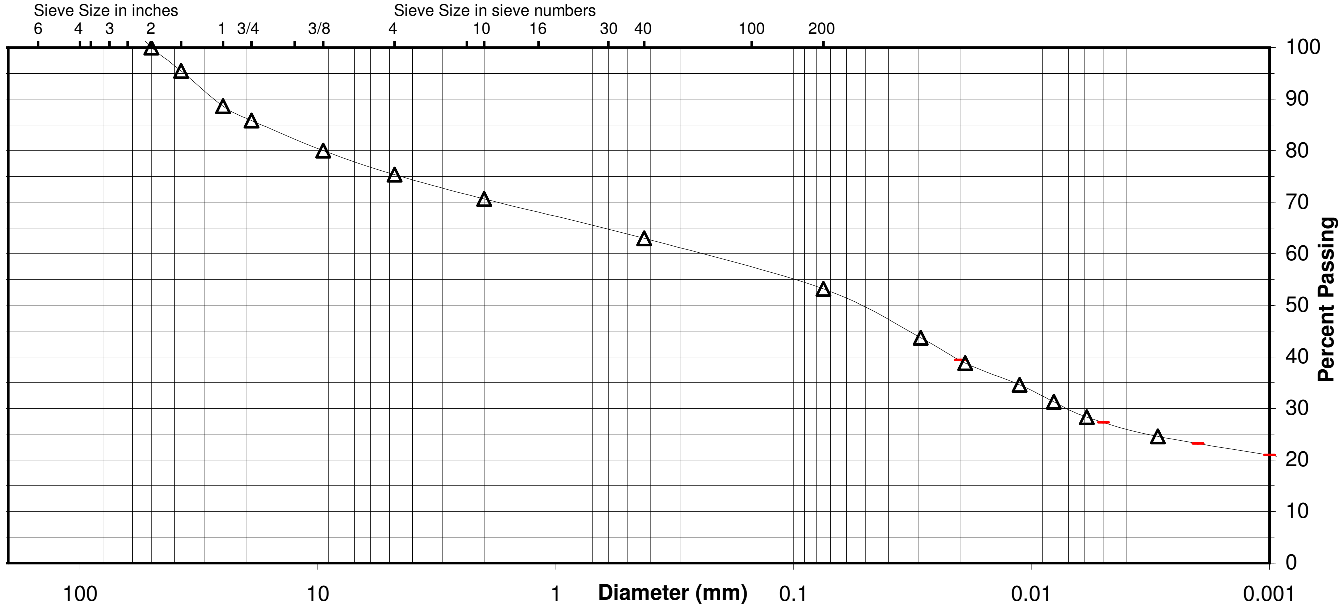
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	63.0
No. 200	53.2
0.02 mm	39.4
0.005 mm	27.3
0.002 mm	23.2
0.001 mm	21.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	14.1	10.6	4.7	7.6	9.8	25.9	27.3

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	29.4	7.6	9.8	30.0	23.2



Comments

Reviewed By

File: frm_175539016_sum_665 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

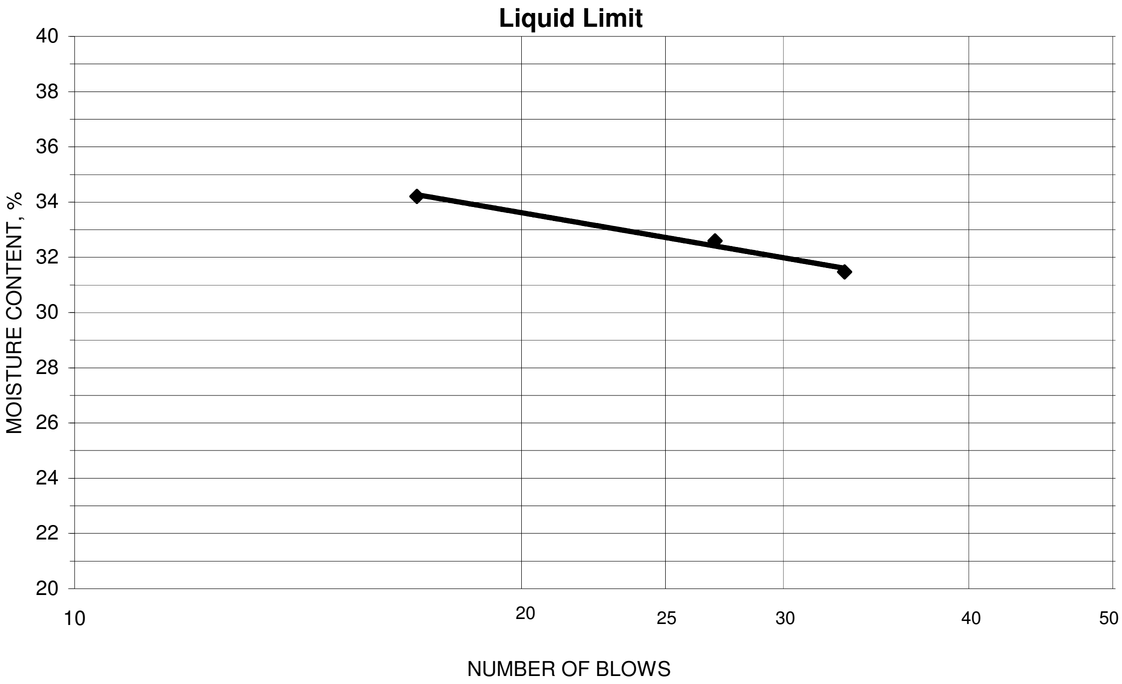
Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

ATTERBERG LIMITS

Project	Cumberland Fossil Plant- Gypsum and Ash stacks	Project No.	175539016
Source	Fill Soil	Lab ID	665
		% + No. 40	37
Tested By	BB	Date Received	09-01-2009
Test Method	ASTM D 4318 Method A		
Test Date	09-03-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
30.55	25.67	10.70	27	32.6	33
22.19	19.54	11.12	33	31.5	
20.25	17.91	11.07	17	34.2	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
19.67	18.39	11.00	17.3	18	15
18.39	17.28	11.03	17.8		

Remarks: ____________________

Reviewed By ____________

Appendix G

Material Properties Calculation

Stantec	Subject Cumberland Fossil Plant	Made by JSH	Job No 175539016
	Ash Pond Geotechnical Exploration	Checked by	Date 1/25/2009
	Soil Properties for Analyses	Approved by	Sheet No 1 of 13

OBJECTIVE:

As part of a TVA system-wide review, Stantec is performing a geotechnical exploration of the existing Ash Pond at the Cumberland Fossil Plant. This calculation summarizes the basis of the material properties selected for the geotechnical analyses.

SITE OVERVIEW:

The Cumberland Fossil Plant was constructed between 1968 and 1973. It has two coal-fired generating units and produces roughly 750,000 tons of coal combustion byproducts (CCBs) in the forms of fly ash and bottom ash each year. Sulfur dioxide scrubbers were installed on the units in 1994. The synthetic gypsum byproduct generated by the scrubbers is marketed as a building material. However, any unsold gypsum (of the approximately one million tons produced each year) must be disposed by the plant.

The CCB storage facilities are located in the southern and southwestern areas of the plant and consist of aboveground cellular systems for dry fly ash, sluiced bottom ash, and sluiced/stacked gypsum. The stacks and retention ponds cover approximately 340 acres. The layout of these structures is shown on Figures 1 and 2 in Attachment 1. The structures include the Gypsum Stack Complex, the Dry Fly Ash Stack Area, the Bottom Ash Area, the Retention Pond, and the Stilling Pond. The Retention Pond and the Stilling Pond are jointly considered the Ash Pond Complex.

GIVEN:

- Data from a geotechnical exploration performed by Stantec between July and August 2009 (Stantec 2010). Field data include standard penetration tests (SPTs), visual soil classification, and visual assessment of existing site conditions. Disturbed and undisturbed soil samples were sent for laboratory testing to determine in-situ unit weight, density, and moisture conditions, strength and permeability, and soil classification testing.
- Compiled data from related TVA facilities with similar material property assumptions and from similar Stantec project experience.

ASSUMPTIONS:

Eight soil horizons were identified based on historical construction data, geotechnical boring logs, and laboratory testing. Classifications are based on the Unified Soil Classification System (USCS). Below is a brief description of each horizon based on the field exploration:

- Fly Ash – Classifies as silt (ML) or silt with sand/silty sand. Light gray to black or gray brown, silt to clay-sized grains, dry to wet. Soft to medium stiff. Can be saturated, possibly hydraulically placed. (Stantec, 2009a).

- Dike 1 – The original perimeter dike. A crushed stone roadbed approximately 0.5-feet thick may be present. Approximate top of dike elevation is 380 feet. Stantec (2010) identified this zone in most borings surrounding the Ash Pond and Stilling Ponds just above natural ground.

    - Dike 1 (Lean Clay) – Lean clay or sandy lean clay (CL) with coarse sand or trace fine gravel. The soil varies from gray to brown with red brown, mottled light greenish gray, and olive brown. It is soft to very stiff and damp to moist.

    - Dike 1 (Fat Clay) – Fat clay (CH) with trace to some coarse sand and fine gravel. The soil is red brown to gray with mottling. It is soft to very stiff and damp to moist. This material was identified on the downstream toe on the north side of the Ash Pond and along the eastern border with the plant area.

- Dike 2 – The raised dike upstream of the original perimeter dike. It has a crushed stone surface between 0.2- and 0.9-feet deep. Dike 2 was identified by Stantec (2010) along the outside perimeter of the Ash Pond and the Stilling Pond. It is not found in the divider dikes between the Dry Fly Ash Stack and the Retention Pond. The approximate top of dike elevation is 395 feet.

    - Dike 2 (Lean Clay) – Sandy lean clay, silty clay, clayey gravel with sand, some to no sand and fine gravel (CL). The soil is red brown, olive yellow/brown, dark gray, brown with some mottling. It is soft to very stiff and damp to wet. Some borings noted interbedded cobbles and boulders, and granular lenses. A minor fly ash zone and a minor organic zone were each noted in a boring.

    - Dike 2 (Fat Clay) – Fat clay or sandy fat clay (CH) with little to some coarse sand and chert gravel. The soil is dark red brown and brown. It is medium stiff to very stiff and damp to moist. Some borings noted sand lenses. This material was identified on the inboard toe of the dike on the eastern half of the Ash Pond.

- Alluvial (Clay) – Lean clay (CL) with trace to some sand and gravel. The soil is red brown, dark gray, dark olive, and brown with some mottling. It is very soft to very stiff and damp to wet. Some borings noted cobble zones and weathered rock fragments. Fat alluvial clay (CH) was noted in B-60.

- Alluvial (Granular) – A sand and gravel zone with fines. The material classifies as a clayey gravel with sand (GC), silty sand (SM), gravel with silt and sand (GP-GM), and silty gravel (GM). Colors vary between red brown, olive yellow, brown, and gray with some mottling. It is moist to wet, very loose to dense, and medium to fine grained.

- Bedrock – Limestone (80 percent) with zones of highly weathered shale (20 percent). Limestone is hard, gray, and water stained with close fracture spacing. Shale is highly weathered, fissile, brown, and eroded. Some clay seams were noted.

Boring logs and geotechnical laboratory results are not included in this calculation but are appendices to the main report (Stantec, 2010). Summary tables of the geotechnical laboratory testing for Stantec (2010) are included in Attachment 2. They are organized by boring, depth, and assumed soil horizon. The first table summarizes all permeability and shear strength testing data. The subsequent two tables list all results by laboratory and assumed material type.

ANALYSIS:

Key properties for slope stability analyses, including unit weight and drained shear strength parameters, were estimated for each soil horizon. Additional properties required for the seepage and piping analyses, such as saturated hydraulic conductivity and horizontal to vertical permeability ratio are also included.

Initial estimates were developed from the available Stantec (2010) geotechnical field and laboratory data. Field data include standard penetration tests (SPTs), visual soil classification, and visual assessment of existing site conditions. Laboratory testing was performed on disturbed (SPT and bulk) and undisturbed (Shelby tube) samples. Table 1 lists the geotechnical laboratory testing and associated ASTM methods performed for Stantec (2010).

Table 1. Geotechnical Laboratory Testing

Test Description	ASTM Method
Consolidated-undrained (CU or R) triaxial with porewater measurements	D 4767
Falling-head permeability	D 5084, Method C
Specific gravity	D 854
Particle size analysis with hydrometer	D 421, 422
Atterberg limits	D 4318, Method A
Moisture-density relationships using standard Proctor	D 698, Method A
Natural moisture content	D 2216

The initial material property estimates were then compared to the material properties selected for Stantec's geotechnical exploration at the Gypsum Stack Complex and the Dry Ash Stack (Stantec, 2009b) and adjusted as needed. The estimates were also compared to compiled data from related TVA facilities with similar materials, to data from similar Stantec projects, and published typical values based on soil types.

The Stantec (2010) consolidated-undrained triaxial test results were based on the maximum principal effective stress ratio (maximum value of σ'_1/σ'_3) or the point of maximum obliquity. This stress condition is where the slope of the failure envelope through the origin of stress has its maximum slope (maximum ϕ for c=0). In routine practice, this failure criterion is used in undrained laboratory tests.

Note that a small amount of effective cohesion was used for the clay dikes and the alluvial clay. Any cementation in the CCBs was neglected. Laboratory tests on a few discreet samples (Stantec 2009b) from the stack will not yield a complete understanding of the cementation in the stacks.

Additional field data from Stantec (2010) was incorporated by creating histograms of the uncorrected SPT blow counts by material type. The histograms are included as Attachment 3. Table 2 is an overview of the Stantec (2010) uncorrected SPT blow count (N) values.

Table 2. Uncorrected SPT N Value by Soil Type*

N (Blow Counts)	Min	Max	Average	Mode	No. of Samples
Fly Ash	0	72	11	0	308**
Alluvial Clay	0	74	13	2	126
Alluvial Granular	0	52	19	21	83
Dike 1 (Lean)	2	46	15	8	87
Dike 1 (Fat)	3	51	16	16	44
Dike 2 (Lean)	3	55	15	10	90
Dike 2 (Fat)	5	42	14	15	65

* Stantec (2010)

** From field investigation for Stantec (2009b). No new sluiced fly ash data was included for this study.

Particle size analyses and Atterberg limits were averaged to estimate D_{10}, D_{60}, and liquid limit for the seepage model. Undisturbed test sample results were averaged to supply specific gravity (G_s) and void ratio (e) values for the piping factor of safety calculations.

The saturated volumetric water content (θ_{sat}) was calculated using the laboratory-calculated void ratio (e) where $\theta_{sat} = e/1+e$. Residual volumetric water content (θ_r) was assumed from typical values based on material type (Rawls et al, 1982). The degree of volume compressibility, m_v, was estimated using typical values by soil type based on Bell (2000). The referenced pages for typical values are included in this calculation as Attachment 4.

Please note that the software used for the seepage model works in terms of feet per second for hydraulic conductivity and an anisotropy ratio of $k_{vertical}/k_{horizontal}$.

Soil Horizons:

1. Fly Ash (Sluiced)

During the Stantec (2010) field investigation, fly ash was generally not encountered in the dike borings.

Some accumulation of sluiced fly ash is assumed to be in the Ash Pond for the geotechnical slope stability and seepage models. Data from Stantec (2009b) was used to determine soil values for the analyses. No additional testing was performed during Stantec (2010) on sluiced fly ash material.

Moist unit weights for the sluiced fly ash were estimated using the Stantec (2009b) undisturbed samples. Typical blow counts for the sluiced fly ash were 0 to 3 (0 to 4 corrected for automatic hammer or N_{60}). Approximately 1/5 of the samples thought to be sluiced fly ash had blow counts of 0. Roughly ¾ of the samples had blow counts of 13 or less ($N_{60} = 17$). A discussion of the historical and recent shear strength testing is discussed in Stantec (2009a). Tables 3, 4, and 5 include the values used on the current analyses. The lab summary table details the hydraulic conductivity and geotechnical testing results in Attachment 5 (Stantec 2009a).

Table 3. Fly Ash (Sluiced) Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2009b)	B-43A (29.0-31.0), B-35A (46.0-48.0)	103.3	0	39.6
	SPT N_{60} values – empirical (sluiced fly ash)			<28
	SPT N_{60} values – empirical (sluiced fly ash/bottom ash)			<28-30.1
	CPT N_{60} minimum, maximum, and average (2, 17, and 9) (fly ash)			13, 30, 22
Stantec (2010)	**Selected Parameters for Stability Analyses**	100	0	22

Table 4. Seepage Model and Piping Material Properties

Material Type	D_{10} (mm)	D_{60} (mm)	Liquid Limit	M_v	Residual Water Content	Saturated Water Content	Specific Gravity, G_s	Void Ratio, e
Fly Ash - Sluiced	0.004	0.049	0	6.2218E-05	0.015	0.3548	2.50	0.550

Table 5. Model Soil Hydraulic Conductivity

Material Type	K_{sat} (cm/sec)	K_{sat} (ft/sec)*	Anisotropy	K_h (ft/sec)
Fly Ash - Sluiced	8.41E-05	2.76E-06	0.02	1.38E-04

(*K_v assumed from testing – average of CPT and laboratory testing (Stantec (2009b))

2. Dike 1 (Lean Clay)
Dike 1 (Fat Clay)

Stantec (2010) breaks Dike 1 into two zones: lean and fat clay. However, testing was not sufficient to separately define the two soil types. As needed, generalized Dike 1 properties were estimated.

Moist unit weights for Dike 1 was estimated using the Stantec (2010) undisturbed samples. The moist unit weight of Dike 1 ranged from 117.9 to 125.7 pcf with an average over five measurements of 121.2 pcf. Typical blow counts for Dike 1 (Lean Clay) were 2 to 46 with an average of 15. For Dike 1 (Fat Clay), typical blow counts ranged from 3 to 51 with an average of 16.

Shear strength testing for Dike 1 (Lean Clay) was used for Dike 1 (Fat Clay). The typical blow counts for the substrata suggest similar shear strengths. The wet unit weight was adjusted to reflect the plasticity difference. Tables 6 and 7 summarize the Dike 1 shear strength properties used for the stability models.

Table 6. Dike 1 (Lean Clay) Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2010)	STN-54A, 30.6'-31.2'	117.8	220.3	22.3
	STN-54A, 31.2'-31.8'	124.3		
Stantec (2010)	**Selected Parameters for Stability Analyses**	123	200	22

Table 7. Dike 1 (Fat Clay) Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2010)	**Selected Parameters for Stability Analyses**	119	200	22

Attachment 2 includes the Stantec (2010) laboratory testing summary tables. Particle size analyses, Atterberg limits, determined specific gravities, and void ratios from undisturbed soil samples are listed supporting Tables 8 and 9 discussing the model parameters for the seepage analyses and the piping factor of safety calculation.

Hydraulic conductivity test results for Dike 1 are also listed in Table 9. The anisotropy parameter is assumed for constructed clay dikes based on experience from similar Stantec project sites. Adjustments may have been made to the model assumptions to reflect measured piezometer levels in the field. The assumed value for hydraulic conductivity of Dike 1 (Lean Clay) is more conservative than the laboratory testing results.

Table 8. Seepage Model and Piping Material Properties

Material Type	D_{10} (mm)	D_{60} (mm)	Liquid Limit	M_v	Residual Water Content	Saturated Water Content	Specific Gravity, G_s	Void Ratio, e
Clay Dike 1 - Lean Clay	0.001	0.1	38	3.0000E-06	0.06	0.413	2.67	0.704
Clay Dike 1 - Fat Clay	0.001	0.05	69	1.4358E-05	0.09	0.415	2.67	0.709

Table 9. Model Soil Hydraulic Conductivity

Boring	Depth (ft)	Material Type	K_{sat} (cm/sec)	K_{sat} (ft/sec)*	Anisotropy	K_h (ft/sec)
STN-48A	26.0-26.5	Dike 1 – Lean Clay	6.3e-8			
STN-58	10-20	Dike 2 (Fat), Dike 1 (Lean)	2.7e-8			
Selected Parameters		Clay Dike 1 - Lean Clay	6.50E-07	2.13E-08	0.1	2.13E-07
		Clay Dike 1 - Fat Clay	2.70E-08	8.86E-10	0.1	8.86E-09

(*K_v assumed from testing)

3. Dike 2 (Lean Clay)
4. Dike 2 (Fat Clay)

Stantec (2010) breaks Dike 2 into two zones: lean and fat clay. Atterberg limits from undisturbed samples show liquid limits between 46 and 68 with an average of 55. Average blow counts for Dike 2 were 15 and 14 for lean and fat clay, respectively.

Moist unit weights were estimated using the Stantec (2010) undisturbed samples. The moist unit weight of Dike 2 (lean clay) ranged from 114.9 to 132.0 pcf with an average over four measurements of 123.8

pcf. Dike 2 (fat clay) ranged from 115.2 to 127.4 pcf with an average over three measurements of 122.1 pcf. Unit weights for the lean and fat clay Dike 1 soils were also considered when selecting the model assumptions.

The field and laboratory data would suggest the two clay substrata should have similar strength properties due to the narrow range of testing results. Tables 10 and 11 summarize the shear strength testing results and model parameters for Dike 2.

Table 10. Dike 2 (Lean Clay) Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2010)	STN-54A, 30.6'-31.2'	132.3	220.3	32.1
	STN-54A, 31.2'-31.8'	130.6		
Stantec (2010)	STN-48A, Bulk	121.2	220.3	29.5
		120.9		
		121.0		
Stantec (2010)	STN-52A, Bulk	119.7	97.2	29.8
		119.1		
		119.3		
Stantec (2010)	**Selected Parameters for Stability Analyses**	123	200	32

Table 11. Dike 2 (Fat Clay) Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2010)	STN-58, Bulk	120.3	254.9	29.4
		121.9		
		122.0		
Stantec (2010)	**Selected Parameters for Stability Analyses**	119	200	29

Please refer to Attachment 2 for the Stantec (2010) laboratory testing summary tables supporting Table 12 geotechnical testing results. Hydraulic conductivity test results for Dike 2 are also listed in Table 13. The anisotropy parameter is assumed for constructed clay dikes based on experience from similar Stantec project sites.

Table 12. Seepage Model and Piping Material Properties

Material Type	D_{10} (mm)	D_{60} (mm)	Liquid Limit	M_v	Residual Water Content	Saturated Water Content	Specific Gravity, G_s	Void Ratio, e
Clay Dike 2 - Lean Clay	0.001	0.075	48	3.0000E-06	0.08	0.351	2.71	0.540
Clay Dike 2 - Fat Clay	0.001	0.043	54	1.4358E-05	0.09	0.351	2.71	0.540

Table 13. Model Soil Hydraulic Conductivity

Material Type	Boring	Depth (ft)	K_{sat} (cm/sec)	K_{sat} (ft/sec)*	Anisotropy	K_h (ft/sec)
Clay Dike 2 - Lean Clay	STN-48A	5-15 (Bulk)	2.8e-8			
	STN-52A	5-10 (Bulk)	3.5e-8			
	STN-54A	30.0-30.6	6.5e-8			
Clay Dike 2 - Lean Clay	**Selected Parameters**		4.27E-08	1.40E-09	0.1	1.40E-08
Clay Dike 2 - Fat Clay	STN-58	10-20 (Bulk)	2.7e-8			
Clay Dike 2 - Fat Clay	**Selected Parameters**		2.70E-08	8.86E-10	0.1	8.86E-09

(*K_v assumed from testing)

5. Alluvial (Clay)
6. Alluvial (Granular)

Field investigations for Stantec (2010 and 2009b) suggested two primary layers: alluvial (clay) and alluvial (granular). The alluvial material showed increased sand and gravel percentages in zones classifying as silty gravel with sand or poorly graded clayey gravel. This would also be logical based on the nearby meandering creek channel.

Moist unit weights for alluvial (clay) were estimated using the Stantec (2010) undisturbed samples. The moist unit weights ranged from 100.7 to 127.2 pcf with an average over 10 measurements of 118.3 pcf. Average blow counts for alluvial (clay) and alluvial (granular) were 13 and 19, respectively. Undisturbed samples of the alluvial (granular) layer were not available. The soil properties used were based on

Stantec (2009b) and empirical values. Tables 14 and 15 summarize the shear strength testing results and model parameters for the alluvial soils.

Table 14. Alluvial (Clay) Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2010)	STN-54A, 45.2-46.4	124.9	220.3	33.3
	STN-54A, 45.2-46.4	125.8		
Stantec (2010)	**Selected Parameters for Stability Analyses**	124	200	33

Table 15. Alluvial (Granular) Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2010)	**Selected Parameters for Stability Analyses**	130	0	32

Please refer to Attachment 2 for the Stantec (2010) laboratory testing summary tables supporting Table 16 geotechnical testing results. Hydraulic conductivity test results for alluvial soils are also listed in Table 17. The anisotropy parameter is assumed for alluvial soils based on experience from similar Stantec project sites.

Table 16. Seepage Model and Piping Material Properties

Material Type	D_{10} (mm)	D_{60} (mm)	Liquid Limit	M_v	Residual Water Content	Saturated Water Content	Specific Gravity, G_s	Void Ratio, e
Alluvial – Clay	0.001	0.1	47	4.7860E-05	0.07	0.401	2.67	0.667
Alluvial – Granular	0.001	6	0	2.3925E-06	0.02	0.27	2.68	0.370

Table 17. Model Soil Hydraulic Conductivity

Material Type	Boring	Depth (ft)	K_{sat} (cm/sec)	K_{sat} (ft/sec)*	Anisotropy	K_h (ft/sec)
Alluvial – Clay	STN-53A	43.8-43.2	7.4e-8			
Alluvial – Clay	**Selected Parameters**		7.41E-08	2.43E-09	0.05	4.86E-08
Alluvial – Granular	**Selected Parameters**		1.00E-04	3.28E-06	0.05	6.56E-05

(*K_v assumed from testing)

7. Bedrock

This shale and limestone layer will be modeled as largely impenetrable layer in the slope stability and seepage models. The weaker, shallower materials will control the slope stability. Low hydraulic conductivity of the rock layer is conservative, forcing more seepage through the alluvial and dike soils. The seepage model results were compared to field piezometric readings along the dike to try to reflect what was happening in the field.

Table 18. Seepage Model and Piping Material Properties

Material Type	D_{10} (mm)	D_{60} (mm)	Liquid Limit	M_v	Residual Water Content	Saturated Water Content	Specific Gravity, G_s	Void Ratio, e
Bedrock	--	--	--	0.0000E+00	0	0.05	--	--

Table 19. Model Soil Hydraulic Conductivity

Material Type	K_{sat} (cm/sec)	K_{sat} (ft/sec)*	Anisotropy	K_h (ft/sec)
Bedrock	3.05E-11	1.00E-12	0.1	1.00E-11

(*K_v assumed from testing)

CONCLUSIONS:

Table 20 summarizes the recommended soil material properties for the slope stability analyses. Tables 21 and 22 summarize the recommended soil material properties for the seepage model and piping analyses. Care should still be taken when applying these properties to specific model cross sections. Field investigation data varying greatly from these recommended properties should be discussed with the project team prior to performing the analyses.

Table 20. Slope Stability Model Material Properties

Material Type	Unit Weight, γ (pcf)	Effective Stress	
		Cohesion, c' (psf)	Friction Angle, ϕ' (deg)
Clay Dike 1 - Lean Clay**	123	200	22
Clay Dike 1 - Fat Clay	119	200	22
Clay Dike 2 - Lean Clay***	123	200	32
Clay Dike 2 - Fat Clay	119	220	29
Fly Ash - Sluiced	100	0	22
Alluvial – Clay*	124	200	33
Alluvial – Granular	130	0	32
Bedrock	Impenetrable		

* Covers Alluvial (Clay) or Alluvial (Fat)

** Covers Dike 1 (Clay), Dike 1 (Lean), or Dike 1 (Lean) - Gravel

*** Covers Dike 2 (Lean) or Dike 2 (Lean) - Gravel

Table 21. Seepage Model and Piping Material Properties

Material Type	D_{10} (mm)	D_{60} (mm)	Liquid Limit	M_v	Residual Water Content	Saturated Water Content	Specific Gravity, G_s	Void Ratio, e
Clay Dike 1 - Lean Clay	0.001	0.1	38	3.0000E-06	0.06	0.413	2.67	0.704
Clay Dike 1 - Fat Clay	0.001	0.05	69	1.4358E-05	0.09	0.415	2.67	0.709
Clay Dike 2 - Lean Clay	0.001	0.075	48	3.0000E-06	0.08	0.351	2.71	0.540
Clay Dike 2 - Fat Clay	0.001	0.043	54	1.4358E-05	0.09	0.351	2.71	0.540
Fly Ash - Sluiced	0.004	0.049	0	6.2218E-05	0.015	0.3548	2.50	0.550
Alluvial – Clay	0.001	0.1	47	4.7860E-05	0.07	0.401	2.67	0.667
Alluvial – Granular	0.001	6	0	2.3925E-06	0.02	0.27	2.68	0.370
Bedrock	--	--	--	0.0000E+00	0	0.05	--	--

Table 22. Model Soil Hydraulic Conductivity

Material Type	K_{sat} (cm/sec)	K_{sat} (ft/sec)*	Anisotropy	K_h (ft/sec)
Clay Dike 1 - Lean Clay	6.50E-07	2.13E-08	0.1	2.13E-07
Clay Dike 1 - Fat Clay	2.70E-08	8.86E-10	0.1	8.86E-09
Clay Dike 2 - Lean Clay	4.27E-08	1.40E-09	0.1	1.40E-08
Clay Dike 2 - Fat Clay	2.70E-08	8.86E-10	0.1	8.86E-09
Fly Ash - Sluiced	8.41E-05	2.76E-06	0.02	1.38E-04
Alluvial – Clay	7.41E-08	2.43E-09	0.05	4.86E-08
Alluvial – Granular	1.00E-04	3.28E-06	0.05	6.56E-05
Bedrock	3.05E-11	1.00E-12	0.1	1.00E-11

(*K_v assumed from testing)

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Attachment 1
Figures

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STANTEC
CONSULTING
SERVICES INC.

1409 N. Forbes Rd.
Lexington, Kentucky
40511-2050
859-422-3000

Stantec

Proposed Boring Plan - Ash Pond

Tennesee Valley Authority
Cumberland Fossil Plant
Cumberland, Stewart County, Tennessee

PROJECT NO.	175539016
DATE	JULY 2009
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STANTEC
CONSULTING
SERVICES INC.

1409 N. Forbes Rd.
Lexington, Kentucky
40511-2050
859-422-3000

Proposed Boring Plan
Dry Ash Stack & Gypsum Disposal Area

Tennessee Valley Authority
Cumberland Fossil Plant
Cumberland, Stewart County, Tennessee

PROJECT NO.	171468118
DATE	March 27, 2009
DRAWN BY	DLF
CHECKED BY	
CHECKED BY	
SCALE	1:6000
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Attachment 2
Geotechnical Laboratory Summary Tables

Cumberland Fossil Plant
Ash Pond Laboratory Results Summary
Project No. 175539016

				Particle Size				Atterberg Limits					Standard Proctor			Classification										CU Triaxial							
Hole	Depth	Sample Type	Material	Gravel	Sand	Silt	Clay	Gs	LL	PL	PI	AI	w_{opt} (%)	γ_{dmax} (pcf)	MC	USCS	Group Name	AASHTO	FHP, 2.8" (cm/s)	FHP, 2.8" (ft/s)	w_0 (%)	γ_t (pcf)	γ_d (pcf)	% Compaction		S_{r0} (%)	e_0	γ_{w0} (pcf)	w_0 (%)	γ_{d0} (pcf)	c' (psi)	c' (psf)	ϕ' (deg)
47	16.5-32.5	comp	Alluvial (Clay)	1.3	9.1	44.2	45.4	2.67	45	18	27	0.73			25.2	CL	Lean clay	A-7-6 (25)															
51	31-50	comp	Alluvial (Clay)	0.2	8.3	64.8	26.7	2.62	30	20	10	0.48			27.4	CL	Lean Clay	A-4 (9)															
52	22.5-42.5	comp	Alluvial (Clay)	13.2	19.7	26	41.1	2.71	48	16	32	0.91			22.8	CL	Sandy Lean Clay	A-7-6 (19)															
53A	43.8-44.2	ST	Alluvial (Clay)																7.40E-08	2.43E-09	27.2	120.6	94.9		Gray-brown sandy lean clay								
54A	45.2-46.4	ST	Alluvial (Clay)																							98.1	0.686	124.9	24.9	99.97	0.349	220.3	33.3
54A	45.2-46.4	ST	Alluvial (Clay)																							96.3	0.651	125.8	23.2	102.1			
60	33-42	comp	Alluvial (Fat Clay)	1.9	7.4	28.7	62	2.68	68	23	45	0.83			29.7	CH	Fat Clay	A-7-6 (46)															
51	53.5-62.5	comp	Alluvial (Granular)	33	48.7	11	7.3	2.66	NP	NP	NP	NP			21.7	SM	Silty Sand with Gravel	A-1-b (0)															
52	68.5-80	comp	Alluvial (Granular)	58.8	29.3	6.8	5.1	2.66	NP	NP	NP	NP			21.5	GP-GM	Poorly graded gravel with silt and sand	A-1-a (0)															
55	24-48.5	comp	Alluvial (Granular)	46.3	18.4	15.9	19.4	2.65	45	25	20	1.25			30.1	GC	Clayey gravel with sand	A-2-7 (2)															
56	34.5-39	comp	Alluvial (Granular)	30.8	20	26.5	22.7	2.73	41	28	13	0.76			35.7	GM	Silty gravel with sand	A-7-6 (4)															
58	32.5-39	comp	Alluvial (Granular)	17.8	40.1	15.1	27	2.68	68	36	32	1.33			37.4	SM	Silty Sand with Gravel	A-7-5 (8)															
58	42.5-58.1	comp	Alluvial (Granular)	25.7	28.8	17.3	28.2	2.67	57	23	34	1.42			27.1	SC	Clayey Sand with Gravel	A-7-6 (11)															
58	60 - 60.2	SPT	Alluvial (Granular)												6.7																		
47	0-13.5	comp	Dike 1 (Clay)	2.3	9.1	43.9	44.7	2.70	40	21	19	0.49			21.4	CL	Lean clay	A-6 (17)															
51	1.5-18	comp	Dike 1 (Clay)	1	18.2	45.7	35.1	2.67	35	18	17	0.59			18.8	CL	Lean Clay with Sand	A-6 (13)															
55	0-7.5	comp	Dike 1 (Clay)	23	17.4	25	34.6	2.65	52	20	32	1.07			19.9	CH	Gravelly Fat Clay with Sand	A-7-6 (16)															
55	9-19.5	comp	Dike 1 (Clay)	7.6	16.9	38.1	37.4	2.65	42	17	25	0.83			21.8	CL	Lean Clay with Sand	A-7-6 (18)															
59	4.5-18	comp	Dike 1 (Fat)	22	27.7	12.5	37.8	2.67	72	25	47	1.38			43.5	CH	Sandy fat clay with Gravel	A-7-6 (18)															
60	18-31.5	comp	Dike 1 (Fat)	1.1	9	24.9	65	2.66	69	27	42	0.70			36.4	CH	Fat Clay	A-7-6 (43)															
57	7.5-18	comp	Dike 1 (Lean)	4.7	29	38.7	27.6	2.69	34	21	13	0.68			25.5	CL	Sandy lean clay	A-6 (7)															
58A	25.4-26.0	ST	Dike 1 (Lean)																6.30E-08	2.07E-09	30.8	127.5	97.4		Gray-brown sandy lean clay	90.7	0.83	117.8	27.9	92.13	4.16	220.3	22.3
58A	25.4-26.0	ST	Dike 1 (Lean)																							98.6	0.705	124.3	25.7	98.88			
58	1.5-13.5	comp	Dike 2 (Fat)	7.5	28.3	22.3	41.9	2.68	54	18	36	0.95			21.3	CH	Sandy Fat Clay	A-7-6 (21)															
60	1.5-15	comp	Dike 2 (Fat)	6.5	27	26	40.5	2.70	52	16	36	1.00			22.4	CH	Sandy Fat Clay	A-7-6 (22)															
58	10-20	Bulk	Dike 2 (Fat), Dike 1 (Lean @16)	0	31.6	11.3	57.1	2.7	68	23	45		20.2	103.1		CH	Fat Clay	A-7-6 (30)	2.70E-08	8.86E-10	23.1	121.1	98.4	95.4	Brown sandy fat clay	86.7	0.731	120.3	23.5	97.37	1.77	254.9	29.4
58	10-20	Bulk	Dike 2 (Fat), Dike 1 (Lean @16)																							89.3	0.707	121.9	23.4	98.75			
58	10-20	Bulk	Dike 2 (Fat), Dike 1 (Lean @16)																							90.1	0.707	122.0	23.6	98.72			
48	1.5-16.5	comp	Dike 2 (Lean)	16.5	18.2	30.1	35.2	2.76	49	17	32	1.07			20.9	CL/CH	Sandy lean clay with gravel	A-7-6 (18)															
52	1.5-18	comp	Dike 2 (Lean)	14.7	24.8	27.6	32.9	2.74	46	17	29	0.97			22.4	CL	Sandy Lean Clay	A-7-6 (15)															
48A	5-15	Bulk	Dike 2 (Lean)	0	26.9	36.9	36.2	2.7	54	20	34		18.9	105.6	29.3	CH	Fat Clay	A-7-6 (24)	2.80E-08	9.19E-10	22.1	122.2	100.1	94.8	Brown fat clay with sand	83.0	0.682	121.2	21.0	100.2	1.53	220.3	29.5
48A	5-15	Bulk	Dike 2 (Lean)																							82.1	0.686	120.9	20.9	100.0			
48A	5-15	Bulk	Dike 2 (Lean)																							81.5	0.681	121.0	20.6	100.3			
52A	5-10	Bulk	Dike 2 (Lean)	0	30.6	15.1	54.3	2.7	61	21	40		21.9	102.1		CH	Fat Clay	A-7-6 (27)	3.50E-08	1.15E-09	24.5	120.6	96.8	94.8	Brown sandy fat clay	86.1	0.74	119.7	23.6	96.87	0.675	97.2	29.8
52A	5-10	Bulk	Dike 2 (Lean)																							84.5	0.747	119.1	23.4	96.48			
52A	5-10	Bulk	Dike 2 (Lean)																							84.8	0.744	119.3	23.4	96.68			
54 A	22 - 24	ST	Dike 2 (Lean)																														
54A	30.0-30.6	ST	Dike 2 (Lean)																6.50E-08	2.13E-09	31.1	127.4	97.1		Gray brown lean clay								
54A	30.6-31.8	ST	Dike 2 (Lean)																						Brown silty lean clay with sand	102.7	0.533	132.3	20.3	110	3.06	220.3	32.1
54A	30.6-31.8	ST	Dike 2 (Lean)																							96.9	0.541	130.6	19.4	109.4			
48	18-33.7	comp	Dike 2 (Lean) - Gravel	43.7	24.1	11.6	20.6	2.70	52	18	34	1.89			21.3	GC	Clayey gravel with sand	A-2-7 (4)															
	fill soil		Fill					2.70					14.6	114.3	14.2																		
	fill soil		Fill	24.7	22.1	25.9	27.3	2.68	33	18	15	0.65			14.2	CL	Gravelly lean clay with sand	A-6 (5)															

Cumberland Fossil Plant
Stantec Ash Pond Laboratory Results
Project No. 175539016

						Particle Size						Atterberg Limits				Standard Proctor			Classification		
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	Particle Size	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO
1	47	0 - 1.5	SPT	Dike 1 (Clay)	1													20.2			
3	47	1.5 - 3	SPT	Dike 1 (Clay)	1					1	1				1			15.4			
4	47	3 - 4.5	SPT	Dike 1 (Clay)	1					1	1				1			17.3			
5	47	4.5 - 6	SPT	Dike 1 (Clay)	1					1	1				1			18.1			
6	47	6 - 7.5	SPT	Dike 1 (Clay)	1					1	1				1			19.1			
7	47	7.5 - 9	SPT	Dike 1 (Clay)	1					1	1				1			21.4			
8	47	9 - 10.5	SPT	Dike 1 (Clay)	1					1	1				1			22.6			
9	47	10.5 - 12	SPT	Dike 1 (Clay)	1					1	1				1			29.4			
10	47	12 - 13.5	SPT	Dike 1 (Clay)	1					1	1				1			27.7			
2	47	0-13.5	comp	Dike 1 (Clay)	1	2.3	9.1	43.9	44.7	100	2.70	40	21	19	0.49			21.4	CL	Lean clay	A-6 (17)
11	47	13.5 - 15	SPT	Dike 1 (Clay)														23.8			
12	47	15 - 16.5	SPT	Dike 1 (Clay)														24.5			
14	47	16.5 - 18	SPT	Dike 1 (Clay)	2					2	2				2			20.5			
15	47	18 - 19.5	SPT	Dike 1 (Clay)	2					2	2				2			25.7			
16	47	19.5 - 21	SPT	Alluvial (Clay)	2					2	2				2			22.4			
17	47	21 - 22.5	SPT	Alluvial (Clay)	2					2	2				2			25			
18	47	22.5 - 24	SPT	Alluvial (Clay)	2					2	2				2			22.9			
19	47	24 - 25.5	SPT	Alluvial (Clay)	2					2	2				2			22.1			
20	47	25.5 - 27	SPT	Alluvial (Clay)	2					2	2				2			26			
21	47	27 - 28.5	SPT	Alluvial (Clay)	2					2	2				2			30.7			
22	47	28.5 - 30	SPT	Alluvial (Clay)	2					2	2				2			28.3			
23	47	31 - 32.5	SPT	Alluvial (Clay)	2					2	2				2			28.8			
13	47	16.5-32.5	comp	Alluvial (Clay)	2	1.3	9.1	44.2	45.4	100	2.67	45	18	27	0.73			25.2	CL	Lean clay	A-7-6 (25)
24	47	33.5 - 35	SPT	Alluvial (Clay)														36.8			
25	47	36 - 37.5	SPT	Alluvial (Clay)														32.6			
26	47	38.5 - 40	SPT	Alluvial (Clay)														34.1			
27	47	40.4 - 40.5	SPT	Alluvial (Clay)														2.6			
28	48	0 - 1.5	SPT	Dike 2 (Lean)														11.6			
29	48	1.5 - 3	SPT	Dike 2 (Lean)	3													20.8			
31	48	3 - 4.5	SPT	Dike 2 (Lean)	3					3	3				3			23.6			
32	48	4.5 - 6	SPT	Dike 2 (Lean)	3					3	3				3			18.8			
33	48	6 - 7.5	SPT	Dike 2 (Lean)	3					3	3				3			18.4			
34	48	7.5 - 9	SPT	Dike 2 (Lean)	3					3	3				3			15.6			
35	48	9 - 10.5	SPT	Dike 2 (Lean)	3					3	3				3			20.2			
36	48	10.5 - 12	SPT	Dike 2 (Lean)	3					3	3				3			23.9			
37	48	12 - 13.5	SPT	Dike 2 (Lean)	3					3	3				3			20			
38	48	13.5 - 15	SPT	Dike 2 (Lean)	3					3	3				3			22.4			
39	48	15 - 16.5	SPT	Dike 2 (Lean)	3					3	3				3			25.1			
30	48	1.5-16.5	comp	Dike 2 (Lean)	3	16.5	18.2	30.1	35.2	100	2.76	49	17	32	1.07			20.9	CL/CH	Sandy lean clay with gravel	A-7-6 (18)
40	48	16.5 - 18	SPT	Dike 2 (Lean)														18.5			
42	48	18 - 19.5	SPT	Dike 2 (Lean) - Gravel	4					4	4				4			22.4			
43	48	19.5 - 21	SPT	Dike 2 (Lean) - Gravel	4					4	4				4			23.9			
44	48	21 - 22.5	SPT	Dike 2 (Lean) - Gravel	4					4	4				4			9.6			
45	48	22.5 - 24	SPT	Dike 2 (Lean) - Gravel	4					4	4				4			23.4			
46	48	24 - 25.5	SPT	Dike 2 (Lean) - Gravel	4					4	4				4			17.9			
47	48	25.5 - 27	SPT	Dike 2 (Lean) - Gravel	4					4	4				4			21.5			
48	48	27 - 27.9	SPT	Dike 2 (Lean) - Gravel	4					4	4				4			17.9			

						Particle Size						Atterberg Limits				Standard Proctor			Classification		
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	Particle Size	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO
49	48	28.5 - 28.8	SPT	Dike 2 (Lean) - Gravel	4					4	4				4			NR			
50	48	31 - 32.5	SPT	Dike 2 (Lean) - Gravel	4					4	4				4			20.8			
51	48	33.5 - 33.7	SPT	Dike 2 (Lean) - Gravel	4					4	4				4			34.5			
41	48	18-33.7	comp	Dike 2 (Lean) - Gravel	4	43.7	24.1	11.6	20.6	100	2.70	52	18	34	1.89			21.3	GC	Clayey gravel with sand	A-2-7 (4)
52	48	36 - 37.5	SPT	Alluvial (Granular)														24.7			
53	48	38.5 - 40	SPT	Alluvial (Granular)														26.5			
54	48	41 - 42.5	SPT	Alluvial (Granular)														27.5			
55	48	43.5 - 45	SPT	Alluvial (Granular)														24			
56	48	46 - 47.5	SPT	Alluvial (Granular)														29.1			
57	48	48.5 - 49.9	SPT	Alluvial (Granular)														19.9			
58	48	51 - 52.5	SPT	Alluvial (Granular)														27.1			
59	48	53.5 - 54.8	SPT	Alluvial (Granular)														26.1			
	48 A	5-15	BAG	Dike 2 (Lean)						X	X				x		x		x		
60	49	0 - 1.5	SPT	Dike 1 (Clay)														24.3			
61	49	1.5 - 3	SPT	Dike 1 (Clay)														27.8			
62	49	3 - 4.5	SPT	Dike 1 (Clay)														21.7			
63	49	4.5 - 6	SPT	Dike 1 (Clay)														19.9			
64	49	6 - 7.5	SPT	Dike 1 (Clay)														20			
65	49	7.5 - 9	SPT	Dike 1 (Clay)														23			
66	49	9 - 10.5	SPT	Dike 1 (Clay)														21.7			
67	49	10.5 - 12	SPT	Dike 1 (Clay)														27.1			
68	49	12 - 13.5	SPT	Dike 1 (Clay)														27.2			
69	49	13.5 - 15	SPT	Dike 1 (Clay)														23.6			
70	49	15 - 16.5	SPT	Dike 1 (Clay)														30.7			
71	49	16.5 - 18	SPT	Dike 1 (Clay)														30.8			
72	49	18 - 19.5	SPT	Dike 1 (Clay)														29.4			
73	49	19.5 - 21	SPT	Alluvial (Clay)														31			
74	49	21 - 22.5	SPT	Alluvial (Clay)														29.4			
75	49	22.5 - 24	SPT	Alluvial (Clay)														31.8			
76	49	24 - 25.5	SPT	Alluvial (Clay)														32.9			
77	49	26 - 27.5	SPT	Alluvial (Clay)														31			
78	49	28.5 - 30	SPT	Alluvial (Clay)														31.8			
79	49	31 - 32.5	SPT	Alluvial (Clay)														31.5			
80	49	33.5 - 35	SPT	Alluvial (Clay)														32.3			
81	49	36 - 37.5	SPT	Alluvial (Clay)														27.8			
82	49	38.5 - 40	SPT	Alluvial (Clay)														31.6			
83	49	41 - 42.5	SPT	Alluvial (Clay)														25.4			
84	49	43.5 - 45	SPT	Alluvial (Clay)														26.8			
85	49	46 - 47.5	SPT	Alluvial (Granular)														36.5			
86	49	48.5 - 50	SPT	Alluvial (Granular)														26.9			
87	49	51 - 52.5	SPT	Alluvial (Granular)														36.2			
88	49	53.5 - 55	SPT	Alluvial (Clay)														28			
89	49	56 - 57.5	SPT	Alluvial (Clay)														26			
90	49	58.5 - 60	SPT	Alluvial (Clay)														21			
91	49	61 - 62.5	SPT	Alluvial (Clay)														20.4			
92	49	63.5 - 64.1	SPT	Alluvial (Clay)														10.9			

Cumberland Fossil Plant
Stantec Ash Pond Laboratory Results

Project No. 175539016

						Particle Size						Atterberg Limits				Standard Proctor			Classification		
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	Particle Size	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO
93	50	0 - 1.5	SPT	Dike 2 (Lean)														16.8			
94	50	1.5 - 3	SPT	Dike 2 (Lean)														15.2			
95	50	3 - 4.5	SPT	Dike 2 (Lean)														24.1			
96	50	4.5 - 6	SPT	Dike 2 (Lean)														22			
97	50	6 - 7.5	SPT	Dike 2 (Lean)														23.5			
98	50	7.5 - 9	SPT	Dike 2 (Lean)														23.6			
99	50	9 - 10.5	SPT	Dike 2 (Lean)														24.7			
100	50	10.5 - 12	SPT	Dike 2 (Lean)														20.4			
101	50	12 - 13.5	SPT	Dike 2 (Lean)														20.7			
102	50	13.5 - 15	SPT	Dike 2 (Lean)														22.5			
103	50	15 - 16.5	SPT	Dike 2 (Lean)														22.4			
104	50	16.5 - 18	SPT	Dike 2 (Lean)														19.7			
105	50	18 - 19.5	SPT	Dike 2 (Lean)														19.1			
106	50	19.5 - 21	SPT	Dike 2 (Lean) - Gravel														20.2			
107	50	21 - 22.5	SPT	Dike 2 (Lean) - Gravel														8.7			
108	50	22.5 - 24	SPT	Dike 2 (Lean) - Gravel														20.2			
109	50	24 - 25.5	SPT	Dike 2 (Lean) - Gravel														20.6			
110	50	25.5 - 27	SPT	Dike 2 (Lean) - Gravel														31.4			
111	50	27 - 28.5	SPT	Dike 2 (Lean) - Gravel														28			
112	50	28.5 - 30	SPT	Dike 2 (Lean) - Gravel														40.1			
113	50	31 - 32.5	SPT	Dike 2 (Lean) - Gravel														38.5			
114	50	33.5 - 35	SPT	Dike 2 (Lean) - Gravel														NR			
115	50	36 - 37.3	SPT	Dike 2 (Lean) - Gravel														NR			
424	50 A	33.5 - 35	SPT	Dike 2 (Lean) - Gravel														33			
425	50 A	36 - 36	SPT	Dike 2 (Lean) - Gravel														NR			
426	50 A	43.5 - 45	SPT	Alluvial (Clay)														NR			
427	50 A	46 - 47.3	SPT	Alluvial (Clay)														19.9			
428	50 A	48.5 - 50	SPT	Alluvial (Clay)														31.7			
429	50 A	51 - 52.5	SPT	Alluvial (Clay)														36.4			
430	50 A	54 - 54	SPT	Alluvial (Clay)														NR			
431	50 A	56 - 57.5	SPT	Alluvial (Clay)														29			
432	50 A	58.5 - 60	SPT	Alluvial (Clay)														28.2			
433	50 A	61 - 62.5	SPT	Alluvial (Clay)														31.5			
434	50 A	63.5 - 65	SPT	Alluvial (Clay)														26.4			
435	50 A	66 - 67.5	SPT	Alluvial (Clay)														26.8			
436	50 A	68.5 - 70	SPT	Alluvial (Clay)														29.1			
437	50 A	71 - 72.5	SPT	Alluvial (Clay)														32.2			
438	50 A	73.5 - 75	SPT	Alluvial (Clay)														19.1			
439	50 A	76 - 77.5	SPT	Alluvial (Clay)														33.7			
440	50 A	78.5 - 80	SPT	Alluvial (Clay)														27.1			
441	50 A	81 - 82.5	SPT	Alluvial (Clay)														36			
442	50 A	83.5 - 85	SPT	Alluvial (Clay)														30			
443	50 A	86 - 87.5	SPT	Alluvial (Clay)														29.4			
444	50 A	88.5 - 90	SPT	Alluvial (Clay)														25.7			
	50 B	15-17	ST	Dike 2 (Lean)																	

Cumberland Fossil Plant
Stantec Ash Pond Laboratory Results
Project No. 175539016

						Particle Size						Atterberg Limits				Standard Proctor			Classification		
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	Particle Size	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO
116	51	0 - 1.5	SPT	Dike 1 (Clay)														20.3			
118	51	1.5 - 3	SPT	Dike 1 (Clay)	5					5	5				5			11.9			
119	51	3 - 4.5	SPT	Dike 1 (Clay)	5					5	5				5			19.6			
120	51	4.5 - 6	SPT	Dike 1 (Clay)	5					5	5				5			18.7			
121	51	6 - 7.5	SPT	Dike 1 (Clay)	5					5	5				5			20.3			
122	51	7.5 - 9	SPT	Dike 1 (Clay)	5					5	5				5			17.1			
123	51	9 - 10.5	SPT	Dike 1 (Clay)	5					5	5				5			19.1			
124	51	10.5 - 12	SPT	Dike 1 (Clay)	5					5	5				5			21.3			
125	51	12 - 13.5	SPT	Dike 1 (Clay)	5					5	5				5			20.2			
126	51	13.5 - 15	SPT	Dike 1 (Clay)	5					5	5				5			19.5			
127	51	15 - 16.5	SPT	Dike 1 (Clay)	5					5	5				5			19.2			
128	51	16.5 - 18	SPT	Dike 1 (Clay)	5					5	5				5			19.6			
117	51	1.5-18	comp	Dike 1 (Clay)	5	1	18.2	45.7	35.1	100	2.67	35	18	17	0.59			18.8	CL	Lean Clay with Sand	A-6 (13)
129	51	18 - 19.5	SPT	Dike 1 (Clay)														20			
130	51	19.5 - 21	SPT	Alluvial (Clay)														20.7			
131	51	21 - 22.5	SPT	Alluvial (Clay)														20.9			
132	51	23.5 - 25	SPT	Alluvial (Clay)														20.2			
133	51	26 - 27.5	SPT	Alluvial (Clay)														24.5			
134	51	28.5 - 30	SPT	Alluvial (Clay)														26.5			
136	51	31 - 31.3	SPT	Alluvial (Clay)	6					6	6				6			24			
137	51	33.5 - 35	SPT	Alluvial (Clay)	6					6	6				6			26.7			
138	51	36 - 37.5	SPT	Alluvial (Clay)	6					6	6				6			28.5			
139	51	38.5 - 40	SPT	Alluvial (Clay)	6					6	6				6			29.1			
140	51	41 - 42.5	SPT	Alluvial (Clay)	6					6	6				6			26.2			
141	51	43.5 - 45	SPT	Alluvial (Clay)	6					6	6				6			26.5			
142	51	46 - 47.5	SPT	Alluvial (Clay)	6					6	6				6			26.4			
143	51	48.5 - 50	SPT	Alluvial (Clay)	6					6	6				6			32			
135	51	31-50	comp	Alluvial (Clay)	6	0.2	8.3	64.8	26.7	100	2.62	30	20	10	0.48			27.4	CL	Lean Clay	A-4 (9)
144	51	51 - 52.5	SPT	Alluvial (Granular)														25.8			
146	51	53.5 - 55	SPT	Alluvial (Granular)	7					7	7				7			24.7			
147	51	56 - 57.5	SPT	Alluvial (Granular)	7					7	7				7			21.1			
148	51	58.5 - 60	SPT	Alluvial (Granular)	7					7	7				7			21.7			
149	51	61 - 62.5	SPT	Alluvial (Granular)	7					7	7				7			19.1			
145	51	53.5-62.5	comp	Alluvial (Granular)	7	33	48.7	11	7.3	100	2.66	NP	NP	NP	NP			21.7	SM	Silty Sand with Gravel	A-1-b (0)
150	51	63.5 - 65	SPT	Alluvial (Granular)														19.7			
151	51	66 - 66.4	SPT	Alluvial (Granular)														14.5			
152	52	0 - 1.5	SPT	Dike 2 (Lean)														17.4			
153	52	1.5 - 3	SPT	Dike 2 (Lean)	8													23			
155	52	3 - 4.5	SPT	Dike 2 (Lean)	8					8	8				8			27			
156	52	4.5 - 6	SPT	Dike 2 (Lean)	8					8	8				8			23			
157	52	6 - 7.5	SPT	Dike 2 (Lean)	8					8	8				8			20.9			
158	52	7.5 - 9	SPT	Dike 2 (Lean)	8					8	8				8			22.2			
159	52	9 - 10.5	SPT	Dike 2 (Lean)	8					8	8				8			26.9			
160	52	10.5 - 12	SPT	Dike 2 (Lean)	8					8	8				8			21			
161	52	12 - 13.5	SPT	Dike 2 (Lean)	8					8	8				8			23.7			
162	52	13.5 - 15	SPT	Dike 2 (Lean)	8					8	8				8			19.6			

Cumberland Fossil Plant
Stantec Ash Pond Laboratory Results

Project No. 175539016

						Particle Size						Atterberg Limits				Standard Proctor			Classification		
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	Particle Size	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO
163	52	15 - 16.5	SPT	Dike 2 (Lean)	8					8	8				8			23.3			
164	52	16.5 - 18	SPT	Dike 2 (Lean)	8					8	8				8			16.1			
154	52	1.5-18	comp	Dike 2 (Lean)	8	14.7	24.8	27.6	32.9	100	2.74	46	17	29	0.97			22.4	CL	Sandy Lean Clay	A-7-6 (15)
165	52	18 - 18.9	SPT	Dike 2 (Lean)														18.1			
166	52	19.5 - 21	SPT	Dike 2 (Lean) - Gravel														8			
167	52	21 - 22.5	SPT	Dike 2 (Lean) - Gravel														18.4			
169	52	22.5 - 24	SPT	Dike 2 (Lean) - Gravel	9					9	9				9			29.4			
170	52	24 - 25.5	SPT	Dike 2 (Lean) - Gravel	9					9	9				9			33.6			
171	52	25.5 - 27	SPT	Dike 2 (Lean) - Gravel	9					9	9				9			21.1			
172	52	27 - 28.5	SPT	Dike 2 (Lean) - Gravel	9					9	9				9			23.7			
173	52	28.5 - 30	SPT	Dike 2 (Lean) - Gravel	9					9	9				9			10.8			
174	52	31 - 32.5	SPT	Dike 2 (Lean) - Gravel	9					9	9				9			24.3			
175	52	33.5 - 35	SPT	Dike 2 (Lean) - Gravel	9					9	9				9			22.5			
176	52	36 - 37.5	SPT	Alluvial (Clay)	9					9	9				9			13.6			
177	52	38.5 - 40	SPT	Alluvial (Clay)	9					9	9				9			19.5			
178	52	41 - 42.5	SPT	Alluvial (Clay)	9					9	9				9			29.4			
168	52	22.5-42.5	comp	Alluvial (Clay)	9	13.2	19.7	26	41.1	100	2.71	48	16	32	0.91			22.8	CL	Sandy Lean Clay	A-7-6 (19)
179	52	43.5 - 45	SPT	Alluvial (Clay)														25.8			
180	52	46 - 47.5	SPT	Alluvial (Clay)														24.9			
181	52	48.5 - 50	SPT	Alluvial (Clay)														25.4			
182	52	51 - 52.5	SPT	Alluvial (Clay)														27.3			
183	52	53.5 - 55	SPT	Alluvial (Clay)														27.8			
184	52	56 - 57.5	SPT	Alluvial (Clay)														28.7			
185	52	58.5 - 60	SPT	Alluvial (Clay)														27.6			
186	52	61 - 62.5	SPT	Alluvial (Clay)														27.3			
187	52	63.5 - 65	SPT	Alluvial (Clay)														36.4			
188	52	66 - 67.5	SPT	Alluvial (Clay)														26.9			
190	52	68.5 - 70	SPT	Alluvial (Granular)	10					10	10				10			26.3			
191	52	71 - 72.5	SPT	Alluvial (Granular)	10					10	10				10			18.3			
192	52	73.5 - 75	SPT	Alluvial (Granular)	10					10	10				10			24.8			
193	52	76 - 77.5	SPT	Alluvial (Granular)	10					10	10				10			21.7			
194	52	78.5 - 80	SPT	Alluvial (Granular)	10					10	10				10			16.2			
189	52	68.5-80	comp	Alluvial (Granular)	10	58.8	29.3	6.8	5.1	100	2.66	NP	NP	NP	NP			21.5	GP-GM	Poorly graded gravel with silt and sand	A-1-a (0)
195	52	81 - 81.8	SPT	Alluvial (Granular)														15.1			
196	52	83.5 - 83.7	SPT	Alluvial (Granular)														11.3			
	52 A	5-10	BAG	Dike 2 (Lean)						x					x				x		
197	53	0 - 1.5	SPT	Dike 1 (Clay)														22.1			
198	53	1.5 - 3	SPT	Dike 1 (Clay)														18.3			
199	53	3 - 4.5	SPT	Dike 1 (Clay)														27			
200	53	4.5 - 6	SPT	Dike 1 (Clay)														26.5			
201	53	6 - 7.5	SPT	Dike 1 (Clay)														17			
202	53	7.5 - 9	SPT	Dike 1 (Clay)														23.1			
203	53	9 - 10.5	SPT	Dike 1 (Clay)														27.3			
204	53	10.5 - 12	SPT	Dike 1 (Clay)														20.5			
205	53	12 - 13.5	SPT	Dike 1 (Clay)														21.5			
206	53	13.5 - 15	SPT	Dike 1 (Clay)														22.4			

						Particle Size						Atterberg Limits				Standard Proctor			Classification		
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	Particle Size	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO
207	53	15 - 16.5	SPT	Dike 1 (Clay)														20.3			
208	53	16.5 - 18	SPT	Dike 1 (Clay)														23.3			
209	53	18 - 19.5	SPT	Dike 1 (Clay)														18.5			
210	53	19.5 - 21	SPT	Dike 1 (Clay)														18			
211	53	21 - 22.5	SPT	Dike 1 (Clay)														26.7			
212	53	22.5 - 24	SPT	Dike 1 (Clay)														27.8			
213	53	24 - 25.5	SPT	Dike 1 (Clay)														26.1			
214	53	25.5 - 27	SPT	Dike 1 (Clay)														NR			
	53 A	8-10	ST	Dike 1 (Clay)																	
445	53 A	29.5 - 31	SPT	Alluvial (Clay)														25.8			
446	53 A	31 - 33.5	SPT	Alluvial (Clay)														22.3			
447	53 A	33.5 - 38.5	SPT	Alluvial (Clay)														27.8			
448	53 A	38.5 - 41	SPT	Alluvial (Clay)														26.8			
449	53 A	41 - 46	SPT	Alluvial (Clay)														25.1			
	53 A	43-45	ST	Alluvial (Clay)																	
450	53 A	46 - 48.5	SPT	Alluvial (Clay)														25.8			
451	53 A	48.5 - 51	SPT	Alluvial (Granular)														35.7			
452	53 A	51 - 53.5	SPT	Alluvial (Granular)														32.5			
453	53 A	53.5 - 56	SPT	Alluvial (Granular)														20.1			
454	53 A	56 - 58.5	SPT	Alluvial (Granular)														22.1			
455	53 A	58.5 - 61	SPT	Alluvial (Granular)														21.8			
456	53 A	61 - 63.5	SPT	Alluvial (Granular)														29.4			
457	53 A	63.5 - 66	SPT	Alluvial (Granular)														25.7			
458	53 A	66 - 68.5	SPT	Alluvial (Granular)														19.4			
459	53 A	68.5 - 71	SPT	Alluvial (Granular)														19.4			
460	53 A	71 - 73.5	SPT	Alluvial (Granular)														30.7			
461	53 A	73.5 - 76	SPT	Alluvial (Granular)														24.5			
462	53 A	76 - 78.5	SPT	Alluvial (Granular)														24.6			
463	53 A	78.5 - 81	SPT	Alluvial (Granular)														35.2			
464	53 A	81 - 83.5	SPT	Alluvial (Granular)														28.6			
465	53 A	83.5 - 86	SPT	Alluvial (Granular)														35.9			
466	53 A	86 - 88.5	SPT	Alluvial (Granular)														43.6			
467	53 A	88.5 - 91	SPT	Alluvial (Granular)														43.6			
468	53 A	91 - 93.5	SPT	Alluvial (Granular)														43.3			
469	53 A	93.5 - 95	SPT	Alluvial (Granular)														55.3			
215	54	0 - 1.5	SPT	Dike 2 (Fat)														22.2			
216	54	1.5 - 3	SPT	Dike 2 (Fat)														20.3			
217	54	3 - 4.5	SPT	Dike 2 (Fat)														27.6			
218	54	4.5 - 6	SPT	Dike 2 (Fat)														26.1			
219	54	6 - 7.5	SPT	Dike 2 (Fat)														21.2			
220	54	7.5 - 9	SPT	Dike 2 (Fat)														22.2			
221	54	9 - 10.5	SPT	Dike 2 (Fat)														22.2			
222	54	10.5 - 12	SPT	Dike 2 (Fat)														22.7			
223	54	12 - 13.5	SPT	Dike 2 (Fat)														19.3			
224	54	13.5 - 15	SPT	Dike 2 (Fat)														21.1			
225	54	15 - 16.5	SPT	Dike 2 (Fat)														24.9			

Cumberland Fossil Plant
Stantec Ash Pond Laboratory Results
Project No. 175539016

						Particle Size						Atterberg Limits				Standard Proctor			Classification		
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	Particle Size	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO
226	54	16.5 - 18	SPT	Dike 2 (Fat)														24.3			
227	54	18 - 19.5	SPT	Dike 2 (Lean)														13.7			
228	54	19.5 - 21	SPT	Dike 2 (Lean)														17.9			
229	54	21 - 22.5	SPT	Dike 2 (Lean)														19.3			
230	54	22.5 - 24	SPT	Dike 2 (Lean)														17.5			
231	54	24 - 25.5	SPT	Dike 2 (Lean)														16.1			
232	54	25.5 - 27	SPT	Dike 2 (Lean)														13.2			
233	54	27 - 28.5	SPT	Dike 2 (Lean)														18.2			
234	54	28.5 - 30	SPT	Dike 2 (Lean)														21.1			
235	54	30 - 31.5	SPT	Dike 2 (Lean)														19.5			
236	54	31.5 - 33	SPT	Dike 2 (Lean)														23.2			
237	54	33 - 34.5	SPT	Dike 2 (Lean)														22.2			
238	54	34.5 - 36	SPT	Dike 2 (Lean)														19.6			
239	54	36 - 37.5	SPT	Alluvial (Clay)														22.3			
240	54	37.5 - 39	SPT	Alluvial (Clay)														21			
241	54	39 - 40.5	SPT	Alluvial (Clay)														21			
242	54	40.5 - 42	SPT	Alluvial (Clay)														22.1			
243	54	42 - 43.5	SPT	Alluvial (Clay)														19.7			
244	54	43.5 - 45	SPT	Alluvial (Clay)														21.9			
245	54	45 - 46.5	SPT	Alluvial (Clay)														23.8			
246	54	47.5 - 49	SPT	Alluvial (Clay)														24.8			
247	54	50 - 51.5	SPT	Alluvial (Clay)														23.7			
248	54	52.5 - 54	SPT	Alluvial (Clay)														25.7			
249	54	55 - 56.5	SPT	Alluvial (Clay)														28.3			
250	54	57.5 - 59	SPT	Alluvial (Clay)														36.9			
251	54	60 - 61.5	SPT	Alluvial (Clay)														28.8			
252	54	62.5 - 64	SPT	Alluvial (Clay)														24.5			
253	54	65 - 66.5	SPT	Alluvial (Clay)														26.7			
254	54	67.5 - 69	SPT	Alluvial (Granular)														31.7			
255	54	70 - 71.5	SPT	Alluvial (Granular)														25.4			
256	54	72.5 - 74	SPT	Alluvial (Granular)														27.9			
257	54	75 - 76.5	SPT	Alluvial (Granular)														23.9			
258	54	77.5 - 79	SPT	Alluvial (Granular)														18.7			
259	54	80 - 81.5	SPT	Alluvial (Granular)														16.1			
260	54	82.5 - 84	SPT	Alluvial (Clay)														22.2			
261	54	85 - 86.5	SPT	Alluvial (Granular)														15.6			
262	54	87.5 - 89	SPT	Alluvial (Granular)														16.2			
263	54	90 - 90.1	SPT	Alluvial (Granular)														NR			
470	54 A	6 - 8	ST	Dike 2 (Fat)														NR			
471	54 A	8 - 9.4	ST	Dike 2 (Fat)														NR			
472	54 A	22 - 24	ST	Dike 2 (Lean)														NR			
473	54 A	30 - 32	ST	Dike 2 (Lean)														NR			
474	54 A	45 - 47	ST	Alluvial (Clay)														NR			
265	55	0 - 1.5	SPT	Dike 1 (Clay)	11					11	11				11			21.2			
266	55	1.5 - 3	SPT	Dike 1 (Clay)	11					11	11				11			14.2			
267	55	3 - 4.5	SPT	Dike 1 (Clay)	11					11	11				11			19.7			

						Particle Size						Atterberg Limits				Standard Proctor			Classification		
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	Particle Size	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO
268	55	4.5 - 6	SPT	Dike 1 (Clay)	11					11	11				11			21.8			
269	55	6 - 7.5	SPT	Dike 1 (Clay)	11					11	11				11			22.5			
264	55	0-7.5	comp	Dike 1 (Clay)	11	23	17.4	25	34.6	100	2.65	52	20	32	1.07			19.9	CH	Gravelly Fat Clay with Sand	A-7-6 (16)
270	55	7.5 - 9	SPT	Dike 1 (Clay)														23.4			
272	55	9 - 10.5	SPT	Dike 1 (Clay)	12					12	12				12			20.3			
273	55	10.5 - 12	SPT	Dike 1 (Clay)	12					12	12				12			22.4			
274	55	12 - 13.5	SPT	Dike 1 (Clay)	12					12	12				12			24.2			
275	55	13.5 - 15	SPT	Dike 1 (Clay)	12					12	12				12			20.6			
276	55	15 - 16.5	SPT	Dike 1 (Clay)	12					12	12				12			19.9			
277	55	16.5 - 18	SPT	Dike 1 (Clay)	12					12	12				12			23.7			
278	55	18 - 19.5	SPT	Dike 1 (Clay)	12					12	12				12			21.7			
271	55	9-19.5	comp	Dike 1 (Clay)	12	7.6	16.9	38.1	37.4	100	2.65	42	17	25	0.83			21.8	CL	Lean Clay with Sand	A-7-6 (18)
279	55	19.5 - 21	SPT	Dike 1 (Clay)														23.7			
280	55	21 - 22.5	SPT	Alluvial (Granular)														18			
281	55	22.5 - 24	SPT	Alluvial (Granular)														19.1			
283	55	24 - 25.5	SPT	Alluvial (Granular)	13					13	13				13			17.7			
284	55	25.5 - 28.5	SPT	Alluvial (Granular)	13					13	13				13			25.5			
285	55	28.5 - 31	SPT	Alluvial (Granular)	13					13	13				13			33.6			
286	55	31 - 33.5	SPT	Alluvial (Granular)	13					13	13				13			24.3			
287	55	33.5 - 36	SPT	Alluvial (Granular)	13					13	13				13			23.4			
288	55	36 - 38.5	SPT	Alluvial (Granular)	13					13	13				13			LR			
289	55	38.5 - 41	SPT	Alluvial (Granular)	13					13	13				13			25.1			
290	55	41 - 43.5	SPT	Alluvial (Granular)	13					13	13				13			27.5			
291	55	43.5 - 46	SPT	Alluvial (Granular)	13					13	13				13			64.4			
292	55	46 - 48.5	SPT	Alluvial (Granular)	13					13	13				13			29.5			
282	55	24-48.5	comp	Alluvial (Granular)	13	46.3	18.4	15.9	19.4	100	2.65	45	25	20	1.25			30.1	GC	Clayey gravel with sand	A-2-7 (2)
293	55	48.5 - 51	SPT	Alluvial (Granular)														27.2			
294	55	51 - 53.5	SPT	Alluvial (Granular)														15.9			
295	55	53.5 - 56	SPT	Alluvial (Granular)														37.7			
296	55	56 - 58.5	SPT	Alluvial (Granular)														41.3			
297	55	58.5 - 61	SPT	Alluvial (Granular)														42			
298	55	61 - 63.5	SPT	Alluvial (Granular)														40.4			
299	55	63.5 - 66	SPT	Alluvial (Granular)														63			
300	55	66 - 68.5	SPT	Alluvial (Granular)														63.1			
301	55	68.5 - 71	SPT	Alluvial (Granular)														39.4			
302	55	71 - 73.5	SPT	Alluvial (Granular)														74.2			
303	55	73.5 - 75	SPT	Alluvial (Granular)														36.7			
304	55	75 - 75.1	SPT	Alluvial (Granular)														22			
477	56	0-1.5	SPT	Dike 2 (Fat)														12.5			
478	56	1.5-3	SPT	Dike 2 (Fat)														18.7			
479	56	3-4.5	SPT	Dike 2 (Fat)														22.8			
480	56	4.5-6	SPT	Dike 2 (Fat)														21.7			
481	56	6-7.5	SPT	Dike 2 (Fat)														22.9			
482	56	7.5-9	SPT	Dike 2 (Fat)														26.6			
483	56	9-10.5	SPT	Dike 2 (Fat)														22.5			
484	56	10.5-12	SPT	Dike 2 (Fat)														20.9			
485	56	12-13.5	SPT	Dike 2 (Fat)														23.3			

Cumberland Fossil Plant
Stantec Ash Pond Laboratory Results

Project No. 175539016

						Particle Size						Atterberg Limits				Standard Proctor			Classification		
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	Particle Size	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO
486	56	13.5-15	SPT	Dike 2 (Fat)														23.7			
487	56	15-16.5	SPT	Dike 2 (Fat)														23.2			
488	56	16.5-18	SPT	Dike 2 (Fat)														22.9			
489	56	18-19.5	SPT	Dike 2 (Fat)														22			
490	56	19.5-21	SPT	Dike 2 (Fat)														21.8			
491	56	21-22.5	SPT	Dike 2 (Fat)														26.4			
492	56	22.5-24	SPT	Dike 2 (Fat)														17.6			
493	56	24-25.5	SPT	Dike 2 (Fat)														17.8			
494	56	25.5-27	SPT	Dike 2 (Fat)														17.8			
495	56	27-28.5	SPT	Dike 2 (Fat)														18.5			
496	56	28.5-30	SPT	Dike 2 (Fat)														31.5			
497	56	30-31.5	SPT	Dike 2 (Fat)														25.9			
498	56	31.5-33	SPT	Dike 2 (Fat)														15.8			
499	56	33-34.5	SPT	Dike 2 (Fat)														41.3			
501	56	34.5-36	SPT	Alluvial (Granular)	1					1	1				1			47			
502	56	36-37.5	SPT	Alluvial (Granular)	1					1	1				1			25.7			
503	56	37.5-39	SPT	Alluvial (Granular)	1					1	1				1			34.3			
500	56	34.5-39	comp	Alluvial (Granular)	1	30.8	20	26.5	22.7	100	2.73	41	28	13	0.76			35.7	GM	Silty gravel with sand	A-7-6 (4)
504	56	39-40.5	SPT	Alluvial (Clay)														28.2			
505	56	40.5-42	SPT	Alluvial (Clay)														29.3			
506	56	42-43.5	SPT	Alluvial (Clay)														29.6			
507	56	43.5-45	SPT	Alluvial (Clay)														54.3			
508	56	45-46.5	SPT	Alluvial (Clay)														57.9			
509	56	46.5-48	SPT	Alluvial (Clay)														34.1			
510	56	48-49.5	SPT	Alluvial (Clay)														48.2			
511	56	49.5-51	SPT	Alluvial (Clay)														65.4			
512	56	52.5-54	SPT	Alluvial (Clay)														26.1			
513	56	55-56.5	SPT	Alluvial (Clay)														60.8			
514	56	57.5-59	SPT	Alluvial (Clay)														47.3			
515	56	60-61.5	SPT	Alluvial (Clay)														35.7			
516	56	62.5-64	SPT	Alluvial (Clay)														27.8			
517	56	65-66.5	SPT	Alluvial (Clay)														25.2			
518	56	67.5-69	SPT	Alluvial (Clay)														43.7			
519	56	70-71.5	SPT	Alluvial (Clay)														32.1			
520	56	72.5-74	SPT	Alluvial (Clay)														28.5			
521	56	75-75.7	SPT	Alluvial (Clay)														3.7			
	56 A	6-10	BAG	Dike 2 (Fat)																	
522	57	0-1.5	SPT	Dike 1 (Lean) - Fill														7.7			
523	57	1.5-2.3	SPT	Dike 1 (Lean) - Fill														9.9			
524	57	3-4.5	SPT	Dike 1 (Lean)														19.4			
525	57	4.5-6	SPT	Dike 1 (Lean)														25.3			
526	57	6-7.5	SPT	Dike 1 (Lean)														27.7			
528	57	7.5-9	SPT	Dike 1 (Lean)	2													28.6			
529	57	9-10.5	SPT	Dike 1 (Lean)	2					2	2				2			25.1			
530	57	10.5-12	SPT	Dike 1 (Lean)	2					2	2				2			23.7			
531	57	12-13.5	SPT	Dike 1 (Lean)	2					2	2				2			24.3			

Cumberland Fossil Plant
Stantec Ash Pond Laboratory Results

Project No. 175539016

						Particle Size						Atterberg Limits				Standard Proctor			Classification		
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	Particle Size	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO
532	57	13.5-15	SPT	Dike 1 (Lean)	2					2	2				2			27.5			
533	57	15-16.5	SPT	Dike 1 (Lean)	2					2	2				2			24.6			
534	57	16.5-18	SPT	Dike 1 (Lean)	2					2	2				2			24.9			
527	57	7.5-18	comp	Dike 1 (Lean)	2	4.7	29	38.7	27.6	100	2.69	34	21	13	0.68			25.5	CL	Sandy lean clay	A-6 (7)
535	57	18-19.5	SPT	Dike 1 (Lean)														45.1			
536	57	19.5-21	SPT	Dike 1 (Lean)														25.4			
537	57	21-22.5	SPT	Dike 1 (Lean)														26.4			
538	57	22.5-24	SPT	Dike 1 (Lean)														35.4			
539	57	24-25.5	SPT	Dike 1 (Lean)														25.5			
540	57	25.5-27	SPT	Dike 1 (Lean)														32.1			
541	57	27-28.5	SPT	Alluvial (Clay)														53			
542	57	28.5-30	SPT	Alluvial (Clay)														30.3			
543	57	30-30.7	SPT	Alluvial (Clay)														26.3			
544	57	32.5-34	SPT	Alluvial (Clay)														34			
545	57	35-36.5	SPT	Alluvial (Clay)														48.5			
546	57	37.5-39	SPT	Alluvial (Clay)														19			
547	57	40-41.5	SPT	Alluvial (Clay)														32			
548	57	42.5-44	SPT	Alluvial (Clay)														51			
549	57	45-46.5	SPT	Alluvial (Clay)														27.9			
550	57	47.5-49	SPT	Alluvial (Clay)														59.3			
551	57	50-50.9	SPT	Alluvial (Clay)														32.5			
552	57	52.5-54	SPT	Alluvial (Clay)														50.3			
553	57	55-56.5	SPT	Alluvial (Clay)														54.2			
	57 A	5-7	ST	Dike 1 (Lean)																	
	57 A	10-12	ST	Dike 1 (Lean)																	
554	57B	57.5-59	SPT	Alluvial (Clay)														38.2			
555	57B	60-61.5	SPT	Alluvial (Clay)														41.4			
556	57B	62.5-64	SPT															35.7			
557	57B	65-66.5	SPT															43.7			
	58	10-20	BAG	Dike 2 (Fat), Dike 1 (Lean @16-20)						x					x				x		
305	58	0 - 1.5	SPT	Dike 2 (Fat)														15.5			
307	58	1.5 - 3	SPT	Dike 2 (Fat)	14					14	14				14			21			
308	58	3 - 4.5	SPT	Dike 2 (Fat)	14					14	14				14			21.9			
309	58	4.5 - 6	SPT	Dike 2 (Fat)	14					14	14				14			23.9			
310	58	6 - 7.5	SPT	Dike 2 (Fat)	14					14	14				14			25.5			
311	58	7.5 - 9	SPT	Dike 2 (Fat)	14					14	14				14			15.9			
312	58	9 - 10.5	SPT	Dike 2 (Fat)	14					14	14				14			29.9			
313	58	10.5 - 12	SPT	Dike 2 (Fat)	14					14	14				14			16.1			
314	58	12 - 13.5	SPT	Dike 2 (Fat)	14					14	14				14			16.1			
306	58	1.5-13.5	comp	Dike 2 (Fat)	14	7.5	28.3	22.3	41.9	100	2.68	54	18	36	0.95			21.3	CH	Sandy Fat Clay	A-7-6 (21)
315	58	13.5 - 15	SPT	Dike 2 (Fat)														23.3			
316	58	15 - 16.5	SPT	Dike 2 (Fat)														19.8			
317	58	16.5 - 18	SPT	Dike 1 (Lean)														19.9			
318	58	18 - 19.5	SPT	Dike 1 (Lean)														19.8			
319	58	19.5 - 21	SPT	Dike 1 (Lean)														28.9			

Cumberland Fossil Plant
Stantec Ash Pond Laboratory Results

Project No. 175539016

						Particle Size						Atterberg Limits				Standard Proctor			Classification		
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	Particle Size	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO
320	58	21 - 22.5	SPT	Dike 1 (Lean)														29.8			
321	58	22.5 - 24	SPT	Dike 1 (Lean)														28.3			
322	58	24 - 25.5	SPT	Dike 1 (Lean)														26			
323	58	25.5 - 27	SPT	Dike 1 (Lean)														20.6			
324	58	27 - 28.5	SPT	Dike 1 (Lean)														33.1			
325	58	28.5 - 30	SPT	Dike 1 (Lean)														40.7			
326	58	30 - 31.5	SPT	Dike 1 (Lean)														70.3			
328	58	32.5 - 34	SPT	Alluvial (Granular)	15					15	15				15			43.1			
329	58	35 - 36.5	SPT	Alluvial (Granular)	15					15	15				15			48.9			
330	58	37.5 - 39	SPT	Alluvial (Granular)	15					15	15				15			20.3			
327	58	32.5-39	comp	Alluvial (Granular)	15	17.8	40.1	15.1	27	100	2.68	68	36	32	1.33			37.4	SM	Silty Sand with Gravel	A-7-5 (8)
331	58	40 - 41.5	SPT	Alluvial (Granular)														48.8			
333	58	42.5 - 44	SPT	Alluvial (Granular)	16					16	16				16			35.4			
334	58	45 - 46.5	SPT	Alluvial (Granular)	16					16	16				16			33.6			
335	58	47.5 - 49	SPT	Alluvial (Granular)	16					16	16				16			35.5			
336	58	50 - 51.5	SPT	Alluvial (Granular)	16					16	16				16			16.6			
337	58	52.5 - 54	SPT	Alluvial (Granular)	16					16	16				16			41.4			
338	58	55 - 56.5	SPT	Alluvial (Granular)	16					16	16				16			14			
339	58	57.5 - 58.1	SPT	Alluvial (Granular)	16					16	16				16			13.4			
332	58	42.5-58.1	comp	Alluvial (Granular)	16	25.7	28.8	17.3	28.2	100	2.67	57	23	34	1.42			27.1	SC	Clayey Sand with Gravel	A-7-6 (11)
340	58	60 - 60.2	SPT	Alluvial (Granular)														6.7			
	58 A	5-7	ST	Dike 2 (Fat)																	
	58 A	15-17	ST	Dike 2 (Fat), Dike 1 (Lean)																	
	58 A	25-27	ST	Dike 1 (Lean)																	
	58 A	35-37	ST	Alluvial (Granular)																	
	58 A	45-47	ST	Alluvial (Granular)																	
341	59	0 - 1.5	SPT	Dike 1 (Fat)														16.3			
342	59	1.5 - 3	SPT	Dike 1 (Fat)														36.6			
343	59	3 - 4.5	SPT	Dike 1 (Fat)														43.4			
345	59	4.5 - 6	SPT	Dike 1 (Fat)	17					17	17				17			45			
346	59	6 - 7.5	SPT	Dike 1 (Fat)	17					17	17				17			33.4			
347	59	7.5 - 9	SPT	Dike 1 (Fat)	17					17	17				17			29.8			
348	59	9 - 10.5	SPT	Dike 1 (Fat)	17					17	17				17			36.1			
349	59	10.5 - 12	SPT	Dike 1 (Fat)	17					17	17				17			36.7			
350	59	12 - 13.5	SPT	Dike 1 (Fat)	17					17	17				17			51.8			
351	59	13.5 - 15	SPT	Dike 1 (Fat)	17					17	17				17			51.6			
352	59	15 - 16.5	SPT	Dike 1 (Fat)	17					17	17				17			45.5			
353	59	16.5 - 18	SPT	Dike 1 (Fat)	17					17	17				17			61.2			
344	59	4.5-18	comp	Dike 1 (Fat)	17	22	27.7	12.5	37.8	100	2.67	72	25	47	1.38			43.5	CH	Sandy fat clay with Gravel	A-7-6 (18)
354	59	18 - 19.5	SPT	Dike 1 (Fat)														44.8			
355	59	19.5 - 21	SPT	Dike 1 (Fat)														51.3			
356	59	21 - 23.5	SPT	Dike 1 (Fat)														49.3			
357	59	23.5 - 26	SPT	Dike 1 (Fat)														30.8			
358	59	26 - 28.5	SPT	Dike 1 (Fat)														32			
359	59	28.5 - 31	SPT	Dike 1 (Fat)														29.6			
360	59	31 - 33.5	SPT	Dike 1 (Fat)														28.2			

						Particle Size						Atterberg Limits				Standard Proctor			Classification		
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	Particle Size	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO
361	59	33.5 - 35	SPT	Dike 1 (Fat)														NR			
475	59 A	38 - 38	SPT	Alluvial (Fat Clay)														NR			
362	60	0 - 1.5	SPT	Dike 2 (Fat)														16.7			
364	60	1.5 - 3	SPT	Dike 2 (Fat)	18					18	18				18			13			
365	60	3 - 4.5	SPT	Dike 2 (Fat)	18					18	18				18			21.5			
366	60	4.5 - 6	SPT	Dike 2 (Fat)	18					18	18				18			21.6			
367	60	6 - 7.5	SPT	Dike 2 (Fat)	18					18	18				18			25.5			
368	60	7.5 - 9	SPT	Dike 2 (Fat)	18					18	18				18			24.6			
369	60	9 - 10.5	SPT	Dike 2 (Fat)	18					18	18				18			25.5			
370	60	10.5 - 12	SPT	Dike 2 (Fat)	18					18	18				18			23.6			
371	60	12 - 13.5	SPT	Dike 2 (Fat)	18					18	18				18			21.6			
372	60	13.5 - 15	SPT	Dike 2 (Fat)	18					18	18				18			24.3			
363	60	1.5-15	comp	Dike 2 (Fat)	18	6.5	27	26	40.5	100	2.70	52	16	36	1.00			22.4	CH	Sandy Fat Clay	A-7-6 (22)
373	60	15 - 16.5	SPT	Dike 2 (Fat)														31.3			
374	60	16.5 - 18	SPT	Dike 1 (Fat)														35.6			
376	60	18 - 19.5	SPT	Dike 1 (Fat)	19					19	19				19			33.4			
377	60	19.5 - 21	SPT	Dike 1 (Fat)	19					19	19				19			28.2			
378	60	21 - 22.5	SPT	Dike 1 (Fat)	19					19	19				19			32.4			
379	60	22.5 - 24	SPT	Dike 1 (Fat)	19					19	19				19			41.8			
380	60	24 - 25.5	SPT	Dike 1 (Fat)	19					19	19				19			37.5			
381	60	25.5 - 27	SPT	Dike 1 (Fat)	19					19	19				19			40.3			
382	60	27 - 28.5	SPT	Dike 1 (Fat)	19					19	19				19			40.9			
383	60	28.5 - 30	SPT	Dike 1 (Fat)	19					19	19				19			39.7			
384	60	30 - 31.5	SPT	Dike 1 (Fat)	19					19	19				19			33.1			
375	60	18-31.5	comp	Dike 1 (Fat)	19	1.1	9	24.9	65	100	2.66	69	27	42	0.70			36.4	CH	Fat Clay	A-7-6 (43)
385	60	31.5 - 33	SPT	Dike 1 (Fat)														38.6			
387	60	33 - 34.5	SPT	Alluvial (Fat Clay)	20					20	20				20			41.1			
388	60	34.5 - 36	SPT	Alluvial (Fat Clay)	20					20	20				20			34.3			
389	60	36 - 37.5	SPT	Alluvial (Fat Clay)	20					20	20				20			23.9			
390	60	37.5 - 39	SPT	Alluvial (Fat Clay)	20					20	20				20			23			
391	60	39 - 40.5	SPT	Alluvial (Fat Clay)	20					20	20				20			29.9			
392	60	40.5 - 42	SPT	Alluvial (Fat Clay)	20					20	20				20			25.7			
386	60	33-42	comp	Alluvial (Fat Clay)	20	1.9	7.4	28.7	62	100	2.68	68	23	45	0.83			29.7	CH	Fat Clay	A-7-6 (46)
393	60	42 - 43.5	SPT	Alluvial (Fat Clay)														28.4			
394	60	43.5 - 43.6	SPT	Alluvial (Fat Clay)														2.6			
395	61	4.5 - 6	SPT	Dike 1 (Fat)														2			
396	61	6 - 7.5	SPT	Dike 1 (Fat)														22.6			
397	61	7.5 - 9	SPT	Dike 1 (Fat)														NR			
398	61	9 - 10.5	SPT	Dike 1 (Fat)														23.9			
399	61	10.5 - 12	SPT	Dike 1 (Fat)														23.6			
400	61	12 - 13.5	SPT	Dike 1 (Fat)														23.2			
401	61	13.5 - 15	SPT	Dike 1 (Fat)														38.4			
402	61	15 - 16.5	SPT	Dike 1 (Fat)														23			
403	61	16.5 - 18	SPT	Dike 1 (Fat)														27.1			
404	61	18 - 19.5	SPT	Dike 1 (Fat)														34			

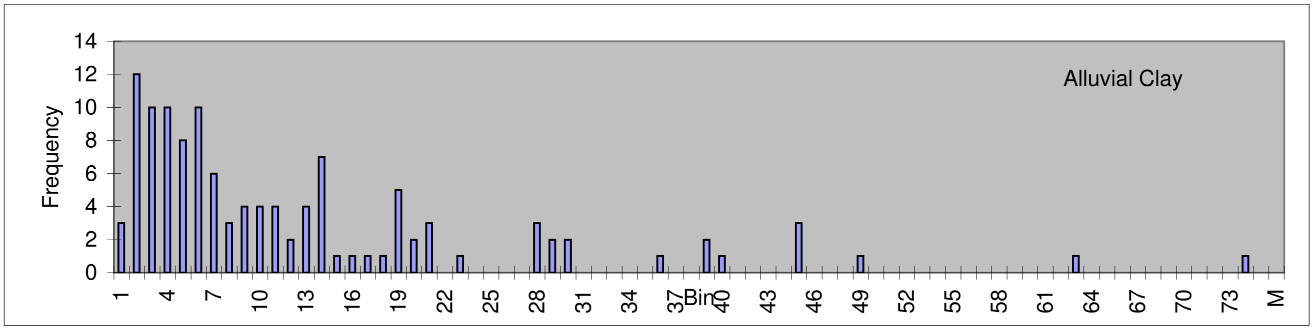
Cumberland Fossil Plant
Stantec Ash Pond Laboratory Results
Project No. 175539016

						Particle Size						Atterberg Limits				Standard Proctor			Classification		
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	Particle Size	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO
405	61	19.5 - 21	SPT	Dike 1 (Fat)														34.4			
406	61	21 - 22.5	SPT	Dike 1 (Fat)														23.1			
407	61	22.5 - 22.5	SPT	Dike 1 (Fat)														31.5			
408	62	0 - 1.5	SPT	Dike 2 (Fat)														21			
409	62	1.5 - 3	SPT	Dike 2 (Fat)														16.8			
410	62	3 - 4.5	SPT	Dike 2 (Fat)														20.8			
411	62	4.5 - 6	SPT	Dike 2 (Fat)														18.9			
412	62	6 - 7.5	SPT	Dike 2 (Fat)														22.2			
413	62	7.5 - 9	SPT	Dike 2 (Fat)														23.5			
414	62	9 - 10.5	SPT	Dike 2 (Fat)														21.8			
415	62	10.5 - 12	SPT	Dike 2 (Fat)														17.9			
416	62	12 - 13.5	SPT	Dike 2 (Fat)														24.5			
417	62	13.5 - 15	SPT	Dike 1 (Fat)														NR			
418	62	15 - 16.5	SPT	Dike 1 (Fat)														24.5			
419	62	16.5 - 18	SPT	Dike 1 (Fat)														17.8			
420	62	18 - 19.5	SPT	Dike 1 (Fat)														15.3			
421	62	19.5 - 19.9	SPT	Dike 1 (Fat)														10.8			
422	62	21 - 21.4	SPT	Dike 1 (Fat)														14.2			
423	62	22.5 - 23.8	SPT	Dike 1 (Fat)														41.8			
	62 A	5-10	BAG	Dike 2 (Fat)																	
476		fill soil									2.70					14.6	114.3	14.2			
665		fill soil				24.7	22.1	25.9	27.3	100	2.68	33	18	15	0.65			14.2	CL	Gravelly lean clay with sand	A-6 (5)

Cumberland Fossil Plant
External Ash Pond Laboratory Test Results
Project No. 175539016

						Particle Size							Atterberg Limits				Standard Proctor			Classification			Permeability							CU Triaxial														
Sample No.	Hole	Depth	Sample Type	Material	Composite	Gravel	Sand	Silt	Clay	%> No. 4	%< No. 200	Gs	LL	PL	PI	AI	w_{opt} (%)	g_{dmax} (pcf)	MC	USCS	Group Name	AASHTO	CU, ST	FHP, 2.8"	w_0 (%)	γ_t (pcf)	γ_d (pcf)	% Compaction			**G_s**	**S_{r0} (%)**	**e_0**	**γ_{w0} (pcf)**	**w_0 (%)**	**γ_{d0} (pcf)**	**Lateral Pressure (psi)**	**e_c**	**w_c (%)**	**γ_{dc} (pcf)**	**c' (psi)**	**c' (psf)**	**ϕ' (deg)**	**tan ϕ' (deg)**
	B-48A	5-15	Bulk	Dike 2 (Lean)		0	26.9	36.9	36.2	0	73.1	2.7	54	20	34		18.9	105.6	29.3	CH	Fat Clay	A-7-6 (24)		$2.8*10^{-8}$	22.1	122.2	100.1	94.8	Remolded	Brown fat cl	2.7*	83.0	0.682	121.2	21.0	100.2	9.939	0.606	22.4	105				
																															2.7*	82.1	0.686	120.9	20.9	100.0	29.99	0.572	21.2	107.2				
																															2.7*	81.5	0.681	121.0	20.6	100.3	49.94	0.548	20.3	108.9	1.53	220.3	29.5	0.57
	B-52A	5-10	Bulk	Dike 2 (Lean)		0	30.6	15.1	54.3	0	69.4	2.7	61	21	40		21.9	102.1		CH	Fat Clay	A-7-6 (27)		$3.5*10^{-8}$	24.5	120.6	96.8	94.8	Remolded	Brown sand	2.7*	86.1	0.74	119.7	23.6	96.87	9.972	0.627	23.2	103.6				
																															2.7*	84.5	0.747	119.1	23.4	96.48	29.82	0.592	21.9	105.9				
																															2.7*	84.8	0.744	119.3	23.4	96.68	49.99	0.541	20	109.4	0.675	97.2	29.8	0.57
	B-53A	43.8-44.2	ST	Alluvial (Clay)																				$7.4*10^{-8}$	27.2	120.6	94.9		UD	Gray-brown sandy lean clay														
	B-54A	30.0-30.6	ST	Dike 2 (Lean)																				$6.5*10^{-8}$	31.1	127.4	97.1		UD	Gray brown lean clay														
	B-54A	30.6-31.8	ST	Dike 2 (Lean)																										Brown silty	2.7*	102.7	0.533	132.3	20.3	110	9.972	0.546	20.2	109				
																															2.7*	96.9	0.541	130.6	19.4	109.4	49.99	0.503	18.6	112.1	3.06	220.3	32.1	0.63
	B-54A	45.2-46.4	ST	Alluvial (Clay)																											2.7*	98.1	0.686	124.9	24.9	99.97	9.687	0.68	25.2	100.3				
																															2.7*	96.3	0.651	125.8	23.2	102.1	29.97	0.624	23.1	103.8	0.349	220.3	33.3	0.66
	B-58	10-20	Bulk	Dike 2 (Fat)		0	31.6	11.3	57.1	0	68.4	2.7	68	23	45		20.2	103.1		CH	Fat Clay	A-7-6 (30)		$2.7*10^{-8}$	23.1	121.1	98.4	95.4	Remolded	Brown sand	2.7*	86.7	0.731	120.3	23.5	97.37	10.01	0.671	24.9	100.9				
				Dike 1 (Lean @ 16-20)																											2.7*	89.3	0.707	121.9	23.4	98.75	29.99	0.654	24.2	101.9				
																															2.7*	90.1	0.707	122.0	23.6	98.72	49.98	0.615	22.8	104.4	1.77	254.9	29.4	0.56
	B-58A	25.4-26.0	ST	Dike 1 (Lean)																				$6.3*10^{-8}$	30.8	127.5	97.4		UD	Gray-brown	2.7*	90.7	0.83	117.8	27.9	92.13	9.96	0.814	30.1	92.94				
																															2.7*	98.6	0.705	124.3	25.7	98.88	49.98	0.697	25.8	99.32	4.16	220.3	22.3	0.41

Attachment 3
Soil N-Count Histograms


Alluvial Clay
Frequency
0
2
4
6
8
10
12
14
Bin
1
4
7
10
13
16
19
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31
34
37
40
43
46
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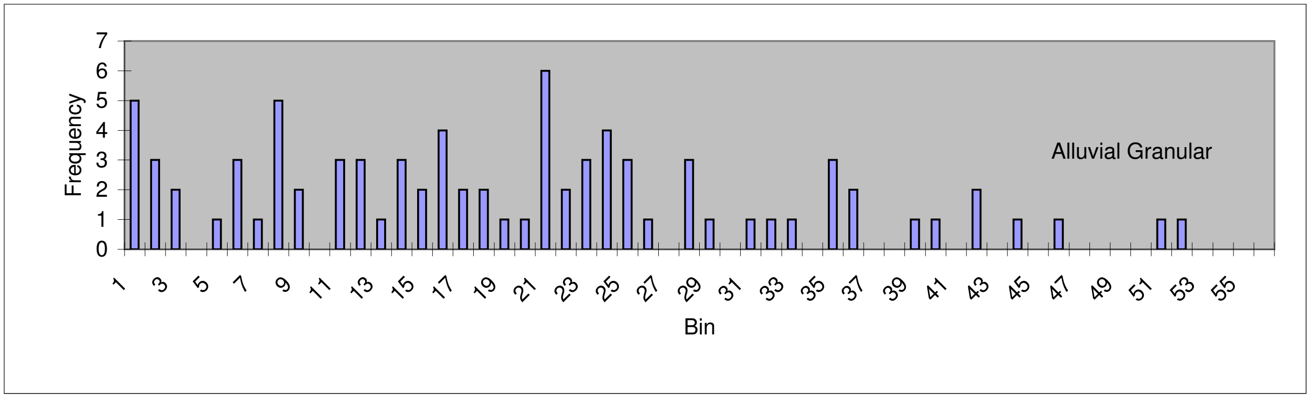
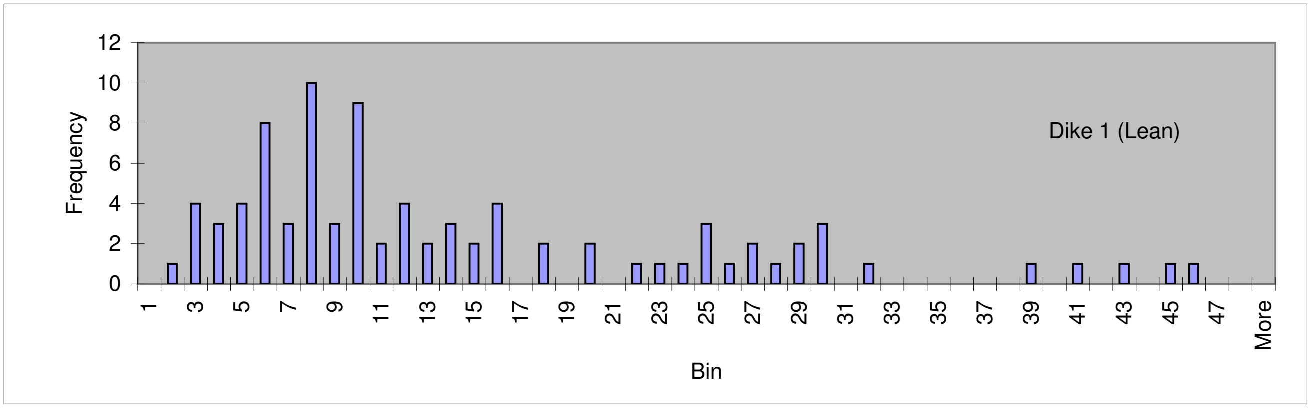
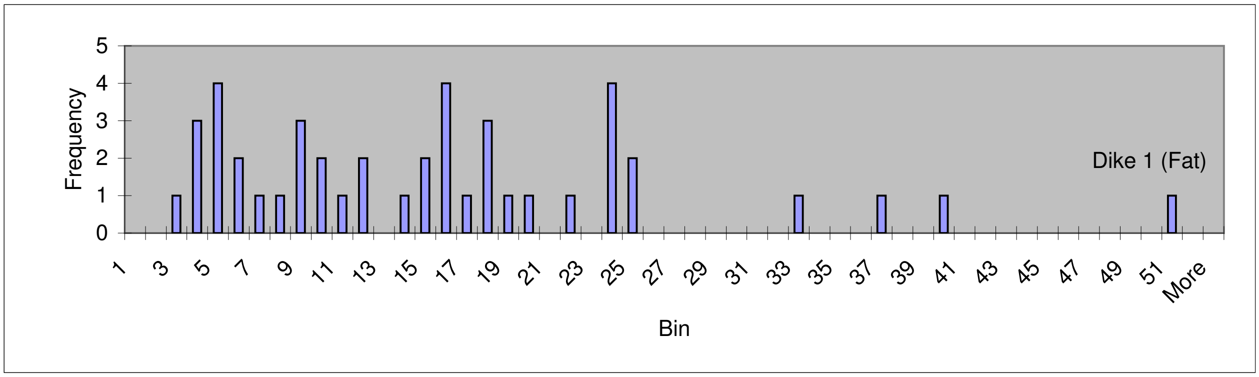
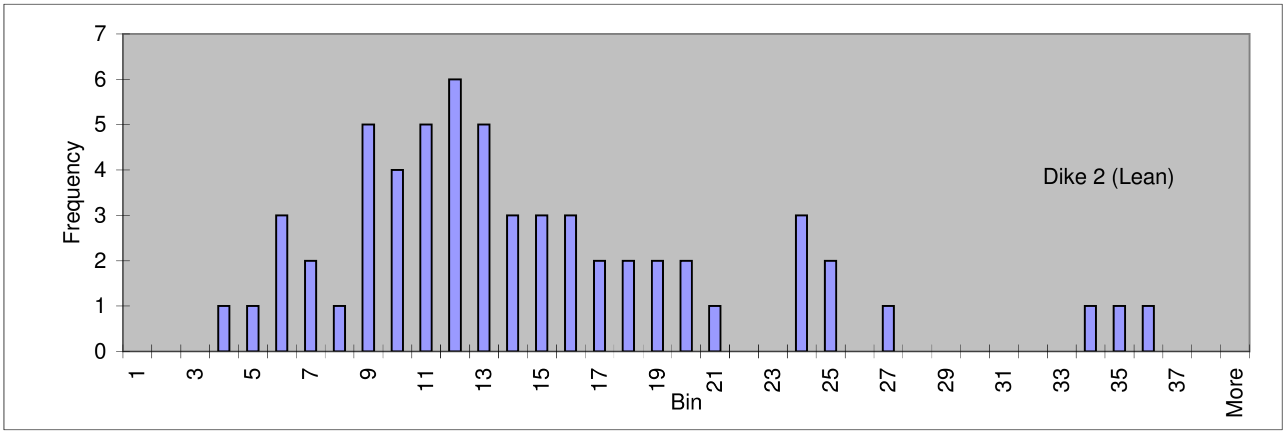
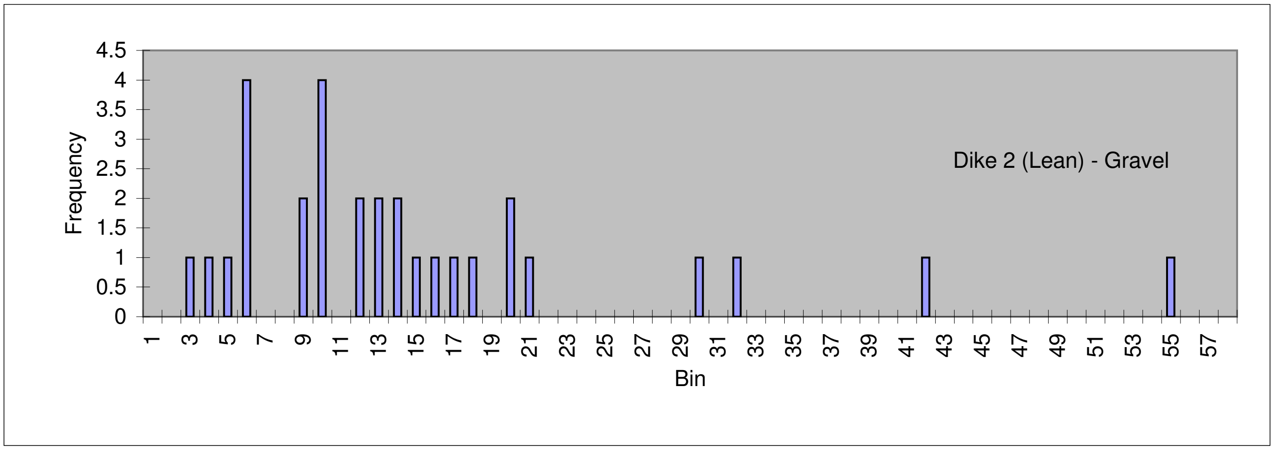
52
55
58
61
64
67
70
73
M

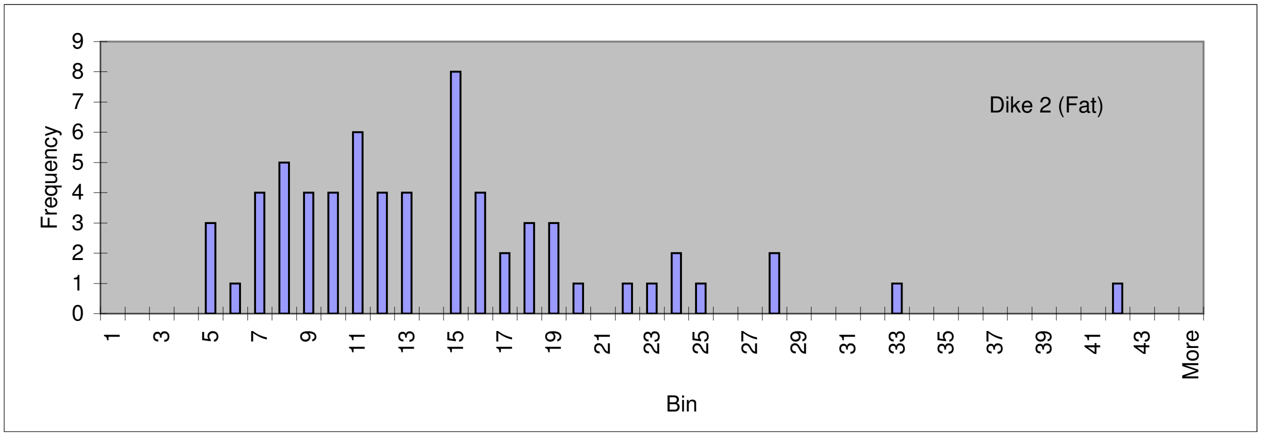

Alluvial Granular
Frequency
0
1
2
3
4
5
6
7
Bin
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
49
51
53
55

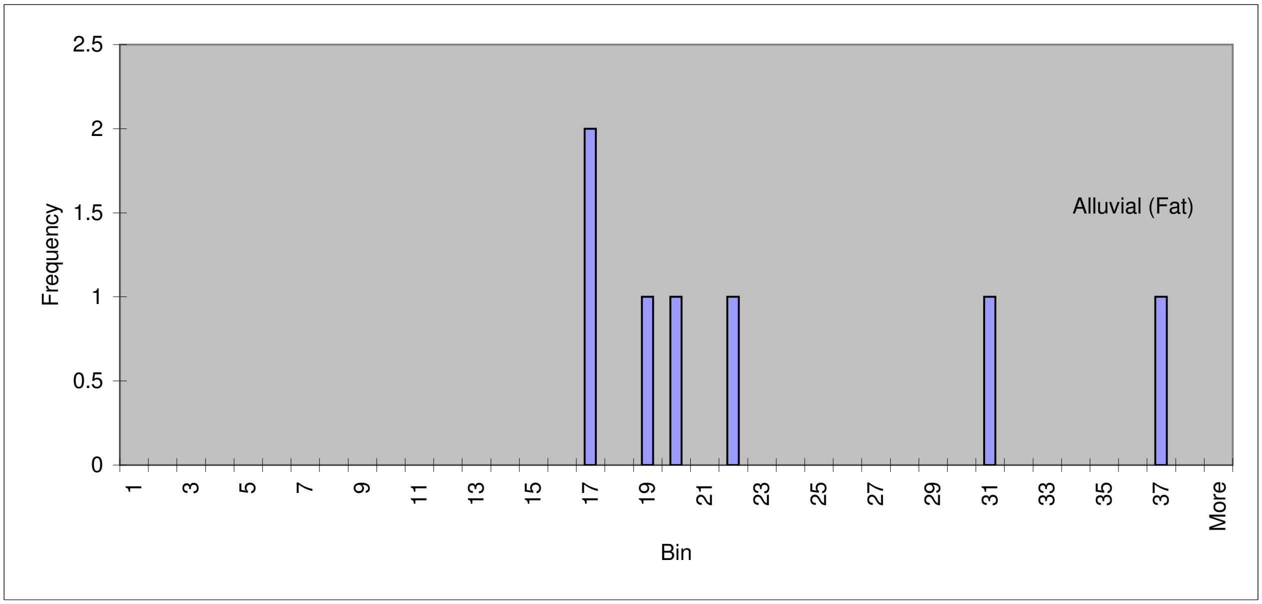

Dike 1 (Lean)
Frequency
0
2
4
6
8
10
12
Bin
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
More


Dike 1 (Fat)
Frequency
0
1
2
3
4
5
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 More
Bin


Dike 2 (Lean)
Frequency
0
1
2
3
4
5
6
7
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 More
Bin


Dike 2 (Lean) - Gravel
Frequency
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57
Bin


Dike 2 (Fat)
Frequency
Bin
0
1
2
3
4
5
6
7
8
9
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
More


Alluvial (Fat)
Frequency
Bin
0
0.5
1
1.5
2
2.5
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
More

Attachment 4
Technical References

Rawls et al (1982)

TABLE 2. HYDROLOGIC SOIL PROPERTIES CLASSIFIED BY SOIL TEXTURE

Texture class	Sample size	Total porosity (θ), cm³/cm³	Residual saturation (θ_r) cm³/cm³	Effective porosity (θ_e), cm³/cm³	Bubbling pressure (ψb) Arithmetic, cm	Bubbling pressure (ψb) Geometric†, cm	Pore size distribution (λ) Arithmetic	Pore size distribution (λ) Geometric†	Water retained at -0.33 bar tension, cm³/cm³	Water retained at -15 bar tension, cm³/cm³	Saturated Hydraulic Conductivity‡ (K_s) cm/h
Sand	762	0.437** (0.374-0.500)	0.020 (0.001-0.039)	0.417 (0.354-0.480)	15.98 (0.24-31.72)	7.26 (1.36-38.74)	0.694 (0.298-1.090)	0.592 (0.334-1.051)	0.091 (0.018-0.164)	0.033 (0.007-0.059)	21.00
Loamy sand	338	0.437 (0.368-0.506)	0.035 (0.003-0.067)	0.401 (0.329-0.473)	20.58 (0.0-45.20)	8.69 (1.80-41.85)	0.553 (0.234-0.872)	0.474 (0.271-0.827)	0.125 (0.060-0.190)	0.055 (0.019-0.091)	6.11
Sandy loam	666	0.453 (0.351-0.555)	0.041 (0.0-0.106)	0.412 (0.283-0.541)	30.20 (0.0-64.01)	14.66 (3.45-62.24)	0.378 (0.140-0.616)	0.322 (0.186-0.558)	0.207 (0.126-0.288)	0.095 (0.031-0.159)	2.59
Loam	383	0.463 (0.375-0.551)	0.027 (0.0-0.074)	0.434 (0.334-0.534)	40.12 (0.0-100.3)	11.15 (1.63-76.40)	0.252 (0.086-0.418)	0.220 (0.137-0.355)	0.270 (0.195-0.345)	0.117 (0.069-0.165)	1.32
Silt loam	1206	0.501 (0.420-0.582)	0.015 (0.0-0.058)	0.486 (0.394-0.578)	50.87 (0.0-109.4)	20.76 (3.58-120.4)	0.234 (0.105-0.363)	0.211 (0.136-0.326)	0.330 (0.258-0.402)	0.133 (0.078-0.188)	0.68
Sandy clay loam	498	0.398 (0.332-0.464)	0.068 (0.0-0.137)	0.330 (0.235-0.425)	59.41 (0.0-123.4)	28.08 (5.57-141.5)	0.319 (0.079-0.559)	0.250 (0.125-0.502)	0.255 (0.186-0.324)	0.148 (0.085-0.211)	0.43
Clay loam	366	0.464 (0.409-0.519)	0.075 (0.0-0.174)	0.390 (0.279-0.501)	56.43 (0.0-124.3)	35.89 (5.80-115.7)	0.242 (0.070-0.414)	0.194 (0.100-0.377)	0.318 (0.250-0.386)	0.197 (0.115-0.279)	0.23
Silty clay loam	689	0.471 (0.418-0.524)	0.040 (0.0-0.118)	0.432 (0.347-0.517)	70.33 (0.0-143.9)	32.56 (6.68-158.7)	0.177 (0.039-0.315)	0.151 (0.090-0.253)	0.366 (0.304-0.428)	0.208 (0.138-0.278)	0.15
Sandy clay	45	0.430 (0.370-0.490)	0.109 (0.0-0.205)	0.321 (0.207-0.435)	79.48 (0.0-179.1)	29.17 (4.96-171.6)	0.223 (0.048-0.398)	0.168 (0.078-0.364)	0.339 (0.245-0.433)	0.239 (0.162-0.316)	0.12
Silty clay	127	0.479 (0.425-0.533)	0.056 (0.0-0.136)	0.423 (0.334-0.512)	76.54 (0.0-159.6)	34.19 (7.04-166.2)	0.150 (0.040-0.260)	0.127 (0.074-0.219)	0.387 (0.332-0.442)	0.250 (0.193-0.307)	0.09
Clay	291	0.475 (0.427-0.523)	0.090 (0.0-0.195)	0.385 (0.269-0.501)	85.60 (0.0-176.1)	37.30 (7.43-187.2)	0.165 (0.037-0.293)	0.131 (0.068-0.253)	0.396 (0.326-0.466)	0.272 (0.208-0.336)	0.06

* First line is the mean value
Second line is ± one standard deviation about the mean
† Antilog of the log mean
‡ Obtained from Fig. 2

water retention at specific matric potentials to (a) percent sand, silt, clay, organic matter content, and bulk density; (b) percent sand, silt, and clay, organic matter, bulk density and 15 bar water retention; and (c) percent particle size content, organic matter, bulk density, and 1/3 and 15 bar water retention. These levels of analysis demonstrate the predictive ability achieved by adding factors which require more costly and/or time consuming laboratory procedures to the standard soil survey data analysis. For example, particle size distribution and organic matter data are the least expensive data to obtain while 1/3 bar water retention and bulk density data are the most expensive. The 15 bar water retention value is an intermediate cost item.

The three levels of regression equations are summarized in Table 3 for the 12 matric potentials reported in the Gupta and Larson (1979) paper. The addition of the 15 bar water retention value and both the 1/3 and 15 bar water retention values to the percent sand, silt and clay, bulk density and organic matter content markedly increased the accuracy (Table 3). In general, the 1/3 bar water retention value was more significant for the matric potentials between 0 and −1/3 bar and the 15 bar water retention was significant for the matric potentials between −1/3 and the −15 bar.

The data base used to develop the equations in Table 3 included 2,541 soils horizons with a wide range of sand (mean 56 percent, range 0.1-99 percent), silt (mean 26 percent, range 0.1-93 percent), clay (mean 18 percent, range 0.1-94 percent), organic matter (mean 0.66 percent, range 0.1-12.5 percent), bulk density (mean 1.42 gm/cm³, range 0.1-2.09 percent). Most agricultural soils, including both expanding (montmorillonite) and nonexpanding (kolinite, illite, chlorite, and vermiculite) type clay minerals are represented.

HYDRAULIC CONDUCTIVITY

A generalized set of unsaturated hydraulic conductivity values was defined for the USDA soil texture classes (SCS, 1975) by combining the results of numerous experiments reported in the literature. Table 4 contains the principle references from which the unsaturated hydraulic conductivity data were obtained. The generalized conductivity curves were obtained by first digitizing the many reference curves by enough points to adequately define them by straight line segments. Using information from the reference or standard soil survey reports, these data were classed and sorted according to the USDA soil texture classes. An average representative curve was estimated by visual analyses for each soil texture class. Some minor adjustments of the average curves were made to provide a uniform family of relationships as shown in Fig. 2.

Generalized curves given in Fig. 2 cannot accurately define the conductivity of any particular soil based only on texture. Each soil will have other characteristics which will cause deviation. However, the degree of definition provided by textural sorting shows that this is a major determinant. Thus, these relationships will provide adequate estimates for applications where more detailed data are not available.

Saturated Hydraulic Conductivity Relationship

The saturated hydraulic conductivities given in Table 2 were taken from Fig. 2. Using the saturated hydraulic conductivity data set compiled by Mualem (1976) a set of mean saturated hydraulic conductivity values were developed according to soil texture and compared with those in Table 2. The Mualem values were similar to those in Table 2, further verifying the representativeness of the saturated hydraulic conductivities in Table 2.

Brutsaert (1967) derived a saturated conductivity relationship by substituting the Brooks and Corey equation into the Childs, Collis-George (1950) permeability in-

Bell (2000)

Table 1.17 Range of compressibility of fine soils.

(a) Compressibility index

Soil type	Range C_c	Degree of compressibility
Soft clay	Over 0.3	Very high
Clay	0.3–0.15	High
Silt	0.15–0.075	Medium
Sandy clay	Less than 0.075	Low

(b) Coefficient of volume compressibility. Some typical values of coefficient of volume compressibility.

Coefficient of volume compressibilty ($m^2\,MN^{-1}$)	Degree of compressibility	Soil types
Above 1.5	Very high	Organic alluvial clays and peats
0.3–1.5	High	Normally consolidated alluvial clays
0.1–0.3	Medium	Varved and laminated clays Firm to stiff clays
0.05–0.1	Low	Very stiff or hard clays Tills
Below 0.05	Very low	Heavily overconsolidated tills

consolidated clays is related to their liquid limit, the relationship between the two being expressed as:

$$C_c = 0.009(\mathrm{LL} - 10) \qquad (1.11)$$

This relationship does not apply to highly organic clays, to where the liquid limit exceeds 100% or to where the liquid limit is exceeded by the natural moisture content. The coefficient of volume compressibility is defined as the volume change per unit volume per unit increase in load. The value of m_v for a given soil depends upon the stress range over which it is determined. Anon (1990) recommended that it should be calculated for a pressure increment of 100 kPa in excess of the effective overburden pressure on the soil at the depth in question. Some typical values of m_v are given in Table 1.17b.

The compressibility of a soil is dependent on the average rate of compression and the soil structure has a substantial time-dependent resistance to compression. At the instant when a load, p, on a layer of clay is suddenly increased by Δp, the thickness of the layer remains unchanged. Hence, the application of the load, Δp, produces an equal increase, Δu, in the hydrostatic pressure of the pore water. As time proceeds, the excess pore water pressure is dissipated gradually and finally disappears, whilst the grain-to-grain pressure simultaneously increases from an initial value p to $p + \Delta p$. The ratio between the decrease of the void ratio, Δe, at time, t, and the ultimate decrease, Δe_1, represents the degree of consolidation, U, at time, t:

$$U = 100\,\frac{\Delta e}{\Delta e_1} \qquad (1.12)$$

With a given thickness, H, of a layer of clay the degree of consolidation at time, t, depends exclusively on the coefficient of consolidation, c_v:

Attachment 5
Stantec (2009a)
Reference Tables

Geotechnical Laboratory Summary

			Shelby Tube Extractions (UC Summary Sheet)			CU Triaxial								Moisture-Density Relationship		Atterberg Limits				Particle Size Analysis (ASTM) (%)									Permeability
Boring	Depth (ft)	Material Type	γ_{w0} (pcf)	w_0 (%)	γ_{d0} (pcf)	G_s	S_{r0} (%)	e_0	γ_{w0} (pcf)	w_0 (%)	γ_{d0} (pcf)	c' (psf)	ϕ' (deg)	γ_{dmax} (pcf)	ω_{opt} (%)	LL	PL	PI	Activity Index	Gravel *(3"- 4.75 mm) (> No. 4)*	Coarse Sand *(4.75-2 mm) (No. 4-No. 10)*	Medium Sand *(2-0.425 mm) (No. 10-No. 40)*	Fine Sand *(0.425 - 0.075 mm) (No. 40-No. 200)*	Silt *(0.075-0.005 mm) (<No. 200)*	Clay *(<0.005 mm)*	USCS	Group Name	AASHTO	Avg. k (20ºC) (cm/s)
B-5	18.0-20.0	Dike 1	119.1	24.3	95.8	2.64	89.3	0.719	119.2	24.3	95.9	320	28.7																
B-5	18.0-20.0	Dike 1	121.5	27.2	95.5	2.64	95.3	0.699	121.5	25.2	97																		
B-9A	25.5-27.5	Dike 1	126.9	24.9	101.6																								
B-21B	59.0-61.0	Dike 1		31.1																									
B-21B	59.0-61.0	Dike 1		22.5																									
B-29A	29.0-31.0	Dike 1	124.3	23.8	100.3	2.7*	94.1	0.646	125.4	22.5	102.4	16.4	36.8																
B-29A	29.0-31.0	Dike 1	125.6	20.1	104.6	2.7*	97	0.595	128.3	21.4	105.7																		
B-63A	5.0-7.0	Dike 1		19.9								1000	17.7																
B-63A	8.0-10.0	Dike 1	125.2	27.1	98.5																								
B-63A	8.0-10.0	Dike 1	126.3	20.4	104.8																								
B-63A	5.0-7.0	Dike 1	120.2	22.1	98.5																								
B-6	24.0-34.5	Dike 1		31.1		2.68										56	20	36	1.57	42.5	6.3	8.5	2.2	15.0	25.5	GC	Clayey gravel with sand	A-7-6 (8)	
B-8	1.5-19.5	Dike 1		15.8		2.64										36	19	17	0.57	1.3	0.8	7.4	4.9	49.0	36.6	CL	Lean clay	A-6 (14)	
B-14	1.5-18.0	Dike 1														44	19	25											
B-26	1.5-13.5	Dike 1														44	17	27											
B-26	15.0-21.0	Dike 1/Alluvial Clay														38	16	22											
B-30	0.0-7.5	Dike 1														46	20	26											
B-30	9.0--16.5	Dike 1														36	19	17											
B-34	0.0-6.0	Dike 1														44	18	26											
B-34	7.5-16.5	Dike 1														36	17	19											
B-3A	8.0-10.0	Dike 2	127.4	19.4	106.7																								
B-3A	14.0-16.0	Dike 2	125.2	25.1	100.1																								
B-3A	14.0-16.0	Dike 2	115.9	28.8	90.0																								
B-9A	3.0-5.0	Dike 2		17.3																									
B-9A	13.0-15.0	Dike 2		21.0																									
B-9B	6.0-8.0	Dike 2	129.6	22.2	106.0																								7.00E-08
B-9B	9.5-11.5	Dike 2	131.4	20.9	108.7																								2.30E-08
B-9B	14.0-16.0	Dike 2		21.7																									
B-21B	15.0-17.0	Dike 2		25.1																									
B-21B	20.0-22.0	Dike 2	128.1	24.6	102.8																								1.80E-08
B-29A	17.0-19.0	Dike 2	123.4	25.8	98.1																								2.20E-08
B-29B	12.0-13.4	Dike 2	124.6	20.0	103.8	2.7*	102.4	0.675	126.4	25.6	100.6	0	36.5																
B-29B	12.0-13.4	Dike 2	131.3	21.4	108.2	2.7*	99.9	0.507	132.8	18.8	111.8																		
B-29B	14.5-16.5	Dike 2	127.5	18.3	107.7	2.7*	98.7	0.466	134.6	17	115																		
B-37A	19.5-21.5	Dike 2	117.1	30.0	90.1																								
B-37A	19.5-21.5	Dike 2		34.9																									
B-37B	8.0-10.0	Dike 2	128.4	22.1	105.2																								
B-37B	11.0-12.4	Dike 2	133.1	18.5	112.3																								1.40E-08
B-37B	11.0-12.4	Dike 2	127.8	18.9	107.5																								
B-6	0.0-10.0	Dike 2		24.3		2.55										55	18	37	0.93	6.0	4.3	7.9	13.9	22.4	45.5	CH	Sandy fat clay	A-7-6 (23)	
B-9	0.0-6.0	Dike 2		20.3		2.70										50	17	33	0.92	8.8	3.1	6.2	13.2	27.7	41.0	CH/CL	Sandy fat clay	A-7-6 (21)	
B-9	9.0-12.0	Dike 2		22.2		2.68										51	19	32	0.78	4.9	2.4	3.8	5.9	34.3	48.7	CH/CL	Fat clay with sand	A-7-6 (27)	
B-12	15.0	Dike 2		21.2		2.77										51	18	33	0.94	10.8	2.6	6.2	7.4	32.0	41.0	CH/CL	Fat clay with sand	A-7-6 (23)	
B-21	0.0-9.0	Dike 2		23.6		2.81										49	18	31	0.97	6.8	3.3	7.1	12.2	33.1	37.5	CL/CH	Lean clay with sand	A-7-6 (21)	
B-21	12.0-18.0	Dike 2		91.1		2.78										56	20	36	0.77	0.7	2.1	6.1	5.5	31.8	53.8	CH	Fat clay	A-7-6 (33)	
B-25	10.5-18.0	Dike 2		21.5		2.54								104.4	18.4	58	22	36	0.72	0.3	1.8	3.9	6.3	30.3	57.4	CH	Fat clay	A-7-6 (34)	
B-29	0.3-10.0	Dike 2		12.6		2.58										46	21	25	0.48	4.4	3.0	7.6	7.7	21.2	56.1	CL	Lean clay with sand	A-7-6 (19)	
B-29	10.4-14.5	Dike 2		24.8		2.57										46	17	29	0.63	8.4	3.5	7.3	7.3	21.9	51.6	CL	Lean clay with sand	A-7-6 (20)	
B-37	6.0-14.5	Dike 2		16.3		2.61								112.0	16.6	53	18	35	0.63	0.6	0.3	2.1	3.2	28.8	65.0	CH	Fat clay	A-7-6 (35)	
B-42	4.5-15.0	Dike 2														44	18	26											
B-19C	17.5-19.5	Dike 3	128.7	12.4	114.5	2.7*	88.8	0.547	128.6	18	109	0	31																
B-19C		Dike 3				2.7*	92.6	0.687	123.5	23.6	99.89																		
B-19C	10.5-12.5	Dike 3	125.9	17.5	107.1	2.7*	89.3	0.633	124.8	20.9	103.2																		
B-19C	15.0-16.0	Dike 3		18.8																									
B-19C	20.0-22.0	Dike 3	127.3	13.8	111.8																								3.20E-08
B-22C	22.0-24.0	Dike 3		27.3																									
B-24C	10.0-11.6	Dike 3		14.7																									
B-28A	8.0-9.5	Dike 3		18.6																									
B-28C	14.5-16.5	Dike 3	121.9	20.0	101.6																								
B-36A	13.0-14.6	Dike 3	128.7	14.9	112.0																								
B-36B	10.8-12.8	Dike 3		20.8																									
B-36B	13.0-13.7	Dike 3		12.7																									
B-36B	19.0-21.0	Dike 3	123.3	29.7	95.1																								
B-43A	20.0-22.0	Dike 3		27.3																									
B-19	7.5-25.5	Dike 3		19.8		2.78										48	19	29	1.32	26.2	6.6	9.4	8.8	22.5	26.5	GC	Clayey gravel with sand	A-7-6 (10)	
B-22	6.0-13.5, …	Dike 3		14.3		2.72										36	18	18	1.38	44.6	6.7	10.1	6.4	15.5	16.7	GC	Clayey gravel with sand	A-2-6 (1)	
B-24	4.5-22.5	Dike 3		16.4		2.51										39	19	20	1.05	30.2	7.5	10.1	7.3	21.5	23.4	GC	Clayey gravel with sand	A-6 (5)	
B-28	1.5-15.0	Dike 3		6.5		2.66								124.3	11.0	36	17	19	0.63	23.2	7.9	12.7	8.7	11.7	35.8	SC	Clayey sand with gravel	A-6 (5)	
B-32	1.5-16.5	Dike 3		16.0		2.63										40	17	23	1.15	32.8	6.7	9.1	6.9	20.1	24.4	GC	Clayey gravel with sand	A-6 (6)	
B-5	20.0-22.0	Alluvial Clay		25.2																									
B-15B	46.0-48.0	Alluvial Clay	120.3	26.5	95.1																								2.30E-08
B-15B	46.0-48.0	Alluvial Clay	121.4	26.9	95.6																								
B-29A	50.0-52.0	Alluvial Clay	110.0	33.1	82.7																								6.60E-09
B-29A	50.0-52.0	Alluvial Clay	112.9	30.3	86.6																								
B-43A	47.0-49.0	Alluvial Clay	128.0	20.2	106.4																								
B-43A	50.0-52.0	Alluvial Clay	123.7	25.6	98.5	2.67	98.6	0.657	125.0	24.3	100.6	440	30.3																
B-43A	50.0-52.0	Alluvial Clay	125.0	24.2	100.6	2.67	96.9	0.677	123.9	24.6	99.4																		

Geotechnical Laboratory Summary

			Extractions (UC Summary Sheet)			CU Triaxial								Moisture-Density Relationship		Atterberg Limits				Particle Size Analysis (ASTM) (%)									Permeability
Boring	Depth (ft)	Material Type	γ_{w0} (pcf)	w_0 (%)	γ_{d0} (pcf)	G_s	S_{r0} (%)	e_0	γ_{w0} (pcf)	w_0 (%)	γ_{d0} (pcf)	c' (psf)	ϕ' (deg)	γ_{dmax} (pcf)	ω_{opt} (%)	LL	PL	PI	Activity Index	Gravel (3"- 4.75 mm) (> No. 4)	Coarse Sand (4.75-2 mm) (No. 4-No. 10)	Medium Sand (2-0.425 mm) (No. 10-No. 40)	Fine Sand (0.425 - 0.075 mm) (No. 40-No. 200)	Silt (0.075-0.005 mm) (<No. 200)	Clay (<0.005 mm)	USCS	Group Name	AASHTO	Avg. k (20ºC) (cm/s)
B-2	55.0-69.0	Alluvial Clay		26.9		2.56										36	20	16	0.62	0.0	0.0	1.3	3.6	59.3	35.8	CL	Lean clay	A-6 (16)	
B-4	43.5-56.5	Alluvial Clay		27.2		2.53										40	21	19	0.59	0.0	0.0	4.4	3.5	47.7	44.4	CL	Lean clay	A-6 (18)	
B-6	36.0-44.0	Alluvial Clay		26.5		2.55										37	18	19	0.66	1.9	0.3	4.1	3.6	53.8	36.3	CL	Lean clay	A-6 (17)	
B-11	15.0-36.0	Alluvial Clay		20.8		2.66										41	24	17	0.5	4.5	0.5	2.2	3.1	47.8	41.9	CL	Lean clay	A-7-6 (17)	
B-12	35.0-46.5	Alluvial Clay		25.5		2.64										40	19	21	0.62	3.7	1.3	2.8	3.4	42.8	46.0	CL	Lean clay	A-6 (19)	
B-33	30.0-39.0	Alluvial Clay		22.8		2.62										35	23	12	0.57	8.0	1.7	4.9	10.7	46.7	28.0	CL	Lean clay with sand	A-6 (8)	
B-42	21.0-34.0	Alluvial Clay														49	18	31											
B-12	60.0-69.0	Alluvial Granular		19.8		2.62											NP		N/A	45.6	10.2	12.7	10.1	14.3	7.1	GM	Silty gravel with sand	A-1-b (0)	
B-14	40.0-49.0	Alluvial Granular		23.4		2.70											NP		N/A	18.8	8.6	36.9	18.9	12.2	4.6	SM	Silty sand with gravel	A-1-b (0)	
B-14	52.5-64.0	Alluvial Granular		21.0		2.70											NP		N/A	53.0	8.6	15.7	6.4	9.1	7.2	GM	Silty gravel with sand	A-1-b (0)	
B-22	75.0-89.0	Alluvial Granular		21.9		2.66											NP		N/A	54.2	15.4	15.5	5.1	5.7	4.1	GP-GC	Poorly graded clayey gravel	A-1-a (0)	
B-17A	32.0-34.0	Fly Ash (Sluiced)		30.9																									
B-17A	32.0-34.0	Fly Ash (Sluiced)	106.2	27.4	83.4																								7.00E-07
B-17A	70.0-72.0	Fly Ash (Sluiced)	104.1	41.1	73.8																								6.50E-07
B-28	52.0-54.0	Fly Ash (Sluiced)	97.4	57.1	62.0																								
B-28A	50.0-52.0	Fly Ash (Sluiced)	100.7	41.4	71.2																								
B-28A	52.0-54.0	Fly Ash (Sluiced)	101.9	52.3	66.9																								
B-35A	37.0-38.0	Fly Ash (Sluiced)		47.5																									
B-36A	24.0-26.0	Fly Ash (Sluiced)		45.1																									
B-36A	44.0-46.0	Fly Ash (Sluiced)	102.8	40.5	73.2																								6.60E-07
B-37A	24.0-26.0	Fly Ash (Sluiced)		53.2																									
B-43A	29.0-31.0	Fly Ash (Sluiced)	104.6	32.0	79.3	2.47	97.5	1.134	104.5	44.8	72.2	0	39.6																
B-43A	29.0-31.0	Fly Ash (Sluiced)	100.6	39.7	72.0	2.47	94	1.262	100.9	48	68.2																		
B-35A	46.0-48.0	Fly Ash (Sluiced)	104.8	46.0	71.8	2.47	100.2	1.174	104.6	47.6	70.9																		
B-18	15.0-34.5	Fly Ash (Sluiced)		37.2		2.58											NP		N/A	4.8	0.1	4.5	16.6	61.0	13.0	ML	Silt with sand	A-4 (0)	
B-19	28.5-49.0	Fly Ash (Sluiced)		30.3		2.46											NP		N/A	2.0	0.8	5.8	11.4	68.3	11.7	ML	Silt with sand	A-4 (0)	
B-24	27.0-51.5	Fly Ash (Sluiced)		44.8		2.44											NP		N/A	0.2	0.1	7.1	14.6	64.3	13.7	ML	Silt with sand	A-4 (0)	
B-32	20.0-49.0	Fly Ash (Sluiced)		34.6		2.52											NP		N/A	2.6	1.3	9.9	6.9	69.7	9.6	ML	Silt with sand	A-4 (0)	
B-37	7.5-21.0	Fly Ash (Sluiced)		23.1		2.62										45	18	27	0.71	2.6	2.0	4.3	4.7	41.1	45.3	CL	Lean clay	A-7-6 (24)	
B-4	1.5-31.5	Fly Ash (Sluiced)		40.7		2.42											NP		N/A	2.4	3.1	14.6	7.4	58.6	13.9	ML	Silt with sand	A-4 (0)	
B-41	24.0-34.5	Fly Ash (Sluiced)		26.2		2.52											NP		N/A	0.3	0.8	15.2	16.4	42.9	24.4	ML	Sandy silt	A-4 (0)	
B-45	25.0-39.6	Fly Ash (Sluiced)		35.7		2.71											NP		N/A	8.3	9.4	17.0	23.4	25.3	16.6	SM	Silty sand	A-4 (0)	
B-17A	50.0-52.0	BA-FA (Sluiced)		20.0																									
B-21B	25.0-27.0	BA-FA (Sluiced)		16.3																									
B-21B	48.0-50.0	BA-FA (Sluiced)	125.0	25.2	99.8																								
B-24C	3.5-4.8	BA-FA (Sluiced)		15.6																									
B-2	4.5-39.0	BA-FA (Sluiced)		25.9		2.62											NP		N/A	15.0	11.8	21.4	17.9	30.0	3.9	SM	Silty sand with gravel	A-2-4 (0)	
B-18	0.0-7.5	BA-FA (Sluiced)		14.4		2.61											NP		N/A	8.9	8.4	25.1	18.1	32.4	7.1	SM	Silty sand	A-4 (0)	
B-21	18.0-30.0	BA-FA (Sluiced)		22.9		2.61											NP		N/A	20.6	16.5	28.4	17.9	12.8	3.8	SM	Silty sand with gravel	A-1-b (0)	
B-22	28.5-49.5	BA-FA (Sluiced)		33.6		2.55											NP		N/A	7.6	5.4	14.3	16.7	46.5	9.5	ML	Sandy silt	A-4 (0)	
B-41	0.1-2.1	Gypsum		7.2																									
B-20	0.0-15.0	Gypsum		15.7		2.31											NP		N/A	0.0	0.0	6.4	6.5	83.2	3.9	ML	Silt	A-4 (0)	
B-35	1.5-22.5	Gypsum		10.6		2.94											NP		N/A	0.4	0.1	11.1	7.2	76.1	5.1	ML	Silt with sand	A-4 (0)	
B-41	0.0-12.9	Gypsum		22.1		2.31											NP		N/A	0.0	0.2	2.0	6.2	67.5	24.1	ML	Silt	A-4 (0)	
B-45	3.0-9.0	Gypsum		16.1		2.36											NP		N/A	0.2	0.1	2.0	5.4	70.8	21.5	ML	Silt	A-4 (0)	
	Gypsum Bulk	Gypsum				2.75*								86.3	35.1														8.10E-08
	Gypsum Rejects Bulk	Gypsum Rejects				2.73								86.2	35.2	33	32	1		0.0	7.4			86.1	6.5	ML		A-4 (0)	5.30E-07
	Gypsum Rejects Bulk	Gypsum Rejects				2.7*	72.6	1.08	104.5	29.1	80.97	90.9	42.5																
						2.5*	76.2	0.947	103.3	28.9	80.17																		
						2.7*	72	1.1	103.9	29.2	80.41																		
	Gypsum Rejects Bulk	Gypsum Rejects				2.7*	67.4	1.09	102.7	27.2	80.71	0.0	44																
						2.7*	66.9	1.09	102.5	26.9	80.79																		
						2.7*	66.8	1.09	102.5	26.9	80.75																		
	Bottom Ash Bulk	Bottom Ash				2.5*								103.7	17.2														2.30E-06
	Bottom Ash Bulk	Bottom Ash				2.7*	48.3	0.923	102.1	16.5	87.66	0	44																
						2.5*	53.8	0.782	102.3	16.8	87.57																		
						2.7*	47.5	0.913	102.3	16.1	88.12																		
	Bottom Ash Bulk	Bottom Ash				2.7*	48.3	0.923	102.1	16.5	87.66	261	41																
						2.7*	47.5	0.913	102.3	16.1	88.12																		
	Fly Ash Bulk	Fly Ash				2.5*								83.6	32.7														4.20E-07
	Fly Ash Bulk					2.5*	61.2	1.37	87.8	33.6	65.75	14.3	36																
						2.5*	62	1.36	88.4	33.8	66.09																		
						2.5*	63.3	1.36	89.0	34.4	66.21																		
						* G_s is assumed.																							

	Permeability Summary										
								t_{50} chart from CPT Application Guide			
	CPT	El (ft)	El of Test (ft)	Material Type	k_h (ft/s)	Assumed kh/kv	Assumed kv/kh	**Avg. k_v (20ºC) (cm/s)**	ft/s	**Visual Description**	
	CPT15	430.0	344.1	Alluvial (Clay)	4.30E-09						
	CPT5	380.0	350.7	Alluvial (Clay)	7.50E-08						
	CPT14C	405.0	353.2	FA (Sluiced)/Alluvial (Clay)	6.50E-09						
	CPT16	430.0	343.9	FA (Sluiced)/Alluvial (Clay)	1.70E-08						
	CPT16	430.0	350.4	FA (Sluiced)/Alluvial (Clay)	6.70E-08						
	CPT22	425.0	362.9	FA (Sluiced)/Alluvial (Clay)	7.90E-09						
	CPT26	425.0	368.5	FA/BA (Sluiced)	2.00E-08						
1605A	B-15B		46.0-48.0	Alluvial Clay				2.30E-08	7.54593E-10	Lean Clay (CL), gray, moist, firm	brown lean clay
1617A	B-29A		50.0-52.0	Alluvial Clay				6.60E-09	2.16535E-10	Fat Clay (CH), brown, moist, firm	brown lean clay, 50.2-50.7
					2.82E-08	**58.1650**	**0.0172**	**1.48E-08**	**4.86E-10**		
	CPT3	380.0	367.1	Dike 1	2.80E-09						
	CPT4	380.0	367.8	Dike 1							
	CPT5	380.0	368.4	Dike 1	7.80E-09						
	CPT5	380.0	375.1	Dike 1	2.20E-07						
	CPT6	380.0	367.1	Dike 1	1.40E-07						
1262	B-9B		6.0-8.0	Dike 2				7.00E-08	2.29659E-09	Fat Clay with Gravel (CH), red brown, moist, firm	brown lean clay, 6-6.9
1263	B-9B		9.5-11.5	Dike 2				2.30E-08	7.54593E-10	Lean Clay with Gravel (CL), light brown, moist, firm	brown lean clay, 10.1-10.6
1610	B-21B		20.0-22.0	Dike 2				1.80E-08	5.90551E-10	Fat Clay (CH), red brown, moist, firm	brown lean clay
1615	B-29A		17.0-19.0	Dike 2				2.20E-08	7.21785E-10	Gravelly Lean Clay (CL), brown, moist, soft to firm	brown lean clay
1624A	B-37B		11.0-12.4	Dike 2				1.40E-08	4.59318E-10	Lean Clay (CL), brown, moist, firm	brown lean clay
1629	B-19C		20.0-22.0	Dike 3				3.20E-08	1.04987E-09	Sandy Fat Clay (CH), brown, moist, firm	brown lean clay
					9.27E-08	**94.6583**	**0.0106**	**2.98E-08**	**9.79E-10**		
	CPT14C	405.0	368.9	FA (Sluiced)	2.10E-06						
	CPT14C	405.0	375.9	FA (Sluiced)	4.60E-06						
	CPT14C	405.0	385.3	FA (Sluiced)	7.20E-07						
	CPT15	430.0	370.5	FA (Sluiced)	9.80E-07						
	CPT15	430.0	376.6	FA (Sluiced)	9.40E-07						
	CPT16	430.0	373.0	FA (Sluiced)	1.50E-06						
	CPT16	430.0	378.6	FA (Sluiced)	2.30E-06						
	CPT18	425.0	386.0	FA (Sluiced)	3.70E-06						
	CPT20	425.0	388.7	FA (Sluiced)	4.60E-06						
	CPT22	425.0	372.3	FA (Sluiced)	6.40E-06						
	CPT22	425.0	383.0	FA (Sluiced)	2.10E-06						
	CPT23	425.0	366.0	FA (Sluiced)	4.60E-06						
	CPT23	425.0	370.6	FA (Sluiced)	6.00E-06						
	CPT25	425.0	376.9	FA (Sluiced)	5.30E-06						
	CPT25	425.0	386.2	FA (Sluiced)	9.10E-07						
	CPT25	425.0	390.8	FA (Sluiced)	1.30E-06						
	CPT15	430.0	357.3	FA (Sluiced)/Alluvial (Clay)	2.20E-06						
	CPT18	425.0	376.4	FA (Sluiced)/Alluvial (Clay)	4.30E-06						

	Permeability Summary										
								t_{50} chart from CPT Application Guide			
	CPT	El (ft)	El of Test (ft)	Material Type	k_h (ft/s)	Assumed kh/kv	Assumed kv/kh	**Avg. k_v (20ºC) (cm/s)**	ft/s	**Visual Description**	
1606B	B-17A		32.0-34.0	Fly Ash (Sluiced)				7.00E-07	2.29659E-08	Silt (ML), black, moist, firm, fly ash	gray silt - ASH, 32.7-33.2
1608	B-17A		70.0-72.0	Fly Ash (Sluiced)				6.50E-07	2.13255E-08	Silt (ML), gray, moist, firm, flyash	gray silt - ASH, 70-70.5
1620	B-36A		44.0-46.0	Fly Ash (Sluiced)				6.60E-07	2.16535E-08	Silt (ML), black, wet, soft, fly ash	gray silt - ASH, 44.7-45.2
	CPT14	405.0	373.2	FA/BA (Sluiced)	2.90E-06						
	CPT14	405.0	386.6	FA/BA (Sluiced)	9.70E-07						
	CPT17	400.0	372.9	FA/BA (Sluiced)	1.00E-06						
	CPT17	400.0	385.1	FA/BA (Sluiced)	2.10E-06						
	CPT26	425.0	371.7	FA/BA (Sluiced)	2.20E-07						
	CPT26	425.0	378.9	FA/BA (Sluiced)	4.60E-06	1.2000	0.8333	3.83E-06	1.25766E-07		
					2.76E-06	**57.6738**	**0.0173**	**1.46E-06**	**4.79E-08**		
	CPT15	430.0	406.4	FA (Stacked)	1.30E-06						
	CPT16	430.0	406.4	FA (Stacked)	8.00E-06			2.20E-05	7.22E-07		
1636			Fly Ash Bulk	Fly Ash				4.20E-07	1.37795E-08		
					4.65E-06	**12.6434**	**0.0791**	**1.12E-05**	**3.68E-07**		
					1.97E-06						
1635			Gypsum Bulk	Gypsum				8.10E-08	2.65748E-09		
1634			Gypsum Rejects Bulk	Gypsum Rejects				5.30E-07	1.73885E-08		
1637			Bottom Ash Bulk	Bottom Ash				2.30E-06	7.54593E-08		
								6.80E-02	0.002230971		

Appendix H

Seepage Analyses Output

Steady-State Seepage

Report generated using GeoStudio 2007, version 7.14. Copyright © 1991-2009 GEO-SLOPE International Ltd.

File Information

Created By: Cooper, Paul
Revision Number: 238
Last Edited By: Rogers, Daniel
Date: 1/31/2010
Time: 12:34:30 PM
File Name: Section P.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/31/2010
Last Solved Time: 12:35:12 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Mass(M) Units: lbs
Mass Flux Units: lbs/sec
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Steady-State Seepage

Kind: SEEP/W
Method: Steady-State
Settings
    Include Air Flow: No
Control
    Apply Runoff: Yes
Convergence
    Convergence Type: Gauss Point K
    Convergence Settings
        Maximum Number of Iterations: 500
        Tolerance: 0.01
        Maximum Change in K: 0.1
        Rate of Change in K: 1.02
        Minimum Change in K: 0.0001
    Equation Solver: Parallel Direct
    Potential Seepage Max # of Reviews: 10
Time
    Starting Time: 0 sec

Duration: 0 sec
Ending Time: 0 sec

Materials

Dike 1 (Lean Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 1 (Lean Clay)
Vol. WC. Function: Dike 1 (Lean Clay)
K-Ratio: 0.1
K-Direction: 0 °

Dike 2 (Lean Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 2 (Lean Clay)
Vol. WC. Function: Dike 2 (Lean Clay)
K-Ratio: 0.1
K-Direction: 0 °

Fly Ash (Sluiced)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Fly Ash (Sluiced)
Vol. WC. Function: Fly Ash (Sluiced)
K-Ratio: 0.02
K-Direction: 0 °

Alluvial - Clay

Model: Saturated / Unsaturated
Hydraulic
K-Function: Alluvial (Clay)
Vol. WC. Function: Alluvial (Clay)
K-Ratio: 0.05
K-Direction: 0 °

Alluvial - Granular

Model: Saturated / Unsaturated
Hydraulic
K-Function: Alluvial (Granular)
Vol. WC. Function: Alluvial (Granular)
K-Ratio: 0.05
K-Direction: 0 °

Bedrock

Model: Saturated Only
Hydraulic
K-Sat: 1e-011 ft/sec

Volumetric Water Content: 0 ft^3/ft^3
Mv: 0 /psf
K-Ratio: 0.1
K-Direction: 0 °

Boundary Conditions

Potential Seepage Face

Review: true
Type: Total Flux (Q) 0

Ash Pond

Type: Head (H) 384.23

Wells Creek

Type: Head (H) 359

K Functions

Dike 1 (Lean Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 2.13e-007
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 2.13e-007)
Data Point: (0.018329807, 2.1234388e-007)
Data Point: (0.033598183, 2.1168814e-007)
Data Point: (0.061584821, 2.1103203e-007)
Data Point: (0.11288379, 2.1037498e-007)
Data Point: (0.20691381, 2.0971735e-007)
Data Point: (0.37926902, 2.0905824e-007)
Data Point: (0.6951928, 2.0839653e-007)
Data Point: (1.274275, 2.077303e-007)
Data Point: (2.3357215, 2.070555e-007)
Data Point: (4.2813324, 2.0636507e-007)
Data Point: (7.8475997, 2.0564593e-007)
Data Point: (14.384499, 2.0487454e-007)
Data Point: (26.366509, 2.0400629e-007)
Data Point: (48.329302, 2.0295363e-007)
Data Point: (88.586679, 2.016313e-007)
Data Point: (162.37767, 1.9978076e-007)
Data Point: (297.63514, 1.9457772e-007)
Data Point: (545.55948, 1.9521936e-007)
Data Point: (1000, 7.5557482e-008)
Estimation Properties
Volume Water Content Function: Dike 1 (Lean Clay)

    - Hydraulic K Sat: 2.13e-007 ft/sec
    - Hyd. K-Function Estimation Method: Fredlund-Xing Function
    - Maximum: 1000
    - Minimum: 0.01
    - Num. Points: 20
    - Residual Water Content: 0.06 ft^3/ft^3

Dike 2 (Lean Clay)

- Model: Data Point Function
- Function: X-Conductivity vs. Pore-Water Pressure
    - Curve Fit to Data: 100 %
    - Segment Curvature: 100 %
- K-Saturation: 1.4e-008
- Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
    - Data Point: (0.01, 1.4e-008)
    - Data Point: (0.018329807, 1.3839755e-008)
    - Data Point: (0.033598183, 1.3679456e-008)
    - Data Point: (0.061584821, 1.3519067e-008)
    - Data Point: (0.11288379, 1.3358687e-008)
    - Data Point: (0.20691381, 1.3198313e-008)
    - Data Point: (0.37926902, 1.3037842e-008)
    - Data Point: (0.6951928, 1.2877185e-008)
    - Data Point: (1.274275, 1.2716167e-008)
    - Data Point: (2.3357215, 1.2554511e-008)
    - Data Point: (4.2813324, 1.2391694e-008)
    - Data Point: (7.8475997, 1.2226739e-008)
    - Data Point: (14.384499, 1.2057859e-008)
    - Data Point: (26.366509, 1.1881796e-008)
    - Data Point: (48.329302, 1.1692595e-008)
    - Data Point: (88.586679, 1.147907e-008)
    - Data Point: (162.37767, 1.1221098e-008)
    - Data Point: (297.63514, 1.0889148e-008)
    - Data Point: (545.55948, 1.0384296e-008)
    - Data Point: (1000, 9.4081422e-009)
- Estimation Properties
    - Volume Water Content Function: Dike 2 (Lean Clay)
    - Hydraulic K Sat: 1.4e-008 ft/sec
    - Hyd. K-Function Estimation Method: Fredlund-Xing Function
    - Maximum: 1000
    - Minimum: 0.01
    - Num. Points: 20
    - Residual Water Content: 0.08 ft^3/ft^3

Alluvial (Clay)

- Model: Data Point Function
- Function: X-Conductivity vs. Pore-Water Pressure
    - Curve Fit to Data: 100 %
    - Segment Curvature: 100 %
- K-Saturation: 4.86e-008
- Data Points: Matric Suction (psf), X-Conductivity (ft/sec)

Data Point: (0.01, 4.86e-008)
Data Point: (0.018329807, 4.6081772e-008)
Data Point: (0.033598183, 4.3561857e-008)
Data Point: (0.061584821, 4.104302e-008)
Data Point: (0.11288379, 3.8524125e-008)
Data Point: (0.20691381, 3.6005291e-008)
Data Point: (0.37926902, 3.3486567e-008)
Data Point: (0.6951928, 3.0968085e-008)
Data Point: (1.274275, 2.8449893e-008)
Data Point: (2.3357215, 2.5932304e-008)
Data Point: (4.2813324, 2.3415812e-008)
Data Point: (7.8475997, 2.0901374e-008)
Data Point: (14.384499, 1.8390713e-008)
Data Point: (26.366509, 1.5886901e-008)
Data Point: (48.329302, 1.3395726e-008)
Data Point: (88.586679, 1.0927777e-008)
Data Point: (162.37767, 8.5023183e-009)
Data Point: (297.63514, 6.1503404e-009)
Data Point: (545.55948, 3.9524194e-009)
Data Point: (1000, 2.0421444e-009)

Estimation Properties
Volume Water Content Function: Alluvial (Clay)
Hydraulic K Sat: 4.86e-008 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.07 ft³/ft³

Alluvial (Granular)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 6.56e-005
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 6.56e-005)
Data Point: (0.018329807, 6.559664e-005)
Data Point: (0.033598183, 6.5593247e-005)
Data Point: (0.061584821, 6.55898e-005)
Data Point: (0.11288379, 6.5586256e-005)
Data Point: (0.20691381, 6.5582531e-005)
Data Point: (0.37926902, 6.5578478e-005)
Data Point: (0.6951928, 6.5573821e-005)
Data Point: (1.274275, 6.5568056e-005)
Data Point: (2.3357215, 6.5560304e-005)
Data Point: (4.2813324, 6.5548627e-005)
Data Point: (7.8475997, 6.5529381e-005)
Data Point: (14.384499, 6.5508533e-005)
Data Point: (26.366509, 6.5443255e-005)

    - Data Point: (48.329302, 6.5007842e-005)
    - Data Point: (88.586679, 6.6743187e-005)
    - Data Point: (162.37767, 3.9015316e-005)
    - Data Point: (297.63514, 1.0152365e-005)
    - Data Point: (545.55948, 1.9697495e-006)
    - Data Point: (1000, 3.085697e-007)
- Estimation Properties
    - Volume Water Content Function: Alluvial (Granular)
    - Hydraulic K Sat: 6.56e-005 ft/sec
    - Hyd. K-Function Estimation Method: Fredlund-Xing Function
    - Maximum: 1000
    - Minimum: 0.01
    - Num. Points: 20
    - Residual Water Content: 0.02 ft³/ft³

Fly Ash (Sluiced)

- Model: Data Point Function
- Function: X-Conductivity vs. Pore-Water Pressure
    - Curve Fit to Data: 100 %
    - Segment Curvature: 100 %
- K-Saturation: 0.000138
- Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
    - Data Point: (0.01, 0.000138)
    - Data Point: (0.018329807, 0.00013124901)
    - Data Point: (0.033598183, 0.00012449327)
    - Data Point: (0.061584821, 0.00011774033)
    - Data Point: (0.11288379, 0.0001109872)
    - Data Point: (0.20691381, 0.00010423397)
    - Data Point: (0.37926902, 9.7480512e-005)
    - Data Point: (0.6951928, 9.0726822e-005)
    - Data Point: (1.274275, 8.3972556e-005)
    - Data Point: (2.3357215, 7.7217303e-005)
    - Data Point: (4.2813324, 7.0460153e-005)
    - Data Point: (7.8475997, 6.3699615e-005)
    - Data Point: (14.384499, 5.6933028e-005)
    - Data Point: (26.366509, 5.0154616e-005)
    - Data Point: (48.329302, 4.3351508e-005)
    - Data Point: (88.586679, 3.6533731e-005)
    - Data Point: (162.37767, 2.9661049e-005)
    - Data Point: (297.63514, 2.2042999e-005)
    - Data Point: (545.55948, 1.5988106e-005)
    - Data Point: (1000, 1.5284174e-006)
- Estimation Properties
    - Volume Water Content Function: Fly Ash (Sluiced)
    - Hydraulic K Sat: 0.000138 ft/sec
    - Hyd. K-Function Estimation Method: Fredlund-Xing Function
    - Maximum: 1000
    - Minimum: 0.01
    - Num. Points: 20
    - Residual Water Content: 0.015 ft³/ft³

Vol. Water Content Functions

Dike 1 (Lean Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 3e-006 /psf
Porosity: 0.41556948
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.41308567)
Data Point: (0.018329807, 0.41308567)
Data Point: (0.033598183, 0.41308567)
Data Point: (0.061584821, 0.41308567)
Data Point: (0.11288379, 0.41308567)
Data Point: (0.20691381, 0.41308567)
Data Point: (0.37926902, 0.41308567)
Data Point: (0.6951928, 0.41308567)
Data Point: (1.274275, 0.41308567)
Data Point: (2.3357215, 0.41308567)
Data Point: (4.2813324, 0.41308567)
Data Point: (7.8475997, 0.41308567)
Data Point: (14.384499, 0.41308567)
Data Point: (26.366509, 0.41308567)
Data Point: (48.329302, 0.41308567)
Data Point: (88.586679, 0.41308567)
Data Point: (162.37767, 0.41308567)
Data Point: (297.63514, 0.41308567)
Data Point: (545.55948, 0.4125467)
Data Point: (1000, 0.38347036)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.413 ft³/ft³
Liquid Limit: 38 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.1
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Dike 2 (Lean Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 3e-006 /psf
Porosity: 0.35421721

Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.35121721)
Data Point: (0.018329807, 0.35121721)
Data Point: (0.033598183, 0.35121721)
Data Point: (0.061584821, 0.35121721)
Data Point: (0.11288379, 0.35121721)
Data Point: (0.20691381, 0.35121721)
Data Point: (0.37926902, 0.35121721)
Data Point: (0.6951928, 0.35121721)
Data Point: (1.274275, 0.35121721)
Data Point: (2.3357215, 0.35121721)
Data Point: (4.2813324, 0.35121721)
Data Point: (7.8475997, 0.35121721)
Data Point: (14.384499, 0.35121721)
Data Point: (26.366509, 0.35121721)
Data Point: (48.329302, 0.35121721)
Data Point: (88.586679, 0.35121721)
Data Point: (162.37767, 0.35121721)
Data Point: (297.63514, 0.35121721)
Data Point: (545.55948, 0.35121721)
Data Point: (1000, 0.35121721)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.351 ft³/ft³
Liquid Limit: 48 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.075
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Alluvial (Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 4.786e-005 /psf
Porosity: 0.46611653
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.40088927)
Data Point: (0.018329807, 0.40088927)
Data Point: (0.033598183, 0.40088927)
Data Point: (0.061584821, 0.40088927)
Data Point: (0.11288379, 0.40088927)
Data Point: (0.20691381, 0.40088927)
Data Point: (0.37926902, 0.40088927)
Data Point: (0.6951928, 0.40088927)
Data Point: (1.274275, 0.40088927)
Data Point: (2.3357215, 0.40088927)

Data Point: (4.2813324, 0.40088927)
Data Point: (7.8475997, 0.40088927)
Data Point: (14.384499, 0.40088927)
Data Point: (26.366509, 0.40088927)
Data Point: (48.329302, 0.40088927)
Data Point: (88.586679, 0.40088927)
Data Point: (162.37767, 0.40088927)
Data Point: (297.63514, 0.40088927)
Data Point: (545.55948, 0.40088927)
Data Point: (1000, 0.39828281)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.401 ft³/ft³
Liquid Limit: 47 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.1
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Alluvial (Granular)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 2.3925e-006 /psf
Porosity: 0.27269448
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.27030198)
Data Point: (0.018329807, 0.27030198)
Data Point: (0.033598183, 0.27030198)
Data Point: (0.061584821, 0.27030198)
Data Point: (0.11288379, 0.27030198)
Data Point: (0.20691381, 0.27030198)
Data Point: (0.37926902, 0.27030198)
Data Point: (0.6951928, 0.27030198)
Data Point: (1.274275, 0.27030198)
Data Point: (2.3357215, 0.27030198)
Data Point: (4.2813324, 0.27030198)
Data Point: (7.8475997, 0.27030198)
Data Point: (14.384499, 0.27030198)
Data Point: (26.366509, 0.27030198)
Data Point: (48.329302, 0.27030198)
Data Point: (88.586679, 0.27030198)
Data Point: (162.37767, 0.27030198)
Data Point: (297.63514, 0.27030198)
Data Point: (545.55948, 0.27030198)
Data Point: (1000, 0.27030198)
Estimation Properties

Vol. WC Estimation Method: Grain Size Function
Sample Material: Silty Sand
Saturated Water Content: 0.27 ft³/ft³
Liquid Limit: 0 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 6
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Fly Ash (Sluiced)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 6.2218e-005 /psf
Porosity: 0.37786527
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.35499418)
Data Point: (0.018329807, 0.35499418)
Data Point: (0.033598183, 0.35499418)
Data Point: (0.061584821, 0.35499418)
Data Point: (0.11288379, 0.35499418)
Data Point: (0.20691381, 0.35499418)
Data Point: (0.37926902, 0.35499418)
Data Point: (0.6951928, 0.35499418)
Data Point: (1.274275, 0.35499418)
Data Point: (2.3357215, 0.35499418)
Data Point: (4.2813324, 0.35499418)
Data Point: (7.8475997, 0.35499418)
Data Point: (14.384499, 0.35499418)
Data Point: (26.366509, 0.35499418)
Data Point: (48.329302, 0.35499418)
Data Point: (88.586679, 0.35499418)
Data Point: (162.37767, 0.35499418)
Data Point: (297.63514, 0.35499418)
Data Point: (545.55948, 0.34147401)
Data Point: (1000, 0.26813417)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Silt
Saturated Water Content: 0.3548 ft³/ft³
Liquid Limit: 0 %
Diameter at 10% passing: 0.004
Diameter at 60% passing: 0.049
Maximum: 1000
Minimum: 0.01
Num. Points: 20

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section P.gsz

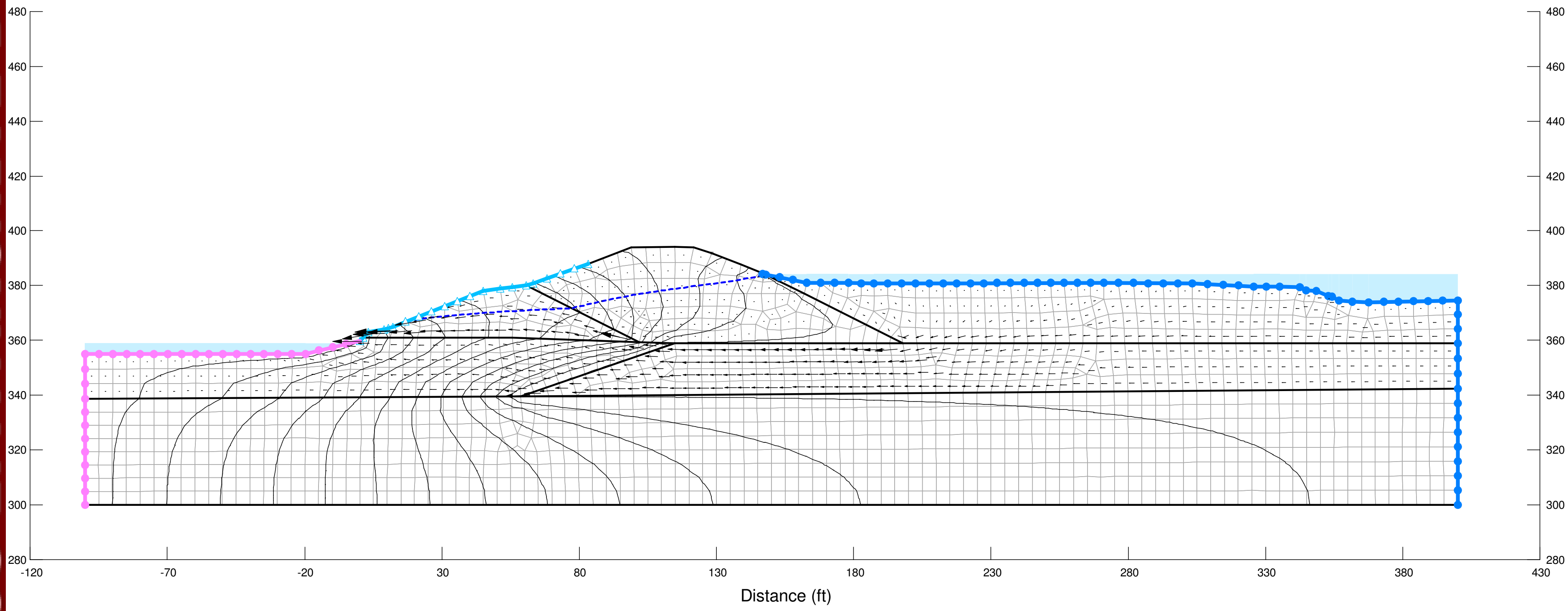
Analysis Name: Steady-State Seepage

Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 12:35:12 PM

Stantec

Boundary Conditions with Mesh



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section P.gsz

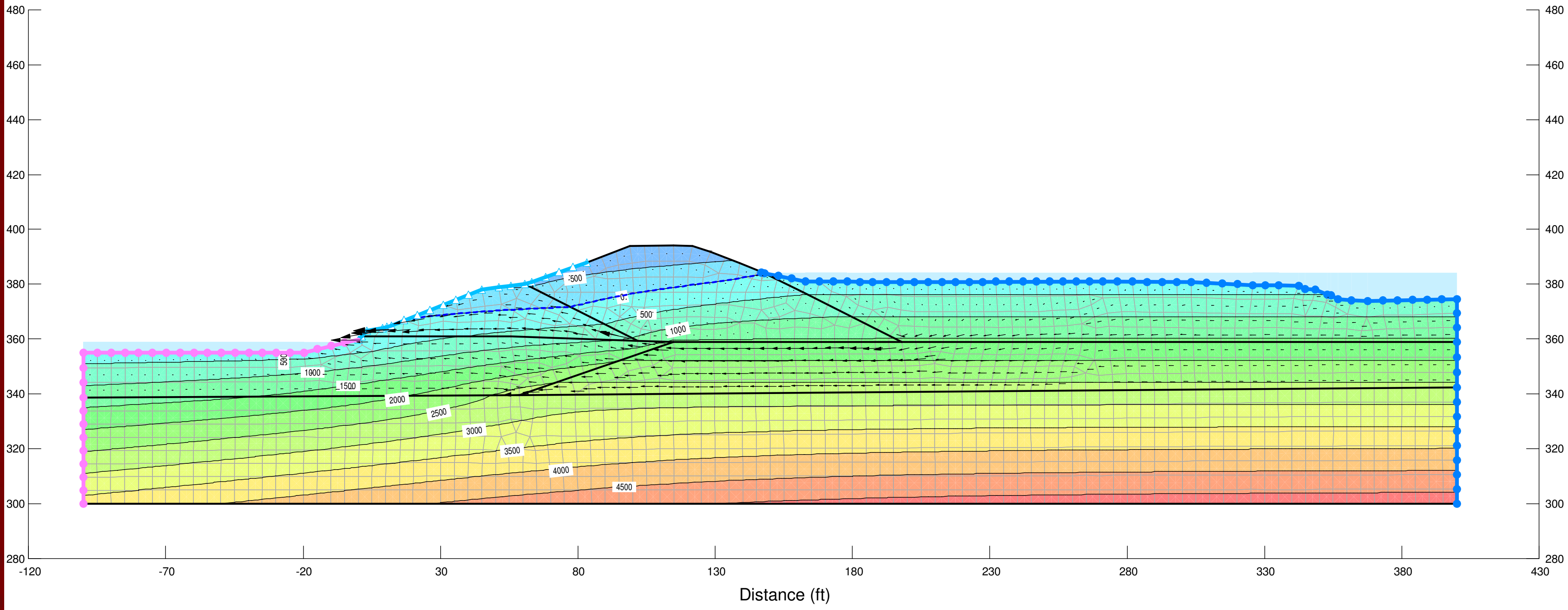
Analysis Name: Steady-State Seepage

Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 12:35:12 PM

Stantec

Pore-Water Pressure (psf)



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section P.gsz

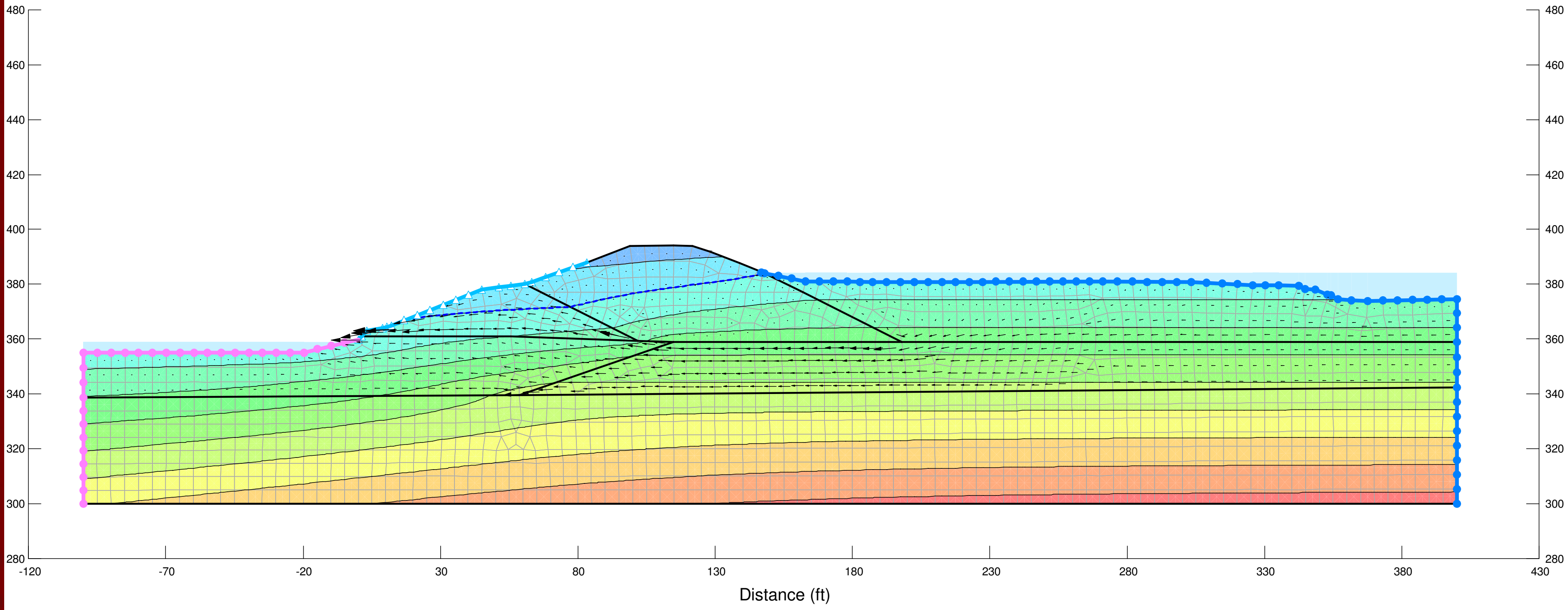
Analysis Name: Steady-State Seepage

Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 12:35:12 PM

Stantec

Pressure Head (ft)



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section P.gsz

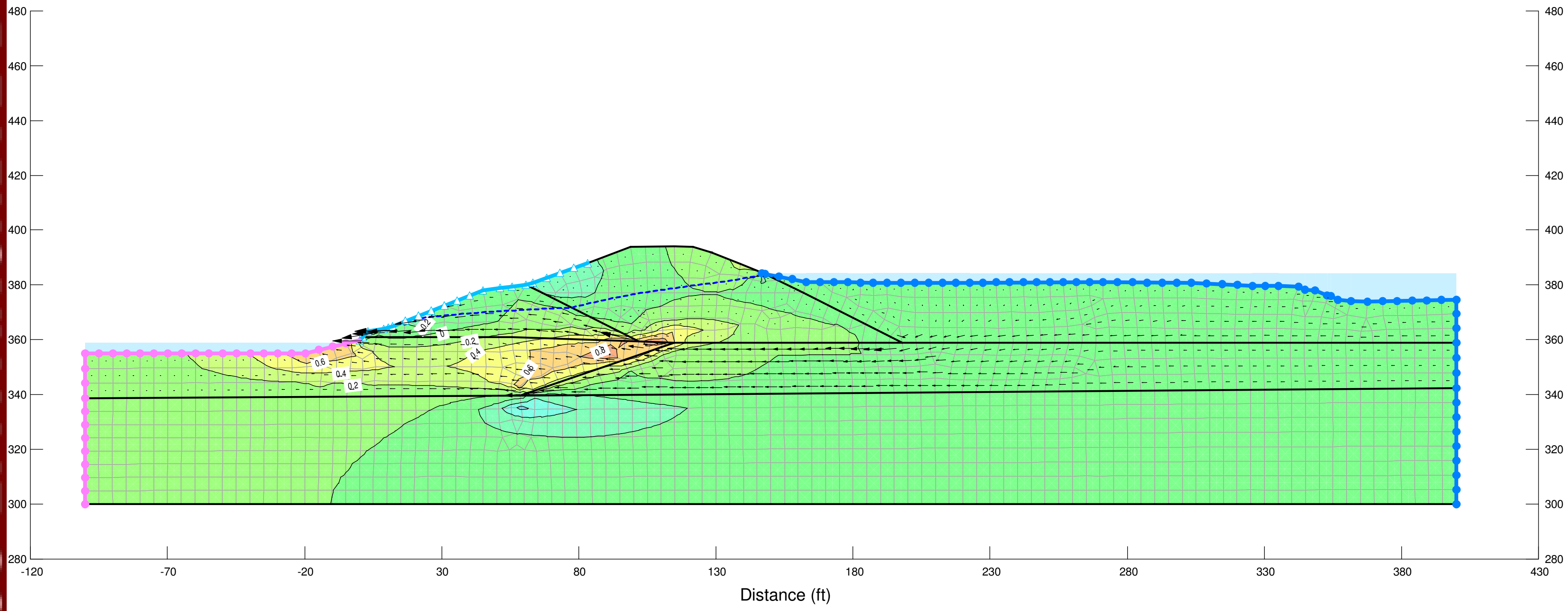
Analysis Name: Steady-State Seepage

Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 12:35:12 PM

Stantec

Y-Gradient



Steady-State Seepage

File Information

Revision Number: 233
Last Edited By: Rogers, Daniel
Date: 1/12/2010
Time: 4:27:40 PM
File Name: Section Q.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/12/2010
Last Solved Time: 4:28:22 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Mass(M) Units: lbs
Mass Flux Units: lbs/sec
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Steady-State Seepage

- Kind: SEEP/W
- Method: Steady-State
- Settings
  - Include Air Flow: No
- Control
  - Apply Runoff: Yes
- Convergence
  - Convergence Type: Gauss Point K
  - Convergence Settings
    - Maximum Number of Iterations: 500
    - Tolerance: 0.01
    - Maximum Change in K: 0.1
    - Rate of Change in K: 1.02
    - Minimum Change in K: 0.0001
  - Equation Solver: Parallel Direct
  - Potential Seepage Max # of Reviews: 10
- Time
  - Starting Time: 0 sec
  - Duration: 0 sec

Ending Time: 0 sec

Materials

Dike 1 (Lean Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 1 (Lean)
Vol. WC. Function: Dike 1 (Lean)
K-Ratio: 0.02
K-Direction: 0 °

Dike 2 (Lean Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 2 (Lean)
Vol. WC. Function: Dike 2 (Lean)
K-Ratio: 0.01
K-Direction: 0 °

Fly Ash (Sluiced)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Fly Ash (Sluiced)
Vol. WC. Function: Fly Ash (Sluiced)
K-Ratio: 0.02
K-Direction: 0 °

Alluvial Clay

Model: Saturated / Unsaturated
Hydraulic
K-Function: Alluvial (Clay)
Vol. WC. Function: Alluvial (Clay)
K-Ratio: 0.05
K-Direction: 0 °

Alluvial Granular

Model: Saturated / Unsaturated
Hydraulic
K-Function: Alluvial (Granular)
Vol. WC. Function: Alluvial (Granular)
K-Ratio: 0.05
K-Direction: 0 °

Bedrock

Model: Saturated Only
Hydraulic
K-Sat: 1e-011 ft/sec
Volumetric Water Content: 0 ft³/ft³

Mv: 0 /psf
K-Ratio: 0.1
K-Direction: 0 °

Boundary Conditions

Potential Seepage Face

Review: true
Type: Total Flux (Q) 0

Ash Pond Pool (384.23 ft)

Type: Head (H) 384.23

Wells Creek Water El 359 ft

Type: Head (H) 359

K Functions

Dike 1 (Lean)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 4.64e-006
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 4.64e-006)
Data Point: (0.018329807, 4.6134528e-006)
Data Point: (0.033598183, 4.5869157e-006)
Data Point: (0.061584821, 4.5603567e-006)
Data Point: (0.11288379, 4.5337861e-006)
Data Point: (0.20691381, 4.5071982e-006)
Data Point: (0.37926902, 4.4805703e-006)
Data Point: (0.6951928, 4.4538831e-006)
Data Point: (1.274275, 4.4270843e-006)
Data Point: (2.3357215, 4.4000706e-006)
Data Point: (4.2813324, 4.3726674e-006)
Data Point: (7.8475997, 4.3445481e-006)
Data Point: (14.384499, 4.315122e-006)
Data Point: (26.366509, 4.2832896e-006)
Data Point: (48.329302, 4.2469954e-006)
Data Point: (88.586679, 4.2030639e-006)
Data Point: (162.37767, 4.1448602e-006)
Data Point: (297.63514, 4.0416294e-006)
Data Point: (545.55948, 3.9502528e-006)
Data Point: (1000, 2.4315931e-006)
Estimation Properties
Volume Water Content Function: Dike 1 (Lean)
Hydraulic K Sat: 4.64e-006 ft/sec

Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.06 ft³/ft³

Dike 2 (Lean)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 1.4e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 1.4e-008)
Data Point: (0.018329807, 1.3841502e-008)
Data Point: (0.033598183, 1.3682956e-008)
Data Point: (0.061584821, 1.3524347e-008)
Data Point: (0.11288379, 1.3365851e-008)
Data Point: (0.20691381, 1.3207316e-008)
Data Point: (0.37926902, 1.304866e-008)
Data Point: (0.6951928, 1.2889801e-008)
Data Point: (1.274275, 1.273063e-008)
Data Point: (2.3357215, 1.2570815e-008)
Data Point: (4.2813324, 1.2409841e-008)
Data Point: (7.8475997, 1.2246731e-008)
Data Point: (14.384499, 1.2079701e-008)
Data Point: (26.366509, 1.1905499e-008)
Data Point: (48.329302, 1.1718188e-008)
Data Point: (88.586679, 1.1506607e-008)
Data Point: (162.37767, 1.1250676e-008)
Data Point: (297.63514, 1.0920964e-008)
Data Point: (545.55948, 1.0418615e-008)
Data Point: (1000, 9.4447797e-009)
Estimation Properties
Volume Water Content Function: Dike 2 (Lean)
Hydraulic K Sat: 1.4e-008 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.08 ft³/ft³

Alluvial (Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 4.786e-005
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 4.786e-005)

Data Point: (0.018329807, 4.5322563e-005)
Data Point: (0.033598183, 4.2783344e-005)
Data Point: (0.061584821, 4.0245152e-005)
Data Point: (0.11288379, 3.7706958e-005)
Data Point: (0.20691381, 3.5168763e-005)
Data Point: (0.37926902, 3.2630738e-005)
Data Point: (0.6951928, 3.009295e-005)
Data Point: (1.274275, 2.7555601e-005)
Data Point: (2.3357215, 2.5019106e-005)
Data Point: (4.2813324, 2.2484135e-005)
Data Point: (7.8475997, 1.9951983e-005)
Data Point: (14.384499, 1.7425006e-005)
Data Point: (26.366509, 1.4907462e-005)
Data Point: (48.329302, 1.240735e-005)
Data Point: (88.586679, 9.9389376e-006)
Data Point: (162.37767, 7.5288407e-006)
Data Point: (297.63514, 5.2266027e-006)
Data Point: (545.55948, 3.1174951e-006)
Data Point: (1000, 1.3648433e-006)

Estimation Properties
Volume Water Content Function: Alluvial (Clay)
Hydraulic K Sat: 4.786e-005 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.07 ft³/ft³

Alluvial (Granular)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 6.56e-005
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 6.56e-005)
Data Point: (0.018329807, 6.5599955e-005)
Data Point: (0.033598183, 6.5599889e-005)
Data Point: (0.061584821, 6.5599786e-005)
Data Point: (0.11288379, 6.5599613e-005)
Data Point: (0.20691381, 6.5599318e-005)
Data Point: (0.37926902, 6.5598819e-005)
Data Point: (0.6951928, 6.5597653e-005)
Data Point: (1.274275, 6.5595797e-005)
Data Point: (2.3357215, 6.5601509e-005)
Data Point: (4.2813324, 6.5561273e-005)
Data Point: (7.8475997, 6.5357469e-005)
Data Point: (14.384499, 6.6547157e-005)
Data Point: (26.366509, 2.8488866e-005)
Data Point: (48.329302, 3.302432e-006)

- Data Point: (88.586679, 2.3582744e-007)
- Data Point: (162.37767, 2.432944e-008)
- Data Point: (297.63514, 3.6817723e-009)
- Data Point: (545.55948, 6.4215817e-010)
- Data Point: (1000, 8.1778609e-011)

Estimation Properties

- Volume Water Content Function: Alluvial (Granular)
- Hydraulic K Sat: 6.56e-005 ft/sec
- Hyd. K-Function Estimation Method: Fredlund-Xing Function
- Maximum: 1000
- Minimum: 0.01
- Num. Points: 20
- Residual Water Content: 0.02 ft^3/ft^3

Fly Ash (Sluiced)

Model: Data Point Function

Function: X-Conductivity vs. Pore-Water Pressure

- Curve Fit to Data: 100 %
- Segment Curvature: 100 %

K-Saturation: 0.000138

Data Points: Matric Suction (psf), X-Conductivity (ft/sec)

- Data Point: (0.01, 0.000138)
- Data Point: (0.018329807, 0.0001368885)
- Data Point: (0.033598183, 0.00013577621)
- Data Point: (0.061584821, 0.00013466289)
- Data Point: (0.11288379, 0.0001335475)
- Data Point: (0.20691381, 0.00013242828)
- Data Point: (0.37926902, 0.00013130206)
- Data Point: (0.6951928, 0.00013016303)
- Data Point: (1.274275, 0.00012900049)
- Data Point: (2.3357215, 0.00012779495)
- Data Point: (4.2813324, 0.00012651011)
- Data Point: (7.8475997, 0.00012507948)
- Data Point: (14.384499, 0.00012339947)
- Data Point: (26.366509, 0.00012120171)
- Data Point: (48.329302, 0.00011765521)
- Data Point: (88.586679, 0.00011552727)
- Data Point: (162.37767, 6.6817109e-005)
- Data Point: (297.63514, 1.1152644e-005)
- Data Point: (545.55948, 8.9103191e-007)
- Data Point: (1000, 5.9862353e-008)

Estimation Properties

- Volume Water Content Function: Fly Ash (Sluiced)
- Hydraulic K Sat: 0.000138 ft/sec
- Hyd. K-Function Estimation Method: Fredlund-Xing Function
- Maximum: 1000
- Minimum: 0.01
- Num. Points: 20
- Residual Water Content: 0.015 ft^3/ft^3

Vol. Water Content Functions

Dike 1 (Lean)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
  Curve Fit to Data: 100 %
  Segment Curvature: 100 %
  Mv: 3e-006 /psf
Porosity: 0.41556948
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
  Data Point: (0.01, 0.41308567)
  Data Point: (0.018329807, 0.41308567)
  Data Point: (0.033598183, 0.41308567)
  Data Point: (0.061584821, 0.41308567)
  Data Point: (0.11288379, 0.41308567)
  Data Point: (0.20691381, 0.41308567)
  Data Point: (0.37926902, 0.41308567)
  Data Point: (0.6951928, 0.41308567)
  Data Point: (1.274275, 0.41308567)
  Data Point: (2.3357215, 0.41308567)
  Data Point: (4.2813324, 0.41308567)
  Data Point: (7.8475997, 0.41308567)
  Data Point: (14.384499, 0.41308567)
  Data Point: (26.366509, 0.41308567)
  Data Point: (48.329302, 0.41308567)
  Data Point: (88.586679, 0.41308567)
  Data Point: (162.37767, 0.41308567)
  Data Point: (297.63514, 0.41308567)
  Data Point: (545.55948, 0.4125467)
  Data Point: (1000, 0.38347036)
Estimation Properties
  Vol. WC Estimation Method: Grain Size Function
  Sample Material: Clay
  Saturated Water Content: 0.413 ft³/ft³
  Liquid Limit: 38 %
  Diameter at 10% passing: 0.0001
  Diameter at 60% passing: 0.1
  Maximum: 1000
  Minimum: 0.01
  Num. Points: 20

Dike 2 (Lean)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
  Curve Fit to Data: 100 %
  Segment Curvature: 100 %
  Mv: 3e-006 /psf
Porosity: 0.35421721

Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)

Data Point: (0.01, 0.35121721)
Data Point: (0.018329807, 0.35121721)
Data Point: (0.033598183, 0.35121721)
Data Point: (0.061584821, 0.35121721)
Data Point: (0.11288379, 0.35121721)
Data Point: (0.20691381, 0.35121721)
Data Point: (0.37926902, 0.35121721)
Data Point: (0.6951928, 0.35121721)
Data Point: (1.274275, 0.35121721)
Data Point: (2.3357215, 0.35121721)
Data Point: (4.2813324, 0.35121721)
Data Point: (7.8475997, 0.35121721)
Data Point: (14.384499, 0.35121721)
Data Point: (26.366509, 0.35121721)
Data Point: (48.329302, 0.35121721)
Data Point: (88.586679, 0.35121721)
Data Point: (162.37767, 0.35121721)
Data Point: (297.63514, 0.35121721)
Data Point: (545.55948, 0.35121721)
Data Point: (1000, 0.35121721)

Estimation Properties

Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.351 ft³/ft³
Liquid Limit: 48 %
Diameter at 10% passing: 0.0001
Diameter at 60% passing: 0.075
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Alluvial (Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure

Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 4.786e-005 /psf

Porosity: 0.46611653
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)

Data Point: (0.01, 0.40088927)
Data Point: (0.018329807, 0.40088927)
Data Point: (0.033598183, 0.40088927)
Data Point: (0.061584821, 0.40088927)
Data Point: (0.11288379, 0.40088927)
Data Point: (0.20691381, 0.40088927)
Data Point: (0.37926902, 0.40088927)
Data Point: (0.6951928, 0.40088927)
Data Point: (1.274275, 0.40088927)
Data Point: (2.3357215, 0.40088927)

Data Point: (4.2813324, 0.40088927)
Data Point: (7.8475997, 0.40088927)
Data Point: (14.384499, 0.40088927)
Data Point: (26.366509, 0.40088927)
Data Point: (48.329302, 0.40088927)
Data Point: (88.586679, 0.40088927)
Data Point: (162.37767, 0.40088927)
Data Point: (297.63514, 0.40088927)
Data Point: (545.55948, 0.40088927)
Data Point: (1000, 0.39828281)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.401 ft^3/ft^3
Liquid Limit: 47 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.1
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Alluvial (Granular)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 2.3925e-006 /psf
Porosity: 0.27269448
Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
Data Point: (0.01, 0.27030198)
Data Point: (0.018329807, 0.27030198)
Data Point: (0.033598183, 0.27030198)
Data Point: (0.061584821, 0.27030198)
Data Point: (0.11288379, 0.27030198)
Data Point: (0.20691381, 0.27030198)
Data Point: (0.37926902, 0.27030198)
Data Point: (0.6951928, 0.27030198)
Data Point: (1.274275, 0.27030198)
Data Point: (2.3357215, 0.27030198)
Data Point: (4.2813324, 0.27030198)
Data Point: (7.8475997, 0.27030198)
Data Point: (14.384499, 0.27030198)
Data Point: (26.366509, 0.27030198)
Data Point: (48.329302, 0.27030198)
Data Point: (88.586679, 0.27030198)
Data Point: (162.37767, 0.27030198)
Data Point: (297.63514, 0.27030198)
Data Point: (545.55948, 0.27030198)
Data Point: (1000, 0.27030198)
Estimation Properties

Vol. WC Estimation Method: Grain Size Function
Sample Material: Silty Sand
Saturated Water Content: 0.27 ft^3/ft^3
Liquid Limit: 0 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 6
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Fly Ash (Sluiced)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 6.2218e-005 /psf
Porosity: 0.360409
Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
Data Point: (0.01, 0.35460006)
Data Point: (0.018329807, 0.35460006)
Data Point: (0.033598183, 0.35460006)
Data Point: (0.061584821, 0.35460006)
Data Point: (0.11288379, 0.35460006)
Data Point: (0.20691381, 0.35460006)
Data Point: (0.37926902, 0.35460006)
Data Point: (0.6951928, 0.35460006)
Data Point: (1.274275, 0.35460006)
Data Point: (2.3357215, 0.35460006)
Data Point: (4.2813324, 0.35460006)
Data Point: (7.8475997, 0.35460006)
Data Point: (14.384499, 0.35460006)
Data Point: (26.366509, 0.35460006)
Data Point: (48.329302, 0.35460006)
Data Point: (88.586679, 0.35328934)
Data Point: (162.37767, 0.31177741)
Data Point: (297.63514, 0.23596761)
Data Point: (545.55948, 0.18417704)
Data Point: (1000, 0.15479589)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Silt
Saturated Water Content: 0.3548 ft^3/ft^3
Liquid Limit: 0 %
Diameter at 10% passing: 0.004
Diameter at 60% passing: 0.49
Maximum: 1000
Minimum: 0.01
Num. Points: 20

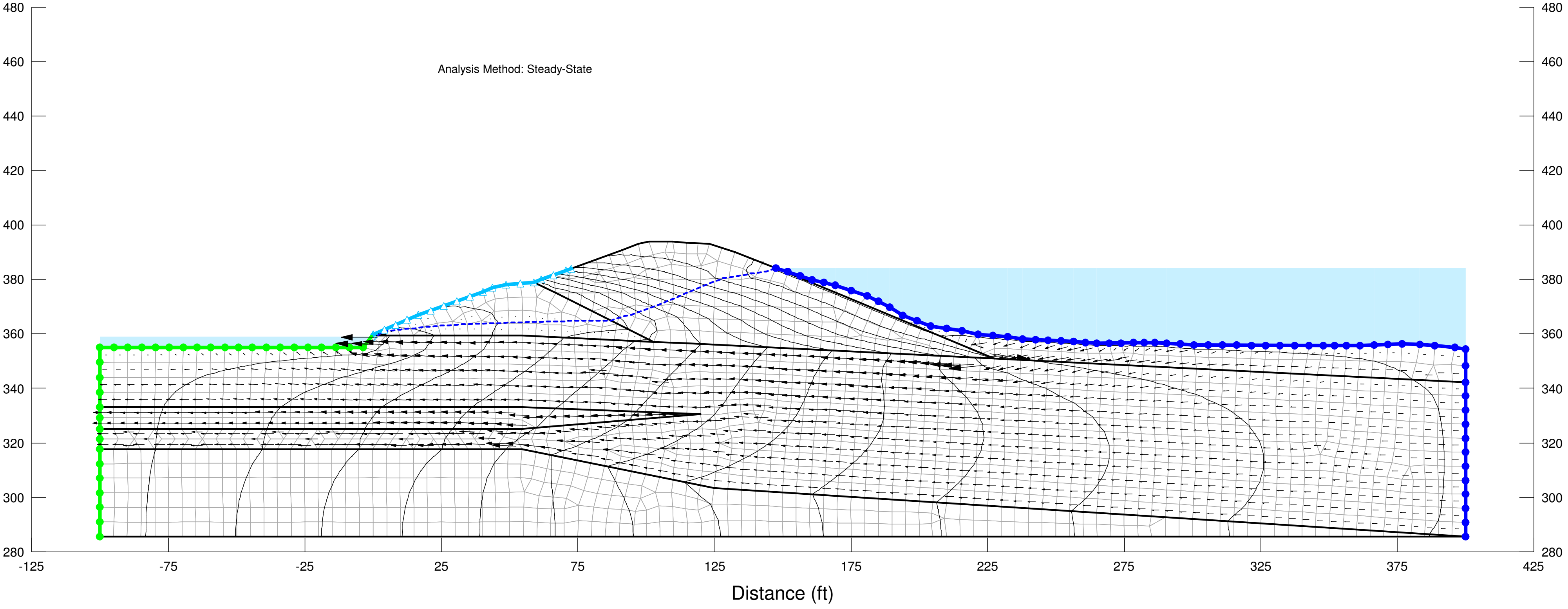
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section Q.gsz

Analysis Name: Steady-State Seepage
Last Solved on 1/12/2010 at 4:28:22 PM
Date Saved: 1/12/2010

Stantec

Boundary Conditions with Mesh



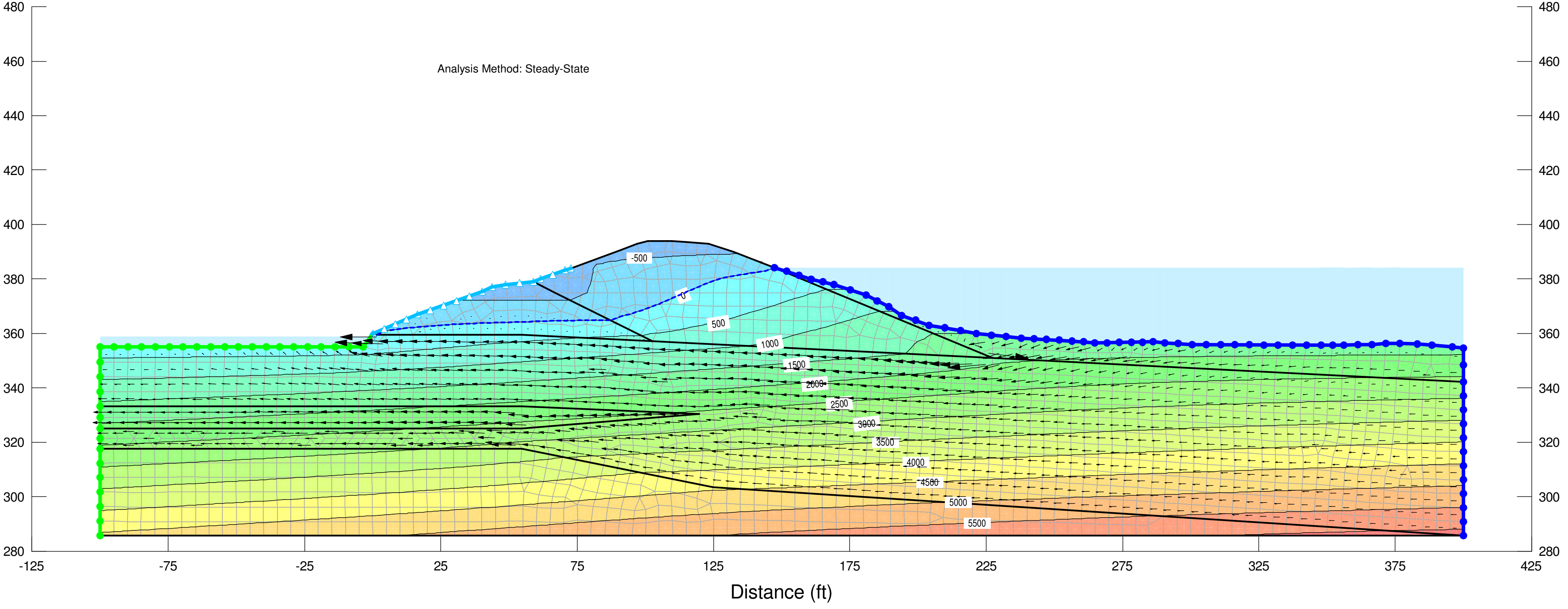
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section Q.gsz

Analysis Name: Steady-State Seepage
Last Solved on 1/12/2010 at 4:28:22 PM
Date Saved: 1/12/2010

Stantec

Pore-Water Pressure (psf)



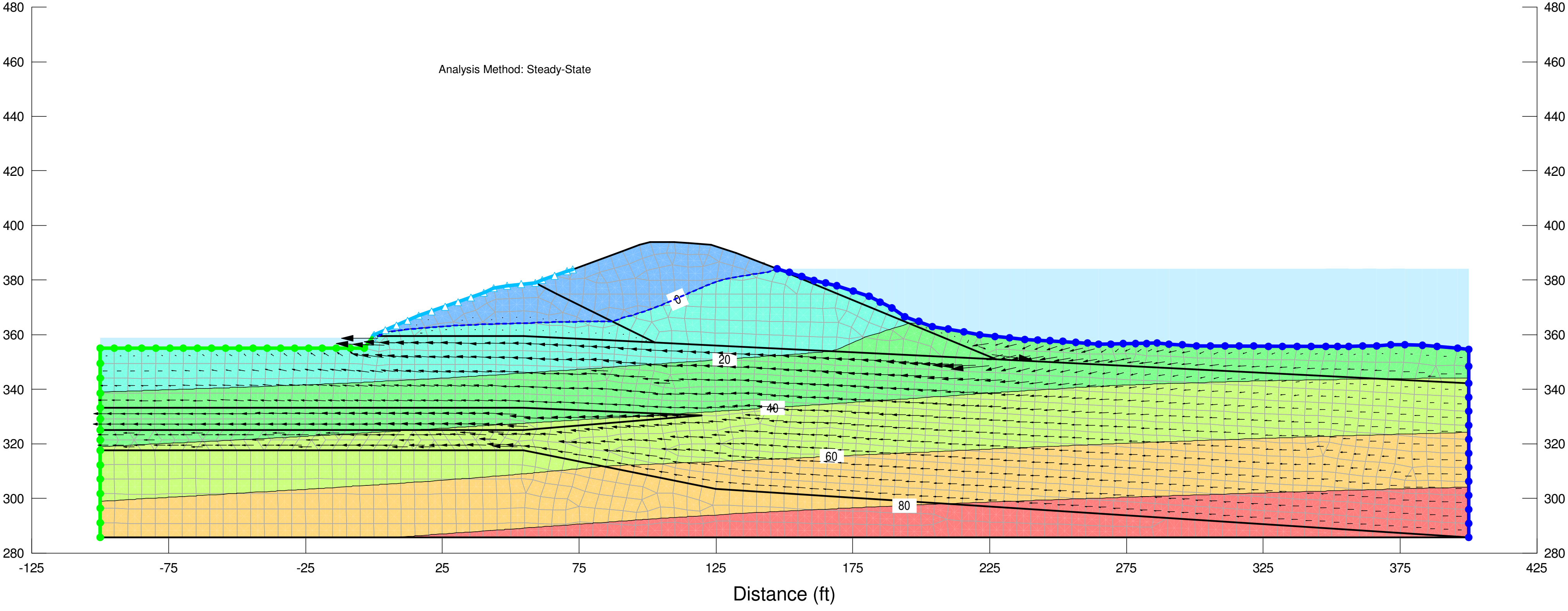
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section Q.gsz

Analysis Name: Steady-State Seepage
Last Solved on 1/12/2010 at 4:28:22 PM
Date Saved: 1/12/2010

Stantec

Pressure Head (ft)

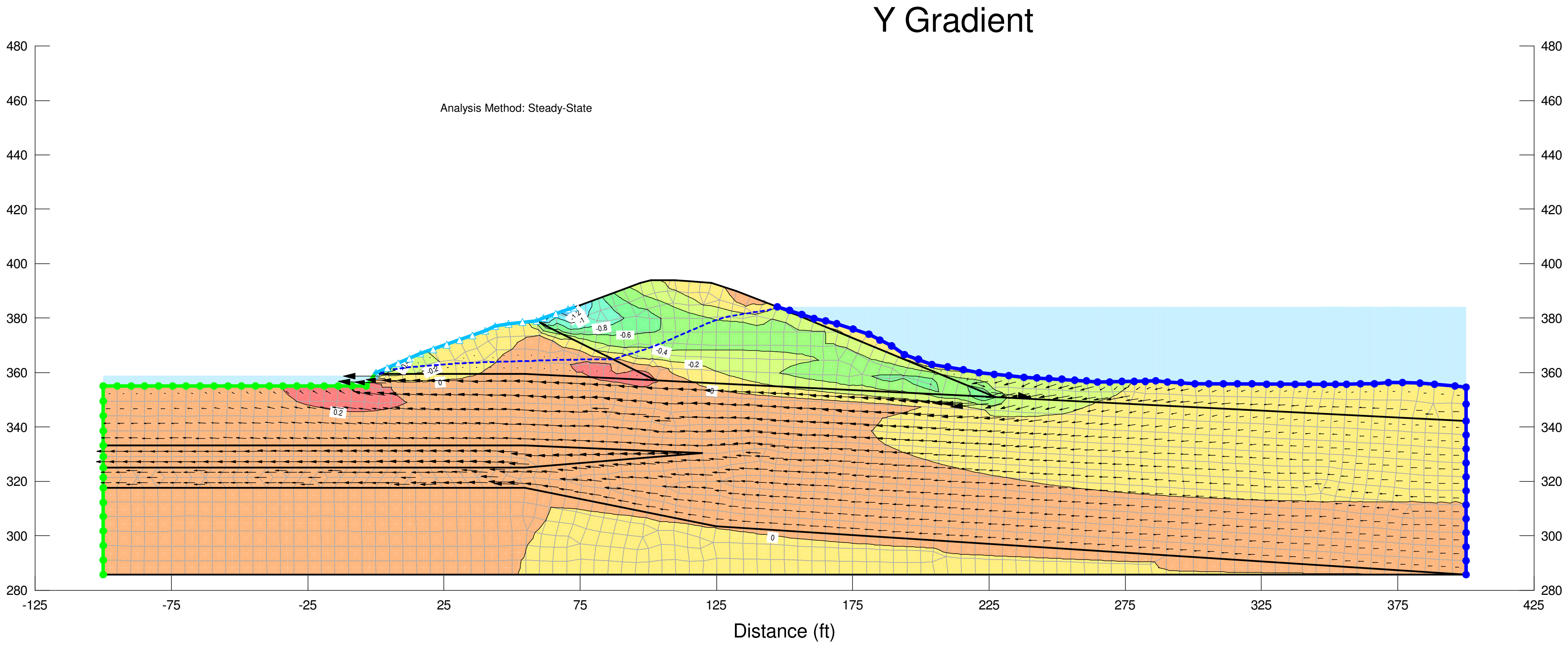


SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section Q.gsz

Analysis Name: Steady-State Seepage
Last Solved on 1/12/2010 at 4:28:22 PM
Date Saved: 1/12/2010

Stantec


Y Gradient

Analysis Method: Steady-State

Steady-State Seepage

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File Information

Created By: Cooper, Paul
Revision Number: 226
Last Edited By: Rogers, Daniel
Date: 1/31/2010
Time: 1:07:45 PM
File Name: Section R.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/31/2010
Last Solved Time: 1:10:06 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Mass(M) Units: lbs
Mass Flux Units: lbs/sec
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Steady-State Seepage

- Kind: SEEP/W
- Method: Steady-State
- Settings
  - Include Air Flow: No
- Control
  - Apply Runoff: Yes
- Convergence
  - Convergence Type: Gauss Point K
  - Convergence Settings
    - Maximum Number of Iterations: 500
    - Tolerance: 0.01
    - Maximum Change in K: 0.1
    - Rate of Change in K: 1.02
    - Minimum Change in K: 0.0001
  - Equation Solver: Parallel Direct
  - Potential Seepage Max # of Reviews: 10
- Time
  - Starting Time: 0 sec

Duration: 0 sec
Ending Time: 0 sec

Materials

Dike 1 (Lean Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 1 (Lean Clay)
Vol. WC. Function: Dike 1 (Lean Clay)
K-Ratio: 0.1
K-Direction: 0 °

Dike 2 (Lean Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 2 (Lean Clay)
Vol. WC. Function: Dike 2 (Lean Clay)
K-Ratio: 0.1
K-Direction: 0 °

Fly Ash (Sluiced)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Fly Ash (Sluiced)
Vol. WC. Function: Fly Ash (Sluiced)
K-Ratio: 0.02
K-Direction: 0 °

Alluvial Clay

Model: Saturated / Unsaturated
Hydraulic
K-Function: Alluvial (Clay)
Vol. WC. Function: Alluvial (Clay)
K-Ratio: 0.05
K-Direction: 0 °

Alluvial Granular

Model: Saturated / Unsaturated
Hydraulic
K-Function: Alluvial (Granular)
Vol. WC. Function: Alluvial (Granular)
K-Ratio: 0.05
K-Direction: 0 °

Bedrock

Model: Saturated Only
Hydraulic
K-Sat: 1e-011 ft/sec

Volumetric Water Content: 0.05 ft³/ft³
Mv: 0 /psf
K-Ratio: 0.1
K-Direction: 0 °

Boundary Conditions

Potential Seepage Face

Review: true
Type: Total Flux (Q) 0

Ash Pond

Type: Head (H) 384.23

Wells Creek

Type: Head (H) 359.5

K Functions

Dike 1 (Lean Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 2.13e-007
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 2.13e-007)
Data Point: (0.018329807, 2.1234388e-007)
Data Point: (0.033598183, 2.1168814e-007)
Data Point: (0.061584821, 2.1103203e-007)
Data Point: (0.11288379, 2.1037498e-007)
Data Point: (0.20691381, 2.0971735e-007)
Data Point: (0.37926902, 2.0905824e-007)
Data Point: (0.6951928, 2.0839653e-007)
Data Point: (1.274275, 2.077303e-007)
Data Point: (2.3357215, 2.070555e-007)
Data Point: (4.2813324, 2.0636507e-007)
Data Point: (7.8475997, 2.0564593e-007)
Data Point: (14.384499, 2.0487454e-007)
Data Point: (26.366509, 2.0400629e-007)
Data Point: (48.329302, 2.0295363e-007)
Data Point: (88.586679, 2.016313e-007)
Data Point: (162.37767, 1.9978076e-007)
Data Point: (297.63514, 1.9457772e-007)
Data Point: (545.55948, 1.9521936e-007)
Data Point: (1000, 7.5557482e-008)
Estimation Properties
Volume Water Content Function: Dike 1 (Lean Clay)

Hydraulic K Sat: 2.13e-007 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.062 ft^3/ft^3

Dike 2 (Lean Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 1.4e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 1.4e-008)
Data Point: (0.018329807, 1.3839712e-008)
Data Point: (0.033598183, 1.3679373e-008)
Data Point: (0.061584821, 1.3518951e-008)
Data Point: (0.11288379, 1.335855e-008)
Data Point: (0.20691381, 1.3198165e-008)
Data Point: (0.37926902, 1.3037684e-008)
Data Point: (0.6951928, 1.2877019e-008)
Data Point: (1.274275, 1.2715999e-008)
Data Point: (2.3357215, 1.2554349e-008)
Data Point: (4.2813324, 1.2391548e-008)
Data Point: (7.8475997, 1.2226602e-008)
Data Point: (14.384499, 1.2057731e-008)
Data Point: (26.366509, 1.1881667e-008)
Data Point: (48.329302, 1.1692468e-008)
Data Point: (88.586679, 1.1478944e-008)
Data Point: (162.37767, 1.1220975e-008)
Data Point: (297.63514, 1.0889028e-008)
Data Point: (545.55948, 1.0384181e-008)
Data Point: (1000, 9.408038e-009)
Estimation Properties
Volume Water Content Function: Dike 2 (Lean Clay)
Hydraulic K Sat: 1.4e-008 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.08 ft^3/ft^3

Alluvial (Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 4.86e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)

- Data Point: (0.01, 4.86e-008)
- Data Point: (0.018329807, 4.6081957e-008)
- Data Point: (0.033598183, 4.3562037e-008)
- Data Point: (0.061584821, 4.1043284e-008)
- Data Point: (0.11288379, 3.8524355e-008)
- Data Point: (0.20691381, 3.6005505e-008)
- Data Point: (0.37926902, 3.348676e-008)
- Data Point: (0.6951928, 3.0968229e-008)
- Data Point: (1.274275, 2.8450022e-008)
- Data Point: (2.3357215, 2.5932423e-008)
- Data Point: (4.2813324, 2.3415929e-008)
- Data Point: (7.8475997, 2.0901504e-008)
- Data Point: (14.384499, 1.8390826e-008)
- Data Point: (26.366509, 1.5886992e-008)
- Data Point: (48.329302, 1.3395802e-008)
- Data Point: (88.586679, 1.0927841e-008)
- Data Point: (162.37767, 8.5023705e-009)
- Data Point: (297.63514, 6.1503781e-009)
- Data Point: (545.55948, 3.9524429e-009)
- Data Point: (1000, 2.0421567e-009)

Estimation Properties

- Volume Water Content Function: Alluvial (Clay)
- Hydraulic K Sat: 4.86e-008 ft/sec
- Hyd. K-Function Estimation Method: Fredlund-Xing Function
- Maximum: 1000
- Minimum: 0.01
- Num. Points: 20
- Residual Water Content: 0.07 ft^3/ft^3

Alluvial (Granular)

- Model: Data Point Function
- Function: X-Conductivity vs. Pore-Water Pressure
  - Curve Fit to Data: 100 %
  - Segment Curvature: 100 %
- K-Saturation: 6.56e-005
- Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
  - Data Point: (0.01, 6.56e-005)
  - Data Point: (0.018329807, 6.4809238e-005)
  - Data Point: (0.033598183, 6.4018422e-005)
  - Data Point: (0.061584821, 6.3227812e-005)
  - Data Point: (0.11288379, 6.2437049e-005)
  - Data Point: (0.20691381, 6.1646212e-005)
  - Data Point: (0.37926902, 6.0854776e-005)
  - Data Point: (0.6951928, 6.0062124e-005)
  - Data Point: (1.274275, 5.9267829e-005)
  - Data Point: (2.3357215, 5.8470547e-005)
  - Data Point: (4.2813324, 5.7667753e-005)
  - Data Point: (7.8475997, 5.6854825e-005)
  - Data Point: (14.384499, 5.6023348e-005)
  - Data Point: (26.366509, 5.5157894e-005)

Data Point: (48.329302, 5.4230286e-005)
Data Point: (88.586679, 5.3187637e-005)
Data Point: (162.37767, 5.1934764e-005)
Data Point: (297.63514, 5.0331243e-005)
Data Point: (545.55948, 4.7912406e-005)
Data Point: (1000, 4.3290175e-005)

Estimation Properties

Volume Water Content Function: Alluvial (Granular)
Hydraulic K Sat: 6.56e-005 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.02 ft³/ft³

Fly Ash (Sluiced)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 0.000138
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 0.000138)
Data Point: (0.018329807, 0.00013124899)
Data Point: (0.033598183, 0.00012449358)
Data Point: (0.061584821, 0.00011774069)
Data Point: (0.11288379, 0.00011098751)
Data Point: (0.20691381, 0.00010423412)
Data Point: (0.37926902, 9.7480653e-005)
Data Point: (0.6951928, 9.072693e-005)
Data Point: (1.274275, 8.3972583e-005)
Data Point: (2.3357215, 7.7217317e-005)
Data Point: (4.2813324, 7.046016e-005)
Data Point: (7.8475997, 6.3699627e-005)
Data Point: (14.384499, 5.6933042e-005)
Data Point: (26.366509, 5.015463e-005)
Data Point: (48.329302, 4.3351522e-005)
Data Point: (88.586679, 3.6533744e-005)
Data Point: (162.37767, 2.9661059e-005)
Data Point: (297.63514, 2.2043007e-005)
Data Point: (545.55948, 1.5988112e-005)
Data Point: (1000, 1.5284178e-006)

Estimation Properties

Volume Water Content Function: Vol. Water Content Function 9
Hydraulic K Sat: 0.000138 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.015 ft³/ft³

Vol. Water Content Functions

Dike 1 (Lean Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
  Curve Fit to Data: 100 %
  Segment Curvature: 100 %
  Mv: 3e-006 /psf
Porosity: 0.41556948
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
  Data Point: (0.01, 0.41308567)
  Data Point: (0.018329807, 0.41308567)
  Data Point: (0.033598183, 0.41308567)
  Data Point: (0.061584821, 0.41308567)
  Data Point: (0.11288379, 0.41308567)
  Data Point: (0.20691381, 0.41308567)
  Data Point: (0.37926902, 0.41308567)
  Data Point: (0.6951928, 0.41308567)
  Data Point: (1.274275, 0.41308567)
  Data Point: (2.3357215, 0.41308567)
  Data Point: (4.2813324, 0.41308567)
  Data Point: (7.8475997, 0.41308567)
  Data Point: (14.384499, 0.41308567)
  Data Point: (26.366509, 0.41308567)
  Data Point: (48.329302, 0.41308567)
  Data Point: (88.586679, 0.41308567)
  Data Point: (162.37767, 0.41308567)
  Data Point: (297.63514, 0.41308567)
  Data Point: (545.55948, 0.4125467)
  Data Point: (1000, 0.38347036)
Estimation Properties
  Vol. WC Estimation Method: Grain Size Function
  Sample Material: Clay
  Saturated Water Content: 0.413 ft³/ft³
  Liquid Limit: 38 %
  Diameter at 10% passing: 0.001
  Diameter at 60% passing: 0.1
  Maximum: 1000
  Minimum: 0.01
  Num. Points: 20

Dike 2 (Lean Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
  Curve Fit to Data: 100 %
  Segment Curvature: 100 %
  Mv: 3e-006 /psf
Porosity: 0.35421721

Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
Data Point: (0.01, 0.35121721)
Data Point: (0.018329807, 0.35121721)
Data Point: (0.033598183, 0.35121721)
Data Point: (0.061584821, 0.35121721)
Data Point: (0.11288379, 0.35121721)
Data Point: (0.20691381, 0.35121721)
Data Point: (0.37926902, 0.35121721)
Data Point: (0.6951928, 0.35121721)
Data Point: (1.274275, 0.35121721)
Data Point: (2.3357215, 0.35121721)
Data Point: (4.2813324, 0.35121721)
Data Point: (7.8475997, 0.35121721)
Data Point: (14.384499, 0.35121721)
Data Point: (26.366509, 0.35121721)
Data Point: (48.329302, 0.35121721)
Data Point: (88.586679, 0.35121721)
Data Point: (162.37767, 0.35121721)
Data Point: (297.63514, 0.35121721)
Data Point: (545.55948, 0.35121721)
Data Point: (1000, 0.35121721)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.351 ft^3/ft^3
Liquid Limit: 48 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.075
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Alluvial (Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 4.786e-005 /psf
Porosity: 0.46611653
Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
Data Point: (0.01, 0.40088927)
Data Point: (0.018329807, 0.40088927)
Data Point: (0.033598183, 0.40088927)
Data Point: (0.061584821, 0.40088927)
Data Point: (0.11288379, 0.40088927)
Data Point: (0.20691381, 0.40088927)
Data Point: (0.37926902, 0.40088927)
Data Point: (0.6951928, 0.40088927)
Data Point: (1.274275, 0.40088927)
Data Point: (2.3357215, 0.40088927)

Data Point: (4.2813324, 0.40088927)
Data Point: (7.8475997, 0.40088927)
Data Point: (14.384499, 0.40088927)
Data Point: (26.366509, 0.40088927)
Data Point: (48.329302, 0.40088927)
Data Point: (88.586679, 0.40088927)
Data Point: (162.37767, 0.40088927)
Data Point: (297.63514, 0.40088927)
Data Point: (545.55948, 0.40088927)
Data Point: (1000, 0.39828281)

Estimation Properties

Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.401 ft³/ft³
Liquid Limit: 47 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.1
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Alluvial (Granular)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure

Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 2.3925e-006 /psf

Porosity: 0.27269448
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)

Data Point: (0.01, 0.27030198)
Data Point: (0.018329807, 0.27030198)
Data Point: (0.033598183, 0.27030198)
Data Point: (0.061584821, 0.27030198)
Data Point: (0.11288379, 0.27030198)
Data Point: (0.20691381, 0.27030198)
Data Point: (0.37926902, 0.27030198)
Data Point: (0.6951928, 0.27030198)
Data Point: (1.274275, 0.27030198)
Data Point: (2.3357215, 0.27030198)
Data Point: (4.2813324, 0.27030198)
Data Point: (7.8475997, 0.27030198)
Data Point: (14.384499, 0.27030198)
Data Point: (26.366509, 0.27030198)
Data Point: (48.329302, 0.27030198)
Data Point: (88.586679, 0.27030198)
Data Point: (162.37767, 0.27030198)
Data Point: (297.63514, 0.27030198)
Data Point: (545.55948, 0.27030198)
Data Point: (1000, 0.27030198)

Estimation Properties

Vol. WC Estimation Method: Grain Size Function
Sample Material: Silty Sand
Saturated Water Content: 0.27 ft³/ft³
Liquid Limit: 0 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 6
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Fly Ash (Sluiced)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 6.2218e-005 /psf
Porosity: 0.37786527
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.35499418)
Data Point: (0.018329807, 0.35499418)
Data Point: (0.033598183, 0.35499418)
Data Point: (0.061584821, 0.35499418)
Data Point: (0.11288379, 0.35499418)
Data Point: (0.20691381, 0.35499418)
Data Point: (0.37926902, 0.35499418)
Data Point: (0.6951928, 0.35499418)
Data Point: (1.274275, 0.35499418)
Data Point: (2.3357215, 0.35499418)
Data Point: (4.2813324, 0.35499418)
Data Point: (7.8475997, 0.35499418)
Data Point: (14.384499, 0.35499418)
Data Point: (26.366509, 0.35499418)
Data Point: (48.329302, 0.35499418)
Data Point: (88.586679, 0.35499418)
Data Point: (162.37767, 0.35499418)
Data Point: (297.63514, 0.35499418)
Data Point: (545.55948, 0.34147401)
Data Point: (1000, 0.26813417)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Silt
Saturated Water Content: 0.3548 ft³/ft³
Liquid Limit: 0 %
Diameter at 10% passing: 0.004
Diameter at 60% passing: 0.049
Maximum: 1000
Minimum: 0.01
Num. Points: 20

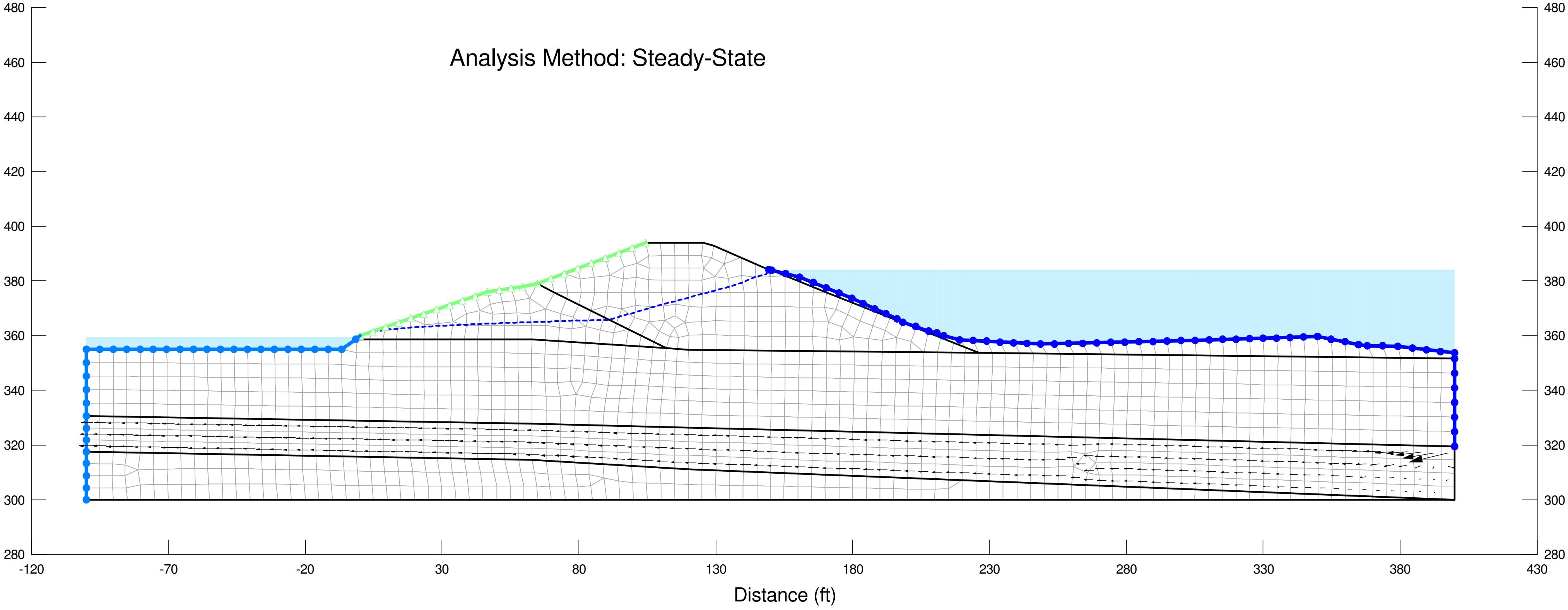
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section R.gsz

Analysis Name: Steady-State Seepage
Last Solved on 1/31/2010 at 1:10:06 PM
Date Saved: 1/31/2010

Stantec

Boundary Conditions with Mesh



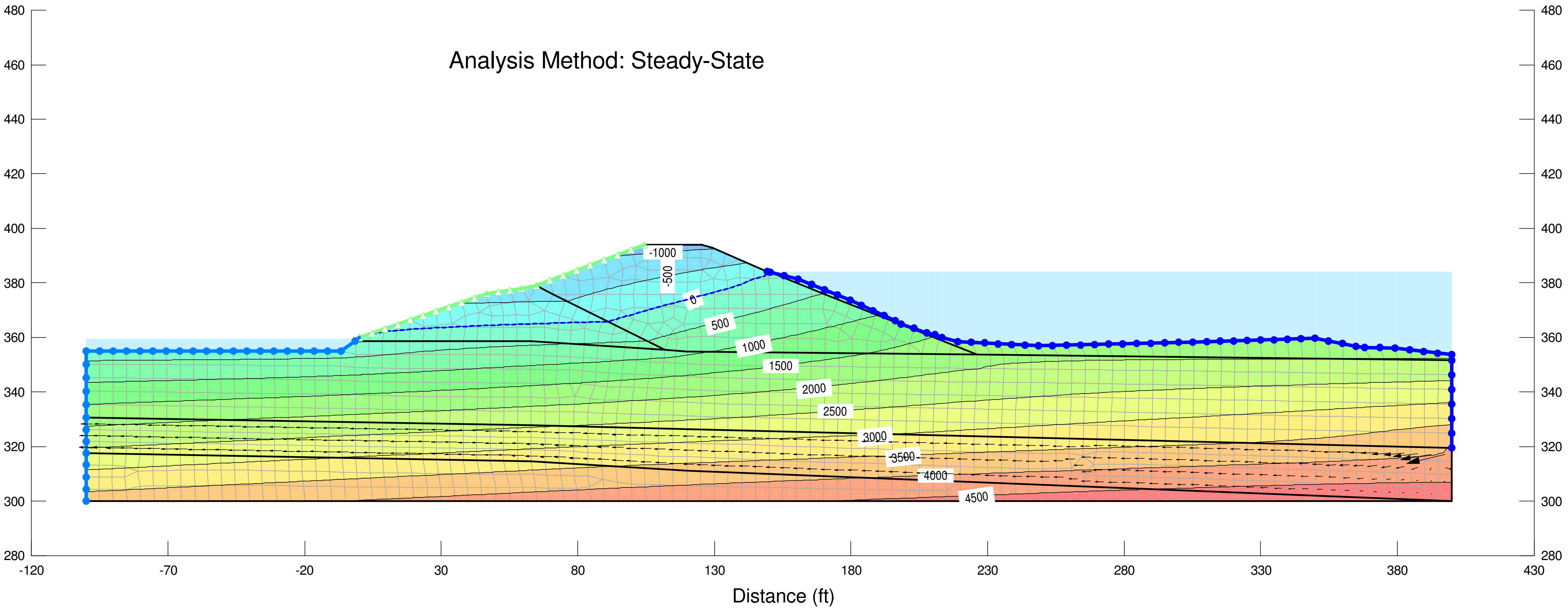
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section R.gsz

Analysis Name: Steady-State Seepage
Last Solved on 1/31/2010 at 1:10:06 PM
Date Saved: 1/31/2010

Stantec

Pore-Water Pressure



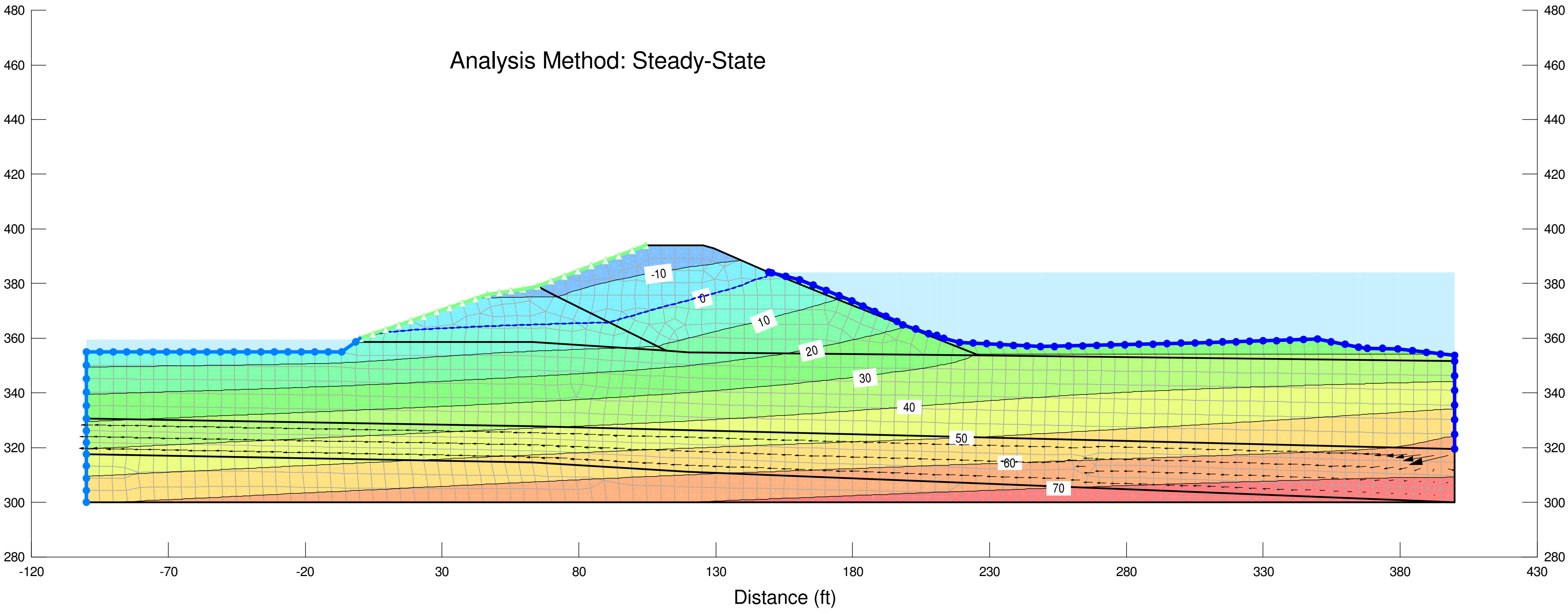
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section R.gsz

Analysis Name: Steady-State Seepage
Last Solved on 1/31/2010 at 1:10:06 PM
Date Saved: 1/31/2010

Stantec

Pressure Head



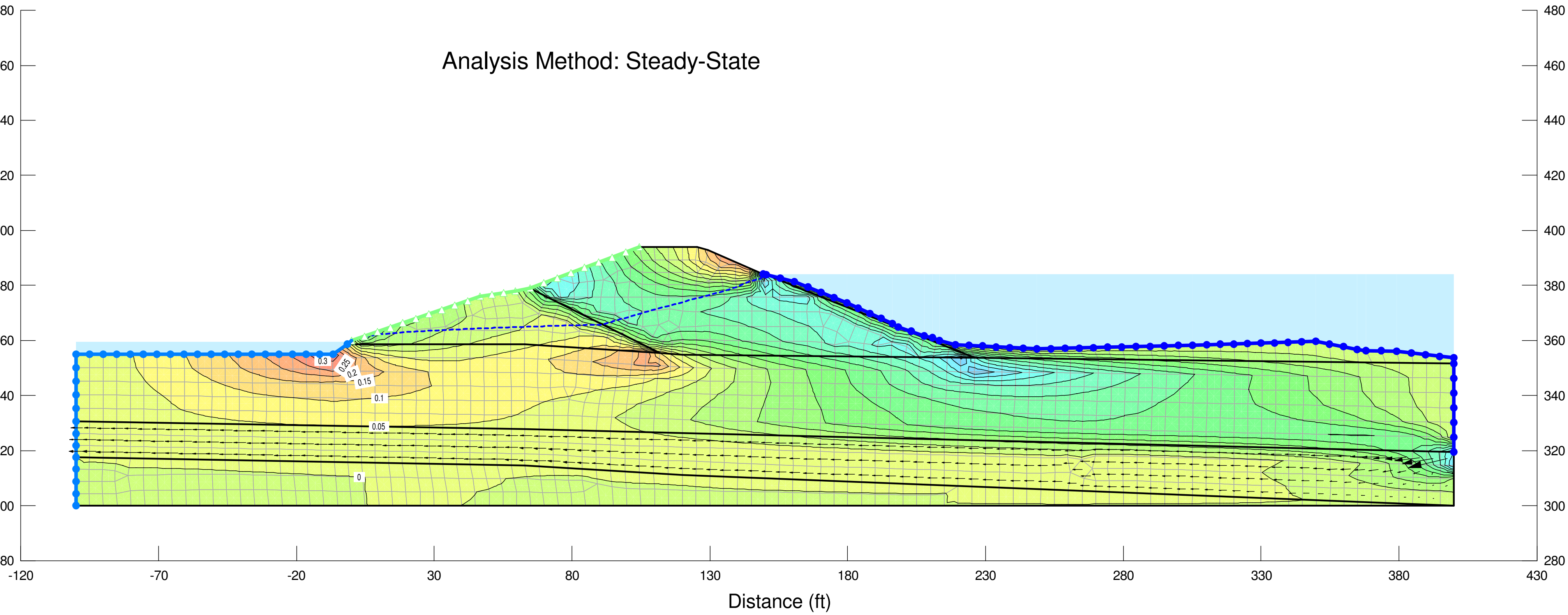
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section R.gsz

Analysis Name: Steady-State Seepage
Last Solved on 1/31/2010 at 1:10:06 PM
Date Saved: 1/31/2010

Stantec

Y-Gradient



Steady-State Seepage

File Information

Created By: Cooper, Paul
Revision Number: 241
Last Edited By: Rogers, Daniel
Date: 1/21/2010
Time: 7:53:51 PM
File Name: Section S.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/21/2010
Last Solved Time: 7:54:34 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Mass(M) Units: lbs
Mass Flux Units: lbs/sec
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Steady-State Seepage

Kind: SEEP/W
Method: Steady-State
Settings
  - Include Air Flow: No

Control
  - Apply Runoff: Yes

Convergence
  - Convergence Type: Gauss Point K
  - Convergence Settings
    - Maximum Number of Iterations: 500
    - Tolerance: 0.01
    - Maximum Change in K: 0.1
    - Rate of Change in K: 1.02
    - Minimum Change in K: 0.0001
  - Equation Solver: Parallel Direct
  - Potential Seepage Max # of Reviews: 10

Time
  - Starting Time: 0 sec

Duration: 0 sec
Ending Time: 0 sec

Materials

Dike 1 (Lean Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 1 (Lean Clay)
Vol. WC. Function: Dike 1 (Lean Clay)
K-Ratio: 0.1
K-Direction: 0 °

Dike 2 (Lean Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 2 (Lean Clay)
Vol. WC. Function: Dike 2 (Lean Clay)
K-Ratio: 0.01
K-Direction: 0 °

Dike 2 (Fat Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 2 (Fat Clay)
Vol. WC. Function: Dike 2 (Fat Clay)
K-Ratio: 0.01
K-Direction: 0 °

Fly Ash (Sluiced)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Fly Ash (Sluiced)
Vol. WC. Function: Fly Ash (Sluiced)
K-Ratio: 0.02
K-Direction: 0 °

Alluvial Clay

Model: Saturated / Unsaturated
Hydraulic
K-Function: Alluvial (Clay)
Vol. WC. Function: Alluvial Clay
K-Ratio: 0.05
K-Direction: 0 °

Alluvial Granular

Model: Saturated / Unsaturated
Hydraulic
K-Function: Alluvial (Granular)

Vol. WC. Function: Alluvial Granular
K-Ratio: 0.05
K-Direction: 0 °

Bedrock

Model: Saturated Only
Hydraulic
K-Sat: 1e-011 ft/sec
Volumetric Water Content: 0.05 ft^3/ft^3
Mv: 0 /psf
K-Ratio: 0.1
K-Direction: 0 °

Boundary Conditions

Ash Pond

Type: Head (H) 384.23

Wells Creek

Type: Head (H) 361

K Functions

Dike 1 (Lean Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 2.13e-007
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 2.13e-007)
Data Point: (0.018329807, 2.1234388e-007)
Data Point: (0.033598183, 2.1168814e-007)
Data Point: (0.061584821, 2.1103203e-007)
Data Point: (0.11288379, 2.1037498e-007)
Data Point: (0.20691381, 2.0971735e-007)
Data Point: (0.37926902, 2.0905824e-007)
Data Point: (0.6951928, 2.0839653e-007)
Data Point: (1.274275, 2.077303e-007)
Data Point: (2.3357215, 2.070555e-007)
Data Point: (4.2813324, 2.0636507e-007)
Data Point: (7.8475997, 2.0564593e-007)
Data Point: (14.384499, 2.0487454e-007)
Data Point: (26.366509, 2.0400629e-007)
Data Point: (48.329302, 2.0295363e-007)
Data Point: (88.586679, 2.016313e-007)
Data Point: (162.37767, 1.9978076e-007)
Data Point: (297.63514, 1.9457772e-007)

Data Point: (545.55948, 1.9521936e-007)
Data Point: (1000, 7.5557482e-008)
Estimation Properties
Volume Water Content Function: Dike 1 (Lean Clay)
Hydraulic K Sat: 2.13e-007 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.06 ft³/ft³

Dike 2 (Lean Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 1.4e-007
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 1.4e-007)
Data Point: (0.018329807, 1.3839712e-007)
Data Point: (0.033598183, 1.3679373e-007)
Data Point: (0.061584821, 1.3518951e-007)
Data Point: (0.11288379, 1.335855e-007)
Data Point: (0.20691381, 1.3198165e-007)
Data Point: (0.37926902, 1.3037684e-007)
Data Point: (0.6951928, 1.2877019e-007)
Data Point: (1.274275, 1.2715999e-007)
Data Point: (2.3357215, 1.2554349e-007)
Data Point: (4.2813324, 1.2391548e-007)
Data Point: (7.8475997, 1.2226602e-007)
Data Point: (14.384499, 1.2057731e-007)
Data Point: (26.366509, 1.1881667e-007)
Data Point: (48.329302, 1.1692468e-007)
Data Point: (88.586679, 1.1478944e-007)
Data Point: (162.37767, 1.1220975e-007)
Data Point: (297.63514, 1.0889028e-007)
Data Point: (545.55948, 1.0384181e-007)
Data Point: (1000, 9.408038e-008)
Estimation Properties
Volume Water Content Function: Dike 2 (Lean Clay)
Hydraulic K Sat: 1.4e-007 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.08 ft³/ft³

Alluvial (Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure

Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 4.86e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 4.86e-008)
Data Point: (0.018329807, 4.6081772e-008)
Data Point: (0.033598183, 4.3561857e-008)
Data Point: (0.061584821, 4.104302e-008)
Data Point: (0.11288379, 3.8524125e-008)
Data Point: (0.20691381, 3.6005291e-008)
Data Point: (0.37926902, 3.3486567e-008)
Data Point: (0.6951928, 3.0968085e-008)
Data Point: (1.274275, 2.8449893e-008)
Data Point: (2.3357215, 2.5932304e-008)
Data Point: (4.2813324, 2.3415812e-008)
Data Point: (7.8475997, 2.0901374e-008)
Data Point: (14.384499, 1.8390713e-008)
Data Point: (26.366509, 1.5886901e-008)
Data Point: (48.329302, 1.3395726e-008)
Data Point: (88.586679, 1.0927777e-008)
Data Point: (162.37767, 8.5023183e-009)
Data Point: (297.63514, 6.1503404e-009)
Data Point: (545.55948, 3.9524194e-009)
Data Point: (1000, 2.0421444e-009)
Estimation Properties
Volume Water Content Function: Alluvial Clay
Hydraulic K Sat: 4.86e-008 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.07 ft³/ft³

Alluvial (Granular)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 6.56e-005
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 6.56e-005)
Data Point: (0.018329807, 6.4809238e-005)
Data Point: (0.033598183, 6.4018422e-005)
Data Point: (0.061584821, 6.3227812e-005)
Data Point: (0.11288379, 6.2437049e-005)
Data Point: (0.20691381, 6.1646212e-005)
Data Point: (0.37926902, 6.0854776e-005)
Data Point: (0.6951928, 6.0062124e-005)
Data Point: (1.274275, 5.9267829e-005)
Data Point: (2.3357215, 5.8470547e-005)

Data Point: (4.2813324, 5.7667753e-005)
Data Point: (7.8475997, 5.6854825e-005)
Data Point: (14.384499, 5.6023348e-005)
Data Point: (26.366509, 5.5157894e-005)
Data Point: (48.329302, 5.4230286e-005)
Data Point: (88.586679, 5.3187637e-005)
Data Point: (162.37767, 5.1934764e-005)
Data Point: (297.63514, 5.0331243e-005)
Data Point: (545.55948, 4.7912406e-005)
Data Point: (1000, 4.3290175e-005)
Estimation Properties
Volume Water Content Function: Alluvial Granular
Hydraulic K Sat: 6.56e-005 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.02 ft³/ft³

Fly Ash (Sluiced)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 0.000138
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 0.000138)
Data Point: (0.018329807, 0.00013124901)
Data Point: (0.033598183, 0.00012449327)
Data Point: (0.061584821, 0.00011774033)
Data Point: (0.11288379, 0.0001109872)
Data Point: (0.20691381, 0.00010423397)
Data Point: (0.37926902, 9.7480512e-005)
Data Point: (0.6951928, 9.0726822e-005)
Data Point: (1.274275, 8.3972556e-005)
Data Point: (2.3357215, 7.7217303e-005)
Data Point: (4.2813324, 7.0460153e-005)
Data Point: (7.8475997, 6.3699615e-005)
Data Point: (14.384499, 5.6933028e-005)
Data Point: (26.366509, 5.0154616e-005)
Data Point: (48.329302, 4.3351508e-005)
Data Point: (88.586679, 3.6533731e-005)
Data Point: (162.37767, 2.9661049e-005)
Data Point: (297.63514, 2.2042999e-005)
Data Point: (545.55948, 1.5988106e-005)
Data Point: (1000, 1.5284174e-006)
Estimation Properties
Volume Water Content Function: Fly Ash (Sluiced)
Hydraulic K Sat: 0.000138 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function

Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.015 ft³/ft³

Dike 2 (Fat Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
    Curve Fit to Data: 100 %
    Segment Curvature: 100 %
K-Saturation: 8.86e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
    Data Point: (0.01, 8.86e-008)
    Data Point: (0.018329807, 8.4667011e-008)
    Data Point: (0.033598183, 8.0730953e-008)
    Data Point: (0.061584821, 7.6795897e-008)
    Data Point: (0.11288379, 7.2861087e-008)
    Data Point: (0.20691381, 6.8926585e-008)
    Data Point: (0.37926902, 6.4991665e-008)
    Data Point: (0.6951928, 6.10567e-008)
    Data Point: (1.274275, 5.7121196e-008)
    Data Point: (2.3357215, 5.3184636e-008)
    Data Point: (4.2813324, 4.9246187e-008)
    Data Point: (7.8475997, 4.5304276e-008)
    Data Point: (14.384499, 4.1356077e-008)
    Data Point: (26.366509, 3.7396344e-008)
    Data Point: (48.329302, 3.3415636e-008)
    Data Point: (88.586679, 2.9395678e-008)
    Data Point: (162.37767, 2.5304446e-008)
    Data Point: (297.63514, 2.1098297e-008)
    Data Point: (545.55948, 1.6607161e-008)
    Data Point: (1000, 1.1464819e-008)
Estimation Properties
    Volume Water Content Function: Dike 2 (Fat Clay)
    Hydraulic K Sat: 8.86e-008 ft/sec
    Hyd. K-Function Estimation Method: Fredlund-Xing Function
    Maximum: 1000
    Minimum: 0.01
    Num. Points: 20
    Residual Water Content: 0.09 ft³/ft³

Vol. Water Content Functions

Dike 1 (Lean Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
    Curve Fit to Data: 100 %
    Segment Curvature: 100 %
    Mv: 3e-006 /psf

- Porosity: 0.41556948
- Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
  - Data Point: (0.01, 0.41308567)
  - Data Point: (0.018329807, 0.41308567)
  - Data Point: (0.033598183, 0.41308567)
  - Data Point: (0.061584821, 0.41308567)
  - Data Point: (0.11288379, 0.41308567)
  - Data Point: (0.20691381, 0.41308567)
  - Data Point: (0.37926902, 0.41308567)
  - Data Point: (0.6951928, 0.41308567)
  - Data Point: (1.274275, 0.41308567)
  - Data Point: (2.3357215, 0.41308567)
  - Data Point: (4.2813324, 0.41308567)
  - Data Point: (7.8475997, 0.41308567)
  - Data Point: (14.384499, 0.41308567)
  - Data Point: (26.366509, 0.41308567)
  - Data Point: (48.329302, 0.41308567)
  - Data Point: (88.586679, 0.41308567)
  - Data Point: (162.37767, 0.41308567)
  - Data Point: (297.63514, 0.41308567)
  - Data Point: (545.55948, 0.4125467)
  - Data Point: (1000, 0.38347036)
- Estimation Properties
  - Vol. WC Estimation Method: Grain Size Function
  - Sample Material: Clay
  - Saturated Water Content: 0.413 ft^3/ft^3
  - Liquid Limit: 38 %
  - Diameter at 10% passing: 0.001
  - Diameter at 60% passing: 0.1
  - Maximum: 1000
  - Minimum: 0.01
  - Num. Points: 20

Dike 2 (Lean Clay)

- Model: Data Point Function
- Function: Vol. Water Content vs. Pore-Water Pressure
  - Curve Fit to Data: 100 %
  - Segment Curvature: 100 %
  - Mv: 3e-006 /psf
- Porosity: 0.35421721
- Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
  - Data Point: (0.01, 0.35121721)
  - Data Point: (0.018329807, 0.35121721)
  - Data Point: (0.033598183, 0.35121721)
  - Data Point: (0.061584821, 0.35121721)
  - Data Point: (0.11288379, 0.35121721)
  - Data Point: (0.20691381, 0.35121721)
  - Data Point: (0.37926902, 0.35121721)
  - Data Point: (0.6951928, 0.35121721)
  - Data Point: (1.274275, 0.35121721)

Data Point: (2.3357215, 0.35121721)
Data Point: (4.2813324, 0.35121721)
Data Point: (7.8475997, 0.35121721)
Data Point: (14.384499, 0.35121721)
Data Point: (26.366509, 0.35121721)
Data Point: (48.329302, 0.35121721)
Data Point: (88.586679, 0.35121721)
Data Point: (162.37767, 0.35121721)
Data Point: (297.63514, 0.35121721)
Data Point: (545.55948, 0.35121721)
Data Point: (1000, 0.35121721)

Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.351 ft³/ft³
Liquid Limit: 48 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.075
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Alluvial Clay

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 4.786e-005 /psf
Porosity: 0.46611653
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.40088927)
Data Point: (0.018329807, 0.40088927)
Data Point: (0.033598183, 0.40088927)
Data Point: (0.061584821, 0.40088927)
Data Point: (0.11288379, 0.40088927)
Data Point: (0.20691381, 0.40088927)
Data Point: (0.37926902, 0.40088927)
Data Point: (0.6951928, 0.40088927)
Data Point: (1.274275, 0.40088927)
Data Point: (2.3357215, 0.40088927)
Data Point: (4.2813324, 0.40088927)
Data Point: (7.8475997, 0.40088927)
Data Point: (14.384499, 0.40088927)
Data Point: (26.366509, 0.40088927)
Data Point: (48.329302, 0.40088927)
Data Point: (88.586679, 0.40088927)
Data Point: (162.37767, 0.40088927)
Data Point: (297.63514, 0.40088927)
Data Point: (545.55948, 0.40088927)
Data Point: (1000, 0.39828281)

Estimation Properties
- Vol. WC Estimation Method: Grain Size Function
- Sample Material: Clay
- Saturated Water Content: 0.401 ft³/ft³
- Liquid Limit: 47 %
- Diameter at 10% passing: 0.001
- Diameter at 60% passing: 0.1
- Maximum: 1000
- Minimum: 0.01
- Num. Points: 20

Alluvial Granular

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
- Curve Fit to Data: 100 %
- Segment Curvature: 100 %
- Mv: 2.3925e-006 /psf

Porosity: 0.27269448
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
- Data Point: (0.01, 0.27030198)
- Data Point: (0.018329807, 0.27030198)
- Data Point: (0.033598183, 0.27030198)
- Data Point: (0.061584821, 0.27030198)
- Data Point: (0.11288379, 0.27030198)
- Data Point: (0.20691381, 0.27030198)
- Data Point: (0.37926902, 0.27030198)
- Data Point: (0.6951928, 0.27030198)
- Data Point: (1.274275, 0.27030198)
- Data Point: (2.3357215, 0.27030198)
- Data Point: (4.2813324, 0.27030198)
- Data Point: (7.8475997, 0.27030198)
- Data Point: (14.384499, 0.27030198)
- Data Point: (26.366509, 0.27030198)
- Data Point: (48.329302, 0.27030198)
- Data Point: (88.586679, 0.27030198)
- Data Point: (162.37767, 0.27030198)
- Data Point: (297.63514, 0.27030198)
- Data Point: (545.55948, 0.27030198)
- Data Point: (1000, 0.27030198)

Estimation Properties
- Vol. WC Estimation Method: Grain Size Function
- Sample Material: Silty Sand
- Saturated Water Content: 0.27 ft³/ft³
- Liquid Limit: 0 %
- Diameter at 10% passing: 0.001
- Diameter at 60% passing: 6
- Maximum: 1000
- Minimum: 0.01
- Num. Points: 20

Fly Ash (Sluiced)

Model: Data Point Function

Function: Vol. Water Content vs. Pore-Water Pressure

    Curve Fit to Data: 100 %
    Segment Curvature: 100 %
    Mv: 6.2218e-005 /psf

Porosity: 0.37786527

Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)

Data Point:	(0.01, 0.35499418)
Data Point:	(0.018329807, 0.35499418)
Data Point:	(0.033598183, 0.35499418)
Data Point:	(0.061584821, 0.35499418)
Data Point:	(0.11288379, 0.35499418)
Data Point:	(0.20691381, 0.35499418)
Data Point:	(0.37926902, 0.35499418)
Data Point:	(0.6951928, 0.35499418)
Data Point:	(1.274275, 0.35499418)
Data Point:	(2.3357215, 0.35499418)
Data Point:	(4.2813324, 0.35499418)
Data Point:	(7.8475997, 0.35499418)
Data Point:	(14.384499, 0.35499418)
Data Point:	(26.366509, 0.35499418)
Data Point:	(48.329302, 0.35499418)
Data Point:	(88.586679, 0.35499418)
Data Point:	(162.37767, 0.35499418)
Data Point:	(297.63514, 0.35499418)
Data Point:	(545.55948, 0.34147401)
Data Point:	(1000, 0.26813417)

Estimation Properties

    Vol. WC Estimation Method: Grain Size Function
    Sample Material: Silt
    Saturated Water Content: 0.3548 ft³/ft³
    Liquid Limit: 0 %
    Diameter at 10% passing: 0.004
    Diameter at 60% passing: 0.049
    Maximum: 1000
    Minimum: 0.01
    Num. Points: 20

Dike 2 (Fat Clay)

Model: Data Point Function

Function: Vol. Water Content vs. Pore-Water Pressure

    Curve Fit to Data: 100 %
    Segment Curvature: 100 %
    Mv: 1.4358e-005 /psf

Porosity: 0.36512838

Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)

Data Point:	(0.01, 0.35077038)
Data Point:	(0.018329807, 0.35077038)

Data Point: (0.033598183, 0.35077038)
Data Point: (0.061584821, 0.35077038)
Data Point: (0.11288379, 0.35077038)
Data Point: (0.20691381, 0.35077038)
Data Point: (0.37926902, 0.35077038)
Data Point: (0.6951928, 0.35077038)
Data Point: (1.274275, 0.35077038)
Data Point: (2.3357215, 0.35077038)
Data Point: (4.2813324, 0.35077038)
Data Point: (7.8475997, 0.35077038)
Data Point: (14.384499, 0.35077038)
Data Point: (26.366509, 0.35077038)
Data Point: (48.329302, 0.35077038)
Data Point: (88.586679, 0.35077038)
Data Point: (162.37767, 0.35077038)
Data Point: (297.63514, 0.35077038)
Data Point: (545.55948, 0.35077038)
Data Point: (1000, 0.35077038)

Estimation Properties

Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.351 ft³/ft³
Liquid Limit: 54 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.043
Maximum: 1000
Minimum: 0.01
Num. Points: 20

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section S.gsz

Analysis Name: Steady-State Seepage

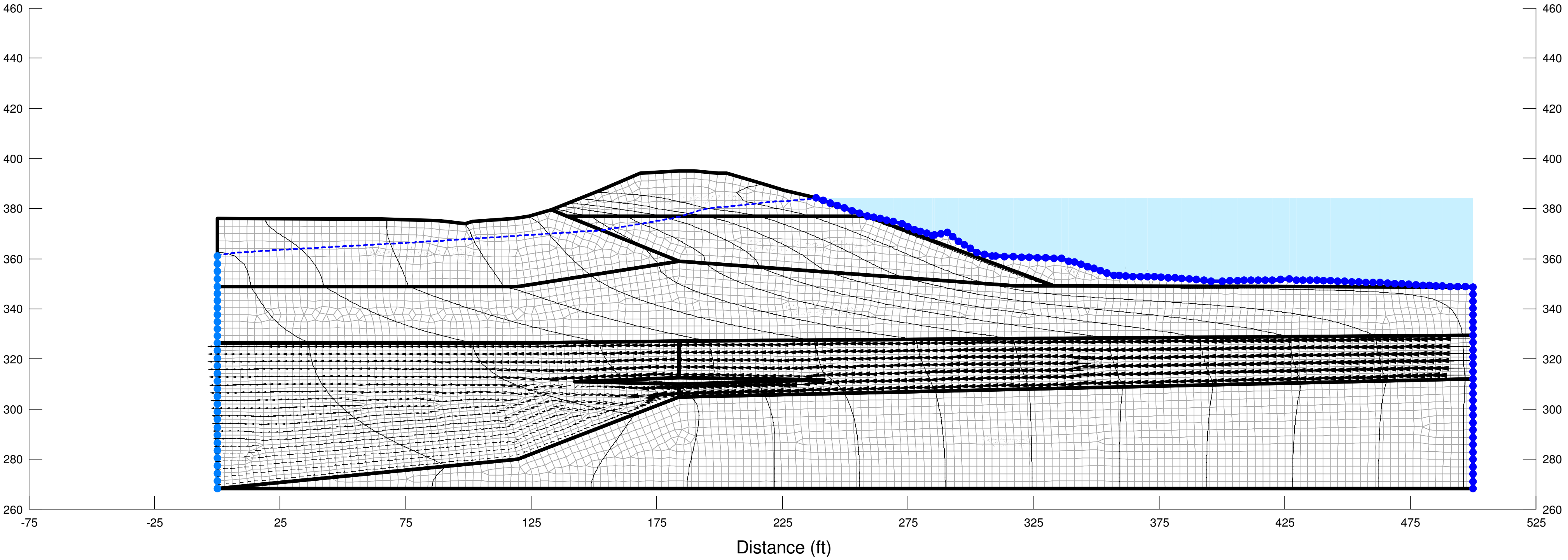
Date Saved: 1/21/2010

Last Solved on 1/21/2010 at 7:54:34 PM

Analysis Method: Steady-State

Stantec

Boundry Conditions with Mesh



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section S.gsz

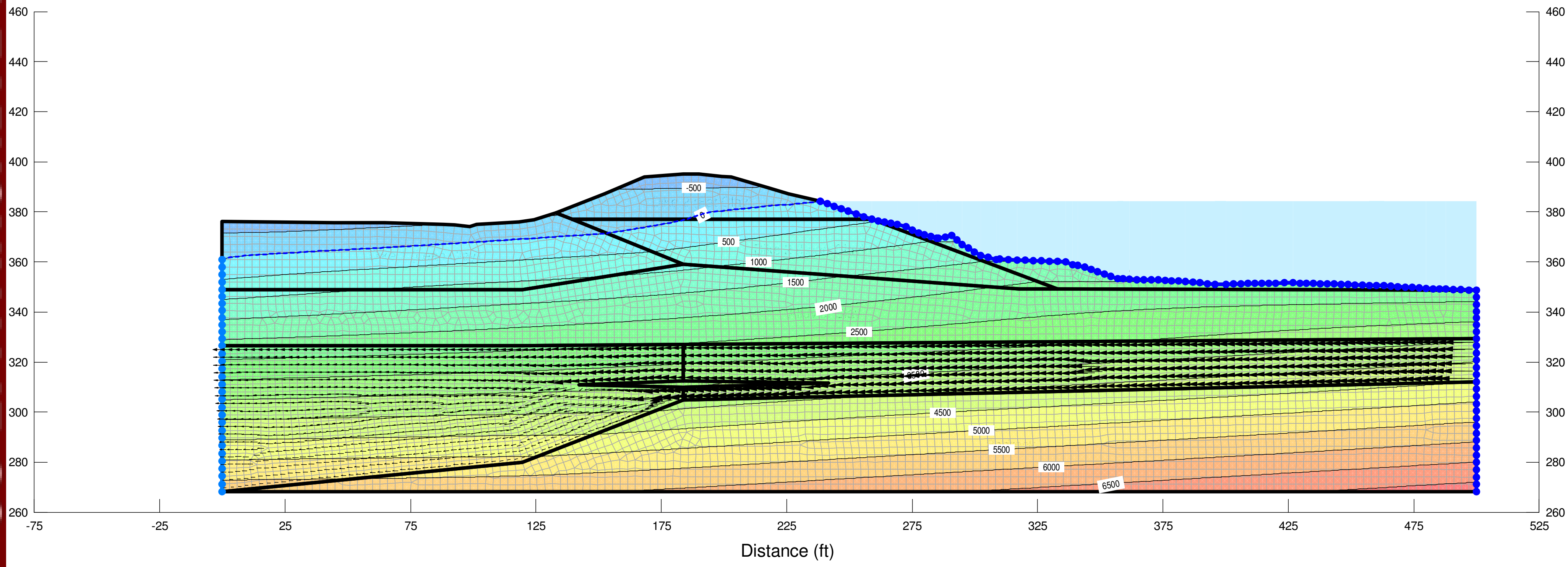
Analysis Name: Steady-State Seepage

Date Saved: 1/21/2010

Last Solved on 1/21/2010 at 7:54:34 PM

Analysis Method: Steady-State

Pore-Water Pressure



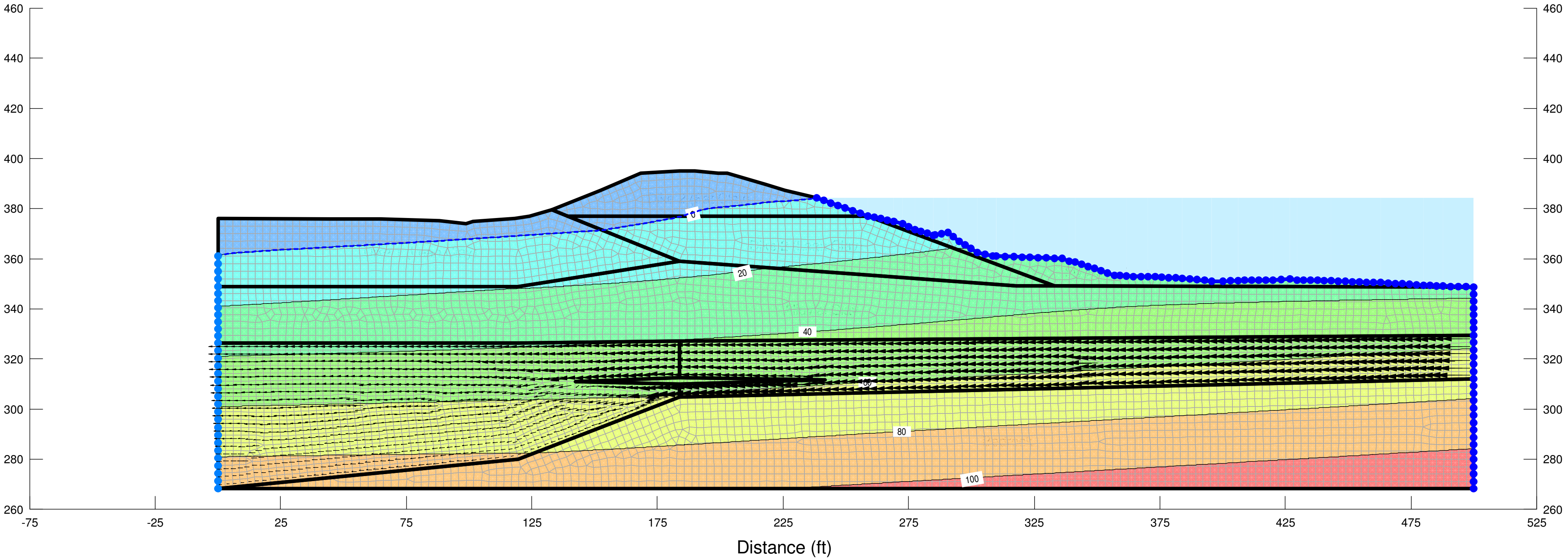
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section S.gsz
Analysis Name: Steady-State Seepage
Date Saved: 1/21/2010
Last Solved on 1/21/2010 at 7:54:34 PM

Analysis Method: Steady-State

Stantec

Pressure Head



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

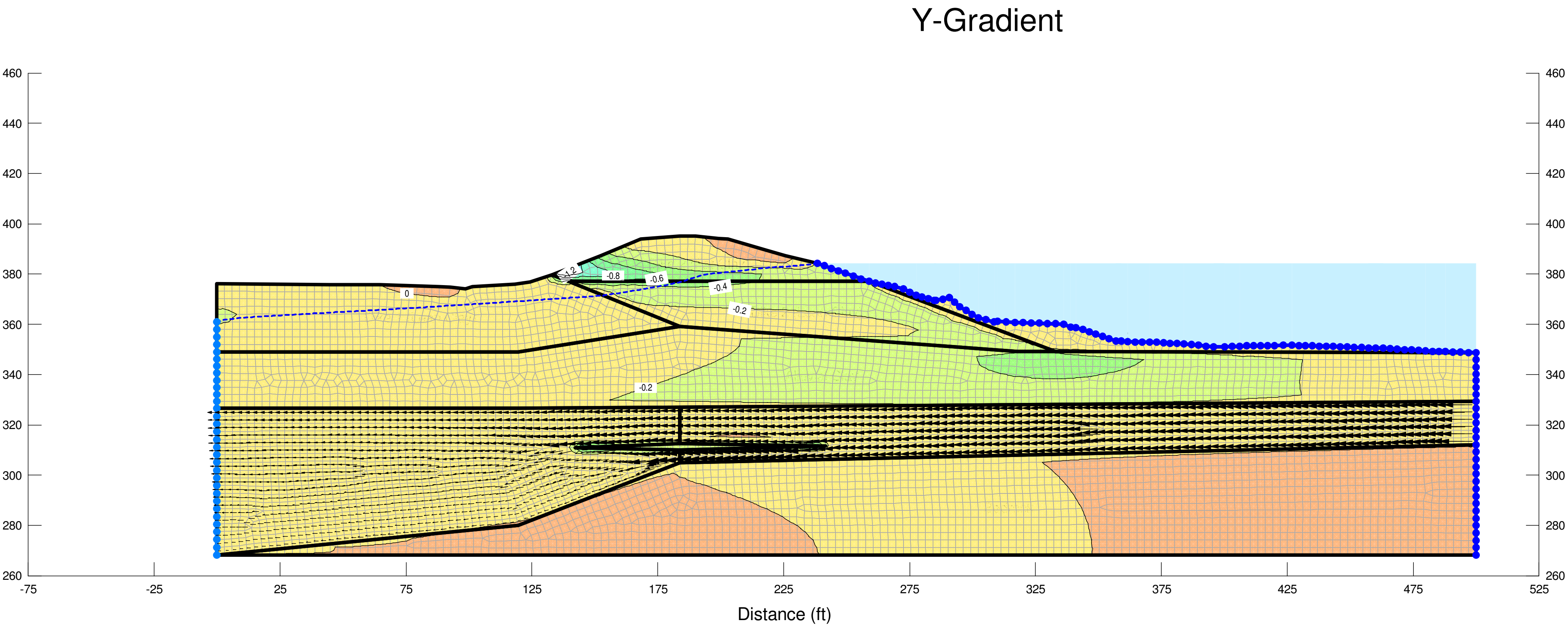
File Name: Section S.gsz

Analysis Name: Steady-State Seepage

Date Saved: 1/21/2010

Last Solved on 1/21/2010 at 7:54:34 PM

Analysis Method: Steady-State



Steady-State Seepage

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File Information

Created By: Cooper, Paul
Revision Number: 243
Last Edited By: Rogers, Daniel
Date: 1/22/2010
Time: 2:02:48 PM
File Name: Section T.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/22/2010
Last Solved Time: 2:03:38 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Mass(M) Units: lbs
Mass Flux Units: lbs/sec
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Steady-State Seepage

- Kind: SEEP/W
- Method: Steady-State
- Settings
  - Include Air Flow: No
- Control
  - Apply Runoff: Yes
- Convergence
  - Convergence Type: Gauss Point K
  - Convergence Settings
    - Maximum Number of Iterations: 500
    - Tolerance: 0.01
    - Maximum Change in K: 0.1
    - Rate of Change in K: 1.02
    - Minimum Change in K: 0.0001
  - Equation Solver: Parallel Direct
  - Potential Seepage Max # of Reviews: 10
- Time
  - Starting Time: 0 sec

Duration: 0 sec
Ending Time: 0 sec

Materials

Dike 1 (Lean Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 1 (Lean Clay)
Vol. WC. Function: Dike 1 (Lean Clay)
K-Ratio: 0.1
K-Direction: 0 °

Dike 2 (Lean Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 2 (Lean Clay)
Vol. WC. Function: Dike 2 (Lean Clay)
K-Ratio: 0.1
K-Direction: 0 °

Dike 2 (Fat Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 2 (Fat Clay)
Vol. WC. Function: Dike 2 (Fat Clay)
K-Ratio: 0.1
K-Direction: 0 °

Fly Ash (Sluiced)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Fly Ash (Sluiced)
Vol. WC. Function: Fly Ash (Sluiced)
K-Ratio: 0.02
K-Direction: 0 °

Alluvial Clay

Model: Saturated / Unsaturated
Hydraulic
K-Function: Alluvial (Clay)
Vol. WC. Function: Alluvial (Clay)
K-Ratio: 0.05
K-Direction: 0 °

Alluvial Granular

Model: Saturated / Unsaturated
Hydraulic
K-Function: Alluvial (Granular)

Vol. WC. Function: Alluvial (Granular)
K-Ratio: 0.05
K-Direction: 0 °

Bedrock

Model: Saturated Only
Hydraulic
K-Sat: 1e-011 ft/sec
Volumetric Water Content: 0.05 ft³/ft³
Mv: 0 /psf
K-Ratio: 0.1
K-Direction: 0 °

Boundary Conditions

Potential Seepage Face

Review: true
Type: Total Flux (Q) 0

Ash Pond

Type: Head (H) 384.23

Wells Creek

Type: Head (H) 359.5

K Functions

Dike 1 (Lean Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 2.13e-007
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 2.13e-007)
Data Point: (0.018329807, 2.1234388e-007)
Data Point: (0.033598183, 2.1168814e-007)
Data Point: (0.061584821, 2.1103203e-007)
Data Point: (0.11288379, 2.1037498e-007)
Data Point: (0.20691381, 2.0971735e-007)
Data Point: (0.37926902, 2.0905824e-007)
Data Point: (0.6951928, 2.0839653e-007)
Data Point: (1.274275, 2.077303e-007)
Data Point: (2.3357215, 2.070555e-007)
Data Point: (4.2813324, 2.0636507e-007)
Data Point: (7.8475997, 2.0564593e-007)
Data Point: (14.384499, 2.0487454e-007)
Data Point: (26.366509, 2.0400629e-007)

Data Point: (48.329302, 2.0295363e-007)
Data Point: (88.586679, 2.016313e-007)
Data Point: (162.37767, 1.9978076e-007)
Data Point: (297.63514, 1.9457772e-007)
Data Point: (545.55948, 1.9521936e-007)
Data Point: (1000, 7.5557482e-008)
Estimation Properties
Volume Water Content Function: Dike 1 (Lean Clay)
Hydraulic K Sat: 2.13e-007 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.06 ft^3/ft^3

Dike 2 (Lean Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 1.4e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 1.4e-008)
Data Point: (0.018329807, 1.3839712e-008)
Data Point: (0.033598183, 1.3679373e-008)
Data Point: (0.061584821, 1.3518951e-008)
Data Point: (0.11288379, 1.335855e-008)
Data Point: (0.20691381, 1.3198165e-008)
Data Point: (0.37926902, 1.3037684e-008)
Data Point: (0.6951928, 1.2877019e-008)
Data Point: (1.274275, 1.2715999e-008)
Data Point: (2.3357215, 1.2554349e-008)
Data Point: (4.2813324, 1.2391548e-008)
Data Point: (7.8475997, 1.2226602e-008)
Data Point: (14.384499, 1.2057731e-008)
Data Point: (26.366509, 1.1881667e-008)
Data Point: (48.329302, 1.1692468e-008)
Data Point: (88.586679, 1.1478944e-008)
Data Point: (162.37767, 1.1220975e-008)
Data Point: (297.63514, 1.0889028e-008)
Data Point: (545.55948, 1.0384181e-008)
Data Point: (1000, 9.408038e-009)
Estimation Properties
Volume Water Content Function: Dike 2 (Lean Clay)
Hydraulic K Sat: 1.4e-008 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.08 ft^3/ft^3

Alluvial (Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 4.86e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 4.86e-008)
Data Point: (0.018329807, 4.6081957e-008)
Data Point: (0.033598183, 4.3562037e-008)
Data Point: (0.061584821, 4.1043284e-008)
Data Point: (0.11288379, 3.8524355e-008)
Data Point: (0.20691381, 3.6005505e-008)
Data Point: (0.37926902, 3.348676e-008)
Data Point: (0.6951928, 3.0968229e-008)
Data Point: (1.274275, 2.8450022e-008)
Data Point: (2.3357215, 2.5932423e-008)
Data Point: (4.2813324, 2.3415929e-008)
Data Point: (7.8475997, 2.0901504e-008)
Data Point: (14.384499, 1.8390826e-008)
Data Point: (26.366509, 1.5886992e-008)
Data Point: (48.329302, 1.3395802e-008)
Data Point: (88.586679, 1.0927841e-008)
Data Point: (162.37767, 8.5023705e-009)
Data Point: (297.63514, 6.1503781e-009)
Data Point: (545.55948, 3.9524429e-009)
Data Point: (1000, 2.0421567e-009)
Estimation Properties
Volume Water Content Function: Alluvial (Clay)
Hydraulic K Sat: 4.86e-008 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.07 ft^3/ft^3

Alluvial (Granular)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 6.56e-005
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 6.56e-005)
Data Point: (0.018329807, 6.4809238e-005)
Data Point: (0.033598183, 6.4018422e-005)
Data Point: (0.061584821, 6.3227812e-005)
Data Point: (0.11288379, 6.2437049e-005)
Data Point: (0.20691381, 6.1646212e-005)

        Data Point: (0.37926902, 6.0854776e-005)
        Data Point: (0.6951928, 6.0062124e-005)
        Data Point: (1.274275, 5.9267829e-005)
        Data Point: (2.3357215, 5.8470547e-005)
        Data Point: (4.2813324, 5.7667753e-005)
        Data Point: (7.8475997, 5.6854825e-005)
        Data Point: (14.384499, 5.6023348e-005)
        Data Point: (26.366509, 5.5157894e-005)
        Data Point: (48.329302, 5.4230286e-005)
        Data Point: (88.586679, 5.3187637e-005)
        Data Point: (162.37767, 5.1934764e-005)
        Data Point: (297.63514, 5.0331243e-005)
        Data Point: (545.55948, 4.7912406e-005)
        Data Point: (1000, 4.3290175e-005)
    Estimation Properties
        Volume Water Content Function: Alluvial (Granular)
        Hydraulic K Sat: 6.56e-005 ft/sec
        Hyd. K-Function Estimation Method: Fredlund-Xing Function
        Maximum: 1000
        Minimum: 0.01
        Num. Points: 20
        Residual Water Content: 0.02 ft^3/ft^3

Fly Ash (Sluiced)

    Model: Data Point Function
    Function: X-Conductivity vs. Pore-Water Pressure
        Curve Fit to Data: 100 %
        Segment Curvature: 100 %
    K-Saturation: 0.000138
    Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
        Data Point: (0.01, 0.000138)
        Data Point: (0.018329807, 0.00013124899)
        Data Point: (0.033598183, 0.00012449358)
        Data Point: (0.061584821, 0.00011774069)
        Data Point: (0.11288379, 0.00011098751)
        Data Point: (0.20691381, 0.00010423412)
        Data Point: (0.37926902, 9.7480653e-005)
        Data Point: (0.6951928, 9.072693e-005)
        Data Point: (1.274275, 8.3972583e-005)
        Data Point: (2.3357215, 7.7217317e-005)
        Data Point: (4.2813324, 7.046016e-005)
        Data Point: (7.8475997, 6.3699627e-005)
        Data Point: (14.384499, 5.6933042e-005)
        Data Point: (26.366509, 5.015463e-005)
        Data Point: (48.329302, 4.3351522e-005)
        Data Point: (88.586679, 3.6533744e-005)
        Data Point: (162.37767, 2.9661059e-005)
        Data Point: (297.63514, 2.2043007e-005)
        Data Point: (545.55948, 1.5988112e-005)
        Data Point: (1000, 1.5284178e-006)

Estimation Properties

Volume Water Content Function: Fly Ash (Sluiced)
Hydraulic K Sat: 0.000138 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.015 ft³/ft³

Dike 2 (Fat Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 8.86e-009
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 8.86e-009)
Data Point: (0.018329807, 8.4667011e-009)
Data Point: (0.033598183, 8.0730953e-009)
Data Point: (0.061584821, 7.6795897e-009)
Data Point: (0.11288379, 7.2861087e-009)
Data Point: (0.20691381, 6.8926585e-009)
Data Point: (0.37926902, 6.4991665e-009)
Data Point: (0.6951928, 6.10567e-009)
Data Point: (1.274275, 5.7121196e-009)
Data Point: (2.3357215, 5.3184636e-009)
Data Point: (4.2813324, 4.9246187e-009)
Data Point: (7.8475997, 4.5304276e-009)
Data Point: (14.384499, 4.1356077e-009)
Data Point: (26.366509, 3.7396344e-009)
Data Point: (48.329302, 3.3415636e-009)
Data Point: (88.586679, 2.9395678e-009)
Data Point: (162.37767, 2.5304446e-009)
Data Point: (297.63514, 2.1098297e-009)
Data Point: (545.55948, 1.6607161e-009)
Data Point: (1000, 1.1464819e-009)

Estimation Properties

Volume Water Content Function: Dike 2 (Fat Clay)
Hydraulic K Sat: 8.86e-009 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.09 ft³/ft³

Vol. Water Content Functions

Dike 1 (Lean Clay)

Model: Data Point Function

Function: Vol. Water Content vs. Pore-Water Pressure
    Curve Fit to Data: 100 %
    Segment Curvature: 100 %
    Mv: 3e-006 /psf
Porosity: 0.41556948
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
    Data Point: (0.01, 0.41308567)
    Data Point: (0.018329807, 0.41308567)
    Data Point: (0.033598183, 0.41308567)
    Data Point: (0.061584821, 0.41308567)
    Data Point: (0.11288379, 0.41308567)
    Data Point: (0.20691381, 0.41308567)
    Data Point: (0.37926902, 0.41308567)
    Data Point: (0.6951928, 0.41308567)
    Data Point: (1.274275, 0.41308567)
    Data Point: (2.3357215, 0.41308567)
    Data Point: (4.2813324, 0.41308567)
    Data Point: (7.8475997, 0.41308567)
    Data Point: (14.384499, 0.41308567)
    Data Point: (26.366509, 0.41308567)
    Data Point: (48.329302, 0.41308567)
    Data Point: (88.586679, 0.41308567)
    Data Point: (162.37767, 0.41308567)
    Data Point: (297.63514, 0.41308567)
    Data Point: (545.55948, 0.4125467)
    Data Point: (1000, 0.38347036)
Estimation Properties
    Vol. WC Estimation Method: Grain Size Function
    Sample Material: Clay
    Saturated Water Content: 0.413 ft³/ft³
    Liquid Limit: 38 %
    Diameter at 10% passing: 0.001
    Diameter at 60% passing: 0.1
    Maximum: 1000
    Minimum: 0.01
    Num. Points: 20

Dike 2 (Lean Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
    Curve Fit to Data: 100 %
    Segment Curvature: 100 %
    Mv: 3e-006 /psf
Porosity: 0.35421721
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
    Data Point: (0.01, 0.35121721)
    Data Point: (0.018329807, 0.35121721)
    Data Point: (0.033598183, 0.35121721)
    Data Point: (0.061584821, 0.35121721)
    Data Point: (0.11288379, 0.35121721)

Data Point: (0.20691381, 0.35121721)
Data Point: (0.37926902, 0.35121721)
Data Point: (0.6951928, 0.35121721)
Data Point: (1.274275, 0.35121721)
Data Point: (2.3357215, 0.35121721)
Data Point: (4.2813324, 0.35121721)
Data Point: (7.8475997, 0.35121721)
Data Point: (14.384499, 0.35121721)
Data Point: (26.366509, 0.35121721)
Data Point: (48.329302, 0.35121721)
Data Point: (88.586679, 0.35121721)
Data Point: (162.37767, 0.35121721)
Data Point: (297.63514, 0.35121721)
Data Point: (545.55948, 0.35121721)
Data Point: (1000, 0.35121721)

Estimation Properties

Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.351 ft³/ft³
Liquid Limit: 48 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.075
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Alluvial (Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 4.786e-005 /psf
Porosity: 0.46611653
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.40088927)
Data Point: (0.018329807, 0.40088927)
Data Point: (0.033598183, 0.40088927)
Data Point: (0.061584821, 0.40088927)
Data Point: (0.11288379, 0.40088927)
Data Point: (0.20691381, 0.40088927)
Data Point: (0.37926902, 0.40088927)
Data Point: (0.6951928, 0.40088927)
Data Point: (1.274275, 0.40088927)
Data Point: (2.3357215, 0.40088927)
Data Point: (4.2813324, 0.40088927)
Data Point: (7.8475997, 0.40088927)
Data Point: (14.384499, 0.40088927)
Data Point: (26.366509, 0.40088927)
Data Point: (48.329302, 0.40088927)
Data Point: (88.586679, 0.40088927)

Data Point: (162.37767, 0.40088927)
Data Point: (297.63514, 0.40088927)
Data Point: (545.55948, 0.40088927)
Data Point: (1000, 0.39828281)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.401 ft³/ft³
Liquid Limit: 47 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.1
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Alluvial (Granular)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 2.3925e-006 /psf
Porosity: 0.27269448
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.27030198)
Data Point: (0.018329807, 0.27030198)
Data Point: (0.033598183, 0.27030198)
Data Point: (0.061584821, 0.27030198)
Data Point: (0.11288379, 0.27030198)
Data Point: (0.20691381, 0.27030198)
Data Point: (0.37926902, 0.27030198)
Data Point: (0.6951928, 0.27030198)
Data Point: (1.274275, 0.27030198)
Data Point: (2.3357215, 0.27030198)
Data Point: (4.2813324, 0.27030198)
Data Point: (7.8475997, 0.27030198)
Data Point: (14.384499, 0.27030198)
Data Point: (26.366509, 0.27030198)
Data Point: (48.329302, 0.27030198)
Data Point: (88.586679, 0.27030198)
Data Point: (162.37767, 0.27030198)
Data Point: (297.63514, 0.27030198)
Data Point: (545.55948, 0.27030198)
Data Point: (1000, 0.27030198)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Silty Sand
Saturated Water Content: 0.27 ft³/ft³
Liquid Limit: 0 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 6

Maximum: 1000
Minimum: 0.01
Num. Points: 20

Fly Ash (Sluiced)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 6.2218e-005 /psf
Porosity: 0.37786527
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.35499418)
Data Point: (0.018329807, 0.35499418)
Data Point: (0.033598183, 0.35499418)
Data Point: (0.061584821, 0.35499418)
Data Point: (0.11288379, 0.35499418)
Data Point: (0.20691381, 0.35499418)
Data Point: (0.37926902, 0.35499418)
Data Point: (0.6951928, 0.35499418)
Data Point: (1.274275, 0.35499418)
Data Point: (2.3357215, 0.35499418)
Data Point: (4.2813324, 0.35499418)
Data Point: (7.8475997, 0.35499418)
Data Point: (14.384499, 0.35499418)
Data Point: (26.366509, 0.35499418)
Data Point: (48.329302, 0.35499418)
Data Point: (88.586679, 0.35499418)
Data Point: (162.37767, 0.35499418)
Data Point: (297.63514, 0.35499418)
Data Point: (545.55948, 0.34147401)
Data Point: (1000, 0.26813417)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Silt
Saturated Water Content: 0.3548 ft³/ft³
Liquid Limit: 0 %
Diameter at 10% passing: 0.004
Diameter at 60% passing: 0.049
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Dike 2 (Fat Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 1.4358e-005 /psf
Porosity: 0.36512838

- Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
  - Data Point: (0.01, 0.35077038)
  - Data Point: (0.018329807, 0.35077038)
  - Data Point: (0.033598183, 0.35077038)
  - Data Point: (0.061584821, 0.35077038)
  - Data Point: (0.11288379, 0.35077038)
  - Data Point: (0.20691381, 0.35077038)
  - Data Point: (0.37926902, 0.35077038)
  - Data Point: (0.6951928, 0.35077038)
  - Data Point: (1.274275, 0.35077038)
  - Data Point: (2.3357215, 0.35077038)
  - Data Point: (4.2813324, 0.35077038)
  - Data Point: (7.8475997, 0.35077038)
  - Data Point: (14.384499, 0.35077038)
  - Data Point: (26.366509, 0.35077038)
  - Data Point: (48.329302, 0.35077038)
  - Data Point: (88.586679, 0.35077038)
  - Data Point: (162.37767, 0.35077038)
  - Data Point: (297.63514, 0.35077038)
  - Data Point: (545.55948, 0.35077038)
  - Data Point: (1000, 0.35077038)
- Estimation Properties
  - Vol. WC Estimation Method: Grain Size Function
  - Sample Material: Clay
  - Saturated Water Content: 0.351 ft^3/ft^3
  - Liquid Limit: 54 %
  - Diameter at 10% passing: 0.001
  - Diameter at 60% passing: 0.043
  - Maximum: 1000
  - Minimum: 0.01
  - Num. Points: 20

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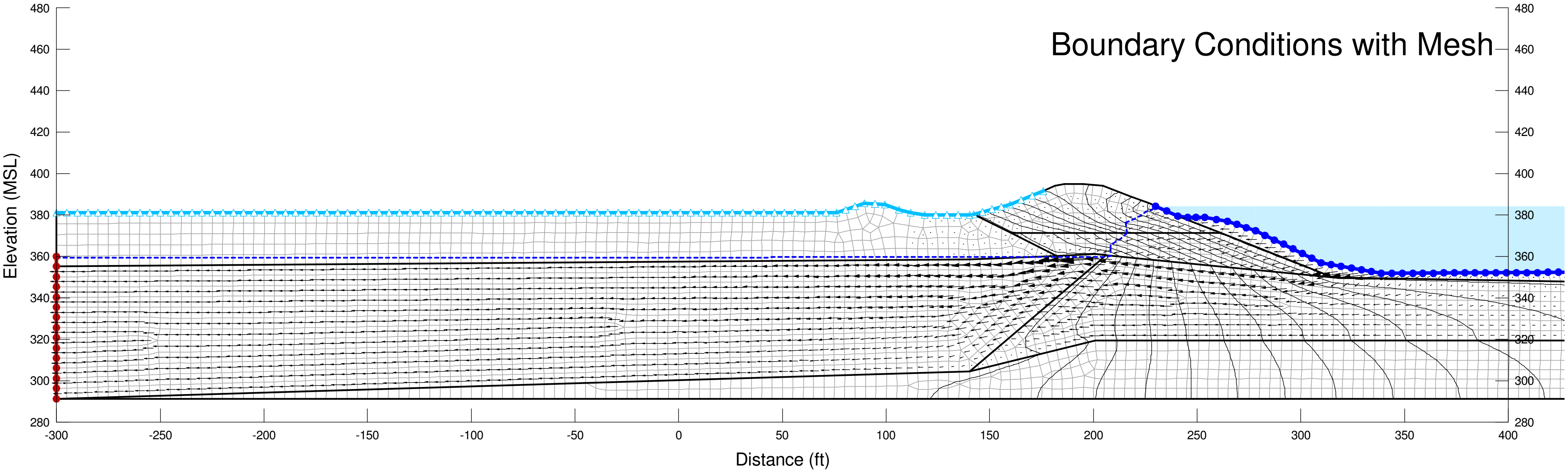
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section T.gsz
Analysis Name: Steady-State Seepage
Date Saved: 1/22/2010
Last Solved on 1/22/2010 at 2:03:38 PM

Analysis Method: Steady-State



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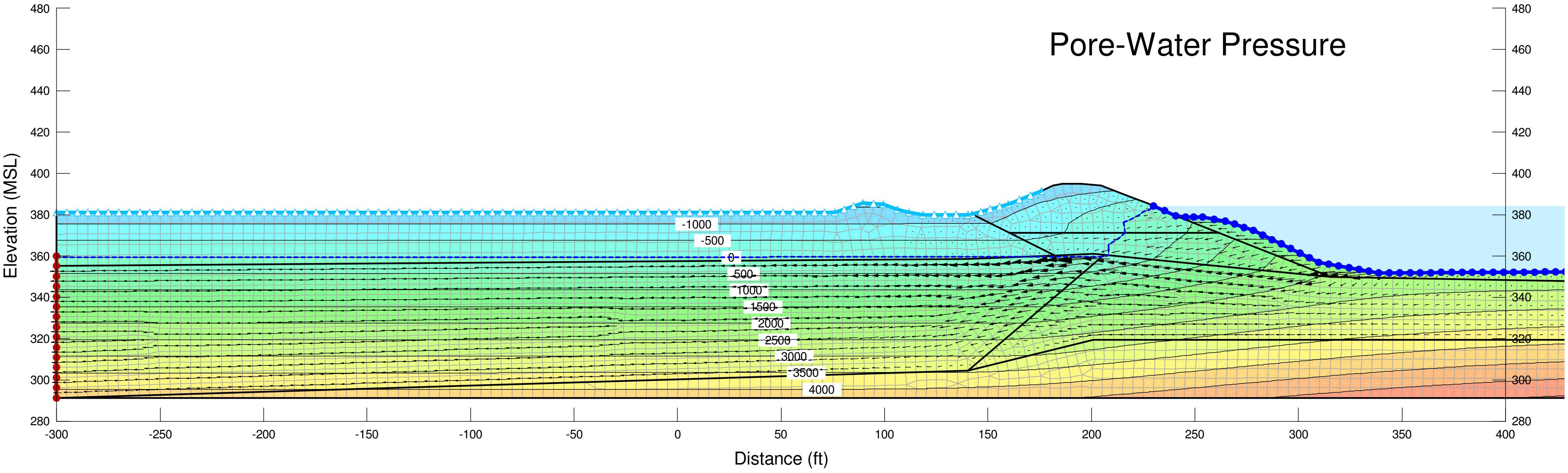
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section T.gsz
Analysis Name: Steady-State Seepage
Date Saved: 1/22/2010
Last Solved on 1/22/2010 at 2:03:38 PM

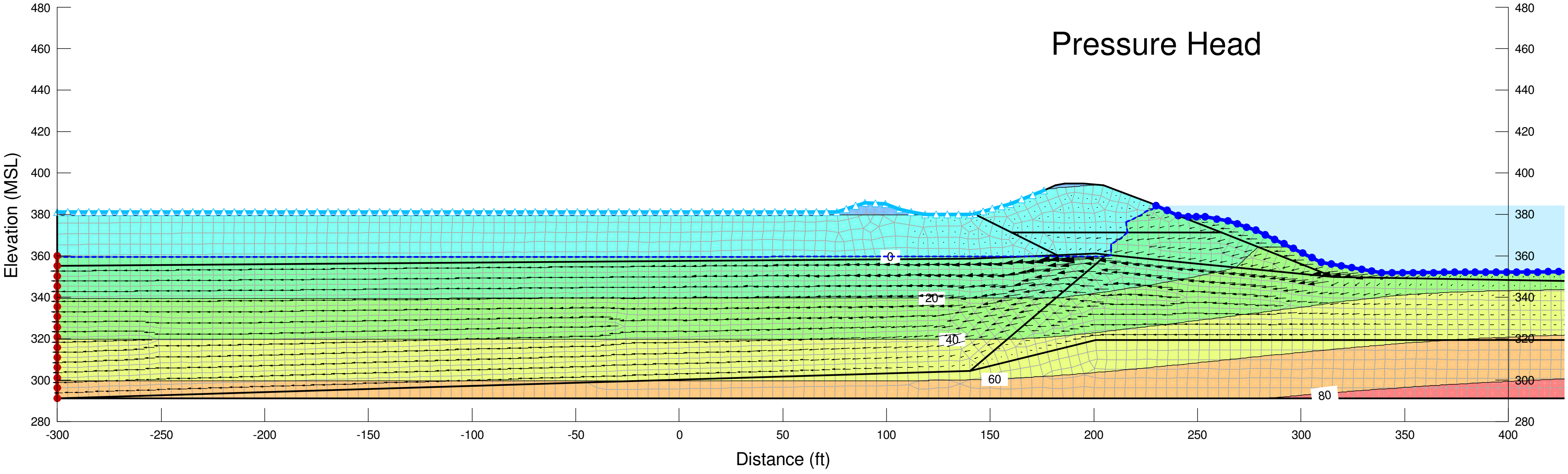
Analysis Method: Steady-State



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section T.gsz
Analysis Name: Steady-State Seepage
Date Saved: 1/22/2010
Last Solved on 1/22/2010 at 2:03:38 PM

Analysis Method: Steady-State

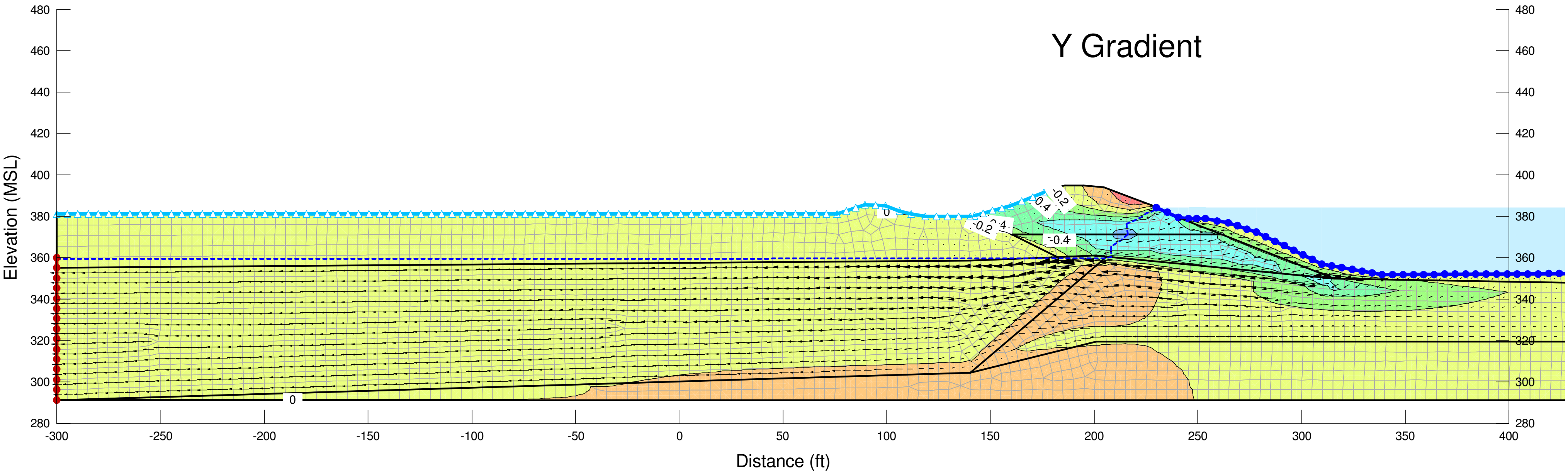


Stantec

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section T.gsz
Analysis Name: Steady-State Seepage
Date Saved: 1/22/2010
Last Solved on 1/22/2010 at 2:03:38 PM

Analysis Method: Steady-State



Steady-State Seepage

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File Information

- Created By: Daniel B. Rogers
- Revision Number: 292
- Last Edited By: Rogers, Daniel
- Date: 1/31/2010
- Time: 1:45:49 PM
- File Name: Section U.gsz
- Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
- Last Solved Date: 1/31/2010
- Last Solved Time: 1:46:32 PM

Project Settings

- Length(L) Units: feet
- Time(t) Units: Seconds
- Force(F) Units: lbf
- Pressure(p) Units: psf
- Mass(M) Units: lbs
- Mass Flux Units: lbs/sec
- Unit Weight of Water: 62.4 pcf
- View: 2D

Analysis Settings

Steady-State Seepage

- Kind: SEEP/W
- Method: Steady-State
- Settings
  - Include Air Flow: No
- Control
  - Apply Runoff: Yes
- Convergence
  - Convergence Type: Gauss Point K
  - Convergence Settings
    - Maximum Number of Iterations: 500
    - Tolerance: 0.01
    - Maximum Change in K: 0.1
    - Rate of Change in K: 1.02
    - Minimum Change in K: 0.0001
  - Equation Solver: Parallel Direct
  - Potential Seepage Max # of Reviews: 10
- Time
  - Starting Time: 0 sec

Duration: 0 sec
Ending Time: 0 sec

Materials

Dike 1 (Lean Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 1 (Lean Clay)
Vol. WC. Function: Dike 1 (Lean Clay)
K-Ratio: 0.1
K-Direction: 0 °

Dike 2 (Fat Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 2 (Fat Clay)
Vol. WC. Function: Dike 2 (Fat Clay)
K-Ratio: 0.1
K-Direction: 0 °

Fly Ash (Sluiced)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Fly Ash (Sluiced)
Vol. WC. Function: Fly Ash (Sluiced)
K-Ratio: 0.02
K-Direction: 0 °

Alluvial Clay

Model: Saturated / Unsaturated
Hydraulic
K-Function: Alluvial (Clay)
Vol. WC. Function: Alluvial (Clay)
K-Ratio: 0.05
K-Direction: 0 °

Alluvial Granular

Model: Saturated / Unsaturated
Hydraulic
K-Function: Alluvial (Granular)
Vol. WC. Function: Alluvial (Granular)
K-Ratio: 0.05
K-Direction: 0 °

Bedrock

Model: Saturated Only
Hydraulic
K-Sat: 1e-012 ft/sec

Volumetric Water Content: 0.05 ft^3/ft^3
Mv: 0 /psf
K-Ratio: 0.1
K-Direction: 0 °

Boundary Conditions

Potential Seepage Face
Review: true
Type: Total Flux (Q) 0

Ash Pond Surface Elevation
Type: Head (H) 384.23

River Surface Elevation
Type: Head (H) 359.5

K Functions

Dike 1 (Lean Clay)
Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
- Curve Fit to Data: 100 %
- Segment Curvature: 100 %

K-Saturation: 2.13e-007
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
- Data Point: (0.01, 2.13e-007)
- Data Point: (0.018329807, 2.1234388e-007)
- Data Point: (0.033598183, 2.1168814e-007)
- Data Point: (0.061584821, 2.1103203e-007)
- Data Point: (0.11288379, 2.1037498e-007)
- Data Point: (0.20691381, 2.0971735e-007)
- Data Point: (0.37926902, 2.0905824e-007)
- Data Point: (0.6951928, 2.0839653e-007)
- Data Point: (1.274275, 2.077303e-007)
- Data Point: (2.3357215, 2.070555e-007)
- Data Point: (4.2813324, 2.0636507e-007)
- Data Point: (7.8475997, 2.0564593e-007)
- Data Point: (14.384499, 2.0487454e-007)
- Data Point: (26.366509, 2.0400629e-007)
- Data Point: (48.329302, 2.0295363e-007)
- Data Point: (88.586679, 2.016313e-007)
- Data Point: (162.37767, 1.9978076e-007)
- Data Point: (297.63514, 1.9457772e-007)
- Data Point: (545.55948, 1.9521936e-007)
- Data Point: (1000, 7.5557482e-008)

Estimation Properties
- Volume Water Content Function: Dike 1 (Lean Clay)

Hydraulic K Sat: 2.13e-007 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.06 ft³/ft³

Alluvial (Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
- Curve Fit to Data: 100 %
- Segment Curvature: 100 %

K-Saturation: 4.86e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)

Data Point: (0.01, 4.86e-008)
Data Point: (0.018329807, 4.6081772e-008)
Data Point: (0.033598183, 4.3561857e-008)
Data Point: (0.061584821, 4.104302e-008)
Data Point: (0.11288379, 3.8524125e-008)
Data Point: (0.20691381, 3.6005291e-008)
Data Point: (0.37926902, 3.3486567e-008)
Data Point: (0.6951928, 3.0968085e-008)
Data Point: (1.274275, 2.8449893e-008)
Data Point: (2.3357215, 2.5932304e-008)
Data Point: (4.2813324, 2.3415812e-008)
Data Point: (7.8475997, 2.0901374e-008)
Data Point: (14.384499, 1.8390713e-008)
Data Point: (26.366509, 1.5886901e-008)
Data Point: (48.329302, 1.3395726e-008)
Data Point: (88.586679, 1.0927777e-008)
Data Point: (162.37767, 8.5023183e-009)
Data Point: (297.63514, 6.1503404e-009)
Data Point: (545.55948, 3.9524194e-009)
Data Point: (1000, 2.0421444e-009)

Estimation Properties

Volume Water Content Function: Alluvial (Clay)
Hydraulic K Sat: 4.86e-008 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.07 ft³/ft³

Alluvial (Granular)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
- Curve Fit to Data: 100 %
- Segment Curvature: 100 %

K-Saturation: 6.56e-005
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)

- Data Point: (0.01, 6.56e-005)
- Data Point: (0.018329807, 6.4809238e-005)
- Data Point: (0.033598183, 6.4018422e-005)
- Data Point: (0.061584821, 6.3227812e-005)
- Data Point: (0.11288379, 6.2437049e-005)
- Data Point: (0.20691381, 6.1646212e-005)
- Data Point: (0.37926902, 6.0854776e-005)
- Data Point: (0.6951928, 6.0062124e-005)
- Data Point: (1.274275, 5.9267829e-005)
- Data Point: (2.3357215, 5.8470547e-005)
- Data Point: (4.2813324, 5.7667753e-005)
- Data Point: (7.8475997, 5.6854825e-005)
- Data Point: (14.384499, 5.6023348e-005)
- Data Point: (26.366509, 5.5157894e-005)
- Data Point: (48.329302, 5.4230286e-005)
- Data Point: (88.586679, 5.3187637e-005)
- Data Point: (162.37767, 5.1934764e-005)
- Data Point: (297.63514, 5.0331243e-005)
- Data Point: (545.55948, 4.7912406e-005)
- Data Point: (1000, 4.3290175e-005)

Estimation Properties

- Volume Water Content Function: Alluvial (Granular)
- Hydraulic K Sat: 6.56e-005 ft/sec
- Hyd. K-Function Estimation Method: Fredlund-Xing Function
- Maximum: 1000
- Minimum: 0.01
- Num. Points: 20
- Residual Water Content: 0.02 ft^3/ft^3

Fly Ash (Sluiced)

Model: Data Point Function

Function: X-Conductivity vs. Pore-Water Pressure

- Curve Fit to Data: 100 %
- Segment Curvature: 100 %

K-Saturation: 0.000138

Data Points: Matric Suction (psf), X-Conductivity (ft/sec)

- Data Point: (0.01, 0.000138)
- Data Point: (0.018329807, 0.00013124901)
- Data Point: (0.033598183, 0.00012449327)
- Data Point: (0.061584821, 0.00011774033)
- Data Point: (0.11288379, 0.0001109872)
- Data Point: (0.20691381, 0.00010423397)
- Data Point: (0.37926902, 9.7480512e-005)
- Data Point: (0.6951928, 9.0726822e-005)
- Data Point: (1.274275, 8.3972556e-005)
- Data Point: (2.3357215, 7.7217303e-005)
- Data Point: (4.2813324, 7.0460153e-005)
- Data Point: (7.8475997, 6.3699615e-005)
- Data Point: (14.384499, 5.6933028e-005)
- Data Point: (26.366509, 5.0154616e-005)

Data Point: (48.329302, 4.3351508e-005)
Data Point: (88.586679, 3.6533731e-005)
Data Point: (162.37767, 2.9661049e-005)
Data Point: (297.63514, 2.2042999e-005)
Data Point: (545.55948, 1.5988106e-005)
Data Point: (1000, 1.5284174e-006)
Estimation Properties
Volume Water Content Function: Fly Ash (Sluiced)
Hydraulic K Sat: 0.000138 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.015 ft³/ft³

Dike 2 (Fat Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 8.86e-009
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 8.86e-009)
Data Point: (0.018329807, 8.4666934e-009)
Data Point: (0.033598183, 8.0730423e-009)
Data Point: (0.061584821, 7.6795473e-009)
Data Point: (0.11288379, 7.286077e-009)
Data Point: (0.20691381, 6.8926343e-009)
Data Point: (0.37926902, 6.499149e-009)
Data Point: (0.6951928, 6.1056576e-009)
Data Point: (1.274275, 5.7121094e-009)
Data Point: (2.3357215, 5.3184503e-009)
Data Point: (4.2813324, 4.9246054e-009)
Data Point: (7.8475997, 4.5304167e-009)
Data Point: (14.384499, 4.1355984e-009)
Data Point: (26.366509, 3.7396264e-009)
Data Point: (48.329302, 3.3415567e-009)
Data Point: (88.586679, 2.939562e-009)
Data Point: (162.37767, 2.5304396e-009)
Data Point: (297.63514, 2.1098255e-009)
Data Point: (545.55948, 1.6607128e-009)
Data Point: (1000, 1.1464795e-009)
Estimation Properties
Volume Water Content Function: Dike 2 (Fat Clay)
Hydraulic K Sat: 1.77e-009 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.09 ft³/ft³

Vol. Water Content Functions

Dike 1 (Lean Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
  Curve Fit to Data: 100 %
  Segment Curvature: 100 %
  Mv: 3e-006 /psf
Porosity: 0.41556948
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
  Data Point: (0.01, 0.41308567)
  Data Point: (0.018329807, 0.41308567)
  Data Point: (0.033598183, 0.41308567)
  Data Point: (0.061584821, 0.41308567)
  Data Point: (0.11288379, 0.41308567)
  Data Point: (0.20691381, 0.41308567)
  Data Point: (0.37926902, 0.41308567)
  Data Point: (0.6951928, 0.41308567)
  Data Point: (1.274275, 0.41308567)
  Data Point: (2.3357215, 0.41308567)
  Data Point: (4.2813324, 0.41308567)
  Data Point: (7.8475997, 0.41308567)
  Data Point: (14.384499, 0.41308567)
  Data Point: (26.366509, 0.41308567)
  Data Point: (48.329302, 0.41308567)
  Data Point: (88.586679, 0.41308567)
  Data Point: (162.37767, 0.41308567)
  Data Point: (297.63514, 0.41308567)
  Data Point: (545.55948, 0.4125467)
  Data Point: (1000, 0.38347036)
Estimation Properties
  Vol. WC Estimation Method: Grain Size Function
  Sample Material: Clay
  Saturated Water Content: 0.413 ft³/ft³
  Liquid Limit: 38 %
  Diameter at 10% passing: 0.001
  Diameter at 60% passing: 0.1
  Maximum: 1000
  Minimum: 0.01
  Num. Points: 20

Alluvial (Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
  Curve Fit to Data: 100 %
  Segment Curvature: 100 %
  Mv: 4.786e-005 /psf
Porosity: 0.46611653

Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)

Data Point: (0.01, 0.40088927)
Data Point: (0.018329807, 0.40088927)
Data Point: (0.033598183, 0.40088927)
Data Point: (0.061584821, 0.40088927)
Data Point: (0.11288379, 0.40088927)
Data Point: (0.20691381, 0.40088927)
Data Point: (0.37926902, 0.40088927)
Data Point: (0.6951928, 0.40088927)
Data Point: (1.274275, 0.40088927)
Data Point: (2.3357215, 0.40088927)
Data Point: (4.2813324, 0.40088927)
Data Point: (7.8475997, 0.40088927)
Data Point: (14.384499, 0.40088927)
Data Point: (26.366509, 0.40088927)
Data Point: (48.329302, 0.40088927)
Data Point: (88.586679, 0.40088927)
Data Point: (162.37767, 0.40088927)
Data Point: (297.63514, 0.40088927)
Data Point: (545.55948, 0.40088927)
Data Point: (1000, 0.39828281)

Estimation Properties

Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.401 ft³/ft³
Liquid Limit: 47 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.1
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Alluvial (Granular)

Model: Data Point Function

Function: Vol. Water Content vs. Pore-Water Pressure

Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 2.3925e-006 /psf

Porosity: 0.27269448

Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)

Data Point: (0.01, 0.27030198)
Data Point: (0.018329807, 0.27030198)
Data Point: (0.033598183, 0.27030198)
Data Point: (0.061584821, 0.27030198)
Data Point: (0.11288379, 0.27030198)
Data Point: (0.20691381, 0.27030198)
Data Point: (0.37926902, 0.27030198)
Data Point: (0.6951928, 0.27030198)
Data Point: (1.274275, 0.27030198)
Data Point: (2.3357215, 0.27030198)

Data Point: (4.2813324, 0.27030198)
Data Point: (7.8475997, 0.27030198)
Data Point: (14.384499, 0.27030198)
Data Point: (26.366509, 0.27030198)
Data Point: (48.329302, 0.27030198)
Data Point: (88.586679, 0.27030198)
Data Point: (162.37767, 0.27030198)
Data Point: (297.63514, 0.27030198)
Data Point: (545.55948, 0.27030198)
Data Point: (1000, 0.27030198)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Silty Sand
Saturated Water Content: 0.27 ft³/ft³
Liquid Limit: 0 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 6
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Fly Ash (Sluiced)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 6.2218e-005 /psf
Porosity: 0.37786527
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.35499418)
Data Point: (0.018329807, 0.35499418)
Data Point: (0.033598183, 0.35499418)
Data Point: (0.061584821, 0.35499418)
Data Point: (0.11288379, 0.35499418)
Data Point: (0.20691381, 0.35499418)
Data Point: (0.37926902, 0.35499418)
Data Point: (0.6951928, 0.35499418)
Data Point: (1.274275, 0.35499418)
Data Point: (2.3357215, 0.35499418)
Data Point: (4.2813324, 0.35499418)
Data Point: (7.8475997, 0.35499418)
Data Point: (14.384499, 0.35499418)
Data Point: (26.366509, 0.35499418)
Data Point: (48.329302, 0.35499418)
Data Point: (88.586679, 0.35499418)
Data Point: (162.37767, 0.35499418)
Data Point: (297.63514, 0.35499418)
Data Point: (545.55948, 0.34147401)
Data Point: (1000, 0.26813417)
Estimation Properties

Vol. WC Estimation Method: Grain Size Function
Sample Material: Silty Sand
Saturated Water Content: 0.3548 ft³/ft³
Liquid Limit: 0 %
Diameter at 10% passing: 0.004
Diameter at 60% passing: 0.049
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Dike 2 (Fat Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 1.4358e-005 /psf
Porosity: 0.36512838
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.35077038)
Data Point: (0.018329807, 0.35077038)
Data Point: (0.033598183, 0.35077038)
Data Point: (0.061584821, 0.35077038)
Data Point: (0.11288379, 0.35077038)
Data Point: (0.20691381, 0.35077038)
Data Point: (0.37926902, 0.35077038)
Data Point: (0.6951928, 0.35077038)
Data Point: (1.274275, 0.35077038)
Data Point: (2.3357215, 0.35077038)
Data Point: (4.2813324, 0.35077038)
Data Point: (7.8475997, 0.35077038)
Data Point: (14.384499, 0.35077038)
Data Point: (26.366509, 0.35077038)
Data Point: (48.329302, 0.35077038)
Data Point: (88.586679, 0.35077038)
Data Point: (162.37767, 0.35077038)
Data Point: (297.63514, 0.35077038)
Data Point: (545.55948, 0.35077038)
Data Point: (1000, 0.35077038)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.351 ft³/ft³
Liquid Limit: 54 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.043
Maximum: 1000
Minimum: 0.01
Num. Points: 20

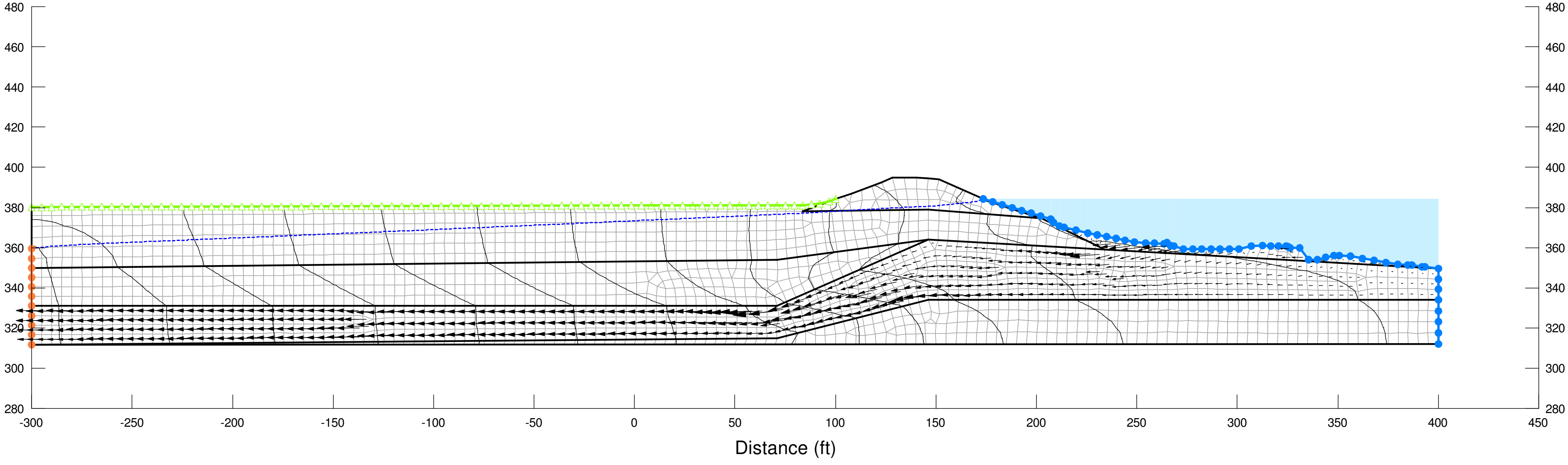
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section U.gsz
Analysis Name: Steady-State Seepage
Date Saved: 1/31/2010
Last Solved on 1/31/2010 at 1:46:32 PM

Analysis Method: Steady-State

Boundary Conditions with Mesh



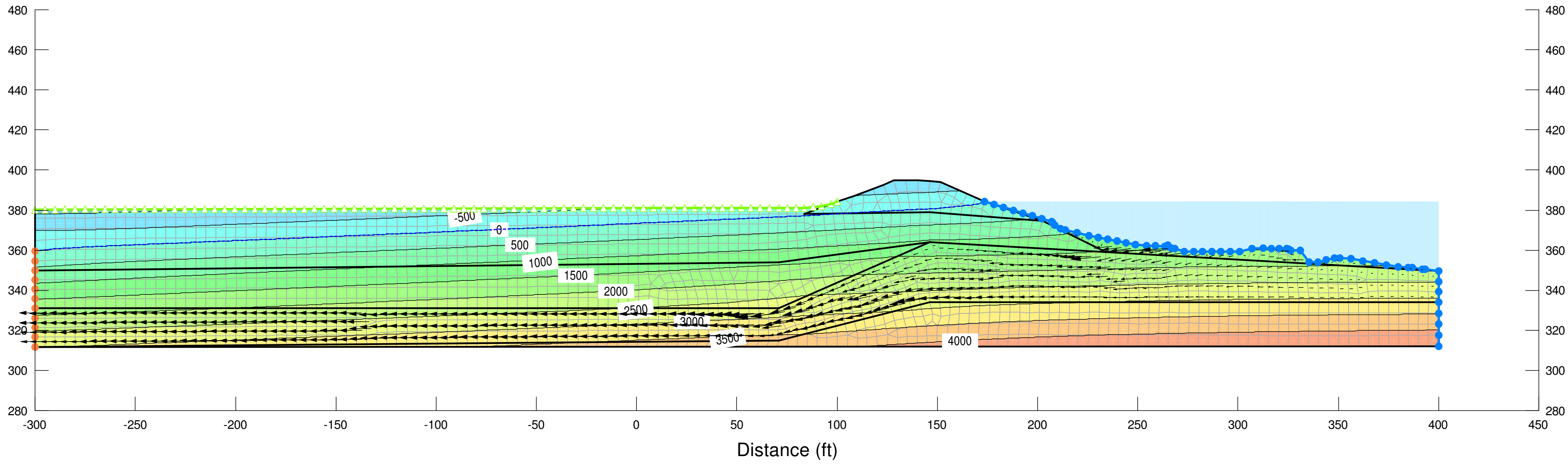
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section U.gsz
Analysis Name: Steady-State Seepage
Date Saved: 1/31/2010
Last Solved on 1/31/2010 at 1:46:32 PM

Analysis Method: Steady-State

Pore-Water Pressure



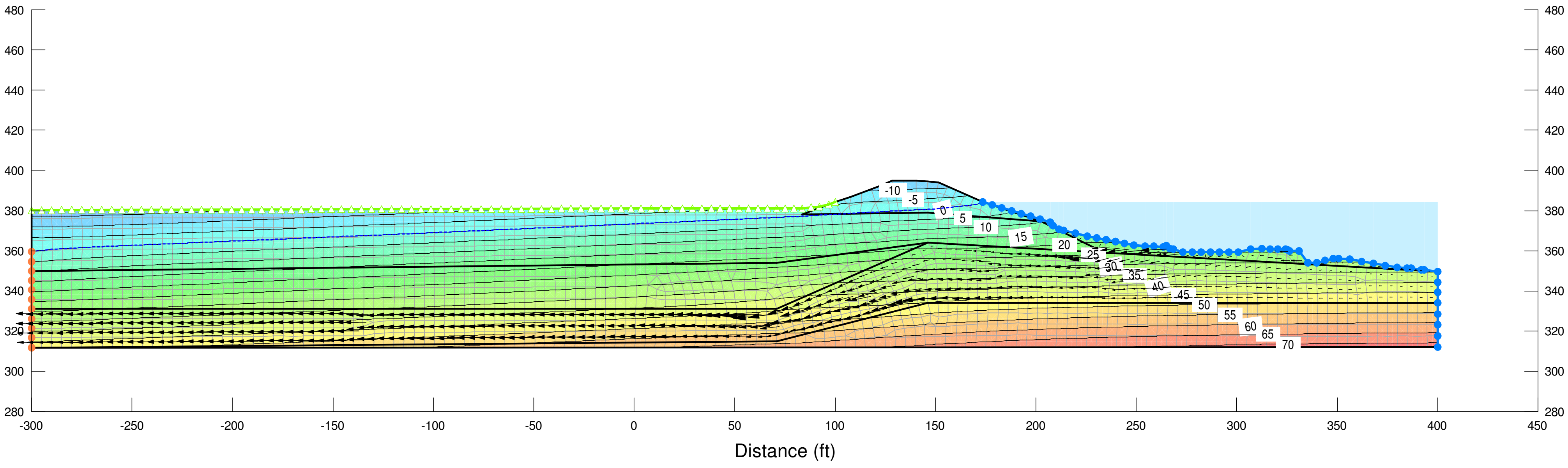
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section U.gsz
Analysis Name: Steady-State Seepage
Date Saved: 1/31/2010
Last Solved on 1/31/2010 at 1:46:32 PM

Analysis Method: Steady-State

Pressure Head

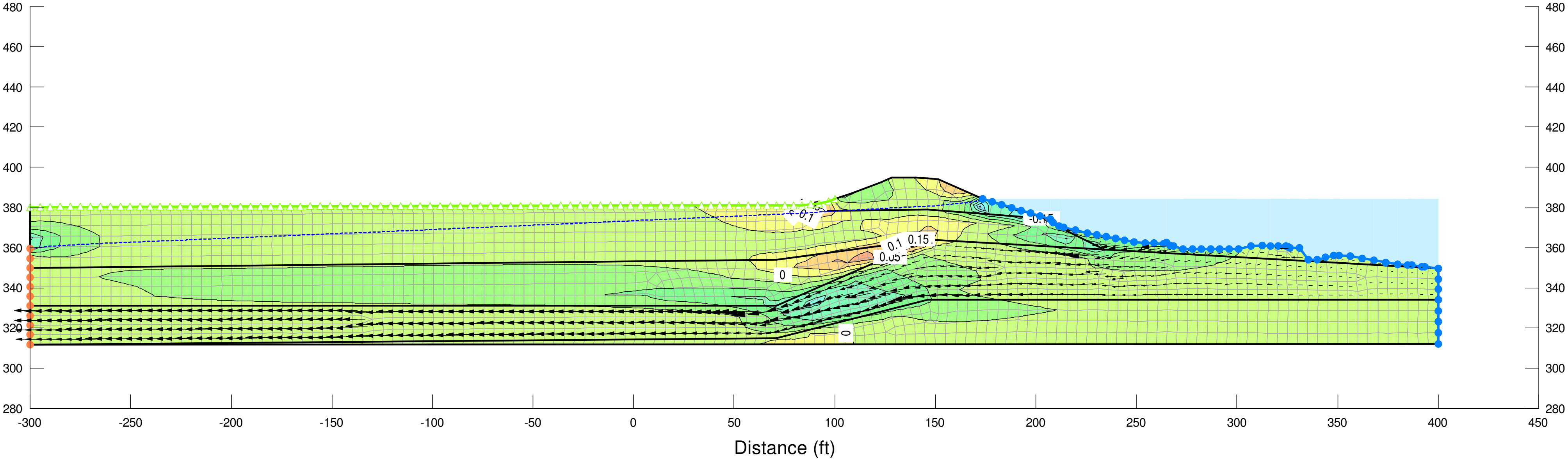


SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section U.gsz
Analysis Name: Steady-State Seepage
Date Saved: 1/31/2010
Last Solved on 1/31/2010 at 1:46:32 PM

Analysis Method: Steady-State

Y Gradient



Steady-State Seepage

File Information

Created By: Cooper, Paul
Revision Number: 235
Last Edited By: Rogers, Daniel
Date: 1/31/2010
Time: 2:19:05 PM
File Name: Section V.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/31/2010
Last Solved Time: 2:19:46 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Mass(M) Units: lbs
Mass Flux Units: lbs/sec
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Steady-State Seepage

- Kind: SEEP/W
- Method: Steady-State
- Settings
  - Include Air Flow: No
- Control
  - Apply Runoff: Yes
- Convergence
  - Convergence Type: Gauss Point K
  - Convergence Settings
    - Maximum Number of Iterations: 500
    - Tolerance: 0.01
    - Maximum Change in K: 0.1
    - Rate of Change in K: 1.02
    - Minimum Change in K: 0.0001
  - Equation Solver: Parallel Direct
  - Potential Seepage Max # of Reviews: 10
- Time
  - Starting Time: 0 sec

Duration: 0 sec
Ending Time: 0 sec

Materials

Dike 1 (Fat Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 1 (Fat Clay)
Vol. WC. Function: Dike 1 (Fat Clay)
K-Ratio: 0.1
K-Direction: 0 °

Dike 2 (Fat Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 2 (Fat Clay)
Vol. WC. Function: Dike 2 (Fat Clay)
K-Ratio: 0.1
K-Direction: 0 °

Fly Ash (Sluiced)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Fly Ash (Sluiced)
Vol. WC. Function: Fly Ash (Sluiced)
K-Ratio: 0.02
K-Direction: 0 °

Alluvial Clay

Model: Saturated / Unsaturated
Hydraulic
K-Function: Alluvial (Clay)
Vol. WC. Function: Alluvial (Clay)
K-Ratio: 0.05
K-Direction: 0 °

Boundary Conditions

Potential Seepage Face

Review: true
Type: Total Flux (Q) 0

Ash Pond

Type: Head (H) 384.23

Ditchline

Type: Head (H) 375

K Functions

Dike 1 (Fat Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
  Curve Fit to Data: 100 %
  Segment Curvature: 100 %
K-Saturation: 8.86e-009
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
  Data Point: (0.01, 8.86e-009)
  Data Point: (0.018329807, 8.4909248e-009)
  Data Point: (0.033598183, 8.1215152e-009)
  Data Point: (0.061584821, 7.7521994e-009)
  Data Point: (0.11288379, 7.3829367e-009)
  Data Point: (0.20691381, 7.0136766e-009)
  Data Point: (0.37926902, 6.6443895e-009)
  Data Point: (0.6951928, 6.2750695e-009)
  Data Point: (1.274275, 5.9056454e-009)
  Data Point: (2.3357215, 5.5360634e-009)
  Data Point: (4.2813324, 5.1661799e-009)
  Data Point: (7.8475997, 4.7957545e-009)
  Data Point: (14.384499, 4.4243248e-009)
  Data Point: (26.366509, 4.0510601e-009)
  Data Point: (48.329302, 3.6744529e-009)
  Data Point: (88.586679, 3.2916299e-009)
  Data Point: (162.37767, 2.8974833e-009)
  Data Point: (297.63514, 2.4844296e-009)
  Data Point: (545.55948, 2.0278951e-009)
  Data Point: (1000, 1.4732348e-009)
Estimation Properties
  Volume Water Content Function: Dike 1 (Fat Clay)
  Hydraulic K Sat: 8.86e-009 ft/sec
  Hyd. K-Function Estimation Method: Fredlund-Xing Function
  Maximum: 1000
  Minimum: 0.01
  Num. Points: 20
  Residual Water Content: 0.09 ft³/ft³

Alluvial (Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
  Curve Fit to Data: 100 %
  Segment Curvature: 100 %
K-Saturation: 4.86e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
  Data Point: (0.01, 4.86e-008)
  Data Point: (0.018329807, 4.6081957e-008)
  Data Point: (0.033598183, 4.3562037e-008)

- Data Point: (0.061584821, 4.1043284e-008)
- Data Point: (0.11288379, 3.8524355e-008)
- Data Point: (0.20691381, 3.6005505e-008)
- Data Point: (0.37926902, 3.348676e-008)
- Data Point: (0.6951928, 3.0968229e-008)
- Data Point: (1.274275, 2.8450022e-008)
- Data Point: (2.3357215, 2.5932423e-008)
- Data Point: (4.2813324, 2.3415929e-008)
- Data Point: (7.8475997, 2.0901504e-008)
- Data Point: (14.384499, 1.8390826e-008)
- Data Point: (26.366509, 1.5886992e-008)
- Data Point: (48.329302, 1.3395802e-008)
- Data Point: (88.586679, 1.0927841e-008)
- Data Point: (162.37767, 8.5023705e-009)
- Data Point: (297.63514, 6.1503781e-009)
- Data Point: (545.55948, 3.9524429e-009)
- Data Point: (1000, 2.0421567e-009)

Estimation Properties
- Volume Water Content Function: Alluvial (Clay)
- Hydraulic K Sat: 4.86e-008 ft/sec
- Hyd. K-Function Estimation Method: Fredlund-Xing Function
- Maximum: 1000
- Minimum: 0.01
- Num. Points: 20
- Residual Water Content: 0.07 ft³/ft³

Fly Ash (Sluiced)

Model: Data Point Function

Function: X-Conductivity vs. Pore-Water Pressure
- Curve Fit to Data: 100 %
- Segment Curvature: 100 %

K-Saturation: 0.000138

Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
- Data Point: (0.01, 0.000138)
- Data Point: (0.018329807, 0.00013124899)
- Data Point: (0.033598183, 0.00012449358)
- Data Point: (0.061584821, 0.00011774069)
- Data Point: (0.11288379, 0.00011098751)
- Data Point: (0.20691381, 0.00010423412)
- Data Point: (0.37926902, 9.7480653e-005)
- Data Point: (0.6951928, 9.072693e-005)
- Data Point: (1.274275, 8.3972583e-005)
- Data Point: (2.3357215, 7.7217317e-005)
- Data Point: (4.2813324, 7.046016e-005)
- Data Point: (7.8475997, 6.3699627e-005)
- Data Point: (14.384499, 5.6933042e-005)
- Data Point: (26.366509, 5.015463e-005)
- Data Point: (48.329302, 4.3351522e-005)
- Data Point: (88.586679, 3.6533744e-005)
- Data Point: (162.37767, 2.9661059e-005)

  - Data Point: (297.63514, 2.2043007e-005)
  - Data Point: (545.55948, 1.5988112e-005)
  - Data Point: (1000, 1.5284178e-006)
- Estimation Properties
  - Volume Water Content Function: Vol. Water Content Function 9
  - Hydraulic K Sat: 0.000138 ft/sec
  - Hyd. K-Function Estimation Method: Fredlund-Xing Function
  - Maximum: 1000
  - Minimum: 0.01
  - Num. Points: 20
  - Residual Water Content: 0.015 ft^3/ft^3

Dike 2 (Fat Clay)

- Model: Data Point Function
- Function: X-Conductivity vs. Pore-Water Pressure
  - Curve Fit to Data: 100 %
  - Segment Curvature: 100 %
- K-Saturation: 8.86e-009
- Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
  - Data Point: (0.01, 8.86e-009)
  - Data Point: (0.018329807, 8.4667011e-009)
  - Data Point: (0.033598183, 8.0730953e-009)
  - Data Point: (0.061584821, 7.6795897e-009)
  - Data Point: (0.11288379, 7.2861087e-009)
  - Data Point: (0.20691381, 6.8926585e-009)
  - Data Point: (0.37926902, 6.4991665e-009)
  - Data Point: (0.6951928, 6.10567e-009)
  - Data Point: (1.274275, 5.7121196e-009)
  - Data Point: (2.3357215, 5.3184636e-009)
  - Data Point: (4.2813324, 4.9246187e-009)
  - Data Point: (7.8475997, 4.5304276e-009)
  - Data Point: (14.384499, 4.1356077e-009)
  - Data Point: (26.366509, 3.7396344e-009)
  - Data Point: (48.329302, 3.3415636e-009)
  - Data Point: (88.586679, 2.9395678e-009)
  - Data Point: (162.37767, 2.5304446e-009)
  - Data Point: (297.63514, 2.1098297e-009)
  - Data Point: (545.55948, 1.6607161e-009)
  - Data Point: (1000, 1.1464819e-009)
- Estimation Properties
  - Volume Water Content Function: Vol. Water Content Function 13
  - Hydraulic K Sat: 8.86e-009 ft/sec
  - Hyd. K-Function Estimation Method: Fredlund-Xing Function
  - Maximum: 1000
  - Minimum: 0.01
  - Num. Points: 20
  - Residual Water Content: 0.09 ft^3/ft^3

Vol. Water Content Functions

Dike 1 (Fat Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
- Curve Fit to Data: 100 %
- Segment Curvature: 100 %
- Mv: 1.4358e-005 /psf

Porosity: 0.42969067
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
- Data Point: (0.01, 0.41533267)
- Data Point: (0.018329807, 0.41533267)
- Data Point: (0.033598183, 0.41533267)
- Data Point: (0.061584821, 0.41533267)
- Data Point: (0.11288379, 0.41533267)
- Data Point: (0.20691381, 0.41533267)
- Data Point: (0.37926902, 0.41533267)
- Data Point: (0.6951928, 0.41533267)
- Data Point: (1.274275, 0.41533267)
- Data Point: (2.3357215, 0.41533267)
- Data Point: (4.2813324, 0.41533267)
- Data Point: (7.8475997, 0.41533267)
- Data Point: (14.384499, 0.41533267)
- Data Point: (26.366509, 0.41533267)
- Data Point: (48.329302, 0.41533267)
- Data Point: (88.586679, 0.41533267)
- Data Point: (162.37767, 0.41533267)
- Data Point: (297.63514, 0.41533267)
- Data Point: (545.55948, 0.41533267)
- Data Point: (1000, 0.41533267)

Estimation Properties
- Vol. WC Estimation Method: Grain Size Function
- Sample Material: Clay
- Saturated Water Content: 0.415 ft³/ft³
- Liquid Limit: 69 %
- Diameter at 10% passing: 0.001
- Diameter at 60% passing: 0.05
- Maximum: 1000
- Minimum: 0.01
- Num. Points: 20

Alluvial (Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
- Curve Fit to Data: 100 %
- Segment Curvature: 100 %
- Mv: 4.786e-005 /psf

Porosity: 0.46611653
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
- Data Point: (0.01, 0.40088927)
- Data Point: (0.018329807, 0.40088927)

Data Point: (0.033598183, 0.40088927)
Data Point: (0.061584821, 0.40088927)
Data Point: (0.11288379, 0.40088927)
Data Point: (0.20691381, 0.40088927)
Data Point: (0.37926902, 0.40088927)
Data Point: (0.6951928, 0.40088927)
Data Point: (1.274275, 0.40088927)
Data Point: (2.3357215, 0.40088927)
Data Point: (4.2813324, 0.40088927)
Data Point: (7.8475997, 0.40088927)
Data Point: (14.384499, 0.40088927)
Data Point: (26.366509, 0.40088927)
Data Point: (48.329302, 0.40088927)
Data Point: (88.586679, 0.40088927)
Data Point: (162.37767, 0.40088927)
Data Point: (297.63514, 0.40088927)
Data Point: (545.55948, 0.40088927)
Data Point: (1000, 0.39828281)

Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.401 ft³/ft³
Liquid Limit: 47 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.1
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Fly Ash (Sluiced)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 6.2218e-005 /psf
Porosity: 0.37786527
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.35499418)
Data Point: (0.018329807, 0.35499418)
Data Point: (0.033598183, 0.35499418)
Data Point: (0.061584821, 0.35499418)
Data Point: (0.11288379, 0.35499418)
Data Point: (0.20691381, 0.35499418)
Data Point: (0.37926902, 0.35499418)
Data Point: (0.6951928, 0.35499418)
Data Point: (1.274275, 0.35499418)
Data Point: (2.3357215, 0.35499418)
Data Point: (4.2813324, 0.35499418)
Data Point: (7.8475997, 0.35499418)
Data Point: (14.384499, 0.35499418)

Data Point: (26.366509, 0.35499418)
Data Point: (48.329302, 0.35499418)
Data Point: (88.586679, 0.35499418)
Data Point: (162.37767, 0.35499418)
Data Point: (297.63514, 0.35499418)
Data Point: (545.55948, 0.34147401)
Data Point: (1000, 0.26813417)

Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Silt
Saturated Water Content: 0.3548 ft³/ft³
Liquid Limit: 0 %
Diameter at 10% passing: 0.004
Diameter at 60% passing: 0.049
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Dike 2 (Fat Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 1.4358e-005 /psf
Porosity: 0.36512838
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.35077038)
Data Point: (0.018329807, 0.35077038)
Data Point: (0.033598183, 0.35077038)
Data Point: (0.061584821, 0.35077038)
Data Point: (0.11288379, 0.35077038)
Data Point: (0.20691381, 0.35077038)
Data Point: (0.37926902, 0.35077038)
Data Point: (0.6951928, 0.35077038)
Data Point: (1.274275, 0.35077038)
Data Point: (2.3357215, 0.35077038)
Data Point: (4.2813324, 0.35077038)
Data Point: (7.8475997, 0.35077038)
Data Point: (14.384499, 0.35077038)
Data Point: (26.366509, 0.35077038)
Data Point: (48.329302, 0.35077038)
Data Point: (88.586679, 0.35077038)
Data Point: (162.37767, 0.35077038)
Data Point: (297.63514, 0.35077038)
Data Point: (545.55948, 0.35077038)
Data Point: (1000, 0.35077038)

Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.351 ft³/ft³

Liquid Limit: 54 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.043
Maximum: 1000
Minimum: 0.01
Num. Points: 20

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section V.gsz

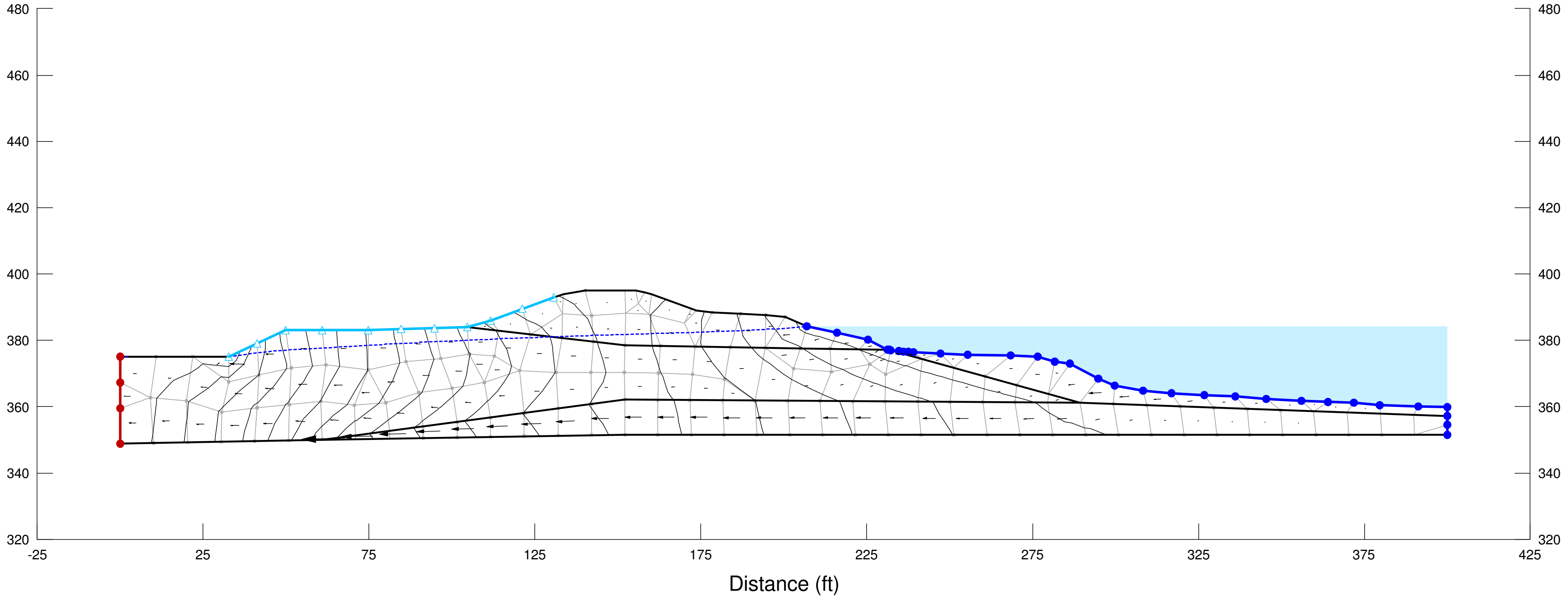
Analysis Name: Steady-State Seepage

Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 2:19:46 PM

Boundary Conditions with Mesh

Analysis Method: Steady-State



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section V.gsz

Analysis Name: Steady-State Seepage

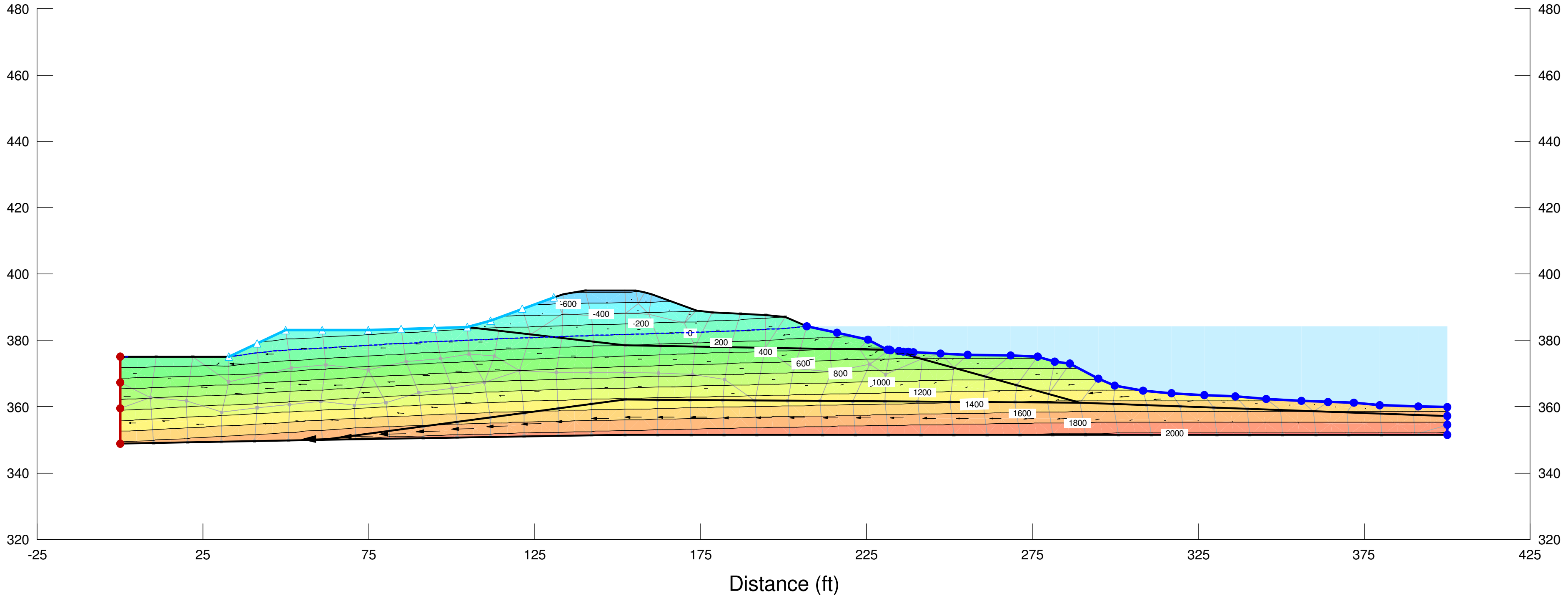
Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 2:19:46 PM

Stantec

Pore-Water Pressure

Analysis Method: Steady-State



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section V.gsz

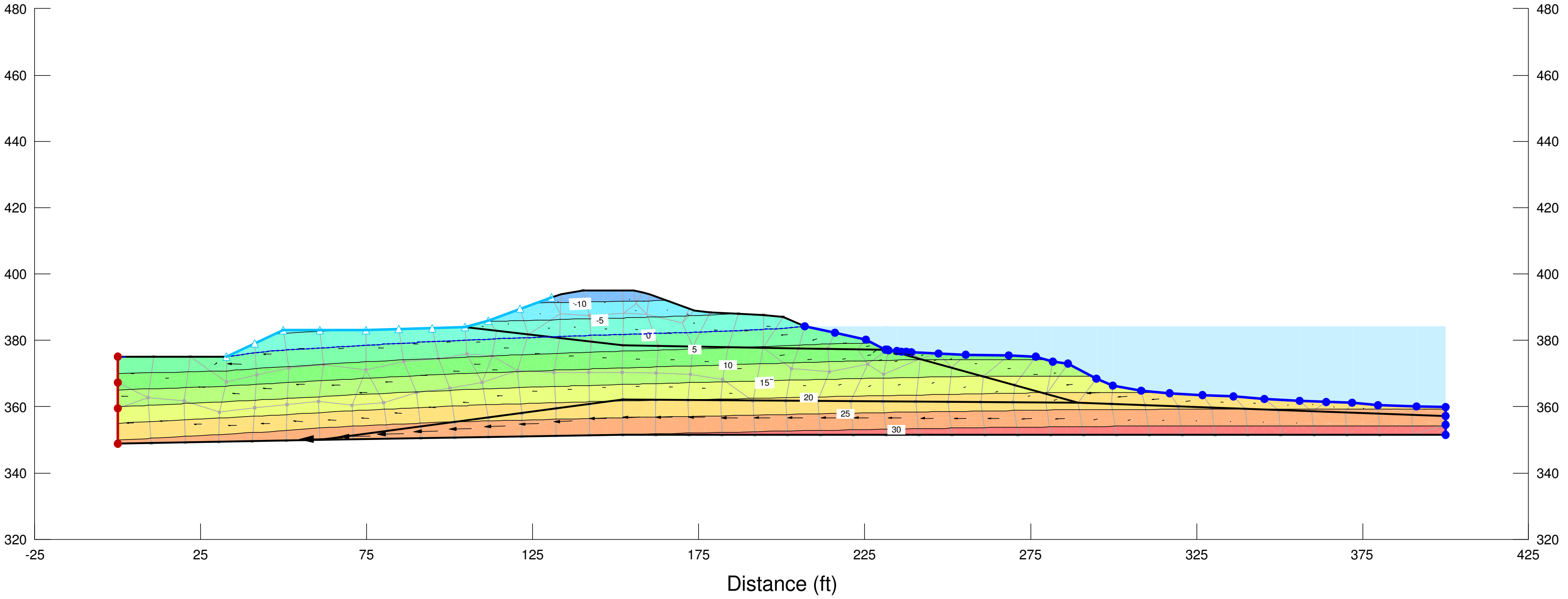
Analysis Name: Steady-State Seepage

Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 2:19:46 PM

Pressure Head

Analysis Method: Steady-State



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section V.gsz

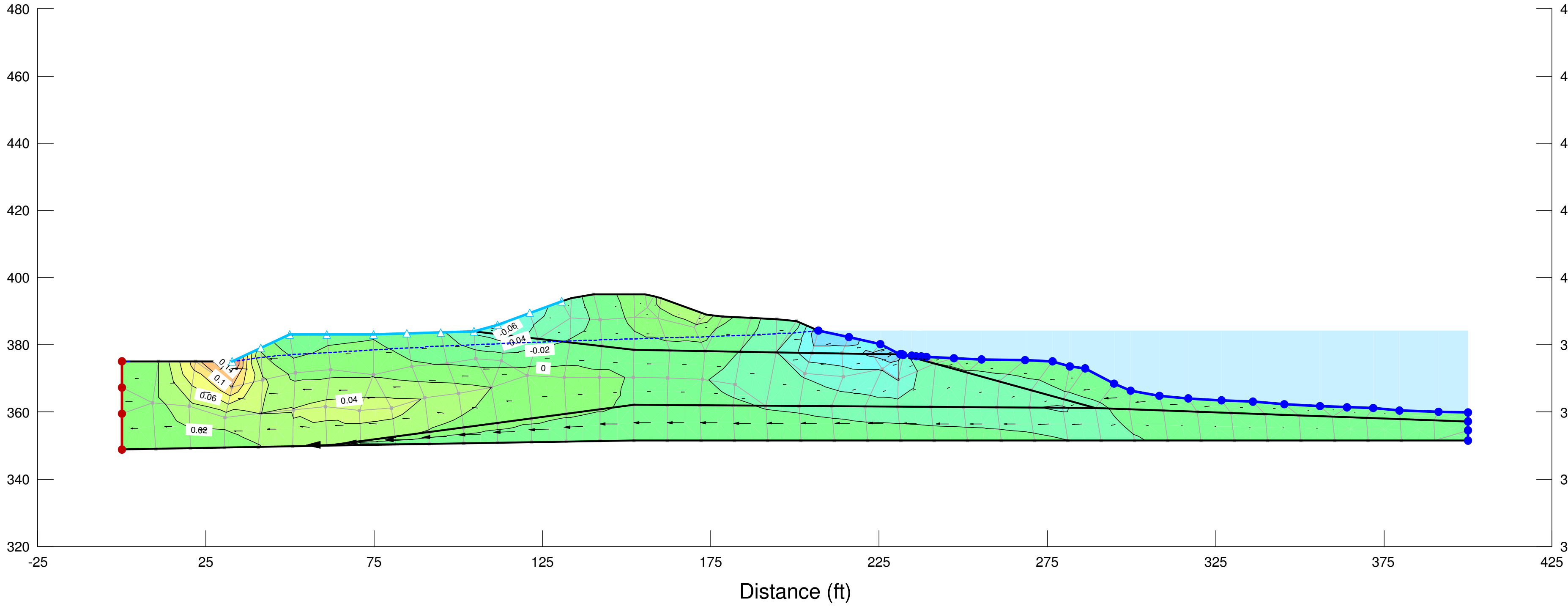
Analysis Name: Steady-State Seepage

Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 2:19:46 PM

Y-Gradient

Analysis Method: Steady-State



Steady-State Seepage

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File Information

Created By: Cooper, Paul
Revision Number: 227
Last Edited By: Rogers, Daniel
Date: 1/22/2010
Time: 1:19:03 PM
File Name: Section W.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/22/2010
Last Solved Time: 3:25:00 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Mass(M) Units: lbs
Mass Flux Units: lbs/sec
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Steady-State Seepage

- Kind: SEEP/W
- Method: Steady-State
- Settings
  - Include Air Flow: No
- Control
  - Apply Runoff: Yes
- Convergence
  - Convergence Type: Gauss Point K
  - Convergence Settings
    - Maximum Number of Iterations: 500
    - Tolerance: 0.01
    - Maximum Change in K: 0.1
    - Rate of Change in K: 1.02
    - Minimum Change in K: 0.0001
  - Equation Solver: Parallel Direct
  - Potential Seepage Max # of Reviews: 10
- Time
  - Starting Time: 0 sec

Duration: 0 sec
Ending Time: 0 sec

Materials

Dike 1 (Fat Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 1 (Lean Clay)
Vol. WC. Function: Dike 1 (Lean Clay)
K-Ratio: 0.1
K-Direction: 0 °

Dike 2 (Fat Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 1 (Fat Clay)
Vol. WC. Function: Dike 1 (Fat Clay)
K-Ratio: 0.1
K-Direction: 0 °

Fly Ash (Sluiced)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Fly Ash (Sluiced)
Vol. WC. Function: Fly Ash (Sluiced)
K-Ratio: 0.02
K-Direction: 0 °

Bedrock

Model: Saturated Only
Hydraulic
K-Sat: 1e-011 ft/sec
Volumetric Water Content: 0.05 ft^3/ft^3
Mv: 0 /psf
K-Ratio: 0.1
K-Direction: 0 °

Boundary Conditions

Potential Seepage Face

Review: true
Type: Total Flux (Q) 0

Ash Pond

Type: Head (H) 384.23

Ditchline

Type: Head (H) 375.5

K Functions

Dike 1 (Lean Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
  Curve Fit to Data: 100 %
  Segment Curvature: 100 %
K-Saturation: 9.27e-007
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
  Data Point: (0.01, 9.27e-007)
  Data Point: (0.018329807, 9.241445e-007)
  Data Point: (0.033598183, 9.2129064e-007)
  Data Point: (0.061584821, 9.1843515e-007)
  Data Point: (0.11288379, 9.1557564e-007)
  Data Point: (0.20691381, 9.1271354e-007)
  Data Point: (0.37926902, 9.0984501e-007)
  Data Point: (0.6951928, 9.0696516e-007)
  Data Point: (1.274275, 9.0406567e-007)
  Data Point: (2.3357215, 9.0112887e-007)
  Data Point: (4.2813324, 8.9812403e-007)
  Data Point: (7.8475997, 8.9499425e-007)
  Data Point: (14.384499, 8.9163709e-007)
  Data Point: (26.366509, 8.8785834e-007)
  Data Point: (48.329302, 8.8327705e-007)
  Data Point: (88.586679, 8.7752214e-007)
  Data Point: (162.37767, 8.6946837e-007)
  Data Point: (297.63514, 8.4682415e-007)
  Data Point: (545.55948, 8.4961667e-007)
  Data Point: (1000, 3.2883467e-007)
Estimation Properties
  Volume Water Content Function: Dike 1 (Lean Clay)
  Hydraulic K Sat: 9.27e-007 ft/sec
  Hyd. K-Function Estimation Method: Fredlund-Xing Function
  Maximum: 1000
  Minimum: 0.01
  Num. Points: 20
  Residual Water Content: 0.06 ft³/ft³

Dike 1 (Fat Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
  Curve Fit to Data: 100 %
  Segment Curvature: 100 %
K-Saturation: 8.86e-009
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
  Data Point: (0.01, 8.86e-009)
  Data Point: (0.018329807, 8.4909248e-009)

Data Point: (0.033598183, 8.1215152e-009)
Data Point: (0.061584821, 7.7521994e-009)
Data Point: (0.11288379, 7.3829367e-009)
Data Point: (0.20691381, 7.0136766e-009)
Data Point: (0.37926902, 6.6443895e-009)
Data Point: (0.6951928, 6.2750695e-009)
Data Point: (1.274275, 5.9056454e-009)
Data Point: (2.3357215, 5.5360634e-009)
Data Point: (4.2813324, 5.1661799e-009)
Data Point: (7.8475997, 4.7957545e-009)
Data Point: (14.384499, 4.4243248e-009)
Data Point: (26.366509, 4.0510601e-009)
Data Point: (48.329302, 3.6744529e-009)
Data Point: (88.586679, 3.2916299e-009)
Data Point: (162.37767, 2.8974833e-009)
Data Point: (297.63514, 2.4844296e-009)
Data Point: (545.55948, 2.0278951e-009)
Data Point: (1000, 1.4732348e-009)
Estimation Properties
Volume Water Content Function: Dike 1 (Fat Clay)
Hydraulic K Sat: 8.86e-009 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.09 ft³/ft³

Fly Ash (Sluiced)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 0.000138
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 0.000138)
Data Point: (0.018329807, 0.00013124899)
Data Point: (0.033598183, 0.00012449358)
Data Point: (0.061584821, 0.00011774069)
Data Point: (0.11288379, 0.00011098751)
Data Point: (0.20691381, 0.00010423412)
Data Point: (0.37926902, 9.7480653e-005)
Data Point: (0.6951928, 9.072693e-005)
Data Point: (1.274275, 8.3972583e-005)
Data Point: (2.3357215, 7.7217317e-005)
Data Point: (4.2813324, 7.046016e-005)
Data Point: (7.8475997, 6.3699627e-005)
Data Point: (14.384499, 5.6933042e-005)
Data Point: (26.366509, 5.015463e-005)
Data Point: (48.329302, 4.3351522e-005)
Data Point: (88.586679, 3.6533744e-005)

Data Point: (162.37767, 2.9661059e-005)
Data Point: (297.63514, 2.2043007e-005)
Data Point: (545.55948, 1.5988112e-005)
Data Point: (1000, 1.5284178e-006)
Estimation Properties
Volume Water Content Function: Vol. Water Content Function 9
Hydraulic K Sat: 0.000138 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.015 ft³/ft³

Vol. Water Content Functions

Dike 1 (Lean Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 3e-006 /psf
Porosity: 0.41556948
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.41308567)
Data Point: (0.018329807, 0.41308567)
Data Point: (0.033598183, 0.41308567)
Data Point: (0.061584821, 0.41308567)
Data Point: (0.11288379, 0.41308567)
Data Point: (0.20691381, 0.41308567)
Data Point: (0.37926902, 0.41308567)
Data Point: (0.6951928, 0.41308567)
Data Point: (1.274275, 0.41308567)
Data Point: (2.3357215, 0.41308567)
Data Point: (4.2813324, 0.41308567)
Data Point: (7.8475997, 0.41308567)
Data Point: (14.384499, 0.41308567)
Data Point: (26.366509, 0.41308567)
Data Point: (48.329302, 0.41308567)
Data Point: (88.586679, 0.41308567)
Data Point: (162.37767, 0.41308567)
Data Point: (297.63514, 0.41308567)
Data Point: (545.55948, 0.4125467)
Data Point: (1000, 0.38347036)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.413 ft³/ft³
Liquid Limit: 38 %
Diameter at 10% passing: 0.001

Diameter at 60% passing: 0.1
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Dike 1 (Fat Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 1.4358e-005 /psf
Porosity: 0.42969067
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.41533267)
Data Point: (0.018329807, 0.41533267)
Data Point: (0.033598183, 0.41533267)
Data Point: (0.061584821, 0.41533267)
Data Point: (0.11288379, 0.41533267)
Data Point: (0.20691381, 0.41533267)
Data Point: (0.37926902, 0.41533267)
Data Point: (0.6951928, 0.41533267)
Data Point: (1.274275, 0.41533267)
Data Point: (2.3357215, 0.41533267)
Data Point: (4.2813324, 0.41533267)
Data Point: (7.8475997, 0.41533267)
Data Point: (14.384499, 0.41533267)
Data Point: (26.366509, 0.41533267)
Data Point: (48.329302, 0.41533267)
Data Point: (88.586679, 0.41533267)
Data Point: (162.37767, 0.41533267)
Data Point: (297.63514, 0.41533267)
Data Point: (545.55948, 0.41533267)
Data Point: (1000, 0.41533267)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.415 ft³/ft³
Liquid Limit: 69 %
Diameter at 10% passing: 0.001
Diameter at 60% passing: 0.05
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Fly Ash (Sluiced)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 6.2218e-005 /psf

Porosity: 0.37786527
Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
Data Point: (0.01, 0.35499418)
Data Point: (0.018329807, 0.35499418)
Data Point: (0.033598183, 0.35499418)
Data Point: (0.061584821, 0.35499418)
Data Point: (0.11288379, 0.35499418)
Data Point: (0.20691381, 0.35499418)
Data Point: (0.37926902, 0.35499418)
Data Point: (0.6951928, 0.35499418)
Data Point: (1.274275, 0.35499418)
Data Point: (2.3357215, 0.35499418)
Data Point: (4.2813324, 0.35499418)
Data Point: (7.8475997, 0.35499418)
Data Point: (14.384499, 0.35499418)
Data Point: (26.366509, 0.35499418)
Data Point: (48.329302, 0.35499418)
Data Point: (88.586679, 0.35499418)
Data Point: (162.37767, 0.35499418)
Data Point: (297.63514, 0.35499418)
Data Point: (545.55948, 0.34147401)
Data Point: (1000, 0.26813417)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Silt
Saturated Water Content: 0.3548 ft^3/ft^3
Liquid Limit: 0 %
Diameter at 10% passing: 0.004
Diameter at 60% passing: 0.049
Maximum: 1000
Minimum: 0.01
Num. Points: 20

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section W.gsz

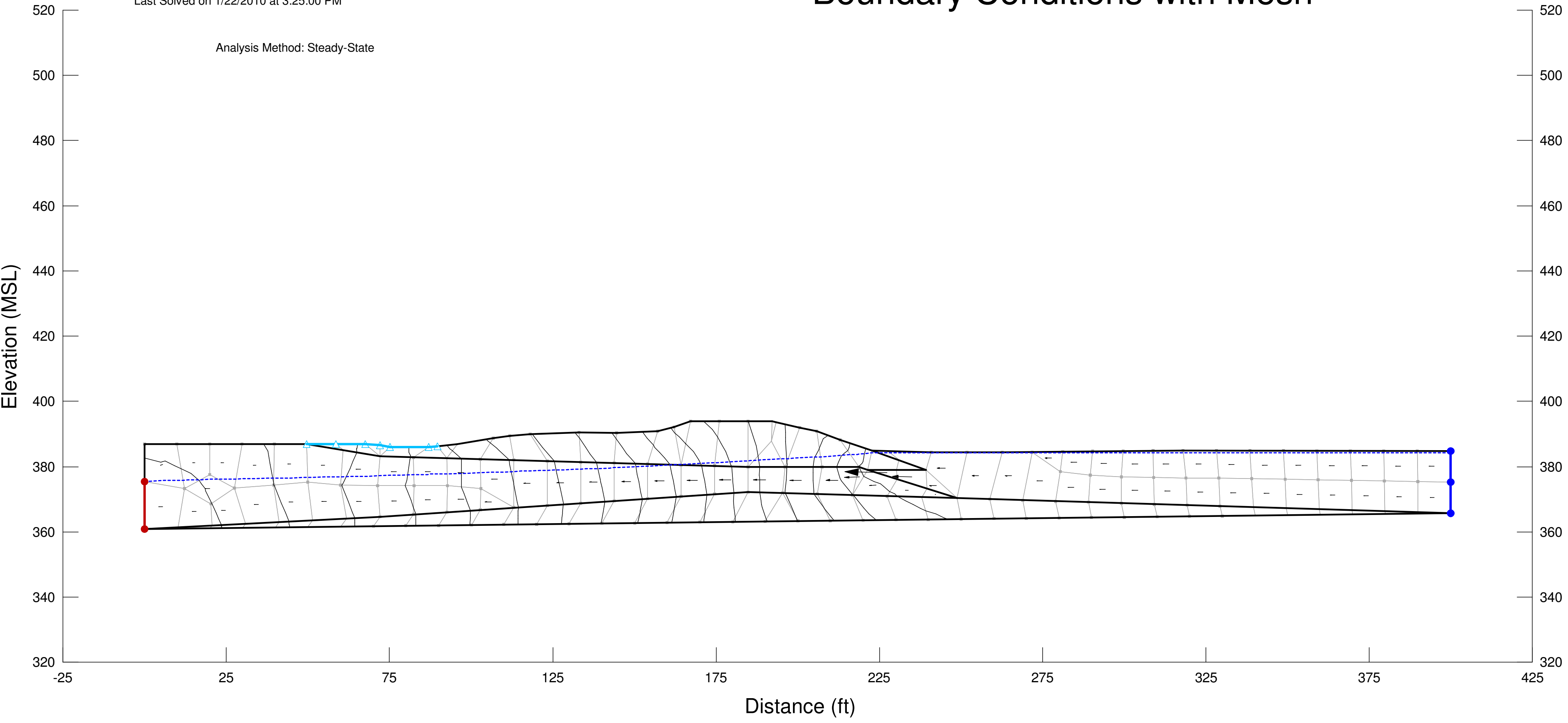
Analysis Name: Steady-State Seepage

Date Saved: 1/22/2010

Last Solved on 1/22/2010 at 3:25:00 PM

Analysis Method: Steady-State

Boundary Conditions with Mesh



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

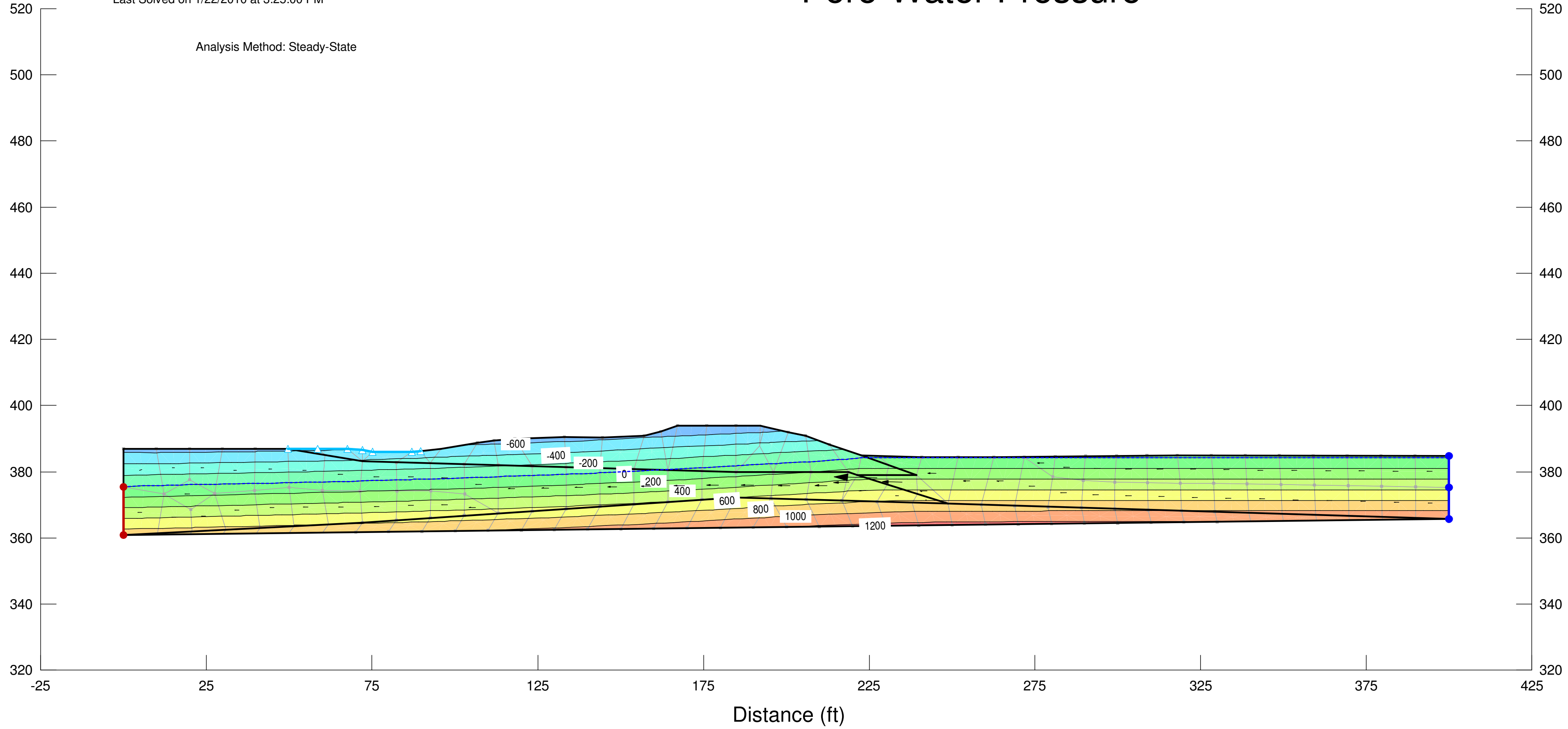
File Name: Section W.gsz

Analysis Name: Steady-State Seepage

Date Saved: 1/22/2010

Last Solved on 1/22/2010 at 3:25:00 PM

Pore-Water Pressure



Stantec

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section W.gsz

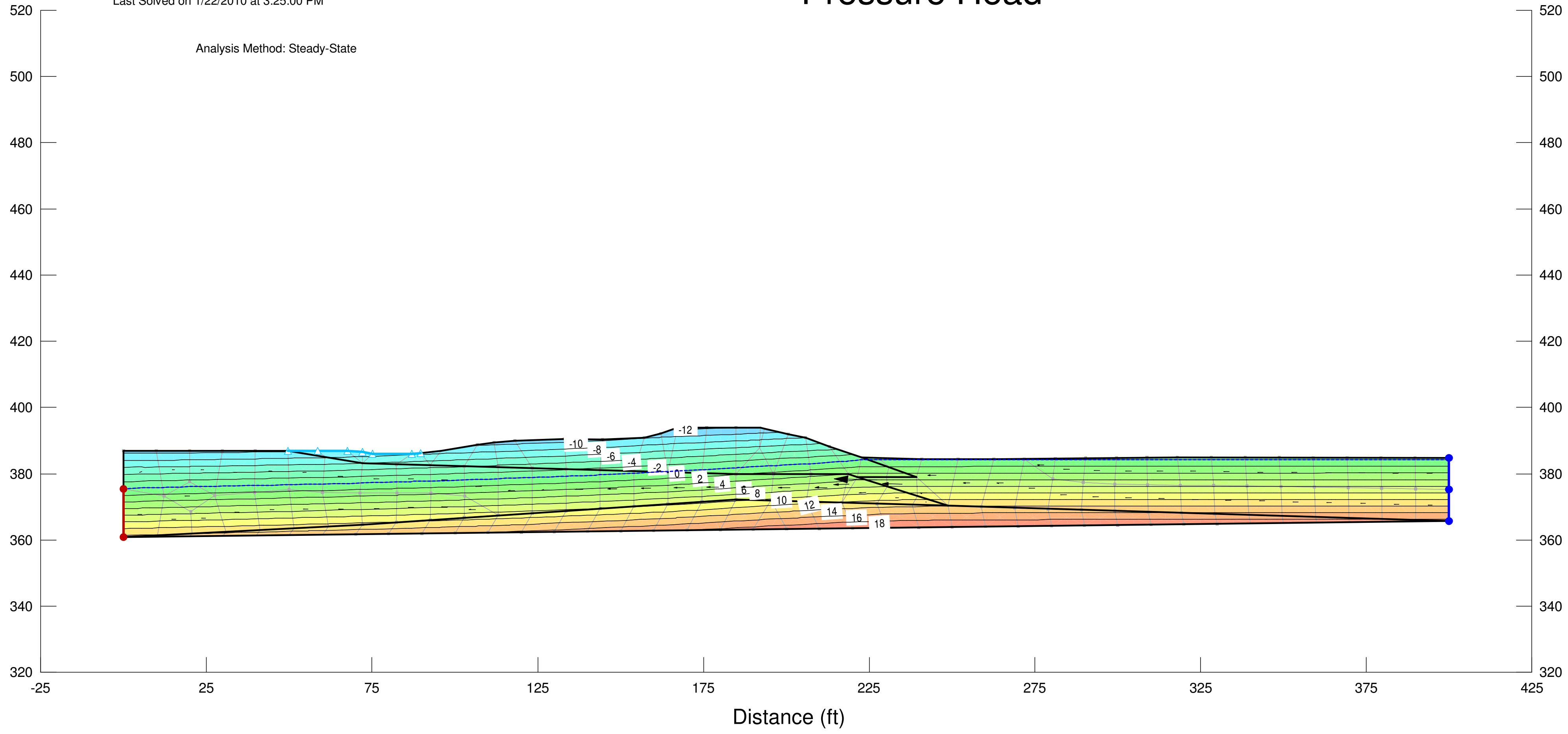
Analysis Name: Steady-State Seepage

Date Saved: 1/22/2010

Last Solved on 1/22/2010 at 3:25:00 PM

Analysis Method: Steady-State

Pressure Head



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

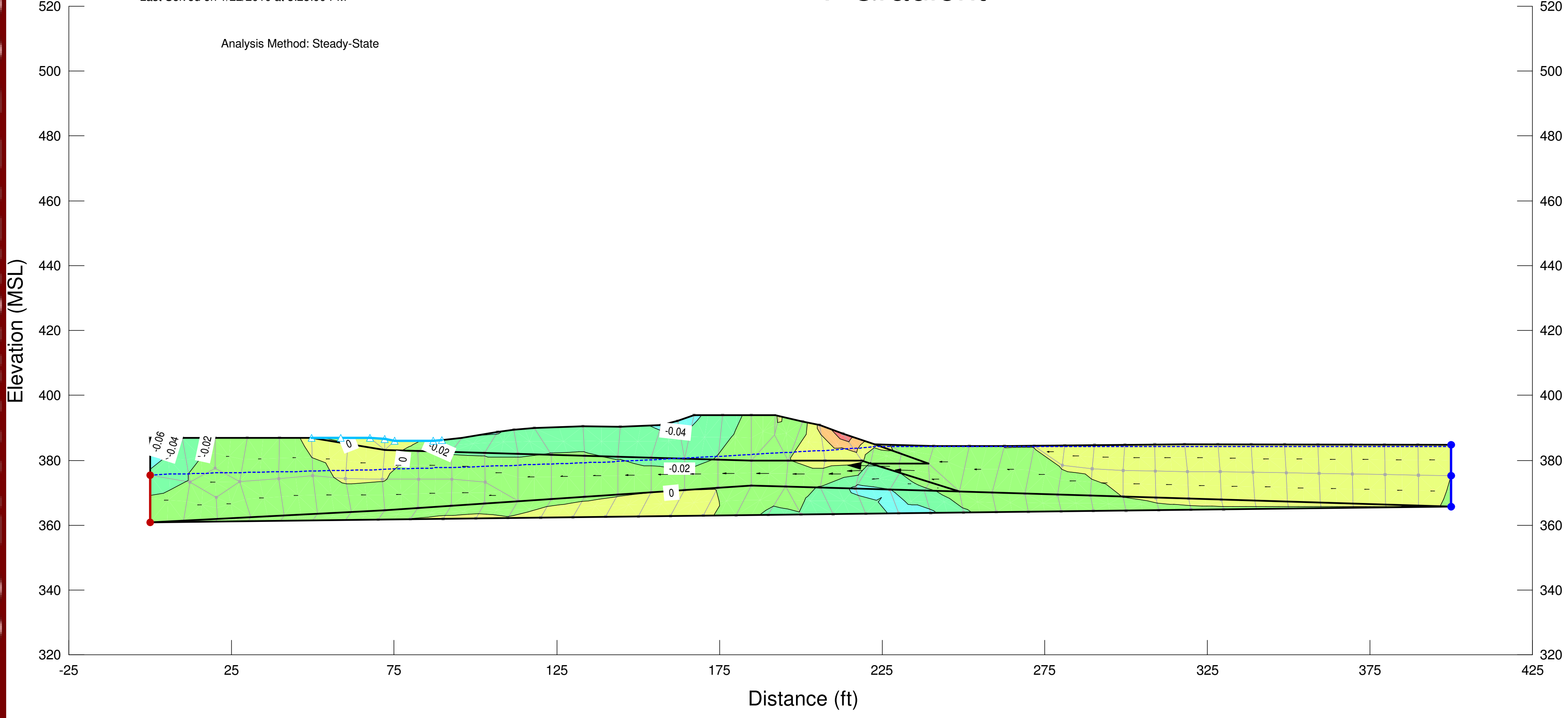
File Name: Section W.gsz

Analysis Name: Steady-State Seepage

Date Saved: 1/22/2010

Last Solved on 1/22/2010 at 3:25:00 PM

Y-Gradient



Analysis Method: Steady-State

Appendix I

Slope Stability Analyses Output

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

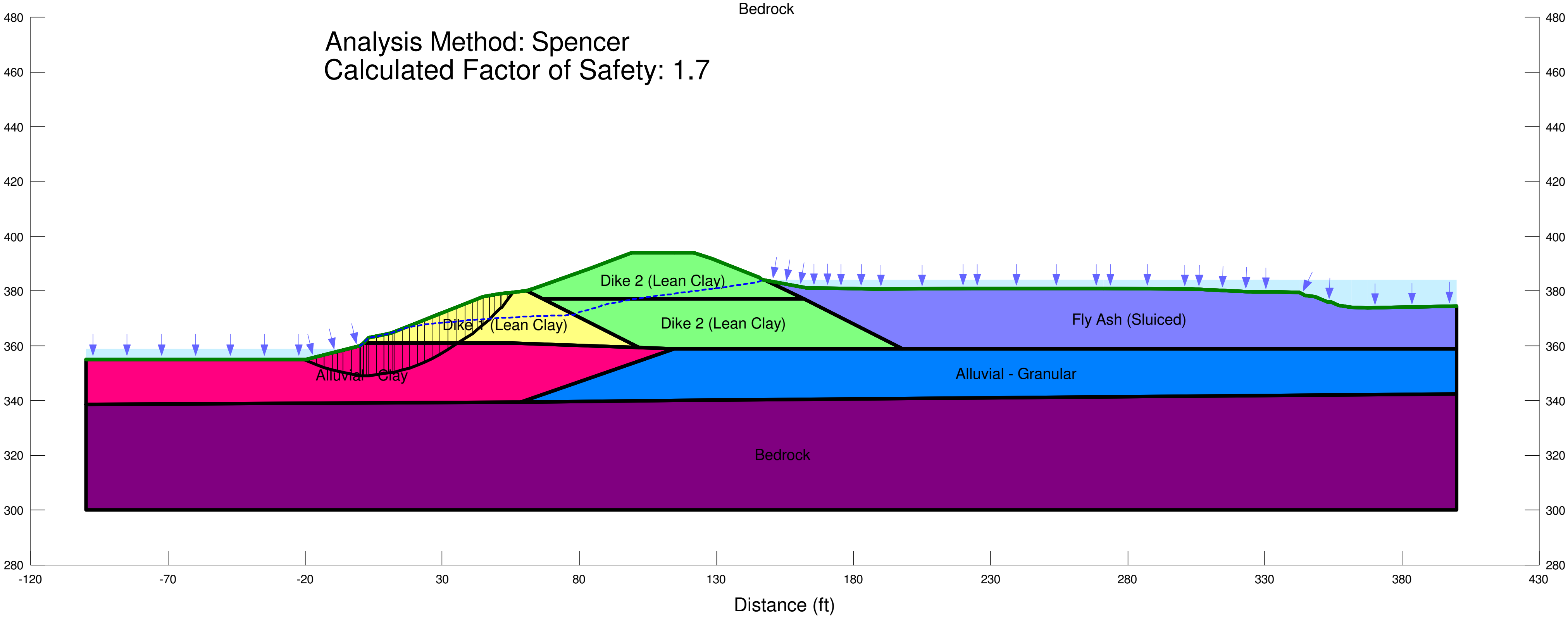
File Name: Section P.gsz

Analysis Name: Stability - Existing Condition

Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 12:08:20 PM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial - Clay	124 pcf	200 psf	33 °
Alluvial - Granular	130 pcf	0 psf	32 °
Bedrock			



Analysis Method: Spencer
Calculated Factor of Safety: 1.7

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

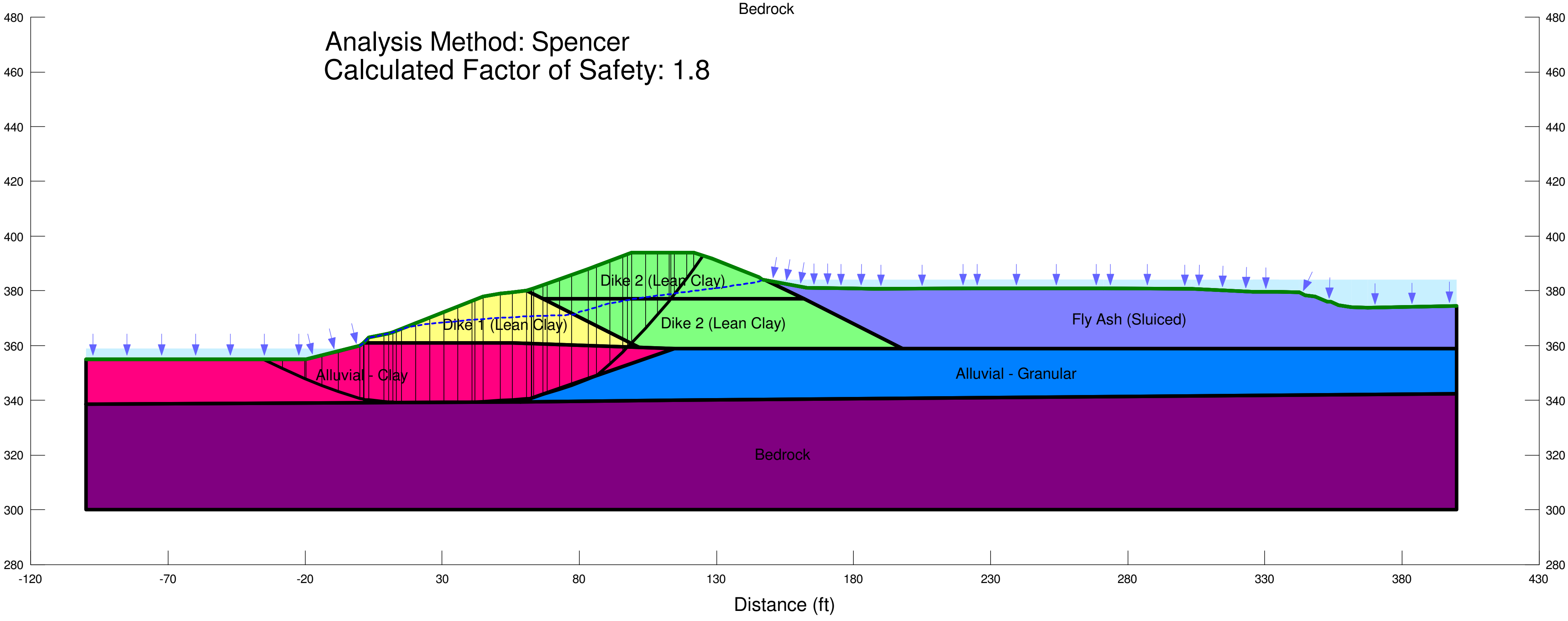
File Name: Section P.gsz

Analysis Name: Stability - Existing Condition (Deep)

Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 12:09:56 PM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial - Clay	124 pcf	200 psf	33 °
Alluvial - Granular	130 pcf	0 psf	32 °
Bedrock			



Analysis Method: Spencer
Calculated Factor of Safety: 1.8

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section P.gsz

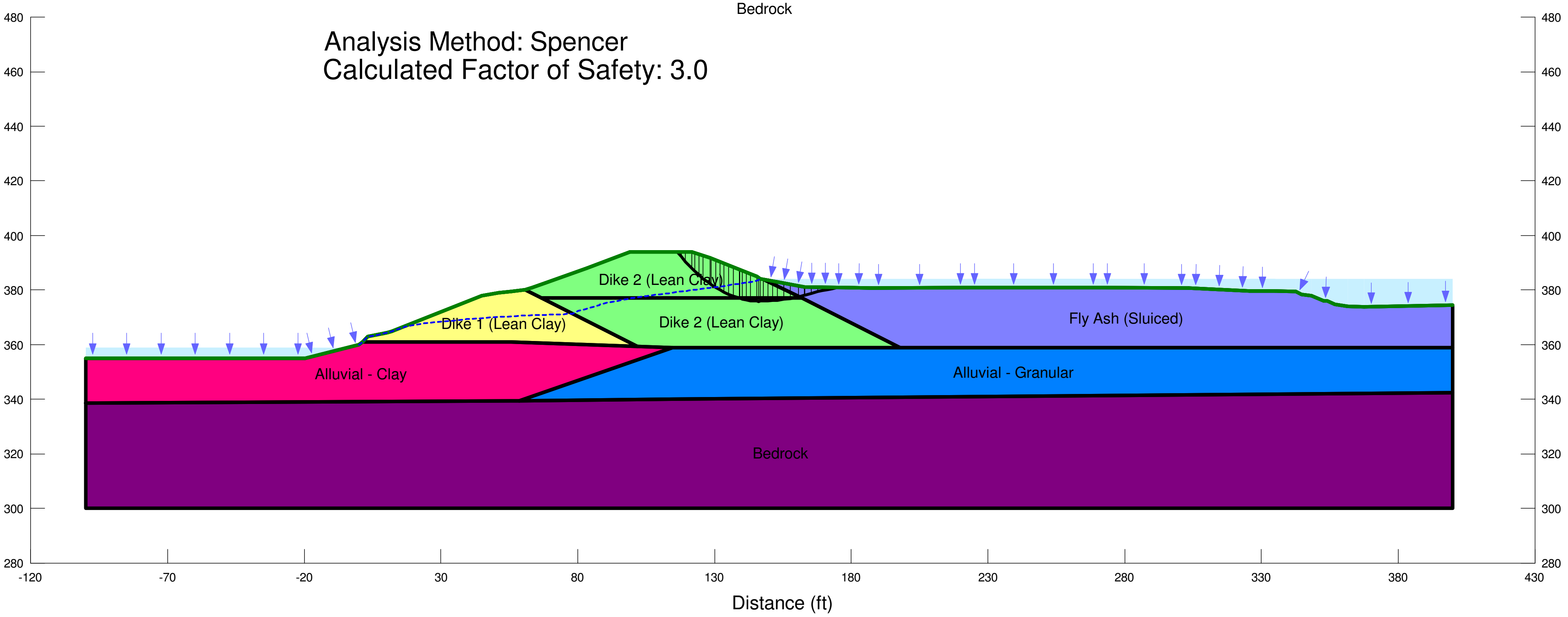
Analysis Name: Stability - Existing Condition (L2R)

Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 12:20:12 PM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial - Clay	124 pcf	200 psf	33 °
Alluvial - Granular	130 pcf	0 psf	32 °
Bedrock			

Analysis Method: Spencer
Calculated Factor of Safety: 3.0



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section P.gsz

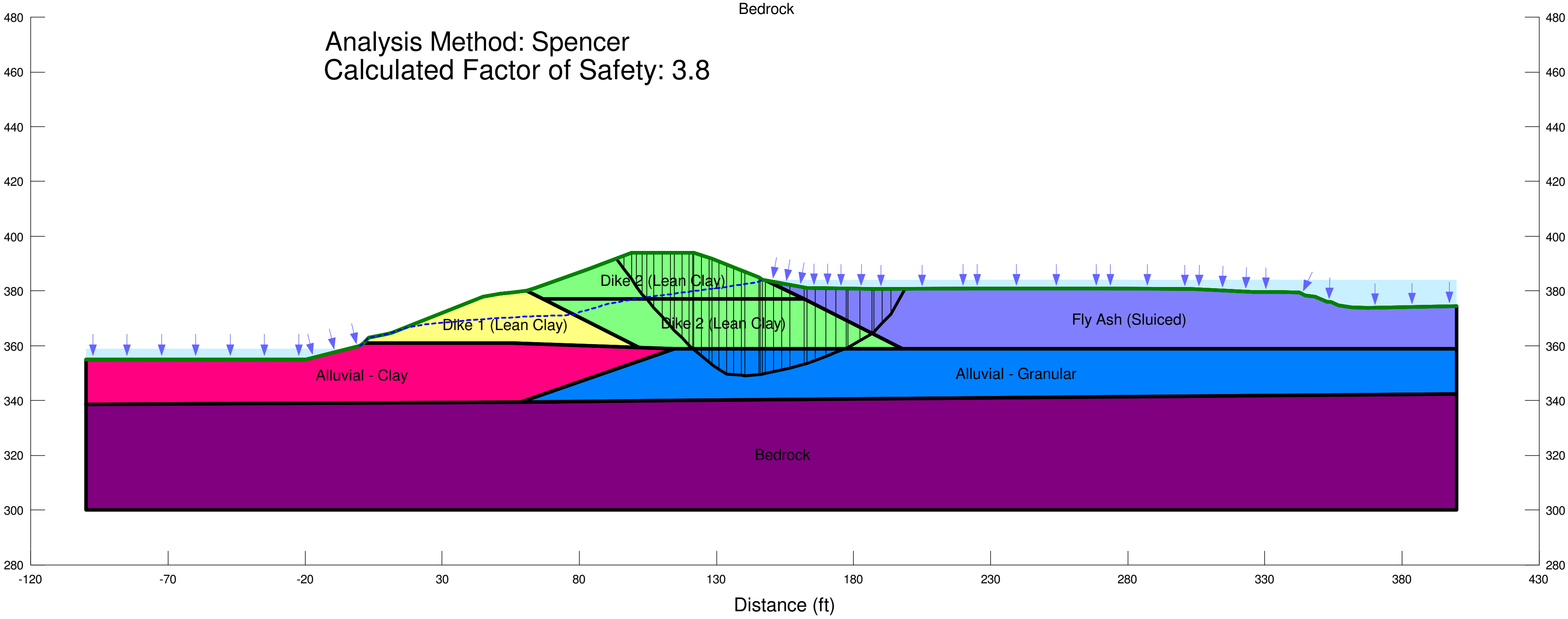
Analysis Name: Stability - Existing Condition (Deep) (L2R)

Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 12:18:00 PM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial - Clay	124 pcf	200 psf	33 °
Alluvial - Granular	130 pcf	0 psf	32 °
Bedrock			



Analysis Method: Spencer
Calculated Factor of Safety: 3.8

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

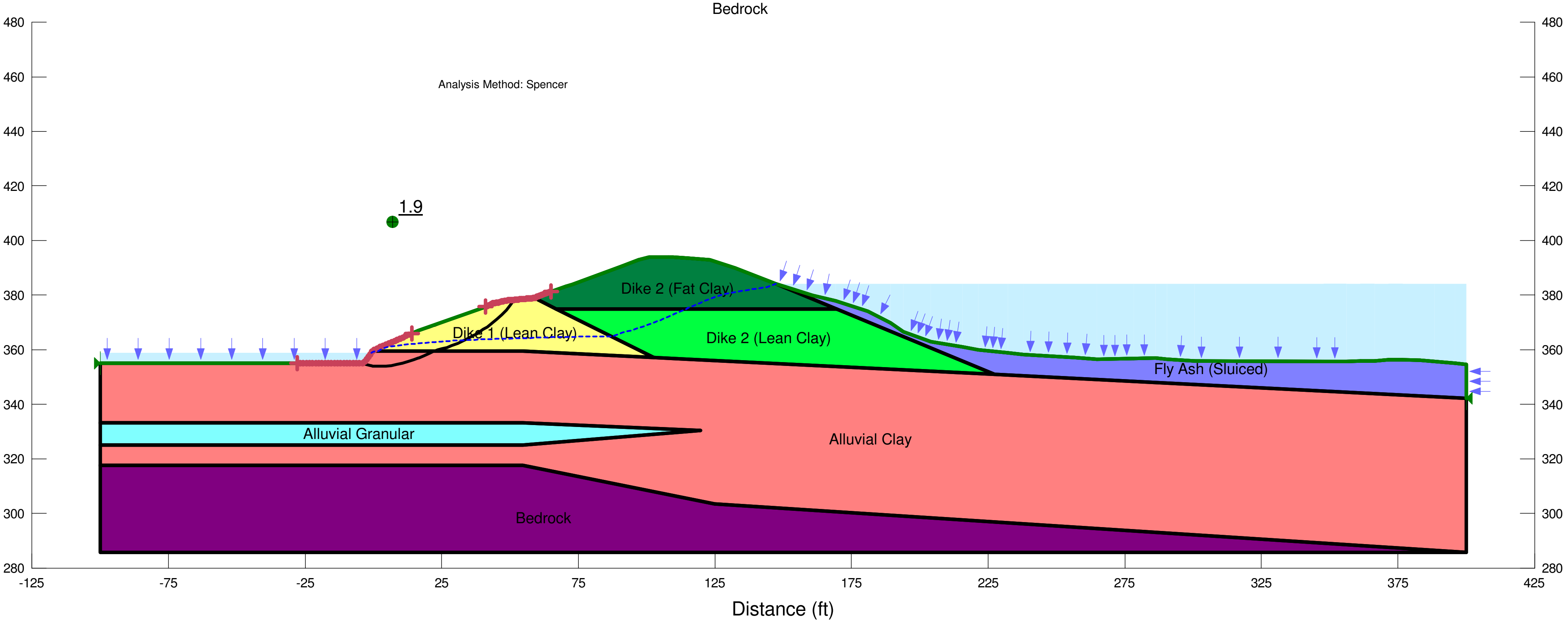
Stantec

File Name: Section Q.gsz

Analysis Name: Stability - Existing Condition
Last Solved on 1/13/2010 at 9:52:26 AM
Date Saved: 1/13/2010

Material Type	Unit Weight	Friction Angle	Cohesion
Dike 1 (Lean Clay)	123 pcf	22 °	200 psf
Dike 2 (Lean Clay)	123 pcf	32 °	200 psf
Dike 2 (Fat Clay)	119 pcf	29 °	200 psf
Fly Ash (Sluiced)	100 pcf	22 °	0 psf
Alluvial Clay	124 pcf	33 °	200 psf
Alluvial Granular	130 pcf	32 °	0 psf
Bedrock			

Calculated Factor of Safety: 1.9



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

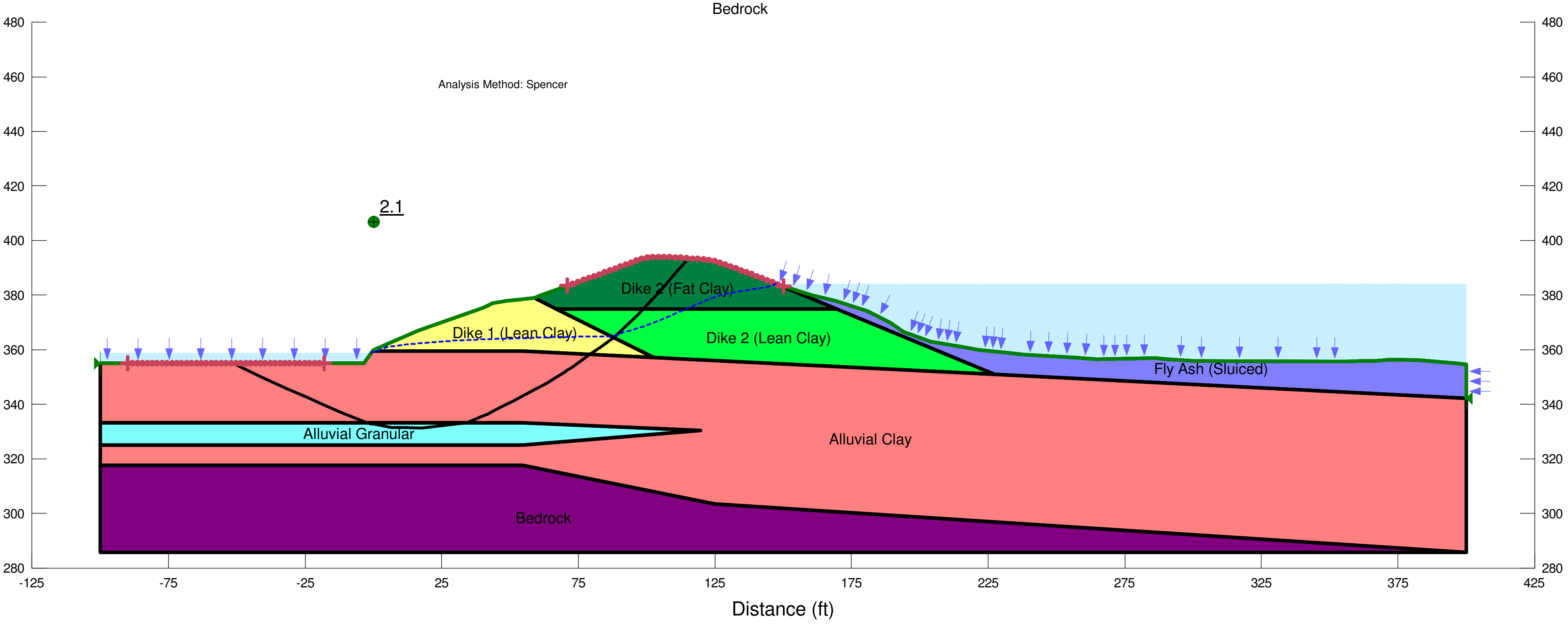
File Name: Section Q.gsz

Analysis Name: Stability - Existing Condition (Deep)
Last Solved on 1/13/2010 at 9:55:30 AM
Date Saved: 1/13/2010

Material Type	Unit Weight	Friction Angle	Cohesion
Dike 1 (Lean Clay)	123 pcf	22 °	200 psf
Dike 2 (Lean Clay)	123 pcf	32 °	200 psf
Dike 2 (Fat Clay)	119 pcf	29 °	200 psf
Fly Ash (Sluiced)	100 pcf	22 °	0 psf
Alluvial Clay	124 pcf	33 °	200 psf
Alluvial Granular	130 pcf	32 °	0 psf
Bedrock			

Calculated Factor of Safety: 2.1

Analysis Method: Spencer



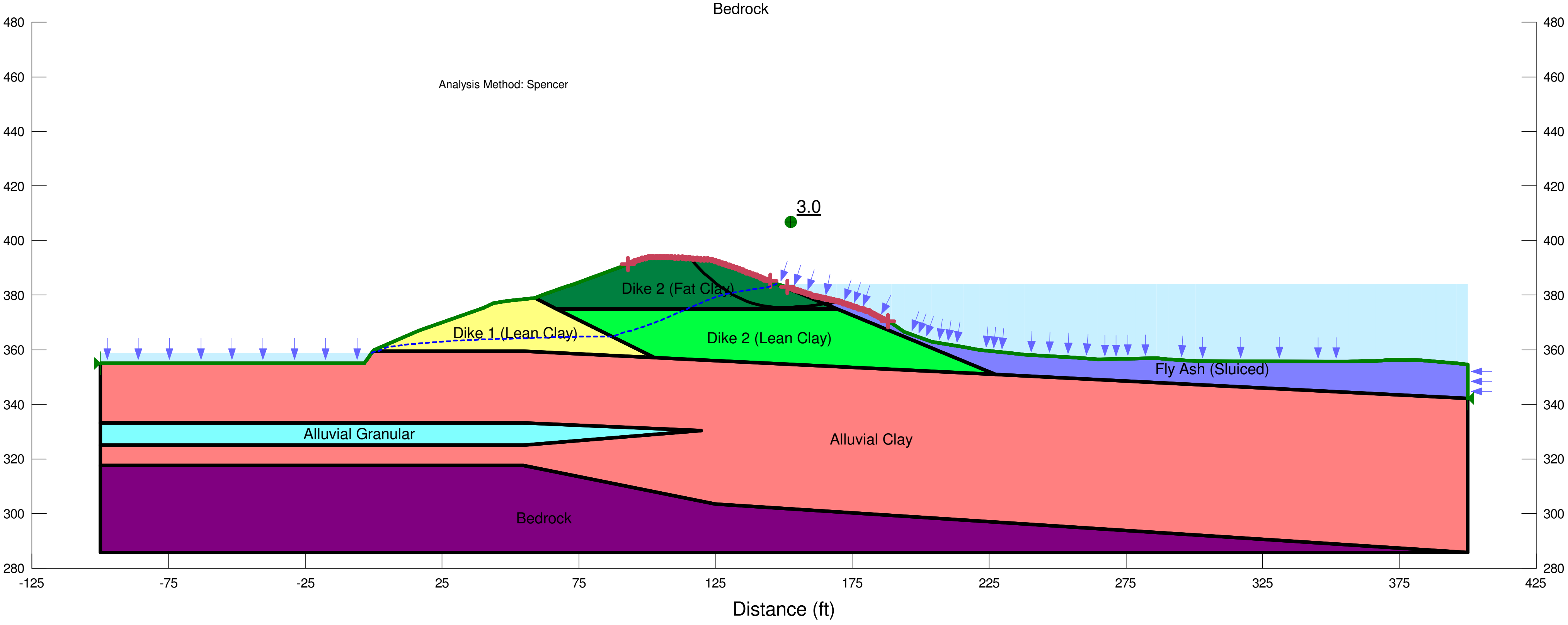
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section Q.gsz

Analysis Name: Stability - Existing Condition (L2R)
Last Solved on 1/13/2010 at 9:58:20 AM
Date Saved: 1/13/2010

Calculated Factor of Safety: 3.0

Material Type	Unit Weight	Friction Angle	Cohesion
Dike 1 (Lean Clay)	123 pcf	22 °	200 psf
Dike 2 (Lean Clay)	123 pcf	32 °	200 psf
Dike 2 (Fat Clay)	119 pcf	29 °	200 psf
Fly Ash (Sluiced)	100 pcf	22 °	0 psf
Alluvial Clay	124 pcf	33 °	200 psf
Alluvial Granular	130 pcf	32 °	0 psf
Bedrock			



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

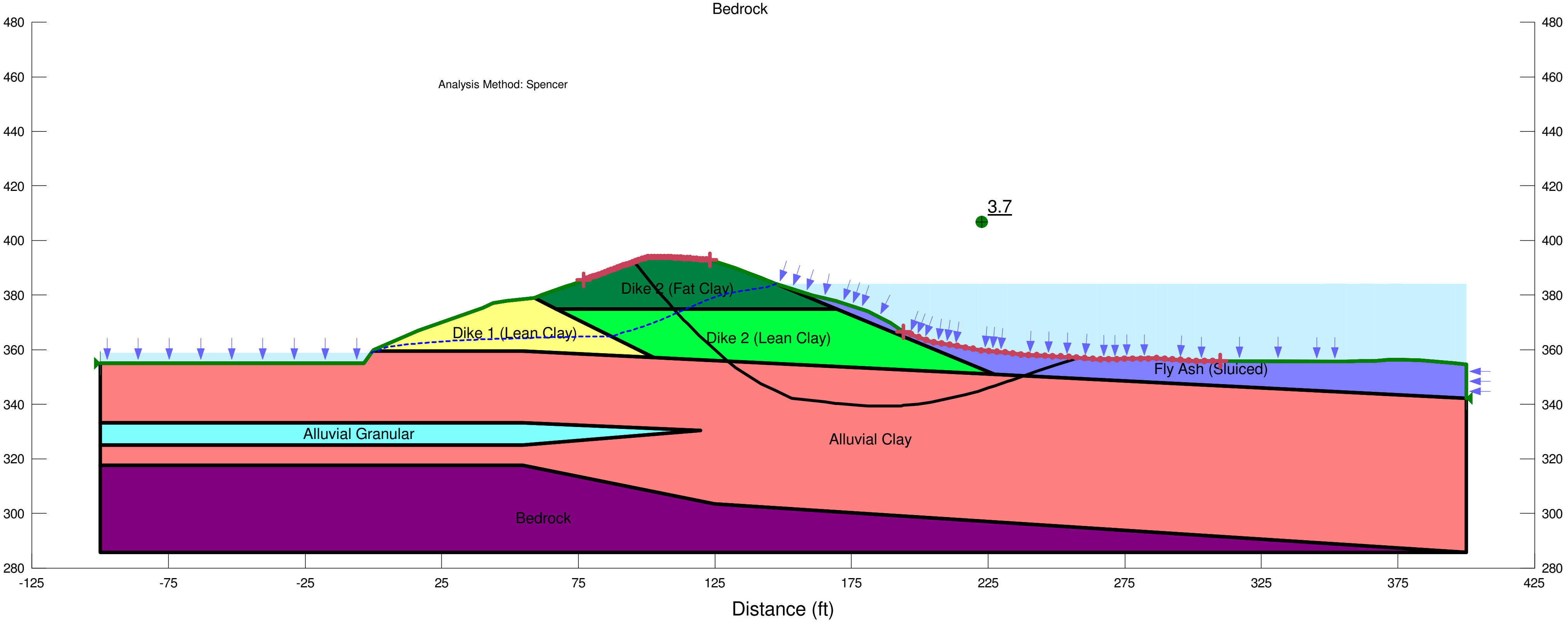
Stantec

File Name: Section Q.gsz

Analysis Name: Stability - Existing Condition (L2R)(Deep)
Last Solved on 1/13/2010 at 10:03:04 AM
Date Saved: 1/13/2010

Material Type	Unit Weight	Friction Angle	Cohesion
Dike 1 (Lean Clay)	123 pcf	22 °	200 psf
Dike 2 (Lean Clay)	123 pcf	32 °	200 psf
Dike 2 (Fat Clay)	119 pcf	29 °	200 psf
Fly Ash (Sluiced)	100 pcf	22 °	0 psf
Alluvial Clay	124 pcf	33 °	200 psf
Alluvial Granular	130 pcf	32 °	0 psf
Bedrock			

Calculated Factor of Safety: 3.7



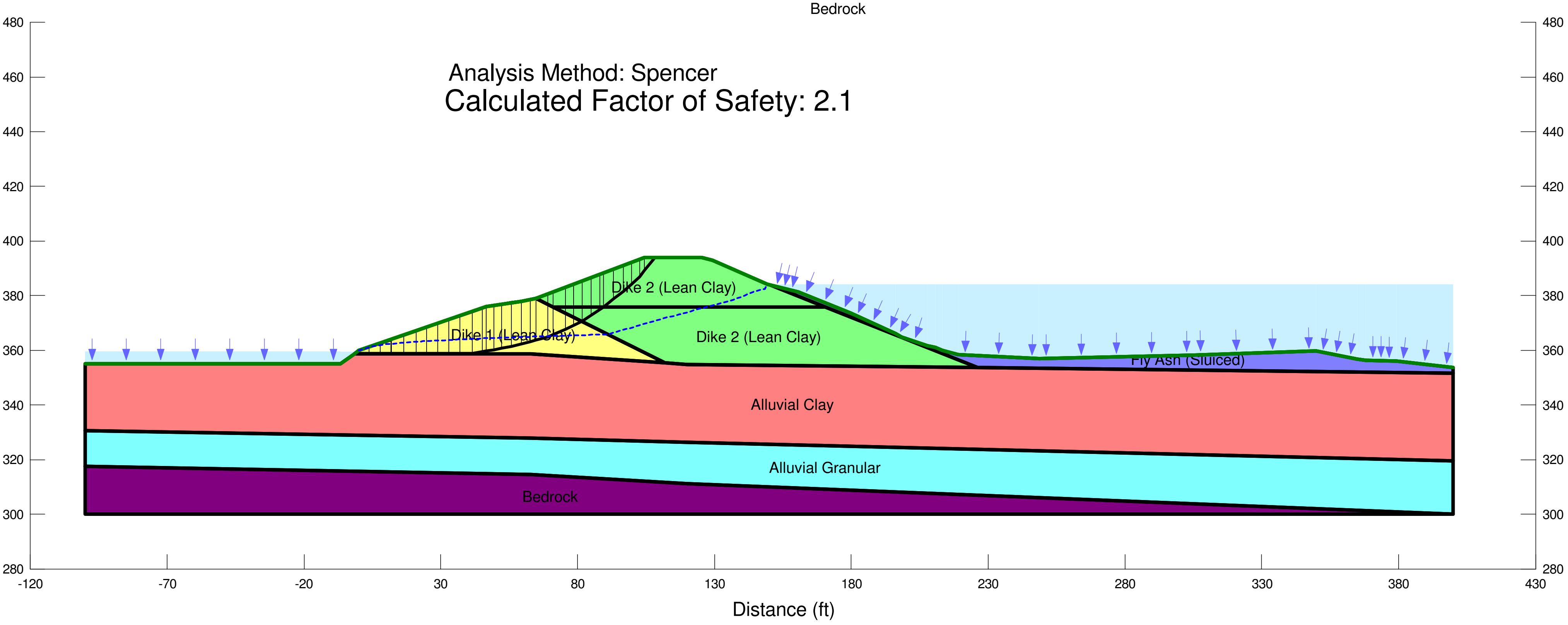
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section R.gsz

Analysis Name: Stability - Existing Condition
Last Solved on 1/31/2010 at 1:11:55 PM
Date Saved: 1/31/2010

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



Analysis Method: Spencer

Calculated Factor of Safety: 2.1

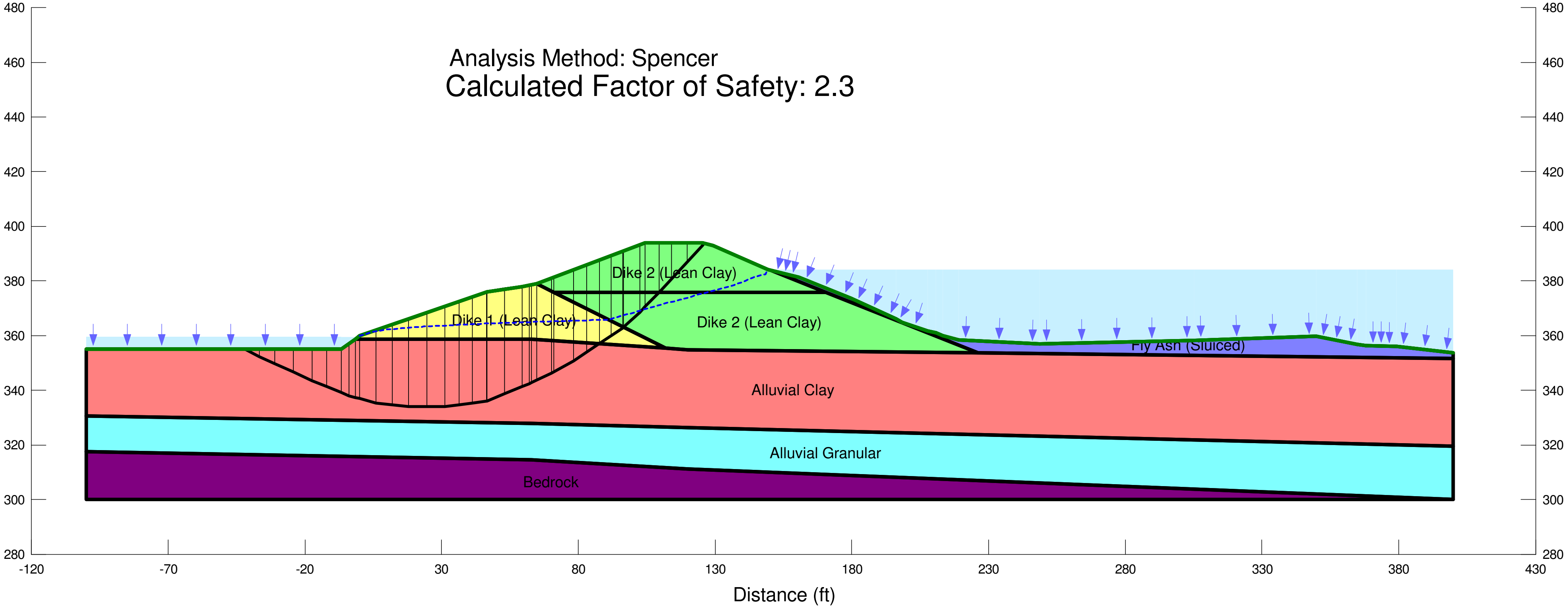
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section R.gsz

Analysis Name: Stability - Existing Condition (Deep)
Last Solved on 1/31/2010 at 1:13:26 PM
Date Saved: 1/31/2010

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



Analysis Method: Spencer

Calculated Factor of Safety: 2.3

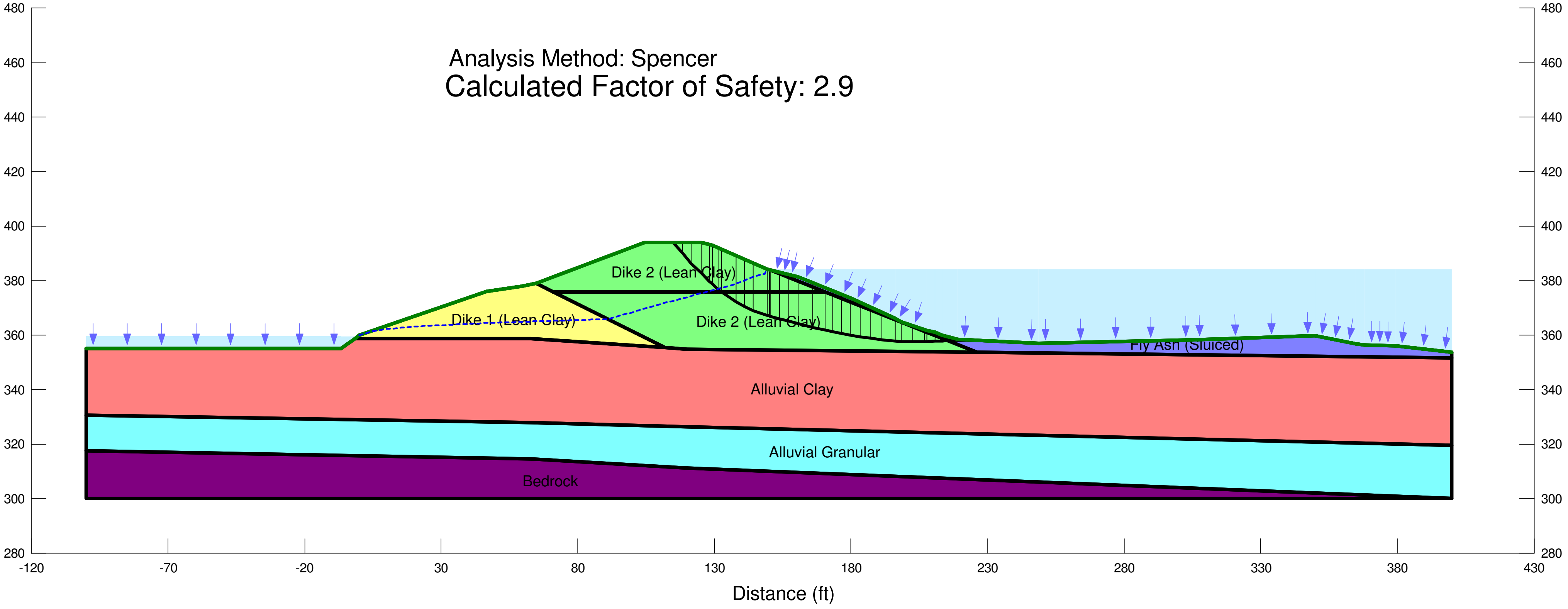
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section R.gsz

Analysis Name: Stability - Existing Condition (L2R)
Last Solved on 1/31/2010 at 1:34:50 PM
Date Saved: 1/31/2010

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			


Analysis Method: Spencer

Calculated Factor of Safety: 2.9

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

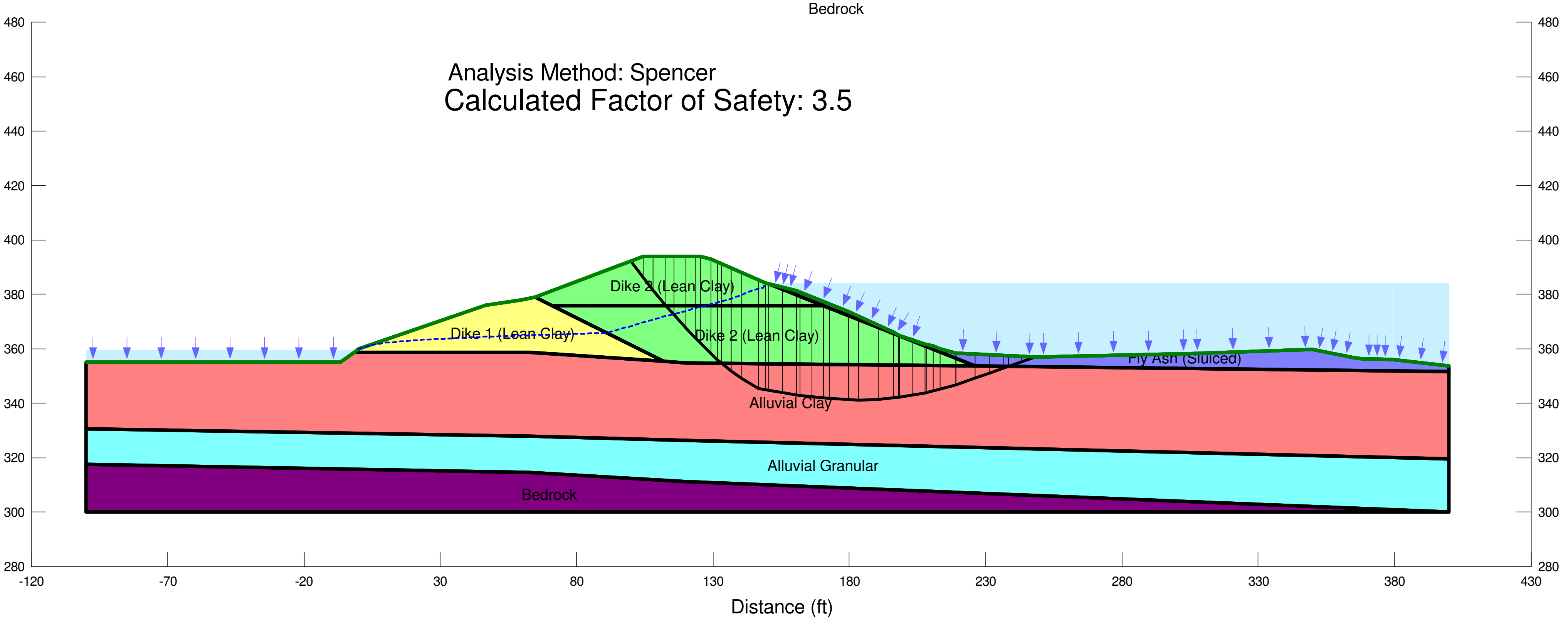
File Name: Section R.gsz

Analysis Name: Stability - Existing Condition (Deep) (L2R)
Last Solved on 1/31/2010 at 1:26:56 PM
Date Saved: 1/31/2010

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			

Analysis Method: Spencer

Calculated Factor of Safety: 3.5



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section S.gsz

Analysis Name: Stability - Existing Condition with Existing PZ Levels

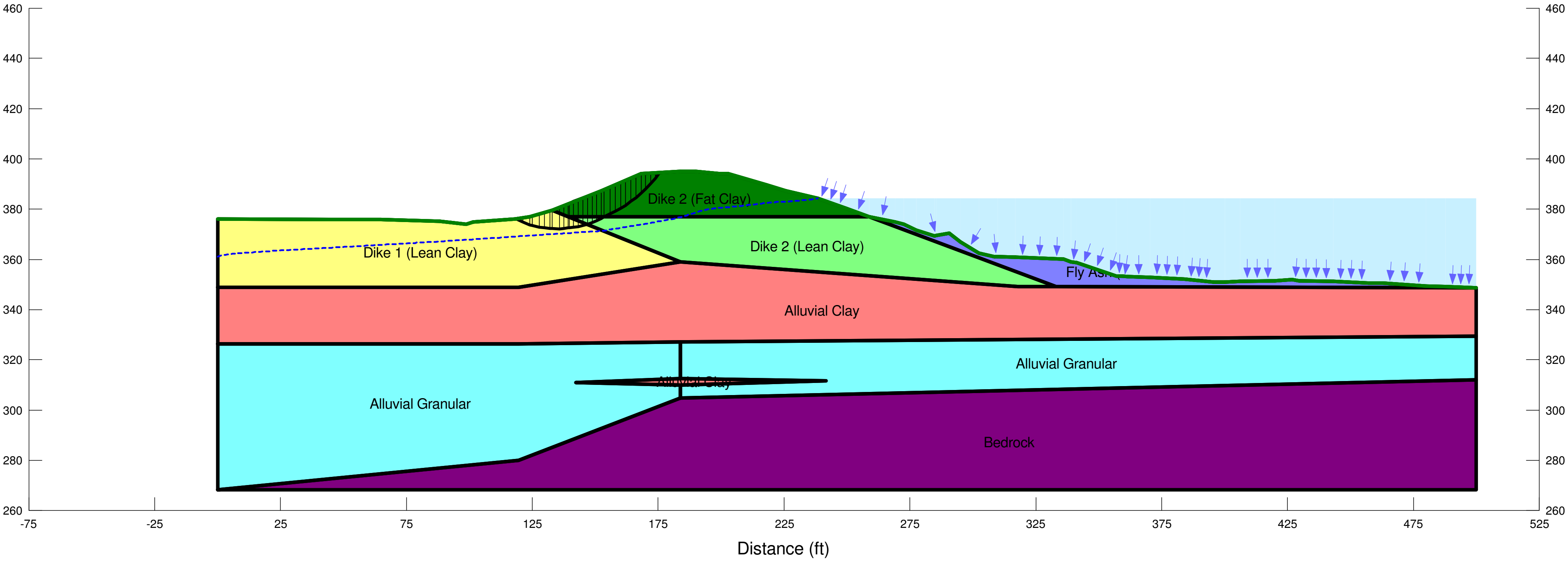
Date Saved: 1/21/2010

Last Solved on 1/21/2010 at 7:58:42 PM

Analysis Method: Spencer

Calculated Factor of Safety: 2.5

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section S.gsz

Analysis Name: Stability - Existing Condition with Existing PZ Levels (Deep)

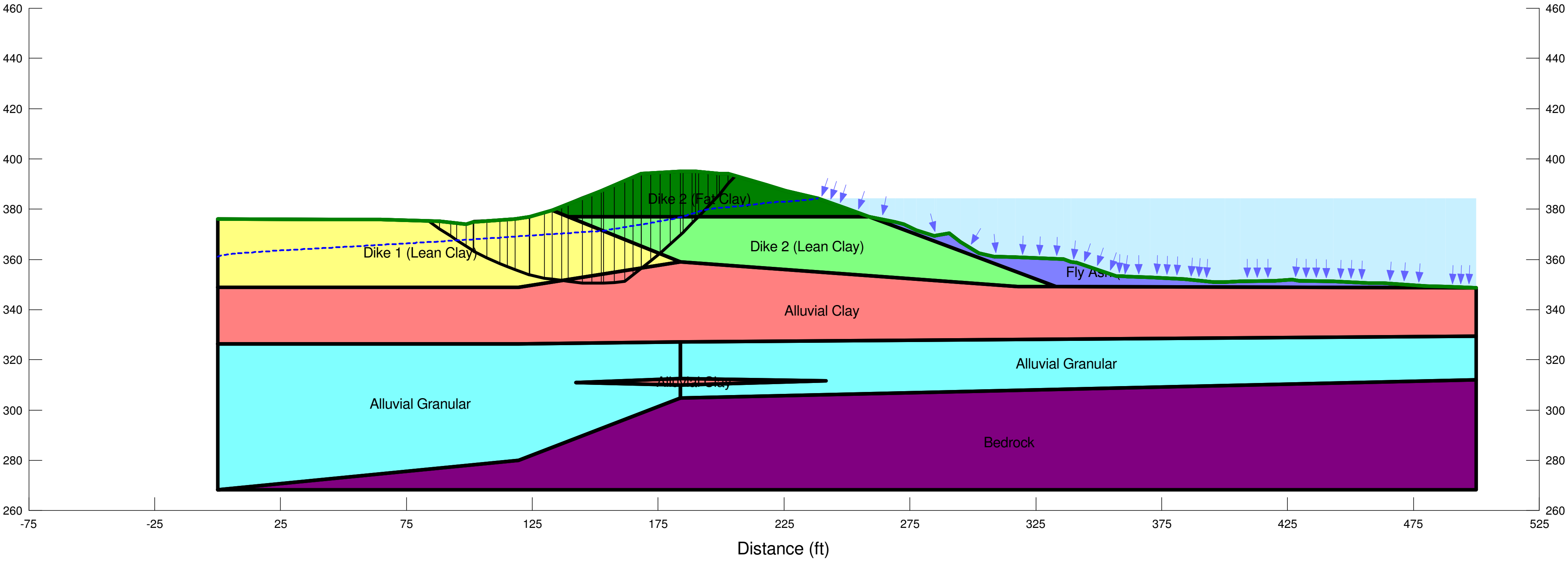
Date Saved: 1/21/2010

Last Solved on 1/21/2010 at 8:00:54 PM

Analysis Method: Spencer

Calculated Factor of Safety: 3.4

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



Stantec

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section S.gsz

Analysis Name: Stability - Existing Condition with Existing PZ Levels (L2R)

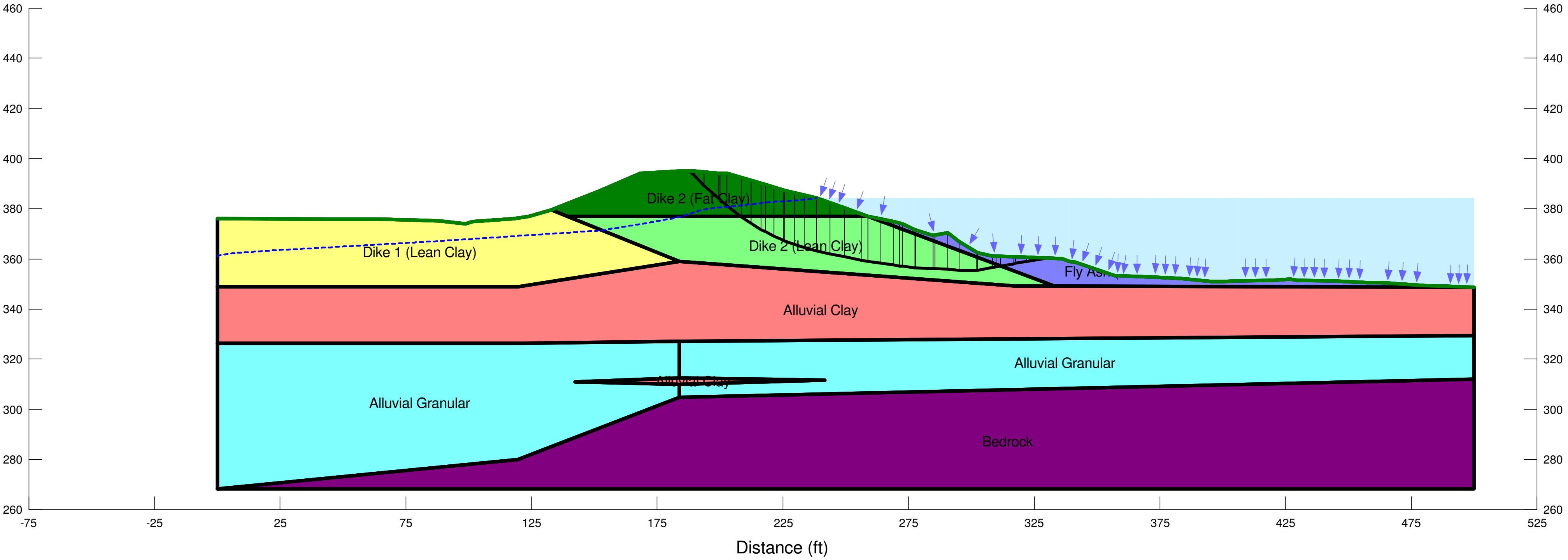
Date Saved: 1/21/2010

Last Solved on 1/21/2010 at 8:05:36 PM

Analysis Method: Spencer

Calculated Factor of Safety: 3.2

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section S.gsz

Analysis Name: Stability - Existing Condition with Existing PZ Levels (Deep) (L2R)

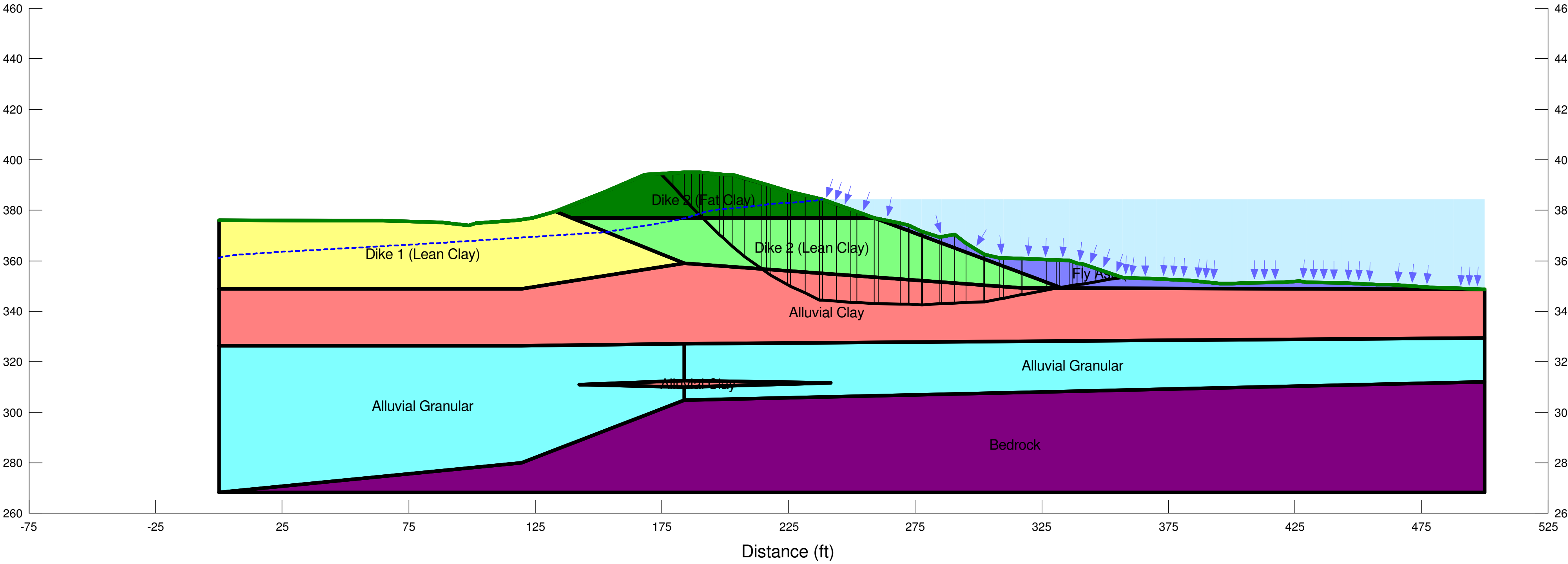
Date Saved: 1/21/2010

Last Solved on 1/21/2010 at 8:03:10 PM

Analysis Method: Spencer

Calculated Factor of Safety: 3.6

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



Stability - Existing Condition

Report generated using GeoStudio 2007, version 7.14.

File Information

Created By: Cooper, Paul
Revision Number: 236
Last Edited By: Rogers, Daniel
Date: 1/31/2010
Time: 12:06:28 PM
File Name: Section P.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/31/2010
Last Solved Time: 12:08:20 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition

Kind: SLOPE/W
Parent: Steady-State Seepage
Method: Spencer
Settings
- PWP Conditions Source: Parent Analysis

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 200 psf
Phi: 22 °
Phi-B: 0 °

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 200 psf
Phi: 32 °
Phi-B: 0 °

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °

Alluvial - Clay

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 200 psf
Phi: 33 °
Phi-B: 0 °

Alluvial - Granular

Model: Mohr-Coulomb
Unit Weight: 130 pcf

Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °

Bedrock

Model: Bedrock (Impenetrable)

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-49.53475, 355.05335) ft
Left-Zone Right Coordinate: (-1, 359.64475) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (3.10803, 363) ft
Right-Zone Right Coordinate: (146.88, 384.232) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-100, 355.05335) ft
Right Coordinate: (400, 374.60838) ft

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.7	(3.558, 405.251)	41.09	(55.7899, 379.434)	(-20.7596, 355.053)
2	29685	1.7	(3.558, 405.251)	56.019	(53.1429, 379.183)	(-21.3083, 355.053)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-20.240625	354.8405	269.69501	433.32317	106.26137	200
2	Optimized	-17.826235	353.8503	398.42174	634.82905	153.5247	200
3	Optimized	-14.45986	352.61685	563.85803	815.98386	163.73243	200
4	Optimized	-11.51786	351.7045	693.75185	994.18611	195.10429	200
5	Optimized	-9.084805	351.00865	776.88224	1095.8049	207.11079	200
6	Optimized	-7.160695	350.5293	841.0803	1195.0522	229.87201	200

7	Optimized	-4.64898	350.0077	918.899	1264.0853	224.1666	200
8	Optimized	-1.54966	349.4439	1005.4019	1436.2975	279.82688	200
9	Optimized	0.09424	349.14485	1048.8425	1538.8904	318.24084	200
10	Optimized	0.68646	349.11055	1058.1512	1508.4048	292.39811	200
11	Optimized	1.74991	349.07395	1072.1018	1658.7001	380.94144	200
12	Optimized	2.71267	349.10785	1078.7166	1652.6076	372.6892	200
13	Optimized	4.526955	349.35135	1076.6267	1704.4521	407.71454	200
14	Optimized	7.360945	349.73165	1074.9131	1718.9656	418.25262	200
15	Optimized	9.649815	350.0388	1074.2983	1742.9425	434.22266	200
16	Optimized	11.2828	350.25795	1074.1178	1777.5	456.7817	200
17	Optimized	12.249705	350.3877	1073.542	1802.0393	473.09169	200
18	Optimized	13.881375	350.7895	1056.5046	1730.3151	437.57761	200
19	Optimized	16.73312	351.53785	1024.6898	1772.5766	485.68339	200
20	Optimized	19.521465	352.4354	980.20206	1703.4749	469.69888	200
21	Optimized	22.24642	353.4822	922.30735	1702.7213	506.80672	200
22	Optimized	24.94179	354.6888	850.38113	1594.8402	483.45735	200
23	Optimized	27.607575	356.05525	768.4943	1555.0151	510.77255	200
24	Optimized	30.50496	357.7039	675.83813	1431.0122	490.4158	200
25	Optimized	33.66038	359.8038	542.98638	1280.1633	478.7283	200
26	Optimized	36.73189	361.82815	423.90371	1286.7916	348.62935	200
27	Optimized	39.641105	363.5766	338.49394	1220.576	356.38429	200
28	Optimized	42.04357	365.25855	250.49029	1030.9278	315.31723	200
29	Optimized	43.991235	366.90525	161.50445	940.90691	314.89903	200
30	Optimized	46.092215	368.6816	66.655352	819.80291	304.29137	200
31	Optimized	48.21616	370.65045	-43.486402	610.41868	246.62515	200
32	Optimized	50.20976	372.6821	-160.14224	463.18042	187.13704	200
33	Optimized	51.45633	373.95245	-233.23488	369.68465	149.36229	200
34	Optimized	52.687075	375.46265	-322.42193	209.32165	84.571436	200
35	Optimized	54.649025	377.97395	-472.63446	25.225476	10.191754	200
36	Optimized	55.709965	379.33195	-554.77669	-74.205039	-29.980782	200

Slices of Slip Surface: 29685

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	29685	-20.514935	354.67575	287.64655	484.01856	127.52547	200
2	29685	-18.48901	353.77025	400.29667	639.0204	155.02901	200
3	29685	-16.02381	352.78235	531.75317	796.45163	171.89719	200
4	29685	-13.55861	351.92665	646.17198	930.5958	184.70699	200
5	29685	-11.093408	351.1969	745.60775	1043.7882	193.64065	200
6	29685	-8.6282045	350.588	820.51818	1140.3081	207.67397	200
7	29685	-6.163003	350.09595	893.89581	1216.3631	209.41268	200
8	29685	-3.6978015	349.71765	957.62293	1293.3621	218.03158	200
9	29685	-1.2326005	349.45075	1007.812	1371.3938	236.11281	200
10	29685	0.59222	349.3135	1038.8634	1480.5616	286.84216	200
11	29685	2.1472	349.25785	1060.7794	1680.623	402.53115	200
12	29685	4.526955	349.2581	1084.4217	1810.9563	471.81712	200
13	29685	7.360945	349.37905	1104.5412	1814.9328	461.3337	200
14	29685	9.649815	349.57085	1113.5852	1819.1105	458.17348	200
15	29685	11.2828	349.7722	1115.0989	1831.4742	465.21953	200
16	29685	13.33723	350.10755	1111.0764	1851.6164	480.91228	200
17	29685	15.923875	350.6297	1095.4338	1870.7439	503.49229	200
18	29685	18.51052	351.2808	1069.865	1872.0402	520.93866	200
19	29685	21.097165	352.0656	1032.9116	1855.4445	534.15912	200
20	29685	23.68381	352.99015	984.08444	1820.8286	543.38801	200
21	29685	26.270455	354.06205	922.4615	1767.7096	548.91054	200
22	29685	28.8571	355.2908	846.14904	1695.4367	551.53385	200
23	29685	31.44374	356.68835	765.03176	1604.2567	544.99908	200
24	29685	34.030385	358.26985	668.19457	1492.3693	535.22534	200
25	29685	36.61703	360.0547	549.46735	1357.5828	524.79633	200
26	29685	39.08614	361.96575	432.87041	1260.6459	334.44301	200
27	29685	41.437715	364.01075	323.77166	1104.4817	315.42731	200
28	29685	43.789285	366.3053	195.73817	924.71188	294.52449	200
29	29685	46.00532	368.7289	63.425902	712.85171	262.38506	200
30	29685	48.085815	371.3023	-83.262275	483.73193	195.44039	200
31	29685	50.16631	374.2296	-253.05567	250.45374	101.18988	200

32	29685	52.17471	377.48785	-446.44629	8.4105646	3.3980887	200

Stability - Existing Condition

File Information

Revision Number: 238
Last Edited By: Rogers, Daniel
Date: 1/13/2010
Time: 9:50:32 AM
File Name: Section Q.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/13/2010
Last Solved Time: 9:52:26 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition

Kind: SLOPE/W
Parent: Steady-State Seepage
Method: Spencer
Settings
    PWP Conditions Source: Parent Analysis
SlipSurface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: Yes
FOS Distribution
    FOS Calculation Option: Constant
Advanced
    Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 200 psf
Phi: 22 °
Phi-B: 0 °

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 200 psf
Phi: 32 °
Phi-B: 0 °

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 119 pcf
Cohesion: 200 psf
Phi: 29 °
Phi-B: 0 °

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °

Alluvial Clay

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 200 psf

Phi: 33 °
Phi-B: 0 °

Alluvial Granular

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °

Bedrock

Model: Bedrock (Impenetrable)

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-28, 355) ft
Left-Zone Right Coordinate: (14, 365.91256) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (41, 375.78242) ft
Right-Zone Right Coordinate: (65, 381.27707) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-100, 355) ft
Right Coordinate: (400, 342.32681) ft

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.9	(0.254, 423.244)	32.14978	(51.559, 378.286)	(-4.04426, 355)
2	27260	2.0	(0.254, 423.244)	68.377	(51.7928, 378.309)	(-4.00392, 355)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-3.8293455	354.9405	254.89001	377.94036	79.90983	200
2	Optimized	-2.24089	354.50075	304.53674	684.60687	246.82043	200

3	Optimized	-0.762595	354.1108	350.23958	717.60784	238.57174	200
4	Optimized	-0.473055	354.084	354.89417	764.05169	265.71	200
5	Optimized	-0.144135	354.05355	360.16686	833.9761	307.69531	200
6	Optimized	0.44611	353.99885	369.77082	897.89368	342.967	200
7	Optimized	1.8355925	353.9747	385.91819	910.57085	340.71342	200
8	Optimized	3.7223375	354.0091	397.77262	1015.0191	400.84458	200
9	Optimized	5.6381225	354.1634	400.81219	1018.5524	401.16516	200
10	Optimized	7.5829475	354.4376	393.0324	1089.0695	452.01177	200
11	Optimized	9.619125	354.84615	379.36052	1068.7732	447.70984	200
12	Optimized	11.746655	355.389	357.94589	1111.9942	489.68467	200
13	Optimized	13.70934	355.9783	332.31494	1076.2872	483.14122	200
14	Optimized	15.507175	356.61405	302.35573	1090.4985	511.82592	200
15	Optimized	16.512385	356.9695	285.34328	1097.5663	527.46378	200
16	Optimized	17.55619	357.42255	262.13704	1032.5163	500.29012	200
17	Optimized	19.431215	358.2535	219.57061	1013.4028	515.52066	200
18	Optimized	21.30624	359.0845	176.70188	994.28937	530.94753	200
19	Optimized	22.29735	359.52375	154.62524	995.07324	339.56304	200
20	Optimized	22.87655	359.7279	149.12118	1049.238	363.67079	200
21	Optimized	24.25684	360.1658	137.41845	1079.6084	380.66944	200
22	Optimized	25.966215	360.6808	121.61138	1090.251	391.3558	200
23	Optimized	27.67559	361.1958	104.06228	1100.8936	402.74599	200
24	Optimized	29.678445	361.9402	74.282999	1026.1221	384.56797	200
25	Optimized	31.97477	362.91395	30.125749	1008.7622	395.39478	200
26	Optimized	33.89761	363.8106	-15.167766	931.31203	376.27448	200
27	Optimized	35.446975	364.6302	-59.430761	904.15542	365.3025	200
28	Optimized	36.99634	365.4498	-104.19353	877.05586	354.35357	200
29	Optimized	38.96642	366.62325	-169.98357	782.13452	316.00286	200
30	Optimized	40.91414	367.8675	-242.99305	735.44814	297.14034	200
31	Optimized	42.701555	369.18175	-320.28712	627.88856	253.68345	200
32	Optimized	44.505705	370.63475	-408.04567	552.42576	223.1945	200
33	Optimized	46.122955	372.06955	-495.5382	415.08602	167.70564	200
34	Optimized	47.819345	373.70045	-595.86971	305.56277	123.45537	200
35	Optimized	48.697355	374.54455	-648.03644	248.61707	100.44782	200
36	Optimized	49.43513	375.50135	-707.22703	131.1696	52.99596	200

37	Optimized	50.851055	377.3576	-822.06415	1.8168337	0.73404847	200

Slices of Slip Surface: 27260

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	27260	-3.809174	354.9884	250.63215	303.0929	34.068411	200
2	27260	-2.8752825	354.94295	262.31108	472.6235	136.57849	200
3	27260	-1.3969875	354.89125	283.0477	546.43659	171.04675	200
4	27260	-0.473055	354.8714	294.89362	615.38312	208.12831	200
5	27260	-0.144135	354.86855	298.75997	675.01541	244.34314	200
6	27260	0.9114495	354.8765	309.66279	745.37173	282.9527	200
7	27260	2.7343485	354.91835	323.82563	829.28613	328.24989	200
8	27260	4.5572475	355.0089	330.50847	904.50743	372.75928	200
9	27260	6.3801465	355.1484	333.32969	970.90031	414.0432	200
10	27260	8.203045	355.33705	334.60212	1028.581	450.67516	200
11	27260	10.025942	355.57535	332.7332	1077.9637	483.95834	200
12	27260	11.84884	355.8638	326.41163	1119.3774	514.95797	200
13	27260	13.67174	356.20305	316.85034	1152.8481	542.90331	200
14	27260	15.49464	356.5939	303.62893	1178.643	568.2408	200
15	27260	17.264955	357.0229	286.94092	1189.1169	585.87993	200
16	27260	18.98269	357.4881	267.63588	1185.1878	595.86521	200
17	27260	20.700425	358.0019	244.87406	1175.1511	604.12895	200
18	27260	22.41816	358.5654	218.70945	1159.056	610.6682	200
19	27260	24.135895	359.17985	189.37912	1136.8639	615.30379	200
20	27260	25.9427	359.88435	160.87783	1115.127	385.54168	200
21	27260	27.838585	360.68665	131.02755	1080.9809	383.80607	200
22	27260	29.73447	361.55765	94.828998	1039.5211	381.68039	200
23	27260	31.63035	362.5003	51.643573	990.55373	379.34433	200
24	27260	33.52623	363.518	0.65353183	933.9197	377.06401	200
25	27260	35.422115	364.6147	-58.57632	872.04082	352.32736	200
26	27260	37.318	365.79485	-123.74379	803.25539	324.53625	200
27	27260	39.21388	367.06375	-196.11727	727.52412	293.93882	200
28	27260	41.05553	368.3858	-273.95139	654.74494	264.53413	200
29	27260	42.842945	369.7622	-355.12323	584.75284	236.25548	200

30	27260	44.558465	371.1731	-440.93388	493.45337	199.3681	200
31	27260	46.202095	372.6182	-529.18491	382.32326	154.46862	200
32	27260	47.845725	374.1609	-624.31614	266.69171	107.75044	200
33	27260	49.448865	375.7673	-723.65518	142.95789	57.758738	200
34	27260	51.011515	377.44275	-827.34057	11.803472	4.7689123	200

Stability - Existing Condition

File Information

Created By: Cooper, Paul
Revision Number: 226
Last Edited By: Rogers, Daniel
Date: 1/31/2010
Time: 1:07:45 PM
File Name: Section R.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/31/2010
Last Solved Time: 1:11:55 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition

Kind: SLOPE/W
Parent: Steady-State Seepage
Method: Spencer
Settings
    PWP Conditions Source: Parent Analysis
SlipSurface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: Yes
FOS Distribution
    FOS Calculation Option: Constant
Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 200 psf
Phi: 22 °
Phi-B: 0 °

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 200 psf
Phi: 32 °
Phi-B: 0 °

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °

Alluvial Clay

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 200 psf
Phi: 33 °
Phi-B: 0 °

Alluvial Granular

Model: Mohr-Coulomb
Unit Weight: 130 pcf

Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °

Bedrock

Model: Bedrock (Impenetrable)

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-47, 355) ft
Left-Zone Right Coordinate: (44.48748, 375.22737) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (49, 376.35564) ft
Right-Zone Right Coordinate: (140.43152, 388.11609) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-100, 355) ft
Right Coordinate: (400, 353.67109) ft

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	2.1	(26.139, 472.46)	56.95689	(108.293, 394.002)	(-1.47143, 358.807)
2	28779	2.1	(26.139, 472.46)	113.486	(108.135, 394.002)	(3.79007, 361.197)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-0.735713	358.80755	52.95951	120.88953	27.44551	200
2	Optimized	1.9545065	358.80895	87.90452	249.09606	65.125611	200
3	Optimized	5.86352	358.811	134.17194	420.95014	115.86591	200
4	Optimized	9.7725335	358.813	173.22527	593.19307	169.678	200
5	Optimized	11.80411	358.81705	189.08398	667.70604	193.37587	200
6	Optimized	14.12673	358.82165	205.87356	784.72875	233.87268	200

7	Optimized	18.617835	358.82475	233.17196	983.45485	303.13397	200
8	Optimized	22.88874	358.82395	256.32619	1174.1927	370.84214	200
9	Optimized	26.939435	358.81925	274.8909	1354.8776	436.34295	200
10	Optimized	30.990125	358.8145	291.45594	1535.6613	502.69158	200
11	Optimized	35.04082	358.80975	306.86069	1716.519	569.53892	200
12	Optimized	39.236625	358.90595	315.62235	1848.1685	619.18884	200
13	Optimized	43.291515	359.2251	308.78106	1918.1742	650.23704	200
14	Optimized	45.95515	359.58855	294.2023	1926.1089	659.33307	200
15	Optimized	48.12244	359.98595	275.92479	1936.8483	671.05664	200
16	Optimized	50.89862	360.49505	251.92101	1928.1679	677.24772	200
17	Optimized	54.10194	361.16105	218.93565	1870.9462	667.45557	200
18	Optimized	57.7324	361.98395	176.68779	1841.2354	672.52089	200
19	Optimized	61.11965	362.75175	136.53784	1820.0909	680.1996	200
20	Optimized	63.727135	363.4161	100.53189	1742.5651	663.42446	200
21	Optimized	66.88536	364.35555	48.207824	1749.145	687.22324	200
22	Optimized	69.987565	365.38455	-10.077016	1678.9507	678.34013	200
23	Optimized	73.25344	366.7102	-88.064863	1668.9813	674.31222	200
24	Optimized	77.04269	368.3808	-187.71803	1579.6389	638.21555	200
25	Optimized	80.11132	369.8969	-279.83984	1542.2568	623.1122	200
26	Optimized	83.29573	371.75135	-347.01769	1321.1231	825.52936	200
27	Optimized	86.532935	373.91305	-395.49432	1232.0823	769.89049	200
28	Optimized	88.75147	375.44695	-432.18358	1117.2047	698.107	200
29	Optimized	91.207585	377.3018	-480.8826	1032.4649	645.15567	200
30	Optimized	94.91996	380.1054	-560.2451	904.4144	565.14084	200
31	Optimized	98.235455	382.8676	-653.13154	701.72607	438.48712	200
32	Optimized	101.15408	385.58845	-756.05972	564.01233	352.43402	200
33	Optimized	103.54075	388.10045	-867.40505	362.45019	226.48401	200
34	Optimized	106.3808	391.627	-1042.1951	121.23089	75.753469	200

Slices of Slip Surface: 28779

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	28779	5.579417	360.867	33.444007	179.03948	58.824391	200

2	28779	9.158106	360.2665	93.884508	422.96517	132.95722	200
3	28779	12.736795	359.78285	144.52061	644.68779	202.08066	200
4	28779	16.315485	359.41455	186.59442	845.28152	266.12686	200
5	28779	19.894175	359.16045	221.10861	1025.635	325.04977	200
6	28779	23.472865	359.01975	247.86866	1186.671	379.30076	200
7	28779	27.051555	358.9921	265.18621	1329.2143	429.89524	200
8	28779	30.630245	359.0774	274.41319	1453.8055	476.50542	200
9	28779	34.208935	359.27585	275.8367	1560.9117	519.20401	200
10	28779	37.787625	359.5881	269.37225	1651.028	558.22514	200
11	28779	41.366315	360.0151	254.45013	1724.5046	593.94056	200
12	28779	44.945005	360.5581	231.66947	1781.598	626.21177	200
13	28779	48.33601	361.1783	202.87623	1785.4076	639.38417	200
14	28779	51.53933	361.86565	168.65436	1739.1492	634.52111	200
15	28779	54.74265	362.65075	127.81345	1681.9451	627.90996	200
16	28779	57.94597	363.5357	80.225321	1613.8559	619.62696	200
17	28779	62.155115	364.8763	6.1520776	1515.6444	609.87449	200
18	28779	66.313705	366.3364	-77.004985	1444.2316	583.50744	200
19	28779	69.41591	367.56355	-148.29008	1416.0028	572.10226	200
20	28779	72.937785	369.09575	-239.25729	1369.0731	553.14143	200
21	28779	76.87934	370.97335	-351.89254	1299.8943	525.19138	200
22	28779	80.578575	372.90385	-427.76617	1188.527	742.6741	200
23	28779	84.03549	374.8745	-464.50566	1095.3238	684.43427	200
24	28779	87.63437	377.10625	-512.43273	983.30471	614.43698	200
25	28779	91.375205	379.6269	-575.85826	851.39712	532.01196	200
26	28779	95.11604	382.37345	-658.01161	703.26291	439.44744	200
27	28779	98.85688	385.3673	-763.39653	538.78727	336.67165	200
28	28779	102.5977	388.63505	-901.06371	357.89351	223.63668	200
29	28779	106.3014	392.17155	-1073.0489	105.02747	65.628449	200

Stability - Existing Condition with Existing PZ Levels

File Information

Created By: Cooper, Paul
Revision Number: 243
Last Edited By: Rogers, Daniel
Date: 1/21/2010
Time: 7:56:44 PM
File Name: Section S.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/21/2010
Last Solved Time: 7:58:42 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Parent: Steady-State Seepage
Method: Spencer
Settings
- PWP Conditions Source: Parent Analysis

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
  FOS Calculation Option: Constant
Advanced
  Number of Slices: 30
  Optimization Tolerance: 0.01
  Minimum Slip Surface Depth: 10 ft
  Optimization Maximum Iterations: 5000
  Optimization Convergence Tolerance: 1e-007
  Starting Optimization Points: 8
  Ending Optimization Points: 16
  Complete Passes per Insertion: 1
  Driving Side Maximum Convex Angle: 5 °
  Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 200 psf
Phi: 22 °
Phi-B: 0 °

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 200 psf
Phi: 32 °
Phi-B: 0 °

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 119 pcf
Cohesion: 200 psf
Phi: 29 °
Phi-B: 0 °

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °

Alluvial Clay

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 200 psf
Phi: 33 °
Phi-B: 0 °

Alluvial Granular

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °

Bedrock

Model: Bedrock (Impenetrable)

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (0, 376.13) ft
Left-Zone Right Coordinate: (146.49388, 385) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (148, 385.60027) ft
Right-Zone Right Coordinate: (232, 385.80881) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (0, 376.13) ft
Right Coordinate: (500, 348.67699) ft

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	2.5	(135.44, 418.878)	30.58291	(175.665, 394.477)	(118.578, 376.066)
2	41091	2.5	(135.44, 418.878)	46.134	(174.549, 394.406)	(118.342, 376.03)

Slices of Slip Surface: **Optimized**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	119.94605	375.42985	-364.58423	216.49053	87.467851	200
2	Optimized	122.72135	374.3095	-288.807	426.11255	172.16064	200
3	Optimized	124.59055	373.6663	-244.44121	578.45289	233.71014	200
4	Optimized	126.39785	373.1807	-208.84322	688.6914	278.24939	200
5	Optimized	128.832	372.71605	-172.24187	804.45136	325.01945	200
6	Optimized	131.00985	372.4399	-147.75303	932.49851	376.75386	200
7	Optimized	132.5233	372.29055	-133.0617	960.57079	388.09579	200
8	Optimized	134.3501	372.242	-123.14423	1051.7285	424.92589	200
9	Optimized	136.65805	372.2658	-115.74564	1104.9048	446.41052	200
10	Optimized	138.4693	372.388	-115.96598	1173.8718	474.27501	200
11	Optimized	139.5214	372.459	-116.05287	1214.1591	490.55213	200
12	Optimized	140.57085	372.60995	-120.85179	1192.1592	481.66359	200
13	Optimized	142.37675	372.892	-130.6287	1241.9465	501.77896	200
14	Optimized	144.2005	373.257	-145.13743	1230.4683	497.14145	200
15	Optimized	146.0857	373.71555	-164.6703	1261.6024	509.72045	200
16	Optimized	147.90625	374.3325	-186.01511	1144.0521	714.88312	200
17	Optimized	149.6186	375.09735	-209.52428	1133.0147	707.98618	200
18	Optimized	151.3951	375.9302	-235.63876	1093.502	683.29591	200
19	Optimized	152.9483	376.6903	-259.62884	1078.1264	673.68813	200
20	Optimized	154.69535	377.54525	-262.97364	1070.5336	593.40644	200
21	Optimized	156.92365	378.63575	-250.98566	1054.8936	584.73705	200
22	Optimized	159.0252	379.76895	-242.28741	978.90433	542.61553	200
23	Optimized	160.99995	380.94485	-246.82103	945.40256	524.04519	200
24	Optimized	163.0305	382.28935	-259.89017	845.46466	468.64871	200
25	Optimized	165.1169	383.80245	-292.01705	786.99218	436.23689	200
26	Optimized	167.2013	385.50535	-345.67495	653.83749	362.42804	200
27	Optimized	169.0938	387.2255	-408.72968	548.4846	304.02998	200
28	Optimized	170.9583	389.0538	-492.96588	376.57971	208.74154	200
29	Optimized	172.9847	391.1628	-602.51386	214.46649	118.88071	200
30	Optimized	174.8314	393.34735	-732.21556	25.023804	13.870921	200

Slices of Slip Surface: 41091

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	41091	119.3065	375.6697	-381.3526	144.48133	58.374245	200
2	41091	121.2353	374.9974	-334.09574	282.09197	113.97255	200
3	41091	123.1641	374.4189	-293.31525	399.40289	161.36924	200
4	41091	125.0104	373.9479	-259.28749	514.09069	207.70612	200
5	41091	126.77425	373.5745	-230.47025	628.1705	253.79736	200
6	41091	128.53815	373.2723	-205.93557	728.21303	294.21716	200
7	41091	130.30205	373.03995	-185.75516	815.30573	329.4049	200
8	41091	132.0659	372.8764	-169.40432	890.24765	359.6834	200
9	41091	134.019	372.7787	-156.21654	968.94098	391.47757	200
10	41091	136.16135	372.76245	-147.08195	1048.6718	423.69092	200
11	41091	138.3037	372.8458	-143.70876	1112.6516	449.54043	200
12	41091	140.27065	373.00675	-145.50759	1159.9196	468.63793	200
13	41091	142.06215	373.23105	-152.12137	1193.3612	482.14922	200
14	41091	143.85365	373.52715	-162.68221	1216.7413	491.5954	200
15	41091	145.64515	373.89655	-177.2365	1230.242	497.05002	200
16	41091	147.50335	374.36055	-190.759	1234.1519	771.18369	200
17	41091	149.4282	374.9276	-202.71658	1222.3986	763.83944	200
18	41091	151.353	375.5877	-219.11528	1199.7092	749.6615	200
19	41091	153.5545	376.47075	-243.63146	1162.1236	726.17543	200
20	41091	155.75425	377.4713	-253.34905	1121.489	621.65153	200
21	41091	157.67555	378.4712	-243.56366	1071.0745	593.7063	200
22	41091	159.5968	379.59045	-235.59718	1009.3222	559.47642	200
23	41091	161.51805	380.83965	-241.61628	935.95078	518.80599	200
24	41091	163.4393	382.23215	-257.09607	850.54869	471.46684	200
25	41091	165.36055	383.78515	-290.25626	752.62331	417.18591	200
26	41091	167.28185	385.52115	-346.05782	641.47671	355.57635	200
27	41091	169.2935	387.57475	-422.87702	479.52762	265.8065	200
28	41091	171.39555	390.0209	-542.80617	269.30678	149.27919	200
29	41091	173.4976	392.86825	-703.55749	47.694809	26.437664	200

Stability - Existing Condition

File Information

Created By: Cooper, Paul
Revision Number: 243
Last Edited By: Rogers, Daniel
Date: 1/22/2010
Time: 2:02:48 PM
File Name: Section T.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/22/2010
Last Solved Time: 2:05:36 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition

Kind: SLOPE/W
Parent: Steady-State Seepage
Method: Spencer
Settings
- PWP Conditions Source: Parent Analysis

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 200 psf
Phi: 22 °
Phi-B: 0 °

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 200 psf
Phi: 32 °
Phi-B: 0 °

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 119 pcf
Cohesion: 200 psf
Phi: 29 °
Phi-B: 0 °

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °

Alluvial Clay

Model: Mohr-Coulomb
Unit Weight: 124 pcf

Cohesion: 200 psf
Phi: 33 °
Phi-B: 0 °

Alluvial Granular

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °

Bedrock

Model: Bedrock (Impenetrable)

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (34, 380.99656) ft
Left-Zone Right Coordinate: (163.95006, 386.70696) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (171, 389.62159) ft
Right-Zone Right Coordinate: (225.92962, 385.8937) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-300, 380.99) ft
Right Coordinate: (800, 354.28616) ft

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	2.9	(155.6, 417.08)	26.82845	(191.39, 394.998)	(139.256, 379.85)
2	41122	2.9	(155.6, 417.08)	40.982	(190.124, 394.998)	(138.457, 379.856)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	139.718	379.5728	-1242.1455	124.38162	50.253436	200

2	Optimized	140.86815	378.883	-1199.0801	268.10443	108.32122	200
3	Optimized	141.855	378.3533	-1165.9662	341.72641	138.06643	200
4	Optimized	143.4274	377.73745	-1127.4532	491.99287	198.77802	200
5	Optimized	145.68875	376.99185	-1080.7195	632.10597	255.38739	200
6	Optimized	147.6641	376.49835	-1049.7772	768.79214	310.61219	200
7	Optimized	149.9429	376.0457	-1021.31	868.41561	350.86268	200
8	Optimized	152.31075	375.90145	-993.46038	879.92338	487.74949	200
9	Optimized	154.46425	376.02475	-966.84942	934.21159	517.84194	200
10	Optimized	156.2675	376.16295	-946.26235	951.66917	527.51883	200
11	Optimized	157.72055	376.3161	-932.02666	979.18237	542.76965	200
12	Optimized	159.17365	376.4693	-919.91264	1006.6956	558.02046	200
13	Optimized	160.38325	376.5968	-911.52276	1038.2287	575.49954	200
14	Optimized	161.5937	376.77865	-900.52853	1037.3125	574.99173	200
15	Optimized	163.04855	377.0405	-888.82545	1076.4807	596.70297	200
16	Optimized	164.6424	377.3981	-878.28954	1068.955	592.53145	200
17	Optimized	166.37515	377.85145	-868.07232	1098.2667	608.77917	200
18	Optimized	168.2958	378.4509	-859.57387	1073.7519	595.19041	200
19	Optimized	170.40435	379.1965	-853.22454	1087.3001	602.70031	200
20	Optimized	172.4766	380.04685	-850.58833	1033.8768	573.08727	200
21	Optimized	174.5126	381.00195	-850.85512	1022.2267	566.62953	200
22	Optimized	175.64075	381.544	-852.57223	965.2456	535.04437	200
23	Optimized	176.53025	382.06485	-857.7278	950.45962	526.84837	200
24	Optimized	178.089	382.97755	-868.35736	924.6608	512.54785	200
25	Optimized	179.53365	383.9155	-883.62876	841.80342	466.61926	200
26	Optimized	180.86415	384.87865	-906.76359	803.57007	445.42616	200
27	Optimized	181.7283	385.5042	-922.11398	775.20532	429.70333	200
28	Optimized	182.7321	386.3285	-944.41896	684.47364	379.40993	200
29	Optimized	184.3419	387.6891	-987.30827	595.27904	329.96856	200
30	Optimized	185.51265	388.73035	-1026.587	495.37296	274.58972	200
31	Optimized	186.60295	389.8059	-1071.0564	410.10482	227.32481	200
32	Optimized	188.05185	391.2351	-1136.4558	287.17754	159.18511	200
33	Optimized	189.4297	392.71165	-1211.8453	143.17687	79.364235	200
34	Optimized	190.73655	394.23555	-1296.1285	19.155504	10.618069	200

Slices of Slip Surface: 41122

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	41122	139.31845	379.48245	-1236.6732	115.322	46.593112	200
2	41122	141.16685	378.7379	-1190.011	255.85048	103.3703	200
3	41122	143.11145	378.0599	-1147.5204	413.78655	167.18062	200
4	41122	145.02695	377.4976	-1112.2488	545.63337	220.45019	200
5	41122	146.94245	377.0347	-1083.1506	658.14651	265.90845	200
6	41122	148.85795	376.66785	-1060.1102	753.205	304.31457	200
7	41122	150.65605	376.40595	-1034.2451	847.25291	469.63996	200
8	41122	152.3368	376.23665	-1004.0899	906.82425	502.66089	200
9	41122	154.01755	376.13705	-976.87045	955.3485	529.55832	200
10	41122	155.6983	376.1066	-952.25119	993.54218	550.72943	200
11	41122	157.37905	376.14515	-930.61077	1021.7935	566.38939	200
12	41122	159.0598	376.2529	-913.87411	1040.6249	576.82778	200
13	41122	160.7808	376.43635	-901.23986	1065.7622	590.76162	200
14	41122	162.542	376.7	-885.49207	1096.177	607.62081	200
15	41122	164.30315	377.04285	-872.37415	1115.9487	618.58046	200
16	41122	166.0643	377.4669	-861.1078	1125.1604	623.68658	200
17	41122	167.8255	377.9748	-852.07689	1124.0175	623.05306	200
18	41122	169.5867	378.56995	-845.62726	1112.5776	616.71181	200
19	41122	171.3479	379.25645	-842.35532	1090.7112	604.59111	200
20	41122	173.1091	380.03935	-841.5099	1058.3426	586.64886	200
21	41122	174.8703	380.92495	-843.34844	1015.3152	562.79838	200
22	41122	176.714	381.97355	-852.16491	958.62992	531.37724	200
23	41122	178.64015	383.20785	-869.18895	886.78908	491.55522	200
24	41122	180.5663	384.6033	-899.18404	800.77019	443.87416	200
25	41122	182.25425	385.9646	-934.88347	701.97459	389.11087	200
26	41122	183.70395	387.26885	-973.66502	593.76551	329.1296	200
27	41122	185.15365	388.70725	-1028.7067	477.54559	264.70784	200
28	41122	186.93985	390.7243	-1116.876	300.74753	166.70708	200
29	41122	189.0625	393.4919	-1259.148	63.232902	35.05057	200

Stability - Existing Condition

File Information

Created By: Daniel B. Rogers
Revision Number: 292
Last Edited By: Rogers, Daniel
Date: 1/31/2010
Time: 1:45:49 PM
File Name: Section U.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/31/2010
Last Solved Time: 1:56:33 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition

Kind: SLOPE/W
Parent: Steady-State Seepage
Method: Spencer
Settings
- PWP Conditions Source: Parent Analysis

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 200 psf
Phi: 22 °
Phi-B: 0 °

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 119 pcf
Cohesion: 200 psf
Phi: 29 °
Phi-B: 0 °

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °

Alluvial Clay

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 200 psf
Phi: 33 °
Phi-B: 0 °

Alluvial Granular

Model: Mohr-Coulomb
Unit Weight: 130 pcf

Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °

Bedrock

Model: Bedrock (Impenetrable)

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (18, 381.05658) ft
Left-Zone Right Coordinate: (107.87833, 386.9374) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (115, 389.55862) ft
Right-Zone Right Coordinate: (166.15417, 387.49536) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-300, 380.27072) ft
Right Coordinate: (400, 349.46793) ft

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	2.6	(103.95, 411.126)	30.51641	(140.911, 394.924)	(79.991, 381.003)
2	34926	2.7	(103.95, 411.126)	38.968	(139.414, 394.976)	(79.2301, 381.003)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	81.512905	379.97825	-190.06938	251.46639	101.59901	200
2	Optimized	83.361165	378.77085	-107.03648	416.5619	168.30193	200
3	Optimized	83.90132	378.46835	-86.276781	467.39717	188.84072	200
4	Optimized	84.266985	378.26355	-70.881423	533.03979	295.46878	200
5	Optimized	85.274445	377.69935	-28.604468	608.5352	245.86418	200
6	Optimized	87.34785	376.66715	46.403912	753.94674	285.86586	200

7	Optimized	89.783475	375.5611	126.01916	947.14373	331.75586	200
8	Optimized	91.65159	374.78005	182.07767	1037.7593	345.7178	200
9	Optimized	93.80589	374.02455	237.14969	1201.3714	389.57087	200
10	Optimized	96.05537	373.3324	288.36425	1303.3401	410.07687	200
11	Optimized	98.29837	372.8368	327.03221	1460.8373	458.087	200
12	Optimized	99.897945	372.49945	353.63579	1489.8137	459.04569	200
13	Optimized	101.14955	372.4205	362.89416	1553.4561	481.01826	200
14	Optimized	103.4487	372.2755	379.8842	1670.2681	521.34894	200
15	Optimized	105.46685	372.2736	386.9654	1672.3001	519.30893	200
16	Optimized	107.204	372.41475	384.13673	1726.1194	542.19619	200
17	Optimized	108.8657	372.54975	381.42795	1779.9929	565.05693	200
18	Optimized	110.51605	372.814	370.59296	1731.9445	550.02173	200
19	Optimized	112.23055	373.21365	351.50124	1756.7109	567.74157	200
20	Optimized	113.94505	373.6133	332.38111	1781.4773	585.47288	200
21	Optimized	116.04135	374.2952	296.99266	1702.4034	567.82279	200
22	Optimized	118.5195	375.2594	245.34781	1691.9864	584.47994	200
23	Optimized	120.5549	376.1953	193.86518	1575.4922	558.21353	200
24	Optimized	122.1475	377.1029	142.59622	1536.814	563.30056	200
25	Optimized	123.8504	378.0734	87.561932	1504.6143	572.52633	200
26	Optimized	124.82955	378.65295	54.491684	1358.074	526.68144	200
27	Optimized	125.6838	379.3934	12.600363	1281.9311	703.6015	200
28	Optimized	127.2472	380.7486	-63.673641	1223.0617	677.95418	200
29	Optimized	128.10425	381.5	-105.99623	1146.214	635.3568	200
30	Optimized	128.9774	382.35505	-154.4392	1073.5206	595.06219	200
31	Optimized	130.57305	383.9176	-242.8776	935.07115	518.3184	200
32	Optimized	132.17475	385.5115	-333.23943	784.88273	435.0676	200
33	Optimized	133.78245	387.1367	-425.81736	642.14894	355.94897	200
34	Optimized	135.5383	388.95315	-529.58108	474.28462	262.90026	200
35	Optimized	137.44225	390.9608	-647.94442	300.04655	166.31852	200
36	Optimized	139.3106	393.04225	-773.51144	108.92571	60.378506	200
37	Optimized	140.5688	394.52185	-864.04988	-17.730564	-9.8282119	200

Slices of Slip Surface: 34926

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	34926	80.214765	380.24585	-209.42018	223.14078	90.154725	200
2	34926	82.18409	378.82545	-113.33054	434.5327	175.5626	200
3	34926	83.402145	378.01705	-57.13696	547.79764	221.32461	200
4	34926	83.66153	377.85635	-45.966719	569.61545	230.13958	200
5	34926	84.764315	377.231	-0.64634776	669.54274	270.51282	200
6	34926	86.91791	376.0979	80.945489	835.34542	304.79736	200
7	34926	89.071505	375.1292	150.74792	973.68852	332.48958	200
8	34926	91.225095	374.3119	210.07854	1088.2445	354.80207	200
9	34926	93.42663	373.62405	260.97288	1203.9174	380.9743	200
10	34926	95.67611	373.0639	303.88094	1320.449	410.72016	200
11	34926	97.600635	372.6873	334.00709	1415.0167	436.75621	200
12	34926	99.20021	372.45695	353.88456	1493.4236	460.40366	200
13	34926	101.00905	372.2823	371.0427	1568.9371	483.98075	200
14	34926	103.0272	372.18195	384.27568	1638.9699	506.92937	200
15	34926	105.04535	372.1864	390.95802	1694.059	526.48695	200
16	34926	107.0635	372.2957	391.09145	1734.4524	542.75304	200
17	34926	109.1348	372.51925	384.2628	1763.8637	557.39493	200
18	34926	111.25925	372.8648	369.97464	1781.3765	570.24336	200
19	34926	113.3837	373.33285	348.01091	1782.5729	579.60066	200
20	34926	115.50815	373.92805	318.04539	1767.2884	585.5322	200
21	34926	117.63265	374.6566	279.87826	1734.9931	587.90456	200
22	34926	119.7571	375.52675	232.84418	1684.9841	586.7026	200
23	34926	121.88155	376.5493	176.22373	1616.2791	581.82014	200
24	34926	124.2717	377.91265	98.942261	1526.7075	576.8546	200
25	34926	126.8896	379.6657	0.099413503	1375.4347	762.36077	200
26	34926	129.1158	381.39885	-96.746159	1216.8477	674.5097	200
27	34926	130.98815	383.0944	-192.30015	1018.1229	564.35476	200
28	34926	132.8605	385.03475	-302.99333	803.95551	445.63982	200
29	34926	134.7329	387.2807	-431.88583	572.48994	317.33635	200
30	34926	136.6053	389.93175	-586.40436	321.46403	178.19042	200
31	34926	138.4777	393.1749	-783.18278	48.427254	26.843665	200

Stability - Existing Condition

File Information

Created By: Cooper, Paul
Revision Number: 235
Last Edited By: Rogers, Daniel
Date: 1/31/2010
Time: 2:19:05 PM
File Name: Section V.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/31/2010
Last Solved Time: 2:22:00 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition

Kind: SLOPE/W
Parent: Steady-State Seepage
Method: Spencer
Settings
- PWP Conditions Source: Parent Analysis

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 119 pcf
Cohesion: 200 psf
Phi: 22 °
Phi-B: 0 °

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 119 pcf
Cohesion: 200 psf
Phi: 29 °
Phi-B: 0 °

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °

Alluvial Clay

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 200 psf
Phi: 33 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (6, 375.04) ft
Left-Zone Right Coordinate: (49.8739, 383) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (133.49044, 394) ft
Right-Zone Right Coordinate: (208.37922, 383.92517) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (0, 375.04) ft
Right Coordinate: (400, 359.838) ft

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	2.8	(72.734, 468.535)	65.86463	(158.338, 394.376)	(8.91613, 375.04)
2	448	2.9	(72.734, 468.535)	114.869	(160.138, 394.001)	(6, 375.04)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	11.215214	373.4783	108.09917	294.00801	75.112048	200
2	Optimized	15.813385	370.35485	313.59895	722.5081	165.21002	200
3	Optimized	21.72884	366.54065	574.25495	1225.567	263.14715	200
4	Optimized	29.0798	362.1571	882.56475	1784.7116	364.49097	200
5	Optimized	33.94721	359.3796	1080.1724	2225.1314	462.59347	200
6	Optimized	37.928295	357.84675	1191.7159	2526.1401	539.14236	200
7	Optimized	43.555955	356.57845	1291.4787	2911.9535	654.7143	200
8	Optimized	48.10784	356.21155	1331.3847	3119.7939	722.5642	200
9	Optimized	51.27623	356.2383	1341.4525	3217.3442	757.90942	200
10	Optimized	54.7291	356.295	1351.6683	3203.7114	748.27399	200
11	Optimized	58.843035	356.3848	1362.6284	3195.6918	740.60568	200
12	Optimized	64.50916	356.50845	1376.1837	3185.1629	730.87502	200
13	Optimized	71.4208	356.7121	1387.7365	3155.2189	714.10923	200

14	Optimized	76.340855	356.8982	1391.6757	3140.7299	706.66377	200
15	Optimized	80.44731	357.1538	1388.2065	3097.588	690.63496	200
16	Optimized	85.42507	357.54255	1377.7117	3068.1463	682.97994	200
17	Optimized	90.40283	357.9313	1366.7361	3038.7046	675.51913	200
18	Optimized	95.830945	358.3187	1355.9178	3018.7711	671.83635	200
19	Optimized	101.70944	358.70475	1346.0046	2992.6301	665.27991	200
20	Optimized	107.5165	359.08615	1335.1888	3053.918	694.41166	200
21	Optimized	111.0391	359.4248	1321.5243	3026.8681	689.00364	200
22	Optimized	113.7867	360.0554	1286.906	3063.2304	717.68162	200
23	Optimized	117.97235	361.01605	1234.2339	3127.9646	765.11687	200
24	Optimized	122.39855	362.6399	1139.429	2962.4846	736.56228	200
25	Optimized	127.0653	364.92685	1002.4074	2893.9834	764.24634	200
26	Optimized	130.08225	366.62225	900.32872	2650.3355	707.04865	200
27	Optimized	132.1322	368.27745	798.95845	2551.1267	707.92194	200
28	Optimized	136.80815	372.05295	570.65754	2253.6906	679.98949	200
29	Optimized	140.43395	374.9806	397.02679	1995.8351	645.96051	200
30	Optimized	142.8217	377.33505	256.57167	1669.0129	570.66329	200
31	Optimized	147.36925	381.94315	-19.728678	1154.4021	639.89554	200
32	Optimized	151.04265	385.8513	-255.87948	757.33181	419.79588	200
33	Optimized	153.7839	389.0545	-451.64746	472.19891	261.74413	200
34	Optimized	156.74205	392.5112	-666.79601	138.2877	76.654126	200
35	Optimized	158.24715	394.26995	-777.20217	-46.048209	-25.524939	200

Slices of Slip Surface: 448

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	448	8.68144	373.2377	120.74423	319.63848	80.358493	200
2	448	14.04432	369.8409	344.46957	768.65774	171.38314	200
3	448	19.407195	366.8403	549.30446	1148.4977	242.08976	200
4	448	24.77007	364.2015	736.59555	1470.7853	296.63192	200
5	448	30.13295	361.8976	902.47853	1738.0132	337.57791	200
6	448	35.658715	359.85605	1054.7444	2145.3922	440.65034	200
7	448	41.34736	358.0775	1188.5336	2686.2402	605.11273	200

8	448	47.036005	356.6162	1301.494	3174.7517	756.84523	200
9	448	52.635245	355.4734	1396.5866	3448.0442	828.84268	200
10	448	58.14508	354.63085	1475.271	3516.3904	824.66578	200
11	448	63.20388	354.08615	1532.277	3551.4794	815.8107	200
12	448	67.81164	353.79545	1569.4716	3559.195	803.90041	200
13	448	72.4194	353.6903	1593.545	3544.8764	788.38907	200
14	448	77.21706	353.78145	1602.8071	3513.2653	771.87522	200
15	448	82.204625	354.08525	1597.9867	3462.6075	753.35571	200
16	448	87.19219	354.60805	1577.2838	3386.7276	731.06275	200
17	448	92.17975	355.353	1541.6229	3285.9474	704.75284	200
18	448	97.167315	356.3245	1490.4107	3160.1949	674.63662	200
19	448	102.1549	357.52845	1424.0181	3009.0512	640.39495	200
20	448	108.1713	359.3325	1320.7298	2889.4718	633.81294	200
21	448	114.0779	361.39555	1200.9387	2830.1579	658.24728	200
22	448	118.8459	363.3607	1085.3395	2772.702	681.73871	200
23	448	123.61385	365.58415	953.09025	2684.7851	699.65013	200
24	448	128.3818	368.08305	803.30687	2564.9827	711.76324	200
25	448	132.1322	370.2293	674.3954	2450.035	717.40496	200
26	448	136.80815	373.2811	494.50774	2191.2379	685.52349	200
27	448	142.65345	377.4539	248.89528	1756.641	609.16882	200
28	448	148.7146	382.5144	-52.76867	1152.0625	638.59865	200
29	448	153.7839	387.16615	-333.02465	682.40912	378.26555	200
30	448	156.74205	390.22105	-521.02143	359.83555	199.4601	200
31	448	159.14715	392.8697	-687.35639	67.18986	37.243948	200

Stability - Existing Condition

File Information

Created By: Cooper, Paul
Revision Number: 227
Last Edited By: Rogers, Daniel
Date: 1/22/2010
Time: 1:19:03 PM
File Name: Section W.gsz
Directory: V:\1755\active\175539016\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 1/22/2010
Last Solved Time: 3:26:20 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition

Kind: SLOPE/W
Parent: Steady-State Seepage
Method: Spencer
Settings
    PWP Conditions Source: Parent Analysis
SlipSurface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: Yes
FOS Distribution
    FOS Calculation Option: Constant
Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 200 psf
Phi: 22 °
Phi-B: 0 °

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 119 pcf
Cohesion: 200 psf
Phi: 29 °
Phi-B: 0 °

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °

Bedrock

Model: Bedrock (Impenetrable)

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (49.58321, 386.97948) ft
Left-Zone Right Coordinate: (163, 392.50518) ft
Left-Zone Increment: 40

Right Projection: Range
Right-Zone Left Coordinate: (167.10528, 394) ft
Right-Zone Right Coordinate: (397, 384.77972) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (0, 387) ft
Right Coordinate: (400, 384.77052) ft

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	7.2	(129.353, 438.251)	48.31055	(191.303, 394)	(74.4848, 386.122)
2	11579	7.2	(129.353, 438.251)	75.261	(190.23, 394)	(75.16, 386.028)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	74.747405	385.87385	-537.22558	59.523669	32.994509	200
2	Optimized	76.37952	384.33135	-436.35285	263.30292	145.95119	200
3	Optimized	79.467145	381.41325	-247.52596	652.26463	263.53202	200
4	Optimized	82.647085	378.68755	-70.5676	996.9104	402.77795	200
5	Optimized	85.570755	376.4836	72.962916	1288.7184	491.19708	200
6	Optimized	88.36028	374.38075	209.70838	1584.9545	555.63551	200
7	Optimized	89.7748	373.31445	278.29942	1746.9642	593.3791	200
8	Optimized	92.77913	371.73205	381.38283	1942.1907	630.60733	200
9	Optimized	96.198685	369.9541	497.64696	2222.6228	696.93548	200
10	Optimized	99.51587	368.85925	571.54369	2368.7021	726.09914	200
11	Optimized	104.53205	367.78305	647.88062	2549.9306	768.47807	200
12	Optimized	108.1374	367.38605	680.01185	2664.1289	801.63531	200
13	Optimized	110.69375	367.3091	690.19062	2664.1124	797.51618	200
14	Optimized	113.09115	367.4708	685.30712	2676.5753	804.52458	200
15	Optimized	116.23385	367.6828	678.98359	2685.5399	810.70139	200
16	Optimized	120.67275	367.9822	670.05466	2680.2579	812.17483	200

17	Optimized	124.85555	368.2643	661.92536	2662.5953	808.32312	200
18	Optimized	128.13805	368.4857	655.90702	2648.7045	805.14243	200
19	Optimized	131.42055	368.7071	649.8583	2634.8137	801.97403	200
20	Optimized	133.27105	368.8319	646.47007	2625.8898	799.73746	200
21	Optimized	135.1873	368.96115	643.25286	2607.116	793.45222	200
22	Optimized	138.60135	369.19145	637.55415	2573.7713	782.28249	200
23	Optimized	142.01545	369.4217	631.88466	2540.4557	771.11276	200
24	Optimized	144.1077	369.5628	628.49496	2520.041	764.2342	200
25	Optimized	146.8155	369.74545	624.57862	2508.7101	761.23855	200
26	Optimized	151.4607	370.05875	617.85579	2493.6751	757.88018	200
27	Optimized	155.4585	370.3284	612.4773	2480.88	754.88369	200
28	Optimized	158.10335	370.5068	609.35643	2494.6879	761.72337	200
29	Optimized	160.55025	370.9293	590.56744	2465.2761	757.43146	200
30	Optimized	162.37955	371.3715	568.71843	2467.4607	767.14169	200
31	Optimized	164.0877	372.07905	530.09975	2398.3495	754.8219	200
32	Optimized	166.27455	373.28655	462.7104	2285.7733	736.56524	200
33	Optimized	169.4001	375.48785	337.05115	2062.6369	697.1819	200
34	Optimized	173.70455	378.6795	154.02597	1675.5821	614.74858	200
35	Optimized	176.5944	380.94495	24.770242	1396.475	760.34835	200
36	Optimized	179.27845	383.1972	-103.20863	1138.0251	630.81763	200
37	Optimized	182.88615	386.3216	-282.74098	802.96428	445.09037	200
38	Optimized	185.06685	388.21015	-392.25398	600.44708	332.83325	200
39	Optimized	186.9085	389.9024	-491.22807	414.03758	229.50478	200
40	Optimized	189.83815	392.63415	-651.87515	123.38994	68.396161	200

Slices of Slip Surface: 11579

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	11579	76.692635	384.5258	-447.82664	238.54422	132.22722	200
2	11579	80.427125	381.13735	-228.35212	679.22727	274.42563	200
3	11579	84.83077	377.63395	-0.45215519	1134.1125	458.21118	200
4	11579	88.36028	375.15415	161.31956	1462.3069	525.63299	200
5	11579	91.190135	373.4075	275.12377	1718.3726	583.11036	200

6	11579	94.194465	371.7295	384.26904	1964.3982	638.41361	200
7	11579	98.092815	369.84065	508.27597	2258.3084	707.05901	200
8	11579	102.88515	367.8449	640.5903	2585.448	785.77352	200
9	11579	106.0072	366.99305	699.77121	2626.032	778.25988	200
10	11579	109.28945	367.2144	693.04995	2653.2373	791.96711	200
11	11579	113.41715	367.4928	684.63252	2677.5116	805.17541	200
12	11579	116.55985	367.7048	678.31478	2686.5278	811.37074	200
13	11579	119.99755	367.93665	671.40214	2683.1494	812.79865	200
14	11579	123.7302	368.1884	663.99795	2667.352	809.40758	200
15	11579	127.46285	368.44015	657.12836	2651.5546	805.80052	200
16	11579	131.1955	368.6919	650.2855	2635.7573	802.18266	200
17	11579	134.967	368.9463	643.62331	2609.2667	794.17148	200
18	11579	138.77735	369.2033	637.28658	2572.0581	781.69842	200
19	11579	142.5877	369.4603	630.94985	2534.8756	769.23593	200
20	11579	146.5997	369.7309	624.88353	2509.4792	761.42608	200
21	11579	150.8133	370.0151	618.79808	2495.7455	758.33599	200
22	11579	155.0269	370.2993	612.99677	2482.2486	755.22676	200
23	11579	159.5806	370.60645	607.63367	2523.9917	774.2589	200
24	11579	162.40495	370.79695	604.30244	2585.5062	800.45828	200
25	11579	164.94385	371.98325	538.83735	2425.5833	762.29484	200
26	11579	168.79845	374.1866	415.48774	2235.3557	735.27439	200
27	11579	172.1848	376.40165	289.8213	1959.0249	674.40204	200
28	11579	175.5712	378.89255	147.37858	1652.3355	608.04205	200
29	11579	179.1208	381.84895	-21.48019	1280.41	709.74285	200
30	11579	182.8336	385.3642	-224.21223	887.36077	491.87211	200
31	11579	187.46	390.6207	-533.96318	320.11701	177.44376	200

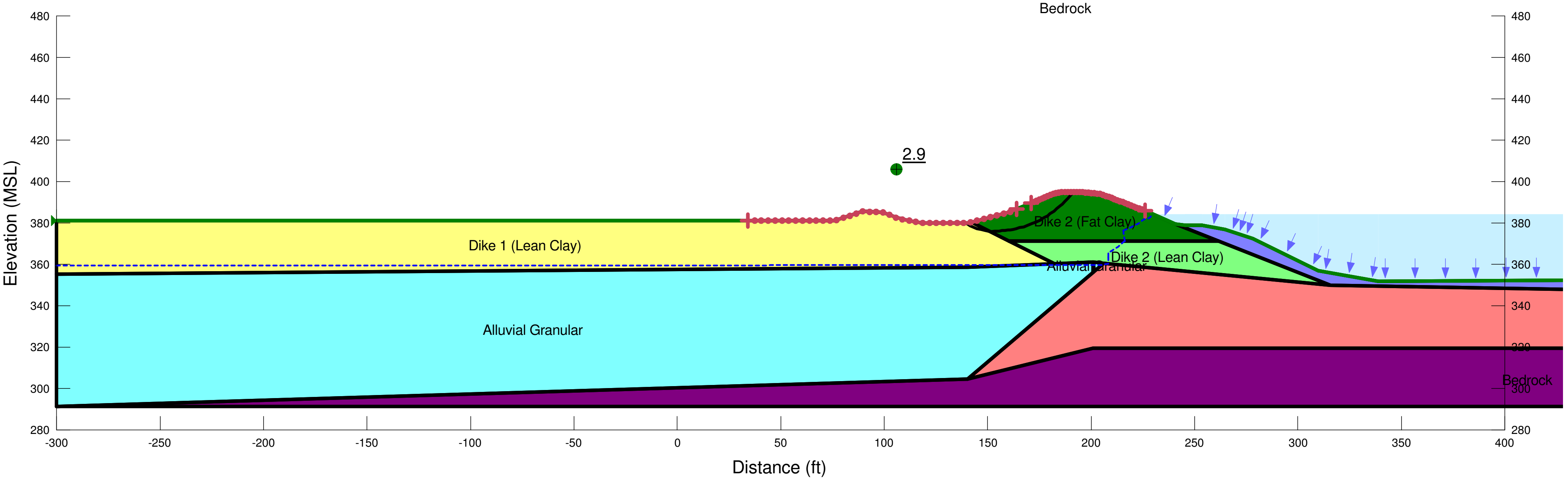
Stantec

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section T.gsz
Analysis Name: Stability - Existing Condition
Date Saved: 1/22/2010
Last Solved on 1/22/2010 at 2:05:36 PM

Analysis Method: Spencer
Calculated Factor of Safety: 2.9

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



Stantec

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section T.gsz

Analysis Name: Stability - Existing Condition (Deep)

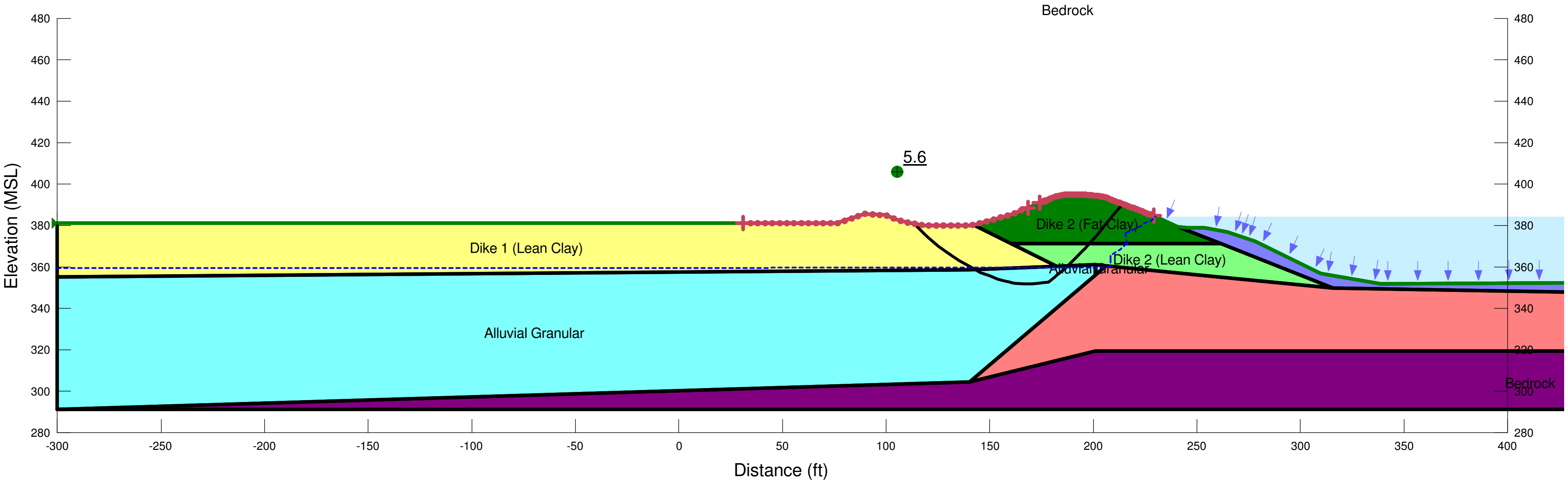
Date Saved: 1/22/2010

Last Solved on 1/22/2010 at 2:13:52 PM

Analysis Method: Spencer

Calculated Factor of Safety: 5.6

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



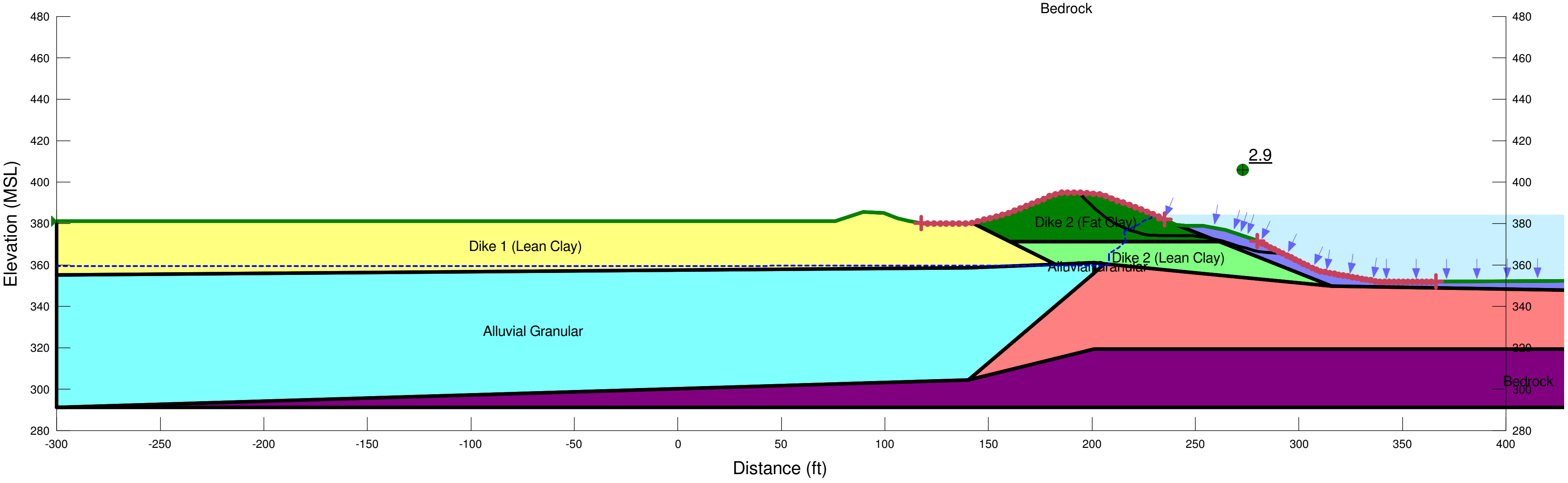
Stantec

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section T.gsz
Analysis Name: Stability - Existing Condition (L2R)
Date Saved: 1/22/2010
Last Solved on 1/22/2010 at 2:24:14 PM

Analysis Method: Spencer
Calculated Factor of Safety: 2.9

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



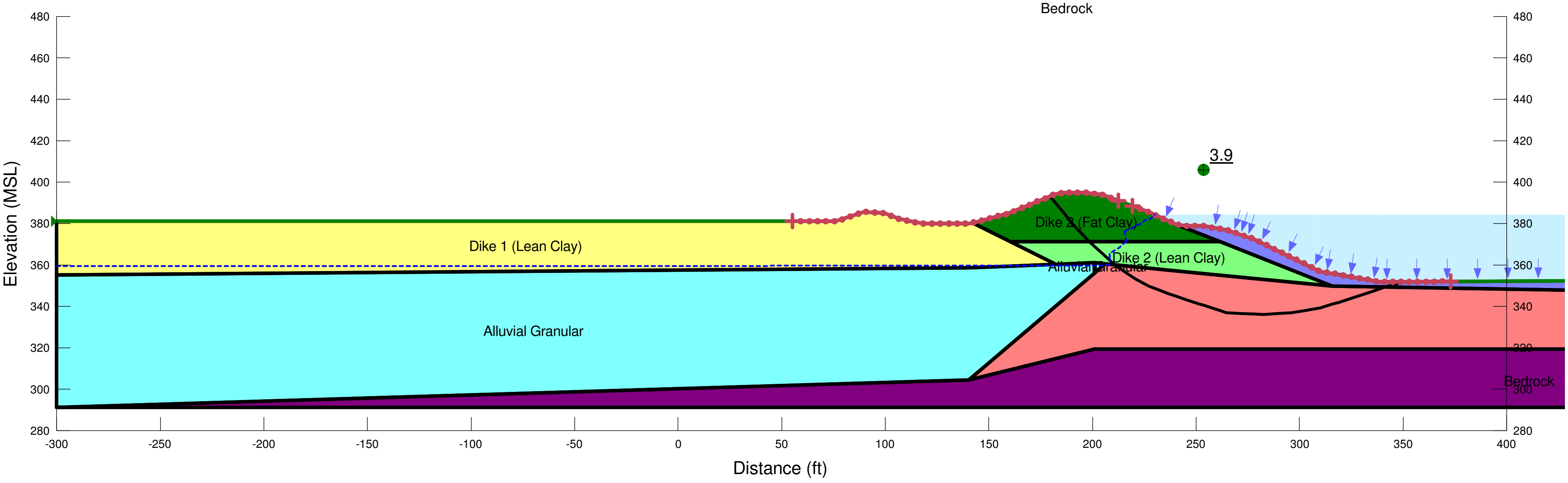
Stantec

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section T.gsz
Analysis Name: Stability - Existing Condition (Deep) (L2R)
Date Saved: 1/22/2010
Last Solved on 1/22/2010 at 2:18:08 PM

Analysis Method: Spencer
Calculated Factor of Safety: 3.9

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

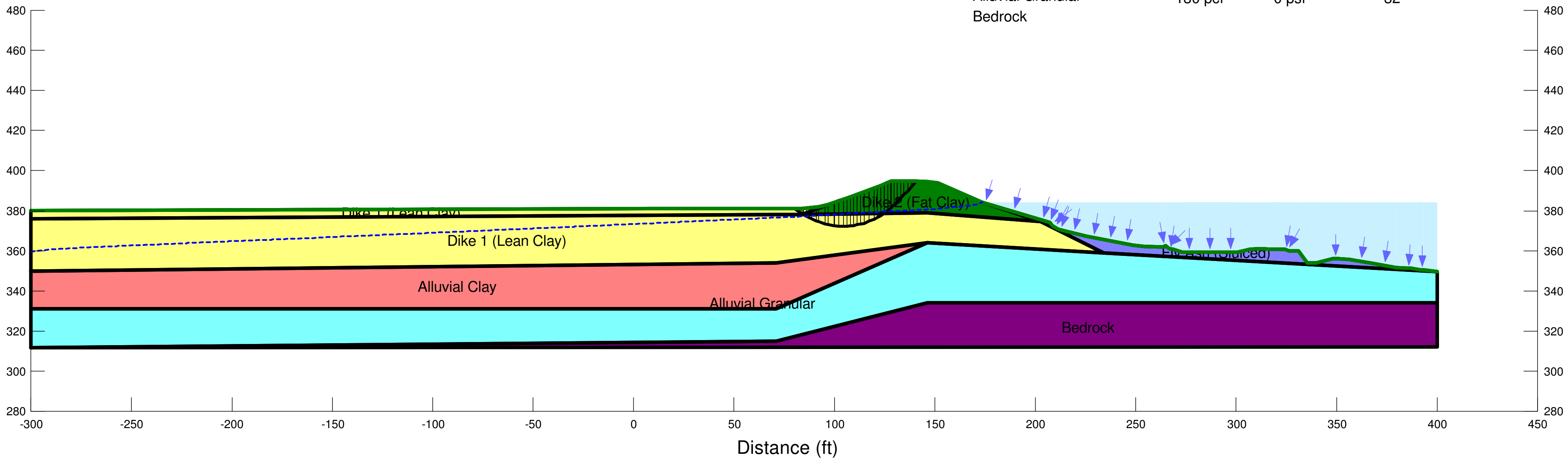
Stantec

File Name: Section U.gsz
Analysis Name: Stability - Existing Condition
Date Saved: 1/31/2010
Last Solved on 1/31/2010 at 1:56:33 PM

Analysis Method: Spencer

Calculated Factor of Safety: 2.6

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

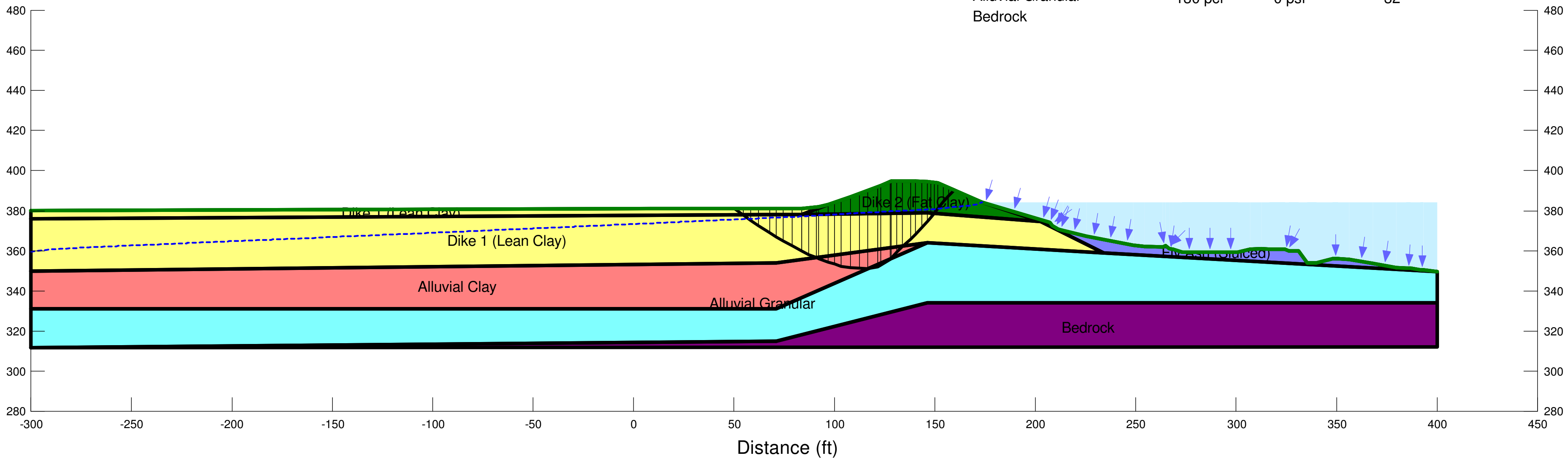
Stantec

File Name: Section U.gsz
Analysis Name: Stability - Existing Condition (Deep)
Date Saved: 1/31/2010
Last Solved on 1/31/2010 at 1:58:18 PM

Analysis Method: Spencer

Calculated Factor of Safety: 4.2

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

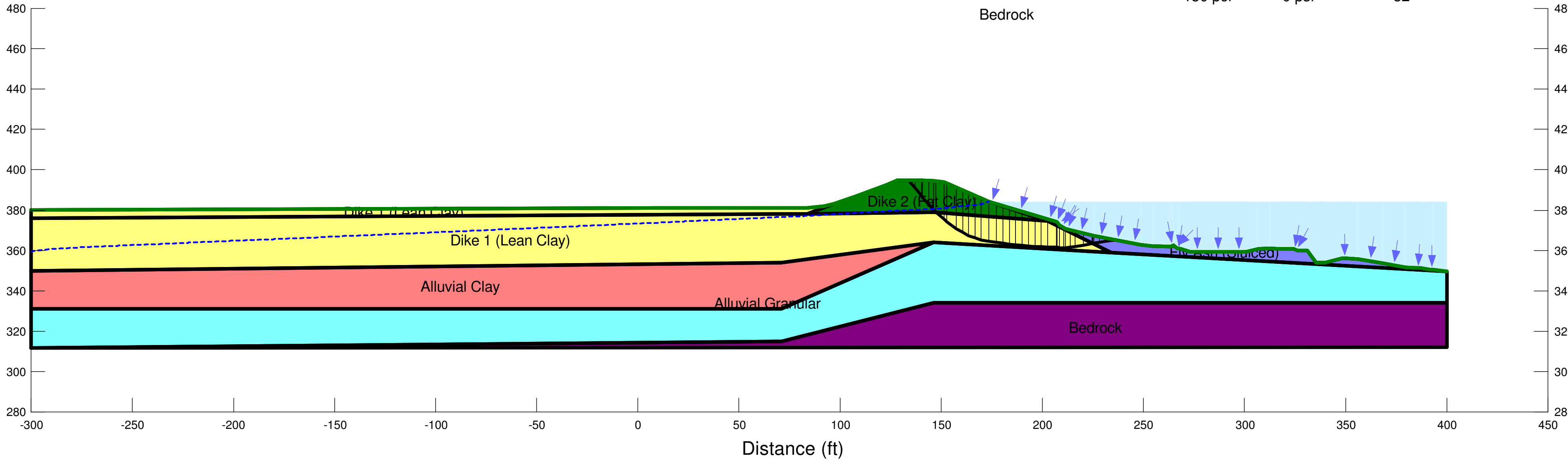
Stantec

File Name: Section U.gsz
Analysis Name: Stability - Existing Condition (L2R)
Date Saved: 1/31/2010
Last Solved on 1/31/2010 at 2:05:33 PM

Analysis Method: Spencer

Calculated Factor of Safety: 2.1

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

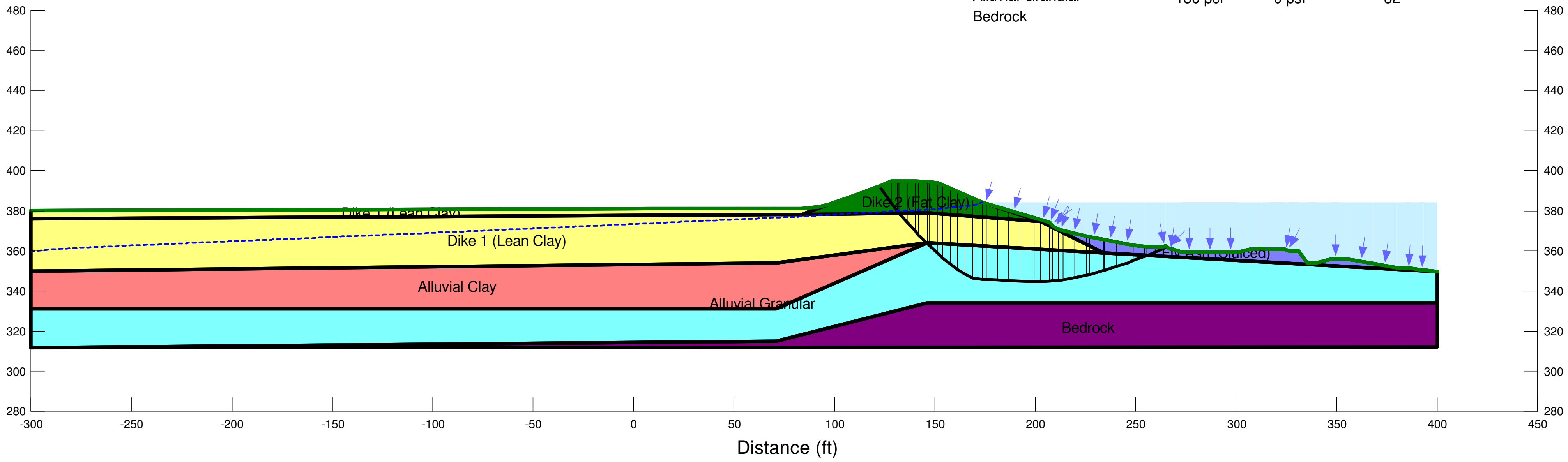
Stantec

File Name: Section U.gsz
Analysis Name: Stability - Existing Condition (Deep) (L2R)
Date Saved: 1/31/2010
Last Solved on 1/31/2010 at 2:00:11 PM

Analysis Method: Spencer

Calculated Factor of Safety: 2.7

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section V.gsz

Analysis Name: Stability - Existing Condition

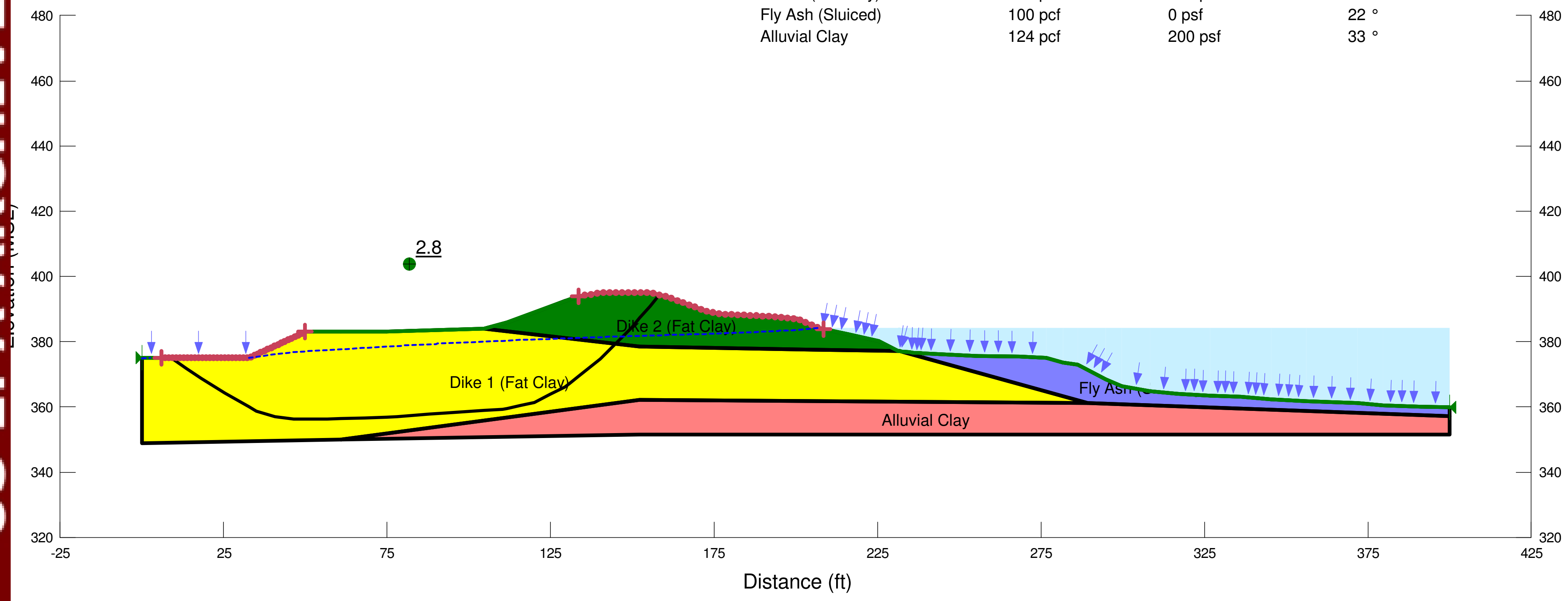
Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 2:22:00 PM

Analysis Method: Spencer

Calculated Factor of Safety: 2.8

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Fat Clay)	119 pcf	200 psf	22 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section V.gsz

Analysis Name: Stability - Existing Condition (Deep)

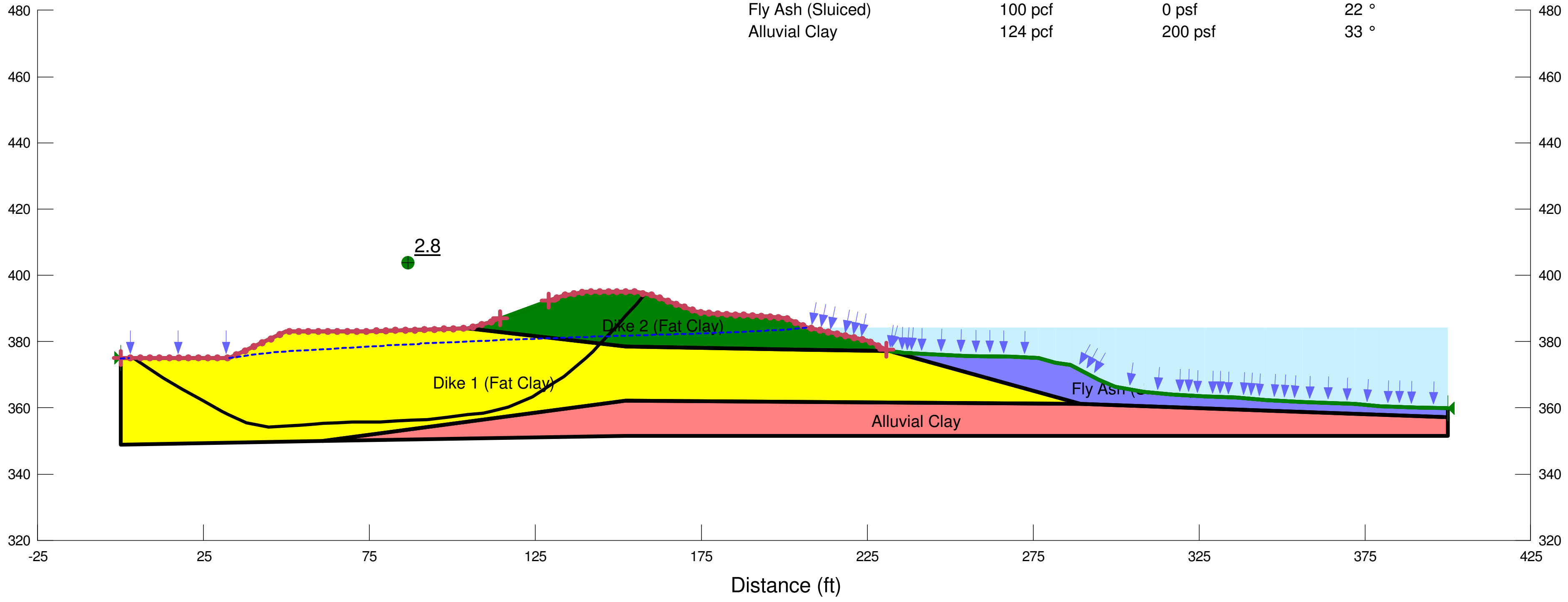
Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 2:24:07 PM

Analysis Method: Spencer

Calculated Factor of Safety: 2.8

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Fat Clay)	119 pcf	200 psf	22 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section V.gsz

Analysis Name: Stability - Existing Condition (L2R)

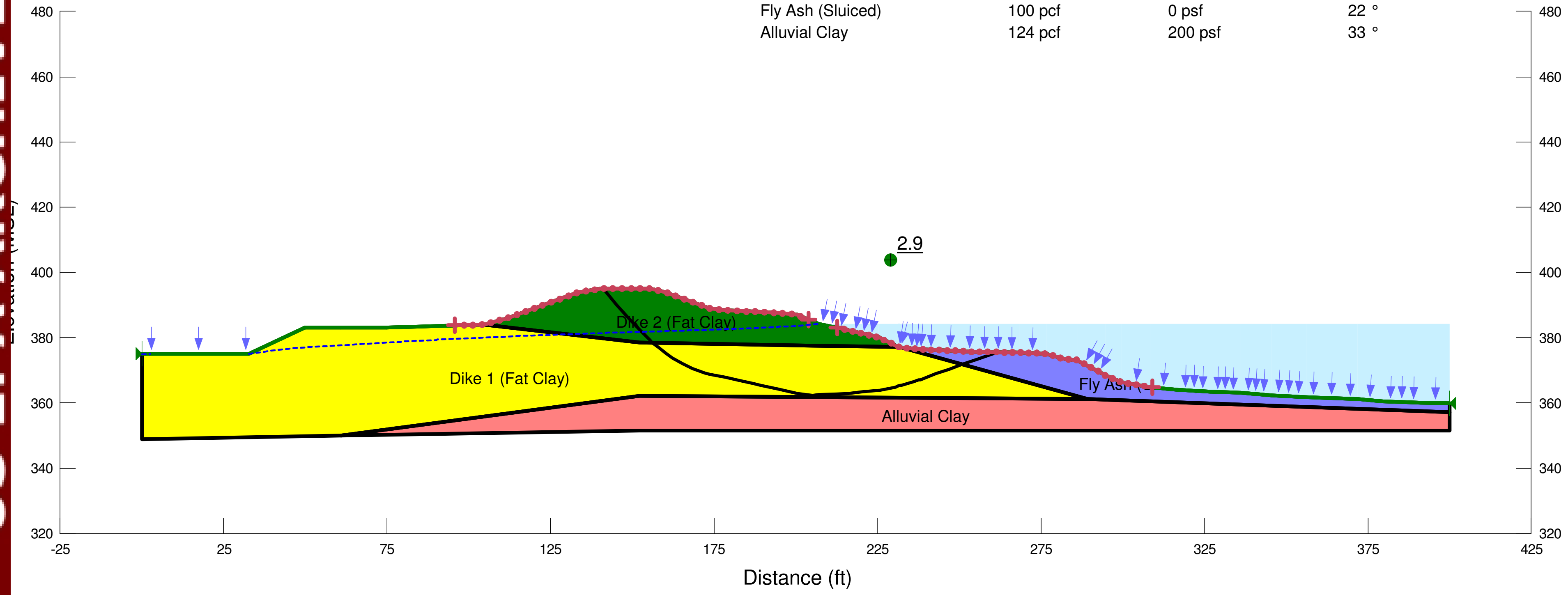
Date Saved: 1/31/2010

Last Solved on 1/31/2010 at 2:29:28 PM

Analysis Method: Spencer

Calculated Factor of Safety: 2.9

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Fat Clay)	119 pcf	200 psf	22 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section V.gsz

Analysis Name: Stability - Existing Condition (Deep) (L2R)

Date Saved: 1/31/2010

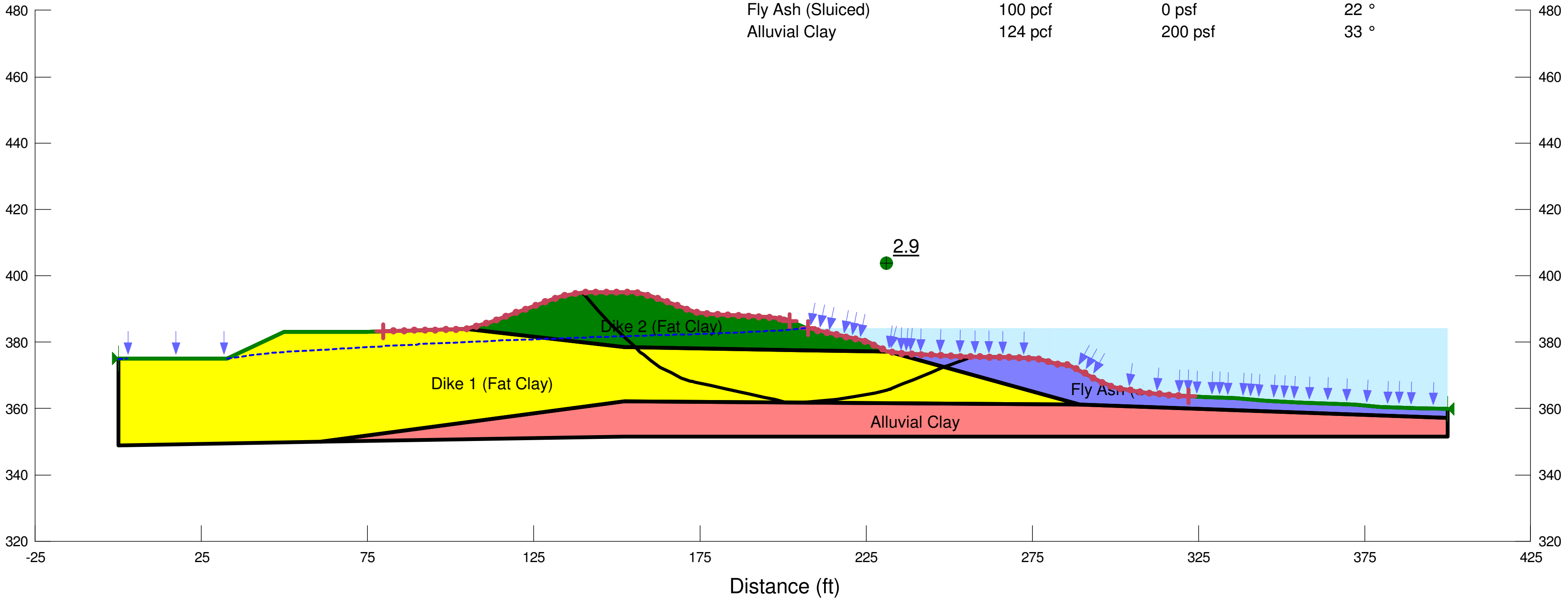
Last Solved on 1/31/2010 at 2:27:07 PM

Stantec

Analysis Method: Spencer

Calculated Factor of Safety: 2.9

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Fat Clay)	119 pcf	200 psf	22 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °



Stantec

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section W.gsz

Analysis Name: Stability - Existing Condition

Date Saved: 1/22/2010

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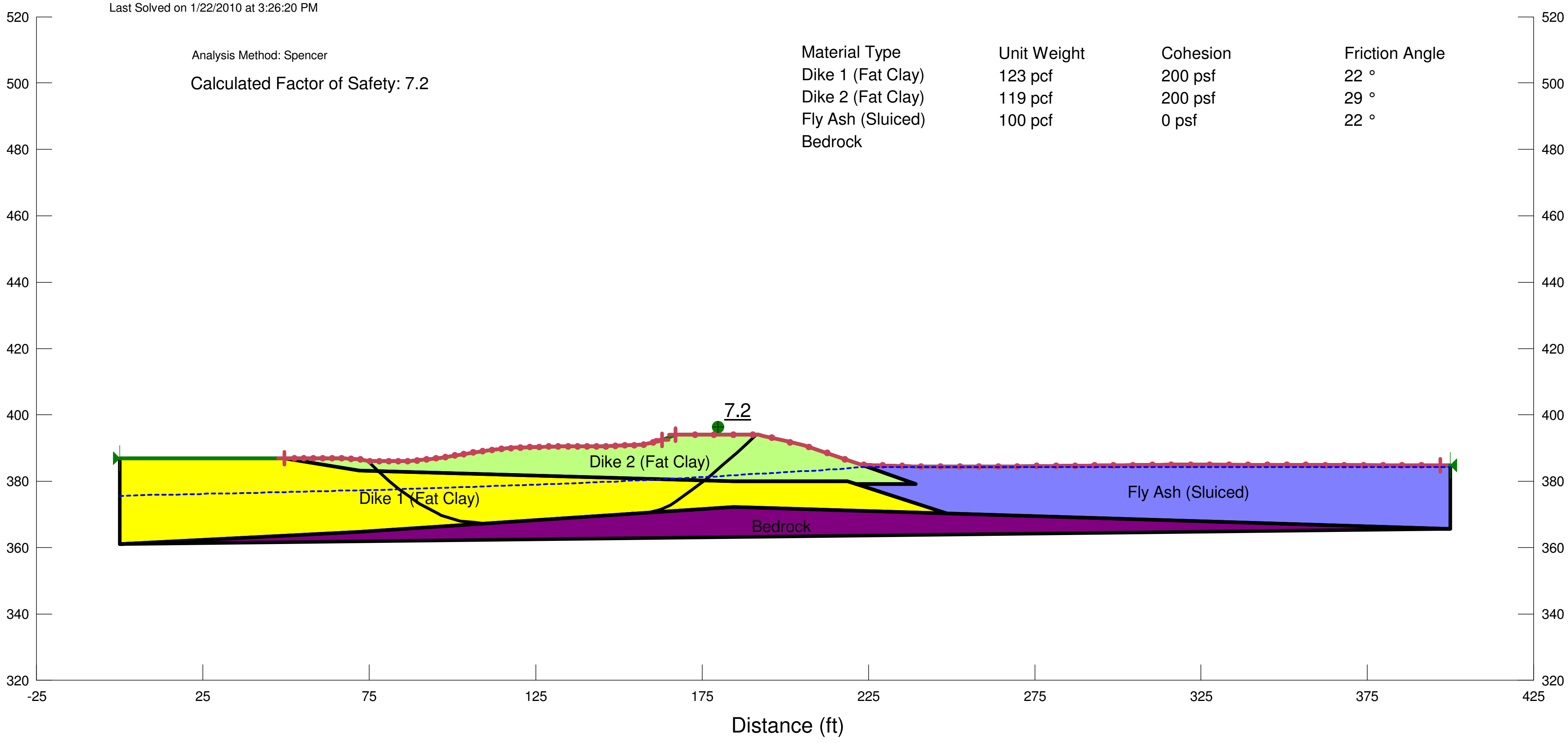


Analysis Method: Spencer

Calculated Factor of Safety: 7.2

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Fat Clay)	123 pcf	200 psf	22 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Bedrock			

Stantec

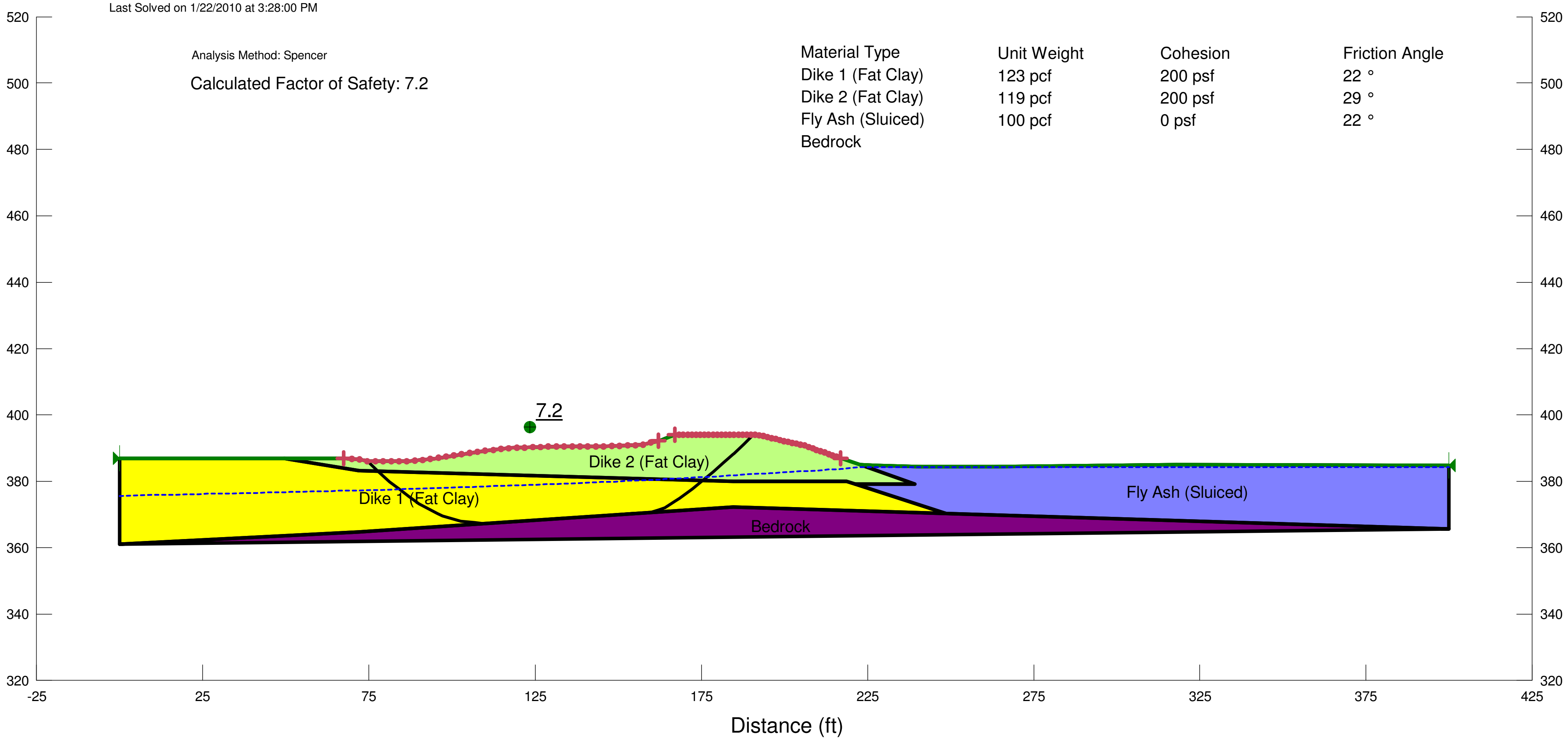
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section W.gsz

Analysis Name: Stability - Existing Condition (Deep)

Date Saved: 1/22/2010

Last Solved on 1/22/2010 at 3:28:00 PM



Analysis Method: Spencer

Calculated Factor of Safety: 7.2

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Fat Clay)	123 pcf	200 psf	22 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Bedrock			

Stantec

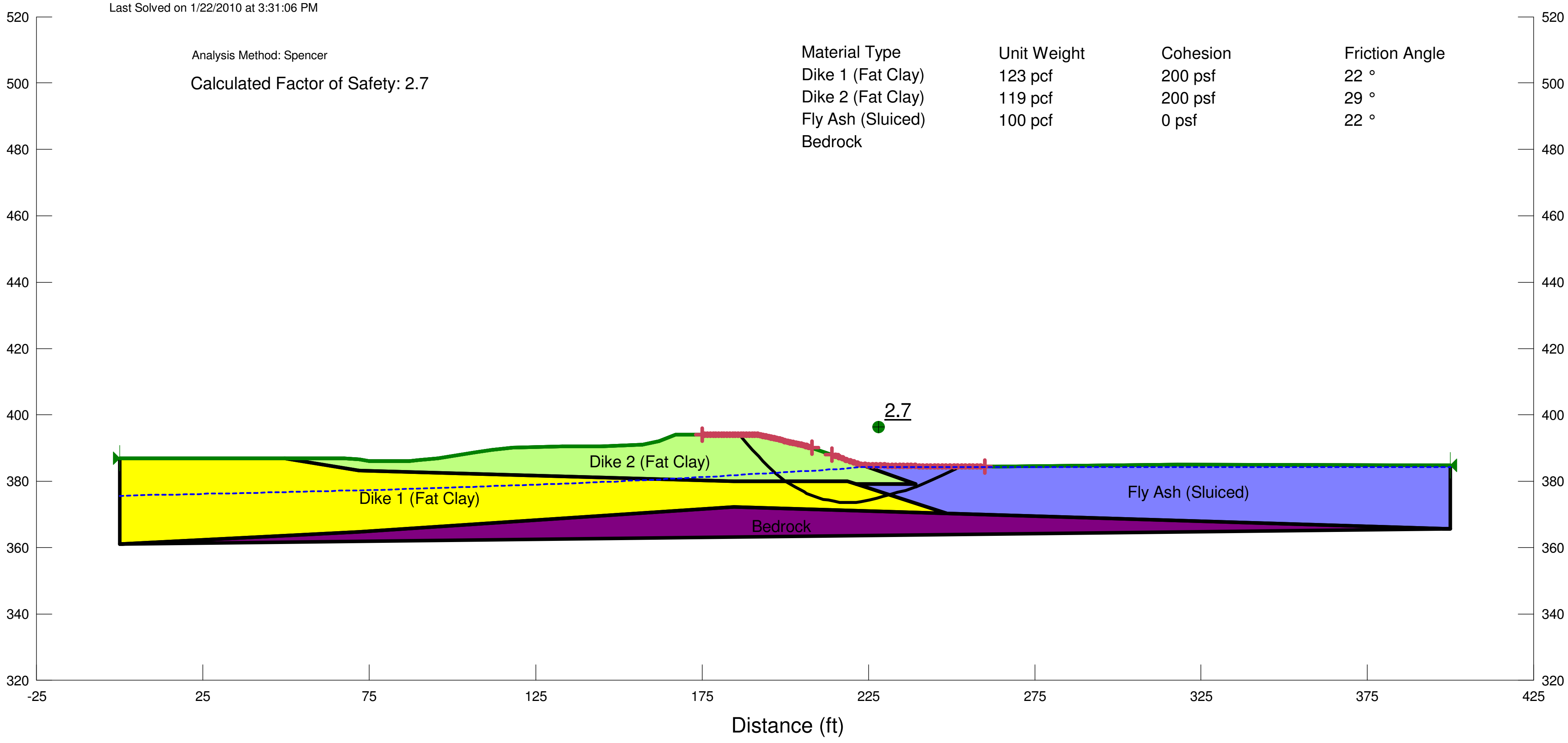
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section W.gsz

Analysis Name: Stability - Existing Condition (L2R)

Date Saved: 1/22/2010

Last Solved on 1/22/2010 at 3:31:06 PM



Analysis Method: Spencer

Calculated Factor of Safety: 2.7

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Fat Clay)	123 pcf	200 psf	22 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Bedrock			

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section W.gsz

Analysis Name: Stability - Existing Condition (Deep) (L2R)

Date Saved: 1/22/2010

Last Solved on 1/22/2010 at 3:29:34 PM

Analysis Method: Spencer

Calculated Factor of Safety: 2.9

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Fat Clay)	123 pcf	200 psf	22 °
Dike 2 (Fat Clay)	119 pcf	200 psf	29 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Bedrock			

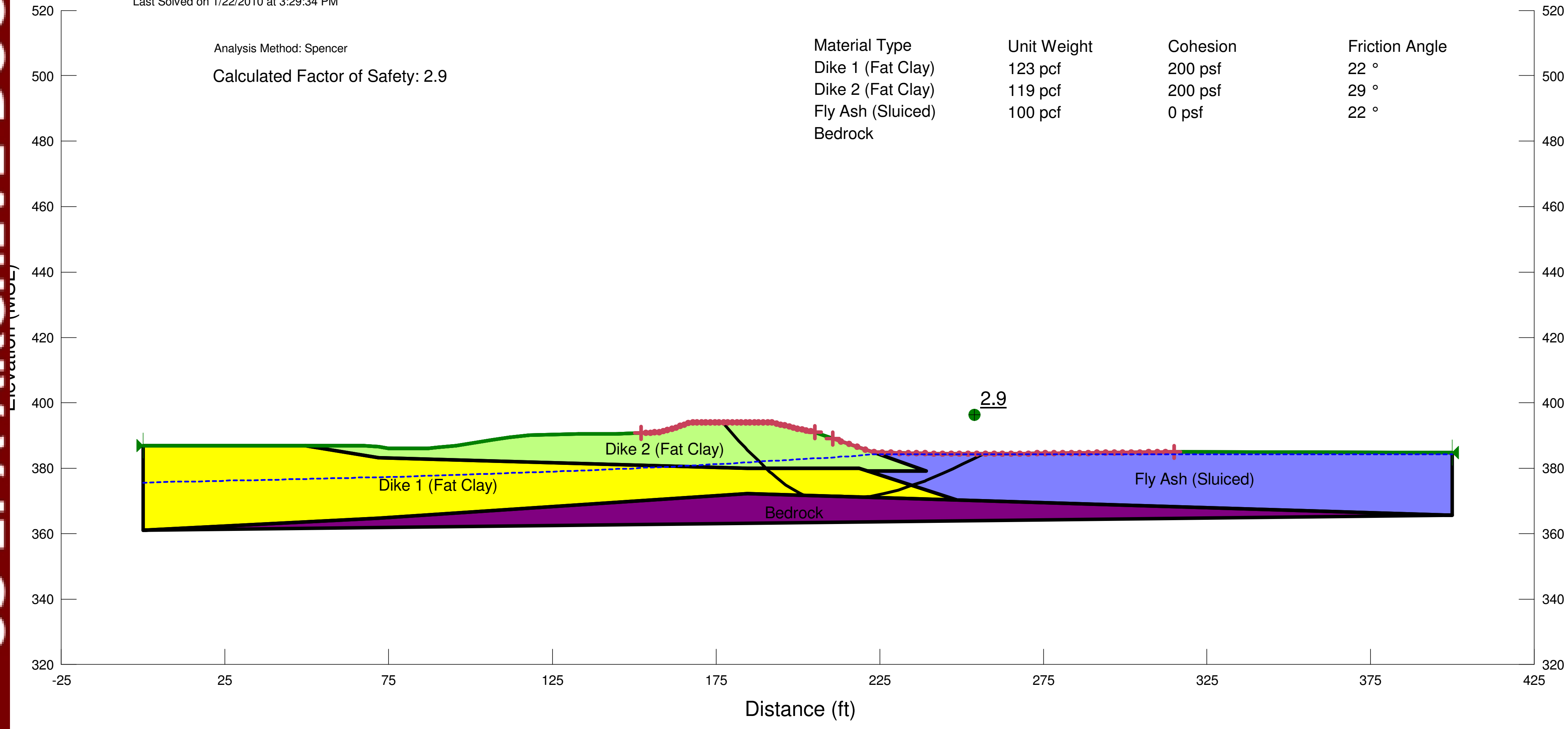


Figure 3. General layout of the Cumberland Fossil Plant showing the components of the coal combustion by-product disposal complex

4. Scope of Work

The scope of the geotechnical exploration was divided into the following tasks.

a. Review of Available Information

b. Review of General Site Geology

c. Subsurface Exploration

d. Field Instrumentation and Monitoring

e. Surveying

f. Laboratory Testing

g. Engineering Analyses

h. Conceptual Design of Repairs

APPENDIX A

Document 7

Dry Fly Ash Stack and Gypsum Report, Stantec, June 2010

Report of Geotechnical Exploration

Dry Fly Ash Stack and Gypsum Disposal Complex
Cumberland Fossil Plant
Stewart County, Tennessee

Stantec Consulting Services Inc.
One Team. Infinite Solutions
11687 Lebanon Road
Cincinnati, Ohio 45241-2026
Tel: (513) 842-4200 • Fax: (513) 842-8250
www.stantec.com

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

June, 2010

Stantec

Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241-2026
Tel: (513) 842-8200
Fax: (513) 842-8250

June 11, 2010
File: 175539009R01

Mr. Michael. S. Turnbow
Tennessee Valley Authority
1101 Market Street, LP 2G-C
Chattanooga, Tennessee 37402-2801

Re: Report of Geotechnical Exploration
Dry Fly Ash Stack and Gypsum Disposal Complex
Cumberland Fossil Plant
Stewart County, Tennessee

Dear Mr. Turnbow:

Stantec Consulting Services Inc. (Stantec) has completed a geotechnical exploration of the Dry Fly Ash Stack and Gypsum Disposal Complex at the Cumberland Fossil Plant. Our final report includes discussions of general site conditions, scope of work performed, subsurface conditions, and results of laboratory testing and our engineering analyses. The report also includes a review of historical documentation provided by TVA, and our conclusions and recommendations relative to future use of the facility. These services were performed under Engineering Service Request ESR/TAO 700 in accordance with the terms and provisions established in our System-Wide Services Agreement dated December 22, 2008.

Stantec appreciates the opportunity to provide engineering services for this project. If you have any questions, or if we may be of further assistance, please contact our office.

Sincerely,

STANTEC CONSULTING SERVICES INC.

Daniel B. Rogers lfb
Daniel B. Rogers, PE
Project Engineer

Harris
Stan A. Harris, PE
Principal

/lfb

Report of Geotechnical Exploration

Dry Fly Ash Stack and Gypsum Disposal Complex
Cumberland Fossil Plant
Stewart County, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

June, 2010

Report of Geotechnical Exploration

Dry Fly Ash Stack and Gypsum Disposal Complex
Cumberland Fossil Plant
Stewart County, Tennessee

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Executive Summary

Stantec Consulting Services Inc. (Stantec) has completed a Geotechnical Exploration of the Dry Fly Ash Stack and Gypsum Disposal Complex at Cumberland Fossil Plant. This study was performed to evaluate slope stability and seepage for existing conditions of the disposal areas and surrounding dikes.

Background Information

The Gypsum Disposal Complex is approximately 100 acres in area. It was constructed in 1995-1996 over Area No.1, which was the original ash pond. Approximately 1,000,000 tons of gypsum is produced each year. Roughly, 75 percent of the gypsum is marketed to the adjacent wallboard company and the remaining 25 percent is sent to the Gypsum Disposal Complex. The complex is formed by a series of earth dikes around its perimeter and an upper gypsum dike. The total height of the facility is approximately 50 feet. Dike slopes generally vary from 2H:1V to 3H:1V.

TVA has classified the Gypsum Disposal Complex as a “high hazard” facility due to the consequences of failure relative to potential damage to the adjoining wallboard plant. Currently, Stantec and TVA are in the early stages of preparing a 5 to 7 year operation plan for the facility while a new dry disposal facility is being designed, permitted and constructed. Modifications being considered include constructing two small lined ponds on top of the gypsum stack and significantly reducing the amount of water which could be impounded.

A small landslide occurred on the facility in 2005 and temporary stabilization measures were implemented by TVA. Stantec has developed construction drawings for permanent repairs, which include the construction of a seepage collection system and the placement of a more substantial rock buttress. Other historical geotechnical issues on the gypsum disposal complex include seepage at various locations around the stack. Since May 2009, TVA has not been sending gypsum sluice to the stack except when the dewatering plant experiences outages.

The Dry Fly Ash stack is approximately 110 acres in size. It is also built over the original ash pond. Its current height is about 35 feet and slopes generally vary from 2.5H:1V to 3H:1V. A small dredge cell within the Dry Fly Ash Stack was filled with dredged coal fines from the Coal Yard Drainage Basin in 2007. Stantec performed an analysis of this area in early 2009 and concluded that is presence would not have a detrimental effect on the long-term stability of the stack. It was recommended that TVA excavate parallel trenches across the area and backfill the trenches with more permeable bottom ash. This work was completed on April 24, 2009.

Scope of Geotechnical Exploration

This study began with a review of TVA-provided historical information along with site inspections. A geotechnical exploration program was then developed and executed. The exploration consisted of drilling soil test/sample borings at 74 locations and advancing cone penetrometer test borings at 17 locations. Piezometers were installed at 19 locations and slope inclinometer casings at eight locations. Drilling locations were positioned along fifteen cross sections around the Dry Fly Ash Stack and the Gypsum Disposal Complex. Laboratory testing included moisture content, classification, permeability and shear strength testing to establish key index properties and strength parameters.

Results of Exploration and Engineering Analyses

Thirteen primary soil horizons were identified from the field and laboratory program. These primary horizons generally fall into one of three categories: 1) natural foundation soils, which included alluvial clay and alluvial sands and gravels, 2) dikes constructed with natural clays and varying amounts of gravel, and 3) coal combustion byproducts including fly ash, bottom ash and gypsum.

Following the drilling and laboratory testing program, slope stability analyses were performed to quantify factors of safety for current conditions. The dikes were assessed under static, long-term steady state conditions since the dikes have been in their current configuration for a long time. Analyses were performed on fifteen sections. Factors of safety for slope stability were computed using Spencer's method of analysis, optimized curved failure surfaces, and search routines that help to identify the critical (minimum factor of safety) failure surface. The slope stability models were evaluated using phreatic surfaces based on piezometric readings and field observations. In their new Master Programmatic Document, TVA has adopted a minimum target factor of safety of 1.5 against slope failure based on U. S. Army Corps of Engineers (USACE) criteria. Factors of safety ranged from approximately 1.0 to 2.5. Lower than acceptable values were determined for eight of the fifteen sections analyzed. For the most part, the lower factors of safety correspond to sloughing shallow disturbance, not massive dike failures.

Selected cross sections were also analyzed for short-term (undrained) conditions. Acceptable factors of safety were obtained for these analyses. Furthermore, undrained analyses were performed for future increases in stack heights. These analyses were performed assuming instantaneous loading of the stack and no pore pressure dissipation. Acceptable results were obtained for the Gypsum Stack. The analyses for the Dry Ash Stack indicate that 12.5 to 20.0 feet of material can be placed quickly before FS values fall below acceptable levels.

Conclusions and Recommendations

Work Plans should be developed to improve the long-term slope stability factor of safety at Sections A, B and F on the Dry Ash Stack. Re-grading only is needed at Sections A and B. At Section F, a toe buttress and slope flattening are needed.

A Work Plan has been developed for slope repair at Section H of the Gypsum Disposal Complex. This Work Plan has been issued for construction and should be implemented as soon as practical.

A Work Plan should be developed to construct toe buttresses below the bottom ash road dike around the Gypsum Disposal Complex. This work should be coordinated with re-grading of the perimeter ditch system to promote improved surface drainage and reduce ponding of water.

Stantec recommends that full time sluicing of gypsum slurry to the Gypsum Disposal Complex not be resumed until lined ponds are constructed on top of the stack. These lined ponds will prevent the sluice water from infiltrating the stack.

A study should be performed of the Dry Ash Stack to determine if it is in full compliance with the existing permit. If not, a study should be performed to determine if it would be preferable to redesign the stack or to re-grade it so that it is in compliance.

Additional piezometers are recommended for the Dry Ash Stack to provide for better definition of phreatic levels and to monitor pore pressures during future fill placement.

Fill material should not be placed over phragmites or other vegetation. Fine ash or gypsum dipped from ponds should not be placed near the toe of slopes or concentrated at any one location. Fines should be dispersed evenly across the interior of the active stacks and not be placed near the edges.

Operations and Maintenance Manuals should be developed or updated for each facility. Elements of a maintenance program should include elimination of animal burrows, a mowing program, repair of erosion areas and a regular inspection program. A program should be established to develop record (as-built) drawings and construction records for future maintenance and construction activities.

An instrumentation program should be developed for the site. The program should include regular collection and analysis of various data including phreatic levels, rainfall and slope movements.

Report of Geotechnical Exploration

Dry Fly Ash Stack and Gypsum Disposal Complex
Cumberland Fossil Plant
Stewart County, Tennessee

1. Introduction

1.1. General

Tennessee Valley Authority (TVA) retained Stantec Consulting Services Inc. (Stantec) to perform facility assessments at eleven (11) active and one inactive (closed) electricity-generating fossil plants. Specifically, Stantec was requested to assess the coal combustion product (CCP) disposal facilities at these generating plants. In general, the facilities consisted of ash ponds, scrubber sludge (gypsum) ponds, wet ash dredge cells, dry ash stacks and gypsum stacks. A number of facilities were abandoned (having completed their design life), while a majority of them were actively receiving combustion by-products at the time of this project.

1.2. Facilities Assessment Project

Stantec's scope of work for the facilities assessment project is divided into four main phases, with Phase 1 divided into two sub-phases, 1A and 1B. Brief descriptions of Stantec's scope of work for each phase are presented in the following paragraphs.

- Phase 1A – Review most recent TVA inspection reports, observe critical disposal features while accompanied by TVA personnel, develop a list of primary concerns and recommend immediate action or engineering assessment as considered necessary.

- Phase 1B – Review available historical documentation, re-visit sites for more detailed observations and measurements, complete dam safety checklists adapted from standard dam safety protocols, recommend immediate action as judged necessary and recommend sites/features that should undergo further evaluation.

- Phase 2 – Evaluate TVA facilities based on current dam safety criteria adopted by the state in which the plant is located, conduct geotechnical explorations and engineering analyses at sites recommended in Phase 1B, and complete conceptual and final repair designs and budget level costs estimates.

- Phase 3 – Design repairs for sites recommended in Phase 2 and prepare construction plans and specifications as well as permit/planning documents.

- Phase 4 – Provide dam safety training for TVA staff and prepare operation manuals.

At the time of this report, Phase 1 of the assessment is complete. Phase 2 is being implemented at several facilities located within the different plants. The Phase 1 report recommended that Phase 2 evaluations include geotechnical explorations and hydraulic/hydrologic assessments. This document reports the results of a geotechnical exploration of the Dry Ash and Gypsum Stacking Facility within the Cumberland Fossil Plant.

2. Cumberland Fossil Plant

2.1. Location

The Cumberland Fossil Plant (CUF) is located in western Tennessee west-southwest of Clarksville, Tennessee on the south shore of Barkley Reservoir. The plant is adjacent to the town of Cumberland City, Tennessee. The plant can be accessed by state Highway 233, which connects to TVA-owned roads.

Figure 1. Portions of 7 ½-minute U.S.G.S. topographic maps (Cumberland City and Clarksville quadrangles) showing the vicinity of the Cumberland Fossil Plant near Cumberland City.

2.2. **Power Generation**

Cumberland Fossil Plant has two coal-fired generating units. The plant was constructed between 1968 and 1973. The winter net dependable generating capacity is about 2,530 megawatts. The plant consumes approximately 20,000 tons of coal a day and produces roughly 750,000 tons of combustion byproducts in the forms of fly ash and bottom ash each year.

Sulfur dioxide scrubbers for both coal-fired generating units were installed in 1994. The process generates a synthetic gypsum byproduct. Approximately 1,000,000 tons of gypsum is produced each year, depending upon the actual amount of coal burned. The gypsum is marketed as a building material.

2.3. **Previous Work Plans**

Three work plans have been issued by Stantec during Phase 1 work. The first plan was issued March 16, 2009 for the Bottom Ash Stack and Bottom Ash Drains (TVA Reference No. CUF-WP-090316). It was completed April 24, 2009. The second work plan was also issued March 16, 2009 for Gypsum Stack – Slurry Outfall Routing (TVA Reference No. CUF-LT-090316). It was completed May 11, 2009. The third was issued August 12, 2009 for Gypsum Stack – South Cell B Temporary Grading (TVA Reference No. CUF-WP-090812). It was completed on August 17, 2009.

3. Dry Fly Ash Stack and Gypsum Disposal Complex

3.1. **General**

The Dry Fly Ash Stack and Gypsum Disposal Complex are located in the southern and southwestern areas of the plant (see Figure 2). They consist of above-ground cellular systems for dry fly ash, sluiced bottom ash and sluiced gypsum disposal. The facilities cover approximately 340 acres. The facility also includes the Retention (Ash) Pond and the Stilling Pond. The Gypsum Complex consists of the North Cell and South Cell separated by the Divider Dike. A settling pond (also known as the Duck Pond) exists at the west end of the Divider Dike. A general layout of the waste disposal areas is shown in Figure 3.

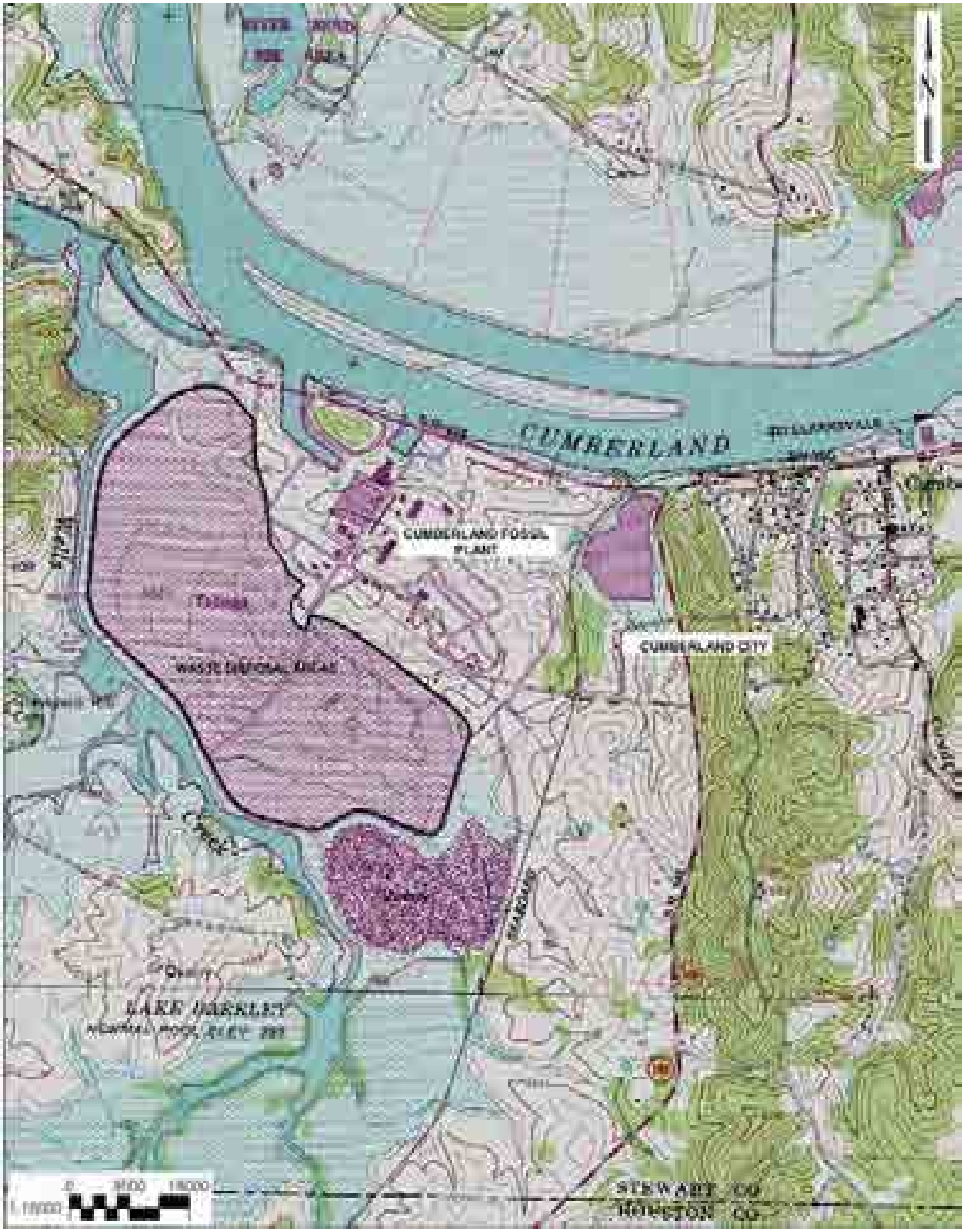

Figure 2. Portion of 7 ½-minute U.S.G.S. topographic map (Cumberland City quadrangle) showing Cumberland Fossil Plant.

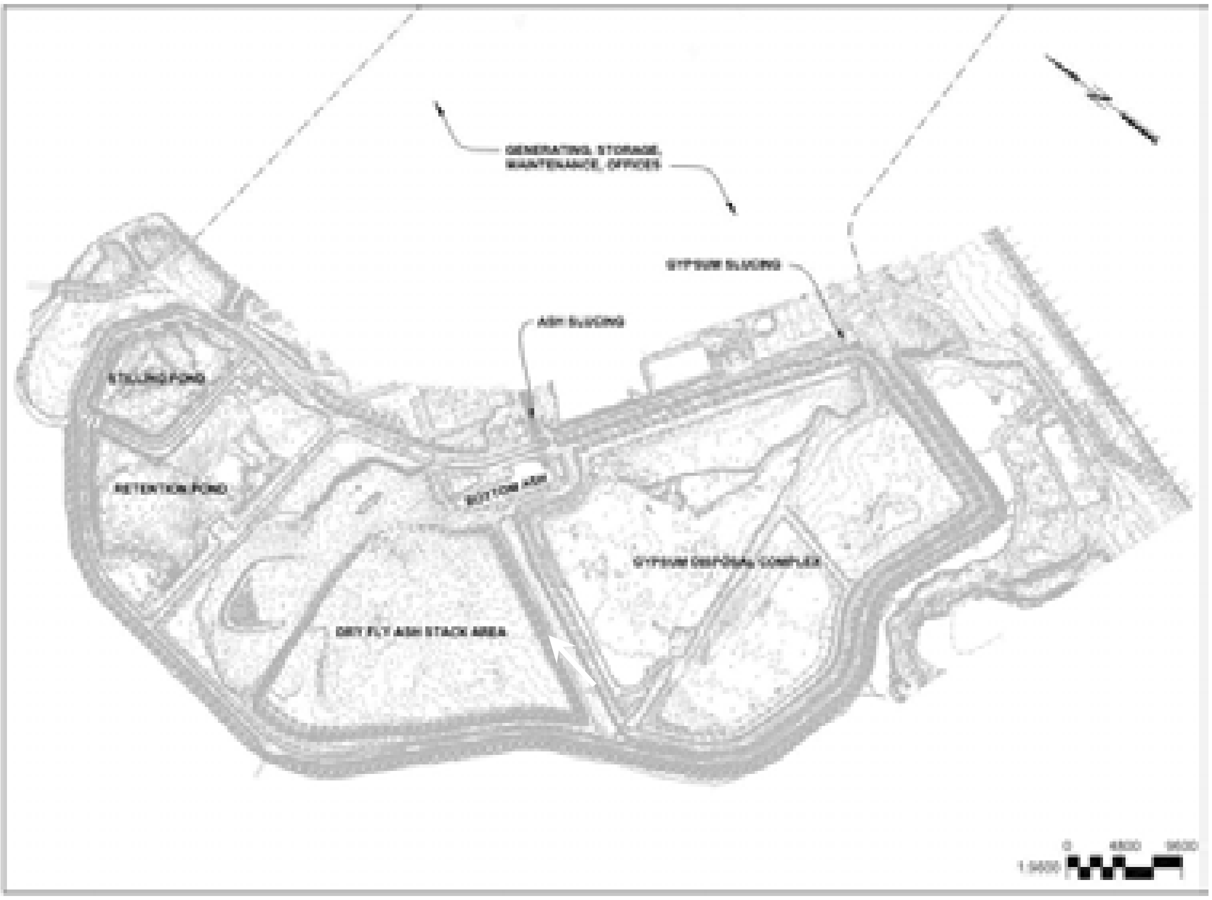

Figure 3. General layout of the Cumberland Fossil Plant showing the Dry Fly Ash Stack and Gypsum Disposal Complex

The entire CCP disposal area was originally constructed in 1969 as one large ash pond. Wells Creek was relocated in order to construct what was initially known as Disposal Area 1. Area 1 was located within the perimeter dikes that now include a majority of the current ash and gypsum disposal areas. In 1977, the divider dike for the stilling pond to the north (interior divider dike) was constructed. In 1979, the dikes around the Ash Pond were raised to elevation 395 feet with clay. In 1986, approximately 300 feet of the west portion of the divider dike between the Ash Pond and the Dry Ash Stack was constructed. In 1995-96, the current divider dike between the Ash Pond and Dry Stack was constructed (exterior divider dike) to form the current configuration. In 1996, stacking within the Dry Fly Ash Stack began. Appendix A contains a timeline of development of the disposal complex as well as a plan view that shows the locations of Area 1 and Area 2.

The gypsum storage area was constructed during 1995-96. It was built over Area No. 1, the original ash pond. The pond was constructed in several stages beginning with construction of a rock drainage blanket to collect and divert water away from the base. It is surrounded by a lower earth dike capped with bottom ash, and an upper gypsum dike. Table 1 presents key details of the Complex.

Table 1. Details of Complex

Item	Value
Original Construction Completed	1972
Scrubber Construction Completed	1994
Elevation of Initial Ash Dike	380 feet
Elevation of Perimeter Ash Dike	395 feet
Current Ash Stack Elevation	430 +/-feet
Planned Maximum Ash Elevation	600 feet
Elevation of Initial Gypsum Dike	380 feet
Elevation of Perimeter Gypsum Dike	395 feet
Current Gypsum Stack Elevation	418 +/-feet
Planned Maximum Height (Gypsum)	570 feet
Current Overall Dike Length	17,200 feet
Current Total Area	337 acres

3.2. Disposal Operations

The plant currently generates fly ash, bottom ash and synthetic gypsum wastes in addition to other Coal Combustion Products (CCPs) such as calcium silicate thermal insulation, boiler sandblasting residue, spent resin and activated alumina.

Scrubbers are installed on both generating units. According to the introduction of the current operations manual of the facility (Operations Manual, Dry Ash and Gypsum Stacking Facility, Permit IDL 81-102-0082, Tennessee Valley Authority Fossil Engineering Services, September 2003):

> Fly ash is collected in a dry state, conditioned with moisture and then spread and compacted. Bottom ash is sluiced to a processing area, reclaimed, and then placed on the ash stack. The gypsum is sluiced into the gypsum stack area. Gypsum can also be diverted at a valve station into the gypsum processing plant operated by Synthetic Materials, Inc (SynMat). SynMat dewaters gypsum slurry using vacuum filter presses and the filtrate is returned to the gypsum stack area where any remaining fines can settle. During unit outages SynMat may also reclaim gypsum from the gypsum stack area either by direct excavation and truck hauling or by dredging using a small portable hydraulic dredge.

TVA operates the gypsum disposal complex using the elevated rim ditching method. Dozers and excavators are used to construct rim ditches and to raise the perimeter gypsum dike. TVA augments the method with a riser and spillway decant system on the west end of the gypsum disposal complex. Water is allowed to pool around the decant structure, then the clearest water at the top of the pool is captured with the riser pipe. The pipe spillway from the riser conveys water to a small settling pond where it then flows to the perimeter ditch and eventually to the retention and stilling ponds. The perimeter ditch collects runoff and seepage from both the gypsum disposal complex and the ash stacks.

Due to concerns about elevated piezometric levels in the Gypsum Stack and surrounding dikes, TVA elected to cease regular pumping of gypsum slurry to the gypsum stack in May,

2009. Since May, SynMat operates its gypsum processing plant full time. Dewatered gypsum is either conveyed to Temple Inland for use in dry wall production or stockpiled and later hauled by truck to the gypsum disposal area.

After the gypsum slurry from the plant scrubbers is screened at SynMat the resultant low-concentration mix of gypsum “fines” is pumped to a small collection pond adjacent to the existing bottom ash pond. The mix is allowed to settle and the gypsum is regularly excavated then trucked to the gypsum stacking area. “Rejects” or the unwanted fractions of the screening process from SynMat are also regularly trucked to the stacking area.

The only exceptions to the process described above are when the SynMat filter plant must shut down temporarily due to power outages or mechanical problems. At those times, the full gypsum slurry flow is diverted to the gypsum stack. Over the past six months, full gypsum slurry flow has been diverted to the stack on 70 occasions, for an average duration of approximately 1 hour each occasion.

4. Scope of Work

The scope of the geotechnical exploration was divided into the following tasks.

a. Review of Available Information

b. Review of General Site Geology

c. Subsurface Exploration

d. Field Instrumentation and Monitoring

e. Surveying

f. Laboratory Testing

g. Review of Existing Conditions and Previous Repairs

h. Engineering Analyses

i. Conceptual Design of Repairs

The work performed as part of these tasks is described in the following paragraphs

5. Review of Available Information

5.1. General

As part of the facilities assessment (Phase 1) project, Stantec reviewed documents provided by TVA pertaining to the waste disposal area.

5.2. Reviewed Documents

Below is a summary of the documents reviewed for the geotechnical exploration.

Table 2. List of Documents Reviewed for Geotechnical Exploration

Reference No. (1)	Document Name	Type of Document	Dated	Agency	TVA Reference No.
1	Ash Dike Raising, Borrow Areas B & D	Memo	June 16, 1981	TVA	CDB 81 0619 005
2	Ash Pond Pressure Grouting Records	Grouting Records	3/1991 – 8/1991	TVA	
3	Ash Pond Dikes - Chronological Events	Memo	January 17, 1992	TVA	N/A(2)
4	Recommendations for Stability Improvement	Letter	March 13, 1992	Law Engrg	N/A(2)
5	Evaluation of Water Resource Impacts from Proposed Disposal Facilities at CUF	Report	August, 1992	TVA & GeoTrans	WR28-2-46-106
6	Stacking Plan Scopes	Scope Memos	April 12, 2000	TVA	N/A(2)
7	Operations Manual	Manual	September, 2003	TVA	IDL811020082
8	Dry Ash and Gypsum Stacking Areas	Drawings	October 10, 2003	TVA	10W302-1 to 27
9	Wastewater Flow Schematic – NPDES Permit No. TN0005789	Schematic	May, 2005	TVA	N/A(2)
10	Project Updates	Memos	May, October, 2007	Geosyntec	N/A(2)
11	Report of Geotechnical Exploration, Gypsum Area Seepage Study	Report	May 1, 2007	Mactec	N/A(2)
12	Notebook of Kelly E. Evans: Gypsum Stack Seep Next to Ash Sluice Discharge	Notebook	November 5, 2008ff	TVA	N/A(2)
13	2009 Annual Inspection of Waste Disposal Areas(3)	Report	February 11, 2009	TVA	N/A(2)
14	Reports of Annual Waste Area Inspections	Reports	1972 - 2008	TVA	Various

(1) Presented as attachment in Appendix A

(2) TVA Reference Number Not Applicable

(3) Copies of annual reports received from TVA are not included with the report due to space constraints

Contained in Appendix A is a chronological list of geotechnical reports of explorations performed at the Cumberland Fossil Plant waste disposal area. The list was compiled during the review of TVA documents. A short summary of each item in Table 2 appears below.

Item No. 1 Ash Dike Raising, Borrow Areas B & D – This memo from the chief of the Construction Services Branch reports borrow area soil boring and laboratory soil testing results for soil used in raising the original perimeter dike of the ash disposal area.

Item No. 2 Ash Pond Pressure Grouting Records – Daily records of the pressure grouting of over 5,000 feet of the foundation of the ash pond dike in 1991.

Item No. 3 Ash Pond Dikes – Chronological Events – A brief history is given by K.W. Burnett, manager, Civil Section One, Fossil Engineering, of the ash pond dikes from construction in 1969 to the October, 1991 pressure grouting of the dike foundation in a memo to Gary Nuyt.

Item No. 4 Recommendations for Stability Improvements, Ash Pond Dike System – The letter from a consulting firm is an addendum to a 2003 geotechnical exploration they performed. Additional information was provided and more stability analyses were performed. Recommendations for increasing dike stability were also given in the letter.

Item No. 5 Evaluation of Water Resource Impacts from Proposed Disposal Facilities – The report states results of analyses performed to determine the impact of leachate generation from the waste disposal facilities on the water quality of the Cumberland River. A geologic buffer was also modeled to determine its effectiveness in minimizing leachate generation. Design alternatives for the gypsum complex, the dry ash stack and closure of the facilities were considered.

Item No. 6 Stacking Plan Scopes – This document outlines the preparations to be made in developing the dry ash stack and gypsum complex. Major scope items include: document preparation, exploration, dredging plan, sampling, analysis of stacking materials, cost estimation and scheduling.

Item No. 7 Operations Manual, Dry Ash and Gypsum Stacking Facility – The manual contains sections on site information, description of the solid waste, general site preparation, daily operations, surface water management and geologic buffer system. It also contains sections on the gas control system, groundwater monitoring, environmental protection, closure and post closure and quality assurance/quality control. Appendices contain specifications, calculations, studies, regulations, policies, and miscellaneous information.

Item No. 8 Dry Ash and Gypsum Stacking drawings. These drawings are for construction of the disposal facilities of the Flue Gas Desulfurization Retrofit Project of 2003. They show existing conditions, boring layout and the proposed construction in eight stages. Final grading, cross-sections and details are also shown in the drawings.

Item No. 9 Wastewater Flow Schematic for NPDES Permit No. TN0-005789 – This one-page schematic flow diagram shows amounts and sources of drainage and process water flows in millions of gallons per day. The schematic shows intake of 2096.877 MGD gallons with 2097.062 MGD flowing out to the Cumberland River.

Item No. 10 Project Updates – This document is a hard copy of a slideshow presented in May, 2007. Results of soil borings and groundwater monitoring program of 2006/2007 were presented. The results of stability and seepage analyses were also discussed. A design of remedial measures was proposed.

Item No. 11 Report of Geotechnical Exploration, Gypsum Area Seepage Study – This report contains findings from a geotechnical exploration conducted at a seepage area in the southwest corner of the gypsum complex in 2005. Boring, laboratory test and well installation results are discussed.

Item No. 12 Notebook of Kelly E. Evans: Gypsum Stack Seep Next to Ash Sluice Discharge - This volume includes field notes of observations and events of a seep observed in November/December, 2008. It also contains messages, action lists, photographs and drawings. The results of slope stability analyses are also included in the binder.

Item No. 13 2009 Annual Inspection of Waste Disposal Areas – Prepared by Stantec, the report contains the results of an annual inspection of the waste disposal areas at Cumberland Fossil Plant. The pages contain descriptions, observations and recommendations for the Coal Yard Drainage Basin, Chemical Treatment Pond, Active Ash Pond, Dry Ash Stack, Wet Gypsum Stacking Area and the slough beside Highway 233, including associated ditches, dikes, roads and effluent points.

Item No. 14 Reports of Annual Waste Area Inspections, 1972-2008 – These annual reports were prepared by various persons within TVA. The reports contain the results of an annual inspection of the waste disposal areas (as they existed at the time of the inspection) at Cumberland Fossil (or Steam) Plant. Also included is the 2007 (performed 2006) Annual Ash Pond Dike Stability Report and Quarterly Red Water Seep Inspections as well as the 2008 (performed 2007) Quarterly Red Water Seep Inspections. A copy of the Dredge Report for the Coal Yard Runoff Pond is also included in the binder.

5.3. Design Drawings

The Dry Ash and Gypsum Stack were originally designed in 1993. TVA cannot locate the original drawings but obtained a scanned copy of the proposed final stack configuration from TDEC. This drawing was used as the basis for the analysis of future buildout conditions discussed in Section 12.2.10.

One set of reduced-sized drawings were included in the documents obtained from TVA during Phase 1. The drawings were entitled “Dry Ash and Gypsum Stacking Area, Stages 1 through 8, TVA Fossil and Hydro Engineering" dated October 10, 2003 and included Drawing Nos. 10W302-1 through 10W302-27. The drawings were part of Law Engineering’s 1992 geotechnical exploration report on the FGD Retrofit Project for Units 1 and 2 and were used in the TVA Operations Manual revised in 2003. Copies of the drawings are contained in Appendix A. It is understood that these drawings were not approved by TDEC.

The 2003 drawings show 8 stages of disposal area development ending in final preparation of areas for total build-out of both the gypsum and fly ash stacks. The drawings show the construction within Ash Disposal Areas Nos. 1A (inactive), 2 and 2B (sluicing operations). Modifications also included the construction of the Retention Pond out of Area 2 with no modification of the Stilling Pond, which has remained unchanged.

Copies of a few of the original construction drawings of the waste disposal area were found with miscellaneous memorandums and with a few of the annual reports. Sheets 10N212 through -214, 10N218, 10N224 and 10N225 were used to show particular aspects of the facilities and are contained in Appendix A. No drawings marked “As-Built” or similar were found.

5.3.1. **Proposed Design of Ash Disposal Area**

Portions of the Ash Disposal Area were to be built during Stages 2, 4, 7 and 8. During Stage 2 and within Ash Disposal Area 2 the Structural Dike (Top Elev. 394.5 feet) between the Retention Pond and the Fly Ash Stacking area was to be built. The Bottom Ash Dredge Cells, Wastewater Ditch and a 10-acre Dry Fly Ash Disposal Area were to be constructed during Stage 4. Preparation for a 20-acre Dry Fly Ash Disposal Area was planned for Stage 7. The preparation for a 60-acre Dry Fly Ash Disposal Area was to occur in Stage 8. Improvements in Stages 4, 7 and 8, the preparation for the 10-, 20-, and 60-acre Ash Disposal Areas lie within what is now called the Dry Fly Ash Stack.

However, a note on the drawings states “Dry ash stages were not constructed in the sequence shown. Dry ash disposal area has proceeded east to west as a continual development.” This note was likely added to the drawings for use in the Operations Manual.

The Operations Manual indicates the Disposal Area was prepared by constructing a bottom ash blanket drain 4 feet thick. As the stack expanded the blanket was extended as needed. Ash is reclaimed from settling basins then stacked in lifts. Side slopes of the stack are to be 3H:1V and have intermediate 15 feet wide benches every 30 vertical feet for drainage control.

5.3.2. **Proposed Design of Gypsum Disposal Complex**

The Gypsum Stacking Area improvements were scheduled for Stages 1, 2, 3, 5 and 6. During Stage 1 the 80-acre Gypsum Stacking Area including Separator Dike and Spillway was to be constructed. The construction of the north and west dikes were scheduled for Stage 2. During Stage 3 the southern dike construction was planned. Placement of dredged material up to Elevation 400.0 in the south end of the stacking area (in the former wastewater holding basin) was to occur in Stage 5 to expand the stacking area to 132 acres. Stage 6 included the completion of the Drainage Trenches and Blankets and the Blanket Drain Ditch around the perimeter of the stacking area.

Stacking was to be accomplished by use of the rim ditch method after sluicing gypsum slurry to the stack. The coarser fraction of the gypsum was to be placed and compacted toward the outer edge of the stack. The finer fraction was to be placed and compacted toward an interior area.

Side slopes of the stack were to be 3H:1V and have intermediate 15 feet wide benches every 30 vertical feet for drainage control.

6. Site Geology

6.1. General

The Physiographic Regions of Tennessee Map (Tennessee Department of Environment and Conservation (TDEC)) indicates that the project site is located in the Western Highland Rim of Middle Tennessee. Underlying bedrock of the region is chiefly Mississippian limestone, chert, shale, and sandstone with exposures of Devonian, Silurian, Ordovician, and Cambrian limestone, chert, and shale. In the northern part of the Western Highland Rim, caves and other karst features may be present. The ground surface elevation in the vicinity of the project ranges from approximately 360 feet to 650 feet above mean sea level.

The Generalized Geologic Map of Tennessee (Tennessee Department of Environment and Conservation, 2009) indicates that the areas surrounding the project site are underlain by rock of Mississippian age. In the immediate vicinity of the project site, rock of Ordovician age predominates.

6.2. Soils

The soil survey (Web Soil Survey of Stewart County, Tennessee, United States Department of Agriculture (USDA), 2009) indicates that the soils surrounding the Cumberland Fossil Plant are Silt-Loams or Silty Clay-Loams of the Nolen, Sengtown, Bodine, Egam, Maury, Lindside, Melvinville, Byler and Wolftever Associations. These soils are described as moderately deep to deep, moderately well to well drained, moderately sloped soils that formed from the weathering of interbedded sedimentary rock. These soils generally range from silt loam to clay loam in texture. Typical USCS soil classifications of these soil types are CL, CL-ML, SM, GC and GM.

6.3. Bedrock Geology

The Cumberland Fossil Plant is underlain by bedrock primarily of Ordovician age, with smaller amounts of Silurian and Devonian aged rock. The plant is situated in an ancient meteorite impact crater just north of the impact zone. This event has produced a large variation in the contour of the bedrock below the facility as well as several mapped faults.

According to the Geologic Map of the Cumberland City Quadrangle (USGS 1968, revised 1986), the complex site is predominantly underlain by bedrock belonging to the Mannie Shale, Fernvale Limestone, Hermitage, Carters, Lebanon, Ridley, Pierce and Murfreesboro Limestone Formations, in general order of descending geology. Each of these formations is of Ordovician age and is comprised of limestones that may be described as thin to thick bedded, greenish-gray to gray, coarse to crystalline grained, argillaceous and hard. The Hermitage Formation also contains thin bedded to laminated gray sandy shale and the Mannie Shale Formation contains shale and limestone interbedded.

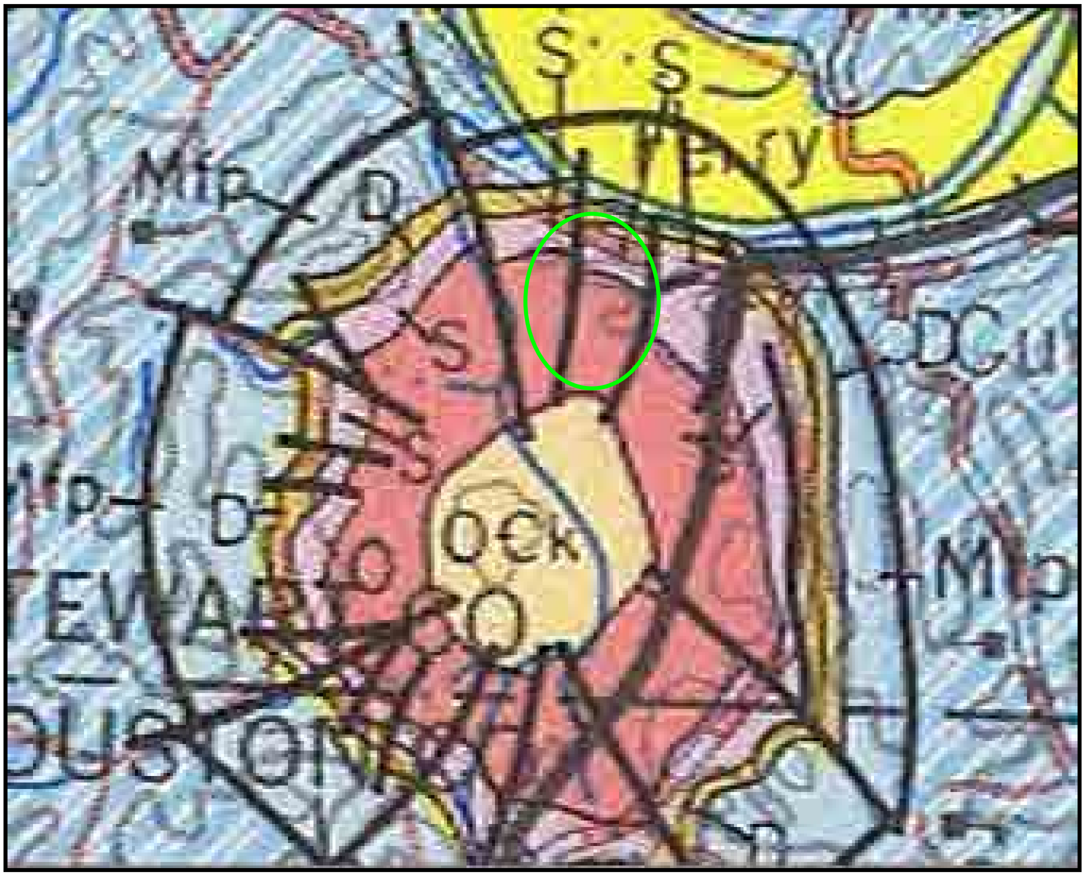

Figure 4. **Portion of Geologic Map with Approximate Location of Cumberland Fossil Plant Indicated (USGS Geologic Map of the Cumberland City Quadrangle (1966, revised 1986).**

6.4. **Hydrology and Hydrogeology**

Surface water migrates along natural drainage swales and diversions along local hillsides. The Cumberland River and Wells Creek, which bound the project area, together with their respective tributaries collect the surface water and drain the groundwater from this area. The water levels in the Cumberland River and Wells Creek are generally maintained between 357 feet and 360 feet elevation. These bodies of water flow generally northward and are part of the Lake Barkley watershed.

Groundwater migrates through both primary and secondary porosity at the site. Groundwater seeps into the alluvium, residual soils and/or unconsolidated material within the project area. Some of that water migrates along the top of bedrock, saturating the interface between the top of bedrock and unconsolidated material, until the groundwater seeps into the bedrock or finds a fracture or joint to follow. Below top of bedrock, the water migrates through the fractures, joints, bedding planes and other voids in the bedrock. The groundwater eventually intercepts the existing groundwater in the area and/or eventually flows to the surface at a lower elevation. Water levels encountered in borings are discussed in Section 7.4 of this report.

7. Subsurface Exploration

7.1. General

Stantec performed the fieldwork for the geotechnical exploration from April through July, 2009. The exploration consisted of test borings, sampling, rock coring, instrumentation and backfilling. The work was performed around and on the Dry Fly Ash Stack and Gypsum Disposal Complex. Borings to explore conditions around the Retention and Stilling Ponds were performed as part of a separate project and the results will be presented in a separate document later. Stantec drilled 74 soil test borings and advanced 17 cone penetrometer test (CPT) borings mainly atop the dike system of the two waste areas. The locations were chosen by Stantec to be along pre-determined cross-section alignments and at locations where dike materials were believed to be deepest. The boring locations were surveyed by TVA after drilling. The locations are shown on the boring layout in Appendix B.

The borings were drilled using both 3¼- and 4¼-inch inside diameter hollow-stemmed augers powered by a truck-mounted drill rig. A 6-inch diameter roller bit was also used with a mud-rotary technique to drill certain borings in order to obtain undisturbed tube samples with fewer disturbances.

In the soil test borings continuous standard penetration tests (SPT's) were performed in accordance with ASTM D1586 until natural materials were encountered, after which SPTs were continued at 2.5-foot intervals. The results of SPT testing are presented on the boring logs included in Appendix C.

After soil borings with SPT samples were drilled and an understanding of the subsurface profile at a particular location was obtained, offset borings were advanced. The offset borings were used to obtain undisturbed, thin-walled (Shelby) tube samples in particular materials at specific depths. Thin-walled (Shelby) tube samples were obtained in accordance with ASTM D 1587. Sample depths and percent of recovery are presented on the boring logs.

In addition to the samples described above, disturbed bag samples of soils, typically consisting of auger cuttings obtained from the borehole during the drilling process, were also taken for laboratory testing. The samples consisted of gypsum, gypsum rejects, fly ash, bottom ash, original dike material and "raised dike" material.

A Stantec geotechnical engineer or geologist directed the drill crews, logged the subsurface materials encountered during the exploration and collected soil samples. During field logging particular attention was given to the material's color, texture, moisture content and consistency or relative density.

Rock coring was performed in selected borings using NQ2-size (2-inch diameter) wire-line coring equipment. Core runs began at top of weathered rock and were either 5 or 10 feet in length. Upon retrieval, the core was extracted and sequentially placed in a core storage box and labeled.

CPT borings were conducted at offset locations to borings as shown in the list of borings in Table 3 and the site plan in Appendix B. Cone penetration testing was performed by advancing an integrated electronic seismic piezo cone within the soil-like overburden materials to measure tip resistance, sleeve friction and dynamic pore pressure at roughly one-inch intervals. In addition, pore pressure dissipation testing was performed at selected intervals. The logs and correlations of the CPT borings are included in Appendix D.

The onsite representative then logged the core noting its physical appearance, integrity and bedding characteristics. The amount of core recovered from the operation was also noted and expressed in the log as a percentage recovered. The Rock Quality Designation (RQD) value, a simple, quantitative indication of rock competency, was determined for each coring run by adding the length of all naturally occurring pieces in a run greater than 4 inches and dividing by the length of the total run. The resultant is expressed as a percentage.

Upon completion of drilling, the boreholes without instrumentation were backfilled using a mixture of Portland cement and bentonite clay. Boreholes with piezometers received a quartz sand filter pack around the piezometer, a bentonite seal above the sand then backfill with the cement and bentonite mixture. Boreholes with slope inclinometers were backfilled with high-solids cement-bentonite grout placed by tremie pipe to displace cuttings and drilling fluid. Soil auger cuttings were disposed of by plant personnel.

Following the field exploration, the SPT samples, Shelby tubes and bag samples were transported to Stantec's (or certified vendor's) laboratory for testing. The remnant samples will be available for review up to thirty (30) days following testing and the submittal of the final version of this report, at which time the samples will be discarded unless prior arrangements have been made with Stantec.

7.2. **Summary of Borings**

A boring layout drawing is presented on a drawing included in Appendix B. Typed boring logs are presented in Appendix C. A summary of boring information is presented in Table 3, where all measurements are expressed in feet.

Table 3. Summary of Borings

Boring No.$^{(1)}$	Northing$^{(2)}$	Easting$^{(2)}$	Top of Hole (Elevation)	Bottom of Hole (Elevation)	Bottom of Hole (Feet)
STN-1	731,972.89	1,510,623.03	392.6	362.6	30.0
STN-2	731,620.35	1,510,594.16	406.5	302.6	103.9
STN-3	732,139.24	1,509,478.38	394.8	322.8	72.0
STN-3A	732,139.24	1,509,474.38	394.8	356.8	38.0
STN-4	731,897.61	1,509,866.05	393.9	314.6	79.3
STN-5	731,525.23	1,509,330.56	377.9	328.2	49.7
STN-6	731,522.23	1,509,376.77	394.3	329.3	65.0
STN-7	731,468.66	1,509,521.56	402.7	322.8	79.9
STN-8	730,646.60	1,509,359.17	380.8	337.5	43.3
STN-9	730,659.51	1,509,396.49	394.7	337.9	56.8
STN-9 A	730,655.56	1,509,398.56	394.7	335.7	59.0
STN-9 B	730,663.13	1,509,394.84	394.7	378.7	16.0
STN-10	730,721.30	1,509,488.66	397.1	336.9	60.2
STN-11	730,171.02	1,509,771.93	378.8	313.7	65.1
STN-12	730,206.65	1,509,805.16	394.8	311.5	83.3
STN-13	730,257.53	1,509,873.48	396.5	321.3	75.2

Boring No.[1]	Northing[2]	Easting[2]	Top of Hole (Elevation)	Bottom of Hole (Elevation)	Bottom of Hole (Feet)
STN-14	729,668.17	1,510,309.27	379.0	312.2	66.8
STN-15	729,710.31	1,510,333.99	395.0	312.8	82.2
STN-15 A	729,713.11	1,510,331.12	395.0	355.0	40.0
STN-15 B	729,715.91	1,510,328.25	395.0	312.7	82.3
STN-16	729,763.04	1,510,385.22	397.8	313.3	84.5
STN-17	729,839.12	1,510,498.97	428.4	311.0	117.4
STN-17 A	729,842.82	1,510,494.59	428.4	356.4	72.0
STN-18	729,626.30	1,511,020.93	401.2	335.6	65.6
STN-19	729,567.00	1,511,146.57	410.9	359.4	51.5
STN-19 C	729,562.64	1,511,144.49	410.9	388.9	22.0
STN-20	729,545.69	1,511,210.45	419.3	363.8	55.5
STN-21	728,813.36	1,510,875.59	395.1	351.6	43.5
STN-21 A	728,808.93	1,510,877.54	410.2	362.2	48.0
STN-21 B	728,804.50	1,510,879.50	410.2	332.2	78.0
STN-22	728,838.52	1,510,961.21	410.2	318.2	92.0
STN-22 A	728,829.60	1,510,964.76	395.1	334.4	60.7
STN-22 C	728,834.06	1,510,962.99	395.1	371.1	24.0
STN-23	728,291.47	1,511,590.83	420.7	321.2	99.5
STN-24	728,215.90	1,511,562.59	410.4	319.9	90.5
STN-24 C	728,217.51	1,511,558.03	410.4	392.4	18.0
STN-25	728,130.72	1,511,539.43	395.4	318.1	77.3
STN-26	728,079.09	1,511,517.81	380.6	320.2	60.4
STN-27	728,342.65	1,512,519.26	422.2	334.3	87.9
STN-28	728,264.15	1,512,555.40	410.6	339.4	71.2
STN-28 A	728,265.77	1,512,559.91	410.6	356.6	54.0
STN-28 B	728,262.26	1,512,550.95	410.6	391.1	19.5
STN-28 C	728,260.38	1,512,546.50	410.6	394.1	16.5
STN-29	728,179.37	1,512,587.54	395.2	334.9	60.3
STN-29 A	728,181.10	1,512,591.60	395.2	338.3	56.9
STN-29 B	728,177.54	1,512,583.48	395.2	378.7	16.5
STN-30	728,119.63	1,512,564.49	379.7	340.0	39.7
STN-31	728,180.44	1,513,622.99	422.5	351.6	70.9
STN-32	728,155.57	1,513,707.59	410.7	350.3	60.4
STN-33	728,122.27	1,513,797.59	395.4	341.1	54.3
STN-34	728,103.27	1,513,844.16	378.7	354.0	24.7
STN-35	728,903.76	1,513,833.70	425.7	357.8	67.9
STN-35 A	728,899.92	1,513,832.70	425.7	377.7	48.0
STN-36	728,879.61	1,513,930.45	411.2	359.5	51.7
STN-36 A	728,875.02	1,513,928.98	411.2	365.2	46.0
STN-36 B	728,883.94	1,513,932.09	411.2	390.2	21.0
STN-37	728,853.00	1,514,022.47	395.2	356.9	38.3
STN-37 A	728,848.41	1,514,021.00	395.2	360.2	35.0
STN-37 B	728,857.33	1,514,024.11	395.2	377.7	17.5
STN-38	728,840.42	1,514,066.12	380.0	359.8	20.2
STN-39	729,874.75	1,513,445.67	395.9	376.7	19.2
STN-40	729,801.23	1,513,385.97	411.3	379.4	31.9
STN-41	729,715.15	1,513,343.22	422.6	376.6	46.0
STN-42	730,342.74	1,512,760.25	396.2	353.6	42.6
STN-43	730,394.20	1,512,495.22	411.3	349.3	62.0

Boring No.[1]	Northing[2]	Easting[2]	Top of Hole (Elevation)	Bottom of Hole (Elevation)	Bottom of Hole (Feet)
STN-43 A	730,397.50	1,512,491.36	411.3	345.6	65.7
STN-44	730,328.91	1,512,450.02	419.5	345.6	73.9
STN-45	730,351.51	1,511,970.28	411.6	348.4	63.2
STN-45A	730,351.38	1,511,965.25	411.66	391.66	20.0
STN-45B	730,346.02	1,512,020.28	411.6	396.6	15.0
STN-45C	730,345.72	1,512,070.28	411.6	396.6	15.0
STN-46	730,307.77	1,511,950.82	420.3	346.7	73.6
STN-46A	730,309.78	1,511,946.44	420.3	399.3	21.0
STN-63	730,171.50	1,509,773.10	379.0	359.0	20.0
Cone Penetrometer Test Borings					
STN-64	729,396.89	1,510,532.03	379.3	353.8	25.5
STN-65	729,791.10	1,510,179.24	379.8	355.1	24.7
STN-66	730,179.49	1,509,764.23	379.0	346.3	32.7
STN-67	731,487.75	1,509,327.79	378.4	345.4	33.0
STN-68	731,848.23	1,510,340.93	396.1	357.0	39.1
STN-69	731,860.16	1,509,967.60	392.4	324.2	68.2
STN-70	730,986.46	1,509,851.43	428.1	330.2	97.9
STN-71	729,958.36	1,510,375.99	427.2	324.4	102.8
STN-72	729,727.44	1,511,067.07	401.4	368.0	33.4
STN-73	729,588.29	1,511,238.50	419.3	351.9	67.4
STN-74	730,325.68	1,512,461.37	419.9	395.0	24.9
STN-75	730,184.63	1,512,659.31	420.6	382.1	38.5
STN-76	728,563.33	1,513,742.62	424.5	352.8	71.7
STN-77	728,286.09	1,513,112.60	421.8	347.1	74.7
STN-78	728,161.70	1,512,113.05	421.7	371.8	49.9
STN-79	728,475.41	1,511,251.81	418.1	365.7	52.4
STN-80	729,115.32	1,512,685.30	423.4	363.2	60.2

7.3. Subsurface Soil Conditions

Thirteen primary soil horizons have been identified using soil boring results and available historical documents from TVA archives. Below are brief descriptions of the horizons. Two-letter classification codes (CL, SM, SP, etc.) in the descriptions refer to the Unified Soil Classification System (USCS).

<u>**Coal Combustion Products:**</u>

- <u>Fly Ash</u> – Classifies as silt (ML) or silt with sand/silty sand. Light gray to black or gray brown, silt to clay-sized grains, dry to wet. Soft to very stiff. Lenses of bottom ash or lean clay may be present.
    - o <u>Fly Ash (Sluiced) or Fly Ash/Bottom Ash (Sluiced)</u> – Saturated fly ash, bottom ash, or a laminated zone of both that is wet to saturated, probably hydraulically placed, soft to medium stiff. Fly ash alone classifies as silt (ML). The fly ash/bottom ash (sluiced) was visually classified as silty sand with gravel (SP), silty sand (SM), and sandy lean clay (CL). For purposes of slope stability analyses, a distinction was not drawn between sluiced fly ash and a combination material of

sluiced fly ash and bottom ash. Definite zones were unclear. Sluiced fly ash properties were conservatively assumed for both materials.

  - Fly Ash (Stacked) – Distinct from sluiced fly ash based on higher blow counts, lower moisture contents, and stronger cone penetrometer test (CPT) results. It appears some compactive effort was used during placement of this material.

- Bottom Ash – Segregated and stacked bottom ash. Classifies as a silty sand with gravel (SP) or silty sand (SM). Dark gray to black, coarse grained, damp to wet, very loose to very dense with occasional interbedded layers of fly ash and clay. Medium sand to gravel-sized grains with some fines. It appears some compactive effort was used during placement of this material. Sluiced bottom ash intermixed with fly ash is modeled as sluiced material (see above).

- Gypsum – Classifies as silt (ML), white to gray brown or tan, medium stiff to very stiff, damp to wet. Material has been placed both by stacking and slucing. Where placed by stacking, it appears some compactive effort was used.

Natural Soils Used In Dike Construction:

- Dike 1 – The original perimeter dike. A lean clay (CL), red brown to gray brown, moist to wet, very soft to very stiff. Occasional gray mottling, with areas of sand or gravel, chert fragments, few organics and manganese concretions. Approximate top of dike elevation is 380 feet.

  Stantec (2009a) identified this zone in most borings surrounding the Dry Fly Ash Stack and Gypsum Stack Complex just above natural ground. It was not found in the borings on the northeast perimeter on the Gypsum Stack Complex near the Coal Yard Runoff Pond and Metal Cleaning Pond. Here, the initial surface topography appeared to be at a higher elevation than the rest of the initial dike structure.

- Dike 2 – The raised dike uphill of the original perimeter dike. It has a crushed stone surface between 0.5 and 1.0 feet deep. Dike 2 was identified by Stantec (2009a) along the outside perimeter of the Dry Fly Ash Stack and Gypsum Stack Complex. It is not found in the divider dikes between the Gypsum Stack Complex, Dry Fly Ash Stack, and Retention Pond. The approximate top of dike elevation is 395 feet. The raised dike has two distinct soil horizons:

  - Dike 2 (Lean Clay) – Lean clay (CL) to lean clay with gravel, some cobbles, light brown to brown, some gray mottling, moist to wet, soft to very stiff.

  - Dike 2 (Fat Clay) – Fat clay (CH) to fat clay with gravel, dark brown to reddish brown, damp to wet, firm to very stiff. This layer is typically near the top of Dike 2 or may compose the complete Dike 2 zone.

- Dike 3 –The starter dike for stacking gypsum. Classifies as clayey gravel with sand (GC) or clayey sand with gravel (SC) with just greater than 50% retained on the No. 200 sieve. Reddish brown to light gray, moist to wet, loose to dense, angular grains. The clay tends to be lean with some borderline fat clay present with manganese concretions. A bottom ash road (from 1.1 to 4.0 feet thick) is located along the dike's crest. The top of Dike 3 is at approximate elevation 410 feet.

Stantec (2009a) identified this zone in borings along the embankment crest surrounding the Gypsum Stack Complex. One exception was Boring 45 located next to the small pond at the northwestern tip of the complex.

- Divider Dike – Located between the Retention Pond and the Dry Fly Ash Stack, this dike has a distinct composition of riprap or boulder zones with a reddish brown silty clay matrix. The clay matrix is light brown to reddish or grayish brown, stiff to very stiff, and moist to wet. Typically, the clay was field-classified as lean with some fat clay present.

Natural Foundation Soils:

- Alluvial (Clay) – Lean clay (CL), silty grading to sandy, manganese concretions, reddish brown to light gray, some gray mottling, soft to very stiff, moist to wet, with rock fragments. Few organics and wood fragments, but typically has a faint organic odor near the suspected natural ground interface.
  - Alluvial (Clay – Soft) – Historical reports denote a separate soft alluvial clay zone.
- Alluvial (Granular) – Varying between silty sand with gravel (SM), (yellowish brown to light gray, moist to wet, very loose to compact, medium to coarse grained, poorly sorted with increasing gravel size) and gravel with clay to silt and sand (GP-GC or GM) (gray, wet, angular, loose to very dense). Some wood fragments with a slight organic odor near the suspected natural ground interface.

Bedrock:

- Interbedded Limestone and Shale – Limestone is light gray, hard, and thick bedded. Shale is light gray, calcareous, moderately hard and laminated. Core recovery ranged from 94 to 100 percent. RQD ranged from 56 to 100 percent. When core was obtained, limestone comprised approximately 50 to 90 percent of the recovery.

7.4. Subsurface Water

Subsurface water was encountered in most of the borings advanced during this exploration. The water level reading was taken after the boring had been drilled but before the installation of instrumentation. Typically, subsurface water was not found in borings advanced purposely to a shallow depth to obtain undisturbed samples. The depths to water noted immediately after drilling are shown on the boring logs presented in Appendix C.

The elevation at which subsurface water was encountered generally varied based on the offset distance from the disposal operations. The borings advanced at the crest of the original dike (Dike 1, elevation 380) encountered subsurface water between elevations 370 feet and 378 feet with a few exceptions. The exceptions were believed to have occurred because of the slow response time of the cohesive soils when compared to the granular deposits in other borings. The borings that were advanced at the crest of Dike 2 (approximately elevation 395 feet) encountered subsurface water at elevations varying from 375 feet to 392 feet. The borings that encountered subsurface water at higher elevations were on the south side of the facility in Sections F and H. Generally, it appears that subsurface water flows in a northeast to southwest direction; following the slope of the bedrock surface. Additional water level readings were and are being obtained from piezometers installed in some of the borings, as discussed in the following section of this report.

8. Field Instrumentation and Monitoring

8.1. General

Stantec's exploration included the installation and monitoring of geotechnical instrumentation. Piezometers and slope inclinometer casings were installed in some of the boreholes to provide data about existing conditions and to provide a baseline for future monitoring efforts. Initial or baseline readings preceded a regular and on-going instrumentation monitoring program.

8.2. Instrumentation

Two types of instruments were installed as part of the geotechnical exploration. These include standpipe piezometers (PZ) and slope inclinometer (SI) casings.

Standpipe piezometers, installed in a borehole, consist of a screened interval of pipe (generally 10-ft) joined to a 1-inch diameter riser pipe. The screened interval was placed in a sand pack and a bentonite seal was placed above the sand to isolate the target pore water pressure reading zone. The annular space between the riser pipe and the borehole was backfilled to the surface with bentonite grout to prevent vertical migration of water. The riser pipe was terminated above ground and protected with either a lockable metal cover or a flush-mounted 6" diameter manhole.

Slope inclinometer casings consist of 2.75-inch outside diameter PVC casing with interior vertical grooves also installed in a borehole. The annular space between the casing and borehole was backfilled to the surface with cement bentonite grout. The casing was terminated above ground and protected with either a lockable metal cover or a flush-mounted 6" diameter manhole. (Lockable covers used in typical installation are shown in Figure 5.) Table 4 provides a summary of the instruments installed. Appendix E presents the PZ and SI instrumentation logs.

Figure 5. Typical Instrumentation (Slope Inclinometers, Piezometers) Installation

Table 4. Summary of Instrumentation

Boring No.	Instrument	Surface Elevation	Tip Elevation
STN-3	SI	394.80	323.8
STN-3A	PZ	394.80	357.3
STN-4	PZ	393.92	354.8
STN-9	PZ	394.68	338.2
STN-9A	SI	394.68	336.7
STN-10	PZ	397.09	357.9
STN-15A	PZ	395.03	356.5
STN-15B	SI	395.03	313.0
STN-16	PZ	397.80	340.8
STN-21	PZ	395.13	356.0
STN-21A	SI	395.13	347.1
STN-21B	SI	395.13	318.1
STN-22A	PZ	410.19	350.8
STN-27	PZ	422.15	355.3
STN-28	PZ	410.57	341.8
STN-29	PZ	395.17	341.2
STN-29A	SI	395.17	338.3
STN-35	PZ	425.65	367.2
STN-36	PZ	411.16	363.2
STN-37	PZ	395.22	367.2
STN-37A	SI	395.22	360.2
STN-42	PZ	396.20	357.2
STN-43	PZ	411.27	374.3
STN-43A	SI	411.27	345.6
STN-44	PZ	419.48	382.5
STN-45A	PZ	411.60	392.9
STN-46A	PZ	420.30	400.3

8.3. Monitoring of Dike Slope Conditions

Stantec is monitoring the instruments installed during the exploration. Water level readings (from PZs) and slope movement data (from SIs) are obtained on a monthly basis and the results are included in Appendix F. PZ readings are taken using a water level indicator and SI readings are obtained using a portable traversing inclinometer designed for this purpose. The first SI survey established the initial profile of the casing and subsequent surveys measure changes in the profile of the casing if movement of the slope has occurred.

Instrumentation readings are currently obtained on a monthly schedule. Future reading schedules may be modified in response to detection of any significant variation in readings. Depending on factors such as the magnitude, location and circumstances of the reading variation, the schedule may be adjusted to read the instruments more often, say, weekly or daily.

Generally, water levels across the site have been steady and varied by a few tenths of a foot between monthly readings. Around the Gypsum Stack Complex, the instruments that are monitoring the water levels in the fly ash show that water levels are at the upper limits of the fly ash strata. The water levels of the remaining instruments around the gypsum stack show lower water levels in the foundation soils and no static water accumulated in the gypsum.

The piezometers along the south side of the dry fly ash stack show the same trends as the piezometers around the gypsum stack. However, three exceptions should be noted. PZ-15 and PZ-21 are showing elevated pore pressure levels that are within five to seven feet of the ground surface. This correlates with the seep that was observed below PZ-21. In addition, PZ-16 appears to be a non-responsive piezometer. Stantec has attempted to develop the well with no change in the reading levels.

Slope Inclinometers have been installed around the perimeter of the site and are being monitored for slope movement. No significant lateral movements have been detected to date.

9. Surveying

9.1. General

Topographic mapping of the Dry Fly Ash Disposal Area and Gypsum Stack Complex was developed from aerial photography provided by TVA. Contour mapping of the bottom of the stilling and retention ponds was developed from a hydrographic field survey, also provided by TVA.

9.2. Aerial Survey

Topographic mapping and aerial photogrammetry were created by Tuck Mapping Solutions Inc., Big Stone Gap, Virginia. The project site was flown April 17, 2009. The base mapping was completed May 19, 2009. Horizontal datum is NAD27 and vertical datum is NGVD29. The coordinate system is Tennessee State Plane and the contour interval of the mapping is one foot. The limits of the topographic mapping as well as control points referenced to the State Plane Coordinates system were established by TVA. The results of aerial survey can be seen on the boring layout presented in Appendix B.

9.3. Topographic Survey

Topographic surveying was performed by TVA to locate the soil and CPT borings. Field cross sections were also taken to provide a check on the aerial mapping.

9.4. Hydrographic Survey

TVA performed a hydrographic survey of the retention and stilling ponds in September of 2008. The results (contour lines) of the hydrographic survey of the ponds are shown on the boring layout Appendix A.

10. Laboratory Testing

10.1. General

Soil and rock samples from the field exploration were returned to a Stantec (or certified vendor's) materials laboratory for inventory and testing. The laboratory tests were performed in accordance with ASTM standard testing procedures. Detailed results of laboratory testing are presented in Appendix G.

10.2. Laboratory Tests Performed

Each soil sample was visually classified and tested for natural moisture content. Engineering classification tests were performed on samples reflecting the main soil horizons. The represented horizons are: gypsum, fly ash, bottom ash, “bottom ash” dike, “raised” dike, “original” dike and foundation soils. A summary of laboratory tests and the corresponding testing standard are presented in Table 5. Not all tests were performed on all samples.

Table 5. Laboratory Tests

Test	Standard
Natural Moisture Content	ASTM D 2216
Particle Size Analysis	ASTM D 422
Dry Density	ASTM D 2166
Shear Strength	ASTM D 4767
Permeability	ASTM D 5084
Atterberg Limits	ASTM D 4318
Specific Gravity	ASTM D 422
Particle Size Analysis	ASTM D 854

10.3. Natural Moisture Content

Natural moisture content tests were performed on all SPT, bag and Shelby tube samples. The results of moisture content determinations are presented in Appendix G.

10.4. Particle Size Analyses, Atterberg Limits and Specific Gravity, Classification

Particle size analyses and Atterberg limits tests were performed on 4 samples of gypsum, 7 of fly ash, 4 of bottom ash, 5 samples from the “bottom ash” dike, 1 from the “raised” dike, 1 sample from the “original” dike and 8 samples from the foundation soils.

Many of the test samples were composite SPT samples. Composite SPT samples consist of materials from different depths but of the same material, as determined through visual classification.

The particle size analyses were performed in accordance with ASTM D-422, “Particle Size Analysis of Soils,” using sieve analysis for the soil fraction greater than 0.074mm (No. 200 sieve size) and hydrometer analysis for the fraction smaller than 0.074mm. The individual grain size distribution curves generated from these tests are presented in Appendix G.

Atterberg limits tests were conducted in accordance with ASTM D 4318 Method A. The liquid limit, plastic limit and plasticity index are reported in Appendix G. The samples were also tested for specific gravity in accordance with ASTM D 854. The results of particle size analyses and Atterberg limits tests were used to classify the soil samples.

The samples were classified in accordance with the Unified Soil Classification Soil System (USCS) and the American Association of State Highway and Transportation Officials (AASHTO) method. The results of the classification testing are contained in Appendix G. Table 6 summarizes the classification testing results.

Table 6. Summary of Classification Testing Results

Material Type		w_0 (%)	G_s	Atterberg Limits			Particle Size Analysis (ASTM) (%)						USCS	AASHTO
				LL	PL	PI	Gravel *(3"- 4.75 mm) (> No. 4)*	Coarse Sand *(4.75-2 mm) (No. 4- No. 10)*	Medium Sand *(2-0.425 mm) (No. 10-No. 40)*	Fine Sand *(0.425 - 0.075 mm) (No. 40-*	Silt *(0.075- 0.005 mm) (<No. 200)*	Clay *(<0.005 mm)*		
Dike 1	*max*	31.1	2.68	56.0	20.0	36.0	42.5	6.3	8.5	4.9	49.0	36.6	GC	A-7-6 (8)
	min	15.8	2.64	36.0	16.0	17.0	1.3	0.8	7.4	2.2	15.0	25.5	CL	A-6 (14)
	average	23.9	2.65	42.2	18.3	23.9	21.9	3.6	8.0	3.6	32.0	31.1		
Dike 2	*max*	91.1	2.81	58.0	22.0	37.0	10.8	4.3	7.9	13.9	34.3	65.0	CH	A-7-6 (23-35)
	min	12.6	2.54	44.0	17.0	25.0	0.3	0.3	2.1	3.2	21.2	37.5	CL	A-7-6 (19-20)
	average	24.6	2.659	50.8	18.7	32.1	5.2	2.6	5.8	8.3	28.4	49.8	CH-CL	A-7-6 (21-27)
Dike 3	*max*	29.7	2.78	48.0	19.0	29.0	44.6	7.9	12.7	8.8	22.5	35.8	GC	A-7-6 (10)
	min	6.5	2.51	36.0	17.0	18.0	23.2	6.6	9.1	6.4	11.7	16.7	GC	A-2-6 (1)
	average	17.9	2.66	39.8	18.0	21.8	31.4	7.1	10.3	7.6	18.3	25.4	GC	A-6 (5-6)
													SC	A-6 (5)
Alluvial Clay	*max*	33.1	2.67	49.0	24.0	31.0	8.0	1.7	4.9	10.7	59.3	46.0	CL	A-6 (8-19)
	min	20.2	2.53	35.0	18.0	12.0	0.0	0.0	1.3	3.1	42.8	28.0	CL	A-7-6 (17)
	average	25.8	2.6125	39.7	20.4	19.3	3.0	0.6	3.3	4.7	49.7	38.7		
Alluvial Granular														
	max	23.4	2.7		NP		54.2	15.4	36.9	18.9	14.3	7.2	GM	A-1-b (0)
	min	19.8	2.62		NP		18.8	8.6	12.7	5.1	5.7	4.1	SM	A-1-b (0)
	average	21.5	2.67		NP		42.9	10.7	20.2	10.1	10.3	5.8	GP-GC	A-1-a (0)
Fly Ash (Sluiced)														
	max	57.1	2.71	45.0	18.0	27.0	8.3	9.4	17.0	23.4	69.7	45.3	ML	A-4 (0)
	min	23.1	2.42	45.0	NP	27.0	0.2	0.1	4.3	4.7	25.3	9.6	CL	A-7-6 (24)
	average	39.4	2.516364	45.0	NP	27.0	2.9	2.2	9.8	12.7	53.9	18.5	SM	A-4 (0)
BA-FA (Sluiced)	*max*	33.6	2.62		NP		20.6	16.5	28.4	18.1	46.5	9.5	SM	A-2-4 (0)
	min	14.4	2.55		NP		7.6	5.4	14.3	16.7	12.8	3.8	SM	A-4 (0)
	average	21.7	2.5975		NP		13.0	10.5	22.3	17.7	30.4	6.1	SM	A-1-b (0)
													ML	A-4 (0)
Gypsum	*max*	22.1	2.94		NP		0.4	0.2	11.1	7.2	83.2	24.1	ML	A-4 (0)
	min	7.2	2.31		NP		0.0	0.0	2.0	5.4	67.5	3.9		
	average	14.3	2.48		NP		0.2	0.1	5.4	6.3	74.4	13.7		
Gypsum Rejects			2.73	33.0	32.0	1.0	0.0	7.4			86.1	6.5	ML	A-4 (0)

10.5. Shear Strength and Unit Weight

Once the Shelby tube samples were extruded, suitable portions representative of selected soil horizons were trimmed for testing. The natural moisture content and both the unit weight wet and unit weight dry was determined for each sample. The test results are presented in Appendix G. Table 7 summarizes the unit weight test results.

Table 7. Summary of Unit Weight Test Results

Material	Boring Number	Test Interval (ft)	g_{wo} (pcf)	w_o (%)	g_{do} (pcf)
Dike 1	B-5	18.0-18.5	119.1	24.3	95.8
	B-5	18.6-19.1	121.5	27.2	95.5
	B-9A	25.5-26.0	126.9	24.9	101.6
	B-29A	29.2-29.7	124.3	23.8	100.3
	B-29A	29.7-30.2	125.6	20.1	104.6
	B-63A	8.0-8.5	125.2	27.1	98.5
	B-63A	8.6-9.1	126.3	20.4	104.8
	B-63A	5.5-6.0	120.2	22.1	98.5
			123.6	**23.7**	**100.0**
Dike 2	B-3A	8.5-9.0	127.4	19.4	106.7
	B-3A	14.5-15.0	125.2	25.1	100.1
	B-3A	14.0-14.5	115.9	28.8	90.0
	B-9B	6.0-6.5	129.6	22.2	106.0
	B-9B	10.1-10.6	131.4	20.9	108.7
	B-21B	20.0-20.5	128.1	24.6	102.8
	B-29A	17.6-18.1	123.4	25.8	98.1
	B-29B	12.0-12.5	124.6	20.0	103.8
	B-29B	12.5-13.0	131.3	21.4	108.2
	B-29B	14.8-15.3	127.5	18.3	107.7
	B-37A	19.5-20.0	117.1	30.0	90.1
	B-37B	8.0-8.5	128.4	22.1	105.2
	B-37B	11.4-11.9	133.1	18.5	112.3
	B-37B	11.9-12.4	127.8	18.9	107.5
			126.5	**22.6**	**103.4**
Dike 3	B-19C	17.5-18.0	128.7	12.4	114.5
	B-19C	10.8-11.3	125.9	17.5	107.1
	B-19C	20.0-20.5	127.3	13.8	111.8
	B-28C	14.5-15.0	121.9	20.0	101.6
	B-36A	13.0-13.5	128.7	14.9	112.0
	B-36B	19.0-19.5	123.3	29.7	95.1
			126.0	**18.1**	**107.0**
Alluvial Clay	B-15B	46.3-46.8	120.3	26.5	95.1
	B-15B	46.9-47.4	121.4	26.9	95.6
	B-29A	50.2-50.7	110.0	33.1	82.7
	B-29A	50.8-51.3	112.9	30.3	86.6
	B-43A	47.5-48.0	128.0	20.2	106.4
	B-43A	50.2-50.7	123.7	25.6	98.5
	B-43A	50.7-51.2	125.0	24.2	100.6
			120.2	**26.7**	**95.1**
Sluiced Ash	B-17A	32.7-33.2	106.2	27.4	83.4
	B-17A	70.0-70.5	104.1	41.1	73.8
	B-28	52.0-52.5	97.4	57.1	62.0
	B-28A	50.0-50.5	100.7	41.4	71.2
	B-28A	52.6-53.1	101.9	52.3	66.9
	B-36A	44.7-45.2	102.8	40.5	73.2
	B-43A	29.0-29.5	104.6	32.0	79.3
	B-43A	29.5-30.3	100.6	39.7	72.0
	B-35A	46.0-46.5	104.8	46.0	71.8

Consolidated-undrained triaxial compression tests were performed on the trimmed samples. All shear strength tests were conducted in accordance with ASTM D 4767. The test results are presented in Appendix G. Table 8 summarizes the consolidated-undrained triaxial compression test results.

Table 8. Summary of Consolidated-Undrained Triaxial Testing

Boring	Depth (ft)	Material Type	Visual Description	γ_{w0} (pcf)	w_0 (%)	c' (psf)	ϕ' (deg)
B-5	18.0-20.0	Dike 1	Lean Clay (CL), brown, moist, soft	119.2	24.3	320	28.7
B-5	18.0-20.0			121.5	25.2		
B-29A	29.0-31.0	Dike 1	Fat Clay (CH), gray brown, moist, firm	125.4	22.5	16.4	36.8
B-29A	29.0-31.0			128.3	21.4		
B-63A	5.0-7.0	Dike 1	Fat Clay with Gravel (CH), red brown, moist, firm	120.0	21	1000	17.7
B-63A	8.0-10.0			125.2	23.1		
B-63A	8.0-10.0			126.4	23.6		
B-29B	12.0-13.4	Dike 2	Lean Clay (CL), red brown, moist, firm	126.4	25.6	0	36.5
B-29B	12.0-13.4			132.8	18.8		
B-29B	14.5-16.5			134.6	17		
B-19C	17.5-19.5	Dike 3	Gravelly Fat Clay (CH), brown, moist, firm	128.6	18	0	31
B-19C	14.5-15.0			123.5	23.6		
B-19C	10.5-12.5			124.8	20.9		
B-43A	50.0-52.0	Alluvial Clay	Lean Clay (CL), dark brown, moist, firm	125.0	24.3	440	30.3
B-43A	50.0-52.0			123.9	24.6		
B-43A	29.0-31.0	Fly Ash (Sluiced)	Silt (ML), gray brown, moist, firm, fly ash	104.5	44.8	0	39.6
B-43A	29.0-31.0			100.9	48		
B-35A	46.0-48.0			104.6	47.6		
Gypsum Bulk			Silt (ML), white to gray brown.	104.5	29.1	90.9	42.5
				103.3	28.9		
				103.9	29.2		
Gypsum Rejects Bulk			Silt (ML), white to gray brown.	102.7	27.2	0.0	44
				102.5	26.9		
				102.5	26.9		
Bottom Ash Bulk			Silty sand with gravel (SP) or silty sand (SM). Dark gray to black, coarse grained.	102.1	16.5	261	41
				102.3	16.1		
Fly Ash Bulk			Silt (ML) or silt with sand/silty sand. Light gray to black or gray brown, silt to clay-sized grains.	87.8	33.6	14.3	36
				88.4	33.8		
				89.0	34.4		

10.6. Moisture-Density (Proctor) Testing

The moisture-density relationship (Proctor) of the soils observed in the “bottom ash” dike and the “raised” dike were determined. One sample from the bottom ash dike and two from the raised dike were tested in accordance with ASTM D 698, Method ‘A’. Table 9 summarizes the moisture-density relationships of the samples.

Table 9. Summary of Moisture-Density Relationship (Proctor) Test Results

Material	Boring	w_{opt} (%)	g_d (pcf)
Dike 2 (Lean Clay)	B-25	18.4	104.4
	B-37	16.6	112.0
Dike 3	B-28	11.0	124.3
Stacked Ash	Bulk Sample	32.7	83.6

Once these values were obtained, they were compared to the unit weights of the Shelby tube samples that were obtained in the same vicinity from where the proctor samples were taken. In Dike 2, the unit weights of the samples ranged from as low as 80 percent to over 100 percent of maximum Standard Proctor. The high unit weights may be attributed to the significant gravel content. The unit weights ranged between 77 and 92 percent maximum standard proctor for Dike 3.

The unit weights of the sampled fly ash were also compared to the Proctor results for the dry stacked fly ash. The unit weights generally ranged between 74 and 92 percent of the maximum Standard Proctor value. Also, the unit weights were generally inversely related to the depth at which the sample was taken. This may be due to the ability of the material near the top of the hydraulically placed fly ash to drain and consolidate under the weight of the added fill material.

11. Review of Existing Conditions and On-Going Repairs

11.1. General

This discussion is limited to the existing conditions of the Fly Ash Stack and the Gypsum Disposal Complex. It does not include discussion of the Detention Pond and the Settling Pond.

This discussion reflects the status of the facilities as of February 2009, except as noted. Since May 2009, all gypsum slurry is being diverted to the Synthetic Materials (SynMat) gypsum processing facility. The only exceptions to this are the fine particulates that are returned to a small pond adjacent to the existing bottom ash pond and slurry pumped onto the stack during fairly brief outages at the SynMat plant as previously described in Section 3.2. For a more detailed description of the existing conditions of the waste disposal facilities refer to the 2009 “Annual Inspection of Waste Disposal Areas” by Stantec and dated February 11, 2009.

Stantec’s Phase 1 Coal Combustion Product Disposal Facility Summaries for the Dry Ash Stack (DS-1) and the Gypsum Storage Area (GSA) contain detailed information about conditions in early 2009. The entire summaries are contained in Appendix H.

A chronology of events from 1969 to 1991 related to the Ash Pond Dikes is contained in a TVA memorandum dated January 17, 1992. The memorandum has been included in Appendix A of this report.

11.2. **Dry Fly Ash Stack**

According to the 2009 annual inspection report by Stantec, the construction of the stack is expanding northward from its present configuration. The current Operation Manual states that filling consists of density-controlled vertical lifts of bottom and fly ash in a manner that controls storm water runoff to prevent erosion. The side slopes are constructed at 3H:1V with intermediate benches at 30-foot vertical increments. The slopes are vegetated using cover soil, mulch and seed. Storm water runoff from the stack is conveyed to the retention pond by way of the perimeter ditch.

A flat-bottomed perimeter ditch is located near the toe of the Ash Stack. It was formed behind Dike 2 (approximate Elevation 395 feet) and varies in width from about 6 to 20 feet. It conveys storm water and seepage runoff to the Detention Pond at the north end of the disposal facility. The gradient of the ditch is slight. One to several feet of water stands in the bottom of the ditch most of the year.

Further, the report states that erosion of slopes and roads and the lack of vegetation in some areas are ongoing problems. In addition, the perimeter ditch flows slowly and is choked with vegetation in stretches. Good stands of vegetation cover the facility for the most part. Stantec observed that overgrowth and tree removal was stepped up during 2009 over previous years. The dike faces in some areas are devoid of topsoil and vegetation and show some signs of erosion. The bare areas are scheduled for re-soiling and re-vegetation.

A letter (Item 4 of Section 5.2 of this report) states that excavated rock from precipitator construction in 1992 was placed in the Ash Pond. The rock was reported to have been placed “adjacent to the interior face of the impoundment dike along the southwestern and western sides of the dike system.” New, compacted fill was placed on top of the rock when the dike was raised. Though possessing strength, the rock, the author of the letter states, provides a ready seepage path to the original dike.

Prior to being converted to a dry fly ash stack, the ash disposal area contained sluiced ash. Historic documents show that seepage through the original dike of the ash disposal area was observed in 1973. In a letter dated August 7, 1974, Gene Farmer of TVA ‘s Construction Services Branch reports the results of a geotechnical exploration. The exploration, consisting of 9 borings, was located at the site of observed dike seepage.

A boring layout accompanying the letter shows the seepage site to be located about 1,000 feet south of the divider dike between the present Detention Pond and Dry Fly Ash Stack. The main cluster of borings at the seepage site can also be described as being about 300 feet north of the construction bridge and at Station 30+00 (on a baseline along the original ash pond dike) on some plans contained in TVA historic drawings.

Surface elevations of some of the borings indicate that the top of the dike was at Elevation 381 feet at the time of drilling. Mainly, a layer of soft, saturated topsoil was encountered from Elevations 360 to 363 feet and was suspected of being the medium for seepage of ash pond water. Reportedly, a stabilizing layer of gravel that was used in some soft areas during construction of the original dike was not encountered. The water level in the ash pond was at Elevation 367.5 feet and Wells Creek was at Elevation 359.9 feet at the time of the exploration.

According to a January 17, 1992 TVA memorandum by K.W. Burnett, Fossil Engineering, a project was submitted in FY 1991 for pressure grouting the ash pond dike in order to stabilize it and address seepage. Historical field records of the grouting were reviewed by Stantec.

A summary sheet accompanying copies of the reports given to Stantec indicates that grouting with cement began January 3, 1991 and ended August 29, 1991. Holes were drilled between Stations 0+00 and 54+26, centerline original ash dike (Elevation 380 feet). Grout “takes” ranged between 1 and 304 cubic feet.

The field reports also indicate that the grout holes were usually spaced 7 feet apart in known seepage areas and 14 feet apart elsewhere, with density of the grouting holes increased in areas of larger takes. Holes usually ranged from 30 to 40 feet deep, but a few were up to 55 feet deep.

11.2.1. **Dredge Cell for Coal Yard Drainage Basin Fines on Dry Ash Stack**

The 2007 annual TVA report on dike stability of the waste area recommended that the Coal Yard Drainage Basin should be dredged of fines. The 2008 TVA report stated that this was done and the fines deposited in a dredge cell on the Dry Ash Stack. Approximately 50,000 cubic yards of coal fines were sluiced to a cell on the stack. As reported in a letter to TVA dated February 9, 2009, Stantec evaluated the stack to determine whether the placement of the coal fines would significantly affect the stability of the slopes of the final stack configuration.

Stantec’s slope stability analysis using assumed parameters and boundary conditions found the coal fines did not have a significant impact on the overall slope stability and did not have to be removed from the stack. To ensure free drainage and meet the drained condition assumption, Stantec recommended that parallel trenches be excavated across the dredge cell. The trenches would be filled with more permeable bottom ash to drain pore water from the fines. The work plan was issued on March 16, 2009 (TVA Reference No. CUF-WP-090316) and completed on April 24, 2009.

11.3. **Gypsum Disposal Complex**

Gypsum slurry has been rerouted from the stack as described previously. Dewatered gypsum is hauled to and spread on the stack. In addition, gypsum fines that make it to the small pond next to the bottom ash pond, are removed by excavators every few days and disposed of on top of the stack. Gypsum slurry is only routed to the stack when the SynMat plant must be taken off line for a limited time.

As with the Dry Fly Ash Stack, the Complex is ringed with the flat-bottom perimeter ditch. It was also formed behind Dike 2 (Elevation 395 feet) and varies in width from about 6 to 20 feet. It conveys storm water and seepage runoff to the perimeter ditch of the Dry Fly Ash Stack.

The gradient of the ditch is slight to non-existent. One to several feet of water stands in the bottom of the ditch most of the year. Some stretches of the ditch are choked with vegetation and some areas of the clay dikes below the ditch are eroded. Vegetation removal efforts have been significantly increased during the course of the past year. The outside face of the gypsum perimeter dike has not been covered with topsoil and re-vegetated.

Perimeter clay dikes, trapezoidal in cross section, are used to contain gypsum slurry on the gypsum disposal complex. Three clay dikes have been constructed. Initially, the dikes contained sluiced ash, before the area was converted to a gypsum disposal area.

In this report the lowest and first dike constructed is referred to as Dike 1. The approximate crest elevation for Dike 1 is 380 feet. Once sluiced bottom and fly ash reached a particular elevation against Dike 1, Dike 2 was constructed upon Dike 1 and sluiced ash to enable more waste product to be sluiced and contained. The approximate crest elevation of Dike 2 is 395 feet. The outside toe of Dike 2 abuts the inside top of Dike 1 allowing contact between dike materials, thus creating a hydraulic barrier to contain the sluiced ash.

Above Dike 2 is Dike 3, with an approximate crest elevation of 410 feet. Due to its surface layer of bottom ash, Dike 3 is commonly referred to as the “Bottom Ash Road Dike”. It is built upon sluiced ash deposits. The toe of Dike 3 does not abut Dike 2. The perimeter ditch is constructed at the toe of Dike 3. So, Dike 3 is “set back” from Dike 2, not allowing contact between the materials of Dike 2 and 3. In some locations ash can be seen in the perimeter ditch because of the lack of contact between the materials of Dikes 2 and 3. The exposed ash layer is an active seepage path.

Uphill from Dike 3 is the Gypsum Dike. The Gypsum Dike is founded upon sluiced ash deposits. In several of Stantec’s borings, a granular drainage layer, approximately 2 feet thick, was observed between the gypsum and the underlying sluiced ash. The crest of the Gypsum Dike is at approximate elevation 420-422 feet.

A relatively small landslide occurred in Dike 1 and Dike 2 below the southwest corner of the gypsum stack sometime in 2005. The failure was confined to the surrounding earth dikes and no CCP’s were released to Wells Creek. Seepage was noted in the slide area. The area was reinforced with riprap and numerous borings were performed by others. Piezometers were also installed in this area and are monitored weekly by TVA personnel. A summary of the piezometer data is presented in Appendix I. Based on the material encountered during the explorations and the continued high piezometer readings, Stantec recommended that a permanent repair be constructed in this area. Several meetings were held to discuss the repair approach that best fit the failed area and it was decided by TVA and Stantec that a seepage collection system and rock toe buttress should be constructed. Stantec then prepared construction plans for the installation of a seepage collection system and rock toe buttress in this area. Construction is scheduled to begin in June 2010.

The slope repair will consist of a buried seepage collection system and rock toe buttress. The collection system will consist of a perforated pipe bedded in sand and connected to an outlet pipe to Wells Creek. A temporary sump will collect seepage from the outlet pipe and convey it to the perimeter ditch until an NPDES permit is obtained for a new discharge point.

Dual electric pumps will empty the sump. A natural gas-powered generator placed nearby will power the pumps. A nearby control panel will contain an automatic telephone dialer system to notify TVA of sump system failure. The rock toe will include crushed limestone arranged in a toe buttress and blanket to counter gravity forces acting on the soil mass of the slope. Some existing piezometers and slope inclinometers must be destroyed by the construction. Other instrumentation is to be protected during the excavation and crushed rock placement.

Drawings (Item 7 in Section 5.2 of this report) show that the wet gypsum stacking area originally was limited to the northern three-quarters of Ash Disposal Area 1A. The southern quarter contained, at one time, a wastewater holding basin. A 4-acre pond with a water surface elevation of 387.6 is shown to have existed in the southwest corner of Area 1A, the same general vicinity as the 2005 dike slope failure.

A figure (contained in Appendix A) from a leachate modeling report purportedly by GeoTrans (unavailable, year unknown) shows that the dike slope failure area was also the site of “boiler wash” dumping. Boiler wash is taken to be hardened ash removed from boilers during long-term maintenance. The material may not have been properly placed (uncompacted, end-dumped) and may exist as a porous layer near the perimeter dike of Ash Disposal Area 1. The figure was with a chronological history created by MACTEC for its 2007 geotechnical exploration. The history is contained in Appendix A.

12. Engineering Analyses

12.1. **General**

Engineering analyses of the Dry Fly Ash Stack and the Gypsum Disposal Complex consists of examining slope stability and seepage of ground water through in-situ materials. The analyses were performed using available historic information, results of the geotechnical field exploration and the results of the laboratory testing. Multiple cross-sections were analyzed for slope stability and one cross-section on the Gypsum Stack Complex was analyzed for seepage.

Cross-section locations and extents to use for analyses were chosen according to several factors. The cross-sections were selected because they are representative of the facilities as a whole, are along the most critical slopes and are at regular intervals along the dike alignment. The cross-sections are named using letters ‘A’ through ‘O’. Figure 6 shows the cross-section locations and orientations for the Gypsum Disposal Complex. Figure 7 shows the cross-section locations and orientations for the Dry Fly Ash Stack.

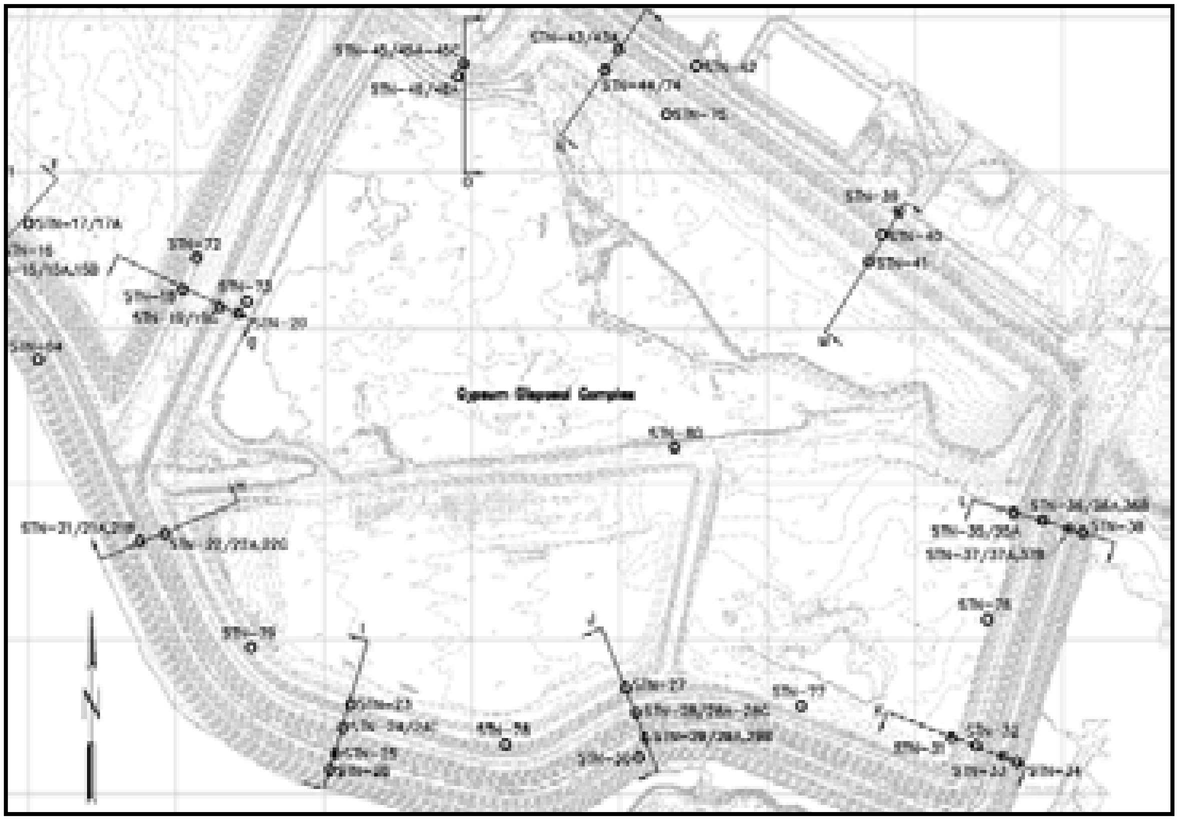

Figure 6. Plan View of the Gypsum Stack Complex and the Stability Cross Sections

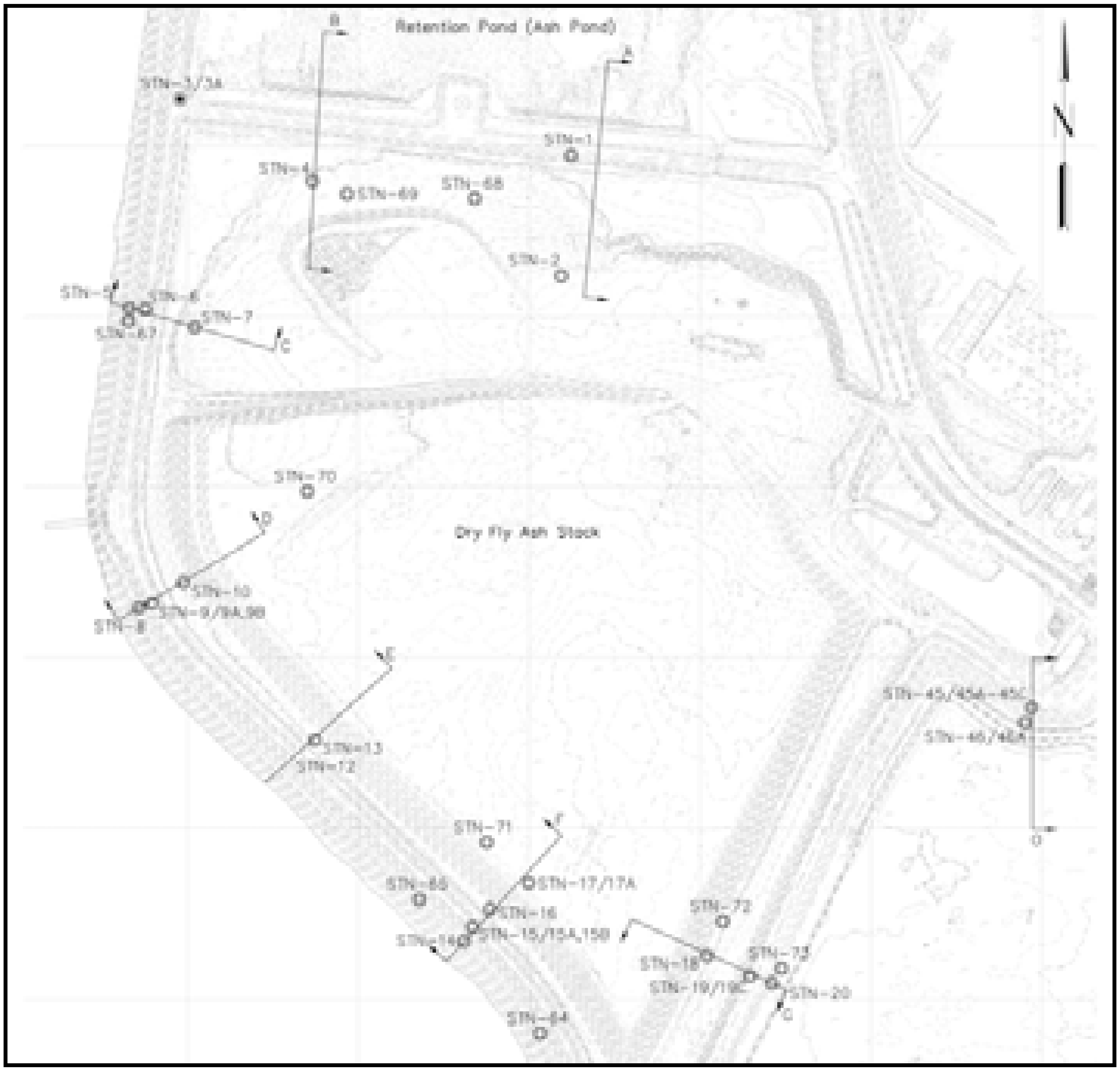

Figure 7. Plan View of the Dry Fly Ash Stack and the Stability Cross-Sections

12.2. **Slope Stability Analysis**

The stability of the slopes of the “original” and “raised” perimeter dikes, the “bottom ash” dike, the dry fly ash stack and the gypsum stack were analyzed using limit equilibrium methods. Analyses were performed for static, long-term conditions with steady-state seepage conditions and also for undrained conditions within the saturated ash materials.

The slopes were analyzed using both SLOPE/W and UTEXAS4 software. SLOPE/W which is available from GEO-SLOPE International, Ltd., of Calgary, Alberta, Canada (www.geo-slope.com), is a special-purpose computer program designed to analyze the stability of earth slopes using two-dimensional, limit equilibrium methods. UTEXAS4, which is available from Shinoak Software of Austin, Texas, was used to evaluate slope stability in the event of the sudden development of undrained loading conditions within saturated ash materials where reduced shear strength can prevail (i.e. undrained conditions in saturated ash can be triggered under low strains induced by high fills or stacks). With both software packages, the distribution of pore water pressures within the earth mass can be determined using a defined piezometric line. SLOPE/W also has the capability to directly incorporate a SEEP/W solution.

In this study, steady-state pore pressures were obtained from a defined piezometric line. The line was established by using the borehole water levels observed at the time of drilling, piezometer readings, the normal pool level of Wells Creek and visual observations of free water in surface ditches. The piezometer levels used were the highest average water levels observed after allowing the dissipation of excess drilling fluid from the borehole. Seepage analysis was not used to establish phreatic levels since ponds do not exist on either area. The unit weight and shear strength properties used in the stability analyses are summarized in Tables 7 and 8.

In addition to the long-term stability analysis, stability analyses were conducted for a partially undrained condition. Saturated fly ash typically exhibits an undrained peak shearing resistance at small strain, followed by a rapid loss in strength to a smaller, residual value. To guard against slope failures developing from undrained conditions within the CCP disposal areas, even when no specific triggering mechanism has been identified, slope stability analyses were completed where the static driving stresses were compared to the both drained and undrained shearing resistance of the saturated materials. The drained stability was evaluated as previously explained (using SLOPE/W). These results were compared to a criteria value of **FSd > 1.5**. Next, for current conditions and slope geometry, the undrained stability was evaluated using the three-stage calculation method available in UTEXAS4. In these calculations, the undrained strength capacity at points along the failure surface is estimated for the existing, anisotropic consolidation stresses, and the computed safety factor is compared to a criteria value of **FSu > 1.3**. In a third set of calculations, the undrained capacity is compared to the stresses imposed when additional lifts of embankment are placed. The acceptability of these conditions is judged based on a safety factor identified as FSul. The minimum FSul value is defined by equation 1.

$$FS_{UL} = \frac{2 * \mathrm{FS_U}}{(1 + (\mathrm{FS_U})} \qquad \textbf{Eqn. 1}$$

The calculation procedure and FS criteria will be further explained in a forthcoming memorandum being prepared be Stantec.

12.2.1. Limit Equilibrium Methods in SLOPE/W and UTEXAS4

The limit equilibrium method for analyzing slope stability evaluates the static equilibrium of a soil mass above a potential failure surface. For conventional, two-dimensional methods of analysis, the slide mass above an assumed failure surface is split into vertical slices and stresses are evaluated along the sides and base of each slice. The factor of safety against a slope failure (FS_{slope}) is defined as:

$$FS_{slope} = \frac{\text{shear strength of soil}}{\text{shear stress required for equilibrium}} \qquad \textbf{Eqn. 2}$$

where the strengths and stresses are computed along a defined failure surface, on the base of the vertical slices. The shearing resistance at locations along the potential slip surface are computed, with appropriate Mohr-Coulomb strength parameters, as a function of the total or effective normal stress.

Spencer's solution procedure (Spencer 1967; USACE 2003; Duncan and Wright 2005), which satisfies all of the conditions of equilibrium for each slice, was used in this study. Spencer's procedure computes FS_{slope} for an assumed failure surface. A search must be made to find the critical slip surface corresponding to the lowest FS_{slope}. Both curved and noncircular potential failure surfaces can be evaluated.

12.2.2. **Slope Stability of the Dry Fly Ash Stack and Gypsum Stack Complex**

The outslope of each cross-section was analyzed for slope stability using SLOPE/W 2007. SLOPE/W incorporates various search routines to locate the critical slip surface. For the analyses presented here, the "Entrance and Exit" method was employed. Once the potential failure surface with the lowest factor of safety was identified, the optimization routine was run.

Optimization allows the failure surface geometry to be modified based on the properties of the material through which the surface penetrates. The minimum and maximum range for the entrance and exit points of the failure surface was parametrically varied over a wide range to determine the likely solution region for the critical surface. In subsequent runs, the search was refined by narrowing the range and spacing for the candidate points. In addition, the entrance and exit ranges were also specified so that each “structure” was investigated individually. This allows for a comparison of the factors of safety of each portion of the slope within the cross-section.

Where the surface slope is composed of cohesionless (c' = 0) materials, an infinite slope failure (shallow sliding parallel to the surface) will be critical. While solutions were initially obtained for this case, these shallow sloughs were deemed to be minor and would be able to be repaired before any additional instabilities occurred. To force the search routine to evaluate deeper failure mechanisms, a minimum failure depth of at least 10 feet was specified for each section. Where the minimum factor of safety was found for shallow failure surfaces, additional analyses were performed for “deep seated” failure surfaces. This was done to demonstrate the factors of safety against large, catastrophic failures.

12.2.3. **Slope Stability Parameters**

Tables 10 and 11 summarize the parameters selected for each of the soil horizons used in the analyses. Specifics of how the parameters were selected are provided in Appendix J (Material Property Calculation). Further information on the selection of strength parameters and the derivation of the properties used in the UTEXAS4 calculations will be explained in a forthcoming document to be issued by Stantec.

Table 10. Slope Stability Shear Strength Parameters (Drained Conditions)

Material Type	Unit Weight, γ' (pcf)	Effective Stress	
		Cohesion, c' (psf)	Friction Angle, φ' (deg)
Clay Dike 1	124	100	25
Clay Dike 2 - Lean Clay	128	100	28
Clay Dike 2 - Fat Clay	127	200	19
Clay Dike 3	126	50	30
Fly Ash – Stacked	100	0	32
Bottom Ash or Fly Ash - Sluiced	100	0	22
Bottom Ash - Stacked	105	0	35
Gypsum	105	0	38
Alluvial – Clay	121	200	30
Alluvial – Granular	130	0	32
Matrix (gravel, clay & boulder)	130	0	35
Bedrock	Impenetrable		

Table 11. Slope Stability Shear Strength Parameters (Undrained Conditions)

Material Type	Unit Weight, γ (pcf)	Effective Stress	
		Cohesion, c (psf)	Friction Angle, φ (deg)
Fly Ash – Stacked (Saturated)	100	140	11
Bottom Ash or Fly Ash - Sluiced	100	140	11

12.2.4. Long Term (Drained) Slope Stability Results

Using the strength parameters selected (c' and ϕ') listed in Table 10, the existing dike configuration was analyzed at each of the fifteen cross sections. Geo-Slope's Slope/W computer program was used for the analyses with pore pressures calculated from the defined piezometric line. Long term (effective stress), steady state seepage conditions were analyzed using Spencer's method. For the Spencer's method analyses, curved failure surfaces with optimization were analyzed. Minor details of the geometry, such as various small riprap zones and limited clay cover, were not represented in the stability model.

The stability analyses focused on the potential for failure of the dike outslopes. SLOPE/W failure surfaces from these analyses are presented on the drawings in Appendix B. The results are summarized in Table 12. Results are presented for two cases, "Global (Dee-Seated)" and "Non-Global (Minimum)". The "Non-Global (Minimum)" factors for safety for Sections A, B, J, K, L and M represent very shallow failure surfaces that would not be considered global in nature.

Table 12. Summary of Computed Factors of Safety (As Found) for Long Term Slope Stability

Section*	Global (Deep-Seated)	Non-Global (Minimum)
A	2.6	1.0
B	2.8	1.3
C	1.5	--
D	1.6	--
E	1.9	--
F	1.4	--
G	1.7	--
H	1.4	--
I	1.6	--
J	1.7	1.3
K	2.0	1.2
L	2.0	1.3
M	2.5	1.2
N	1.5	--
O	2.5	--

*Refer to Figures 6 and 7 for plan view of site with section locations
-- Minimum FS is considered a Global Failure for this section

The Tennessee Department of Environment and Conservation (TDEC) "Rules and Regulations Applied to the Safe Dams Act of 1973" provides guidance and standards with regards to existing dams. The standards do not specifically address target factors of safety for slope stability, but instead merely indicate that the dam shall be "stable". Based on discussions with TVA and to be in accordance with current prevailing practice, a minimum factor of safety of 1.5 was adopted for long-term conditions using the guidelines presented in USACE Manual EM 1110-2-1902 “Slope Stability”.

Considering only potential failure mechanisms that would immediately compromise the system of dikes or the stacked material itself, the slope stability results show that there are several areas of concern. These areas can be divided into four groups:

- Potential failure of the “Bottom Ash Road” Dike (Sections H, J, K, L, and M)
- Potential failure of the “Original and Raised” Dikes (Section H)
- Potential failure of the stacked fly ash slope (Section F)
- Potential failure of the divider dike bottom ash slope (Sections A and B)

The lowest factors of safety (FS) in the “Bottom Ash Road” Dike ranged between 1.2 and 1.4 for the sections listed above. The potential failure of this dike generally initiated mid-slope of the dike, followed an optimized surface and terminated into the perimeter ditch. Although the geometry of each section varied slightly, the main factor that reduced the FS of sections J through N was the setback of the dike. This setback does not allow the dike to “key into” the original dike structure for additional support. The potential failure in section H may be attributed to elevated water levels.

Section H is the location of the slope movement that occurred in 2005. Slope stability analyses performed by Geosyntec Consultants in early 2009 indicated that FS values were being adversely affected by rising phreatic levels. Factors of Safety as low as 1.2 were determined in this area. Soon after being informed of this, TVA decided to halt regular slurry pumping to the stack. A plan for bypassing the slurry flow around the stack was developed by Stantec on March 16, 2009 (TVA Reference No. CUF-CT-090316). It was completed on May 11, 2009. The current FS value computed for Section H by Stantec is 1.4. Phreatic levels in the area of Section H are monitored weekly.

The FS of Section F in the stacked fly ash slope was 1.4. The potential failure surface in this section initiated at the existing crest of the stacked fly ash, followed an optimized curved path into the sluiced fly ash and terminated into the perimeter ditch. The main factor that reduced the FS of section F was the surface slope. The design slope on the permit drawings indicated a maximum slope of 3H:1V and the actual surveyed slope in Section F was 2.8H:1V. Elevated piezometric levels also contributed to the lower factor of safety in this section.

The FS in Sections A and B ranged between 1.0 and 1.3. The potential failure surfaces in these sections begin in the visible bottom ash bench north of the divider dike and follow an optimized curved path into the sluiced fly ash in the retention pond. The hydrographic survey provided by TVA indicates that the slopes below the water surface are very steep (almost 1H:1V).

A rapid drawdown analysis of the divider dike was performed using Slope/W. During rapid drawdown, the stabilizing effect of the water on the pond face of the dike is lost, but the pore-water pressures within the dike may remain high. As a result, the stability of the pond face of the dike can be much reduced. The dissipation of pore-water pressure in the embankment is largely influenced by the permeability of the dike materials. Highly permeable materials drain quickly during rapid drawdown, but low permeability materials take longer to drain. Sections A and B both achieved a FS of 1.7 against rapid drawdown failure.

There was no indication in the slope stability analyses that a translational (noncircular) failure surface would give a factor of safety lower than obtained for optimized curved surfaces. Overall, the geometry of the dike cross sections and the foundation stratigraphy do not appear to be susceptible to sliding along a planar surface. The results in Table 11 and Appendix B represent factors of safety computed from the optimized, curved slip surface routine.

12.2.5. **Remedial Improvements**

A review of the stability analyses results indicates that while most of the minimum factor of safety failure surfaces do not represent true global failures of the dike system, it is likely that some of the modeled shallow failures could subsequently lead to an eventual breach. The smaller failures were generally located from the middle to the toe of the slope. If one of these shallow failures occurred, it would leave a steep slope that would then likely fail again; thus producing a progressive failure that may compromise the crest and possibly release CCPs. Therefore, remedial improvements at selected locations are needed to increase the dike slope stability to meet TVA Programmatic design criteria. The conceptual improvements are shown in Appendix K.

Improvements to slope stability factors of safety can generally be obtained most efficiently by flattening slopes, adding toe support, lowering phreatic levels, or some combination thereof. Typically, flattening of slopes is the least costly of these approaches, followed by adding toe support and lowering of phreatic levels. For each of the stability sections, these remediation methods were considered. The remediation alternatives presented were based on engineering judgment and past experience taking into account effectiveness and cost.

12.2.6. **"Bottom Ash Road" Dike (Sections H, J, K, L, M, and N)**

To raise the minimum factor of safety to 1.5 or greater, a toe buttress can be added below the bottom ash road dike. Conceptually, the toe buttress could consist of compacted clay, possibly with a layer of rock at the surface to discourage overexcavation during maintenance. The slope protection is to be installed at the toe of the slope; filling the existing ditch. The new ditch itself must be relatively impervious in order to prevent surface water infiltration into the dikes. This repair must be completed in conjunction with the site-wide regrading of the perimeter ditch.

These repairs will add structural support to the toe of the slope and help reduce the amount of ponded water in the ditch above Dikes 1 and 2; both improving the slope stability factor of safety.

Slope stability analyses were performed for this repair scenario and the results are presented in Table 13. The analyses were performed for Sections J and M, but the results would be typical for all sections.

Table 13. Summary of Long Term Stability Analyses – Bottom Ash Road Dike

Section	Original Factor of Safety (Non-Global, Minimum F.S.)	Repair Factor of Safety (Non-Global, Minimum F.S.)	Original Factor of Safety (Global, Deep-seated F.S.)	Repair Factor of Safety (Global, Deep-seated F.S.)
J	1.3	1.6	1.8	1.8
M	1.2	1.6	2.5	2.8

12.2.7. **"Original and Raised" Dikes (Section H)**

A past slope failure of the downstream face of the "Original and Raised" Dikes in the vicinity of Section H was reported in the project records. This slope failure was temporarily repaired by TVA by removing disturbed soil and placing riprap. A permanent repair is currently being designed by Stantec for this area. This repair includes two primary features, a trench drain to control the phreatic (water) surface within the dikes and a more substantial toe buttress constructed using riprap.

For Section H, the trench drain has been designed to intercept seepage flowing from the Gypsum Stack towards the face of the slope. It will be installed along the length of the instability on the crest of Dike 2 and extend to a depth of at least 16 feet where it will penetrate the sluiced ash layer. The trench will be filled with granular material to allow free flow of water to enter a pipe located two feet above the bottom of the excavated trench. The water will be transferred through the piping to a single collection point and then either pumped into the perimeter collection ditch or allowed to flow into Wells Creek when the necessary permits are obtained.

The toe buttress includes the installation of slope protection consisting of geotextile fabric, bedding stone (TDOT No. 2 stone) and riprap (Class A). The slope protection is to be installed at the toe of the slope and along the face of the slope. The lower part of the buttress will be constructed at a 2H:1V slope up to elevation 375 feet, where there will be a 35-foot wide bench. Above the bench, the rock will be placed at a 3H:1V slope with a thickness of five feet.

These repairs will help keep the phreatic (water) surface lowered and will add structural support to the toe of the slope, both improving the slope stability factor of safety.

Slope stability analyses were performed for this repair scenario and the results are presented in Table 14.

Table 14. Summary of Long Term Stability Analyses – Original and Raised Dikes

Section	Original Factor of Safety (Non-Global, Minimum F.S.)	Repair Factor of Safety (Non-Global, Minimum F.S.)	Original Factor of Safety (Global, Deep-seated F.S.)	Repair Factor of Safety (Global, Deep-seated F.S.)
H	*(1)*	*(1)*	1.4	1.8

(*1*) Minimum FS is considered a Global Failure for this section

12.2.8. Stacked Fly Ash Slope (Section F)

The main factors that reduced the factor of safety of section F were the surface slope and the setback of the fly ash slope from Dike 2. The design slope on the permit drawings indicated a maximum slope of 3:1 (H:V) and the actual surveyed slope in Section F was 2.8:1 (H:V). The repair for this section consists of re-grading the existing slope to the design grade and placing a toe buttress at the toe of the stacked fly ash slope.

Slope stability analyses were performed for this repair scenario and the results are presented in Table 15.

Table 15. Summary of Long Term Stability Analyses –

Stacked Fly Ash Slope (Section F)

Section	Original Factor of Safety (Non-Global, Minimum F.S.)	Repair Factor of Safety (Non-Global, Minimum F.S.)	Original Factor of Safety (Global, Deep-seated F.S.)	Repair Factor of Safety (Global, Deep-seated F.S.)
F	*(1)*	*(1)*	1.4	1.5

(*1*) Minimum FS is considered a Global Failure for this section

12.2.9. Stacked Divider Dike Bottom Ash Slope (Sections A and B)

The main factor that reduced the factor of safety of sections A and B was the surface slope. The design slope on the permit drawings indicated a maximum slope of 3:1 (H:V) and the actual surveyed slope in Section A was 1.2:1 (H:V) and in Section B was 1.3:1 (H:V). The repair for this section consists of re-grading the existing slope to the design grade.

Slope stability analyses were performed for this repair scenario for Section A and the results are presented in Table 16.

Table 16. Summary of Long Term Stability Analyses – Stacked Bottom Ash Slope (Section A)

Section	Original Factor of Safety (Non-Global, Minimum F.S.)	Repair Factor of Safety (Non-Global, Minimum F.S.)	Original Factor of Safety (Global, Deep-seated F.S.)	Repair Factor of Safety (Global, Deep-seated F.S.)
A	1.0	1.6	2.6	2.8

12.2.10. Buildout

Once the analyses of the conceptual repair designs were completed, slope stability analyses of the completed “as permitted” Dry Fly Ash Stack and the Gypsum Disposal Complex were conducted. The geometry of each permitted facility, as shown on the permit drawings Stantec obtained from TVA, was used to compare against the surveyed cross-sections. Stantec compared the cross-sections against the permit drawings to check for conformance relative to maximum permitted slopes, heights and setbacks.

For the Dry Fly Ash Stack, Sections C, E and F were evaluated. Each section yielded a satisfactory FS

For the Gypsum Stack Complex, Sections J and M were evaluated. In addition to using the provided CADD files to create the cross sections, it was assumed that the existing dikes and perimeter ditches would remain as constructed in their current positions. Using the assumptions that the repairs discussed above were implemented and water is not allowed to pond on the stack; each section yielded acceptable factors of safety.

12.2.11. Undrained Analysis

After the drained factors of safety were obtained and required conceptual repairs were made, the model was transferred to UTEXAS4 to complete the undrained analysis. Stantec conducted an undrained slope stability analysis on four selected sections at CUF. Two of these sections were located through the Dry Fly Ash Stack and two were located through the Gypsum Disposal Complex. The selected sections were chosen where the lowest factors of safety were realized for the drained analysis and the thickness of the sluiced fly ash deposits was generally greater. Table 17 summarizes the factors of safety as found by SLOPE/W and UTEXAS4 for drained and undrained conditions. The target factor of safety for the undrained analysis (Existing-Repaired Conditions) has been set at 1.3. Each section modeled for both the Dry Fly Ash Stack and the Gypsum Disposal Area meet this criteria and these sections are acceptable for the modeled conditions.

Table 17 – Undrained Factors of Safety for Selected Sections

Section	Undrained Factor of Safety (Existing-Repaired Conditions) (FS_U) **Target Value = 1.3 or Greater**
C	1.6
F	1.4
J	1.6
M	1.6

To continue the analysis, the same sections were modeled with an additional load placed over the existing section representing a lift of material. The analysis was repeated with varying lift thicknesses until a lift was found that met the final factor of safety criteria. The results of these additional analyses are presented in Table 18.

Table 18 – Factors of Safety for Additional Loading

Section	**Target Factor of Safety**	**Factor of Safety (FS_{UL})**	**Lift Thickness (feet)**
C	1.23	1.28	12.5
F	1.16	1.19	20.0
J	1.24	1.32	Full Buildout
M	1.23	1.61	Full Buildout

12.3. **Seepage Analysis**

12.3.1. **Background**

The plant is not currently sluicing gypsum slurry to the Gypsum Stack Complex on a regular basis. All slurry is being sent to the SynMat plant except during plant outages. TVA has made the decision that in the future all gypsum disposal will be converted to a dry operation. A 5- to 7-year operation plan that will include lined ponds on the existing complex is currently in the early planning stages. Based on the fact that water is not being ponded on the gypsum disposal complex, a seepage analysis is not appropriate for existing conditions and was not used to establish phreatic surfaces for slope stability analyses. However, a seepage analysis was performed to explore the effects of active sluicing and ponded water on the stability of the gypsum complex.

The objective of this seepage analysis was to observe the effect of active sluicing on the stability of the Gypsum Stack Complex. Seepage was examined in terms of total head (and pore water pressure) distribution within a given cross section of the dike assuming steady-state water conditions were achieved.

The seepage analysis was performed using SEEP/W, a numerical software tool developed by Geo-Slope International Inc. SEEP/W is a finite element software product for analyzing groundwater seepage and excess pore water pressure dissipation problems within porous materials such as soil and rock.

12.3.2. **Cross Sections**

The first step in the seepage analysis was to select a typical cross section for the Gypsum Stack Complex. From the stability analyses, Section H (the cross section through borings STN 21, 21A, 21B, 22, 22A, and 22C) was selected. Figure 6 shows Section H in the plan view of the Gypsum Stack Complex. Two geometrics were analyzed for Section H; existing conditions and the planned repairs. The cross sections are shown in Figure 8.

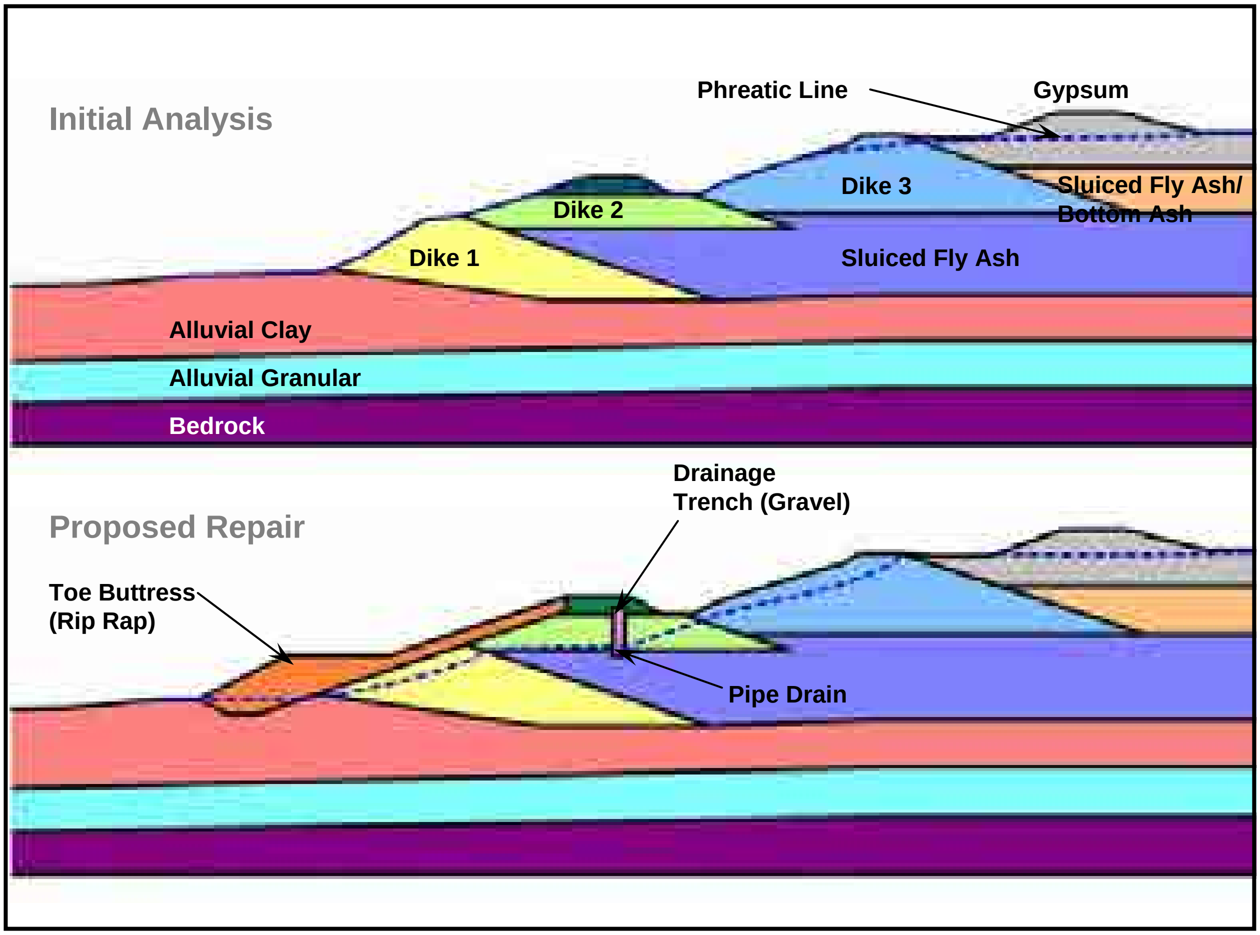

Figure 8. Section H (Existing Layout and Proposed Repair, Assuming Active Sluicing)

SEEP/W uses the concept of regions and points to define the geometry of a problem and to facilitate discretization (or meshing) of the problem. Section H's subsurface model was defined based on a combination of boring logs from the 2009 Stantec geotechnical exploration, piezometer data, historic drawings, and topographic survey information to estimate the dimensions of the cross section and build its geometry.

Piezometric data was available from the instrumentation installed during the 2009 Stantec field activities. Table 19 lists the installed piezometers referenced for Section H.

Table 19. Instrumentation at Seepage Analysis Cross-Sections

Cross Section	Boring	Type	Surface Elevation (ft)	Casing Depth (ft)	Tip Elevation (ft)
H	STN-21	Piezometer	395.13	39.1	356.0
	STN-22A	Piezometer	410.19	59.4	350.8

The average piezometer levels for STN-21 and 22A were 390.5 and 389.5 feet, respectively, between June 13, 2009 and September 15, 2009. However, these elevations do not reflect active sluicing and were lower than the model's suggested phreatic surface. The model's groundwater conditions were limited by the water level in Wells Creek and the water level in the stack at the top of the placed gypsum layer. No pooled water was assumed above the gypsum stratum.

12.3.3. Material Properties

Upon defining the geometry of the model (with automatic mesh generation) material properties were assigned using the *Saturated/Unsaturated Model* offered in SEEP/W. Only bedrock was modeled as *Saturated Only Model* conditions. The hydraulic conductivities and material properties estimated for the seepage analyses are presented in Tables 20 and 21. Locally at the Cumberland Fossil Plant, Dike 1 is commonly referred to as the original perimeter dike, Dike 2 is the raised dike, and Dike 3 is the bottom ash (gypsum stacking) dike.

Table 20. Hydraulic Conductivity Estimates for Seepage Analysis

Material	K_v/K_h	K_h/K_v	k_{sat} (K_h) (ft/sec)	k_{sat} (K_h) (cm/sec)	K_v (cm/sec)
Dike 1 (Clay)	0.10	10	9.27E-08	2.83E-06	2.83E-07
Dike 2 (Lean Clay)	0.10	10	9.28E-08	2.83E-06	2.83E-07
Dike 2 (Fat Clay)	0.10	10	9.28E-08	2.83E-06	2.83E-07
Dike 3 (Clay)	0.10	10	1.37E-06	4.17E-05	4.17E-06
Alluvial (Clay)	0.05	20	2.82E-08	8.60E-07	4.30E-08
Alluvial (Granular)	0.05	20	2.36E-03	7.19E-02	3.60E-03
Gypsum (Stacked)	0.02	50	4.65E-06	1.42E-04	2.83E-06
Fly Ash (Stacked and/or Sluiced)	0.02	50	3.03E-06	9.24E-05	1.85E-06
Fly Ash/Bottom Ash (Sluiced)	0.02	50	3.03E-06	9.24E-05	1.85E-06
Toe Buttress (Rip Rap)	0.50	2	3.28	1.00E+02	5.00E+01
Drainage Trench (Gravel)	0.10	10	0.0328	1.00E+00	1.00E-01
Bedrock (saturated only)	0.10	10	1.00E-12	3.05E-11	3.05E-12

Table 21. Material Property Estimates for Seepage Analyses

			Grain Size Data/ Sample Function			Volumetric Water Content	
Material	**m_v /psf**	**n**	**LL (%)**	**D_{10} (mm)**	**D_{60} (mm)**	**θ_{sat} cm^3/cm^3**	**θ_{res} cm^3/cm^3**
Dike 1 (Clay)	0.000003	0.401	40.5	0.0001	2	0.399	0.060
Dike 2 (Lean Clay)	3.00E-06	0.357	46	0.0001	0.004	0.355	0.109
Dike 2 (Fat Clay)	1.44E-05	0.454	53	0.0001	0.007	0.444	0.090
Dike 3 (Clay)	4.79E-06	0.386	39.8	0.0001	1.1	0.384	0.109
Alluvial (Clay)	4.79E-05	0.443	39.7	0.0001	0.04	0.400	0.056
Alluvial (Granular)	2.39E-06	0.269	NP	0.018	8	0.270	0.041
Gypsum (Stacked)	4.79E-06	0.520	NP	0.0108	0.025	0.516	0.041
Fly Ash (Stacked and/or Sluiced)	7.18E-05	0.558	NP	0.004	0.033	0.543	0.015
Fly Ash/Bottom Ash (Sluiced)	6.22E-05	0.378	NP	0.004	0.049	0.355	0.027
Toe Buttress (Rip Rap)	2.00E-05	0.399	NP	Gravel		0.400	0.020
Drainage Trench (Gravel)	2.00E-05	0.399	NP	Gravel		0.400	0.020
Bedrock (saturated only)	0	N/A	NP	N/A		0.050	0.050

For these tables, the variables referenced are:

- K_v is the vertical hydraulic conductivity,
- K_h is the horizontal hydraulic conductivity,
- m_v is coefficient of volume compressibility,
- n is porosity,
- LL is liquid limit,
- D_{10} is the diameter passing 10% of the grain size distribution,
- D_{60} is the diameter passing 60% of the grain size distribution,
- θ_{sat} is the saturated volumetric water content, and
- θ_{res} is the residual volumetric water content.

Horizontal Hydraulic Conductivity (K_h): The K_h values for the in-situ materials (with the exception of bedrock) were estimated based on permeability test results on Shelby tube samples and CPT dissipation results. These estimates were compared to typical values from similar TVA projects, similar facility types, and technical literature. A tabular summary of the hydraulic conductivity information is included in Appendix L, Seepage Analysis.

The K_v values for gravel and rip rap were assumed based on typical values. A low K_v value was assigned to bedrock assuming some fractures would be present in the shale and limestone, allowing minimal flow.

Vertical Hydraulic Conductivity (K_v): The ratio of K_v to K_h was estimated based on permeability test results on Shelby tube samples and CPT dissipation results. These estimates were compared to typical values from similar TVA projects, similar facility types, and technical literature. This ratio was used to calculation the K_v.

The gravel and rip rap used for the repair section are assumed to be dumped into place, reducing anisotropy of the materials.

Coefficient of Volume Compressibility (m_v): Typical values after Head (1982) were used as a guideline for estimating these values.

Porosity (n): Porosity values were estimated based on an average of the void ratios from the geotechnical test results from the Stantec (2009) field investigation. Void ratio was converted to porosity using the equation:

$$n = \frac{e}{1+e}$$

Liquid limit (LL), D_{10}, D_{60}: Geotechnical test results from the Stantec (2009) field investigation were separated by approximate material type. The liquid limit used is an average of the available information. The grain size distributions for each material type were plotted together to estimate typical D_{10} and D_{60} values. A summary of the laboratory information used is included in Appendix L, Seepage Analysis.

Saturated Volumetric Water Content (θ_{sat}): The θ_{sat} values of all materials were estimated based on general material type using the article, “Estimation of Soil Water Properties” (Rawls et al. 1982).

Residual Water Content ($\theta_{\rho es}$): The θ_{res} values of all materials were estimated based on general material type using the article, “Estimation of Soil Water Properties” (Rawls et al. 1982).

12.3.4. **Drains**

There is documentation of an existing gravel drain placed on top of the sluiced ash prior to gypsum stacking. Underdrain outlet pipes daylight in several locations around the perimeter of the Gypsum Stack Complex. These drains are shown on the boring layout in Appendix B.

Observations of the drains made during Phase 1 site visits show that the flow rates of the outlet pipes differ from drain to drain. Since many of the underdrain pipe outlets exhibit no flow, the underdrain layer and pipe drains were neglected in the seepage analysis.

The proposed repair section includes a pipe drain in the gravel trench approximately one foot vertically into Dike 2. This is an estimate based on the repair cross sections (Appendix K). The pipe location will vary in the field as needed to promote drainage. However, this analysis suggests that the pipe drain should be maintained near the interface with the sluiced ash material.

12.3.5. **Boundary Conditions**

The next step in the process was to define boundary conditions. All boundary conditions were applied directly on geometry items such as region faces and region lines. Four boundary conditions were included in these models. First, water elevation in Wells Creek was assumed to be 359 feet, the ordinary water level. The gypsum stack was assumed to have water at the highest gypsum elevation in the model (ignoring gypsum dikes). For the models including the proposed repair section, a point boundary condition was added at elevation 378 feet to represent the pipe in the gravel trench drain. Potential seepage faces were allowed along the outboard sides of the dikes and the alluvial material.

12.3.6. **Results**

Upon defining the boundary conditions, the model was analyzed using *Steady State* seepage analysis option available in SEEP/W based on the assumption that the boundary conditions are constant over time. Detailed results of seepage analysis are presented in Appendix L. Figure 9 illustrates the total head contours for Section H for the three cases analyzed.

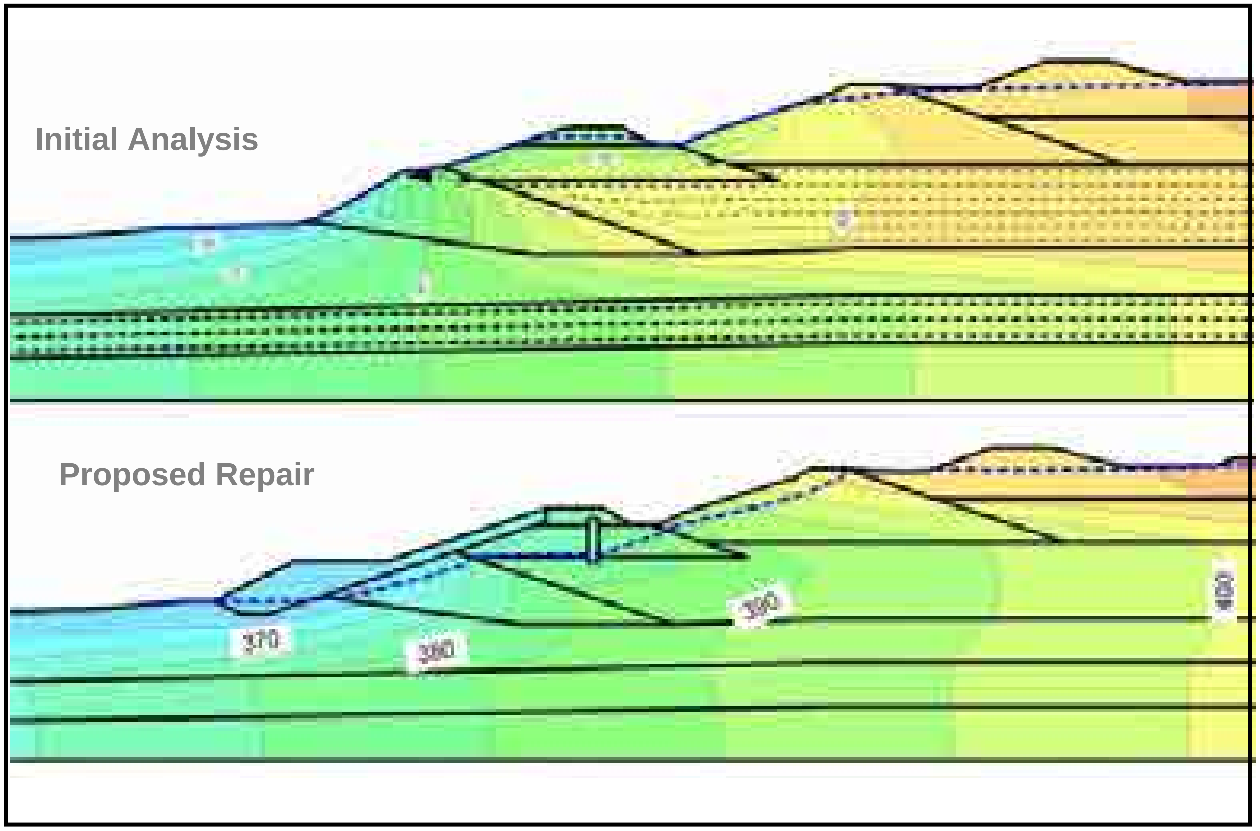

Figure 9. Section H Total Head Contours (Assuming Active Sluicing)

The results of the seepage model were then used as the water conditions for slope stability analyses similar to those performed for the entire complex. Table 22 summarizes the slope stability for the seepage conditions used for Section H. The graphical results are included in Appendix L, Seepage Analysis.

Table 22. Section H Slope Stability Results Incorporating Seepage and Active Sluicing

Condition	Factor of Safety	Failure Location	Seepage Location
Existing Conditions	0.7	Dike 2 above Dike 1	Dike 3 toe, Dike 2 toe, Dike 1 crest and face
Proposed Repair	1.6	Dike 2 into Alluvial to Wells Creek	Toe of Dike 1 to Wells Creek

For the Section H repair, careful placement and long-term maintenance of the drainage trench pipe is required to achieve a factor of safety of 1.5 during active sluicing. Control of the water level within the gypsum stack and seepage conditions from the complex to surrounding terrain is necessary for the gypsum stack complex based on the material properties and water conditions found during Stantec's 2009 field exploration.

12.3.7. Critical Exit Gradients

Seepage forces, resulting from hydrodynamic drag on the soil particles, can destabilize earthen structures. Excessive hydraulic gradients near the ground surface can lead to the initiation of soil erosion and piping, which has caused numerous dam failures in the past. Hydraulic gradients, computed where seepage flows to the ground surface, can be evaluated to understand the potential severity of this problem.

Where upward seepage through a uniform soil exits to the ground surface, the factor of safety with respect to soil piping (FS_{piping}) is defined as:

$$FS_{piping} = \frac{i_{crit}}{i} \qquad \textbf{Eqn. 3}$$

where i is the vertical gradient in the soil at the exit point. The critical gradient (i_{crit}) is related to the submerged unit weight of the soil and can be computed as:

$$i_{crit} = \frac{\gamma_{sub}}{\gamma_w} = \frac{G_s - 1}{1 + e} \qquad \textbf{Eqn. 4}$$

where γ_{sub} is the submerged unit weight of the soil, γ_w is the unit weight of water, G_s is the specific gravity of the soil particles, and e is the void ratio. For nearly all soils, the critical gradient is between about 0.6 and 1.4, with a typical value near 1.0.

Where FS_{piping} = 1, the effective stress is zero and the near-surface soils are subject to piping or heaving. Note that Eqn. 2 is valid only for vertical seepage that exits to the ground surface. If the phreatic surface is buried, then the FS_{piping} will be greater than 1.0 even when $i=i_{crit}$.

12.3.8. Seepage Gradients

Contour plots of the hydraulic gradients computed from the SEEP/W solutions are shown for Section H's existing conditions, repair section, and repair section with build out to elevation 430 feet (assuming active sluicing) in Appendix L. Large gradients and significant seepage can be seen at various locations within the cross section, but the concern is for areas where these gradients can initiate the erosion or piping of material. In general, areas of potential concern are where water seeps laterally out onto a sloping ground surface, or where vertical, upward seepage occurs at the ground surface. Away from the ground surface, the potential movement of material due to seepage forces is arrested by the adjacent soil. Hence, the evaluation of seepage gradients within Section H is focused near the phreatic surface in Dikes 1 and 2 and the alluvial clay around the creek.

Considering the SEEP/W results in Appendix L, the predicted phreatic surface is observed to intersect the sloping ground surface below the top of Dike 3, the outer face of Dike 2, the exposed area of Dike 1, and the ground surface between the creek and the embankment. Groundwater seeping through the saturated dike materials may be flowing out to the ground surface, even though direct observations might be obscured by vegetation, evaporation, or the submerged ground surface. In these locations, the seepage forces associated with the hydraulic exit gradients are acting in the same direction as gravity. Because of the high potential for initiating the movement of soil particles and piping, a condition of groundwater seeping to the sloping surface of the downstream face is usually considered unacceptable in the evaluation of earth dams.

The potential for piping due to vertical seepage to the ground surface was also evaluated using the factor of safety defined in Equation 2. First, contour plots of vertical gradient (Appendix L) were examined to determine the general location of the maximum vertical exit gradient for each material type.

For the factor of safety calculations, average vertical gradients were determined over a depth of 3 to 5 feet just below the ground surface. The maximum computed gradients might occur at the very toe of the dikes. The model geometry converges to a sharp point at this location, such that the computed gradients in this small area are not reflective of the actual conditions in the field. However, to evaluate the potential for heaving of the dike toe in this area, gradients were taken across a thickness of no less than 3 feet.

Assuming active sluicing, the factors of safety against piping, computed based on the exit gradients from SEEP/W and the critical gradients determined from the soil properties, are summarized in Table 23. The lowest computed factor of safety of 1.2 is in the alluvial clay for the section build out to elevation 430 feet. According to TVA's newly adopted standard, the minimum acceptable factor of safety for piping is four (FS_{piping} = 4.0). Hence, Section H does not meet the design criteria for piping at the seepage exits, given continuous sluicing.

Table 23. Summary of Computed Exit Gradients and Factors of Safety against Piping (Assuming Active Sluicing)

Cross Section*	Vertical Gradient (i_v) at Critical Exit Point	Location of Critical Exit Point	Material	Critical Gradient (i_{crit})	FS_{piping}
H (Existing)	0.98	Top of Dike 1 near Dike 2 toe	Dike 1	1.02	1.04
	1.56	Toe of Dike 2	Dike 2	1.07	0.68
	1.32	Toe Dike 2 side of drainage channel	Dike 2	1.07	0.81
	0.92	Toe of Dike 1	Alluvial Clay	0.97	1.05
H Repair	0.77	Toe Dike 2 side of drainage channel	Dike 2	1.07	1.39
	0.72	20 ft into creek, 45 ft from toe of Dike 1	Alluvial Clay	0.97	1.35

Should active sluicing to the stack cease, the factor of safety against piping will improve with time. Three SEEP/W models were run to illustrate the falling water level within the stack. The first is the Section H (Existing) with a water elevation beginning at the top of the sluiced fly ash/bottom ash layer below the gypsum (elevation 399 ft). The second is the Section H Repair with a water elevation of 399 ft. The third is the Second H Repair pulls the water elevation level with the drainage trench pipe at elevation 378 ft. The results are summarized in Table 24. Graphical cross sections are included in Appendix L, Seepage Analysis.

The third SEEP/W model, assuming a water elevation of 378 feet at the collection trench pipe, still does not indicate acceptable factors of safety against piping. Since gypsum slurry is still sent to the stack on occasion, it is difficult to determine if dewatering will occur over time and produce a FS of 4.0 or greater. Mechanical means, such as a series of dewatering wells, may be required to lower the water level. Field pump tests would be required to determine the feasibility of this approach.

Table 24. Summary of Computed Exit Gradients and Factors of Safety against Piping (Without Active Sluicing, Stack Dewatering)

Cross Section*	Vertical Gradient (i_v) at Critical Exit Point	Location of Critical Exit Point	Material	Critical Gradient (i_{crit})	FS_{piping}
H (Existing) – Water El. 399 ft.	0.93	Toe of Dike 1	Alluvial Clay	0.97	1.04
H (Existing) – Water El. 399 ft.	0.57	Edge of creek, 60 ft from toe of Dike 1	Alluvial Clay	0.97	1.70
H Repair – Water El. 399 ft.	0.41	Toe Dike 2 side of drainage channel	Dike 2	1.07	2.61
H Repair – Water El. 399 ft.	0.43	20 ft into creek, 45 ft from toe of Dike 1	Alluvial Clay	0.97	2.26
H Repair – Water El. 378 ft.	0.33	Toe Dike 2 side of drainage channel	Dike 2	1.07	3.24
H Repair – Water El. 378 ft.	0.27	20 ft into creek, 45 ft from toe of Dike 1	Alluvial Clay	0.97	3.59

13. Conclusions and Recommendations

13.1. General

13.1.1. The conclusions and recommendations that follow are based upon Stantec's understanding of the facility as outlined in this report, and in TVA's plans for future operations. This understanding of the facility developed from reviews of historical information provided by TVA, discussions with TVA personnel throughout the course of this work and results of the geotechnical exploration and stability analysis.

13.1.2. It is recommended that the Operations and Maintenance Manual for each facility be reviewed and updated. The update should include information pertinent to any modifications made as a result of this study, routine monitoring and facility maintenance.

13.1.3. It is recommended that a program be established to develop record (as-built) drawings and construction records for future maintenance and construction activities.

13.1.4. Maintenance recommendations include: removal of trees that may cause instability of slopes, elimination of animal burrows in dikes, establish mowing program of ponds and disposal areas, regrade and repair eroded areas, and continue annual inspection program. A consistent maintenance program is a best management practice.

13.1.5. Water seeps on the slopes of dikes should be identified and observed at regular intervals. An accurate approximation of flow should be recorded along with photographs of the seep area. The seep area should be kept clear of vegetation in order to facilitate visual observation. Any rapid changes in the seep should be reported. This recommendation is supported by the TVA Master Programmatic Document in Section 3: Inspections, Monitoring and Reporting.

13.1.6. It is recommended that an instrumentation monitoring program be developed for the entire site. Best management practices suggest that routine monitoring of piezometric levels and precipitation allow for closer monitoring of the disposal facilities and quicker reaction to any problems that may arise. Additionally, if it is desired, remote monitoring of the instrumentation via the use of electronic piezometers and tiltmeters would reduce lag time associated with data entry and analysis and aid in developing accurate correlations between precipitation/releases and instrument response.

13.2. Dry Fly Ash Stack

13.2.1. The results of the slope stability analyses indicate that factors of safety against long-term failure are mostly greater than the target value of 1.5. Exceptions are the bottom ash divider dike at Sections A and B and the stacked fly ash slope at Section F. It is recommended that a work plan be developed for both of these areas to increase the minimum factors of safety. At Sections A and B, simply regrading the bottom ash slope to 3H:1V will increase the factor of safety above the required minimum value. At Section F, it is recommended that a toe buttress be constructed at the toe of the Dry Ash Stack and that the slope be flattened to 3H:1V as called for in the permit drawings. The design of the toe buttress at Section F should be coordinated with the pending redesign of the perimeter ditch system at the site. This recommendation is discussed in detail in Sections 12.2.5 thru 12.2.9 and is supported by Slope/W analyses.

13.2.2. Standing and slow-flowing water in the perimeter ditch likely contributes to saturation of the soil on the dike slopes. It is recommended that the ditches be cleared of dense stands of vegetation and the gradient of the invert improved to promote flow. The improvements should result in ditches that flow readily and not pool water. Ditches should be cleaned at regular intervals so that dense vegetation does not re-appear. Reducing pooled water and improving drainage is a best management practice.

13.2.3. During a recent site visit by Stantec, it was noted that fines removed from the bottom ash pond were being deposited at the northwest corner of the stack, near the toe of the future slope. This is undesirable because the toe of a slope is a critical location with regards to slope stability. The finer fractions of coal and ash should not be placed near the toe of slopes or concentrated in any one location. It is recommended that fines be dispersed evenly across the active stack and kept from being deposited near the edges of the stack. When possible, fines should be mixed with coarser material to reduce pore pressures and promote drainage. This is a best management practice.

13.2.4. To provide for better definition of phreatic levels, additional piezometer installations are recommended at the following locations:

- Section C – Top of Dikes 1 and 2 (elevations 380 and 395)
- Section D – Top of existing stack and crest of original dike (elevations 430 and 380)
- Section F – Top of existing stack and crest of original dike (elevations 430 and 380) and Replace PZ-16
- Section G – Along Base of dry fly ash stack (elevation 400)

The installation of these instruments will allow for better monitoring of slope stability and should be considered a best management practice.

13.2.5. It appears that bottom ash and fly ash are sometimes placed over phragmites. Best management practices dictate that fill should not be placed over vegetation; including phragmites. Over time, buried vegetation will decay and cause localized soft zones. Depending on the location, these soft zones may contribute to rutting, excessive settlement and slope failure. Vegetation should be removed prior to the placement of fill. This is a best management practice.

13.2.6. It appears that the stack is not conforming to the approved permit drawings in some areas, i.e., slopes and the presence of benches. Through discussions with TVA, Stantec also understands that they wish to modify the current design to provide for better drainage control and construction layout control. It is recommended that the

Dry Fly Ash Stack be redesigned and the Permit be modified to provide for these improvements.

13.2.7. If the water level in the ash pond is going to be lowered substantially (more than a few feet), it is recommended that it not be dropped more than 2 feet per week in order to minimize the potential for shallow failures in the bottom ash berm. Analyses in Slope/W show that the Divider Dike has an acceptable factor of safety against failure during rapid drawdown. However, this recommendation is made as a best management practice.

13.2.8. The results of the additional analyses conducted on the Dry Fly Ash Stack show that the maximum lift thickness that should be placed instantaneously within the facility is 12.5 feet. Further calculations show that if the amount of fly ash and bottom ash disposed of in 2009 (~348,500 cy) was placed evenly across the available disposal area (~69 acres), the resulting lift thickness would be approximately 3.2 feet. Knowing that it is more efficient to conduct operations in a concentrated area, Stantec also calculated the allowable time rate of construction. Using one-dimensional consolidation equations, it has been calculated that if the maximum lift thickness is placed instantaneously, no further fill should be placed in that area for a period of 2.5 years. This analysis does not account for the pore pressure dissipation that occurs as fill is being placed, and is therefore conservative. It is recommended that additional piezometers be installed around and in the Dry Fly Ash Stack so that the pore pressures generated by fill placement may be monitored. If increased piezometric levels are detected, additional slope stability analyses should be performed to verify that adequate factors of safety still exist.

13.3. Gypsum Disposal Complex

13.3.1. Less than adequate factors of safety against slope failure were obtained for most cross sections analyzed for the Gypsum Stack. These areas can be divided into two groups; the “Original and Raised” dike at Section H (site of the 2005 slope movement) and the lower part of the “Bottom Ash Road” dike. The toe drain/slope repair design prepared by Stantec for Section H should be implemented as soon as possible. This is supported by Slope/W analyses.

13.3.2. After the slope repair at Cross-section ‘H’ the repaired slope should continue to be monitored using inclinometers and piezometers. Following best management practices, the seepage effluent from the outlet pipe should be monitored for volume and visual clarity. The temporary sump pump system should be removed in its entirety once the NPDES permit is received.

13.3.3. The same conclusion and recommendation for the perimeter ditch around the Dry Fly Ash Stack is applicable to the perimeter ditch around the Gypsum Disposal Complex. Standing and slow-flowing water in the perimeter ditch likely contributes to saturation of the soil on the dike slopes. It is recommended that the ditches be cleared of dense stands of vegetation and the gradient of the invert improved to promote flow. The improvements should result in ditches that flow readily and not pool water. Ditches should be cleaned at regular intervals so that dense vegetation does not re-appear. Reducing pooled water and improving drainage is a best management practice.

13.3.4. It is recommended that the impoundment of water and gypsum sluicing operations atop the gypsum disposal facility not be resumed. Seep/W and Slope/W Analyses indicate that dike slope stability decreases with increased seepage through the stack material caused by sluicing gypsum. If sluicing occurs, factors of safety against piping are also unacceptably low. While sluicing gypsum slurry to the top of the existing stack is not recommended, sluicing gypsum slurry to lined ponds located atop the stack is practicable. Stantec is currently preparing a Work Plan which will include three small (about 5 acres) lined gypsum sluicing ponds. Pond features include a 60-mil geomembrane protected by 12 inches of gypsum. A 24-inch "marker" layer of crushed rock will overlie the protective gypsum layer. Each pond will be about 11 feet deep. Sluicing would alternate between ponds to allow for settlement of solids and subsequent removal. Stability analyses did not indicate placing a restriction on design stacking height of gypsum as long as it is "dry stacked".

13.3.5. Toe buttresses should be constructed below the bottom ash road dike. This recommendation is supported by Slope/W analyses discussed in Section 12.2.6. This repair must be completed in conjunction with the site-wide re-grading of the perimeter ditch.

13.3.6. Additional piezometer installations are recommended at the following locations:

- Section G – Along the Bottom Ash Road Dike and the crest of the existing gypsum dike (elevations 410 and 420)
- Section M – Top of Gypsum Dike and Bottom Ash Road (elevations 420 and 410)

The installation of these instruments will allow for better monitoring of slope stability and should be considered a best management practice.

13.3.7. Exposed bare slopes should be covered with topsoil and vegetation per TVA slope vegetation specifications.

13.3.8. Fine gypsum that settles in the dipping pond next to the bottom ash pond is excavated and hauled to the gypsum stack every few days. After the material has a chance to dry, it appears to have similar characteristics to the "regular" gypsum. Due to its wet condition at the time of placement, we recommend that it be placed in the interior of the stack. A buffer distance of 100 feet from the outslope is recommended. This recommendation is based on engineering judgement and should be considered a best management practice.

13.3.9. The seep on the slope of Dike 3 that was discovered in the summer of 2009 near Section 'J' should be addressed. The seepage can be controlled and the slope stability increased through installation of a crushed rock blanket drain. The blanket drain should consist of a 12-inch blanket of TDOT 903.01 Concrete Sand followed by a 6-inch layer of #57 stone, a 6-inch layer of #1 stone and 12-18 inches of TDOT Class 'A-1' crushed limestone embedded into the slope after vegetation and topsoil is removed. Plans detailing the limits of the repair have been prepared and included in the Gypsum Stack Modification Project. This repair was evaluated using Slope/W.

14. Closure and Limitations of Study

14.1. The scope of this evaluation was limited to consider the potential risks of dike failure under long-term, steady-state seepage loading conditions and undrained loading conditions.

14.2. The recommendations presented herein are based on information gathered (from various sources) using that degree of care and skill ordinarily exercised under similar circumstances by competent members of the engineering profession. Subsurface profiles are generally based on straight-line interpolation between borings and no warranties can be made regarding the continuity of subsurface conditions between the borings.

14.3. The boring logs and related information presented in this report depict approximate subsurface conditions only at the specific boring locations noted and at the time of drilling. Conditions at other locations may differ from those occurring at the boring locations. Also, the passage of time may result in a change in the subsurface conditions at the boring locations.

Appendix A

Historic Documents

Geotechnical Reports
Cumberland Fossil Plant

1. "Cumberland Steam Plant – Ash Disposal Area – Soils Investigation", Memorandum from Gene Farmer to W.W.Engle, August 7, 1974.

2. "Cumberland Steam Plant – Ash Dike Raising – Borrow Area B Expansion and Proposed Borrow Area D", Memorandum from Frank Van Meter to G. L. Buchanan, June 16, 1981.

3. "Site Investigation – Cumberland Fossil Plant Soils Investigation for Ash Pond Dike and Borrow Areas", Hall, Blake and Associates, Inc., October 3, 1986.

4. "Ash Pond Dike – Recommended Engineering Properties for Slope Stability Analyses", TVA, December 12, 1986.

5. "Cumberland Fossil Plant – Chemical Treatment Point – Soils Test Report", Memorandum from R.E. Bruer to J.L. Golden, August 13, 1987.

6. "Cumberland Fossil Plant – Ash Disposal Area No. 1A", Power Engineering & Construction Calculations, K.W. Burnett, December 19, 1990.

7. "Report of Subsurface Exploration and Stability Analyses, Proposed Fly Ash / Scrubber Sludge Disposal Facility, Cumberland Fossil Plant, Cumberland City, Tennessee", Law Engineering and Environmental Services, Inc., January 27, 1992.

8. "Recommendations for Stability Improvement, Ash Pond Dike System, Cumberland Fossil Plant, Cumberland City, Tennessee", Law Engineering and Environmental Services, Inc., March 13, 1992.

9. "Results of Laboratory Testing, TVA Fly Ash & Gypsum Disposal Facilities, Cumberland Fossil Plant, United Engineers and Constructors Inc.", June 1992.

10. "Report of Hydrogeologic Evaluation, Proposed Dry Fly Ash and Gypsum Disposal Facility, TVA Cumberland Fossil Plant, Cumberland City, Tennessee", Law Engineering and Environmental Services, Inc., July 3, 1992.

11. "Geotechnical Investigation Report, Dry Ash Conversion Project, CUF 1 & 2", Raytheon Engineers and Constructors, July 7, 1993.

12. "TVA – Fly Ash, Bottom Ash, and Scrubber Gypsum Study", Law Engineering and Environmental Services, Inc., October 1995.

Geotechnical Reports
Cumberland Fossil Plant

13. "Report of Preliminary Geotechnical Exploration, Proposed Gypsum Wallboard Plant, TVA Cumberland Fossil Plant, Cumberland City, Tennessee", Law Engineering and Environmental Services, Inc., January 3, 1997.

14. "Operations Manual: Dry Ash and Gypsum Stacking Facility", TVA, October 10, 2003.

15. "Laboratory Test Results, Samples from Gypsum Pond at Cumberland Fossil Plant", MACTEC Engineering and Consulting, Inc., May 13, 2004.

16. "Report of Geotechnical Exploration, Gypsum Area Seepage Study, Cumberland Fossil Plant, Cumberland City Tennessee", MACTEC Engineering and Consulting, Inc., May 1, 2007.

17. "Project Update – Seepage Investigation and Repair, TVA Cumberland Fossil Plant", Geosyntec Consultants, May 2007, October 2007 and July 2008.

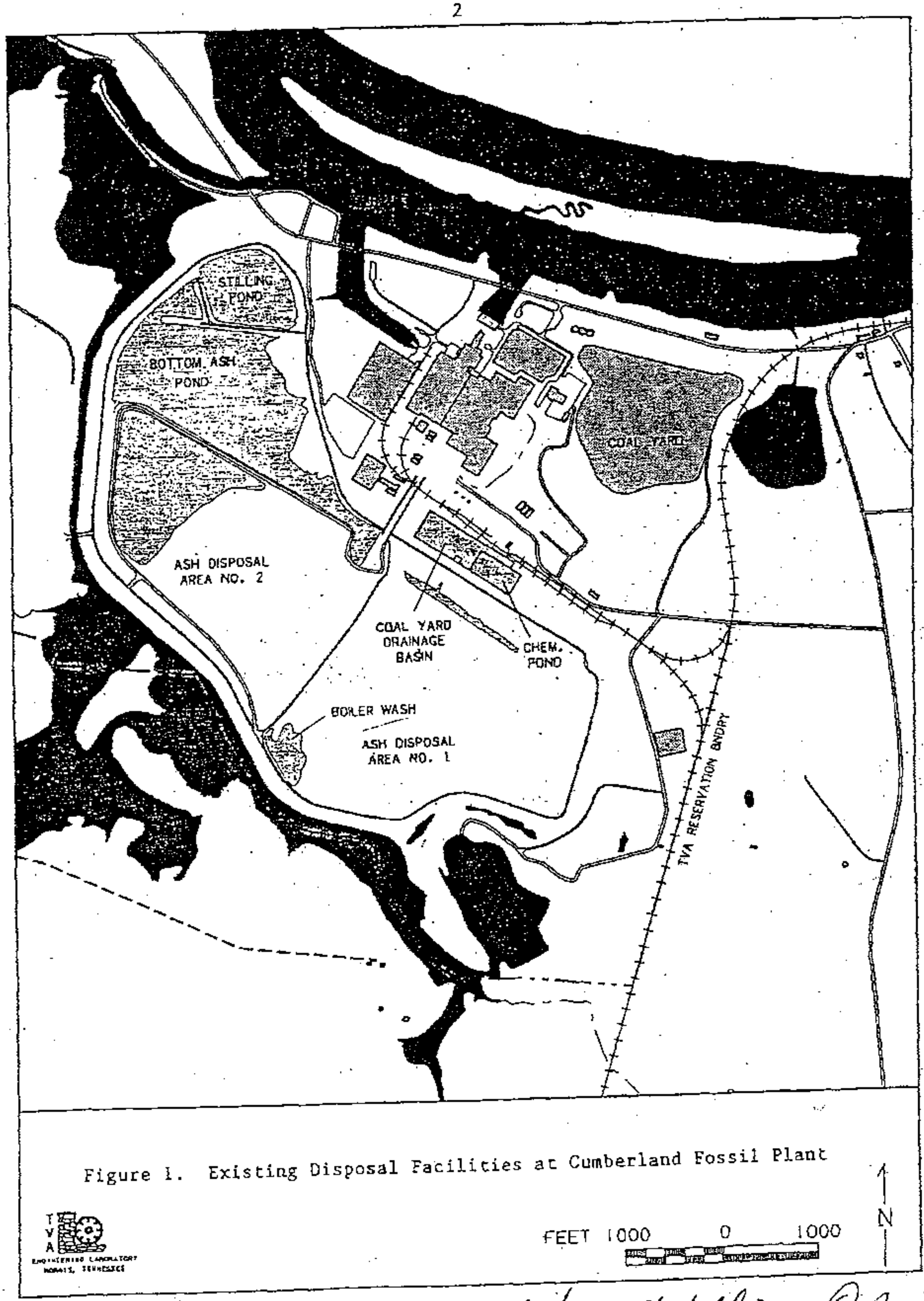

Figure 1. Existing Disposal Facilities at Cumberland Fossil Plant

TVA
ENGINEERING LABORATORY
NORRIS, TENNESSEE

- GEO TRANS Report - Leachate Modelling Report

TVA Cumberland Fossil Plant (CUF)
Assessment of Seepage Area

Background

- 1969 - Initial dikes (top elevation 380') constructed.
- 1973 - Seepage observed along relocated Wells Creek channel bank. Appeared that seepage was occurring through a "soft, saturated topsoil layer between el. 360 and el. 363."
- 1976 - Divider dike between Pond 1&2 constructed with bottom ash.
- 1981 - Initial dikes raised to top elevation 395'.
- 1986 - Discharge spillways raised to el. 372. This resulted in increased seepage along a portion of the Area 2 (western portion) perimeter dikes adjacent to Wells Creek. As a result, spillways were lowered to original elevation.
- 1987 - Because of the seepage below the exterior dikes in the Pond 2 area, interior dikes were constructed in the area (approximately 100 feet inside of exterior dike) with bottom ash.
- 1989 - New dredge cell constructed within Pond 1. Dike constructed using fly ash and bottom ash.
- 1991 - Pressure grouting of Pond 2 dike completed to reduce seepage.
- X - Pond 1 area converted to gypsum disposal in ? (permit documents dated 2003).
- 2004/2005 - Areas of seepage along toe of exterior dikes noted in 2005 Annual Ash Pond Dike Stability Inspection (inspection conducted in December 2004). Report states that same areas were noted in previous inspections.
- 2005 - Discovered slope failure in original ash pond dike below the gypsum area near where the ash/gypsum areas interface. The area was repaired by placing a drainage blanket consisting of a geotextile overlain by crushed stone and riprap. Geoprobes conducted within the failure area and outside the failure area did not indicate any noticeable changes in dike materials between the two areas. The 2006 Inspection indicates that standing water in the perimeter ditch may be contributing to the seeps.

Preliminary Review of Information

- GeoSyntec has spent two days reviewing available data and reports (one day at TVA's office in Chattanooga, TN and one day at GeoSyntec in Kennesaw, GA); key documents found to date include:
  - Hall, Blake, and Associates, *Site Investigation, Proposed Cumberland Fossil Project, Soils Investigation for Ash Pond Dike and Borrow Areas,* October 1986
    - 14 soil borings through perimeter dikes and 56 borings in borrow areas, associated laboratory testing
  - Law Engineering, Inc., *Report of Subsurface Exploration and Stability Analyses, Proposed Fly Ash/Scrubber Sludge Disposal Facility, Cumberland Fossil Fuel Plant,* January 1992
    - 15 soil borings through perimeter dikes, 6 dilatometer tests in ash areas, laboratory tests on remolded samples
  - Law Engineering, Inc., *Report of Hydrogeologic Evaluation, Proposed Dry Fly Ash and Gypsum Disposal Facility Site, Cumberland Fossil Fuel Plant,* July 1992 (part of the September 2003 O&M Manual)
    - 15 soil borings, well installations, slug testing

    - GeoTrans, Inc. *Evaluation of Water Resource Impacts from Proposed Disposal Facilities at Cumberland Fossil Plant*, August 1992 (part of the September 2003 O&M Manual)
        - Boiler Wash Area on Figure 1 (see attached)
    - United Engineers and Constructors, Slope Stability Analysis, August 1992
    - Various Memorandums and Calculation Packages related to Slope Stability Assessments and Site Inspection Reports
- Mr. Neil Davies and Ms. Tamara Hebeler of GeoSyntec visited the site on 6 October 2006 with Mr. Randy Petty of TVA.
- Summary of Key Findings from Documents and Site Visit:
    - Generalized cross section through seepage area appears consistent with Figure 2 (see attached). Some variation in cross sections with respect to interior slope of original berm and width of berm between original and raised dikes (topography would help to confirm this).
    - Limited to no information regarding QA/QC associated with original dike construction has been located.
    - Discrepancies exist between various reports regarding detailed stratigraphy and material properties (e.g.., thickness of "soft layer" below original ground surface, questions posed concerning strength properties of natural materials below the dike).
    - Seeps in original dike observed/heard during site visit. Dike in area of previous slope failure has several "wet" spots.
    - Approximately 2 feet of standing water in perimeter ditch.
    - Water levels in piezometers located along the top of the perimeter dike were approximately 5 feet below ground surface (corresponding to the approximate elevation of the standing water in the perimeter ditch)

Objectives for Present Assessment

GeoSyntec understanding of TVA's current needs regarding this assessment is as follows:

- Assess current situation in terms of:
    - Slope stability (current FS, identify options for improvement if needed)
    - Seepage (attempt to quantify, identify possible causes, identify options for management of seepage water)
- Future conditions
    - Full-build out
        - Stability (identify options for improvements if needed)
        - Seepage – (estimate seepage after implementation of recommended fix, under full build-out conditions)
- Interim conditions
    - Is there an "interim condition" that is more likely than full build-out given the current success of marketing at CUF?

Geotechnical Investigation

Based on our review of currently available information, GeoSyntec recommends the following:

- Baseline Cross-section (in the vicinity of Boring Range B shown in Figure 2)
    - Drill 3 borings on existing dikes (existing roadway, bench of original dike, toe of slope)
    - Prepare boring logs indicating material description (visual classification) from ground surface to refusal (continuous sampling).

- Obtain disturbed samples of each material type or at 5 ft depths or each strata change
- Obtain undisturbed samples for triaxial and permeability testing at selected depths (assuming undisturbed samples can be recovered).
- Provide physical classification (grain size distribution, Atterberg Limits (clay samples only)) of major materials
- Install 2" ID temporary monitoring wells at locations and depths determined by TVA or their designated representatives. Actual locations and depths to be determined based on stratigraphy observed during drilling of borings. Allow 2-hours for development of each well, include blank section of casing at base of each well. Use surge block development with pumping (instructions to be forwarded by TVA). Assume two temporary wells per location. Temporary wells shall be installed in separate borings, offset approximately 5-ft from initial boring. [Each location: primary exploration hole; two offset holes (3 total, A, B, C per location)]. Protection of wells to be addressed by TVA. Use double density slotted screen; 5-ft. screen length; 2-in ID, schedule 40 PVC.
- Test pit down to "groundwater" in ash/gypsum disposal area
- Perform slug tests and provide estimates of in-situ hydraulic conductivity at selected temporary well locations.

- Failure Area (Boring Range A shown in Figure 2)
  - Essentially the same as for Range B, but locations and depths of piezometers may be adjusted based on baseline results
- Grouted Area (optional)
  - Consider installing a transect of 3 piezometers (toe of slope, original dike, existing roadway) to assess impact of grouting on phreatic surface. Compare to baseline and failure zone.

Analysis of Sections

- Current, Future, Interim conditions using:
  - SEEP/W –steady-state and transient seepage estimates
  - SLIDE – stability and steady-state seepage estimates

Data Needs

- Electronic Topography
- Available Aerial Photographs
- Groundwater Levels (requesting from Amos Smith)
- Documents (most likely with additional soil information)
  - TVA (CSB 78 1121 107)
  - Soil Schedule No. 70.1 (MED 811201 224)

Deliverable

- Sketches
- PowerPoint document with text, data, key output, figures

January 17, 1992

Gary Nuyt, BR 4A-C

CUMBERLAND FOSSIL PLANT- ASH POND DIKES-CHRONOLOGICAL EVENTS

This is a listing of events compiled primarily from design drawings, ash pond inspection reports, and memory. This information may BE incomplete.

A 295-acre pond was constructed in 1969 to provide ash disposal at Cumberland. The dikes were constructed to an elevation of 380 and compacted with sheepfoot roller to a 95% standard proctor maximum density. No foundation investigations were performed. The borrow material used to build the dikes came from inside the disposal area.

In October 1973, seepage along relocated Wells Creek channel bank was first observed by plant personnel. There was no apparent stability problem.

In December 1973, a limited investigation (drilled 2 or 3 holes in area of seepage where the original Wells Creek crosses the dike) to determined the cause of seepage through the ash dike at Cumberland Fossil Plant was performed. This investigation disclosed the presence of a continuous, soft, and saturated topsoil layer between el .360 and el. 363.

In February 1974, increased seepage under the dikes in the area where the original Wells Creek crosses the dike was reported by plant personnel.

In 1976 a divider dike (separate area into pond 1 & 2) was added by the plant. The interior dike was constructed out of bottom ash.

In late 1977 and early 1978, soils exploration of the dike foundation were performed in preparation of raising the ash dikes to el. 395 (existing top of dike elevation). This dike raising was completed in the fall of 1981.

In the fall of 1981, plant personnel raised the level of area 1 above the level of area 2.

In APRIL 1986 immediately after raising the discharge spillways four feet to an el. 372, an unacceptable amount of ash pond seepage began along a portion of the area 2 perimeter dike adjacent to Wells Creek. The seepage was inspected thoroughly by representatives of the plant, central staff, and engineering design, and a decision was make to lower the spillways four feet returning the ash pond water to its previous elevation. This was followed by an abatement of the seepage. Subsequent dike and foundation investigations revealed a thick soft layer of soil (by trenching with backhoe) below the original groundline under the dike with a potential for seepage and instability as water is raised in the pond.

In 1987, because of excessive seepage below the base of the exterior dike of pond 2b adjacent to Wells Creek, plant personnel constructed an internal dike approximately 100 feet inside of and parallel to the exterior dike. The dike was constructed with bottom ash.

In 1989, CSB (CONSTRUCTION SERVICES BRANCH) constructed a new dredge cell in fly ash pond 1 to elevation 401. This dike was constructed using fly ash and bottom ash. In October 1989, the dredge cell in area 1 was completed and dredging ash from area 2 into it began.

In January 1990, FHE prepared and submitted a cost estimate for repairing seeps and stabilizing ash pond 2 dike along Wells Creek and raise dikes around the stilling pond. This scheme would allow for the full ash pond capacity to be utilized at Cumberland.

In 1990, continued to dredge into fly ash no. 1 dredge cell.

In FY 1991 a project was submitted to correct the ash pond seepage problems (pressure grouting) and to provide sufficient dike stability (add riprap along toe of dike) to allow the full ash pond 2 capacity to be utilized at Cumberland.

In October 1991 the pressure grouting of ash pond 2 dike along Wells Creek was completed. The discharged spillway elevation was raised 4 feet to el. 372.

Riprapping along the toe of dike for dike stability has been delayed until the water level against the dike is raised to el. 378.

K. W. Burnett
Manager, Civil Section One
Fossil Engineering
MR 3B-C

KWB:PHF

6416J

Stantec

TVA Disposal Facility Assessment
Phase 1 Coal Combustion Product Disposal Facility Summary
Cumberland Fossil Plant (CUF)
Dry Ash Stack (DS-1)

1. General Facility Information

Facility Status: Active

Surface Area: 110 acres (estimated)

Maximum Height (toe to top of stack): 35 feet Existing
200 feet Proposed

2. Site Visit Information

Stantec Assessment Team: Stephen Bickel, PE, Nathan Bader, PE, Stan Harris, PE and Matthew Hoy, EIT

TVA Staff Present: Stuart Harris and Carrie McCarty

Field Assessment Dates: January 14, 2009 and February 3 - 4, 2009

Weather/Site Conditions: Mid-30 degrees F, sunny, moist ground both days.

3. History/Description of Usage

History, Operation and Stacking Plan:

In 1972, Wells Creek was relocated in order to construct old Disposal Area 1. Old Area 1 was enclosed by the existing perimeter dike and contained sluiced ash. In the 1980s, sluicing operations ceased within Area 1 and began in the current Area 2 to the north. Divider dikes were constructed to separate the current pond from the gypsum and ash stacking operations. In 1995-96, the current divider dike between the Ash Pond and Dry Stack was constructed. In 1996, stacking within this area began. The Dry Stack is bordered by the Ash Pond to the north, by the bottom ash pond to the east, the Wet Gypsum Storage Area to the south, and by perimeter ditches and the old Area 1 perimeter dike to the west. There is a stacking plan available, and construction is currently proceeding to the north. The sequence consists of building the base and closing it, then moving up to the next level. The stack's maximum height is currently 35 feet. A small dredge cell was constructed within the northwest portion of the Dry Stack in 2007 to dispose of coal fines dredged to remove sediment build up in the Coal Yard Drainage Basin.

Stacking over Dredge Cells or CCB Ponds: Previous Area 1 (the original ash pond) is located beneath the Dry Ash Stack and was used as the original ash pond for the plant. This pond operated until the 1980s when sluicing to Area 2 (current active ash pond) began. The stack is being constructed over sluiced bottom and fly ash. It is unknown how much sluiced ash is beneath the stack. A small dredge cell within the Dry Ash Stack area was also filled with dredged coal fines from the Coal Yard Drainage Basin in 2007.

Past Failures/Releases: No failures or releases reported.

4. Owner's Operations, Maintenance and Inspection Information

TVA Maintenance: Mowing is performed every two years.

TVA Inspections: TVA Engineering performs annual dike inspections and prepares reports. Plant personnel recently started making daily observations, with documented inspections made weekly.

Problems Previously Identified During Past TVA Inspections: Lack of vegetation and erosion along stack, erosion along access road, seepage areas along Wells Creek, animal burrow on exterior perimeter dike, tree growth on exterior dike, standing water, sedimentation and heavy growth in perimeter ditch.

5. Documents Reviewed

See attached Document Log for complete list of documents provided by TVA for review. In particular, the following provided pertinent information for the assessment of this facility:

TVA Design Drawings: 10W288-1 through 5

TVA As-Built Drawings: None available.

TVA Construction Testing Records: None available.

TVA Annual Inspection Reports: TVA Annual Inspection Reports 1972-1984, 1986-1990, 1994-1995, 1997-2004, 2006-2008.

Geotechnical Data:	"Operations Manual: Dry Ash and Gypsum Stacking Facility", prepared by Tennessee Valley Authority, October 10, 2003. "TVA-Fly Ash, Bottom Ash, and Scrubber Gypsum Study", Law Engineering, Inc., October 1995. "Report of Subsurface Exploration and Stability Analyses, Proposed Fly Ash/Scrubber Sludge Disposal Facility, Cumberland Fossil Plant, Cumberland City, Tennessee", Law Engineering, January 27, 1992. "Report of Hydrogeologic Evaluation, Proposed Dry Fly Ash and Gypsum Disposal Facility, TVA Cumberland Fossil Plant, Cumberland City, Tennessee", Law Engineering, July 3, 1992. "Geotechnical Investigation Report, Dry Ash Conversion Project, CUF 1 & 2", Raytheon Engineers and Constructors, July 7, 1993. Results of Laboratory Testing, TVA Fly Ash & Gypsum Disposal Facilities, Cumberland Fossil Plant, United Engineers and Constructors Inc., June 1992.

6. Stantec Field Observations

See attached Concerns/Photo Log, Photos, and Site Plan Drawing.

6.1. Exterior Slopes and Benches

Vegetation:	Sparse to good vegetation coverage. Some areas of exposed soil present primarily along the southeast face and in areas to the north where the stack is just recently being constructed.
Trees:	None observed.
Erosion:	Several areas of erosion along the dry stack were noted where vegetation is sparse, primarily along the southeast face.
Instabilities:	No evidence of instabilities were observed.
Uniform Appearance	Good.

Benches:	None observed.
Slope:	Design: 3H:1V along Dry Ash Stack (from Drawing 10W288-4); 3H:1V along outer perimeter dike to west (from Drawing 10N213). Measured: 2.25H:1V along Dry Ash Stack at Section 4. 2.7H:1V along perimeter dike to west at Section 2.
Height:	35 feet along Dry Ash Stack at Section 4. 15 feet along perimeter dike to west at Section 2.
Other:	None.

6.2. Perimeter Drainage Ditches and Down-Drains

Vegetation:	Phragmites/tall grass along majority of west perimeter ditch.
Rip-Rap Channel Lining:	None observed.
Erosion:	Some scarping of the ditch side slopes was observed along west perimeter ditch. In addition, sedimentation had accumulated in ditch at several areas along the adjacent stack faces.
Siltation in Ditches:	Sedimentation observed throughout majority of west perimeter ditch.
Standing Water in Ditches or on Benches:	Standing water noted within the perimeter ditch to the west.
Silted/Impeded Drainage Pipes:	The drainage pipe for the perimeter ditch along the northwest corner of the stack area to the Ash Pond had signs of erosion around the inlet and outlet.
Other:	None.

7. Notable Observations and Concerns

- The area beneath the Dry Ash Stack was initially operated as a wet ash disposal pond. Constructing embankments over hydraulically placed ash is a potential slope stability concern and requires engineering analysis and geotechnical exploration.
- The southeast face of the stack consists of exposed soil cover which is eroded throughout. Other small areas of sparse vegetation or erosion were also observed. Further to the north, soil cover and vegetation have not yet been completed and the exposed ash slopes exhibit some erosion.
- Erosion was noted around the existing rock check within active portions of the stack.
- Areas of erosion and rutting were noted along the access road at the base of the stack.
- Eroded ash sedimentation, vegetation, poor drainage, and standing water were observed throughout the perimeter ditch. The side slopes of the ditch also exhibit shallow sloughs and scarps due to excavations made for cleaning of sedimentation.
- Vegetation has not yet been established where recent tree removal has occurred along the exterior west perimeter dike slope in the vicinity of the old bridge.
- Seepage was observed below the west perimeter dike along the banks of Wells Creek. The seepage does not appear to have changed from previous descriptions provided in inspection reports.
- The absence of an Emergency Action Plan, Operation and Maintenance Plan, as-built drawings and construction testing records is a concern.

8. Recommendations

8.1. Phase 2 Engineering and Programmatic Recommendations

- It is recommended that the Dry Ash Stack undergo further engineering study to evaluate the stacking plan and slope stability. This should include test borings, installation of piezometers, and installation of slope inclinometers; followed by laboratory testing and slope stability analysis of critical cross-sections.
- It is recommended that a program be established to develop as-built drawings and construction records for future maintenance and construction activities.
- Based on the findings of Phase 2 and designs from Phase 3, if performed, Stantec recommends that the existing O&M Manual be reviewed and updated. These updates may include sections on routine monitoring and facility maintenance.

8.2. Maintenance Recommendations

- CUF plant personnel should continue to monitor the seepage area below the west perimeter clay dike.
- Cut and maintain heavy/tall phragmite growth to allow better observation specifically in the perimeter ditches. Establish mowing program.
- Regrade and repair erosion areas where noted.
- Regrade, place new clay cover, and reseed the southeast face of the stack. Monitor other dry stack areas for erosion/sparse vegetation and repair as needed.
- Repair ruts and eroded areas along access road at base of stack if it is to remain in service.
- Clean sedimentation and phragmites from Dry Ash Stack perimeter ditches. Remove sedimentation, check grades and regrade the perimeter ditches as needed to promote positive drainage and alleviate standing water issues.
- Continue annual inspection program and execute recommendations.

Stantec

TVA Disposal Facility Assessment
Phase 1 Coal Combustion Product Disposal Facility Summary
Cumberland Fossil Plant (CUF)
Gypsum Storage Area (GSA)

1. General Facility Information

Facility Status:	Temporarily Inactive	**NID Identification:**	TN16110
Surface Area (inside dikes)	170 acres (estimated)	**Maximum Height (toe to top of dike):**	50 feet (estimated, current phase) 140 feet (Proposed)
Free Water Volume:	Currently drained	**Maximum Water Storage:**	Currently drained
Estimated CCB Storage:	1,825,579 CY	**Dike Length:**	9,000 feet (estimated)
Plant Discharge to Facility:	6,000 gpm when active	**Current Pool Elevation:**	Drained

2. Site Visit Information

Stantec Assessment Team:	Steve Bickel, PE, Nathan Bader, PE, Stan Harris, PE and Matthew Hoy, EIT
TVA Staff Present:	Stuart Harris and Carrie McCarty
Field Assessment Dates:	January 14, 2009 and February 3 - 4, 2009
Weather/Site Conditions:	Mid-30 degrees F, sunny, moist ground both days.

3. History/Description of Usage

History and Operation: The gypsum storage area was constructed during 1995-1996. It was built over Area No. 1, which was the original ash pond. Approximately 1,100,000 tons of gypsum is produced each year. Roughly 75 percent of the gypsum is marketed to the adjacent wallboard company and the remaining 25 percent is wet-sluiced to the Gypsum Storage Area. The pond was constructed in several stages beginning with construction of a rock drainage blanket to collect and divert water away from the base. When gypsum is discharged to the pond intermittently, it is wet-sluiced to the northeast corner of the pond. Currently the pond is separated into a north and south area. The pond consists of an upper gypsum dike being constructed using rim-ditching operations, a lower perimeter ash dike, and an even lower clay dike which was the original perimeter dike for the disposal area. Discharge for the pond is through an RCP riser to outlet pipes in the northwest corner of the pond into the adjacent perimeter ditches. The perimeter ditches around the Gypsum Storage Area flow to the north along the neighboring Dry Stack and ultimately into the Ash Pond.

Past Failures/Releases: A slope slough along the perimeter clay dike in the northwest corner of the Gypsum Storage Area reportedly occurred in 2005. The slope was temporarily repaired using rip rap and Stantec is currently evaluating slope stability. Seepage has also been reported in this area and along the Gypsum Storage Area to the east. As a result, the pond has also been drained until Stantec's evaluation is complete.

4. Owner's Operations, Maintenance and Inspection Information

Emergency Action Plan: No EAP has been prepared for this facility.

Operations Manual: "Operations Manual: Dry Ash and Gypsum Stacking Facility", prepared by Tennessee Valley Authority, October 10, 2003.

TVA Maintenance: Exterior slopes mowed every two years.

TVA Inspections: TVA Engineering performs annual inspections and prepares reports. Plant personnel recently started making daily observations, with documented inspections made weekly.

Problems Previously Identified During Past TVA Inspections: Seepage areas around exterior dike, slope failure along northwest corner of perimeter dike.

5. Documents Reviewed

See attached Document Log for complete list of documents provided by TVA for review. In particular, the following provided pertinent information for the assessment of this facility:

TVA Design Drawings:	10W300-1 through 19, 6314-W-C110200 through 224, 6314-W-C110300 through 316.
TVA As-Built Drawings:	None available.
TVA Construction Testing Records:	None available.
TVA Annual Inspection Reports:	TVA Annual Inspection Reports 1972-1984, 1986-1990, 1994-1995, 1997-2004, 2006-2008.
Geotechnical Data:	"TVA-Fly Ash, Bottom Ash, and Scrubber Gypsum Study", Law Engineering, Inc., October 1995. "Report of Geotechnical Exploration, Gypsum Area Seepage Study, Cumberland Fossil Plant, Cumberland City, Tennessee", prepared by MACTEC Engineering and Consulting, Inc., May 1, 2007. "Report of Preliminary Geotechnical Exploration, Proposed Gypsum Wallboard Plant, TVA Cumberland Fossil Plant, Cumberland City, Tennessee", Law Engineering and Environmental Services, Inc., January 3, 1997. "Report of Subsurface Exploration and Stability Analyses, Proposed Fly Ash/Scrubber Sludge Disposal Facility, Cumberland Fossil Plant, Cumberland City, Tennessee", Law Engineering, January 27, 1992. "Report of Hydrogeologic Evaluation, Proposed Dry Fly Ash and Gypsum Disposal Facility, TVA Cumberland City, Tennessee", Law Engineering, March 13, 1992. "Laboratory Test Results, Samples from Gypsum Pond at Cumberland Fossil Plant", MACTEC Engineering and Consulting, May 13, 2004.

Project Update - Seepage Investigation and Repair, TVA Cumberland Fossil Plant, presented by Geosyntec Consultants to TVA, October 2007, May 2007, and July 2008.

Results of Laboratory Testing, TVA Fly Ash & Gypsum Disposal Facilities, Cumberland Fossil Plant, United Engineers and Constructors Inc., June 1992.

6. Stantec Field Observations

See attached Concerns/Photo Log, Photos, and Site Plan Drawing.

6.1. Interior Slopes

Vegetation:	None. Top dike consists of gypsum with no vegetation established.
Trees:	None observed.
Wave Wash Protection:	None observed.
Erosion:	None observed.
Instabilities:	Portions of the dike are currently being reconstructed using rim-ditching operations, but no evidence of instabilities were observed.
Animal Burrows:	None observed.
Freeboard:	**Measured:** Pond drained. **Design:** Not available on drawings.
Encroachments:	None observed.
Slope:	**Measured:** Currently being constructed, not measured. **Design:** Not available on drawings.

6.2. Crest

Crest Cover and Slope:	Gypsum cover from rim-ditching operations.
Erosion:	None observed.
Alignment:	Alignment appeared to agree with design drawings. No problem.

Settlement/Cracking:	None observed.
Bare Spots/Rutting:	No rutting observed. Crest is bare with no vegetation established.
Width:	**Measured:** 23 feet at Section 5; 20 feet at Section 6 **Design:** Not available on drawings.

6.3. Exterior Slopes

Vegetation:	Upper Gypsum slopes are bare and lack vegetation. Phragmites and brush are present on the intermediate ash dike slopes. A grass cover is present along the lower perimeter dike slopes.
Trees:	Small trees were located in a few areas around the perimeter of the pond.
Erosion:	Areas of erosion were observed along the upper gypsum dike and the lower ash dike in several areas.
Instabilities:	A slope failure has been repaired in the northwest corner of the pond along the perimeter clay dike. Slope instability in the form of shallow sloughing was also observed along the ash dike along the northwest side of the pond.
Uniform Appearance:	Good.
Seepage:	Seepage observed in the past when pond was filled at the northernmost portion of the pond. Seepage was also observed at the southeast side of the perimeter clay dike.
Benches:	One bench that consists of the surrounding access road was observed along the toe of the upper gypsum dike. The bench is 20 feet wide at Section 5 and Section 6.
Foundations, Drains, Relief Wells, Instrumentation:	Drainage pipes extending from the base of the Gypsum Storage Area were reportedly installed on 200-foot intervals. These pipes outlet along the toe of the slope in the perimeter drainage ditches. Flow was observed in selected outlets similar to the flow reported in previous annual inspection reports.

Animal Burrows:	None observed.	
Slope:	**Measured:**	3H:1V along upper gypsum dike at Section 5 and 6; 1.5H:1V to 2.3H:1V along the intermediate ash dike slope at Sections 5 and 6; 2.7H1V along the perimeter clay dike at Section 5.
	Design:	3H:1V for the upper gypsum dikes, intermediate ash dike, and lower perimeter clay dike (from Drawing 10W300-16)
Height:	**Measured:**	Approximately 50 feet at current phase.
	Design:	Approximately 140 feet at final stage (from Drawing 10W300-16).

6.4. Spillway Weirs/Riser Inlets

Number:	One located at northwest end of pond.
Size, Type and Material:	Unknown size, RCP
Height of Riser Inlets:	10 feet or less (estimated)
Access:	None
Joints:	Unknown, unable to observe.
Mis-Alignment:	Unknown, unable to observe.
Closed/Abandoned Conduits:	None reported or observed.

6.5. Outlet Pipes

Number:	Four
Size, Type and Material:	Outlets vary in size and range from steel pipe to corrugated metal pipe.
Headwall:	None was observed.
Joint Separations:	Unknown, could not observe.
Mis-Alignment:	Unknown, could not observe.
Closed/Abandoned Conduits:	None reported or observed.

7. Notable Observations and Concerns

- The gypsum pond is formed by a lower perimeter clay dike, an intermediate ash perimeter dike above the lower clay dike, and an upper gypsum dike. The pond contains two active cells (north and south). Rim-ditching operations are currently on-going to construct the upper gypsum dike. Seepage areas and past slope failures have been noted. Some slopes are also relatively steep (1.5H:1V). Seepage, slope instability, and on-going rim-ditching operations are a concern for the Gypsum Storage Area.
- The absence of an Emergency Action Plan, Operation and Maintenance Plan, as-built drawings and construction testing records is a concern.
- Reconstructed upper gypsum dikes are lacking vegetation.
- Some trees were observed along the perimeter ash dike to the northeast of the Gypsum Storage Area.
- Erosion was observed along the crest and outslopes of the ash divider dike at several areas.
- The southwest and southeast sides of the perimeter ditch contain sediment build-up and standing water.
- Vegetation has not yet been re-established where trees have been removed from the downstream slope of the perimeter clay dike.
- Discharge pipes from interior pond drainage are elevated above a rip-rap channel. Over time, toe erosion will likely occur.

8. Recommendations

8.1. Phase 2 Engineering and Programmatic Recommendations

- It is recommended that the Gypsum Storage Area undergo further engineering study to evaluate the seepage, slope stability, and the on-going rim-ditching stacking plan. Remediation efforts to address these items will be developed based on the results. It is also recommended that a hydraulic and hydrologic analysis be performed to check freeboard and pond outlet adequacy relative to process flow and stormwater. The pond is scheduled to remain drained and temporarily inactive until Phase 2 studies and remedial construction activities, if needed, are performed.

- Based on the findings of Phase 2 and designs from Phase 3, if performed, Stantec recommends that the existing O&M Manual be reviewed and updated. These updates may include sections on routine monitoring and facility maintenance.
- It is recommended that a program be established to develop as-built drawings and construction records for future maintenance and construction activities.

8.2. Maintenance Recommendations

- The loosely stacked gypsum material around the perimeter of the Gypsum Storage Area should be spread in appropriate thicknesses and compacted properly wherever it is to be used as structural dike material. The material used for dikes at outlet areas should consist of coarser gypsum, which has higher strength. Efforts to establish vegetation on completed slopes should also be made.
- CUF plant personnel should continue to monitor the existing slope failure along the perimeter dike outslope at the northwest corner of the Gypsum Storage Area until Phase 2 evaluations are complete and permanent repairs executed.
- CUF plant personnel should continue to monitor the seepage area below the perimeter clay dike.
- CUF personnel have reported a seepage area along the north corner of the Gypsum Storage Area that could not be seen because the pond is currently drained. If this seep re-appears upon re-filling, a crushed stone French drain should be installed by excavating back to intercept the gravel drainage layer that underlies the gypsum disposal area.
- The discharge pipes that drain the interior portion of the Gypsum Storage Area should be extended to ground level and away from the toe of slope.
- Remove trees from noted locations.
- Cut and maintain heavy/tall phragmite growth on slopes and the perimeter drainage ditch to allow better inspection. Establish annual mowing program.
- Regrade and repair erosion areas where noted.
- Clean sedimentation and phragmites from Gypsum Storage Area perimeter ditches. Remove sedimentation, check grades and regrade the perimeter ditches as needed to promote positive drainage and alleviate standing water issues. Use of rip-rap to re-establish ditch side slopes should be considered.

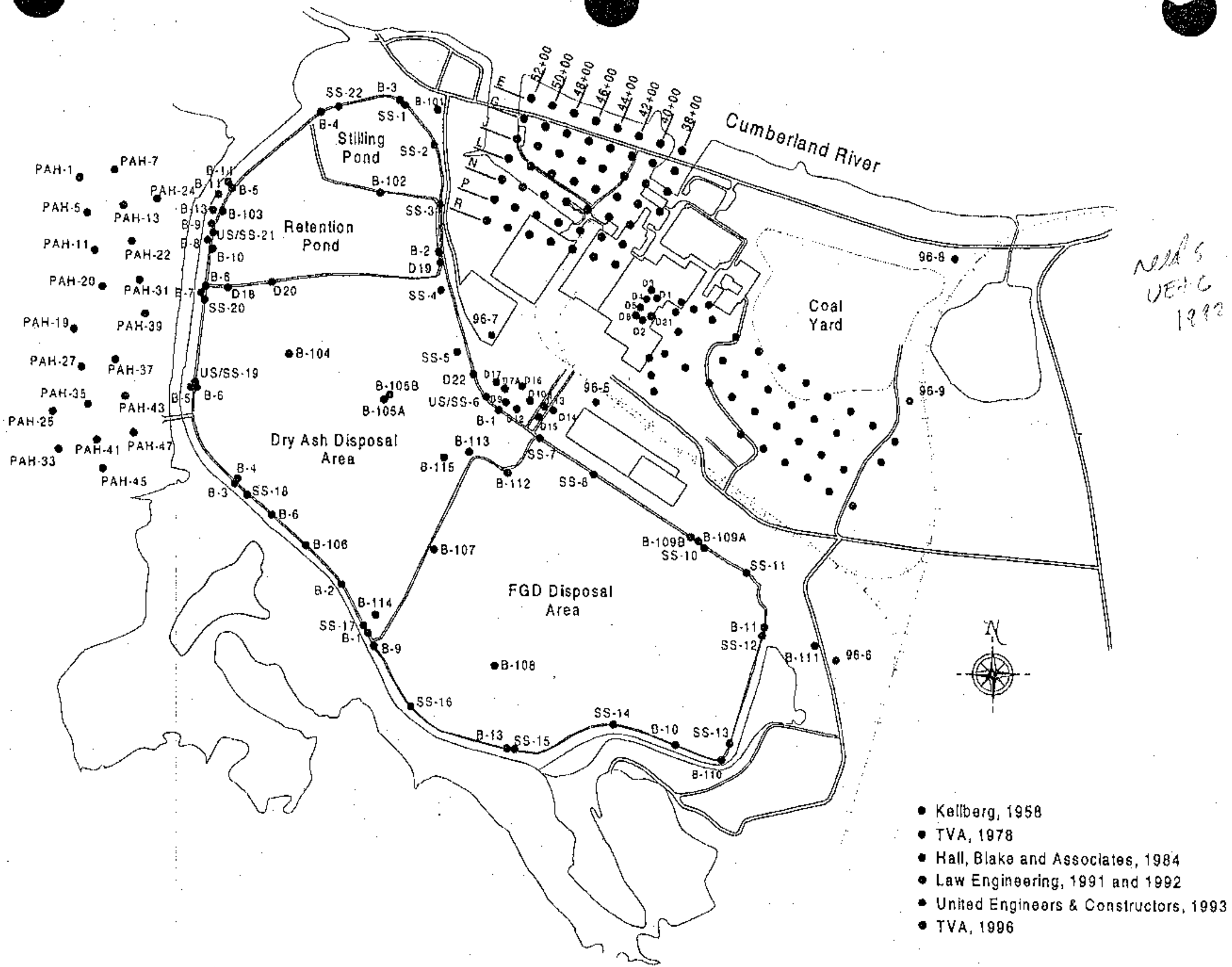

Figure 5.7 Site Map Showing the Locations of Known Exploratory Boreholes

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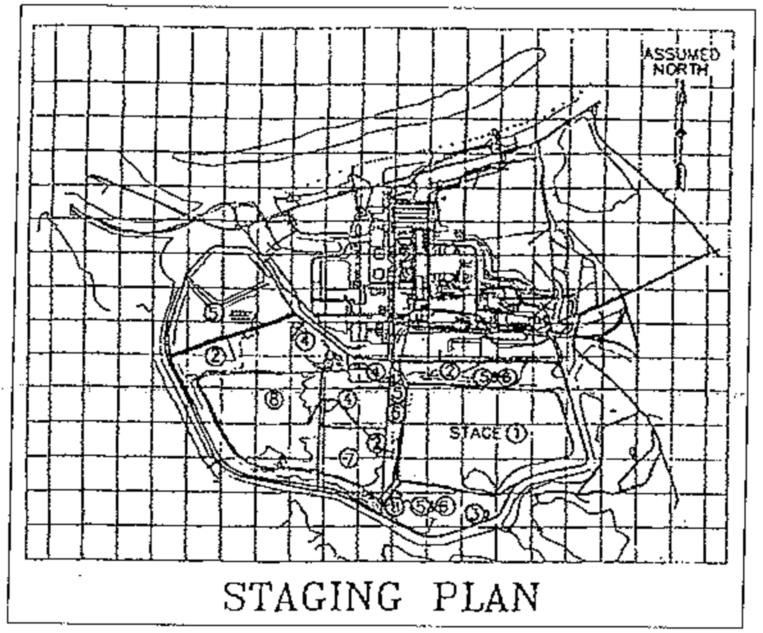
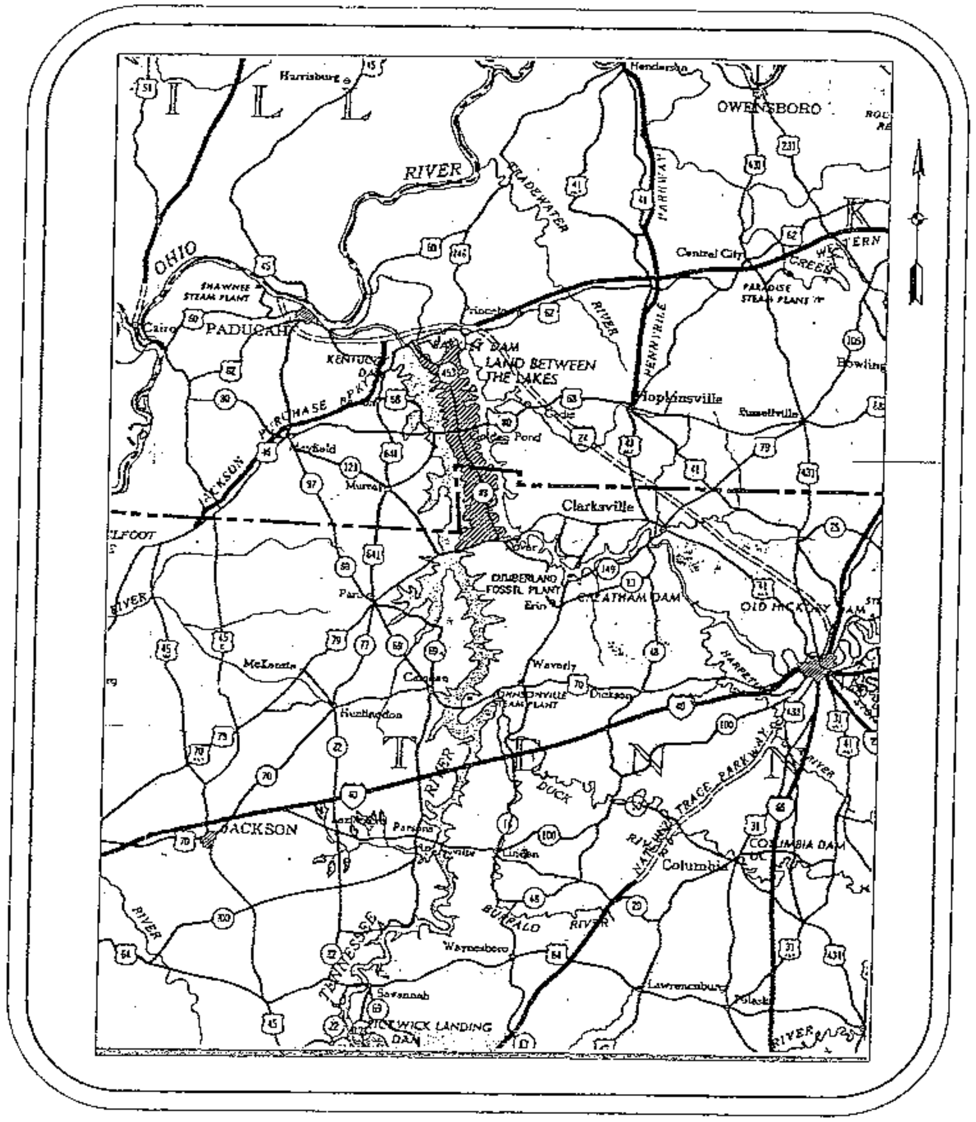
TENNESSEE VALLEY AUTHORITY
CUMBERLAND FOSSIL PLANT
DRY ASH AND GYPSUM STACKING AREA
STEWART COUNTY, TENNESSEE

REQUESTED MODIFICATION OF
IDL 811020082



STAGING PLAN

STAGE 1 – GYPSUM STACKING AREA & SPILLWAY
STAGE 2 – NORTH AND WEST DIKES OF GYPSUM STACKING AND STRUCTURAL DIKE BETWEEN RETENTION POND AND FLY ASH STACKING
STAGE 3 – SOUTHERN DIKE OF GYPSUM STACKING AREA
STAGE 4 – BOTTOM ASH DREDGE CELLS, WASTEWATER DITCH & DRY FLY ASH DISPOSAL AREA (10 ACRES)
STAGE 5 – RETENTION POND DREDGING & PLACEMENT OF DREDGED MATERIALS
STAGE 6 – COMPLETION OF GYPSUM STACKING AREA DRAINAGE BLANKETS
STAGE 7 – DRY FLY ASH DISPOSAL AREA PREPARATION (20 ACRES)
STAGE 8 – DRY FLY ASH DISPOSAL AREA PREPARATION (60 ACRES)



VICINITY MAP

INDEX OF DRAWINGS

DRAWING NO.	DESCRIPTION
10W302–1	INDEX
10W302–2	EXISTING SITE CONDITIONS (SHEET 1 OF 4)
10W302–3	EXISTING SITE CONDITIONS (SHEET 2 OF 4)
10W302–4	EXISTING SITE CONDITIONS (SHEET 3 OF 4)
10W302–5	EXISTING SITE CONDITIONS (SHEET 4 OF 4)
10W302–6	CONSTRUCTION SEQUENCE STAGE NO. 1
10W302–7	CONSTRUCTION SEQUENCE STAGE NO. 2 & 3 (SHEET 1 OF 3)
10W302–8	CONSTRUCTION SEQUENCE STAGE NO. 2 & 3 (SHEET 2 OF 3)
10W302–9	CONSTRUCTION SEQUENCE STAGE NO. 2 (SHEET 3 OF 3)
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10W302–13	CONSTRUCTION SEQUENCE STAGE NO. 5 & 6 (SHEET 2 OF 2)
10W302–14	CONSTRUCTION SEQUENCE STAGE NO. 7
10W302–15	CONSTRUCTION SEQUENCE STAGE NO. 8
10W302–16	PROPOSED FINAL CONTOURS (SHEET 1 OF 4)
10W302–17	PROPOSED FINAL CONTOURS (SHEET 2 OF 4)
10W302–18	PROPOSED FINAL CONTOURS (SHEET 3 OF 4)
10W302–19	PROPOSED FINAL CONTOURS (SHEET 4 OF 4)
10W302–20	CROSS SECTION A–A' (SHEET 1 OF 4)
10W302–21	CROSS SECTION B–B' (SHEET 2 OF 4)
10W302–22	CROSS SECTION C–C' (SHEET 3 OF 4)
10W302–23	CROSS SECTION D–D' (SHEET 4 OF 4)
10W302–24	DETAILS (SHEET 1 OF 3)
10W302–25	DETAILS (SHEET 2 OF 3)
10W302–26	SECTIONS & DETAILS (SHEET 3 OF 3)
10W302–27	STORM DRAINS SECTIONS & DETAILS

HAROLD L. PETTY

10/10/03

R 0		JLG	MCH	JCA	HLP	REP		JCA	
INITIAL ISSUE; FOR DCN CUF-03-536									

SCALE: NONE EXCEPT AS NOTED

VICINITY MAP

DRY ASH AND GYPSUM STACKING AREA
STEWART COUNTY, TENNESSEE

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
J.L. GRAY	M.C. HRANEK	J.C. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.C. ADAIR

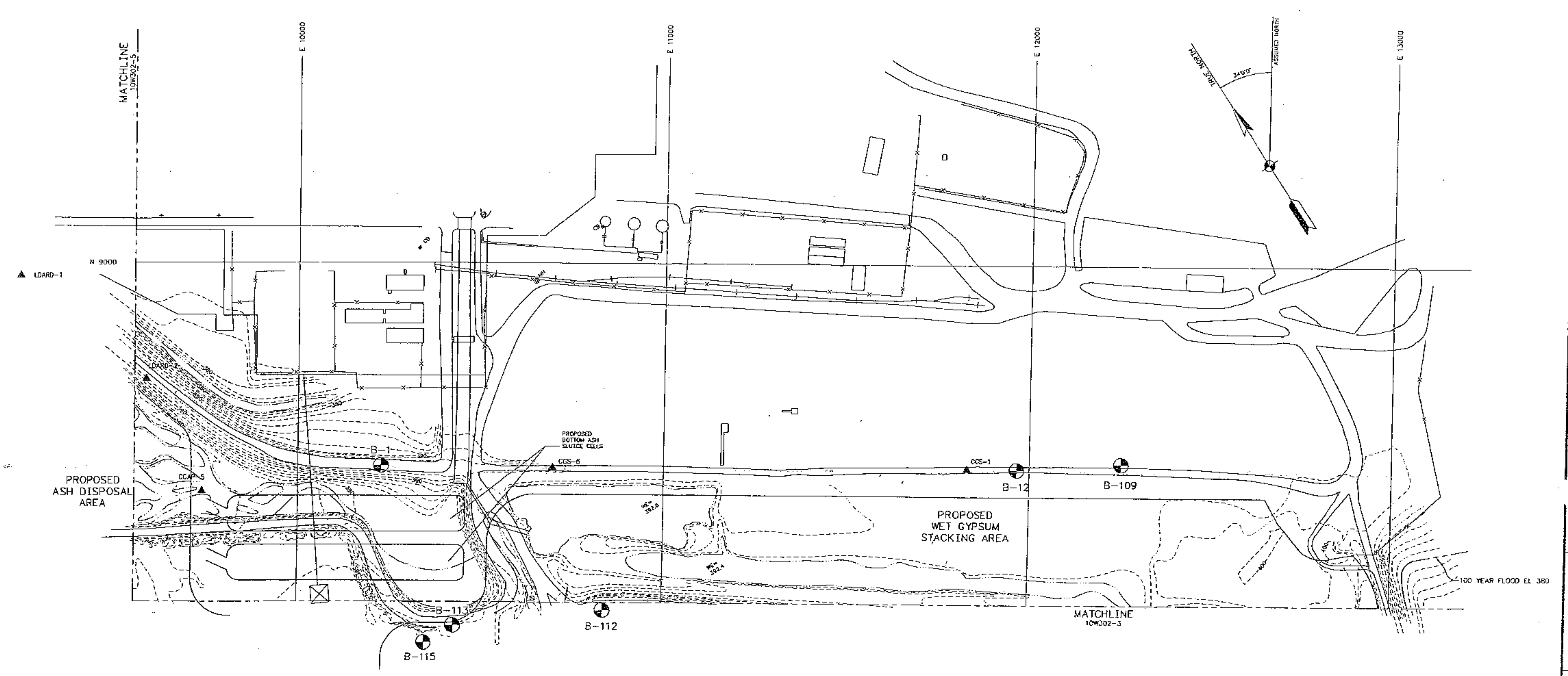
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302–1 | R 0

PLOT FACTOR:1
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: | RTY NO.



LEGEND

● B-102	BORING LOCATION
— - - —	100-YR FLOOD PLAIN
———	DISPOSAL AREA BOUNDARY
Ⓦ CUF 93-1	PROPOSED GROUNDWATER MONITOR WELL
- - - - -	EXISTING CONTOUR
▲	BENCHMARK LOCATION

BORING COORDINATES

BORING NO.	TENNESSEE LAMBERT COORDINATES (FEET) NORTH	EAST	PLANT GRID * COORDINATES (FEET) NORTH	EAST	ELEV. (FEET)
1	730875.30	1511979.60	8446.70	10227.00	395.20
12	729900.20	1513418.70	8442.00	11965.40	395.40
109	729752.44	1513668.68	8460.28	12255.24	394.12
112	730211.62	1512265.76	8056.49	10836.38	394.06
113	730401.23	1511902.36	8010.47	10428.01	389.98
115	730406.33	1511811.59	7963.94	10349.97	388.56

* N10,000 PLANT COORDINATE COINCIDES WITH THE EXISTING E-W PLANT BASELINE (℄ OF EXISTING UNIT 1 CHIMNEY). E10,000 PLANT COORDINATE COINCIDES WITH THE EXISTING N-S PLANT BASELINE (EXISTING COLUMN LINE "A"). I.E. 10,000:10,000=TVA 0:0

BENCH MARK LOCATIONS

BENCH MARK NO. NO.	TENNESSEE LAMBERT COORDINATES (FEET) NORTH	EAST	PLANT GRID COORDINATES (FEET)		ELEV. (FEET)
178-0	727,926.48	1,513,693.70	S 3030.48	E 3297.03	395.21
CCAP-1	732,957.97	1,509,794.23	S 1048.75	W 2749.35	394.71
CCAP-2	732,295.18	1,509,469.16	S 1780.00	W 2648.22	395.18
CCAP-3	730,824.08	1,509,309.41	S 3088.93	W 1958.03	393.61
CCAP-4	730,235.80	1,509,772.02	S 3317.95	W 1245.55	394.91
CCAP-5	731,089.67	1,511,532.96	S 1625.35	W 263.14	399.35
CGS-1	729,975.39	1,513,304.73	S 1558.37	E 1828.82	395.64
CGS-2	729,645.42	1,511,188.50	S 3015.31	E 258.90	410.16
CGS-3	728,420.59	1,511,078.11	S 4092.47	E 852.30	395.30
CGS-4	728,064.78	1,512,362.32	S 3669.33	E 2115.92	395.26
CGS-5	727,951.74	1,513,734.10	S 2995.95	E 3316.39	395.30
CGS-6	730,607.17	1,512,364.68	S 1560.27	E 696.20	396.32
CGS-7	729,077.74	1,510,746.13	S 3733.31	E 209.60	395.19
LDARD-1	731,855.90	1,511,450.22	S 1036.39	W 760.21	393.87
LDARD-2	731,429.43	1,511,577.58	S 1318.73	W 416.14	393.67
PP-F-6 RESET	729,984.36	1,510,783.36	S 3789.94	E 292.62	394.86
T-1	734,549.93	1,509,921.94	N 342.46	W 3533.69	365.43

HAROLD L. PETTY
No. 015578
Harold L. Petty
10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWINGS LIST

R 0 JLG MGH JGA HLP REP JGA
INITIAL ISSUE; FOR DCN CUF-03-536

SCALE: 1"=100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
EXISTING SITE CONDITIONS
SHEET 1 OF 4

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
J.L. GRAF	M.G. GRANDE	J.R. ALBRECHT	H.L. PETTY	R.E. PURDY		A.G. ADAIR

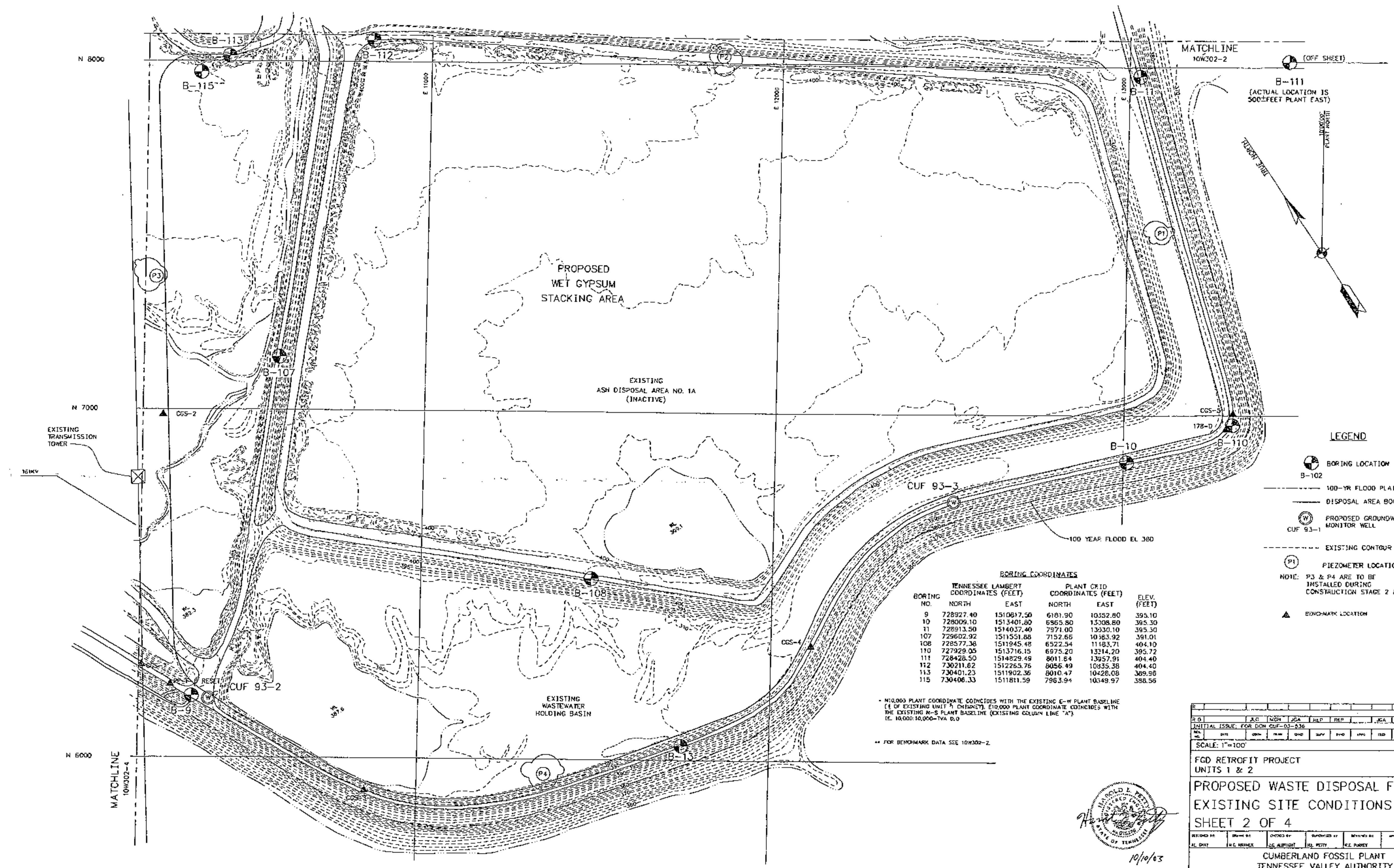
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | DATE | 46 | C | 10W302-2 | R 0

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER

TASK COMPLETED BY: | REV NO.



LEGEND

B-102	BORING LOCATION
	100-YR FLOOD PLAIN
	DISPOSAL AREA BOUNDARY
CUF 93-1	PROPOSED GROUNDWATER MONITOR WELL
	EXISTING CONTOUR
P1	PIEZOMETER LOCATION
▲	BENCHMARK LOCATION

NOTE: P3 & P4 ARE TO BE INSTALLED DURING CONSTRUCTION STAGE 2 & 3.

BORING COORDINATES

BORING NO.	TENNESSEE LAMBERT COORDINATES (FEET) NORTH	TENNESSEE LAMBERT COORDINATES (FEET) EAST	PLANT GRID COORDINATES (FEET) NORTH	PLANT GRID COORDINATES (FEET) EAST	ELEV. (FEET)
9	728927.40	1510817.50	6181.90	10352.80	395.10
10	728009.10	1513401.80	6965.80	13308.80	395.30
11	728913.50	1514037.40	7971.00	13030.10	395.30
107	729602.92	1511551.88	7152.66	10363.92	391.01
108	728577.38	1511945.48	6522.54	11183.71	404.10
110	727929.05	1513716.15	6975.20	13314.20	395.72
111	728428.50	1514829.49	8011.64	13957.91	404.40
112	730211.62	1512265.76	8056.49	10835.38	404.40
113	730401.23	1511902.36	8010.47	10428.08	389.96
115	730406.33	1511811.59	7963.94	10349.97	388.56

* N10,000 PLANT COORDINATE COINCIDES WITH THE EXISTING E-W PLANT BASELINE (℄ OF EXISTING UNIT 1 CHIMNEY). E10,000 PLANT COORDINATE COINCIDES WITH THE EXISTING N-S PLANT BASELINE (EXISTING COLUMN LINE "A"). (E. 10,000:10,000-TVA 0.0

** FOR BENCHMARK DATA SEE 10W302-2.

HAROLD L. PETTY

10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWINGS LIST

R 0 | J.L.G | MGH | JGA | JLLP | REP | JGA
INITIAL ISSUE; FOR DCN CUF-03-536

SCALE: 1"=100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
EXISTING SITE CONDITIONS
SHEET 2 OF 4

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
J.L. GRAY	M.C. MRANEK	J.C. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

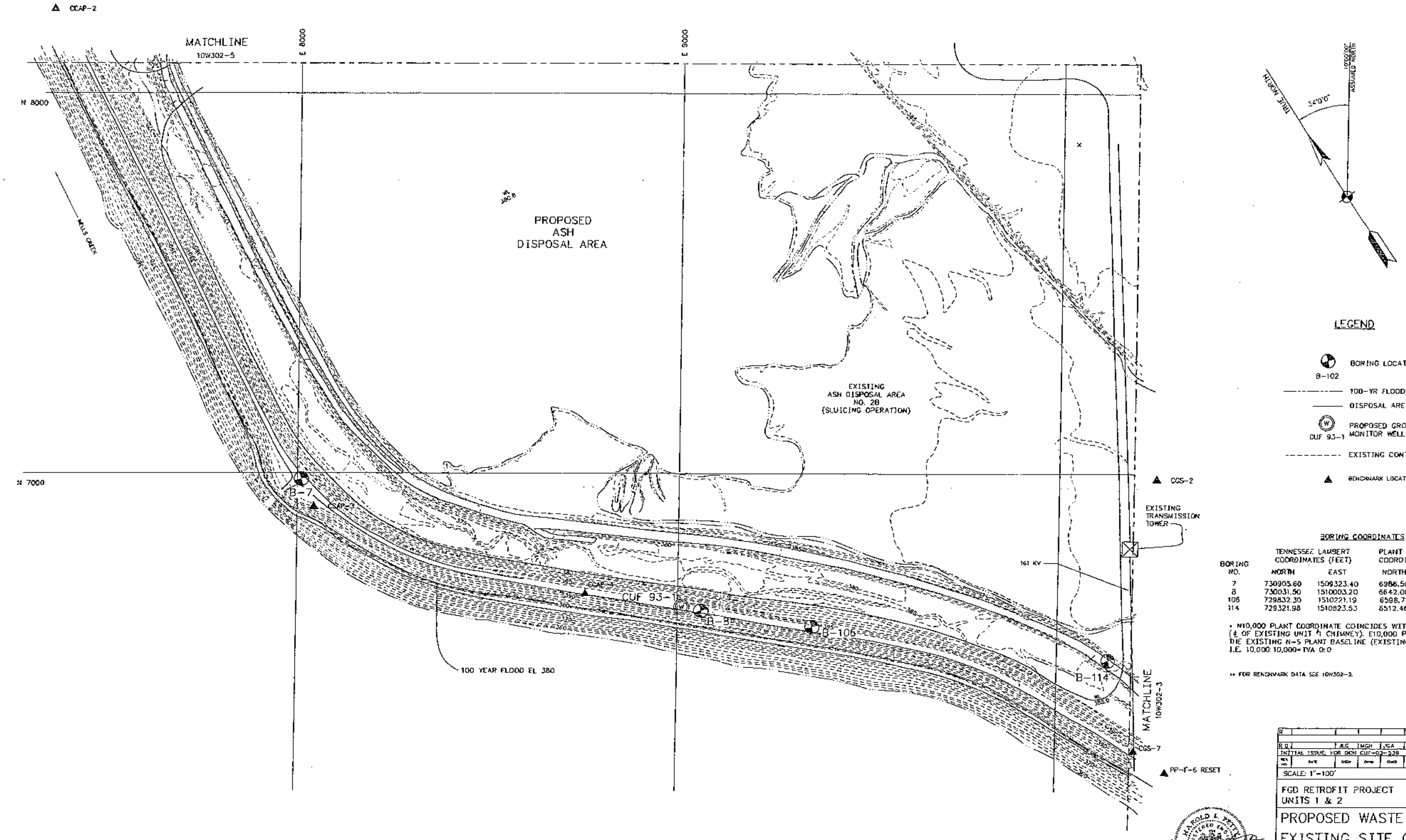
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-3 | R 0

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: | REV NO.



LEGEND

B-102	BORING LOCATION
————	100-YR FLOOD PLAIN
————	DISPOSAL AREA BOUNDARY
Ⓦ CUF 93-1	PROPOSED GROUNDWATER MONITOR WELL
- - - - - -	EXISTING CONTOUR
▲	BENCHMARK LOCATION

BORING COORDINATES

BORING NO.	TENNESSEE LAMBERT COORDINATES (FEET) NORTH	EAST	PLANT GRID * COORDINATES (FEET) NORTH	EAST	ELEV. (FEET)
7	730905.60	1509323.40	6986.50	8008.00	395.10
8	730031.50	1510003.20	6642.00	9060.30	395.30
106	729832.30	1510221.19	6598.71	9352.46	395.44
114	729321.98	1510823.53	6512.46	10137.19	384.24

* N10,000 PLANT COORDINATE COINCIDES WITH THE EXISTING E-W PLANT BASELINE (℄ OF EXISTING UNIT 1 CHIMNEY). E10,000 PLANT COORDINATE COINCIDES WITH THE EXISTING N-S PLANT BASELINE (EXISTING COLUMN LINE "A"). I.E. 10,000:10,000=TVA 0:0

** FOR BENCHMARK DATA SEE 10W302-2.

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWINGS LIST

HAROLD L. PETTY
10/10/03

R 0		JLG	MGH	JGA	HLP	REP		JGA
INITIAL ISSUE; FOR DCN CUF-03-535								

SCALE: 1"=100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
EXISTING SITE CONDITIONS
SHEET 3 OF 4

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
J.L. GRAY	M.G. HRANEK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

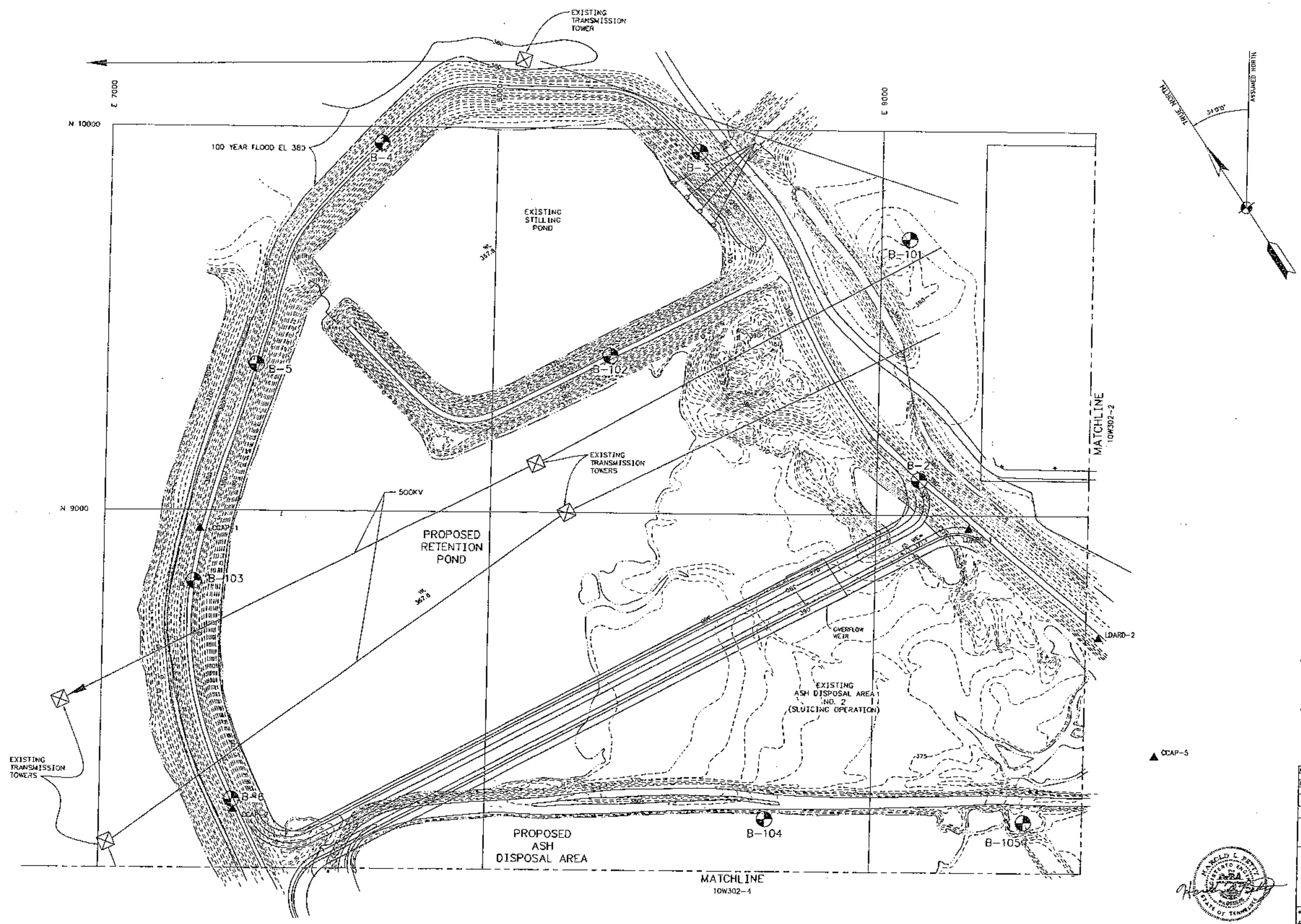
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-4 | R 0

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER

TASK COMPLETED BY:
REV NO.



LEGEND

B-102	BORING LOCATION
	100-YR FLOOD PLAIN
	DISPOSAL AREA BOUNDARY
CUF 93-1	PROPOSED GROUNDWATER MONITOR WELL
	EXISTING CONTOUR
▲	BENCHMARK LOCATION

BORING COORDINATES

BORING NO.	TENNESSEE LAMBERT COORDINATES (FEET)		PLANT GRID * COORDINATES (FEET)		ELEV. (FEET)
	NORTH	EAST	NORTH	EAST	
2	732035.90	1511415.10	9093.20	9110.00	394.70
3	733062.80	1511406.40	9939.60	8528.5	395.50
4	733539.90	1510732.50	9958.40	7703.10	395.40
5	733237.10	1510150.60	9382.00	7392.00	395.40
6	733237.10	1510160.60	8253.30	7346.40	396.40
101	732575.16	1511734.25	9718.74	9073.06	387.83
102	732750.08	1510926.12	9411.83	8305.29	394.96
103	732854.94	1509709.06	8848.21	7237.54	394.35
104	731516.81	1510607.21	8211.09	6730.52	383.53

* N10,000 PLANT COORDINATE COINCIDES WITH THE EXISTING E-W PLANT BASELINE (C OF EXISTING UNIT 5 CHIMNEY). E10,000 PLANT COORDINATE COINCIDES WITH THE EXISTING N-S PLANT BASELINE (EXISTING COLUMN LINE "A"). I.E. 10,000:10,000-TVA 0:0

** FOR BENCHMARK DATA SEE 10W302-2.

SEE 10W302-1 FOR DRAWING INDEX/COMPANION DRAWINGS LIST

HAROLD L. PETTY

10/10/03

R0		JLC	MGM	JGA	MLP	REP		JGA		
INITIAL ISSUE; FOR DCN CUF-03-535										

SCALE: 1"=100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
EXISTING SITE CONDITIONS
SHEET 4 OF 4

J.L. GRAY | M.G. SPANEK | J.C. ALBRIGHT | M.L. PETTY | R.E. PURVEY | | J.C. ADAIR

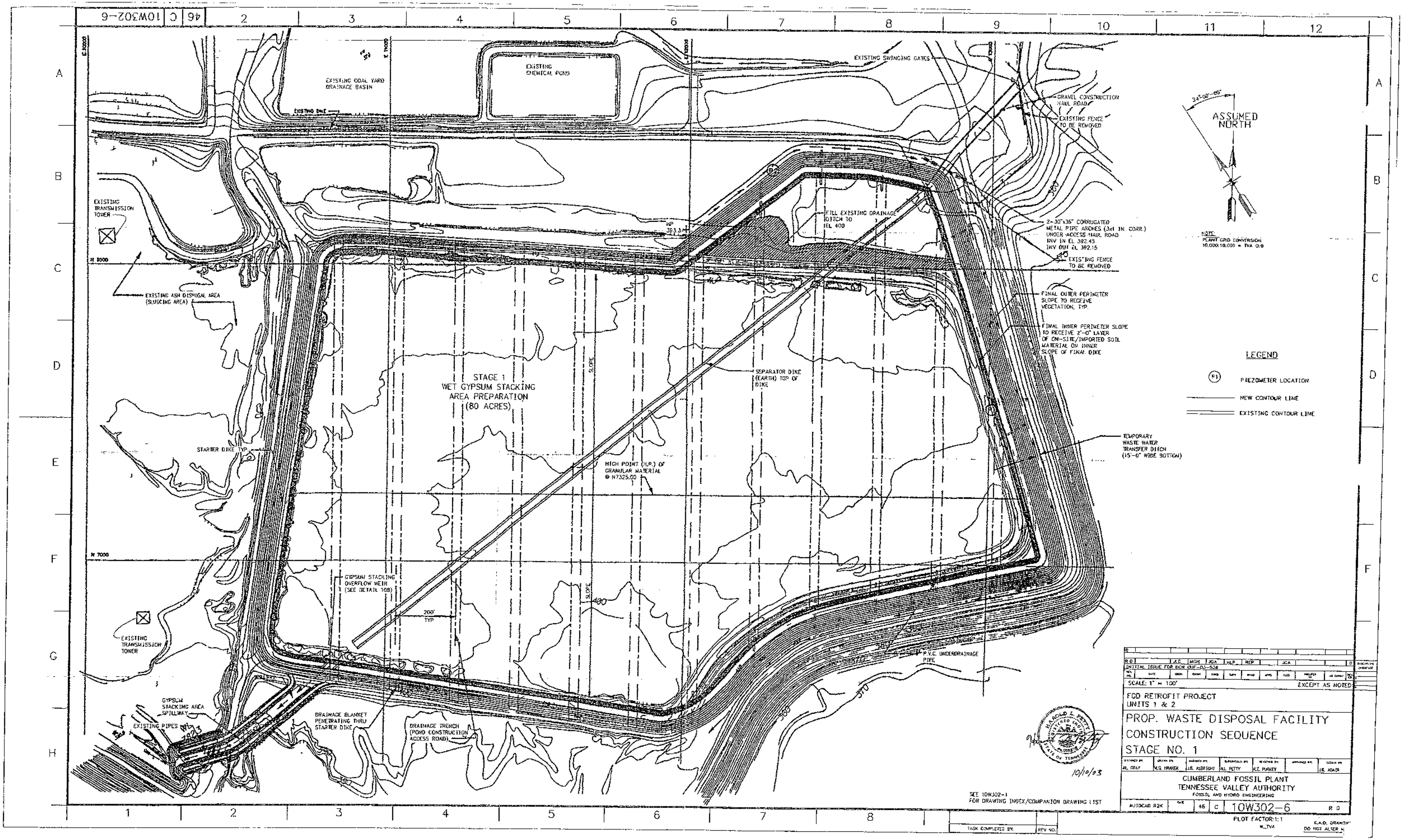
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 45 | C | 10W302-5 | R 0

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: REV NO.



HAROLD L. PETTY
10/10/03

R 0		JLC	MGH	JGA	HLP	REP		JGA		D
INITIAL ISSUE FOR DCN CUF-03-536										

SCALE: 1" = 100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROP. WASTE DISPOSAL FACILITY
CONSTRUCTION SEQUENCE
STAGE NO. 1

J.L. GRAY	M.G. HRANSK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

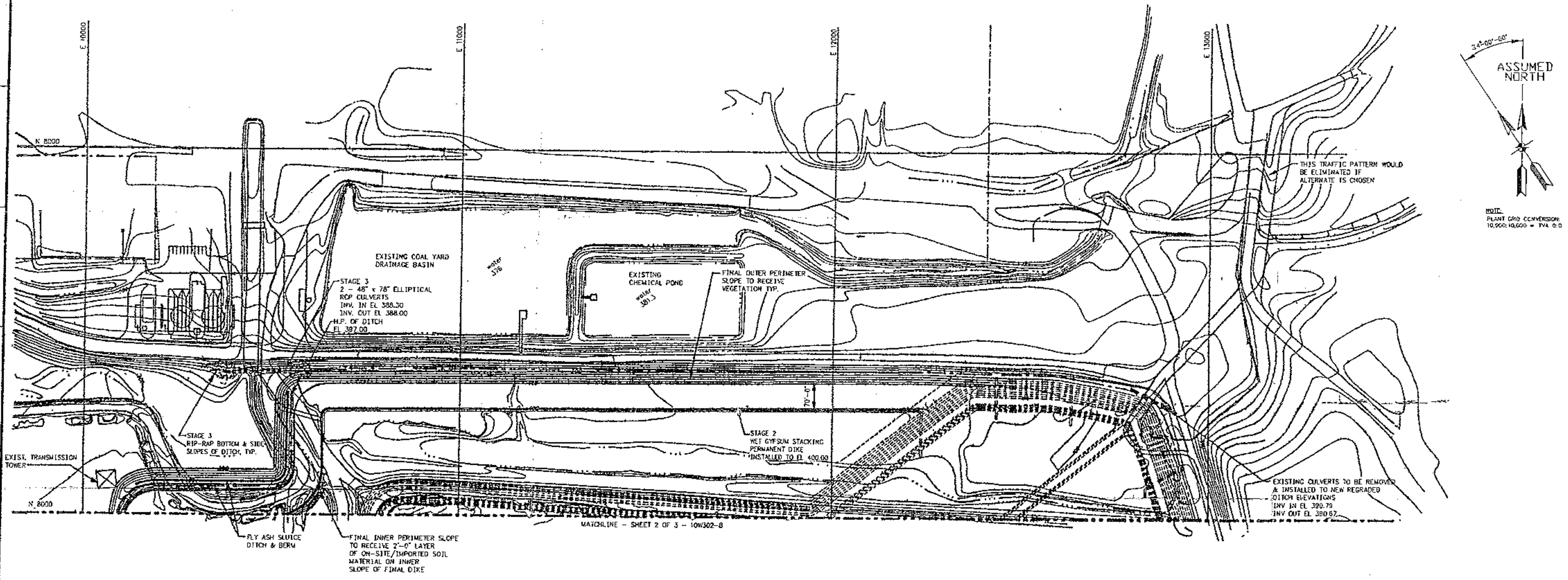
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-6 | R 0

PLOT FACTOR:1:1
W_TVA

C.A.D. DRAWIN
DO NOT ALTER

TASK COMPLETED BY: | REV NO.



NOTE:
PLANT GRID CONVERSION:
10,000:10,000 = TVA 0:0

LEGEND

————	EXISTING CONTOUR LINE
- - - - - - - -	EXISTING CONTOUR LINE FROM A PREVIOUS STAGE
————	NEW CONTOUR LINES

10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWING LIST

TASK COMPLETED BY: REV NO.

R0 JLG MGH JGA HLP REP JGA 0
INITIAL ISSUE FOR DCN CUF-03-536

SCALE: 1" = 100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROP. WASTE DISPOSAL FACILITY
CONSTRUCTION SEQUENCE
STAGE NO. 2 & 3 – SH 1 OF 3

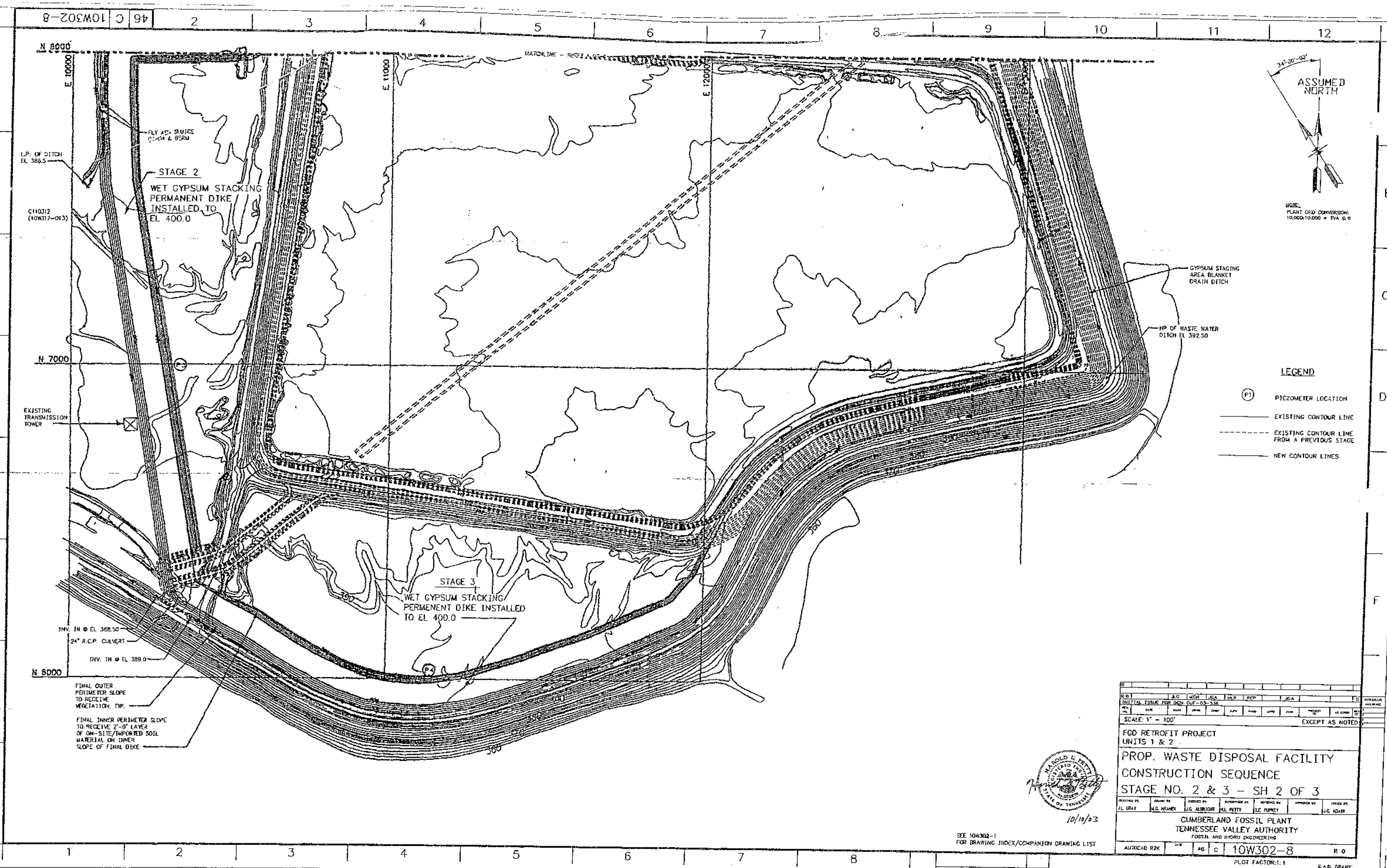
J.L. GRAY	H.G. HRANEK	J.G. ALBRIGHT	H.L. PETTY	P.E. PURKEY		J.C. ADAIR

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K 46 C 10W302-7 R 0

PLOT FACTOR:1:1
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY



NOTE:
PLANT GRID CONVERSION:
10,000:10,000 = TVA 0,0

LEGEND

(P1)	PIEZOMETER LOCATION
——	EXISTING CONTOUR LINE
- - - -	EXISTING CONTOUR LINE FROM A PREVIOUS STAGE
——	NEW CONTOUR LINES

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWING LIST

10/10/03

R 0		JLG	MGH	JGA	HLP	REP		JGA	
INITIAL ISSUE FOR DCN CUF-03-536									

SCALE: 1" - 100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROP. WASTE DISPOSAL FACILITY
CONSTRUCTION SEQUENCE
STAGE NO. 2 & 3 - SH 2 OF 3

J.L. GRAY	M.G. HRANEK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

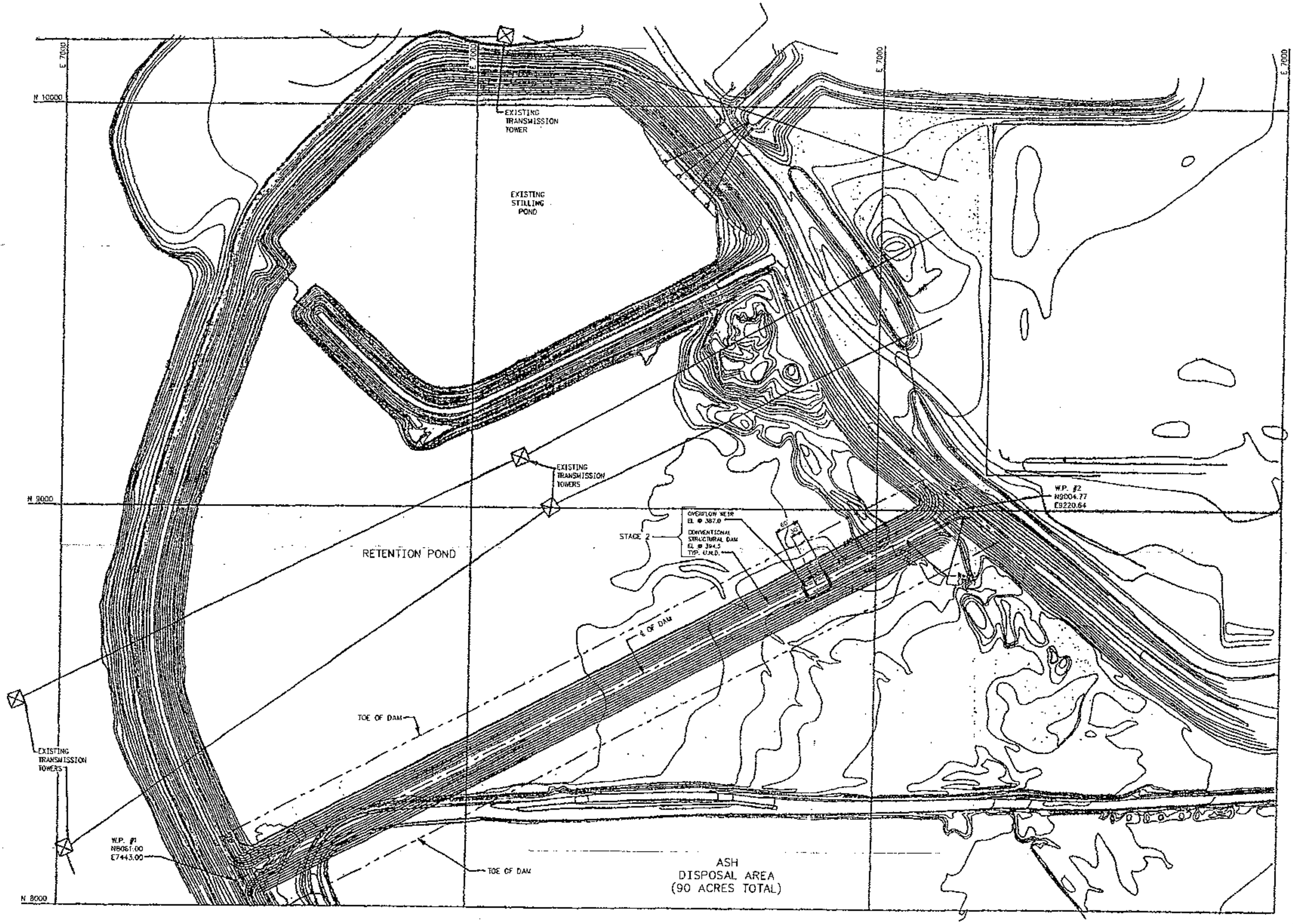
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

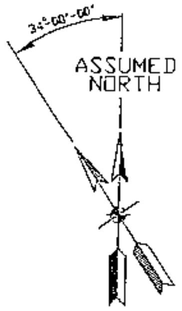
AUTOCAD R2K | 46 | C | 10W302-8 | R 0

PLOT FACTOR:1:1
W_TVA

C.A.D. DRAWI
DO NOT ALTER I

TASK COMPLETED BY: | REV NO.





NOTE:
PLANT GRID CONVERSION
10,000;10,000 = TVA 0,0

LEGEND

—400— PROPOSED CONTOURS
—399— EXISTING CONTOURS

NOTE: DRY ASH STAGES WERE NOT CONSTRUCTED IN THE SEQUENCE SHOWN. DRY ASH DISPOSAL AREA HAS PROCEEDED EAST TO WEST AS A CONTINUAL DEVELOPMENT

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWING LIST

HAROLD L. PETTY
10/10/03

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	
R 0		JLG	MGH	JGA	HLD	REP		JGA			D
INITIAL ISSUE FOR DCN CUF-03-536											

SCALE: 1" = 100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROP. WASTE DISPOSAL FACILITY CONSTRUCTION SEQUENCE STAGE NO. 2 - SHEET 3 OF 3

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
J.L. GRAY	M.G. HRANEK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

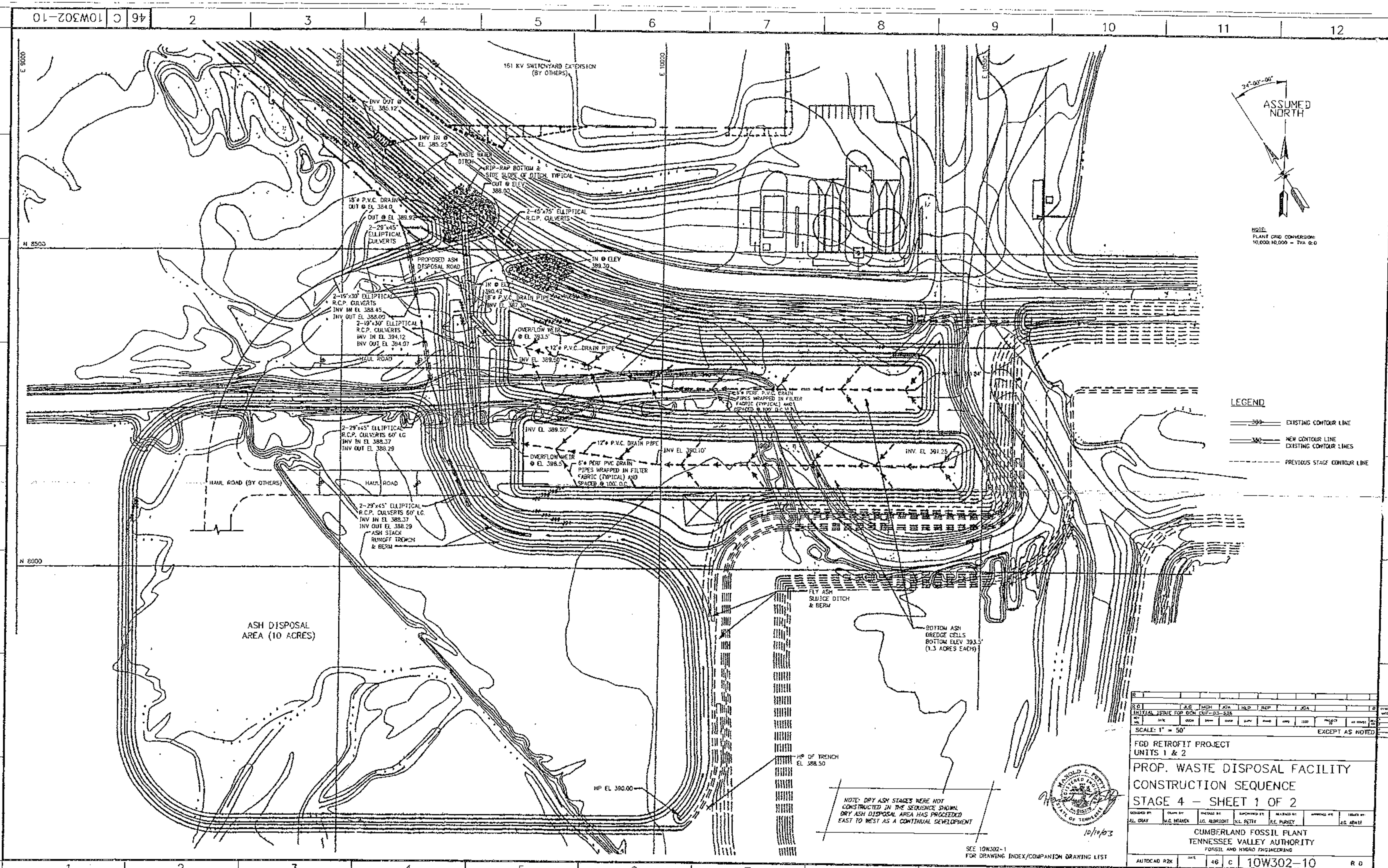
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | DATE | 46 | C | 10W302-9 | R 0

PLOT FACTOR:1:1
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: | REV NO.



NOTE:
PLANT GRID CONVERSION:
10,000:10,000 = TVA 0:0

LEGEND

393	EXISTING CONTOUR LINE
390	NEW CONTOUR LINE EXISTING CONTOUR LINES
- - - - - -	PREVIOUS STAGE CONTOUR LINE

NOTE: DRY ASH STAGES WERE NOT CONSTRUCTED IN THE SEQUENCE SHOWN. DRY ASH DISPOSAL AREA HAS PROCEEDED EAST TO WEST AS A CONTINUAL DEVELOPMENT

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWING LIST

HAROLD L. PETTY

10/10/03

R 0	JLG	MGH	JGA	HLP	REP		JGA	
INITIAL ISSUE FOR DCN CUF-03-536								

SCALE: 1" = 50' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROP. WASTE DISPOSAL FACILITY
CONSTRUCTION SEQUENCE
STAGE 4 – SHEET 1 OF 2

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
J.L. GRAY	M.G. HRANEK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

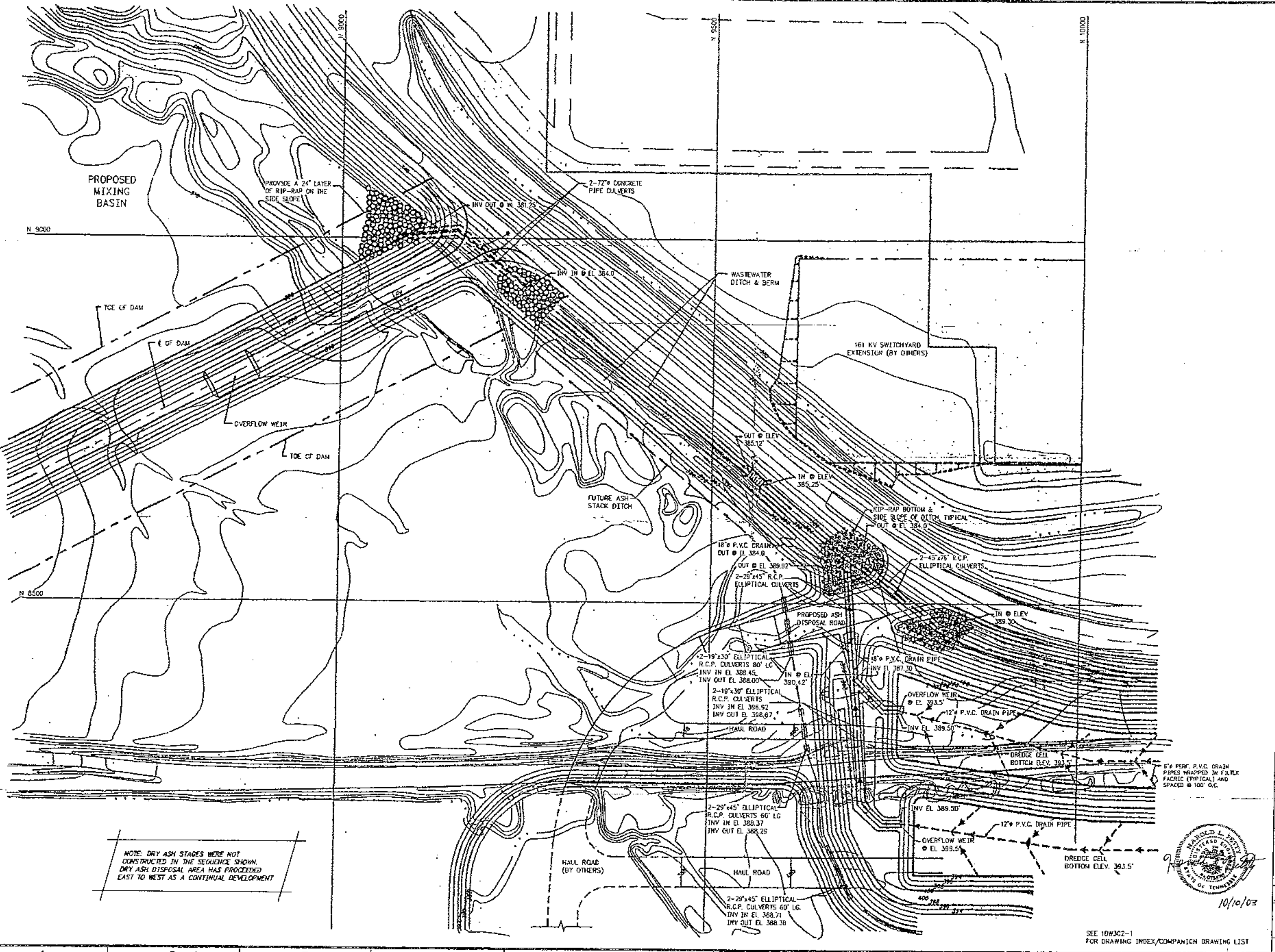
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-10 | R 0

PLOT FACTOR:1:1
W_TVA

C.A.D. DRAWING
DO NOT ALTER MAN

TASK COMPLETED BY: | REV NO.



NOTE: DRY ASH STAGES WERE NOT CONSTRUCTED IN THE SEQUENCE SHOWN. DRY ASH DISPOSAL AREA HAS PROCEEDED EAST TO WEST AS A CONTINUAL DEVELOPMENT

34°-00'-00"

ASSUMED NORTH

NOTE:
PLANT GRID CONVERSION:
10,000:10,000 = TVA 0:0

LEGEND

———	EXISTING CONTOUR LINE
——350——	NEW CONTOUR LINE

HAROLD L. PETTY
REGISTERED ENGINEER
STATE OF TENNESSEE

10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWING LIST

R 0		JLG	MCH	JGA	HLP	REP		JGA			D
INITIAL ISSUE FOR DCN CUF-03-536											

SCALE: 1" = 50' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROP. WASTE DISPOSAL FACILITY
CONSTRUCTION SEQUENCE
STAGE 4 – SHEET 2 OF 2

J.L. GRAY	M.C. KRANEK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

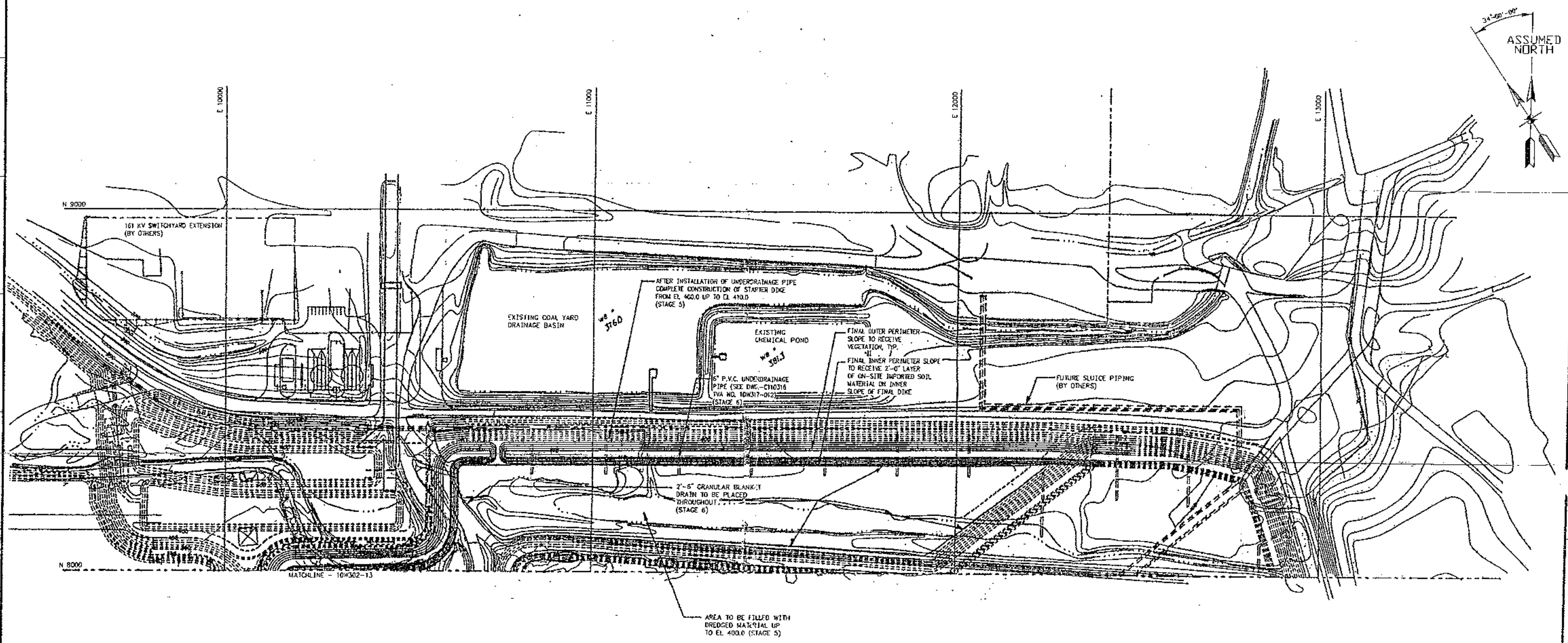
AUTOCAD R2K | 45 | C | 10W302-11 | R 0

PLOT FACTOR:1:1
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: | REV NO.

NOTE:
PLANT GRID CONVERSION:
10,000:10,000 = TVA 0:0



LEGEND

———— EXISTING CONTOUR LINE
- - - - - NEW CONTOUR LINE FROM A PREVIOUS STAGE
———— NEW CONTOUR LINE

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWING LIST

HAROLD L. PETTY
10/10/03

R										
R 0		JLG	MCH	JGA	HLP	REP		JGA		D
INITIAL ISSUE FOR DCN CUF-03-536										

SCALE: 1" = 100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROP. WASTE DISPOSAL FACILITY
CONSTRUCTION SEQUENCE
STAGE NO. 5 & 6 - SHEET 1 OF 2

J.L. GRAY	M.C. HRANEK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

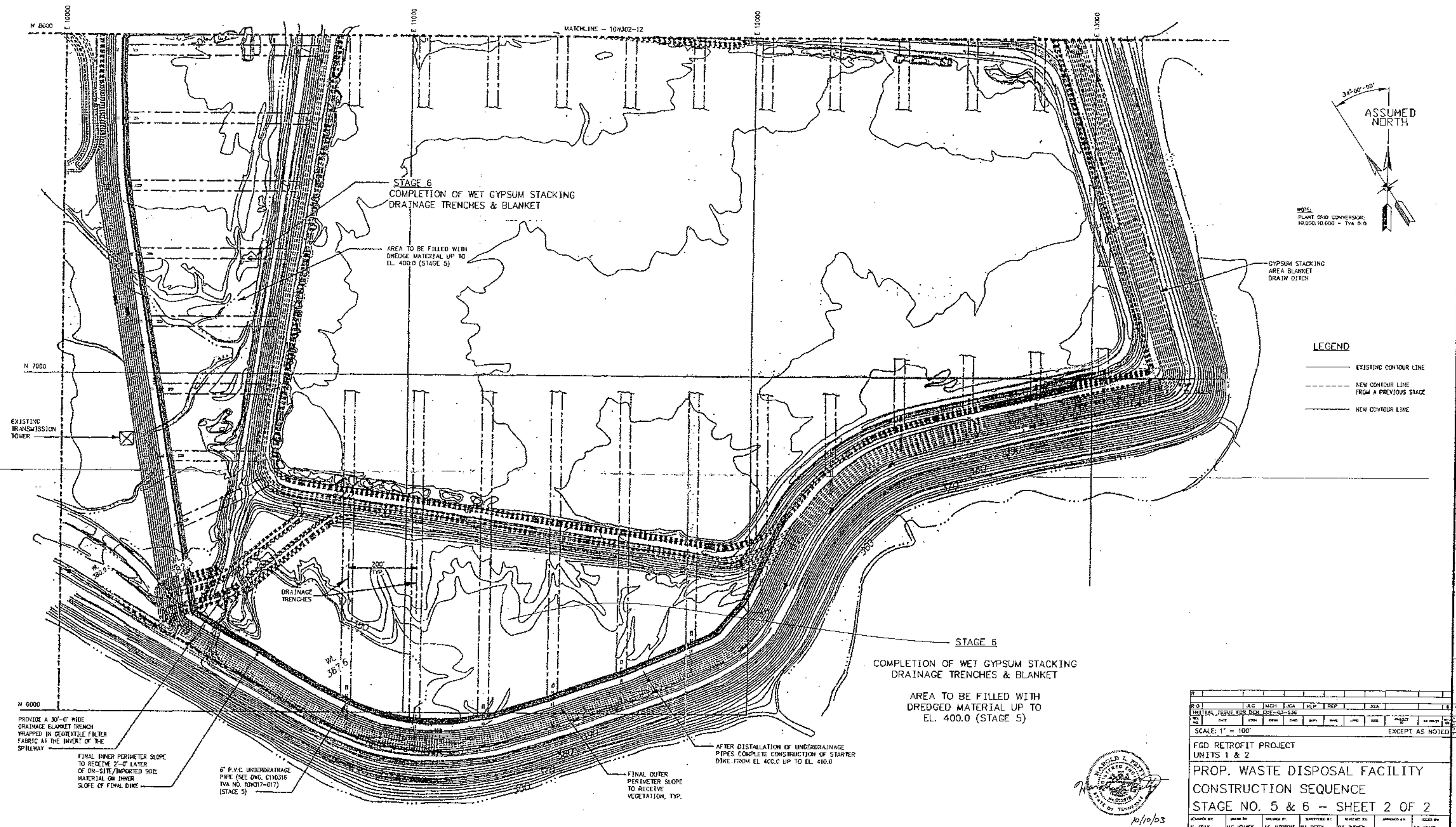
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-12 | R 0

PLOT FACTOR: 1:1
W_TVA

C.A.D. DRAWING
DO NOT ALTER

TASK COMPLETED BY: | REV NO.



HAROLD L. PETTY
No. 015978
10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWING LIST

R 0	INITIAL ISSUE FOR DCN CUF-03-536	JLG	MCH	JGA	RLP	REP		JGA	0
REV NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID

SCALE: 1" = 100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROP. WASTE DISPOSAL FACILITY
CONSTRUCTION SEQUENCE
STAGE NO. 5 & 6 – SHEET 2 OF 2

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
J.L. GRAY	M.G. KRANEK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

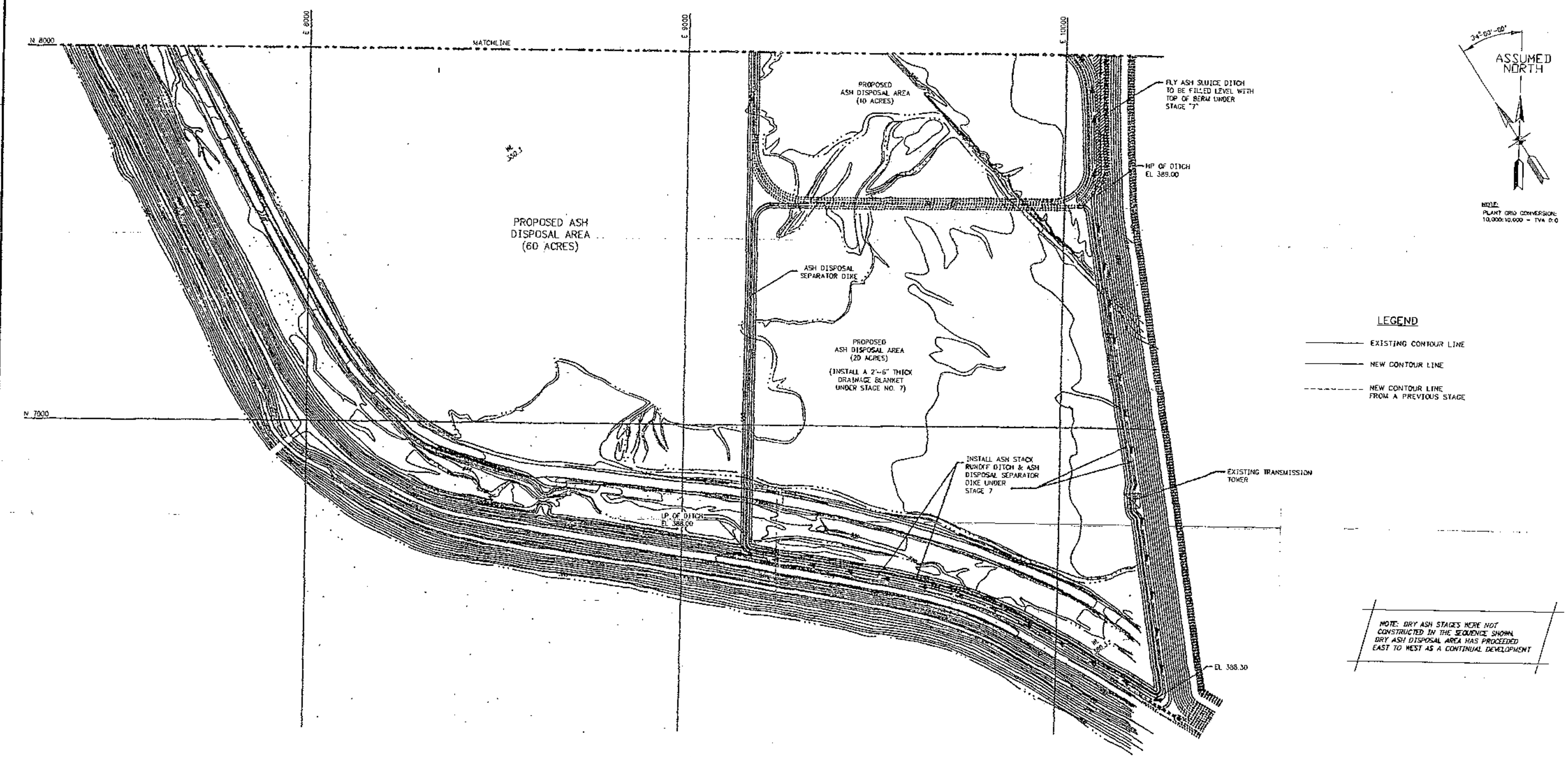
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | DATE | 46 | C | 10W302-13 | R 0

PLOT FACTOR:1:1
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: | REV NO.



46 C 10W302-14

NOTE:
PLANT GRID CONVERSION:
10,000:10,000 = TVA 0:0

LEGEND

———————	EXISTING CONTOUR LINE
———————	NEW CONTOUR LINE
– – – – – –	NEW CONTOUR LINE FROM A PREVIOUS STAGE

NOTE: DRY ASH STAGES WERE NOT CONSTRUCTED IN THE SEQUENCE SHOWN. DRY ASH DISPOSAL AREA HAS PROCEEDED EAST TO WEST AS A CONTINUAL DEVELOPMENT

HAROLD L. PETTY
10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWING LIST

TASK COMPLETED BY: | REV NO.

R										
R 0		JLG	MCH	JCA	HLP	REP		JCA		
INITIAL ISSUE FOR DCN CUF-03-536										

SCALE: 1" = 100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROP. WASTE DISPOSAL FACILITY
CONSTRUCTION SEQUENCE
STAGE NO. 7

J.L. GRAY	M.C. HRANEK	J.D. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.C. ADAIR

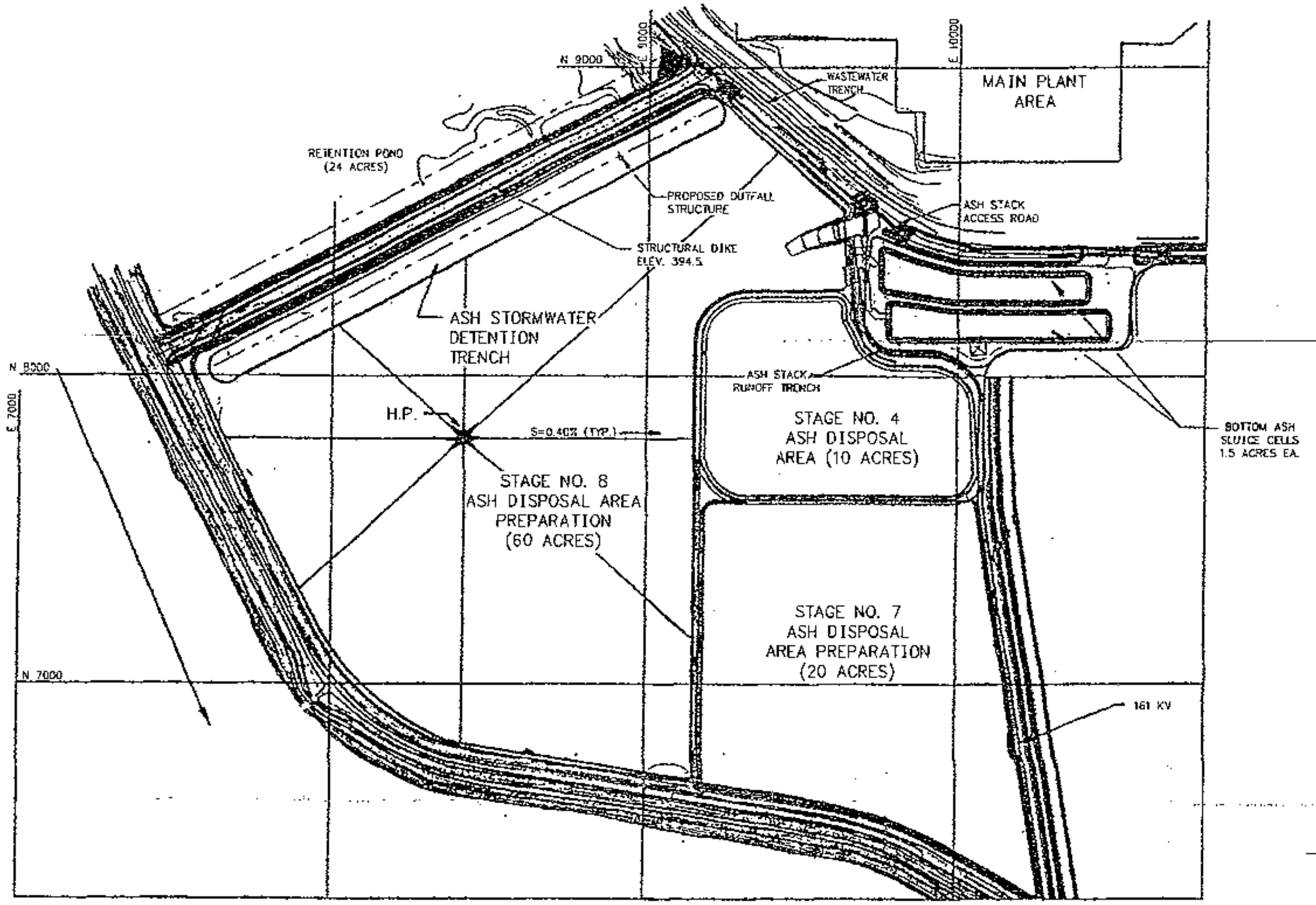
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-14 | R 0

PLOT FACTOR:1:1
W_TVA

C.A.D. DRAWING
DO NOT ALTER M

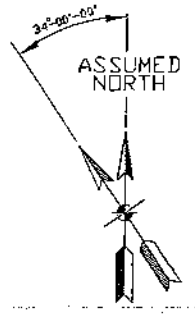
46 C 10W302-15



NOTES:

1. PREPARE STAGE 8 INTERIM CLOSURE FOR THE FLY ASH. PREPARATION WILL INCLUDE THE 60 ACRE SITE TO BE SLOPED .004'/FT. FROM THE CENTER OF THE DESIGNATED AREA. PROVIDE 1'-1.5' OF COVER (MIN. PERMEABILITY 1×10^{-7} CM/SEC) AND SEEDING.

PARTIAL PLAN



NOTE:
PLANT GRID CONVERSION:
10,000:10,000 = TVA 0:0

NOTE: DRY ASH STAGES WERE NOT CONSTRUCTED IN THE SEQUENCE SHOWN. DRY ASH DISPOSAL AREA HAS PROCEEDED EAST TO WEST AS A CONTINUAL DEVELOPMENT

LEGEND

——380——	PROPOSED CONTOURS (3' INTERVALS ON STACK 2' INTERVAL ON STARTER DIKE)
————	EXISTING CONTOURS

HAROLD L. PETTY
10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWING LIST

R 0		JLG	MGH	JGA	HLP	REP		JGA		
INITIAL ISSUE FOR DCN CUF-03-536										

SCALE: 1" = 100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROP. WASTE DISPOSAL FACILITY CONSTRUCTION SEQUENCE STAGE NO. 8

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
J.L. GRAY	M.G. HRANEK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

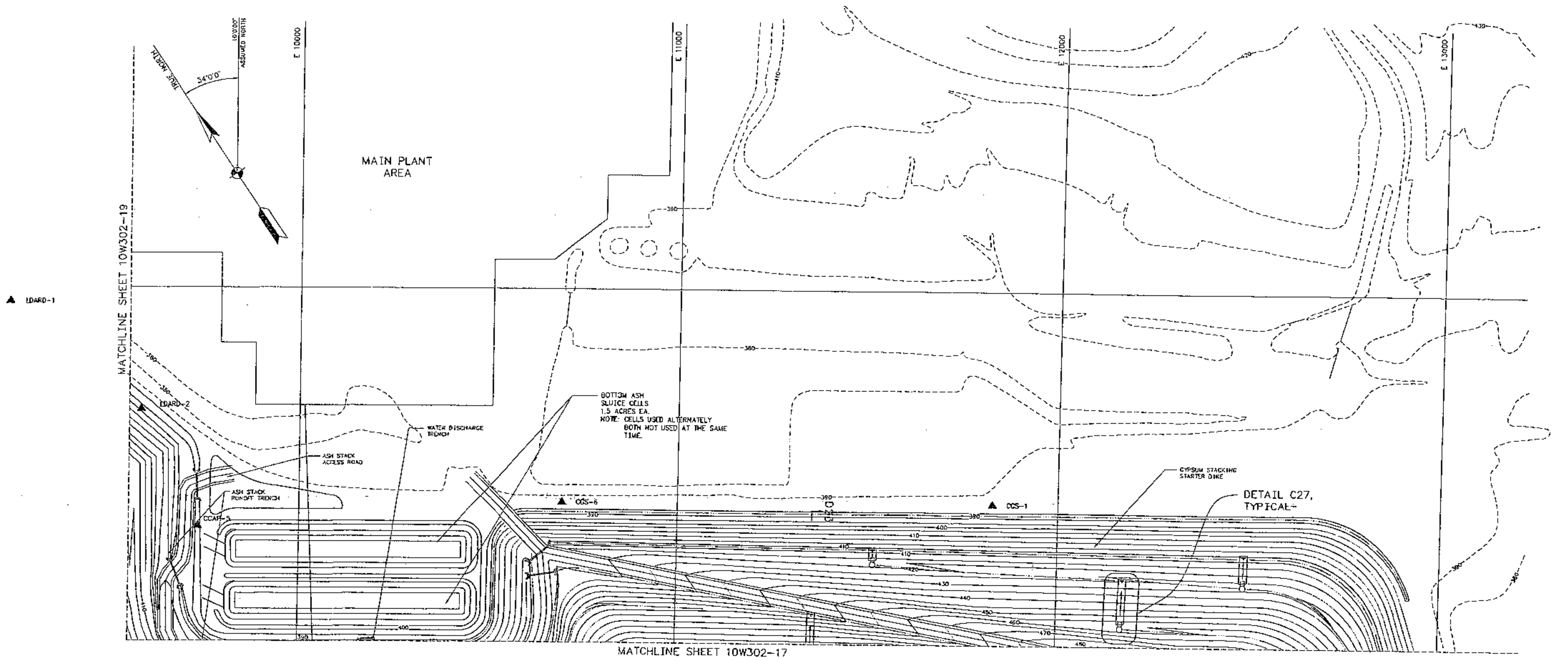
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-15 | R 0

PLOT FACTOR:1:1
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: | REV NO.



WET GYPSUM
STACKING AREA
132 ACRES
MAX. HEIGHT=185'
VOLUME=20,000,000 CY

LEGEND

——400——	PROPOSED COUNTOURS
- - -380- - -	EXISTING CONTOURS
⟍	CULVERT
▨	RIPRAP
C# └┘ C#	CROSS SECTION LOCATION
▲	BENCHMARK LOCATION

← FOR BENCHMARK DATA SEE 10W302-2.

REFER TO DWG. NO. 10W302-3 FOR CONVERSION FROM PLANT COORDINATES TO TENNESSEE STATE COORDINATE DATUM.

SEE 10W302-1 FOR DRAWING INDEX/COMPANION DRAWINGS LIST

HAROLD L. PETTY
10/10/03

R 0		J.G	MCM	JCA	HLP	REP		JCA		
INITIAL ISSUE: FOR DCN CUF-03-536										

SCALE: 1"=100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
PROPOSED FINAL CONTOURS
SHEET 1 OF 4

J.L. GRAY	M.C. MRANEK	J.C. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

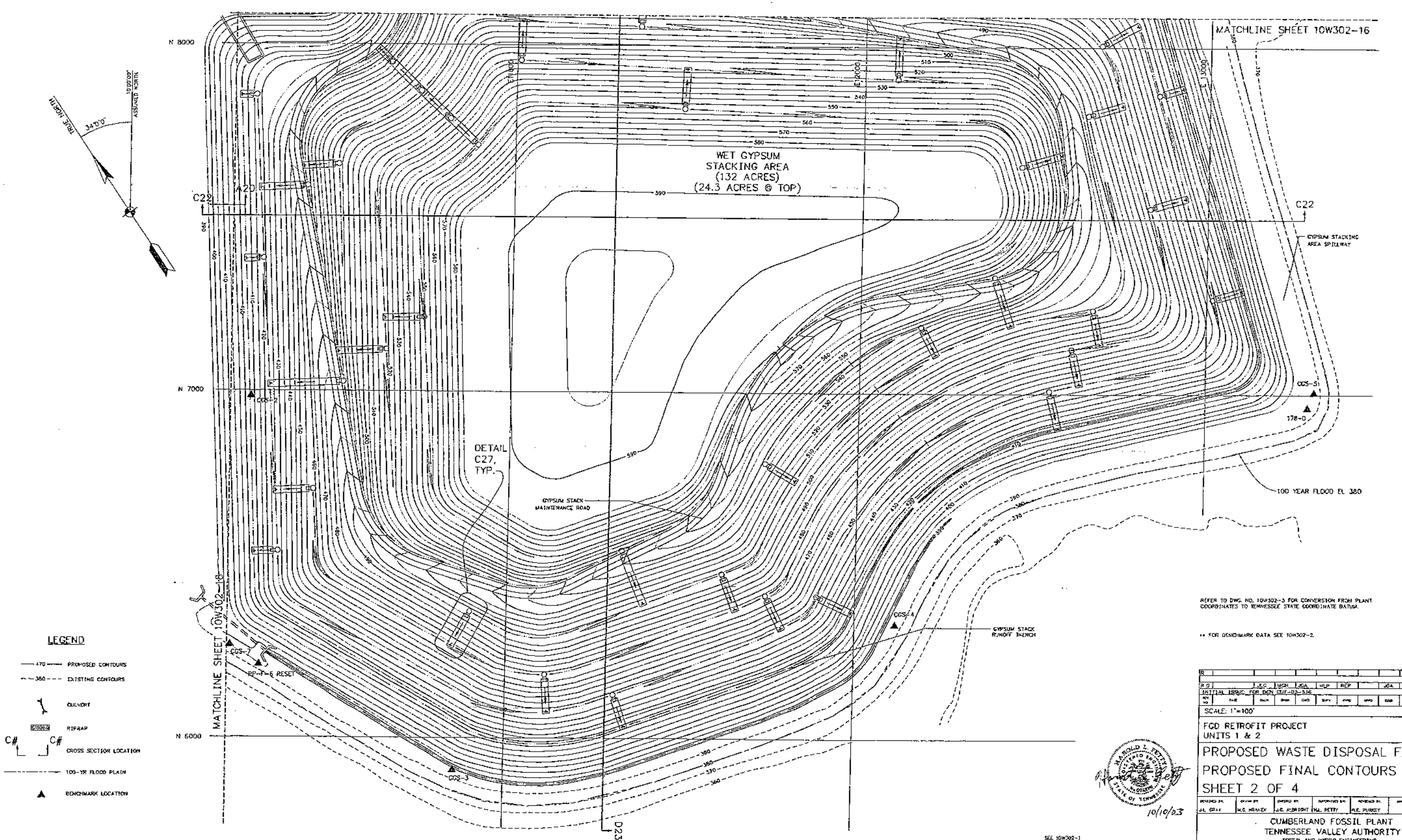
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-16 | R 0

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING DO NOT ALTER

TASK COMPLETED BY: REV NO.



REFER TO DWG. NO. 10W302-3 FOR CONVERSION FROM PLANT COORDINATES TO TENNESSEE STATE COORDINATE DATUM.

** FOR BENCHMARK DATA SEE 10W302-2.

SEE 10W302-1 FOR DRAWING INDEX/COMPANION DRAWINGS LIST

10/10/03

R 0		JLC	MGH	JGA	HLP	REP		JGA		
INITIAL ISSUE: FOR DCN CUF-03-536										

SCALE: 1"=100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
PROPOSED FINAL CONTOURS
SHEET 2 OF 4

J.L. GRAY	M.G. HRANEK	J.C. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

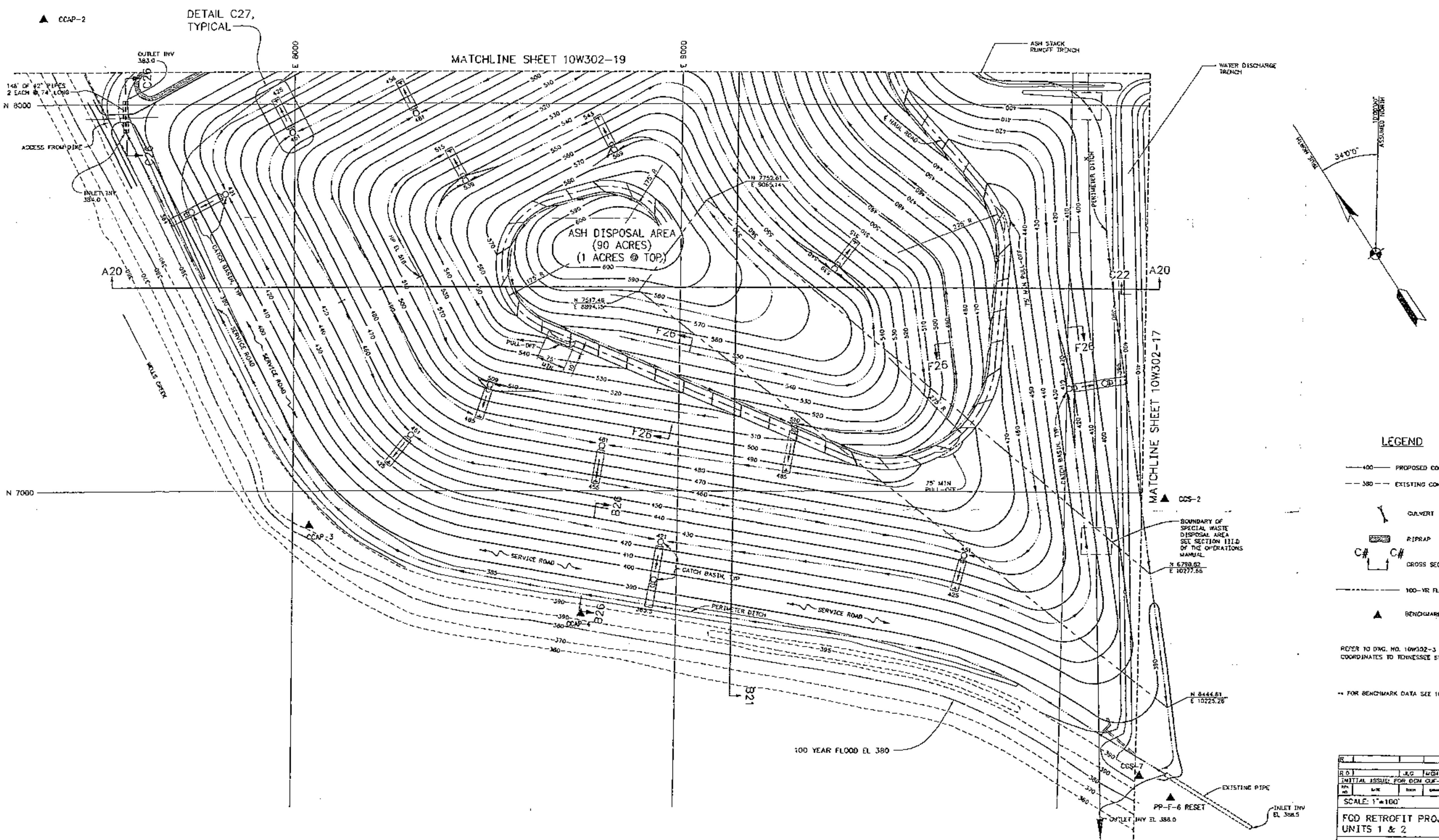
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-17 | R 0

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: | REV NO.



LEGEND

—400—	PROPOSED CONTOURS
– – 380 – –	EXISTING CONTOURS
⟋	CULVERT
▨	RIPRAP
C# ⌴ C#	CROSS SECTION LOCATION
——— – – –	100-YR FLOODPLAIN
▲	BENCHMARK LOCATION

REFER TO DWG. NO. 10W302-3 FOR CONVERSION FROM PLANT COORDINATES TO TENNESSEE STATE COORDINATE DATUM.

** FOR BENCHMARK DATA SEE 10W302-2.

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWINGS LIST

10/10/03

R 0		JLG	MGH	JGA	HLP	REP		JCA
INITIAL ISSUE: FOR DCN CUF-03-536								

SCALE: 1"=100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
PROPOSED FINAL CONTOURS
SHEET 3 OF 4

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
J.L. GRAY	M.G. HRANEK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.C. ADAIR

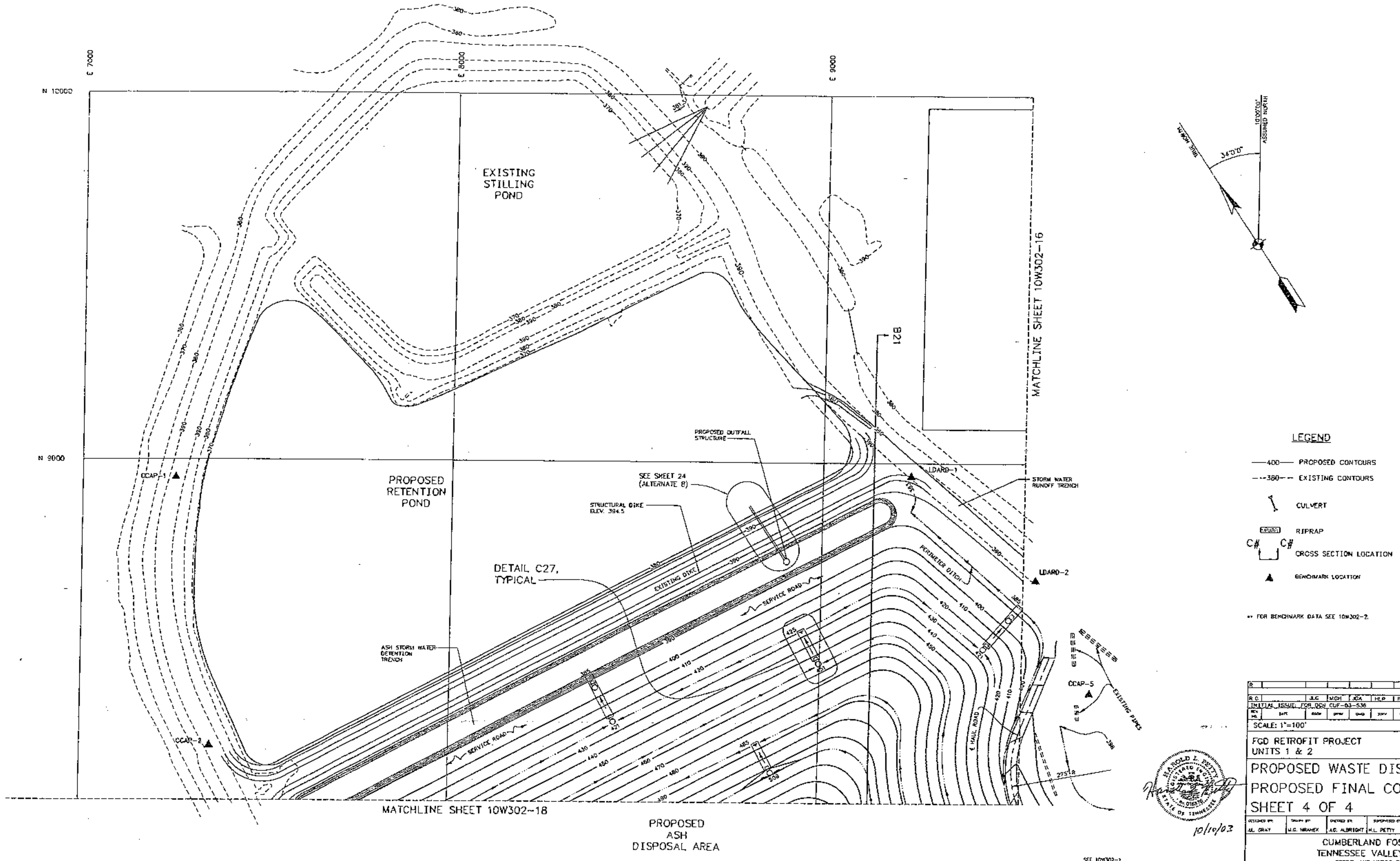
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-18 | R 0

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER MA

TASK COMPLETED BY: | REV NO.



PROPOSED
ASH
DISPOSAL AREA

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWINGS LIST

46 | C | 10W300-19

R										
R.0		JLG	MGH	JGA	HLP	REP		JGA		0
INITIAL ISSUE: FOR DCN CUF-03-536										

SCALE: 1"=100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
PROPOSED FINAL CONTOURS
SHEET 4 OF 4

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
J.L. GRAY	M.G. HRANEK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

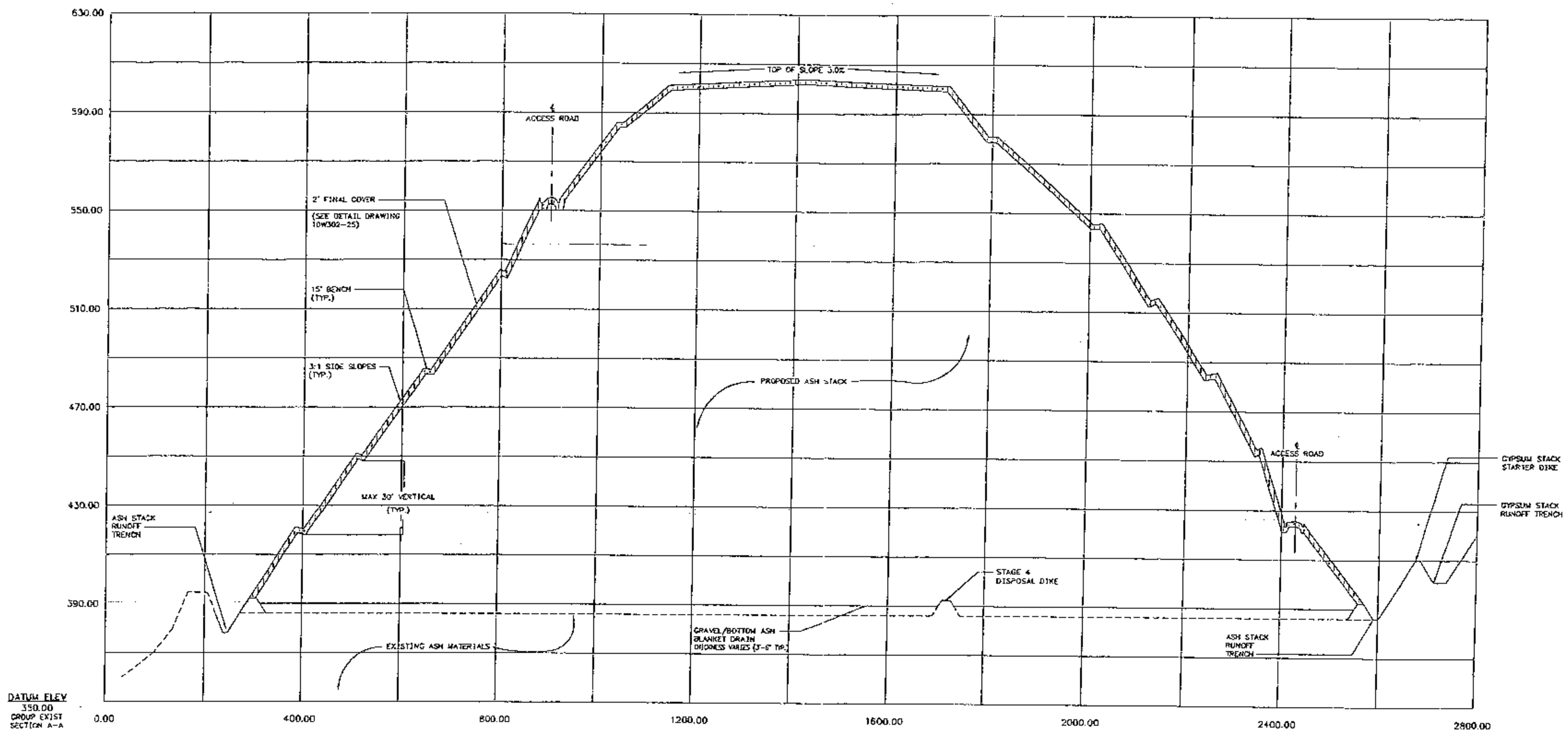
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | DATE | 46 | C | 10W302-19 | R 0

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: | REV NO.



CROSS SECTION A20-A20

HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=20'

10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWINGS LIST

R 0		JLG	MGH	JGA	HLP	REP		JGA	
INITIAL ISSUE; FOR DCN CUF-03-536									

SCALE: 1"=100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
CROSS SECTION A20-A20

J.L. GRAY	M.G. HRANEK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

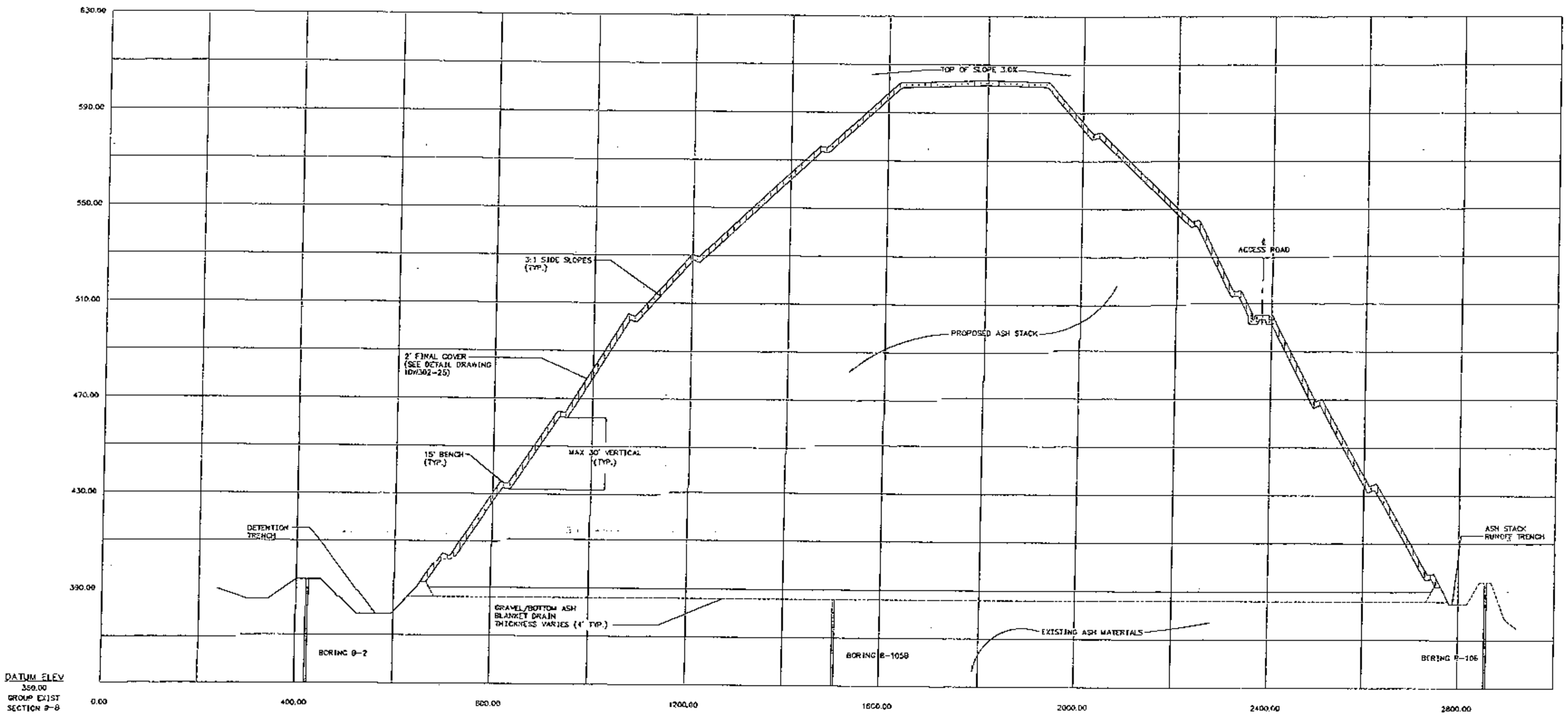
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-20 | R 0

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER MA

TASK COMPLETED BY: | REV NO.



CROSS SECTION B21–B21

HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=20'

HAROLD L. PETTY

10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWINGS LIST

R										
R 0		JLG	MCK	JGA	HLP	REP		JGA		
INITIAL ISSUE: FOR DCN CUF-03-536										
REV. NO.	DATE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	APPD	[illegible]	PROJECT ID	AS CONST

SCALE: 1"=100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL
FACILITY CROSS SECTION B21–B21

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
J.L. GRAY	N.G. KRAMER	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

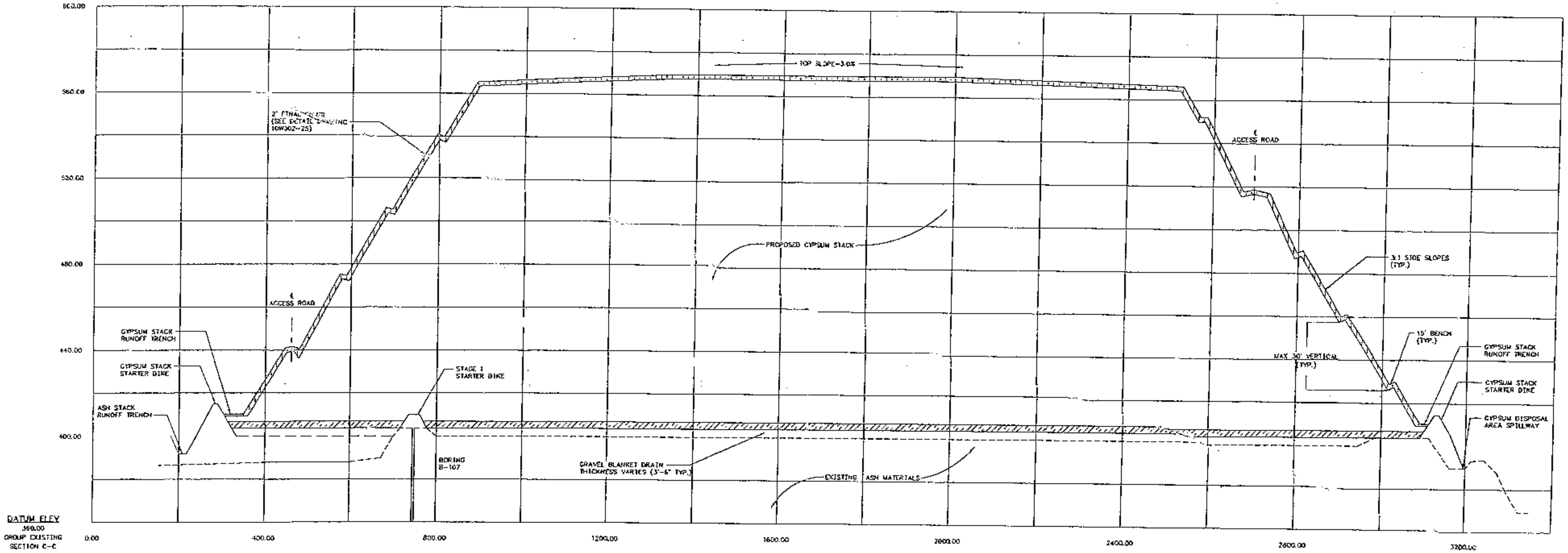
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | DATE | 46 | C | 10W302–21 | R 0

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY:
REV NO.



CROSS SECTION C22–C22

HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=20'

HAROLD L. PETTY

10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWINGS LIST

R 0		JLG	MGH	JGA	HLP	REP		JGA		0
INITIAL ISSUE; FOR DCN CUF-03-536										

SCALE: 1"=100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL
FACILITY CROSS SECTION C22–C22

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
J.L. GRAY	M.G. HRANEK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302–22 | R 0

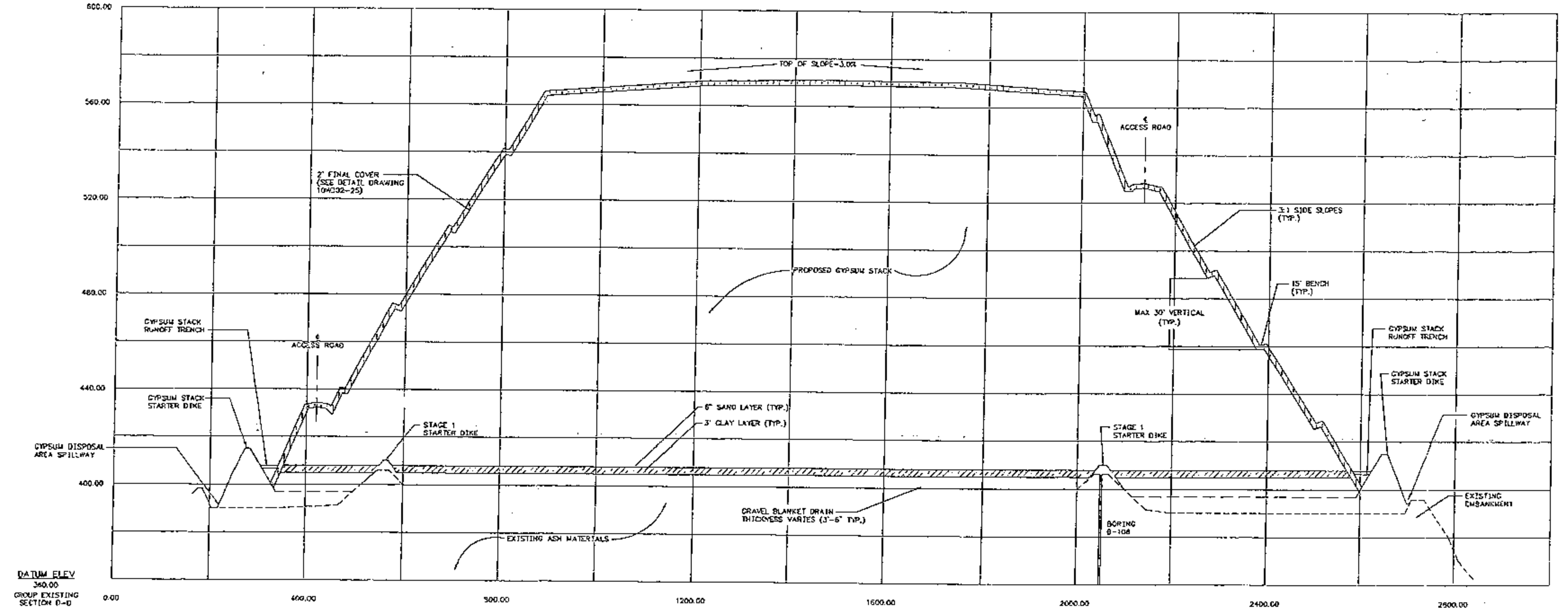
PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER

TASK COMPLETED BY: | REV NO.

46 C 10W302-22

46 C 10W302-23



CROSS SECTION D23-D23
HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=20'

HAROLD L. PETTY

10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWINGS LIST

R 0		J.L.G	M.G.H	J.C.A	H.L.P	R.E.P		J.G.A			D
INITIAL ISSUE; FOR DCN CUF-03-536											
REV. NO.	DATE	DSGN	CHKD	DRWN	SUPV	RVWD	APPD	ISSD	PROJECT ID	IS CONST	

SCALE: 1"=100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL
FACILITY CROSS SECTION D23-D23

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
J.L. GRAY	M.G. HRANEK	J.C. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

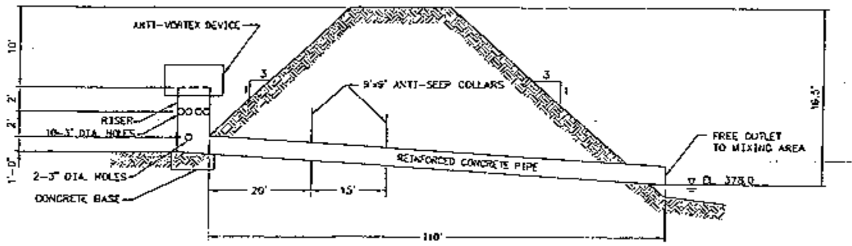
AUTOCAD R2K | DATE | 46 | C | 10W302-23 | R 0

PLOT FACTOR:1200
W_TVA

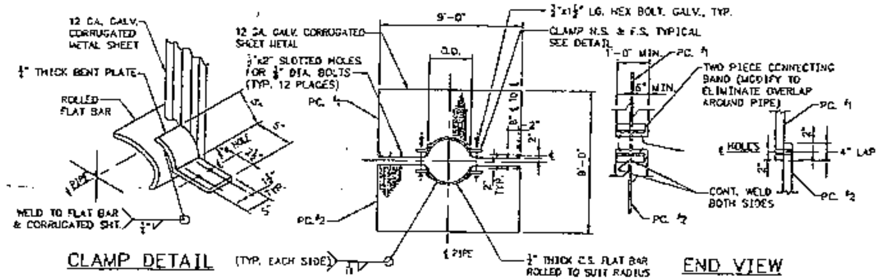
C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY:

REV NO.



ASH DETENTION TRENCH OUTLET DETAIL (ALTERNATE A)
(NOT TO SCALE)



CLAMP DETAIL

ELEVATION

END VIEW

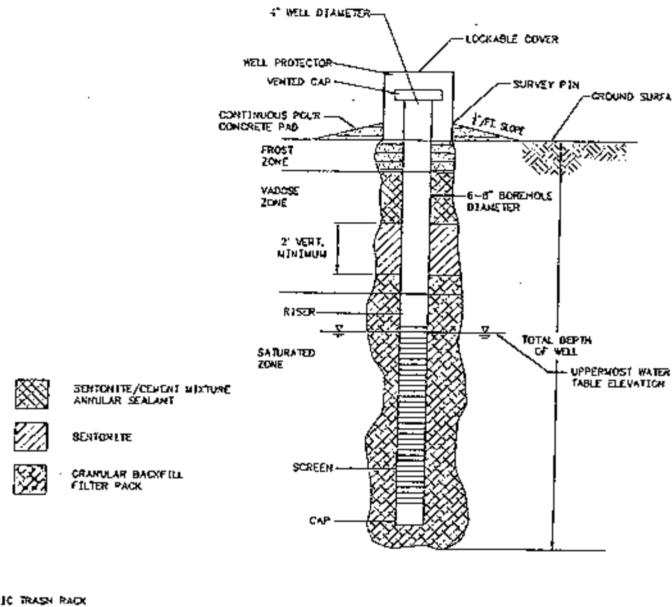
ANTI-SEEP COLLAR
SCALE: NONE

NOTE:

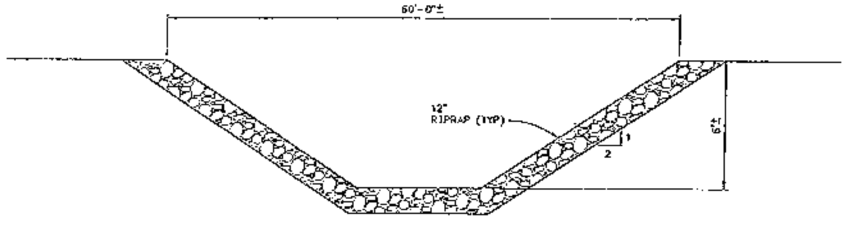
1) PROVIDE TWO ANTI-SEEP COLLARS, LOCATIONS LATER.

2) THE LAP BETWEEN THE TWO HALF SECTIONS AND BETWEEN THE PIPE & CONNECTING BAND SHALL BE CAULKED WITH BITUMINOUS MASTIC AT THE TIME OF INSTALLATION.

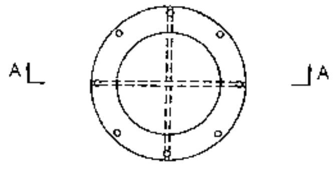
3) UNASSEMBLED COLLARS SHALL BE MARKED BY PAINTING OR TAGGING TO IDENTIFY MATCHING PAIRS.



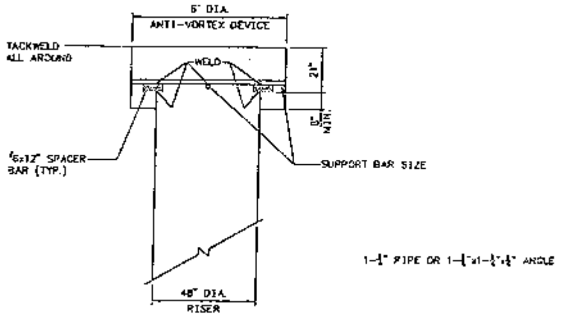
MONITORING WELL
(NOT TO SCALE)



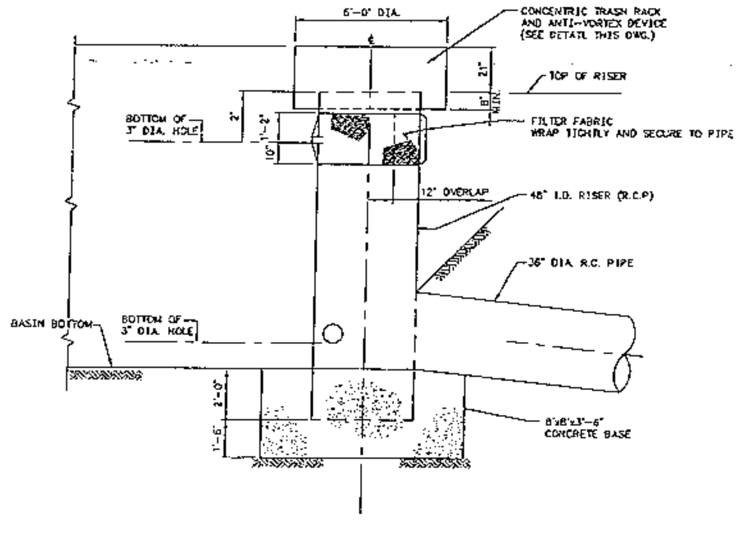
ASH DETENTION TRENCH OUTLET DETAIL (ALTERNATE B)
(NOT TO SCALE)



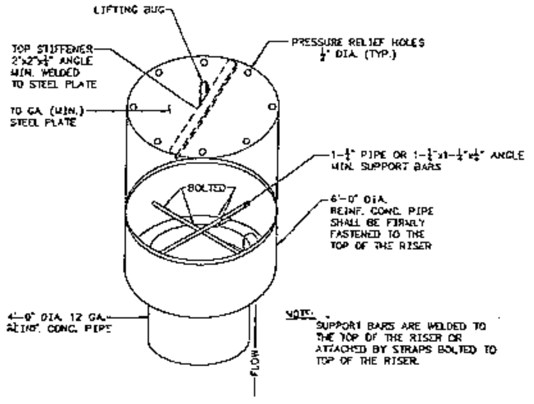
PLAN
SCALE: NONE



SECTION A-A
SCALE: NONE



RISER PIPE DETAIL
SCALE: NONE



NOTE:
SUPPORT BARS ARE WELDED TO THE TOP OF THE RISER OR ATTACHED BY STRAPS BOLTED TO TOP OF THE RISER.

CONCENTRIC TRASH RACK AND ANTI-VORTEX DEVICE
SCALE: NONE

HAROLD L. PETTY
10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWINGS LIST

R O		JLG	MGH	JCA	HLP	REP		JCA			0
INITIAL ISSUE FOR DCN CUF-03-536											
REV. NO.	DATE								PROJECT ID		REV ID

SCALE: 3/4"=1'-0" EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
DETAILS
SHEET 1 OF 3

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
J.L. GRAY	M.G. HRUNEK	J.G. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.G. ADAIR

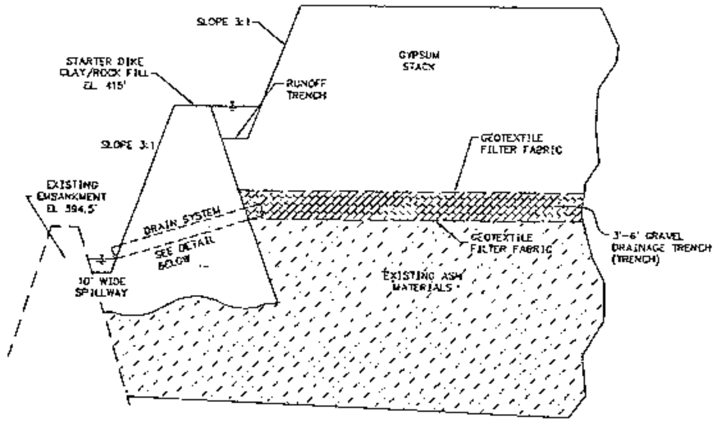
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R14 | DATE | 46 | C | 10W302-24 | R 0

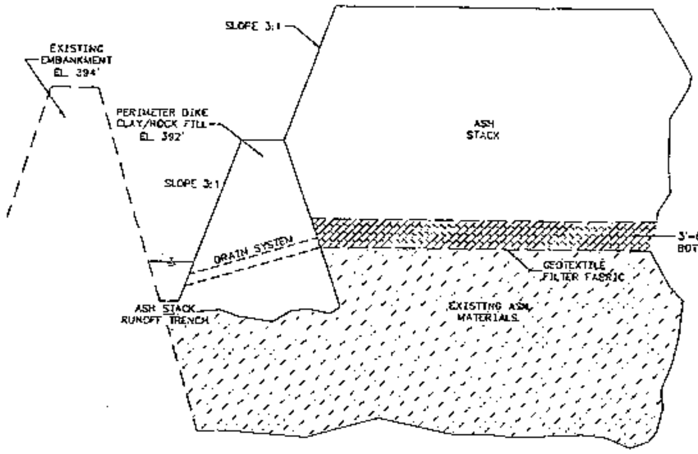
PLOT FACTOR:32
W_TVA

C.A.D. DRAWING
DO NOT ALTER M/

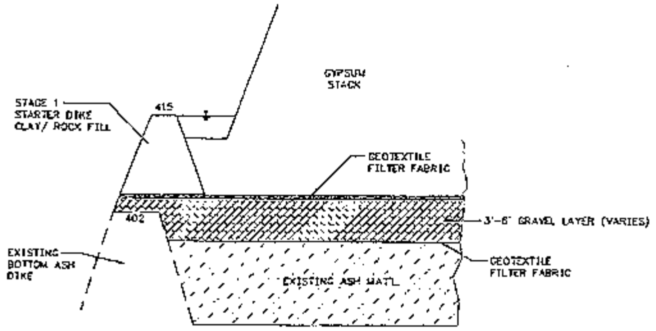
TASK COMPLETED BY: | REV NO.



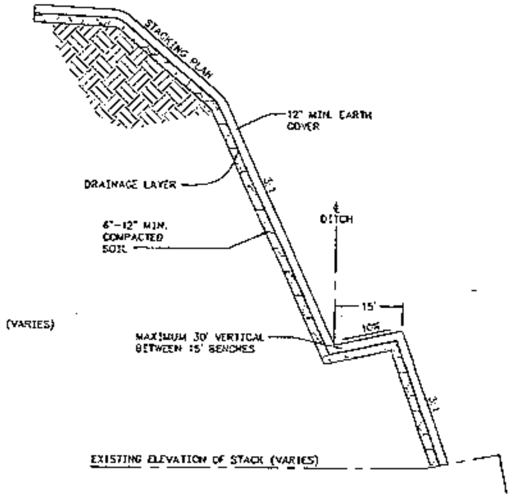
GYPSUM STACK STARTER DIKE
(NOT TO SCALE)



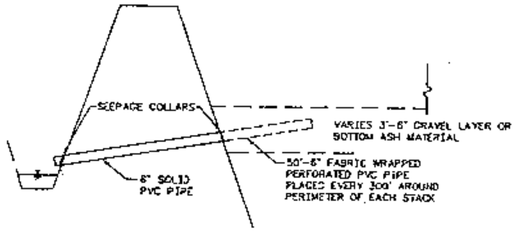
ASH STACK PERIMETER DIKE
(NOT TO SCALE)



GYPSUM STACK STAGE 1 STARTER DIKE
(NOT TO SCALE)

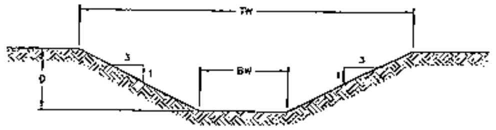


TYPICAL ASH OR GYPSUM STACKING AREA SECTION
(NOT TO SCALE)



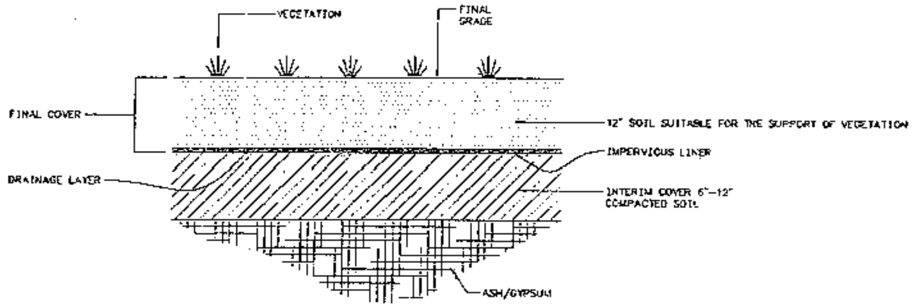
DRAIN SYSTEM (TYP.)
(NOT TO SCALE)

DITCH	DIMENSION		
	BW	TW	D
GYPSUM STACK RUNOFF TRENCH	4'	19.0'	2.5'
GYPSUM STACK SPILLWAY	2'	8.0'	1.0'
ASH STACK RUNOFF TRENCH	4'	16.0'	2.0'



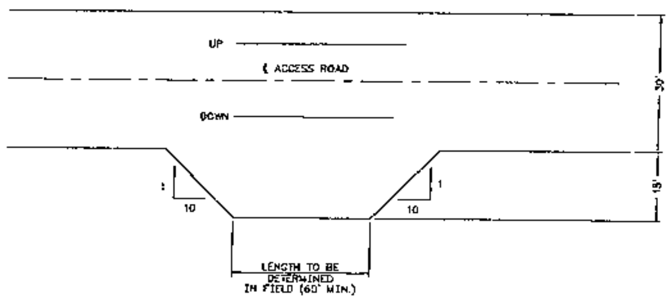
DITCH DIMENSIONS REFER TO UPSTREAM END OF DITCHES.

DRAINAGE DITCH DETAIL
(NOT TO SCALE)



TYPICAL INTERIM/FINAL COVER SECTION
(NOT TO SCALE)

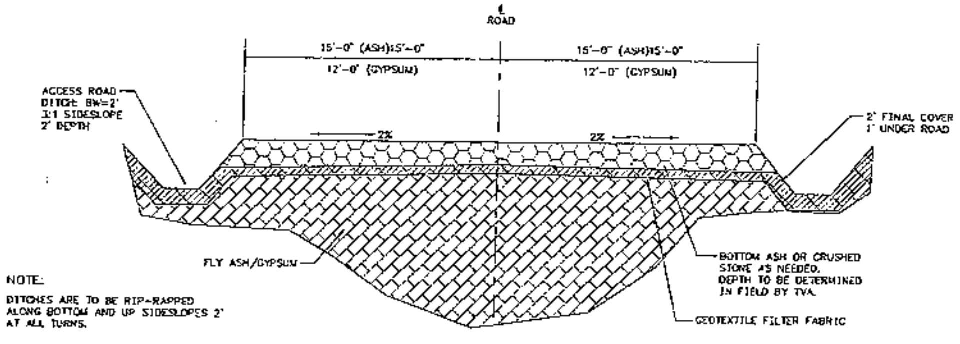
NOTE:
THE INTERIM COVER SHALL BE CONSTRUCTED INCREMENTALLY WITH THE ACTIVE ASH/GYPSUM STACKING AREA. THE FINAL COVER SHALL BE PLACED AT CLOSURE OF THE ACTIVE STACKING OPERATIONS.



NOTES:

1. NECESSITY OF USING TEMPORARY TRUCK TURNOUTS TO BE DETERMINED BY TVA PERSONNEL.
2. LOCATION, LENGTH AND DEPTH OF TEMPORARY TRUCK TURNOUTS TO BE DETERMINED BY TVA PERSONNEL.

TEMPORARY TRUCK TURNOUT
(NOT TO SCALE)



NOTE:
DITCHES ARE TO BE RIP-RAPPED ALONG BOTTOM AND UP SIDESLOPES 2' AT ALL TURNS.

TYPICAL ACCESS ROAD SECTION
(NOT TO SCALE)

HAROLD L. PETTY
10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWINGS LIST

R 0		JLC	MGH	JGA	HLP	REP		JGA			D
INITIAL ISSUE: FOR DCN CUF-03-536											

SCALE: ½"=1'-0" EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
DETAILS
SHEET 2 OF 3

J.L. GRAY	M.C. HRANEK	J.C. ALBRIGHT	H.L. PETTY	R.E. PURKEY		J.C. ADAIR

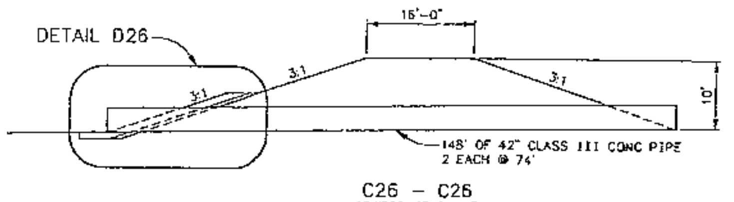
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-25 | R 0

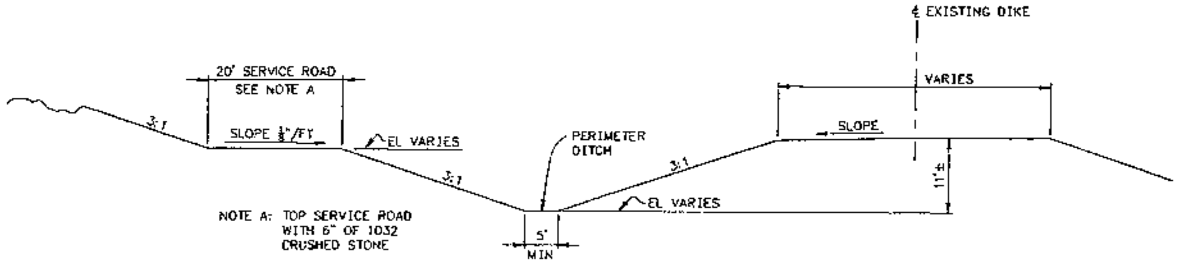
PLOT FACTOR: 48
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: | REV NO.

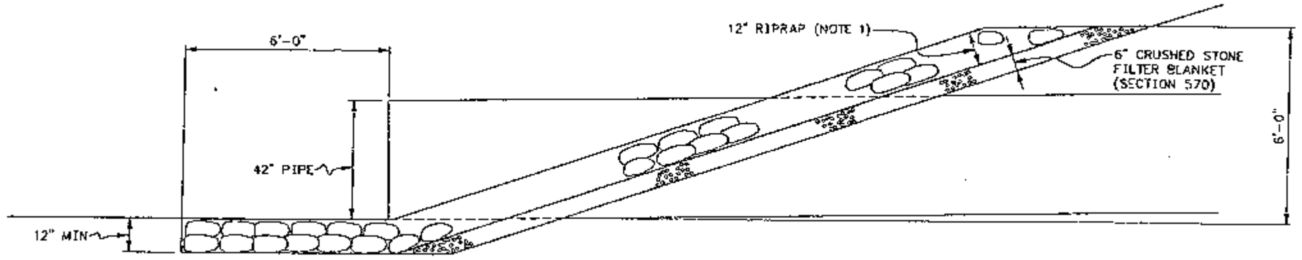


C26 – C26
10W302-12 & -13
1" = 10'

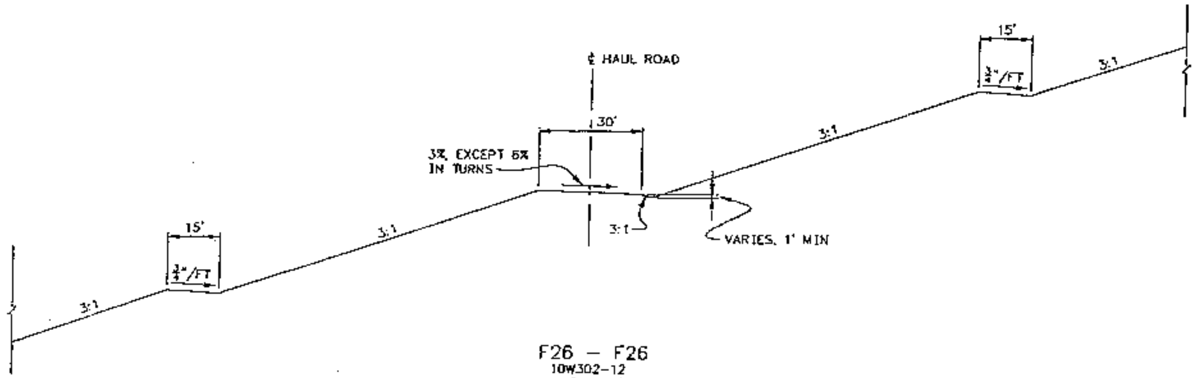


NOTE A: TOP SERVICE ROAD
WITH 6" OF 1032
CRUSHED STONE

B26 – B26
TYPICAL SECTION AT
PERIMETER DITCH AND SERVICE ROAD
NTS



DETAIL D26
1/2" = 1'-0"



F26 – F26
10W302-12
1" = 20'

NOTES:

1. RIPRAP SHALL BE IN ACCORDANCE WITH SECTION 576. THE AVERAGE WEIGHT OF EACH STONE SHALL BE 100 POUNDS WITH A MINIMUM WEIGHT OF A STONE SHALL BE 60 POUNDS.

10/10/03

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWINGS LIST

R 0 | J.G | JGH | JCA | HLP | REP | JCA
INITIAL ISSUE 2003 PERMIT REVISION DCN CUF-03-538

SCALE: 1" = 10' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
DETAILS & SECTIONS
SHEET 3 OF 3

J.L. GRAY | M.G. HRABEK | J.G. ALBRIGHT | H.L. GLOVER | P.E. PURVEY | J.G. ADAIR

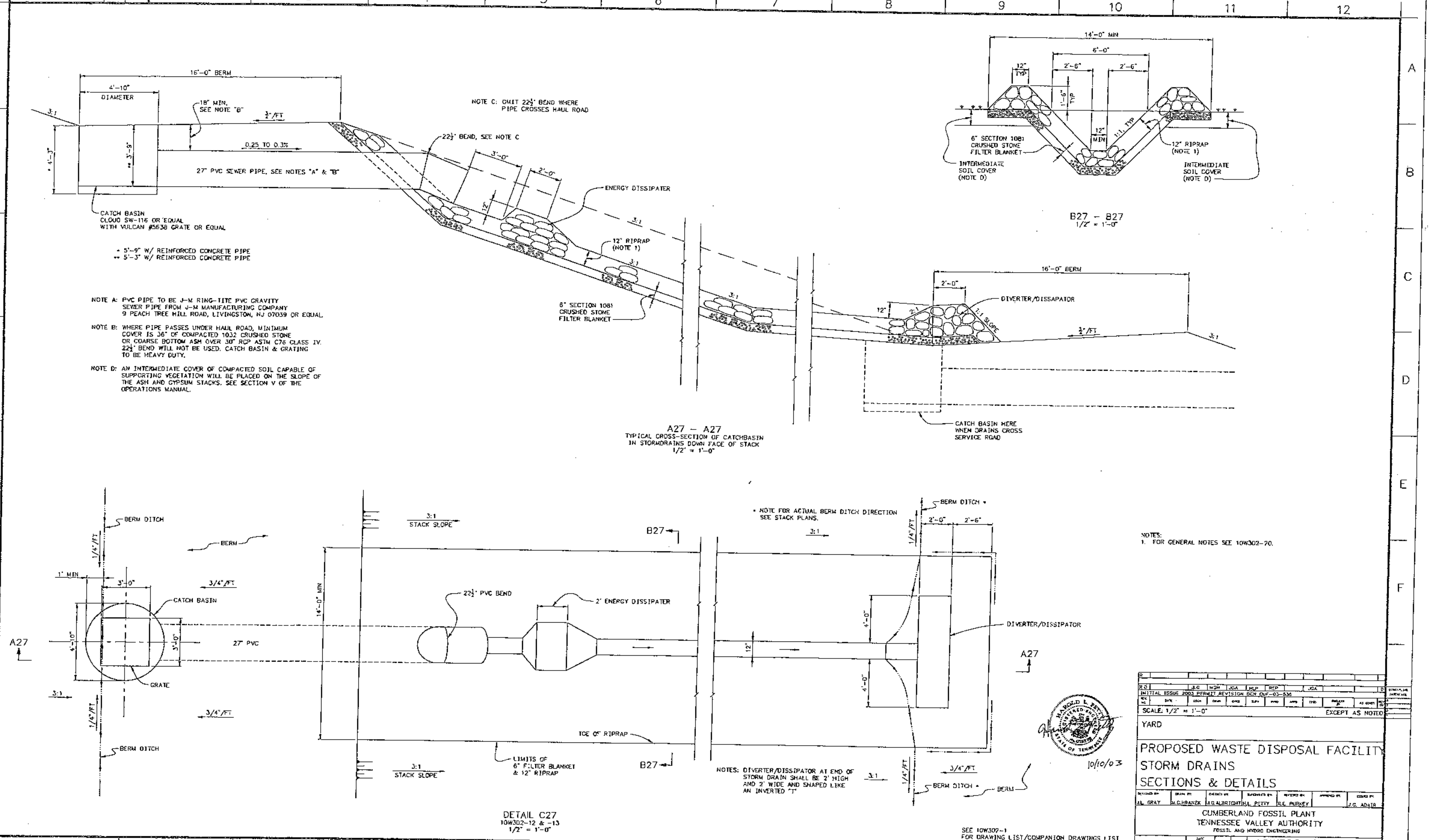
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-26 | R 0

PLOT FACTOR:120
W_TVA

C.A.D. DRAWING
DO NOT ALTER MAN

TASK COMPLETED BY: | REV NO.



* 5'-9" W/ REINFORCED CONCRETE PIPE
** 5'-3" W/ REINFORCED CONCRETE PIPE

NOTE A: PVC PIPE TO BE J-M RING-TITE PVC GRAVITY SEWER PIPE FROM J-M MANUFACTURING COMPANY 9 PEACH TREE HILL ROAD, LIVINGSTON, NJ 07039 OR EQUAL.

NOTE B: WHERE PIPE PASSES UNDER HAUL ROAD, MINIMUM COVER IS 36" OF COMPACTED 1032 CRUSHED STONE OR COARSE BOTTOM ASH OVER 30" RCP ASTM C76 CLASS IV. 22½° BEND WILL NOT BE USED. CATCH BASIN & GRATING TO BE HEAVY DUTY.

NOTE D: AN INTERMEDIATE COVER OF COMPACTED SOIL CAPABLE OF SUPPORTING VEGETATION WILL BE PLACED ON THE SLOPE OF THE ASH AND GYPSUM STACKS. SEE SECTION V OF THE OPERATIONS MANUAL.

A27 – A27
TYPICAL CROSS-SECTION OF CATCHBASIN IN STORMDRAINS DOWN FACE OF STACK
1/2" = 1'-0"

B27 – B27
1/2" = 1'-0"

NOTES:
1. FOR GENERAL NOTES SEE 10W302-70.

NOTES: DIVERTER/DISSIPATOR AT END OF STORM DRAIN SHALL BE 2' HIGH AND 2' WIDE AND SHAPED LIKE AN INVERTED "T".

DETAIL C27
10W302-12 & -13
1/2" = 1'-0"

SEE 10W302-1
FOR DRAWING LIST/COMPANION DRAWINGS LIST

10/10/03

R 0 | J.L.G | MGH | JGA | HLP | REP | JGA
INITIAL ISSUE 2003 PERMIT REVISION DCN CUF-03-536

SCALE: 1/2" = 1'-0" EXCEPT AS NOTED

YARD

PROPOSED WASTE DISPOSAL FACILITY
STORM DRAINS
SECTIONS & DETAILS

J.L. GRAY | M.C.HRANEK | J.G.ALBRIGHT | H.L. PETTY | R.E. PURKEY | J.G. ADAIR

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-27 | R 0

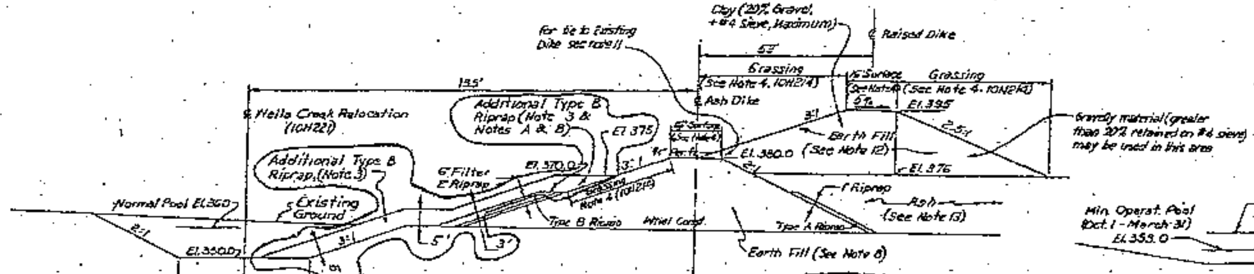
PLOT FACTOR:24
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: | REV NO.

46 C 10W302-27

10N213 | 4 | C | 46

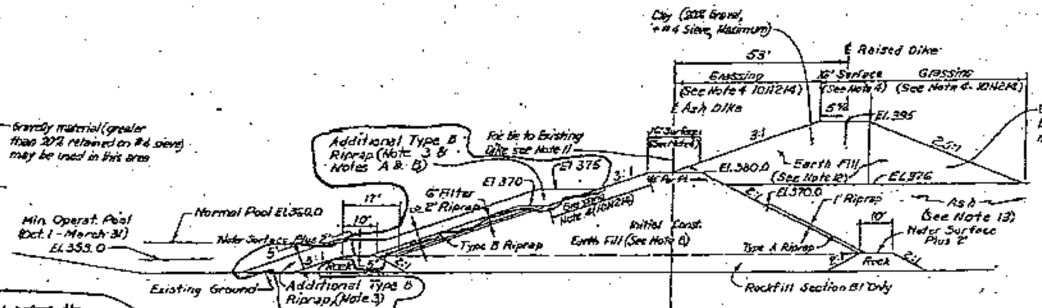


SECTION A

Dike where Exist. Ground is above water surface.
Scale: 1"=20'

Note A:
This additional riprap must be added before the ash pond water level is raised to El. 378.

Note B:
This additional riprap is to be added only from Sta 0+00 to Sta 54+00 along Wells Creek as shown on dwg 10N212 R11

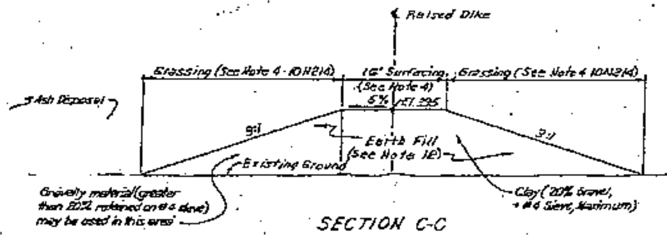


SECTION B & B1

Dike where Exist. Ground is below water surface.
Scale: 1"=20'

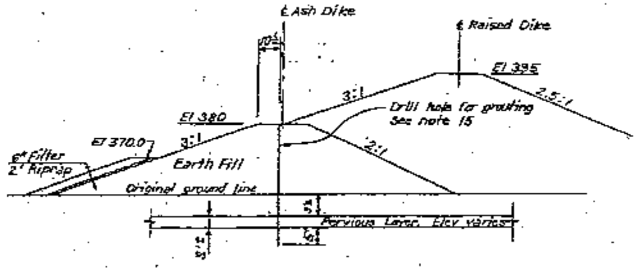
NOTES:

1. All work on the construction of these dikes shall be in accordance with the T-1 Specifications unless otherwise noted.
2. Embankments shall be compacted with sheepsfoot rollers. Two density tests per day shall be made to insure achivement of 95% of standard Proctor maximum density. Fill moisture shall be controlled to obtain optimum compaction (Initial const).
3. Riprap shall consist of sound, durable limestone, section 575 Filter shall be crushed stone conforming to section 570 (a) Type A Riprap shall be 12 inches thick and at least 50 % of the stone shall weigh 25 lb. or more. Riprap laid without filter. (b) Type B Riprap shall be 24 inches thick and at least 50% of the stone shall weigh 150 lb. or more. Filter blanket shall be 6 inches thick.
4. Crushed stone surfacing, 4 inches thick, shall be applied for the full width of the top of the dike in accordance with section 305
5. Rockfill shall be sound, durable stone in accordance with section 124 and chocked with fines.
6. Where practical borrow shall be obtained from inside disposal areas.
7.
8. Initial ash dikes to be built by construction of earth to elevation shown on sections.
9. The results of the soil investigation for the raising of the dikes at the ash disposal area no 2 are reported in a memorandum from Gene Farmer to G.L. Buchanan dated Nov. 20, 1978 Cumberland Steam Plant Ash Disposal Area Dikes Soils Investigation.
10. The minimum factor of safety for all loading conditions on ash disposal area dikes is 1.50.
11. When connecting the new dike to the old dike extreme care shall be used to insure an impervious and stable connection. The existing dikes shall be stripped of all vegetation, riprap, gravel, crushed stone, course ash and other pervious material on top of dike and above elevation 370 on inside slope. Benched and scarified to a minimum depth of 6 inches and compacted so as to form a bond with the new earth fill. The utmost caution shall be used in benching the existing dike slopes so as not to create an unstable condition. Small benches of minimum depth shall be used.
12. Earth fill for raised dikes shall be placed in accordance with all applicable sections of general construction specification G-9 for Rolled Earth Fill for Dams and Power Plants. Earth fill shall be obtained from designated borrow areas. The earth fill moisture content shall not exceed 3.0 % above optimum moisture content and shall be placed and compacted to be at least 95% maximum dry density as determined by the TVA Materials Laboratory. At least one moisture-density assurance test shall be made on each 5000 cu. yd. of fill placed.
13. Placement of the underwater ash fill shall be by end dumping along the length of the dike. The top surface of the underwater dike just above the water shall be thoroughly compacted and scarified before placing the overlaying ash fill. Bottom ash for that portion of the divider dike above water shall be placed in not more than 9 inch layers, and well compacted with rubber tired hauling equipment.
14. Dike foundation shall have all weak surface soils removed to material that will easily bear the weight of loaded rubber-tired earth hauling equipment.
15. Refer to the memorandum J.H. Coulson to R.G. Haynes dated Nov. 28, 1980 (B65801120029), for specifications for grouting Ash Pond seep repair.



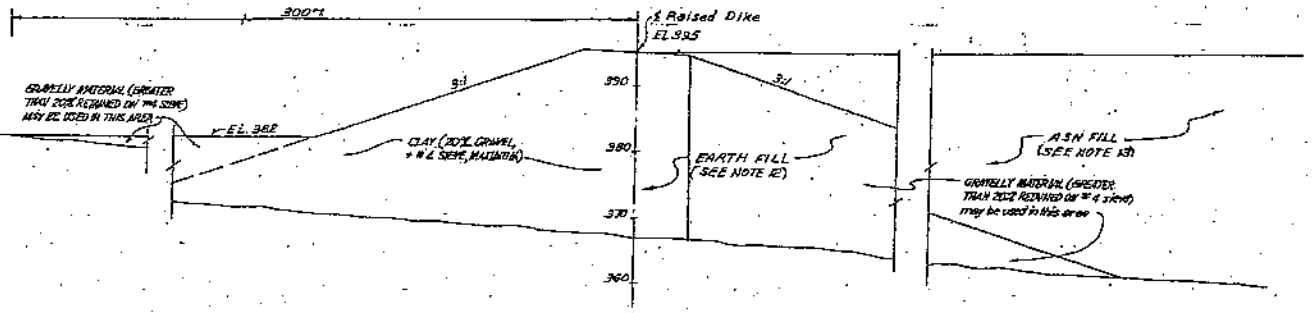
SECTION C-C

Scale: 1"=10'-0"
(10N212)



TYP. GROUTING SECTION

NTS



SECTION E-E

SCALE: 1"=10'
(10N212)

SUMMARY OF QUANTITIES

Area	Item No. Location	Ash Fill Cu. Yd.	123 Earth Emb Cu. Yd.	305 Surfacing Ton	580 Seeding Sq. Yd.	582 Mulching Sq. Yd.	600 Class III Reinf. Conc. Pipe - Lin. Ft. 15"	36"	48"	570 Filter Blanket Ton	575 Riprap - Cu. Yd. Type A	Type B	Rockfill Cu. Yd.
Ash Disposal Dike	A-B		54,900	910						520	600	1540	1060
(Initial Const)	B-C		75,200	310						880	915	2600	4015
	C-D		143,500	920						2195	2300	6485	6280
	D-E		104,850	380						1425	1485	4215	4125
	E-F		140,150	640						2375	2450	7020	1690
	F-G		28,850	440						885	720	2625	345
	G-H		5,000	200							515		
	H-I		12,050	440							1235		
	I-J		40,450	840							615		
Ash Disposal Dikes (Raising To EL 395)		95,300	310,200	3000	47,300	47,300		272					
Total		95,300	921,750	8280	47,300	47,300		272		8280	10,905	24485	17,515
Dike Stability												81,000	

CAPACITY OF DISPOSAL AREAS

ACCUMULATION OF UNIT YEARS

AREA NO. 1 Elevations	AREA NO. 1 Unit Yrs.*	AREA NO. 2 Elevations	AREA NO. 2 Unit Yrs.*
345	0.2		
350	.06		
355	1.5		
360	3.4	360	0.6
365	5.9	365	2.0
370	8.8	370	3.8
375	11.9	375	5.9
380	16.3	380	8.5
385	16.8	385	11.3
390	22.3	390	14.2

* Based on 1,300,000 KW unit. 80% Capacity.

Scale: As Noted

COMPANION DRAWINGS: 10N212, 214
10N221-223, 256

MAIN PLANT

ASH DISPOSAL AREAS
SHEET NO. 2

CUMBERLAND STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED J.M. Johnston
RECOMMENDED W.N. Calvert
APPROVED T.P. Lacy

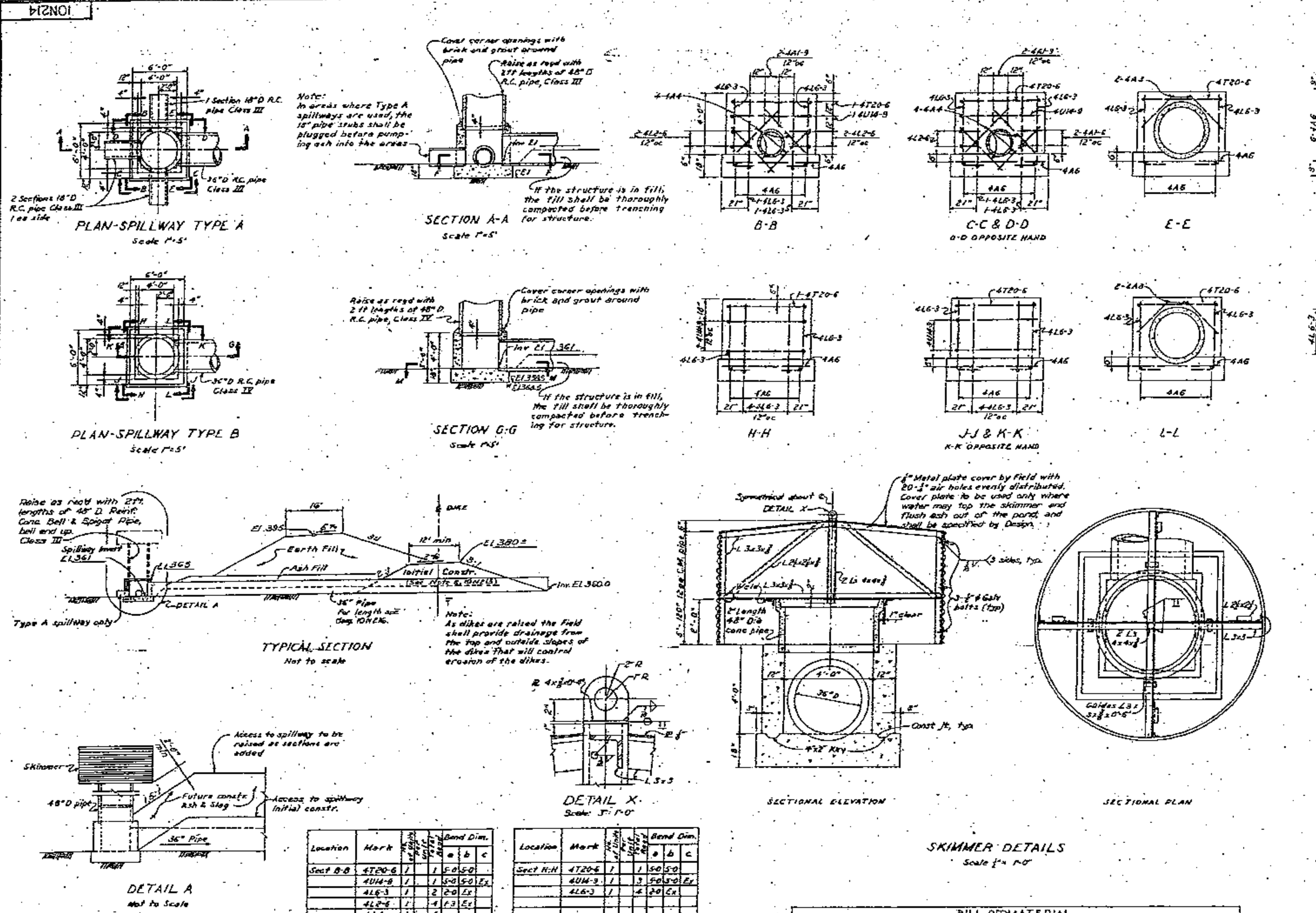
KNOXVILLE | 1-15-69 | 46 | C | 4 | 10N213 R6

RECORD DRAWING AS CONSTRUCTED Clyde C Patton 3-6-79

Frank Van Meter R4 9-3-85

MF
R0
R1
R2
R3
R4
R5
R6

10N214



NOTES:

① SPECIFICATIONS: All work shall be done in accordance with the T-1 Specifications.

② All concrete shall be Class A in accordance with Section 400.

③ Where earth borrow can be obtained economically, for example, from disposal area, it may be used to raise dikes.

④ Vegetation shall be established on all earth slopes, initial and future construction. Seeding specifications to be furnished with drawings for each project. In general, Type G, Mixture E, Section 180 of T-1 Specifications is recommended.

⑤ Location and elevation of the spillways shall be selected so as to maintain the depth of water in the ash pond at an absolute minimum.

⑥ Use Type A spillways for ash areas not scheduled for immediate use.

⑦ A section of 120" corrugated metal pipe is recommended for skimmer device. If structural plates or other metal shapes are used for fabrication at the plant, special care shall be taken to seal all joints by welding or with asphalt paint.

⑧ One 2' section of 48" Dia pipe shall be installed during initial construction.

⑨ As additional sections of 48" pipe are added, grout the joint to form a stable and water-tight connection.

REFERENCE DRAWINGS:

30B519 — REINFORCEMENT BENDING DIAGRAMS

Location	Mark	No. of Units	Per Unit	Total Reqd	Bend Dim. a	b	c
Sect B-B	4T20-6	1		1	5-0	5-0	
	4U14-6	1		1	5-0	5-0	Ex
	4L6-3	1		2	2-0	Ex	
	4L2-6	1		4	1-3	Ex	
	4A4	1		4			
	4A1-9	1		2			
Sect CC&DD	4L6-3	2	2	4	2-0	Ex	
	4A4	2	4	8			
	4A1-9	2	2	4			
	4A1-6	2	2	4			
Sect E-E	4A3	1		2			
Sect F-F	4L6-3	1		4	2-0	Ex	
	4A6	1		12			

TYPE A SPILLWAY

Location	Mark	No. of Units	Per Unit	Total Reqd	Bend Dim. a	b	c
Sect H-H	4T20-6	1		1	5-0	5-0	
	4U14-9	1		3	5-0	5-0	Ex
	4L6-3	1		4	2-0	Ex	
Sect J-J&K-K	4L6-3	2	4	8	2-0	Ex	
Sect L-L	4A3	1		2			
Sect M-M	4L6-3	1		4	2-0	Ex	
	4A6	1		12			

TYPE B SPILLWAY

REINFORCEMENT SCHEDULE

BILL OF MATERIAL

ITEM	DESCRIPTION	NO. of Splwys	PER SPLWY	TOTAL REQD
401	Class A Concrete	4	5 cu yd	20 cu yd
418	Reinforcing Steel	4	170 lb	680 lb
602	18"D Reinforced Concrete Pipe-Class III- Type A Only			
602	36"D Reinforced Concrete Pipe-Class IV	4		876 ft
602	48"D Reinforced Concrete Pipe-Class III (Bell & Spigot)	4	2 ft	8 ft
660	120"-12 Gage Corrugated Metal Pipe	4	5 ft	20 ft
	⅝" ϕ Galvanized Bolt	4	12	48
	⅛" Metal cover (By field-see Skimmer Details)	4	1	4
	2½x2½x⅜ Angle	4	23 ft	92 ft
	3x3x⅜ Angle	4	67 ft	268 ft
	4x4x⅜ Angle	4	8 ft	32 ft

Scale ½"=1'-0"
Except as noted

COMPANION DRAWING: 10N212, 213, 216, 218

STANDARD DRAWING

ASH DISPOSAL SPILLWAY

CUMBERLAND STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

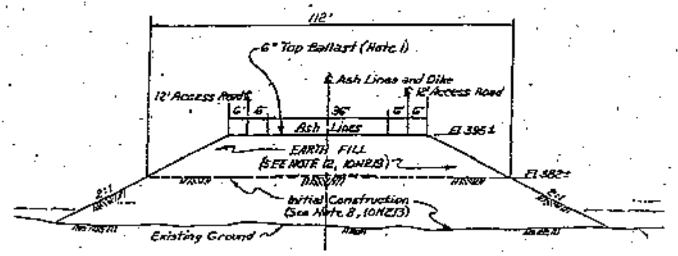
SUBMITTED	RECOMMENDED	APPROVED
J M Slenton	M Galant	F. P. Lacy

KNOXVILLE | 1-13-69 | 46 | C | 4 | 10N214R2

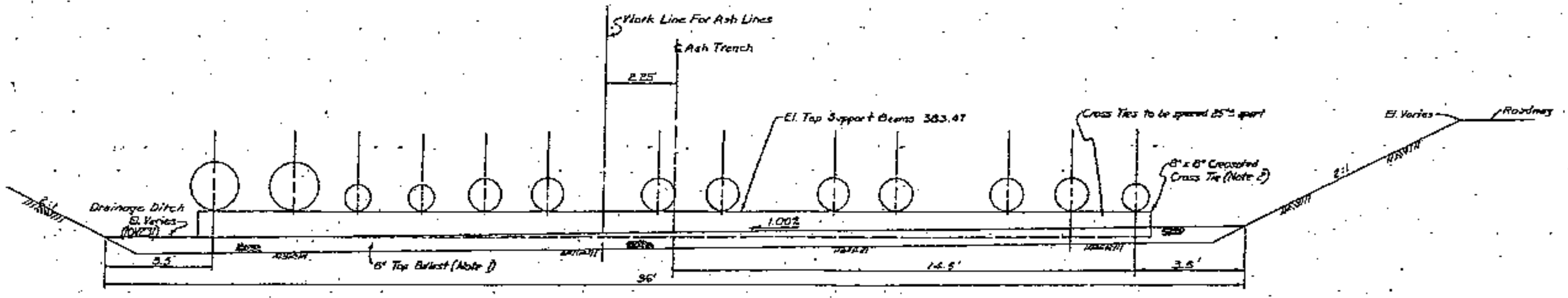
RECORD DRAWING AS CONSTRUCTED R2
9-3-85

SUMMARY OF QUANTITIES

Item No.	Description	Quantities
	8x8' Creosoted Cross Ties	1440 LF
1071	Top Ballast	XXXCY.



SECTION H-H
Scale: 1"=80'
(10N212)



SECTION G-G
Scale: 1"=2'

NOTES:
1. Top ballast shall be size No. 5 and shall conform in quality and gradation to Section 1071.
2. Timbers shall be creosoted cross ties 8"X8". Any length from 7' to 10' may be used and fixed to obtain required 20' length per support. They shall be red oak, gum, or timber of similar texture, fiber, and treating conditions in accordance with current AREA Specification for cross ties. Treatment shall be in accordance with current AREA Specification for Wood Preservation, Rueping process, grade A creosote Coal-tar solution, with initial air pressure of usually 60 psi and 80 psi for red oak ties and gum ties respectively with minimum retention of 6 pounds for red oak and 8 pounds for gum per cubic foot. White oak shall be treated to refusal.

4. For additional notes see Dwg. 10N213.

Scale: As Noted

COMPANION DRAWINGS: 10N212, 213

MAIN PLANT

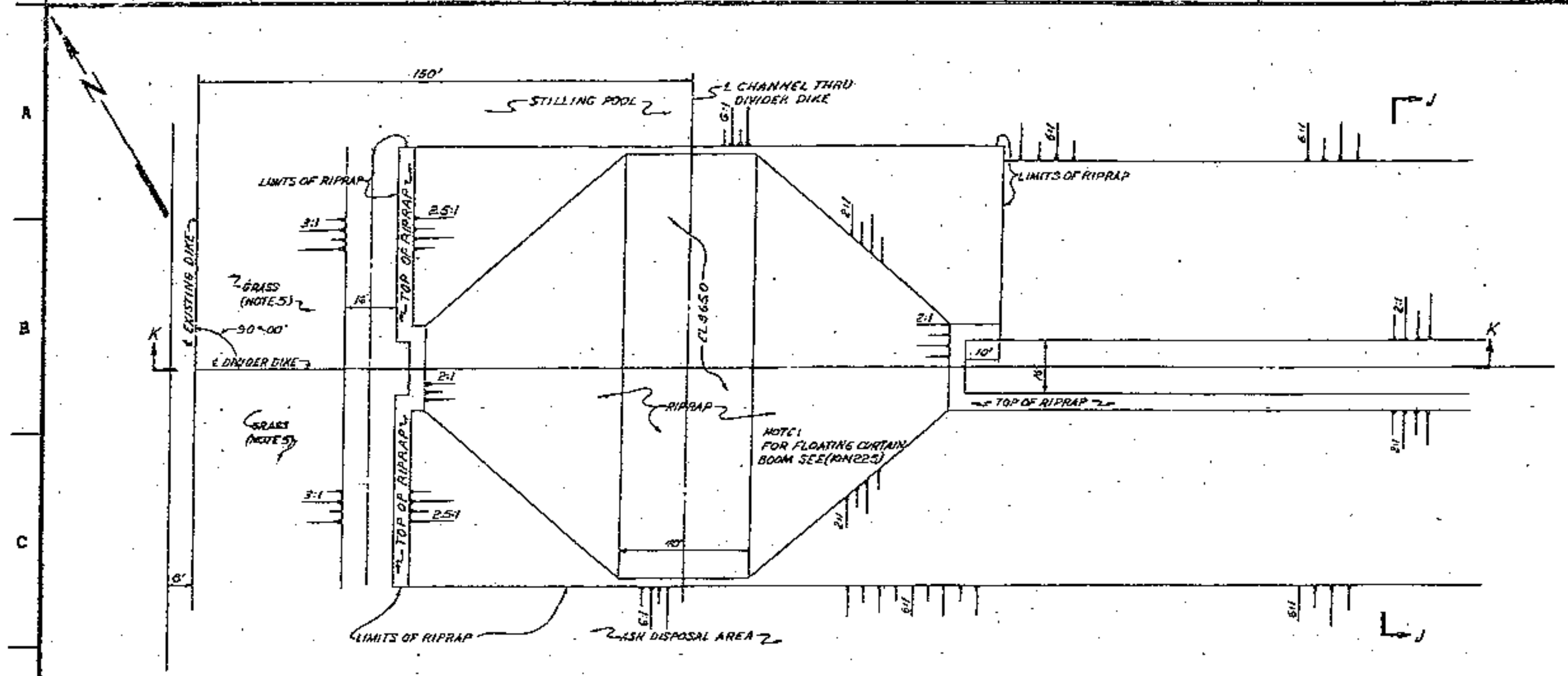
ASH DISPOSAL AREAS
SHEET NO. 3

CUMBERLAND STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

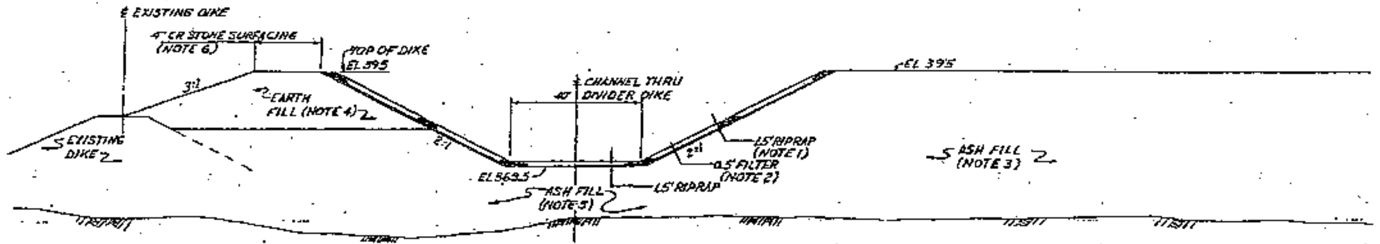
SUBMITTED	RECOMMENDED	APPROVED
J. M. Gilbert	W. M. Calvert	F. P. Fair
KNOXVILLE	1-13-69	45 C 4 10N218 R2

RECORD DRAWING AS CONSTRUCTED Clyde C. Potter 2-6-74

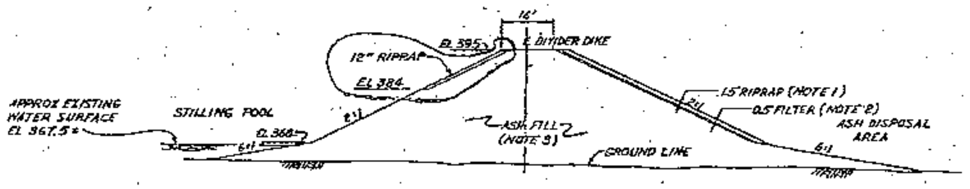
Frank Van Meter RE 9-3-85



DETAIL A
(10N212)



SECTION K-K



SECTION J-J

NOTES:

1. RIPRAP ALONG THE CHANNEL THROUGH DIVIDER DIKE SHALL BE 18 INCHES THICK, WITH A MINIMUM OF 50%, BY WEIGHT, CONSISTING OF STONES AT LEAST 150 POUNDS EACH. RIPRAP SHALL CONFORM TO SECTION 575.
2. FILTER BLANKET, 6 INCHES THICK, SHALL CONFORM TO SECTION 570.
3. THE DIVIDER DIKE SHALL BE CONSTRUCTED OF COMPACTED BOTTOM ASH. PLACEMENT OF THE UNDERWATER ASH FILL SHALL BE BY END DUMPING ALONG THE LENGTH OF THE DIKE. THE TOP SURFACE OF THE UNDERWATER DIKE JUST ABOVE THE WATER SHALL BE THOROUGHLY COMPACTED AND SCARIFIED BEFORE PLACING THE OVERLAYING ASH FILL. BOTTOM ASH FOR THAT PORTION OF THE DIVIDER DIKE ABOVE WATER SHALL BE PLACED IN NOT MORE THAN 9-INCH LAYERS, AND WELL COMPACTED WITH RUBBER TIRED HAULING EQUIPMENT.
4. EARTH FILL COMPACTION SHALL BE DONE WITH SHEEPSFOOT ROLLERS AND SHALL BE AT LEAST 95% OF STANDARD PROCTOR MAXIMUM DENSITY. FILL MOISTURE SHALL BE CONTROLLED TO ACHIEVE OPTIMUM COMPACTION. (SEE NOTE 12-10N213)
5. ALL NEW EARTH DIKE SLOPES SHALL BE SEEDED WITH TYPE 6, MIXTURE E. ALL GRASSED AREAS TO BE FERTILIZED AND MULCHED IN ACCORDANCE WITH SECTIONS 580 & 582 RESPECTIVELY.
6. CRUSHED STONE SURFACING, 4" THICK, SHALL BE APPLIED IN ACCORDANCE WITH SECTION 305 OF THE T-1 SPECIFICATIONS.

SUMMARY OF QUANTITIES-DIVIDER DIKE			
ITEM	DESCRIPTION	QUANTITY	UNIT
575	RIPRAP	3,000	C.Y.
570	FILTER	1,450	TONS
	ASH FILL	163,000	C.Y.

SUMMARY OF QUANTITIES - RAISE DIVIDER DIKE			
ITEM	DESCRIPTION	QUANTITY	UNIT
575	RIPRAP	2,700	C.Y.
570	FILTER	1,800	TONS
	ASH FILL	36,000	C.Y.
575	RIPRAP-EL 384 TO EL 395	1,400	TN

SCALE 1"=20'
COMPANION DRAWING 10N212

R4 5-20-80
ADD RIPRAP TO SECT J-J & REV SUM OF QUAN
R3 11-26-80
ADD SUMMARY OF QUAN FOR RAISING DIVIDER DIKE; REV SPEC NOS.
R2 7-11-79
REV. DETAIL A SECTION K-K & SECTION J-J PA 3375
R1 5-3-77
RAISED DIVIDER DIKE FOR FLOATING CURTAIN BOOM PA 3076

DRAWN G.E. OWENS
DESIGNED G.E. OWENS
CHECKED J.L. GLOVER
SUPV J.L. GLOVER
ENGINEER K.W. Burnett

MAIN PLANT

ASH DISPOSAL AREAS
SHEET NO. 3

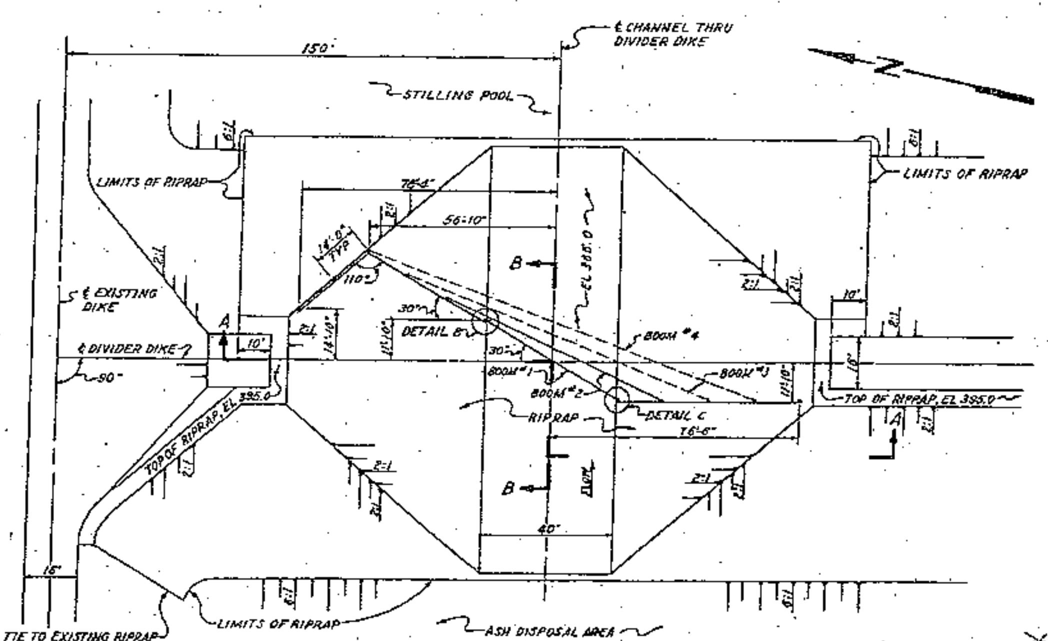
CUMBERLAND STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED Robert G. Bowman
RECOMMENDED
APPROVED G.L. Buchanan

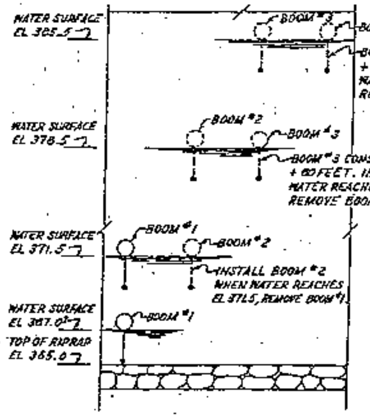
INSPECTED AND APPROVED FOR ISSUE

KNOXVILLE 6-18-75 46 C 10N224 R4

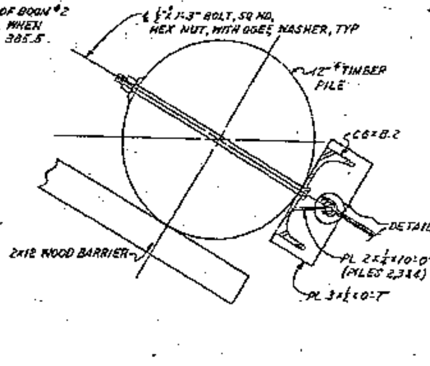
RECORD DRAWING AS CONSTRUCTED



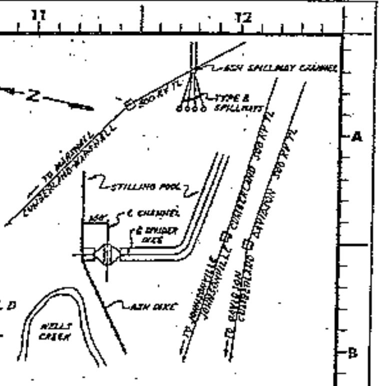
PLAN



B - B
SCALE ⅛"=1'-0"

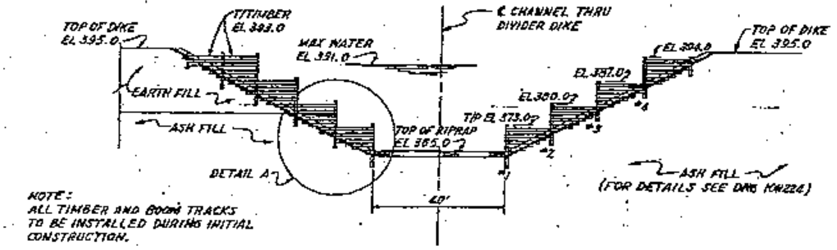


DETAIL B
SCALE 3"=1'-0"



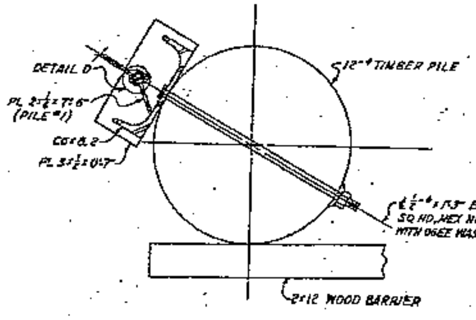
LOCATION PLAN
SCALE 1"=400'

BILL OF FIELD MATERIALS REQUIRED				
ITEM	SIZE	NO	LENGTH	QUANTITY
TIMBER				
BARRIER	2×12 ROUGH	55	16'-0"	880 LF
PILING (CLASS B CREOSOTED)	12"φ	9	15'-0"	135 LF
	12"φ	2	8'-0"	16 LF
HARDWARE				
BOLTS-CHANNEL TO PILE	½" SQ HD, HEX NUT	24	1'-3"	17 LBS
ROOFING NAILS			0'-1"	4 LBS
OGEE WASHERS	FOR ½"φ BOLTS	24		12 LBS
NAILS	20 D COMMON			14 LBS
STEEL				
C6×8.2		6	10'-0"	492 LBS
C6×8.2		2	7'-6"	123 LBS
PL	3×½×0'-7"	8		24 LBS
PL	2×¼×10'-0"	6		102 LBS
PL	2×¼×7'-6"	2		26 LBS
GALV SHEET STEEL	20 GAGE			62 LBS
½"φ ROD		6	10'-0"	40 LBS
½"φ ROD		2	7'-6"	10 LBS

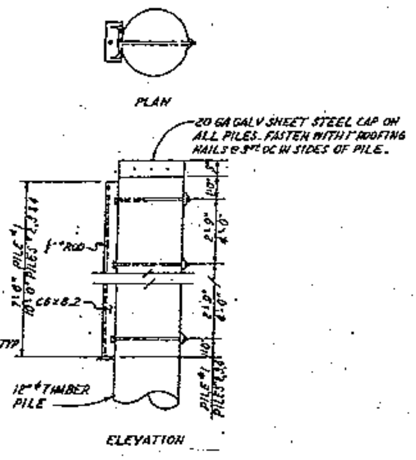


NOTE:
ALL TIMBER AND BOOM TRACKS TO BE INSTALLED DURING INITIAL CONSTRUCTION.

SECTION A-A

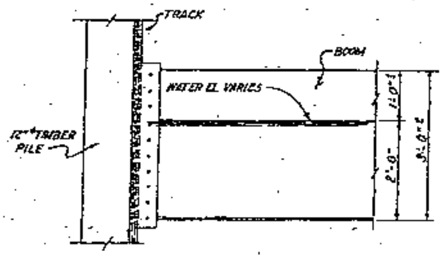


DETAIL C
SCALE 3"=1'-0"

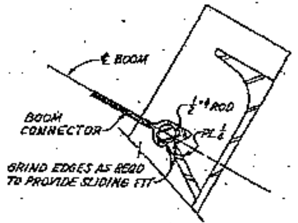


TRACK DETAIL
NTS

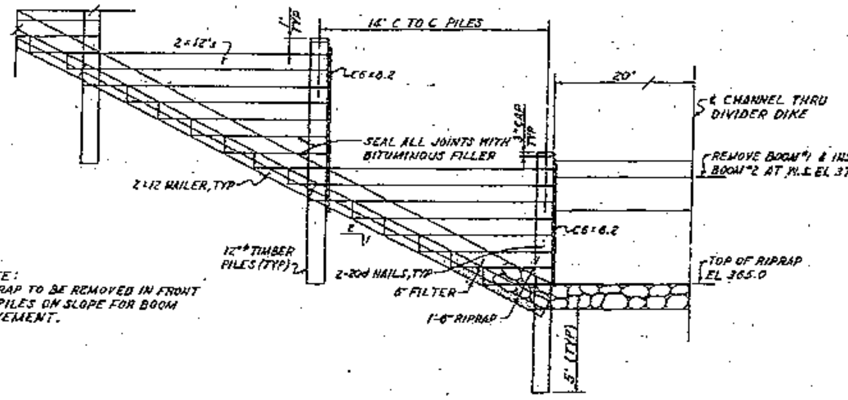
NOTES:
1. MATERIALS:
ALL MATERIALS TO BE FURNISHED AND FABRICATED BY TVA FIELD EXCEPT FLOATING BOOM TO BE PROVIDED UNDER SPECIFICATION 822671.
2. BOLTS TO BE ASTM A307.
3. ALL METAL PARTS FURNISHED BY TVA TO BE GALVANIZED.
4. TIMBER TO BE ROUGH SAWN PINE TREATED WITH COAL-TAR CREOSOTE @ 12# PCF OR AN EQUAL PRESERVATIVE.



FLOATING BOOM
(CONNECTION DETAIL)
SCALE ⅛"=1'-0"



DETAIL D
(HALF SIZE)



NOTE:
RIPRAP TO BE REMOVED IN FRONT OF PILES ON SLOPE FOR BOOM MOVEMENT.

DETAIL A
SCALE ⅛"=1'-0"

FLOATING BOOM			
ITEM	NO	TOTAL LENGTH	REMARKS
BOOM #1	1	50'-0"	
BOOM #2	1	80'-0"	
BOOM #3	1	110'-0"	BOOM #1 + 60'
BOOM #4	1	140'-0"	BOOM #2 + 60'

FIRST ISSUE FOR PA 3076

2 | 11-26-70 | REMOVED HOLD ON DETAILS B, C & D, TRACK DETAIL
1 | 6-20-77 | REVISED PILES & BILL OF FIELD MATERIALS

DRWN R.W. REEP
R.W. REEP
H.L. PARIS
E.R. JACKSON
R.G. Bowman
H.C. Morris

SCALE: 1"=20' EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA
DIVIDER DIKE &
FLOATING BOOM

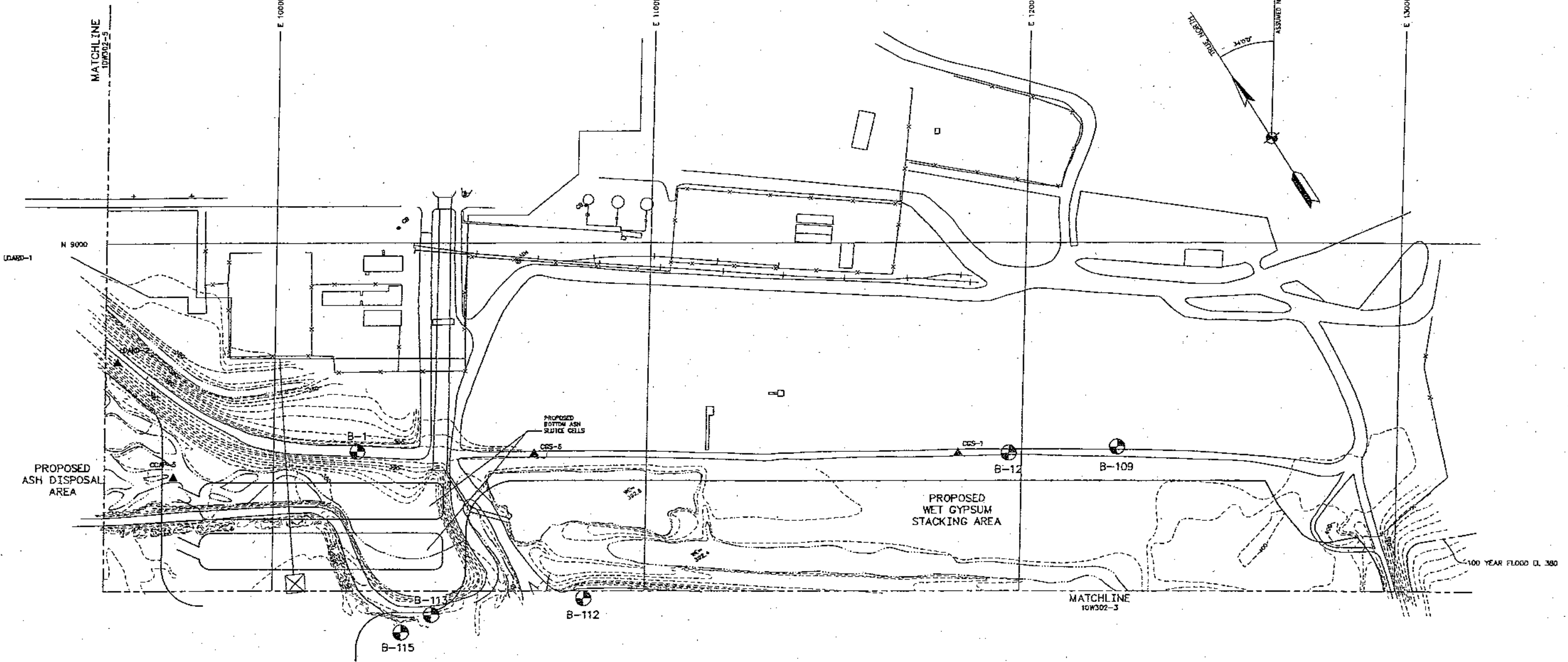
CUMBERLAND STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED R.A. Dorsch | RECOMMENDED | APPROVED

INSPECTED AND APPROVED FOR ISSUE

KNOXVILLE 5-16-77 | 46 | C | 10N225 | R2

AS CONSTRUCTED 2-16-79 R2



LEGEND

B-102	BORING LOCATION
	100-YR FLOOD PLAIN
	DISPOSAL AREA BOUNDARY
CUF 93-1	PROPOSED GROUNDWATER MONITOR WELL
	EXISTING CONTOUR
▲	BENCHMARK LOCATION

BORING COORDINATES

BORING NO.	TENNESSEE LAMBERT COORDINATES (FEET) NORTH	TENNESSEE LAMBERT COORDINATES (FEET) EAST	PLANT GRID * COORDINATES (FEET) NORTH	PLANT GRID * COORDINATES (FEET) EAST	ELEV. (FEET)
1	730675.30	1511979.60	8446.70	10227.00	395.20
12	729900.20	1513418.70	8443.00	11965.40	393.40
109	729752.44	1513668.68	8460.28	12255.24	394.12
112	730211.42	1512265.76	8056.49	10635.38	394.04
113	730401.23	1511902.38	8010.47	10428.04	388.58
115	730406.33	1511811.59	7963.94	10348.97	388.56

* N10,000 PLANT COORDINATE COINCIDES WITH THE EXISTING E-W PLANT BASELINE (℄ OF EXISTING UNIT 1 CHIMNEY). E10,000 PLANT COORDINATE COINCIDES WITH THE EXISTING N-S PLANT BASELINE (EXISTING COLUMN LINE "A").
I.E. 10,000:10,000–TVA 0.0

BENCH MARK LOCATIONS

BENCH MARK NO. NO.	TENNESSEE LAMBERT COORDINATES (FEET) NORTH	TENNESSEE LAMBERT COORDINATES (FEET) EAST	PLANT GRID COORDINATES (FEET)		ELEV. (FEET)
178-D	727,926.48	1,513,693.70	S 3030.48	E 3297.03	395.21
CCAP-1	732,957.97	1,509,794.23	S 1048.75	W 2749.35	394.71
CCAP-2	732,295.18	1,509,469.16	S 1760.00	W 2848.22	395.18
CCAP-3	730,824.08	1,509,309.41	S 3088.93	W 1959.03	393.61
CCAP-4	730,235.80	1,509,772.02	S 3317.95	W 1243.55	394.91
CCAP-5	731,089.67	1,511,532.96	S 1625.35	W 263.14	399.35
CGS-1	729,975.39	1,513,304.73	S 1558.37	E 1828.82	395.64
CGS-2	729,645.42	1,511,188.50	S 3015.31	E 258.90	410.16
CGS-3	729,420.59	1,511,078.11	S 4092.47	E 852.30	395.30
CGS-4	728,064.78	1,512,362.32	S 3669.33	E 2115.92	395.26
CGS-5	727,951.74	1,513,734.70	S 2995.95	E 3316.39	395.30
CGS-6	730,687.17	1,512,364.88	S 1560.27	E 696.20	396.32
CGS-7	729,077.74	1,510,746.13	S 3733.31	E 209.60	395.19
LDARD-1	731,855.90	1,511,450.27	S 1036.39	W 760.21	393.67
LDARD-2	731,429.43	1,511,577.58	S 1318.73	W 416.14	393.57
PP-F-6 RESET	728,984.35	1,510,783.36	S 3789.94	E 292.62	394.86
T-1	734,549.93	1,509,921.94	N 342.46	W 3533.69	365.43

SEE 10W302-1
FOR DRAWING INDEX/COMPANION DRAWINGS LIST

R0 J.L.G. M.G.H. J.G.A. H.O.P. REP J.G.A.
INITIAL ISSUE: FOR DCN CUF-03-536

SCALE: 1"=100' EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
EXISTING SITE CONDITIONS
SHEET 1 OF 4

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2K | 46 | C | 10W302-2 | R 0

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: REV NO.

Appendix F

Instrumentation Monitoring Results

Stantec

Cumberland Fossil Plant
815 Cumberland City Rd
Cumberland City,TN
175539009

	6/13/2009				7/16/2009				8/19/2009			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**
B-3	0.0	0.0	0.0	0.0	394.8	2.5	13.3	384.0	394.8	0.0	11.1	383.6
B-4	0.0	3.0	7.8	-4.8	393.9	3.0	11.2	385.7	393.9	2.6	11.2	385.4
B-9	394.7	0.0	17.2	377.5	394.7	0.0	17.5	377.2	394.7	0.0	17.5	377.2
B-10	0.0	0.0	0.0	0.0	397.1	3.0	21.0	379.1	397.1	2.8	20.8	379.1
B-15A	395.0	0.0	7.8	387.2	395.0	0.0	8.8	386.3	395.0	0.0	8.4	386.7
B-16	397.8	2.3	39.1	361.0	397.8	2.3	39.0	361.2	397.8	2.3	40.2	359.9
B-21	395.1	0.0	4.6	390.5	395.1	0.0	4.9	390.3	395.1	0.0	4.6	390.6
B-22	410.2	3.8	19.9	394.1	410.2	3.8	24.1	389.9	410.2	2.8	23.4	389.6
B-27	0.0	0.0	0.0	0.0	422.2	0.0	0.0	422.2	422.2	2.3	27.5	397.0
B-28	410.6	0.8	28.2	383.2	410.6	0.8	30.5	380.9	410.6	2.5	32.2	380.9
B-29	395.2	0.0	20.0	375.2	395.2	0.0	20.7	374.5	395.2	0.0	19.9	375.3
B-35	425.7	2.2	29.6	398.2	425.7	2.2	33.9	393.9	425.7	2.6	45.4	382.9
B-36	411.2	0.0	25.1	386.1	411.2	0.0	25.7	385.4	411.2	2.4	27.8	385.7
B-37	395.2	1.8	17.1	380.0	395.2	0.0	20.1	375.1	395.2	0.0	18.1	377.1
B-42	0.0	0.0	0.0	0.0	396.2	0.0	18.0	378.3	396.2	0.0	16.7	379.5
B-43	0.0	0.0	0.0	0.0	411.3	0.8	19.8	392.4	411.3	2.2	21.2	392.3
B-44	0.0	0.0	0.0	0.0	419.5	2.0	27.5	394.0	419.5	1.5	27.5	393.5
B-45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	411.6	2.5	21.1	393.0
B-46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	420.3	3.2	23.3	400.2

Change in elevation

Stantec

Cumberland Fossil Plant
815 Cumberland City Rd
Cumberland City,TN
175539009

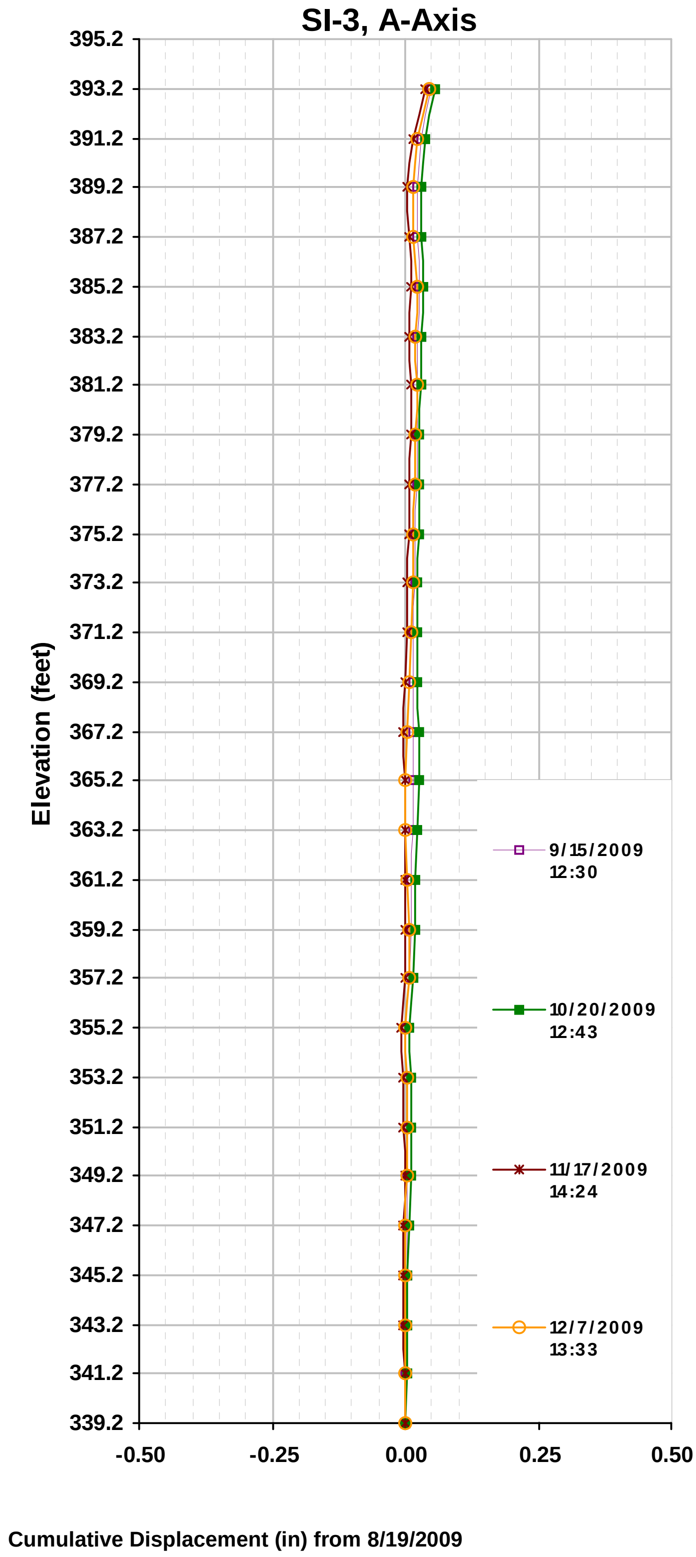
	9/15/2009				10/20/2009				11/5/2009			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**
B-3	394.8	0.0	11.0	383.8	394.8	0.0	10.9	383.9	394.8	0.0	0.0	394.8
B-4	393.9	2.6	11.3	385.2	393.9	2.6	10.9	385.6	393.9	2.6	0.0	396.5
B-9	394.7	0.0	17.8	376.9	394.7	0.0	17.3	377.4	394.7	0.0	0.0	394.7
B-10	397.1	2.8	21.3	378.6	397.1	2.8	21.1	378.8	397.1	2.8	0.0	399.9
B-15A	395.0	0.0	8.7	386.3	395.0	0.0	8.4	386.7	395.0	0.0	0.0	395.0
B-16	397.8	2.3	42.1	358.1	397.8	2.3	40.6	359.5	397.8	2.3	37.5	362.7
B-21	395.1	0.0	0.0	395.1	395.1	0.0	0.0	395.1	395.1	0.0	4.4	390.7
B-22	410.2	2.8	24.0	389.0	410.2	2.8	23.5	389.5	410.2	2.8	0.0	413.0
B-27	422.2	2.3	27.7	396.7	422.2	2.3	27.5	397.0	422.2	2.3	0.0	424.5
B-28	410.6	2.5	32.4	380.7	410.6	2.5	31.8	381.3	410.6	2.5	0.0	413.1
B-29	395.2	0.0	20.1	375.1	395.2	0.0	19.5	375.7	395.2	0.0	0.0	395.2
B-35	425.7	2.6	35.6	392.6	425.7	2.6	35.5	392.8	425.7	2.6	0.0	428.3
B-36	411.2	2.4	27.8	385.7	411.2	2.4	27.6	386.0	411.2	2.4	0.0	413.5
B-37	395.2	0.0	18.1	377.1	395.2	0.0	17.7	377.5	395.2	0.0	0.0	395.2
B-42	396.2	0.0	0.0	396.2	396.2	0.0	0.0	396.2	396.2	0.0	17.1	379.1
B-43	411.3	2.2	21.6	391.9	411.3	2.2	21.2	392.3	411.3	2.2	0.0	413.5
B-44	419.5	1.5	28.0	393.0	419.5	1.5	27.7	393.2	419.5	1.5	0.0	421.0
B-45	411.6	2.5	21.3	392.8	411.6	2.5	21.3	392.8	411.6	2.5	0.0	414.1
B-46	420.3	3.2	24.3	399.2	420.3	3.2	23.4	400.1	420.3	3.2	0.0	423.5

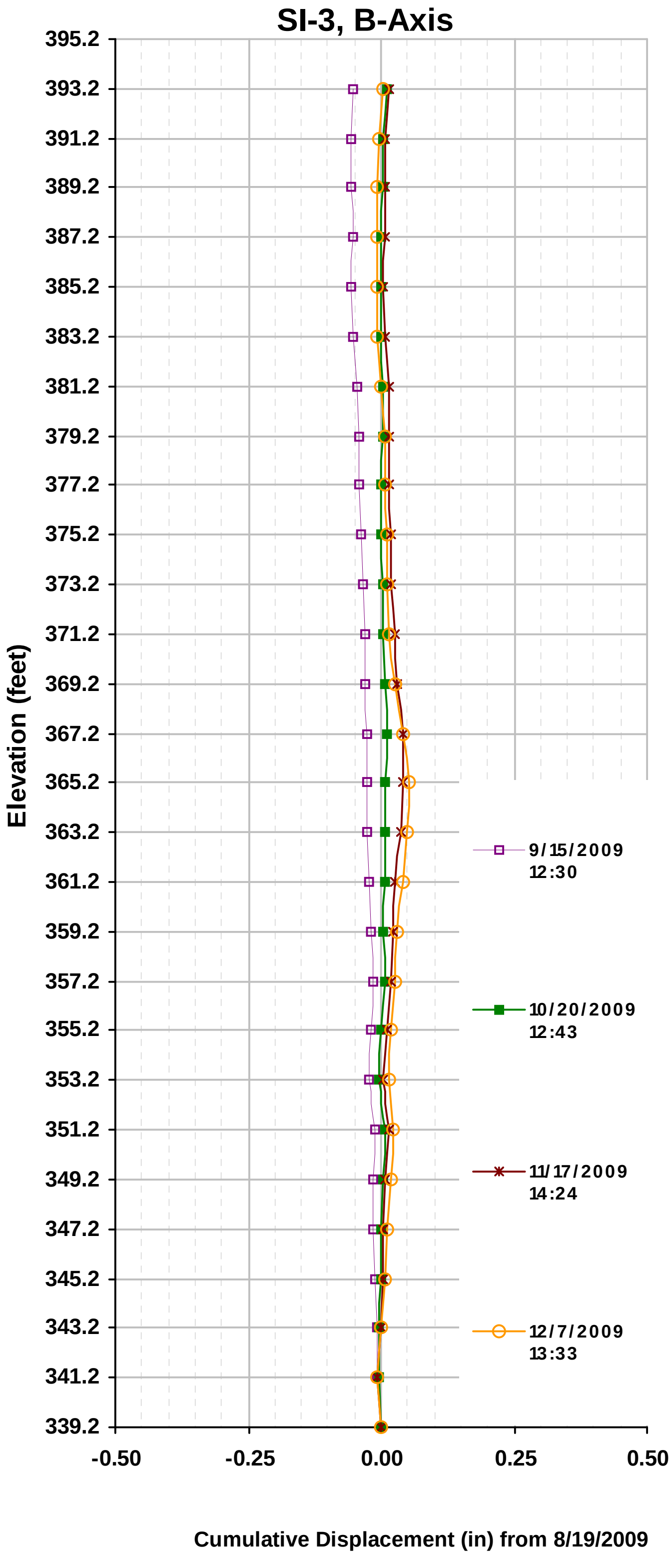
▨ **Change in elevation**

Cumberland Fossil Plant
815 Cumberland City Rd
Cumberland City,TN
175539009

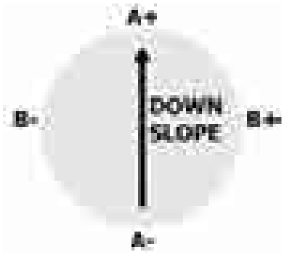
	11/17/2009				12/7/2009			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**
B-3	394.8	0.0	10.8	384.0	394.8	0.0	11.0	383.8
B-4	393.9	2.7	10.9	385.7	393.9	2.7	11.2	385.5
B-9	394.7	0.0	16.9	377.8	394.7	0.0	17.2	377.4
B-10	397.1	2.8	20.8	379.1	397.1	2.8	21.2	378.7
B-15A	395.0	0.0	8.4	386.6	395.0	0.0	8.9	386.1
B-16	397.8	2.3	41.4	358.6	397.8	2.3	41.8	358.2
B-21	395.1	0.0	4.6	390.5	395.1	0.0	5.2	389.9
B-22	410.2	2.9	23.6	389.5	410.2	2.9	24.1	389.0
B-27	422.2	3.0	27.5	397.7	422.2	3.0	27.9	397.3
B-28	410.6	2.7	31.8	381.5	410.6	2.7	32.3	381.0
B-29	395.2	0.0	19.2	376.0	395.2	0.0	19.6	375.6
B-35	425.7	2.5	35.2	392.9	425.7	2.5	35.5	392.6
B-36	411.2	2.4	27.5	386.0	411.2	2.4	27.8	385.8
B-37	395.2	0.0	17.6	377.6	395.2	0.0	18.0	377.3
B-42	396.2	0.0	17.4	378.8	396.2	0.0	17.4	378.8
B-43	411.3	2.3	21.3	392.2	411.3	2.3	21.9	391.6
B-44	419.5	1.6	27.8	393.3	419.5	1.6	28.5	392.5
B-45	411.6	2.6	21.3	392.9	411.6	2.6	21.3	392.9
B-46	420.3	3.3	23.4	400.1	420.3	3.3	23.4	400.1

▨ **Change in elevation**


SI-3, A-Axis


SI-3, B-Axis

Stantec



Cumberland Fossil Plant
B-3
Cumberland City, TN
175539009
12/8/2009

SITE CUFTVA
INSTALLATION SI-29A
DESCRIPTION

CURRENT SURVEY 9/15/2009 12:30:54 PM
INITIAL SURVEY 8/19/2009 2:10:15 PM

DATE PRINTED 12/8/2009 11:01:57 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	141	-131	0.1632	154	-152	0.1836	0.0204	0.0492
4	174	-161	0.2010	175	-169	0.2064	0.0054	0.0288
6	152	-137	0.1734	147	-141	0.1728	-0.0006	0.0234
8	80	-69	0.0894	76	-72	0.0888	-0.0006	0.0240
10	39	-23	0.0372	35	-28	0.0378	0.0006	0.0246
12	36	-27	0.0378	33	-30	0.0378	0.0000	0.0240
14	47	-35	0.0492	45	-40	0.0510	0.0018	0.0240
16	30	-18	0.0288	28	-22	0.0300	0.0012	0.0222
18	-14	25	-0.0234	-17	21	-0.0228	0.0006	0.0210
20	-91	103	-0.1164	-93	98	-0.1146	0.0018	0.0204
22	-201	209	-0.2460	-203	204	-0.2442	0.0018	0.0186
24	-294	308	-0.3612	-297	302	-0.3594	0.0018	0.0168
26	-347	357	-0.4224	-351	353	-0.4224	0.0000	0.0150
28	-315	325	-0.3840	-319	320	-0.3834	0.0006	0.0150
30	-251	262	-0.3078	-255	257	-0.3072	0.0006	0.0144
32	-198	205	-0.2418	-201	200	-0.2406	0.0012	0.0138
34	-153	162	-0.1890	-156	156	-0.1872	0.0018	0.0126
36	-129	139	-0.1608	-130	133	-0.1578	0.0030	0.0108
38	-128	139	-0.1602	-127	130	-0.1542	0.0060	0.0078
40	-168	181	-0.2094	-175	178	-0.2118	-0.0024	0.0018
42	-269	279	-0.3288	-274	276	-0.3300	-0.0012	0.0042
44	-236	248	-0.2904	-240	244	-0.2904	0.0000	0.0054
46	-189	202	-0.2346	-193	197	-0.2340	0.0006	0.0054
48	-186	197	-0.2298	-189	191	-0.2280	0.0018	0.0048
50	-169	181	-0.2100	-172	176	-0.2088	0.0012	0.0030
52	-97	107	-0.1224	-100	102	-0.1212	0.0012	0.0018
54	-1	15	-0.0096	-5	10	-0.0090	0.0006	0.0006
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE	CUFTVA
INSTALLATION	SI-29A
DESCRIPTION	

CURRENT SURVEY	10/20/2009	12:43:03 PM
INITIAL SURVEY	8/19/2009	2:10:15 PM
DATE PRINTED	12/8/2009	11:01:57 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	141	-131	0.1632	157	-150	0.1842	0.0210	0.0576
4	174	-161	0.2010	179	-168	0.2082	0.0072	0.0366
6	152	-137	0.1734	149	-137	0.1716	-0.0018	0.0294
8	80	-69	0.0894	77	-68	0.0870	-0.0024	0.0312
10	39	-23	0.0372	39	-26	0.0390	0.0018	0.0336
12	36	-27	0.0378	36	-29	0.0390	0.0012	0.0318
14	47	-35	0.0492	49	-39	0.0528	0.0036	0.0306
16	30	-18	0.0288	31	-19	0.0300	0.0012	0.0270
18	-14	25	-0.0234	-14	24	-0.0228	0.0006	0.0258
20	-91	103	-0.1164	-90	102	-0.1152	0.0012	0.0252
22	-201	209	-0.2460	-200	209	-0.2454	0.0006	0.0240
24	-294	308	-0.3612	-294	308	-0.3612	0.0000	0.0234
26	-347	357	-0.4224	-349	357	-0.4236	-0.0012	0.0234
28	-315	325	-0.3840	-317	323	-0.3840	0.0000	0.0246
30	-251	262	-0.3078	-251	261	-0.3072	0.0006	0.0246
32	-198	205	-0.2418	-194	203	-0.2382	0.0036	0.0240
34	-153	162	-0.1890	-152	159	-0.1866	0.0024	0.0204
36	-129	139	-0.1608	-127	136	-0.1578	0.0030	0.0180
38	-128	139	-0.1602	-122	132	-0.1524	0.0078	0.0150
40	-168	181	-0.2094	-172	183	-0.2130	-0.0036	0.0072
42	-269	279	-0.3288	-270	279	-0.3294	-0.0006	0.0108
44	-236	248	-0.2904	-235	246	-0.2886	0.0018	0.0114
46	-189	202	-0.2346	-187	200	-0.2322	0.0024	0.0096
48	-186	197	-0.2298	-185	194	-0.2274	0.0024	0.0072
50	-169	181	-0.2100	-168	179	-0.2082	0.0018	0.0048
52	-97	107	-0.1224	-98	106	-0.1224	0.0000	0.0030
54	-1	15	-0.0096	2	13	-0.0066	0.0030	0.0030
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-29A
DESCRIPTION

CURRENT SURVEY 11/17/2009 2:24:32 PM
INITIAL SURVEY 8/19/2009 2:10:15 PM

DATE PRINTED 12/8/2009 11:01:57 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	141	-131	0.1632	156	-154	0.1860	0.0228	0.0360
4	174	-161	0.2010	177	-172	0.2094	0.0084	0.0132
6	152	-137	0.1734	147	-139	0.1716	-0.0018	0.0048
8	80	-69	0.0894	73	-69	0.0852	-0.0042	0.0066
10	39	-23	0.0372	36	-29	0.0390	0.0018	0.0108
12	36	-27	0.0378	31	-29	0.0360	-0.0018	0.0090
14	47	-35	0.0492	45	-39	0.0504	0.0012	0.0108
16	30	-18	0.0288	28	-21	0.0294	0.0006	0.0096
18	-14	25	-0.0234	-17	21	-0.0228	0.0006	0.0090
20	-91	103	-0.1164	-91	98	-0.1134	0.0030	0.0084
22	-201	209	-0.2460	-202	205	-0.2442	0.0018	0.0054
24	-294	308	-0.3612	-296	302	-0.3588	0.0024	0.0036
26	-347	357	-0.4224	-347	351	-0.4188	0.0036	0.0012
28	-315	325	-0.3840	-319	322	-0.3846	-0.0006	-0.0024
30	-251	262	-0.3078	-256	261	-0.3102	-0.0024	-0.0018
32	-198	205	-0.2418	-202	202	-0.2424	-0.0006	0.0006
34	-153	162	-0.1890	-157	159	-0.1896	-0.0006	0.0012
36	-129	139	-0.1608	-130	134	-0.1584	0.0024	0.0018
38	-128	139	-0.1602	-126	130	-0.1536	0.0066	-0.0006
40	-168	181	-0.2094	-175	178	-0.2118	-0.0024	-0.0072
42	-269	279	-0.3288	-273	276	-0.3294	-0.0006	-0.0048
44	-236	248	-0.2904	-243	245	-0.2928	-0.0024	-0.0042
46	-189	202	-0.2346	-190	198	-0.2328	0.0018	-0.0018
48	-186	197	-0.2298	-189	193	-0.2292	0.0006	-0.0036
50	-169	181	-0.2100	-172	177	-0.2094	0.0006	-0.0042
52	-97	107	-0.1224	-102	107	-0.1254	-0.0030	-0.0048
54	-1	15	-0.0096	-5	14	-0.0114	-0.0018	-0.0018
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-29A
DESCRIPTION

CURRENT SURVEY 12/7/2009 1:33:48 PM
INITIAL SURVEY 8/19/2009 2:10:15 PM

DATE PRINTED 12/8/2009 11:01:57 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	141	-131	0.1632	158	-154	0.1872	0.0240	0.0468
4	174	-161	0.2010	179	-171	0.2100	0.0090	0.0228
6	152	-137	0.1734	147	-138	0.1710	-0.0024	0.0138
8	80	-69	0.0894	74	-67	0.0846	-0.0048	0.0162
10	39	-23	0.0372	37	-27	0.0384	0.0012	0.0210
12	36	-27	0.0378	34	-27	0.0366	-0.0012	0.0198
14	47	-35	0.0492	46	-39	0.0510	0.0018	0.0210
16	30	-18	0.0288	29	-21	0.0300	0.0012	0.0192
18	-14	25	-0.0234	-15	22	-0.0222	0.0012	0.0180
20	-91	103	-0.1164	-90	99	-0.1134	0.0030	0.0168
22	-201	209	-0.2460	-201	207	-0.2448	0.0012	0.0138
24	-294	308	-0.3612	-293	303	-0.3576	0.0036	0.0126
26	-347	357	-0.4224	-344	349	-0.4158	0.0066	0.0090
28	-315	325	-0.3840	-317	320	-0.3822	0.0018	0.0024
30	-251	262	-0.3078	-254	261	-0.3090	-0.0012	0.0006
32	-198	205	-0.2418	-203	205	-0.2448	-0.0030	0.0018
34	-153	162	-0.1890	-157	162	-0.1914	-0.0024	0.0048
36	-129	139	-0.1608	-130	137	-0.1602	0.0006	0.0072
38	-128	139	-0.1602	-123	131	-0.1524	0.0078	0.0066
40	-168	181	-0.2094	-174	182	-0.2136	-0.0042	-0.0012
42	-269	279	-0.3288	-271	277	-0.3288	0.0000	0.0030
44	-236	248	-0.2904	-238	246	-0.2904	0.0000	0.0030
46	-189	202	-0.2346	-189	199	-0.2328	0.0018	0.0030
48	-186	197	-0.2298	-187	193	-0.2280	0.0018	0.0012
50	-169	181	-0.2100	-170	178	-0.2088	0.0012	-0.0006
52	-97	107	-0.1224	-102	106	-0.1248	-0.0024	-0.0018
54	-1	15	-0.0096	-3	12	-0.0090	0.0006	0.0006
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-29A

DESCRIPTION

CURRENT SURVEY 9/15/2009 12:30:54 PM

INITIAL SURVEY 8/19/2009 2:10:15 PM

DATE PRINTED 12/8/2009 11:02:07 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-284	351	-0.3810	-283	346	-0.3774	0.0036	-0.0522
4	-273	339	-0.3672	-277	336	-0.3678	-0.0006	-0.0558
6	-280	339	-0.3714	-285	337	-0.3732	-0.0018	-0.0552
8	-297	357	-0.3924	-297	355	-0.3912	0.0012	-0.0534
10	-301	362	-0.3978	-305	359	-0.3984	-0.0006	-0.0546
12	-259	318	-0.3462	-268	323	-0.3546	-0.0084	-0.0540
14	-150	206	-0.2136	-154	208	-0.2172	-0.0036	-0.0456
16	-63	111	-0.1044	-67	110	-0.1062	-0.0018	-0.0420
18	27	34	-0.0042	22	34	-0.0072	-0.0030	-0.0402
20	120	-86	0.1236	115	-86	0.1206	-0.0030	-0.0372
22	310	-277	0.3522	304	-277	0.3486	-0.0036	-0.0342
24	513	-465	0.5868	510	-465	0.5850	-0.0018	-0.0306
26	583	-532	0.6690	581	-532	0.6678	-0.0012	-0.0288
28	503	-440	0.5658	499	-443	0.5652	-0.0006	-0.0276
30	421	-357	0.4668	417	-359	0.4656	-0.0012	-0.0270
32	357	-293	0.3900	353	-293	0.3876	-0.0024	-0.0258
34	333	-266	0.3594	327	-266	0.3558	-0.0036	-0.0234
36	310	-255	0.3390	305	-254	0.3354	-0.0036	-0.0198
38	279	-214	0.2958	280	-220	0.3000	0.0042	-0.0162
40	221	-173	0.2364	220	-179	0.2394	0.0030	-0.0204
42	91	-36	0.0762	79	-29	0.0648	-0.0114	-0.0234
44	-27	81	-0.0648	-29	77	-0.0636	0.0012	-0.0120
46	-150	194	-0.2064	-151	191	-0.2052	0.0012	-0.0132
48	-211	270	-0.2886	-215	272	-0.2922	-0.0036	-0.0144
50	-333	369	-0.4212	-337	368	-0.4230	-0.0018	-0.0108
52	-595	638	-0.7398	-598	636	-0.7404	-0.0006	-0.0090
54	-645	678	-0.7938	-653	684	-0.8022	-0.0084	-0.0084
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-29A
DESCRIPTION

CURRENT SURVEY 10/20/2009 12:43:03 PM
INITIAL SURVEY 8/19/2009 2:10:15 PM

DATE PRINTED 12/8/2009 11:02:07 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-284	351	-0.3810	-279	343	-0.3732	0.0078	0.0120
4	-273	339	-0.3672	-272	338	-0.3660	0.0012	0.0042
6	-280	339	-0.3714	-280	337	-0.3702	0.0012	0.0030
8	-297	357	-0.3924	-294	357	-0.3906	0.0018	0.0018
10	-301	362	-0.3978	-303	363	-0.3996	-0.0018	0.0000
12	-259	318	-0.3462	-264	319	-0.3498	-0.0036	0.0018
14	-150	206	-0.2136	-151	203	-0.2124	0.0012	0.0054
16	-63	111	-0.1044	-61	109	-0.1020	0.0024	0.0042
18	27	34	-0.0042	27	33	-0.0036	0.0006	0.0018
20	120	-86	0.1236	118	-86	0.1224	-0.0012	0.0012
22	310	-277	0.3522	308	-276	0.3504	-0.0018	0.0024
24	513	-465	0.5868	514	-461	0.5850	-0.0018	0.0042
26	583	-532	0.6690	581	-528	0.6654	-0.0036	0.0060
28	503	-440	0.5658	502	-442	0.5664	0.0006	0.0096
30	421	-357	0.4668	420	-360	0.4680	0.0012	0.0090
32	357	-293	0.3900	357	-295	0.3912	0.0012	0.0078
34	333	-266	0.3594	334	-267	0.3606	0.0012	0.0066
36	310	-255	0.3390	310	-253	0.3378	-0.0012	0.0054
38	279	-214	0.2958	282	-221	0.3018	0.0060	0.0066
40	221	-173	0.2364	223	-177	0.2400	0.0036	0.0006
42	91	-36	0.0762	83	-28	0.0666	-0.0096	-0.0030
44	-27	81	-0.0648	-26	77	-0.0618	0.0030	0.0066
46	-150	194	-0.2064	-145	191	-0.2016	0.0048	0.0036
48	-211	270	-0.2886	-210	272	-0.2892	-0.0006	-0.0012
50	-333	369	-0.4212	-331	368	-0.4194	0.0018	-0.0006
52	-595	638	-0.7398	-593	636	-0.7374	0.0024	-0.0024
54	-645	678	-0.7938	-650	681	-0.7986	-0.0048	-0.0048
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-29A

DESCRIPTION

CURRENT SURVEY 11/17/2009 2:24:32 PM

INITIAL SURVEY 8/19/2009 2:10:15 PM

DATE PRINTED 12/8/2009 11:02:07 AM

Data Reduction for B Axis:

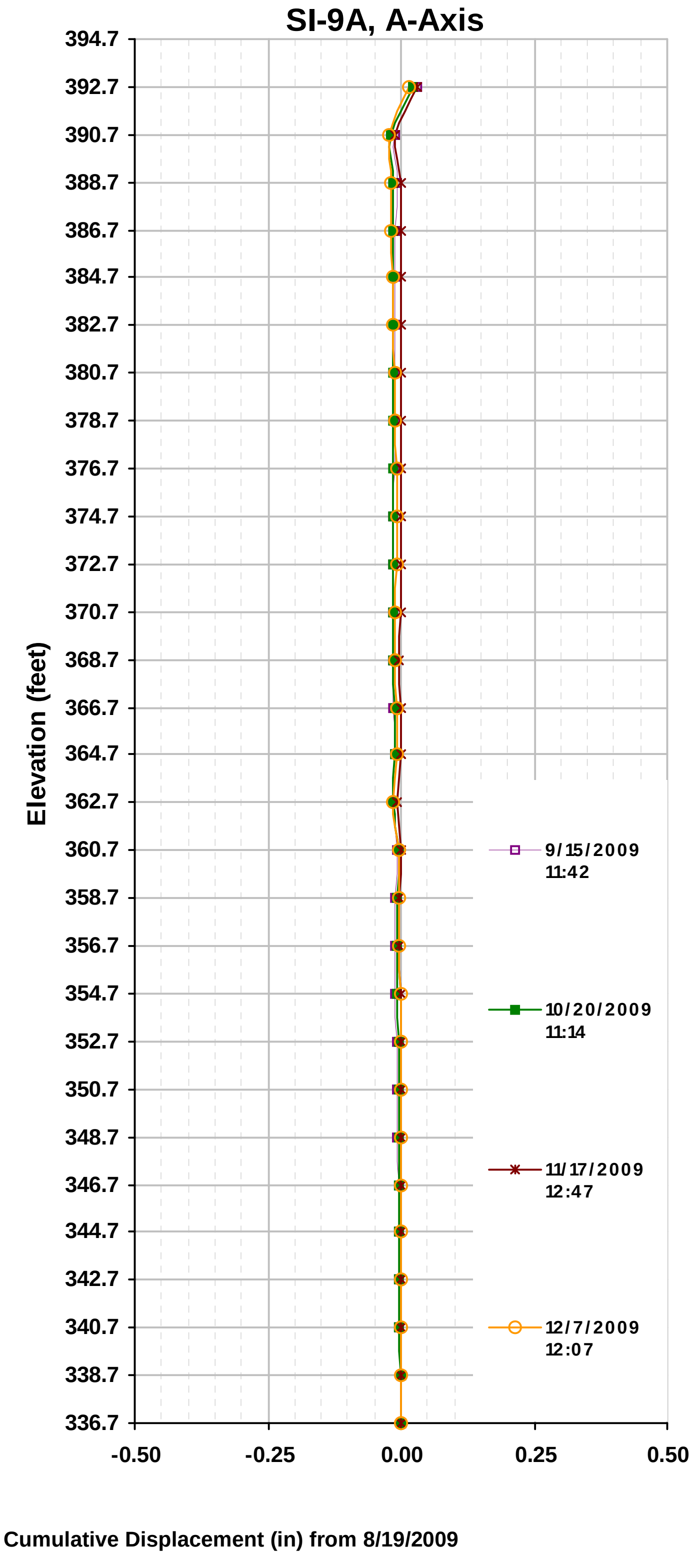
	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-284	351	-0.3810	-277	348	-0.3750	0.0060	0.0150
4	-273	339	-0.3672	-269	341	-0.3660	0.0012	0.0090
6	-280	339	-0.3714	-277	341	-0.3708	0.0006	0.0078
8	-297	357	-0.3924	-292	359	-0.3906	0.0018	0.0072
10	-301	362	-0.3978	-302	366	-0.4008	-0.0030	0.0054
12	-259	318	-0.3462	-265	326	-0.3546	-0.0084	0.0084
14	-150	206	-0.2136	-147	209	-0.2136	0.0000	0.0168
16	-63	111	-0.1044	-61	110	-0.1026	0.0018	0.0168
18	27	34	-0.0042	26	38	-0.0072	-0.0030	0.0150
20	120	-86	0.1236	119	-83	0.1212	-0.0024	0.0180
22	310	-277	0.3522	307	-272	0.3474	-0.0048	0.0204
24	513	-465	0.5868	513	-456	0.5814	-0.0054	0.0252
26	583	-532	0.6690	579	-519	0.6588	-0.0102	0.0306
28	503	-440	0.5658	503	-437	0.5640	-0.0018	0.0408
30	421	-357	0.4668	425	-361	0.4716	0.0048	0.0426
32	357	-293	0.3900	363	-305	0.4008	0.0108	0.0378
34	333	-266	0.3594	341	-267	0.3648	0.0054	0.0270
36	310	-255	0.3390	314	-257	0.3426	0.0036	0.0216
38	279	-214	0.2958	287	-217	0.3024	0.0066	0.0180
40	221	-173	0.2364	226	-178	0.2424	0.0060	0.0114
42	91	-36	0.0762	85	-29	0.0684	-0.0078	0.0054
44	-27	81	-0.0648	-21	79	-0.0600	0.0048	0.0132
46	-150	194	-0.2064	-143	193	-0.2016	0.0048	0.0084
48	-211	270	-0.2886	-207	275	-0.2892	-0.0006	0.0036
50	-333	369	-0.4212	-329	366	-0.4170	0.0042	0.0042
52	-595	638	-0.7398	-589	630	-0.7314	0.0084	0.0000
54	-645	678	-0.7938	-651	686	-0.8022	-0.0084	-0.0084
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

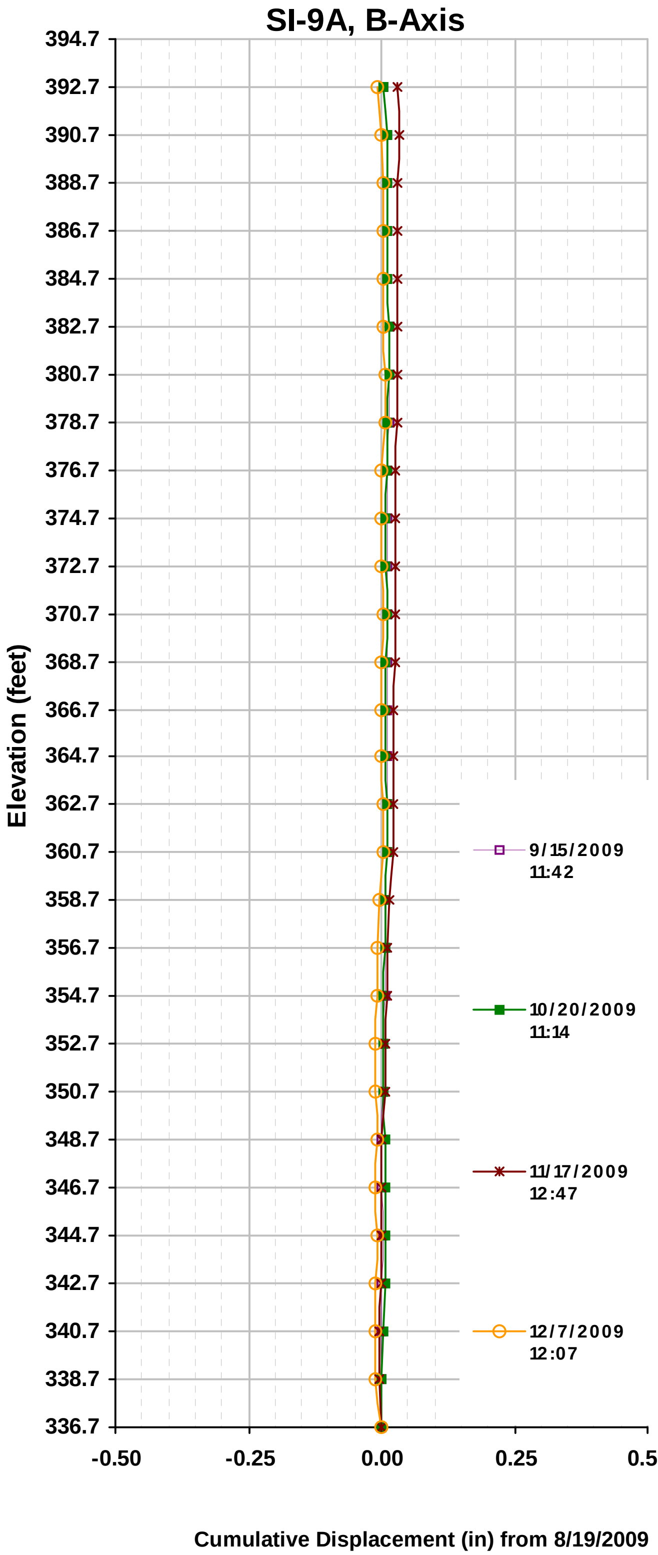
SITE	CUFTVA
INSTALLATION	SI-29A
DESCRIPTION	

CURRENT SURVEY	12/7/2009	1:33:48 PM
INITIAL SURVEY	8/19/2009	2:10:15 PM
DATE PRINTED	12/8/2009	11:02:07 AM

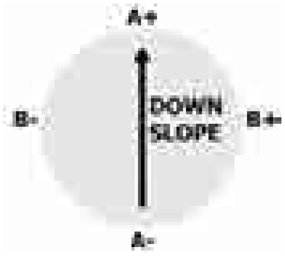
Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-284	351	-0.3810	-277	346	-0.3738	0.0072	0.0024
4	-273	339	-0.3672	-270	340	-0.3660	0.0012	-0.0048
6	-280	339	-0.3714	-278	341	-0.3714	0.0000	-0.0060
8	-297	357	-0.3924	-293	357	-0.3900	0.0024	-0.0060
10	-301	362	-0.3978	-302	362	-0.3984	-0.0006	-0.0084
12	-259	318	-0.3462	-263	327	-0.3540	-0.0078	-0.0078
14	-150	206	-0.2136	-155	213	-0.2208	-0.0072	0.0000
16	-63	111	-0.1044	-61	113	-0.1044	0.0000	0.0072
18	27	34	-0.0042	27	38	-0.0066	-0.0024	0.0072
20	120	-86	0.1236	120	-81	0.1206	-0.0030	0.0096
22	310	-277	0.3522	306	-274	0.3480	-0.0042	0.0126
24	513	-465	0.5868	511	-453	0.5784	-0.0084	0.0168
26	583	-532	0.6690	573	-515	0.6528	-0.0162	0.0252
28	503	-440	0.5658	496	-430	0.5556	-0.0102	0.0414
30	421	-357	0.4668	423	-358	0.4686	0.0018	0.0516
32	357	-293	0.3900	367	-299	0.3996	0.0096	0.0498
34	333	-266	0.3594	343	-273	0.3696	0.0102	0.0402
36	310	-255	0.3390	317	-255	0.3432	0.0042	0.0300
38	279	-214	0.2958	286	-218	0.3024	0.0066	0.0258
40	221	-173	0.2364	228	-175	0.2418	0.0054	0.0192
42	91	-36	0.0762	86	-27	0.0678	-0.0084	0.0138
44	-27	81	-0.0648	-23	79	-0.0612	0.0036	0.0222
46	-150	194	-0.2064	-143	189	-0.1992	0.0072	0.0186
48	-211	270	-0.2886	-206	270	-0.2856	0.0030	0.0114
50	-333	369	-0.4212	-327	363	-0.4140	0.0072	0.0084
52	-595	638	-0.7398	-587	629	-0.7296	0.0102	0.0012
54	-645	678	-0.7938	-654	684	-0.8028	-0.0090	-0.0090
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000





Stantec



Cumberland Fossil Plant
B-9
Cumberland City, TN
175539009
12/8/2009

SITE CUFTVA

INSTALLATION SI-9A

DESCRIPTION

CURRENT SURVEY 9/15/2009 11:42:31 AM

INITIAL SURVEY 8/19/2009 12:28:54 PM

DATE PRINTED 12/8/2009 11:29:49 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-229	238	-0.2802	-201	200	-0.2406	0.0396	0.0282
4	-257	267	-0.3144	-263	265	-0.3168	-0.0024	-0.0114
6	-257	266	-0.3138	-260	262	-0.3132	0.0006	-0.0090
8	-235	245	-0.2880	-240	239	-0.2874	0.0006	-0.0096
10	-310	320	-0.3780	-314	315	-0.3774	0.0006	-0.0102
12	-342	352	-0.4164	-346	347	-0.4158	0.0006	-0.0108
14	-390	400	-0.4740	-394	395	-0.4734	0.0006	-0.0114
16	-458	467	-0.5550	-462	462	-0.5544	0.0006	-0.0120
18	-533	543	-0.6456	-537	537	-0.6444	0.0012	-0.0126
20	-601	610	-0.7266	-606	605	-0.7266	0.0000	-0.0138
22	-563	571	-0.6804	-567	566	-0.6798	0.0006	-0.0138
24	-553	563	-0.6696	-557	558	-0.6690	0.0006	-0.0144
26	-567	578	-0.6870	-573	574	-0.6882	-0.0012	-0.0150
28	-591	599	-0.7140	-597	595	-0.7152	-0.0012	-0.0138
30	-661	669	-0.7980	-665	663	-0.7968	0.0012	-0.0126
32	-684	693	-0.8262	-692	693	-0.8310	-0.0048	-0.0138
34	-757	767	-0.9144	-759	761	-0.9120	0.0024	-0.0090
36	-838	846	-1.0104	-843	841	-1.0104	0.0000	-0.0114
38	-899	909	-1.0848	-905	905	-1.0860	-0.0012	-0.0114
40	-1002	1015	-1.2102	-1009	1011	-1.2120	-0.0018	-0.0102
42	-1070	1079	-1.2894	-1075	1075	-1.2900	-0.0006	-0.0084
44	-1177	1191	-1.4208	-1185	1186	-1.4226	-0.0018	-0.0078
46	-1242	1253	-1.4970	-1247	1250	-1.4982	-0.0012	-0.0060
48	-1298	1307	-1.5630	-1304	1302	-1.5636	-0.0006	-0.0048
50	-1390	1399	-1.6734	-1395	1394	-1.6734	0.0000	-0.0042
52	-1407	1418	-1.6950	-1414	1413	-1.6962	-0.0012	-0.0042
54	-1446	1458	-1.7424	-1454	1453	-1.7442	-0.0018	-0.0030
56	-1579	1591	-1.9020	-1586	1586	-1.9032	-0.0012	-0.0012
58	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-9A
DESCRIPTION

CURRENT SURVEY 10/20/2009 11:14:37 AM
INITIAL SURVEY 8/19/2009 12:28:54 PM

DATE PRINTED 12/8/2009 11:29:49 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-229	238	-0.2802	-195	205	-0.2400	0.0402	0.0210
4	-257	267	-0.3144	-258	270	-0.3168	-0.0024	-0.0192
6	-257	266	-0.3138	-257	266	-0.3138	0.0000	-0.0168
8	-235	245	-0.2880	-235	245	-0.2880	0.0000	-0.0168
10	-310	320	-0.3780	-311	321	-0.3792	-0.0012	-0.0168
12	-342	352	-0.4164	-342	353	-0.4170	-0.0006	-0.0156
14	-390	400	-0.4740	-390	401	-0.4746	-0.0006	-0.0150
16	-458	467	-0.5550	-457	469	-0.5556	-0.0006	-0.0144
18	-533	543	-0.6456	-532	544	-0.6456	0.0000	-0.0138
20	-601	610	-0.7266	-601	611	-0.7272	-0.0006	-0.0138
22	-563	571	-0.6804	-561	571	-0.6792	0.0012	-0.0132
24	-553	563	-0.6696	-553	563	-0.6696	0.0000	-0.0144
26	-567	578	-0.6870	-569	580	-0.6894	-0.0024	-0.0144
28	-591	599	-0.7140	-593	601	-0.7164	-0.0024	-0.0120
30	-661	669	-0.7980	-657	667	-0.7944	0.0036	-0.0096
32	-684	693	-0.8262	-690	701	-0.8346	-0.0084	-0.0132
34	-757	767	-0.9144	-754	765	-0.9114	0.0030	-0.0048
36	-838	846	-1.0104	-838	846	-1.0104	0.0000	-0.0078
38	-899	909	-1.0848	-900	911	-1.0866	-0.0018	-0.0078
40	-1002	1015	-1.2102	-1002	1017	-1.2114	-0.0012	-0.0060
42	-1070	1079	-1.2894	-1069	1081	-1.2900	-0.0006	-0.0048
44	-1177	1191	-1.4208	-1174	1192	-1.4196	0.0012	-0.0042
46	-1242	1253	-1.4970	-1241	1255	-1.4976	-0.0006	-0.0054
48	-1298	1307	-1.5630	-1298	1309	-1.5642	-0.0012	-0.0048
50	-1390	1399	-1.6734	-1389	1401	-1.6740	-0.0006	-0.0036
52	-1407	1418	-1.6950	-1407	1419	-1.6956	-0.0006	-0.0030
54	-1446	1458	-1.7424	-1446	1459	-1.7430	-0.0006	-0.0024
56	-1579	1591	-1.9020	-1578	1595	-1.9038	-0.0018	-0.0018
58	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-9A
DESCRIPTION

CURRENT SURVEY 11/17/2009 12:47:18 PM
INITIAL SURVEY 8/19/2009 12:28:54 PM

DATE PRINTED 12/8/2009 11:29:49 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-229	238	-0.2802	-198	204	-0.2412	0.0390	0.0294
4	-257	267	-0.3144	-259	280	-0.3234	-0.0090	-0.0096
6	-257	266	-0.3138	-258	264	-0.3132	0.0006	-0.0006
8	-235	245	-0.2880	-237	243	-0.2880	0.0000	-0.0012
10	-310	320	-0.3780	-313	320	-0.3798	-0.0018	-0.0012
12	-342	352	-0.4164	-343	351	-0.4164	0.0000	0.0006
14	-390	400	-0.4740	-391	399	-0.4740	0.0000	0.0006
16	-458	467	-0.5550	-459	466	-0.5550	0.0000	0.0006
18	-533	543	-0.6456	-534	541	-0.6450	0.0006	0.0006
20	-601	610	-0.7266	-602	609	-0.7266	0.0000	0.0000
22	-563	571	-0.6804	-562	569	-0.6786	0.0018	0.0000
24	-553	563	-0.6696	-553	561	-0.6684	0.0012	-0.0018
26	-567	578	-0.6870	-570	578	-0.6888	-0.0018	-0.0030
28	-591	599	-0.7140	-591	598	-0.7134	0.0006	-0.0012
30	-661	669	-0.7980	-657	664	-0.7926	0.0054	-0.0018
32	-684	693	-0.8262	-692	699	-0.8346	-0.0084	-0.0072
34	-757	767	-0.9144	-755	763	-0.9108	0.0036	0.0012
36	-838	846	-1.0104	-838	845	-1.0098	0.0006	-0.0024
38	-899	909	-1.0848	-901	909	-1.0860	-0.0012	-0.0030
40	-1002	1015	-1.2102	-1003	1014	-1.2102	0.0000	-0.0018
42	-1070	1079	-1.2894	-1070	1079	-1.2894	0.0000	-0.0018
44	-1177	1191	-1.4208	-1179	1190	-1.4214	-0.0006	-0.0018
46	-1242	1253	-1.4970	-1243	1253	-1.4976	-0.0006	-0.0012
48	-1298	1307	-1.5630	-1298	1309	-1.5642	-0.0012	-0.0006
50	-1390	1399	-1.6734	-1388	1398	-1.6716	0.0018	0.0006
52	-1407	1418	-1.6950	-1409	1419	-1.6968	-0.0018	-0.0012
54	-1446	1458	-1.7424	-1446	1457	-1.7418	0.0006	0.0006
56	-1579	1591	-1.9020	-1579	1591	-1.9020	0.0000	0.0000
58	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-9A

DESCRIPTION

CURRENT SURVEY 12/7/2009 12:07:11 PM

INITIAL SURVEY 8/19/2009 12:28:54 PM

DATE PRINTED 12/8/2009 11:29:49 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-229	238	-0.2802	-199	205	-0.2424	0.0378	0.0156
4	-257	267	-0.3144	-261	270	-0.3186	-0.0042	-0.0222
6	-257	266	-0.3138	-259	265	-0.3144	-0.0006	-0.0180
8	-235	245	-0.2880	-237	245	-0.2892	-0.0012	-0.0174
10	-310	320	-0.3780	-312	321	-0.3798	-0.0018	-0.0162
12	-342	352	-0.4164	-345	352	-0.4182	-0.0018	-0.0144
14	-390	400	-0.4740	-392	401	-0.4758	-0.0018	-0.0126
16	-458	467	-0.5550	-459	469	-0.5568	-0.0018	-0.0108
18	-533	543	-0.6456	-534	542	-0.6456	0.0000	-0.0090
20	-601	610	-0.7266	-602	610	-0.7272	-0.0006	-0.0090
22	-563	571	-0.6804	-562	569	-0.6786	0.0018	-0.0084
24	-553	563	-0.6696	-553	562	-0.6690	0.0006	-0.0102
26	-567	578	-0.6870	-570	579	-0.6894	-0.0024	-0.0108
28	-591	599	-0.7140	-592	599	-0.7146	-0.0006	-0.0084
30	-661	669	-0.7980	-656	665	-0.7926	0.0054	-0.0078
32	-684	693	-0.8262	-694	701	-0.8370	-0.0108	-0.0132
34	-757	767	-0.9144	-756	765	-0.9126	0.0018	-0.0024
36	-838	846	-1.0104	-841	846	-1.0122	-0.0018	-0.0042
38	-899	909	-1.0848	-900	909	-1.0854	-0.0006	-0.0024
40	-1002	1015	-1.2102	-1003	1015	-1.2108	-0.0006	-0.0018
42	-1070	1079	-1.2894	-1070	1079	-1.2894	0.0000	-0.0012
44	-1177	1191	-1.4208	-1177	1190	-1.4202	0.0006	-0.0012
46	-1242	1253	-1.4970	-1243	1254	-1.4982	-0.0012	-0.0018
48	-1298	1307	-1.5630	-1298	1307	-1.5630	0.0000	-0.0006
50	-1390	1399	-1.6734	-1389	1399	-1.6728	0.0006	-0.0006
52	-1407	1418	-1.6950	-1409	1419	-1.6968	-0.0018	-0.0012
54	-1446	1458	-1.7424	-1446	1458	-1.7424	0.0000	0.0006
56	-1579	1591	-1.9020	-1578	1591	-1.9014	0.0006	0.0006
58	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-9A
DESCRIPTION

CURRENT SURVEY 9/15/2009 11:42:31 AM
INITIAL SURVEY 8/19/2009 12:28:54 PM

DATE PRINTED 12/8/2009 11:29:59 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-298	345	-0.3858	-301	354	-0.3930	-0.0072	0.0036
4	-270	314	-0.3504	-267	320	-0.3522	-0.0018	0.0108
6	-238	285	-0.3138	-233	287	-0.3120	0.0018	0.0126
8	-211	275	-0.2916	-215	273	-0.2928	-0.0012	0.0108
10	-191	249	-0.2640	-195	247	-0.2652	-0.0012	0.0120
12	-193	250	-0.2658	-195	249	-0.2664	-0.0006	0.0132
14	-176	234	-0.2460	-176	233	-0.2454	0.0006	0.0138
16	-214	273	-0.2922	-214	271	-0.2910	0.0012	0.0132
18	-248	299	-0.3282	-247	298	-0.3270	0.0012	0.0120
20	-253	311	-0.3384	-255	310	-0.3390	-0.0006	0.0108
22	-229	286	-0.3090	-233	284	-0.3102	-0.0012	0.0114
24	-200	257	-0.2742	-202	254	-0.2736	0.0006	0.0126
26	-238	292	-0.3180	-238	291	-0.3174	0.0006	0.0120
28	-298	351	-0.3894	-298	351	-0.3894	0.0000	0.0114
30	-296	350	-0.3876	-298	350	-0.3888	-0.0012	0.0114
32	-330	383	-0.4278	-330	382	-0.4272	0.0006	0.0126
34	-366	421	-0.4722	-364	417	-0.4686	0.0036	0.0120
36	-384	438	-0.4932	-384	437	-0.4926	0.0006	0.0084
38	-399	449	-0.5088	-399	446	-0.5070	0.0018	0.0078
40	-447	494	-0.5646	-444	492	-0.5616	0.0030	0.0060
42	-509	557	-0.6396	-507	558	-0.6390	0.0006	0.0030
44	-586	630	-0.7296	-582	629	-0.7266	0.0030	0.0024
46	-665	707	-0.8232	-666	707	-0.8238	-0.0006	-0.0006
48	-739	776	-0.9090	-743	777	-0.9120	-0.0030	0.0000
50	-747	799	-0.9276	-748	795	-0.9258	0.0018	0.0030
52	-755	806	-0.9366	-753	805	-0.9348	0.0018	0.0012
54	-774	825	-0.9594	-773	825	-0.9588	0.0006	-0.0006
56	-810	850	-0.9960	-810	852	-0.9972	-0.0012	-0.0012
58	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-9A
DESCRIPTION

CURRENT SURVEY 10/20/2009 11:14:37 AM
INITIAL SURVEY 8/19/2009 12:28:54 PM

DATE PRINTED 12/8/2009 11:29:59 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-298	345	-0.3858	-300	354	-0.3924	-0.0066	0.0048
4	-270	314	-0.3504	-265	321	-0.3516	-0.0012	0.0114
6	-238	285	-0.3138	-231	292	-0.3138	0.0000	0.0126
8	-211	275	-0.2916	-211	274	-0.2910	0.0006	0.0126
10	-191	249	-0.2640	-193	249	-0.2652	-0.0012	0.0120
12	-193	250	-0.2658	-194	250	-0.2664	-0.0006	0.0132
14	-176	234	-0.2460	-174	233	-0.2442	0.0018	0.0138
16	-214	273	-0.2922	-214	270	-0.2904	0.0018	0.0120
18	-248	299	-0.3282	-246	299	-0.3270	0.0012	0.0102
20	-253	311	-0.3384	-253	311	-0.3384	0.0000	0.0090
22	-229	286	-0.3090	-230	286	-0.3096	-0.0006	0.0090
24	-200	257	-0.2742	-198	255	-0.2718	0.0024	0.0096
26	-238	292	-0.3180	-236	293	-0.3174	0.0006	0.0072
28	-298	351	-0.3894	-297	352	-0.3894	0.0000	0.0066
30	-296	350	-0.3876	-298	353	-0.3906	-0.0030	0.0066
32	-330	383	-0.4278	-329	385	-0.4284	-0.0006	0.0096
34	-366	421	-0.4722	-362	419	-0.4686	0.0036	0.0102
36	-384	438	-0.4932	-382	439	-0.4926	0.0006	0.0066
38	-399	449	-0.5088	-396	448	-0.5064	0.0024	0.0060
40	-447	494	-0.5646	-447	494	-0.5646	0.0000	0.0036
42	-509	557	-0.6396	-506	559	-0.6390	0.0006	0.0036
44	-586	630	-0.7296	-594	631	-0.7350	-0.0054	0.0030
46	-665	707	-0.8232	-662	709	-0.8226	0.0006	0.0084
48	-739	776	-0.9090	-739	778	-0.9102	-0.0012	0.0078
50	-747	799	-0.9276	-746	797	-0.9258	0.0018	0.0090
52	-755	806	-0.9366	-750	804	-0.9324	0.0042	0.0072
54	-774	825	-0.9594	-772	824	-0.9576	0.0018	0.0030
56	-810	850	-0.9960	-807	851	-0.9948	0.0012	0.0012
58	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-9A

DESCRIPTION

CURRENT SURVEY 11/17/2009 12:47:18 PM

INITIAL SURVEY 8/19/2009 12:28:54 PM

DATE PRINTED 12/8/2009 11:29:59 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-298	345	-0.3858	-299	353	-0.3912	-0.0054	0.0294
4	-270	314	-0.3504	-266	310	-0.3456	0.0048	0.0348
6	-238	285	-0.3138	-230	290	-0.3120	0.0018	0.0300
8	-211	275	-0.2916	-211	275	-0.2916	0.0000	0.0282
10	-191	249	-0.2640	-192	253	-0.2670	-0.0030	0.0282
12	-193	250	-0.2658	-191	251	-0.2652	0.0006	0.0312
14	-176	234	-0.2460	-172	234	-0.2436	0.0024	0.0306
16	-214	273	-0.2922	-212	272	-0.2904	0.0018	0.0282
18	-248	299	-0.3282	-244	301	-0.3270	0.0012	0.0264
20	-253	311	-0.3384	-253	312	-0.3390	-0.0006	0.0252
22	-229	286	-0.3090	-230	288	-0.3108	-0.0018	0.0258
24	-200	257	-0.2742	-195	258	-0.2718	0.0024	0.0276
26	-238	292	-0.3180	-233	294	-0.3162	0.0018	0.0252
28	-298	351	-0.3894	-294	353	-0.3882	0.0012	0.0234
30	-296	350	-0.3876	-297	352	-0.3894	-0.0018	0.0222
32	-330	383	-0.4278	-325	385	-0.4260	0.0018	0.0240
34	-366	421	-0.4722	-358	417	-0.4650	0.0072	0.0222
36	-384	438	-0.4932	-378	438	-0.4896	0.0036	0.0150
38	-399	449	-0.5088	-397	449	-0.5076	0.0012	0.0114
40	-447	494	-0.5646	-446	493	-0.5634	0.0012	0.0102
42	-509	557	-0.6396	-506	558	-0.6384	0.0012	0.0090
44	-586	630	-0.7296	-576	630	-0.7236	0.0060	0.0078
46	-665	707	-0.8232	-659	711	-0.8220	0.0012	0.0018
48	-739	776	-0.9090	-737	777	-0.9084	0.0006	0.0006
50	-747	799	-0.9276	-747	801	-0.9288	-0.0012	0.0000
52	-755	806	-0.9366	-748	806	-0.9324	0.0042	0.0012
54	-774	825	-0.9594	-771	829	-0.9600	-0.0006	-0.0030
56	-810	850	-0.9960	-811	853	-0.9984	-0.0024	-0.0024
58	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-9A

DESCRIPTION

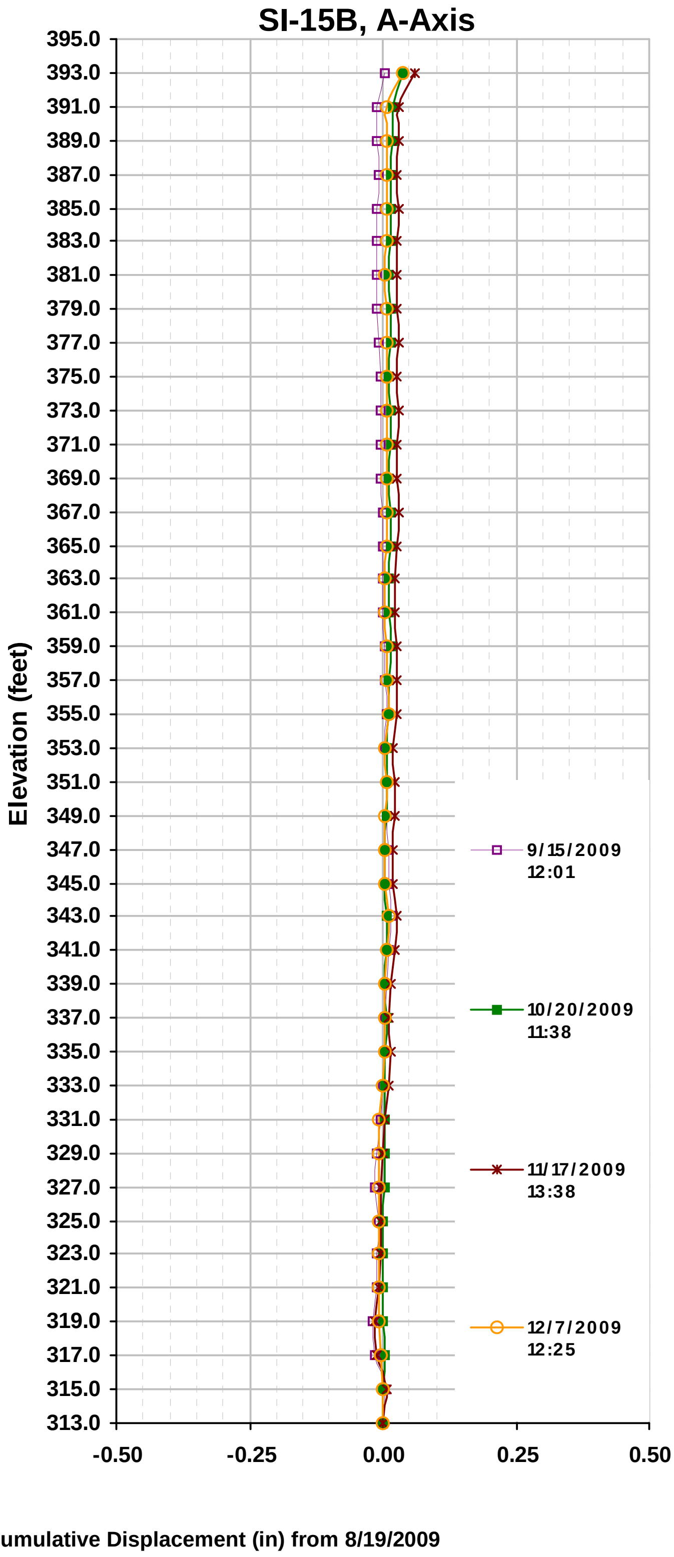
CURRENT SURVEY 12/7/2009 12:07:11 PM

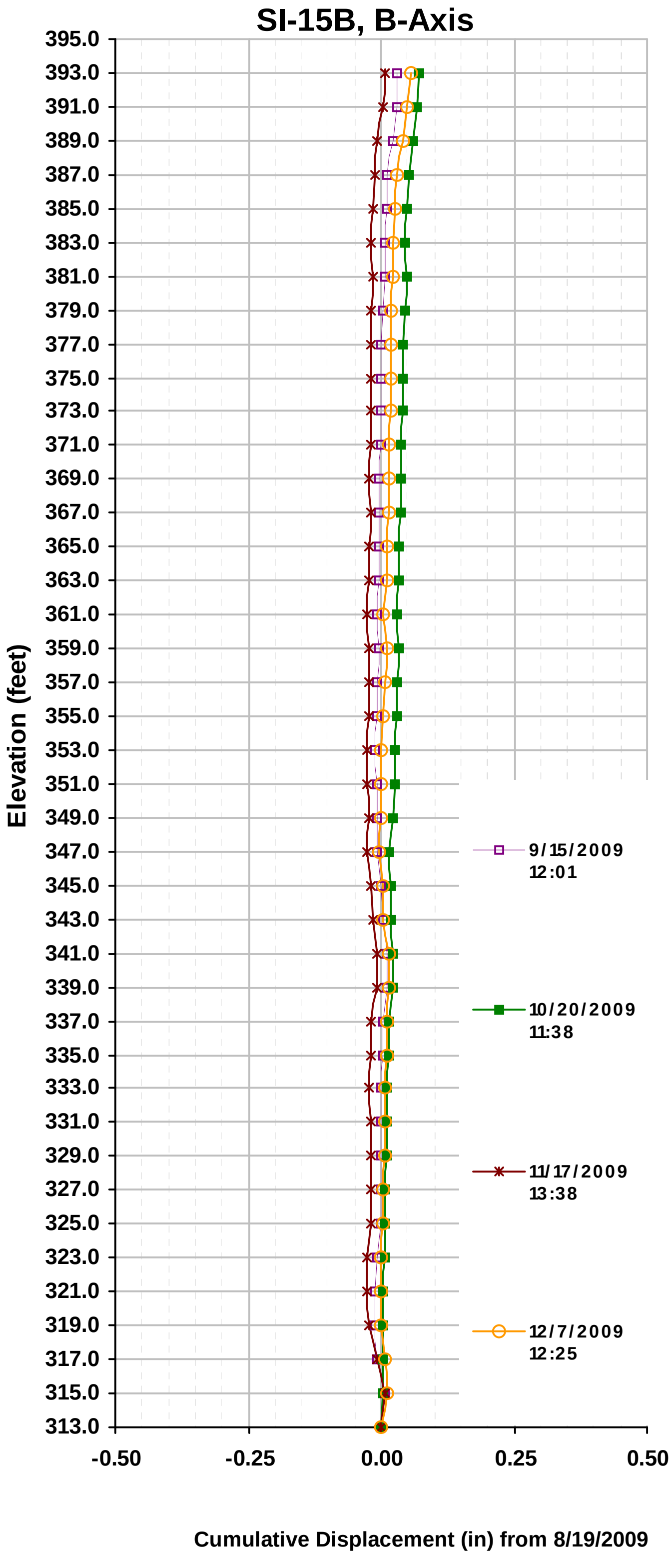
INITIAL SURVEY 8/19/2009 12:28:54 PM

DATE PRINTED 12/8/2009 11:29:59 AM

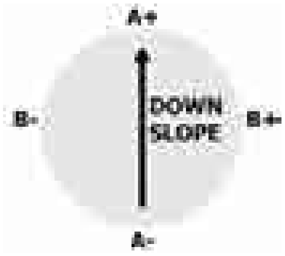
Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-298	345	-0.3858	-299	355	-0.3924	-0.0066	-0.0060
4	-270	314	-0.3504	-266	323	-0.3534	-0.0030	0.0006
6	-238	285	-0.3138	-230	291	-0.3126	0.0012	0.0036
8	-211	275	-0.2916	-211	276	-0.2922	-0.0006	0.0024
10	-191	249	-0.2640	-191	251	-0.2652	-0.0012	0.0030
12	-193	250	-0.2658	-194	253	-0.2682	-0.0024	0.0042
14	-176	234	-0.2460	-174	235	-0.2454	0.0006	0.0066
16	-214	273	-0.2922	-211	266	-0.2862	0.0060	0.0060
18	-248	299	-0.3282	-244	302	-0.3276	0.0006	0.0000
20	-253	311	-0.3384	-253	315	-0.3408	-0.0024	-0.0006
22	-229	286	-0.3090	-229	288	-0.3102	-0.0012	0.0018
24	-200	257	-0.2742	-196	258	-0.2724	0.0018	0.0030
26	-238	292	-0.3180	-233	295	-0.3168	0.0012	0.0012
28	-298	351	-0.3894	-294	354	-0.3888	0.0006	0.0000
30	-296	350	-0.3876	-297	355	-0.3912	-0.0036	-0.0006
32	-330	383	-0.4278	-327	386	-0.4278	0.0000	0.0030
34	-366	421	-0.4722	-359	419	-0.4668	0.0054	0.0030
36	-384	438	-0.4932	-378	438	-0.4896	0.0036	-0.0024
38	-399	449	-0.5088	-394	449	-0.5058	0.0030	-0.0060
40	-447	494	-0.5646	-441	494	-0.5610	0.0036	-0.0090
42	-509	557	-0.6396	-512	559	-0.6426	-0.0030	-0.0126
44	-586	630	-0.7296	-593	629	-0.7332	-0.0036	-0.0096
46	-665	707	-0.8232	-656	709	-0.8190	0.0042	-0.0060
48	-739	776	-0.9090	-738	779	-0.9102	-0.0012	-0.0102
50	-747	799	-0.9276	-745	798	-0.9258	0.0018	-0.0090
52	-755	806	-0.9366	-754	805	-0.9354	0.0012	-0.0108
54	-774	825	-0.9594	-775	826	-0.9606	-0.0012	-0.0120
56	-810	850	-0.9960	-821	857	-1.0068	-0.0108	-0.0108
58	0	0	0.0000	0	0	0.0000	0.0000	0.0000





Stantec



Cumberland Fossil Plant
B-15
Cumberland City, TN
175539009
12/8/2009

SITE CUFTVA
INSTALLATION SI-15B
DESCRIPTION

CURRENT SURVEY 9/15/2009 12:01:05 PM
INITIAL SURVEY 8/19/2009 12:56:14 PM

DATE PRINTED 12/8/2009 10:57:44 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-262	272	-0.3204	-251	258	-0.3054	0.0150	0.0054
4	-236	245	-0.2886	-238	243	-0.2886	0.0000	-0.0096
6	-223	237	-0.2760	-227	235	-0.2772	-0.0012	-0.0096
8	-237	246	-0.2898	-238	243	-0.2886	0.0012	-0.0084
10	-265	274	-0.3234	-266	272	-0.3228	0.0006	-0.0096
12	-287	298	-0.3510	-289	295	-0.3504	0.0006	-0.0102
14	-315	325	-0.3840	-318	324	-0.3852	-0.0012	-0.0108
16	-281	293	-0.3444	-284	293	-0.3462	-0.0018	-0.0096
18	-151	160	-0.1866	-154	161	-0.1890	-0.0024	-0.0078
20	-41	51	-0.0552	-43	50	-0.0558	-0.0006	-0.0054
22	66	-57	0.0738	63	-57	0.0720	-0.0018	-0.0048
24	166	-158	0.1944	164	-159	0.1938	-0.0006	-0.0030
26	219	-209	0.2568	216	-209	0.2550	-0.0018	-0.0024
28	264	-255	0.3114	261	-255	0.3096	-0.0018	-0.0006
30	336	-326	0.3972	336	-329	0.3990	0.0018	0.0012
32	387	-377	0.4584	383	-378	0.4566	-0.0018	-0.0006
34	451	-443	0.5364	447	-442	0.5334	-0.0030	0.0012
36	565	-554	0.6714	562	-555	0.6702	-0.0012	0.0042
38	629	-619	0.7488	626	-621	0.7482	-0.0006	0.0054
40	681	-673	0.8124	681	-675	0.8136	0.0012	0.0060
42	763	-755	0.9108	758	-755	0.9078	-0.0030	0.0048
44	854	-847	1.0206	851	-848	1.0194	-0.0012	0.0078
46	960	-950	1.1460	957	-951	1.1448	-0.0012	0.0090
48	1074	-1064	1.2828	1071	-1064	1.2810	-0.0018	0.0102
50	1173	-1163	1.4016	1169	-1164	1.3998	-0.0018	0.0120
52	1159	-1147	1.3836	1161	-1151	1.3872	0.0036	0.0138
54	1025	-1015	1.2240	1025	-1020	1.2270	0.0030	0.0102
56	786	-773	0.9354	787	-780	0.9402	0.0048	0.0072
58	714	-705	0.8514	711	-703	0.8484	-0.0030	0.0024
60	820	-809	0.9774	822	-813	0.9810	0.0036	0.0054
62	470	-459	0.5574	472	-467	0.5634	0.0060	0.0018
64	183	-170	0.2118	186	-176	0.2172	0.0054	-0.0042
66	-110	123	-0.1398	-109	118	-0.1362	0.0036	-0.0096
68	-33	44	-0.0462	-38	47	-0.0510	-0.0048	-0.0132
70	-39	39	-0.0468	-40	35	-0.0450	0.0018	-0.0084
72	-134	141	-0.1650	-134	137	-0.1626	0.0024	-0.0102
74	-494	506	-0.6000	-490	499	-0.5934	0.0066	-0.0126
76	-818	822	-0.9840	-821	824	-0.9870	-0.0030	-0.0192
78	-92	97	-0.1134	-109	112	-0.1326	-0.0192	-0.0162

SITE	CUFTVA
INSTALLATION	SI-15B
DESCRIPTION	

CURRENT SURVEY	9/15/2009	12:01:05 PM
INITIAL SURVEY	8/19/2009	12:56:14 PM
DATE PRINTED	12/8/2009	10:57:44 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	366	-353	0.4314	365	-359	0.4344	0.0030	0.0030
82	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-15B

DESCRIPTION

CURRENT SURVEY 10/20/2009 11:38:20 AM

INITIAL SURVEY 8/19/2009 12:56:14 PM

DATE PRINTED 12/8/2009 10:57:44 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-262	272	-0.3204	-247	259	-0.3036	0.0168	0.0360
4	-236	245	-0.2886	-234	246	-0.2880	0.0006	0.0192
6	-223	237	-0.2760	-223	231	-0.2724	0.0036	0.0186
8	-237	246	-0.2898	-235	248	-0.2898	0.0000	0.0150
10	-265	274	-0.3234	-263	275	-0.3228	0.0006	0.0150
12	-287	298	-0.3510	-285	297	-0.3492	0.0018	0.0144
14	-315	325	-0.3840	-314	327	-0.3846	-0.0006	0.0126
16	-281	293	-0.3444	-280	295	-0.3450	-0.0006	0.0132
18	-151	160	-0.1866	-148	161	-0.1854	0.0012	0.0138
20	-41	51	-0.0552	-40	53	-0.0558	-0.0006	0.0126
22	66	-57	0.0738	68	-55	0.0738	0.0000	0.0132
24	166	-158	0.1944	169	-156	0.1950	0.0006	0.0132
26	219	-209	0.2568	220	-206	0.2556	-0.0012	0.0126
28	264	-255	0.3114	266	-253	0.3114	0.0000	0.0138
30	336	-326	0.3972	340	-327	0.4002	0.0030	0.0138
32	387	-377	0.4584	389	-376	0.4590	0.0006	0.0108
34	451	-443	0.5364	449	-439	0.5328	-0.0036	0.0102
36	565	-554	0.6714	567	-554	0.6726	0.0012	0.0138
38	629	-619	0.7488	629	-619	0.7488	0.0000	0.0126
40	681	-673	0.8124	689	-676	0.8190	0.0066	0.0126
42	763	-755	0.9108	762	-751	0.9078	-0.0030	0.0060
44	854	-847	1.0206	857	-846	1.0218	0.0012	0.0090
46	960	-950	1.1460	963	-951	1.1484	0.0024	0.0078
48	1074	-1064	1.2828	1076	-1063	1.2834	0.0006	0.0054
50	1173	-1163	1.4016	1172	-1159	1.3986	-0.0030	0.0048
52	1159	-1147	1.3836	1161	-1147	1.3848	0.0012	0.0078
54	1025	-1015	1.2240	1027	-1015	1.2252	0.0012	0.0066
56	786	-773	0.9354	787	-771	0.9348	-0.0006	0.0054
58	714	-705	0.8514	717	-705	0.8532	0.0018	0.0060
60	820	-809	0.9774	821	-807	0.9768	-0.0006	0.0042
62	470	-459	0.5574	471	-459	0.5580	0.0006	0.0048
64	183	-170	0.2118	186	-168	0.2124	0.0006	0.0042
66	-110	123	-0.1398	-109	124	-0.1398	0.0000	0.0036
68	-33	44	-0.0462	-29	43	-0.0432	0.0030	0.0036
70	-39	39	-0.0468	-38	41	-0.0474	-0.0006	0.0006
72	-134	141	-0.1650	-131	142	-0.1638	0.0012	0.0012
74	-494	506	-0.6000	-495	506	-0.6006	-0.0006	0.0000
76	-818	822	-0.9840	-818	826	-0.9864	-0.0024	0.0006
78	-92	97	-0.1134	-85	99	-0.1104	0.0030	0.0030

SITE	CUFTVA
INSTALLATION	SI-15B
DESCRIPTION	

CURRENT SURVEY	10/20/2009	11:38:20 AM
INITIAL SURVEY	8/19/2009	12:56:14 PM
DATE PRINTED	12/8/2009	10:57:45 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	366	-353	0.4314	367	-352	0.4314	0.0000	0.0000
82	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-15B
DESCRIPTION

CURRENT SURVEY 11/17/2009 1:38:06 PM
INITIAL SURVEY 8/19/2009 12:56:14 PM

DATE PRINTED 12/8/2009 10:57:45 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-262	272	-0.3204	-235	248	-0.2898	0.0306	0.0600
4	-236	245	-0.2886	-235	246	-0.2886	0.0000	0.0294
6	-223	237	-0.2760	-222	235	-0.2742	0.0018	0.0294
8	-237	246	-0.2898	-237	247	-0.2904	-0.0006	0.0276
10	-265	274	-0.3234	-263	275	-0.3228	0.0006	0.0282
12	-287	298	-0.3510	-285	297	-0.3492	0.0018	0.0276
14	-315	325	-0.3840	-315	327	-0.3852	-0.0012	0.0258
16	-281	293	-0.3444	-281	295	-0.3456	-0.0012	0.0270
18	-151	160	-0.1866	-149	161	-0.1860	0.0006	0.0282
20	-41	51	-0.0552	-40	53	-0.0558	-0.0006	0.0276
22	66	-57	0.0738	67	-57	0.0744	0.0006	0.0282
24	166	-158	0.1944	168	-157	0.1950	0.0006	0.0276
26	219	-209	0.2568	219	-207	0.2556	-0.0012	0.0270
28	264	-255	0.3114	266	-254	0.3120	0.0006	0.0282
30	336	-326	0.3972	340	-328	0.4008	0.0036	0.0276
32	387	-377	0.4584	389	-378	0.4602	0.0018	0.0240
34	451	-443	0.5364	448	-437	0.5310	-0.0054	0.0222
36	565	-554	0.6714	567	-554	0.6726	0.0012	0.0276
38	629	-619	0.7488	630	-619	0.7494	0.0006	0.0264
40	681	-673	0.8124	689	-678	0.8202	0.0078	0.0258
42	763	-755	0.9108	761	-749	0.9060	-0.0048	0.0180
44	854	-847	1.0206	856	-846	1.0212	0.0006	0.0228
46	960	-950	1.1460	963	-951	1.1484	0.0024	0.0222
48	1074	-1064	1.2828	1075	-1063	1.2828	0.0000	0.0198
50	1173	-1163	1.4016	1170	-1158	1.3968	-0.0048	0.0198
52	1159	-1147	1.3836	1162	-1149	1.3866	0.0030	0.0246
54	1025	-1015	1.2240	1030	-1020	1.2300	0.0060	0.0216
56	786	-773	0.9354	791	-775	0.9396	0.0042	0.0156
58	714	-705	0.8514	714	-699	0.8478	-0.0036	0.0114
60	820	-809	0.9774	825	-812	0.9822	0.0048	0.0150
62	470	-459	0.5574	474	-466	0.5640	0.0066	0.0102
64	183	-170	0.2118	186	-171	0.2142	0.0024	0.0036
66	-110	123	-0.1398	-106	119	-0.1350	0.0048	0.0012
68	-33	44	-0.0462	-31	47	-0.0468	-0.0006	-0.0036
70	-39	39	-0.0468	-37	38	-0.0450	0.0018	-0.0030
72	-134	141	-0.1650	-130	141	-0.1626	0.0024	-0.0048
74	-494	506	-0.6000	-492	498	-0.5940	0.0060	-0.0072
76	-818	822	-0.9840	-818	826	-0.9864	-0.0024	-0.0132
78	-92	97	-0.1134	-110	107	-0.1302	-0.0168	-0.0108

SITE	CUFTVA
INSTALLATION	SI-15B
DESCRIPTION	

CURRENT SURVEY	11/17/2009	1:38:06 PM
INITIAL SURVEY	8/19/2009	12:56:14 PM
DATE PRINTED	12/8/2009	10:57:45 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	366	-353	0.4314	371	-358	0.4374	0.0060	0.0060
82	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE	CUFTVA	
INSTALLATION	SI-15B	
DESCRIPTION		
CURRENT SURVEY	12/7/2009	12:25:39 PM
INITIAL SURVEY	8/19/2009	12:56:14 PM
DATE PRINTED	12/8/2009	10:57:45 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-262	272	-0.3204	-238	250	-0.2928	0.0276	0.0366
4	-236	245	-0.2886	-234	245	-0.2874	0.0012	0.0090
6	-223	237	-0.2760	-223	237	-0.2760	0.0000	0.0078
8	-237	246	-0.2898	-237	247	-0.2904	-0.0006	0.0078
10	-265	274	-0.3234	-262	274	-0.3216	0.0018	0.0084
12	-287	298	-0.3510	-285	298	-0.3498	0.0012	0.0066
14	-315	325	-0.3840	-315	327	-0.3852	-0.0012	0.0054
16	-281	293	-0.3444	-281	296	-0.3462	-0.0018	0.0066
18	-151	160	-0.1866	-149	161	-0.1860	0.0006	0.0084
20	-41	51	-0.0552	-40	53	-0.0558	-0.0006	0.0078
22	66	-57	0.0738	67	-58	0.0750	0.0012	0.0084
24	166	-158	0.1944	168	-157	0.1950	0.0006	0.0072
26	219	-209	0.2568	219	-205	0.2544	-0.0024	0.0066
28	264	-255	0.3114	266	-254	0.3120	0.0006	0.0090
30	336	-326	0.3972	341	-328	0.4014	0.0042	0.0084
32	387	-377	0.4584	389	-377	0.4596	0.0012	0.0042
34	451	-443	0.5364	447	-437	0.5304	-0.0060	0.0030
36	565	-554	0.6714	566	-554	0.6720	0.0006	0.0090
38	629	-619	0.7488	629	-617	0.7476	-0.0012	0.0084
40	681	-673	0.8124	689	-677	0.8196	0.0072	0.0096
42	763	-755	0.9108	761	-750	0.9066	-0.0042	0.0024
44	854	-847	1.0206	857	-846	1.0218	0.0012	0.0066
46	960	-950	1.1460	965	-950	1.1490	0.0030	0.0054
48	1074	-1064	1.2828	1073	-1062	1.2810	-0.0018	0.0024
50	1173	-1163	1.4016	1168	-1157	1.3950	-0.0066	0.0042
52	1159	-1147	1.3836	1161	-1149	1.3860	0.0024	0.0108
54	1025	-1015	1.2240	1029	-1017	1.2276	0.0036	0.0084
56	786	-773	0.9354	789	-774	0.9378	0.0024	0.0048
58	714	-705	0.8514	714	-702	0.8496	-0.0018	0.0024
60	820	-809	0.9774	824	-811	0.9810	0.0036	0.0042
62	470	-459	0.5574	475	-465	0.5640	0.0066	0.0006
64	183	-170	0.2118	186	-170	0.2136	0.0018	-0.0060
66	-110	123	-0.1398	-113	122	-0.1410	-0.0012	-0.0078
68	-33	44	-0.0462	-30	46	-0.0456	0.0006	-0.0066
70	-39	39	-0.0468	-39	40	-0.0474	-0.0006	-0.0072
72	-134	141	-0.1650	-131	140	-0.1626	0.0024	-0.0066
74	-494	506	-0.6000	-495	506	-0.6006	-0.0006	-0.0090
76	-818	822	-0.9840	-818	828	-0.9876	-0.0036	-0.0084
78	-92	97	-0.1134	-90	106	-0.1176	-0.0042	-0.0048

SITE	CUFTVA
INSTALLATION	SI-15B
DESCRIPTION	

CURRENT SURVEY	12/7/2009	12:25:39 PM
INITIAL SURVEY	8/19/2009	12:56:14 PM
DATE PRINTED	12/8/2009	10:57:45 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	366	-353	0.4314	366	-352	0.4308	-0.0006	-0.0006
82	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-15B

DESCRIPTION

CURRENT SURVEY 9/15/2009 12:01:05 PM

INITIAL SURVEY 8/19/2009 12:56:14 PM

DATE PRINTED 12/8/2009 10:57:53 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-105	158	-0.1578	-103	156	-0.1554	0.0024	0.0306
4	-86	136	-0.1332	-77	135	-0.1272	0.0060	0.0282
6	-61	107	-0.1008	-46	105	-0.0906	0.0102	0.0222
8	-34	88	-0.0732	-30	89	-0.0714	0.0018	0.0120
10	-47	106	-0.0918	-45	104	-0.0894	0.0024	0.0102
12	-66	117	-0.1098	-67	115	-0.1092	0.0006	0.0078
14	-101	162	-0.1578	-99	157	-0.1536	0.0042	0.0072
16	-171	231	-0.2412	-171	229	-0.2400	0.0012	0.0030
18	-185	248	-0.2598	-185	247	-0.2592	0.0006	0.0018
20	-213	274	-0.2922	-211	272	-0.2898	0.0024	0.0012
22	-236	293	-0.3174	-237	293	-0.3180	-0.0006	-0.0012
24	-268	331	-0.3594	-267	329	-0.3576	0.0018	-0.0006
26	-329	389	-0.4308	-328	387	-0.4290	0.0018	-0.0024
28	-359	422	-0.4686	-359	421	-0.4680	0.0006	-0.0042
30	-387	449	-0.5016	-387	448	-0.5010	0.0006	-0.0048
32	-399	454	-0.5118	-398	452	-0.5100	0.0018	-0.0054
34	-401	462	-0.5178	-403	463	-0.5196	-0.0018	-0.0072
36	-368	429	-0.4782	-367	427	-0.4764	0.0018	-0.0054
38	-350	410	-0.4560	-348	409	-0.4542	0.0018	-0.0072
40	-386	446	-0.4992	-385	443	-0.4968	0.0024	-0.0090
42	-372	417	-0.4734	-375	418	-0.4758	-0.0024	-0.0114
44	-293	353	-0.3876	-293	353	-0.3876	0.0000	-0.0090
46	-230	275	-0.3030	-230	275	-0.3030	0.0000	-0.0090
48	-95	134	-0.1374	-103	139	-0.1452	-0.0078	-0.0090
50	57	-10	0.0402	54	-6	0.0360	-0.0042	-0.0012
52	147	-120	0.1602	143	-111	0.1524	-0.0078	0.0030
54	86	-61	0.0882	85	-60	0.0870	-0.0012	0.0108
56	-117	153	-0.1620	-108	149	-0.1542	0.0078	0.0120
58	-243	299	-0.3252	-244	296	-0.3240	0.0012	0.0042
60	-324	367	-0.4146	-318	367	-0.4110	0.0036	0.0030
62	-439	483	-0.5532	-439	485	-0.5544	-0.0012	-0.0006
64	-417	481	-0.5388	-418	480	-0.5388	0.0000	0.0006
66	-471	533	-0.6024	-472	530	-0.6012	0.0012	0.0006
68	-453	487	-0.5640	-453	487	-0.5640	0.0000	-0.0006
70	-771	791	-0.9372	-766	784	-0.9300	0.0072	-0.0006
72	-973	1004	-1.1862	-971	1002	-1.1838	0.0024	-0.0078
74	-1161	1209	-1.4220	-1160	1209	-1.4214	0.0006	-0.0102
76	-1022	1052	-1.2444	-1023	1057	-1.2480	-0.0036	-0.0108
78	-306	318	-0.3744	-317	329	-0.3876	-0.0132	-0.0072

SITE CUFTVA

INSTALLATION SI-15B

DESCRIPTION

CURRENT SURVEY 9/15/2009 12:01:05 PM

INITIAL SURVEY 8/19/2009 12:56:14 PM

DATE PRINTED 12/8/2009 10:57:54 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-157	189	-0.2076	-154	182	-0.2016	0.0060	0.0060
82	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-15B

DESCRIPTION

CURRENT SURVEY 10/20/2009 11:38:20 AM

INITIAL SURVEY 8/19/2009 12:56:14 PM

DATE PRINTED 12/8/2009 10:57:54 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-105	158	-0.1578	-100	157	-0.1542	0.0036	0.0720
4	-86	136	-0.1332	-73	135	-0.1248	0.0084	0.0684
6	-61	107	-0.1008	-48	110	-0.0948	0.0060	0.0600
8	-34	88	-0.0732	-27	88	-0.0690	0.0042	0.0540
10	-47	106	-0.0918	-41	105	-0.0876	0.0042	0.0498
12	-66	117	-0.1098	-69	118	-0.1122	-0.0024	0.0456
14	-101	162	-0.1578	-99	159	-0.1548	0.0030	0.0480
16	-171	231	-0.2412	-169	230	-0.2394	0.0018	0.0450
18	-185	248	-0.2598	-182	247	-0.2574	0.0024	0.0432
20	-213	274	-0.2922	-210	275	-0.2910	0.0012	0.0408
22	-236	293	-0.3174	-233	295	-0.3168	0.0006	0.0396
24	-268	331	-0.3594	-267	332	-0.3594	0.0000	0.0390
26	-329	389	-0.4308	-327	389	-0.4296	0.0012	0.0390
28	-359	422	-0.4686	-355	421	-0.4656	0.0030	0.0378
30	-387	449	-0.5016	-386	450	-0.5016	0.0000	0.0348
32	-399	454	-0.5118	-394	454	-0.5088	0.0030	0.0348
34	-401	462	-0.5178	-402	465	-0.5202	-0.0024	0.0318
36	-368	429	-0.4782	-364	428	-0.4752	0.0030	0.0342
38	-350	410	-0.4560	-346	410	-0.4536	0.0024	0.0312
40	-386	446	-0.4992	-382	444	-0.4956	0.0036	0.0288
42	-372	417	-0.4734	-370	418	-0.4728	0.0006	0.0252
44	-293	353	-0.3876	-290	351	-0.3846	0.0030	0.0246
46	-230	275	-0.3030	-225	267	-0.2952	0.0078	0.0216
48	-95	134	-0.1374	-98	137	-0.1410	-0.0036	0.0138
50	57	-10	0.0402	57	-10	0.0402	0.0000	0.0174
52	147	-120	0.1602	150	-110	0.1560	-0.0042	0.0174
54	86	-61	0.0882	91	-57	0.0888	0.0006	0.0216
56	-117	153	-0.1620	-107	154	-0.1566	0.0054	0.0210
58	-243	299	-0.3252	-240	298	-0.3228	0.0024	0.0156
60	-324	367	-0.4146	-320	369	-0.4134	0.0012	0.0132
62	-439	483	-0.5532	-438	485	-0.5538	-0.0006	0.0120
64	-417	481	-0.5388	-415	481	-0.5376	0.0012	0.0126
66	-471	533	-0.6024	-470	530	-0.6000	0.0024	0.0114
68	-453	487	-0.5640	-451	487	-0.5628	0.0012	0.0090
70	-771	791	-0.9372	-769	791	-0.9360	0.0012	0.0078
72	-973	1004	-1.1862	-971	1003	-1.1844	0.0018	0.0066
74	-1161	1209	-1.4220	-1159	1210	-1.4214	0.0006	0.0048
76	-1022	1052	-1.2444	-1019	1053	-1.2432	0.0012	0.0042
78	-306	318	-0.3744	-308	318	-0.3756	-0.0012	0.0030

SITE CUFTVA

INSTALLATION SI-15B

DESCRIPTION

CURRENT SURVEY 10/20/2009 11:38:20 AM

INITIAL SURVEY 8/19/2009 12:56:14 PM

DATE PRINTED 12/8/2009 10:57:54 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-157	189	-0.2076	-156	183	-0.2034	0.0042	0.0042
82	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-15B

DESCRIPTION

CURRENT SURVEY 11/17/2009 1:38:06 PM

INITIAL SURVEY 8/19/2009 12:56:14 PM

DATE PRINTED 12/8/2009 10:57:54 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-105	158	-0.1578	-99	159	-0.1548	0.0030	0.0060
4	-86	136	-0.1332	-69	136	-0.1230	0.0102	0.0030
6	-61	107	-0.1008	-47	114	-0.0966	0.0042	-0.0072
8	-34	88	-0.0732	-23	91	-0.0684	0.0048	-0.0114
10	-47	106	-0.0918	-39	108	-0.0882	0.0036	-0.0162
12	-66	117	-0.1098	-66	122	-0.1128	-0.0030	-0.0198
14	-101	162	-0.1578	-98	161	-0.1554	0.0024	-0.0168
16	-171	231	-0.2412	-169	234	-0.2418	-0.0006	-0.0192
18	-185	248	-0.2598	-181	250	-0.2586	0.0012	-0.0186
20	-213	274	-0.2922	-209	278	-0.2922	0.0000	-0.0198
22	-236	293	-0.3174	-232	296	-0.3168	0.0006	-0.0198
24	-268	331	-0.3594	-266	332	-0.3588	0.0006	-0.0204
26	-329	389	-0.4308	-327	392	-0.4314	-0.0006	-0.0210
28	-359	422	-0.4686	-355	422	-0.4662	0.0024	-0.0204
30	-387	449	-0.5016	-383	452	-0.5010	0.0006	-0.0228
32	-399	454	-0.5118	-394	455	-0.5094	0.0024	-0.0234
34	-401	462	-0.5178	-401	469	-0.5220	-0.0042	-0.0258
36	-368	429	-0.4782	-365	430	-0.4770	0.0012	-0.0216
38	-350	410	-0.4560	-347	413	-0.4560	0.0000	-0.0228
40	-386	446	-0.4992	-383	445	-0.4968	0.0024	-0.0228
42	-372	417	-0.4734	-369	421	-0.4740	-0.0006	-0.0252
44	-293	353	-0.3876	-290	357	-0.3882	-0.0006	-0.0246
46	-230	275	-0.3030	-224	277	-0.3006	0.0024	-0.0240
48	-95	134	-0.1374	-99	143	-0.1452	-0.0078	-0.0264
50	57	-10	0.0402	58	-3	0.0366	-0.0036	-0.0186
52	147	-120	0.1602	148	-105	0.1518	-0.0084	-0.0150
54	86	-61	0.0882	93	-58	0.0906	0.0024	-0.0066
56	-117	153	-0.1620	-104	150	-0.1524	0.0096	-0.0090
58	-243	299	-0.3252	-239	301	-0.3240	0.0012	-0.0186
60	-324	367	-0.4146	-319	370	-0.4134	0.0012	-0.0198
62	-439	483	-0.5532	-437	488	-0.5550	-0.0018	-0.0210
64	-417	481	-0.5388	-416	482	-0.5388	0.0000	-0.0192
66	-471	533	-0.6024	-470	535	-0.6030	-0.0006	-0.0192
68	-453	487	-0.5640	-449	489	-0.5628	0.0012	-0.0186
70	-771	791	-0.9372	-765	788	-0.9318	0.0054	-0.0198
72	-973	1004	-1.1862	-970	1008	-1.1868	-0.0006	-0.0252
74	-1161	1209	-1.4220	-1159	1212	-1.4226	-0.0006	-0.0246
76	-1022	1052	-1.2444	-1039	1065	-1.2624	-0.0180	-0.0240
78	-306	318	-0.3744	-318	328	-0.3876	-0.0132	-0.0060

SITE	CUFTVA
INSTALLATION	SI-15B
DESCRIPTION	

CURRENT SURVEY	11/17/2009	1:38:06 PM
INITIAL SURVEY	8/19/2009	12:56:14 PM
DATE PRINTED	12/8/2009	10:57:54 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-157	189	-0.2076	-149	185	-0.2004	0.0072	0.0072
82	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-15B

DESCRIPTION

CURRENT SURVEY 12/7/2009 12:25:39 PM

INITIAL SURVEY 8/19/2009 12:56:14 PM

DATE PRINTED 12/8/2009 10:57:54 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-105	158	-0.1578	-96	156	-0.1512	0.0066	0.0546
4	-86	136	-0.1332	-71	138	-0.1254	0.0078	0.0480
6	-61	107	-0.1008	-44	109	-0.0918	0.0090	0.0402
8	-34	88	-0.0732	-23	91	-0.0684	0.0048	0.0312
10	-47	106	-0.0918	-38	109	-0.0882	0.0036	0.0264
12	-66	117	-0.1098	-63	121	-0.1104	-0.0006	0.0228
14	-101	162	-0.1578	-97	160	-0.1542	0.0036	0.0234
16	-171	231	-0.2412	-167	234	-0.2406	0.0006	0.0198
18	-185	248	-0.2598	-180	251	-0.2586	0.0012	0.0192
20	-213	274	-0.2922	-209	279	-0.2928	-0.0006	0.0180
22	-236	293	-0.3174	-231	295	-0.3156	0.0018	0.0186
24	-268	331	-0.3594	-265	329	-0.3564	0.0030	0.0168
26	-329	389	-0.4308	-327	393	-0.4320	-0.0012	0.0138
28	-359	422	-0.4686	-352	422	-0.4644	0.0042	0.0150
30	-387	449	-0.5016	-383	451	-0.5004	0.0012	0.0108
32	-399	454	-0.5118	-392	454	-0.5076	0.0042	0.0096
34	-401	462	-0.5178	-401	469	-0.5220	-0.0042	0.0054
36	-368	429	-0.4782	-363	429	-0.4752	0.0030	0.0096
38	-350	410	-0.4560	-345	411	-0.4536	0.0024	0.0066
40	-386	446	-0.4992	-381	446	-0.4962	0.0030	0.0042
42	-372	417	-0.4734	-366	418	-0.4704	0.0030	0.0012
44	-293	353	-0.3876	-291	357	-0.3888	-0.0012	-0.0018
46	-230	275	-0.3030	-226	274	-0.3000	0.0030	-0.0006
48	-95	134	-0.1374	-103	141	-0.1464	-0.0090	-0.0036
50	57	-10	0.0402	62	-6	0.0408	0.0006	0.0054
52	147	-120	0.1602	146	-106	0.1512	-0.0090	0.0048
54	86	-61	0.0882	89	-56	0.0870	-0.0012	0.0138
56	-117	153	-0.1620	-109	157	-0.1596	0.0024	0.0150
58	-243	299	-0.3252	-238	301	-0.3234	0.0018	0.0126
60	-324	367	-0.4146	-318	369	-0.4122	0.0024	0.0108
62	-439	483	-0.5532	-435	488	-0.5538	-0.0006	0.0084
64	-417	481	-0.5388	-414	482	-0.5376	0.0012	0.0090
66	-471	533	-0.6024	-466	534	-0.6000	0.0024	0.0078
68	-453	487	-0.5640	-450	489	-0.5634	0.0006	0.0054
70	-771	791	-0.9372	-767	790	-0.9342	0.0030	0.0048
72	-973	1004	-1.1862	-970	1006	-1.1856	0.0006	0.0018
74	-1161	1209	-1.4220	-1159	1211	-1.4220	0.0000	0.0012
76	-1022	1052	-1.2444	-1030	1057	-1.2522	-0.0078	0.0012
78	-306	318	-0.3744	-301	325	-0.3756	-0.0012	0.0090

SITE CUFTVA

INSTALLATION SI-15B

DESCRIPTION

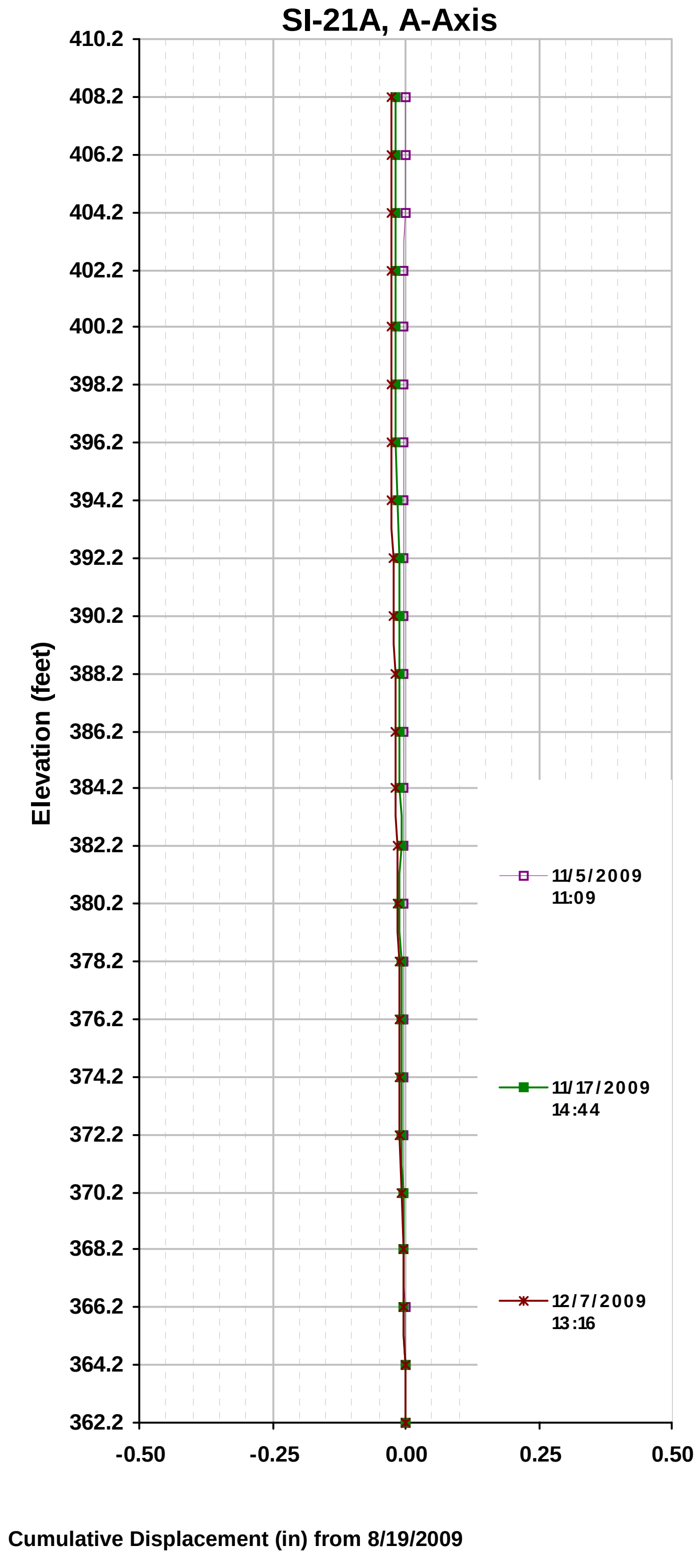
CURRENT SURVEY 12/7/2009 12:25:39 PM

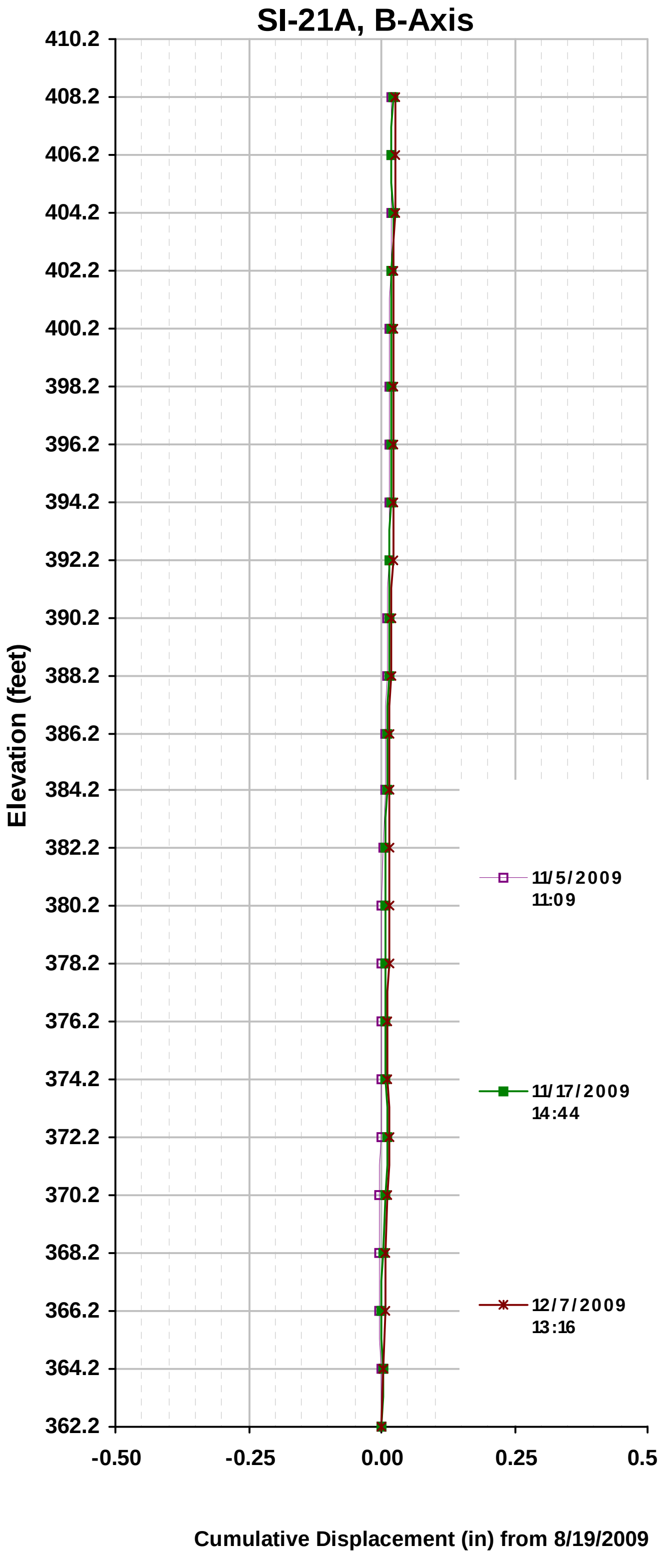
INITIAL SURVEY 8/19/2009 12:56:14 PM

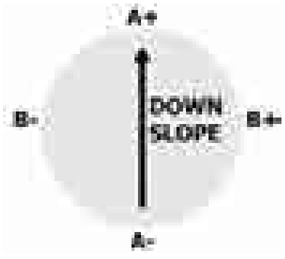
DATE PRINTED 12/8/2009 10:57:54 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
80	-157	189	-0.2076	-154	175	-0.1974	0.0102	0.0102
82	0	0	0.0000	0	0	0.0000	0.0000	0.0000


SI-21A, A-Axis


SI-21A, B-Axis



Cumberland Fossil Plant
B-21A
Cumberland City, TN
175539009
12/8/2009

SITE CUFTVA

INSTALLATION SI-21A

DESCRIPTION

CURRENT SURVEY 11/5/2009 11:09:26 AM

INITIAL SURVEY 8/19/2009 1:49:26 PM

DATE PRINTED 12/8/2009 10:58:29 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	138	-126	0.1584	138	-125	0.1578	-0.0006	-0.0018
4	117	-105	0.1332	118	-105	0.1338	0.0006	-0.0012
6	120	-107	0.1362	121	-107	0.1368	0.0006	-0.0018
8	116	-103	0.1314	117	-104	0.1326	0.0012	-0.0024
10	176	-166	0.2052	178	-165	0.2058	0.0006	-0.0036
12	221	-209	0.2580	223	-209	0.2592	0.0012	-0.0042
14	297	-285	0.3492	298	-284	0.3492	0.0000	-0.0054
16	401	-391	0.4752	401	-389	0.4740	-0.0012	-0.0054
18	494	-482	0.5856	494	-481	0.5850	-0.0006	-0.0042
20	537	-528	0.6390	538	-526	0.6384	-0.0006	-0.0036
22	550	-538	0.6528	551	-538	0.6534	0.0006	-0.0030
24	557	-547	0.6624	559	-546	0.6630	0.0006	-0.0036
26	558	-547	0.6630	558	-545	0.6618	-0.0012	-0.0042
28	570	-558	0.6768	571	-557	0.6768	0.0000	-0.0030
30	595	-586	0.7086	597	-585	0.7092	0.0006	-0.0030
32	654	-642	0.7776	655	-641	0.7776	0.0000	-0.0036
34	686	-676	0.8172	687	-675	0.8172	0.0000	-0.0036
36	678	-667	0.8070	680	-667	0.8082	0.0012	-0.0036
38	587	-575	0.6972	586	-572	0.6948	-0.0024	-0.0048
40	589	-579	0.7008	590	-579	0.7014	0.0006	-0.0024
42	609	-597	0.7236	609	-595	0.7224	-0.0012	-0.0030
44	640	-627	0.7602	639	-625	0.7584	-0.0018	-0.0018
46	683	-673	0.8136	685	-671	0.8136	0.0000	0.0000
48	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-21A

DESCRIPTION

CURRENT SURVEY 11/17/2009 2:44:50 PM

INITIAL SURVEY 8/19/2009 1:49:26 PM

DATE PRINTED 12/8/2009 10:58:29 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	138	-126	0.1584	137	-126	0.1578	-0.0006	-0.0186
4	117	-105	0.1332	116	-105	0.1326	-0.0006	-0.0180
6	120	-107	0.1362	120	-109	0.1374	0.0012	-0.0174
8	116	-103	0.1314	115	-103	0.1308	-0.0006	-0.0186
10	176	-166	0.2052	175	-166	0.2046	-0.0006	-0.0180
12	221	-209	0.2580	221	-209	0.2580	0.0000	-0.0174
14	297	-285	0.3492	295	-285	0.3480	-0.0012	-0.0174
16	401	-391	0.4752	399	-387	0.4716	-0.0036	-0.0162
18	494	-482	0.5856	494	-481	0.5850	-0.0006	-0.0126
20	537	-528	0.6390	537	-526	0.6378	-0.0012	-0.0120
22	550	-538	0.6528	550	-538	0.6528	0.0000	-0.0108
24	557	-547	0.6624	558	-546	0.6624	0.0000	-0.0108
26	558	-547	0.6630	557	-545	0.6612	-0.0018	-0.0108
28	570	-558	0.6768	569	-563	0.6792	0.0024	-0.0090
30	595	-586	0.7086	594	-581	0.7050	-0.0036	-0.0114
32	654	-642	0.7776	653	-642	0.7770	-0.0006	-0.0078
34	686	-676	0.8172	686	-675	0.8166	-0.0006	-0.0072
36	678	-667	0.8070	679	-666	0.8070	0.0000	-0.0066
38	587	-575	0.6972	585	-573	0.6948	-0.0024	-0.0066
40	589	-579	0.7008	588	-580	0.7008	0.0000	-0.0042
42	609	-597	0.7236	607	-596	0.7218	-0.0018	-0.0042
44	640	-627	0.7602	639	-625	0.7584	-0.0018	-0.0024
46	683	-673	0.8136	684	-671	0.8130	-0.0006	-0.0006
48	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-21A

DESCRIPTION

CURRENT SURVEY 12/7/2009 1:16:21 PM

INITIAL SURVEY 8/19/2009 1:49:26 PM

DATE PRINTED 12/8/2009 10:58:29 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	138	-126	0.1584	137	-126	0.1578	-0.0006	-0.0276
4	117	-105	0.1332	115	-106	0.1326	-0.0006	-0.0270
6	120	-107	0.1362	119	-109	0.1368	0.0006	-0.0264
8	116	-103	0.1314	114	-104	0.1308	-0.0006	-0.0270
10	176	-166	0.2052	175	-165	0.2040	-0.0012	-0.0264
12	221	-209	0.2580	221	-210	0.2586	0.0006	-0.0252
14	297	-285	0.3492	295	-286	0.3486	-0.0006	-0.0258
16	401	-391	0.4752	399	-390	0.4734	-0.0018	-0.0252
18	494	-482	0.5856	493	-481	0.5844	-0.0012	-0.0234
20	537	-528	0.6390	535	-526	0.6366	-0.0024	-0.0222
22	550	-538	0.6528	549	-538	0.6522	-0.0006	-0.0198
24	557	-547	0.6624	557	-546	0.6618	-0.0006	-0.0192
26	558	-547	0.6630	555	-546	0.6606	-0.0024	-0.0186
28	570	-558	0.6768	569	-558	0.6762	-0.0006	-0.0162
30	595	-586	0.7086	594	-582	0.7056	-0.0030	-0.0156
32	654	-642	0.7776	653	-642	0.7770	-0.0006	-0.0126
34	686	-676	0.8172	685	-675	0.8160	-0.0012	-0.0120
36	678	-667	0.8070	678	-667	0.8070	0.0000	-0.0108
38	587	-575	0.6972	581	-574	0.6930	-0.0042	-0.0108
40	589	-579	0.7008	588	-578	0.6996	-0.0012	-0.0066
42	609	-597	0.7236	607	-596	0.7218	-0.0018	-0.0054
44	640	-627	0.7602	637	-625	0.7572	-0.0030	-0.0036
46	683	-673	0.8136	683	-672	0.8130	-0.0006	-0.0006
48	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-21A
DESCRIPTION

CURRENT SURVEY 11/5/2009 11:09:26 AM
INITIAL SURVEY 8/19/2009 1:49:26 PM

DATE PRINTED 12/8/2009 10:58:38 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-57	119	-0.1056	-57	119	-0.1056	0.0000	0.0192
4	3	59	-0.0336	4	61	-0.0342	-0.0006	0.0192
6	59	-3	0.0372	61	-5	0.0396	0.0024	0.0198
8	82	-34	0.0696	86	-32	0.0708	0.0012	0.0174
10	140	-81	0.1326	142	-81	0.1338	0.0012	0.0162
12	169	-104	0.1638	170	-104	0.1644	0.0006	0.0150
14	188	-127	0.1890	190	-126	0.1896	0.0006	0.0144
16	182	-121	0.1818	183	-121	0.1824	0.0006	0.0138
18	151	-101	0.1512	153	-101	0.1524	0.0012	0.0132
20	164	-102	0.1596	163	-103	0.1596	0.0000	0.0120
22	187	-122	0.1854	191	-123	0.1884	0.0030	0.0120
24	223	-160	0.2298	226	-161	0.2322	0.0024	0.0090
26	246	-185	0.2586	247	-190	0.2622	0.0036	0.0066
28	263	-214	0.2862	265	-215	0.2880	0.0018	0.0030
30	312	-254	0.3396	313	-255	0.3408	0.0012	0.0012
32	350	-286	0.3816	353	-285	0.3828	0.0012	0.0000
34	359	-296	0.3930	361	-295	0.3936	0.0006	-0.0012
36	367	-305	0.4032	369	-302	0.4026	-0.0006	-0.0018
38	355	-302	0.3942	355	-304	0.3954	0.0012	-0.0012
40	353	-298	0.3906	357	-298	0.3930	0.0024	-0.0024
42	384	-321	0.4230	385	-321	0.4236	0.0006	-0.0048
44	388	-339	0.4362	382	-338	0.4320	-0.0042	-0.0054
46	255	-220	0.2850	254	-219	0.2838	-0.0012	-0.0012
48	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-21A
DESCRIPTION

CURRENT SURVEY 11/17/2009 2:44:50 PM
INITIAL SURVEY 8/19/2009 1:49:26 PM

DATE PRINTED 12/8/2009 10:58:38 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-57	119	-0.1056	-53	120	-0.1038	0.0018	0.0222
4	3	59	-0.0336	3	62	-0.0354	-0.0018	0.0204
6	59	-3	0.0372	63	-2	0.0390	0.0018	0.0222
8	82	-34	0.0696	88	-30	0.0708	0.0012	0.0204
10	140	-81	0.1326	145	-78	0.1338	0.0012	0.0192
12	169	-104	0.1638	172	-101	0.1638	0.0000	0.0180
14	188	-127	0.1890	193	-122	0.1890	0.0000	0.0180
16	182	-121	0.1818	185	-121	0.1836	0.0018	0.0180
18	151	-101	0.1512	156	-99	0.1530	0.0018	0.0162
20	164	-102	0.1596	166	-99	0.1590	-0.0006	0.0144
22	187	-122	0.1854	193	-122	0.1890	0.0036	0.0150
24	223	-160	0.2298	227	-157	0.2304	0.0006	0.0114
26	246	-185	0.2586	248	-186	0.2604	0.0018	0.0108
28	263	-214	0.2862	267	-210	0.2862	0.0000	0.0090
30	312	-254	0.3396	313	-253	0.3396	0.0000	0.0090
32	350	-286	0.3816	354	-282	0.3816	0.0000	0.0090
34	359	-296	0.3930	362	-293	0.3930	0.0000	0.0090
36	367	-305	0.4032	370	-299	0.4014	-0.0018	0.0090
38	355	-302	0.3942	361	-302	0.3978	0.0036	0.0108
40	353	-298	0.3906	360	-296	0.3936	0.0030	0.0072
42	384	-321	0.4230	389	-321	0.4260	0.0030	0.0042
44	388	-339	0.4362	384	-337	0.4326	-0.0036	0.0012
46	255	-220	0.2850	254	-229	0.2898	0.0048	0.0048
48	0	0	0.0000	0	0	0.0000	0.0000	0.0000

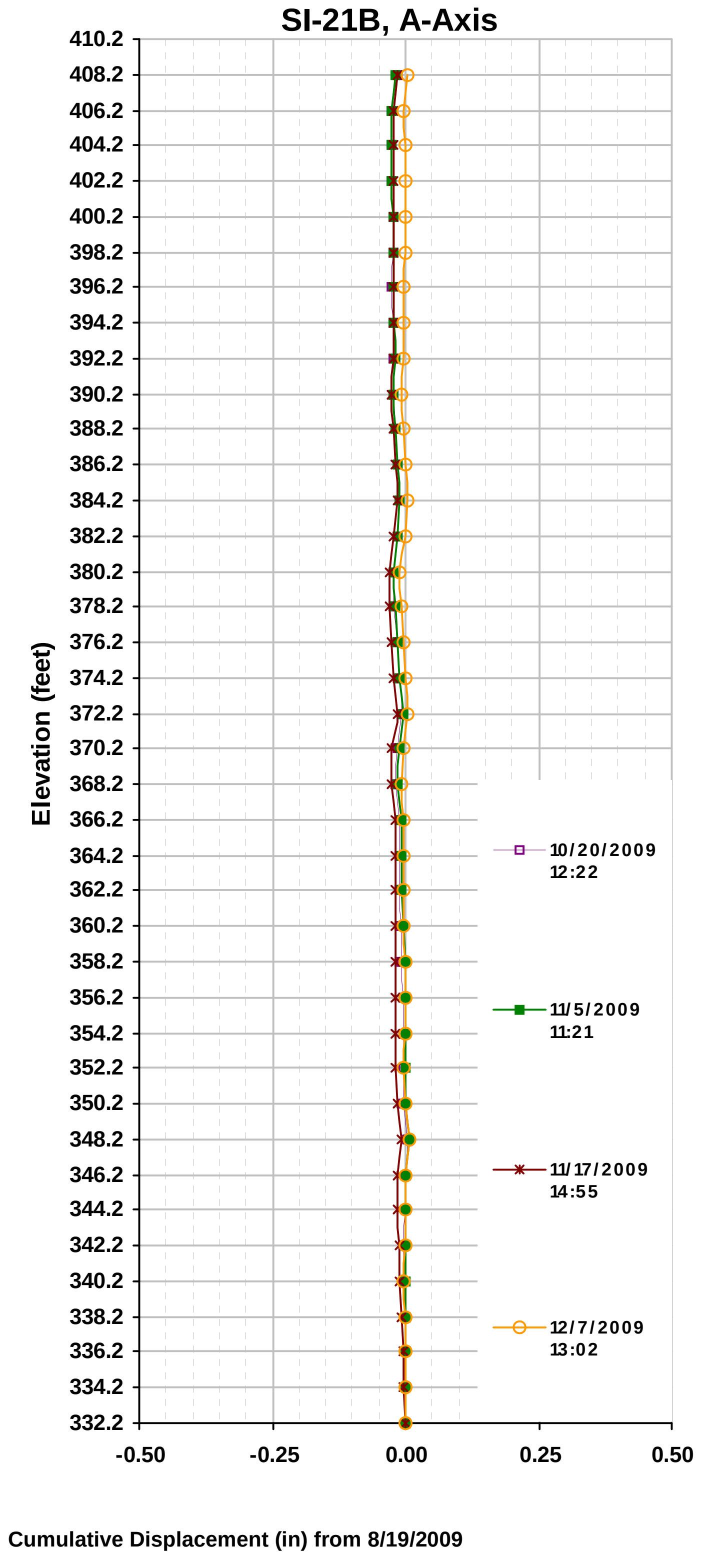
SITE CUFTVA
INSTALLATION SI-21A
DESCRIPTION

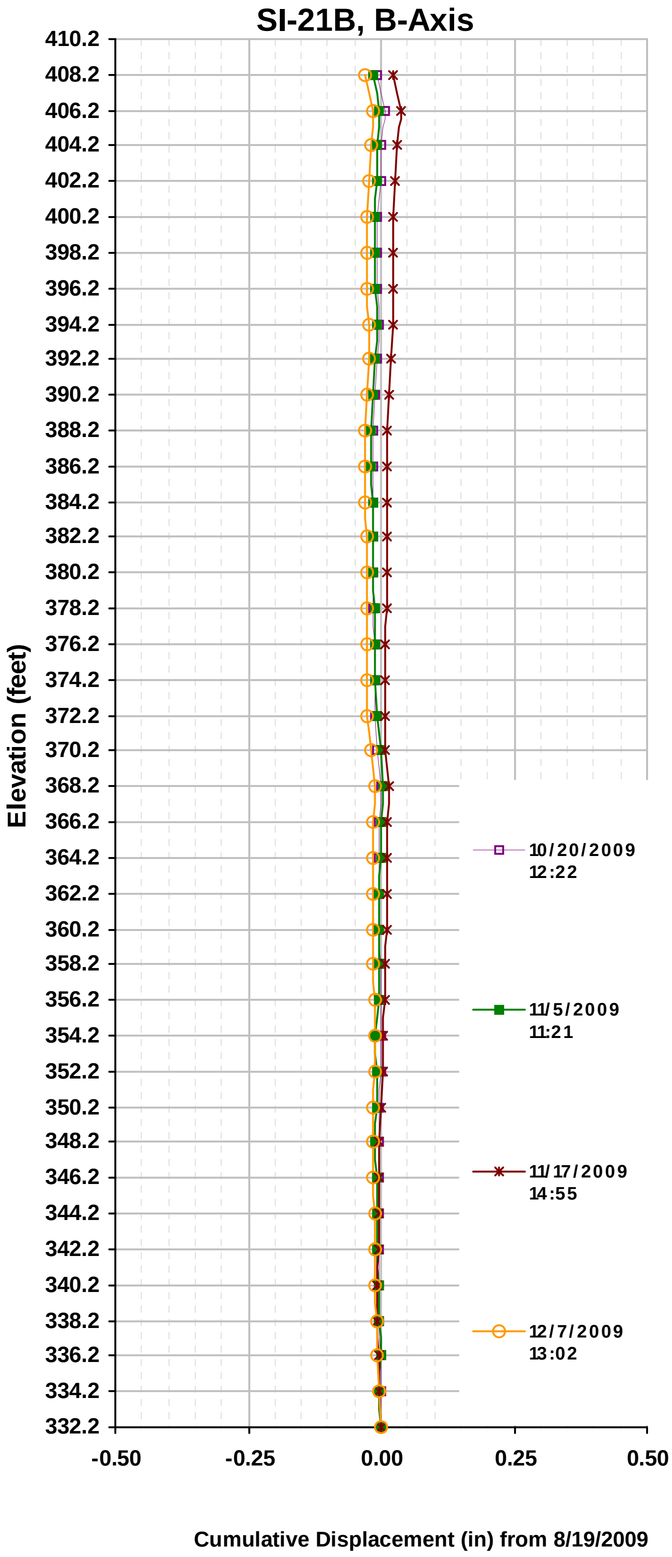
CURRENT SURVEY 12/7/2009 1:16:21 PM
INITIAL SURVEY 8/19/2009 1:49:26 PM

DATE PRINTED 12/8/2009 10:58:39 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-57	119	-0.1056	-54	121	-0.1050	0.0006	0.0252
4	3	59	-0.0336	5	61	-0.0336	0.0000	0.0246
6	59	-3	0.0372	62	-1	0.0378	0.0006	0.0246
8	82	-34	0.0696	87	-30	0.0702	0.0006	0.0240
10	140	-81	0.1326	145	-78	0.1338	0.0012	0.0234
12	169	-104	0.1638	171	-101	0.1632	-0.0006	0.0222
14	188	-127	0.1890	192	-124	0.1896	0.0006	0.0228
16	182	-121	0.1818	186	-119	0.1830	0.0012	0.0222
18	151	-101	0.1512	155	-99	0.1524	0.0012	0.0210
20	164	-102	0.1596	166	-103	0.1614	0.0018	0.0198
22	187	-122	0.1854	192	-121	0.1878	0.0024	0.0180
24	223	-160	0.2298	227	-157	0.2304	0.0006	0.0156
26	246	-185	0.2586	249	-185	0.2604	0.0018	0.0150
28	263	-214	0.2862	267	-210	0.2862	0.0000	0.0132
30	312	-254	0.3396	315	-251	0.3396	0.0000	0.0132
32	350	-286	0.3816	354	-283	0.3822	0.0006	0.0132
34	359	-296	0.3930	362	-293	0.3930	0.0000	0.0126
36	367	-305	0.4032	367	-299	0.3996	-0.0036	0.0126
38	355	-302	0.3942	361	-302	0.3978	0.0036	0.0162
40	353	-298	0.3906	359	-298	0.3942	0.0036	0.0126
42	384	-321	0.4230	387	-318	0.4230	0.0000	0.0090
44	388	-339	0.4362	397	-339	0.4416	0.0054	0.0090
46	255	-220	0.2850	259	-222	0.2886	0.0036	0.0036
48	0	0	0.0000	0	0	0.0000	0.0000	0.0000





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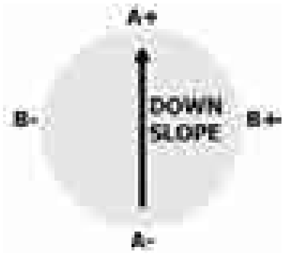


Cumberland Fossil Plant
B-21B
Cumberland City, TN
175539009
12/8/2009

SITE CUFTVA

INSTALLATION SI-21B

DESCRIPTION

CURRENT SURVEY 10/20/2009 12:22:40 PM

INITIAL SURVEY 8/19/2009 1:32:46 PM

DATE PRINTED 12/8/2009 10:59:22 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	714	-702	0.8496	721	-711	0.8592	0.0096	-0.0162
4	491	-476	0.5802	488	-477	0.5790	-0.0012	-0.0258
6	375	-362	0.4422	373	-364	0.4422	0.0000	-0.0246
8	301	-284	0.3510	297	-286	0.3498	-0.0012	-0.0246
10	251	-239	0.2940	250	-240	0.2940	0.0000	-0.0234
12	220	-205	0.2550	218	-209	0.2562	0.0012	-0.0234
14	122	-109	0.1386	119	-110	0.1374	-0.0012	-0.0246
16	43	-30	0.0438	40	-30	0.0420	-0.0018	-0.0234
18	50	-36	0.0516	49	-38	0.0522	0.0006	-0.0216
20	75	-65	0.0840	72	-63	0.0810	-0.0030	-0.0222
22	17	-3	0.0120	13	-3	0.0096	-0.0024	-0.0192
24	-93	106	-0.1194	-99	109	-0.1248	-0.0054	-0.0168
26	-127	141	-0.1608	-125	135	-0.1560	0.0048	-0.0114
28	-206	222	-0.2568	-202	216	-0.2508	0.0060	-0.0162
30	-288	300	-0.3528	-291	299	-0.3540	-0.0012	-0.0222
32	-330	345	-0.4050	-337	347	-0.4104	-0.0054	-0.0210
34	-307	319	-0.3756	-311	320	-0.3786	-0.0030	-0.0156
36	-344	357	-0.4206	-349	359	-0.4248	-0.0042	-0.0126
38	-447	463	-0.5460	-442	455	-0.5382	0.0078	-0.0084
40	-358	369	-0.4362	-358	367	-0.4350	0.0012	-0.0162
42	-362	377	-0.4434	-369	380	-0.4494	-0.0060	-0.0174
44	-358	372	-0.4380	-361	370	-0.4386	-0.0006	-0.0114
46	-342	355	-0.4182	-345	354	-0.4194	-0.0012	-0.0108
48	-411	426	-0.5022	-414	426	-0.5040	-0.0018	-0.0096
50	-435	447	-0.5292	-438	446	-0.5304	-0.0012	-0.0078
52	-525	540	-0.6390	-528	539	-0.6402	-0.0012	-0.0066
54	-589	603	-0.7152	-593	602	-0.7170	-0.0018	-0.0054
56	-515	526	-0.6246	-515	524	-0.6234	0.0012	-0.0036
58	-489	505	-0.5964	-491	504	-0.5970	-0.0006	-0.0048
60	-490	503	-0.5958	-498	506	-0.6024	-0.0066	-0.0042
62	-498	511	-0.6054	-496	506	-0.6012	0.0042	0.0024
64	-440	455	-0.5370	-442	453	-0.5370	0.0000	-0.0018
66	-308	321	-0.3774	-309	318	-0.3762	0.0012	-0.0018
68	-190	205	-0.2370	-191	204	-0.2370	0.0000	-0.0030
70	-93	105	-0.1188	-97	105	-0.1212	-0.0024	-0.0030
72	-9	23	-0.0192	-11	21	-0.0192	0.0000	-0.0006
74	83	-70	0.0918	83	-71	0.0924	0.0006	-0.0006
76	146	-131	0.1662	143	-132	0.1650	-0.0012	-0.0012
78	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-21B

DESCRIPTION

CURRENT SURVEY 11/5/2009 11:21:07 AM

INITIAL SURVEY 8/19/2009 1:32:46 PM

DATE PRINTED 12/8/2009 10:59:22 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	714	-702	0.8496	721	-707	0.8568	0.0072	-0.0204
4	491	-476	0.5802	490	-474	0.5784	-0.0018	-0.0276
6	375	-362	0.4422	374	-361	0.4410	-0.0012	-0.0258
8	301	-284	0.3510	299	-282	0.3486	-0.0024	-0.0246
10	251	-239	0.2940	251	-238	0.2934	-0.0006	-0.0222
12	220	-205	0.2550	221	-206	0.2562	0.0012	-0.0216
14	122	-109	0.1386	122	-107	0.1374	-0.0012	-0.0228
16	43	-30	0.0438	42	-29	0.0426	-0.0012	-0.0216
18	50	-36	0.0516	53	-37	0.0540	0.0024	-0.0204
20	75	-65	0.0840	74	-62	0.0816	-0.0024	-0.0228
22	17	-3	0.0120	14	0	0.0084	-0.0036	-0.0204
24	-93	106	-0.1194	-97	112	-0.1254	-0.0060	-0.0168
26	-127	141	-0.1608	-122	137	-0.1554	0.0054	-0.0108
28	-206	222	-0.2568	-201	218	-0.2514	0.0054	-0.0162
30	-288	300	-0.3528	-289	302	-0.3546	-0.0018	-0.0216
32	-330	345	-0.4050	-335	350	-0.4110	-0.0060	-0.0198
34	-307	319	-0.3756	-309	323	-0.3792	-0.0036	-0.0138
36	-344	357	-0.4206	-348	363	-0.4266	-0.0060	-0.0102
38	-447	463	-0.5460	-439	457	-0.5376	0.0084	-0.0042
40	-358	369	-0.4362	-355	368	-0.4338	0.0024	-0.0126
42	-362	377	-0.4434	-368	382	-0.4500	-0.0066	-0.0150
44	-358	372	-0.4380	-358	373	-0.4386	-0.0006	-0.0084
46	-342	355	-0.4182	-343	357	-0.4200	-0.0018	-0.0078
48	-411	426	-0.5022	-413	428	-0.5046	-0.0024	-0.0060
50	-435	447	-0.5292	-436	449	-0.5310	-0.0018	-0.0036
52	-525	540	-0.6390	-526	542	-0.6408	-0.0018	-0.0018
54	-589	603	-0.7152	-590	605	-0.7170	-0.0018	0.0000
56	-515	526	-0.6246	-513	527	-0.6240	0.0006	0.0018
58	-489	505	-0.5964	-489	506	-0.5970	-0.0006	0.0012
60	-490	503	-0.5958	-495	509	-0.6024	-0.0066	0.0018
62	-498	511	-0.6054	-492	506	-0.5988	0.0066	0.0084
64	-440	455	-0.5370	-439	454	-0.5358	0.0012	0.0018
66	-308	321	-0.3774	-306	320	-0.3756	0.0018	0.0006
68	-190	205	-0.2370	-189	206	-0.2370	0.0000	-0.0012
70	-93	105	-0.1188	-94	107	-0.1206	-0.0018	-0.0012
72	-9	23	-0.0192	-8	23	-0.0186	0.0006	0.0006
74	83	-70	0.0918	85	-69	0.0924	0.0006	0.0000
76	146	-131	0.1662	146	-130	0.1656	-0.0006	-0.0006
78	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE	CUFTVA
INSTALLATION	SI-21B
DESCRIPTION	

CURRENT SURVEY	11/17/2009	2:55:49 PM
INITIAL SURVEY	8/19/2009	1:32:46 PM
DATE PRINTED	12/8/2009	10:59:22 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	714	-702	0.8496	719	-708	0.8562	0.0066	-0.0156
4	491	-476	0.5802	490	-476	0.5796	-0.0006	-0.0222
6	375	-362	0.4422	375	-362	0.4422	0.0000	-0.0216
8	301	-284	0.3510	301	-285	0.3516	0.0006	-0.0216
10	251	-239	0.2940	251	-238	0.2934	-0.0006	-0.0222
12	220	-205	0.2550	221	-207	0.2568	0.0018	-0.0216
14	122	-109	0.1386	122	-109	0.1386	0.0000	-0.0234
16	43	-30	0.0438	42	-30	0.0432	-0.0006	-0.0234
18	50	-36	0.0516	52	-38	0.0540	0.0024	-0.0228
20	75	-65	0.0840	73	-62	0.0810	-0.0030	-0.0252
22	17	-3	0.0120	14	-2	0.0096	-0.0024	-0.0222
24	-93	106	-0.1194	-97	109	-0.1236	-0.0042	-0.0198
26	-127	141	-0.1608	-122	135	-0.1542	0.0066	-0.0156
28	-206	222	-0.2568	-199	216	-0.2490	0.0078	-0.0222
30	-288	300	-0.3528	-288	299	-0.3522	0.0006	-0.0300
32	-330	345	-0.4050	-335	349	-0.4104	-0.0054	-0.0306
34	-307	319	-0.3756	-310	323	-0.3798	-0.0042	-0.0252
36	-344	357	-0.4206	-348	360	-0.4248	-0.0042	-0.0210
38	-447	463	-0.5460	-440	456	-0.5376	0.0084	-0.0168
40	-358	369	-0.4362	-357	368	-0.4350	0.0012	-0.0252
42	-362	377	-0.4434	-367	382	-0.4494	-0.0060	-0.0264
44	-358	372	-0.4380	-359	373	-0.4392	-0.0012	-0.0204
46	-342	355	-0.4182	-343	355	-0.4188	-0.0006	-0.0192
48	-411	426	-0.5022	-411	426	-0.5022	0.0000	-0.0186
50	-435	447	-0.5292	-435	446	-0.5286	0.0006	-0.0186
52	-525	540	-0.6390	-524	539	-0.6378	0.0012	-0.0192
54	-589	603	-0.7152	-590	605	-0.7170	-0.0018	-0.0204
56	-515	526	-0.6246	-515	528	-0.6258	-0.0012	-0.0186
58	-489	505	-0.5964	-490	505	-0.5970	-0.0006	-0.0174
60	-490	503	-0.5958	-499	510	-0.6054	-0.0096	-0.0168
62	-498	511	-0.6054	-493	505	-0.5988	0.0066	-0.0072
64	-440	455	-0.5370	-441	455	-0.5376	-0.0006	-0.0138
66	-308	321	-0.3774	-309	323	-0.3792	-0.0018	-0.0132
68	-190	205	-0.2370	-190	207	-0.2382	-0.0012	-0.0114
70	-93	105	-0.1188	-97	108	-0.1230	-0.0042	-0.0102
72	-9	23	-0.0192	-10	25	-0.0210	-0.0018	-0.0060
74	83	-70	0.0918	83	-68	0.0906	-0.0012	-0.0042
76	146	-131	0.1662	143	-129	0.1632	-0.0030	-0.0030
78	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-21B

DESCRIPTION

CURRENT SURVEY 12/7/2009 1:02:35 PM

INITIAL SURVEY 8/19/2009 1:32:46 PM

DATE PRINTED 12/8/2009 10:59:23 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	714	-702	0.8496	717	-711	0.8568	0.0072	0.0048
4	491	-476	0.5802	486	-479	0.5790	-0.0012	-0.0024
6	375	-362	0.4422	374	-364	0.4428	0.0006	-0.0012
8	301	-284	0.3510	298	-286	0.3504	-0.0006	-0.0018
10	251	-239	0.2940	250	-240	0.2940	0.0000	-0.0012
12	220	-205	0.2550	219	-210	0.2574	0.0024	-0.0012
14	122	-109	0.1386	121	-111	0.1392	0.0006	-0.0036
16	43	-30	0.0438	41	-31	0.0432	-0.0006	-0.0042
18	50	-36	0.0516	51	-40	0.0546	0.0030	-0.0036
20	75	-65	0.0840	71	-63	0.0804	-0.0036	-0.0066
22	17	-3	0.0120	13	-2	0.0090	-0.0030	-0.0030
24	-93	106	-0.1194	-98	110	-0.1248	-0.0054	0.0000
26	-127	141	-0.1608	-123	133	-0.1536	0.0072	0.0054
28	-206	222	-0.2568	-200	215	-0.2490	0.0078	-0.0018
30	-288	300	-0.3528	-289	300	-0.3534	-0.0006	-0.0096
32	-330	345	-0.4050	-336	347	-0.4098	-0.0048	-0.0090
34	-307	319	-0.3756	-311	320	-0.3786	-0.0030	-0.0042
36	-344	357	-0.4206	-350	359	-0.4254	-0.0048	-0.0012
38	-447	463	-0.5460	-441	454	-0.5370	0.0090	0.0036
40	-358	369	-0.4362	-357	365	-0.4332	0.0030	-0.0054
42	-362	377	-0.4434	-369	379	-0.4488	-0.0054	-0.0084
44	-358	372	-0.4380	-360	370	-0.4380	0.0000	-0.0030
46	-342	355	-0.4182	-343	354	-0.4182	0.0000	-0.0030
48	-411	426	-0.5022	-413	425	-0.5028	-0.0006	-0.0030
50	-435	447	-0.5292	-437	446	-0.5298	-0.0006	-0.0024
52	-525	540	-0.6390	-526	539	-0.6390	0.0000	-0.0018
54	-589	603	-0.7152	-592	602	-0.7164	-0.0012	-0.0018
56	-515	526	-0.6246	-515	523	-0.6228	0.0018	-0.0006
58	-489	505	-0.5964	-492	503	-0.5970	-0.0006	-0.0024
60	-490	503	-0.5958	-501	509	-0.6060	-0.0102	-0.0018
62	-498	511	-0.6054	-492	502	-0.5964	0.0090	0.0084
64	-440	455	-0.5370	-442	453	-0.5370	0.0000	-0.0006
66	-308	321	-0.3774	-309	318	-0.3762	0.0012	-0.0006
68	-190	205	-0.2370	-192	202	-0.2364	0.0006	-0.0018
70	-93	105	-0.1188	-97	105	-0.1212	-0.0024	-0.0024
72	-9	23	-0.0192	-11	21	-0.0192	0.0000	0.0000
74	83	-70	0.0918	83	-72	0.0930	0.0012	0.0000
76	146	-131	0.1662	142	-133	0.1650	-0.0012	-0.0012
78	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-21B
DESCRIPTION

CURRENT SURVEY 10/20/2009 12:22:40 PM
INITIAL SURVEY 8/19/2009 1:32:46 PM

DATE PRINTED 12/8/2009 10:59:31 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	148	-94	0.1452	139	-79	0.1308	-0.0144	-0.0072
4	205	-154	0.2154	216	-153	0.2214	0.0060	0.0072
6	181	-124	0.1830	185	-125	0.1860	0.0030	0.0012
8	50	-8	0.0348	56	-9	0.0390	0.0042	-0.0018
10	6	51	-0.0270	5	50	-0.0270	0.0000	-0.0060
12	33	34	-0.0006	34	33	0.0006	0.0012	-0.0060
14	47	15	0.0192	43	17	0.0156	-0.0036	-0.0072
16	88	-29	0.0702	91	-33	0.0744	0.0042	-0.0036
18	89	-37	0.0756	92	-39	0.0786	0.0030	-0.0078
20	64	-6	0.0420	67	-9	0.0456	0.0036	-0.0108
22	0	63	0.0000	1	61	-0.0360	0.0000	-0.0144
24	-69	132	-0.1206	-70	132	-0.1212	-0.0006	-0.0144
26	-101	162	-0.1578	-101	162	-0.1578	0.0000	-0.0138
28	-137	189	-0.1956	-136	189	-0.1950	0.0006	-0.0138
30	-159	217	-0.2256	-160	217	-0.2262	-0.0006	-0.0144
32	-168	235	-0.2418	-170	237	-0.2442	-0.0024	-0.0138
34	-168	231	-0.2394	-168	231	-0.2394	0.0000	-0.0114
36	-182	243	-0.2550	-182	241	-0.2538	0.0012	-0.0114
38	-245	294	-0.3234	-250	298	-0.3288	-0.0054	-0.0126
40	-186	233	-0.2514	-191	237	-0.2568	-0.0054	-0.0072
42	-54	104	-0.0948	-48	105	-0.0918	0.0030	-0.0018
44	54	5	0.0294	53	6	0.0282	-0.0012	-0.0048
46	126	-70	0.1176	125	-71	0.1176	0.0000	-0.0036
48	149	-94	0.1458	147	-94	0.1446	-0.0012	-0.0036
50	106	-47	0.0918	104	-48	0.0912	-0.0006	-0.0024
52	69	-2	0.0426	67	-2	0.0414	-0.0012	-0.0018
54	115	-58	0.1038	115	-59	0.1044	0.0006	-0.0006
56	210	-147	0.2142	210	-148	0.2148	0.0006	-0.0012
58	109	-57	0.0996	108	-59	0.1002	0.0006	-0.0018
60	72	-18	0.0540	75	-17	0.0552	0.0012	-0.0024
62	46	19	0.0162	46	19	0.0162	0.0000	-0.0036
64	21	39	-0.0108	21	41	-0.0120	-0.0012	-0.0036
66	30	30	0.0000	30	31	-0.0006	0.0000	-0.0024
68	-12	59	-0.0426	-11	59	-0.0420	0.0006	-0.0024
70	-33	91	-0.0744	-34	91	-0.0750	-0.0006	-0.0030
72	-10	77	-0.0522	-13	76	-0.0534	-0.0012	-0.0024
74	41	23	0.0108	39	21	0.0108	0.0000	-0.0012
76	89	-58	0.0882	87	-58	0.0870	-0.0012	-0.0012
78	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-21B

DESCRIPTION

CURRENT SURVEY 11/5/2009 11:21:07 AM

INITIAL SURVEY 8/19/2009 1:32:46 PM

DATE PRINTED 12/8/2009 10:59:31 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	148	-94	0.1452	141	-79	0.1320	-0.0132	-0.0162
4	205	-154	0.2154	217	-150	0.2202	0.0048	-0.0030
6	181	-124	0.1830	182	-123	0.1830	0.0000	-0.0078
8	50	-8	0.0348	56	-6	0.0372	0.0024	-0.0078
10	6	51	-0.0270	6	50	-0.0264	0.0006	-0.0102
12	33	34	-0.0006	34	35	-0.0006	0.0000	-0.0108
14	47	15	0.0192	46	19	0.0162	-0.0030	-0.0108
16	88	-29	0.0702	90	-34	0.0744	0.0042	-0.0078
18	89	-37	0.0756	90	-39	0.0774	0.0018	-0.0120
20	64	-6	0.0420	66	-10	0.0456	0.0036	-0.0138
22	0	63	0.0000	-1	63	-0.0384	0.0000	-0.0174
24	-69	132	-0.1206	-71	134	-0.1230	-0.0024	-0.0174
26	-101	162	-0.1578	-101	162	-0.1578	0.0000	-0.0150
28	-137	189	-0.1956	-138	190	-0.1968	-0.0012	-0.0150
30	-159	217	-0.2256	-161	218	-0.2274	-0.0018	-0.0138
32	-168	235	-0.2418	-170	237	-0.2442	-0.0024	-0.0120
34	-168	231	-0.2394	-167	232	-0.2394	0.0000	-0.0096
36	-182	243	-0.2550	-183	243	-0.2556	-0.0006	-0.0096
38	-245	294	-0.3234	-251	300	-0.3306	-0.0072	-0.0090
40	-186	233	-0.2514	-188	240	-0.2568	-0.0054	-0.0018
42	-54	104	-0.0948	-47	102	-0.0894	0.0054	0.0036
44	54	5	0.0294	55	7	0.0288	-0.0006	-0.0018
46	126	-70	0.1176	128	-72	0.1200	0.0024	-0.0012
48	149	-94	0.1458	147	-96	0.1458	0.0000	-0.0036
50	106	-47	0.0918	105	-47	0.0912	-0.0006	-0.0036
52	69	-2	0.0426	69	-2	0.0426	0.0000	-0.0030
54	115	-58	0.1038	118	-66	0.1104	0.0066	-0.0030
56	210	-147	0.2142	209	-147	0.2136	-0.0006	-0.0096
58	109	-57	0.0996	107	-59	0.0996	0.0000	-0.0090
60	72	-18	0.0540	74	-17	0.0546	0.0006	-0.0090
62	46	19	0.0162	46	21	0.0150	-0.0012	-0.0096
64	21	39	-0.0108	21	43	-0.0132	-0.0024	-0.0084
66	30	30	0.0000	30	31	-0.0006	0.0000	-0.0060
68	-12	59	-0.0426	-11	62	-0.0438	-0.0012	-0.0060
70	-33	91	-0.0744	-34	92	-0.0756	-0.0012	-0.0048
72	-10	77	-0.0522	-13	77	-0.0540	-0.0018	-0.0036
74	41	23	0.0108	42	22	0.0120	0.0012	-0.0018
76	89	-58	0.0882	83	-59	0.0852	-0.0030	-0.0030
78	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE	CUFTVA
INSTALLATION	SI-21B
DESCRIPTION	

CURRENT SURVEY	11/17/2009	2:55:49 PM
INITIAL SURVEY	8/19/2009	1:32:46 PM
DATE PRINTED	12/8/2009	10:59:32 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	148	-94	0.1452	138	-79	0.1302	-0.0150	0.0222
4	205	-154	0.2154	217	-153	0.2220	0.0066	0.0372
6	181	-124	0.1830	185	-125	0.1860	0.0030	0.0306
8	50	-8	0.0348	57	-9	0.0396	0.0048	0.0276
10	6	51	-0.0270	7	51	-0.0264	0.0006	0.0228
12	33	34	-0.0006	34	33	0.0006	0.0012	0.0222
14	47	15	0.0192	46	18	0.0168	-0.0024	0.0210
16	88	-29	0.0702	91	-32	0.0738	0.0036	0.0234
18	89	-37	0.0756	94	-39	0.0798	0.0042	0.0198
20	64	-6	0.0420	69	-8	0.0462	0.0042	0.0156
22	0	63	0.0000	2	61	-0.0354	0.0000	0.0114
24	-69	132	-0.1206	-70	133	-0.1218	-0.0012	0.0114
26	-101	162	-0.1578	-100	162	-0.1572	0.0006	0.0126
28	-137	189	-0.1956	-135	188	-0.1938	0.0018	0.0120
30	-159	217	-0.2256	-158	217	-0.2250	0.0006	0.0102
32	-168	235	-0.2418	-168	233	-0.2406	0.0012	0.0096
34	-168	231	-0.2394	-166	231	-0.2382	0.0012	0.0084
36	-182	243	-0.2550	-180	243	-0.2538	0.0012	0.0072
38	-245	294	-0.3234	-246	298	-0.3264	-0.0030	0.0060
40	-186	233	-0.2514	-190	238	-0.2568	-0.0054	0.0090
42	-54	104	-0.0948	-49	102	-0.0906	0.0042	0.0144
44	54	5	0.0294	54	7	0.0282	-0.0012	0.0102
46	126	-70	0.1176	126	-69	0.1170	-0.0006	0.0114
48	149	-94	0.1458	150	-94	0.1464	0.0006	0.0120
50	106	-47	0.0918	108	-50	0.0948	0.0030	0.0114
52	69	-2	0.0426	69	-1	0.0420	-0.0006	0.0084
54	115	-58	0.1038	114	-67	0.1086	0.0048	0.0090
56	210	-147	0.2142	211	-148	0.2154	0.0012	0.0042
58	109	-57	0.0996	112	-61	0.1038	0.0042	0.0030
60	72	-18	0.0540	78	-15	0.0558	0.0018	-0.0012
62	46	19	0.0162	49	19	0.0180	0.0018	-0.0030
64	21	39	-0.0108	22	42	-0.0120	-0.0012	-0.0048
66	30	30	0.0000	30	34	-0.0024	0.0000	-0.0036
68	-12	59	-0.0426	-8	59	-0.0402	0.0024	-0.0036
70	-33	91	-0.0744	-32	92	-0.0744	0.0000	-0.0060
72	-10	77	-0.0522	-12	78	-0.0540	-0.0018	-0.0060
74	41	23	0.0108	40	24	0.0096	-0.0012	-0.0042
76	89	-58	0.0882	87	-55	0.0852	-0.0030	-0.0030
78	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-21B

DESCRIPTION

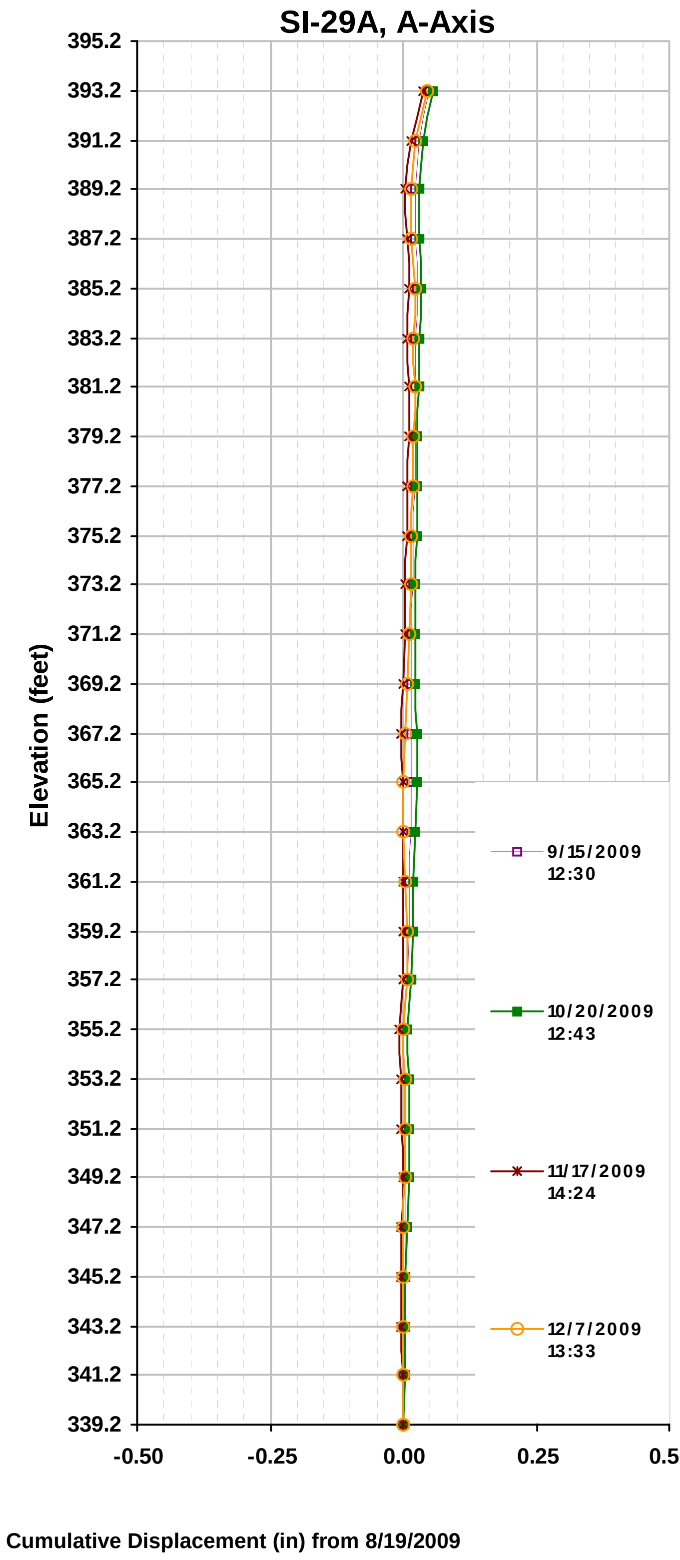
CURRENT SURVEY 12/7/2009 1:02:35 PM

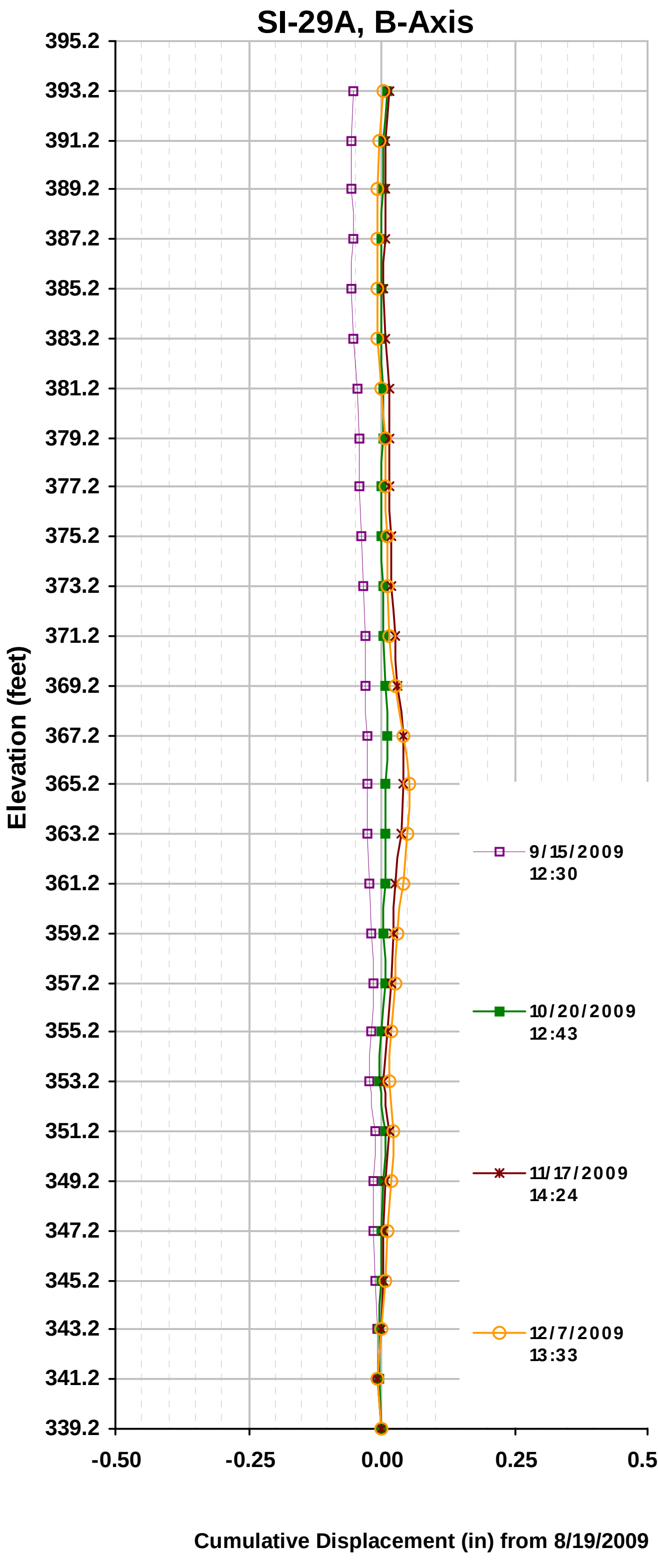
INITIAL SURVEY 8/19/2009 1:32:46 PM

DATE PRINTED 12/8/2009 10:59:32 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	148	-94	0.1452	140	-77	0.1302	-0.0150	-0.0312
4	205	-154	0.2154	217	-149	0.2196	0.0042	-0.0162
6	181	-124	0.1830	189	-122	0.1866	0.0036	-0.0204
8	50	-8	0.0348	58	-3	0.0366	0.0018	-0.0240
10	6	51	-0.0270	9	53	-0.0264	0.0006	-0.0258
12	33	34	-0.0006	35	37	-0.0012	-0.0006	-0.0264
14	47	15	0.0192	46	22	0.0144	-0.0048	-0.0258
16	88	-29	0.0702	92	-29	0.0726	0.0024	-0.0210
18	89	-37	0.0756	97	-35	0.0792	0.0036	-0.0234
20	64	-6	0.0420	70	-6	0.0456	0.0036	-0.0270
22	0	63	0.0000	3	63	-0.0360	0.0000	-0.0306
24	-69	132	-0.1206	-68	137	-0.1230	-0.0024	-0.0306
26	-101	162	-0.1578	-97	167	-0.1584	-0.0006	-0.0282
28	-137	189	-0.1956	-133	194	-0.1962	-0.0006	-0.0276
30	-159	217	-0.2256	-157	219	-0.2256	0.0000	-0.0270
32	-168	235	-0.2418	-166	239	-0.2430	-0.0012	-0.0270
34	-168	231	-0.2394	-164	236	-0.2400	-0.0006	-0.0258
36	-182	243	-0.2550	-178	247	-0.2550	0.0000	-0.0252
38	-245	294	-0.3234	-246	301	-0.3282	-0.0048	-0.0252
40	-186	233	-0.2514	-187	246	-0.2598	-0.0084	-0.0204
42	-54	104	-0.0948	-45	105	-0.0900	0.0048	-0.0120
44	54	5	0.0294	55	10	0.0270	-0.0024	-0.0168
46	126	-70	0.1176	127	-68	0.1170	-0.0006	-0.0144
48	149	-94	0.1458	151	-91	0.1452	-0.0006	-0.0138
50	106	-47	0.0918	108	-46	0.0924	0.0006	-0.0132
52	69	-2	0.0426	70	1	0.0414	-0.0012	-0.0138
54	115	-58	0.1038	118	-55	0.1038	0.0000	-0.0126
56	210	-147	0.2142	213	-144	0.2142	0.0000	-0.0126
58	109	-57	0.0996	111	-56	0.1002	0.0006	-0.0126
60	72	-18	0.0540	77	-13	0.0540	0.0000	-0.0132
62	46	19	0.0162	50	22	0.0168	0.0006	-0.0132
64	21	39	-0.0108	25	45	-0.0120	-0.0012	-0.0138
66	30	30	0.0000	29	35	-0.0036	0.0000	-0.0126
68	-12	59	-0.0426	-8	64	-0.0432	-0.0006	-0.0126
70	-33	91	-0.0744	-33	96	-0.0774	-0.0030	-0.0120
72	-10	77	-0.0522	-10	81	-0.0546	-0.0024	-0.0090
74	41	23	0.0108	42	26	0.0096	-0.0012	-0.0066
76	89	-58	0.0882	87	-51	0.0828	-0.0054	-0.0054
78	0	0	0.0000	0	0	0.0000	0.0000	0.0000





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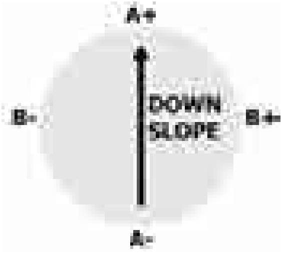


Cumberland Fossil Plant
B-29
Cumberland City, TN
175539009
12/8/2009

SITE CUFTVA
INSTALLATION SI-29A
DESCRIPTION

CURRENT SURVEY 9/15/2009 12:30:54 PM
INITIAL SURVEY 8/19/2009 2:10:15 PM

DATE PRINTED 12/8/2009 11:00:11 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	141	-131	0.1632	154	-152	0.1836	0.0204	0.0492
4	174	-161	0.2010	175	-169	0.2064	0.0054	0.0288
6	152	-137	0.1734	147	-141	0.1728	-0.0006	0.0234
8	80	-69	0.0894	76	-72	0.0888	-0.0006	0.0240
10	39	-23	0.0372	35	-28	0.0378	0.0006	0.0246
12	36	-27	0.0378	33	-30	0.0378	0.0000	0.0240
14	47	-35	0.0492	45	-40	0.0510	0.0018	0.0240
16	30	-18	0.0288	28	-22	0.0300	0.0012	0.0222
18	-14	25	-0.0234	-17	21	-0.0228	0.0006	0.0210
20	-91	103	-0.1164	-93	98	-0.1146	0.0018	0.0204
22	-201	209	-0.2460	-203	204	-0.2442	0.0018	0.0186
24	-294	308	-0.3612	-297	302	-0.3594	0.0018	0.0168
26	-347	357	-0.4224	-351	353	-0.4224	0.0000	0.0150
28	-315	325	-0.3840	-319	320	-0.3834	0.0006	0.0150
30	-251	262	-0.3078	-255	257	-0.3072	0.0006	0.0144
32	-198	205	-0.2418	-201	200	-0.2406	0.0012	0.0138
34	-153	162	-0.1890	-156	156	-0.1872	0.0018	0.0126
36	-129	139	-0.1608	-130	133	-0.1578	0.0030	0.0108
38	-128	139	-0.1602	-127	130	-0.1542	0.0060	0.0078
40	-168	181	-0.2094	-175	178	-0.2118	-0.0024	0.0018
42	-269	279	-0.3288	-274	276	-0.3300	-0.0012	0.0042
44	-236	248	-0.2904	-240	244	-0.2904	0.0000	0.0054
46	-189	202	-0.2346	-193	197	-0.2340	0.0006	0.0054
48	-186	197	-0.2298	-189	191	-0.2280	0.0018	0.0048
50	-169	181	-0.2100	-172	176	-0.2088	0.0012	0.0030
52	-97	107	-0.1224	-100	102	-0.1212	0.0012	0.0018
54	-1	15	-0.0096	-5	10	-0.0090	0.0006	0.0006
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-29A

DESCRIPTION

CURRENT SURVEY 10/20/2009 12:43:03 PM

INITIAL SURVEY 8/19/2009 2:10:15 PM

DATE PRINTED 12/8/2009 11:00:11 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	141	-131	0.1632	157	-150	0.1842	0.0210	0.0576
4	174	-161	0.2010	179	-168	0.2082	0.0072	0.0366
6	152	-137	0.1734	149	-137	0.1716	-0.0018	0.0294
8	80	-69	0.0894	77	-68	0.0870	-0.0024	0.0312
10	39	-23	0.0372	39	-26	0.0390	0.0018	0.0336
12	36	-27	0.0378	36	-29	0.0390	0.0012	0.0318
14	47	-35	0.0492	49	-39	0.0528	0.0036	0.0306
16	30	-18	0.0288	31	-19	0.0300	0.0012	0.0270
18	-14	25	-0.0234	-14	24	-0.0228	0.0006	0.0258
20	-91	103	-0.1164	-90	102	-0.1152	0.0012	0.0252
22	-201	209	-0.2460	-200	209	-0.2454	0.0006	0.0240
24	-294	308	-0.3612	-294	308	-0.3612	0.0000	0.0234
26	-347	357	-0.4224	-349	357	-0.4236	-0.0012	0.0234
28	-315	325	-0.3840	-317	323	-0.3840	0.0000	0.0246
30	-251	262	-0.3078	-251	261	-0.3072	0.0006	0.0246
32	-198	205	-0.2418	-194	203	-0.2382	0.0036	0.0240
34	-153	162	-0.1890	-152	159	-0.1866	0.0024	0.0204
36	-129	139	-0.1608	-127	136	-0.1578	0.0030	0.0180
38	-128	139	-0.1602	-122	132	-0.1524	0.0078	0.0150
40	-168	181	-0.2094	-172	183	-0.2130	-0.0036	0.0072
42	-269	279	-0.3288	-270	279	-0.3294	-0.0006	0.0108
44	-236	248	-0.2904	-235	246	-0.2886	0.0018	0.0114
46	-189	202	-0.2346	-187	200	-0.2322	0.0024	0.0096
48	-186	197	-0.2298	-185	194	-0.2274	0.0024	0.0072
50	-169	181	-0.2100	-168	179	-0.2082	0.0018	0.0048
52	-97	107	-0.1224	-98	106	-0.1224	0.0000	0.0030
54	-1	15	-0.0096	2	13	-0.0066	0.0030	0.0030
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-29A
DESCRIPTION

CURRENT SURVEY 11/17/2009 2:24:32 PM
INITIAL SURVEY 8/19/2009 2:10:15 PM

DATE PRINTED 12/8/2009 11:00:11 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	141	-131	0.1632	156	-154	0.1860	0.0228	0.0360
4	174	-161	0.2010	177	-172	0.2094	0.0084	0.0132
6	152	-137	0.1734	147	-139	0.1716	-0.0018	0.0048
8	80	-69	0.0894	73	-69	0.0852	-0.0042	0.0066
10	39	-23	0.0372	36	-29	0.0390	0.0018	0.0108
12	36	-27	0.0378	31	-29	0.0360	-0.0018	0.0090
14	47	-35	0.0492	45	-39	0.0504	0.0012	0.0108
16	30	-18	0.0288	28	-21	0.0294	0.0006	0.0096
18	-14	25	-0.0234	-17	21	-0.0228	0.0006	0.0090
20	-91	103	-0.1164	-91	98	-0.1134	0.0030	0.0084
22	-201	209	-0.2460	-202	205	-0.2442	0.0018	0.0054
24	-294	308	-0.3612	-296	302	-0.3588	0.0024	0.0036
26	-347	357	-0.4224	-347	351	-0.4188	0.0036	0.0012
28	-315	325	-0.3840	-319	322	-0.3846	-0.0006	-0.0024
30	-251	262	-0.3078	-256	261	-0.3102	-0.0024	-0.0018
32	-198	205	-0.2418	-202	202	-0.2424	-0.0006	0.0006
34	-153	162	-0.1890	-157	159	-0.1896	-0.0006	0.0012
36	-129	139	-0.1608	-130	134	-0.1584	0.0024	0.0018
38	-128	139	-0.1602	-126	130	-0.1536	0.0066	-0.0006
40	-168	181	-0.2094	-175	178	-0.2118	-0.0024	-0.0072
42	-269	279	-0.3288	-273	276	-0.3294	-0.0006	-0.0048
44	-236	248	-0.2904	-243	245	-0.2928	-0.0024	-0.0042
46	-189	202	-0.2346	-190	198	-0.2328	0.0018	-0.0018
48	-186	197	-0.2298	-189	193	-0.2292	0.0006	-0.0036
50	-169	181	-0.2100	-172	177	-0.2094	0.0006	-0.0042
52	-97	107	-0.1224	-102	107	-0.1254	-0.0030	-0.0048
54	-1	15	-0.0096	-5	14	-0.0114	-0.0018	-0.0018
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-29A

DESCRIPTION

CURRENT SURVEY 12/7/2009 1:33:48 PM

INITIAL SURVEY 8/19/2009 2:10:15 PM

DATE PRINTED 12/8/2009 11:00:12 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	141	-131	0.1632	158	-154	0.1872	0.0240	0.0468
4	174	-161	0.2010	179	-171	0.2100	0.0090	0.0228
6	152	-137	0.1734	147	-138	0.1710	-0.0024	0.0138
8	80	-69	0.0894	74	-67	0.0846	-0.0048	0.0162
10	39	-23	0.0372	37	-27	0.0384	0.0012	0.0210
12	36	-27	0.0378	34	-27	0.0366	-0.0012	0.0198
14	47	-35	0.0492	46	-39	0.0510	0.0018	0.0210
16	30	-18	0.0288	29	-21	0.0300	0.0012	0.0192
18	-14	25	-0.0234	-15	22	-0.0222	0.0012	0.0180
20	-91	103	-0.1164	-90	99	-0.1134	0.0030	0.0168
22	-201	209	-0.2460	-201	207	-0.2448	0.0012	0.0138
24	-294	308	-0.3612	-293	303	-0.3576	0.0036	0.0126
26	-347	357	-0.4224	-344	349	-0.4158	0.0066	0.0090
28	-315	325	-0.3840	-317	320	-0.3822	0.0018	0.0024
30	-251	262	-0.3078	-254	261	-0.3090	-0.0012	0.0006
32	-198	205	-0.2418	-203	205	-0.2448	-0.0030	0.0018
34	-153	162	-0.1890	-157	162	-0.1914	-0.0024	0.0048
36	-129	139	-0.1608	-130	137	-0.1602	0.0006	0.0072
38	-128	139	-0.1602	-123	131	-0.1524	0.0078	0.0066
40	-168	181	-0.2094	-174	182	-0.2136	-0.0042	-0.0012
42	-269	279	-0.3288	-271	277	-0.3288	0.0000	0.0030
44	-236	248	-0.2904	-238	246	-0.2904	0.0000	0.0030
46	-189	202	-0.2346	-189	199	-0.2328	0.0018	0.0030
48	-186	197	-0.2298	-187	193	-0.2280	0.0018	0.0012
50	-169	181	-0.2100	-170	178	-0.2088	0.0012	-0.0006
52	-97	107	-0.1224	-102	106	-0.1248	-0.0024	-0.0018
54	-1	15	-0.0096	-3	12	-0.0090	0.0006	0.0006
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-29A

DESCRIPTION

CURRENT SURVEY 9/15/2009 12:30:54 PM

INITIAL SURVEY 8/19/2009 2:10:15 PM

DATE PRINTED 12/8/2009 11:00:24 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-284	351	-0.3810	-283	346	-0.3774	0.0036	-0.0522
4	-273	339	-0.3672	-277	336	-0.3678	-0.0006	-0.0558
6	-280	339	-0.3714	-285	337	-0.3732	-0.0018	-0.0552
8	-297	357	-0.3924	-297	355	-0.3912	0.0012	-0.0534
10	-301	362	-0.3978	-305	359	-0.3984	-0.0006	-0.0546
12	-259	318	-0.3462	-268	323	-0.3546	-0.0084	-0.0540
14	-150	206	-0.2136	-154	208	-0.2172	-0.0036	-0.0456
16	-63	111	-0.1044	-67	110	-0.1062	-0.0018	-0.0420
18	27	34	-0.0042	22	34	-0.0072	-0.0030	-0.0402
20	120	-86	0.1236	115	-86	0.1206	-0.0030	-0.0372
22	310	-277	0.3522	304	-277	0.3486	-0.0036	-0.0342
24	513	-465	0.5868	510	-465	0.5850	-0.0018	-0.0306
26	583	-532	0.6690	581	-532	0.6678	-0.0012	-0.0288
28	503	-440	0.5658	499	-443	0.5652	-0.0006	-0.0276
30	421	-357	0.4668	417	-359	0.4656	-0.0012	-0.0270
32	357	-293	0.3900	353	-293	0.3876	-0.0024	-0.0258
34	333	-266	0.3594	327	-266	0.3558	-0.0036	-0.0234
36	310	-255	0.3390	305	-254	0.3354	-0.0036	-0.0198
38	279	-214	0.2958	280	-220	0.3000	0.0042	-0.0162
40	221	-173	0.2364	220	-179	0.2394	0.0030	-0.0204
42	91	-36	0.0762	79	-29	0.0648	-0.0114	-0.0234
44	-27	81	-0.0648	-29	77	-0.0636	0.0012	-0.0120
46	-150	194	-0.2064	-151	191	-0.2052	0.0012	-0.0132
48	-211	270	-0.2886	-215	272	-0.2922	-0.0036	-0.0144
50	-333	369	-0.4212	-337	368	-0.4230	-0.0018	-0.0108
52	-595	638	-0.7398	-598	636	-0.7404	-0.0006	-0.0090
54	-645	678	-0.7938	-653	684	-0.8022	-0.0084	-0.0084
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-29A

DESCRIPTION

CURRENT SURVEY 10/20/2009 12:43:03 PM

INITIAL SURVEY 8/19/2009 2:10:15 PM

DATE PRINTED 12/8/2009 11:00:24 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-284	351	-0.3810	-279	343	-0.3732	0.0078	0.0120
4	-273	339	-0.3672	-272	338	-0.3660	0.0012	0.0042
6	-280	339	-0.3714	-280	337	-0.3702	0.0012	0.0030
8	-297	357	-0.3924	-294	357	-0.3906	0.0018	0.0018
10	-301	362	-0.3978	-303	363	-0.3996	-0.0018	0.0000
12	-259	318	-0.3462	-264	319	-0.3498	-0.0036	0.0018
14	-150	206	-0.2136	-151	203	-0.2124	0.0012	0.0054
16	-63	111	-0.1044	-61	109	-0.1020	0.0024	0.0042
18	27	34	-0.0042	27	33	-0.0036	0.0006	0.0018
20	120	-86	0.1236	118	-86	0.1224	-0.0012	0.0012
22	310	-277	0.3522	308	-276	0.3504	-0.0018	0.0024
24	513	-465	0.5868	514	-461	0.5850	-0.0018	0.0042
26	583	-532	0.6690	581	-528	0.6654	-0.0036	0.0060
28	503	-440	0.5658	502	-442	0.5664	0.0006	0.0096
30	421	-357	0.4668	420	-360	0.4680	0.0012	0.0090
32	357	-293	0.3900	357	-295	0.3912	0.0012	0.0078
34	333	-266	0.3594	334	-267	0.3606	0.0012	0.0066
36	310	-255	0.3390	310	-253	0.3378	-0.0012	0.0054
38	279	-214	0.2958	282	-221	0.3018	0.0060	0.0066
40	221	-173	0.2364	223	-177	0.2400	0.0036	0.0006
42	91	-36	0.0762	83	-28	0.0666	-0.0096	-0.0030
44	-27	81	-0.0648	-26	77	-0.0618	0.0030	0.0066
46	-150	194	-0.2064	-145	191	-0.2016	0.0048	0.0036
48	-211	270	-0.2886	-210	272	-0.2892	-0.0006	-0.0012
50	-333	369	-0.4212	-331	368	-0.4194	0.0018	-0.0006
52	-595	638	-0.7398	-593	636	-0.7374	0.0024	-0.0024
54	-645	678	-0.7938	-650	681	-0.7986	-0.0048	-0.0048
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-29A

DESCRIPTION

CURRENT SURVEY 11/17/2009 2:24:32 PM

INITIAL SURVEY 8/19/2009 2:10:15 PM

DATE PRINTED 12/8/2009 11:00:24 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-284	351	-0.3810	-277	348	-0.3750	0.0060	0.0150
4	-273	339	-0.3672	-269	341	-0.3660	0.0012	0.0090
6	-280	339	-0.3714	-277	341	-0.3708	0.0006	0.0078
8	-297	357	-0.3924	-292	359	-0.3906	0.0018	0.0072
10	-301	362	-0.3978	-302	366	-0.4008	-0.0030	0.0054
12	-259	318	-0.3462	-265	326	-0.3546	-0.0084	0.0084
14	-150	206	-0.2136	-147	209	-0.2136	0.0000	0.0168
16	-63	111	-0.1044	-61	110	-0.1026	0.0018	0.0168
18	27	34	-0.0042	26	38	-0.0072	-0.0030	0.0150
20	120	-86	0.1236	119	-83	0.1212	-0.0024	0.0180
22	310	-277	0.3522	307	-272	0.3474	-0.0048	0.0204
24	513	-465	0.5868	513	-456	0.5814	-0.0054	0.0252
26	583	-532	0.6690	579	-519	0.6588	-0.0102	0.0306
28	503	-440	0.5658	503	-437	0.5640	-0.0018	0.0408
30	421	-357	0.4668	425	-361	0.4716	0.0048	0.0426
32	357	-293	0.3900	363	-305	0.4008	0.0108	0.0378
34	333	-266	0.3594	341	-267	0.3648	0.0054	0.0270
36	310	-255	0.3390	314	-257	0.3426	0.0036	0.0216
38	279	-214	0.2958	287	-217	0.3024	0.0066	0.0180
40	221	-173	0.2364	226	-178	0.2424	0.0060	0.0114
42	91	-36	0.0762	85	-29	0.0684	-0.0078	0.0054
44	-27	81	-0.0648	-21	79	-0.0600	0.0048	0.0132
46	-150	194	-0.2064	-143	193	-0.2016	0.0048	0.0084
48	-211	270	-0.2886	-207	275	-0.2892	-0.0006	0.0036
50	-333	369	-0.4212	-329	366	-0.4170	0.0042	0.0042
52	-595	638	-0.7398	-589	630	-0.7314	0.0084	0.0000
54	-645	678	-0.7938	-651	686	-0.8022	-0.0084	-0.0084
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-29A

DESCRIPTION

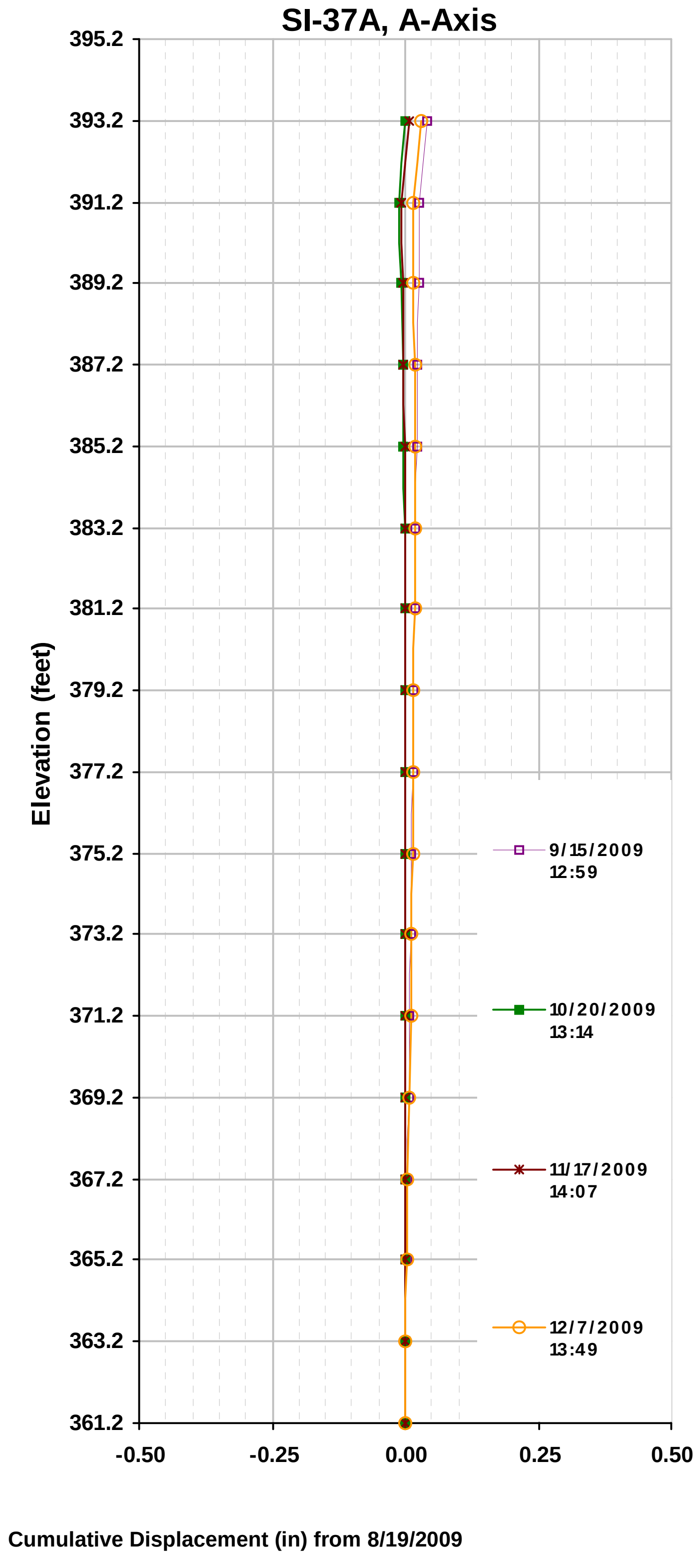
CURRENT SURVEY 12/7/2009 1:33:48 PM

INITIAL SURVEY 8/19/2009 2:10:15 PM

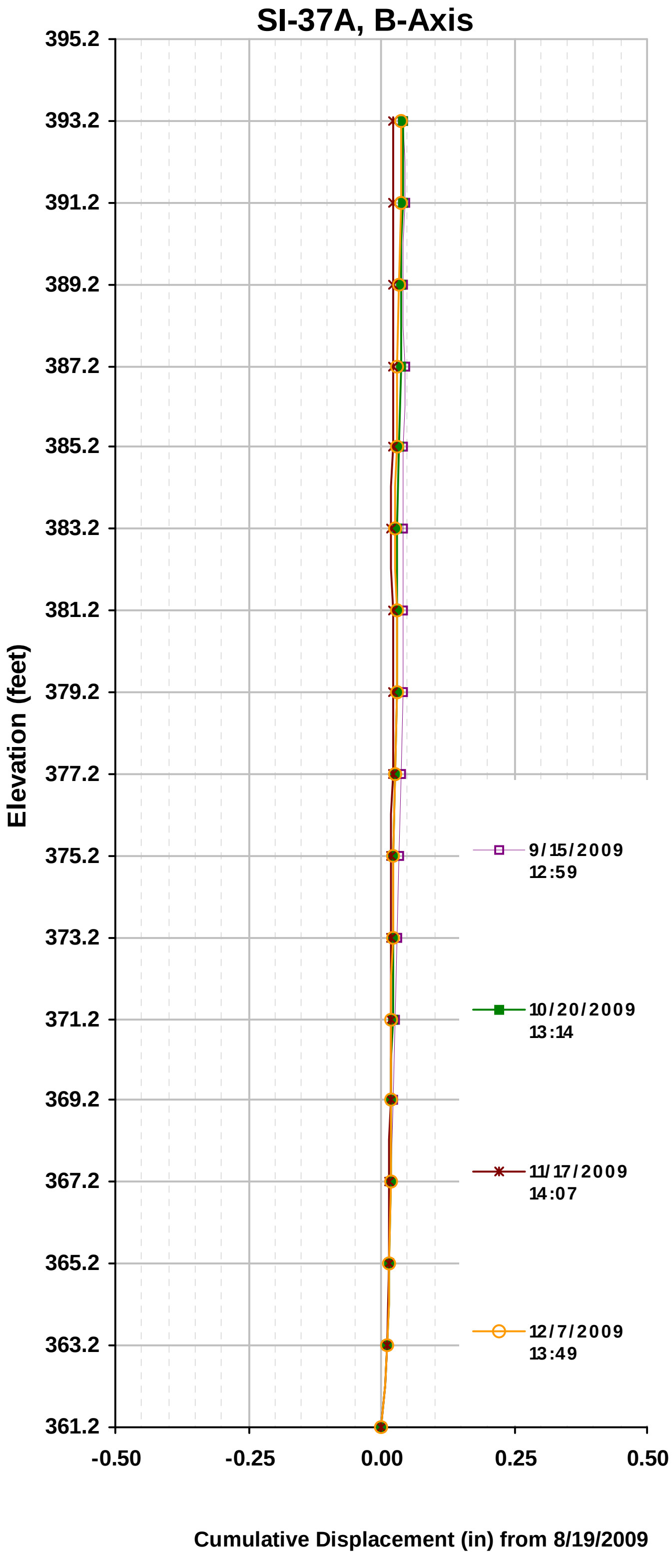
DATE PRINTED 12/8/2009 11:00:24 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-284	351	-0.3810	-277	346	-0.3738	0.0072	0.0024
4	-273	339	-0.3672	-270	340	-0.3660	0.0012	-0.0048
6	-280	339	-0.3714	-278	341	-0.3714	0.0000	-0.0060
8	-297	357	-0.3924	-293	357	-0.3900	0.0024	-0.0060
10	-301	362	-0.3978	-302	362	-0.3984	-0.0006	-0.0084
12	-259	318	-0.3462	-263	327	-0.3540	-0.0078	-0.0078
14	-150	206	-0.2136	-155	213	-0.2208	-0.0072	0.0000
16	-63	111	-0.1044	-61	113	-0.1044	0.0000	0.0072
18	27	34	-0.0042	27	38	-0.0066	-0.0024	0.0072
20	120	-86	0.1236	120	-81	0.1206	-0.0030	0.0096
22	310	-277	0.3522	306	-274	0.3480	-0.0042	0.0126
24	513	-465	0.5868	511	-453	0.5784	-0.0084	0.0168
26	583	-532	0.6690	573	-515	0.6528	-0.0162	0.0252
28	503	-440	0.5658	496	-430	0.5556	-0.0102	0.0414
30	421	-357	0.4668	423	-358	0.4686	0.0018	0.0516
32	357	-293	0.3900	367	-299	0.3996	0.0096	0.0498
34	333	-266	0.3594	343	-273	0.3696	0.0102	0.0402
36	310	-255	0.3390	317	-255	0.3432	0.0042	0.0300
38	279	-214	0.2958	286	-218	0.3024	0.0066	0.0258
40	221	-173	0.2364	228	-175	0.2418	0.0054	0.0192
42	91	-36	0.0762	86	-27	0.0678	-0.0084	0.0138
44	-27	81	-0.0648	-23	79	-0.0612	0.0036	0.0222
46	-150	194	-0.2064	-143	189	-0.1992	0.0072	0.0186
48	-211	270	-0.2886	-206	270	-0.2856	0.0030	0.0114
50	-333	369	-0.4212	-327	363	-0.4140	0.0072	0.0084
52	-595	638	-0.7398	-587	629	-0.7296	0.0102	0.0012
54	-645	678	-0.7938	-654	684	-0.8028	-0.0090	-0.0090
56	0	0	0.0000	0	0	0.0000	0.0000	0.0000

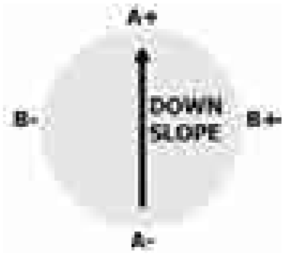


SI-37A, A-Axis



SI-37A, B-Axis

Stantec



Cumberland Fossil Plant
B-37
Cumberland City, TN
175539009
12/8/2009

SITE CUFTVA
INSTALLATION SI-37A
DESCRIPTION

CURRENT SURVEY 9/15/2009 12:59:47 PM
INITIAL SURVEY 8/19/2009 2:35:44 PM

DATE PRINTED 12/8/2009 11:02:53 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-28	37	-0.0390	-17	22	-0.0234	0.0156	0.0408
4	50	-42	0.0552	49	-44	0.0558	0.0006	0.0252
6	123	-114	0.1422	123	-117	0.1440	0.0018	0.0246
8	121	-114	0.1410	120	-117	0.1422	0.0012	0.0228
10	162	-155	0.1902	162	-158	0.1920	0.0018	0.0216
12	194	-186	0.2280	194	-189	0.2298	0.0018	0.0198
14	155	-147	0.1812	156	-150	0.1836	0.0024	0.0180
16	123	-114	0.1422	123	-117	0.1440	0.0018	0.0156
18	102	-96	0.1188	102	-99	0.1206	0.0018	0.0138
20	88	-82	0.1020	88	-85	0.1038	0.0018	0.0120
22	42	-35	0.0462	42	-38	0.0480	0.0018	0.0102
24	18	-10	0.0168	18	-14	0.0192	0.0024	0.0084
26	62	-55	0.0702	62	-58	0.0720	0.0018	0.0060
28	74	-67	0.0846	74	-70	0.0864	0.0018	0.0042
30	91	-86	0.1062	92	-89	0.1086	0.0024	0.0024
32	129	-121	0.1500	127	-123	0.1500	0.0000	0.0000
34	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-37A

DESCRIPTION

CURRENT SURVEY 10/20/2009 1:14:41 PM

INITIAL SURVEY 8/19/2009 2:35:44 PM

DATE PRINTED 12/8/2009 11:02:53 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-28	37	-0.0390	-15	29	-0.0264	0.0126	0.0012
4	50	-42	0.0552	50	-35	0.0510	-0.0042	-0.0114
6	123	-114	0.1422	124	-109	0.1398	-0.0024	-0.0072
8	121	-114	0.1410	122	-110	0.1392	-0.0018	-0.0048
10	162	-155	0.1902	164	-151	0.1890	-0.0012	-0.0030
12	194	-186	0.2280	197	-182	0.2274	-0.0006	-0.0018
14	155	-147	0.1812	159	-144	0.1818	0.0006	-0.0012
16	123	-114	0.1422	126	-110	0.1416	-0.0006	-0.0018
18	102	-96	0.1188	105	-91	0.1176	-0.0012	-0.0012
20	88	-82	0.1020	91	-78	0.1014	-0.0006	0.0000
22	42	-35	0.0462	46	-31	0.0462	0.0000	0.0006
24	18	-10	0.0168	22	-6	0.0168	0.0000	0.0006
26	62	-55	0.0702	66	-51	0.0702	0.0000	0.0006
28	74	-67	0.0846	77	-65	0.0852	0.0006	0.0006
30	91	-86	0.1062	95	-82	0.1062	0.0000	0.0000
32	129	-121	0.1500	132	-118	0.1500	0.0000	0.0000
34	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-37A
DESCRIPTION

CURRENT SURVEY 11/17/2009 2:07:57 PM
INITIAL SURVEY 8/19/2009 2:35:44 PM

DATE PRINTED 12/8/2009 11:02:53 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-28	37	-0.0390	-14	25	-0.0234	0.0156	0.0078
4	50	-42	0.0552	49	-38	0.0522	-0.0030	-0.0078
6	123	-114	0.1422	123	-111	0.1404	-0.0018	-0.0048
8	121	-114	0.1410	121	-111	0.1392	-0.0018	-0.0030
10	162	-155	0.1902	162	-153	0.1890	-0.0012	-0.0012
12	194	-186	0.2280	195	-184	0.2274	-0.0006	0.0000
14	155	-147	0.1812	158	-146	0.1824	0.0012	0.0006
16	123	-114	0.1422	124	-113	0.1422	0.0000	-0.0006
18	102	-96	0.1188	103	-93	0.1176	-0.0012	-0.0006
20	88	-82	0.1020	90	-80	0.1020	0.0000	0.0006
22	42	-35	0.0462	44	-33	0.0462	0.0000	0.0006
24	18	-10	0.0168	19	-8	0.0162	-0.0006	0.0006
26	62	-55	0.0702	64	-53	0.0702	0.0000	0.0012
28	74	-67	0.0846	76	-66	0.0852	0.0006	0.0012
30	91	-86	0.1062	94	-85	0.1074	0.0012	0.0006
32	129	-121	0.1500	130	-119	0.1494	-0.0006	-0.0006
34	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-37A

DESCRIPTION

CURRENT SURVEY 12/7/2009 1:49:45 PM

INITIAL SURVEY 8/19/2009 2:35:44 PM

DATE PRINTED 12/8/2009 11:02:53 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-28	37	-0.0390	-11	28	-0.0234	0.0156	0.0300
4	50	-42	0.0552	53	-35	0.0528	-0.0024	0.0144
6	123	-114	0.1422	126	-109	0.1410	-0.0012	0.0168
8	121	-114	0.1410	125	-109	0.1404	-0.0006	0.0180
10	162	-155	0.1902	167	-151	0.1908	0.0006	0.0186
12	194	-186	0.2280	199	-182	0.2286	0.0006	0.0180
14	155	-147	0.1812	162	-144	0.1836	0.0024	0.0174
16	123	-114	0.1422	129	-111	0.1440	0.0018	0.0150
18	102	-96	0.1188	107	-91	0.1188	0.0000	0.0132
20	88	-82	0.1020	95	-78	0.1038	0.0018	0.0132
22	42	-35	0.0462	49	-31	0.0480	0.0018	0.0114
24	18	-10	0.0168	25	-7	0.0192	0.0024	0.0096
26	62	-55	0.0702	69	-51	0.0720	0.0018	0.0072
28	74	-67	0.0846	81	-63	0.0864	0.0018	0.0054
30	91	-86	0.1062	98	-82	0.1080	0.0018	0.0036
32	129	-121	0.1500	135	-118	0.1518	0.0018	0.0018
34	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-37A

DESCRIPTION

CURRENT SURVEY 9/15/2009 12:59:47 PM

INITIAL SURVEY 8/19/2009 2:35:44 PM

DATE PRINTED 12/8/2009 11:03:01 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-19	81	-0.0600	-22	83	-0.0630	-0.0030	0.0408
4	-69	125	-0.1164	-68	125	-0.1158	0.0006	0.0438
6	-81	145	-0.1356	-81	146	-0.1362	-0.0006	0.0432
8	-81	140	-0.1326	-79	139	-0.1308	0.0018	0.0438
10	-54	117	-0.1026	-53	116	-0.1014	0.0012	0.0420
12	-10	73	-0.0498	-10	72	-0.0492	0.0006	0.0408
14	14	29	-0.0090	14	28	-0.0084	0.0006	0.0402
16	18	45	-0.0162	19	42	-0.0138	0.0024	0.0396
18	-9	65	-0.0444	-6	62	-0.0408	0.0036	0.0372
20	-21	76	-0.0582	-18	74	-0.0552	0.0030	0.0336
22	-45	106	-0.0906	-43	103	-0.0876	0.0030	0.0306
24	-54	102	-0.0936	-50	99	-0.0894	0.0042	0.0276
26	22	37	-0.0090	23	33	-0.0060	0.0030	0.0234
28	51	5	0.0276	56	3	0.0318	0.0042	0.0204
30	40	21	0.0114	43	17	0.0156	0.0042	0.0162
32	7	41	-0.0204	24	38	-0.0084	0.0120	0.0120
34	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-37A

DESCRIPTION

CURRENT SURVEY 10/20/2009 1:14:41 PM

INITIAL SURVEY 8/19/2009 2:35:44 PM

DATE PRINTED 12/8/2009 11:03:01 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-19	81	-0.0600	-18	82	-0.0600	0.0000	0.0408
4	-69	125	-0.1164	-67	123	-0.1140	0.0024	0.0408
6	-81	145	-0.1356	-81	143	-0.1344	0.0012	0.0384
8	-81	140	-0.1326	-79	137	-0.1296	0.0030	0.0372
10	-54	117	-0.1026	-52	112	-0.0984	0.0042	0.0342
12	-10	73	-0.0498	-11	73	-0.0504	-0.0006	0.0300
14	14	29	-0.0090	14	28	-0.0084	0.0006	0.0306
16	18	45	-0.0162	19	42	-0.0138	0.0024	0.0300
18	-9	65	-0.0444	-5	62	-0.0402	0.0042	0.0276
20	-21	76	-0.0582	-19	76	-0.0570	0.0012	0.0234
22	-45	106	-0.0906	-44	105	-0.0894	0.0012	0.0222
24	-54	102	-0.0936	-55	100	-0.0930	0.0006	0.0210
26	22	37	-0.0090	24	37	-0.0078	0.0012	0.0204
28	51	5	0.0276	55	3	0.0312	0.0036	0.0192
30	40	21	0.0114	43	18	0.0150	0.0036	0.0156
32	7	41	-0.0204	24	38	-0.0084	0.0120	0.0120
34	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-37A

DESCRIPTION

CURRENT SURVEY 11/17/2009 2:07:57 PM

INITIAL SURVEY 8/19/2009 2:35:44 PM

DATE PRINTED 12/8/2009 11:03:01 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-19	81	-0.0600	-18	82	-0.0600	0.0000	0.0228
4	-69	125	-0.1164	-67	127	-0.1164	0.0000	0.0228
6	-81	145	-0.1356	-82	146	-0.1368	-0.0012	0.0228
8	-81	140	-0.1326	-78	139	-0.1302	0.0024	0.0240
10	-54	117	-0.1026	-53	115	-0.1008	0.0018	0.0216
12	-10	73	-0.0498	-13	75	-0.0528	-0.0030	0.0198
14	14	29	-0.0090	14	31	-0.0102	-0.0012	0.0228
16	18	45	-0.0162	19	44	-0.0150	0.0012	0.0240
18	-9	65	-0.0444	-5	65	-0.0420	0.0024	0.0228
20	-21	76	-0.0582	-18	77	-0.0570	0.0012	0.0204
22	-45	106	-0.0906	-44	106	-0.0900	0.0006	0.0192
24	-54	102	-0.0936	-52	102	-0.0924	0.0012	0.0186
26	22	37	-0.0090	23	37	-0.0084	0.0006	0.0174
28	51	5	0.0276	56	5	0.0306	0.0030	0.0168
30	40	21	0.0114	43	20	0.0138	0.0024	0.0138
32	7	41	-0.0204	22	37	-0.0090	0.0114	0.0114
34	0	0	0.0000	0	0	0.0000	0.0000	0.0000

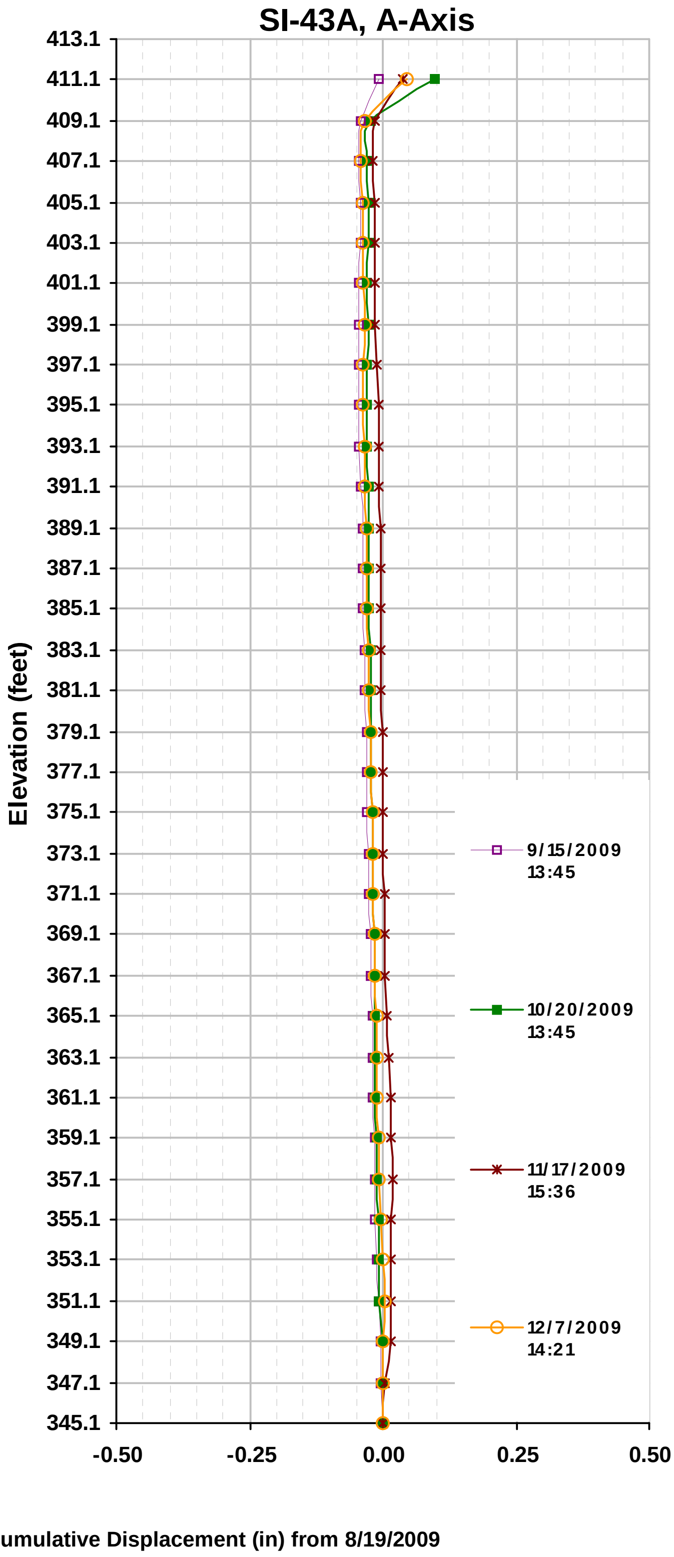
SITE CUFTVA
INSTALLATION SI-37A
DESCRIPTION

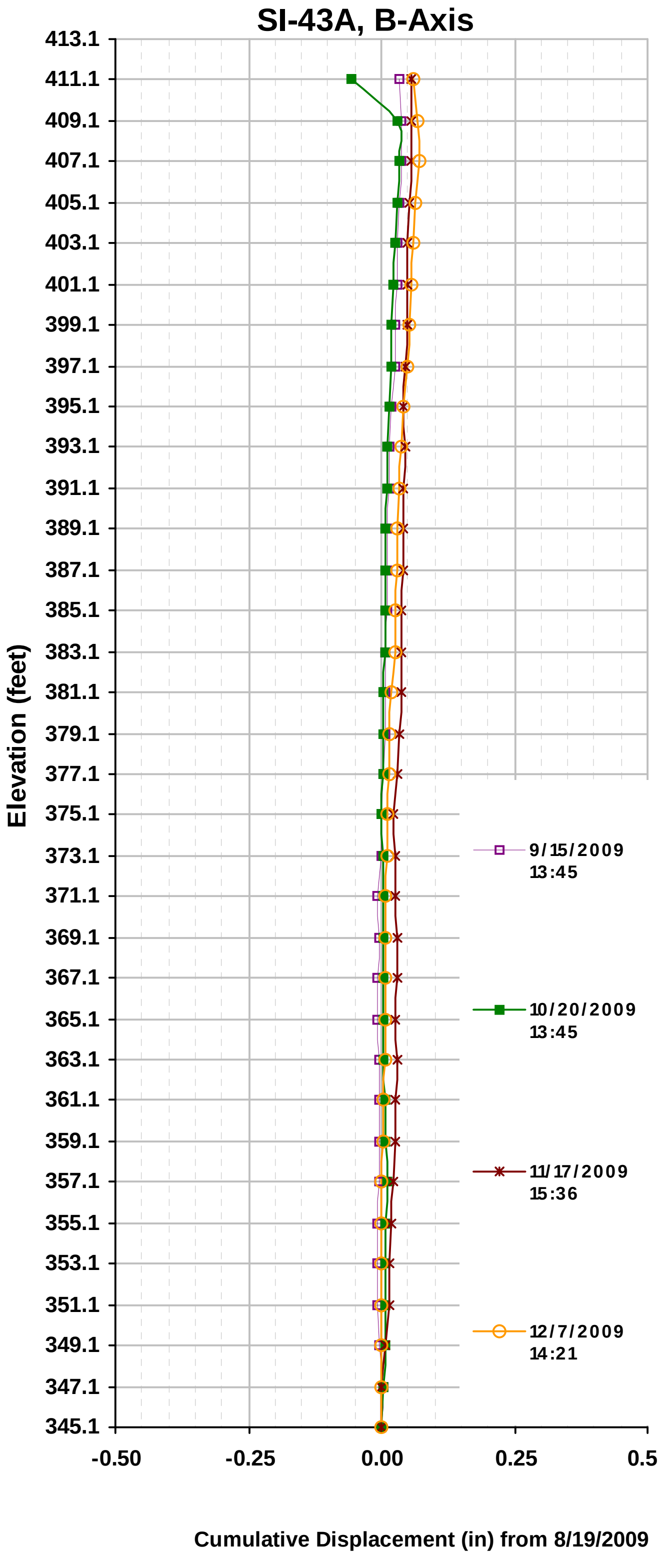
CURRENT SURVEY 12/7/2009 1:49:45 PM
INITIAL SURVEY 8/19/2009 2:35:44 PM

DATE PRINTED 12/8/2009 11:03:01 AM

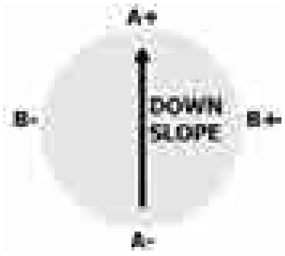
Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	-19	81	-0.0600	-14	83	-0.0582	0.0018	0.0378
4	-69	125	-0.1164	-63	127	-0.1140	0.0024	0.0360
6	-81	145	-0.1356	-78	145	-0.1338	0.0018	0.0336
8	-81	140	-0.1326	-76	140	-0.1296	0.0030	0.0318
10	-54	117	-0.1026	-49	117	-0.0996	0.0030	0.0288
12	-10	73	-0.0498	-9	78	-0.0522	-0.0024	0.0258
14	14	29	-0.0090	15	33	-0.0108	-0.0018	0.0282
16	18	45	-0.0162	23	45	-0.0132	0.0030	0.0300
18	-9	65	-0.0444	-2	66	-0.0408	0.0036	0.0270
20	-21	76	-0.0582	-16	78	-0.0564	0.0018	0.0234
22	-45	106	-0.0906	-40	109	-0.0894	0.0012	0.0216
24	-54	102	-0.0936	-50	105	-0.0930	0.0006	0.0204
26	22	37	-0.0090	26	40	-0.0084	0.0006	0.0198
28	51	5	0.0276	59	6	0.0318	0.0042	0.0192
30	40	21	0.0114	47	21	0.0156	0.0042	0.0150
32	7	41	-0.0204	25	41	-0.0096	0.0108	0.0108
34	0	0	0.0000	0	0	0.0000	0.0000	0.0000





Stantec



Cumberland Fossil Plant
B-43
Cumberland City, TN
175539009
12/8/2009

SITE CUFTVA

INSTALLATION SI-43A

DESCRIPTION

CURRENT SURVEY 9/15/2009 1:45:45 PM

INITIAL SURVEY 8/19/2009 3:12:33 PM

DATE PRINTED 12/8/2009 11:25:21 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	331	-313	0.3864	347	-351	0.4188	0.0324	-0.0072
4	391	-382	0.4638	392	-388	0.4680	0.0042	-0.0396
6	342	-341	0.4098	339	-342	0.4086	-0.0012	-0.0438
8	423	-418	0.5046	423	-419	0.5052	0.0006	-0.0426
10	485	-481	0.5796	485	-484	0.5814	0.0018	-0.0432
12	514	-508	0.6132	511	-509	0.6120	-0.0012	-0.0450
14	567	-560	0.6762	564	-565	0.6774	0.0012	-0.0438
16	670	-662	0.7992	666	-667	0.7998	0.0006	-0.0450
18	811	-806	0.9702	809	-806	0.9690	-0.0012	-0.0456
20	766	-762	0.9168	762	-762	0.9144	-0.0024	-0.0444
22	700	-694	0.8364	695	-694	0.8334	-0.0030	-0.0420
24	682	-677	0.8154	679	-678	0.8142	-0.0012	-0.0390
26	662	-657	0.7914	658	-658	0.7896	-0.0018	-0.0378
28	626	-619	0.7470	622	-620	0.7452	-0.0018	-0.0360
30	546	-542	0.6528	543	-542	0.6510	-0.0018	-0.0342
32	496	-491	0.5922	493	-492	0.5910	-0.0012	-0.0324
34	458	-455	0.5478	456	-455	0.5466	-0.0012	-0.0312
36	404	-401	0.4830	401	-401	0.4812	-0.0018	-0.0300
38	465	-458	0.5538	462	-460	0.5532	-0.0006	-0.0282
40	448	-443	0.5346	444	-444	0.5328	-0.0018	-0.0276
42	403	-396	0.4794	399	-397	0.4776	-0.0018	-0.0258
44	394	-388	0.4692	390	-389	0.4674	-0.0018	-0.0240
46	404	-397	0.4806	400	-397	0.4782	-0.0024	-0.0222
48	494	-489	0.5898	490	-490	0.5880	-0.0018	-0.0198
50	531	-527	0.6348	528	-529	0.6342	-0.0006	-0.0180
52	573	-567	0.6840	570	-569	0.6834	-0.0006	-0.0174
54	595	-589	0.7104	591	-590	0.7086	-0.0018	-0.0168
56	541	-531	0.6432	537	-532	0.6414	-0.0018	-0.0150
58	434	-426	0.5160	430	-426	0.5136	-0.0024	-0.0132
60	250	-244	0.2964	246	-243	0.2934	-0.0030	-0.0108
62	-1	8	-0.0054	-5	9	-0.0084	-0.0030	-0.0078
64	-323	335	-0.3948	-327	334	-0.3966	-0.0018	-0.0048
66	-560	567	-0.6762	-565	567	-0.6792	-0.0030	-0.0030
68	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-43A

DESCRIPTION

CURRENT SURVEY 10/20/2009 1:45:50 PM

INITIAL SURVEY 8/19/2009 3:12:33 PM

DATE PRINTED 12/8/2009 11:25:21 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	331	-313	0.3864	422	-424	0.5076	0.1212	0.0972
4	391	-382	0.4638	398	-385	0.4698	0.0060	-0.0240
6	342	-341	0.4098	343	-336	0.4074	-0.0024	-0.0300
8	423	-418	0.5046	427	-414	0.5046	0.0000	-0.0276
10	485	-481	0.5796	490	-478	0.5808	0.0012	-0.0276
12	514	-508	0.6132	516	-504	0.6120	-0.0012	-0.0288
14	567	-560	0.6762	570	-560	0.6780	0.0018	-0.0276
16	670	-662	0.7992	673	-659	0.7992	0.0000	-0.0294
18	811	-806	0.9702	814	-801	0.9690	-0.0012	-0.0294
20	766	-762	0.9168	769	-758	0.9162	-0.0006	-0.0282
22	700	-694	0.8364	701	-689	0.8340	-0.0024	-0.0276
24	682	-677	0.8154	685	-673	0.8148	-0.0006	-0.0252
26	662	-657	0.7914	665	-654	0.7914	0.0000	-0.0246
28	626	-619	0.7470	628	-616	0.7464	-0.0006	-0.0246
30	546	-542	0.6528	549	-538	0.6522	-0.0006	-0.0240
32	496	-491	0.5922	498	-487	0.5910	-0.0012	-0.0234
34	458	-455	0.5478	462	-450	0.5472	-0.0006	-0.0222
36	404	-401	0.4830	406	-395	0.4806	-0.0024	-0.0216
38	465	-458	0.5538	468	-455	0.5538	0.0000	-0.0192
40	448	-443	0.5346	450	-439	0.5334	-0.0012	-0.0192
42	403	-396	0.4794	404	-392	0.4776	-0.0018	-0.0180
44	394	-388	0.4692	396	-385	0.4686	-0.0006	-0.0162
46	404	-397	0.4806	405	-393	0.4788	-0.0018	-0.0156
48	494	-489	0.5898	497	-485	0.5892	-0.0006	-0.0138
50	531	-527	0.6348	535	-523	0.6348	0.0000	-0.0132
52	573	-567	0.6840	574	-563	0.6822	-0.0018	-0.0132
54	595	-589	0.7104	597	-586	0.7098	-0.0006	-0.0114
56	541	-531	0.6432	542	-527	0.6414	-0.0018	-0.0108
58	434	-426	0.5160	434	-422	0.5136	-0.0024	-0.0090
60	250	-244	0.2964	251	-242	0.2958	-0.0006	-0.0066
62	-1	8	-0.0054	-1	15	-0.0096	-0.0042	-0.0060
64	-323	335	-0.3948	-323	336	-0.3954	-0.0006	-0.0018
66	-560	567	-0.6762	-559	570	-0.6774	-0.0012	-0.0012
68	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-43A
DESCRIPTION

CURRENT SURVEY 11/17/2009 3:36:22 PM
INITIAL SURVEY 8/19/2009 3:12:33 PM

DATE PRINTED 12/8/2009 11:25:21 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	331	-313	0.3864	393	-335	0.4368	0.0504	0.0360
4	391	-382	0.4638	398	-383	0.4686	0.0048	-0.0144
6	342	-341	0.4098	344	-334	0.4068	-0.0030	-0.0192
8	423	-418	0.5046	427	-411	0.5028	-0.0018	-0.0162
10	485	-481	0.5796	490	-476	0.5796	0.0000	-0.0144
12	514	-508	0.6132	517	-503	0.6120	-0.0012	-0.0144
14	567	-560	0.6762	570	-554	0.6744	-0.0018	-0.0132
16	670	-662	0.7992	671	-657	0.7968	-0.0024	-0.0114
18	811	-806	0.9702	814	-799	0.9678	-0.0024	-0.0090
20	766	-762	0.9168	771	-757	0.9168	0.0000	-0.0066
22	700	-694	0.8364	703	-687	0.8340	-0.0024	-0.0066
24	682	-677	0.8154	687	-672	0.8154	0.0000	-0.0042
26	662	-657	0.7914	666	-651	0.7902	-0.0012	-0.0042
28	626	-619	0.7470	630	-615	0.7470	0.0000	-0.0030
30	546	-542	0.6528	551	-537	0.6528	0.0000	-0.0030
32	496	-491	0.5922	500	-485	0.5910	-0.0012	-0.0030
34	458	-455	0.5478	463	-450	0.5478	0.0000	-0.0018
36	404	-401	0.4830	408	-396	0.4824	-0.0006	-0.0018
38	465	-458	0.5538	468	-451	0.5514	-0.0024	-0.0012
40	448	-443	0.5346	452	-437	0.5334	-0.0012	0.0012
42	403	-396	0.4794	406	-391	0.4782	-0.0012	0.0024
44	394	-388	0.4692	397	-382	0.4674	-0.0018	0.0036
46	404	-397	0.4806	406	-392	0.4788	-0.0018	0.0054
48	494	-489	0.5898	494	-483	0.5862	-0.0036	0.0072
50	531	-527	0.6348	534	-520	0.6324	-0.0024	0.0108
52	573	-567	0.6840	575	-561	0.6816	-0.0024	0.0132
54	595	-589	0.7104	598	-583	0.7086	-0.0018	0.0156
56	541	-531	0.6432	545	-528	0.6438	0.0006	0.0174
58	434	-426	0.5160	439	-421	0.5160	0.0000	0.0168
60	250	-244	0.2964	255	-239	0.2964	0.0000	0.0168
62	-1	8	-0.0054	9	13	-0.0024	0.0030	0.0168
64	-323	335	-0.3948	-309	331	-0.3840	0.0108	0.0138
66	-560	567	-0.6762	-550	572	-0.6732	0.0030	0.0030
68	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-43A

DESCRIPTION

CURRENT SURVEY 12/7/2009 2:21:33 PM

INITIAL SURVEY 8/19/2009 3:12:33 PM

DATE PRINTED 12/8/2009 11:25:21 AM

Data Reduction for A Axis:

	Initial			Current				
Depth (ft)	A0	A180	Incr. Dev (in)	A0	A180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	331	-313	0.3864	376	-402	0.4668	0.0804	0.0450
4	391	-382	0.4638	395	-386	0.4686	0.0048	-0.0354
6	342	-341	0.4098	342	-335	0.4062	-0.0036	-0.0402
8	423	-418	0.5046	426	-414	0.5040	-0.0006	-0.0366
10	485	-481	0.5796	488	-478	0.5796	0.0000	-0.0360
12	514	-508	0.6132	515	-505	0.6120	-0.0012	-0.0360
14	567	-560	0.6762	570	-562	0.6792	0.0030	-0.0348
16	670	-662	0.7992	670	-660	0.7980	-0.0012	-0.0378
18	811	-806	0.9702	814	-801	0.9690	-0.0012	-0.0366
20	766	-762	0.9168	768	-757	0.9150	-0.0018	-0.0354
22	700	-694	0.8364	700	-690	0.8340	-0.0024	-0.0336
24	682	-677	0.8154	685	-673	0.8148	-0.0006	-0.0312
26	662	-657	0.7914	664	-652	0.7896	-0.0018	-0.0306
28	626	-619	0.7470	626	-615	0.7446	-0.0024	-0.0288
30	546	-542	0.6528	549	-537	0.6516	-0.0012	-0.0264
32	496	-491	0.5922	498	-486	0.5904	-0.0018	-0.0252
34	458	-455	0.5478	461	-450	0.5466	-0.0012	-0.0234
36	404	-401	0.4830	406	-395	0.4806	-0.0024	-0.0222
38	465	-458	0.5538	467	-455	0.5532	-0.0006	-0.0198
40	448	-443	0.5346	449	-439	0.5328	-0.0018	-0.0192
42	403	-396	0.4794	405	-392	0.4782	-0.0012	-0.0174
44	394	-388	0.4692	395	-384	0.4674	-0.0018	-0.0162
46	404	-397	0.4806	405	-393	0.4788	-0.0018	-0.0144
48	494	-489	0.5898	495	-485	0.5880	-0.0018	-0.0126
50	531	-527	0.6348	535	-522	0.6342	-0.0006	-0.0108
52	573	-567	0.6840	574	-562	0.6816	-0.0024	-0.0102
54	595	-589	0.7104	596	-585	0.7086	-0.0018	-0.0078
56	541	-531	0.6432	542	-527	0.6414	-0.0018	-0.0060
58	434	-426	0.5160	433	-421	0.5124	-0.0036	-0.0042
60	250	-244	0.2964	249	-238	0.2922	-0.0042	-0.0006
62	-1	8	-0.0054	0	14	0.0000	0.0054	0.0036
64	-323	335	-0.3948	-323	338	-0.3966	-0.0018	-0.0018
66	-560	567	-0.6762	-555	572	-0.6762	0.0000	0.0000
68	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-43A

DESCRIPTION

CURRENT SURVEY 9/15/2009 1:45:45 PM

INITIAL SURVEY 8/19/2009 3:12:33 PM

DATE PRINTED 12/8/2009 11:25:50 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	98	-70	0.1008	94	-68	0.0972	-0.0036	0.0330
4	-210	238	-0.2688	-212	240	-0.2712	-0.0024	0.0366
6	-353	413	-0.4596	-351	408	-0.4554	0.0042	0.0390
8	-455	501	-0.5736	-451	498	-0.5694	0.0042	0.0348
10	-523	582	-0.6630	-523	578	-0.6606	0.0024	0.0306
12	-537	601	-0.6828	-538	598	-0.6816	0.0012	0.0282
14	-477	518	-0.5970	-479	514	-0.5958	0.0012	0.0270
16	-331	370	-0.4206	-332	360	-0.4152	0.0054	0.0258
18	-116	167	-0.1698	-118	159	-0.1662	0.0036	0.0204
20	-49	110	-0.0954	-50	105	-0.0930	0.0024	0.0168
22	-64	126	-0.1140	-66	121	-0.1122	0.0018	0.0144
24	-135	191	-0.1956	-135	188	-0.1938	0.0018	0.0126
26	-214	269	-0.2898	-217	266	-0.2898	0.0000	0.0108
28	-205	261	-0.2796	-206	257	-0.2778	0.0018	0.0108
30	-256	314	-0.3420	-256	311	-0.3402	0.0018	0.0090
32	-320	381	-0.4206	-321	378	-0.4194	0.0012	0.0072
34	-377	440	-0.4902	-378	436	-0.4884	0.0018	0.0060
36	-429	489	-0.5508	-431	483	-0.5484	0.0024	0.0042
38	-352	398	-0.4500	-354	395	-0.4494	0.0006	0.0018
40	-261	319	-0.3480	-265	303	-0.3408	0.0072	0.0012
42	-181	246	-0.2562	-185	243	-0.2568	-0.0006	-0.0060
44	-138	203	-0.2046	-141	199	-0.2040	0.0006	-0.0054
46	-156	213	-0.2214	-159	209	-0.2208	0.0006	-0.0060
48	-160	204	-0.2184	-166	202	-0.2208	-0.0024	-0.0066
50	-177	235	-0.2472	-179	232	-0.2466	0.0006	-0.0042
52	-223	285	-0.3048	-226	282	-0.3048	0.0000	-0.0048
54	-296	357	-0.3918	-298	354	-0.3912	0.0006	-0.0048
56	-358	414	-0.4632	-361	410	-0.4626	0.0006	-0.0054
58	-427	469	-0.5376	-428	468	-0.5376	0.0000	-0.0060
60	-487	546	-0.6198	-491	542	-0.6198	0.0000	-0.0060
62	-569	629	-0.7188	-575	624	-0.7194	-0.0006	-0.0060
64	-680	735	-0.8490	-698	733	-0.8586	-0.0096	-0.0054
66	-753	767	-0.9120	-750	763	-0.9078	0.0042	0.0042
68	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-43A

DESCRIPTION

CURRENT SURVEY 10/20/2009 1:45:50 PM

INITIAL SURVEY 8/19/2009 3:12:33 PM

DATE PRINTED 12/8/2009 11:25:50 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	98	-70	0.1008	-29	-57	0.0168	-0.0840	-0.0558
4	-210	238	-0.2688	-213	244	-0.2742	-0.0054	0.0282
6	-353	413	-0.4596	-349	410	-0.4554	0.0042	0.0336
8	-455	501	-0.5736	-450	499	-0.5694	0.0042	0.0294
10	-523	582	-0.6630	-520	578	-0.6588	0.0042	0.0252
12	-537	601	-0.6828	-534	601	-0.6810	0.0018	0.0210
14	-477	518	-0.5970	-477	516	-0.5958	0.0012	0.0192
16	-331	370	-0.4206	-330	363	-0.4158	0.0048	0.0180
18	-116	167	-0.1698	-117	165	-0.1692	0.0006	0.0132
20	-49	110	-0.0954	-47	108	-0.0930	0.0024	0.0126
22	-64	126	-0.1140	-64	123	-0.1122	0.0018	0.0102
24	-135	191	-0.1956	-133	192	-0.1950	0.0006	0.0084
26	-214	269	-0.2898	-213	269	-0.2892	0.0006	0.0078
28	-205	261	-0.2796	-203	261	-0.2784	0.0012	0.0072
30	-256	314	-0.3420	-254	313	-0.3402	0.0018	0.0060
32	-320	381	-0.4206	-320	380	-0.4200	0.0006	0.0042
34	-377	440	-0.4902	-377	439	-0.4896	0.0006	0.0036
36	-429	489	-0.5508	-429	487	-0.5496	0.0012	0.0030
38	-352	398	-0.4500	-354	397	-0.4506	-0.0006	0.0018
40	-261	319	-0.3480	-262	318	-0.3480	0.0000	0.0024
42	-181	246	-0.2562	-182	245	-0.2562	0.0000	0.0024
44	-138	203	-0.2046	-139	202	-0.2046	0.0000	0.0024
46	-156	213	-0.2214	-156	213	-0.2214	0.0000	0.0024
48	-160	204	-0.2184	-162	207	-0.2214	-0.0030	0.0024
50	-177	235	-0.2472	-178	235	-0.2478	-0.0006	0.0054
52	-223	285	-0.3048	-225	285	-0.3060	-0.0012	0.0060
54	-296	357	-0.3918	-297	361	-0.3948	-0.0030	0.0072
56	-358	414	-0.4632	-358	412	-0.4620	0.0012	0.0102
58	-427	469	-0.5376	-426	469	-0.5370	0.0006	0.0090
60	-487	546	-0.6198	-489	545	-0.6204	-0.0006	0.0084
62	-569	629	-0.7188	-569	626	-0.7170	0.0018	0.0090
64	-680	735	-0.8490	-681	731	-0.8472	0.0018	0.0072
66	-753	767	-0.9120	-746	765	-0.9066	0.0054	0.0054
68	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA
INSTALLATION SI-43A
DESCRIPTION

CURRENT SURVEY 11/17/2009 3:36:22 PM
INITIAL SURVEY 8/19/2009 3:12:33 PM

DATE PRINTED 12/8/2009 11:25:50 AM

Data Reduction for B Axis:

	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	98	-70	0.1008	93	-73	0.0996	-0.0012	0.0570
4	-210	238	-0.2688	-206	242	-0.2688	0.0000	0.0582
6	-353	413	-0.4596	-347	411	-0.4548	0.0048	0.0582
8	-455	501	-0.5736	-447	504	-0.5706	0.0030	0.0534
10	-523	582	-0.6630	-520	582	-0.6612	0.0018	0.0504
12	-537	601	-0.6828	-535	601	-0.6816	0.0012	0.0486
14	-477	518	-0.5970	-476	517	-0.5958	0.0012	0.0474
16	-331	370	-0.4206	-329	367	-0.4176	0.0030	0.0462
18	-116	167	-0.1698	-121	166	-0.1722	-0.0024	0.0432
20	-49	110	-0.0954	-46	109	-0.0930	0.0024	0.0456
22	-64	126	-0.1140	-62	125	-0.1122	0.0018	0.0432
24	-135	191	-0.1956	-131	192	-0.1938	0.0018	0.0414
26	-214	269	-0.2898	-211	270	-0.2886	0.0012	0.0396
28	-205	261	-0.2796	-202	263	-0.2790	0.0006	0.0384
30	-256	314	-0.3420	-252	315	-0.3402	0.0018	0.0378
32	-320	381	-0.4206	-317	381	-0.4188	0.0018	0.0360
34	-377	440	-0.4902	-375	438	-0.4878	0.0024	0.0342
36	-429	489	-0.5508	-425	480	-0.5430	0.0078	0.0318
38	-352	398	-0.4500	-353	399	-0.4512	-0.0012	0.0240
40	-261	319	-0.3480	-262	322	-0.3504	-0.0024	0.0252
42	-181	246	-0.2562	-181	249	-0.2580	-0.0018	0.0276
44	-138	203	-0.2046	-136	205	-0.2046	0.0000	0.0294
46	-156	213	-0.2214	-151	213	-0.2184	0.0030	0.0294
48	-160	204	-0.2184	-159	208	-0.2202	-0.0018	0.0264
50	-177	235	-0.2472	-173	237	-0.2460	0.0012	0.0282
52	-223	285	-0.3048	-219	285	-0.3024	0.0024	0.0270
54	-296	357	-0.3918	-291	357	-0.3888	0.0030	0.0246
56	-358	414	-0.4632	-353	413	-0.4596	0.0036	0.0216
58	-427	469	-0.5376	-422	471	-0.5358	0.0018	0.0180
60	-487	546	-0.6198	-484	545	-0.6174	0.0024	0.0162
62	-569	629	-0.7188	-562	625	-0.7122	0.0066	0.0138
64	-680	735	-0.8490	-673	733	-0.8436	0.0054	0.0072
66	-753	767	-0.9120	-749	768	-0.9102	0.0018	0.0018
68	0	0	0.0000	0	0	0.0000	0.0000	0.0000

SITE CUFTVA

INSTALLATION SI-43A

DESCRIPTION

CURRENT SURVEY 12/7/2009 2:21:33 PM

INITIAL SURVEY 8/19/2009 3:12:33 PM

DATE PRINTED 12/8/2009 11:25:51 AM

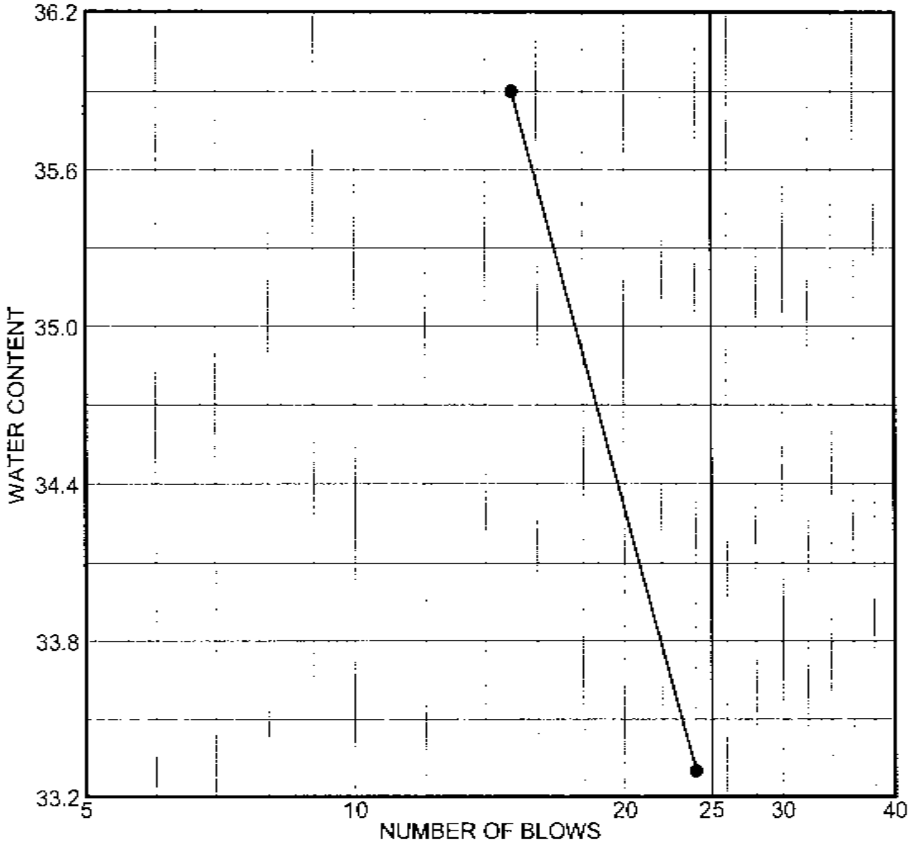
Data Reduction for B Axis:

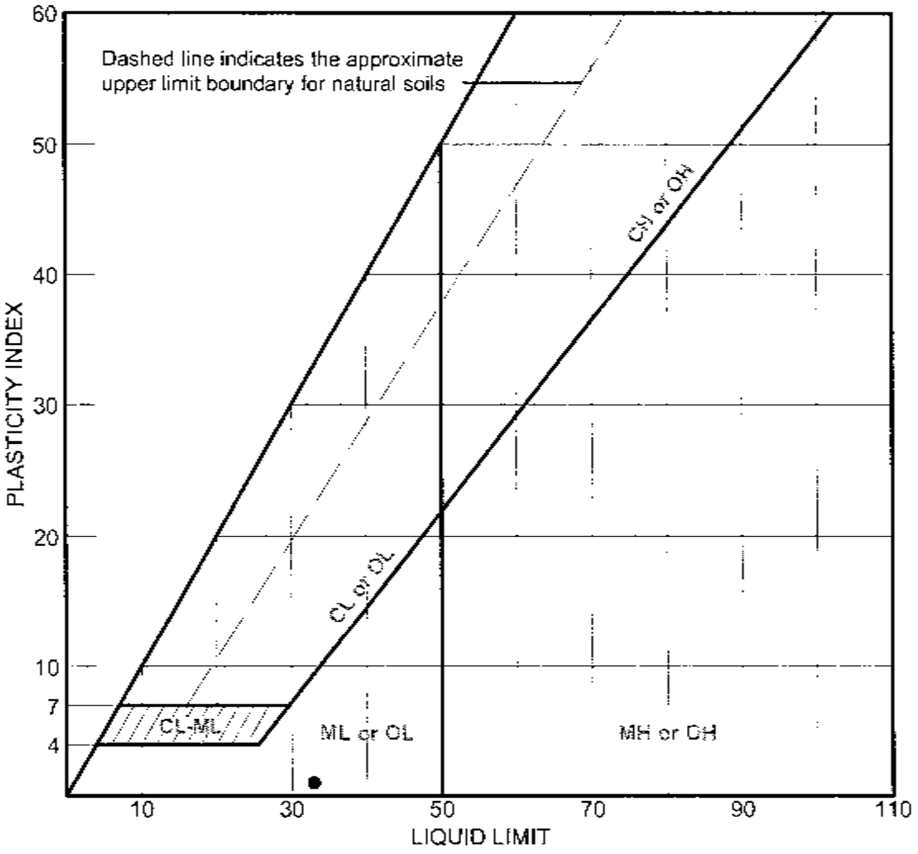
	Initial			Current				
Depth (ft)	B0	B180	Incr. Dev (in)	B0	B180	Incr. Dev (in)	Incr. Disp. (in)	Cum. Disp. (in)
2	98	-70	0.1008	96	-65	0.0966	-0.0042	0.0618
4	-210	238	-0.2688	-210	245	-0.2730	-0.0042	0.0660
6	-353	413	-0.4596	-346	411	-0.4542	0.0054	0.0702
8	-455	501	-0.5736	-445	502	-0.5682	0.0054	0.0648
10	-523	582	-0.6630	-518	582	-0.6600	0.0030	0.0594
12	-537	601	-0.6828	-531	601	-0.6792	0.0036	0.0564
14	-477	518	-0.5970	-474	517	-0.5946	0.0024	0.0528
16	-331	370	-0.4206	-326	362	-0.4128	0.0078	0.0504
18	-116	167	-0.1698	-112	163	-0.1650	0.0048	0.0426
20	-49	110	-0.0954	-46	109	-0.0930	0.0024	0.0378
22	-64	126	-0.1140	-59	124	-0.1098	0.0042	0.0354
24	-135	191	-0.1956	-129	193	-0.1932	0.0024	0.0312
26	-214	269	-0.2898	-211	268	-0.2874	0.0024	0.0288
28	-205	261	-0.2796	-201	262	-0.2778	0.0018	0.0264
30	-256	314	-0.3420	-250	310	-0.3360	0.0060	0.0246
32	-320	381	-0.4206	-315	381	-0.4176	0.0030	0.0186
34	-377	440	-0.4902	-375	441	-0.4896	0.0006	0.0156
36	-429	489	-0.5508	-425	489	-0.5484	0.0024	0.0150
38	-352	398	-0.4500	-347	400	-0.4482	0.0018	0.0126
40	-261	319	-0.3480	-258	318	-0.3456	0.0024	0.0108
42	-181	246	-0.2562	-179	248	-0.2562	0.0000	0.0084
44	-138	203	-0.2046	-137	205	-0.2052	-0.0006	0.0084
46	-156	213	-0.2214	-153	215	-0.2208	0.0006	0.0090
48	-160	204	-0.2184	-155	207	-0.2172	0.0012	0.0084
50	-177	235	-0.2472	-172	237	-0.2454	0.0018	0.0072
52	-223	285	-0.3048	-220	286	-0.3036	0.0012	0.0054
54	-296	357	-0.3918	-290	359	-0.3894	0.0024	0.0042
56	-358	414	-0.4632	-356	415	-0.4626	0.0006	0.0018
58	-427	469	-0.5376	-422	474	-0.5376	0.0000	0.0012
60	-487	546	-0.6198	-485	547	-0.6192	0.0006	0.0012
62	-569	629	-0.7188	-565	630	-0.7170	0.0018	0.0006
64	-680	735	-0.8490	-677	737	-0.8484	0.0006	-0.0012
66	-753	767	-0.9120	-753	770	-0.9138	-0.0018	-0.0018
68	0	0	0.0000	0	0	0.0000	0.0000	0.0000

Appendix G

Results of Laboratory Testing

LIQUID AND PLASTIC LIMITS TEST REPORT





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●		Gypsum Rejects		9/21/09	ML			33	1

Client STANTEC

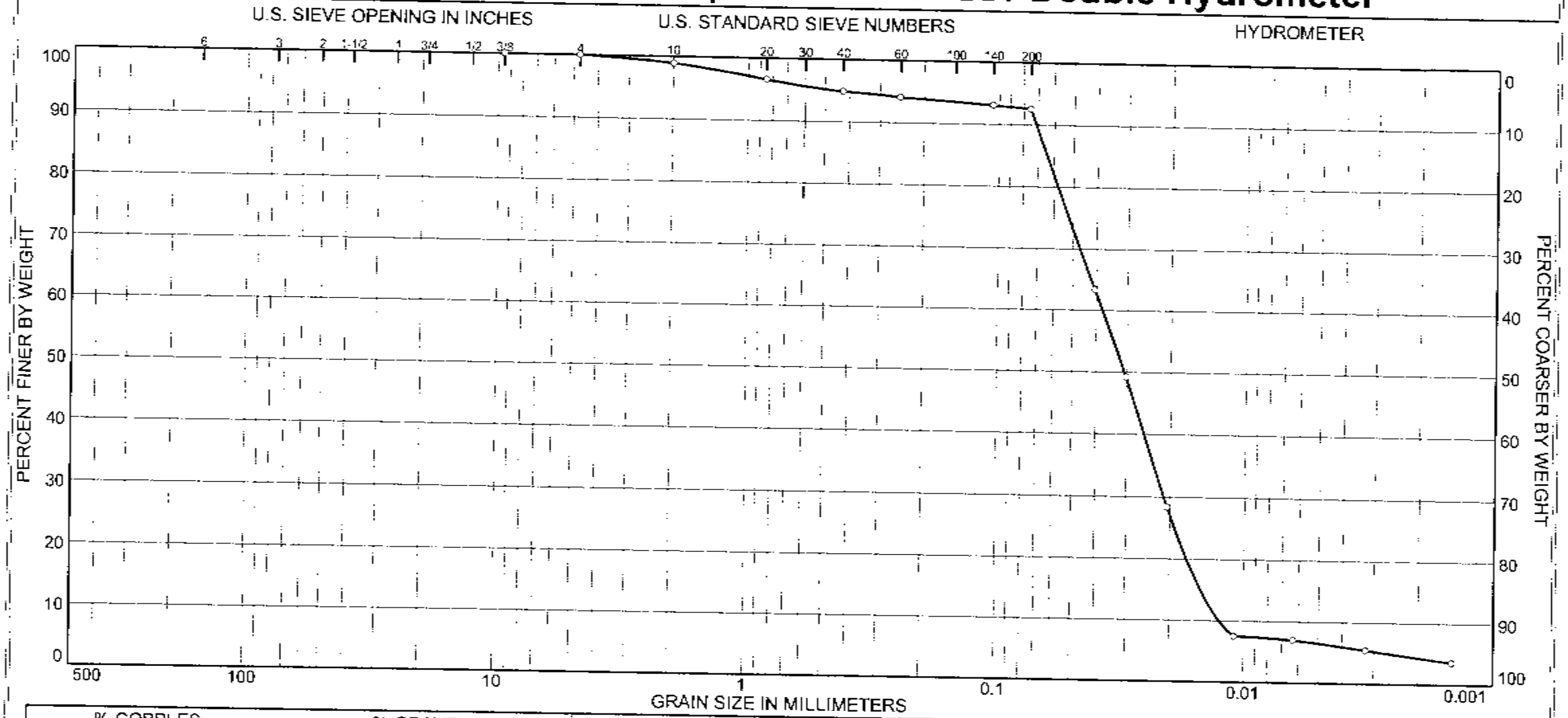
Project Cumberland Fossil Plant (Ash and Gypsum Stacks)

Project No. GTX-1484 Lab no.

GeoTesting Express Inc.

● Could not get >25 blows on LL, Could not roll <1/4" thread

Particle Size Distribution Report ASTM D4221-Double Hydrometer



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	7.4	86.1	6.5

SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
	Gypsum Rejects		9/21/09	ML			33	32

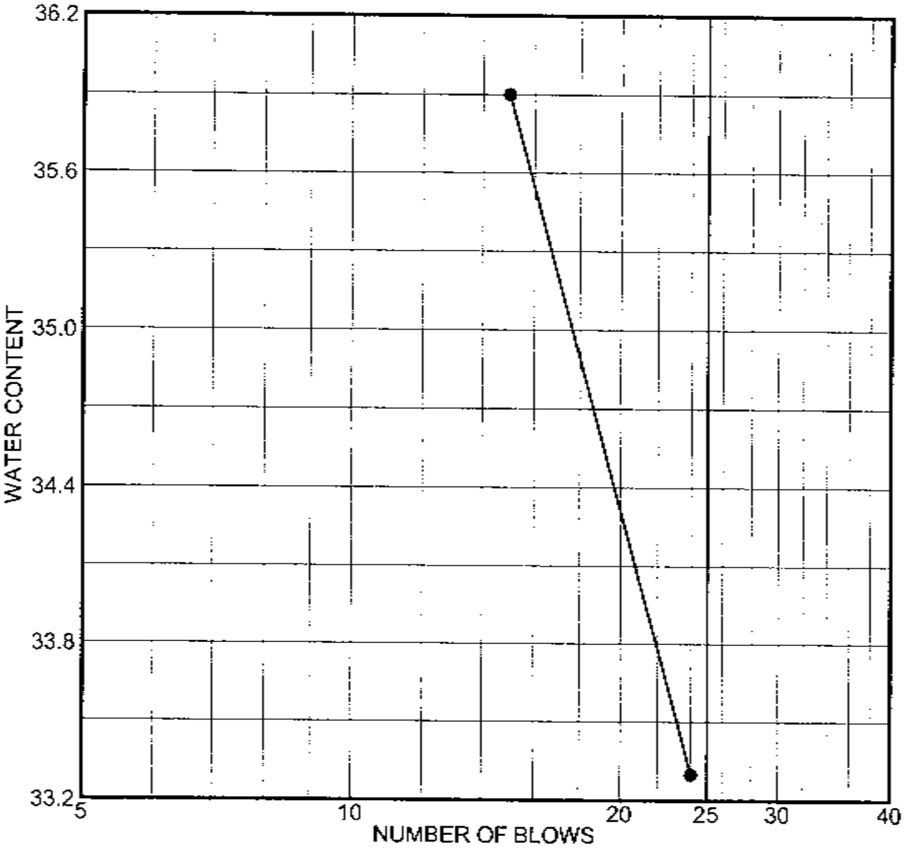
Client STANTEC

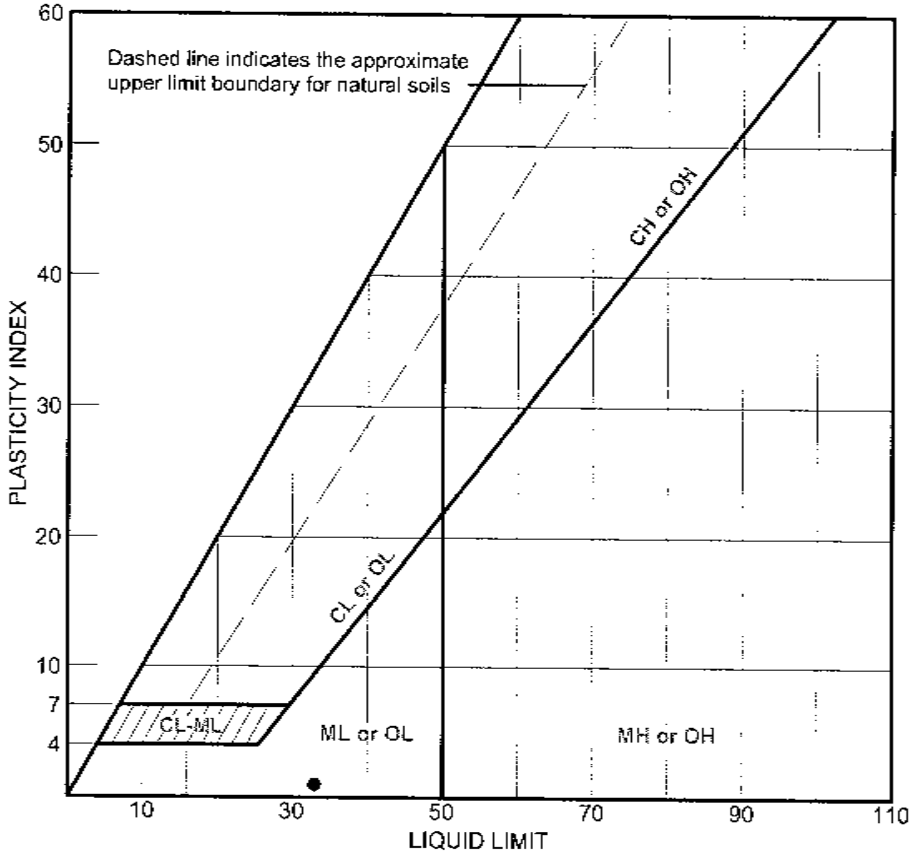
Project Cumberland Fossil Plant (Ash and Gypsum Stacks)

Project No. GTX-1484 Lab no.

GeoTesting Express Inc.

LIQUID AND PLASTIC LIMITS TEST REPORT





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●		Gypsum Rejects		9/21/09	ML			33	1

Client STANTEC

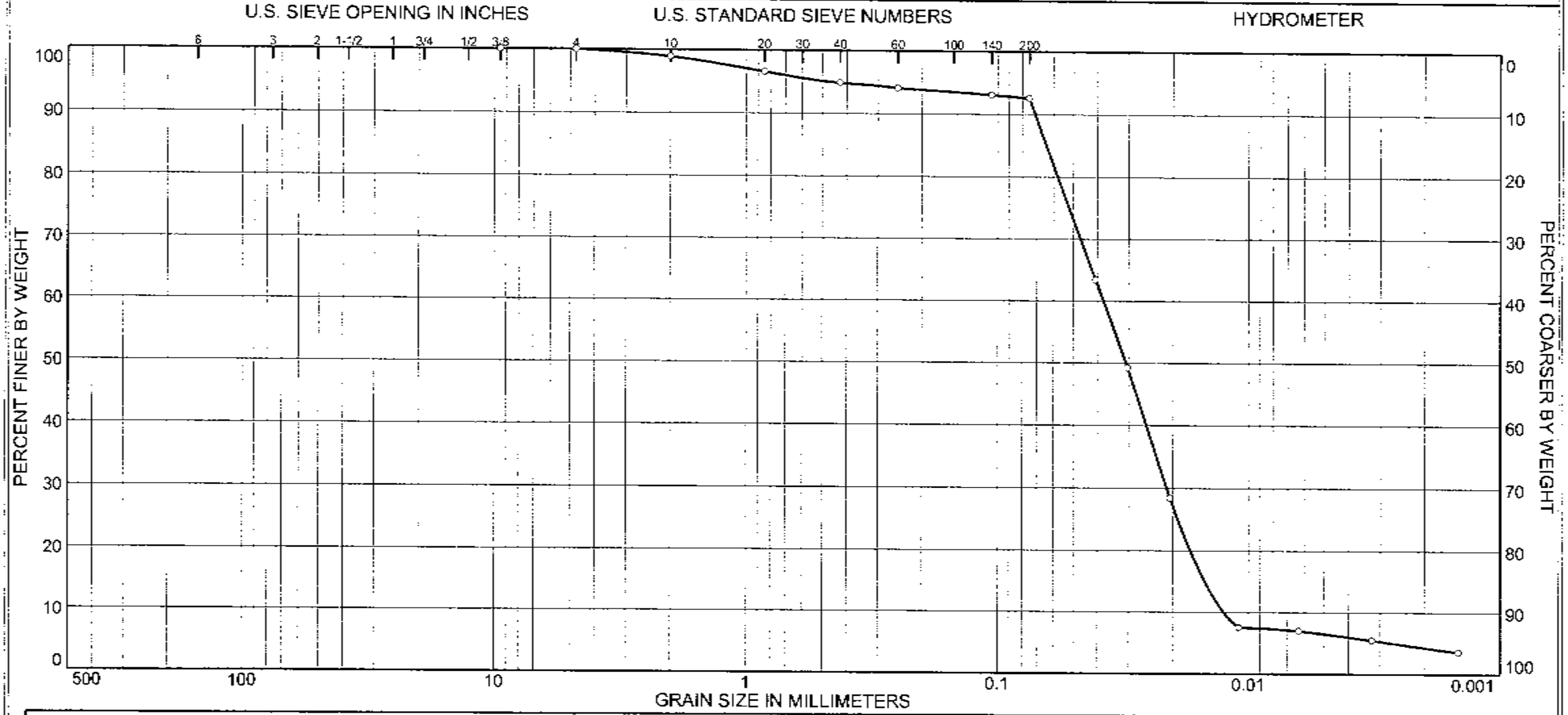
Project Cumberland Fossil Plant (Ash and Gypsum Stacks)

Project No. GTX-1484 | Lab no.

GeoTesting Express Inc.

● Could not get >25 blows on LL, Could not roll <1/4" thread

Particle Size Distribution Report ASTM D4221-Double Hydrometer



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	7.4	86.1	6.5

	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
○		Gypsum Rejects		9/21/09	ML			33	32

Client STANTEC

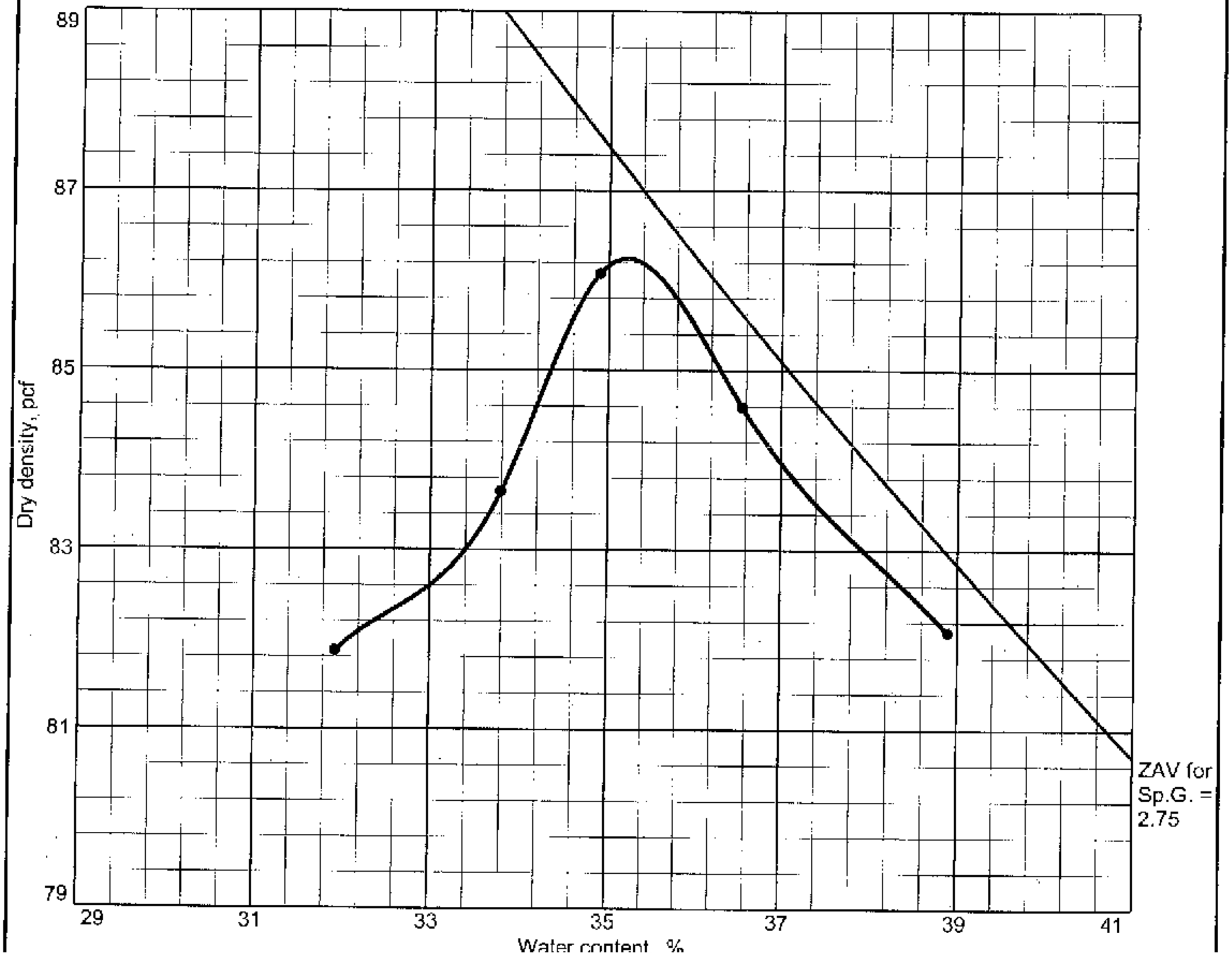
Project Cumberland Fossil Plant (Ash and Gypsum Stacks)

Project No. GTX-1484 Lab no.

GeoTesting Express Inc.

○

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	ML	A-4(0)		2.75	33	1	0.0	92.6

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 86.2 pcf Optimum moisture – 35.2 %	

Project No. GTX-1484 **Client:** STANTEC

Project: Cumberland Fossil Plant (Ash and Gypsum Stacks)

● **Source:** **Sample No.:** Gypsum Rejects

Remarks:

COMPACTION TEST REPORT

GeoTesting Express Inc.

Lab no.

GeoTesting Express

SPECIFIC GRAVITY TEST

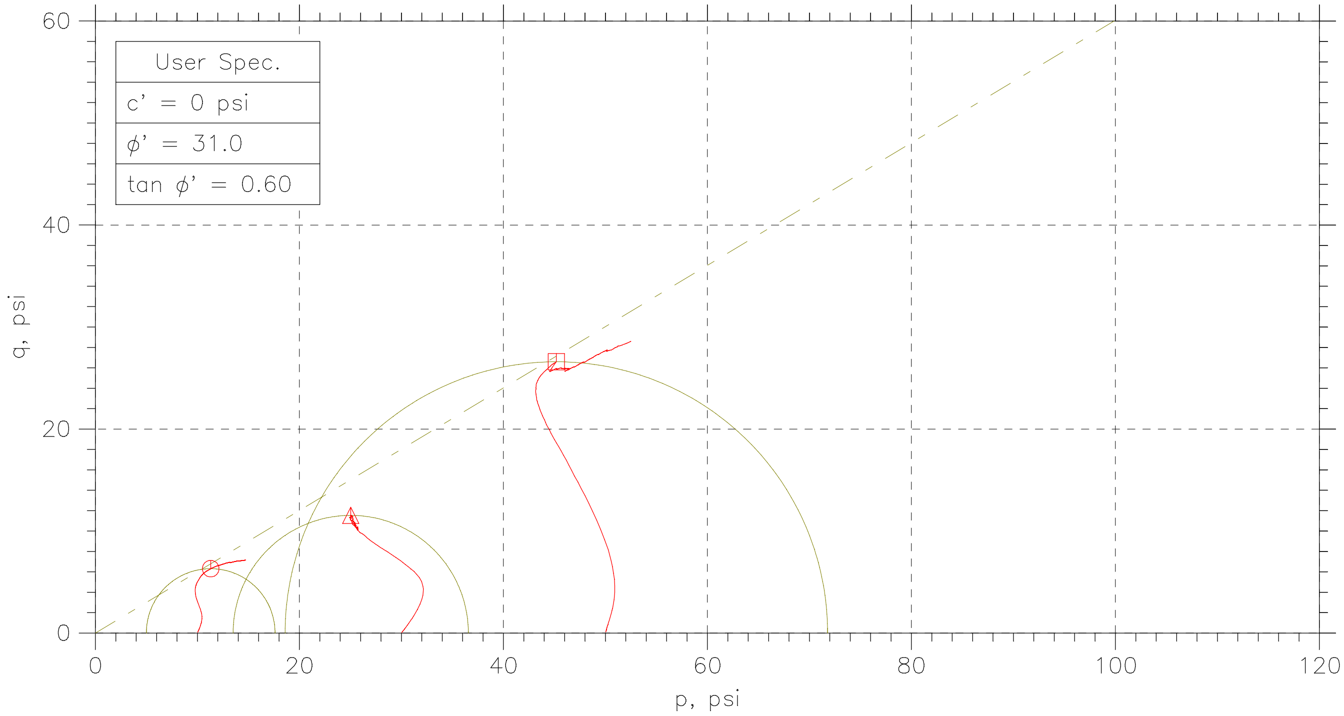
(ASTM D854)

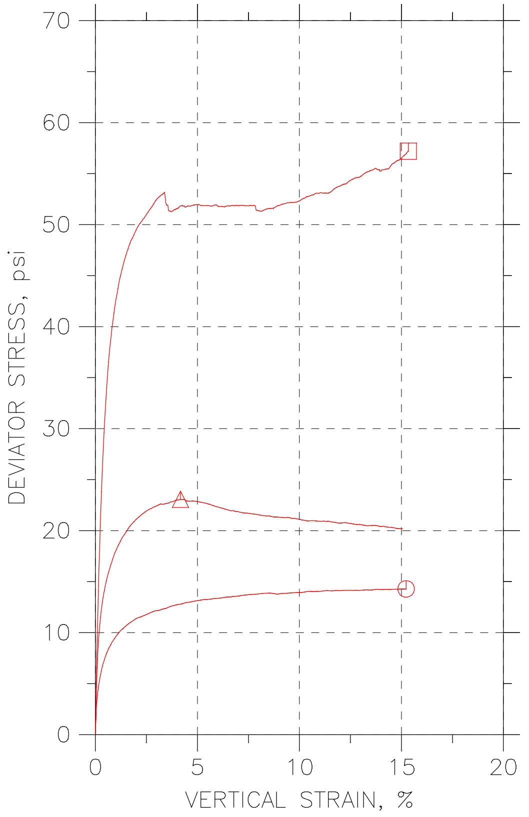
oject No. GTX-1484
Project Name Cumberland Ash
Tested By JM
Test Date 9/9/2009
Reviewed By MM
Review Date 9/17/2009

(1) Boring No.	(2) Depth (ft)	(3) Sample No.	(4) Lab No.	(5) Flask No.	(6) Temperature (^{0}C)	(7) Weight, WF (grams)	(8) Weight, WFS (grams)	(9) Weight of Soil (grams) (8)-(7)	(10) Weight, CWF (grams)	(11) Weight, DS (grams)	(12) Specific Gravity (9)/[(10)-(11)+(9)]	(13) Specific Gravity at 20^{0} C
--	--	Gypsum Rejects	---	41	20	304.60	358.10	53.50	433.68	467.56	2.727	2.728

WF - Water and Flask
WFS - Water, Flask and Soil
CWF - Calibration Water and Flask
DS - Deaired Sample

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



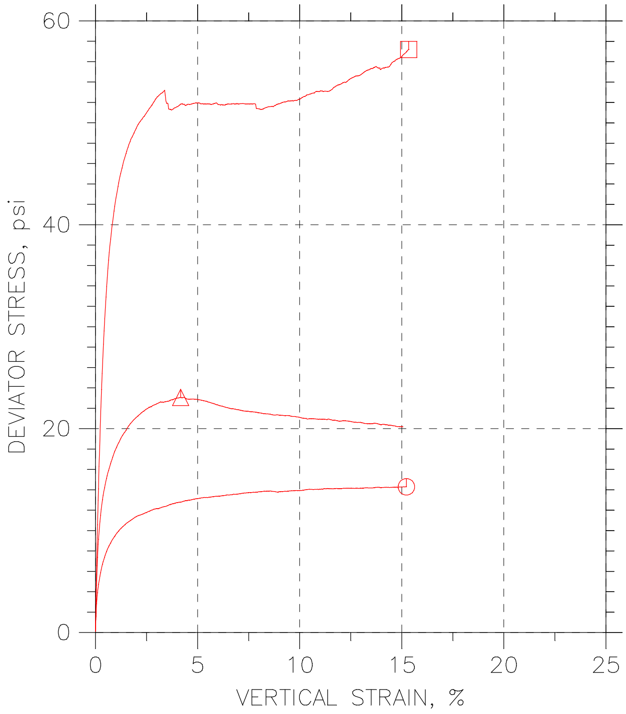


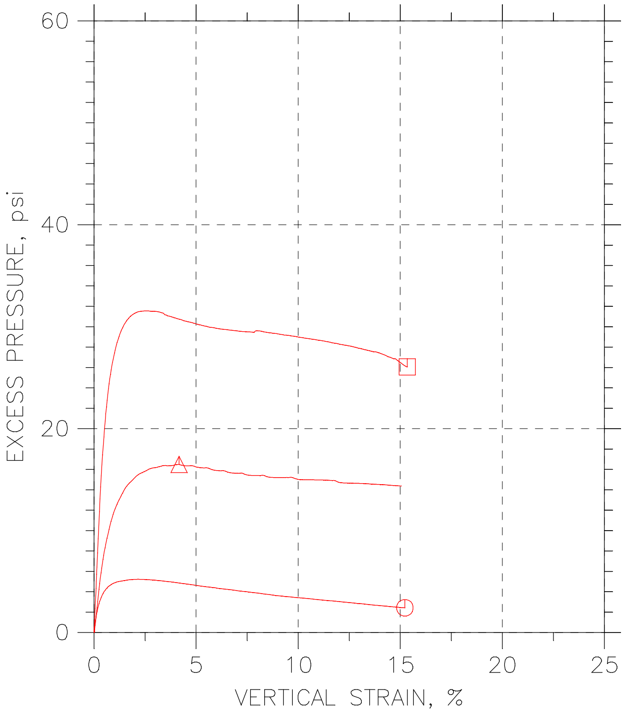
Symbol		○	△	□	
Sample No.		1628	1633	1626	
Test No.		4.1	4.2	4.3	
Depth		17.5-18.0'	14.5-15.0'	10.8-11.3	
Initial	Diameter, in	2.888	2.859	2.882	
	Height, in	6.054	5.96	5.973	
	Water Content, %	18.0	23.6	20.9	
	Dry Density, pcf	109.	99.89	103.2	
	Saturation, %	88.8	92.6	89.3	
	Void Ratio	0.547	0.687	0.633	
Before Shear	Water Content, %	18.7	23.1	20.8	
	Dry Density, pcf	111.9	103.7	108.	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.506	0.625	0.56	
	Back Press., psi	62.52	59.45	68.46	
Ver. Eff. Cons. Stress, psi		9.959	29.98	49.94	
Shear Strength, psi		7.145	11.53	28.6	
Strain at Failure, %		15.2	4.17	15.3	
Strain Rate, %/min		0.016	0.016	0.016	
B-Value		0.95	0.95	0.95	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

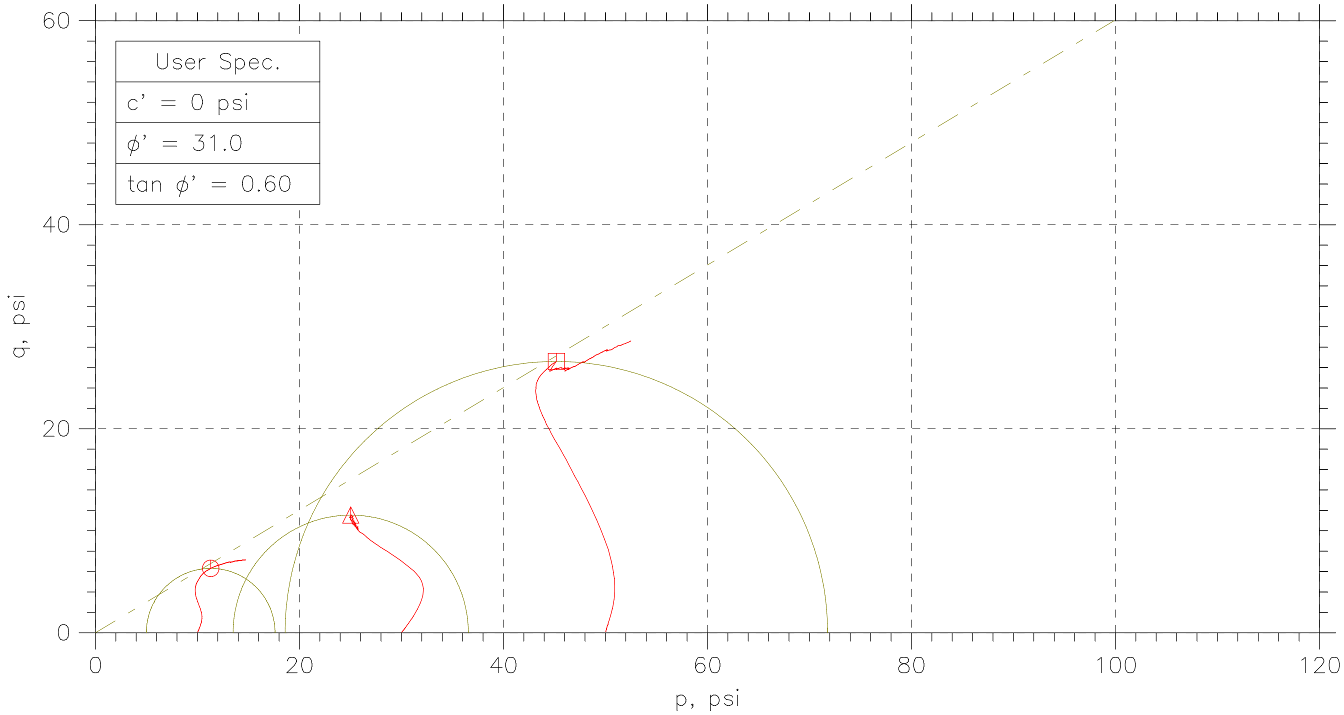
Project: Cumberland Ash
Location: ---
Project No.: GTX-1484
Boring No.: 19-C
Sample Type: UD
Description: Gray-Brown Lean clay with sand
Remarks: 2054

Mon, 21-SEP-2009 18:00:29

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	1628	4.1	17.5-18.0'	JM	9/3/09	MM		1484-4.1.dat
△	1633	4.2	14.5-15.0	JM	9/4/09	MM		1484-4.2.dat
□	1626	4.3	10.8-11.3	JM	9/2/09	MM		1484-4.3.dat

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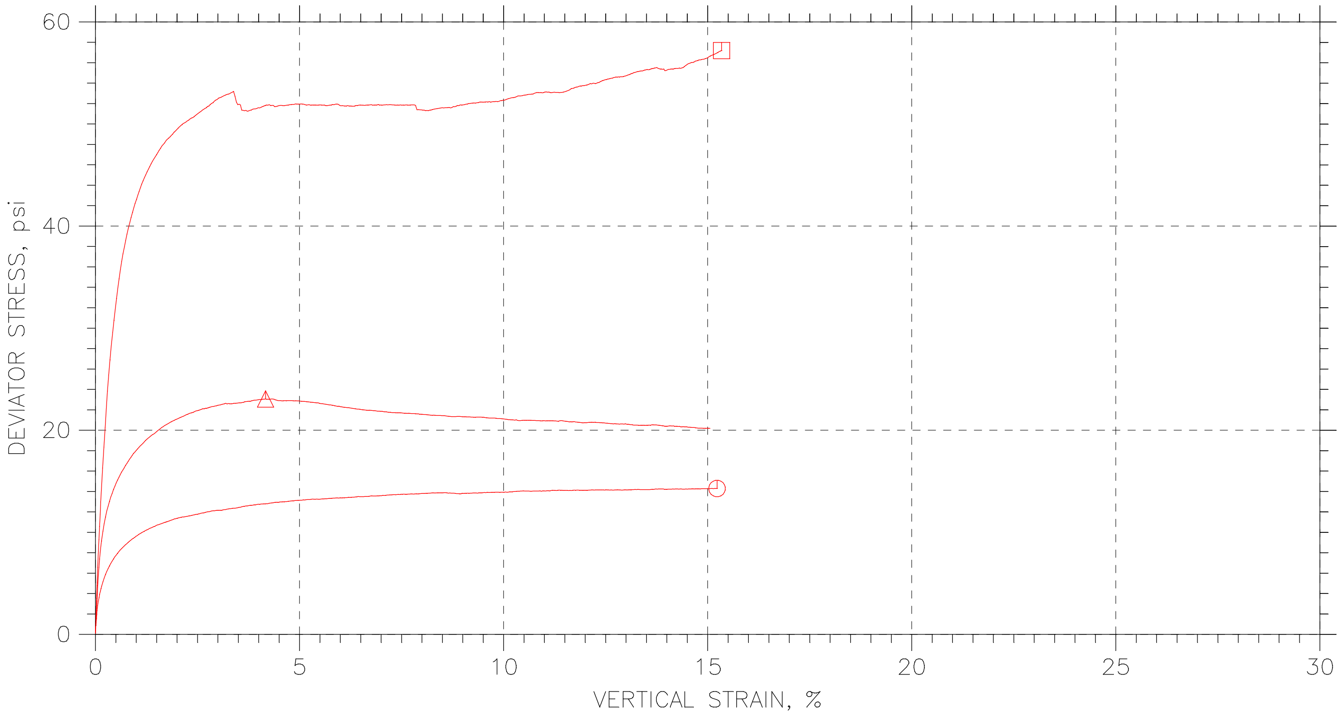
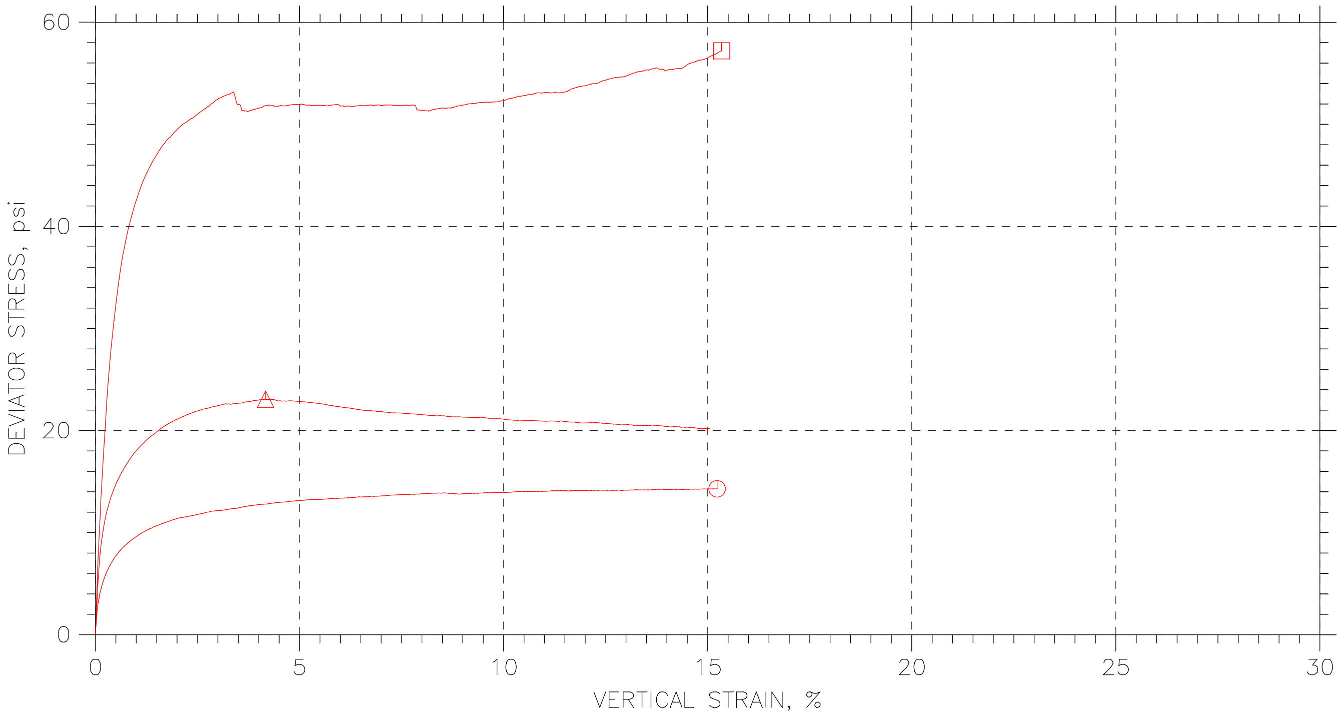
Project: Cumberland Ash	Location: ---	Project No.: GTX-1484
Boring No.: 19-C	Sample Type: UD	
Description: Gray-Brown Lean clay with sand		
Remarks: 2054		

Mon, 21-SEP-2009 18:00:31

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	1628	4.1	17.5-18.0'	JM	9/3/09	MM		1484-4.1.dat
△	1633	4.2	14.5-15.0	JM	9/4/09	MM		1484-4.2.dat
□	1626	4.3	10.8-11.3	JM	9/2/09	MM		1484-4.3.dat

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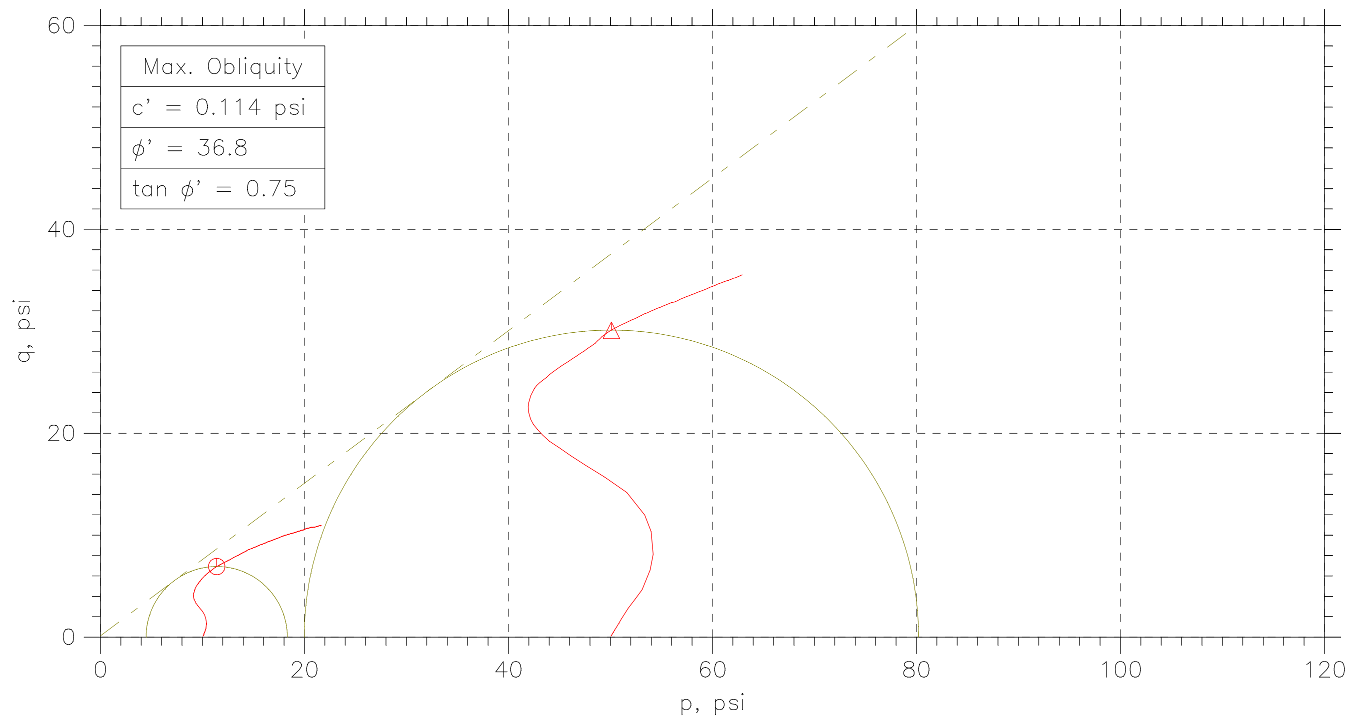
Project: Cumberland Ash	Location: ---	Project No.: GTX-1484
Boring No.: 19-C	Sample Type: UD	

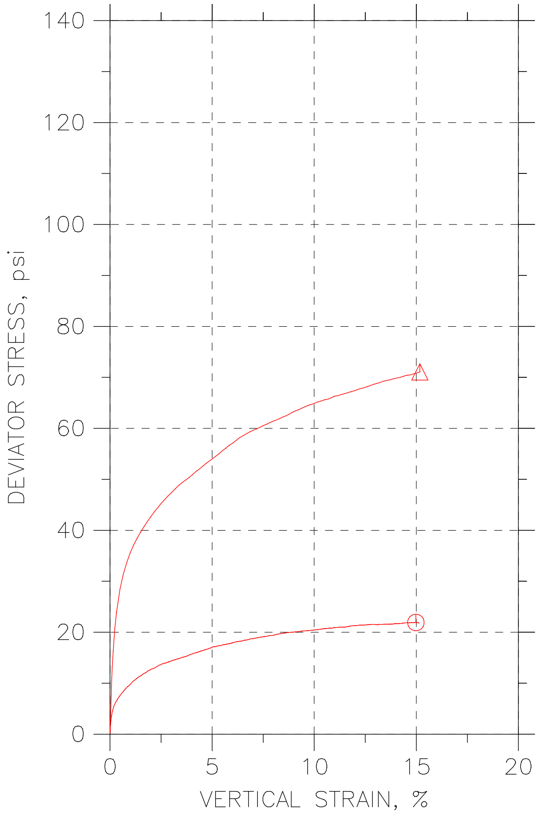
Description: Gray-Brown Lean clay with sand

Remarks: 2054

Mon, 21-SEP-2009 18:00:33

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		⦶	△		
Sample No.		1616A	1616B		
Test No.		1.1	1.2		
Depth		29.2-29.7'	29.7-30.2'		
Initial	Diameter, in	2.85	2.851		
	Height, in	5.939	5.973		
	Water Content, %	22.5	21.4		
	Dry Density, pcf	102.4	105.7		
	Saturation, %	94.1	97.0		
	Void Ratio	0.646	0.595		
Before Shear	Water Content, %	22.3	19.5		
	Dry Density, pcf	105.2	110.4		
	Saturation*, %	100.0	100.0		
	Void Ratio	0.603	0.527		
	Back Press., psi	103.9	100.5		
Ver. Eff. Cons. Stress, psi		9.965	49.96		
Shear Strength, psi		10.96	35.54		
Strain at Failure, %		15	15.2		
Strain Rate, %/min		0.016	0.016		
B-Value		0.95	0.95		
Estimated Specific Gravity		2.7	2.7		
Liquid Limit		---	---		
Plastic Limit		---	---		

GeoTesting express

Project: Cumberland Ash
Location: ---
Project No.: GTX-1484
Boring No.: B-29A
Sample Type: UD
Description: Brown Lean clay with sand
Remarks: System 1057

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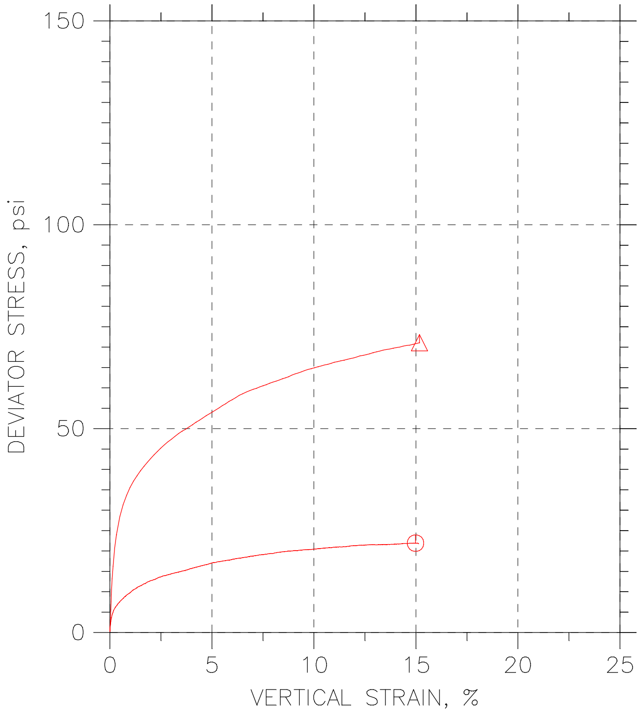
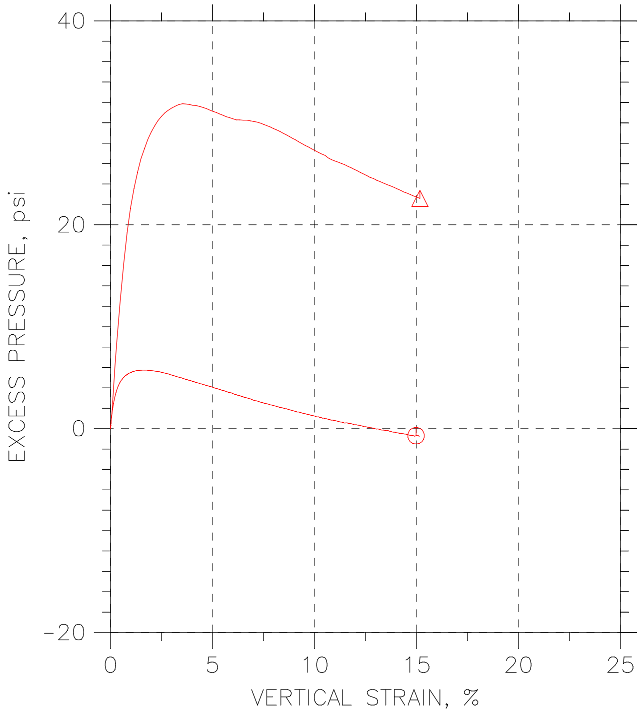
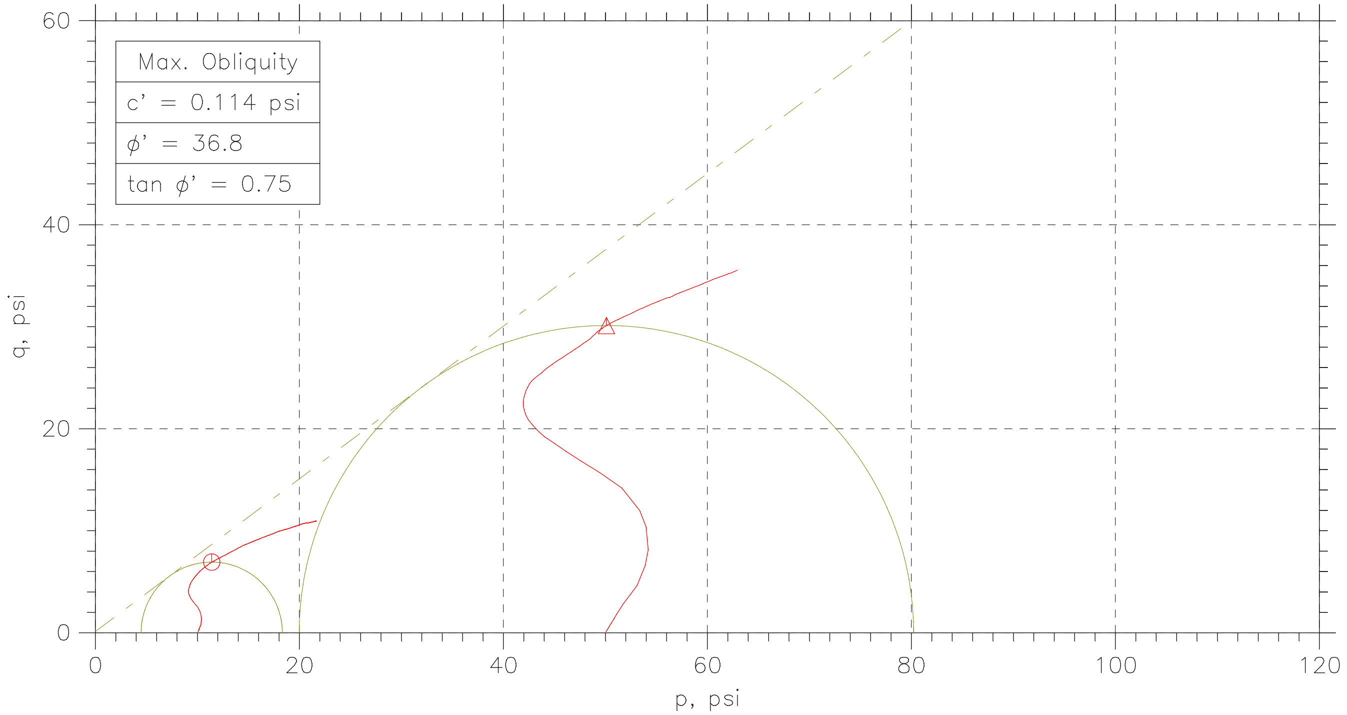
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	1616A	1.1	29.2-29.7'	MM	9/2/09	CA		1484-1.1.dat
△	1616B	1.2	29.7-30.2'	MM	9/2/09	CA		1484-1.2.dat

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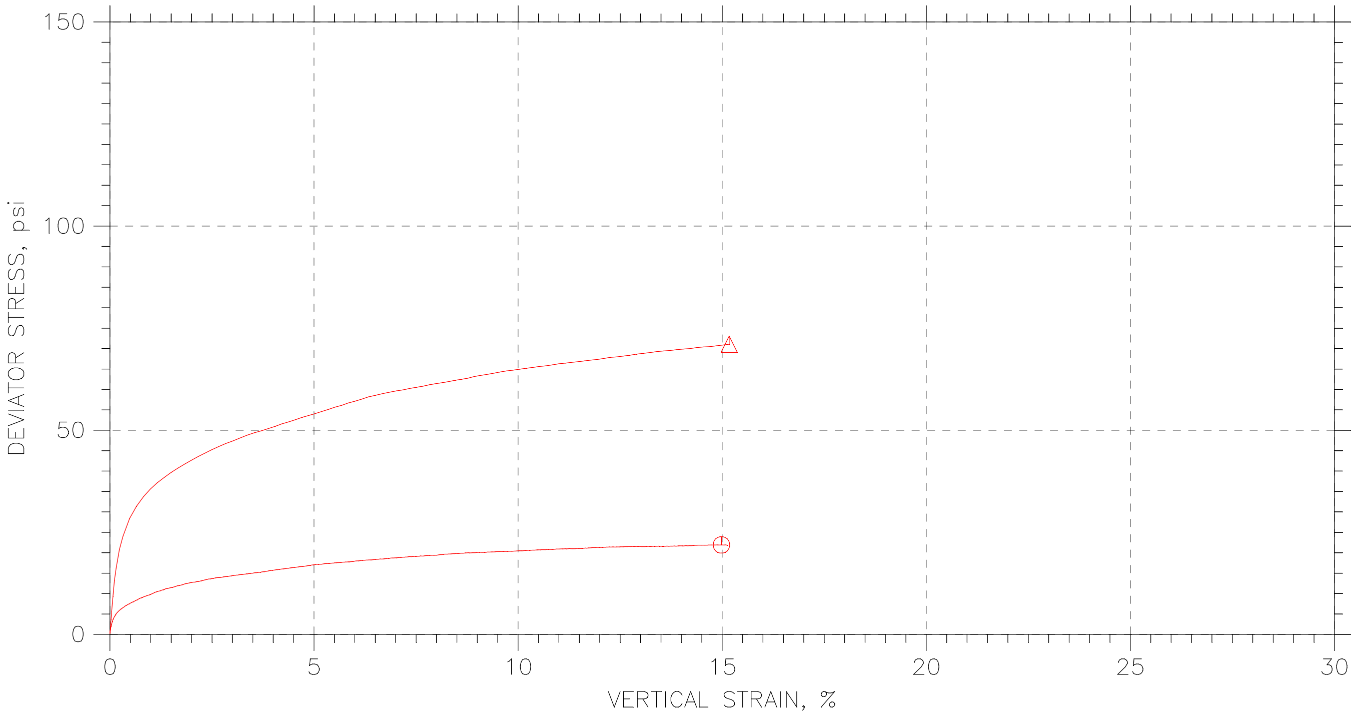
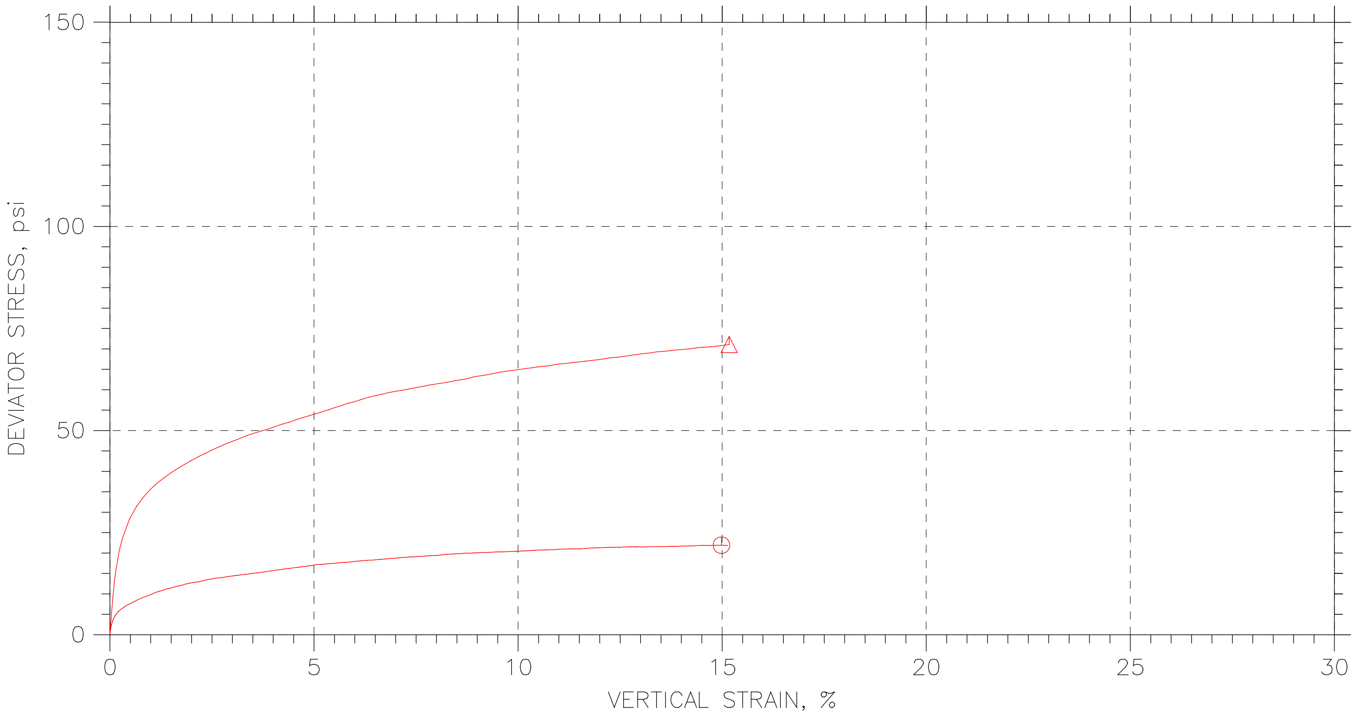
Project: Cumberland Ash	Location: ---	Project No.: GTX-1484
Boring No.: B-29A	Sample Type: UD	
Description: Brown Lean clay with sand		
Remarks: System 1057		

Mon, 21-SEP-2009 17:41:36

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	1616A	1.1	29.2-29.7'	MM	9/2/09	CA		1484-1.1.dat
△	1616B	1.2	29.7-30.2'	MM	9/2/09	CA		1484-1.2.dat

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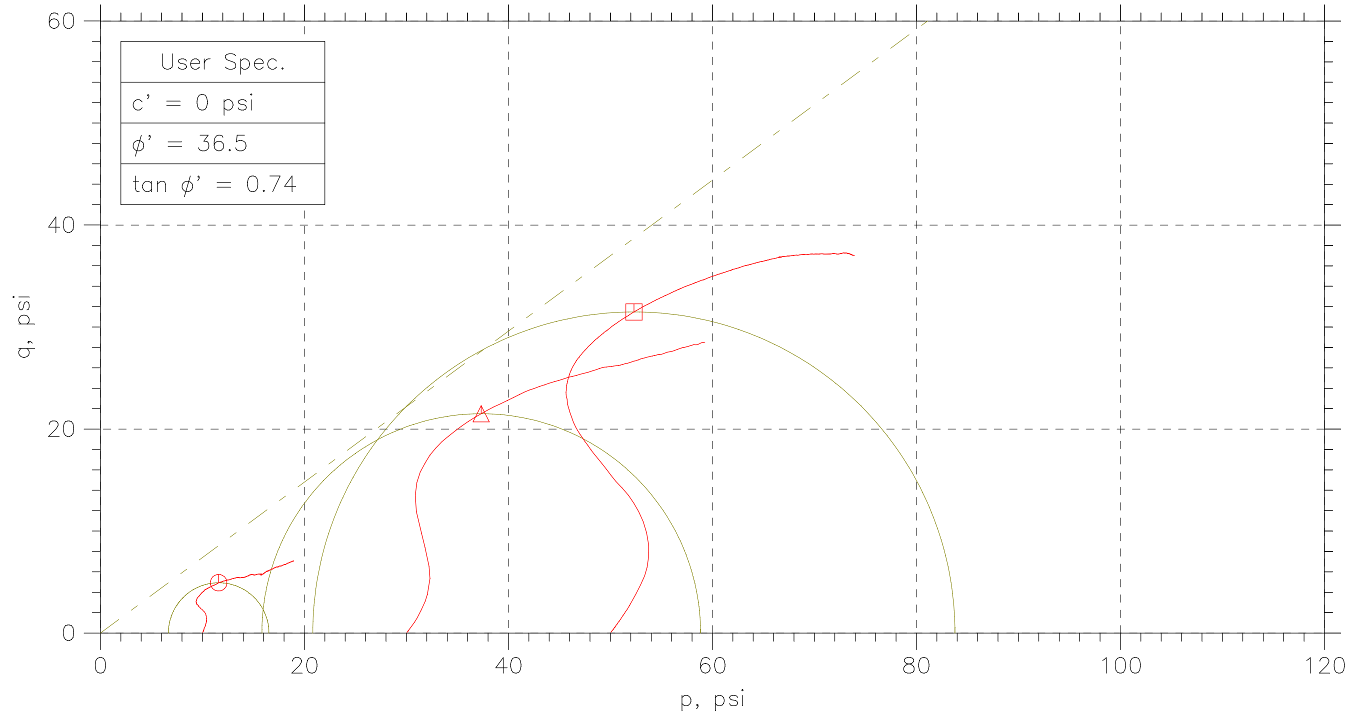
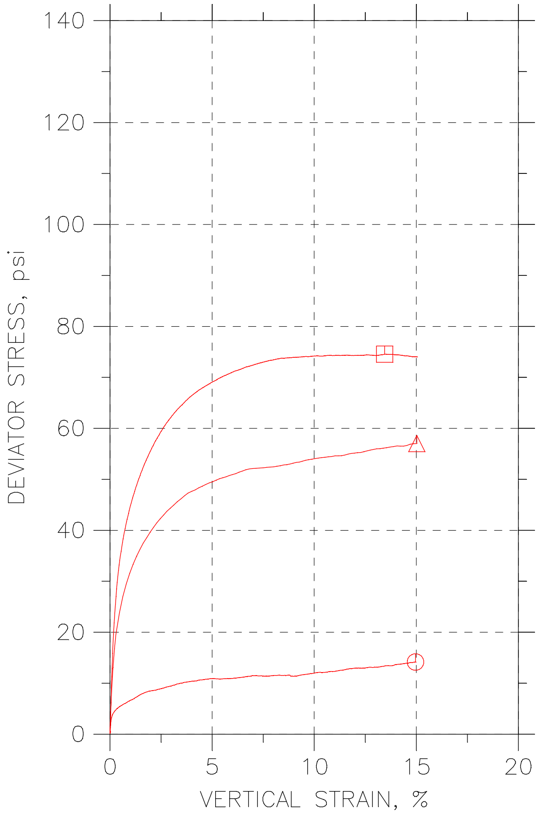
Project: Cumberland Ash	Location: ---	Project No.: GTX-1484
Boring No.: B-29A	Sample Type: UD	
Description: Brown Lean clay with sand		
Remarks: System 1057		

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





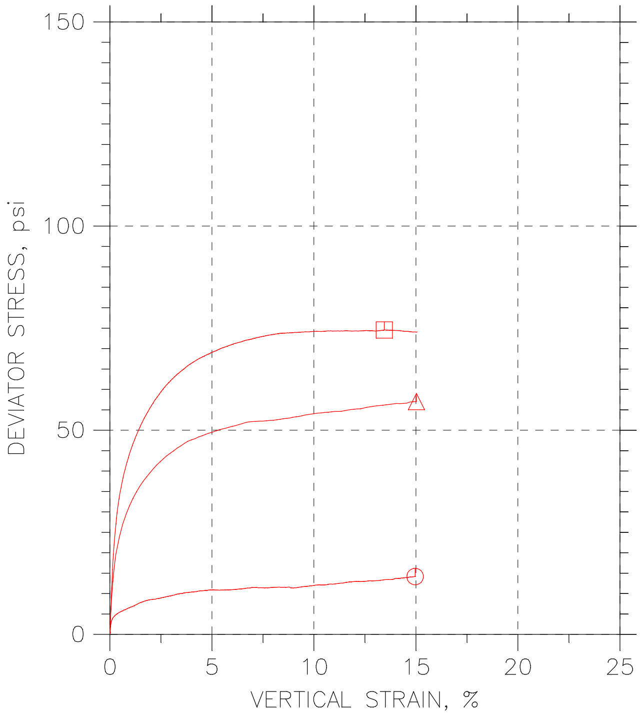
	Symbol	○	△	□	
	Sample No.	1618A	1618B	1619	
	Test No.	3.1	3.2	3.3	
	Depth	12-12.5 ft	12.5-13 ft	14.8-15.3 '	
Initial	Diameter, in	2.884	2.88	2.812	
	Height, in	5.985	5.956	5.936	
	Water Content, %	25.6	18.8	17.0	
	Dry Density, pcf	100.6	111.8	115.	
	Saturation, %	102.4	99.9	98.7	
	Void Ratio	0.675	0.507	0.466	
Before Shear	Water Content, %	25.5	18.8	17.4	
	Dry Density, pcf	99.78	111.8	114.6	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.689	0.508	0.471	
	Back Press., psi	140	119	80.58	
	Ver. Eff. Cons. Stress, psi	9.972	30	49.98	
	Shear Strength, psi	7.078	28.51	37.27	
	Strain at Failure, %	15	15	13.4	
	Strain Rate, %/min	0.016	0.016	0.016	
	B-Value	0.95	0.95	0.95	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	---	---	---	
	Plastic Limit	---	---	---	

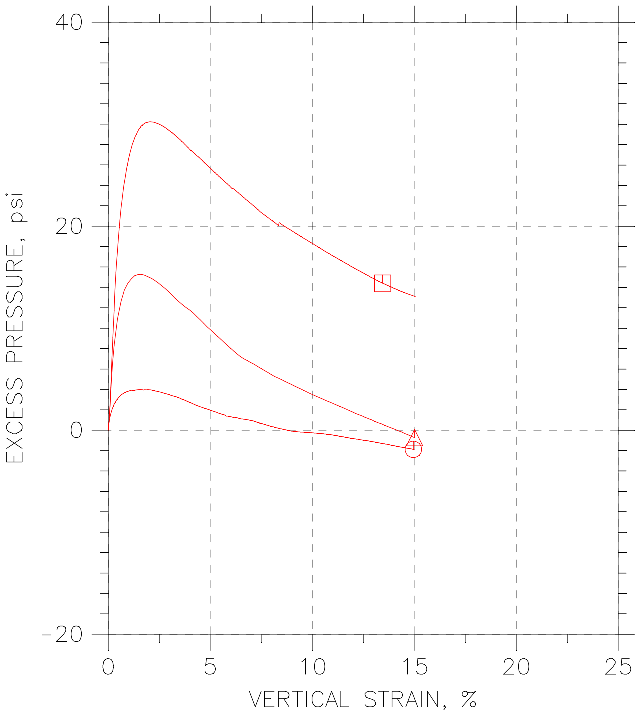
GeoTesting express

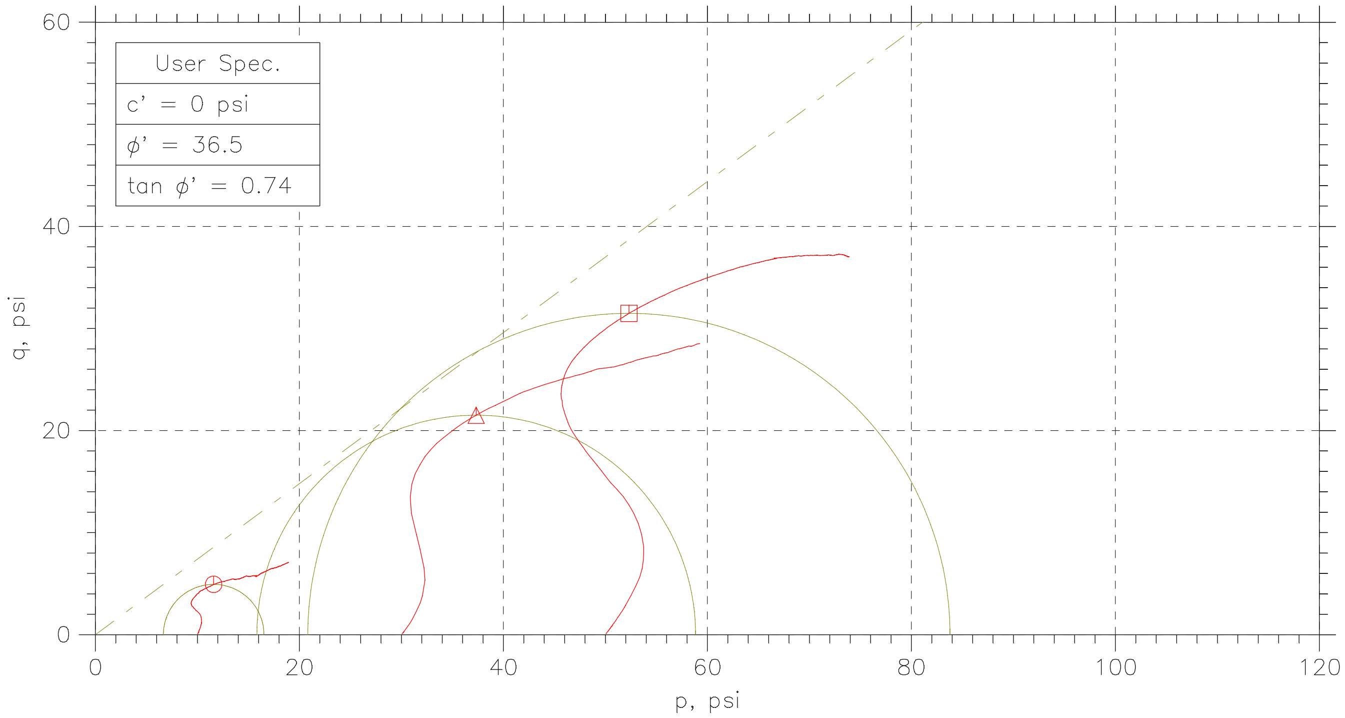
Project: Cumberland
Location: ---
Project No.: GTX-1484
Boring No.: B-29B
Sample Type: Remolded
Description:
Remarks: System 1057

Mon, 21-SEP-2009 17:51:58

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	1618A	3.1	12-12.5 ft	MM	8/31/09	CA		1484-3.1.dat
△	1618B	3.2	12.5-13 ft	MM	8/31/09	CA		1484-3.2.dat
□	1619	3.3	14.8-15.3 '	JM	8/31/09	MM		1484-3.3.dat

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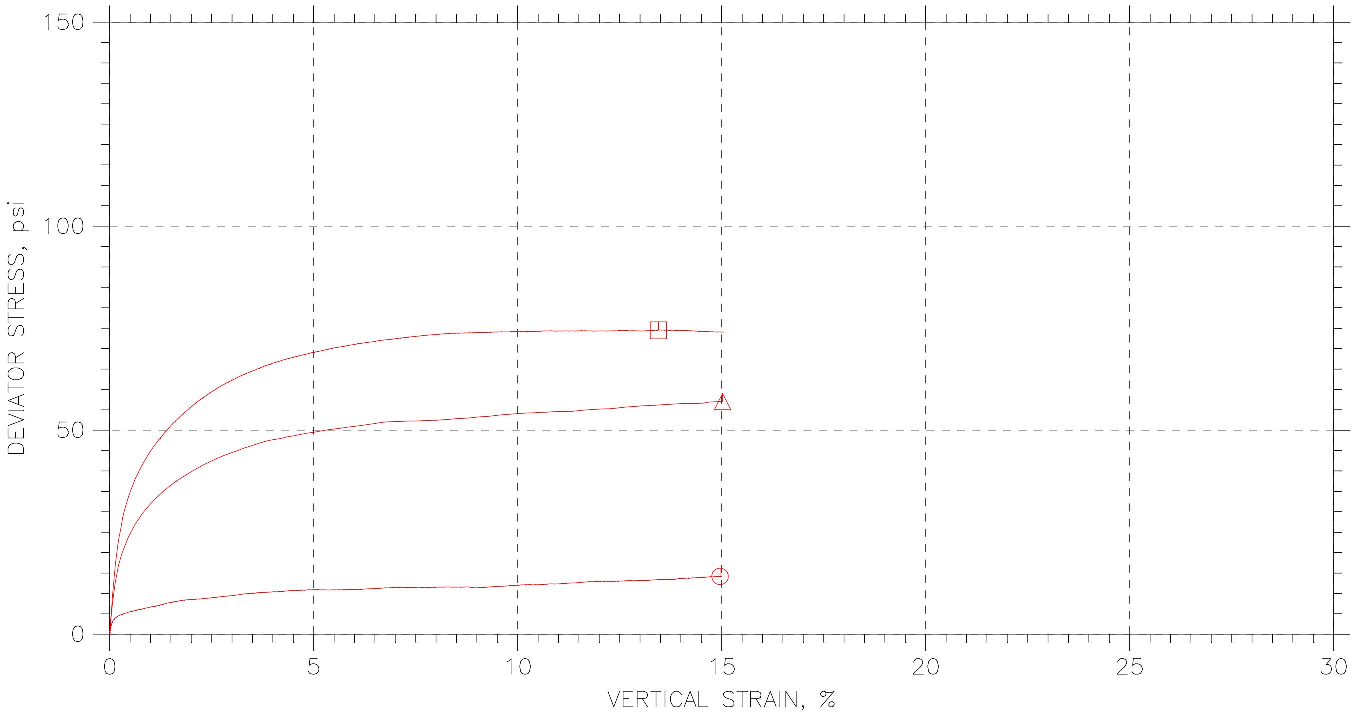
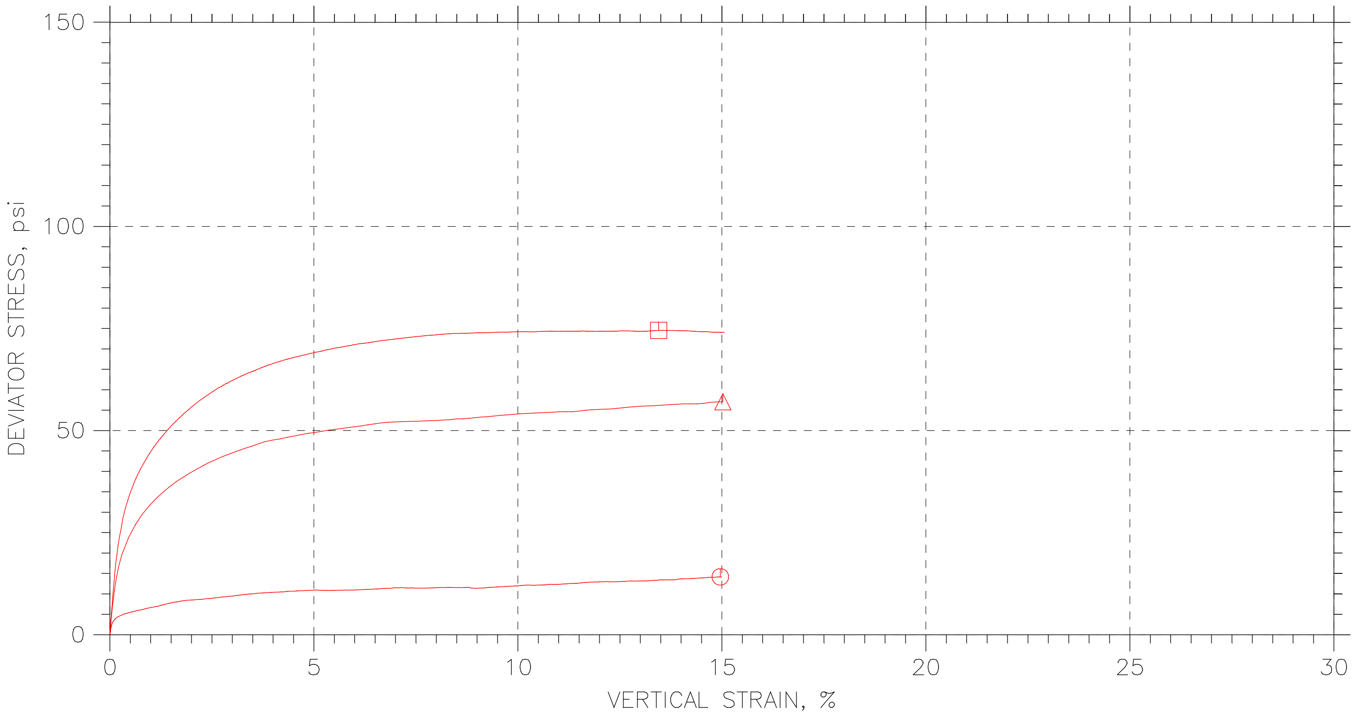
Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: B-29B	Sample Type: Remolded	
Description:		
Remarks: System 1057		

Mon, 21-SEP-2009 17:51:59

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	1618A	3.1	12-12.5 ft	MM	8/31/09	CA		1484-3.1.dat
△	1618B	3.2	12.5-13 ft	MM	8/31/09	CA		1484-3.2.dat
□	1619	3.3	14.8-15.3 '	JM	8/31/09	MM		1484-3.3.dat

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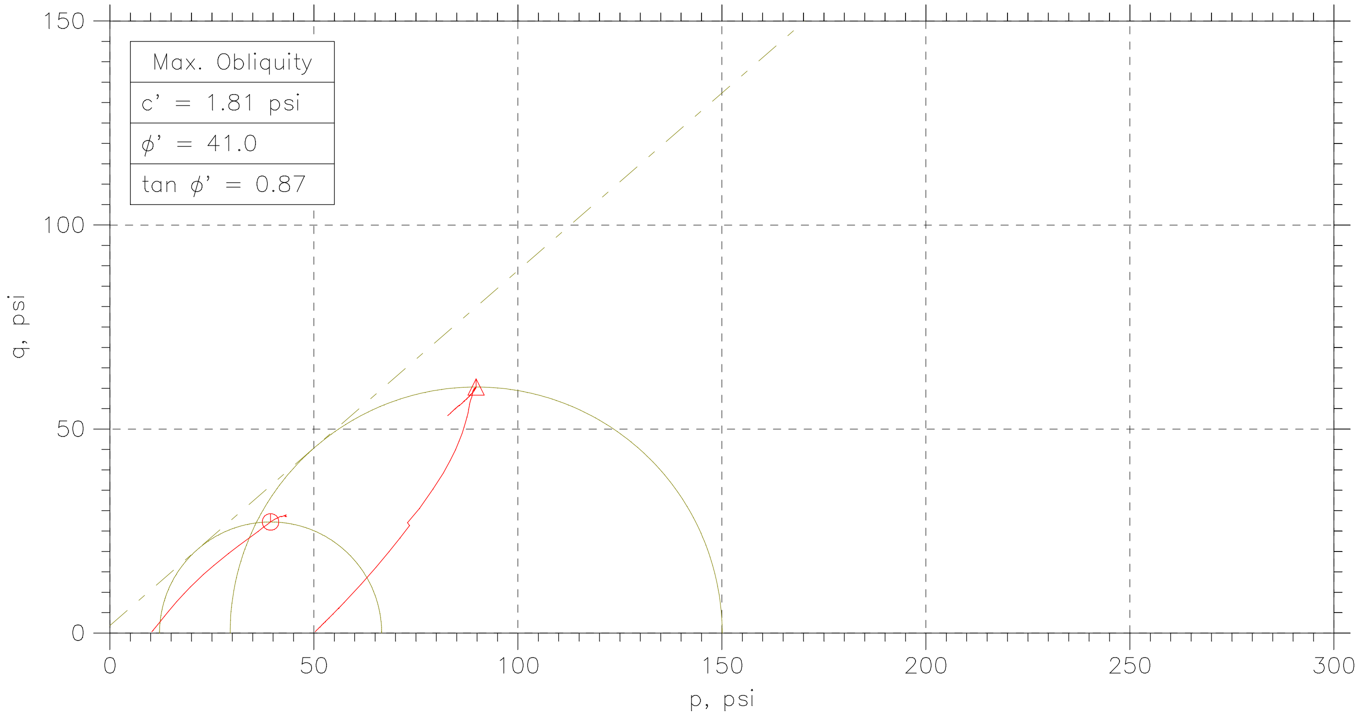
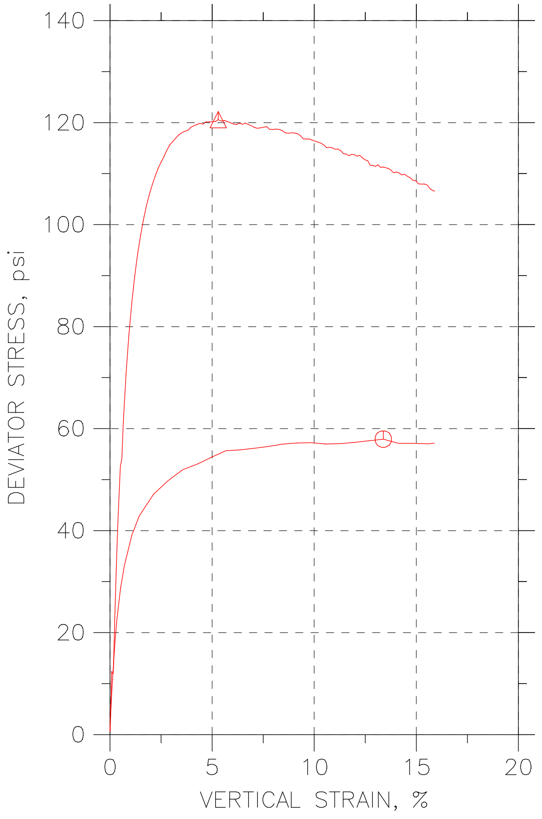
Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: B-29B	Sample Type: Remolded	
Description:		
Remarks: System 1057		

Mon, 21-SEP-2009 17:52:00

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





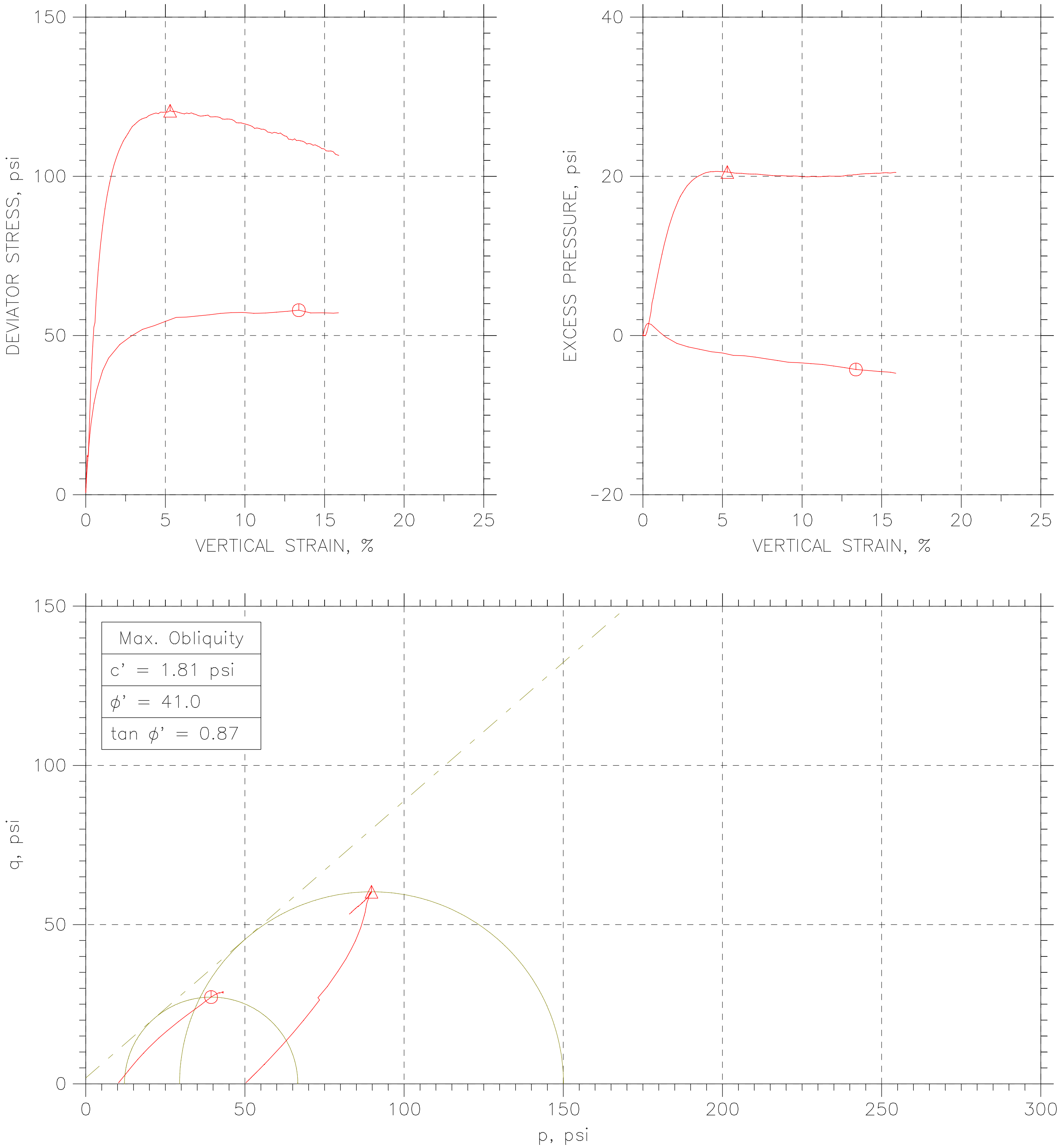
Symbol		○	△		
Sample No.		----	------		
Test No.		BA-1.1	BA-1.3		
Depth		----	-----		
Initial	Diameter, in	2.872	2.87		
	Height, in	5.76	5.758		
	Water Content, %	16.5	16.1		
	Dry Density, pcf	87.66	88.12		
	Saturation, %	48.3	47.5		
	Void Ratio	0.923	0.913		
Before Shear	Water Content, %	29.8	28.6		
	Dry Density, pcf	93.43	95.09		
	Saturation*, %	100.0	100.0		
	Void Ratio	0.804	0.773		
	Back Press., psi	140	68.08		
Ver. Eff. Cons. Stress, psi		9.973	50		
Shear Strength, psi		28.97	60.29		
Strain at Failure, %		13.4	5.3		
Strain Rate, %/min		0.07	0.07		
B-Value		0.95	0.95		
Estimated Specific Gravity		2.7	2.7		
Liquid Limit		---	---		
Plastic Limit		---	---		

GeoTesting express

Project: Cumberland
Location: ---
Project No.: GTX-1484
Boring No.: ---
Sample Type: UD
Description: Bottom ASH
Remarks: System 1062

Tue, 22-SEP-2009 15:36:06

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	BA-1.1	----	MM	9/17/09	CA		1484-BA-1.1.dat
△	------	BA-1.3	-----	JM	9/17/09	MM		1484-BA-1.3.dat

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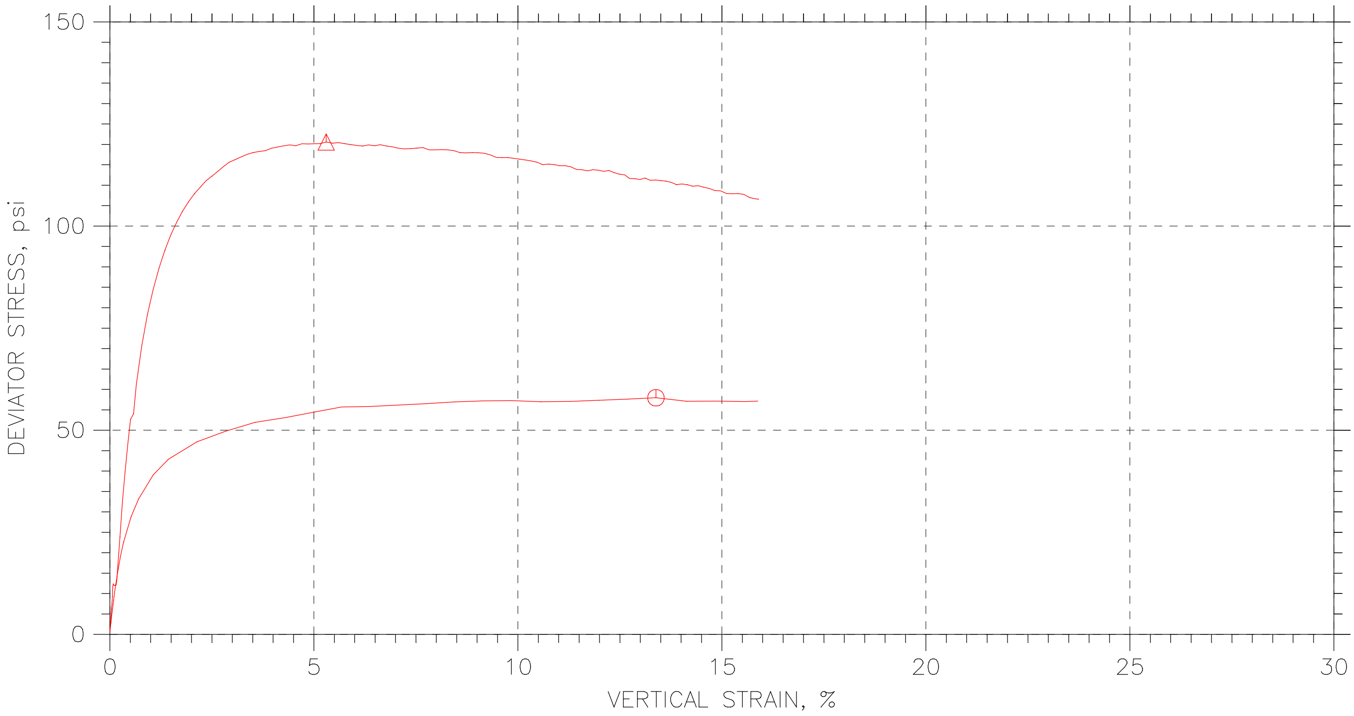
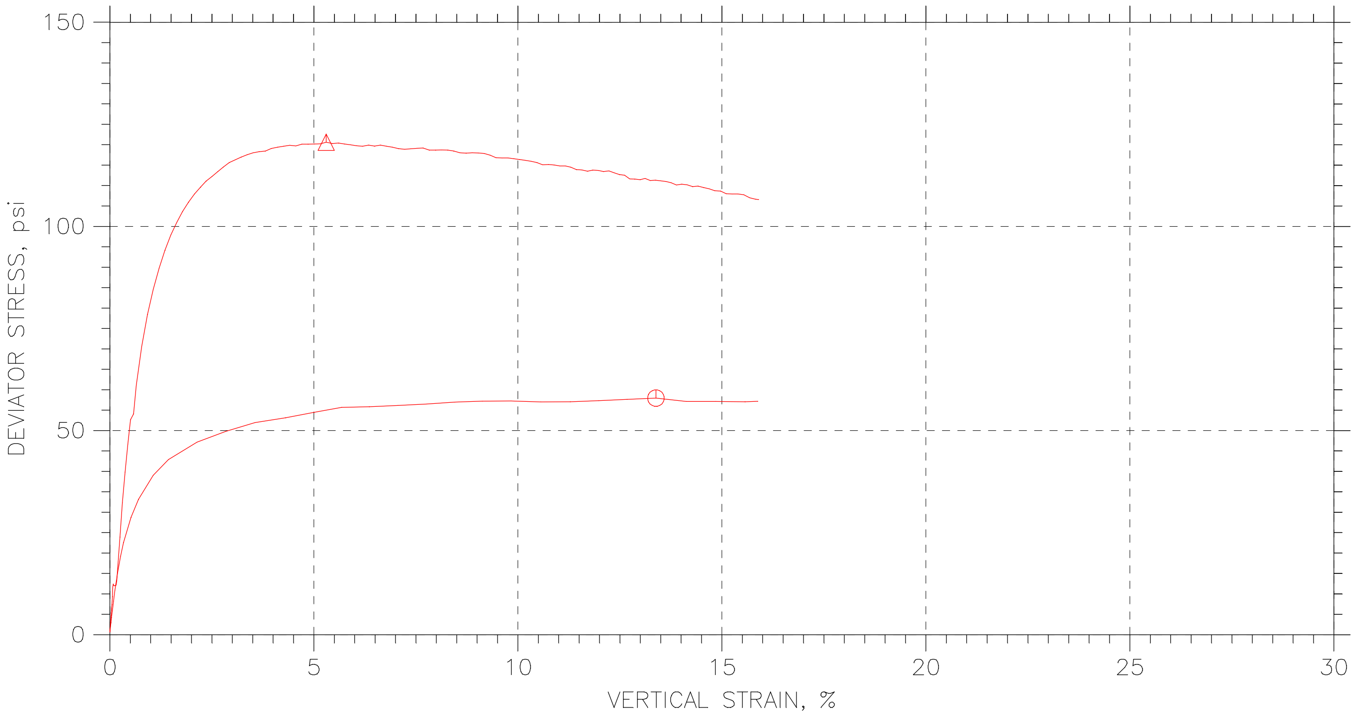
Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: UD	
Description: Bottom ASH		
Remarks: System 1062		

Tue, 22-SEP-2009 15:36:07

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	BA-1.1	----	MM	9/17/09	CA		1484-BA-1.1.dat
△	------	BA-1.3	-----	JM	9/17/09	MM		1484-BA-1.3.dat

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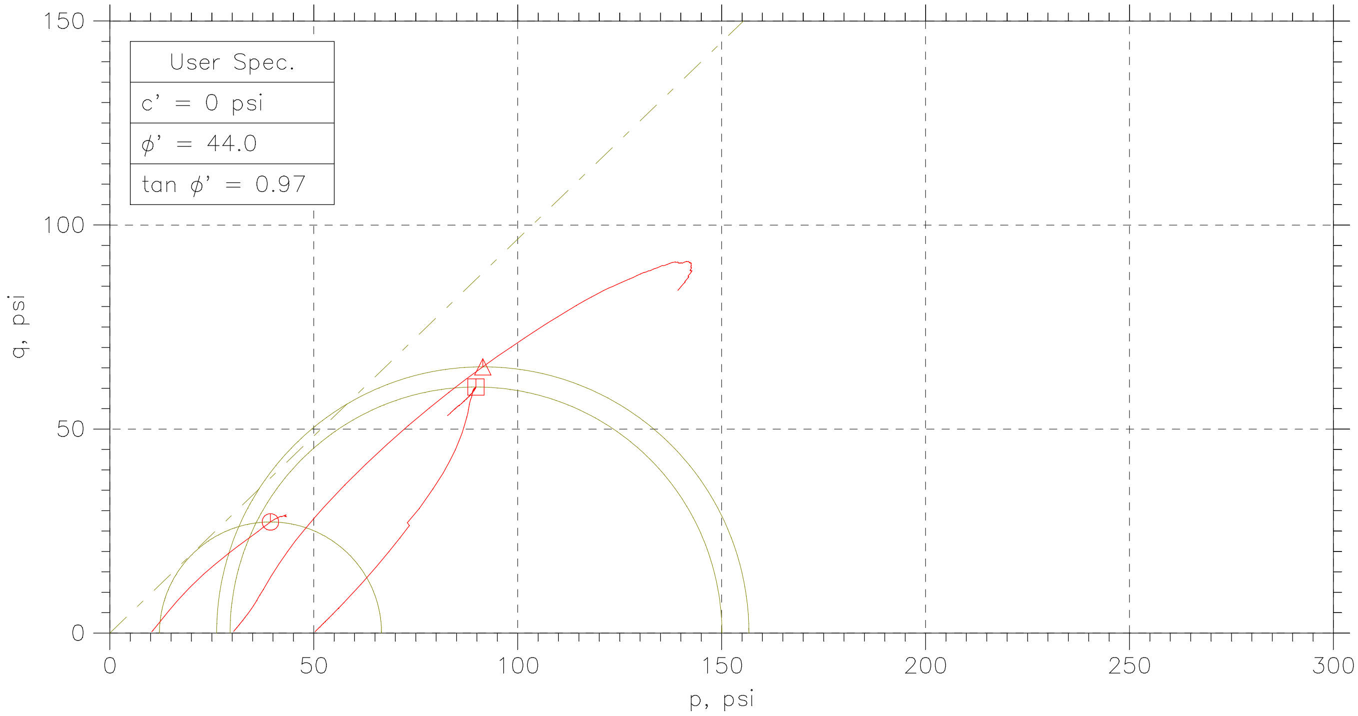
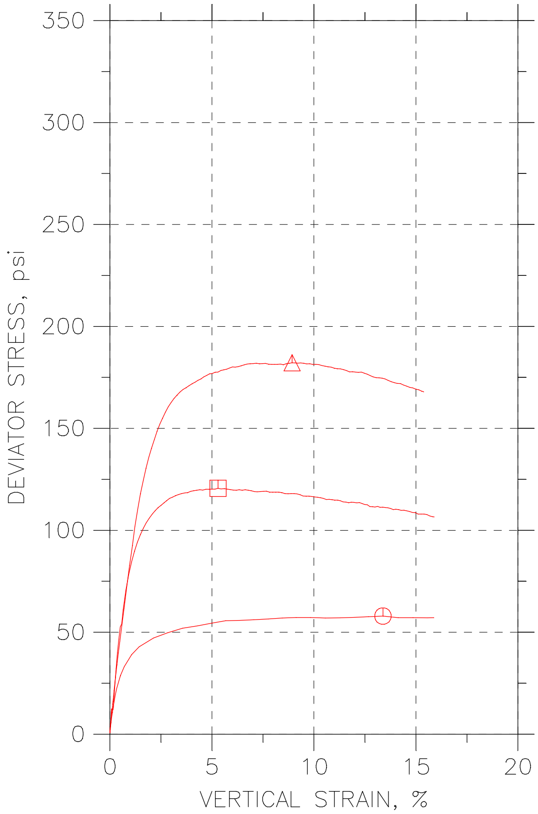
Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: UD	
Description: Bottom ASH		
Remarks: System 1062		

Tue, 22-SEP-2009 15:36:10

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





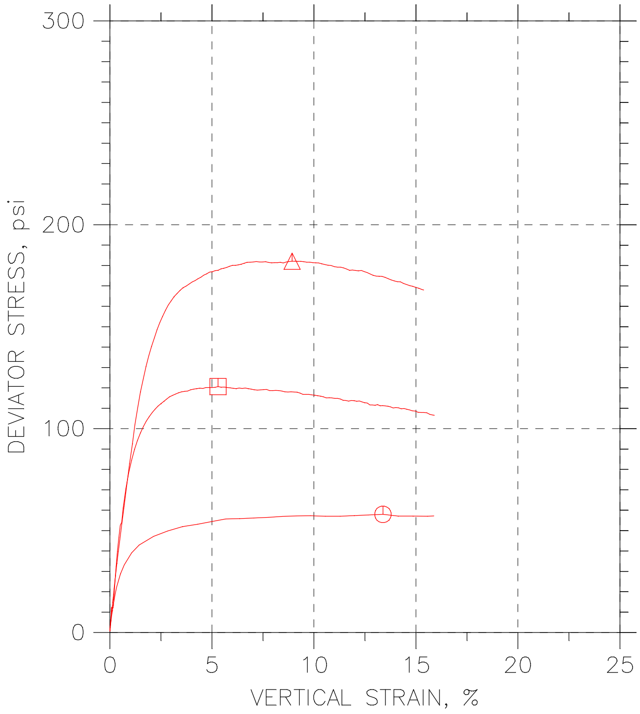
Symbol		○	△	□	
Sample No.		----	----	------	
Test No.		BA-1.1	BA-1.2	BA-1.3	
Depth		----	----	-----	
Initial	Diameter, in	2.872	2.871	2.87	
	Height, in	5.76	5.751	5.758	
	Water Content, %	16.5	16.8	16.1	
	Dry Density, pcf	87.66	87.57	88.12	
	Saturation, %	48.3	53.8	47.5	
	Void Ratio	0.923	0.782	0.913	
Before Shear	Water Content, %	29.8	25.9	28.6	
	Dry Density, pcf	93.43	94.74	95.09	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.804	0.647	0.773	
	Back Press., psi	140	119	68.08	
Ver. Eff. Cons. Stress, psi		9.973	29.95	50	
Shear Strength, psi		28.97	91.06	60.29	
Strain at Failure, %		13.4	8.93	5.3	
Strain Rate, %/min		0.07	0.07	0.07	
B-Value		0.95	0.95	0.95	
Estimated Specific Gravity		2.7	2.5	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

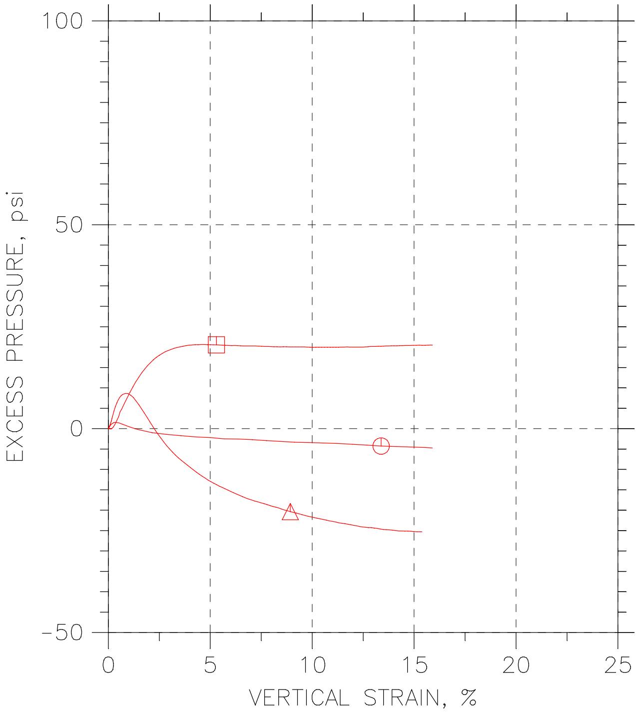
GeoTesting express

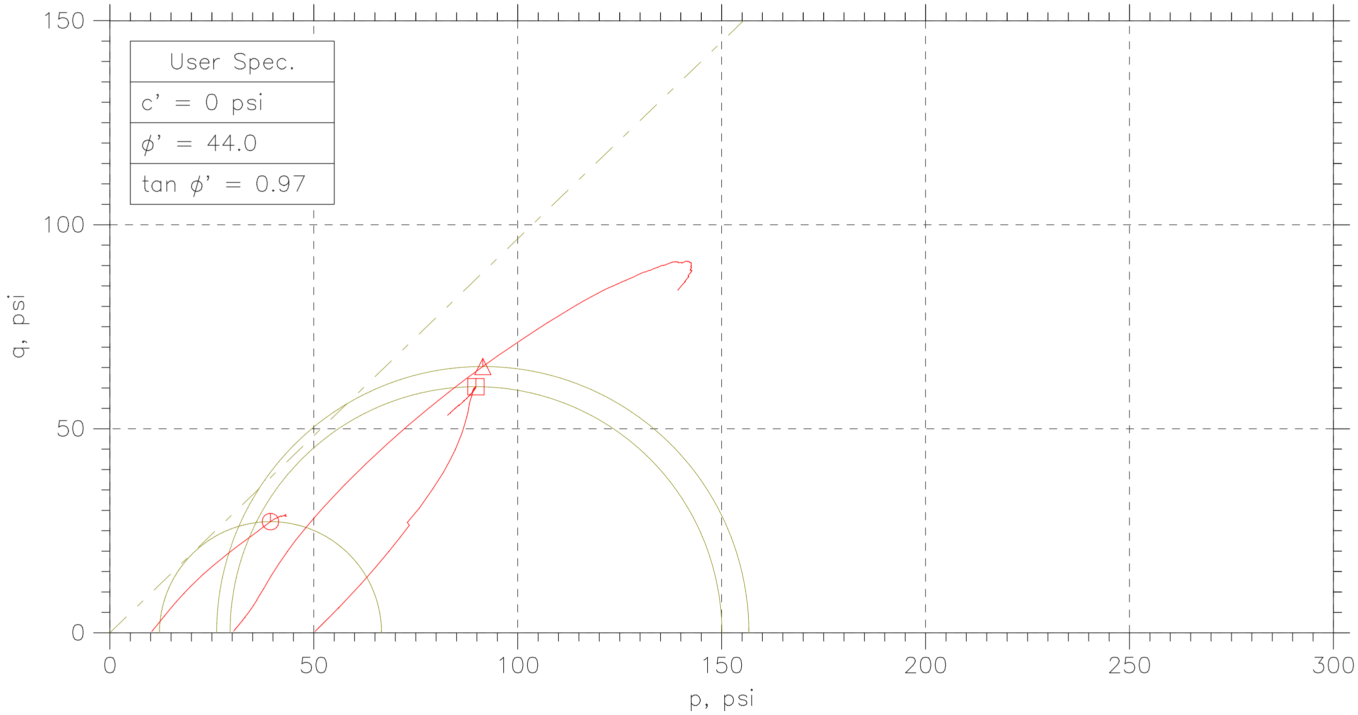
Project: Cumberland
Location: ---
Project No.: GTX-1484
Boring No.: ---
Sample Type: UD
Description: Bottom ASH
Remarks: System 1062

Tue, 22-SEP-2009 15:40:43

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	BA-1.1	----	MM	9/17/09	CA		1484-BA-1.1.dat
△	----	BA-1.2	----	JM	9/18/09	MM		1484-BA-1.2.dat
□	------	BA-1.3	-----	JM	9/17/09	MM		1484-BA-1.3.dat

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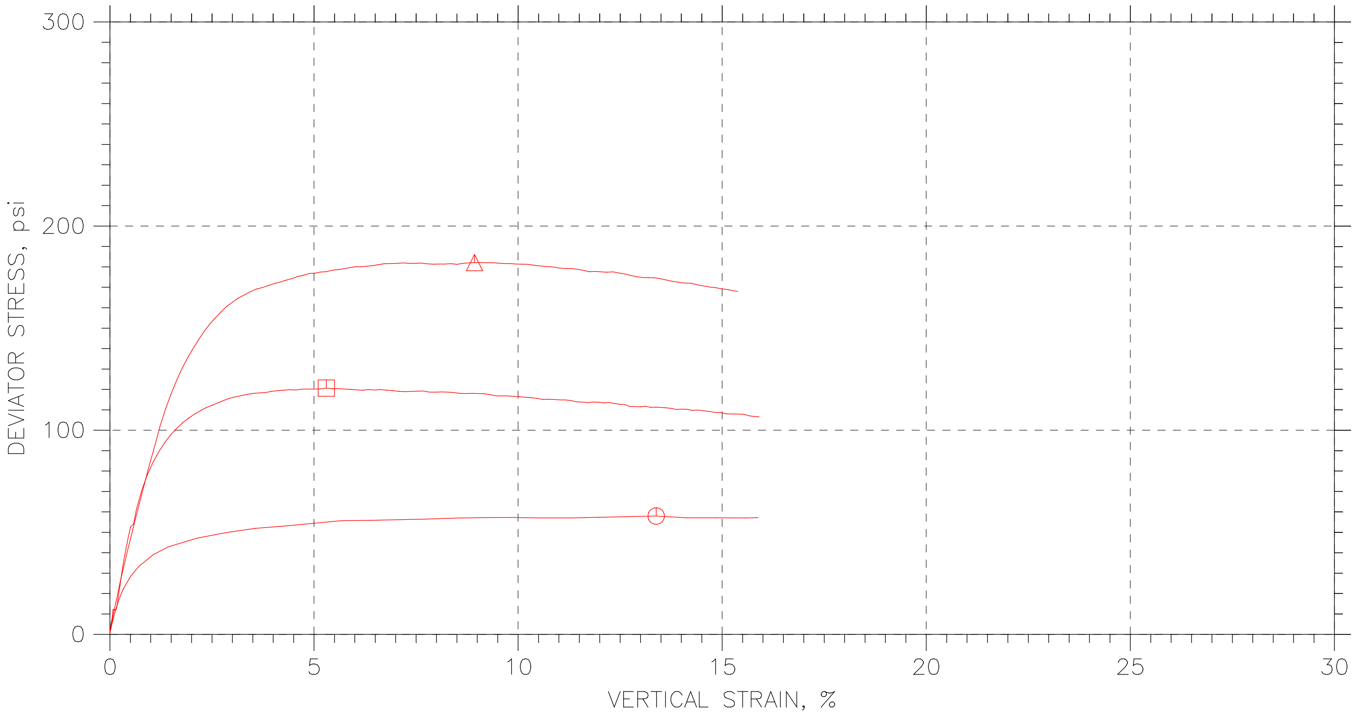
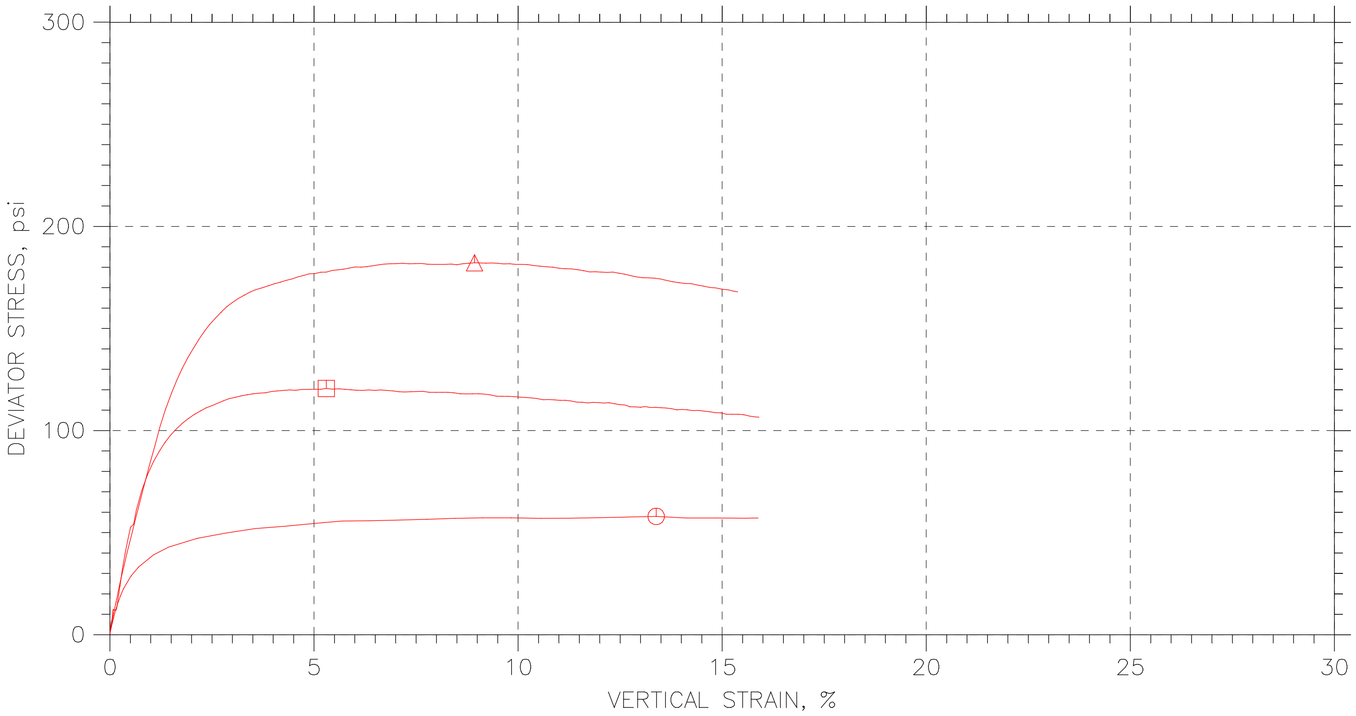
Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: UD	
Description: Bottom ASH		
Remarks: System 1062		

Tue, 22-SEP-2009 15:40:44

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	BA-1.1	----	MM	9/17/09	CA		1484-BA-1.1.dat
△	----	BA-1.2	----	JM	9/18/09	MM		1484-BA-1.2.dat
□	------	BA-1.3	-----	JM	9/17/09	MM		1484-BA-1.3.dat

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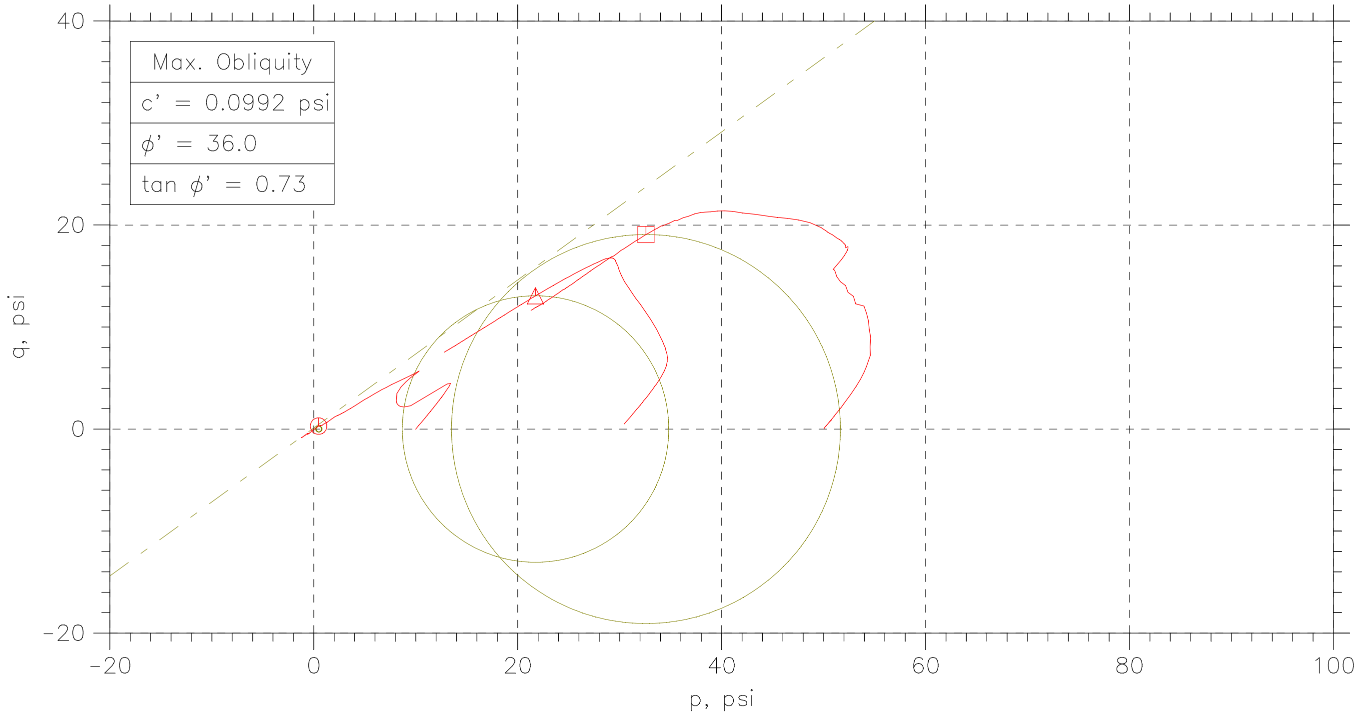
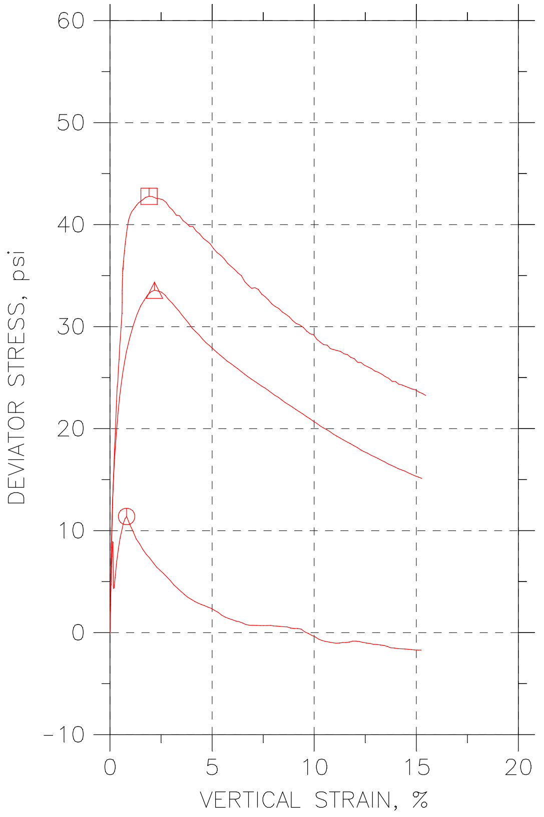
Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: UD	
Description: Bottom ASH		
Remarks: System 1062		

Tue, 22-SEP-2009 15:40:45

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





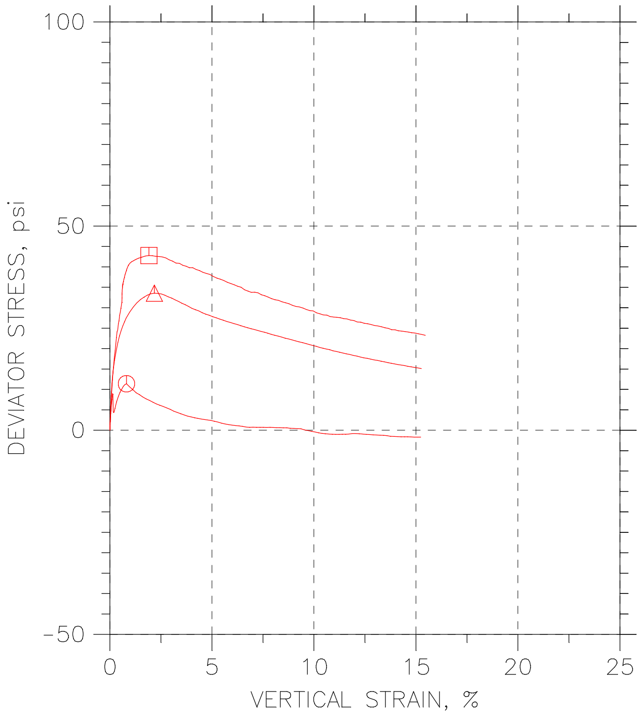
	Symbol	○	△	□	
	Sample No.	----	----	----	
	Test No.	FA-1.1	FA-1.2	FA-1.3	
	Depth	----	----	----	
Initial	Diameter, in	2.871	2.85	2.87	
	Height, in	5.831	5.721	5.836	
	Water Content, %	33.6	33.8	34.4	
	Dry Density, pcf	65.75	66.09	66.21	
	Saturation, %	61.2	62.0	63.3	
	Void Ratio	1.37	1.36	1.36	
Before Shear	Water Content, %	46.9	43.7	43.8	
	Dry Density, pcf	71.87	74.6	74.53	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	1.17	1.09	1.09	
	Back Press., psi	140	119	101	
	Ver. Eff. Cons. Stress, psi	10	29.94	50	
	Shear Strength, psi	5.693	16.78	21.39	
	Strain at Failure, %	0.81	2.18	1.91	
	Strain Rate, %/min	0.08	0.08	0.08	
	B-Value	0.95	0.95	0.96	
	Estimated Specific Gravity	2.5	2.5	2.5	
	Liquid Limit	---	---	---	
	Plastic Limit	---	---	---	

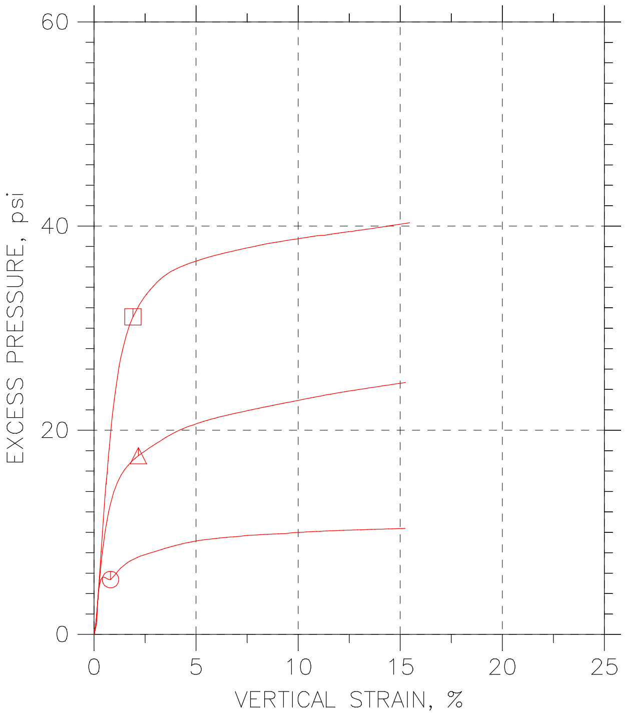
GeoTesting express

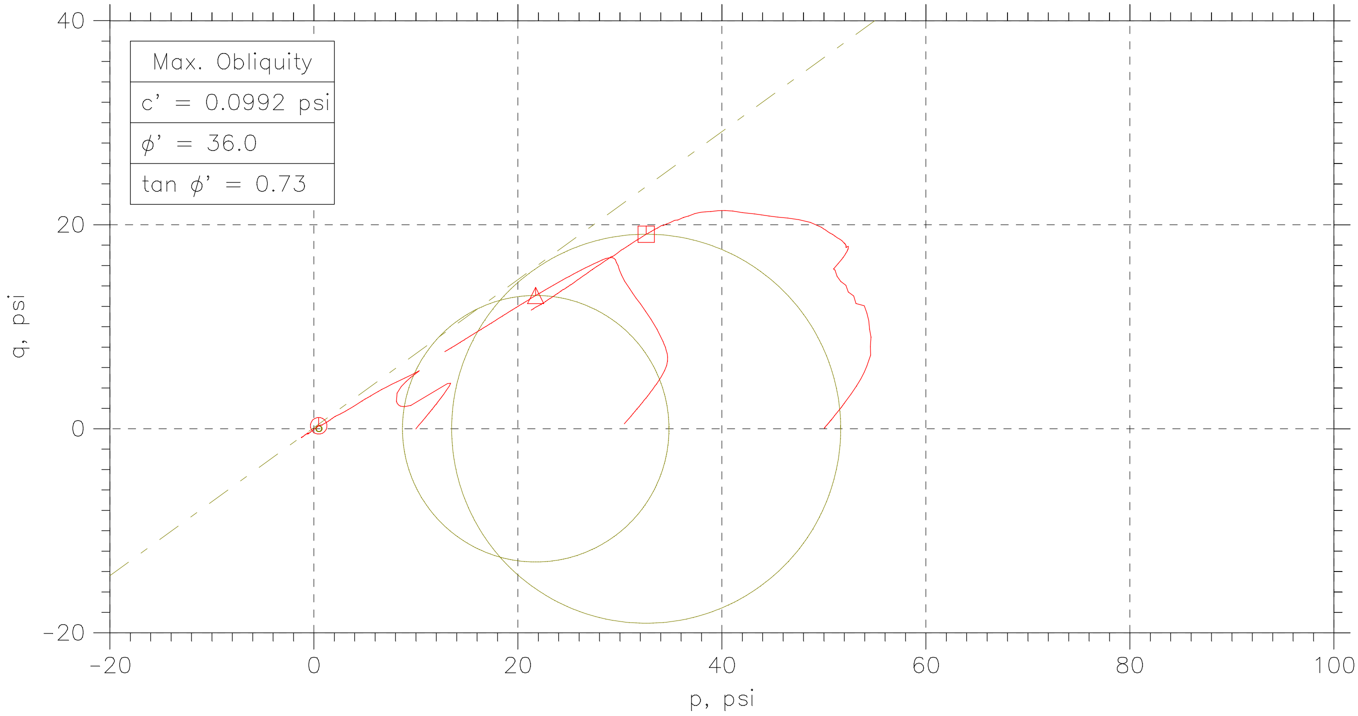
Project: Cumberland
Location: ---
Project No.: GTX-1484
Boring No.: ---
Sample Type: Remolded
Description: Dark Gray-Black (FLY ASH-BULK)
Remarks: System 1057

Mon, 21-SEP-2009 18:26:32

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	FA-1.1	----	JM	9/4/09	MM		1484-FA-1.1.dat
△	----	FA-1.2	----	JM	9/10/09	MM		1484-FA-1.2.dat
□	----	FA-1.3	----	JM	9/3/09	MM		1484-FA-1.3.dat

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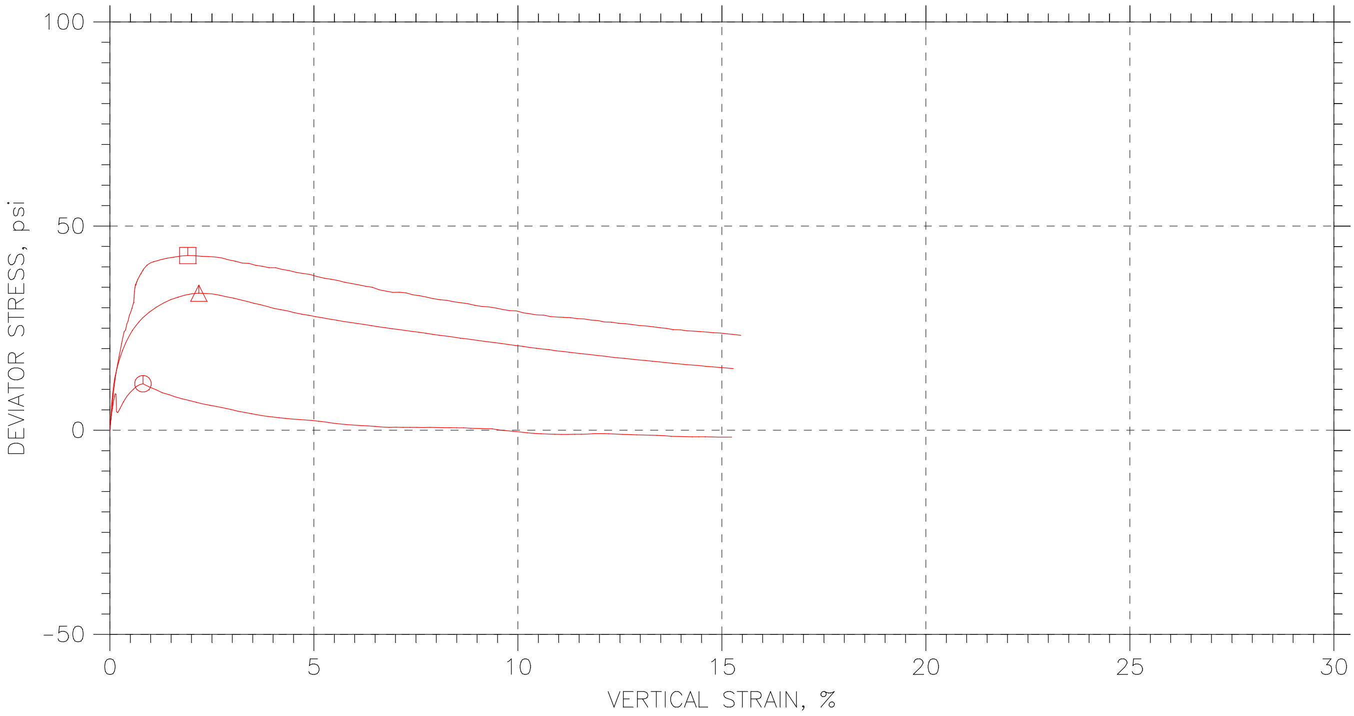
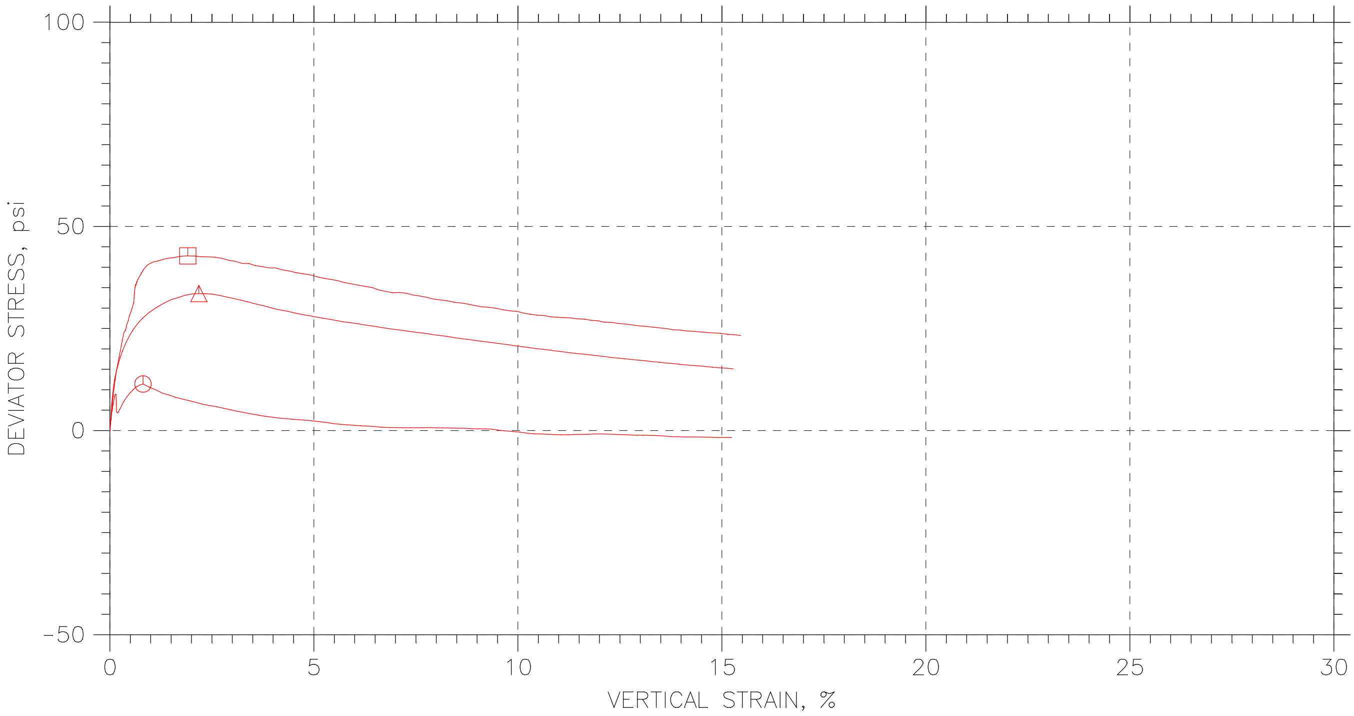
Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: Remolded	
Description: Dark Gray-Black (FLY ASH-BULK)		
Remarks: System 1057		

Mon, 21-SEP-2009 18:26:33

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	FA-1.1	----	JM	9/4/09	MM		1484-FA-1.1.dat
△	----	FA-1.2	----	JM	9/10/09	MM		1484-FA-1.2.dat
□	----	FA-1.3	----	JM	9/3/09	MM		1484-FA-1.3.dat

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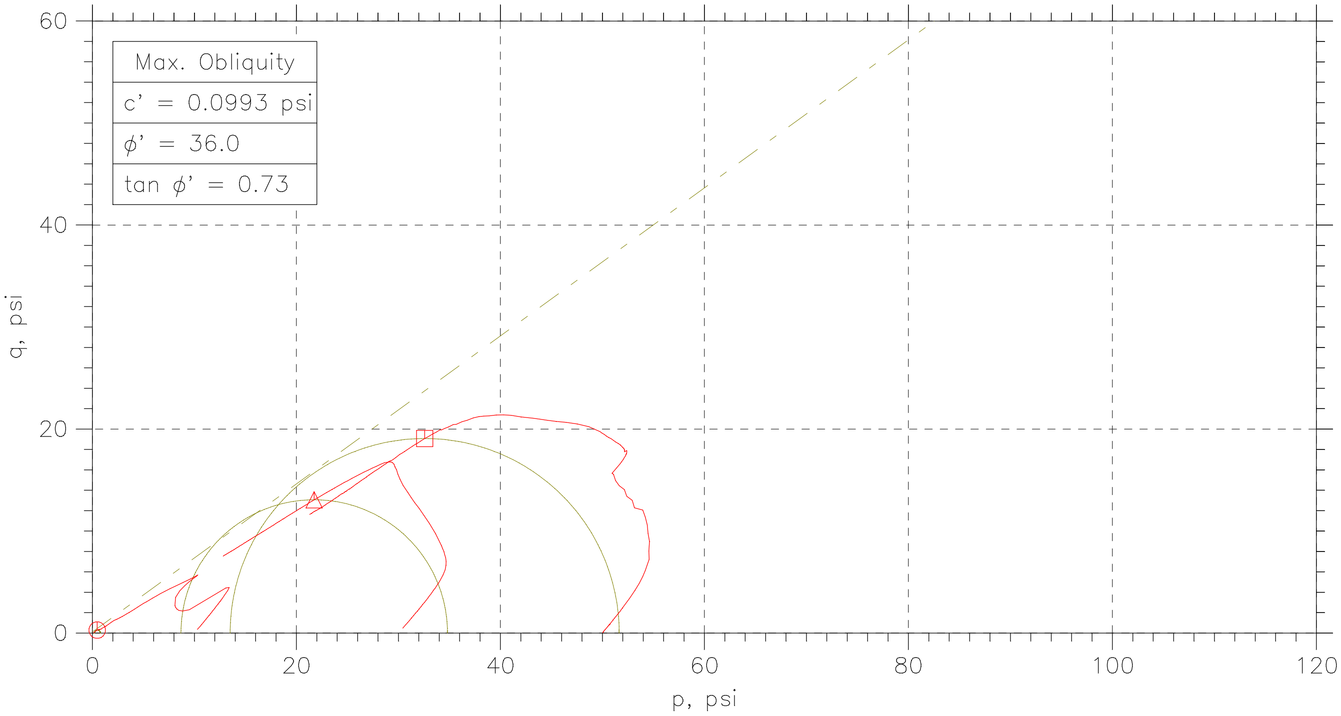
Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: Remolded	

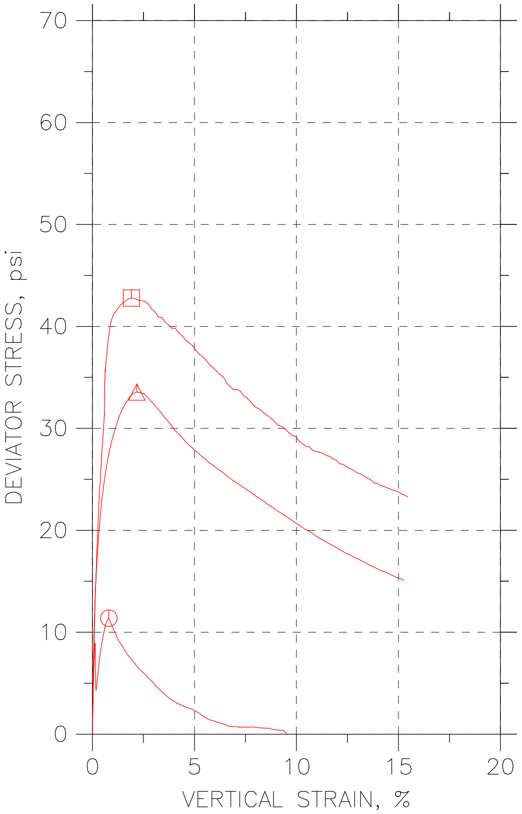
Description: Dark Gray-Black (FLY ASH-BULK)

Remarks: System 1057

Mon, 21-SEP-2009 18:26:35

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





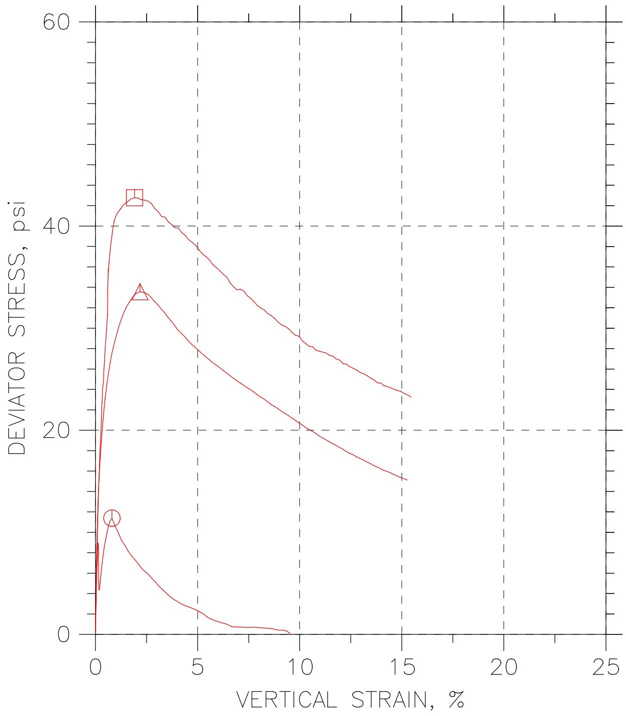
Symbol		○	△	□	
Sample No.		----	----	----	
Test No.		FA-1.1	FA-1.2	FA-1.3	
Depth		----	----	----	
Initial	Diameter, in	2.871	2.85	2.87	
	Height, in	5.831	5.721	5.836	
	Water Content, %	33.6	33.8	34.4	
	Dry Density, pcf	65.75	66.09	66.21	
	Saturation, %	61.2	62.0	63.3	
	Void Ratio	1.37	1.36	1.36	
Before Shear	Water Content, %	46.9	43.7	43.8	
	Dry Density, pcf	71.87	74.6	74.53	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	1.17	1.09	1.09	
	Back Press., psi	140	119	101	
Ver. Eff. Cons. Stress, psi		9.948	29.94	50	
Shear Strength, psi		5.693	16.78	21.39	
Strain at Failure, %		0.804	2.18	1.91	
Strain Rate, %/min		0.08	0.08	0.08	
B-Value		0.95	0.95	0.96	
Estimated Specific Gravity		2.5	2.5	2.5	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

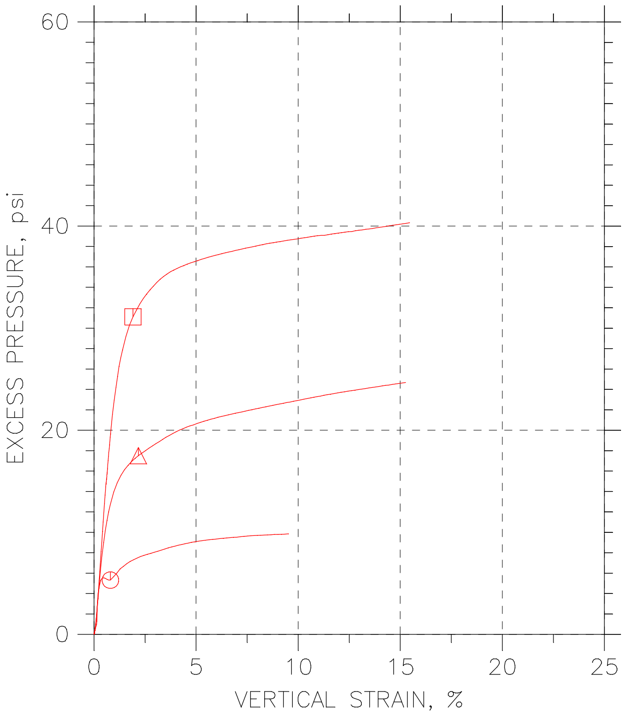
GeoTesting express

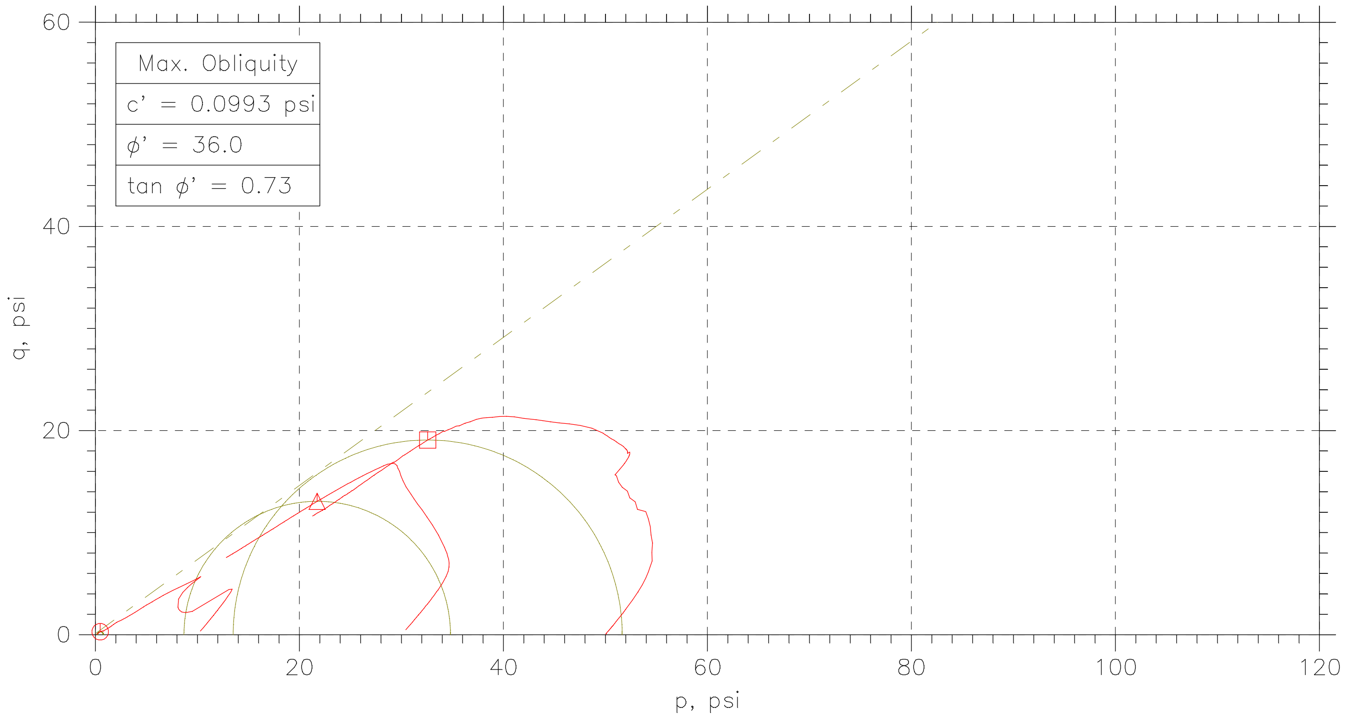
Project: Cumberland
Location: ---
Project No.: GTX-1484
Boring No.: ---
Sample Type: Remolded
Description: Dark Gray-Black (FLY ASH-BULK)
Remarks: System 1057

Mon, 21-SEP-2009 18:29:24

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	FA-1.1	----	JM	9/4/09	MM		1484-FA-1.1ammended.dat
△	----	FA-1.2	----	JM	9/10/09	MM		1484-FA-1.2.dat
□	----	FA-1.3	----	JM	9/3/09	MM		1484-FA-1.3.dat

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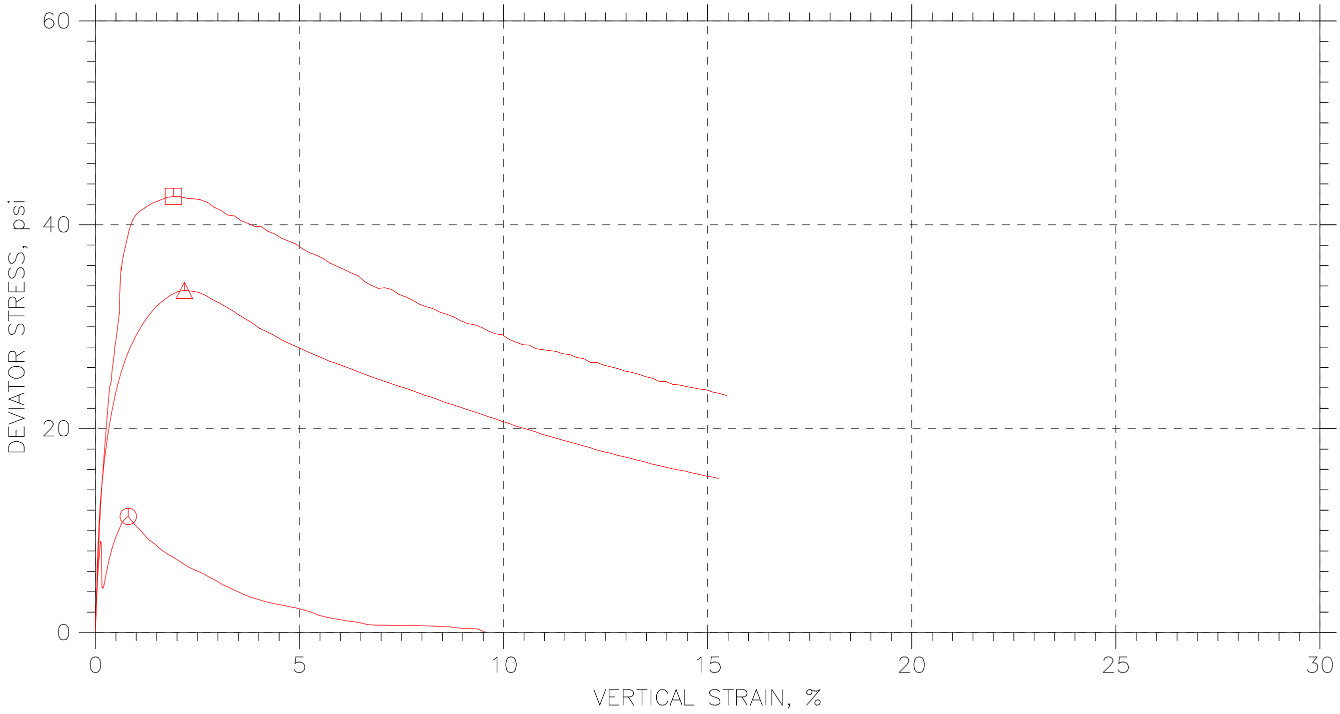
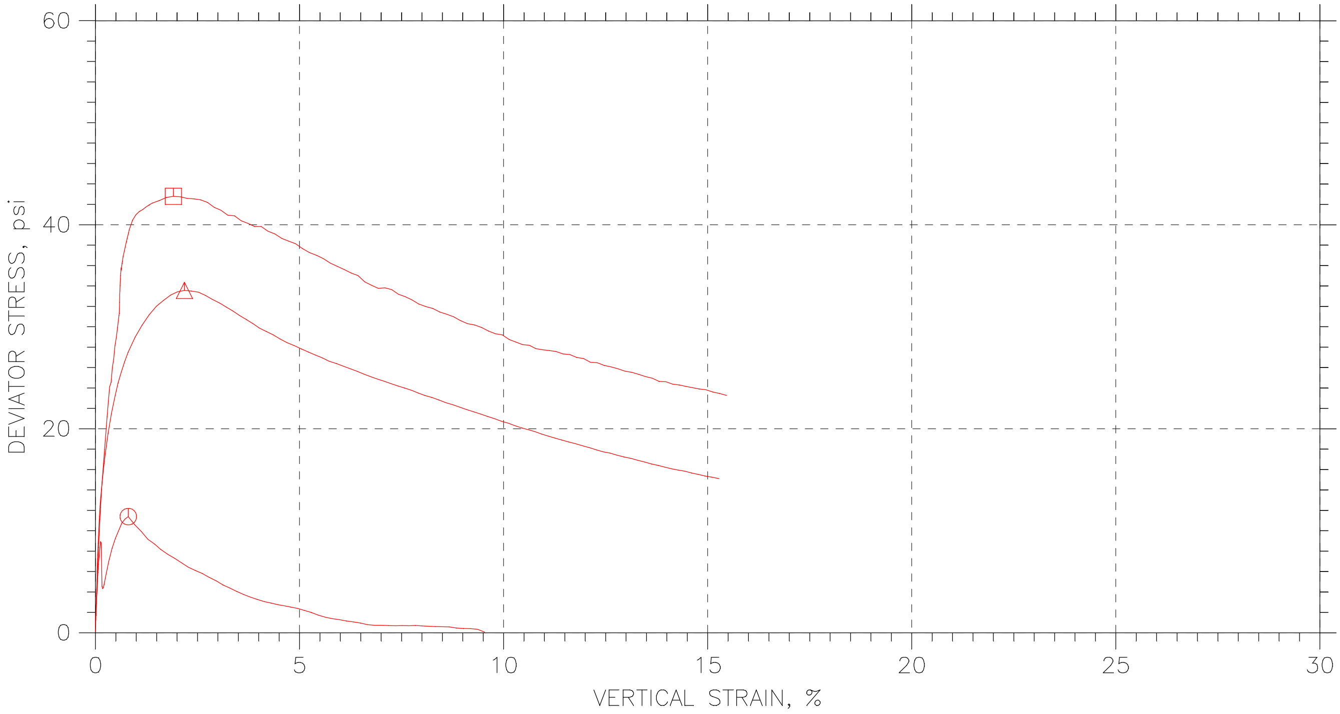
Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: Remolded	
Description: Dark Gray-Black (FLY ASH-BULK)		
Remarks: System 1057		

Mon, 21-SEP-2009 18:29:25

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	FA-1.1	----	JM	9/4/09	MM		1484-FA-1.1ammended.dat
△	----	FA-1.2	----	JM	9/10/09	MM		1484-FA-1.2.dat
□	----	FA-1.3	----	JM	9/3/09	MM		1484-FA-1.3.dat

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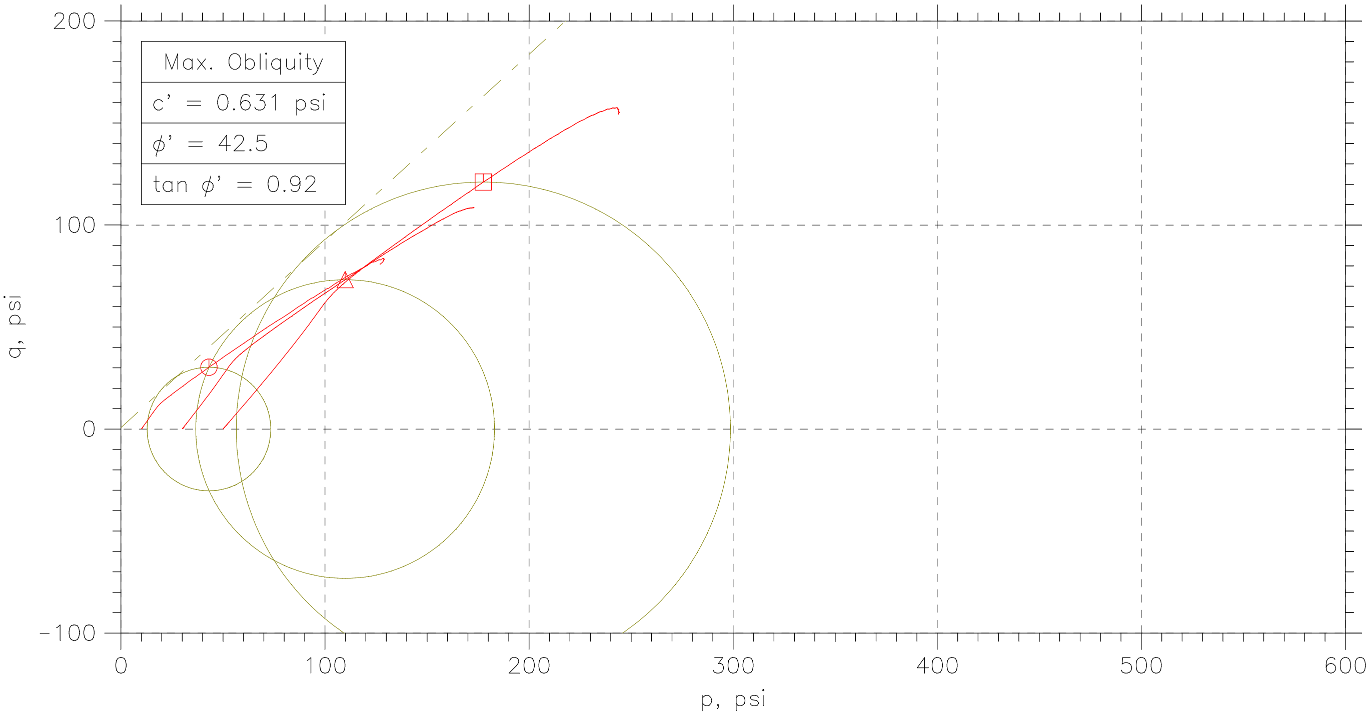
Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: Remolded	

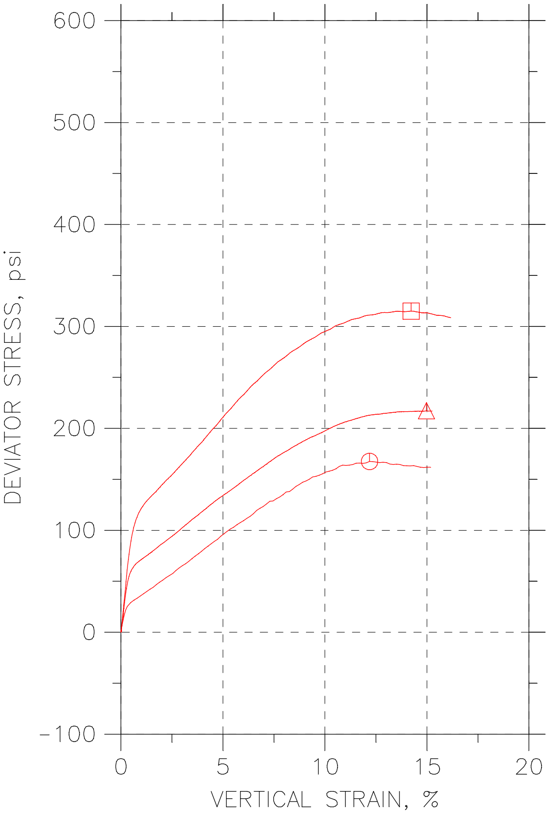
Description: Dark Gray-Black (FLY ASH-BULK)

Remarks: System 1057

Mon, 21-SEP-2009 18:29:26

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





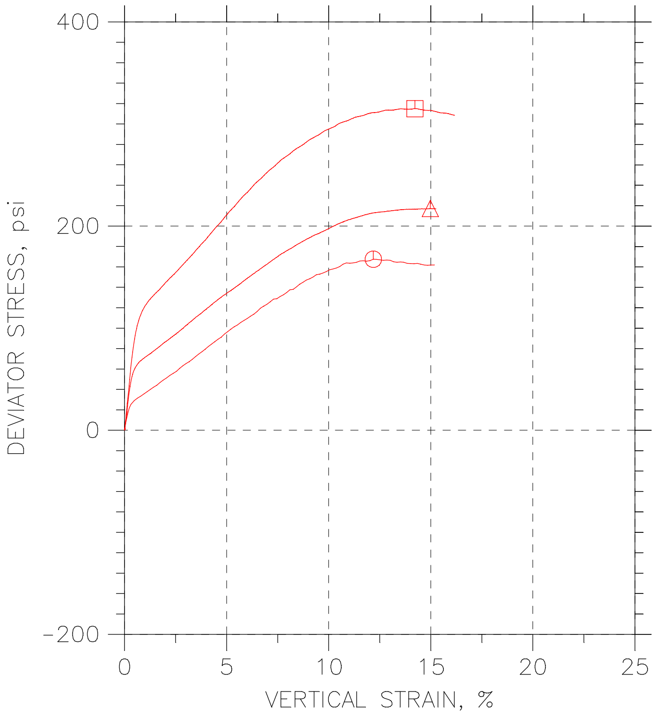
Symbol		○	△	□	
Sample No.		----	----	------	
Test No.		GB-1.1	GB-1.2	BA-1.3	
Depth		----	----	-----	
Initial	Diameter, in	2.851	2.873	2.87	
	Height, in	5.901	5.901	5.901	
	Water Content, %	29.1	28.9	29.2	
	Dry Density, pcf	80.97	80.17	80.41	
	Saturation, %	72.6	76.2	72.0	
	Void Ratio	1.08	0.947	1.1	
Before Shear	Water Content, %	40.0	37.1	36.9	
	Dry Density, pcf	81.09	80.96	84.44	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	1.08	0.928	0.996	
	Back Press., psi	140	119	101.4	
Ver. Eff. Cons. Stress, psi		9.976	29.98	50	
Shear Strength, psi		83.75	108.6	157.5	
Strain at Failure, %		12.2	15	14.2	
Strain Rate, %/min		0.016	0.016	0.016	
B-Value		0.95	0.95	0.95	
Estimated Specific Gravity		2.7	2.5	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

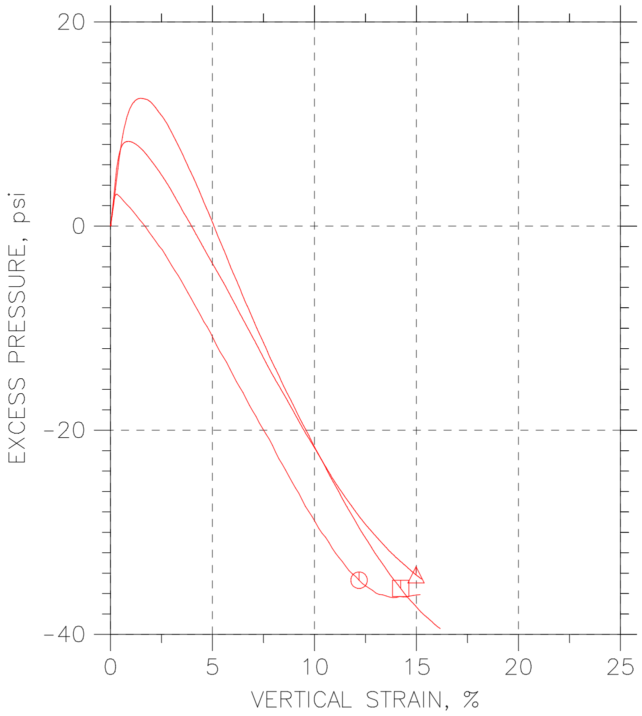
GeoTesting express

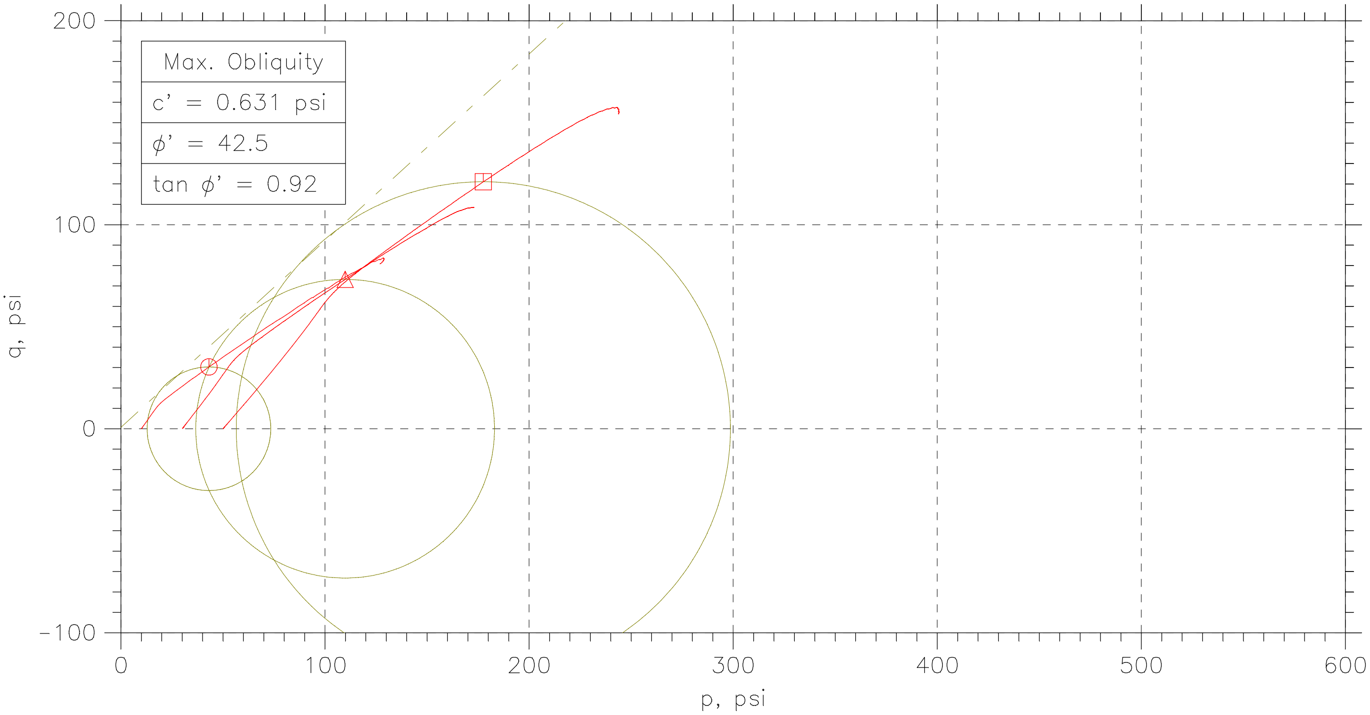
Project: Cumberland
Location: ---
Project No.: GTX-1484
Boring No.: ---
Sample Type: UD
Description: Gypsum BULK
Remarks: System 1062

Tue, 22-SEP-2009 09:52:02

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	GB-1.1	----	MM	9/10/09	CA		1484-GB-1.1.dat
△	----	GB-1.2	----	JM	9/11/09	MM		1484-GB-1.2.dat
□	------	BA-1.3	-----	JM	9/10/09	MM		1484-GB-1.3.dat

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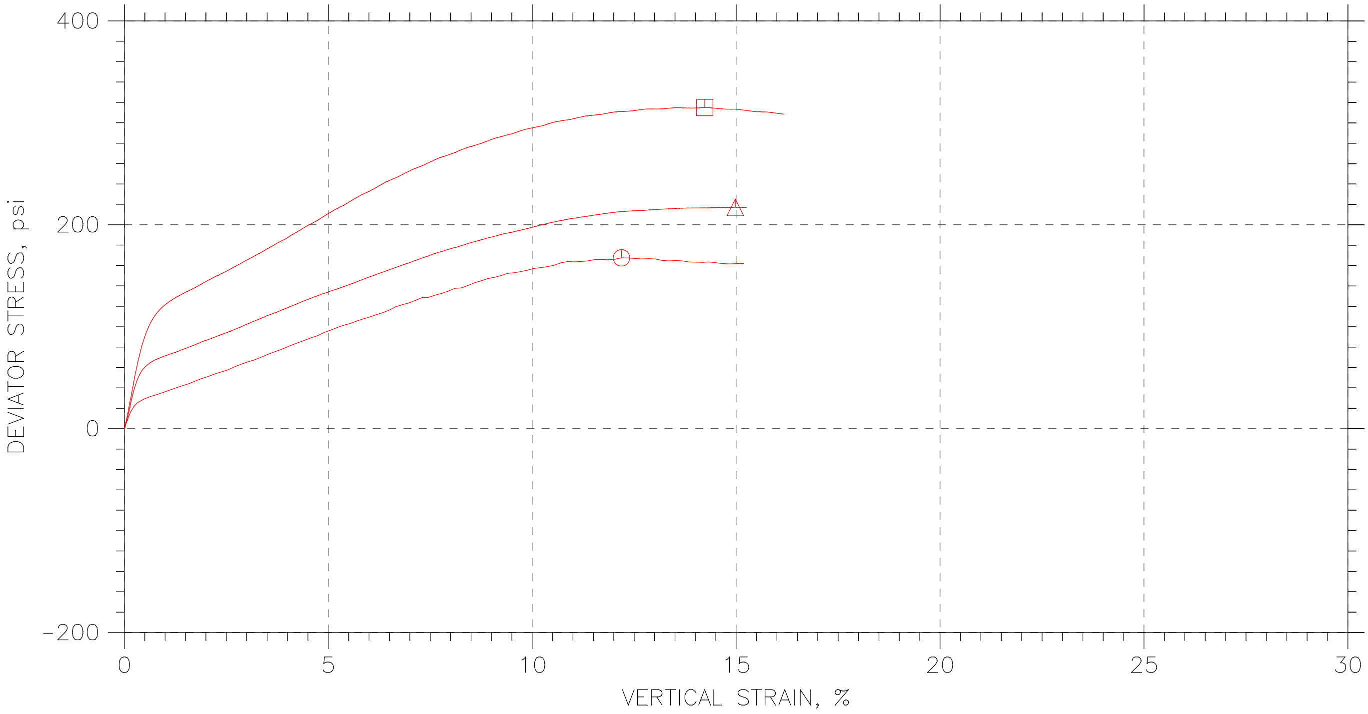
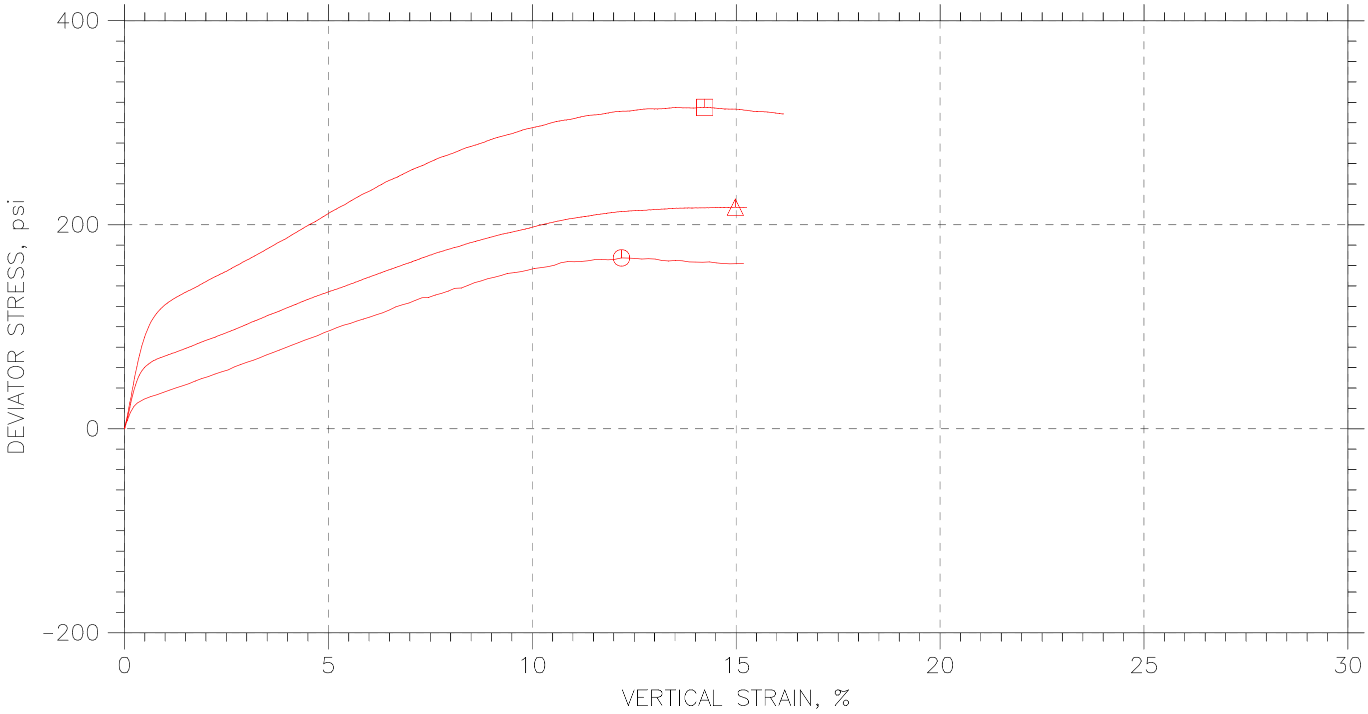
Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: UD	
Description: Gypsum BULK		
Remarks: System 1062		

Tue, 22-SEP-2009 09:52:04

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	GB-1.1	----	MM	9/10/09	CA		1484-GB-1.1.dat
△	----	GB-1.2	----	JM	9/11/09	MM		1484-GB-1.2.dat
□	------	BA-1.3	-----	JM	9/10/09	MM		1484-GB-1.3.dat

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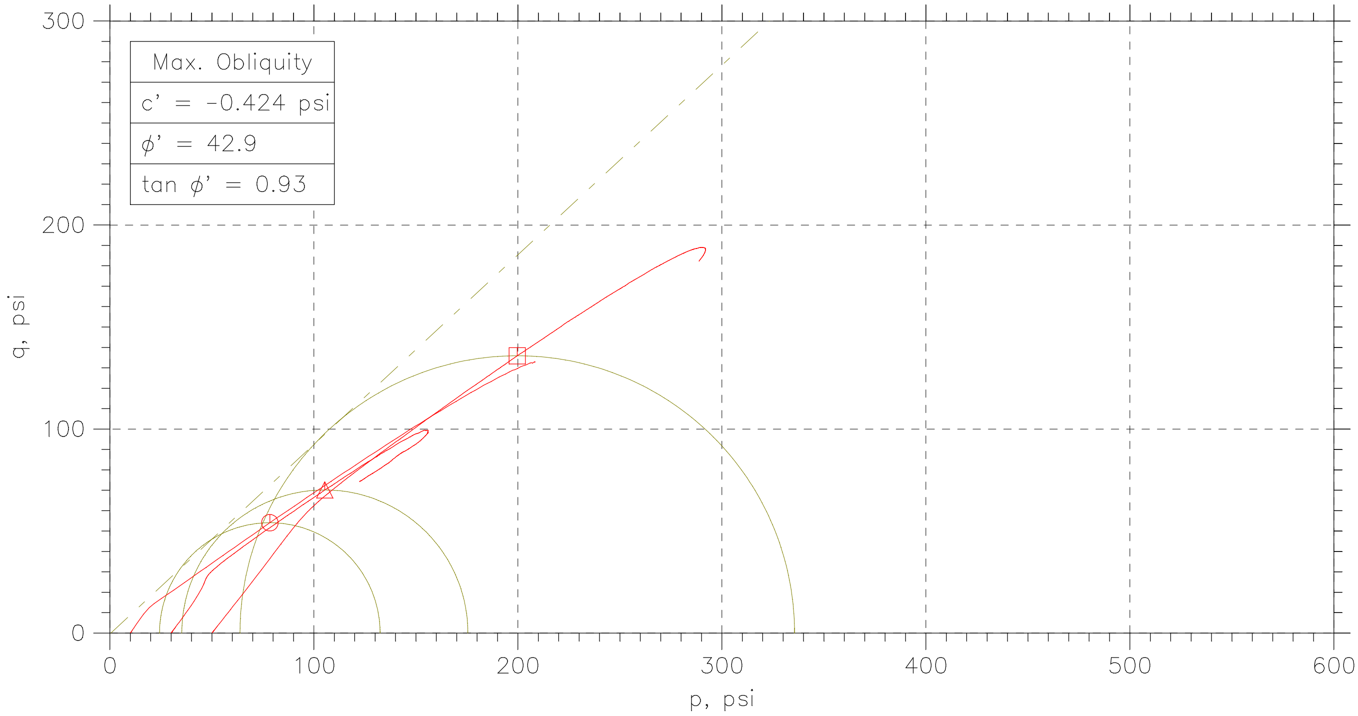
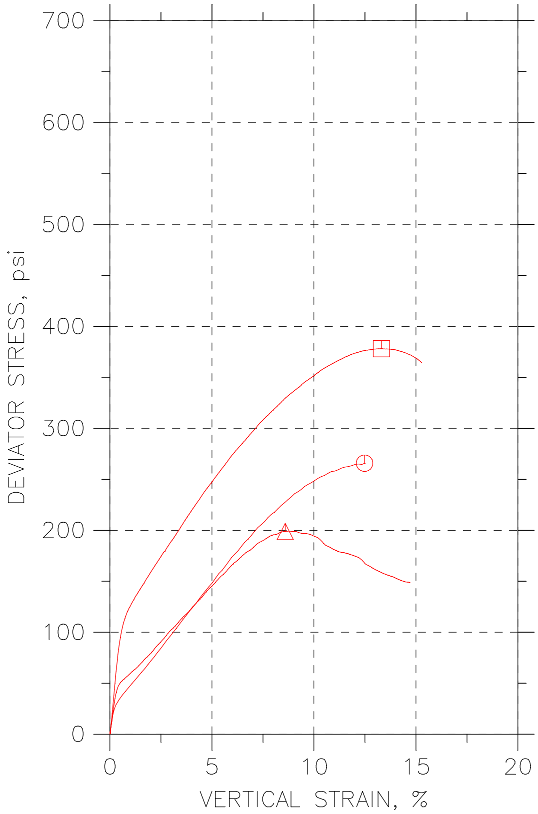
Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: UD	
Description: Gypsum BULK		
Remarks: System 1062		

Tue, 22-SEP-2009 09:52:05

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Symbol	○	△	□	
	Sample No.	----	----	------	
	Test No.	GR-1.1	GR-1.2	GR-1.3	
	Depth	----	----	-----	
Initial	Diameter, in	2.875	2.874	2.875	
	Height, in	5.995	5.988	5.981	
	Water Content, %	27.2	26.9	26.9	
	Dry Density, pcf	80.71	80.79	80.75	
	Saturation, %	67.4	66.9	66.8	
	Void Ratio	1.09	1.09	1.09	
Before Shear	Water Content, %	33.6	31.0	25.8	
	Dry Density, pcf	88.41	91.8	99.36	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.907	0.836	0.696	
	Back Press., psi	140	119	101	
	Ver. Eff. Cons. Stress, psi	9.981	29.97	49.98	
	Shear Strength, psi	132.9	99.42	189.1	
	Strain at Failure, %	12.5	8.59	13.3	
	Strain Rate, %/min	0.016	0.016	0.016	
	B-Value	0.95	0.95	0.95	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	33	33	33	
	Plastic Limit	32	32	32	

GeoTesting express

Project: Cumberland
Location: ---
Project No.: GTX-1484
Boring No.: ---
Sample Type: UD
Description: Gypsum REJECTS
Remarks: System 1062

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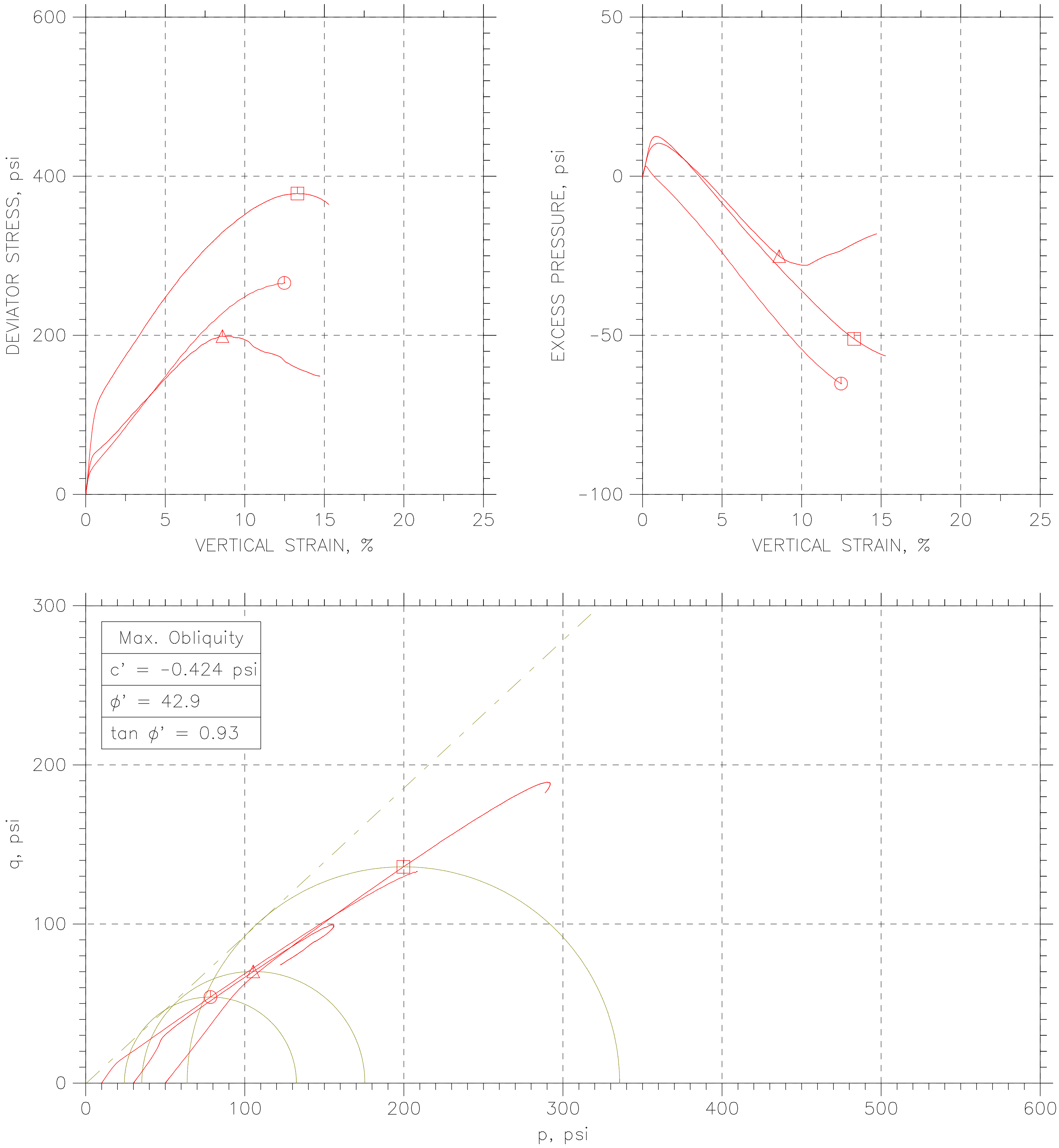
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	GR-1.1	----	MM	9/13/09	CA		1484-GR-1.1.dat
△	----	GR-1.2	----	JM	9/14/09	MM		1484-GR-1.2.dat
□	------	GR-1.3	-----	JM	9/13/09	MM		1484-GR-1.3.dat

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Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: UD	
Description: Gypsum REJECTS		
Remarks: System 1062		

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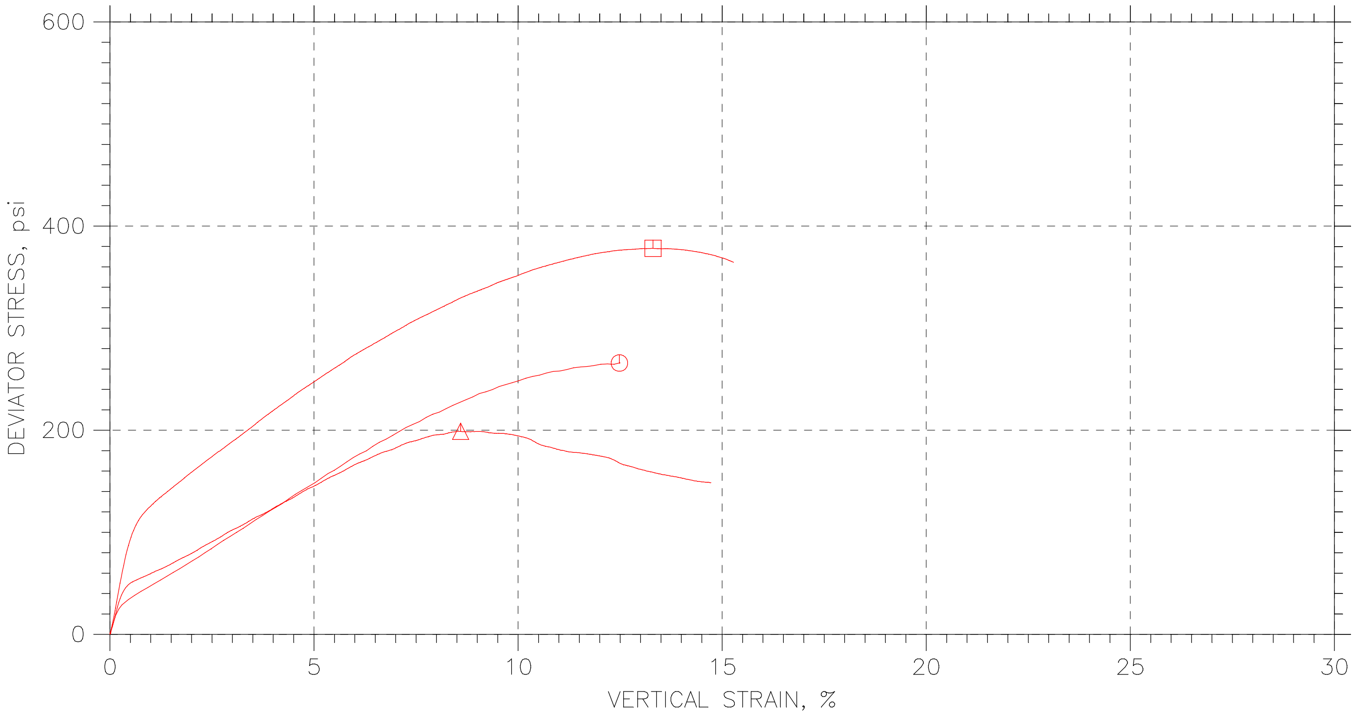
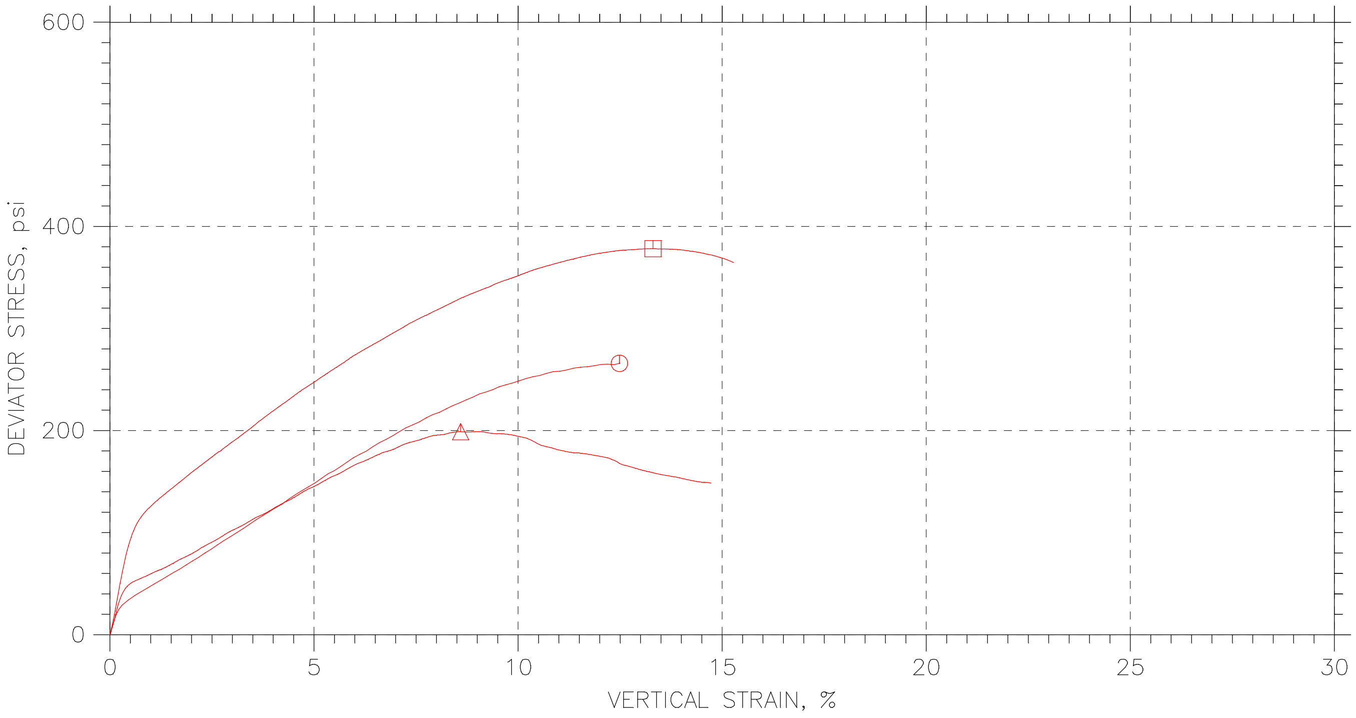
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	GR-1.1	----	MM	9/13/09	CA		1484-GR-1.1.dat
△	----	GR-1.2	----	JM	9/14/09	MM		1484-GR-1.2.dat
□	------	GR-1.3	-----	JM	9/13/09	MM		1484-GR-1.3.dat

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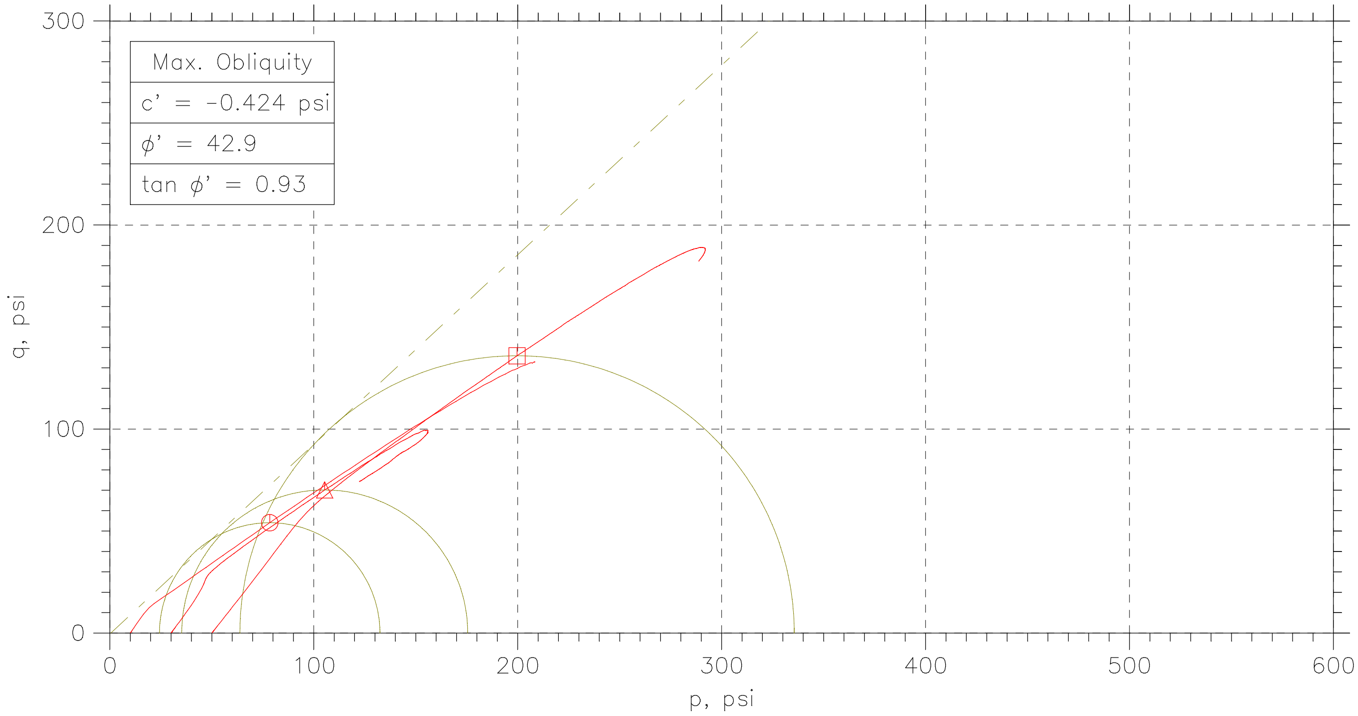
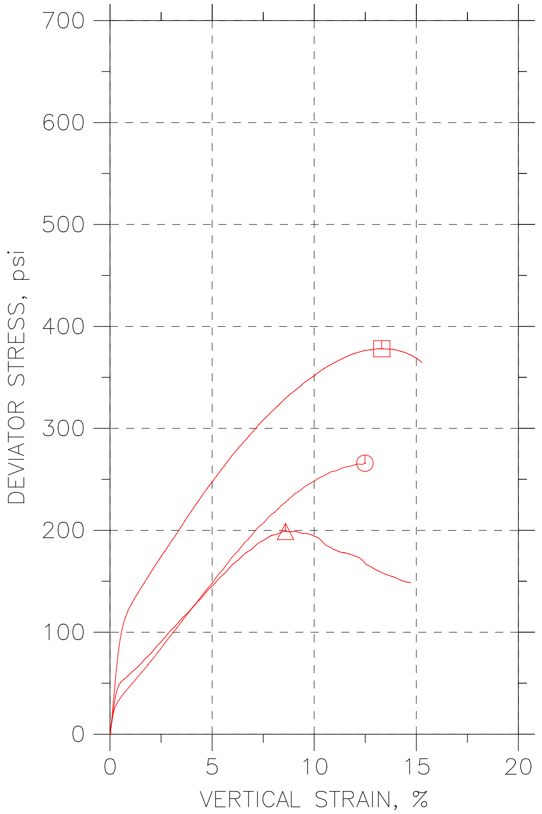
Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: UD	
Description: Gypsum REJECTS		
Remarks: System 1062		

Tue, 22-SEP-2009 17:18:52

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		----	----	------	
Test No.		GR-1.1	GR-1.2	GR-1.3	
Depth		----	----	-----	
Initial	Diameter, in	2.875	2.874	2.875	
	Height, in	5.995	5.988	5.981	
	Water Content, %	27.2	26.9	26.9	
	Dry Density, pcf	80.71	80.79	80.75	
	Saturation, %	67.4	66.9	66.8	
	Void Ratio	1.09	1.09	1.09	
Before Shear	Water Content, %	33.6	31.0	25.8	
	Dry Density, pcf	88.41	91.8	99.36	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.907	0.836	0.696	
	Back Press., psi	140	119	101	
Ver. Eff. Cons. Stress, psi		9.981	29.97	49.98	
Shear Strength, psi		132.9	99.42	189.1	
Strain at Failure, %		12.5	8.59	13.3	
Strain Rate, %/min		0.016	0.016	0.016	
B-Value		0.95	0.95	0.95	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		33	33	33	
Plastic Limit		32	32	32	

GeoTesting express

Project: Cumberland
Location: ---
Project No.: GTX-1484
Boring No.: ---
Sample Type: UD
Description: Gypsum REJECTS
Remarks: System 1062

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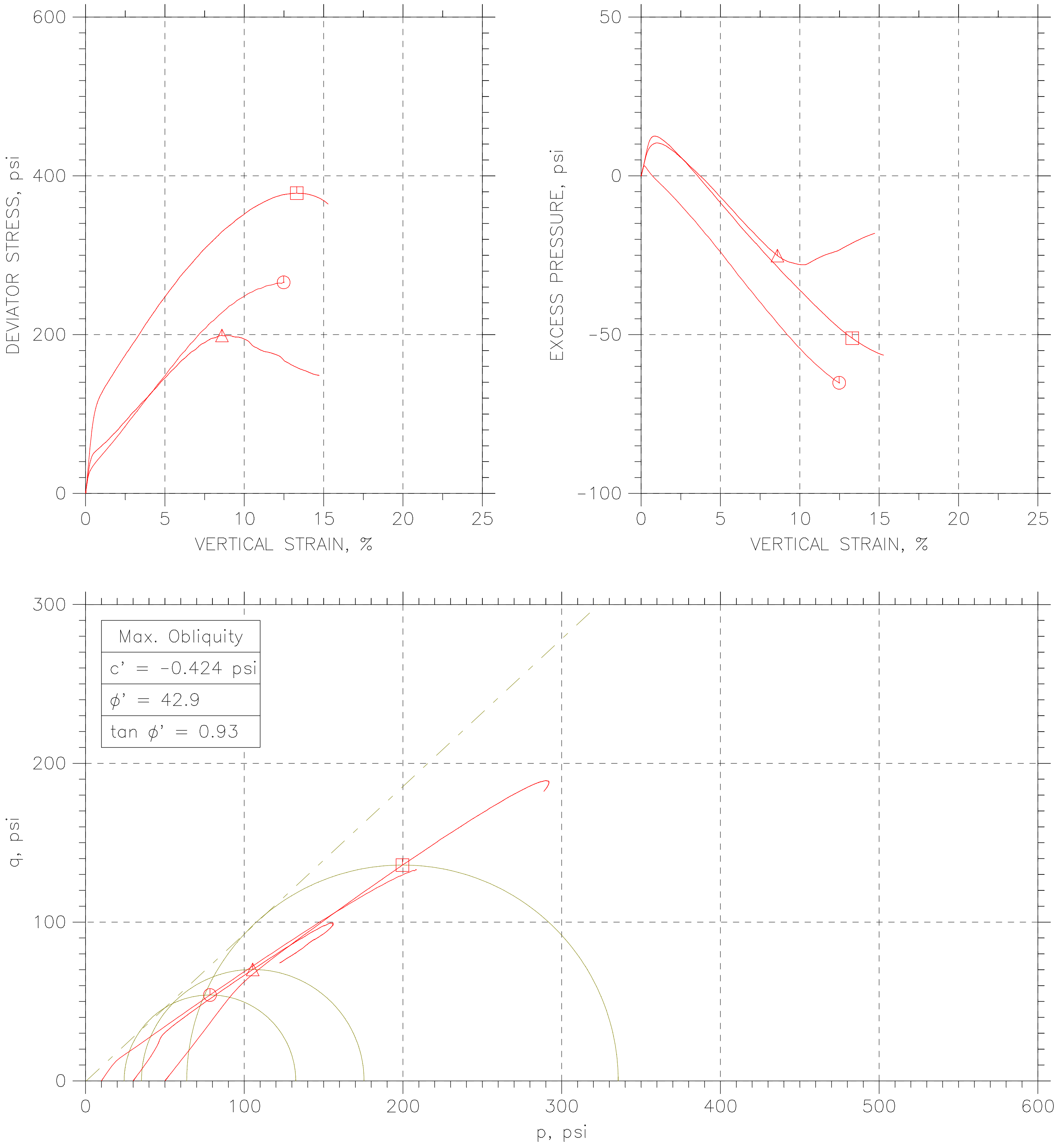
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	GR-1.1	----	MM	9/13/09	CA		1484-GR-1.1.dat
△	----	GR-1.2	----	JM	9/14/09	MM		1484-GR-1.2.dat
□	------	GR-1.3	-----	JM	9/13/09	MM		1484-GR-1.3.dat

Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: UD	
Description: Gypsum REJECTS		
Remarks: System 1062		

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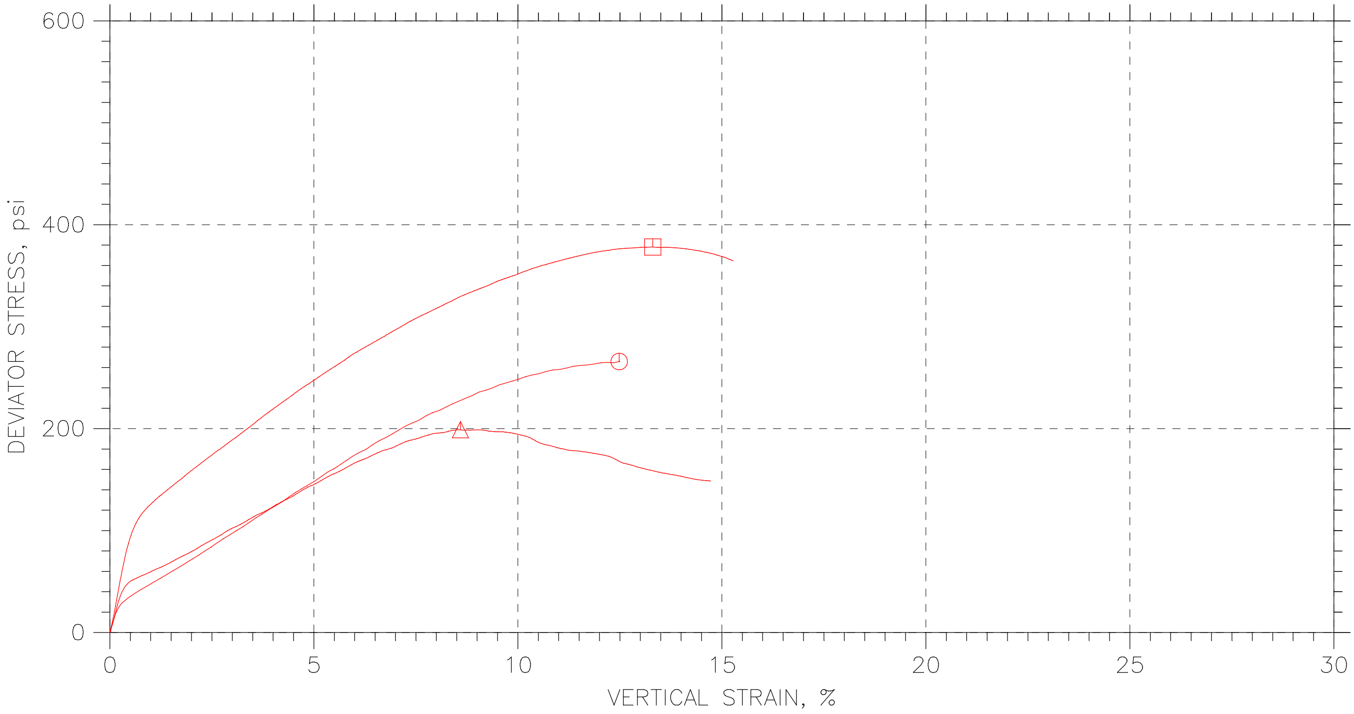
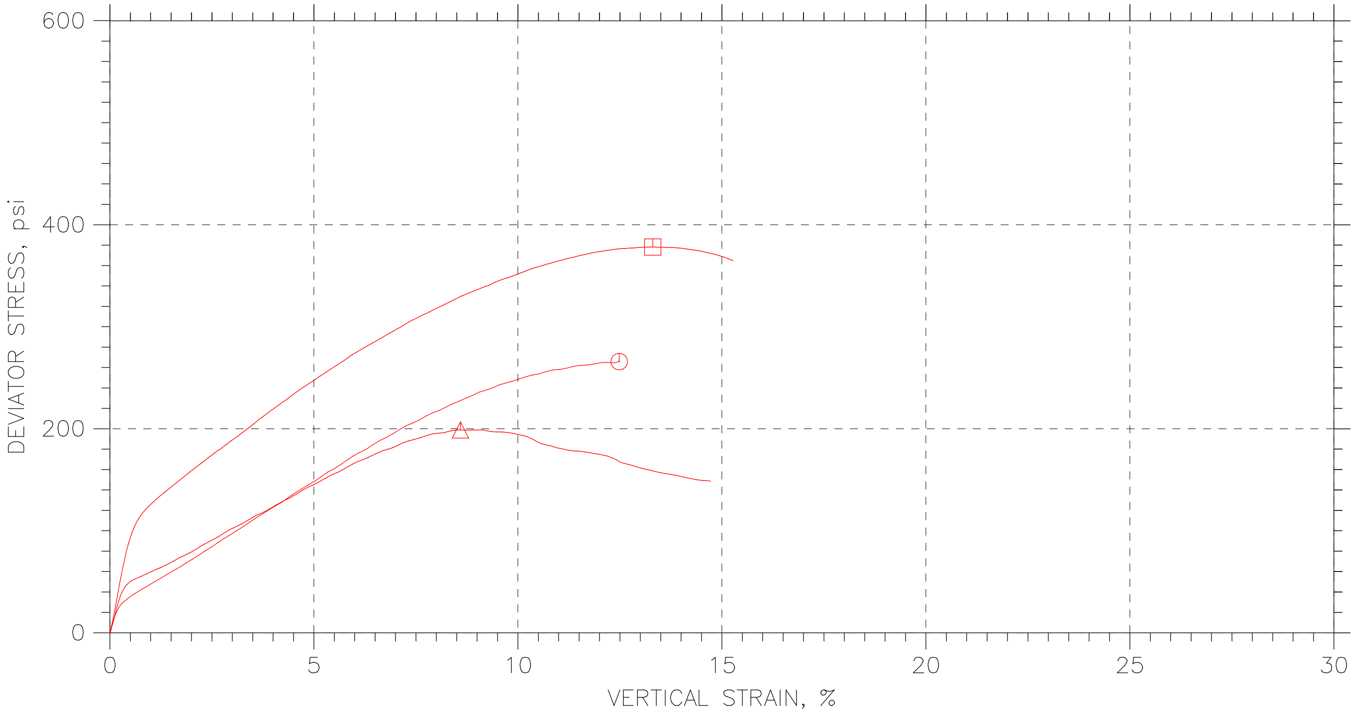
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	GR-1.1	----	MM	9/13/09	CA		1484-GR-1.1.dat
△	----	GR-1.2	----	JM	9/14/09	MM		1484-GR-1.2.dat
□	------	GR-1.3	-----	JM	9/13/09	MM		1484-GR-1.3.dat

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Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: UD	
Description: Gypsum REJECTS		
Remarks: System 1062		

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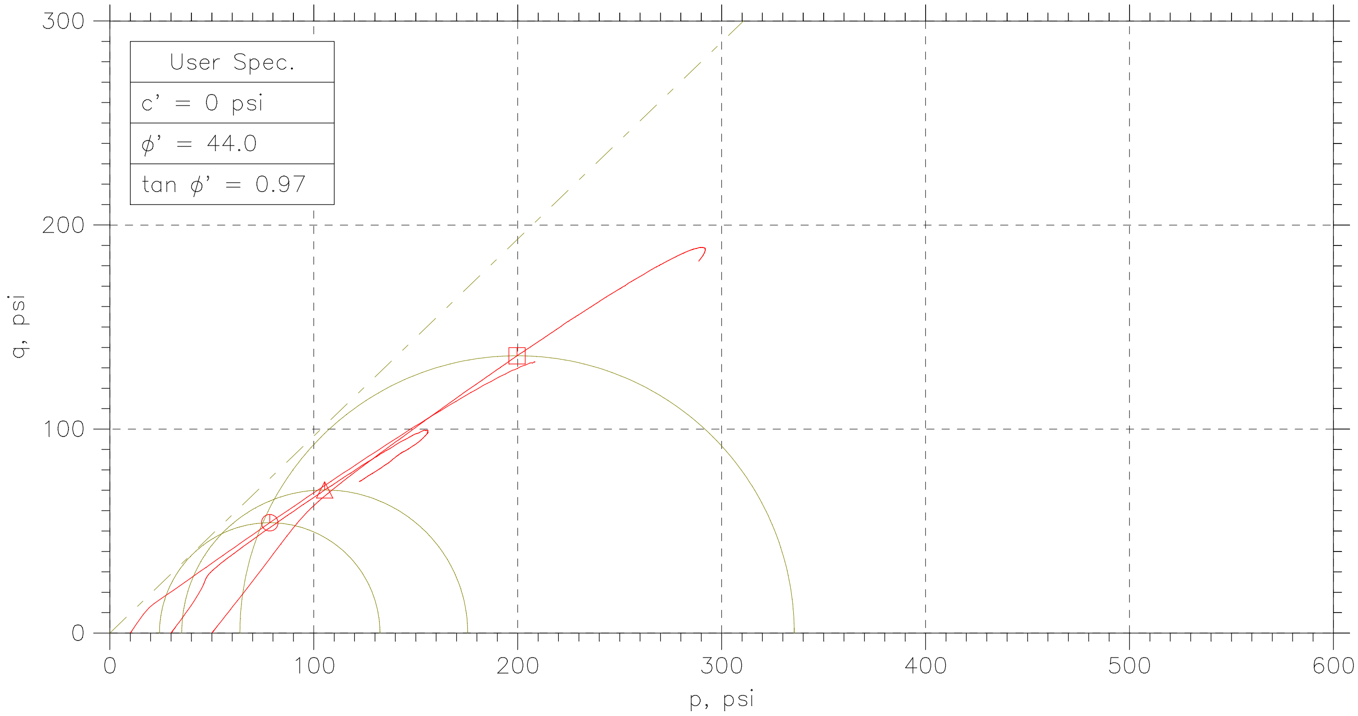
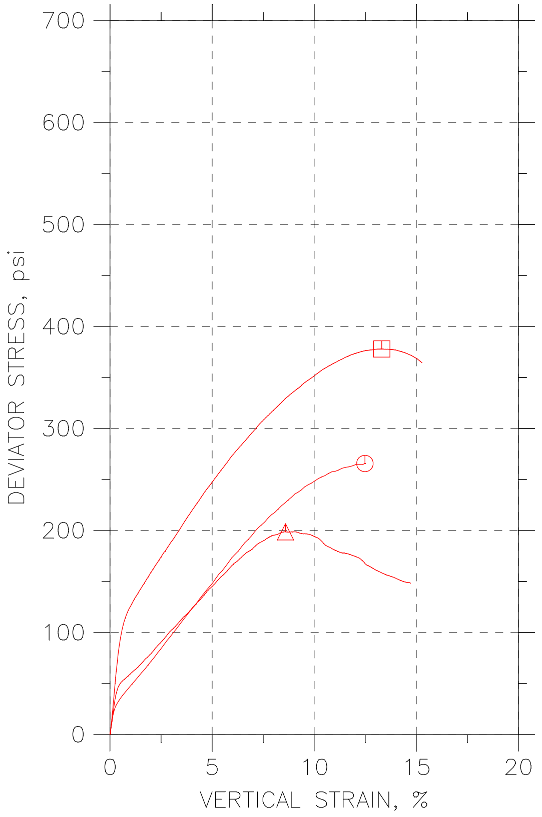
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Symbol	○	△	□	
	Sample No.	----	----	------	
	Test No.	GR-1.1	GR-1.2	GR-1.3	
	Depth	----	----	-----	
Initial	Diameter, in	2.875	2.874	2.875	
	Height, in	5.995	5.988	5.981	
	Water Content, %	27.2	26.9	26.9	
	Dry Density, pcf	80.71	80.79	80.75	
	Saturation, %	67.4	66.9	66.8	
	Void Ratio	1.09	1.09	1.09	
Before Shear	Water Content, %	33.6	31.0	25.8	
	Dry Density, pcf	88.41	91.8	99.36	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.907	0.836	0.696	
	Back Press., psi	140	119	101	
	Ver. Eff. Cons. Stress, psi	9.981	29.97	49.98	
	Shear Strength, psi	132.9	99.42	189.1	
	Strain at Failure, %	12.5	8.59	13.3	
	Strain Rate, %/min	0.016	0.016	0.016	
	B-Value	0.95	0.95	0.95	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	33	33	33	
	Plastic Limit	32	32	32	

GeoTesting express

Project: Cumberland
Location: ---
Project No.: GTX-1484
Boring No.: ---
Sample Type: UD
Description: Gypsum REJECTS
Remarks: System 1062

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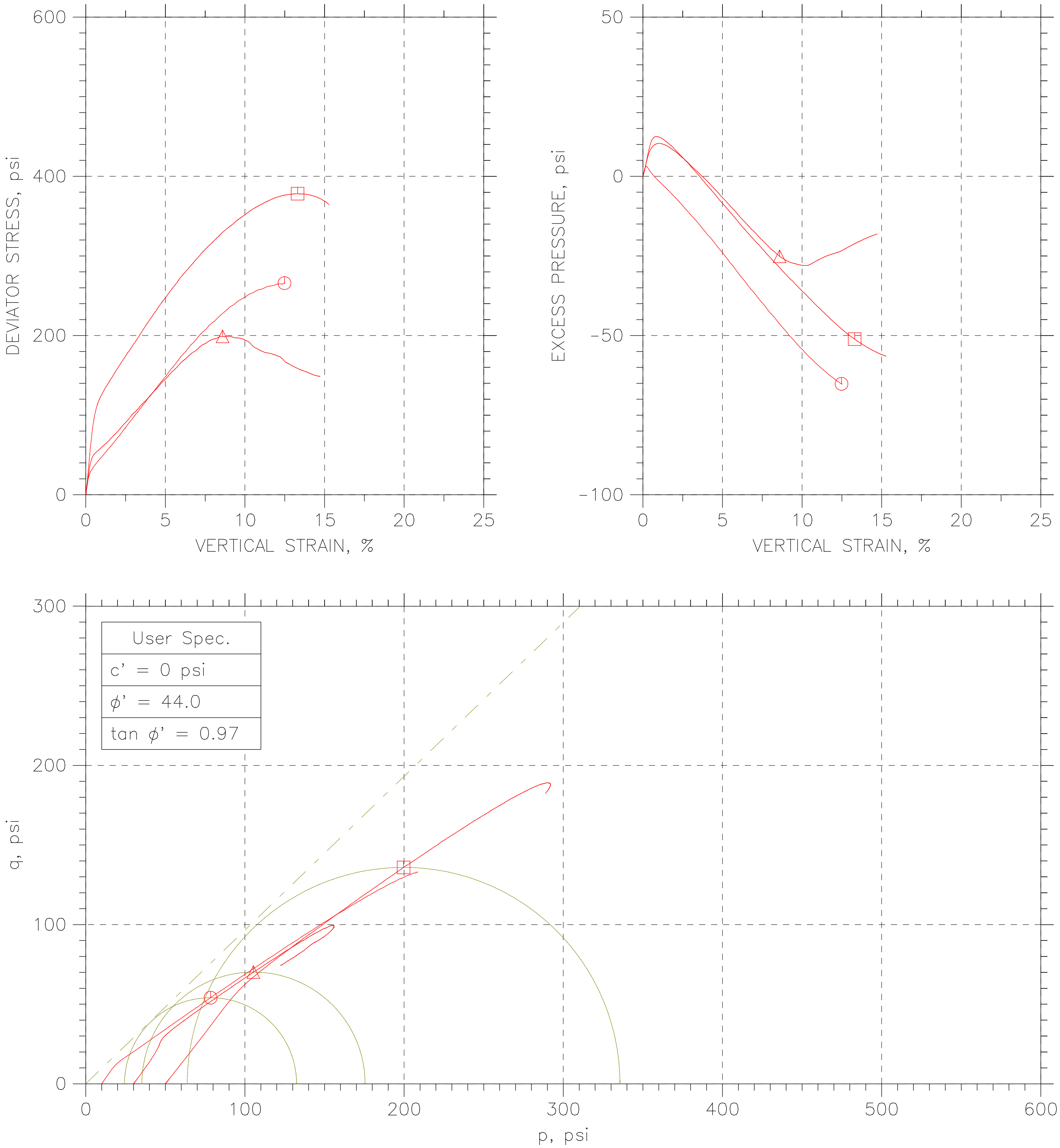
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	GR-1.1	----	MM	9/13/09	CA		1484-GR-1.1.dat
△	----	GR-1.2	----	JM	9/14/09	MM		1484-GR-1.2.dat
□	------	GR-1.3	-----	JM	9/13/09	MM		1484-GR-1.3.dat

Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: UD	
Description: Gypsum REJECTS		
Remarks: System 1062		

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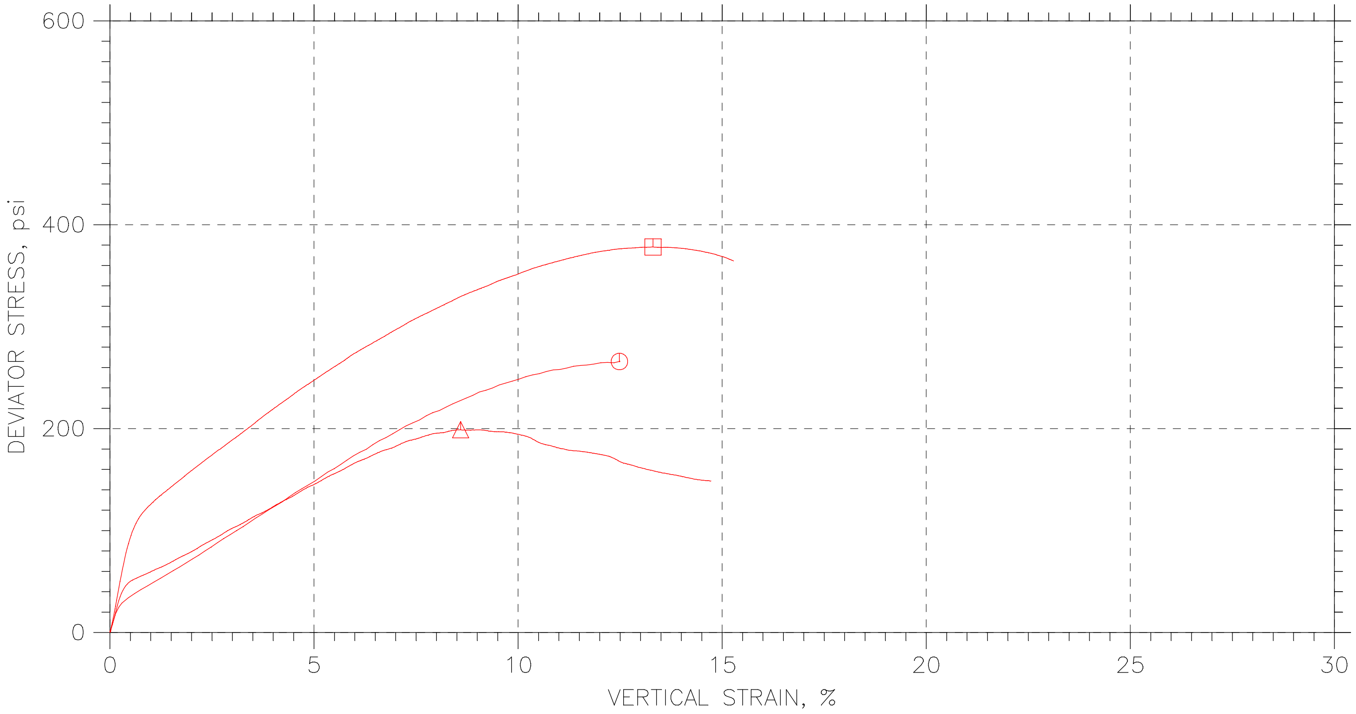
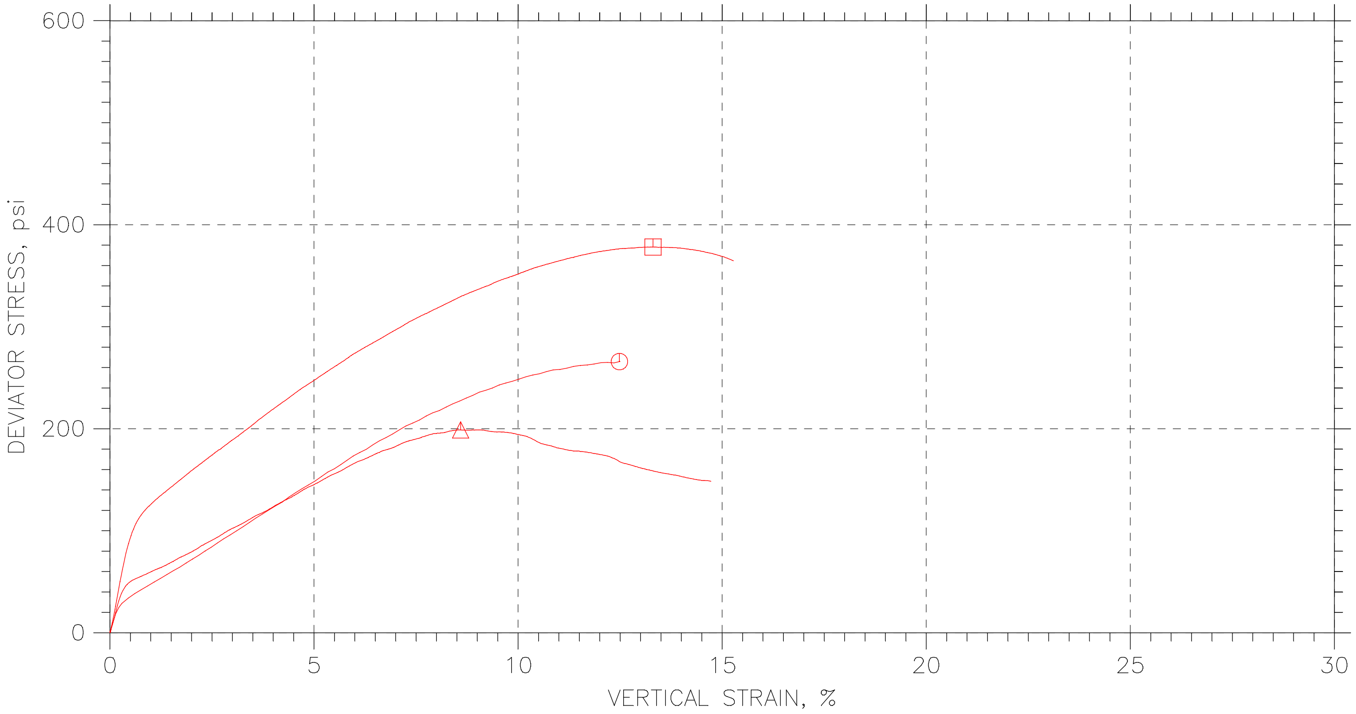
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	----	GR-1.1	----	MM	9/13/09	CA		1484-GR-1.1.dat
△	----	GR-1.2	----	JM	9/14/09	MM		1484-GR-1.2.dat
□	------	GR-1.3	-----	JM	9/13/09	MM		1484-GR-1.3.dat

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Project: Cumberland	Location: ---	Project No.: GTX-1484
Boring No.: ---	Sample Type: UD	
Description: Gypsum REJECTS		
Remarks: System 1062		

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PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number	GTX-1484	Tested By	MM
Project Name	Cumberland Ash	Test Date	09/12/09
Boring No.	B9B	Reviewed By	JM
Sample No.	1262	Review Date	09/16/09
Sample Depth	6-6.8	Lab No.	--
Sample Description	Brown Lean clay		

Sample Data

Length, in		Diameter, in		Pan No.	A-33
Location 1	1.819	Location 1	2.882	Dry Soil+Pan, grams	344.13
Location 2	1.823	Location 2	2.884	Pan Weight, grams	17.01
Location3	1.825	Location 3	2.883		
Average	1.822	Average	2.883	Moisture Content, %	26.3
		Wet Soil + Tare, grams	413.12	Wet Unit Weight, pcf	132.3
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	104.8

Remarks:

Chamber Pressure, psi	75
Back Pressure, psi	65
Confining Pressure, psi	10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				3800	7.8	210.1	11.00	206.9	7.5E-08	22	7.1E-08
				4890	7.8	210.1	12.00	205.9	7.6E-08	24	6.9E-08
				5189	7.8	210.1	12.30	205.6	7.7E-08	24	7.0E-08
				5989	7.8	210.1	12.80	205.1	7.5E-08	24	6.8E-08
				9056	7.8	210.1	7.40	194.3	7.7E-08	24	7.0E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	na	N/A	Vertical

Avg. k at 20 °C 7.0E-08 cm/sec

a = area of burette in cm^2
L = length of sample in cm
A = area of sample in cm^2

Ha = initial inlet head in cm
H_1 = initial outlet head in cm
t = time in seconds

H_b = final inlet head in cm
H_2 = final outlet head in cm

a = 0.16 cm^2
A = 42.12 cm^2
L = 4.63 cm

GeoTesting express

HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1484*	Tested By	*MM*
Project Name	*Cumberland Ash*	Test Date	*9/12/2009*
Boring No.	*B9B*	Reviewed By	*JM*
Sample No.	*1262*	Review Date	*9/16/2009*
Sample Depth	*6-6.8*	Lab No.	--
Sample Description	*Brown Lean clay*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*26.3*
Wet Unit Weight, pcf:	*132.3*
Dry Unit Weight, pcf:	*104.8*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***7.0E-08***

Remarks:

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number	GTX-1484	Tested By	MM
Project Name	Cumberland Ash	Test Date	09/11/09
Boring No.	B9B	Reviewed By	JM
Sample No.	1263	Review Date	09/13/09
Sample Depth	10.1-10.6	Lab No.	--

Sample Description Brown Lean clay

Sample Data

Length, in		Diameter, in		Pan No.	A-19
Location 1	2.491	Location 1	2.891	Dry Soil+Pan, grams	488.27
Location 2	2.497	Location 2	2.890	Pan Weight, grams	16.49
Location3	2.502	Location 3	2.889		
Average	2.497	Average	2.890	Moisture Content, %	18.4
		Wet Soil + Tare, grams	558.39	Wet Unit Weight, pcf	129.9
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	109.7

Remarks:

Chamber Pressure, psi	75
Back Pressure, psi	65
Confining Pressure, psi	10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				2010	6.0	193.5	6.40	193.1	2.6E-08	22	2.4E-08
				6500	6.0	193.5	7.20	192.3	2.4E-08	24	2.2E-08
				18987	6.0	193.5	10.40	189.1	3.0E-08	24	2.8E-08
				31234	6.0	193.5	11.80	187.7	2.5E-08	24	2.2E-08
				41098	6.0	193.5	12.70	186.8	2.2E-08	24	2.0E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	na	N/A	Vertical

Avg. k at 20 °C 2.3E-08 cm/sec

a = area of burette in cm²

L = length of sample in cm

A = area of sample in cm²

Ha = initial inlet head in cm

H_1 = initial outlet head in cm

t = time in seconds

H_b = final inlet head in cm

H_2 = final outlet head in cm

a = 0.16 cm²

A = 42.32 cm²

L = 6.34 cm

GeoTesting express

HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1484*	Tested By	*MM*
Project Name	*Cumberland Ash*	Test Date	*9/11/2009*
Boring No.	*B9B*	Reviewed By	*JM*
Sample No.	*1263*	Review Date	*9/13/2009*
Sample Depth	*10.1-10.6*	Lab No.	--
Sample Description	*Brown Lean clay*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*18.4*
Wet Unit Weight, pcf:	*129.9*
Dry Unit Weight, pcf:	*109.7*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***2.3E-08***

Remarks:

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number	GTX-1484	Tested By	MM
Project Name	Cumberland Ash	Test Date	09/12/09
Boring No.	B-15B	Reviewed By	JM
Sample No.	1605A	Review Date	09/14/09
Sample Depth	---	Lab No.	--
Sample Description	Brown Lean clay		

Sample Data

Length, in		Diameter, in		Pan No.	A-19
Location 1	2.361	Location 1	2.826	Dry Soil+Pan, grams	395.31
Location 2	2.368	Location 2	2.831	Pan Weight, grams	15.97
Location3	2.364	Location 3	2.822		
Average	2.364	Average	2.826	Moisture Content, %	26.7
		Wet Soil + Tare, grams	480.55	Wet Unit Weight, pcf	123.4
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	97.4

Remarks:

Chamber Pressure, psi	75
Back Pressure, psi	65
Confining Pressure, psi	10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				900	3.8	207.6	4.00	207.4	2.6E-08	22	2.5E-08
				1800	3.8	207.6	4.20	207.2	2.6E-08	24	2.4E-08
				3720	3.8	207.6	4.60	206.8	2.5E-08	24	2.3E-08
				7080	3.8	207.6	5.20	206.2	2.3E-08	24	2.1E-08
				11760	3.8	207.6	6.20	205.1	2.5E-08	24	2.2E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	na	N/A	Vertical

Avg. k at 20 °C 2.3E-08 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

Ha = initial inlet head in cm
H_1 = initial outlet head in cm
t = time in seconds

H_b = final inlet head in cm
H_2 = final outlet head in cm

a = 0.16 cm²
A = 40.48 cm²
L = 6.01 cm

GeoTesting express

HYDRAULIC CONDUCTIVITY

Project No.	***GTX-1484***	Tested By	***MM***
Project Name	***Cumberland Ash***	Test Date	***9/12/2009***
Boring No.	***B-15B***	Reviewed By	***JM***
Sample No.	***1605A***	Review Date	***9/14/2009***
Sample Depth	---	Lab No.	--
Sample Description	***Brown Lean clay***		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*26.7*
Wet Unit Weight, pcf:	*123.4*
Dry Unit Weight, pcf:	*97.4*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***2.3E-08***

Remarks: ______________________

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number GTX-1484
Tested By MM
Project Name Cumberland Ash
Test Date 09/12/09
Boring No. B-17A
Reviewed By JM
Sample No. 1606B
Review Date 09/15/09
Sample Depth 32.7-33.2
Lab No. --
Sample Description Gray Silt-ASH

Sample Data

Length, in		Diameter, in		Pan No.	A-43
Location 1	2.454	Location 1	2.854	Dry Soil+Pan, grams	308.33
Location 2	2.456	Location 2	2.859	Pan Weight, grams	17.05
Location3	2.501	Location 3	2.861		
Average	2.470	Average	2.858	Moisture Content, %	40.8
		Wet Soil + Tare, grams	410.19	Wet Unit Weight, pcf	98.6
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	70.0

Remarks:

Chamber Pressure, psi	75
Back Pressure, psi	65
Confining Pressure, psi	10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				320	5.4	198.5	7.30	196.6	7.5E-07	22	7.2E-07
				1547	5.4	198.5	14.30	189.6	7.6E-07	24	6.9E-07
				2565	5.4	198.5	19.60	184.3	7.5E-07	24	6.8E-07
				3299	5.4	198.5	23.80	180.1	7.8E-07	24	7.0E-07
				4901	5.4	198.5	31.30	172.6	7.7E-07	24	7.0E-07

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	na	N/A	Vertical

Avg. k at 20 °C 7.0E-07 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

Ha = initial inlet head in cm
H_1 = initial outlet head in cm
t = time in seconds

H_b = final inlet head in cm
H_2 = final outlet head in cm

a = 0.16 cm²
A = 41.39 cm²
L = 6.27 cm

GeoTesting express

HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1484*	Tested By	*MM*
Project Name	*Cumberland Ash*	Test Date	*9/12/2009*
Boring No.	*B-17A*	Reviewed By	*JM*
Sample No.	*1606B*	Review Date	*9/15/2009*
Sample Depth	*32.7-33.2*	Lab No.	--
Sample Description	*Gray Silt-ASH*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*40.8*
Wet Unit Weight, pcf:	*98.6*
Dry Unit Weight, pcf:	*70.0*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***7.0E-07***

Remarks:

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number	GTX-1484	Tested By	MM
Project Name	Cumberland Ash	Test Date	09/12/09
Boring No.	B-17A	Reviewed By	JM
Sample No.	1608	Review Date	09/15/09
Sample Depth	70-70.5 ft	Lab No.	--
Sample Description	Gray Silt-ASH		

Sample Data

Length, in		Diameter, in		Pan No.	A-27
Location 1	2.504	Location 1	2.856	Dry Soil+Pan, grams	309.59
Location 2	2.501	Location 2	2.857	Pan Weight, grams	16.98
Location3	2.507	Location 3	2.854		
Average	2.504	Average	2.856	Moisture Content, %	42.6
		Wet Soil + Tare, grams	417.15	Wet Unit Weight, pcf	99.1
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	69.5

Remarks:

Chamber Pressure, psi	75
Back Pressure, psi	65
Confining Pressure, psi	10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				1020	4.7	193.3	7.30	186.1	6.4E-07	22	6.2E-07
				1651	4.7	193.3	11.10	182.3	7.2E-07	24	6.5E-07
				2365	4.7	193.3	14.50	178.9	7.2E-07	24	6.5E-07
				2987	4.7	193.3	17.80	175.6	7.4E-07	24	6.7E-07
				4104	4.7	193.3	23.20	170.2	7.5E-07	24	6.8E-07

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	na	N/A	Vertical

Avg. k at 20 °C 6.5E-07 cm/sec

a = area of burette in cm²

L = length of sample in cm

A = area of sample in cm²

Ha = initial inlet head in cm

H_1 = initial outlet head in cm

t = time in seconds

H_b = final inlet head in cm

H_2 = final outlet head in cm

a = 0.16 cm²

A = 41.32 cm²

L = 6.36 cm

GeoTesting express

HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1484*	Tested By	*MM*
Project Name	*Cumberland Ash*	Test Date	*9/12/2009*
Boring No.	*B-17A*	Reviewed By	*JM*
Sample No.	*1608*	Review Date	*9/15/2009*
Sample Depth	*70-70.5 ft*	Lab No.	--
Sample Description	*Gray Silt-ASH*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*42.6*
Wet Unit Weight, pcf:	*99.1*
Dry Unit Weight, pcf:	*69.5*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***6.5E-07***

Remarks: ______________________________

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number	GTX-1484	Tested By	MM
Project Name	Cumberland Ash	Test Date	09/12/09
Boring No.	B-19C	Reviewed By	JM
Sample No.	1629	Review Date	09/15/09
Sample Depth	20-20.5 ft	Lab No.	--

Sample Description Brown Lean clay

Sample Data

Length, in		Diameter, in		Pan No.	A-44
Location 1	2.345	Location 1	2.873	Dry Soil+Pan, grams	429.22
Location 2	2.342	Location 2	2.870	Pan Weight, grams	17.01
Location3	2.346	Location 3	2.869		
Average	2.344	Average	2.871	Moisture Content, %	24.5
		Wet Soil + Tare, grams	513.22	Wet Unit Weight, pcf	128.9
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	103.5

Remarks:

Chamber Pressure, psi	75
Back Pressure, psi	65
Confining Pressure, psi	10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				1134	6.8	213.2	7.10	212.9	2.9E-08	22	2.8E-08
				1892	6.8	213.2	7.40	212.6	3.5E-08	24	3.2E-08
				3998	6.8	213.2	8.10	211.9	3.6E-08	24	3.3E-08
				6211	6.8	213.2	8.80	211.1	3.7E-08	24	3.3E-08
				12990	6.8	213.2	10.90	209	3.6E-08	24	3.3E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	na	N/A	Vertical

Avg. k at 20 °C 3.2E-08 cm/sec

a = area of burette in cm²

L = length of sample in cm

A = area of sample in cm²

Ha = initial inlet head in cm

H_1 = initial outlet head in cm

t = time in seconds

H_b = final inlet head in cm

H_2 = final outlet head in cm

a = 0.16 cm²

A = 41.76 cm²

L = 5.95 cm

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HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1484*	Tested By	*MM*
Project Name	*Cumberland Ash*	Test Date	*9/12/2009*
Boring No.	*B-19C*	Reviewed By	*JM*
Sample No.	*1629*	Review Date	*9/15/2009*
Sample Depth	*20-20.5 ft*	Lab No.	--
Sample Description	*Brown Lean clay*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*24.5*
Wet Unit Weight, pcf:	*128.9*
Dry Unit Weight, pcf:	*103.5*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***3.2E-08***

Remarks:

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

Project Number	GTX-1484	Tested By	MM
Project Name	Cumberland Ash	Test Date	09/12/09
Boring No.	B-21B	Reviewed By	JM
Sample No.	1610	Review Date	09/14/09
Sample Depth	---	Lab No.	--
Sample Description	Brown Lean clay		

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Sample Data

Length, in		Diameter, in		Pan No.	A-21
Location 1	1.961	Location 1	2.882	Dry Soil+Pan, grams	366.03
Location 2	1.955	Location 2	2.879	Pan Weight, grams	16.74
Location3	1.963	Location 3	2.877		
Average	1.960	Average	2.879	Moisture Content, %	22.0
		Wet Soil + Tare, grams	426.01	Wet Unit Weight, pcf	127.2
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	104.3

Remarks: ____________

Chamber Pressure, psi	75
Back Pressure, psi	65
Confining Pressure, psi	10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				900	2.1	213.6	2.40	213.3	3.1E-08	22	3.0E-08
				1800	2.1	213.6	2.60	213.1	2.5E-08	24	2.3E-08
				3720	2.1	213.6	2.90	212.8	2.0E-08	24	1.8E-08
				7080	2.1	213.6	3.00	212.7	1.2E-08	24	1.0E-08
				46675	2.1	213.6	7.90	207.8	1.1E-08	24	1.0E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	na	N/A	Vertical

Avg. k at 20 °C 1.8E-08 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

Ha = initial inlet head in cm
H_1 = initial outlet head in cm
t = time in seconds

H_b = final inlet head in cm
H_2 = final outlet head in cm

a = 0.16 cm²
A = 42.01 cm²
L = 4.98 cm

GeoTesting express

HYDRAULIC CONDUCTIVITY

Project No.	***GTX-1484***	Tested By	***MM***
Project Name	***Cumberland Ash***	Test Date	***9/12/2009***
Boring No.	***B-21B***	Reviewed By	***JM***
Sample No.	***1610***	Review Date	***9/14/2009***
Sample Depth	---	Lab No.	--
Sample Description	***Brown Lean clay***		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*22.0*
Wet Unit Weight, pcf:	*127.2*
Dry Unit Weight, pcf:	*104.3*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***1.8E-08***

Remarks:

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number	GTX-1484	Tested By	MM
Project Name	Cumberland Ash	Test Date	09/10/09
Boring No.	B-29A	Reviewed By	JM
Sample No.	1615	Review Date	09/13/09
Sample Depth	---	Lab No.	--
Sample Description	Brown Lean clay		

Sample Data

Length, in		Diameter, in		Pan No.	A-21
Location 1	2.787	Location 1	2.874	Dry Soil+Pan, grams	495.86
Location 2	2.794	Location 2	2.876	Pan Weight, grams	16.73
Location3	2.785	Location 3	2.875		
Average	2.789	Average	2.875	Moisture Content, %	22.1
		Wet Soil + Tare, grams	584.85	Wet Unit Weight, pcf	123.1
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	100.8

Remarks:

Chamber Pressure, psi	75
Back Pressure, psi	65
Confining Pressure, psi	10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				800	3.3	195.1	3.50	194.9	3.4E-08	22	3.3E-08
				1659	3.3	195.1	3.60	194.8	2.5E-08	24	2.3E-08
				2567	3.3	195.1	3.70	194.7	2.2E-08	24	2.0E-08
				3989	3.3	195.1	3.90	194.5	2.1E-08	24	1.9E-08
				6565	3.3	195.1	4.20	194.2	1.9E-08	24	1.8E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	na	N/A	Vertical

Avg. k at 20 °C 2.2E-08 cm/sec

a = area of burette in cm²

L = length of sample in cm

A = area of sample in cm²

Ha = initial inlet head in cm

H_1 = initial outlet head in cm

t = time in seconds

H_b = final inlet head in cm

H_2 = final outlet head in cm

a = 0.16 cm²

A = 41.88 cm²

L = 7.08 cm

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number GTX-1484
Project Name Cumberland Ash
Boring No. B29A
Sample No. 1617A
Sample Depth 50.2-50.7'
Sample Description Brown Lean clay

Tested By MM
Test Date 09/11/09
Reviewed By JM
Review Date 09/13/09
Lab No. --

Sample Data

Length, in		Diameter, in		Pan No.	A37
Location 1	2.534	Location 1	2.859	Dry Soil+Pan, grams	382.44
Location 2	2.536	Location 2	2.861	Pan Weight, grams	16.03
Location3	2.541	Location 3	2.853		
Average	2.537	Average	2.858	Moisture Content, %	35.5
		Wet Soil + Tare, grams	496.50	Wet Unit Weight, pcf	116.2
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	85.8

Remarks:

Chamber Pressure, psi 75
Back Pressure, psi 65
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				1890	5.3	178.9	5.40	178.8	7.6E-09	22	7.3E-09
				6960	5.3	178.9	5.60	178.6	6.2E-09	24	5.6E-09
				9300	5.3	178.9	5.80	178.4	7.7E-09	24	7.0E-09
				30800	5.3	178.9	6.90	177.3	7.5E-09	24	6.8E-09
				65090	5.3	178.9	8.80	176.2	7.0E-09	24	6.3E-09

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	na	N/A	Vertical

Avg. k at 20 °C 6.6E-09 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

Ha = initial inlet head in cm
H_1 = initial outlet head in cm
t = time in seconds

H_b = final inlet head in cm
H_2 = final outlet head in cm

a = 0.16 cm²
A = 41.38 cm²
L = 6.44 cm

HYDRAULIC CONDUCTIVITY

Project No.	***GTX-1484***	Tested By	***MM***
Project Name	***Cumberland Ash***	Test Date	***9/11/2009***
Boring No.	***B29A***	Reviewed By	***JM***
Sample No.	***1617A***	Review Date	***9/13/2009***
Sample Depth	***50.2-50.7'***	Lab No.	--
Sample Description	***Brown Lean clay***		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*35.5*
Wet Unit Weight, pcf:	*116.2*
Dry Unit Weight, pcf:	*85.8*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***6.6E-09***

Remarks:

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HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1484*	Tested By	*MM*
Project Name	*Cumberland Ash*	Test Date	*9/10/2009*
Boring No.	*B-29A*	Reviewed By	*JM*
Sample No.	*1615*	Review Date	*9/13/2009*
Sample Depth	---	Lab No.	--
Sample Description	*Brown Lean clay*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*22.1*
Wet Unit Weight, pcf:	*123.1*
Dry Unit Weight, pcf:	*100.8*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***2.2E-08***

Remarks:

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number GTX-1484
Project Name Cumberland Ash
Boring No. B-36A
Sample No. 1620
Sample Depth 44.7-45.2
Sample Description Gray Silt-ASH

Tested By MM
Test Date 09/12/09
Reviewed By JM
Review Date 09/15/09
Lab No. --

Sample Data

Length, in		Diameter, in		Pan No.	A-1
Location 1	2.286	Location 1	2.721	Dry Soil+Pan, grams	274.42
Location 2	2.287	Location 2	2.724	Pan Weight, grams	17.31
Location3	2.283	Location 3	2.720		
Average	2.285	Average	2.722	Moisture Content, %	41.3
		Wet Soil + Tare, grams	363.24	Wet Unit Weight, pcf	104.1
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	73.7

Remarks:

Chamber Pressure, psi	75
Back Pressure, psi	65
Confining Pressure, psi	10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				1841	3.3	205.5	6.70	188.7	7.1E-07	22	6.8E-07
				2055	3.3	205.5	8.10	187.3	7.3E-07	24	6.6E-07
				2699	3.3	205.5	11.30	184.1	7.2E-07	24	6.5E-07
				3099	3.3	205.5	12.90	182.5	7.0E-07	24	6.4E-07
				4224	3.3	205.5	19.10	176.3	7.4E-07	24	6.7E-07

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	na	N/A	Vertical

Avg. k at 20 °C 6.6E-07 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

Ha = initial inlet head in cm
H_1 = initial outlet head in cm
t = time in seconds

H_b = final inlet head in cm
H_2 = final outlet head in cm

a = 0.16 cm²
A = 37.53 cm²
L = 5.80 cm

HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1484*	Tested By	*MM*
Project Name	*Cumberland Ash*	Test Date	*9/12/2009*
Boring No.	*B-36A*	Reviewed By	*JM*
Sample No.	*1620*	Review Date	*9/15/2009*
Sample Depth	*44.7-45.2*	Lab No.	--
Sample Description	*Gray Silt-ASH*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*41.3*
Wet Unit Weight, pcf:	*104.1*
Dry Unit Weight, pcf:	*73.7*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***6.6E-07***

Remarks:

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number	GTX-1484	Tested By	MM
Project Name	Cumberland Ash	Test Date	09/08/09
Boring No.	B-37B	Reviewed By	JM
Sample No.	1624A	Review Date	9/11/.09
Sample Depth	---	Lab No.	--
Sample Description	Brown Lean clay		

Sample Data

Length, in		Diameter, in		Pan No.	A37
Location 1	2.457	Location 1	2.867	Dry Soil+Pan, grams	466.73
Location 2	2.461	Location 2	2.865	Pan Weight, grams	15.97
Location3	2.471	Location 3	2.859		
Average	2.463	Average	2.864	Moisture Content, %	18.0
		Wet Soil + Tare, grams	531.77	Wet Unit Weight, pcf	127.7
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	108.3

Remarks: ______

Chamber Pressure, psi	75
Back Pressure, psi	65
Confining Pressure, psi	10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				900	1.5	206.7	1.60	206.6	1.2E-08	22	1.2E-08
				1800	1.5	206.7	1.80	206.4	2.0E-08	24	1.8E-08
				3720	1.5	206.7	2.00	206.2	1.6E-08	24	1.4E-08
				7080	1.5	206.7	2.40	205.8	1.5E-08	24	1.4E-08
				11760	1.5	206.7	3.00	205.2	1.5E-08	24	1.4E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	na	N/A	Vertical

Avg. k at 20 °C 1.4E-08 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

Ha = initial inlet head in cm
H_1 = initial outlet head in cm
t = time in seconds

H_b = final inlet head in cm
H_2 = final outlet head in cm

a = 0.16 cm²
A = 41.55 cm²
L = 6.26 cm

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HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1484*	Tested By	*MM*
Project Name	*Cumberland Ash*	Test Date	*9/8/2009*
Boring No.	*B-37B*	Reviewed By	*JM*
Sample No.	*1624A*	Review Date	*9/11/.09*
Sample Depth	---	Lab No.	--
Sample Description	*Brown Lean clay*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*18.0*
Wet Unit Weight, pcf:	*127.7*
Dry Unit Weight, pcf:	*108.3*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***1.4E-08***

Remarks:

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number GTX-1490
Project Name Cumberland Ash
Boring No. ----
Sample No. Bottom Ash
Sample Depth ---
Sample Description Bottom ASH

Tested By MM
Test Date 09/17/09
Reviewed By JM
Review Date 09/21/09
Lab No. --

Sample Data

Length, in		Diameter, in		Pan No.	B-28
Location 1	2.450	Location 1	2.872	Dry Soil+Pan, grams	407.71
Location 2	2.451	Location 2	2.871	Pan Weight, grams	58.73
Location3	2.449	Location 3	2.873		
Average	2.450	Average	2.872	Moisture Content, %	16.5
		Wet Soil + Tare, grams	406.57	Wet Unit Weight, pcf	97.6
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	83.8

Remarks:

Chamber Pressure, psi 75
Back Pressure, psi 65
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				120	10.1	99.6	11.10	98.5	2.4E-06	21.5	2.3E-06
				240	10.1	99.6	12.10	97.5	2.3E-06	21.5	2.3E-06
				480	10.1	99.6	14.20	95.4	2.4E-06	21.5	2.3E-06
				1020	10.1	99.6	18.20	91.4	2.3E-06	21.5	2.3E-06
				2210	10.1	99.6	27.20	82.4	2.6E-06	21.5	2.5E-06

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	103.7	N/A	Vertical

Avg. k at 20 °C 2.3E-06 cm/sec

a = area of burette in cm^2
L = length of sample in cm
A = area of sample in cm^2

Ha = initial inlet head in cm
H_1 = initial outlet head in cm
t = time in seconds

H_b = final inlet head in cm
H_2 = final outlet head in cm

a = 0.16 cm^2
A = 41.80 cm^2
L = 6.22 cm

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HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1490*	Tested By	*MM*
Project Name	*Cumberland Ash*	Test Date	*9/17/2009*
Boring No.	----	Reviewed By	*JM*
Sample No.	*Bottom Ash*	Review Date	*9/21/2009*
Sample Depth	---	Lab No.	--
Sample Description	*Bottom ASH*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*16.5*
Wet Unit Weight, pcf:	*97.6*
Dry Unit Weight, pcf:	*83.8*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***2.3E-06***

Remarks:

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number	GTX-1484	Tested By	MM
Project Name	Cumberland Ash	Test Date	09/08/09
Boring No.	---	Reviewed By	JM
Sample No.	Fly ASH	Review Date	09/11/09
Sample Depth	---	Lab No.	--
Sample Description	Black Fly ASH		

Sample Data

Length, in		Diameter, in		Pan No.	A2
Location 1	2.666	Location 1	2.867	Dry Soil+Pan, grams	293.67
Location 2	2.671	Location 2	2.865	Pan Weight, grams	19.01
Location3	2.673	Location 3	2.859		
Average	2.670	Average	2.864	Moisture Content, %	33.0
		Wet Soil + Tare, grams	365.33	Wet Unit Weight, pcf	80.9
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	60.9

Remarks:

Chamber Pressure, psi	75
Back Pressure, psi	65
Confining Pressure, psi	10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				120	1.5	206.7	1.90	206.3	4.2E-07	22	4.0E-07
				360	1.5	206.7	2.70	205.5	4.3E-07	24	3.9E-07
				2300	1.5	206.7	9.70	198.5	4.7E-07	24	4.3E-07
				3000	1.5	206.7	11.90	196.3	4.7E-07	24	4.2E-07
				20451	1.5	206.7	15.30	104.3	5.3E-07	24	4.8E-07

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	Remolded	83.6	72.8	Vertical

Avg. k at 20 °C 4.2E-07 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

Ha = initial inlet head in cm
H_1 = initial outlet head in cm
t = time in seconds

H_b = final inlet head in cm
H_2 = final outlet head in cm

a = 0.16 cm²
A = 41.55 cm²
L = 6.78 cm

GeoTesting express

HYDRAULIC CONDUCTIVITY

Project No.	***GTX-1484***	Tested By	***MM***
Project Name	***Cumberland Ash***	Test Date	***9/8/2009***
Boring No.	---	Reviewed By	***JM***
Sample No.	***Fly ASH***	Review Date	***9/11/2009***
Sample Depth	---	Lab No.	--
Sample Description	***Black Fly ASH***		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*Remolded*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*33.0*
Wet Unit Weight, pcf:	*80.9*
Dry Unit Weight, pcf:	*60.9*
Compaction, %:	*72.8*
Hydraulic Conductivity, cm/sec. @20 °C	***4.2E-07***

Remarks: ______________________

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number GTX-1484
Tested By MM
Project Name Cumberland Ash
Test Date 09/18/09
Boring No. ----
Reviewed By JM
Sample No. ----
Review Date 09/20/09
Sample Depth ---
Lab No. --
Sample Description Gypsum Bulk

Sample Data

Length, in		Diameter, in		Pan No.	A41
Location 1	2.589	Location 1	2.872	Dry Soil+Pan, grams	375.20
Location 2	2.588	Location 2	2.874	Pan Weight, grams	19.56
Location3	2.585	Location 3	2.877		
Average	2.587	Average	2.874	Moisture Content, %	29.0
		Wet Soil + Tare, grams	458.77	Wet Unit Weight, pcf	104.1
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	80.7

Remarks:

Chamber Pressure, psi 75
Back Pressure, psi 65
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				660	1.5	206.7	1.90	206.3	7.3E-08	22	7.0E-08
				1800	1.5	206.7	2.80	205.4	8.9E-08	24	8.1E-08
				6434	1.5	206.7	6.30	201.9	9.4E-08	24	8.5E-08
				14089	1.5	206.7	11.90	196.3	9.5E-08	24	8.6E-08
				20043	1.5	206.7	15.30	192.9	9.1E-08	24	8.2E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	86.3	N/A	Vertical

Avg. k at 20 °C 8.1E-08 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

Ha = initial inlet head in cm
H_1 = initial outlet head in cm
t = time in seconds

H_b = final inlet head in cm
H_2 = final outlet head in cm

a = 0.16 cm²
A = 41.86 cm²
L = 6.57 cm

GeoTesting express

HYDRAULIC CONDUCTIVITY

Project No.	***GTX-1484***	Tested By	***MM***
Project Name	***Cumberland Ash***	Test Date	***9/18/2009***
Boring No.	----	Reviewed By	***JM***
Sample No.	----	Review Date	***9/20/2009***
Sample Depth	---	Lab No.	--
Sample Description	***Gypsum Bulk***		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*29.0*
Wet Unit Weight, pcf:	*104.1*
Dry Unit Weight, pcf:	*80.7*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***8.1E-08***

Remarks:

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number	GTX-1484	Tested By	MM
Project Name	Cumberland Ash	Test Date	09/18/09
Boring No.	---	Reviewed By	JM
Sample No.	Gypsum REJECTS	Review Date	09/20/09
Sample Depth	---	Lab No.	---
Sample Description	Gypsum REJECTS		

Sample Data

Length, in		Diameter, in		Pan No.	B-12
Location 1	2.899	Location 1	2.875	Dry Soil+Pan, grams	422.72
Location 2	2.899	Location 2	2.875	Pan Weight, grams	56.76
Location3	2.899	Location 3	2.875		
Average	2.899	Average	2.875	Moisture Content, %	27.0
		Wet Soil + Tare, grams	464.77	Wet Unit Weight, pcf	94.1
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	74.1

Remarks: ____________

Chamber Pressure, psi	45
Back Pressure, psi	40
Confining Pressure, psi	5

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				240	10.1	99.6	10.40	99.2	4.6E-07	22	4.4E-07
				660	10.1	99.6	11.20	98.4	5.5E-07	22	5.3E-07
				1305	10.1	99.6	12.40	97.2	5.8E-07	22	5.6E-07
				2044	10.1	99.6	13.80	95.8	6.0E-07	22	5.8E-07
				3500	10.1	99.6	16.60	94.4	5.6E-07	22	5.4E-07

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	86.2	N/A	Vertical

Avg. k at 20 °C 5.3E-07 cm/sec

a = area of burette in cm^2

L = length of sample in cm

A = area of sample in cm^2

Ha = initial inlet head in cm

H_1 = initial outlet head in cm

t = time in seconds

H_b = final inlet head in cm

H_2 = final outlet head in cm

a = 0.16 cm^2

A = 41.88 cm^2

L = 7.36 cm

GeoTesting express

HYDRAULIC CONDUCTIVITY

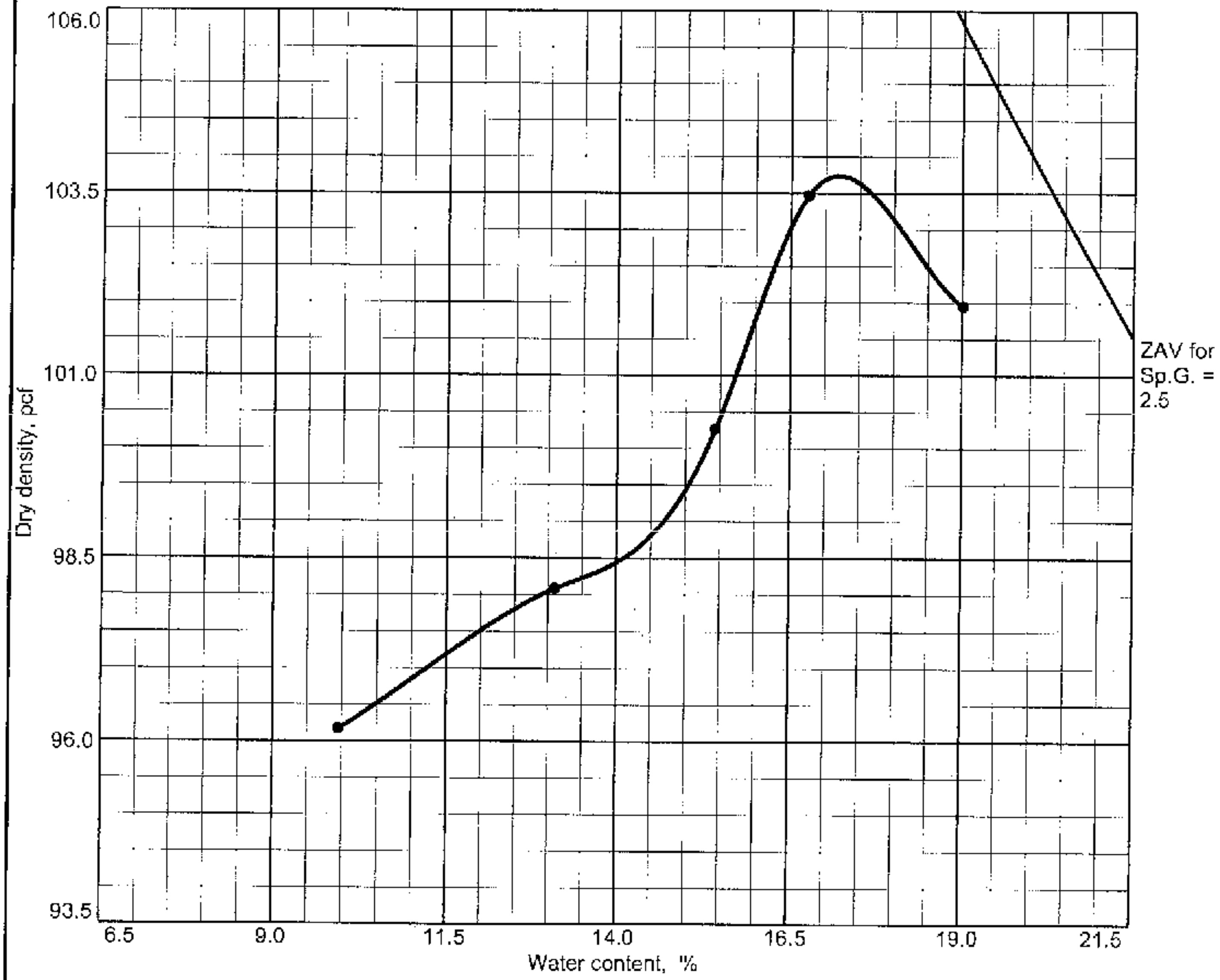
Project No.	*GTX-1484*	Tested By	*MM*
Project Name	*Cumberland Ash*	Test Date	*9/18/2009*
Boring No.	---	Reviewed By	*JM*
Sample No.	*Gypsum REJECTS*	Review Date	*9/20/2009*
Sample Depth	---	Lab No.	---
Sample Description	*Gypsum REJECTS*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*27.0*
Wet Unit Weight, pcf:	*94.1*
Dry Unit Weight, pcf:	*74.1*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***5.3E-07***

Remarks: ______________________________

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method C Standard
Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
				2.5				

TEST RESULTS

Maximum dry density = 103.7 pcf

Optimum moisture = 17.2 %

MATERIAL DESCRIPTION

Project No. GTX-1484 **Client:** STANTEC
Project: Cumberland Fossil Plant (Ash and Gypsum Stacks)

● **Source:** **Sample No.:** Bottom Ash

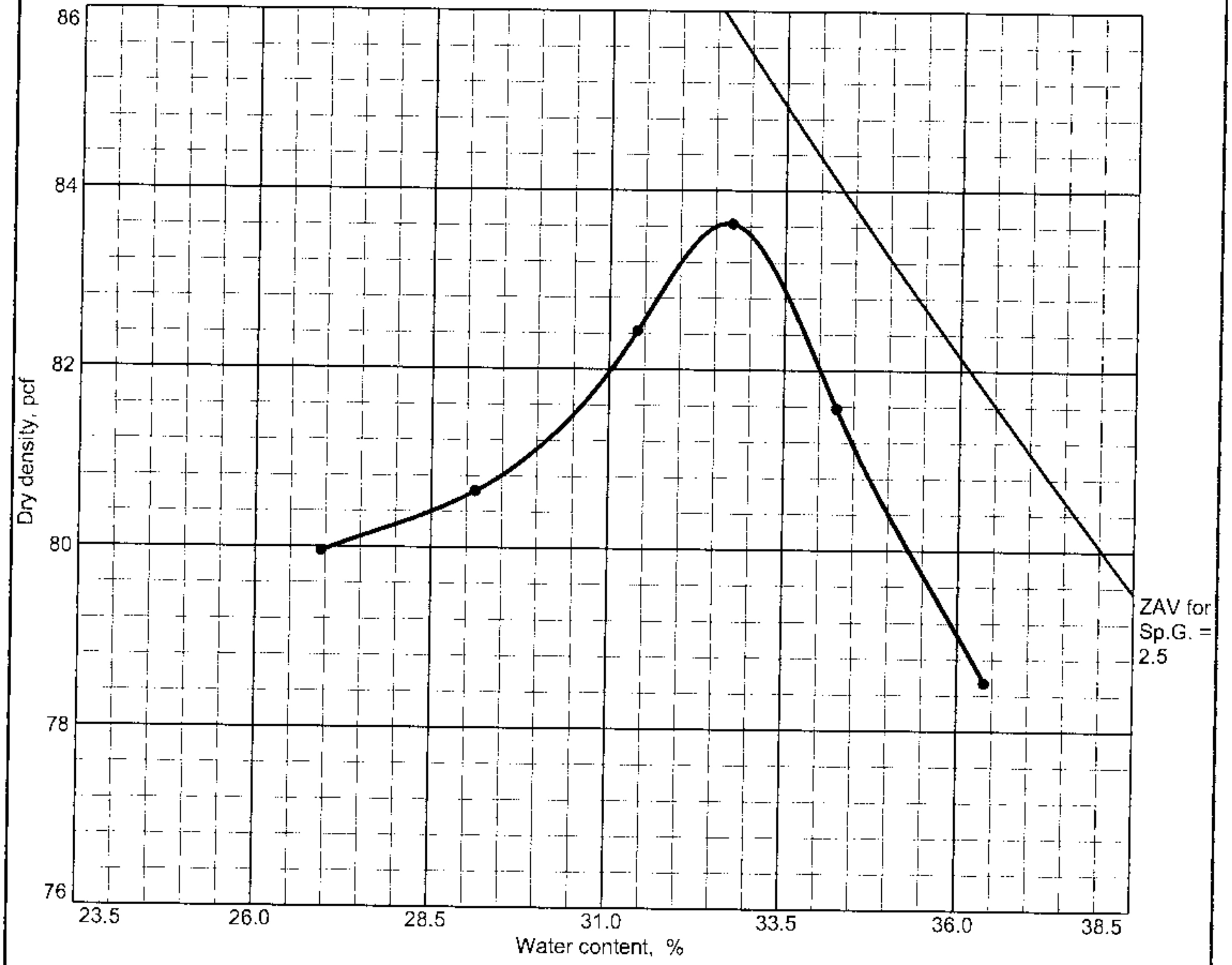
Remarks:

COMPACTION TEST REPORT

GeoTesting Express Inc.

Lab no.

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
				2.5			0.0	

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 83.6 pcf Optimum moisture = 32.7 %	

Project No. GTX-1484 **Client:** STANTEC
Project: Cumberland Fossil Plant (Ash and Gypsum Stacks)

● **Source:** **Sample No.:** FlY ASH (BULK)

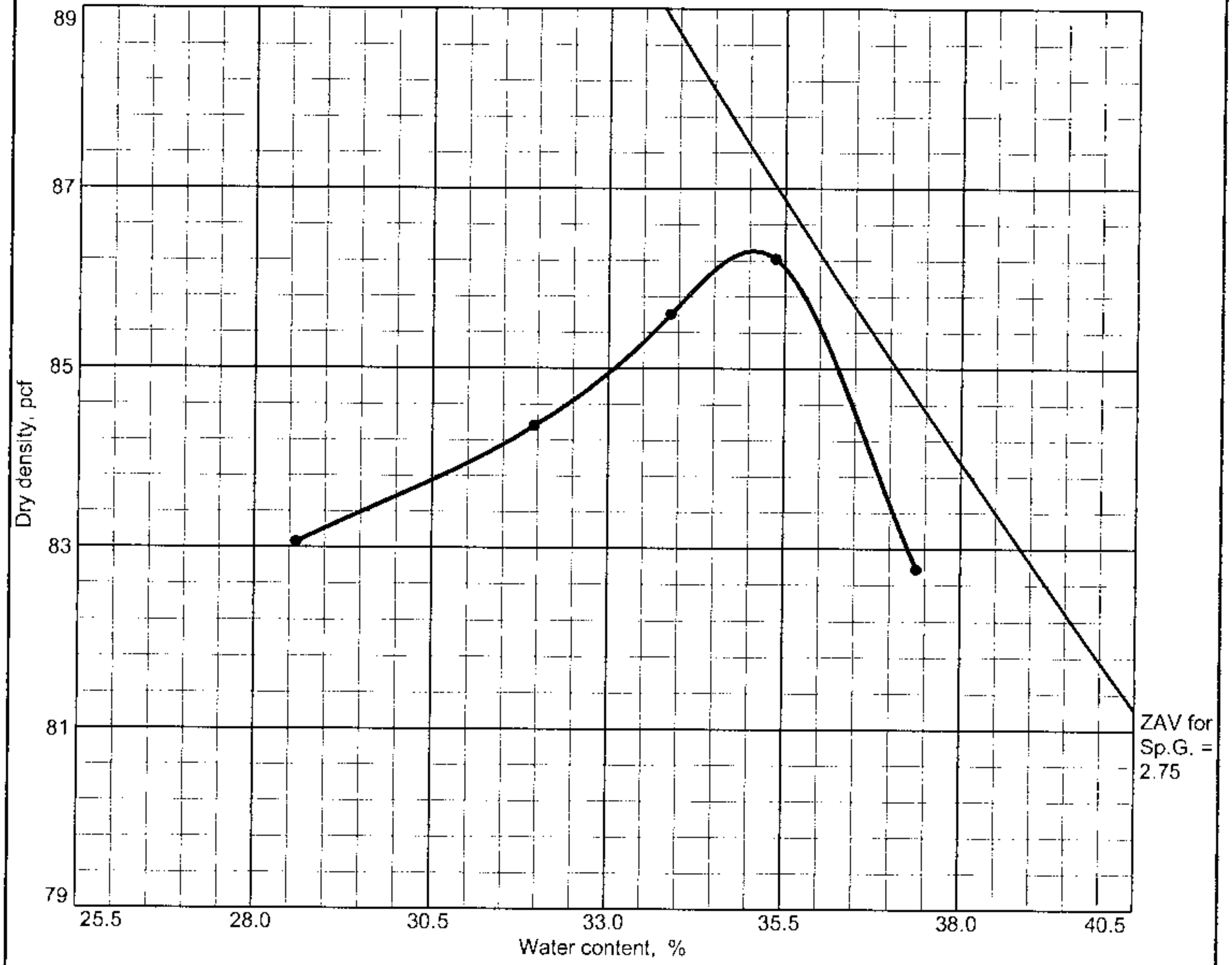
COMPACTION TEST REPORT

GeoTesting Express Inc.

Remarks:

Lab no.

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
				2.75				

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 86.3 pcf Optimum moisture = 35.1 %	

Project No. GTX-1484 **Client:** STANTEC

Project: Cumberland Fossil Plant (Ash and Gypsum Stacks)

● **Source:** **Sample No.:** Gypsum Bulk

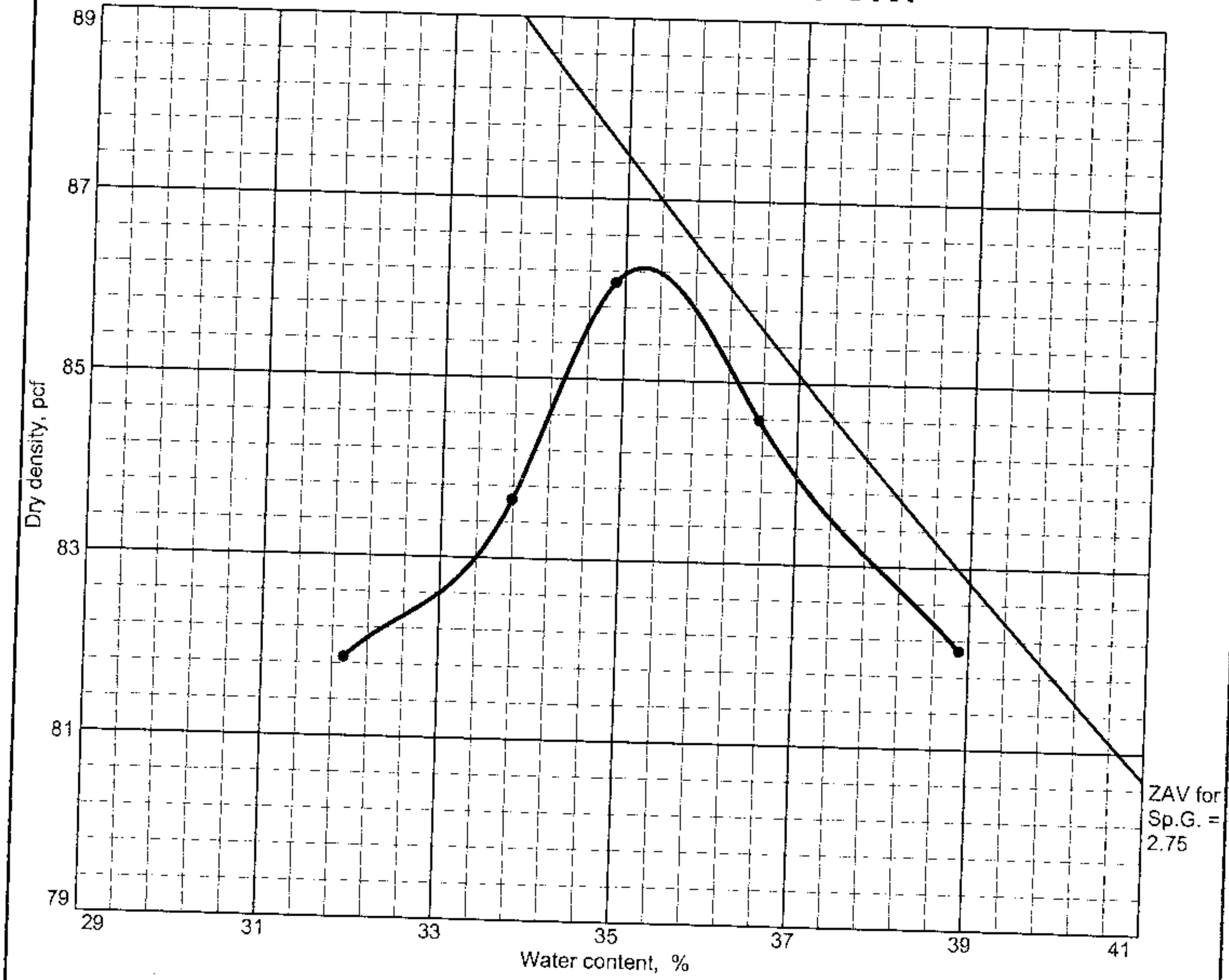
Remarks:

COMPACTION TEST REPORT

GeoTesting Express Inc.

Lab no.

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	ML	A-4(0)		2.75	33	1	0.0	92.6

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 86.2 pcf Optimum moisture = 35.2 %	

Project No. GTX-1484 **Client:** STANTEC

Project: Cumberland Fossil Plant (Ash and Gypsum Stacks)

Remarks:

● **Source:** **Sample No.:** Gypsum Rejects

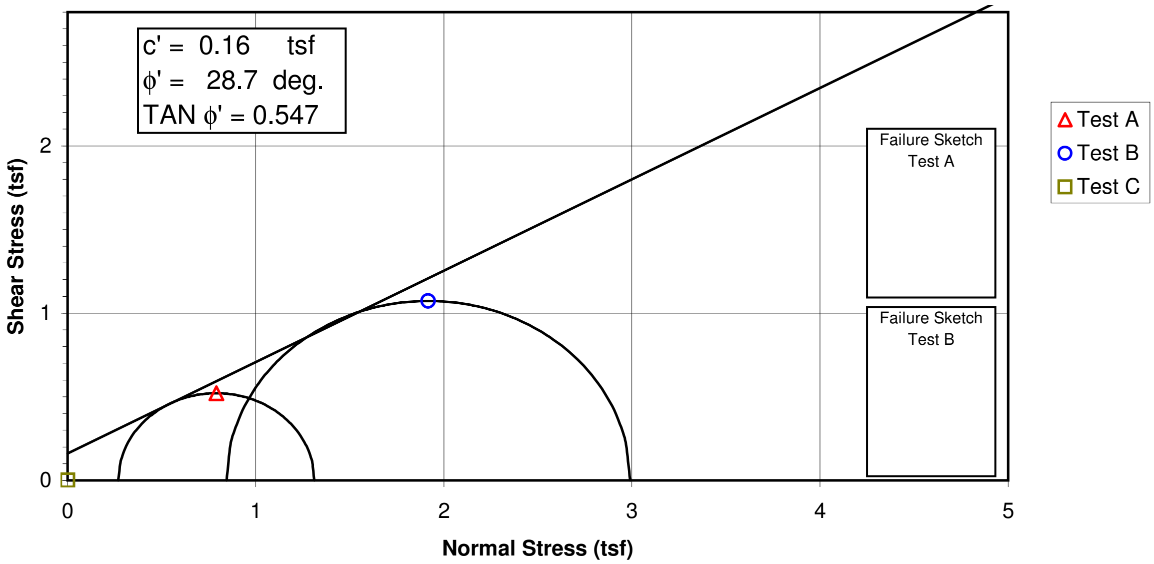
COMPACTION TEST REPORT

GeoTesting Express Inc.

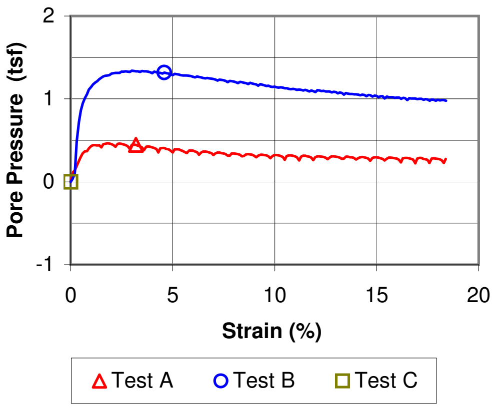
Lab no.

Failure Criterion: Maximum Effective Principal Stress Ratio

Effective Strength Envelope



Induced Pore Pressure vs. Strain



Specimen No.			A	B	C	
Initial Data	Water content %	W_o	24.3	25.2	######	
	Dry Density PCF	γ_{d_o}	96.0	97.1	######	
	Saturation %	S_o	89.6	95.5	######	
	Void Ratio	e_o	0.716	0.698	######	
After Shear	Water content %	W_f	23.6	23.2	######	
	Dry Density PCF	γ_{d_f}	101.5	102.2	######	
	Saturation %	S_f	100.0	100.0	######	
	Void Ratio	e_f	0.623	0.612	######	
	Final Back Pressure TSF	u_c	5.76	4.32	0.00	
Minor Principal Stress TSF @ failure		$\sigma_3'f$	0.27	0.85	0.00	
Maximum Deviator Stress (tsf) @ failure		$(\sigma_1'-\sigma_3')_{max}$	1.04	2.15	0.00	
Time to (σ1'-σ3')max min.		t_f	40.7	151.0	0.0	
Ultimate Deviator Stress, t/sq ft		$(\sigma1'-\sigma3')_{ult}$	n/a	n/a	0.00	
Initial Diameter, in.		D_o	2.851	2.878	######	
Initial Height, in.		H_o	6.002	5.981	######	

Controlled - Strain Test

Description of Specimens Lean Clay (CL), brown, moist, soft

Type of Specimen Undisturbed Type of test $\bar{R}$

LL PL PI Gs 2.64

Project Cumberland Dry Ash Stack and Gypsum Disposal Area

Remarks:

Boring No. B-5 Sample No. 1257

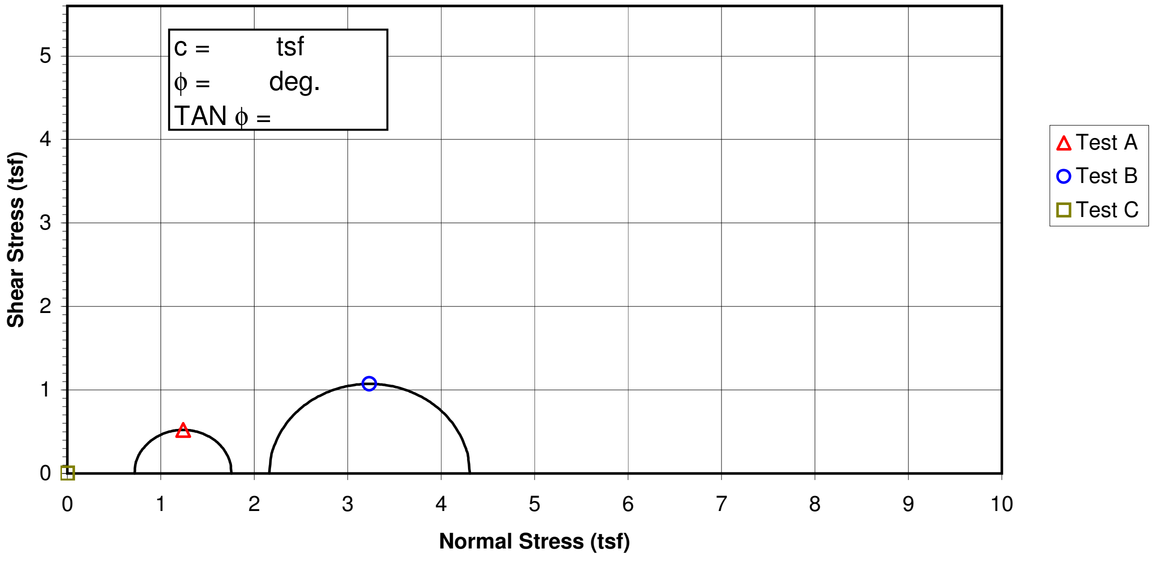
Depth Elev. 18.0'-18.5', 18.6'-19.1'

Laboratory Stantec Date 8-19-09

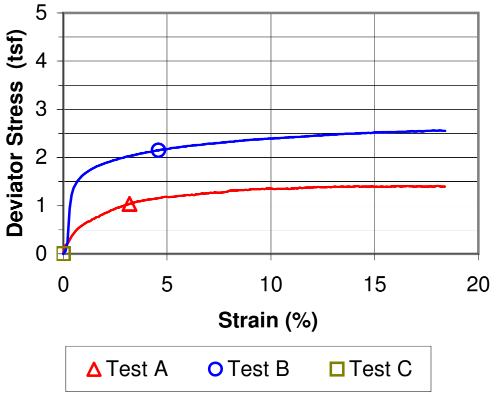
TRIAXIAL COMPRESSION TEST REPORT

Failure Criterion: Maximum Effective Principal Stress Ratio

Total Strength Envelope



Deviator Stress vs. Strain



Specimen No.			A	B	C	
Initial Data	Water content %	W_o	24.3	25.2	######	
	Dry Density PCF	γ_{d_o}	96.0	97.1	######	
	Saturation %	S_o	89.6	95.5	######	
	Void Ratio	e_o	0.716	0.698	######	
After Shear	Water content %	W_f	23.6	23.2	######	
	Dry Density PCF	γ_{d_f}	101.5	102.2	######	
	Saturation %	S_f	100.0	100.0	######	
	Void Ratio	e_f	0.623	0.612	######	
	Final Back Pressure TSF	u_c	5.76	4.32	0.00	
Minor Principal Stress TSF		σ_3	0.72	2.16	0.00	
Maximum Deviator Stress (tsf) @ failure		$(\sigma_1-\sigma_3)_{max}$	1.04	2.15	0.00	
Time to $(\sigma_1-\sigma_3)_{Max.}$ min.		t_f	40.7	151.0	0.0	
Ultimate Deviator Stress, t/sq ft		$(\sigma_1-\sigma_3)_{ult}$	n/a	n/a	0.00	
Initial Diameter, in.		D_o	2.851	2.878	######	
Initial Height, in.		H_o	6.002	5.981	######	

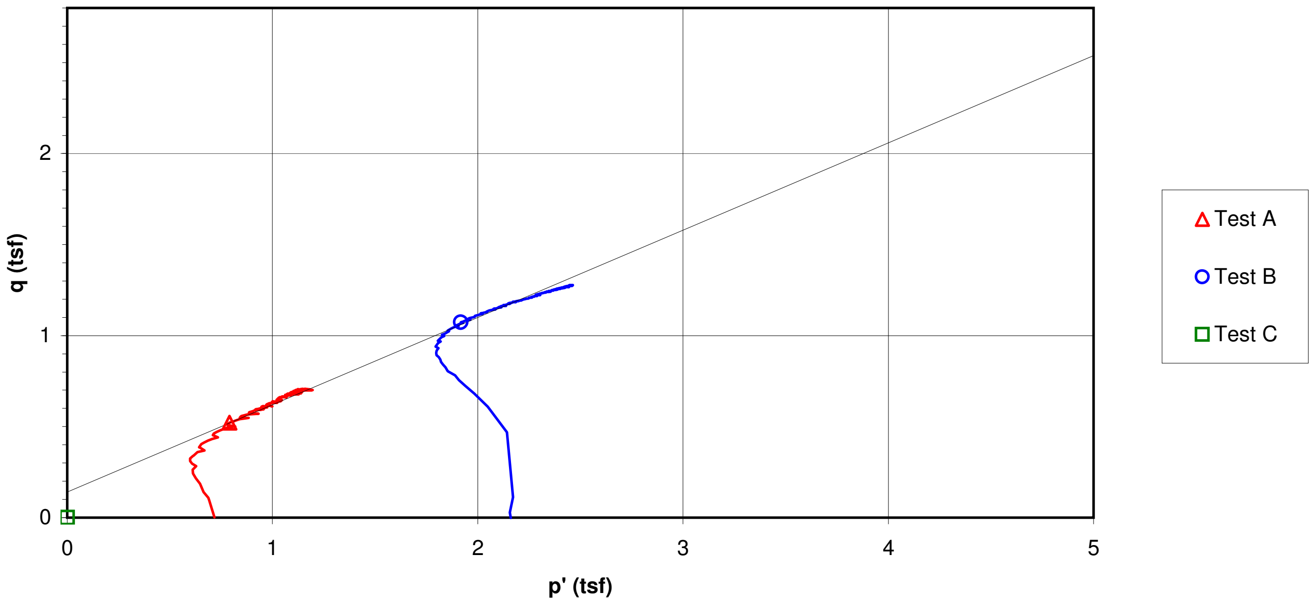
Controlled - Strain Test

Description of Specimens	Lean Clay (CL), brown, moist, soft				
				Type of Specimen Undisturbed	Type of test $\overline{R}$
LL	PL	PI	Gs 2.64	Project	Cumberland Dry Ash Stack and Gypsum Disposal Area
Remarks:					
				Boring No. B-5	Sample No. 1257
				Depth Elev.	18.0'-18.5', 18.6'-19.1'
				Laboratory Stantec	Date 8-19-09
				TRIAXIAL COMPRESSION TEST REPORT	

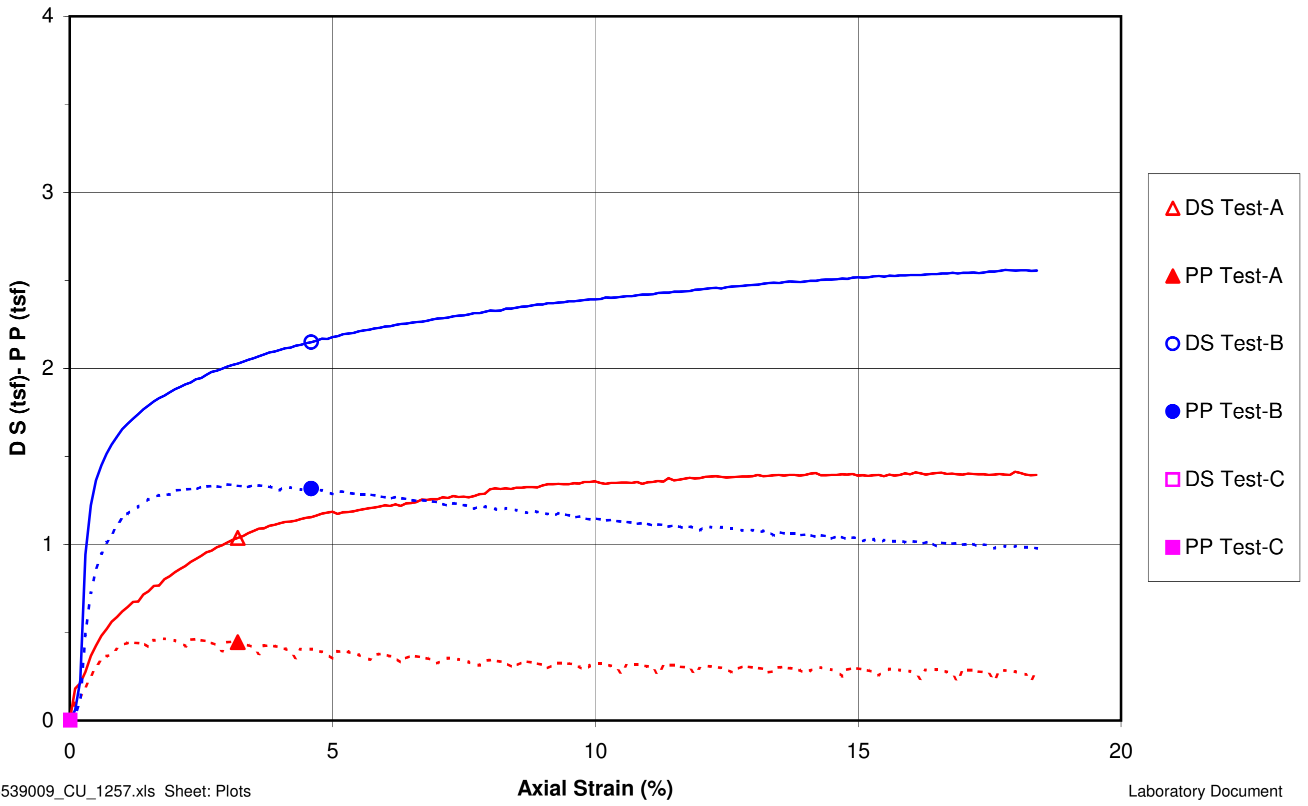
Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Project	Cumberland Dry Ash Stack and Gypsum Disposal Area	Project No.	175539009
Sample ID	B-5, 18.0'-18.5' & B-5, 18.6'-19.1'	Test Number	1257
Failure Criterion:	Maximum Effective Principal Stress Ratio ϕ' = 28.7 deg.	c' =	0.16 tsf

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain



File: 175539009_CU_1257.xls Sheet: Plots
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

Consolidated Undrained Triaxial Test

ASTM D4767-04

Project Name	Cumberland Dry Ash Stack and Gypsum Disposal Area	Project Number	175539009
Sample Identification	B-5, 18.0'-18.5'	Test Number	CU-1257A
Visual Description	Lean Clay (CL), brown, moist, soft	Prepared By	CM
Undisturbed	Source B-5, 18.0'-20.0'	Date	7-24-2009

Specific Gravity 2.64 ASTM D854 Method A Liquid Limit N/A Plastic Limit N/A Plasticity Index N/A

Initial Specimen Data

Specimen Diameter (in.)		Specimen Height (in.)		Volumes (in^3)		Specimen	
Top	2.869	1	5.991	Sample	38.3756 (V_o)	Wet Weight (g)	1200.80
Middle	2.845	2	6.019	Solids	22.3297 (VS_o)	Dry Weight (g)	966.08
Bottom	2.846	3	6.005	Water	14.3223 (Vw_o)	Wet Unit Weight (pcf)	119.2
Avg.	2.8533 (D_o)	4	5.991	Voids	16.0458 (Vv_o)	Dry Unit Weight (pcf)	95.9
Area (in^2)	6.3943 (A_o)	Avg. (H_o)	6.0015	Degree of Saturation (%)	89.3 (S_o)		
Moisture Content (%)	24.3	Final Trimmings		Void Ratio	0.719		

Saturation

Set Up & Saturated: Wet xx Dry

Back Pressure Saturated to: 80 (psi)

Final Pore Pressure Parameter B 0.96

Set up By KDG

Date 8-13-09

Panel Board Number A

Height Readings (in.)		Back Pressure Burette		Chamber Burette			
Initial	0.1213	Initial	16.13 (in.)	Initial	10.94 (in.)	Specimen Height (in.)	5.9983 (H_s)
Final	0.1245	Final	11.58 (in.)	Final	5.13 (in.)	Area (in^2) Method A	6.3875 (A_s)
Change	-0.0032 (ΔH_o)	Change	-4.55 (in.)	Change	-5.81 (in.)	Specimen Volume (in^3)	38.31 (Vs)

Consolidation

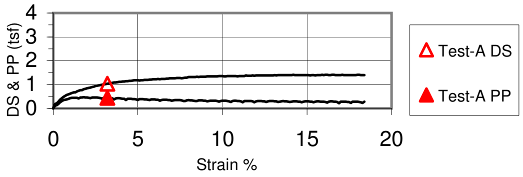
Height Readings (in.)		Back Pressure Burette Readings		Chamber Burette Readings		Pressures (psi)	
Initial	0.1245	Initial	1.22 (in.)	Initial	17.53 (in.)	Chamber	90
Final	0.1281	Final	3.96 (in.)	Final	14.63 (in.)	Back	80
Change	-0.0036 (ΔH_c)	Change	-2.74 (in.)	Change	-2.90 (in.)	Lateral	10 (σ_3)
Height (in.)	5.9947 (H_c)			Volume (in^3)	36.2414 (V_c)		
Area (in^3) Method B	6.0456 (A_c)			Volume - Water (in^3)	13.9117 (VWc)	t_{50} (min.)	2.362
Diameter (in.)	2.7744 (D_c)			Water Content (%)	23.6		
Dry Density (pcf)	101.5			Degree of Saturation (%)	100.0 (S_c)	Void Ratio	0.623

After Test

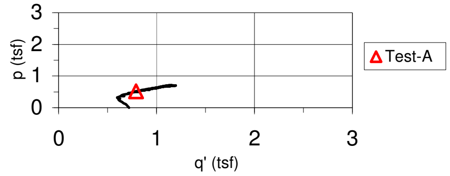
Final Measurements		Final Moisture Content		Stresses (membrane corrected) at Failure (psi)	
Maximum Diameter	3.185 (in.)	Wet Weight (g)	1194.07	Corrected Deviator	1.04 σ_d (tsf)
Wet weight (g)	1194.07 (WWf)	Dry Weight (g)	966.08	Major Principal	1.31 $\sigma_1'_f$ (tsf)
Corrected Diameter	3.161 (in.)	Tare Weight (g)	0.00	Minor Principal	0.27 $\sigma_3'_f$ (tsf)
				Rate of Strain (% / min.)	0.079
Youngs Modulus for Membrane (psi)	200			Axial Strain at Failure (%)	3.20
Membrane Thickness (in.)	0.012			Failure Criterion:	Maximum Effective Principal Stress Ratio

Failure Sketch

Deviator Stress and Induced Pore Pressure vs. Strain



p' vs. q Plot



Comments:

File: 175539009_CU_1257.xls Sheet: Specimen-A
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

Consolidated Undrained Triaxial Test

ASTM D4767-04

Project Name	Cumberland Dry Ash Stack and Gypsum Disposal Area	Project Number	175539009
Sample Identification	B-5, 18.6'-19.1'	Test Number	CU-1257B
Visual Description	Lean Clay (CL), brown, moist, firm	Prepared By	CM
Undisturbed	Source B-5, 18.0'-20.0'	Date	7-24-2009

Specific Gravity 2.64 ASTM D854 Method A Liquid Limit N/A Plastic Limit N/A Plasticity Index N/A

Initial Specimen Data

Specimen Diameter (in.)		Specimen Height (in.)		Volumes (in3)		Specimen	
Top	2.885	1	5.984	Sample	38.9528 (V_o)	Wet Weight (g)	1242.10
Middle	2.874	2	5.979	Solids	22.9232 (VS_o)	Dry Weight (g)	991.76
Bottom	2.880	3	5.977	Water	15.2756 (Vw_o)	Wet Unit Weight (pcf)	121.5
Avg.	2.8797 (D_o)	4	5.984	Voids	16.0296 (Vv_o)	Dry Unit Weight (pcf)	97.0
Area (in^2)	6.5129 (A_o)	Avg. (H_o)	5.9809	Degree of Saturation (%)	95.3 (S_o)		
Moisture Content (%)	25.2	Final Trimmings		Void Ratio	0.699		

Saturation

Set Up & Saturated: Wet xx Dry

Back Pressure Saturated to: 60 (psi) Final Pore Pressure Parameter B 0.99

Set up By KDG

Date 8-13-09

Panel Board Number B

Height Readings (in.)		Back Pressure Burette		Chamber Burette			
Initial	0.1153	Initial	16.49 (in.)	Initial	10.86 (in.)	Specimen Height (in.)	5.9817 (H_s)
Final	0.1145	Final	13.45 (in.)	Final	4.36 (in.)	Area (in^2) Method A	6.5146 (A_s)
Change	0.0008 (ΔH_o)	Change	-3.04 (in.)	Change	-6.50 (in.)	Specimen Volume (in^3)	38.97 (V_s)

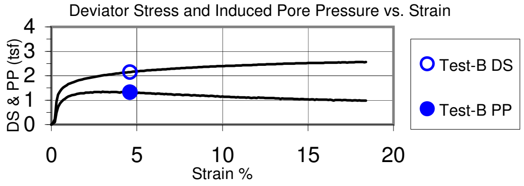
Consolidation

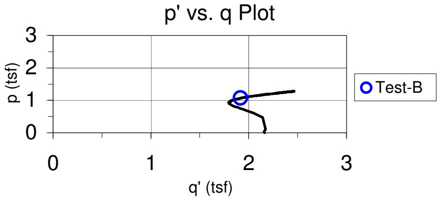
Height Readings (in.)		Back Pressure Burette Readings		Chamber Burette Readings		Pressures (psi)	
Initial	0.1106	Initial	1.16 (in.)	Initial	17.61 (in.)	Chamber	90
Final	0.1806	Final	9.26 (in.)	Final	9.22 (in.)	Back	60
Change	-0.0700 (ΔH_c)	Change	-8.10 (in.)	Change	-8.39 (in.)	Lateral	30 (σ_3)
Height (in.)	5.9117 (H_c)			Volume (in^3)	36.9632 (V_c)		
Area (in^3) Method B	6.2526 (A_c)			Volume - Water (in^3)	14.0399 (VWc)	D_{50} (min.)	17
Diameter (in.)	2.8215 (D_c)			Water Content (%)	23.2		
Dry Density (pcf)	102.2			Degree of Saturation (%)	100.0 (S_c)	Void Ratio	0.612

After Test

Final Measurements		Final Moisture Content		Stresses (membrane corrected) at Failure (psi)	
Maximum Diameter	3.423 (in.)	Wet Weight (g)	1221.85	Corrected Deviator	2.15 σ_d (tsf)
Wet weight (g)	1221.85 (WWf)	Dry Weight (g)	991.76	Major Principal	2.99 $\sigma_1'_f$ (tsf)
Corrected Diameter	3.399 (in.)	Tare Weight (g)	0.00	Minor Principal	0.85 $\sigma_3'_f$ (tsf)
				Rate of Strain (% / min.)	0.030
Youngs Modulus for Membrane (psi)	200			Axial Strain at Failure (%)	4.60
Membrane Thickness (in.)	0.012			Failure Criterion:	Maximum Effective Principal Stress Ratio

Failure Sketch





Comments:

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values				Final Values	
Height	5.995 (in.)	15.227 (cm)		Height	4.892 (in.)	
Diameter	2.775 (in)	7.047 (cm)		Dia. avg.	3.111 (in)	
Area	6.046 (in^2)	39.006 (cm^2)		Area avg.	7.603 (in^2)	

Tested By	KDG
Date	8-14-09
Press No.	1
Panel No.	A

Project Number	175539009
Test Number	CU-1257A
Data File ID	1257A
Lateral Pressure (psi)	10.0
Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
0:00:00	9.7	-0.022	80.1	5.995	0.00	39.0060	0.0	0.000	0.000	0.720	0.720	0.715	0.718	0.002	1.007
0:01:03	25.0	-0.016	81.7	5.988	0.11	39.0471	15.3	0.182	0.182	0.902	0.786	0.600	0.693	0.093	1.311
0:01:58	27.6	-0.010	82.0	5.983	0.20	39.0846	17.9	0.213	0.212	0.932	0.796	0.579	0.688	0.108	1.374
0:03:14	33.0	-0.004	82.7	5.977	0.30	39.1234	23.3	0.277	0.276	0.996	0.805	0.524	0.665	0.140	1.536
0:04:27	40.7	0.002	83.6	5.971	0.40	39.1631	31.0	0.368	0.367	1.087	0.833	0.462	0.647	0.186	1.805
0:05:48	45.7	0.008	84.3	5.965	0.50	39.2029	36.0	0.427	0.426	1.146	0.841	0.411	0.626	0.215	2.049
0:07:08	50.4	0.014	84.9	5.959	0.60	39.2424	40.7	0.482	0.481	1.201	0.856	0.370	0.613	0.243	2.311
0:08:27	54.0	0.020	85.2	5.952	0.70	39.2828	44.3	0.524	0.522	1.242	0.875	0.348	0.612	0.263	2.514
0:09:46	57.3	0.026	85.2	5.947	0.80	39.3208	47.6	0.563	0.561	1.281	0.911	0.345	0.628	0.283	2.639
0:11:04	59.7	0.032	85.7	5.941	0.90	39.3605	50.0	0.590	0.588	1.308	0.905	0.312	0.608	0.297	2.902
0:12:22	62.3	0.038	86.0	5.935	1.00	39.3999	52.6	0.621	0.619	1.339	0.910	0.287	0.598	0.312	3.176
0:13:41	64.7	0.044	86.2	5.929	1.10	39.4405	55.0	0.648	0.646	1.366	0.924	0.274	0.599	0.325	3.377
0:15:00	67.2	0.050	86.2	5.923	1.20	39.4809	57.5	0.677	0.674	1.394	0.952	0.273	0.612	0.339	3.489
0:16:13	67.4	0.056	86.2	5.917	1.30	39.5199	57.8	0.680	0.676	1.396	0.957	0.276	0.616	0.341	3.471
0:17:33	70.9	0.062	86.2	5.911	1.40	39.5600	61.2	0.719	0.716	1.436	0.995	0.274	0.634	0.360	3.629
0:18:48	72.5	0.068	85.8	5.905	1.50	39.5996	62.8	0.737	0.733	1.453	1.037	0.299	0.668	0.369	3.465
0:20:08	75.2	0.074	86.4	5.899	1.60	39.6400	65.5	0.768	0.764	1.484	1.031	0.262	0.646	0.384	3.936
0:21:27	75.5	0.080	86.4	5.893	1.70	39.6801	65.8	0.771	0.767	1.487	1.028	0.256	0.642	0.386	4.012
0:22:48	78.7	0.086	86.5	5.887	1.80	39.7212	69.0	0.808	0.803	1.523	1.058	0.250	0.654	0.404	4.235
0:24:10	80.2	0.092	86.5	5.881	1.90	39.7610	70.5	0.824	0.820	1.540	1.080	0.255	0.668	0.412	4.228
0:25:30	82.3	0.098	86.4	5.875	2.00	39.8024	72.6	0.848	0.843	1.563	1.110	0.261	0.685	0.424	4.244
0:26:51	83.9	0.104	86.2	5.869	2.10	39.8431	74.2	0.866	0.860	1.580	1.139	0.273	0.706	0.433	4.165
0:28:08	85.5	0.110	85.9	5.863	2.20	39.8833	75.8	0.884	0.878	1.598	1.175	0.292	0.734	0.441	4.020
0:29:24	87.6	0.116	86.4	5.857	2.30	39.9242	77.9	0.907	0.901	1.621	1.162	0.256	0.709	0.453	4.534
0:30:42	89.1	0.122	86.5	5.851	2.40	39.9646	79.4	0.924	0.918	1.638	1.176	0.253	0.715	0.461	4.643
0:32:00	90.7	0.128	86.4	5.845	2.50	40.0061	81.0	0.942	0.935	1.655	1.199	0.258	0.729	0.470	4.638
0:33:18	92.5	0.134	86.3	5.839	2.60	40.0468	82.8	0.962	0.955	1.675	1.225	0.265	0.745	0.480	4.623
0:34:29	93.5	0.140	86.2	5.833	2.70	40.0877	83.8	0.972	0.965	1.685	1.243	0.272	0.757	0.485	4.562
0:35:44	95.3	0.146	86.0	5.827	2.80	40.1292	85.6	0.992	0.985	1.705	1.276	0.286	0.781	0.495	4.457
0:36:56	96.4	0.152	85.6	5.821	2.90	40.1706	86.7	1.003	0.996	1.716	1.319	0.318	0.819	0.501	4.144
0:38:09	97.9	0.158	86.2	5.815	3.00	40.2118	88.2	1.020	1.013	1.733	1.288	0.271	0.779	0.509	4.759
0:39:28	99.2	0.164	86.3	5.809	3.10	40.2540	89.5	1.034	1.026	1.746	1.299	0.268	0.783	0.516	4.850
0:40:42	100.3	0.170	86.3	5.803	3.20	40.2946	90.6	1.045	1.037	1.757	1.312	0.270	0.791	0.521	4.867
0:41:54	101.3	0.176	86.1	5.797	3.30	40.3361	91.6	1.056	1.048	1.768	1.332	0.279	0.806	0.526	4.767
0:43:09	102.9	0.182	86.0	5.791	3.40	40.3779	93.2	1.073	1.065	1.785	1.356	0.287	0.822	0.535	4.728
0:44:26	104.1	0.188	85.8	5.785	3.50	40.4204	94.4	1.086	1.078	1.798	1.382	0.299	0.840	0.541	4.618
0:45:42	105.3	0.193	85.3	5.779	3.60	40.4617	95.6	1.099	1.090	1.810	1.431	0.336	0.884	0.548	4.259
0:46:56	105.5	0.200	85.9	5.773	3.70	40.5040	95.8	1.100	1.091	1.811	1.388	0.292	0.840	0.548	4.747
0:48:09	107.0	0.206	86.0	5.767	3.80	40.5462	97.3	1.116	1.107	1.827	1.401	0.290	0.845	0.556	4.839
0:49:23	107.5	0.211	85.9	5.761	3.90	40.5880	97.8	1.121	1.111	1.831	1.408	0.292	0.850	0.558	4.824
0:50:38	108.5	0.218	85.8	5.755	4.00	40.6305	98.8	1.130	1.120	1.840	1.425	0.300	0.862	0.563	4.755
0:51:54	109.3	0.224	85.7	5.749	4.10	40.6730	99.6	1.138	1.128	1.848	1.440	0.307	0.873	0.566	4.690
0:53:10	109.6	0.229	85.6	5.743	4.20	40.7151	99.9	1.141	1.131	1.851	1.454	0.319	0.886	0.568	4.564
0:54:28	110.2	0.235	85.0	5.737	4.30	40.7577	100.5	1.146	1.136	1.856	1.502	0.362	0.932	0.570	4.152
0:55:44	111.0	0.241	85.7	5.731	4.40	40.8001	101.3	1.155	1.144	1.864	1.460	0.311	0.886	0.574	4.690
0:57:03	111.8	0.248	85.7	5.725	4.50	40.8440	102.1	1.162	1.151	1.871	1.463	0.307	0.885	0.578	4.764
0:58:20	112.4	0.253	85.7	5.719	4.60	40.8856	102.7	1.168	1.156	1.876	1.469	0.308	0.889	0.580	4.766
0:59:38	113.2	0.259	85.6	5.713	4.70	40.9284	103.5	1.176	1.164	1.884	1.489	0.320	0.905	0.585	4.649
1:00:50	114.3	0.265	85.5	5.707	4.80	40.9714	104.6	1.187	1.175	1.895	1.504	0.325	0.915	0.590	4.632
1:02:09	114.9	0.271	85.3	5.701	4.90	41.0149	105.2	1.193	1.180	1.900	1.523	0.338	0.930	0.593	4.507
1:03:28	115.5	0.277	85.0	5.695	5.00	41.0579	105.8	1.198	1.185	1.905	1.553	0.363	0.958	0.595	4.280
1:04:42	114.6	0.283	85.5	5.689	5.10	41.1010	104.9	1.186	1.174	1.894	1.502	0.324	0.913	0.589	4.638
1:05:57	115.5	0.289	85.5	5.683	5.20	41.1439	105.8	1.195	1.183	1.903	1.510	0.322	0.916	0.594	4.683
1:07:14	115.8	0.295	85.5	5.677	5.30	41.1873	106.1	1.198	1.185	1.905	1.514	0.324	0.919	0.595	4.675
1:08:31	116.3	0.301	85.4	5.671	5.40	41.2309	106.6	1.202	1.189	1.909	1.527	0.333	0.930	0.597	4.585
1:09:47	117.1	0.307	85.3	5.665	5.50	41.2750	107.4	1.210	1.196	1.916	1.543	0.342	0.942	0.600	4.515
1:11:06	117.6	0.313	85.1	5.659	5.60	41.3182	107.9	1.214	1.200	1.920	1.561	0.356	0.959	0.603	4.384
1:12:24	118.3	0.319	84.9	5.653	5.70	41.3625	108.6	1.221	1.206	1.926	1.580	0.369	0.974	0.606	4.284
1:13:42	118.7	0.325	85.3	5.647	5.80	41.4060	109.0	1.224	1.210	1.930	1.554	0.339	0.947	0.607	4.581
1:14:59	119.3	0.331	85.3	5.641	5.90	41.4498	109.6	1.230	1.215	1.935	1.557	0.337	0.947	0.610	4.622

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			Final Values					
Height	5.995 (in.)	15.227 (cm)	Height	4.892 (in.)	Tested By	KDG	Project Number	175539009
Diameter	2.775 (in)	7.047 (cm)	Dia. avg.	3.111 (in)	Date	8-14-09	Test Number	CU-1257A
Area	6.046 (in^2)	39.006 (cm^2)	Area avg.	7.603 (in^2)	Press No.	1	Data File ID	1257A
					Panel No.	A	Lateral Pressure (psi)	10.0
							Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
1:16:22	120.1	0.337	85.3	5.635	6.00	41.4944	110.4	1.237	1.222	1.942	1.567	0.340	0.954	0.614	4.606
1:17:41	119.9	0.343	85.1	5.629	6.10	41.5384	110.2	1.234	1.219	1.939	1.573	0.350	0.961	0.612	4.499
1:18:59	120.9	0.349	85.0	5.623	6.20	41.5825	111.2	1.244	1.228	1.948	1.592	0.359	0.975	0.617	4.438
1:20:18	120.2	0.355	84.6	5.617	6.30	41.6268	110.5	1.234	1.219	1.939	1.610	0.387	0.999	0.612	4.161
1:21:35	121.7	0.361	85.0	5.611	6.40	41.6713	112.0	1.250	1.234	1.954	1.599	0.360	0.979	0.619	4.438
1:22:51	122.0	0.367	85.2	5.605	6.50	41.7161	112.3	1.252	1.236	1.956	1.590	0.349	0.969	0.620	4.553
1:24:03	122.7	0.373	85.1	5.599	6.60	41.7601	113.0	1.258	1.241	1.961	1.597	0.351	0.974	0.623	4.552
1:25:16	124.0	0.379	85.1	5.593	6.69	41.8047	114.3	1.271	1.255	1.975	1.615	0.355	0.985	0.630	4.543
1:26:33	124.0	0.385	85.0	5.587	6.80	41.8505	114.3	1.270	1.253	1.973	1.619	0.362	0.990	0.629	4.478
1:27:46	124.6	0.391	84.9	5.581	6.89	41.8946	114.9	1.275	1.258	1.978	1.633	0.371	1.002	0.631	4.406
1:29:00	124.7	0.397	84.6	5.575	7.00	41.9403	115.0	1.275	1.258	1.978	1.654	0.391	1.022	0.631	4.230
1:30:15	125.8	0.403	84.8	5.569	7.09	41.9847	116.1	1.286	1.268	1.988	1.647	0.374	1.010	0.636	4.406
1:31:30	125.6	0.409	85.0	5.563	7.20	42.0306	115.9	1.282	1.264	1.984	1.630	0.361	0.996	0.634	4.513
1:32:44	126.6	0.415	85.0	5.557	7.30	42.0758	117.0	1.292	1.274	1.994	1.641	0.362	1.001	0.640	4.536
1:33:56	126.4	0.421	84.9	5.551	7.40	42.1209	116.7	1.289	1.270	1.990	1.644	0.369	1.006	0.638	4.456
1:35:12	126.7	0.427	84.8	5.545	7.49	42.1663	117.0	1.290	1.272	1.992	1.649	0.372	1.011	0.638	4.428
1:36:28	126.4	0.433	84.7	5.539	7.59	42.2116	116.7	1.286	1.267	1.987	1.654	0.383	1.019	0.636	4.325
1:37:40	127.3	0.439	84.4	5.533	7.69	42.2576	117.6	1.294	1.275	1.995	1.681	0.401	1.041	0.640	4.196
1:38:56	128.5	0.445	84.4	5.527	7.80	42.3041	118.8	1.306	1.287	2.007	1.691	0.400	1.046	0.646	4.228
1:40:11	128.7	0.451	84.8	5.521	7.89	42.3491	119.0	1.307	1.287	2.007	1.666	0.374	1.020	0.646	4.454
1:41:27	131.2	0.457	84.8	5.515	8.00	42.3958	121.5	1.333	1.313	2.033	1.689	0.372	1.031	0.659	4.542
1:42:40	131.9	0.463	84.8	5.510	8.09	42.4410	122.2	1.339	1.319	2.039	1.699	0.376	1.038	0.662	4.524
1:43:59	131.7	0.469	84.7	5.503	8.20	42.4881	122.1	1.336	1.315	2.035	1.701	0.381	1.041	0.660	4.465
1:45:14	132.3	0.475	84.6	5.497	8.29	42.5339	122.6	1.340	1.319	2.039	1.713	0.389	1.051	0.662	4.402
1:46:30	132.0	0.481	84.3	5.491	8.39	42.5804	122.3	1.336	1.315	2.035	1.727	0.407	1.067	0.660	4.240
1:47:45	132.9	0.487	84.4	5.486	8.49	42.6266	123.2	1.344	1.323	2.043	1.733	0.405	1.069	0.664	4.276
1:49:02	133.0	0.493	84.7	5.479	8.59	42.6736	123.3	1.343	1.322	2.042	1.710	0.384	1.047	0.663	4.458
1:50:20	133.5	0.499	84.7	5.473	8.69	42.7205	123.8	1.348	1.326	2.046	1.712	0.380	1.046	0.666	4.499
1:51:36	133.7	0.505	84.7	5.467	8.79	42.7673	124.0	1.349	1.327	2.047	1.715	0.384	1.050	0.666	4.468
1:52:53	133.6	0.511	84.6	5.462	8.89	42.8139	123.9	1.346	1.324	2.044	1.718	0.390	1.054	0.664	4.410
1:54:10	134.8	0.517	84.5	5.455	9.00	42.8614	125.1	1.357	1.335	2.055	1.738	0.399	1.068	0.670	4.360
1:55:26	135.7	0.523	84.2	5.450	9.09	42.9081	126.0	1.365	1.342	2.062	1.765	0.418	1.092	0.674	4.222
1:56:44	135.8	0.529	84.4	5.444	9.19	42.9550	126.1	1.365	1.342	2.062	1.748	0.401	1.074	0.673	4.357
1:58:01	136.1	0.535	84.6	5.438	9.29	43.0028	126.4	1.367	1.344	2.064	1.737	0.388	1.062	0.674	4.472
1:59:14	136.1	0.541	84.6	5.432	9.39	43.0495	126.4	1.365	1.342	2.062	1.735	0.388	1.062	0.673	4.468
2:00:31	136.3	0.547	84.5	5.426	9.49	43.0970	126.6	1.366	1.343	2.063	1.740	0.392	1.066	0.674	4.434
2:01:50	137.0	0.553	84.5	5.420	9.59	43.1452	127.3	1.372	1.348	2.068	1.749	0.396	1.073	0.676	4.413
2:03:09	136.9	0.559	84.3	5.414	9.69	43.1928	127.2	1.369	1.345	2.065	1.759	0.408	1.083	0.675	4.306
2:04:25	138.0	0.565	84.0	5.408	9.79	43.2405	128.3	1.380	1.355	2.075	1.790	0.430	1.110	0.680	4.162
2:05:44	138.2	0.571	84.4	5.402	9.89	43.2885	128.5	1.380	1.355	2.075	1.764	0.403	1.084	0.680	4.371
2:07:05	138.7	0.577	84.5	5.396	9.99	43.3370	129.0	1.384	1.359	2.079	1.756	0.392	1.074	0.682	4.476
2:08:24	137.9	0.583	84.6	5.390	10.09	43.3853	128.2	1.374	1.349	2.069	1.746	0.392	1.069	0.677	4.455
2:09:43	137.7	0.589	84.5	5.384	10.19	43.4334	128.0	1.370	1.345	2.065	1.748	0.398	1.073	0.675	4.392
2:11:04	138.3	0.595	84.4	5.378	10.29	43.4814	128.6	1.375	1.349	2.069	1.758	0.404	1.081	0.677	4.352
2:12:24	138.4	0.601	84.3	5.372	10.39	43.5300	128.7	1.375	1.349	2.069	1.768	0.414	1.091	0.677	4.271
2:13:43	138.8	0.607	83.7	5.366	10.49	43.5792	129.1	1.378	1.351	2.071	1.807	0.451	1.129	0.678	4.008
2:14:57	138.9	0.613	84.4	5.360	10.59	43.6274	129.2	1.378	1.351	2.071	1.761	0.405	1.083	0.678	4.345
2:16:13	139.0	0.619	84.5	5.354	10.69	43.6761	129.3	1.377	1.350	2.070	1.752	0.397	1.075	0.677	4.409
2:17:29	139.6	0.625	84.5	5.348	10.79	43.7251	129.9	1.381	1.355	2.075	1.756	0.397	1.077	0.680	4.423
2:18:44	138.9	0.631	84.4	5.342	10.89	43.7740	129.2	1.372	1.345	2.065	1.751	0.401	1.076	0.675	4.364
2:20:00	139.9	0.637	84.3	5.336	10.99	43.8240	130.2	1.381	1.354	2.074	1.767	0.408	1.087	0.679	4.329
2:21:14	140.2	0.643	84.2	5.330	11.09	43.8724	130.5	1.383	1.355	2.075	1.778	0.418	1.098	0.680	4.256
2:22:29	140.9	0.649	83.7	5.324	11.19	43.9222	131.2	1.389	1.361	2.081	1.823	0.457	1.140	0.683	3.989
2:23:42	140.7	0.655	84.3	5.318	11.29	43.9710	131.0	1.386	1.358	2.078	1.773	0.410	1.091	0.681	4.321
2:24:57	142.7	0.661	84.4	5.312	11.39	44.0211	133.0	1.405	1.377	2.097	1.783	0.402	1.093	0.691	4.440
2:26:08	141.7	0.667	84.4	5.306	11.49	44.0706	132.0	1.393	1.365	2.085	1.770	0.401	1.086	0.685	4.415
2:27:19	142.3	0.673	84.3	5.300	11.59	44.1201	132.6	1.397	1.368	2.088	1.782	0.409	1.095	0.687	4.360
2:28:31	142.9	0.679	84.3	5.294	11.69	44.1701	133.2	1.402	1.373	2.093	1.791	0.413	1.102	0.689	4.339
2:29:46	143.6	0.685	84.1	5.288	11.79	44.2206	133.9	1.408	1.379	2.099	1.805	0.422	1.114	0.692	4.281
2:30:55	143.4	0.691	83.7	5.282	11.89	44.2704	133.7	1.405	1.375	2.095	1.834	0.454	1.144	0.690	4.041

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values				Final Values					
Height	5.995 (in.)	15.227 (cm)	Height	4.892 (in.)	Tested By	KDG	Project Number	175539009
Diameter	2.775 (in)	7.047 (cm)	Dia. avg.	3.111 (in)	Date	8-14-09	Test Number	CU-1257A
Area	6.046 (in^2)	39.006 (cm^2)	Area avg.	7.603 (in^2)	Press No.	1	Data File ID	1257A
					Panel No.	A	Lateral Pressure (psi)	10.0
							Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1'/σ_3'
2:32:08	143.8	0.697	84.2	5.276	11.99	44.3204	134.1	1.407	1.377	2.097	1.802	0.420	1.111	0.691	4.288
2:33:26	144.6	0.703	84.3	5.270	12.09	44.3712	134.9	1.414	1.384	2.104	1.796	0.407	1.101	0.694	4.412
2:34:38	145.0	0.709	84.3	5.264	12.19	44.4218	135.3	1.416	1.386	2.106	1.798	0.407	1.103	0.695	4.413
2:35:52	145.4	0.715	84.3	5.258	12.29	44.4724	135.7	1.419	1.388	2.108	1.805	0.413	1.109	0.696	4.376
2:37:09	145.3	0.721	84.2	5.252	12.39	44.5226	135.6	1.416	1.385	2.105	1.805	0.415	1.110	0.695	4.345
2:38:25	145.0	0.727	84.1	5.246	12.49	44.5737	135.3	1.412	1.381	2.101	1.810	0.425	1.117	0.693	4.262
2:39:40	145.4	0.733	83.9	5.240	12.59	44.6243	135.7	1.414	1.383	2.103	1.829	0.442	1.135	0.694	4.143
2:40:56	145.8	0.739	84.1	5.234	12.69	44.6760	136.1	1.416	1.385	2.105	1.814	0.424	1.119	0.695	4.275
2:42:14	146.1	0.745	84.3	5.228	12.79	44.7269	136.4	1.418	1.386	2.106	1.799	0.408	1.104	0.696	4.409
2:43:30	146.2	0.751	84.3	5.222	12.89	44.7778	136.5	1.418	1.386	2.106	1.798	0.408	1.103	0.695	4.408
2:44:44	146.7	0.757	84.3	5.216	12.99	44.8293	137.0	1.421	1.389	2.109	1.807	0.413	1.110	0.697	4.374
2:46:01	147.5	0.763	84.2	5.210	13.09	44.8810	137.8	1.427	1.395	2.115	1.815	0.416	1.116	0.700	4.364
2:47:20	146.9	0.769	84.1	5.204	13.19	44.9332	137.2	1.420	1.387	2.107	1.815	0.423	1.119	0.696	4.290
2:48:34	147.4	0.775	83.9	5.198	13.29	44.9850	137.7	1.423	1.390	2.110	1.836	0.441	1.138	0.698	4.167
2:49:49	147.9	0.781	84.0	5.192	13.39	45.0371	138.2	1.426	1.393	2.113	1.833	0.435	1.134	0.699	4.213
2:51:05	148.2	0.786	84.3	5.186	13.49	45.0881	138.5	1.429	1.395	2.115	1.814	0.414	1.114	0.700	4.385
2:52:20	148.1	0.793	84.3	5.180	13.59	45.1407	138.4	1.426	1.392	2.112	1.809	0.412	1.110	0.698	4.389
2:53:35	148.5	0.798	84.2	5.174	13.69	45.1926	138.8	1.428	1.394	2.114	1.817	0.418	1.117	0.700	4.348
2:54:55	148.8	0.805	84.2	5.168	13.79	45.2456	139.1	1.430	1.395	2.115	1.821	0.420	1.121	0.700	4.330
2:56:12	148.7	0.810	84.1	5.162	13.89	45.2975	139.0	1.427	1.392	2.112	1.824	0.428	1.126	0.698	4.267
2:57:28	149.2	0.816	83.8	5.156	13.99	45.3503	139.5	1.430	1.395	2.115	1.847	0.447	1.147	0.700	4.135
2:58:48	150.0	0.823	84.0	5.150	14.09	45.4039	140.3	1.437	1.402	2.122	1.838	0.432	1.135	0.703	4.257
3:00:09	150.6	0.829	84.2	5.144	14.19	45.4568	140.9	1.442	1.406	2.126	1.829	0.418	1.123	0.706	4.377
3:01:27	149.5	0.834	84.2	5.138	14.29	45.5091	139.8	1.429	1.393	2.113	1.812	0.414	1.113	0.699	4.374
3:02:47	149.8	0.840	84.2	5.132	14.39	45.5620	140.1	1.430	1.394	2.114	1.820	0.421	1.120	0.699	4.323
3:04:08	150.0	0.846	84.1	5.126	14.49	45.6155	140.3	1.430	1.394	2.114	1.826	0.427	1.126	0.700	4.278
3:05:28	150.3	0.852	84.0	5.120	14.59	45.6684	140.6	1.431	1.395	2.115	1.834	0.434	1.134	0.700	4.225
3:06:48	150.8	0.858	83.6	5.114	14.69	45.7226	141.1	1.435	1.398	2.118	1.867	0.463	1.165	0.702	4.028
3:08:05	150.8	0.864	84.1	5.108	14.79	45.7763	141.1	1.434	1.397	2.117	1.829	0.427	1.128	0.701	4.281
3:09:20	151.4	0.870	84.2	5.102	14.89	45.8297	141.7	1.438	1.401	2.121	1.825	0.419	1.122	0.703	4.351
3:10:36	150.7	0.876	84.2	5.096	14.99	45.8836	141.0	1.429	1.392	2.112	1.816	0.419	1.117	0.698	4.330
3:11:53	151.1	0.882	84.1	5.090	15.09	45.9371	141.4	1.431	1.394	2.114	1.823	0.424	1.123	0.699	4.298
3:13:06	150.8	0.888	84.0	5.084	15.19	45.9916	141.1	1.427	1.389	2.109	1.824	0.430	1.127	0.697	4.240
3:14:20	151.5	0.894	83.9	5.078	15.29	46.0468	141.8	1.432	1.394	2.114	1.836	0.438	1.137	0.699	4.194
3:15:34	151.8	0.900	83.6	5.072	15.39	46.1000	142.1	1.433	1.395	2.115	1.859	0.460	1.160	0.700	4.043
3:16:47	151.3	0.906	83.9	5.066	15.49	46.1547	141.6	1.427	1.388	2.108	1.831	0.439	1.135	0.696	4.176
3:18:01	152.3	0.912	84.1	5.060	15.59	46.2098	142.6	1.435	1.396	2.116	1.825	0.424	1.124	0.701	4.308
3:19:12	152.0	0.918	84.1	5.054	15.69	46.2641	142.3	1.430	1.391	2.111	1.819	0.423	1.121	0.698	4.300
3:20:26	152.6	0.924	84.1	5.048	15.79	46.3200	142.9	1.434	1.395	2.115	1.828	0.428	1.128	0.700	4.272
3:21:39	153.6	0.930	84.0	5.042	15.89	46.3738	143.9	1.443	1.404	2.124	1.839	0.431	1.135	0.704	4.270
3:22:54	153.3	0.936	84.0	5.036	15.99	46.4298	143.7	1.439	1.399	2.119	1.839	0.435	1.137	0.702	4.224
3:24:09	154.6	0.942	83.7	5.030	16.09	46.4851	144.9	1.450	1.410	2.130	1.865	0.451	1.158	0.707	4.139
3:25:16	154.2	0.948	83.3	5.024	16.19	46.5399	144.5	1.444	1.404	2.124	1.888	0.479	1.184	0.704	3.938
3:26:32	153.7	0.954	84.0	5.018	16.29	46.5959	144.0	1.437	1.397	2.117	1.832	0.430	1.131	0.701	4.258
3:27:44	154.4	0.960	84.1	5.012	16.39	46.6515	144.7	1.442	1.402	2.122	1.832	0.426	1.129	0.703	4.302
3:28:57	155.0	0.966	84.1	5.006	16.49	46.7074	145.3	1.447	1.406	2.126	1.837	0.426	1.132	0.705	4.307
3:30:10	155.4	0.972	84.0	5.000	16.59	46.7625	145.7	1.449	1.408	2.128	1.845	0.433	1.139	0.706	4.265
3:31:26	154.9	0.978	83.9	4.994	16.69	46.8188	145.2	1.443	1.401	2.121	1.844	0.439	1.141	0.703	4.205
3:32:43	155.2	0.984	83.8	4.988	16.79	46.8752	145.5	1.443	1.402	2.122	1.854	0.448	1.151	0.703	4.140
3:34:00	155.1	0.990	83.1	4.982	16.89	46.9330	145.4	1.440	1.398	2.118	1.897	0.494	1.195	0.702	3.841
3:35:16	155.2	0.996	84.0	4.976	16.99	46.9877	145.5	1.440	1.397	2.117	1.835	0.433	1.134	0.701	4.237
3:36:35	155.9	1.002	84.1	4.970	17.09	47.0451	146.3	1.446	1.403	2.123	1.836	0.428	1.132	0.704	4.287
3:37:47	155.8	1.008	84.0	4.964	17.19	47.1017	146.1	1.443	1.400	2.120	1.833	0.429	1.131	0.702	4.276
3:39:03	155.9	1.014	83.9	4.958	17.29	47.1582	146.2	1.442	1.399	2.119	1.842	0.438	1.140	0.702	4.205
3:40:21	156.0	1.020	83.9	4.952	17.39	47.2152	146.3	1.441	1.398	2.118	1.844	0.442	1.143	0.701	4.176
3:41:38	156.0	1.026	83.7	4.946	17.49	47.2723	146.3	1.439	1.395	2.115	1.852	0.452	1.152	0.700	4.096
3:42:54	156.3	1.032	83.2	4.940	17.59	47.3309	146.6	1.441	1.397	2.117	1.891	0.490	1.190	0.701	3.863
3:44:09	157.0	1.038	84.0	4.934	17.69	47.3873	147.3	1.445	1.401	2.121	1.840	0.435	1.137	0.703	4.235
3:45:26	156.7	1.044	84.0	4.928	17.79	47.4447	147.0	1.441	1.397	2.117	1.833	0.431	1.132	0.701	4.254
3:46:41	156.8	1.050	84.0	4.922	17.89	47.5027	147.1	1.440	1.395	2.115	1.834	0.434	1.134	0.700	4.228

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Consolidation Values				
Height	5.995	(in.)	15.227	(cm)
Diameter	2.775	(in)	7.047	(cm)
Area	6.046	(in^2)	39.006	(cm^2)

Final Values		
Height	4.892	(in.)
Dia. avg.	3.111	(in)
Area avg.	7.603	(in^2)

Tested By	KDG
Date	8-14-09
Press No.	1
Panel No.	A

Project Number	175539009
Test Number	CU-1257A
Data File ID	1257A
Lateral Pressure (psi)	10.0
Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
3:47:59	158.8	1.056	83.9	4.916	17.99	47.5606	149.1	1.457	1.413	2.133	1.855	0.438	1.147	0.709	4.238
3:49:17	158.4	1.062	83.8	4.910	18.09	47.6194	148.7	1.452	1.407	2.127	1.856	0.444	1.150	0.706	4.177
3:50:35	157.6	1.068	83.7	4.904	18.19	47.6773	147.9	1.442	1.397	2.117	1.858	0.456	1.157	0.701	4.074
3:51:52	157.4	1.074	83.2	4.899	18.29	47.7348	147.7	1.439	1.393	2.113	1.887	0.489	1.188	0.699	3.856
3:53:12	157.7	1.080	83.9	4.892	18.39	47.7936	148.0	1.440	1.394	2.114	1.837	0.438	1.137	0.700	4.195

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			Final Values	
Height	5.912 (in.)	15.016 (cm)	Height	4.824 (in.)	
Diameter	2.822 (in)	7.167 (cm)	Dia. avg.	3.177 (in)	
Area	6.253 (in^2)	40.342 (cm^2)	Area avg.	7.929 (in^2)	

Tested By	KDG
Date	8-17-09
Press No.	1
Panel No.	B

Project Number	175539009
Test Number	CU-1257B
Data File ID	1257B
Lateral Pressure (psi)	30.0
Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
0:00:00	12.0	-0.019	60.0	5.912	0.00	40.3416	0.0	0.000	0.000	2.160	2.160	2.163	2.162	-0.002	0.999
0:03:25	17.2	-0.013	60.4	5.906	0.10	40.3825	5.2	0.060	0.060	2.220	2.185	2.128	2.156	0.028	1.027
0:06:36	31.7	-0.007	61.4	5.900	0.20	40.4227	19.7	0.227	0.227	2.387	2.283	2.060	2.171	0.112	1.109
0:10:56	94.0	-0.001	66.8	5.894	0.30	40.4634	82.1	0.943	0.942	3.102	2.612	1.673	2.143	0.470	1.561
0:14:27	118.6	0.005	70.0	5.888	0.40	40.5040	106.6	1.223	1.223	3.383	2.658	1.438	2.048	0.610	1.848
0:18:01	131.1	0.011	71.9	5.882	0.50	40.5443	119.1	1.366	1.365	3.525	2.664	1.302	1.983	0.681	2.046
0:21:20	138.6	0.017	73.1	5.876	0.60	40.5851	126.6	1.450	1.449	3.609	2.662	1.216	1.939	0.723	2.189
0:24:39	144.5	0.023	74.0	5.870	0.70	40.6260	132.5	1.516	1.515	3.675	2.664	1.152	1.908	0.756	2.312
0:28:06	149.2	0.028	74.6	5.864	0.80	40.6668	137.2	1.569	1.567	3.727	2.671	1.107	1.889	0.782	2.413
0:31:21	153.4	0.034	75.4	5.858	0.90	40.7079	141.4	1.616	1.614	3.774	2.660	1.049	1.855	0.805	2.535
0:34:38	157.2	0.040	75.9	5.853	1.00	40.7491	145.2	1.657	1.654	3.814	2.668	1.017	1.843	0.826	2.623
0:37:53	160.1	0.046	76.3	5.846	1.10	40.7913	148.1	1.688	1.686	3.846	2.672	0.989	1.830	0.841	2.701
0:41:07	162.6	0.052	76.6	5.841	1.20	40.8317	150.6	1.716	1.713	3.873	2.676	0.966	1.821	0.855	2.770
0:44:14	165.2	0.058	76.8	5.835	1.30	40.8738	153.2	1.743	1.740	3.900	2.687	0.950	1.818	0.869	2.829
0:47:23	167.8	0.064	77.1	5.829	1.40	40.9143	155.8	1.770	1.767	3.927	2.692	0.928	1.810	0.882	2.900
0:50:34	169.8	0.070	77.4	5.823	1.50	40.9557	157.8	1.792	1.788	3.948	2.691	0.906	1.799	0.893	2.971
0:53:44	172.1	0.076	77.6	5.817	1.60	40.9974	160.1	1.816	1.812	3.972	2.703	0.894	1.798	0.904	3.024
0:56:46	174.0	0.082	77.7	5.811	1.70	41.0396	162.0	1.836	1.832	3.992	2.713	0.885	1.799	0.914	3.067
0:59:53	175.5	0.088	77.8	5.805	1.80	41.0812	163.5	1.851	1.846	4.006	2.723	0.880	1.802	0.922	3.094
1:02:57	177.3	0.093	77.8	5.799	1.90	41.1227	165.3	1.869	1.864	4.024	2.739	0.878	1.809	0.931	3.120
1:06:05	178.9	0.099	78.1	5.793	2.00	41.1654	167.0	1.886	1.881	4.041	2.733	0.855	1.794	0.939	3.195
1:09:11	180.4	0.105	78.1	5.787	2.10	41.2073	168.4	1.900	1.895	4.055	2.745	0.853	1.799	0.946	3.217
1:12:16	181.7	0.111	78.2	5.782	2.20	41.2493	169.8	1.914	1.908	4.068	2.756	0.850	1.803	0.953	3.240
1:15:26	183.1	0.117	78.2	5.776	2.30	41.2911	171.1	1.927	1.921	4.081	2.766	0.848	1.807	0.959	3.260
1:18:44	184.8	0.123	78.2	5.770	2.40	41.3333	172.8	1.945	1.939	4.099	2.787	0.851	1.819	0.968	3.274
1:21:54	185.7	0.129	78.4	5.764	2.50	41.3757	173.7	1.952	1.946	4.106	2.776	0.833	1.805	0.971	3.331
1:25:10	187.4	0.135	78.4	5.758	2.60	41.4182	175.4	1.969	1.963	4.123	2.793	0.833	1.813	0.980	3.352
1:28:23	189.1	0.141	78.4	5.752	2.70	41.4608	177.2	1.987	1.980	4.140	2.809	0.832	1.820	0.989	3.377
1:31:41	190.0	0.147	78.4	5.746	2.80	41.5033	178.0	1.994	1.987	4.147	2.818	0.833	1.826	0.992	3.381
1:35:01	191.1	0.153	78.3	5.740	2.90	41.5464	179.1	2.004	1.997	4.157	2.833	0.839	1.836	0.997	3.377
1:38:22	192.6	0.158	78.6	5.734	3.00	41.5893	180.6	2.019	2.012	4.172	2.831	0.822	1.826	1.004	3.444
1:41:38	193.6	0.164	78.5	5.728	3.10	41.6318	181.6	2.028	2.020	4.180	2.843	0.826	1.835	1.009	3.443
1:44:58	194.4	0.170	78.5	5.723	3.20	41.6748	182.5	2.036	2.028	4.188	2.854	0.829	1.842	1.013	3.442
1:48:15	195.6	0.176	78.4	5.717	3.30	41.7179	183.6	2.047	2.039	4.199	2.868	0.832	1.850	1.018	3.447
1:51:34	196.8	0.182	78.4	5.711	3.40	41.7615	184.8	2.058	2.050	4.210	2.883	0.837	1.860	1.023	3.447
1:54:54	197.8	0.188	78.5	5.705	3.50	41.8048	185.8	2.067	2.058	4.218	2.881	0.825	1.853	1.028	3.490
1:58:10	199.0	0.194	78.5	5.699	3.60	41.8477	187.0	2.078	2.069	4.229	2.895	0.829	1.862	1.033	3.493
2:01:24	200.2	0.200	78.5	5.693	3.70	41.8912	188.3	2.090	2.081	4.241	2.908	0.830	1.869	1.039	3.502
2:04:38	201.3	0.206	78.4	5.687	3.80	41.9348	189.3	2.099	2.090	4.250	2.922	0.835	1.878	1.043	3.500
2:07:53	202.1	0.212	78.3	5.681	3.90	41.9792	190.1	2.106	2.096	4.256	2.934	0.840	1.887	1.047	3.491
2:11:07	203.2	0.218	78.1	5.675	4.00	42.0221	191.2	2.116	2.106	4.266	2.958	0.855	1.906	1.051	3.459
2:14:21	204.2	0.223	78.4	5.669	4.10	42.0661	192.2	2.125	2.115	4.275	2.946	0.834	1.890	1.056	3.532
2:17:42	204.7	0.229	78.3	5.663	4.20	42.1099	192.7	2.128	2.118	4.278	2.956	0.841	1.898	1.057	3.514
2:21:00	205.9	0.235	78.3	5.658	4.30	42.1538	193.9	2.139	2.129	4.289	2.971	0.845	1.908	1.063	3.515
2:24:20	206.7	0.241	78.2	5.652	4.40	42.1978	194.7	2.146	2.135	4.295	2.983	0.851	1.917	1.066	3.506
2:27:40	207.8	0.247	78.1	5.646	4.50	42.2419	195.8	2.155	2.144	4.304	2.999	0.858	1.929	1.071	3.495
2:30:59	208.4	0.253	78.3	5.640	4.60	42.2863	196.4	2.160	2.149	4.309	2.991	0.845	1.918	1.073	3.538
2:34:20	209.5	0.259	78.2	5.634	4.70	42.3307	197.5	2.169	2.158	4.318	3.007	0.852	1.929	1.077	3.530
2:37:34	210.7	0.265	78.1	5.628	4.80	42.3751	198.7	2.180	2.168	4.328	3.021	0.855	1.938	1.083	3.532
2:41:01	210.8	0.271	78.0	5.622	4.90	42.4196	198.8	2.180	2.168	4.328	3.029	0.864	1.947	1.082	3.504
2:44:18	211.9	0.277	77.8	5.616	5.00	42.4642	200.0	2.190	2.177	4.337	3.051	0.877	1.964	1.087	3.480
2:47:35	212.8	0.283	78.0	5.610	5.10	42.5094	200.8	2.196	2.184	4.344	3.041	0.861	1.951	1.090	3.534
2:50:55	213.9	0.288	78.0	5.604	5.20	42.5538	201.9	2.206	2.194	4.354	3.056	0.865	1.960	1.095	3.533
2:54:12	214.6	0.294	77.9	5.598	5.30	42.5991	202.6	2.212	2.199	4.359	3.064	0.869	1.966	1.098	3.527
2:57:31	215.2	0.300	77.9	5.592	5.40	42.6441	203.2	2.216	2.203	4.363	3.074	0.875	1.974	1.100	3.515
3:00:45	216.1	0.306	77.8	5.587	5.50	42.6891	204.1	2.223	2.210	4.370	3.088	0.881	1.985	1.103	3.504
3:04:01	216.9	0.312	77.8	5.581	5.60	42.7346	205.0	2.230	2.216	4.376	3.094	0.881	1.987	1.107	3.514
3:07:13	217.5	0.318	77.8	5.575	5.70	42.7796	205.5	2.234	2.220	4.380	3.095	0.879	1.987	1.108	3.524
3:10:23	218.4	0.324	77.7	5.569	5.80	42.8250	206.4	2.241	2.227	4.387	3.109	0.885	1.997	1.112	3.514
3:13:38	219.0	0.330	77.6	5.563	5.90	42.8708	207.0	2.245	2.231	4.391	3.117	0.890	2.003	1.114	3.504

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			Final Values				
Height	5.912 (in.)	15.016 (cm)	Height	4.824 (in.)	Tested By	KDG	Project Number	175539009
Diameter	2.822 (in)	7.167 (cm)	Dia. avg.	3.177 (in)	Date	8-17-09	Test Number	CU-1257B
Area	6.253 (in^2)	40.342 (cm^2)	Area avg.	7.929 (in^2)	Press No.	1	Data File ID	1257B
					Panel No.	B	Lateral Pressure (psi)	30.0
							Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
3:16:52	219.9	0.336	77.6	5.557	6.00	42.9163	207.9	2.253	2.238	4.398	3.131	0.896	2.013	1.117	3.495
3:19:57	220.3	0.342	77.4	5.551	6.10	42.9617	208.3	2.255	2.240	4.400	3.142	0.905	2.023	1.118	3.472
3:23:06	221.3	0.348	77.6	5.545	6.20	43.0075	209.3	2.263	2.248	4.408	3.137	0.892	2.015	1.122	3.515
3:26:19	221.9	0.353	77.5	5.539	6.30	43.0533	209.9	2.267	2.252	4.412	3.148	0.899	2.024	1.124	3.500
3:29:34	222.3	0.359	77.4	5.533	6.40	43.1001	210.4	2.270	2.254	4.414	3.155	0.904	2.029	1.125	3.490
3:32:44	223.1	0.365	77.4	5.527	6.50	43.1457	211.1	2.275	2.259	4.419	3.166	0.910	2.038	1.128	3.480
3:35:58	223.7	0.371	77.3	5.522	6.60	43.1914	211.7	2.280	2.263	4.423	3.176	0.916	2.046	1.130	3.468
3:39:19	224.2	0.377	77.3	5.516	6.70	43.2377	212.2	2.282	2.266	4.426	3.174	0.911	2.043	1.131	3.484
3:42:36	225.0	0.383	77.3	5.510	6.80	43.2843	213.0	2.288	2.271	4.431	3.183	0.915	2.049	1.134	3.480
3:45:51	225.9	0.389	77.2	5.504	6.90	43.3305	213.9	2.296	2.279	4.439	3.194	0.919	2.057	1.138	3.477
3:49:14	226.6	0.395	77.2	5.498	7.00	43.3773	214.7	2.301	2.284	4.444	3.204	0.923	2.064	1.141	3.471
3:52:35	227.0	0.401	77.1	5.492	7.10	43.4245	215.0	2.303	2.285	4.445	3.213	0.931	2.072	1.141	3.451
3:56:00	227.6	0.407	76.9	5.486	7.20	43.4709	215.6	2.306	2.288	4.448	3.229	0.943	2.086	1.143	3.422
3:59:26	228.6	0.413	77.1	5.480	7.30	43.5176	216.6	2.314	2.296	4.456	3.223	0.930	2.076	1.147	3.467
4:02:49	229.2	0.419	77.0	5.474	7.40	43.5646	217.2	2.318	2.300	4.460	3.230	0.933	2.081	1.148	3.462
4:06:15	229.6	0.424	77.0	5.468	7.50	43.6116	217.6	2.320	2.302	4.462	3.238	0.939	2.089	1.149	3.447
4:09:38	230.4	0.430	76.9	5.462	7.60	43.6588	218.4	2.326	2.308	4.468	3.250	0.945	2.098	1.152	3.438
4:12:56	231.2	0.436	76.7	5.457	7.70	43.7060	219.2	2.332	2.313	4.473	3.271	0.961	2.116	1.155	3.404
4:16:24	231.6	0.442	76.9	5.451	7.80	43.7535	219.6	2.334	2.315	4.475	3.257	0.946	2.102	1.156	3.444
4:19:43	232.4	0.448	76.8	5.445	7.90	43.8011	220.5	2.340	2.321	4.481	3.268	0.950	2.109	1.159	3.440
4:23:04	233.4	0.454	76.8	5.439	8.00	43.8488	221.4	2.348	2.328	4.488	3.277	0.952	2.115	1.162	3.441
4:26:21	233.6	0.460	76.7	5.433	8.10	43.8962	221.6	2.347	2.328	4.488	3.285	0.960	2.123	1.162	3.421
4:29:41	234.0	0.466	76.5	5.427	8.20	43.9441	222.1	2.350	2.330	4.490	3.301	0.974	2.137	1.163	3.389
4:33:01	235.2	0.472	76.7	5.421	8.30	43.9920	223.2	2.360	2.339	4.499	3.293	0.956	2.124	1.168	3.443
4:36:25	235.6	0.478	76.6	5.415	8.40	44.0399	223.6	2.361	2.340	4.500	3.300	0.963	2.132	1.169	3.427
4:39:54	236.2	0.484	76.6	5.409	8.50	44.0882	224.3	2.365	2.345	4.505	3.309	0.968	2.139	1.171	3.419
4:43:12	237.0	0.489	76.5	5.403	8.60	44.1363	225.0	2.371	2.350	4.510	3.321	0.974	2.148	1.173	3.409
4:46:33	237.6	0.495	76.3	5.397	8.70	44.1849	225.6	2.375	2.353	4.513	3.334	0.983	2.159	1.175	3.390
4:49:59	238.2	0.501	76.5	5.392	8.80	44.2333	226.3	2.379	2.357	4.517	3.325	0.971	2.148	1.177	3.425
4:53:23	239.1	0.507	76.4	5.386	8.90	44.2819	227.1	2.384	2.363	4.523	3.338	0.978	2.158	1.180	3.412
4:56:46	239.5	0.513	76.3	5.380	9.00	44.3312	227.5	2.386	2.364	4.524	3.346	0.985	2.166	1.180	3.397
5:00:12	240.3	0.519	76.3	5.374	9.10	44.3793	228.3	2.392	2.370	4.530	3.357	0.990	2.173	1.183	3.391
5:03:34	240.6	0.525	76.1	5.368	9.20	44.4281	228.6	2.393	2.370	4.530	3.369	1.002	2.186	1.184	3.363
5:06:51	241.3	0.531	76.3	5.362	9.30	44.4771	229.4	2.398	2.375	4.535	3.356	0.984	2.170	1.186	3.410
5:10:05	241.7	0.537	76.2	5.356	9.40	44.5258	229.7	2.399	2.376	4.536	3.364	0.991	2.178	1.186	3.394
5:13:19	242.5	0.543	76.1	5.350	9.50	44.5755	230.5	2.404	2.381	4.541	3.377	0.999	2.188	1.189	3.381
5:16:39	242.7	0.549	76.0	5.344	9.60	44.6246	230.7	2.404	2.381	4.541	3.387	1.009	2.198	1.189	3.357
5:19:53	243.5	0.554	76.1	5.338	9.70	44.6737	231.5	2.409	2.386	4.546	3.387	1.004	2.195	1.191	3.373
5:23:17	244.0	0.560	75.9	5.332	9.80	44.7233	232.1	2.413	2.389	4.549	3.401	1.015	2.208	1.193	3.349
5:26:40	244.6	0.566	75.8	5.327	9.90	44.7728	232.7	2.416	2.392	4.552	3.409	1.020	2.214	1.195	3.343
5:29:55	244.9	0.572	75.9	5.321	10.00	44.8227	233.0	2.417	2.392	4.552	3.406	1.017	2.212	1.195	3.349
5:32:59	245.5	0.578	75.8	5.315	10.10	44.8729	233.5	2.420	2.395	4.555	3.413	1.021	2.217	1.196	3.343
5:36:19	246.5	0.584	75.8	5.309	10.20	44.9228	234.5	2.427	2.402	4.562	3.425	1.026	2.226	1.200	3.339
5:39:23	246.7	0.590	75.8	5.303	10.30	44.9726	234.7	2.427	2.402	4.562	3.424	1.025	2.224	1.199	3.341
5:42:23	247.1	0.596	75.7	5.297	10.40	45.0227	235.1	2.428	2.403	4.563	3.428	1.029	2.228	1.200	3.333
5:45:39	247.8	0.602	75.7	5.291	10.50	45.0733	235.8	2.432	2.407	4.567	3.437	1.033	2.235	1.202	3.327
5:48:50	248.3	0.608	75.6	5.285	10.60	45.1235	236.4	2.436	2.410	4.570	3.441	1.034	2.238	1.203	3.327
5:52:03	248.8	0.614	75.5	5.279	10.70	45.1738	236.8	2.437	2.411	4.571	3.449	1.041	2.245	1.204	3.314
5:55:21	249.6	0.619	75.5	5.273	10.80	45.2248	237.6	2.443	2.416	4.576	3.459	1.045	2.252	1.207	3.308
5:58:36	250.1	0.625	75.5	5.267	10.90	45.2758	238.1	2.445	2.419	4.579	3.458	1.042	2.250	1.208	3.318
6:01:56	250.5	0.631	75.5	5.262	11.00	45.3264	238.5	2.447	2.420	4.580	3.463	1.046	2.254	1.209	3.311
6:05:09	251.0	0.637	75.3	5.256	11.10	45.3770	239.0	2.449	2.422	4.582	3.474	1.055	2.264	1.209	3.293
6:08:25	251.8	0.643	75.4	5.250	11.20	45.4281	239.9	2.455	2.428	4.588	3.474	1.049	2.261	1.212	3.311
6:11:48	252.4	0.649	75.4	5.244	11.30	45.4802	240.4	2.458	2.430	4.590	3.479	1.053	2.266	1.213	3.306
6:15:05	252.6	0.655	75.3	5.238	11.40	45.5310	240.6	2.458	2.430	4.590	3.488	1.062	2.275	1.213	3.285
6:18:25	253.5	0.661	75.3	5.232	11.50	45.5827	241.5	2.463	2.435	4.595	3.488	1.055	2.271	1.216	3.304
6:21:47	253.9	0.667	75.3	5.226	11.60	45.6342	241.9	2.465	2.437	4.597	3.494	1.060	2.277	1.217	3.295
6:25:10	254.3	0.673	75.1	5.220	11.70	45.6856	242.3	2.466	2.438	4.598	3.507	1.072	2.289	1.217	3.271
6:28:34	254.8	0.679	75.2	5.214	11.80	45.7371	242.9	2.469	2.440	4.600	3.500	1.063	2.281	1.219	3.293
6:31:50	255.8	0.684	75.2	5.208	11.90	45.7890	243.8	2.476	2.447	4.607	3.511	1.068	2.290	1.222	3.288

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			Final Values	
Height	5.912 (in.)	15.016 (cm)	Height	4.824 (in.)	
Diameter	2.822 (in)	7.167 (cm)	Dia. avg.	3.177 (in)	
Area	6.253 (in^2)	40.342 (cm^2)	Area avg.	7.929 (in^2)	

Tested By	KDG
Date	8-17-09
Press No.	1
Panel No.	B

Project Number	175539009
Test Number	CU-1257B
Data File ID	1257B
Lateral Pressure (psi)	30.0
Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
6:35:10	256.3	0.690	75.0	5.202	12.00	45.8413	244.3	2.478	2.449	4.609	3.528	1.082	2.305	1.223	3.260
6:38:27	256.9	0.696	75.3	5.197	12.10	45.8934	244.9	2.481	2.452	4.612	3.506	1.058	2.282	1.224	3.315
6:41:47	257.7	0.702	75.2	5.191	12.20	45.9454	245.7	2.487	2.457	4.617	3.517	1.063	2.290	1.227	3.307
6:45:06	258.1	0.708	75.2	5.185	12.30	45.9978	246.2	2.488	2.458	4.618	3.523	1.068	2.296	1.228	3.299
6:48:24	258.0	0.714	75.2	5.179	12.40	46.0502	246.1	2.485	2.454	4.614	3.518	1.066	2.292	1.226	3.299
6:51:44	259.1	0.720	75.1	5.173	12.50	46.1030	247.1	2.492	2.461	4.621	3.531	1.072	2.302	1.229	3.292
6:55:09	259.7	0.726	75.1	5.167	12.60	46.1560	247.7	2.495	2.465	4.625	3.534	1.073	2.303	1.231	3.295
6:58:37	260.2	0.732	75.1	5.161	12.70	46.2091	248.2	2.497	2.466	4.626	3.537	1.074	2.305	1.232	3.294
7:01:56	260.7	0.738	74.9	5.155	12.80	46.2623	248.8	2.500	2.469	4.629	3.550	1.084	2.317	1.233	3.275
7:05:11	261.5	0.744	75.0	5.149	12.90	46.3145	249.5	2.505	2.473	4.633	3.548	1.078	2.313	1.235	3.291
7:08:36	261.8	0.749	75.0	5.143	13.00	46.3679	249.8	2.505	2.473	4.633	3.553	1.083	2.318	1.235	3.282
7:11:59	262.4	0.755	74.8	5.137	13.10	46.4216	250.4	2.508	2.476	4.636	3.568	1.095	2.332	1.237	3.258
7:15:19	263.2	0.761	74.9	5.132	13.20	46.4747	251.2	2.514	2.482	4.642	3.565	1.086	2.326	1.239	3.281
7:18:46	263.9	0.767	74.8	5.126	13.30	46.5281	251.9	2.517	2.485	4.645	3.573	1.091	2.332	1.241	3.274
7:22:11	264.4	0.773	74.5	5.120	13.40	46.5818	252.4	2.520	2.487	4.647	3.597	1.113	2.355	1.242	3.231
7:25:34	264.5	0.779	74.8	5.114	13.50	46.6358	252.5	2.517	2.484	4.644	3.575	1.093	2.334	1.241	3.269
7:28:50	265.4	0.785	74.7	5.108	13.60	46.6898	253.4	2.524	2.490	4.650	3.588	1.101	2.344	1.244	3.260
7:32:06	266.1	0.791	74.7	5.102	13.70	46.7437	254.1	2.528	2.494	4.654	3.593	1.102	2.348	1.246	3.260
7:35:21	266.2	0.797	74.7	5.096	13.80	46.7982	254.2	2.526	2.492	4.652	3.592	1.103	2.347	1.245	3.258
7:38:30	266.4	0.803	74.6	5.090	13.90	46.8528	254.4	2.525	2.491	4.651	3.597	1.109	2.353	1.244	3.243
7:41:45	267.0	0.809	74.6	5.084	14.00	46.9067	255.0	2.528	2.494	4.654	3.599	1.108	2.353	1.245	3.249
7:45:09	267.8	0.814	74.6	5.078	14.10	46.9616	255.8	2.533	2.498	4.658	3.605	1.110	2.358	1.248	3.248
7:48:26	268.0	0.820	74.4	5.072	14.20	47.0160	256.0	2.532	2.497	4.657	3.615	1.121	2.368	1.247	3.225
7:51:40	268.9	0.826	74.6	5.067	14.30	47.0712	257.0	2.538	2.503	4.663	3.612	1.112	2.362	1.250	3.248
7:54:53	269.5	0.832	74.5	5.061	14.40	47.1259	257.5	2.541	2.506	4.666	3.620	1.117	2.368	1.251	3.240
7:58:01	269.7	0.838	74.3	5.055	14.50	47.1816	257.7	2.540	2.504	4.664	3.631	1.130	2.381	1.251	3.213
8:01:07	270.3	0.844	74.5	5.049	14.60	47.2365	258.4	2.543	2.508	4.668	3.621	1.117	2.369	1.252	3.242
8:04:20	271.0	0.850	74.4	5.043	14.70	47.2919	259.1	2.547	2.511	4.671	3.628	1.120	2.374	1.254	3.239
8:07:31	271.0	0.856	74.2	5.037	14.80	47.3474	259.1	2.544	2.508	4.668	3.640	1.135	2.388	1.253	3.206
8:10:40	272.1	0.862	74.4	5.031	14.90	47.4029	260.2	2.552	2.516	4.676	3.637	1.124	2.380	1.256	3.235
8:13:57	272.7	0.868	74.3	5.025	15.00	47.4586	260.7	2.554	2.518	4.678	3.643	1.128	2.386	1.257	3.229
8:17:16	272.9	0.874	74.1	5.019	15.10	47.5143	260.9	2.554	2.517	4.677	3.657	1.144	2.400	1.257	3.198
8:20:26	273.3	0.879	74.3	5.013	15.20	47.5702	261.4	2.555	2.518	4.678	3.644	1.130	2.387	1.257	3.225
8:23:42	274.3	0.885	74.3	5.007	15.30	47.6268	262.3	2.561	2.523	4.683	3.653	1.132	2.393	1.260	3.225
8:26:58	274.8	0.891	73.9	5.002	15.40	47.6826	262.8	2.563	2.525	4.685	3.679	1.157	2.418	1.261	3.179
8:30:13	274.8	0.897	74.2	4.996	15.50	47.7393	262.8	2.560	2.522	4.682	3.655	1.136	2.396	1.259	3.217
8:33:29	275.6	0.903	74.1	4.990	15.60	47.7959	263.6	2.564	2.526	4.686	3.665	1.142	2.404	1.261	3.208
8:36:55	275.8	0.909	74.1	4.984	15.70	47.8525	263.8	2.564	2.525	4.685	3.666	1.144	2.405	1.261	3.204
8:40:21	276.4	0.915	74.1	4.978	15.80	47.9091	264.4	2.567	2.528	4.688	3.666	1.141	2.404	1.262	3.212
8:43:45	276.8	0.921	74.0	4.972	15.90	47.9666	264.9	2.568	2.529	4.689	3.674	1.149	2.412	1.263	3.199
8:47:08	277.3	0.927	74.1	4.966	16.00	48.0234	265.3	2.569	2.530	4.690	3.672	1.145	2.408	1.263	3.207
8:50:40	277.7	0.933	74.1	4.960	16.10	48.0804	265.7	2.570	2.530	4.690	3.674	1.147	2.411	1.264	3.203
8:54:06	278.0	0.939	73.9	4.954	16.20	48.1381	266.0	2.570	2.530	4.690	3.689	1.162	2.426	1.263	3.174
8:57:19	278.7	0.944	74.0	4.948	16.30	48.1953	266.7	2.574	2.534	4.694	3.679	1.149	2.414	1.265	3.203
9:00:36	279.2	0.950	74.0	4.942	16.40	48.2528	267.2	2.575	2.535	4.695	3.685	1.154	2.420	1.266	3.195
9:04:03	279.7	0.956	73.6	4.936	16.50	48.3112	267.7	2.577	2.536	4.696	3.711	1.177	2.444	1.267	3.152
9:07:19	280.4	0.962	74.0	4.931	16.60	48.3687	268.4	2.580	2.540	4.700	3.690	1.153	2.421	1.268	3.200
9:10:43	280.8	0.968	73.9	4.925	16.70	48.4272	268.8	2.581	2.540	4.700	3.696	1.159	2.427	1.269	3.190
9:14:09	281.5	0.974	73.9	4.919	16.80	48.4847	269.5	2.585	2.544	4.704	3.698	1.158	2.428	1.270	3.195
9:17:35	281.5	0.980	73.9	4.913	16.90	48.5436	269.5	2.582	2.540	4.700	3.695	1.157	2.426	1.269	3.192
9:20:53	282.1	0.986	73.8	4.907	17.00	48.6019	270.1	2.584	2.543	4.703	3.704	1.164	2.434	1.270	3.181
9:24:19	282.6	0.992	73.9	4.901	17.10	48.6603	270.6	2.586	2.544	4.704	3.701	1.160	2.430	1.270	3.190
9:27:46	283.0	0.998	73.9	4.895	17.20	48.7190	271.1	2.587	2.545	4.705	3.702	1.160	2.431	1.271	3.191
9:31:08	283.0	1.004	73.7	4.889	17.30	48.7783	271.0	2.583	2.541	4.701	3.712	1.174	2.443	1.269	3.161
9:34:34	283.7	1.010	73.8	4.883	17.40	48.8375	271.7	2.587	2.544	4.704	3.705	1.164	2.435	1.271	3.183
9:38:03	284.7	1.015	73.8	4.877	17.50	48.8960	272.8	2.594	2.551	4.711	3.716	1.168	2.442	1.274	3.182
9:41:31	285.0	1.021	73.5	4.871	17.60	48.9557	273.0	2.593	2.550	4.710	3.734	1.187	2.460	1.273	3.146
9:44:51	285.7	1.027	73.8	4.866	17.70	49.0150	273.7	2.597	2.554	4.714	3.719	1.168	2.443	1.275	3.183
9:48:14	286.6	1.033	73.7	4.860	17.80	49.0744	274.7	2.602	2.559	4.719	3.729	1.173	2.451	1.278	3.179
9:51:27	286.9	1.039	73.5	4.854	17.90	49.1344	275.0	2.602	2.558	4.718	3.740	1.184	2.462	1.278	3.157

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values		Final Values	
Height	5.912 (in.)	15.016 (cm)	Height	4.824 (in.)
Diameter	2.822 (in)	7.167 (cm)	Dia. avg.	3.177 (in)
Area	6.253 (in^2)	40.342 (cm^2)	Area avg.	7.929 (in^2)

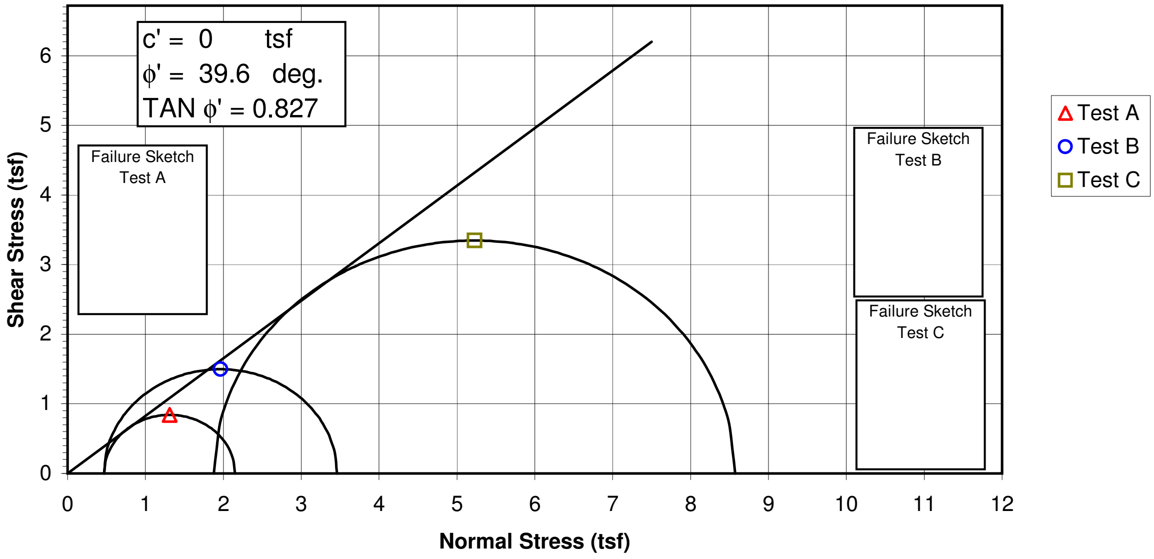
Tested By KDG
Date 8-17-09
Press No. 1
Panel No. B

Project Number 175539009
Test Number CU-1257B
Data File ID 1257B
Lateral Pressure (psi) 30.0
Chamber Pressure - σ_3 (psi) 90

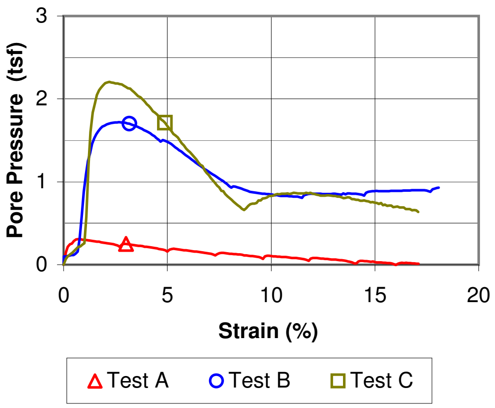
Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
9:54:47	287.0	1.045	73.7	4.848	18.00	49.1940	275.1	2.600	2.556	4.716	3.725	1.172	2.448	1.276	3.178
9:58:04	287.6	1.051	73.6	4.842	18.09	49.2541	275.7	2.603	2.558	4.718	3.735	1.179	2.457	1.278	3.167
10:01:25	288.0	1.057	73.6	4.836	18.20	49.3143	276.1	2.603	2.558	4.718	3.733	1.178	2.456	1.278	3.170
10:04:42	288.0	1.063	73.6	4.830	18.30	49.3749	276.0	2.599	2.555	4.715	3.730	1.178	2.454	1.276	3.166
10:08:01	288.5	1.069	73.5	4.824	18.40	49.4357	276.5	2.601	2.556	4.716	3.740	1.187	2.463	1.277	3.152

Failure Criterion: Maximum Effective Principal Stress Ratio

Effective Strength Envelope



Induced Pore Pressure vs. Strain



Specimen No.			A	B	C	
Initial Data	Water content %	W_o	44.8	48.0	47.6	
	Dry Density PCF	γ_{d_o}	72.2	68.2	70.9	
	Saturation %	S_o	97.5	94.0	100.2	
	Void Ratio	e_o	1.134	1.262	1.174	
After Shear	Water content %	W_f	43.0	45.7	37.1	
	Dry Density PCF	γ_{d_f}	74.8	72.4	80.4	
	Saturation %	S_f	100.0	100.0	100.0	
	Void Ratio	e_f	1.062	1.130	0.917	
	Final Back Pressure TSF	u_c	5.76	4.32	2.88	
Minor Principal Stress TSF @ failure		σ_3'f	0.47	0.47	1.88	
Maximum Deviator Stress (tsf) @ failure		$(\sigma_1'-\sigma_3')_{max}$	1.68	3.00	6.68	
Time to (σ1'-σ3')max min.		t_f	22.3	15.5	26.8	
Ultimate Deviator Stress, t/sq ft		$(\sigma 1'-\sigma 3')_{ult}$	n/a	n/a	n/a	
Initial Diameter, in.		D_o	2.845	2.840	2.895	
Initial Height, in.		H_o	6.123	5.937	5.851	

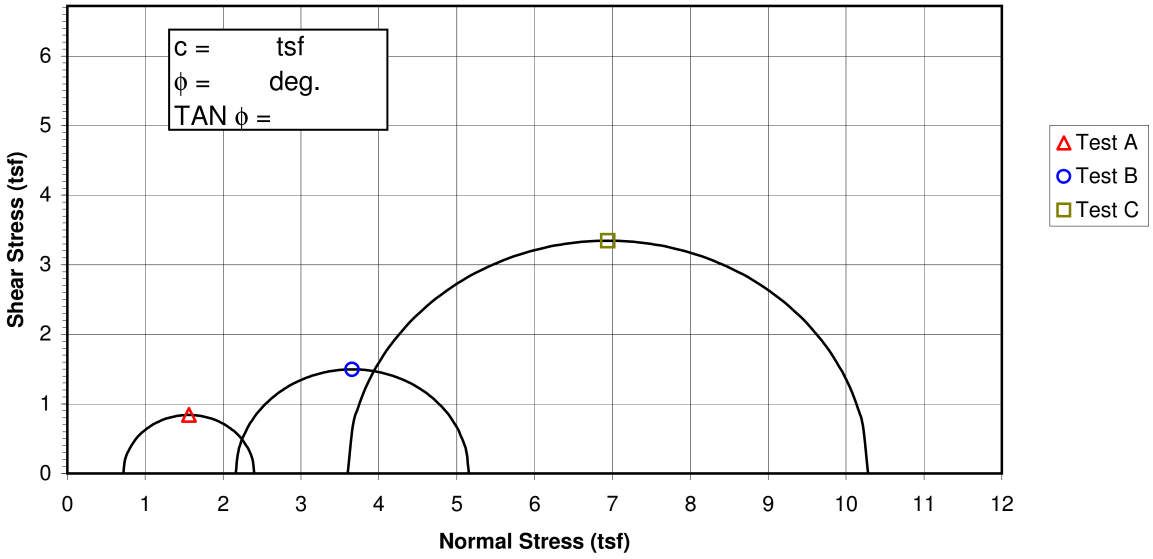
Controlled - Strain Test

Description of Specimens Silt (ML), gray brown, moist, firm, fly ash

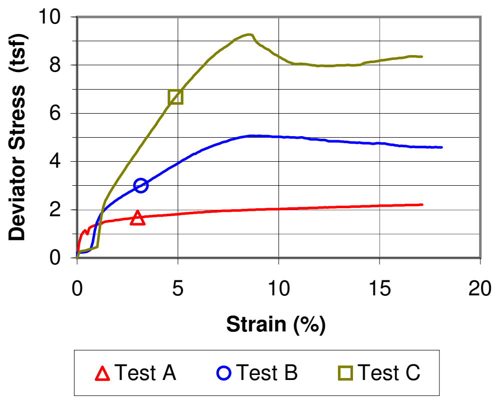
				Type of Specimen Undisturbed	Type of test $\overline{R}$
LL	PL	PI	Gs 2.47	Project	Cumberland Dry Ash Stack and Gypsum Disposal Area
Remarks:					
				Boring No. B-43A & B-35A	Sample No. 1278
				Depth Elev. 29.0'-29.5', 29.5'-30.0', 46.0'-46.5'	
				Laboratory Stantec	Date 8-24-09
				TRIAXIAL COMPRESSION TEST REPORT	

Failure Criterion: Maximum Effective Principal Stress Ratio

Total Strength Envelope



Deviator Stress vs. Strain



Specimen No.			A	B	C	
Initial Data	Water content %	W_o	44.8	48.0	47.6	
	Dry Density PCF	γ_{d_o}	72.2	68.2	70.9	
	Saturation %	S_o	97.5	94.0	100.2	
	Void Ratio	e_o	1.134	1.262	1.174	
After Shear	Water content %	W_f	43.0	45.7	37.1	
	Dry Density PCF	γ_{d_f}	74.8	72.4	80.4	
	Saturation %	S_f	100.0	100.0	100.0	
	Void Ratio	e_f	1.062	1.130	0.917	
	Final Back Pressure TSF	u_c	5.76	4.32	2.88	
Minor Principal Stress TSF		σ_3	0.72	2.16	3.60	
Maximum Deviator Stress (tsf) @ failure		$(\sigma_1\text{-}\sigma_3)_{max}$	1.68	3.00	6.68	
Time to $(\sigma_1\text{-}\sigma_3)_{Max.}$ min.		t_f	22.3	15.5	26.8	
Ultimate Deviator Stress, t/sq ft		$(\sigma_1\text{-}\sigma_3)_{ult}$	n/a	n/a	n/a	
Initial Diameter, in.		D_o	2.845	2.840	2.895	
Initial Height, in.		H_o	6.123	5.937	5.851	

Controlled - Strain Test

Description of Specimens Silt (ML), gray brown, moist, firm, fly ash

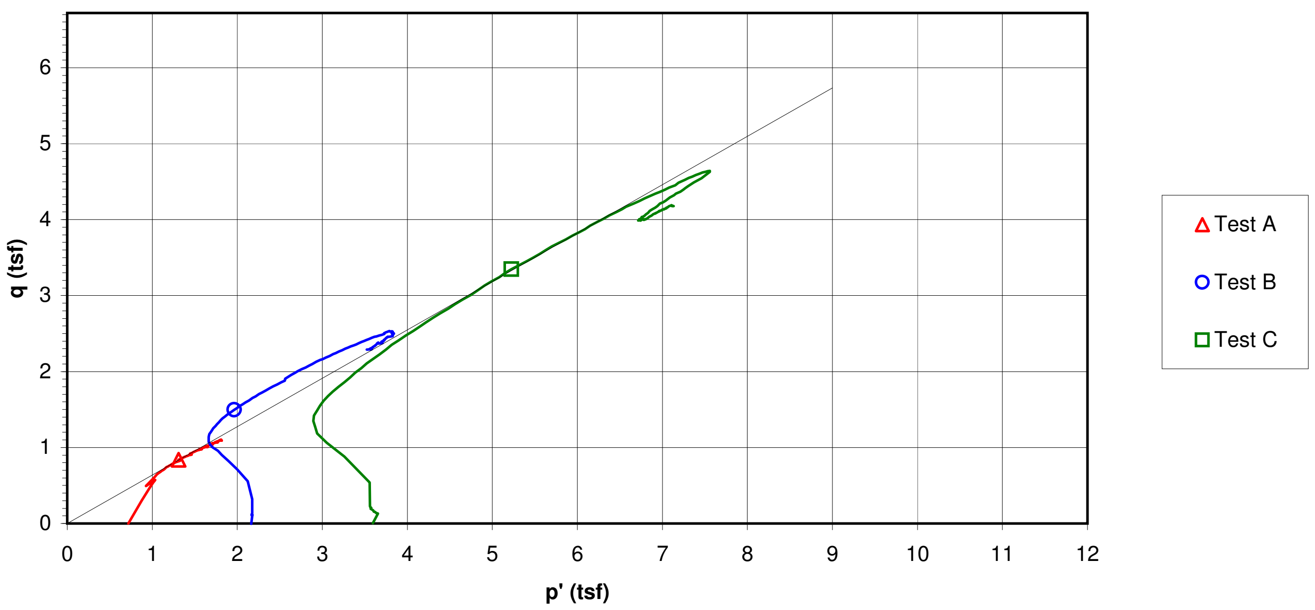
				Type of Specimen Undisturbed		Type of test $\bar{R}$
LL	PL	PI	Gs 2.47	Project	Cumberland Dry Ash Stack and Gypsum Disposal Area	
Remarks:						
				Boring No.	B-43A & B-35A	Sample No. 1278
				Depth Elev.	29.0'-29.5', 29.5'-30.0', 46.0'-46.5'	
				Laboratory	Stantec	Date 8-24-09

TRIAXIAL COMPRESSION TEST REPORT

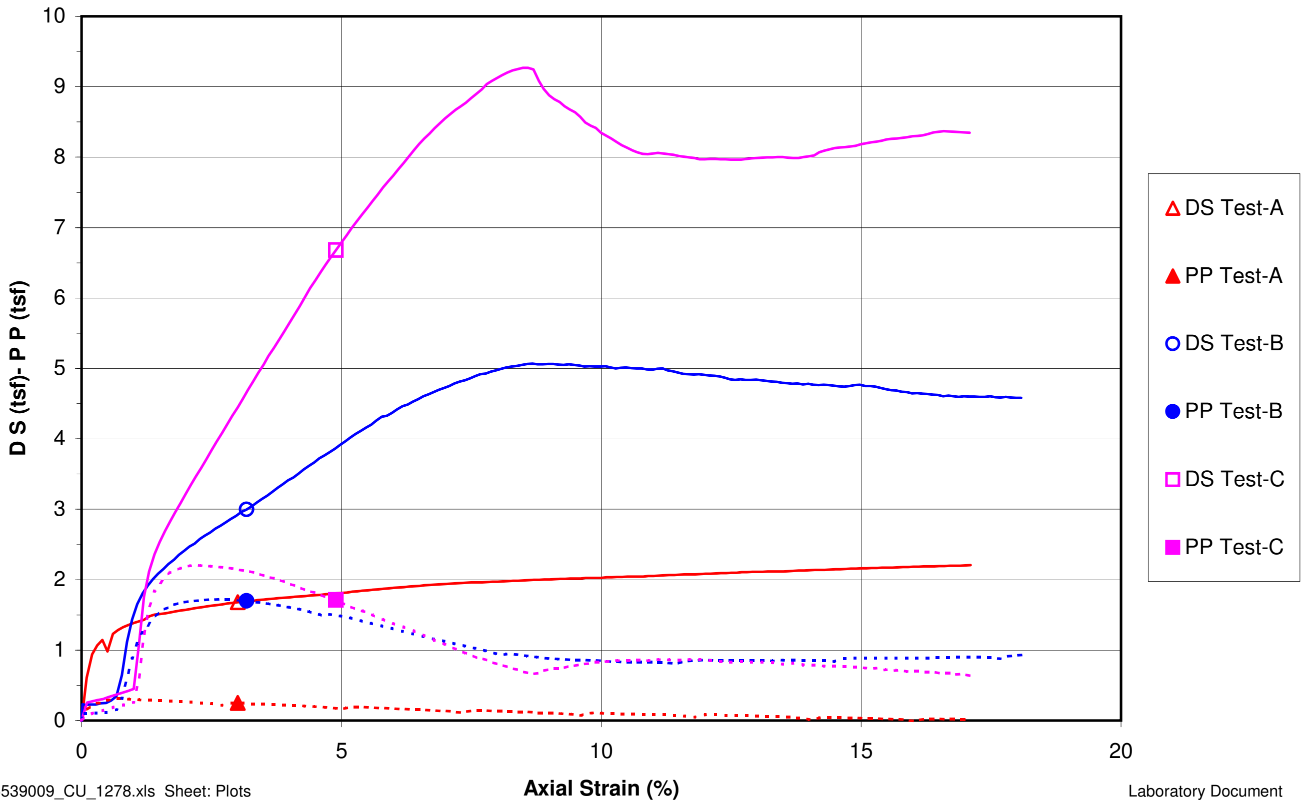
Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Project Cumberland Dry Ash Stack and Gypsum Disposal Area
Project No. 175539009
Sample ID B-43A, 29.0'-29.5' & B-43A, 29.5'-30.0' & B-35A, 46.0'-46.5'
Test Number 1278
Failure Criterion: Maximum Effective Principal Stress Ratio
ϕ' = 39.6 deg.
c' = 0.00 tsf

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain



File: 175539009_CU_1278.xls Sheet: Plots
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

Consolidated Undrained Triaxial Test
ASTM D4767-04

Project Name	Cumberland Dry Ash Stack and Gypsum Disposal Area	Project Number	175539009
Sample Identification	B-43A, 29.0'-29.5'	Test Number	CU-1278A
Visual Description	Silt (ML), gray brown, moist, firm, fly ash	Prepared By	RC
Undisturbed	Source B-43A, 29.0'-31.0'	Date	7-18-2009

Specific Gravity 2.47 ASTM D854 Method A   Liquid Limit N/A   Plastic Limit N/A   Plasticity Index N/A

Initial Specimen Data

Specimen Diameter (in.)		Specimen Height (in.)		Volumes (in^3)		Specimen	
Top	2.834	1	6.119	Sample	38.8860 (V_o)	Wet Weight (g)	1068.41
Middle	2.847	2	6.130	Solids	18.2276 (VS_o)	Dry Weight (g)	737.83
Bottom	2.850	3	6.123	Water	20.1722 (Vw_o)	Wet Unit Weight (pcf)	104.7
Avg.	2.8437 (D_o)	4	6.119	Voids	20.6584 (Vv_o)	Dry Unit Weight (pcf)	72.3
Area (in^2)	6.3511 (A_o)	Avg. (H_o)	6.1228	Degree of Saturation (%)	97.6 (S_o)		
Moisture Content (%)	44.8	Final Trimmings		Void Ratio	1.133		

Saturation

Set Up & Saturated: Wet xx Dry ____   Set up By KDG

Back Pressure Saturated to: 80 (psi)   Final Pore Pressure Parameter B 0.96   Date 8-13-09

Panel Board Number F

Height Readings (in.)		Back Pressure Burette		Chamber Burette			
Initial	0.1274	Initial	16.67 (in.)	Initial	10.75 (in.)	Specimen Height (in.)	6.1289 (H_s)
Final	0.1213	Final	13.39 (in.)	Final	6.34 (in.)	Area (in^2) Method A	6.3637 (A_s)
Change	0.0061 (ΔH_o)	Change	-3.28 (in.)	Change	-4.41 (in.)	Specimen Volume (in^3)	39.00 (Vs)

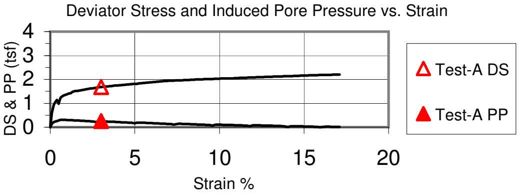
Consolidation

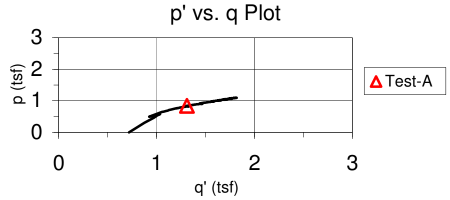
Height Readings (in.)		Back Pressure Burette Readings		Chamber Burette Readings		Pressures (psi)	
Initial	0.1213	Initial	1.23 (in.)	Initial	17.72 (in.)	Chamber	90
Final	0.1304	Final	3.35 (in.)	Final	15.66 (in.)	Back	80
Change	-0.0091 (ΔH_c)	Change	-2.12 (in.)	Change	-2.06 (in.)	Lateral	10 (σ_3)
Height (in.)	6.1198 (H_c)			Volume (in^3)	37.5925 (V_c)		
Area (in^3) Method B	6.1428 (A_c)			Volume - Water (in^3)	19.3649 (VWc)	t_{50} (min.)	0.089
Diameter (in.)	2.7967 (D_c)			Water Content (%)	43.0		
Dry Density (pcf)	74.8			Degree of Saturation (%)	100.0 (S_c)	Void Ratio	1.062

After Test

Final Measurements		Final Moisture Content		Stresses (membrane corrected) at Failure (psi)	
Maximum Diameter	3.382 (in.)	Wet Weight (g)	1055.18	Corrected Deviator	1.68 σ_d (tsf)
Wet weight (g)	1055.18 (WWf)	Dry Weight (g)	737.83	Major Principal	2.15 $\sigma_1'_f$ (tsf)
Corrected Diameter	3.358 (in.)	Tare Weight (g)	0.00	Minor Principal	0.47 $\sigma_3'_f$ (tsf)
				Rate of Strain (% / min.)	0.140
Youngs Modulus for Membrane (psi)	200			Axial Strain at Failure (%)	3.01
Membrane Thickness (in.)	0.012			Failure Criterion:	Maximum Effective Principal Stress Ratio

Failure Sketch





Comments: One + 1 1/2" rock found in specimen after testing.

Stantec

Consolidated Undrained Triaxial Test

ASTM D4767-04

Project Name	Cumberland Dry Ash Stack and Gypsum Disposal Area	Project Number	175539009
Sample Identification	B-43A, 29.5'-30.0'	Test Number	CU-1278B
Visual Description	Silt (ML), gray brown, moist, firm, fly ash	Prepared By	RC
Undisturbed	Source B-43A, 29.0'-31.0'	Date	7-28-2009

Specific Gravity 2.47 ASTM D854 Method A Liquid Limit N/A Plastic Limit N/A Plasticity Index N/A

Initial Specimen Data

Specimen Diameter (in.)		Specimen Height (in.)		Volumes (in3)		Specimen	
Top	2.851	1	5.942	Sample	37.7256 (V_o)	Wet Weight (g)	996.10
Middle	2.827	2	5.921	Solids	16.6250 (VS_o)	Dry Weight (g)	672.96
Bottom	2.855	3	5.944	Water	19.7182 (Vw_o)	Wet Unit Weight (pcf)	100.6
Avg.	2.8443 (D_o)	4	5.942	Voids	21.1006 (Vv_o)	Dry Unit Weight (pcf)	68.0
Area (in^2)	6.3541 (A_o)	Avg. (H_o)	5.9373	Degree of Saturation (%)	93.4 (S_o)		
Moisture Content (%)	48.0	Final Trimmings		Void Ratio	1.269		

Saturation

Set Up & Saturated: Wet xx Dry

Back Pressure Saturated to: 60 (psi) Final Pore Pressure Parameter B 0.98

Set up By KDG

Date 8-14-09

Panel Board Number A

Height Readings (in.)		Back Pressure Burette		Chamber Burette			
Initial	0.1217	Initial	16.56 (in.)	Initial	11.25 (in.)	Specimen Height (in.)	5.9382 (H_s)
Final	0.1208	Final	11.36 (in.)	Final	7.95 (in.)	Area (in^2) Method A	6.3560 (A_s)
Change	0.0009 (ΔH_o)	Change	-5.20 (in.)	Change	-3.30 (in.)	Specimen Volume (in^3)	37.74 (V_s)

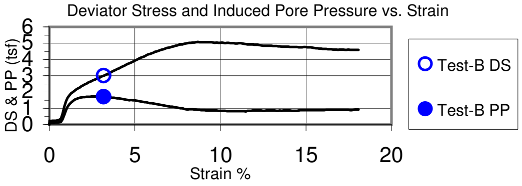
Consolidation

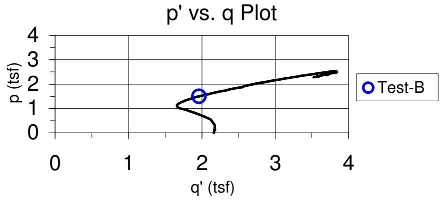
Height Readings (in.)		Back Pressure Burette Readings		Chamber Burette Readings		Pressures (psi)	
Initial	0.1208	Initial	1.23 (in.)	Initial	16.13 (in.)	Chamber	90
Final	0.1212	Final	5.04 (in.)	Final	11.69 (in.)	Back	60
Change	-0.0004 (ΔH_c)	Change	-3.81 (in.)	Change	-4.44 (in.)	Lateral	30 (σ_3)
Height (in.)	5.9378 (H_c)			Volume (in^3)	35.4102 (V_c)		
Area (in^3) Method B	5.9636 (A_c)			Volume - Water (in^3)	18.7852 (VWc)	D_{50} (min.)	0.063
Diameter (in.)	2.7556 (D_c)			Water Content (%)	45.7		
Dry Density (pcf)	72.4			Degree of Saturation (%)	100.0 (S_c)	Void Ratio	1.130

After Test

Final Measurements		Final Moisture Content		Stresses (membrane corrected) at Failure (psi)	
Maximum Diameter	3.204 (in.)	Wet Weight (g)	980.81	Corrected Deviator	3.00 σ_d (tsf)
Wet weight (g)	980.81 (WWf)	Dry Weight (g)	672.96	Major Principal	3.46 $\sigma_1'_f$ (tsf)
Corrected Diameter	3.180 (in.)	Tare Weight (g)	0.00	Minor Principal	0.47 $\sigma_3'_f$ (tsf)
				Rate of Strain (% / min.)	0.221
Youngs Modulus for Membrane (psi)	200			Axial Strain at Failure (%)	3.17
Membrane Thickness (in.)	0.012			Failure Criterion:	Maximum Effective Principal Stress Ratio

Failure Sketch





Comments:

File: 175539009_CU_1278.xls Sheet: Specimen-B
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

Consolidated Undrained Triaxial Test

ASTM D4767-04

Project Name	Cumberland Dry Ash Stack and Gypsum Disposal Area	Project Number	175539009
Sample Identification	B-35A, 46.0'-46.5'	Test Number	CU-1278C
Visual Description	Silt (ML), gray brown, moist, firm, fly ash	Prepared By	RC
Undisturbed	Source B-35A, 46.0'-48.0'	Date	7-28-2009

Specific Gravity	2.47	ASTM D854 Method A	Liquid Limit	N/A	Plastic Limit	N/A	Plasticity Index	N/A

Initial Specimen Data

Specimen Diameter (in.)		Specimen Height (in.)		Volumes (in^3)		Specimen	
Top	2.883	1	5.851	Sample	38.4607 (V_o)	Wet Weight (g)	1058.02
Middle	2.899	2	5.865	Solids	17.7080 (VS_o)	Dry Weight (g)	716.80
Bottom	2.897	3	5.837	Water	20.8215 (Vw_o)	Wet Unit Weight (pcf)	104.8
Avg.	2.8930 (D_o)	4	5.851	Voids	20.7526 (Vv_o)	Dry Unit Weight (pcf)	71.0
Area (in^2)	6.5733 (A_o)	Avg. (H_o)	5.8510	Degree of Saturation (%)	100.3 (S_o)		
Moisture Content (%)	47.6	Final Trimmings		Void Ratio	1.172		

Saturation

Set Up & Saturated:	Wet xx	Dry		Set up By	KDG
Back Pressure Saturated to:	40 (psi)	Final Pore Pressure Parameter B	0.97	Date	8-13-09
				Panel Board Number	E

Height Readings (in.)		Back Pressure Burette		Chamber Burette			
Initial	0.1191	Initial	17.15 (in.)	Initial	9.54 (in.)	Specimen Height (in.)	5.8422 (H_s)
Final	0.1279	Final	14.75 (in.)	Final	7.08 (in.)	Area (in^2) Method A	6.5535 (A_s)
Change	-0.0088 (ΔH_o)	Change	-2.40 (in.)	Change	-2.46 (in.)	Specimen Volume (in^3)	38.29 (V_s)

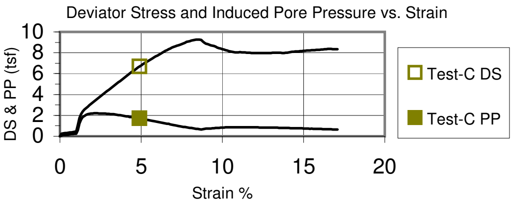
Consolidation

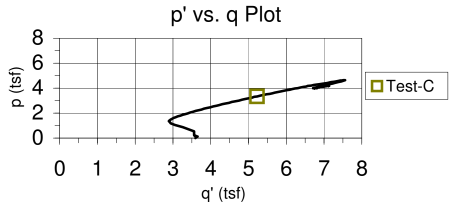
Height Readings (in.)		Back Pressure Burette Readings		Chamber Burette Readings		Pressures (psi)	
Initial	0.1279	Initial	1.36 (in.)	Initial	16.86 (in.)	Chamber	90
Final	0.1242	Final	7.46 (in.)	Final	10.83 (in.)	Back	40
Change	0.0037 (ΔH_c)	Change	-6.10 (in.)	Change	-6.03 (in.)	Lateral	50 (σ_3)
Height (in.)	5.8459 (H_c)			Volume (in^3)	33.9506 (V_c)		
Area (in^3) Method B	5.8076 (A_c)			Volume - Water (in^3)	16.2426 (VWc)	D_{50} (min.)	0.206
Diameter (in.)	2.7193 (D_c)			Water Content (%)	37.1		
Dry Density (pcf)	80.4			Degree of Saturation (%)	100.0 (S_c)	Void Ratio	0.917

After Test

Final Measurements		Final Moisture Content		Stresses (membrane corrected) at Failure (psi)	
Maximum Diameter	3.109 (in.)	Wet Weight (g)	982.98	Corrected Deviator	6.68 σ_d (tsf)
Wet weight (g)	982.98 (WWf)	Dry Weight (g)	716.80	Major Principal	8.57 $\sigma_1'_f$ (tsf)
Corrected Diameter	3.085 (in.)	Tare Weight (g)	0.00	Minor Principal	1.88 $\sigma_3'_f$ (tsf)
				Rate of Strain (% / min.)	0.186
Youngs Modulus for Membrane (psi)	200			Axial Strain at Failure (%)	4.90
Membrane Thickness (in.)	0.012			Failure Criterion:	Maximum Effective Principal Stress Ratio

Failure Sketch





Comments:

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			Final Values	
Height	6.120 (in.)	15.544 (cm)	Height	5.073 (in.)	
Diameter	2.797 (in)	7.104 (cm)	Dia. avg.	3.239 (in)	
Area	6.143 (in^2)	39.633 (cm^2)	Area avg.	8.237 (in^2)	

Tested By	KDG
Date	8-19-09
Press No.	2
Panel No.	F

Project Number	175539009
Test Number	CU-1278A
Data File ID	CU-1278A
Lateral Pressure (psi)	10.0
Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
0:00:00	8.9	-0.003	80.0	6.120	0.00	39.6334	0.0	0.000	0.000	0.720	0.720	0.719	0.719	0.001	1.002
0:00:59	60.9	0.003	82.1	6.114	0.10	39.6737	52.0	0.610	0.610	1.330	1.181	0.571	0.876	0.305	2.071
0:01:50	89.1	0.010	83.0	6.107	0.20	39.7144	80.3	0.940	0.939	1.659	1.443	0.503	0.973	0.470	2.871
0:02:39	100.0	0.016	83.4	6.101	0.30	39.7534	91.2	1.067	1.066	1.786	1.541	0.473	1.007	0.534	3.255
0:03:25	106.9	0.022	83.6	6.095	0.40	39.7932	98.0	1.145	1.144	1.864	1.609	0.463	1.036	0.573	3.474
0:04:09	93.1	0.028	84.0	6.089	0.50	39.8328	84.3	0.984	0.982	1.702	1.417	0.433	0.925	0.492	3.270
0:04:58	114.6	0.034	84.3	6.083	0.60	39.8729	105.7	1.233	1.231	1.951	1.646	0.413	1.030	0.616	3.982
0:05:47	119.5	0.040	84.3	6.077	0.70	39.9147	110.6	1.289	1.287	2.007	1.699	0.410	1.054	0.644	4.142
0:06:28	123.0	0.046	84.3	6.071	0.80	39.9538	114.1	1.328	1.326	2.046	1.737	0.410	1.074	0.664	4.237
0:07:14	125.9	0.052	84.2	6.065	0.90	39.9944	117.0	1.361	1.359	2.079	1.777	0.417	1.097	0.680	4.264
0:07:58	128.4	0.059	84.2	6.058	1.00	40.0354	119.6	1.389	1.386	2.106	1.807	0.419	1.113	0.694	4.309
0:08:40	130.4	0.064	84.1	6.052	1.10	40.0745	121.5	1.410	1.407	2.127	1.832	0.423	1.128	0.704	4.327
0:09:24	132.4	0.071	84.1	6.046	1.20	40.1160	123.5	1.432	1.429	2.149	1.858	0.427	1.142	0.715	4.347
0:10:08	136.9	0.077	84.1	6.040	1.31	40.1579	128.0	1.482	1.479	2.199	1.909	0.428	1.168	0.740	4.456
0:10:49	138.9	0.083	84.0	6.034	1.40	40.1963	130.1	1.505	1.501	2.221	1.935	0.433	1.184	0.751	4.474
0:11:33	140.2	0.089	83.9	6.028	1.50	40.2388	131.4	1.518	1.515	2.235	1.954	0.438	1.196	0.758	4.464
0:12:17	141.1	0.095	83.9	6.021	1.61	40.2805	132.3	1.527	1.523	2.243	1.967	0.442	1.205	0.762	4.447
0:12:58	142.3	0.101	83.9	6.015	1.70	40.3206	133.4	1.539	1.535	2.255	1.978	0.442	1.210	0.768	4.474
0:13:42	143.6	0.107	83.8	6.010	1.80	40.3601	134.7	1.552	1.548	2.268	1.996	0.447	1.222	0.775	4.464
0:14:27	145.1	0.114	83.7	6.003	1.90	40.4025	136.2	1.568	1.563	2.283	2.016	0.451	1.233	0.782	4.467
0:15:08	145.9	0.120	83.7	5.997	2.00	40.4438	137.1	1.576	1.571	2.291	2.028	0.456	1.242	0.786	4.450
0:15:52	147.4	0.126	83.6	5.991	2.10	40.4853	138.5	1.591	1.586	2.306	2.046	0.459	1.253	0.794	4.457
0:16:33	148.5	0.132	83.6	5.985	2.20	40.5263	139.6	1.602	1.596	2.316	2.060	0.463	1.261	0.799	4.454
0:17:17	149.6	0.138	83.5	5.979	2.31	40.5689	140.8	1.614	1.608	2.328	2.078	0.469	1.274	0.805	4.431
0:18:01	151.0	0.145	83.4	5.972	2.41	40.6125	142.1	1.627	1.621	2.341	2.095	0.473	1.284	0.811	4.432
0:18:43	151.8	0.150	83.4	5.967	2.50	40.6507	142.9	1.635	1.629	2.349	2.109	0.479	1.294	0.815	4.406
0:19:24	152.7	0.156	83.2	5.961	2.60	40.6923	143.9	1.644	1.638	2.358	2.126	0.487	1.306	0.819	4.368
0:20:08	153.9	0.163	83.0	5.954	2.71	40.7358	145.0	1.655	1.649	2.369	2.154	0.504	1.329	0.825	4.273
0:20:49	155.2	0.168	83.4	5.948	2.80	40.7753	146.4	1.669	1.662	2.382	2.138	0.474	1.306	0.832	4.510
0:21:36	156.2	0.175	83.5	5.942	2.91	40.8205	147.4	1.679	1.671	2.391	2.141	0.469	1.305	0.836	4.570
0:22:17	157.1	0.181	83.5	5.936	3.01	40.8623	148.3	1.687	1.680	2.400	2.151	0.469	1.310	0.841	4.582
0:22:59	157.8	0.187	83.4	5.930	3.10	40.9034	149.0	1.694	1.686	2.406	2.160	0.473	1.316	0.844	4.570
0:23:40	158.8	0.193	83.4	5.924	3.20	40.9443	149.9	1.703	1.695	2.415	2.173	0.476	1.324	0.848	4.563
0:24:24	159.5	0.199	83.3	5.917	3.31	40.9883	150.6	1.709	1.701	2.421	2.183	0.481	1.332	0.851	4.540
0:25:06	160.6	0.205	83.3	5.912	3.40	41.0291	151.7	1.719	1.711	2.431	2.196	0.484	1.340	0.856	4.539
0:25:49	161.2	0.212	83.2	5.905	3.51	41.0737	152.3	1.725	1.716	2.436	2.204	0.486	1.345	0.859	4.531
0:26:33	162.1	0.218	83.2	5.899	3.61	41.1177	153.2	1.733	1.724	2.444	2.215	0.490	1.353	0.862	4.517
0:27:12	162.7	0.224	83.2	5.893	3.70	41.1564	153.9	1.739	1.730	2.450	2.224	0.493	1.358	0.865	4.512
0:27:56	163.7	0.230	83.1	5.887	3.80	41.1998	154.9	1.748	1.738	2.458	2.237	0.497	1.367	0.870	4.501
0:28:38	164.4	0.236	83.0	5.881	3.90	41.2425	155.6	1.754	1.744	2.464	2.247	0.501	1.374	0.873	4.485
0:29:19	165.1	0.242	83.0	5.875	4.00	41.2852	156.2	1.759	1.750	2.470	2.254	0.503	1.379	0.875	4.478
0:30:01	165.9	0.248	83.0	5.869	4.10	41.3282	157.0	1.767	1.756	2.476	2.265	0.507	1.386	0.879	4.465
0:30:45	166.5	0.254	82.9	5.863	4.20	41.3723	157.7	1.772	1.762	2.482	2.275	0.511	1.393	0.882	4.447
0:31:26	167.1	0.260	82.8	5.857	4.30	41.4146	158.3	1.777	1.767	2.487	2.284	0.516	1.400	0.884	4.430
0:32:08	168.0	0.266	82.8	5.850	4.40	41.4586	159.2	1.785	1.774	2.494	2.295	0.519	1.407	0.888	4.419
0:32:50	168.7	0.272	82.7	5.844	4.50	41.5011	159.8	1.791	1.779	2.499	2.305	0.524	1.414	0.890	4.399
0:33:33	169.5	0.279	82.7	5.838	4.60	41.5458	160.6	1.798	1.786	2.506	2.316	0.528	1.422	0.894	4.385
0:34:15	170.2	0.285	82.6	5.832	4.70	41.5894	161.4	1.804	1.792	2.512	2.326	0.532	1.429	0.897	4.369
0:34:57	171.1	0.291	82.5	5.826	4.80	41.6321	162.3	1.812	1.800	2.520	2.339	0.537	1.438	0.901	4.353
0:35:41	171.8	0.297	82.4	5.820	4.91	41.6779	163.0	1.818	1.806	2.526	2.352	0.545	1.449	0.904	4.318
0:36:22	172.6	0.303	82.2	5.814	5.00	41.7197	163.7	1.825	1.812	2.532	2.373	0.559	1.466	0.907	4.245
0:37:04	173.2	0.309	82.5	5.807	5.10	41.7646	164.3	1.830	1.817	2.537	2.355	0.537	1.446	0.909	4.389
0:37:50	174.4	0.316	82.7	5.801	5.21	41.8108	165.6	1.841	1.829	2.549	2.358	0.528	1.443	0.915	4.467
0:38:32	175.1	0.322	82.7	5.795	5.31	41.8538	166.3	1.847	1.834	2.554	2.363	0.527	1.445	0.918	4.481
0:39:13	176.0	0.328	82.7	5.789	5.40	41.8959	167.2	1.856	1.842	2.562	2.372	0.528	1.450	0.922	4.492
0:39:57	176.7	0.334	82.6	5.783	5.50	41.9421	167.9	1.861	1.847	2.567	2.382	0.533	1.457	0.924	4.470
0:40:41	177.6	0.340	82.5	5.777	5.61	41.9872	168.8	1.869	1.855	2.575	2.393	0.537	1.465	0.928	4.460
0:41:22	178.3	0.346	82.5	5.771	5.70	42.0302	169.5	1.875	1.861	2.581	2.402	0.540	1.471	0.931	4.448
0:42:06	179.3	0.352	82.4	5.765	5.80	42.0756	170.4	1.883	1.869	2.589	2.414	0.544	1.479	0.935	4.441
0:42:48	180.1	0.358	82.4	5.759	5.90	42.1192	171.2	1.890	1.876	2.596	2.423	0.546	1.485	0.938	4.436

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			Final Values	
Height	6.120 (in.)	15.544 (cm)	Height	5.073 (in.)	
Diameter	2.797 (in)	7.104 (cm)	Dia. avg.	3.239 (in)	
Area	6.143 (in^2)	39.633 (cm^2)	Area avg.	8.237 (in^2)	

Tested By: KDG
Date: 8-19-09
Press No.: 2
Panel No.: F

Project Number: 175539009
Test Number: CU-1278A
Data File ID: CU-1278A
Lateral Pressure (psi): 10.0
Chamber Pressure - σ_3 (psi): 90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
0:43:32	181.0	0.365	82.4	5.752	6.01	42.1655	172.2	1.899	1.884	2.604	2.435	0.550	1.492	0.943	4.429
0:44:13	181.7	0.371	82.3	5.746	6.10	42.2098	172.8	1.904	1.889	2.609	2.443	0.553	1.498	0.945	4.419
0:44:55	182.3	0.377	82.3	5.740	6.20	42.2533	173.5	1.909	1.894	2.614	2.450	0.555	1.502	0.947	4.415
0:45:39	183.4	0.383	82.2	5.734	6.30	42.3001	174.6	1.919	1.903	2.623	2.463	0.559	1.511	0.952	4.409
0:46:20	184.2	0.389	82.2	5.728	6.40	42.3447	175.3	1.925	1.909	2.629	2.473	0.562	1.517	0.955	4.400
0:47:04	184.7	0.395	82.1	5.722	6.51	42.3914	175.9	1.929	1.913	2.633	2.480	0.565	1.522	0.957	4.387
0:47:45	185.6	0.401	82.1	5.716	6.60	42.4358	176.7	1.937	1.920	2.640	2.490	0.569	1.530	0.961	4.379
0:48:29	186.4	0.407	82.0	5.709	6.70	42.4818	177.5	1.943	1.927	2.647	2.501	0.572	1.537	0.964	4.368
0:49:11	187.0	0.413	82.0	5.703	6.80	42.5261	178.2	1.948	1.931	2.651	2.509	0.576	1.543	0.966	4.353
0:49:55	187.5	0.420	81.9	5.697	6.91	42.5731	178.6	1.951	1.934	2.654	2.516	0.581	1.549	0.968	4.332
0:50:36	188.2	0.426	81.9	5.691	7.01	42.6189	179.4	1.957	1.940	2.660	2.525	0.584	1.554	0.971	4.325
0:51:18	188.8	0.432	81.8	5.685	7.10	42.6639	179.9	1.961	1.944	2.664	2.534	0.589	1.562	0.972	4.301
0:51:59	189.4	0.438	81.7	5.679	7.20	42.7090	180.6	1.966	1.948	2.668	2.544	0.594	1.569	0.975	4.282
0:52:43	190.1	0.444	81.6	5.673	7.31	42.7573	181.2	1.971	1.953	2.673	2.562	0.608	1.585	0.977	4.217
0:53:24	190.6	0.450	81.8	5.667	7.40	42.8029	181.8	1.975	1.956	2.676	2.551	0.593	1.572	0.979	4.300
0:54:07	191.2	0.456	81.9	5.661	7.50	42.8489	182.3	1.979	1.960	2.680	2.542	0.581	1.562	0.981	4.378
0:54:48	191.4	0.462	82.0	5.654	7.60	42.8949	182.5	1.978	1.960	2.680	2.538	0.577	1.557	0.980	4.399
0:55:30	191.8	0.468	82.0	5.648	7.70	42.9408	182.9	1.981	1.962	2.682	2.540	0.577	1.558	0.982	4.404
0:56:11	192.3	0.474	81.9	5.642	7.80	42.9866	183.4	1.984	1.965	2.685	2.546	0.580	1.563	0.983	4.390
0:56:55	193.0	0.481	81.9	5.636	7.90	43.0353	184.2	1.990	1.971	2.691	2.556	0.584	1.570	0.986	4.377
0:57:36	193.4	0.487	81.9	5.630	8.00	43.0811	184.6	1.992	1.973	2.693	2.560	0.586	1.573	0.987	4.370
0:58:18	193.8	0.493	81.8	5.624	8.10	43.1279	184.9	1.994	1.974	2.694	2.564	0.588	1.576	0.988	4.357
0:59:02	194.4	0.499	81.8	5.618	8.21	43.1766	185.6	1.998	1.978	2.698	2.570	0.590	1.580	0.990	4.354
0:59:43	195.1	0.505	81.8	5.612	8.30	43.2224	186.2	2.003	1.983	2.703	2.576	0.592	1.584	0.992	4.352
1:00:25	195.4	0.511	81.7	5.606	8.40	43.2683	186.6	2.005	1.984	2.704	2.580	0.594	1.587	0.993	4.343
1:01:09	196.3	0.517	81.7	5.599	8.50	43.3171	187.4	2.012	1.991	2.711	2.589	0.596	1.592	0.996	4.341
1:01:50	196.9	0.523	81.7	5.593	8.60	43.3629	188.0	2.016	1.995	2.715	2.594	0.598	1.596	0.998	4.338
1:02:34	197.3	0.530	81.6	5.587	8.70	43.4119	188.4	2.018	1.997	2.717	2.603	0.605	1.604	0.999	4.300
1:03:18	197.6	0.536	81.5	5.581	8.81	43.4602	188.8	2.020	1.998	2.718	2.608	0.608	1.608	1.000	4.286
1:03:59	198.3	0.542	81.5	5.575	8.90	43.5067	189.5	2.025	2.003	2.723	2.615	0.611	1.613	1.002	4.283
1:04:43	198.7	0.548	81.5	5.569	9.00	43.5553	189.9	2.027	2.005	2.725	2.619	0.613	1.616	1.003	4.274
1:05:25	199.2	0.554	81.4	5.563	9.10	43.6017	190.4	2.030	2.008	2.728	2.625	0.616	1.620	1.005	4.263
1:06:08	199.8	0.560	81.4	5.557	9.20	43.6509	190.9	2.034	2.011	2.731	2.632	0.620	1.626	1.006	4.248
1:06:52	200.1	0.566	81.3	5.550	9.30	43.6996	191.3	2.035	2.012	2.732	2.638	0.624	1.631	1.007	4.227
1:07:34	200.7	0.572	81.3	5.544	9.40	43.7457	191.8	2.039	2.016	2.736	2.645	0.628	1.636	1.009	4.215
1:08:18	200.9	0.579	81.2	5.538	9.50	43.7949	192.1	2.040	2.016	2.736	2.651	0.634	1.642	1.009	4.183
1:09:02	201.2	0.585	81.0	5.532	9.60	43.8443	192.3	2.040	2.016	2.736	2.666	0.648	1.657	1.009	4.111
1:09:43	202.1	0.591	81.4	5.526	9.70	43.8913	193.3	2.048	2.024	2.744	2.643	0.618	1.631	1.013	4.276
1:10:27	202.5	0.597	81.5	5.520	9.80	43.9412	193.6	2.049	2.025	2.745	2.639	0.612	1.625	1.013	4.309
1:11:11	202.9	0.603	81.5	5.514	9.91	43.9913	194.1	2.051	2.027	2.747	2.639	0.611	1.625	1.014	4.319
1:11:52	203.2	0.609	81.5	5.508	10.00	44.0383	194.3	2.052	2.027	2.747	2.642	0.613	1.627	1.014	4.310
1:12:36	204.1	0.615	81.4	5.501	10.10	44.0878	195.2	2.059	2.034	2.754	2.652	0.616	1.634	1.018	4.302
1:13:20	204.3	0.622	81.4	5.495	10.20	44.1375	195.5	2.060	2.034	2.754	2.654	0.619	1.636	1.018	4.291
1:14:02	204.8	0.627	81.4	5.489	10.30	44.1847	196.0	2.062	2.037	2.757	2.659	0.621	1.640	1.019	4.285
1:14:45	205.2	0.634	81.4	5.483	10.40	44.2351	196.3	2.064	2.038	2.758	2.661	0.622	1.642	1.020	4.280
1:15:30	205.9	0.640	81.3	5.477	10.50	44.2855	197.0	2.069	2.043	2.763	2.668	0.624	1.646	1.022	4.275
1:16:14	206.2	0.646	81.3	5.471	10.61	44.3353	197.3	2.069	2.043	2.763	2.671	0.626	1.648	1.022	4.265
1:16:55	206.5	0.652	81.3	5.465	10.70	44.3831	197.6	2.071	2.044	2.764	2.673	0.628	1.651	1.023	4.257
1:17:39	206.8	0.658	81.2	5.459	10.80	44.4343	197.9	2.071	2.045	2.765	2.677	0.631	1.654	1.023	4.242
1:18:23	207.6	0.664	81.2	5.452	10.90	44.4844	198.7	2.078	2.051	2.771	2.686	0.634	1.660	1.026	4.237
1:19:04	208.3	0.670	81.2	5.447	11.00	44.5324	199.4	2.082	2.055	2.775	2.692	0.636	1.664	1.028	4.232
1:19:48	208.7	0.676	81.2	5.440	11.10	44.5827	199.9	2.085	2.057	2.777	2.694	0.636	1.665	1.029	4.237
1:20:32	209.4	0.683	81.1	5.434	11.20	44.6337	200.5	2.089	2.061	2.781	2.701	0.638	1.670	1.031	4.231
1:21:16	210.0	0.689	81.1	5.428	11.30	44.6843	201.1	2.093	2.065	2.785	2.709	0.643	1.676	1.033	4.216
1:22:00	210.5	0.695	81.0	5.422	11.41	44.7356	201.6	2.096	2.068	2.788	2.715	0.646	1.681	1.035	4.202
1:22:41	210.8	0.701	81.0	5.416	11.50	44.7839	202.0	2.097	2.069	2.789	2.720	0.650	1.685	1.035	4.185
1:23:25	211.5	0.707	80.9	5.410	11.60	44.8361	202.7	2.102	2.073	2.793	2.729	0.655	1.692	1.037	4.169
1:24:09	212.1	0.713	80.8	5.403	11.70	44.8874	203.2	2.105	2.076	2.796	2.740	0.663	1.701	1.039	4.135
1:24:53	212.4	0.720	80.7	5.397	11.81	44.9385	203.6	2.107	2.077	2.797	2.752	0.673	1.713	1.039	4.088
1:25:35	213.0	0.725	81.0	5.391	11.90	44.9880	204.2	2.110	2.081	2.801	2.729	0.647	1.688	1.041	4.221

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			Final Values				
Height	6.120 (in.)	15.544 (cm)	Height	5.073 (in.)	Tested By	KDG	Project Number	175539009
Diameter	2.797 (in)	7.104 (cm)	Dia. avg.	3.239 (in)	Date	8-19-09	Test Number	CU-1278A
Area	6.143 (in²)	39.633 (cm²)	Area avg.	8.237 (in²)	Press No.	2	Data File ID	CU-1278A
					Panel No.	F	Lateral Pressure (psi)	10.0
							Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
1:26:19	213.5	0.732	81.1	5.385	12.01	45.0408	204.7	2.113	2.083	2.803	2.723	0.638	1.680	1.042	4.269
1:27:00	214.1	0.738	81.2	5.379	12.10	45.0899	205.2	2.116	2.086	2.806	2.724	0.637	1.680	1.044	4.279
1:27:44	214.8	0.744	81.1	5.373	12.20	45.1426	206.0	2.121	2.091	2.811	2.731	0.638	1.684	1.046	4.280
1:28:25	215.5	0.750	81.1	5.367	12.30	45.1924	206.6	2.126	2.095	2.815	2.738	0.641	1.690	1.048	4.269
1:29:09	215.6	0.756	81.1	5.361	12.40	45.2456	206.7	2.125	2.094	2.814	2.740	0.644	1.692	1.048	4.253
1:29:51	216.2	0.762	81.0	5.355	12.50	45.2957	207.4	2.129	2.098	2.818	2.746	0.646	1.696	1.050	4.248
1:30:35	216.7	0.768	81.0	5.348	12.60	45.3486	207.8	2.131	2.100	2.820	2.749	0.648	1.698	1.051	4.245
1:31:19	217.5	0.775	81.0	5.342	12.71	45.4020	208.6	2.137	2.105	2.825	2.756	0.650	1.703	1.053	4.241
1:32:00	217.9	0.781	80.9	5.336	12.80	45.4524	209.1	2.139	2.107	2.827	2.760	0.652	1.706	1.054	4.235
1:32:44	218.6	0.787	80.9	5.330	12.90	45.5059	209.8	2.144	2.112	2.832	2.769	0.656	1.712	1.057	4.223
1:33:25	218.8	0.793	80.9	5.324	13.00	45.5567	209.9	2.143	2.111	2.831	2.768	0.656	1.712	1.056	4.221
1:34:09	219.3	0.799	80.9	5.318	13.10	45.6101	210.4	2.145	2.113	2.833	2.772	0.658	1.715	1.057	4.214
1:34:51	219.8	0.805	80.8	5.312	13.20	45.6611	210.9	2.148	2.116	2.836	2.779	0.662	1.720	1.058	4.198
1:35:35	219.9	0.811	80.8	5.306	13.30	45.7151	211.1	2.147	2.114	2.834	2.779	0.663	1.721	1.058	4.189
1:36:19	220.3	0.817	80.8	5.299	13.41	45.7692	211.5	2.149	2.116	2.836	2.783	0.666	1.724	1.058	4.179
1:37:00	220.8	0.823	80.7	5.293	13.50	45.8203	211.9	2.151	2.117	2.837	2.787	0.668	1.727	1.059	4.172
1:37:44	221.6	0.830	80.7	5.287	13.61	45.8751	212.7	2.156	2.122	2.842	2.794	0.671	1.732	1.062	4.167
1:38:25	222.1	0.836	80.6	5.281	13.70	45.9267	213.3	2.159	2.125	2.845	2.806	0.679	1.742	1.063	4.132
1:39:07	222.7	0.842	80.5	5.275	13.80	45.9790	213.8	2.162	2.128	2.848	2.813	0.683	1.748	1.065	4.117
1:39:51	223.0	0.848	80.4	5.269	13.90	46.0343	214.2	2.163	2.129	2.849	2.821	0.691	1.756	1.065	4.085
1:40:32	223.6	0.854	80.2	5.263	14.00	46.0866	214.8	2.167	2.132	2.852	2.837	0.704	1.770	1.067	4.032
1:41:16	224.4	0.860	80.2	5.257	14.10	46.1416	215.6	2.173	2.138	2.858	2.844	0.705	1.774	1.070	4.035
1:41:58	224.7	0.866	80.6	5.251	14.20	46.1938	215.9	2.173	2.138	2.858	2.818	0.678	1.748	1.070	4.154
1:42:39	225.2	0.872	80.7	5.245	14.30	46.2471	216.3	2.175	2.140	2.860	2.813	0.672	1.743	1.070	4.185
1:43:23	225.9	0.878	80.7	5.238	14.40	46.3019	217.1	2.180	2.144	2.864	2.819	0.673	1.746	1.073	4.188
1:44:07	226.5	0.885	80.6	5.232	14.50	46.3575	217.6	2.183	2.147	2.867	2.825	0.676	1.750	1.074	4.177
1:44:48	227.0	0.891	80.6	5.226	14.60	46.4103	218.1	2.185	2.149	2.869	2.827	0.677	1.752	1.075	4.178
1:45:32	227.5	0.897	80.5	5.220	14.71	46.4664	218.7	2.188	2.152	2.872	2.834	0.681	1.757	1.077	4.164
1:46:14	228.2	0.903	80.5	5.214	14.80	46.5198	219.4	2.193	2.156	2.876	2.840	0.682	1.761	1.079	4.163
1:46:58	228.7	0.909	80.5	5.208	14.90	46.5752	219.8	2.195	2.158	2.878	2.840	0.681	1.760	1.080	4.171
1:47:39	229.4	0.915	80.5	5.202	15.00	46.6285	220.5	2.199	2.162	2.882	2.850	0.686	1.768	1.082	4.153
1:48:23	229.8	0.921	80.4	5.195	15.10	46.6843	221.0	2.201	2.164	2.884	2.855	0.690	1.773	1.083	4.138
1:49:07	230.4	0.928	80.4	5.189	15.21	46.7409	221.5	2.204	2.166	2.886	2.859	0.691	1.775	1.084	4.137
1:49:48	230.9	0.934	80.4	5.183	15.30	46.7947	222.0	2.206	2.168	2.888	2.862	0.693	1.777	1.085	4.133
1:50:30	231.5	0.940	80.3	5.177	15.40	46.8487	222.6	2.210	2.172	2.892	2.870	0.697	1.783	1.087	4.119
1:51:14	231.8	0.946	80.3	5.171	15.50	46.9059	222.9	2.210	2.172	2.892	2.870	0.697	1.784	1.087	4.118
1:51:55	232.2	0.952	80.3	5.165	15.60	46.9600	223.3	2.211	2.173	2.893	2.874	0.700	1.787	1.087	4.106
1:52:39	232.8	0.958	80.3	5.159	15.71	47.0183	224.0	2.215	2.176	2.896	2.878	0.700	1.789	1.089	4.110
1:53:21	233.5	0.964	80.2	5.153	15.80	47.0732	224.6	2.219	2.180	2.900	2.885	0.704	1.795	1.091	4.098
1:54:02	234.0	0.970	80.1	5.146	15.90	47.1286	225.1	2.221	2.182	2.902	2.895	0.712	1.804	1.092	4.066
1:54:43	234.6	0.976	80.0	5.140	16.00	47.1835	225.7	2.225	2.185	2.905	2.910	0.723	1.816	1.093	4.024
1:55:27	234.8	0.983	80.2	5.134	16.11	47.2427	226.0	2.224	2.184	2.904	2.893	0.708	1.800	1.093	4.089
1:56:09	235.4	0.989	80.3	5.128	16.21	47.2987	226.5	2.227	2.187	2.907	2.887	0.699	1.793	1.094	4.131
1:56:50	235.9	0.995	80.3	5.122	16.30	47.3543	227.0	2.229	2.189	2.909	2.886	0.696	1.791	1.095	4.147
1:57:32	236.4	1.001	80.3	5.116	16.40	47.4098	227.5	2.231	2.191	2.911	2.890	0.698	1.794	1.096	4.142
1:58:13	236.8	1.007	80.3	5.110	16.50	47.4665	227.9	2.233	2.192	2.912	2.889	0.696	1.793	1.097	4.151
1:58:55	237.2	1.013	80.3	5.104	16.60	47.5227	228.3	2.234	2.193	2.913	2.894	0.699	1.796	1.097	4.138
1:59:39	237.9	1.019	80.3	5.097	16.71	47.5824	229.0	2.238	2.197	2.917	2.898	0.700	1.799	1.099	4.141
2:00:20	238.1	1.025	80.3	5.091	16.80	47.6384	229.2	2.237	2.196	2.916	2.899	0.701	1.800	1.099	4.132
2:01:02	238.6	1.031	80.2	5.085	16.90	47.6954	229.7	2.239	2.198	2.918	2.902	0.703	1.803	1.100	4.127
2:01:43	239.4	1.038	80.2	5.079	17.00	47.7523	230.5	2.245	2.203	2.923	2.911	0.707	1.809	1.102	4.117
2:02:27	240.1	1.044	80.2	5.073	17.11	47.8119	231.2	2.249	2.206	2.926	2.914	0.706	1.810	1.104	4.127

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Consolidation Values				Final Values						
Height	5.938 (in.)	15.082 (cm)		Height	4.864 (in.)	Tested By	KDG	Project Number	175539009
Diameter	2.756 (in)	6.999 (cm)		Dia. avg.	3.155 (in)	Date	8-17-09	Test Number	CU-1278B
Area	5.964 (in^2)	38.477 (cm^2)		Area avg.	7.819 (in^2)	Press No.	1	Data File ID	1278B
						Panel No.	A	Lateral Pressure (psi)	30.0
								Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
0:00:00	9.9	0.000	59.9	5.938	0.00	38.4770	0.0	0.000	0.000	2.160	2.160	2.165	2.163	-0.003	0.998
0:00:28	26.7	0.001	61.2	5.937	0.02	38.4835	16.8	0.203	0.203	2.363	2.273	2.075	2.174	0.099	1.095
0:00:57	29.1	0.001	61.3	5.937	0.02	38.4835	19.2	0.232	0.232	2.392	2.293	2.067	2.180	0.113	1.110
0:01:24	28.5	0.004	61.3	5.934	0.07	38.5042	18.6	0.225	0.225	2.385	2.287	2.067	2.177	0.110	1.106
0:01:49	28.9	0.010	61.4	5.928	0.17	38.5428	19.0	0.230	0.229	2.389	2.286	2.062	2.174	0.112	1.109
0:02:18	28.7	0.016	61.4	5.922	0.27	38.5822	18.8	0.227	0.226	2.386	2.279	2.058	2.169	0.110	1.107
0:02:45	30.2	0.022	61.5	5.916	0.37	38.6212	20.3	0.245	0.244	2.404	2.289	2.051	2.170	0.119	1.116
0:03:13	30.9	0.028	61.5	5.910	0.47	38.6602	21.0	0.253	0.252	2.412	2.296	2.050	2.173	0.123	1.120
0:03:40	33.9	0.034	61.7	5.904	0.57	38.6995	24.0	0.288	0.287	2.447	2.316	2.034	2.175	0.141	1.138
0:04:06	38.8	0.040	62.1	5.898	0.67	38.7369	28.9	0.347	0.346	2.506	2.348	2.007	2.177	0.170	1.170
0:04:38	63.9	0.046	64.2	5.892	0.77	38.7769	54.1	0.648	0.647	2.807	2.497	1.856	2.177	0.321	1.345
0:05:09	103.5	0.052	68.3	5.886	0.87	38.8165	93.6	1.121	1.119	3.279	2.678	1.565	2.122	0.557	1.712
0:05:37	129.8	0.058	72.1	5.880	0.97	38.8550	120.0	1.436	1.433	3.593	2.715	1.287	2.001	0.714	2.110
0:06:04	148.2	0.064	75.1	5.874	1.07	38.8944	138.3	1.654	1.651	3.811	2.718	1.073	1.896	0.823	2.534
0:06:32	161.3	0.070	77.3	5.868	1.18	38.9347	151.4	1.809	1.806	3.966	2.717	0.917	1.817	0.900	2.963
0:06:58	170.9	0.076	78.7	5.862	1.27	38.9734	161.0	1.921	1.918	4.078	2.727	0.815	1.771	0.956	3.346
0:07:23	178.7	0.082	80.2	5.856	1.38	39.0135	168.8	2.012	2.009	4.169	2.709	0.706	1.708	1.002	3.838
0:07:50	185.3	0.087	81.1	5.850	1.47	39.0525	175.5	2.089	2.086	4.246	2.720	0.640	1.680	1.040	4.249
0:08:16	191.1	0.093	81.8	5.844	1.57	39.0924	181.3	2.156	2.152	4.312	2.739	0.592	1.665	1.073	4.629
0:08:42	197.1	0.099	82.3	5.838	1.67	39.1311	187.2	2.225	2.221	4.381	2.771	0.556	1.663	1.108	4.987
0:09:10	202.7	0.106	82.7	5.832	1.78	39.1734	192.8	2.289	2.284	4.444	2.802	0.523	1.662	1.139	5.360
0:09:36	208.8	0.111	83.1	5.827	1.87	39.2112	198.9	2.359	2.355	4.515	2.848	0.498	1.673	1.175	5.713
0:10:04	214.0	0.117	83.2	5.820	1.98	39.2525	204.1	2.418	2.413	4.573	2.894	0.486	1.690	1.204	5.953
0:10:30	218.9	0.123	83.4	5.815	2.08	39.2924	209.0	2.474	2.469	4.629	2.937	0.474	1.706	1.232	6.198
0:10:56	222.8	0.129	83.5	5.809	2.17	39.3324	213.0	2.518	2.512	4.672	2.972	0.465	1.718	1.253	6.394
0:11:24	228.8	0.135	83.6	5.803	2.28	39.3729	218.9	2.586	2.580	4.740	3.033	0.459	1.746	1.287	6.615
0:11:50	232.7	0.141	83.7	5.797	2.37	39.4120	222.8	2.629	2.623	4.783	3.071	0.453	1.762	1.309	6.774
0:12:18	237.1	0.147	83.8	5.791	2.48	39.4537	227.2	2.678	2.671	4.831	3.115	0.449	1.782	1.333	6.932
0:12:44	242.0	0.153	83.8	5.785	2.57	39.4926	232.2	2.733	2.727	4.887	3.169	0.447	1.808	1.361	7.082
0:13:12	245.8	0.159	83.8	5.779	2.67	39.5331	235.9	2.775	2.768	4.928	3.209	0.446	1.827	1.381	7.194
0:13:41	250.3	0.165	83.8	5.773	2.78	39.5759	240.4	2.825	2.818	4.978	3.261	0.449	1.855	1.406	7.266
0:14:07	254.4	0.171	83.8	5.767	2.87	39.6146	244.5	2.870	2.863	5.023	3.307	0.449	1.878	1.429	7.366
0:14:34	258.4	0.177	83.7	5.761	2.98	39.6570	248.6	2.914	2.907	5.067	3.356	0.454	1.905	1.451	7.392
0:15:02	263.2	0.183	83.6	5.755	3.07	39.6973	253.4	2.968	2.960	5.120	3.416	0.461	1.938	1.477	7.412
0:15:30	266.8	0.188	83.5	5.749	3.17	39.7384	256.9	3.007	2.999	5.159	3.460	0.467	1.963	1.497	7.416
0:15:57	270.9	0.195	83.4	5.743	3.28	39.7806	261.1	3.052	3.043	5.203	3.513	0.475	1.994	1.519	7.400
0:16:24	275.9	0.200	83.3	5.737	3.37	39.8207	266.0	3.106	3.098	5.258	3.576	0.484	2.030	1.546	7.395
0:16:51	280.3	0.206	83.1	5.732	3.47	39.8616	270.4	3.154	3.146	5.306	3.634	0.493	2.064	1.570	7.366
0:17:19	284.6	0.212	83.0	5.726	3.57	39.9022	274.7	3.201	3.192	5.352	3.688	0.502	2.095	1.593	7.354
0:17:48	289.5	0.218	82.8	5.720	3.67	39.9437	279.7	3.256	3.246	5.406	3.757	0.516	2.136	1.621	7.283
0:18:16	295.0	0.224	82.7	5.714	3.77	39.9855	285.2	3.316	3.307	5.467	3.829	0.528	2.179	1.651	7.257
0:18:44	299.7	0.230	82.5	5.708	3.87	40.0270	289.8	3.366	3.357	5.517	3.892	0.540	2.216	1.676	7.204
0:19:12	304.5	0.236	82.3	5.702	3.97	40.0687	294.6	3.419	3.409	5.569	3.956	0.552	2.254	1.702	7.165
0:19:41	308.7	0.242	82.1	5.696	4.08	40.1123	298.8	3.464	3.454	5.614	4.015	0.567	2.291	1.724	7.087
0:20:08	313.5	0.248	81.9	5.690	4.18	40.1536	303.7	3.517	3.506	5.666	4.082	0.582	2.332	1.750	7.021
0:20:36	318.9	0.254	81.7	5.684	4.28	40.1954	309.0	3.575	3.564	5.724	4.157	0.598	2.378	1.779	6.948
0:21:03	323.5	0.260	81.4	5.678	4.37	40.2371	313.7	3.625	3.614	5.774	4.224	0.616	2.420	1.804	6.861
0:21:31	328.4	0.266	81.1	5.672	4.47	40.2795	318.6	3.678	3.666	5.826	4.298	0.637	2.468	1.831	6.745
0:21:58	333.7	0.272	80.8	5.666	4.58	40.3219	323.8	3.734	3.723	5.883	4.377	0.660	2.518	1.859	6.637
0:22:26	337.5	0.278	80.6	5.660	4.67	40.3636	327.7	3.775	3.763	5.923	4.437	0.679	2.558	1.879	6.535
0:22:54	342.2	0.284	80.8	5.654	4.77	40.4062	332.3	3.824	3.812	5.972	4.467	0.660	2.563	1.904	6.770
0:23:21	346.5	0.290	80.7	5.648	4.88	40.4493	336.7	3.870	3.858	6.018	4.521	0.668	2.595	1.926	6.765
0:23:48	351.9	0.295	80.5	5.642	4.97	40.4908	342.1	3.928	3.916	6.076	4.591	0.681	2.636	1.955	6.745
0:24:15	356.7	0.301	80.4	5.636	5.07	40.5336	346.9	3.979	3.966	6.126	4.655	0.694	2.675	1.981	6.706
0:24:43	361.7	0.307	80.2	5.630	5.18	40.5770	351.8	4.031	4.018	6.178	4.722	0.709	2.716	2.007	6.660
0:25:09	366.6	0.313	79.9	5.625	5.27	40.6191	356.7	4.084	4.071	6.231	4.791	0.726	2.759	2.033	6.599
0:25:37	370.9	0.319	79.6	5.619	5.37	40.6626	361.0	4.129	4.115	6.275	4.858	0.749	2.803	2.055	6.490
0:26:04	375.2	0.325	79.3	5.613	5.48	40.7066	365.3	4.173	4.159	6.319	4.921	0.767	2.844	2.077	6.413
0:26:29	379.1	0.331	79.1	5.607	5.57	40.7477	369.3	4.214	4.200	6.360	4.979	0.784	2.882	2.097	6.348
0:26:56	384.8	0.337	78.9	5.601	5.67	40.7913	374.9	4.274	4.260	6.420	5.056	0.802	2.929	2.127	6.305

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Consolidation Values				Final Values						
Height	5.938 (in.)	15.082 (cm)		Height	4.864 (in.)	Tested By	KDG	Project Number	175539009
Diameter	2.756 (in)	6.999 (cm)		Dia. avg.	3.155 (in)	Date	8-17-09	Test Number	CU-1278B
Area	5.964 (in^2)	38.477 (cm^2)		Area avg.	7.819 (in^2)	Press No.	1	Data File ID	1278B
						Panel No.	A	Lateral Pressure (psi)	30.0
								Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1'/σ_3'
0:27:23	389.8	0.343	78.6	5.595	5.77	40.8352	380.0	4.327	4.312	6.472	5.130	0.823	2.977	2.154	6.232
0:27:49	391.5	0.349	78.3	5.589	5.88	40.8790	381.7	4.342	4.327	6.487	5.163	0.842	3.003	2.161	6.133
0:28:14	395.8	0.355	78.1	5.583	5.97	40.9212	385.9	4.385	4.370	6.530	5.224	0.859	3.042	2.182	6.080
0:28:42	400.4	0.361	77.8	5.577	6.07	40.9652	390.5	4.433	4.418	6.578	5.292	0.879	3.085	2.206	6.019
0:29:10	405.1	0.367	77.5	5.571	6.18	41.0096	395.2	4.481	4.466	6.626	5.358	0.897	3.127	2.230	5.972
0:29:37	407.6	0.373	77.3	5.565	6.28	41.0531	397.7	4.505	4.489	6.649	5.399	0.915	3.157	2.242	5.898
0:30:03	411.6	0.378	77.0	5.559	6.37	41.0962	401.7	4.546	4.530	6.690	5.459	0.935	3.197	2.262	5.840
0:30:31	415.2	0.385	76.8	5.553	6.48	41.1414	405.3	4.581	4.565	6.725	5.513	0.953	3.233	2.280	5.784
0:30:58	419.3	0.390	76.5	5.547	6.58	41.1855	409.4	4.623	4.606	6.766	5.572	0.971	3.272	2.300	5.736
0:31:25	421.9	0.396	76.3	5.541	6.67	41.2284	412.0	4.647	4.631	6.791	5.614	0.989	3.302	2.313	5.677
0:31:52	425.4	0.402	76.0	5.535	6.78	41.2736	415.5	4.681	4.664	6.824	5.666	1.007	3.336	2.329	5.627
0:32:19	428.7	0.408	75.8	5.530	6.87	41.3169	418.8	4.713	4.696	6.856	5.714	1.023	3.369	2.345	5.585
0:32:46	431.4	0.414	75.6	5.524	6.98	41.3620	421.5	4.739	4.722	6.882	5.756	1.040	3.398	2.358	5.534
0:33:12	434.2	0.420	75.3	5.518	7.07	41.4057	424.4	4.766	4.748	6.908	5.801	1.059	3.430	2.371	5.480
0:33:40	438.0	0.426	75.1	5.512	7.18	41.4518	428.1	4.803	4.785	6.945	5.854	1.075	3.464	2.390	5.447
0:34:08	440.9	0.432	74.9	5.506	7.28	41.4972	431.1	4.830	4.812	6.972	5.897	1.091	3.494	2.403	5.408
0:34:34	443.3	0.438	74.6	5.500	7.38	41.5409	433.5	4.852	4.834	6.994	5.935	1.106	3.520	2.414	5.365
0:35:00	446.2	0.444	74.4	5.494	7.48	41.5862	436.3	4.879	4.860	7.020	5.978	1.123	3.551	2.427	5.322
0:35:26	449.5	0.450	74.2	5.488	7.57	41.6298	439.7	4.911	4.892	7.052	6.026	1.140	3.583	2.443	5.288
0:35:54	452.5	0.456	74.0	5.482	7.67	41.6756	442.6	4.939	4.919	7.079	6.070	1.156	3.613	2.457	5.252
0:36:20	453.9	0.462	73.7	5.476	7.78	41.7208	444.0	4.949	4.930	7.090	6.098	1.174	3.636	2.462	5.194
0:36:48	456.7	0.468	73.4	5.470	7.88	41.7663	446.8	4.974	4.955	7.115	6.144	1.195	3.670	2.475	5.142
0:37:14	458.9	0.473	73.1	5.464	7.97	41.8108	449.1	4.994	4.974	7.134	6.185	1.216	3.701	2.484	5.085
0:37:42	461.2	0.480	72.8	5.458	8.08	41.8573	451.4	5.014	4.994	7.154	6.226	1.237	3.732	2.494	5.031
0:38:08	463.6	0.485	73.1	5.452	8.17	41.9020	453.8	5.036	5.015	7.175	6.230	1.220	3.725	2.505	5.106
0:38:35	465.1	0.491	73.0	5.446	8.28	41.9485	455.2	5.046	5.025	7.185	6.245	1.225	3.735	2.510	5.098
0:39:02	466.8	0.497	72.9	5.440	8.38	41.9952	456.9	5.059	5.038	7.198	6.264	1.232	3.748	2.516	5.086
0:39:28	468.2	0.503	72.8	5.435	8.47	42.0398	458.3	5.069	5.048	7.208	6.281	1.238	3.760	2.521	5.072
0:39:54	470.1	0.509	72.6	5.429	8.58	42.0865	460.2	5.085	5.063	7.223	6.308	1.249	3.778	2.529	5.048
0:40:21	471.1	0.515	72.5	5.423	8.67	42.1316	461.2	5.091	5.069	7.229	6.321	1.258	3.790	2.532	5.025
0:40:48	470.9	0.521	72.4	5.417	8.77	42.1779	461.0	5.082	5.060	7.220	6.321	1.267	3.794	2.527	4.991
0:41:14	471.3	0.527	72.3	5.411	8.87	42.2238	461.4	5.082	5.060	7.220	6.330	1.276	3.803	2.527	4.962
0:41:42	472.1	0.533	72.2	5.405	8.98	42.2716	462.3	5.085	5.063	7.223	6.342	1.285	3.814	2.529	4.936
0:42:08	472.7	0.539	72.1	5.399	9.07	42.3168	462.8	5.085	5.063	7.223	6.348	1.290	3.819	2.529	4.920
0:42:35	472.6	0.545	72.0	5.393	9.18	42.3644	462.8	5.079	5.056	7.216	6.345	1.294	3.820	2.526	4.903
0:43:01	472.8	0.551	72.0	5.387	9.28	42.4107	462.9	5.075	5.052	7.212	6.346	1.299	3.822	2.523	4.885
0:43:29	474.0	0.557	71.9	5.381	9.38	42.4593	464.1	5.083	5.059	7.219	6.356	1.302	3.829	2.527	4.881
0:43:55	473.6	0.563	71.9	5.375	9.48	42.5056	463.7	5.073	5.049	7.209	6.349	1.305	3.827	2.522	4.864
0:44:21	473.2	0.569	71.8	5.369	9.58	42.5534	463.3	5.063	5.039	7.199	6.342	1.308	3.825	2.517	4.850
0:44:46	472.5	0.575	71.8	5.363	9.68	42.5990	462.6	5.050	5.026	7.186	6.329	1.308	3.819	2.510	4.837
0:45:13	473.6	0.581	71.8	5.357	9.78	42.6479	463.7	5.056	5.031	7.191	6.337	1.311	3.824	2.513	4.832
0:45:38	473.6	0.586	71.8	5.351	9.88	42.6936	463.8	5.051	5.026	7.186	6.335	1.314	3.824	2.510	4.822
0:46:05	474.3	0.592	71.7	5.345	9.98	42.7410	464.4	5.053	5.027	7.187	6.340	1.318	3.829	2.511	4.811
0:46:31	475.2	0.598	71.7	5.339	10.08	42.7893	465.3	5.057	5.031	7.191	6.346	1.320	3.833	2.513	4.807
0:46:57	474.0	0.604	71.5	5.333	10.18	42.8366	464.1	5.038	5.012	7.172	6.337	1.330	3.834	2.504	4.765
0:47:23	473.3	0.610	71.6	5.328	10.28	42.8837	463.4	5.025	4.999	7.159	6.319	1.326	3.822	2.497	4.767
0:47:49	474.9	0.616	71.5	5.322	10.38	42.9323	465.1	5.037	5.011	7.171	6.338	1.333	3.836	2.503	4.757
0:48:15	475.8	0.622	71.5	5.316	10.48	42.9800	465.9	5.041	5.015	7.175	6.344	1.335	3.839	2.505	4.753
0:48:41	475.3	0.628	71.5	5.310	10.58	43.0281	465.4	5.030	5.004	7.164	6.334	1.335	3.834	2.499	4.743
0:49:08	475.7	0.634	71.4	5.304	10.68	43.0762	465.9	5.029	5.002	7.162	6.334	1.338	3.836	2.498	4.735
0:49:34	476.0	0.640	71.4	5.298	10.77	43.1236	466.2	5.027	5.000	7.160	6.332	1.338	3.835	2.497	4.733
0:50:00	475.3	0.646	71.4	5.292	10.87	43.1719	465.4	5.013	4.985	7.145	6.319	1.339	3.829	2.490	4.719
0:50:27	475.3	0.652	71.4	5.286	10.98	43.2210	465.5	5.008	4.980	7.140	6.315	1.340	3.827	2.488	4.713
0:50:53	477.3	0.658	71.4	5.280	11.08	43.2693	467.5	5.024	4.996	7.156	6.333	1.342	3.837	2.495	4.718
0:51:21	478.5	0.664	71.3	5.274	11.18	43.3200	468.6	5.030	5.002	7.162	6.340	1.344	3.842	2.498	4.719
0:51:47	476.2	0.670	71.3	5.268	11.28	43.3670	466.4	5.001	4.972	7.132	6.313	1.346	3.829	2.484	4.691
0:52:13	475.4	0.676	71.2	5.262	11.38	43.4167	465.5	4.986	4.958	7.118	6.303	1.351	3.827	2.476	4.665
0:52:41	474.5	0.682	71.1	5.256	11.48	43.4674	464.6	4.971	4.942	7.102	6.295	1.358	3.827	2.468	4.634
0:53:05	473.1	0.687	71.6	5.250	11.58	43.5137	463.2	4.950	4.921	7.081	6.243	1.327	3.785	2.458	4.704
0:53:33	473.5	0.693	71.7	5.244	11.68	43.5652	463.6	4.948	4.919	7.079	6.233	1.319	3.776	2.457	4.724

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Consolidation Values			Final Values		Tested By	KDG	Project Number	175539009
Height	5.938 (in.)	15.082 (cm)	Height	4.864 (in.)	Date	8-17-09	Test Number	CU-1278B
Diameter	2.756 (in)	6.999 (cm)	Dia. avg.	3.155 (in)	Press No.	1	Data File ID	1278B
Area	5.964 (in^2)	38.477 (cm^2)	Area avg.	7.819 (in^2)	Panel No.	A	Lateral Pressure (psi)	30.0
							Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
0:53:59	473.6	0.699	71.7	5.238	11.78	43.6138	463.7	4.944	4.914	7.074	6.223	1.314	3.769	2.455	4.736
0:54:25	474.4	0.705	71.8	5.233	11.88	43.6624	464.5	4.947	4.917	7.077	6.222	1.310	3.766	2.456	4.748
0:54:52	474.1	0.711	71.8	5.227	11.98	43.7115	464.2	4.938	4.908	7.068	6.210	1.308	3.759	2.451	4.749
0:55:18	473.8	0.717	71.8	5.221	12.08	43.7617	463.9	4.929	4.899	7.059	6.202	1.308	3.755	2.447	4.742
0:55:46	473.8	0.723	71.8	5.215	12.18	43.8126	464.0	4.924	4.894	7.054	6.199	1.311	3.755	2.444	4.729
0:56:13	473.8	0.729	71.8	5.209	12.28	43.8633	463.9	4.918	4.888	7.048	6.192	1.310	3.751	2.441	4.727
0:56:39	472.5	0.735	71.8	5.203	12.38	43.9129	462.6	4.899	4.868	7.028	6.174	1.311	3.742	2.431	4.709
0:57:05	471.1	0.741	71.8	5.197	12.48	43.9628	461.2	4.878	4.847	7.007	6.154	1.313	3.734	2.421	4.688
0:57:31	470.7	0.747	71.8	5.191	12.58	44.0116	460.8	4.869	4.837	6.997	6.144	1.312	3.728	2.416	4.682
0:57:59	471.9	0.753	71.8	5.185	12.68	44.0629	462.0	4.876	4.844	7.004	6.150	1.312	3.731	2.419	4.689
0:58:25	471.7	0.759	71.8	5.179	12.78	44.1127	461.8	4.868	4.836	6.996	6.143	1.312	3.727	2.415	4.682
0:58:52	472.2	0.765	71.8	5.173	12.88	44.1642	462.3	4.868	4.835	6.995	6.142	1.312	3.727	2.415	4.682
0:59:20	473.3	0.771	71.8	5.167	12.98	44.2153	463.4	4.873	4.841	7.001	6.146	1.311	3.729	2.418	4.689
0:59:46	472.8	0.776	71.8	5.161	13.08	44.2651	462.9	4.863	4.830	6.990	6.135	1.310	3.723	2.412	4.682
1:00:12	472.5	0.782	71.8	5.155	13.18	44.3162	462.7	4.855	4.822	6.982	6.128	1.312	3.720	2.408	4.671
1:00:39	472.4	0.788	71.7	5.149	13.28	44.3686	462.5	4.848	4.814	6.974	6.125	1.316	3.720	2.405	4.655
1:01:06	472.7	0.795	71.7	5.143	13.38	44.4208	462.8	4.845	4.811	6.971	6.127	1.321	3.724	2.403	4.638
1:01:31	471.8	0.800	71.9	5.138	13.48	44.4702	461.9	4.830	4.796	6.956	6.097	1.306	3.702	2.395	4.668
1:01:58	472.0	0.806	71.7	5.131	13.58	44.5235	462.2	4.827	4.793	6.953	6.104	1.317	3.710	2.394	4.636
1:02:24	471.5	0.812	71.9	5.126	13.68	44.5742	461.6	4.815	4.781	6.941	6.082	1.306	3.694	2.388	4.657
1:02:49	472.5	0.818	71.8	5.120	13.78	44.6253	462.6	4.821	4.786	6.946	6.088	1.307	3.697	2.390	4.658
1:03:15	472.0	0.824	71.8	5.114	13.88	44.6770	462.1	4.810	4.775	6.935	6.079	1.310	3.695	2.385	4.641
1:03:42	473.1	0.830	71.8	5.108	13.98	44.7310	463.3	4.816	4.781	6.941	6.086	1.311	3.699	2.388	4.643
1:04:07	472.5	0.836	71.8	5.102	14.08	44.7802	462.6	4.804	4.769	6.929	6.074	1.311	3.693	2.382	4.633
1:04:33	472.4	0.842	71.7	5.096	14.18	44.8339	462.5	4.797	4.762	6.922	6.071	1.315	3.693	2.378	4.618
1:04:58	473.4	0.848	71.7	5.090	14.28	44.8850	463.6	4.802	4.767	6.927	6.078	1.317	3.698	2.381	4.616
1:05:24	473.9	0.854	71.6	5.084	14.38	44.9372	464.0	4.802	4.766	6.926	6.082	1.321	3.702	2.380	4.603
1:05:50	473.4	0.860	71.5	5.078	14.48	44.9905	463.6	4.791	4.755	6.915	6.081	1.332	3.706	2.375	4.567
1:06:16	473.1	0.866	72.0	5.072	14.58	45.0425	463.2	4.782	4.746	6.906	6.037	1.296	3.666	2.370	4.657
1:06:42	473.2	0.871	72.2	5.066	14.68	45.0951	463.3	4.777	4.740	6.900	6.020	1.285	3.653	2.368	4.685
1:07:09	474.7	0.878	72.2	5.060	14.78	45.1499	464.9	4.788	4.751	6.911	6.026	1.281	3.653	2.373	4.705
1:07:35	476.4	0.883	72.2	5.054	14.88	45.2017	466.5	4.799	4.762	6.922	6.036	1.279	3.658	2.378	4.718
1:08:00	477.4	0.889	72.3	5.048	14.98	45.2544	467.6	4.804	4.767	6.927	6.039	1.277	3.658	2.381	4.728
1:08:28	476.4	0.895	72.3	5.042	15.08	45.3085	466.5	4.788	4.750	6.910	6.020	1.275	3.648	2.372	4.721
1:08:55	476.8	0.901	72.3	5.036	15.18	45.3625	467.0	4.787	4.749	6.909	6.021	1.278	3.649	2.372	4.713
1:09:20	476.7	0.907	72.3	5.031	15.28	45.4146	466.8	4.779	4.741	6.901	6.013	1.278	3.645	2.368	4.707
1:09:47	475.3	0.913	72.2	5.025	15.38	45.4693	465.4	4.760	4.721	6.881	5.995	1.279	3.637	2.358	4.688
1:10:15	474.4	0.919	72.2	5.019	15.48	45.5244	464.5	4.744	4.706	6.866	5.979	1.279	3.629	2.350	4.676
1:10:40	473.7	0.925	72.2	5.013	15.58	45.5771	463.8	4.732	4.693	6.853	5.967	1.279	3.623	2.344	4.665
1:11:06	473.8	0.931	72.2	5.007	15.68	45.6302	464.0	4.728	4.689	6.849	5.962	1.278	3.620	2.342	4.664
1:11:33	472.4	0.937	72.3	5.001	15.78	45.6858	462.5	4.708	4.668	6.828	5.938	1.275	3.606	2.331	4.658
1:11:59	472.6	0.943	72.3	4.995	15.88	45.7393	462.8	4.705	4.665	6.825	5.936	1.276	3.606	2.330	4.652
1:12:26	471.4	0.949	72.3	4.989	15.98	45.7956	461.6	4.687	4.646	6.806	5.916	1.275	3.596	2.321	4.640
1:12:52	472.3	0.955	72.3	4.983	16.08	45.8477	462.5	4.690	4.650	6.810	5.920	1.275	3.597	2.322	4.644
1:13:20	472.1	0.961	72.3	4.977	16.18	45.9050	462.2	4.682	4.641	6.801	5.909	1.273	3.591	2.318	4.642
1:13:46	472.0	0.967	72.3	4.971	16.28	45.9579	462.1	4.676	4.635	6.795	5.903	1.273	3.588	2.315	4.637
1:14:13	471.9	0.972	72.3	4.965	16.38	46.0126	462.0	4.669	4.628	6.788	5.895	1.272	3.584	2.311	4.633
1:14:40	471.8	0.978	72.4	4.959	16.48	46.0685	461.9	4.662	4.621	6.781	5.886	1.270	3.578	2.308	4.635
1:15:06	470.8	0.984	72.4	4.953	16.58	46.1240	460.9	4.647	4.605	6.765	5.869	1.269	3.569	2.300	4.624
1:15:33	472.2	0.990	72.4	4.947	16.68	46.1792	462.3	4.655	4.613	6.773	5.879	1.271	3.575	2.304	4.626
1:16:00	471.9	0.996	72.4	4.941	16.78	46.2348	462.0	4.647	4.605	6.765	5.867	1.267	3.567	2.300	4.629
1:16:27	471.8	1.002	72.4	4.935	16.88	46.2910	461.9	4.640	4.598	6.758	5.859	1.266	3.563	2.296	4.627
1:16:53	473.2	1.008	72.4	4.930	16.98	46.3457	463.3	4.648	4.606	6.766	5.866	1.266	3.566	2.300	4.634
1:17:20	473.3	1.014	72.4	4.924	17.08	46.4011	463.4	4.644	4.601	6.761	5.861	1.266	3.563	2.298	4.631
1:17:47	473.8	1.020	72.4	4.918	17.18	46.4571	464.0	4.644	4.601	6.761	5.861	1.265	3.563	2.298	4.633
1:18:14	474.0	1.026	72.4	4.912	17.28	46.5150	464.1	4.640	4.597	6.757	5.857	1.265	3.561	2.296	4.628
1:18:40	474.3	1.032	72.4	4.906	17.38	46.5702	464.4	4.637	4.594	6.754	5.857	1.268	3.563	2.294	4.617
1:19:07	475.9	1.038	72.3	4.900	17.48	46.6269	466.1	4.648	4.604	6.764	5.871	1.272	3.572	2.299	4.614
1:19:33	475.4	1.044	72.2	4.894	17.58	46.6833	465.5	4.637	4.593	6.753	5.867	1.279	3.573	2.294	4.586
1:19:59	475.5	1.050	72.1	4.888	17.68	46.7392	465.7	4.633	4.588	6.748	5.871	1.288	3.579	2.292	4.560

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Consolidation Values					Final Values						
Height	5.938	(in.)	15.082	(cm)	Height	4.864	(in.)	Tested By	KDG	Project Number	175539009
Diameter	2.756	(in)	6.999	(cm)	Dia. avg.	3.155	(in)	Date	8-17-09	Test Number	CU-1278B
Area	5.964	(in^2)	38.477	(cm^2)	Area avg.	7.819	(in^2)	Press No.	1	Data File ID	1278B
								Panel No.	A	Lateral Pressure (psi)	30.0
										Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
1:20:26	476.7	1.056	72.6	4.882	17.78	46.7978	466.9	4.639	4.594	6.754	5.844	1.255	3.549	2.295	4.657
1:20:53	476.6	1.062	72.7	4.876	17.88	46.8553	466.7	4.632	4.587	6.747	5.827	1.246	3.537	2.291	4.678
1:21:19	476.9	1.068	72.8	4.870	17.98	46.9131	467.0	4.629	4.584	6.744	5.817	1.239	3.528	2.289	4.695
1:21:43	477.2	1.073	72.8	4.864	18.08	46.9682	467.3	4.626	4.581	6.741	5.811	1.236	3.524	2.288	4.703

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Consolidation Values			Final Values		Tested By	KDG	Project Number	175539009
Height	5.846 (in.)	14.849 (cm)	Height	4.847 (in.)	Date	8-14-09	Test Number	CU-1278C
Diameter	2.719 (in)	6.907 (cm)	Dia. avg.	3.058 (in)	Press No.	2	Data File ID	1278C
Area	5.808 (in^2)	37.471 (cm^2)	Area avg.	7.342 (in^2)	Panel No.	E	Lateral Pressure (psi)	50.0
							Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
0:00:00	8.0	-0.003	40.1	5.846	0.00	37.4706	0.0	0.000	0.000	3.600	3.600	3.591	3.595	0.005	1.003
0:00:39	28.5	0.003	41.1	5.840	0.11	37.5103	20.5	0.254	0.254	3.854	3.785	3.522	3.653	0.132	1.075
0:01:11	30.1	0.009	41.5	5.834	0.21	37.5479	22.1	0.273	0.273	3.873	3.774	3.492	3.633	0.141	1.081
0:01:43	31.7	0.015	41.8	5.828	0.31	37.5860	23.7	0.293	0.292	3.892	3.770	3.469	3.619	0.151	1.087
0:02:15	32.8	0.021	42.1	5.822	0.41	37.6249	24.8	0.306	0.305	3.905	3.763	3.448	3.605	0.157	1.091
0:02:47	35.1	0.027	42.4	5.816	0.51	37.6623	27.1	0.334	0.333	3.933	3.769	3.427	3.598	0.171	1.100
0:03:17	37.0	0.032	42.7	5.810	0.61	37.6994	28.9	0.357	0.355	3.955	3.768	3.404	3.586	0.182	1.107
0:03:49	38.9	0.038	43.1	5.804	0.71	37.7380	30.8	0.380	0.378	3.978	3.762	3.375	3.568	0.194	1.115
0:04:22	40.8	0.044	43.2	5.799	0.81	37.7755	32.8	0.403	0.401	4.001	3.780	3.370	3.575	0.205	1.122
0:04:54	42.7	0.050	43.5	5.793	0.91	37.8129	34.7	0.426	0.424	4.024	3.780	3.347	3.564	0.217	1.129
0:05:24	44.9	0.056	43.7	5.787	1.00	37.8509	36.8	0.452	0.450	4.050	3.791	3.332	3.561	0.229	1.138
0:06:01	95.3	0.061	48.1	5.781	1.10	37.8880	87.3	1.071	1.068	4.668	4.094	3.017	3.556	0.539	1.357
0:06:38	151.5	0.067	57.0	5.776	1.20	37.9266	143.5	1.760	1.756	5.356	4.144	2.378	3.261	0.883	1.742
0:07:13	181.3	0.073	62.4	5.770	1.30	37.9641	173.2	2.122	2.119	5.719	4.117	1.990	3.053	1.064	2.069
0:07:48	201.3	0.079	65.6	5.764	1.40	38.0032	193.3	2.365	2.361	5.961	4.124	1.754	2.939	1.185	2.352
0:08:20	215.5	0.085	67.2	5.758	1.50	38.0425	207.5	2.536	2.532	6.132	4.186	1.645	2.916	1.271	2.545
0:08:55	228.8	0.091	68.6	5.752	1.61	38.0826	220.8	2.696	2.692	6.292	4.244	1.543	2.893	1.350	2.750
0:09:27	240.3	0.097	69.4	5.746	1.71	38.1214	232.2	2.833	2.828	6.428	4.323	1.485	2.904	1.419	2.911
0:09:59	251.6	0.102	69.8	5.740	1.80	38.1587	243.5	2.968	2.963	6.563	4.427	1.455	2.941	1.486	3.043
0:10:32	262.3	0.108	70.2	5.734	1.91	38.1989	254.3	3.096	3.091	6.691	4.523	1.423	2.973	1.550	3.178
0:11:04	273.0	0.114	70.5	5.729	2.00	38.2358	265.0	3.222	3.217	6.817	4.628	1.402	3.015	1.613	3.301
0:11:36	283.7	0.120	70.7	5.723	2.10	38.2748	275.7	3.349	3.344	6.944	4.744	1.392	3.068	1.676	3.410
0:12:08	294.1	0.125	70.7	5.717	2.20	38.3132	286.1	3.472	3.467	7.067	4.862	1.386	3.124	1.738	3.508
0:12:41	304.6	0.131	70.6	5.711	2.30	38.3530	296.5	3.595	3.590	7.190	4.992	1.393	3.193	1.799	3.583
0:13:13	315.0	0.137	70.6	5.706	2.40	38.3916	307.0	3.718	3.712	7.312	5.120	1.398	3.259	1.861	3.661
0:13:45	325.8	0.143	70.5	5.700	2.50	38.4308	317.8	3.845	3.839	7.439	5.251	1.403	3.327	1.924	3.742
0:14:18	336.1	0.149	70.5	5.694	2.60	38.4714	328.1	3.965	3.959	7.559	5.373	1.405	3.389	1.984	3.824
0:14:50	346.6	0.155	70.4	5.688	2.70	38.5110	338.6	4.088	4.081	7.681	5.505	1.414	3.459	2.045	3.893
0:15:22	357.1	0.161	70.3	5.682	2.80	38.5498	349.1	4.210	4.203	7.803	5.630	1.418	3.524	2.106	3.971
0:15:54	367.6	0.166	70.1	5.676	2.90	38.5897	359.6	4.333	4.326	7.926	5.767	1.432	3.600	2.168	4.027
0:16:27	378.1	0.172	69.9	5.670	3.00	38.6305	370.1	4.455	4.447	8.047	5.903	1.446	3.674	2.228	4.081
0:17:00	388.7	0.178	69.7	5.665	3.10	38.6698	380.7	4.578	4.570	8.170	6.040	1.461	3.750	2.290	4.135
0:17:32	399.6	0.184	69.6	5.659	3.20	38.7092	391.6	4.704	4.696	8.296	6.170	1.466	3.818	2.352	4.210
0:18:04	410.0	0.190	69.3	5.653	3.30	38.7490	402.0	4.824	4.815	8.415	6.313	1.489	3.901	2.412	4.240
0:18:37	420.5	0.196	69.0	5.647	3.40	38.7888	412.5	4.945	4.936	8.536	6.454	1.509	3.981	2.473	4.278
0:19:09	431.0	0.202	68.7	5.641	3.50	38.8299	422.9	5.065	5.056	8.656	6.600	1.535	4.067	2.532	4.300
0:19:41	441.4	0.207	68.4	5.636	3.60	38.8689	433.4	5.184	5.175	8.775	6.741	1.557	4.149	2.592	4.330
0:20:13	451.5	0.213	68.2	5.630	3.70	38.9102	443.4	5.299	5.290	8.890	6.869	1.570	4.220	2.649	4.375
0:20:48	462.3	0.219	67.8	5.623	3.80	38.9527	454.3	5.423	5.413	9.013	7.018	1.596	4.307	2.711	4.398
0:21:18	472.0	0.225	67.5	5.618	3.90	38.9905	463.9	5.533	5.523	9.123	7.153	1.621	4.387	2.766	4.413
0:21:53	483.1	0.231	67.0	5.612	4.00	39.0335	475.0	5.659	5.649	9.249	7.311	1.654	4.483	2.829	4.422
0:22:25	493.5	0.237	66.7	5.606	4.10	39.0732	485.4	5.777	5.767	9.367	7.451	1.675	4.563	2.888	4.449
0:22:57	504.1	0.242	66.4	5.600	4.20	39.1131	496.1	5.898	5.887	9.487	7.599	1.702	4.650	2.948	4.464
0:23:30	515.3	0.248	65.9	5.595	4.30	39.1535	507.3	6.024	6.013	9.613	7.761	1.738	4.750	3.011	4.464
0:24:04	526.6	0.254	65.6	5.589	4.40	39.1947	518.6	6.152	6.141	9.741	7.907	1.757	4.832	3.075	4.501
0:24:37	536.6	0.260	65.3	5.583	4.50	39.2358	528.5	6.264	6.253	9.853	8.039	1.778	4.908	3.131	4.523
0:25:09	546.6	0.266	64.9	5.577	4.60	39.2772	538.6	6.377	6.365	9.965	8.178	1.804	4.991	3.187	4.533
0:25:41	556.6	0.272	64.4	5.571	4.70	39.3180	548.6	6.488	6.476	10.076	8.325	1.840	5.083	3.242	4.524
0:26:13	566.1	0.277	64.2	5.566	4.80	39.3580	558.1	6.593	6.581	10.181	8.446	1.856	5.151	3.295	4.551
0:26:46	575.2	0.283	63.9	5.560	4.90	39.3995	567.2	6.694	6.682	10.282	8.571	1.880	5.225	3.345	4.559
0:27:20	585.4	0.289	63.4	5.553	5.00	39.4441	577.4	6.807	6.794	10.394	8.721	1.918	5.320	3.401	4.546
0:27:53	594.6	0.295	62.9	5.548	5.10	39.4851	586.6	6.908	6.895	10.495	8.856	1.952	5.404	3.452	4.537
0:28:25	603.5	0.301	62.5	5.542	5.20	39.5253	595.5	7.005	6.992	10.592	8.980	1.978	5.479	3.501	4.539
0:28:57	612.3	0.306	62.0	5.536	5.30	39.5657	604.3	7.102	7.088	10.688	9.110	2.013	5.561	3.549	4.526
0:29:30	621.6	0.312	61.8	5.530	5.40	39.6085	613.6	7.203	7.189	10.789	9.232	2.034	5.633	3.599	4.540
0:30:02	630.0	0.318	61.5	5.525	5.50	39.6503	622.0	7.294	7.280	10.880	9.344	2.054	5.699	3.645	4.548
0:30:34	638.7	0.324	61.0	5.519	5.60	39.6921	630.6	7.388	7.374	10.974	9.472	2.089	5.781	3.692	4.533
0:31:06	647.2	0.330	60.5	5.513	5.70	39.7338	639.2	7.480	7.466	11.066	9.602	2.127	5.865	3.738	4.514
0:31:41	656.8	0.336	60.1	5.507	5.80	39.7782	648.7	7.584	7.569	11.169	9.732	2.154	5.943	3.789	4.519
0:32:13	665.3	0.342	59.6	5.501	5.90	39.8210	657.3	7.675	7.660	11.260	9.861	2.192	6.026	3.835	4.499

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Consolidation Values			Final Values		Tested By	KDG	Project Number	175539009
Height	5.846 (in.)	14.849 (cm)	Height	4.847 (in.)	Date	8-14-09	Test Number	CU-1278C
Diameter	2.719 (in)	6.907 (cm)	Dia. avg.	3.058 (in)	Press No.	2	Data File ID	1278C
Area	5.808 (in^2)	37.471 (cm^2)	Area avg.	7.342 (in^2)	Panel No.	E	Lateral Pressure (psi)	50.0
							Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
0:32:43	672.7	0.347	59.2	5.495	5.99	39.8601	664.7	7.754	7.739	11.339	9.964	2.216	6.090	3.874	4.497
0:33:16	681.2	0.353	59.0	5.490	6.09	39.9025	673.2	7.845	7.829	11.429	10.071	2.233	6.152	3.919	4.511
0:33:50	689.9	0.359	58.5	5.484	6.20	39.9469	681.9	7.938	7.922	11.522	10.197	2.266	6.231	3.966	4.501
0:34:23	698.3	0.365	58.1	5.478	6.30	39.9897	690.3	8.027	8.011	11.611	10.314	2.294	6.304	4.010	4.496
0:34:55	707.0	0.371	57.8	5.472	6.40	40.0330	698.9	8.118	8.102	11.702	10.432	2.321	6.376	4.056	4.495
0:35:27	715.1	0.377	57.3	5.466	6.50	40.0748	707.1	8.205	8.188	11.788	10.554	2.357	6.455	4.099	4.478
0:35:59	722.5	0.383	56.9	5.460	6.60	40.1173	714.5	8.281	8.265	11.865	10.661	2.387	6.524	4.137	4.467
0:36:30	729.2	0.388	56.7	5.455	6.69	40.1589	721.2	8.351	8.334	11.934	10.742	2.399	6.571	4.171	4.477
0:37:02	736.6	0.394	55.9	5.449	6.79	40.2018	728.6	8.428	8.410	12.010	10.874	2.454	6.664	4.210	4.430
0:37:35	743.8	0.400	55.5	5.443	6.90	40.2461	735.7	8.501	8.483	12.083	10.975	2.482	6.728	4.246	4.421
0:38:08	750.6	0.406	55.1	5.437	7.00	40.2897	742.6	8.570	8.553	12.153	11.072	2.510	6.791	4.281	4.411
0:38:40	756.8	0.412	54.7	5.431	7.10	40.3340	748.8	8.632	8.614	12.214	11.168	2.545	6.857	4.312	4.389
0:39:13	762.8	0.418	54.2	5.425	7.20	40.3778	754.8	8.692	8.674	12.274	11.260	2.576	6.918	4.342	4.370
0:39:42	767.3	0.423	53.8	5.420	7.29	40.4182	759.3	8.736	8.717	12.317	11.331	2.605	6.968	4.363	4.350
0:40:15	773.2	0.429	53.4	5.414	7.40	40.4630	765.2	8.794	8.775	12.375	11.421	2.637	7.029	4.392	4.332
0:40:47	779.4	0.435	53.1	5.408	7.50	40.5070	771.4	8.855	8.836	12.436	11.504	2.659	7.081	4.423	4.327
0:41:20	785.4	0.441	52.5	5.402	7.60	40.5505	777.4	8.915	8.895	12.495	11.605	2.701	7.153	4.452	4.297
0:41:52	791.8	0.447	52.4	5.396	7.69	40.5939	783.7	8.978	8.958	12.558	11.673	2.706	7.189	4.484	4.314
0:42:25	799.7	0.452	52.0	5.390	7.79	40.6377	791.6	9.058	9.039	12.639	11.787	2.739	7.263	4.524	4.303
0:42:57	804.6	0.458	51.6	5.384	7.89	40.6817	796.6	9.105	9.085	12.685	11.859	2.765	7.312	4.547	4.289
0:43:29	808.9	0.464	51.3	5.379	7.99	40.7255	800.9	9.144	9.124	12.724	11.919	2.786	7.352	4.567	4.278
0:44:02	813.5	0.470	51.0	5.373	8.09	40.7701	805.4	9.186	9.166	12.766	11.982	2.807	7.394	4.587	4.269
0:44:34	817.5	0.476	50.7	5.367	8.19	40.8140	809.4	9.222	9.201	12.801	12.040	2.830	7.435	4.605	4.255
0:45:07	821.1	0.482	50.4	5.361	8.29	40.8590	813.1	9.253	9.232	12.832	12.094	2.853	7.473	4.621	4.240
0:45:39	823.8	0.487	50.1	5.355	8.39	40.9032	815.8	9.274	9.253	12.853	12.137	2.875	7.506	4.631	4.222
0:46:11	826.1	0.493	49.8	5.349	8.49	40.9482	818.0	9.289	9.268	12.868	12.171	2.894	7.533	4.638	4.205
0:46:44	827.2	0.499	49.5	5.344	8.59	40.9924	819.1	9.292	9.270	12.870	12.196	2.917	7.557	4.640	4.181
0:47:16	826.2	0.505	49.3	5.338	8.69	41.0376	818.1	9.270	9.248	12.848	12.189	2.931	7.560	4.629	4.158
0:47:48	812.6	0.511	49.5	5.332	8.80	41.0848	804.5	9.106	9.083	12.683	12.006	2.913	7.459	4.546	4.121
0:48:18	803.1	0.517	50.0	5.326	8.89	41.1281	795.1	8.989	8.967	12.567	11.858	2.882	7.370	4.488	4.115
0:48:50	796.1	0.523	50.2	5.320	9.00	41.1742	788.1	8.900	8.878	12.478	11.751	2.864	7.307	4.443	4.103
0:49:22	792.2	0.529	50.4	5.314	9.10	41.2201	784.1	8.846	8.823	12.423	11.686	2.854	7.270	4.416	4.094
0:49:54	789.6	0.535	50.4	5.308	9.20	41.2659	781.6	8.807	8.783	12.383	11.646	2.853	7.250	4.396	4.082
0:50:24	785.3	0.540	50.5	5.303	9.29	41.3086	777.3	8.749	8.726	12.326	11.580	2.845	7.212	4.368	4.070
0:50:56	781.8	0.546	50.9	5.297	9.39	41.3546	773.8	8.700	8.676	12.276	11.501	2.816	7.159	4.343	4.085
0:51:28	779.2	0.552	50.9	5.291	9.49	41.4005	771.1	8.661	8.637	12.237	11.461	2.814	7.138	4.323	4.072
0:52:01	774.5	0.558	51.2	5.285	9.59	41.4458	766.5	8.600	8.575	12.175	11.378	2.794	7.086	4.292	4.073
0:52:33	768.1	0.564	51.3	5.279	9.69	41.4925	760.1	8.519	8.494	12.094	11.290	2.787	7.038	4.252	4.051
0:53:05	764.9	0.569	51.4	5.273	9.79	41.5388	756.9	8.473	8.448	12.048	11.237	2.780	7.009	4.229	4.042
0:53:37	762.7	0.575	51.7	5.268	9.89	41.5846	754.7	8.439	8.414	12.014	11.183	2.760	6.972	4.211	4.051
0:54:09	757.8	0.581	51.6	5.262	9.99	41.6310	749.7	8.374	8.349	11.949	11.119	2.762	6.941	4.179	4.026
0:54:41	754.8	0.587	51.7	5.256	10.09	41.6772	746.7	8.331	8.306	11.906	11.071	2.756	6.914	4.157	4.017
0:55:14	751.8	0.593	51.9	5.250	10.19	41.7238	743.8	8.289	8.263	11.863	11.018	2.746	6.882	4.136	4.013
0:55:46	748.5	0.599	52.0	5.244	10.30	41.7710	740.5	8.243	8.217	11.817	10.963	2.737	6.850	4.113	4.006
0:56:18	745.1	0.605	51.9	5.238	10.40	41.8177	737.0	8.196	8.169	11.769	10.923	2.744	6.833	4.089	3.980
0:56:50	742.5	0.610	52.0	5.232	10.50	41.8650	734.5	8.158	8.131	11.731	10.876	2.735	6.805	4.070	3.977
0:57:22	740.2	0.616	52.0	5.226	10.60	41.9119	732.2	8.123	8.096	11.696	10.842	2.736	6.789	4.053	3.962
0:57:52	738.6	0.622	52.0	5.221	10.69	41.9558	730.5	8.097	8.069	11.669	10.812	2.734	6.773	4.039	3.955
0:58:24	737.2	0.628	52.0	5.215	10.79	42.0033	729.2	8.073	8.045	11.645	10.787	2.732	6.760	4.027	3.948
0:58:56	737.7	0.634	52.0	5.209	10.89	42.0503	729.7	8.069	8.042	11.642	10.790	2.740	6.765	4.025	3.939
0:59:29	739.3	0.639	52.1	5.203	10.99	42.0977	731.3	8.078	8.050	11.650	10.791	2.732	6.762	4.029	3.950
1:00:01	741.0	0.645	52.2	5.197	11.09	42.1453	732.9	8.087	8.059	11.659	10.791	2.723	6.757	4.034	3.963
1:00:33	741.0	0.651	52.1	5.192	11.19	42.1928	733.0	8.078	8.050	11.650	10.785	2.726	6.755	4.030	3.957
1:01:05	741.2	0.657	52.1	5.186	11.29	42.2408	733.1	8.071	8.042	11.642	10.781	2.730	6.755	4.026	3.949
1:01:37	741.2	0.663	52.1	5.180	11.39	42.2888	733.2	8.062	8.033	11.633	10.773	2.731	6.752	4.021	3.944
1:02:10	740.6	0.669	52.1	5.174	11.50	42.3378	732.6	8.046	8.017	11.617	10.758	2.731	6.744	4.013	3.939
1:02:42	740.3	0.675	52.1	5.168	11.60	42.3854	732.3	8.034	8.004	11.604	10.743	2.729	6.736	4.007	3.936
1:03:12	740.6	0.680	52.2	5.163	11.69	42.4308	732.5	8.028	7.998	11.598	10.732	2.724	6.728	4.004	3.939
1:03:44	740.5	0.686	52.1	5.157	11.79	42.4783	732.5	8.019	7.989	11.589	10.730	2.732	6.731	3.999	3.927
1:04:16	739.8	0.692	52.2	5.151	11.89	42.5273	731.7	8.001	7.971	11.571	10.704	2.724	6.714	3.990	3.929

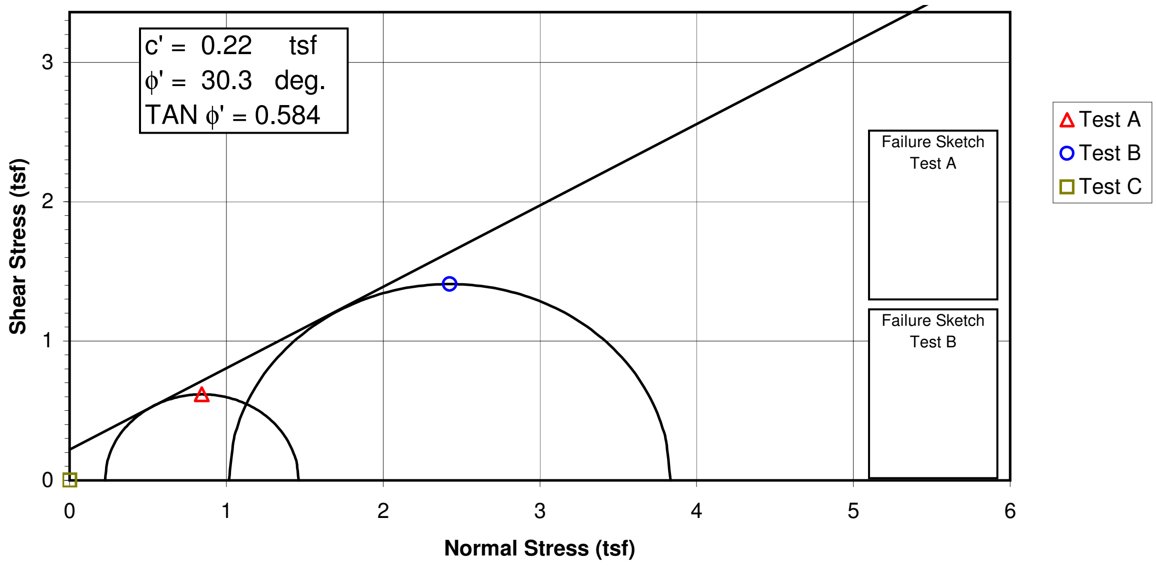
Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			Final Values					
Height	5.846 (in.)	14.849 (cm)	Height	4.847 (in.)	Tested By	KDG	Project Number	175539009
Diameter	2.719 (in)	6.907 (cm)	Dia. avg.	3.058 (in)	Date	8-14-09	Test Number	CU-1278C
Area	5.808 (in^2)	37.471 (cm^2)	Area avg.	7.342 (in^2)	Press No.	2	Data File ID	1278C
					Panel No.	E	Lateral Pressure (psi)	50.0
							Chamber Pressure - σ_3 (psi)	90

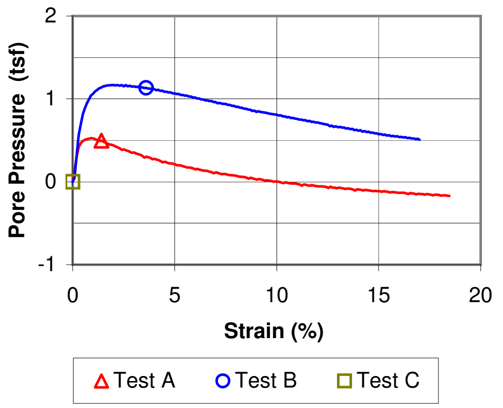
Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1'/σ_3'
1:04:48	740.7	0.698	52.0	5.145	11.99	42.5754	732.7	8.002	7.972	11.572	10.714	2.733	6.724	3.991	3.920
1:05:20	741.7	0.704	51.9	5.139	12.09	42.6244	733.7	8.004	7.974	11.574	10.722	2.740	6.731	3.991	3.914
1:05:52	742.7	0.710	51.9	5.133	12.19	42.6727	734.6	8.005	7.974	11.574	10.728	2.745	6.736	3.992	3.909
1:06:25	743.2	0.715	51.8	5.127	12.29	42.7205	735.2	8.002	7.971	11.571	10.731	2.751	6.741	3.990	3.901
1:06:57	744.1	0.721	51.7	5.122	12.39	42.7694	736.1	8.003	7.972	11.572	10.737	2.757	6.747	3.990	3.895
1:07:29	744.3	0.727	51.7	5.116	12.49	42.8179	736.2	7.995	7.964	11.564	10.732	2.759	6.745	3.986	3.890
1:08:04	745.5	0.733	51.7	5.110	12.59	42.8700	737.4	7.999	7.967	11.567	10.735	2.759	6.747	3.988	3.891
1:08:34	746.3	0.739	51.7	5.104	12.69	42.9159	738.3	7.999	7.967	11.567	10.730	2.754	6.742	3.988	3.896
1:09:06	748.0	0.744	51.7	5.098	12.79	42.9650	740.0	8.008	7.976	11.576	10.739	2.754	6.747	3.993	3.899
1:09:41	749.8	0.751	51.7	5.092	12.89	43.0174	741.8	8.018	7.986	11.586	10.754	2.759	6.757	3.997	3.897
1:10:13	751.0	0.756	51.7	5.086	12.99	43.0661	743.0	8.022	7.989	11.589	10.759	2.761	6.760	3.999	3.897
1:10:45	752.1	0.762	51.7	5.080	13.09	43.1158	744.0	8.024	7.991	11.591	10.760	2.760	6.760	4.000	3.899
1:11:17	753.6	0.768	51.6	5.075	13.19	43.1650	745.5	8.031	7.998	11.598	10.775	2.768	6.771	4.003	3.893
1:11:49	754.5	0.774	51.5	5.069	13.29	43.2145	746.4	8.032	7.998	11.598	10.778	2.771	6.775	4.004	3.890
1:12:22	755.7	0.780	51.4	5.063	13.39	43.2641	747.7	8.036	8.002	11.602	10.789	2.777	6.783	4.006	3.885
1:12:54	756.6	0.786	51.2	5.057	13.49	43.3145	748.5	8.036	8.001	11.601	10.801	2.790	6.796	4.005	3.871
1:13:27	756.7	0.791	51.3	5.051	13.59	43.3641	748.7	8.028	7.994	11.594	10.790	2.787	6.788	4.001	3.872
1:13:59	757.1	0.797	51.4	5.046	13.69	43.4144	749.1	8.023	7.989	11.589	10.776	2.779	6.777	3.999	3.878
1:14:31	757.8	0.803	51.4	5.040	13.79	43.4645	749.8	8.021	7.986	11.586	10.778	2.783	6.780	3.998	3.873
1:15:03	760.0	0.809	51.1	5.034	13.89	43.5143	752.0	8.036	8.001	11.601	10.812	2.802	6.807	4.005	3.859
1:15:35	761.7	0.815	51.1	5.028	13.99	43.5637	753.6	8.044	8.009	11.609	10.819	2.801	6.810	4.009	3.862
1:16:10	764.2	0.821	51.0	5.022	14.09	43.6179	756.1	8.061	8.025	11.625	10.841	2.807	6.824	4.017	3.863
1:16:42	769.3	0.826	51.0	5.016	14.19	43.6673	761.2	8.106	8.070	11.670	10.888	2.809	6.849	4.040	3.876
1:17:14	772.5	0.832	50.9	5.011	14.29	43.7175	764.4	8.131	8.094	11.694	10.922	2.819	6.870	4.052	3.875
1:17:46	775.1	0.838	50.9	5.005	14.39	43.7680	767.1	8.149	8.113	11.713	10.940	2.818	6.879	4.061	3.882
1:18:17	777.6	0.844	50.9	4.999	14.49	43.8182	769.6	8.167	8.130	11.730	10.956	2.817	6.887	4.069	3.889
1:18:52	779.2	0.850	50.8	4.993	14.59	43.8727	771.2	8.174	8.137	11.737	10.970	2.824	6.897	4.073	3.884
1:19:23	780.8	0.856	50.7	4.987	14.69	43.9241	772.8	8.181	8.144	11.744	10.981	2.828	6.905	4.077	3.883
1:19:55	782.3	0.862	50.6	4.981	14.79	43.9752	774.3	8.188	8.150	11.750	10.997	2.838	6.918	4.080	3.875
1:20:27	784.5	0.867	50.6	4.975	14.89	44.0270	776.5	8.201	8.163	11.763	11.006	2.833	6.920	4.086	3.884
1:20:58	787.2	0.873	50.5	4.969	14.99	44.0788	779.2	8.220	8.181	11.781	11.034	2.843	6.938	4.095	3.881
1:21:30	789.8	0.879	50.5	4.964	15.09	44.1305	781.8	8.237	8.199	11.799	11.054	2.846	6.950	4.104	3.884
1:22:02	791.8	0.885	50.3	4.958	15.19	44.1821	783.8	8.249	8.210	11.810	11.076	2.856	6.966	4.110	3.878
1:22:33	793.9	0.891	50.5	4.952	15.29	44.2344	785.8	8.261	8.222	11.822	11.078	2.847	6.963	4.116	3.891
1:23:05	796.1	0.897	50.1	4.946	15.39	44.2874	788.1	8.274	8.235	11.835	11.116	2.872	6.994	4.122	3.871
1:23:34	798.4	0.902	50.2	4.941	15.49	44.3360	790.3	8.289	8.250	11.850	11.125	2.867	6.996	4.129	3.881
1:24:06	800.5	0.908	50.0	4.935	15.58	44.3883	792.5	8.302	8.262	11.862	11.154	2.883	7.019	4.136	3.869
1:24:38	801.8	0.914	50.0	4.929	15.69	44.4428	793.8	8.306	8.266	11.866	11.152	2.877	7.015	4.137	3.876
1:25:10	803.6	0.920	50.0	4.923	15.79	44.4953	795.6	8.315	8.274	11.874	11.162	2.878	7.020	4.142	3.878
1:25:41	805.6	0.926	49.7	4.917	15.89	44.5488	797.6	8.325	8.285	11.885	11.192	2.898	7.045	4.147	3.862
1:26:13	807.5	0.932	49.8	4.911	15.99	44.6016	799.5	8.335	8.295	11.895	11.197	2.893	7.045	4.152	3.870
1:26:45	809.4	0.937	49.9	4.905	16.09	44.6556	801.3	8.344	8.303	11.903	11.202	2.890	7.046	4.156	3.877
1:27:16	811.2	0.943	49.7	4.899	16.19	44.7090	803.1	8.353	8.312	11.912	11.223	2.902	7.063	4.161	3.867
1:27:48	813.8	0.949	49.7	4.894	16.29	44.7621	805.8	8.371	8.329	11.929	11.239	2.901	7.070	4.169	3.874
1:28:20	816.7	0.955	49.7	4.888	16.39	44.8157	808.7	8.391	8.349	11.949	11.260	2.902	7.081	4.179	3.881
1:28:51	818.8	0.961	49.5	4.882	16.49	44.8694	810.8	8.402	8.361	11.961	11.288	2.918	7.103	4.185	3.868
1:29:23	820.5	0.967	49.4	4.876	16.59	44.9229	812.5	8.410	8.368	11.968	11.297	2.920	7.108	4.189	3.869
1:29:55	821.2	0.973	49.4	4.870	16.69	44.9771	813.2	8.407	8.365	11.965	11.295	2.921	7.108	4.187	3.867
1:30:27	821.6	0.978	49.2	4.864	16.79	45.0316	813.6	8.401	8.359	11.959	11.304	2.937	7.121	4.184	3.849
1:30:59	822.3	0.984	49.3	4.859	16.89	45.0857	814.3	8.398	8.355	11.955	11.297	2.933	7.115	4.182	3.852
1:31:30	822.7	0.990	49.2	4.853	16.99	45.1387	814.7	8.393	8.349	11.949	11.293	2.935	7.114	4.179	3.848
1:32:02	823.6	0.996	48.9	4.847	17.09	45.1930	815.5	8.391	8.348	11.948	11.313	2.956	7.135	4.178	3.827

Failure Criterion: Maximum Effective Principal Stress Ratio

Effective Strength Envelope



Induced Pore Pressure vs. Strain



Specimen No.			A	B	C	
Initial Data	Water content %	W_o	24.3	24.6	######	
	Dry Density PCF	γ_{d_o}	100.6	99.4	######	
	Saturation %	S_o	98.6	96.9	######	
	Void Ratio	e_o	0.657	0.677	######	
After Shear	Water content %	W_f	24.2	21.9	######	
	Dry Density PCF	γ_{d_f}	101.2	105.1	######	
	Saturation %	S_f	100.0	100.0	######	
	Void Ratio	e_f	0.647	0.586	######	
	Final Back Pressure TSF	u_c	5.76	4.32	0.00	
Minor Principal Stress TSF @ failure		σ_3'f	0.23	1.02	0.00	
Maximum Deviator Stress (tsf) @ failure		$(\sigma_1'-\sigma_3')_{max}$	1.24	2.81	0.00	
Time to (σ1'-σ3')max min.		t_f	43.4	227.6	0.0	
Ultimate Deviator Stress, t/sq ft		$(\sigma1'-\sigma3')_{ult}$	n/a	n/a	0.00	
Initial Diameter, in.		D_o	2.884	2.887	######	
Initial Height, in.		H_o	6.188	6.054	######	

Controlled - Strain Test

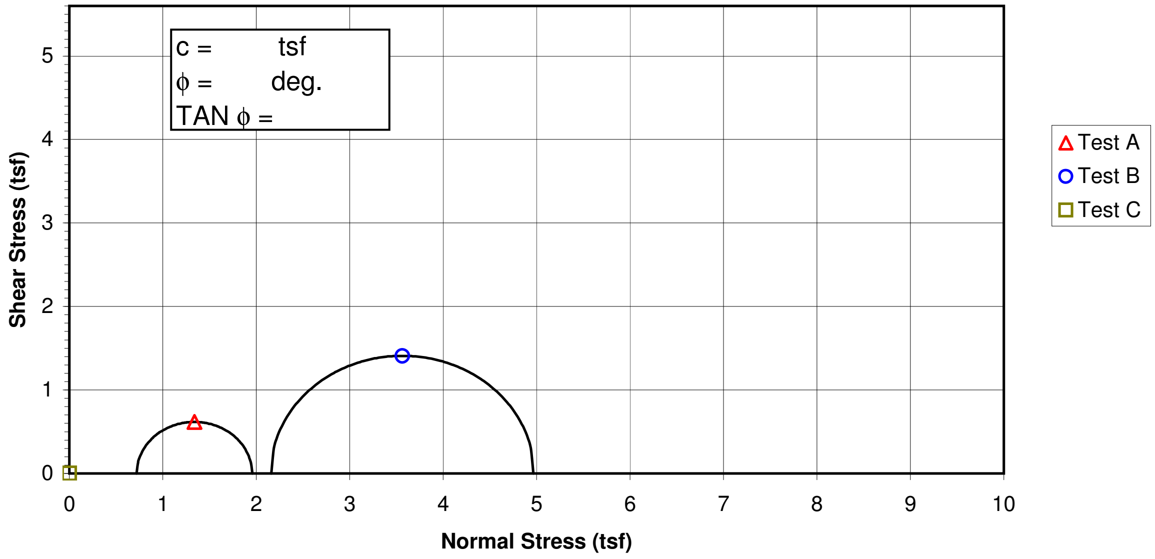
Description of Specimens	Lean Clay (CL), dark brown, moist, firm				
	Type of Specimen	Undisturbed	Type of test	$\bar{R}$	
LL	PL	PI	Gs 2.67	Project	Cumberland Dry Ash Stack and Gypsum Disposal Area
Remarks:					
	Boring No.	B-43A	Sample No.	1260	
	Depth Elev.	50.7'-51.2', 50.2'-50.7'			
	Laboratory	Stantec	Date	8-19-09	

TRIAXIAL COMPRESSION TEST REPORT

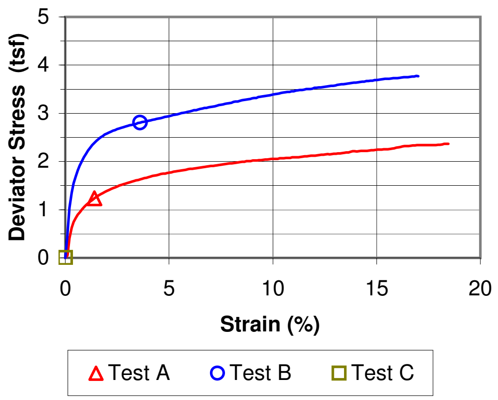
EM 1110-2-1906
Appendix X
30 Nov. 70

Failure Criterion: Maximum Effective Principal Stress Ratio

Total Strength Envelope



Deviator Stress vs. Strain



Specimen No.			A	B	C	
Initial Data	Water content %	W_o	24.3	24.6	######	
	Dry Density PCF	γ_{d_o}	100.6	99.4	######	
	Saturation %	S_o	98.6	96.9	######	
	Void Ratio	e_o	0.657	0.677	######	
After Shear	Water content %	W_f	24.2	21.9	######	
	Dry Density PCF	γ_{d_f}	101.2	105.1	######	
	Saturation %	S_f	100.0	100.0	######	
	Void Ratio	e_f	0.647	0.586	######	
	Final Back Pressure TSF	u_c	5.76	4.32	0.00	
Minor Principal Stress TSF		σ_3	0.72	2.16	0.00	
Maximum Deviator Stress (tsf) @ failure		$(\sigma_1\text{-}\sigma_3)_{max}$	1.24	2.81	0.00	
Time to $(\sigma_1\text{-}\sigma_3)_{Max.}$ min.		t_f	43.4	227.6	0.0	
Ultimate Deviator Stress, t/sq ft		$(\sigma_1\text{-}\sigma_3)_{ult}$	n/a	n/a	0.00	
Initial Diameter, in.		D_o	2.884	2.887	######	
Initial Height, in.		H_o	6.188	6.054	######	

Controlled - Strain Test

Description of Specimens Lean Clay (CL), dark brown, moist, firm

		Type of Specimen	Undisturbed	Type of test	$\overline{R}$
LL	PL	PI	Gs 2.67	Project	Cumberland Dry Ash Stack and Gypsum Disposal Area
Remarks:					
		Boring No.	B-43A	Sample No.	1260
		Depth Elev.	50.7'-51.2', 50.2'-50.7'		
		Laboratory	Stantec	Date	8-19-09

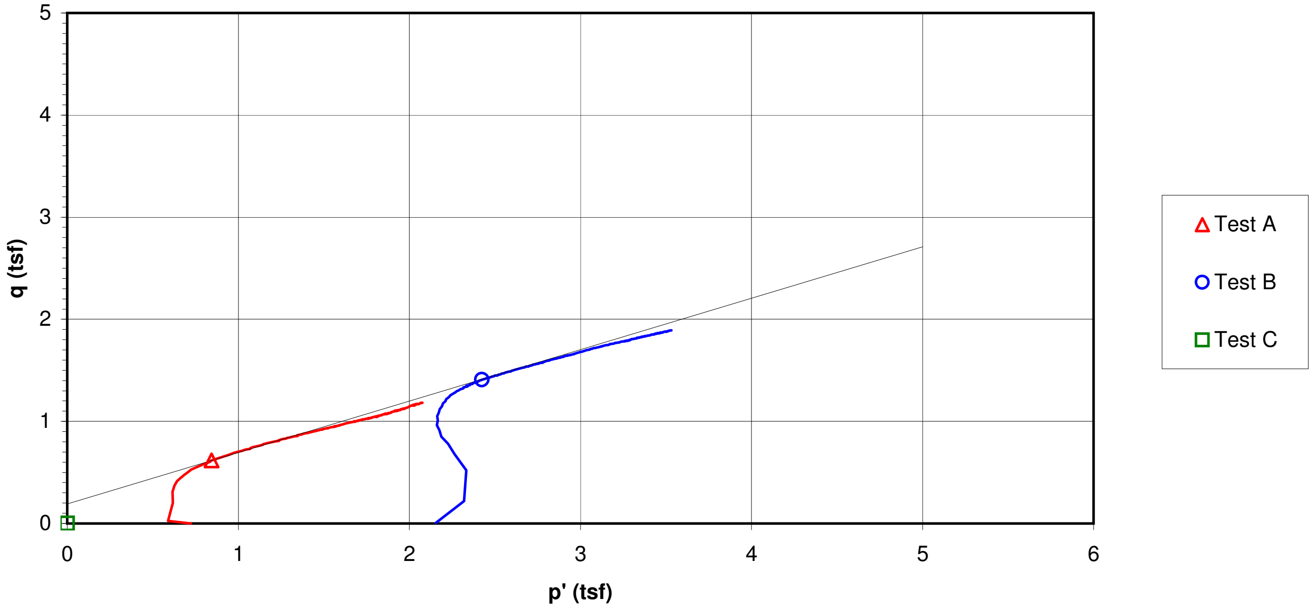
TRIAXIAL COMPRESSION TEST REPORT

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

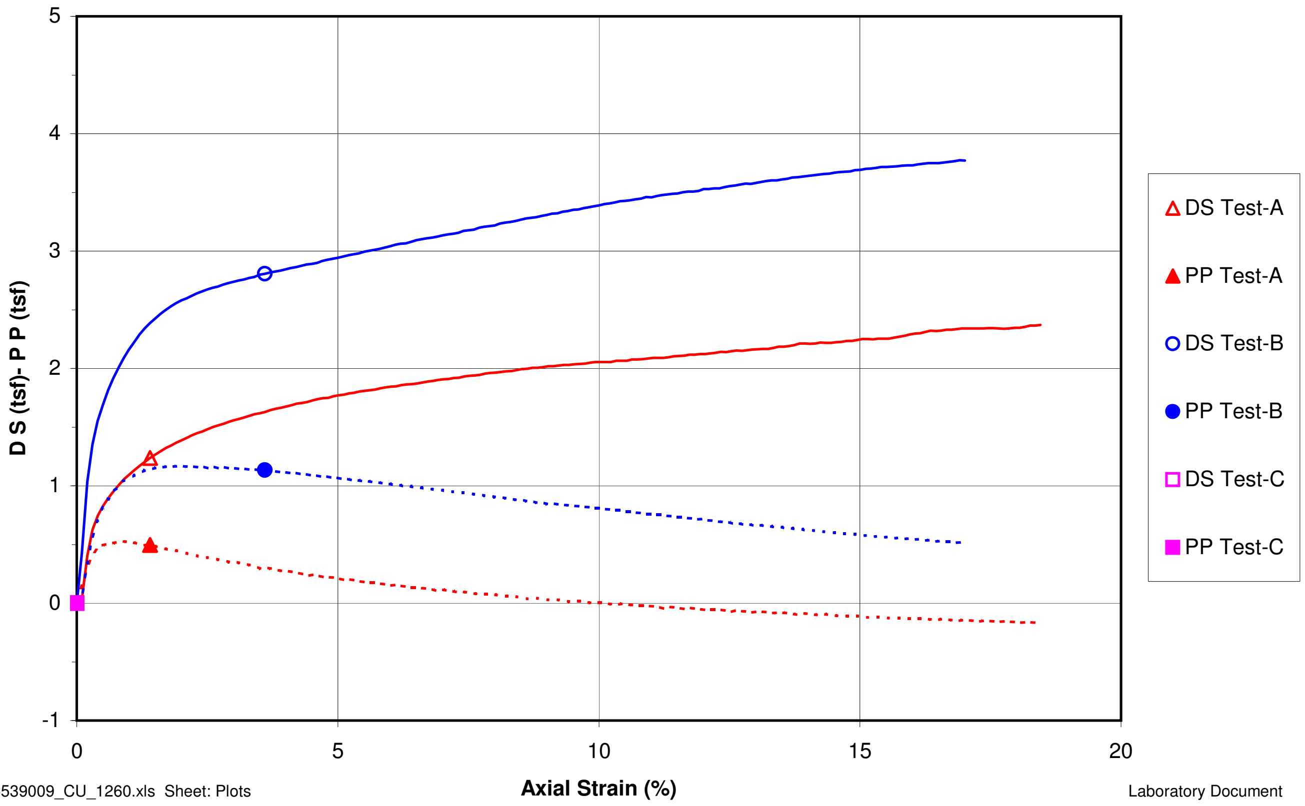
Project	Cumberland Dry Ash Stack and Gypsum Disposal Area	Project No.	175539009
Sample ID	B-43A, 50.7'-51.2' & B-43A, 50.2'-50.7'	Test Number	1260

Failure Criterion: Maximum Effective Principal Stress Ratio φ' = 30.3 deg. c' = 0.22 tsf

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain



File: 175539009_CU_1260.xls Sheet: Plots
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

Consolidated Undrained Triaxial Test

ASTM D4767-04

Project Name	Cumberland Dry Ash Stack and Gypsum Disposal Area	Project Number	175539009
Sample Identification	B-43A, 50.7'-51.2'	Test Number	CU-1260A
Visual Description	Lean Clay (CL), dark brown, moist, firm	Prepared By	RJ
Undisturbed	Source B-43A, 50.0'-52.0'	Date	7-27-2009

Specific Gravity	2.67	ASTM D854 Method A	Liquid Limit	N/A	Plastic Limit	N/A	Plasticity Index	N/A

Initial Specimen Data

Specimen Diameter (in.)		Specimen Height (in.)		Volumes (in^3)		Specimen	
Top	2.888	1	6.187	Sample	40.4309 (V_o)	Wet Weight (g)	1326.47
Middle	2.884	2	6.184	Solids	24.3976 (VS_o)	Dry Weight (g)	1067.55
Bottom	2.881	3	6.193	Water	15.7995 (Vw_o)	Wet Unit Weight (pcf)	125.0
Avg.	2.8843 (D_o)	4	6.187	Voids	16.0333 (Vv_o)	Dry Unit Weight (pcf)	100.6
Area (in^2)	6.5340 (A_o)	Avg. (H_o)	6.1878	Degree of Saturation (%)	98.5 (S_o)		
Moisture Content (%)	24.3	Final Trimmings		Void Ratio	0.657		

Saturation

Set Up & Saturated:	Wet xx	Dry		Set up By	KDG
Back Pressure Saturated to:	80 (psi)	Final Pore Pressure Parameter B	0.96	Date	8-13-09
				Panel Board Number	C

Height Readings (in.)		Back Pressure Burette		Chamber Burette			
Initial	0.1364	Initial	10.96 (in.)	Initial	12.22 (in.)	Specimen Height (in.)	6.1942 (H_s)
Final	0.13	Final	8.36 (in.)	Final	8.93 (in.)	Area (in^2) Method A	6.5475 (A_s)
Change	0.0064 (ΔH_o)	Change	-2.60 (in.)	Change	-3.29 (in.)	Specimen Volume (in^3)	40.56 (Vs)

Consolidation

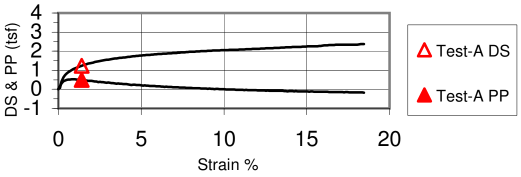
Height Readings (in.)		Back Pressure Burette Readings		Chamber Burette Readings		Pressures (psi)	
Initial	0.13	Initial	1.27 (in.)	Initial	17.63 (in.)	Chamber	90
Final	0.1435	Final	2.83 (in.)	Final	15.95 (in.)	Back	80
Change	-0.0135 (ΔH_c)	Change	-1.56 (in.)	Change	-1.68 (in.)	Lateral	10 (σ_3)
Height (in.)	6.1807 (H_c)			Volume (in^3)	40.1825 (V_c)		
Area (in^3) Method B	6.5013 (A_c)			Volume - Water (in^3)	15.7848 (VWc)	t_{50} (min.)	6.7
Diameter (in.)	2.8771 (D_c)			Water Content (%)	24.2		
Dry Density (pcf)	101.2			Degree of Saturation (%)	100.0 (S_c)	Void Ratio	0.647

After Test

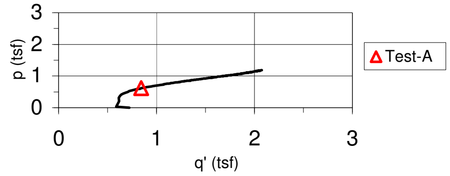
Final Measurements		Final Moisture Content		Stresses (membrane corrected) at Failure (psi)	
Maximum Diameter	3.375 (in.)	Wet Weight (g)	1326.23	Corrected Deviator	1.24 σ_d (tsf)
Wet weight (g)	1326.23 (WWf)	Dry Weight (g)	1067.55	Major Principal	1.46 $\sigma_1'_f$ (tsf)
Corrected Diameter	3.351 (in.)	Tare Weight (g)	0.00	Minor Principal	0.23 $\sigma_3'_f$ (tsf)
				Rate of Strain (% / min.)	0.033
Youngs Modulus for Membrane (psi)	200			Axial Strain at Failure (%)	1.40
Membrane Thickness (in.)	0.012			Failure Criterion:	Maximum Effective Principal Stress Ratio

Failure Sketch

Deviator Stress and Induced Pore Pressure vs. Strain



p' vs. q Plot



Comments:

Stantec

Consolidated Undrained Triaxial Test

ASTM D4767-04

Project Name	Cumberland Dry Ash Stack and Gypsum Disposal Area	Project Number	175539009
Sample Identification	B-43A, 50.2'-50.7'	Test Number	CU-1260B
Visual Description	Lean Clay (CL), dark brown, moist, firm	Prepared By	RJ
Undisturbed	Source B-43A, 50.0'-52.0'	Date	7-27-2009

Specific Gravity 2.67 ASTM D854 Method A   Liquid Limit N/A   Plastic Limit N/A   Plasticity Index N/A

Initial Specimen Data

Specimen Diameter (in.)		Specimen Height (in.)		Volumes (in3)		Specimen	
Top	2.885	1	6.043	Sample	39.6285 (V_o)	Wet Weight (g)	1287.66
Middle	2.886	2	6.094	Solids	23.6216 (VS_o)	Dry Weight (g)	1033.59
Bottom	2.890	3	6.036	Water	15.5034 (Vw_o)	Wet Unit Weight (pcf)	123.8
Avg.	2.8870 (D_o)	4	6.043	Voids	16.0069 (Vv_o)	Dry Unit Weight (pcf)	99.4
Area (in^2)	6.5461 (A_o)	Avg. (H_o)	6.0538	Degree of Saturation (%)	96.9 (S_o)		
Moisture Content (%)	24.6	Final Trimmings		Void Ratio	0.678		

Saturation

Set Up & Saturated: Wet xx Dry ____   Set up By KDG

Back Pressure Saturated to: 60 (psi)   Final Pore Pressure Parameter B 0.97   Date 8-13-09

Panel Board Number D

Height Readings (in.)		Back Pressure Burette		Chamber Burette			
Initial	0.1518	Initial	16.64 (in.)	Initial	12.17 (in.)	Specimen Height (in.)	6.0574 (H_s)
Final	0.1482	Final	13.6 (in.)	Final	9.78 (in.)	Area (in^2) Method A	6.5539 (A_s)
Change	0.0036 (ΔH_o)	Change	-3.04 (in.)	Change	-2.39 (in.)	Specimen Volume (in^3)	39.70 (V_s)

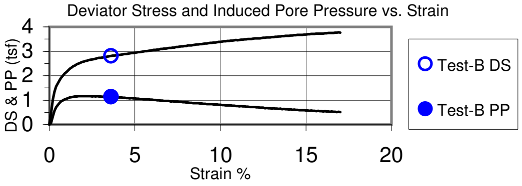
Consolidation

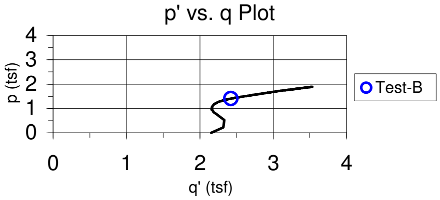
Height Readings (in.)		Back Pressure Burette Readings		Chamber Burette Readings		Pressures (psi)	
Initial	0.1482	Initial	0.95 (in.)	Initial	17.56 (in.)	Chamber	90
Final	0.1986	Final	7.09 (in.)	Final	11.46 (in.)	Back	60
Change	-0.0504 (ΔH_c)	Change	-6.14 (in.)	Change	-6.10 (in.)	Lateral	30 (σ_3)
Height (in.)	6.0070 (H_c)			Volume (in^3)	37.4591 (V_c)		
Area (in^3) Method B	6.2360 (A_c)			Volume - Water (in^3)	13.8375 (VWc)	D_{50} (min.)	3.9
Diameter (in.)	2.8178 (D_c)			Water Content (%)	21.9		
Dry Density (pcf)	105.1			Degree of Saturation (%)	100.0 (S_c)	Void Ratio	0.586

After Test

Final Measurements		Final Moisture Content		Stresses (membrane corrected) at Failure (psi)	
Maximum Diameter	3.312 (in.)	Wet Weight (g)	1260.36	Corrected Deviator	2.81 σ_d (tsf)
Wet weight (g)	1260.36 (WWf)	Dry Weight (g)	1033.59	Major Principal	3.83 $\sigma_1'_f$ (tsf)
Corrected Diameter	3.288 (in.)	Tare Weight (g)	0.00	Minor Principal	1.02 $\sigma_3'_f$ (tsf)
				Rate of Strain (% / min.)	0.015
Youngs Modulus for Membrane (psi)	200			Axial Strain at Failure (%)	3.60
Membrane Thickness (in.)	0.012			Failure Criterion:	Maximum Effective Principal Stress Ratio

Failure Sketch





Comments:

File: 175539009_CU_1260.xls Sheet: Specimen-B
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			Final Values	
Height	6.181 (in.)	15.699 (cm)	Height	5.040 (in.)	
Diameter	2.877 (in)	7.308 (cm)	Dia. avg.	3.277 (in)	
Area	6.502 (in^2)	41.947 (cm^2)	Area avg.	8.432 (in^2)	

Tested By	KDG
Date	8-14-09
Press No.	1
Panel No.	C

Project Number	175539009
Test Number	CU-1260A
Data File ID	1260A
Lateral Pressure (psi)	10.0
Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1'/σ_3'
0:00:00	13.5	-0.022	80.0	6.181	0.00	41.9466	0.0	0.000	0.000	0.720	0.720	0.723	0.721	-0.001	0.996
0:03:28	18.5	-0.015	82.2	6.174	0.10	41.9899	5.0	0.056	0.055	0.775	0.616	0.563	0.589	0.026	1.093
0:06:43	50.1	-0.009	84.2	6.168	0.20	42.0317	36.6	0.405	0.404	1.124	0.817	0.416	0.617	0.201	1.964
0:09:56	70.0	-0.003	85.8	6.162	0.30	42.0732	56.5	0.624	0.623	1.343	0.925	0.305	0.615	0.310	3.034
0:13:04	81.1	0.003	86.5	6.156	0.40	42.1164	67.6	0.747	0.746	1.466	0.998	0.255	0.626	0.371	3.911
0:16:07	88.7	0.009	86.8	6.150	0.50	42.1585	75.2	0.829	0.828	1.548	1.055	0.229	0.642	0.413	4.597
0:19:09	94.9	0.016	87.0	6.143	0.60	42.2016	81.4	0.897	0.896	1.616	1.108	0.215	0.661	0.446	5.155
0:22:00	100.3	0.022	87.1	6.137	0.70	42.2433	86.8	0.955	0.954	1.674	1.160	0.209	0.685	0.475	5.542
0:25:01	105.1	0.028	87.2	6.131	0.81	42.2871	91.6	1.008	1.006	1.726	1.207	0.204	0.705	0.501	5.924
0:28:04	109.8	0.034	87.3	6.125	0.90	42.3294	96.3	1.058	1.056	1.776	1.250	0.197	0.724	0.527	6.339
0:31:03	113.6	0.040	87.2	6.119	1.00	42.3718	100.1	1.099	1.096	1.816	1.295	0.201	0.748	0.547	6.431
0:34:04	117.1	0.046	87.1	6.112	1.10	42.4149	103.6	1.136	1.134	1.854	1.340	0.209	0.774	0.565	6.412
0:37:11	120.5	0.053	87.0	6.106	1.20	42.4577	107.0	1.172	1.169	1.889	1.385	0.218	0.801	0.583	6.346
0:40:17	123.9	0.059	86.8	6.100	1.30	42.5009	110.4	1.208	1.205	1.925	1.433	0.231	0.832	0.601	6.205
0:43:23	127.0	0.065	86.9	6.094	1.40	42.5442	113.5	1.241	1.237	1.957	1.461	0.227	0.844	0.617	6.445
0:46:32	129.9	0.071	86.7	6.088	1.51	42.5876	116.4	1.271	1.267	1.987	1.503	0.239	0.871	0.632	6.287
0:49:34	132.6	0.077	86.5	6.081	1.61	42.6315	119.1	1.299	1.295	2.015	1.541	0.249	0.895	0.646	6.178
0:52:32	135.1	0.084	86.4	6.075	1.71	42.6749	121.6	1.325	1.321	2.041	1.578	0.260	0.919	0.659	6.061
0:55:34	137.2	0.090	86.2	6.069	1.81	42.7183	123.7	1.347	1.342	2.062	1.614	0.274	0.944	0.670	5.888
0:58:39	139.7	0.096	86.2	6.063	1.91	42.7622	126.2	1.372	1.367	2.087	1.641	0.276	0.958	0.682	5.940
1:01:35	141.6	0.102	86.0	6.057	2.01	42.8055	128.1	1.392	1.387	2.107	1.670	0.285	0.977	0.692	5.853
1:04:36	143.7	0.108	85.9	6.050	2.11	42.8494	130.2	1.413	1.408	2.128	1.702	0.297	0.999	0.702	5.730
1:07:35	145.8	0.115	85.7	6.044	2.21	42.8935	132.3	1.435	1.429	2.149	1.735	0.308	1.022	0.713	5.627
1:10:35	147.9	0.121	85.5	6.038	2.31	42.9376	134.4	1.455	1.450	2.170	1.767	0.321	1.044	0.723	5.512
1:13:33	149.4	0.127	85.3	6.032	2.41	42.9816	135.9	1.470	1.464	2.184	1.801	0.340	1.070	0.731	5.300
1:16:30	151.1	0.133	85.4	6.026	2.51	43.0257	137.6	1.487	1.481	2.201	1.810	0.332	1.071	0.739	5.449
1:19:21	153.1	0.139	85.3	6.019	2.61	43.0699	139.6	1.507	1.501	2.221	1.839	0.341	1.090	0.749	5.391
1:22:20	154.6	0.146	85.1	6.013	2.71	43.1146	141.1	1.522	1.516	2.236	1.864	0.351	1.108	0.756	5.304
1:25:14	156.1	0.152	85.0	6.007	2.81	43.1597	142.6	1.537	1.530	2.250	1.889	0.362	1.125	0.763	5.220
1:28:05	157.6	0.158	84.8	6.001	2.91	43.2036	144.1	1.551	1.544	2.264	1.913	0.373	1.143	0.770	5.136
1:31:04	159.0	0.164	84.9	5.995	3.01	43.2486	145.5	1.565	1.557	2.277	1.923	0.369	1.146	0.777	5.211
1:34:01	160.3	0.170	84.7	5.988	3.11	43.2931	146.8	1.577	1.569	2.289	1.947	0.380	1.163	0.783	5.120
1:36:58	161.8	0.177	84.6	5.982	3.21	43.3383	148.3	1.592	1.584	2.304	1.970	0.389	1.180	0.790	5.063
1:39:54	163.2	0.183	84.5	5.976	3.31	43.3835	149.7	1.605	1.597	2.317	1.992	0.398	1.195	0.797	5.003
1:42:50	164.6	0.189	84.3	5.970	3.41	43.4278	151.2	1.618	1.610	2.330	2.017	0.410	1.213	0.804	4.924
1:45:49	165.6	0.195	84.0	5.964	3.51	43.4732	152.1	1.627	1.618	2.338	2.046	0.430	1.238	0.808	4.757
1:48:53	166.7	0.201	84.2	5.957	3.61	43.5185	153.2	1.637	1.629	2.349	2.045	0.420	1.232	0.813	4.874
1:51:57	168.4	0.208	84.1	5.951	3.71	43.5637	154.9	1.654	1.645	2.365	2.070	0.428	1.249	0.821	4.839
1:55:02	169.7	0.214	83.9	5.945	3.81	43.6096	156.2	1.666	1.656	2.376	2.090	0.437	1.264	0.827	4.784
1:58:07	170.7	0.220	83.8	5.939	3.91	43.6548	157.2	1.674	1.665	2.385	2.110	0.449	1.279	0.831	4.705
2:01:10	171.9	0.226	83.8	5.933	4.01	43.7003	158.4	1.685	1.675	2.395	2.120	0.447	1.283	0.836	4.741
2:04:09	173.2	0.232	83.7	5.926	4.11	43.7459	159.7	1.697	1.687	2.407	2.139	0.455	1.297	0.842	4.704
2:07:12	174.5	0.239	83.6	5.920	4.21	43.7920	161.0	1.709	1.699	2.419	2.159	0.463	1.311	0.848	4.667
2:10:17	175.4	0.245	83.4	5.914	4.31	43.8377	161.9	1.717	1.707	2.427	2.179	0.475	1.327	0.852	4.590
2:13:21	176.3	0.251	83.2	5.908	4.42	43.8843	162.8	1.725	1.714	2.434	2.202	0.491	1.346	0.856	4.486
2:16:21	177.8	0.257	83.3	5.902	4.52	43.9301	164.3	1.739	1.728	2.448	2.206	0.481	1.343	0.863	4.586
2:19:21	179.0	0.263	83.2	5.895	4.61	43.9759	165.5	1.750	1.739	2.459	2.226	0.489	1.357	0.868	4.548
2:22:26	179.8	0.270	83.1	5.889	4.72	44.0223	166.3	1.757	1.746	2.466	2.242	0.499	1.371	0.871	4.491
2:25:26	180.5	0.276	83.1	5.883	4.82	44.0686	167.0	1.762	1.750	2.470	2.246	0.499	1.373	0.874	4.501
2:28:26	181.9	0.282	83.0	5.877	4.92	44.1159	168.4	1.775	1.764	2.484	2.266	0.505	1.386	0.880	4.483
2:31:29	182.9	0.288	82.9	5.871	5.02	44.1618	169.4	1.784	1.772	2.492	2.282	0.514	1.398	0.884	4.444
2:34:33	183.6	0.294	82.7	5.864	5.12	44.2086	170.1	1.789	1.777	2.497	2.298	0.524	1.411	0.887	4.385
2:37:38	184.8	0.301	82.7	5.858	5.22	44.2558	171.3	1.800	1.788	2.508	2.307	0.522	1.415	0.892	4.417
2:40:38	185.6	0.307	82.7	5.852	5.32	44.3021	172.1	1.807	1.794	2.514	2.319	0.528	1.423	0.895	4.391
2:43:41	186.7	0.313	82.5	5.846	5.42	44.3494	173.2	1.816	1.803	2.523	2.336	0.536	1.436	0.900	4.355
2:46:47	187.5	0.319	82.5	5.840	5.52	44.3964	174.0	1.822	1.809	2.529	2.349	0.543	1.446	0.903	4.325
2:49:49	188.3	0.325	82.4	5.833	5.62	44.4434	174.8	1.829	1.816	2.536	2.362	0.549	1.455	0.906	4.303
2:52:47	189.1	0.332	82.4	5.827	5.72	44.4905	175.6	1.835	1.821	2.541	2.367	0.549	1.458	0.909	4.313
2:55:48	190.3	0.338	82.3	5.821	5.82	44.5380	176.8	1.846	1.832	2.552	2.385	0.556	1.470	0.914	4.288
2:58:45	191.3	0.344	82.2	5.815	5.92	44.5854	177.8	1.854	1.840	2.560	2.400	0.563	1.482	0.918	4.261

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Consolidation Values				Final Values		Tested By	KDG	Project Number	175539009
Height	6.181 (in.)	15.699 (cm)		Height	5.040 (in.)	Date	8-14-09	Test Number	CU-1260A
Diameter	2.877 (in)	7.308 (cm)		Dia. avg.	3.277 (in)	Press No.	1	Data File ID	1260A
Area	6.502 (in^2)	41.947 (cm^2)		Area avg.	8.432 (in^2)	Panel No.	C	Lateral Pressure (psi)	10.0
								Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
3:01:40	192.0	0.350	82.0	5.809	6.02	44.6335	178.5	1.860	1.846	2.566	2.415	0.573	1.494	0.921	4.218
3:04:42	192.5	0.356	82.1	5.802	6.12	44.6811	179.1	1.863	1.849	2.569	2.414	0.568	1.491	0.923	4.250
3:07:37	193.6	0.363	82.0	5.796	6.22	44.7289	180.1	1.872	1.857	2.577	2.431	0.576	1.503	0.927	4.218
3:10:38	194.4	0.369	81.9	5.790	6.32	44.7765	180.9	1.878	1.863	2.583	2.443	0.583	1.513	0.930	4.190
3:13:36	194.9	0.375	81.8	5.784	6.42	44.8247	181.4	1.882	1.867	2.587	2.454	0.591	1.523	0.932	4.155
3:16:33	195.6	0.381	81.8	5.778	6.52	44.8726	182.1	1.887	1.872	2.592	2.458	0.589	1.523	0.934	4.173
3:19:24	196.8	0.387	81.8	5.771	6.62	44.9210	183.3	1.897	1.881	2.601	2.472	0.594	1.533	0.939	4.163
3:22:17	197.8	0.394	81.7	5.765	6.72	44.9692	184.3	1.905	1.889	2.609	2.486	0.600	1.543	0.943	4.146
3:25:18	198.4	0.400	81.6	5.759	6.82	45.0180	184.9	1.909	1.893	2.613	2.497	0.607	1.552	0.945	4.114
3:28:08	199.5	0.406	81.4	5.753	6.92	45.0659	186.0	1.919	1.903	2.623	2.521	0.621	1.571	0.950	4.060
3:31:03	200.2	0.412	81.5	5.747	7.02	45.1149	186.7	1.925	1.908	2.628	2.514	0.610	1.562	0.952	4.124
3:34:06	200.7	0.418	81.4	5.740	7.12	45.1634	187.2	1.927	1.910	2.630	2.524	0.617	1.571	0.954	4.091
3:37:03	201.7	0.425	81.3	5.734	7.22	45.2124	188.2	1.935	1.918	2.638	2.538	0.623	1.581	0.958	4.072
3:40:01	202.3	0.431	81.2	5.728	7.32	45.2616	188.8	1.940	1.922	2.642	2.552	0.633	1.593	0.960	4.032
3:43:02	203.4	0.437	81.3	5.722	7.42	45.3101	189.9	1.949	1.931	2.651	2.555	0.627	1.591	0.964	4.075
3:46:00	204.3	0.443	81.2	5.716	7.52	45.3593	190.8	1.956	1.938	2.658	2.567	0.632	1.600	0.967	4.059
3:49:05	204.6	0.449	81.1	5.709	7.62	45.4090	191.1	1.957	1.939	2.659	2.576	0.640	1.608	0.968	4.025
3:52:07	205.5	0.456	81.0	5.703	7.73	45.4582	192.1	1.965	1.946	2.666	2.588	0.645	1.617	0.972	4.012
3:55:11	206.7	0.462	81.1	5.697	7.83	45.5077	193.2	1.974	1.955	2.675	2.595	0.643	1.619	0.976	4.037
3:58:14	207.5	0.468	81.0	5.691	7.93	45.5570	194.0	1.981	1.961	2.681	2.605	0.646	1.626	0.979	4.031
4:01:17	208.1	0.474	80.9	5.685	8.03	45.6068	194.6	1.984	1.965	2.685	2.615	0.653	1.634	0.981	4.005
4:04:15	208.9	0.480	80.8	5.678	8.13	45.6565	195.4	1.990	1.970	2.690	2.627	0.660	1.643	0.984	3.983
4:07:18	209.7	0.487	80.8	5.672	8.23	45.7068	196.2	1.996	1.976	2.696	2.636	0.662	1.649	0.987	3.980
4:10:20	210.2	0.493	80.8	5.666	8.33	45.7569	196.7	1.999	1.979	2.699	2.638	0.662	1.650	0.988	3.987
4:13:18	211.1	0.499	80.7	5.660	8.43	45.8064	197.6	2.006	1.986	2.706	2.651	0.668	1.659	0.991	3.970
4:16:17	212.1	0.505	80.6	5.654	8.53	45.8567	198.6	2.014	1.994	2.714	2.665	0.674	1.669	0.995	3.954
4:19:15	212.6	0.511	80.5	5.647	8.63	45.9073	199.1	2.017	1.996	2.716	2.680	0.687	1.683	0.997	3.903
4:22:15	213.8	0.518	80.6	5.641	8.73	45.9576	200.3	2.026	2.005	2.725	2.678	0.676	1.677	1.001	3.964
4:25:21	214.1	0.524	80.5	5.635	8.83	46.0083	200.6	2.027	2.006	2.726	2.685	0.682	1.684	1.002	3.937
4:28:25	214.8	0.530	80.4	5.629	8.93	46.0590	201.3	2.032	2.011	2.731	2.696	0.689	1.692	1.004	3.916
4:31:25	215.8	0.536	80.3	5.623	9.03	46.1096	202.3	2.040	2.018	2.738	2.711	0.696	1.704	1.008	3.896
4:34:31	216.1	0.542	80.4	5.616	9.13	46.1605	202.6	2.041	2.019	2.739	2.706	0.690	1.698	1.008	3.924
4:37:32	216.8	0.549	80.3	5.610	9.23	46.2115	203.3	2.046	2.024	2.744	2.716	0.695	1.706	1.010	3.907
4:40:36	217.6	0.555	80.3	5.604	9.33	46.2625	204.1	2.051	2.029	2.749	2.727	0.701	1.714	1.013	3.892
4:43:40	217.9	0.561	80.2	5.598	9.43	46.3140	204.4	2.052	2.029	2.749	2.734	0.708	1.721	1.013	3.862
4:46:47	218.8	0.567	80.2	5.592	9.53	46.3652	205.3	2.059	2.036	2.756	2.737	0.704	1.721	1.017	3.889
4:49:50	219.3	0.573	80.2	5.585	9.63	46.4167	205.8	2.062	2.039	2.759	2.744	0.708	1.726	1.018	3.876
4:52:46	219.8	0.580	80.1	5.579	9.73	46.4683	206.3	2.064	2.041	2.761	2.752	0.714	1.733	1.019	3.854
4:55:46	220.7	0.586	80.0	5.573	9.83	46.5199	207.3	2.072	2.048	2.768	2.765	0.719	1.742	1.023	3.842
4:58:48	221.5	0.592	80.0	5.567	9.93	46.5720	208.0	2.077	2.053	2.773	2.770	0.720	1.745	1.025	3.847
5:01:45	221.9	0.598	80.0	5.561	10.03	46.6242	208.4	2.078	2.054	2.774	2.771	0.720	1.745	1.026	3.850
5:04:41	222.1	0.604	79.9	5.554	10.13	46.6757	208.6	2.078	2.054	2.774	2.776	0.725	1.750	1.026	3.830
5:07:40	222.5	0.611	79.9	5.548	10.23	46.7281	209.0	2.080	2.056	2.776	2.783	0.731	1.757	1.026	3.809
5:10:41	223.8	0.617	79.7	5.542	10.33	46.7802	210.3	2.091	2.066	2.786	2.803	0.740	1.772	1.031	3.786
5:13:34	224.0	0.623	79.9	5.536	10.43	46.8327	210.5	2.090	2.065	2.785	2.792	0.730	1.761	1.031	3.826
5:16:24	224.3	0.629	79.8	5.530	10.53	46.8854	210.8	2.091	2.066	2.786	2.799	0.736	1.768	1.031	3.801
5:19:16	225.6	0.635	79.7	5.523	10.63	46.9376	212.1	2.101	2.075	2.795	2.812	0.739	1.775	1.036	3.804
5:22:08	225.9	0.642	79.7	5.517	10.73	46.9904	212.4	2.102	2.076	2.796	2.818	0.745	1.781	1.037	3.784
5:25:01	226.3	0.648	79.7	5.511	10.83	47.0438	212.8	2.104	2.078	2.798	2.819	0.744	1.781	1.037	3.789
5:27:54	227.3	0.654	79.7	5.505	10.93	47.0964	213.8	2.111	2.085	2.805	2.827	0.745	1.786	1.041	3.795
5:30:52	228.2	0.660	79.6	5.499	11.04	47.1501	214.7	2.118	2.091	2.811	2.839	0.750	1.795	1.044	3.782
5:33:50	228.3	0.666	79.5	5.492	11.14	47.2027	214.8	2.116	2.089	2.809	2.842	0.756	1.799	1.043	3.761
5:36:51	228.6	0.673	79.3	5.486	11.24	47.2563	215.1	2.116	2.089	2.809	2.856	0.769	1.812	1.043	3.713
5:39:45	229.5	0.679	79.5	5.480	11.34	47.3098	216.0	2.123	2.096	2.816	2.848	0.755	1.802	1.047	3.771
5:42:47	230.5	0.685	79.5	5.474	11.44	47.3636	217.0	2.131	2.103	2.823	2.860	0.759	1.810	1.050	3.765
5:45:49	231.0	0.691	79.4	5.468	11.54	47.4168	217.5	2.133	2.105	2.825	2.869	0.766	1.817	1.051	3.743
5:48:50	231.7	0.697	79.3	5.461	11.64	47.4710	218.2	2.137	2.109	2.829	2.878	0.772	1.825	1.053	3.729
5:51:56	232.7	0.704	79.4	5.455	11.74	47.5254	219.2	2.144	2.116	2.836	2.878	0.765	1.821	1.057	3.764
5:55:03	233.1	0.710	79.3	5.449	11.84	47.5788	219.6	2.146	2.118	2.838	2.885	0.770	1.827	1.057	3.748
5:58:03	234.0	0.716	79.2	5.443	11.94	47.6328	220.5	2.152	2.124	2.844	2.895	0.774	1.835	1.060	3.739

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Consolidation Values
Height 6.181 (in.) 15.699 (cm)
Diameter 2.877 (in) 7.308 (cm)
Area 6.502 (in^2) 41.947 (cm^2)

Final Values
Height 5.040 (in.)
Dia. avg. 3.277 (in)
Area avg. 8.432 (in^2)

Tested By KDG
Date 8-14-09
Press No. 1
Panel No. C

Project Number 175539009
Test Number CU-1260A
Data File ID 1260A
Lateral Pressure (psi) 10.0
Chamber Pressure - σ_3 (psi) 90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
6:01:06	234.1	0.722	79.2	5.437	12.04	47.6872	220.6	2.151	2.122	2.842	2.899	0.779	1.839	1.060	3.719
6:04:12	235.0	0.728	79.2	5.430	12.14	47.7415	221.5	2.158	2.129	2.849	2.902	0.777	1.839	1.063	3.737
6:07:15	235.9	0.735	79.2	5.424	12.24	47.7967	222.4	2.164	2.134	2.854	2.909	0.778	1.844	1.066	3.741
6:10:15	236.8	0.741	79.1	5.418	12.34	47.8507	223.3	2.170	2.141	2.861	2.919	0.782	1.850	1.069	3.735
6:13:12	237.1	0.747	79.1	5.412	12.44	47.9055	223.6	2.170	2.140	2.860	2.924	0.787	1.855	1.069	3.716
6:16:13	238.1	0.753	78.9	5.406	12.54	47.9605	224.6	2.178	2.148	2.868	2.942	0.798	1.870	1.072	3.688
6:19:12	238.8	0.759	79.1	5.399	12.64	48.0157	225.3	2.182	2.152	2.872	2.933	0.784	1.858	1.074	3.742
6:22:14	238.9	0.766	79.0	5.393	12.74	48.0707	225.4	2.181	2.150	2.870	2.939	0.792	1.865	1.074	3.712
6:25:21	239.8	0.772	79.0	5.387	12.84	48.1263	226.3	2.187	2.156	2.876	2.948	0.795	1.872	1.076	3.707
6:28:21	240.7	0.778	78.9	5.381	12.94	48.1816	227.2	2.193	2.162	2.882	2.960	0.801	1.880	1.079	3.695
6:31:29	241.2	0.784	79.0	5.375	13.04	48.2377	227.8	2.195	2.164	2.884	2.955	0.793	1.874	1.081	3.724
6:34:34	241.7	0.790	78.9	5.368	13.14	48.2928	228.2	2.197	2.165	2.885	2.960	0.798	1.879	1.081	3.711
6:37:34	242.1	0.797	78.8	5.362	13.24	48.3486	228.6	2.198	2.166	2.886	2.967	0.803	1.885	1.082	3.694
6:40:41	243.2	0.803	78.8	5.356	13.34	48.4047	229.7	2.207	2.175	2.895	2.979	0.808	1.894	1.086	3.689
6:43:52	244.5	0.809	78.8	5.350	13.44	48.4611	231.0	2.216	2.184	2.904	2.985	0.804	1.894	1.091	3.713
6:46:56	245.0	0.815	78.8	5.344	13.54	48.5171	231.5	2.218	2.186	2.906	2.988	0.805	1.897	1.091	3.710
6:50:04	245.7	0.821	78.8	5.337	13.64	48.5734	232.2	2.223	2.190	2.910	2.997	0.810	1.903	1.093	3.701
6:53:06	246.8	0.828	78.7	5.331	13.74	48.6300	233.3	2.231	2.198	2.918	3.010	0.815	1.912	1.097	3.693
6:56:07	248.6	0.834	78.5	5.325	13.84	48.6869	235.1	2.245	2.212	2.932	3.036	0.827	1.932	1.104	3.670
6:59:07	248.9	0.840	78.7	5.319	13.94	48.7432	235.4	2.245	2.212	2.932	3.020	0.811	1.916	1.105	3.722
7:02:10	249.0	0.846	78.7	5.313	14.04	48.8000	235.5	2.244	2.210	2.930	3.023	0.816	1.919	1.103	3.706
7:05:11	249.6	0.852	78.6	5.306	14.15	48.8577	236.1	2.247	2.213	2.933	3.032	0.822	1.927	1.105	3.690
7:08:09	250.7	0.859	78.5	5.300	14.25	48.9147	237.2	2.255	2.220	2.940	3.045	0.828	1.936	1.109	3.679
7:11:16	250.8	0.865	78.6	5.294	14.35	48.9716	237.3	2.254	2.219	2.939	3.035	0.819	1.927	1.108	3.705
7:14:15	251.0	0.871	78.5	5.288	14.45	49.0291	237.5	2.252	2.218	2.938	3.040	0.825	1.933	1.107	3.683
7:17:06	251.9	0.877	78.5	5.282	14.55	49.0865	238.4	2.258	2.223	2.943	3.049	0.829	1.939	1.110	3.680
7:20:01	252.6	0.883	78.4	5.275	14.65	49.1441	239.1	2.262	2.227	2.947	3.058	0.834	1.946	1.112	3.668
7:23:00	253.6	0.890	78.4	5.269	14.75	49.2023	240.1	2.269	2.234	2.954	3.066	0.835	1.950	1.115	3.671
7:25:51	253.9	0.896	78.4	5.263	14.85	49.2601	240.4	2.269	2.234	2.954	3.062	0.832	1.947	1.115	3.682
7:28:41	255.2	0.902	78.4	5.257	14.95	49.3180	241.7	2.278	2.243	2.963	3.075	0.835	1.955	1.120	3.681
7:31:42	256.3	0.908	78.4	5.251	15.05	49.3764	242.8	2.286	2.250	2.970	3.085	0.838	1.961	1.124	3.683
7:34:43	256.6	0.914	78.3	5.244	15.15	49.4349	243.1	2.286	2.250	2.970	3.092	0.845	1.968	1.123	3.660
7:37:40	256.8	0.921	78.4	5.238	15.25	49.4934	243.3	2.286	2.249	2.969	3.084	0.838	1.961	1.123	3.682
7:40:43	257.6	0.927	78.3	5.232	15.35	49.5518	244.1	2.290	2.253	2.973	3.091	0.841	1.966	1.125	3.677
7:43:44	258.0	0.933	78.3	5.226	15.45	49.6108	244.5	2.291	2.254	2.974	3.096	0.845	1.970	1.126	3.666
7:46:45	258.3	0.939	78.2	5.220	15.55	49.6695	244.8	2.292	2.254	2.974	3.102	0.850	1.976	1.126	3.648
7:49:51	259.3	0.945	78.2	5.213	15.65	49.7287	245.8	2.299	2.261	2.981	3.104	0.846	1.975	1.129	3.669
7:52:50	260.6	0.952	78.2	5.207	15.75	49.7877	247.1	2.308	2.270	2.990	3.114	0.847	1.981	1.133	3.676
7:56:02	261.7	0.958	78.2	5.201	15.85	49.8478	248.2	2.315	2.277	2.997	3.126	0.851	1.988	1.137	3.671
7:59:12	263.2	0.964	78.1	5.195	15.95	49.9066	249.7	2.326	2.288	3.008	3.140	0.855	1.997	1.143	3.674
8:02:17	264.5	0.970	78.1	5.189	16.05	49.9671	251.0	2.336	2.297	3.017	3.150	0.855	2.003	1.147	3.682
8:05:22	265.1	0.976	78.1	5.182	16.15	50.0260	251.6	2.339	2.300	3.020	3.152	0.855	2.003	1.149	3.688
8:08:28	266.6	0.983	78.1	5.176	16.25	50.0863	253.1	2.350	2.311	3.031	3.163	0.855	2.009	1.154	3.698
8:11:32	268.0	0.989	78.0	5.170	16.35	50.1462	254.5	2.360	2.320	3.040	3.179	0.862	2.020	1.159	3.690
8:14:31	268.3	0.995	77.9	5.164	16.45	50.2063	254.8	2.360	2.320	3.040	3.190	0.873	2.031	1.159	3.656
8:17:34	268.6	1.001	78.1	5.158	16.55	50.2667	255.1	2.360	2.320	3.040	3.176	0.859	2.018	1.159	3.698
8:20:37	269.9	1.007	78.0	5.151	16.65	50.3272	256.4	2.369	2.329	3.049	3.187	0.861	2.024	1.163	3.701
8:23:41	270.4	1.014	77.9	5.145	16.75	50.3879	256.9	2.371	2.331	3.051	3.196	0.868	2.032	1.164	3.681
8:26:50	271.4	1.020	77.8	5.139	16.85	50.4486	257.9	2.377	2.336	3.056	3.208	0.875	2.042	1.167	3.667
8:29:54	272.0	1.026	78.0	5.133	16.95	50.5096	258.5	2.380	2.340	3.060	3.203	0.866	2.035	1.168	3.697
8:33:02	272.6	1.032	77.9	5.127	17.05	50.5707	259.1	2.383	2.342	3.062	3.208	0.869	2.039	1.169	3.690
8:36:12	272.9	1.038	77.9	5.120	17.15	50.6321	259.4	2.383	2.341	3.061	3.210	0.872	2.041	1.169	3.681
8:39:17	273.1	1.045	77.8	5.114	17.25	50.6934	259.7	2.382	2.340	3.060	3.217	0.880	2.049	1.169	3.656
8:42:22	273.5	1.051	77.9	5.108	17.35	50.7549	260.0	2.382	2.340	3.060	3.210	0.872	2.041	1.169	3.679
8:45:31	274.1	1.057	77.8	5.102	17.46	50.8169	260.6	2.385	2.343	3.063	3.216	0.875	2.045	1.170	3.673
8:48:40	274.5	1.063	77.8	5.096	17.56	50.8791	261.0	2.386	2.343	3.063	3.220	0.879	2.049	1.170	3.662
8:51:49	274.7	1.069	77.7	5.089	17.66	50.9407	261.2	2.384	2.342	3.062	3.224	0.885	2.054	1.169	3.644
8:54:53	274.6	1.076	77.8	5.083	17.76	51.0030	261.1	2.381	2.338	3.058	3.214	0.878	2.046	1.168	3.659
8:57:52	275.2	1.082	77.8	5.077	17.86	51.0648	261.7	2.383	2.340	3.060	3.218	0.880	2.049	1.169	3.655
9:00:59	276.1	1.088	77.7	5.071	17.96	51.1277	262.6	2.388	2.345	3.065	3.225	0.883	2.054	1.171	3.652

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values				Final Values		
Height	6.181 (in.)	15.699 (cm)		Height	5.040 (in.)	Tested By	KDG
Diameter	2.877 (in)	7.308 (cm)		Dia. avg.	3.277 (in)	Date	8-14-09
Area	6.502 (in^2)	41.947 (cm^2)		Area avg.	8.432 (in^2)	Press No.	1
						Panel No.	C

Project Number	175539009
Test Number	CU-1260A
Data File ID	1260A
Lateral Pressure (psi)	10.0
Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
9:04:03	276.6	1.094	77.7	5.065	18.06	51.1899	263.1	2.390	2.347	3.067	3.233	0.889	2.061	1.172	3.638
9:07:06	277.7	1.101	77.7	5.058	18.16	51.2535	264.2	2.397	2.354	3.074	3.238	0.887	2.062	1.175	3.651
9:10:13	279.3	1.107	77.7	5.052	18.26	51.3155	265.8	2.409	2.365	3.085	3.248	0.886	2.067	1.181	3.666
9:13:21	279.6	1.113	77.7	5.046	18.36	51.3783	266.1	2.409	2.365	3.085	3.251	0.889	2.070	1.181	3.656
9:16:24	280.5	1.119	77.6	5.040	18.46	51.4417	267.0	2.414	2.369	3.089	3.259	0.893	2.076	1.183	3.650

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			Final Values	
Height	6.007 (in.)	15.258 (cm)	Height	4.985 (in.)	
Diameter	2.818 (in)	7.157 (cm)	Dia. avg.	3.206 (in)	
Area	6.236 (in^2)	40.234 (cm^2)	Area avg.	8.071 (in^2)	

Tested By	KDG	Project Number	175539009
Date	8-14-09	Test Number	CU-1260B
Press No.	2	Data File ID	1260B
Panel No.	D	Lateral Pressure (psi)	30.0
		Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
0:00:00	-0.5	0.000	60.1	6.007	0.00	40.2344	0.0	0.000	0.000	2.160	2.160	2.150	2.155	0.005	1.005
0:08:00	36.6	0.006	60.8	6.001	0.10	40.2747	37.1	0.428	0.428	2.588	2.539	2.101	2.320	0.219	1.209
0:14:01	89.2	0.012	64.8	5.995	0.20	40.3152	89.7	1.035	1.034	3.194	2.856	1.811	2.334	0.522	1.577
0:20:05	116.8	0.018	68.0	5.989	0.30	40.3560	117.3	1.351	1.351	3.511	2.944	1.583	2.263	0.680	1.860
0:25:44	134.2	0.024	69.9	5.983	0.40	40.3963	134.7	1.551	1.550	3.710	3.006	1.446	2.226	0.780	2.079
0:31:40	146.8	0.030	71.5	5.977	0.50	40.4376	147.3	1.694	1.693	3.853	3.038	1.335	2.186	0.852	2.276
0:37:32	157.6	0.036	72.4	5.971	0.60	40.4784	158.1	1.816	1.815	3.975	3.089	1.264	2.176	0.912	2.444
0:43:20	166.5	0.042	73.4	5.965	0.70	40.5184	167.0	1.917	1.915	4.075	3.124	1.198	2.161	0.963	2.607
0:49:39	174.9	0.048	73.9	5.959	0.80	40.5594	175.4	2.011	2.009	4.169	3.176	1.157	2.166	1.010	2.746
0:55:57	182.2	0.054	74.6	5.953	0.90	40.6004	182.7	2.093	2.090	4.250	3.212	1.112	2.162	1.050	2.889
1:02:12	188.5	0.060	74.9	5.947	1.00	40.6414	189.0	2.163	2.160	4.320	3.258	1.088	2.173	1.085	2.995
1:08:18	194.5	0.066	75.3	5.941	1.10	40.6824	195.1	2.229	2.227	4.387	3.297	1.060	2.178	1.118	3.111
1:14:48	200.2	0.072	75.5	5.935	1.20	40.7234	200.7	2.291	2.288	4.448	3.339	1.041	2.190	1.149	3.208
1:20:58	205.1	0.078	75.8	5.929	1.30	40.7647	205.6	2.345	2.342	4.502	3.372	1.020	2.196	1.176	3.306
1:27:11	209.3	0.084	75.9	5.923	1.40	40.8065	209.8	2.390	2.387	4.547	3.410	1.012	2.211	1.199	3.368
1:33:19	212.8	0.090	76.2	5.917	1.50	40.8474	213.3	2.428	2.424	4.584	3.431	0.997	2.214	1.217	3.441
1:39:52	216.6	0.096	76.2	5.911	1.60	40.8906	217.1	2.469	2.465	4.625	3.469	0.994	2.231	1.238	3.491
1:46:05	219.7	0.102	76.3	5.905	1.70	40.9306	220.2	2.502	2.497	4.657	3.494	0.986	2.240	1.254	3.542
1:52:15	222.6	0.108	76.3	5.899	1.80	40.9729	223.1	2.532	2.528	4.688	3.524	0.986	2.255	1.269	3.574
1:58:33	225.4	0.114	76.3	5.893	1.90	41.0144	225.9	2.561	2.557	4.717	3.551	0.985	2.268	1.283	3.607
2:04:51	227.7	0.120	76.4	5.887	2.00	41.0566	228.2	2.584	2.579	4.739	3.571	0.982	2.276	1.295	3.638
2:11:16	229.5	0.126	76.3	5.881	2.10	41.0981	230.0	2.602	2.597	4.757	3.594	0.987	2.290	1.304	3.642
2:17:51	231.6	0.132	76.4	5.875	2.20	41.1400	232.1	2.624	2.618	4.778	3.611	0.982	2.297	1.314	3.676
2:24:22	233.7	0.138	76.2	5.869	2.30	41.1827	234.2	2.645	2.639	4.799	3.641	0.992	2.316	1.325	3.672
2:30:49	235.5	0.144	76.3	5.863	2.40	41.2245	236.0	2.662	2.656	4.816	3.650	0.984	2.317	1.333	3.711
2:37:12	237.2	0.150	76.1	5.857	2.50	41.2669	237.7	2.678	2.672	4.832	3.682	1.000	2.341	1.341	3.683
2:43:32	238.7	0.156	76.3	5.851	2.60	41.3092	239.2	2.692	2.686	4.846	3.681	0.984	2.333	1.348	3.739
2:49:55	240.0	0.162	76.1	5.845	2.70	41.3515	240.5	2.705	2.698	4.858	3.707	0.999	2.353	1.354	3.711
2:56:23	241.7	0.168	76.3	5.839	2.80	41.3944	242.2	2.721	2.714	4.874	3.714	0.990	2.352	1.362	3.753
3:02:51	243.2	0.174	76.1	5.833	2.90	41.4371	243.7	2.735	2.728	4.888	3.739	1.001	2.370	1.369	3.734
3:09:18	244.4	0.180	76.2	5.827	3.00	41.4795	244.9	2.745	2.738	4.898	3.745	0.997	2.371	1.374	3.756
3:15:34	245.7	0.186	76.0	5.821	3.10	41.5227	246.2	2.757	2.750	4.910	3.766	1.006	2.386	1.380	3.743
3:21:59	246.8	0.192	76.1	5.815	3.20	41.5654	247.3	2.767	2.759	4.919	3.771	1.002	2.387	1.384	3.762
3:28:24	248.3	0.198	75.9	5.809	3.30	41.6084	248.8	2.780	2.772	4.932	3.794	1.012	2.403	1.391	3.749
3:34:52	249.2	0.204	76.0	5.803	3.40	41.6513	249.8	2.788	2.780	4.940	3.800	1.010	2.405	1.395	3.763
3:41:15	251.1	0.210	75.9	5.797	3.50	41.6946	251.6	2.807	2.798	4.958	3.826	1.018	2.422	1.404	3.759
3:47:35	252.3	0.216	75.9	5.790	3.60	41.7384	252.8	2.816	2.807	4.967	3.834	1.017	2.425	1.409	3.771
3:53:53	253.5	0.222	75.8	5.785	3.70	41.7811	254.0	2.827	2.818	4.978	3.853	1.025	2.439	1.414	3.758
4:00:18	254.5	0.228	75.8	5.779	3.80	41.8250	255.0	2.835	2.825	4.985	3.860	1.025	2.442	1.418	3.767
4:06:34	255.6	0.234	75.6	5.773	3.90	41.8681	256.1	2.845	2.835	4.995	3.880	1.035	2.457	1.423	3.749
4:12:52	256.8	0.240	75.6	5.767	4.00	41.9119	257.3	2.855	2.845	5.005	3.889	1.034	2.462	1.428	3.761
4:19:12	258.0	0.246	75.5	5.760	4.10	41.9559	258.5	2.865	2.855	5.015	3.909	1.044	2.477	1.433	3.744
4:25:32	259.2	0.252	75.5	5.755	4.20	41.9993	259.7	2.875	2.865	5.025	3.917	1.042	2.480	1.437	3.758
4:31:58	260.4	0.258	75.4	5.749	4.30	42.0433	260.9	2.886	2.875	5.035	3.938	1.053	2.496	1.443	3.740
4:38:25	261.6	0.264	75.4	5.742	4.40	42.0875	262.1	2.896	2.886	5.046	3.948	1.052	2.500	1.448	3.752
4:44:50	262.4	0.270	75.2	5.736	4.50	42.1313	262.9	2.902	2.891	5.051	3.964	1.064	2.514	1.450	3.727
4:51:16	263.4	0.276	75.2	5.730	4.60	42.1755	263.9	2.910	2.898	5.058	3.972	1.064	2.518	1.454	3.734
4:57:39	265.2	0.283	75.1	5.724	4.70	42.2201	265.7	2.926	2.914	5.074	3.997	1.073	2.535	1.462	3.727
5:04:09	266.5	0.289	75.1	5.718	4.80	42.2643	267.0	2.938	2.926	5.086	4.006	1.070	2.538	1.468	3.744
5:10:36	267.6	0.295	75.0	5.712	4.90	42.3087	268.1	2.946	2.934	5.094	4.026	1.082	2.554	1.472	3.722
5:17:09	268.6	0.301	75.0	5.706	5.00	42.3532	269.1	2.954	2.942	5.102	4.035	1.083	2.559	1.476	3.726
5:23:39	270.1	0.307	74.8	5.700	5.10	42.3978	270.6	2.967	2.955	5.115	4.057	1.092	2.574	1.482	3.716
5:30:11	271.3	0.313	74.8	5.694	5.20	42.4426	271.8	2.978	2.965	5.125	4.067	1.092	2.580	1.488	3.724
5:36:34	272.3	0.319	74.7	5.688	5.30	42.4876	272.8	2.986	2.973	5.133	4.086	1.103	2.595	1.491	3.704
5:43:11	273.4	0.325	74.7	5.682	5.40	42.5328	273.9	2.995	2.981	5.141	4.094	1.103	2.598	1.496	3.713
5:49:39	274.8	0.331	74.6	5.676	5.50	42.5776	275.4	3.007	2.994	5.154	4.115	1.111	2.613	1.502	3.703
5:56:09	276.1	0.337	74.6	5.670	5.60	42.6225	276.6	3.017	3.004	5.164	4.125	1.111	2.618	1.507	3.712
6:02:51	277.1	0.343	74.4	5.664	5.70	42.6680	277.6	3.025	3.011	5.171	4.142	1.121	2.632	1.511	3.695
6:09:31	278.1	0.349	74.4	5.658	5.80	42.7132	278.6	3.033	3.019	5.179	4.152	1.123	2.637	1.515	3.698
6:16:16	279.5	0.355	74.3	5.652	5.90	42.7584	280.0	3.046	3.031	5.191	4.174	1.133	2.654	1.521	3.684

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			Final Values	Tested By	KDG	Project Number	175539009
Height	6.007 (in.)	15.258 (cm)	Height	4.985 (in.)	Date	8-14-09	Test Number	CU-1260B
Diameter	2.818 (in)	7.157 (cm)	Dia. avg.	3.206 (in)	Press No.	2	Data File ID	1260B
Area	6.236 (in^2)	40.234 (cm^2)	Area avg.	8.071 (in^2)	Panel No.	D	Lateral Pressure (psi)	30.0
							Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1'/σ_3'
6:22:55	280.8	0.361	74.3	5.646	6.00	42.8041	281.3	3.056	3.041	5.201	4.185	1.134	2.659	1.526	3.691
6:29:35	282.3	0.367	74.1	5.640	6.10	42.8501	282.8	3.068	3.053	5.213	4.208	1.145	2.677	1.532	3.676
6:36:13	283.5	0.373	74.1	5.634	6.20	42.8953	284.0	3.079	3.064	5.224	4.218	1.145	2.682	1.537	3.685
6:42:55	284.0	0.379	73.9	5.628	6.30	42.9412	284.5	3.081	3.066	5.226	4.233	1.157	2.695	1.538	3.657
6:49:40	285.5	0.385	73.9	5.622	6.40	42.9871	286.0	3.094	3.078	5.238	4.245	1.157	2.701	1.544	3.670
6:56:23	287.1	0.391	73.8	5.616	6.50	43.0335	287.6	3.108	3.092	5.252	4.269	1.167	2.718	1.551	3.658
7:03:01	288.3	0.397	73.8	5.610	6.60	43.0792	288.8	3.118	3.101	5.261	4.278	1.167	2.723	1.556	3.667
7:09:41	289.4	0.403	73.7	5.604	6.70	43.1254	290.0	3.126	3.110	5.270	4.296	1.176	2.736	1.560	3.653
7:16:23	290.2	0.409	73.7	5.598	6.80	43.1716	290.7	3.131	3.114	5.274	4.301	1.177	2.739	1.562	3.654
7:23:05	291.3	0.415	73.5	5.592	6.90	43.2180	291.8	3.139	3.122	5.282	4.321	1.189	2.755	1.566	3.635
7:29:45	292.6	0.421	73.5	5.586	7.00	43.2646	293.1	3.151	3.134	5.294	4.330	1.186	2.758	1.572	3.650
7:36:37	293.7	0.427	73.3	5.580	7.10	43.3116	294.2	3.159	3.141	5.301	4.356	1.204	2.780	1.576	3.616
7:43:24	294.6	0.433	73.3	5.574	7.20	43.3580	295.1	3.165	3.147	5.307	4.357	1.199	2.778	1.579	3.633
7:50:18	295.8	0.439	73.2	5.568	7.30	43.4049	296.3	3.174	3.156	5.316	4.373	1.207	2.790	1.583	3.623
7:57:22	297.6	0.445	73.2	5.562	7.40	43.4520	298.1	3.190	3.172	5.332	4.390	1.208	2.799	1.591	3.633
8:04:24	298.3	0.451	73.2	5.556	7.50	43.4986	298.8	3.195	3.176	5.336	4.398	1.212	2.805	1.593	3.629
8:11:28	299.4	0.457	73.0	5.550	7.60	43.5458	299.9	3.202	3.184	5.344	4.416	1.222	2.819	1.597	3.613
8:18:18	301.1	0.463	73.0	5.544	7.70	43.5928	301.7	3.218	3.199	5.359	4.430	1.221	2.826	1.604	3.627
8:25:20	302.3	0.469	72.9	5.538	7.80	43.6402	302.8	3.227	3.207	5.367	4.451	1.233	2.842	1.609	3.609
8:32:19	303.2	0.475	72.8	5.532	7.90	43.6878	303.7	3.232	3.213	5.373	4.458	1.235	2.847	1.611	3.609
8:39:16	304.1	0.481	72.7	5.526	8.00	43.7352	304.6	3.239	3.219	5.379	4.475	1.246	2.861	1.615	3.592
8:46:01	306.0	0.487	72.7	5.520	8.10	43.7826	306.5	3.255	3.235	5.395	4.492	1.247	2.869	1.623	3.604
8:52:56	307.0	0.493	72.5	5.514	8.20	43.8306	307.5	3.263	3.243	5.403	4.510	1.257	2.884	1.626	3.587
8:59:41	307.9	0.499	72.5	5.508	8.30	43.8783	308.4	3.268	3.248	5.408	4.516	1.258	2.887	1.629	3.589
9:06:35	309.1	0.505	72.4	5.502	8.40	43.9261	309.6	3.278	3.257	5.417	4.536	1.269	2.903	1.634	3.574
9:13:17	310.5	0.511	72.4	5.496	8.50	43.9741	311.0	3.289	3.268	5.428	4.546	1.268	2.907	1.639	3.586
9:20:02	311.9	0.517	72.2	5.490	8.60	44.0224	312.4	3.300	3.279	5.439	4.569	1.280	2.925	1.644	3.569
9:26:42	312.8	0.523	72.3	5.484	8.70	44.0706	313.3	3.306	3.284	5.444	4.572	1.278	2.925	1.647	3.578
9:33:29	313.7	0.529	72.0	5.478	8.80	44.1189	314.2	3.311	3.290	5.450	4.593	1.294	2.943	1.650	3.551
9:40:11	314.9	0.535	72.1	5.472	8.91	44.1677	315.4	3.321	3.299	5.459	4.599	1.290	2.945	1.654	3.564
9:46:48	316.2	0.541	71.9	5.466	9.01	44.2162	316.8	3.331	3.309	5.469	4.624	1.305	2.964	1.660	3.544
9:53:26	317.4	0.547	71.9	5.460	9.10	44.2647	318.0	3.340	3.318	5.478	4.628	1.300	2.964	1.664	3.560
10:00:08	318.1	0.553	71.9	5.454	9.21	44.3135	318.6	3.343	3.321	5.481	4.638	1.307	2.972	1.665	3.549
10:06:40	319.9	0.559	71.8	5.448	9.31	44.3627	320.4	3.358	3.335	5.495	4.655	1.310	2.983	1.673	3.554
10:13:20	320.9	0.565	71.7	5.442	9.41	44.4114	321.4	3.365	3.342	5.502	4.667	1.315	2.991	1.676	3.548
10:20:00	322.1	0.571	71.7	5.436	9.51	44.4608	322.6	3.374	3.351	5.511	4.680	1.319	3.000	1.681	3.548
10:26:37	322.9	0.577	71.6	5.430	9.61	44.5098	323.4	3.378	3.355	5.515	4.689	1.325	3.007	1.682	3.540
10:33:12	324.3	0.583	71.5	5.424	9.71	44.5591	324.8	3.389	3.366	5.526	4.705	1.329	3.017	1.688	3.540
10:39:54	325.4	0.589	71.5	5.418	9.81	44.6083	325.9	3.397	3.373	5.533	4.715	1.332	3.024	1.691	3.539
10:46:32	326.5	0.595	71.4	5.412	9.91	44.6578	327.0	3.405	3.381	5.541	4.730	1.339	3.035	1.695	3.532
10:53:14	327.6	0.601	71.4	5.406	10.01	44.7079	328.2	3.413	3.389	5.549	4.741	1.342	3.041	1.699	3.533
10:59:56	329.1	0.607	71.2	5.400	10.11	44.7575	329.6	3.424	3.399	5.559	4.760	1.350	3.055	1.705	3.526
11:06:34	330.2	0.613	71.2	5.394	10.21	44.8072	330.7	3.432	3.407	5.567	4.767	1.350	3.059	1.708	3.530
11:13:11	331.3	0.619	71.1	5.388	10.31	44.8573	331.8	3.439	3.414	5.574	4.785	1.361	3.073	1.712	3.516
11:19:39	332.8	0.625	71.1	5.382	10.41	44.9072	333.3	3.451	3.426	5.586	4.796	1.360	3.078	1.718	3.527
11:26:16	333.4	0.631	71.0	5.376	10.51	44.9576	333.9	3.454	3.428	5.588	4.809	1.371	3.090	1.719	3.508
11:32:51	334.4	0.637	71.0	5.370	10.61	45.0076	334.9	3.460	3.434	5.594	4.814	1.370	3.092	1.722	3.515
11:39:28	335.5	0.643	70.9	5.364	10.71	45.0582	336.0	3.468	3.442	5.602	4.831	1.379	3.105	1.726	3.504
11:45:56	336.5	0.649	70.8	5.358	10.81	45.1089	337.0	3.474	3.447	5.607	4.838	1.380	3.109	1.729	3.505
11:52:28	338.1	0.655	70.7	5.352	10.91	45.1594	338.6	3.487	3.460	5.620	4.859	1.389	3.124	1.735	3.498
11:59:03	338.2	0.661	70.7	5.346	11.01	45.2101	338.7	3.484	3.457	5.617	4.857	1.390	3.123	1.733	3.494
12:05:35	339.8	0.667	70.6	5.340	11.11	45.2612	340.4	3.497	3.469	5.629	4.878	1.399	3.138	1.740	3.488
12:12:08	340.9	0.673	70.6	5.334	11.21	45.3121	341.4	3.503	3.476	5.636	4.883	1.398	3.140	1.743	3.494
12:18:50	341.9	0.679	70.5	5.328	11.31	45.3631	342.4	3.510	3.482	5.642	4.899	1.407	3.153	1.746	3.482
12:25:28	342.8	0.685	70.4	5.322	11.41	45.4144	343.3	3.515	3.487	5.647	4.905	1.408	3.157	1.748	3.483
12:32:00	343.6	0.691	70.3	5.316	11.51	45.4660	344.1	3.519	3.491	5.651	4.918	1.417	3.167	1.751	3.471
12:38:33	345.0	0.697	70.3	5.310	11.61	45.5172	345.5	3.529	3.501	5.661	4.927	1.416	3.172	1.756	3.479
12:45:00	345.9	0.703	70.2	5.304	11.71	45.5688	346.4	3.535	3.507	5.667	4.943	1.426	3.184	1.758	3.466
12:51:35	346.3	0.709	70.2	5.298	11.81	45.6205	346.8	3.535	3.506	5.666	4.944	1.428	3.186	1.758	3.462
12:58:03	347.4	0.715	70.1	5.292	11.91	45.6723	347.9	3.542	3.513	5.673	4.958	1.435	3.197	1.762	3.455

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			
Height	6.007	(in.)	15.258	(cm)
Diameter	2.818	(in)	7.157	(cm)
Area	6.236	(in^2)	40.234	(cm^2)

	Final Values	
Height	4.985	(in.)
Dia. avg.	3.206	(in)
Area avg.	8.071	(in^2)

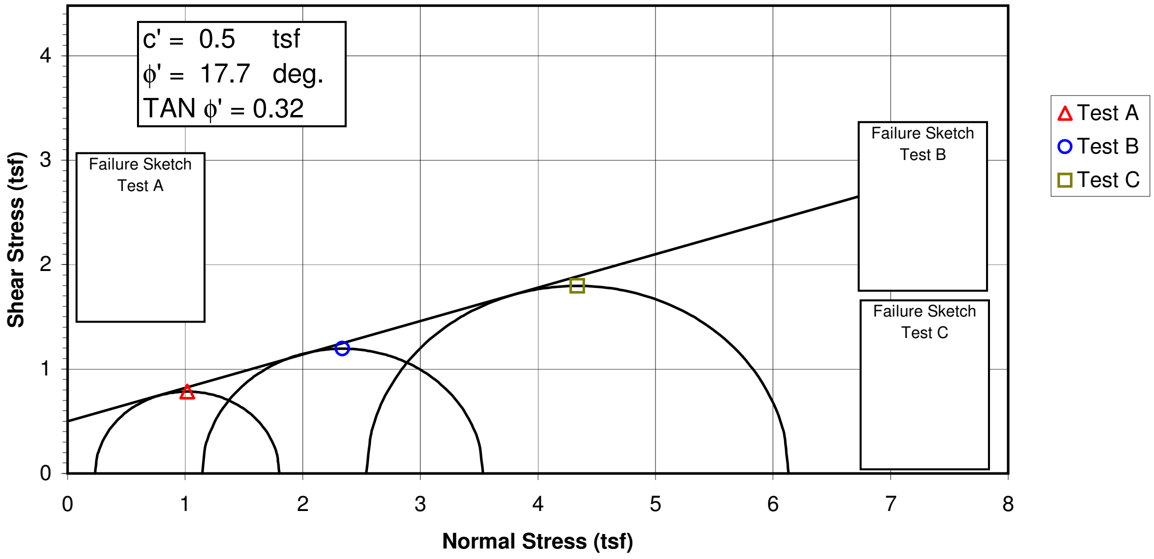
Tested By	KDG
Date	8-14-09
Press No.	2
Panel No.	D

Project Number	175539009
Test Number	CU-1260B
Data File ID	1260B
Lateral Pressure (psi)	30.0
Chamber Pressure - σ_3 (psi)	90

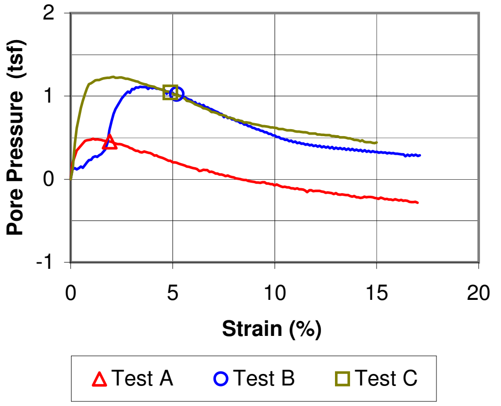
Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
13:04:35	349.3	0.721	70.1	5.286	12.01	45.7242	349.8	3.558	3.528	5.688	4.973	1.435	3.204	1.769	3.467
13:11:05	349.9	0.727	70.0	5.280	12.11	45.7764	350.4	3.560	3.530	5.690	4.983	1.443	3.213	1.770	3.453
13:17:42	350.8	0.733	69.9	5.274	12.21	45.8285	351.3	3.565	3.535	5.695	4.991	1.446	3.219	1.772	3.451
13:24:17	351.2	0.739	69.8	5.268	12.31	45.8806	351.7	3.564	3.534	5.694	4.998	1.454	3.226	1.772	3.437
13:30:57	352.7	0.745	69.8	5.262	12.41	45.9331	353.2	3.576	3.546	5.706	5.013	1.457	3.235	1.778	3.440
13:37:35	353.9	0.751	69.7	5.256	12.51	45.9856	354.4	3.584	3.553	5.713	5.023	1.460	3.241	1.782	3.441
13:44:09	354.9	0.757	69.5	5.250	12.61	46.0383	355.4	3.589	3.559	5.719	5.047	1.479	3.263	1.784	3.414
13:50:39	356.0	0.763	69.6	5.244	12.71	46.0909	356.5	3.597	3.566	5.726	5.047	1.471	3.259	1.788	3.431
13:57:12	357.2	0.769	69.3	5.238	12.81	46.1443	357.8	3.605	3.574	5.734	5.072	1.488	3.280	1.792	3.409
14:03:49	357.7	0.775	69.4	5.232	12.91	46.1969	358.2	3.605	3.573	5.733	5.063	1.480	3.272	1.792	3.422
14:10:24	358.7	0.781	69.3	5.226	13.01	46.2507	359.2	3.611	3.579	5.739	5.083	1.494	3.288	1.795	3.403
14:16:54	359.9	0.787	69.4	5.220	13.11	46.3037	360.4	3.620	3.587	5.747	5.084	1.486	3.285	1.799	3.421
14:23:34	361.2	0.793	69.2	5.214	13.21	46.3570	361.7	3.628	3.596	5.756	5.102	1.496	3.299	1.803	3.411
14:30:04	362.2	0.799	69.2	5.208	13.31	46.4101	362.7	3.634	3.601	5.761	5.106	1.495	3.301	1.806	3.415
14:36:44	362.8	0.805	69.1	5.202	13.41	46.4639	363.3	3.636	3.603	5.763	5.119	1.506	3.312	1.807	3.400
14:43:16	364.1	0.811	69.1	5.196	13.51	46.5176	364.6	3.645	3.612	5.772	5.124	1.502	3.313	1.811	3.411
14:49:52	365.1	0.817	68.9	5.190	13.61	46.5715	365.6	3.650	3.617	5.777	5.144	1.517	3.330	1.813	3.391
14:56:31	366.4	0.823	69.0	5.184	13.71	46.6259	366.9	3.659	3.626	5.786	5.148	1.512	3.330	1.818	3.405
15:03:02	367.2	0.829	68.8	5.178	13.81	46.6797	367.7	3.663	3.629	5.789	5.164	1.525	3.344	1.819	3.386
15:09:39	368.2	0.835	68.9	5.172	13.91	46.7338	368.7	3.669	3.635	5.795	5.167	1.522	3.344	1.822	3.395
15:16:14	369.2	0.841	68.7	5.166	14.01	46.7883	369.7	3.675	3.640	5.800	5.186	1.536	3.361	1.825	3.377
15:22:56	370.1	0.847	68.8	5.160	14.11	46.8428	370.7	3.679	3.645	5.805	5.183	1.528	3.356	1.827	3.391
15:29:33	371.2	0.853	68.6	5.154	14.21	46.8973	371.7	3.686	3.651	5.811	5.205	1.544	3.374	1.830	3.371
15:36:18	372.4	0.860	68.6	5.147	14.31	46.9527	372.9	3.693	3.658	5.818	5.207	1.539	3.373	1.834	3.384
15:42:58	373.0	0.865	68.5	5.141	14.41	47.0071	373.5	3.694	3.659	5.819	5.219	1.550	3.385	1.835	3.367
15:49:40	374.3	0.871	68.5	5.135	14.51	47.0620	374.8	3.704	3.668	5.828	5.225	1.547	3.386	1.839	3.378
15:56:31	375.3	0.878	68.4	5.129	14.61	47.1173	375.8	3.708	3.673	5.833	5.241	1.558	3.400	1.841	3.363
16:03:23	376.0	0.883	68.4	5.123	14.71	47.1723	376.5	3.711	3.675	5.835	5.240	1.555	3.398	1.843	3.369
16:10:12	376.9	0.889	68.2	5.117	14.81	47.2277	377.4	3.716	3.679	5.839	5.256	1.567	3.411	1.845	3.355
16:16:58	378.5	0.896	68.3	5.111	14.91	47.2832	379.0	3.727	3.691	5.851	5.265	1.564	3.415	1.850	3.366
16:23:47	379.2	0.902	68.1	5.105	15.01	47.3393	379.7	3.730	3.693	5.853	5.280	1.578	3.429	1.851	3.347
16:30:31	380.3	0.908	68.2	5.099	15.11	47.3948	380.8	3.736	3.699	5.859	5.281	1.572	3.427	1.855	3.359
16:37:11	381.3	0.914	68.0	5.093	15.21	47.4506	381.8	3.741	3.704	5.864	5.300	1.586	3.443	1.857	3.342
16:43:53	382.3	0.920	68.1	5.087	15.31	47.5066	382.8	3.747	3.710	5.870	5.299	1.579	3.439	1.860	3.355
16:50:47	383.5	0.926	67.9	5.081	15.41	47.5630	384.0	3.754	3.717	5.877	5.319	1.592	3.456	1.863	3.341
16:57:34	384.1	0.932	68.0	5.075	15.51	47.6200	384.6	3.755	3.717	5.877	5.314	1.586	3.450	1.864	3.350
17:04:15	384.8	0.938	67.8	5.069	15.61	47.6760	385.3	3.758	3.719	5.879	5.328	1.599	3.464	1.865	3.333
17:11:02	385.6	0.944	67.9	5.063	15.71	47.7322	386.1	3.761	3.723	5.883	5.327	1.594	3.461	1.867	3.342
17:17:51	386.5	0.950	67.7	5.057	15.81	47.7892	387.0	3.766	3.727	5.887	5.340	1.603	3.472	1.868	3.331
17:24:32	387.4	0.956	67.8	5.051	15.91	47.8462	387.9	3.770	3.731	5.891	5.340	1.599	3.469	1.870	3.339
17:31:18	387.9	0.962	67.6	5.045	16.01	47.9030	388.4	3.770	3.731	5.891	5.350	1.609	3.480	1.870	3.324
17:38:02	389.1	0.968	67.7	5.039	16.11	47.9600	389.6	3.778	3.738	5.898	5.354	1.606	3.480	1.874	3.334
17:45:11	390.3	0.974	67.6	5.033	16.21	48.0174	390.8	3.784	3.745	5.905	5.370	1.616	3.493	1.877	3.324
17:52:00	391.3	0.980	67.6	5.027	16.31	48.0751	391.8	3.789	3.749	5.909	5.373	1.613	3.493	1.880	3.331
17:58:37	391.7	0.986	67.5	5.021	16.41	48.1321	392.2	3.789	3.748	5.908	5.381	1.623	3.502	1.879	3.316
18:05:18	392.2	0.992	67.5	5.015	16.51	48.1898	392.7	3.790	3.749	5.909	5.379	1.620	3.500	1.880	3.320
18:12:10	393.4	0.998	67.4	5.009	16.61	48.2480	393.9	3.797	3.756	5.916	5.394	1.628	3.511	1.883	3.313
18:18:49	394.4	1.004	67.4	5.003	16.71	48.3060	394.9	3.801	3.760	5.920	5.396	1.626	3.511	1.885	3.319
18:25:26	395.3	1.010	67.3	4.997	16.81	48.3640	395.8	3.806	3.765	5.925	5.409	1.634	3.522	1.887	3.310
18:32:10	396.8	1.016	67.3	4.991	16.91	48.4221	397.3	3.816	3.774	5.934	5.416	1.632	3.524	1.892	3.319
18:38:47	396.9	1.022	67.2	4.985	17.01	48.4803	397.4	3.812	3.770	5.930	5.422	1.642	3.532	1.890	3.302

Failure Criterion: Maximum Effective Principal Stress Ratio

Effective Strength Envelope



Induced Pore Pressure vs. Strain



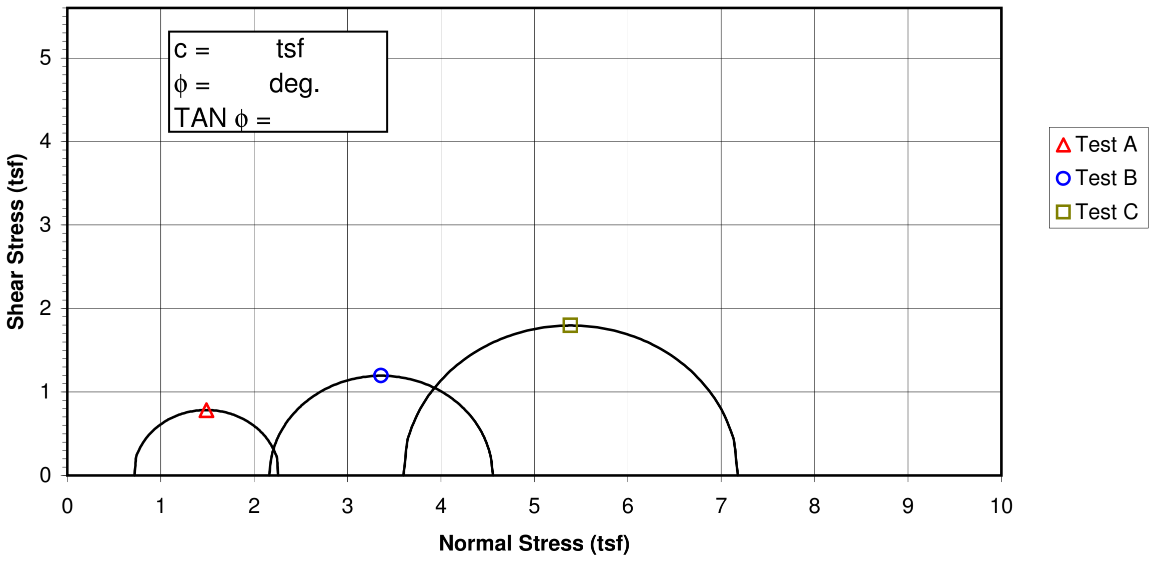
Specimen No.			A	B	C	
Initial Data	Water content %	W_o	21.0	23.1	23.6	
	Dry Density PCF	γ_{d_o}	99.2	101.7	102.3	
	Saturation %	S_o	82.8	97.1	100.6	
	Void Ratio	e_o	0.674	0.633	0.623	
After Shear	Water content %	W_f	22.9	23.2	22.5	
	Dry Density PCF	γ_{d_f}	103.2	102.7	103.9	
	Saturation %	S_f	100.0	100.0	100.0	
	Void Ratio	e_f	0.609	0.617	0.599	
	Final Back Pressure TSF	u_c	5.76	4.32	2.88	
Minor Principal Stress TSF @ failure		σ_3'f	0.24	1.14	2.54	
Maximum Deviator Stress (tsf) @ failure		$(\sigma_1'-\sigma_3')_{max}$	1.54	2.40	3.58	
Time to (σ1'-σ3')max min.		t_f	10.5	369.7	345.1	
Ultimate Deviator Stress, t/sq ft		$(\sigma1'-\sigma3')_{ult}$	n/a	n/a	3.17	
Initial Diameter, in.		D_o	2.894	2.881	2.878	
Initial Height, in.		H_o	6.024	6.032	6.020	

Controlled - Strain Test

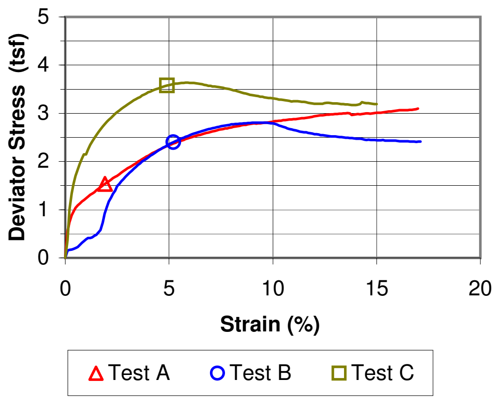
Description of Specimens	Fat Clay with Gravel (CH), red brown, moist, firm						
				Type of Specimen	Undisturbed	Type of test	$\bar{R}$
LL	PL	PI	Gs 2.66	Project	Cumberland Dry Ash Stack and Gypsum Disposal Area		
Remarks:							
				Boring No.	B-63A	Sample No.	1270
				Depth Elev.	5.5'-6.0', 8.0'-8.5', 8.6'-9.1'		
				Laboratory	Stantec	Date	8-24-09
				TRIAXIAL COMPRESSION TEST REPORT			

Failure Criterion: Maximum Effective Principal Stress Ratio

Total Strength Envelope



Deviator Stress vs. Strain



Specimen No.			A	B	C	
Initial Data	Water content %	W_o	21.0	23.1	23.6	
	Dry Density PCF	γ_{d_o}	99.2	101.7	102.3	
	Saturation %	S_o	82.8	97.1	100.6	
	Void Ratio	e_o	0.674	0.633	0.623	
After Shear	Water content %	W_f	22.9	23.2	22.5	
	Dry Density PCF	γ_{d_f}	103.2	102.7	103.9	
	Saturation %	S_f	100.0	100.0	100.0	
	Void Ratio	e_f	0.609	0.617	0.599	
	Final Back Pressure TSF	u_c	5.76	4.32	2.88	
Minor Principal Stress TSF		σ_3	0.72	2.16	3.60	
Maximum Deviator Stress (tsf) @ failure		$(\sigma_1-\sigma_3)_{max}$	1.54	2.40	3.58	
Time to $(\sigma_1-\sigma_3)_{Max.}$ min.		t_f	10.5	369.7	345.1	
Ultimate Deviator Stress, t/sq ft		$(\sigma_1-\sigma_3)_{ult}$	n/a	n/a	3.17	
Initial Diameter, in.		D_o	2.894	2.881	2.878	
Initial Height, in.		H_o	6.024	6.032	6.020	

Controlled - Strain Test

Description of Specimens Fat Clay with Gravel (CH), red brown, moist, firm

Type of Specimen Undisturbed
Type of test $\overline{R}$

LL	PL	PI	Gs 2.66

Project Cumberland Dry Ash Stack and Gypsum Disposal Area

Remarks:

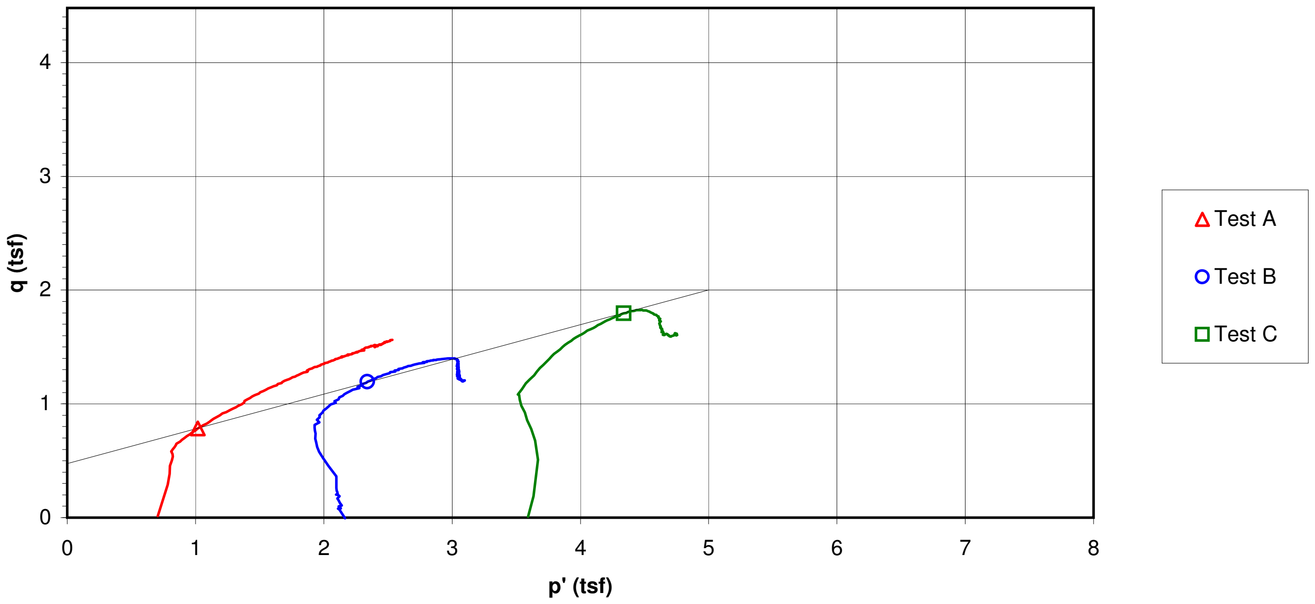
Boring No. B-63A
Sample No. 1270
Depth Elev. 5.5'-6.0', 8.0'-8.5', 8.6'-9.1'
Laboratory Stantec
Date 8-24-09

TRIAXIAL COMPRESSION TEST REPORT

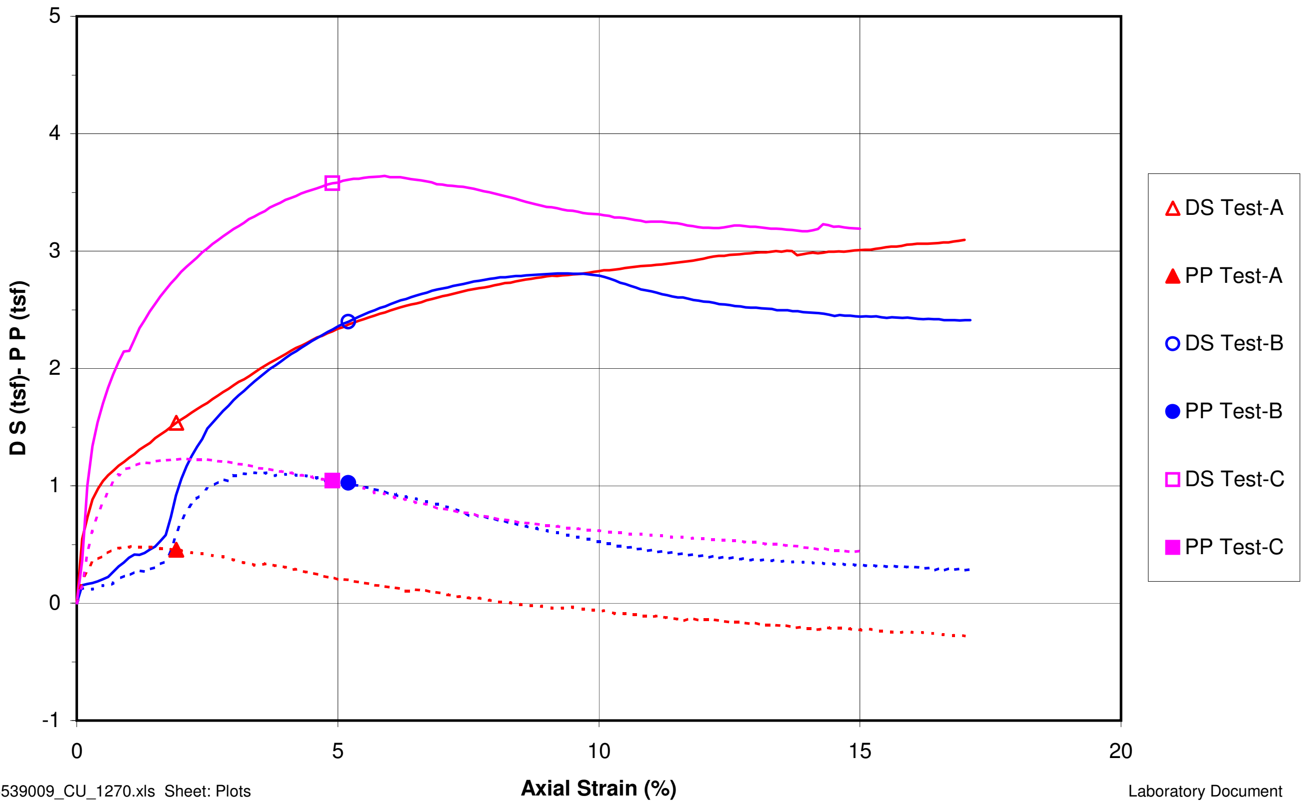
Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Project	Cumberland Dry Ash Stack and Gypsum Disposal Area	Project No.	175539009
Sample ID	B-63A, 5.5'-6.0' & B-63A, 8.0'-8.5' & B-63A, 8.6'-9.1'	Test Number	1270
Failure Criterion:	Maximum Effective Principal Stress Ratio ϕ' = 17.7 deg.	c' =	0.50 tsf

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain



Stantec

Consolidated Undrained Triaxial Test

ASTM D4767-04

Project Name	Cumberland Dry Ash Stack and Gypsum Disposal Area	Project Number	175539009
Sample Identification	B-63A, 5.5'-6.0'	Test Number	CU-1270A
Visual Description	Fat Clay with Gravel (CH), red brown, moist, firm	Prepared By	RC
Undisturbed	Source B-63A, 5.0'-7.0'	Date	7-28-2009

Specific Gravity 2.66 ASTM D854 Method A Liquid Limit N/A Plastic Limit N/A Plasticity Index N/A

Initial Specimen Data

Specimen Diameter (in.)		Specimen Height (in.)		Volumes (in^3)		Specimen	
Top	2.901	1	6.034	Sample	39.5887 (V_o)	Wet Weight (g)	1248.42
Middle	2.899	2	6.000	Solids	23.6715 (VS_o)	Dry Weight (g)	1031.89
Bottom	2.878	3	6.028	Water	13.2124 (Vw_o)	Wet Unit Weight (pcf)	120.1
Avg.	2.8927 (D_o)	4	6.034	Voids	15.9172 (Vv_o)	Dry Unit Weight (pcf)	99.3
Area (in^2)	6.5718 (A_o)	Avg. (H_o)	6.0240	Degree of Saturation (%)	83.0 (S_o)		
Moisture Content (%)	21.0	Final Trimmings		Void Ratio	0.672		

Saturation

Set Up & Saturated: Wet xx Dry

Back Pressure Saturated to: 80 (psi)

Final Pore Pressure Parameter B 0.96

Set up By KDG

Date 8-14-09

Panel Board Number E

Height Readings (in.)		Back Pressure Burette		Chamber Burette			
Initial	0.1375	Initial	16.66 (in.)	Initial	12.15 (in.)	Specimen Height (in.)	6.0280 (H_s)
Final	0.1335	Final	8.64 (in.)	Final	10.56 (in.)	Area (in^2) Method A	6.5806 (A_s)
Change	0.0040 (ΔH_o)	Change	-8.02 (in.)	Change	-1.59 (in.)	Specimen Volume (in^3)	39.67 (Vs)

Consolidation

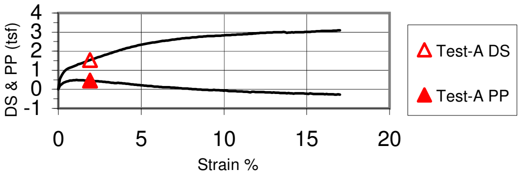
Height Readings (in.)		Back Pressure Burette Readings		Chamber Burette Readings		Pressures (psi)	
Initial	0.1335	Initial	1.28 (in.)	Initial	17.79 (in.)	Chamber	90
Final	0.1392	Final	3.87 (in.)	Final	15.27 (in.)	Back	80
Change	-0.0057 (ΔH_c)	Change	-2.59 (in.)	Change	-2.52 (in.)	Lateral	10 (σ_3)
Height (in.)	6.0223 (H_c)			Volume (in^3)	38.0951 (V_c)		
Area (in^3) Method B	6.3257 (A_c)			Volume - Water (in^3)	14.4236 (VWc)	t_{50} (min.)	0.133
Diameter (in.)	2.8380 (D_c)			Water Content (%)	22.9		
Dry Density (pcf)	103.2			Degree of Saturation (%)	100.0 (S_c)	Void Ratio	0.609

After Test

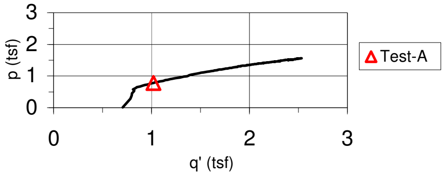
Final Measurements		Final Moisture Content		Stresses (membrane corrected) at Failure (psi)	
Maximum Diameter	3.351 (in.)	Wet Weight (g)	1268.27	Corrected Deviator	1.54 σ_d (tsf)
Wet weight (g)	1268.27 (WWf)	Dry Weight (g)	1031.89	Major Principal	1.80 $\sigma_1'_f$ (tsf)
Corrected Diameter	3.327 (in.)	Tare Weight (g)	0.00	Minor Principal	0.24 $\sigma_3'_f$ (tsf)
				Rate of Strain (% / min.)	0.186
Youngs Modulus for Membrane (psi)	200			Axial Strain at Failure (%)	1.91
Membrane Thickness (in.)	0.012			Failure Criterion:	Maximum Effective Principal Stress Ratio

Failure Sketch

Deviator Stress and Induced Pore Pressure vs. Strain



p' vs. q Plot



Comments:

Consolidated Undrained Triaxial Test

ASTM D4767-04

Project Name	Cumberland Dry Ash Stack and Gypsum Disposal Area	Project Number	175539009
Sample Identification	B-63A, 8.0'-8.5'	Test Number	CU-1270B
Visual Description	Fat Clay with Gravel (CH), red brown, moist, firm	Prepared By	CM
Undisturbed	Source B-63A, 8.0'-10.0'	Date	7-28-2009

Specific Gravity 2.66 ASTM D854 Method A   Liquid Limit N/A   Plastic Limit N/A   Plasticity Index N/A

Initial Specimen Data

Specimen Diameter (in.)		Specimen Height (in.)		Volumes (in3)		Specimen	
Top	2.881	1	6.039	Sample	39.3396 (V_o)	Wet Weight (g)	1292.30
Middle	2.880	2	6.031	Solids	24.0783 (VS_o)	Dry Weight (g)	1049.63
Bottom	2.884	3	6.019	Water	14.8080 (Vw_o)	Wet Unit Weight (pcf)	125.1
Avg.	2.8817 (D_o)	4	6.039	Voids	15.2613 (Vv_o)	Dry Unit Weight (pcf)	101.6
Area (in^2)	6.5219 (A_o)	Avg. (H_o)	6.0319	Degree of Saturation (%)	97.0 (S_o)		
Moisture Content (%)	23.1	Final Trimmings		Void Ratio	0.634		

Saturation

Set Up & Saturated:	Wet xx	Dry		Set up By	KDG
Back Pressure Saturated to:	60 (psi)	Final Pore Pressure Parameter B	0.97	Date	8-14-09
				Panel Board Number	F

Height Readings (in.)		Back Pressure Burette		Chamber Burette			
Initial	0.1411	Initial	16.23 (in.)	Initial	9.47 (in.)	Specimen Height (in.)	6.0412 (H_s)
Final	0.1318	Final	10.55 (in.)	Final	8.97 (in.)	Area (in^2) Method A	6.5420 (A_s)
Change	0.0093 (ΔH_o)	Change	-5.68 (in.)	Change	-0.50 (in.)	Specimen Volume (in^3)	39.52 (V_s)

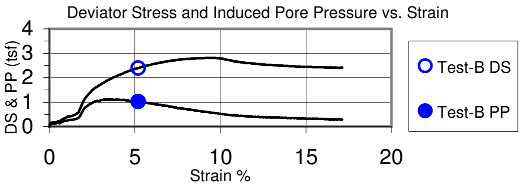
Consolidation

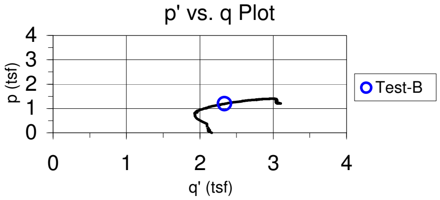
Height Readings (in.)		Back Pressure Burette Readings		Chamber Burette Readings		Pressures (psi)	
Initial	0.1318	Initial	1.27 (in.)	Initial	17.23 (in.)	Chamber	90
Final	0.1375	Final	9.67 (in.)	Final	9.34 (in.)	Back	60
Change	-0.0057 (ΔH_c)	Change	-8.40 (in.)	Change	-7.89 (in.)	Lateral	30 (σ_3)
Height (in.)	6.0355 (H_c)			Volume (in^3)	38.9247 (V_c)		
Area (in^3) Method B	6.4493 (A_c)			Volume - Water (in^3)	14.8464 (VWc)	D_{50} (min.)	25
Diameter (in.)	2.8656 (D_c)			Water Content (%)	23.2		
Dry Density (pcf)	102.7			Degree of Saturation (%)	100.0 (S_c)	Void Ratio	0.617

After Test

Final Measurements		Final Moisture Content		Stresses (membrane corrected) at Failure (psi)	
Maximum Diameter	3.322 (in.)	Wet Weight (g)	1292.93	Corrected Deviator	2.40 σ_d (tsf)
Wet weight (g)	1292.93 (WWf)	Dry Weight (g)	1049.63	Major Principal	3.53 $\sigma_1'{}_f$ (tsf)
Corrected Diameter	3.298 (in.)	Tare Weight (g)	0.00	Minor Principal	1.14 $\sigma_3'{}_f$ (tsf)
				Rate of Strain (% / min.)	0.018
Youngs Modulus for Membrane (psi)	200			Axial Strain at Failure (%)	5.20
Membrane Thickness (in.)	0.012			Failure Criterion:	Maximum Effective Principal Stress Ratio

Failure Sketch





Comments:

Stantec

Consolidated Undrained Triaxial Test

ASTM D4767-04

Project Name	Cumberland Dry Ash Stack and Gypsum Disposal Area	Project Number	175539009
Sample Identification	B-63A, 8.6'-9.1'	Test Number	1270C
Visual Description	Fat Clay with Gravel (CH), red brown, moist, firm	Prepared By	CM
Undisturbed	Source B-63A, 8.0'-10.0'	Date	7-28-2009

Specific Gravity	2.66 ASTM D854 Method A	Liquid Limit	N/A	Plastic Limit	N/A	Plasticity Index	N/A

Initial Specimen Data

Specimen Diameter (in.)		Specimen Height (in.)		Volumes (in^3)		Specimen	
Top	2.878	1	5.993	Sample	39.1500 (V_o)	Wet Weight (g)	1299.6
Middle	2.879	2	6.068	Solids	24.1261 (VS_o)	Dry Weight (g)	1051.71
Bottom	2.876	3	6.024	Water	15.1261 (Vw_o)	Wet Unit Weight (pcf)	126.5
Avg.	2.8777 (D_o)	4	5.993	Voids	15.0238 (Vv_o)	Dry Unit Weight (pcf)	102.3
Area (in^2)	6.5039 (A_o)	Avg. (H_o)	6.0195	Degree of Saturation (%)	100.7 (S_o)		
Moisture Content (%)	23.6	Final Trimmings		Void Ratio	0.623		

Saturation

Set Up & Saturated:	Wet xx	Dry		Set up By	KDG
Back Pressure Saturated to:	40 (psi)	Final Pore Pressure Parameter B	0.96	Date	8-17-09
				Panel Board Number	D

Height Readings (in.)		Back Pressure Burette		Chamber Burette			
Initial	0.151	Initial	16.85 (in.)	Initial	12.73 (in.)	Specimen Height (in.)	6.0250 (H_s)
Final	0.1455	Final	13.54 (in.)	Final	12.82 (in.)	Area (in^2) Method A	6.5157 (A_s)
Change	0.0055 (ΔH_o)	Change	-3.31 (in.)	Change	0.09 (in.)	Specimen Volume (in^3)	39.26 (V_s)

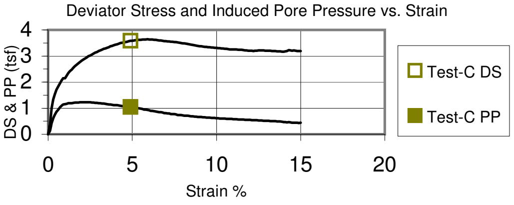
Consolidation

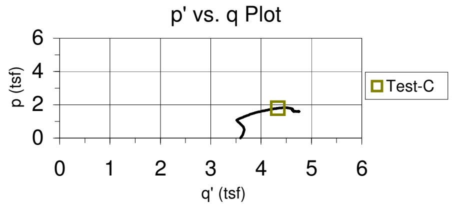
Height Readings (in.)		Back Pressure Burette Readings		Chamber Burette Readings		Pressures (psi)	
Initial	0.1455	Initial	0.95 (in.)	Initial	17.83 (in.)	Chamber	90
Final	0.1986	Final	7.66 (in.)	Final	11.14 (in.)	Back	40
Change	-0.0531 (ΔH_c)	Change	-6.71 (in.)	Change	-6.69 (in.)	Lateral	50 (σ_3)
Height (in.)	5.9719 (H_c)			Volume (in^3)	38.5700 (V_c)		
Area (in^3) Method B	6.4586 (A_c)			Volume - Water (in^3)	14.4439 (VWc)	D_{50} (min.)	39
Diameter (in.)	2.8676 (D_c)			Water Content (%)	22.5		
Dry Density (pcf)	103.9			Degree of Saturation (%)	100.0 (S_c)	Void Ratio	0.599

After Test

Final Measurements		Final Moisture Content		Stresses (membrane corrected) at Failure (psi)	
Maximum Diameter	3.229 (in.)	Wet Weight (g)	1288.42	Corrected Deviator	3.58 σ_d (tsf)
Wet weight (g)	1288.42 (WWf)	Dry Weight (g)	1051.71	Major Principal	6.13 $\sigma_1'_f$ (tsf)
Corrected Diameter	3.205 (in.)	Tare Weight (g)	0.00	Minor Principal	2.54 $\sigma_3'_f$ (tsf)
				Rate of Strain (% / min.)	0.014
Youngs Modulus for Membrane (psi)	200			Axial Strain at Failure (%)	4.90
Membrane Thickness (in.)	0.012			Failure Criterion:	Maximum Effective Principal Stress Ratio

Failure Sketch





Comments:

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values				Final Values			Tested By	KDG	Project Number	175539009
Height	6.022	(in.)	15.297	(cm)	Height	4.999	(in.)	Date	8-17-09	Test Number	CU-1270A
Diameter	2.838	(in)	7.209	(cm)	Dia. avg.	3.140	(in)	Press No.	2	Data File ID	CU-1270A
Area	6.326	(in^2)	40.813	(cm^2)	Area avg.	7.745	(in^2)	Panel No.	E	Lateral Pressure (psi)	10.0
										Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
0:00:00	-0.3	0.000	80.4	6.022	0.00	40.8132	0.0	0.000	0.000	0.720	0.720	0.690	0.705	0.015	1.044
0:00:51	47.7	0.006	83.1	6.016	0.10	40.8548	48.0	0.547	0.546	1.266	1.072	0.495	0.783	0.288	2.165
0:01:25	64.7	0.012	84.3	6.010	0.21	40.8974	65.0	0.739	0.739	1.459	1.182	0.413	0.798	0.385	2.861
0:01:57	77.4	0.018	85.2	6.004	0.30	40.9367	77.7	0.883	0.882	1.602	1.257	0.344	0.801	0.456	3.649
0:02:31	85.9	0.024	85.7	5.998	0.41	40.9810	86.2	0.978	0.977	1.697	1.321	0.313	0.817	0.504	4.220
0:03:01	91.6	0.030	86.0	5.992	0.50	41.0186	91.9	1.042	1.040	1.760	1.358	0.287	0.823	0.535	4.726
0:03:32	96.0	0.036	86.4	5.986	0.60	41.0599	96.4	1.091	1.090	1.810	1.381	0.261	0.821	0.560	5.294
0:04:04	99.9	0.042	86.8	5.980	0.71	41.1031	100.2	1.134	1.132	1.852	1.392	0.230	0.811	0.581	6.056
0:04:36	103.6	0.048	86.9	5.974	0.80	41.1436	103.9	1.174	1.172	1.892	1.424	0.222	0.823	0.601	6.420
0:05:08	106.6	0.054	87.0	5.968	0.90	41.1857	106.9	1.207	1.205	1.925	1.454	0.218	0.836	0.618	6.653
0:05:40	109.8	0.060	87.1	5.962	1.00	41.2265	110.1	1.242	1.239	1.959	1.481	0.212	0.847	0.635	6.999
0:06:09	112.6	0.066	87.2	5.956	1.10	41.2674	113.0	1.273	1.270	1.990	1.501	0.200	0.850	0.650	7.502
0:06:43	116.2	0.072	87.1	5.950	1.20	41.3108	116.5	1.312	1.309	2.029	1.551	0.212	0.881	0.669	7.319
0:07:15	118.8	0.078	87.1	5.944	1.30	41.3525	119.1	1.340	1.337	2.057	1.577	0.210	0.894	0.683	7.500
0:07:47	121.6	0.084	87.0	5.938	1.40	41.3944	121.9	1.370	1.366	2.086	1.609	0.213	0.911	0.698	7.570
0:08:19	125.2	0.090	87.0	5.932	1.50	41.4353	125.5	1.408	1.405	2.125	1.652	0.217	0.934	0.718	7.625
0:08:50	128.2	0.096	86.9	5.926	1.60	41.4767	128.5	1.441	1.437	2.157	1.691	0.224	0.958	0.734	7.550
0:09:25	131.1	0.103	86.8	5.919	1.71	41.5225	131.4	1.472	1.468	2.188	1.725	0.227	0.976	0.749	7.589
0:09:54	134.2	0.108	86.8	5.914	1.80	41.5625	134.5	1.505	1.500	2.220	1.763	0.232	0.997	0.765	7.600
0:10:28	137.6	0.115	86.7	5.907	1.91	41.6065	137.9	1.542	1.537	2.257	1.802	0.235	1.019	0.784	7.669
0:10:58	140.1	0.120	86.7	5.902	2.00	41.6464	140.4	1.568	1.563	2.283	1.833	0.239	1.036	0.797	7.656
0:11:29	142.8	0.126	86.5	5.896	2.10	41.6884	143.2	1.597	1.592	2.312	1.872	0.250	1.061	0.811	7.491
0:12:04	146.0	0.132	86.4	5.890	2.20	41.7323	146.3	1.630	1.625	2.345	1.914	0.259	1.086	0.828	7.396
0:12:35	148.9	0.138	86.3	5.884	2.30	41.7752	149.2	1.661	1.655	2.375	1.952	0.267	1.109	0.843	7.318
0:13:07	151.3	0.144	86.3	5.878	2.40	41.8180	151.6	1.686	1.680	2.400	1.979	0.268	1.123	0.855	7.379
0:13:39	153.7	0.150	86.2	5.872	2.50	41.8602	154.0	1.711	1.705	2.425	2.007	0.272	1.140	0.868	7.381
0:14:11	156.9	0.156	86.1	5.866	2.60	41.9030	157.2	1.745	1.739	2.459	2.052	0.283	1.168	0.884	7.241
0:14:42	159.9	0.163	86.0	5.859	2.70	41.9475	160.2	1.776	1.769	2.489	2.091	0.291	1.191	0.900	7.175
0:15:16	162.8	0.169	85.9	5.854	2.80	41.9897	163.1	1.806	1.800	2.520	2.126	0.296	1.211	0.915	7.188
0:15:49	165.4	0.175	85.7	5.847	2.90	42.0341	165.7	1.834	1.826	2.546	2.169	0.312	1.240	0.928	6.951
0:16:23	168.5	0.181	85.5	5.841	3.01	42.0790	168.8	1.866	1.858	2.578	2.211	0.322	1.266	0.944	6.869
0:16:55	171.0	0.187	85.4	5.835	3.10	42.1204	171.4	1.892	1.884	2.604	2.249	0.334	1.292	0.957	6.726
0:17:26	173.4	0.193	85.2	5.829	3.20	42.1637	173.7	1.916	1.908	2.628	2.285	0.346	1.316	0.969	6.600
0:17:58	175.9	0.199	85.2	5.824	3.30	42.2065	176.2	1.942	1.934	2.654	2.313	0.349	1.331	0.982	6.631
0:18:32	178.9	0.205	84.9	5.817	3.40	42.2516	179.2	1.972	1.964	2.684	2.359	0.364	1.362	0.997	6.472
0:19:04	181.8	0.211	84.9	5.812	3.50	42.2933	182.2	2.003	1.994	2.714	2.392	0.367	1.379	1.012	6.517
0:19:38	184.7	0.217	85.1	5.805	3.61	42.3414	185.1	2.032	2.024	2.744	2.409	0.356	1.382	1.027	6.777
0:20:08	187.3	0.223	84.9	5.799	3.70	42.3817	187.6	2.058	2.049	2.769	2.444	0.364	1.404	1.040	6.714
0:20:42	189.7	0.229	84.8	5.793	3.81	42.4277	190.0	2.082	2.073	2.793	2.475	0.372	1.423	1.052	6.659
0:21:14	192.3	0.235	84.8	5.787	3.90	42.4714	192.6	2.109	2.099	2.819	2.506	0.376	1.441	1.065	6.660
0:21:46	194.7	0.241	84.7	5.781	4.00	42.5151	195.1	2.133	2.124	2.844	2.538	0.384	1.461	1.077	6.603
0:22:18	197.3	0.247	84.4	5.775	4.10	42.5595	197.6	2.159	2.149	2.869	2.584	0.404	1.494	1.090	6.390
0:22:49	199.7	0.253	84.4	5.769	4.20	42.6030	200.1	2.184	2.173	2.893	2.606	0.402	1.504	1.102	6.485
0:23:21	201.8	0.259	84.2	5.763	4.30	42.6473	202.2	2.204	2.194	2.914	2.641	0.417	1.529	1.112	6.337
0:23:53	204.1	0.265	84.1	5.757	4.40	42.6916	204.4	2.227	2.216	2.936	2.672	0.425	1.548	1.123	6.283
0:24:25	206.6	0.271	84.0	5.751	4.50	42.7369	207.0	2.252	2.241	2.961	2.702	0.431	1.567	1.136	6.269
0:24:59	208.9	0.277	83.8	5.745	4.61	42.7838	209.3	2.274	2.263	2.983	2.737	0.444	1.590	1.147	6.171
0:25:28	210.6	0.283	83.7	5.739	4.70	42.8262	210.9	2.290	2.279	2.999	2.764	0.455	1.609	1.155	6.077
0:26:00	212.7	0.289	83.5	5.733	4.80	42.8711	213.0	2.310	2.299	3.019	2.797	0.469	1.633	1.164	5.971
0:26:32	214.6	0.295	83.5	5.727	4.90	42.9154	215.0	2.329	2.317	3.037	2.815	0.467	1.641	1.174	6.026
0:27:03	216.8	0.301	83.2	5.721	5.00	42.9606	217.1	2.350	2.338	3.058	2.857	0.488	1.672	1.184	5.850
0:27:35	218.3	0.307	83.3	5.715	5.10	43.0068	218.6	2.364	2.352	3.072	2.867	0.486	1.677	1.191	5.905
0:28:07	220.6	0.313	83.2	5.709	5.20	43.0516	220.9	2.386	2.373	3.093	2.896	0.492	1.694	1.202	5.886
0:28:38	222.3	0.319	83.0	5.703	5.30	43.0975	222.7	2.402	2.390	3.110	2.923	0.504	1.714	1.210	5.805
0:29:10	224.1	0.325	82.9	5.697	5.40	43.1427	224.5	2.419	2.406	3.126	2.947	0.511	1.729	1.218	5.771
0:29:42	225.7	0.331	82.8	5.691	5.50	43.1884	226.1	2.434	2.420	3.140	2.970	0.519	1.744	1.225	5.725
0:30:14	227.5	0.337	82.7	5.685	5.60	43.2348	227.8	2.450	2.436	3.156	2.990	0.523	1.757	1.233	5.714
0:30:45	228.9	0.343	82.6	5.679	5.70	43.2809	229.3	2.463	2.449	3.169	3.015	0.536	1.776	1.240	5.628
0:31:17	230.6	0.349	82.5	5.673	5.80	43.3272	231.0	2.479	2.465	3.185	3.036	0.541	1.788	1.248	5.616
0:31:49	232.1	0.355	82.4	5.667	5.90	43.3734	232.5	2.492	2.478	3.198	3.056	0.548	1.802	1.254	5.579

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Consolidation Values						Final Values					
Height	6.022	(in.)	15.297	(cm)		Height	4.999	(in.)			
Diameter	2.838	(in)	7.209	(cm)		Dia. avg.	3.140	(in)			
Area	6.326	(in^2)	40.813	(cm^2)		Area avg.	7.745	(in^2)			

Tested By	KDG
Date	8-17-09
Press No.	2
Panel No.	E

Project Number	175539009
Test Number	CU-1270A
Data File ID	CU-1270A
Lateral Pressure (psi)	10.0
Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
0:32:21	233.8	0.361	82.3	5.661	6.00	43.4189	234.1	2.507	2.492	3.212	3.078	0.555	1.817	1.261	5.544
0:32:52	235.3	0.367	82.2	5.655	6.10	43.4643	235.6	2.520	2.506	3.226	3.095	0.559	1.827	1.268	5.538
0:33:24	236.9	0.373	82.1	5.649	6.20	43.5099	237.2	2.535	2.520	3.240	3.118	0.568	1.843	1.275	5.490
0:33:58	238.6	0.379	81.8	5.643	6.30	43.5593	238.9	2.550	2.535	3.255	3.154	0.589	1.872	1.283	5.355
0:34:30	239.7	0.385	81.8	5.637	6.40	43.6054	240.0	2.560	2.544	3.264	3.163	0.588	1.875	1.287	5.377
0:35:02	240.9	0.392	82.0	5.631	6.50	43.6526	241.3	2.570	2.554	3.274	3.160	0.576	1.868	1.292	5.490
0:35:31	242.2	0.397	81.9	5.625	6.60	43.6968	242.5	2.581	2.565	3.285	3.175	0.580	1.877	1.297	5.474
0:36:03	243.9	0.403	81.9	5.619	6.70	43.7432	244.2	2.596	2.580	3.300	3.191	0.581	1.886	1.305	5.496
0:36:38	245.3	0.410	81.7	5.612	6.81	43.7936	245.7	2.609	2.592	3.312	3.223	0.601	1.912	1.311	5.365
0:37:07	246.6	0.415	81.7	5.607	6.90	43.8372	246.9	2.619	2.602	3.322	3.229	0.597	1.913	1.316	5.410
0:37:41	248.1	0.422	81.6	5.601	7.00	43.8867	248.5	2.633	2.615	3.335	3.251	0.605	1.928	1.323	5.371
0:38:13	249.2	0.427	81.4	5.595	7.10	43.9333	249.6	2.641	2.624	3.344	3.274	0.620	1.947	1.327	5.282
0:38:45	250.4	0.433	81.3	5.589	7.20	43.9806	250.8	2.651	2.634	3.354	3.287	0.623	1.955	1.332	5.276
0:39:16	251.9	0.440	81.2	5.583	7.30	44.0281	252.2	2.664	2.646	3.366	3.311	0.634	1.973	1.338	5.218
0:39:48	253.2	0.445	81.2	5.577	7.40	44.0747	253.5	2.675	2.657	3.377	3.319	0.632	1.975	1.344	5.254
0:40:20	254.4	0.451	81.1	5.571	7.50	44.1217	254.8	2.685	2.667	3.387	3.339	0.642	1.991	1.349	5.201
0:40:51	255.6	0.457	81.0	5.565	7.60	44.1691	255.9	2.694	2.675	3.395	3.356	0.650	2.003	1.353	5.160
0:41:26	256.7	0.464	81.0	5.558	7.70	44.2199	257.1	2.703	2.684	3.404	3.361	0.646	2.003	1.357	5.202
0:41:57	257.5	0.470	80.9	5.552	7.80	44.2675	257.8	2.708	2.689	3.409	3.375	0.656	2.015	1.360	5.147
0:42:29	258.7	0.476	80.8	5.546	7.90	44.3146	259.0	2.718	2.699	3.419	3.394	0.665	2.030	1.364	5.102
0:43:01	259.8	0.482	80.7	5.541	8.00	44.3619	260.1	2.727	2.707	3.427	3.407	0.670	2.038	1.369	5.088
0:43:33	261.1	0.487	80.6	5.535	8.10	44.4095	261.4	2.737	2.718	3.438	3.427	0.679	2.053	1.374	5.048
0:44:07	262.4	0.494	80.5	5.528	8.20	44.4597	262.8	2.748	2.728	3.448	3.440	0.682	2.061	1.379	5.046
0:44:38	263.1	0.500	80.5	5.522	8.30	44.5090	263.4	2.752	2.732	3.452	3.449	0.688	2.069	1.381	5.017
0:45:10	264.4	0.506	80.4	5.516	8.40	44.5569	264.7	2.762	2.742	3.462	3.466	0.693	2.079	1.386	4.999
0:45:42	265.5	0.512	80.3	5.510	8.50	44.6052	265.8	2.771	2.751	3.471	3.481	0.700	2.090	1.390	4.973
0:46:14	266.5	0.518	80.3	5.504	8.60	44.6534	266.8	2.779	2.758	3.478	3.486	0.697	2.092	1.394	4.998
0:46:45	267.2	0.524	80.1	5.498	8.70	44.7015	267.6	2.783	2.762	3.482	3.503	0.711	2.107	1.396	4.930
0:47:17	268.5	0.530	80.1	5.492	8.80	44.7508	268.8	2.793	2.772	3.492	3.516	0.714	2.115	1.401	4.927
0:47:49	269.3	0.536	80.0	5.486	8.90	44.7992	269.6	2.798	2.777	3.497	3.525	0.718	2.121	1.404	4.910
0:48:21	270.4	0.542	80.0	5.480	9.00	44.8495	270.8	2.807	2.785	3.505	3.538	0.722	2.130	1.408	4.898
0:48:53	271.3	0.548	79.9	5.474	9.10	44.8989	271.7	2.813	2.791	3.511	3.551	0.730	2.140	1.411	4.867
0:49:25	271.4	0.554	79.9	5.468	9.20	44.9483	271.7	2.811	2.789	3.509	3.549	0.729	2.139	1.410	4.864
0:49:56	272.2	0.560	79.8	5.462	9.30	44.9978	272.5	2.816	2.793	3.513	3.557	0.734	2.145	1.412	4.848
0:50:28	272.6	0.566	79.9	5.456	9.40	45.0476	273.0	2.818	2.795	3.515	3.549	0.724	2.136	1.413	4.904
0:51:00	273.5	0.572	79.9	5.450	9.50	45.0980	273.9	2.824	2.801	3.521	3.556	0.725	2.141	1.415	4.903
0:51:31	274.3	0.578	79.7	5.444	9.60	45.1483	274.6	2.829	2.805	3.525	3.576	0.741	2.159	1.418	4.827
0:52:03	275.0	0.584	79.7	5.438	9.70	45.1977	275.3	2.832	2.809	3.529	3.579	0.740	2.160	1.420	4.835
0:52:35	275.8	0.590	79.6	5.432	9.80	45.2486	276.2	2.838	2.814	3.534	3.592	0.748	2.170	1.422	4.804
0:53:07	276.9	0.596	79.6	5.426	9.90	45.2980	277.2	2.846	2.822	3.542	3.602	0.750	2.176	1.426	4.803
0:53:39	277.8	0.602	79.4	5.420	10.00	45.3478	278.2	2.852	2.828	3.548	3.622	0.764	2.193	1.429	4.742
0:54:11	279.0	0.608	79.5	5.414	10.10	45.3974	279.3	2.861	2.837	3.557	3.619	0.752	2.186	1.433	4.810
0:54:42	279.3	0.614	79.4	5.408	10.20	45.4477	279.6	2.861	2.836	3.556	3.630	0.763	2.197	1.433	4.756
0:55:16	280.3	0.620	79.2	5.402	10.30	45.5009	280.7	2.868	2.843	3.563	3.651	0.778	2.214	1.437	4.696
0:55:48	281.2	0.626	79.1	5.396	10.40	45.5505	281.5	2.873	2.848	3.568	3.661	0.782	2.221	1.439	4.680
0:56:20	282.3	0.632	79.2	5.390	10.50	45.6014	282.7	2.882	2.857	3.577	3.666	0.779	2.223	1.444	4.706
0:56:52	283.1	0.638	79.1	5.384	10.60	45.6525	283.4	2.887	2.861	3.581	3.678	0.787	2.233	1.446	4.674
0:57:24	284.0	0.644	79.0	5.378	10.70	45.7043	284.3	2.893	2.867	3.587	3.685	0.789	2.237	1.448	4.674
0:57:57	284.8	0.650	78.9	5.372	10.80	45.7556	285.1	2.898	2.871	3.591	3.700	0.798	2.249	1.451	4.636
0:58:29	285.5	0.656	78.9	5.366	10.90	45.8066	285.8	2.901	2.875	3.595	3.703	0.798	2.250	1.453	4.641
0:59:01	286.2	0.662	78.8	5.360	11.00	45.8578	286.5	2.905	2.878	3.598	3.716	0.807	2.262	1.454	4.603
0:59:33	286.9	0.668	78.9	5.354	11.10	45.9085	287.2	2.909	2.882	3.602	3.711	0.799	2.255	1.456	4.644
1:00:05	287.5	0.674	78.7	5.348	11.20	45.9592	287.9	2.912	2.885	3.605	3.726	0.811	2.268	1.458	4.597
1:00:37	288.3	0.680	78.7	5.342	11.30	46.0105	288.6	2.917	2.890	3.610	3.731	0.811	2.271	1.460	4.600
1:01:10	289.4	0.686	78.7	5.336	11.40	46.0631	289.7	2.925	2.897	3.617	3.742	0.815	2.279	1.464	4.592
1:01:45	290.3	0.692	78.5	5.330	11.50	46.1174	290.6	2.930	2.902	3.622	3.760	0.827	2.293	1.466	4.546
1:02:17	291.2	0.698	78.3	5.324	11.60	46.1683	291.5	2.936	2.908	3.628	3.783	0.846	2.315	1.469	4.474
1:02:49	292.0	0.704	78.6	5.318	11.70	46.2204	292.3	2.941	2.912	3.632	3.766	0.823	2.294	1.471	4.575
1:03:22	292.9	0.710	78.6	5.312	11.80	46.2727	293.3	2.947	2.918	3.638	3.770	0.821	2.295	1.474	4.591
1:03:54	294.0	0.716	78.4	5.306	11.90	46.3238	294.4	2.955	2.926	3.646	3.789	0.833	2.311	1.478	4.548

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values					Final Values						
Height	6.022	(in.)	15.297	(cm)	Height	4.999	(in.)	Tested By	KDG	Project Number	175539009
Diameter	2.838	(in)	7.209	(cm)	Dia. avg.	3.140	(in)	Date	8-17-09	Test Number	CU-1270A
Area	6.326	(in^2)	40.813	(cm^2)	Area avg.	7.745	(in^2)	Press No.	2	Data File ID	CU-1270A
								Panel No.	E	Lateral Pressure (psi)	10.0
										Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
1:04:29	295.4	0.723	78.5	5.300	12.00	46.3794	295.7	2.965	2.936	3.656	3.794	0.828	2.311	1.483	4.582
1:05:01	296.6	0.729	78.5	5.294	12.10	46.4316	296.9	2.974	2.944	3.664	3.804	0.829	2.317	1.487	4.588
1:05:33	297.8	0.734	78.5	5.288	12.20	46.4836	298.1	2.982	2.952	3.672	3.813	0.830	2.322	1.491	4.592
1:06:06	298.7	0.740	78.4	5.282	12.30	46.5352	299.0	2.988	2.958	3.678	3.825	0.837	2.331	1.494	4.572
1:06:40	299.1	0.747	78.3	5.275	12.40	46.5917	299.5	2.989	2.958	3.678	3.831	0.842	2.336	1.494	4.551
1:07:13	300.3	0.753	78.2	5.269	12.50	46.6448	300.6	2.997	2.966	3.686	3.848	0.852	2.350	1.498	4.517
1:07:45	301.0	0.759	78.2	5.263	12.60	46.6980	301.3	3.000	2.970	3.690	3.850	0.850	2.350	1.500	4.528
1:08:17	301.7	0.765	78.2	5.257	12.70	46.7506	302.1	3.005	2.974	3.694	3.855	0.851	2.353	1.502	4.529
1:08:49	302.6	0.771	78.1	5.252	12.80	46.8036	303.0	3.010	2.979	3.699	3.866	0.856	2.361	1.505	4.514
1:09:21	303.2	0.777	78.0	5.245	12.90	46.8573	303.5	3.012	2.981	3.701	3.878	0.867	2.372	1.505	4.474
1:09:53	304.1	0.783	78.1	5.239	13.00	46.9111	304.5	3.018	2.986	3.706	3.875	0.858	2.367	1.508	4.515
1:10:26	304.7	0.789	77.9	5.233	13.10	46.9658	305.0	3.020	2.988	3.708	3.891	0.873	2.382	1.509	4.459
1:10:58	305.2	0.795	77.9	5.227	13.20	47.0201	305.5	3.021	2.989	3.709	3.894	0.875	2.384	1.510	4.452
1:11:30	306.1	0.801	77.9	5.221	13.30	47.0746	306.4	3.027	2.995	3.715	3.899	0.874	2.386	1.512	4.461
1:12:00	307.1	0.806	77.8	5.216	13.40	47.1259	307.4	3.033	3.000	3.720	3.908	0.877	2.392	1.515	4.456
1:12:32	306.9	0.813	77.8	5.209	13.50	47.1816	307.3	3.028	2.995	3.715	3.906	0.880	2.393	1.513	4.440
1:13:05	308.0	0.819	77.8	5.203	13.60	47.2372	308.4	3.035	3.002	3.722	3.913	0.880	2.397	1.516	4.445
1:13:37	308.2	0.825	77.6	5.197	13.70	47.2930	308.6	3.034	3.001	3.721	3.923	0.892	2.408	1.515	4.396
1:14:07	304.9	0.831	77.5	5.191	13.80	47.3467	305.2	2.998	2.964	3.684	3.894	0.899	2.396	1.497	4.330
1:14:39	306.2	0.837	77.6	5.185	13.90	47.4029	306.6	3.007	2.973	3.693	3.895	0.892	2.394	1.502	4.368
1:15:11	307.4	0.843	77.4	5.179	14.00	47.4586	307.7	3.015	2.981	3.701	3.919	0.907	2.413	1.506	4.318
1:15:41	308.2	0.849	77.4	5.173	14.10	47.5107	308.5	3.020	2.985	3.705	3.924	0.909	2.416	1.508	4.319
1:16:13	308.1	0.855	77.3	5.167	14.20	47.5667	308.5	3.016	2.981	3.701	3.926	0.915	2.421	1.506	4.291
1:16:45	309.2	0.861	77.4	5.161	14.30	47.6229	309.5	3.022	2.987	3.707	3.926	0.909	2.417	1.509	4.320
1:17:18	310.2	0.867	77.5	5.155	14.40	47.6793	310.6	3.029	2.994	3.714	3.924	0.900	2.412	1.512	4.359
1:17:50	310.8	0.873	77.4	5.149	14.50	47.7353	311.1	3.031	2.996	3.716	3.932	0.906	2.419	1.513	4.338
1:18:19	311.4	0.879	77.5	5.143	14.59	47.7877	311.7	3.033	2.998	3.718	3.930	0.902	2.416	1.514	4.358
1:18:51	311.3	0.885	77.5	5.137	14.69	47.8437	311.7	3.029	2.993	3.713	3.926	0.902	2.414	1.512	4.353
1:19:25	312.5	0.891	77.4	5.131	14.80	47.9039	312.8	3.037	3.001	3.721	3.937	0.906	2.422	1.516	4.345
1:19:55	313.4	0.897	77.3	5.125	14.90	47.9572	313.7	3.042	3.006	3.726	3.951	0.915	2.433	1.518	4.317
1:20:27	314.2	0.903	77.3	5.119	15.00	48.0134	314.5	3.046	3.009	3.729	3.957	0.917	2.437	1.520	4.315
1:20:59	314.8	0.909	77.1	5.113	15.09	48.0689	315.1	3.048	3.011	3.731	3.968	0.926	2.447	1.521	4.283
1:21:33	315.2	0.915	77.4	5.107	15.20	48.1292	315.5	3.048	3.011	3.731	3.951	0.909	2.430	1.521	4.346
1:22:05	316.4	0.921	77.2	5.101	15.30	48.1853	316.7	3.056	3.019	3.739	3.970	0.920	2.445	1.525	4.314
1:22:36	317.4	0.927	77.1	5.095	15.40	48.2419	317.7	3.062	3.025	3.745	3.985	0.930	2.457	1.528	4.286
1:23:08	318.7	0.933	77.1	5.089	15.50	48.2982	319.0	3.071	3.034	3.754	3.992	0.928	2.460	1.532	4.303
1:23:40	319.5	0.939	77.0	5.083	15.60	48.3548	319.8	3.076	3.038	3.758	4.003	0.935	2.469	1.534	4.282
1:24:11	319.8	0.945	77.0	5.077	15.70	48.4115	320.1	3.075	3.037	3.757	4.000	0.933	2.467	1.534	4.288
1:24:43	321.0	0.951	76.9	5.071	15.79	48.4687	321.4	3.083	3.045	3.765	4.015	0.940	2.478	1.537	4.271
1:25:17	322.4	0.957	77.1	5.065	15.90	48.5301	322.8	3.093	3.054	3.774	4.014	0.930	2.472	1.542	4.318
1:25:49	323.2	0.963	77.0	5.059	16.00	48.5871	323.5	3.096	3.057	3.777	4.026	0.939	2.483	1.544	4.289
1:26:21	324.2	0.969	76.9	5.053	16.10	48.6440	324.5	3.102	3.063	3.783	4.038	0.945	2.491	1.547	4.275
1:26:52	324.5	0.975	77.0	5.047	16.20	48.7017	324.9	3.102	3.062	3.782	4.030	0.937	2.484	1.546	4.299
1:27:24	325.1	0.981	76.8	5.041	16.30	48.7585	325.4	3.103	3.064	3.784	4.044	0.950	2.497	1.547	4.257
1:27:56	325.6	0.987	76.9	5.035	16.39	48.8161	325.9	3.104	3.064	3.784	4.041	0.947	2.494	1.547	4.269
1:28:30	326.3	0.993	76.8	5.029	16.50	48.8784	326.7	3.108	3.067	3.787	4.048	0.951	2.499	1.549	4.259
1:29:02	327.3	0.999	76.7	5.023	16.60	48.9354	327.7	3.114	3.073	3.793	4.063	0.960	2.511	1.552	4.234
1:29:33	327.8	1.005	76.6	5.017	16.70	48.9929	328.1	3.114	3.074	3.794	4.067	0.963	2.515	1.552	4.223
1:30:05	329.1	1.011	76.6	5.011	16.79	49.0512	329.4	3.123	3.082	3.802	4.077	0.965	2.521	1.556	4.226
1:30:37	330.1	1.017	76.7	5.005	16.89	49.1096	330.4	3.128	3.087	3.807	4.077	0.959	2.518	1.559	4.250
1:31:11	331.4	1.024	76.5	4.999	17.00	49.1725	331.7	3.137	3.095	3.815	4.097	0.971	2.534	1.563	4.219

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Consolidation Values			Final Values		Tested By	KDG	Project Number	175539009
Height	6.035 (in.)	15.330 (cm)	Height	5.003 (in.)	Date	8-20-09	Test Number	CU-1270B
Diameter	2.866 (in)	7.279 (cm)	Dia. avg.	3.164 (in)	Press No.	2	Data File ID	CU-1270B
Area	6.450 (in²)	41.611 (cm²)	Area avg.	7.863 (in²)	Panel No.	F	Lateral Pressure (psi)	30.0
							Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm²)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
0:00:00	10.2	-0.001	59.9	6.035	0.00	41.6109	0.0	0.000	0.000	2.160	2.160	2.169	2.164	-0.004	0.996
0:18:58	23.9	0.005	61.6	6.029	0.10	41.6533	13.7	0.153	0.153	2.313	2.192	2.048	2.120	0.072	1.070
0:27:41	24.9	0.011	61.8	6.023	0.20	41.6949	14.7	0.164	0.164	2.324	2.188	2.033	2.111	0.077	1.076
0:36:34	25.5	0.017	61.5	6.017	0.30	41.7366	15.4	0.171	0.171	2.331	2.213	2.051	2.132	0.081	1.079
0:45:19	27.0	0.023	61.7	6.011	0.40	41.7785	16.8	0.187	0.186	2.346	2.213	2.036	2.125	0.089	1.087
0:54:39	28.5	0.029	62.0	6.005	0.50	41.8212	18.4	0.205	0.203	2.363	2.212	2.017	2.115	0.097	1.096
1:04:30	30.4	0.035	61.8	5.999	0.60	41.8624	20.2	0.224	0.223	2.383	2.247	2.032	2.139	0.107	1.105
1:14:29	34.4	0.041	62.3	5.993	0.70	41.9046	24.3	0.269	0.267	2.427	2.254	1.996	2.125	0.129	1.130
1:24:21	38.5	0.047	62.7	5.987	0.80	41.9473	28.4	0.314	0.312	2.472	2.268	1.965	2.117	0.152	1.155
1:34:17	41.6	0.053	63.1	5.981	0.90	41.9897	31.5	0.348	0.346	2.506	2.275	1.937	2.106	0.169	1.174
1:44:18	45.2	0.059	63.1	5.975	1.00	42.0320	35.1	0.388	0.386	2.546	2.310	1.933	2.122	0.188	1.195
1:54:07	48.0	0.065	63.5	5.969	1.10	42.0742	37.8	0.418	0.415	2.575	2.311	1.904	2.108	0.203	1.214
2:03:46	47.8	0.071	63.7	5.963	1.20	42.1176	37.6	0.415	0.412	2.572	2.297	1.893	2.095	0.202	1.213
2:13:39	49.2	0.077	63.6	5.957	1.30	42.1598	39.0	0.430	0.427	2.587	2.317	1.899	2.108	0.209	1.220
2:23:45	51.9	0.083	63.9	5.951	1.40	42.2023	41.8	0.460	0.457	2.617	2.329	1.881	2.105	0.224	1.238
2:33:49	54.3	0.089	64.1	5.945	1.50	42.2451	44.1	0.486	0.482	2.642	2.337	1.864	2.101	0.237	1.254
2:43:50	58.9	0.095	64.5	5.939	1.60	42.2892	48.8	0.536	0.532	2.692	2.360	1.837	2.099	0.262	1.285
2:53:56	63.3	0.101	64.8	5.933	1.70	42.3314	53.1	0.583	0.579	2.739	2.383	1.813	2.098	0.285	1.315
3:04:12	77.4	0.107	65.9	5.927	1.80	42.3749	67.3	0.738	0.734	2.894	2.460	1.735	2.097	0.363	1.418
3:14:33	94.2	0.113	68.0	5.921	1.90	42.4178	84.1	0.922	0.917	3.077	2.489	1.581	2.035	0.454	1.575
3:24:41	107.3	0.119	69.6	5.915	2.00	42.4610	97.1	1.064	1.059	3.219	2.518	1.468	1.993	0.525	1.716
3:35:14	117.3	0.126	70.8	5.908	2.10	42.5052	107.2	1.172	1.167	3.327	2.543	1.384	1.964	0.579	1.837
3:45:42	125.3	0.132	71.6	5.903	2.20	42.5478	115.2	1.259	1.253	3.413	2.571	1.326	1.949	0.622	1.938
3:56:12	132.7	0.138	72.2	5.896	2.30	42.5926	122.5	1.338	1.332	3.492	2.602	1.279	1.940	0.662	2.035
4:06:08	138.9	0.144	72.8	5.890	2.40	42.6352	128.7	1.404	1.398	3.558	2.628	1.239	1.934	0.695	2.121
4:12:09	147.2	0.150	73.4	5.884	2.50	42.6793	137.1	1.493	1.487	3.647	2.674	1.195	1.935	0.739	2.237
4:16:35	152.1	0.156	73.8	5.878	2.60	42.7237	141.9	1.545	1.539	3.699	2.697	1.167	1.932	0.765	2.311
4:20:57	156.8	0.162	74.2	5.872	2.70	42.7669	146.7	1.595	1.588	3.748	2.718	1.139	1.929	0.790	2.387
4:25:20	161.4	0.168	74.5	5.866	2.80	42.8106	151.3	1.643	1.637	3.797	2.743	1.115	1.929	0.814	2.459
4:29:32	165.7	0.174	74.3	5.860	2.90	42.8555	155.6	1.688	1.681	3.841	2.803	1.131	1.967	0.836	2.479
4:33:52	170.5	0.180	74.9	5.854	3.01	42.9005	160.4	1.738	1.731	3.891	2.806	1.084	1.945	0.861	2.589
4:38:08	174.5	0.186	74.9	5.848	3.10	42.9435	164.3	1.779	1.772	3.932	2.849	1.086	1.967	0.881	2.624
4:42:20	178.2	0.192	75.2	5.842	3.20	42.9880	168.1	1.818	1.810	3.970	2.865	1.064	1.965	0.901	2.693
4:46:41	182.2	0.198	75.2	5.836	3.30	43.0326	172.0	1.859	1.851	4.011	2.909	1.067	1.988	0.921	2.727
4:51:03	186.0	0.204	75.3	5.830	3.41	43.0779	175.8	1.898	1.890	4.050	2.938	1.057	1.997	0.940	2.780
4:55:13	189.5	0.210	75.3	5.824	3.50	43.1215	179.4	1.934	1.926	4.086	2.976	1.059	2.017	0.958	2.810
4:59:33	193.1	0.216	75.3	5.818	3.60	43.1666	183.0	1.971	1.962	4.122	3.014	1.061	2.038	0.977	2.841
5:03:51	196.7	0.222	75.3	5.812	3.70	43.2119	186.5	2.007	1.998	4.158	3.047	1.058	2.053	0.995	2.881
5:08:08	199.4	0.228	74.9	5.806	3.80	43.2561	189.3	2.035	2.026	4.186	3.101	1.084	2.092	1.008	2.861
5:12:24	202.5	0.234	75.3	5.800	3.90	43.3016	192.4	2.066	2.056	4.216	3.107	1.059	2.083	1.024	2.933
5:16:41	205.9	0.240	75.1	5.794	4.00	43.3466	195.8	2.100	2.091	4.251	3.156	1.074	2.115	1.041	2.939
5:21:01	209.1	0.246	75.2	5.788	4.10	43.3917	199.0	2.132	2.122	4.282	3.178	1.064	2.121	1.057	2.986
5:25:21	211.7	0.252	75.0	5.782	4.20	43.4373	201.6	2.158	2.148	4.308	3.218	1.079	2.149	1.070	2.982
5:29:41	214.6	0.258	75.0	5.776	4.30	43.4827	204.5	2.187	2.176	4.336	3.244	1.077	2.161	1.084	3.013
5:33:59	217.6	0.264	74.9	5.770	4.40	43.5276	207.4	2.216	2.205	4.365	3.281	1.085	2.183	1.098	3.024
5:38:24	220.6	0.270	74.8	5.764	4.50	43.5733	210.4	2.245	2.235	4.395	3.320	1.094	2.207	1.113	3.034
5:42:48	223.2	0.277	74.7	5.758	4.61	43.6196	213.0	2.271	2.260	4.420	3.349	1.099	2.224	1.125	3.049
5:47:16	225.7	0.283	74.2	5.752	4.70	43.6648	215.5	2.295	2.284	4.444	3.415	1.139	2.277	1.138	2.997
5:51:40	228.4	0.289	74.6	5.745	4.80	43.7111	218.2	2.321	2.310	4.470	3.413	1.112	2.263	1.151	3.069
5:56:13	230.8	0.295	74.2	5.739	4.90	43.7572	220.7	2.345	2.333	4.493	3.463	1.139	2.301	1.162	3.042
6:00:42	233.6	0.301	74.3	5.733	5.00	43.8032	223.4	2.372	2.360	4.520	3.479	1.128	2.303	1.176	3.085
6:05:13	235.8	0.307	74.1	5.727	5.10	43.8493	225.6	2.392	2.380	4.540	3.519	1.148	2.333	1.186	3.066
6:09:42	237.7	0.313	74.1	5.721	5.20	43.8955	227.5	2.410	2.397	4.557	3.533	1.145	2.339	1.194	3.087
6:14:14	240.0	0.319	73.9	5.715	5.30	43.9420	229.8	2.432	2.419	4.579	3.573	1.162	2.367	1.205	3.074
6:18:46	242.2	0.325	73.8	5.709	5.40	43.9885	232.1	2.453	2.440	4.600	3.598	1.166	2.382	1.216	3.085
6:23:14	244.5	0.331	73.6	5.703	5.50	44.0348	234.4	2.475	2.462	4.622	3.634	1.181	2.407	1.226	3.078
6:27:43	246.5	0.337	73.6	5.697	5.60	44.0815	236.4	2.493	2.480	4.640	3.655	1.184	2.420	1.236	3.086
6:32:16	248.3	0.343	73.3	5.691	5.70	44.1284	238.2	2.510	2.496	4.656	3.687	1.200	2.444	1.244	3.073
6:36:43	250.4	0.349	73.2	5.685	5.80	44.1752	240.3	2.529	2.515	4.675	3.716	1.210	2.463	1.253	3.072
6:41:12	252.0	0.355	73.1	5.679	5.91	44.2228	241.9	2.543	2.529	4.689	3.739	1.219	2.479	1.260	3.068

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values				Final Values	
Height	6.035	(in.)	15.330	(cm)	Height	5.003 (in.)
Diameter	2.866	(in)	7.279	(cm)	Dia. avg.	3.164 (in)
Area	6.450	(in^2)	41.611	(cm^2)	Area avg.	7.863 (in^2)

Tested By: KDG
Date: 8-20-09
Press No.: 2
Panel No.: F

Project Number: 175539009
Test Number: CU-1270B
Data File ID: CU-1270B
Lateral Pressure (psi): 30.0
Chamber Pressure - σ_3 (psi): 90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
6:45:40	254.1	0.361	72.7	5.673	6.00	44.2691	243.9	2.562	2.547	4.707	3.784	1.245	2.515	1.269	3.039
6:50:12	256.0	0.367	72.8	5.667	6.11	44.3167	245.9	2.580	2.565	4.725	3.796	1.240	2.518	1.278	3.062
6:54:46	257.7	0.373	72.3	5.661	6.21	44.3639	247.6	2.595	2.580	4.740	3.842	1.271	2.557	1.286	3.023
6:59:16	259.2	0.379	72.5	5.655	6.31	44.4112	249.0	2.607	2.592	4.752	3.843	1.260	2.552	1.292	3.050
7:03:43	260.9	0.385	72.2	5.649	6.40	44.4585	250.8	2.623	2.607	4.767	3.883	1.285	2.584	1.299	3.022
7:08:10	262.5	0.391	72.3	5.643	6.50	44.5060	252.4	2.637	2.621	4.781	3.889	1.277	2.583	1.306	3.046
7:12:37	264.0	0.397	71.9	5.637	6.61	44.5537	253.9	2.649	2.634	4.794	3.926	1.302	2.614	1.312	3.016
7:17:12	265.5	0.403	71.9	5.631	6.71	44.6023	255.3	2.662	2.646	4.806	3.940	1.303	2.622	1.318	3.023
7:21:36	267.3	0.409	71.7	5.625	6.81	44.6494	257.1	2.678	2.661	4.821	3.973	1.320	2.646	1.326	3.009
7:26:08	268.6	0.415	71.6	5.619	6.91	44.6974	258.5	2.689	2.672	4.832	3.988	1.325	2.657	1.332	3.011
7:30:36	269.8	0.421	71.4	5.613	7.01	44.7457	259.6	2.698	2.681	4.841	4.014	1.342	2.678	1.336	2.992
7:35:08	270.9	0.427	71.2	5.607	7.11	44.7938	260.7	2.707	2.690	4.850	4.033	1.352	2.693	1.340	2.983
7:39:40	272.4	0.434	71.1	5.601	7.21	44.8421	262.3	2.720	2.702	4.862	4.055	1.362	2.709	1.347	2.977
7:44:15	273.6	0.440	70.8	5.595	7.31	44.8905	263.4	2.729	2.711	4.871	4.083	1.381	2.732	1.351	2.957
7:48:47	274.8	0.446	70.8	5.588	7.41	44.9393	264.7	2.739	2.721	4.881	4.097	1.385	2.741	1.356	2.958
7:53:26	276.2	0.452	70.2	5.582	7.51	44.9880	266.0	2.750	2.732	4.892	4.147	1.424	2.785	1.361	2.912
7:58:03	277.5	0.458	70.5	5.576	7.61	45.0367	267.4	2.760	2.742	4.902	4.139	1.405	2.772	1.367	2.945
8:02:38	278.2	0.464	70.1	5.570	7.71	45.0852	268.0	2.764	2.746	4.906	4.172	1.435	2.804	1.368	2.907
8:07:17	279.4	0.470	70.2	5.564	7.81	45.1341	269.2	2.774	2.755	4.915	4.174	1.428	2.801	1.373	2.924
8:11:56	280.4	0.476	69.9	5.558	7.91	45.1832	270.2	2.781	2.762	4.922	4.204	1.451	2.827	1.377	2.898
8:16:38	281.4	0.482	69.9	5.552	8.01	45.2324	271.3	2.789	2.769	4.929	4.209	1.449	2.829	1.380	2.906
8:21:13	282.3	0.488	69.6	5.546	8.11	45.2816	272.2	2.795	2.775	4.935	4.237	1.470	2.853	1.383	2.882
8:25:57	282.9	0.494	69.6	5.540	8.21	45.3309	272.7	2.797	2.777	4.937	4.238	1.469	2.853	1.384	2.885
8:30:39	283.5	0.500	69.3	5.534	8.31	45.3806	273.3	2.801	2.781	4.941	4.263	1.491	2.877	1.386	2.859
8:35:26	284.5	0.506	69.3	5.528	8.41	45.4304	274.3	2.808	2.787	4.947	4.268	1.489	2.878	1.389	2.866
8:40:12	284.9	0.512	69.0	5.522	8.51	45.4798	274.7	2.809	2.788	4.948	4.290	1.510	2.900	1.390	2.841
8:44:59	285.6	0.518	69.0	5.516	8.61	45.5296	275.5	2.813	2.793	4.953	4.295	1.511	2.903	1.392	2.842
8:49:41	286.3	0.524	68.7	5.510	8.71	45.5794	276.1	2.817	2.796	4.956	4.317	1.530	2.924	1.393	2.821
8:54:30	286.7	0.530	68.7	5.504	8.81	45.6295	276.6	2.818	2.797	4.957	4.319	1.530	2.925	1.394	2.822
8:59:14	287.4	0.536	68.5	5.498	8.91	45.6795	277.2	2.822	2.801	4.961	4.343	1.551	2.947	1.396	2.800
9:03:59	288.0	0.542	68.5	5.492	9.01	45.7300	277.8	2.825	2.803	4.963	4.346	1.551	2.949	1.397	2.802
9:08:50	288.7	0.548	68.2	5.486	9.11	45.7801	278.6	2.830	2.808	4.968	4.367	1.568	2.968	1.399	2.785
9:13:40	289.2	0.554	68.2	5.480	9.21	45.8307	279.1	2.831	2.809	4.969	4.368	1.568	2.968	1.400	2.786
9:18:29	289.5	0.560	68.0	5.474	9.31	45.8812	279.3	2.831	2.809	4.969	4.386	1.586	2.986	1.400	2.766
9:23:20	289.9	0.566	68.0	5.468	9.41	45.9319	279.7	2.832	2.809	4.969	4.388	1.588	2.988	1.400	2.764
9:28:17	289.9	0.572	67.7	5.462	9.51	45.9829	279.8	2.829	2.806	4.966	4.402	1.605	3.003	1.399	2.743
9:33:06	290.2	0.578	67.7	5.456	9.61	46.0335	280.1	2.829	2.806	4.966	4.402	1.605	3.003	1.399	2.743
9:37:56	290.6	0.585	67.5	5.450	9.71	46.0845	280.5	2.830	2.807	4.967	4.420	1.622	3.021	1.399	2.725
9:42:47	290.4	0.591	67.5	5.444	9.81	46.1360	280.2	2.824	2.801	4.961	4.415	1.623	3.019	1.396	2.720
9:47:39	290.2	0.597	67.2	5.437	9.91	46.1871	280.0	2.819	2.795	4.955	4.429	1.642	3.035	1.393	2.697
9:52:33	290.1	0.603	67.2	5.431	10.01	46.2385	279.9	2.815	2.791	4.951	4.425	1.643	3.034	1.391	2.693
9:57:27	289.3	0.609	66.9	5.425	10.11	46.2901	279.1	2.804	2.779	4.939	4.432	1.661	3.046	1.385	2.668
10:02:19	288.1	0.615	66.9	5.419	10.21	46.3414	278.0	2.789	2.764	4.924	4.417	1.662	3.040	1.378	2.658
10:07:13	286.9	0.621	66.7	5.413	10.31	46.3930	276.8	2.774	2.749	4.909	4.421	1.681	3.051	1.370	2.631
10:12:04	285.5	0.627	66.7	5.407	10.41	46.4452	275.3	2.756	2.731	4.891	4.403	1.680	3.041	1.361	2.620
10:17:03	284.6	0.633	66.4	5.401	10.51	46.4971	274.5	2.745	2.720	4.880	4.408	1.697	3.052	1.355	2.598
10:22:00	283.4	0.639	66.5	5.395	10.61	46.5497	273.3	2.730	2.704	4.864	4.387	1.692	3.040	1.348	2.593
10:26:59	282.2	0.645	66.2	5.389	10.71	46.6016	272.0	2.714	2.688	4.848	4.391	1.711	3.051	1.340	2.566
10:31:51	280.8	0.651	66.3	5.383	10.81	46.6534	270.7	2.698	2.672	4.832	4.367	1.704	3.036	1.331	2.562
10:36:52	280.4	0.657	66.1	5.377	10.91	46.7063	270.2	2.690	2.664	4.824	4.379	1.724	3.051	1.328	2.540
10:41:46	279.9	0.663	66.2	5.371	11.01	46.7585	269.7	2.682	2.656	4.816	4.363	1.716	3.040	1.324	2.542
10:46:40	279.2	0.669	65.9	5.365	11.11	46.8113	269.0	2.672	2.646	4.806	4.370	1.733	3.051	1.318	2.522
10:51:32	278.2	0.675	66.0	5.359	11.21	46.8639	268.0	2.660	2.633	4.793	4.350	1.726	3.038	1.312	2.520
10:56:23	277.6	0.681	65.8	5.353	11.31	46.9166	267.4	2.650	2.623	4.783	4.357	1.743	3.050	1.307	2.500
11:01:07	277.0	0.687	65.9	5.347	11.41	46.9695	266.8	2.642	2.614	4.774	4.342	1.736	3.039	1.303	2.501
11:06:00	276.5	0.693	65.6	5.341	11.51	47.0227	266.3	2.634	2.606	4.766	4.351	1.754	3.053	1.299	2.480
11:10:49	276.8	0.699	65.8	5.335	11.61	47.0768	266.6	2.633	2.605	4.765	4.342	1.746	3.044	1.298	2.488
11:15:43	276.1	0.705	65.5	5.329	11.71	47.1301	265.9	2.624	2.595	4.755	4.347	1.761	3.054	1.293	2.469
11:20:37	275.2	0.711	65.6	5.323	11.81	47.1829	265.0	2.612	2.583	4.743	4.328	1.754	3.041	1.287	2.468
11:25:31	275.0	0.717	65.4	5.317	11.91	47.2368	264.8	2.607	2.578	4.738	4.340	1.771	3.055	1.285	2.451

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			Final Values			
Height	6.035 (in.)	15.330 (cm)	Height	5.003 (in.)	Tested By	KDG	Project Number	175539009
Diameter	2.866 (in)	7.279 (cm)	Dia. avg.	3.164 (in)	Date	8-20-09	Test Number	CU-1270B
Area	6.450 (in^2)	41.611 (cm^2)	Area avg.	7.863 (in^2)	Press No.	2	Data File ID	CU-1270B
					Panel No.	F	Lateral Pressure (psi)	30.0
							Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
11:30:23	274.4	0.723	65.6	5.311	12.01	47.2906	264.2	2.598	2.569	4.729	4.320	1.760	3.040	1.280	2.455
11:35:17	274.4	0.729	65.3	5.305	12.11	47.3439	264.2	2.595	2.566	4.726	4.335	1.778	3.056	1.278	2.438
11:40:11	274.0	0.736	65.5	5.299	12.21	47.3981	263.9	2.589	2.559	4.719	4.316	1.766	3.041	1.275	2.444
11:45:07	273.0	0.742	65.2	5.293	12.31	47.4522	262.9	2.576	2.546	4.706	4.322	1.784	3.053	1.269	2.422
11:50:09	273.2	0.748	65.4	5.287	12.41	47.5062	263.1	2.575	2.545	4.705	4.308	1.772	3.040	1.268	2.431
11:55:08	272.9	0.754	65.2	5.280	12.51	47.5610	262.7	2.569	2.538	4.698	4.318	1.788	3.053	1.265	2.414
12:00:07	272.6	0.760	65.3	5.274	12.61	47.6152	262.4	2.563	2.532	4.692	4.301	1.778	3.039	1.262	2.420
12:05:03	272.6	0.766	65.1	5.268	12.71	47.6697	262.4	2.560	2.529	4.689	4.317	1.796	3.056	1.260	2.403
12:09:55	272.1	0.772	65.3	5.262	12.81	47.7245	261.9	2.552	2.521	4.681	4.294	1.781	3.038	1.256	2.411
12:14:54	272.0	0.778	65.0	5.256	12.91	47.7795	261.9	2.549	2.518	4.678	4.312	1.803	3.057	1.254	2.392
12:19:45	272.4	0.784	65.2	5.250	13.01	47.8343	262.3	2.549	2.518	4.678	4.297	1.788	3.042	1.255	2.404
12:24:35	272.2	0.790	64.9	5.244	13.11	47.8898	262.0	2.544	2.513	4.673	4.309	1.805	3.057	1.252	2.387
12:29:26	272.2	0.796	65.1	5.238	13.21	47.9444	262.0	2.541	2.510	4.670	4.294	1.793	3.043	1.250	2.395
12:34:23	272.1	0.802	64.9	5.232	13.31	47.9999	262.0	2.538	2.506	4.666	4.306	1.809	3.058	1.249	2.380
12:39:14	271.6	0.808	65.1	5.226	13.41	48.0552	261.4	2.529	2.497	4.657	4.283	1.795	3.039	1.244	2.386
12:44:11	271.8	0.814	64.8	5.220	13.51	48.1109	261.6	2.529	2.496	4.656	4.301	1.814	3.057	1.244	2.371
12:49:07	272.1	0.820	65.0	5.214	13.61	48.1665	261.9	2.528	2.496	4.656	4.288	1.801	3.044	1.243	2.381
12:54:01	271.7	0.826	64.7	5.208	13.71	48.2229	261.6	2.522	2.489	4.649	4.299	1.819	3.059	1.240	2.364
12:58:50	271.9	0.832	64.9	5.202	13.81	48.2787	261.8	2.521	2.488	4.648	4.284	1.805	3.044	1.240	2.374
13:03:42	271.5	0.838	64.7	5.196	13.91	48.3348	261.3	2.514	2.480	4.640	4.295	1.823	3.059	1.236	2.356
13:08:34	271.4	0.844	64.9	5.190	14.01	48.3910	261.2	2.510	2.476	4.636	4.277	1.810	3.043	1.234	2.363
13:13:25	271.4	0.850	64.6	5.184	14.11	48.4479	261.3	2.508	2.474	4.634	4.293	1.828	3.061	1.232	2.348
13:18:12	271.4	0.856	64.8	5.178	14.21	48.5037	261.3	2.505	2.471	4.631	4.277	1.815	3.046	1.231	2.356
13:23:08	271.2	0.862	64.5	5.172	14.31	48.5603	261.0	2.499	2.465	4.625	4.290	1.834	3.062	1.228	2.339
13:27:58	270.6	0.868	64.7	5.166	14.41	48.6174	260.5	2.491	2.457	4.617	4.268	1.821	3.044	1.224	2.345
13:32:47	270.0	0.875	64.5	5.160	14.51	48.6747	259.9	2.483	2.448	4.608	4.278	1.839	3.059	1.219	2.326
13:37:34	271.1	0.881	64.6	5.154	14.61	48.7314	261.0	2.490	2.455	4.615	4.273	1.827	3.050	1.223	2.339
13:42:20	270.8	0.887	64.4	5.148	14.71	48.7883	260.6	2.484	2.448	4.608	4.281	1.841	3.061	1.220	2.325
13:47:07	271.2	0.893	64.6	5.142	14.81	48.8459	261.0	2.485	2.449	4.609	4.272	1.832	3.052	1.220	2.333
13:51:49	271.0	0.899	64.4	5.135	14.91	48.9031	260.8	2.480	2.444	4.604	4.279	1.843	3.061	1.218	2.321
13:56:31	270.9	0.905	64.5	5.129	15.01	48.9610	260.7	2.476	2.440	4.600	4.270	1.839	3.054	1.216	2.322
14:01:17	271.6	0.911	64.3	5.123	15.11	49.0190	261.4	2.480	2.443	4.603	4.285	1.851	3.068	1.217	2.315
14:05:57	271.7	0.917	64.4	5.117	15.21	49.0764	261.6	2.479	2.442	4.602	4.274	1.841	3.058	1.217	2.321
14:10:38	272.3	0.923	64.3	5.111	15.31	49.1343	262.2	2.481	2.444	4.604	4.287	1.852	3.070	1.218	2.315
14:15:18	271.8	0.929	64.4	5.105	15.41	49.1925	261.7	2.474	2.436	4.596	4.274	1.846	3.060	1.214	2.315
14:19:56	271.7	0.935	64.2	5.099	15.51	49.2510	261.5	2.469	2.432	4.592	4.280	1.857	3.069	1.211	2.305
14:24:33	272.4	0.941	64.3	5.093	15.61	49.3092	262.2	2.473	2.435	4.595	4.275	1.848	3.062	1.213	2.313
14:29:06	272.6	0.947	64.2	5.087	15.71	49.3676	262.5	2.472	2.434	4.594	4.283	1.858	3.070	1.213	2.306
14:33:43	272.7	0.953	64.2	5.081	15.81	49.4264	262.5	2.470	2.432	4.592	4.277	1.855	3.066	1.211	2.306
14:38:19	273.0	0.959	64.2	5.075	15.91	49.4852	262.9	2.470	2.432	4.592	4.284	1.861	3.073	1.212	2.302
14:42:52	272.9	0.965	64.2	5.069	16.01	49.5440	262.7	2.466	2.427	4.587	4.279	1.861	3.070	1.209	2.299
14:47:29	272.8	0.971	64.1	5.063	16.11	49.6034	262.7	2.462	2.424	4.584	4.279	1.864	3.072	1.207	2.295
14:52:04	272.7	0.977	64.0	5.057	16.21	49.6627	262.5	2.458	2.419	4.579	4.281	1.871	3.076	1.205	2.288
14:56:41	273.4	0.983	64.0	5.051	16.31	49.7218	263.2	2.462	2.422	4.582	4.283	1.870	3.076	1.207	2.291
15:01:16	273.4	0.989	63.7	5.045	16.41	49.7814	263.3	2.459	2.419	4.579	4.305	1.894	3.099	1.205	2.273
15:05:56	273.7	0.995	64.0	5.039	16.51	49.8413	263.6	2.459	2.419	4.579	4.283	1.873	3.078	1.205	2.287
15:10:31	273.2	1.001	63.7	5.033	16.61	49.9007	263.0	2.451	2.411	4.571	4.292	1.890	3.091	1.201	2.271
15:15:08	273.7	1.007	64.0	5.027	16.71	49.9616	263.5	2.452	2.412	4.572	4.276	1.873	3.075	1.202	2.283
15:19:38	273.8	1.013	63.8	5.021	16.81	50.0209	263.7	2.451	2.410	4.570	4.288	1.886	3.087	1.201	2.273
15:24:16	274.0	1.019	64.0	5.015	16.91	50.0812	263.8	2.450	2.409	4.569	4.275	1.875	3.075	1.200	2.280
15:28:48	274.6	1.025	63.8	5.009	17.01	50.1415	264.4	2.452	2.411	4.571	4.290	1.887	3.089	1.201	2.273
15:33:18	275.0	1.032	63.9	5.003	17.11	50.2023	264.9	2.453	2.412	4.572	4.284	1.880	3.082	1.202	2.278

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values			Final Values				
Height	5.972 (in.)	15.169 (cm)	Height	5.076 (in.)	Tested By	KDG	Project Number	175539009
Diameter	2.868 (in)	7.284 (cm)	Dia. avg.	3.141 (in)	Date	8-18-09	Test Number	1270C
Area	6.459 (in^2)	41.671 (cm^2)	Area avg.	7.746 (in^2)	Press No.	2	Data File ID	1270C
					Panel No.	D	Lateral Pressure (psi)	50.0
							Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
0:00:00	14.1	0.000	40.2	5.972	0.00	41.6708	0.0	0.000	0.000	3.600	3.600	3.585	3.593	0.007	1.004
0:03:37	46.7	0.007	42.2	5.966	0.11	41.7151	32.6	0.364	0.363	3.963	3.823	3.445	3.634	0.189	1.110
0:06:25	103.9	0.012	46.1	5.960	0.20	41.7552	89.9	1.001	1.000	4.600	4.176	3.161	3.669	0.508	1.321
0:09:15	134.5	0.018	48.7	5.954	0.30	41.7968	120.4	1.339	1.339	4.939	4.325	2.971	3.648	0.677	1.456
0:11:52	152.7	0.024	50.6	5.948	0.40	41.8383	138.6	1.541	1.540	5.140	4.394	2.839	3.617	0.777	1.547
0:14:42	167.5	0.030	52.1	5.942	0.50	41.8802	153.4	1.703	1.702	5.302	4.443	2.726	3.585	0.858	1.630
0:17:25	179.7	0.036	53.3	5.936	0.60	41.9223	165.6	1.837	1.836	5.436	4.493	2.642	3.568	0.925	1.700
0:20:11	190.3	0.042	54.5	5.930	0.70	41.9645	176.2	1.952	1.951	5.551	4.521	2.556	3.539	0.983	1.769
0:22:57	200.2	0.048	55.4	5.924	0.80	42.0069	186.1	2.060	2.058	5.658	4.565	2.492	3.528	1.036	1.832
0:25:41	208.2	0.054	56.1	5.918	0.90	42.0499	194.1	2.147	2.144	5.744	4.602	2.442	3.522	1.080	1.884
0:29:50	208.9	0.060	56.2	5.912	1.00	42.0934	194.8	2.152	2.150	5.750	4.596	2.431	3.514	1.082	1.890
0:38:43	217.7	0.066	56.5	5.906	1.10	42.1346	203.6	2.247	2.245	5.845	4.674	2.415	3.545	1.130	1.936
0:49:00	227.0	0.072	56.7	5.900	1.20	42.1769	212.9	2.347	2.344	5.944	4.753	2.395	3.574	1.179	1.985
0:58:35	233.4	0.078	56.8	5.894	1.30	42.2198	219.3	2.415	2.412	6.012	4.817	2.390	3.604	1.214	2.015
1:08:09	240.2	0.084	56.8	5.888	1.40	42.2626	226.1	2.488	2.484	6.084	4.890	2.391	3.641	1.250	2.045
1:17:37	246.4	0.090	57.0	5.882	1.50	42.3054	232.3	2.553	2.550	6.150	4.942	2.378	3.660	1.282	2.079
1:27:10	252.5	0.096	57.1	5.876	1.60	42.3490	238.4	2.618	2.614	6.214	4.999	2.370	3.685	1.314	2.109
1:37:01	257.6	0.102	57.1	5.870	1.70	42.3914	243.5	2.671	2.667	6.267	5.050	2.368	3.709	1.341	2.132
1:46:20	263.2	0.108	57.2	5.864	1.80	42.4350	249.1	2.730	2.725	6.325	5.105	2.365	3.735	1.370	2.159
1:55:48	267.7	0.114	57.2	5.858	1.90	42.4776	253.6	2.776	2.771	6.371	5.149	2.363	3.756	1.393	2.179
2:04:14	272.8	0.120	57.3	5.852	2.00	42.5214	258.7	2.829	2.824	6.424	5.196	2.357	3.776	1.420	2.205
2:11:54	276.9	0.126	57.3	5.846	2.10	42.5654	262.8	2.871	2.865	6.465	5.234	2.354	3.794	1.440	2.224
2:19:10	280.8	0.132	57.2	5.841	2.20	42.6081	266.7	2.911	2.905	6.505	5.282	2.362	3.822	1.460	2.236
2:27:09	284.5	0.138	57.2	5.835	2.30	42.6518	270.5	2.949	2.943	6.543	5.320	2.362	3.841	1.479	2.252
2:34:53	289.1	0.144	57.2	5.829	2.40	42.6954	275.0	2.995	2.989	6.589	5.365	2.361	3.863	1.502	2.273
2:42:32	292.5	0.150	57.2	5.823	2.50	42.7394	278.4	3.029	3.023	6.623	5.398	2.361	3.879	1.519	2.287
2:50:09	296.2	0.156	57.1	5.817	2.60	42.7829	282.1	3.066	3.060	6.660	5.442	2.367	3.904	1.537	2.299
2:57:37	299.5	0.162	57.0	5.811	2.70	42.8276	285.4	3.099	3.093	6.693	5.482	2.375	3.929	1.554	2.308
3:05:16	302.8	0.168	57.0	5.805	2.80	42.8710	288.7	3.131	3.125	6.725	5.516	2.377	3.947	1.570	2.321
3:12:57	305.9	0.174	56.9	5.799	2.90	42.9150	291.8	3.162	3.155	6.755	5.551	2.382	3.966	1.585	2.331
3:20:35	309.2	0.180	56.8	5.793	3.00	42.9598	295.1	3.194	3.187	6.787	5.594	2.392	3.993	1.601	2.339
3:28:09	311.9	0.185	56.7	5.787	3.10	43.0035	297.8	3.220	3.213	6.813	5.626	2.399	4.013	1.614	2.346
3:35:55	314.8	0.191	56.6	5.781	3.20	43.0479	300.7	3.249	3.241	6.841	5.661	2.405	4.033	1.628	2.354
3:43:37	318.0	0.197	56.5	5.775	3.30	43.0926	303.9	3.279	3.271	6.871	5.696	2.410	4.053	1.643	2.364
3:51:21	320.5	0.203	56.3	5.769	3.40	43.1375	306.4	3.302	3.294	6.894	5.734	2.425	4.080	1.655	2.365
3:58:50	323.1	0.209	56.2	5.763	3.50	43.1822	309.0	3.327	3.319	6.919	5.768	2.434	4.101	1.667	2.370
4:06:28	325.3	0.215	56.1	5.757	3.60	43.2274	311.2	3.348	3.339	6.939	5.796	2.442	4.119	1.677	2.374
4:14:07	328.5	0.221	56.1	5.751	3.70	43.2713	314.4	3.378	3.370	6.970	5.828	2.443	4.135	1.692	2.385
4:21:48	330.9	0.228	55.9	5.745	3.80	43.3182	316.8	3.401	3.391	6.991	5.862	2.455	4.158	1.703	2.387
4:29:22	333.1	0.233	55.8	5.739	3.90	43.3617	319.0	3.421	3.412	7.012	5.890	2.463	4.177	1.713	2.391
4:36:56	335.7	0.239	55.7	5.733	4.00	43.4066	321.6	3.446	3.436	7.036	5.919	2.468	4.194	1.725	2.398
4:44:24	337.7	0.245	55.6	5.727	4.10	43.4517	323.6	3.463	3.453	7.053	5.942	2.473	4.207	1.734	2.402
4:52:05	339.4	0.251	55.5	5.721	4.20	43.4971	325.3	3.478	3.468	7.068	5.969	2.487	4.228	1.741	2.401
4:59:41	342.0	0.257	55.4	5.715	4.30	43.5426	327.9	3.502	3.491	7.091	6.000	2.494	4.247	1.753	2.406
5:07:20	343.7	0.263	55.3	5.709	4.40	43.5880	329.6	3.516	3.506	7.106	6.022	2.501	4.262	1.760	2.408
5:15:01	345.4	0.269	55.2	5.703	4.50	43.6337	331.3	3.530	3.519	7.119	6.041	2.507	4.274	1.767	2.410
5:22:39	347.1	0.275	54.9	5.697	4.60	43.6795	333.1	3.546	3.534	7.134	6.080	2.531	4.305	1.775	2.403
5:29:51	349.1	0.281	54.9	5.691	4.70	43.7252	335.0	3.562	3.551	7.151	6.093	2.527	4.310	1.783	2.411
5:37:22	350.8	0.287	54.8	5.685	4.80	43.7712	336.7	3.577	3.565	7.165	6.114	2.534	4.324	1.790	2.413
5:45:08	352.3	0.293	54.7	5.679	4.90	43.8172	338.2	3.589	3.577	7.177	6.133	2.541	4.337	1.796	2.414
5:52:34	353.3	0.299	54.5	5.673	5.00	43.8638	339.2	3.596	3.584	7.184	6.157	2.558	4.357	1.800	2.407
6:00:08	355.1	0.305	54.4	5.667	5.10	43.9101	341.0	3.611	3.598	7.198	6.176	2.563	4.369	1.807	2.410
6:07:36	356.2	0.311	54.4	5.661	5.20	43.9559	342.1	3.619	3.606	7.206	6.188	2.567	4.377	1.811	2.411
6:15:01	357.4	0.317	54.2	5.655	5.30	44.0025	343.3	3.628	3.615	7.215	6.210	2.580	4.395	1.815	2.407
6:22:14	357.8	0.323	54.0	5.650	5.40	44.0487	343.7	3.628	3.615	7.215	6.223	2.593	4.408	1.815	2.400
6:29:50	359.0	0.329	53.8	5.644	5.50	44.0956	344.9	3.637	3.624	7.224	6.243	2.604	4.423	1.820	2.398
6:37:16	360.0	0.335	53.7	5.638	5.60	44.1421	345.9	3.644	3.631	7.231	6.259	2.614	4.437	1.823	2.395
6:44:44	360.5	0.341	53.3	5.632	5.70	44.1892	346.4	3.645	3.632	7.232	6.288	2.641	4.464	1.823	2.381
6:52:02	361.3	0.347	53.3	5.626	5.80	44.2359	347.2	3.650	3.636	7.236	6.295	2.644	4.470	1.825	2.381
6:59:30	362.1	0.353	53.1	5.620	5.90	44.2828	348.0	3.654	3.640	7.240	6.308	2.653	4.481	1.827	2.377

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

Consolidation Values			Final Values		Tested By	KDG	Project Number	175539009
Height	5.972 (in.)	15.169 (cm)	Height	5.076 (in.)	Date	8-18-09	Test Number	1270C
Diameter	2.868 (in)	7.284 (cm)	Dia. avg.	3.141 (in)	Press No.	2	Data File ID	1270C
Area	6.459 (in²)	41.671 (cm²)	Area avg.	7.746 (in²)	Panel No.	D	Lateral Pressure (psi)	50.0
							Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
7:07:21	361.5	0.359	53.0	5.614	6.00	44.3300	347.4	3.644	3.630	7.230	6.311	2.666	4.489	1.822	2.367
7:14:57	361.9	0.365	52.7	5.608	6.10	44.3776	347.8	3.645	3.630	7.230	6.329	2.685	4.507	1.822	2.358
7:22:46	362.3	0.371	52.6	5.602	6.20	44.4245	348.2	3.645	3.630	7.230	6.335	2.690	4.513	1.822	2.355
7:30:46	361.8	0.377	52.5	5.596	6.30	44.4718	347.7	3.636	3.621	7.221	6.338	2.702	4.520	1.818	2.345
7:38:06	361.6	0.383	52.4	5.590	6.40	44.5192	347.5	3.630	3.614	7.214	6.340	2.711	4.525	1.815	2.339
7:45:37	361.3	0.388	52.1	5.584	6.50	44.5669	347.2	3.623	3.607	7.207	6.351	2.729	4.540	1.811	2.327
7:53:23	361.1	0.394	52.0	5.578	6.60	44.6145	347.0	3.617	3.601	7.201	6.350	2.734	4.542	1.808	2.323
8:01:17	360.7	0.400	51.9	5.572	6.70	44.6625	346.6	3.609	3.593	7.193	6.350	2.743	4.547	1.804	2.315
8:09:19	360.5	0.406	51.8	5.566	6.80	44.7103	346.4	3.602	3.586	7.186	6.353	2.752	4.552	1.800	2.309
8:17:37	359.4	0.412	51.4	5.560	6.90	44.7584	345.3	3.587	3.571	7.171	6.363	2.777	4.570	1.793	2.291
8:25:42	359.5	0.418	51.4	5.554	7.00	44.8066	345.4	3.584	3.568	7.168	6.360	2.778	4.569	1.791	2.290
8:33:31	359.1	0.424	51.3	5.548	7.10	44.8547	345.0	3.576	3.559	7.159	6.360	2.786	4.573	1.787	2.283
8:41:30	359.2	0.430	51.2	5.542	7.20	44.9029	345.1	3.574	3.556	7.156	6.363	2.792	4.577	1.786	2.279
8:49:04	359.1	0.436	51.0	5.536	7.30	44.9512	345.0	3.569	3.551	7.151	6.375	2.809	4.592	1.783	2.270
8:56:40	359.1	0.442	51.0	5.530	7.40	44.9997	345.0	3.565	3.547	7.147	6.372	2.810	4.591	1.781	2.268
9:04:26	358.8	0.448	50.9	5.524	7.50	45.0485	344.7	3.558	3.540	7.140	6.371	2.817	4.594	1.777	2.262
9:12:05	358.3	0.454	50.8	5.518	7.60	45.0974	344.3	3.550	3.531	7.131	6.370	2.824	4.597	1.773	2.256
9:20:04	357.7	0.460	50.5	5.512	7.70	45.1461	343.6	3.539	3.520	7.120	6.379	2.844	4.611	1.767	2.243
9:27:56	357.1	0.466	50.5	5.506	7.80	45.1950	343.0	3.529	3.510	7.110	6.369	2.844	4.607	1.762	2.239
9:35:37	356.7	0.472	50.4	5.500	7.90	45.2440	342.6	3.521	3.502	7.102	6.366	2.849	4.608	1.759	2.234
9:43:07	355.9	0.478	50.3	5.494	8.00	45.2931	341.8	3.510	3.490	7.090	6.362	2.857	4.610	1.753	2.227
9:51:00	355.2	0.484	50.1	5.488	8.10	45.3429	341.1	3.498	3.479	7.079	6.369	2.875	4.622	1.747	2.215
9:58:49	354.7	0.490	50.1	5.482	8.20	45.3919	340.6	3.489	3.469	7.069	6.358	2.873	4.616	1.742	2.212
10:06:35	354.0	0.496	50.0	5.476	8.30	45.4413	339.9	3.478	3.458	7.058	6.352	2.879	4.616	1.736	2.206
10:14:29	353.2	0.502	49.9	5.470	8.40	45.4910	339.1	3.466	3.446	7.046	6.346	2.885	4.615	1.730	2.200
10:22:23	352.4	0.508	49.7	5.464	8.50	45.5406	338.3	3.455	3.434	7.034	6.352	2.903	4.628	1.724	2.188
10:30:23	351.5	0.514	49.7	5.458	8.60	45.5903	337.4	3.441	3.420	7.020	6.337	2.902	4.619	1.718	2.184
10:38:23	350.8	0.520	49.7	5.452	8.70	45.6403	336.7	3.430	3.409	7.009	6.329	2.905	4.617	1.712	2.179
10:46:22	350.2	0.526	49.6	5.447	8.80	45.6905	336.1	3.420	3.399	6.999	6.322	2.908	4.615	1.707	2.174
10:54:19	349.3	0.532	49.5	5.441	8.90	45.7409	335.2	3.408	3.386	6.986	6.319	2.918	4.619	1.701	2.166
11:02:16	348.8	0.538	49.4	5.435	9.00	45.7910	334.7	3.398	3.377	6.977	6.316	2.924	4.620	1.696	2.160
11:10:08	348.7	0.544	49.4	5.429	9.10	45.8410	334.6	3.394	3.372	6.972	6.313	2.926	4.620	1.693	2.158
11:18:12	348.3	0.550	49.3	5.423	9.20	45.8916	334.2	3.386	3.364	6.964	6.310	2.931	4.620	1.689	2.153
11:26:09	347.8	0.556	49.2	5.417	9.30	45.9424	333.7	3.378	3.355	6.955	6.308	2.937	4.623	1.685	2.147
11:34:06	347.2	0.562	49.1	5.411	9.40	45.9930	333.1	3.368	3.345	6.945	6.307	2.946	4.627	1.680	2.141
11:42:08	347.4	0.568	49.1	5.405	9.50	46.0438	333.3	3.366	3.343	6.943	6.304	2.946	4.625	1.679	2.140
11:49:57	346.9	0.574	49.0	5.399	9.60	46.0945	332.8	3.357	3.334	6.934	6.300	2.950	4.625	1.675	2.135
11:57:57	346.4	0.580	49.0	5.393	9.70	46.1457	332.3	3.349	3.325	6.925	6.294	2.953	4.623	1.670	2.131
12:05:46	346.3	0.585	48.9	5.387	9.80	46.1967	332.2	3.343	3.320	6.920	6.297	2.962	4.629	1.667	2.126
12:13:39	346.3	0.591	48.9	5.381	9.90	46.2480	332.2	3.340	3.316	6.916	6.293	2.962	4.628	1.665	2.124
12:21:37	346.3	0.597	48.8	5.375	10.00	46.2995	332.2	3.337	3.313	6.913	6.294	2.966	4.630	1.664	2.122
12:29:25	346.1	0.603	48.8	5.369	10.10	46.3509	332.0	3.331	3.306	6.906	6.291	2.969	4.630	1.661	2.118
12:37:20	345.9	0.609	48.6	5.363	10.20	46.4025	331.8	3.325	3.301	6.901	6.295	2.979	4.637	1.658	2.113
12:45:09	344.9	0.615	48.6	5.357	10.30	46.4542	330.8	3.311	3.286	6.886	6.282	2.981	4.632	1.650	2.107
12:53:05	345.3	0.621	48.6	5.351	10.40	46.5060	331.2	3.312	3.287	6.887	6.284	2.982	4.633	1.651	2.107
13:00:44	345.1	0.627	48.5	5.345	10.50	46.5580	331.0	3.306	3.281	6.881	6.282	2.987	4.635	1.648	2.103
13:08:42	344.6	0.633	48.4	5.339	10.60	46.6099	330.5	3.297	3.272	6.872	6.283	2.996	4.640	1.643	2.097
13:16:44	344.2	0.639	48.4	5.333	10.70	46.6625	330.1	3.290	3.264	6.864	6.275	2.996	4.636	1.639	2.094
13:24:35	344.0	0.645	48.4	5.327	10.80	46.7146	329.9	3.284	3.258	6.858	6.271	2.998	4.635	1.636	2.091
13:32:24	343.3	0.651	48.3	5.321	10.90	46.7668	329.2	3.273	3.247	6.847	6.264	3.002	4.633	1.631	2.087
13:40:10	344.0	0.657	48.2	5.315	11.00	46.8198	329.9	3.276	3.250	6.850	6.273	3.008	4.640	1.632	2.085
13:47:57	344.5	0.663	48.2	5.309	11.10	46.8722	330.4	3.278	3.251	6.851	6.277	3.011	4.644	1.633	2.085
13:55:28	344.9	0.669	48.2	5.303	11.20	46.9247	330.8	3.279	3.252	6.852	6.278	3.011	4.644	1.633	2.085
14:03:07	344.6	0.675	48.1	5.297	11.30	46.9779	330.5	3.272	3.244	6.844	6.274	3.015	4.644	1.630	2.081
14:10:45	344.6	0.681	48.1	5.291	11.40	47.0306	330.5	3.268	3.240	6.840	6.275	3.020	4.648	1.628	2.078
14:18:24	344.8	0.687	48.0	5.285	11.50	47.0842	330.7	3.266	3.238	6.838	6.274	3.021	4.647	1.627	2.077
14:26:05	344.4	0.693	48.0	5.279	11.60	47.1369	330.3	3.258	3.230	6.830	6.267	3.022	4.645	1.622	2.074
14:33:59	343.5	0.699	47.8	5.273	11.70	47.1903	329.4	3.246	3.218	6.818	6.269	3.036	4.653	1.616	2.065
14:41:43	343.4	0.705	47.9	5.267	11.80	47.2441	329.3	3.241	3.212	6.812	6.260	3.033	4.647	1.614	2.064
14:49:26	343.0	0.711	47.9	5.261	11.90	47.2977	328.9	3.234	3.205	6.805	6.255	3.035	4.645	1.610	2.061

Consolidated Undrained Triaxial Test
EM 1110-2-1906 Appendix X

	Consolidation Values				Final Values			
Height	5.972 (in.)	15.169 (cm)		Height	5.076 (in.)		Tested By	KDG
Diameter	2.868 (in)	7.284 (cm)		Dia. avg.	3.141 (in)		Date	8-18-09
Area	6.459 (in^2)	41.671 (cm^2)		Area avg.	7.746 (in^2)		Press No.	2
							Panel No.	D

Project Number	175539009
Test Number	1270C
Data File ID	1270C
Lateral Pressure (psi)	50.0
Chamber Pressure - σ_3 (psi)	90

Clock Time (min.)	Load (lbf)	Deflection Dial Reading (in.)	Pore Pressure Reading (psi)	Corrected Hieght (in.)	Strain (%)	Corrected Area (cm^2)	Corrected Load (lbf)	Deviator Stress (tsf)	Corrected Deviator Stress* (tsf)	σ_1 (tsf)	σ_1' (tsf)	σ_3' (tsf)	p' $(\sigma_1'+\sigma_3')/2$ (tsf)	q $(\sigma_1-\sigma_3)/2$ (tsf)	Effective Principal Stress Ratio σ_1' / σ_3'
14:57:10	342.8	0.717	47.8	5.255	12.00	47.3515	328.7	3.228	3.199	6.799	6.250	3.036	4.643	1.607	2.059
15:04:57	343.2	0.723	47.7	5.249	12.10	47.4052	329.1	3.228	3.199	6.799	6.262	3.048	4.655	1.607	2.054
15:12:41	343.2	0.729	47.7	5.244	12.20	47.4592	329.1	3.225	3.195	6.795	6.255	3.045	4.650	1.605	2.054
15:20:25	343.8	0.735	47.7	5.238	12.30	47.5131	329.7	3.226	3.197	6.797	6.260	3.049	4.654	1.606	2.054
15:28:06	344.5	0.741	47.7	5.232	12.40	47.5673	330.4	3.230	3.200	6.800	6.264	3.049	4.657	1.608	2.055
15:35:50	345.9	0.747	47.6	5.226	12.50	47.6219	331.8	3.240	3.209	6.809	6.280	3.055	4.668	1.612	2.055
15:43:20	347.1	0.753	47.6	5.220	12.60	47.6763	333.0	3.248	3.218	6.818	6.287	3.054	4.670	1.616	2.059
15:50:49	347.4	0.759	47.6	5.214	12.70	47.7309	333.3	3.247	3.217	6.817	6.286	3.055	4.671	1.616	2.058
15:58:22	347.3	0.765	47.4	5.208	12.80	47.7855	333.2	3.242	3.212	6.812	6.292	3.065	4.679	1.613	2.053
16:05:59	347.3	0.771	47.4	5.202	12.90	47.8402	333.2	3.239	3.208	6.808	6.290	3.067	4.679	1.611	2.051
16:13:27	347.6	0.777	47.4	5.196	13.00	47.8956	333.5	3.237	3.206	6.806	6.290	3.069	4.679	1.610	2.050
16:20:58	347.6	0.783	47.3	5.190	13.10	47.9506	333.5	3.234	3.203	6.803	6.289	3.071	4.680	1.609	2.048
16:28:36	347.4	0.788	47.2	5.184	13.20	48.0057	333.3	3.229	3.197	6.797	6.292	3.080	4.686	1.606	2.043
16:36:10	347.2	0.794	47.2	5.178	13.30	48.0610	333.1	3.223	3.191	6.791	6.288	3.082	4.685	1.603	2.040
16:43:46	347.6	0.800	47.2	5.172	13.40	48.1169	333.5	3.223	3.191	6.791	6.287	3.081	4.684	1.603	2.040
16:51:25	347.7	0.806	47.1	5.166	13.50	48.1723	333.6	3.220	3.188	6.788	6.289	3.086	4.687	1.601	2.038
16:58:58	347.6	0.812	47.0	5.160	13.60	48.2278	333.5	3.215	3.182	6.782	6.291	3.093	4.692	1.599	2.034
17:06:31	347.7	0.818	47.0	5.154	13.70	48.2840	333.6	3.213	3.180	6.780	6.289	3.094	4.692	1.597	2.033
17:13:52	347.5	0.824	46.9	5.148	13.80	48.3395	333.4	3.207	3.174	6.774	6.288	3.100	4.694	1.594	2.029
17:21:15	347.5	0.830	46.8	5.142	13.90	48.3957	333.4	3.203	3.170	6.770	6.296	3.112	4.704	1.592	2.023
17:28:41	347.8	0.836	46.8	5.136	14.00	48.4521	333.7	3.203	3.169	6.769	6.298	3.113	4.706	1.592	2.023
17:36:07	349.2	0.842	46.7	5.130	14.10	48.5086	335.1	3.212	3.178	6.778	6.309	3.116	4.713	1.597	2.025
17:43:19	350.7	0.848	46.6	5.124	14.20	48.5648	336.6	3.223	3.188	6.788	6.331	3.128	4.729	1.602	2.024
17:49:51	355.4	0.854	46.7	5.118	14.30	48.6219	341.3	3.264	3.229	6.829	6.359	3.114	4.737	1.622	2.042
17:52:11	354.8	0.860	46.5	5.112	14.40	48.6798	340.7	3.254	3.220	6.820	6.368	3.134	4.751	1.617	2.032
17:54:25	354.0	0.866	46.4	5.106	14.50	48.7352	339.9	3.243	3.208	6.808	6.361	3.138	4.750	1.612	2.027
17:56:48	354.5	0.872	46.4	5.100	14.60	48.7928	340.4	3.244	3.209	6.809	6.361	3.138	4.750	1.612	2.027
17:59:08	354.2	0.878	46.4	5.094	14.70	48.8496	340.1	3.238	3.202	6.802	6.358	3.141	4.750	1.609	2.024
18:01:28	353.9	0.884	46.3	5.088	14.80	48.9068	339.8	3.231	3.195	6.795	6.356	3.145	4.750	1.605	2.021
18:03:48	354.3	0.890	46.2	5.082	14.90	48.9647	340.2	3.230	3.195	6.795	6.360	3.150	4.755	1.605	2.019
18:06:08	354.3	0.896	46.4	5.076	15.00	49.0225	340.2	3.227	3.191	6.791	6.347	3.141	4.744	1.603	2.021

Appendix H

Phase 1 Coal Combustion Product Facility Summaries, 2009

TVA Disposal Facility Assessment
Phase 1 Coal Combustion Product Disposal Facility Summary
Cumberland Fossil Plant (CUF)
Dry Ash Stack (DS-1)

1. General Facility Information

Facility Status:	Active		
Surface Area:	110 acres (estimated)	Maximum Height (toe to top of stack):	35 feet Existing 200 feet Proposed

2. Site Visit Information

Stantec Assessment Team:	Stephen Bickel, PE, Nathan Bader, PE, Stan Harris, PE and Matthew Hoy, EIT
TVA Staff Present:	Stuart Harris and Carrie McCarty
Field Assessment Dates:	January 14, 2009 and February 3 - 4, 2009
Weather/Site Conditions:	Mid-30 degrees F, sunny, moist ground both days.

3. History/Description of Usage

History, Operation and Stacking Plan:

In 1972, Wells Creek was relocated in order to construct old Disposal Area 1. Old Area 1 was enclosed by the existing perimeter dike and contained sluiced ash. In the 1980s, sluicing operations ceased within Area 1 and began in the current Area 2 to the north. Divider dikes were constructed to separate the current pond from the gypsum and ash stacking operations. In 1995-96, the current divider dike between the Ash Pond and Dry Stack was constructed. In 1996, stacking within this area began. The Dry Stack is bordered by the Ash Pond to the north, by the bottom ash pond to the east, the Wet Gypsum Storage Area to the south, and by perimeter ditches and the old Area 1 perimeter dike to the west. There is a stacking plan available, and construction is currently proceeding to the north. The sequence consists of building the base and closing it, then moving up to the next level. The stack's maximum height is currently 35 feet. A small dredge cell was constructed within the northwest portion of the Dry Stack in 2007 to dispose of coal fines dredged to remove sediment build up in the Coal Yard Drainage Basin.

Stacking over Dredge Cells or CCB Ponds:	Previous Area 1 (the original ash pond) is located beneath the Dry Ash Stack and was used as the original ash pond for the plant. This pond operated until the 1980s when sluicing to Area 2 (current active ash pond) began. The stack is being constructed over sluiced bottom and fly ash. It is unknown how much sluiced ash is beneath the stack. A small dredge cell within the Dry Ash Stack area was also filled with dredged coal fines from the Coal Yard Drainage Basin in 2007.
Past Failures/Releases:	No failures or releases reported.

4. Owner's Operations, Maintenance and Inspection Information

TVA Maintenance:	Mowing is performed every two years.
TVA Inspections:	TVA Engineering performs annual dike inspections and prepares reports. Plant personnel recently started making daily observations, with documented inspections made weekly.
Problems Previously Identified During Past TVA Inspections:	Lack of vegetation and erosion along stack, erosion along access road, seepage areas along Wells Creek, animal burrow on exterior perimeter dike, tree growth on exterior dike, standing water, sedimentation and heavy growth in perimeter ditch.

5. Documents Reviewed

See attached Document Log for complete list of documents provided by TVA for review. In particular, the following provided pertinent information for the assessment of this facility:

TVA Design Drawings:	10W288-1 through 5
TVA As-Built Drawings:	None available.
TVA Construction Testing Records:	None available.
TVA Annual Inspection Reports:	TVA Annual Inspection Reports 1972-1984, 1986-1990, 1994-1995, 1997-2004, 2006-2008.

Geotechnical Data:	"Operations Manual: Dry Ash and Gypsum Stacking Facility", prepared by Tennessee Valley Authority, October 10, 2003. "TVA-Fly Ash, Bottom Ash, and Scrubber Gypsum Study", Law Engineering, Inc., October 1995. "Report of Subsurface Exploration and Stability Analyses, Proposed Fly Ash/Scrubber Sludge Disposal Facility, Cumberland Fossil Plant, Cumberland City, Tennessee", Law Engineering, January 27, 1992. "Report of Hydrogeologic Evaluation, Proposed Dry Fly Ash and Gypsum Disposal Facility, TVA Cumberland Fossil Plant, Cumberland City, Tennessee", Law Engineering, July 3, 1992. "Geotechnical Investigation Report, Dry Ash Conversion Project, CUF 1 & 2", Raytheon Engineers and Constructors, July 7, 1993. Results of Laboratory Testing, TVA Fly Ash & Gypsum Disposal Facilities, Cumberland Fossil Plant, United Engineers and Constructors Inc., June 1992.

6. Stantec Field Observations

See attached Concerns/Photo Log, Photos, and Site Plan Drawing.

6.1. Exterior Slopes and Benches

Vegetation:	Sparse to good vegetation coverage. Some areas of exposed soil present primarily along the southeast face and in areas to the north where the stack is just recently being constructed.
Trees:	None observed.
Erosion:	Several areas of erosion along the dry stack were noted where vegetation is sparse, primarily along the southeast face.
Instabilities:	No evidence of instabilities were observed.
Uniform Appearance	Good.

Benches:	None observed.
Slope:	Design: 3H:1V along Dry Ash Stack (from Drawing 10W288-4); 3H:1V along outer perimeter dike to west (from Drawing 10N213). Measured: 2.25H:1V along Dry Ash Stack at Section 4. 2.7H:1V along perimeter dike to west at Section 2.
Height:	35 feet along Dry Ash Stack at Section 4. 15 feet along perimeter dike to west at Section 2.
Other:	None.

6.2. Perimeter Drainage Ditches and Down-Drains

Vegetation:	Phragmites/tall grass along majority of west perimeter ditch.
Rip-Rap Channel Lining:	None observed.
Erosion:	Some scarping of the ditch side slopes was observed along west perimeter ditch. In addition, sedimentation had accumulated in ditch at several areas along the adjacent stack faces.
Siltation in Ditches:	Sedimentation observed throughout majority of west perimeter ditch.
Standing Water in Ditches or on Benches:	Standing water noted within the perimeter ditch to the west.
Silted/Impeded Drainage Pipes:	The drainage pipe for the perimeter ditch along the northwest corner of the stack area to the Ash Pond had signs of erosion around the inlet and outlet.
Other:	None.

7. Notable Observations and Concerns

- The area beneath the Dry Ash Stack was initially operated as a wet ash disposal pond. Constructing embankments over hydraulically placed ash is a potential slope stability concern and requires engineering analysis and geotechnical exploration.
- The southeast face of the stack consists of exposed soil cover which is eroded throughout. Other small areas of sparse vegetation or erosion were also observed. Further to the north, soil cover and vegetation have not yet been completed and the exposed ash slopes exhibit some erosion.
- Erosion was noted around the existing rock check within active portions of the stack.
- Areas of erosion and rutting were noted along the access road at the base of the stack.
- Eroded ash sedimentation, vegetation, poor drainage, and standing water were observed throughout the perimeter ditch. The side slopes of the ditch also exhibit shallow sloughs and scarps due to excavations made for cleaning of sedimentation.
- Vegetation has not yet been established where recent tree removal has occurred along the exterior west perimeter dike slope in the vicinity of the old bridge.
- Seepage was observed below the west perimeter dike along the banks of Wells Creek. The seepage does not appear to have changed from previous descriptions provided in inspection reports.
- The absence of an Emergency Action Plan, Operation and Maintenance Plan, as-built drawings and construction testing records is a concern.

8. Recommendations

8.1. Phase 2 Engineering and Programmatic Recommendations

- It is recommended that the Dry Ash Stack undergo further engineering study to evaluate the stacking plan and slope stability. This should include test borings, installation of piezometers, and installation of slope inclinometers; followed by laboratory testing and slope stability analysis of critical cross-sections.
- It is recommended that a program be established to develop as-built drawings and construction records for future maintenance and construction activities.
- Based on the findings of Phase 2 and designs from Phase 3, if performed, Stantec recommends that the existing O&M Manual be reviewed and updated. These updates may include sections on routine monitoring and facility maintenance.

8.2. Maintenance Recommendations

- CUF plant personnel should continue to monitor the seepage area below the west perimeter clay dike.
- Cut and maintain heavy/tall phragmite growth to allow better observation specifically in the perimeter ditches. Establish mowing program.
- Regrade and repair erosion areas where noted.
- Regrade, place new clay cover, and reseed the southeast face of the stack. Monitor other dry stack areas for erosion/sparse vegetation and repair as needed.
- Repair ruts and eroded areas along access road at base of stack if it is to remain in service.
- Clean sedimentation and phragmites from Dry Ash Stack perimeter ditches. Remove sedimentation, check grades and regrade the perimeter ditches as needed to promote positive drainage and alleviate standing water issues.
- Continue annual inspection program and execute recommendations.

Drawing Mark DS-1-1 Eroded ash from the adjacent dry stack deposited within the west perimeter ditch.

Drawing Mark DS-1-2 Seepage observed below the perimeter dike along the banks of Wells Creek.

Drawing Mark DS-1-3 Erosion around existing rock check in north portion of Dry Ash Stack

Drawing Mark DS-1-4 Exposed soil and erosion along southeast face of Dry Ash Stack.

Drawing Mark DS-1-5 Erosion and rutting along access road at the base of the Dry Ash Stack.

Drawing Mark DS-1-6 Uncompleted soil cover and vegetation along north end of Dry Ash Stack.

Concerns/Photo Log

Drawing Mark	Comments	Photo/GPS ID
DS-1-1	Eroded ash from the adjacent dry stack deposited within the west perimeter ditch.	Photo 20A
DS-1-2	Seepage observed below the perimeter dike along the banks of Wells Creek.	Photo 3B
DS-1-3	Erosion around existing rock check in north portion of Dry Ash Stack	Photo 37B
DS-1-4	Exposed soil and erosion along southeast face of Dry Ash Stack.	Photo 20B
DS-1-5	Erosion and rutting along access road at the base of the Dry Ash Stack.	Photo 35B
DS-1-6	Uncompleted soil cover and vegetation along north end of Dry Ash Stack.	Photo 36B

TVA Disposal Facility Assessment
Phase 1 Coal Combustion Product Disposal Facility Summary
Cumberland Fossil Plant (CUF)
Gypsum Storage Area (GSA)

1. General Facility Information

Facility Status:	Temporarily Inactive	NID Identification:	TN16110
Surface Area (inside dikes)	170 acres (estimated)	Maximum Height (toe to top of dike):	50 feet (estimated, current phase) 140 feet (Proposed)
Free Water Volume:	Currently drained	Maximum Water Storage:	Currently drained
Estimated CCB Storage:	1,825,579 CY	Dike Length:	9,000 feet (estimated)
Plant Discharge to Facility:	6,000 gpm when active	Current Pool Elevation:	Drained

2. Site Visit Information

Stantec Assessment Team:	Steve Bickel, PE, Nathan Bader, PE, Stan Harris, PE and Matthew Hoy, EIT
TVA Staff Present:	Stuart Harris and Carrie McCarty
Field Assessment Dates:	January 14, 2009 and February 3 - 4, 2009
Weather/Site Conditions:	Mid-30 degrees F, sunny, moist ground both days.

3. History/Description of Usage

History and Operation:

The gypsum storage area was constructed during 1995-1996. It was built over Area No. 1, which was the original ash pond. Approximately 1,100,000 tons of gypsum is produced each year. Roughly 75 percent of the gypsum is marketed to the adjacent wallboard company and the remaining 25 percent is wet-sluiced to the Gypsum Storage Area. The pond was constructed in several stages beginning with construction of a rock drainage blanket to collect and divert water away from the base. When gypsum is discharged to the pond intermittently, it is wet-sluiced to the northeast corner of the pond. Currently the pond is separated into a north and south area. The pond consists of an upper gypsum dike being

	constructed using rim-ditching operations, a lower perimeter ash dike, and an even lower clay dike which was the original perimeter dike for the disposal area. Discharge for the pond is through an RCP riser to outlet pipes in the northwest corner of the pond into the adjacent perimeter ditches. The perimeter ditches around the Gypsum Storage Area flow to the north along the neighboring Dry Stack and ultimately into the Ash Pond.
Past Failures/Releases:	A slope slough along the perimeter clay dike in the northwest corner of the Gypsum Storage Area reportedly occurred in 2005. The slope was temporarily repaired using rip rap and Stantec is currently evaluating slope stability. Seepage has also been reported in this area and along the Gypsum Storage Area to the east. As a result, the pond has also been drained until Stantec's evaluation is complete.

4. Owner's Operations, Maintenance and Inspection Information

Emergency Action Plan:	No EAP has been prepared for this facility.
Operations Manual:	"Operations Manual: Dry Ash and Gypsum Stacking Facility", prepared by Tennessee Valley Authority, October 10, 2003.
TVA Maintenance:	Exterior slopes mowed every two years.
TVA Inspections:	TVA Engineering performs annual inspections and prepares reports. Plant personnel recently started making daily observations, with documented inspections made weekly.
Problems Previously Identified During Past TVA Inspections:	Seepage areas around exterior dike, slope failure along northwest corner of perimeter dike.

5. Documents Reviewed

See attached Document Log for complete list of documents provided by TVA for review. In particular, the following provided pertinent information for the assessment of this facility:

TVA Design Drawings:	10W300-1 through 19, 6314-W-C110200 through 224, 6314-W-C110300 through 316.
TVA As-Built Drawings:	None available.
TVA Construction Testing Records:	None available.
TVA Annual Inspection Reports:	TVA Annual Inspection Reports 1972-1984, 1986-1990, 1994-1995, 1997-2004, 2006-2008.
Geotechnical Data:	"TVA-Fly Ash, Bottom Ash, and Scrubber Gypsum Study", Law Engineering, Inc., October 1995. "Report of Geotechnical Exploration, Gypsum Area Seepage Study, Cumberland Fossil Plant, Cumberland City, Tennessee", prepared by MACTEC Engineering and Consulting, Inc., May 1, 2007. "Report of Preliminary Geotechnical Exploration, Proposed Gypsum Wallboard Plant, TVA Cumberland Fossil Plant, Cumberland City, Tennessee", Law Engineering and Environmental Services, Inc., January 3, 1997. "Report of Subsurface Exploration and Stability Analyses, Proposed Fly Ash/Scrubber Sludge Disposal Facility, Cumberland Fossil Plant, Cumberland City, Tennessee", Law Engineering, January 27, 1992. "Report of Hydrogeologic Evaluation, Proposed Dry Fly Ash and Gypsum Disposal Facility, TVA Cumberland City, Tennessee", Law Engineering, March 13, 1992. "Laboratory Test Results, Samples from Gypsum Pond at Cumberland Fossil Plant", MACTEC Engineering and Consulting, May 13, 2004.

Project Update - Seepage Investigation and Repair, TVA Cumberland Fossil Plant, presented by Geosyntec Consultants to TVA, October 2007, May 2007, and July 2008.

Results of Laboratory Testing, TVA Fly Ash & Gypsum Disposal Facilities, Cumberland Fossil Plant, United Engineers and Constructors Inc., June 1992.

6. Stantec Field Observations

See attached Concerns/Photo Log, Photos, and Site Plan Drawing.

6.1. Interior Slopes

Vegetation:	None. Top dike consists of gypsum with no vegetation established.
Trees:	None observed.
Wave Wash Protection:	None observed.
Erosion:	None observed.
Instabilities:	Portions of the dike are currently being reconstructed using rim-ditching operations, but no evidence of instabilities were observed.
Animal Burrows:	None observed.
Freeboard:	**Measured:** Pond drained. **Design:** Not available on drawings.
Encroachments:	None observed.
Slope:	**Measured:** Currently being constructed, not measured. **Design:** Not available on drawings.

6.2. Crest

Crest Cover and Slope:	Gypsum cover from rim-ditching operations.
Erosion:	None observed.
Alignment:	Alignment appeared to agree with design drawings. No problem.

Settlement/Cracking:	None observed.
Bare Spots/Rutting:	No rutting observed. Crest is bare with no vegetation established.
Width:	**Measured:** 23 feet at Section 5; 20 feet at Section 6 **Design:** Not available on drawings.

6.3. Exterior Slopes

Vegetation:	Upper Gypsum slopes are bare and lack vegetation. Phragmites and brush are present on the intermediate ash dike slopes. A grass cover is present along the lower perimeter dike slopes.
Trees:	Small trees were located in a few areas around the perimeter of the pond.
Erosion:	Areas of erosion were observed along the upper gypsum dike and the lower ash dike in several areas.
Instabilities:	A slope failure has been repaired in the northwest corner of the pond along the perimeter clay dike. Slope instability in the form of shallow sloughing was also observed along the ash dike along the northwest side of the pond.
Uniform Appearance:	Good.
Seepage:	Seepage observed in the past when pond was filled at the northernmost portion of the pond. Seepage was also observed at the southeast side of the perimeter clay dike.
Benches:	One bench that consists of the surrounding access road was observed along the toe of the upper gypsum dike. The bench is 20 feet wide at Section 5 and Section 6.
Foundations, Drains, Relief Wells, Instrumentation:	Drainage pipes extending from the base of the Gypsum Storage Area were reportedly installed on 200-foot intervals. These pipes outlet along the toe of the slope in the perimeter drainage ditches. Flow was observed in selected outlets similar to the flow reported in previous annual inspection reports.

Animal Burrows:	None observed.	
Slope:	**Measured:**	3H:1V along upper gypsum dike at Section 5 and 6; 1.5H:1V to 2.3H:1V along the intermediate ash dike slope at Sections 5 and 6; 2.7H1V along the perimeter clay dike at Section 5.
	Design:	3H:1V for the upper gypsum dikes, intermediate ash dike, and lower perimeter clay dike (from Drawing 10W300-16)
Height:	**Measured:**	Approximately 50 feet at current phase.
	Design:	Approximately 140 feet at final stage (from Drawing 10W300-16).

6.4. Spillway Weirs/Riser Inlets

Number:	One located at northwest end of pond.
Size, Type and Material:	Unknown size, RCP
Height of Riser Inlets:	10 feet or less (estimated)
Access:	None
Joints:	Unknown, unable to observe.
Mis-Alignment:	Unknown, unable to observe.
Closed/Abandoned Conduits:	None reported or observed.

6.5. Outlet Pipes

Number:	Four
Size, Type and Material:	Outlets vary in size and range from steel pipe to corrugated metal pipe.
Headwall:	None was observed.
Joint Separations:	Unknown, could not observe.
Mis-Alignment:	Unknown, could not observe.
Closed/Abandoned Conduits:	None reported or observed.

7. Notable Observations and Concerns

- The gypsum pond is formed by a lower perimeter clay dike, an intermediate ash perimeter dike above the lower clay dike, and an upper gypsum dike. The pond contains two active cells (north and south). Rim-ditching operations are currently on-going to construct the upper gypsum dike. Seepage areas and past slope failures have been noted. Some slopes are also relatively steep (1.5H:1V). Seepage, slope instability, and on-going rim-ditching operations are a concern for the Gypsum Storage Area.
- The absence of an Emergency Action Plan, Operation and Maintenance Plan, as-built drawings and construction testing records is a concern.
- Reconstructed upper gypsum dikes are lacking vegetation.
- Some trees were observed along the perimeter ash dike to the northeast of the Gypsum Storage Area.
- Erosion was observed along the crest and outslopes of the ash divider dike at several areas.
- The southwest and southeast sides of the perimeter ditch contain sediment build-up and standing water.
- Vegetation has not yet been re-established where trees have been removed from the downstream slope of the perimeter clay dike.
- Discharge pipes from interior pond drainage are elevated above a rip-rap channel. Over time, toe erosion will likely occur.

8. Recommendations

8.1. Phase 2 Engineering and Programmatic Recommendations

- It is recommended that the Gypsum Storage Area undergo further engineering study to evaluate the seepage, slope stability, and the on-going rim-ditching stacking plan. Remediation efforts to address these items will be developed based on the results. It is also recommended that a hydraulic and hydrologic analysis be performed to check freeboard and pond outlet adequacy relative to process flow and stormwater. The pond is scheduled to remain drained and temporarily inactive until Phase 2 studies and remedial construction activities, if needed, are performed.

- Based on the findings of Phase 2 and designs from Phase 3, if performed, Stantec recommends that the existing O&M Manual be reviewed and updated. These updates may include sections on routine monitoring and facility maintenance.
- It is recommended that a program be established to develop as-built drawings and construction records for future maintenance and construction activities.

8.2. Maintenance Recommendations

- The loosely stacked gypsum material around the perimeter of the Gypsum Storage Area should be spread in appropriate thicknesses and compacted properly wherever it is to be used as structural dike material. The material used for dikes at outlet areas should consist of coarser gypsum, which has higher strength. Efforts to establish vegetation on completed slopes should also be made.
- CUF plant personnel should continue to monitor the existing slope failure along the perimeter dike outslope at the northwest corner of the Gypsum Storage Area until Phase 2 evaluations are complete and permanent repairs executed.
- CUF plant personnel should continue to monitor the seepage area below the perimeter clay dike.
- CUF personnel have reported a seepage area along the north corner of the Gypsum Storage Area that could not be seen because the pond is currently drained. If this seep re-appears upon re-filling, a crushed stone French drain should be installed by excavating back to intercept the gravel drainage layer that underlies the gypsum disposal area.
- The discharge pipes that drain the interior portion of the Gypsum Storage Area should be extended to ground level and away from the toe of slope.
- Remove trees from noted locations.
- Cut and maintain heavy/tall phragmite growth on slopes and the perimeter drainage ditch to allow better inspection. Establish annual mowing program.
- Regrade and repair erosion areas where noted.
- Clean sedimentation and phragmites from Gypsum Storage Area perimeter ditches. Remove sedimentation, check grades and regrade the perimeter ditches as needed to promote positive drainage and alleviate standing water issues. Use of rip-rap to re-establish ditch side slopes should be considered.

Drawing Mark GP-1-1 Riprap placed in area to temporarily repair slope slough along the perimeter dike at the NW corner of the Gypsum Stack.

Drawing Mark GP-1-2 Small slope slough along ash divider dike outslope at NW side of the Gypsum Storage Area.

Drawing Mark GP-1-3 Trees and erosion along the perimeter ash dike at the northeast side of the Gypsum Storage Area.

Drawing Mark GP-1-4 Reconstructed gypsum dikes surrounding the two ponds lacking vegetation.

Drawing Mark GP-1-5 Heavy vegetation and sedimentation in perimeter drainage ditch along the southwest and southeast sides of the Gypsum Stack.

Drawing Mark GP-1-6 Seepage observed below the perimeter dike along the southeast side of the Gypsum Stack.

Drawing Mark GP-1-7 Discharge pipes and riprap channel along northwest corner of Gypsum Storage Area.

Concerns/Photo Log

Drawing Mark	Comments	Photo/GPS ID
GP-1-1	Riprap placed in area to temporarily repair slope slough along the perimeter dike at the NW corner of the Gypsum Stack.	Photo 27B
GP-1-2	Small slope slough along ash divider dike outslope at NW side of the Gypsum Storage Area.	Photo 65B
GP-1-3	Trees and erosion along the perimeter ash dike at the northeast side of the Gypsum Storage Area.	Photo 79B
GP-1-4	Reconstructed gypsum dikes surrounding the two ponds lacking vegetation.	Photo 76B
GP-1-5	Heavy vegetation and sedimentation in perimeter drainage ditch along the southwest and southeast sides of the Gypsum Stack.	Photo 31B
GP-1-6	Seepage observed below the perimeter dike along the southeast side of the Gypsum Stack.	Photo 30B
GP-1-7	Discharge pipes and riprap channel along northwest corner of Gypsum Storage Area.	Photo 70B

Appendix I

Evaluation of Additional Piezometers in the Vicinity of Section ‘H’

Monitoring and Evaluating Piezometric Levels at Section H

Overview

Section H is located along the south dike of the Gypsum Disposal Area where previous instability and a temporary repair that included placement of rip-rap was performed. A total of 17 piezometers have been installed in this area. The Aerial Map (Figure 1) provided below shows the specific locations.

Figure 1 – Aerial Map of Section H and Vicinity

These piezometers were installed to monitor the piezometric (water) levels within the dikes at different elevations and in selected materials. The piezometric levels were evaluated and used in the slope stability models.

Evaluation of Data

Using the data gathered, several evaluations were performed. They included the following:

- Variation in Elevation
- Variation in Depth Below Ground Surface
- Change from Previous Readings
- Correlation with Precipitation Readings (and Influent Flow)

Each of these evaluations provided a different view of the data obtained and allowed for establishment of a typical range of values using minimum, maximum and average values. These evaluations are updated on a weekly basis (minimum) with the data provided by TVA and Stantec.

<u>Variation in Elevation</u>

Figure 2 is output from the Variation in Elevation evaluation:

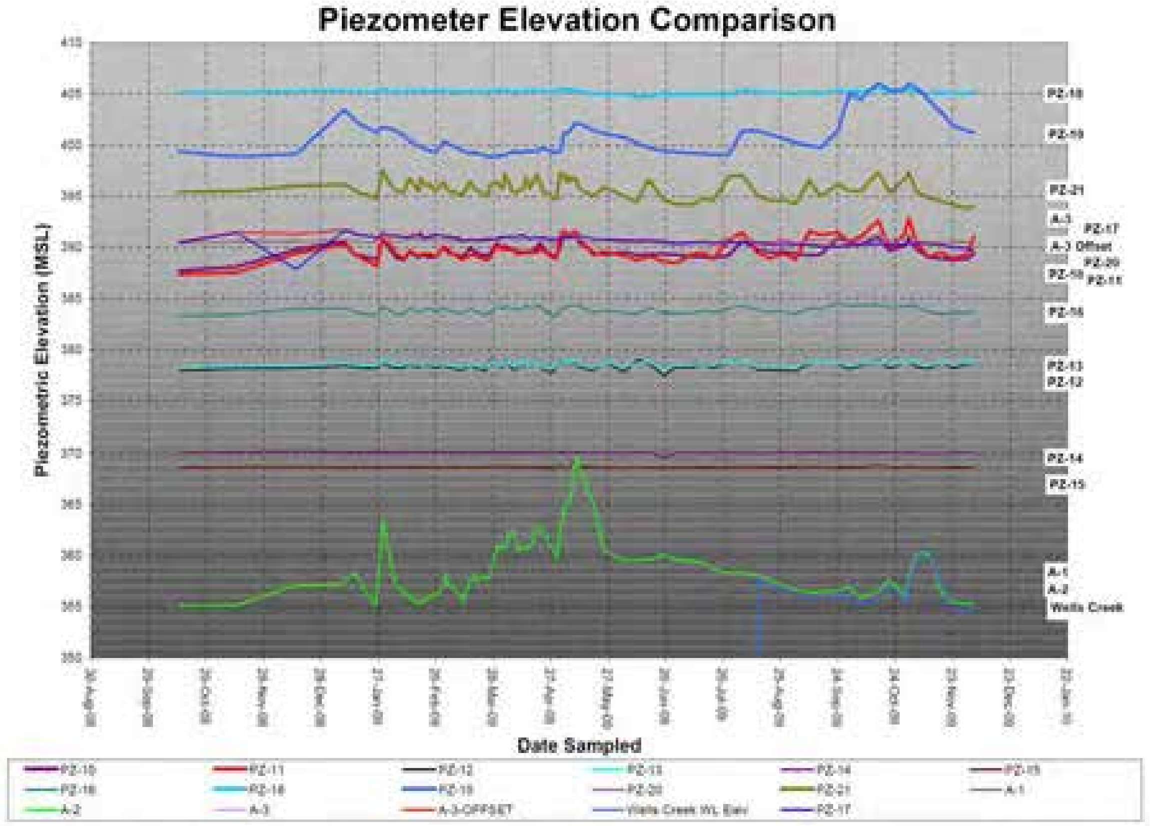


Figure 2

Note that a majority of the piezometric (PZ) levels are consistent, meaning they vary within a specific range. Other PZ levels such as PZ-19 and A-2 have more variance in there values. These differences could be attributed to differences in depths being monitored or the location on the dike. They are more directly connected to the piezometric variations that are encountered in the dikes.

<u>Variation in Depth Below The Ground Surface</u>

Figure 3 is from the Variation in Depth Below The Ground Surface evaluation:

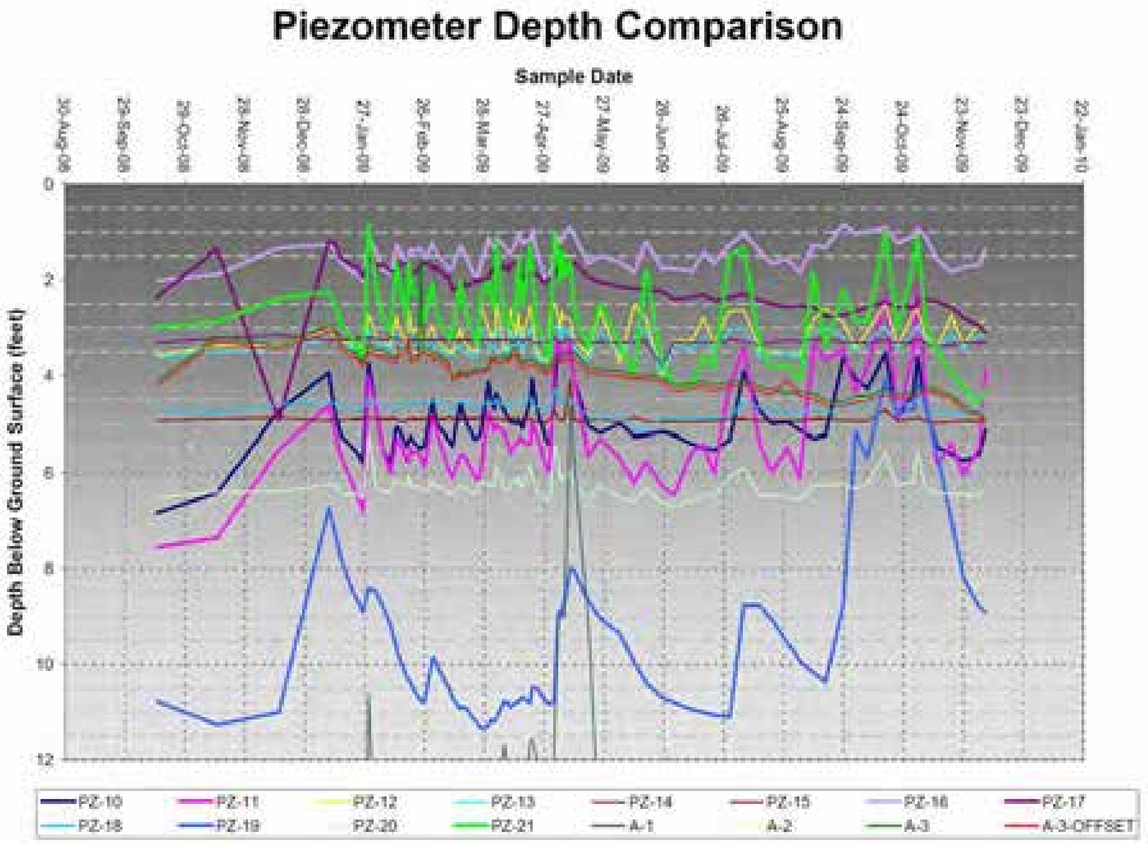


Figure 3

Note this evaluation has similar range consistencies and a couple that show more variances. In addition to determination of ranges, this evaluation also provides a graphical representation of what PZ levels are trending closer to the ground surface. For example, PZ-19 was near its highest level recorded on October 31, 2009, but it was approximately 4 feet below the ground surface. Currently the level have returned to a depth of 9 feet.

Change from Previous Readings

The data in Figure 4 shows how the change from previous readings are evaluated:

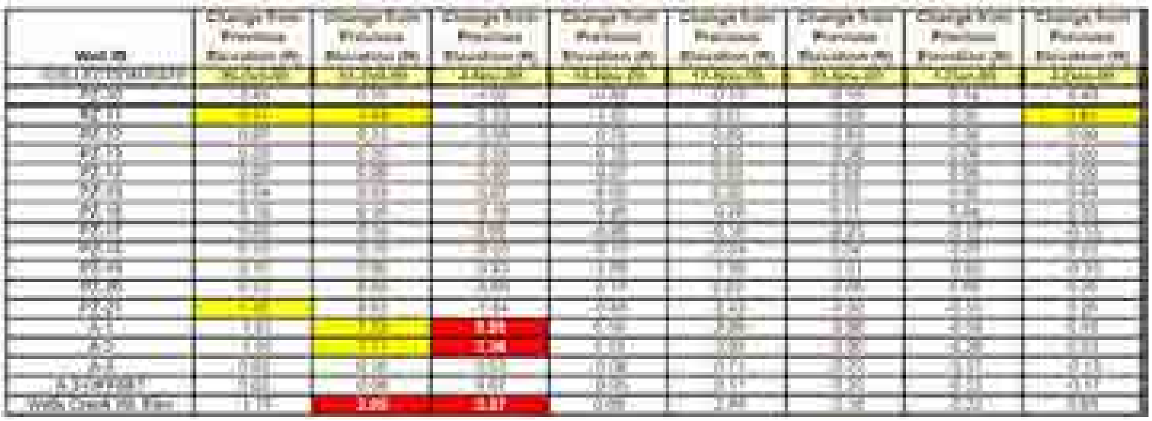


Figure 4

A data point highlighted in yellow indicates an increase in elevation of more than 1 foot from the previous reading. A data point highlighted in red indicates an increase of more than 2 feet. This allows for evaluation of the ordinary fluctuations in PZ levels.

Correlation with Precipitation Readings

Figure 5 shows how the precipitation data is evaluated with the changes in PZ levels:

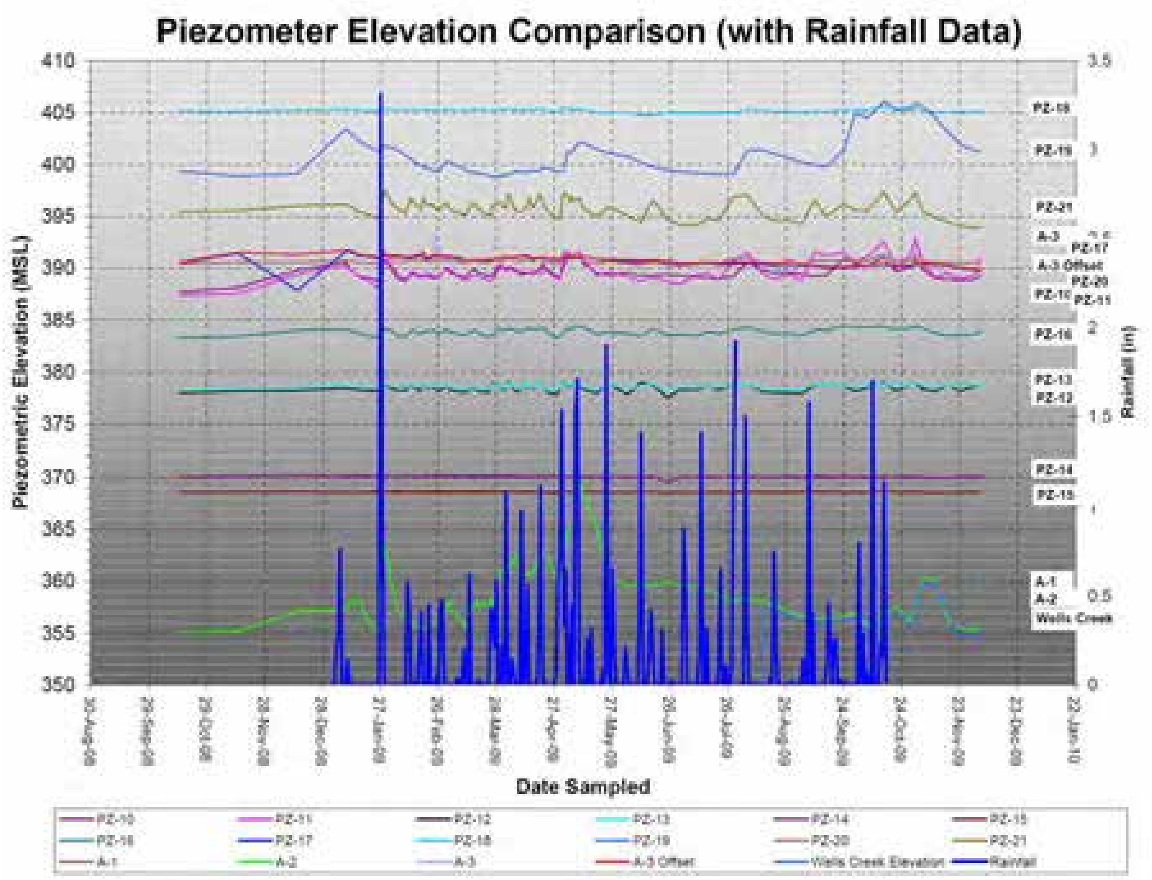
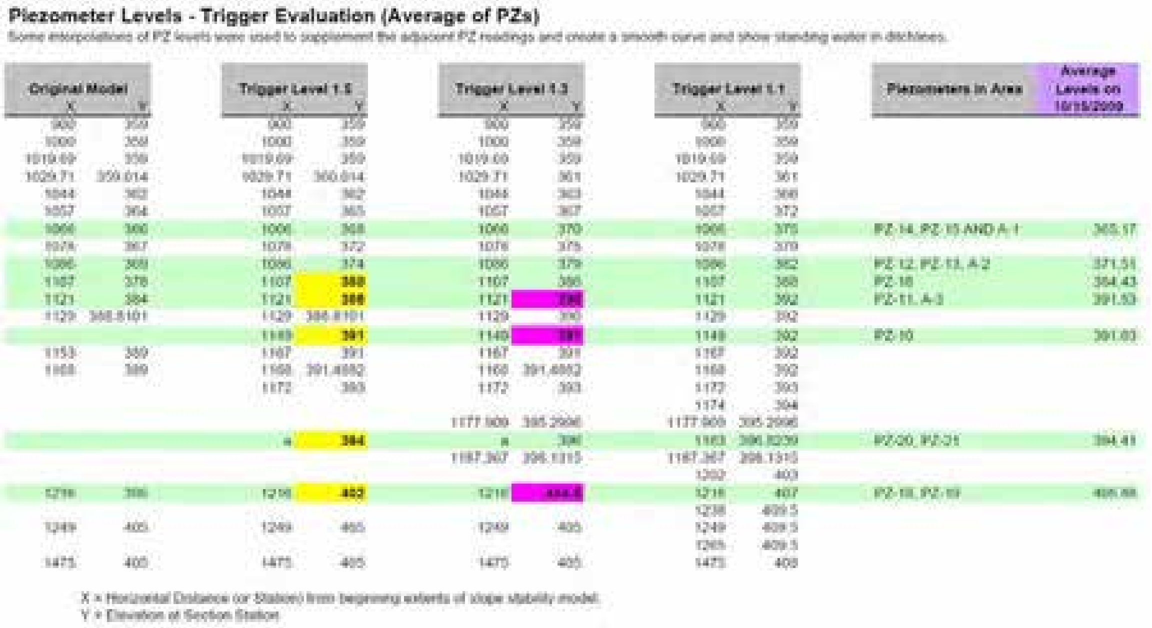


Figure 5
Some isolated locations show PZ level increases after a rainfall event such as around January 27, 2009 and May 10, 2009, however most locations do not show any clear connection with the increase in PZ levels versus the amount of precipitation. Continued data gathering may allow for comparisons in the future.

Establishment of Trigger Levels

Gathering all of the data can also be used to establish specific “Trigger Levels” using the slope stability models. Trigger levels are established by raising or lowering the piezometric levels along a selected section to predict Factors of Safety.

For Section H, trigger levels were selected at three Factors of Safety, 1.1, 1.3 and 1.5. A factor of safety greater than 1.5 is considered acceptable with 1.3 and 1.1 being established to raise awareness and determine what action might be appropriate to reduce the risk of slope instability. The following output shows the trigger level evaluation on October 15, 2009:



Piezometer Levels - Trigger Evaluation (Average of PZs)

Some interpolations of PZ levels were used to supplement the adjacent PZ readings and create a smooth curve and show standing water in ditchlines.

Original Model		Trigger Level 1.5		Trigger Level 1.3		Trigger Level 1.1		Piezometers in Area	Average Levels on 10/15/2009
X	Y	X	Y	X	Y	X	Y		
900	359	900	359	900	359	900	359		
1000	359	1000	359	1000	359	1000	359		
1019.69	359	1019.69	359	1019.69	359	1019.69	359		
1029.71	359.014	1029.71	360.014	1029.71	361	1029.71	361		
1044	362	1044	362	1044	363	1044	366		
1057	364	1057	365	1057	367	1057	372		
1066	366	1066	368	1066	370	1066	375	PZ-14, PZ-15 AND A-1	365.17
1078	367	1078	372	1078	375	1078	379		
1086	369	1086	374	1086	379	1086	382	PZ-12, PZ-13, A-2	371.51
1107	378	1107	380	1107	386	1107	388	PZ-16	384.43
1121	384	1121	388	1121	390	1121	392	PZ-11, A-3	391.53
1129	388.8101	1129	388.8101	1129	390	1129	392		
		1149	391	1149	391	1149	392	PZ-10	391.03
1153	389	1167	391	1167	391	1167	392		
1168	389	1168	391.4882	1168	391.4882	1168	392		
		1172	393	1172	393	1172	393		
						1174	394		
				1177.909	395.2906	1177.909	395.2906		
		a	394	a	396	1183	396.8239	PZ-20, PZ-21	394.41
				1187.367	398.1315	1187.367	398.1315		
						1202	403		
1216	396	1216	402	1216	404.5	1216	407	PZ-18, PZ-19	405.88
						1238	409.5		
1249	405	1249	405	1249	405	1249	409.5		
						1265	409.5		
1475	400	1475	405	1475	405	1475	408		

X = Horizontal Distance (or Station) from beginning extents of slope stability model.
Y = Elevation at Section Station

Figure 6

Figure 6 (shown above) illustrates that five of the seven areas being monitored (highlighted in green) have piezometric levels higher than the 1.5 F.S. trigger and three of those areas are higher than the 1.3 F.S. trigger level. No readings above the 1.1 F.S. trigger level were recorded during this evaluation.

Using two of the PZ locations, the following figure (7) illustrates how the trigger levels may be used:

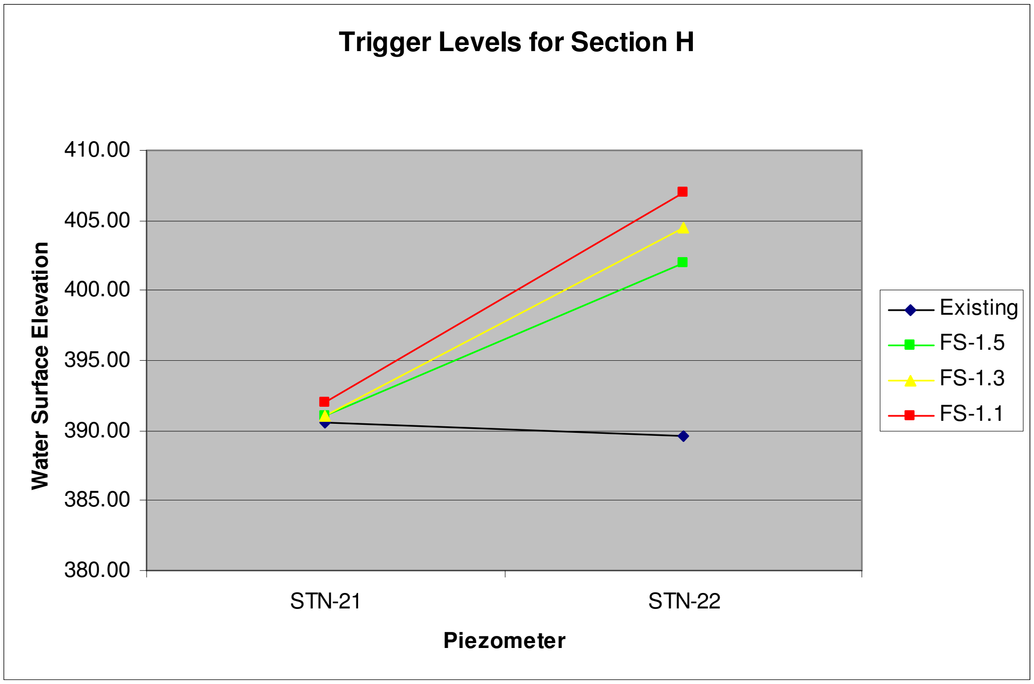


Figure 7

As the piezometric level increases in elevation, the factor of safety decreases. In this case, the existing readings are below the trigger levels, meaning the factor of safety is greater than 1.5. Note that at STN-21, the trigger levels are close together so a slight increase in piezometric level will reduce the factor of safety dramatically. On the other hand, trigger level elevations at piezometer STN-22 are further apart so it will take larger increases to reduce the factor of safety.

The following slope stability sections (Figures 8, 9 and 10) show the change in the piezometric level at each of the trigger levels (note the blue line near the face of the slope as it trends upward):

- Factor of Safety at 1.5:

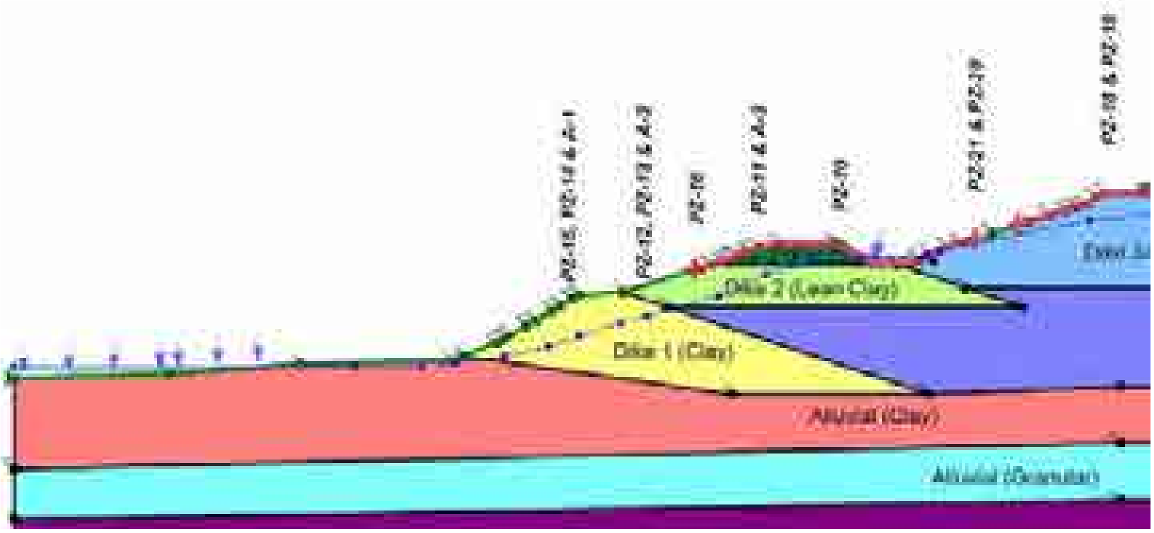


Figure 8

- Factor of Safety at 1.3:

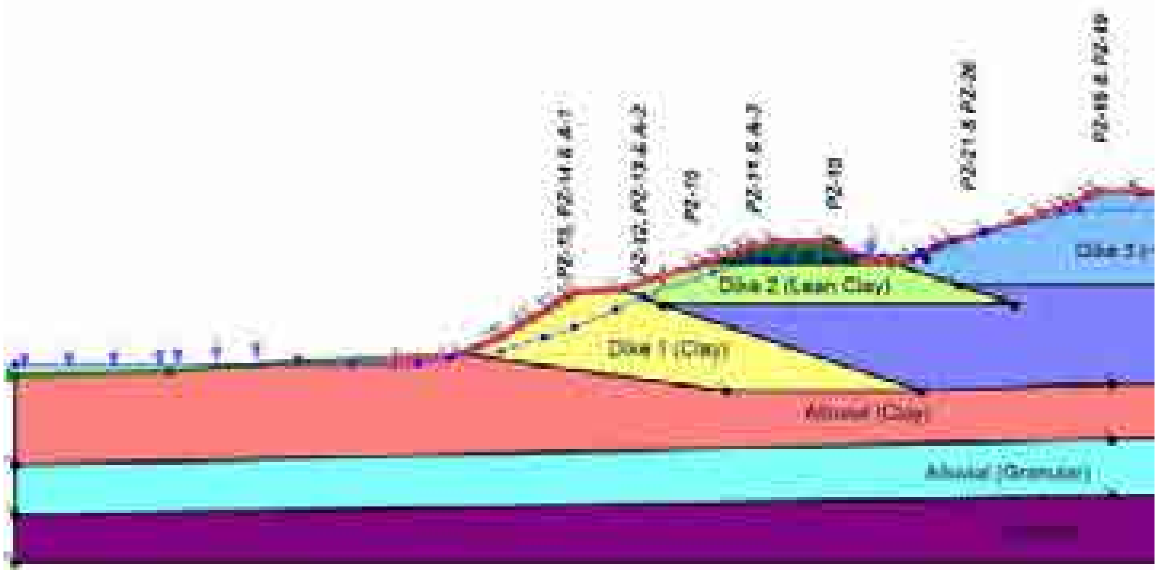


Figure 9

- Factor of Safety at 1.1:

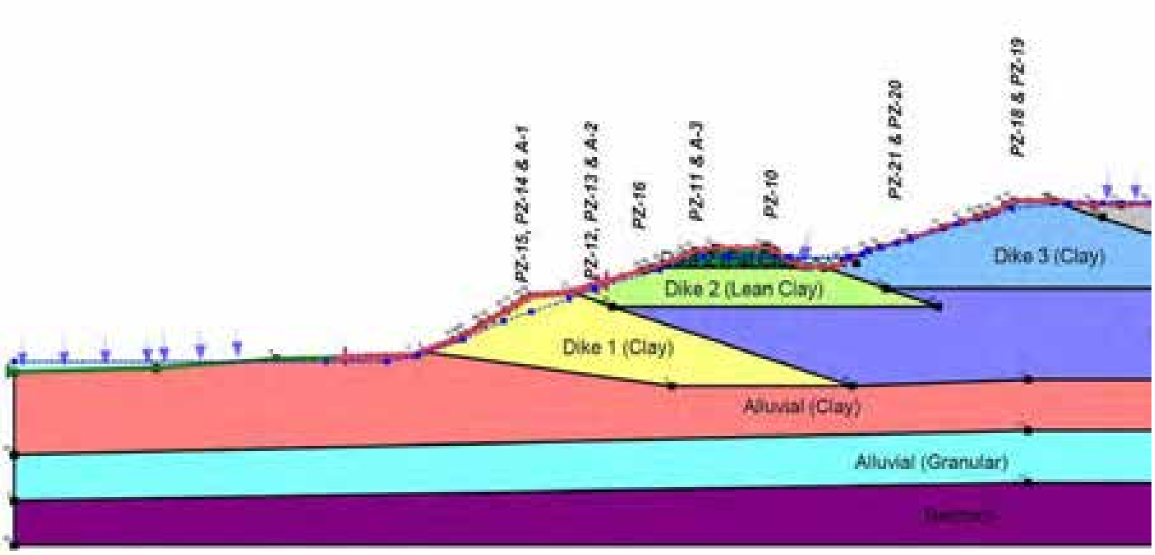


Figure 10

Monitoring the piezometric levels in the field on a weekly basis provides a relatively easy way to track changes and identify potential stability risks. It is also easy to increase the frequency (i.e., daily) during rain event or other conditions that could affect these levels.

Appendix J

Material Properties Calculation

Stantec	Subject Cumberland Fossil Plant	Made by JSH	Job No 175539009
	Gypsum Stack Complex and Dry Ash Stack	Checked by DBR	Date 10/13/2009
	Soil Properties for Analyses	Approved by SAH	Sheet No 1 of 17

OBJECTIVE:

As part of a TVA system-wide review, Stantec is analyzing the geotechnical stability of the existing Dry Fly Ash Stack and Gypsum Stack Complex at the Cumberland Fossil Plant. This calculation summarizes the basis of the material properties selected for the geotechnical analyses.

SITE OVERVIEW:

The Cumberland Fossil Plant was constructed between 1968 and 1973. It has two coal-fired generating units and produces roughly 750,000 tons of coal combustion byproducts (CCBs) in the forms of fly ash and bottom ash each year. Sulfur dioxide scrubbers were installed on the units in 1994. The synthetic gypsum byproduct generated by the scrubbers is marketed as a building material. However, any unsold gypsum (of the approximately one million tons produced each year) must be disposed by the plant.

The CCB storage facilities are located in the southern and southwestern areas of the plant and consist of aboveground cellular systems for dry fly ash, sluiced bottom ash, and sluiced/stacked gypsum. The stacks and retention ponds cover approximately 340 acres. The layout of these structures is shown on Figures 1 and 2 in Attachment 1. The structures include the Gypsum Stack Complex, the Dry Fly Ash Stack Area, the Bottom Ash Area, the Retention Pond (Ash Pond) and the Stilling Pond. The Gypsum Stack Complex consists of the North Cell and the South Cell separated by a Divider Dike. According to the introduction of the current operations manual of the facility (TVA, 2003):

> Fly ash is collected in a dry state, conditioned with moisture and then spread and compacted. Bottom ash is sluiced to a processing area, reclaimed, and then placed on the ash stack. The gypsum is sluiced into the gypsum stack area. Gypsum can also be diverted at a valve station into (the gypsum processing plant). (The processing plant) dewaters gypsum slurry using vacuum filter presses, and the filtrate is returned to the gypsum stack area where any remaining fines can settle. During unit outages, (the process plant) may also reclaim gypsum from the gypsum stack area either by direct excavation and truck hauling or by dredging using a small portable hydraulic dredge.

TVA operates the Gypsum Stack using the elevated rim ditching method. Dozers and excavators are used to construct rim ditches and to raise the perimeter gypsum dike. Currently minor sluicing is directed into the North Cell of the Gypsum Stack Complex as needed. Active dry stacking occurs in the South Cell.

GIVEN:

- Data from a geotechnical exploration performed by Stantec between April and July 2009 (Stantec 2009a). Field data include standard penetration tests (SPTs), cone penetration tests (CPTs), and

Stantec	Subject Cumberland Fossil Plant	Made by JSH JSH	Job No 175539009
	Gypsum Stack Complex and Dry Ash Stack	Checked by DBK	Date 10/13/2009
	Soil Properties for Analyses	Approved by JBH	Sheet No 2 of 17

visual assessment of existing site conditions. Disturbed and undisturbed soil samples were sent for laboratory testing to determine in-situ unit weight, density, and moisture conditions, strength and permeability, and soil classification testing.

- Plant-provided historical information for the facilities referencing previous engineering work and maintenance measures.
- Compiled data from related TVA facilities with similar material property assumptions and from similar Stantec project experience.

ASSUMPTIONS:

Thirteen soil horizons were identified based on historical construction data, geotechnical boring logs, and laboratory testing. Below is a brief description of each horizon based on the field exploration:

CCBs:

- Fly Ash – Classifies as silt (ML) or silt with sand/silty sand. Light gray to black or gray brown, silt to clay-sized grains, dry to wet. Soft to very stiff. Lenses of bottom ash or lean clay may be present.
    - Fly Ash (Sluiced) or Fly Ash/Bottom Ash (Sluiced) – Saturated fly ash, bottom ash, or a laminated zone of both that is wet to saturated, possibly hydraulically placed, soft to medium stiff. Fly ash alone classifies as silt (ML). The fly ash/bottom ash (sluiced) was visually classified as silty sand with gravel (SP), silty sand (SM), and sandy lean clay (CL). A distinction was not drawn between sluiced fly ash and a combination material of sluiced fly ash and bottom ash. Definite zones were unclear. Sluiced fly ash properties were conservatively assumed for both materials.
    - Fly Ash (Stacked) – Distinct from sluiced fly ash based on higher blow counts, lower moisture contents, and stronger cone penetrometer test (CPT) results. Some compaction effort is anticipated during controlled placement of this material.
- Bottom Ash – Segregated and stacked bottom ash. Classifies as a silty sand with gravel (SP) or silty sand (SM). Dark gray to black, coarse grained, damp to wet, very loose to very dense with occasional interbedded layers of fly ash and clay. Medium sand to gravel-sized grains with some fines. Some compaction effort is anticipated during controlled placement of this material. Sluiced bottom ash intermixed with fly ash is modeled as sluiced material (see above).
- Gypsum – Classifies as silt (ML), white to grey brown or tan, medium stiff to very stiff, damp to wet. Typically stacked material though some sluicing does occur as needed. Some compaction effort is anticipated during controlled placement of this material.

Stack Construction:

- Dike 1 – The original perimeter dike. A lean clay (CL), red brown to gray brown, moist to wet, very soft to very stiff. Occasional gray mottling, with areas of sand or gravel, chert fragments, wood or roots, and manganese concretions.

  Stantec (2009a) identified this zone in most borings surrounding the Dry Fly Ash Stack and Gypsum Stack Complex just above natural ground. It was not found in the borings on the northeast perimeter on the Gypsum Stack Complex near the Coal Yard Runoff Pond and Metal Cleaning Pond. Here the initial surface topography appeared to be at a higher elevation than the rest of the initial dike structure.

- Dike 2 – The raised dike upstream of the original perimeter dike. It has a crushed stone surface between 0.5 and 1.0 feet deep. Dike 2 was identified by Stantec (2009a) along the outside perimeter of the Dry Fly Ash Stack and Gypsum Stack Complex. It is not found in the divider dikes between the Gypsum Stack Complex, Dry Fly Ash Stack, and Retention Pond. The raised dike has two distinct soil horizons:

  - Dike 2 (Lean Clay) – Lean clay (CL) to lean clay with gravel, some cobbles, light brown to brown, some gray mottling, moist to wet, soft to very stiff.

  - Dike 2 (Fat Clay) – Fat clay (CH) to fat clay with gravel, dark brown to reddish brown, damp to wet, firm to very stiff. This layer is typically near the top of Dike 2 or may compose the complete Dike 2 zone.

- Dike 3 –The starter dike for stacking gypsum. Classifies as a clayey gravel with sand (GC) or clayey sand with gravel (SC) with just greater than 50% retained on the No. 200 sieve. Reddish brown to light gray, moist to wet, loose to dense, angular grains. The clay tends to be lean with some borderline fat clay present with manganese concretions. A bottom ash road (from 1.1 to 4 feet thick) is located along the dike's crest.

  Stantec (2009a) identified this zone in borings along the embankment crest surrounding the Gypsum Stack Complex. One exception was Boring 45 located next to the small pond at the complex's northwestern tip.

- Divider Dike – Located between the Retention Pond and the Dry Fly Ash Stack, this dike has a distinct composition of rip rap or boulder zones with a reddish brown silty clay matrix. The clay matrix is light brown to reddish or grayish brown, stiff to very stiff, and moist to wet. Typically, it was field-classified as lean with some fat clay present.

Foundation Materials:

- Alluvial (Clay) – Lean clay (CL), silty grading to sandy, manganese concretions, reddish brown to light gray, some gray mottling, soft to very stiff, moist to wet, with rock fragments. Few organics and wood fragments, but typically has a faint organic odor near the suspected natural ground interface.
    - Alluvial (Clay – Soft) – Historical reports denote a separate soft alluvial clay zone. This segregates the wettest and softest material as distinct layer in the stability analyses.
- Alluvial (Granular) – Varying between silty sand with gravel (SM), (yellowish brown to light gray, moist to wet, very loose to compact, medium to coarse grained, poorly sorted with increasing gravel size) and gravel with clay to silt and sand (GP-GC or GM) (gray, wet, very stiff to hard, angular, loose to very dense). Wood fragments with a slight organic odor near the suspected natural ground interface.
- Bedrock – Several borings indicate shale grading into limestone. The shale is light to dark gray, calcareous, moderately hard, and laminated. The limestone is light gray, hard, and turbulent bedded. A weathered zone is present before reaching competent rock.

Boring logs from Stantec (2009a) are included as Attachment 2. Geotechnical laboratory results from Stantec (2009a) are included as Attachment 3. A summary table of the geotechnical laboratory testing for Stantec (2009a) is also included in Attachment 3. It is organized by boring, depth, and assumed soil horizon. Historical data referenced for this calculation are included in Attachment 4. Table 1 outlines the design elevations for the various dikes.

Table 1. Details of Complex

Item	Value
Elevation of Initial Ash Dike (Dike 1)	380 feet
Elevation of Perimeter Ash Dike (Dike 2)	395 feet
Current Ash Stack Elevation	430 feet
Planned Maximum Ash Elevation	600 feet
Elevation of Initial Gypsum Dike (Dike 1)	380 feet
Elevation of Perimeter Gypsum Dike (Dike 2)	395 feet
Elevation of Gypsum Stacking Dike (Dike 3)	410 feet
Current Gypsum Stack Elevation	418-423 feet
Planned Maximum Height (Gypsum)	570 feet

ANALYSIS:

Key properties for slope stability analyses, including unit weight and drained shear strength parameters, were estimated for each soil horizon. Additional properties required for seepage analyses, such as saturated hydraulic conductivity and horizontal to vertical permeability ratio will be handled separately.

Initial estimates were developed from the available Stantec (2009a) geotechnical field and laboratory data. Field data included standard penetration tests (SPTs), cone penetrometer tests (CPTs), and visual assessments of the existing conditions. Laboratory testing was performed on disturbed (SPT and bulk) and undisturbed (Shelby tube) samples. Table 2 lists the geotechnical laboratory testing and associated ASTM methods performed for Stantec (2009a).

Table 2. Geotechnical Laboratory Testing

Test Description	ASTM Method
Consolidated-undrained (CU or R) triaxial with porewater measurements	D 4767
Falling-head permeability	D 5084, Method C
Specific gravity	D 854
Particle size analysis with hydrometer	D 421, 422
Atterberg limits	D 4318, Method A
Moisture-density relationships using standard Proctor	D 698, Method A
Natural moisture content	D 2216

The initial material property estimates were then compared to plant-provided historical geotechnical data from previous engineering and maintenance work on site and adjusted as needed. Finally, the estimates were compared to compiled data from related TVA facilities with similar materials, to data from similar Stantec projects, and published typical values based on soil types.

In fitting strength parameters to multiple test results, the design values of effective cohesion (c') and effective internal friction angle (ϕ') were selected so that data from about two-thirds of the tests were above the failure envelope (Stantec, 2009b from USACE, 2003). This straight-line assumption of the curved shearing resistance envelope over normal stresses is specific to the range of stresses tested.

The Stantec (2009a) consolidated-undrained triaxial test results were based on the maximum principal effective stress ratio (maximum value of σ'_1/σ'_3) or the point of maximum obliquity. This stress condition is where the slope of the failure envelope through the origin of stress has its maximum slope (maximum ϕ for c=0). In routine practice, this failure criterion is used in undrained laboratory tests.

Note that a small amount of effective cohesion was used for the clay dikes and the alluvial clay. Any cementation in the CCBs was neglected. Laboratory tests on a few discreet samples from the stack will not yield a complete understanding of the cementation in the stacks.

Additional field data from Stantec (2009a) was incorporated by creating histograms of the uncorrected SPT blow counts and from the analysis of the CPT data by material type. Stiffer materials such as gypsum and bottom ash are not represented in the CPT data. The histograms are included as Attachment 5. The CPT data (Stantec, 2009a) was reduced to determine equivalent SPT N60 using the Jefferies and Davies (1993) approach and to determine the effective angle of internal friction. This data is listed on the histogram charts included in Attachment 5 and included in the shear strength data discussed below. The CPT data from Stantec (2009a) is included as Attachment 6.

When possible, SPT blow counts (Stantec, 2009a) were converted to effective friction angles using N_{60} and the empirical chart originally from Peck et al. (1974) and modified by Carter and Bentley (1991). This chart is included as Attachment 7. Table 3 is an overview of the Stantec (2009a) uncorrected SPT blow count values.

Table 3. Uncorrected SPT N Value by Soil Type*

N (Blow Counts)	Min	Max	Average	Mode	Std Dev
Bottom Ash	0	87	23	13	15.1
Bottom Ash/Fly Ash	0	75	13	4	12.7
Fly Ash	0	72	11	0	13.4
Fly Ash Stacked	2	99	36	50	25.4
Matrix	0	50	19	50	16.8
Alluvial Clay	0	70	17	6	14.4
Alluvial Granular	0	116	27	50	18.8
Dike 1	3	83	16	13	13.4
Dike 2	3	61	18	9	9.8
Dike 3	3	84	25	30	16.4
Gypsum	3	98	47	50	24.9

* Stantec (2009a)

Soil Horizons:

1. **Fly Ash (Sluiced) or Fly Ash/Bottom Ash (Sluiced)**
2. **Fly Ash (Stacked)**
3. **Bottom Ash**

Historical reports were not always clear when differentiating between fly ash and bottom ash, compacted or sluiced material. When available, distinctions are provided. However, for clarity, these three materials will be discussed together.

Moist unit weights for the sluiced materials were estimated using the Stantec (2009a) undisturbed samples. The moist unit weight of sluiced fly ash ranged from 97.4 to 106.2 pounds per cubic feet (pcf) with an average over nine measurements of 102.6 pcf. Sluiced bottom ash-fly ash had a single reading of 125.0 pcf. For the stacked material, standard Proctor compaction testing resulted in a maximum moist unit weight for bottom ash of 121.5 pcf and fly ash of 110.9 pcf.

Typical blow counts for the sluiced fly ash were 0 to 3 (0 to 4 corrected for automatic hammer or N_{60}). Approximately 1/5 of the samples thought to be sluiced fly ash had blow counts of 0. Roughly ¾ of the samples had blow counts of 13 or less ($N_{60} = 17$). Sluiced bottom ash/fly ash zones tended to have N values of 3 to 8 ($N_{60} = 3.9$ to 10.4). Stacked bottom ash typical values were 10 to 23 ($N_{60} = 13$ to 29.9). Stacked fly ash had 27% of the blow counts at N = 50 ($N_{60} = 65$). An additional 40% of the stacked fly ash N values were less than 20 ($N_{60} = 26$).

Shear strength testing available for the fly ash and bottom ash is summarized below.

Table 4. Fly Ash (Sluiced) or Fly Ash/Bottom Ash (Sluiced) Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2009a)	B-43A (29.0-31.0), B-35A (46.0-48.0)	103.3	0	39.6
Law (1992)	Sluiced ash	110	0	28
	Sluiced ash (dilatometer data and published sources)	71.6-139.5	0-900	11-28
TVA (1992)	Sluiced fly ash (stability analysis)	100	0	25
United (1992)	Sluiced fly ash (undrained parameters)	100	0	25
Stantec (2009a)	SPT N_{60} values – empirical (sluiced fly ash)			<28
	SPT N_{60} values – empirical (sluiced fly ash/bottom ash)			<28-30.1
	CPT N_{60} minimum, maximum, and average (2, 17, and 9) (fly ash)			13, 30, 22
Stantec (2009a)	CPT N_{60} minimum, maximum, and average (3, 11, and 7) (bottom ash/fly ash)			13, 28, 21
	Recommended unit weight (fly ash sluiced)	97.4-106.2 (average 102.6)		
	Recommended unit weight (bottom ash/fly ash sluiced)	125.0		
Stantec (2009a)	**Selected Parameters for Stability Analyses**	100	0	22

Stantec	Subject Cumberland Fossil Plant	Made by JSH	Job No 175539009
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Table 5. Fly Ash (Stacked) Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2009a)	Bulk sample (80% Standard Proctor)	87.8-89.0	14.3	36
Law (1992)	Compacted ash	105	0	36
	Compacted ash (Standard Proctor and published data)	102.6-123	0	37.5
United (1992)	Compacted fly ash (undrained parameters)	105	0	32
Law (April 1995)	Dry fly ash (Units 1-2) (Standard Proctor max at 13.2% moisture)	111.4	0	53.5
Stantec (2009a)	SPT N_{60} values -- empirical (single value)			43.5
	CPT N_{60} (single value)			32
	Recommended unit weight	110.9 (maximum)		
Stantec (2009a)	**Selected Parameters for Stability Analyses**	100	0	32

Table 6. Bottom Ash Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2009a)	Bulk sample (84% Standard Proctor)	102.1-102.3	261	41
HBA (1986)	Recommended soil properties (compacted)	108	0	34
TVA (1987)	Recommended soil properties (compacted)	108	0	34
	Test 1 (maximum value of σ'_1/σ'_3)		500	39.8
	Test 2 (maximum value of σ'_1/σ'_3)		1500	36
United (1992)	Bottom ash (undrained parameters)	120	0	35
	Compact bottom ash (undrained parameters)	125	0	38
Law (April 1995)	Bottom ash – from pond (Standard Proctor max at 15.4% moisture)	90.1		30.8 (angle of repose)
Stantec (2009a)	SPT N_{60} values – empirical (N_{60} = 13-29.9)			31.3-36.2
	CPT N_{60} (single value)			50
	Recommended unit weight (maximum)	121.5		
Stantec (2009a)	**Selected Parameters for Stability Analyses**	105	0	35

4. Gypsum

Gypsum's moist unit weight was estimated using standard Proctor compaction on a bulk sample from the facility (Stantec, 2009a). SPT blow counts for the material ranged greatly from 3 to 98 with 16% of the 111 readings at an N of 50 (N_{60} = 65). Gypsum's shear strength is dependent on the compaction effort in the field. A more conservative effective internal friction angle was selected based on the United (1992) parameters. Though conservative, gypsum's shear strength does not appear to drive the stability of the current analyses.

Table 7. Gypsum Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2009a)	Bulk sample (89% Standard Proctor)	103.3-104.5	90.5	42.5
	Bulk sample - rejects (88% Standard Proctor)	102.5-102.7	0	44
United (1992)	Gypsum (undrained parameters)	100	0	35
Stantec (2009a)	SPT N_{60} values – empirical (single value)			43.5
Stantec (2009a)	**Selected Parameters for Stability Analyses**	105	0	38

5. Dike 1

Moist unit weights for Dike 1 was estimated using the Stantec (2009a) undisturbed samples. The moist unit weight of Dike 1 ranged from 119.1 to 126.9 pcf with an average over eight measurements of 123.6 pcf. Typical blow counts for Dike 1 were 9 to 13 (11.7 to 16.9 for N_{60}).

Shear strength values for this material would suggest that a higher effective internal friction angle could be used for stability analyses. However, several low values (17.7°, 18°, and 15°) were also found in the current study and historical data. Perhaps the differentiation between the bottom of Dike 1 and the historical substratum of soft alluvial clay is unclear.

Table 8. Dike 1 Shear Strength Summary

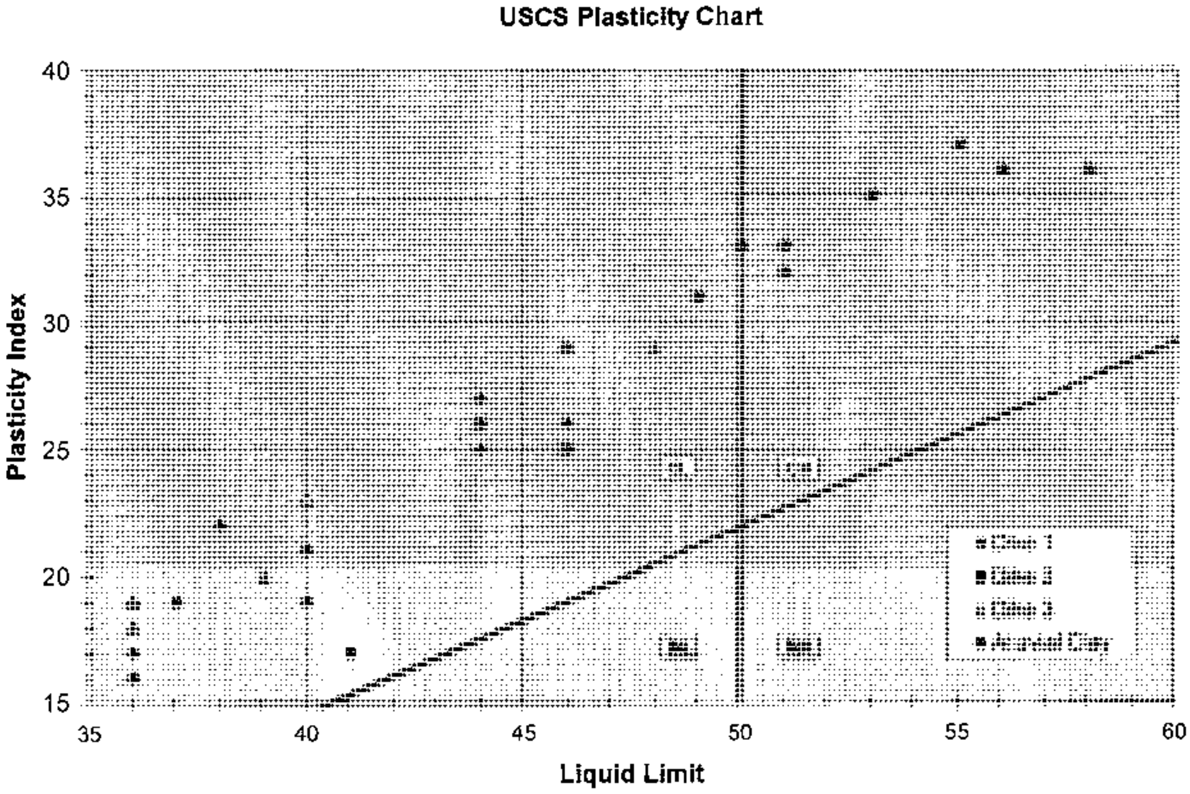
Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2009a)	B-5 (18.0-20.0)	119.2-121.5	320	28.7
	B-29A (29.0-31.0)	125.4-128.3	16.4	36.8

Stantec (2009a)	B-63A (5.0-7.0, 8.0-10.0)	120.2-126.3	1000	17.7
HBA (1986)	Recommended soil properties	125	0	25
TVA (1987)	Boring No. 1 - original dike (10-12)			30 (max) 25.5 (min)
	Boring No. 5 – original dike (10-12)			42 (max) 35 (min)
	Boring No. 5 – original dike to alluvial (17-19)			29 (max) 18 (min)
	Boring No. 8 – original dike to alluvial (17-19)			34 (max) 15 (min)
	Recommended		0	27
	Recommended		0	25
Law (1992)	Dike fill	124	300	25
Mactec (2007)	MWA2 – brown sandy silty clay	126.5-130.2	0	36.6
	MWB2 – tan brown lean clay	123.2-123.6	105.7	31.4
Stantec (2009a)	CPT N_{60} minimum, maximum, and average (6, 8, and 7)			31, 43, 39
	Recommended unit weight	123.6		
Stantec (2009a)	**Selected Parameters for Stability Analyses**	124	100	25

6. Dike 2 (Lean Clay)
7. Dike 2 (Fat Clay)

Stantec (2009a) breaks Dike 2 into two zones: lean and fat clay. Historical reports do not separate Dike 2. However, the shear strength testing suggests a change in material properties with effective internal friction angles ranging from 11° to 36.5°. Atterberg limits from undisturbed samples show liquid limits between 44 and 58, and plasticity indices between 25 and 39.

Stantec	Subject Cumberland Fossil Plant	Made by JSH	Job No 175539009
	Gypsum Stack Complex and Dry Ash Stack	Checked by DBW	Date 10/13/2009
	Soil Properties for Analyses	Approved by SAH	Sheet No 11 of 17



Moist unit weights were estimated using the Stantec (2009a) undisturbed samples. The moist unit weight of Dike 2 (lean clay) ranged from 123.4 to 133.1 pcf with an average over eight measurements of 128.4 pcf. One outlying value of 117.1 pcf was neglected in the estimate. Dike 2 (fat clay) ranged from 125.2 to 129.6 pcf with an average over four measurements of 127.6 pcf. One outlying value of 115.9 pcf was neglected in the estimate.

Typical blow counts for Dike 2 was 8 to 18 (N_{60} = 10.4 to 23.4).

Table 9. Dike 2 (Lean Clay) Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2009a)	B-29B (12.0-13.4, 14.5-16.5)	126.4-134.6	0	36.5
HBA (1986) Raised Dike Borrow Study	Recommended soil properties	121	0	25
	Boring 1 (26.0-28.0) - CL	125.3	0	33.6
	Boring 2 (26.0-28.0)	127.9	570	22.8
	Boring 2 (30.0-32.0)	124.5	590	14.4

HBA (1986) Raised Dike Borrow Study	Boring 5 (10.0-12.0)	124.2	940	30.9
	Boring 5 (17.0-19.0)	118.3	220	24.8
	Boring 8 (20.0-22.0)	123.6	980	11
TVA (1987)	W (95% compaction) average		520	23.78
	W (95% compaction) lower third		460	18.43
	W (95% compaction) recommended	121	0	25
	W (98% compaction) average		1240	23.9
	W (98% compaction) lower third		1040	17.2
	W (98% compaction) recommended	125	0	30
	E (95% compaction) average		1240	18.8
	E (95% compaction) lower third		1160	14.6
	E (95% compaction) recommended	119	400	28
	E (98% compaction) average		580	25.4
	E (98% compaction) lower third		620	18.6
	E (98% compaction) recommended	123	0	30
Law (1992)	Dike fill	124	300	25
	Triaxial shear strength test		260	27
Mactec (2007)	MWA3 – brown lean clay	126.1-129.9	568.8	28.9
Stantec (2009a)	**Selected Parameters for Stability Analyses**	128	100	28

Table 10. Dike 2 (Fat Clay) Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
HBA (1986) Raised Dike Borrow Study	Boring 1 (10.0-12.0) - CH	125.5	170	27.5
	Boring 2 (24.0-26.0)	123.3	150	34.3
	Boring 8 (28.0-30.0)	126.8	0	19.5
Stantec (2009a)	**Selected Parameters for Stability Analyses**	127	200	19

8. Dike 3

Dike 3 contains more granular material than Dikes 1 and 2. Moist unit weights for Dike 3 were estimated using the Stantec (2009a) undisturbed samples. The moist unit weight ranged from 121.9 to 128.7 pcf with an average over six measurements of 126.0 pcf. Typical blow counts for Dike 3 were 12 to 30 (15.6 to 39 for N_{60}). Field data (Stantec, 2009a) suggested a mix of lean and fat clay was present. Data for Dike 3 is not available in the historical documentation for the facility. Though the triaxial test results do not show effective cohesion, a minimal value of 50 psf was assigned to the material. Field observations and similarities to Dikes1 and 2 suggest that some effective cohesion is anticipated for Dike 3.

Table 11. Dike 3 Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2009a)	B-19C (10.5-12.5, 17.5-19.5), B-28C (14.5-16.5)	123.5-128.6	0	31
Stantec (2009a)	**Selected Parameters for Stability Analyses**	126	50	30

9. Divider Dike

The divider dike separating the Retention Pond and the Dry Fly Ash Stack is markedly different from the other soil strata on site. It is a matrix of gravel, clay, and boulders combined onsite prior to placement. The intermixed boulders made field testing difficult. This material is conservatively modeled as slightly stronger than Dike 3.

Table 12. Divider Dike Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2009a)	**Selected Parameters for Stability Analyses**	130	0	35

10. Alluvial (Clay)
11. Alluvial (Clay – Soft)
12. Alluvial (Granular)

Historical reports break the alluvial layer into a soft foundation layer and a lower, stronger foundation layer. Field investigations for Stantec (2009a) suggested two primary layers: alluvial (clay) and alluvial (granular). The alluvial material showed increased sand and gravel percentages in zones classifying as silty gravel with sand or poorly graded clayey gravel. This would also be logical based on the nearby meandering creek channel.

Blow counts also indicated possible strength gain in the alluvial (clay) under the Dikes 1 and 2 for a depth of 5-10 feet. Softer zones were present in the alluvial (clay), but appeared to be discontinuous and not globally a concern for the site. The historical properties for the soft alluvial clay layer are summarized below in Table 13. Though not specifically called out as a separate layer in the stability analyses, the historical values were referenced in estimating the appropriate shear strength values for the alluvial (clay) zone. Please refer to the geotechnical exploration cross sections included in the report's drawings to see how the blow counts correspond to assigned material type.

Moist unit weights for alluvial (clay) were estimated using the Stantec (2009a) undisturbed samples. The moist unit weights ranged from 110.0 to 128.0 pcf with an average over seven measurements of 120.2 pcf. Typical blow counts for alluvial (clay) were 5 to 15 (6.5 to 19.5 for N_{60}). Typical blow counts for alluvial (granular) were 8 to 20 (10.4 to 26 for N_{60}). Undisturbed samples of the alluvial (granular) layer were not available.

Table 13. (Historical Layer) Alluvial (Clay – Soft) Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
HBA (1986)	Recommended soil properties – soft layer	119	0	18
TVA (1987)	Boring No. 1 - soft foundation layer (26-28)			28 (max) 24.5 (min)
	Boring No. 2 – soft foundation layer (24-26)			34.5 (max) 14 (min)
	Boring No. 2 – soft foundation layer (26-28)			27 (max) 24.5 (min)
	Boring No. 2 – soft foundation layer (30-32)			21 (max) 17 (min)
	Boring No. 8 – soft foundation layer (30-31?)			18 (max) 10 (min)
	Recommended	119	0	18-20
	TVA US-6 Sample 4		300	19.5
	Recommended average		0	24.3
	Recommended lower third		0	22.7
	Recommended for analysis		0	24
	Recommended based on blow counts and engineering judgment		0	28
Law (1992)	Upper soil subgrade	124	300	27
United (1992)	In-situ soft clay (undrained parameters)	120	400	10

Table 14. Alluvial (Clay) Shear Strength Summary

Report	Boring/Depth (ft)	γ_w (pcf)	c' (psf)	ϕ' (deg.)
Stantec (2009a)	B-43A (50.0-52.0)	123.9-125.0	440	30.3
HBA (1986)	Recommended soil properties - foundation	125	0	24

TVA (1987)	Recommended soil properties – foundation clay	125	0	28
Law (1992)	Lower soil subgrade	125	500	30
United (1992)	In-situ stiff clay (undrained parameters)	125	500	20
Mactec (2007)	MWA1 – brown lean clay	128.2-131.4	0	31.5
	MWA1 – brown silty clay with sand	123.2-126.1	0	35.2
Mactec (2007)	MWB1 – brown lean clay	126.0-131.0	72.144	32.0
	MWB1 – tan brown lean clay	125.3-126.5	89.712	32.1
Stantec (2009a)	CPT N_{60} minimum, maximum, and average (7, 25, and 12)			16, 28, and 20
Stantec (2009a)	**Selected Parameters for Stability Analyses**	121	200	30

Table 15. Alluvial (Granular) Shear Strength Summary

Report	**Boring/Depth (ft)**	**γ_w (pcf)**	**c' (psf)**	**ϕ' (deg.)**
Stantec (2009a)	SPT N_{60} values – empirical			30.1-34.5
Stantec (2009a)	**Selected Parameters for Stability Analyses**	130	0	32

13. Bedrock

This shale and limestone layer will be modeled as an impenetrable layer in the slope stability. The weaker, shallower materials will control the slope stability.

CONCLUSIONS:

Table 16 summarizes the recommended soil material properties for the slope stability analyses. Care should still be taken when applying these properties to specific slope stability cross sections. Field investigation data varying greatly from these recommended properties should be discussed with the project team prior to performing the analyses.

Table 16. Slope Stability Material Properties

Material Type	Unit Weight, γ (pcf)	Effective Stress	
		Cohesion, c' (psf)	Friction Angle, ϕ' (deg)
Clay Dike 1	124	100	25
Clay Dike 2 - Lean Clay	128	100	28
Clay Dike 2 - Fat Clay	127	200	19
Clay Dike 3	126	50	30
Fly Ash – Stacked	100	0	32
Bottom Ash or Fly Ash - Sluiced	100	0	22
Bottom Ash - Stacked	105	0	35
Gypsum	105	0	38
Alluvial – Clay	121	200	30
Alluvial – Granular	130	0	32
Matrix (gravel, clay & boulder)	130	0	35
Bedrock	Impenetrable		

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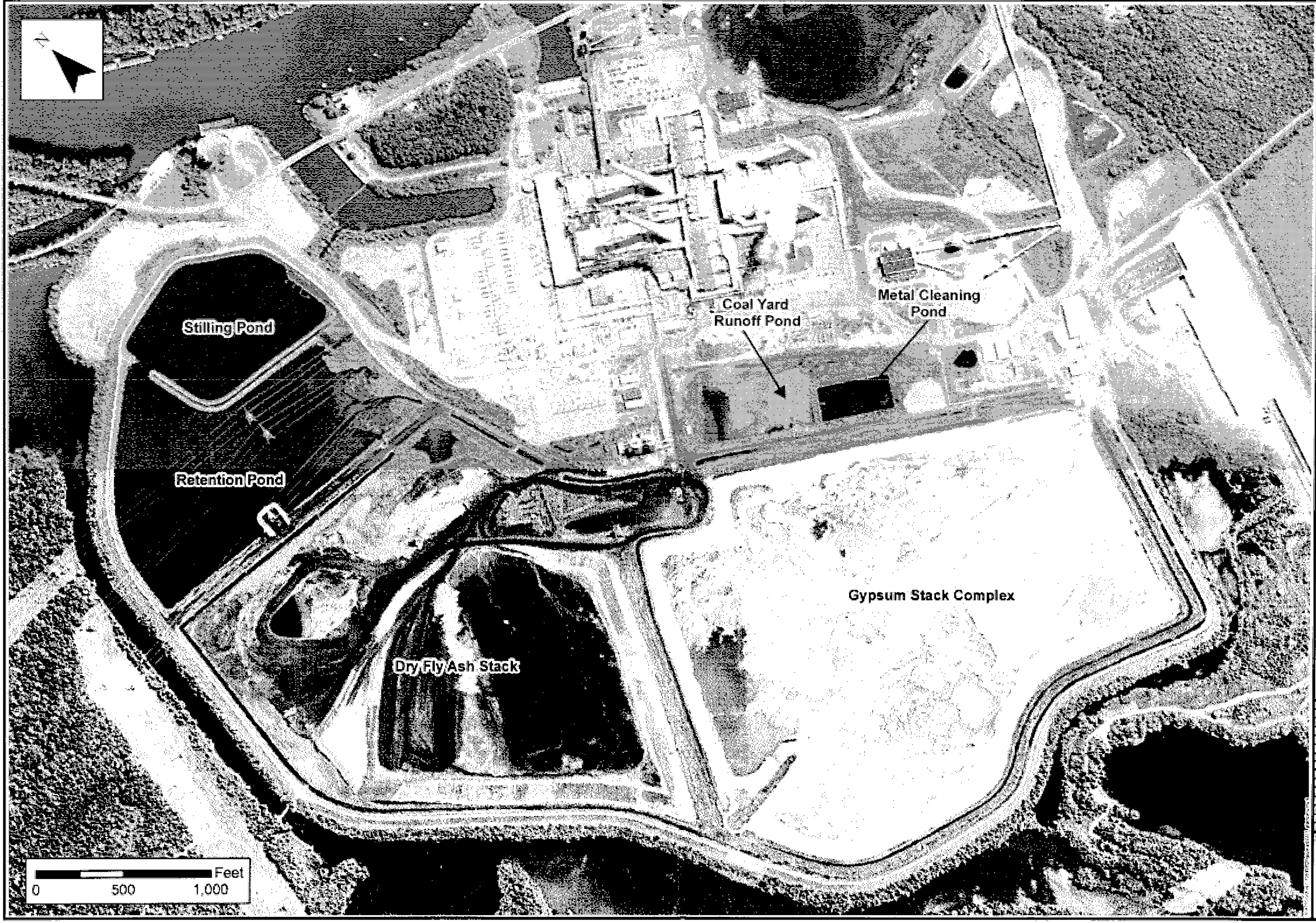
Attachment 1
Figures



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Aerial Plan View

Tennessee Valley Authority
Cumberland Fossil Plant
Cumberland, Stewart County, Tennessee

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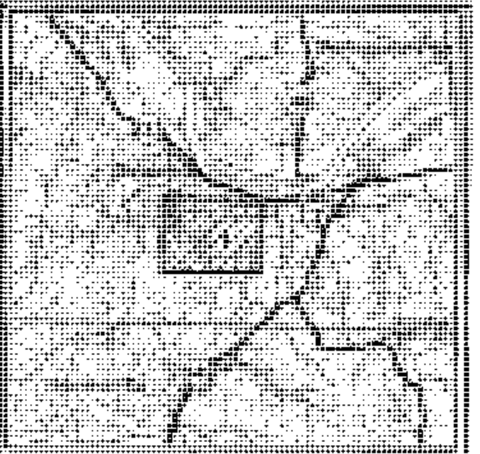

LEGEND

- Cross Section Data
- Geotechnical Boring

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- Cross Section Location

This Is A Draft Plot
For Visual Representation Only

CUMBERLAND FOSSIL PLANT

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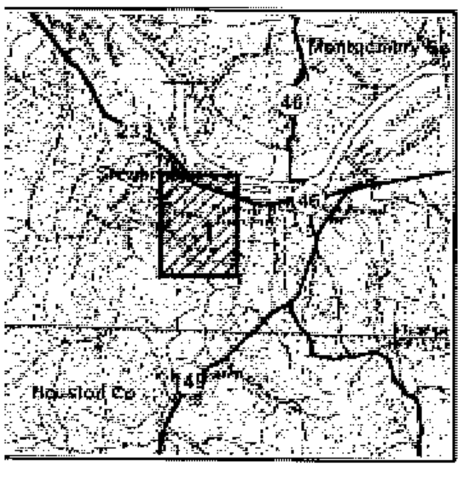
Last Updated: Sep 22, 2009

Sheet 1 of 1



LEGEND

- ◑ Geotechnical Boring (September 2009)
- ● Drainage Feature (September 2009)
- ▨ By-Products Disposal Features

This Is A Draft Plot
For Visual Representation Only

TVA

CUMBERLAND
FOSSIL PLANT
BY-PRODUCTS DISPOSAL
EMBANKMENT STABILITY ANALYSIS
ADDENDUM
SEPTEMBER 2009 PROJECT: PCF555
FILES: PCF555.XYZ, PCF555.XLSX

500 250 0 500
Feet

Last Updated: Sep 22, 2009
Sheet 1 of 1

Attachment 2
Boring Logs (Stantec, 2009a)

Attachment 3
Geotechnical Laboratory Results
(Stantec, 2009a)

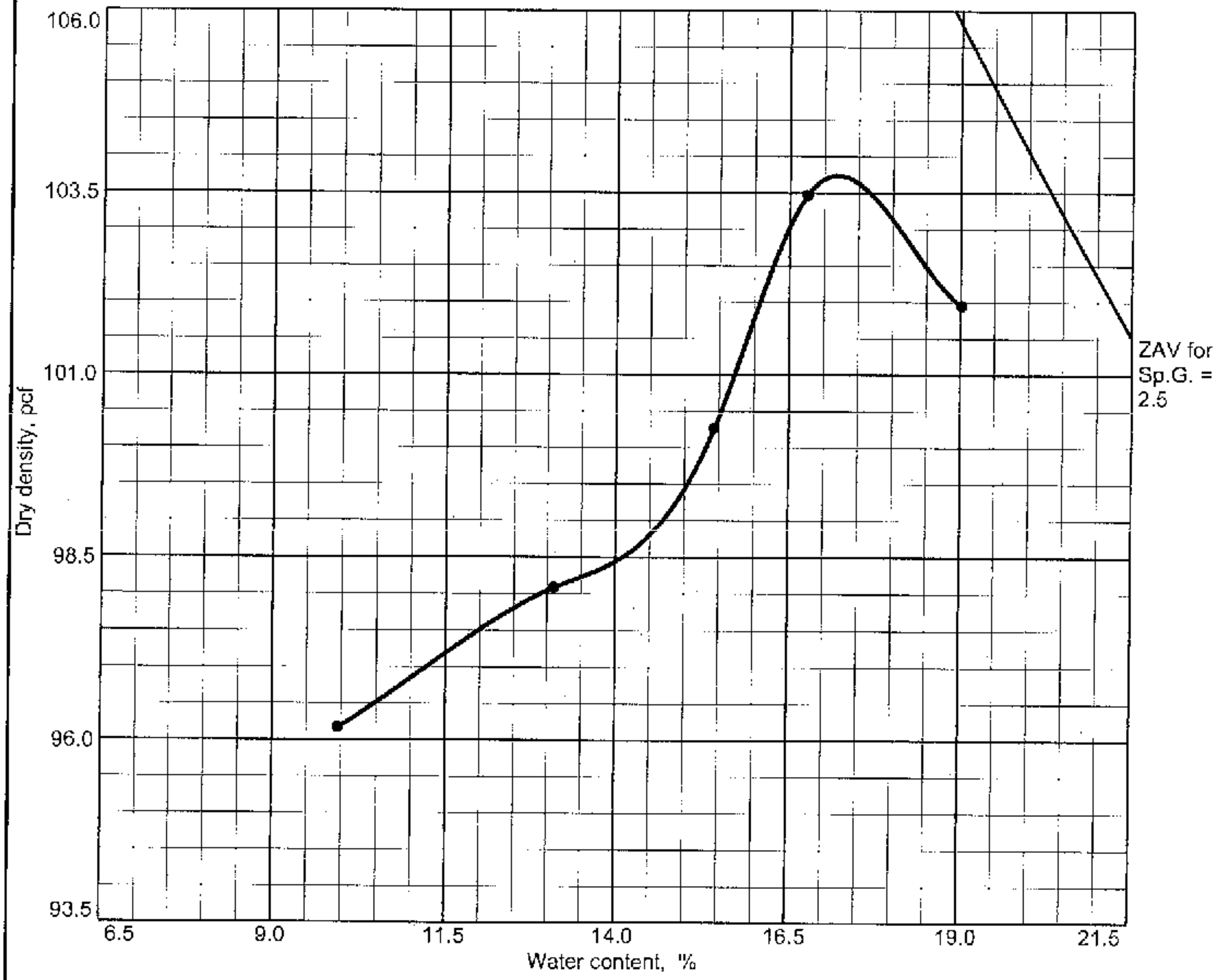
Geotechnical Laboratory Summary

			Shelby Tube Extractions (UC Summary Sheet)			CU Triaxial								Moisture-Density Relationship		Atterberg Limits				Particle Size Analysis (ASTM) (%)									Permeability
Boring	Depth (ft)	Material Type	γ_{w0} (pcf)	w_0 (%)	γ_{d0} (pcf)	G_s	S_{r0} (%)	e_0	γ_{w0} (pcf)	w_0 (%)	γ_{d0} (pcf)	c' (psf)	ϕ' (deg)	γ_{dmax} (pcf)	ω_{opt} (%)	LL	PL	PI	Activity Index	Gravel (3"- 4.75 mm) (> No. 4)	Coarse Sand (4.75-2 mm) (No. 4-No. 10)	Medium Sand (2-0.425 mm) (No. 10-No. 40)	Fine Sand (0.425 - 0.075 mm) (No. 40-No. 200)	Silt (0.075-0.005 mm) (<No. 200)	Clay (<0.005 mm)	USCS	Group Name	AASHTO	Avg. k (20ºC) (cm/s)
B-5	18.0-20.0	Dike 1	119.1	24.3	95.8	2.64	89.3	0.719	119.2	24.3	95.9	320	28.7																
B-5	18.0-20.0	Dike 1	121.5	27.2	95.5	2.64	95.3	0.699	121.5	25.2	97																		
B-9A	25.5-27.5	Dike 1	126.9	24.9	101.6																								
B-21B	59.0-61.0	Dike 1		31.1																									
B-21B	59.0-61.0	Dike 1		22.5																									
B-29A	29.0-31.0	Dike 1	124.3	23.8	100.3	2.7*	94.1	0.646	125.4	22.5	102.4	16.4	36.8																
B-29A	29.0-31.0	Dike 1	125.6	20.1	104.6	2.7*	97	0.595	128.3	21.4	105.7																		
B-63A	5.0-7.0	Dike 1		19.9								1000	17.7																
B-63A	8.0-10.0	Dike 1	125.2	27.1	98.5																								
B-63A	8.0-10.0	Dike 1	126.3	20.4	104.8																								
B-63A	5.0-7.0	Dike 1	120.2	22.1	98.5																								
B-6	24.0-34.5	Dike 1		31.1		2.68										56	20	36	1.57	42.5	6.3	8.5	2.2	15.0	25.5	GC	Clayey gravel with sand	A-7-6 (8)	
B-8	1.5-19.5	Dike 1		15.8		2.64										36	19	17	0.57	1.3	0.8	7.4	4.9	49.0	36.6	CL	Lean clay	A-6 (14)	
B-14	1.5-18.0	Dike 1														44	19	25											
B-26	1.5-13.5	Dike 1														44	17	27											
B-26	15.0-21.0	Dike 1/Alluvial Clay														38	16	22											
B-30	0.0-7.5	Dike 1														46	20	26											
B-30	9.0--16.5	Dike 1														36	19	17											
B-34	0.0-6.0	Dike 1														44	18	26											
B-34	7.5-16.5	Dike 1														36	17	19											
B-3A	8.0-10.0	Dike 2	127.4	19.4	106.7																								
B-3A	14.0-16.0	Dike 2	125.2	25.1	100.1																								
B-3A	14.0-16.0	Dike 2	115.9	28.8	90.0																								
B-9A	3.0-5.0	Dike 2		17.3																									
B-9A	13.0-15.0	Dike 2		21.0																									
B-9B	6.0-8.0	Dike 2	129.6	22.2	106.0																								7.00E-08
B-9B	9.5-11.5	Dike 2	131.4	20.9	108.7																								2.30E-08
B-9B	14.0-16.0	Dike 2		21.7																									
B-21B	15.0-17.0	Dike 2		25.1																									
B-21B	20.0-22.0	Dike 2	128.1	24.6	102.8																								1.80E-08
B-29A	17.0-19.0	Dike 2	123.4	25.8	98.1																								2.20E-08
B-29B	12.0-13.4	Dike 2	124.6	20.0	103.8	2.7*	102.4	0.675	126.4	25.6	100.6	0	36.5																
B-29B	12.0-13.4	Dike 2	131.3	21.4	108.2	2.7*	99.9	0.507	132.8	18.8	111.8																		
B-29B	14.5-16.5	Dike 2	127.5	18.3	107.7	2.7*	98.7	0.466	134.6	17	115																		
B-37A	19.5-21.5	Dike 2	117.1	30.0	90.1																								
B-37A	19.5-21.5	Dike 2		34.9																									
B-37B	8.0-10.0	Dike 2	128.4	22.1	105.2																								
B-37B	11.0-12.4	Dike 2	133.1	18.5	112.3																								
B-37B	11.0-12.4	Dike 2	127.8	18.9	107.5																								1.40E-08
B-6	0.0-10.0	Dike 2		24.3		2.55										55	18	37	0.93	6.0	4.3	7.9	13.9	22.4	45.5	CH	Sandy fat clay	A-7-6 (23)	
B-9	0.0-6.0	Dike 2		20.3		2.70										50	17	33	0.92	8.8	3.1	6.2	13.2	27.7	41.0	CH/CL	Sandy fat clay	A-7-6 (21)	
B-9	9.0-12.0	Dike 2		22.2		2.68										51	19	32	0.78	4.9	2.4	3.8	5.9	34.3	48.7	CH/CL	Fat clay with sand	A-7-6 (27)	
B-12	15.0	Dike 2		21.2		2.77										51	18	33	0.94	10.8	2.6	6.2	7.4	32.0	41.0	CH/CL	Fat clay with sand	A-7-6 (23)	
B-21	0.0-9.0	Dike 2		23.6		2.81										49	18	31	0.97	6.8	3.3	7.1	12.2	33.1	37.5	CL/CH	Lean clay with sand	A-7-6 (21)	
B-21	12.0-18.0	Dike 2		91.1		2.78										56	20	36	0.77	0.7	2.1	6.1	5.5	31.8	53.8	CH	Fat clay	A-7-6 (33)	
B-25	10.5-18.0	Dike 2		21.5		2.54								104.4	18.4	58	22	36	0.72	0.3	1.8	3.9	6.3	30.3	57.4	CH	Fat clay	A-7-6 (34)	
B-29	0.3-10.0	Dike 2		12.6		2.58										46	21	25	0.48	4.4	3.0	7.6	7.7	21.2	56.1	CL	Lean clay with sand	A-7-6 (19)	
B-29	10.4-14.5	Dike 2		24.8		2.57										46	17	29	0.63	8.4	3.5	7.3	7.3	21.9	51.6	CL	Lean clay with sand	A-7-6 (20)	
B-37	6.0-14.5	Dike 2		16.3		2.61								112.0	16.6	53	18	35	0.63	0.6	0.3	2.1	3.2	28.8	65.0	CH	Fat clay	A-7-6 (35)	
B-42	4.5-15.0	Dike 2														44	18	26											
B-19C	17.5-19.5	Dike 3	128.7	12.4	114.5	2.7*	88.8	0.547	128.6	18	109	0	31																
B-19C		Dike 3				2.7*	92.6	0.687	123.5	23.6	99.89																		
B-19C	10.5-12.5	Dike 3	125.9	17.5	107.1	2.7*	89.3	0.633	124.8	20.9	103.2																		
B-19C	15.0-16.0	Dike 3		18.8																									
B-19C	20.0-22.0	Dike 3	127.3	13.8	111.8																								3.20E-08
B-22C	22.0-24.0	Dike 3		27.3																									
B-24C	10.0-11.6	Dike 3		14.7																									
B-28A	8.0-9.5	Dike 3		18.6																									
B-28C	14.5-16.5	Dike 3	121.9	20.0	101.6																								
B-36A	13.0-14.6	Dike 3	128.7	14.9	112.0																								
B-36B	10.8-12.8	Dike 3		20.8																									
B-36B	13.0-13.7	Dike 3		12.7																									
B-36B	19.0-21.0	Dike 3	123.3	29.7	95.1																								
B-43A	20.0-22.0	Dike 3		27.3																									
B-19	7.5-25.5	Dike 3		19.8		2.78										48	19	29	1.32	26.2	6.6	9.4	8.8	22.5	26.5	GC	Clayey gravel with sand	A-7-6 (10)	
B-22	6.0-13.5, …	Dike 3		14.3		2.72										36	18	18	1.38	44.6	6.7	10.1	6.4	15.5	16.7	GC	Clayey gravel with sand	A-2-6 (1)	
B-24	4.5-22.5	Dike 3		16.4		2.51										39	19	20	1.05	30.2	7.5	10.1	7.3	21.5	23.4	GC	Clayey gravel with sand	A-6 (5)	
B-28	1.5-15.0	Dike 3		6.5		2.66								124.3	11.0	36	17	19	0.63	23.2	7.9	12.7	8.7	11.7	35.8	SC	Clayey sand with gravel	A-6 (5)	
B-32	1.5-16.5	Dike 3		16.0		2.63										40	17	23	1.15	32.8	6.7	9.1	6.9	20.1	24.4	GC	Clayey gravel with sand	A-6 (6)	
B-5	20.0-22.0	Alluvial Clay		25.2																									
B-15B	46.0-48.0	Alluvial Clay	120.3	26.5	95.1																								2.30E-08
B-15B	46.0-48.0	Alluvial Clay	121.4	26.9	95.6																								
B-29A	50.0-52.0	Alluvial Clay	110.0	33.1	82.7																								6.60E-09
B-29A	50.0-52.0	Alluvial Clay	112.9	30.3	86.6																								
B-43A	47.0-49.0	Alluvial Clay	128.0	20.2	106.4																								
B-43A	50.0-52.0	Alluvial Clay	123.7	25.6	98.5	2.67	98.6	0.657	125.0	24.3	100.6	440	30.3																
B-43A	50.0-52.0	Alluvial Clay	125.0	24.2	100.6	2.67	96.9	0.677	123.9	24.6	99.4																		

Geotechnical Laboratory Summary

			Extractions (UC Summary Sheet)			CU Triaxial								Moisture-Density Relationship		Atterberg Limits				Particle Size Analysis (ASTM) (%)									Permeability
Boring	**Depth (ft)**	**Material Type**	**γ_{w0} (pcf)**	**w_0 (%)**	**γ_{d0} (pcf)**	**G_s**	**S_{r0} (%)**	**e_0**	**γ_{w0} (pcf)**	**w_0 (%)**	**γ_{d0} (pcf)**	**c' (psf)**	**ϕ' (deg)**	**γ_{dmax} (pcf)**	**ω_{opt} (%)**	**LL**	**PL**	**PI**	**Activity Index**	**Gravel** *(3"- 4.75 mm) (> No. 4)*	**Coarse Sand** *(4.75-2 mm) (No. 4-No. 10)*	**Medium Sand** *(2-0.425 mm) (No. 10-No. 40)*	**Fine Sand** *(0.425 - 0.075 mm) (No. 40-No. 200)*	**Silt** *(0.075-0.005 mm) (<No. 200)*	**Clay** *(<0.005 mm)*	**USCS**	**Group Name**	**AASHTO**	**Avg. k (20ºC) (cm/s)**
B-2	55.0-69.0	Alluvial Clay		26.9		2.56										36	20	16	0.62	0.0	0.0	1.3	3.6	59.3	35.8	CL	Lean clay	A-6 (16)	
B-4	43.5-56.5	Alluvial Clay		27.2		2.53										40	21	19	0.59	0.0	0.0	4.4	3.5	47.7	44.4	CL	Lean clay	A-6 (18)	
B-6	36.0-44.0	Alluvial Clay		26.5		2.55										37	18	19	0.66	1.9	0.3	4.1	3.6	53.8	36.3	CL	Lean clay	A-6 (17)	
B-11	15.0-36.0	Alluvial Clay		20.8		2.66										41	24	17	0.5	4.5	0.5	2.2	3.1	47.8	41.9	CL	Lean clay	A-7-6 (17)	
B-12	35.0-46.5	Alluvial Clay		25.5		2.64										40	19	21	0.62	3.7	1.3	2.8	3.4	42.8	46.0	CL	Lean clay	A-6 (19)	
B-33	30.0-39.0	Alluvial Clay		22.8		2.62										35	23	12	0.57	8.0	1.7	4.9	10.7	46.7	28.0	CL	Lean clay with sand	A-6 (8)	
B-42	21.0-34.0	Alluvial Clay														49	18	31											
B-12	60.0-69.0	Alluvial Granular		19.8		2.62											NP		N/A	45.6	10.2	12.7	10.1	14.3	7.1	GM	Silty gravel with sand	A-1-b (0)	
B-14	40.0-49.0	Alluvial Granular		23.4		2.70											NP		N/A	18.8	8.6	36.9	18.9	12.2	4.6	SM	Silty sand with gravel	A-1-b (0)	
B-14	52.5-64.0	Alluvial Granular		21.0		2.70											NP		N/A	53.0	8.6	15.7	6.4	9.1	7.2	GM	Silty gravel with sand	A-1-b (0)	
B-22	75.0-89.0	Alluvial Granular		21.9		2.66											NP		N/A	54.2	15.4	15.5	5.1	5.7	4.1	GP-GC	Poorly graded clayey gravel	A-1-a (0)	
B-17A	32.0-34.0	Fly Ash (Sluiced)		30.9																									
B-17A	32.0-34.0	Fly Ash (Sluiced)	106.2	27.4	83.4																								7.00E-07
B-17A	70.0-72.0	Fly Ash (Sluiced)	104.1	41.1	73.8																								6.50E-07
B-28	52.0-54.0	Fly Ash (Sluiced)	97.4	57.1	62.0																								
B-28A	50.0-52.0	Fly Ash (Sluiced)	100.7	41.4	71.2																								
B-28A	52.0-54.0	Fly Ash (Sluiced)	101.9	52.3	66.9																								
B-35A	37.0-38.0	Fly Ash (Sluiced)		47.5																									
B-36A	24.0-26.0	Fly Ash (Sluiced)		45.1																									
B-36A	44.0-46.0	Fly Ash (Sluiced)	102.8	40.5	73.2																								6.60E-07
B-37A	24.0-26.0	Fly Ash (Sluiced)		53.2																									
B-43A	29.0-31.0	Fly Ash (Sluiced)	104.6	32.0	79.3	2.47	97.5	1.134	104.5	44.8	72.2	0	39.6																
B-43A	29.0-31.0	Fly Ash (Sluiced)	100.6	39.7	72.0	2.47	94	1.262	100.9	48	68.2																		
B-35A	46.0-48.0	Fly Ash (Sluiced)	104.8	46.0	71.8	2.47	100.2	1.174	104.6	47.6	70.9																		
B-18	15.0-34.5	Fly Ash (Sluiced)		37.2		2.58											NP		N/A	4.8	0.1	4.5	16.6	61.0	13.0	ML	Silt with sand	A-4 (0)	
B-19	28.5-49.0	Fly Ash (Sluiced)		30.3		2.46											NP		N/A	2.0	0.8	5.8	11.4	68.3	11.7	ML	Silt with sand	A-4 (0)	
B-24	27.0-51.5	Fly Ash (Sluiced)		44.8		2.44											NP		N/A	0.2	0.1	7.1	14.6	64.3	13.7	ML	Silt with sand	A-4 (0)	
B-32	20.0-49.0	Fly Ash (Sluiced)		34.6		2.52											NP		N/A	2.6	1.3	9.9	6.9	69.7	9.6	ML	Silt with sand	A-4 (0)	
B-37	7.5-21.0	Fly Ash (Sluiced)		23.1		2.62										45	18	27	0.71	2.6	2.0	4.3	4.7	41.1	45.3	CL	Lean clay	A-7-6 (24)	
B-4	1.5-31.5	Fly Ash (Sluiced)		40.7		2.42											NP		N/A	2.4	3.1	14.6	7.4	58.6	13.9	ML	Silt with sand	A-4 (0)	
B-41	24.0-34.5	Fly Ash (Sluiced)		26.2		2.52											NP		N/A	0.3	0.8	15.2	16.4	42.9	24.4	ML	Sandy silt	A-4 (0)	
B-45	25.0-39.6	Fly Ash (Sluiced)		35.7		2.71											NP		N/A	8.3	9.4	17.0	23.4	25.3	16.6	SM	Silty sand	A-4 (0)	
B-17A	50.0-52.0	BA-FA (Sluiced)		20.0																									
B-21B	25.0-27.0	BA-FA (Sluiced)		16.3																									
B-21B	48.0-50.0	BA-FA (Sluiced)	125.0	25.2	99.8																								
B-24C	3.5-4.8	BA-FA (Sluiced)		15.6																									
B-2	4.5-39.0	BA-FA (Sluiced)		25.9		2.62											NP		N/A	15.0	11.8	21.4	17.9	30.0	3.9	SM	Silty sand with gravel	A-2-4 (0)	
B-18	0.0-7.5	BA-FA (Sluiced)		14.4		2.61											NP		N/A	8.9	8.4	25.1	18.1	32.4	7.1	SM	Silty sand	A-4 (0)	
B-21	18.0-30.0	BA-FA (Sluiced)		22.9		2.61											NP		N/A	20.6	16.5	28.4	17.9	12.8	3.8	SM	Silty sand with gravel	A-1-b (0)	
B-22	28.5-49.5	BA-FA (Sluiced)		33.6		2.55											NP		N/A	7.6	5.4	14.3	16.7	46.5	9.5	ML	Sandy silt	A-4 (0)	
B-41	0.1-2.1	Gypsum		7.2																									
B-20	0.0-15.0	Gypsum		15.7		2.31											NP		N/A	0.0	0.0	6.4	6.5	83.2	3.9	ML	Silt	A-4 (0)	
B-35	1.5-22.5	Gypsum		10.6		2.94											NP		N/A	0.4	0.1	11.1	7.2	76.1	5.1	ML	Silt with sand	A-4 (0)	
B-41	0.0-12.9	Gypsum		22.1		2.31											NP		N/A	0.0	0.2	2.0	6.2	67.5	24.1	ML	Silt	A-4 (0)	
B-45	3.0-9.0	Gypsum		16.1		2.36											NP		N/A	0.2	0.1	2.0	5.4	70.8	21.5	ML	Silt	A-4 (0)	
	Gypsum Bulk	Gypsum				2.75*								86.3	35.1														8.10E-08
	Gypsum Rejects Bulk	Gypsum Rejects				2.73								86.2	35.2	33	32	1		0.0	7.4			86.1	6.5	ML		A-4 (0)	5.30E-07
	Gypsum Rejects Bulk	Gypsum Rejects				2.7*	72.6	1.08	104.5	29.1	80.97	90.9	42.5																
						2.5*	76.2	0.947	103.3	28.9	80.17																		
						2.7*	72	1.1	103.9	29.2	80.41																		
	Gypsum Rejects Bulk	Gypsum Rejects				2.7*	67.4	1.09	102.7	27.2	80.71	0.0	44																
						2.7*	66.9	1.09	102.5	26.9	80.79																		
						2.7*	66.8	1.09	102.5	26.9	80.75																		
	Bottom Ash Bulk	Bottom Ash				2.5*								103.7	17.2														2.30E-06
	Bottom Ash Bulk	Bottom Ash				2.7*	48.3	0.923	102.1	16.5	87.66	0	44																
						2.5*	53.8	0.782	102.3	16.8	87.57																		
						2.7*	47.5	0.913	102.3	16.1	88.12																		
	Bottom Ash Bulk	Bottom Ash				2.7*	48.3	0.923	102.1	16.5	87.66	261	41																
						2.7*	47.5	0.913	102.3	16.1	88.12																		
	Fly Ash Bulk	Fly Ash				2.5*								83.6	32.7														4.20E-07
	Fly Ash Bulk					2.5*	61.2	1.37	87.8	33.6	65.75	14.3	36																
						2.5*	62	1.36	88.4	33.8	66.09																		
						2.5*	63.3	1.36	89.0	34.4	66.21																		
						* G_s is assumed.																							

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method C Standard
Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
				2.5				

TEST RESULTS

Maximum dry density = 103.7 pcf

Optimum moisture = 17.2 %

MATERIAL DESCRIPTION

Project No. GTX-1484 **Client:** STANTEC

Project: Cumberland Fossil Plant (Ash and Gypsum Stacks)

● **Source:** **Sample No.:** Bottom Ash

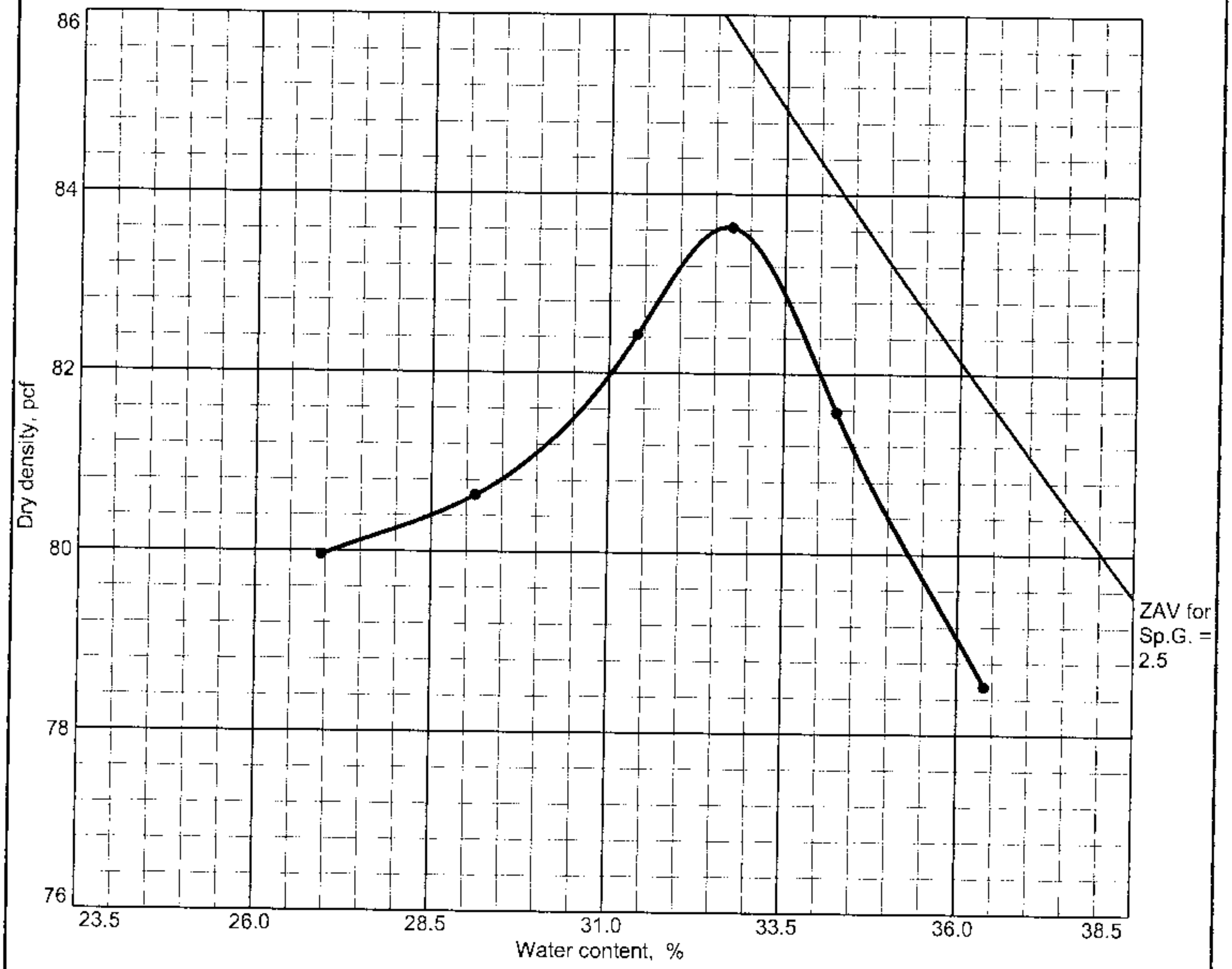
Remarks:

COMPACTION TEST REPORT

GeoTesting Express Inc.

Lab no.

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
				2.5			0.0	

TEST RESULTS

Maximum dry density = 83.6 pcf

Optimum moisture = 32.7 %

MATERIAL DESCRIPTION

Project No. GTX-1484 **Client:** STANTEC

Project: Cumberland Fossil Plant (Ash and Gypsum Stacks)

● **Source:** **Sample No.:** FLY ASH (BULK)

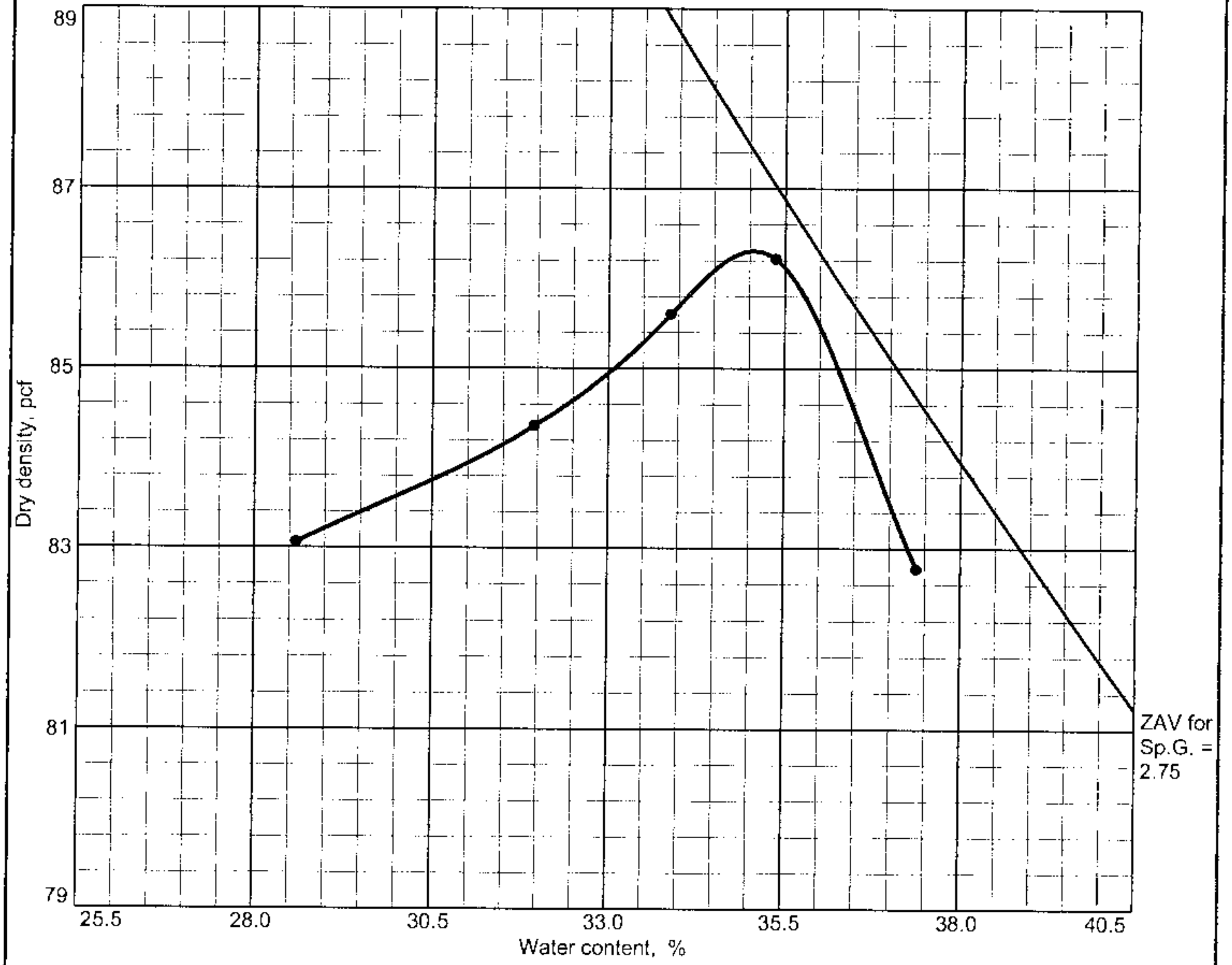
Remarks:

COMPACTION TEST REPORT

GeoTesting Express Inc.

Lab no.

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
				2.75				

TEST RESULTS

Maximum dry density = 86.3 pcf

Optimum moisture = 35.1 %

MATERIAL DESCRIPTION

Project No. GTX-1484 **Client:** STANTEC

Project: Cumberland Fossil Plant (Ash and Gypsum Stacks)

● **Source:** **Sample No.:** Gypsum Bulk

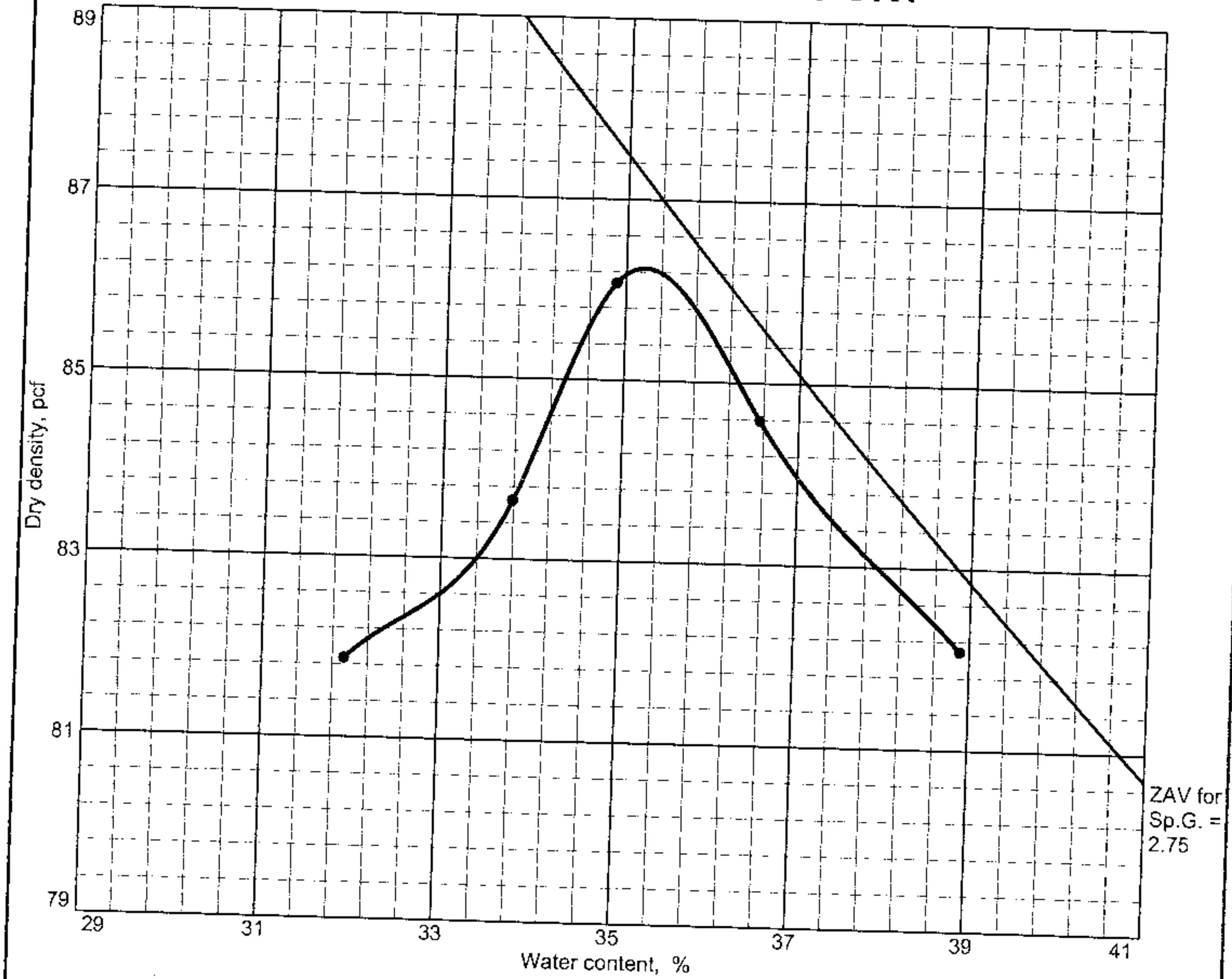
Remarks:

COMPACTION TEST REPORT

GeoTesting Express Inc.

Lab no.

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	ML	A-4(0)		2.75	33	1	0.0	92.6

TEST RESULTS

Maximum dry density = 86.2 pcf

Optimum moisture = 35.2 %

MATERIAL DESCRIPTION

Project No. GTX-1484 **Client:** STANTEC

Project: Cumberland Fossil Plant (Ash and Gypsum Stacks)

● **Source:** **Sample No.:** Gypsum Rejects

Remarks:

COMPACTION TEST REPORT

GeoTesting Express Inc.

Lab no.

Attachment 4
Referenced Historical Data

Hall, Blake and Associates, Inc. (1986)

CUMBERLAND S.P.

1 57

B41 '87 0401 002

12-2-86

RECOMMENDED SOIL PARAMETERS

SOIL DESCRIPTION	[illegible] γ (PCF)	WEIGHT γ (PCF)	[illegible] c	[illegible]	[illegible]	[illegible]
RAISED DIKE FILL (EARTH FILL)	121	124	0.1	5	0	25
ORIGINAL DIKE FILL (EARTH FILL)	125	126	0.25	20	[illegible]	25
SOFT LAYER	119	121	0.2	11	0	18
FOUNDATION CLAY	125	126	0.2	20	0	28
ASH (COMPACTED)	102	124	0.75	24	0	34
BORROW AREA W 95%	[illegible]	126	0.25	21	0	25
BORROW AREA W 99%	125	128	0.6	22	0	30
BORROW AREA E (95%)	119	125	0.6	20	0.2	28
BORROW AREA E (95%)	123	127	0.2	25	0.0	30

Tennessee Valley Authority (1986)

SHEET *ii* OF

Preliminary
JMH 11-4-86

COMPUTED [illegible] DATE ~~[illegible]~~

Preliminary

CHECKED [illegible] DATE ~~[illegible]~~

send FEP 11-4-86

PRELIMINARY

RECOMMENDED SOIL PROPERTIES

SOIL IDENTIFICATION PRELIMINARY	UNIT WEIGHT γ_{MOIST} (PCF)	γ_{SAT} (PCF)	γ_{SUB} (PCF)	R-TRIAXIAL TEST APPARENT C (TSF)	ϕ (DEG)	EFFECTIVE $\bar{c}$ (TSF)	ϕ (DEG)
RAISED DIKE FILL	121 ✓ ~~120~~	124 ~~126~~	62 ✓ ~~63~~	✓✓ 0.1	✓✓ 15	✓✓ 0	✓✓ 25
FILL-EXISTING DIKE	125 ✓ ~~127~~	126 ✓ ~~124~~	63 ✓ 62	0.25 ✓ ~~0.2~~	20 ✓ ~~[illegible]~~	✓✓ 0	✓✓ 25
SOFT LAYER	119 ✓ ~~120~~	✓✓ 121	58 ✓ ~~59~~	0.3 ✓ ~~[illegible]~~	11 ✓ ~~10~~	0 ✓ ~~0~~	18 ✓ ~~20~~
FOUNDATION	125 ~~122~~	126 ~~123~~	63 ~~[illegible]~~	0.2 ✓ ~~0.5~~	20 ✓ ~~15~~	0 ~~0~~	24 ~~[illegible]~~ ~~[illegible]~~
ASH (BOTTOM ASH) COMPACTED	✓ 108	✓ 124	✓ 62	0.75	24	✓ 0	✓ 34

PRELIMINARY

pl. reevaluate considering negative pore pressure developed during testing & using the effective stress ratio criteria.

Conc. from re-evaluation $\frac{SBA}{4/25/86}$

BORROW AREA W

95% $\gamma_m = 121^{PCF}$ $\gamma_{SAT} = 126^{PCF}$

$R - \phi = 21^\circ$

$c = 0.15^{TSF}$

CUMBERLAND STEAM PLANT

UNDISTURBED SAMPLES

SUMMARY OF LABORATORY TEST DATA

			Atterb. Limits				Saturated Triaxial R			
							Apparent		Effective	
Elevation depth	Soil Symbol	Nat. Moist %	Liq. Limit %	Plastic Index %	Dry Dens. pcf	Vane Shear tsf	φ deg	c ksf	φ deg	c ksf
Boring 1										
10.0-12.0	CH	21.0	52	29	103.7	0.95	28.0	0.42	27.5	0.17
26-0.28.0	CL	25.3	38	20	100.0	100+	25.0	0.85	33.6	0.0
Boring 2										
24.0-26.0	CH	31.4	54	37	93.8	0.25	28.3	1.0	34.3	0.15
26.0-28.0	CL	23.3	45	24	103.7	0.30	11.1	2.64	22.8	0.57
30.0-32.0	CL	25.3	39	20	99.4	0.35	14.5	0.56	14.4	0.59
Boring 4										
5.0-7.0		29.7	47	28	91.4	1.00+				
Boring 5										
10.0-12.0	CL	24.0	39	18	100.2	0.67	32.1	0.97	30.9	0.94
17.0-19.0	CL	24.4	40	21	95.1	0.60	17.3	1.51	24.8	0.22
Boring 8										
20.0-22.0	CL	25.6	46	23	98.4	1.00+	11.9	1.12	11.0	0.98
28.0-30.0	CH	22.1	30	11	103.6	0.15	17.7	0.10	19.5	0.0
Boring 10										
4.0-6.0		19.4	52	32	99.3	1.00+				

CH = INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
CL = INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY,
GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS,
LEAN CLAYS.

TVA 489E (EN DES-12-76)

TENNESSEE VALLEY AUTHORITY

SHEET OF

SUBJECT ASH POND DIKE - Recommended Engg Properties for Slope Stability Analysis

PROJECT CUMBERLAND STEAM PLANT

COMPUTED BY AMK DATE 12-11-86 CHECKED BY SBA DATE 12-12-86

SOIL IDENTIFICATION	UNIT WEIGHT (pcf)			SHEAR STRENGTH						REMARKS
				Q		R		$\bar{R}$		
	γ moist	γ sat	γ sub	c (tsf)	φ (deg)	c (tsf)	φ (deg)	$\bar{c}$ (tsf)	$\bar{\phi}$ (deg)	
Raised Dike Embankment- Earthfill	121	124				0.10	15	0	25	
Original Dike Embankment- Earthfill	125	126				0.25	18	0	25	
Bottom Ash	108	124				0.75	24	0	34	
In situ Foundation Soft layer	119	121				0.20	11	0	19	
In situ Foundation Stiff-Hard Soils	125	126				0.25	20	0	28	
Borrow Soil- Area W 95% Compaction	121	126				0.25	18	0	25	Compacted to 95% Std. Max. Dry Density at opt. Moist ± 2%
Borrow Soil- Area W 98% Compaction	125	128				0.40	18	0	30	Compacted to 98% Std. Max. Dry Density at opt. moist ± 2%
Borrow Soil- Area E 95% Compaction	119	125				0.30	15	0	25	Compacted to 95% Std. max. Dry Density at opt. moist ± 2%
Borrow Soil- Area E 98% Compaction	123	127				0.40	17	0	30	Compacted to 98% Std. Max. Dry Density at opt. moist ± 2% .

TVA 489 (EN DES-3-77)

SHEET ____ OF ____

COMPUTED ____ DATE ____

CHECKED ____ DATE ____

Boring No. 1

Sample depth: [illegible] — Original dike fill N=13-17

ϕ = [illegible] max, 25.5° min.

Sample depth: 26'-28' — Soft foundation area N= [illegible]

ϕ = 28° max; 24.5° Min

Boring No. 2

Sample depth: 24'-26' — Soft foundation area, N = 7

ϕ = 34.5° Max Seems high but 2 tests @ this value

[illegible] ϕ = 19° Min Mohrs Circle appears there may be an error in plotting

Sample depth: 28'-30' — Soft foundation area N = 9

ϕ = 27° Max, 24.5° Min. Good general agreement between circles

Sample depth: [illegible] — Soft foundation area N = 5

ϕ = 21° Max, 17° Min [illegible] agreement between circles

Boring No. 5

Sample depth: [illegible] — Original dike fill, N = 12-13

ϕ = 42° Max — Seems high, one circle

ϕ = 21° Min — Two circles good agreement

Sample depth: [illegible] — Bottom of dike fill & top of Fdn. matl. N=7-8

ϕ = 29° Max other circle shows 27°

ϕ = 18° Min

Boring No. 8

Sample depth: 20'-22' — Bottom of dike fill & top of Fdn. N=9

ϕ = 34° Max, 15° Min; Very poor circle agreement, one circle [illegible]

Sample depth: 28'-30' — Soft foundation area, N = 4

ϕ = 18° Max (2 circles), 10° Min (the circles in poor agreement)

TVA 488 (EN DES-5-77)

SHEET ______ OF ______

COMPUTED ______ DATE ______

CHECKED ______ DATE ______

1. Strength parameters used by LAW are consistently higher than those recommended earlier by the old Geotech group. LAW states that a trend was noted (pg. 8) in the relationship between c & φ enabling them to determine likely combinations of c & φ from the Hull-Blake data. They do not expound on what this trend is for TVA to agree or disagree with its validity.

2. LAW conducted only one triaxial test and one direct shear test on remolded dike material (?) from an undisclosed location. There was a large disparity in the results of these tests.

3. Strength parameters for foundation materials were estimated based on SPT-N values, results of tests noted in (2) above and their experience.

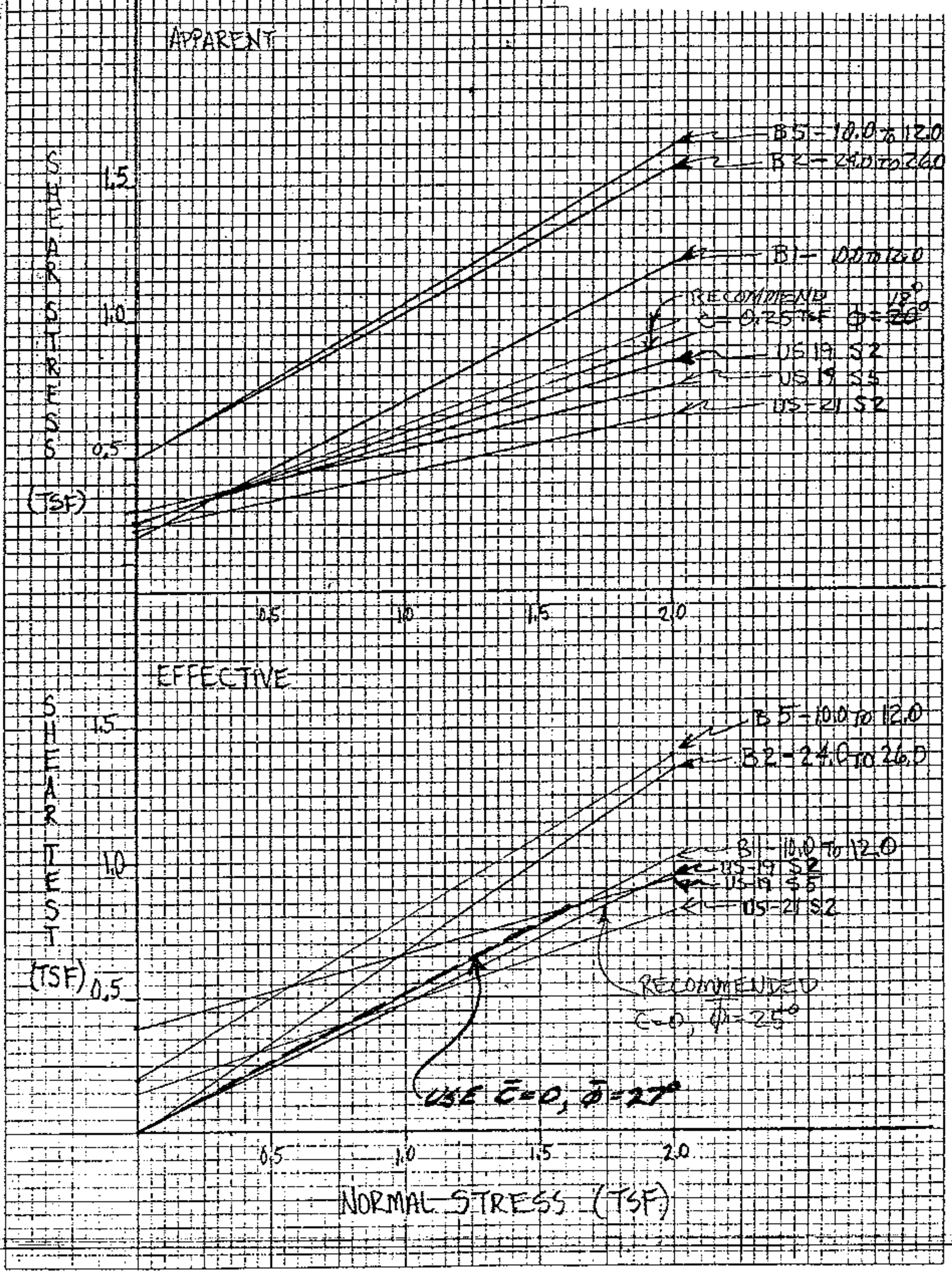
4. Some of LAWS analyses are based on a lowered phreatic surface. Is this economically feasible? We cannot extend drainage pipes thru dike as shown in Figure 10.

5. Soft foundation soils in some areas noted in Hull-Blake report is not addressed in LAW's report.

COMPUTED JMH date 11-18-86 CHECKED SGA DATE 12-8-86

CUMBERLAND S.P. TRIAXIAL R TEST

EARTH FILL + ORIGINAL DIKE

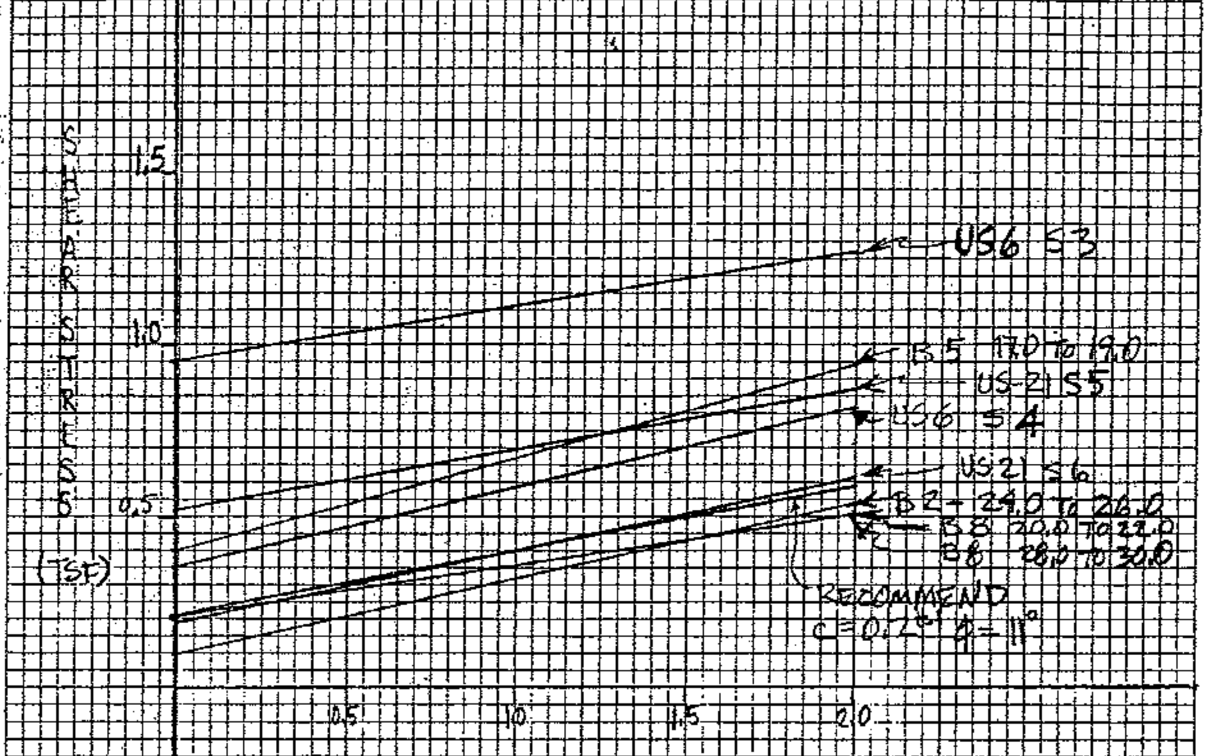


COMPUTED JMPH date 11-18-86 checked SEA date 12-8-86

COMBERLAND S.P. TRIAXIAL R TEST

SOFT LAYER

APPARENT



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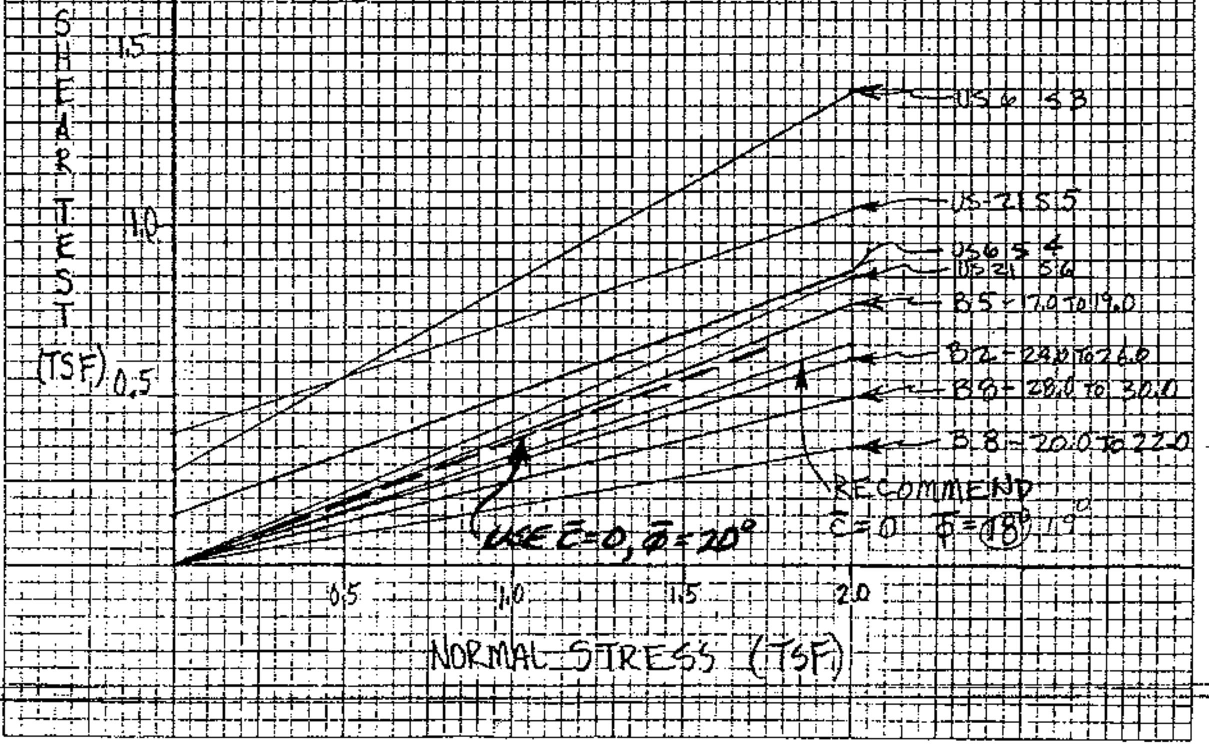

TVA 10697 (DNE-6-86)

DNE CALCULATIONS

Revised at
Revision 0

NEP-3.1
ATTACHMENT 2
PAGE 1 OF 1

TITLE CUMBERLAND S.P. - SOIL EVALUATION - ASH POND DIKE	PLANT/UNIT CUMBERLAND S.P.
PREPARING ORGANIZATION GES - CEB	KEY NOUNS (Consult RIMS DESCRIPTORS LIST) DIKES, SOIL, SLOPE, STABILITY

QA Record

BRANCH/PROJECT IDENTIFIERS

Each time these calculations are issued, preparers must ensure that the original (RO) RIMS accession number is filled in.

Rev	(for RIMS' use)	RIMS accession number
R0	870413A0004 (73)	B41 870401 002
R _		
R _		
R _		

APPLICABLE DESIGN DOCUMENT(S)
DG-C1.4.2

SAR SECTION(S)	UNID SYSTEM(S)
NA	NA

Revision 0	R1	R2	R3
ECN No. (or indicate Not Applicable) NA			
Prepared James M Hoskins			
Checked Syed B Ahmed			
Reviewed Carl [illegible]			
Approved Samuel D. Stone, Jr.			
Date 3-13-87			
List all pages added by this revision.			
List all pages deleted by this revision.			
List all pages changed by this revision.			

Use form TVA 01534 if more space required.

Safety-related? Yes ☐ No ☑

Statement of Problem

A SOIL EVALUATION IS REQUIRED FOR A SLOPE STABILITY ANALYSIS.

Abstract

These calculations contain an unverified assumption(s) that must be verified later. Yes ☐ No ☑

A SOIL EVALUATION HAS DETERMINED THE SOIL PROPERTIES AND THE CROSS SECTIONS FOR A SLOPE STABILITY ANALYSIS FROM SOIL INVESTIGATIONS BY TVA (C5B 78 1121 107) AND HALL, BLAKE AND ASSOCIATES, INC. (B46 861120 010).

☐ Microfilm and store calculations in RIMS Service Center.
Microfilm and destroy. ☐
☑ Microfilm and return calculations to: J. M. HOSKINS
Address: 157 LB-K

cc: RIMS, SL 26 C-K

[illegible] date 11-19-86 checked date

CUMBERLAND STEAM PLANT (HBA)
BORING 2 24.0-26.0

SOFT LAYER

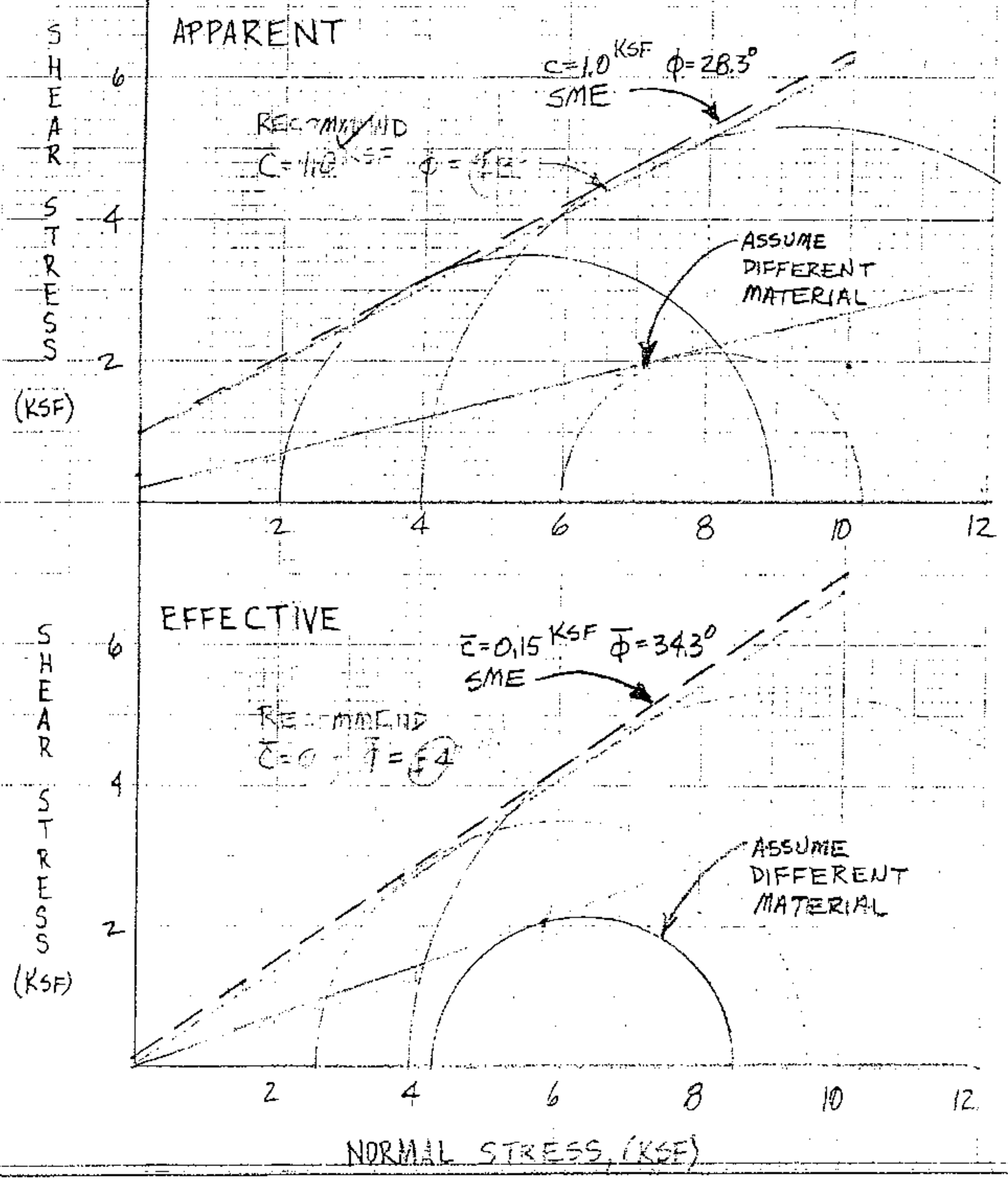

TABLE OF CONTENTS

APPENDIX

CUMBERLAND S.P.

VMR 12-2-86

RECOMMENDED SOIL PROPERTIES

SOIL DESCRIPTION	[illegible] γ (PCF)	[illegible] γ (PCF)	[illegible] c	φ	[illegible] c̄	φ̄
RAISED DIKE FILL (EARTH FILL)	121	124	0.1	5	0	25
ORIGINAL DIKE FILL (EARTH FILL)	125	126	0.25	20	0	25
SOFT LAYER	119	121	0.2	11	0	18
FOUNDATION CLAY	125	126	0.2	20	0	28
SOIL (COMPACTED)	102	124	0.75	24	0	34
BORROW AREA W 95%	[illegible]	126	0.25	21	0	25
BORROW AREA W 98%	125	128	0.6	22	0	30
BORROW AREA E (95%)	119	125	0.6	20	0.2	28
BORROW AREA E (98%)	123	127	0.2	25	0.0	30

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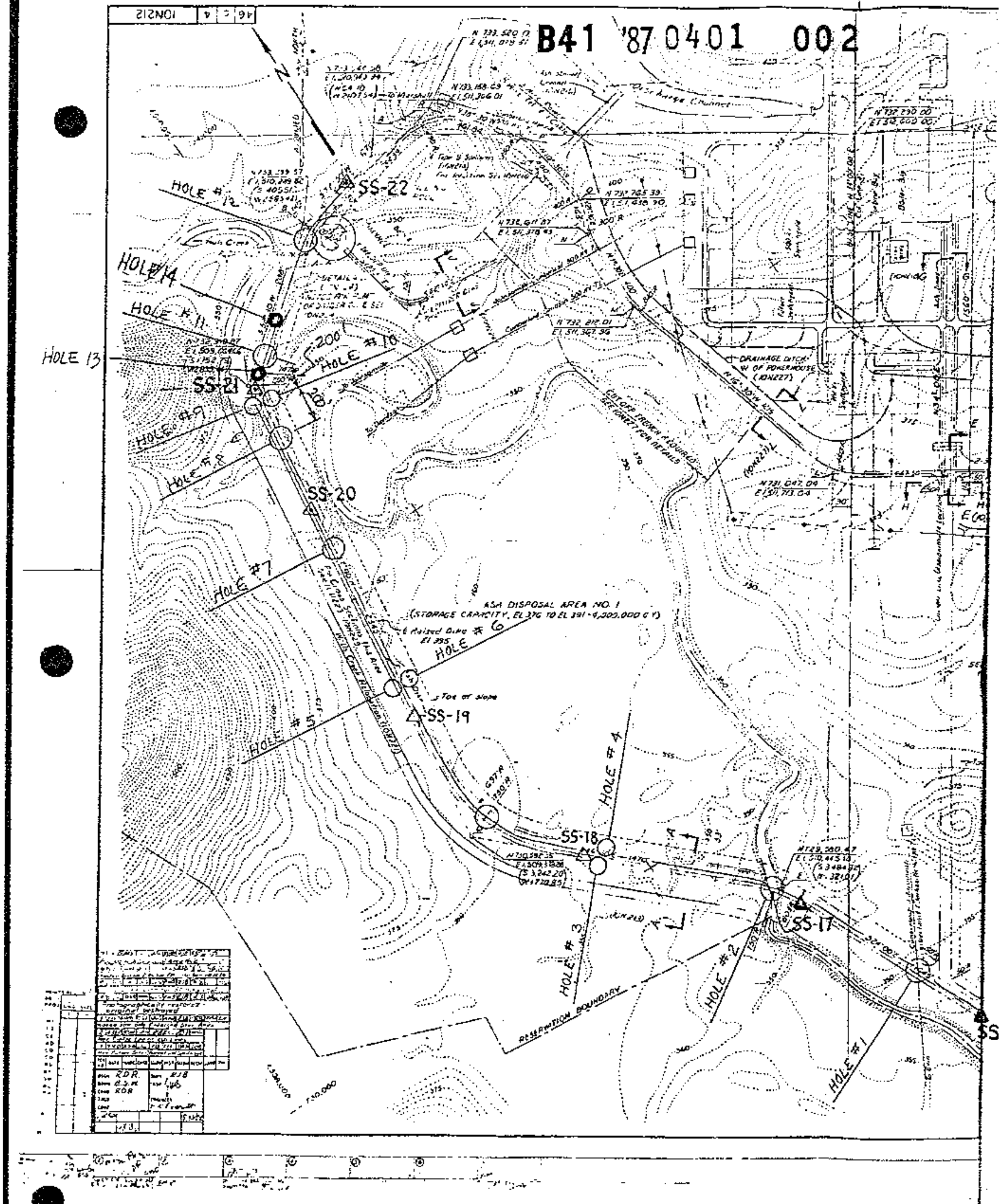

LEGEND:

△ TVA SPLIT SPOON BORING (CSB 781121 107 - MED 811201 224)

○ HALL, BLAKE AND ASSOCIATES (B46 861120 010)

CUMBERLAND S.P.

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11-19-86

REF. 1. HALL, BLAKE AND ASSOCIATES, INC. - SITE INVESTIGATION - PROPOSED CUMBERLAND FOSSIL PLANT SOILS INVESTIGATION FOR ASH POND DIKE AND BORROW AREAS, DATED OCT. 3, 1986
(B46 861120 010)

REF 2. CUMBERLAND ASH DISPOSAL AREA DIKE RAISING - SOIL EXPLORATION AND TESTING - EN DES SOIL SCHEDULE No. 70.1 (MED 811201 234)

RAISED DIKE FILL

FROM REF. 2 EVALUATION $C = 0.1^{TSF}$ $\phi = 15°$ R-APPARENT
$\bar{C} = 0^{TSF}$ $\bar{\phi} = 25°$ $\bar{R}$-EFFECTIVE

UNIT WEIGHT
$\gamma_{MOIST} = 123$; $\gamma_{SAT} = 126$; γ_{B} [illegible]

FROM REF 1 ([illegible])

BORING 4, 5'-[illegible] $\gamma_d = 91.4^{PCF}$, MC = [illegible]% [illegible]
$G = 2.69$
BORING 10, 1'-6', $\gamma_d = 99.3^{PCF}$, MC = 19.4 $G = 2.66$

AVG $\gamma_d = 95.35$ MC = 24.[illegible] G = 2.675

$\gamma_m = 118.8^{PCF}$; $\gamma_{SAT} = 122.1^{PCF}$; $\gamma_{SUB} = 59.7^{PCF}$

USE THE AVERAGE OF REF. 1 AND REF. 2

$\gamma_{MOIST} = \frac{122.6 + 118.8}{2} = 120.7$ USE $\underline{121^{PCF}}$

$\gamma_{SAT} = \frac{125.8 + 122.1}{2} = 123.95$ USE $\underline{124^{PCF}}$

$\gamma_{SUB} = 61.55$ USE $\gamma_{SUB} = 62^{PCF}$

CUMBERLAND S.P.
SOIL EVALUATION

8 57
B41 '87 0401 002
JMcH 11-19-86

RAISED DIKE FILL

TRIAXIAL SHEAR TEST ON THE RAISED DIKE FILL WERE NOT PERFORMED BY HALL, BLAKE, AND ASSOCIATES

APPENDIX B

USE PREVIOUS VALUES FROM REMOLDED SAMPLES IN ENDES SOIL SCHEDULE No. 721 (MED 811201 224)

$\gamma_{MOIST} = 123^{PCF}$; $\gamma_{SAT} = 126^{PCF}$; $\gamma_{SUB} = 63^{PCF}$

R-APPARENT $c = 0.1^{TSF}$; $\phi = 15°$

$\bar{R}$-EFFECTIVE $c = 0^{TSF}$; $\phi =$ [illegible]°

COMPUTATION S.F

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11-19-86

FILL EXISTING DIKE (ORIGINAL)

$e = \frac{G\gamma_W}{\gamma_d} - 1$

	γ_{Dry} (PCF)	M.C. (%)	G	e
TUA US-6 SAMPLE 1	100.9	28.8	-	0.702
" US-6 SAMPLE 2	102.9	22.2	-	0.657
" US-19 SAMPLE 1	100.4	24.4	-	0.697
" US-19 " 2	100.7	25.0	-	0.705
" US-19 " 3	93.5	28.5	-	0.793
" US-19 " 4	94.4	27.4	-	0.791
" US-21 " 2	100.9	24.5	-	0.707
" US-21 " 3	92.3	32.2	-	0.830
TUA US-21 " 4	105.4	20.6	-	0.617
11BA SAMPLE 1 10.0-12.0	103.7	21.0	2.71	0.631
11BA BORING 2 34.0-36.0	93.8	31.4	2.70	0.796
11BA BORING 5 10.0-12.0	100.2	24.0	2.68	0.669
TOTAL	1188.6	310.0		8.595
AVG	99.05	25.83		0.7163

MOIST UNIT WEIGHT $\gamma_m = 99.05\,(1.2583) = 124.6^{PCF}$

USE 125^{PCF}

SATURATED UNIT WEIGHT

$$\gamma_{SAT} = \gamma_{dry} + \left(\frac{e}{1+e}\right)\gamma_W$$

$$\gamma_{SAT} = 99.05 + \left(\frac{.7163}{1+.7163}\right) 62.4 = 125.09^{PCF}$$

USE 126^{PCF}

SUBMERGED UNIT WEIGHT

$$\gamma_{SUB} = 125.09 - 62.4 = 62.6^{PCF}$$

USE 63^{PCF}

CUMBERLAND

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B41 '87 0401 002

[illegible] 11-18-86

EARTH FILL - ORIGINAL DIKE

TRIAXIAL R
[illegible]

	C (ksf)	Φ (deg)
TVA US-19 SAMPLE 2	0.27	14.0
TVA US-19 SAMPLE 5	0.30	15.0
TVA US-21 SAMPLE 2	0.22	12.0
[illegible] HBA BORING 1 10.0-12.0	0.20	27.0
HBA BORING 2 24.0-26.0	0.50	28.0
HBA BORING 5 10.0-12.0	0.50	30.0
AVG	0.33	21.0
LOWER THIRD	0.3	13.0
USE	[illegible]	20°

R̄ EFFECTIVE

	C̄ (ksf)	Φ̄ (deg)
TVA US-19 SAMPLE 2	0	22.5
TVA US-19 SAMPLE 5	0.22	15.5
TVA US-21 SAMPLE 2	0.15	18.5
HBA BORING 1 10.0-12.0	0	27
HBA BORING 2 24.0-26.0	0	34
HBA BORING 5 10.0-12.0	0.20	31
AVG	0.12	25.25
LOWER THIRD	0.13	21.7

USE C̄ = 0 Φ̄ = 25°

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COMPUTED JML [illegible] DATE

CUMBERLAND S.P. TRIAXIAL R TEST
EARTH FILL - ORIGINAL DIKE

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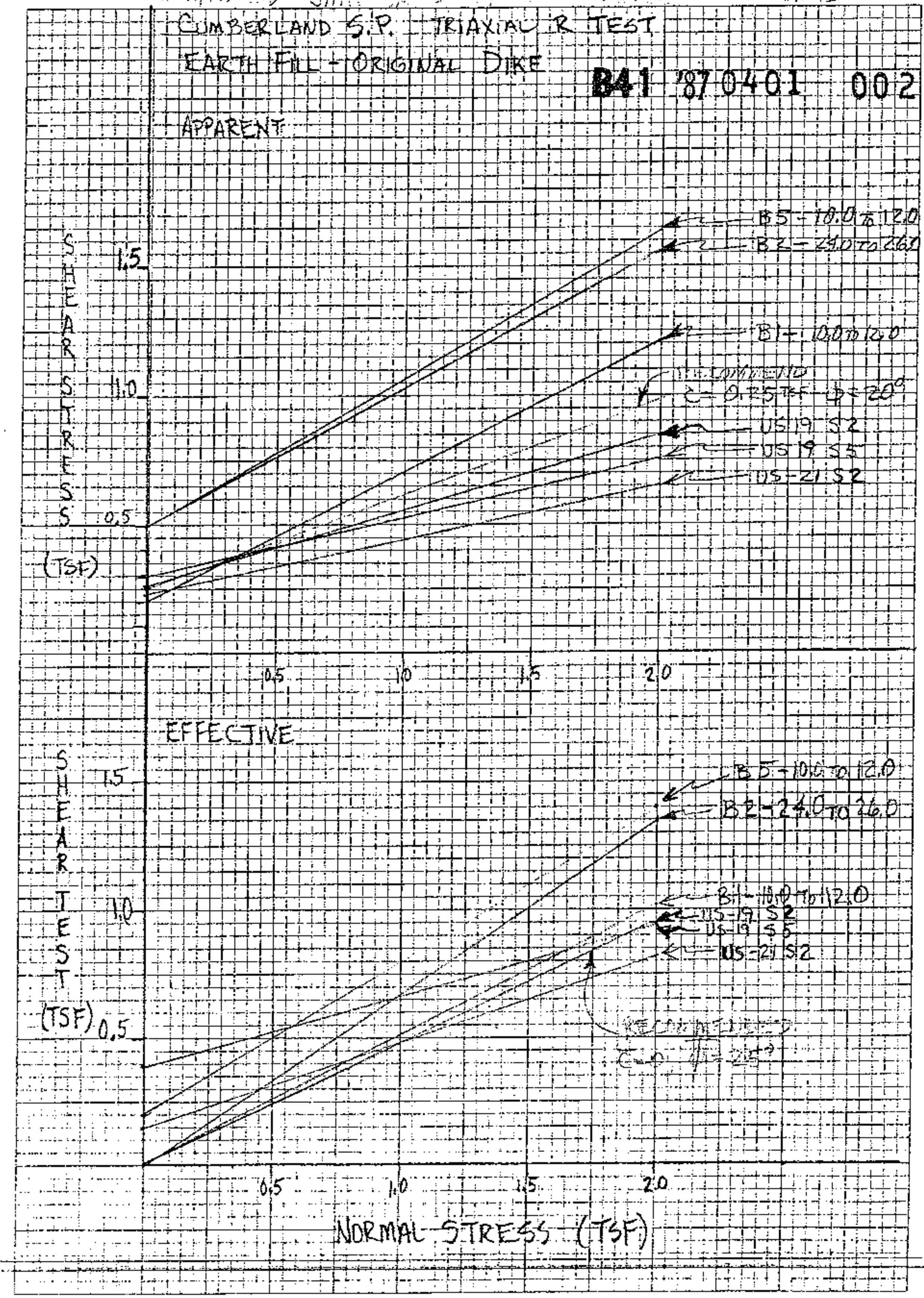

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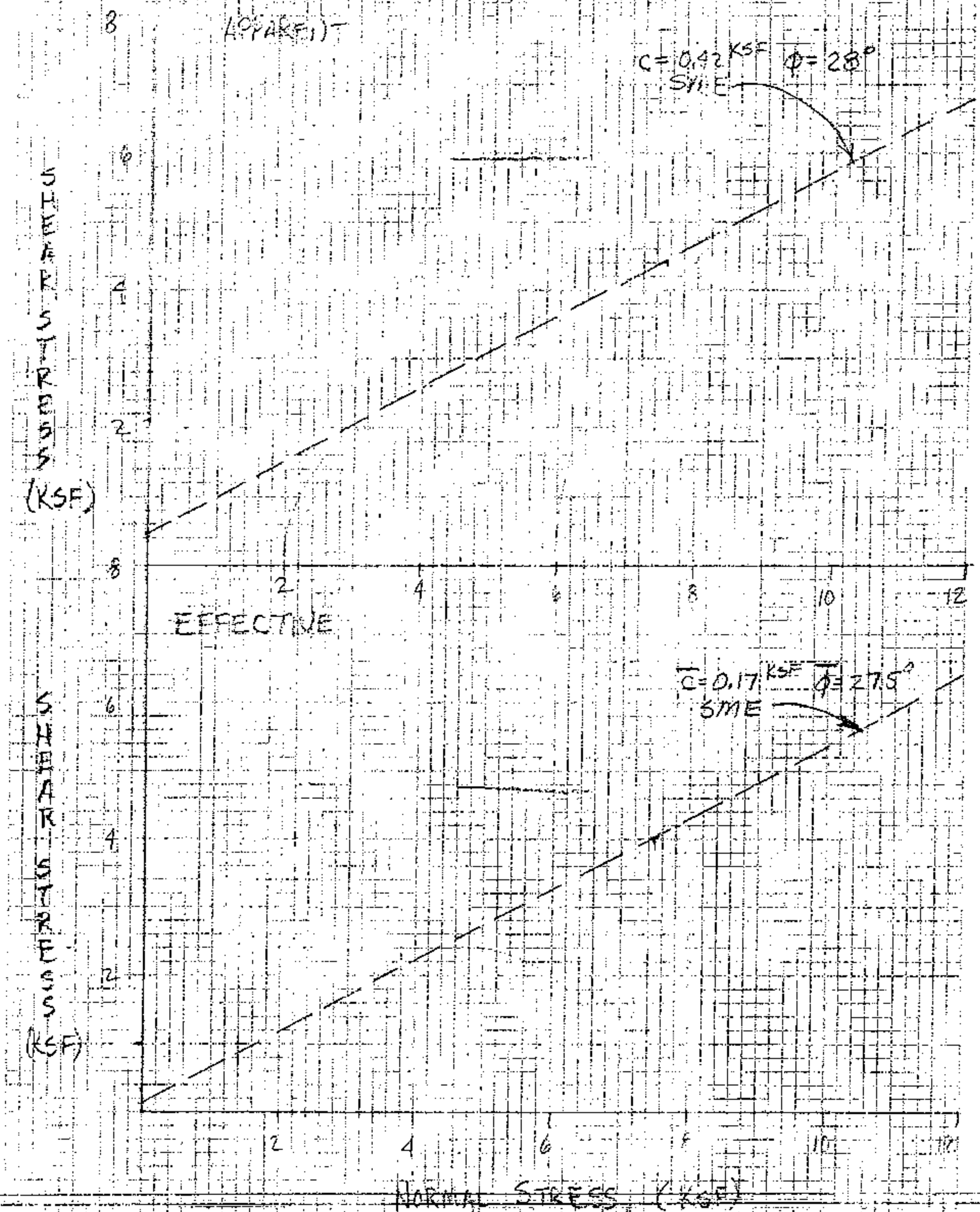
[illegible] 11-19-86 checked

CUMBERLAND STEAM PLANT (HBA)

BORING 1 DEPTH 10.0 - 12.0

EARTHFILL - ORIGINAL DIKE



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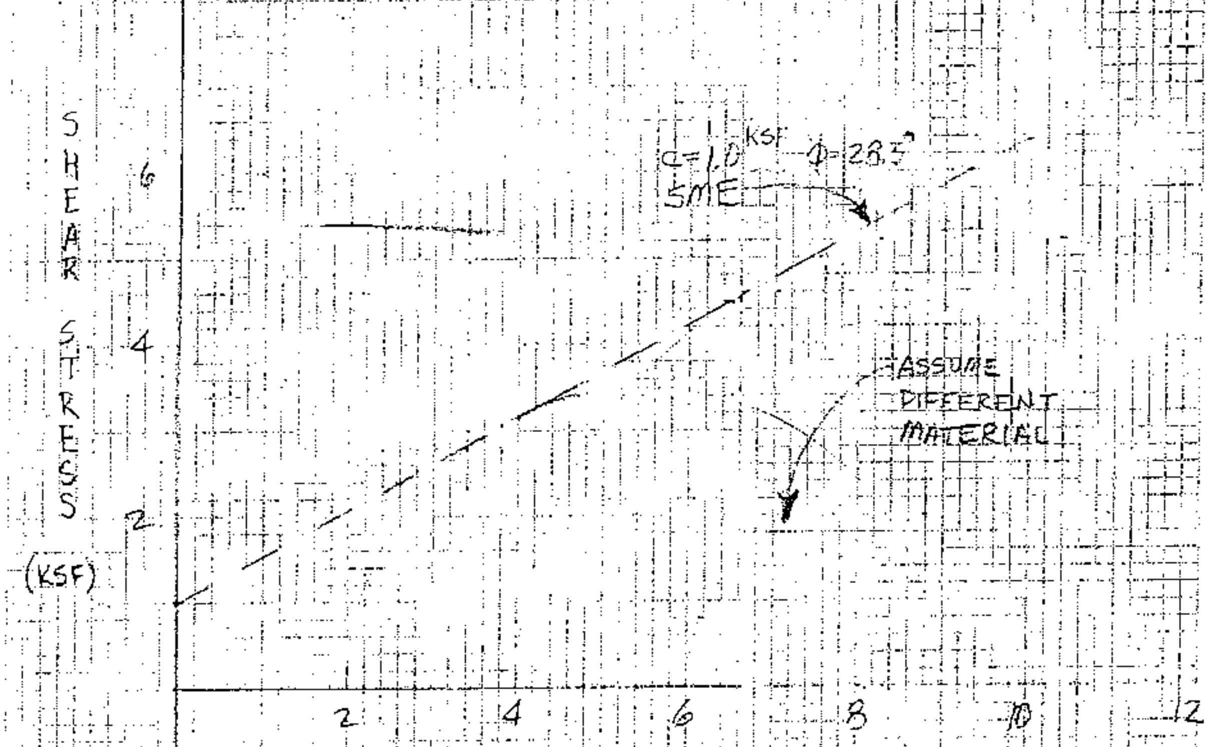
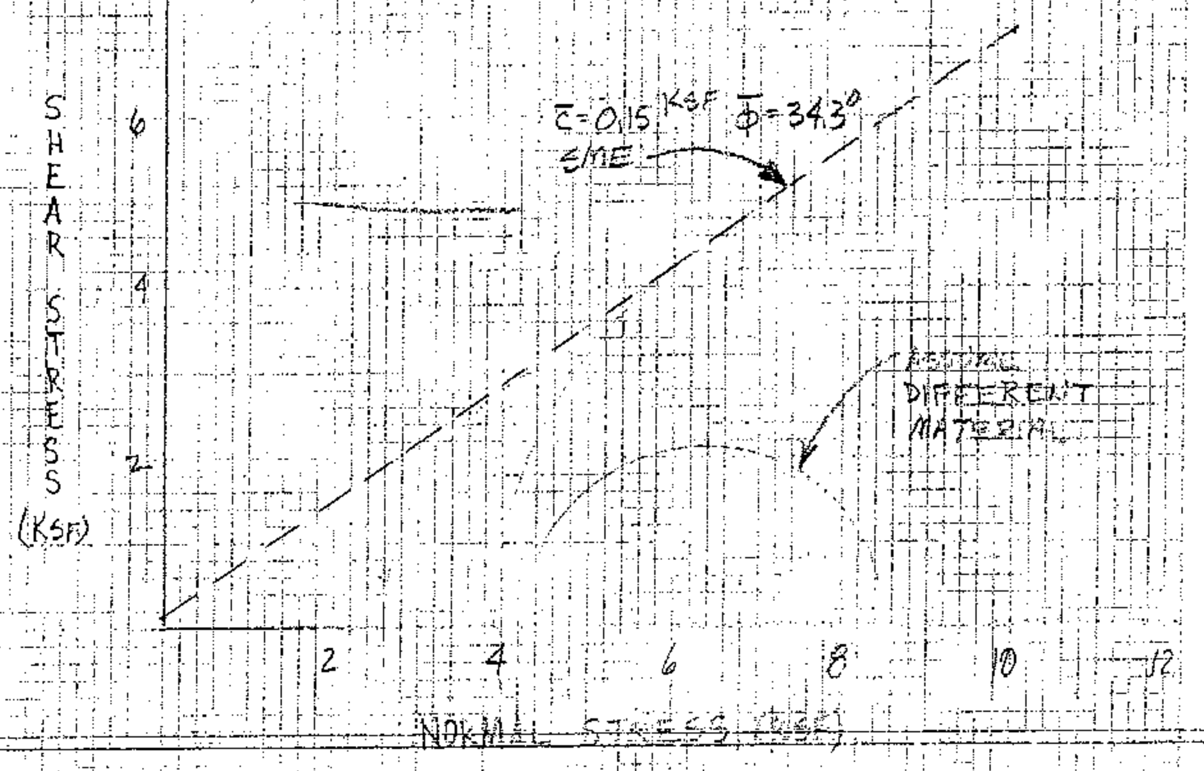
CUMBERLAND STEAM PLANT (GHEA)
BORING 2 24.0-26.0

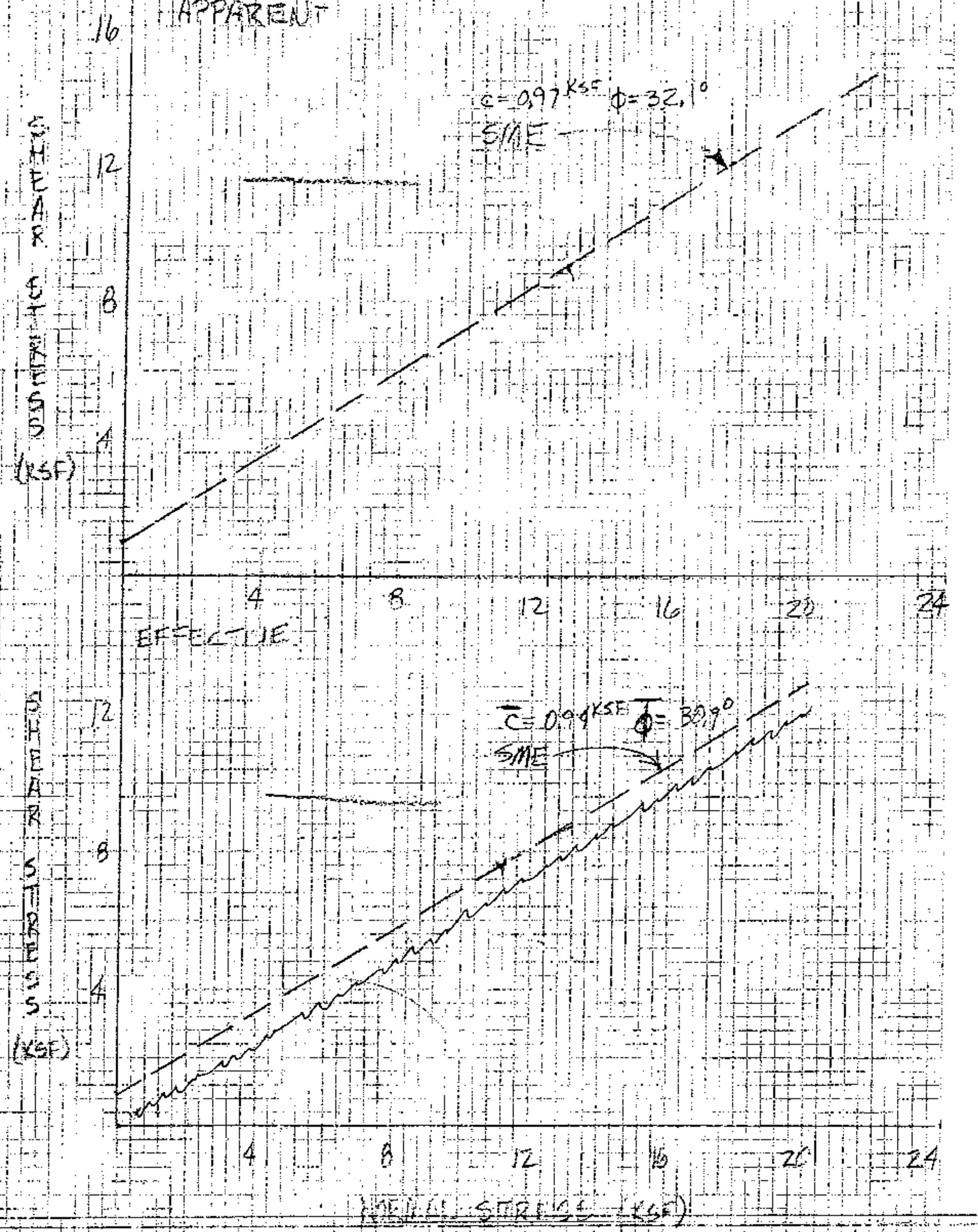
EARTH FILL - ORIGINAL DIKE





computed [illegible] date [illegible] checked SEP date 12-8-86

CUMBERLAND STEAM PLANT (CHEM)
BORING 5 DEPTH 10-12
EARTH FILL - ORIGINAL DIKE



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CUMBERLAND S.P.

B41 '87 0401 002

gmh 11-13-86
SEP 12-8-86

IN SITU SOFT LAYER

	γ_{dry} (PCF)	MC (%)	G	e
TVA US-6 SAMPLE 3	96.7	26.4	–	.724
TVA US-19 SAMPLE 5	97.5	32.4	–	.920
TVA US-19 " 6	96.4	27.0	–	.741
TVA US-19 " 7	96.2	28.2	–	.745
TVA US-19 " 8	96.7	20.8	–	.723
TVA US-19 " 9	94.3	26.8	–	.795
TVA US-21 SAMPLE 5	97.8	26.3	–	.711
TVA US-21 " 6	84.3	35.5	–	1.003
TVA US-21 " 7	95.8	27.4	–	.746
TVA US-21 " 8	92.6	28.7	–	.333
TVA US-21 " 9	82.5	39.7	–	1.085
HBA BORING 5 17.0-19.0	95.3	24.5	2.68	0.758
HBA BORING 8 20.0-22.0	98.4	25.6	2.70	0.712
~~HBA BORING 8 23.0-24.0~~	~~[illegible]~~	~~[illegible]~~	~~2.68~~	~~0.614~~
TVA US-6 SAMPLE 4	90.0	30.9		0.928
TVA US-6 SAMPLE 5	86.7	36.0		1.015
TVA US-19 SAMPLE 14	84.0	36.9		1.079
TOTAL	1376.9	447.5		12.810
AVG	91.79	29.83		0.854

MOIST UNIT WEIGHT $\gamma_m = 91.79\,(1.2983) = 119.17^{PCF}$ USE $\underline{119}^{PCF}$

SATURATED UNIT WEIGHT

$$\gamma_{SAT} = 91.79 + \left(\frac{0.854}{1.854}\right)62.4 = 120.53^{PCF} \text{ USE } \underline{121}^{PCF}$$

SUBMERGED UNIT WEIGHT $\gamma_{SUB} = 120.53 - 62.4 = \underline{58.1}^{PCF}$

USE $\underline{58}^{PCF}$

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B41 '87 0401 007

11-13-86

CUMBERLAND S.P.

SOIL PROPERTIES

TRIAXIAL - R

SOFT LAYER

	R-APPARENT	C (TSF)	Φ (deg)
	TVA US-21 SAMPLE 5	0.52	10
	TVA US-21 SAMPLE 6	0.18	12
	TVA US-6 SAMPLE 3	0.95	9
SOFT AREA →	HBA BORING 2 24.0-26.0	0.10	12
	HBA BORING 5 17.0-19.0	0.40	15
	HBA BORING 8 20.0-22.0	0.20	9
	HBA BORING 8 28.0-30.0	0.20	9
APPENDIX →	TVA US6 SAMPLE 4	0.35	13
	AVG	0.363	11.1
	LOWER THIRD	0.38	11
	USE	0.2	11

	R̄-EFFECTIVE	C (TSF)	Φ (deg)
	TVA US-21 SAMPLE 5	0.39	18.3
	TVA US-21 SAMPLE 6	0	23
	TVA US-6 SAMPLE 3	0.23	29
SOFT AREA →	HBA BORING 2 24.0-26.0	0	17
	HBA BORING 5 17.0-19.0	0	21
	HBA BORING 8 20.0-22.0	0	10
	HBA BORING 8 28.0-30.0	0	14
APPENDIX E →	TVA US 6 SAMPLE 4	0.15	19.5
	AVG	0.10	19.0
	LOWER THIRD	0.13	16.3
	USE	0	18

COMPUTED [illegible] date 11-13-86 checked date 17/57

CUMBERLAND S.P. TRIAXIAL R TEST

SOFT LAYER

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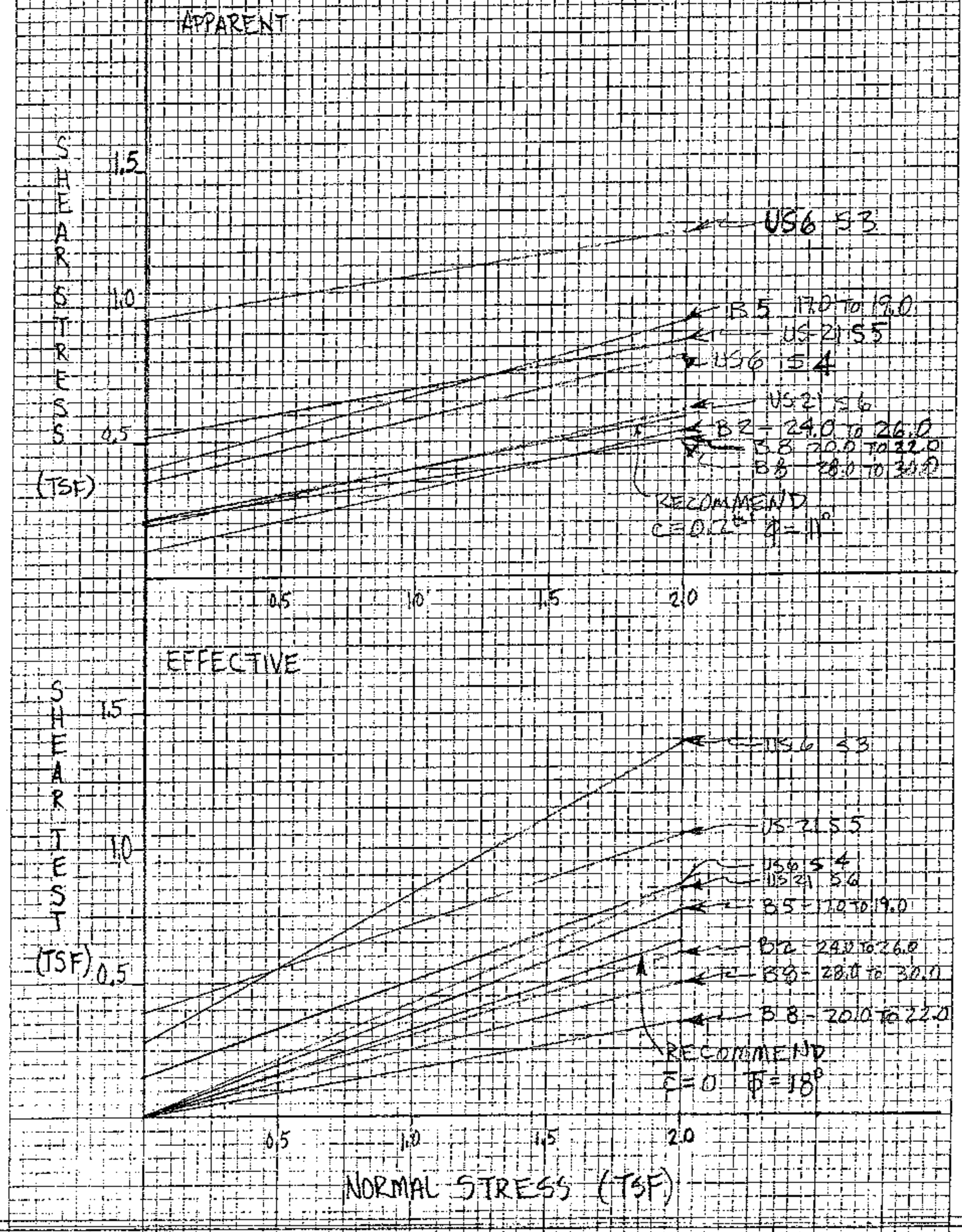

computed WHA date 11-17-86 checked date

19/57

CUMBERLAND STEAM PLANT (CHEA)
BORING 5 17.0 - 19.0

SOFT LAYER

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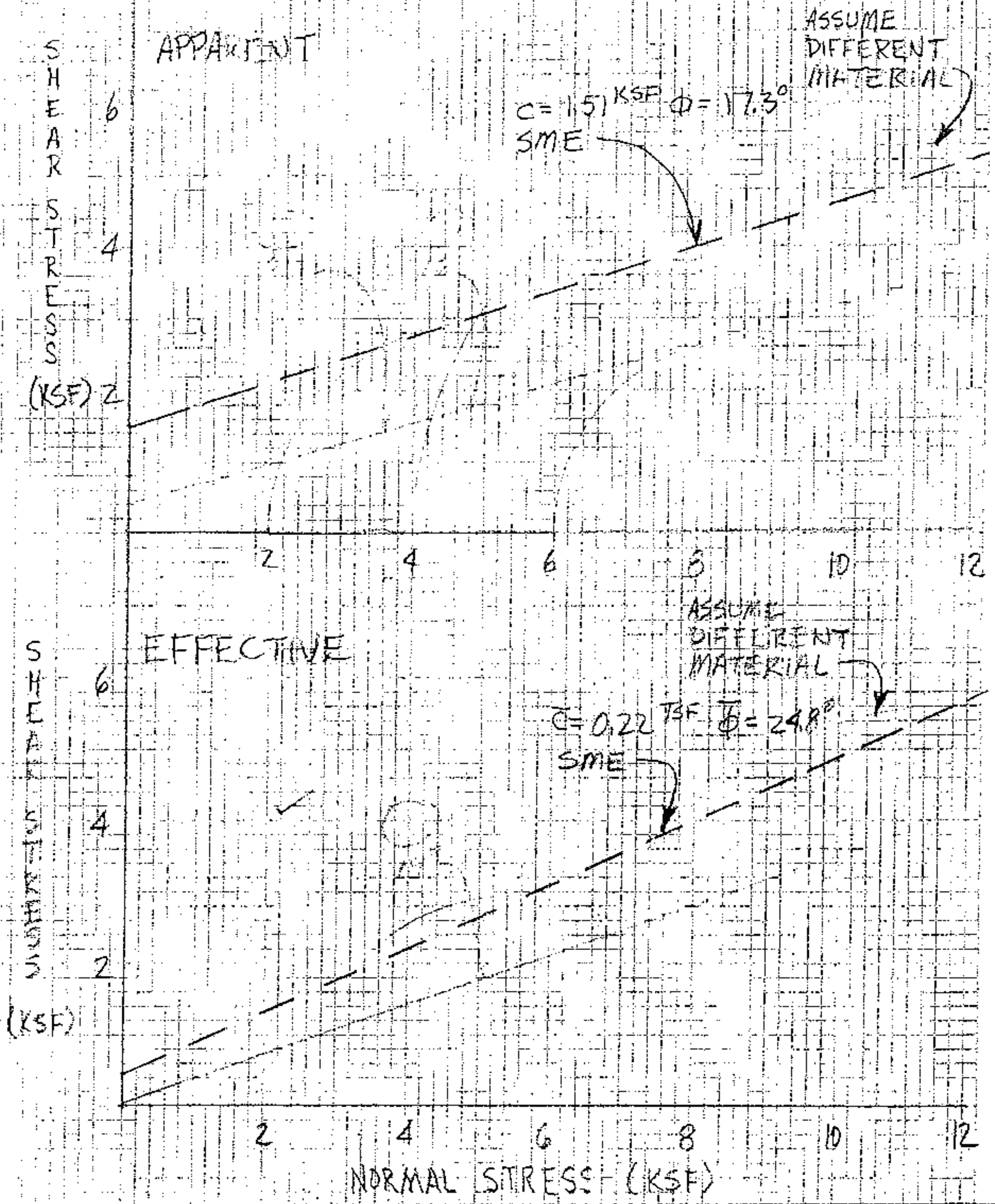

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CUMBERLAND STEAM PLANT (HBA)
BORING 8 DEPTH 20.0-22.0

SOFT LAYER

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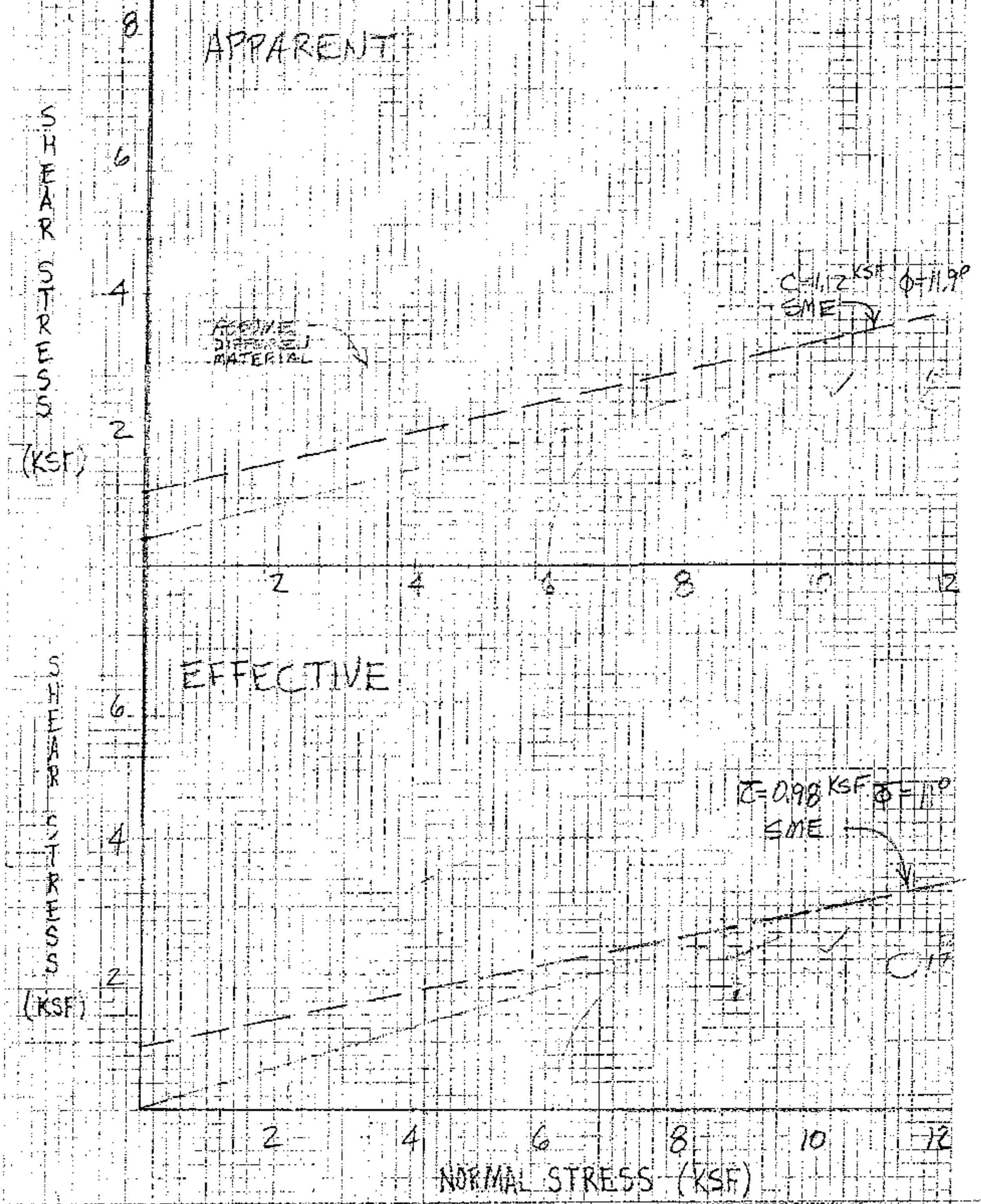

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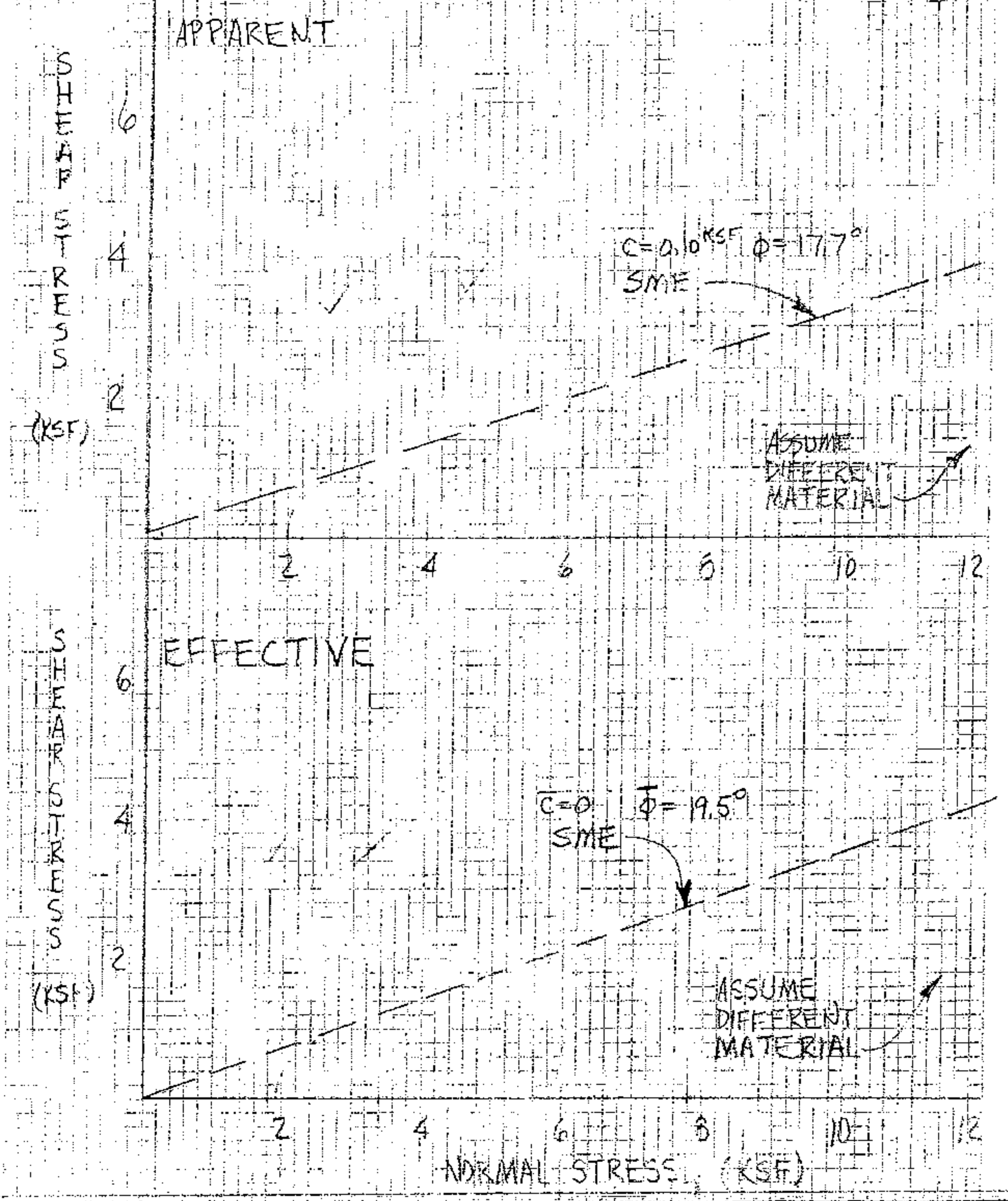
CUMBERLAND STEAM PLANT (HBA)
BORING 8 28.0-30.0
SOFT LAYER



CUMBERLAND S.P.

JMG 10-27-86

FOUNDATION

$e = \frac{G\gamma_w}{\gamma_d} - 1$

	γ_{dry} (PCF)	MC %	G	e
HBA BORING 1 26.0-28.0	100.0	25.3	2.67	0.679
HBA BORING 2 26.0-28.0	103.7	23.3	2.68	0.613
HBA BORING 2 30.0-32.0	99.4	25.3	2.70	0.695
HBA BORING 8 28.0-30.0	103.6	22.1	2.68	0.614
TVA US-19 SAMPLE 10	102.6	24.3	—	0.660
TVA US-19 SAMPLE 11	106.2	21.2	—	0.582
TVA US-19 SAMPLE 12	104.1	21.2	—	0.632
TVA US-21 SAMPLE 10	99.7	25.6	—	0.679
TVA US-21 SAMPLE 11	93.9	26.4	—	0.756
TVA US-21 SAMPLE 12	96.0	27.7	—	0.750
TOTAL	1009.2	242.4		6.660
AVG.	100.9	24.2		0.666

MOIST UNIT WEIGHT, $\gamma_m = 100.9(1.242) = 125.3^{PCF}$ USE 125 PCF

SATURATED UNIT WEIGHT, $\gamma_{SAT} = 100.9 + \left(\frac{.666}{1.666}\right) 62.4 = 125.8^{PCF}$

USE 126 PCF

SUBMERGED UNIT WEIGHT $\gamma_{sub} = 125.8 - 62.4 = 63.4^{PCF}$

SAY 63 PCF

Cumberland S.P.

23 57

B41 '87 0401 002

PMH 11-19-86

Foundation Soil

R-APPARENT

not large hydraulicity

	C (TSF)	Φ (deg.)
~~TVA US-6 SAMPLE 4~~	~~0.35~~	~~13~~
HBA BORING 1 26.0-28.0	0.30	25
HBA BORING 2 26.0-28.0	0.20	23
HBA BORING 2 30.0-32.0	0.20	15
AVG	0.23	21
LOWER THIRD	0.23	18.3
USE	0.20	20

R-EFFECTIVE

not large hydraulicity

	C (TSF)	Φ (deg.)
~~TVA US-6 SAMPLE 4~~	~~0.15~~	~~19.5~~
HBA BORING 1 26.0-28.0	0	28
HBA BORING 2 26.0-28.0	0	25
HBA BORING 2 30.0-32.0	0	20
AVG.	0	24.3
LOWER THIRD	0	22.7
USE	0	~~24~~

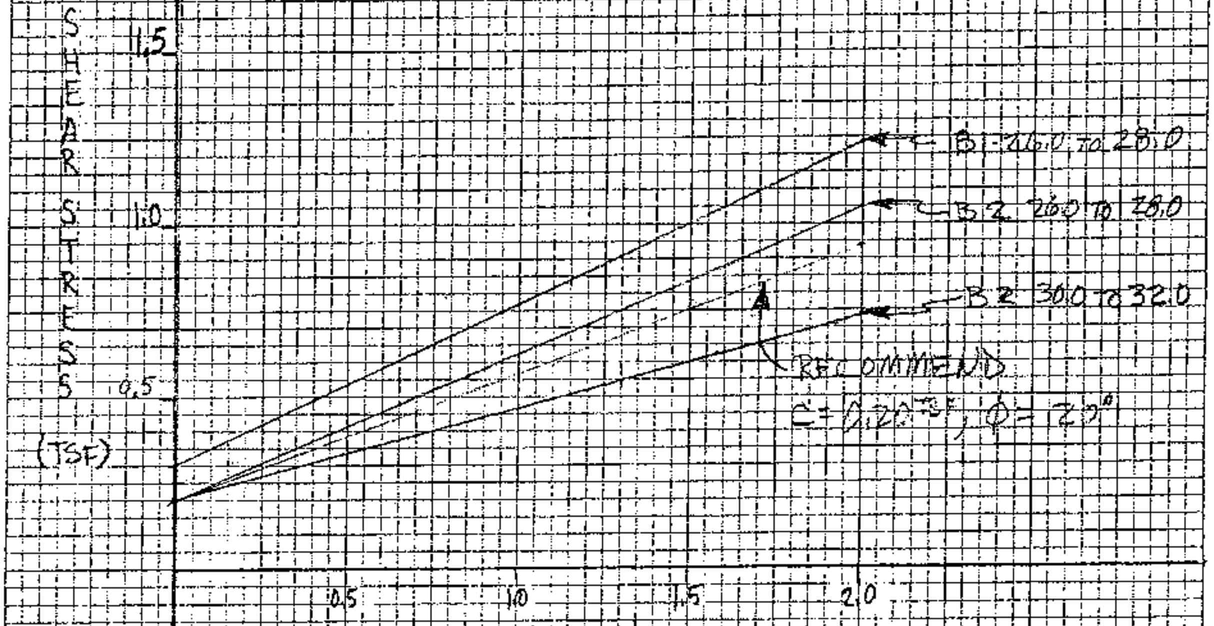
BASED ON BLOW COUNTS
AND ENGINEERING JUDGEMENT USE $\phi = 28°$

computed JMH date 11-12-86 checked date

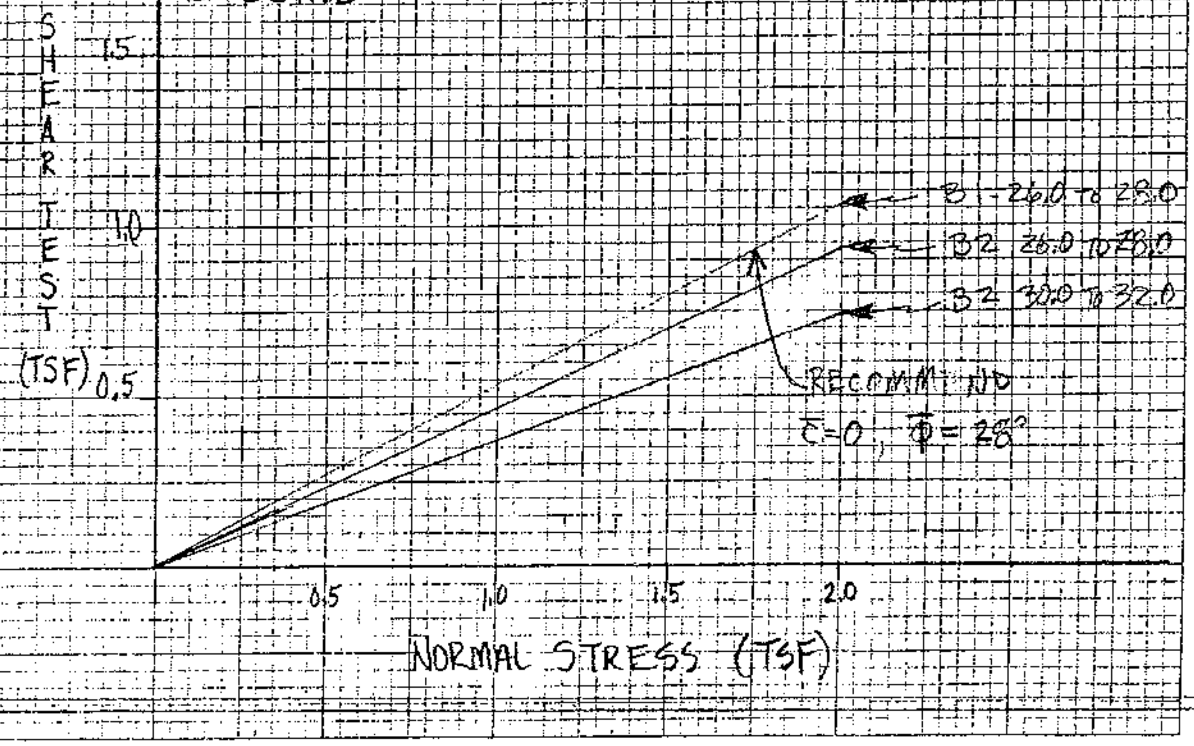
CUMBERLAND S.P. TRIAXIAL R TEST
FOUNDATION SOIL

B41 '87 0401 002

APPARENT



EFFECTIVE



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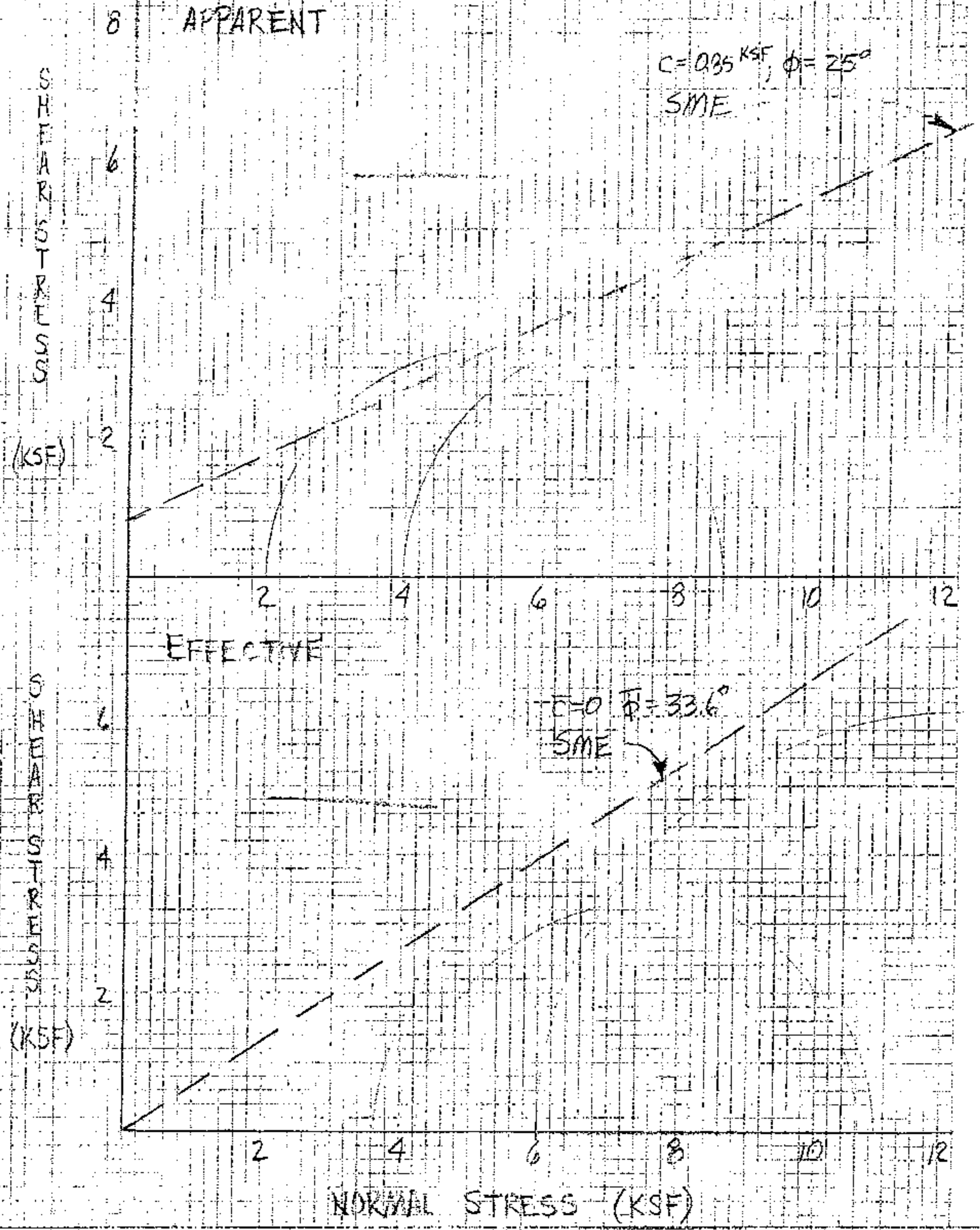
CUMBERLAND STEAM PLANT (HBA)
BORING 1 26.0-28.0
FOUNDATION

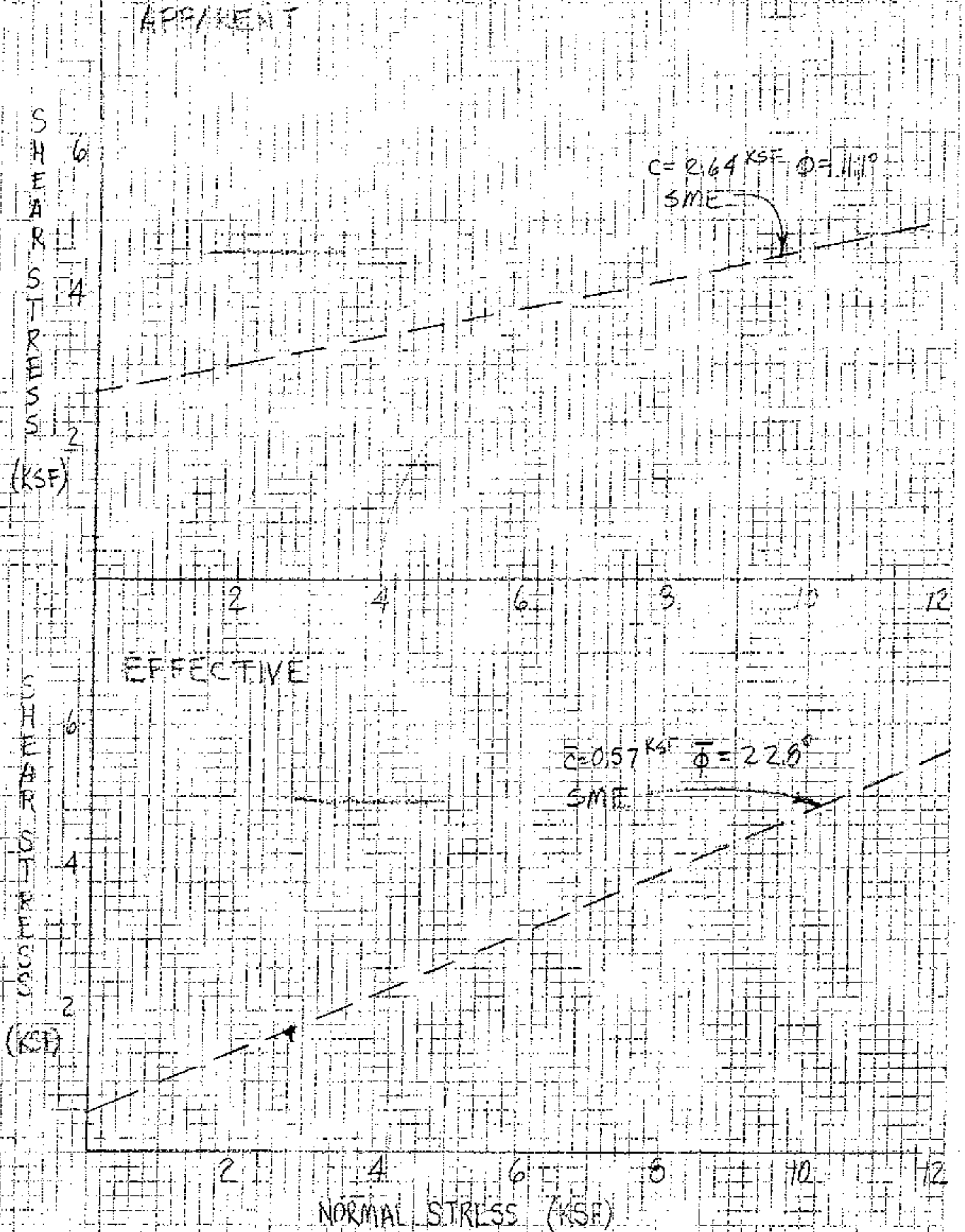
B41 '87 0401 002



Computed GMR date 11-19-86 Checked date 26/57

CUMBERLAND STEAM PLANT (HCAY)
BORING 2 26.0 - 28.0
FOUNDATION

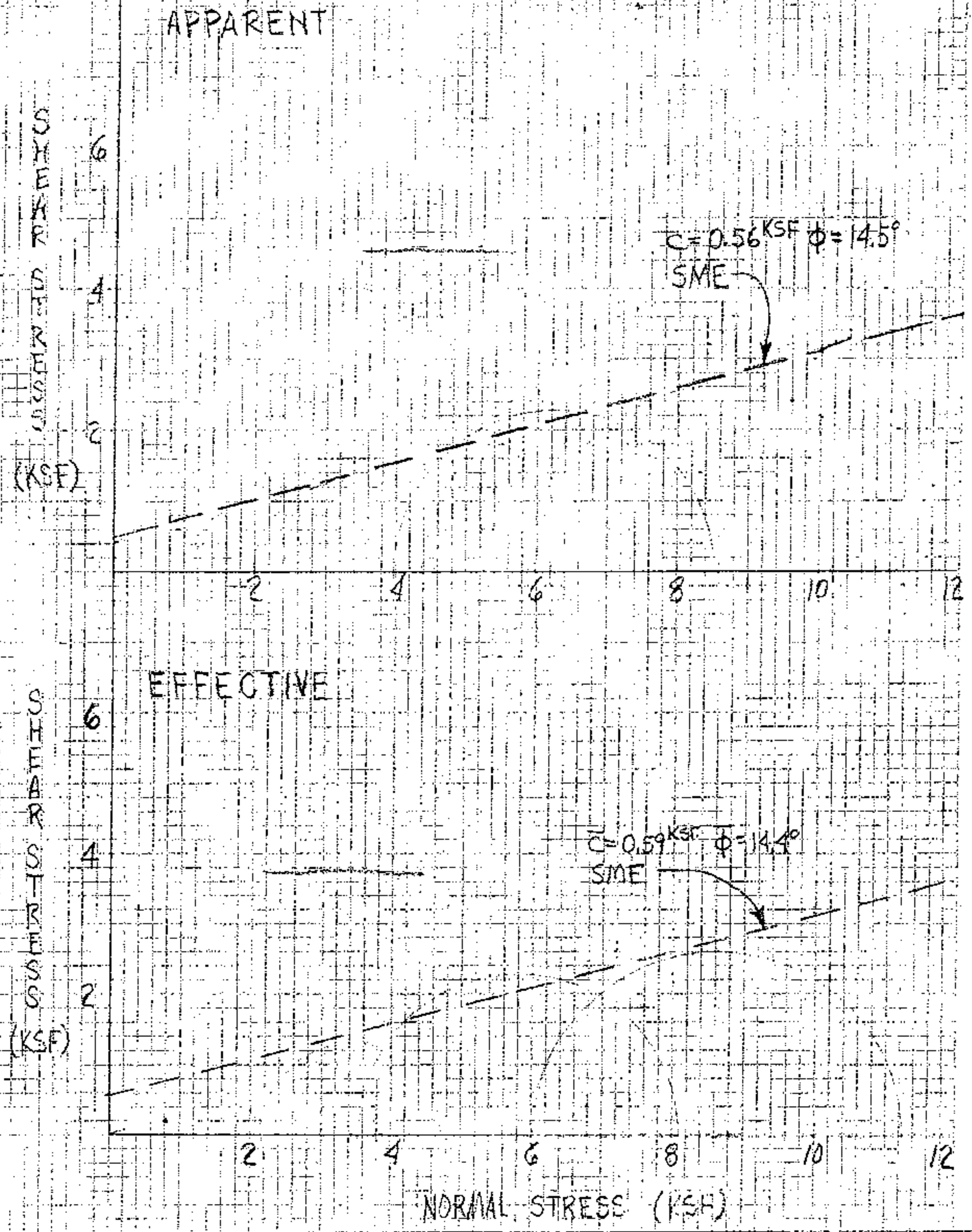
B41 '87 0401 002



computed JMH date 11-19-86 checked [illegible] date 12-3-86 27/57

CUMBERLAND STEAM PLANT (HBA)
BORING 2 30.0 - 32.0
FOUNDATION

B41 87 U401 002



CUMBERLAND S. P.

APPENDIX 3

ASH PROPERTIES

RE-EVALUATION CONSIDERING EFFECTIVE STRESS PATH FAILURE CRITERIA

R- APPARENT ($\bar{\sigma}_1/\bar{\sigma}_3$ CRITERIA)

	C	Φ
TEST 1	1.0^{TSF}	31°
TEST 2	1.25^{TSF}	30°

RECOMMEND c = 0.75^{TSF} φ = 24°

$\bar{R}$ - EFFECTIVE ($\bar{\sigma}_1/\bar{\sigma}_3$ CRITERIA)

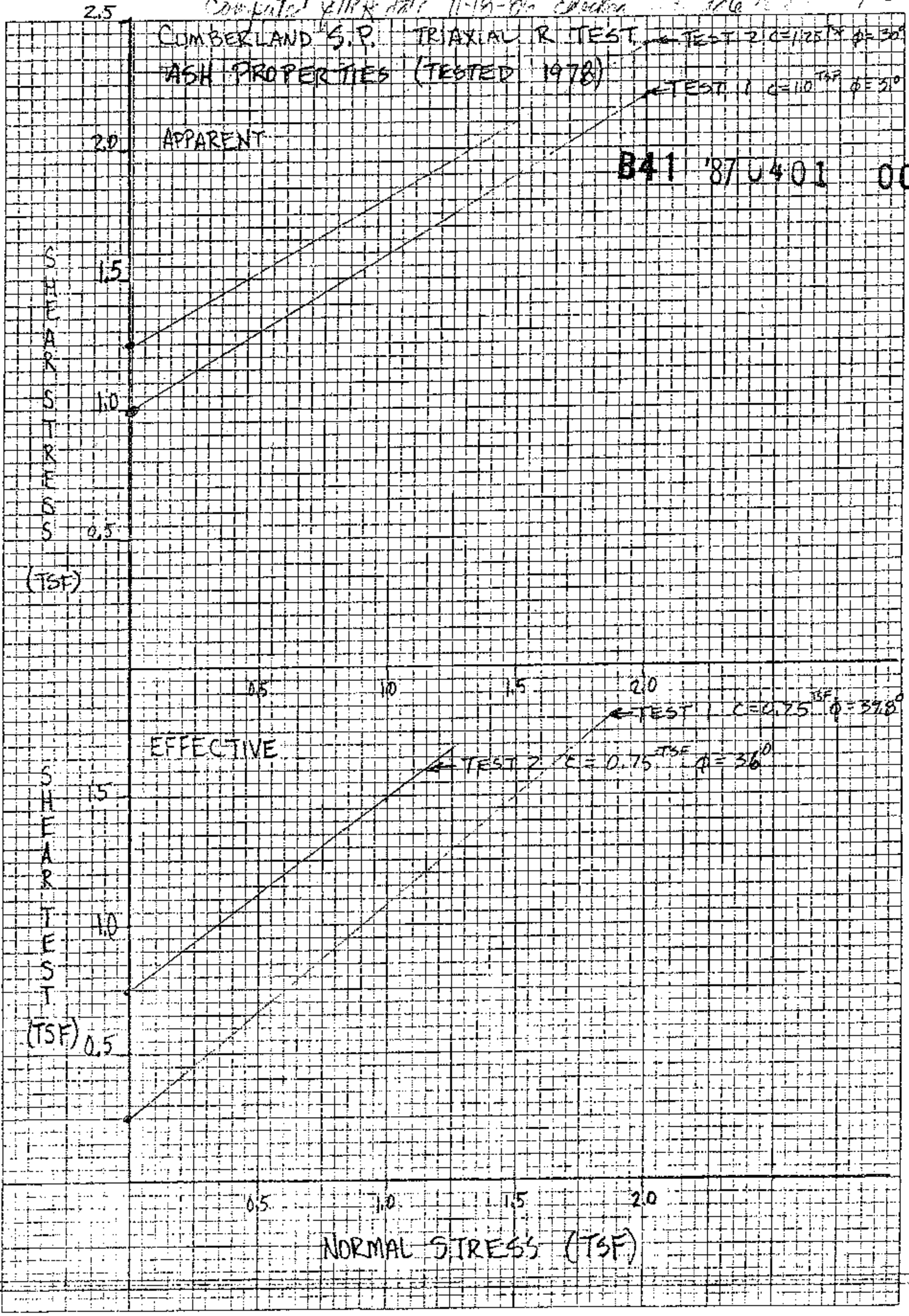
	C	φ
TEST 1	0.25^{TSF}	39.5°
TEST 2	0.75^{TSF}	36°

RECOMMEND c = 0 φ = 34°

computed [illegible] date 11-19-86 checked [illegible] date [illegible] 29/57

B41 '87 0401 002

CUMBERLAND S.P. TRIAXIAL R TEST
ASH PROPERTIES (TESTED 1978)

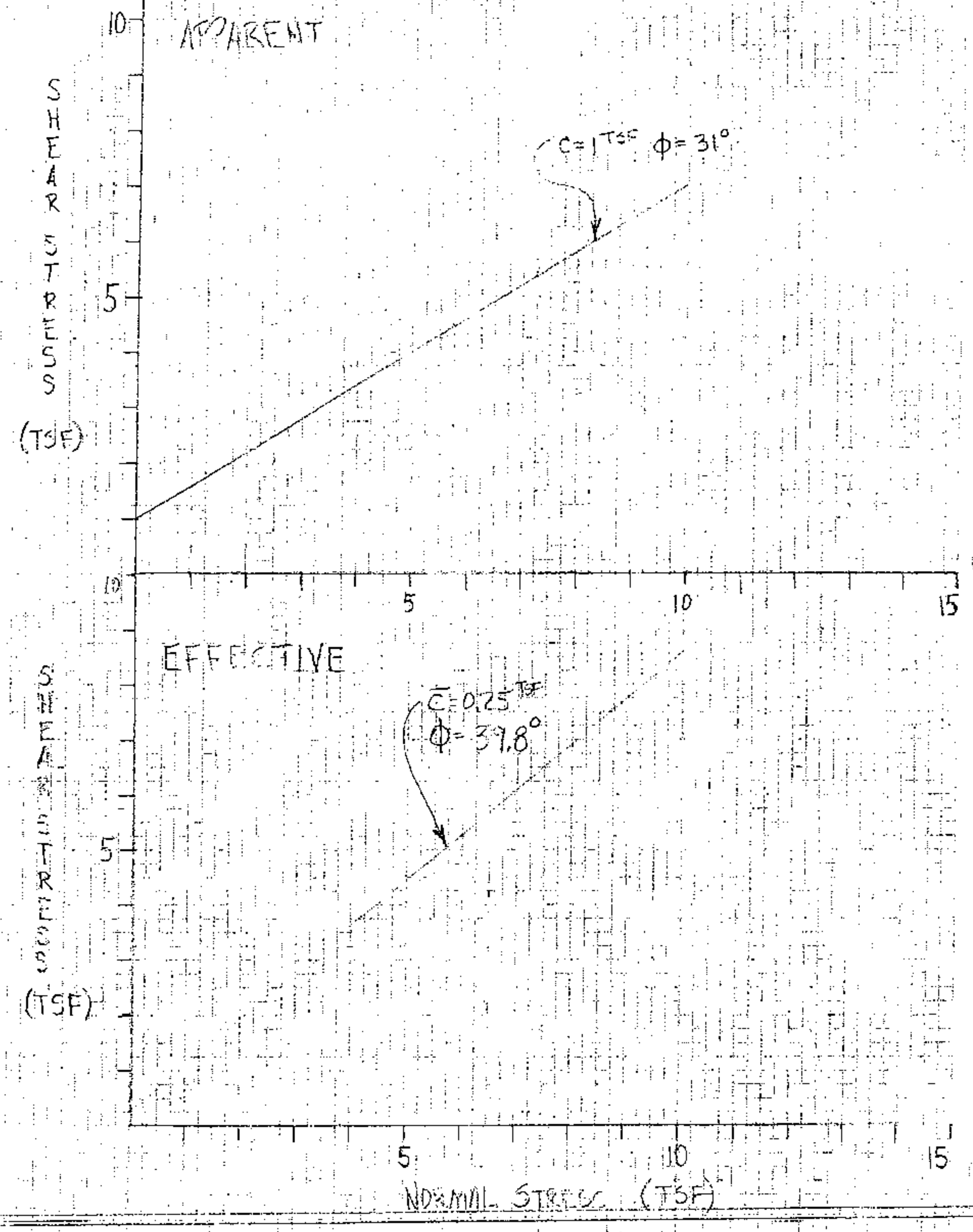


computed JMK date 11-19-86 checked date 37/57

CUMBERLAND S.P. TEST 1
ASH PROPERTIES

B41 '87 0401 002

$\overline{\sigma}_1/\overline{\sigma}_3$ CRITERIA



CUMBERLAND S.P. 42 of 57

[illegible] [illegible] TEST 2

B41 '87 0401 002

JMD 11-19-86

TRIAXIAL R

TEST 2 (No. 11726/1540)

	σ_3 (tsf)	$\sigma_1-\sigma_3$ (tsf)	σ_1 (tsf)	u (tsf)	$\bar{\sigma}_3$ (tsf)	$\bar{\sigma}_1$ (tsf)	$\bar{\sigma}_1/\bar{\sigma}_3$
	1.00	5.48	6.48	[illegible]	0.93	6.35	6.83
[illegible]	1.00	7.55	8.55★	-0.66	1.66	9.21	5.55
Pressure	1.00	3.18	4.18	-0.58	1.58	4.76	2.89
	1.00	2.82	3.82	-0.59	1.59	4.41	2.77
	1.00	2.68	3.68	-0.53	1.53	4.21	2.75

$H_{original}$ = 7.9860

$A_{original}$ = 12.730

Constant = 7.6

t	Δ (in)	ε (%)	$A_{corr.}$ (in²)	P.R.	P (#)	$\sigma_1-\sigma_3$ (tsf)	σ_3 (tsf)	σ_1 (tsf)	u (tsf)	$\bar{\sigma}_3$ (tsf)	$\bar{\sigma}_1$ (tsf)	$\bar{\sigma}_1/\bar{\sigma}_3$
8	.081	1.01	12.860	162	1231	6.89	1.0	7.89	-0.15	1.15	8.04	6.99 ←
10	.121	1.52	12.926	186	1414	7.87	1.0	8.87	-0.42	1.42	9.29	6.54
4	.032	0.41	12.78	87	661	3.72	1.0	4.72	0.22	0.78	4.50	5.77

★ MAXIMUM σ_1 IN REPORT; σ_1 = 8.55
P.R. CONSTANT NOT STATED IN THE REPORT

$\bar{\sigma}_1/\bar{\sigma}_3$ FAILURE CRITERIA – σ_3 = 1.00 tsf, σ_1 = 7.89 tsf
$\bar{\sigma}_3$ = 1.15 tsf, $\bar{\sigma}_1$ = 8.04 tsf

SHEET 43 OF 57

C[illegible] LAND S.P.

B41 '87 0401 00

A.S.[illegible] [illegible]

DATE 11-19-86

TRIAXIAL R
TEST 2 ([illegible], 0542)

σ_3 (tsf)	$\sigma_1-\sigma_3$ (tsf)	σ_1 (tsf)	u (tsf)	$\bar{\sigma}_3$ (tsf)	$\bar{\sigma}_1$ (tsf)	$\bar{\sigma}_1/\bar{\sigma}_3$
2.00	1.99	3.99	.29	1.71	3.70	2.16
2.00	3.79	5.79	.43	1.57	5.36	3.41
2.00	6.80	8.80	.35	1.65	8.45	5.12
2.00	8.32	10.32	.08	1.92	10.24	5.33 ← $\varepsilon = 1.4$
2.00	8.96	10.96	−.13	2.13	11.09	5.21
2.00	9.15	11.15	−.26	2.26	11.41	5.05
2.00	9.38★	11.38★	−.45	2.45	11.83	4.83
2.00	9.34	11.34	−.48	2.48	11.82	4.77
2.00	9.14	11.14	−.48	2.48	11.62	4.69

★ MAXIMUM $\sigma_1 = 11.38$

$\bar{\sigma}_1/\bar{\sigma}_3$ FAILURE CRITERIA ~ $\sigma_3 = 2.00^{tsf}$, $\sigma_1 = 10.32^{tsf}$
$\bar{\sigma}_3 = 1.92^{tsf}$, $\bar{\sigma}_1 = 10.24^{tsf}$

CUMBERLAND S. P.

ASH PROPERTIES

TRIAXIAL R
TEST 2 (ROLL 11726, 0541)

σ_3 (tsf)	$\sigma_1-\sigma_3$ (tsf)	σ_1 (tsf)	u (tsf)	$\bar{\sigma}_3$ (tsf)	$\bar{\sigma}_1$ (tsf)	$\bar{\sigma}_1/\bar{\sigma}_3$
3.00	6.54	9.54	0.76	2.24	8.78	3.92
3.00	10.56	13.56	0.53	2.47	13.03	5.28 ←
3.00	10.84	13.84	0.37	2.63	13.47	5.12
3.00	10.91*	13.91*	0.34	2.66	13.57	4.95
3.00	10.81	13.81	0.30	2.70	13.51	5.00
3.00	10.60	13.60	0.30	2.70	13.30	4.93
3.00	10.44	13.44	0.31	2.69	13.13	4.88
3.00	9.69	12.69	0.45	2.55	12.24	4.80
3.00	8.86	11.86	0.66	2.34	11.20	4.79

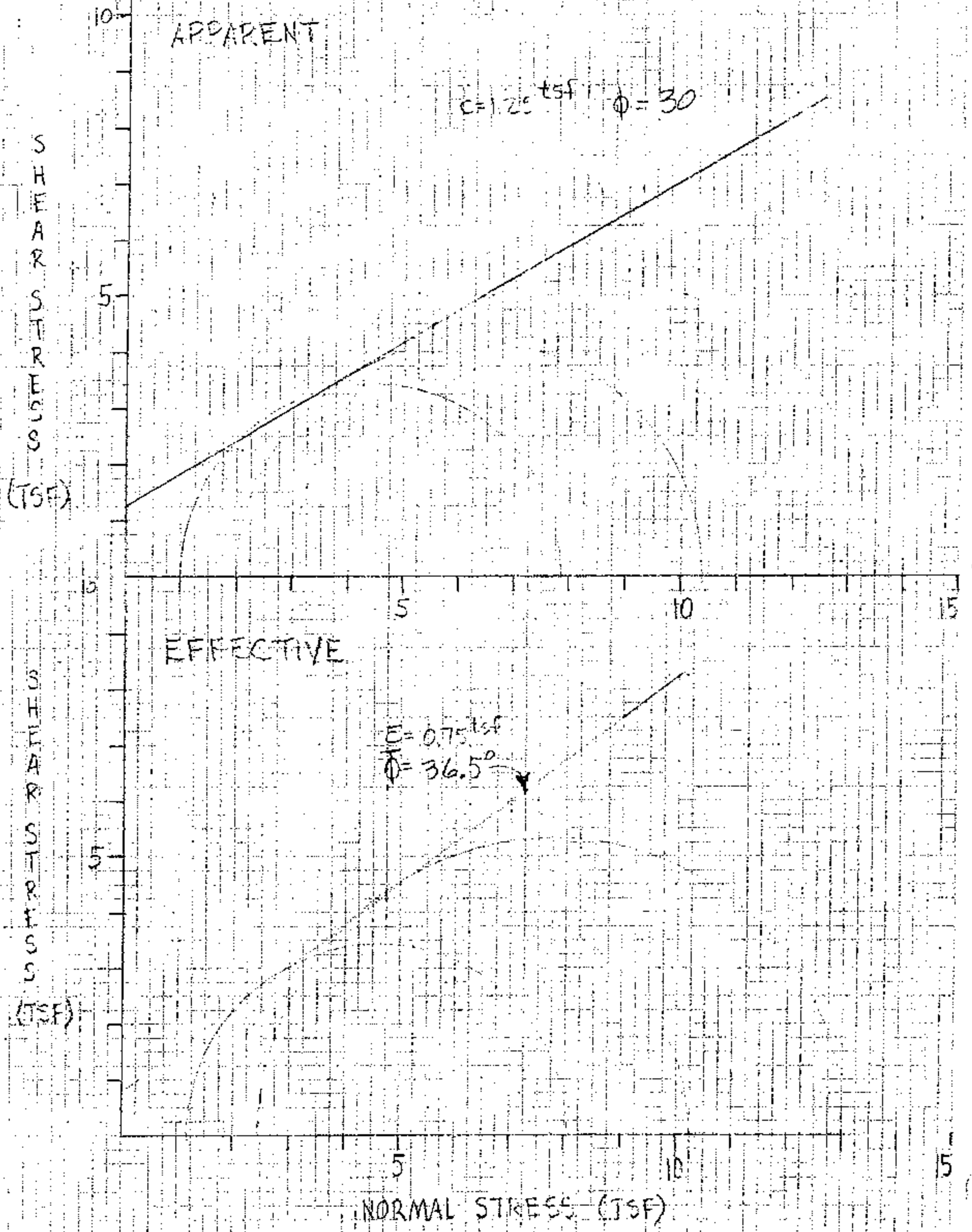
★ MAXIMUM $\sigma_1 = 13.91^{tsf}$

$\bar{\sigma}_1/\bar{\sigma}_3$ FAILURE CRITERIA $\sigma_3 = 3.00^{tsf}$, $\sigma_1 = 13.56^{tsf}$
$\bar{\sigma}_3 = 2.47^{tsf}$, $\bar{\sigma}_1 = 13.03^{tsf}$

computed GMA date 11-19-86 checked date 47/57

CUMBERLAND S.P. TEST 2 **B41 '87 0401 002**

ASH PROPERTIES $\bar{\sigma}_1/\bar{\sigma}_3$ CRITERIA



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CUMBERLAND S.P.

B41 '67 :401 002
JMH 11-17-86

BORROW AREA W

EVALUATION OF SOIL PROPERTIES

UNIT WEIGHT

THREE SOIL CLASSES WERE FOUND FROM 20 GROUPS
CLASS I HAD 8 GROUPS ASSUME 40% DISTRIBUTION
CLASS II HAD 9 GROUPS ASSUME 45% "
CLASS III HAD 3 GROUPS ASSUME 15% "
TOTAL 20 GROUPS TOTAL 100%

SOIL CLASS	SOIL DISTRIBUTION %	OPTIMUM MOISTURE CONTENT, %	MAXIMUM DRY DENSITY, PCF	SPECIFIC GRAVITY, G
I	40	17.0	110.0	2.68
II	45	16.0	105.9	2.69
III	15	19.4	102.3	2.68

WEIGHTED AVG. MAX. DRY DENSITY $= .4(110)+.45(105.9)+.15(102.3) = \underline{107.0}^{PCF}$

" " OPTIMUM MOISTURE CONTENT $= .4(17)+.45(16)+.15(19.4) = 16.71\%$

ANTICIPATED PLACEMENT REQUIREMENTS

DENSITY CONTROL = 95% COMPACTION
AND 98% COMPACTION

MOISTURE CONTROL = 2% DRY TO 2% WET OF OPTIMUM
MOISTURE CONTENT (O.M.C)

DRY DENSITY AT 95% = .95 (107.0) = 101.7^{PCF}
98% = .98 (107.0) = 104.9^{PCF}

MOISTURE CONTENT AT 2% WET OF OMC = 18.91%

γ_{MOIST} AT 95% $= 101.7\,(1.1891) = 120.9^{PCF} \cong \underline{121}^{PCF}$
AT 98% $= 104.9\,(1.1891) = 124.7^{PCF} \cong \underline{125}^{PCF}$

γ_{SAT} AT 95% $= (1-\frac{1}{2.68})(101.7)+62.5 = 126.3 \cong \underline{126}^{PCF}$
98% $= (1-\frac{1}{2.68})(104.9)+62.5 = 128.3 \cong \underline{128}^{PCF}$

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CUMBERLAND S.P.

B41 '87 0401 002

JMH 11/10/81

EVALUATION OF SOIL PROPERTIES
BORROW AREA E

UNIT WEIGHT

FOUR SOIL CLASSES WERE FOUND FROM 20 GROUPS

CLASS I HAD 1 GROUP REPRESENTING 5% DISTRIBUTION
CLASS II HAD 11 GROUPS " 55% "
CLASS III HAD 3 GROUPS " 15% "
CLASS IV HAD 5 GROUPS " 25% "
100%

SOIL CLASS	SOIL DISTRIBUTION %	(OMC) OPTIMUM MOISTURE CONTENT, %	MAX. DRY DENSITY, PCF	SPECIFIC GRAVITY, G
I	5	15.3	108.3	2.61
II	55	17.4	105.4	2.64
III	15	17.6	102.2	2.68
IV	25	18.6	105.1	2.71

WEIGHTED AVG. MAX. DRY DENSITY = $(.05)(108.3)+(.55)(105.4)+(.15)(102.2)+(.25)(105.1) = 104.99$

" " OPTIMUM MOISTURE CONTENT = $(.05)(15.3)+(.55)(17.4)+(.15)(17.6)+(.25)(18.6) = 17.63$

" " SPECIFIC GRAVITY = $(.05)(2.61)(.55)(2.64)+(.15)(2.68)+(.25)(2.71) = 2.66$

ANTICIPATED PLACEMENT REQUIREMENTS

DENSITY CONTROL AT 95% AND 98% COMPACTION

MOISTURE CONTROL AT 2% DRY TO 2% WET OF OPTIMUM MOISTURE CONTENT

DRY DENSITY, γ_d @ 95% = $.95(104.99) = 99.74$
@ 98% = $.98(104.99) = 102.89$

MOISTURE CONTENT AT 2% WET OF O.M.C. = $2+17.63 = 19.63\%$

$$\gamma_{MOIST} \text{ AT } 95\% = 99.74(1.1963) = 119.32^{PCF} \approx \underline{119^{PCF}}$$
$$\text{AT } 98\% = 102.89(1.1963) = 123.09^{PCF} \approx \underline{123^{PCF}}$$

$$\gamma_{SAT} \text{ AT } 95\% = \left(1-\frac{1}{2.66}\right)(99.74)+62.5 = 124.7 \approx \underline{125^{PCF}}$$
$$\text{AT } 98\% = \left(1-\frac{1}{2.66}\right)(102.89)+62.5 = 126.7^{PCF} \approx \underline{127^{PCF}}$$

SHEET 50 OF 57

CUMBERLAND S.P.

B41 '87 0401 002

BORROW PROPERTIES

BY gmH DATE 11-21-86

REF 3 B46 86 1120 [illegible]

BORROW AREA W

TRIAXIAL R TEST 95% MAX. DRY DENSITY

R- APPARENT

	c (TSF)	Φ (DEG)
CLASS I +2%	0.50	22.0
CLASS I -2%	0.70	21.3
CLASS II +2%	0.07	24.0
CLASS II -2%	0.00	27.0
CLASS III +2%	0.62	20.4
CLASS III -2%	0.57	14.2
AVG	0.41	21.48
LOWER THIRD	0.23	18.47

RECOMMEND $\underline{\underline{0.25^{TSF}}}$ $\underline{\underline{21^{\circ}}}$

$\overline{R}$- EFFECTIVE

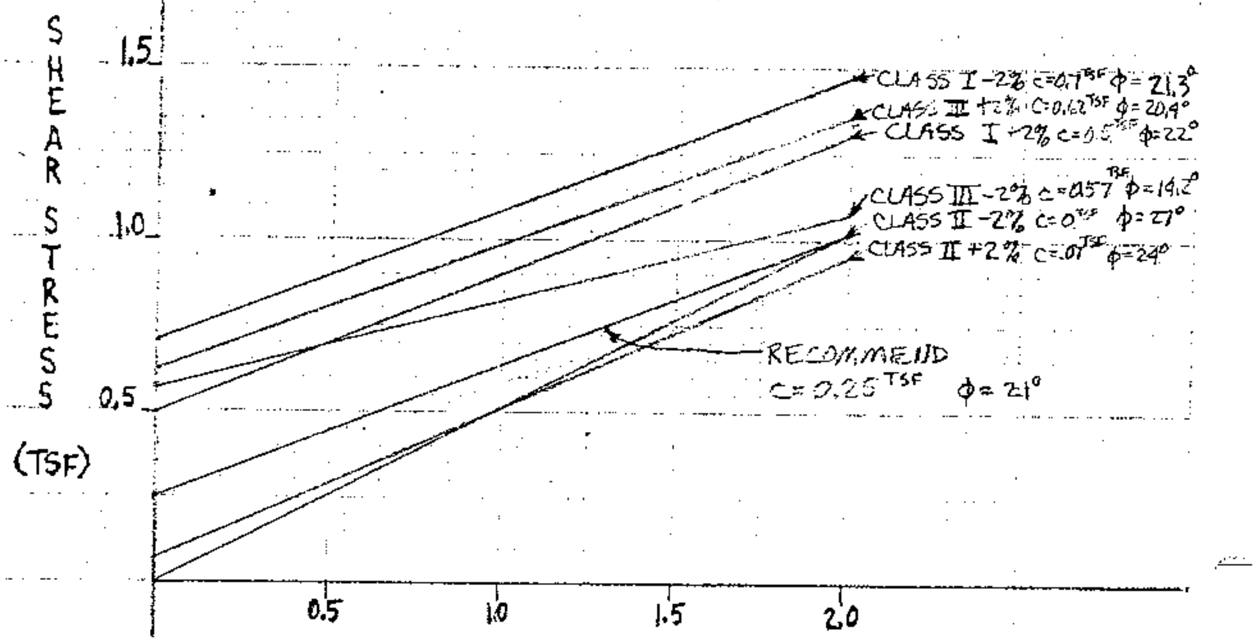
	$\overline{c}$ (TSF)	$\overline{\Phi}$ (DEG)
CLASS I +2%	0.10	27.8
CLASS I -2%	0.27	29.1
CLASS II +2%	0.06	23.3
CLASS II -2%	0.03	28.7
CLASS III +2%	0.47	20.7
CLASS III -2%	0.63	13.1
AVG	0.26	23.78
LOWER THIRD	0.23	18.43

USE $\underline{\underline{\overline{c}=0}}$ $\underline{\underline{\overline{\phi}=25^{\circ}}}$

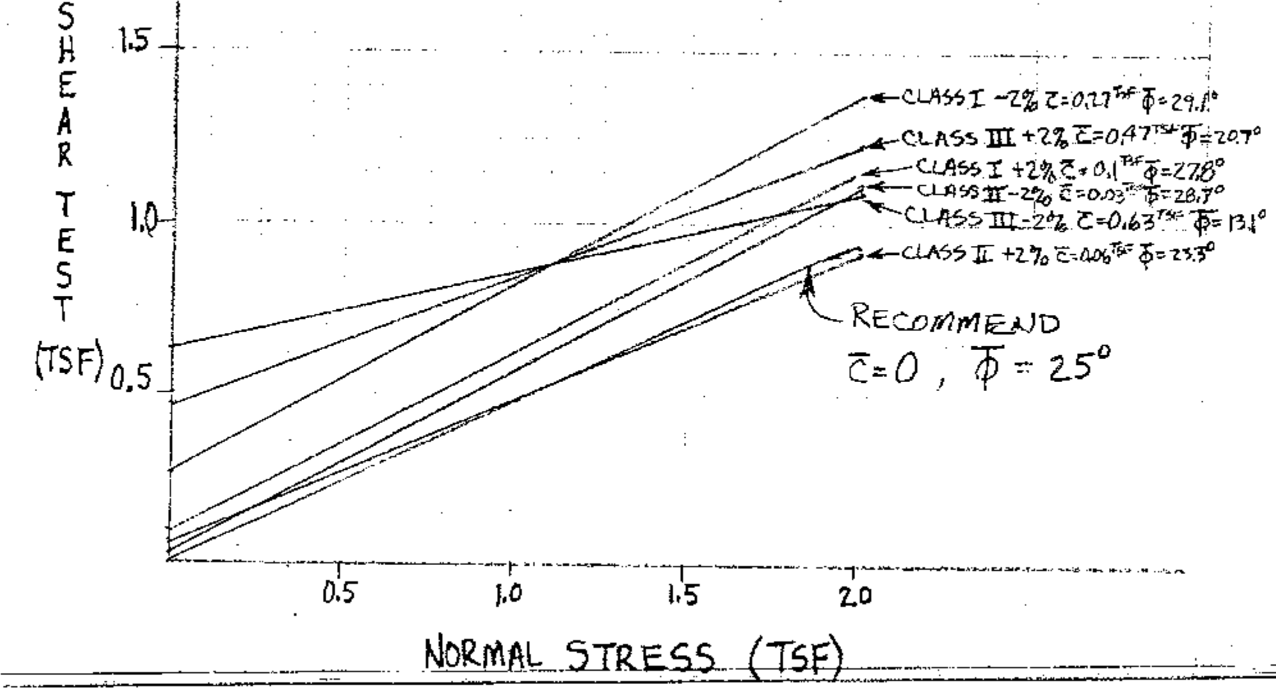
computed JMB date 11-21-86 checked date 51/57

CUMBERLAND S.P. TRIAXIAL R TEST
BORROW AREA W (95% MAX. DRY DENSITY)

APPARENT



EFFECTIVE



CUMBERLAND S.P

BORROW PROPERTIES 11-21-86

BORROW AREA W

TRIAXIAL R TEST 98% MAX. DRY DENSITY

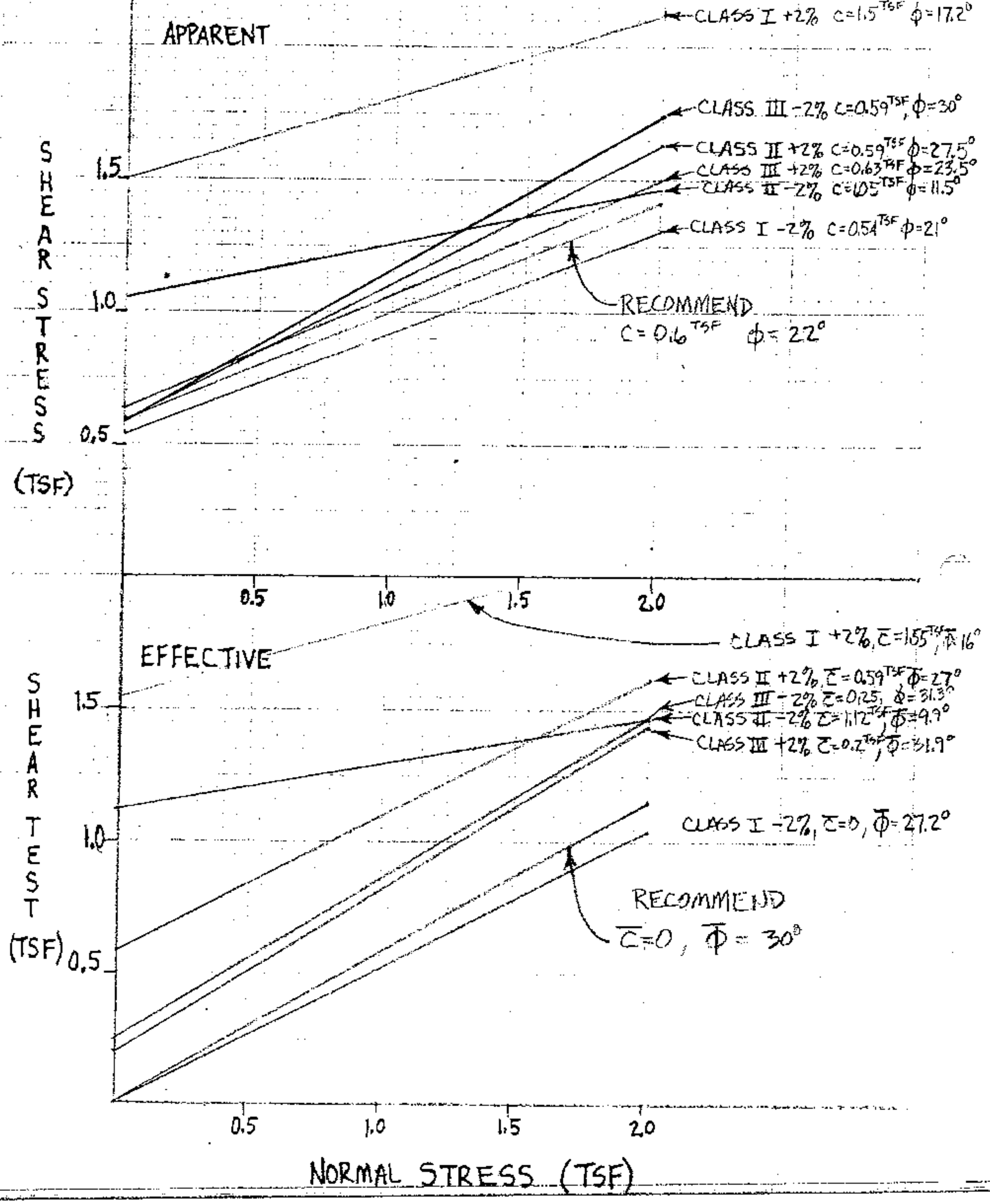
R-APPARENT	C (TSF)	ϕ (DEG)
CLASS I +2%	1.50	17.2
CLASS I -2%	0.54	21.0
CLASS II +2%	0.59	27.5
CLASS II -2%	1.05	11.5
CLASS III +2%	0.63	23.5
CLASS III -2%	0.59	30.0
AVG.	0.82	21.78
LOWER THIRD	0.56	17.67

RECOMMEND $C = 0.6^{TSF}$ ϕ 22°

$\overline{R}$-EFFECTIVE	$\overline{C}$ (TSF)	$\overline{\phi}$ (DEG)
CLASS I +2%	1.55	16.9
CLASS I -2%	0.00	27.2
CLASS II +2%	0.59	27.9
CLASS II -2%	1.12	9.9
CLASS III +2%	0.20	31.9
CLASS III -2%	0.25	31.3
AVG.	0.62	23.9
LOWER THIRD	0.52	17.2

RECOMMEND $\overline{C} = 0.0^{TSF}$ $\overline{\phi} = 30°$

CUMBERLAND S.P. TRIAXIAL R TEST
BORROW AREA W (98% MAX DRY DENSITY) **B41 '87-0401 00**



BORROW AREA E

TRIAXIAL R TEST 95% MAX. DRY DENSITY

R - APPARENT	C (TSF)	ϕ (DEG)
CLASS I +2%	1.04	9.3
CLASS I -2%	1.25	10.2
CLASS II +2%	0.86	27.4
CLASS II -2%	1.21	8.2
CLASS III +2%	0.48	25.9
CLASS III -2%	0.30	18.6
CLASS IV +2%	0.79	18.1
CLASS IV -2%	0.44	5.8
AVG	0.80	15.4
LOWER THIRD	0.71	13.6

RECOMMEND $c = 0.6^{TSF}$ $\phi = 20^{\circ}$

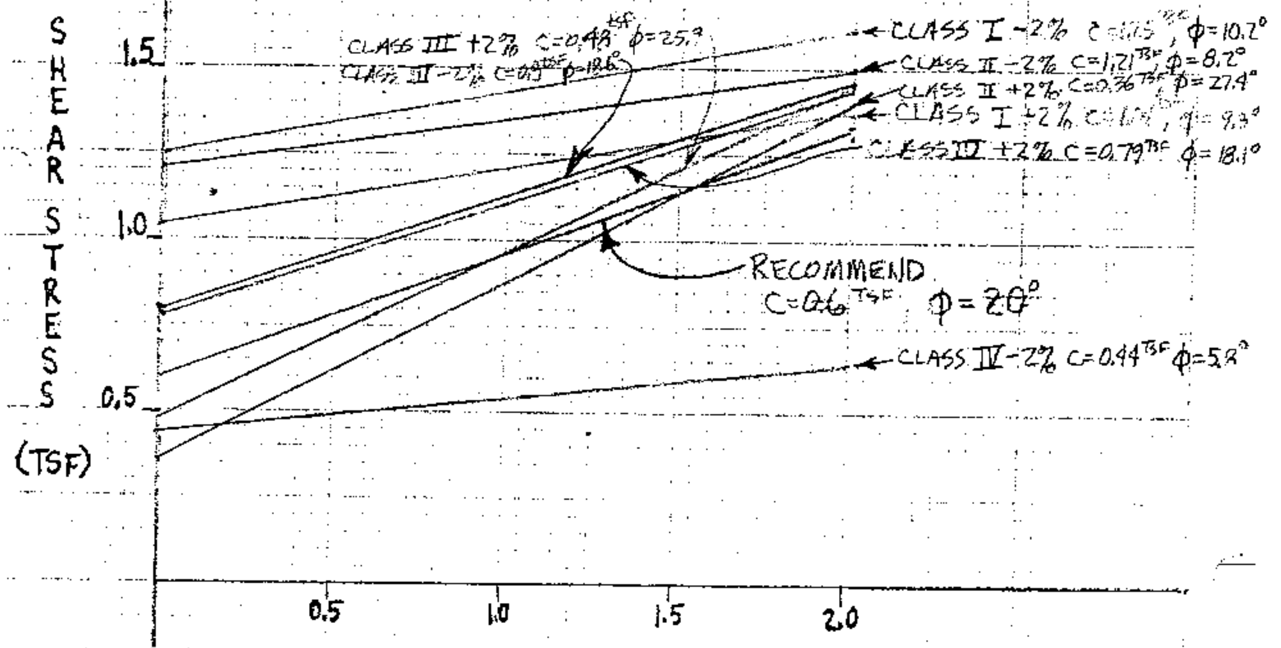
$\bar{R}$ - EFFECTIVE	$\bar{C}$ (TSF)	$\bar{\Phi}$ (DEG)
CLASS I +2%	0.91	11.1
CLASS I -2%	0.54	26.0
CLASS II +2%	0.57	26.6
CLASS II -2%	1.27	7.7
CLASS III +2%	0.23	28.4
CLASS III -2%	0.47	23.0
CLASS IV +2%	0.61	19.6
CLASS IV -2%	0.35	7.8
AVG.	0.62	18.8
LOWER THIRD	0.58	14.6

RECOMMEND $\bar{c} = 0.2^{TF}$ $\bar{\Phi} = 28^{\circ}$

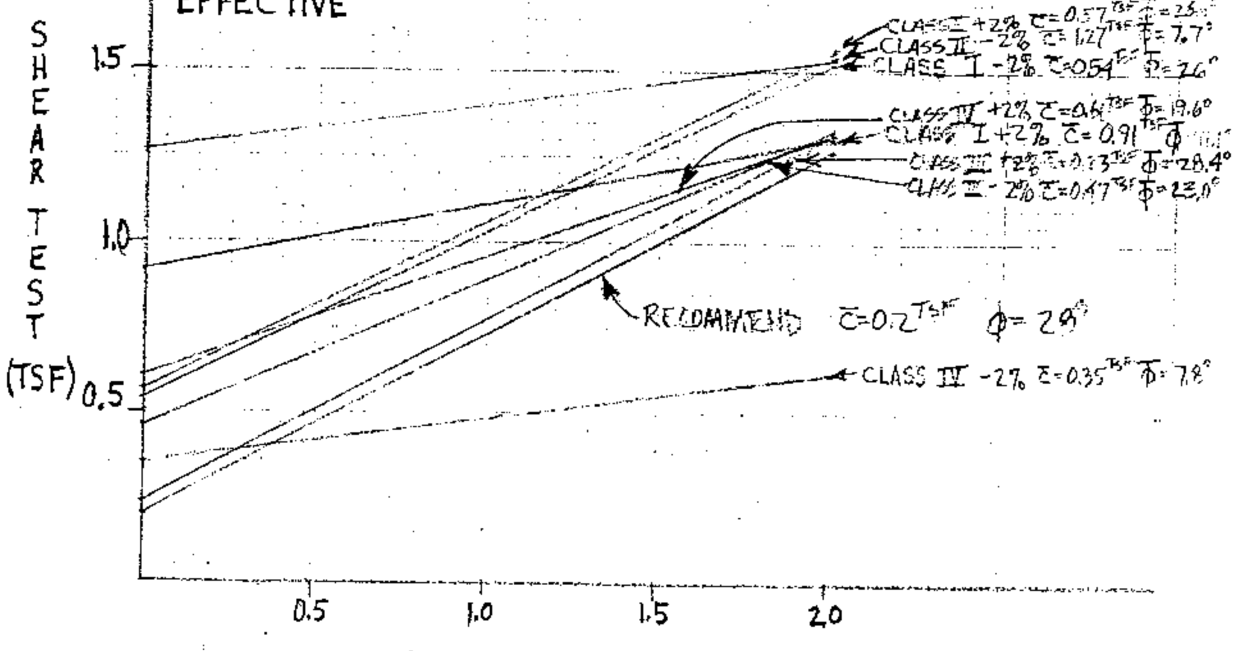
gmk date 11-24-86 55/57

CUMBERLAND S.P. TRIAXIAL R TEST B41 '87 0401 002
BORROW AREA E (95% MAX. DRY DENSITY)

APPARENT



EFFECTIVE



NORMAL STRESS (TSF)

56 57

CUMBERLAND S.P.

B41 '87 0401 002

BORROW PROPERTIES

SMITH 12-2-86

BORROW AREA E

TRIAXIAL R TEST 96% MAX. DRY DENSITY

R-APPARENT		C (TSF)	Φ (DEG)
CLASS I +2%		1.25	17.0
CLASS I -2%		0.23	35.0
CLASS II +2%		0.17	31.3
CLASS II -2%		0.00	29.0
CLASS III +2%		0.36	18.1
CLASS III -2%		0.00	28.0
CLASS IV +2%		0.51	25.4
CLASS IV -2%		0.83	8.5
	AVG.	0.42	24.0
	LOWER THIRD	0.47	17.3

RECOMMEND $c = 0.2$ TSF $\phi = 25^\circ$

$\bar{R}$-EFFECTIVE		$\bar{c}$ (TSF)	$\bar{\phi}$ (DEG)
CLASS I +2%		0.93	20.1
CLASS I -2%		0.43	35.0
CLASS II +2%		0.00	30.0
CLASS II -2%		0.00	28.0
CLASS III +2%		0.21	20.1
CLASS III -2%		0.00	26.7
CLASS IV +2%		0.00	31.0
CLASS IV -2%		0.71	10.4
	AVG	0.29	25.4
	LOWER THIRD	0.71	18.6

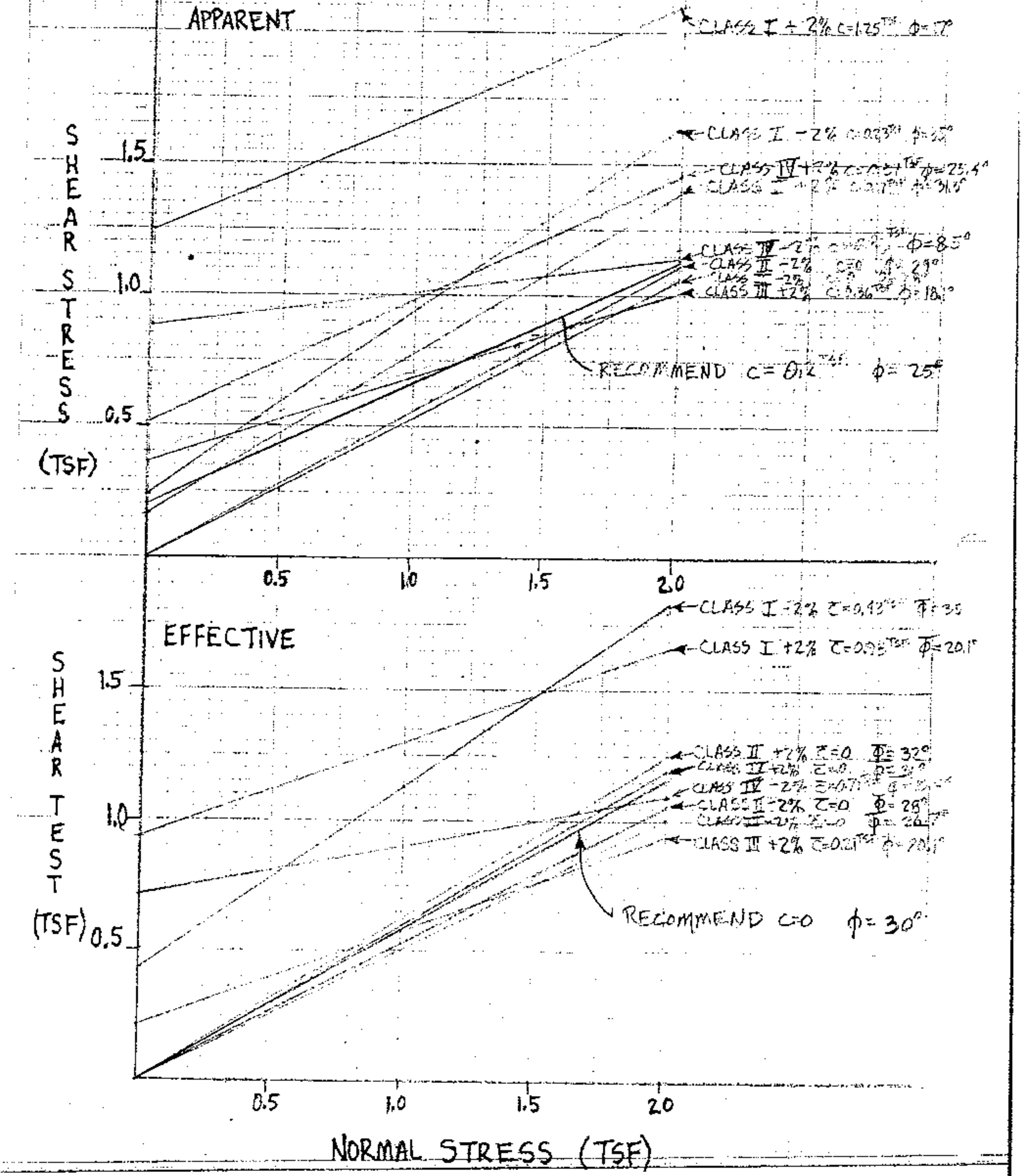
RECOMMEND $\bar{c} = 0.0$ $\bar{\phi} = 30$

computed by JMH date 11-1-86 checked date

B41 '87 0401 002

57/57

CUMBERLAND S.P. TRIAXIAL R TEST
BORROW AREA E (98% MAX. DRY DENSITY)



Law Engineering and Environmental Services, Inc.
(1992)

January 27, 1992

LAW ENGINEERING

GEOTECHNICAL, ENVIRONMENTAL
& CONSTRUCTION MATERIALS
CONSULTANTS

Mr. Steve Baugh
Tennessee Valley Authority
1 D Blue Ridge Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

Subject: Report of Subsurface Exploration and Stability Analyses
Proposed Fly Ash/Scrubber Sludge Disposal Facility
Cumberland Fossil Fuel Plant
Cumberland City, Tennessee
Law Engineering Project No. 57401442.01

Dear Mr. Baugh:

As authorized, Law Engineering has conducted an exploration of the existing fly/bottom ash pond area for the purpose of evaluating its suitability for use as a new disposal facility for coal combustion by-products. This report presents a brief description of the proposed disposal facility, a discussion of the scope of our work, the results of field and laboratory tests, an overview of our analyses of stability, and our recommendations.

We appreciate the opportunity to have worked with you during this phase of the project. If there are any questions, or if we may be of further service, please feel free to contact us at your convenience.

Very truly yours,

LAW ENGINEERING, INC.

Karl E Suter

Karl E. Suter, PE
Senior Engineer

James W. Niehoff

James W. Niehoff, PE
Principal Engineer

0144201.rja

396 PLASTERS AVENUE, N.E.
ATLANTA, GEORGIA 30324
404-873-4761
TELEFAX 404-881-0508

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Test Boring Records
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APPENDIX C - LABORATORY EXPLORATION

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Summary of Law Engineering Laboratory Test Results
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1.0 PROJECT DESCRIPTION

The Cumberland Fossil Fuel Plant is located on the south bank of the Cumberland River, just west of Cumberland City, Tennessee as shown on Figure 1. Currently, the plant generates approximately 500,000 tons of coal combustion by-products each year, consisting of bottom ash and fly ash. These materials are presently removed from the plant by means of a sluicing process, and discharged into a large pond located to the south. At current production rates, it is estimated that the pond may have about 5 years of remaining capacity.

As a result of new clean air regulations, the Tennessee Valley Authority (TVA) is considering the installation of SO_2 scrubbers at the plant. These would produce an estimated 1.2 million tons of scrubber sludge annually.

Considering the above factors, TVA is currently performing a study of by-product disposal needs through the year 2015. As part of this study, a detailed search has been conducted for suitable disposal sites for scrubber sludge, bottom ash, and fly ash. Although many potential sites have been considered, the most favorable location found thus far from an operations standpoint is the existing fly ash/bottom ash pond located to the south of the plant. Although project planning is preliminary at this point, the configuration of the facility will include a wet scrubber sludge stack within the eastern portion of the pond, a basin for reclaimed water in the central portion, a dry fly ash stack in the western portion, and runoff ponds at the western extreme (Figure 2). Both disposal stacks will incorporate 3:1 side slopes (horizontal to vertical) with 20 foot wide horizontal benches every 30 vertical feet.

The purpose of our study has been to evaluate the geotechnical characteristics of the site and to determine if it can be developed as a disposal area without incurring excessive costs related to site preparation or slope configuration.

2.0 SITE DESCRIPTION

The proposed disposal site occupies approximately 360 acres southwest of and adjacent to the generating facility. The existing ash ponds in this location are built above the original ground surface elevation by means of compacted soil dikes up to 40 feet in height with a crest elevation of approximately 395 feet (MSL). These dikes incorporate exterior side slopes of 3 horizontal to 1 vertical. Interior slopes vary from 2.5:1 to 3:1. The crest of the dikes are generally 12 to 15 feet in width.

An intermediate dike extends from northeast to southwest across the middle of the pond, forming two separate storage cells. The easternmost portion has been used both for sluiced ash and as a dredge cell. At the time of this study, the ash surface in this portion of the disposal area was within 4 to 5 feet of the dike crest in some locations. This area is not active at this time. The northwestern section is currently receiving both bottom and fly ash sluiced from the plant. Pond surface elevations vary, but typically are greater than 10 to 15 feet below the surrounding dike crest. Excess water currently drains towards the western extent of this cell.

Beyond the perimeter dike, the ash pond is bounded to the northeast by the remainder of the Cumberland Facility, to the south by an abandoned quarry, and to the north, west, and east by undeveloped land. Further to the north lies the Cumberland River. Wells Creek flows from the south towards the river along the western portions of the perimeter dike. The water surface of the stream is approximately 35 to 40 feet below the dike crest.

3.0 FIELD EXPLORATION

Previous subsurface work within the general site area was conducted by Hall, Blake & Associates in 1986. During their study, a total of 14 borings were drilled in the western portion of the dike to explore the conditions both within and beneath the dike. The study included the exploration of two potential borrow sources to the east and west of the site.

To supplement the available information, we conducted a series of soil test borings within dike areas and dilatometer probes in open pond areas. Descriptions of the testing procedures are presented in the Appendix. A total of 15 soil test borings and 6 dilatometer probes were made. Twelve soil test borings were originally planned at 1000 foot centers along the perimeter dike. The boring locations were modified during the field exploration to include 13 soil test borings and 2 offset borings adjacent to B-9 and B-12 where shallow refusal was encountered. The borings extended to depths of 14 to 45 feet. Five of the borings encountered refusal in the foundation materials. Three of the borings encountered refusal within the dike fill due to the presence of rock fragments and boulders. The dilatometer probes were extended to refusal at depths of 9 to 33 feet.

4.0 SUBSURFACE CONDITIONS

The site stratigraphy was interpreted by reviewing both new and previous data. A drawing indicating the test boring and dilatometer probe locations is included as Figure 3 in Appendix A. Soil test boring and dilatometer records are included in Appendix B. Summaries of prior laboratory test results and the results of the testing from this study are included in Appendix C.

4.1 AREA GEOLOGY

In general, this portion of Tennessee is underlain by nearly flat-lying sedimentary rock consisting of limestone, dolomite and shale of Mississippian and earlier age. However, the plant site itself lies within a large geologic feature known as the Wells Creek Structure. The Wells Creek Structure is roughly circular in shape with a diameter of nearly 2 miles. Within the central part of the structure Knox Dolomite and bedrock of the Stones River Group are exposed. Around the periphery, a series of more recent sedimentary strata are exposed in parallel bands. The rock within the central portion of the feature is highly fractured to a depth of several thousand feet. Beyond the central portion of the structure, a radial and longitudinal pattern has been mapped extending several miles in all directions. Although there is some disagreement among several experts, it appears that the structure was most likely the result of a meteor impact.

4.2 SUBSURFACE MATERIALS

Four general types of subsurface materials were encountered at the site. The subsurface materials existent prior to construction of the dikes included alluvium in and adjacent to the Wells Creek channel and residual soils beneath the alluvium and in areas adjacent to the creek. The dikes are composed of silty clay fill with limestone and chert fragments. The basin formed by the dikes is filled with sluiced bottom ash and fly ash. A second stage of dike construction was conducted on the southern portion of the dike. More detailed descriptions of the materials encountered are provided in the following subsections. Cross sections drawn to represent conditions along the longitudinal axis of the dike are presented on Figures 4 through 6 in Appendix A.

4.2.1 Alluvium

The alluvial soils were deposited in the former floodplain of Wells Creek. Based upon the materials encountered in the borings, it is apparent that the creek changed path numerous times. As a consequence, both the nature and thickness of the alluvial materials varies widely over the site limits. The thickness generally was found to range from 5 to 25 feet in the soil borings. Its composition includes soils with various percentages of clay, sand and gravel. In some locations, sections of tree limbs and other organics were also encountered. Standard Penetration Test "N-values" in the alluvium ranged from 4 to more than 50 blows per foot (bpf). Although some soft and loose zones were encountered in the borings, the alluvium is generally stiff to very stiff where composed of clay, and medium dense where it is sandy.

4.2.2 Residuum

The residual soils encountered were typically moderate to high plasticity silty clays with chert and limestone fragments. Residuum was encountered beneath the alluvium where it was present and at the former ground level where alluvium was absent. Standard penetration test N-values in the residuum ranged from 8 to 26 bpf indicating firm to very stiff soils.

4.2.3 Dike Fill

The dike fill is composed of remolded residual soils. Consequently, it includes moderate to high plasticity silty clay with chert and limestone fragments. Standard penetration test N-value in the fill ranged from 4 to more than 50 bpf with an average of about 17 bpf.

4.2.4 Sluiced Ash

The ash contained by the dike is variable in composition and includes coarse grained bottom ash as well as fine grained fly ash. Typically, the upper 15 to 17 feet of the ash is loose in nature. Below this depth, the ash is somewhat denser and exhibits some cementation. The thickness of ash inside the pond varies based on the pond bottom topography. At our dilatometer probe locations, the ash typically extended to a depth of 20 to 30 feet.

4.3 MATERIAL PROPERTIES

Material properties were obtained from a variety of sources including prior soil test borings and triaxial shear tests conducted by Hall, Blake & Associates, our field and laboratory test results, published data and our experience with similar soils. The following discussion outlines the sources of the soil parameters used in our analyses for each of the major strata.

4.3.1 Dike Materials

Triaxial shear strength tests were conducted by Hall, Blake & Associates on over 30 samples of undisturbed and re-molded soils obtained from the dike and borrow areas. Our review of these tests results revealed some inconsistencies, possibly relating to the initial degree of saturation of the samples. To derive a parameters for stability analysis, we conducted regression analysis of the strength intercept (c) and friction angle (ϕ) for effective and total stress conditions in an effort to establish a trend in the data. A significant trend was noted in the relationship between c and ϕ. As a result, we were able to determine likely combinations of c and ϕ from this data. From the HBA data we estimate undrained strength parameters of $c=1000$ psf, $\phi=20°$ and drained parameters of $c'=400$ psf, and $\phi'=25°$.

As part of our work on this project, a limited program of strength testing was conducted to confirm the order of magnitude of parameters derived during previous studies. The confirmation program included one direct shear test and one triaxial shear strength test conducted on remolded samples of the dike material. The results of the tests are included in Appendix C. Drained strength parameters of $c'=260$ psf, $\phi'=27°$ and undrained parameters of $c=360$ psf, $\phi=14°$ were obtained in the triaxial test. The direct shear test results indicate undrained strength parameters of $c=1080$ psf, and $\phi=34°$.

4.3.2 Foundation Soils

The foundation soils include both alluvium and residual soils. Laboratory test data was not obtained for these materials. The strength parameters were estimated based on the Standard Penetration Test N-values, the results of the tests on the remolded samples of residuum, and on our experience with similar soils. A summary of the soil properties estimated for our stability analyses is included below.

Moist Density	Undrained		Drained	
pcf	c	ϕ	c	ϕ
124	1000	20	300	27
125	1200	20	500	30

4.3.3 Sluiced Ash

Properties of sluiced ash were obtained from the dilatometer data and from published sources. A summary of the published data is presented below:

Dry Density PCF	Moisture Content Percent	Void Ratio e_o	Undrained C psf	Undrained $\phi°$	Drained C'psf	Drained $\phi°$
53 - 90	35 - 55	0.85-1.3	0-660	11-22	0-900	11-28

4.3.4 Compacted Ash

Compacted ash was not present on site at the time of our exploration. The final design includes placement of compacted ash over the sluiced ash within the existing dike. Properties of compacted ash were estimated based on results of a standard Proctor compaction test and published values. The range of values is summarized below:

Maximum Dry PCF Density	Optimum Moisture Content Percent	Specific Gravity	Undrained		Drained	
			psf	ϕ°	C'psf	ϕ°
90 - 100	14 - 23	2.3-2.5	0	34-35.5	0	37.5

4.3.5 Scrubber Sludge

Based upon our discussions with TVA, the process to be used to clean SO_2 emissions is new. As such, the properties of the resulting scrubber sludge are not known at this time. For the purposes of our study, we have assumed that the new scrubber sludge will have properties similar to that of compacted fly ash.

5.0 ANALYSES

The primary emphasis of this study concerned the stability of the new waste disposal facilities when constructed atop a relatively loose zone of granular material. Our analyses considered two major factors including: 1) the resistance of the sluiced ash to liquefaction under dynamic (earthquake) loading conditions, and 2) the resistance of the overall disposal facility configuration to instability under both static, steady state conditions, and under dynamic, earthquake loading conditions. Descriptions of both of these factors follow in the next subsections.

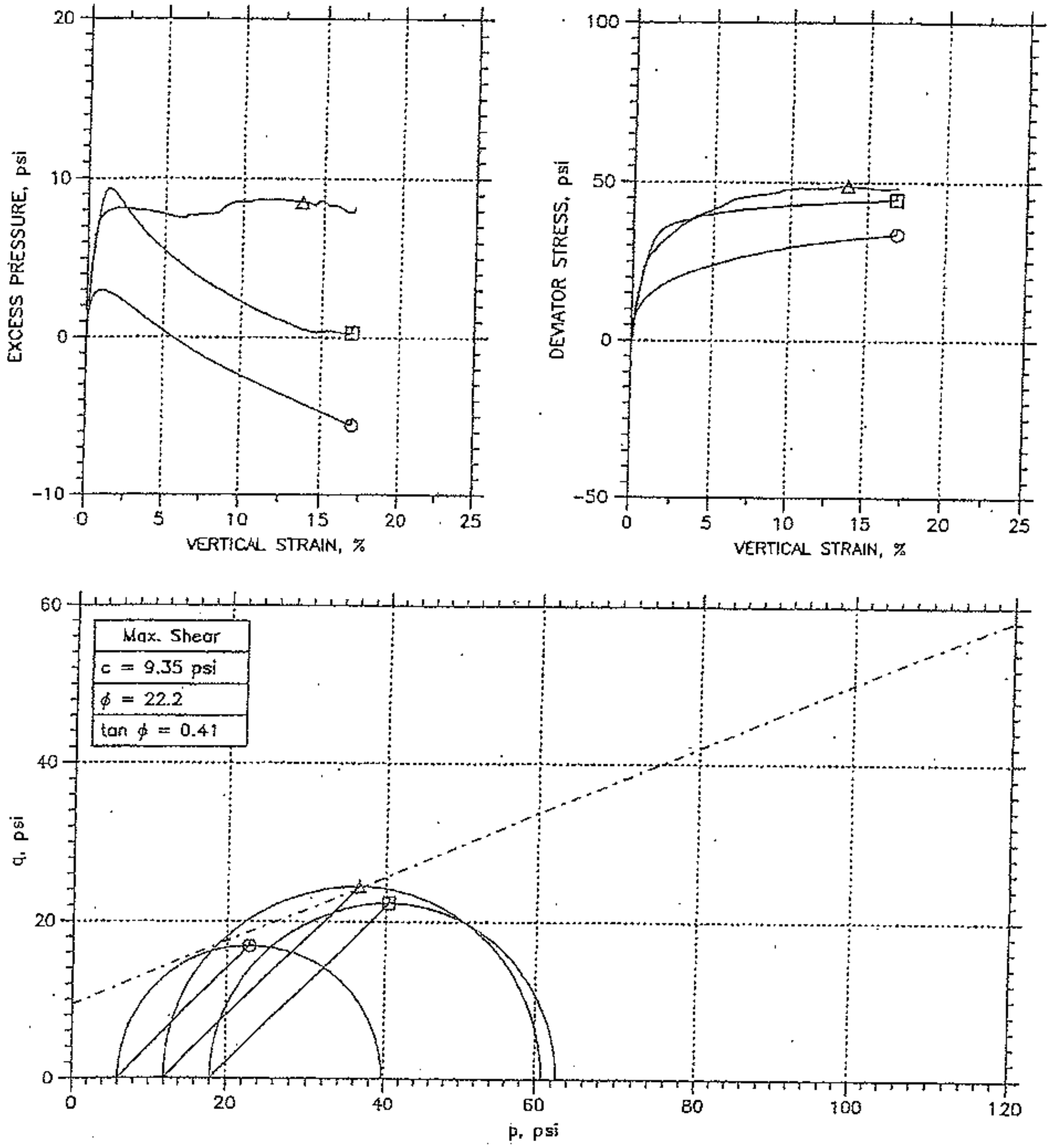
5.1 LIQUEFACTION ASSESSMENT

Liquefaction is a temporary loss of shear strength in cohesionless materials caused by an increase in pore water pressure. In the case of liquefaction, the pore water pressure equals the contact pressure between soil particles and the frictional resistance between the particles is lost. It is a documented phenomenon which can be caused by dynamic loading such as the rapid cyclic shear loading during an earthquake. During an earthquake, the cyclic waves propagating from the underlying rock create shear stresses and resulting shear strains in the soil mass. In the case of loose cohesionless soils, this tends to densify the soil. If the soil is below the water table, the voids between soil particles are filled with water which is relatively incompressible. As the soil tries to densify, it compresses the pore water between the soil particles creating an increase in pore water pressure. If the pore water pressure reaches a point where it exceeds the confining stress, the soil liquefies temporarily until the

TVA – CUMBERLAND CITY
SLOPE STABILITY ANALYSIS – TABLE #1
SOIL STRENGTH PARAMETERS

SOIL DESCRIPTION	STRENGTH PARAMETERS				UNIT WEIGHT	UNIT WEIGHT
	C (PSF)	Ø (DEG.)	C′ (PSF)	Ø′ (DEG.)	(MOIST) (PCF)	(SAT.) (PCF)
COMPACTED ASH	0	34	0	36	105	110
SLUICED ASH	0	25	0	28	100	105
DIKE FILL	1000	20	300	25	124	130
WATER	0	0	0	0	62.4	62.4
UPPER SOIL SUBGRADE	1000	20	300	27	124	130
LOWER SOIL SUBGRADE	1200	20	500	30	125	130

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	UD-1	7066.1	5-7 ft	HJ	3/3/07	JL	4/13/07	7066.1a_90.dat
△	UD-2	7067.2	7-9 ft	HJ	3/3/07	JL	4/13/07	7067.2a_93.dat
⊡	UD-3	7067.3	9-11 ft	HJ	3/4/07	JL	4/13/07	7067.3a_96.dat

MACTEC

Project: TVA CUF Gypsum Seepage	Location: MWA1	Project No.: 3043061041
Boring No.: MWA1	Sample Type: Shelby Tube	
Description: Brown Lean Clay		
Remarks:		

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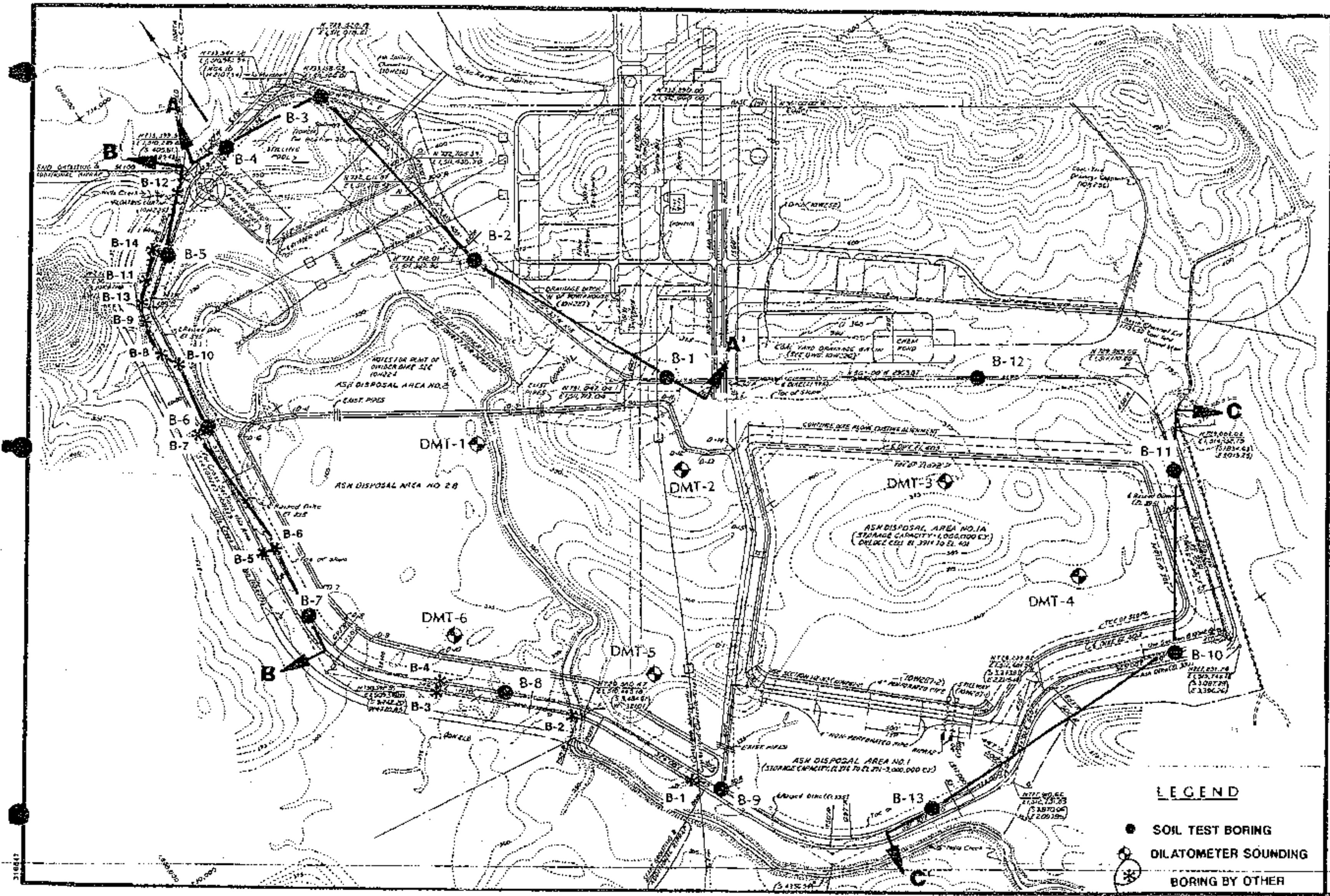


HBA 1986

LAW ENGINEERING

Atlanta, Georgia

Geotechnical, Materials & Environmental Consultants

TVA - CUMBERLAND CITY
CUMBERLAND CITY, TENNESSEE

SCALE	PROJECT NO.	DATE
1"=500'	57401442.01	JAN./1992

FIGURE 3

BORING LOCATION PLAN

United Engineers and Constructors Inc. (1992)

GENERAL COMPUTATION SHEET

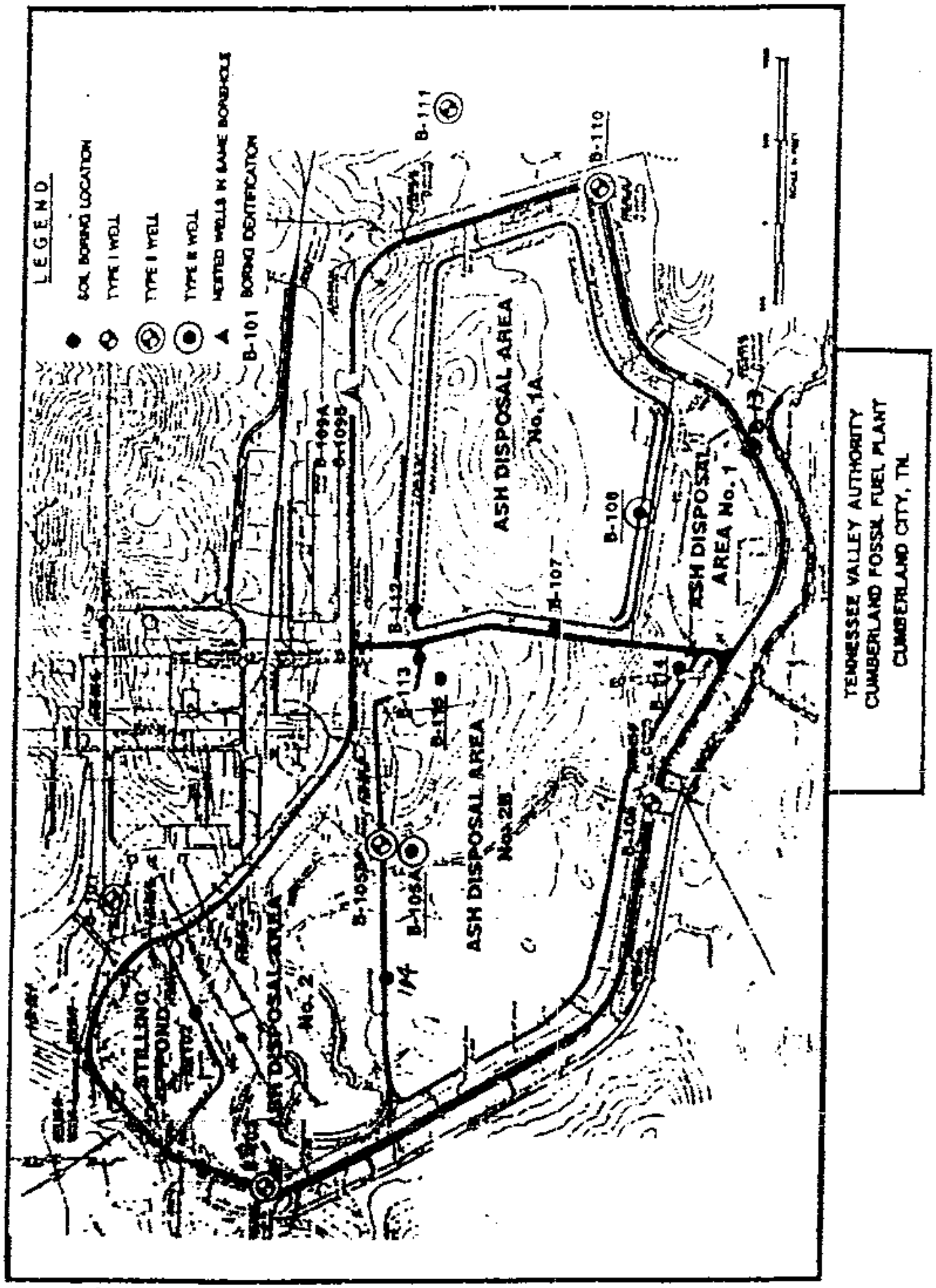
(DISCIPLINE)

United Engineers & Constructors
A Raytheon Company

NAME OF COMPANY TVA UNIT/S

SUBJECT FLY ASH/GYPSUM STACK STABILITY

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	8.S DATE 8-14-92	DJV DATE 8-14-92
FINAL	6314-GT-DA-001			
VOID			DATE	DATE
SHEET	4 OF 45			
JO	6314.006/009			



GENERAL COMPUTATION SHEET

(DISCIPLINE)

United Engineers & Constructors
A Raytheon Company

NAME OF COMPANY TVA UNIT/S

SUBJECT FLY ASH/GYPSUM STACK STABILITY

CALC SET NO		REV	COMP BY	CHKD BY
PRELIM		0	S. C. DATE 8-14-92	DATE 8-14-92
FINAL	6314-GT-DA-001			
VOID				
SHEET	6 OF 45		DATE	DATE
SO	6314.006/009			

SOIL PROPERTIES

The undrained strength parameters of the dike materials, flyash, bottom ash, gypsum, and in-situ clay are summarized as follows:

	Density (pcf)	Cohesion (psf)	Phi (deg)
Dike Fill:	125	1000	0
Sluiced Flyash:	100	0	25
Compacted Flyash:	105	0	32
Bottom Ash:	120	0	35
Compact Bottom Ash:	125	0	38
Gypsum:	100	0	35
In-situ Soft Clay:	120	400	10
In-situ Stiff Clay:	125	500	20

The impact of seismic loading upon the strength parameters of soils may be approximated as follows:

1. Dynamic friction angle of soil is equal to the static friction angle reduced by 2 degrees.(P. 228, Ref. 4)

2. Dynamic undrained cohesion of soil is equal to 1.5 times the static undrained cohesion.(P. 232, Ref. 4)

For seismic conditions, the undrained strength parameters of the dike materials, flyash, bottom ash, gypsum, and in-situ clay are summarized as follows:

	Density (pcf)	Cohesion (psf)	Phi (deg)
Dike Fill:	125	1500	0
Sluiced Flyash:	100	0	23
Compacted Flyash:	105	0	30
Bottom Ash:	120	0	33
Compact Bottom Ash:	125	0	36
Gypsum:	100	0	33
In-situ Soft Clay:	120	600	8
In-situ Stiff Clay:	125	750	18

MACTEC Engineering and Consulting, Inc. (2007)

GROUP SYMBOLS	TYPICAL NAMES	GROUP SYMBOLS	TYPICAL NAMES
▨	TOPSOIL	▨	CONCRETE
▨	ASPHALT	▤	DOLOMITE
▨	GRAVEL	▦	LIMESTONE
▨	FILL	▤	SHALE
▦	SUBSOIL	▤	LIMESTONE/SHALE - Limestone with shale interbeds
▨	ALLUVIUM	▨	SANDSTONE
▨	ASH	▥	SILTSTONE
▨	RESIDUUM - Soft to firm	▥	AUGER BORING
▨	RESIDUUM - Stiff to very hard	▥	UNDISTURBED SAMPLE ATTEMPT

BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.

SILT OR CLAY	SAND			GRAVEL		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

No.200 No.40 No.10 No.4 3/4" 3" 12"

U.S. STANDARD SIEVE SIZE

Reference: The Unified Soil Classification System, Corps of Engineers, U.S. Army Technical Memorandum No. 3-357, Vol. 1, March, 1953 (Revised April, 1960)

▨	Undisturbed Sample 1.5-2.0 = Recovered (ft) / Pushed (ft)		
▨	Split Spoon Sample	▨	Auger Cuttings
▯	Rock Core 60-100 = RQD / Recovery	▩	Dilatometer
	No Sample	▧	Crandall Sampler
▯	Rotary Drill	▨	Pressure Meter
▽	Water Table at time of drilling	○	No Recovery
		▼	Water Table after 24 hours

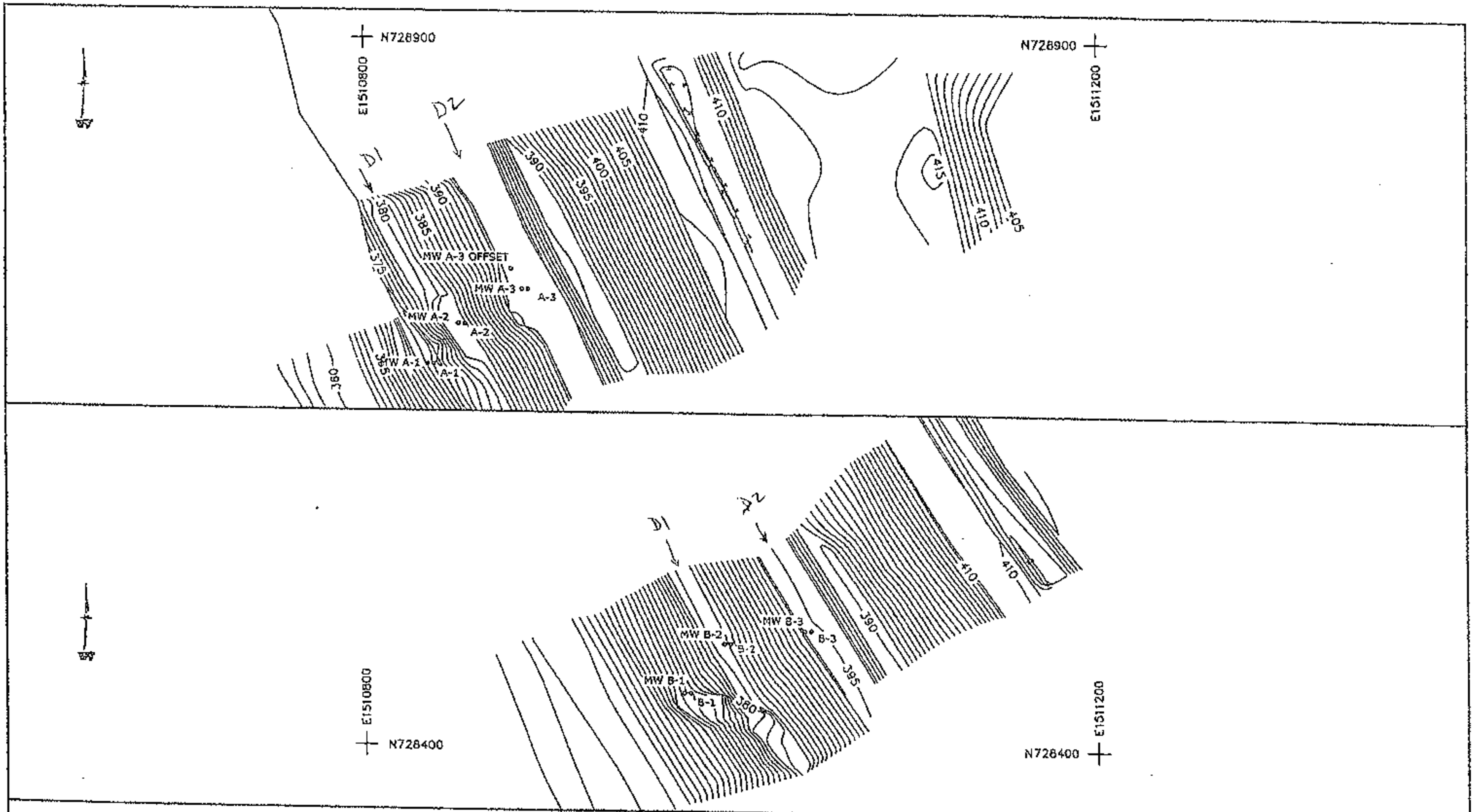
Correlation of Penetration Resistance with Relative Density and Consistency

SAND & GRAVEL		SILT & CLAY	
No. of Blows	Relative Density	No. of Blows	Consistency
0 - 4	Very Loose	0 - 2	Very Soft
5 - 10	Loose	3 - 4	Soft
11 - 20	Firm	5 - 8	Firm
21 - 30	Very Firm	9 - 15	Stiff
31 - 50	Dense	16 - 30	Very Stiff
Over 50	Very Dense	31 - 50	Hard
		Over 50	Very Hard

KEY TO SYMBOLS AND DESCRIPTIONS

MACTEC

MACTEC Engineering and Consulting of Georgia, Inc.
1725 Louisville Drive
Knoxville, Tennessee 37921-5904
865-588-8544 • Fax: 865-588-8026



LEGEND

A-1	BORING LOCATION AND IDENTIFICATION
MW A-1	MONITORING WELL LOCATION AND IDENTIFICATION

MACTEC

MACTEC Engineering and Consulting, Inc.
1725 Louisville Drive
Knoxville, Tennessee 37921-5904
865-588-8544 • Fax: 865-588-8026

FIGURE 2: BORING AND MONITORING WELL LOCATION PLAN
GYPSUM SEEPAGE AREA STUDY - TVA CUMBERLAND FOSSIL PLANT
CUMBERLAND CITY, TENNESSEE

DRAFTING BY:	PREPARED BY:	CHECKED BY:
JOB NUMBER: 3043061041/001	DATE: APRIL 27, 2007	SCALE: 0 50'

SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

DEPTH (ft)	ELEV (ft)
0	374.0
5	369.0
10	364.0
15	359.0
20	354.0
25	349.0
30	344.0
35	339.0
40	334.0
45	329.0

VERY LOOSE TO LOOSE, GRAY, MOIST, SANDY GRAVEL WITH A LITTLE SILT - FILL

FIRM TO STIFF, REDDISH BROWN, MOIST TO VERY MOIST, SILTY CLAY WITH CHERT AND ROCK FRAGMENTS - FILL

FIRM TO STIFF, BROWN TO GRAY AND REDDISH BROWN, MOIST, SILTY CLAY WITH SOME SAND AND ROCK FRAGMENTS - FILL

VERY STIFF, ORANGISH BROWN TO GRAY, MOIST, SILTY CLAY WITH ROCK FRAGMENTS AND A TRACE OF SAND - FILL

STIFF, REDDISH TO ORANGISH BROWN, MOIST, SILTY CLAY WITH CHERT AND ROCK FRAGMENTS - FILL

STIFF TO FIRM, ORANGISH BROWN TO GRAY, MOIST, SILTY CLAY WITH ROCK FRAGMENTS - FILL

FIRM, GRAY, MOIST, CLAYEY SILT WITH A TRACE OF SAND - ALLUVIUM

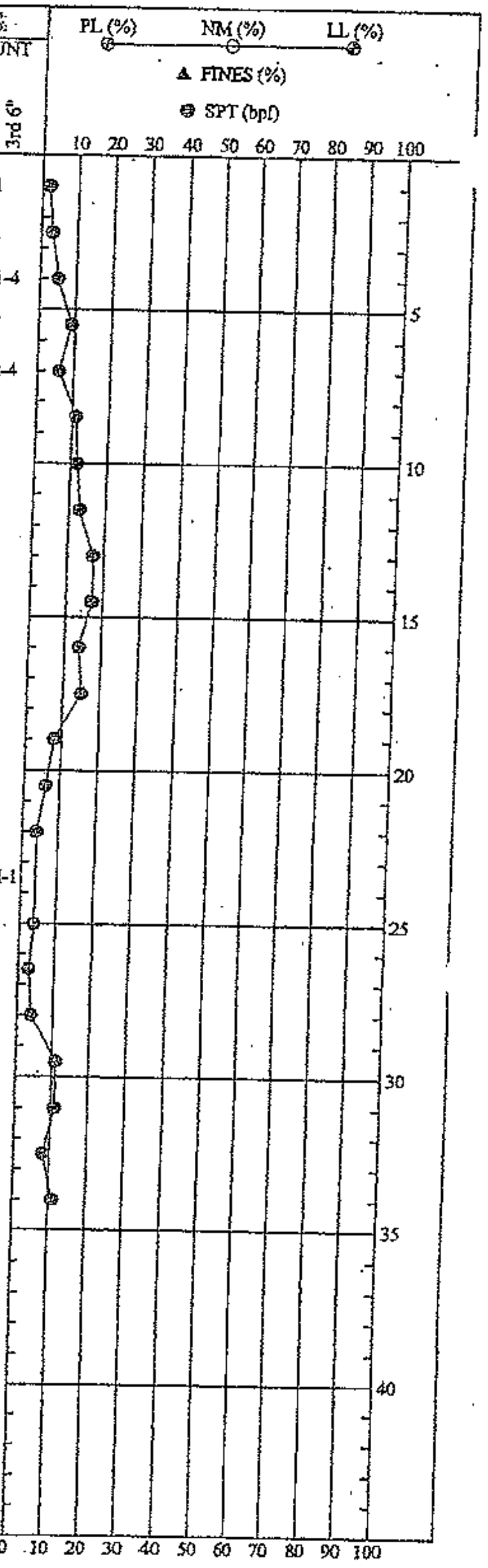
SOFT TO VERY SOFT, GRAY TO BROWN, MOIST TO VERY MOIST, SILTY CLAY - ALLUVIUM

VERY LOOSE, ORANGISH BROWN, VERY MOIST TO WET, SILTY SAND - ALLUVIUM ▽

FIRM TO LOOSE, ORANGISH BROWN, WET, SILTY SAND - ALLUVIUM

BORING TERMINATED AT 35.0'

SAMPLES IDENT	N-COUNT 1st 6" 2nd 6" 3rd 6"
SPT-1	1-1-1
SPT-2	1-2-1
SPT-3	WOH-1-4
SPT-4	2-4-5
SPT-5	WOH-2-4
SPT-6	4-5-6
SPT-7	5-5-7
SPT-8	4-5-8
SPT-9	4-7-10
SPT-10	7-9-8
SPT-11	4-6-8
SPT-12	5-7-8
SPT-13	3-4-4
SPT-14	3-3-3
SPT-15	1-2-2
SPT-16	WOH-WOH-1
SPT-17	WOH-2-2
SPT-18	WOH-1-2
SPT-19	1-2-2
SPT-20	5-6-5
SPT-21	4-6-5
SPT-22	5-3-5
SPT-23	5-6-5-8



SOIL 3043061041 01.GPJ LAW GIBB.GDT 4/25/07

REMARKS: STANDARD PENETRATION RESISTANCE TESTING PERFORMED USING AN AUTOMATIC HAMMER. DRILLER REPORTED GROUNDWATER STABILIZING WITHIN THE BOREHOLE AT A DEPTH OF ABOUT 20' AFTER SAMPLING THE SUBMERGED ZONE AT A DEPTH OF ABOUT 25'.

SOIL TEST BORING RECORD

PROJECT: TVA CUF Gypsum Seepage Study

DRILLED: December 7, 2006

BORING NO.: A-1

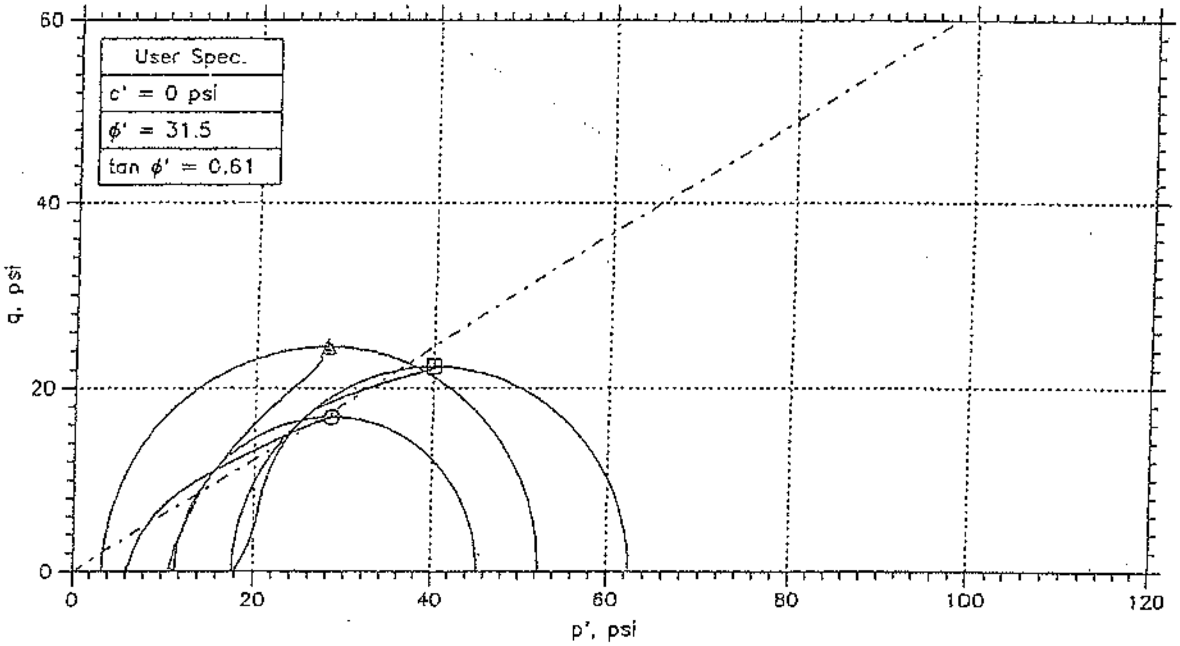
PROJ. NO.: 3043061041/0001

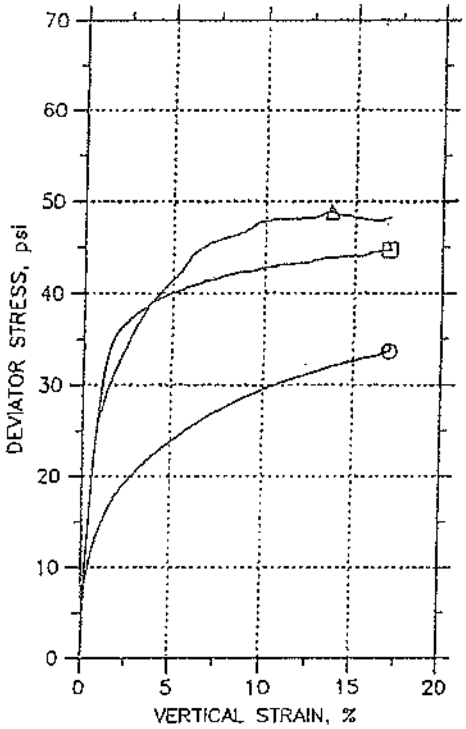
PAGE 1 OF 1

Driller: Akins
Prepared By: RDR
Checked By: Justice

MACTEC

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

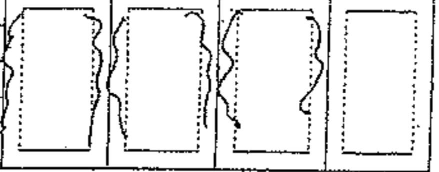




	Symbol	○	△	⊡	
	Sample No.	UD-1	UD-2	UD-3	
	Test No.	7066.1	7067.2	7067.3	
	Depth	5-7 ft	7-9 ft	9-11 ft	
Initial	Diameter, in	2.86	2.795	2.87	
	Height, in	5.6	5.6	6	
	Water Content, %	18.9	17.4	17.9	
	Dry Density, pcf	107.8	111.9	110.2	
	Saturation, %	90.3	92.7	91.2	
	Void Ratio	0.564	0.506	0.529	
Before Shear	Water Content, %	20.0	19.5	20.1	
	Dry Density, pcf	109.4	110.4	109.2	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.541	0.527	0.544	
	Back Press., psi	25.	20.95	35.89	
	Ver. Eff. Cons. Stress, psi	6.001	11.97	17.99	
	Shear Strength, psi	16.83	24.42	22.33	
	Strain at Failure, %	17	13.7	16.9	
	Strain Rate, %/min	0.1	0.1	0.1	
	B-Value	0.96	0.97	0.97	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	45	45	45	
	Plastic Limit	19	19	19	

MACTEC

Project: TVA CUF Gypsum Seepage
Location: MWA1
Project No.: 3043061041
Boring No.: MWA1
Sample Type: Shelby Tube
Description: Brown Lean Clay
Remarks:



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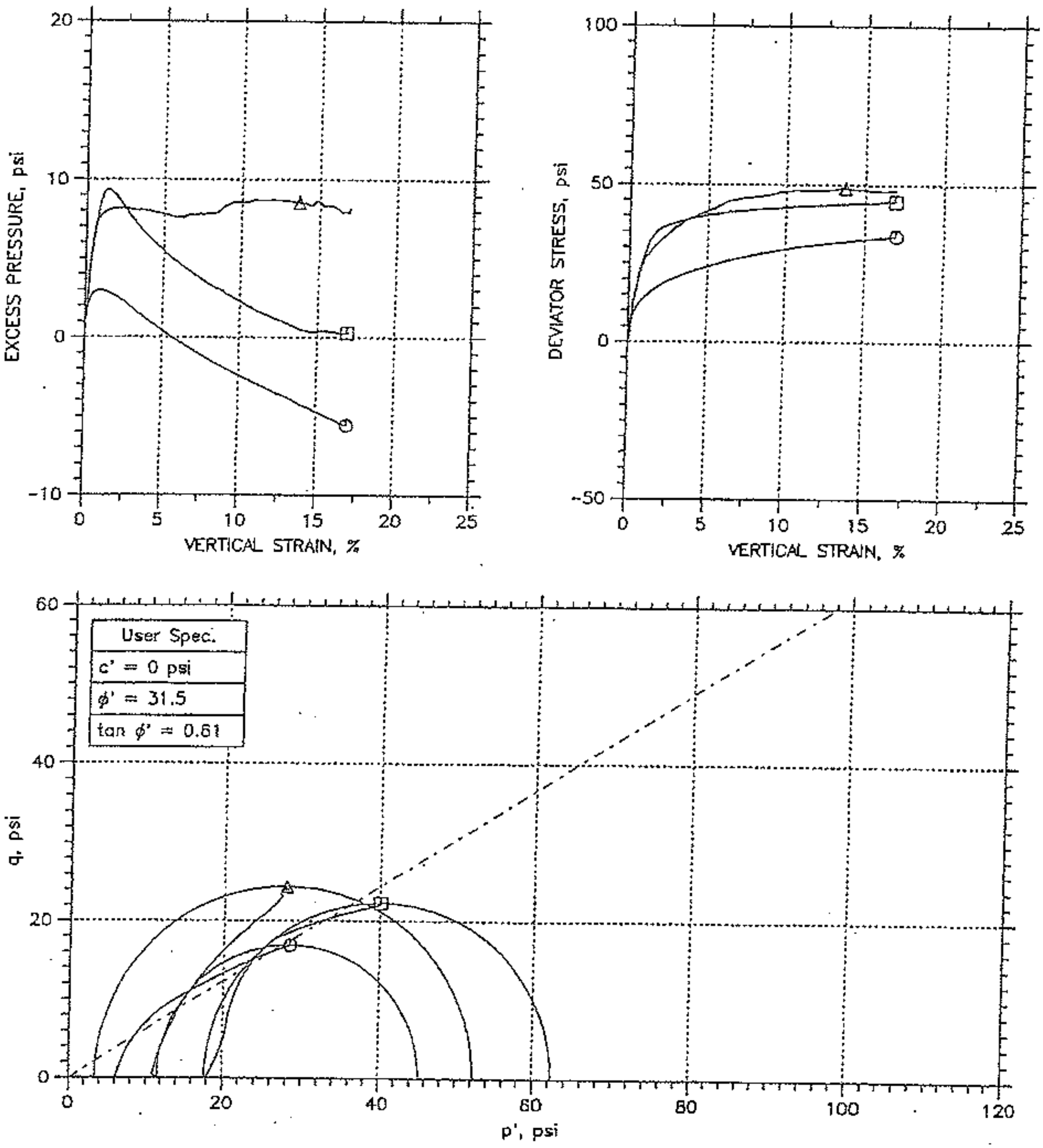
Phase calculations based on start and end of test.

* Saturation is set to 100% for phase calculations.

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
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△	UD-2	7067.2	7-9 ft	HJ	3/3/07	JL	4/13/07	7067.2a_93.dat
□	UD-3	7067.3	9-11 ft	HJ	3/4/07	JL	4/13/07	7067.3a_96.dat

MACTEC

Project: TVA CUF Gypsum Seepag
Location: MWA1
Project No.: 3043061041
Boring No.: MWA1
Sample Type: Shelby Tube
Description: Brown Lean Clay
Remarks:

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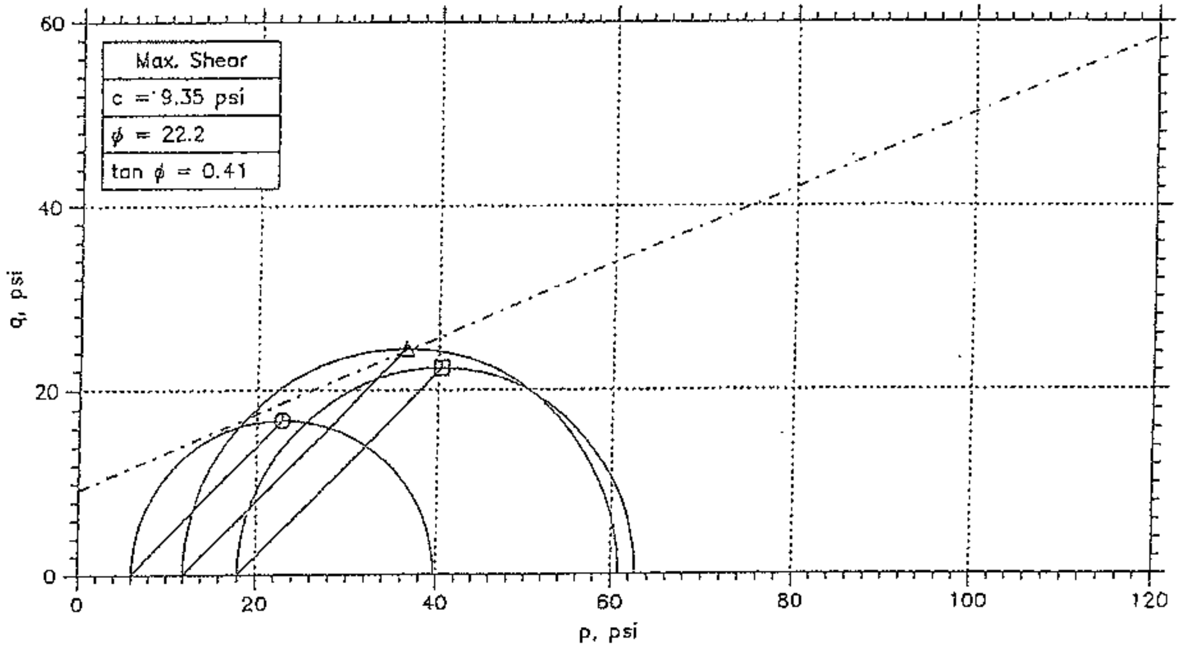
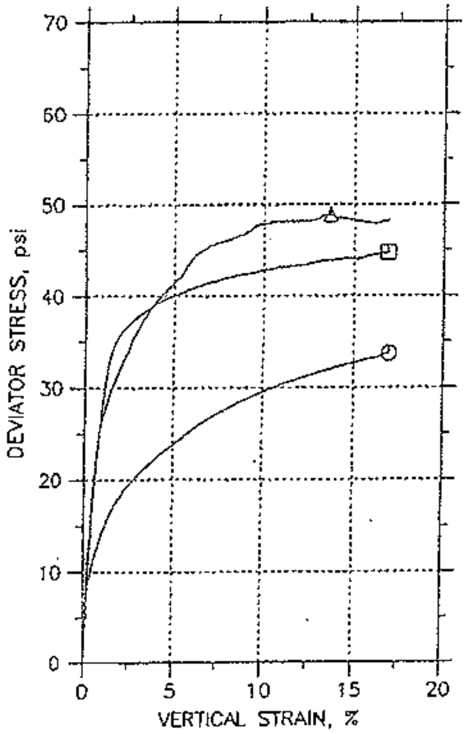
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

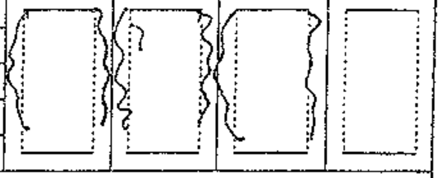




	Symbol	○	△	□	
	Sample No.	UD-1	UD-2	UD-3	
	Test No.	7066.1	7067.2	7067.3	
	Depth	5-7 ft	7-9 ft	9-11 ft	
Initial	Diameter, in	2.86	2.795	2.87	
	Height, in	5.6	5.6	6	
	Water Content, %	18.9	17.4	17.9	
	Dry Density, pcf	107.8	111.9	110.2	
	Saturation, %	90.3	92.7	91.2	
	Void Ratio	0.564	0.506	0.529	
Before Shear	Water Content, %	20.0	19.5	20.1	
	Dry Density, pcf	109.4	110.4	109.2	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.541	0.527	0.544	
	Back Press., psi	25.	20.95	35.89	
	Ver. Eff. Cons. Stress, psi	6.001	11.97	17.99	
	Shear Strength, psi	16.83	24.42	22.33	
	Strain at Failure, %	17	13.7	16.9	
	Strain Rate, %/min	0.1	0.1	0.1	
	B-Value	0.96	0.97	0.97	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	45	45	45	
	Plastic Limit	19	19	19	

MACTEC

Project: TVA CUF Gypsum Seepage
Location: MWA1
Project No.: 3043061041
Boring No.: MWA1
Sample Type: Shelby Tube



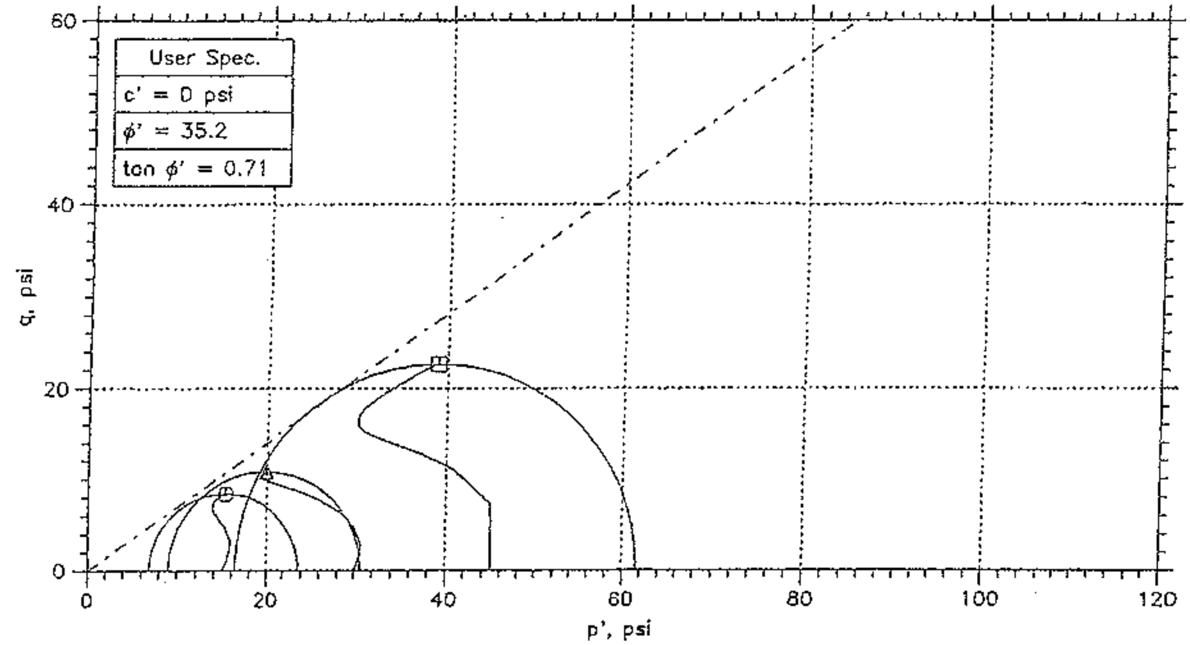
Description: Brown Lean Clay
Remarks:

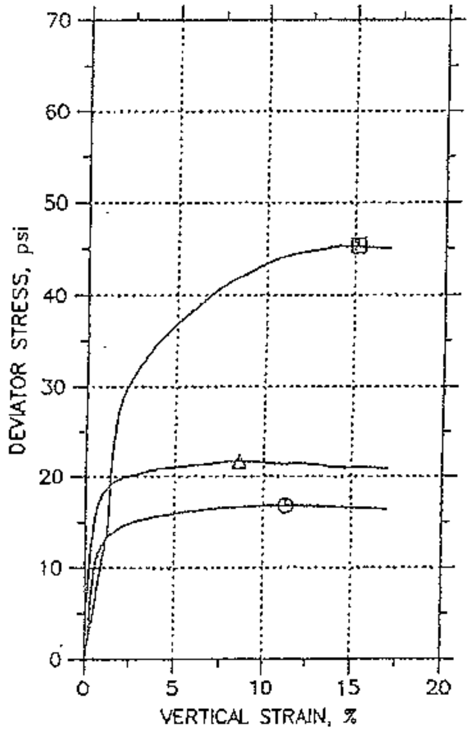
~~Phase calculations based on start and end of test.~~

Mon, 16-APR-2007 08:23:58

* Saturation is set to 100% for phase calculations.

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

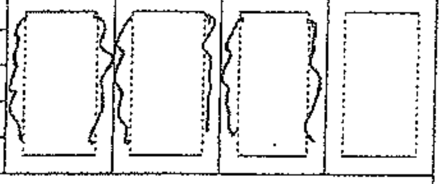




Symbol		○	△	□	
Sample No.		UD-6	UD-6	UD-6	
Test No.		7074.1	7074.2	7074.3	
Depth		22-24 ft.	22-24 ft.	22-24 ft.	
Initial	Diameter, in	2.824	2.86	2.866	
	Height, in	5.6	5.6	5.6	
	Water Content, %	25.1	24.8	23.5	
	Dry Density, pcf	100.4	98.68	102.1	
	Saturation, %	99.7	94.6	97.6	
	Void Ratio	0.679	0.708	0.651	
Before Shear	Water Content, %	23.1	22.0	19.8	
	Dry Density, pcf	103.8	105.7	109.8	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.624	0.595	0.535	
	Back Press., psi	28.93	73.99	61.01	
Ver. Eff. Cons. Stress, psi		15.	30.	44.99	
Shear Strength, psi		8.389	10.84	22.61	
Strain at Failure, %		11.3	8.55	15.2	
Strain Rate, %/min		0.1	0.1	0.1	
B-Value		0.96	0.98	0.99	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		25	25	25	
Plastic Limit		19	19	19	

MACTEC

Project: TVA CUF Gypsum Seepage
Location: MWA1
Project No.: 3043061041
Boring No.: MWA1
Sample Type: Shelby Tube
Description: Brown Silty Clay with Sand
Remarks:



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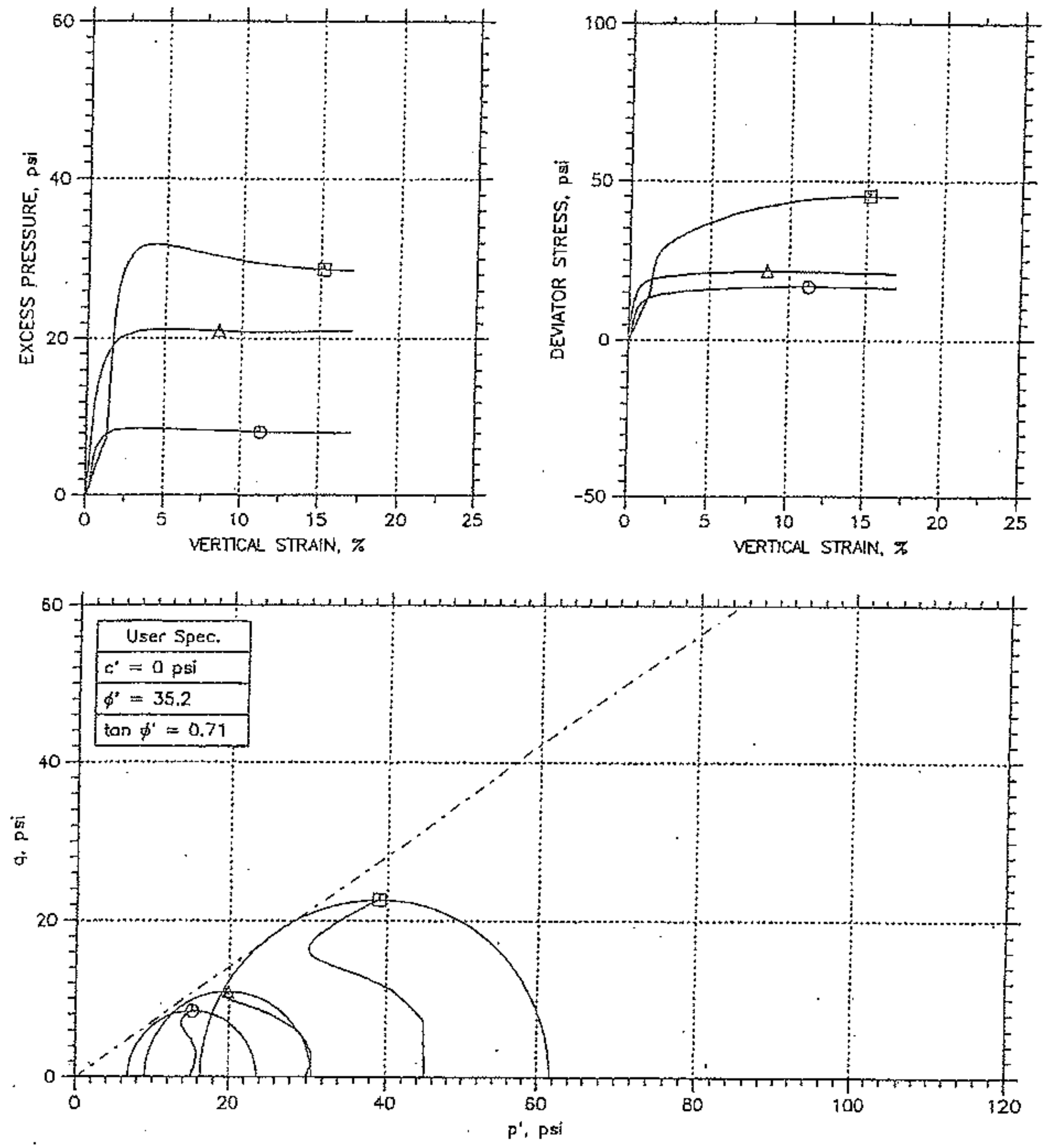
Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	UD-6	7074.1	22-24 ft.	HJ	2/10/07/	JL	4/13/07	7074.1_90.dat
△	UD-6	7074.2	22-24 ft.	HJ	2/10/07	JL	4/13/07	7074.2_82.dat
□	UD-6	7074.3	22-24 ft.	HJ	2/10/07	JL	4/13/07	7074.3_65.dat

MACTEC

Project: TVA CUF Gypsum Seepage	Location: MWA1	Project No.: 3043061041
Boring No.: MWA1	Sample Type: Shelby Tube	

Description: Brown Silty Clay with Sand

Remarks:

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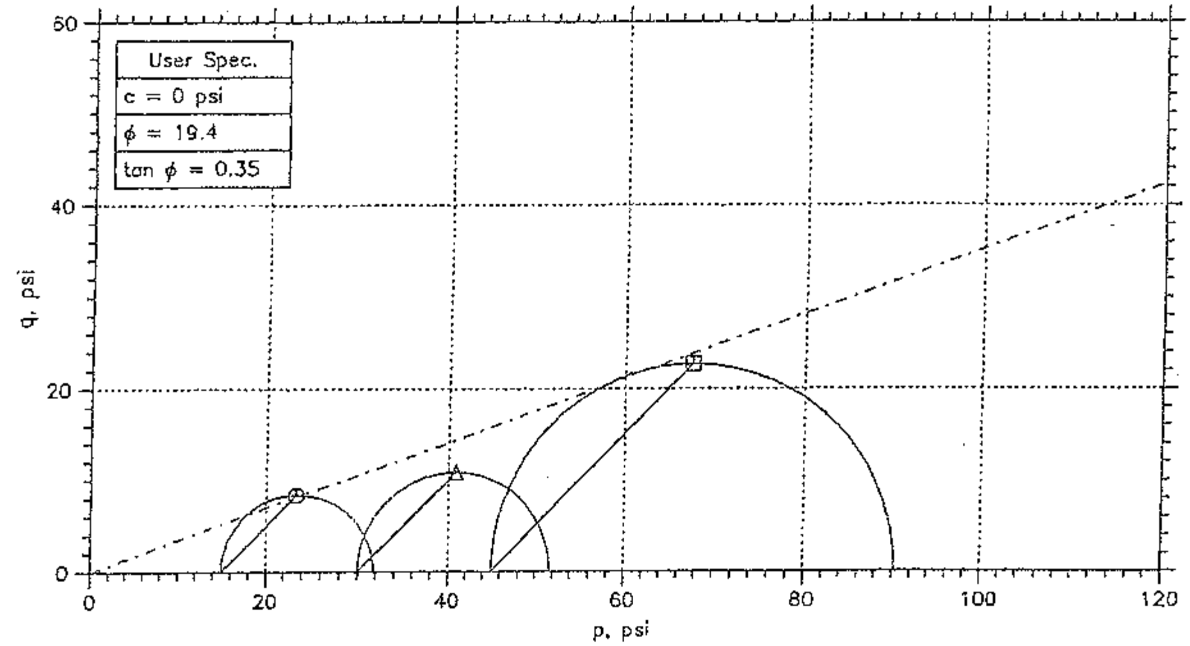
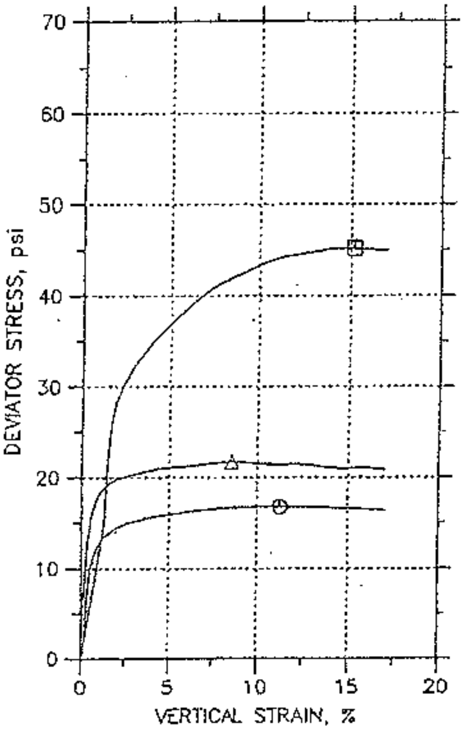
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

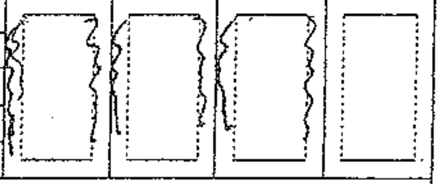




	Symbol	○	△	□	
	Sample No.	UD-6	UD-6	UD-6	
	Test No.	7074.1	7074.2	7074.3	
	Depth	22-24 ft.	22-24 ft.	22-24 ft.	
Initial	Diameter, in	2.824	2.86	2.866	
	Height, in	5.6	5.6	5.6	
	Water Content, %	25.1	24.8	23.5	
	Dry Density, pcf	100.4	98.68	102.1	
	Saturation, %	99.7	94.6	97.6	
	Void Ratio	0.679	0.708	0.651	
Before Shear	Water Content, %	23.1	22.0	19.8	
	Dry Density, pcf	103.8	105.7	109.8	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.624	0.595	0.535	
	Back Press., psi	28.93	73.99	61.01	
	Ver. Eff. Cons. Stress, psi	15.	30.	44.99	
	Shear Strength, psi	8.389	10.84	22.61	
	Strain at Failure, %	11.3	8.55	15.2	
	Strain Rate, %/min	0.1	0.1	0.1	
	B-Value	0.96	0.98	0.99	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	25	25	25	
	Plastic Limit	19	19	19	

MACTEC

Project: TVA CUF Gypsum Seepage
Location: MWA1
Project No.: 3043061041
Boring No.: MWA1
Sample Type: Shelby Tube



Description: Brown Silty Clay with Sand
Remarks:

~~Phase calculations based on start and end of test.~~

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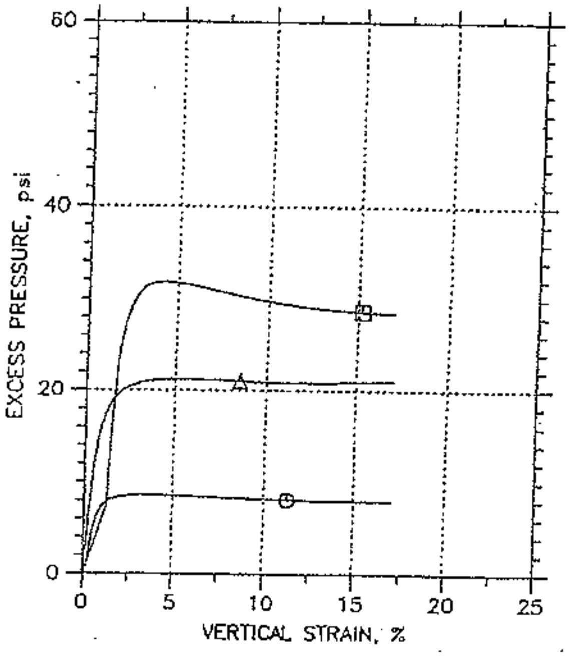
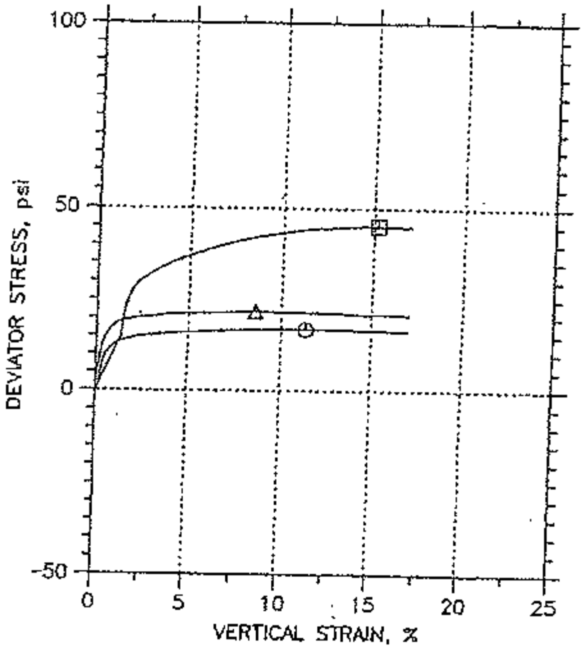
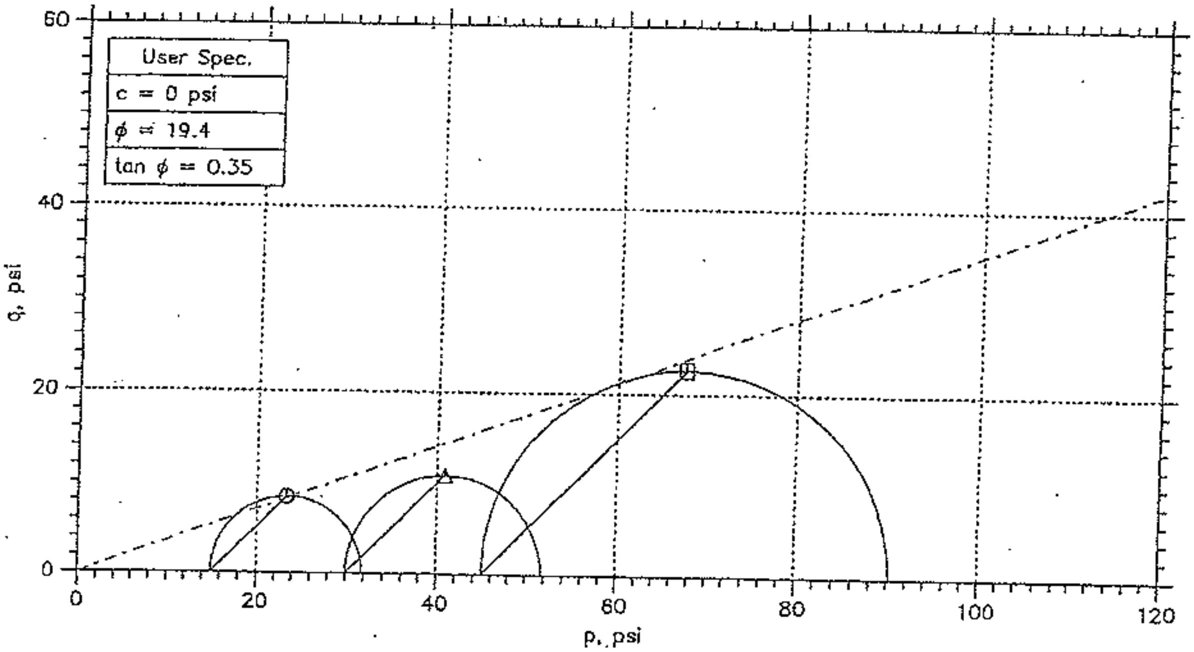
* Saturation is set to 100% for phase calculations.

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





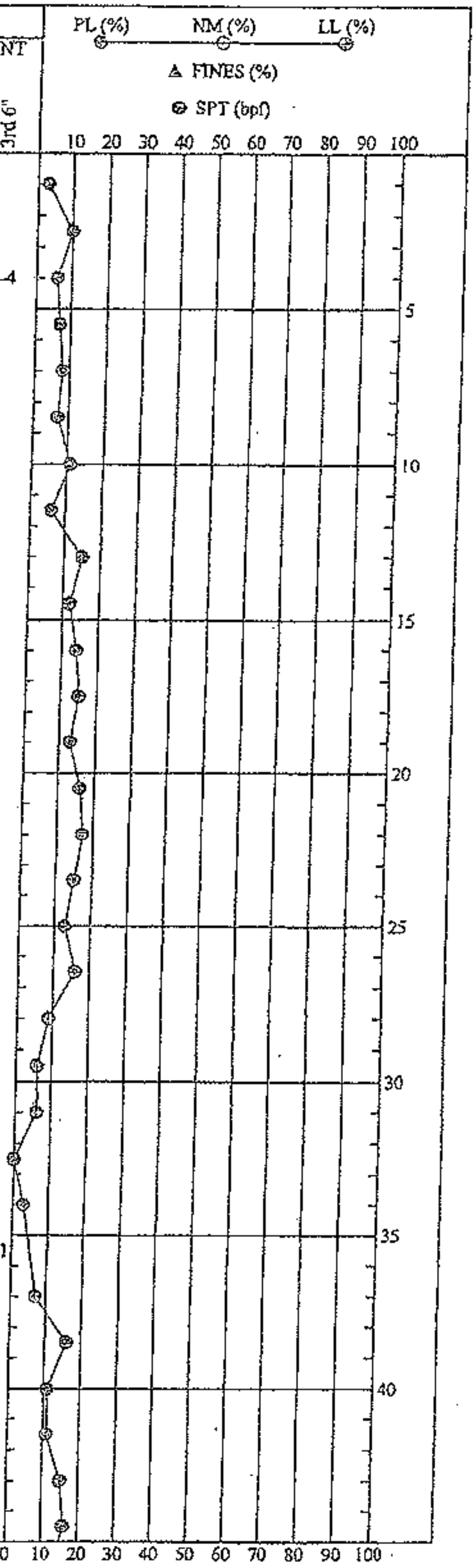


	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	UD-6	7074.1	22-24 ft.	HJ	2/10/07/	JL	4/13/07	7074.1_90.dat
△	UD-6	7074.2	22-24 ft.	HJ	2/10/07	JL	4/13/07	7074.2_82.dat
□	UD-6	7074.3	22-24 ft.	HJ	2/10/07	JL	4/13/07	7074.3_65.dat

MACTEC	Project: TVA CUF Gypsum Seepage	Location: MWA1	Project No.: 3043061041
	Boring No.: MWA1	Sample Type: Shelby Tube	
	Description: Brown Silty Clay with Sand		
	Remarks:		

Mon, 16-APR-2007 08:49:10

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	ELEV (ft)	SAMPLES IDENT	N-COUNT 1st 6" 2nd 6" 3rd 6"
0	VERY LOOSE, GRAY TO BROWN, MOIST, SANDY GRAVEL - FILL	382.0	SPT-1	1-2-1
	STIFF TO FIRM, BLACK, VERY MOIST, CLAYEY SILT WITH ORGAINCS - FILL		SPT-2	5-8-2
	FIRM TO STIFF, ORANGISH BROWN, BROWN, AND GRAY, MOIST, SILTY CLAY WITH ROCK FRAGMENTS AND A TRACE OF SAND - FILL		SPT-3	WOH-2-4
5		377.0	SPT-4	1-3-4
			SPT-5	2-4-4
			SPT-6	3-4-3
10		372.0	SPT-7	2-5-6
			SPT-8	5-2-4
	STIFF, REDDISH BROWN, MOIST, SILTY CLAY WITH ROCK FRAGMENTS - FILL		SPT-9	5-7-8
15	STIFF TO VERY STIFF, GRAY TO BROWN, MOIST, SILTY CLAY WITH A LITTLE SAND AND ROCK FRAGMENTS - FILL	367.0	SPT-10	10-5-7
			SPT-11	4-7-7
			SPT-12	5-7-8
			SPT-13	5-6-7
20		362.0	SPT-14	3-9-7
			SPT-15	5-6-11
			SPT-16	6-7-8
25		357.0	SPT-17	4-5-8
	VERY STIFF, BROWN TO REDDISH BROWN, MOIST, SILTY CLAY WITH CHERT AND ROCK FRAGMENTS - FILL		SPT-18	5-6-10
	STIFF TO FIRM, GRAYISH BROWN TO BLACK, MOIST TO VERY MOIST, CLAYEY SILT WITH A FEW ROCK FRAGMENTS - ALLUVIUM		SPT-19	4-4-5
30		352.0	SPT-20	2-3-3
			SPT-21	2-3-3
	VERY SOFT, DARK GRAYISH BROWN, VERY MOIST, SILTY CLAY WITH A LITTLE SAND - ALLUVIUM ▽		SPT-22	WOH
	VERY LOOSE TO LOOSE, BROWN, WET, SILTY SAND - ALLUVIUM		SPT-23	WOH-1-2
35		347.0	SPT-24	WOH-WOH-1
			SPT-25	1-3-4
	FIRM, ORANGISH BROWN, WET, SILTY SAND WITH GRAVEL - ALLUVIUM		SPT-26	2-7-9
40		342.0	SPT-27	8-6-5
			SPT-28	4-6-5
			SPT-29	4-7-8
	FIRM, ORANGISH BROWN TO BROWN, WET, SANDY GRAVEL WITH A LITTLE SILT - ALLUVIUM		SPT-30	7-8-8
45		337.0		



SOIL 3043061041 01.GPJ LAW GIBB.GDT 4/25/07

REMARKS: STANDARD PENETRATION RESISTANCE TESTING PERFORMED USING AN AUTOMATIC HAMMER. GROUNDWATER WAS MEASURED WITHIN THE BOREHOLE AT A DEPTH OF ABOUT 20' AT THE TERMINATION OF THE BORING.

SOIL TEST BORING RECORD

PROJECT: TVA CUF Gypsum Seepage Study

DRILLED: December 6, 2006 **BORING NO.:** A-2

PROJ. NO.: 3043061041/0001 **PAGE 1 OF 2**

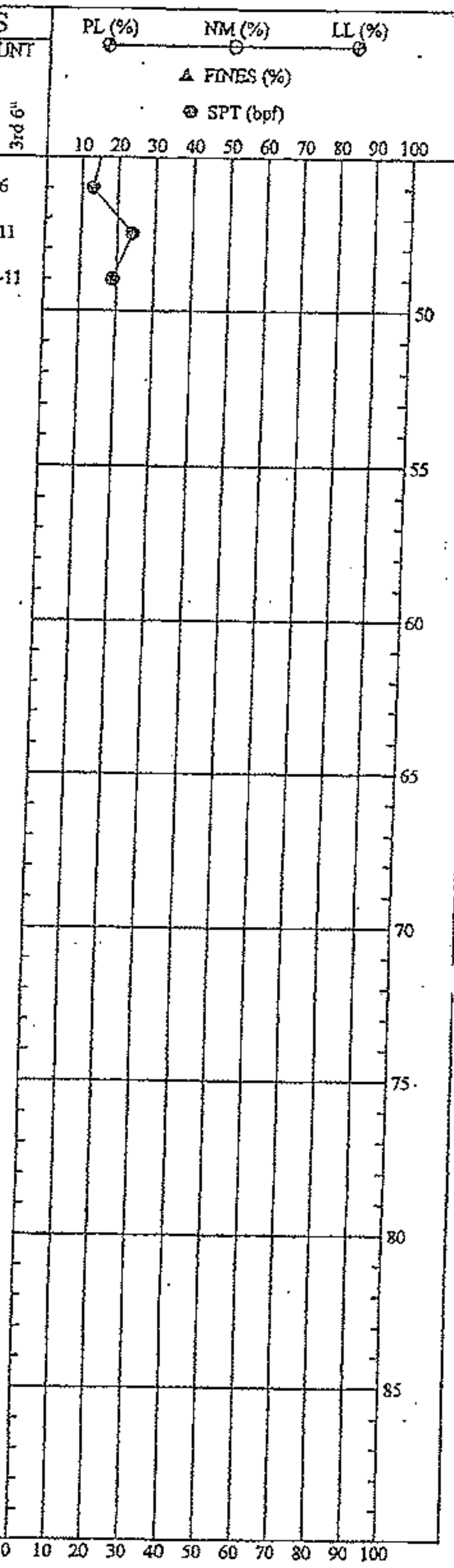
THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

Driller: Atkins
Prepared By: RDR
Checked By: Justice

MACTEC

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	N-COUNT 1st 6" 2nd 6" 3rd 6"
45	FIRM, ORANGISH BROWN TO BROWN, WET, SANDY GRAVEL WITH A LITTLE SILT - ALLUVIUM		337.0	SPT-31	▨	7-7-6
	VERY FIRM TO FIRM, ORANGISH BROWN, WET, SILTY SAND WITH GRAVEL - ALLUVIUM			SPT-32	▨	7-13-11
				SPT-33	▨	7-12-7-11
50	BORING TERMINATED AT 50.0'		332.0			
55			327.0			
60			322.0			
65			317.0			
70			312.0			
75			307.0			
80			302.0			
85			297.0			
90			292.0			



SOIL 3043061041 01.GPJ LAW GIBB.GDT 4/25/07

REMARKS: STANDARD PENETRATION RESISTANCE TESTING PERFORMED USING AN AUTOMATIC HAMMER. GROUNDWATER WAS MEASURED WITHIN THE BOREHOLE AT A DEPTH OF ABOUT 20' AT THE TERMINATION OF THE BORING.

SOIL TEST BORING RECORD

PROJECT: TVA CUF Gypsum Seepage Study

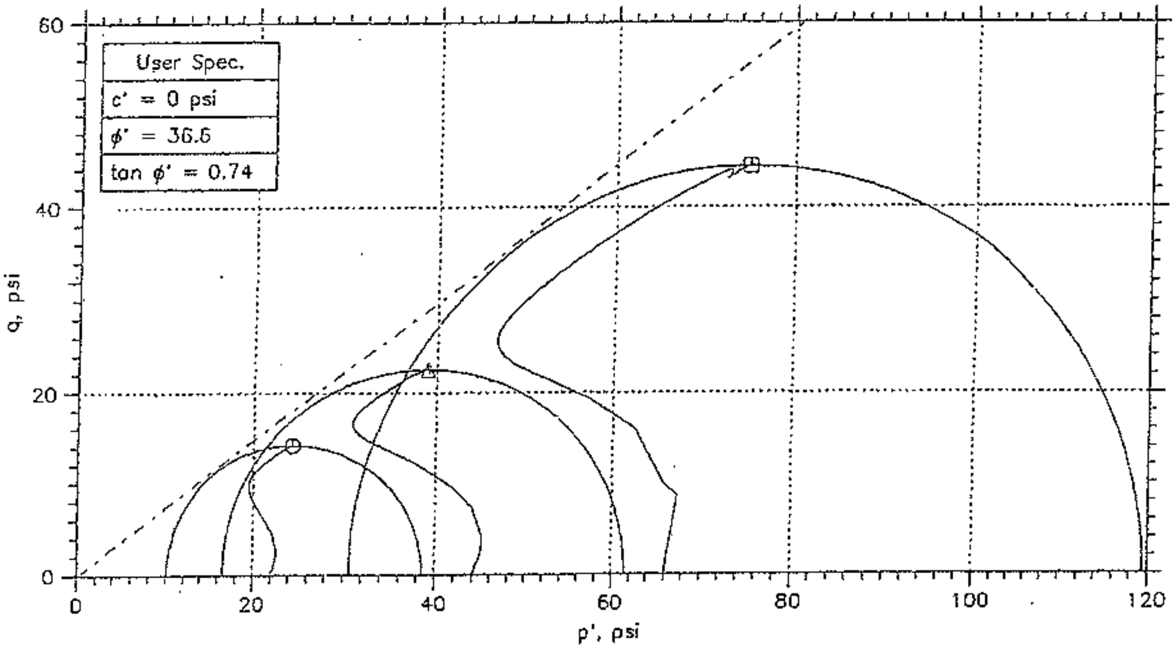
DRILLED: December 6, 2006 **BORING NO.:** A-2

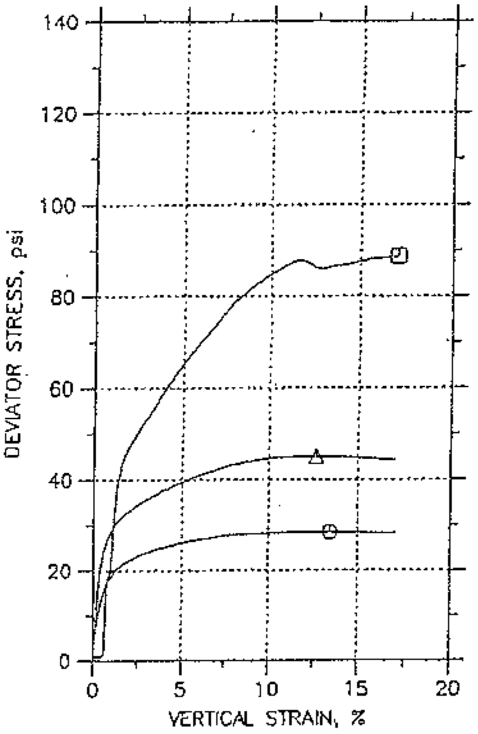
PROJ. NO.: 3043061041/0001 **PAGE 2 OF 2**

Driller : Atkins
Prepared By: RDR
Checked By: Justice

MACTEC

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

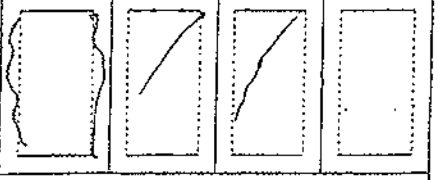




Symbol		⊙	△	⊡	
Sample No.		UD-6	UD-6	UD-6	
Test No.		7071.1	7074.2	7071.3	
Depth		32-34 ft	32-34 ft.	32-34 ft.	
Initial	Diameter, in	2.837	2.861	2.855	
	Height, in	5.6	5.6	5.6	
	Water Content, %	22.2	22.8	22.1	
	Dry Density, pcf	103.5	105.	106.6	
	Saturation, %	95.4	101.9	102.6	
	Void Ratio	0.629	0.605	0.582	
Before Shear	Water Content, %	22.8	23.4	21.8	
	Dry Density, pcf	104.4	103.3	106.	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.615	0.632	0.59	
	Back Press., psi	71.99	81.99	60.98	
Ver. Eff. Cons. Stress, psi		22..	44.01	66.01	
Shear Strength, psi		14.22	22.5	44.36	
Strain at Failure, %		13.5	12.7	17	
Strain Rate, %/min		0.1	0.1	0.1	
B-Value		0.98	0.98	0.99	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		24	24	24	
Plastic Limit		20	20	20	

MACTEC

Project: TVA CUF Gypsum Deepage
Location: MWA2
Project No.: 3043061041
Boring No.: MWA2
Sample Type: Shelby Tube



Description: Brown Sandy Silty Clay
Remarks:
Phase calculations based on start and end of test.

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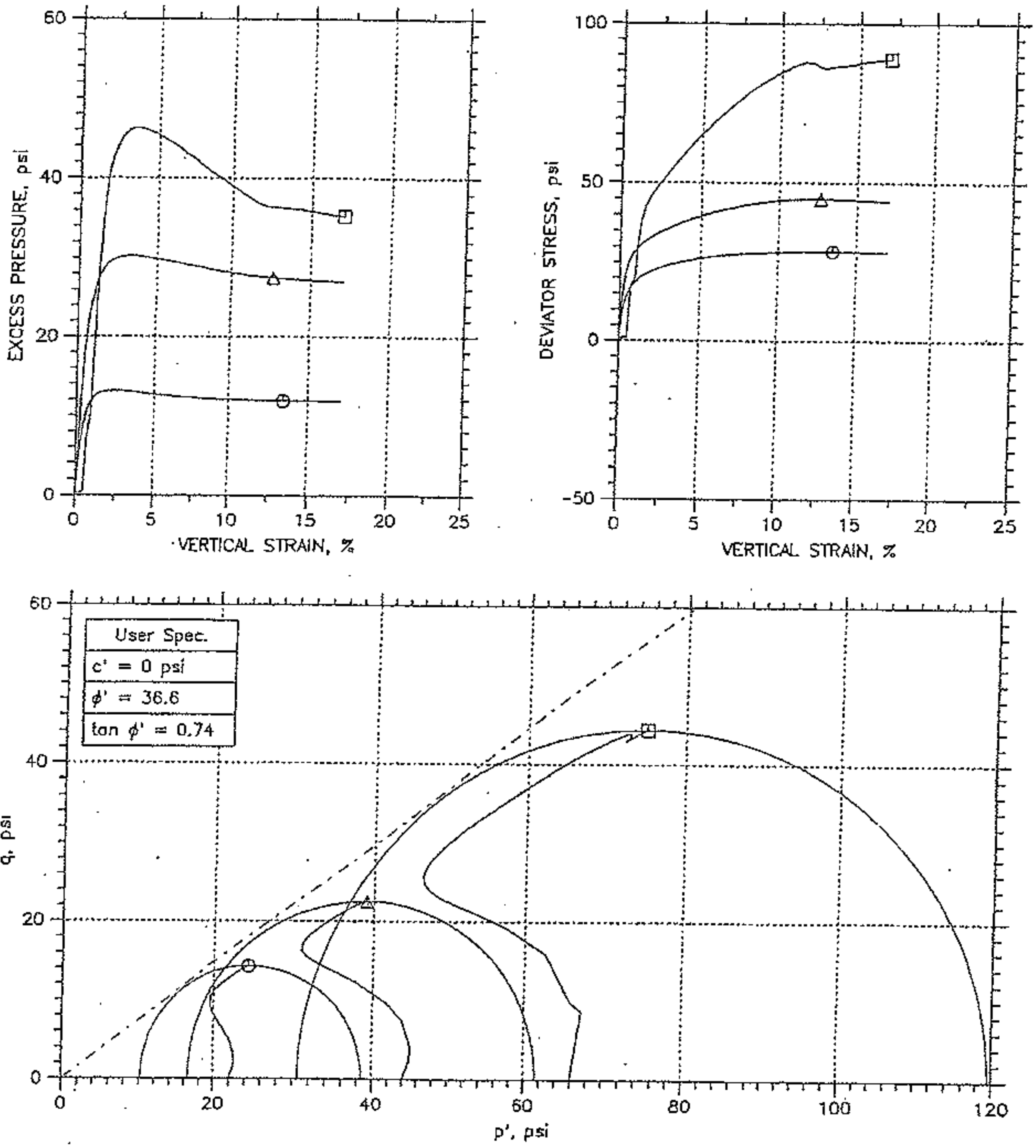
* Saturation is set to 100% for phase calculations.

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



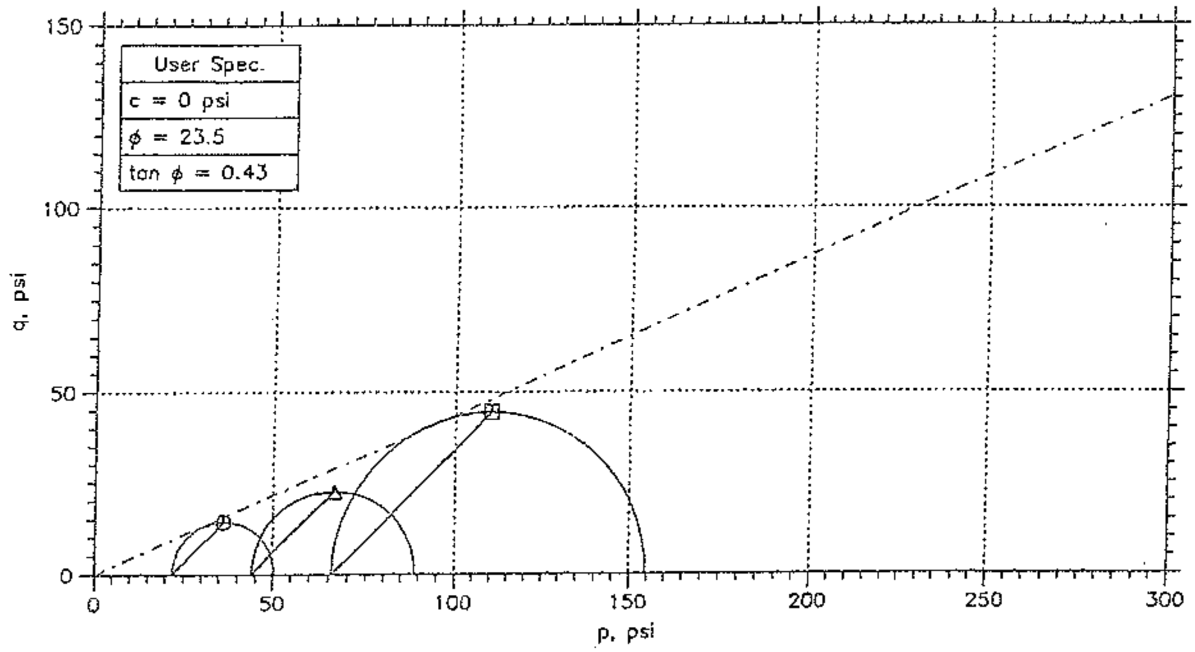
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	UD-6	7071.1	32-34 ft	HJ	2/15/07	JL	4/13/07	7071.1_71.dat
△	UD-6	7074.2	32-34 ft.	HJ	2/15/07	JL	4/13/07	7071.2_82.dat
□	UD-6	7071.3	32-34 ft.	HJ	2/16/07	JL	4/13/07	7071.3_65.dat

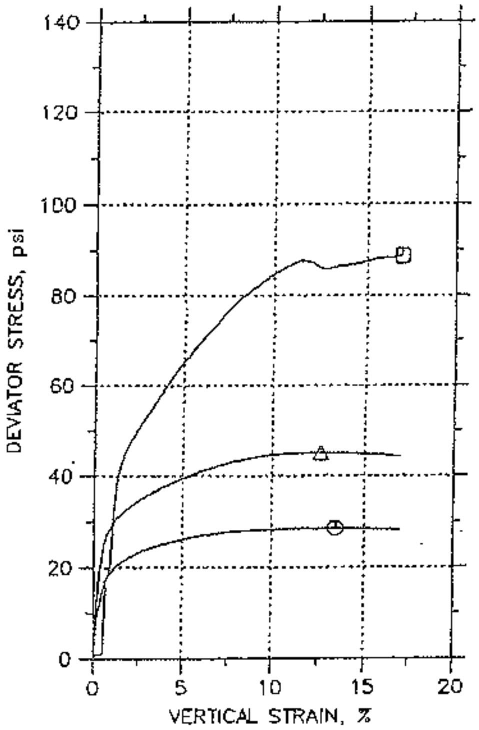
MACTEC

Project: TVA CUF Gypsum Deepag	Location: MWA2	Project No.: 3043061041
Boring No.: MWA2	Sample Type: Shelby Tube	
Description: Brown Sandy Silty Clay		
Remarks:		

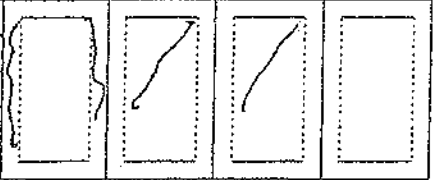
Mon. 16-APR-2007 08:40:21

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		UD-6	UD-6	UD-6	
Test No.		7071.1	7074.2	7071.3	
Depth		32-34 ft	32-34 ft.	32-34 ft.	
Initial	Diameter, in	2.837	2.861	2.855	
	Height, in	5.6	5.6	5.6	
	Water Content, %	22.2	22.8	22.1	
	Dry Density, pcf	103.5	105.	106.6	
	Saturation, %	95.4	101.9	102.6	
	Void Ratio	0.629	0.605	0.582	
Before Shear	Water Content, %	22.8	23.4	21.8	
	Dry Density, pcf	104.4	103.3	106.	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.615	0.632	0.59	
	Back Press., psi	71.99	81.99	60.98	
Ver. Eff. Cons. Stress, psi		22.	44.01	66.01	
Shear Strength, psi		14.22	22.5	44.36	
Strain at Failure, %		13.5	12.7	17	
Strain Rate, %/min		0.1	0.1	0.1	
B-Value		0.98	0.98	0.99	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		24	24	24	
Plastic Limit		20	20	20	



MACTEC

Project: TVA CUF Gypsum Deepage
Location: MWA2
Project No.: 3043081041
Boring No.: MWA2
Sample Type: Shelby Tube
Description: Brown Sandy Silty Clay
Remarks:

~~Phase calculations based on start and end of test.~~
* Saturation is set to 100% for phase calculations.

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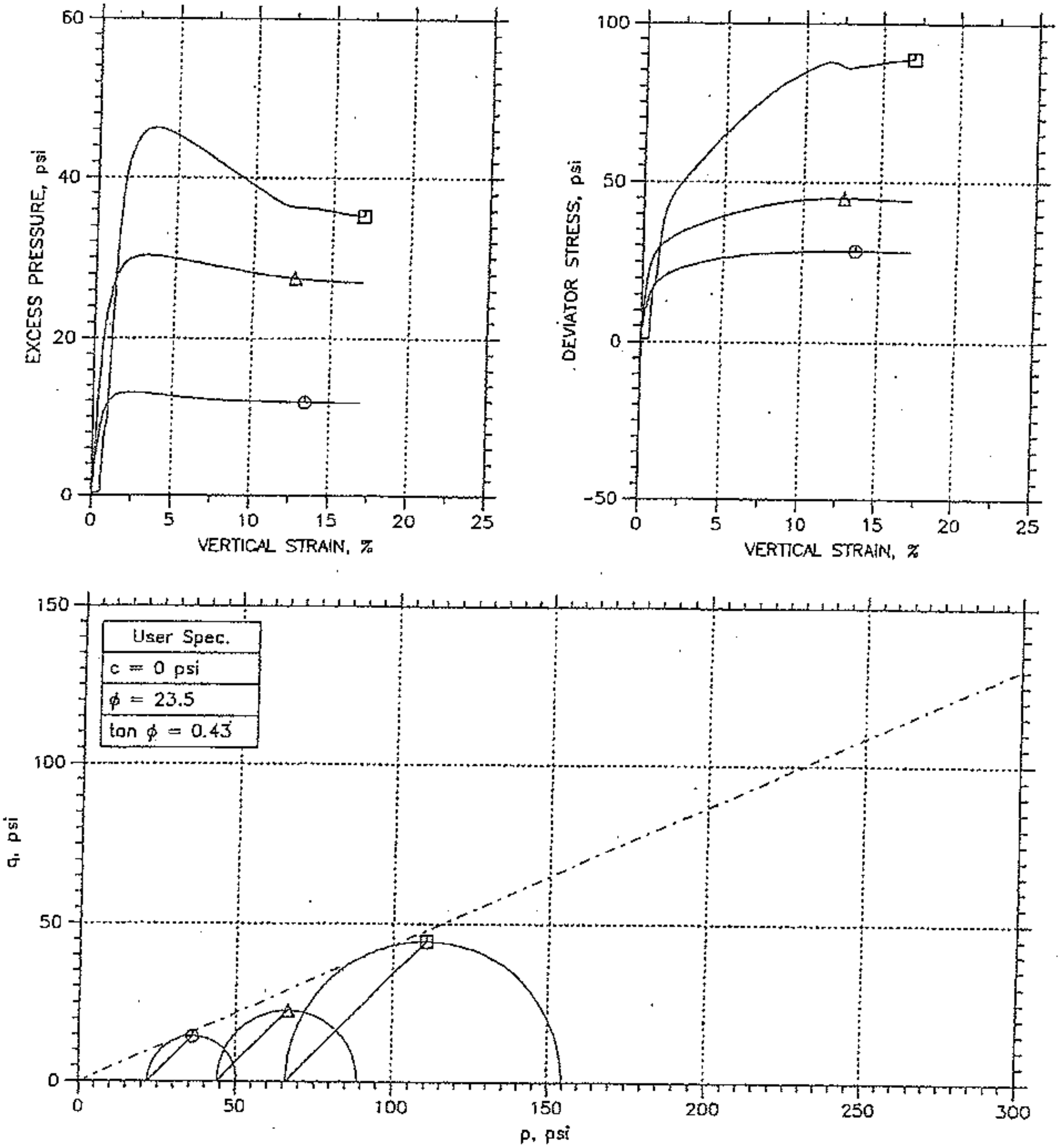
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⊕	UD-6	7071.1	32-34 ft	HJ	2/15/07	JL	4/13/07	7071.1_71.dat
△	UD-6	7074.2	32-34 ft.	HJ	2/15/07	JL	4/13/07	7071.2_82.dat
□	UD-6	7071.3	32-34 ft.	HJ	2/16/07	JL		7071.3_65.dat

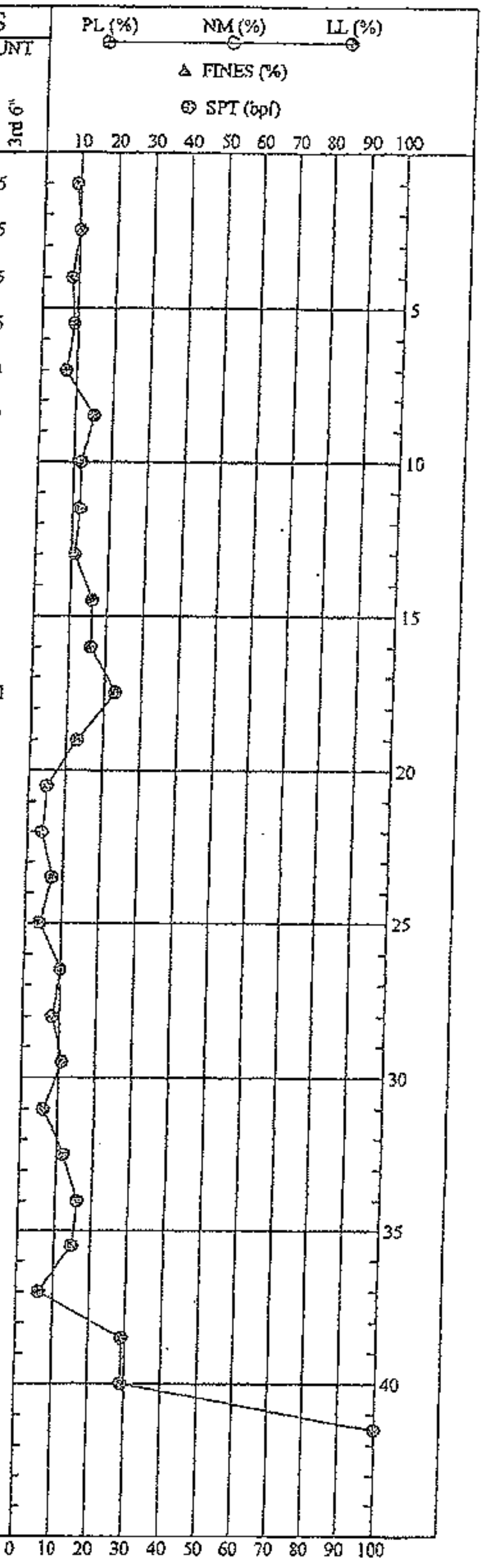
MACTEC

Project: TVA CUF Gypsum Deepage	Location: MWA2	Project No.: 3043061041
Boring No.: MWA2	Sample Type: Shelby Tube	
Description: Brown Sandy Silty Clay		
Remarks:		

Mon, 16-APR-2007 08:41:19

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)
0	LOOSE, GRAY TO BROWN, MOIST, GRAVEL WITH SILTY SAND - FILL		395.0
	STIFF TO FIRM, REDDISH BROWN, MOIST, SILTY CLAY WITH LITTLE SAND AND ROCK FRAGMENTS - FILL		
5			390.0
	STIFF, TAN TO YELLOW BROWN, MOIST, SILTY CLAY WITH LITTLE SAND AND ROCK FRAGMENTS - FILL		
10			385.0
15	FIRM TO VERY FIRM, BLACK TO BROWN, MOIST TO WET, BOTTOM ASH ∇		380.0
	LOOSE TO VERY LOOSE, BLACK TO BROWN, WET, BOTTOM ASH		
20			375.0
25	STIFF TO FIRM, REDDISH BROWN TO GRAY, MOIST, SILTY CLAY WITH A TRACE OF SAND AND CHERT FRAGMENTS - FILL		370.0
	FIRM TO STIFF, REDDISH BROWN TO GRAY, MOIST, SILTY CLAY WITH ROUNDED GRAVEL - POSSIBLE ALLUVIUM		
30			365.0
	VERY STIFF, BROWN TO GRAY, MOIST, SILTY CLAY - POSSIBLE ALLUVIUM		
35	STIFF TO FIRM, BROWN TO GRAY, VERY MOIST, SILTY CLAY WITH CALCAREOUS SHALE ROCK FRAGMENTS - POSSIBLE ALLUVIUM		360.0
	VERY STIFF, BROWN TO GRAY, VERY MOIST TO WET, SILTY CLAY WITH ROCK FRAGMENTS - POSSIBLE ALLUVIUM		
40			355.0
	VERY HARD, GRAY, WET, CLAYEY SILT WITH CALCAREOUS SHALE ROCK FRAGMENTS - POSSIBLE ALLUVIUM		
	AUGER REFUSAL AT 41.8'		
45			350.0

SAMPLES IDENT	TYPE	N-COUNT 1st 6" 2nd 6" 3rd 6"
SPT-1		9-4-5
SPT-2		4-5-5
SPT-3		3-3-5
SPT-4		4-3-6
SPT-5		3-3-4
SPT-6		7-6-9
SPT-7		4-4-8
SPT-8		7-6-6
SPT-9		3-5-6
SPT-10		6-8-8
SPT-11		5-6-10
SPT-12		15-12-11
SPT-13		3-6-7
SPT-14		4-2-3
SPT-15		2-2-2
SPT-16		2-3-4
SPT-17		3-2-2
SPT-18		3-5-5
SPT-19		3-4-4
SPT-20		2-5-6
SPT-21		1-2-4
SPT-22		3-5-7
SPT-23		5-8-8
SPT-24		2-6-9
SPT-25		2-3-3
SPT-26		7-18-11
SPT-27		15-19-10
SPT-28		6-13-50/0.2



REMARKS: STANDARD PENETRATION RESISTANCE TESTING PERFORMED USING AN AUTOMATIC HAMMER. DRILLER REPORTED GROUNDWATER STABILIZING WITHIN THE BOREHOLE AT A DEPTH OF ABOUT 8' AFTER SAMPLING THE SUBMERGED ZONE AT A DEPTH OF ABOUT 17.3'.

SOIL TEST BORING RECORD

PROJECT: TVA CUF Gypsum Seepage Study

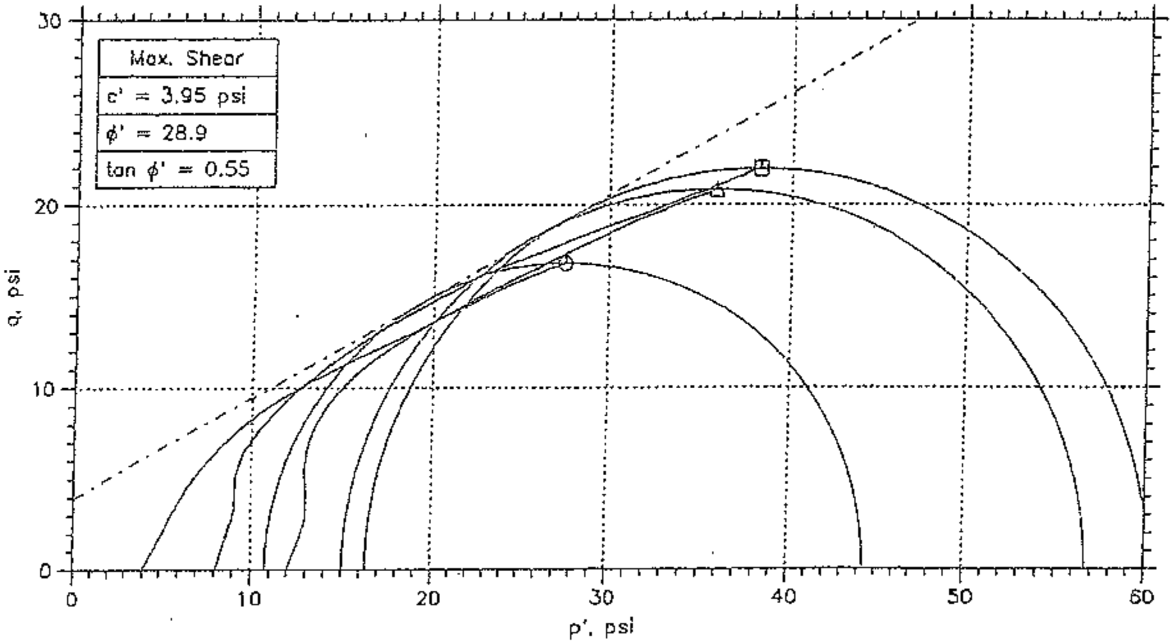
DRILLED: November 28, 2006 **BORING NO.:** A-3

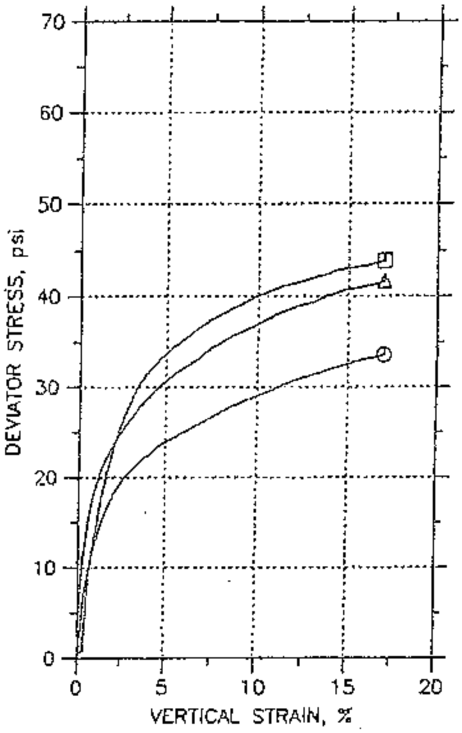
PROJ. NO.: 3043061041/0001 **PAGE** 1 **OF** 1

Driller: Atkins
Prepared By: RDR
Checked By: Justice

MACTEC

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

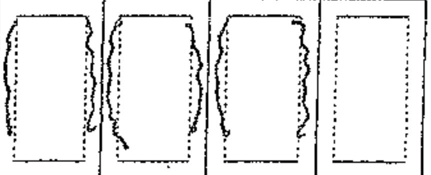




	Symbol	○	△	□	
	Sample No.	UD-2	UD-2	UD-2	
	Test No.	7065.1	7064.3	7065.2	
	Depth	7-9 ft.	5-7 ft.	7-9 ft.	
Initial	Diameter, in	2.867	2.861	2.862	
	Height, in	6	6	5.6	
	Water Content, %	21.0	19.1	20.2	
	Dry Density, pcf	104.2	109.1	108.1	
	Saturation, %	91.9	94.5	97.8	
	Void Ratio	0.618	0.546	0.559	
Before Shear	Water Content, %	23.0	19.9	21.7	
	Dry Density, pcf	103.9	109.6	106.3	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.622	0.538	0.586	
	Back Press., psi	53.94	80.99	110.9	
	Ver. Eff. Cons. Stress, psi	4.	12.	7.996	
	Shear Strength, psi	16.78	20.83	21.95	
	Strain at Failure, %	17	17	17	
	Strain Rate, %/min	0.1	0.1	0.1	
	B-Value	0.97	0.98	0.96	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	45	45	45	
	Plastic Limit	19	19	19	

MACTEC

Project: TVA CUF Gypsum Seepage
Location: MWA3
Project No.: 3043061041
Boring No.: MWA3
Sample Type: Shelby Tube
Description: Brown Lean Clay
Remarks:
Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.



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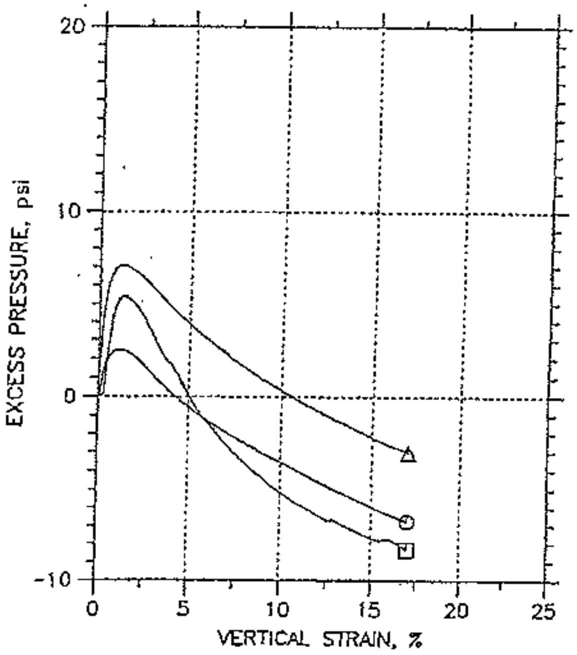
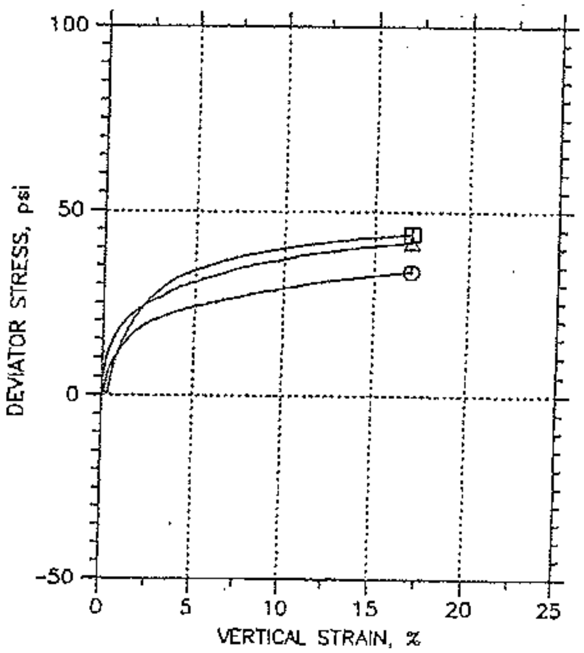
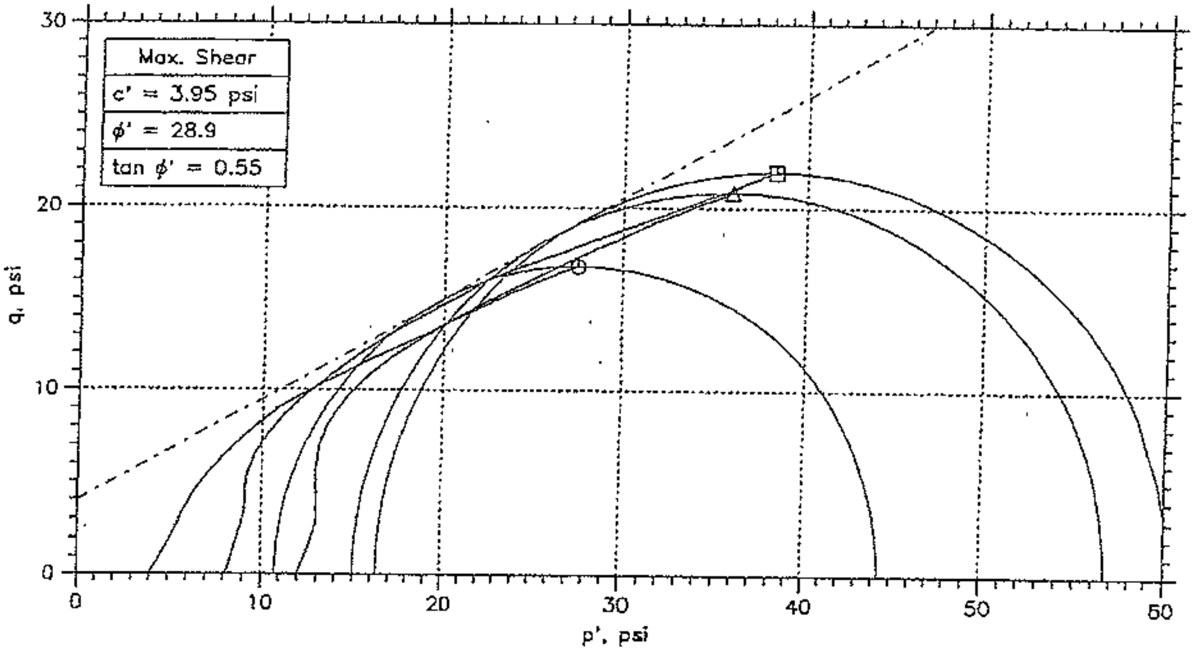
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





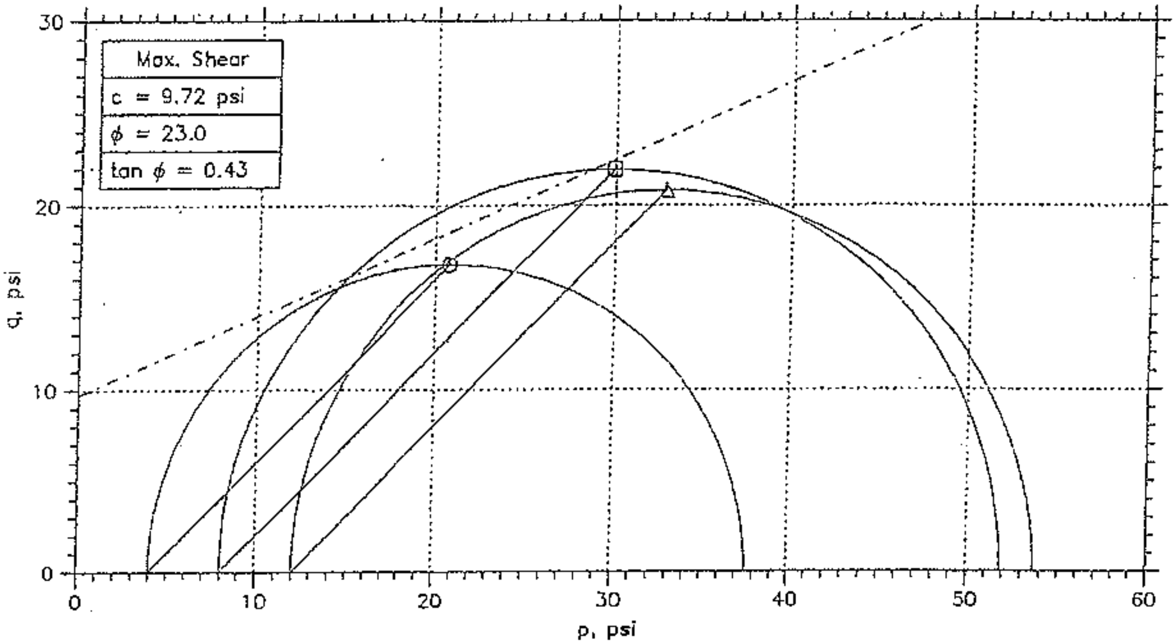


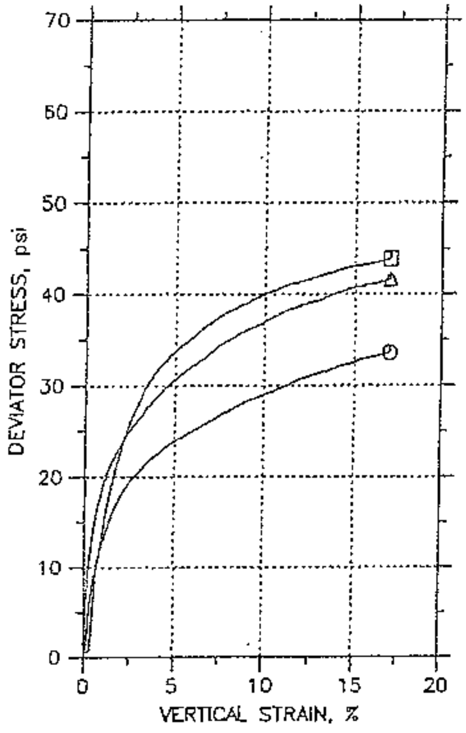
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	UD-2	7065.1	7-9 ft.	HJ	2/18/07	JL	4/13/07	7065.1_82.dat
△	UD-2	7064.3	5-7 ft.	HJ	2/18/07	JL	4/13/07	7064.3_71.dat
□	UD-2	7065.2	7-9 ft.	HJ	2/18/07	JL	4/13/07	7065.2_65.dat

MACTEC	Project: TVA CUF Gypsum Seepage	Location: MWA3	Project No.: 3043061041
	Boring No.: MWA3	Sample Type: Shelby Tube	
	Description: Brown Lean Clay		
	Remarks:		

Mon, 16-APR-2007 08:15:55

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

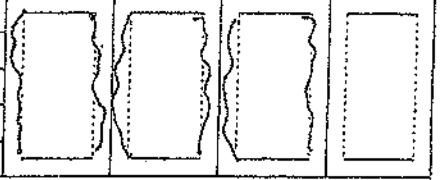




	Symbol	○	△	⊡	
	Sample No.	UD-2	UD-2	UD-2	
	Test No.	7065.1	7064.3	7065.2	
	Depth	7-9 ft.	5-7 ft.	7-9 ft.	
Initial	Diameter, in	2.867	2.861	2.862	
	Height, in	6	6	5.6	
	Water Content, %	21.0	19.1	20.2	
	Dry Density, pcf	104.2	109.1	108.1	
	Saturation, %	91.9	94.5	97.8	
	Void Ratio	0.618	0.546	0.559	
Before Shear	Water Content, %	23.0	19.9	21.7	
	Dry Density, pcf	103.9	109.6	106.3	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.622	0.538	0.586	
	Back Press., psi	53.94	80.99	110.9	
	Ver. Eff. Cons. Stress, psi	4.	12.	7.996	
	Shear Strength, psi	16.78	20.83	21.95	
	Strain at Failure, %	17	17	17	
	Strain Rate, %/min	0.1	0.1	0.1	
	B-Value	0.97	0.98	0.96	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	45	45	45	
	Plastic Limit	19	19	19	

MACTEC

Project: TVA CUF Gypsum Seepage
Location: MWA3
Project No.: 3043061041
Boring No.: MWA3
Sample Type: Shelby Tube
Description: Brown Lean Clay
Remarks:



Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.

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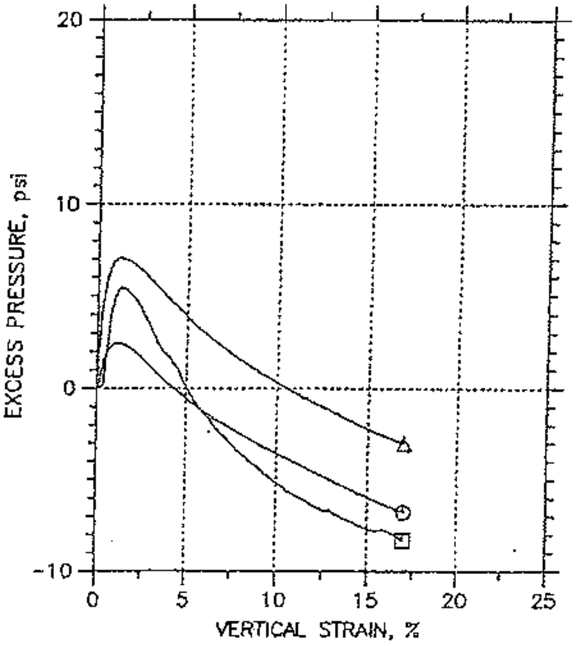
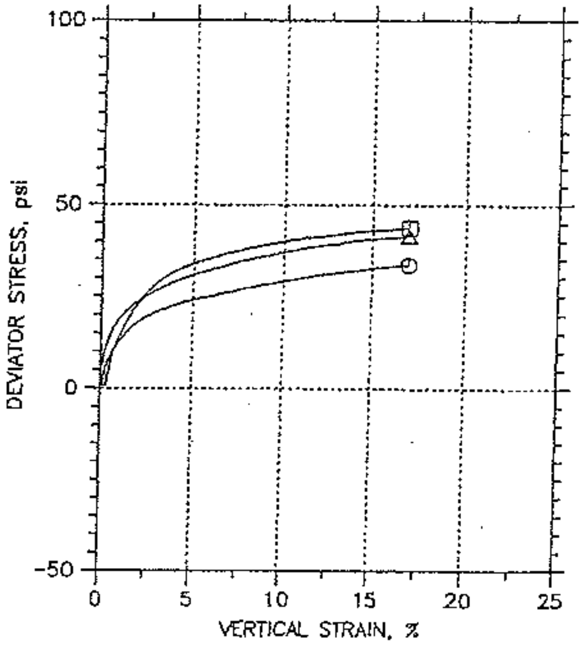
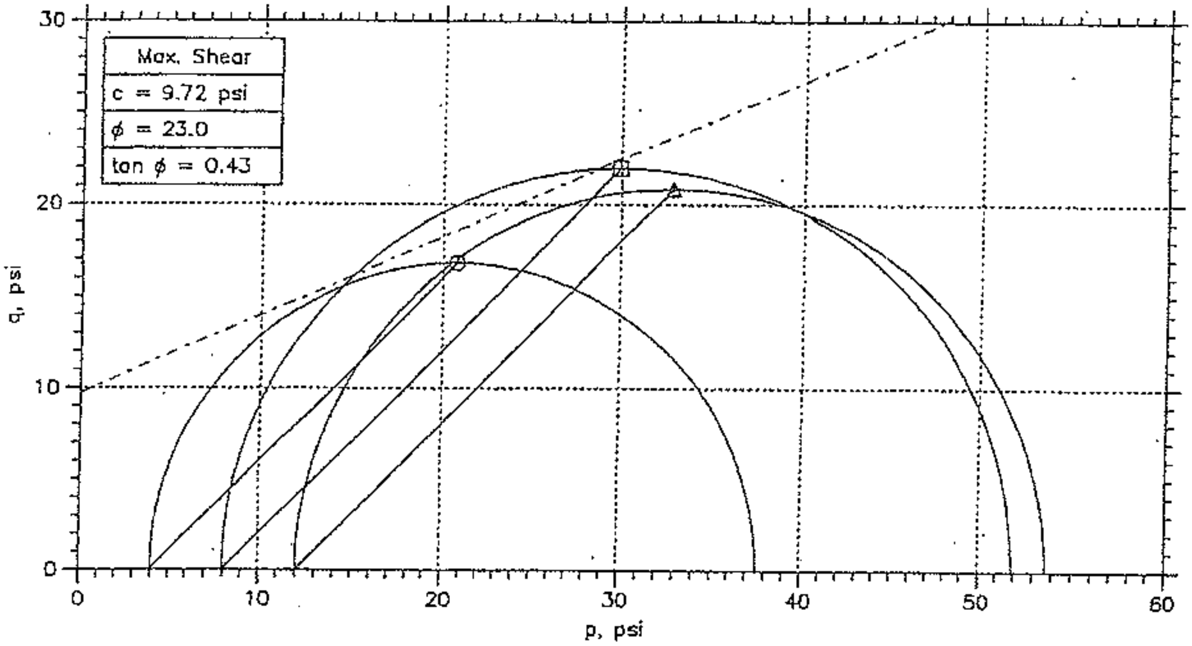
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	UD-2	7065.1	7-9 ft.	HJ	2/18/07	JL	4/13/07	7065.1_82.dat
△	UD-2	7064.3	5-7 ft.	HJ	2/18/07	JL	4/13/07	7064.3_71.dat
□	UD-2	7065.2	7-9 ft.	HJ	2/18/07	JL	4/13/07	7065.2_65.dat

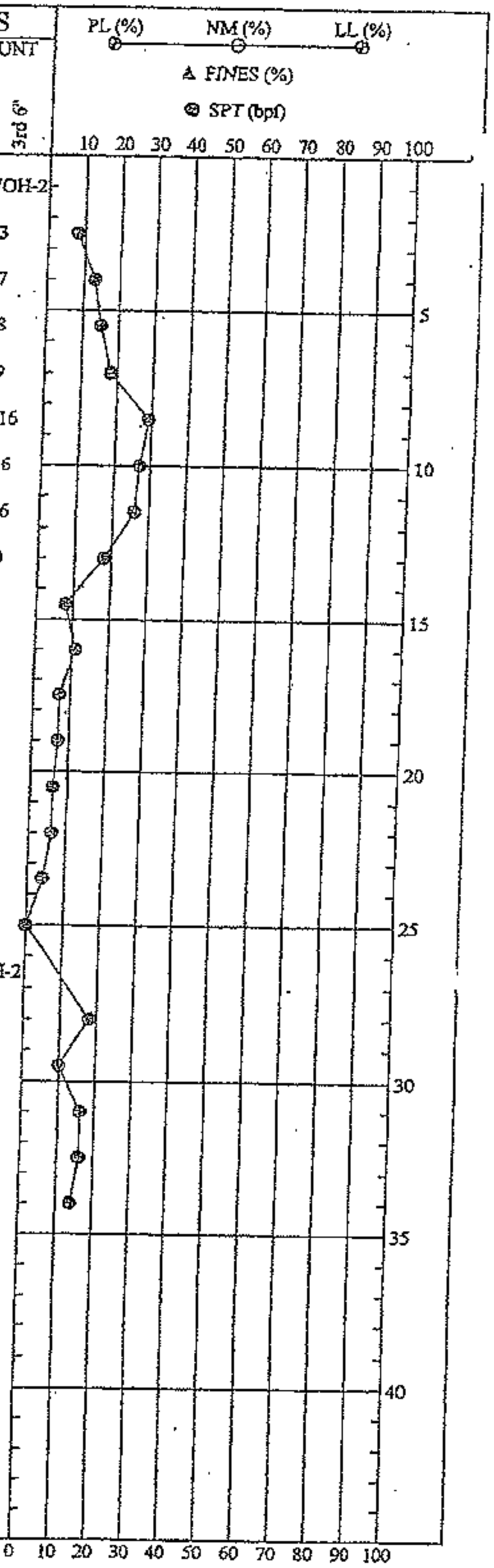
MACTEC

Project: TVA CUF Gypsum Seepage	Location: MWA3	Project No.: 3043061041
Boring No.: MWA3	Sample Type: Shelby Tube	
Description: Brown Lean Clay		
Remarks:		

Mon, 16-APR-2007 08:16:06

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	ELEV (ft)
0	VERY SOFT, MOIST, CLAYEY SILT WITH FINE ROOTS - FILL FIRM TO STIFF, BROWN, MOIST TO SLIGHTLY MOIST, SILTY CLAY WITH OCCASIONAL CHERT AND LIMESTONE GRAVEL - FILL	371.5
5	STIFF, YELLOWISH BROWN, DRY TO SLIGHTLY MOIST, SILTY CLAY WITH OCCASIONAL GRAVEL - FILL VERY STIFF, DARK YELLOWISH BROWN, DRY, SILTY CLAY WITH OCCASIONAL LIMESTONE GRAVEL - FILL	366.5
10	VERY STIFF, OLIVE YELLOW TO DARK YELLOWISH BROWN, DRY, SILTY CLAY WITH OCCASIONAL CHERT GRAVEL - FILL VERY STIFF, DARK GRAY, DRY, SILT - POSSIBLE ALLUVIUM VERY STIFF TO FIRM, YELLOWISH RED, DRY TO SLIGHTLY MOIST, SILTY CLAY WITH SOME ROUNDED GRAVEL - POSSIBLE ALLUVIUM	361.5
15	STIFF TO FIRM, BROWN, BLACK, TO DARK YELLOWISH BROWN, SLIGHTLY MOIST TO MOIST, CLAYEY SILT - ALLUVIUM FIRM, YELLOWISH BROWN, MOIST TO WET, SILTY CLAY - ALLUVIUM	356.5
20	▽	351.5
	SOFT TO VERY SOFT, YELLOWISH BROWN, WET, CLAYEY SILT WITH A LITTLE SAND - ALLUVIUM	
25	VERY STIFF, YELLOWISH BROWN, WET, SANDY SILT - ALLUVIUM LOOSE, YELLOWISH BROWN, WET, SAND - ALLUVIUM	346.5
30	LOOSE, YELLOWISH BROWN, WET, GRAVELLY SAND - ALLUVIUM FIRM, YELLOWISH BROWN, WET, SANDY GRAVEL - ALLUVIUM NOTE: INSPITE OF CHARGING THE AUGERS WITH WATER, THE DRILLER COULD ATTAIN, AT BEST, A MINIMUM OF ABOUT 1.5' OF SAND/GRAVEL HEAVING IN THE LEAD AUGER. SPT-24 WAS DRIVEN THROUGH THIS TO GET A REPRESENTATIVE SAMPLE FROM 34.5 TO 35.0'.	341.5
35	BORING TERMINATED AT 35.0'	336.5
40		331.5
45		326.5

SAMPLES IDENT	N-COUNT 1st 6" 2nd 6" 3rd 6"
SPT-1	WOH-WOH-2
SPT-2	6-5-3
SPT-3	4-6-7
SPT-4	5-7-8
SPT-5	5-9-9
SPT-6	11-13-16
SPT-7	8-11-16
SPT-8	7-10-16
SPT-9	7-8-10
SPT-10	4-3-5
SPT-11	3-5-6
SPT-12	3-3-4
SPT-13	3-3-4
SPT-14	3-3-3
SPT-15	3-3-3
SPT-16	1-2-2
SPT-17	WOH
SPT-18	WOH-WOH-2
SPT-19	6-8-10
SPT-20	4-5-5
SPT-21	8-9-7
SPT-22	8-9-7
SPT-23	6-8-6
SPT-24	X-X-5



SOIL 3043061041 01.GPJ LAW GIBB.GDT 4/25/07

REMARKS: STANDARD PENETRATION RESISTANCE TESTING PERFORMED USING AN AUTOMATIC HAMMER. APPROXIMATE 12-HOUR GROUNDWATER LEVEL WAS MEASURED AT 14.7'.

SOIL TEST BORING RECORD

PROJECT: TVA CUF Gypsum Seepage Study

DRILLED: December 5, 2006 **BORING NO.:** B-1

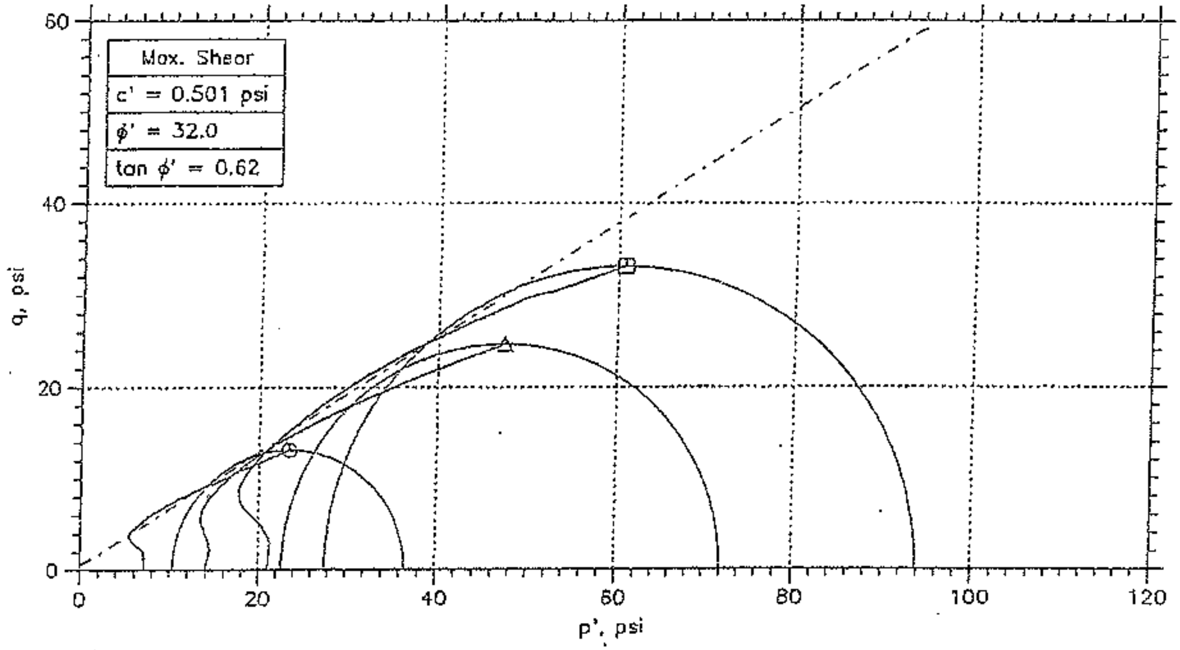
PROJ. NO.: 3043061041/0001 **PAGE** 1 **OF** 1

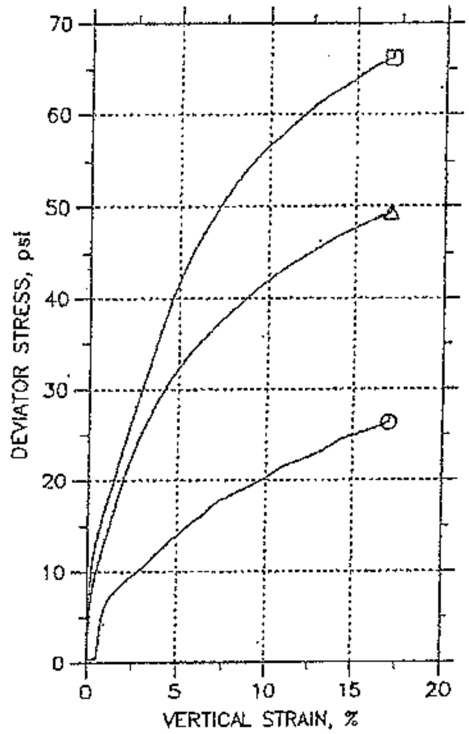
THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

Driller: Akins
Prepared By: Mason
Checked By: Justice

MACTEC

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

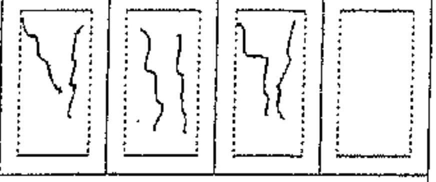




	Symbol	○	△	□	
	Sample No.	UD-2	UD-2	UD-2	
	Test No.	7080.1	7080.2	7080.3	
	Depth	8-10 ft.	8-10 ft	8-10 ft	
Initial	Diameter, in	2.84	2.84	2.837	
	Height, in	5.6	5.6	5.6	
	Water Content, %	19.4	18.3	17.9	
	Dry Density, pcf	105.5	109.5	111.1	
	Saturation, %	87.6	91.6	93.3	
	Void Ratio	0.597	0.54	0.517	
Before Shear	Water Content, %	22.1	19.5	18.5	
	Dry Density, pcf	105.6	110.4	112.4	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.596	0.526	0.5	
	Back Press., psi	94.93	80.	102.	
	Ver. Eff. Cons. Stress, psi	6.996	14.	20.99	
	Shear Strength, psi	13.15	24.69	33.11	
	Strain at Failure, %	17	17	17	
	Strain Rate, %/min	0.1	0.1	0.1	
	B-Value	0.97	0.99	0.98	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	30	30	30	
	Plastic Limit	19	19	19	

MACTEC

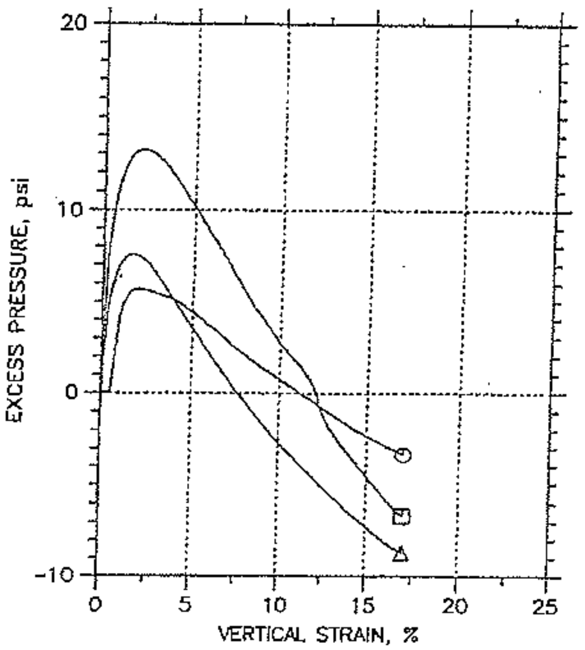
Project: TVA CUF Gypsum Seepage
Location: MWB1
Project No.: 3043061041
Boring No.: MWB1
Sample Type: Shelby Tube
Description: Brown Lean Clay
Remarks:

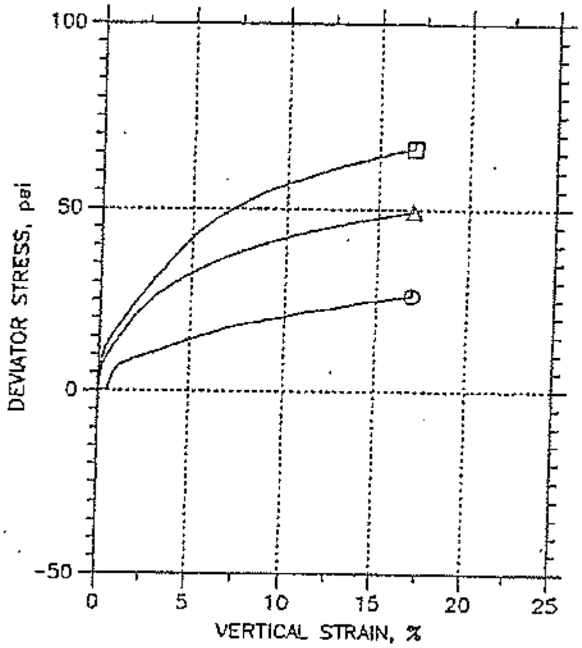


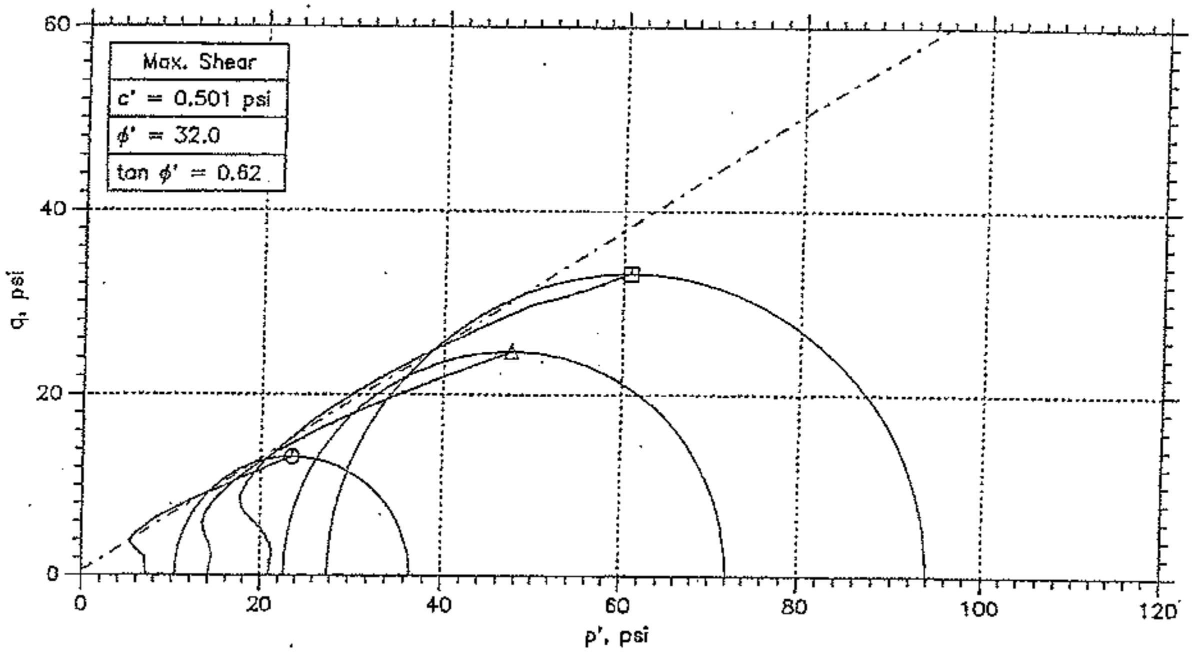
Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.

Mon, 16-APR-2007 08:54:19

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







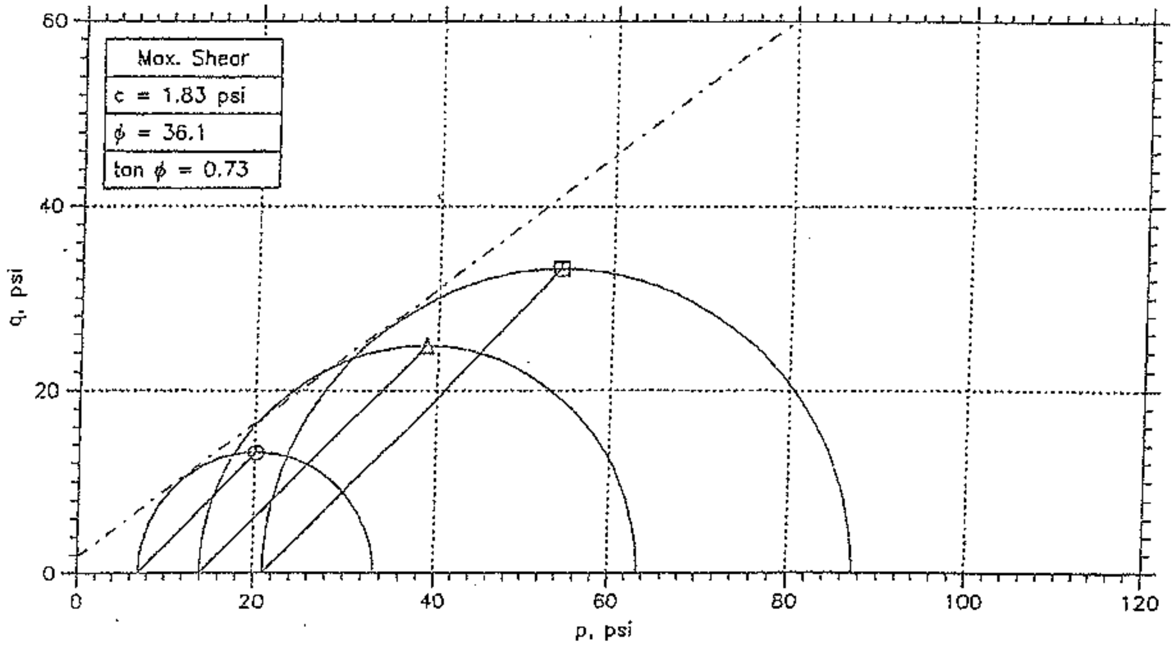
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	UD-2	7080.1	8-10 ft.	HJ	3/12/07	JL	4/13/07	7080.1_65.dat
△	UD-2	7080.2	8-10 ft	HJ	3/12/07	JL	4/13/07	7080.2_82.dat
□	UD-2	7080.3	8-10 ft	HJ	3/12/07	JL	4/13/07	7080.3_71.dat

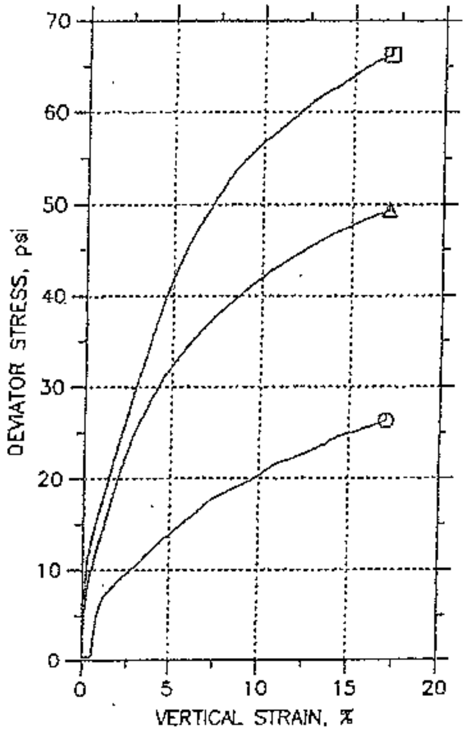
MACTEC

Project: TVA CUF Gypsum Seepage	Location: MWB1	Project No.: 3043061041
Boring No.: MWB1	Sample Type: Shelby Tube	
Description: Brown Lean Clay		
Remarks:		

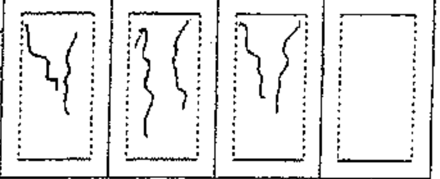
Mon, 16-APR-2007 08:54:19

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		UD-2	UD-2	UD-2	
Test No.		7080.1	7080.2	7080.3	
Depth		8-10 ft.	8-10 ft	8-10 ft	
Initial	Diameter, in	2.84	2.84	2.837	
	Height, in	5.6	5.6	5.6	
	Water Content, %	19.4	18.3	17.9	
	Dry Density, pcf	105.5	109.5	111.1	
	Saturation, %	87.6	91.6	93.3	
	Void Ratio	0.597	0.54	0.517	
Before Shear	Water Content, %	22.1	19.5	18.5	
	Dry Density, pcf	105.6	110.4	112.4	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.596	0.526	0.5	
	Back Press., psi	94.93	80.	102.	
Ver. Eff. Cons. Stress, psi		6.996	14.	20.99	
Shear Strength, psi		13.15	24.69	33.11	
Strain at Failure, %		17	17	17	
Strain Rate, %/min		0.1	0.1	0.1	
B-Value		0.97	0.99	0.98	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		30	30	30	
Plastic Limit		19	19	19	

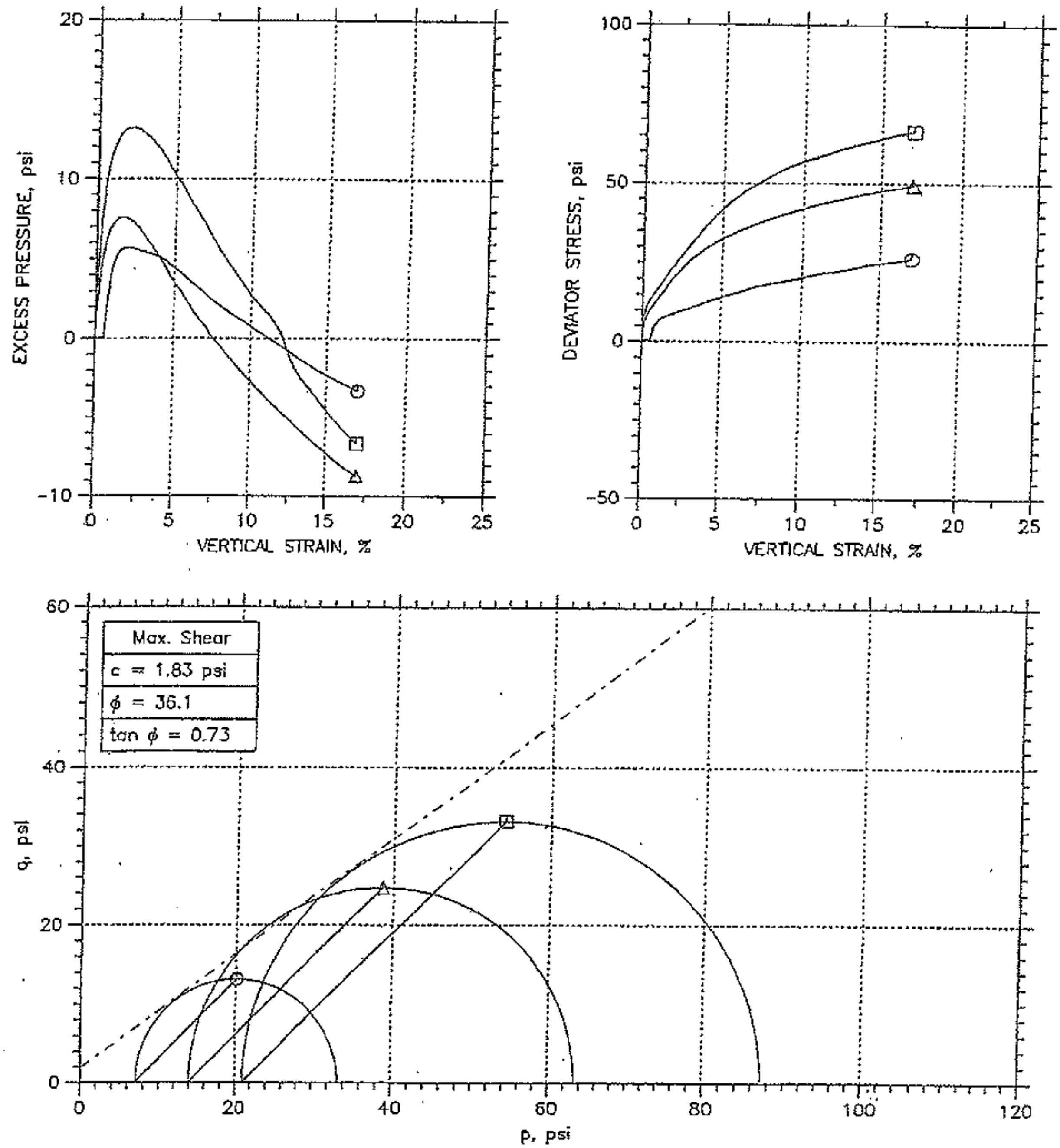


Project: TVA CUF Gypsum Seepage
Location: MWB1
Project No.: 3043061041
Boring No.: MWB1
Sample Type: Shelby Tube
Description: Brown Lean Clay
Remarks:

Mon, 16-APR-2007 08:54:41

Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

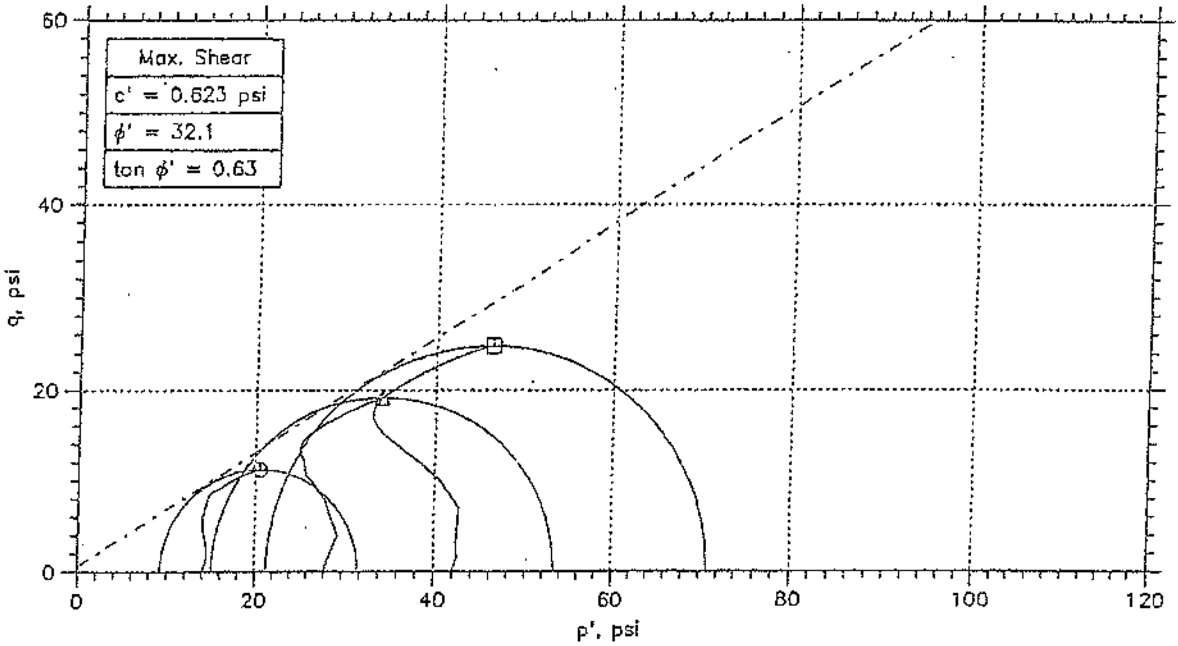


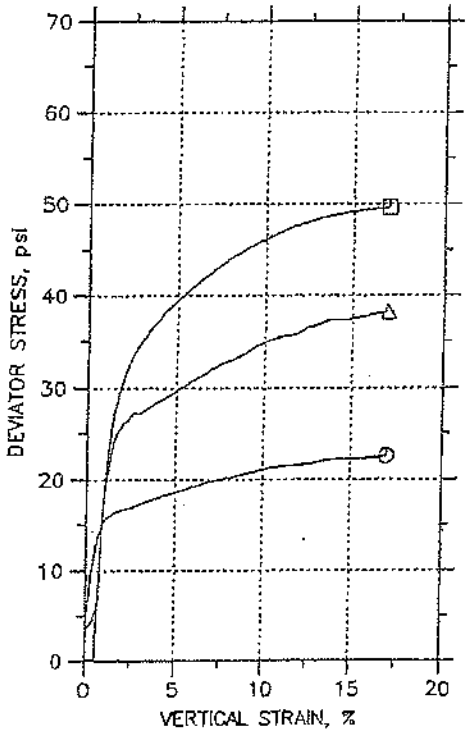
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	UD-2	7080.1	8-10 ft.	HJ	3/12/07	JL	4/13/07	7080.1_65.dat
△	UD-2	7080.2	8-10 ft	HJ	3/12/07	JL	4/13/07	7080.2_82.dat
⊡	UD-2	7080.3	8-10 ft	HJ	3/12/07	JL	4/13/07	7080.3_71.dat

MACTEC	Project: TVA CUF Gypsum Seepage	Location: MWB1	Project No.: 3043061041
	Boring No.: MWB1	Sample Type: Shelby Tube	
	Description: Brown Lean Clay		
	Remarks:		

Mon, 16-APR-2007 08:54:41

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

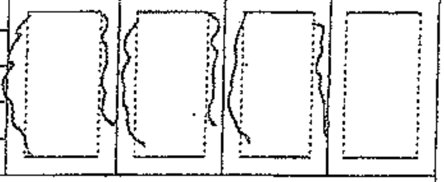




Symbol		○	△	□	
Sample No.		UD-5	UD-5	UD-5	
Test No.		7086.1	7086.2	7086.3	
Depth		20-22 ft	20-22 ft	20-22 ft.	
Initial	Diameter, in	2.845	2.846	2.834	
	Height, in	5.6	5.6	5.6	
	Water Content, %	25.6	25.2	25.5	
	Dry Density, pcf	99.76	100.8	100.6	
	Saturation, %	100.2	101.2	101.7	
	Void Ratio	0.69	0.673	0.676	
Before Shear	Water Content, %	25.2	23.8	22.8	
	Dry Density, pcf	100.3	102.6	104.3	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.68	0.643	0.616	
	Back Press., psi	53.9	38.91	38.97	
Ver. Eff. Cons. Stress, psi		14.	28.02	42.	
Shear Strength, psi		11.24	19.1	24.79	
Strain at Failure, %		17	17	17	
Strain Rate, %/min		0.1	0.1	0.1	
B-Value		0.97	0.97	0.98	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		32	32	32	
Plastic Limit		20	20	20	

MACTEC

Project: TVA CUF Gypsum Seepage
Location: MWB1
Project No.: 3043061041
Boring No.: MWB1
Sample Type: Undisturbed
Description: Tan Brown Lean Clay
Remarks:
Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.



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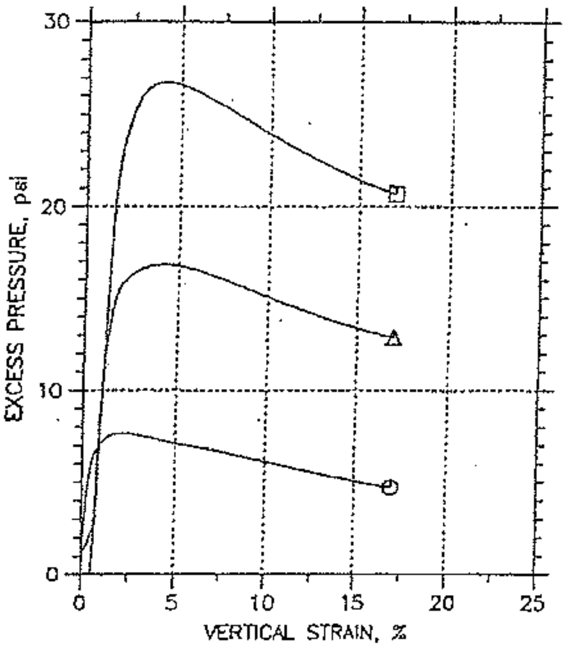
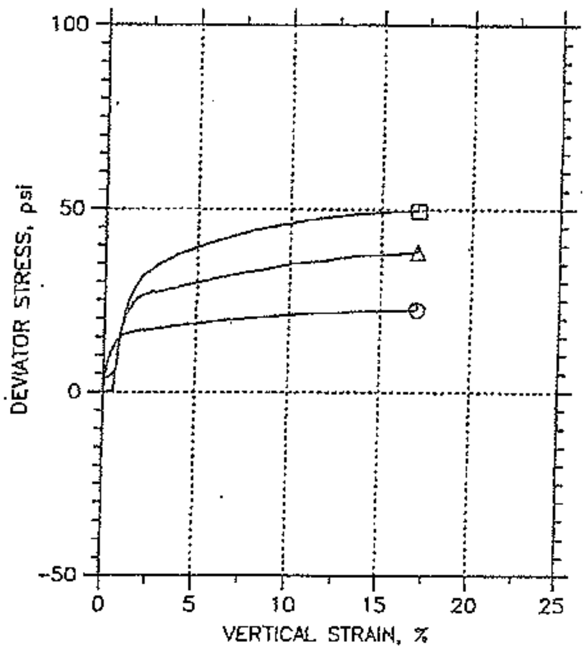
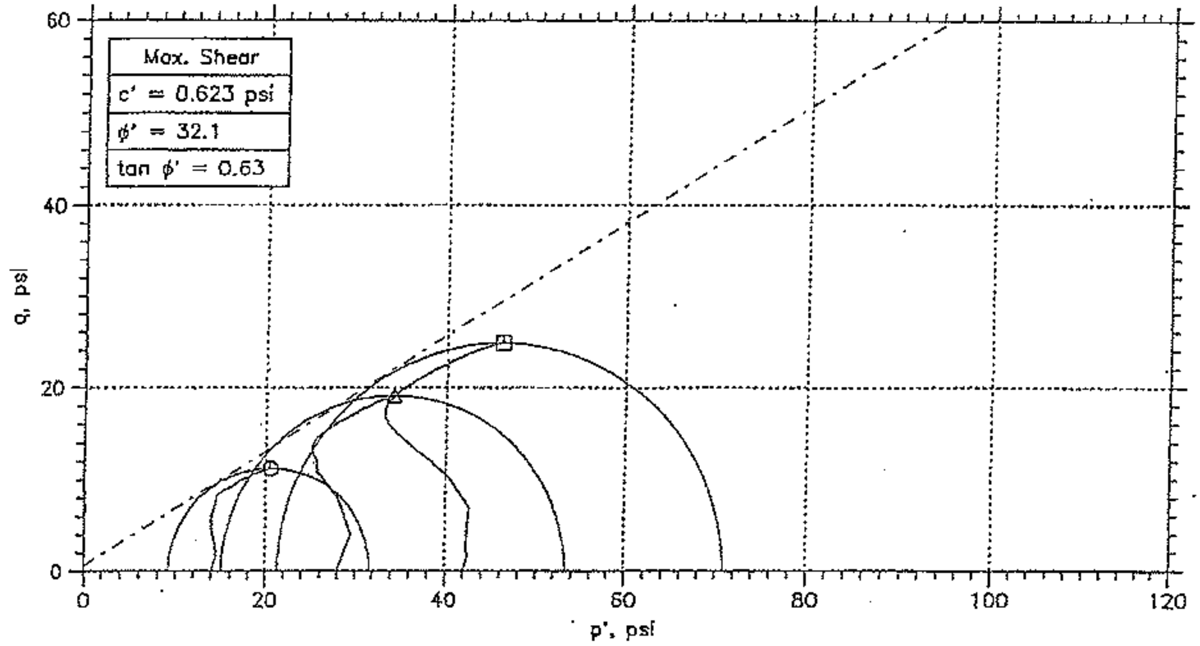
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







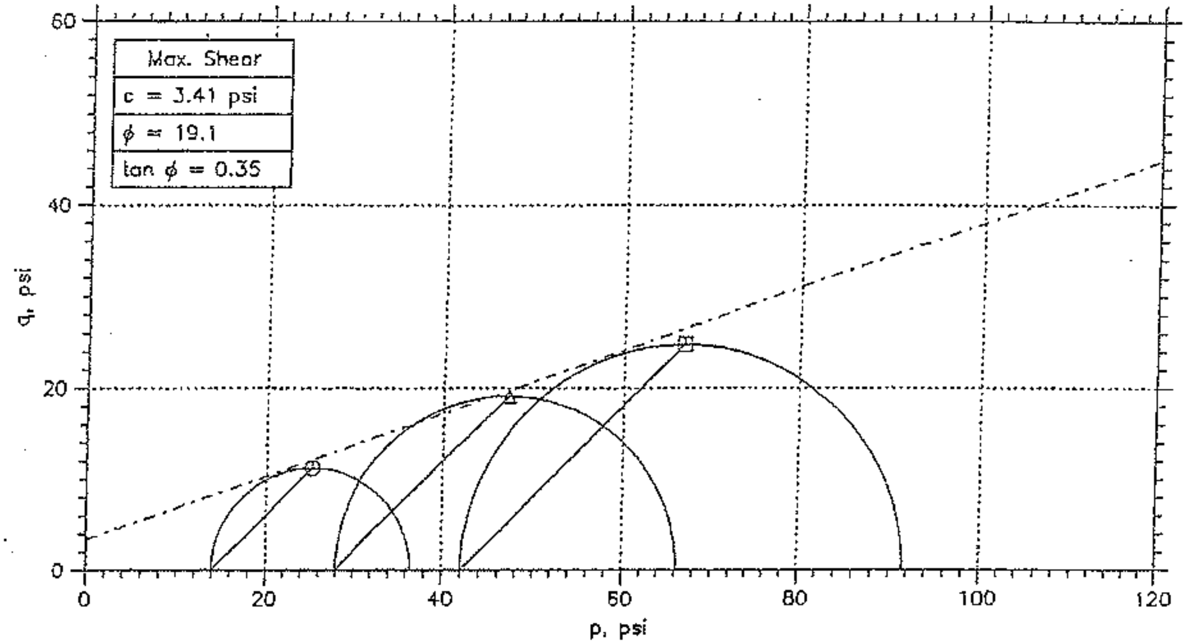
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	UD-5	7086.1	20-22 ft	HJ	3/16/07	JL	4/13/07	7086.1_96.dat
△	UD-5	7086.2	20-22 ft	HJ	3/16/07	JL	4/13/07	7086.2_93.dat
☐	UD-5	7086.3	20-22 ft	HJ	3/16/07	JL	4/13/07	7086.3_90.dat

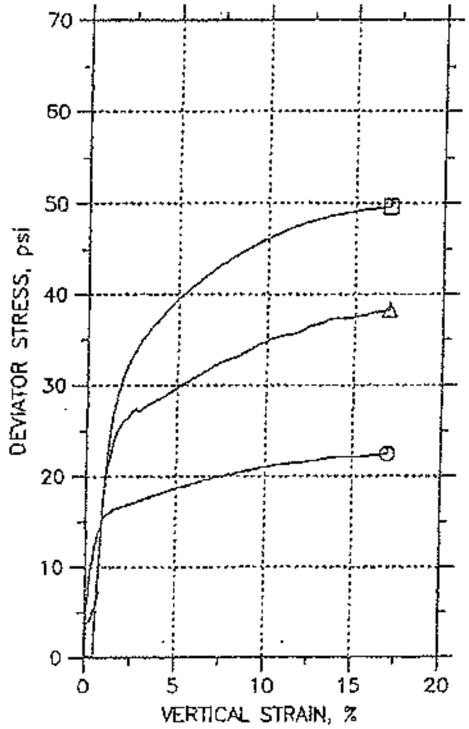
MACTEC

Project: TVA CUF Gypsum Seepage	Location: MWB1	Project No.: 3043061041
Boring No.: MWB1	Sample Type: Undisturbed	
Description: Tan Brown Lean Clay		
Remarks:		

Mon, 16-APR-2007 09:06:02

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Symbol	○	△	☐	
	Sample No.	UD-5	UD-5	UD-5	
	Test No.	7086.1	7086.2	7086.3	
	Depth	20-22 ft	20-22 ft	20-22 ft	
Initial	Diameter, in	2.845	2.846	2.834	
	Height, in	5.6	5.6	5.6	
	Water Content, %	25.6	25.2	25.5	
	Dry Density, pcf	99.76	100.8	100.6	
	Saturation, %	100.2	101.2	101.7	
	Void Ratio	0.69	0.673	0.676	
Before Shear	Water Content, %	25.2	23.8	22.8	
	Dry Density, pcf	100.3	102.6	104.3	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.68	0.643	0.616	
	Back Press., psi	53.9	38.91	38.97	
	Ver. Eff. Cons. Stress, psi	14.	28.02	42.	
	Shear Strength, psi	11.24	19.1	24.79	
	Strain at Failure, %	17	17	17	
	Strain Rate, %/min	0.1	0.1	0.1	
	B-Value	0.97	0.97	0.98	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	32	32	32	
	Plastic Limit	20	20	20	

MACTEC

Project: TVA CUF Gypsum Seepage
Location: MWB1
Project No.: 3043061041
Boring No.: MWB1
Sample Type: Undisturbed
Description: Tan Brown Lean Clay
Remarks:
Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.

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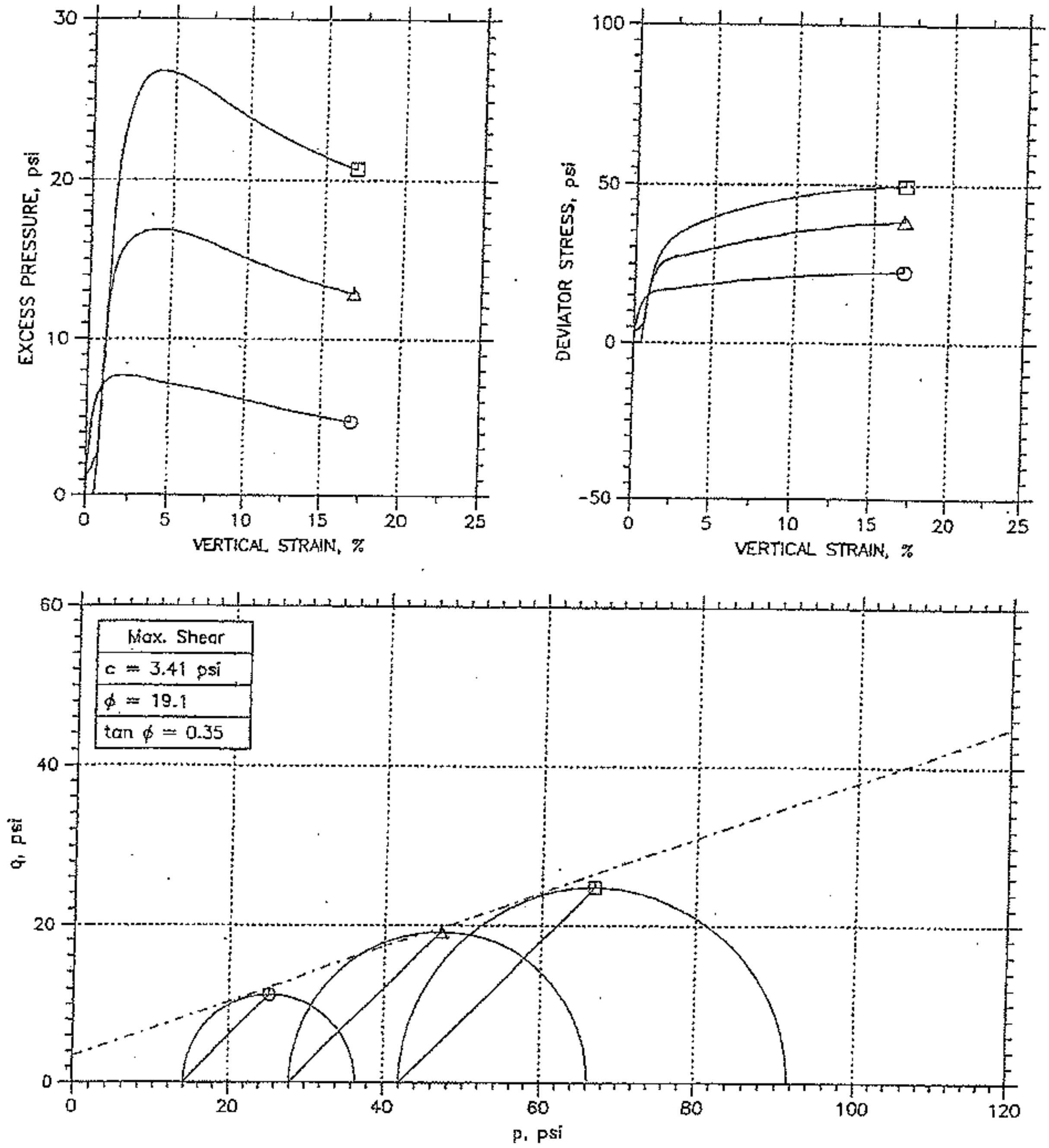
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	UD-5	7086.1	20-22 ft	HJ	3/16/07	JL	4/13/07	7086.1_96.dat
△	UD-5	7086.2	20-22 ft	HJ	3/16/07	JL	4/13/07	7086.2_93.dat
□	UD-5	7086.3	20-22 ft	HJ	3/16/07	JL	4/13/07	7086.3_90.dat

MACTEC

Project: TVA CUF Gypsum Seepage	Location: MWB1	Project No.: 3043061041
Boring No.: MWB1	Sample Type: Undisturbed	
Description: Tan Brown Lean Clay		
Remarks:		

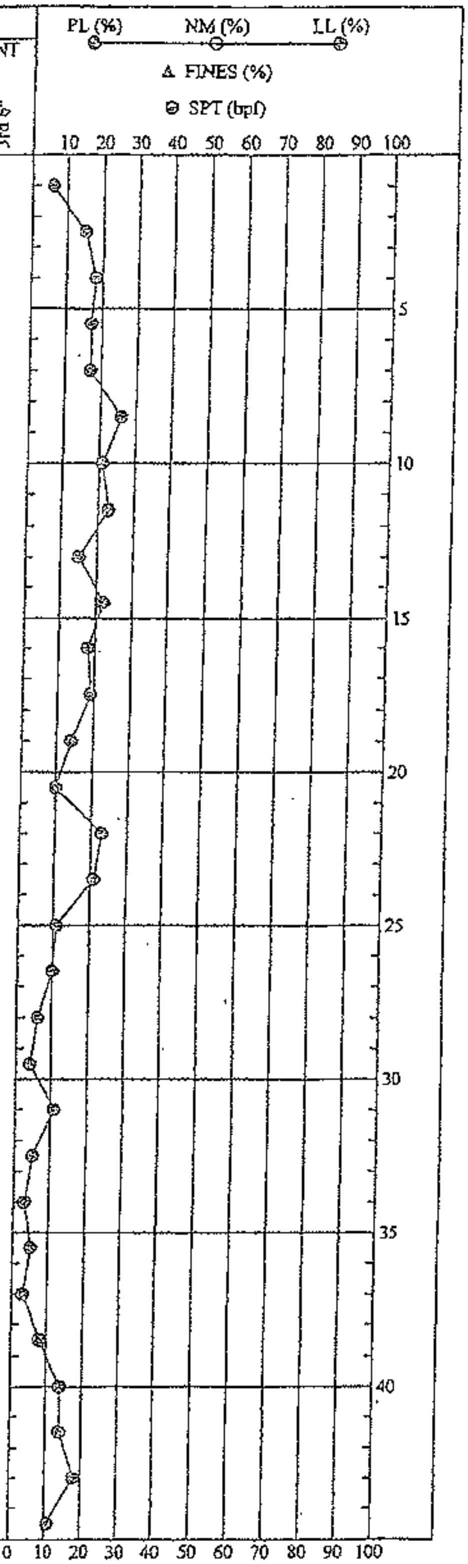
Mon, 16-APR-2007 09:06:12

SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS
0	TOPSOIL (0.3')
	FIRM, REDDISH BROWN, MOIST, SILTY CLAY WITH A TRACE OF SAND AND ROCK FRAGMENTS - FILL
	STIFF TO VERY STIFF, ORANGISH BROWN TO BROWN, MOIST, SILTY CLAY TO FAT CLAY WITH A LITTLE SAND, ORGANICS, AND ROCK FRAGMENTS - FILL
15	VERY STIFF, GRAY TO BROWN, MOIST, FLYASH - FILL
	VERY STIFF TO STIFF, ORANGISH BROWN TO BROWN, MOIST, SILTY CLAY WITH A LITTLE SAND, ORGANICS, AND ROCK FRAGMENTS - FILL
	VERY STIFF, SLIGHTLY MOIST, BLACK TO BROWN, CLAYEY SILT - ALLUVIUM
	STIFF, REDDISH BROWN, MOIST, SILTY CLAY WITH ROCK FRAGMENTS - ALLUVIUM
	STIFF TO SOFT, BROWN TO BLACK, MOIST TO WET, SILTY CLAY - ALLUVIUM ∇
	VERY LOOSE TO LOOSE, BROWN, WET, SILTY SAND - ALLUVIUM
	FIRM, ORANGISH BROWN, WET, SILTY SAND WITH GRAVEL - ALLUVIUM
	FIRM TO LOOSE, YELLOWISH BROWN, WET, SANDY GRAVEL - ALLUVIUM
45	

DEPTH (ft)	ELEV (ft)	SAMPLES IDENT	TYPE	N-COUNT 1st 6" 2nd 6" 3rd 6"
0	381.0			
		SPT-1		1-3-3
		SPT-2		10-7-8
		SPT-3		6-7-11
5	376.0	SPT-4		8-8-9
		SPT-5		6-8-9
		SPT-6		5-10-16
10	371.0	SPT-7		8-9-12
		SPT-8		9-11-12
		SPT-9		5-6-9
		SPT-10		7-9-13
15	366.0			
		SPT-11		6-7-11
		SPT-12		5-8-11
		SPT-13		5-6-8
20	361.0	SPT-14		4-4-6
		SPT-15		4-10-13
		SPT-16		4-10-11
25	356.0	SPT-17		3-5-6
		SPT-18		3-4-6
		SPT-19		2-3-3
		SPT-20		2-2-2
30	351.0			
		SPT-21		1-3-8
		SPT-22		WOH-2-3
		SPT-23		WOH-1-2
35	346.0	SPT-24		WOH-1-4
		SPT-25		2-1-2
		SPT-26		4-4-4
40	341.0	SPT-27		WOH-6-8
		SPT-28		5-8-6
		SPT-29		8-9-9
		SPT-30		4-4-7
45	336.0			



REMARKS: STANDARD PENETRATION RESISTANCE TESTING PERFORMED USING AN AUTOMATIC HAMMER. APPROXIMATE 12-HOUR GROUNDWATER LEVEL WAS MEASURED AT 27.0'

SOIL TEST BORING RECORD

PROJECT: TVA CUF Gypsum Seepage Study

DRILLED: November 30, 2006 **BORING NO.:** B-2

PROJ. NO.: 3043061041/0001 **PAGE 1 OF 2**

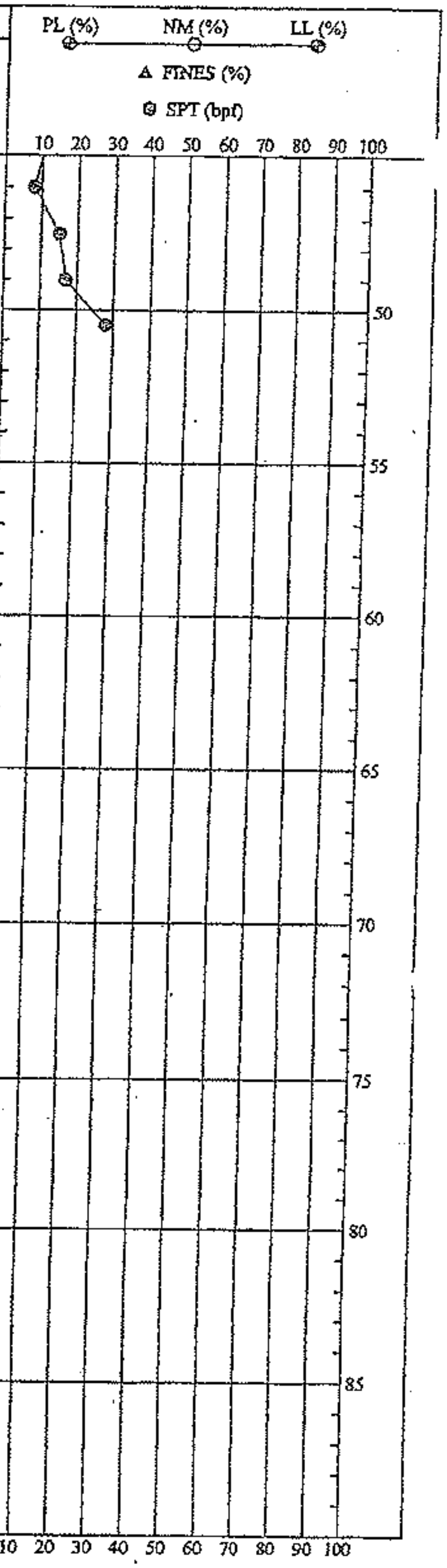
THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

Driller: Akins
Prepared By: Mason
Checked By: Justice

MACTEC

SOIL 3043061041 01.GPJ LAW GIBB.GDT 4/25/07

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	IDENT	TYPE	N-COUNT 1st 6" 2nd 6" 3rd 6"
45	FIRM TO LOOSE, YELLOWISH BROWN, WET, SANDY GRAVEL - ALLUVIUM		336.0	SPT-31		6-5-3
	STIFF, BROWN, VERY MOIST, SANDY SILT WITH GRAVEL - ALLUVIUM			SPT-32		6-8-7
	FIRM TO VERY FIRM, LIGHT YELLOWISH BROWN, WET, SILTY GRAVEL WITH SAND - ALLUVIUM			SPT-33		6-9-8
50			331.0	SPT-34		10-16-12
	BORING TERMINATED AT 51.0'					
55			326.0			
60			321.0			
65			316.0			
70			311.0			
75			306.0			
80			301.0			
85			296.0			
90			291.0			



SOIL_3043061041_01.GPJ LAW GIBB.GDT 4/25/07

REMARKS: STANDARD PENETRATION RESISTANCE TESTING PERFORMED USING AN AUTOMATIC HAMMER. APPROXIMATE 12-HOUR GROUNDWATER LEVEL WAS MEASURED AT 27.0'

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

Driller: Akins
Prepared By: Mason
Checked By: Justice

SOIL TEST BORING RECORD

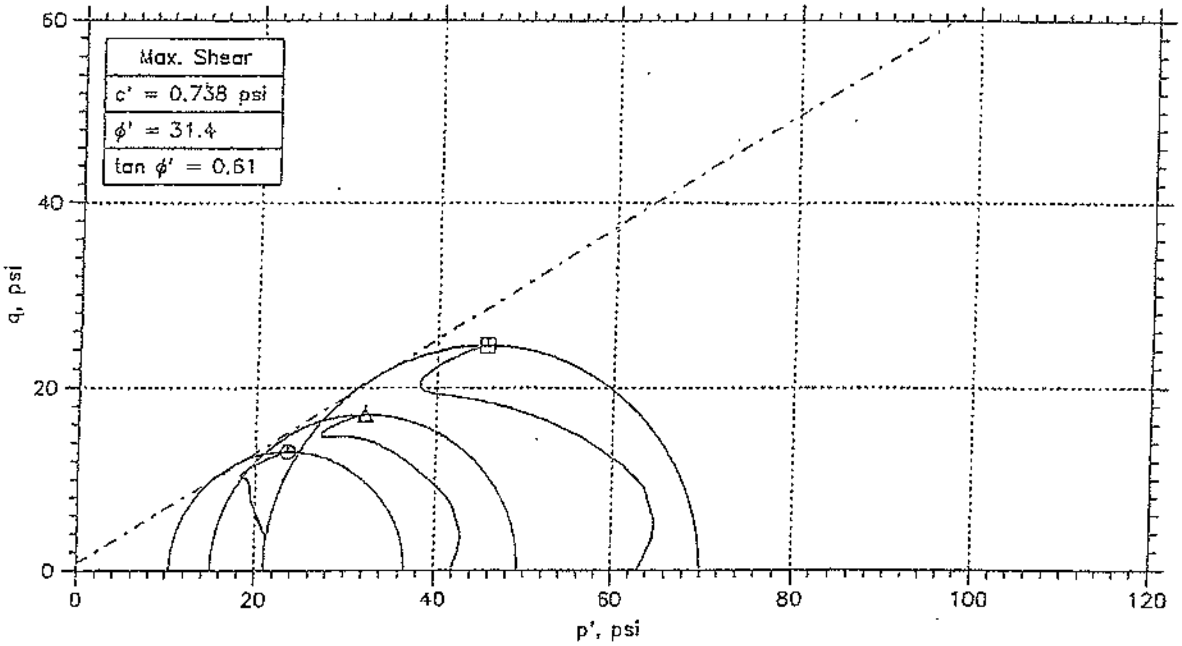
PROJECT: TVA CUF Gypsum Seepage Study

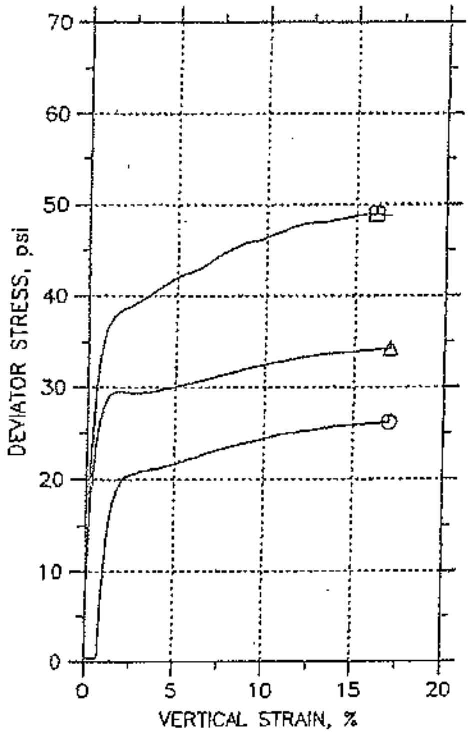
DRILLED: November 30, 2006 **BORING NO.:** B-2

PROJ. NO.: 3043061041/0001 **PAGE** 2 **OF** 2

MACTEC

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

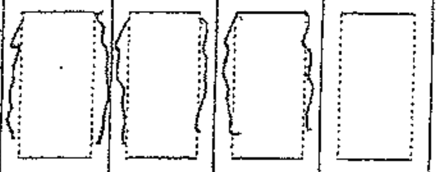




	Symbol	○	△	□	
	Sample No.	UD-5	UD-5	UD-5	
	Test No.	7083.1	7083.2	7083.3	
	Depth	30-32'	30-32'	30-32 ft	
Initial	Diameter, in	2.848	2.855	2.833	
	Height, in	5.6	5.6	5.6	
	Water Content, %	25.1	25.1	25.1	
	Dry Density, pcf	98.46	98.78	98.79	
	Saturation, %	95.3	95.9	96.0	
	Void Ratio	0.712	0.706	0.706	
Before Shear	Water Content, %	25.0	25.5	24.4	
	Dry Density, pcf	100.6	99.83	101.6	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.676	0.688	0.659	
	Back Press., psi	83.	80.01	96.01	
	Ver. Eff. Cons. Stress, psi	20.99	41.99	62.98	
	Shear Strength, psi	13.09	17.11	24.46	
	Strain at Failure, %	17	17	16.2	
	Strain Rate, %/min	0.1	0.1	0.1	
	B-Value	0.98	0.99	0.98	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	36	36	36	
	Plastic Limit	19	19	19	

MACTEC

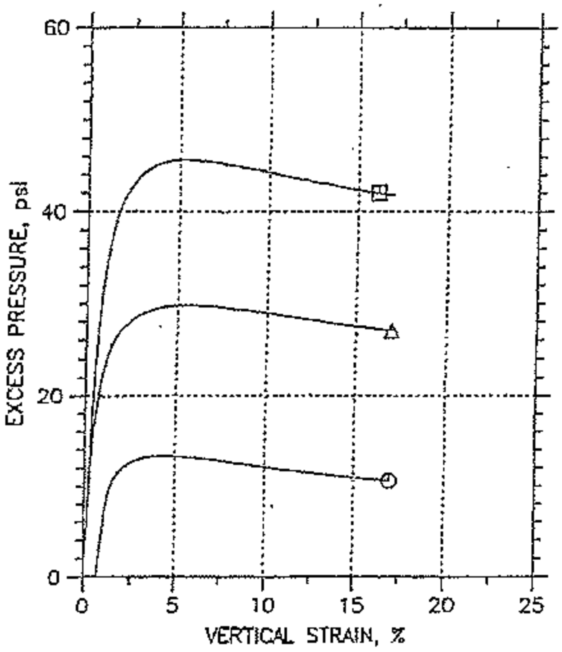
Project: TVA CUF Gypsum Seepage
Location: MWB2
Project No.: 3043061041
Boring No.: MWB2
Sample Type: Shelby Tube
Description: Tan Brown Lean Clay
Remarks:

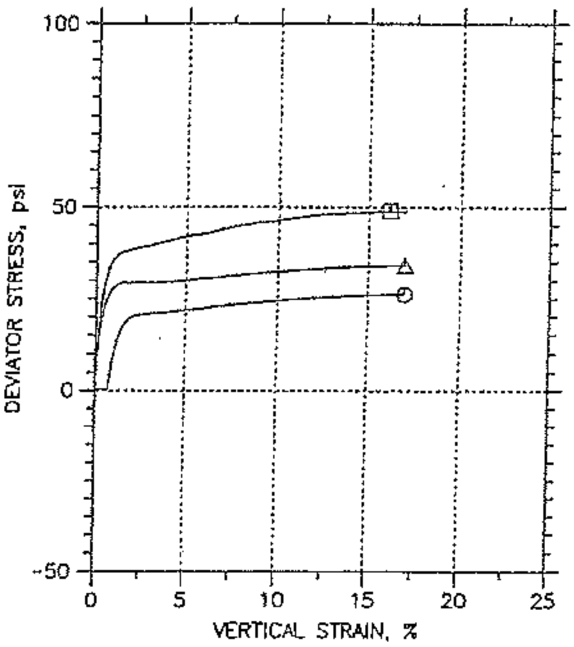


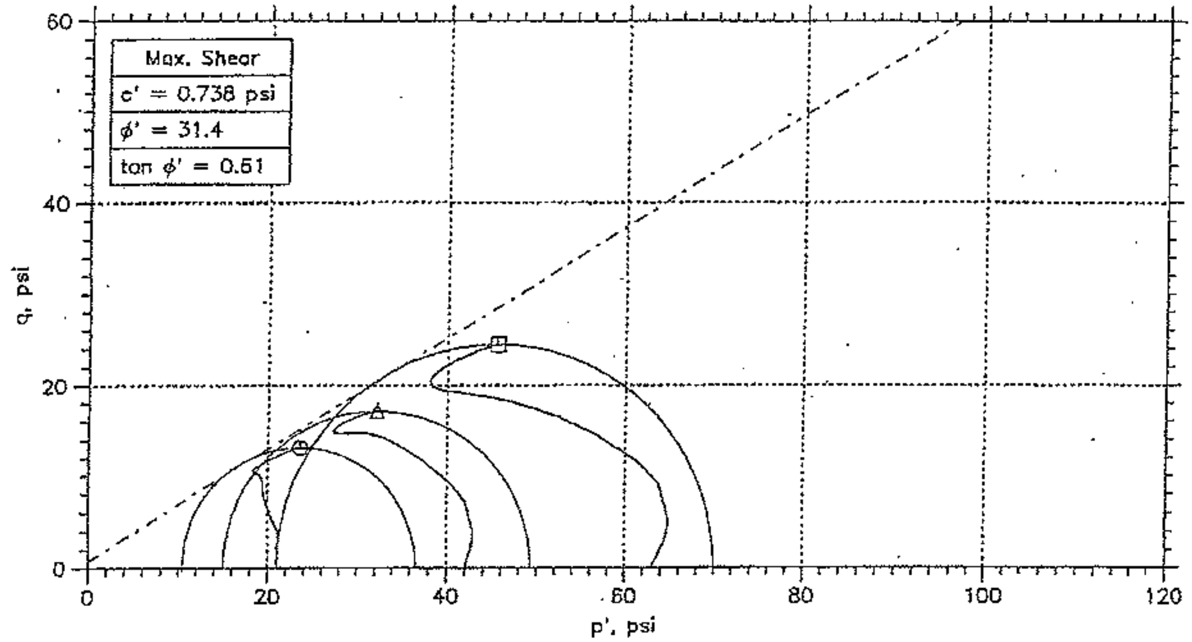
Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.

Mon, 16-APR-2007 09:00:09

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







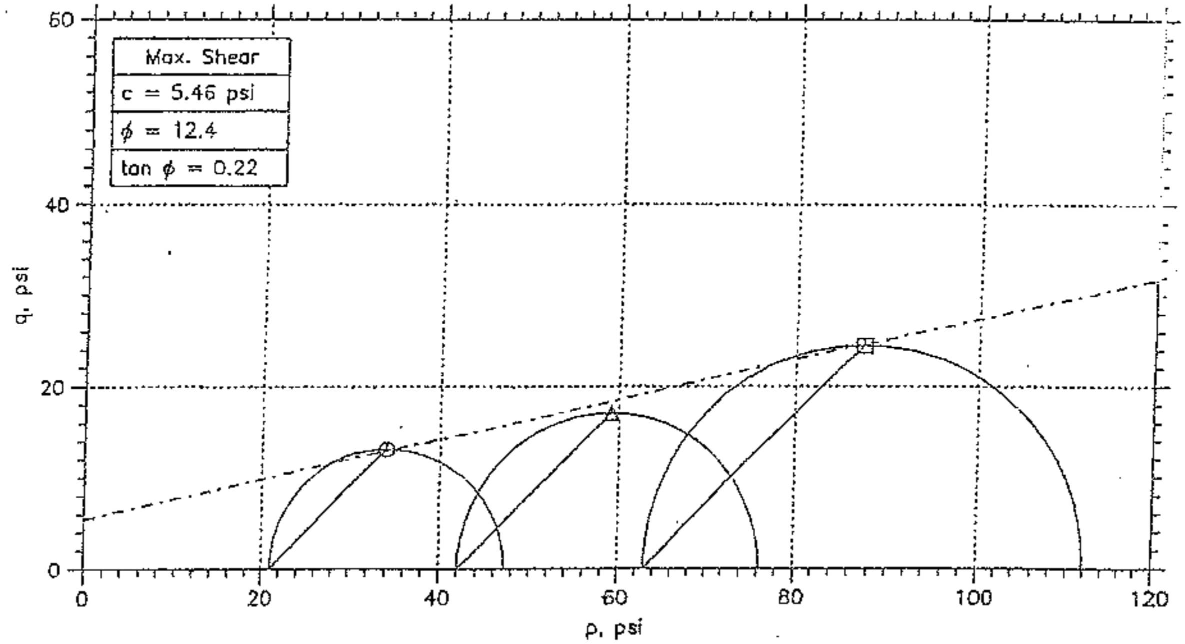
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	UD-5	7083.1	30-32'	HJ	3/14/07	JL	4/13/07	7083.1_65.dat
△	UD-5	7083.2	30-32'	HJ	3/14/07	JL	4/13/07	7083.2_82.dat
□	UD-5	7083.3	30-32 ft	HJ	3/14/07	JL	4/13/07	7083.3_71.dat

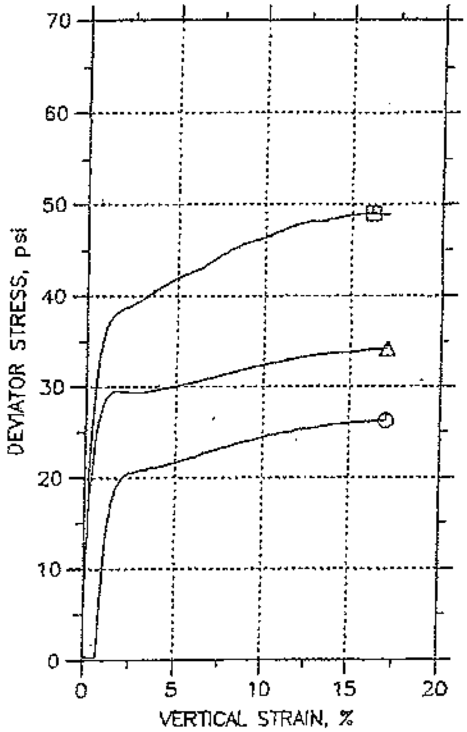
MACTEC

Project: TVA CUF Gypsum Seepage
Location: MWB2
Project No.: 3043061041
Boring No.: MWB2
Sample Type: Shelby Tube
Description: Tan Brown Lean Clay
Remarks:

Mon, 16-APR-2007 09:00:10

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

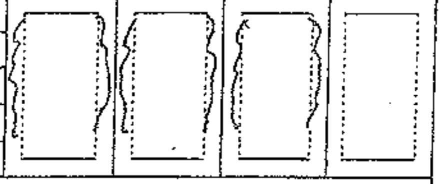




Symbol		○	△	□	
Sample No.		UD-5	UD-5	UD-5	
Test No.		7083.1	7083.2	7083.3	
Depth		30-32'	30-32'	30-32 ft	
Initial	Diameter, in	2.848	2.855	2.833	
	Height, in	5.6	5.6	5.6	
	Water Content, %	25.1	25.1	25.1	
	Dry Density, pcf	98.46	98.78	98.79	
	Saturation, %	95.3	95.9	96.0	
	Void Ratio	0.712	0.706	0.706	
Before Shear	Water Content, %	25.0	25.5	24.4	
	Dry Density, pcf	100.6	99.83	101.6	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.676	0.688	0.659	
	Back Press., psi	83.	80.01	96.01	
Ver. Eff. Cons. Stress, psi		20.99	41.99	62.98	
Shear Strength, psi		13.09	17.11	24.46	
Strain at Failure, %		17	17	16.2	
Strain Rate, %/min		0.1	0.1	0.1	
B-Value		0.98	0.99	0.98	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		36	36	36	
Plastic Limit		19	19	19	

MACTEC

Project: TVA CUF Gypsum Seepage
Location: MW82
Project No.: 3043061041
Boring No.: MW82
Sample Type: Shelby Tube
Description: Tan Brown Lean Clay
Remarks:
Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.



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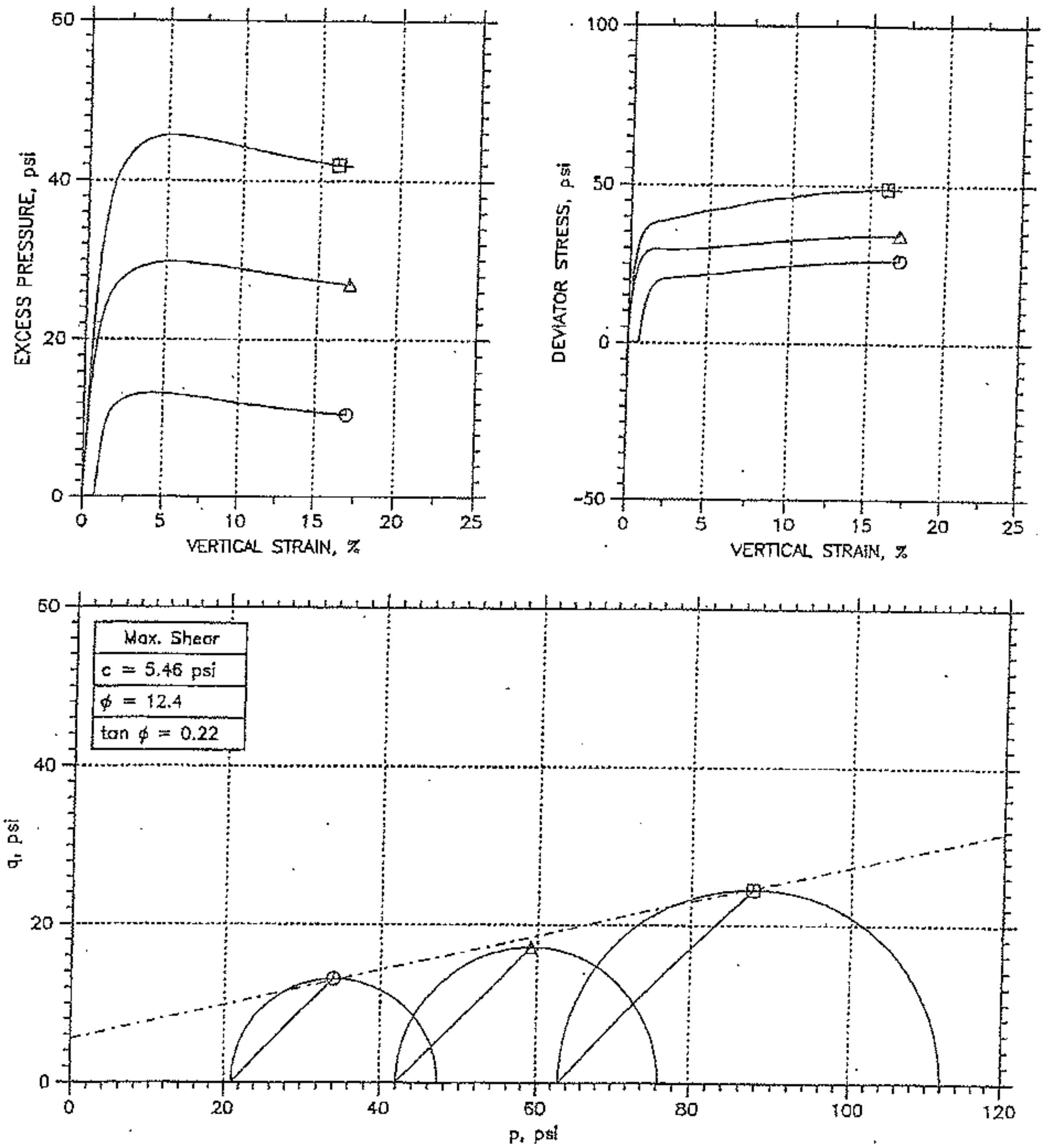
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



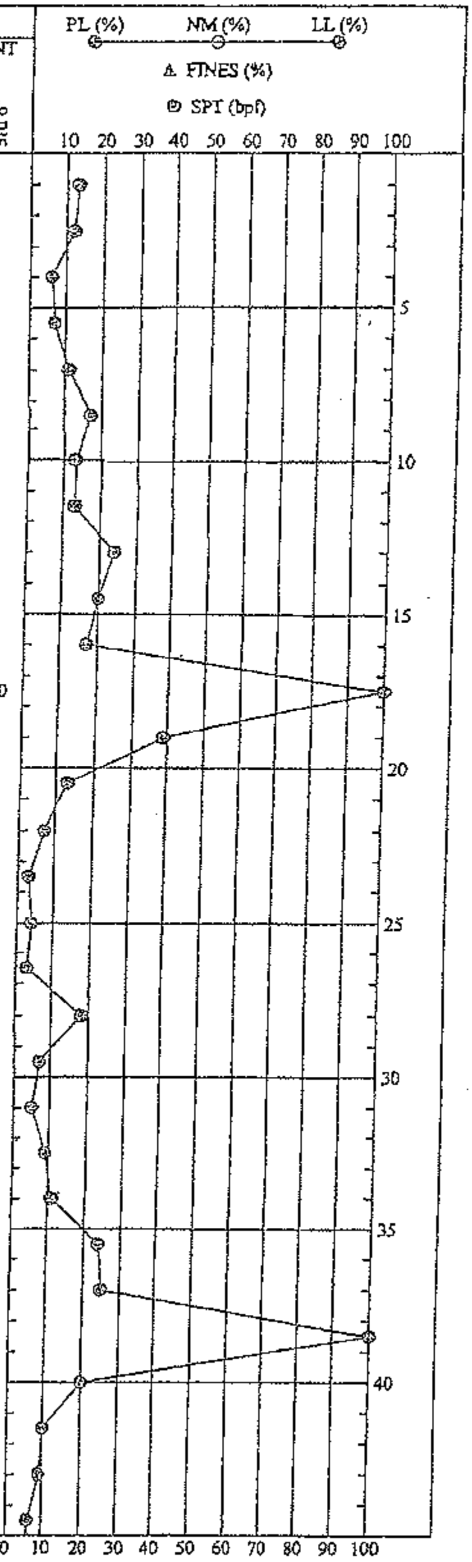
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	UD-5	7083.1	30-32'	HJ	3/14/07	JL	4/13/07	7083.1_65.dat
△	UD-5	7083.2	30-32'	HJ	3/14/07	JL	4/13/07	7083.2_82.dat
□	UD-5	7083.3	30-32 ft	HJ	3/14/07	JL	4/13/07	7083.3_71.dat

MACTEC	Project: TVA CUF Gypsum Seepage	Location: MWB2	Project No.: 3043061041
	Boring No.: MWB2	Sample Type: Shelby Tube	
	Description: Tan Brown Lean Clay		
	Remarks:		

Mon, 16-APR-2007 09:00:27

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLES IDENT	N-COUNT (1st 6" 2nd 6" 3rd 6")
0	FIRM, GRAY TO BROWN, MOIST, GRAVEL - FILL	395.0		
	STIFF TO FIRM, REDDISH BROWN, MOIST, SILTY CLAY WITH A LITTLE SAND AND ROCK FRAGMENTS AND A TRACE OF ORGANICS - FILL		SPT-1	7-5-8
			SPT-2	6-5-7
			SPT-3	3-3-3
5		390.0	SPT-4	3-4-3
			SPT-5	3-5-4
	VERY STIFF, BROWN TO TAN, MOIST, CLAYEY SILT WITH A TRACE OF SAND AND ROCK FRAGMENTS - FILL		SPT-6	5-8-9
10	STIFF TO VERY STIFF, REDDISH BROWN TO BROWN, MOIST, SILTY CLAY WITH VARYING AMOUNTS OF SILT AND A LITTLE SAND AND ROCK FRAGMENTS - FILL	385.0	SPT-7	6-6-7
			SPT-8	6-6-7
			SPT-9	6-10-14
15		380.0	SPT-10	6-9-11
			SPT-11	4-7-10
	VERY HARD TO HARD, VERY MOIST TO WET, LIMESTONE FRAGMENTS WITH REDDISH BROWN SILTY CLAY - FILL ▽		SPT-12	8-50-50/0.0
			SPT-13	36-15-24
20	FIRM TO LOOSE, BLACK TO BROWN, WET, BOTTOM ASH	375.0	SPT-14	6-8-5
			SPT-15	4-4-3
	VERY LOOSE, BLACK TO BROWN, WET, BOTTOM ASH		SPT-16	2-1-2
25		370.0	SPT-17	2-2-2
			SPT-18	2-2-1
	VERY STIFF, GRAY TO BROWN, WET, FLY ASH		SPT-19	3-12-6
30	LOOSE, BLACK TO BROWN, WET, BOTTOM ASH WITH SOME CLAY	365.0	SPT-20	6-4-3
	FIRM TO VERY STIFF, BROWN TO DARK GRAY, MOIST CLAYEY SILT WITH A TRACE OF SAND, ROCK FRAGMENTS, AND ORGANICS - ALLUVIUM		SPT-21	1-2-3
			SPT-22	1-3-6
			SPT-23	1-4-7
35		360.0	SPT-24	3-9-15
			SPT-25	5-9-16
	VERY HARD, BROWN TO BLACK, VERY MOIST, CLAYEY SILT WITH ROCK FRAGMENTS - ALLUVIUM		SPT-26	11-17-50/0.3
40	VERY STIFF TO STIFF, BROWN, VERY MOIST, CLAYEY SILT - ALLUVIUM	355.0	SPT-27	10-10-10
			SPT-28	5-5-5
	STIFF TO FIRM, BROWN, VERY MOIST TO WET, SILTY CLAY WITH VARYING AMOUNTS OF SILT - ALLUVIUM		SPT-29	5-6-3
			SPT-30	1-3-3
45		350.0		



SOIL 3043061041 01.GPJ LAW GIBB.GDT 4/25/07

REMARKS: STANDARD PENETRATION RESISTANCE TESTING PERFORMED USING AN AUTOMATIC HAMMER. DRILLER REPORTED GROUNDWATER STABILIZING WITHIN THE BOREHOLE AT A DEPTH OF ABOUT 7' AFTER SAMPLING THE SUBMERGED ZONE AT A DEPTH OF ABOUT 18.9'.

SOIL TEST BORING RECORD

PROJECT: TVA CUF Gypsum Seepage Study

DRILLED: November 29, 2006 **BORING NO.:** B-3

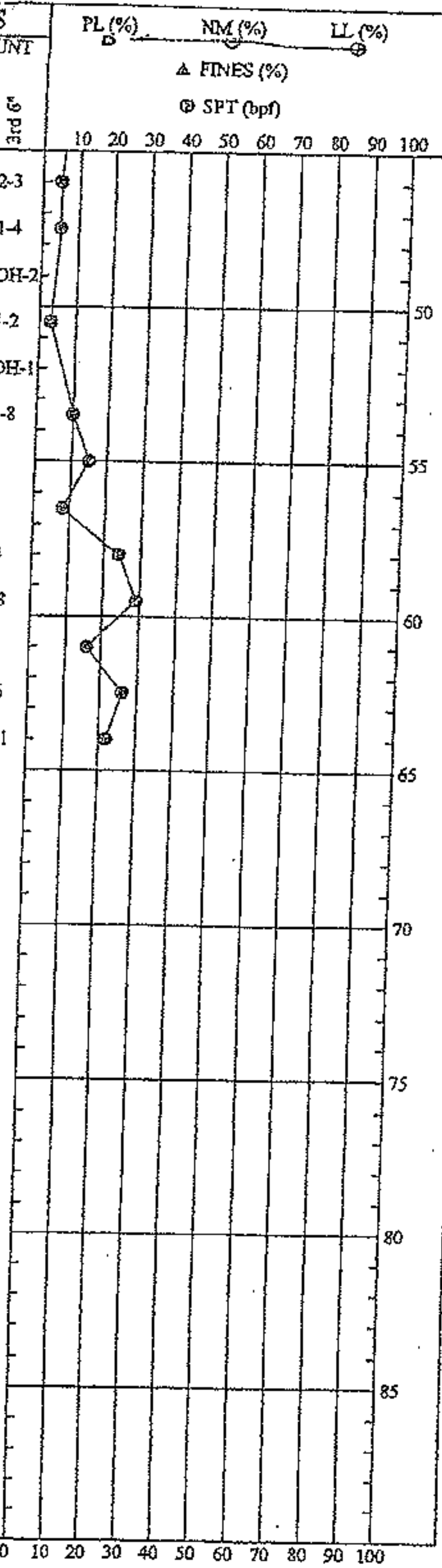
PROJ. NO.: 3043061041/0001 **PAGE 1 OF 2**

Driller : Aians
Prepered By: RDR
Checked By: Justice

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	ELEV (ft)
45	STIFF TO FIRM, BROWN, VERY MOIST TO WET, SILTY CLAY WITH VARYING AMOUNTS OF SILT - ALLUVIUM	350.0
	VERY SOFT TO SOFT, BROWN TO GRAY, VERY MOIST TO WET, SILTY CLAY - ALLUVIUM	
50		345.0
	LOOSE TO VERY FIRM, BROWN, WET, SILTY SAND WITH GRAVEL - ALLUVIUM	
55		340.0
60		335.0
65	BORING TERMINATED AT 65.0'	330.0
70		325.0
75		320.0
80		315.0
85		310.0
90		305.0

SAMPLES IDENT	N-COUNT 1st 6" 2nd 6" 3rd 6"
SPT-31	WOH-2-3
SPT-32	WOH-1-4
SPT-33	WOH-WOH-2
SPT-34	WOH-1-2
SPT-35	WOH-WOH-1
SPT-36	WOH-2-8
SPT-37	4-8-7
SPT-38	4-3-5
SPT-39	9-10-14
SPT-40	15-11-18
SPT-41	6-7-9
SPT-42	10-10-16
SPT-43	2-10-12-11



SOIL 3043061041 01.GPJ LAW_GIBB.GDT 4/25/07

REMARKS: STANDARD PENETRATION RESISTANCE TESTING PERFORMED USING AN AUTOMATIC HAMMER. DRILLER REPORTED GROUNDWATER STABILIZING WITHIN THE BOREHOLE AT A DEPTH OF ABOUT 7' AFTER SAMPLING THE SUBMERGED ZONE AT A DEPTH OF ABOUT 18.9'.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

Driller : Akins
Prepared By: RDR
Checked By: Justice

SOIL TEST BORING RECORD

PROJECT: TVA CUF Gypsum Seepage Study

DRILLED: November 29, 2006 **BORING NO.:** B-3

PROJ. NO.: 3043061041/0001 **PAGE 2 OF 2**

MACTEC

Law Engineering and Environmental Services, Inc.
(1995)

TVA - Fly Ash, Bottom Ash and Scrubber Sludge Study
Classification (Index Property) Summary
Law Engineering Project No. 5810860101

Ash Sample Source	Plant Code	Material	Bucket Code	Date Collected	Moisture Content, %	Grain Size ASTM D422			Atterberg Limits ASTM D4318			Specific Gravity	USCS Classification	AASHTO Classification
						% Ret'd on No. 4	% Pass No. 200	% Pass 0.005mm	LL	PL	PI			
Allen	ALF	Boiler Slag - Fine Reed Rejects	A-B	5/11/95	0.06	0.0	16.2	0.8	NL	NP	N/A	2.75	SM	A-2-4(0.0)
			C-D		0.12	0.0	14.6	0.8	NL	NP	N/A	2.79	SM	A-2-4(0.0)
			E-F		0.10	0.0	16.0	0.6	NL	NP	N/A	2.81	SM	A-2-4(0.0)
Bull Run	BRF	Dry Fly Ash	A-B	4/4/95	0.02	0.0	91.3	16.6	NL	NP	N/A	2.36	ML	A-4(0.0)
			C-D	4/5/95	0.05	0.0	91.2	19.5	NL	NP	N/A	2.28	ML	A-4(0.0)
			E-F	4/6/95	0.03	0.0	90.7	17.5	NL	NP	N/A	2.37	ML	A-4(0.0)
		Bottom Ash - From Pond	A-B	3/29/95	6.99	21.0	4.0	—	NL	NP	N/A	2.31	SW	A-1-b
			C-D		6.07	21.3	6.9	—	NL	NP	N/A	2.29	SW-SM	A-1-b
			E-F		6.74	17.9	5.7	—	NL	NP	N/A	2.35	SW-SM	A-1-b
Colbert	COF	Dry Fly Ash - Units 1&2 - Units 1&4	A B	5/25/95 5/25/95	0.01	0.0	81.6	14.9	NL	NP	N/A	2.02	ML	A-4(0.0)
		- Units 1&2 - Units 3&4	C D	5/26/95 5/26/95	0.01	0.0	69.9	11.3	NL	NP	N/A	2.00	ML	A-4(0.0)
		- Units 1&2 - Units 3&4	E F	5/30/95 5/30/95	0.17	0.0	61.6	3.9	NL	NP	N/A	1.95	ML	A-4(0.0)
		Bottom Ash - From Pond	A-B	5/25/95	8.01	7.2	13.6	—	NL	NP	N/A	2.15	SM	A-1-b
			C-D		6.86	15.9	10.4	—	NL	NP	N/A	2.08	SP-SM	A-1-b
			E-F		7.92	12.8	10.5	—	NL	NP	N/A	2.10	SP-SM	A-1-b
Cumberland	CUF	Dry Fly Ash - Units 1&2	A-B	4/17/95	0.31	0.0	95.1	30.0	NL	NP	N/A	2.57	ML	A-4(0.0)
		- Units 1&2	C-D	4/11/95		0.0	92.0	20.7	NL	NP	N/A	2.64	ML	A-4(0.0)
		- Units 1&2	E-F	4/19/95	0.01	0.0	93.2	29.8	NL	NP	N/A	2.65	ML	A-4(0.0)
		Bottom Ash - From Pond	A-B	4/6/95	14.32	30.9	1.1	—	NL	NP	N/A	2.59	SW	A-1-a
			C-D		13.66	46.2	7.2	—	NL	NP	N/A	2.66	SW	A-1-a
			E-F		5.09	32.2	2.8	—	NL	NP	N/A	2.63	SW	A-1-a
		Scrubber Gypsum	A-B	4/6/95	30.44	—	—	—	NL	NP	N/A	—	—	—
			C-D		30.39	—	—	—	NL	NP	N/A	—	—	—
			E-F		29.41	—	—	—	NL	NP	N/A	—	—	—
Gallatin	GAF	Dry Fly Ash - Unit 2 Hoppers	A-B	6/9/95	0.02	0.0	94.2	12.0	NL	NP	N/A	2.37	ML	A-4(0.0)
			C-D		0.01	0.0	93.2	13.8	NL	NP	N/A	2.40	ML	A-4(0.0)
			E-F		0.01	0.0	93.5	14.8	NL	NP	N/A	2.39	ML	A-4(0.0)
		Bottom Ash - From Pond	A-B	6/9/95	19.16	18.2	5.9	—	NL	NP	N/A	2.56	SP-SM	A-1-b
			C-D		7.32	27.0	4.0	—	NL	NP	N/A	2.57	SW	A-1-b
			E-F		10.20	16.8	5.6	—	NL	NP	N/A	2.52	SW-SM	A-1-b
John Sevier	JSF	Dry Fly Ash - Unit 4, Hoppers 11&12 - Unit 3, Hoppers 11&12	A B	5/25/95	0.06	0.0	94.2	17.4	NL	NP	N/A	2.27	ML	A-4(0.0)
		- Unit 4, Hoppers 9, 10&13 - Unit 3, Hoppers 9&10	C D	5/25/95	0.08	0.0	96.1	22.1	NL	NP	N/A	2.35	ML	A-4(0.0)
		- Unit 4, Hopper 15, - Unit 3, Hopper 16 - Unit 4, Hopper 13	E F	5/25/95	0.20	0.0	94.8	28.0	NL	NP	N/A	2.43	ML	A-4(0.0)
		Bottom Ash - From Pond	A-B	4/12/95	26.48	22.8	4.3	—	NL	NP	N/A	2.25	SP	A-1-a
			C-D		27.72	12.2	3.3	—	NL	NP	N/A	2.24	SW	A-1-a
			E-F		30.30	27.8	3.7	—	NL	NP	N/A	2.22	SW	A-1-a

TVA - Fly Ash, Bottom Ash and Scrubber Sludge Study
Volumetric Testing Summary
Law Engineering Project No. 5810860101

Source	Code	Material	Standard Proctor		Modified Proctor		Relative Dens. Dry Method (pcf)	
			Max. Dry Dens. (pcf)	Opt. Moisture (%)	Max. Dry Dens. (pcf)	Opt. Moisture (%)	Minimum	Maximum
Allen	ALF	Boiler Slag (Fine Reed Rejects)	95.3	21.5	102.6	23.2	---	---
Bull Run	BRF	Dry Fly Ash	91.6	17.4	95.7	15.1	---	---
		Bottom Ash - From Pond	91.9	22.6	98.7	18.5	73.9	92.1
Colbert	COF	Dry Fly Ash (Units 1-4)	56.7	45.4	62.9	40.3	---	---
		Bottom Ash - From Pond	64.2	27.4	73.2	17.2	55.7	71.2
Cumberland	CUF	Dry Fly Ash (Units 1-2)	111.4	13.2	116.3	11.5	---	---
		Bottom Ash - From Pond	90.1	15.4	103.3	15.7	67.0	87.1
		Scrubber Gypsum	---	---	---	---	---	---
Gallatin	GAF	Dry Fly Ash (Unit 2 Hoppers)	86.6	21.4	88.9	18.8	---	---
		Bottom Ash - From Pond	92.0	25.5	102.5	20.9	71.3	90.7
John Sevier	JSF	Dry Fly Ash (Units 3-4)	83.7	18.6	86.7	17.8	---	---
		Bottom Ash - From Pond	78.9	30.3	96.2	21.9	55.7	73.9
Johnsonville	JOF	Ponded Fly Ash (New Dredge Cell)	75.8	31.4	92.5	20.6	---	---
		Ponded Fly Ash (Old Dredge Cell)	89.5	20.5	96.0	16.1	---	---
		Ponded Fly Ash (Active Ash Pond)	86.6	22.8	91.7	18.0	---	---
		Bottom Ash - From Pond	99.2	18.0	104.1	12.0	80.2	99.2
Kingston	KIF	Ponded Fly Ash (Cell I)	81.0	25.2	84.7	24.1	---	---
		Ponded Fly Ash (Cell III)	81.0	23.5	84.4	23.7	---	---
		Bottom Ash - From Pond	89.0	24.1	97.6	21.0	71.0	88.4
Paradise	PAF	Ponded Fly Ash (East Cell)	110.0	16.5	114.4	13.7	---	---
		Boiler Slag (Reed Rejects)	112.5	18.2	116.0	18.7	---	---
		Scrubber Gypsum	---	---	---	---	---	---
Shawnee	SHF	Dry Fly Ash	72.4	28.3	77.2	24.4	---	---
		Bottom Ash - From Pond	71.7	30.5	81.4	26.1	57.4	74.0
		Spent Bed Material (SBM)	---	---	---	---	---	---
		Char	---	---	---	---	---	---
Widows Creek	WCF	Ponded Fly Ash (Ash Pond)	67.0	39.8	73.5	27.8	---	---
		Scrubber Gypsum	---	---	---	---	---	---
		Bottom Ash - From Pond	106.2	17.6	120.8	15.8	83.0	103.3

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TVA - Fly Ash, Bottom Ash and Scrubber Sludge Study
Consolidation/Hydraulic Conductivity/Chemical Testing Summary
Law Engineering Project No. 5810860101

Source	Code	Material	Consolidation Compression Index, C_c	Hydraulic Conductivity (cm/sec)	Resistivity (Ohm-cm)	pH	Water Soluble Sulfate (mg/kg)	Water Soluble Chloride (mg/kg)
Allen	ALF	Boiler Slag (Fine Reed Rejects)	0.04	9.0E-4	30000	7.5	43	<10
Bull Run	BRF	Dry Fly Ash	0.04	4.0E-5	690	8.4	4630	<10
		Bottom Ash - From Pond	----	1.8E-2	7300	7.2	370	<10
Colbert	COF	Dry Fly Ash (Units 1-4)	0.08	2.8E-4	850	9.4	1660	<10
		Bottom Ash - From Pond	----	1.6E-2	4500	5.4	215	<10
Cumberland	CUF	Dry Fly Ash (Units 1-2)	0.01	2.2E-5	2600	11.6	5020	<10
		Bottom Ash - From Pond	----	6.8E-2	1200	2.7	4790	<10
		Scrubber Gypsum	----	----	1100	7.8	4830	<10
Gallatin	GAF	Dry Fly Ash (Unit 2 Hoppers)	0.05	7.7E-5	420	10.6	5800	<10
		Bottom Ash - From Pond	----	2.9E-2	1600	2.8	1660	<10
John Sevier	JSF	Dry Fly Ash (Units 3-4)	0.05	5.5E-5	440	4.1	4910	<10
		Bottom Ash - From Pond	----	2.6E-2	5200	6.8	285	<10
Johnsonville	JOF	Ponded Fly Ash (New Dredge Cell)	0.06	5.0E-4	2800	8.1	83	<10
		Ponded Fly Ash (Old Dredge Cell)	0.10	5.8E-4	2600	6.8	1520	20
		Ponded Fly Ash (Active Ash Pond)	0.11	3.5E-5	690	8.4	2960	60
		Bottom Ash - From Pond	----	4.7E-3	740	6.0	2200	<10
Kingston	KIF	Ponded Fly Ash (Cell I)	0.05	8.3E-5	7700	7.6	200	<10
		Ponded Fly Ash (Cell III)	0.05	3.4E-5	6400	6.8	140	<10
		Bottom Ash - From Pond	----	9.1E-3	1900	4.0	490	<10
Paradise	PAF	Ponded Fly Ash (East Cell)	0.04	1.0E-5	2600	8.1	340	<10
		Boiler Slag (Reed Rejects)	----	1.3E-3	9700	4.3	220	<10
		Scrubber Gypsum	----	----	1100	7.7	4630	10
Shawnee	SHF	Dry Fly Ash	0.04	9.2E-5	1000	11.5	2270	<10
		Bottom Ash - From Pond	----	8.9E-3	3000	8.1	4200	10
		Spent Bed Material (SBM)	----	----	----	12.0	4190	150
		Char	----	----	190	12.0	4130	980
Widows Creek	WCF	Ponded Fly Ash (Ash Pond)	0.12	1.8E-4	1400	9.2	1060	<10
		Scrubber Gypsum	----	----	1200	6.7	3050	<10
		Bottom Ash - From Pond	----	3.4E-2	3100	8.0	4070	130

Note: Consolidation and Hydraulic Conductivity test specimen were remolded to approximately 95 percent of the Standard Proctor maximum dry density

TVA - Fly Ash, Bottom Ash and Scrubber Sludge Study
Strength Testing Summary
Law Engineering Project No. 5810860101

Source	Code	Material	CBR %	Resilient Modulus (Standard Effort)				Resilient Modulus (Modified Effort)			
				K1	K2	K5	M_r at S_c=4psi, S_d=4psi	K1	K2	K5	M_r at S_c=4psi, S_d=4psi
Allen	ALF	Boiler Slag (Fine Reed Rejects)	37	2,662	0.09516	0.53980	6,419	2,468	0.14322	0.51069	6,110
Bull Run	BRF	Dry Fly Ash	2	3,225	-0.17750	0.54531	5,370	3,283	-0.01625	0.38843	5,500
		Bottom Ash - From Pond	35	1,857	0.10936	0.78070	6,378	1,977	0.13522	0.76648	6,901
Colbert	COF	Dry Fly Ash (Units 1-4)	9	1,353	-0.00868	0.56321	2,918	1,639	0.01011	0.53301	3,480
		Bottom Ash - From Pond	24	2,368	0.11934	0.58242	6,264	2,455	0.09488	0.59309	6,372
Cumberland	CUF	Dry Fly Ash (Units 1-2)	24	7,531	-0.03317	0.34550	11,612	10,959	0.14896	0.24877	19,021
		Bottom Ash - From Pond	15	2,194	0.09530	0.67882	6,417	1,994	0.13866	0.76150	6,945
		Scrubber Gypsum	---	---	---	---	---	---	---	---	---
Gallatin	GAF	Dry Fly Ash (Unit 2 Hoppers)	2	2,713	-0.09930	0.47991	4,598	3,602	-0.12389	0.45133	5,671
		Bottom Ash - From Pond	30	1,972	0.20995	0.65540	6,545	2,427	0.20416	0.61364	7,541
John Sevier	JSF	Dry Fly Ash (Units 3-4)	1	2,965	-0.08694	0.43636	4,813	4,033	-0.09489	0.39276	6,095
		Bottom Ash - From Pond	40	2,156	0.08085	0.76340	6,949	2,108	0.09702	0.69867	6,352
Johnsonville	JOF	Ponded Fly Ash (New Dredge Cell)	12	1,487	0.03358	0.63725	3,769	2,541	-0.01211	0.48836	4,917
		Ponded Fly Ash (Old Dredge Cell)	28	1,495	0.03707	0.78260	4,657	2,255	0.09559	0.65332	6,368
		Ponded Fly Ash (Active Ash Pond)	1	2,146	-0.18159	0.60215	3,844	3,980	-0.14235	0.42844	5,917
		Bottom Ash - From Pond	50	2,373	0.16927	0.51994	6,169	2,389	0.13323	0.56010	6,247
Kingston	KIF	Ponded Fly Ash (Cell I)	2	1,803	0.07728	0.41203	3,553	2,374	-0.04388	0.47386	4,309
		Ponded Fly Ash (Cell II)	1	2,592	-0.10787	0.48134	4,350	3,254	-0.09252	0.43051	5,199
		Bottom Ash - From Pond	60	1,427	0.13665	0.75876	4,938	1,822	0.19126	0.64487	5,807
Paradise	PAF	Ponded Fly Ash (East Cell)	4	5,929	-0.09595	0.40269	9,071	5,551	-0.06155	0.44309	9,421
		Boiler Slag (Reed Rejects)	55	1,661	0.06737	0.79102	5,460	1,715	0.08023	0.76411	5,529
		Scrubber Gypsum	---	---	---	---	---	---	---	---	---
Shawnee	SHF	Dry Fly Ash	9	2,390	-0.04340	0.45385	4,222	2,774	-0.03472	0.41978	4,731
		Bottom Ash - From Pond	25	1,928	0.11134	0.73640	6,244	1,558	0.08323	0.76224	5,030
		Spent Bed Material (SBM)	---	---	---	---	---	---	---	---	---
		Char	---	---	---	---	---	---	---	---	---
Widows Creek	WCF	Ponded Fly Ash (Ash Pond)	3	1,026	-0.02608	0.63430	2,384	3,283	-0.01625	0.38843	5,500
		Scrubber Gypsum	---	---	---	---	---	---	---	---	---
		Bottom Ash - From Pond	30	2,258	0.19103	0.66319	7,379	2,260	0.28011	0.26147	4,788

Note: CBR and Resilient Modulus test specimen were remolded to approximately 95 percent of the Standard Proctor (and Modified Proctor for Res. Mod.) maximum dry density at or near optimum moisture content

TVA - Fly Ash, Bottom Ash and Scrubber Sludge Study
Strength Testing Summary
Law Engineering Project No. 5810860101

Source	Code	Material	Triaxial CU with pore pressure				Direct Shear (P)		
			Effective Stress $(\overline{R})$		Total Stress (R)		Cohesion, c (ksf)	Internal friction, φ	Angle of Repose
			Cohesion, c (ksf)	Internal friction, φ	Cohesion, c (ksf)	Internal friction, φ			
Allen	ALF	Boiler Slag (Fine Reed Rejects)	0.00	37.3	1.15	39.2	2.32	25.2	—
Bull Run	BRF	Dry Fly Ash	0.31	27.7	1.12	21.2	1.36	27.4	----
		Bottom Ash - From Pond	----	----	----	----	----	----	32.4
Colbert	COF	Dry Fly Ash (Units 1-4)	0.34	27.6	0.69	19.9	1.31	28.6	----
		Bottom Ash - From Pond	----	----	----	----	----	----	30.9
Cumberland	CUF	Dry Fly Ash (Units 1-2)	0.00	53.5	1.70	50.5	2.53	33.4	----
		Bottom Ash - From Pond	----	----	----	----	----	----	30.8
		Scrubber Gypsum	----	----	----	----	----	----	----
Gallatin	GAF	Dry Fly Ash (Unit 2 Hoppers)	0.00	31.7	0.57	26.2	1.37	34.5	----
		Bottom Ash - From Pond	----	----	----	----	----	----	31.8
John Sevier	JSF	Dry Fly Ash (Units 3-4)	0.22	22.4	0.26	17.7	1.11	33.6	----
		Bottom Ash - From Pond	----	----	----	----	----	----	27.4
Johnsonville	JOF	Av Pont Ponded Fly Ash (New Dredge Cell)	0.23	32.4	1.26	25.8	1.29	32.4	----
	South Loop	Ponded Fly Ash (Old Dredge Cell)	0.12	30.5	0.66	15.2	2.14	39.3	----
		Ponded Fly Ash (Active Ash Pond)	0.00	22.6	0.01	15.8	1.41	36.6	----
		Bottom Ash - From Pond	----	----	----	----	----	----	30.8
Kingston	KJF	Ponded Fly Ash (Cell I)	0.14	26.1	0.36	19.6	0.82	39.1	----
		Ponded Fly Ash (Cell III)	0.03	24.4	0.00	17.8	1.47	37.6	----
		Bottom Ash - From Pond	----	----	----	----	----	----	31.3
Paradise	PAF	Ponded Fly Ash (East Cell)	0.37	21.2	0.55	15.6	2.27	20.2	----
		Boiler Slag (Reed Rejects)	0.06	40.6	2.00	40.3	----	----	----
		Scrubber Gypsum	----	----	----	—	----	----	----
Shawnee	SHF	Dry Fly Ash	1.24	22.4	1.79	14.7	1.10	39.8	----
		Bottom Ash - From Pond	----	----	----	----	----	----	31.6
		Spent Bed Material (SBM)	----	----	----	----	----	----	----
		Char	----	----	----	----	----	----	----
Widows Creek	WCF	Ponded Fly Ash (Ash Pond)	1.85	25.5	1.94	21.5	1.70	31.2	----
		Scrubber Gypsum	----	----	----	----	----	----	----
		Bottom Ash - From Pond	----	----	----	----	----	----	29.0

Note: Triaxial CU and Direct Shear test specimen were remolded to approximately 95 percent of the Standard Proctor maximum dry density at or near optimum moisture content

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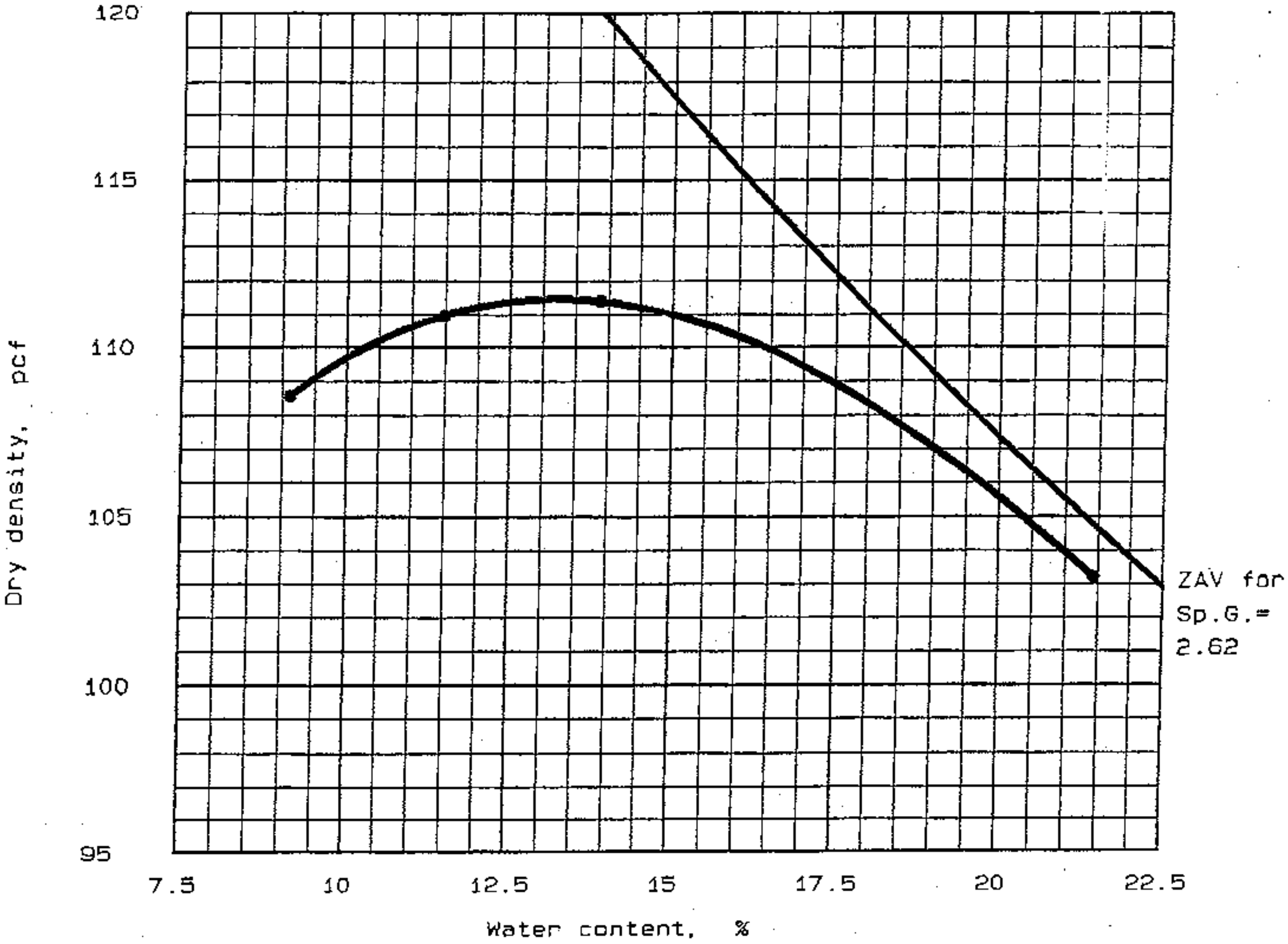
TVA - CUMBERLAND
DRY FLY ASH (UNITS 1-2)

Description	Test Method	Property	Sample 1	Sample 2	Sample 3
Grain Size	ASTM D 422	Percent Retained on the #4 Sieve Percent Passing the #200 Sieve Percent Passing the 0.005 mm Sieve	0.0 95.1 30.0	0.0 92.0 20.7	0.0 93.2 29.8
Atterberg Limits	ASTM D 4318	Liquid Limit Plastic Limit Plasticity Index	NL NP N/A	NL NP N/A	NL NP N/A
Specific Gravity	ASTM D 854	Specific Gravity at 20°C	2.57	2.64	2.65
Classification	ASTM D 2487 AASHTO M 145	Unified Soil Classification System (USCS) AASHTO Classification	ML A-4(0.0)	ML A-4(0.0)	ML A-4(0.0)
			Composite Sample		
Moisture-Density Relations (Standard Effort)	ASTM D 698	Maximum Dry Density, pcf Optimum Moisture Content, %	111.4 13.2		
Moisture-Density Relations (Modified Effort)	ASTM D 1557	Maximum Dry Density, pcf Optimum Moisture Content, %	116.3 11.5		
			Result	Dry Density, pcf	Moisture Content, %
Consolidation	ASTM D2435	Compression Index C_c	0.01	104.8	11.6
Hydraulic Conductivity	ASTM D 5084	Hydraulic Conductivity, cm/sec	2.2E-5	106.3	12.4
Triaxial Shear Strength Consolidated-Undrained (CU)	ASTM D4767	Effective Stress, Cohesion, c', ksf Effective Stress, Internal Friction Angle, ϕ',degrees	0.00 53.5	106.3	12.2
		Total Stress, Cohesion, c, ksf Total Stress, Internal Friction Angle, ϕ, degrees	1.70 50.5	106.3	12.2
Direct Shear Strength	ASTM D 3080	Cohesion, c, ksf Internal Friction Angle, ϕ, degrees	2.53 33.4	93.7	12.9
California Bearing Ratio	ASTM D 1883	CBR, %	24	106.6	13.1
Resilient Modulus (Standard Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	11,612	104.4	13.0
Resilient Modulus (Modified Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	19,021	107.6	10.2
Soil Resistivity	AASHTO T 288	Minimum Resistivity, Ohm-cm	2,600		
pH of Soil	AASHTO T 289	pH	11.6		
Water Soluble Sulfate Ion	AASHTO T 290	Sulfate Ion Content, mg/kg	5020		
Water Soluble Chloride Ion	AASHTO T 290	Chloride Ion Content, mg/kg	<10		

cuf-fa.xls

MOISTURE-DENSITY RELATIONSHIP



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	ML	A-4(0.0)	.160 %	2.62	NL	NP	0 %	93.4 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 13.2 % Maximum dry density = 111.4 pcf	

Project No.: 5810850101
Project: TVA - Cumberland
Location: Dry Fly Ash
Units 1-2
Date: July 25, 1995

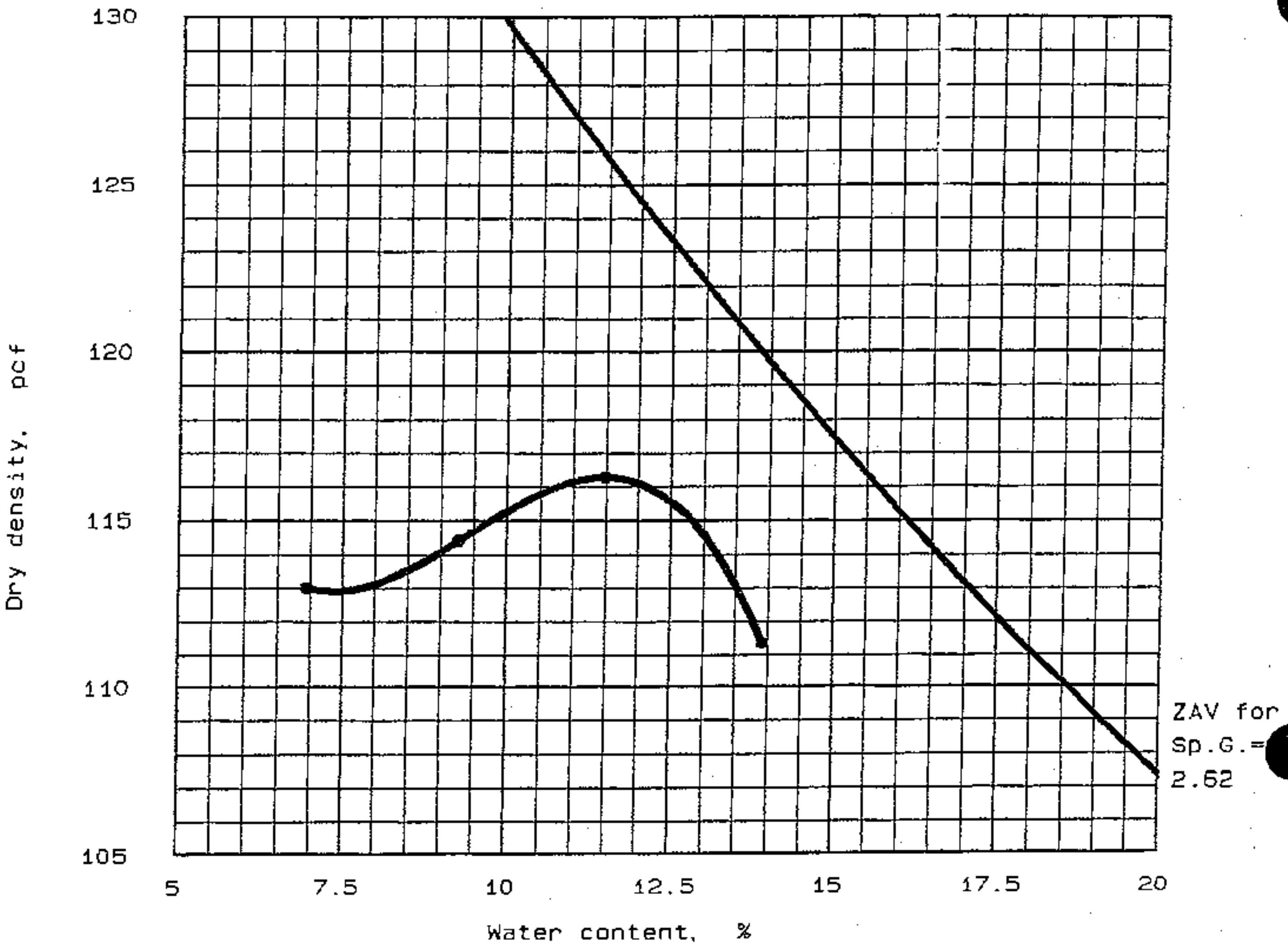
Remarks:
Tested by: JCR
Reviewed by: HS/RLB

MOISTURE-DENSITY RELATIONSHIP

LAW ENGINEERING, INC.

Figure No. ______

MOISTURE-DENSITY RELATIONSHIP



"Modified" Proctor, ASTM D 1557, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	ML	A-4(0.0)	.160 %	2.62	NL	NP	0 %	93.4 %

TEST RESULTS

Optimum moisture = 11.5 %
Maximum dry density = 116.3 pcf

MATERIAL DESCRIPTION

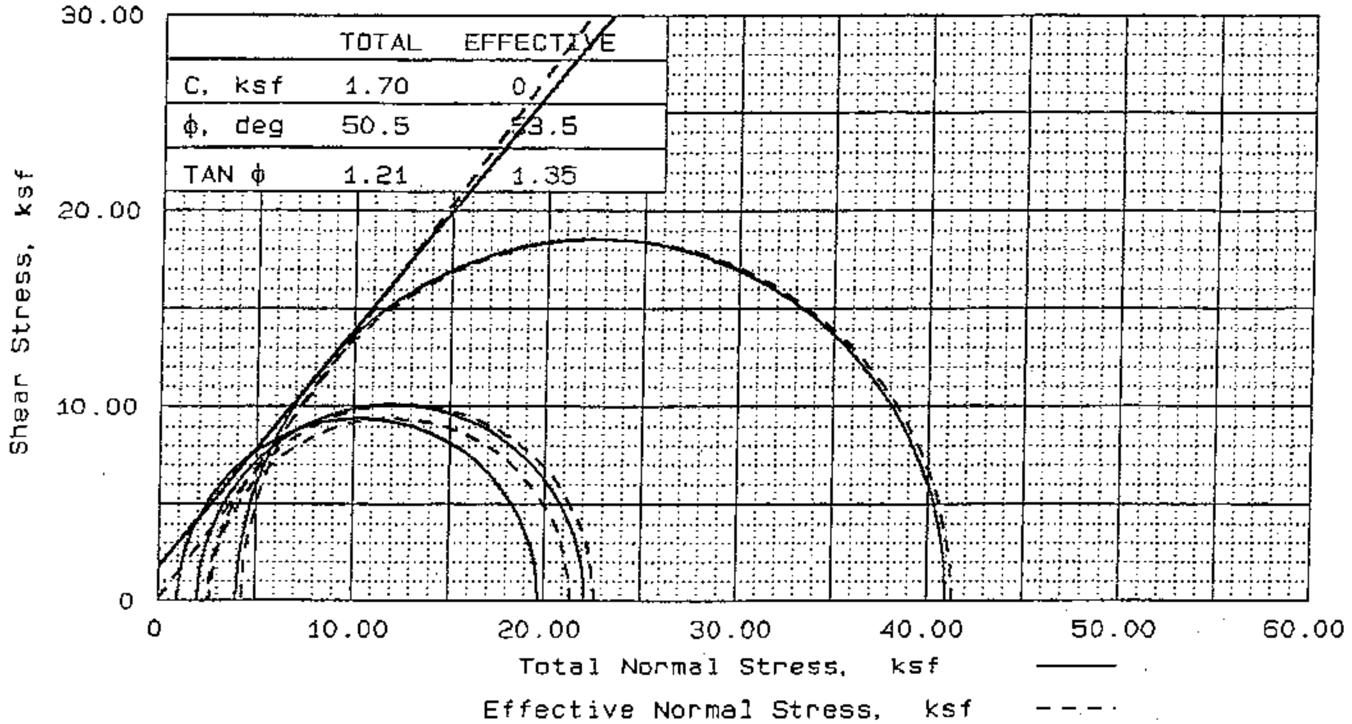
Project No.: 5810860101
Project: TVA - Cumberland
Location: Dry Fly Ash
Units 1-2
Date: July 25, 1995

MOISTURE-DENSITY RELATIONSHIP

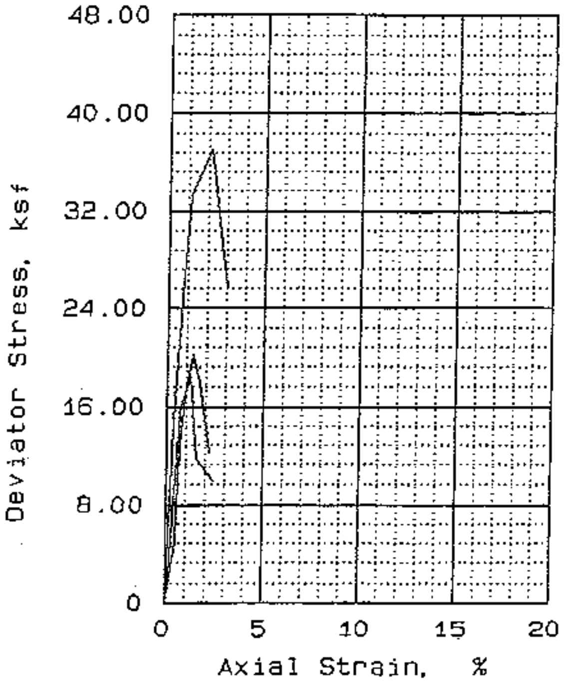
LAW ENGINEERING, INC.

Remarks:
Tested by: JCB
Reviewed by: RLB

Figure No. ______



	TOTAL	EFFECTIVE
C, ksf	1.70	0
ϕ, deg	50.5	53.5
TAN ϕ	1.21	1.35



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	12.2	12.4	12.1
	DRY DENSITY, pcf	106.3	106.3	106.4
	SATURATION, %	59.6	60.1	59.3
	VOID RATIO	0.538	0.539	0.537
	DIAMETER, in	2.83	2.83	2.83
	HEIGHT, in	6.00	6.00	6.00
AT TEST	WATER CONTENT, %	20.5	20.3	20.1
	DRY DENSITY, pcf	106.5	106.8	107.1
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.536	0.531	0.527
	DIAMETER, in	2.84	2.82	2.82
	HEIGHT, in	5.97	6.00	6.00
BACK PRESSURE, ksf		4.08	2.94	4.09
CELL PRESSURE, ksf		5.07	4.94	8.09
FAILURE STRESS, ksf		18.74	20.16	37.05
PORE PRESSURE, ksf		2.40	2.43	3.80
STRAIN RATE, %/min.		0.100	0.100	0.100
ULTIMATE STRESS, ksf				
PORE PRESSURE, ksf				
$\bar{\sigma}_1$ FAILURE, ksf		21.41	22.67	41.35
$\bar{\sigma}_3$ FAILURE, ksf		2.67	2.51	4.29

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: Remolded
DESCRIPTION:

LL= NL PL= NP PI=
SPECIFIC GRAVITY= 2.62
REMARKS: Tested by: Hy

Reviewed by: RLB

FIG. NO.

CLIENT:

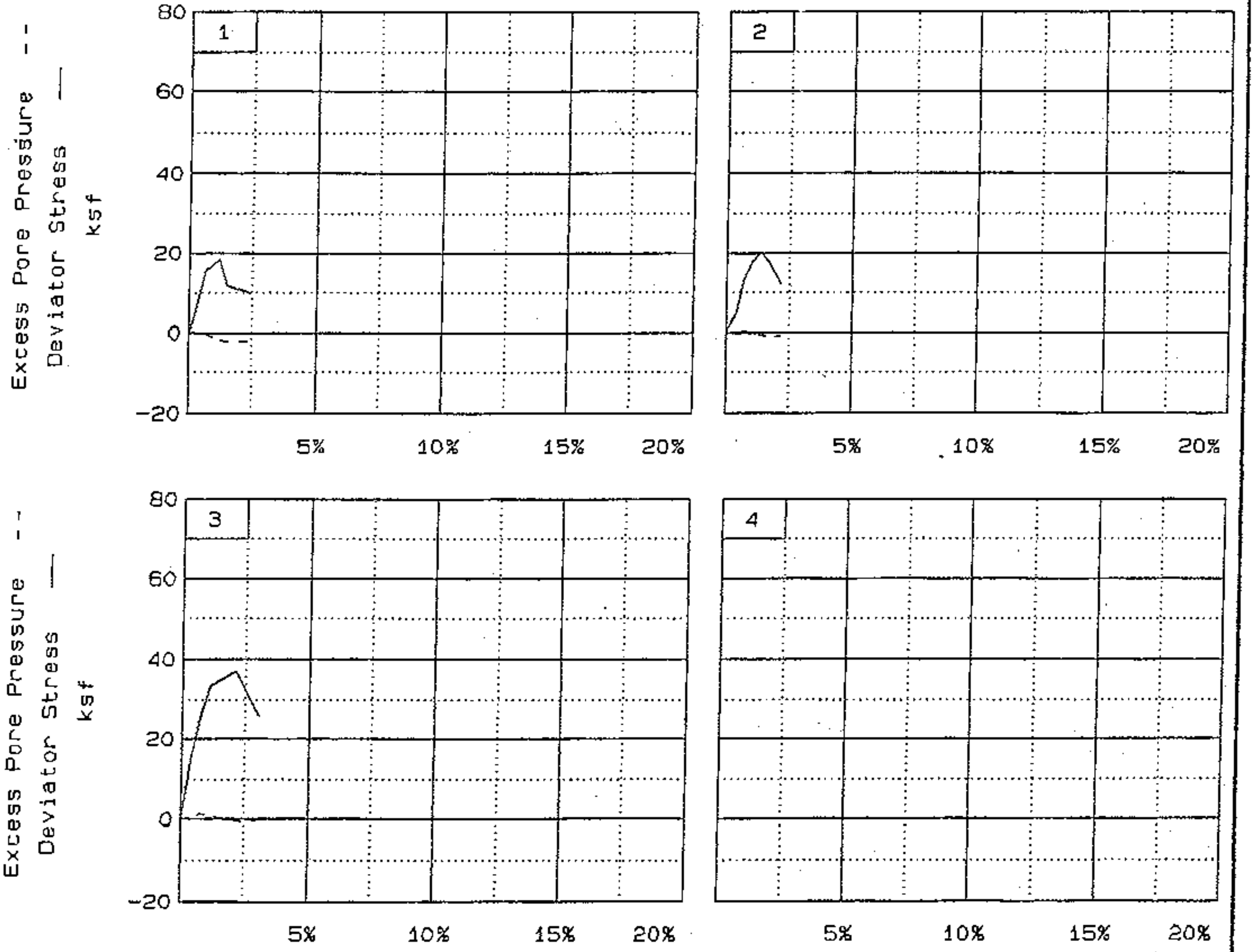
PROJECT: TVA - Cumberland

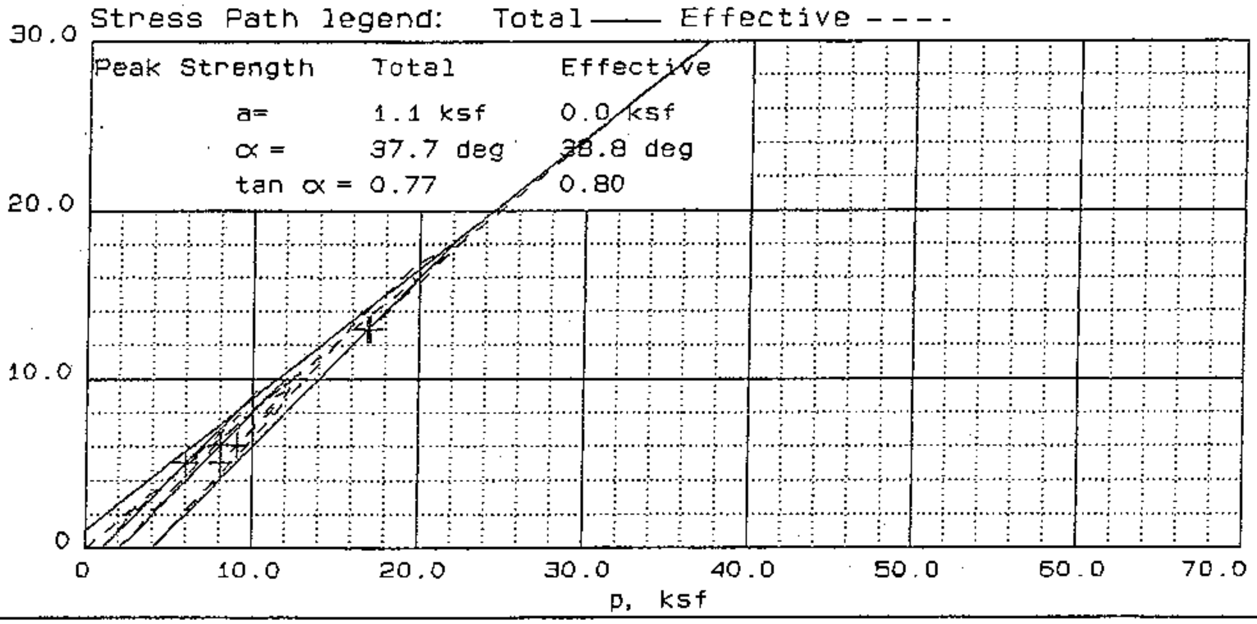
SAMPLE LOCATION: Dry Fly Ash
Units 1-2

PROJ. NO.: 5810860101 DATE: August 23, 1995

TRIAXIAL COMPRESSION TEST

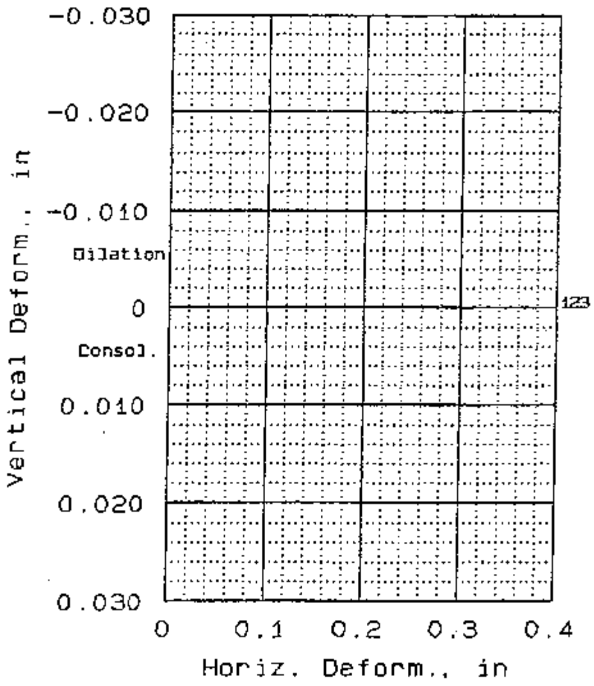
LAW ENGINEERING, INC.

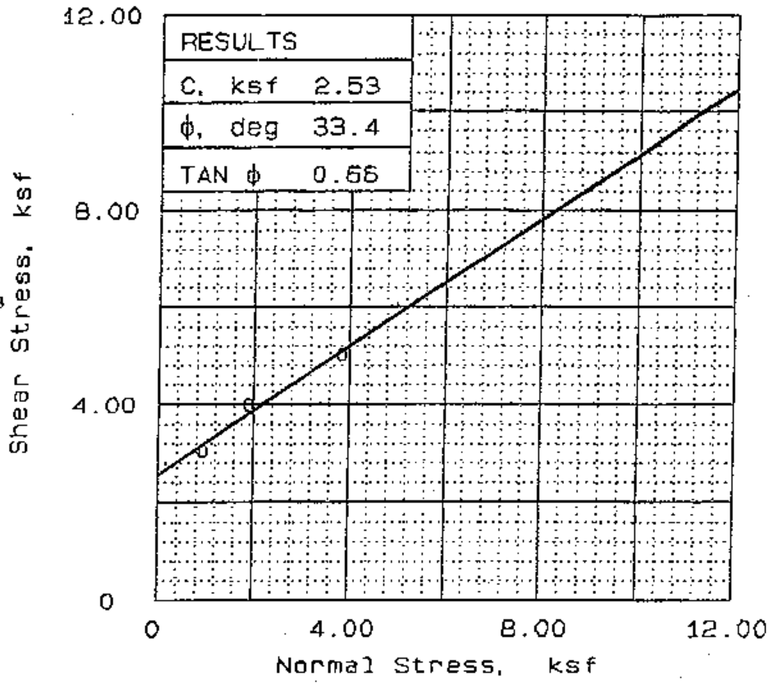




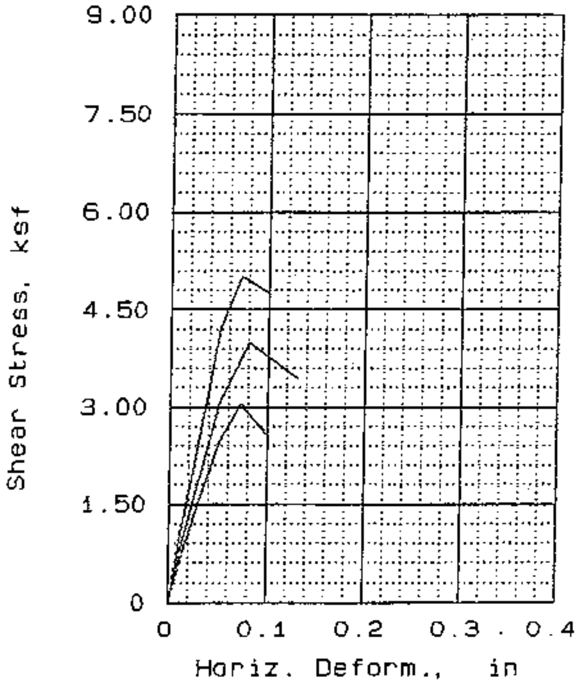
Peak Strength	Total	Effective
a=	1.1 ksf	0.0 ksf
α =	37.7 deg	38.8 deg
tan α =	0.77	0.80

Client:
Project: TVA - Cumberland
Location: Dry Fly Ash Units 1-2
File: 8601D Project No.: 5810860101 Page 2/2 Fig. No. _____





RESULTS	
C, ksf	2.53
ϕ, deg	33.4
TAN ϕ	0.66



	SAMPLE NO.	1	2	3
INITIAL	WATER CONTENT, %	13.0	12.9	12.8
	DRY DENSITY, pcf	94.6	93.1	93.4
	SATURATION, %	46.8	44.6	44.8
	VOID RATIO	0.728	0.757	0.750
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	0.81	0.81	0.81
AT TEST	WATER CONTENT, %	13.0	12.9	12.8
	DRY DENSITY, pcf	94.6	93.1	93.4
	SATURATION, %	46.8	44.6	44.8
	VOID RATIO	0.728	0.757	0.750
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	0.81	0.81	0.81
	NORMAL STRESS, ksf	0.97	1.94	3.88
	MAX. SHEAR, ksf	3.04	4.00	5.02
	STRAIN RATE, %/min.	0.500	0.500	0.500
	ULT. SHEAR, ksf			

SAMPLE DATA

SAMPLE TYPE: Remolded

DESCRIPTION:

LL= NL PL= NP PI=

SPECIFIC GRAVITY= 2.62

REMARKS: Tested by:

Reviewed by: RLB

FIG. NO.

CLIENT:

PROJECT: TVA - Cumberland

SAMPLE LOCATION: Dry Fly Ash
Units 1-2

PROJ. NO.: 5810860101 DATE: August 23, 1995

DIRECT SHEAR TEST

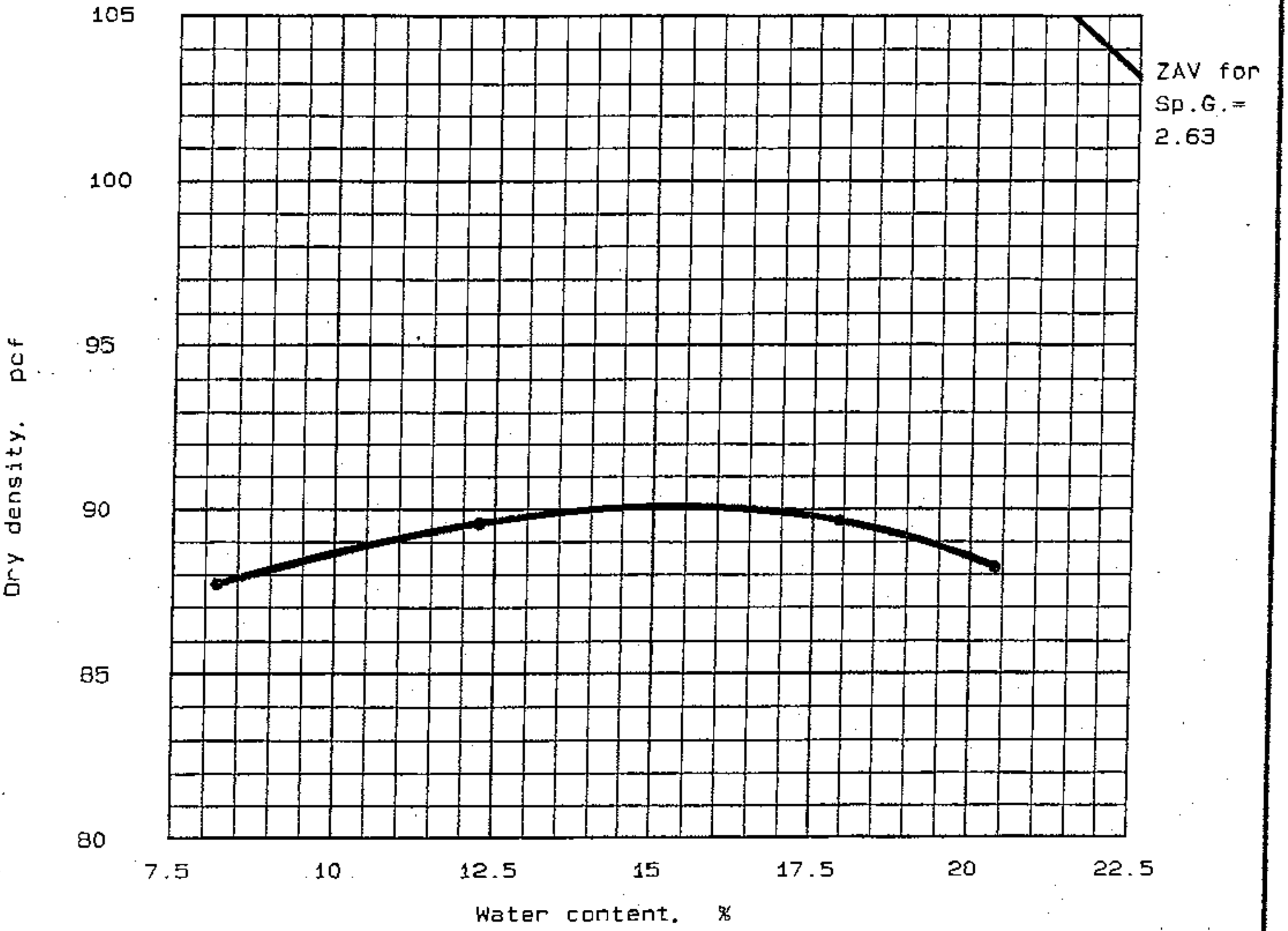
LAW ENGINEERING, INC.

TVA - CUMBERLAND
BOTTOM ASH - FROM POND

Description	Test Method	Property	Sample 1	Sample 2	Sample 3
Grain Size	ASTM D 422	Percent Retained on the #4 Sieve	30.9	46.2	32.2
		Percent Passing the #200 Sieve	1.1	2.2	2.8
Atterberg Limits	ASTM D 4318	Liquid Limit	NL	NL	NL
		Plastic Limit	NP	NP	NP
		Plasticity Index	N/A	N/A	N/A
Specific Gravity	ASTM D 854	Specific Gravity at 20°C	2.59	2.66	2.63
Classification	ASTM D 2487	Unified Soil Classification System (USCS)	SW	SW	SW
	AASHTO M 145	AASHTO Classification	A-1-a	A-1-a	A-1-a
			Composite Sample		
Moisture-Density Relations (Standard Effort)	ASTM D 698	Maximum Dry Density, pcf	90.1		
		Optimum Moisture Content, %	15.4		
Moisture-Density Relations (Modified Effort)	ASTM D 1557	Maximum Dry Density, pcf	103.3		
		Optimum Moisture Content, %	15.7		
Relative Density	ASTM D 4254	Minimum Dry Density, pcf	67.0		
	ASTM D 4253	Maximum Dry Density (Dry Method), pcf	87.1		
			Result	**Dry Density, pcf**	**Moisture Content, %**
Hydraulic Conductivity	ASTM D 2434	Hydraulic Conductivity, cm/sec	6.8E-2	77.0	0.0
Angle of Repose	LAW TP6	Angle of Repose, degrees	30.8	67.0	0.0
California Bearing Ratio	ASTM D 1883	CBR, %	15	81.6	14.1
Resilient Modulus (Standard Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	6,417	84.4	14.2
Resilient Modulus (Modified Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	6,945	96.7	14.6
Soil Resistivity	AASHTO T 288	Minimum Resistivity, Ohm-cm	1,200		
pH of Soil	AASHTO T 289	pH	2.7		
Water Soluble Sulfate Ion	AASHTO T 290	Sulfate Ion Content, mg/kg	4790		
Water Soluble Chloride Ion	AASHTO T 290	Chloride Ion Content, mg/kg	<10		

cuf-ba.xls

MOISTURE-DENSITY RELATIONSHIP



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	SW	A-1-a	11.0 %	2.63	NL	NP	36.4 %	3.03 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 15.4 % Maximum dry density = 90.1 pcf	

Project No.: 5810860101

Project: TVA - Cumberland

Location: Bottom Ash

Date: July 25, 1995

Remarks:

Tested by: EM

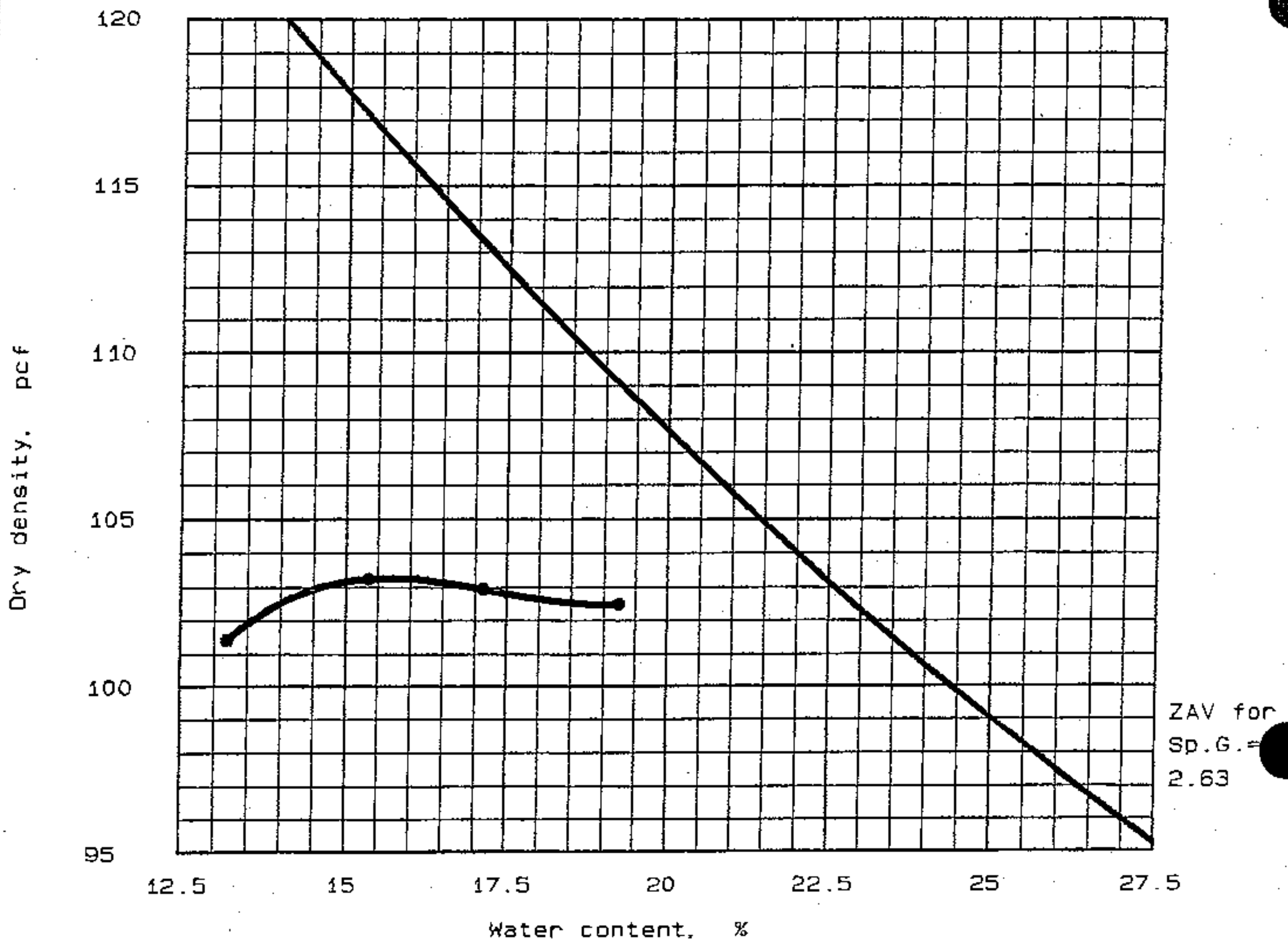
Reviewed by: RLB

MOISTURE-DENSITY RELATIONSHIP

LAW ENGINEERING, INC.

Figure No. ______

MOISTURE-DENSITY RELATIONSHIP



"Modified" Proctor, ASTM D 1557, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	SW	A-1-a	11.0 %	2.63	NL	NP	36.4 %	3.03 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 15.7 % Maximum dry density = 103.3 pcf	

Project No.: 5810860101

Project: TVA - Cumberland

Location: Bottom Ash

Date: July 25, 1995

Remarks:

Tested by: JCR

Reviewed by: RLB

MOISTURE-DENSITY RELATIONSHIP

LAW ENGINEERING, INC.

Figure No. ______

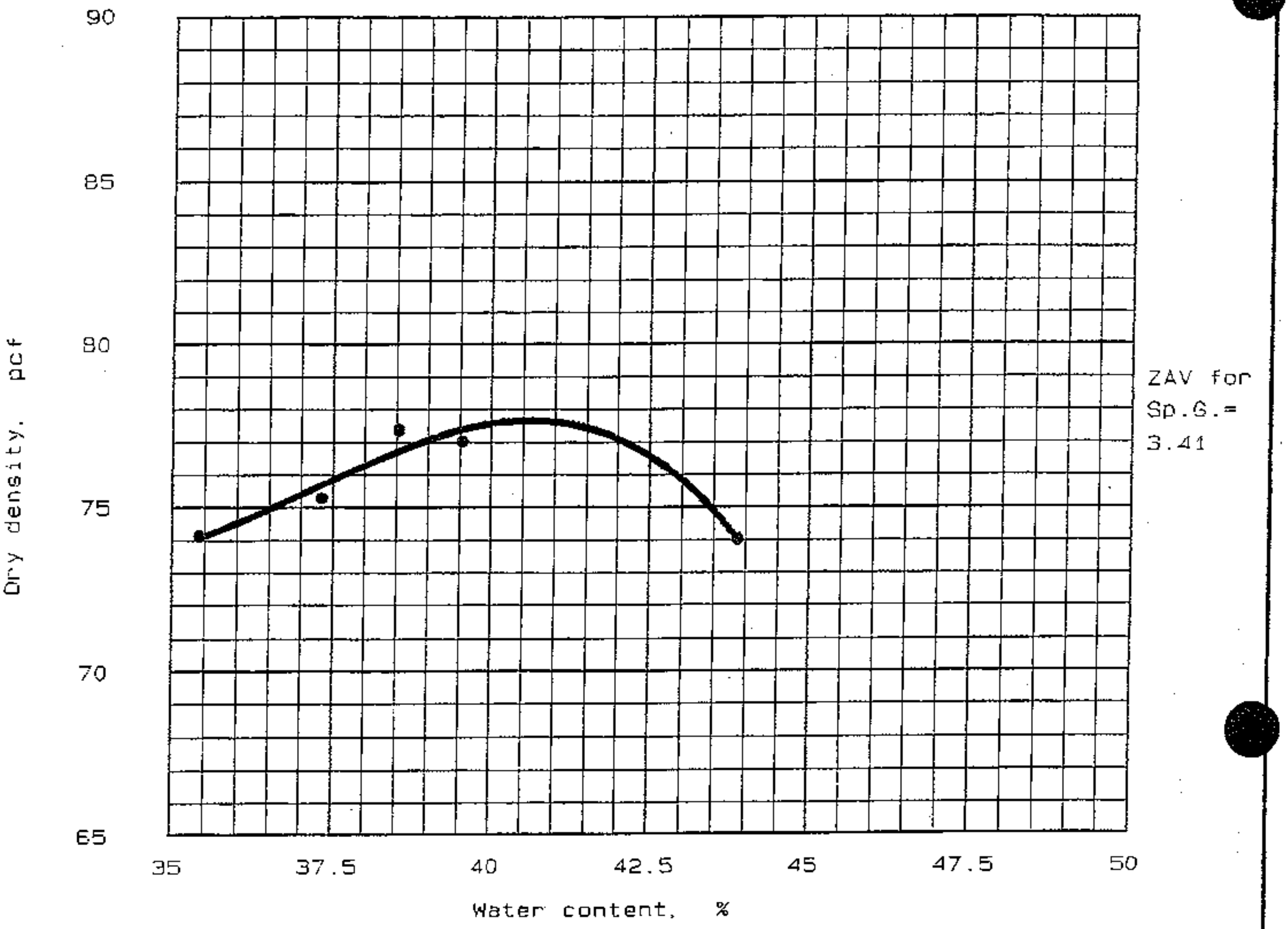
TVA - CUMBERLAND
SCRUBBER GYPSUM

Description	Test Method	Property	Sample 1	Sample 2	Sample 3
Grain Size	ASTM D 422	Percent Retained on the #4 Sieve Percent Passing the #200 Sieve Percent Passing the 0.005 mm Sieve	see note 1 see note 1 see note 1	see note 1 see note 1 see note 1	see note 1 see note 1 see note 1
Atterberg Limits	ASTM D 4318	Liquid Limit Plastic Limit Plasticity Index	NL NP N/A	NL NP N/A	NL NP N/A
Specific Gravity	ASTM D 854	Specific Gravity at 20°C		3.41 (see note 2)	
Classification	ASTM D 2487 AASHTO M 145	Unified Soil Classification System (USCS) AASHTO Classification	see note 3 see note 3	see note 3 see note 3	see note 3 see note 3
				Composite Sample	
Moisture-Density Relations (Standard Effort)	ASTM D 698	Maximum Dry Density, pcf Optimum Moisture Content, %		77.6 40.6	
Moisture-Density Relations (Modified Effort)	ASTM D 1557	Maximum Dry Density, pcf Optimum Moisture Content, %		85.9 29.7	
			Result	Dry Density, pcf	Moisture Content, %
Consolidation	ASTM D2435	Compression Index C_c	0.12	73.5	56.9
Hydraulic Conductivity	ASTM D 5084	Hydraulic Conductivity, cm/sec	1.2E-3	67.6	52.3
Triaxial Shear Strength Consolidated-Undrained (CU)	ASTM D4767	Effective Stress, Cohesion, c', ksf Effective Stress, Internal Friction Angle, ϕ',degrees	0.00 38.1	68.1	51.4
		Total Stress, Cohesion, c, ksf Total Stress, Internal Friction Angle, ϕ, degrees	3.33 33.4	68.1	51.4
Direct Shear Strength	ASTM D 3080	Cohesion, c, ksf Internal Friction Angle, ϕ, degrees	1.32 41.4	67.8	52.7
California Bearing Ratio	ASTM D 1883	CBR, %	20	74.0	42.0
Resilient Modulus (Standard Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	15,646	70.5	46.0
Resilient Modulus (Modified Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	17,515	74.7	40.0
Soil Resistivity	AASHTO T 288	Minimum Resistivity, Ohm-cm		1,100	
pH of Soil	AASHTO T 289	pH		7.8	
Water Soluble Sulfate Ion	AASHTO T 290	Sulfate Ion Content, mg/kg		4830	
Water Soluble Chloride Ion	AASHTO T 290	Chloride Ion Content, mg/kg		<10	

Note 1: Material observed to chrystalize/set-up upon wetting. Test could not be performed.
Note 2: A test was performed on a composite sample from the 3 independant samples.
Note 3: A classification could not be performed without the ASTM D 422 results.

cul-gy.xls

MOISTURE-DENSITY RELATIONSHIP



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
				3.41	NL	NP		

TEST RESULTS

Optimum moisture = 40.6 %
Maximum dry density = 77.6 pcf

MATERIAL DESCRIPTION

Gypsum

Project No.: 5810860101
Project: TVA - Cumberland
Location: Scrubber Gypsum

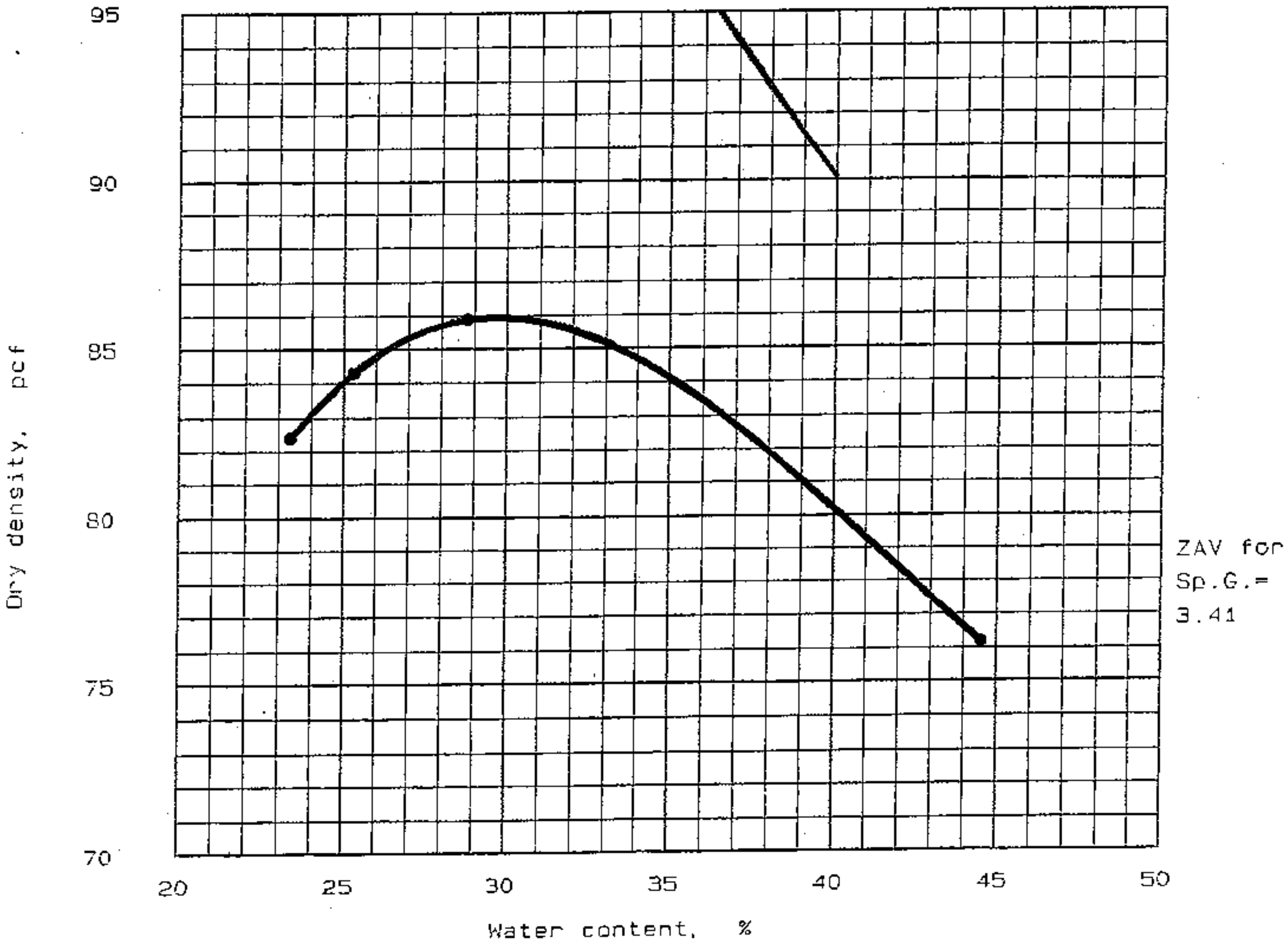
Date: September 28, 1995

Remarks:
Tested by: CS
Reviewed by:

MOISTURE-DENSITY RELATIONSHIP
LAW ENGINEERING, INC.

Figure No. ______

MOISTURE-DENSITY RELATIONSHIP



"Modified" Proctor, ASTM D 1557, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
				3.41	NL	NP		

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 29.7 % Maximum dry density = 85.9 pcf	Gypsum

Project No.: 5810860101

Project: TVA - Cumberland

Location: Scrubber Gypsum

Date: September 27, 1995

Remarks:

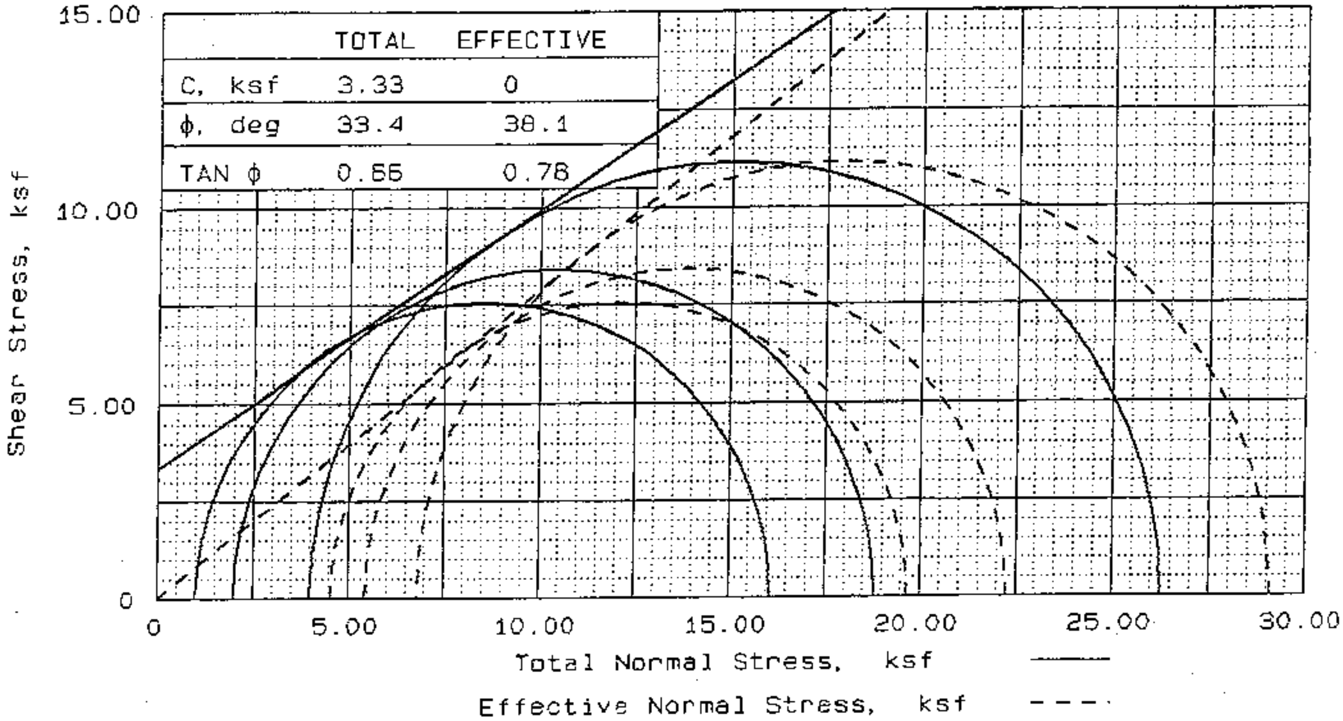
Tested by: EM

Reviewed by: HB

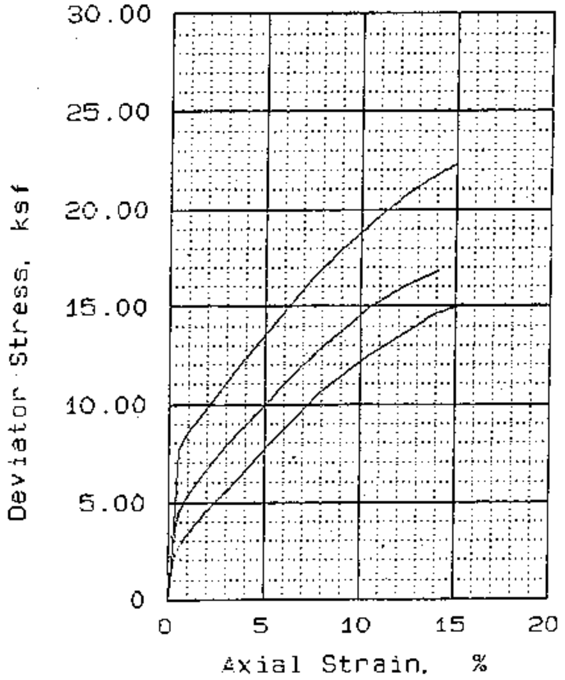
MOISTURE-DENSITY RELATIONSHIP

LAW ENGINEERING, INC.

Figure No. ______



	TOTAL	EFFECTIVE
C, ksf	3.33	0
ϕ, deg	33.4	38.1
TAN ϕ	0.66	0.78



	SAMPLE NO.	1	2	3
INITIAL	WATER CONTENT, %	52.9	52.3	48.9
	DRY DENSITY, pcf	67.5	67.6	69.2
	SATURATION, %	83.6	83.1	80.3
	VOID RATIO	2.156	2.147	2.075
	DIAMETER, in	2.83	2.83	2.83
	HEIGHT, in	6.00	6.00	6.00
AT TEST	WATER CONTENT, %	61.7	60.9	58.5
	DRY DENSITY, pcf	68.6	69.2	71.1
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	2.105	2.076	1.994
	DIAMETER, in	2.81	2.80	2.80
	HEIGHT, in	5.98	5.97	5.96
	BACK PRESSURE, ksf	4.98	5.08	5.08
	CELL PRESSURE, ksf	5.98	7.08	9.08
	FAILURE STRESS, ksf	15.11	16.82	22.27
	PORE PRESSURE, ksf	1.43	1.64	2.26
	STRAIN RATE, %/min.	0.100	0.100	0.100
	ULTIMATE STRESS, ksf			
	PORE PRESSURE, ksf			
	$\bar{\sigma}_1$ FAILURE, ksf	19.67	22.26	29.09
	$\bar{\sigma}_3$ FAILURE, ksf	4.56	5.44	6.82

TYPE OF TEST:
CU with pore pressures

SAMPLE TYPE: Remolded

DESCRIPTION: Gypsum

LL= NL PL= NP PI=

SPECIFIC GRAVITY= 3.41

REMARKS: Tested by: Hb

Reviewed by: RLB

FIG. NO.

CLIENT:

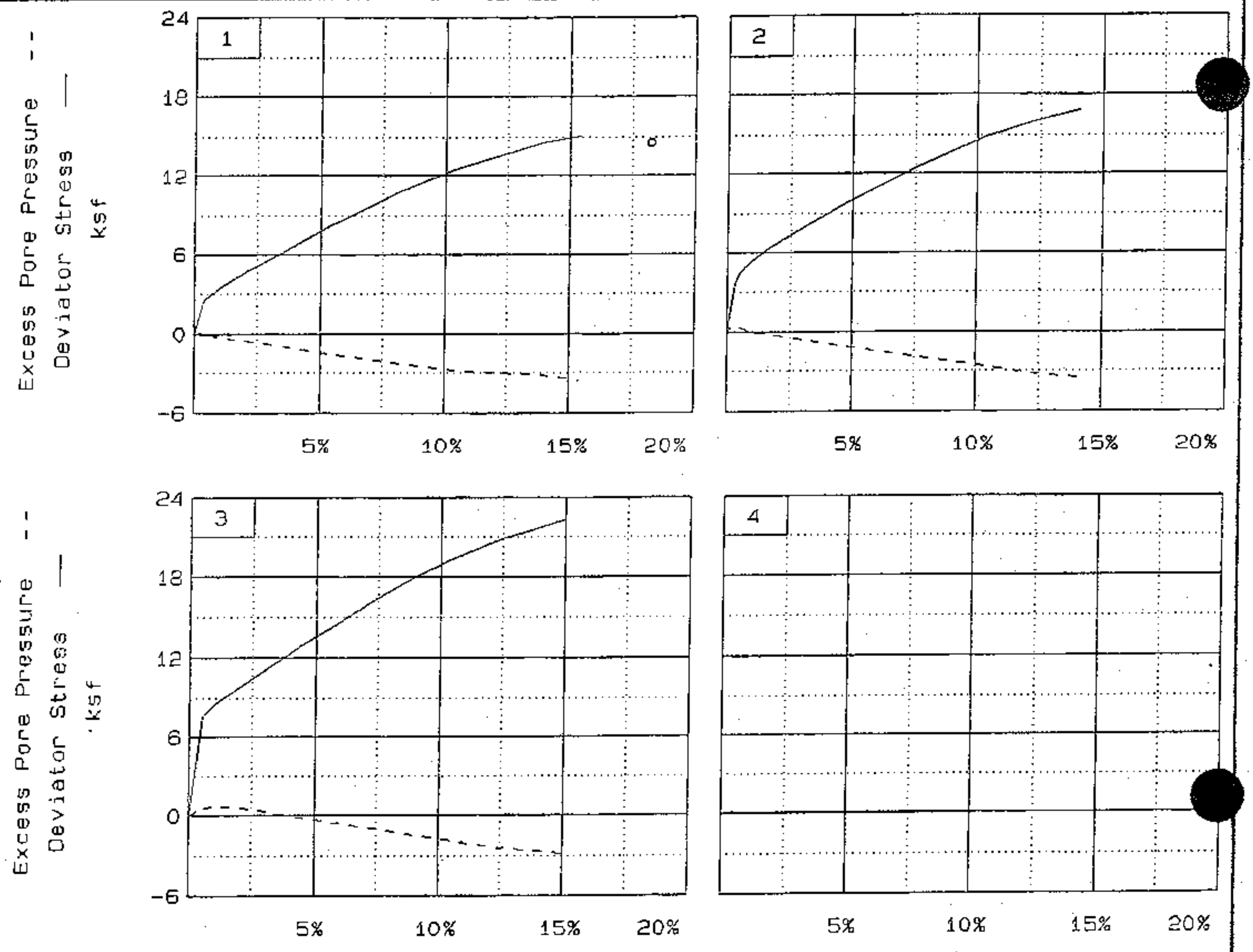
PROJECT: TVA - Cumberland

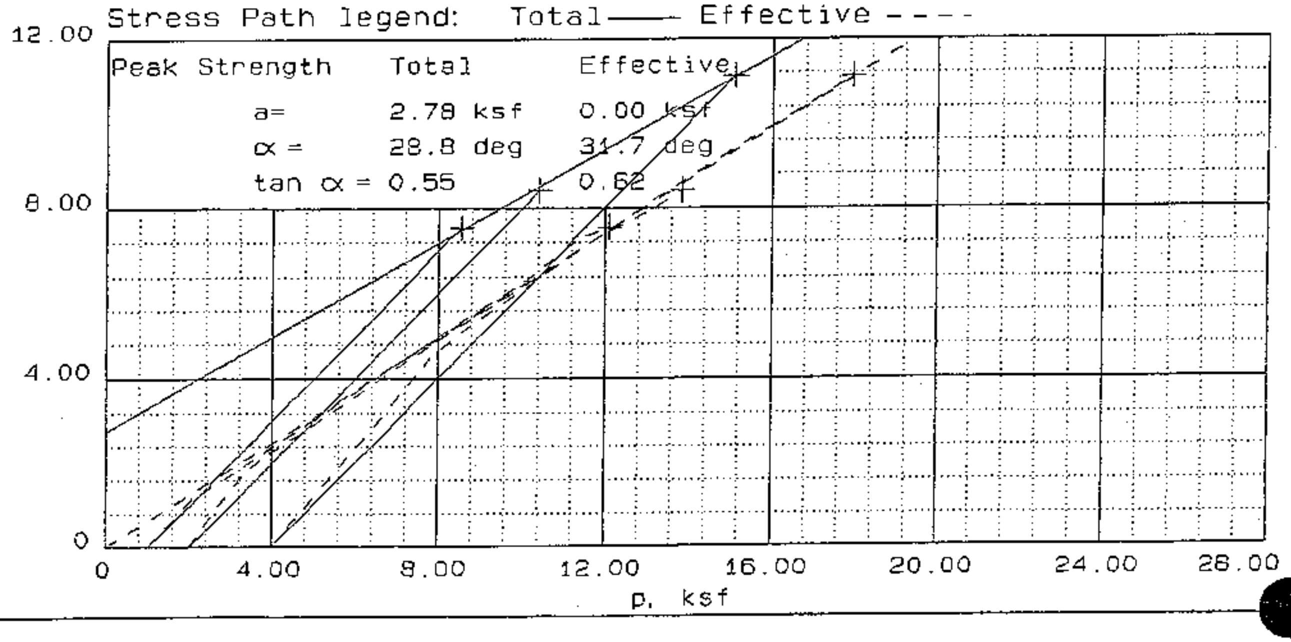
SAMPLE LOCATION: Scrubber Gypsum

PROJ. NO.: 5810660101 DATE: 10/23/95

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING, INC.





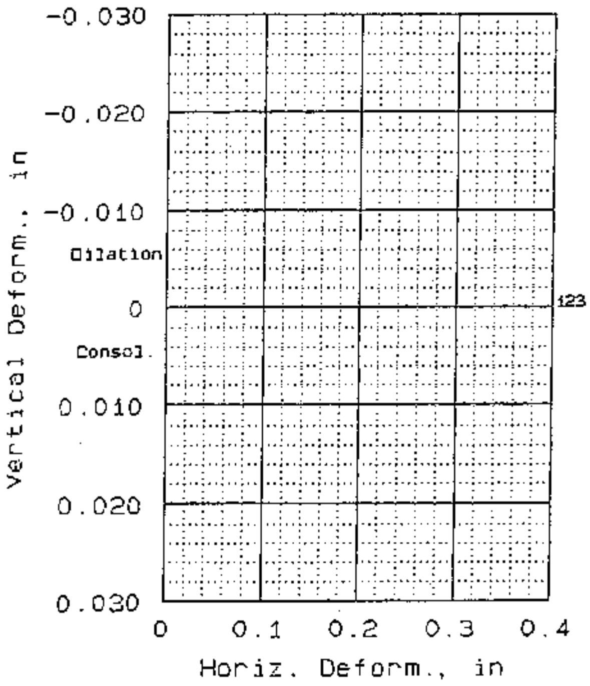
Peak Strength	Total	Effective
a=	2.78 ksf	0.00 ksf
α =	28.8 deg	31.7 deg
tan α =	0.55	0.62

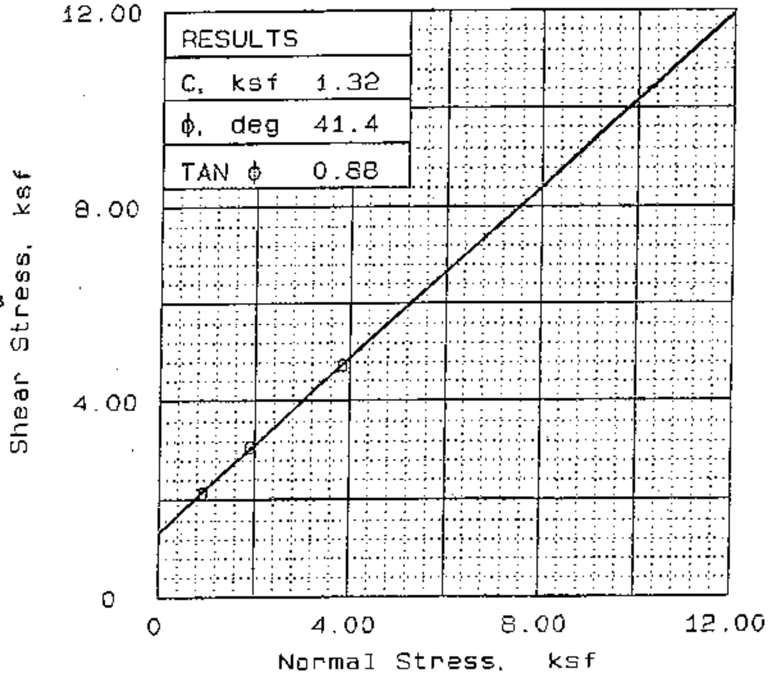
Client:

Project: TVA - Cumberland

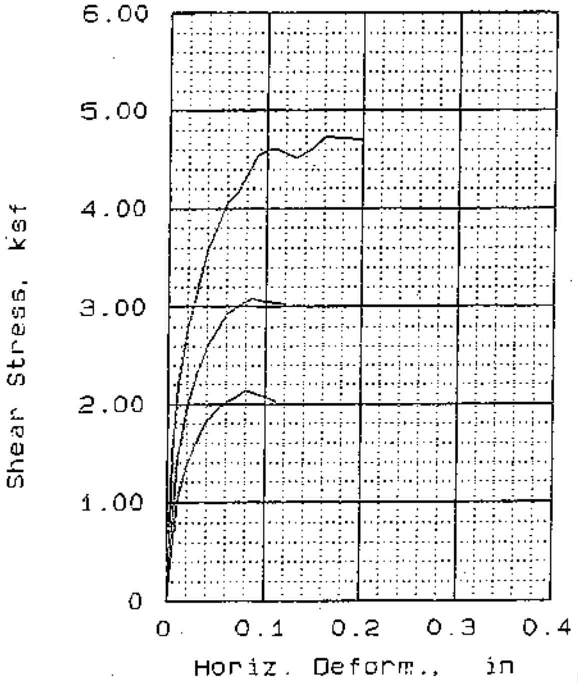
Location: Scrubber Gypsum

File: 8601P Project No.: 5810860101 Page 2/2 Fig. No. ____





RESULTS	
C, ksf	1.32
ϕ, deg	41.4
TAN ϕ	0.88



	SAMPLE NO.	1	2	3
INITIAL	WATER CONTENT, %	52.4	52.3	53.3
	DRY DENSITY, pcf	68.2	67.7	67.5
	SATURATION, %	97.4	96.0	97.4
	VOID RATIO	1.427	1.444	1.451
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	0.81	0.81	0.81
AT TEST	WATER CONTENT, %	52.4	52.3	53.3
	DRY DENSITY, pcf	68.2	67.7	67.5
	SATURATION, %	97.4	96.0	97.4
	VOID RATIO	1.427	1.444	1.451
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	0.81	0.81	0.81
NORMAL STRESS, ksf		0.97	1.94	3.88
MAX. SHEAR, ksf		2.14	3.06	4.73
STRAIN RATE, %/min.		0.500	0.500	0.500
ULT. SHEAR, ksf				

SAMPLE DATA

SAMPLE TYPE: Remolded

DESCRIPTION: Gypsum

LL= NL PL= NP PI=

SPECIFIC GRAVITY= 3.41

REMARKS: Tested by:

Reviewed by: RLB

FIG. NO.

CLIENT:

PROJECT: TVA - Cumberland

SAMPLE LOCATION: Scrubber Gypsum

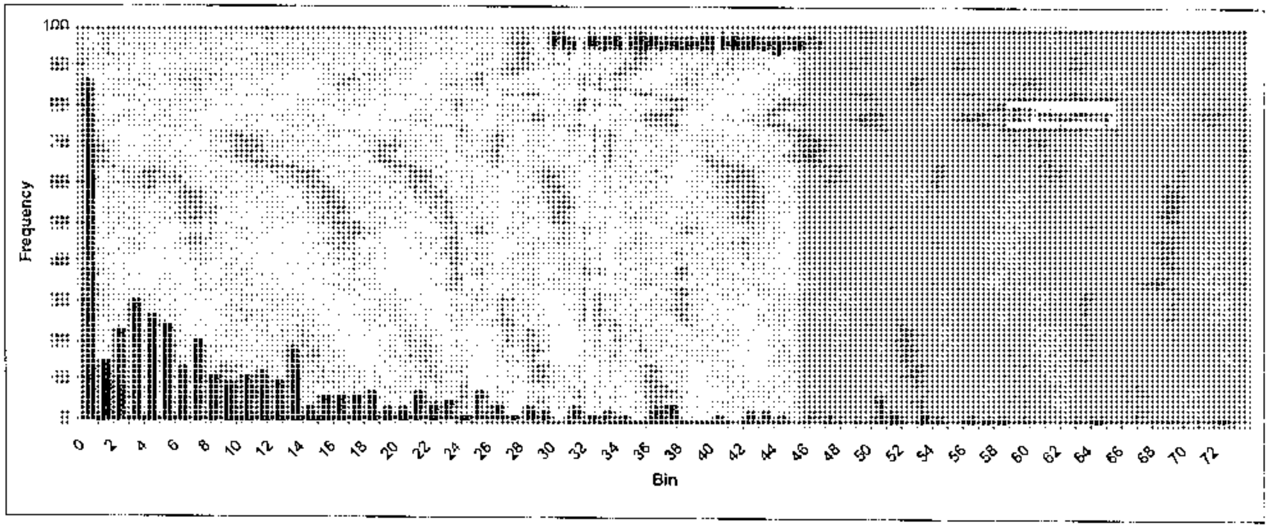
PROJ. NO.: 5810860101 DATE: 10/10/95

DIRECT SHEAR TEST

LAW ENGINEERING, INC.

Attachment 5
SPT N-Value Histograms
(Stantec, 2009a)

N (Blow Counts)	Min	Max	Average	Mode	Std Dev
Bottom Ash	0	87	23	13	15.1
Bottom Ash/Fly Ash	0	75	13	4	12.7
Fly Ash	0	72	11	0	13.4
Fly Ash Stacked	2	99	36	50	25.4
Matrix	0	50	19	50	16.8
Alluvial Clay	0	70	17	6	14.4
Alluvial Granular	0	116	27	50	18.8
Dike 1	3	83	16	13	13.4
Dike 2	3	61	18	9	9.8
Dike 3	3	84	25	30	16.4
Gypsum	3	98	47	50	24.9

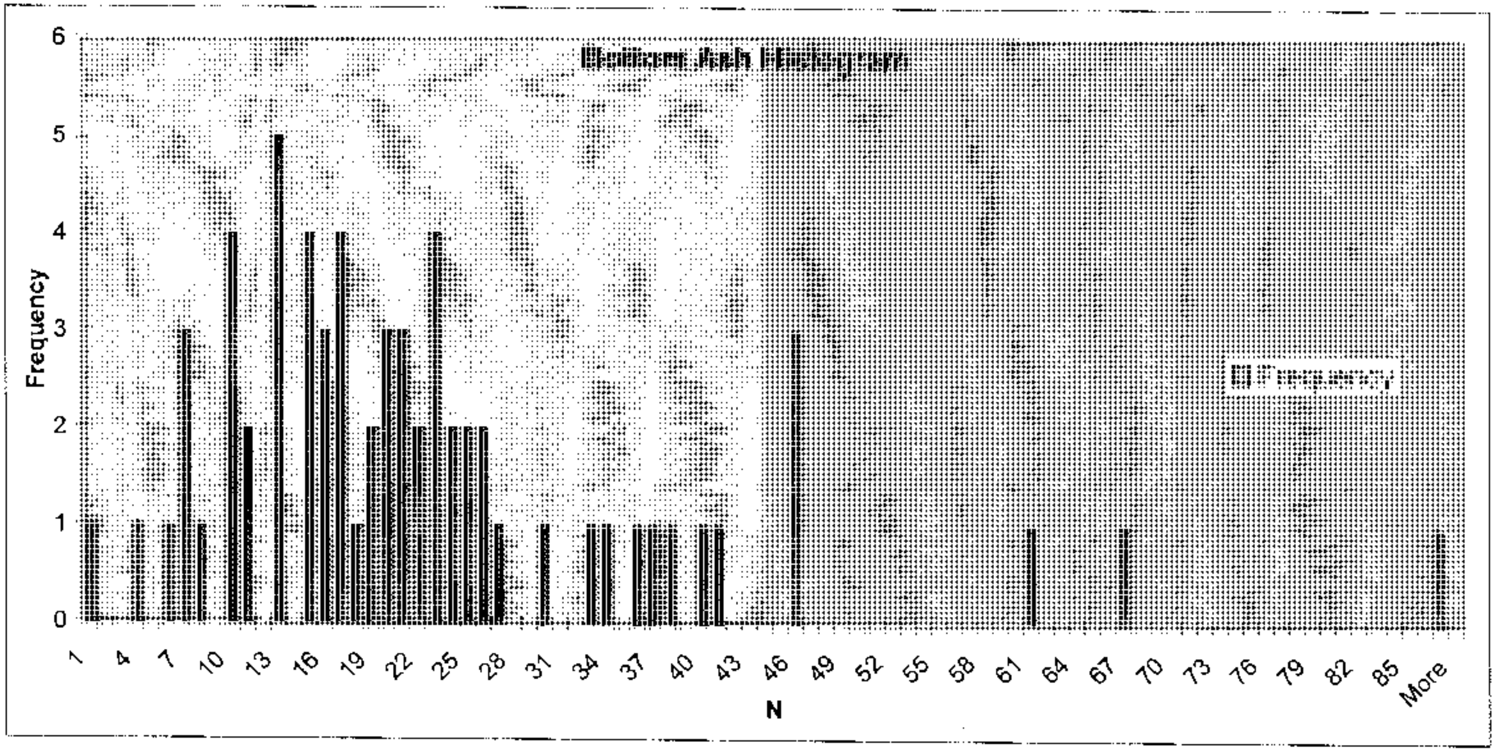


Fly Ash (Sluiced)	N	0	3
	N60 (1.3*N)	0	3.9

ϕ
<28

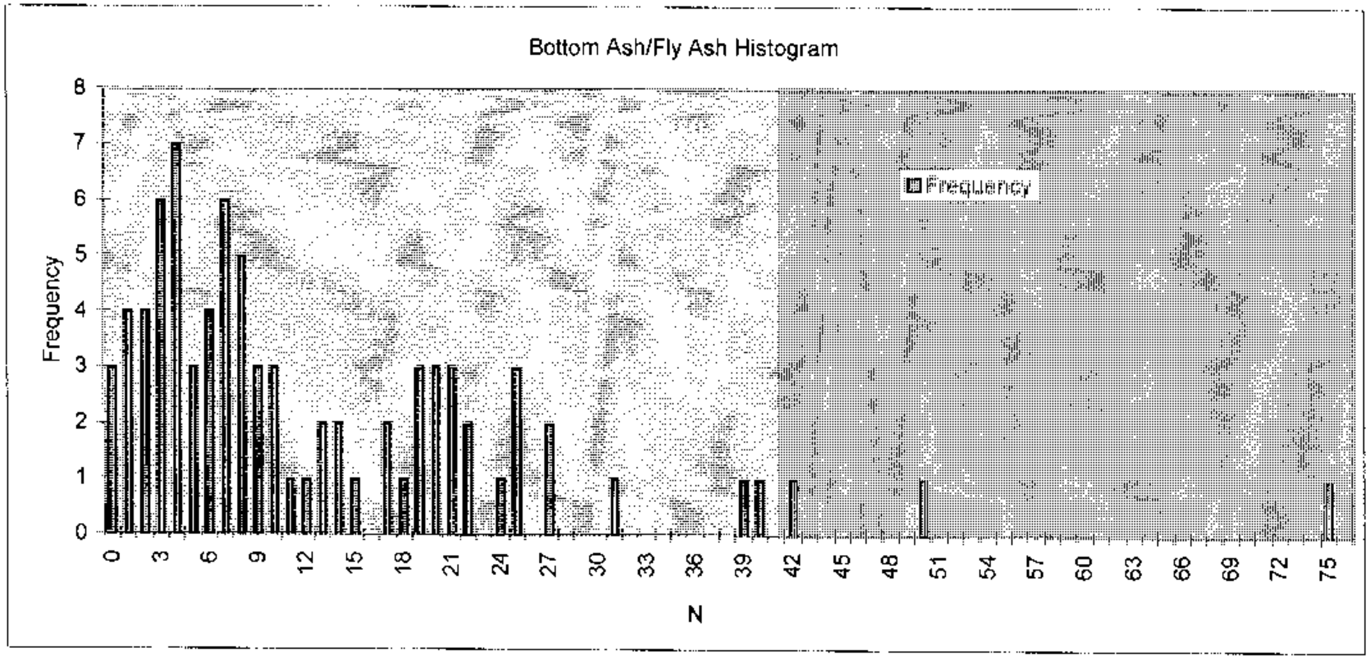
(Originally from Peck et al., 1974, modified by Carter and Bentley, 1991)

CPTs	N60	ϕ'	su
	5	13	2
	6	14	5
	2	15	12
	7	22	34
	10	28	42
	10	30	30
	16	22	25
	6	26	56
	17	21	38
	6	25	54
	13	25	
min	2	13	2
max	17	30	56
average	9	22	30
mode	6	22	#N/A
st dev	5	6	19



Bottom Ash	N	10	23	
	N60 (1.3*N)	13	29.9	
		ϕ 31.3	ϕ 36.2	(Originally from Peck et al., 1974, modified by Carter and Bentley, 19

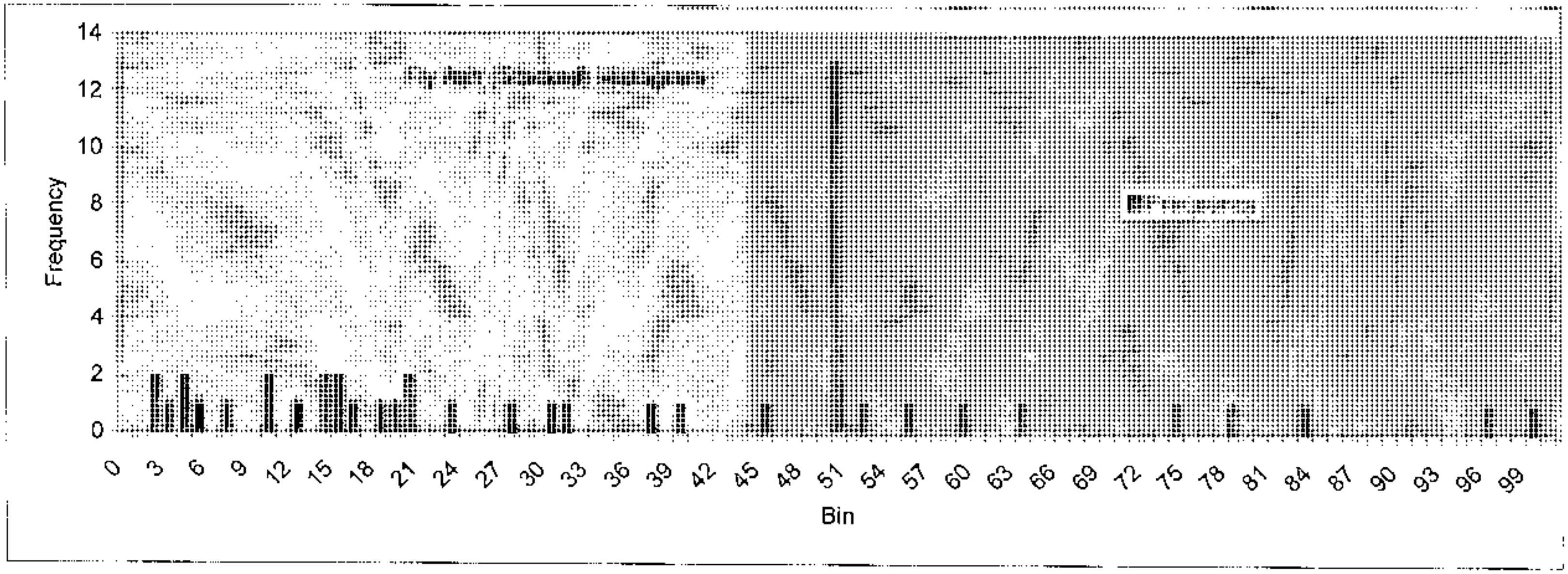
CPTs	N60 7	ϕ' 14	su 5
BA Stacked		50	



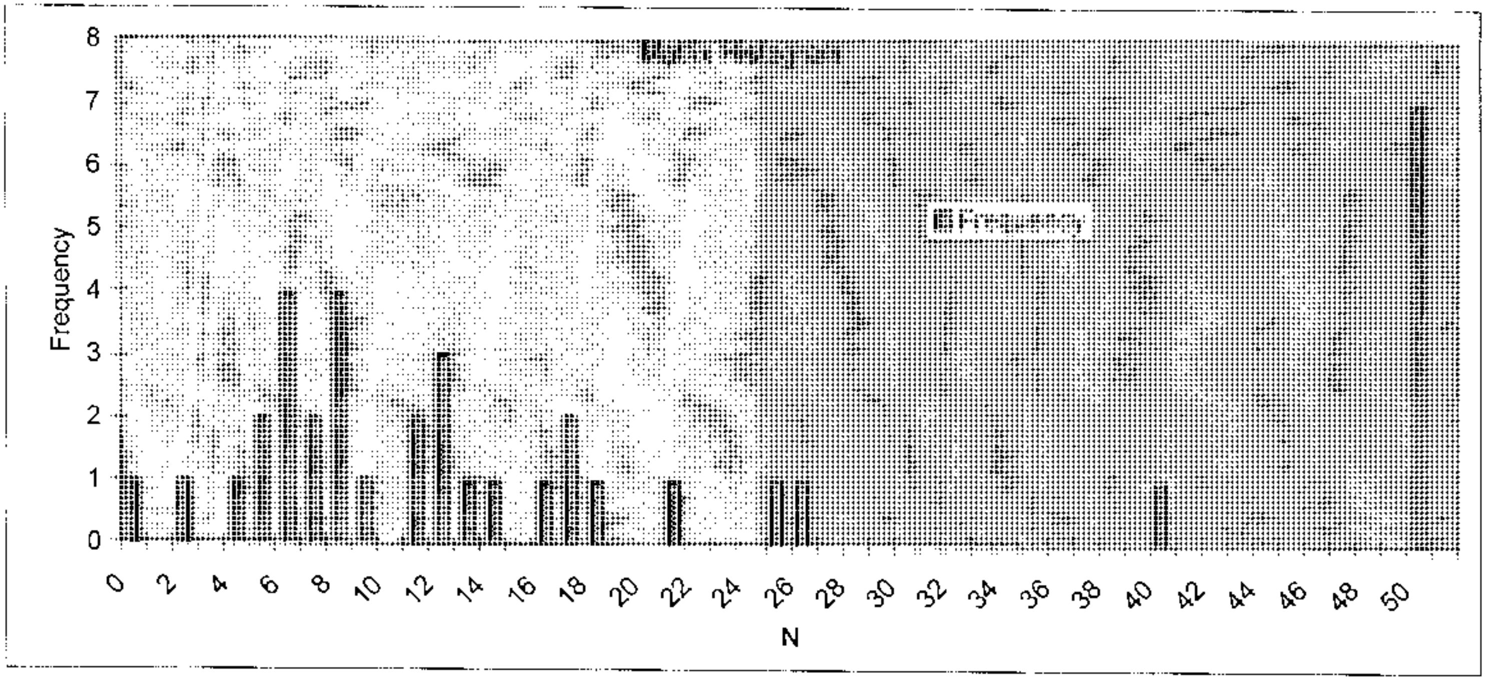
Bottom Ash/Fly Ash	N	3	8
	N60 (1.3*N)	3.9	10.4
		ϕ	ϕ
		<28	30.1

(Originally from Peck et al., 1974, modified by Carter and Bentley, 1

CPTs	N60	ϕ'	su
	3	13	5
	6	22	22
	11	28	52
min	3	13	5
max	11	28	52
average	7	21	26

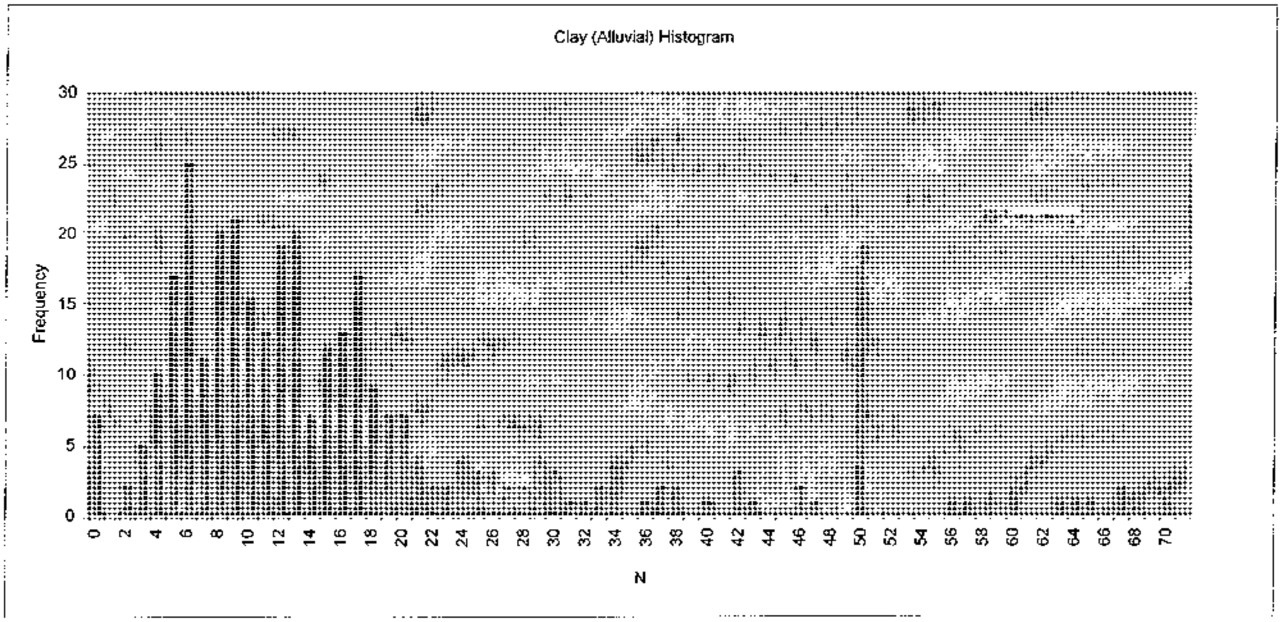


Fly Ash (Stacked)	N	50	
	N60 (1.3*N)	65	
		ϕ 43.5	(Originally from Peck et al., 1974, modified by Carter and Bentley, 1991)
CPT		32	



Matrix	N	6	8
	N60 (1.3*N)	7.8	10.4
	qu (kgf/cm2)	0.6	0.8 (after NAVFAC, 1982)
	qu(lb/in2)	9	11
	cu (lb/in2)	4	6

1	14.22334
kgf/cm2	lb/in2

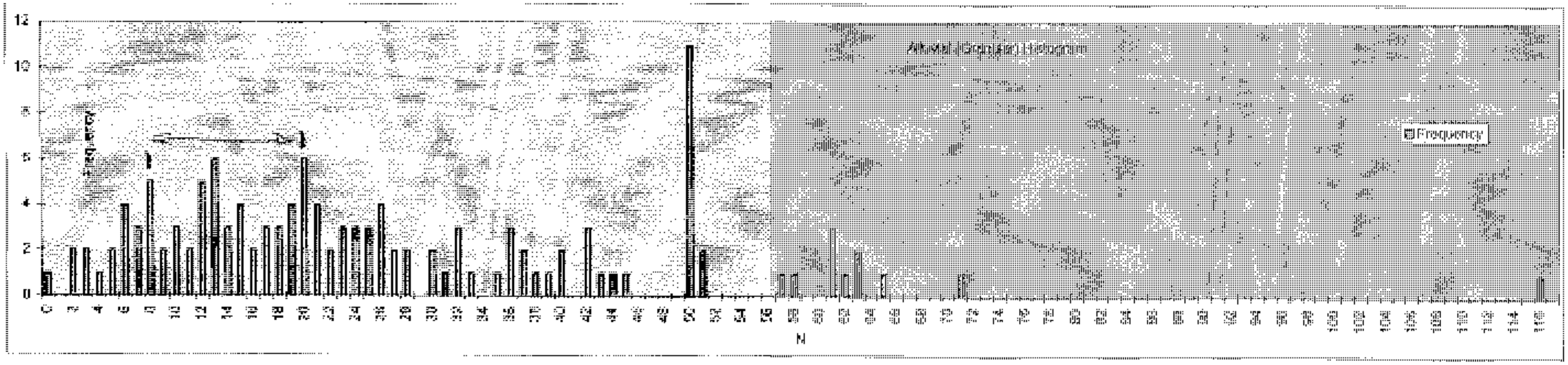


Clay (Alluvial)	N	5	15	
	N60 (1.3*N)	6.5	19.5	
	qu (kgf/cm:	0.5	1.47	(after NAVFAC, 1982)
	qu(lb/in2)	7	21	
	cu (lb/in2)	4	10	

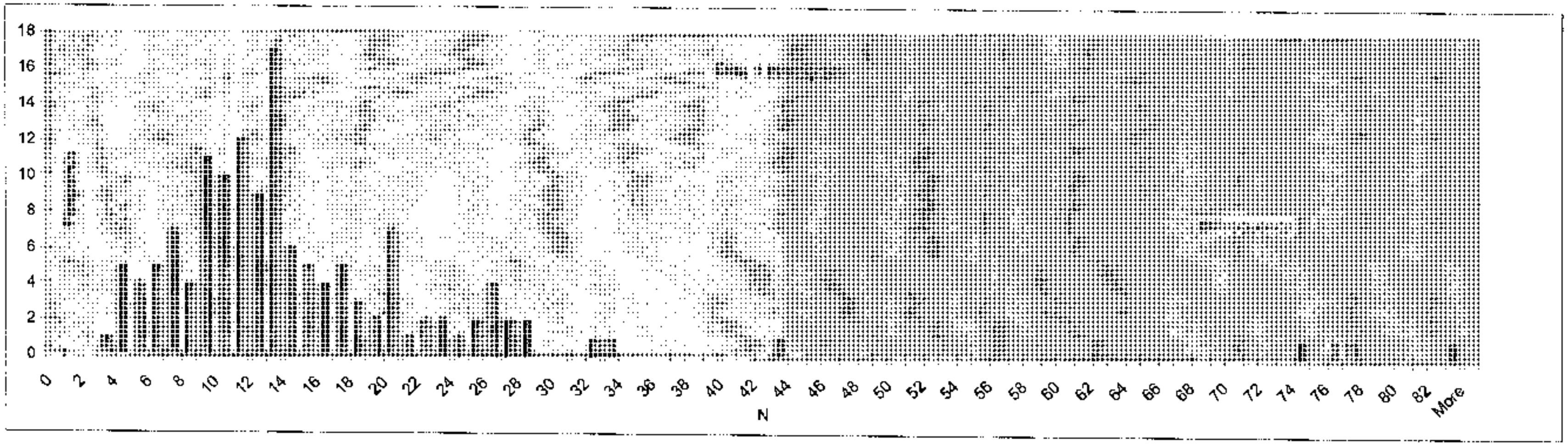
1	14.22334
kgf/cm2	lb/in2

CPTs	N60	ϕ'	su
	10	17	10
	20	18	30
	7	28	20
	8	16	50
	25	20	38
	13	23	22
	8	21	14
	8	19	

min	7	16	10
max	25	28	50
average	12	20	26
mode	8	#N/A	#N/A
st dev	7	4	14



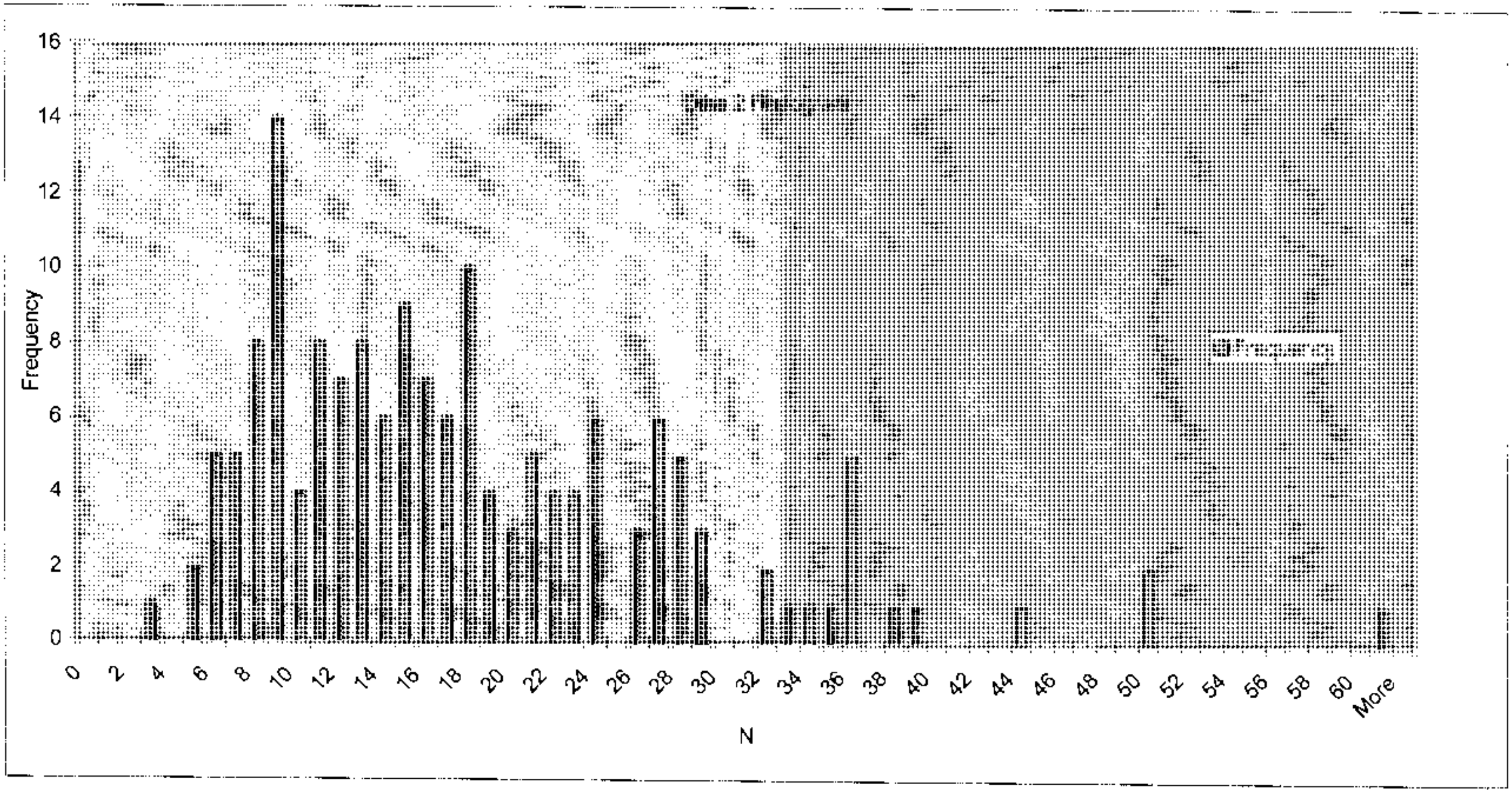
Alluvial (Granular)	N	8	20	
	N60 (1.3*N)	10.4	26	
		ϕ 30.1	ϕ 34.5	(Originally from Peck et al., 1974, modified by Carter and Bentley, 1991)



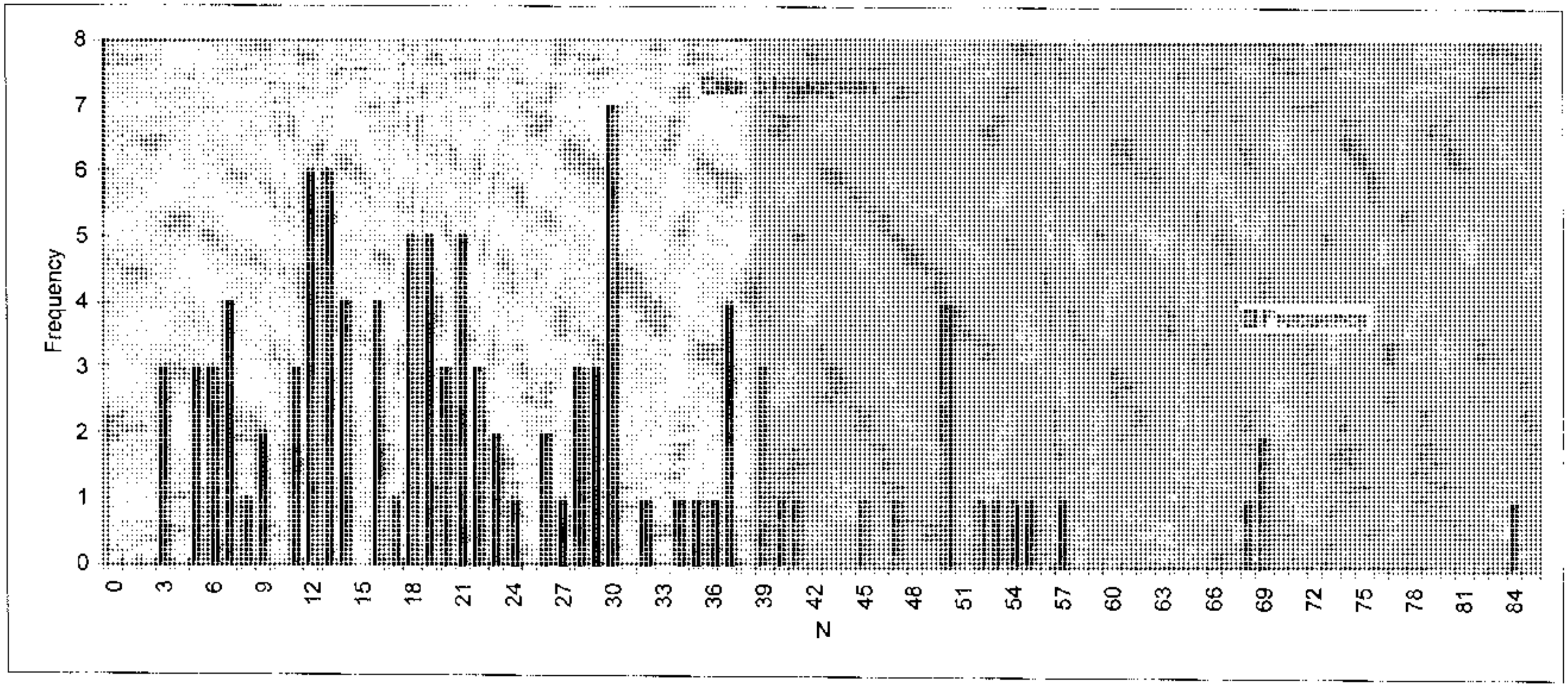
Dike 1	N	9	13	
	N60 (1.3*N)	11.7	16.9	
	qu (kgf/cm.	0.9	1.3	(after NAVFAC, 1982)
	qu(lb/in2)	13	18	
	cu (lb/in2)	6	9	

1	14.22334
kgf/cm2	lb/in2

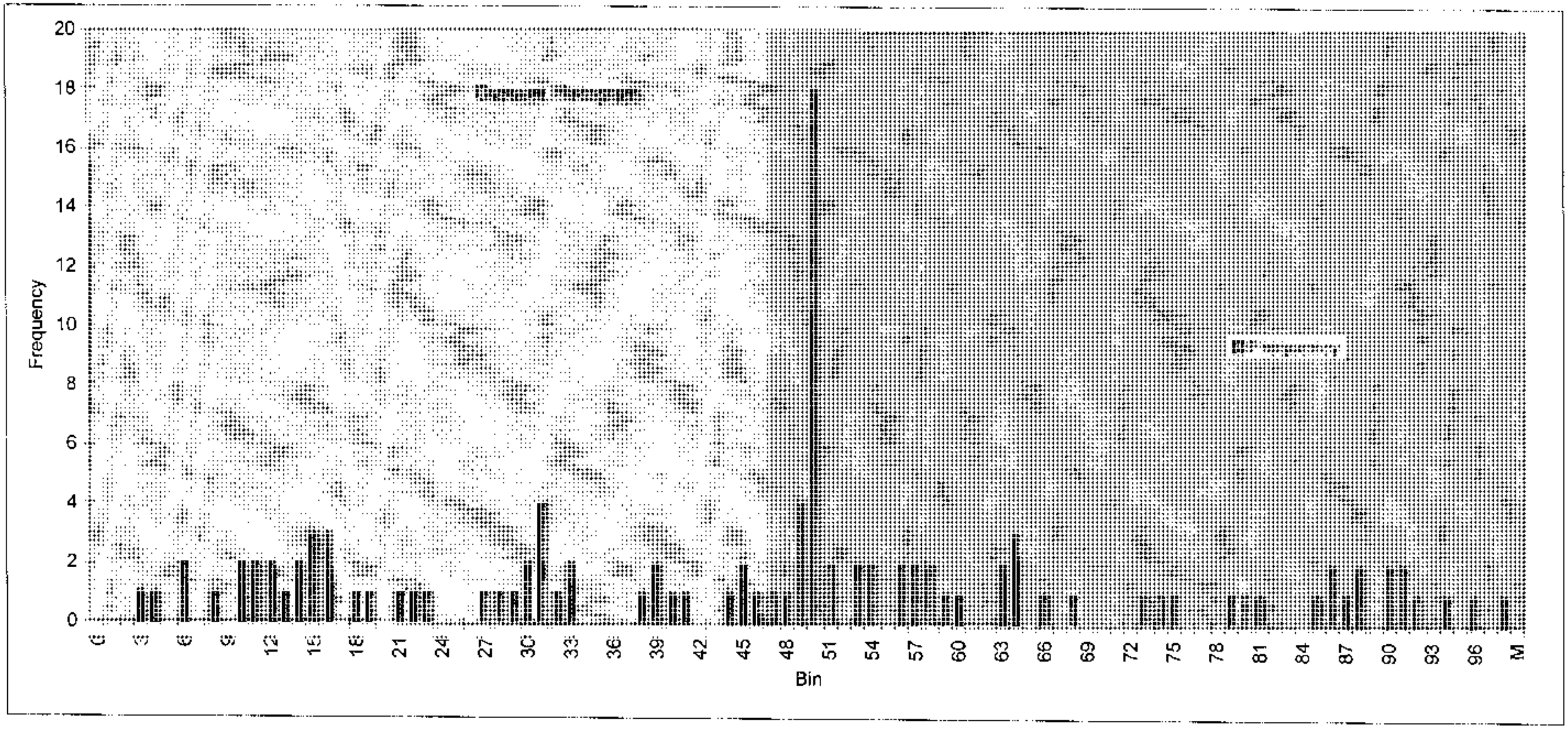
CPTs	N60	φ'	su
	6	42	40
	7	38	42
	8	43	60
	8	37	54
	8	43	50
	6	31	30
min	6	31	30
max	8	43	60
average	7	39	46
mode	8	43	#N/A
st dev	1	5	11



Dike 2	N	8	18	
	N60 (1.3*N)	10.4	23.4	
	qu (kgf/cm	0.82	1.78	(after NAVFAC, 1982)
	qu(lb/in2)	12	25	
	cu (lb/in2)	6	13	
	1 kgf/cm2	14.22334 lb/in2		



Dike 3	N	12	30
	N60 (1.3*N)	15.6	39
	qu (kgf/cm:	1.21	3.9 (after NAVFAC, 1982)
	qu(lb/in2)	17	55
	cu (lb/in2)	9	28
	1 kgf/cm2	14.22334 lb/in2	



Gypsum	N	50
	N60 (1.3*N)	65

ϕ
43.5

(Originally from Peck et al., 1974, modified by Carter and Bentley, 1991)

Attachment 6
CPT Data Analysis

Stantec (2009a)

Attachment 7
SPT Blow Counts (N60) to Effective Friction Angle (ϕ') Empirical Chart

Originally from Peck et al. (1974) and modified by Carter and Bentley (1991)

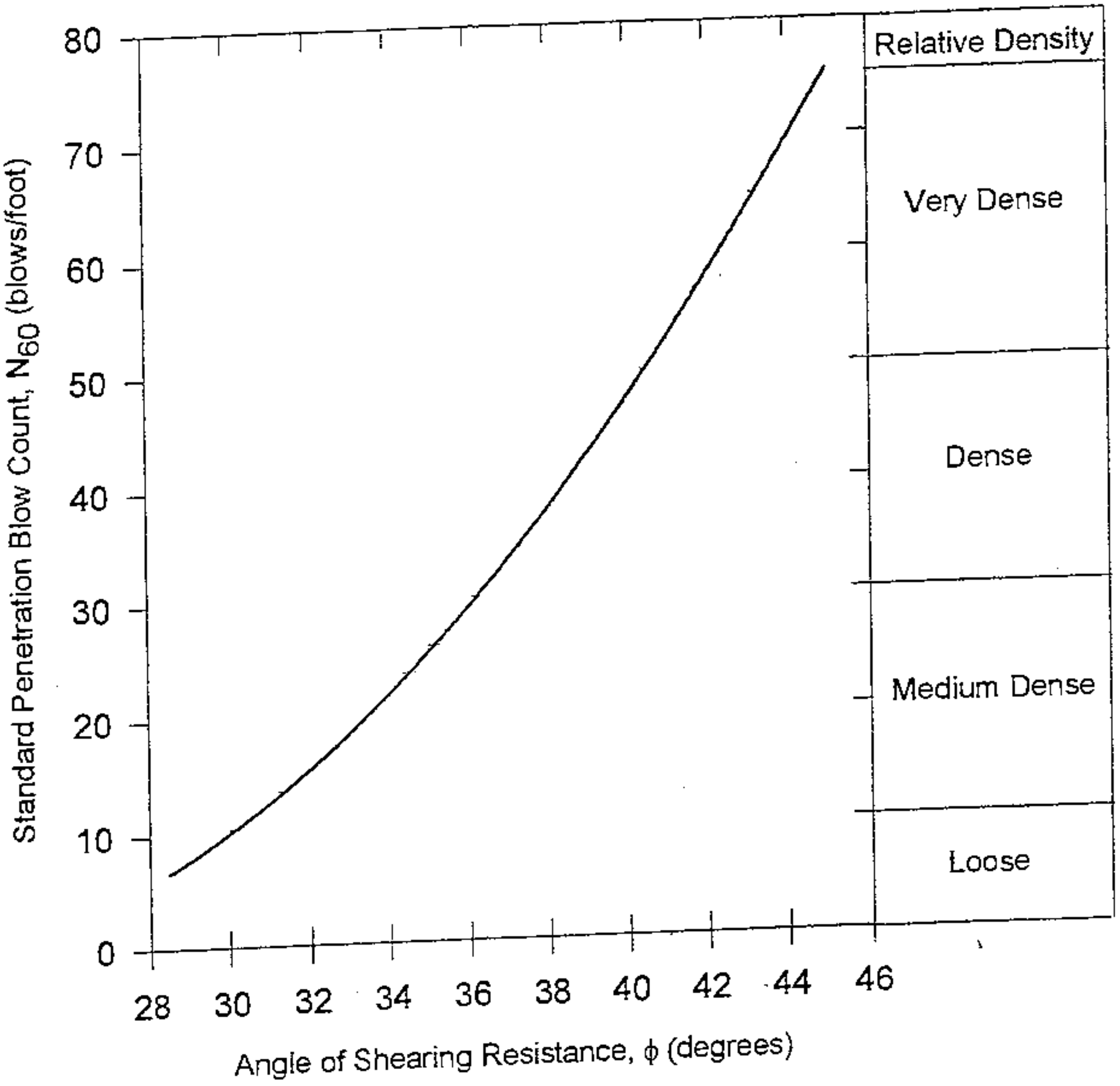
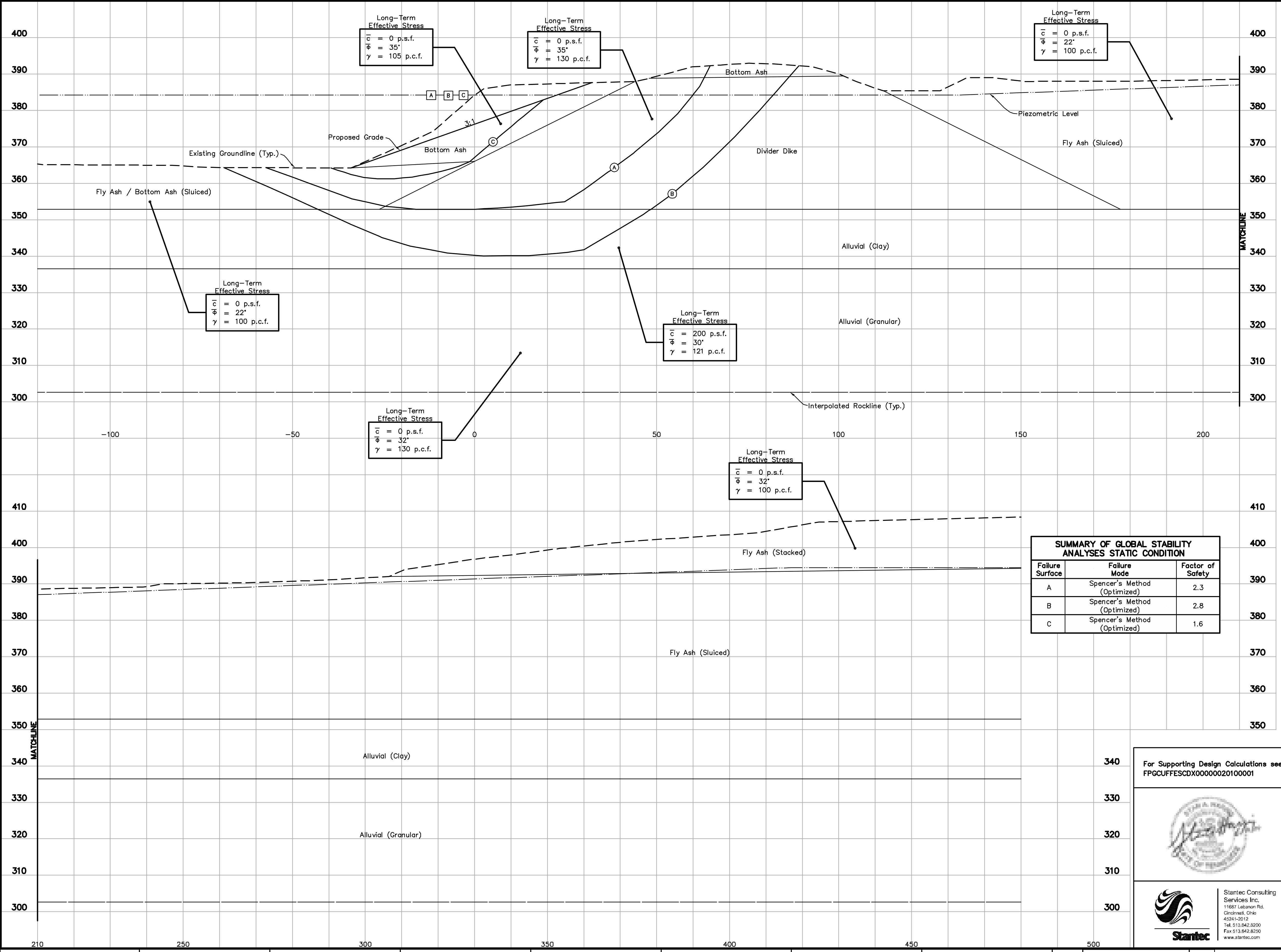


Figure 35. Estimation of the angle of shearing resistance of granular soils from standard penetration test results (Originally from Peck et al., 1974, modified by Carter and Bentley, 1991).

Appendix K

Proposed Repair and Buildout Cross Sections

46 C 10W543-21



SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	2.3
B	Spencer's Method (Optimized)	2.8
C	Spencer's Method (Optimized)	1.6

RECORD DRAWING

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–											
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RECORD DRAWING											
REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=10' EXCEPT AS NOTED

YARD
DRY FLY ASH STACK

GEOTECHNICAL EXPLORATION
DRY FLY ASH STACK STABILITY
SECTION A – REPAIR

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
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TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

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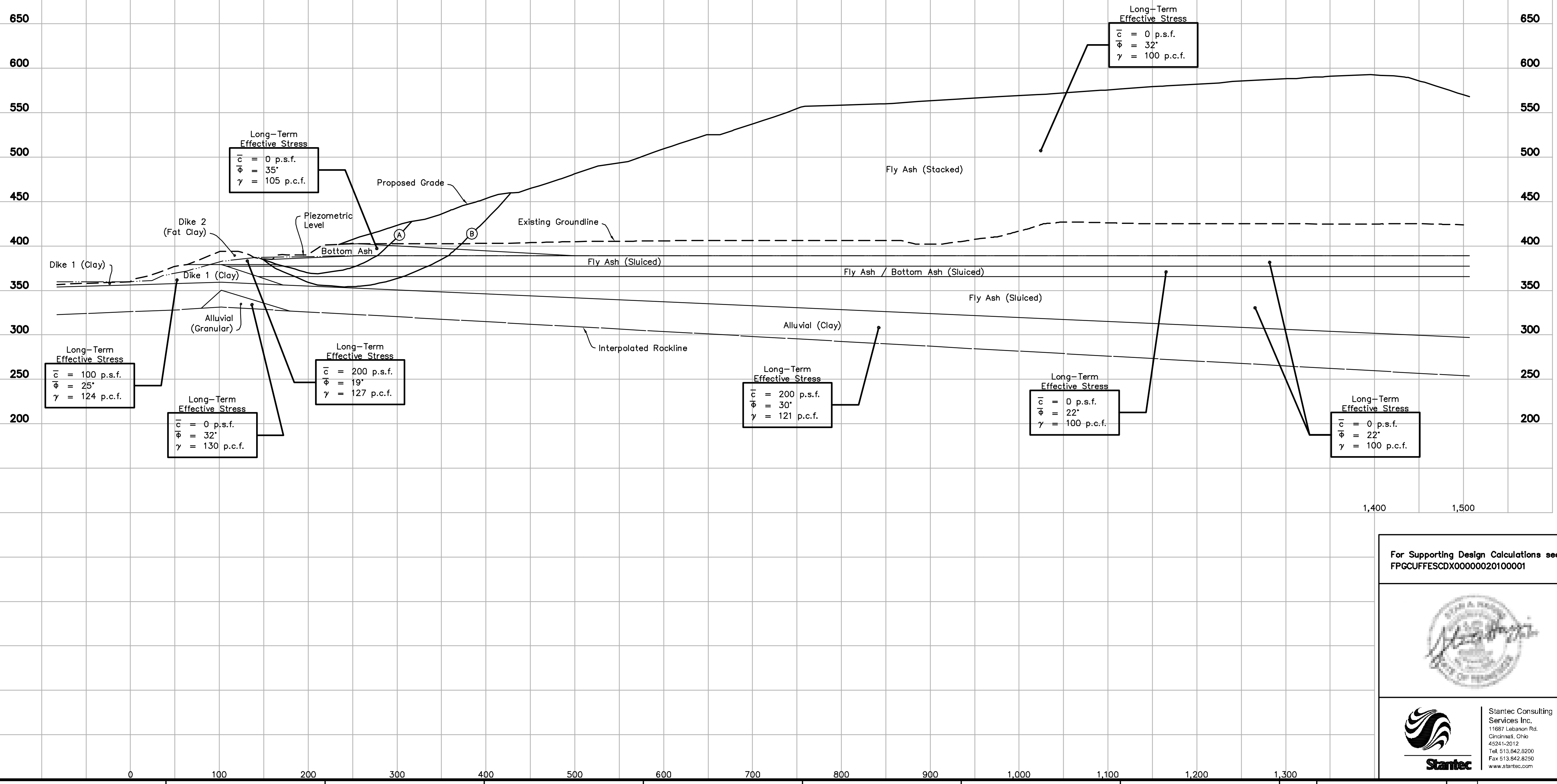
46 C 10W543-22

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	1.5
B	Spencer's Method (Optimized)	1.5

NOTE:

1. Buildout was developed from a CAD file transmitted from TVA on 10/16/2009.



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For Supporting Design Calculations see FPGCUFFESCDX00000020100001

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–											
R 0	06/11/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–
RECORD DRAWING											

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=50' EXCEPT AS NOTED

YARD
DRY FLY ASH STACK

GEOTECHNICAL EXPLORATION
DRY FLY ASH STACK STABILITY
SECTION C – BUILDOUT

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
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TASK COMPLETED BY:	REV NO.

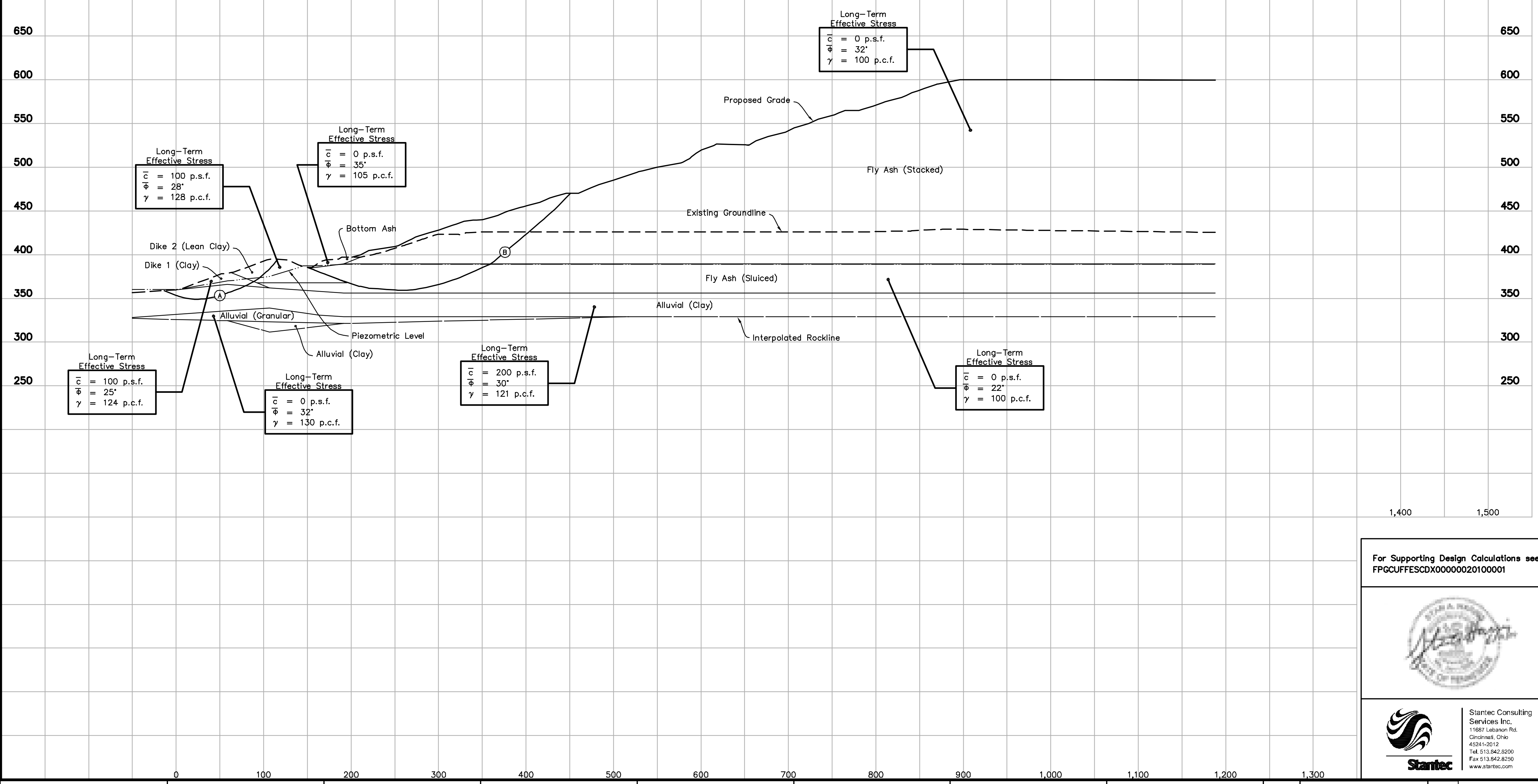
PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	1.9
B	Spencer's Method (Optimized)	1.6

NOTE:

1. Buildout was developed from a CAD file transmitted from TVA on 10/16/2009.



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RECORD DRAWING

For Supporting Design Calculations see FPGCUFFESCDX00000020100001

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–											
R 0	06/11/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–
RECORD DRAWING											

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=50' EXCEPT AS NOTED

YARD
DRY FLY ASH STACK

GEOTECHNICAL EXPLORATION
DRY FLY ASH STACK STABILITY
SECTION E – BUILDOUT

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
D. ROGERS	C. WITHERS	D. ROGERS	S. HARRIS	S. HARRIS	S. HARRIS	T. JOHNSON

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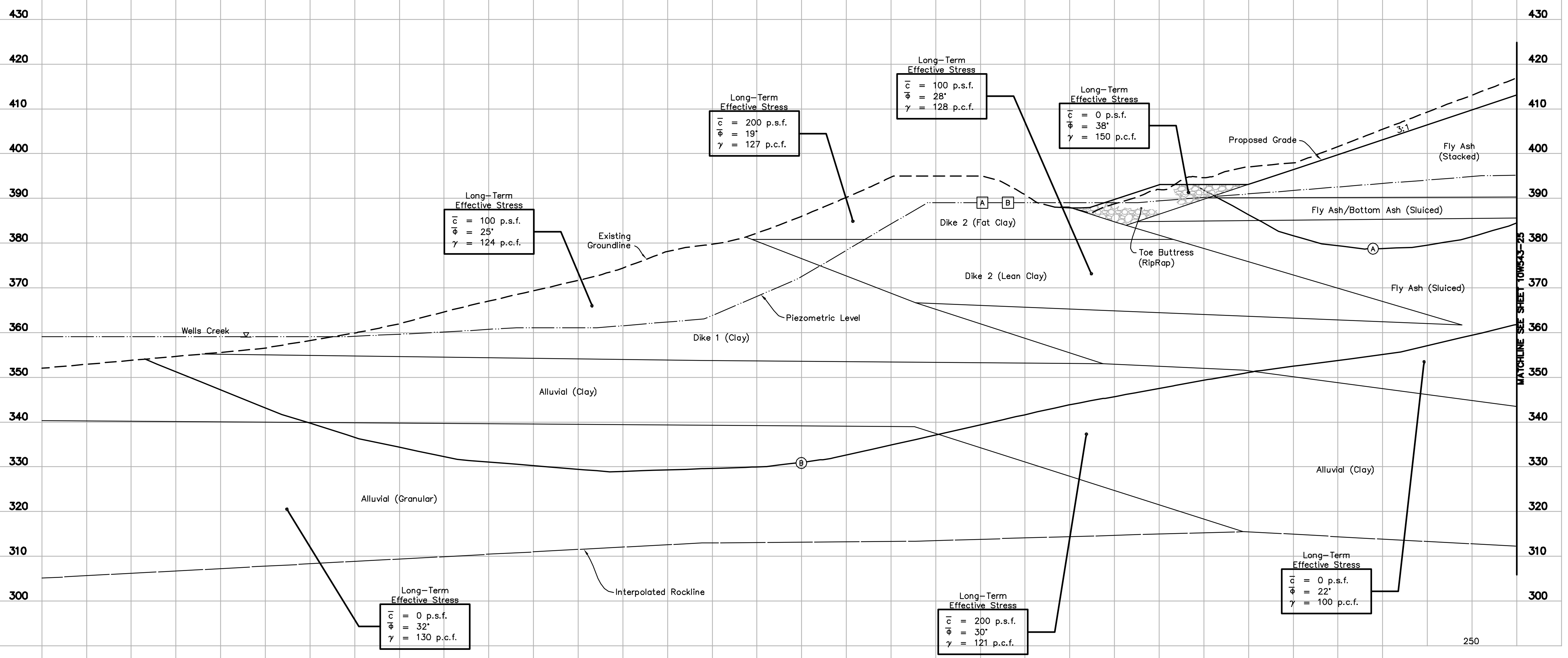
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION

Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	1.5
B	Spencer's Method (Optimized)	2.1



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For Supporting Design Calculations see FPGCUFFESCDX00000020100001

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–											
R 0	06/11/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–
RECORD DRAWING											

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=10' EXCEPT AS NOTED

YARD
DRY FLY ASH STACK

GEOTECHNICAL EXPLORATION
DRY FLY ASH STACK STABILITY
SECTION F – REPAIR

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
D. ROGERS	C. WITHERS	D. ROGERS	S. HARRIS	S. HARRIS	S. HARRIS	T. JOHNSON

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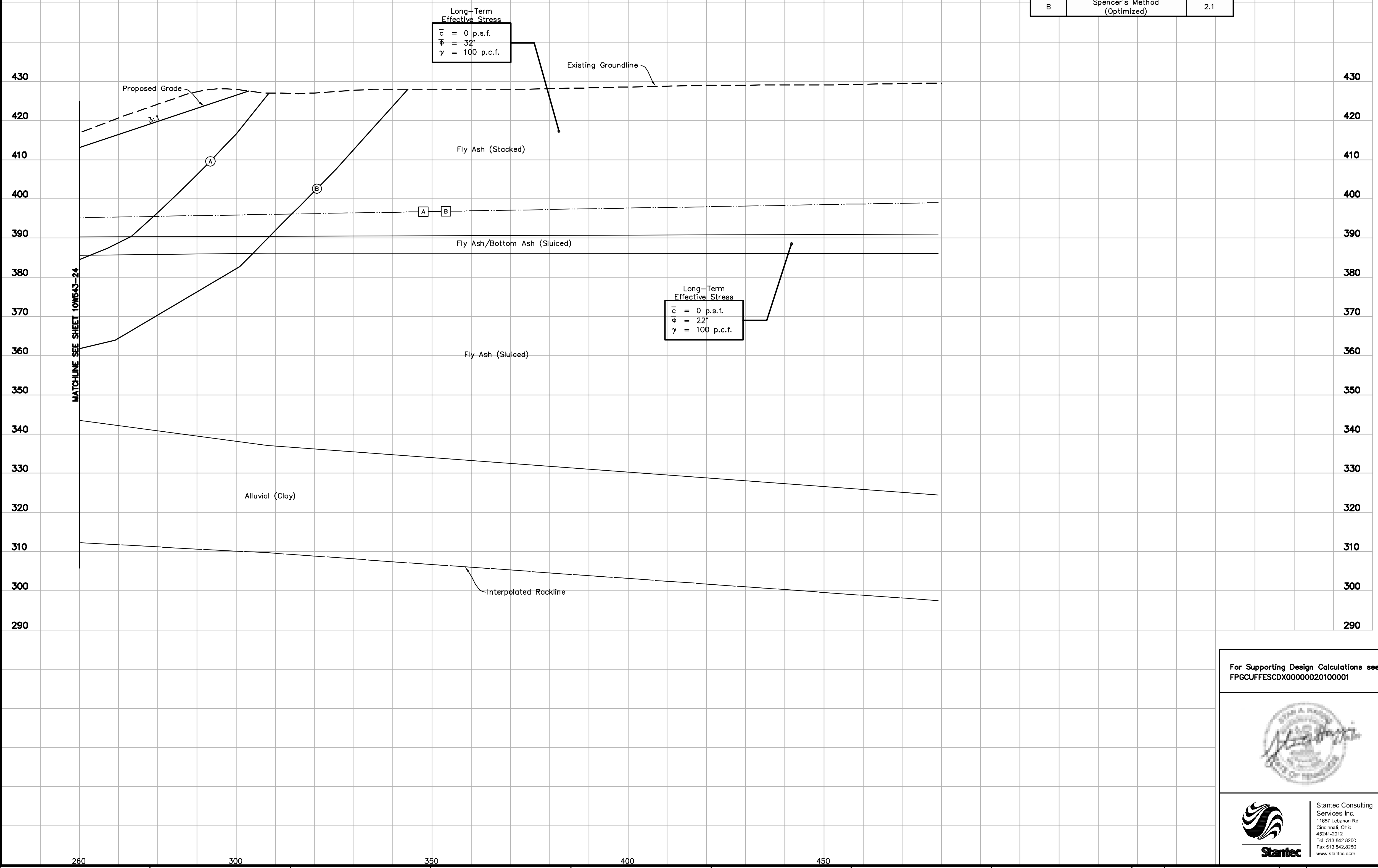
STANTEC	0
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	1.5
B	Spencer's Method (Optimized)	2.1



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–											
R 0	06/11/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–
RECORD DRAWING											

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=10' EXCEPT AS NOTED

YARD
DRY FLY ASH STACK

GEOTECHNICAL EXPLORATION
DRY FLY ASH STACK STABILITY
SECTION F – REPAIR

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PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
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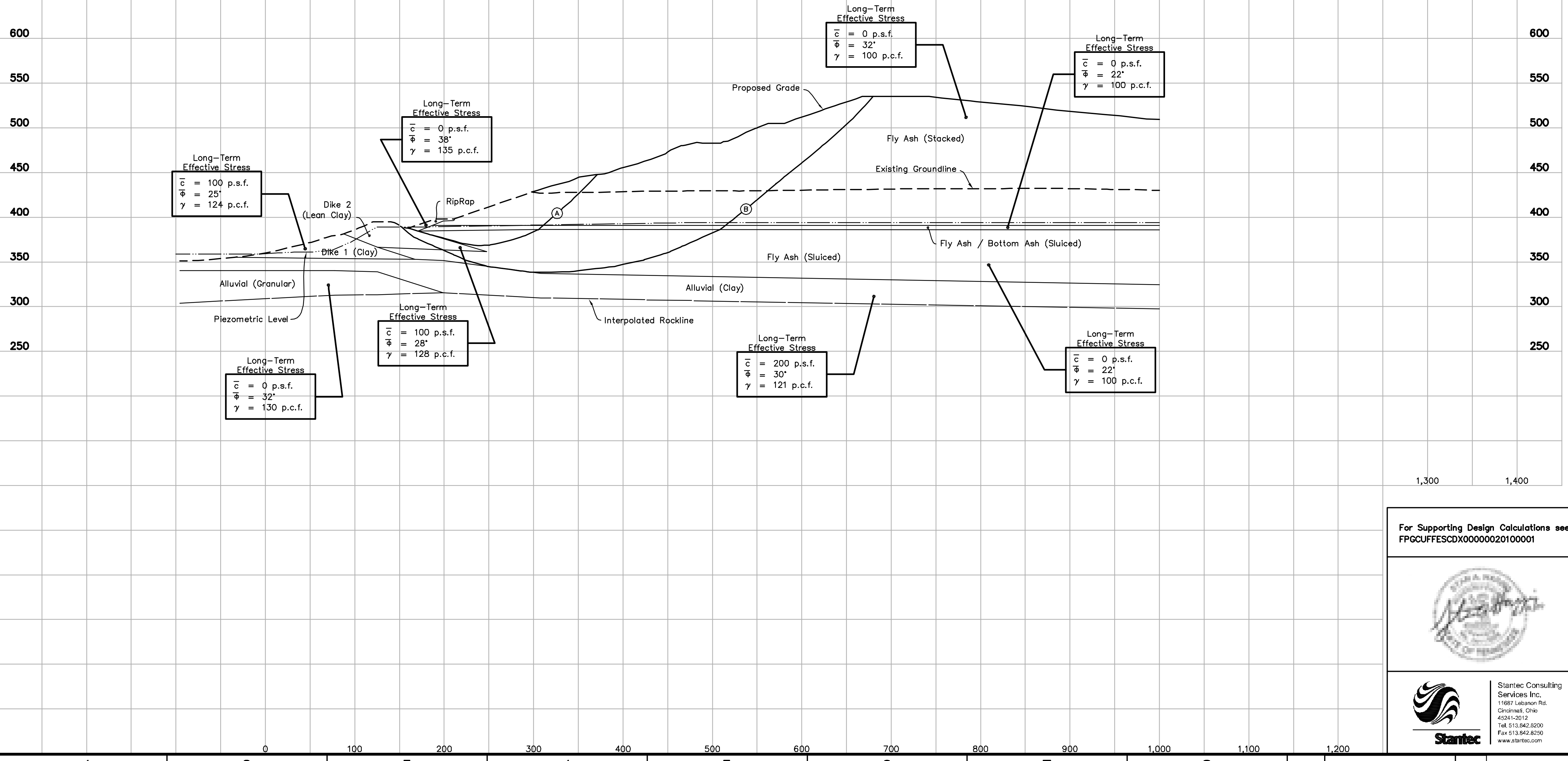
46 C 10W543-26

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	1.6
B	Spencer's Method (Optimized)	1.7

NOTE:

1. Buildout was developed from a CAD file transmitted from TVA on 10/16/2009.



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For Supporting Design Calculations see FPGCUFFESCDX00000020100001

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R 0	06/11/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–
RECORD DRAWING											

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=50' EXCEPT AS NOTED

YARD
DRY FLY ASH STACK

GEOTECHNICAL EXPLORATION
DRY FLY ASH STACK STABILITY
SECTION F – BUILDOUT

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
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AUTOCAD R 2000 | DATE 06/11/10 | 46 | C | 10W543-26 | R 0

STANTEC	0
TASK COMPLETED BY:	REV NO.

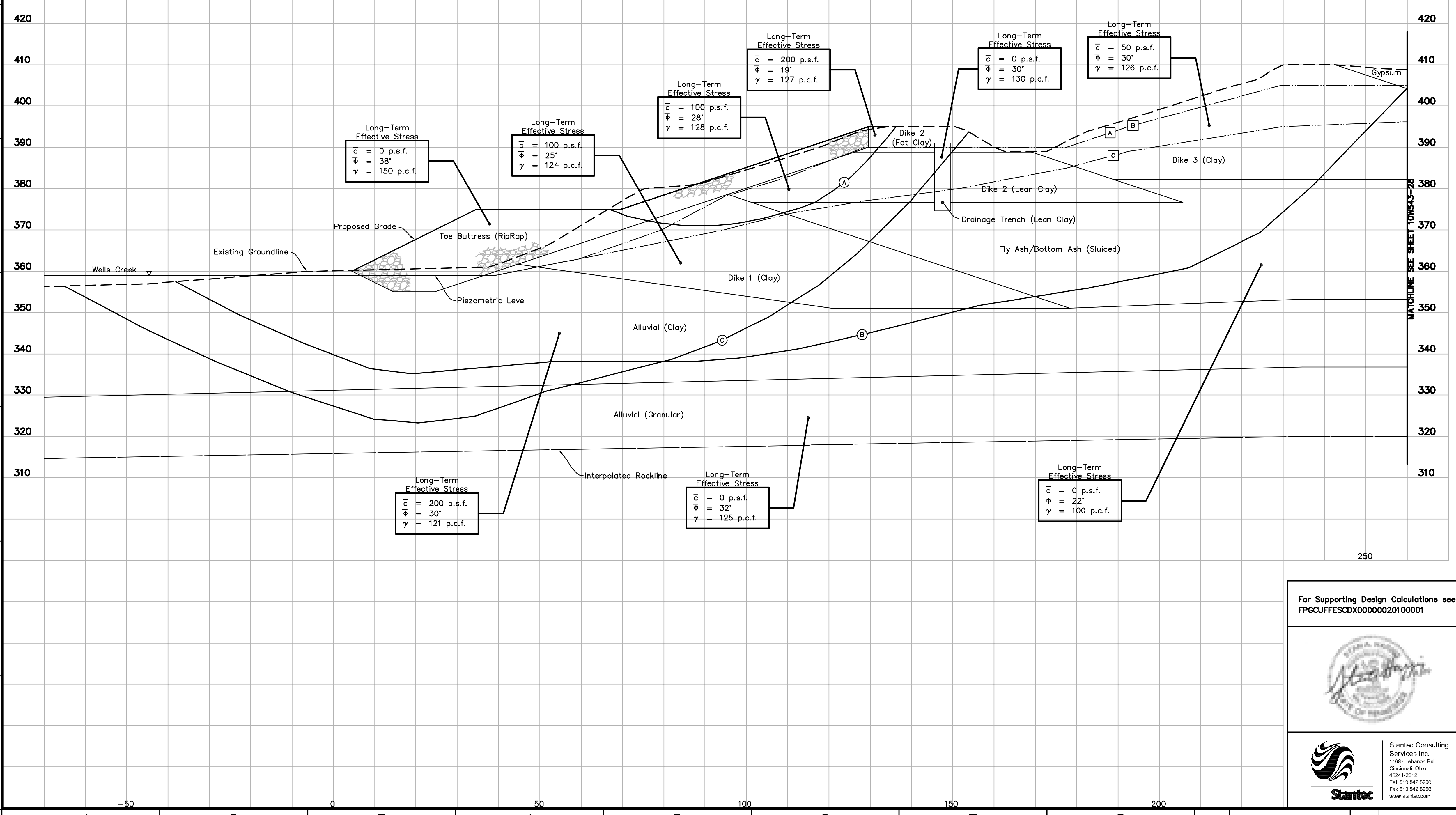
PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

46 C 10W543-27

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION

Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	1.8
B	Spencer's Method (Optimized)	2.1
C	Spencer's Method (Optimized)	2.4



RECORD DRAWING

For Supporting Design Calculations see FPGCUFFESCDX00000020100001

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R –	–	–	–	–	–	–	–	–	–	–	–
R 0	06/11/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–

RECORD DRAWING

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=10' EXCEPT AS NOTED

YARD
DRY FLY ASH STACK

GEOTECHNICAL EXPLORATION
DRY FLY ASH STACK STABILITY
SECTION H – REPAIR

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
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AUTOCAD R 2000 | DATE 06/11/10 | 46 | C | 10W543-27 | R 0

STANTEC	0
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

PLOT DATE: 06/10/2010 USER: WITHERS, CHEYENNE
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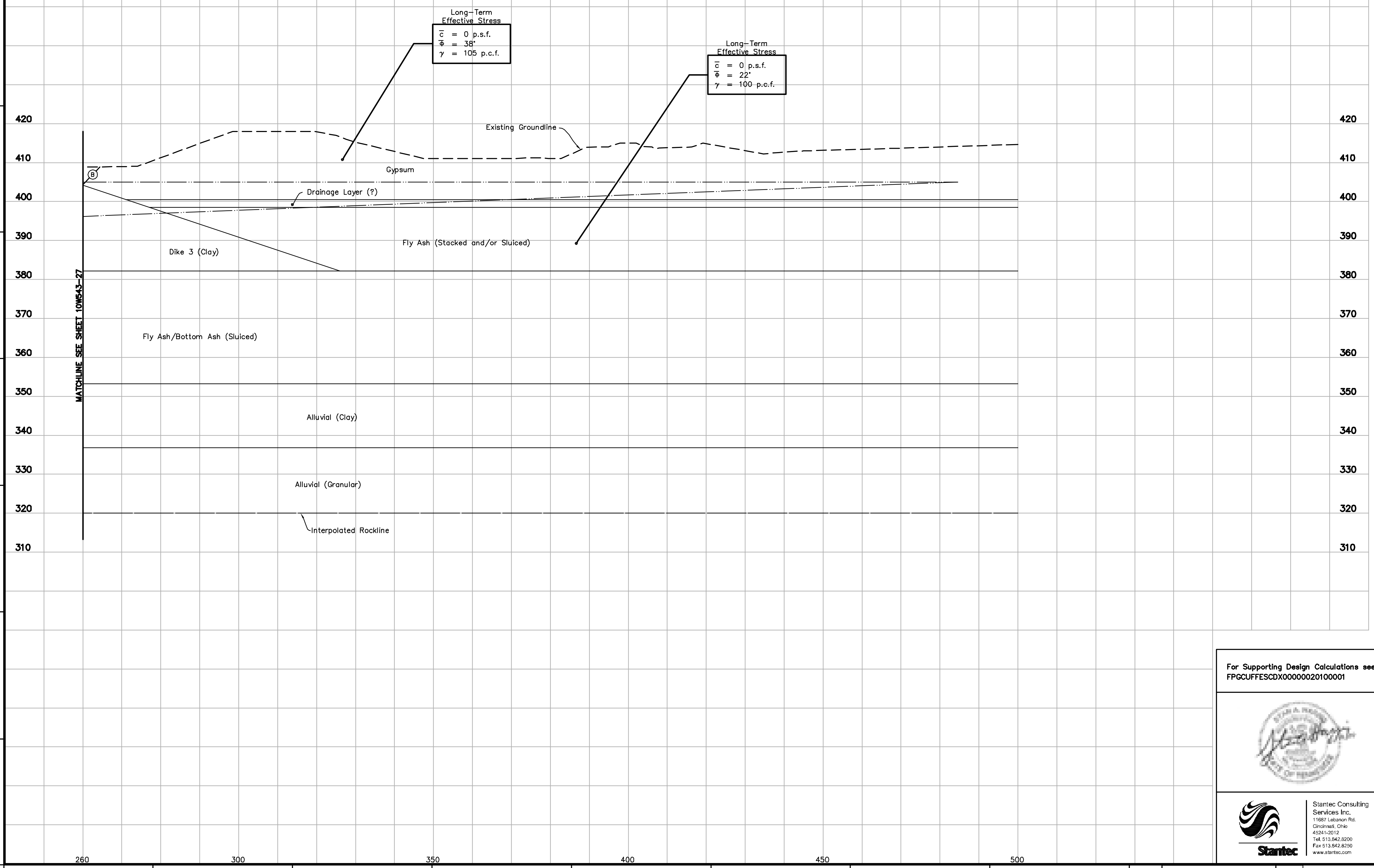

NOTE:

1. Presence of drainage layer beneath gypsum was ignored for the slope stability analysis.

RECORD DRAWING

PLOT DATE: 06/10/2010 USER: WITHERS, CHEYENNE
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For Supporting Design Calculations see FPGCUFFESCDX00000020100001

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R –	–	–	–	–	–	–	–	–	–	–	–
–											
R 0	06/11/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–
RECORD DRAWING											

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=10' EXCEPT AS NOTED

YARD
DRY FLY ASH STACK

GEOTECHNICAL EXPLORATION
DRY FLY ASH STACK STABILITY
SECTION H – REPAIR

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
D. ROGERS	C. WITHERS	D. ROGERS	S. HARRIS	S. HARRIS	S. HARRIS	T. JOHNSON

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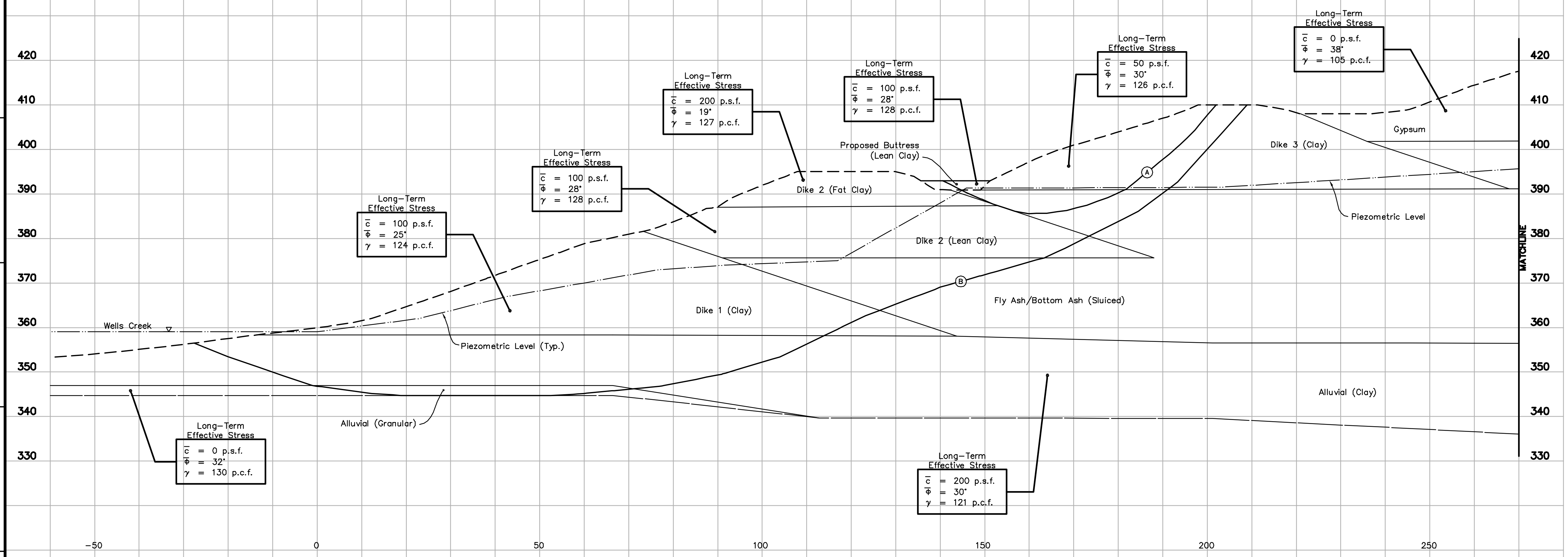
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

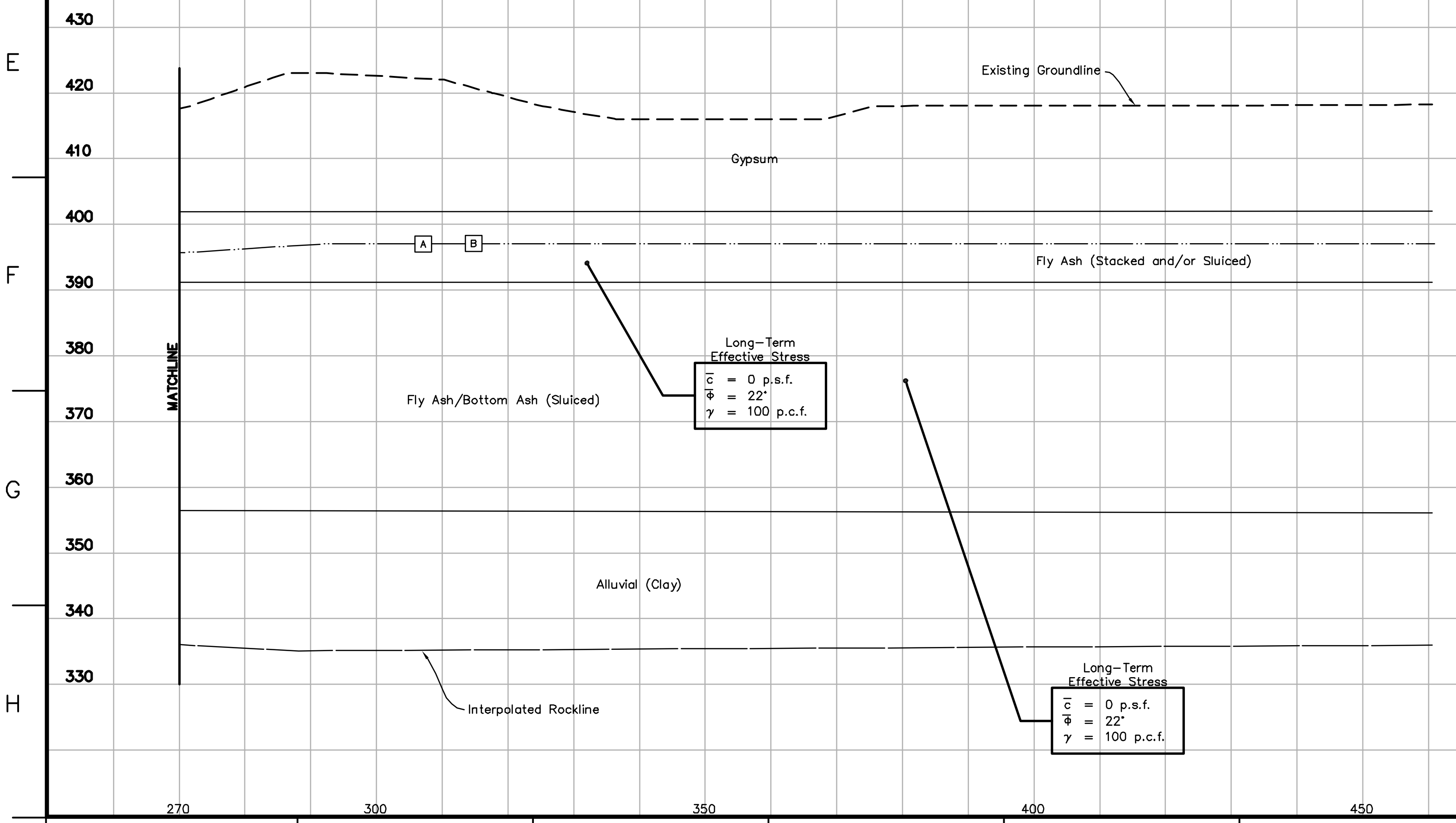
AUTOCAD R 2000 | DATE 06/11/10 | 46 | C | 10W543–28 | R 0

STANTEC	0
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY





SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION

Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	1.6
B	Spencer's Method (Optimized)	1.8

RECORD DRAWING

PLOT DATE: 06/10/2010 USER: WITHERS, CHEYENNE
V:\1755\ACTIVE\175539009\GEOTECHNICAL\DRAWING\REV0_RECORD\R2000\10W543-29-R0.DWG

For Supporting Design Calculations see FPGCUFFESCDX00000020100001

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R –	–	–	–	–	–	–	–	–	–	–	–
R 0	06/11/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–
RECORD DRAWING											

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=10' EXCEPT AS NOTED

YARD
GYPSUM DISPOSAL COMPLEX

GEOTECHNICAL EXPLORATION
GYPSUM DISPOSAL COMPLEX STABILITY
SECTION J – REPAIR

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
D. ROGERS	C. WITHERS	D. ROGERS	S. HARRIS	S. HARRIS	S. HARRIS	T. JOHNSON

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CUMBERLAND FOSSIL PLANT
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FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000	DATE 06/11/10	46	C	10W543-29	R 0

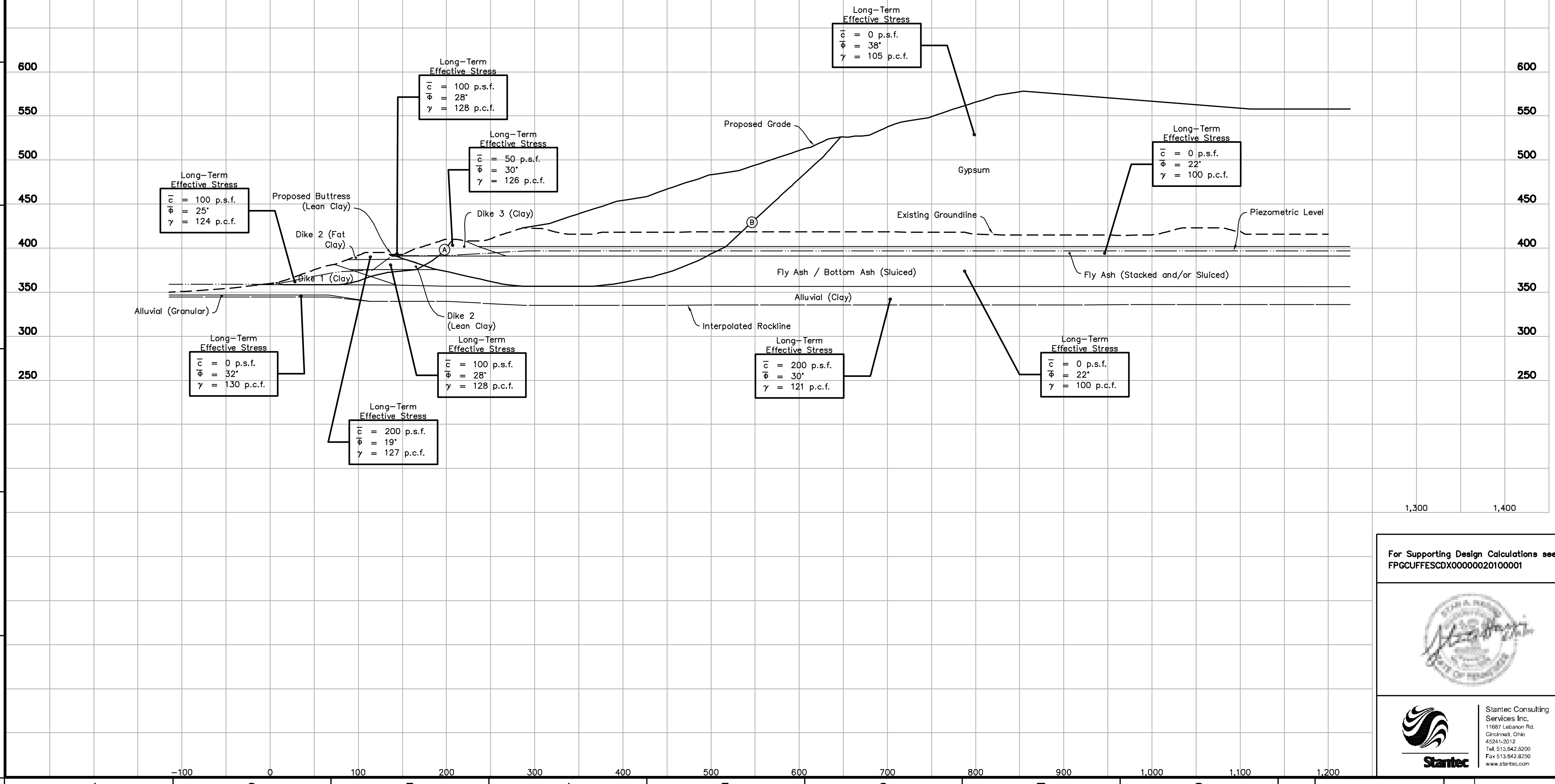
STANTEC	0
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

46 C 10W543-30

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	1.7
B	Spencer's Method (Deep Failure)	1.8



RECORD DRAWING

PLOT DATE: 06/10/2010 USER: WITHERS, CHEYENNE
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For Supporting Design Calculations see FPGCUFFESCDX00000020100001

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R –	–	–	–	–	–	–	–	–	–	–	–
R 0	06/11/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–
RECORD DRAWING											

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=50' EXCEPT AS NOTED

YARD
GYPSUM DISPOSAL COMPLEX

GEOTECHNICAL EXPLORATION
GYPSUM DISPOSAL COMPLEX STABILITY
SECTION J – BUILDOUT

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
D. ROGERS	C. WITHERS	D. ROGERS	S. HARRIS	S. HARRIS	S. HARRIS	T. JOHNSON

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CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

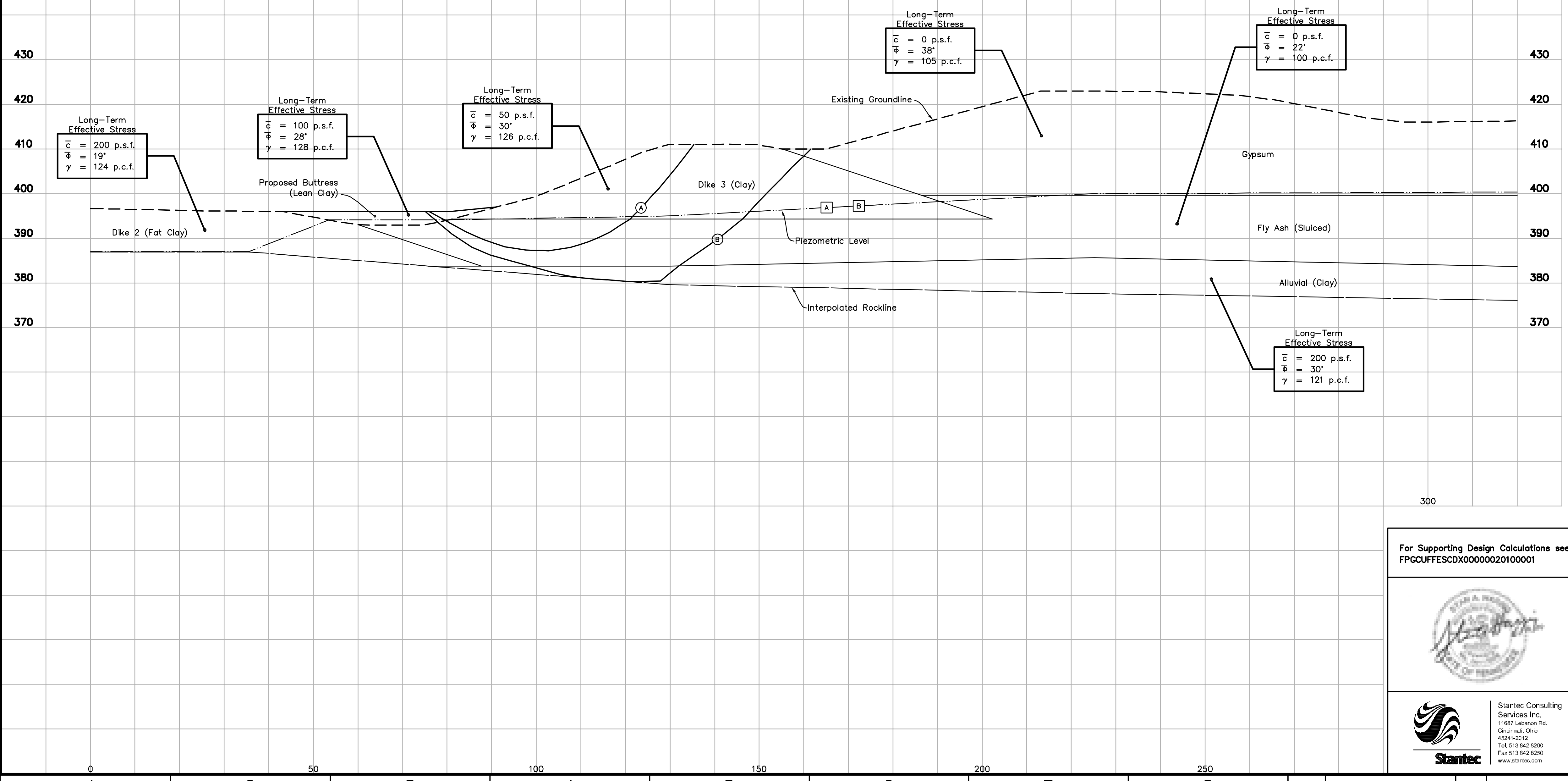
AUTOCAD R 2000 | DATE 06/11/10 | 46 | C | 10W543-30 | R 0

STANTEC	0
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	1.6
B	Spencer's Method (Optimized)	2.8



RECORD DRAWING

PLOT DATE: 06/10/2010 USER: WITHERS, CHEYENNE
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For Supporting Design Calculations see FPGCUFFESCDX00000020100001

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R –	–	–	–	–	–	–	–	–	–	–	–
–											
R 0	06/11/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–
RECORD DRAWING											

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=10' EXCEPT AS NOTED

YARD
GYPSUM DISPOSAL COMPLEX

GEOTECHNICAL EXPLORATION
GYPSUM DISPOSAL COMPLEX STABILITY
SECTION M – REPAIR

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
D. ROGERS	C. WITHERS	D. ROGERS	S. HARRIS	S. HARRIS	S. HARRIS	T. JOHNSON

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CUMBERLAND FOSSIL PLANT
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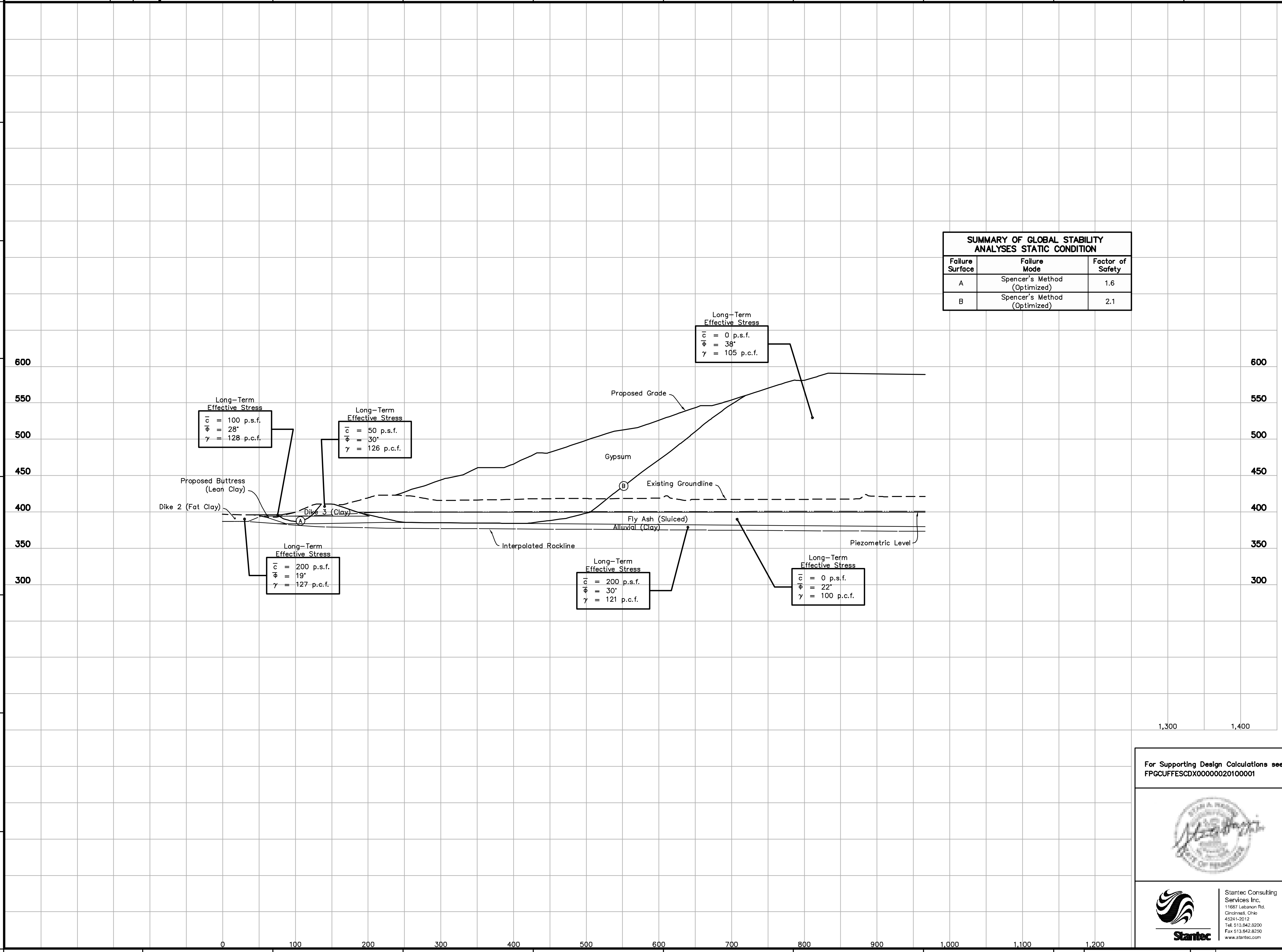
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000	DATE 06/11/10	46	C	10W543-31	R 0

STANTEC	0
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY



SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION

Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	1.6
B	Spencer's Method (Optimized)	2.1

NOTE:

1. Buildout was developed from a CAD file transmitted from TVA on 10/16/2009 and cross sections modified to maintain existing dike structure.

RECORD DRAWING

PLOT DATE: 06/10/2010 USER: WITHERS, CHEYENNE
V:\1755\ACTIVE\175539009\GEOTECHNICAL\DRAWING\REV0_RECORD\R2000\10W543-32-R0.DWG

For Supporting Design Calculations see FPGCUFFESCDX00000020100001

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R –	–	–	–	–	–	–	–	–	–	–	–
–											
R 0	06/11/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–
RECORD DRAWING											

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=50' EXCEPT AS NOTED

YARD
GYPSUM DISPOSAL COMPLEX

GEOTECHNICAL EXPLORATION
GYPSUM DISPOSAL COMPLEX STABILITY
SECTION M – BUILDOUT

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
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CUMBERLAND FOSSIL PLANT
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FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | DATE 06/11/10 | 46 | C | 10W543–32 | R 0

STANTEC	0
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

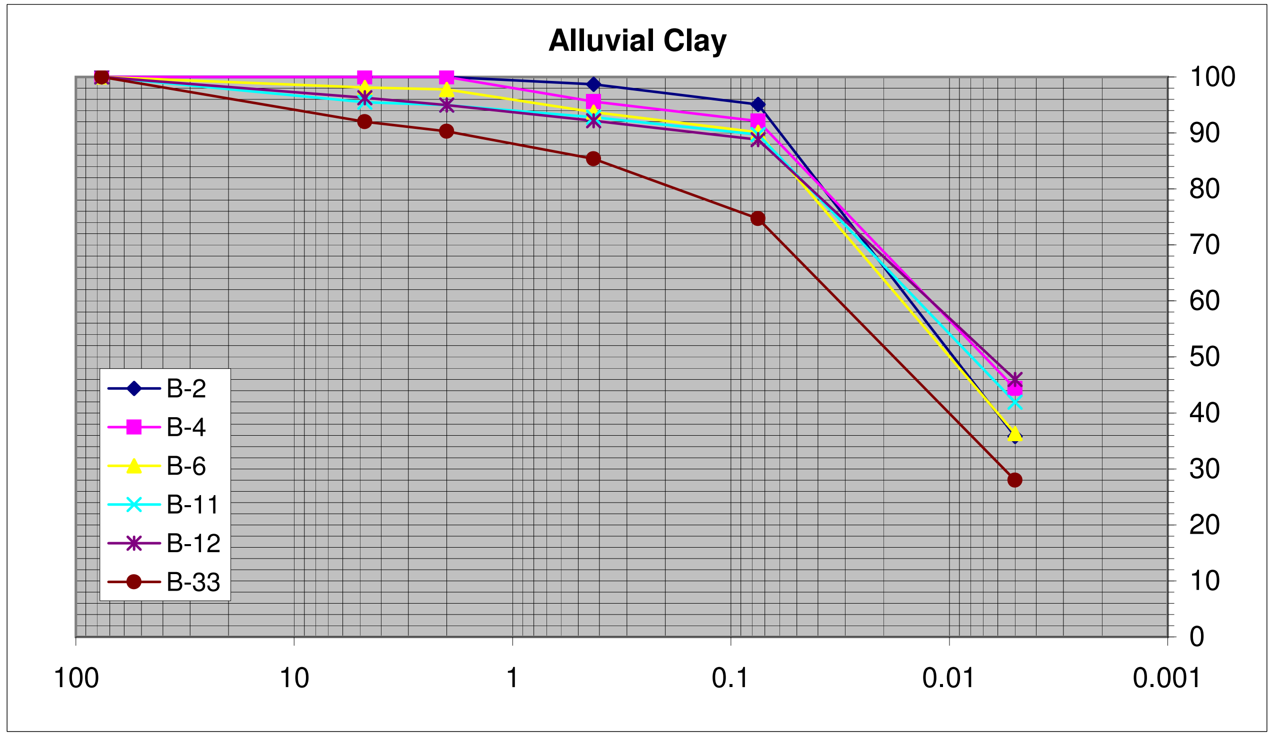
C.A.D. DRAWING
DO NOT ALTER MANUALLY

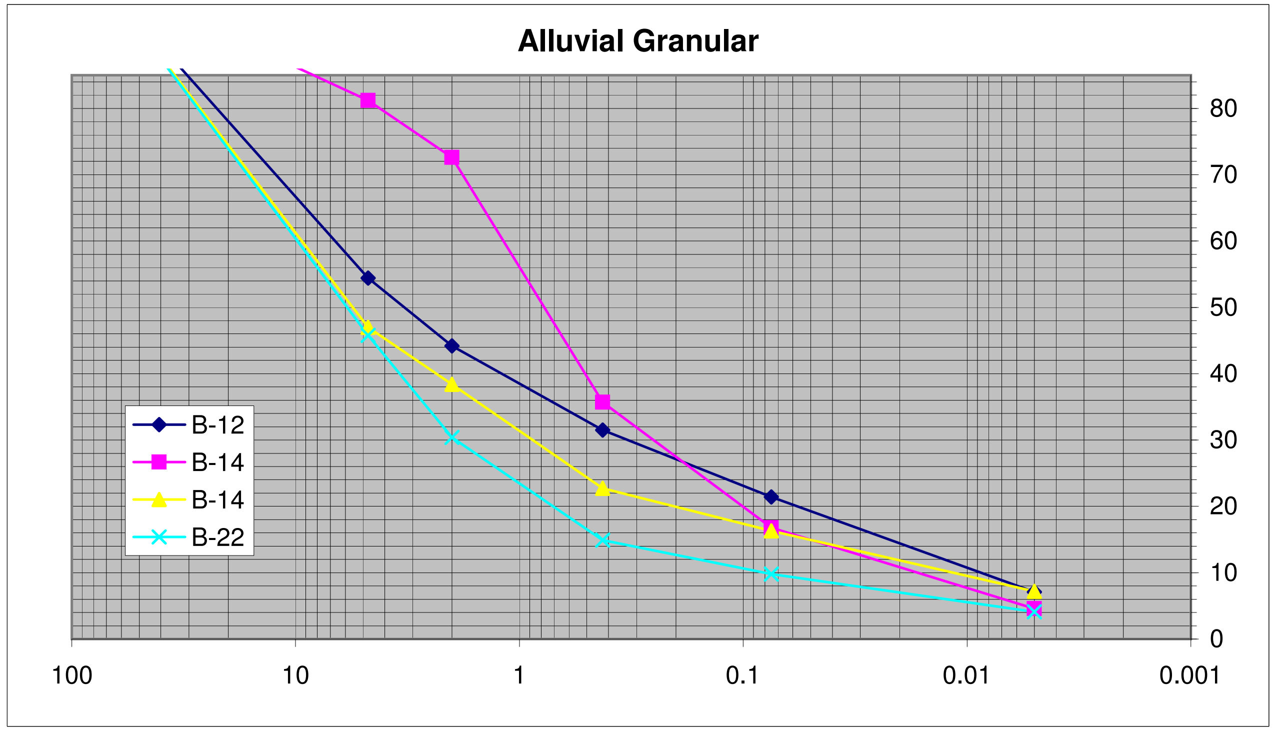
Appendix L

Seepage Analysis

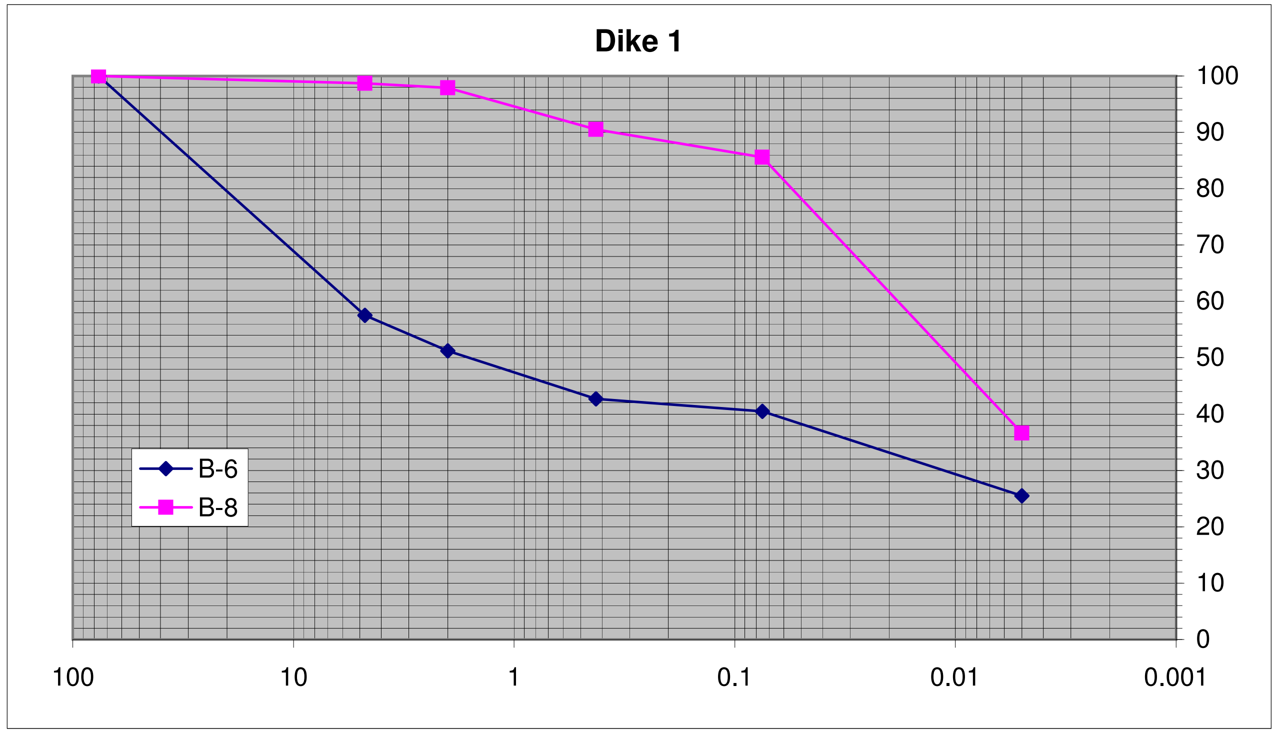
Particle Size Summary and Charts

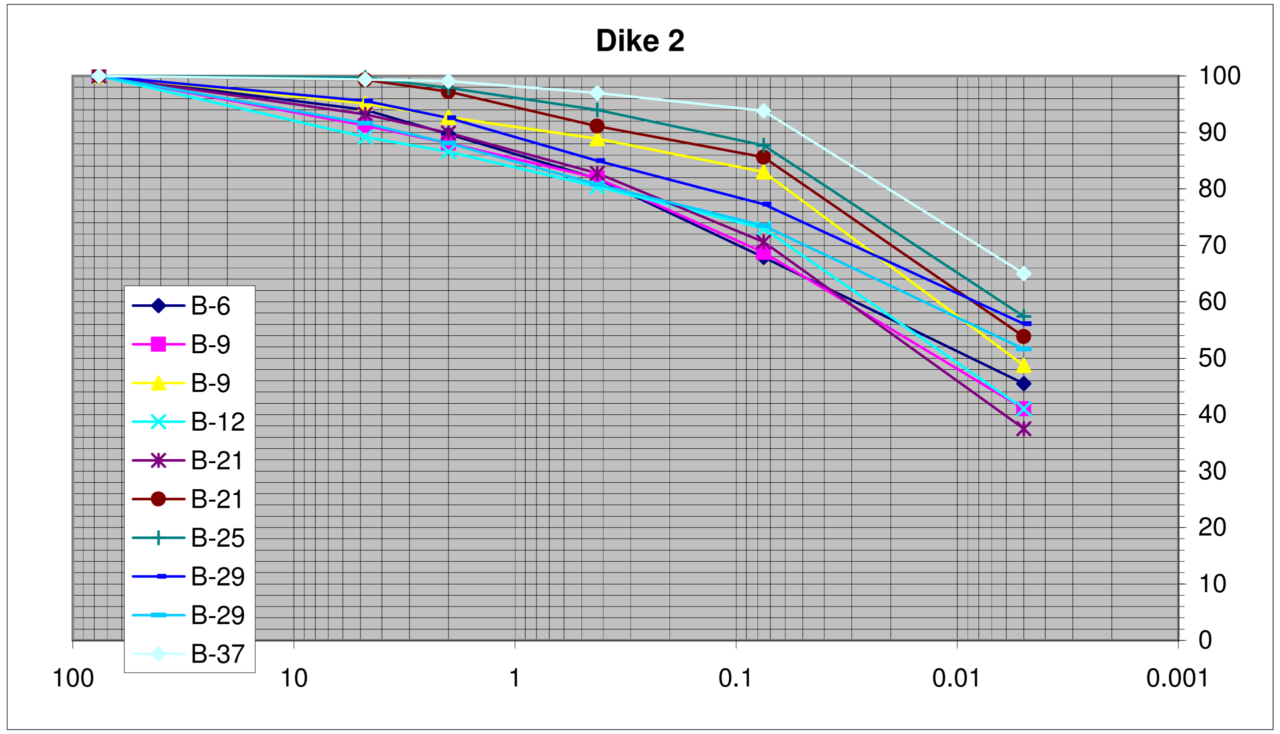
			Atterberg Limits	Grain Size (mm)					
Lab ID	**Boring**	**Material Type**	**LL**	**76.2**	**4.75**	**2**	**0.425**	**0.075**	**0.005**
512	B-2	Alluvial Clay	36	100.0	100.0	100.0	98.7	95.1	35.8
611	B-4	Alluvial Clay	40	100.0	100.0	100.0	95.6	92.1	44.4
26	B-6	Alluvial Clay	37	100.0	98.1	97.8	93.7	90.1	36.3
841	B-11	Alluvial Clay	41	100.0	95.5	95.0	92.8	89.7	41.9
186	B-12	Alluvial Clay	40	100.0	96.3	95.0	92.2	88.8	46.0
381	B-33	Alluvial Clay	35	100.0	92.0	90.3	85.4	74.7	28.0
1081	B-42	Alluvial Clay	49						
			39.7						
197	B-12	Alluvial Granular		100.0	54.4	44.2	31.5	21.4	7.1
896	B-14	Alluvial Granular		100.0	81.2	72.6	35.7	16.8	4.6
902	B-14	Alluvial Granular		100.0	47.0	38.4	22.7	16.3	7.2
121	B-22	Alluvial Granular		100.0	45.8	30.4	14.9	9.8	4.1
491	B-2	BA-FA (Sluiced)		100.0	85.0	73.2	51.8	33.9	3.9
727	B-18	BA-FA (Sluiced)		100.0	91.1	82.7	57.6	39.5	7.1
53	B-21	BA-FA (Sluiced)		100.0	79.4	62.9	34.5	16.6	3.8
93	B-22	BA-FA (Sluiced)		100.0	92.4	87.0	72.7	56.0	9.5
1637		Bottom Ash							
17	B-6	Dike 1	56	100.0	57.5	51.2	42.7	40.5	25.5
802	B-8	Dike 1	36	100.0	98.7	97.9	90.5	85.6	36.6
871	B-14	Dike 1	44						
910	B-26	Dike 1	44						
920	B-26	Dike 1/Alluvial Clay	38						
944	B-30	Dike 1	46						
951	B-30	Dike 1	36						
969	B-34	Dike 1	44						
975	B-34	Dike 1	36						
			40.5						
39	B-6	Dike 2	55	100.0	94.0	89.7	81.8	67.9	45.5
161	B-9	Dike 2	50	100.0	91.2	88.1	81.9	68.7	41.0
162	B-9	Dike 2	51	100.0	95.1	92.7	88.9	83.0	48.7
208	B-12	Dike 2	51	100.0	89.2	86.6	80.4	73.0	41.0
71	B-21	Dike 2	49	100.0	93.2	89.9	82.8	70.6	37.5

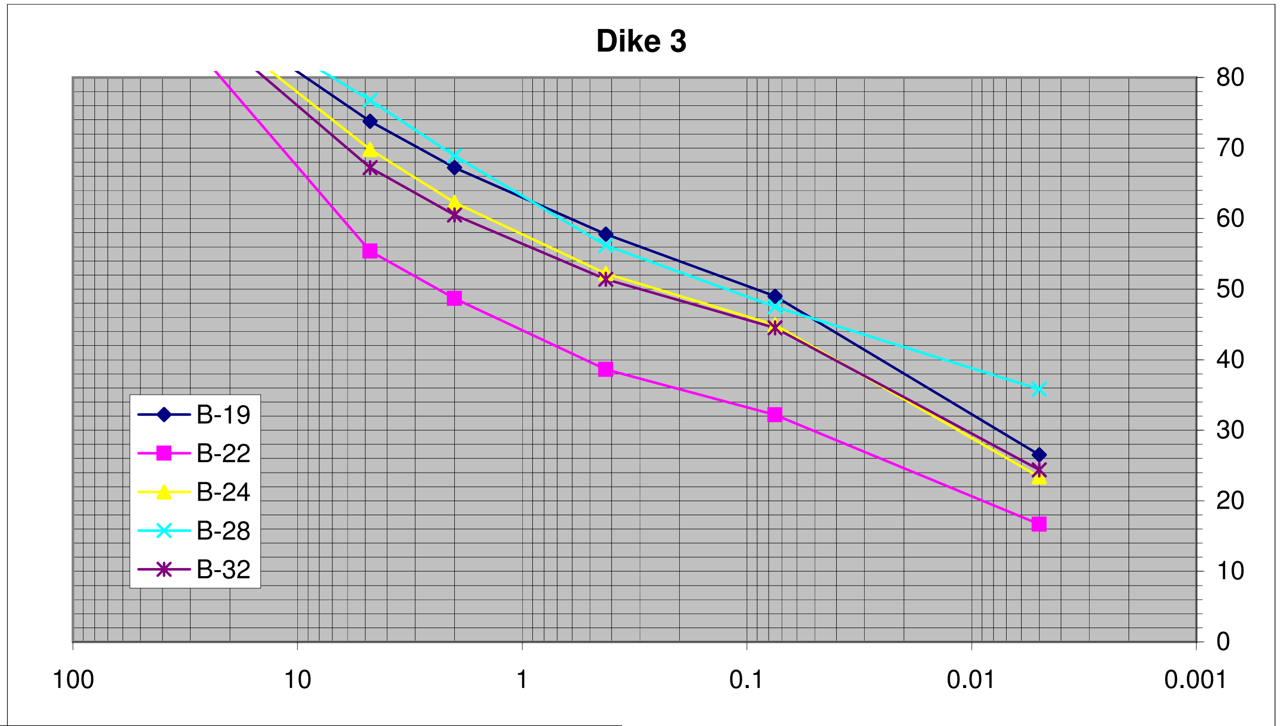


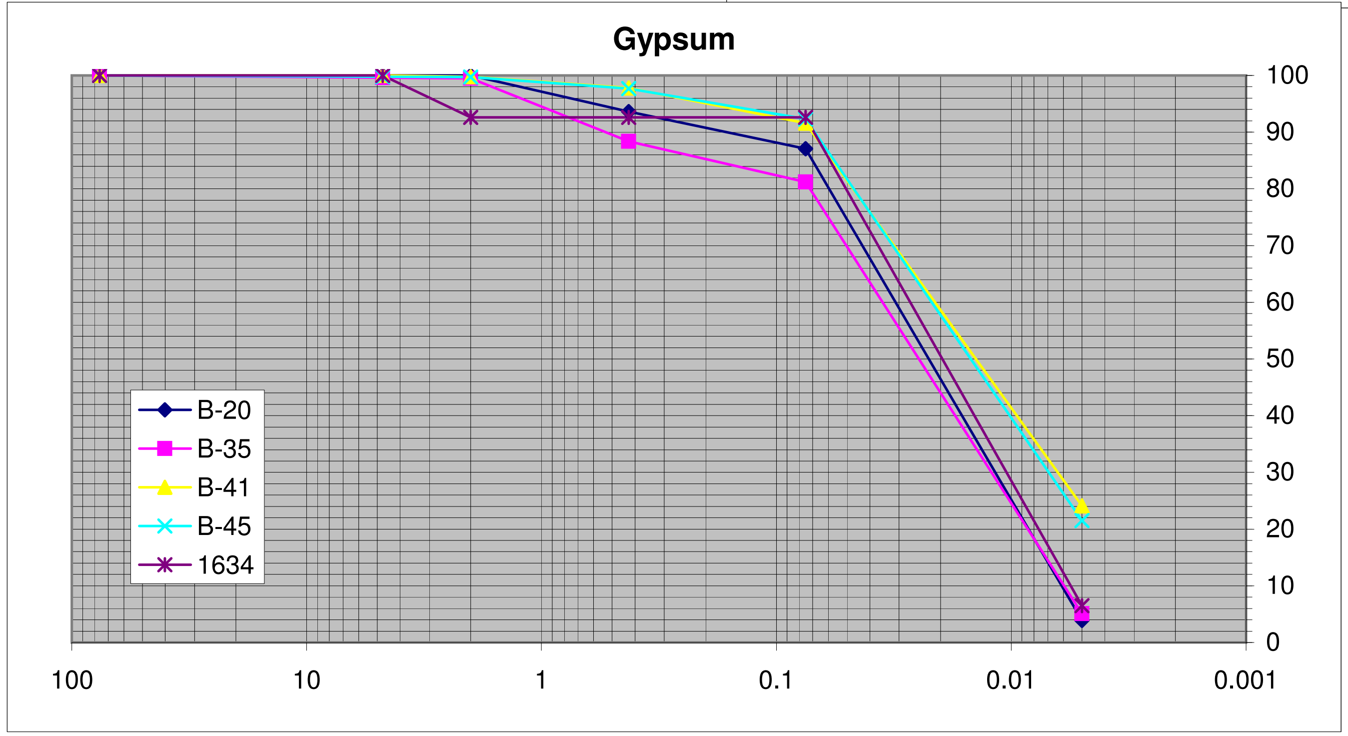


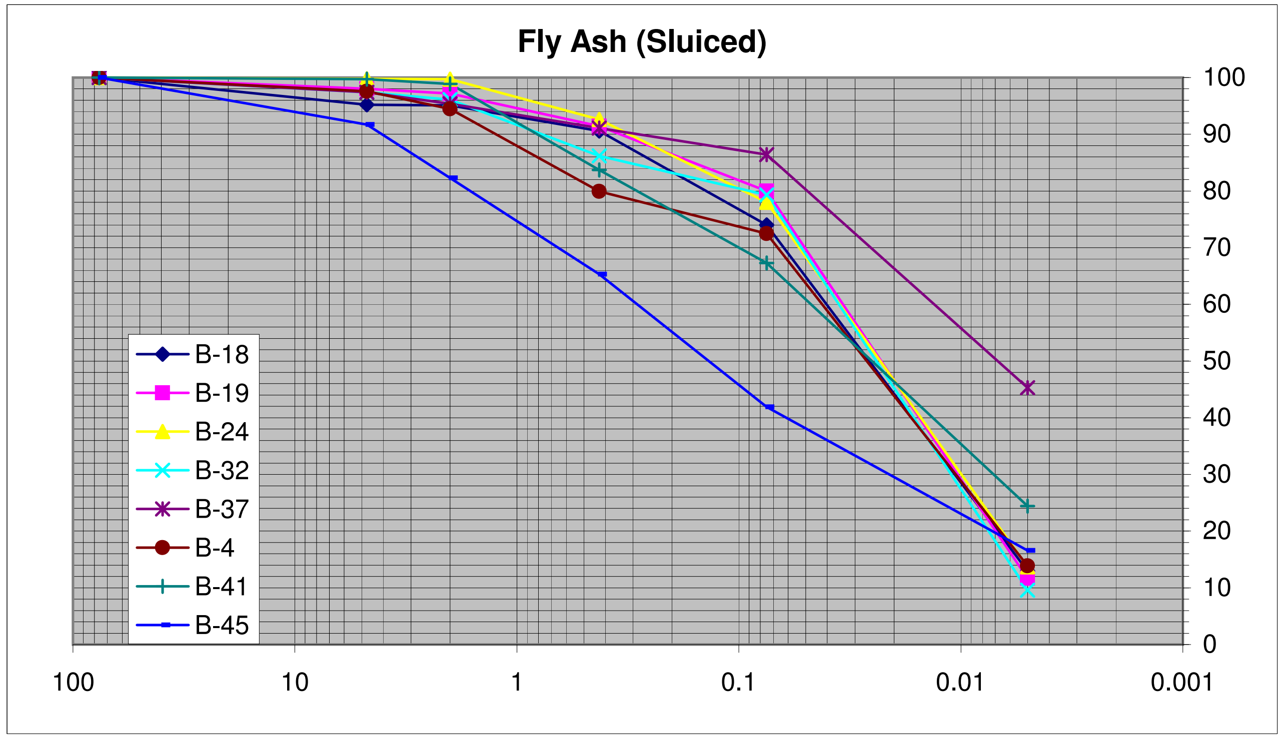
72	B-21	Dike 2	56	100.0	99.3	97.2	91.1	85.6	53.8
294	B-25	Dike 2	58	100.0	99.7	97.9	94.0	87.7	57.4
1457	B-29	Dike 2	46	100.0	95.6	92.6	85.0	77.3	56.1
1458	B-29	Dike 2	46	100.0	91.6	88.1	80.8	73.5	51.6
1460	B-37	Dike 2	53	100.0	99.4	99.1	97.0	93.8	65.0
1069	B-42	Dike 2	44						
			50.8						
663	B-19	Dike 3	48	100.0	73.8	67.2	57.8	49.0	26.5
77	B-22	Dike 3	36	100.0	55.4	48.7	38.6	32.2	16.7
536	B-24	Dike 3	39	100.0	69.8	62.3	52.2	44.9	23.4
1459	B-28	Dike 3	36	100.0	76.8	68.9	56.2	47.5	35.8
330	B-32	Dike 3	40	100.0	67.2	60.5	51.4	44.5	24.4
			39.8						
1636		Fly Ash							
738	B-18	Fly Ash (Sluiced)		100.0	95.2	95.1	90.6	74.0	13.0
678	B-19	Fly Ash (Sluiced)		100.0	98.0	97.2	91.4	80.0	11.7
552	B-24	Fly Ash (Sluiced)		100.0	99.8	99.7	92.6	78.0	13.7
343	B-32	Fly Ash (Sluiced)		100.0	97.4	96.1	86.2	79.3	9.6
425	B-37	Fly Ash (Sluiced)	45	100.0	97.4	95.4	91.1	86.4	45.3
582	B-4	Fly Ash (Sluiced)		100.0	97.6	94.5	79.9	72.5	13.9
1051	B-41	Fly Ash (Sluiced)		100.0	99.7	98.9	83.7	67.3	24.4
1478	B-45	Fly Ash (Sluiced)		100.0	91.7	82.3	65.3	41.9	16.6
691	B-20	Gypsum		100.0	100.0	100.0	93.6	87.1	3.9
445	B-35	Gypsum		100.0	99.6	99.5	88.4	81.2	5.1
1033	B-41	Gypsum		100.0	100.0	99.8	97.8	91.6	24.1
1463	B-45	Gypsum		100.0	99.8	99.7	97.7	92.3	21.5
1635		Gypsum							
1634		Gypsum	33	100.0	100.0	92.6	92.6	92.6	6.5






Dike 3
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
B-19
B-22
B-24
B-28
B-32


Gypsum
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
B-20
B-35
B-41
B-45
1634


Fly Ash (Sluiced)
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
B-18
B-19
B-24
B-32
B-37
B-4
B-41
B-45

Laboratory Permeability Summary

				UC Summary Sheet	Permeability		
Lab ID	**Boring**	**Depth (ft)**	**Material Type**	**Visual Description**	**Avg. k (20ºC) (cm/s)**		**Avg. k (20ºC) ft/s**
1262	B-9B	6.0-8.0	Dike 2	Fat Clay with Gravel (CH), red brown, moist, firm	7.00E-08	brown lean clay, 6-6.9	2.29659E-09
1263	B-9B	9.5-11.5	Dike 2	Lean Clay with Gravel (CL), light brown, moist, firm	2.30E-08	brown lean clay, 10.1-10.6	7.54593E-10
1610	B-21B	20.0-22.0	Dike 2	Fat Clay (CH), red brown, moist, firm	1.80E-08	brown lean clay	5.90551E-10
1615	B-29A	17.0-19.0	Dike 2	Gravelly Lean Clay (CL), brown, moist, soft to firm	2.20E-08	brown lean clay	7.21785E-10
1624A	B-37B	11.0-12.4	Dike 2	Lean Clay (CL), brown, moist, firm	1.40E-08	brown lean clay	4.59318E-10
1629	B-19C	20.0-22.0	Dike 3	Sandy Fat Clay (CH), brown, moist, firm	3.20E-08	brown lean clay	1.04987E-09
1605A	B-15B	46.0-48.0	Alluvial Clay	Lean Clay (CL), gray, moist, firm	2.30E-08	brown lean clay	7.54593E-10
1617A	B-29A	50.0-52.0	Alluvial Clay	Fat Clay (CH), brown, moist, firm	6.60E-09	brown lean clay, 50.2-50.7	2.16535E-10
1606B	B-17A	32.0-34.0	Fly Ash (Sluiced)	Silt (ML), black, moist, firm, fly ash	7.00E-07	gray silt - ASH, 32.7-33.2	2.29659E-08
1608	B-17A	70.0-72.0	Fly Ash (Sluiced)	Silt (ML), gray, moist, firm, flyash	6.50E-07	gray silt - ASH, 70-70.5	2.13255E-08
1620	B-36A	44.0-46.0	Fly Ash (Sluiced)	Silt (ML), black, wet, soft, fly ash	6.60E-07	gray silt - ASH, 44.7-45.2	2.16535E-08
1635		Gypsum Bulk	Gypsum		8.10E-08		2.65748E-09
1634		Gypsum Rejects Bulk	Gypsum Rejects		5.30E-07		1.73885E-08
1637		Bottom Ash Bulk	Bottom Ash		2.30E-06		7.54593E-08
1636		Fly Ash Bulk	Fly Ash		4.20E-07		1.37795E-08

	Permeability Summary										
								t_{50} chart from CPT Application Guide			
	CPT	El (ft)	El of Test (ft)	Material Type	k_h (ft/s)	Assumed kh/kv	Assumed kv/kh	**Avg. k_v (20ºC) (cm/s)**	ft/s	**Visual Description**	
	CPT15	430.0	344.1	Alluvial (Clay)	4.30E-09						
	CPT5	380.0	350.7	Alluvial (Clay)	7.50E-08						
	CPT14C	405.0	353.2	FA (Sluiced)/Alluvial (Clay)	6.50E-09						
	CPT16	430.0	343.9	FA (Sluiced)/Alluvial (Clay)	1.70E-08						
	CPT16	430.0	350.4	FA (Sluiced)/Alluvial (Clay)	6.70E-08						
	CPT22	425.0	362.9	FA (Sluiced)/Alluvial (Clay)	7.90E-09						
	CPT26	425.0	368.5	FA/BA (Sluiced)	2.00E-08						
1605A	B-15B		46.0-48.0	Alluvial Clay				2.30E-08	7.54593E-10	Lean Clay (CL), gray, moist, firm	brown lean clay
1617A	B-29A		50.0-52.0	Alluvial Clay				6.60E-09	2.16535E-10	Fat Clay (CH), brown, moist, firm	brown lean clay, 50.2-50.7
					2.82E-08	**58.1650**	**0.0172**	**1.48E-08**	**4.86E-10**		
	CPT3	380.0	367.1	Dike 1	2.80E-09						
	CPT4	380.0	367.8	Dike 1							
	CPT5	380.0	368.4	Dike 1	7.80E-09						
	CPT5	380.0	375.1	Dike 1	2.20E-07						
	CPT6	380.0	367.1	Dike 1	1.40E-07						
1262	B-9B		6.0-8.0	Dike 2				7.00E-08	2.29659E-09	Fat Clay with Gravel (CH), red brown, moist, firm	brown lean clay, 6-6.9
1263	B-9B		9.5-11.5	Dike 2				2.30E-08	7.54593E-10	Lean Clay with Gravel (CL), light brown, moist, firm	brown lean clay, 10.1-10.6
1610	B-21B		20.0-22.0	Dike 2				1.80E-08	5.90551E-10	Fat Clay (CH), red brown, moist, firm	brown lean clay
1615	B-29A		17.0-19.0	Dike 2				2.20E-08	7.21785E-10	Gravelly Lean Clay (CL), brown, moist, soft to firm	brown lean clay
1624A	B-37B		11.0-12.4	Dike 2				1.40E-08	4.59318E-10	Lean Clay (CL), brown, moist, firm	brown lean clay
1629	B-19C		20.0-22.0	Dike 3				3.20E-08	1.04987E-09	Sandy Fat Clay (CH), brown, moist, firm	brown lean clay
					9.27E-08	**94.6583**	**0.0106**	**2.98E-08**	**9.79E-10**		
	CPT14C	405.0	368.9	FA (Sluiced)	2.10E-06						
	CPT14C	405.0	375.9	FA (Sluiced)	4.60E-06						
	CPT14C	405.0	385.3	FA (Sluiced)	7.20E-07						
	CPT15	430.0	370.5	FA (Sluiced)	9.80E-07						
	CPT15	430.0	376.6	FA (Sluiced)	9.40E-07						
	CPT16	430.0	373.0	FA (Sluiced)	1.50E-06						
	CPT16	430.0	378.6	FA (Sluiced)	2.30E-06						
	CPT18	425.0	386.0	FA (Sluiced)	3.70E-06						
	CPT20	425.0	388.7	FA (Sluiced)	4.60E-06						
	CPT22	425.0	372.3	FA (Sluiced)	6.40E-06						
	CPT22	425.0	383.0	FA (Sluiced)	2.10E-06						
	CPT23	425.0	366.0	FA (Sluiced)	4.60E-06						
	CPT23	425.0	370.6	FA (Sluiced)	6.00E-06						
	CPT25	425.0	376.9	FA (Sluiced)	5.30E-06						
	CPT25	425.0	386.2	FA (Sluiced)	9.10E-07						
	CPT25	425.0	390.8	FA (Sluiced)	1.30E-06						
	CPT15	430.0	357.3	FA (Sluiced)/Alluvial (Clay)	2.20E-06						
	CPT18	425.0	376.4	FA (Sluiced)/Alluvial (Clay)	4.30E-06						

Permeability Summary

								t_{50} chart from CPT Application Guide			
	CPT	El (ft)	El of Test (ft)	Material Type	k_h (ft/s)	Assumed kh/kv	Assumed kv/kh	**Avg. k_v (20ºC) (cm/s)**	ft/s	**Visual Description**	
1606B	B-17A		32.0-34.0	Fly Ash (Sluiced)				7.00E-07	2.29659E-08	Silt (ML), black, moist, firm, fly ash	gray silt - ASH, 32.7-33.2
1608	B-17A		70.0-72.0	Fly Ash (Sluiced)				6.50E-07	2.13255E-08	Silt (ML), gray, moist, firm, flyash	gray silt - ASH, 70-70.5
1620	B-36A		44.0-46.0	Fly Ash (Sluiced)				6.60E-07	2.16535E-08	Silt (ML), black, wet, soft, fly ash	gray silt - ASH, 44.7-45.2
	CPT14	405.0	373.2	FA/BA (Sluiced)	2.90E-06						
	CPT14	405.0	386.6	FA/BA (Sluiced)	9.70E-07						
	CPT17	400.0	372.9	FA/BA (Sluiced)	1.00E-06						
	CPT17	400.0	385.1	FA/BA (Sluiced)	2.10E-06						
	CPT26	425.0	371.7	FA/BA (Sluiced)	2.20E-07						
	CPT26	425.0	378.9	FA/BA (Sluiced)	4.60E-06	1.2000	0.8333	3.83E-06	1.25766E-07		
					2.76E-06	**57.6738**	**0.0173**	**1.46E-06**	**4.79E-08**		
	CPT15	430.0	406.4	FA (Stacked)	1.30E-06						
	CPT16	430.0	406.4	FA (Stacked)	8.00E-06			2.20E-05	7.22E-07		
1636			Fly Ash Bulk	Fly Ash				4.20E-07	1.37795E-08		
					4.65E-06	**12.6434**	**0.0791**	**1.12E-05**	**3.68E-07**		
					1.97E-06						
1635			Gypsum Bulk	Gypsum				8.10E-08	2.65748E-09		
1634			Gypsum Rejects Bulk	Gypsum Rejects				5.30E-07	1.73885E-08		
1637			Bottom Ash Bulk	Bottom Ash				2.30E-06	7.54593E-08		
								6.80E-02	0.002230971		

CPT Hydraulic Conductivity
SCPTu Dissipation Results
Coefficient of Consolidation

CPT	El (ft)	SCPTu El (ft)	GW El (ft)	Depth of Test (ft)	El of Test (ft)	Material Type	Push Pore Pressure (psi)	Static GW Pressure (psi)	Pore Pressure, U_{50} (psi)	t_{50} (min)	c_h (in^2/min)	k_h (ft/s)	Assumed kh/kv	
CPT15	430.0	425.5	395.0	85.9	344.1	Alluvial (Clay)	86.2	22.0	54.1	25.23	3.40E-02	4.30E-09		t_{50} chart from CPT Application Gui
CPT5	380.0	380.0	370.0	29.3	350.7	Alluvial (Clay)	33.3	23.5	28.4	1.72	5.30E-01	7.50E-08		
CPT3	380.0	380.0	380.0	12.9	367.1	Dike 1	42.5	5.6	24.0	37.50	2.30E-02	2.80E-09		
CPT4	380.0	380.0	365.0	12.2	367.8	Dike 1	42.5	0.0	21.2					
CPT5	380.0	380.0	370.0	11.6	368.4	Dike 1	56.5	34.1	45.3	14.40	6.10E-02	7.80E-09		
CPT5	380.0	380.0	370.0	4.9	375.1	Dike 1	10.4	0.0	5.2	0.64	1.40E+00	2.20E-07		
CPT6	380.0	380.0	350.0	12.9	367.1	Dike 1	2.0	0.0	1.0	0.94	9.70E-01	1.40E-07		
CPT14C	405.0	396.0	395.0	36.1	368.9	FA (Sluiced)	36.0	11.3	23.7	0.08	1.20E+01	2.10E-06		
CPT14C	405.0	396.0	395.0	29.1	375.9	FA (Sluiced)	26.0	8.3	17.1	0.04	2.60E+01	4.60E-06		
CPT14C	405.0	396.0	395.0	19.7	385.3	FA (Sluiced)	32.0	4.2	18.1	0.21	4.50E+00	7.20E-07		
CPT15	430.0	425.5	395.0	59.5	370.5	FA (Sluiced)	61.2	10.6	35.9	0.16	6.10E+00	9.80E-07		
CPT15	430.0	425.5	395.0	53.4	376.6	FA (Sluiced)	62.3	8.0	35.1	0.16	5.80E+00	9.40E-07		
CPT16	430.0	386.1	395.0	57.0	373.0	FA (Sluiced)	75.6	9.5	42.6	0.11	8.80E+00	1.50E-06		
CPT16	430.0	386.1	395.0	51.4	378.6	FA (Sluiced)	62.5	7.1	34.8	0.07	1.40E+01	2.30E-06		
CPT18	425.0	395.0	395.0	39.0	386.0	FA (Sluiced)	24.9	3.9	14.4	0.05	2.10E+01	3.70E-06		
CPT20	425.0	425.0	400.0	36.3	388.7	FA (Sluiced)	32.0	4.9	21.5	0.04	2.60E+01	4.60E-06		
CPT22	425.0	386.5	396.5	52.7	372.3	FA (Sluiced)	24.5	10.5	17.5	0.03	3.60E+01	6.40E-06		
CPT22	425.0	386.5	396.5	42.0	383.0	FA (Sluiced)	12.5	5.8	9.2	0.08	1.30E+01	2.10E-06		
CPT23	425.0	382.8	384.5	59.0	366.0	FA (Sluiced)	24.0	8.0	16.0	0.04	2.60E+01	4.60E-06		
CPT23	425.0	382.8	384.5	54.4	370.6	FA (Sluiced)	32.0	6.0	11.5	0.03	3.40E+01	6.00E-06		
CPT25	425.0	425.0	399.0	48.1	376.9	FA (Sluiced)	49.0	9.6	29.3	0.03	3.00E+01	5.30E-06		
CPT25	425.0	425.0	399.0	38.8	386.2	FA (Sluiced)	49.3	5.5	27.4	0.17	5.60E+00	9.10E-07		
CPT25	425.0	425.0	399.0	34.2	390.8	FA (Sluiced)	38.9	3.5	21.2	0.12	8.10E+00	1.30E-06		
CPT14C	405.0	396.0	395.0	51.8	353.2	FA (Sluiced)/Alluvial (Clay)	82.0	18.1	50.1	17.08	5.20E-02	6.50E-09		
CPT15	430.0	425.5	395.0	72.7	357.3	FA (Sluiced)/Alluvial (Clay)	49.1	16.3	32.7	0.07	1.30E+01	2.20E-06		
CPT16	430.0	386.1	395.0	86.1	343.9	FA (Sluiced)/Alluvial (Clay)	105.4	22.1	63.8	7.05	1.30E-01	1.70E-08		
CPT16	430.0	386.1	395.0	79.6	350.4	FA (Sluiced)/Alluvial (Clay)	87.6	19.3	53.5	1.92	4.70E-01	6.70E-08		
CPT18	425.0	395.0	395.0	48.6	376.4	FA (Sluiced)/Alluvial (Clay)	24.0	8.0	16.0	0.04	2.40E+01	4.30E-06		
CPT22	425.0	386.5	396.5	62.1	362.9	FA (Sluiced)/Alluvial (Clay)	77.7	14.6	46.1	14.25	6.20E-02	7.90E-09		
CPT15	430.0	425.5	395.0	23.6	406.4	FA (Stacked)	30.0	13.5	21.7	0.12	8.10E+00	1.30E-06		
CPT16	430.0	386.1	395.0	23.6	406.4	FA (Stacked)	34.0	18.4	26.2	0.02	4.40E+01	8.00E-06		
CPT14	405.0	405.0	389.0	31.8	373.2	FA/BA (Sluiced)	16.0	6.9	11.4	0.06	1.70E+01	2.90E-06		
CPT14	405.0	405.0	389.0	18.4	386.6	FA/BA (Sluiced)	18.0	1.0	9.5	0.16	6.00E+00	9.70E-07		
CPT17	400.0	390.5	385.0	27.1	372.9	FA/BA (Sluiced)	45.0	5.3	25.1	0.15	6.30E+00	1.00E-06		
CPT17	400.0	390.5	385.0	14.9	385.1	FA/BA (Sluiced)	15.3	0.0	7.6	0.08	1.30E+01	2.10E-06		
CPT26	425.0	382.5	399.0	56.5	368.5	FA/BA (Sluiced)	96.6	13.2	54.9	6.05	1.50E+01	2.00E-08		
CPT26	425.0	382.5	399.0	53.3	371.7	FA/BA (Sluiced)	59.2	11.8	35.5	0.63	1.40E+00	2.20E-07		
CPT26	425.0	382.5	399.0	46.1	378.9	FA/BA (Sluiced)	31.2	8.7	20.0	0.04	2.60E+01	4.60E-06	1.2	

Critical Gradient

Boring	Depth (ft)	Material Type	CU Triaxial G_s	e_0	i_{crit}
B-29A	29.0-31.0	Dike 1	2.7	0.646	1.03
B-29A	29.0-31.0	Dike 1	2.7	0.595	1.07
B-6	24.0-34.5	Dike 1	2.68		
B-8	1.5-19.5	Dike 1	2.64		
			2.66	0.6205	1.02
B-29B	12.0-13.4	Dike 2	2.7	0.675	1.01
B-29B	12.0-13.4	Dike 2	2.7	0.507	1.13
B-29B	14.5-16.5	Dike 2	2.7	0.466	1.16
B-6	0.0-10.0	Dike 2	2.55		
B-9	0.0-6.0	Dike 2	2.70		
B-9	9.0-12.0	Dike 2	2.68		
B-12	15.0	Dike 2	2.77		
B-21	0.0-9.0	Dike 2	2.81		
B-21	12.0-18.0	Dike 2	2.78		
B-25	10.5-18.0	Dike 2	2.54		
B-29	0.3-10.0	Dike 2	2.58		
B-29	10.4-14.5	Dike 2	2.57		
B-37	6.0-14.5	Dike 2	2.61		
			2.66	0.549333	1.07
B-19C	17.5-19.5	Dike 3	2.7	0.547	1.10
B-19C		Dike 3	2.7	0.687	1.01
B-19C	10.5-12.5	Dike 3	2.7	0.633	1.04
B-19	7.5-25.5	Dike 3	2.78		
B-22	6.0-13.5, …	Dike 3	2.72		
B-24	4.5-22.5	Dike 3	2.51		
B-28	1.5-15.0	Dike 3	2.66		
B-32	1.5-16.5	Dike 3	2.63		
			2.66	0.622333	1.02
B-43A	50.0-52.0	Alluvial Clay	2.67	0.657	1.01
B-43A	50.0-52.0	Alluvial Clay	2.67	0.677	1.00
B-2	55.0-69.0	Alluvial Clay	2.56		
B-4	43.5-56.5	Alluvial Clay	2.53		
B-6	36.0-44.0	Alluvial Clay	2.55		
B-11	15.0-36.0	Alluvial Clay	2.66		
B-12	35.0-46.5	Alluvial Clay	2.64		
B-33	30.0-39.0	Alluvial Clay	2.62		
			2.61	0.667	0.97
B-12	60.0-69.0	Alluvial Granular	2.62		
B-14	40.0-49.0	Alluvial Granular	2.70		
B-14	52.5-64.0	Alluvial Granular	2.70		
B-22	75.0-89.0	Alluvial Granular	2.66		
B-43A	29.0-31.0	Fly Ash (Sluiced)	2.47	1.134	0.69
B-43A	29.0-31.0	Fly Ash (Sluiced)	2.47	1.262	0.65
B-35A	46.0-48.0	Fly Ash (Sluiced)	2.47	1.174	0.68
B-18	15.0-34.5	Fly Ash (Sluiced)	2.58		
B-19	28.5-49.0	Fly Ash (Sluiced)	2.46		

$$i_{crit} = \frac{\gamma_{sub}}{\gamma_w} = \frac{G_s - 1}{1 + e}$$

$$FS_{piping} = \frac{i_{crit}}{i}$$

Critical Gradient

Boring	Depth (ft)	Material Type	CU Triaxial		
			G_s	e_0	i_{crit}
B-24	27.0-51.5	Fly Ash (Sluiced)	2.44		
B-32	20.0-49.0	Fly Ash (Sluiced)	2.52		
B-37	7.5-21.0	Fly Ash (Sluiced)	2.62		
B-4	1.5-31.5	Fly Ash (Sluiced)	2.42		
B-41	24.0-34.5	Fly Ash (Sluiced)	2.52		
B-45	25.0-39.6	Fly Ash (Sluiced)	2.71		
			2.52	1.19	0.69
B-2	4.5-39.0	BA-FA (Sluiced)	2.62		
B-18	0.0-7.5	BA-FA (Sluiced)	2.61		
B-21	18.0-30.0	BA-FA (Sluiced)	2.61		
B-22	28.5-49.5	BA-FA (Sluiced)	2.55		
B-20	0.0-15.0	Gypsum	2.31		
B-35	1.5-22.5	Gypsum	2.94		
B-41	0.0-12.9	Gypsum	2.31		
B-45	3.0-9.0	Gypsum	2.36		
	Gypsum Rejects Bulk	Gypsum Rejects	2.73		
	Gypsum Rejects Bulk	Gypsum Rejects	2.7	1.08	0.82
			2.5	0.947	0.77
			2.7	1.1	0.81
	Bulk	Gypsum Rejects	2.7	1.09	0.81
	Bottom Ash Bulk	Bottom Ash	2.7	0.923	0.88
			2.7	0.913	0.89
	Bulk	Fly Ash	2.5	1.37	0.63
			2.5	1.36	0.64
	Fly Ash Bulk		2.5	1.37	0.63
			2.5	1.36	0.64

▨ Indicates laboratory-assumed values.

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

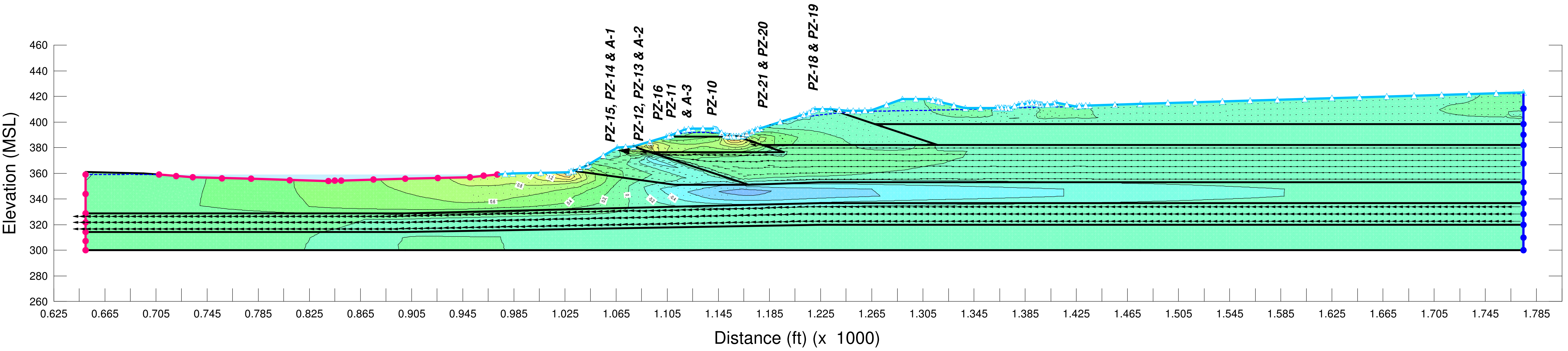
Stantec

File Name: Section H.gsz
Analysis Name: Steady-State Seepage
Date Saved: 10/30/2009
Last Solved on 10/30/2009 at 11:17:44 AM
Analysis Method: Steady-State

Material Type

Dike 1 (Clay)	Saturated / Unsaturated	Dike 1 (Clay)	Dike 1 (Clay)	0.1	0 °
Dike 2 (Lean Clay)	Saturated / Unsaturated	Dike 2 (Lean Clay)	Dike 2 (Lean Clay)	0.1	0 °
Dike 3 (Clay)	Saturated / Unsaturated	Dike 3 (Clay)	Dike 3 (Clay)	0.1	0 °
Alluvial (Clay)	Saturated / Unsaturated	Alluvial (Clay)	Alluival (Clay)	0.05	0 °
Alluvial (Granular)	Saturated / Unsaturated	Alluvial (Granular)	Alluvial (Granular)	0.05	0 °
Gypsum	Saturated / Unsaturated	Gypsum	Gypsum	0.02	0 °
Fly Ash (Stacked and/or Sluiced)	Saturated / Unsaturated	Fly Ash (Stacked and/or Sluiced)	Fly Ash (Stacked and/or Sluiced)	0.02	0 °
Fly Ash / Bottom Ash (Sluiced)	Saturated / Unsaturated	Fly Ash/Bottom Ash (Sluiced)	Fly Ash/Bottom Ash (Sluiced)	0.02	0 °
Dike 2 (Fat Clay)	Saturated / Unsaturated	Dike 2 (Fat Clay)	Dike 2 (Fat Clay)	0.1	0 °
Bedrock	Saturated Only	1e-012 ft/sec	0.05 ft³/ft³	0 /psf	0.1 0 °

Seepage - Y Gradient



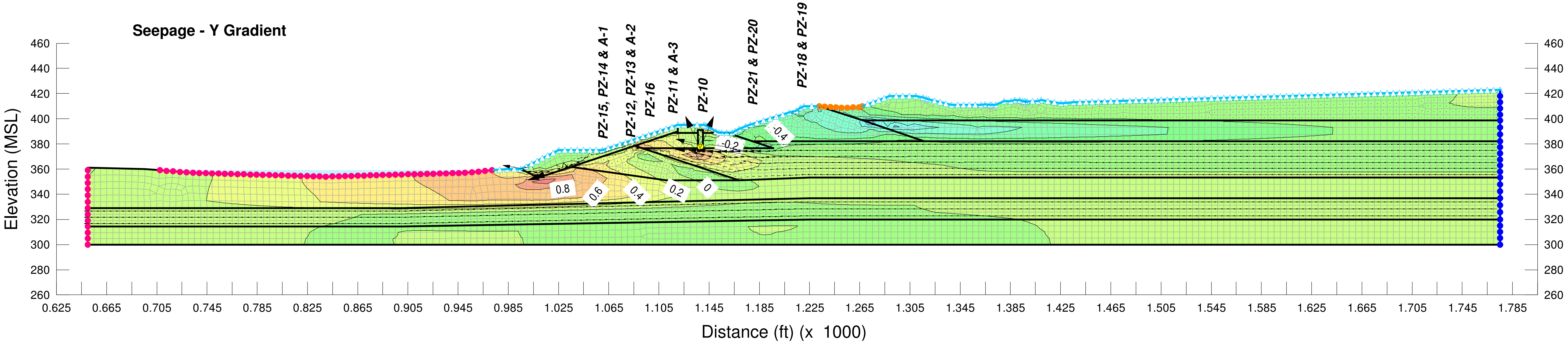
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

Stantec

File Name: Section H (Stability - Repair Design).gsz
Analysis Name: Steady-State Seepage
Date Saved: 11/2/2009
Last Solved on 11/2/2009 at 1:58:04 PM
Analysis Method: Steady-State

Material Type

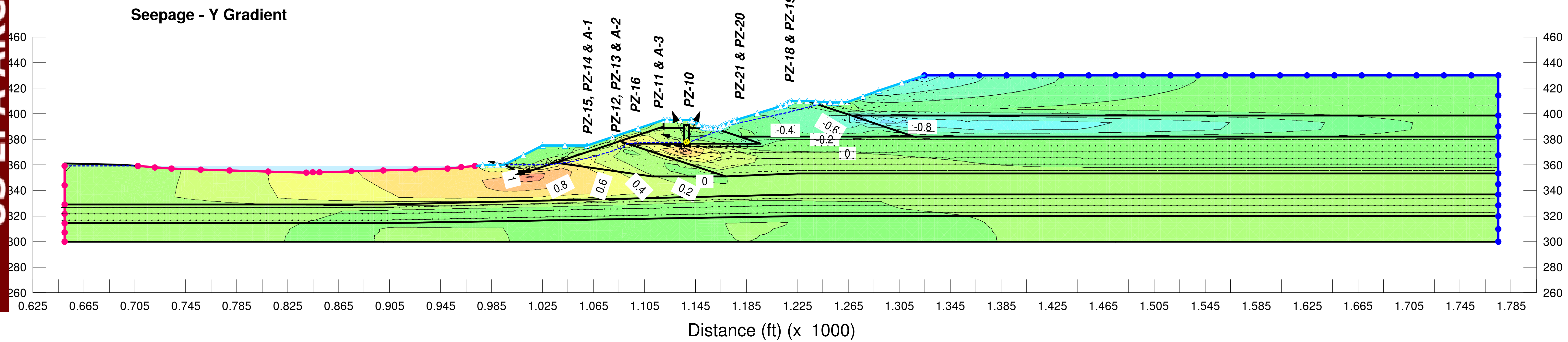
Dike 1 (Clay)	Saturated / Unsaturated	Dike 1 (Clay)	Dike 1 (Clay)	0.1	0 °	
Dike 2 (Lean Clay)	Saturated / Unsaturated	Dike 2 (Lean Clay)	Dike 2 (Lean Clay)	0.1	0 °	
Dike 3 (Clay)	Saturated / Unsaturated	Dike 3 (Clay)	Dike 3 (Clay)	0.1	0 °	
Alluvial (Clay)	Saturated / Unsaturated	Alluvial (Clay)	Alluival (Clay)	0.05	0 °	
Alluvial (Granular)	Saturated / Unsaturated	Alluvial (Granular)	Alluvial (Granular)	0.05	0 °	
Gypsum	Saturated / Unsaturated	Gypsum	Gypsum	0.02	0 °	
Fly Ash (Stacked and/or Sluiced)	Saturated / Unsaturated	Fly Ash (Stacked and/or Sluiced)	Fly Ash (Stacked and/or Sluiced)	0.02	0 °	
Fly Ash / Bottom Ash (Sluiced)	Saturated / Unsaturated	Fly Ash/Bottom Ash (Sluiced)	Fly Ash/Bottom Ash (Sluiced)	0.02	0 °	
Dike 2 (Fat Clay)	Saturated / Unsaturated	Dike 2 (Fat Clay)	Dike 2 (Fat Clay)	0.1	0 °	
Toe Buttress (Rip Rap)	Saturated / Unsaturated	Rip Rap	Rip Rap	0.5	0 °	
Drainage Trench (Gravel)	Saturated / Unsaturated	Gravel	Gravel	0.1	0 °	
Bedrock	Saturated Only	1e-012 ft/sec	0.05 ft³/ft³	0 /psf	0.1	0 °



SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

File Name: Section H (StabRepDgn-Buildout 430)2.gsz
Analysis Name: Steady-State Seepage
Date Saved: 11/2/2009
Last Solved on 11/2/2009 at 1:02:44 PM
Analysis Method: Steady-State

Material Type
Dike 1 (Clay) Saturated / Unsaturated Dike 1 (Clay) Dike 1 (Clay) 0.1 0 °
Dike 2 (Lean Clay) Saturated / Unsaturated Dike 2 (Lean Clay) Dike 2 (Lean Clay) 0.1 0 °
Dike 3 (Clay) Saturated / Unsaturated Dike 3 (Clay) Dike 3 (Clay) 0.1 0 °
Alluvial (Clay) Saturated / Unsaturated Alluvial (Clay) Alluvial (Clay) 0.05 0 °
Alluvial (Granular) Saturated / Unsaturated Alluvial (Granular) Alluvial (Granular) 0.05 0 °
Gypsum Saturated / Unsaturated Gypsum Gypsum 0.02 0 °
Fly Ash (Stacked and/or Sluiced) Saturated / Unsaturated Fly Ash (Stacked and/or Sluiced) Fly Ash (Stacked and/or Sluiced) 0.02 0 °
Fly Ash / Bottom Ash (Sluiced) Saturated / Unsaturated Fly Ash/Bottom Ash (Sluiced) Fly Ash/Bottom Ash (Sluiced) 0.02 0 °
Dike 2 (Fat Clay) Saturated / Unsaturated Dike 2 (Fat Clay) Dike 2 (Fat Clay) 0.1 0 °
Toe Buttress (Rip Rap) Saturated / Unsaturated Rip Rap Rip Rap 0.5 0 °
Drainage Trench (Gravel) Saturated / Unsaturated Gravel Gravel 0.1 0 °
Bedrock Saturated Only 1e-012 ft/sec 0.05 ft³/ft³ 0 /psf 0.1 0 °



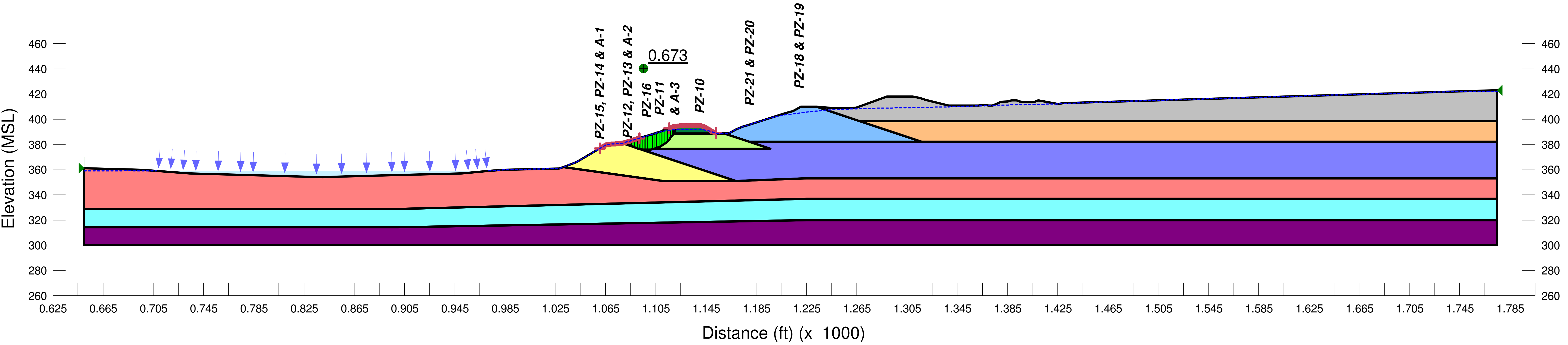
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

Stantec

File Name: Section H.gsz
Analysis Name: Stability - Existing Condition with Existing PZ Levels
Date Saved: 10/30/2009
Last Solved on 10/30/2009 at 11:20:56 AM
Analysis Method: Spencer

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Stacked and/or Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Bedrock			

Calculated Factor of Safety: 0.673



Stability - Existing Condition with Existing PZ Levels

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File Information

Created By: Kirkbride, Rob
Revision Number: 331
Last Edited By: Harmon, Jacqueline
Date: 11/2/2009
Time: 1:58:24 PM
File Name: Section H (Stability - Repair Design).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 11/2/2009
Last Solved Time: 2:01:28 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Parent: Steady-State Seepage
Method: Spencer
Settings
  PWP Conditions Source: Parent Analysis
SlipSurface
  Direction of movement: Right to Left
  Use Passive Mode: No
  Slip Surface Option: Entry and Exit
  Critical slip surfaces saved: 1
  Optimize Critical Slip Surface Location: Yes
  Tension Crack
    Tension Crack Option: (none)

FOS Distribution

FOS Calculation Option: Constant

Advanced

Number of Slices: 30

Optimization Tolerance: 0.01

Minimum Slip Surface Depth: 10 ft

Optimization Maximum Iterations: 5000

Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8

Ending Optimization Points: 16

Complete Passes per Insertion: 1

Driving Side Maximum Convex Angle: 5 °

Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb

Unit Weight: 124 pcf

Cohesion: 100 psf

Phi: 25 °

Phi-B: 0 °

Dike 2 (Lean Clay)

Model: Mohr-Coulomb

Unit Weight: 128 pcf

Cohesion: 100 psf

Phi: 28 °

Phi-B: 0 °

Dike 3 (Clay)

Model: Mohr-Coulomb

Unit Weight: 126 pcf

Cohesion: 50 psf

Phi: 30 °

Phi-B: 0 °

Alluvial (Clay)

Model: Mohr-Coulomb

Unit Weight: 121 pcf

Cohesion: 200 psf

Phi: 30 °

Phi-B: 0 °

Alluvial (Granular)

Model: Mohr-Coulomb

Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °

Fly Ash (Stacked and/or Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °

Toe Buttress (Rip Rap)

Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °

Drainage Trench (Gravel)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °

Bedrock

Model: Bedrock (Impenetrable)

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (893, 355.4891) ft
Left-Zone Right Coordinate: (932, 356.4905) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (1105, 390) ft
Right-Zone Right Coordinate: (1146, 392.7181) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (650, 361.0346) ft
Right Coordinate: (1775, 423) ft

Regions

	Material	Points	Area (ft²)
Region 1	Alluvial (Clay)	98,1,2,32,3,117,111,112,113,6,83,7,8,90,89,88,87,86,85,84,94,91,80,10,11,99	23170.811
Region 2	Alluvial (Granular)	100,99,11,10,80,91,92,9,12,13	18041.479
Region 3	Fly Ash (Stacked and/or Sluiced)	97,96,28,29,30,31	7878.8292
Region 4	Fly Ash / Botto	30,14,27,123,125,124,122,26,32,2,1,98,97,31	18513.972

	m Ash (Sluiced)		
Region 5	Dike 3 (Clay)	29,30,14,82,15,33,34,35,36,37,38,39,40,41,42,43	2464.0352
Region 6	Gypsum	96,95,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,129,69,70,71,42,43,29,28	9366.1015
Region 7	Dike 1 (Clay)	26,118,117,3,32	1707.8902
Region 8	Bedrock	9,92,93,75,76,101,100,13,12	20133.643
Region 9	Dike 2 (Lean Clay)	26,118,119,126,122	449.02152
Region 10	Dike 2 (Fat Clay)	82,15,16,77,17,18,19,20,21,22,116,110,119,126,120,121,127	164.07778
Region 11	Drainage Trench (Gravel)	127,121,120,126,122,124,125,123	65.48
Region 12	Dike 2 (Lean Clay)	127,123,27,14,82	461.38125
Region 13	Toe Buttress (Rip Rap)	111,112,113,114,115,116,110,119,118,117	1012.5

Points

	X (ft)	Y (ft)
Point 1	1475	353.19
Point 2	1225.0651	353.19
Point 3	1111.0025	351.03
Point 4	1031.6471	362.1655
Point 5	1028.0434	361.0017
Point 6	984.1443	359.9523
Point 7	950.6064	356.9591
Point 8	900	355.6847
Point 9	900	314.2811
Point 10	1225.0651	336.79
Point 11	1475	336.79
Point 12	1225.0651	319.99
Point 13	1475	319.99
Point 14	1179.475	382.19
Point 15	1159.0394	389.0012
Point 16	1154.7809	389.0017
Point 17	1150.4833	390.0017
Point 18	1144.3259	393.7324
Point 19	1143.197	394.2883
Point 20	1142.3686	394.55
Point 21	1140.9385	395.0017
Point 22	1124.8971	395.0017
Point 23	1118.2614	393.9807
Point 24	1108.1233	390.0017
Point 25	1078.7109	381.0017
Point 26	1091.7416	376.63
Point 27	1196.1567	376.63
Point 28	1475	398.5017
Point 29	1267.513	398.5017
Point 30	1316.4529	382.19
Point 31	1475	382.19
Point 32	1168.7329	351.03
Point 33	1163.2539	389.0017

Point 34	1165.7562	390.3163
Point 35	1168.9831	392.0017
Point 36	1174	394
Point 37	1177.9093	395.2996
Point 38	1208.8534	405.0017
Point 39	1214.4744	406.4996
Point 40	1217.7547	408.7126
Point 41	1220.5864	410.0017
Point 42	1232.7632	410.0017
Point 43	1233.6482	409.7888
Point 44	1475	414.1588
Point 45	1435.4684	413.0017
Point 46	1429.0876	412.5892
Point 47	1425.1901	412.2142
Point 48	1409.6758	415.0017
Point 49	1406.7021	414.0017
Point 50	1398.3521	413.7404
Point 51	1397.2875	413.4962
Point 52	1396.5743	414.0072
Point 53	1394.6161	414.0679
Point 54	1392.5046	415.0017
Point 55	1388.3079	415.0017
Point 56	1385.3407	414.0565
Point 57	1379.8252	413.9558
Point 58	1373.1553	411.0017
Point 59	1369.9178	411.0017
Point 60	1368.4737	411.2319
Point 61	1364.6893	411.2664
Point 62	1361.7463	411.0017
Point 63	1338.2008	411.0017
Point 64	1319.8195	415.397
Point 65	1317.9669	416.0017
Point 66	1315.4368	417.0017
Point 67	1309.737	418.0017
Point 68	1288.8897	418.0017
Point 69	1264.4456	409.0513

Point 70	1255.0277	408.8585
Point 71	1246.0502	408.9271
Point 72	1065.8502	380.0017
Point 73	1043.7085	367.0614
Point 74	1041.6113	366.0017
Point 75	900	300
Point 76	1475	300
Point 77	1153	389
Point 78	1170	390
Point 79	1249	405
Point 80	900	329
Point 81	1104.3302	388.8067
Point 82	1159.6	388.8143
Point 83	971.8829	359
Point 84	650	361.0346
Point 85	695.2744	359.9523
Point 86	707.5358	359
Point 87	733.8123	356.9591
Point 88	779.4187	355.6847
Point 89	839.7094	354
Point 90	850	354.2876
Point 91	650	329
Point 92	650	314.2811
Point 93	650	300
Point 94	650	359
Point 95	1775	423
Point 96	1775	398.5017
Point 97	1775	382.19
Point 98	1775	353.19
Point 99	1775	336.79
Point 100	1775	319.99
Point 101	1775	300
Point 102	945.6064	356.9591
Point 103	1173.3768	393.9777
Point 104	1187.3669	398.1315
Point 105	1197.7316	401.4796

Point 106	1204.1501	403.553
Point 107	1211.6339	405.7426
Point 108	1457.2701	413.6006
Point 109	1475	405
Point 110	1120	390
Point 111	1015	355
Point 112	1005	355
Point 113	995	360
Point 114	1025	375
Point 115	1060	375
Point 116	1120	395
Point 117	1035.1	361.7
Point 118	1085.8	378.6
Point 119	1116.4	388.8
Point 120	1136	391
Point 121	1140	391
Point 122	1136	376.63
Point 123	1140	376.63
Point 124	1136	374.63
Point 125	1140	374.63
Point 126	1136	388.8
Point 127	1140	388.8
Point 128	1138	378
Point 129	1267.0366	410

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.588	(1003.87, 494.422)	99.57434	(1134.2, 395.002)	(917.198, 356.118)
2	27636	1.623	(1003.87, 494.422)	165.306	(1135.94, 395.002)	(913.475, 356.024)

Slices of Slip Surface: **Optimized**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal	Frictional Strength	Cohesive

					Stress (psf)	(psf)	Strength (psf)
1	Optimized	921.67365	353.9729	402.98211	615.61562	122.76401	200
2	Optimized	930.6248	349.68315	856.9213	1225.0656	212.54821	200
3	Optimized	940.48255	345.24795	1334.0263	1811.3557	275.58627	200
4	Optimized	948.23555	342.03475	1685.7406	2226.8874	312.43126	200
5	Optimized	955.92585	339.04125	2019.8853	2669.034	374.78619	200
6	Optimized	966.5641	335.2235	2455.2573	3182.162	419.67866	200
7	Optimized	975.7414	332.20895	2806.0991	3656.3128	490.87109	200
8	Optimized	981.8721	330.56405	2987.6219	3716.1301	455.22248	0
9	Optimized	986.8582	329.73575	3056.3971	3860.0713	502.19134	0
10	Optimized	992.28605	328.8341	3131.2759	3991.2908	537.39698	0
11	Optimized	997.613	327.94925	3204.773	4361.7533	722.96151	0
12	Optimized	1002.613	327.5698	3246.1876	4614.2268	854.84576	0
13	Optimized	1006.5885	327.6607	3254.9416	4917.1867	1038.686	0
14	Optimized	1011.5885	328.33325	3232.1694	4956.022	1077.1826	0
15	Optimized	1016.87	329.31825	3191.1401	5176.5339	1240.6118	0
16	Optimized	1021.87	330.75235	3121.8528	5072.9919	1219.207	0
17	Optimized	1025.2445	331.9225	3062.6833	5109.8829	1279.2323	0
18	Optimiz	1030.294	333.6736	2910.0082	4870.493	1131.8869	200

	ed	5			7		
19	Optimized	1035.919	335.62385	2738.9547	4618.539	1085.1785	200
20	Optimized	1039.63	336.8633	2632.8689	4483.0019	1068.1748	200
21	Optimized	1045.414	338.77425	2471.6595	4240.3669	1021.1637	200
22	Optimized	1051.2295	340.55155	2328.02	4072.7179	1007.3018	200
23	Optimized	1057.0765	342.19525	2204.5394	3858.3556	954.83122	200
24	Optimized	1063.4225	343.9792	2076.6133	3772.3877	979.05576	200
25	Optimized	1070.866	346.47935	1899.5115	3651.9775	1011.7867	200
26	Optimized	1077.615	349.428	1689.4424	3423.3268	1001.0586	200
27	Optimized	1083.0715	352.2492	1495.6563	3307.7453	1046.2101	200
28	Optimized	1086.4945	354.01875	1382.9481	3237.8399	1070.9223	200
29	Optimized	1089.4655	355.5547	1302.6131	3241.7542	904.23631	100
30	Optimized	1094.488	358.1514	1177.7742	3123.2845	907.20633	100
31	Optimized	1100.1385	361.5325	1026.5245	2789.523	822.09972	100
32	Optimized	1105.948	365.45525	864.35985	2542.0251	782.30814	100
33	Optimized	1110.2955	368.6989	740.16422	2188.7802	675.50073	100
34	Optimized	1114.069	372.0538	495.96699	2056.7378	630.59235	0
35	Optimized	1117.862	375.42625	192.69328	1878.8573	681.25447	0
36	Optimized	1119.662	377.14145	37.636171	1477.7902	765.74348	100
37	Optimiz	1122.448	380.5656	-	1151.445	612.23441	100

	ed	5	5	223.87033	5		
38	Optimized	1127.0235	386.18725	-602.48287	684.26855	363.83204	100
39	Optimized	1131.673	391.90085	-940.19062	182.18499	62.731323	200

Slices of Slip Surface: **27636**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	27636	917.18795	353.7361	420.99734	702.2469	162.37951	200
2	27636	924.61425	349.4186	871.33788	1295.711	245.01194	200
3	27636	932.04055	345.5968	1276.3597	1796.1201	300.08378	200
4	27636	939.4669	342.2332	1637.7795	2218.6351	335.35711	200
5	27636	946.89325	339.2979	1960.9511	2572.9741	353.35166	200
6	27636	954.1525	336.8153	2241.0445	2881.5158	369.77628	200
7	27636	961.24465	334.7499	2481.4173	3147.3063	384.45118	200
8	27636	968.3368	333.02245	2688.9157	3365.5855	390.67551	200
9	27636	975.7444	331.5747	2871.6346	3562.6847	398.97795	200
10	27636	981.8751	330.603	2985.2708	3680.8149	434.62418	0
11	27636	989.57215	329.8267	3060.7712	3771.8187	444.31178	0
12	27636	1000	329.23785	3134.7379	4224.9381	681.23269	0
13	27636	1010	329.30615	3167.0211	4927.1101	1099.8257	0
14	27636	1020	329.98205	3162.1281	5426.5633	1414.9762	0
15	27636	1030.05	331.2827	3119.3086	5441.2911	1450.9357	0
16	27636	1035.5225	332.1754	3084.7115	5242.569	1348.379	0
17	27636	1039.954	333.1548	3009.0213	5060.1068	1184.1947	200
18	27636	1047.9725	335.16195	2846.9565	4715.561	1078.8393	200
19	27636	1055.991	337.60455	2648.9942	4329.7795	970.40181	200
20	27636	1064.3	340.6265	2406.0629	4059.8524	954.81581	200
21	27636	1072.9	344.29305	2121.7112	3887.0746	1019.2331	200
22	27636	1081.5	348.5585	1808.2466	3643.6949	1059.6966	200
23	27636	1088.3345	352.3536	1549.8088	3411.1768	1074.6613	200
24	27636	1091.3055	354.1323	1438.623	3373.3799	902.19195	100
25	27636	1095.189	356.68975	1298.972	3178.099	876.25134	100
26	27636	1102.083	361.5226	1058.8122	2800.9231	812.35967	100
27	27636	1108.9775	366.9114	826.33075	2377.286	723.22233	100

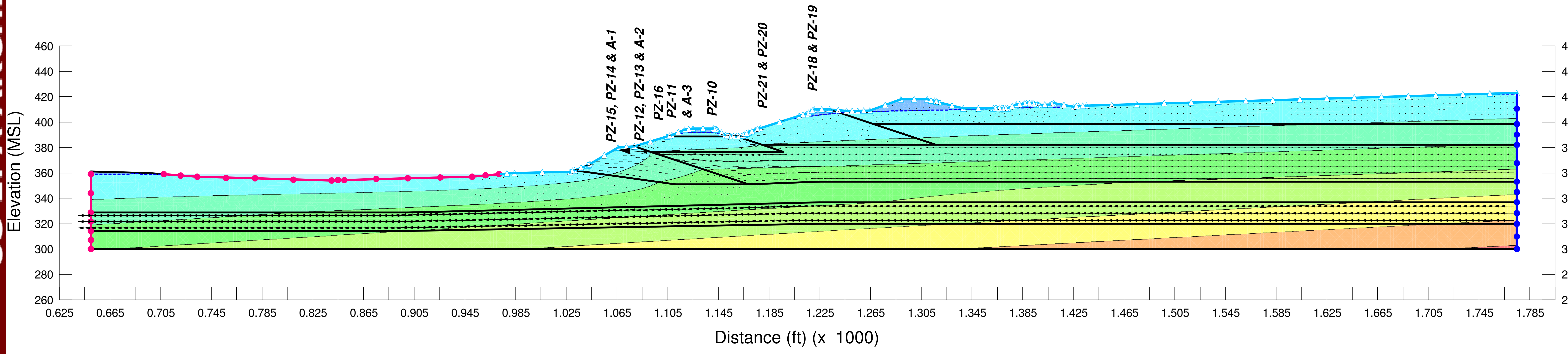
28	27636	1114.4125	371.54085	543.04996	2109.6999	632.96767	0
29	27636	1118.2	375.05285	227.11069	1888.8444	671.38398	0
30	27636	1122.4485	379.2988	-124.98329	1353.0029	719.40442	100
31	27636	1127.9655	385.3104	-533.83772	786.54228	418.21195	100
32	27636	1133.4865	391.90085	-919.31102	179.88609	61.939749	200

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

Stantec

File Name: Section H.gsz
Analysis Name: Steady-State Seepage
Date Saved: 10/30/2009
Last Solved on 10/30/2009 at 11:17:44 AM
Analysis Method: Steady-State

Material Type
Dike 1 (Clay) Saturated / Unsaturated Dike 1 (Clay) Dike 1 (Clay) 0.1 0 °
Dike 2 (Lean Clay) Saturated / Unsaturated Dike 2 (Lean Clay) Dike 2 (Lean Clay) 0.1 0 °
Dike 3 (Clay) Saturated / Unsaturated Dike 3 (Clay) Dike 3 (Clay) 0.1 0 °
Alluvial (Clay) Saturated / Unsaturated Alluvial (Clay) Alluival (Clay) 0.05 0 °
Alluvial (Granular) Saturated / Unsaturated Alluvial (Granular) Alluvial (Granular) 0.05 0 °
Gypsum Saturated / Unsaturated Gypsum Gypsum 0.02 0 °
Fly Ash (Stacked and/or Sluiced) Saturated / Unsaturated Fly Ash (Stacked and/or Sluiced) Fly Ash (Stacked and/or Sluiced) 0.02 0 °
Fly Ash / Bottom Ash (Sluiced) Saturated / Unsaturated Fly Ash/Bottom Ash (Sluiced) Fly Ash/Bottom Ash (Sluiced) 0.02 0 °
Dike 2 (Fat Clay) Saturated / Unsaturated Dike 2 (Fat Clay) Dike 2 (Fat Clay) 0.1 0 °
Bedrock Saturated Only 1e-012 ft/sec 0.05 ft³/ft³ 0 /psf 0.1 0 °



Steady-State Seepage

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File Information

Created By: Kirkbride, Rob
Revision Number: 330
Last Edited By: Harmon, Jacqueline
Date: 11/2/2009
Time: 1:54:16 PM
File Name: Section H (Stability - Repair Design).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\Seepage\
Last Solved Date: 11/2/2009
Last Solved Time: 1:58:05 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Mass(M) Units: lbs
Mass Flux Units: lbs/sec
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Steady-State Seepage

- Kind: SEEP/W
- Method: Steady-State
- Settings
  - Include Air Flow: No
- Control
  - Apply Runoff: Yes
- Convergence
  - Convergence Type: Gauss Point K
  - Convergence Settings
    - Maximum Number of Iterations: 500
    - Tolerance: 0.01
    - Maximum Change in K: 0.1
    - Rate of Change in K: 1.02
    - Minimum Change in K: 0.0001
  - Equation Solver: Parallel Direct

Potential Seepage Max # of Reviews: 10

Time

Starting Time: 0 sec

Duration: 0 sec

Ending Time: 0 sec

Materials

Dike 1 (Clay)

Model: Saturated / Unsaturated

Hydraulic

K-Function: Dike 1 (Clay)

Vol. WC. Function: Dike 1 (Clay)

K-Ratio: 0.1

K-Direction: 0 °

Dike 2 (Lean Clay)

Model: Saturated / Unsaturated

Hydraulic

K-Function: Dike 2 (Lean Clay)

Vol. WC. Function: Dike 2 (Lean Clay)

K-Ratio: 0.1

K-Direction: 0 °

Dike 3 (Clay)

Model: Saturated / Unsaturated

Hydraulic

K-Function: Dike 3 (Clay)

Vol. WC. Function: Dike 3 (Clay)

K-Ratio: 0.1

K-Direction: 0 °

Alluvial (Clay)

Model: Saturated / Unsaturated

Hydraulic

K-Function: Alluvial (Clay)

Vol. WC. Function: Alluival (Clay)

K-Ratio: 0.05

K-Direction: 0 °

Alluvial (Granular)

Model: Saturated / Unsaturated

Hydraulic

K-Function: Alluvial (Granular)

Vol. WC. Function: Alluvial (Granular)

K-Ratio: 0.05

K-Direction: 0 °

Gypsum

Model: Saturated / Unsaturated
Hydraulic
K-Function: Gypsum
Vol. WC. Function: Gypsum
K-Ratio: 0.02
K-Direction: 0 °

Fly Ash (Stacked and/or Sluiced)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Fly Ash (Stacked and/or Sluiced)
Vol. WC. Function: Fly Ash (Stacked and/or Sluiced)
K-Ratio: 0.02
K-Direction: 0 °

Fly Ash / Bottom Ash (Sluiced)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Fly Ash/Bottom Ash (Sluiced)
Vol. WC. Function: Fly Ash/Bottom Ash (Sluiced)
K-Ratio: 0.02
K-Direction: 0 °

Dike 2 (Fat Clay)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Dike 2 (Fat Clay)
Vol. WC. Function: Dike 2 (Fat Clay)
K-Ratio: 0.1
K-Direction: 0 °

Toe Buttress (Rip Rap)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Rip Rap
Vol. WC. Function: Rip Rap
K-Ratio: 0.5
K-Direction: 0 °

Drainage Trench (Gravel)

Model: Saturated / Unsaturated
Hydraulic
K-Function: Gravel
Vol. WC. Function: Gravel
K-Ratio: 0.1

K-Direction: 0 °

Bedrock

Model: Saturated Only
Hydraulic
K-Sat: 1e-012 ft/sec
Volumetric Water Content: 0.05 ft^3/ft^3
Mv: 0 /psf
K-Ratio: 0.1
K-Direction: 0 °

Boundary Conditions

Potential Seepage Face

Review: true
Type: Total Flux (Q) 0

Wells Creek Water Elevation 359

Type: Head (H) 359

Gypsum Stack Water Elevation 423

Type: Head (H) 423

Drainage Trench Pipe 378

Type: Head (H) 378

Gypsum Stack Water Elevation 410

Type: Head (H) 410

Initial Water Tables

Initial Water Table 1

Max. negative head: 5
Coordinates
Coordinate: (900, 359) ft
Coordinate: (1000, 359) ft
Coordinate: (1019.69, 359) ft
Coordinate: (1029.71, 359.014) ft
Coordinate: (1050, 363) ft
Coordinate: (1070, 370) ft
Coordinate: (1085, 378) ft
Coordinate: (1101, 383) ft
Coordinate: (1119, 390) ft
Coordinate: (1142, 390) ft
Coordinate: (1168, 390) ft

Coordinate: (1183, 395) ft
Coordinate: (1220, 405) ft
Coordinate: (1475, 405) ft

K Functions

Dike 1 (Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 9.27e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 9.27e-008)
Data Point: (0.018329807, 9.2169627e-008)
Data Point: (0.033598183, 9.1639459e-008)
Data Point: (0.061584821, 9.1108851e-008)
Data Point: (0.11288379, 9.0578011e-008)
Data Point: (0.20691381, 9.0046826e-008)
Data Point: (0.37926902, 8.9514842e-008)
Data Point: (0.6951928, 8.8981673e-008)
Data Point: (1.274275, 8.8446276e-008)
Data Point: (2.3357215, 8.7906582e-008)
Data Point: (4.2813324, 8.7359109e-008)
Data Point: (7.8475997, 8.6797329e-008)
Data Point: (14.384499, 8.6209441e-008)
Data Point: (26.366509, 8.557348e-008)
Data Point: (48.329302, 8.4848378e-008)
Data Point: (88.586679, 8.3970694e-008)
Data Point: (162.37767, 8.2807874e-008)
Data Point: (297.63514, 8.0745483e-008)
Data Point: (545.55948, 7.8919922e-008)
Data Point: (1000, 4.8579457e-008)
Estimation Properties
Volume Water Content Function: Dike 1 (Clay)
Hydraulic K Sat: 9.27e-008 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.06 ft^3/ft^3

Rip Rap

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %

Segment Curvature: 100 %
K-Saturation: 3.28
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 3.28)
Data Point: (0.018329807, 3.2799881)
Data Point: (0.033598183, 3.2799726)
Data Point: (0.061584821, 3.2799502)
Data Point: (0.11288379, 3.2799154)
Data Point: (0.20691381, 3.279858)
Data Point: (0.37926902, 3.2797606)
Data Point: (0.6951928, 3.2795703)
Data Point: (1.274275, 3.2792454)
Data Point: (2.3357215, 3.2792685)
Data Point: (4.2813324, 3.2759027)
Data Point: (7.8475997, 3.2586345)
Data Point: (14.384499, 2.5276764)
Data Point: (26.366509, 0.23163578)
Data Point: (48.329302, 0.0066290958)
Data Point: (88.586679, 0.00055090577)
Data Point: (162.37767, 5.3636887e-005)
Data Point: (297.63514, 7.0517584e-006)
Data Point: (545.55948, 8.5516803e-007)
Data Point: (1000, 8.0892457e-008)
Estimation Properties
Volume Water Content Function: Rip Rap
Hydraulic K Sat: 3.28 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.02 ft^3/ft^3

Gravel

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 0.0328
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 0.0328)
Data Point: (0.018329807, 0.032799881)
Data Point: (0.033598183, 0.032799726)
Data Point: (0.061584821, 0.032799502)
Data Point: (0.11288379, 0.032799154)
Data Point: (0.20691381, 0.03279858)
Data Point: (0.37926902, 0.032797606)
Data Point: (0.6951928, 0.032795703)
Data Point: (1.274275, 0.032792454)

Data Point: (2.3357215, 0.032792685)
Data Point: (4.2813324, 0.032759027)
Data Point: (7.8475997, 0.032586345)
Data Point: (14.384499, 0.025276764)
Data Point: (26.366509, 0.0023163578)
Data Point: (48.329302, 6.6290958e-005)
Data Point: (88.586679, 5.5090577e-006)
Data Point: (162.37767, 5.3636887e-007)
Data Point: (297.63514, 7.0517584e-008)
Data Point: (545.55948, 8.5516803e-009)
Data Point: (1000, 8.0892457e-010)
Estimation Properties
Volume Water Content Function: Gravel
Hydraulic K Sat: 0.0328 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.02 ft^3/ft^3

Dike 2 (Lean Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 9.27e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 9.27e-008)
Data Point: (0.018329807, 9.1650515e-008)
Data Point: (0.033598183, 9.0600715e-008)
Data Point: (0.061584821, 8.9550498e-008)
Data Point: (0.11288379, 8.8501027e-008)
Data Point: (0.20691381, 8.7451297e-008)
Data Point: (0.37926902, 8.6400772e-008)
Data Point: (0.6951928, 8.5348899e-008)
Data Point: (1.274275, 8.4294959e-008)
Data Point: (2.3357215, 8.3236754e-008)
Data Point: (4.2813324, 8.2170877e-008)
Data Point: (7.8475997, 8.1090857e-008)
Data Point: (14.384499, 7.9984877e-008)
Data Point: (26.366509, 7.8831412e-008)
Data Point: (48.329302, 7.7591143e-008)
Data Point: (88.586679, 7.6190179e-008)
Data Point: (162.37767, 7.4495545e-008)
Data Point: (297.63514, 7.2312385e-008)
Data Point: (545.55948, 6.8986115e-008)
Data Point: (1000, 6.2537934e-008)
Estimation Properties

Volume Water Content Function: Dike 2 (Lean Clay)
Hydraulic K Sat: 9.28e-008 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.109 ft^3/ft^3

Dike 2 (Fat Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 9.27e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 9.27e-008)
Data Point: (0.018329807, 8.8933713e-008)
Data Point: (0.033598183, 8.5164663e-008)
Data Point: (0.061584821, 8.139644e-008)
Data Point: (0.11288379, 7.7628413e-008)
Data Point: (0.20691381, 7.3860601e-008)
Data Point: (0.37926902, 7.0092235e-008)
Data Point: (0.6951928, 6.6323547e-008)
Data Point: (1.274275, 6.2553832e-008)
Data Point: (2.3357215, 5.8782165e-008)
Data Point: (4.2813324, 5.5006971e-008)
Data Point: (7.8475997, 5.1225309e-008)
Data Point: (14.384499, 4.7431845e-008)
Data Point: (26.366509, 4.3616747e-008)
Data Point: (48.329302, 3.9762167e-008)
Data Point: (88.586679, 3.5834286e-008)
Data Point: (162.37767, 3.1772781e-008)
Data Point: (297.63514, 2.7486773e-008)
Data Point: (545.55948, 2.2691519e-008)
Data Point: (1000, 1.6747254e-008)
Estimation Properties
Volume Water Content Function: Dike 2 (Fat Clay)
Hydraulic K Sat: 9.28e-008 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.09 ft^3/ft^3

Dike 3 (Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %

Segment Curvature: 100 %
K-Saturation: 9.27e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 9.27e-008)
Data Point: (0.018329807, 9.1335539e-008)
Data Point: (0.033598183, 8.9970992e-008)
Data Point: (0.061584821, 8.8606153e-008)
Data Point: (0.11288379, 8.7241948e-008)
Data Point: (0.20691381, 8.587726e-008)
Data Point: (0.37926902, 8.4511613e-008)
Data Point: (0.6951928, 8.3144534e-008)
Data Point: (1.274275, 8.1774585e-008)
Data Point: (2.3357215, 8.0399265e-008)
Data Point: (4.2813324, 7.9014508e-008)
Data Point: (7.8475997, 7.7612585e-008)
Data Point: (14.384499, 7.6179098e-008)
Data Point: (26.366509, 7.4687722e-008)
Data Point: (48.329302, 7.3089827e-008)
Data Point: (88.586679, 7.1301301e-008)
Data Point: (162.37767, 6.9160863e-008)
Data Point: (297.63514, 6.6215873e-008)
Data Point: (545.55948, 6.2586118e-008)
Data Point: (1000, 4.3040637e-008)
Estimation Properties
Volume Water Content Function: Dike 3 (Clay)
Hydraulic K Sat: 1.367e-006 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.109 ft^3/ft^3

Alluvial (Clay)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 2.82e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 2.82e-008)
Data Point: (0.018329807, 2.6704895e-008)
Data Point: (0.033598183, 2.520874e-008)
Data Point: (0.061584821, 2.371319e-008)
Data Point: (0.11288379, 2.2217639e-008)
Data Point: (0.20691381, 2.0722088e-008)
Data Point: (0.37926902, 1.9226636e-008)
Data Point: (0.6951928, 1.7731325e-008)
Data Point: (1.274275, 1.6236271e-008)

Data Point: (2.3357215, 1.4741722e-008)
Data Point: (4.2813324, 1.324807e-008)
Data Point: (7.8475997, 1.1756079e-008)
Data Point: (14.384499, 1.0267137e-008)
Data Point: (26.366509, 8.7837534e-009)
Data Point: (48.329302, 7.3106411e-009)
Data Point: (88.586679, 5.8562064e-009)
Data Point: (162.37767, 4.4361326e-009)
Data Point: (297.63514, 3.0796113e-009)
Data Point: (545.55948, 1.836886e-009)
Data Point: (1000, 8.0419101e-010)

Estimation Properties
Volume Water Content Function: Alluival (Clay)
Hydraulic K Sat: 2.82e-008 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.056 ft^3/ft^3

Alluvial (Granular)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 3.28e-006
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 3.28e-006)
Data Point: (0.018329807, 3.2799977e-006)
Data Point: (0.033598183, 3.2799945e-006)
Data Point: (0.061584821, 3.2799893e-006)
Data Point: (0.11288379, 3.2799807e-006)
Data Point: (0.20691381, 3.2799659e-006)
Data Point: (0.37926902, 3.279941e-006)
Data Point: (0.6951928, 3.2798827e-006)
Data Point: (1.274275, 3.2797899e-006)
Data Point: (2.3357215, 3.2800754e-006)
Data Point: (4.2813324, 3.2780636e-006)
Data Point: (7.8475997, 3.2678735e-006)
Data Point: (14.384499, 3.3273578e-006)
Data Point: (26.366509, 1.4244433e-006)
Data Point: (48.329302, 1.651216e-007)
Data Point: (88.586679, 1.1791372e-008)
Data Point: (162.37767, 1.216472e-009)
Data Point: (297.63514, 1.8408862e-010)
Data Point: (545.55948, 3.2107908e-011)
Data Point: (1000, 4.0889304e-012)

Estimation Properties

Volume Water Content Function: Alluvial (Granular)
Hydraulic K Sat: 0.00236 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.041 ft^3/ft^3

Gypsum

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 5.0115e-007
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 5.0115e-007)
Data Point: (0.018329807, 5.0111464e-007)
Data Point: (0.033598183, 5.0107916e-007)
Data Point: (0.061584821, 5.0104346e-007)
Data Point: (0.11288379, 5.0100734e-007)
Data Point: (0.20691381, 5.0097044e-007)
Data Point: (0.37926902, 5.0093215e-007)
Data Point: (0.6951928, 5.008913e-007)
Data Point: (1.274275, 5.0084579e-007)
Data Point: (2.3357215, 5.007917e-007)
Data Point: (4.2813324, 5.0072188e-007)
Data Point: (7.8475997, 5.0062326e-007)
Data Point: (14.384499, 5.0047181e-007)
Data Point: (26.366509, 5.0022354e-007)
Data Point: (48.329302, 4.9979844e-007)
Data Point: (88.586679, 4.9904433e-007)
Data Point: (162.37767, 4.9768962e-007)
Data Point: (297.63514, 4.8249652e-007)
Data Point: (545.55948, 1.1771989e-007)
Data Point: (1000, 7.4126036e-010)
Estimation Properties
Volume Water Content Function: Gypsum
Hydraulic K Sat: 4.65e-006 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.041 ft^3/ft^3

Fly Ash (Stacked and/or Sluiced)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %

Segment Curvature: 100 %
K-Saturation: 4.79e-008
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 4.79e-008)
Data Point: (0.018329807, 4.7259093e-008)
Data Point: (0.033598183, 4.6617951e-008)
Data Point: (0.061584821, 4.5976651e-008)
Data Point: (0.11288379, 4.533499e-008)
Data Point: (0.20691381, 4.4692633e-008)
Data Point: (0.37926902, 4.4049026e-008)
Data Point: (0.6951928, 4.3403145e-008)
Data Point: (1.274275, 4.2753085e-008)
Data Point: (2.3357215, 4.2095366e-008)
Data Point: (4.2813324, 4.1423588e-008)
Data Point: (7.8475997, 4.0726056e-008)
Data Point: (14.384499, 3.9981312e-008)
Data Point: (26.366509, 3.9149997e-008)
Data Point: (48.329302, 3.8160256e-008)
Data Point: (88.586679, 3.6878927e-008)
Data Point: (162.37767, 3.506396e-008)
Data Point: (297.63514, 3.1556345e-008)
Data Point: (545.55948, 8.077977e-009)
Data Point: (1000, 9.4818218e-011)
Estimation Properties
Volume Water Content Function: Fly Ash (Stacked and/or Sluiced)
Hydraulic K Sat: 3.03e-006 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.015 ft^3/ft^3

Fly Ash/Bottom Ash (Sluiced)

Model: Data Point Function
Function: X-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
K-Saturation: 2.76e-006
Data Points: Matric Suction (psf), X-Conductivity (ft/sec)
Data Point: (0.01, 2.76e-006)
Data Point: (0.018329807, 2.6249802e-006)
Data Point: (0.033598183, 2.4898654e-006)
Data Point: (0.061584821, 2.3548067e-006)
Data Point: (0.11288379, 2.219744e-006)
Data Point: (0.20691381, 2.0846794e-006)
Data Point: (0.37926902, 1.9496102e-006)
Data Point: (0.6951928, 1.8145364e-006)
Data Point: (1.274275, 1.6794511e-006)

Data Point: (2.3357215, 1.5443461e-006)
Data Point: (4.2813324, 1.4092031e-006)
Data Point: (7.8475997, 1.2739923e-006)
Data Point: (14.384499, 1.1386606e-006)
Data Point: (26.366509, 1.0030923e-006)
Data Point: (48.329302, 8.6703015e-007)
Data Point: (88.586679, 7.3067463e-007)
Data Point: (162.37767, 5.9322097e-007)
Data Point: (297.63514, 4.4085998e-007)
Data Point: (545.55948, 3.1976211e-007)
Data Point: (1000, 3.0568348e-008)

Estimation Properties

Volume Water Content Function: Fly Ash/Bottom Ash (Sluiced)
Hydraulic K Sat: 3.03e-006 ft/sec
Hyd. K-Function Estimation Method: Fredlund-Xing Function
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: 0.027 ft^3/ft^3

Vol. Water Content Functions

Dike 1 (Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 3e-006 /psf
Porosity: 0.40137854
Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
Data Point: (0.01, 0.39927389)
Data Point: (0.018329807, 0.39927389)
Data Point: (0.033598183, 0.39927389)
Data Point: (0.061584821, 0.39927389)
Data Point: (0.11288379, 0.39927389)
Data Point: (0.20691381, 0.39927389)
Data Point: (0.37926902, 0.39927389)
Data Point: (0.6951928, 0.39927389)
Data Point: (1.274275, 0.39927389)
Data Point: (2.3357215, 0.39927389)
Data Point: (4.2813324, 0.39927389)
Data Point: (7.8475997, 0.39927389)
Data Point: (14.384499, 0.39927389)
Data Point: (26.366509, 0.39927389)
Data Point: (48.329302, 0.39927389)
Data Point: (88.586679, 0.39927389)

Data Point: (162.37767, 0.39927389)
Data Point: (297.63514, 0.39927389)
Data Point: (545.55948, 0.39922726)
Data Point: (1000, 0.38641719)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.3993 ft³/ft³
Liquid Limit: 40.5 %
Diameter at 10% passing: 0.0001
Diameter at 60% passing: 2
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Rip Rap

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 2e-005 /psf
Porosity: 0.39943641
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.39999999)
Data Point: (0.018329807, 0.39999998)
Data Point: (0.033598183, 0.39999996)
Data Point: (0.061584821, 0.39999993)
Data Point: (0.11288379, 0.39999988)
Data Point: (0.20691381, 0.39999977)
Data Point: (0.37926902, 0.39999958)
Data Point: (0.6951928, 0.39999922)
Data Point: (1.274275, 0.3999983)
Data Point: (2.3357215, 0.39999053)
Data Point: (4.2813324, 0.39983414)
Data Point: (7.8475997, 0.39627977)
Data Point: (14.384499, 0.33441755)
Data Point: (26.366509, 0.1497699)
Data Point: (48.329302, 0.077147868)
Data Point: (88.586679, 0.051761117)
Data Point: (162.37767, 0.039157663)
Data Point: (297.63514, 0.031594128)
Data Point: (545.55948, 0.026529945)
Data Point: (1000, 0.022885538)
Estimation Properties
Vol. WC Estimation Method: Sample functions
Sample Material: Gravel
Saturated Water Content: 0.4 ft³/ft³
Liquid Limit: 0 %

Diameter at 10% passing: 0
Diameter at 60% passing: 0
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Gravel

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 2e-005 /psf
Porosity: 0.39943641
Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
Data Point: (0.01, 0.39999999)
Data Point: (0.018329807, 0.39999998)
Data Point: (0.033598183, 0.39999996)
Data Point: (0.061584821, 0.39999993)
Data Point: (0.11288379, 0.39999988)
Data Point: (0.20691381, 0.39999977)
Data Point: (0.37926902, 0.39999958)
Data Point: (0.6951928, 0.39999922)
Data Point: (1.274275, 0.3999983)
Data Point: (2.3357215, 0.39999053)
Data Point: (4.2813324, 0.39983414)
Data Point: (7.8475997, 0.39627977)
Data Point: (14.384499, 0.33441755)
Data Point: (26.366509, 0.1497699)
Data Point: (48.329302, 0.077147868)
Data Point: (88.586679, 0.051761117)
Data Point: (162.37767, 0.039157663)
Data Point: (297.63514, 0.031594128)
Data Point: (545.55948, 0.026529945)
Data Point: (1000, 0.022885538)
Estimation Properties
Vol. WC Estimation Method: Sample functions
Sample Material: Gravel
Saturated Water Content: 0.4 ft^3/ft^3
Liquid Limit: 0 %
Diameter at 10% passing: 0
Diameter at 60% passing: 0
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Dike 2 (Lean Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure

Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 3e-006 /psf
Porosity: 0.35697485
Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
Data Point: (0.01, 0.35397485)
Data Point: (0.018329807, 0.35397485)
Data Point: (0.033598183, 0.35397485)
Data Point: (0.061584821, 0.35397485)
Data Point: (0.11288379, 0.35397485)
Data Point: (0.20691381, 0.35397485)
Data Point: (0.37926902, 0.35397485)
Data Point: (0.6951928, 0.35397485)
Data Point: (1.274275, 0.35397485)
Data Point: (2.3357215, 0.35397485)
Data Point: (4.2813324, 0.35397485)
Data Point: (7.8475997, 0.35397485)
Data Point: (14.384499, 0.35397485)
Data Point: (26.366509, 0.35397485)
Data Point: (48.329302, 0.35397485)
Data Point: (88.586679, 0.35397485)
Data Point: (162.37767, 0.35397485)
Data Point: (297.63514, 0.35397485)
Data Point: (545.55948, 0.35397485)
Data Point: (1000, 0.35397485)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.35456 ft^3/ft^3
Liquid Limit: 46 %
Diameter at 10% passing: 0.0001
Diameter at 60% passing: 0.004
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Dike 2 (Fat Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 1.4358e-005 /psf
Porosity: 0.4543618
Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
Data Point: (0.01, 0.44378537)
Data Point: (0.018329807, 0.44378537)
Data Point: (0.033598183, 0.44378537)
Data Point: (0.061584821, 0.44378537)

Data Point: (0.11288379, 0.44378537)
Data Point: (0.20691381, 0.44378537)
Data Point: (0.37926902, 0.44378537)
Data Point: (0.6951928, 0.44378537)
Data Point: (1.274275, 0.44378537)
Data Point: (2.3357215, 0.44378537)
Data Point: (4.2813324, 0.44378537)
Data Point: (7.8475997, 0.44378537)
Data Point: (14.384499, 0.44378537)
Data Point: (26.366509, 0.44378537)
Data Point: (48.329302, 0.44378537)
Data Point: (88.586679, 0.44378537)
Data Point: (162.37767, 0.44378537)
Data Point: (297.63514, 0.44378537)
Data Point: (545.55948, 0.44378537)
Data Point: (1000, 0.4400038)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.444 ft³/ft³
Liquid Limit: 53 %
Diameter at 10% passing: 0.0001
Diameter at 60% passing: 0.007
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Dike 3 (Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 4.786e-006 /psf
Porosity: 0.38639791
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.38361303)
Data Point: (0.018329807, 0.38361303)
Data Point: (0.033598183, 0.38361303)
Data Point: (0.061584821, 0.38361303)
Data Point: (0.11288379, 0.38361303)
Data Point: (0.20691381, 0.38361303)
Data Point: (0.37926902, 0.38361303)
Data Point: (0.6951928, 0.38361303)
Data Point: (1.274275, 0.38361303)
Data Point: (2.3357215, 0.38361303)
Data Point: (4.2813324, 0.38361303)
Data Point: (7.8475997, 0.38361303)
Data Point: (14.384499, 0.38361303)

Data Point: (26.366509, 0.38361303)
Data Point: (48.329302, 0.38361303)
Data Point: (88.586679, 0.38361303)
Data Point: (162.37767, 0.38361303)
Data Point: (297.63514, 0.38361303)
Data Point: (545.55948, 0.38354257)
Data Point: (1000, 0.37459607)

Estimation Properties

Vol. WC Estimation Method: Grain Size Function
Sample Material: Clay
Saturated Water Content: 0.3836 ft³/ft³
Liquid Limit: 39.8 %
Diameter at 10% passing: 0.0001
Diameter at 60% passing: 1.1
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Alluival (Clay)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure

Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 4.786e-005 /psf

Porosity: 0.44254793
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)

Data Point: (0.01, 0.40001102)
Data Point: (0.018329807, 0.40001102)
Data Point: (0.033598183, 0.40001102)
Data Point: (0.061584821, 0.40001102)
Data Point: (0.11288379, 0.40001102)
Data Point: (0.20691381, 0.40001102)
Data Point: (0.37926902, 0.40001102)
Data Point: (0.6951928, 0.40001102)
Data Point: (1.274275, 0.40001102)
Data Point: (2.3357215, 0.40001102)
Data Point: (4.2813324, 0.40001102)
Data Point: (7.8475997, 0.40001102)
Data Point: (14.384499, 0.40001102)
Data Point: (26.366509, 0.40001102)
Data Point: (48.329302, 0.40001102)
Data Point: (88.586679, 0.40001102)
Data Point: (162.37767, 0.40001102)
Data Point: (297.63514, 0.40001102)
Data Point: (545.55948, 0.3999073)
Data Point: (1000, 0.38449634)

Estimation Properties

Vol. WC Estimation Method: Grain Size Function

Sample Material: Clay
Saturated Water Content: 0.4 ft³/ft³
Liquid Limit: 39.7 %
Diameter at 10% passing: 0.0001
Diameter at 60% passing: 0.04
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Alluvial (Granular)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 2.3925e-006 /psf
Porosity: 0.26931422
Data Points: Matric Suction (psf), Vol. Water Content (ft³/ft³)
Data Point: (0.01, 0.27004271)
Data Point: (0.018329807, 0.27004271)
Data Point: (0.033598183, 0.27004271)
Data Point: (0.061584821, 0.27004271)
Data Point: (0.11288379, 0.27004271)
Data Point: (0.20691381, 0.27004271)
Data Point: (0.37926902, 0.27004271)
Data Point: (0.6951928, 0.27004271)
Data Point: (1.274275, 0.27004271)
Data Point: (2.3357215, 0.27004271)
Data Point: (4.2813324, 0.27004271)
Data Point: (7.8475997, 0.27004271)
Data Point: (14.384499, 0.26476794)
Data Point: (26.366509, 0.20945658)
Data Point: (48.329302, 0.13846113)
Data Point: (88.586679, 0.099029845)
Data Point: (162.37767, 0.079958221)
Data Point: (297.63514, 0.068945156)
Data Point: (545.55948, 0.060786901)
Data Point: (1000, 0.053624426)
Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Silty Sand
Saturated Water Content: 0.27 ft³/ft³
Liquid Limit: 0 %
Diameter at 10% passing: 0.018
Diameter at 60% passing: 8
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Gypsum

- Model: Data Point Function
- Function: Vol. Water Content vs. Pore-Water Pressure
  - Curve Fit to Data: 100 %
  - Segment Curvature: 100 %
  - Mv: 4.786e-006 /psf
- Porosity: 0.51984061
- Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
  - Data Point: (0.01, 0.51717808)
  - Data Point: (0.018329807, 0.51717808)
  - Data Point: (0.033598183, 0.51717808)
  - Data Point: (0.061584821, 0.51717808)
  - Data Point: (0.11288379, 0.51717808)
  - Data Point: (0.20691381, 0.51717808)
  - Data Point: (0.37926902, 0.51717808)
  - Data Point: (0.6951928, 0.51717808)
  - Data Point: (1.274275, 0.51717808)
  - Data Point: (2.3357215, 0.51717808)
  - Data Point: (4.2813324, 0.51717808)
  - Data Point: (7.8475997, 0.51717808)
  - Data Point: (14.384499, 0.51717808)
  - Data Point: (26.366509, 0.51717808)
  - Data Point: (48.329302, 0.51717808)
  - Data Point: (88.586679, 0.51717808)
  - Data Point: (162.37767, 0.51717808)
  - Data Point: (297.63514, 0.49885374)
  - Data Point: (545.55948, 0.31231747)
  - Data Point: (1000, 0.14422066)
- Estimation Properties
  - Vol. WC Estimation Method: Grain Size Function
  - Sample Material: Silt
  - Saturated Water Content: 0.516 ft^3/ft^3
  - Liquid Limit: 0 %
  - Diameter at 10% passing: 0.0108
  - Diameter at 60% passing: 0.025
  - Maximum: 1000
  - Minimum: 0.01
  - Num. Points: 20

Fly Ash (Stacked and/or Sluiced)

- Model: Data Point Function
- Function: Vol. Water Content vs. Pore-Water Pressure
  - Curve Fit to Data: 100 %
  - Segment Curvature: 100 %
  - Mv: 7.179e-005 /psf
- Porosity: 0.55841772
- Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)

Data Point: (0.01, 0.54398049)
Data Point: (0.018329807, 0.54398049)
Data Point: (0.033598183, 0.54398049)
Data Point: (0.061584821, 0.54398049)
Data Point: (0.11288379, 0.54398049)
Data Point: (0.20691381, 0.54398049)
Data Point: (0.37926902, 0.54398049)
Data Point: (0.6951928, 0.54398049)
Data Point: (1.274275, 0.54398049)
Data Point: (2.3357215, 0.54398049)
Data Point: (4.2813324, 0.54398049)
Data Point: (7.8475997, 0.54398049)
Data Point: (14.384499, 0.54398049)
Data Point: (26.366509, 0.54398049)
Data Point: (48.329302, 0.54398049)
Data Point: (88.586679, 0.54398049)
Data Point: (162.37767, 0.54398049)
Data Point: (297.63514, 0.52190637)
Data Point: (545.55948, 0.35987439)
Data Point: (1000, 0.20209818)

Estimation Properties
Vol. WC Estimation Method: Grain Size Function
Sample Material: Silt
Saturated Water Content: 0.543 ft^3/ft^3
Liquid Limit: 0 %
Diameter at 10% passing: 0.004
Diameter at 60% passing: 0.033
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Fly Ash/Bottom Ash (Sluiced)

Model: Data Point Function
Function: Vol. Water Content vs. Pore-Water Pressure
Curve Fit to Data: 100 %
Segment Curvature: 100 %
Mv: 6.2218e-005 /psf
Porosity: 0.37786527
Data Points: Matric Suction (psf), Vol. Water Content (ft^3/ft^3)
Data Point: (0.01, 0.35499418)
Data Point: (0.018329807, 0.35499418)
Data Point: (0.033598183, 0.35499418)
Data Point: (0.061584821, 0.35499418)
Data Point: (0.11288379, 0.35499418)
Data Point: (0.20691381, 0.35499418)
Data Point: (0.37926902, 0.35499418)
Data Point: (0.6951928, 0.35499418)
Data Point: (1.274275, 0.35499418)

Data Point: (2.3357215, 0.35499418)
Data Point: (4.2813324, 0.35499418)
Data Point: (7.8475997, 0.35499418)
Data Point: (14.384499, 0.35499418)
Data Point: (26.366509, 0.35499418)
Data Point: (48.329302, 0.35499418)
Data Point: (88.586679, 0.35499418)
Data Point: (162.37767, 0.35499418)
Data Point: (297.63514, 0.35499418)
Data Point: (545.55948, 0.34147401)
Data Point: (1000, 0.26813417)

Estimation Properties

Vol. WC Estimation Method: Grain Size Function
Sample Material: Silty Sand
Saturated Water Content: 0.3548 ft³/ft³
Liquid Limit: 0 %
Diameter at 10% passing: 0.004
Diameter at 60% passing: 0.049
Maximum: 1000
Minimum: 0.01
Num. Points: 20

Regions

	Material	Points
Region 1	Alluvial (Clay)	98,1,2,32,3,117,111,112,113,6,83,7,8,90,89,88,87,86,85,84,94,91,80,10,11,99
Region 2	Alluvial (Granular)	100,99,11,10,80,91,92,9,12,13
Region 3	Fly Ash (Stacked and/or Sluiced)	97,96,28,29,30,31
Region 4	Fly Ash / Bottom Ash (Sluiced)	30,14,27,123,125,124,122,26,32,2,1,98,97,31
Region 5	Dike 3 (Clay)	29,30,14,82,15,33,34,35,36,37,38,39,40,41,42,43
Region 6	Gypsum	96,95,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,129,6
Region 7	Dike 1 (Clay)	26,118,117,3,32

Region 8	Bedrock	9,92,93,75,76,101,100,13,12
Region 9	Dike 2 (Lean Clay)	26,118,119,126,122
Region 10	Dike 2 (Fat Clay)	82,15,16,77,17,18,19,20,21,22,116,110,119,126,120,121,127
Region 11	Drainage Trench (Gravel)	127,121,120,126,122,124,125,123
Region 12	Dike 2 (Lean Clay)	127,123,27,14,82
Region 13	Toe Buttress (Rip Rap)	111,112,113,114,115,116,110,119,118,117

Lines

	Start Point	End Point	Hydraulic Boundary
Line 1	1	2	
Line 2	7	8	Wells Creek Water Elevation 359
Line 3	10	11	
Line 4	12	13	
Line 5	27	14	
Line 6	28	29	
Line 7	29	30	
Line 8	30	31	
Line 9	30	14	
Line 10	26	32	
Line 11	32	3	
Line 12	15	33	Potential Seepage Face
Line 13	33	34	Potential Seepage Face
Line 14	34	35	Potential Seepage Face
Line 15	35	36	Potential Seepage Face
Line 16	36	37	Potential Seepage Face
Line 17	39	40	Potential Seepage Face

Line 18	40	41	Potential Seepage Face
Line 19	41	42	Potential Seepage Face
Line 20	42	43	
Line 21	43	29	
Line 22	45	46	Potential Seepage Face
Line 23	46	47	Potential Seepage Face
Line 24	47	48	Potential Seepage Face
Line 25	48	49	Potential Seepage Face
Line 26	49	50	Potential Seepage Face
Line 27	50	51	Potential Seepage Face
Line 28	51	52	Potential Seepage Face
Line 29	52	53	Potential Seepage Face
Line 30	53	54	Potential Seepage Face
Line 31	54	55	Potential Seepage Face
Line 32	55	56	Potential Seepage Face
Line 33	56	57	Potential Seepage Face
Line 34	57	58	Potential Seepage Face
Line 35	58	59	Potential Seepage Face
Line 36	59	60	Potential Seepage Face
Line 37	60	61	Potential Seepage Face
Line 38	61	62	Potential Seepage Face
Line 39	62	63	Potential Seepage Face
Line 40	63	64	Potential Seepage Face
Line 41	64	65	Potential Seepage Face
Line 42	65	66	Potential Seepage Face
Line 43	66	67	Potential Seepage Face
Line 44	67	68	Potential Seepage Face
Line 45	69	70	Gypsum Stack Water Elevation 410
Line 46	70	71	Gypsum Stack Water Elevation 410
Line 47	71	42	Gypsum Stack Water Elevation 410
Line 48	75	76	
Line 49	12	9	
Line 50	10	80	
Line 51	2	32	
Line 52	14	82	
Line 53	82	15	

Line 54	15	16	Potential Seepage Face
Line 55	16	77	Potential Seepage Face
Line 56	77	17	Potential Seepage Face
Line 57	17	18	Potential Seepage Face
Line 58	18	19	Potential Seepage Face
Line 59	19	20	Potential Seepage Face
Line 60	20	21	Potential Seepage Face
Line 61	21	22	Potential Seepage Face
Line 62	6	83	Potential Seepage Face
Line 63	83	7	Wells Creek Water Elevation 359
Line 64	8	90	Wells Creek Water Elevation 359
Line 65	90	89	Wells Creek Water Elevation 359
Line 66	89	88	Wells Creek Water Elevation 359
Line 67	88	87	Wells Creek Water Elevation 359
Line 68	87	86	Wells Creek Water Elevation 359
Line 69	86	85	
Line 70	85	84	
Line 71	91	92	Wells Creek Water Elevation 359
Line 72	92	93	Wells Creek Water Elevation 359
Line 73	84	94	
Line 74	94	91	Wells Creek Water Elevation 359
Line 75	96	95	Gypsum Stack Water Elevation 423
Line 76	95	44	Potential Seepage Face
Line 77	28	96	
Line 78	97	96	Gypsum Stack Water Elevation 423
Line 79	31	97	
Line 80	1	98	
Line 81	98	97	Gypsum Stack Water Elevation 423
Line 82	99	98	Gypsum Stack Water Elevation 423
Line 83	11	99	
Line 84	100	99	Gypsum Stack Water Elevation 423
Line 85	13	100	
Line 86	76	101	
Line 87	101	100	Gypsum Stack Water Elevation 423
Line 88	80	91	
Line 89	9	92	

Line 90	75	93	
Line 91	38	37	Potential Seepage Face
Line 92	39	38	Potential Seepage Face
Line 93	45	44	Potential Seepage Face
Line 94	22	116	Potential Seepage Face
Line 95	116	110	
Line 96	110	119	
Line 97	119	126	
Line 98	126	120	
Line 99	120	121	
Line 100	121	127	
Line 101	127	82	
Line 102	26	118	
Line 103	118	119	
Line 104	126	122	
Line 105	122	26	
Line 106	27	123	
Line 107	123	125	
Line 108	125	124	
Line 109	124	122	
Line 110	123	127	
Line 111	118	117	
Line 112	117	3	
Line 113	117	111	
Line 114	111	112	
Line 115	112	113	
Line 116	113	6	Potential Seepage Face
Line 117	113	114	Potential Seepage Face
Line 118	114	115	Potential Seepage Face
Line 119	115	116	Potential Seepage Face
Line 120	69	129	Gypsum Stack Water Elevation 410
Line 121	129	68	Potential Seepage Face

Points

	X (ft)	Y (ft)	Hydraulic Boundary

Point 1	1475	353.19	
Point 2	1225.0651	353.19	
Point 3	1111.0025	351.03	
Point 4	1031.6471	362.1655	
Point 5	1028.0434	361.0017	
Point 6	984.1443	359.9523	
Point 7	950.6064	356.9591	
Point 8	900	355.6847	
Point 9	900	314.2811	
Point 10	1225.0651	336.79	
Point 11	1475	336.79	
Point 12	1225.0651	319.99	
Point 13	1475	319.99	
Point 14	1179.475	382.19	
Point 15	1159.0394	389.0012	
Point 16	1154.7809	389.0017	
Point 17	1150.4833	390.0017	
Point 18	1144.3259	393.7324	
Point 19	1143.197	394.2883	
Point 20	1142.3686	394.55	
Point 21	1140.9385	395.0017	
Point 22	1124.8971	395.0017	
Point 23	1118.2614	393.9807	
Point 24	1108.1233	390.0017	
Point 25	1078.7109	381.0017	
Point 26	1091.7416	376.63	
Point 27	1196.1567	376.63	
Point 28	1475	398.5017	
Point 29	1267.513	398.5017	
Point 30	1316.4529	382.19	
Point 31	1475	382.19	
Point 32	1168.7329	351.03	
Point 33	1163.2539	389.0017	
Point 34	1165.7562	390.3163	
Point 35	1168.9831	392.0017	
Point 36	1174	394	

Point 37	1177.9093	395.2996	
Point 38	1208.8534	405.0017	
Point 39	1214.4744	406.4996	
Point 40	1217.7547	408.7126	
Point 41	1220.5864	410.0017	
Point 42	1232.7632	410.0017	
Point 43	1233.6482	409.7888	
Point 44	1475	414.1588	
Point 45	1435.4684	413.0017	
Point 46	1429.0876	412.5892	
Point 47	1425.1901	412.2142	
Point 48	1409.6758	415.0017	
Point 49	1406.7021	414.0017	
Point 50	1398.3521	413.7404	
Point 51	1397.2875	413.4962	
Point 52	1396.5743	414.0072	
Point 53	1394.6161	414.0679	
Point 54	1392.5046	415.0017	
Point 55	1388.3079	415.0017	
Point 56	1385.3407	414.0565	
Point 57	1379.8252	413.9558	
Point 58	1373.1553	411.0017	
Point 59	1369.9178	411.0017	
Point 60	1368.4737	411.2319	
Point 61	1364.6893	411.2664	
Point 62	1361.7463	411.0017	
Point 63	1338.2008	411.0017	
Point 64	1319.8195	415.397	
Point 65	1317.9669	416.0017	
Point 66	1315.4368	417.0017	
Point 67	1309.737	418.0017	
Point 68	1288.8897	418.0017	
Point 69	1264.4456	409.0513	
Point 70	1255.0277	408.8585	
Point 71	1246.0502	408.9271	
Point 72	1065.8502	380.0017	

Point 73	1043.7085	367.0614	
Point 74	1041.6113	366.0017	
Point 75	900	300	
Point 76	1475	300	
Point 77	1153	389	
Point 78	1170	390	
Point 79	1249	405	
Point 80	900	329	
Point 81	1104.3302	388.8067	
Point 82	1159.6	388.8143	
Point 83	971.8829	359	
Point 84	650	361.0346	
Point 85	695.2744	359.9523	
Point 86	707.5358	359	
Point 87	733.8123	356.9591	
Point 88	779.4187	355.6847	
Point 89	839.7094	354	
Point 90	850	354.2876	
Point 91	650	329	
Point 92	650	314.2811	
Point 93	650	300	
Point 94	650	359	
Point 95	1775	423	
Point 96	1775	398.5017	
Point 97	1775	382.19	
Point 98	1775	353.19	
Point 99	1775	336.79	
Point 100	1775	319.99	
Point 101	1775	300	
Point 102	945.6064	356.9591	
Point 103	1173.3768	393.9777	
Point 104	1187.3669	398.1315	
Point 105	1197.7316	401.4796	
Point 106	1204.1501	403.553	
Point 107	1211.6339	405.7426	
Point 108	1457.2701	413.6006	

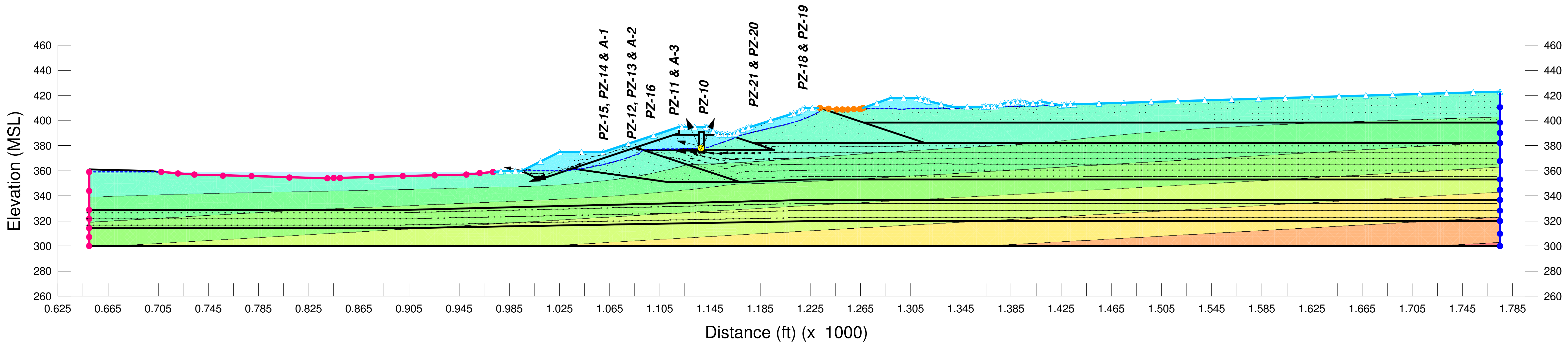
Point 109	1475	405	
Point 110	1120	390	
Point 111	1015	355	
Point 112	1005	355	
Point 113	995	360	
Point 114	1025	375	
Point 115	1060	375	
Point 116	1120	395	
Point 117	1035.1	361.7	
Point 118	1085.8	378.6	
Point 119	1116.4	388.8	
Point 120	1136	391	
Point 121	1140	391	
Point 122	1136	376.63	
Point 123	1140	376.63	
Point 124	1136	374.63	
Point 125	1140	374.63	
Point 126	1136	388.8	
Point 127	1140	388.8	
Point 128	1138	378	Drainage Trench Pipe 378
Point 129	1267.0366	410	

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

Stantec

File Name: Section H (Stability - Repair Design).gsz
Analysis Name: Steady-State Seepage
Date Saved: 11/2/2009
Last Solved on 11/2/2009 at 1:58:05 PM
Analysis Method: Steady-State

Material Type
Dike 1 (Clay) Saturated / Unsaturated Dike 1 (Clay) Dike 1 (Clay) 0.1 0 °
Dike 2 (Lean Clay) Saturated / Unsaturated Dike 2 (Lean Clay) Dike 2 (Lean Clay) 0.1 0 °
Dike 3 (Clay) Saturated / Unsaturated Dike 3 (Clay) Dike 3 (Clay) 0.1 0 °
Alluvial (Clay) Saturated / Unsaturated Alluvial (Clay) Alluival (Clay) 0.05 0 °
Alluvial (Granular) Saturated / Unsaturated Alluvial (Granular) Alluvial (Granular) 0.05 0 °
Gypsum Saturated / Unsaturated Gypsum Gypsum 0.02 0 °
Fly Ash (Stacked and/or Sluiced) Saturated / Unsaturated Fly Ash (Stacked and/or Sluiced) Fly Ash (Stacked and/or Sluiced) 0.02 0 °
Fly Ash / Bottom Ash (Sluiced) Saturated / Unsaturated Fly Ash/Bottom Ash (Sluiced) Fly Ash/Bottom Ash (Sluiced) 0.02 0 °
Dike 2 (Fat Clay) Saturated / Unsaturated Dike 2 (Fat Clay) Dike 2 (Fat Clay) 0.1 0 °
Toe Buttress (Rip Rap) Saturated / Unsaturated Rip Rap Rip Rap 0.5 0 °
Drainage Trench (Gravel) Saturated / Unsaturated Gravel Gravel 0.1 0 °
Bedrock Saturated Only 1e-012 ft/sec 0.05 ft³/ft³ 0 /psf 0.1 0 °

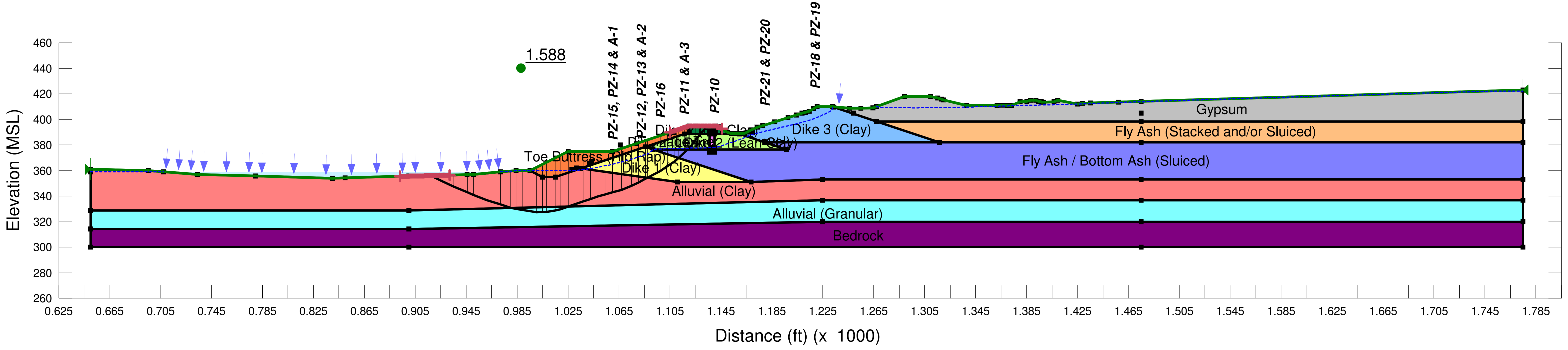


SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

File Name: Section H (Stability - Repair Design).gsz
Analysis Name: Stability - Existing Condition with Existing PZ Levels
Date Saved: 11/2/2009
Last Solved on 11/2/2009 at 2:01:28 PM
Analysis Method: Spencer

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Stacked and/or Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Toe Buttress (Rip Rap)	140 pcf	0 psf	38 °
Drainage Trench (Gravel)	130 pcf	0 psf	30 °
Bedrock			

Calculated Factor of Safety: 1.588

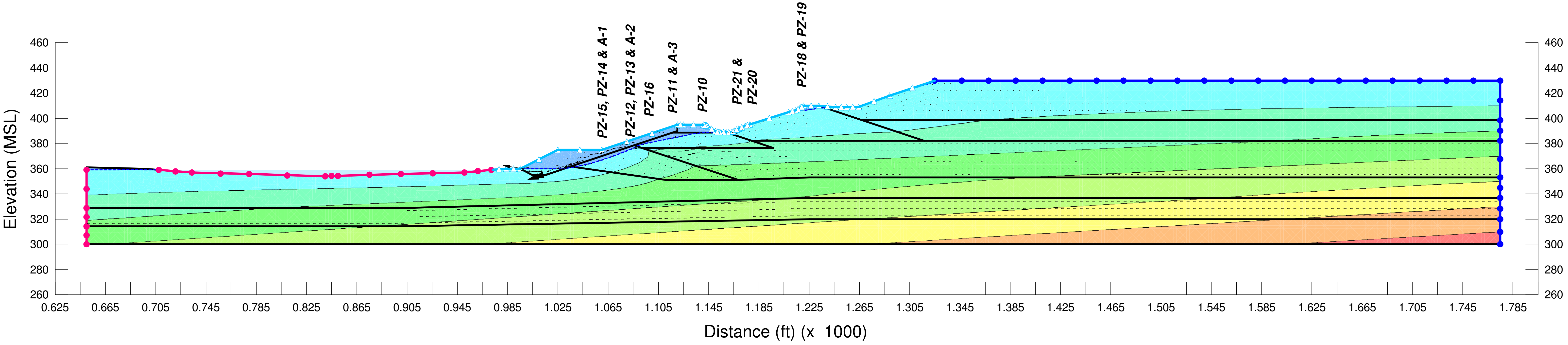


SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

Stantec

File Name: Section H (StabRepDgn-Buildout 430) no drain.gsz
Analysis Name: Steady-State Seepage
Date Saved: 11/2/2009
Last Solved on 11/2/2009 at 10:24:56 AM
Analysis Method: Steady-State

Material Type
Dike 1 (Clay) Saturated / Unsaturated Dike 1 (Clay) Dike 1 (Clay) 0.1 0 °
Dike 2 (Lean Clay) Saturated / Unsaturated Dike 2 (Lean Clay) Dike 2 (Lean Clay) 0.1 0 °
Dike 3 (Clay) Saturated / Unsaturated Dike 3 (Clay) Dike 3 (Clay) 0.1 0 °
Alluvial (Clay) Saturated / Unsaturated Alluvial (Clay) Alluvial (Clay) 0.05 0 °
Alluvial (Granular) Saturated / Unsaturated Alluvial (Granular) Alluvial (Granular) 0.05 0 °
Gypsum Saturated / Unsaturated Gypsum Gypsum 0.02 0 °
Fly Ash (Stacked and/or Sluiced) Saturated / Unsaturated Fly Ash (Stacked and/or Sluiced) Fly Ash (Stacked and/or Sluiced) 0.02 0 °
Fly Ash / Bottom Ash (Sluiced) Saturated / Unsaturated Fly Ash/Bottom Ash (Sluiced) Fly Ash/Bottom Ash (Sluiced) 0.02 0 °
Dike 2 (Fat Clay) Saturated / Unsaturated Dike 2 (Fat Clay) Dike 2 (Fat Clay) 0.1 0 °
Toe Buttress (Rip Rap) Saturated / Unsaturated Rip Rap Rip Rap 0.5 0 °
Bedrock Saturated Only 1e-012 ft/sec 0.05 ft^3/ft^3 0 /psf 0.1 0 °



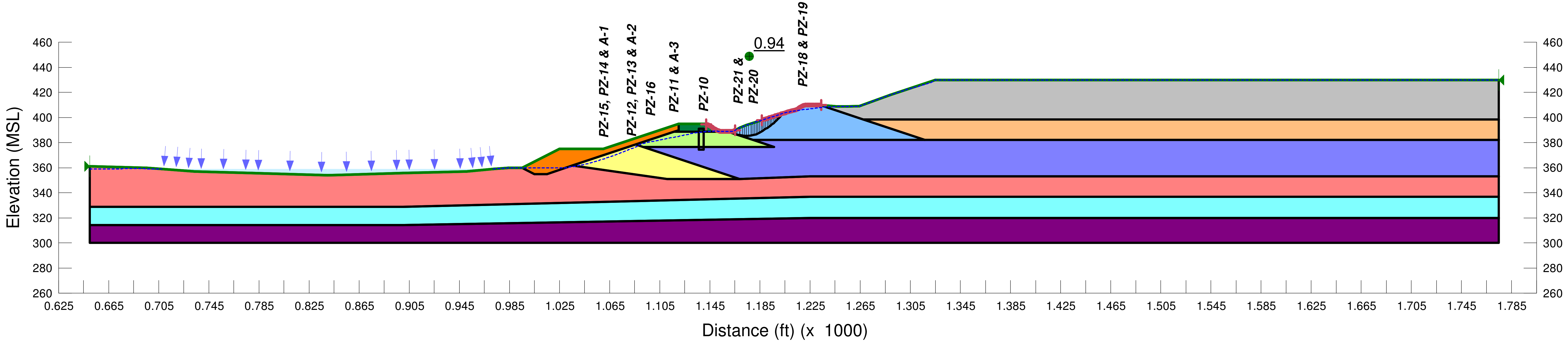
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

Stantec

File Name: Section H (StabRepDgn-Buildout 430) no drain.gsz
Analysis Name: Stability - Existing Condition with Existing PZ Levels
Date Saved: 11/2/2009
Last Solved on 11/2/2009 at 10:30:38 AM
Analysis Method: Spencer

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Stacked and/or Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Toe Buttress (Rip Rap)	140 pcf	0 psf	38 °
Bedrock			

Calculated Factor of Safety: 0.94

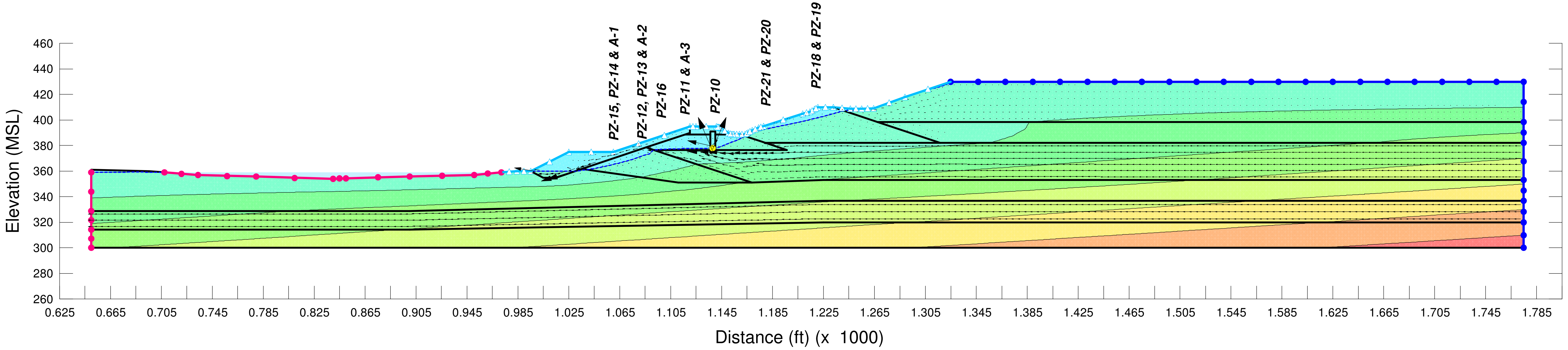


SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

Stantec

File Name: Section H (StabRepDgn-Buildout 430)2.gsz
Analysis Name: Steady-State Seepage
Date Saved: 11/2/2009
Last Solved on 11/2/2009 at 1:02:44 PM
Analysis Method: Steady-State

Material Type						
Dike 1 (Clay)	Saturated / Unsaturated	Dike 1 (Clay)	Dike 1 (Clay)	0.1	0 °	
Dike 2 (Lean Clay)	Saturated / Unsaturated	Dike 2 (Lean Clay)	Dike 2 (Lean Clay)	0.1	0 °	
Dike 3 (Clay)	Saturated / Unsaturated	Dike 3 (Clay)	Dike 3 (Clay)	0.1	0 °	
Alluvial (Clay)	Saturated / Unsaturated	Alluvial (Clay)	Alluvial (Clay)	0.05	0 °	
Alluvial (Granular)	Saturated / Unsaturated	Alluvial (Granular)	Alluvial (Granular)	0.05	0 °	
Gypsum	Saturated / Unsaturated	Gypsum	Gypsum	0.02	0 °	
Fly Ash (Stacked and/or Sluiced)	Saturated / Unsaturated	Fly Ash (Stacked and/or Sluiced)	Fly Ash (Stacked and/or Sluiced)	0.02	0 °	
Fly Ash / Bottom Ash (Sluiced)	Saturated / Unsaturated	Fly Ash/Bottom Ash (Sluiced)	Fly Ash/Bottom Ash (Sluiced)	0.02	0 °	
Dike 2 (Fat Clay)	Saturated / Unsaturated	Dike 2 (Fat Clay)	Dike 2 (Fat Clay)	0.1	0 °	
Toe Buttress (Rip Rap)	Saturated / Unsaturated	Rip Rap	Rip Rap	0.5	0 °	
Drainage Trench (Gravel)	Saturated / Unsaturated	Gravel	Gravel	0.1	0 °	
Bedrock	Saturated Only	1e-012 ft/sec	0.05 ft³/ft³	0 /psf	0.1	0 °

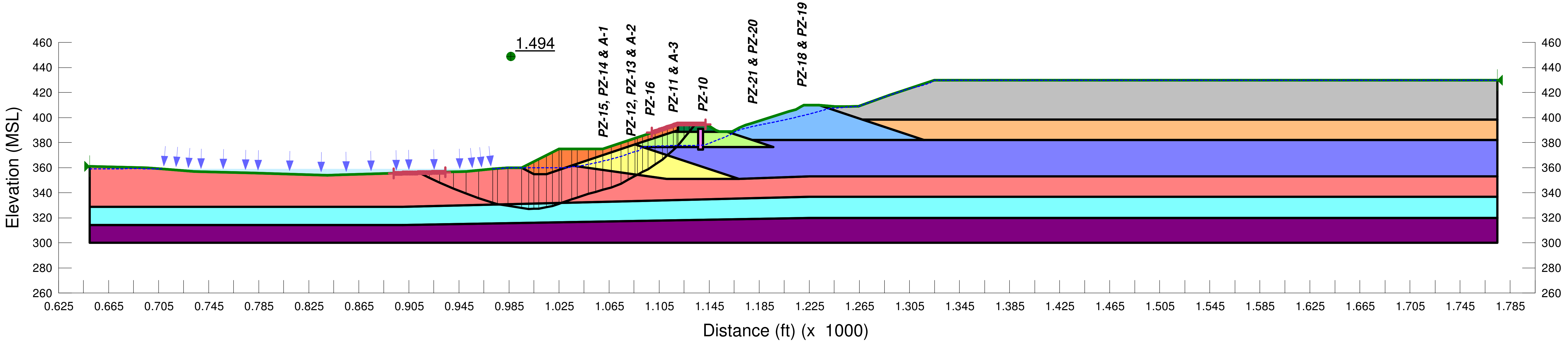


SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

File Name: Section H (StabRepDgn-Buildout 430)2.gsz
Analysis Name: Stability - Existing Condition with Existing PZ Levels
Date Saved: 11/2/2009
Last Solved on 11/2/2009 at 1:06:12 PM
Analysis Method: Spencer

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Stacked and/or Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Toe Buttress (Rip Rap)	140 pcf	0 psf	38 °
Drainage Trench (Gravel)	130 pcf	0 psf	30 °
Bedrock			

Calculated Factor of Safety: 1.494



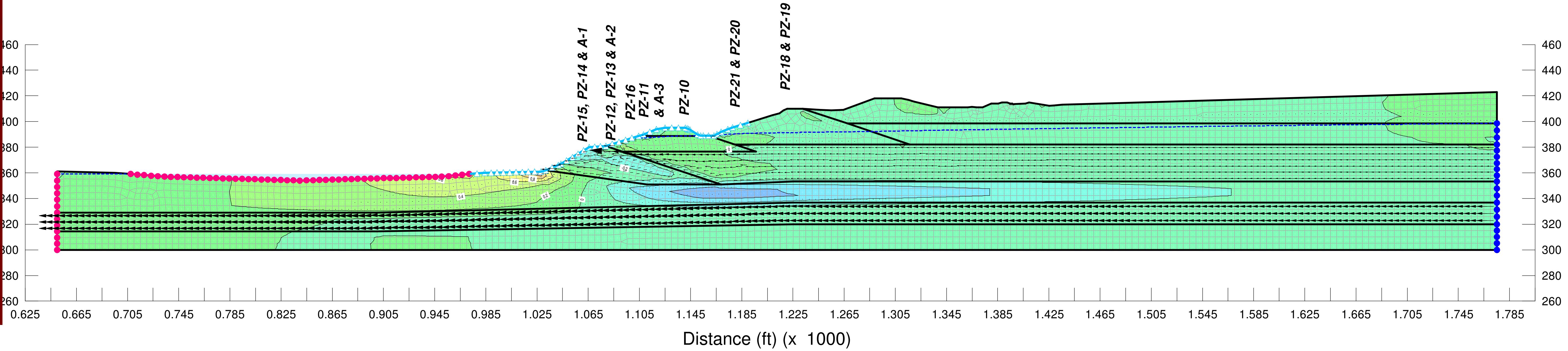
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

Stantec

File Name: Section H ns.gsz
Analysis Name: Steady-State Seepage
Date Saved: 12/9/2009
Last Solved on 12/9/2009 at 7:45:10 PM
Analysis Method: Steady-State

Material Type
Dike 1 (Clay) Saturated / Unsaturated Dike 1 (Clay) Dike 1 (Clay) 0.1 0 °
Dike 2 (Lean Clay) Saturated / Unsaturated Dike 2 (Lean Clay) Dike 2 (Lean Clay) 0.1 0 °
Dike 3 (Clay) Saturated / Unsaturated Dike 3 (Clay) Dike 3 (Clay) 0.1 0 °
Alluvial (Clay) Saturated / Unsaturated Alluvial (Clay) Alluival (Clay) 0.05 0 °
Alluvial (Granular) Saturated / Unsaturated Alluvial (Granular) Alluvial (Granular) 0.05 0 °
Gypsum Saturated / Unsaturated Gypsum Gypsum 0.02 0 °
Fly Ash (Stacked and/or Sluiced) Saturated / Unsaturated Fly Ash (Stacked and/or Sluiced) Fly Ash (Stacked and/or Sluiced) 0.02 0 °
Fly Ash / Bottom Ash (Sluiced) Saturated / Unsaturated Fly Ash/Bottom Ash (Sluiced) Fly Ash/Bottom Ash (Sluiced) 0.02 0 °
Dike 2 (Fat Clay) Saturated / Unsaturated Dike 2 (Fat Clay) Dike 2 (Fat Clay) 0.1 0 °
Bedrock Saturated Only 1e-012 ft/sec 0.05 ft³/ft³ 0 /psf 0.1 0 °

Seepage - Y Gradient

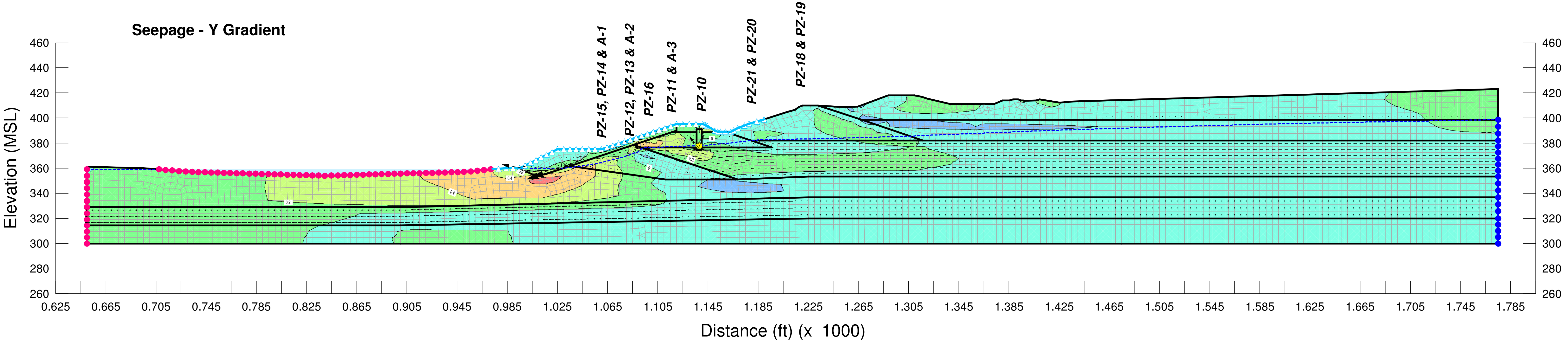


SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

Stantec

File Name: Section H (Stability - Repair Design) ns.gsz
Analysis Name: Steady-State Seepage
Date Saved: 12/9/2009
Last Solved on 12/9/2009 at 7:40:34 PM
Analysis Method: Steady-State

Material Type
Dike 1 (Clay) Saturated / Unsaturated Dike 1 (Clay) Dike 1 (Clay) 0.1 0 °
Dike 2 (Lean Clay) Saturated / Unsaturated Dike 2 (Lean Clay) Dike 2 (Lean Clay) 0.1 0 °
Dike 3 (Clay) Saturated / Unsaturated Dike 3 (Clay) Dike 3 (Clay) 0.1 0 °
Alluvial (Clay) Saturated / Unsaturated Alluvial (Clay) Alluival (Clay) 0.05 0 °
Alluvial (Granular) Saturated / Unsaturated Alluvial (Granular) Alluvial (Granular) 0.05 0 °
Gypsum Saturated / Unsaturated Gypsum Gypsum 0.02 0 °
Fly Ash (Stacked and/or Sluiced) Saturated / Unsaturated Fly Ash (Stacked and/or Sluiced) Fly Ash (Stacked and/or Sluiced) 0.02 0 °
Fly Ash / Bottom Ash (Sluiced) Saturated / Unsaturated Fly Ash/Bottom Ash (Sluiced) Fly Ash/Bottom Ash (Sluiced) 0.02 0 °
Dike 2 (Fat Clay) Saturated / Unsaturated Dike 2 (Fat Clay) Dike 2 (Fat Clay) 0.1 0 °
Toe Buttress (Rip Rap) Saturated / Unsaturated Rip Rap Rip Rap 0.5 0 °
Drainage Trench (Gravel) Saturated / Unsaturated Gravel Gravel 0.1 0 °
Bedrock Saturated Only 1e-012 ft/sec 0.05 ft³/ft³ 0 /psf 0.1 0 °

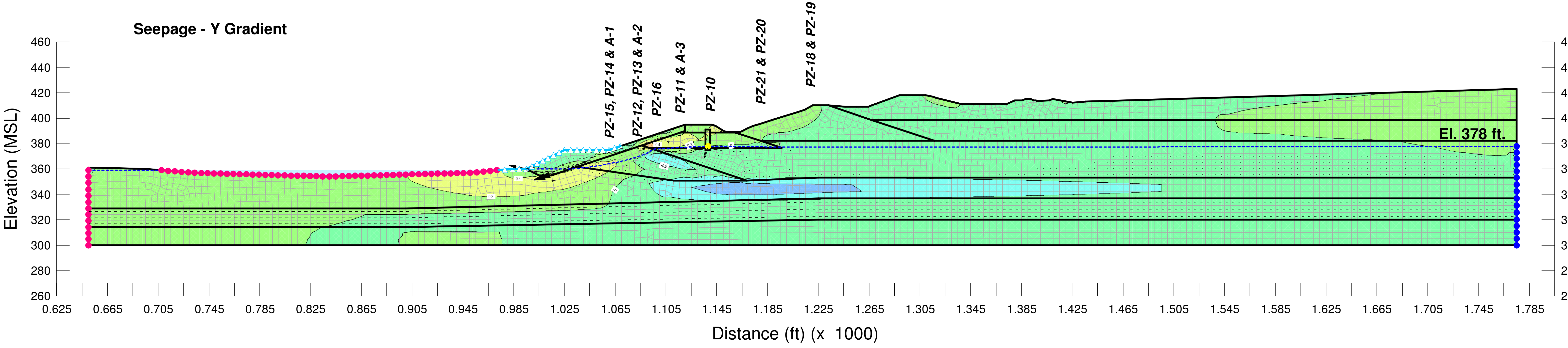


SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

Stantec

File Name: Section H (Stability - Repair Design) ns2.gsz
Analysis Name: Steady-State Seepage
Date Saved: 12/10/2009
Last Solved on 12/10/2009 at 10:11:39 AM
Analysis Method: Steady-State

Material Type
Dike 1 (Clay) Saturated / Unsaturated Dike 1 (Clay) Dike 1 (Clay) 0.1 0 °
Dike 2 (Lean Clay) Saturated / Unsaturated Dike 2 (Lean Clay) Dike 2 (Lean Clay) 0.1 0 °
Dike 3 (Clay) Saturated / Unsaturated Dike 3 (Clay) Dike 3 (Clay) 0.1 0 °
Alluvial (Clay) Saturated / Unsaturated Alluvial (Clay) Alluivial (Clay) 0.05 0 °
Alluvial (Granular) Saturated / Unsaturated Alluvial (Granular) Alluvial (Granular) 0.05 0 °
Gypsum Saturated / Unsaturated Gypsum Gypsum 0.02 0 °
Fly Ash (Stacked and/or Sluiced) Saturated / Unsaturated Fly Ash (Stacked and/or Sluiced) Fly Ash (Stacked and/or Sluiced) 0.02 0 °
Fly Ash / Bottom Ash (Sluiced) Saturated / Unsaturated Fly Ash/Bottom Ash (Sluiced) Fly Ash/Bottom Ash (Sluiced) 0.02 0 °
Dike 2 (Fat Clay) Saturated / Unsaturated Dike 2 (Fat Clay) Dike 2 (Fat Clay) 0.1 0 °
Toe Buttress (Rip Rap) Saturated / Unsaturated Rip Rap Rip Rap 0.5 0 °
Drainage Trench (Gravel) Saturated / Unsaturated Gravel Gravel 0.1 0 °
Bedrock Saturated Only 1e-012 ft/sec 0.05 ft³/ft³ 0 /psf 0.1 0 °



Appendix M

Slope Stability Analyses Output

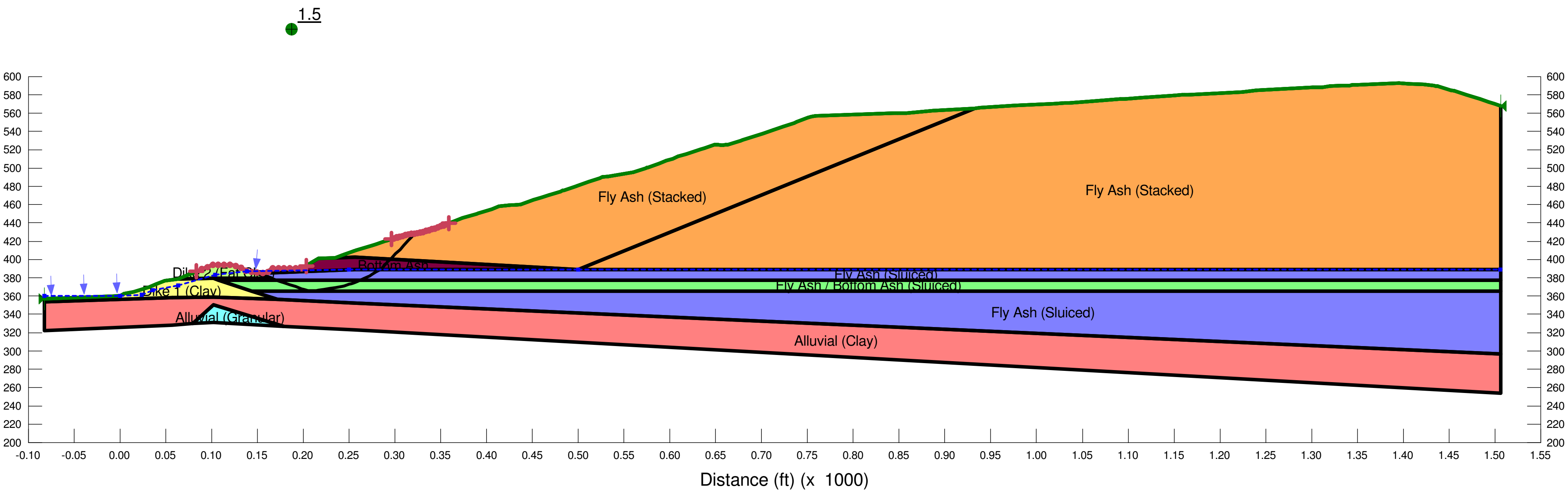
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section C (Stability - Repair Design-TVABuildout).gsz
Analysis Name: Stability - Buildout w Existing PZ Levels
Date Saved: 12/15/2009
Last Solved on 12/15/2009 at 9:00:53 PM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Bottom Ash	105 pcf	0 psf	35 °

Analysis Method: Spencer
Calculated Factor of Safety: 1.5



Stability - Buildout w Existing PZ Levels

File Information

Created By: Cooper, Paul
Revision Number: 227
Last Edited By: Rogers, Daniel
Date: 12/15/2009
Time: 8:59:38 PM
File Name: Section C (Stability - Repair Design-TVABuildout).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\Buildout\
Last Solved Date: 12/15/2009
Last Solved Time: 9:00:53 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Buildout w Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
  Apply Phreatic Correction: No
  PWP Conditions Source: Piezometric Line
  Use Staged Rapid Drawdown: No
SlipSurface
  Direction of movement: Right to Left
  Use Passive Mode: No
  Slip Surface Option: Entry and Exit
  Critical slip surfaces saved: 1
  Optimize Critical Slip Surface Location: Yes
FOS Distribution
  FOS Calculation Option: Constant
Advanced
  Number of Slices: 30
  Optimization Tolerance: 0.01
  Minimum Slip Surface Depth: 10 ft
  Optimization Maximum Iterations: 5000

Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf

Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bottom Ash

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (83.6061, 387) ft
Left-Zone Right Coordinate: (203.3646, 393) ft
Left-Zone Increment: 20
Right Projection: Range
Right-Zone Left Coordinate: (295.8154, 422) ft
Right-Zone Right Coordinate: (359, 439.667) ft
Right-Zone Increment: 20
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-82.7906, 356.7674) ft
Right Coordinate: (1506.5837, 568.049) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-82.7906	359.891
	0	359.891
	24	361.2072
	36	366.578
	63.7	372
	104	383
	138.587	387.003
	249.7	389
	500	389
	1506	389

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.5	(218.394, 477.146)	86.91192	(321.799, 428.467)	(148.342, 385.695)
2	8048	1.5	(218.394, 477.146)	111.213	(318.054, 427.789)	(155.864, 385.177)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	149.85335	385.0984	131.48232	162.8533	12.674696	0
2	Optimized	155.47655	382.8778	276.35162	417.49045	57.023786	0
3	Optimized	160.12185	381.04335	396.0371	683.62477	116.19296	0
4	Optimized	161.5673	380.51745	430.46834	782.33537	142.16351	0
5	Optimized	164.0275	379.66705	486.3009	1084.2474	241.58606	0
6	Optimized	168.16315	378.23755	580.13625	1451.5642	352.07973	0
7	Optimized	173.43045	376.4169	699.65613	1659.7081	387.88617	0
8	Optimized	177.19795	375.11465	785.15588	1776.5911	400.56583	0
9	Optimized	181.63415	373.5835	885.64673	1951.0852	430.4651	0
10	Optimized	188.3306	371.27335	1037.3178	2215.0697	475.84265	0
11	Optimized	195.02705	368.9632	1188.9748	2479.0542	521.22591	0
12	Optimized	199.48495	367.4253	1289.9277	2744.0194	587.49121	0
13	Optimized	202.7549	366.61785	1343.9975	2909.875	632.65556	0
14	Optimized	207.22955	366.03095	1385.6283	3140.6915	709.09153	0
15	Optimized	211.73445	365.9999	1392.6335	3288.0294	765.78968	0
16	Optimized	215.30635	366.3492	1374.8288	3362.4367	803.04569	0

17	Optimized	219.672	367.03855	1336.711	3393.4529	830.97767	0
18	Optimized	225.64055	367.98105	1284.5969	3327.5863	825.42128	0
19	Optimized	231.6091	368.9235	1232.4829	3261.8852	819.93176	0
20	Optimized	238.5302	370.01635	1172.051	3310.8125	864.11577	0
21	Optimized	243.68875	371.00155	1116.3507	3235.6912	856.26914	0
22	Optimized	247.30525	372.07765	1053.2652	3254.9321	889.53117	0
23	Optimized	251.02965	373.18585	986.8159	3273.1911	923.75555	0
24	Optimized	253.80425	374.01145	935.27034	3286.7456	950.05767	0
25	Optimized	255.6746	374.62905	896.75176	3128.689	901.76118	0
26	Optimized	256.97845	375.2041	860.84917	3116.8156	911.46961	0
27	Optimized	259.8617	376.47575	781.51242	3078.9965	928.24381	0
28	Optimized	264.13835	378.36205	663.80404	3015.6619	950.21224	0
29	Optimized	268.6821	380.3661	538.75556	2948.4055	973.56178	0
30	Optimized	271.69305	381.7987	449.36306	2751.2907	930.03914	0
31	Optimized	273.69505	382.96515	376.58657	2697.5078	937.71306	0
32	Optimized	277.31785	385.07595	244.857	2605.6446	953.8201	0
33	Optimized	281.86525	387.72545	79.531787	2493.7247	975.39725	0
34	Optimized	284.187	389.0782	-4.8797524	2436.9149	984.57752	0
35	Optimized	287.38085	392.34755	-208.89123	1703.9282	1193.1034	0
36	Optimized	290.55865	395.66195	-415.71541	1550.3075	1085.537	0
37	Optimized	291.2718	396.40575	-462.11628	1516.1746	1061.6369	0
38	Optimized	293.56485	398.7593	-608.98795	1422.4076	995.9805	0
39	Optimized	297.96625	403.25135	-889.28567	1258.8063	786.58949	0
40	Optimized	303.0783	408.51205	-1217.546	1021.1319	638.07401	0
41	Optimized	307.66375	413.27445	-1514.73	796.58151	497.75937	0
42	Optimized	312.2691	418.1377	-1818.1507	540.37449	337.66346	0
43	Optimized	316.214	422.3651	-2081.9765	322.68014	201.63293	0
44	Optimized	319.76465	426.22875	-2323.1347	117.22781	73.252065	0

Slices of Slip Surface: 8048

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	8048	157.72635	383.96485	211.04529	315.2596	42.105316	0
2	8048	161.03415	381.882	344.73684	671.30781	131.94323	0
3	8048	164.0275	380.14415	456.53609	1129.5056	271.89731	0
4	8048	167.43385	378.3183	574.27302	1542.5935	391.22689	0
5	8048	170.0216	377.0077	658.96089	1710.619	424.89746	0

6	8048	173.43045	375.47045	758.7039	1835.7501	435.15492	0
7	8048	178.89315	373.2276	904.78642	2011.4575	447.12413	0
8	8048	184.4595	371.2776	1032.7138	2181.0764	463.96862	0
9	8048	190.02585	369.65105	1140.442	2310.9696	472.92386	0
10	8048	195.59215	368.3334	1228.9126	2405.0402	475.1864	0
11	8048	201.42735	367.27885	1301.2573	2686.64	559.73097	0
12	8048	207.5315	366.50785	1356.2119	3136.718	719.37114	0
13	8048	213.63565	366.07745	1389.9137	3529.6147	864.49534	0
14	8048	219.672	365.98105	1402.7064	3683.2206	921.38752	0
15	8048	225.64055	366.2103	1395.1009	3615.442	897.07606	0
16	8048	231.6091	366.7625	1367.3335	3518.106	868.9685	0
17	8048	237.1727	367.5618	1323.6984	3483.7387	872.71292	0
18	8048	242.33125	368.57245	1266.4235	3510.6916	906.74314	0
19	8048	247.30525	369.786	1196.2599	3506.7658	933.50495	0
20	8048	251.02965	370.8391	1133.2463	3485.5844	950.40628	0
21	8048	254.22965	371.88405	1068.0269	3452.5378	963.40495	0
22	8048	256.97845	372.84575	1008.0256	3417.2403	973.38593	0
23	8048	260.26645	374.15035	926.61207	3345.138	977.14791	0
24	8048	265.0856	376.245	795.91587	3214.435	977.14514	0
25	8048	269.96365	378.65245	645.68574	3054.9036	973.38719	0
26	8048	273.69505	380.6688	519.88091	2917.4607	968.6851	0
27	8048	277.31785	382.86765	382.66573	2768.0291	963.74934	0
28	8048	282.9418	386.6713	145.31193	2504.5827	953.20726	0
29	8048	286.30965	389.08	-4.9919695	2336.2142	943.89182	0
30	8048	288.42695	390.793	-111.88325	2033.9252	1424.1698	0
31	8048	290.55865	392.5268	-220.07264	1918.7851	1343.5478	0
32	8048	294.73015	396.4625	-465.66267	1662.0057	1163.7489	0
33	8048	302.13525	404.14215	-944.87016	1239.2672	774.38008	0
34	8048	307.7897	411.1038	-1379.2664	841.84279	526.04176	0
35	8048	312.39505	417.8725	-1801.6536	470.46138	293.9769	0
36	8048	316.37575	424.65675	-2224.9162	138.45611	86.516982	0

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section E (Stability -TVABuildout).gsz

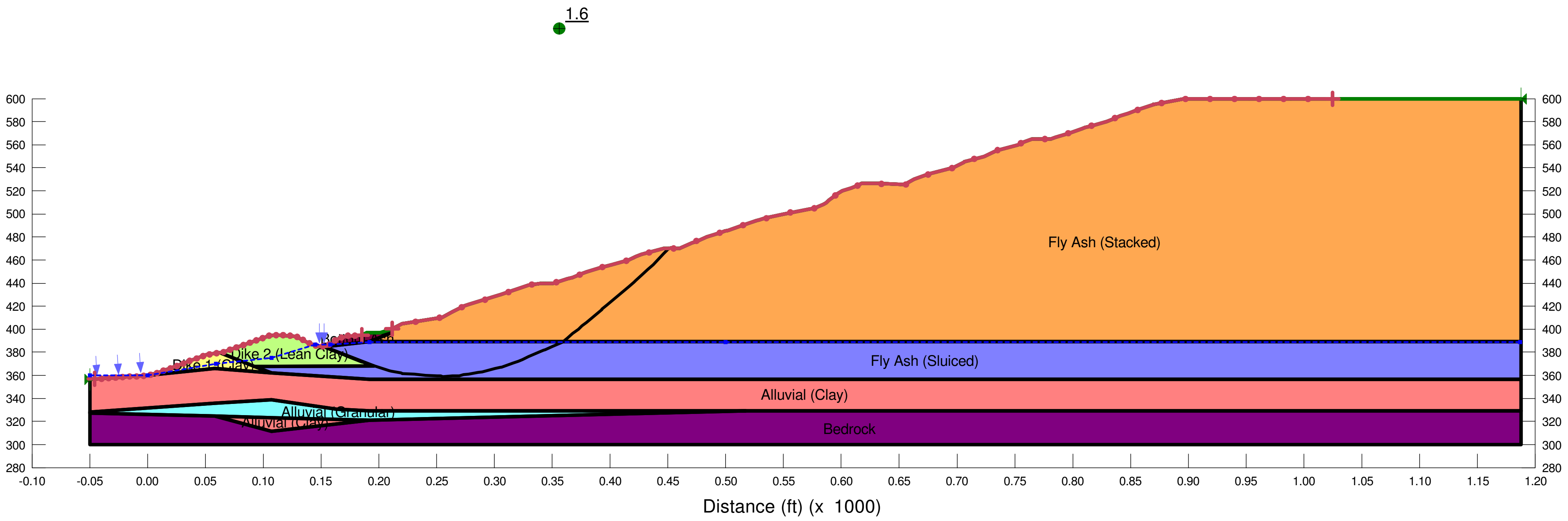
Analysis Name: Stability - Existing Condition with Existing PZ Levels (Deep)

Date Saved: 10/23/2009
Last Solved on 10/23/2009 at 9:22:50 AM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Bottom Ash	105 pcf	0 psf	35 °
Bedrock			

Analysis Method: Spencer
Calculated Factor of Safety: 1.6



Stability - Existing Condition with Existing PZ Levels (Deep)

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File Information

Created By: Cooper, Paul
Revision Number: 212
Last Edited By: Rogers, Daniel
Date: 10/23/2009
Time: 9:19:40 AM
File Name: Section E (Stability -TVABuildout).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\Buildout\
Last Solved Date: 10/23/2009
Last Solved Time: 9:22:50 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels (Deep)

Kind: SLOPE/W
Method: Spencer
Settings
    Apply Phreatic Correction: No
    PWP Conditions Source: Piezometric Line
    Use Staged Rapid Drawdown: No
SlipSurface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: Yes
FOS Distribution
    FOS Calculation Option: Constant
Advanced
    Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 60 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Fly Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bottom Ash

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bedrock

Model: Bedrock (Impenetrable)
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-45.6134, 356.7306) ft
Left-Zone Right Coordinate: (185.478, 395) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (211.575, 400.3748) ft
Right-Zone Right Coordinate: (1025, 599.9336) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-50, 356.4268) ft
Right Coordinate: (1187.8959, 599.5322) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-50	360
	0	360
	59	370
	107	375
	145	387
	158	387
	192	389
	500	389
	1187	389

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.6	(251.188, 613.398)	155.9565	(450.875, 470.31)	(150.115, 385.416)
2	43601	1.6	(251.188, 613.398)	248.801	(454.702, 470.276)	(151.606, 385.396)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	151.26465	384.9722	126.53604	171.57209	31.534582	0
2	Optimized	153.6419	384.0551	183.76217	274.3117	36.584385	0
3	Optimized	156.2783	383.038	247.23189	448.30217	81.237667	0
4	Optimized	157.8434	382.43415	284.90934	569.15137	114.84123	0
5	Optimized	158.6998	382.10375	308.09042	676.86835	148.99596	0
6	Optimized	162.22035	380.74555	405.77015	1167.5484	307.77838	0
7	Optimized	167.7531	378.61105	559.27019	1810.5671	505.55678	0
8	Optimized	170.8946	377.3998	646.38232	2087.1234	582.09719	0
9	Optimized	178.41525	374.51045	854.27724	2507.9379	668.12227	0
10	Optimized	185.61	371.7463	1053.1945	2902.7496	747.26877	0
11	Optimized	186.60285	371.36485	1080.6033	3017.4803	782.5491	0
12	Optimized	188.4437	370.71105	1128.1623	3133.5622	810.23416	0
13	Optimized	190.55765	370.01755	1179.1908	3276.6382	847.42374	0
14	Optimized	191.86	369.5903	1210.6634	3324.1664	853.91061	0
15	Optimized	196.59455	368.03715	1308.0454	3492.533	882.59026	0
16	Optimized	205.17295	365.223	1483.6367	3955.5298	998.70963	0
17	Optimized	209.98865	363.7405	1576.2003	4074.0904	1009.2131	0

18	Optimized	214.99625	362.68355	1642.1996	4469.4495	1142.2831	0
19	Optimized	219.73415	361.7611	1699.7235	4565.8613	1157.9948	0
20	Optimized	220.5319	361.70275	1703.3479	4615.862	1176.7321	0
21	Optimized	225.7007	361.32485	1726.9293	4751.4815	1221.9984	0
22	Optimized	235.56705	360.6035	1771.9119	4993.1748	1301.4747	0
23	Optimized	245.4334	359.8821	1816.9956	5234.868	1380.9101	0
24	Optimized	251.97425	359.40385	1846.8102	5394.7367	1433.4554	0
25	Optimized	254.25115	359.23735	1857.2015	5476.0807	1462.1221	0
26	Optimized	255.45335	359.14945	1862.652	5551.371	1490.3392	0
27	Optimized	259.87945	359.26735	1855.3454	5505.2095	1474.6408	0
28	Optimized	266.27235	359.52495	1839.2516	5814.6634	1606.1707	0
29	Optimized	269.1528	359.68615	1829.1915	5678.1207	1555.0683	0
30	Optimized	271.498	360.0586	1805.9507	5757.3242	1596.4585	0
31	Optimized	275.63305	360.7153	1764.9634	5859.399	1654.2594	0
32	Optimized	281.8018	361.69495	1703.7997	5955.3327	1717.7308	0
33	Optimized	287.5953	362.773	1636.5646	5819.8816	1690.1698	0
34	Optimized	295.0474	364.61235	1521.8229	5859.5416	1752.5521	0
35	Optimized	303.16325	366.61555	1396.7873	5905.8025	1821.7604	0
36	Optimized	305.71765	367.24605	1357.4269	5922.9286	1844.5824	0
37	Optimized	310.96905	369.05585	1244.5274	5691.6372	1796.749	0
38	Optimized	318.31705	371.60145	1085.6729	5680.1147	1856.275	0
39	Optimized	322.2376	372.95965	1000.9063	5674.8362	1888.3903	0
40	Optimized	326.6162	374.73195	890.33386	5440.6512	1838.4475	0
41	Optimized	334.4932	378.21995	672.67206	5282.6627	1862.5571	0
42	Optimized	341.1459	381.1658	488.8656	5088.7558	1858.4763	0
43	Optimized	343.17395	382.06385	432.81911	5004.9904	1847.2771	0
44	Optimized	347.0934	383.7994	324.51168	4865.1254	1834.527	0
45	Optimized	354.62425	387.1341	116.42886	4686.8827	1846.5832	0
46	Optimized	359.1002	389.1161	-7.2445687	4622.9091	1867.7765	0
47	Optimized	359.45765	389.3106	-19.382291	3983.4643	1609.4241	0
48	Optimized	361.38405	390.89675	-118.35705	3678.0926	2298.3273	0
49	Optimized	365.46865	394.25995	-328.22648	3523.6129	2201.7977	0
50	Optimized	370.11045	398.0819	-566.70441	3368.7115	2105.0046	0
51	Optimized	374.19445	401.48175	-778.86468	3217.6078	2010.5845	0
52	Optimized	377.7073	404.45115	-964.15523	3116.0687	1947.1358	0
53	Optimized	386.11035	411.5542	-1407.3736	2806.3399	1753.5958	0
54	Optimized	392.83625	417.23985	-1762.1604	2539.3261	1586.7471	0

55	Optimized	395.0984	419.1566	-1881.752	2451.4188	1531.8165	0
56	Optimized	399.4157	422.81475	-2109.9913	2279.2494	1424.2331	0
57	Optimized	408.71355	430.693	-2601.6463	1904.9916	1190.3708	0
58	Optimized	418.22695	438.7539	-3104.6406	1550.1683	968.65264	0
59	Optimized	421.44645	441.54285	-3278.6654	1406.129	878.64689	0
60	Optimized	424.5885	444.44205	-3459.5619	1309.6789	818.3782	0
61	Optimized	429.80495	449.2553	-3759.8949	1109.3857	693.2211	0
62	Optimized	434.93095	453.9851	-4055.0471	879.1342	549.34402	0
63	Optimized	441.6494	460.71115	-4474.7637	520.17716	325.04276	0
64	Optimized	448.21195	467.539	-4900.8133	167.13468	104.43734	0
65	Optimized	450.58695	470.01	-5054.9685	18.505053	11.56324	0

Slices of Slip Surface: 43601

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	43601	152.476	385.01965	123.57279	169.70684	32.30341	0
2	43601	154.1079	384.3207	167.18851	247.62268	32.497514	0
3	43601	156.2783	383.41655	223.60792	411.81607	76.041027	0
4	43601	157.8434	382.7719	263.83367	537.59463	110.60661	0
5	43601	158.6998	382.4283	287.84041	647.42203	145.28041	0
6	43601	162.22035	381.0679	385.64865	1135.3104	302.88302	0
7	43601	168.1826	378.87585	544.32712	1778.8645	498.78546	0
8	43601	178.41525	375.59395	786.70344	2299.159	611.07172	0
9	43601	185.61	373.3956	950.2696	2574.6012	656.27256	0
10	43601	187.55445	372.88025	989.55773	2749.2091	710.94531	0
11	43601	190.55765	372.10115	1049.2027	2937.2585	762.82408	0
12	43601	191.86	371.7747	1074.3383	2963.9251	763.44263	0
13	43601	196.59455	370.7068	1141.4492	3042.449	768.05377	0
14	43601	206.0048	368.78375	1261.4445	3350.8173	844.16139	0
15	43601	215.5584	367.2085	1359.7546	3895.2336	1024.4	0
16	43601	220.5319	366.49355	1404.3901	4219.5097	1137.3821	0
17	43601	225.7007	365.9562	1437.9092	4333.6901	1169.9714	0
18	43601	235.56705	365.13765	1488.9925	4507.3382	1219.4908	0
19	43601	245.4334	364.71305	1515.5525	4634.711	1260.2218	0
20	43601	251.97425	364.604	1522.3076	4698.7606	1283.3703	0
21	43601	254.25115	364.61735	1521.5139	4740.0234	1300.3622	0

22	43601	259.3465	364.77085	1511.9175	4944.3574	1386.7957	0
23	43601	266.65305	365.0955	1491.6504	5229.8459	1510.329	0
24	43601	271.498	365.4358	1470.4133	5407.1921	1590.5619	0
25	43601	275.63305	365.811	1446.9966	5502.2594	1638.4325	0
26	43601	283.5971	366.78665	1386.1139	5579.7095	1694.3226	0
27	43601	295.0474	368.56135	1275.3955	5638.2241	1762.6972	0
28	43601	303.16325	370.1	1179.3629	5650.3477	1806.3951	0
29	43601	310.8737	371.9233	1065.5457	5641.0697	1848.6317	0
30	43601	318.31705	373.83555	946.26117	5617.9109	1887.469	0
31	43601	324.8876	375.808	823.17929	5571.6966	1918.5255	0
32	43601	334.4932	379.02405	622.4943	5389.0499	1925.8135	0
33	43601	341.1459	381.4348	472.05748	5171.1499	1898.5566	0
34	43601	343.17395	382.2274	422.60734	5074.6971	1879.5663	0
35	43601	347.0934	383.853	321.17008	4903.0871	1851.2146	0
36	43601	354.52825	387.11945	117.34507	4652.4934	1832.3188	0
37	43601	359.0503	389.1945	-12.137397	4535.6708	1832.5299	0
38	43601	361.3349	390.3174	-82.206368	4346.6039	2716.0595	0
39	43601	365.46865	392.41115	-212.85494	4220.6375	2637.347	0
40	43601	371.8061	395.84075	-426.8604	4053.814	2533.1041	0
41	43601	377.7073	399.17825	-635.11994	3916.4308	2447.2576	0
42	43601	386.2504	404.60225	-973.6087	3603.3759	2251.6391	0
43	43601	395.0984	410.45785	-1338.9737	3251.1919	2031.5701	0
44	43601	399.4157	413.5912	-1534.4959	3060.5771	1912.4609	0
45	43601	408.71355	421.03605	-1999.0654	2608.2509	1629.8161	0
46	43601	419.0357	429.79565	-2545.6843	2134.6426	1333.8727	0
47	43601	424.5885	435.0069	-2870.8159	1904.7601	1190.2262	0
48	43601	429.80495	440.2491	-3198.0053	1640.043	1024.8126	0
49	43601	439.40655	451.01045	-3869.4462	1053.8362	658.50995	0
50	43601	448.21195	461.50465	-4524.3137	502.40083	313.93488	0
51	43601	451.55685	465.9208	-4799.8775	251.27966	157.01696	0
52	43601	453.75825	468.95295	-4988.9799	77.253187	48.273149	0

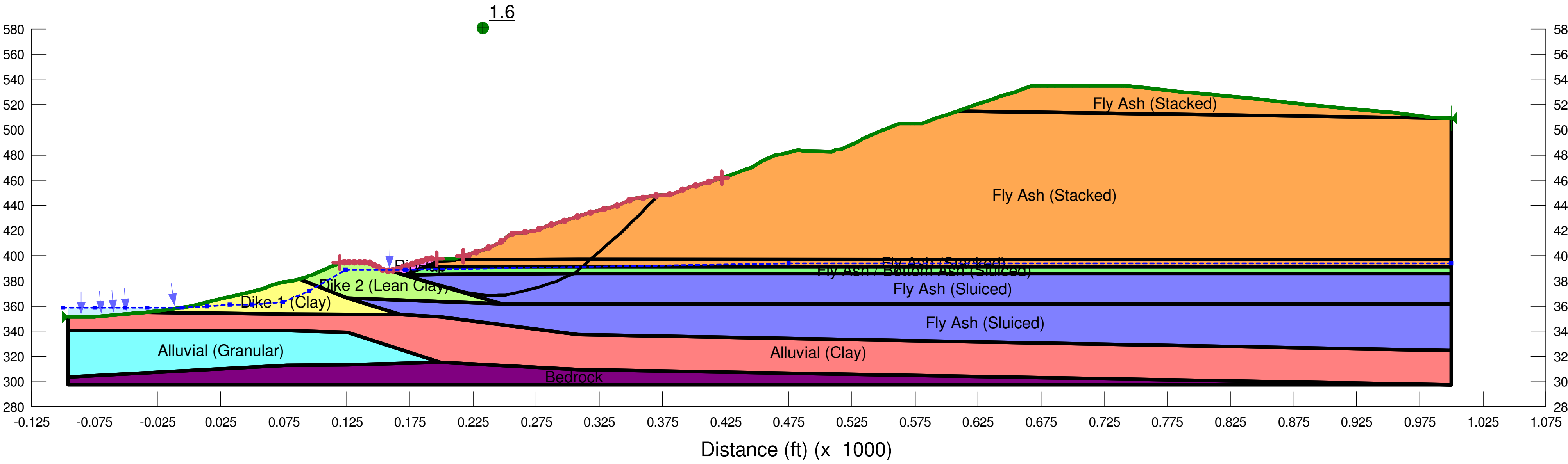
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section F (Stability -TVABuildout).gsz
Analysis Name: Stability - Existing Condition with Existing PZ Levels
Date Saved: 10/26/2009
Last Solved On: 10/26/2009 at 3:13:38 PM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	32 °
RipRap	135 pcf	0 psf	38 °
Bedrock			

Analysis Method: Spencer
Calculated Factor of Safety: 1.6



Stability - Existing Condition with Existing PZ Levels

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File Information

Created By: Cooper, Paul
Revision Number: 227
Last Edited By: Rogers, Daniel
Date: 10/26/2009
Time: 3:07:56 PM
File Name: Section F (Stability -TVABuildout).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\Buildout\
Last Solved Date: 10/26/2009
Last Solved Time: 3:13:38 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
    Apply Phreatic Correction: No
    PWP Conditions Source: Piezometric Line
    Use Staged Rapid Drawdown: No
SlipSurface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: Yes
FOS Distribution
    FOS Calculation Option: Constant
Advanced
    Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

RipRap

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bedrock

Model: Bedrock (Impenetrable)
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (119, 394.2769) ft
Left-Zone Right Coordinate: (196, 397.9986) ft
Left-Zone Increment: 20
Right Projection: Range
Right-Zone Left Coordinate: (217, 399.8946) ft
Right-Zone Right Coordinate: (422, 461.9095) ft
Right-Zone Increment: 20

Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-95.8093, 351.224) ft
Right Coordinate: (1000, 509.3361) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-100	359
	-75	359
	-51	359
	-33	359
	-6	359
	14	360
	32	361
	50	361
	74	363
	95	372
	124	389
	171	389
	475	394
	1000	394

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.6	(237.16, 526.106)	110.4817	(371.406, 447.881)	(159.097, 387.93)
2	8294	1.7	(237.16, 526.106)	154.333	(370.14, 447.781)	(165.221, 389.565)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	159.70655	387.7517	77.895571	138.52721	32.238415	100
2	Optimized	161.93885	387.09895	118.62556	297.84286	95.291528	100
3	Optimized	166.99135	385.62155	210.8179	792.75702	309.42252	100
4	Optimized	170.7105	384.53405	278.67661	1099.7217	331.72375	0
5	Optimized	172.4179	384.0348	311.28302	1224.2152	368.84853	0
6	Optimized	177.89585	382.40915	418.34279	1630.9338	489.91858	0

7	Optimized	183.0895	380.85995	520.3543	2013.9161	603.43815	0
8	Optimized	185.39045	380.21865	562.73892	2137.1974	636.1225	0
9	Optimized	188.2789	379.4686	612.48	2333.6776	695.40897	0
10	Optimized	194.37835	377.88475	717.58763	2504.1124	721.80284	0
11	Optimized	199.27775	376.6125	801.99728	2571.4663	714.91187	0
12	Optimized	200.77775	376.2082	828.76914	2632.0857	728.58718	0
13	Optimized	205.88675	374.80425	921.62214	2778.0926	750.06277	0
14	Optimized	210.29335	373.5933	1001.7017	2900.6079	767.2079	0
15	Optimized	211.1317	373.3629	1016.9465	2912.1573	765.71484	0
16	Optimized	211.82635	373.172	1029.5783	2927.8929	766.96886	0
17	Optimized	214.65545	372.39455	1080.9839	3118.8728	823.36056	0
18	Optimized	219.265	371.12785	1164.7606	3431.8141	915.94909	0
19	Optimized	221.56435	370.496	1206.548	3589.3838	962.72815	0
20	Optimized	224.7895	370.01785	1239.6971	3530.7664	925.65206	0
21	Optimized	230.46775	369.2737	1291.9602	3812.7737	1018.4748	0
22	Optimized	235.5214	368.6114	1338.4761	4081.8282	1108.3862	0
23	Optimized	239.50195	368.37265	1357.4545	4003.0009	1068.8701	0
24	Optimized	243.1678	368.47945	1354.5417	4162.8828	1134.6435	0
25	Optimized	247.31615	368.60035	1351.2534	4377.4094	1222.6464	0
26	Optimized	250.11465	368.6819	1349.0045	4559.0244	1296.9322	0
27	Optimized	251.28275	368.84395	1340.1147	4311.4476	1200.4964	0
28	Optimized	254.54255	369.61415	1295.4148	4454.4218	1276.3217	0
29	Optimized	260.06045	370.91785	1219.7336	4499.4985	1325.111	0
30	Optimized	266.66515	372.47835	1129.1393	4396.3829	1320.0521	0
31	Optimized	272.069	373.75515	1055.0221	4343.2346	1328.5241	0
32	Optimized	275.23115	374.50225	1011.6294	4363.1405	1354.0984	0
33	Optimized	281.1407	376.3671	901.33366	4213.9177	1338.3708	0
34	Optimized	286.6626	378.25685	789.0717	4217.2058	1385.0561	0
35	Optimized	289.2481	379.1417	736.52153	4208.3762	1402.7203	0
36	Optimized	290.8079	379.6755	704.82719	4202.023	1412.9588	0
37	Optimized	291.74065	380.0854	680.18722	4025.8438	1351.733	0
38	Optimized	295.51175	381.7741	578.68431	3973.7138	1371.6809	0
39	Optimized	301.3352	384.3819	421.92988	3893.1581	1402.4672	0
40	Optimized	304.68905	385.8838	331.65919	3848.32	1420.8232	0
41	Optimized	306.56585	387.30455	244.93174	3082.2036	1772.9242	0
42	Optimized	309.45115	389.76365	94.443883	2953.7487	1786.6919	0
43	Optimized	311.02305	391.10335	12.459953	2883.6143	1794.0964	0
44	Optimized	311.20315	391.2568	3.0683629	2875.4744	1794.8785	0
45	Optimized	313.15065	392.9166	-98.506565	2800.2541	1749.793	0
46	Optimized	316.4962	395.8123	-275.77072	2634.9766	1646.5161	0
47	Optimized	318.9049	397.93845	-405.97014	2538.613	1586.3015	0
48	Optimized	323.0848	401.628	-631.89407	2360.1968	1474.8146	0

49	Optimized	329.4763	407.2544	-976.42704	2087.7196	1304.552	0
50	Optimized	336.099	413.06815	-1332.3581	1801.9312	1125.9716	0
51	Optimized	340.65755	417.0699	-1577.4412	1618.1189	1011.1129	0
52	Optimized	343.4471	419.69315	-1738.2643	1454.8707	909.10412	0
53	Optimized	347.9691	424.12945	-2010.3999	1295.8571	809.7414	0
54	Optimized	353.7075	429.75915	-2355.8804	1038.9646	649.21714	0
55	Optimized	359.8539	435.94335	-2735.4117	675.7576	422.26021	0
56	Optimized	366.2089	442.50095	-3138.0677	308.90041	193.0224	0
57	Optimized	370.36515	446.8036	-3402.2822	64.618334	40.378016	0

Slices of Slip Surface: 8294

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	8294	165.7625	389.28245	-17.625006	115.37901	90.143961	0
2	8294	168.6519	387.8366	72.59632	651.26424	452.10493	0
3	8294	172.0605	386.1798	177.0667	1225.1164	818.82614	0
4	8294	174.2393	385.1871	241.24812	1388.8781	717.11881	0
5	8294	178.65675	383.3359	361.3033	1637.5325	515.63005	0
6	8294	184.25685	381.1443	503.8025	2085.0238	638.85488	0
7	8294	188.2789	379.72985	596.1881	2377.588	719.73228	0
8	8294	194.37835	377.89135	717.17893	2525.9532	730.79225	0
9	8294	200.2567	376.25815	825.11418	2581.0833	709.45756	0
10	8294	205.88675	375.0338	907.29099	2656.9547	706.91002	0
11	8294	210.29335	374.13	968.2096	2706.8991	702.47616	0
12	8294	211.1317	373.98495	978.13195	2702.3637	696.63483	0
13	8294	211.82635	373.8667	986.21328	2704.2901	694.14809	0
14	8294	214.65545	373.44715	1015.3048	2823.4507	730.53836	0
15	8294	219.265	372.82635	1058.7688	3008.6269	787.79382	0
16	8294	224.21045	372.34765	1093.7159	3187.7658	846.05109	0
17	8294	230.27475	371.95685	1124.3348	3383.3332	912.69462	0
18	8294	237.28745	371.8247	1139.7667	3598.9988	993.59426	0
19	8294	243.1678	371.90205	1140.9913	3795.4147	1072.4567	0
20	8294	247.31615	372.1244	1131.3612	3955.0713	1140.8529	0
21	8294	250.7328	372.3758	1119.1802	4148.2752	1223.8338	0
22	8294	254.54255	372.7784	1097.9576	4356.0971	1316.3738	0
23	8294	260.06045	373.50955	1057.9998	4397.6881	1349.3217	0

24	8294	266.66515	374.66765	992.52124	4256.2198	1318.6198	0
25	8294	272.069	375.7832	928.46767	4157.5956	1304.6524	0
26	8294	276.6992	376.9556	860.05511	4135.3176	1323.2919	0
27	8294	282.60875	378.6496	760.41182	4108.4199	1352.683	0
28	8294	286.6626	379.93255	684.49502	4072.5429	1368.8602	0
29	8294	289.2481	380.83775	630.68968	4031.183	1373.8885	0
30	8294	291.66725	381.72285	577.93061	3987.4404	1377.5314	0
31	8294	297.28395	384.05755	438.01382	3858.6347	1382.0205	0
32	8294	303.1074	386.5787	286.67478	3622.0842	2084.1951	0
33	8294	306.1237	388.05485	197.65943	3529.3944	2081.8991	0
34	8294	309.5724	389.82765	90.574418	3419.6091	2080.2118	0
35	8294	311.45125	390.83145	29.865085	3355.1815	2077.8883	0
36	8294	312.05075	391.16235	9.831144	3332.1403	2076.0092	0
37	8294	316.1	393.56215	-135.75702	3176.4306	1984.8541	0
38	8294	320.86235	396.4488	-310.99848	2989.7274	1868.189	0
39	8294	324.56095	398.949	-463.21444	2816.0402	1759.6572	0
40	8294	329.9468	402.8268	-699.6696	2552.0346	1594.6882	0
41	8294	336.099	407.7453	-1000.2623	2225.5775	1390.6951	0
42	8294	342.34785	413.2367	-1336.5608	1905.5137	1190.6971	0
43	8294	347.9691	418.75945	-1675.4181	1633.7691	1020.8922	0
44	8294	353.88805	425.2558	-2074.6574	1263.705	789.65053	0
45	8294	360.0625	432.89995	-2545.3602	794.99325	496.76692	0
46	8294	366.23695	441.69145	-3087.5699	306.78023	191.69756	0
47	8294	369.73225	447.0968	-3421.2547	34.263985	21.410514	0

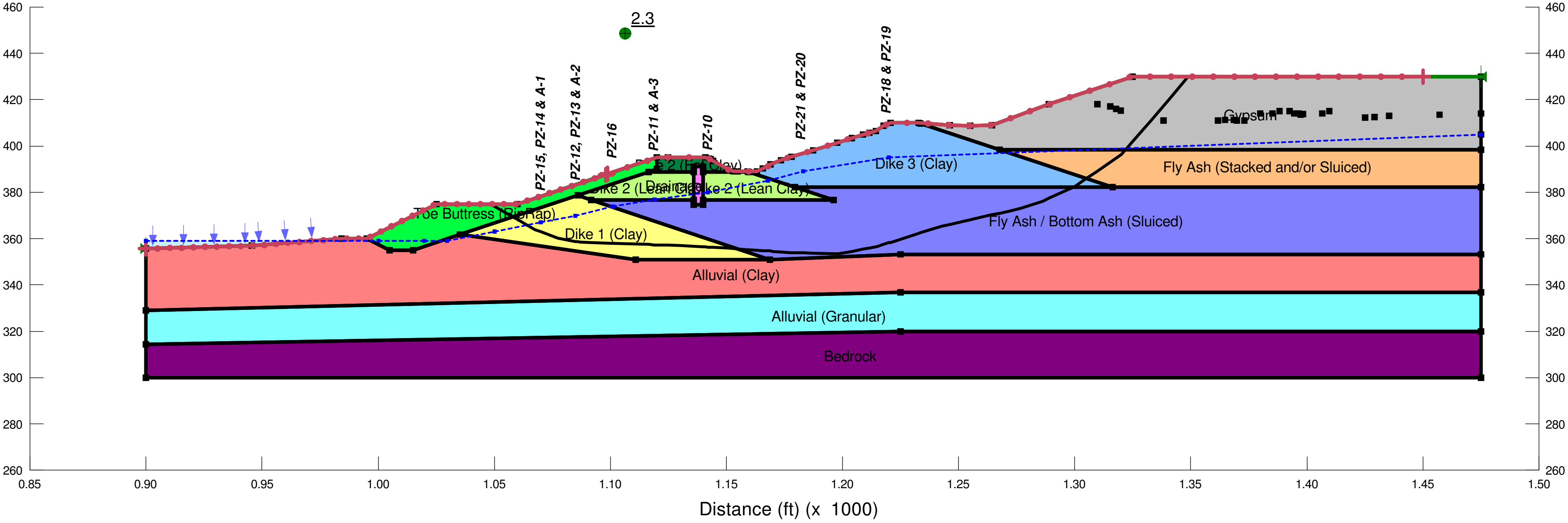
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

File Name: Section H (Stability - Repair Design-Buildout 430).gsz
Analysis Name: Stability - Existing Condition with Drainage Trench
Date Saved: 10/13/2009
Last Solved on 10/13/2009 at 2:33:18 AM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	125 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Dike 3 (Clay)	125 pcf	100 psf	25 °
Alluvial (Clay)	125 pcf	200 psf	28 °
Alluvial (Granular)	125 pcf	0 psf	30 °
Gypsum	100 pcf	0 psf	35 °
Fly Ash (Stacked and/or Sluiced)	100 pcf	0 psf	25 °
Fly Ash / Bottom Ash (Sluiced)	95 pcf	0 psf	25 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Toe Buttress (RipRap)	150 pcf	0 psf	38 °
Drainage Trench	130 pcf	0 psf	30 °
Bedrock			

Analysis Method: Spencer
Calculated Factor of Safety: 2.3



Stability - Existing Condition with Drainage Trench

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File Information

Created By: Cooper, Paul
Revision Number: 206
Last Edited By: Rogers, Daniel
Date: 10/13/2009
Time: 2:31:16 AM
File Name: Section H (Stability - Repair Design-Buildout 430).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\Buildout\
Last Solved Date: 10/13/2009
Last Solved Time: 2:33:18 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Drainage Trench

- Kind: SLOPE/W
- Method: Spencer
- Settings
  - Apply Phreatic Correction: No
  - PWP Conditions Source: Piezometric Line
  - Use Staged Rapid Drawdown: No
- SlipSurface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Optimize Critical Slip Surface Location: Yes
- FOS Distribution
  - FOS Calculation Option: Constant
- Advanced
  - Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 50 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 200 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked and/or Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 95 pcf
Cohesion: 0 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Toe Buttress (RipRap)

Model: Mohr-Coulomb
Unit Weight: 150 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Drainage Trench

Model: Mohr-Coulomb

Unit Weight: 130 pcf

Cohesion: 0 psf

Phi: 30 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Bedrock

Model: Bedrock (Impenetrable)

Pore Water Pressure

Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range

Left-Zone Left Coordinate: (900, 355.68471) ft

Left-Zone Right Coordinate: (1097.9798, 387.65993) ft

Left-Zone Increment: 40

Right Projection: Range

Right-Zone Left Coordinate: (1098.8988, 387.96627) ft

Right-Zone Right Coordinate: (1450, 430) ft

Right-Zone Increment: 40

Radius Increments: 30

Slip Surface Limits

Left Coordinate: (900, 355.68471) ft

Right Coordinate: (1475, 430) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	900	359
	1000	359
	1019.69	359
	1029.71	359.014
	1050	363
	1070	367
	1085	370

	1101	374
	1119	377
	1142	380
	1168	385
	1183	389
	1220	395
	1475	405

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	2.3	(1161.57, 644.289)	136.029	(1348.94, 430)	(1048.31, 375)
2	39071	2.4	(1161.57, 644.289)	291.831	(1359.68, 430)	(1049.11, 375)

Slices of Slip Surface: **Optimized**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	1049.157	374.5132	-728.78287	107.84857	84.260534	0
2	Optimized	1054.0405	371.6934	-492.04266	732.58256	572.35622	0
3	Optimized	1059.0405	368.80645	-249.49542	1209.5886	564.04043	100
4	Optimized	1062.092	367.04465	-101.47687	1595.4586	743.97458	100
5	Optimized	1065.8645	364.86645	81.523027	2133.538	956.8703	100
6	Optimized	1068.7725	363.44105	206.75616	2288.0058	970.50265	100
7	Optimized	1073.655	361.63125	380.61517	2774.4076	1116.2438	100
8	Optimized	1081.155	359.5849	601.91454	3192.004	1207.7785	100
9	Optimized	1085.4	358.82135	703.7945	3483.6025	1296.2458	100
10	Optimized	1086.421	358.6377	731.1755	3554.9372	1316.7417	100
11	Optimized	1089.392	358.44065	789.8141	3548.7514	1286.5136	100
12	Optimized	1095.986	358.20115	907.62936	3827.0066	1361.328	100
13	Optimized	1100.615	358.033	990.33188	4003.5135	1405.0697	100
14	Optimized	1104.85	357.8792	1045.9727	4165.6949	1454.7504	100
15	Optimized	1112.74	357.59265	1145.9153	4471.5569	1550.7722	100
16	Optimized	1117.89	357.4056	1211.1382	4664.9417	1610.535	100
17	Optimized	1119.5	357.34715	1230.3892	4726.0855	1630.07	100
18	Optimized	1122.4485	357.24005	1261.099	4610.7108	1561.9496	100
19	Optimized	1127.7695	357.04675	1316.4578	4578.545	1521.1362	100
20	Optimized	1133.321	356.79955	1377.0681	4574.1981	1490.8462	100
21	Optimized	1138	356.55005	1430.7173	4661.627	1506.5979	100
22	Optimized	1140.4695	356.4184	1458.982	4546.1249	1439.5584	100
23	Optimized	1141.4695	356.3651	1470.544	4519.8155	1421.8987	100
24	Optimized	1142.1845	356.32695	1479.4228	4486.8428	1402.383	100

25	Optimized	1142.783	356.295	1488.59	4459.3811	1385.3027	100
26	Optimized	1143.7615	356.2428	1503.5772	4400.869	1351.0294	100
27	Optimized	1147.4045	356.04855	1559.4176	4100.7773	1185.0555	100
28	Optimized	1151.7415	355.8173	1625.8934	3768.0397	998.89924	100
29	Optimized	1153.069	355.7465	1646.2491	3695.9801	955.80523	100
30	Optimized	1153.9595	355.68465	1660.8022	3711.9706	956.47553	100
31	Optimized	1156.91	355.4757	1709.2327	3713.1365	934.43569	0
32	Optimized	1159.3195	355.30505	1748.7948	3728.264	923.04164	0
33	Optimized	1161.427	355.1558	1783.4031	3739.5036	912.14467	0
34	Optimized	1164.505	354.9378	1833.9547	3842.5508	936.62376	0
35	Optimized	1166.878	354.7697	1872.9264	4019.0787	1000.7672	0
36	Optimized	1168.4915	354.6554	1901.655	4138.6514	1043.1286	0
37	Optimized	1169.337	354.59555	1919.4396	4197.7175	1062.3784	0
38	Optimized	1171.534	354.43995	1965.7556	4339.2067	1106.7584	0
39	Optimized	1175.462	354.16175	2048.4622	4548.7097	1165.8846	0
40	Optimized	1177.728	354.0093	2095.703	4593.6393	1164.8068	0
41	Optimized	1178.692	353.98375	2113.3294	4631.8944	1174.4262	0
42	Optimized	1181.2375	353.9163	2159.8945	4714.9412	1191.4378	0
43	Optimized	1185.1835	353.81175	2217.8433	4831.4808	1218.7591	0
44	Optimized	1191.762	353.63745	2295.2649	5039.984	1279.8836	0
45	Optimized	1196.9445	353.50015	2356.2747	5218.4991	1334.6772	0
46	Optimized	1198.0245	353.47155	2368.9823	5266.2067	1350.9979	0
47	Optimized	1201.2335	353.9995	2368.4795	5078.0834	1263.5091	0
48	Optimized	1206.5015	354.96715	2361.36	5190.5169	1319.2575	0
49	Optimized	1210.2435	355.6545	2356.4389	5259.602	1353.7672	0
50	Optimized	1213.054	356.17075	2352.6467	5302.5875	1375.58	0
51	Optimized	1214.4945	356.43535	2350.7195	5325.8093	1387.3072	0
52	Optimized	1216.135	356.9557	2334.8566	5241.2147	1355.257	0
53	Optimized	1218.8775	357.83035	2308.0285	5348.9369	1417.9989	0
54	Optimized	1220.293	358.2819	2291.9503	5383.2481	1441.4959	0
55	Optimized	1226.6745	360.3172	2180.5618	5215.8224	1415.3653	0
56	Optimized	1233.2055	362.40015	2066.5912	5023.0321	1378.611	0
57	Optimized	1238.1875	363.9891	1979.6048	4805.5129	1317.7426	0
58	Optimized	1244.3885	365.81105	1881.0636	4651.354	1291.8076	0
59	Optimized	1250.539	367.196	1809.6571	4459.7566	1235.7617	0
60	Optimized	1259.737	369.26715	1702.9698	4203.0412	1165.8025	0
61	Optimized	1265.9795	370.67285	1630.5219	4087.5158	1145.7151	0
62	Optimized	1269.712	371.5134	1587.2192	4111.3899	1177.0401	0
63	Optimized	1274.4395	372.578	1532.3412	4141.4055	1216.6266	0
64	Optimized	1281.63	374.7065	1417.1789	4028.1731	1217.5266	0
65	Optimized	1287.591	376.85165	1297.8432	3878.1601	1203.2215	0
66	Optimized	1294.399	379.9235	1122.8091	3762.6349	1230.971	0
67	Optimized	1302.4825	384.19875	875.82989	3289.6442	1125.5801	100
68	Optimized	1307.175	387.4602	683.81383	3096.5082	1125.0578	0
69	Optimized	1314.71	392.69675	375.47914	2841.6563	1149.9973	0

70	Optimized	1321.0315	397.4815	92.382996	2317.5152	1037.5962	0
71	Optimized	1322.1635	398.7585	15.468153	2083.5458	1448.0836	0
72	Optimized	1323.6405	400.42495	-84.901964	1999.7324	1400.2277	0
73	Optimized	1328.8305	406.28005	-437.55865	1626.7786	1139.0826	0
74	Optimized	1336.8125	415.5441	-996.10985	972.41756	680.89411	0
75	Optimized	1344.895	425.18135	-1577.6841	324.13919	226.9647	0

Slices of Slip Surface: 39071

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	39071	1049.5535	374.81435	-742.69091	36.383387	28.425817	0
2	39071	1055	372.6669	-540.82082	450.9695	352.33598	0
3	39071	1060.502	370.51985	-338.17184	886.18349	692.36242	0
4	39071	1065.502	368.76615	-166.33993	1342.5379	626.03569	100
5	39071	1070.1865	367.13615	-6.1676789	1792.9151	836.05005	100
6	39071	1077.6865	364.8789	228.2832	2429.18	1026.295	100
7	39071	1085.4	362.57505	469.55025	3069.519	1212.3853	100
8	39071	1088.771	361.70155	576.6498	3334.1412	1285.8394	100
9	39071	1095.986	359.95715	798.05589	3827.6194	1412.7087	100
10	39071	1100.615	358.8959	936.49203	4109.9661	1479.8153	100
11	39071	1108.89	357.36495	1120.0588	4566.9978	1607.3341	100
12	39071	1117.89	355.74815	1314.5694	5042.0924	1738.1725	100
13	39071	1119.5	355.50725	1345.1974	5120.2405	1760.3315	100
14	39071	1122.4485	355.10315	1394.4346	5022.9515	1692.0052	100
15	39071	1130.4485	354.1763	1517.3795	5012.7971	1629.94	100
16	39071	1138	353.4186	1626.1184	5096.2905	1618.1679	100
17	39071	1140.4695	353.2225	1658.406	4976.0682	1547.0513	100
18	39071	1141.4695	353.15185	1671.0087	4947.0503	1527.6433	100
19	39071	1142.1845	353.1029	1680.5972	4911.8028	1506.7359	100
20	39071	1142.783	353.0639	1690.2323	4882.2909	1488.4814	100
21	39071	1143.7615	353.00265	1705.7336	4820.386	1452.3863	100
22	39071	1147.4045	352.81845	1761.0023	4503.2411	1278.727	100
23	39071	1151.7415	352.6264	1825.0051	4150.6991	1084.489	100
24	39071	1153.8905	352.56055	1854.9349	4062.2099	1029.2692	100
25	39071	1156.91	352.50305	1894.721	4026.4905	994.06043	100
26	39071	1159.3195	352.46685	1925.9148	3996.8485	965.69223	100
27	39071	1161.427	352.46375	1951.3944	3965.6258	939.25151	100

28	39071	1163.8255	352.46725	1979.9789	3967.8298	926.9501	100
29	39071	1165.0765	352.47985	1994.2066	4033.589	950.9796	0
30	39071	1166.878	352.5084	2014.0176	4142.8661	992.69834	0
31	39071	1168.4915	352.54045	2033.7077	4239.5775	1028.6139	0
32	39071	1169.337	352.5615	2046.4017	4286.3742	1044.5164	0
33	39071	1171.534	352.63385	2078.4569	4394.1806	1079.8397	0
34	39071	1175.643	352.8062	2136.0679	4545.6178	1123.5916	0
35	39071	1178.692	352.9616	2177.1218	4628.4082	1143.0536	0
36	39071	1181.2375	353.1266	2209.1802	4677.8544	1151.1617	0
37	39071	1185.1835	353.42285	2242.1165	4738.589	1164.1242	0
38	39071	1191.762	354.0572	2269.0394	4838.5126	1198.165	0
39	39071	1196.9445	354.61045	2287.0332	4924.754	1229.9894	0
40	39071	1200.941	355.14355	2294.1728	5017.2005	1269.7687	0
41	39071	1206.5015	355.94695	2300.395	5134.3977	1321.5171	0
42	39071	1210.2435	356.54855	2300.6424	5195.7539	1350.0127	0
43	39071	1213.054	357.0382	2298.5303	5229.1305	1366.5613	0
44	39071	1216.1145	357.60475	2294.1563	5342.6994	1421.559	0
45	39071	1218.8775	358.14165	2288.5915	5475.3961	1486.0314	0
46	39071	1220.293	358.4267	2282.8278	5519.8127	1509.4309	0
47	39071	1226.6745	359.88055	2207.7807	5372.1142	1475.553	0
48	39071	1233.2055	361.38625	2129.8482	5198.4333	1430.9047	0
49	39071	1239.849	363.22525	2031.3081	4899.6541	1337.5317	0
50	39071	1250.539	366.3892	1860.0057	4436.198	1201.2982	0
51	39071	1259.737	369.50845	1687.9616	4055.9674	1104.2193	0
52	39071	1265.9795	371.7783	1561.5477	3843.1353	1063.9218	0
53	39071	1269.712	373.24325	1479.2684	3795.2051	1079.939	0
54	39071	1276.156	375.93295	1327.2094	3697.6827	1105.3699	0
55	39071	1284.6455	379.7198	1111.6412	3546.7208	1135.4963	0
56	39071	1289.3985	381.94215	984.66318	3451.5789	1150.3417	0
57	39071	1295.123	384.87535	815.60855	3215.134	1118.9171	100
58	39071	1304.816	390.08345	514.34359	2903.3564	1114.015	0
59	39071	1314.1005	395.55395	195.70272	2639.9606	1139.7762	0
60	39071	1319.2205	398.7025	11.763201	2384.738	1661.5748	0
61	39071	1322.2115	400.6694	-103.6522	2290.9147	1604.1157	0
62	39071	1330.688	406.56015	-450.49476	1855.1727	1299.0059	0
63	39071	1342.284	415.25965	-964.98396	1136.8721	796.04645	0
64	39071	1353.8805	424.91725	-1539.1918	381.0628	266.82305	0

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant
Tennessee Valley Authority (TVA)

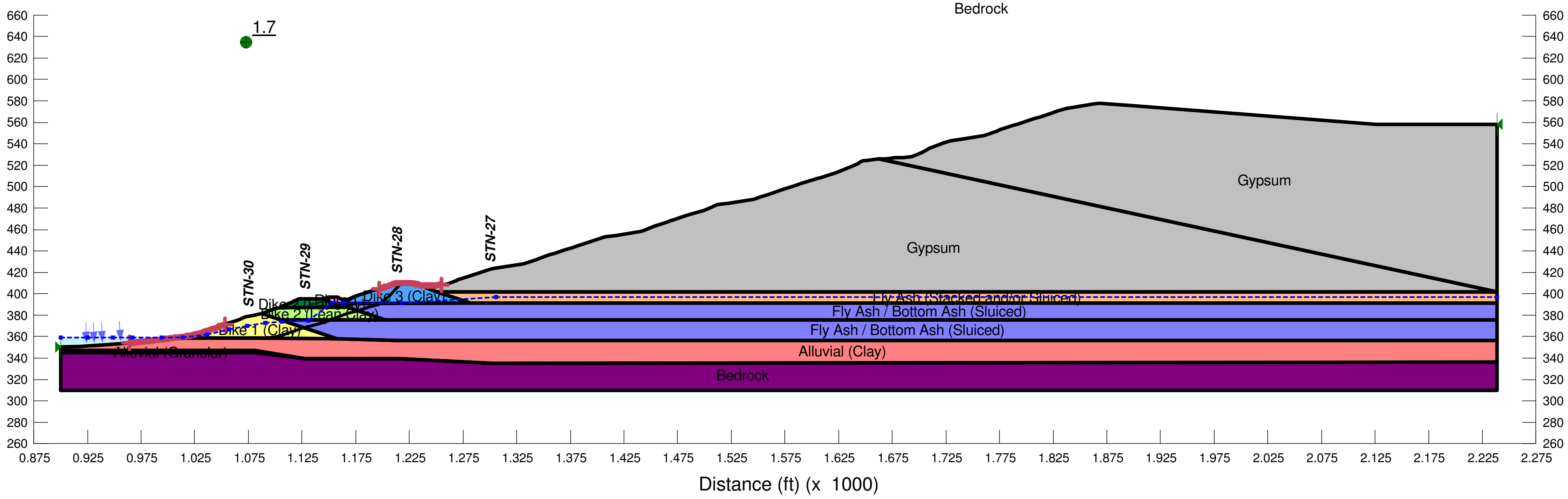
File Name: Section J (Stability - Repair Design-TVABuildout).gsz
Analysis Name: Stability - Existing Condition with Existing PZ Levels
Date Saved: 10/23/2009
Last Solved On: 10/23/2009 at 2:18:26 PM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Stacked and/or Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Riprap	135 pcf	0 psf	38 °
Bedrock			

Analysis Method: Spencer

Calculated Factor of Safety: 1.7



Stability - Existing Condition with Existing PZ Levels

File Information

Created By: Kirkbride, Rob
Revision Number: 97
Last Edited By: Rogers, Daniel
Date: 10/23/2009
Time: 2:04:15 PM
File Name: Section J (Stability - Repair Design-TVABuildout).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\Buildout\
Last Solved Date: 10/23/2009
Last Solved Time: 2:18:26 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

- Kind: SLOPE/W
- Method: Spencer
- Settings
  - Apply Phreatic Correction: No
  - PWP Conditions Source: Piezometric Line
  - Use Staged Rapid Drawdown: No
- SlipSurface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Optimize Critical Slip Surface Location: Yes
- FOS Distribution
  - FOS Calculation Option: Constant
- Advanced
  - Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 50 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked and/or Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Riprap

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Bedrock

Model: Bedrock (Impenetrable)

Pore Water Pressure

Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range

Left-Zone Left Coordinate: (963.8717, 354) ft

Left-Zone Right Coordinate: (1053, 371.1753) ft

Left-Zone Increment: 40

Right Projection: Range

Right-Zone Left Coordinate: (1197, 404.7296) ft

Right-Zone Right Coordinate: (1255, 408.4223) ft

Right-Zone Increment: 40

Radius Increments: 30

Slip Surface Limits

Left Coordinate: (900, 350.1427) ft

Right Coordinate: (2238.9108, 558.0038) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	900	359
	925	359
	949	359
	967	359
	994	359
	1014	359
	1037	362
	1057	367
	1074	370
	1091	373
	1106	374
	1131	375
	1152.4982	391.2342
	1163.5128	391.2682
	1217	391.5

	1306	397
	2238.91	397

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.7	(1053.52, 656.989)	91.30133	(1217.5, 409.977)	(1020.29, 360.854)
2	31038	1.8	(1053.52, 656.989)	298.585	(1221.25, 409.968)	(1018.2, 360.5)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	1021.465	360.4905	-32.246833	127.80692	59.597347	100
2	Optimized	1024.1715	359.6524	42.076689	324.1632	131.5391	100
3	Optimized	1027.057	358.75885	121.32067	559.36331	204.26263	100
4	Optimized	1029.725	358.34275	168.99982	624.32811	212.32307	100
5	Optimized	1034.02	358.3524	203.35519	810.68588	283.20295	100
6	Optimized	1037.6875	358.36065	237.82848	972.66038	342.65774	100
7	Optimized	1042.421	358.37125	311.00461	1185.1296	407.61119	100
8	Optimized	1050.871	358.3902	441.63917	1569.652	526.00101	100
9	Optimized	1056.1375	358.40205	523.06233	1812.2059	601.13752	100
10	Optimized	1058.8665	358.40815	556.69113	1940.6644	645.35735	100
11	Optimized	1060.8365	358.41255	578.09338	2033.409	678.62482	100
12	Optimized	1062.052	358.3963	592.51566	2108.7605	707.03658	100
13	Optimized	1064.412	358.37695	619.67957	2208.2646	740.76936	100
14	Optimized	1068.642	358.36735	666.8662	2413.6425	814.53516	100
15	Optimized	1072.812	358.35795	713.3941	2612.6781	885.65065	100
16	Optimized	1074.3125	358.35455	730.12131	2678.1246	908.36887	100
17	Optimized	1077.438	358.34745	764.97374	2766.3552	933.25952	100
18	Optimized	1080.311	358.34385	796.83595	2780.4418	924.97058	100
19	Optimized	1083.866	358.5064	825.83408	2853.7311	945.62391	100
20	Optimized	1088.2095	358.705	861.30084	2946.0197	972.12035	100
21	Optimized	1090.029	358.78825	876.12454	3006.1261	993.23606	100
22	Optimized	1091.286	358.84575	884.41506	3057.8608	1013.4944	100
23	Optimized	1091.7845	358.8847	884.0616	2975.4628	975.2364	100
24	Optimized	1093.6695	359.11415	877.58712	3035.6899	1006.3399	100
25	Optimized	1096.44	359.4513	868.05972	3129.7265	1054.6325	100
26	Optimized	1098.3545	359.7499	857.42729	3084.074	1038.3024	100
27	Optimized	1100.3705	360.15715	840.35811	3139.0015	1071.875	100
28	Optimized	1102.785	360.64485	819.98622	3163.6165	1092.8527	100
29	Optimized	1104.559	361.00325	804.99805	3187.3802	1110.9231	100
30	Optimized	1105.141	361.1229	799.96599	3102.0936	1073.4997	100
31	Optimized	1105.582	361.2522	793.71991	3118.8615	1084.2313	100
32	Optimized	1106.234	361.44345	784.11846	3143.5638	1100.2274	100

33	Optimized	1108.0905	361.98775	754.77546	3162.5926	1122.7836	100
34	Optimized	1111.029	362.84925	708.36888	3181.2978	1153.1457	100
35	Optimized	1114.3985	363.9599	647.47339	3110.7288	1148.6349	100
36	Optimized	1119.2485	365.6718	552.74402	3106.7299	1190.9432	100
37	Optimized	1124.408	367.493	451.98444	2993.0101	1184.8997	100
38	Optimized	1128.8855	368.8813	376.52042	2948.8992	1039.3085	0
39	Optimized	1131.4435	369.5518	360.87465	2886.0159	1020.2233	0
40	Optimized	1134.892	370.45555	466.95808	2802.3279	943.55068	0
41	Optimized	1140.9015	372.0305	651.8483	2656.4891	809.92744	0
42	Optimized	1145.239	373.16735	785.32246	2609.2387	736.90998	0
43	Optimized	1146.8995	373.6515	833.33357	2504.2943	675.11198	0
44	Optimized	1147.7135	373.9867	850.78292	2508.6555	669.82402	0
45	Optimized	1149.1	374.55765	880.50166	2518.8235	661.92499	0
46	Optimized	1150.901	375.2991	919.06613	2498.5089	638.13632	0
47	Optimized	1152.15	375.8134	945.84512	2427.793	787.96568	100
48	Optimized	1152.6885	376.0353	948.43732	2405.6567	774.81729	100
49	Optimized	1154.653	376.84415	898.35834	2314.2234	752.82882	100
50	Optimized	1157.2135	377.89835	833.03794	2187.6137	720.24071	100
51	Optimized	1159.553	378.86165	773.41747	1949.4562	625.31089	100
52	Optimized	1162.053	379.8011	715.28267	1707.1957	527.40949	100
53	Optimized	1163.068	380.1227	695.3903	1591.059	476.23552	100
54	Optimized	1163.3245	380.20395	690.36276	1577.896	471.90981	100
55	Optimized	1164.413	380.5488	669.1575	1519.7007	452.24183	100
56	Optimized	1165.6565	380.94275	644.89175	1454.5366	430.49578	100
57	Optimized	1166.5	381.2099	628.44859	1437.873	430.37858	100
58	Optimized	1168.1775	381.7413	595.73111	1438.8469	448.29261	100
59	Optimized	1172.5415	383.0318	516.38792	1469.5478	506.8041	100
60	Optimized	1176.139	384.06765	452.72312	1483.4757	548.06088	100
61	Optimized	1178.477	384.74095	411.34565	1528.8276	451.49202	0
62	Optimized	1184.1605	386.3775	310.76347	1592.6388	517.91125	0
63	Optimized	1191.673	388.5407	177.81119	1648.6645	594.2633	0
64	Optimized	1195.6085	389.674	108.15701	1678.2459	634.35707	0
65	Optimized	1196.574	390.35455	65.949747	1361.9246	523.60785	0
66	Optimized	1197.631	391.2003	13.461531	1250.3708	714.12988	50
67	Optimized	1201.7195	394.47345	-189.68164	1062.6588	613.52637	50
68	Optimized	1206.739	398.49185	-439.0718	843.39458	486.93409	50
69	Optimized	1210.175	401.9142	-651.68351	574.04124	331.42286	50
70	Optimized	1214.7045	406.90275	-961.75231	235.57719	136.01056	50
71	Optimized	1217.248	409.70415	-1134.9874	5.677716	3.2780309	50

Slices of Slip Surface: 31038

							Cohesive

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Strength (psf)
1	31038	1020.1605	360.27965	-29.708188	98.507696	45.934893	100
2	31038	1023.9125	359.8808	25.716654	238.14021	99.05473	100
3	31038	1028.372	359.4768	87.221597	444.99634	166.8331	100
4	31038	1034.02	359.0563	159.43248	746.49056	273.74968	100
5	31038	1037.6875	358.8248	208.85956	938.62286	340.29422	100
6	31038	1042.421	358.63785	294.3649	1172.2108	409.34627	100
7	31038	1050.871	358.44835	438.01283	1568.2319	527.02982	100
8	31038	1056.1375	358.4169	522.13331	1802.3429	596.97154	100
9	31038	1058.8665	358.45795	553.57684	1917.7005	636.10131	100
10	31038	1063.1965	358.5713	594.19487	2090.4039	697.69372	100
11	31038	1068.642	358.80245	639.72076	2298.3528	773.43283	100
12	31038	1072.812	359.03065	671.41886	2447.0859	828.00715	100
13	31038	1074.3125	359.1294	681.76701	2492.0937	844.16921	100
14	31038	1077.498	359.3827	701.02914	2534.8142	855.10803	100
15	31038	1083.866	359.9713	734.42621	2600.8082	870.3082	100
16	31038	1088.2095	360.4277	753.78516	2642.3441	880.64949	100
17	31038	1090.029	360.64665	760.1751	2676.7362	893.70714	100
18	31038	1091.4985	360.83025	761.47245	2715.0059	910.94762	100
19	31038	1093.6695	361.1212	752.34857	2771.6265	941.60478	100
20	31038	1097.2565	361.6317	735.40449	2870.0539	995.40337	100
21	31038	1100.3705	362.10575	718.78285	2960.4861	1045.3234	100
22	31038	1102.785	362.4996	704.25679	2986.2323	1064.1026	100
23	31038	1104.582	362.8039	692.74288	3010.8323	1080.9428	100
24	31038	1105.582	362.97895	685.97885	3066.0114	1109.8274	100
25	31038	1106.234	363.095	681.05822	3098.1077	1127.0887	100
26	31038	1108.0905	363.4386	664.2506	3134.4581	1151.8767	100
27	31038	1113.0825	364.4262	615.07929	3202.0535	1206.3259	100
28	31038	1119.2485	365.74335	548.27724	3271.8393	1270.0178	100
29	31038	1125.182	367.15025	475.31075	3167.6037	1255.4368	100
30	31038	1129.6595	368.27945	416.01422	3003.7937	1045.5308	0
31	31038	1131.4435	368.75285	410.72592	2951.7865	1026.6551	0
32	31038	1134.892	369.72395	512.61352	2848.1375	943.61295	0
33	31038	1140.9015	371.4948	685.28124	2663.9837	799.44768	0
34	31038	1145.5665	372.95255	814.12471	2586.9903	716.28418	0
35	31038	1147.7135	373.65245	871.63171	2607.8769	701.48857	0
36	31038	1149.1	374.1184	907.89945	2622.692	692.82115	0
37	31038	1151.249	374.8552	963.18161	2596.2595	659.80631	0
38	31038	1152.6885	375.355	990.89861	2553.7246	631.42269	0
39	31038	1153.229	375.54605	979.08386	2535.3227	628.76129	0
40	31038	1155.003	376.18465	939.58606	2437.2701	796.33274	100
41	31038	1157.2135	376.99055	889.70496	2329.3649	765.48077	100
42	31038	1160.5	378.2413	812.28827	1968.0294	614.51847	100

43	31038	1163.068	379.2277	751.23205	1648.4139	477.04003	100
44	31038	1163.3245	379.32905	744.97364	1632.6717	471.99744	100
45	31038	1164.413	379.76365	718.13795	1563.176	449.31469	100
46	31038	1165.6565	380.2629	687.30619	1484.9474	424.11338	100
47	31038	1166.5	380.6064	666.10202	1457.9804	421.04922	100
48	31038	1171.364	382.68565	537.67759	1386.645	451.40397	100
49	31038	1178.066	385.6337	355.5361	1343.7648	399.2703	0
50	31038	1184.7545	388.8361	157.50663	1282.206	454.40804	0
51	31038	1189.513	391.17395	12.910777	1175.6119	671.2858	50
52	31038	1192.675	392.83355	-89.793488	1090.9621	629.86728	50
53	31038	1200.483	397.14305	-356.59605	872.82547	503.92602	50
54	31038	1208.973	402.09695	-663.42156	647.07054	373.58635	50
55	31038	1214.7045	405.6646	-884.49026	416.09159	240.23059	50
56	31038	1219.1235	408.5524	-1055.8807	128.63911	74.269825	50

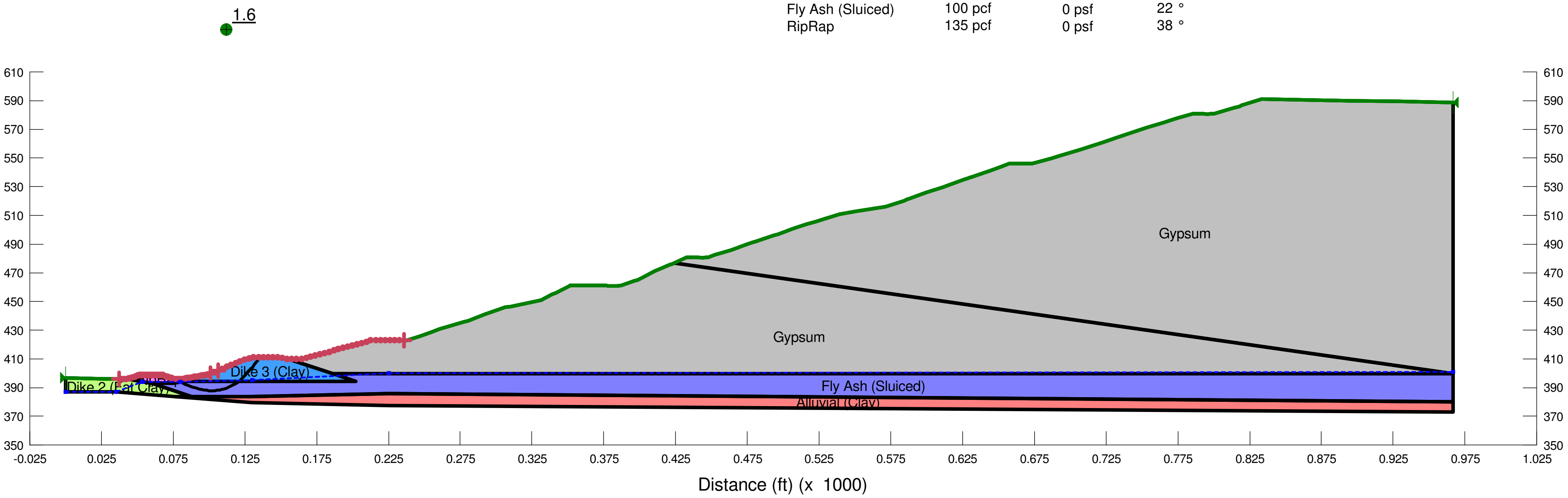
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section M (Stability - Repair Design-TVABuildout).gsz
Analysis Name: Stability - Buildout w Existing PZ Levels
Date Saved: 10/23/2009
Last Solved On: 10/23/2009 at 4:44:38 PM

Analysis Method: Spencer
Calculated Factor of Safety: 1.6

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
RipRap	135 pcf	0 psf	38 °



Stability - Buildout w Existing PZ Levels

File Information

Created By: Cooper, Paul
Revision Number: 224
Last Edited By: Rogers, Daniel
Date: 10/23/2009
Time: 4:42:37 PM
File Name: Section M (Stability - Repair Design-TVABuildout).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\Buildout\
Last Solved Date: 10/23/2009
Last Solved Time: 4:44:38 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Buildout w Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
    Apply Phreatic Correction: No
    PWP Conditions Source: Piezometric Line
    Use Staged Rapid Drawdown: No
SlipSurface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: Yes
FOS Distribution
    FOS Calculation Option: Constant
Advanced
    Number of Slices: 30
    Optimization Tolerance: 0.01
    Minimum Slip Surface Depth: 10 ft
    Optimization Maximum Iterations: 5000

Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 50 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf

Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

RipRap

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (37.378, 396.03165) ft
Left-Zone Right Coordinate: (101, 399.8229) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (106.1173, 401.84614) ft
Right-Zone Right Coordinate: (236, 422.94773) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (0, 396.66) ft
Right Coordinate: (966.79, 588.92493) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	387
	35.5	387
	53.5	394.1
	80	394.1
	130	395
	225	400
	966.79	401

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.6	(100.123, 424.876)	30.85641	(135.599, 411.003)	(76.1043, 395.998)
2	32075	1.6	(100.123, 424.876)	36.981	(134.401, 410.997)	(77.0226, 395.998)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	77.0782	395.5261	-88.989943	112.0135	87.51454	0
2	Optimized	79.026065	394.5817	-30.056279	336.03589	262.54001	0
3	Optimized	80.009415	394.1049	-0.29541493	449.13161	350.90007	0
4	Optimized	80.080805	394.0703	1.9417208	455.78156	354.57854	0
5	Optimized	80.28001	393.9737	8.1951896	367.71311	145.25467	0
6	Optimized	80.44257	393.8949	13.295973	375.39586	146.29785	0
7	Optimized	80.7063	393.76185	21.894046	393.61387	150.18456	0
8	Optimized	81.0007	393.61275	31.530143	410.20409	152.9942	0
9	Optimized	81.1111	393.5568	35.14356	419.0137	155.0936	0
10	Optimized	82.2314	392.9893	71.812211	519.89681	181.03793	0
11	Optimized	84.3632	391.90945	141.5907	713.18426	230.93879	0
12	Optimized	86.84395	390.8227	212.18896	861.07097	262.16535	0
13	Optimized	89.40718	389.95905	268.96031	976.08393	285.69649	0
14	Optimized	91.91208	389.2679	314.90247	1115.3958	323.42029	0
15	Optimized	94.167885	388.7485	349.84757	1168.0065	330.55768	0
16	Optimized	95.96645	388.45835	369.97028	1241.0104	351.92304	0
17	Optimized	97.765015	388.1682	390.09848	1314.0142	373.28618	0
18	Optimized	99.1925	387.9379	406.07107	1386.4656	396.10511	0
19	Optimized	100.60875	387.8417	413.66688	1379.9405	390.39989	0
20	Optimized	102.69115	387.8159	417.61359	1488.0595	432.48821	0
21	Optimized	104.7898	387.9381	412.34555	1488.3362	434.72844	0
22	Optimized	106.59845	388.2121	397.2796	1551.1474	466.19286	0
23	Optimized	107.9655	388.41925	385.89215	1599.7461	490.42885	0
24	Optimized	109.2739	388.76425	365.83083	1531.4921	470.95771	0
25	Optimized	110.96535	389.31395	333.42761	1562.0792	496.40746	0
26	Optimized	112.6568	389.8637	301.02439	1592.6101	521.83449	0
27	Optimized	114.78635	390.79775	245.13566	1502.2029	507.88815	0
28	Optimized	117.27585	392.0759	168.17245	1500.8388	538.43214	0
29	Optimized	119.72935	393.5197	80.833621	1406.0143	535.40774	0
30	Optimized	121.22905	394.5956	15.385976	1137.3166	647.74695	50
31	Optimized	122.7156	396.07755	-75.420876	1062.1386	613.22602	50
32	Optimized	124.50325	397.85965	-184.61513	968.89483	559.39169	50
33	Optimized	126.12605	399.5689	-289.44995	834.89688	482.02794	50
34	Optimized	128.28735	401.97475	-437.13639	672.23216	388.11342	50

35	Optimized	129.5106	403.3824	-523.61215	571.88468	330.17777	50
36	Optimized	129.8212	403.759	-546.75745	545.44086	314.91043	50
37	Optimized	130.90365	405.0716	-625.49505	443.07073	255.807	50
38	Optimized	132.75515	407.3764	-763.24648	256.45616	148.06503	50
39	Optimized	134.6509	409.7944	-907.88284	71.911351	41.518038	50

Slices of Slip Surface: 32075

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	32075	78.321105	395.04915	-59.225677	308.3764	240.93005	0
2	32075	79.719575	394.0339	4.1261113	570.35458	442.38616	0
3	32075	79.895265	393.9183	11.339921	416.44559	163.67332	0
4	32075	79.9855	393.8594	15.015337	422.02708	164.44342	0
5	32075	80.20916	393.7163	24.177778	434.93009	165.95471	0
6	32075	80.68151	393.41995	43.201015	461.17928	168.87418	0
7	32075	81.0007	393.22345	55.820359	480.15352	171.44172	0
8	32075	81.1111	393.157	60.090503	489.2666	173.3984	0
9	32075	82.104505	392.6002	95.953075	575.12334	193.59735	0
10	32075	83.982515	391.62025	159.20836	722.91661	227.75292	0
11	32075	85.860525	390.7718	214.26354	848.24113	256.14357	0
12	32075	87.738535	390.04525	261.71073	954.49864	279.90448	0
13	32075	89.61655	389.433	302.0235	1044.2171	299.8657	0
14	32075	91.56915	388.91355	336.62981	1121.5875	317.14348	0
15	32075	93.596335	388.49065	365.29481	1186.9144	331.95585	0
16	32075	95.62352	388.1845	386.67276	1237.8738	343.90754	0
17	32075	97.650705	387.99225	400.94776	1275.461	353.32628	0
18	32075	100.08055	387.9227	408.01383	1338.2868	375.85467	0
19	32075	102.4978	387.9855	406.81547	1414.8044	407.25398	0
20	32075	104.4998	388.16925	397.59347	1468.4701	432.66223	0
21	32075	106.5018	388.46395	381.45423	1507.957	455.13667	0
22	32075	108.57375	388.8908	357.14967	1536.3749	476.43793	0
23	32075	110.7156	389.4626	323.87206	1552.3315	496.32982	0
24	32075	112.8574	390.1759	281.76854	1551.467	512.9915	0
25	32075	114.99925	391.03975	230.27262	1533.1847	526.41067	0
26	32075	116.8767	391.9206	177.41747	1503.2653	535.67731	0
27	32075	118.4897	392.79225	124.83657	1465.1967	541.54066	0
28	32075	120.1027	393.77195	65.51068	1415.3207	545.35865	0
29	32075	121.3103	394.5704	17.046899	1298.1594	739.65065	50
30	32075	122.83085	395.72275	-53.151361	1205.0672	695.74588	50
31	32075	124.899	397.45175	-158.71867	1057.929	610.79557	50
32	32075	126.79635	399.29805	-271.79775	892.20345	515.1139	50

33	32075	128.6937	401.44405	-403.58119	708.79887	409.22522	50
34	32075	129.8212	402.84175	-489.51854	591.74457	341.64389	50
35	32075	131.1002	404.77845	-606.57301	416.20575	240.2965	50
36	32075	133.3006	408.7356	-846.25342	110.13184	63.584647	50

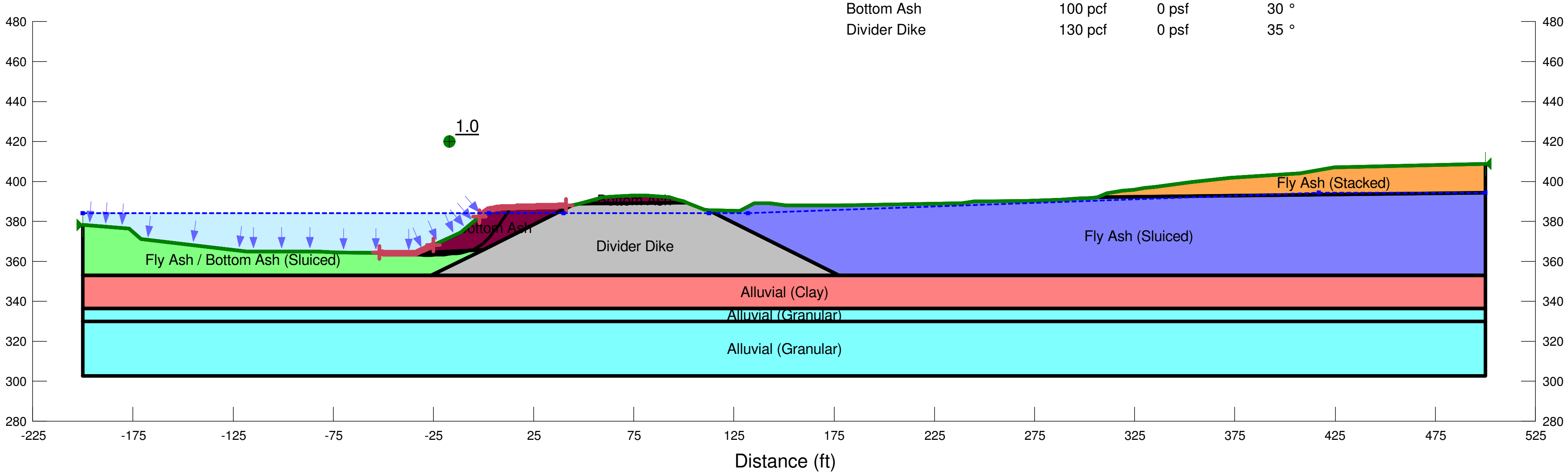
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section A_Extended.gsz
Analysis Name: Stability - Existing Condition (Shallow Failure)
Date Saved: 10/22/2009
Last Solved on 10/22/2009 at 11:01:40 AM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Bottom Ash	100 pcf	0 psf	30 °
Divider Dike	130 pcf	0 psf	35 °

Analysis Method: Spencer
Calculated Factor of Safety: 1.0



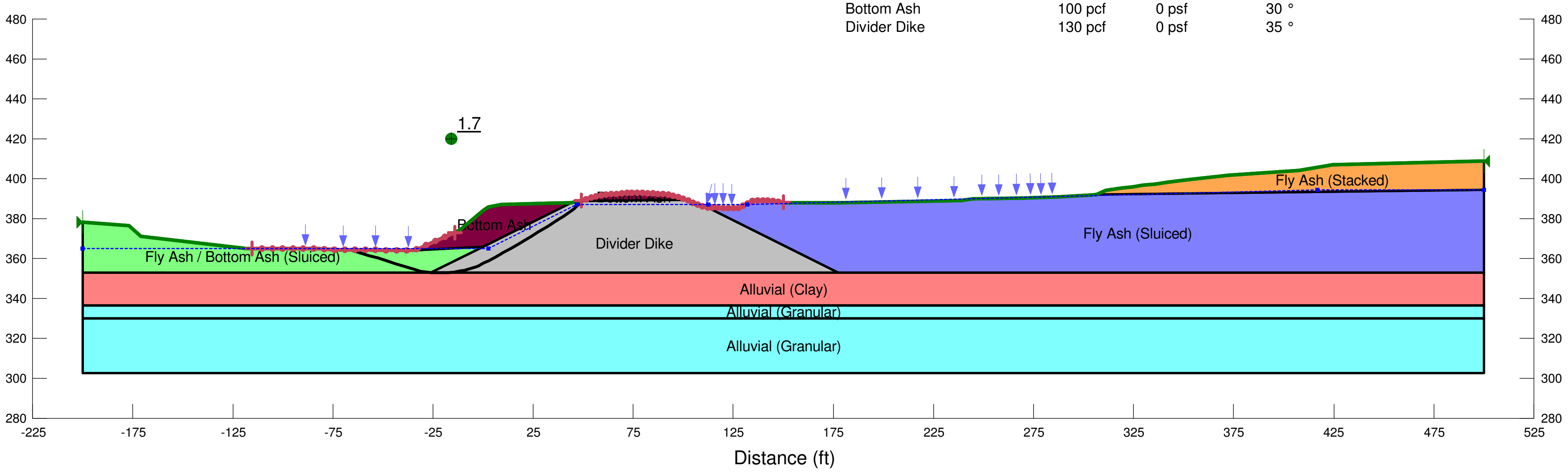
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section A_Extended.gsz
Analysis Name: Stability - Existing Condition with Rapid Drawdown
Date Saved: 5/18/2010
Last Solved on 5/18/2010 at 9:55:00 AM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Bottom Ash	100 pcf	0 psf	30 °
Divider Dike	130 pcf	0 psf	35 °

Analysis Method: Spencer
Calculated Factor of Safety: 1.7



Stability - Existing Condition with Rapid Drawdown

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File Information

Created By: Cooper, Paul
Revision Number: 255
Last Edited By: Rogers, Daniel
Date: 5/18/2010
Time: 9:54:07 AM
File Name: Section A_Extended.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 5/18/2010
Last Solved Time: 9:55:00 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Rapid Drawdown

- Kind: SLOPE/W
- Method: Spencer
- Settings
  - Apply Phreatic Correction: No
  - PWP Conditions Source: Piezometric Line
  - Use Staged Rapid Drawdown: No
- SlipSurface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Optimize Critical Slip Surface Location: Yes
  - Tension Crack

Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Advanced
Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 20 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb

- Unit Weight: 100 pcf
- Cohesion: 0 psf
- Phi: 22 °
- Phi-B: 0 °
- Pore Water Pressure
  - Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

- Model: Mohr-Coulomb
- Unit Weight: 100 pcf
- Cohesion: 0 psf
- Phi: 22 °
- Phi-B: 0 °
- Pore Water Pressure
  - Piezometric Line: 1

Bottom Ash

- Model: Mohr-Coulomb
- Unit Weight: 100 pcf
- Cohesion: 0 psf
- Phi: 30 °
- Phi-B: 0 °
- Pore Water Pressure
  - Piezometric Line: 1

Divider Dike

- Model: Mohr-Coulomb
- Unit Weight: 130 pcf
- Cohesion: 0 psf
- Phi: 35 °
- Phi-B: 0 °
- Pore Water Pressure
  - Piezometric Line: 1

Slip Surface Entry and Exit

- Left Projection: Range
- Left-Zone Left Coordinate: (-115.57435, 365.12621) ft
- Left-Zone Right Coordinate: (-14.24004, 373) ft
- Left-Zone Increment: 20
- Right Projection: Range
- Right-Zone Left Coordinate: (49, 389.12344) ft
- Right-Zone Right Coordinate: (150, 388.11207) ft
- Right-Zone Increment: 40
- Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-200, 378.17346) ft
Right Coordinate: (500, 408.84049) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-200	365
	2.55408	365
	46.85	387
	112.5	387
	132	387
	417	394.47
	500	394.47

Regions

	Material	Points	Area (ft²)
Region 1	Alluvial (Granular)	1,2,3,4	19180
Region 2	Alluvial (Granular)	4,3,5,6	4550
Region 3	Fly Ash (Sluiced)	7,8,60,20,21,22,23,24,25,26,27,28,29,30,31,32	13745.485
Region 4	Divider Dike	33,7,32,34,35,36,44,45,59	4743.6159
Region 5	Fly Ash / Bottom Ash (Sluiced)	51,52,53,54,55,56,57,58,33,59	2725.0786
Region 6	Alluvial (Clay)	58,6,5,8,7,33	11481.079
Region 7	Bottom Ash	45,46,47,48,49,50,51,59	703.64671
Region 8	Bottom Ash	36,37,38,39,40,41,42,43,44	140.63663

Region 9	Fly Ash (Stacked)	60,9,10,11,12,13,14,15,16,17,18,19,20	1950.1592

Points

	X (ft)	Y (ft)
Point 1	-200	302.596
Point 2	500	302.596
Point 3	500	329.996
Point 4	-200	329.996
Point 5	500	336.496
Point 6	-200	336.496
Point 7	177.35321	352.9001
Point 8	500	352.896
Point 9	500	408.84049
Point 10	424.54156	407
Point 11	407.45694	404
Point 12	372.75093	401.71589
Point 13	353.49765	399.74176
Point 14	342.15171	398.22744
Point 15	335.72485	397.46477
Point 16	329.59964	396.75803
Point 17	324.62229	396
Point 18	318.84971	395.16639
Point 19	311.11578	394
Point 20	306.41582	392
Point 21	303.37898	391.83615
Point 22	296.64966	391.47162
Point 23	287.88242	391
Point 24	270.02468	390.37161
Point 25	244.64276	390
Point 26	239.00788	389.13074
Point 27	177.72084	388.01295
Point 28	150.92636	388
Point 29	142.66019	389
Point 30	135.12957	389

Point 31	127.843	385.40673
Point 32	112.25926	385.445
Point 33	-26.19269	352.896
Point 34	110.25353	386
Point 35	104.82527	388
Point 36	101.26774	389.48724
Point 37	100.05725	390
Point 38	96.55264	390.996
Point 39	92.82196	391.996
Point 40	81.04847	392.8415
Point 41	75.34198	392.996
Point 42	67.45291	392.50526
Point 43	59.77612	391.996
Point 44	47.94316	388.84172
Point 45	44.00037	387.99019
Point 46	32.30678	387.65592
Point 47	9.17621	387
Point 48	2.55373	386
Point 49	0	384.23
Point 50	-11.39509	374.27184
Point 51	-33.91119	364.20596
Point 52	-73.45174	364.37631
Point 53	-83.12295	364.95495
Point 54	-118.37511	365.14099
Point 55	-171.03472	371.07123
Point 56	-176.83063	376.61401
Point 57	-200	378.17346
Point 58	-200	352.896
Point 59	0	366
Point 60	500	394.5

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.7	(-25.184,	55.13136	(50.2919,	(-66.5258,

			448.842)		389.468)	364.346)
2	11453	1.7	(-25.184, 448.842)	95.235	(49, 389.123)	(-69.1393, 364.358)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-64.123795	363.65865	83.701827	123.57461	16.10965	0
2	Optimized	-59.31975	362.2829	169.54688	281.64093	45.288936	0
3	Optimized	-54.66011	360.9059	255.46041	443.68771	76.048765	0
4	Optimized	-50.144875	359.5277	341.46118	603.53052	105.88289	0
5	Optimized	-45.62964	358.1495	427.46195	763.35215	135.70845	0
6	Optimized	-41.00681	356.71255	517.14581	934.80097	168.74364	0
7	Optimized	-36.276395	355.2168	610.46869	1109.1918	201.49722	0
8	Optimized	-33.023105	354.18805	674.66589	1252.2761	233.36967	0
9	Optimized	-31.66741	353.75935	701.41222	1344.8348	259.95958	0
10	Optimized	-28.515885	353.26645	732.1679	1451.0505	290.44744	0
11	Optimized	-24.09951	352.9183	753.89864	1702.78	664.4139	0
12	Optimized	-20.634595	352.9121	754.27383	1936.0898	827.51642	0
13	Optimized	-18.184575	352.9077	754.56631	2101.0655	942.82887	0
14	Optimized	-15.94903	353.11775	741.44252	2050.5729	916.66293	0
15	Optimized	-12.91307	353.5404	715.08244	2180.0896	1025.8091	0

16	Optimized	-10.452355	353.88295	693.71814	2325.8416	1142.8252	0
17	Optimized	-7.9451475	354.5122	654.42738	2274.4618	1134.3603	0
18	Optimized	-4.8162025	355.5082	592.30109	2445.4613	1297.5968	0
19	Optimized	-2.625281	356.30355	542.65746	2359.2956	1272.0237	0
20	Optimized	-0.999416	357.07535	494.48411	2410.2315	1341.4208	0
21	Optimized	1.05552	358.05085	433.62384	2458.8564	1418.0831	0
22	Optimized	2.332385	358.67585	394.6369	2375.9416	1387.3245	0
23	Optimized	2.553905	358.7999	386.89397	2377.0795	1393.5429	0
24	Optimized	4.2096125	359.7271	380.32703	2320.8302	1358.755	0
25	Optimized	7.5206775	361.5813	367.25683	2208.3632	1289.1566	0
26	Optimized	9.359405	362.611	359.98986	2144.1269	1249.2662	0
27	Optimized	11.62442	363.91445	348.84582	2025.2322	1173.8184	0
28	Optimized	15.461105	366.15315	328.04117	1836.9913	1056.5783	0
29	Optimized	18.97083	368.2288	307.31787	1674.4912	957.3051	0
30	Optimized	22.412235	370.2756	286.23459	1509.0727	856.24047	0
31	Optimized	25.78533	372.29365	264.83886	1350.9072	760.47321	0
32	Optimized	29.88933	374.76455	237.85167	1153.4364	641.0993	0
33	Optimized	34.42488	377.50725	207.2717	938.36853	511.91952	0
34	Optimized	38.40733	380.0366	172.86511	715.95014	380.27223	0

35	Optimized	42.136025	382.53365	132.60531	519.119	270.6398	0
36	Optimized	44.830815	384.33835	103.51017	383.17923	195.82639	0
37	Optimized	46.25563	385.4815	76.330395	264.1787	131.5328	0
38	Optimized	47.32157	386.53425	29.062105	186.49265	110.23406	0
39	Optimized	47.86815	387.0741	-4.6226869	145.70925	102.02672	0
40	Optimized	48.811185	388.00545	-62.741572	84.581655	59.224713	0
41	Optimized	49.98554	389.16525	-135.1094	14.637432	8.4509253	0

Slices of Slip Surface: 11453

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	11453	-67.182135	363.39575	100.10361	168.88988	27.791456	0
2	11453	-63.267905	361.5797	213.42581	387.84684	70.47067	0
3	11453	-59.353675	359.9731	313.66949	570.84796	103.90684	0
4	11453	-55.439445	358.5647	401.55574	722.66468	129.73643	0
5	11453	-51.525215	357.34535	477.65826	846.94976	149.20345	0
6	11453	-47.61099	356.3076	542.41466	946.55654	163.28392	0
7	11453	-43.696765	355.44535	596.20903	1023.7373	172.73265	0
8	11453	-39.782535	354.75375	639.37415	1080.2661	178.13192	0
9	11453	-35.868305	354.2291	672.10682	1117.6394	180.00684	0
10	11453	-33.023105	353.93475	690.48908	1155.0795	187.70671	0
11	11453	-30.293475	353.76245	701.22375	1263.6072	227.21764	0
12	11453	-26.61038	353.6359	709.10665	1434.2035	292.95814	0
13	11453	-21.835485	353.7116	704.38982	1702.988	699.22599	0
14	11453	-17.025375	353.9763	687.87858	1924.6267	865.98033	0
15	11453	-13.27185	354.37435	663.028	2061.3235	979.09704	0
16	11453	-9.0460255	355.01505	623.05989	2279.5744	1159.9039	0
17	11453	-4.3478965	355.946	564.98008	2562.4836	1398.6671	0

18	11453	-0.999416	356.7353	515.72906	2734.6028	1553.6721	0
19	11453	1.276865	357.3671	476.29616	2812.5999	1635.8975	0
20	11453	2.553905	357.73655	453.23026	2843.6905	1673.8183	0
21	11453	4.2096125	358.2739	471.03171	2795.4814	1627.5972	0
22	11453	7.5206775	359.41665	502.33268	2694.1029	1534.6941	0
23	11453	11.10376	360.81675	525.99292	2549.2658	1416.7109	0
24	11453	14.958855	362.50765	539.97984	2360.6036	1274.8145	0
25	11453	18.81395	364.40835	540.84195	2156.3517	1131.1921	0
26	11453	22.669045	366.53345	527.70768	1936.3185	986.31993	0
27	11453	26.52414	368.9009	499.44754	1699.7682	840.4736	0
28	11453	30.379235	371.53305	454.6816	1446.0038	694.13125	0
29	11453	34.25571	374.47615	391.16413	1172.4703	547.0765	0
30	11453	38.153575	377.7708	306.38985	878.00984	400.25263	0
31	11453	42.05144	381.45215	197.4715	562.64757	255.69904	0
32	11453	45.425185	384.97175	82.405016	283.50339	140.8106	0
33	11453	47.04467	386.77345	14.136023	149.59617	94.850217	0
34	11453	47.59125	387.41695	-26.016455	104.53687	73.197501	0
35	11453	48.361855	388.3429	-83.791678	44.865152	31.414918	0
36	11453	48.890275	388.98765	-124.02878	6.4892719	3.7465829	0

Stability - Existing Condition (Shallow Failure)

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File Information

Created By: Cooper, Paul
Revision Number: 242
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Date: 10/22/2009
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File Name: Section A_Extended.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 10/22/2009
Last Solved Time: 11:01:40 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition (Shallow Failure)

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 15 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bottom Ash

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Divider Dike

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-52, 364.28389) ft
Left-Zone Right Coordinate: (-25, 368.18973) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (-2, 382.4822) ft
Right-Zone Right Coordinate: (41, 387.90442) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-200, 378.17346) ft
Right Coordinate: (500, 408.84049) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-200	384.23
	2.55408	384.23
	40	384.23
	112.5	384.23
	132	384.23
	417	394.47
	500	394.47

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.0	(-23.106, 402.391)	33.07378	(13.6553, 387.127)	(-39.0712, 364.228)
2	28478	1.1	(-23.106, 402.391)	40.515	(14.4323, 387.149)	(-36.6826, 364.218)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-38.211195	364.0738	1257.7447	1285.6704	11.282723	0
2	Optimized	-36.49119	363.76505	1277.0294	1318.1741	16.62352	0
3	Optimized	-34.77119	363.45635	1296.257	1350.6206	21.964318	0
4	Optimized	-33.84751	363.29055	1306.6132	1424.237	47.523093	0
5	Optimized	-32.757935	363.2208	1310.9805	1427.617	47.124201	0
6	Optimized	-30.70614	363.10425	1318.2308	1473.9894	62.930566	0
7	Optimized	-28.84675	363.04285	1322.0819	1500.2472	71.983422	0
8	Optimized	-27.17977	363.0366	1322.4419	1528.0817	83.083896	0
9	Optimized	-25.253375	363.08035	1319.76	1544.4127	90.76556	0
10	Optimized	-23.06756	363.17405	1313.9094	1569.8718	103.41549	0
11	Optimized	-20.880905	363.3036	1305.8089	1583.6454	112.25324	0
12	Optimized	-18.693415	363.469	1295.5068	1601.5145	123.63512	0
13	Optimized	-16.575525	363.658	1283.6974	1608.5187	131.23633	0
14	Optimized	-14.52724	363.87055	1270.4403	1619.202	140.90886	0
15	Optimized	-12.478955	364.0831	1257.1833	1629.9339	150.601	0
16	Optimized	-11.42495	364.19495	1250.1922	1612.3919	146.33817	0
17	Optimized	-10.285555	364.4073	1236.9323	1644.0598	164.4902	0
18	Optimized	-8.126784	364.8947	1206.5453	1631.9597	171.87857	0
19	Optimized	-5.975869	365.46995	1170.6378	1633.5877	187.04393	0
20	Optimized	-4.17563	366.2311	1123.1033	1478.8201	205.37321	0

21	Optimized	-2.77851	367.1641	1064.8886	1426.7364	208.91294	0
22	Optimized	-1.039975	368.4299	985.93262	1330.3458	198.84701	0
23	Optimized	0.35442	369.5016	919.05822	1276.2678	206.23504	0
24	Optimized	1.631285	370.8223	836.65409	1154.0785	183.26506	0
25	Optimized	2.553905	371.8708	771.21065	1106.9414	193.83425	0
26	Optimized	3.20815	372.61435	724.80381	1052.5386	189.21774	0
27	Optimized	4.59075	374.27635	621.08676	912.3118	168.13885	0
28	Optimized	6.04781	376.11365	506.45608	778.06426	156.81306	0
29	Optimized	7.456115	377.94595	392.12277	634.79017	140.10409	0
30	Optimized	8.65605	379.6169	287.85933	502.54699	123.94998	0
31	Optimized	9.83831	381.33815	180.45047	373.19747	111.28254	0
32	Optimized	11.162515	383.26605	60.14873	224.54015	94.911432	0
33	Optimized	11.92235	384.3723	-8.8786697	142.84891	82.473856	0
34	Optimized	12.837705	385.8208	-99.265615	64.613174	37.304434	0

Slices of Slip Surface: **28478**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	28478	-35.989735	363.9855	1263.287	1316.5169	21.506284	0
2	28478	-34.60404	363.548	1290.544	1358.0121	27.258889	0
3	28478	-33.045185	363.1237	1317.0083	1467.7395	60.899328	0
4	28478	-31.313175	362.72535	1341.8971	1532.0944	76.844683	0
5	28478	-29.58117	362.40595	1361.8167	1586.3164	90.703769	0
6	28478	-27.849165	362.1636	1376.9464	1631.0169	102.65115	0
7	28478	-26.117155	361.99695	1387.3695	1666.6743	112.84648	0
8	28478	-24.385145	361.90505	1393.0639	1693.721	121.47336	0
9	28478	-22.65314	361.8874	1394.1907	1712.3564	128.54731	0
10	28478	-20.921135	361.9439	1390.6329	1722.9411	134.26126	0
11	28478	-19.189125	362.07485	1382.4551	1725.4686	138.58643	0
12	28478	-17.457115	362.28095	1369.6163	1720.1388	141.62029	0
13	28478	-15.72511	362.5634	1351.9704	1707.0082	143.44455	0
14	28478	-13.993105	362.9239	1329.5012	1686.0525	144.0561	0
15	28478	-12.261095	363.36455	1301.9812	1657.1125	143.48236	0
		-					

16	28478	10.488478	363.9024	1268.4338	1649.4251	153.93048	0
17	28478	-8.675254	364.54535	1228.3447	1621.9901	159.04307	0
18	28478	-6.8620305	365.288	1181.9749	1584.3193	162.55767	0
19	28478	-4.962849	366.1823	1126.1818	1511.4237	222.41952	0
20	28478	-2.9777095	367.2482	1059.659	1442.2676	220.89913	0
21	28478	-0.99257	368.4637	983.83278	1359.0422	216.62726	0
22	28478	1.276865	370.0741	883.34302	1279.9549	228.984	0
23	28478	2.553905	371.03765	823.21087	1244.3016	243.11686	0
24	28478	3.381846	371.75345	778.52375	1181.9049	232.8922	0
25	28478	5.0373785	373.2691	683.96405	1050.9861	211.90028	0
26	28478	6.692911	374.9686	577.90228	905.93515	189.38986	0
27	28478	8.3484435	376.88915	458.07677	744.3272	165.26676	0
28	28478	10.159735	379.3289	305.82829	536.26392	133.04208	0
29	28478	12.126785	382.4888	108.65013	271.25653	93.880851	0
30	28478	13.77129	385.6895	-91.073664	61.764321	35.659648	0

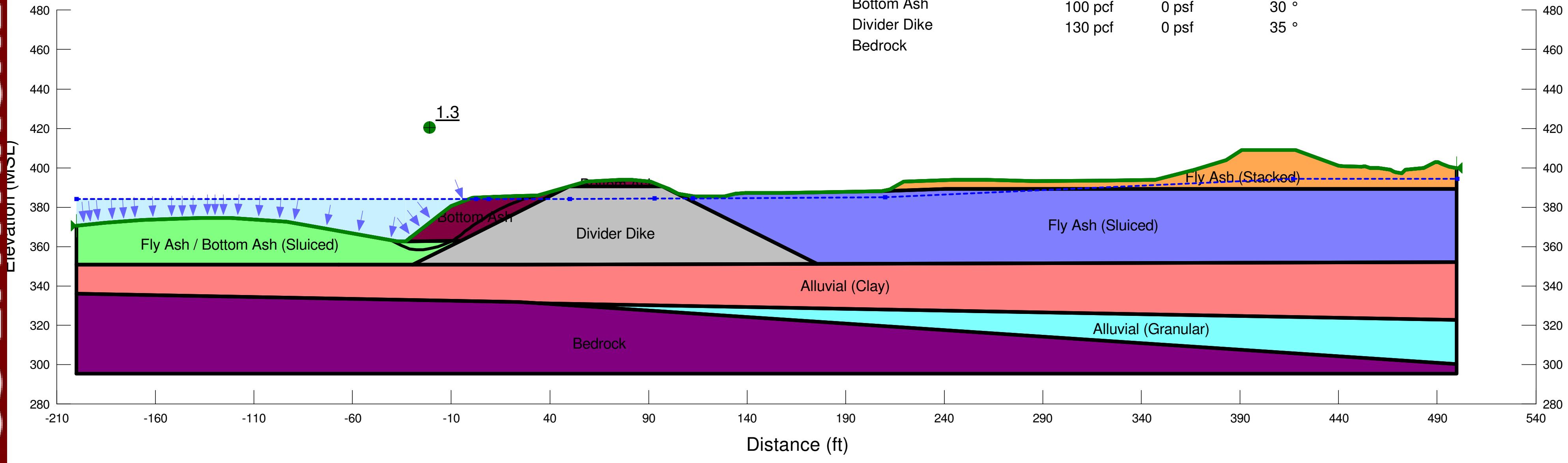
Stantec

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section B_Extended.gsz
Analysis Name: Stability - Existing Condition with Triger at FS = 1.3
Date Saved: 10/26/2009
Last Solved on 10/26/2009 at 8:57:36 AM

Analysis Method: Spencer
Calculated Factor of Safety: 1.3

Material Type	Unit Weight	Cohesion	Friction Angle
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Bottom Ash	100 pcf	0 psf	30 °
Divider Dike	130 pcf	0 psf	35 °
Bedrock			



Stability - Existing Condition with Triger at FS = 1.3

File Information

Created By: Cooper, Paul
Revision Number: 223
Last Edited By: Rogers, Daniel
Date: 10/26/2009
Time: 8:56:53 AM
File Name: Section B_Extended.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 10/26/2009
Last Solved Time: 8:57:36 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Triger at FS = 1.3

Kind: SLOPE/W
Method: Spencer
Settings
    Apply Phreatic Correction: No
    PWP Conditions Source: Piezometric Line
    Use Staged Rapid Drawdown: No
SlipSurface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Auto-Search
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: Yes
FOS Distribution
    FOS Calculation Option: Constant
Advanced
    Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bottom Ash

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Divider Dike

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bedrock

Model: Bedrock (Impenetrable)
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (-200, 370.55929) ft
Right Coordinate: (499.99988, 399.9474) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-200	384
	2.55408	384
	9	384
	50	384
	93	384.5

	112.5	384.5
	210	385
	417	394.47
	500	394.46785

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.3	(-53.323, 559.433)	38.99783	(40.3309, 387.831)	(-40.8313, 363.185)
2	303	1.9	(-53.323, 559.433)	197.494	(48.0705, 389.953)	(-32.7931, 363.009)

Slices of Slip Surface: **Optimized**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-39.020975	362.35005	1350.9511	1388.5465	15.189523	0
2	Optimized	-36.18502	361.0422	1432.564	1530.5799	39.600998	0
3	Optimized	-34.13382	360.09625	1491.5772	1638.8224	59.490929	0
4	Optimized	-32.10934	359.16265	1549.8407	1812.1627	105.98497	0
5	Optimized	-29.461285	358.59015	1585.5798	1889.3682	122.73846	0
6	Optimized	-26.16294	358.36645	1599.5245	2006.9754	164.62084	0
7	Optimized	-23.234245	358.51625	1590.1985	2019.6776	173.52084	0
8	Optimized	-20.675195	359.03955	1557.5415	2035.719	193.19623	0
9	Optimized	-18.116145	359.5628	1524.8846	2051.722	212.85615	0
10	Optimized	-16.818405	359.82815	1508.3181	2059.8486	222.83279	0
11	Optimized	-15.14407	360.51795	1465.2727	1991.0449	212.42575	0
12	Optimized	-11.831835	361.8901	1379.6708	1941.9821	227.18849	0
13	Optimized	-9.68392	362.7799	1324.1786	1901.7339	233.34748	0
14	Optimized	-8.177095	363.75125	1263.5137	1726.9343	267.55602	0
15	Optimized	-6.147045	365.2865	1167.7257	1611.0693	255.96457	0
16	Optimized	-3.980535	366.8948	1067.3468	1494.7415	246.75641	0
17	Optimized	-1.7685609	368.49465	967.53541	1377.1766	236.50648	0
18	Optimized	0.0787391	369.817	885.00605	1292.1905	235.08804	0
19	Optimized	1.709815	370.98455	812.16245	1214.8486	232.49097	0
20	Optimized	2.794945	371.76135	763.69972	1151.6262	223.96947	0
21	Optimized	3.59863	372.31135	729.37778	1114.1745	222.16248	0
22	Optimized	4.5628	372.97335	688.06759	1054.4922	211.55534	0
23	Optimized	5.518845	373.61805	647.83688	1011.0876	209.72288	0
24	Optimized	7.364685	374.81685	573.02198	909.74222	194.40552	0

25	Optimized	8.827915	375.7491	514.8596	843.88487	189.96283	0
26	Optimized	10.24764	376.5219	466.63163	777.2266	179.32209	0
27	Optimized	12.74292	377.88015	381.87271	660.08471	160.62577	0
28	Optimized	15.2382	379.2384	297.12436	542.94282	141.92335	0
29	Optimized	17.68854	380.46095	220.83705	446.74315	130.42695	0
30	Optimized	20.093945	381.5478	153.01862	353.1097	115.52264	0
31	Optimized	22.0626	382.366	101.96125	290.43657	108.81628	0
32	Optimized	24.72312	383.3204	42.408964	208.79559	96.063362	0
33	Optimized	27.17318	384.19925	-12.434201	135.16983	78.040336	0
34	Optimized	29.02095	384.7452	-46.503007	97.531499	56.309837	0
35	Optimized	31.605515	385.4386	-89.76605	43.722692	25.243308	0
36	Optimized	33.27453	385.889	-117.87218	8.7097324	5.0285664	0
37	Optimized	35.321175	386.45235	-153.02333	0.49133283	0.28367114	0
38	Optimized	38.66101	387.37165	-210.38976	0.16377665	0.094556491	0

Slices of Slip Surface: 303

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	303	-31.463365	363.15655	1300.6334	1363.9778	36.571882	0
2	303	-28.803955	363.471	1281.0133	1402.9097	70.37694	0
3	303	-26.144545	363.82215	1259.09	1437.6777	103.10767	0
4	303	-23.48514	364.21015	1234.885	1468.3542	134.79349	0
5	303	-20.825735	364.6352	1208.3477	1494.9033	165.44295	0
6	303	-18.166325	365.09755	1179.5043	1517.2931	195.02248	0
7	303	-15.171395	365.666	1144.0337	1537.2704	227.03533	0
8	303	-11.840945	366.35165	1101.2654	1553.5551	261.12958	0
9	303	-8.992264	366.982	1061.9232	1544.406	278.56156	0
10	303	-6.625352	367.5426	1026.9332	1518.1501	283.60422	0
11	303	-4.25844	368.13415	990.04593	1488.8339	287.9754	0
12	303	-1.8915279	368.7569	951.17159	1456.4127	291.70107	0
13	303	0.0787391	369.2971	917.4615	1444.6531	304.37423	0
14	303	1.709815	369.76305	888.36688	1431.3178	313.47285	0
15	303	4.31381	370.54495	839.58821	1371.5937	307.15354	0
16	303	7.53677	371.5559	776.51705	1288.257	295.45318	0

17	303	10.382855	372.50115	717.51061	1204.1105	280.93856	0
18	303	13.148565	373.4667	657.28591	1118.084	266.04191	0
19	303	15.914275	374.4787	594.14584	1027.9881	250.47895	0
20	303	18.679985	375.53785	528.05325	933.68865	234.19371	0
21	303	21.445695	376.64495	458.94725	835.20099	217.2302	0
22	303	23.850385	377.6444	396.59383	746.2821	201.89262	0
23	303	25.89406	378.52565	341.6016	667.90078	188.38892	0
24	303	28.59974	379.74075	265.77905	554.93458	202.46888	0
25	303	31.96742	381.3147	167.56386	418.78914	175.90983	0
26	303	35.305775	382.9519	65.403358	308.4636	170.19262	0
27	303	37.17097	383.8914	6.777086	262.73417	179.22308	0
28	303	38.79421	384.7449	-46.479881	225.69904	158.03617	0
29	303	41.619335	386.26425	-141.28729	160.04656	112.06581	0
30	303	44.291555	387.7549	-234.30669	97.985495	56.571952	0
31	303	46.810865	389.2121	-325.23632	33.166489	19.148682	0

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section C.gsz

Analysis Name: Stability - Existing Condition with Triger at FS = 1.5

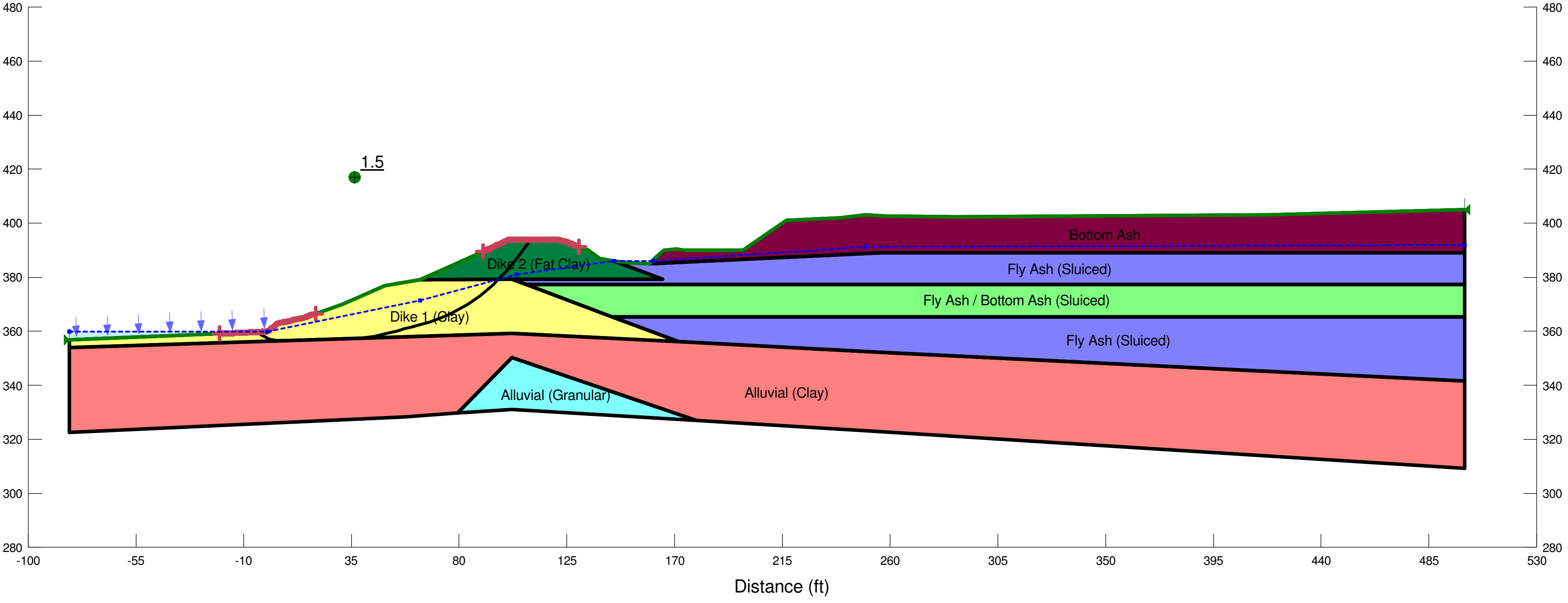
Date Saved: 11/12/2009

Last Solved on 11/12/2009 at 1:33:44 PM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Bottom Ash	105 pcf	0 psf	35 °

Analysis Method: Spencer

Calculated Factor of Safety: 1.5



Stability - Existing Condition with Existing PZ Levels

File Information

Created By: Cooper, Paul
Revision Number: 349
Last Edited By: Rogers, Daniel
Date: 11/12/2009
Time: 1:22:35 PM
File Name: Section C.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 11/12/2009
Last Solved Time: 1:24:28 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bottom Ash

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-20, 359.13643) ft
Left-Zone Right Coordinate: (20, 366.52849) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (90, 389.57657) ft
Right-Zone Right Coordinate: (130, 391.28201) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-82.79061, 356.76744) ft
Right Coordinate: (500, 404.96392) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-82.79062	359.891
	0	359.891
	63.7	372
	104	383
	138.58701	387.003
	249.7	389
	500	389

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.5	(25.081, 477.794)	58.45157	(110.606, 394.003)	(-4.71314, 359.713)
2	24842	1.5	(25.081, 477.794)	120.622	(111.85, 394.003)	(-0.328497, 359.879)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-2.3565715	358.5788	81.881027	293.39905	98.632473	100
2	Optimized	0.28841	357.3056	164.7534	558.18082	183.45822	100
3	Optimized	1.94251	356.9037	209.45109	676.83969	217.94688	100
4	Optimized	3.792395	356.64855	247.31513	799.74485	257.60221	100
5	Optimized	6.03891	356.68555	271.65048	882.8357	285.00035	100
6	Optimized	9.56355	356.74365	309.8336	957.81191	302.15725	100
7	Optimized	13.08819	356.80175	348.01672	1032.7881	319.31415	100
8	Optimized	17.423405	356.8732	394.98781	1169.0497	360.95097	100
9	Optimized	21.51856	356.9539	438.51858	1318.1169	410.16344	100
10	Optimized	24.634415	357.03235	470.57827	1433.7221	449.12135	100
11	Optimized	28.712195	357.14765	511.76488	1578.9711	497.64643	100
12	Optimized	33.113195	357.28075	555.6681	1758.2338	560.76559	100
13	Optimized	36.946825	357.3967	593.89114	1936.1039	625.88409	100
14	Optimized	38.915255	357.461	613.23644	1929.765	613.90736	100
15	Optimized	41.76589	357.81035	625.25721	2029.8164	654.9567	100
16	Optimized	46.7159	358.59925	634.74324	2089.7568	678.48394	100
17	Optimized	50.296935	359.34155	630.90381	2127.948	698.08319	100
18	Optimized	53.722485	360.0792	625.50659	2080.61	678.52588	100
19	Optimized	57.71349	360.96165	617.77552	2039.5816	662.99905	100
20	Optimized	61.704495	361.84415	610.04446	1998.5531	647.47222	100
21	Optimized	63.730635	362.29215	606.2955	1977.6914	639.49243	100
22	Optimized	65.073305	362.589	610.65254	2007.1421	651.19377	100
23	Optimized	68.77822	363.55765	613.29443	2011.8823	652.17225	100
24	Optimized	74.003875	365.30785	593.09235	1969.6556	641.90201	100
25	Optimized	78.660515	367.25015	551.20723	1880.9081	620.04969	100
26	Optimized	82.308245	368.99145	504.67128	1853.6446	629.03658	100

27	Optimized	85.618825	370.81145	447.48671	1682.3482	575.82538	100
28	Optimized	88.59226	372.7101	379.65649	1611.1733	574.2657	100
29	Optimized	90.31644	373.81105	340.32831	1569.9079	573.36236	100
30	Optimized	92.17247	375.2851	279.96295	1387.9732	516.67366	100
31	Optimized	95.409615	377.9299	170.0614	1257.0463	506.86939	100
32	Optimized	97.85593	379.9286	87.011435	1165.1889	371.24627	200
33	Optimized	99.28884	381.2421	29.453852	982.1554	328.04145	200
34	Optimized	100.4392	382.4533	-26.534135	913.33458	314.48632	200
35	Optimized	102.4922	384.61495	-126.45492	744.14664	256.23024	200
36	Optimized	105.13865	387.4015	-266.43108	501.41237	172.65012	200
37	Optimized	108.44155	391.3017	-485.9471	134.62964	46.356701	200

Slices of Slip Surface: **24842**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	24842	-0.16424835	359.84345	2.9670164	46.291445	20.202513	100
2	24842	2.138295	359.39395	56.38019	343.28557	133.78618	100
3	24842	6.03891	358.6978	146.08581	705.13074	260.68693	100
4	24842	9.56355	358.1874	219.74689	848.71897	293.2945	100
5	24842	13.08819	357.78265	286.79949	974.00031	320.44701	100
6	24842	16.893745	357.4675	351.61845	1126.1703	361.17945	100
7	24842	20.980215	357.25895	413.10086	1300.7382	413.91209	100
8	24842	25.06668	357.18915	465.92803	1451.4246	459.54458	100
9	24842	29.153145	357.25795	510.10101	1579.3639	498.60548	100
10	24842	33.139005	357.45705	544.97431	1702.4637	539.74616	100
11	24842	37.02425	357.78045	570.86365	1821.4927	583.17792	100
12	24842	40.616875	358.1881	588.05888	1918.1556	620.23427	100
13	24842	43.91688	358.6633	597.54582	1995.7504	651.99349	100
14	24842	47.216885	359.23225	601.18653	2059.4407	679.99508	100
15	24842	50.72103	359.94365	598.36249	2052.319	677.99107	100
16	24842	54.42931	360.8122	588.14698	1975.8349	647.08949	100
17	24842	58.137585	361.8058	570.13394	1886.7792	613.96179	100
18	24842	61.84586	362.92765	544.12565	1785.1667	578.70694	100
19	24842	63.730635	363.53145	528.95697	1730.6709	560.3684	100
20	24842	65.641105	364.2131	518.96211	1726.1915	562.94031	100
21	24842	69.40078	365.62715	494.7665	1710.3717	566.84603	100
22	24842	73.160455	367.18705	461.47001	1677.5916	567.08679	100
23	24842	76.920125	368.89905	418.66598	1627.7132	563.78797	100
24	24842	80.679795	370.7705	365.919	1560.4959	557.04038	100
25	24842	84.43947	372.80995	302.70854	1475.6636	546.95793	100
26	24842	88.199145	375.02735	228.36851	1372.8401	533.67589	100

27	24842	92.34971	377.70805	131.78442	1236.6109	515.18904	100
28	24842	95.95048	380.20005	37.612774	1108.0939	368.59621	200
29	24842	99.13246	382.6066	-58.357517	970.62924	334.21445	200
30	24842	102.4922	385.30935	-169.78572	760.20876	261.76087	200
31	24842	105.9625	388.34595	-319.41208	457.30996	157.46445	200
32	24842	109.88745	392.06175	-522.929	105.49508	36.32487	200

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section D.gsz

Analysis Name: Stability - Existing Condition with Existing PZ Levels

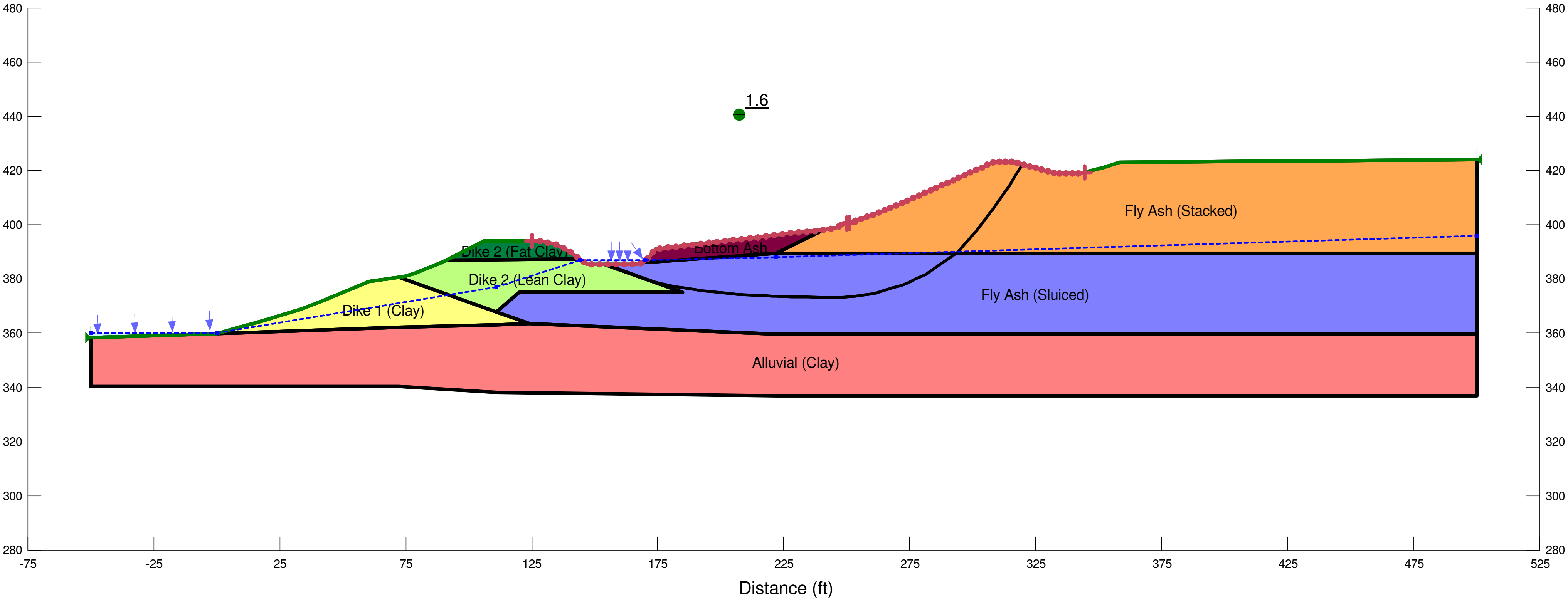
Date Saved: 10/11/2009

Last Solved on 10/11/2009 at 12:20:38 AM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Bottom Ash	105 pcf	0 psf	35 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °

Analysis Method: Spencer
Calculated Factor of Safety: 1.6



Stability - Existing Condition with Existing PZ Levels

File Information

Created By: Cooper, Paul
Revision Number: 312
Last Edited By: Rogers, Daniel
Date: 10/11/2009
Time: 12:18:50 AM
File Name: Section D.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 10/11/2009
Last Solved Time: 12:20:38 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
    Apply Phreatic Correction: No
    PWP Conditions Source: Piezometric Line
    Use Staged Rapid Drawdown: No
SlipSurface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: Yes
FOS Distribution
    FOS Calculation Option: Constant
Advanced
    Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1

Fly Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bottom Ash

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (125, 394.002) ft
Left-Zone Right Coordinate: (250, 400.40648) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (251, 400.73145) ft
Right-Zone Right Coordinate: (344.34149, 419.42785) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-50, 358.25326) ft
Right Coordinate: (500, 424.09795) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-50	360
	0	360
	111	377
	144	387
	170	387
	222	388
	500	396

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.610	(221.488, 487.817)	79.63433	(319.792, 422.323)	(154.802, 385.369)
2	16198	1.682	(221.488, 487.817)	118.578	(320.258, 422.203)	(161.797, 385.358)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	157.5613	384.39865	162.3218	221.60351	23.951369	0
2	Optimized	163.0805	382.45775	283.44397	444.14711	64.928284	0
3	Optimized	167.4687	380.91455	379.72059	640.55222	105.38282	0
4	Optimized	169.54865	380.1831	425.37057	760.39353	135.35806	0
5	Optimized	170.24385	379.93865	440.92912	809.90454	149.07575	0
6	Optimized	171.51305	379.4923	470.27813	1014.2514	219.77947	0
7	Optimized	173.3569	378.956	505.97483	1264.071	306.29075	0
8	Optimized	177.67195	378.0297	568.95301	1518.5036	383.64335	0
9	Optimized	185.1916	376.69505	661.26485	1712.8142	424.85352	0
10	Optimized	190.4879	375.92615	715.58791	1860.5363	462.58919	0
11	Optimized	195.36425	375.407	753.8396	1937.0708	478.05645	0
12	Optimized	203.0199	374.69675	807.34645	2102.8576	523.42047	0
13	Optimized	209.82375	374.17495	848.08233	2204.3644	547.97352	0
14	Optimized	215.32645	373.8832	872.87167	2298.1864	575.86454	0
15	Optimized	219.2696	373.67415	890.66173	2368.0315	596.89615	0
16	Optimized	221.1707	373.5985	897.62836	2370.6523	595.1403	0
17	Optimized	221.94	373.58495	899.44392	2382.2974	599.1117	0
18	Optimized	225.0922	373.5294	908.52079	2424.2849	612.40847	0
19	Optimized	231.3455	373.41925	926.62148	2491.1492	632.11024	0
20	Optimized	237.6677	373.3079	944.91922	2542.7055	645.54757	0
21	Optimized	243.27025	373.2092	961.13268	2625.4593	672.43159	0
22	Optimized	246.34015	373.1551	970.0142	2705.6825	701.25553	0
23	Optimized	247.4331	373.1751	970.74605	2658.3173	681.82306	0
24	Optimized	250.6724	373.3919	963.03644	2743.9814	719.54848	0
25	Optimized	257.28795	374.1544	927.3274	2801.1259	757.06372	0
26	Optimized	262.63505	375.13885	875.51512	2757.4913	760.36775	0

27	Optimized	266.34685	376.14335	819.48666	2782.1011	792.94769	0
28	Optimized	270.253	377.20045	760.55231	2822.4437	833.05819	0
29	Optimized	271.98235	377.66845	734.44634	2845.6215	852.97015	0
30	Optimized	273.38285	378.2667	699.61745	2692.2785	805.08731	0
31	Optimized	276.0186	379.40125	633.57489	2685.5349	829.04564	0
32	Optimized	279.26665	380.79935	552.16099	2677.1301	858.54327	0
33	Optimized	284.3286	383.63785	384.1246	2421.4295	823.12461	0
34	Optimized	290.6349	387.70385	141.73229	2282.3728	864.8749	0
35	Optimized	293.99975	389.93065	8.8161715	1768.2799	1099.4349	0
36	Optimized	297.80375	393.9821	-237.16009	1606.2312	1003.6847	0
37	Optimized	304.3477	401.32245	-683.45457	1246.3179	778.78585	0
38	Optimized	307.6222	405.28715	-924.94812	1034.0937	646.17343	0
39	Optimized	310.31575	408.87595	-1144.0754	840.51854	525.21427	0
40	Optimized	313.5445	413.17785	-1406.7039	591.85297	369.83078	0
41	Optimized	315.82005	416.41705	-1604.7469	373.12975	233.15735	0
42	Optimized	318.4773	420.3679	-1846.5212	128.43446	80.254756	0

Slices of Slip Surface: **16198**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	16198	163.8183	384.23265	172.68172	256.39297	33.821539	0
2	16198	167.4687	382.27345	294.93575	510.91771	87.262374	0
3	16198	169.54865	381.22	360.67402	670.86603	125.32571	0
4	16198	170.24385	380.88325	381.96916	731.96888	141.40907	0
5	16198	172.33155	379.9263	444.20579	1120.9898	273.43847	0
6	16198	176.68195	378.06295	565.67959	1618.5122	425.37198	0
7	16198	181.69505	376.14655	691.28243	1870.2526	476.33487	0
8	16198	186.70815	374.48415	801.03741	2085.882	519.1109	0
9	16198	191.65285	373.08095	894.52979	2266.5417	554.32881	0
10	16198	196.5292	371.9219	972.70609	2415.9277	583.09937	0
11	16198	201.3562	370.9852	1036.9579	2536.9083	606.0193	0
12	16198	206.1338	370.2616	1087.8341	2631.8968	623.84184	0
13	16198	210.9114	369.73565	1126.3888	2704.1254	637.44695	0
14	16198	215.689	369.4047	1152.7707	2754.7668	647.24844	0
15	16198	220.0389	369.26375	1166.7954	2787.7963	654.92689	0
16	16198	225.0922	369.33385	1170.3135	2801.0915	658.87707	0
17	16198	231.3455	369.6917	1159.2196	2769.9395	650.77307	0
18	16198	237.6677	370.3911	1126.9301	2690.8746	631.8746	0
19	16198	243.27025	371.28305	1081.3418	2629.8774	625.64898	0

20	16198	246.80465	371.97825	1044.2919	2619.4449	636.4031	0
21	16198	250.6049	372.9031	993.40961	2619.8988	657.14428	0
22	16198	256.0195	374.4135	908.87665	2599.2639	682.96078	0
23	16198	261.4341	376.2069	806.70052	2549.4887	704.13214	0
24	16198	266.34685	378.0774	698.79485	2486.3574	722.22213	0
25	16198	270.253	379.74635	601.66318	2433.2629	740.01431	0
26	16198	273.3542	381.19505	516.85551	2387.5071	755.79231	0
27	16198	276.0186	382.5309	438.26215	2338.9555	767.92997	0
28	16198	279.94035	384.69205	310.45908	2248.4962	783.01783	0
29	16198	285.2561	387.8948	120.15185	2099.2639	799.61316	0
30	16198	288.14885	389.75065	9.5402039	1908.569	1186.6449	0
31	16198	290.8383	391.681	-106.084	1813.084	1132.9406	0
32	16198	295.7475	395.42455	-330.86611	1629.1651	1018.0154	0
33	16198	300.65665	399.60025	-582.62147	1420.6316	887.70915	0
34	16198	305.5658	404.2734	-865.3986	1186.3803	741.33269	0
35	16198	310.31575	409.3419	-1173.1438	882.99829	551.75857	0
36	16198	314.88665	414.853	-1508.7853	503.65888	314.721	0
37	16198	318.71015	419.98445	-1822.1614	151.23499	94.502113	0

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section E.gsz

Analysis Name: Stability - Existing Condition with Existing PZ Levels

Date Saved: 10/11/2009

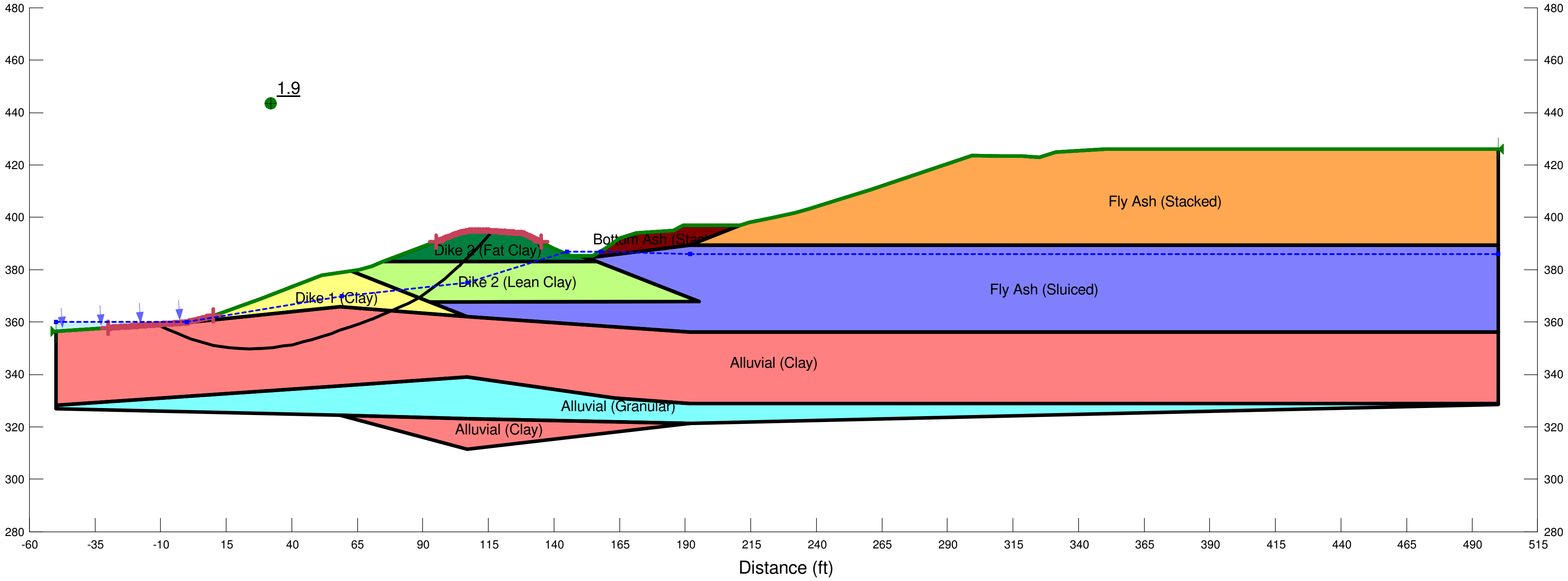
Last Solved on 10/11/2009 at 6:52:24 PM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Bottom Ash (Stacked)	105 pcf	0 psf	35 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °

Analysis Method: Spencer

Calculated Factor of Safety: 1.9



Stability - Existing Condition with Existing PZ Levels

File Information

Created By: Cooper, Paul
Revision Number: 287
Last Edited By: Kirkbride, Rob
Date: 10/11/2009
Time: 6:49:23 PM
File Name: Section E.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 10/11/2009
Last Solved Time: 6:52:24 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

- Kind: SLOPE/W
- Method: Spencer
- Settings
    - Apply Phreatic Correction: No
    - PWP Conditions Source: Piezometric Line
    - Use Staged Rapid Drawdown: No
- SlipSurface
    - Direction of movement: Right to Left
    - Use Passive Mode: No
    - Slip Surface Option: Entry and Exit
    - Critical slip surfaces saved: 1
    - Optimize Critical Slip Surface Location: Yes
- FOS Distribution
    - FOS Calculation Option: Constant
- Advanced
    - Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 5 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Bottom Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-30, 357.8121) ft
Left-Zone Right Coordinate: (10, 362.45286) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (95, 390.7105) ft
Right-Zone Right Coordinate: (135, 390.68494) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-50, 356.42684) ft

Right Coordinate: (500, 426.00135) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-50	360
	0	360
	59	370
	107	375
	145	387
	158	387
	192	386
	500	386

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.9	(26.818, 463.424)	64.25932	(116.63, 394.765)	(-11.4984, 359.094)
2	19730	1.9	(26.818, 463.424)	112.575	(116.061, 394.803)	(-14.8854, 358.859)

Slices of Slip Surface: **Optimized**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-9.582025	358.2887	106.78702	310.09203	117.3782	200
2	Optimized	-5.749215	356.6789	207.23798	585.76146	218.54063	200
3	Optimized	-1.916405	355.06905	307.68653	861.40683	319.69056	200
4	Optimized	0.7821	353.93565	386.68676	1077.1163	398.61969	200
5	Optimized	1.87365	353.4772	426.84571	1187.2666	439.0292	200
6	Optimized	5.371745	352.43695	528.75014	1352.1299	475.37854	200
7	Optimized	9.279645	351.32135	639.68898	1669.5444	594.5873	200
8	Optimized	12.99836	350.6357	721.80263	1824.0939	636.40818	200
9	Optimized	17.99377	350.0553	810.84956	2025.285	701.15462	200
10	Optimized	21.98567	349.8551	865.5667	2241.4765	794.38189	200
11	Optimized	26.235035	349.8772	909.12676	2309.9836	808.78506	200
12	Optimized	30.629715	350.1155	940.74761	2488.3284	893.49617	200
13	Optimized	34.66657	350.526	957.824	2508.228	895.12615	200
14	Optimized	38.457745	351.11475	961.18634	2617.1522	956.07231	200
15	Optimized	42.23072	351.87815	953.43984	2585.9149	942.5099	200
16	Optimized	45.9855	352.81625	934.62943	2647.9272	989.17295	200
17	Optimized	49.69941	353.90845	905.75806	2582.7975	968.23918	200

18	Optimized	53.244445	355.11135	868.1692	2555.6771	974.28312	200
19	Optimized	56.66148	356.27085	831.97585	2479.9925	951.48286	200
20	Optimized	58.685	356.9575	810.5138	2435.3593	938.10501	200
21	Optimized	60.79654	357.674	780.82873	2389.425	928.72348	200
22	Optimized	64.127795	358.8044	731.92268	2326.8872	920.8532	200
23	Optimized	65.690485	359.33465	708.99839	2303.3562	920.50291	200
24	Optimized	68.05611	360.23725	668.06183	2243.19	909.40068	200
25	Optimized	70.516125	361.17715	625.38075	2227.8044	925.15973	200
26	Optimized	72.64374	362.0919	582.13758	2171.7576	917.76754	200
27	Optimized	76.27034	363.66175	507.77468	2161.1696	954.58803	200
28	Optimized	79.388695	365.0116	443.80526	2174.1216	806.85977	100
29	Optimized	82.690265	366.4407	376.09901	2160.0456	831.86797	100
30	Optimized	86.62462	368.29745	285.79074	2062.3329	828.41521	100
31	Optimized	91.67787	371.5408	116.26025	1715.5201	850.34156	100
32	Optimized	96.41931	375.05645	-72.29777	1535.9161	816.6611	100
33	Optimized	100.92475	378.8257	-278.21648	1248.3942	663.78296	100
34	Optimized	103.7982	381.41455	-421.08396	1108.8631	589.59296	100
35	Optimized	104.71575	382.29105	-469.80864	1017.6676	541.10345	100
36	Optimized	106.22365	383.75235	-551.20015	936.96625	322.62335	200
37	Optimized	107.75975	385.241	-624.06721	829.31703	285.55675	200
38	Optimized	109.6522	387.075	-701.21261	674.87078	232.37664	200
39	Optimized	111.96265	389.501	-807.07466	417.52136	143.76413	200
40	Optimized	114.885	392.7969	-955.14503	117.70564	40.529303	200

Slices of Slip Surface: **19730**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	19730	-12.404475	357.93655	128.75922	332.15085	117.42821	200
2	19730	-7.442685	356.22125	235.80242	595.52446	207.68561	200
3	19730	-2.480895	354.75945	327.01004	808.03878	277.72208	200
4	19730	0.7821	353.9046	388.6259	946.45268	322.06144	200
5	19730	3.3132475	353.3452	450.29946	1092.578	370.81966	200
6	19730	6.8113425	352.6558	530.31258	1283.4853	434.84446	200
7	19730	10.553195	352.04885	607.76268	1497.1121	513.46615	200
8	19730	14.538805	351.5391	681.72341	1729.274	604.80359	200
9	19730	18.52442	351.17315	746.70785	1934.179	685.5868	200
10	19730	22.510035	350.9496	802.8261	2113.558	756.75141	200

11	19730	26.495645	350.8676	850.07934	2268.7014	819.04186	200
12	19730	30.7932	350.94335	890.82128	2419.7956	882.75375	200
13	19730	35.402695	351.2011	923.4772	2562.6427	946.37267	200
14	19730	40.01219	351.64945	944.26411	2676.5066	1000.1107	200
15	19730	44.621685	352.2907	952.98687	2761.8368	1044.34	200
16	19730	49.23118	353.12825	949.48577	2819.6927	1079.7645	200
17	19730	53.244445	354.00925	936.96502	2799.061	1075.0816	200
18	19730	56.66148	354.8917	918.03852	2709.3057	1034.1886	200
19	19730	58.685	355.45445	904.30787	2652.5918	1009.3722	200
20	19730	60.79654	356.11625	878.02714	2586.5875	986.43779	200
21	19730	64.127795	357.2243	830.5316	2486.6153	956.14036	200
22	19730	68.028135	358.6943	764.14896	2396.3737	942.36537	200
23	19730	72.521375	360.57055	676.29325	2315.7315	946.53012	200
24	19730	77.318075	362.85625	564.83868	2220.6832	956.00227	200
25	19730	80.43643	364.43985	486.29072	2182.701	791.04912	100
26	19730	82.798755	365.78	418.02154	2111.7162	789.7828	100
27	19730	86.62486	368.07675	299.56878	1983.597	785.27526	100
28	19730	91.69602	371.50575	118.56461	1743.7456	864.12405	100
29	19730	97.043655	375.48325	-94.872147	1479.2032	786.50629	100
30	19730	101.42269	379.17045	-296.49264	1240.5777	659.62689	100
31	19730	104.6012	382.0546	-455.80081	1040.7549	553.37921	100
32	19730	106.2951	383.70275	-547.63665	930.86175	320.52141	200
33	19730	107.75975	385.19155	-620.97029	810.45839	279.0632	200
34	19730	110.82995	388.57075	-771.351	499.85215	172.1129	200
35	19730	114.6006	392.98355	-972.40433	91.537678	31.51895	200

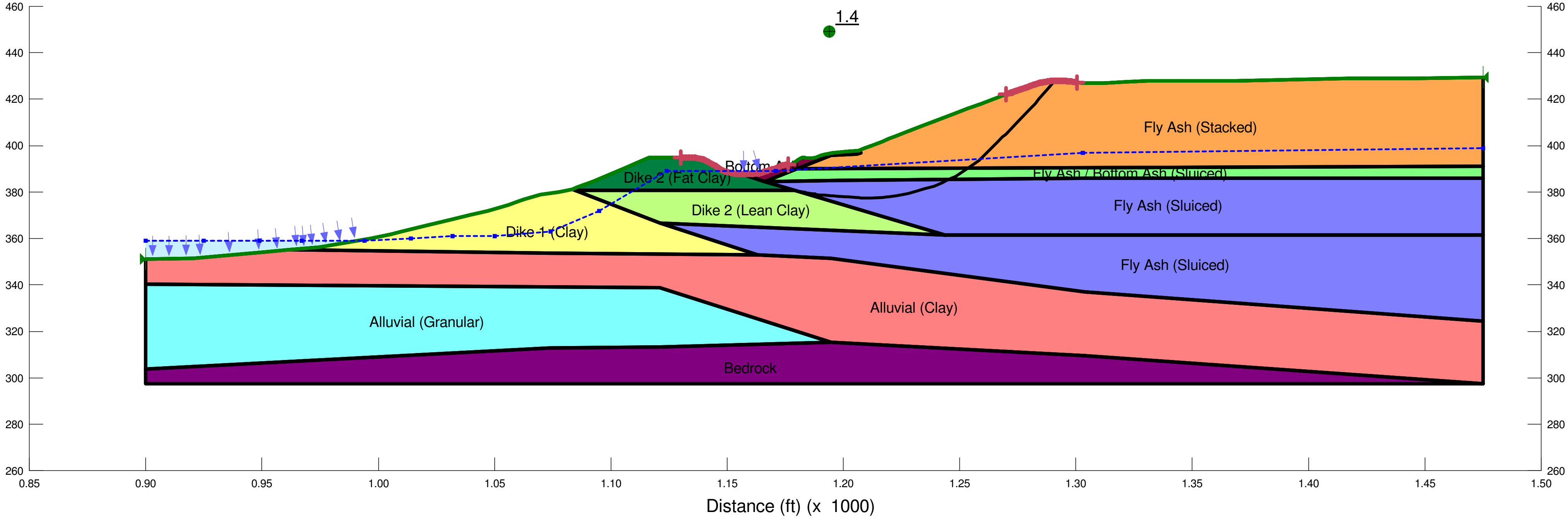
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section F.gsz
Analysis Name: Stability - Existing Condition with Existing PZ Levels
Date Saved: 10/26/2009
Last Solved on 10/26/2009 at 2:34:42 PM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Bottom Ash - Stacked	105 pcf	0 psf	35 °
Bedrock			

Analysis Method: Spencer
Calculated Factor of Safety: 1.4



Stability - Existing Condition with Existing PZ Levels

File Information

Created By: Cooper, Paul
Revision Number: 229
Last Edited By: Rogers, Daniel
Date: 10/26/2009
Time: 2:20:53 PM
File Name: Section F.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 10/26/2009
Last Solved Time: 2:34:42 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

- Kind: SLOPE/W
- Method: Spencer
- Settings
  - Apply Phreatic Correction: No
  - PWP Conditions Source: Piezometric Line
  - Use Staged Rapid Drawdown: No
- SlipSurface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Optimize Critical Slip Surface Location: Yes
- FOS Distribution
  - FOS Calculation Option: Constant
- Advanced
  - Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Bottom Ash - Stacked

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Bedrock

Model: Bedrock (Impenetrable)
Pore Water Pressure
    Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (1130, 394.95234) ft
Left-Zone Right Coordinate: (1176.3653, 391.86252) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (1270, 422.08921) ft
Right-Zone Right Coordinate: (1300.3591, 427.27394) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (900, 351.17633) ft
Right Coordinate: (1475, 429.48497) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	900	359
	925	359
	949	359
	967	359
	994	359
	1014	360
	1032	361
	1050	361
	1074	363
	1095	372
	1124	389
	1171	389
	1303	397
	1475	399

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.4	(1205.2, 472.484)	71.79959	(1290.8, 427.994)	(1156.31, 387.845)
2	35141	1.4	(1205.2, 472.484)	95.337	(1289.45, 427.87)	(1161.21, 387.9)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	1157.234	387.54585	90.741215	121.7405	21.705936	0
2	Optimized	1160.7	386.4199	160.99785	282.79594	85.283937	0
3	Optimized	1164.1975	385.2836	231.89924	469.44408	166.33069	0
4	Optimized	1165.7265	384.78685	262.89912	566.41115	212.52141	0
5	Optimized	1166.3445	384.586	275.42674	550.37583	111.08665	0
6	Optimized	1166.5575	384.5167	279.75276	561.36241	113.77768	0
7	Optimized	1167.157	384.32205	291.90057	603.79798	126.01473	0
8	Optimized	1167.8015	384.1128	304.9568	653.79891	140.94136	0
9	Optimized	1169.03	383.742	328.09981	732.15719	163.24978	0
10	Optimized	1170.521	383.29935	355.7236	846.31956	198.21363	0
11	Optimized	1172.018	382.85505	387.29571	977.1628	238.32178	0
12	Optimized	1173.8705	382.3052	428.60918	1133.9809	284.98869	0
13	Optimized	1175.086	381.9443	455.72319	1224.1567	310.46728	0
14	Optimized	1175.916	381.6978	474.24668	1256.6085	316.0947	0
15	Optimized	1177.008	381.37365	498.60738	1293.4672	321.14422	0
16	Optimized	1178.1225	381.0429	523.45731	1377.958	345.2407	0
17	Optimized	1178.8745	380.8197	540.23061	1470.3943	375.81051	0
18	Optimized	1179.557	380.6171	555.45544	1554.9842	403.83584	0
19	Optimized	1180.205	380.42475	569.91451	1635.8913	430.6826	0
20	Optimized	1180.5405	380.3372	576.65795	1556.596	395.92066	0
21	Optimized	1181.169	380.2353	585.37943	1613.5013	415.38818	0
22	Optimized	1182.055	380.09165	597.68809	1679.3918	437.03666	0
23	Optimized	1182.819	379.96775	608.30398	1706.1752	443.56877	0
24	Optimized	1183.6095	379.83955	619.30192	1713.8854	442.24045	0
25	Optimized	1184.0815	379.763	625.88389	1715.0987	440.07135	0
26	Optimized	1184.796	379.6471	635.79448	1716.3799	436.58484	0
27	Optimized	1186.136	379.42985	654.41924	1732.4647	435.55863	0
28	Optimized	1187.4035	379.2244	672.03466	1771.4006	444.17269	0
29	Optimized	1188.091	379.11295	681.59625	1799.0341	451.47418	0
30	Optimized	1189.035	378.9599	694.71304	1861.2042	471.29302	0
31	Optimized	1190.164	378.80325	708.7498	1860.455	465.3191	0
32	Optimized	1191.1095	378.7259	717.15933	1897.8803	477.04224	0
33	Optimized	1193.146	378.55935	735.24715	1958.8458	494.36595	0
34	Optimized	1195.051	378.40355	752.17198	2017.3002	511.14498	0
35	Optimized	1196.551	378.28085	765.49294	2052.2436	519.881	0
36	Optimized	1199.32	378.05435	790.09879	2104.9698	531.24236	0
37	Optimized	1201.488	377.87705	809.3673	2146.0305	540.04699	0
38	Optimized	1203.864	377.74725	826.46732	2148.4943	534.13358	0
39	Optimized	1206.129	377.6365	841.94268	2181.4598	541.20006	0
40	Optimized	1206.9675	377.5955	847.66908	2206.3489	548.94228	0
41	Optimized	1208.3135	377.52965	856.84993	2264.5804	568.76002	0

42	Optimized	1210.277	377.4336	870.29552	2356.5938	600.50347	0
43	Optimized	1211.5815	377.3865	878.13694	2294.7926	572.36603	0
44	Optimized	1214.13	377.5429	878.02855	2380.2192	606.92442	0
45	Optimized	1217.8185	377.7693	877.87292	2504.2505	657.09918	0
46	Optimized	1219.3275	377.8867	876.23466	2426.2522	626.24775	0
47	Optimized	1221.174	378.2103	863.01565	2464.839	647.17863	0
48	Optimized	1225.042	378.88825	835.35322	2545.9368	691.12064	0
49	Optimized	1227.707	379.35535	816.28495	2601.6907	721.35076	0
50	Optimized	1229.862	379.94915	787.39067	2487.8277	687.02116	0
51	Optimized	1233.32	380.98745	735.68267	2514.3603	718.63239	0
52	Optimized	1236.8975	382.0615	682.16804	2540.6594	750.87926	0
53	Optimized	1240.523	383.375	613.93047	2413.2079	726.95525	0
54	Optimized	1243.879	384.8076	537.22522	2396.1922	751.07143	0
55	Optimized	1246.6	385.9691	475.03834	2382.6406	770.72134	0
56	Optimized	1247.7915	386.47785	447.79331	2376.6454	779.30682	0
57	Optimized	1250.6865	388.4615	334.95902	2061.1082	697.40955	0
58	Optimized	1255.9185	392.07	129.57964	1821.9928	1057.5371	0
59	Optimized	1258.542	393.94625	22.422682	1522.6474	937.44444	0
60	Optimized	1258.858	394.25295	4.4774081	1506.9938	938.87646	0
61	Optimized	1261.1445	396.47445	-125.49691	1419.8812	887.24024	0
62	Optimized	1264.998	400.2436	-346.11675	1264.5326	790.16767	0
63	Optimized	1267.554	402.76545	-493.82339	1164.669	727.76594	0
64	Optimized	1269.123	404.33325	-585.71423	1085.5209	678.30872	0
65	Optimized	1272.28	407.5435	-774.09044	953.89476	596.0596	0
66	Optimized	1274.886	410.1982	-929.8757	829.18387	518.13159	0
67	Optimized	1277.5675	413.03985	-1097.0653	712.01427	444.9159	0
68	Optimized	1281.281	416.97485	-1328.5647	549.80801	343.55817	0
69	Optimized	1283.257	419.16205	-1457.5642	436.85771	272.979	0
70	Optimized	1286.175	422.57845	-1659.6937	278.19642	173.83642	0
71	Optimized	1289.529	426.50495	-1892.0532	79.885613	49.918071	0

Slices of Slip Surface: 35141

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	35141	1162.2285	387.3869	100.65882	173.55499	51.042448	0
2	35141	1164.1975	386.41995	160.9941	355.21334	135.99378	0

3	35141	1165.9395	385.6092	211.5842	510.18001	209.07903	0
4	35141	1167.02	385.1253	241.77806	610.41119	258.1197	0
5	35141	1167.448	384.93925	253.39303	573.78652	129.44737	0
6	35141	1167.916	384.7395	265.8556	615.76286	141.37171	0
7	35141	1169.1445	384.23215	297.51397	721.23505	171.19443	0
8	35141	1170.521	383.67845	332.06572	843.66531	206.69965	0
9	35141	1172.018	383.1135	371.16532	985.64815	248.26717	0
10	35141	1173.8705	382.4453	419.86645	1147.8738	294.13406	0
11	35141	1175.086	382.02805	450.49657	1236.5175	317.57306	0
12	35141	1175.916	381.7562	470.59871	1265.146	321.01795	0
13	35141	1177.008	381.4123	496.19378	1295.0129	322.74386	0
14	35141	1178.1225	381.07365	521.5377	1370.3749	342.95251	0
15	35141	1178.8745	380.85345	538.13014	1454.8836	370.39242	0
16	35141	1179.557	380.66065	552.74292	1530.6506	395.10034	0
17	35141	1180.2945	380.4576	568.19563	1611.6832	421.59633	0
18	35141	1181.169	380.2264	585.92705	1699.298	449.83104	0
19	35141	1182.055	379.99925	603.46043	1768.5221	470.71548	0
20	35141	1182.819	379.81175	618.04261	1795.0237	475.53122	0
21	35141	1183.6095	379.6242	632.73915	1800.7626	471.9121	0
22	35141	1184.0815	379.515	641.35876	1800.3546	468.26473	0
23	35141	1184.796	379.35765	653.86207	1798.426	462.43383	0
24	35141	1186.136	379.07495	676.56198	1807.5624	456.95382	0
25	35141	1187.4035	378.824	697.01828	1838.6944	461.2671	0
26	35141	1188.091	378.6946	707.69906	1861.389	466.121	0
27	35141	1189.364	378.47815	725.99489	1934.633	488.32148	0
28	35141	1191.1095	378.1958	750.22961	2018.7938	512.53322	0
29	35141	1193.146	377.92275	774.95741	2070.3023	523.35329	0
30	35141	1195.051	377.68995	796.70813	2116.7528	533.33267	0
31	35141	1196.551	377.5456	811.37693	2137.5152	535.79466	0
32	35141	1199.32	377.34475	834.38935	2156.8596	534.31267	0
33	35141	1203.45	377.1929	859.49076	2169.0837	529.10991	0
34	35141	1206.129	377.15235	872.15027	2169.944	524.34272	0
35	35141	1206.9675	377.16525	874.51253	2179.8363	527.38502	0
36	35141	1208.3135	377.2017	877.32981	2211.2657	538.94508	0
37	35141	1210.4285	377.2999	879.21541	2262.7475	558.98325	0
38	35141	1214.13	377.5973	874.64453	2338.685	591.51076	0
39	35141	1218.036	378.0281	862.5249	2403.7961	622.714	0
40	35141	1221.174	378.51015	844.316	2440.8903	645.0579	0
41	35141	1225.042	379.2638	811.91573	2468.6833	669.37757	0
42	35141	1229.223	380.24635	766.4081	2478.9855	691.92619	0
43	35141	1233.107	381.34695	712.43815	2467.9311	709.26517	0
44	35141	1236.862	382.5801	649.67857	2438.0313	722.5414	0
45	35141	1240.4875	383.941	578.47962	2390.6613	732.16893	0
46	35141	1243.2255	385.06615	518.62904	2345.2732	738.01215	0
47	35141	1245.9465	386.3178	450.80736	2287.5232	742.08137	0

48	35141	1250.637	388.73765	317.53516	2161.7832	745.12459	0
49	35141	1256.1555	391.969	136.77649	1893.1248	1097.4882	0
50	35141	1259.3275	394.008	21.541737	1762.9899	1088.1776	0
51	35141	1261.568	395.6274	-71.035458	1666.2079	1041.1623	0
52	35141	1264.952	398.2298	-220.63144	1517.6297	948.32029	0
53	35141	1268.213	400.97385	-379.52992	1359.9523	849.79252	0
54	35141	1272.388	404.94945	-611.81789	1132.1086	707.41995	0
55	35141	1277.5675	410.5494	-941.66006	828.14691	517.48363	0
56	35141	1282.117	416.26	-1280.7968	541.18132	338.16762	0
57	35141	1286.175	422.32425	-1643.8138	248.68439	155.39525	0
58	35141	1288.8535	426.77715	-1911.5958	47.675417	29.790907	0

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section G(2).gsz

Analysis Name: Stability - Existing Condition with Existing PZ Levels

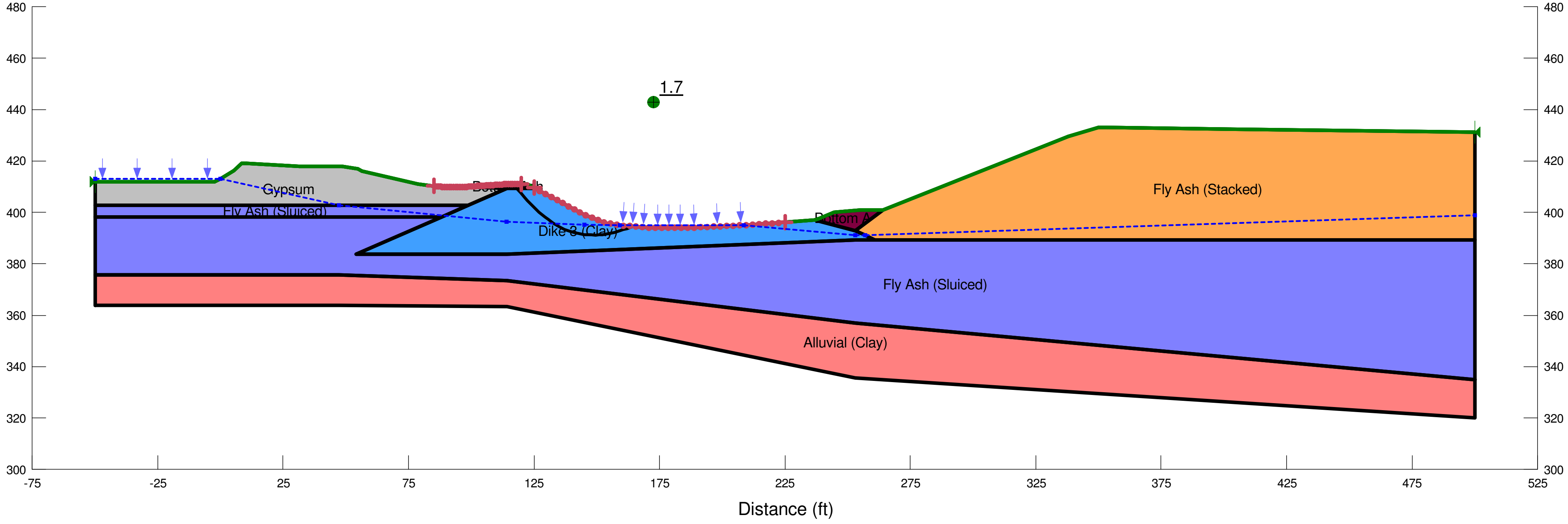
Date Saved: 12/15/2009

Last Solved on 12/15/2009 at 7:00:24 PM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Bottom Ash	105 pcf	0 psf	35 °

Analysis Method: Spencer

Calculated Factor of Safety: 1.7



Stability - Existing Condition with Existing PZ Levels

File Information

Created By: Cooper, Paul
Revision Number: 297
Last Edited By: Rogers, Daniel
Date: 12/15/2009
Time: 6:58:49 PM
File Name: Section G(2).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 12/15/2009
Last Solved Time: 7:00:24 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 50 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bottom Ash

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (85, 410.31979) ft
Left-Zone Right Coordinate: (120, 410.995) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (125, 409.58495) ft
Right-Zone Right Coordinate: (225, 396.1561) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-50, 412.07731) ft
Right Coordinate: (500, 431.16225) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-50	413
	0	413
	47.24	402.8
	114	396.3
	145	395.3
	159.13426	394.995
	208.52666	394.995

	253	391
	257	391.05
	500	399

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.7	(150.192, 428.066)	26.63858	(116.773, 410.995)	(164.393, 394.565)
2	47572	1.7	(150.192, 428.066)	36.995	(117.371, 410.995)	(165.665, 394.462)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	117.44685	410.1975	-874.12386	47.903693	33.542527	0
2	Optimized	118.89075	408.4887	-770.43546	152.3102	87.936333	50
3	Optimized	120.3311	406.8295	-669.77466	285.30021	164.71815	50
4	Optimized	121.67165	405.3337	-579.16365	400.22683	231.07107	50
5	Optimized	122.6019	404.29575	-516.24661	471.15189	272.01967	50
6	Optimized	123.4786	403.3976	-461.97401	541.80327	312.81026	50
7	Optimized	124.71205	402.18145	-388.56435	596.29476	344.27094	50
8	Optimized	125.33875	401.5646	-351.33407	655.37339	378.38	50
9	Optimized	126.2139	400.7921	-304.89511	682.19491	393.86542	50
10	Optimized	128.1871	399.139	-205.71263	764.52492	441.39867	50
11	Optimized	129.99935	397.73915	-122.00716	836.81599	483.13594	50
12	Optimized	131.4078	396.7182	-61.135798	862.85691	498.17067	50
13	Optimized	132.51895	395.9486	-15.34822	921.97106	532.30024	50
14	Optimized	134.0416	394.9792	42.076516	941.93932	519.53603	50
15	Optimized	136.1442	393.8806	106.39873	1080.4412	562.36367	50
16	Optimized	138.118	393.10405	150.88083	1053.3323	521.03061	50
17	Optimized	139.9858	392.48265	185.89535	1093.6764	524.10761	50
18	Optimized	141.7476	392.01635	211.44848	1039.2998	477.96019	50
19	Optimized	143.81425	391.6112	232.57037	1031.3787	461.19221	50
20	Optimized	145.0308	391.4347	241.15727	971.95978	421.92902	50
21	Optimized	145.47735	391.3699	244.58738	957.78476	411.7647	50

22	Optimized	146.78065	391.26895	249.13884	967.21312	414.58038	50
23	Optimized	148.55575	391.18765	251.8232	885.61313	365.91879	50
24	Optimized	150.2041	391.20035	248.81075	864.85863	355.67541	50
25	Optimized	151.7257	391.30705	240.10448	763.70059	302.29836	50
26	Optimized	152.85435	391.4299	230.91924	746.56052	297.70563	50
27	Optimized	154.07605	391.66075	214.86624	666.41158	260.69982	50
28	Optimized	156.0375	392.03145	189.09545	556.59623	212.17667	50
29	Optimized	158.1397	392.53735	154.70074	461.4573	177.10599	50
30	Optimized	159.8805	393.0564	120.97049	339.61506	126.2345	50
31	Optimized	161.37285	393.5014	93.204873	255.6504	93.787971	50
32	Optimized	163.2562	394.1447	53.06162	147.84514	54.723294	50

Slices of Slip Surface: 47572

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	47572	117.8112	410.1975	-874.88651	38.02062	26.622325	0
2	47572	118.93305	408.32065	-760.00133	136.96082	79.074365	50
3	47572	120.2966	406.30465	-636.94762	292.06021	168.62104	50
4	47572	121.66015	404.5411	-529.66136	444.52738	256.64801	50
5	47572	123.0936	402.90465	-430.43447	574.5342	331.70748	50
6	47572	124.597	401.3743	-337.96701	677.86406	391.365	50
7	47572	126.2117	399.9182	-250.35776	771.35946	445.34459	50
8	47572	127.93775	398.5326	-167.36988	853.43695	492.73205	50
9	47572	129.66385	397.3063	-94.324984	922.52861	532.62214	50
10	47572	131.3899	396.22075	-30.059666	978.90725	565.17236	50
11	47572	133.0496	395.29445	24.40138	1023.124	576.61278	50
12	47572	134.643	394.50855	70.23406	1054.8206	568.45131	50
13	47572	136.2364	393.81475	110.31771	1074.582	556.71825	50
14	47572	137.8298	393.20755	144.99989	1082.6193	541.33482	50
15	47572	139.42315	392.68255	174.55506	1078.9235	522.13738	50
16	47572	141.0165	392.23605	199.20915	1063.5918	499.05154	50
17	47572	142.6099	391.86515	219.14543	1036.3891	471.83585	50
18	47572	144.2033	391.56755	234.50912	997.03225	440.24294	50
19	47572	145.0308	391.4325	241.2977	972.84745	422.36045	50
20	47572	145.87765	391.33235	246.40032	957.43917	410.51847	50
21	47572	147.50975	391.17715	253.88773	922.06703	385.7735	50

22	47572	149.14185	391.0946	256.83787	874.33648	356.51299	50
23	47572	150.77395	391.08425	255.28633	813.50271	322.28638	50
24	47572	152.4061	391.14605	249.23336	738.56888	282.51799	50
25	47572	154.07605	391.28515	238.30765	674.86435	252.04613	50
26	47572	155.63065	391.47945	224.08896	627.39263	232.84748	50
27	47572	157.0321	391.71545	207.47607	571.34983	210.08262	50
28	47572	158.43355	392.00745	187.36244	503.67004	182.62027	50
29	47572	159.9506	392.3909	162.4949	434.22366	156.88267	50
30	47572	161.5832	392.87845	132.07097	360.4505	131.85498	50
31	47572	163.2158	393.44985	96.419483	266.87771	98.414103	50
32	47572	164.84845	394.10935	55.266095	149.39701	54.346507	50

Stantec

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

File Name: Section H.gsz

Analysis Name: Stability - Existing Condition with Existing PZ Levels

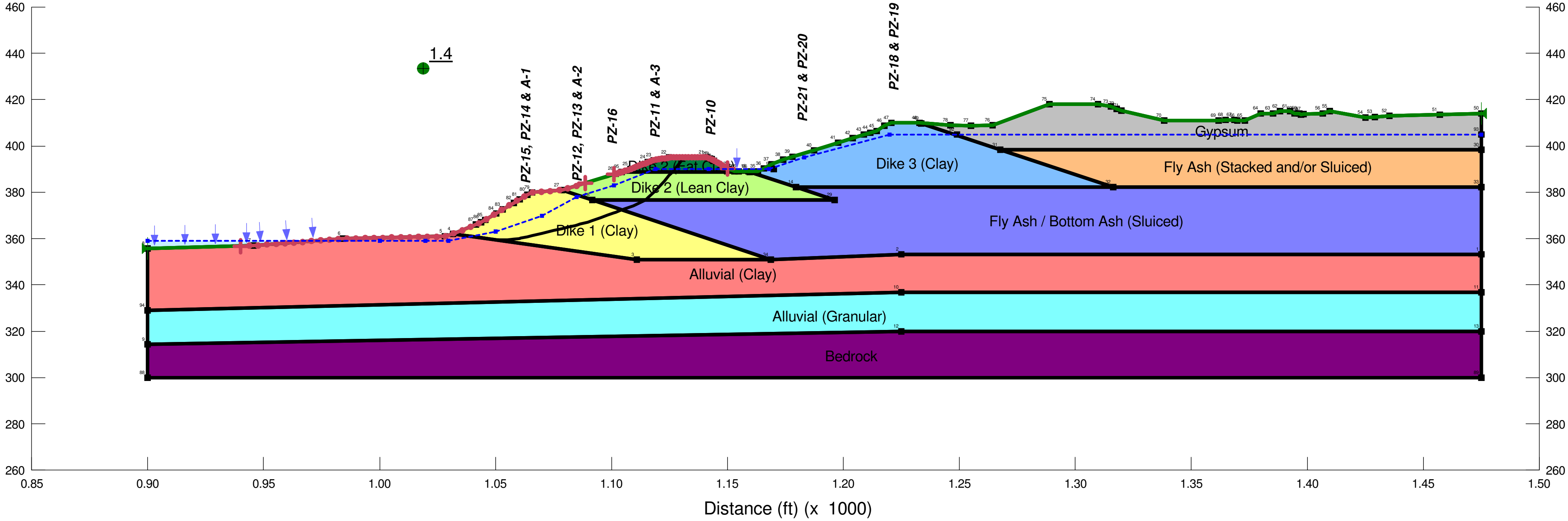
Date Saved: 12/15/2009

Last Solved on 12/15/2009 at 7:12:18 PM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Stacked and/or Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Bedrock			

Analysis Method: Spencer

Calculated Factor of Safety: 1.4



Stability - Existing Condition with Existing PZ Levels

File Information

Created By: Cooper, Paul
Revision Number: 225
Last Edited By: Rogers, Daniel
Date: 12/15/2009
Time: 7:10:17 PM
File Name: Section H.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 12/15/2009
Last Solved Time: 7:12:18 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

- Kind: SLOPE/W
- Method: Spencer
- Settings
  - Apply Phreatic Correction: No
  - PWP Conditions Source: Piezometric Line
  - Use Staged Rapid Drawdown: No
- SlipSurface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Optimize Critical Slip Surface Location: Yes
- FOS Distribution
  - FOS Calculation Option: Constant
- Advanced
  - Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 50 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked and/or Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bedrock

Model: Bedrock (Impenetrable)
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (940, 356.80244) ft
Left-Zone Right Coordinate: (1088.5899, 384) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (1101, 387.76649) ft
Right-Zone Right Coordinate: (1150, 390.29453) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (900, 355.68471) ft
Right Coordinate: (1475, 414.15883) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	900	359
	1000	359
	1019.69	359
	1029.71	359.014
	1050	363
	1070	370
	1085	378
	1101	383
	1119	390
	1142	390
	1168	390
	1183	395
	1220	405
	1475	405

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.4	(1053.36, 472.323)	52.01278	(1131.05, 395.002)	(1031.65, 362.168)
2	31352	1.4	(1053.36, 472.323)	112.086	(1134.5, 395.002)	(1031.98, 362.294)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	1033.7105	361.8791	-129.74148	200.67873	93.578027	100
2	Optimized	1037.824	361.3011	-43.247962	527.69013	246.06595	100
3	Optimized	1040.5435	360.919	13.932262	741.44235	339.24353	100
4	Optimized	1041.4085	360.79745	32.1229	807.03165	361.34588	100
5	Optimized	1042.66	360.6217	58.428779	921.00641	402.22655	100
6	Optimized	1044.597	360.3496	99.150307	1114.9184	473.66043	100
7	Optimized	1047.647	359.92115	163.27485	1445.4583	597.89195	100
8	Optimized	1049.9045	359.6161	209.98362	1542.9744	621.58382	100
9	Optimized	1050.1365	359.61275	214.34639	1562.3078	628.56472	100
10	Optimized	1051.6385	359.59125	248.49532	1682.7141	668.78722	100
11	Optimized	1054.0535	359.55665	303.39517	1878.5781	734.51985	100
12	Optimized	1056.484	359.69805	347.64822	1896.7797	722.37189	100
13	Optimized	1059.1075	359.99525	386.40745	2057.5373	779.26066	100
14	Optimized	1060.5255	360.1559	407.35778	2143.8469	809.73818	100
15	Optimized	1062.25	360.54925	420.46016	2062.3167	765.6103	100
16	Optimized	1064.8245	361.17	437.96499	2152.8579	799.66769	100
17	Optimized	1067.925	361.9176	459.03593	2142.5113	785.01744	100
18	Optimized	1072.4835	363.01665	518.40519	2054.4387	716.26419	100
19	Optimized	1076.839	364.0276	600.26317	1996.2519	650.96025	100
20	Optimized	1080.041	364.7327	662.83071	1979.9025	614.16068	100
21	Optimized	1082.7015	365.3185	714.84551	2011.9116	604.83187	100
22	Optimized	1084.516	365.74675	748.49611	1971.5906	570.3383	100
23	Optimized	1085.688	366.0745	757.54342	1977.5907	568.9174	100
24	Optimized	1088.098	366.7484	762.51758	1989.9276	572.3507	100
25	Optimized	1090.781	367.545	765.10754	1952.78	553.82075	100
26	Optimized	1093.574	368.46125	762.41313	1936.1083	547.30304	100
27	Optimized	1096.8045	369.57515	755.92042	1867.7458	518.4527	100
28	Optimized	1099.6015	370.60065	746.45379	1831.4235	505.92969	100
29	Optimized	1101.3875	371.25545	742.26843	1808.3336	497.11435	100
30	Optimized	1101.8555	371.42695	742.91547	1802.3358	494.01583	100
31	Optimized	1103.133	371.88815	745.14729	1793.3348	488.77785	100
32	Optimized	1106.2265	373.00385	750.58504	1793.8648	421.51237	0
33	Optimized	1108.7725	373.92195	755.06983	1808.7634	425.71985	0
34	Optimized	1112.007	375.4517	738.11663	1719.8972	396.66509	0
35	Optimized	1115.159	377.26415	701.51274	1408.5636	375.9456	100
36	Optimized	1115.831	377.8765	679.61463	1374.9965	369.74111	100
37	Optimized	1117.0985	379.03155	638.28076	1310.8862	357.63068	100
38	Optimized	1118.501	380.3096	592.57067	1235.257	341.7224	100
39	Optimized	1118.8705	380.66205	579.53843	1157.3329	307.21876	100

40	Optimized	1120.884	382.7441	452.7696	989.57676	285.42543	100
41	Optimized	1123.8325	385.9546	252.43121	686.62378	230.86429	100
42	Optimized	1125.5685	388.01335	123.96444	514.82658	207.82509	100
43	Optimized	1126.742	389.40485	37.136541	376.04754	116.69641	200
44	Optimized	1128.0265	390.9282	-57.922984	246.08003	84.732148	200
45	Optimized	1129.9275	393.42905	-213.9734	19.423365	6.6880009	200

Slices of Slip Surface: **31352**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	31352	1033.986	361.94225	-130.30655	215.49574	100.48731	100
2	31352	1037.9955	361.313	-41.888697	534.3304	249.16236	100
3	31352	1040.8055	360.9448	15.53693	734.40462	335.21351	100
4	31352	1042.66	360.7535	50.203672	869.89004	382.22603	100
5	31352	1044.597	360.58335	84.564615	1030.3314	441.01828	100
6	31352	1047.7425	360.40045	134.53955	1295.4473	541.34016	100
7	31352	1050.1365	360.28325	172.50656	1488.9493	613.86732	100
8	31352	1051.6385	360.2584	206.86643	1595.9606	647.74527	100
9	31352	1055.4345	360.28255	288.26879	1853.7531	729.9973	100
10	31352	1059.1075	360.3914	361.68461	2086.6945	804.38533	100
11	31352	1062.0745	360.58975	414.10339	2249.109	855.67716	100
12	31352	1064.8245	360.8298	459.19028	2372.9632	892.40698	100
13	31352	1067.925	361.20735	503.35542	2367.0153	869.03888	100
14	31352	1071.452	361.7169	565.18317	2291.8315	805.14934	100
15	31352	1074.3555	362.2313	629.70699	2220.754	741.91741	100
16	31352	1077.259	362.8251	689.29874	2143.2662	677.99616	100
17	31352	1080.283	363.53115	745.87196	2100.956	631.88608	100
18	31352	1083.4275	364.3582	798.93023	2091.0227	602.51262	100
19	31352	1085.688	365.0034	824.40787	2078.4485	584.76875	100
20	31352	1087.7175	365.64275	824.07611	2060.2612	576.44259	100
21	31352	1090.4005	366.5445	820.13698	2030.0079	564.17207	100
22	31352	1093.285	367.60255	810.36222	1975.2674	543.20419	100
23	31352	1096.371	368.83225	793.78734	1895.3771	513.67974	100
24	31352	1099.457	370.16995	770.5044	1805.3454	482.5543	100
25	31352	1101.3875	371.0501	755.07474	1745.3948	461.79383	100
26	31352	1103.0525	371.8659	744.57285	1690.7409	441.20542	100
27	31352	1106.2265	373.5127	718.83915	1634.148	369.80877	0
28	31352	1109.921	375.57875	679.58606	1570.2809	359.86409	0
29	31352	1113.7225	377.9109	626.29817	1433.7465	429.32792	100
30	31352	1115.831	379.26215	593.11699	1360.9202	408.24821	100
31	31352	1117.0985	380.13655	569.32378	1310.2086	393.93545	100
32	31352	1118.6305	381.20515	539.83125	1240.4221	372.51075	100

33	31352	1120.4745	382.5722	463.49234	1114.8532	346.33472	100
34	31352	1123.423	384.8557	320.99657	906.29187	311.20703	100
35	31352	1126.5065	387.42335	160.7846	654.23332	262.37134	100
36	31352	1128.77	389.405	37.128255	443.48439	139.91964	200
37	31352	1131.9635	392.50085	-156.05268	148.70176	51.202123	200

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section I.gsz

Analysis Name: Stability - Existing Condition with Existing PZ Levels

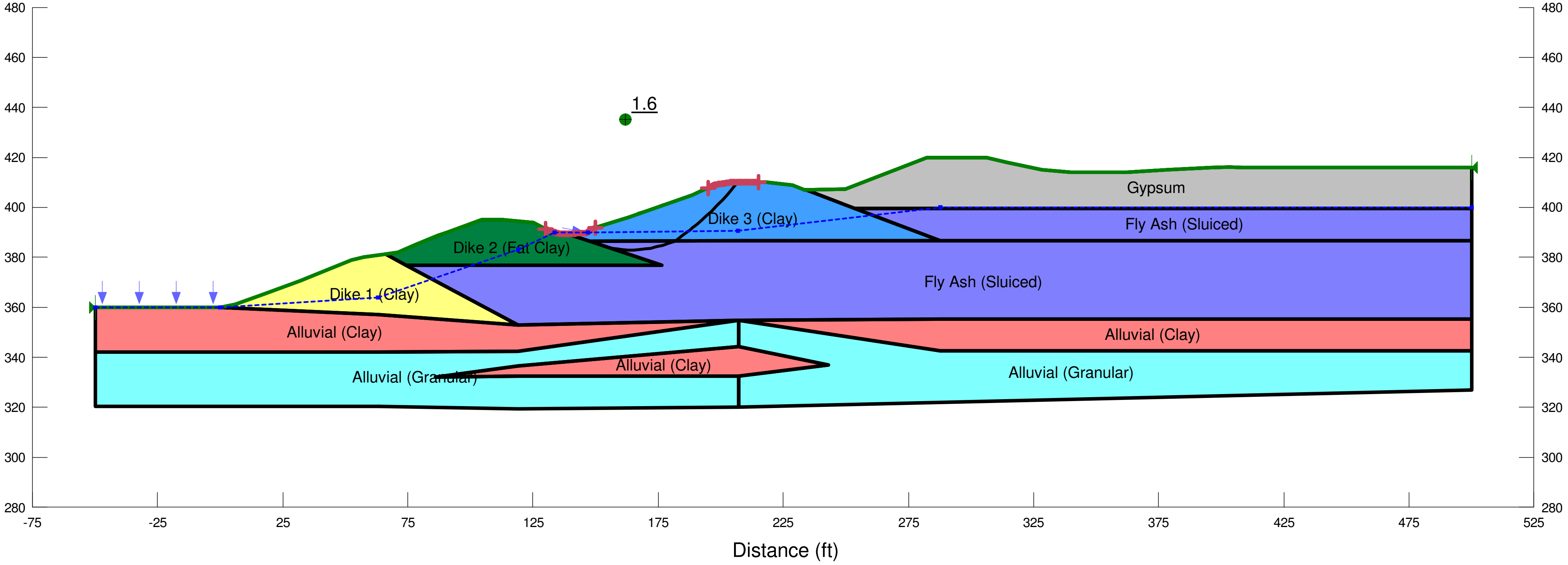
Date Saved: 10/11/2009

Last Solved on 10/11/2009 at 12:42:16 PM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °

Analysis Method: Spencer

Calculated Factor of Safety: 1.6



Stability - Existing Condition with Existing PZ Levels

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File Information

Created By: Cooper, Paul
Revision Number: 259
Last Edited By: Kirkbride, Rob
Date: 10/11/2009
Time: 12:39:36 PM
File Name: Section I.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 10/11/2009
Last Solved Time: 12:42:16 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
    Apply Phreatic Correction: No
    PWP Conditions Source: Piezometric Line
    Use Staged Rapid Drawdown: No
SlipSurface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: Yes
FOS Distribution
    FOS Calculation Option: Constant
Advanced
    Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 50 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (130, 391.32236) ft
Left-Zone Right Coordinate: (150, 391.86103) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (195, 407.77872) ft
Right-Zone Right Coordinate: (215, 410.002) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-50, 359.89) ft
Right Coordinate: (500, 415.99507) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-50	360
	0	360
	63	364
	119	383
	133.62102	390
	146.86482	390
	207	390.5
	287.8	400
	500	400

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.6	(165.109, 428.014)	36.27632	(206.729, 410.002)	(139.732, 389.478)
2	29966	1.6	(165.109, 428.014)	45.004	(206.351, 410.002)	(141.743, 389.552)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	141.4063	388.6984	81.219972	222.50916	81.573353	50
2	Optimized	143.96185	387.62515	148.19132	377.52322	132.40484	50
3	Optimized	145.72335	387.0384	184.80557	478.15048	169.36276	50
4	Optimized	146.62535	386.7379	203.55414	557.47671	204.33729	50
5	Optimized	146.70345	386.7119	205.18049	555.68499	202.36387	50
6	Optimized	146.81255	386.67555	207.44414	569.90658	209.26779	50
7	Optimized	147.2673	386.52405	217.11049	645.07309	247.08432	50
8	Optimized	148.0268	386.2711	233.27989	696.01258	186.95614	0
9	Optimized	149.1897	385.88375	258.05909	849.34713	238.89588	0
10	Optimized	150.1304	385.5706	278.0887	968.26315	278.84858	0
11	Optimized	151.3602	385.16295	304.16328	1085.1922	315.55615	0
12	Optimized	153.5502	384.43705	350.59721	1284.7891	377.43804	0
13	Optimized	155.66135	383.8728	386.89828	1355.8044	391.46349	0
14	Optimized	157.6936	383.4702	413.07411	1497.1819	438.00796	0
15	Optimized	159.7823	383.18305	432.08058	1531.5478	444.21358	0
16	Optimized	161.92745	383.0113	443.9114	1644.698	485.14928	0
17	Optimized	163.1073	382.9168	450.42011	1707.4761	507.8836	0
18	Optimized	164.26065	382.93365	449.9627	1674.9421	494.92382	0
19	Optimized	166.35275	382.98455	447.87452	1767.5485	533.1829	0
20	Optimized	168.5384	383.15885	438.14865	1762.2094	534.95527	0
21	Optimized	170.8176	383.4565	420.74191	1833.8202	570.9207	0
22	Optimized	173.1797	383.89625	394.5268	1805.7644	570.17702	0
23	Optimized	175.62475	384.47815	359.48578	1853.2709	603.52838	0
24	Optimized	178.06625	385.19315	316.13513	1799.6403	599.37501	0

25	Optimized	180.5496	386.0571	263.51281	1819.3003	628.57893	0
26	Optimized	183.08805	387.456	177.54116	1440.1076	728.94308	50
27	Optimized	185.6362	389.374	59.181431	1331.0884	734.33581	50
28	Optimized	187.2715	390.60485	-16.778034	1263.3015	729.36749	50
29	Optimized	188.117	391.2776	-58.320655	1186.5346	685.04609	50
30	Optimized	189.5337	392.4503	-130.7631	1131.9032	653.50463	50
31	Optimized	191.3985	393.99395	-226.11627	1063.3306	613.91419	50
32	Optimized	192.48655	394.90785	-282.57113	983.5658	567.86198	50
33	Optimized	193.49195	395.8252	-339.29771	944.94959	545.5669	50
34	Optimized	195.1914	397.3758	-435.15757	880.96478	508.62525	50
35	Optimized	196.81925	398.94515	-532.26488	774.53872	447.18014	50
36	Optimized	198.20945	400.36385	-620.03812	696.3637	402.04577	50
37	Optimized	199.7937	402.04495	-724.14506	562.65511	324.84908	50
38	Optimized	201.7381	404.1578	-854.9878	418.57835	241.66632	50
39	Optimized	203.40975	406.04755	-972.05352	275.38376	158.99289	50
40	Optimized	205.41905	408.44145	-1120.3691	101.072	58.353946	50

Slices of Slip Surface: 29966

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	29966	142.95855	388.86415	70.87444	218.4964	85.229578	50
2	29966	145.3889	387.5839	150.76219	440.18994	167.10119	50
3	29966	146.62535	386.9816	188.3478	565.76338	217.90099	50
4	29966	146.70345	386.94655	190.53081	564.42001	215.86503	50
5	29966	146.81255	386.89785	193.57781	580.515	223.39829	50
6	29966	147.4311	386.63265	210.41897	691.73734	277.88929	50
7	29966	148.1906	386.31235	230.79678	734.33485	203.44259	0
8	29966	149.3245	385.88155	258.26495	877.87188	250.33745	0
9	29966	151.32645	385.18755	302.6098	1069.2614	309.74734	0
10	29966	153.44895	384.56125	342.79052	1214.6698	352.26208	0
11	29966	155.5714	384.0463	376.02903	1340.7606	389.77684	0
12	29966	157.69385	383.63875	402.56202	1449.5616	423.01528	0
13	29966	159.8163	383.33565	422.57442	1542.4572	452.46202	0
14	29966	161.93875	383.13495	436.19745	1620.6306	478.54205	0
15	29966	164.07805	383.0353	443.52803	1690.9576	503.99425	0

16	29966	166.2342	383.03755	444.50729	1753.4188	528.83458	0
17	29966	168.39035	383.1433	439.02647	1802.2598	550.78201	0
18	29966	170.5465	383.35335	427.03701	1837.9327	570.03884	0
19	29966	172.70265	383.6692	408.44408	1860.6907	586.74572	0
20	29966	174.85875	384.09315	383.11218	1870.5781	600.97525	0
21	29966	177.0149	384.6283	350.83796	1867.7038	612.85359	0
22	29966	179.17105	385.27885	311.36254	1851.8306	622.38951	0
23	29966	181.3272	386.05025	264.34552	1822.7966	629.6551	0
24	29966	183.43795	386.92755	210.69797	1739.3085	882.54368	50
25	29966	185.5033	387.9134	150.25299	1655.4802	869.04335	50
26	29966	187.56865	389.03355	81.426194	1556.5329	851.65324	50
27	29966	189.1764	389.99255	22.416409	1473.4414	837.74967	50
28	29966	191.19685	391.386	-63.48565	1363.4861	787.20908	50
29	29966	193.881	393.4465	-190.6703	1211.6136	699.52542	50
30	29966	196.3586	395.6746	-328.42414	1053.2503	608.09433	50
31	29966	198.6827	398.0892	-477.86989	855.83742	494.11797	50
32	29966	200.8533	400.72855	-641.44084	625.11549	360.91059	50
33	29966	203.0239	403.8534	-835.32143	379.91663	219.34497	50
34	29966	205.23025	407.77925	-1079.1385	106.14237	61.281324	50

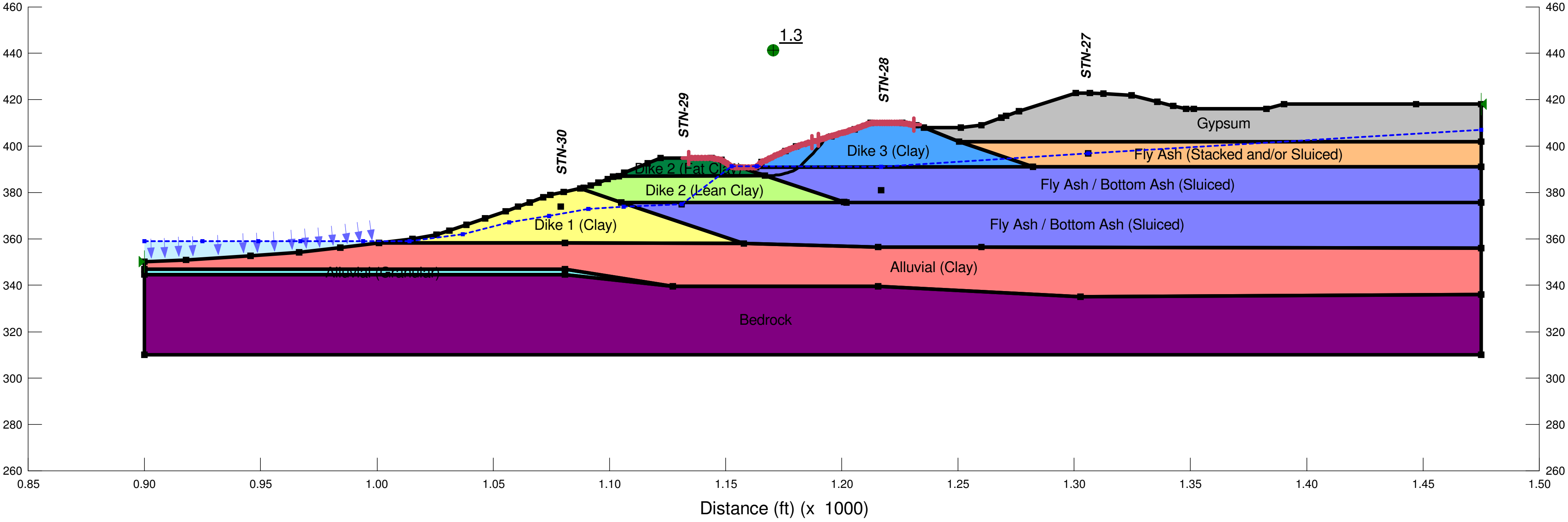
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant
Tennessee Valley Authority (TVA)

File Name: Section J.gsz
Analysis Name: Stability - Existing Condition with Existing PZ Levels
Date Saved: 12/15/2009
Last Solved on 12/15/2009 at 7:42:52 PM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Stacked and/or Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Bedrock			

Analysis Method: Spencer
Calculated Factor of Safety: 1.3



Stability - Existing Condition with Existing PZ Levels

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File Information

Created By: Kirkbride, Rob
Revision Number: 81
Last Edited By: Rogers, Daniel
Date: 12/15/2009
Time: 7:41:17 PM
File Name: Section J.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 12/15/2009
Last Solved Time: 7:42:52 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

- Kind: SLOPE/W
- Method: Spencer
- Settings
  - Apply Phreatic Correction: No
  - PWP Conditions Source: Piezometric Line
  - Use Staged Rapid Drawdown: No
- SlipSurface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Optimize Critical Slip Surface Location: Yes
- FOS Distribution
  - FOS Calculation Option: Constant
- Advanced
  - Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 50 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked and/or Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bedrock

Model: Bedrock (Impenetrable)
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (1134, 394.98991) ft
Left-Zone Right Coordinate: (1187, 401.76094) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (1190, 402.64639) ft
Right-Zone Right Coordinate: (1231, 409.14936) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (900, 350.14265) ft
Right Coordinate: (1475, 418.20122) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	900	359
	925	359
	949	359
	967	359
	994	359
	1014	359
	1037	362
	1057	367
	1074	370
	1091	373
	1106	374
	1131	375
	1152.4982	391.23424
	1163.5128	391.26817
	1217	391
	1306	397
	1475	407

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)

1	Optimized	1.3	(1170.61, 411.294)	20.93371	(1193.18, 403.585)	(1156.43, 390.894)
2	22993	1.3	(1170.61, 411.294)	23.734	(1193.04, 403.543)	(1158.47, 390.898)

Slices of Slip Surface: **Optimized**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	1156.912	390.7337	32.082137	45.514796	5.4271468	0
2	Optimized	1157.8685	390.41395	52.218734	85.988256	13.643773	0
3	Optimized	1158.888	390.07425	73.612932	128.85004	22.317241	0
4	Optimized	1159.97	389.71455	96.264752	174.32911	31.540047	0
5	Optimized	1161.009	389.36905	118.02587	218.01406	40.397851	0
6	Optimized	1162.005	389.03775	138.89206	259.89882	48.889904	0
7	Optimized	1162.8195	388.7663	155.98364	294.5725	55.993535	0
8	Optimized	1163.3245	388.59755	166.60951	337.02874	68.853837	0
9	Optimized	1164.413	388.2336	189.07378	550.20328	145.90579	0
10	Optimized	1165.348	387.921	208.29211	748.18165	218.12953	0
11	Optimized	1166.013	387.78405	216.62853	746.48327	214.07521	0
12	Optimized	1167.2725	387.53335	231.87178	873.10034	259.07315	0
13	Optimized	1168.6205	387.3881	240.51886	889.72281	262.29542	0
14	Optimized	1170.057	387.3483	242.55804	991.89061	302.75001	0
15	Optimized	1171.3	387.39335	239.35158	980.68578	299.51846	0
16	Optimized	1172.3505	387.5233	230.91465	1032.6489	323.92166	0
17	Optimized	1173.401	387.6533	222.47773	1084.612	348.32486	0
18	Optimized	1174.827	387.96515	202.57107	1051.4809	342.98182	0
19	Optimized	1176.2085	388.34375	178.51365	1089.1559	367.92336	0
20	Optimized	1177.17	388.6073	161.76358	1108.7144	382.59296	0
21	Optimized	1178.3165	389.07355	132.31141	995.20521	348.63173	0
22	Optimized	1179.6475	389.7425	90.15649	991.84893	364.30739	0
23	Optimized	1180.3585	390.10445	67.346718	943.07781	353.81833	0
24	Optimized	1181.116	390.56095	38.622882	927.286	359.04321	0
25	Optimized	1181.9195	391.0827	5.8135697	694.56597	397.65138	50
26	Optimized	1182.7305	391.90395	-45.684692	648.43166	374.3722	50
27	Optimized	1184.1185	393.3155	-134.19837	568.19906	328.04988	50
28	Optimized	1185.455	394.6815	-219.85468	493.32697	284.82246	50
29	Optimized	1186.82	396.1013	-308.88206	407.49931	235.26984	50
30	Optimized	1188.214	397.5749	-401.26763	326.97068	188.77661	50
31	Optimized	1189.5185	398.9982	-490.48991	238.64546	137.78202	50
32	Optimized	1190.7335	400.37125	-576.55608	164.2184	94.811537	50

33	Optimized	1191.8005	401.6896	-659.13112	76.78452	44.331563	50
34	Optimized	1192.72	402.9532	-738.28316	11.069128	6.3907643	50

Slices of Slip Surface: 22993

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	22993	1159.055	390.57295	42.52505	76.542095	13.743778	0
2	22993	1160.221	389.96395	80.748119	157.57987	31.042042	0
3	22993	1161.387	389.43405	114.03939	220.99971	43.214775	0
4	22993	1162.553	388.9777	142.73639	270.54341	51.637388	0
5	22993	1163.3245	388.7066	159.80633	318.39894	64.075574	0
6	22993	1163.963	388.5146	171.67627	420.92676	100.70373	0
7	22993	1164.863	388.271	186.59475	581.64021	159.60873	0
8	22993	1165.892	388.0414	200.60066	704.07147	203.41541	0
9	22993	1167.0495	387.83635	213.04028	789.85705	233.0491	0
10	22993	1168.2065	387.68975	221.82483	864.05159	259.47645	0
11	22993	1169.3635	387.60055	227.02952	927.72544	283.09953	0
12	22993	1170.5205	387.5681	228.69725	981.71131	304.23743	0
13	22993	1171.6775	387.5921	226.83401	1026.6451	323.14466	0
14	22993	1172.8345	387.6728	221.43336	1062.9008	339.9749	0
15	22993	1173.992	387.8108	212.45985	1090.8251	354.8826	0
16	22993	1175.1495	388.00705	199.85377	1110.638	367.98072	0
17	22993	1176.3125	388.2647	183.41273	1116.2846	376.90468	0
18	22993	1177.4815	388.58645	162.96384	1108.0657	381.84593	0
19	22993	1178.6505	388.97405	138.4168	1092.4635	385.45988	0
20	22993	1179.8195	389.43105	109.53367	1069.0883	387.68525	0
21	22993	1181.011	389.97355	75.311106	1031.0484	386.14294	0
22	22993	1182.225	390.6106	35.177377	978.07115	380.95381	0
23	22993	1183.01	391.0605	6.857508	901.37385	516.44925	50
24	22993	1183.735	391.5331	-22.859487	850.20154	490.86409	50
25	22993	1184.8295	392.30665	-71.471293	770.73587	444.98456	50
26	22993	1185.924	393.1794	-126.27269	685.1275	395.55855	50
27	22993	1187.0185	394.16665	-188.21577	593.18244	342.47404	50
28	22993	1188.1135	395.28975	-258.64056	494.52317	285.51309	50
29	22993	1189.208	396.5803	-339.51677	388.71791	224.42639	50
30	22993	1190.3025	398.08845	-433.96793	275.32612	158.95961	50
				-			

31	22993	1191.3975	399.90365	547.55748	154.04828	88.939815	50
32	22993	1192.492	402.223	-692.66307	25.448136	14.692488	50

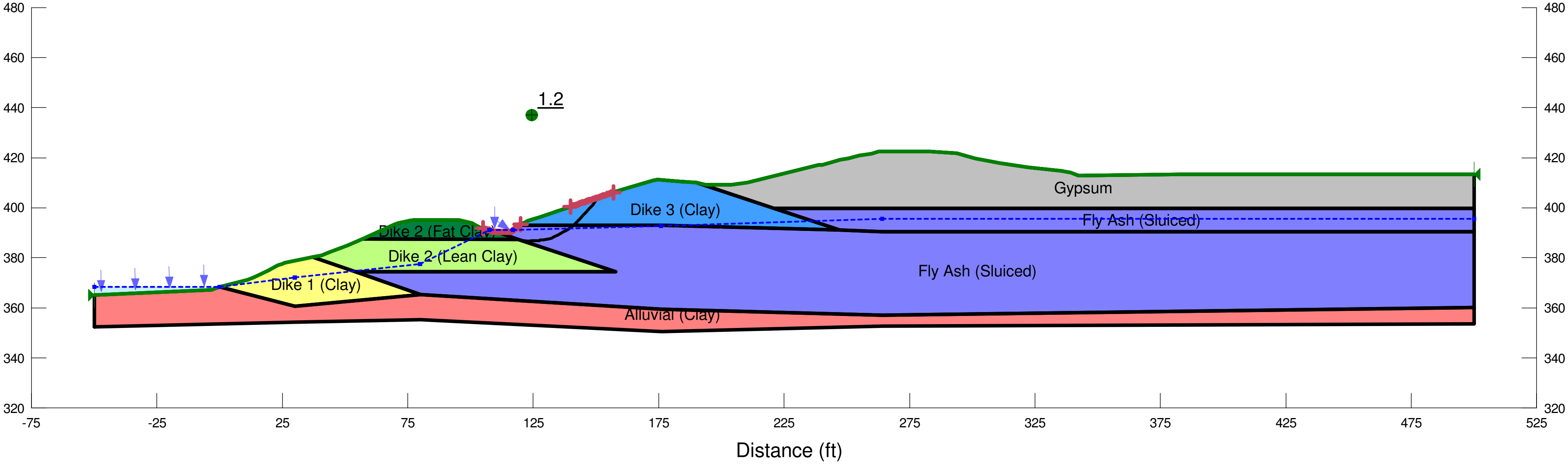
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section K.gsz
Analysis Name: Stability - Existing Condition with Existing PZ Levels
Date Saved: 10/13/2009
Last Solved on 10/13/2009 at 10:41:10 AM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °

Analysis Method: Spencer
Calculated Factor of Safety: 1.2



Stability - Existing Condition with Existing PZ Levels

File Information

Created By: Cooper, Paul
Revision Number: 309
Last Edited By: Rogers, Daniel
Date: 10/13/2009
Time: 10:40:04 AM
File Name: Section K.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 10/13/2009
Last Solved Time: 10:41:10 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
  Apply Phreatic Correction: No
  PWP Conditions Source: Piezometric Line
  Use Staged Rapid Drawdown: No
SlipSurface
  Direction of movement: Right to Left
  Use Passive Mode: No
  Slip Surface Option: Entry and Exit
  Critical slip surfaces saved: 1
  Optimize Critical Slip Surface Location: Yes
FOS Distribution
  FOS Calculation Option: Constant
Advanced
  Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 50 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (105, 391.72847) ft
Left-Zone Right Coordinate: (120, 393.34958) ft
Left-Zone Increment: 20
Right Projection: Range
Right-Zone Left Coordinate: (140, 400.46248) ft
Right-Zone Right Coordinate: (156.97953, 406.17376) ft
Right-Zone Increment: 30
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-50, 365.00654) ft
Right Coordinate: (500, 413.44393) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-50	368.4
	0	368.4
	30	372
	80	377.5
	107.5	391
	117	391
	176	392.6
	264	395.5
	500	395.5

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.2	(125.078, 413.17)	22.77603	(150.746, 404.066)	(110.376, 390.268)
2	9197	1.3	(125.078, 413.17)	26.314	(149.625, 403.69)	(112.12, 390.268)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	111.37725	389.9315	66.674778	93.995151	11.038147	0
2	Optimized	113.19485	389.32265	104.66916	169.67348	26.263451	0
3	Optimized	114.82795	388.77835	138.63522	237.46619	39.930303	0
4	Optimized	116.05765	388.36835	164.21449	288.58357	50.248372	0
5	Optimized	116.5841	388.1927	175.17374	340.93341	66.971253	0
6	Optimized	116.8487	388.10445	180.6822	355.54059	70.647377	0
7	Optimized	117.01685	388.04835	184.21166	367.23678	73.946948	0
8	Optimized	117.03505	388.04225	184.62123	368.72348	74.382139	0
9	Optimized	117.47765	387.89465	194.58279	441.11667	99.606153	0
10	Optimized	118.06025	387.70045	207.68703	535.94054	132.62303	0
11	Optimized	118.84665	387.4389	225.33811	659.20002	175.29159	0
12	Optimized	119.7455	387.14	245.51595	797.52028	223.02423	0
13	Optimized	120.53695	386.99875	255.66301	774.56374	209.6495	0
14	Optimized	122.05545	386.83825	268.24799	897.08331	254.06596	0
15	Optimized	123.04675	386.7351	276.36227	883.41135	245.26375	0
16	Optimized	123.77415	386.76855	275.50437	913.23915	257.66157	0
17	Optimized	125.2081	386.83445	273.81848	971.89712	282.04208	0
18	Optimized	126.64205	386.90035	272.13259	1030.5551	306.42258	0
19	Optimized	127.477	386.95595	270.07889	982.25255	287.73684	0
20	Optimized	128.18725	387.0924	262.76736	998.53917	297.27111	0
21	Optimized	129.37175	387.31995	250.57165	1025.567	313.11847	0
22	Optimized	130.55625	387.54745	238.37594	1052.512	328.93233	0
23	Optimized	131.74075	387.775	226.18023	1079.5399	344.77968	0
24	Optimized	132.93545	388.1694	203.59123	952.31432	302.50376	0

25	Optimized	134.14035	388.73065	170.61609	946.29558	313.39486	0
26	Optimized	135.32895	389.33515	134.90468	898.96634	308.70095	0
27	Optimized	136.50125	389.98285	96.474618	884.03334	318.19438	0
28	Optimized	137.5958	390.63	57.941848	833.45505	313.32767	0
29	Optimized	138.6126	391.2766	19.313949	813.3635	320.81684	0
30	Optimized	139.1286	391.60475	-0.28970505	803.17175	324.50245	0
31	Optimized	140.169	392.35415	-45.29237	748.52386	302.42327	0
32	Optimized	141.8065	393.72595	-128.12236	542.37662	313.14129	50
33	Optimized	143.0159	394.98045	-204.35533	477.53497	275.70495	50
34	Optimized	144.2542	396.28625	-283.74215	402.47296	232.36787	50
35	Optimized	145.5214	397.64335	-366.28013	332.3655	191.89131	50
36	Optimized	146.7934	399.04755	-451.75411	249.82321	144.2355	50
37	Optimized	148.07025	400.4989	-540.17227	175.08265	101.08402	50
38	Optimized	149.21805	401.935	-627.82891	82.837265	47.826117	50
39	Optimized	150.2367	403.3558	-714.77314	12.029193	6.9450576	50

Slices of Slip Surface: 9197

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	9197	112.84505	389.8874	69.42431	111.22295	16.887745	0
2	9197	114.29535	389.18045	113.54031	200.64826	35.193896	0
3	9197	115.74565	388.5793	151.0515	268.71722	47.540035	0
4	9197	116.5841	388.2655	170.63312	331.83583	65.130124	0
5	9197	116.8487	388.17705	176.15153	344.07391	67.845046	0
6	9197	117.01685	388.1218	179.62879	353.95878	70.433888	0
7	9197	117.03505	388.11595	180.02343	355.23571	70.790359	0
8	9197	117.619	387.94325	191.79016	439.22283	99.96929	0
9	9197	118.84665	387.6137	214.43106	597.40068	154.72977	0
10	9197	120.28315	387.30965	235.83124	751.42247	208.31238	0
11	9197	121.57025	387.09625	251.32692	853.72571	243.38491	0
12	9197	122.56155	386.98195	260.14009	902.46228	259.51501	0
13	9197	123.62445	386.9029	266.86534	944.11943	273.62841	0
14	9197	124.7589	386.86465	271.17622	978.37095	285.72522	0
15	9197	125.89335	386.87535	272.43172	1005.815	296.30607	0
16	9197	127.0278	386.93505	270.61762	1026.7383	305.49257	0
17	9197	128.2248	387.0531	265.2762	1041.5878	313.65026	0
18	9197	129.48435	387.236	255.99942	1049.7965	320.71482	0
19	9197	130.74385	387.4819	242.78902	1050.548	326.35583	0
20	9197	132.0034	387.79265	225.53074	1043.9749	330.67289	0
21	9197	133.26295	388.1707	204.07193	1030.0177	333.70376	0
22	9197	134.52245	388.61915	178.22037	1008.589	335.49072	0
23	9197	135.782	389.14195	147.72445	979.43868	336.03436	0
24	9197	137.04155	389.7441	112.28431	942.3256	335.35845	0
25	9197	138.30105	390.4319	71.49544	896.76435	333.43028	0

26	9197	139.56055	391.2135	24.854193	842.3027	330.27063	0
27	9197	141.10745	392.33445	-42.474493	765.34977	309.22138	0
28	9197	142.65795	393.6092	-119.39482	618.34702	357.00282	50
29	9197	143.92465	394.8292	-193.38271	517.59594	298.83415	50
30	9197	145.19135	396.2321	-278.77901	408.49889	235.84695	50
31	9197	146.45805	397.86915	-378.78496	290.68528	167.82722	50
32	9197	147.72475	399.8292	-498.95597	163.91577	94.636814	50
33	9197	148.99145	402.29725	-650.80898	28.855243	16.659583	50

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section L.gsz

Analysis Name: Stability - Existing Condition with Existing PZ Levels

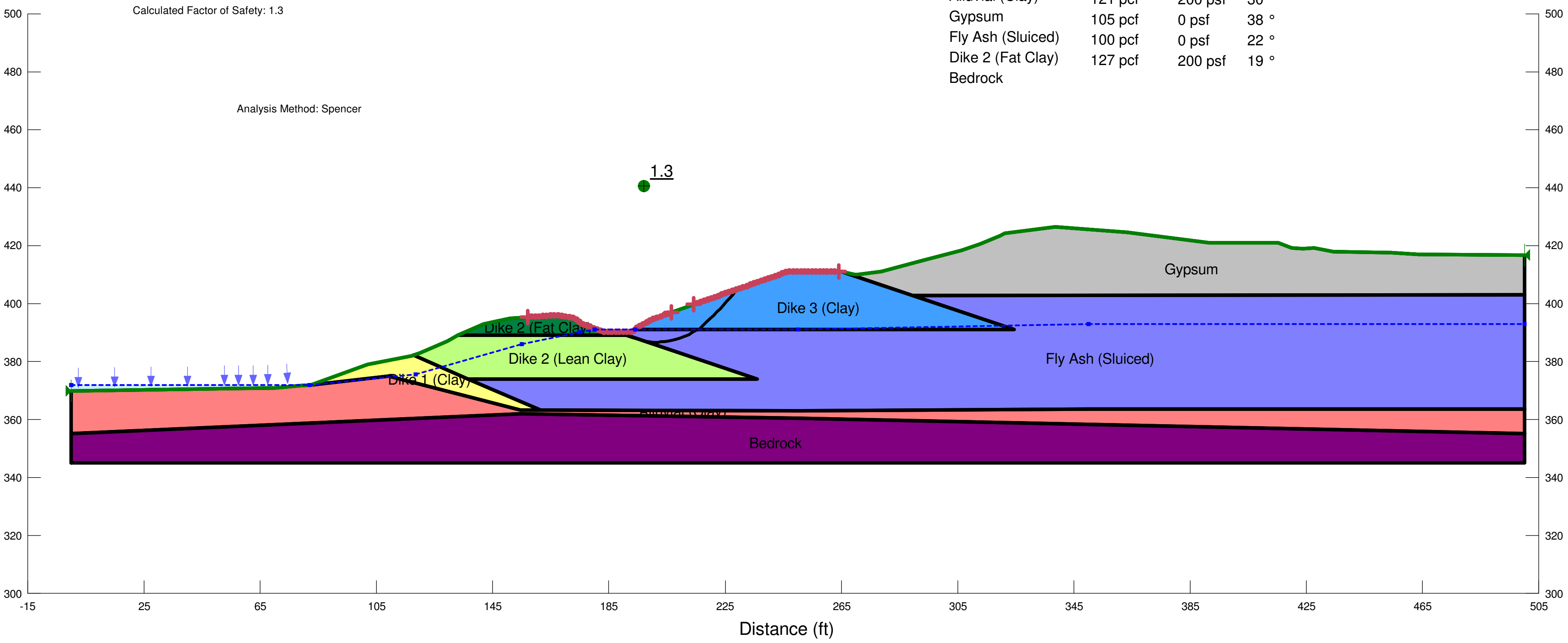
Date Saved: 12/15/2009

Last Solved on 12/15/2009 at 8:00:20 PM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Bedrock			

Calculated Factor of Safety: 1.3

Analysis Method: Spencer



Stability - Existing Condition with Existing PZ Levels

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File Information

Created By: Rogers, Daniel
Revision Number: 280
Last Edited By: Rogers, Daniel
Date: 12/15/2009
Time: 7:58:41 PM
File Name: Section L.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 12/15/2009
Last Solved Time: 8:00:20 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 50 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bedrock

Model: Bedrock (Impenetrable)
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (157, 395.37291) ft
Left-Zone Right Coordinate: (206.46194, 397) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (214.1328, 399.68778) ft
Right-Zone Right Coordinate: (264, 410.99682) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (0, 369.82) ft
Right Coordinate: (500, 416.67809) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	372
	82	372
	118.4	375.5
	155	386
	175	390
	180	391
	194	391
	250	391
	350	393
	500	393

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.3	(201.923, 416.284)	23.50305	(228.501, 404.722)	(187.222, 390.294)
2	32167	1.3	(201.923, 416.284)	29.214	(228.796, 404.826)	(188.595, 390.287)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	187.91555	390.063	58.46997	78.786607	8.208454	0
2	Optimized	189.3034	389.60035	87.337886	136.03438	19.674661	0
3	Optimized	190.69125	389.1377	116.20444	193.28899	31.144181	0
4	Optimized	192.2866	388.60565	149.40617	259.1745	44.349286	0
5	Optimized	193.5157	388.19555	174.99484	339.59882	66.504325	0
6	Optimized	193.86495	388.07905	182.26745	363.08994	73.057028	0
7	Optimized	193.94325	388.05305	183.88603	375.40716	77.379556	0
8	Optimized	194.01895	388.0279	185.45837	389.87355	82.589094	0
9	Optimized	194.3881	387.9054	193.09789	482.73794	117.02218	0
10	Optimized	195.6563	387.4845	219.3652	682.66019	187.18333	0
11	Optimized	196.78715	387.1385	240.94946	741.75724	202.33948	0
12	Optimized	197.7813	386.9456	252.99167	851.13761	241.66665	0
13	Optimized	198.6426	386.79155	262.60971	857.2933	240.26777	0
14	Optimized	199.49865	386.76505	264.26146	909.3567	260.63539	0
15	Optimized	201.0508	386.7169	267.26239	999.89954	296.00462	0
16	Optimized	202.40135	386.75215	265.06258	991.56052	293.52422	0

17	Optimized	203.55025	386.8708	257.66029	1037.7058	315.15884	0
18	Optimized	204.6992	386.9894	250.258	1083.8511	336.79346	0
19	Optimized	205.8633	387.1884	237.84611	1045.1101	326.15584	0
20	Optimized	207.185	387.50155	218.30056	1073.8261	345.65476	0
21	Optimized	208.64925	387.8485	196.65658	1102.6671	366.05199	0
22	Optimized	210.17645	388.35975	164.75495	1017.0202	344.3375	0
23	Optimized	211.7665	389.03525	122.6039	1017.8884	361.71844	0
24	Optimized	213.3208	389.77975	76.145123	957.99596	356.29087	0
25	Optimized	214.8394	390.59325	25.381901	943.3683	370.89058	0
26	Optimized	215.7547	391.0836	-5.215638	934.82628	377.69433	0
27	Optimized	216.6739	391.87285	-54.463878	689.91427	398.32219	50
28	Optimized	218.03675	393.14635	-133.93357	618.29931	356.97527	50
29	Optimized	219.2361	394.28205	-204.80219	560.90699	323.8398	50
30	Optimized	220.40305	395.4051	-274.87844	495.38594	286.0112	50
31	Optimized	221.5375	396.5155	-344.17287	439.08105	253.50357	50
32	Optimized	222.6617	397.64525	-414.66909	370.58234	213.95582	50
33	Optimized	223.77575	398.79435	-486.37253	312.08743	180.18376	50
34	Optimized	224.9139	400.0419	-564.19433	230.3845	133.01256	50
35	Optimized	226.0761	401.3879	-648.20771	161.96477	93.510401	50
36	Optimized	227.2383	402.73385	-732.16487	93.550651	54.011494	50
37	Optimized	228.16045	404.0646	-815.22014	2.2017219	1.2711648	50

Slices of Slip Surface: 32167

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	32167	189.3603	389.922	67.263834	104.64573	15.103268	0
2	32167	190.89135	389.2449	109.52061	188.38029	31.861379	0
3	32167	192.42245	388.66925	145.44284	252.76631	43.361495	0
4	32167	193.53725	388.3012	168.40608	320.15119	61.309004	0
5	32167	193.94325	388.1804	175.93958	348.64127	69.776012	0
6	32167	194.01895	388.15895	177.28091	361.44701	74.407933	0
7	32167	194.3881	388.06015	183.45186	443.42708	105.0368	0
8	32167	195.3037	387.83515	197.49025	570.1465	150.5629	0
9	32167	196.43455	387.5954	212.45088	662.43577	181.8057	0
10	32167	197.8613	387.36625	226.74424	781.81723	224.26404	0

11	32167	199.3668	387.1887	237.82738	886.39198	262.03711	0
12	32167	200.6552	387.1041	243.10109	943.40281	282.94026	0
13	32167	201.94355	387.0766	244.8206	991.32859	301.60881	0
14	32167	203.2319	387.106	242.98502	1030.8855	318.33245	0
15	32167	204.5203	387.1924	237.59604	1062.2359	333.17613	0
16	32167	205.8087	387.3364	228.60479	1085.8285	346.34087	0
17	32167	207.08445	387.5363	216.13868	1098.8095	356.62215	0
18	32167	208.3476	387.79215	200.16882	1101.6235	364.21134	0
19	32167	209.6108	388.1069	180.53012	1097.6305	370.53259	0
20	32167	210.874	388.48255	157.08515	1086.8459	375.64775	0
21	32167	212.1372	388.9217	129.68558	1069.094	379.54562	0
22	32167	213.4004	389.42745	98.128212	1044.3957	382.3169	0
23	32167	214.6636	390.0036	62.177841	1012.3863	383.90913	0
24	32167	215.9268	390.6549	21.535069	972.86077	384.36053	0
25	32167	216.69485	391.08	-4.9921196	946.24622	382.30829	0
26	32167	217.49605	391.579	-36.130786	868.97149	501.70093	50
27	32167	218.8255	392.4698	-91.715713	791.83931	457.16864	50
28	32167	220.1549	393.4729	-154.31125	707.27458	408.34517	50
29	32167	221.4843	394.604	-224.88627	615.0473	355.09772	50
30	32167	222.8137	395.8845	-304.79095	514.97784	297.32259	50
31	32167	224.1431	397.3451	-395.93806	406.72137	234.82069	50
32	32167	225.4725	399.0324	-501.23776	290.04757	167.45904	50
33	32167	226.80195	401.0235	-625.45425	164.95112	95.234574	50
34	32167	228.1314	403.4664	-777.91257	32.309148	18.653695	50

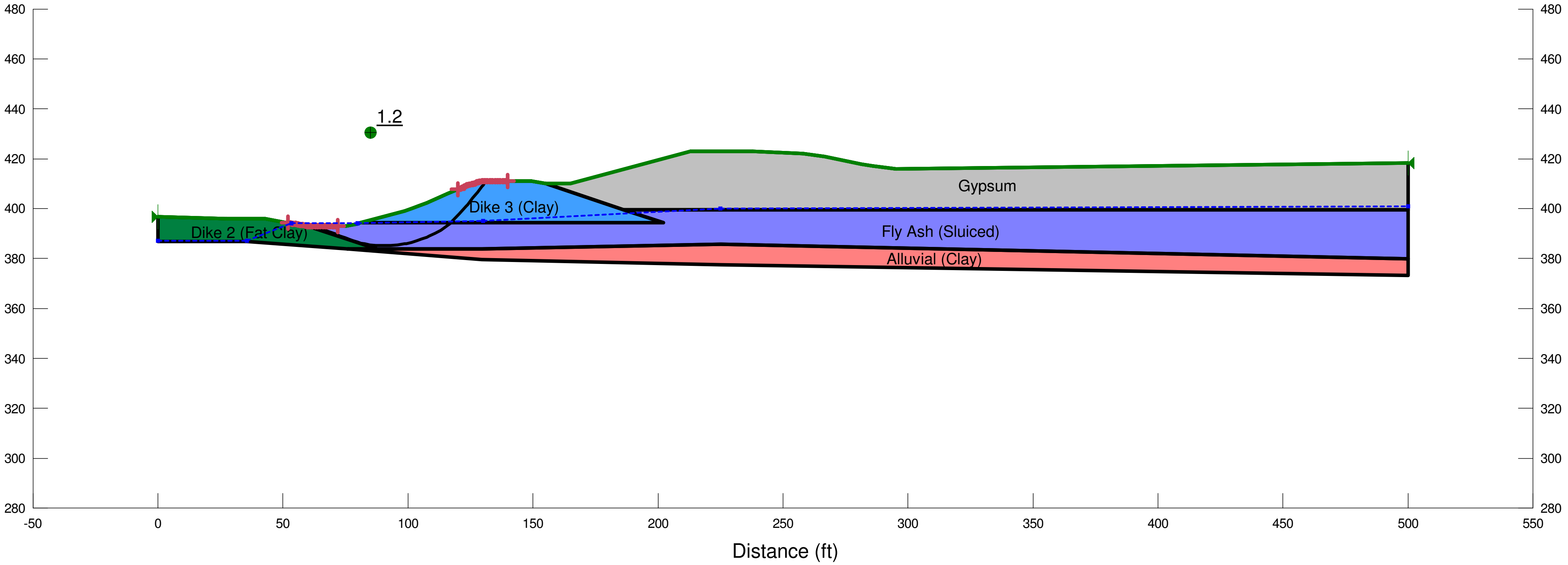
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section M.gsz
Analysis Name: Stability - Existing Condition with Existing PZ Levels
Date Saved: 10/8/2009
Last Solved on 10/8/2009 at 8:42:42 PM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °

Analysis Method: Spencer
Calculated Factor of Safety: 1.2



Stability - Existing Condition with Existing PZ Levels

File Information

Created By: Cooper, Paul
Revision Number: 237
Last Edited By: Rogers, Daniel
Date: 10/8/2009
Time: 8:41:38 PM
File Name: Section M.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 10/8/2009
Last Solved Time: 8:42:42 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 50 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (52, 394.33556) ft
Left-Zone Right Coordinate: (72, 392.97402) ft
Left-Zone Increment: 20
Right Projection: Range
Right-Zone Left Coordinate: (120, 407.66232) ft
Right-Zone Right Coordinate: (140, 411.02676) ft
Right-Zone Increment: 20
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (0, 396.66) ft
Right Coordinate: (500, 418.28266) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	387
	35.5	387
	53.5	394.1
	80	394.1
	130	395
	225	400
	500	401

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.2	(90.91, 428.717)	35.44875	(131.135, 410.98)	(62.5713, 392.978)
2	9475	1.2	(90.91, 428.717)	43.605	(130.744, 410.978)	(65.9669, 392.951)

Slices of Slip Surface: **Optimized**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	63.81192	392.5128	99.041507	134.11431	14.17033	0
2	Optimized	66.293205	391.5818	157.13519	246.5812	36.138535	0
3	Optimized	67.56286	391.1052	186.86928	305.26222	47.83385	0
4	Optimized	69.245345	390.4613	227.05604	385.13417	63.86771	0
5	Optimized	71.92684	389.4484	290.26088	506.91187	87.532685	0
6	Optimized	73.982885	388.68815	337.69947	600.20154	106.05772	0
7	Optimized	76.5466	387.74015	396.84006	734.86412	136.57058	0
8	Optimized	79.026645	386.89235	449.75766	830.57018	153.85824	0
9	Optimized	79.9855	386.6081	467.506	872.79248	163.74637	0
10	Optimized	80.209165	386.5418	471.86535	883.29509	166.2284	0
11	Optimized	80.791935	386.369	483.30948	917.95056	175.60639	0
12	Optimized	81.88258	386.0456	504.7059	999.41034	199.87357	0
13	Optimized	83.73427	385.66535	530.5278	1047.1494	208.72868	0
14	Optimized	86.00357	385.33005	553.98088	1174.5284	250.71747	0
15	Optimized	88.84689	385.1505	568.38233	1226.1304	265.74746	0
16	Optimized	91.78014	385.1301	572.95699	1335.7292	308.17998	0
17	Optimized	94.419615	385.30135	565.21735	1334.7094	310.89498	0
18	Optimized	97.249405	385.6608	545.97128	1395.4975	343.23089	0
19	Optimized	98.983585	385.8811	534.17592	1436.1153	364.40716	0
20	Optimized	100.39984	386.19525	516.16447	1394.5861	354.90537	0
21	Optimized	102.5492	386.73125	485.14419	1439.6207	385.63353	0
22	Optimized	104.5769	387.3751	447.2375	1391.8968	381.66713	0
23	Optimized	106.5275	388.1379	401.83244	1408.8939	406.87922	0
24	Optimized	108.0263	388.724	366.94318	1423.0624	426.69986	0
25	Optimized	109.6932	389.55305	317.08194	1338.9158	412.84768	0
26	Optimized	111.98005	390.8017	241.73483	1329.129	439.33575	0
27	Optimized	114.59685	392.4517	141.71273	1221.6673	436.32996	0
28	Optimized	116.67395	393.8977	53.815326	1184.5448	456.84438	0
29	Optimized	117.4924	394.54835	14.134088	905.80858	514.80851	50
30	Optimized	119.0992	396.27235	-91.637909	822.31928	474.76626	50
31	Optimized	121.91965	399.37255	-281.92181	660.3683	381.26381	50
32	Optimized	123.64915	401.34395	-402.99293	545.62116	315.01453	50
33	Optimized	124.9341	402.90075	-498.69689	462.65742	267.11539	50
34	Optimized	126.9017	405.28465	-645.24874	331.05191	191.13291	50
35	Optimized	128.76395	407.6941	-793.49247	178.73729	103.19402	50
36	Optimized	129.8212	409.15945	-883.75752	96.771375	55.870979	50

37	Optimized	130.56725	410.19345	-946.191	27.096876	15.644389	50

Slices of Slip Surface: 9475

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	9475	66.779375	392.41135	105.3723	167.78078	25.214665	0
2	9475	68.828375	391.1446	184.41778	335.60898	61.085211	0
3	9475	71.30139	389.79495	268.63379	497.26935	92.374764	0
4	9475	73.774405	388.64325	340.49804	622.13273	113.7878	0
5	9475	76.250935	387.67165	401.14374	733.51889	134.28828	0
6	9475	78.73098	386.8679	451.26923	826.65586	151.66604	0
7	9475	79.9855	386.50325	474.03807	867.32275	158.89733	0
8	9475	80.209165	386.44655	477.8114	874.16845	160.13865	0
9	9475	80.791935	386.3045	487.32303	898.25734	166.02824	0
10	9475	82.33929	385.98	509.30397	978.59537	189.60603	0
11	9475	84.686795	385.57525	537.2282	1091.7007	224.02142	0
12	9475	87.0343	385.30115	556.93216	1184.7643	253.66067	0
13	9475	89.381805	385.1552	568.67986	1259.542	279.12643	0
14	9475	91.56915	385.1293	572.74819	1314.2332	299.57938	0
15	9475	93.596335	385.2072	570.19908	1351.9149	315.83369	0
16	9475	95.62352	385.38	561.65835	1377.9338	329.7967	0
17	9475	97.650705	385.64885	547.16155	1392.6375	341.59446	0
18	9475	100.08055	386.11235	520.99368	1408.633	358.62956	0
19	9475	102.4978	386.6932	487.44949	1425.608	379.04063	0
20	9475	104.4998	387.2976	451.98992	1431.5506	395.7682	0
21	9475	106.5018	388.0094	409.82127	1424.8751	410.10838	0
22	9475	108.57375	388.8675	358.60111	1406.5492	423.39851	0
23	9475	110.7156	389.88845	297.30338	1374.7417	435.31333	0
24	9475	112.85745	391.0588	226.67609	1326.6404	444.41444	0
25	9475	114.9993	392.3931	145.81925	1261.191	450.63944	0
26	9475	116.87065	393.69665	66.582928	1189.9415	453.86632	0
27	9475	117.9863	394.5397	15.228637	1056.5302	601.19575	50
28	9475	119.24295	395.59475	-49.192515	976.70691	563.902	50
29	9475	121.12585	397.3057	-153.84321	854.14865	493.14295	50
30	9475	123.0088	399.23635	-272.19885	718.99957	415.11459	50
31	9475	124.899	401.44365	-407.82857	560.78077	323.76693	50
32	9475	126.79635	404.00345	-565.40056	380.83975	219.87793	50
33	9475	128.6937	407.0341	-752.3947	189.81564	109.59011	50
34	9475	129.8212	409.0408	-876.34636	75.539963	43.613018	50

35	9475	130.37175	410.186	-946.38378	8.852659	5.1110851	50

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section N.gsz

Analysis Name: Stability - Existing Condition with Existing PZ Levels

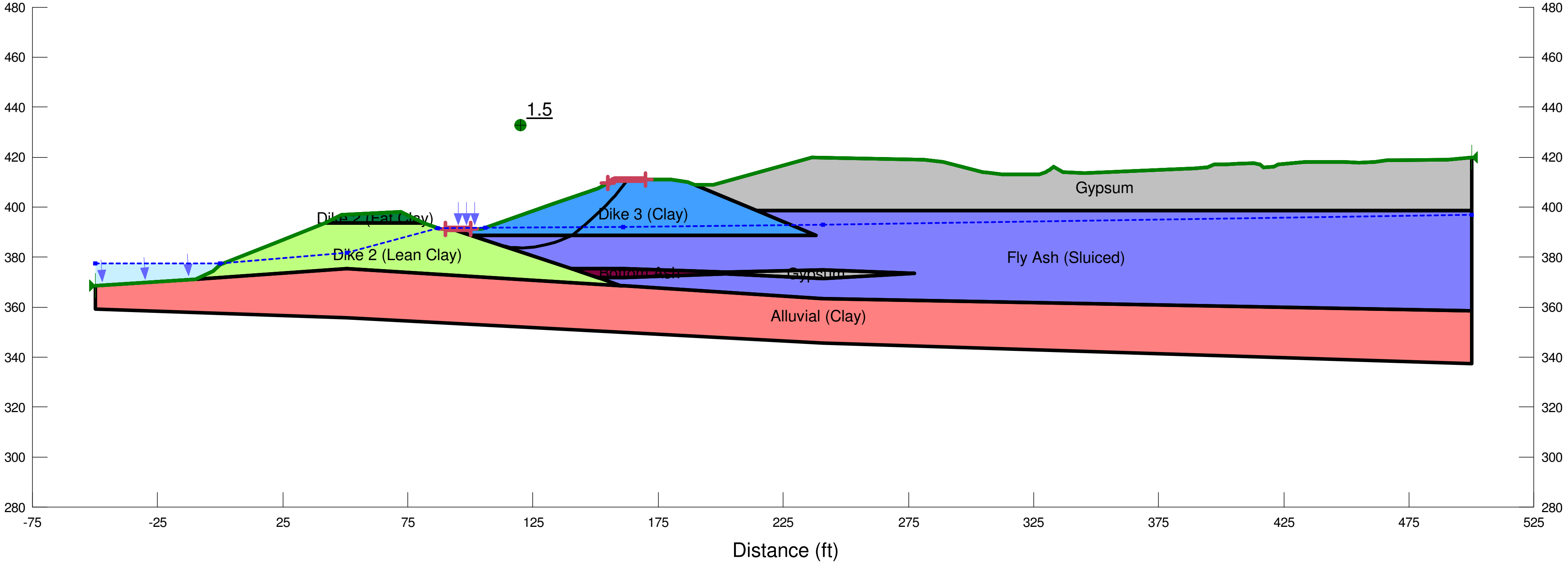
Date Saved: 10/8/2009

Last Solved on 10/8/2009 at 7:01:28 PM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Bottom Ash	105 pcf	0 psf	35 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °

Analysis Method: Spencer

Calculated Factor of Safety: 1.5



Stability - Existing Condition with Existing PZ Levels

File Information

Created By: Cooper, Paul
Revision Number: 236
Last Edited By: Rogers, Daniel
Date: 10/8/2009
Time: 6:59:57 PM
File Name: Section N.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 10/8/2009
Last Solved Time: 7:01:28 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 50 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Bottom Ash

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (90, 391.293) ft
Left-Zone Right Coordinate: (100, 391.293) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (155, 409.62138) ft
Right-Zone Right Coordinate: (170, 411.003) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-50, 368.59846) ft
Right Coordinate: (500, 420.00567) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-50	377.5
	0	377.5
	50.5	381.7
	87	391.65871
	106	391.79413
	161	392
	241	393
	500	397

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.5	(121.308, 426.791)	36.2508	(162.758, 411.003)	(94.5473, 391.293)
2	37407	1.5	(121.308, 426.791)	42.882	(161.178, 411.003)	(97.25, 391.293)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	95.96744	390.6443	67.288915	186.36711	68.749828	50
2	Optimized	98.80781	389.34685	149.51064	418.68231	155.40634	50
3	Optimized	101.3363	388.31485	215.03102	478.50521	106.45048	0
4	Optimized	103.51225	387.5624	262.95441	569.99275	124.05154	0
5	Optimized	105.28995	386.94765	302.10708	667.28957	147.5433	0
6	Optimized	106.27995	386.6053	323.85108	744.4895	169.94896	0
7	Optimized	107.9274	386.05445	358.5952	900.82556	219.07529	0
8	Optimized	110.6624	385.14635	415.92046	1168.6789	304.13415	0
9	Optimized	113.0186	384.49635	457.01836	1287.5468	335.55529	0
10	Optimized	114.99595	384.10445	481.94086	1437.2604	385.97416	0
11	Optimized	117.12875	383.84025	498.91771	1475.2906	394.48023	0
12	Optimized	119.41705	383.7038	507.9477	1602.4956	442.22605	0
13	Optimized	121.80235	383.7267	507.08252	1614.0178	447.2309	0
14	Optimized	124.28465	383.90885	496.3149	1709.5202	490.16675	0
15	Optimized	126.7127	384.2275	476.98167	1696.845	492.85679	0
16	Optimized	129.0865	384.6827	449.13809	1755.4283	527.77549	0
17	Optimized	131.13825	385.1798	418.60473	1705.9909	520.13777	0
18	Optimized	132.86795	385.71885	385.37135	1726.4685	541.83843	0
19	Optimized	134.65615	386.2762	351.01269	1746.5852	563.84787	0
20	Optimized	136.8102	387.0905	300.70265	1672.6662	554.30925	0
21	Optimized	139.32895	388.16805	234.05162	1670.3391	580.29782	0
22	Optimized	141.6078	389.52395	149.97679	1316.3755	673.42059	50
23	Optimized	143.58935	391.13365	49.992264	1218.4513	674.61012	50
24	Optimized	144.77445	392.0964	-9.8057267	1161.4184	670.5452	50
				-			

25	Optimized	146.0502	393.19255	77.906839	1075.113	620.71677	50
26	Optimized	148.21305	395.06905	-194.4947	977.22304	564.19999	50
27	Optimized	150.15665	396.7882	-301.31722	870.88462	502.80547	50
28	Optimized	151.78205	398.26055	-392.81218	805.23827	464.90453	50
29	Optimized	153.51085	399.9435	-497.41502	700.38404	404.36692	50
30	Optimized	155.4419	401.9265	-620.72105	622.67198	359.49984	50
31	Optimized	157.0116	403.6584	-728.42381	504.30347	291.15974	50
32	Optimized	158.57055	405.56885	-847.26543	385.5902	222.6206	50
33	Optimized	160.26265	407.71145	-980.56205	216.13333	124.78464	50
34	Optimized	161.87905	409.8435	-1112.7411	62.533697	36.103847	50

Slices of Slip Surface: 37407

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	37407	98.35477	390.59245	71.585554	241.04177	97.835594	50
2	37407	100.56432	389.28095	154.40532	471.62021	183.1441	50
3	37407	103.1245	387.988	236.22339	554.44913	128.57154	0
4	37407	105.28995	387.02	297.59214	678.05887	153.71854	0
5	37407	106.6803	386.4871	331.31671	788.27358	184.62256	0
6	37407	107.74815	386.111	355.03997	882.89372	213.26676	0
7	37407	109.20225	385.66785	383.02804	999.23682	248.96451	0
8	37407	111.33535	385.09875	419.03737	1152.7107	296.42326	0
9	37407	113.46845	384.6452	447.83583	1285.4897	338.43413	0
10	37407	115.60155	384.30355	469.64935	1399.7019	375.76562	0
11	37407	117.73465	384.0711	484.64429	1496.866	408.96411	0
12	37407	119.8677	383.94605	492.94966	1578.2261	438.48013	0
13	37407	122.00075	383.92745	494.61696	1644.6764	464.65417	0
14	37407	124.13385	384.01515	489.62946	1696.8863	487.76342	0
15	37407	126.26695	384.2098	477.99634	1735.2687	507.97102	0
16	37407	128.40005	384.5129	459.57891	1760.235	525.49918	0
17	37407	130.53315	384.92685	434.24656	1771.8996	540.4469	0
18	37407	132.66625	385.45495	401.79409	1770.2211	552.88042	0
19	37407	134.93515	386.1512	358.87765	1752.0632	562.88351	0
20	37407	137.33985	387.0393	304.02192	1715.1201	570.12066	0
21	37407	139.7446	388.0971	238.57657	1660.2115	574.3778	0
22	37407	141.83935	389.1568	172.94087	1540.1324	789.34841	50
23	37407	143.62405	390.18765	109.03106	1445.4869	771.60311	50
24	37407	145.40875	391.33835	37.644982	1338.0722	750.80202	50

25	37407	147.4805	392.8546	-56.484468	1202.8714	694.47814	50
26	37407	149.83935	394.81665	-178.36261	1038.519	599.58924	50
27	37407	152.1183	397.00645	-314.47473	878.22575	507.04387	50
28	37407	154.3173	399.47235	-467.84182	718.31811	414.72116	50
29	37407	156.5163	402.3872	-649.21355	533.8312	308.20759	50
30	37407	158.46185	405.44625	-839.64791	323.17701	186.58634	50
31	37407	160.15395	408.73975	-1044.7462	97.217605	56.12861	50
32	37407	161.08905	410.78175	-1171.9069	-19.105592	-11.030619	50

SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section O.gsz

Analysis Name: Stability - Existing Condition with Existing PZ Levels

Date Saved: 11/20/2009

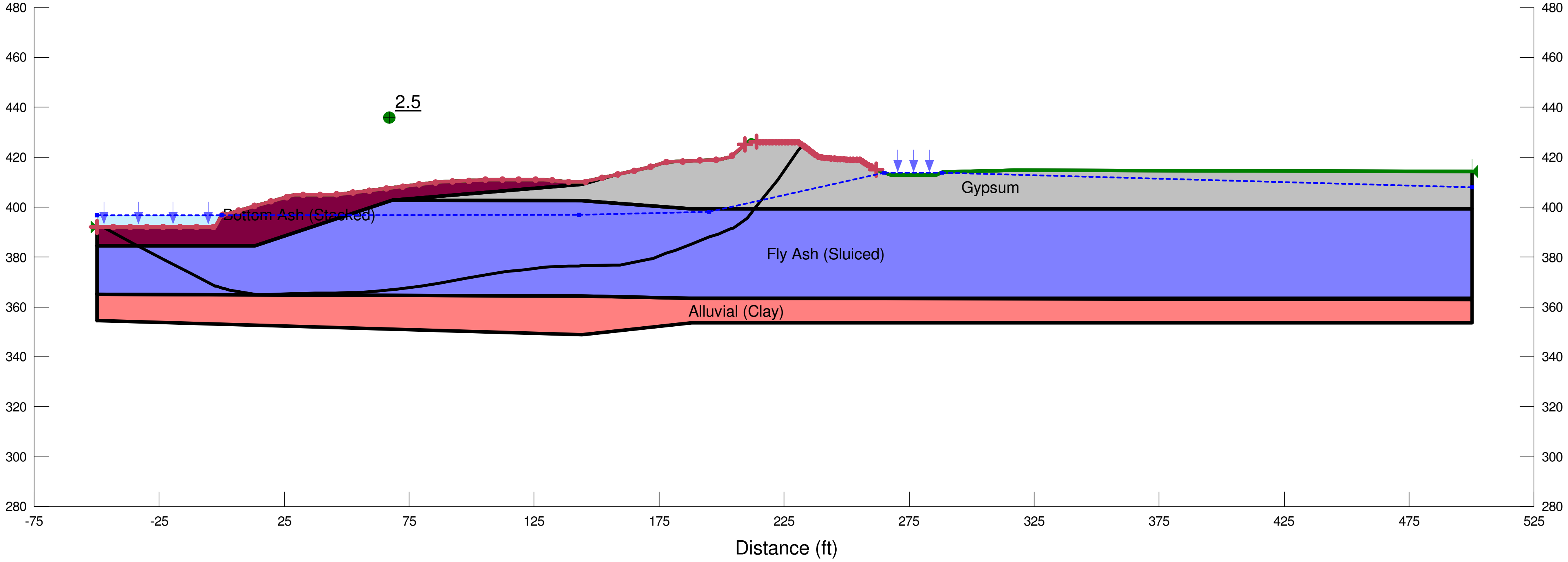
Last Solved on 11/20/2009 at 3:31:22 PM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Alluvial (Clay)	121 pcf	200 psf	30 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Bottom Ash (Stacked)	105 pcf	0 psf	35 °

Analysis Method: Spencer

Calculated Factor of Safety: 2.5



Stability - Existing Condition with Existing PZ Levels

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File Information

Created By: Cooper, Paul
Revision Number: 298
Last Edited By: Rogers, Daniel
Date: 11/20/2009
Time: 3:29:35 PM
File Name: Section O.gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\
Last Solved Date: 11/20/2009
Last Solved Time: 3:31:22 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Bottom Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-50, 391.95996) ft
Left-Zone Right Coordinate: (209.22258, 425) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (214, 426.26426) ft
Right-Zone Right Coordinate: (261.7205, 414.99699) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-50, 391.95996) ft
Right Coordinate: (500, 414.32918) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-50	396.78
	0	396.78
	143	397
	195	398
	265	413.81762
	288	413.81762
	500	408

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	2.5	(62.181, 609.412)	118.5151	(232.21, 424.902)	(-47.604, 391.96)
2	259	2.7	(62.181, 609.412)	244.684	(224.135, 425.997)	(-50, 391.96)

Slices of Slip Surface: **Optimized**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-40.64426	388.2025	535.23541	778.71044	170.48305	0
2	Optimized	-33.050535	384.10285	791.05776	1232.7704	178.4635	0

3	Optimized	-27.428715	381.2071	971.72104	1545.206	231.70296	0
4	Optimized	-17.45307	376.1001	1290.4527	2107.2694	330.01539	0
5	Optimized	-7.477425	370.99305	1609.0951	2669.2436	428.32782	0
6	Optimized	-2.31067	368.3479	1774.1711	3037.833	510.55255	0
7	Optimized	-1.06587	367.9398	1799.6299	3046.7209	503.85749	0
8	Optimized	0.268525	367.5436	1824.441	3164.6134	541.46483	0
9	Optimized	0.70314	367.41455	1832.4732	3188.0266	547.67913	0
10	Optimized	2.00887	367.0268	1856.7968	3270.5919	571.21029	0
11	Optimized	8.187865	365.93385	1925.6074	3491.7825	632.77581	0
12	Optimized	14.06195	365.0543	1981.0174	3764.0575	720.39495	0
13	Optimized	21.94626	365.09035	1979.5304	3868.5825	763.2266	0
14	Optimized	33.121975	365.3457	1964.6434	4038.1982	837.7705	0
15	Optimized	41.374245	365.53425	1953.7402	4013.363	832.14163	0
16	Optimized	47.882225	365.68295	1945.0443	4021.675	839.01327	0
17	Optimized	52.24572	365.78265	1939.2398	4059.6952	856.71961	0
18	Optimized	57.736525	366.0836	1921.0131	4053.0562	861.40135	0
19	Optimized	64.754835	366.59495	1889.7494	4078.4935	884.31004	0
20	Optimized	68.464335	366.8652	1873.2447	4092.3246	896.56647	0
21	Optimized	74.1892	367.5594	1830.5242	4057.8208	899.88621	0
22	Optimized	83.466715	368.8954	1748.0469	4003.0536	911.08185	0
23	Optimized	92.204025	370.4236	1653.465	3924.9167	917.72604	0
24	Optimized	102.17267	372.16715	1545.6583	3805.4498	913.01505	0
25	Optimized	110.4539	373.61555	1456.0685	3689.3203	902.2923	0
26	Optimized	117.4716	374.60605	1394.9833	3636.3054	905.5529	0
27	Optimized	124.91325	375.43375	1343.9652	3554.7032	893.19612	0
28	Optimized	129.94425	375.99335	1309.5446	3485.9998	879.34495	0
29	Optimized	134.98945	376.2299	1295.288	3469.3756	878.38841	0
30	Optimized	140.86225	376.3727	1286.9423	3416.1023	860.23648	0
31	Optimized	143.605	376.4394	1283.6698	3409.4045	858.85257	0
32	Optimized	144.44315	376.45975	1283.4326	3407.5235	858.18842	0
33	Optimized	150.5905	376.60925	1281.4499	3531.8051	909.20251	0
34	Optimized	157.91935	376.78745	1279.1747	3689.2611	973.73811	0
35	Optimized	165.13825	377.9588	1214.7173	3627.667	974.89499	0
36	Optimized	171.6792	379.2401	1142.657	3666.3463	1019.6367	0
37	Optimized	175.0673	380.38875	1075.0306	3527.414	990.82719	0
38	Optimized	179.49195	382.0648	975.7434	3453.9286	1001.2518	0
39	Optimized	184.6076	384.00255	860.96248	3295.4785	983.60833	0
40	Optimized	191.475	386.60385	706.8865	3081.511	959.41058	0
41	Optimized	196.7974	388.61995	610.65533	2915.9221	931.38824	0
42	Optimized	199.6518	389.7012	583.43047	2848.1882	915.02152	0
43	Optimized	202.1588	390.65085	559.54176	2818.8948	912.83788	0
44	Optimized	204.0855	391.38065	541.15295	2824.4559	922.51426	0
45	Optimized	207.3528	393.60095	448.67867	2683.8558	903.0702	0
46	Optimized	210.85675	396.52465	315.64667	2439.7061	858.17574	0

47	Optimized	212.3273	398.34685	222.67719	2317.0936	846.19914	0
48	Optimized	213.9854	400.40385	117.70003	1868.3392	1367.7492	0
49	Optimized	215.36795	402.1145	30.448483	1704.8829	1308.2116	0
50	Optimized	219.12885	406.7747	-207.32151	1366.2479	1067.4298	0
51	Optimized	226.5165	416.73295	-724.54036	624.5716	487.96882	0
52	Optimized	231.13715	423.3628	-1073.0851	154.75128	120.90495	0
53	Optimized	231.9296	424.49985	-1132.8801	41.178759	32.172372	0

Slices of Slip Surface: 259

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	259	-46.01191	389.9935	423.4842	552.08908	90.050113	0
2	259	-38.03573	386.23615	657.93213	989.50586	232.17043	0
3	259	-28.787965	382.3382	901.15769	1388.1817	196.77048	0
4	259	-18.26862	378.3994	1146.9632	1795.4068	261.98821	0
5	259	-7.749275	374.99865	1359.1487	2139.566	315.30907	0
6	259	-1.2448	373.0955	1477.9004	2470.0209	400.84271	0
7	259	0.268525	372.69115	1503.1671	2596.4008	441.69509	0
8	259	0.70314	372.5778	1510.2744	2616.9814	447.13865	0
9	259	7.048225	371.10515	1602.7549	2958.4348	547.73024	0
10	259	17.169375	368.9377	1739.0079	3470.4111	699.53227	0
11	259	25.053685	367.59455	1823.5616	3818.9988	806.20896	0
12	259	33.121975	366.4957	1892.8884	4019.801	859.32845	0
13	259	41.374245	365.6499	1946.4449	4075.3276	860.12442	0
14	259	47.882225	365.15825	1977.7893	4129.6413	869.40465	0
15	259	53.51517	364.9036	1994.2262	4201.4772	891.78731	0
16	259	61.2907	364.7719	2003.2227	4277.638	918.92344	0
17	259	67.03956	364.77975	2003.2694	4322.7866	937.14575	0
18	259	73.00292	365.0139	1989.2178	4354.2073	955.51775	0
19	259	82.48078	365.6183	1952.4411	4383.6084	982.25532	0
20	259	92.204025	366.62925	1890.2769	4337.8704	988.89197	0
21	259	102.17267	368.07155	1801.266	4216.3142	975.74283	0
22	259	112.52625	370.0267	1680.2327	4018.9621	944.908	0
23	259	123.2648	372.5405	1524.3641	3743.0556	896.40954	0
24	259	133.6793	375.467	1342.8022	3381.6475	823.74699	0
25	259	140.86225	377.7349	1201.937	3095.8648	765.19651	0
26	259	143.605	378.6744	1144.2341	2999.1529	749.43581	0
27	259	144.44315	378.97115	1126.725	2968.7859	744.24095	0
28	259	150.5905	381.347	985.88607	2855.4199	755.34071	0
29	259	160.11415	385.2163	755.84539	2675.4555	775.57284	0

30	259	167.33305	388.5111	558.91175	2512.3199	789.22812	0
31	259	174.3306	391.97675	351.04346	2347.4597	806.60452	0
32	259	179.49195	394.6931	187.74047	2184.1565	806.60445	0
33	259	183.1521	396.73515	64.707484	2002.2628	782.82316	0
34	259	186.3195	398.5623	-45.506027	1842.9537	744.60164	0
35	259	191.3	401.6153	-230.03385	1479.076	1155.5808	0
36	259	196.7974	405.09865	-417.61335	1185.4756	926.19502	0
37	259	201.1018	408.01215	-538.71548	986.03615	770.37587	0
38	259	207.58945	412.68365	-738.74327	915.07801	714.9373	0
39	259	213.2282	416.927	-924.00942	790.5203	617.62215	0
40	259	219.5107	422.11255	-1158.9814	315.65457	246.61638	0

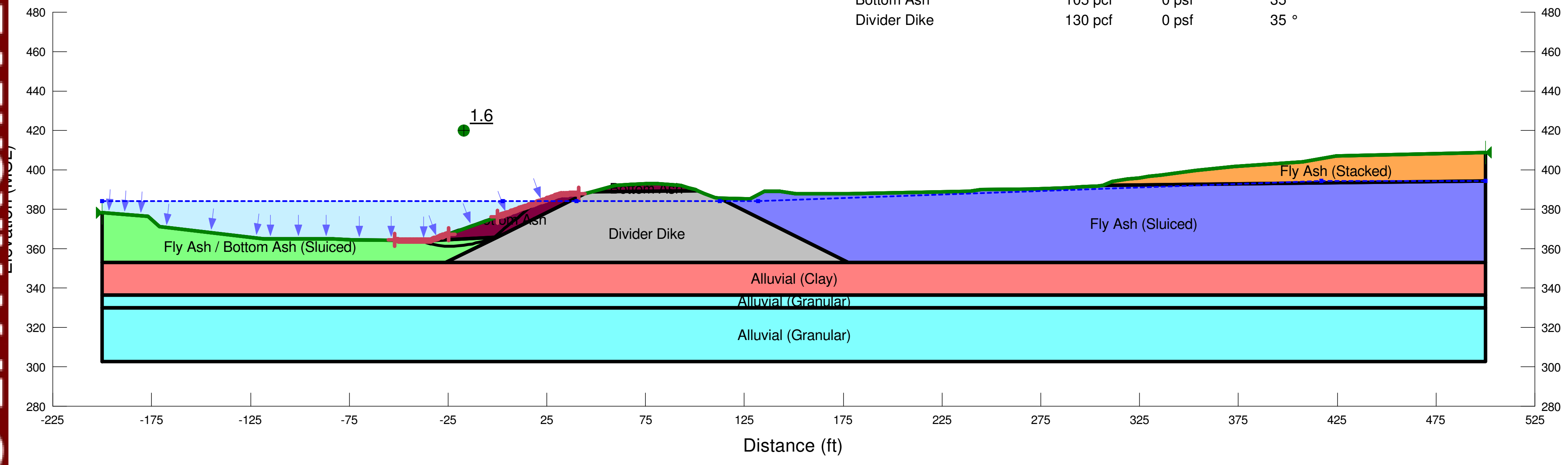
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section A_Ext (Stability - Repair Design).gsz
Analysis Name: Stability - Existing Condition (Shallow Failure)
Date Saved: 11/10/2009
Last Solved on 11/10/2009 at 8:53:06 PM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Bottom Ash	105 pcf	0 psf	35 °
Divider Dike	130 pcf	0 psf	35 °

Analysis Method: Spencer
Calculated Factor of Safety: 1.6



Stability - Existing Condition (Shallow Failure)

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File Information

Created By: Cooper, Paul
Revision Number: 253
Last Edited By: Rogers, Daniel
Date: 11/10/2009
Time: 8:47:42 PM
File Name: Section A_Ext (Stability - Repair Design).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\Repair Sections\
Last Solved Date: 11/10/2009
Last Solved Time: 8:53:06 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition (Shallow Failure)

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Bottom Ash

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Divider Dike

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-52.00001, 364.28389) ft
Left-Zone Right Coordinate: (-24.73945, 367.45398) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (-0.01245, 376.21062) ft
Right-Zone Right Coordinate: (41, 387.90442) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (-200, 378.17346) ft
Right Coordinate: (500, 408.84049) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-200	384.23
	2.55408	384.23
	40	384.23
	112.5	384.23
	132	384.23
	417	394.47
	500	394.47

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.6	(-22.427, 405.269)	30.9175	(18.8253, 382.882)	(-39.4244, 364.23)
2	23359	1.6	(-22.427, 405.269)	44.442	(15.1815, 381.591)	(-39.4816, 364.23)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-38.50552	363.93635	1266.3261	1292.8148	10.702132	0
2	Optimized	-36.667785	363.3496	1302.923	1353.9824	20.629355	0
3	Optimized	-34.830055	362.76285	1339.5717	1415.2019	30.556577	0
4	Optimized	-33.53012	362.34785	1365.4285	1480.9224	46.662585	0
5	Optimized	-31.77687	361.93445	1391.2417	1542.1491	60.970527	0
6	Optimized	-29.48264	361.5484	1415.3185	1606.0165	77.046966	0
7	Optimized	-27.638545	361.3598	1427.0787	1653.111	91.322995	0
8	Optimized	-25.53397	361.2661	1432.9446	1681.9024	100.58546	0
9	Optimized	-23.16891	361.26735	1432.8601	1716.4892	114.59362	0
10	Optimized	-20.77977	361.37995	1425.8612	1727.9752	122.062	0
11	Optimized	-18.366545	361.60385	1411.8736	1740.3123	132.69783	0
12	Optimized	-16.023465	361.9149	1392.4701	1731.4871	136.97175	0
13	Optimized	-13.750535	362.3131	1367.5953	1724.1633	144.06284	0
14	Optimized	-11.796595	362.70505	1343.1748	1704.4622	145.96959	0
15	Optimized	-10.161642	363.09075	1319.0652	1689.4012	149.62545	0
16	Optimized	-8.5266865	363.4764	1295.0151	1674.2806	153.2332	0
17	Optimized	-6.8661	363.9217	1267.2409	1644.7544	152.52535	0
18	Optimized	-5.17988	364.42665	1235.7104	1618.7347	154.75183	0
19	Optimized	-2.834405	365.3306	1179.3102	1545.1062	147.79115	0

20	Optimized	-0.36051	366.8076	1087.156	1354.9839	187.53509	0
21	Optimized	1.58255	368.4586	984.12721	1224.0702	168.00991	0
22	Optimized	3.06823	369.72095	905.37742	1123.9219	153.0265	0
23	Optimized	4.331865	370.7864	838.89461	1040.5421	141.19512	0
24	Optimized	5.830835	372.0436	760.43353	940.91957	126.37769	0
25	Optimized	7.417115	373.3792	677.11096	834.66991	110.32396	0
26	Optimized	9.212835	374.88685	582.99866	715.84039	93.016777	0
27	Optimized	11.01831	376.38915	489.24827	597.24759	75.621935	0
28	Optimized	12.711415	377.7925	401.70289	486.20155	59.166602	0
29	Optimized	14.40452	379.19585	314.13022	375.14642	42.724005	0
30	Optimized	16.14462	380.64355	223.79652	260.40582	25.634107	0
31	Optimized	17.93172	382.13565	130.69043	142.25782	8.0995719	0

Slices of Slip Surface: 23359

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	23359	-38.55323	363.86835	1270.5889	1304.3622	13.645301	0
2	23359	-36.696415	363.19185	1312.7602	1372.2294	24.027126	0
3	23359	-34.8396	362.6069	1349.2556	1429.7187	32.50918	0
4	23359	-33.019195	362.11785	1379.7909	1507.2308	51.489043	0
5	23359	-31.235205	361.7185	1404.6969	1572.4342	67.770268	0
6	23359	-29.451215	361.3953	1424.8591	1628.7662	82.383821	0
7	23359	-27.66723	361.1466	1440.3919	1676.6814	95.467156	0
8	23359	-25.883245	360.9711	1451.3731	1716.4326	107.09102	0
9	23359	-24.099255	360.8679	1457.7766	1748.2676	117.366	0
10	23359	-22.315265	360.83655	1459.7583	1772.3154	126.28127	0
11	23359	-20.531275	360.8769	1457.257	1788.6835	133.90497	0
12	23359	-18.747285	360.98915	1450.2226	1797.4582	140.29229	0
13	23359	-16.963295	361.1738	1438.7253	1798.6986	145.43868	0
14	23359	-15.17931	361.4318	1422.6232	1792.4366	149.41433	0
15	23359	-13.395325	361.7645	1401.843	1778.5108	152.18366	0
16	23359	-11.611335	362.17355	1376.3261	1756.9022	153.76271	0
17	23359	-9.827345	362.6612	1345.8693	1727.516	154.1953	0
18	23359	-8.0433555	363.2302	1310.4029	1690.0845	153.40134	0

19	23359	-6.259367	363.88385	1269.6217	1644.3942	151.41794	0
20	23359	-4.4753785	364.6263	1223.2684	1590.1925	148.24697	0
21	23359	-2.69139	365.46255	1171.0929	1527.0058	143.79818	0
22	23359	-0.7110269	366.5147	1105.4469	1416.8861	218.07208	0
23	23359	1.4657111	367.81895	1024.0448	1307.6991	198.6169	0
24	23359	3.4560365	369.15985	940.40003	1194.6937	178.05835	0
25	23359	5.25995	370.52515	855.1833	1079.1454	156.81997	0
26	23359	7.0638635	372.0445	760.3918	950.5623	133.15882	0
27	23359	8.867777	373.74035	654.56654	807.45742	107.05535	0
28	23359	10.671692	375.6433	535.82579	647.84899	78.439485	0
29	23359	12.475605	377.79695	401.42453	469.00292	47.318896	0
30	23359	14.279515	380.2671	247.28756	267.00728	13.807895	0

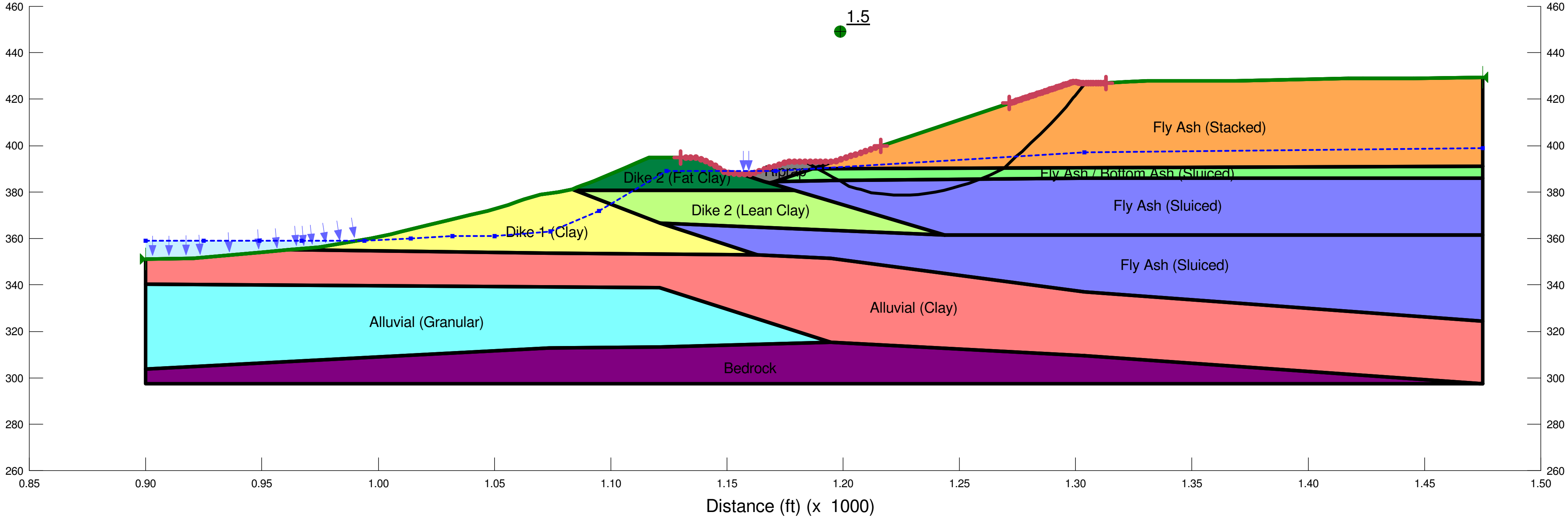
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

File Name: Section F (Stability - Repair Design).gsz
Analysis Name: Stability - Existing Condition with Existing PZ Levels
Date Saved: 10/26/2009
Last Solved on 10/26/2009 at 2:46:10 PM

Stantec

Analysis Method: Spencer
Calculated Factor of Safety: 1.5

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Riprap	150 pcf	0 psf	38 °
Bedrock			



Stability - Existing Condition with Existing PZ Levels

Report generated using GeoStudio 2007, version 7.14.

File Information

Created By: Cooper, Paul
Revision Number: 263
Last Edited By: Rogers, Daniel
Date: 10/26/2009
Time: 2:44:26 PM
File Name: Section F (Stability - Repair Design).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\Repair Sections\
Last Solved Date: 10/26/2009
Last Solved Time: 2:46:10 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Fly Ash (Stacked)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Riprap

Model: Mohr-Coulomb
Unit Weight: 150 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Bedrock

Model: Bedrock (Impenetrable)
Pore Water Pressure
    Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (1130, 394.95234) ft
Left-Zone Right Coordinate: (1216.0232, 399.79868) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (1271.2997, 418.21514) ft
Right-Zone Right Coordinate: (1313, 426.88948) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (900, 351.17633) ft
Right Coordinate: (1475, 429.48497) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	900	359
	925	359
	949	359
	967	359
	994	359
	1014	360
	1032	361
	1050	361
	1074	363
	1095	372
	1124	389
	1171	389
	1303.8099	397.05138
	1475	399

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.5	(1229, 455.973)	63.58513	(1304.16, 426.952)	(1183.5, 393)
2	32695	1.6	(1229, 455.973)	77.664	(1301.13, 427.166)	(1183.55, 393)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	1185.8335	391.74835	-115.38561	379.76443	296.70449	0
2	Optimized	1188.552	390.29195	-14.222509	681.81328	426.04422	0
3	Optimized	1190.613	389.18775	62.480297	664.75382	243.3343	0
4	Optimized	1193.987	387.343	190.35615	828.37029	257.77444	0
5	Optimized	1196.9175	385.70865	303.4221	1056.9902	304.46126	0
6	Optimized	1198.418	384.87175	361.31646	1238.8181	354.53368	0
7	Optimized	1200.5835	383.66405	444.8693	1501.2271	426.79624	0
8	Optimized	1204.155	382.11105	555.29777	1624.3988	431.94485	0
9	Optimized	1206.6645	381.3705	610.97653	1813.8813	486.00506	0
10	Optimized	1209.822	380.4387	681.07825	2052.0021	553.88917	0
11	Optimized	1214.558	379.4742	759.18811	2165.4977	568.18596	0
12	Optimized	1219.3915	378.914	812.4367	2405.3322	643.57155	0
13	Optimized	1223.5705	378.68505	842.53188	2428.1322	640.62413	0
14	Optimized	1227.095	378.7874	849.45206	2539.9612	683.01003	0
15	Optimized	1230.6195	378.8898	856.4006	2651.7902	725.38447	0
16	Optimized	1234.1985	379.23115	848.64822	2598.6726	707.05575	0
17	Optimized	1237.8315	379.8115	826.17089	2660.859	741.2621	0
18	Optimized	1241.4645	380.3919	803.69357	2723.0997	775.49042	0
19	Optimized	1245.076	381.19225	767.42926	2631.3315	753.06538	0
20	Optimized	1248.666	382.21255	717.35331	2646.8714	779.57589	0
21	Optimized	1252.2565	383.23285	667.25057	2662.4112	806.09723	0
22	Optimized	1256.373	384.6769	592.71259	2536.3998	785.30061	0
23	Optimized	1260.8465	386.47685	497.32599	2505.2713	811.26257	0
24	Optimized	1266.0715	388.8748	367.45929	2353.2715	802.32021	0
25	Optimized	1271.816	392.84025	141.74892	1748.1352	1003.7815	0
26	Optimized	1275.668	396.3484	-62.59068	1571.4716	981.96443	0
27	Optimized	1278.83	399.34015	-237.32054	1406.9873	879.18325	0
28	Optimized	1282.794	403.1744	-461.58555	1241.5991	775.83724	0
29	Optimized	1286.999	407.31	-703.73544	1048.3598	655.08791	0
30	Optimized	1290.862	411.27745	-936.6947	850.25335	531.29726	0
31	Optimized	1294.142	414.7754	-1142.5481	698.26673	436.32548	0
32	Optimized	1297.412	418.51825	-1363.7376	499.3058	312.00089	0
33	Optimized	1299.4205	420.97525	-1509.4551	382.3496	238.91855	0
				-			

34	Optimized	1301.23	423.24795	1644.4183	228.60997	142.85136	0
35	Optimized	1303.2355	425.78395	-1795.1015	68.413611	42.749569	0
36	Optimized	1303.9845	426.73135	-1851.9018	12.937045	8.0839627	0

Slices of Slip Surface: 32695

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	32695	1185.553	391.6463	-110.07764	499.0222	389.87887	0
2	32695	1187.767	390.1609	-9.0125778	790.21837	493.78324	0
3	32695	1189.904	388.9058	77.391174	734.72861	265.58156	0
4	32695	1193.7565	386.8013	223.28438	869.63805	261.14383	0
5	32695	1196.561	385.41615	320.32721	1008.9449	278.21961	0
6	32695	1197.503	384.984	350.85794	1094.9419	300.62943	0
7	32695	1198.1245	384.7139	370.06096	1149.2015	314.79322	0
8	32695	1200.469	383.7662	438.06816	1340.9213	364.77636	0
9	32695	1204.0405	382.45415	533.46236	1605.9282	433.30434	0
10	32695	1206.6645	381.596	596.90512	1782.3187	478.93818	0
11	32695	1209.4475	380.83805	654.7562	1946.5261	521.90891	0
12	32695	1213.3365	379.93125	726.04217	2149.1644	574.97871	0
13	32695	1217.2255	379.23215	784.3833	2321.4563	621.01782	0
14	32695	1221.1145	378.7351	830.10786	2465.792	660.8593	0
15	32695	1225.0035	378.43615	863.46627	2584.1074	695.18414	0
16	32695	1228.8925	378.333	884.61875	2677.5383	724.38652	0
17	32695	1232.7815	378.42495	893.58842	2747.5667	749.05586	0
18	32695	1236.6705	378.71265	890.35228	2794.4411	769.30182	0
19	32695	1240.5595	379.1983	874.76648	2818.8417	785.45739	0
20	32695	1244.4485	379.8857	846.57821	2821.3394	797.8553	0
21	32695	1248.3375	380.78035	805.47596	2801.3848	806.39953	0
22	32695	1252.2265	381.88985	750.9547	2759.0948	811.34128	0
23	32695	1256.1155	383.2241	682.40735	2694.2585	812.84064	0
24	32695	1260.0045	384.7957	599.0507	2605.6855	810.73308	0
25	32695	1264.08	386.72195	494.2709	2486.0064	804.71338	0
26	32695	1268.342	389.05405	364.85572	2331.1688	794.44204	0
27	32695	1272.2785	391.5192	225.93107	2065.5616	1149.5287	0
28	32695	1275.89	394.09995	78.554621	1868.4502	1118.4509	0
29	32695	1279.8305	397.318	-107.34716	1638.3979	1023.7847	0
30	32695	1284.0995	401.3196	-340.89072	1377.1391	860.53203	0
31	32695	1288.369	406.0077	-617.28349	1085.8609	678.52117	0
				-			

32	32695	1292.6385	411.60545	950.43077	762.0326	476.17082	0
33	32695	1296.9075	418.5391	-1366.9572	403.23429	251.96875	0
34	32695	1300.085	424.78885	-1744.9123	108.58281	67.850069	0

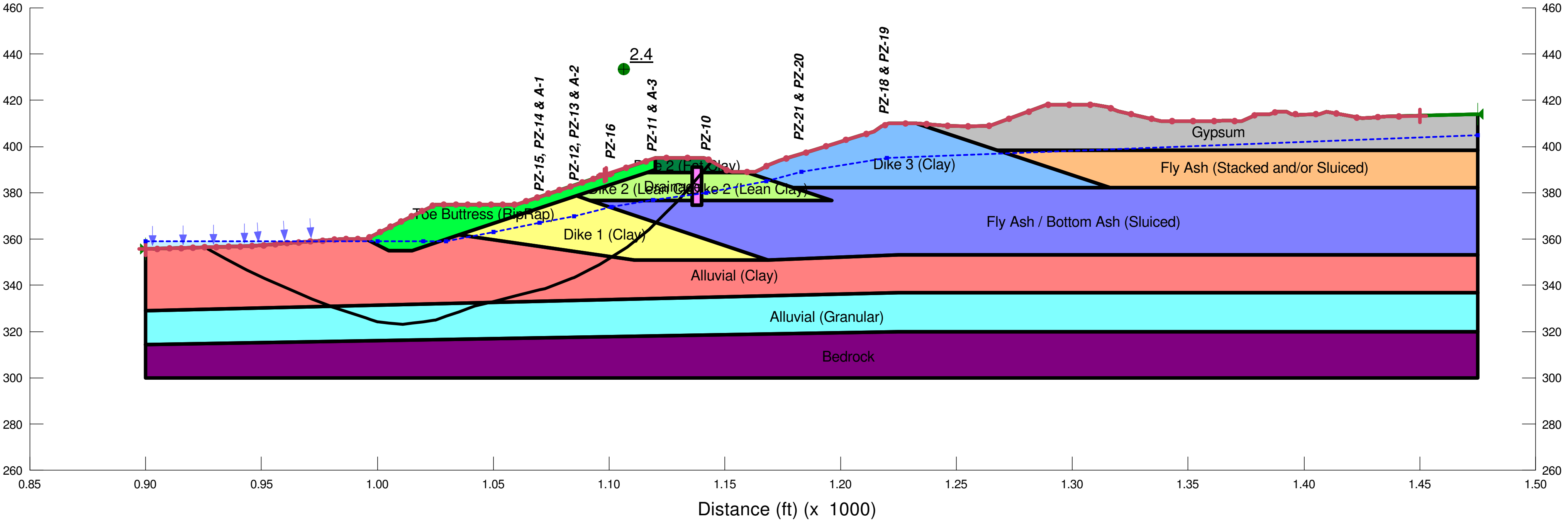
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Gypsum Stack Complex
Tennessee Valley Authority (TVA)

Stantec

File Name: Section H (Stability - Repair Design).gsz
Analysis Name: Stability - Existing Condition with Drainage Trench
Date Saved: 10/12/2009
Last Solved on 10/12/2009 at 7:43:02 PM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	125 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Dike 3 (Clay)	125 pcf	100 psf	25 °
Alluvial (Clay)	125 pcf	200 psf	28 °
Alluvial (Granular)	125 pcf	0 psf	30 °
Gypsum	100 pcf	0 psf	35 °
Fly Ash (Stacked and/or Sluiced)	100 pcf	0 psf	25 °
Fly Ash / Bottom Ash (Sluiced)	95 pcf	0 psf	25 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Toe Buttress (RipRap)	150 pcf	0 psf	38 °
Drainage Trench	130 pcf	0 psf	30 °
Bedrock			

Analysis Method: Spencer
Calculated Factor of Safety: 2.4



Stability - Existing Condition with Drainage Trench

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File Information

Created By: Cooper, Paul
Revision Number: 200
Last Edited By: Kirkbride, Rob
Date: 10/12/2009
Time: 7:39:50 PM
File Name: Section H (Stability - Repair Design).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\Repair Sections\
Last Solved Date: 10/12/2009
Last Solved Time: 7:43:02 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Drainage Trench

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 50 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 200 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked and/or Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 95 pcf
Cohesion: 0 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Toe Buttress (RipRap)

Model: Mohr-Coulomb
Unit Weight: 150 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °

Pore Water Pressure
    Piezometric Line: 1

Drainage Trench

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Bedrock

Model: Bedrock (Impenetrable)
Pore Water Pressure
    Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (900, 355.68471) ft
Left-Zone Right Coordinate: (1097.9798, 387.65993) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (1098.8988, 387.96627) ft
Right-Zone Right Coordinate: (1450, 413.40089) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (900, 355.68471) ft
Right Coordinate: (1475, 414.15883) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	900	359
	1000	359
	1019.69	359
	1029.71	359.014
	1050	363
	1070	367
	1085	370

	1101	374
	1119	377
	1142	380
	1168	385
	1183	389
	1220	395
	1475	405

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	2.4	(1017.09, 473.215)	101.0518	(1144.34, 393.725)	(925.366, 356.394)
2	6527	2.4	(1017.09, 473.215)	148.469	(1142.9, 394.383)	(925.454, 356.396)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	929.91945	353.97175	313.76244	633.90407	170.22232	200
2	Optimized	939.02635	349.12825	615.99777	1386.9378	409.91609	200
3	Optimized	944.5931	346.2234	797.26773	1796.3466	531.21968	200
4	Optimized	948.5396	344.34175	914.68204	2096.6015	628.43774	200
5	Optimized	956.92785	340.4692	1156.2904	2696.397	818.88922	200
6	Optimized	967.1329	336.0477	1432.1862	3350.8579	1020.1758	200
7	Optimized	975.77445	332.50465	1653.2744	3938.2809	1214.9595	200
8	Optimized	979.87985	330.82145	1758.3502	4204.76	1412.4353	0
9	Optimized	982.119	330.07445	1804.9654	4209.7628	1388.4104	0
10	Optimized	989.57215	327.64795	1956.3755	4580.2048	1514.8686	0
11	Optimized	996	325.55525	2086.9358	4984.969	1673.1803	0
12	Optimized	998.5	324.74135	2137.7287	5362.9432	1862.0784	0
13	Optimized	1000.1275	324.21155	2170.8006	5608.8636	1984.9666	0
14	Optimized	1002.6275	323.9682	2185.9674	5433.7385	1875.1015	0
15	Optimized	1007.987	323.51215	2214.4237	5958.4458	2161.6122	0
16	Optimized	1012.987	323.49515	2215.5069	5962.6346	2163.4052	0
17	Optimized	1017.345	324.00855	2183.4061	6203.7871	2321.1681	0
18	Optimized	1022.152	324.57485	2148.3514	6451.5088	2484.4291	0
19	Optimized	1024.807	324.93235	2126.2784	6140.1978	2317.4374	0
20	Optimized	1026.0155	325.3542	2100.0277	6095.055	2306.5301	0
21	Optimized	1028.3705	326.1762	2048.9458	5981.8476	2270.6619	0
22	Optimized	1032.405	327.5845	1994.2511	5789.1962	2191.0126	0
23	Optimized	1037.514	329.36775	1945.5989	5546.059	2078.7266	0
24	Optimized	1040.92	330.55655	1913.154	5384.0323	2003.9125	0
25	Optimized	1045.1555	331.72955	1891.8874	5361.3684	2003.1058	0
26	Optimized	1049.1995	332.76035	1877.1708	5206.3544	1770.1583	200
27	Optimized	1055	334.23885	1857.1222	4986.3708	1663.851	200

28	Optimized	1065	336.78775	1822.819	4842.5686	1605.6293	200
29	Optimized	1071.13	338.35025	1801.8393	4898.6741	1646.6163	200
30	Optimized	1075.251	339.7528	1765.7997	4729.9996	1576.0931	200
31	Optimized	1081.233	341.9818	1701.2584	4700.5488	1594.751	200
32	Optimized	1084.612	343.29115	1661.7575	4511.4879	1515.2285	200
33	Optimized	1085.4	343.68685	1648.1793	4496.1312	1514.2829	200
34	Optimized	1088.771	345.37925	1595.1146	4436.0882	1510.5725	200
35	Optimized	1093.7845	347.89645	1516.2926	4328.546	1495.3017	200
36	Optimized	1098.0285	350.3114	1431.8074	4037.0421	1385.2279	200
37	Optimized	1100.615	351.94365	1370.2925	3932.3824	1362.2874	200
38	Optimized	1104.4595	354.36975	1260.9594	3817.7148	1192.2346	100
39	Optimized	1112.5585	360.367	970.90531	3237.128	1056.757	100
40	Optimized	1118.099	365.06535	735.34479	2773.0887	950.21561	100
41	Optimized	1119.5	366.44035	662.98693	2667.8771	934.89562	100
42	Optimized	1122.4485	369.33435	506.40062	2372.8603	870.34443	0
43	Optimized	1127.5	374.2925	238.12631	1978.7884	811.68405	0
44	Optimized	1130.8615	377.74675	49.945027	1532.7751	788.43476	100
45	Optimized	1133.81	381.2426	-144.19689	1208.5618	642.60371	100
46	Optimized	1138.092	386.3196	-426.15495	777.68617	448.99732	0
47	Optimized	1140.5615	389.24735	-588.74756	482.22929	166.04486	200
48	Optimized	1141.4695	390.3239	-648.53742	363.7956	125.26487	200
49	Optimized	1142.1845	391.17175	-694.90965	261.59247	90.07351	200
50	Optimized	1142.783	391.8814	-732.00059	176.03472	60.613614	200
51	Optimized	1143.7615	393.04175	-792.6822	26.661078	9.1801452	200
52	Optimized	1144.332	393.7181	-828.00315	-64.512302	-22.213367	200

Slices of Slip Surface: 6527

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	6527	928.8125	353.91085	317.56468	710.46076	208.90655	200
2	6527	935.53005	349.21655	610.48778	1435.7688	438.80968	200
3	6527	942.2476	345.04625	870.71862	2043.2295	623.43507	200
4	6527	948.89095	341.386	1099.1182	2564.0818	778.93496	200
5	6527	955.4601	338.18785	1298.6797	3011.1001	910.51005	200
6	6527	962.02925	335.37685	1474.0363	3389.4213	1018.4282	200
7	6527	968.59835	332.92965	1626.8025	3706.6697	1105.885	200
8	6527	973.5016	331.2973	1728.6354	3921.0394	1165.7219	200
9	6527	979.6323	329.62335	1833.0694	4138.9088	1331.277	0
10	6527	989.57215	327.4222	1970.4344	4392.472	1398.364	0

11	6527	996	326.2544	2043.3263	4585.1976	1467.55	0
12	6527	998.5	325.92165	2064.1004	4843.5951	1604.742	0
13	6527	1002.5	325.4856	2091.2328	5237.7352	1816.634	0
14	6527	1010	324.99975	2121.5772	5845.3246	2149.9066	0
15	6527	1017.345	324.7648	2136.2441	6334.7453	2424.0058	0
16	6527	1022.345	324.86305	2130.2997	6595.6667	2578.0809	0
17	6527	1026.0155	325.0184	2121.0124	6694.6742	2640.6049	0
18	6527	1028.3705	325.1817	2111.0121	6620.7543	2603.7009	0
19	6527	1032.405	325.56345	2120.3428	6482.6391	2518.5729	0
20	6527	1037.514	326.1785	2144.5289	6295.1042	2396.3358	0
21	6527	1044.964	327.47725	2154.9059	5980.844	2208.9064	0
22	6527	1055	329.7621	2136.439	5509.611	1947.5018	0
23	6527	1062.912	332.02875	2093.6842	5230.3722	1810.9677	0
24	6527	1067.912	333.73485	2049.6783	5163.7342	1655.7729	200
25	6527	1073.75	336.0449	1978.373	5051.9123	1634.2298	200
26	6527	1081.25	339.39205	1863.167	4863.6872	1595.4048	200
27	6527	1085.4	341.3974	1791.0164	4742.0095	1569.0709	200
28	6527	1088.771	343.24325	1728.4123	4624.0335	1539.6291	200
29	6527	1095.986	347.54655	1572.499	4295.5632	1447.8789	200
30	6527	1100.615	350.47325	1462.1073	4051.5062	1376.8078	200
31	6527	1102.015	351.443	1418.1279	3968.1475	1355.8695	200
32	6527	1106.3725	354.66835	1262.1191	3738.9217	1154.952	100
33	6527	1113.0575	360.01995	997.75209	3272.824	1060.8835	100
34	6527	1116.59	363.02555	846.93592	3010.681	1008.9709	100
35	6527	1117.89	364.22375	785.69395	2904.5775	988.05162	100
36	6527	1119.5	365.7268	707.51439	2771.6319	962.51383	100
37	6527	1120.396	366.5869	661.14196	2594.296	901.44453	100
38	6527	1122.8445	369.05465	527.07627	2386.7572	867.18348	0
39	6527	1127.37	373.88435	262.53485	1961.2308	792.11495	0
40	6527	1130.686	377.63215	55.670831	1552.6901	795.97927	100
41	6527	1133.7645	381.4774	-159.20916	1166.1283	620.04143	100
42	6527	1138	387.1297	-477.45103	668.68373	386.06473	0
43	6527	1140.4695	390.64005	-676.37082	312.41185	107.57203	200
44	6527	1141.4695	392.1556	-762.82833	158.02289	54.411645	200
45	6527	1142.1845	393.25835	-825.1113	38.061718	13.1057	200
46	6527	1142.633	393.96495	-863.82368	-37.7727	-13.006184	200

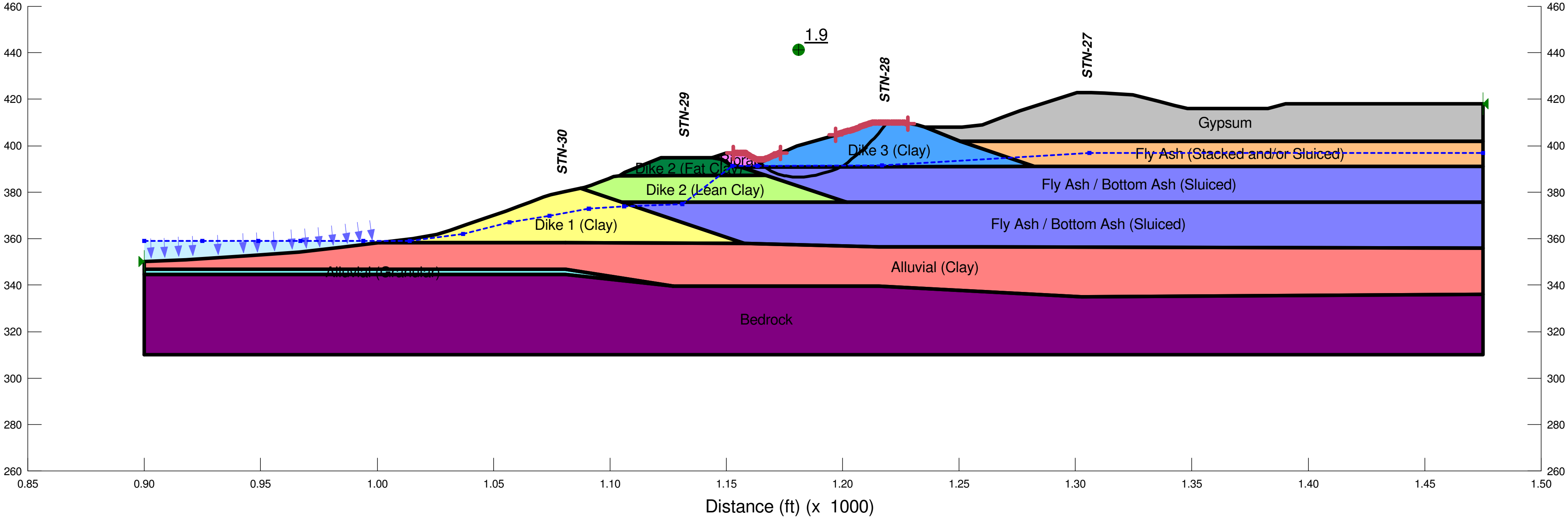
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant
Tennessee Valley Authority (TVA)

File Name: Section J (Stability - Repair Design).gsz
Analysis Name: Stability - Existing Condition with Existing PZ Levels
Date Saved: 10/22/2009
Last Solved on 10/22/2009 at 1:27:14 PM

Stantec

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	100 psf	25 °
Dike 2 (Lean Clay)	128 pcf	100 psf	28 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Stacked and/or Sluiced)	100 pcf	0 psf	22 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	22 °
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Riprap	135 pcf	0 psf	38 °
Bedrock			

Analysis Method: Spencer
Calculated Factor of Safety: 1.9



Stability - Existing Condition with Existing PZ Levels

Report generated using GeoStudio 2007, version 7.14.

File Information

Created By: Kirkbride, Rob
Revision Number: 81
Last Edited By: Rogers, Daniel
Date: 10/22/2009
Time: 1:25:37 PM
File Name: Section J (Stability - Repair Design).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\Repair Sections\
Last Solved Date: 10/22/2009
Last Solved Time: 1:27:14 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 1 (Clay)

Model: Mohr-Coulomb
Unit Weight: 124 pcf
Cohesion: 100 psf
Phi: 25 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Dike 2 (Lean Clay)

Model: Mohr-Coulomb
Unit Weight: 128 pcf
Cohesion: 100 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 50 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Alluvial (Granular)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Stacked and/or Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash / Bottom Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Riprap

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °

Pore Water Pressure
 Piezometric Line: 1

Bedrock

Model: Bedrock (Impenetrable)
Pore Water Pressure
 Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (1153, 397) ft
Left-Zone Right Coordinate: (1173.3143, 397) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (1197, 404.72957) ft
Right-Zone Right Coordinate: (1228, 409.63333) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (900, 350.14265) ft
Right Coordinate: (1475, 418.20122) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	900	359
	925	359
	949	359
	967	359
	994	359
	1014	359
	1037	362
	1057	367
	1074	370
	1091	373
	1106	374
	1131	375
	1152.4982	391.23424
	1163.5128	391.26817
	1217	391.5

	1306	397
	1475	397

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.9	(1183.86, 420.295)	30.06568	(1219.29, 409.973)	(1161.69, 394.786)
2	22405	1.9	(1183.86, 420.295)	33.81	(1216.06, 409.981)	(1161.63, 394.82)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	1162.3445	394.2606	-186.95503	43.907242	34.304097	0
2	Optimized	1163.2565	393.52895	-141.12202	155.91501	121.81415	0
3	Optimized	1164.097	392.8544	-98.82275	379.17207	296.24169	0
4	Optimized	1164.997	392.132	-53.499943	529.56972	305.74722	50
5	Optimized	1165.6565	391.60295	-20.309962	650.28458	375.44198	50
6	Optimized	1166.03	391.30335	-1.5140986	723.33926	417.62012	50
7	Optimized	1166.1425	391.2129	4.159207	753.97959	432.909	50
8	Optimized	1166.3965	391.0312	15.565821	718.4486	405.80956	50
9	Optimized	1167.9415	389.98985	80.962678	858.10236	313.98481	0
10	Optimized	1170.7435	388.43285	178.87706	1124.0764	381.88534	0
11	Optimized	1173.553	387.42065	242.79728	1320.643	435.47793	0
12	Optimized	1175.331	386.986	270.4004	1387.0881	451.17112	0
13	Optimized	1177.157	386.73975	286.2647	1514.1055	496.0799	0
14	Optimized	1179.495	386.55795	298.2402	1562.2001	510.67295	0
15	Optimized	1181.8165	386.58595	297.11816	1660.5161	550.84852	0
16	Optimized	1184.08	386.7184	289.46757	1651.5806	550.32938	0
17	Optimized	1185.7825	386.9492	275.52539	1691.457	572.07349	0
18	Optimized	1187.485	387.18	261.58321	1731.3333	593.8176	0
19	Optimized	1189.24	387.5292	240.26797	1680.3929	581.84824	0
20	Optimized	1191.0485	387.99675	211.58421	1699.2906	601.07238	0
21	Optimized	1192.857	388.46425	182.90045	1718.1882	620.29652	0
22	Optimized	1194.595	389.03	148.06414	1637.6066	601.81421	0
23	Optimized	1196.4505	389.76855	102.48267	1632.8811	618.32109	0
24	Optimized	1198.5305	390.5965	51.383659	1628.356	637.13819	0
25	Optimized	1199.86	391.2224	12.687654	1356.7049	775.96872	50
26	Optimized	1201.136	392.18565	-47.074511	1300.7337	750.97893	50
27	Optimized	1202.99	393.63395	-	1189.4402	686.72362	50

				136.94742			
28	Optimized	1204.688	395.0131	-222.54927	1109.5927	640.62363	50
29	Optimized	1206.4555	396.4485	-311.63896	1033.2887	596.56951	50
30	Optimized	1208.167	397.92235	-403.14687	918.13267	530.08414	50
31	Optimized	1209.753	399.3785	-493.55728	842.69389	486.52954	50
32	Optimized	1211.4775	401.0929	-600.09228	709.73268	409.76435	50
33	Optimized	1212.99	402.6942	-699.60572	604.1539	348.80842	50
34	Optimized	1214.4615	404.31225	-800.1816	454.56816	262.44505	50
35	Optimized	1216.176	406.29075	-923.15644	283.5837	163.72712	50
36	Optimized	1218.1435	408.61945	-1063.8505	93.808397	54.160303	50

Slices of Slip Surface: 22405

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	22405	1162.317	394.25445	-186.5747	52.300821	40.86188	0
2	22405	1163.2565	393.4923	-138.83607	156.78057	122.49041	0
3	22405	1164.1175	392.85995	-99.161519	329.14484	257.15614	0
4	22405	1165.0175	392.2263	-59.381272	436.57701	252.05785	50
5	22405	1165.6565	391.8085	-33.137826	503.31403	290.58849	50
6	22405	1166.2525	391.4351	-9.6769365	584.00555	337.17576	50
7	22405	1166.8165	391.09905	11.444143	678.07397	384.87891	50
8	22405	1167.988	390.4595	51.669108	731.71383	274.7559	0
9	22405	1169.708	389.6054	105.43356	921.70546	329.79526	0
10	22405	1171.428	388.86855	151.88026	1088.4427	378.3958	0
11	22405	1173.148	388.24085	191.51075	1235.3985	421.75802	0
12	22405	1174.868	387.716	224.72452	1365.0154	460.70741	0
13	22405	1176.5075	387.30485	250.82824	1472.6352	493.64205	0
14	22405	1178.066	386.99545	270.55365	1561.0177	521.38133	0
15	22405	1179.6245	386.7613	285.58518	1638.6254	546.66373	0
16	22405	1181.343	386.5926	296.57723	1699.8622	566.96391	0
17	22405	1183.2215	386.5046	302.57313	1743.6896	582.24885	0
18	22405	1185.1	386.5212	302.04692	1775.1316	595.16483	0
19	22405	1186.978	386.64255	294.98214	1794.4186	605.81164	0
20	22405	1188.856	386.8698	281.31196	1801.7425	614.29381	0

21	22405	1190.734	387.20515	260.89772	1797.132	620.67895	0
22	22405	1192.612	387.6519	233.52571	1780.2941	624.935	0
23	22405	1194.49	388.2147	198.91435	1751.0892	627.11934	0
24	22405	1196.3115	388.8755	158.17361	1711.6206	627.63333	0
25	22405	1198.077	389.6344	111.29426	1662.141	626.58275	0
26	22405	1199.8425	390.5172	56.68958	1599.7983	623.4564	0
27	22405	1201.0975	391.21175	13.686534	1494.4084	854.89517	50
28	22405	1202.487	392.10445	-41.643862	1404.6495	810.97477	50
29	22405	1204.5205	393.56195	-132.04495	1262.8627	729.1141	50
30	22405	1206.396	395.11645	-228.53502	1121.4851	647.48973	50
31	22405	1208.114	396.77065	-331.29002	980.32858	565.99297	50
32	22405	1209.832	398.6885	-450.50076	820.17201	473.52653	50
33	22405	1211.55	400.9502	-591.16378	638.2075	368.46927	50
34	22405	1213.3215	403.8108	-769.19703	398.25345	229.93174	50
35	22405	1215.147	407.71145	-1012.1022	103.03561	59.487638	50

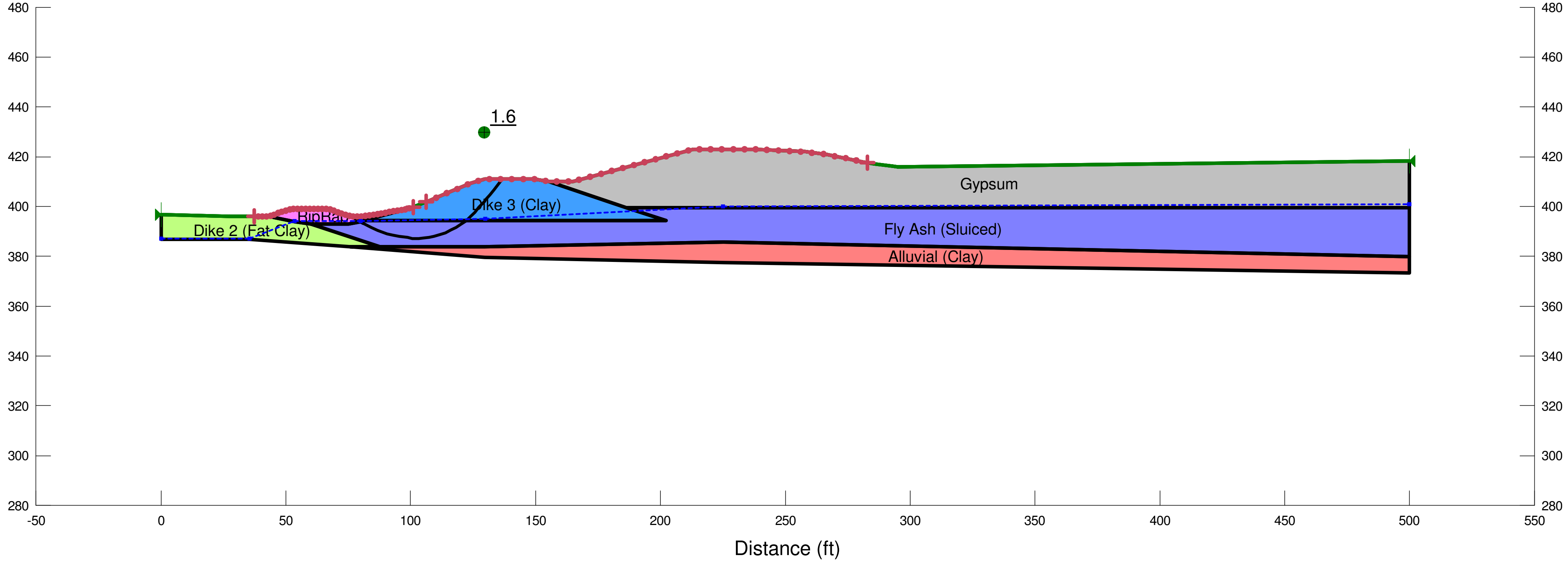
SLOPE STABILITY ANALYSIS
Cumberland Fossil Plant - Fly Ash Stack
Tennessee Valley Authority (TVA)

Stantec

File Name: Section M (Stability - Repair Design).gsz
Analysis Name: Stability - Existing Condition with Existing PZ Levels
Date Saved: 10/22/2009
Last Solved on 10/22/2009 at 6:24:40 PM

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 2 (Fat Clay)	127 pcf	200 psf	19 °
Dike 3 (Clay)	126 pcf	50 psf	30 °
Alluvial (Clay)	121 pcf	200 psf	30 °
Gypsum	105 pcf	0 psf	38 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
RipRap	135 pcf	0 psf	38 °

Analysis Method: Spencer
Calculated Factor of Safety: 1.6



Stability - Existing Condition with Existing PZ Levels

File Information

Created By: Cooper, Paul
Revision Number: 212
Last Edited By: Rogers, Daniel
Date: 10/22/2009
Time: 6:18:23 PM
File Name: Section M (Stability - Repair Design).gsz
Directory: V:\1755\active\175539009\geotechnical\analysis\Slope-W\Repair Sections\
Last Solved Date: 10/22/2009
Last Solved Time: 6:24:40 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Stability - Existing Condition with Existing PZ Levels

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30

Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Dike 2 (Fat Clay)

Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Dike 3 (Clay)

Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 50 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Alluvial (Clay)

Model: Mohr-Coulomb
Unit Weight: 121 pcf
Cohesion: 200 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Gypsum

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Fly Ash (Sluiced)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

RipRap

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (37.37802, 396.03165) ft
Left-Zone Right Coordinate: (101, 399.8229) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (106.11727, 401.84613) ft
Right-Zone Right Coordinate: (283, 417.56925) ft
Right-Zone Increment: 40
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (0, 396.66) ft
Right Coordinate: (500, 418.28266) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	387
	35.5	387
	53.5	394.1
	80	394.1
	130	395
	225	400
	500	401

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.6	(100.997, 425.236)	31.54888	(136.733, 411.009)	(75.4195, 396.173)
2	32013	1.6	(100.997, 425.236)	37.81	(136.028, 411.006)	(77.0226, 395.998)

Slices of Slip Surface: **Optimized**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	75.682115	396.03625	-120.82139	12.159095	9.4997262	0
2	Optimized	77.414725	395.13155	-64.369983	212.52738	166.04459	0
3	Optimized	79.127465	394.232	-8.2380917	445.00786	347.67824	0
4	Optimized	79.519685	394.0187	5.0721501	495.34208	383.04085	0
5	Optimized	79.820075	393.85535	15.266031	398.56696	154.86363	0
6	Optimized	79.9855	393.7654	20.879921	408.10466	156.44895	0
7	Optimized	80.209165	393.64375	28.704633	420.50009	158.29564	0
8	Optimized	80.681535	393.38685	45.265746	446.64962	162.16961	0
9	Optimized	81.00073	393.21325	56.456301	466.13085	165.51926	0
10	Optimized	82.630875	392.3267	113.60665	621.16169	205.06555	0
11	Optimized	85.48173	390.9177	204.73379	828.9043	252.18126	0
12	Optimized	87.69363	390.0437	261.75678	949.70522	277.94921	0
13	Optimized	89.564025	389.4015	303.92489	1070.9657	309.90461	0
14	Optimized	91.72956	388.7873	344.68609	1140.9153	321.69748	0
15	Optimized	94.162075	388.2078	383.57994	1263.4547	355.49246	0
16	Optimized	96.18926	387.8052	410.97748	1301.7308	359.88768	0
17	Optimized	97.839285	387.57275	427.33689	1364.3238	378.56728	0
18	Optimized	99.64415	387.31845	445.23002	1459.3572	409.73398	0
19	Optimized	101.0604	387.1842	455.20235	1454.5578	403.76581	0
20	Optimized	102.31425	387.19505	455.93222	1516.8178	428.62559	0
21	Optimized	103.9491	387.20915	456.88639	1601.5917	462.49099	0
22	Optimized	106.13465	387.43995	444.95387	1596.02	465.0609	0
23	Optimized	108.37555	387.8064	424.59212	1672.7779	504.29977	0
24	Optimized	110.4075	388.3246	394.53756	1629.1621	498.82069	0
25	Optimized	112.72595	389.0756	350.2797	1671.2616	533.71135	0
26	Optimized	114.9777	389.97925	296.42269	1602.6991	527.76992	0
27	Optimized	117.12155	391.0156	234.16472	1607.6131	554.90916	0
28	Optimized	119.22095	392.21535	161.65673	1501.0897	541.16604	0
29	Optimized	121.36215	393.6282	75.896895	1470.636	563.51116	0
30	Optimized	122.7076	394.6114	16.058219	1173.6566	668.33974	50
31	Optimized	123.4551	395.3873	-31.519654	1131.9615	653.5383	50

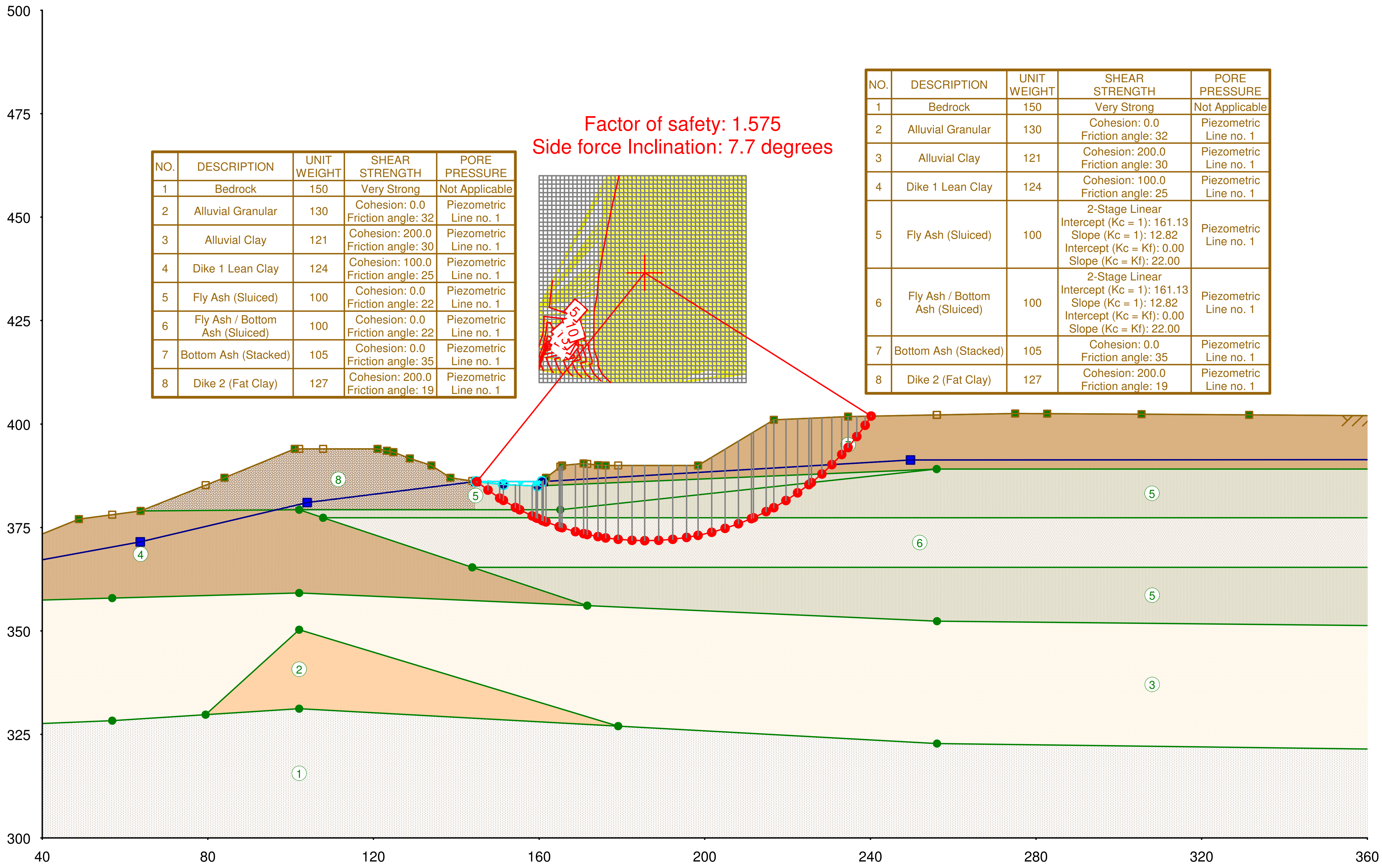
32	Optimized	124.83635	396.8211	-119.4353	1050.8678	606.71879	50
33	Optimized	126.57155	398.6875	-233.94839	909.13523	524.88947	50
34	Optimized	128.2698	400.5807	-350.17945	794.79542	458.87535	50
35	Optimized	129.38065	401.8465	-427.9228	689.83428	398.27601	50
36	Optimized	129.8212	402.3837	-460.9332	653.68031	377.4025	50
37	Optimized	130.87165	403.6645	-537.7893	553.64943	319.64965	50
38	Optimized	132.6149	405.7901	-664.7067	387.70011	223.83876	50
39	Optimized	134.2982	407.892	-790.33577	217.76515	125.72677	50
40	Optimized	135.92155	409.97025	-914.7145	58.799283	33.947782	50

Slices of Slip Surface: **32013**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	32013	78.28404	395.04915	-59.227953	313.52808	244.95498	0
2	32013	79.65135	394.0276	4.5180071	581.69975	450.9438	0
3	32013	79.864105	393.88315	13.532382	423.46389	165.62308	0
4	32013	79.9855	393.8014	18.633345	431.33883	166.74384	0
5	32013	80.209165	393.654	28.063701	444.78619	168.36682	0
6	32013	80.681535	393.34865	47.650701	472.18125	171.52147	0
7	32013	81.00073	393.1461	60.64933	491.93548	174.25091	0
8	32013	81.11113	393.07755	65.050303	501.32244	176.26538	0
9	32013	82.10454	392.50195	102.08204	589.66386	196.99584	0
10	32013	83.982545	391.4866	167.55184	742.0703	232.12053	0
11	32013	85.86055	390.6028	224.81153	871.90339	261.44208	0
12	32013	87.73855	389.84065	274.47856	982.57788	286.0907	0
13	32013	89.616555	389.1924	317.03613	1076.6747	306.91392	0
14	32013	91.56915	388.6348	354.02381	1158.5669	325.05652	0
15	32013	93.596335	388.1713	385.22062	1228.5671	340.73408	0
16	32013	95.62352	387.8233	409.21078	1284.283	353.55212	0
17	32013	97.650705	387.5876	426.19817	1326.7131	363.83165	0
18	32013	100.08055	387.46315	436.6971	1395.7154	387.46855	0
19	32013	102.4978	387.46855	439.07055	1478.9409	420.13488	0
20	32013	104.4998	387.60145	433.02524	1538.4439	446.61814	0
21	32013	106.5018	387.84195	420.26773	1584.0652	470.20468	0
22	32013	108.57375	388.20845	399.72519	1619.2738	492.7296	0
23	32013	110.7156	388.71255	370.67734	1642.6823	513.92336	0
24	32013	112.85745	389.35145	333.21645	1649.8796	531.96643	0
25	32013	114.9993	390.13255	286.87947	1640.3211	546.8259	0
26	32013	117.1789	391.08505	229.89148	1612.9367	558.78656	0
27	32013	119.3963	392.2284	161.03612	1565.8095	567.56528	0
28	32013	121.6137	393.5682	79.923716	1496.9587	572.51929	0

29	32013	123.1335	394.5869	18.06493	1359.4301	774.43753	50
30	32013	123.74745	395.0366	-9.3073877	1321.2537	762.82619	50
31	32013	124.899	395.96405	-65.885517	1234.838	712.93408	50
32	32013	126.79635	397.62515	-167.40548	1079.8887	623.47405	50
33	32013	128.6937	399.5339	-284.3791	908.56618	524.56093	50
34	32013	129.8212	400.7668	-360.04405	798.25389	460.8721	50
35	32013	131.00465	402.29125	-451.68011	645.15797	372.48213	50
36	32013	133.0139	405.21135	-627.29688	380.06236	219.42911	50
37	32013	135.02315	408.91165	-851.59288	99.182788	57.263209	50

TVA Cumberland Fossil Plant Section C FSu - Drained/Undrained Analysis



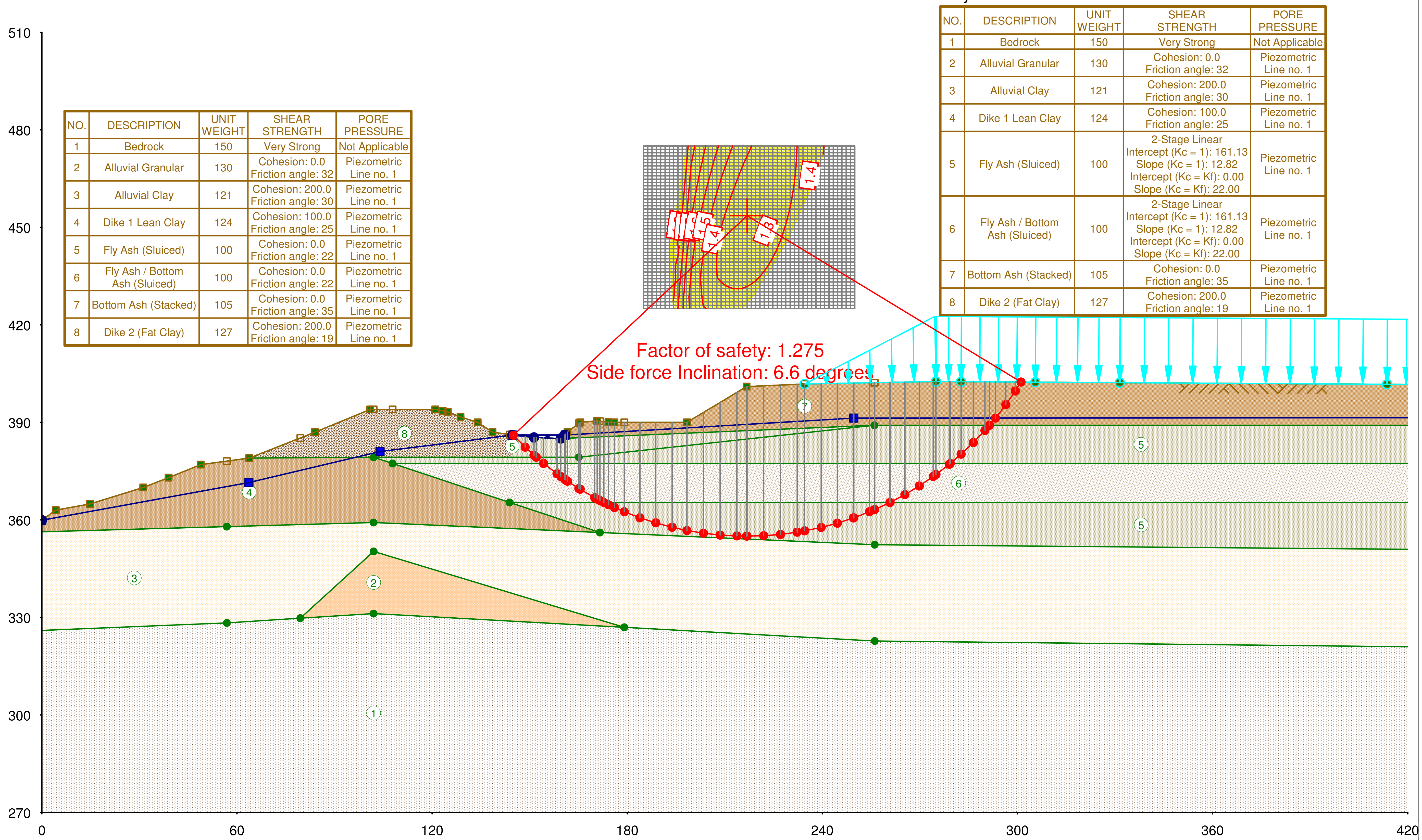
Factor of safety: 1.575
Side force Inclination: 7.7 degrees

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Bedrock	150	Very Strong	Not Applicable
2	Alluvial Granular	130	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
3	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
4	Dike 1 Lean Clay	124	Cohesion: 100.0 Friction angle: 25	Piezometric Line no. 1
5	Fly Ash (Sluiced)	100	Cohesion: 0.0 Friction angle: 22	Piezometric Line no. 1
6	Fly Ash / Bottom Ash (Sluiced)	100	Cohesion: 0.0 Friction angle: 22	Piezometric Line no. 1
7	Bottom Ash (Stacked)	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
8	Dike 2 (Fat Clay)	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Bedrock	150	Very Strong	Not Applicable
2	Alluvial Granular	130	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
3	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
4	Dike 1 Lean Clay	124	Cohesion: 100.0 Friction angle: 25	Piezometric Line no. 1
5	Fly Ash (Sluiced)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 22.00	Piezometric Line no. 1
6	Fly Ash / Bottom Ash (Sluiced)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 22.00	Piezometric Line no. 1
7	Bottom Ash (Stacked)	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
8	Dike 2 (Fat Clay)	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1

Date: Thu Mar 11 2010 Filename: SecC-FSu.UT4 Time: 15:40:06

TVA Cumberland Fossil Plant Section C FSul - Drained/Undrained Analysis



Factor of safety: 1.275
Side force Inclination: 6.6 degrees

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Bedrock	150	Very Strong	Not Applicable
2	Alluvial Granular	130	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
3	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
4	Dike 1 Lean Clay	124	Cohesion: 100.0 Friction angle: 25	Piezometric Line no. 1
5	Fly Ash (Sluiced)	100	Cohesion: 0.0 Friction angle: 22	Piezometric Line no. 1
6	Fly Ash / Bottom Ash (Sluiced)	100	Cohesion: 0.0 Friction angle: 22	Piezometric Line no. 1
7	Bottom Ash (Stacked)	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
8	Dike 2 (Fat Clay)	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Bedrock	150	Very Strong	Not Applicable
2	Alluvial Granular	130	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
3	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
4	Dike 1 Lean Clay	124	Cohesion: 100.0 Friction angle: 25	Piezometric Line no. 1
5	Fly Ash (Sluiced)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 22.00	Piezometric Line no. 1
6	Fly Ash / Bottom Ash (Sluiced)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 22.00	Piezometric Line no. 1
7	Bottom Ash (Stacked)	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
8	Dike 2 (Fat Clay)	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1

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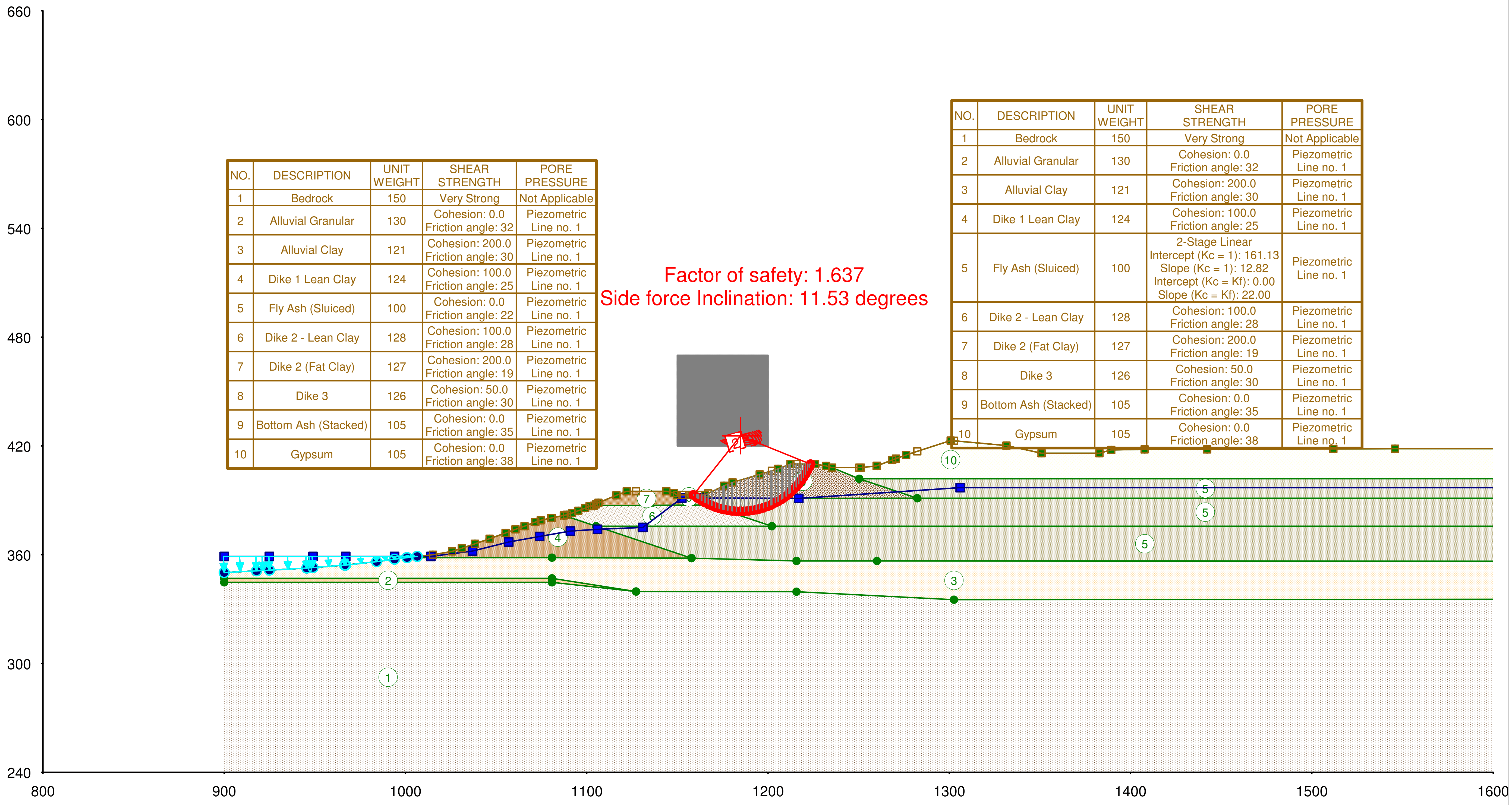
TVA Cumberland Fossil Plant Section J FSu - Drained/Undrained Analysis



Factor of safety: 1.637
Side force Inclination: 11.53 degrees

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Bedrock	150	Very Strong	Not Applicable
2	Alluvial Granular	130	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
3	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
4	Dike 1 Lean Clay	124	Cohesion: 100.0 Friction angle: 25	Piezometric Line no. 1
5	Fly Ash (Sluiced)	100	Cohesion: 0.0 Friction angle: 22	Piezometric Line no. 1
6	Dike 2 - Lean Clay	128	Cohesion: 100.0 Friction angle: 28	Piezometric Line no. 1
7	Dike 2 (Fat Clay)	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1
8	Dike 3	126	Cohesion: 50.0 Friction angle: 30	Piezometric Line no. 1
9	Bottom Ash (Stacked)	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
10	Gypsum	105	Cohesion: 0.0 Friction angle: 38	Piezometric Line no. 1

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Bedrock	150	Very Strong	Not Applicable
2	Alluvial Granular	130	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
3	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
4	Dike 1 Lean Clay	124	Cohesion: 100.0 Friction angle: 25	Piezometric Line no. 1
5	Fly Ash (Sluiced)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 22.00	Piezometric Line no. 1
6	Dike 2 - Lean Clay	128	Cohesion: 100.0 Friction angle: 28	Piezometric Line no. 1
7	Dike 2 (Fat Clay)	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1
8	Dike 3	126	Cohesion: 50.0 Friction angle: 30	Piezometric Line no. 1
9	Bottom Ash (Stacked)	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
10	Gypsum	105	Cohesion: 0.0 Friction angle: 38	Piezometric Line no. 1

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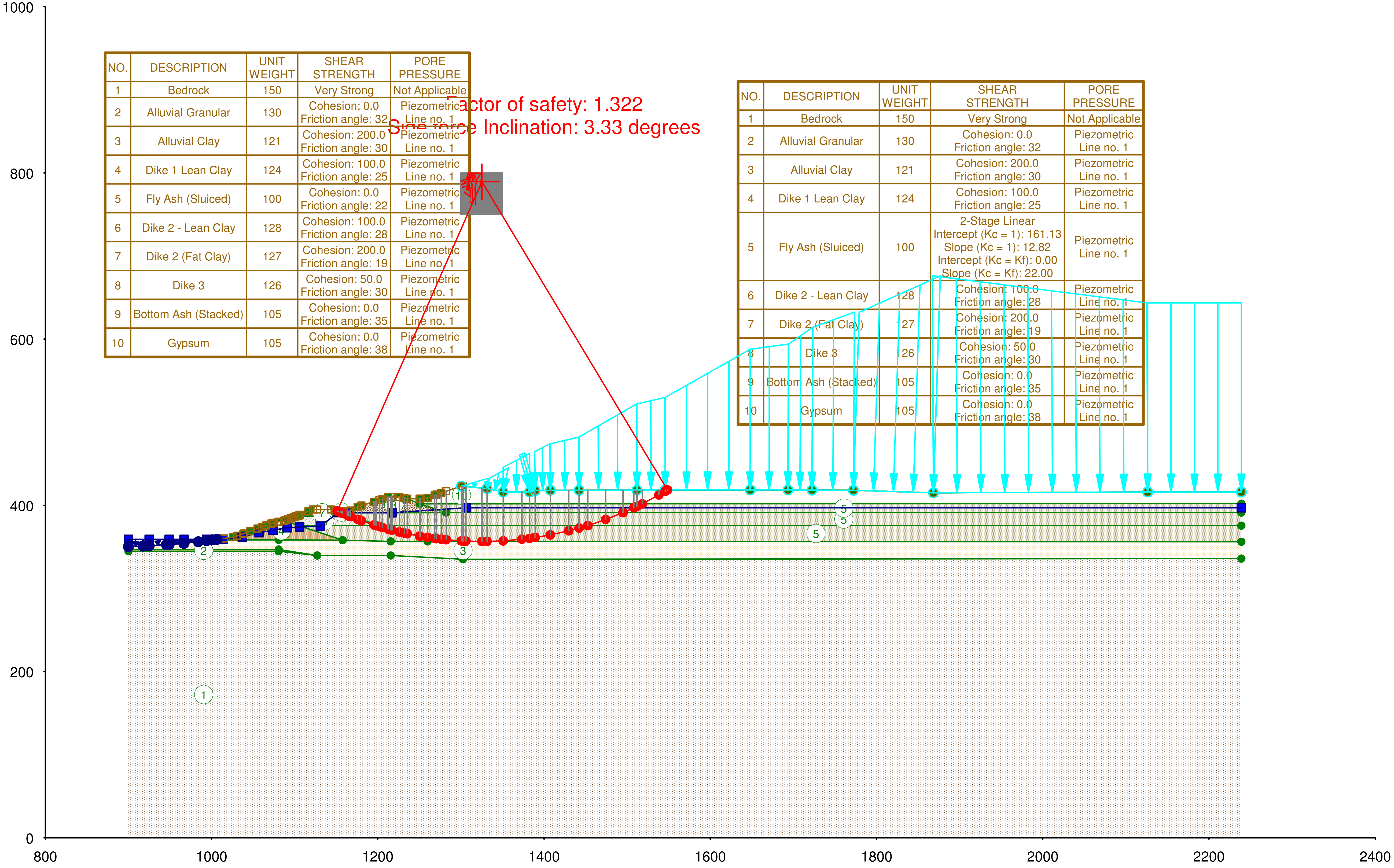
Filename: SecJ-FSu.UT4
Time: 16:28:19

TVA Cumberland Fossil Plant Section J FSul - Drained/Undrained Analysis



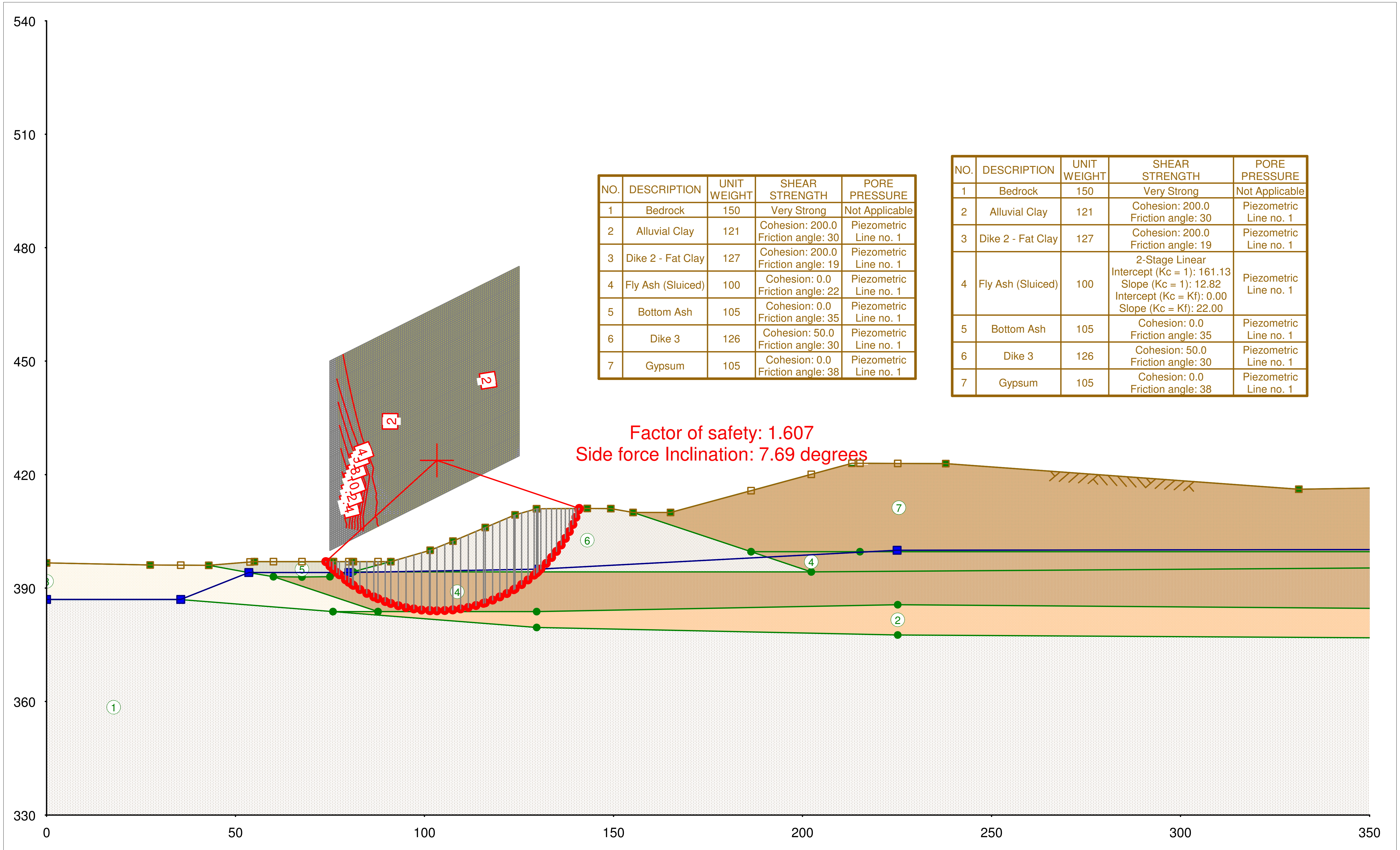
NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Bedrock	150	Very Strong	Not Applicable
2	Alluvial Granular	130	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
3	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
4	Dike 1 Lean Clay	124	Cohesion: 100.0 Friction angle: 25	Piezometric Line no. 1
5	Fly Ash (Sluiced)	100	Cohesion: 0.0 Friction angle: 22	Piezometric Line no. 1
6	Dike 2 - Lean Clay	128	Cohesion: 100.0 Friction angle: 28	Piezometric Line no. 1
7	Dike 2 (Fat Clay)	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1
8	Dike 3	126	Cohesion: 50.0 Friction angle: 30	Piezometric Line no. 1
9	Bottom Ash (Stacked)	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
10	Gypsum	105	Cohesion: 0.0 Friction angle: 38	Piezometric Line no. 1

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Bedrock	150	Very Strong	Not Applicable
2	Alluvial Granular	130	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
3	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
4	Dike 1 Lean Clay	124	Cohesion: 100.0 Friction angle: 25	Piezometric Line no. 1
5	Fly Ash (Sluiced)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 22.00	Piezometric Line no. 1
6	Dike 2 - Lean Clay	128	Cohesion: 100.0 Friction angle: 28	Piezometric Line no. 1
7	Dike 2 (Fat Clay)	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1
8	Dike 3	126	Cohesion: 50.0 Friction angle: 30	Piezometric Line no. 1
9	Bottom Ash (Stacked)	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
10	Gypsum	105	Cohesion: 0.0 Friction angle: 38	Piezometric Line no. 1

Date: Thu Mar 11 2010

Filename: SecJ-FSul.UT4

Time: 16:29:33



NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Bedrock	150	Very Strong	Not Applicable
2	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
3	Dike 2 - Fat Clay	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1
4	Fly Ash (Sluiced)	100	Cohesion: 0.0 Friction angle: 22	Piezometric Line no. 1
5	Bottom Ash	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
6	Dike 3	126	Cohesion: 50.0 Friction angle: 30	Piezometric Line no. 1
7	Gypsum	105	Cohesion: 0.0 Friction angle: 38	Piezometric Line no. 1

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Bedrock	150	Very Strong	Not Applicable
2	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
3	Dike 2 - Fat Clay	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1
4	Fly Ash (Sluiced)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 22.00	Piezometric Line no. 1
5	Bottom Ash	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
6	Dike 3	126	Cohesion: 50.0 Friction angle: 30	Piezometric Line no. 1
7	Gypsum	105	Cohesion: 0.0 Friction angle: 38	Piezometric Line no. 1

Factor of safety: 1.607
Side force Inclination: 7.69 degrees

Date: Thu Mar 11 2010
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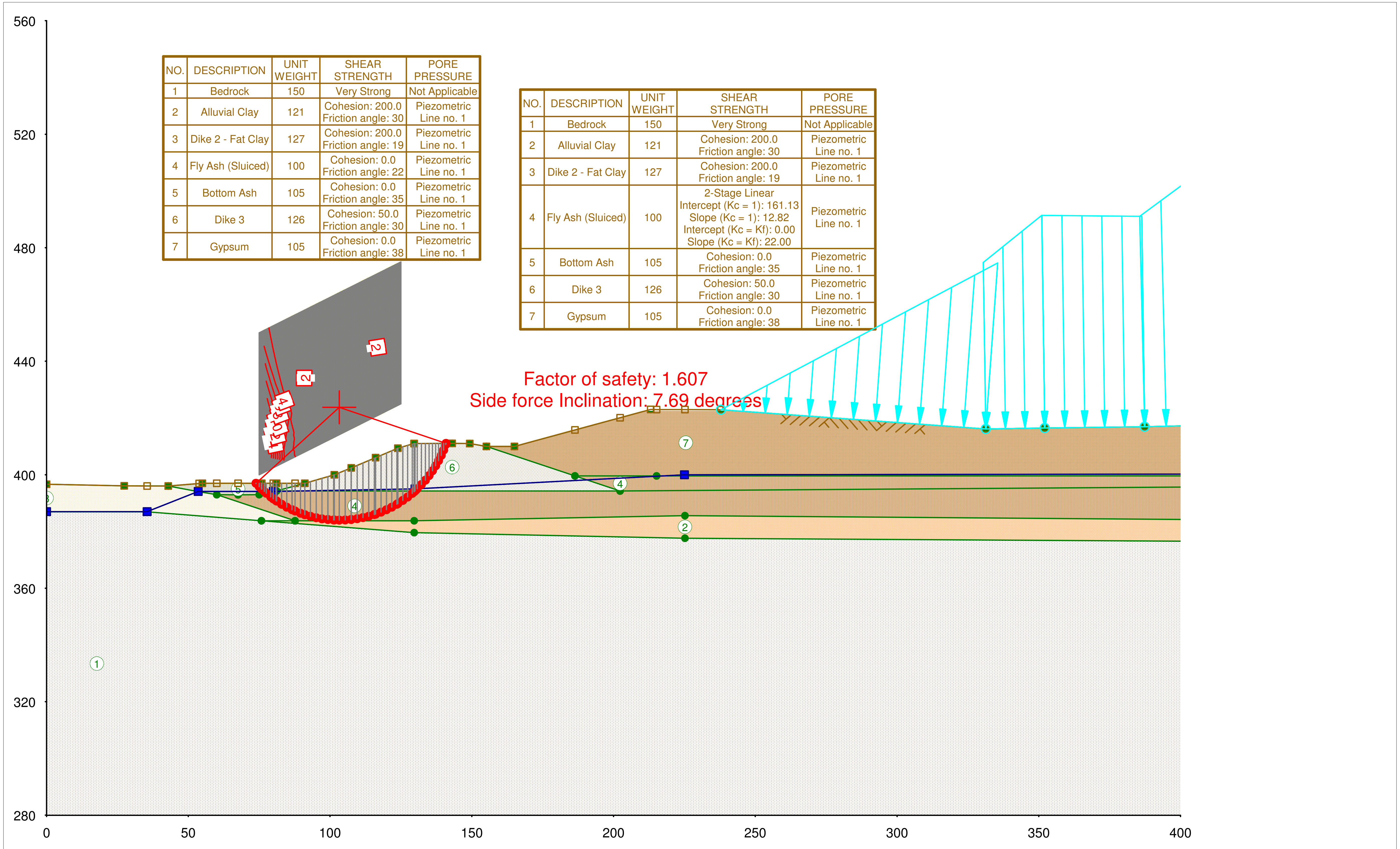


NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Bedrock	150	Very Strong	Not Applicable
2	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
3	Dike 2 - Fat Clay	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1
4	Fly Ash (Sluiced)	100	Cohesion: 0.0 Friction angle: 22	Piezometric Line no. 1
5	Bottom Ash	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
6	Dike 3	126	Cohesion: 50.0 Friction angle: 30	Piezometric Line no. 1
7	Gypsum	105	Cohesion: 0.0 Friction angle: 38	Piezometric Line no. 1

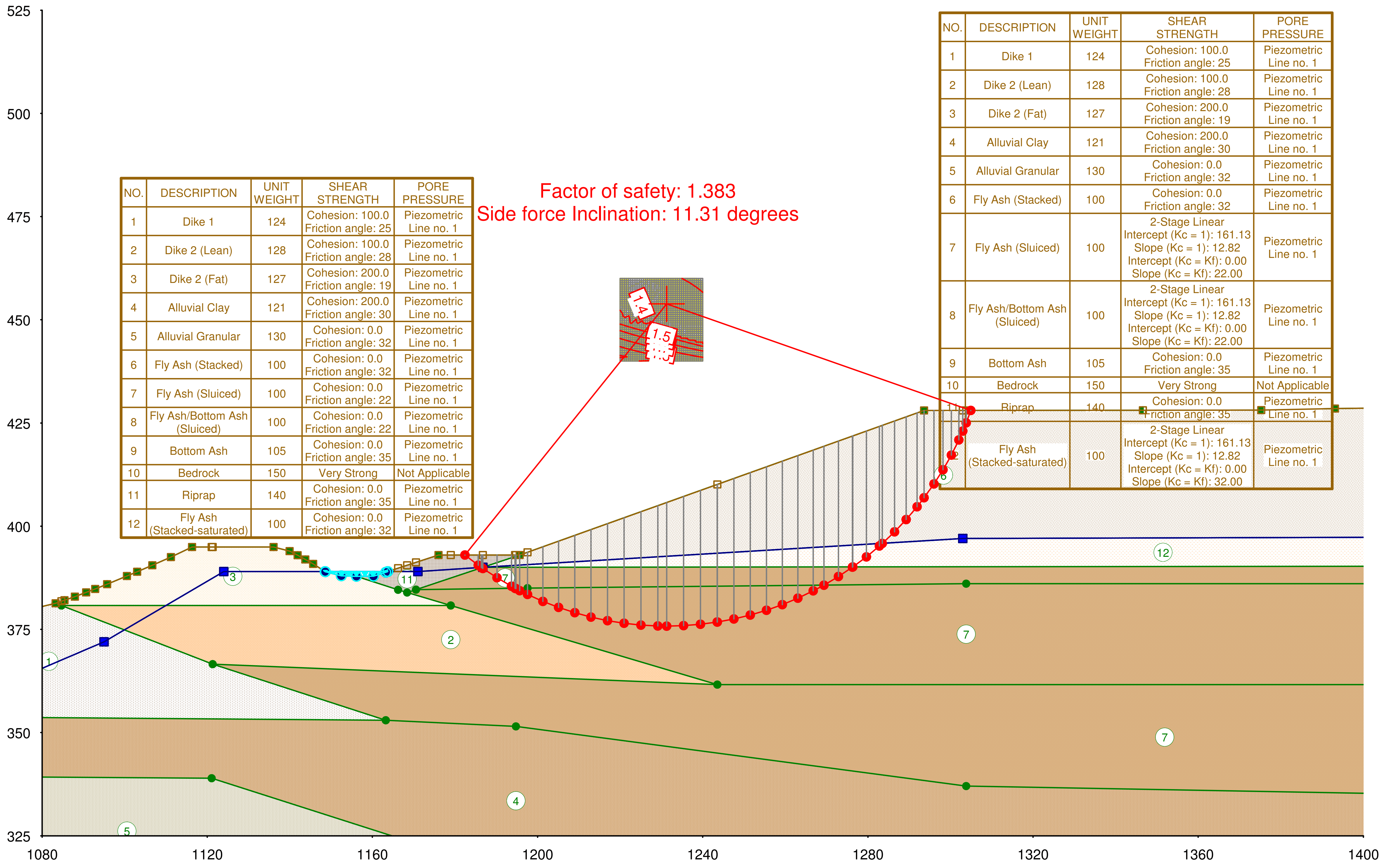
NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Bedrock	150	Very Strong	Not Applicable
2	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
3	Dike 2 - Fat Clay	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1
4	Fly Ash (Sluiced)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 22.00	Piezometric Line no. 1
5	Bottom Ash	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
6	Dike 3	126	Cohesion: 50.0 Friction angle: 30	Piezometric Line no. 1
7	Gypsum	105	Cohesion: 0.0 Friction angle: 38	Piezometric Line no. 1

Date: Thu Mar 11 2010

Filename: SecM-FSul.UT4

Time: 16:32:12

TVA Cumberland Fossil Plant Section F FSu - Drained/Undrained Analysis



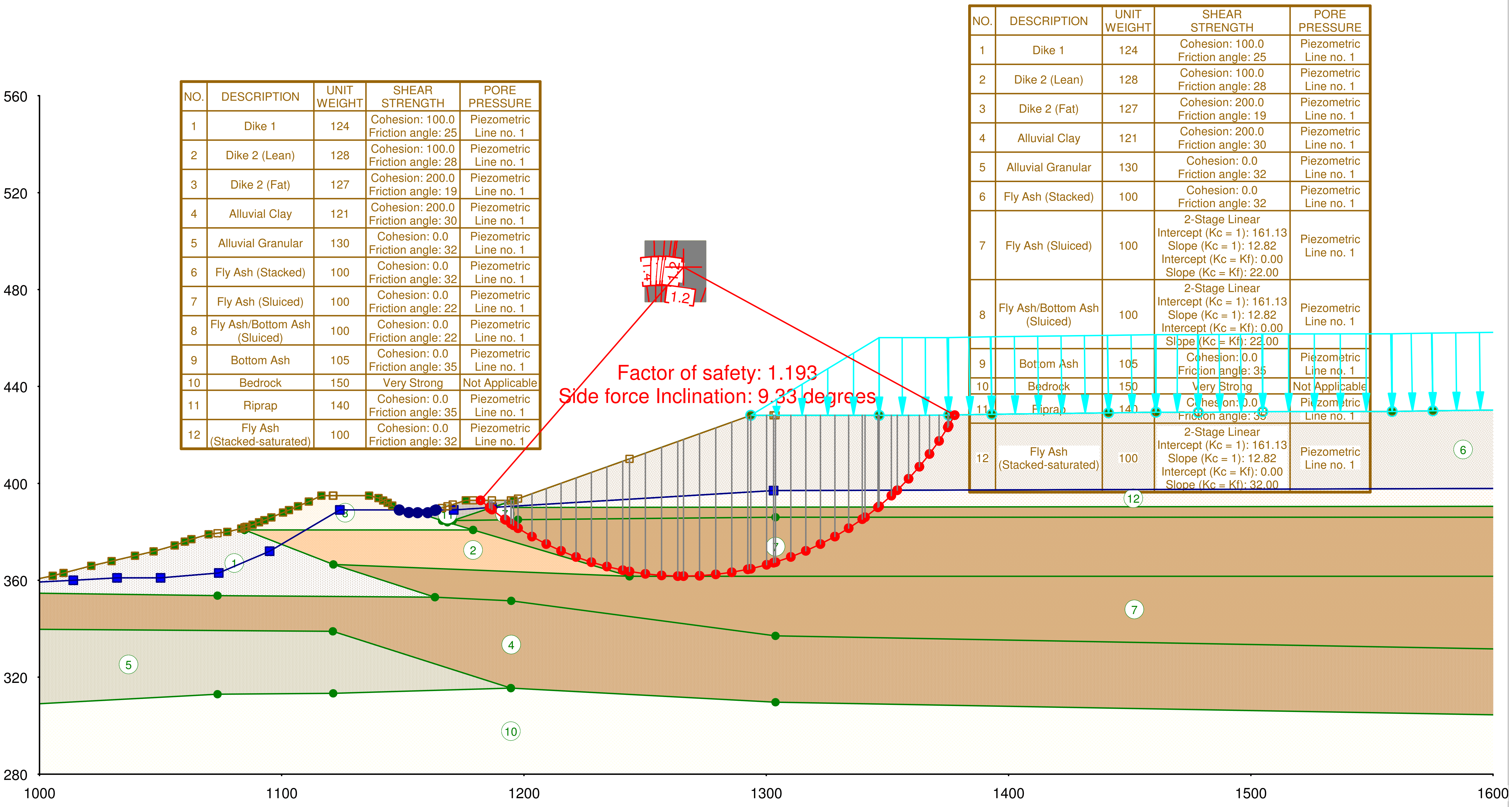
Factor of safety: 1.383
Side force Inclination: 11.31 degrees

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Dike 1	124	Cohesion: 100.0 Friction angle: 25	Piezometric Line no. 1
2	Dike 2 (Lean)	128	Cohesion: 100.0 Friction angle: 28	Piezometric Line no. 1
3	Dike 2 (Fat)	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1
4	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
5	Alluvial Granular	130	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
6	Fly Ash (Stacked)	100	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
7	Fly Ash (Sluiced)	100	Cohesion: 0.0 Friction angle: 22	Piezometric Line no. 1
8	Fly Ash/Bottom Ash (Sluiced)	100	Cohesion: 0.0 Friction angle: 22	Piezometric Line no. 1
9	Bottom Ash	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
10	Bedrock	150	Very Strong	Not Applicable
11	Riprap	140	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
12	Fly Ash (Stacked-saturated)	100	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Dike 1	124	Cohesion: 100.0 Friction angle: 25	Piezometric Line no. 1
2	Dike 2 (Lean)	128	Cohesion: 100.0 Friction angle: 28	Piezometric Line no. 1
3	Dike 2 (Fat)	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1
4	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
5	Alluvial Granular	130	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
6	Fly Ash (Stacked)	100	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
7	Fly Ash (Sluiced)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 22.00	Piezometric Line no. 1
8	Fly Ash/Bottom Ash (Sluiced)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 22.00	Piezometric Line no. 1
9	Bottom Ash	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
10	Bedrock	150	Very Strong	Not Applicable
11	Riprap	140	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
12	Fly Ash (Stacked-saturated)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 32.00	Piezometric Line no. 1

Date: Thu Mar 11 2010
Filename: SectF-FSu.UT4
Time: 16:24:26

TVA Cumberland Fossil Plant Section F FSul - Drained/Undrained Analysis



NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Dike 1	124	Cohesion: 100.0 Friction angle: 25	Piezometric Line no. 1
2	Dike 2 (Lean)	128	Cohesion: 100.0 Friction angle: 28	Piezometric Line no. 1
3	Dike 2 (Fat)	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1
4	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
5	Alluvial Granular	130	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
6	Fly Ash (Stacked)	100	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
7	Fly Ash (Sluiced)	100	Cohesion: 0.0 Friction angle: 22	Piezometric Line no. 1
8	Fly Ash/Bottom Ash (Sluiced)	100	Cohesion: 0.0 Friction angle: 22	Piezometric Line no. 1
9	Bottom Ash	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
10	Bedrock	150	Very Strong	Not Applicable
11	Riprap	140	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
12	Fly Ash (Stacked-saturated)	100	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Dike 1	124	Cohesion: 100.0 Friction angle: 25	Piezometric Line no. 1
2	Dike 2 (Lean)	128	Cohesion: 100.0 Friction angle: 28	Piezometric Line no. 1
3	Dike 2 (Fat)	127	Cohesion: 200.0 Friction angle: 19	Piezometric Line no. 1
4	Alluvial Clay	121	Cohesion: 200.0 Friction angle: 30	Piezometric Line no. 1
5	Alluvial Granular	130	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
6	Fly Ash (Stacked)	100	Cohesion: 0.0 Friction angle: 32	Piezometric Line no. 1
7	Fly Ash (Sluiced)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 22.00	Piezometric Line no. 1
8	Fly Ash/Bottom Ash (Sluiced)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 22.00	Piezometric Line no. 1
9	Bottom Ash	105	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
10	Bedrock	150	Very Strong	Not Applicable
11	Riprap	140	Cohesion: 0.0 Friction angle: 35	Piezometric Line no. 1
12	Fly Ash (Stacked-saturated)	100	2-Stage Linear Intercept (Kc = 1): 161.13 Slope (Kc = 1): 12.82 Intercept (Kc = Kf): 0.00 Slope (Kc = Kf): 32.00	Piezometric Line no. 1

Date: Thu Mar 11 2010 Filename: SectF-FSul.UT4 Time: 16:26:38

APPENDIX A

Document 8

Seismic Slope Stability, Stantec, September 2011

Stantec
Stantec Consulting Services Inc.
10509 Timberwood Circle Suite 100
Louisville, KY 40223-5301
Tel: (502) 212-5000
Fax: (502) 212-5055

September 22, 2011 ltr_001_175551015

Mr. Michael S. Turnbow
Tennessee Valley Authority
1101 Market Street, LP 2G-C
Chattanooga, Tennessee 37402-2801

Re: Results of Seismic Slope Stability Analysis
Active CCP Disposal Facilities
Cumberland Fossil Plant

Dear Mr. Turnbow:

As requested, Stantec Consulting Services Inc. (Stantec) has conducted seismic slope stability analyses to support the U.S. Environmental Protection Agency's assessment of TVA's CCP disposal facilities. The results for Cumberland Fossil Plant (CUF) are presented in this letter.

1. Introduction

The U.S. Environmental Protection Agency is undertaking a nationwide effort to assess coal combustion product (CCP) disposal facilities. These assessments are now underway for facilities at TVA's fossil plants. To support TVA, Stantec has conducted seismic stability analyses for CUF's active disposal facilities, which include the Dry Fly Ash Stack, Gypsum Stack Complex, and the Ash Pond.

The seismic slope stability analyses results presented in this letter employ a pseudostatic approach and are representative of current conditions. For seismic assessment in upcoming closure design of these facilities, TVA will undertake a comprehensive risk/consequences-based approach, with design and mitigation decisions being based on the likelihood and consequences of failure. This approach is described in the document presented in Enclosure A. For CUF, closure of the Dry Fly Ash Stack, Gypsum Stack Complex, and Ash Pond are currently planned for 2021.

2. Seismic Stability Analysis Approach

Seismic slope stability has been performed for current conditions using pseudostatic stability methods, where the added inertial load from an earthquake is represented by a simple horizontal pseudostatic coefficient which provides an approximate representation of the dynamic loads imposed by an earthquake. Specifics related to the analyses/approach are as follows:

- Subsurface data was obtained from the following Stantec geotechnical reports:
    - Report of Geotechnical Exploration and Slope Stability Evaluation; Ash Pond; Cumberland Fossil Plant; Stewart County, Tennessee; March 29, 2010.
    - Report of Geotechnical Exploration; Dry Fly Ash Stack and Gypsum Disposal Complex; Cumberland Fossil Plant; Stewart County, Tennessee; June 11, 2010.
- SLOPE/W software (from GEO-SLOPE International, Inc.) was used to perform the calculations.
- One existing SLOPE/W cross-section model per disposal facility was selected for analysis. The selected sections are representative of the facility's lowest current static (long-term) factor of safety, with consideration given to proper representation of a release/breach. The selected SLOPE/W models were updated to reflect any significant mitigations or operational improvements that have occurred since completion of Stantec's geotechnical studies.
- Undrained shear strength parameters were used.
- Ground motion level corresponding to a return period of 500 years (or approximate exceedance probability of 10% in 50 years) was used for selection of horizontal seismic coefficients. This return period is consistent with seismic stability analysis guidance provided by Tennessee's dam safety regulations Chapter 1200-5-7, "Rules and Regulations Applied to the Safe Dams Act of 1973". The peak ground acceleration (or seismic coefficient) for a 500 year return period was selected from Table 16 of TVA's March 28, 2011 region-specific seismic hazard study performed by AMEC Geomatrix, Inc.
- A target factor of safety (FS) of 1.0 was considered for comparing results.

3. Results

The results of the pseudostatic stability analyses are presented below. Also, Enclosure B presents a summary spreadsheet, SLOPE/W cross-sections, and plan views showing cross-section locations.

Ash Pond:

The results indicate a factor of safety of 1.2 for current conditions, which exceeds the target of 1.0.

Gypsum Stack Complex and Dry Fly Ash Stack:

The minimum factors of safety for current conditions for both CUF stack facilities are 0.8 for ground motion corresponding to a 500 year return period, with resulting failure surfaces that are confined to the interior and that do not constitute a failure of the perimeter dike system. Seismic coefficients and return periods resulting in a factor of safety of 1.0 were then back-calculated for these interior failures for each stack. These resulting return periods for FS = 1.0 are 170 years for the Dry Fly Ash Stack and 225 years for the Gypsum Stack Complex, which corresponds to exceedance probabilities of approximately 25% and 20% in 50 years, respectively (or approximately 0.6% and 0.4% annually). For deeper seated failure surfaces that would result in a failure of the exterior dike systems, resulting factors of safety were found to be 1.0 for the Gypsum Stack and the Fly Ash Stack, which meets the target value.

Although the minimum FS's for the stacks under the conditions analyzed are less than the target of 1.0, it is judged that the risk of slope stability failure under seismic loading conditions is acceptable, considering 1) that the resulting minimum FS failure surfaces are upstream of the perimeter dike systems, 2) deeper seated failure surfaces that would result in a failure of the perimeter dikes meet the target of 1.0, and 3) TVA plans to close the facilities in 2021 and will further consider seismic risks during closure design as previously described.

Stantec appreciates the opportunity to provide these services. If you have questions, or if we can provide additional information, please let us know.

Sincerely,

STANTEC CONSULTING SERVICES INC.

Randy L. Roberts

Randy L. Roberts, PE
Principal

Enclosures

/cdm

Enclosure A

White Paper - Seismic Risk Assessment Closed CCP Storage Facilities

Seismic Risk Assessment
Closed CCP Storage Facilities
Tennessee Valley Authority Fossil Plants

Prepared by:

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Thomas L. Cooling, P.E.
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Independent Consultant

Seismic Risk Assessment
Closed CCP Storage Facilities
Tennessee Valley Authority Fossil Plants

This document outlines proposed engineering analyses to estimate seismic failure risks at wet storage facilities for coal combustion products, following closure, at various TVA fossil power plants. The specific details outlined in this document are subject to future discussion and modification by the project team.

OVERVIEW

Tennessee Valley Authority (TVA) operates storage facilities for coal combustion products (CCPs) at eleven fossil power generating stations. As TVA transitions to dry systems for handling these materials, 18 to 25 wet storage facilities (CCP ponds, impoundments, dredge cells, etc.) will be closed (drained and capped). The CCP storage facilities are currently operated in accordance with state and federal regulations, but previously issued permits have not required evaluations for seismic performance. Moreover, the existing permits do not require seismic qualification for the storage facilities in their closed configurations.

TVA recognizes there is a potential for strong earthquakes to occur within the region, and there is a tangible risk for seismic failure at each closed CCP facility. These risks, including both the likelihood of failure and the consequences, must be understood to effectively manage TVA's portfolio of byproduct storage sites. This white paper summarizes the methodology that will be used to estimate these risks at the CCP storage facilities following closure.

Seismicity in the TVA service area is attributed to the New Madrid fault and smaller, less concentrated crustal faults. These two earthquake scenarios generate significantly different seismic hazards at each locality and will be considered independently within the risk assessment. At each closed byproduct facility, potential seismic failure modes will be evaluated in sequence. Instability due to soil liquefaction, slope instability due to inertial loading, and other potential failure mechanisms will be addressed. Seismic performance will be evaluated for differing earthquake return periods until a limiting (lowest return period) event that would cause failure is obtained. The probability of seismic failure will then correspond to the probability of this limiting earthquake event. The assessment of risk will also include estimates of potential consequences, as well as costs to mitigate the risks, that reflects the unique setting of the individual storage facilities after closure.

Following the same general methodology, seismic risks will be estimated in two phases. The near-term "Portfolio Seismic Assessment" will provide a rough estimate of seismic risks. The likely performance of each facility will be evaluated using simplified analyses, empirical methods, and the judgment of experienced engineers. The results will establish a ranking of the relative risks across the closure portfolio and also provide a preliminary picture of overall seismic risk. For the subsequent "Facility Seismic Assessments", seismic performance will be judged on the basis of site-specific data and detailed engineering analyses, which will be completed during the closure design process for individual facilities.

SEISMIC RISKS

This white paper provides an overview of the engineering methods proposed by Stantec for estimating seismic risks at TVA's closed byproduct storage sites. For each facility, four specific questions must be answered quantitatively:

(1) What is the approximate probability that a strong earthquake will occur?

Several seismic source zones could produce earthquakes large enough to impact these TVA sites. Very large magnitude earthquakes have occurred within the New Madrid seismic zone, which is located along the western boundaries of Tennessee and Kentucky. Because of their observed large magnitude and frequency of occurrence, New Madrid events contribute substantially to the seismic risks at all TVA sites. Ground motions from a New Madrid earthquake would attenuate with distance toward the east, such that local area sources also contribute significantly to site-specific seismic hazards.

Seismicity across the Tennessee Valley was previously characterized by AMEC/Geomatrix (2004), in a probabilistic study that focused on TVA dam sites. The same seismogenic model can be applied in evaluating earthquakes that would impact other TVA sites. Accordingly, probabilistic seismic hazards obtained from the 2004 AMEC/Geomatrix model will be used in the seismic risk assessment of the closed CCP storage facilities.

(2) Will a given earthquake cause failure in the closed facility?

Many of the TVA byproduct storage facilities are underlain by a substantial thickness of loose, saturated, alluvial soils (silts and sands). Some facilities will have layers of ash or other uncemented CCPs that remain saturated following closure. These materials, especially sluiced fly ash, are prone to liquefaction in a strong earthquake, as cyclic motions cause a build up of pore water pressure and a consequent loss of effective stress and shearing resistance. Extensive liquefaction in a foundation or CCP deposit under a storage facility would be expected, in most cases, to result in lateral spreading and massive slope movements (failure). Even without liquefaction, large slope deformations or failures may be triggered by lateral inertial loads during an earthquake. Liquefaction and dynamic loading of slopes are the most likely failure mechanisms, but other seismic failure modes, which may be unique to a particular closed storage facility, must also be evaluated.

(3) What are the potential consequences of a failure?

In addition to understanding the probability of failure, a risk assessment should consider the potential consequences. A failure is likely to have economic costs associated with clean-up and restoration of the site. Depending on the local site conditions, failure of a closed CCP facility may or may not cause significant impacts on the environment, waterways, transportation routes, buried or overhead utilities, or other infrastructure. Substantial economic costs would result if power generation is interrupted. Failure consequences may also include the potential loss of human life at some sites.

In this proposed seismic risk assessment, the definition of "failure" will be constrained to mean the displacement of stored materials to a distance beyond the permitted boundary of the facility. While smaller deformations in a closed storage facility could cause economic damages, the resulting consequences for TVA should be manageable. Hence, this risk assessment will focus on potential "failures" where stored materials could move past the permitted boundary.

(4) What are the approximate costs to mitigate the risks of a seismic failure?

With an understanding of the probability and consequences of failure, the potential risks can be quantified and understood, possibly leading to decisions to mitigate seismic risks in the closure of certain facilities. Mitigation measures might include ground improvement to reduce liquefaction potential (stone columns, deep soil mixing, jet grouting, or other appropriate technology), stabilization of slopes by flattening or buttressing, enhanced drainage features, or some other engineered solution. The potential cost of these risk mitigation strategies are needed to make appropriate management decisions.

PORTFOLIO AND FACILITY ASSESSMENTS

Seismic evaluations will be completed for each of the CCP storage facilities that TVA has slated for closure; a tentative list is given in Table 1. The assessment of seismic risks will be accomplished in two phases:

A. Portfolio Seismic Assessment

In this first phase, the seismic risk assessment will be carried out using general site information, simplified analyses, empirical methods, and the judgment of experienced engineers. A team of four to five engineers will complete this evaluation for the entire portfolio, with assistance from the engineering teams currently working on each facility. After the probabilistic seismic hazards are defined, this phase of the work can be completed in a relatively short timeframe.

Given the level of effort and the simplified engineering analyses to be employed, the seismic risk estimates from the Phase A assessment will be approximate. Rather than attempting to compute precise risk numbers, Phase A will focus on capturing the relative risks between the different closed facilities. The key to successfully meeting this objective will be the consistent application of the assessment process across the portfolio.

This effort will result in a ranked list of sites that can be used to illustrate where seismic risks are greatest within the portfolio. The results will also provide some insight for understanding and communicating the magnitude of potential risks associated with seismic loading of the closed CCP facilities.

As a secondary objective, the Phase A assessment team will also consider the potential for failure of the active storage facilities, due to an earthquake occurring prior to closure. The seismic risks associated with the operating facility will not be estimated, but the Phase A assessment process provides an opportunity to identify potential failure mechanisms that should be addressed in the short term. This information may suggest the need to re-prioritize the closure schedule. Prior to closure, many of the wet CCP storage facilities retain large pools of water and are thus more susceptible to uncontrolled releases in an earthquake. TVA has already made the decision to close these wet storage facilities to manage these risks, so the effort in Phase A will focus on identifying sites that may have unusually high seismic risks and deserve more study or higher priority in the closure program.

B. Facility Seismic Assessment

In this subsequent phase of work, more detailed engineering analyses will be carried out using site-specific geometry, subsurface conditions, material parameters, and results from static slope stability analyses. Simplified, state-of-the-practice methods of engineering analysis will be used; more complex analytical methods will be generally impractical for this risk assessment.

This phase of the work will be accomplished for individual facilities as part of the closure design, after the completion of other engineering analyses. The risks will be quantified by the design team, with assistance from the portfolio seismic assessment team. Significant, detailed effort will be required to assess each closed facility.

Compared to Phase A, the risk estimates obtained at this stage will be more reliable and better represent the actual risks for seismic failure. While it will be impossible to know how accurately the risks have been characterized at the completion of Phase B, the objective is to obtain results that are within perhaps ± 30% of the “actual” risk numbers. TVA expects to use the Phase B results to decide if the risks are acceptable, or if the closure design should be modified to mitigate risks for a seismic failure.

The engineering methodology (described below) to be followed in the Phase A and B evaluations will not characterize all of the uncertainties with respect to seismic performance. The uncertainties in the soil parameters and in the liquefaction, stability, and deformation analyses will not be quantified and carried through the risk assessment. Consequently, the estimated risk numbers will be approximate, but the results will be sufficiently accurate to support TVA decisions regarding prioritization for closure or the need for seismic mitigation. At most sites, the risks are expected to be high enough or low enough that further refinement in the risk numbers would not change these decisions. More detailed analysis beyond Phase B would be unjustified in these cases.

This assessment plan does not preclude the possibility that more detailed risk evaluations could be undertaken in subsequent phases of work. The Phase B results might reveal a subset of closed facilities with marginal risks, where a more rigorous and complete calculation of the risks would be needed to support a management decision. Hence, at the conclusion of the Phase B assessments, a “Phase C” evaluation may be needed for select sites and facilities, wherein uncertainties in the soil parameters and performance analyses would be quantified and carried through the risk assessment.

RESULTS AND APPLICATION

The results from the Phase A Portfolio Assessment will be presented in a table, like Table 1. For each facility evaluated, the estimated annual probability of failure due to a seismic event, the expected consequences (economic costs and potential loss of life), and the mitigation costs (design features to reduce risks) will be tabulated. The same parameters, but more accurate numbers, will be reported from the more in-depth Phase B assessments. A qualitative description of the data quality (based on the number of borings, test data on key soil properties, etc.) will also be included, to indicate how well the site conditions were characterized at the time of the Phase A or B assessment.

In both Phase A and B, the evaluation teams will prepare a discussion of significant issues driving the seismic risks at each site. This summary will include knowledge gaps, likely failure mechanisms, unique consequences, suggested approaches for risk mitigation, and other key information. The Phase A evaluation of a facility may point out the need for additional data to support later seismic analyses in Phase B; needed field or laboratory testing could then be accomplished and documented as part of the facility closure design effort.

In the short term, TVA will utilize the Phase A results to better plan budgets and schedules for managing the closure process over the next several years. The Phase A assessment will also be used as an opportunity to identify operating facilities with especially high seismic risks. While these risks will not be quantified for conditions prior to closure, the consideration of potential seismic failure modes may prompt additional study and reconsideration of priorities. Where justified, the priorities for closure may be changed to more quickly address sites with higher seismic risks.

More accurate risk estimates will be obtained from the Phase B assessments, which will be completed as part of the closure design process. Those results will be used, within TVA's existing decision making framework, to judge if seismic mitigation is needed. For context, the criteria in Tables 2 and 3 represent the risk-based framework TVA uses to guide enterprise-level decisions. This framework relies upon broad, qualitative scoring of consequences and risks for the organization. For managing the seismic risks at the closed CCP facilities, complete probabilistic calculations of risk are not needed; approximate estimates of seismic risk will be sufficient to support TVA decisions.

The risks computed in Phase A and B will not be compared to a prescribed threshold or design risk level. Criteria for tolerable seismic risk in these closed CCP storage facilities has not been defined in the existing permits, in TVA policy, or in TVA design guidance.

METHODOLOGY

The same general methodology, outlined in ten steps below and in Figures 1 through 4, will be used to evaluate seismic risk in both the Phase A Portfolio Assessments and the Phase B Facility Assessments. While advanced engineering analyses may be required to demonstrate acceptable seismic performance in a design situation, simplified analyses will be used here, consistent with the goal of estimating the probability of failure.

In Step 1, seismic hazard parameters will be defined for each site; the results will be used as inputs for both the Phase A and Phase B assessments. Then, the evaluation of a particular facility will begin with a review of existing site information (Step 2), followed by engineering analyses for seismic performance. As described in Steps 3 through 7 below, the engineering analyses in Phase B will be more detailed than the simplified estimates in Phase A. The analyses will commence with an initial selection of an earthquake return period and evaluation for seismic performance. Steps 3 through 7 will be repeated until the limiting (lowest) earthquake return period expected to cause failure is obtained. Flowcharts summarizing Steps 1 through 7 in the Phase A and B seismic performance assessments are given in Figures 3 and 4, respectively. The earthquake event with the lowest return period that causes failure will then be used to compute the probability of failure in Step 8. The potential consequences and mitigation costs will be estimated in Steps 9 and 10.

Step 1 – Define Seismic Input Parameters

Seismic hazards at TVA dam sites were quantified in a 2004 study by AMEC/Geomatrix. The New Madrid fault zone and several area source zones contribute to the seismicity of the region, as represented schematically in Figure 1. The New Madrid seismic zone is characterized by a large linear, combined reverse/strike-slip fault. Earthquakes in the area source zones are more diffuse (less concentrated in clusters) and tend to occur in zones of weakness of large crustal extent rather than along narrow, well-defined faults. Earthquakes occurring within the New Madrid Seismic Zone and in area sources outside of it will be considered in developing seismic input parameters for each CCP facility. However, only seismic source zones that contribute significantly to the ground motion hazard at a particular site will be used to develop seismic input parameters.

The national USGS seismic hazard model will not be used in these seismic risk assessments; instead, TVA will ask AMEC/Geomatrix to compute the site-specific seismic hazards for each closed CCP facility. The needed information can be obtained from the existing seismogenic model, but will need to separately consider the hazards associated with the New Madrid events and all other seismic sources (Figure 2), hereafter referred to in this white paper as the “earthquake scenarios”. The following parameters are needed for each earthquake scenario:

- Uniform hazard spectra for frequencies from 0.25 to 100 Hz (100 Hz value is equivalent to peak ground acceleration, PGA) at the top of rock for a range of return periods from 100 to 2,500 years.
- De-aggregation for relevant ground motion frequencies (one or more of the following: 0.5, 1.0, 2.5, 5.0, and 100 Hz) at each return period. The de-aggregation results will be used to select appropriate, representative earthquake parameters (magnitude and distance from the site), from which inputs needed for liquefaction analyses can be developed.

In the Phase A effort, the project team (including seismologists designated by TVA) will meet to consider the earthquake hazard data produced by the AMEC/Geomatrix model for each site. The team will reach consensus on the appropriate parameters (return period, earthquake magnitude, and peak ground acceleration) to be used in evaluating each facility, before proceeding with work on subsequent steps of the analysis. The seismic parameters to be tabulated (Table 4) will then be used in both the Phase A and Phase B assessments.

Ground motion time histories will be needed for the detailed Phase B calculations, and TVA will need to ask AMEC/Geomatrix to provide:

- Representative acceleration time histories (two orthogonal components), representing ground motions at the top of the rock profile for the specified earthquake return periods.

Given the results of the Phase A assessment, the Phase B analyses will focus on a narrower range of possible earthquakes. Hence, acceleration time histories will not be needed for every seismic event listed in Table 4.

Step 2 – Review Site and Facility Information

To meet the requirements for closure of TVA ash storage facilities, the closed condition may involve placement of compacted ash behind a strengthened dike, drainage of pond water to the levels of the surrounding groundwater table, and capping of the area with native soils. The collection of available site information for each facility will be reviewed from a seismic performance perspective. For the Phase B assessment, this information will be augmented with new data that becomes available during the closure design process.

The project information needed for each storage facility includes:

- Planned geometry of the closed storage facility, as needed to meet current design criteria and regulatory requirements.
- Geologic mapping and related information about the site geology.
- Historical records and other information related to site development.
- Boring logs, SPT data, CPT data, shear wave velocities, etc. from field explorations.
- Laboratory data from testing of site materials, including classification, Atterberg limits, moisture content, particle size, specific gravity, unit weight, compaction tests, and other relevant test data.
- Laboratory data on measured strength properties, for both drained and undrained conditions.
- Previously completed slope stability analyses, where available, will be modified for calculations in the risk assessments.

Step 3 - Evaluate Potential for Soil Liquefaction

The potential for soil liquefaction may be the greatest contributor to failure risk at many of the TVA storage sites. Liquefaction will thus be considered first in the assessment of seismic performance at each closed facility (Figures 3 and 4).

The Phase A assessment will utilize empirical charts and back-of-the-envelope calculations to judge if liquefaction would be likely for a given earthquake scenario. For example, Ambraseys (1988) compiled magnitude, epicentral distance, and whether or not liquefaction was observed in past earthquakes, and then suggested a threshold boundary (in terms of magnitude and epicentral distance) where liquefaction might occur in natural soil deposits. Selected, parametric calculations with the simplified procedure outlined by Youd et al (2001) will also be useful in judging what earthquakes would cause liquefaction in the Phase A Portfolio Assessments. These empirical methods may be unconservative for evaluating saturated CCPs, which are often more prone to liquefaction than a sandy soil, but the results will still provide useful guidance in the Phase A assessment.

For the Phase B liquefaction evaluations, detailed engineering analyses will be undertaken to obtain estimates of cyclic loading, soil resistance, and factor of safety as described below. Potentially liquefiable soils include saturated alluvial soils, loose granular fills, and sluiced ash. The detailed analyses will focus on critical cross sections of the closed facilities; liquefaction safety factors will not be computed for all boring locations at a site.

(a) Soil Loading from Earthquake Motions

The magnitude of the cyclic shear stresses induced by an earthquake are represented by the cyclic stress ratio (CSR). The simplified method proposed by Seed and Idriss (1971) will be used to estimate CSR in the Phase A parametric analyses (ground response analyses will not be completed in Phase A).

In Phase B, the CSR at specific locations (borings and depths where in situ penetration resistance are measured) will be computed using one-dimensional, equivalent-linear elastic methods as implemented in the ProSHAKE software. Using an acceleration time history at the top of rock (obtained from the seismic hazards study in Step 1), the computer program will model the upward propagation of the ground motions through a one-dimensional soil profile. For cases where the one-dimensional assumption is inadequate, the calculations can be accomplished using QUAKE, a two-dimensional finite element program that implements the same dynamic modulus reduction curves and damping relationships as used in ProSHAKE.

The cyclic stresses imparted to the soil will be estimated from the earthquake parameters described in Step 1, representing earthquakes on the New Madrid fault and local crustal events.

(b) Soil Resistance from Correlations with Penetration Resistance

The resistance to soil liquefaction, expressed in terms of the cyclic resistance ratio (CRR), will be assessed using the NCEER empirical methodology (Youd et al. 2001). Updates to the procedure from recently published research will be used where warranted. The analyses will be based on the blowcount value (N) measured in the Standard Penetration Test (SPT) or the tip resistance (q_c) measured in the Cone Penetration Test (CPT). In Phase A, typical or representative values will be used in parametric hand calculations; detailed data from site-specific explorations will be analyzed in Phase B.

The NCEER procedure involves a large number of correction factors. Based on the site-specific conditions and soil characteristics, engineering judgment will be used to select appropriate correction factors consistent with the consensus recommendations of the NCEER panel (Youd et al. 2001). To avoid inappropriately inflating the CRR, the NCEER fines content adjustment will not be applied where zero blowcounts (“weight of hammer” or “weight of rod”) are recorded. The magnitude scaling factor (MSF) is used in the empirical liquefaction procedure to normalize the representative earthquake magnitude to a baseline 7.5M earthquake. The earthquake magnitude (M) considered to be most representative of the liquefaction risk will be determined by applying the MSF to the de-aggregation data (from Step 1) for each selected earthquake return period.

Saturated fly ash, where it remains following closure, is likely to be more susceptible to liquefaction than indicated by these empirical methods. Values of CRR determined via the NCEER procedure are related to the observation of liquefaction in natural soils, mostly silty sands. Given the spherical particle shape and uniform, small grain size of fly ash, the NCEER procedure may give CRR values that are too high for saturated fly ash.

Lacking better methods of analysis, the lower-bound, “clean sand” base curve (Youd et al. 2001) will be assumed to apply for fly ash in the Phase A assessment. Within the liquefaction calculations, this will be accomplished for these materials by neglecting the fines content adjustment to the normalized penetration resistance. For Phase B, published and unpublished data from cyclic laboratory testing on similar materials will be sought to augment the indications of liquefaction resistance obtained from in situ penetration tests.

(c) Factor of Safety Against Liquefaction

The factor of safety against liquefaction (FS_{liq}) is defined as the ratio of the liquefaction resistance (CRR) over the earthquake load (CSR). Following TVA design guidance and the precedent set by Seed and Harder (1990), FS_{liq} is interpreted as follows:

- Soil will liquefy where $FS_{liq} \leq 1.1$.
- Expect substantial soil softening where $1.1 < FS_{liq} \leq 1.4$.
- Soil does not liquefy where $FS_{liq} > 1.4$.

Using this criteria for guidance, values of FS_{liq} computed throughout a soil deposit or cross section (at specific CPT-q_c and SPT-N locations) will be reviewed in aggregate. Occasional pockets of liquefied material in isolated locations are unlikely to induce a larger failure, and are typically considered tolerable. Instead, problems associated with soil liquefaction are indicated where continuous zones of significant lateral extent exhibit low values of FS_{liq}. Engineering judgment, including consideration for the likely performance in critical areas, will be used for the overall assessment of each facility. A determination of “extensive” or “insignificant” liquefaction will then lead to the appropriate stability analyses in the next stage of the evaluation, as indicated in Figures 3 and 4.

Step 4 – Characterize Post-Earthquake Soil Strengths

The post-earthquake shearing resistance of each soil and CCP will be estimated, with consideration for the specific characteristics of that material. The full, static shear strength will be assigned to unsaturated soils. Excess pore pressures will not develop in an unsaturated soil during seismic loading, so drained strength parameters can be used. The undrained strengths of saturated soils will be decreased to account for the softening effects of pore pressure buildup during the earthquake. Specifically:

- In saturated clays and soils with $FS_{liq} > 1.4$, 80% of the static undrained strength will be assumed.
- In saturated, low-plasticity, granular soils with $1.1 < FS_{liq} \leq 1.4$, a reduced strength will be assigned, based on the excess pore pressure ratio, r_u (Seed and Harder 1990).

Typical relationships between FS_{liq} and r_u have been published by Marcuson and Hynes (1989).

- In saturated, low-plasticity, granular soils with $FS_{liq} \leq 1.1$, a residual (steady state) strength (S_{us}) will be estimated for the liquefied soil. Values of S_{us} can be obtained from the empirical correlations published by Seed and Harder (1990), Castro (1995), Olson and Stark (2002), Seed et al. (2003), and Idriss and Boulanger (2008).

Subsequent stability and deformation analyses will be accomplished using these reduced strength parameters. No attempt will be made to model the cyclic reduction in soil shear strength during an earthquake. In the deformation analyses, the fully reduced strengths will be assumed at the start of cyclic loading, which will yield conservative estimates of slope displacements.

Step 5 – Analyze Slope Stability

The next step in the performance evaluation (Figures 3 and 4) will consider slope stability, for conditions with or without significant liquefaction. Slope stability will be evaluated using two-dimensional, limit equilibrium, slope stability methods. Reduced soil strengths (from Step 4), conservatively representing the loss of shearing resistance due to cyclic pore pressure generation during the earthquake, will be used in the stability calculations. The analyses will be accomplished using Spencer's method of analysis, as implemented in the SLOPE/W software, considering both circular and translational slip mechanisms.

Input files for static stability calculations, where previously completed for a particular facility, will be updated to represent seismic conditions. These stability analyses may be not available, or the closure geometry may be undefined, for the Phase A assessment of some sites. In those cases, simplified or approximate geometries will be developed for approximate analysis in Phase A. Engineering experience will also be useful in judging likely seismic stability. For example, a complete failure is likely if liquefaction undermines the foundation of the outslope. In the absence of liquefaction, a slope that exhibits adequate safety factors under static conditions is unlikely to fail in an earthquake. Back-of-the-envelope hand calculations can be useful in assessing stability where extensive liquefaction occurs in the saturated materials within or below CCPs retained by a stable perimeter dike. Detailed slope stability calculations, which accurately represent the planned closure geometry, will be used in the Phase B facility assessments.

(a) Slope Stability if Extensive Liquefaction

If extensive liquefaction is indicated, stability will be evaluated for the static conditions immediately following the cessation of the earthquake motions. Residual or steady state strengths will be assigned in zones of liquefied soil, with reduced strengths that account for cyclic softening and pore pressure build up assumed in non-liquefied soil. In both Phase A and B, complete failure (large, unacceptable displacements) will be assumed if the safety factor (FS_{slope}) computed in this step is less than one (Figures 3 and 4).

For slopes where the post-earthquake $FS_{slope} \geq 1$, deformations will be estimated in the Phase B assessment (Step 6 and Figure 4). Slope deformations will not be estimated in the Phase A portfolio assessment, where ground motion time histories will not be available. In Phase A, slopes exhibiting $FS_{slope} \geq 1$ with liquefaction will be assumed stable with tolerable deformations; this condition may exist, for example, where liquefied ash at the base of a closed storage facility is contained within a stable perimeter dike.

Note that pseudostatic stability analyses are not useful for evaluating a factor of safety where extensive liquefaction is expected, because appropriate pseudostatic coefficients can not be defined.

(b) Slope Stability if No Significant Liquefaction

If no significant liquefaction is expected, seismic stability will be analyzed in Phase A using approximate, pseudostatic stability methods (Figure 3). The added inertial loads from the earthquake will be represented with a simple, horizontal pseudostatic coefficient (k_h), which provides an approximate representation of the dynamic loads imposed by an earthquake. The horizontal pseudostatic coefficient will be set to one-tenth of the peak ground acceleration in rock ($k_h = 0.1 \cdot PGA_{rock}$). In Phase A, tolerable deformations (less than about 5 meters) will be assumed if the pseudostatic $FS_{slope} \geq 1$, and failure will be assumed if the pseudostatic $FS_{slope} < 1$.

This approach and criteria are based on the work of Hynes-Griffin and Franklin (1984). They performed Newmark deformation analyses, integrated over 350 ground motion time histories, used an amplification factor of three to represent peak accelerations at the base of an earth embankment, and assumed a displacement of 1 meter would be tolerable for an embankment dam. For a typical CCP facility, assuming no pool is retained following closure, “failure” would imply displacements significantly greater than 1 meter. A tolerable displacement of about 5 meters will be assumed here, for the Phase A risk assessments. From the upper bound curve plotted by Hynes-Griffin and Franklin (1984), a displacement of 5 meters would correspond to a yield acceleration of about 0.03 times the peak acceleration along the slip surface. Then, assuming an amplification factor of 3 for the ground motions at the base of the embankment, this suggests $k_h = 0.1 \cdot PGA_{rock}$ can be used conservatively in the pseudostatic analysis to judge failure, as described above.

Pseudostatic factors of safety will not be computed in the Phase B assessment. Instead, where a liquefaction failure is not predicted, potential slope displacements will be computed as described in Step 6.

Step 6 – Predict Deformations

In the Phase A Portfolio Assessment, closed facilities that are expected to remain stable (pseudostatic $FS_{slope} \geq 1$ with no liquefaction, or post-earthquake $FS_{slope} \geq 1$ with liquefaction) will be assumed to have tolerable displacements. Dynamic slope deformations are difficult to estimate without detailed analysis; the available empirical or approximate methods do not represent the conditions of interest, or the level of effort is not consistent with the goals of the first phase of risk assessments. In addition, earthquake ground motion time histories will not be available for the Phase A analyses.

In the Phase B Facility Assessments, the potential deformation of stable slopes will be evaluated as indicated in Figure 4. Conventional methods of analysis will be implemented to estimate potential slope displacements that accumulate during earthquake shaking; movements are assumed to stop when the earthquake ends, consistent with a post-earthquake safety factor greater than one. The acceleration time histories obtained from the ground response analyses in Step 3a will be used as inputs for computing deformations with one of the following simplified methods:

- Newmark's (1965) method involves double integration of accelerations greater than the yield acceleration (k_y), which will be determined from a succession of pseudostatic slope stability analyses in which k_h is varied. The value of k_h where the pseudostatic FS_{slope} = 1.0 corresponds to the yield acceleration.
- The Makdisi-Seed (1978, 1979) procedure, which better accounts for the dynamic response of embankments. This procedure was developed based on parametric numerical simulations for earthen dams. The procedure is iterative, considers the fundamental periods of the embankment response, and can be completed in steps using published charts. Results from QUAKE can also be used as input in this procedure.

The slope deformations predicted in Phase B will be conservative, because the yield acceleration will be computed based on reduced, post-earthquake soil strengths. In reality, the yield acceleration declines in successive cycles of seismic loading, as pore pressures accumulate and saturated soils become weaker. The analysis outlined in Figure 4 assumes reduced strengths and, where liquefaction is predicted, residual strengths at the start of the earthquake. Detailed numerical simulations can be used to track the progressive softening and liquefaction of soil within an embankment during an earthquake; such analyses are expensive and time consuming. Rigorous analyses of this type will not be justified except in a "Phase C" analysis, or where performance in a given seismic design event must be demonstrated. Note that the logic in Figure 4 might appear to assume a slope will be stable if there is no significant liquefaction; however, the deformation analysis will indicate unlimited deformations and certain failure if $FS_{slope} < 1$ for static, post-earthquake conditions.

Step 7 – Consider Other Potential Failure Modes

For most of the closed facilities, soil liquefaction, slope instability, and slope deformations will be the most likely seismic failure modes. However, depending on the unique configuration of each CCP facility, other potential failure modes may contribute significantly to the seismic risks. For example, the loss of critical drainage structures or retaining walls could lead to a failure condition. Other potential failure modes will be identified and evaluated quantitatively in this step.

As a secondary objective of the Phase A effort, the assessment team will consider the potential for failure of the active storage facilities, due to an earthquake occurring prior to closure. Many of the wet CCP storage facilities retain large pools of water, so this assessment will need to consider additional failure modes such as seepage and embankment cracking. The objective here will be to identify operating facilities that may have unusually high seismic risks, and might deserve more study or higher priority in the closure program.

Step 8 – Estimate Annual Probability of Seismic Failure

As indicated in the flowcharts in Figures 3 and 4, the assessments of seismic performance (in both the Phase A and Phase B efforts) will consider a range of potential earthquakes with differing return periods. The analyses will be repeated until the limiting (lowest) earthquake return period (from the candidate events defined in Step 1) that predicts failure of a particular CCP storage facility is obtained. Interpolation may be used, as appropriate, to narrow the definition of the limiting earthquake.

The return period for each earthquake scenario (Table 4) represents the annual probability of exceedance for the associated ground motion parameter. Hence, for each earthquake scenario, the event with the smallest return period that causes failure represents a limiting case, where all events having longer return periods would also cause failure. The inverse of the limiting return period thus represents the annual probability of seismic failure due to that earthquake scenario.

Step 9 – Estimate Potential Consequences of Failure

The potential consequences of a failure at each closed facility will be estimated in this step. The potential consequences will be unique to each site, but may include any of the following:

- restoration of the site and storage facility,
- clean-up to address environmental impacts,
- off-site disposal of released materials,
- damages and loss of use for transportation routes, including buried or overhead utilities,
- damages to buildings and other infrastructure,
- economic losses from the possible shutdown of power generation, and
- loss of human life (expected to be unlikely at most sites following closure).

Except for the potential loss of life, the failure consequences will be expressed in terms of present day costs. Detailed cost estimates of the potential consequences of failure will not be attempted in the Phase A assessments; instead, the potential magnitude of total consequence costs will be estimated using broad categories (< $100K, < $500K, < $1M, < $5M, < $10M, < $50M, < $100M). Cost estimates that better reflect the local site conditions will be produced by the closure design teams during the Phase B assessments.

Step 10 – Estimate Possible Mitigation Costs

The final step in the process will involve estimating the costs to mitigate seismic risks, perhaps by altering the closure design to withstand stronger earthquakes. Examples of possible mitigation measures include:

- ground improvements to reduce liquefaction potential (stone columns, deep soil mixing, jet grouting, or other appropriate technology),
- altering the geometry of outslopes (setbacks, benches, or flatter slopes) to improve

stability,

- adding buttresses or other supporting structures at the toe of slopes,
- enhanced drainage features, and
- relocation of infrastructure or people away from potential impact zones.

These mitigation approaches generally involve higher construction costs, which can be quantified in terms of present dollars. As with the consequence costs, detailed estimates of mitigation costs will not be attempted in the Phase A assessments. The potential magnitude of mitigation will be estimated in categories (< $100K, < $500K, < $1M, < $5M, < $10M, < $50M, < $100M). Mitigation cost estimates that better reflect the local conditions and facility layout will be developed by the closure design teams during the Phase B assessments.

Table 1. Expected Results from the Phase A and B Seismic Risk Assessments

TVA Facility	Prob. Failure	Econ. Costs	Loss of Life	Mitigat. Costs	Data Quality
ALF East Ash Disposal					
ALF East Stilling Pond					
BRF Dry Fly Ash Disposal					
BRF Fly Ash Pond And Stilling Basin Area 2					
BRF Bottom Ash Disposal Area 1					
BRF Gypsum Disposal Area 2a					
COF Disposal Area 5					
COF Ash Pond 4					
CUF Dry Ash Stack					
CUF Ash Pond					
CUF Gypsum Storage Area					
GAF Fly Ash Pond E					
GAF Bottom Ash Pond A					
GAF Stilling Pond B, C & D					
JSF Dry Fly Ash Stack					
JSF Bottom Ash Disposal Area 2					
JOF Ash Disposal Area 2					
KIF Dike C					
PAF Scrubber Sludge Complex					
PAF Peabody Ash Pond					
PAF Slag Areas 2a & 2b					
SHF Consolidated Waste Dry Stack					
SHF Ash Pond					
WCF Ash Pond Complex					
WCF Gypsum Stack					

Prob Failure = Annual probability of failure due to earthquakes
Econ. Costs = Economic costs resulting from a failure
Loss of Life = Potential loss of life resulting from a failure
Mitigat. Costs = Costs to mitigate seismic risks in closure design
Data Quality = Qualitative indication of how well conditions in the facility are characterized

Table 2. Risk Severity Scoring (Draft) used by TVA

as of 4/22/2009

TVA Risk Event Consequence Rating Scale (Work-In-Progress)						
Strategic Objective	Success Factor	5 Worst Case	4 Severe	3 Major	2 Moderate	1 Minor
Customer	Public Image	International media attention; nearly unanimous public criticism	National media attention; federal, state officials, and customers publicly critical	Regional / local media attention; customers voice concern	Minimal media attention; letters / emails to executive leadership voicing concern	No media attention; sparse criticism
	Rate Impact	Average total retail rate increases by 15%, relative to peers	Average total retail rate increases by 10%-15%, relative to peers	Average total retail rate increases by 5%-10%, relative to peers	Average total retail rate increases by 2%-5%, relative to peers	Average total retail rate increases by 0-2%, relative to peers
People	Safety	Fatalities	Wide spread injuries	Major injuries	Significant injuries	Minor injuries
	Employee Confidence	Widespread departures of key staff with scarce skills or knowledge	Sharp, sustained drop in CHI results; departures of key staff with scarce skills or knowledge	Sharp decline in CHI results	Modest decline in CHI results	No effect on CHI results
Financial	Cash Flow Impact	>$500M	$100M - $500M	$25M - $100M	$5M - $25M	<$5M
	Credit Worthiness	Credit rating downgrade to below investment grade	Credit Rating Downgrade	TVA put on credit watch	TVA put on negative outlook	Credit rating agencies and bondholders express concern
Assets and Operations	LNS (Load not served)*	10% of System Daily Sales (48,000 MWhrs)	1% of System Daily Sales (4,800 MWhrs)	0.1% of System Daily Sales (480 MWhrs)	0.05% of System Daily Sales (240 MWhrs)	140 MWhrs
	CPI (Connection Point Interruptions)	10% of CPs are down simultaneously	5% of CPs are down simultaneously	CPI totaling 10% of current CP count (124 for FY09)	CPI totaling 7.5% of current CP count (93 for FY09)	CPI totaling 5% of current CP count (62 for FY09)
	Duration (in Hours) of Service Interruption	3,000 cumulative hours for CPs	1,000 cumulative hours for CPs	500 cumulative hours for CPs	150 cumulative hours for CPs	50 cumulative hours for CPs
	Delivered Cost of Power	Sustained increase in delivered cost of power >1 year	Increase in delivered cost of power <1 year	Increase in delivered cost of power <1 month	Increase in delivered cost of power <1 week	Delivered cost of power not effected
	Damage to environment; type and magnitude of contamination / discharge	Major coal, nuclear plant accident or dam failure	Significant hazardous waste discharged; nuclear plant accident; dam integrity failure resulting in drawdown of pool elevation	Hazardous materials / waste discharge; clean up / remediation time takes approximately two weeks	Localized environmental damage, no impact to wildlife, clean up / remediation time less than two weeks	Minimal environmental damage, no hazardous discharge; clean up time takes a few days

Table 3. Risk Likelihood Scoring used by TVA

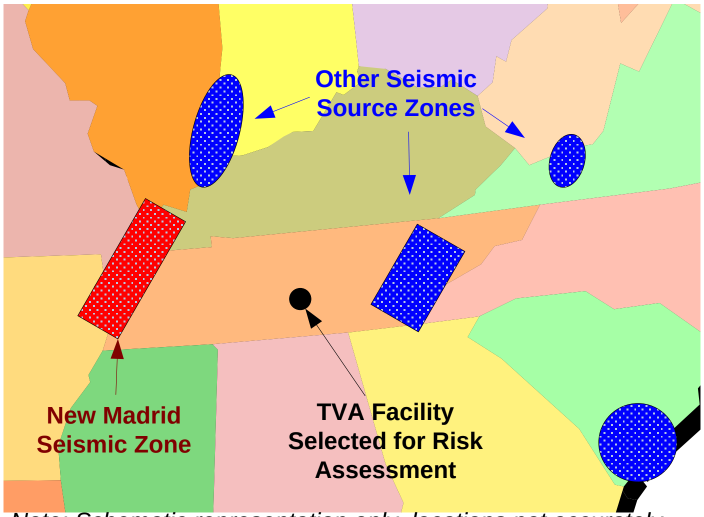
TVA Risk Event Probability Rating Scale		
Score	Rating	Description
5	Virtually Certain	95% probability that the event will occur in the next 3 years /10 years
4	Very Likely	75% probability that the event will occur in the next 3 years/10 years
3	Even Odds	50% probability that the event will occur in the next 3 years/10 years
2	Unlikely	25% probability that the event will occur in the next 3 years/10 years
1	Remote	5% probability that the event will occur in the next 3 years/10 years

- *The 3-year timeframe will be the primary focus for the business unit risk maps*
- *The 10-year risks will be collected by the ERM organization and charted separately for the enterprise*

Table 4. Seismic Hazard Input Data for Probabilistic Assessment of TVA Facilities

Seismic Sources	**Return Period (years)**	**Annual Probability of Exceedance**	**Peak Ground Acceleration (g)**	**Earthquake Magnitude**
New Madrid Seismic Zone	2,500	0.0004	*Values to be determined from the seismic hazard curves*	*Values to be determined from the hazard de-aggregation data**
	1,000	0.001		
	500	0.002		
	250	0.004		
	100	0.01		
All Other Seismic Sources	2,500	0.0004		
	1,000	0.001		
	500	0.002		
	250	0.004		
	100	0.01		

* *Representative magnitude corresponding to the maximum contribution to the seismic hazard for liquefaction, as determined from the de-aggregation data weighted by the magnitude scaling factor (maximum PGA / MSF)*



Note: Schematic representation only, locations not accurately depicted, some sources omitted.

Figure 1. Schematic Representation of Seismic Source Model for TVA Facilities

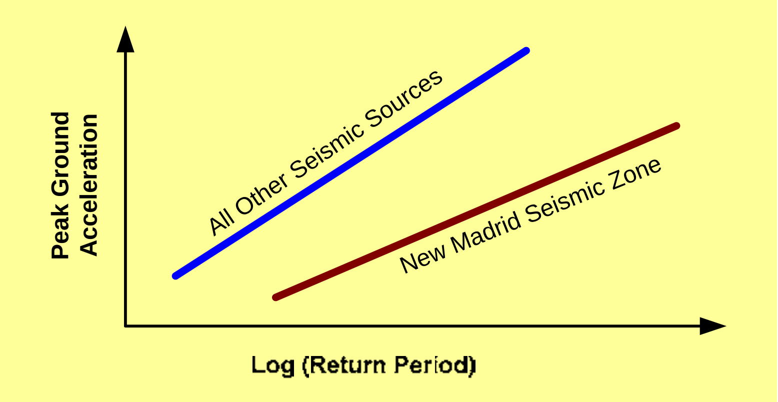


Figure 2. Typical Seismic Hazard Curves for Proposed Probabilistic Assessment of TVA Facilities

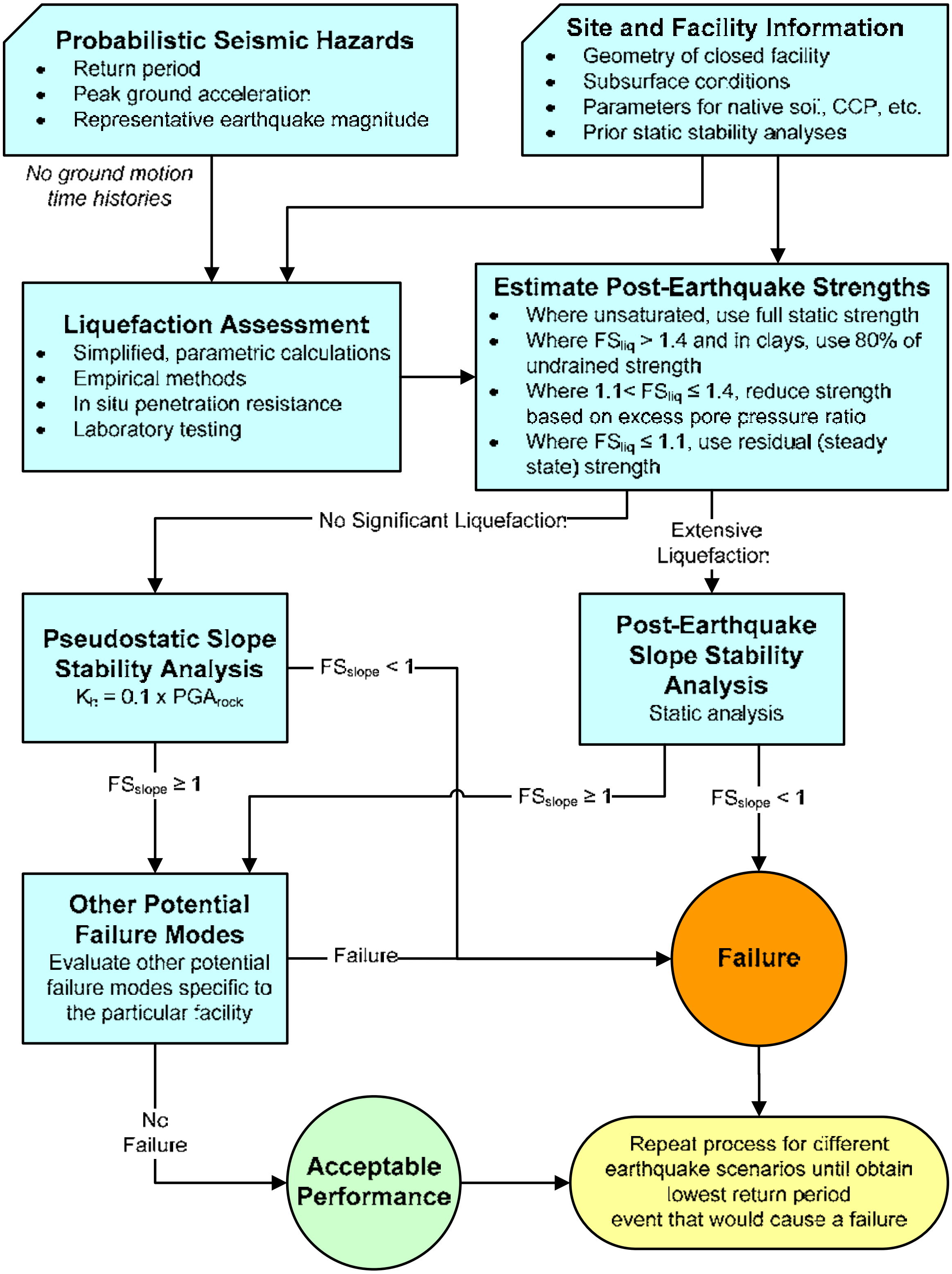


Figure 3. Simplified Flowchart for Assessing Facility Performance During a Probabilistic Seismic Event in Phase A

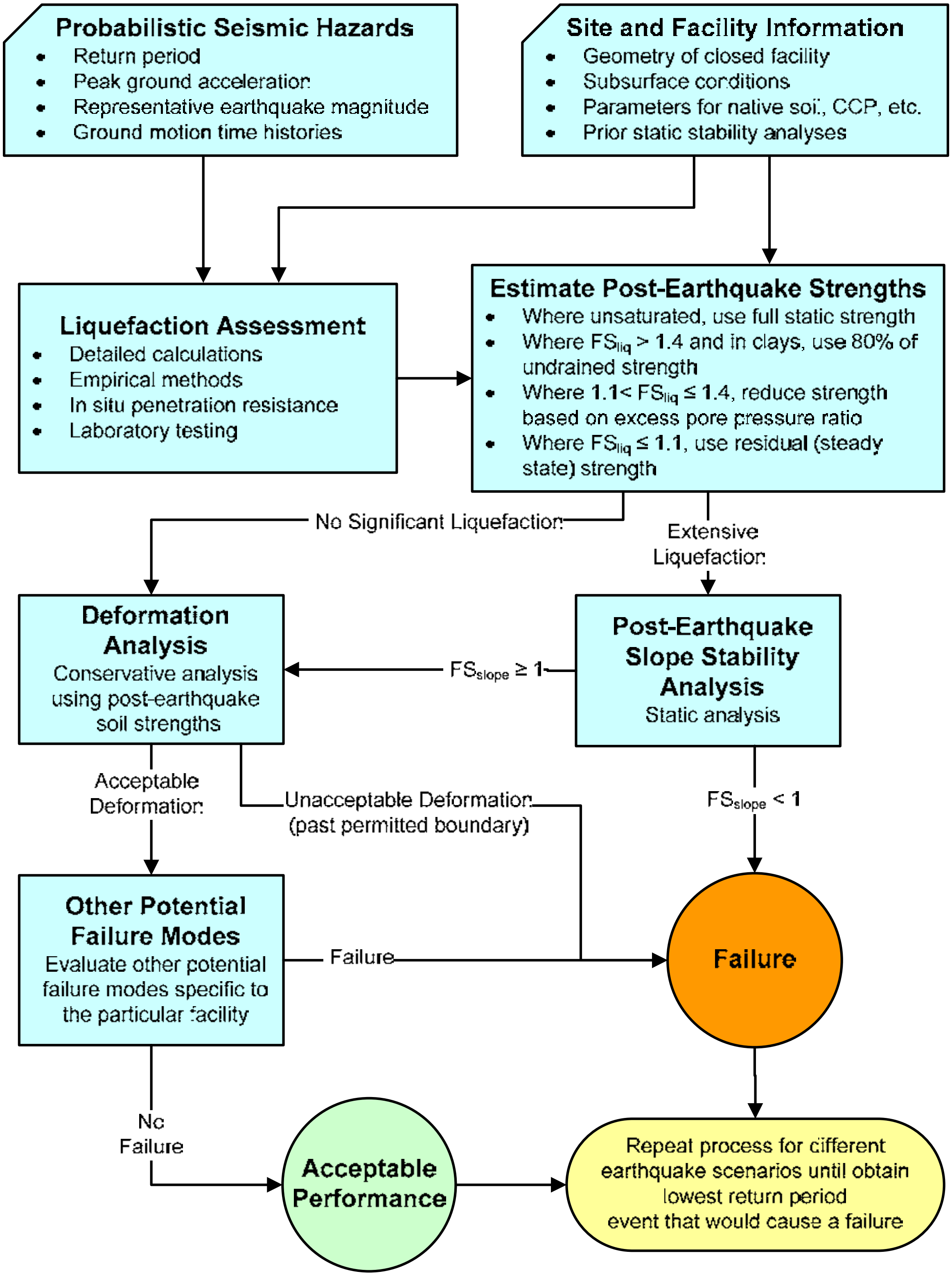


Figure 4. Simplified Flowchart for Assessing Facility Performance During a Probabilistic Seismic Event in Phase B

Enclosure B

Pseudostatic Analysis Results

Cumberland Fossil Plant - Pseudostatic Stability Analysis Summary

CCP Disposal Facility		Cross-Section Information		500 yr Return		FS = 1 Data		Mitigation and Improvement Activities Since January 2009 As-Found Conditions
Name	Type	Section Analyzed	Section Location	PGA (g) for CUF	Factor of Safety	PGA (g)	Approx. Return Period (yrs)	
Ash Pond	Impoundment	P	West side of dike along Wells Creek	0.083	1.2	N/A - FS ok for 500 yr Return		Mitigation activities are currently underway including rehabilitation of spillway system, addition of siphon system, addition of emergency spillway and lowering of permanent pool by six feet.
Dry Fly Ash Stack	Stack	F	Southwest corner of Stack along Wells Creek		1.0 (failure surface beneath perimeter dike)	N/A - FS ok for 500 yr Return		Slope at this section has been flattened. Currently, the stack is being regraded and surface ditches improved to enhance long term performance. Section F represents these conditions.
					0.8 (failure surface inside perimeter dike)	0.03	170	
Gypsum Stack Complex	Stack	H	Southwest corner of Stack along Wells Creek		1.0 (failure surface beneath perimeter dike)	N/A - FS ok for 500 yr Return		Toe buttress at Section H completed in December 2010. Currently, the stack is being regraded and surface ditches improved to enhance long term performance. Section H represents these conditions.
					0.8 (failure surface inside perimeter dike)	0.04	225	

Notes:

1) Accelerations are from March 28, 2011 TVA region-specific sesismic hazard study performed by AMEC Geomatrix, Inc. (total hazard).
2) Refer to layout plan for locations of cross-sections.
3) Stability models reflect current ground lines and recent improvements/mitigations using either construction drawings or as-built information, as appropriate.
4) Liquefaction was not considered in this analysis.

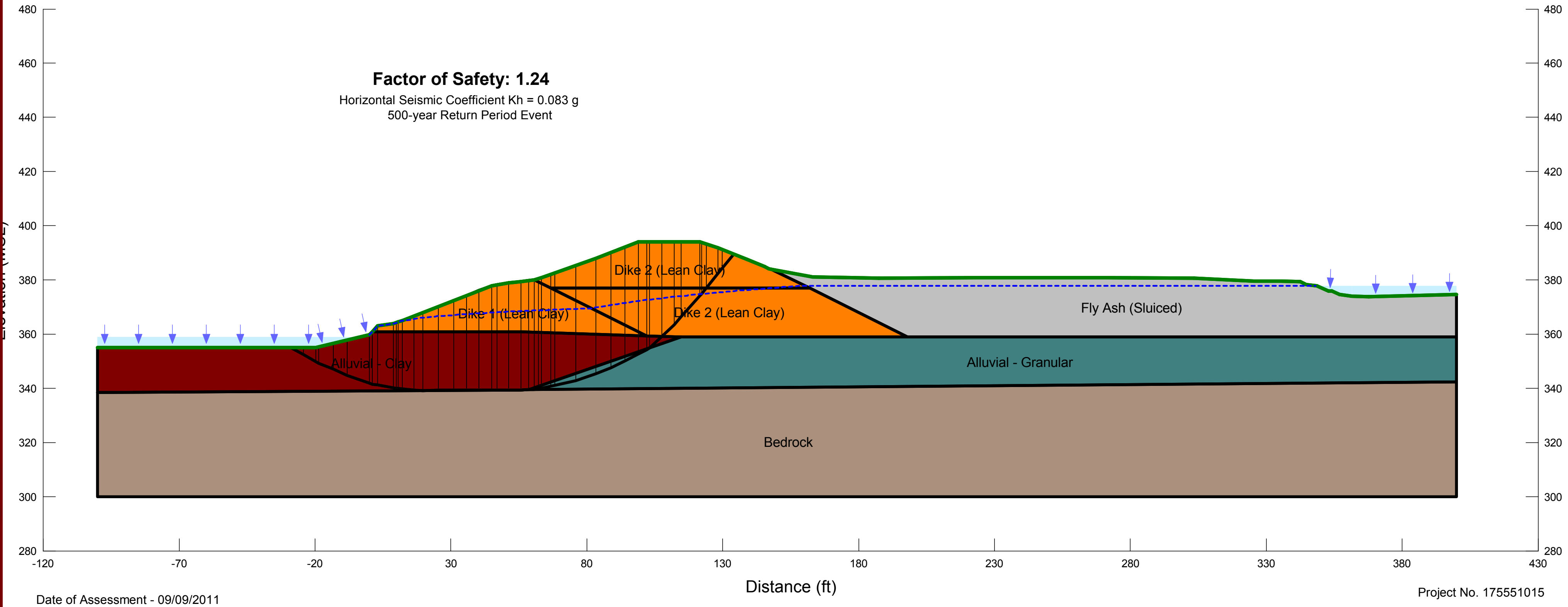
Pseudostatic Slope Stability Analysis
CCP Storage Facilities - Existing Conditions
Tennessee Valley Authority Fossil Plants

Section P - Ash Pond
Cumberland Fossil Plant
Cumberland City, Tennessee

Stantec

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	800 psf	20 °
Dike 2 (Lean Clay)	123 pcf	500 psf	21 °
Fly Ash (Sluiced)	100 pcf	140 psf	11 °
Alluvial - Clay	124 pcf	450 psf	20 °
Alluvial - Granular	130 pcf	100 psf	20 °
Bedrock			



Factor of Safety: 1.24
Horizontal Seismic Coefficient Kh = 0.083 g
500-year Return Period Event

Date of Assessment - 09/09/2011

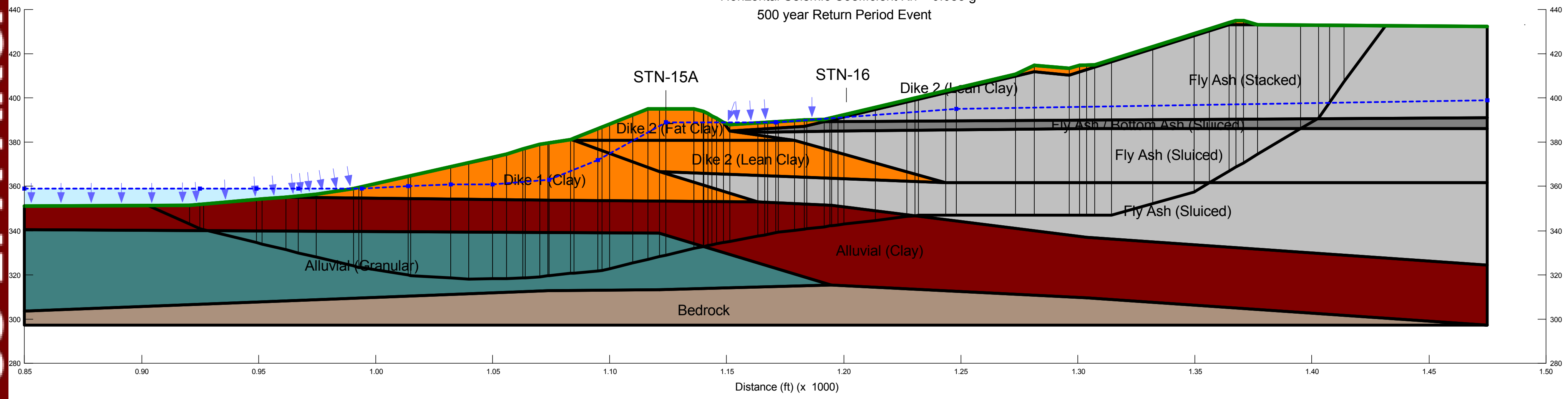
Project No. 175551015

Pseudostatic Slope Stability Analysis
CCP Storage Facilities - Existing Conditions
Tennessee Valley Authority Fossil Plants

Seciton F - Dry Fly Ash Stack
Cumberland Fossil Plant
Cumberland City, Tennessee

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	800 psf	20 °
Dike 2 (Lean Clay)	128 pcf	500 psf	21 °
Alluvial (Clay)	121 pcf	450 psf	20 °
Alluvial (Granular)	130 pcf	100 psf	20 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	140 psf	11 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	140 psf	11 °
Dike 2 (Fat Clay)	127 pcf	200 psf	18 °
Bedrock			

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.



Factor of Safety: 0.99

Horizontal Seismic Coefficient Kh = 0.083 g
500 year Return Period Event

Date of Assessment - 09/09/2011

Project No. 175551015

Stantec

Pseudostatic Slope Stability Analysis
CCP Storage Facilities - Existing Conditions
Tennessee Valley Authority Fossil Plants

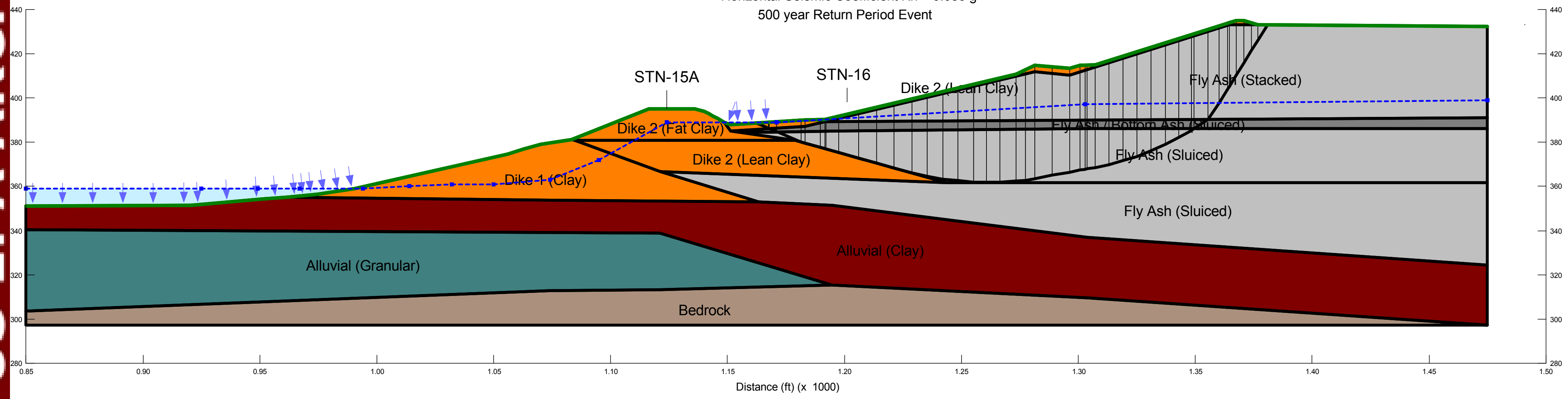
Seciton F - Dry Fly Ash Stack
Cumberland Fossil Plant
Cumberland City, Tennessee

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	800 psf	20 °
Dike 2 (Lean Clay)	128 pcf	500 psf	21 °
Alluvial (Clay)	121 pcf	450 psf	20 °
Alluvial (Granular)	130 pcf	100 psf	20 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	140 psf	11 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	140 psf	11 °
Dike 2 (Fat Clay)	127 pcf	200 psf	18 °
Bedrock			

Factor of Safety: 0.81

Horizontal Seismic Coefficient Kh = 0.083 g
500 year Return Period Event



Date of Assessment - 09/09/2011

Project No. 175551015

Pseudostatic Slope Stability Analysis
CCP Storage Facilities - Existing Conditions
Tennessee Valley Authority Fossil Plants

Section H - Gypsum Stack
Cumberland Fossil Plant
Cumberland City, Tennessee

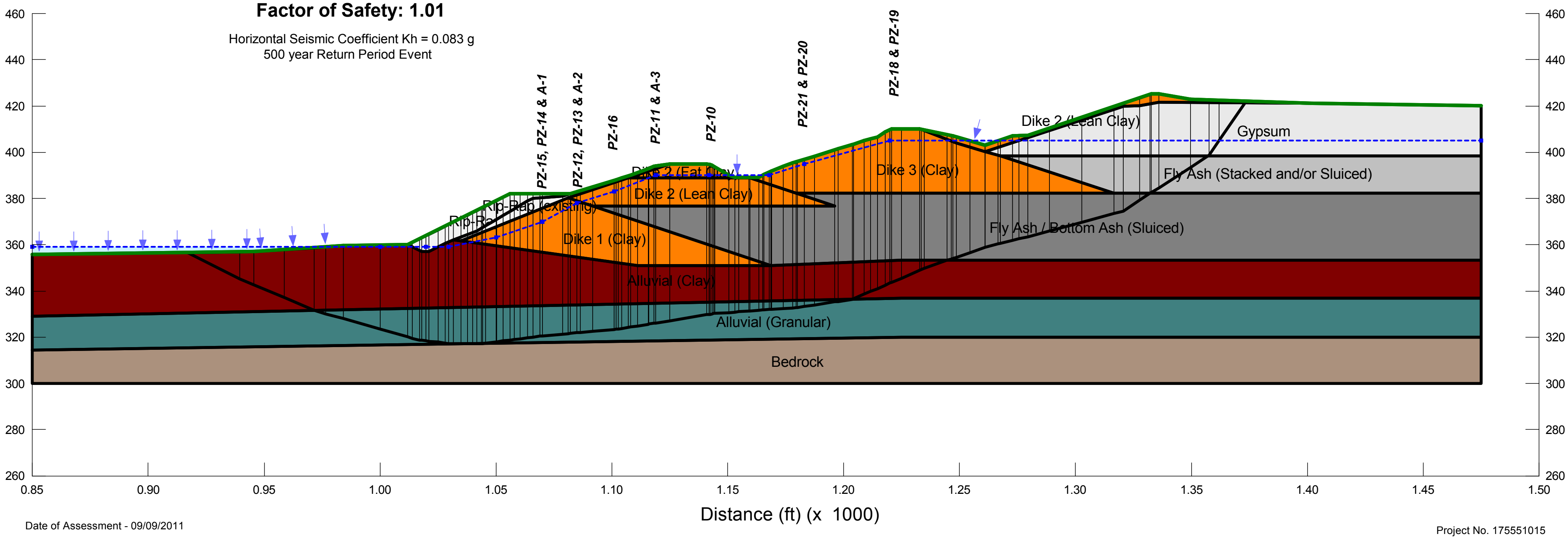
Stantec

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	800 psf	20 °
Dike 2 (Lean Clay)	128 pcf	500 psf	21 °
Dike 3 (Clay)	126 pcf	1000 psf	25 °
Alluvial (Clay)	121 pcf	450 psf	20 °
Alluvial (Granular)	130 pcf	100 psf	20 °
Gypsum	105 pcf	0 psf	33 °
Fly Ash (Stacked and/or Sluiced)	100 pcf	140 psf	11 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	140 psf	11 °
Dike 2 (Fat Clay)	127 pcf	200 psf	18 °
Rip-Rap	150 pcf	0 psf	38 °
Rip-Rap (existing)	150 pcf	0 psf	38 °

Factor of Safety: 1.01

Horizontal Seismic Coefficient Kh = 0.083 g
500 year Return Period Event



Date of Assessment - 09/09/2011

Project No. 175551015

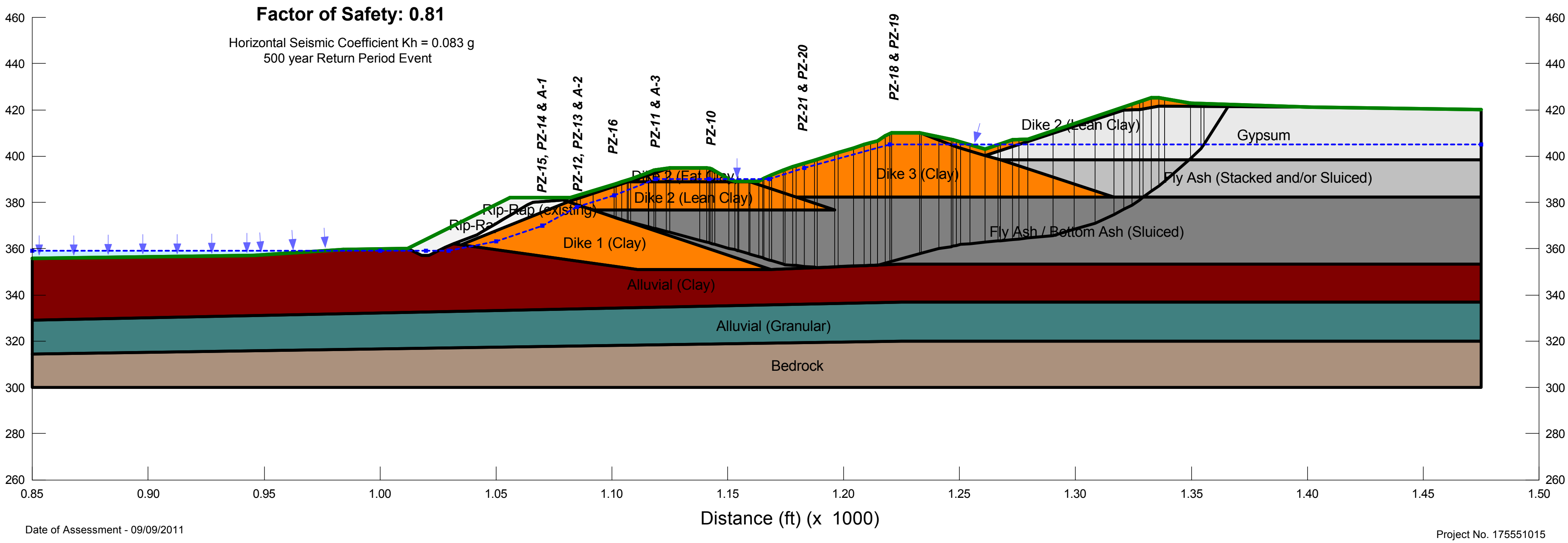
Pseudostatic Slope Stability Analysis
CCP Storage Facilities - Existing Conditions
Tennessee Valley Authority Fossil Plants

Section H - Gypsum Stack
Cumberland Fossil Plant
Cumberland City, Tennessee

Stantec

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Clay)	124 pcf	800 psf	20 °
Dike 2 (Lean Clay)	128 pcf	500 psf	21 °
Dike 3 (Clay)	126 pcf	1000 psf	25 °
Alluvial (Clay)	121 pcf	450 psf	20 °
Alluvial (Granular)	130 pcf	100 psf	20 °
Gypsum	105 pcf	0 psf	33 °
Fly Ash (Stacked and/or Sluiced)	100 pcf	140 psf	11 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	140 psf	11 °
Dike 2 (Fat Clay)	127 pcf	200 psf	18 °
Rip-Rap	150 pcf	0 psf	38 °
Rip-Rap (existing)	150 pcf	0 psf	38 °


Factor of Safety: 0.81

Horizontal Seismic Coefficient Kh = 0.083 g
500 year Return Period Event

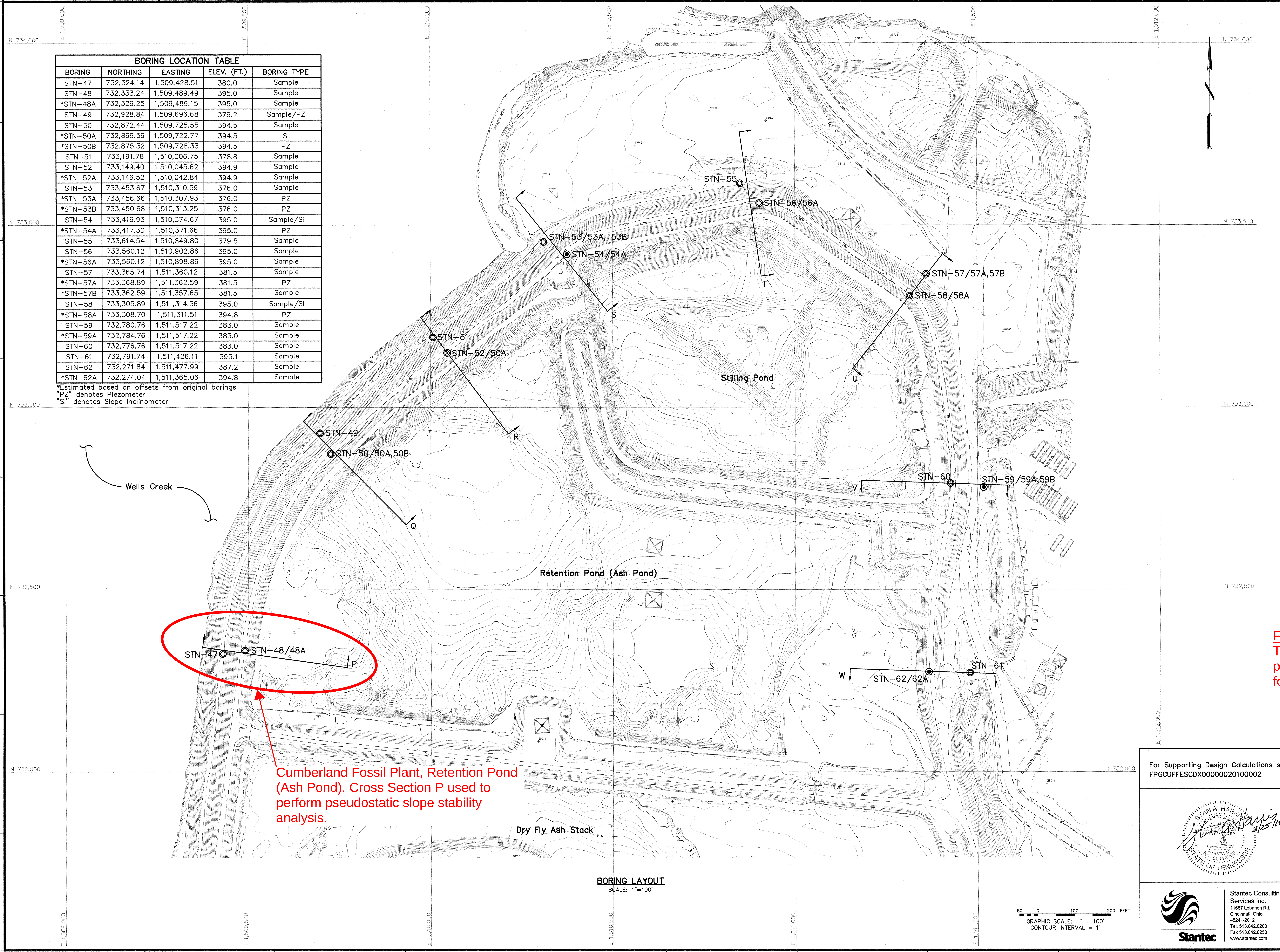
Date of Assessment - 09/09/2011

Project No. 175551015

BORING LOCATION TABLE

BORING	NORTHING	EASTING	ELEV. (FT.)	BORING TYPE
STN-47	732,324.14	1,509,428.51	380.0	Sample
STN-48	732,333.24	1,509,489.49	395.0	Sample
*STN-48A	732,329.25	1,509,489.15	395.0	Sample
STN-49	732,928.84	1,509,696.68	379.2	Sample/PZ
STN-50	732,872.44	1,509,725.55	394.5	Sample
*STN-50A	732,869.56	1,509,722.77	394.5	SI
*STN-50B	732,875.32	1,509,728.33	394.5	PZ
STN-51	733,191.78	1,510,006.75	378.8	Sample
STN-52	733,149.40	1,510,045.62	394.9	Sample
*STN-52A	733,146.52	1,510,042.84	394.9	Sample
STN-53	733,453.67	1,510,310.59	376.0	Sample
*STN-53A	733,456.66	1,510,307.93	376.0	PZ
*STN-53B	733,450.68	1,510,313.25	376.0	PZ
STN-54	733,419.93	1,510,374.67	395.0	Sample/SI
*STN-54A	733,417.30	1,510,371.66	395.0	PZ
STN-55	733,614.54	1,510,849.80	379.5	Sample
STN-56	733,560.12	1,510,902.86	395.0	Sample
*STN-56A	733,560.12	1,510,898.86	395.0	Sample
STN-57	733,365.74	1,511,360.12	381.5	Sample
*STN-57A	733,368.89	1,511,362.59	381.5	PZ
*STN-57B	733,362.59	1,511,357.65	381.5	Sample
STN-58	733,305.89	1,511,314.36	395.0	Sample/SI
*STN-58A	733,308.70	1,511,311.51	394.8	PZ
STN-59	732,780.76	1,511,517.22	383.0	Sample
*STN-59A	732,784.76	1,511,517.22	383.0	Sample
STN-60	732,776.76	1,511,517.22	383.0	Sample
STN-61	732,791.74	1,511,426.11	395.1	Sample
STN-62	732,271.84	1,511,477.99	387.2	Sample
*STN-62A	732,274.04	1,511,365.06	394.8	Sample

*Estimated based on offsets from original borings.
"PZ" denotes Piezometer
"SI" denotes Slope Inclinometer



Cumberland Fossil Plant, Retention Pond (Ash Pond). Cross Section P used to perform pseudostatic slope stability analysis.

BORING LAYOUT
SCALE: 1"=100'

LEGEND

◎ Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests

◉ Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests and Rock Core

NOTE:

The topographic mapping provided is based on horizontal datum NAD27 and vertical datum NGV29 using State Plane Tennessee coordinate system. The site photography was performed on 4/17/2009.

FOR INFORMATION ONLY
This Record Drawing which has been previously submitted to TVA is provided for Information Only.

RECORD DRAWING

For Supporting Design Calculations see FPGCUFFESCDX00000020100002

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R –	–	–	–	–	–	–	–	–	–	–	–
R 0	03/29/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–

RECORD DRAWING

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=100' EXCEPT AS NOTED

YARD
RETENTION AND STILLING PONDS

GEOTECHNICAL EXPLORATION BORING LAYOUT

STAN A. HARRIS
No. 00113308
STATE OF TENNESSEE
S. A. Harris 3/25/10

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
D. ROGERS	C. WITHERS	D. ROGERS	S. HARRIS	S. HARRIS	S. HARRIS	T. JOHNSON

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www.stantec.com

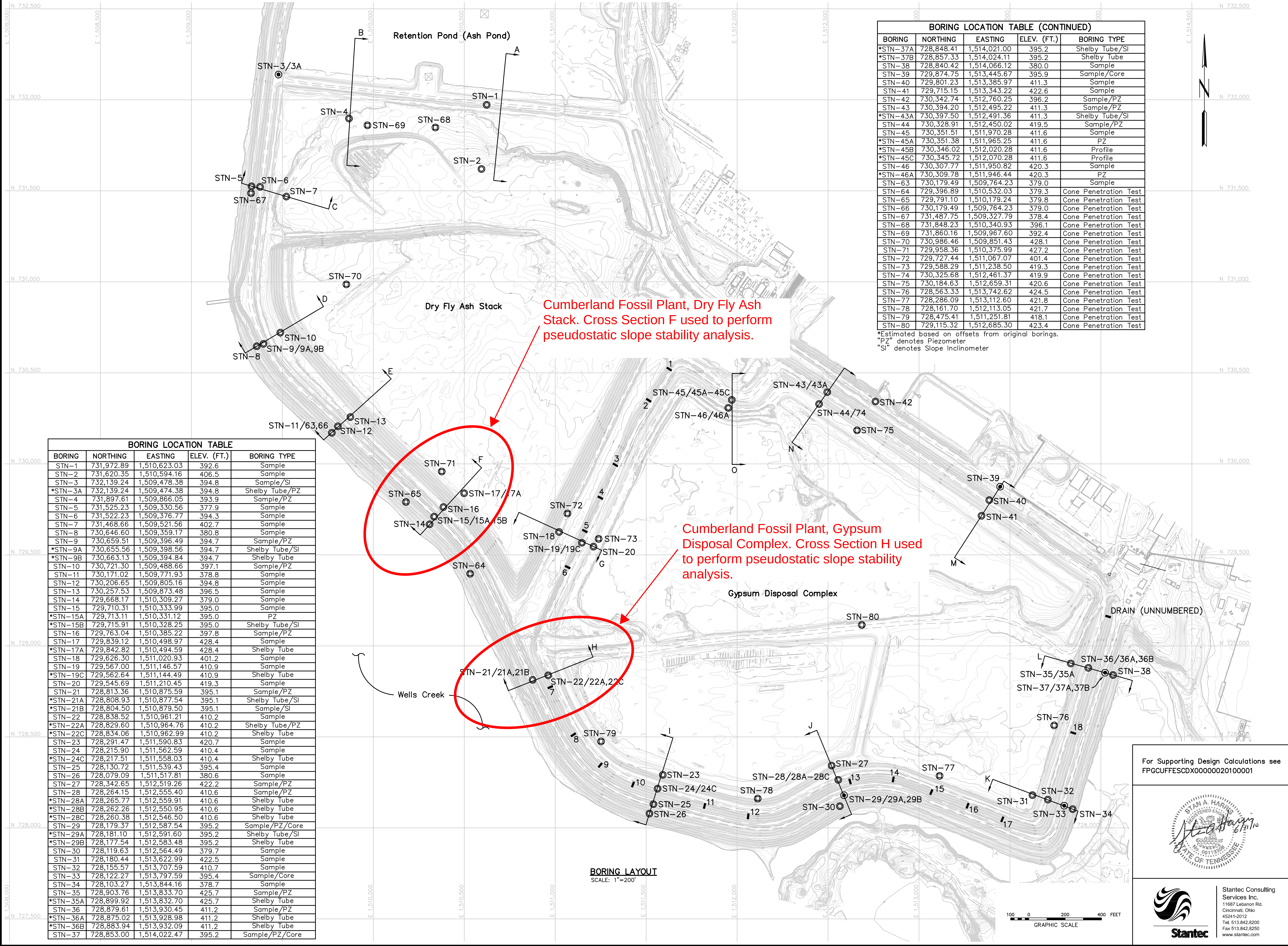
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000	DATE 03/29/10	46	C	10W544-01	R 0

STANTEC	0
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY



Cumberland Fossil Plant, Dry Fly Ash Stack. Cross Section F used to perform pseudostatic slope stability analysis.

Cumberland Fossil Plant, Gypsum Disposal Complex. Cross Section H used to perform pseudostatic slope stability analysis.

BORING LOCATION TABLE

BORING	NORTHING	EASTING	ELEV. (FT.)	BORING TYPE
STN-1	731,972.89	1,510,623.03	392.6	Sample
STN-2	731,620.35	1,510,594.16	406.5	Sample
STN-3	732,139.24	1,509,478.38	394.8	Sample/SI
*STN-3A	732,139.24	1,509,474.38	394.8	Shelby Tube/PZ
STN-4	731,897.61	1,509,866.05	393.9	Sample/PZ
STN-5	731,525.23	1,509,330.56	377.9	Sample
STN-6	731,522.23	1,509,376.77	394.3	Sample
STN-7	731,468.66	1,509,521.56	402.7	Sample
STN-8	730,646.60	1,509,359.17	380.8	Sample
STN-9	730,659.51	1,509,396.49	394.7	Sample/PZ
*STN-9A	730,655.56	1,509,398.56	394.7	Shelby Tube/SI
*STN-9B	730,663.13	1,509,394.84	394.7	Shelby Tube
STN-10	730,721.30	1,509,488.66	397.1	Sample/PZ
STN-11	730,171.02	1,509,771.93	378.8	Sample
STN-12	730,206.65	1,509,805.16	394.8	Sample
STN-13	730,257.53	1,509,873.48	396.5	Sample
STN-14	729,668.17	1,510,309.27	379.0	Sample
STN-15	729,710.31	1,510,333.99	395.0	Sample
*STN-15A	729,713.11	1,510,331.12	395.0	PZ
*STN-15B	729,715.91	1,510,328.25	395.0	Shelby Tube/SI
STN-16	729,763.04	1,510,385.22	397.8	Sample/PZ
STN-17	729,839.12	1,510,498.97	428.4	Sample
*STN-17A	729,842.82	1,510,494.59	428.4	Shelby Tube
STN-18	729,626.30	1,511,020.93	401.2	Sample
STN-19	729,567.00	1,511,146.57	410.9	Sample
*STN-19C	729,562.64	1,511,144.49	410.9	Shelby Tube
STN-20	729,545.69	1,511,210.45	419.3	Sample
STN-21	728,813.36	1,510,875.59	395.1	Sample/PZ
*STN-21A	728,808.93	1,510,877.54	395.1	Shelby Tube/SI
*STN-21B	728,804.50	1,510,879.50	395.1	Sample/SI
STN-22	728,838.52	1,510,961.21	410.2	Sample
*STN-22A	728,829.60	1,510,964.76	410.2	Shelby Tube/PZ
*STN-22C	728,834.06	1,510,962.99	410.2	Shelby Tube
STN-23	728,291.47	1,511,590.83	420.7	Sample
STN-24	728,215.90	1,511,562.59	410.4	Sample
*STN-24C	728,217.51	1,511,558.03	410.4	Shelby Tube
STN-25	728,130.72	1,511,539.43	395.4	Sample
STN-26	728,079.09	1,511,517.81	380.6	Sample
STN-27	728,342.65	1,512,519.26	422.2	Sample/PZ
STN-28	728,264.15	1,512,555.40	410.6	Sample/PZ
*STN-28A	728,265.77	1,512,559.91	410.6	Shelby Tube
*STN-28B	728,262.26	1,512,550.95	410.6	Shelby Tube
*STN-28C	728,260.38	1,512,546.50	410.6	Shelby Tube
STN-29	728,179.37	1,512,587.54	395.2	Sample/PZ/Core
*STN-29A	728,181.10	1,512,591.60	395.2	Shelby Tube/SI
*STN-29B	728,177.54	1,512,583.48	395.2	Shelby Tube
STN-30	728,119.63	1,512,564.49	379.7	Sample
STN-31	728,180.44	1,513,622.99	422.5	Sample
STN-32	728,155.57	1,513,707.59	410.7	Sample
STN-33	728,122.27	1,513,797.59	395.4	Sample/Core
STN-34	728,103.27	1,513,844.16	378.7	Sample
STN-35	728,903.76	1,513,833.70	425.7	Sample/PZ
*STN-35A	728,899.92	1,513,832.70	425.7	Shelby Tube
STN-36	728,879.61	1,513,930.45	411.2	Sample/PZ
*STN-36A	728,875.02	1,513,928.98	411.2	Shelby Tube
*STN-36B	728,883.94	1,513,932.09	411.2	Shelby Tube
STN-37	728,853.00	1,514,022.47	395.2	Sample/PZ/Core

BORING LOCATION TABLE (CONTINUED)

BORING	NORTHING	EASTING	ELEV. (FT.)	BORING TYPE
*STN-37A	728,848.41	1,514,021.00	395.2	Shelby Tube/SI
*STN-37B	728,857.33	1,514,024.11	395.2	Shelby Tube
STN-38	728,840.42	1,514,066.12	380.0	Sample
STN-39	729,874.75	1,513,445.67	395.9	Sample/Core
STN-40	729,801.23	1,513,385.97	411.3	Sample
STN-41	729,715.15	1,513,343.22	422.6	Sample
STN-42	730,342.74	1,512,760.25	396.2	Sample/PZ
STN-43	730,394.20	1,512,495.22	411.3	Sample/PZ
*STN-43A	730,397.50	1,512,491.36	411.3	Shelby Tube/SI
STN-44	730,328.91	1,512,450.02	419.5	Sample/PZ
STN-45	730,351.51	1,511,970.28	411.6	Sample
*STN-45A	730,351.38	1,511,965.25	411.6	PZ
*STN-45B	730,346.02	1,512,020.28	411.6	Profile
*STN-45C	730,345.72	1,512,070.28	411.6	Profile
STN-46	730,307.77	1,511,950.82	420.3	Sample
*STN-46A	730,309.78	1,511,946.44	420.3	PZ
STN-63	730,179.49	1,509,764.23	379.0	Sample
STN-64	729,396.89	1,510,532.03	379.3	Cone Penetration Test
STN-65	729,791.10	1,510,179.24	379.8	Cone Penetration Test
STN-66	730,179.49	1,509,764.23	379.0	Cone Penetration Test
STN-67	731,487.75	1,509,327.79	378.4	Cone Penetration Test
STN-68	731,848.23	1,510,340.93	396.1	Cone Penetration Test
STN-69	731,860.16	1,509,967.60	392.4	Cone Penetration Test
STN-70	730,986.46	1,509,851.43	428.1	Cone Penetration Test
STN-71	729,958.36	1,510,375.99	427.2	Cone Penetration Test
STN-72	729,727.44	1,511,067.07	401.4	Cone Penetration Test
STN-73	729,588.29	1,511,238.50	419.3	Cone Penetration Test
STN-74	730,325.68	1,512,461.37	419.9	Cone Penetration Test
STN-75	730,184.63	1,512,659.31	420.6	Cone Penetration Test
STN-76	728,563.33	1,513,742.62	424.5	Cone Penetration Test
STN-77	728,286.09	1,513,112.60	421.8	Cone Penetration Test
STN-78	728,161.70	1,512,113.05	421.7	Cone Penetration Test
STN-79	728,475.41	1,511,251.81	418.1	Cone Penetration Test
STN-80	729,115.32	1,512,685.30	423.4	Cone Penetration Test

*Estimated based on offsets from original borings.
"PZ" denotes Piezometer
"SI" denotes Slope Inclinometer

FOR INFORMATION ONLY
This Record Drawing which has been previously submitted to TVA is provided for Information Only.

NOTE:

The topographic mapping provided is based on horizontal datum NAD27 and vertical datum NGV29 using State Plane Tennessee coordinate system. The site photography was performed on 4/17/2009.

LEGEND

◎	Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests
◉	Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests and Rock Core
⊡	Cone Penetration Test
▬	Drain, Number

RECORD DRAWING

PLOT DATE: 06/08/2010 USER: WITHERS, CHEYENNE
V:\1755\ACTIVE\175539009\GEOTECHNICAL\DRAWING\REV0_RECORD\10W543-01-R0.DWG

For Supporting Design Calculations see FPGCUFFESCDX00000020100001

STAN A. HARRIS
No. 00113308
06/11/10

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R –	–	–	–	–	–	–	–	–	–	–	–
–											
R 0	06/11/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–
RECORD DRAWING											

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=200' EXCEPT AS NOTED

YARD
DRY FLY ASH STACK AND GYPSUM DISPOSAL COMPLEX

GEOTECHNICAL EXPLORATION
BORING LAYOUT

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
D. ROGERS	C. WITHERS	D. ROGERS	S. HARRIS	S. HARRIS	S. HARRIS	T. JOHNSON

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CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000	DATE 06/11/10	46	C	10W543-01	R 0

STANTEC	0
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

APPENDIX A

Document 9

Seepage Action Plan, Stantec, June 25, 2010

Seepage Action Plan (SAP)

Cumberland Fossil Plant
Cumberland City, Tennessee

Stantec Consulting Services Inc.
One Team. Infinite Solutions
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Tel: (859) 422-3000 • Fax: (859) 422-3100
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Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

June 25, 2010

Seepage Action Plan (SAP)

Cumberland Fossil Plant
Cumberland City, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

June 25, 2010

Seepage Action Plan (SAP)

Cumberland Fossil Plant
Cumberland City, Tennessee

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Seepage Action Plan (SAP)

Cumberland Fossil Plant
Cumberland City, Tennessee

1. Potential Seepage Areas

For readers not familiar with seepage through dams, refer to Appendix B, "Possible Seepage Problems and Recommendations" for more illustrative details. Seepage through an impoundment dam can typically be found on the lower third of the slope and extending beyond the toe approximately fifty feet. Figure 1 below displays the typical area on a cross section that should be reviewed during the seepage inspection for the Ash Pond, Dry Ash Stack and Gypsum Stack Complex. However, other seepage areas may exist, and the field inspector should be familiar with previous inspection reports and observations. Based on geotechnical analysis, plan views illustrating low factors of safety in terms of seepage have been prepared and are included in Appendix A. The areas identified, along with any other area previously identified during inspections, should be reviewed on a regular basis as identified in this document.

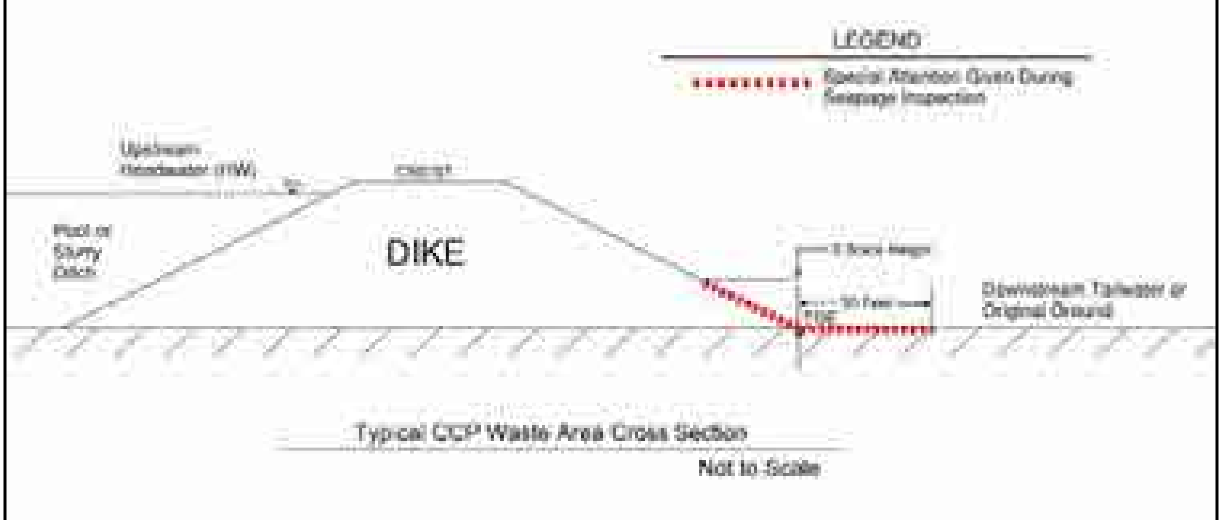


Figure 1. Seepage Inspection Location

2. Basic SAP Data

2.1. Purpose

The purpose of this SAP is to describe potential seepage action levels, and provide seepage short term management measures and actions in the event these action levels are observed.

2.2. Potential Impacted Area

Seepage related issues impact the integrity of earthen embankments. Seepage can lead to internal erosion of the embankment, known as piping, which has been the cause of many catastrophic failures in the past. Piping is a process where soil particles slowly carried out from inside the dam, eventually creating a tunnel or pipe. If the pipe forms all the way to the reservoir, the embankment will fail rapidly. Since the embankments at Cumberland Fossil Plant serve as an impoundment for ash and gypsum slurry, it is imperative to maintain the embankments and prevent any possible failure from occurring. If a failure were to occur, the ash and gypsum slurry mixture could potentially contaminate Cumberland Fossil Plant and the Cumberland River.

2.3. Primary Responsibility and Frequency of Dike Safety Inspections

1. TVA RHO&M Field Supervisor for Cumberland Fossil Plant (**Field Supervisor**)
2. TVA RHO&M West Region Construction Manager
3. TVA RHO&M Program Manager for Cumberland Fossil Plant

Documented inspections should occur at a minimum of once per month. Additionally, there are two criteria which warrant an inspection. A documented inspection should occur following a significant precipitation event (0.5 inches of rain, 4 inches of snow), as well as following a change in the operation of the stack, pond, or other CCP wet waste area (switching between east/west ditch, switching ponds, raising pool elevations, etc.). A documented inspection involves inspecting the potential seepage areas noted on the plan views in Appendix A, paying particular attention to areas of concern previously identified. The **Seepage Log** should be updated to include new descriptions and photographs of any new areas of concern or changes to previously identified areas. Random inspections can occur on a more frequent basis if deemed necessary by the **Field Supervisor**.

3. Seepage Action Level Determination

For the purpose of this plan, three seepage action levels have been identified. The levels are based on potential risk associated with progressive erosion due to seepage and resulting breach of the embankment or impoundment.

Action Level 1 – Non-Flowing

- Wet areas
- Ponded Water

Action Level 2 – Flowing Seepage – No Erosion

- Non turbid (clear water) flow

Action Level 3 – Flowing Seepage – Active Erosion

- Turbid Flow
- Deposition of Sediment from Dike or Dam
- Boils (Ground Surface/ Underwater)
- Upstream Collapse or Sinkhole

3.1. Action Level 1 – Non Flowing

Seepage occurs in all earthen dams and dikes. The key is to properly collect and control seepage in a manner that does not cause damage to the embankment. Seepage that is not flowing but is evident by damp areas or ponded water does not generally represent an imminent threat to the embankment in terms of erosion (see Figure 2). However, if left unattended this seepage can lead to slope instabilities. Therefore, this should be noted so that it can be observed for changing conditions both at the downstream observation point and immediately upstream along the interior slopes.

Figure 2. Example of Action Level 1 – Non-Flowing – Wet Area

3.2. Action Level 2 – Flowing Seepage – No Erosion

Action Level 2 involves observations of flowing seepage, but evidence of erosion is not noted. Evidence of erosion can be in the form of turbid (muddy water) flow, sediment deposition, obvious hole or soil “pipe”. Evidence of erosion can be subtle and as a result, any flowing seepage should be carefully reviewed and monitored at least monthly. A picture of flowing seepage water showing no evidence of erosion is depicted in Figure 3. Note that a seep does not need to be continuously turbid for a piping situation to be forming.

Figure 3. Example of Action Level 2 – Clear Flowing – Seepage Boil

3.3. Action Level 3 – Flowing Seepage – Active Erosion

Left unmitigated seepage demonstrating active erosion can lead to progressive failure of the embankment and catastrophic loss of the impoundment. Evidence of erosion can be in the form of turbid flow, sediment deposition, boil, obvious hole or soil “pipe”. Evidence of erosion can be subtle and as a result, any flowing seepage should be carefully reviewed and monitored frequently. Careful attention should be given to seepage below water such as a stilling pond, creek or river (see Figure 6). This type of seepage is difficult to observe and determine if soil erosion is occurring. In moving water, evidence of seepage boils conveying embankment soil/ash materials will likely be (partially) washed away. Examples of active erosion are shown in Figures 4 thru 5.

Figure 4. Example of Action Level 3 – Turbid Flowing – Seepage Boil

Figure 5. Example of Action Level 3 – Deposition of Sediment from Dike

Figure 6. Example of Action Level 3 – Underwater Turbid Flowing – Seepage Boil

4. Intermediate Corrective Measures

For each action level a typical corrective measure is listed below.

4.1. Action Level 1 – Non Flowing

- **Field Supervisor** should document the seepage area into the **Seepage Log** (see below).
- All observers should pay particular attention to conduits through the embankments.
- **Field Supervisor** should record the date, time, size of area, location, and photographs in the **Seepage Log**.

The **Seepage Log** should be kept at the Shift Operation Supervisor's (SOS) office such that inspectors (TVA, geotechnical consultant, or others) can document event triggers (date, time, location, pool level, etc.) and the site conditions observed for each seepage event. The **Seepage Log** shall function as a "living document" and be part of an ongoing monitoring program (to be controlled by TVA). As the monitoring program progresses, the **Seepage Log** will allow inspectors to summarize the historical conditions observed and provide a baseline of events to compare with future readings.

4.2. Action Level 2 – Flowing Seepage – No Erosion

- **Field Supervisor** should carefully inspect the area for outflow quantity, any transported material, and take photographs.

- If the seepage involves a conduit penetration associated with a spillway pipeline, storm culvert, or underdrain pipeline, the observer(s) should carefully inspect the area by probing and /or carefully shoveling to see if the cause can be determined, determine if embankment materials are being transported, evident by turbid or cloudy water, and determine quantity of flow.
- Contact team members in accordance with Figure 8.
- Send photographs to the RHO&M Regional Construction Manager and CCP Program Manager for distribution.
- Geotechnical consultant, with concurrence of the TVA Program Manager and CCP Engineering Manager, should determine a plan of action within four hours of notification
- **Field Supervisor** should record the date, time, size of area, location, and photographs in the **Seepage Log**.

4.3. Action Level 3 – Flowing Seepage – Active Erosion

- **Field Supervisor** should carefully inspect the area for outflow quantity and transported material.
- **Field Supervisor** should determine if piping has occurred and extent by observing locations of seepage exits, take photographs, and contact team members in accordance with Figure 9.
- Geotechnical consultant, TVA Program Manager, and CCP Engineering Manager should determine a plan of action within four hours of notification such as lowering the pool, constructing a reverse graded filter, or sand bagging
- A typical reverse graded filter will consist of the following:
    - One foot of Concrete Sand (TDOT Concrete Sand)
    - One foot of TDOT No. 57 Stone
    - One foot of TDOT No. 1 Stone
    - Two feet of TDOT Machine Rip-Rap Class A-1
    - Silt Fence as required by guidance provided in the Best Management Practices for Erosion Prevention and Sediment Control
- An example of sandbagging is provided in Figure 7.
- **Field Supervisor** should record the date, time, size of area, location, and photographs in the **Seepage Log**.

Figure 7. Sand Bag Treatment (Temporary)

5. Materials On-Site

In case an emergency situation is observed during the inspection of the potential seepage areas, it is necessary to have materials readily available on-site to correct the situation. Table 1 below lists the materials to be stockpiled on-site and the quantity of each material.

Table 1. Stockpile Material Quantities

Material	Tons	Cubic Yards
Concrete Sand	90	60
TDOT No. 57 Stone	90	60
TDOT No. 1 Stone	90	60
TDOT Machine Rip-Rap Class A-1	180	120
Sandbags (filled)	300 (total)	NA
30” Diameter HDPE Pipe	100 feet	NA

The amount of materials to be stockpiled is based on a production rate of 60 cubic yards per hour for a 2.5 CY long reach excavator assuming a material unit weight of 110 PCF.

The materials should be stockpiled in the corner of the Dry Ash Stack to the northwest of the West Gypsum Pond. The following earthwork equipment and qualified operator(s) should be located to place the material in case of an emergency:

- Long Reach Excavator
- Dump Truck
- Compactor, Bulldozer, Bobcat, any other nearby equipment which aids in the emergency

6. The SAP Process

6.1. Step 1 – Dike Observation or Event Detection

This step describes the detection of an unusual observation or emergency event and provides information to assist the Cumberland RHO&M **Field Supervisor** or appropriate personnel in determining the appropriate emergency level for the observation or event. These observations could be made by inspectors during routine inspections of the embankments, or by everyday personnel.

6.2. Step 2 – Emergency Level Determination

Following an unusual observation or emergency event detection, the **Field Supervisor** is responsible for classifying the event into one of the following three emergency levels:

6.2.1. Action Level 1 – Non Flowing

Observation is routine to other observations and a similar established plan of action for minor repair or continued observation will be required. If a Level 1 Emergency is identified, the following steps should be taken:

- Update maps and **Seepage Log**
- Inform CUF personnel if repairs are needed
- Determine if other work activities need to be made aware of observation.

6.2.2. Action Level 2 – Flowing – No Erosion

A change in condition or a condition that has not been previously identified and discussed with the geotechnical engineers. If a Level 2 Emergency is identified, the following steps should be taken:

- Inform individuals in accordance with the flowchart in Figure 8.
- Update map and **Seepage Log**
- Inform CUF personnel if repairs are needed
- Determine if other work activities need to be made aware of new conditions.

6.2.3. Action Level 3 – Flowing – Active Erosion

A change in condition that is drastic and could rapidly lead to failure of the embankment if not corrected. If a Level 3 Emergency is identified, the following steps should be taken:

- Inform plant SOS, who will initiate TVA plant-specific Emergency Action Plan (see Figure 9).
- Inform geotechnical consultant
- Develop safe plan of action for repair with geotechnical consultants
- Initiate repairs once plan has been approved by site safety and geotechnical consultant
- Update map and **Seepage Log**.

6.3. Step 3 – Notification and Communication

6.3.1. Notification

Following the determination of a possible seepage situation, it is necessary to notify the appropriate personnel discussed below for the required action to occur.

6.3.2. Communication

In case of an Action Level 2 emergency, the flowchart presented in Figure 8 should be followed to ensure the proper personnel are contacted. In an Action Level 3 emergency, the flowchart presented in Figure 9 should be followed.

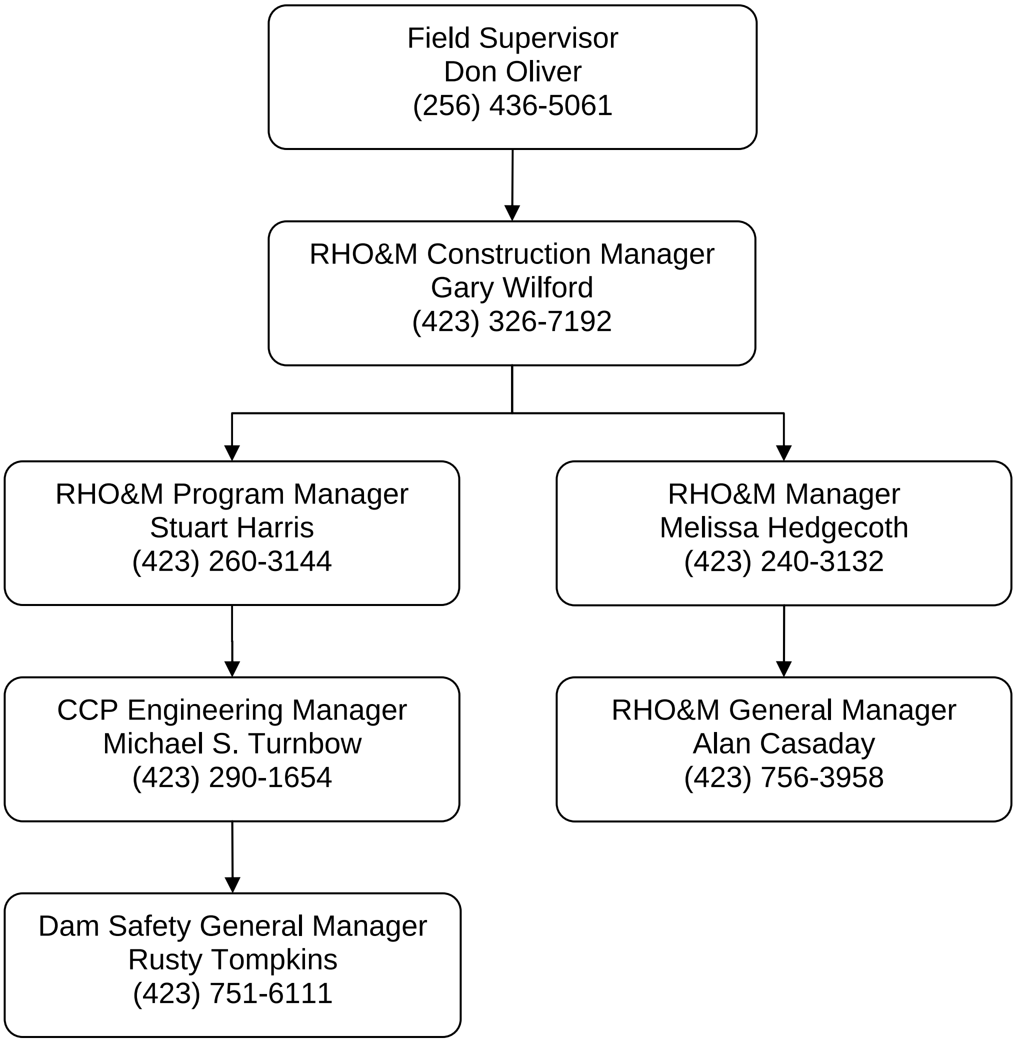


Figure 8. Level 2 Emergency Contact Flowchart

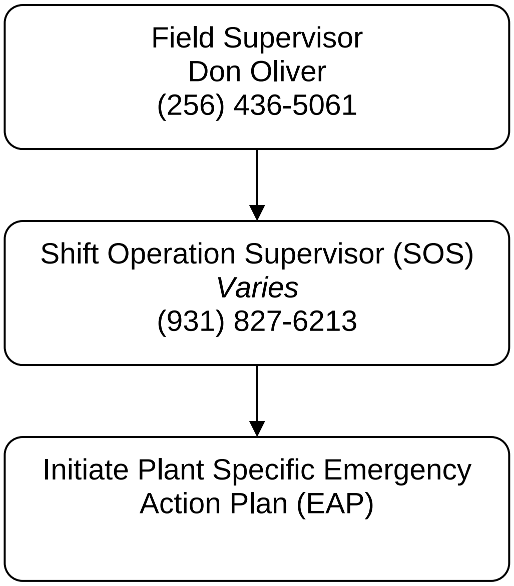


Figure 9. Level 3 Emergency Contact Flowchart

Appendix A

Ash Pond, Dry Ash Stack and Gypsum Stack Complex Site Plan

Notes:

1. The areas identified on this drawing should not be considered as the only areas where seepage might occur. Therefore, a complete inspection of the dike should be performed annually as outlined in Stantec's Dam Safety Training Presentation dated August, 2009.
2. Grid spacing is 500 feet.

LEGEND

N

Areas of Concern

Stockpile Location

Potential Seepage Zone

Feet
0 250 500

STANTEC
CONSULTING
SERVICES INC.

1409 N. Forbes Rd.
Lexington, Kentucky
40511-2050
859-422-3000

Stantec

SEEPAGE ACTION PLAN

Tennessee Valley Authority
Cumberland Fossil Plant
Cumberland, Houston County, Tennessee

PROJECT NO.	175560021
DATE	MAY 2010
DRAWN BY	AMG
CHECKED BY	
CHECKED BY	
SCALE	1" = 500'
REVISED	
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

SHEET

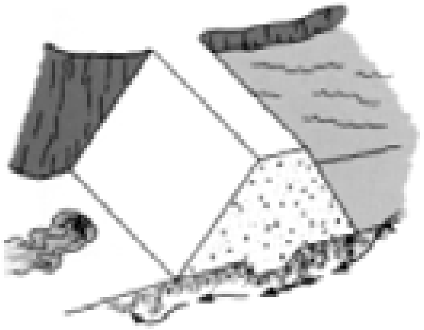
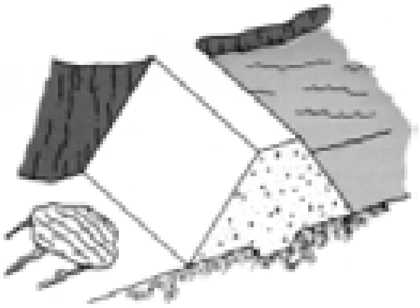
1 OF 1

V:\1755\active\175560021\gis\mxd\cumberland.mxd

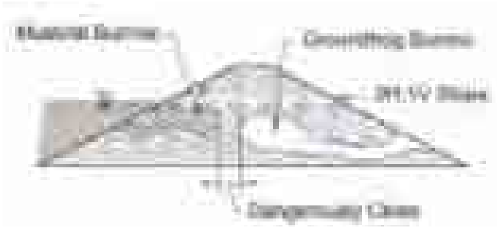
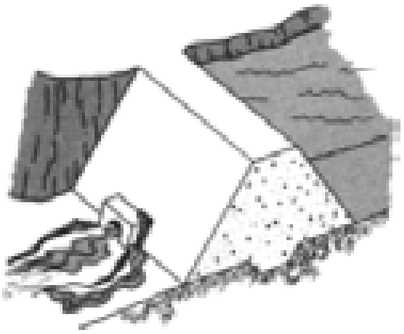
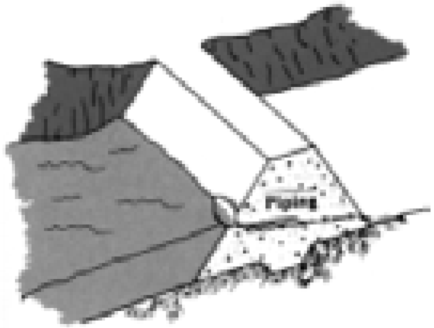
Appendix B

Possible Seepage Problems and Recommendations

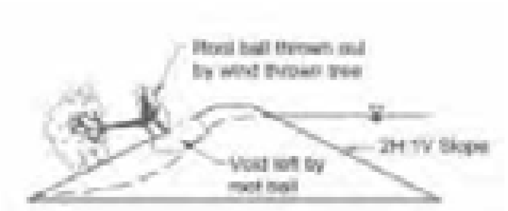
Appendix B – Possible Problems and Recommendations

Seepage Problem	Recommendations
Seepage Water Exiting at Abutment Contact  	Study leakage area to determine quantity of flow and extent of saturation. Stake out the saturated area and monitor for growth or shrinkage. Inspect frequently for slides. Water level in the impoundment may be lowered to increase embankment safety. A QUALIFIED ENGINEER should inspect the conditions and recommend further actions to be taken.
Seepage Water Exiting as a Boil in the Foundation 	Examine boil for transportation of foundation materials, evidenced by discoloration. If soil particles are moving downstream, create a sand bag or earth dike around the boil. This is a temporary control measure. The pressure created by the water level within the dike may control flow velocities and prevent further erosion. If erosion continues, lower the reservoir level. A QUALIFIED ENGINEER should inspect the condition and recommend further actions to be taken.
Spongy Condition at Toe of Dam 	Carefully inspect the area for outflow quantity and any transported material. A QUALIFIED ENGINEER should inspect the condition and recommend further actions to be taken.

Appendix B – Possible Problems and Recommendations

Seepage Problem	Recommendations
Rodent Activity 	Control rodents to prevent more damage. Determine exact location of digging and extent of tunneling. Remove rodents and backfill existing holes.
Seepage Water Exiting from a Point Adjacent to the Outlet 	Investigate the area by probing and/or carefully shoveling to see if the cause can be determined. Determine if leakage water is carrying soil particles evidenced by discoloration. Determine quantity of flow. If flow increases, or is carrying embankment materials, reservoir level should be lowered until leakage stops. A QUALIFIED ENGINEER should inspect the condition and recommend further actions to be taken.
Sinkhole  	Inspect other parts of the dam for seepage or more sinkholes. Identify exact cause of sinkholes. Check seepage and leakage outflows for dirty water. A QUALIFIED ENGINEER should inspect the conditions and recommend further actions to be taken.

Appendix B – Possible Problems and Recommendations

Seepage Problem	Recommendations
Trees and Brush 	Remove all trees and shrubs on and within 25 feet of the embankment. Properly backfill void with compacted material. A QUALIFIED ENGINEER may be required.

Source: Connecticut Department of Environmental Protection, Guidelines for Inspection and Maintenance of Dams, September 2001.

Appendix C

Seepage Log

CUF Seepage Log

Cumberland Fossil Plant
Cumberland City, Tennessee
Updated June 14, 2010 Rev. 1

Area of Concern	Northing	Easting	Date Initially Observed	Time	Approximate Size (Linear Feet)	SAP Level	Description	Mitigation Status/ Future Plans
1	728264.15	1512555.40	8/1/2009	N/A	100' W x 20' H	2	Seep identified in August 2009. Area is wet and soft. There is one small area of flow, with the flow being less than 1 gpm. No movement of soil particles has been observed.	A seepage collection blanket has been designed by Stantec and will be incorporated into the perimeter ditch/slope buttress project.
2	728813.36	1510875.59	2005	N/A	200' W x 30'H	1	Slope failure along perimeter dike at the southwest corner of the complex occurred in 2005. It was reported that seepage was observed. It was addressed by the placement of rip-rap over the area.	Temporary slope repairs consisted of placing riprap on slope. A construction work plan has been prepared to install a subsurface drain and perform permanent slope repairs. Work is scheduled to be completed in the summer of 2010.
3	Survey Requested		5/26/2010	N/A	3' x 3'	1	Seep identified on the southeast toe of dike between subdrain-14 and subdrain-15	Seep should be observed for changes.

Note: Initial Seepage Log was developed based on Stantec's understanding of known issues from Phase 1 and Phase 2 assessments and the 2010 Annual Inspection. No field visit was conducted to verify current seepage areas of concern.

Area of Concern 1

8/31/09
Seepage along the southeast toe of dike.

Area of Concern 1

3/9/10
Seepage along the southeast toe of dike.

Area of Concern 2

6/9/09
Slope failure located along the perimeter of the southwest corner of the complex.

Area of Concern 2

1/19/10
Slope failure located along the perimeter of the southwest corner of the complex. Rip-rap placed over failure.

Area of Concern 3

5/26/2010
Area of erosion and seep located between subdrain-14 and subdrain-15 on the exterior slope of the perimeter ash dike on the south side of the complex.

Appendix D

COF CCP Emergency Action Plan

APPENDIX A

Document 10

2011 Annual Inspection of CCP Facilities Ponds, July 19, 2011

2011 Annual Inspection of CCP Facilities and Ponds

Cumberland Fossil Plant
Cumberland City,
Stewart County, Tennessee

Stantec Consulting Services Inc.
One Team. Infinite Solutions
11687 Lebanon Road
Cincinnati, OH 45241
Tel: (513) 842-8200 • Fax: (513) 842-8250
www.stantec.com

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

July 19, 2011

Stantec

Stantec Consulting Services Inc.
11687 Lebanon Road
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Tel: (513) 842-8200
Fax: (513) 842-8250

July 19, 2011 rpt_001_175531011

Mr. Michael Turnbow
Tennessee Valley Authority
1101 Market Street
LP 2G-C
Chattanooga, Tennessee 37402

Re: 2011 Annual Inspection of CCP Facilities and Ponds
Cumberland Fossil Plant
Cumberland City, Stewart County, Tennessee

Dear Mr. Turnbow:

Stantec Consulting Services Inc. (Stantec) has completed the 2011 annual inspections for the CCP Facilities and Ponds at the Cumberland Fossil Plant (CUF). Facilities reviewed included:

- Coal Yard Drainage Basin
- Chemical Treatment Pond
- Active Ash Pond
- Dry Fly Ash Stack
- Gypsum Disposal Complex

The field work was executed on June 20, 2011. The results of the work along with facility-specific recommendations for maintenance or other activities are included on the enclosed documents. The preparation of work plans was recommended when the deficiencies identified were considered to require some engineering evaluation, or when multiple deficiencies were observed across a wide area and did not lend themselves to recommendations for repair on a case-by-case basis. In addition, the following general plant-wide recommendations and comments are offered:

- It is recommended that vegetation maintenance continues. If lack of vegetation is observed during these operations, re-seeding should be performed as soon as possible. If vegetation establishment difficulties continue in any areas, then TVA should consider refining existing procedures or developing site-specific specifications which address topsoil, fertilizing, seed mixtures, etc.

- It is recommended that TVA catalog, assign a responsible party and due date, and track the completion of the facility-specific recommendations provided herein.
- Note that this scope did not include a review of the current Operations and Maintenance Manual (O&M) for CUF.
- It is recommended that TVA personnel continue dike inspections/monitoring to look for changes or conditions that might affect dike integrity. The frequency and procedures for inspections should be consistent with TVA's inspection program. Particular emphasis should be placed on reviewing and monitoring the seepage areas for changed or worsened conditions, and identifying and repairing other maintenance items such as animal burrows, erosion, and lack of vegetation.

Stantec appreciates the opportunity to provide continued engineering services for the fossil plants. If you have any questions, or if we may be of further assistance, feel free to contact our office.

Sincerely,

STANTEC CONSULTING SERVICES INC.

Stan A. Harris

Daniel B. Rogers lfb

Stan A. Harris, PE
Principal

Daniel B. Rogers, PE
Senior Project Engineer (Geotechnical)

/lfb

Enclosures

Executive Summary

Stantec Consulting Services Inc. (Stantec) in conjunction with TVA Surveying has completed an Annual Inspection of the five facilities at Cumberland Fossil Plant (CUF). These facilities include: Active Ash Pond, Chemical Treatment Pond, Coal Yard Drainage Basin (CYDB), Dry Fly Ash Stack and Gypsum Disposal Complex. This inspection was performed to evaluate the current conditions of the disposal facilities and to provide recommendations for improvement.

During the inspection and reporting process, each facility was inspected by a team of three individuals who walked the perimeter of each facility and recorded the locations of seeps, instabilities, erosional features and other inconsistencies that may affect the stability of the containment system. Once the inspection was complete, the notes, photographs and location coordinates of each item were compiled for each facility and are presented in the following report.

The forms that were completed for each facility include a list of deficiencies that were discovered and recommendations for mitigation. For reference, these deficiencies and recommendations were compiled and are presented below.

Ash Pond

- It is recommended that the rutting adjacent to the crest of the dike be repaired in accordance with the General Guidelines. Additionally, the areas of erosion observed along the exterior divider dike should be monitored and repaired in accordance with General Guidelines. (Priority 4)
- The wave action erosion along the north and west interior dike faces should be addressed by rip-rap armoring as addressed in the general guidelines (Enclosure J). However, this work should be scheduled after the completion of Work Plan 7.
- The drainage ditch on the east side of the Active Ash Pond should be cleaned of phragmites and any accumulated sedimentation. The slope of the ditch in this area should be evaluated to assess if better flow is possible to alleviate the standing water observed. (Priority 4)
- Observation of the toe of the exterior slope on the north side of the Stilling Pond should continue in order to assess if the moist slope is a result of seepage or surface runoff as a result of recent rain events. (TVA Quarterly Inspection Item 2) This should be completed in accordance with the Seepage Action Plan.
- Observation of the moist areas on the midslope and toe of the west exterior slope of the Active Ash Pond should continue to determine if these are seeps or if they are moist from recent precipitation. Any changes in the flow or color of these areas should be reported to Fossil Engineering Design Services (EDS). This should be completed in accordance with the Seepage Action Plan.
- Areas where tire rutting is observed along both the interior and exterior slopes should be repaired and reseeded as described in Enclosure H. Special care should be taken, if possible, to not perform maintenance on the slopes of the ponds during conditions that could result in rutting. (Priority 5).

The trees observed on the interior divider dike should be removed in accordance with the guidelines given in Enclosure F (Priority 4).

Chemical Treatment Pond

- The area around the concrete gutter at the outlet of the recirculation pipe on the east slope of the pond should be monitored for erosion (see Photo 1). This area should be examined during recirculation in order to determine if the gutter is capable of containing the flow. If the gutter is overtopped or if splashing occurs causing the water not to be contained in the gutter, the gutter should be widened. (Priority 5)

Coal Yard Drainage Basin

- The pond should also be sounded as needed to determine when dredging will be required. (Priority 5)
- It is recommended that the small trees that are beginning to grow along the south slope be removed in accordance with the guidelines shown in Enclosure F. (Priority 4)
- It is recommended that the depression observed in the south slope be monitored in accordance with the currently established stability monitoring program (See Photo 3). Any evidence of erosion or slope movement within this area should be reported to Stantec.
- The observed slope instability in the face of the south slope should be regarded and vegetated (see Photo 4). (Priority 3)
- The animal burrows observed on the interior slopes on the east and northeast sides of the CYDB should be repaired in accordance with the guidelines given in enclosure G. (Priority 3)
- It is recommended that a work plan be prepared to address the rutting/erosion spots observed on the west and north slopes, as well as the erosion detected on the platform for the pump station. It is expected that riprap will be needed to stabilize each slope. This work should be conducted in accordance with the general guidelines included in Enclosures H and I. (Priority 4)
- The pond was dredged in 2007 to a cell built in the Dry Fly Ash Stack area. Since that time, sedimentation has continued along the northwest portion of the pond resulting in the effectiveness of the floating boom in this area being compromised. Sedimentation accumulation was also observed in the southeast portion of the pond. Consider removing the sediment built up along the base of the pond in both locations. (Priority 5)
- The pond should also be sounded as needed to determine when dredging will be required. (Priority 5)

- The small trees that are beginning to grow along the south slope be removed in accordance with the general guidelines. (Priority 4)

- The depression observed in the south slope should be monitored in accordance with TVA's Inspection Program. Any evidence of erosion or slope movement within this area should be reported to Stantec.

- The observed slope instability in the face of the south slope should be re-graded and vegetated (see Photo 4). (Priority 3)

- The animal burrows observed on the interior slopes on the east and northeast sides of the CYDB should be repaired in accordance with the general guidelines (Priority 3)

- Erosion spots were observed on the west and north slopes, as well as on the platform for the pump station. It is expected that rip-rap will be needed to stabilize each slope. This work should be conducted in accordance with the general guidelines (Priority 4)

Dry Fly Ash Stack

- The perimeter drainage ditch should be cleaned of large vegetation and sedimentation. (Priority 4) When localized areas of standing water are encountered, it is recommended that these areas be cleared so as to not allow standing water to saturate the ditch and/or the embankment. (Priority 4) Trans Ash is currently operating in this area and should be notified when these situations occur.
- The areas of seepage noted within this report and on the Seep Log should be monitored in accordance with the Seepage Action Plan. Any changes in the flow, size or color of these seepage areas should be reported to EDS.
- The erosion observed on the outslope of the Bottom Ash Pond should be monitored and repaired in accordance with the general guidelines which are included in Enclosure I. (Priority 4)
- The area of sparse vegetation observed on the south west exterior slope of the stack should be monitored as part of TVA's Inspection Program and repaired as conditions warrant. This area should be reworked, graded, and a new soil cover be installed suitable to support vegetation. The area should then be seeded as described in the general guidelines.

Gypsum Disposal Complex

- As the interior cells drain to the southwest corner, flow drops several feet from the discharge pipes down to the rip-rap channel below. Although the rip-rap appears to be controlling erosion at the toe of the slope, continued erosion could undermine the toe. It is recommended that this area be monitored for erosion and stabilization issues during the course of TVA's inspection program and appropriate action taken if problems are noted.
- The perimeter drainage ditch should be cleaned of phragmites and sedimentation. (Priority 4) When localized areas of standing water are encountered, it is

recommended that these areas be cleared so as to not allow the standing water to saturate the ditch and/or the embankment. (Priority 4) Trans Ash is currently operating in this area and should be notified when these situations occur.

- The seep locations observed on the exterior slopes of the perimeter dike on the southwest side should continue to be monitored as described in the Seepage Action Plan. Any changes to the flow or color of these seepage areas should be reported to Stantec.
- The areas of erosion at the outlet of the subdrains along the exterior slopes of the ash dike above the perimeter ditch should be repaired in accordance with the guidelines included in Enclosure I. This work should be coordinated with the execution of Work Plans 11 and 8.
- The seeps (TVA-CUF Seep Log) along the perimeter clay dike at the southwest corner of the complex and the perimeter ash dike on the south perimeter clay dike should be monitored for signs of movement or changes in seepage that may be indicative of slope failure. Any changes should be reported to Stantec.
- The area of erosion of the access road to the north side of the complex should be monitored and repaired in accordance with the guidelines included in Enclosure I. (Priority 5)
- The observed rutting should be repaired in accordance with the general guidelines presented in Enclosure H. Additionally, alternate mowing procedures should be used for the complex to prevent surface rutting of the vegetation cover.
- It is recommended that a work plan be prepared that would address the areas of barren cover soil (see Photo 11) along the exterior slopes of the complex. This work should be conducted in accordance with the guidelines presented in Enclosure F (Priority 4)
- The inlet and outlets of all drainage pipes should be monitored as part of TVA's Inspection Program and cleared as conditions warrant.

Enclosure A

Coal Yard Drainage Basin

TVA 2011 Annual Inspection Program
Cumberland Fossil Plant (CUF)
Coal Yard Drainage Basin (CYDB)

1. General Facility Information

Facility Status:	Active	NID Identification:	Not Available
Surface Area (inside dikes):	5.4 acres	TVA Hazard Classification:	Not Ranked
Maximum Height (toe to top of dike):	20 feet	Dike Length:	2,850 feet (0.54 miles)
Plant Discharge to Facility:	2.0 MGD (Average)	Current Pool Elevation:	377.0 feet (Average)

2. Site Visit Information

Stantec Inspection Team:	Daniel B. Rogers and James R. Swindler Jr.
TVA Staff Present:	M. Jacob Horton
Field Inspection Date:	6/20/2011
Weather/Site Conditions:	Sunny and 85 degrees. The slopes were generally moist due to recent precipitation (previous day)

3. History/Current and Future Operations

History:	The Coal Yard Drainage Basin (CYDB) is located south of the powerhouse, northeast of the Gypsum Disposal Complex. The CYDB collects the storm drainage from the coal yard and many other areas of the plant.
Current Operations:	The storm drainage is temporarily stored in the CYDB. When the CYDB reaches a pre-determined water elevation, or in anticipation of a precipitation event, pumps are activated to lower the pond level. These pumps discharge into the main perimeter ditch system and the flow eventually makes it's way to the Active Ash Pond.
Future Planned Operational Changes:	None

4. Stantec Field Observations

See attached Photos and Site Plan Drawing.

4.1. Interior Slopes

Vegetation:	Heavily vegetated with phragmites at the base of all slopes. There are isolated patches on the south slope that are barren of vegetation cover.
Trees:	Small trees were observed at the base of the south slope of the basin. (See Photo 1)
Wave Wash Protection:	Heavily vegetated with phragmites at the base of all slopes. Rip-rap protection was limited to the pad supporting the pump station.
Erosion:	One area of erosion was observed during the inspection. This area was on the west slope of the basin near an apparent drainage feature (see Photo 2).
Instabilities:	Some of the slopes were not visible due to the heavy growth of vegetation around the pond. On the portions of the slopes that were visible, there were two noted stability issues. • There is a depression in the dike face that extends from the crest to below the water surface. (See Photo 3) • There is a minor slip in the south slope just to the west of the access to the pumps. (See Photo 4) This appears to be surfacial and not deep seated. • There is general rutting of the south slope from the crest to mid-slope. Vegetation is also sparse. This appears to be caused by mowing equipment. (See Photo 5)
Animal Burrows:	There were a total of 2 burrows noted during the inspection. They were located on the east slope and the northeast corner. They were probed to depths of 1-3 feet. (See Photo 6)
Freeboard:	Minimum estimated to be 4 to 6 feet.
Encroachments:	Pump station at the southeast corner of the pond (see Photo 1).
Slope:	Estimated to be on the order of 2H:1V with slightly steeper slopes observed along the south side of the pond where an ash perimeter dike acts as the boundary.

4.2. Crest

Crest Cover and Slope:	Gravel road on the south side, vegetation cover on all other sides. No slope.
Erosion:	None observed.
Alignment:	The alignment was observed to be generally straight.
Settlement/Cracking:	None observed.
Bare Spots/Rutting:	None observed.
Width:	Gravel road on south side, approximately 12 feet.

4.3. Exterior Slopes

Vegetation:	N/A
Trees:	N/A
Erosion:	N/A
Instabilities:	N/A
Uniform Appearance:	N/A
Seepage:	N/A
Benches:	N/A
Foundation Drains, and Seepage Collection Systems:	N/A
Instrumentation:	N/A
Animal Burrows:	N/A
Slope:	N/A
Height:	N/A

4.4. Spillway Weirs/Riser Inlets

Number:	N/A
Size, Type and Material:	N/A

Height of Riser Inlets:	N/A
Access:	N/A
Joints:	N/A
Mis-Alignment:	N/A
Closed/Abandoned Conduits:	N/A

4.5. Outlet Pipes

Number:	There are three plant pumps on the pump deck, located on the southeast corner of the pond, approximately 6-inch diameter outlets.
Size, Type and Material:	Steel, 6-inch diamater pipes that tie into a 24-inch diameter steel pipe that discharges up the slope and into the drainage channel on the northeast side of the Gypsum Disposal Complex.
Headwall:	N/A
Joint Separations:	N/A
Mis-Alignment:	N/A
Closed/Abandoned Conduits:	N/A

5. Repairs/Mitigation/New Construction Activities Since Last Annual Inspection

The following improvement was performed at the CYDB since the last annual inspection:

- No repairs were evident

6. Recommendations

The following recommendations are offered for the CYDB. Priority codes are included in parenthesis and described in Enclosure K.

- The pond was dredged in 2007 to a cell built in the Dry Fly Ash Stack area. Since that time, sedimentation has continued along the northwest portion of the pond resulting in the effectiveness of the floating boom in this area being compromised (see Photo 2). Sedimentation accumulation was also observed in the southeast portion of the pond (see Photo 7). Consider removing the sediment built up along the base of the pond in both locations. (Priority 5)

- The pond should also be sounded as needed to determine when dredging will be required. (Priority 5)
- It is recommended that the small trees that are beginning to grow along the south slope be removed in accordance with the guidelines shown in Enclosure F. (Priority 4)
- It is recommended that the depression observed in the south slope be monitored in accordance with the currently established stability monitoring program (See Photo 3). Any evidence of erosion or slope movement within this area should be reported to Stantec.
- The observed slope instability in the face of the south slope should be re-graded and vegetated (see Photo 4). (Priority 3)
- The animal burrows observed on the interior slopes on the east and northeast sides of the CYDB should be repaired in accordance with the guidelines given in Enclosure G. (Priority 3)
- It is recommended that a workplan be prepared to address the rutting/erosion spots observed on the west and north slopes, as well as the erosion detected on the platform for the pump station. It is expected that rip-rap will be needed to stabilize each slope. This work should be conducted in accordance with the general guidelines included in Enclosures H and I. (Priority 4)

TVA 2011 Annual Inspection Program
Cumberland Fossil Plant (CUF)
Coal Yard Drainage Basin (CYDB)
Photos

Photo 1

Small tree growth along the south slope of the Coal Yard Drainage Basin (CYDB).

Photo 2

Erosion at drainage feature on the west slope of the CYDB.

Photo 3

Depression in dike face. Not previously noted due to vegetation coverage.

Photo 4

Minor surface slip on the south interior dike face.

Photo 5

Rutting and sparse vegetation on the south interior slope face.

Photo 6

Animal burrow observed on the east slope.

Photo 7

Sediment accumulation at primary inlet of CYDB.

Enclosure B

Chemical Treatment Pond

TVA 2011 Annual Inspection Program
Cumberland Fossil Plant (CUF)
Chemical Treatment Pond

1. General Facility Information

Facility Status:	Active	NID Identification:	Not Available
Surface Area (inside dikes):	1.9 Acres	TVA Hazard Classification:	Not Rated
Maximum Height (toe to top of dike):	6.5 feet	Dike Length:	1300 feet (0.25 miles)
Plant Discharge to Facility:	>0.1 MGD Average	Current Pool Elevation:	380.8 feet

2. Site Visit Information

Stantec Inspection Team:	Daniel B. Rogers and James R. Swindler Jr.
TVA Staff Present:	M. Jacob Horton
Field Inspection Date:	06/20/2011
Weather/Site Conditions:	Mostly Sunny, 85 degrees. Slopes were moist from the recent precipitation

3. History/Current and Future Operations

History:	The Chemical Treatment Pond is located east of the Coal Yard Drainage Basin, northeast of the Gypsum Disposal Complex. The southern and eastern boundaries of this area are formed by a slope that was excavated into existing ground. The northern and western boundaries are formed by a dike that seperates this pond from the Coal Yard Drainage Basin.
Current Operations:	Allows metals to precipitate out of solution by recirculating the water using a pump, from the west end to the east end. The pond is only used occasionally. The effluent is pumped to the Active Ash Pond when treatment is complete.
Future Planned Operational Changes:	TVA has intentions to close this facility in the future, however no construction plans have been produced.

4. Stantec Field Observations

See attached Photos and Site Plan Drawing.

4.1. Interior Slopes

Vegetation:	The interior slopes are heavily vegetated above the rip-rap erosion control.
Trees:	None observed.
Wave Wash Protection:	The interior slopes are covered with rip-rap protection along all sides.
Erosion:	Much of the slopes were not visible due to the heavy growth of vegetation around the pond. The portions of the slope that were visible showed no signs of erosion.
Instabilities:	Much of the slopes were not visible due to the heavy growth of vegetation around the pond. The portions of the slope that were visible appear to have no stability problems.
Animal Burrows:	None observed.
Freeboard:	Approximately 6.5 feet.
Encroachments:	Pump station on the west end of the pond.
Slope:	Slopes of the pond are estimated to be on the order of 2H:1V or flatter.

4.2. Crest

Crest Cover and Slope:	Gravel road on the south side, vegetation cover on all other sides. No slope.
Erosion:	None observed.
Alignment:	Generally straight and level.
Settlement/Cracking:	None observed.
Bare Spots/Rutting:	None observed.
Width:	Gravel road on south side, approximately 12 feet.

4.3. Exterior Slopes

Vegetation:	N/A

Trees:	N/A
Erosion:	N/A
Instabilities:	N/A
Uniform Appearance:	N/A
Seepage:	N/A
Benches:	N/A
Foundation Drains, and Seepage Collection Systems:	N/A
Instrumentation:	N/A
Animal Burrows:	N/A
Slope:	N/A
Height:	N/A

4.4. Spillway Weirs/Riser Inlets

Number:	N/A
Size, Type and Material:	N/A
Height of Riser Inlets:	N/A
Access:	N/A
Joints:	N/A
Mis-Alignment:	N/A
Closed/Abandoned Conduits:	N/A

4.5. Outlet Pipes

Number:	N/A
Size, Type and Material:	N/A
Headwall:	N/A
Joint Separations:	N/A

Mis-Alignment: N/A

Closed/Abandoned Conduits: N/A

5. Repairs/Mitigation/New Construction Activities Since Last Annual Inspection

The following improvement was performed at the Chemical Treatment Pond since the last annual inspection:

- Bare areas on the slope that were noted in 2010 were not observed this year. It is presumed that these were repaired by TVA staff.

6. Recommendations

The following recommendation is offered for the Chemical Treatment Pond. Priority codes are included in parenthesis and described in Enclosure K.

- It is recommended that the area around the concrete gutter at the outlet of the recirculation pipe on the east slope of the pond be monitored for erosion (see Photo 1). This area should be examined during recirculation in order to determine if the gutter is capable of containing the flow. If the gutter is overtopped or if splashing occurs causing the water not to be contained in the gutter, the gutter should be widened. (Priority 5)

Photo 1

Recirculation pipe and concrete gutter at the east slope of the pond.

Enclosure C

Active Ash Pond

TVA 2011 Annual Inspection Program
Cumberland Fossil Plant (CUF)
Active Ash and Stilling Ponds

1. General Facility Information

Facility Status:	Active	NID Identification:	TN16109
Surface Area (inside dikes):	54.6 acres	TVA Hazard Classification:	High
Maximum Height (toe to top of dike):	42 feet (Approx)	Dike Length:	Approximately 4,100 feet (0.78 miles) external; approximately 2,000 feet (0.38 miles) internal. Total is approximately 6,100 feet (1.16 miles).
Plant Discharge to Facility:	21.7 MGD	Current Pool Elevation:	384.23 feet (MSL)

2. Site Visit Information

Stantec Inspection Team:	Daniel B. Rogers and James R. Swindler Jr.
TVA Staff Present:	M. Jacob Horton
Field Inspection Date:	06/20/2011
Weather/Site Conditions:	Mostly Sunny, 85 degrees

3. History/Current and Future Operations

History:

The Active Ash Pond is west of the powerhouse and north of the Dry Fly Ash Stack. This disposal area was constructed in 1969. As part of this construction, Wells Creek was relocated in order to construct what was initially known as Disposal Area 1. As a result, portions of the current Active Ash Pond and Dry Stack were constructed over the original location of Wells Creek. Area 1 was located within the perimeter dikes that now include the current ash and gypsum disposal areas. In 1977, the divider dike for the stilling pool to the north (interior divider dike) was constructed of ash. In 1979, the dikes around the Active Ash Pond were raised to elevation 395 feet with clay. In 1986, approximately 300 feet of the west portion of the divider dike between the Ash Pond and the Dry Ash Stack was constructed of ash. During 1995-1996, the current divider dike between the Ashp Pond and the Dry Stack was constructed (exterior divider dike) to form the current configuration.

Current Operations:	The pond receives runoff from the adjacent Dry Fly Ash Stack to the south, the Gypsum Disposal Complex to the southeast, process water from the Bottom Ash Pond, and effluent from various other plant operations and sumps. The effluent flows northwest to the Active Ash Pond Pond and then under a floating skimmer to the Stilling Pond. Runoff from the Dry Fly Ash Stack and Gypsum Disposal Complex flows to the Active Ash Pond via perimeter ditches and piping which extends through the exterior divider dike. The discharge from the Stilling Pond flows to the river via the Condensing Cooling Water Discharge Channel. Four spillways are located along the northeast side of the Stilling Pond with outlets below the adjacent road. These outlets are 48-inch RCP riser pipe/weirs that discharge through four 36-inch RCP sections. Approximately 135,000 dry tons of bottom ash is wet sluiced to the Ash Pond annually. Dewatered bottom ash is reclaimed by pan-scrapers and hauled to construct the Dry Fly Ash Stack.
Future Planned Operational Changes:	During the construction of an emergency spillway, the pool level of the ash pond will be lowered to approximately 378 feet elevation. The designs for this construction have been completed and a contract for the work has been issued. The construction is projected to be completed in 2011.

4. Stantec Field Observations

See attached Photos and Site Plan Drawing.

4.1. Interior Slopes

Vegetation:	The interior slope of the east corner of the Active Ash Pond is vegetated with phragmites. Phragmite vegetation has been cut along toe of the remaining interior slopes of the Active Ash Pond, the interior divider dike, and the interior slopes of the Stilling Pond; but the base of the phragmite vegetation remains (see Photo 1).
Trees:	There were a few small trees in the interior divider dike

	(See Photo 2).
Wave Wash Protection:	The interior divider dike consists of rip-rap along the slope faces. There is rip-rap along the northeast slope of the Stilling Pond at the spillway locations. One area of rip-rap was placed for wave erosion protection on the north interior slope.
Erosion:	Minor erosion was observed around the 36-inch HDPE drain pipe, located along the west end of the exterior divider dike between the Active Ash Pond and the Dry Fly Ash Stack. Several other areas of minor erosion along the divider dike were also observed. Wave action erosion was observed along the toe of the interior slopes of the Active Pond. A small area of rip-rap protection was placed, however more will be required. (TVA Item 1, See Photos 6 and 7)
Instabilities:	The interior slopes appear to be stable.
Animal Burrows:	None observed.
Freeboard:	Approximately 11 feet.
Encroachments:	None observed.
Slope:	The interior slopes of the perimeter dikes of the Active Ash Pond are on the order of 2.5H:1V. The slopes of the interior divider dike are on the order of 1.8H:1V. The interior slope of the exterior divider dike is on the order of 2.2H:1V or flatter.

4.2. Crest

Crest Cover and Slope:	Gravel road on all sides, including divider dikes. No slope of the crest was observed.
Erosion:	None observed.
Alignment:	Generally straight or unicormly curved. No unconformities observed.
Settlement/Cracking:	None observed.
Bare Spots/Rutting:	None observed.
Width:	Approximately 12 feet.

4.3. Exterior Slopes

Vegetation:	The exterior slopes have good vegetation established.
Trees:	None observed.
Erosion:	Tire rutting was observed on the exterior slope along the east side of the Stilling Pond (see Photo 3). This is presumably due to mower rutting.
Instabilities:	The exterior slopes appear to be stable.
Uniform Appearance:	All slopes for the Active Ash Pond and the Stilling Pond are uniform in appearance. The south slope of the Ash Pond does not have an exterior slope, as the Dry Fly Ash Stack serves as its boundary.
Seepage:	Seepage/wet spots were observed at the toe of the perimeter dike and at the midslope of the perimeter dike on the west side of the Active Ash Pond (see Photo 4).
Benches:	None observed.
Foundation Drains, and Seepage Collection Systems:	None observed.
Instrumentation:	As part of the geotechnical exploration conducted between April and July, 2009, Stantec installed four slope inclinometers and 8 piezometers around the crest and at midslope of the Ash Pond. During a system wide project, TVA has had many of the instruments automated.
Animal Burrows:	None observed.
Slope:	The exterior slopes of the perimeter dike are on the order of 2.7H:1V or flatter.
Height:	Approximately 42 feet from toe to crest.

4.4. Spillway Weirs/Riser Inlets

Number:	Four, located on the northeast slope of the Stilling Pond (see Photo 5).
Size, Type and Material:	48-inch riser pipe/weirs.

Height of Riser Inlets:	Unable to measure.
Access:	Walkways from the toe of the northeast interior slope of the Stilling Pond are used to access the spillways. The walkways were in good condition with some rusting observed.
Joints:	Unable to observe.
Mis-Alignment:	None observed.
Closed/Abandoned Conduits:	None observed.

4.5. Outlet Pipes

Number:	Four, located below the adjacent entrance road.
Size, Type and Material:	36-inch RCP sections.
Headwall:	None observed.
Joint Separations:	Unable to observe.
Mis-Alignment:	None observed.
Closed/Abandoned Conduits:	None observed.

5. Repairs/Mitigation/New Construction Activities Since Last Annual Inspection

The following improvements were performed at the Active Ash and Stilling Ponds since the last annual inspection:

- The animal burrow observed to the north of the floating skimmer on the perimeter dike at the entrance to the Stilling Pond has been filled.
- The roots observed on the west side of the pond have been removed.
- Rip-rap wave protection has been added on the north interior slope of the stilling pond.
- The pipe observed in the exterior slope on the west side of the pond was removed. It was not embedded more that 1 foot into the dike. The pipe was removed and the remaining depression was filled.

6. Recommendations

The following recommendations are offered for the Active Ash and Stilling Ponds. Priority codes are included in parenthesis and described in Enclosure K.

- It is recommended that a workplan be prepared to address the erosion locations observed during the inspection. These areas of erosion observed along the exterior divider dike should be monitored and repaired as conditions warrant. (Priority 4) The wave action erosion should be addressed by rip-rap armoring as addressed in the general guidelines (Enclosure J). However, this work should be scheduled after the completion of Work Plan 7.
- It is recommended that the drainage ditch on the east side of the Active Ash Pond be cleaned of phragmites and any accumulated sedimentation. The slope of the ditch in this area should be evaluated to assess if better flow is possible to alleviate the standing water observed. (Priority 4)
- Observation of the toe of the exterior slope on the north side of the Stilling Pond should continue in order to assess if the moist slope is a result of seepage or surface runoff as a result of recent rain events. (TVA Quarterly Inspection Item 2) This should be completed in accordance with the Seepage Action Plan.
- Observation of the moist areas on the midslope and toe of the west exterior slope of the Active Ash Pond should continue. Any changes in the flow or color of these seepage areas should be reported to Fossil Engineering Design Services (EDS). This should be completed in accordance with the Seepage Action Plan.
- Areas where tire rutting is observed along both the interior and exterior slopes should be repaired and reseeded as described in Enclosure H. Special care should be taken, if possible, to not perform maintenance on the slopes of the ponds during conditions that could result in rutting. (Priority 5)
- The trees observed on the interior divider dike should be removed in accordance with the guidelines given in Enclosure F (Priority 4).

TVA 2011 Annual Inspection Program
Cumberland Fossil Plant (CUF)
Active Ash and Stilling Ponds
Photos

Photo 1

Standing water and phragmites in exterior ditch on the east side of the Active Ash Pond.

Photo 2

View of the interior divider dike within the Active Ash Pond. Few small trees visible.

Photo 3

Rutting and absent vegetation on the exterior slope on the east side of the Stilling Pond.

Photo 4

Area at the exterior midslope and toe of the Active Ash Pond where moist/damp areas were observed.

Photo 5

Spillway location on the east side of the Stilling Pond.

Photo 6

Wave action erosion repaired using rip-rap.

Photo 7

Wave action erosion is present.

Enclosure D

Dry Ash Stack

TVA 2010 Annual Inspection Program
Cumberland Fossil Plant (CUF)
Dry Fly Ash Stack and Bottom Ash Pond

1. General Facility Information

Facility Status: Active

Surface Area:	113 Acres	Maximum Height (toe to top of stack):	65 feet (south and west sides) 35 feet (north side)

2. Site Visit Information

Stantec Inspection Team:	Daniel B. Rogers and James R. Swindler Jr.
TVA Staff Present:	None
Field Inspection Date:	June 20, 2011
Weather/Site Conditions:	Mostly Sunny, 85F Precipitation during the previous days

3. History/Current and Future Operations

History:

The Dry Fly Ash Stack is located south of the Active Ash Pond and west of the powerhouse. In 1972, Wells Creek was relocated in order to construct old Disposal Area 1. This area was enclosed by the existing perimeter dike and contained sluiced ash. In the 1980s, sluicing operations ceased within Area 1 and began in the current Area 2 to the north. Divider dikes were constructed to separate the current pond from the gypsum and ash stacking operations. In 1995-96, the current divider dike (exterior divider dike) between the Active Ash Pond and Dry Fly Ash Stack was constructed.

In 1996, operations within the Dry Fly Ash Stack began. The Dry Fly Ash Stack is bordered by the Active Ash Pond to the north, the Bottom Ash Pond to the East, the Gypsum Disposal Complex to the south, and perimeter ditches and the old Area 1 perimeter dike to the west.

The Bottom Ash Pond is located on the east side of the Dry Fly Ash Stack. Process water from the Bottom Ash Pond is sent to the Active Ash Pond.

Current Operations:

The current operations are intermingled with the construction activities based on the Work Plan 11. In addition to disposing of the newly generated CCP, the operations on the dry fly ash stack consist of re-grading the slopes to improve the stability factor of safety and maintain compliance with the approved facility permit. Runoff from the stack area travels through perimeter ditches to the Active Ash Pond.

The bottom ash deposited is removed by an excavator and placed into off-road dump trucks and hauled to construct the Dry Fly Ash Stack.

Future Planned Operational Changes: No immediate changes planned.

4. Stantec Field Observations

See attached Photos and Site Plan Drawing.

4.1. Exterior Slopes and Benches

Vegetation: Due to the progress of Work Plan 11, the vegetation and interim soil cover is being removed from the Dry Fly Ash Stack (see Photo 1). The vegetation on the exterior slopes of the perimeter dikes appears to be adequate and maintained regularly, however one area of sparse vegetation was noted (see Photo 6).

Trees: None observed.

Erosion: Minor erosion was observed at various locations around the exposed CCP portion of the stack. Due to this being an active work plan, these observed rills will be excavated and graded prior to completion of the project. No significant erosion was noted across the site.

Instabilities: None observed.

Uniform Appearance The slopes display a predominant uniform appearance. There is a bench at the approximate midslope that is used for a construction access road (see Photo 2). Whereas the slope of the perimeter dike for the Dry Fly Ash Stack extends to Wells Creek on the west and southwest sides, the slope extends to a divider dike between the Gypsum Disposal Complex and the Dry Fly Ash Stack on the southeast side.

Benches: There are two benches on the exterior slope on the west side of the stack that serve as access roads. There is one bench that extends along the exterior slope on the east and north sides that is used as an access road.

Slope: The exterior slopes are on the order of 2.7H:1V or flatter and appear stable.

Height:	Approximately 65 feet on the south and west faces. Approximately 35 feet on the north face.
Other:	One seep and two wet areas were recorded during the annual inspection. The first is located just west of the recent slope repair area on the Gypsum Disposal Complex. It is wet and not flowing or transporting sediment. This area was logged as Seep # 15 on the Seep Log for CUF (see Photo 3). A possible seep was noted on the south side of the stack approximately 1000 feet southeast of the construction bridge (see Photo 4). It is not evident if this is a seep or if the area is wet from the recent precipitation. One wet area was observed on the exterior slope of the stack on the North Side (TVA Item Number 5). Each appears at the approximate midslope of the perimeter dike. The previously identified red-water seeps located at the toe of the perimeter dike near the bridge that crosses Wells Creek are still present. The seeps do not appear to be worse than in past inspections. Due to the high water level of Wells Creek, it was not possible to visually inspect the seeps from creek level. During the geotechnical exploration performed by Stantec between April and July, 2009, three slope inclinometers and six piezometers were installed along the west and southwest slopes of the stack. Three of these piezometers were abandoned during the week of June 13-17, 2011 due to conflicts with the current construction projects. The remaining instruments were automated by a separate TVA contractor.

4.2. Perimeter Drainage Ditches and Down-Drains

Vegetation:	During the course of construction of Work Plan 11, the vegetation has been removed from the perimeter ditch (See Photo 2).
Rip-Rap Channel Lining:	None observed.
Erosion:	Eroded fly ash from the stack has deposited sediment within the ditch in several areas.
Sedimentation in Ditches:	Sedimentation from construction activities was observed in the perimeter drainage ditch (see Photo 5). The side slopes of the ditch show shallow sloughs and scarps due to excavations along the ditch to clean them.
Standing Water in Ditches	Standing water was observed along the entire perimeter

or on Benches:	ditch.
Silted/Impeded Drainage Pipes:	None observed.
Other:	N/A

5. Repairs/Mitigation/New Construction Activities Since Last Annual Inspection

The following improvements and activities were performed at the Dry Fly Ash Stack since the last annual inspection:

- Work Plan 11 construction activities have been initiated. These activities include slope re-grading, ditch cleanout and re-grading, buttressing of the ditch and seepage filter construction (where necessary).
- Previously observed animal burrows have been repaired.
- Previously observed erosion areas have been repaired.
- RHO&M daily operations have been turned over to Trans Ash.

6. Recommendations

The following recommendations are offered for the Dry Fly Ash Stack. Priority codes are included in parenthesis and described in Enclosure K.

- It is recommended that the perimeter drainage ditch be cleaned of large vegetation and sedimentation. (Priority 4) When localized areas of standing water are encountered, it is recommended that these areas be cleared so as to not allow standing water to saturate the ditch and/or the embankment. (Priority 4)
- It is recommended that the areas of seepage noted within this report and on the Seep Log be monitored in accordance with the Seepage Action Plan. Any changes in the flow, size or color of these seepage areas should be reported to EDS.
- The erosion observed on the outslope of the Bottom Ash Pond should be monitored and repaired in accordance with the general guidelines which are included in Enclosure I. (Priority 4)
- The area of sparse vegetation (see Photo 6) observed on the south west exterior slope of the stack should be monitored as part of TVA's Inspection Program and repaired as conditions warrant. This area should be reworked, graded, and a new soil cover be installed suitable to support vegetation. The area should then be seeded. (Enclosure F)

Photo 1

Vegetation and soil cover being removed as part of WP 11

Photo 2

Construction access road and vegetation removal from ditch.

Photo 3

Seep #15 adjacent to the completed slope repair project.

Photo 4

Wet area noted just above the bench on the exterior slope.

Photo 5

Sedimentation and obstructions observed in perimeter ditch.

Photo 6

Sparse vegetation on the slope.

Enclosure E

Gypsum Disposal Complex

TVA 2010 Annual Inspection Program
Cumberland Fossil Plant (CUF)
Gypsum Disposal Complex

1. General Facility Information

Facility Status:	Active		
Surface Area:	153 Acres	Maximum Height (toe to top of stack):	60 feet (south side) 30 feet (north side)

2. Site Visit Information

Stantec Inspection Team:	Daniel B. Rogers and James R. Swindler Jr.
TVA Staff Present:	M. Jacob Horton
Field Inspection Date:	June 20, 2011
Weather/Site Conditions:	Mostly Sunny, 85F

3. History/Current and Future Operations

History:

The Gypsum Disposal Complex is located east of the Dry Fly Ash Stack and south of the powerhouse. It was constructed during 1995-1996 and built over Area No. 1, which was the original ash pond. Approximately 1,100,000 tons of gypsum is produced each year. According to TVA personnel, approximately 50 percent of the gypsum is conveyed directly to the adjacent wallboard manufacturing company east of the plant. Gypsum that does not go directly to the wallboard plant is stored in a shed for later use by the wallboard plant or is disposed of on the stack. If the dewatering plant goes offline, slurry is piped to the stack where it travels through a ditch to a sump at the northwest corner. A Siphon system then discharges the flow to the Bottom Ash Pond.

The complex was constructed in several stages beginning with construction of a rock drainage blanket to collect and divert water away from the base. Currently the complex is separated into north and south cells. The complex consists of an upper gypsum dike with a perimeter ash dike at lower elevations. Below the ash dike along the southwest and southeast sides, the area is encompassed by the outer clay perimeter dike at lower elevations. Along the remaining sides, the ash divider dike separates the area from the Dry Fly Ash Stack to the northwest and the perimeter ash dike separates the area from the Coal Yard Drainage Basin and the Chemical Treatment Pond to the northeast. Discharge for the complex is through a reinforced concrete pipe (RCP) riser to outlet pipes in the northwest corner of the complex into the adjacent perimeter

	ditches. The perimeter ditches around the Gypsum Disposal Complex flow to the north along the neighboring Dry Fly Ash Stack and ultimately into the Active Ash Pond.
Current Operations:	Beginning in May 2009, TVA diverted the flow of gypsum slurry to Synthetic Materials for dewatering prior to stacking the gypsum in the complex. Occasionally, due to power outages or maintenance, slurry must still be pumped to the top of the complex.
Future Planned Operational Changes:	Currently, Stantec and TVA are in the early stages of preparing a five- to seven-year operation plan for the facility while a new dry disposal facility is being designed, permitted and constructed. Modifications being considered include constructing small lined ponds on top of the gypsum stack and significantly reducing the amount of water which could be impounded. Pond features include a 60-mil geomembrane protected by 12 inches of gypsum. A 24-inch “marker” layer of crushed rock will overlie the protective gypsum layer. Each pond will be about 11 feet deep. Sluicing would alternate between ponds to allow for settlement of solids and subsequent movement.

4. Stantec Field Observations

See attached Photos and Site Plan Drawing.

4.1. Exterior Slopes and Benches

Vegetation:	Vegetation has not yet been established on all of the exterior slopes that are currently being constructed of gypsum. Most of the perimeter ash dike slopes are heavily vegetated, including the growth of phragmites along the perimeter ditches. There are sparse locations which are rutted and barren of vegetation located on the perimeter ash dike on the south side (see Photo 1). The perimeter clay dike slopes have good vegetation growth.
Trees:	None observed.
Erosion:	Seep and erosion were observed on the ash perimeter dike between subdrain-14 and subdrain-15. Erosion was observed on the access road at the crest of the bottom ash road dike on the northeast and northwest corners

of the complex (see Photos 2 (TVA Item Number 7) and 3) as well as above the CYDB pump station (TVA Item Number 6, see Photo 4).

Instabilities: All exterior slopes currently appear to be stable.

A slope failure along the perimeter dike at the southwest corner of the complex occurred in 2005 and was addressed by the construction of a seepage blanket and rip-rap stability berm.

Uniform Appearance The complex consists of an upper gypsum dike with a perimeter ash dike at lower elevations. Below the perimeter ash dike along the southwest and southeast sides, the area is encompassed by the outer clay perimeter dike at lower elevations. Along the remaining sides, the ash divider dike separates the area from the Dry Fly Ash Stack to the northwest and the perimeter ash dike separates the area from the Coal Yard Drainage Basin and the Chemical Treatment Pond to the northeast.

Benches: There are two benches that extend along the northeast, southeast, and south sides of the complex that serve as access roads. One bench extends along the northwest side that serves as an access road.

Slope: The gypsum dikes surrounding the two cells are being constructed on approximate 3H:1V slopes or flatter.

The ash divider dike along the northwest side of the gypsum stack has relatively steep slopes on the order of about 1.5H:1V.

The exterior slopes of the perimeter clay dike along the southwest and southeast sides are on the order of 2.7H:1V or flatter.

Height: Approximately 60 feet on the south side and 30 feet on the north side.

Other: Two 24-inch corrugated metal pipes (CMP) were observed on the southwest side of the perimeter ash dike. On March 2, 2011, these pipes were explored by CCTV. The outlet of one of the pipes was damaged and it was determined that it extended only 3 to 5 feet into the dike. The other pipe was measured to a length of 114.5 feet and proceeds perpendicular into the complex from the face of the dike. No turns or wyes were noted.

During the course of the annual inspection, the seep log was reviewed and the condition of each seep was noted. Each of the previously recorded seeps around the perimeter of the gypsum stack was observed to have maintained its' size with the exception of CUF Seep #8. Seep #8 has shrunk in size by about 8 feet in width. TVA Seep #3 continues to flow but does not transport sediment.

During the geotechnical exploration perfomed by Stantec between April and July, 2009, six slope inclinometers and thirteen piezometers were installed on the south, east, and north sides of the complex. Five of these piezometers were abandoned during the week of June 13-17, 2011 for construction. The remaining instruments were automated by a separate TVA contractor.

4.2. Perimeter Drainage Ditches and Down-Drains

Vegetation:	The perimeter ditch along the southwest and southeast sides has a heavy growth of phragmites along most of its length.
Rip-Rap Channel Lining:	There is a rip-rap channel on the southwest corner of the complex, used for the drainage of the interior cells. The flow drops several feet from the pipes down to the rip-rap channel below, allowing for the possibility of erosion of the toe (Photo 5).
Erosion:	Erosion was noted below subdrains-12, 13 18 and 21 (see Photos 6, 7, 8 and 9)
Sedimentation in Ditches:	The perimeter ditch along the southwest and southeast sides has sedimentation along most of its length. The upstream slopes of the perimeter dike along the ditch consist of shallow sloughs and scarps throughout due to excavations for ditch cleaning.
Standing Water in Ditches or on Benches:	The perimeter ditch has standing water along the entire length of the complex. This is potentially due to the excess material in the ditch from the construction activities along the Dry Ash Stack.
Silted/Impeded	None observed.

Drainage Pipes:	
Other:	The siphon system was observed on the northwest corner of the stack to aid in the drainage of surface water. Although the running of the siphon did not occur during the inspection, Trans Ash personnel indicated that the siphon system had operated without problem.

5. Repairs/Mitigation/New Construction Activities Since Last Annual Inspection

Since the annual inspection in 2010, major construction activities have commenced.

During the course of a permit review, it was determined that the Gypsum Disposal Complex was being built outside of the permitted plan limits. To correct this, a work plan was issued (CUF-110310-WP-11) that provides for the re-grading of the facility to maintain compliance with the approved permit and to provide a base for the lined ponds to be constructed. Due to the extensive nature of the re-grading project, observations are only being listed that pertain to the perimeter clay dikes and general maintainence practices.

- A workplan has been conducted to determine the depth of the two 24-inch CMP structures located on the southwest side of the ash perimeter dike. A camera was used to determine the depth and propagation of the pipes into the stack. One pipe was damaged and penetrated only 3 to 5 feet into the dike. The second pipe was observed to be 114.5 feet in length and not bent, elbowed or wyed.
- The animal burrow observed on the perimeter ash dike on the south side of the complex appears to have been repaired.

6. Recommendations

The following recommendations are offered for the Gypsum Disposal Complex. Priority codes are included in parenthesis and described in Enclosure K.

- As the interior cells drain to the southwest corner, flow drops several feet from the discharge pipes down to the rip-rap channel below. Although the rip-rap appears to be controlling erosion at the toe of the slope, continued erosion could undermine the toe. It is recommended that this area be monitored for erosion and stabilization issues during the course of TVA's inspection program and appropriate action taken if problems are noted.
- It is recommended that the perimeter drainage ditch be cleaned of phragmites and sedimentation. (Priority 4) When localized areas of standing water are encountered, it is recommended that these areas be cleared so as to not allow the standing water to saturate the ditch and/or the embankment. (Priority 4)
- It is recommended that the seep locations observed on the exterior slopes of the

perimeter dike on the southwest side continue to be monitored as described in the Seepage Action Plan. Any changes to the flow or color of these seepage areas should be reported to Stantec.

- It is recommended that the areas of erosion at the outlet of the subdrains along the exterior slopes of the ash dike above the perimeter ditch be repaired in accordance with the guidelines included in Enclosure I. This work should be coordinated with the execution of Work Plans 11 and 8.
- It is recommended that the seeps (TVA-CUF Seep Log) along the perimeter clay dike at the southwest corner of the complex and the perimeter ash dike on the south perimeter clay dike (see Photo 10) be monitored for signs of movement or changes in seepage that may be indicative of slope failure. Any changes should be reported to Stantec.
- The area of erosion of the access road to the north side of the complex should be monitored and repaired in accordance with the guidelines included in Enclosure I. (Priority 5)
- It is recommended that the observed rutting be repaired in accordance with the general guidelines presented in Enclosure H. Additionally, alternate mowing procedures should be used for the complex to prevent surface rutting of the vegetation cover. (See Photos 9, 13 and 14)
- It is recommended that a work plan be prepared that would address the areas of barren cover soil (see Photo 11) along the exterior slopes of the complex. This work should be conducted in accordance with the guidelines presented in Enclosure F (Priority 4)
- The inlet and outlets of all drainage pipes should be monitored as part of TVA's Inspection Program and cleared as conditions warrant (see Photo 12).

Photo 1

Vegetation and rutting along bottom ash road dike crest.

Photo 2

Erosion of road at the northeast corner of the complex.

Photo 3

Erosion at north end of the diversion ditch between Dry Fly Ash Stack and Gypsum Stack Complex.

Photo 4

Erosion on bottom ash road dike above the CYDB pump station

Photo 5

Pipes and rip-rap channel used for drainage of the complex on the southwest corner.

Photo 6

Erosion noted below subdrain 12.

Photo 7

Erosion noted below subdrain 13.

Photo 8

Erosion noted below subdrain 18.

Photo 9

Ponding/Rutting below subdrain #21.

Photo 10

Area of recent seep activity located on the perimeter ash dike on the south side of the complex.

Photo 11

Area of barren soil located on the perimeter ash dike on the south side of the complex.

Photo 12

Culvert at access crossing between Gypsum Stack/Dry Ash Stack Diversion and Perimeter Dikes.

Photo 13

Rutting on exterior slope of the dike

Photo 14

Rutting on exterior slope of the dike

Enclosure F

GL – Tree Removal

General Guidelines for Tree Removal on Slopes at TVA Fossil Plants

Identification

Trees and heavy brush growth should be controlled on TVA dams and dikes. If left in place, trees can result in the creation of seepage paths within the embankment. Allowing vegetation to become overgrown restricts the level of inspection that can be performed on the structure. General guidelines for removal of trees and maintenance of vegetation are provided below. Evaluations other than those outlined below shall be made by a geotechnical engineer in consultation with facility representatives on a case-by-case basis.

Guidelines for Tree Removal and Maintenance of Vegetation

Tree Removal

At locations where it is not reasonable to remove trees by a mowing them with a bush hog or with similar mowing equipment:

- All trees shall be cut using a handsaw or chainsaw and the cut tree and branches discarded.

- Remove the remaining tree trunk, stump, and rootwad.

- Grub any remaining roots of the tree so that only 2 inches or smaller roots are left in place.

- The resulting cavity from removal of the rootwad shall be cleaned of loose soil and debris.

- The cavity shall then be backfilled with cohesive soil and compacted and the area seeded to re-establish vegetation. If the tree has been removed from along the upstream or downstream face of a slope, benches shall be cut into the slope face where the cavity is to be backfilled. This will allow for a proper bond between the existing dike and the backfill being used to reform the slope. If benches are needed, bench heights shall not exceed 4 to 5 feet in height.

Maintenance of Vegetation

- Mowing is recommended at regular intervals to allow for appropriate inspection of embankment slopes.

- If areas lacking vegetation are observed during mowing and clearing operations or subsequent inspections, the areas should be seeded to re-establish vegetation as soon as practicable.

Enclosure G

Animal Burrow Repairs

General Guidelines for Repair of Animal Burrows at TVA Fossil Plants

Identification

Animal burrows are relatively common along slopes of dams and dikes. If left untreated, these burrows can result in the creation of seepage paths through the embankment. Additionally tunnels may eventually collapse resulting in surface irregularities in the embankment. General guidelines for repair of animal burrows are provided below. However, if the burrow extends more than three (3) feet below the embankment surface or extends across a dam, the repair of these features should be evaluated by a geotechnical engineer on a case-by-case basis so that appropriate recommendations can be made.

Guidelines for Burrow Repair

It is recommended that shallow animal burrows (up to 3 feet) shall be repaired with surface treatment methods as follows:

- Animals shall be captured and removed from the area. It is recommended that a local conservation representative be consulted prior to this action.
- The animal burrow shall be excavated and cleaned of excess soil along its pathway up to a depth of 3 feet. With this type of repair, an isolated excavated area of the embankment is exposed.
- The excavated area shall be backfilled with compacted cohesive material.
- If the burrow extends more than three feet into the embankment, a geotechnical engineer shall further evaluate the burrow depth and recommend a deep burrow treatment method or other exploratory methods.
- One possible method which may be recommended to treat a deep burrow can consist of a special grout (flowable fill) pumping system with a hose inserted into the burrow.

Ultimately, these repairs will not prevent rodents from creating new burrows within dam embankments. Accordingly, continual efforts must be made to discourage rodent activity. Mowing of vegetation on the slopes / crest of the embankment and trimming of water-side vegetation at regular intervals will tend to discourage rodents from re-establishing burrows along the dike and will allow timely observation of new activity if it occurs.

Enclosure H

Rutting Repair

General Guidelines for Rutting Repair at TVA Fossil Plants

Identification

Rutting due to maintenance vehicle traffic can commonly occur along dike crests, slopes, and other areas at TVA fossil plant facilities. It is typically caused by near-surface materials which have become weak over time because of moisture infiltration. Repeated passes of equipment over weakened materials can lead to rutting. Maintenance traffic/equipment should avoid wet/rutted areas until repairs can be made. General guidelines for the repair of rutting are provided below. The following guide is intended to be applicable for minor to moderate cases of rutting, and generally consists of reworking the upper portion of the affected area, followed by re-shaping to provide positive surface drainage. Where widespread or extensively deep rutting has occurred or is recurring, case-specific engineering evaluations may be needed.

Guidelines for Rutting and Repair

- Drain any standing water and undercut affected areas to remove rutted and overly wet/soft materials. The undercut depth will be determined by TVA in the field, depending on the severity of the rutting.

- Fill undercut area with clay or bottom ash material and compact in 6 to 8 inch lifts to restore original ground line. Excavated material can be re-used if it is free of organics and can be dried to facilitate re-compaction. Otherwise, borrow material will be needed. For compaction, use hand held jumping jacks or small power equipment.

- Grade and shape repaired areas to provide positive/improved drainage. For dike crests, grade the area to drain inwardly toward the pond or perimeter ditch, as applicable. Re-grade surrounding areas and/or drainage ditches to improve drainage, if possible.

- Repaired surfaces or dike crests that are to be used as access roads should be topped with crushed stone or bottom ash. The thickness should be equal to that which was originally in place prior to the repair, or as judged by TVA to be sufficient for the expected amount of vehicle/equipment traffic.

- For other repaired areas, place seed and cover with erosion control blanket to re-establish vegetation. Materials and placement of erosion control blankets should comply with the following specifications, depending on the state in which the work is being performed.

Kentucky Plants –	KYTC Standard Specifications, Sections 212.03.03 E and 827.07
Tennessee Plants –	TDOT Standard Specifications, Section 805
Alabama Plants –	ALDOT Standard Specifications, Section 659

Enclosure I

Rill and Gully Erosion Repair

General Guidelines for Rill and Gully Erosion Repair at TVA Fossil Plants

Identification

Erosion features can commonly occur along dike slopes, dry stack slopes, or other sloped surfaces at TVA fossil plant facilities. Erosion normally appears in the form of rills (shallow channels) and gullies (larger and deeper eroded channels) and is formed by concentrated flow of storm water runoff, especially on bare slopes or where vegetation is sparse. If left untreated, the rills and gullies can progress in size and could lead to slope instability or other adverse issues. General guidelines for the repair of rills and gullies are provided below. The following guide is intended to be applicable to minor to moderate cases of rill/gully erosion. Where widespread or extensively deep gullies have formed or are recurring, case-specific engineering evaluations may be needed.

Guidelines for Rill and Gully Erosion Repair

Shallow Rills and Gullies:

For cases where shallow rills and gullies are present, repair should consist of the following:

- Dump and spread clay soil to fill, re-grade, and shape affected areas to conform to original ground line. Tracking and blading material with a dozer should be performed until the original ground line is reformed and material is reasonably compacted.

- Repaired areas should be seeded to re-establish vegetative cover. Erosion control blankets should be placed over re-graded areas following seeding. Materials and placement of erosion control blankets should comply with the following specifications, depending on the state in which the work is being performed.

Kentucky Plants –	KYTC Standard Specifications, Sections 212.03.03 E and 827.07
Tennessee Plants –	TDOT Standard Specifications, Section 805
Alabama Plants –	ALDOT Standard Specifications, Section 659

Deep Rills and Gullies:

For deep gullies that cannot be repaired as described above, the following filling procedures apply:

- Clean loose soil/debris from bottom and sides of gullies.

- Place and compact clay in 6 inch lifts using small compaction equipment or hand-held tampers. Vibratory plate compactors are not applicable for clay. Filling should start at the toe (or lowest elevation) and progress upslope.

- In some cases, over-excavation may be required to create benches to facilitate compaction on level surfaces. Benching, if required, will likely have to be performed by hand methods or using small excavation equipment.

- If several side-by-side deeper gullies are present in an area to be repaired, it may be more practical to rework the entire affected area to facilitate use of larger equipment. In this case, slight over-excavation of the slope face will be needed so that foundation benches can be cut to facilitate compaction on level surfaces. Filling should start at the lowest elevation and progress upslope.

- Final filling/shaping to reform the original ground line can be executed by tracking and blading with a dozer.

- Repaired areas should be seeded to re-establish vegetative cover. Erosion control blankets should be placed over re-graded areas following seeding. Materials and placement of erosion control blankets should comply with the following specifications, depending on the state in which the work is being performed.

  Kentucky Plants – KYTC Standard Specifications, Sections 212.03.03 E and 827.07

  Tennessee Plants – TDOT Standard Specifications, Section 805

  Alabama Plants – ALDOT Standard Specifications, Section 659

Enclosure J

Wave Wash Riprap Protection

General Guidelines for Wave Wash Erosion Repair and Riprap Protection at TVA Fossil Plants

Identification

Wave erosion should be controlled on TVA facilities to maintain the integrity of dams and dikes. When present, wave wash erosion typically occurs along interior slopes of dikes near pool level. If left unrepaired, erosion can expand, deepen, and can eventually lead to interior slope sloughing. General guidelines for repair of wave erosion using riprap are provided below.

Guidelines for Wave Wash Erosion Repair and Riprap Protection

The following describes repair of wave wash erosion using riprap protection:

- Vegetation and loose soil should be removed within the affected slope areas to be repaired. This includes undercutting the slope a minimum of 12 inches to remove vegetation and associated roots. The minimum vertical extent of the vegetation removal should extend from one-foot below the pool level upwardly to two feet above pool level.

- Place non-woven geotextile fabric along the slope where vegetation and loose soil have been removed. Use fabric meeting or exceeding the following designations, depending on the state in which the work is being performed.

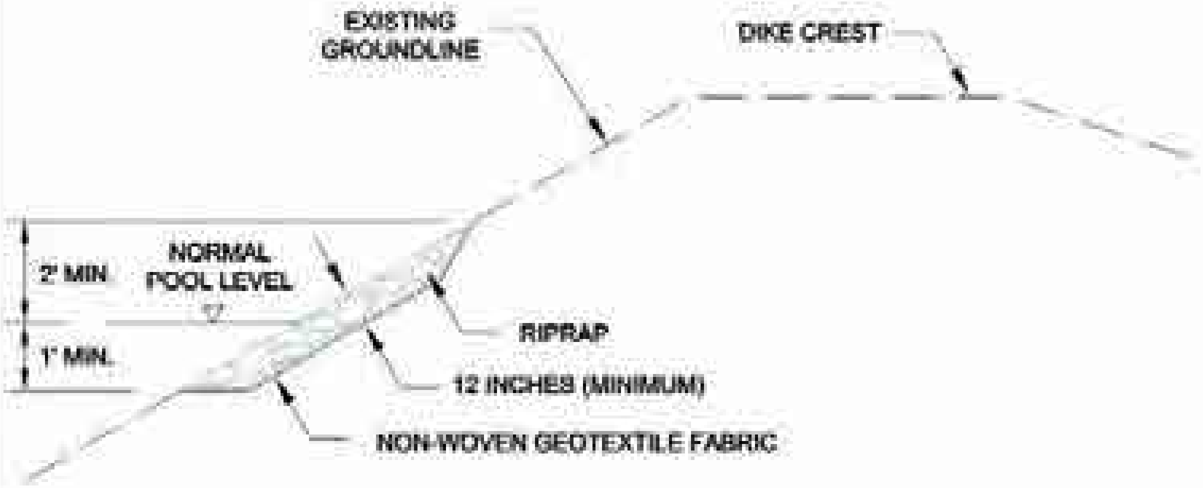
Kentucky Plants -	KYTC Type I Geotextile Fabric
Tennessee Plants -	TDOT Type III Geotextile Fabric
Alabama Plants -	Fabric conforming to Section 608 of ALDOT Standard Specifications

- Place riprap over the geotextile fabric. An excavator should be used to place the riprap in layers (starting from the bottom). Place thickness of riprap to conform to original ground line, or as necessary to create a stable slope face. Use riprap meeting the following designations, depending on the state in which the work is being performed.

Kentucky Plants -	KYTC Class II Channel Lining
Tennessee Plants -	TDOT Class A-1 Machined Riprap
Alabama Plants -	ALDOT Class 2 Riprap

- Field adjustments may be necessary as the work progresses, depending on actual conditions encountered.

A typical cross-section is presented on the following page.



TYPICAL SECTION
WAVE WASH EROSION REPAIR & RIPRAP PROTECTION

NOT TO SCALE

Enclosure K

Maximo – Dam Safety Priorities

Dam Safety Priorities

	Description
1	Urgent - Correct Immediately
2	Complete Within 1 Week of inspection
3	Complete Within 1 Month (30 days) of Inspection
4	Complete Within 6 Months of Original Entry Date
5	Complete Within 1 Year of Original Entry Date
6	Complete Within 3 Years of Original Entry Date
7	Complete Within 5 Years of Original Entry Date
8	Work During Scheduled Outage - Blank Until Outage is Scheduled

Enclosure L

3rd Quarter Dike Inspection CUF 6.20.11

TVA Monthly /Quarterly/Special Facility Inspection Form

Form Date 6-01-10

1. Site Name: CUF 2. Facility Name: Ash Complex
3. Date and Start Time of Inspection: 6/20/11 10 am CST
4. Operator Name: Trans Ash
5. Inspection Method: ☒ Walk ☐ Ride ☐ Both
(KNOWN KEY DEFICIENCIES MUST BE INSPECTED)
6. Inspector's Name(s): Griffin Lifsey, Robert Bagwell, Shane Harris, Shannon Bennett, Jacob Horton, Jake Booth, Bronson Reed, Mike Hulslander, Jason Toler, Brian Diaz, Jim Swindler, Mick McClung, Stuart Harris
7. Hazard Classification: ☐ High ☐ Significant ☐ Low
8. Inspection Frequency: ☐ MONTHLY ☒ QUARTERLY (MUST BE WALKED) ☐ SPECIAL (after significant rain or earthquake event)
9. Current weather conditions Sunny 87°F Prior Conditions, if notable Rain Previous Days.

Check the appropriate box below. If not applicable, record "N/A". Provide comments when appropriate. Any other areas that should be brought to the attention of the Program Manager should also be noted in the "Comments" section. Indicate the locations of any areas identified, and photograph and attach to the form. Previous observation forms should be reviewed and any NEW observations or degradation of pervious conditions should be reported on this inspection form. (NOTE - ONE FORM PER FACILITY)

	Yes	No
10. Pre-Job Safety Briefing Performed	✓	
11. Activity / Construction on/ at facility	✓	
12. DIKE CREST		
A. Settlement / Cracking		✓
B. Rutting		✓
C. Lateral Displacement		✓
D. Erosion		✓
13. INTERIOR / EXTERIOR DIKE SLOPES		
A. Minimum Freeboard		ft.
B. Current Freeboard		ft.
C. Instabilities (Sloughs or Slides)		✓
D. Erosion	✓	
E. Sinkholes/Depressions ○ New ○ Existing		✓
F. Vegetation / Brush / Trees	✓	
○ Heavy/[✓ Adequate]/Sparse/Bare		
G. Animal Burrows ○ New ○ Existing		✓
H. Seepage ○ New ☒ Existing		
○ Clear/Cloudy/Red/Muddy		
○ Flow Increased/Decreased/Same		gpm
○ Ash or Clay Deposits Below Seep Outlet		
I. Seep around Drain Pipe(s)		✓
○ Clear/Cloudy/Red/Muddy		
14. DEFICIENCIES		
A. Prior Key Deficiencies Checked	✓	
B. New Deficiencies Identified / Flagged	✓	
C. Immediate Actions Taken (Note Below)		✓
D. Photos of deficiencies attached	✓	

	Yes	No
15. DIKE TOE AREAS		
A. Seepage ○ New ☒ Existing	✓	
○ Clear/Cloudy/Red/Muddy		
○ Flow Increased / Decreased/Same	Marked with signs	gpm
○ Aquatic Vegetation Growing		
○ Ash or Clay Deposits Below Seep Outlet		
B. Boils ○ New ○ Existing		✓
○ Clear/Cloudy/Red/Muddy		
○ Flow Increased / Decreased/Same		gpm
○ Growing in Size		
C. Sinkholes/Depressions ○ New ○ Existing		✓
16. SEEPAGE COLLECTION SYSTEM		
A. Estimated Flow Measurement	N/A	gpm
B. Increased Flow		
C. Emitting Clear or Dirty Water		
17. SPILLWAY WEIRS & OUTLETS		
A. Decant Riser Misaligned		✓
B. Decant Pipe Joints		✓
○ Leaking		✓
○ Separated		✓
C. Headwall In Good Condition		
18. OPERATIONS & MAINTENANCE		
A. Routine O&M Performed	✓	
B. Weekly Observations Performed	✓	
C. Any Changes in Operations		✓

19. Major adverse changes in these items could cause instability and should be reported to the Program Manager as soon as possible for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, etc.) in the space below and on the backside of this sheet if needed.

NOTE: Quarterly Inspection Deficiencies to be documented on spreadsheet with applicable latitude and longitude coordinates referenced. SHOW ALL QUARTERLY INSPECTION DEFICIENCIES ON AERIAL PHOTOS

Item #	Comments/New Observations/Action Taken:

20. PA(E) was Notified of New Key Deficiency: (Date / Time)

21. Who else Notified of New Key Deficiency: (Date / Time)

22. I hereby attest the above is original information (not reproduced) based on actual field observations made during the period indicated, by either myself or an appointed representative and are accurate, complete, and correct to the best of my knowledge.

Period Covered:
From: Apr 2011 To: Jun 2011 Signature: Griffin R. Lifsey Date: 6/27/11

TVA Monthly /Quarterly/Special Facility Inspection Form

Form Date 6-01-10

1. Site Name: CUF 2. Facility Name: Gypsum Complex

3. Date and Start Time of Inspection: 6/20/11 10 am CST

4. Operator Name: Trans Ash

5. Inspection Method: ☒ Walk ☐ Ride ☐ Both

(KNOWN KEY DEFICIENCIES MUST BE INSPECTED)

6. Inspector's Name(s): Griffin Lifsey, Robert Bagwell, Shane Harris, Shannon Bennett, Jacob Horton, Jake Booth, Bronson Reed, Mike Hulslander, Jason Toler, Brian Diaz, Jim Swindler, Mick McClung, Stuart Harris

7. Hazard Classification: ☐ High ☐ Significant ☐ Low

8. Inspection Frequency: ☐ MONTHLY ☒ QUARTERLY (MUST BE WALKED) ☐ SPECIAL (after significant rain or earthquake event)

9. Current weather conditions Sunny 87°F Prior Conditions, if notable Rain Previous days

Check the appropriate box below. If not applicable, record "N/A". Provide comments when appropriate. Any other areas that should be brought to the attention of the Program Manager should also be noted in the "Comments" section. Indicate the locations of any areas identified, and photograph and attach to the form. Previous observation forms should be reviewed and any NEW observations or degradation of pervious conditions should be reported on this inspection form. (NOTE - ONE FORM PER FACILITY)

	Yes	No
10. Pre-Job Safety Briefing Performed	✓	
11. Activity / Construction on/ at facility	✓	
12. DIKE CREST		
A. Settlement / Cracking		✓
B. Rutting		✓
C. Lateral Displacement		✓
D. Erosion		✓
13. INTERIOR / EXTERIOR DIKE SLOPES		
A. Minimum Freeboard		ft.
B. Current Freeboard	>4'	ft.
C. Instabilities (Sloughs or Slides)		✓
D. Erosion	✓	
E. Sinkholes/Depressions ○ New ○ Existing		✓
F. Vegetation / Brush / Trees	✓	
○ Heavy/[✓ Adequate]/Sparse/Bare		
G. Animal Burrows ☒ New ○ Existing	✓	
H. Seepage ● New ☒ Existing	✓	
○ Clear/Cloudy/Red/Muddy		
○ Flow Increased/Decreased/Same		gpm
○ Ash or Clay Deposits Below Seep Outlet		
I. Seep around Drain Pipe(s)		✓
○ Clear/Cloudy/Red/Muddy		
14. DEFICIENCIES		
A. Prior Key Deficiencies Checked	✓	
B. New Deficiencies Identified / Flagged	✓	
C. Immediate Actions Taken (Note Below)		✓
D. Photos of deficiencies attached	✓	

	Yes	No
15. DIKE TOE AREAS		
A. Seepage ☒ New ○ Existing	✓	
○ Clear/Cloudy/Red/Muddy		
○ Flow Increased / Decreased/Same		gpm
○ Aquatic Vegetation Growing		
○ Ash or Clay Deposits Below Seep Outlet		
B. Boils ○ New ○ Existing		✓
○ Clear/Cloudy/Red/Muddy		
○ Flow Increased / Decreased/Same		gpm
○ Growing in Size		
C. Sinkholes/Depressions ○ New ○ Existing		✓
16. SEEPAGE COLLECTION SYSTEM		
A. Estimated Flow Measurement	N/A	gpm
B. Increased Flow		
C. Emitting Clear or Dirty Water		
17. SPILLWAY WEIRS & OUTLETS		
A. Decant Riser Misaligned		✓
B. Decant Pipe Joints		✓
○ Leaking		✓
○ Separated		✓
C. Headwall In Good Condition		
18. OPERATIONS & MAINTENANCE		
A. Routine O&M Performed	✓	
B. Weekly Observations Performed	✓	
C. Any Changes in Operations		✓

19. Major adverse changes in these items could cause instability and should be reported to the Program Manager as soon as possible for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, etc.) in the space below and on the backside of this sheet if needed.

NOTE: Quarterly Inspection Deficiencies to be documented on spreadsheet with applicable latitude and longitude coordinates referenced. SHOW ALL QUARTERLY INSPECTION DEFICIENCIES ON AERIAL PHOTOS

Item #	Comments/New Observations/Action Taken:

20. PA(E) was Notified of New Key Deficiency: (Date / Time)

21. Who else Notified of New Key Deficiency: (Date / Time)

22. I hereby attest the above is original information (not reproduced) based on actual field observations made during the period indicated, by either myself or an appointed representative and are accurate, complete, and correct to the best of my knowledge.

Period Covered:

From: Apr 2011 To: Jun 2011

Signature: Griffin R. [illegible]

Date: 6/27/11

LOCATION: Cumberland Fossil Plant - 3rd Quarter FY2011 Dike Inspection
WEATHER: 87 degrees F, Sunny
INSPECTION BY: Robert Bagwell, Shane Harris, Griffin Lifsey, Jacob Horton, Jake Booth, Bronson Reed, Mike Hulslander, Jim Swindler, Nick McClung, Stuart Harris, Shannon Bennett, Jason toler, Brian Diaz
DATE: 06/20/2011

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	COMMENTS
1	Wave erosion	1179	1000	733431.71	1511088.16	To be addressed as part of WP-7
2	Possible seeapge area (5' x 15')	1085	2000	732097.84	1511453.16	Monitor to determine if seep. If so notify Engineering and add to Seepage Log
3	Several small trees on slope	1086	2001	730414.07	1512726.13	Repair in accordance to the General Guidelines
4	(2) Animal burrows	1087	2002	730244.73	1512923.23	Repair in accordance to the General Guidelines
5	Possible seeapge area (50' L)	5707	5000	731152.02	1511747.64	Monitor to determine if seep. If so notify Engineering and add to Seepage Log
6	Erosion (typical of top of slope)	5708	5001	730352.60	1512581.31	Repair in accordance to the General Guidelines
7	Erosion/rill (15' L X 1' D)	5709	5002	729203.14	1514021.32	Previously Identified (FY11 - 2nd Quarter PT# 1013) Repair in accordance to the General Guidelines
8	Erosion under Drain #18 (3' dia)	5710	5003	728035.03	1513450.84	Repair in accordance to the General Guidelines
9	Erosion under Drain #11 (10' L rill)	5711	5004	728049.57	1512059.18	Repair in accordance to the General Guidelines
10	Erosion under Drain #12 (10' L)	5712	5005	728101.93	1511815.72	Repair in accordance to the General Guidelines


IMG_1086.jpg


IMG_1087.jpg


DSCN5707.JPG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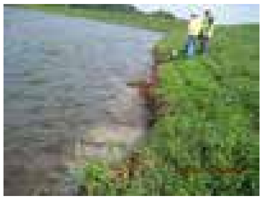
DSCN5709.JPG


DSCN5710.JPG


DSCN5711.JPG


DSCN5712.JPG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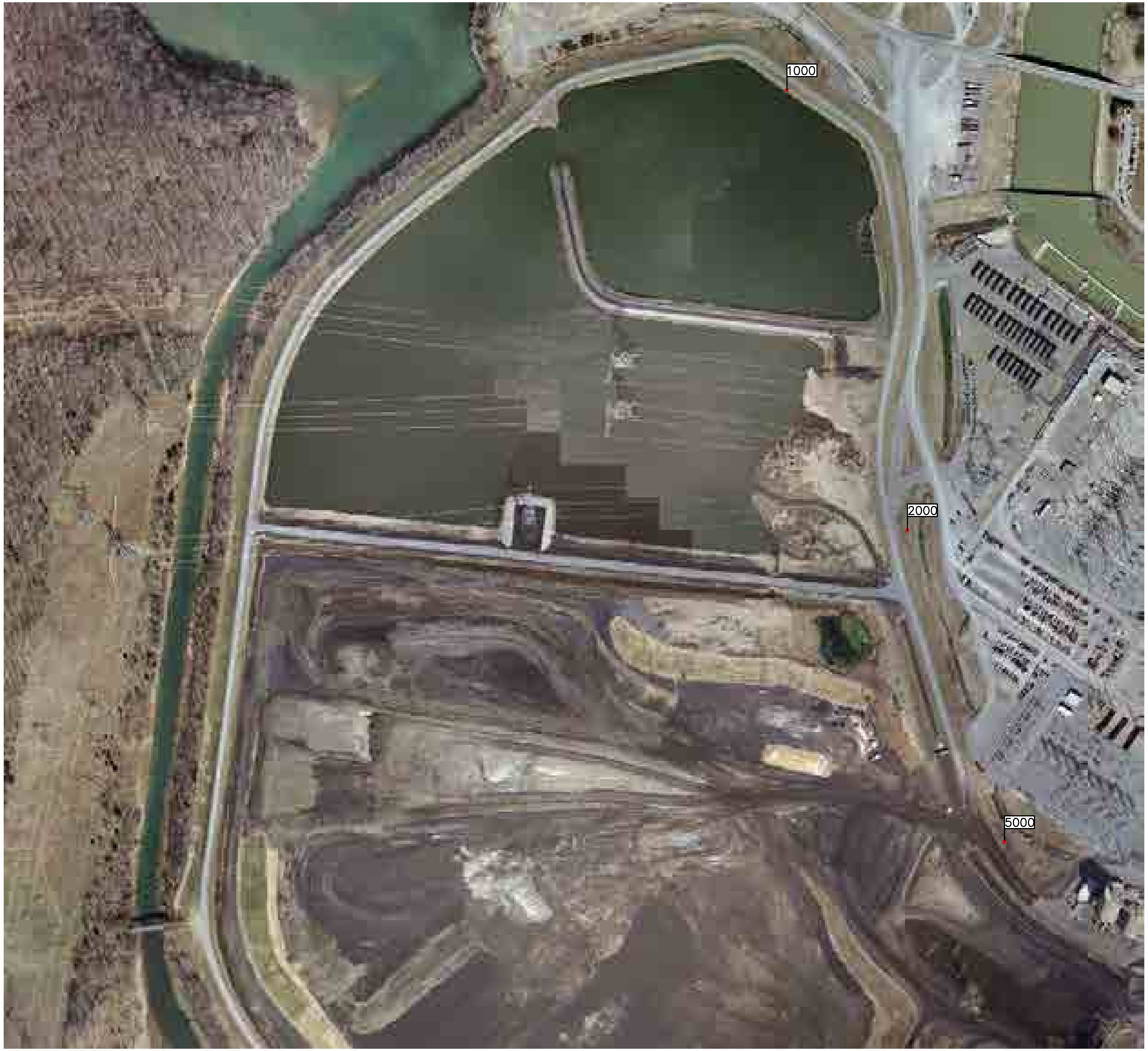
1000
2000
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2001
5001
2002
5002
5004
5004
5003

Enclosure M

Annual Report Survey Coordinates and Plan View

LOCATION: Cumberland Fossil Plant - 3rd Quarter FY2011 Dike Inspection
WEATHER: 87 degrees F, Sunny
INSPECTION BY: Robert Bagwell, Shane Harris, Griffin Lifsey, Jacob Horton, Jake Booth, Bronson Reed, Mike Hulslander, Jim Swindler, Nick McClung, Stuart Harris, Shannon Bennett, Jason toler, Brian Diaz
DATE: 6/20/2011

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	Recommendations
3rd Quarter - Ash Pond						
1	Wave erosion	1179	1000	733431.71	1511088.16	To be addressed as part of WP-7
2	Possible seeapge area (5' x 15')	1085	2000	732097.84	1511453.16	Monitor to determine if seep. If so notify Engineering and add to Seepage Log
3rd Quarter - Coal Yard Drainage Basin						
3	Several small trees on slope	1086	2001	730414.07	1512726.13	Repair in accordance to the General Guidelines
3rd Quarter - Chemical Treatment Pond						
4	(2) Animal burrows	1087	2002	730244.73	1512923.23	Repair in accordance to the General Guidelines
3rd Quarter - Dry Fly Ash Stack and Bottom Ash Pond						
5	Possible seeapge area (50' L)	5707	5000	731152.02	1511747.64	Monitor to determine if seep. If so notify Engineering and add to Seepage Log
3rd Quarter - Gypsum Disposal Complex						
6	Erosion (typical of top of slope)	5708	5001	730352.60	1512581.31	Repair in accordance to the General Guidelines
7	Erosion/rill (15' L X 1' D)	5709	5002	729203.14	1514021.32	Previously Identified (FY11 - 2nd Quarter PT# 1013) Repair in accordance to the General Guidelines
8	Erosion under Drain #18 (3' dia)	5710	5003	728035.03	1513450.84	Repair in accordance to the General Guidelines
9	Erosion under Drain #11 (10' L rill)	5711	5004	728049.57	1512059.18	Repair in accordance to the General Guidelines
10	Erosion under Drain #12 (10' L)	5712	5005	728101.93	1511815.72	Repair in accordance to the General Guidelines

OCATION: Cumberland Fossil Plant - 2011 Annual Dike Inspection
VEATHER: 93 degrees F, Sunny
NSPECTION BY: Daniel Rogers, Jim Swindler, Jacob Horton
ATE: 6/20/2011

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	Recommendations
Annual Inspection - Coal Yard Drainage Basin						
11	Erosion at Drain to the CYDB	2	100	730787.815	1512408.175	Repair in accordance to the General Guidelines
12	DEPRESSION in Dike Face	3	101	730434.356	1512635.655	Monitor for evidence of erosion or slope movement. If observed, notify Engineering.
13	SMALL SLIP	4	102	730406.812	1512736.619	Repair by re-grading and establishing vegetation
14	Animal Burrows	6	103	730460.571	1512992.755	Repair in accordance to the General Guidelines
15	Animal Burrow		104	730297.324	1513341.827	Repair in accordance to the General Guidelines
Annual Inspection - Gypsum Stack Complex						
16	Rutting	13	105	727948.786	1513474.615	Repair in accordance to the General Guidelines
17	Rutting	14	106	728131.271	1512547.519	Repair in accordance to the General Guidelines
18	PONDING		107	728256.175	1511163.533	Repair in accordance to the General Guidelines
19	POSSIBLE SEEP		108	730482.167	1512429.948	Monitor to determine if seep. If so notify Engineering and add to Seepage Log
20	PONDING Below Drain #21	9	109	729567.314	1513763.112	Repair in accordance to the General Guidelines
Annual Inspection - Dry Fly Ash Stack						
21	POSSIBLE SEEP	4	110	729943.216	1510036.437	Monitor to determine if seep. If so notify Engineering and add to Seepage Log
Annual Inspection - Ash Pond						
22	POSSIBLE SEEP	4	111	733384.285	1510260.948	Monitor to determine if seep. If so notify Engineering and add to Seepage Log
23	POSSIBLE SEEP	4	112	733183.536	1510007.549	Monitor to determine if seep. If so notify Engineering and add to Seepage Log

NOTE: 2007 NAIP Public Imagery

V:\1755\active\175531011\gis\mxd\ANNUAL_INSPECTION.mxd

STANTEC
CONSULTING
SERVICES INC.

11687 Lebanon Rd.
Cincinnati, Ohio
45241-2012
513-842-8200

Stantec

Plan View - CUF 2011 Annual Inspection

Tennessee Valley Authority
Cumberland Fossil Plant
Cumberland, Stewart County, Tennessee

PROJECT NO.	175531011
DATE	JUNE 2011
DRAWN BY	ANP
CHECKED BY	DBR
CHECKED BY	SAH
SCALE	AS SHOWN
REVISED	
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

SHEET

1 OF 1

APPENDIX A

Document 11

TVA Monthly / Quarterly Safety Inspections, June 1, 2010

TVA Monthly /Quarterly/Special Facility Inspection Form Form Date 6-01-10

1. Site Name: CUF 2. Facility Name: Gypsum Complex 3. Date and Start Time of Inspection: 9:01 Am CST

4. Operator Name: TVA RHO&M 5. Inspection Method: ☑ Walk ☐ Ride ☐ Both

(KNOWN KEY DEFICIENCIES MUST BE INSPECTED)

6. Inspector's Name(s): Stuart Harris 7. Hazard Classification: ☑ High ☐ Significant ☐ Low

8. Inspection Frequency: ☐ MONTHLY ☑ QUARTERLY (MUST BE WALKED) ☐ SPECIAL (after significant rain or earthquake event)

9. Current weather conditions 22°F, Sunny Prior Conditions, if notable

Check the appropriate box below. If not applicable, record "N/A". Provide comments when appropriate. Any other areas that should be brought to the attention of the Program Manager should also be noted in the "Comments" section. Indicate the locations of any areas identified, and photograph and attach to the form. Previous observation forms should be reviewed and any NEW observations or degradation of pervious conditions should be reported on this inspection form. (NOTE - ONE FORM PER FACILITY)

	Yes	No
10. Pre-Job Safety Briefing Performed	✓	
11. Activity / Construction on/ at facility	✓	
12. DIKE CREST		
A. Settlement / Cracking		✓
B. Rutting		✓
C. Lateral Displacement		✓
D. Erosion	✓	
13. INTERIOR / EXTERIOR DIKE SLOPES		
A. Minimum Freeboard	NA	ft.
B. Current Freeboard	NA	ft.
C. Instabilities (Sloughs or Slides)		✓
D. Erosion	✓	
E. Sinkholes/Depressions ○ New [✓ ○ Existing]	✓	
F. Vegetation / Brush / Trees		
○ Heavy/Adequate/[✓ Sparse]/Bare	In Places	
G. Animal Burrows [✓ ○ New] ○ Existing	✓	
H. Seepage ○ New ○ Existing		✓
○ Clear/Cloudy/Red/Muddy		
○ Flow Increased/Decreased/Same		gpm
○ Ash or Clay Deposits Below Seep Outlet		
I. Seep around Drain Pipe(s)		✓
○ Clear/Cloudy/Red/Muddy		
14. DEFICIENCIES		
A. Prior Key Deficiencies Checked	✓	
B. New Deficiencies Identified / Flagged	✓	
C. Immediate Actions Taken (Note Below)		✓
D. Photos of deficiencies attached	✓	

	Yes	No
15. DIKE TOE AREAS		
A. Seepage ○ New [✓ ○ Existing]	✓	
○ Clear/Cloudy/Red/Muddy		
○Flow Increased / Decreased/Same	Same	gpm
○ Aquatic Vegetation Growing	✓	
○ Ash or Clay Deposits Below Seep Outlet		✓
B. Boils ○ New ○ Existing		✓
○ Clear/Cloudy/Red/Muddy		
○ Flow Increased / Decreased/Same		gpm
○ Growing in Size		
C. Sinkholes/Depressions ○ New ○ Existing	NA	
16. SEEPAGE COLLECTION SYSTEM	NA	
A. Estimated Flow Measurement		gpm
B. Increased Flow		
C. Emitting Clear or Dirty Water		
17. SPILLWAY WEIRS & OUTLETS	NA	
A. Decant Riser Misaligned		
B. Decant Pipe Joints		
○ Leaking		
○ Separated		
C. Headwall In Good Condition		
18. OPERATIONS & MAINTENANCE		
A. Major Changes in Operations		✓

19. Major adverse changes in these items could cause instability and should be reported to the Program Manager as soon as possible for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, etc.) in the space below and on the backside of this sheet if needed.

NOTE: Quarterly Inspection Deficiencies to be documented on spreadsheet with applicable latitude and longitude coordinates referenced. SHOW ALL QUARTERLY INSPECTION DEFICIENCIES ON AERIAL PHOTOS

20. Item #	Comments/New Observations/Action Taken:

21. PA(E) was Notified of New Key Deficiency: (Date / Time)

22. Who else Notified of New Key Deficiency: (Date / Time)

23. I hereby attest the above is original information (not reproduced) based on actual field observations made during the period indicated, by either myself or an appointed representative and are accurate, complete, and correct to the best of my knowledge.

Period Covered:
From: 9/10 To: 12/10 Signature: Date: 12/15/10

TVA Monthly /Quarterly/Special Facility Inspection Form Form Date 6-01-10

1. Site Name: CUF 2. Facility Name: Ash Complex 3. Date and Start Time of Inspection: 9:01 Am CST

4. Operator Name: TVA RHO&M 5. Inspection Method: ☑ Walk ☐ Ride ☐ Both

(KNOWN KEY DEFICIENCIES MUST BE INSPECTED)

6. Inspector's Name(s): Stuart Harris 7. Hazard Classification: ☐ High ☐ Significant ☐ Low

8. Inspection Frequency: ☐ MONTHLY ☑ QUARTERLY (MUST BE WALKED) ☐ SPECIAL (after significant rain or earthquake event)

9. Current weather conditions 22°F Sunny Prior Conditions, if notable

Check the appropriate box below. If not applicable, record "N/A". Provide comments when appropriate. Any other areas that should be brought to the attention of the Program Manager should also be noted in the "Comments" section. Indicate the locations of any areas identified, and photograph and attach to the form. Previous observation forms should be reviewed and any NEW observations or degradation of pervious conditions should be reported on this inspection form. (NOTE - ONE FORM PER FACILITY)

	Yes	No
10. Pre-Job Safety Briefing Performed	✓	
11. Activity / Construction on/ at facility	✓	
12. DIKE CREST		
A. Settlement / Cracking		✓
B. Rutting		✓
C. Lateral Displacement		✓
D. Erosion		✓
13. INTERIOR / EXTERIOR DIKE SLOPES		
A. Minimum Freeboard	> 3'	ft.
B. Current Freeboard	> 3'	ft.
C. Instabilities (Sloughs or Slides)		✓
D. Erosion	✓	
E. Sinkholes/Depressions ○ New ○ Existing		✓
F. Vegetation / Brush / Trees		
○ Heavy/Adequate/Sparse/Bare		
G. Animal Burrows [✓ New] ○ Existing	✓	
H. Seepage ○ New [✓ Existing]	✓	
○ Clear/Cloudy/Red/Muddy		
○ Flow Increased/Decreased/Same	SAME	CAN'T TELL gpm
○ Ash or Clay Deposits Below Seep Outlet		✓
I. Seep around Drain Pipe(s)		✓
○ Clear/Cloudy/Red/Muddy		
14. DEFICIENCIES		
A. Prior Key Deficiencies Checked	✓	
B. New Deficiencies Identified / Flagged	✓	
C. Immediate Actions Taken (Note Below)		✓
D. Photos of deficiencies attached	✓	

	Yes	No
15. DIKE TOE AREAS		
A. Seepage ○ New [✓ Existing]	✓	
○ Clear/Cloudy/Red/Muddy		
○ Flow Increased / Decreased/Same		gpm
○ Aquatic Vegetation Growing		✓
○ Ash or Clay Deposits Below Seep Outlet		✓
B. Boils ○ New ○ Existing		✓
○ Clear/Cloudy/Red/Muddy		
○ Flow Increased / Decreased/Same		gpm
○ Growing in Size		
C. Sinkholes/Depressions ○ New ○ Existing		✓
16. SEEPAGE COLLECTION SYSTEM	NA	
A. Estimated Flow Measurement		gpm
B. Increased Flow		
C. Emitting Clear or Dirty Water		
17. SPILLWAY WEIRS & OUTLETS	NA	
A. Decant Riser Misaligned		
B. Decant Pipe Joints		
○ Leaking		
○ Separated		
C. Headwall In Good Condition		
18. OPERATIONS & MAINTENANCE		
A. Major Changes in Operations		✓

19. Major adverse changes in these items could cause instability and should be reported to the Program Manager as soon as possible for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, etc.) in the space below and on the backside of this sheet if needed.

NOTE: Quarterly Inspection Deficiencies to be documented on spreadsheet with applicable latitude and longitude coordinates referenced. SHOW ALL QUARTERLY INSPECTION DEFICIENCIES ON AERIAL PHOTOS

20. Item #	Comments/New Observations/Action Taken:

21. PA(E) was Notified of New Key Deficiency: (Date / Time)

22. Who else Notified of New Key Deficiency: (Date / Time)

23. I hereby attest the above is original information (not reproduced) based on actual field observations made during the period indicated, by either myself or an appointed representative and are accurate, complete, and correct to the best of my knowledge.

Period Covered:

From: 9/10 To: 12/10 Signature: Stuart Harris Date: 12/15/10

LOCATION:	Cumberland Fossil Plant - 4th Quarter FY2010 Dike Inspection
WEATHER:	22 degrees F, Sunny
INSPECTION BY:	Stuart Harris,Jason Hill, Jacob Horton, Jake Booth, Mike Hulslander, Robert Bagwell, Bronson Reed, Danny Stephens, Dan Rogers (Stantec), Carrie McCarty, Jessica Tnin
DATE:	12/09/2010

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	COMMENTS
1	Wave wash erosion	662	1000	733273.00	1511317.62	Repair in accordance to the General Guidelines
2	Animal burrow	663	1001	733586.42	1510796.96	Repair in accordance to the General Guidelines
3	Animal burrow	-	1002	733571.09	1510736.47	Repair in accordance to the General Guidelines
4	Red water seep	664	1003	730964.45	1509203.98	Previously Identified. Continue to monitor seep. Appears unchanged.
5	Red water seep (end)	664	1004	731060.66	1509206.96	Previously Identified. Continue to monitor seep. Appears unchanged.
6	Red water seep (beginning)	665	1005	731151.04	1509213.77	Previously Identified. Continue to monitor seep. Appears unchanged.
7	Red water seep near old bridge	665	1006	730901.20	1509200.97	Previously Identified. Continue to monitor seep. Appears unchanged.
8	Red water seep near old bridge	666	1007	730861.69	1509216.60	Previously Identified. Continue to monitor seep. Appears unchanged.
9	Erosion/rill (40' Long x 2'wide x 1'deep)	-	2000	731960.59	1511371.80	Repair in accordance to the General Guidelines
10	Erosion/rill (20' Long x 4'wide x 3'deep)	661	2005	729908.40	1510214.83	Repair in accordance to the General Guidelines
11	No vegetation	1679	3000	731436.09	1511616.37	Reseed in accordance with the TVA T-1 Section 580 Grassing Specifications
12	Animal burrow (2' deep)	1681	3002	730185.23	1513039.87	Repair in accordance to the General Guidelines
13	Animal burrow (1' deep)	1682	3003	728624.99	1513896.65	Repair in accordance to the General Guidelines
14	Metal pipe	1683	3004	728079.89	1513337.41	Field Supervisor to investigate and determine if it's just old trash and remove.
15	Seep	1684	3005	728185.72	1513057.30	Previously Identified. Continue to monitor seep. Appears unchanged.
16	Seep	1685	3006	728216.69	1512974.53	Previously Identified. Continue to monitor seep. Appears unchanged.
17	Seep	1686	3007	728257.94	1512751.79	Previously Identified. Continue to monitor seep. Appears unchanged.
18	Seep	1687	3008	728232.07	1512572.11	Previously Identified. Continue to monitor seep. Appears unchanged.
19	Seep	1687	3009	728189.12	1512471.07	Previously Identified. Continue to monitor seep. Appears unchanged.
20	Seep	1688	3010	728139.77	1512409.93	Previously Identified. Continue to monitor seep. Appears unchanged.
21	Seep	1689	3011	728033.75	1512155.44	Previously Identified. Continue to monitor seep. Appears unchanged.
22	Seep	1690	3012	728048.98	1512079.71	Previously Identified. Continue to monitor seep. Appears unchanged.
23	Seep	1691	3013	728067.05	1511972.07	Previously Identified. Continue to monitor seep. Appears unchanged.
24	Seep	1692	3014	728074.85	1511917.78	Previously Identified. Continue to monitor seep. Appears unchanged.
25	Seep	1693	3015	728566.28	1511049.66	Previously Identified. Continue to monitor seep. Appears unchanged.
26	Seep	1694	3016	728651.91	1511006.69	Previously Identified. Continue to monitor seep. Appears unchanged.
27	Hole (1' deep)	1695	3017	728680.91	1510979.88	Repair in accordance to the General Guidelines
28	24" Dia. Corrugated Metal Pipe (2)	1696-1697	3018	728845.75	1510896.82	**Engineering is investigating using CCTV to inspect - Previously Identified (4th quarter, PT# 2005)**
29	Erosion area by rock (6'x20')	1152	5000	731257.09	1511684.28	Repair in accordance to the General Guidelines
30	Skid Steer ruts from mowing (typical of area)	1153	5001	730302.71	1512703.52	Field Supervisor to talk with mowing crew to prevent/repair in the future.
31	Erosion/rill	1155	5003	730086.32	1512977.08	Repair in accordance to the General Guidelines
32	Erosion/rill	1156	5004	729972.34	1513160.58	Repair in accordance to the General Guidelines
33	Seep #1 (beginning)	1157	5007	728159.58	1512656.14	Previously Identified. Continue to monitor seep. Appears unchanged.
34	Seep #1 (end)	1158	5008	728073.17	1512470.31	Previously Identified. Continue to monitor seep. Appears unchanged.
35	Erosion gullies by outlet pipes	1159-1161	5009	731230.12	1511603.56	Repair in accordance to the General Guidelines and divert runoff to prevent recurrence of erosion.


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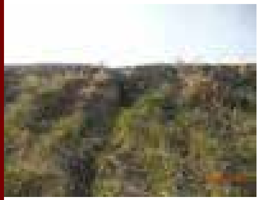
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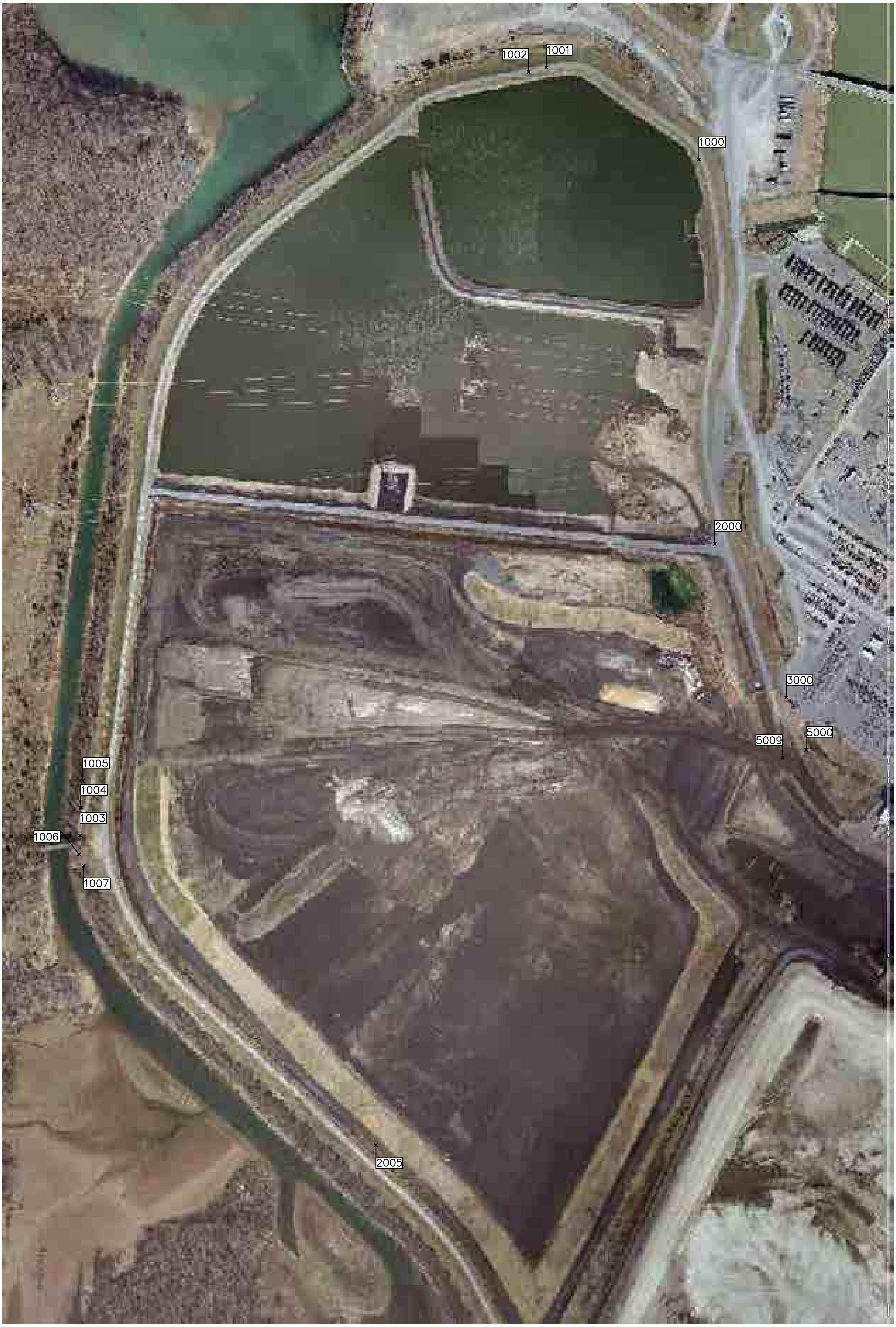
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APPENDIX A

Document 12

CCR Generation and Handling Questions

CCR Generation and Handling Questions:	Cumberland
1. Does the utility have drawings showing the CCR generation/handling/storage train for:	
a. Fly Ash	Yes
b. Bottom Ash	Yes
c. Boiler Slag	Yes
d. FGD wastes	Yes
2. What specific equipment is used to collect, handle, and store CCR material? For:	
a. Fly Ash	SCR Hoppers, Precipitator Hoppers, Surge Bins, piping, silos, ash pond
b. Bottom Ash	Economizer Hoppers, Hydroveyor, Air separator tank, bottom ash hoppers, jet pumps, piping, bottom ash reclaim pit
c. Boiler Slag	N/A
d. FGD wastes	Limestone preparation facilities, absorbers, recycle pumps, piping, FGD pond
3. Is there design information on the handling and transport equipment?	Yes
a. Example:size and length of pipe for sluicing the CCR	Yes
b. Is equipment within a secondary containment or just sitting on the ground?	Precip Hoppers, Economizer Hoppers and bottom ash hoppers are inside a building. Limestone preparation is done inside a building, the absorbers and recycle pumps are inside a building. Some piping is inside the building. The remainder is outside going to the ponds or wallboard plant.
c. Volume of storage silo	32000 Tons
4. What equipment is outside versus enclosed?	Precip Hoppers, Economizer Hoppers and bottom ash hoppers are inside a building. Limestone preparation is done inside a building, the absorbers and recycle pumps are inside a building. Some piping is inside the building. The remainder is outside going to the ponds or wallboard plant.
5. Has there ever been a release of CCR to the environment from the collection/handling/disposal system?	Yes, release of gypsum wastewater into Wells Creek
6. How much CCR per hour are they handling in each system, actual and design?	

APPENDIX A

Document 13

Dam Breach Analysis – Gypsum, Stantec, September 2010

Stantec

Dam Breach Analysis

Cumberland Gypsum Disposal Complex
Cumberland Fossil Plant
Stewart County, Tennessee

September, 2010

Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati OH 45241-2012
Tel: (513) 842-8200
Fax: (513) 842-8250

Stantec

September 10, 2010
File: 175639026

Daniel G. Stephens, PE
Program Manager - CUF
Tennessee Valley Authority – CCP Engineering
1101 Market Street, LP5E-C
Chattanooga, Tennessee 37402

**Reference: Cumberland Fossil Plant Gypsum Stack
Breach Inundation Analysis**

Dear Mr. Stephens:

Enclosed is our report of the breach inundation analysis for the Cumberland Fossil Plant Gypsum Stack. This report summarizes Stantec Consulting Services Inc.'s analysis, methodologies, modeling results and hazard classification recommendation. We appreciate the opportunity to assist Tennessee Valley Authority on this project. If you have any questions, please call our office.

Sincerely,

STANTEC CONSULTING SERVICES INC.

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/lfb

Table of Contents

Appendices

1.0 Study Description

The Cumberland Fossil Plant is located at the confluence of Wells Creek and the Cumberland River in Stewart County, Tennessee. The Gypsum Disposal Complex has a total footprint of approximately 153 acres with a proposed dike crest elevation of the wet operation cell at approximately 432 feet.

Stantec had previously performed breach analyses of the existing Gypsum Disposal Complex at the Cumberland Fossil Plant using approximate methods. The results of this study were included in the summary titled, “Preliminary Dam Breach Approximate Limits of Impact – Methodology” and submitted to the TVA on July 24, 2009 (Reference 1). Since that time, plans have been made to modify the facility and limit wet operations to a series of lined water quality cells. Construction of the lined cells is not expected to be completed until 2011. The current layout and operation of the gypsum facility, as of September 2010, limits wet operations to emergency events when the dewatering facility is nonoperational. Based on the current dike configuration and site grading at the gypsum facility, a storm event would cause water to pool at the west side of the facility with minor pooling (less than 3 feet) along the northeast dike. A failure of the existing gypsum facility would most likely occur along the west dike with impacts limited to property owned and operated by the TVA. Based on this review of the existing facility, no additional breach analyses were performed for existing conditions.

The remainder of this report summarizes Stantec ‘s review of impacts of the proposed gypsum disposal complex changes on the risk classification including the methodology utilized to model possible breach scenarios and calculate the impact to downstream areas. Specifically, the impact of these breach events on the adjacent Synthetic Materials (SynMat) Dewatering Facility and the Temple Inland Wall Board Plant was studied.

2.0 Breach Hydrograph Development

2.1 FAILURE SCENARIOS

Stantec performed breach analyses of the Gypsum Disposal Complex using the U.S. Army Corps of Engineers (USACE) HEC-HMS computer modeling software, Version 3.4. Breach analyses were performed for two failure scenarios: (1) A "Sunny Day" breach to the northeast of the Gypsum Disposal Complex which consists of a piping failure that is assumed to occur during normal operational conditions. (2) A PMP Event breach to the southeast of the Gypsum Stack which consists of a piping failure of an internal dike causing an overtopping failure of the external dike during a PMP event. Specific assumptions for the two scenarios are outlined below. It was decided that a PMP breach to the northeast was not a concern because a failure through the liner would have an extremely low likelihood of coinciding with the peak PMP event.

For a piping failure, HEC-HMS simulates a rectangular breach that begins at the bottom elevation of the breach and has a gradually increasing breach orifice height and width, until the dam crest is reached and then expands as a trapezoid. Likewise, for a PMP failure, HEC-HMS simulates a trapezoid failure that begins at the top of the embankment and has gradually increasing breach width and decreasing weir elevation until the bottom elevation is reached.

2.1.1 "Sunny Day" Northeast Breach Scenario

The proposed design for the Cumberland Gypsum Disposal Complex limits all wet operations to the water quality cell along the northern edge of the complex with a dike crest elevation of 432.0 feet. The water quality cell is divided into three long rectangular lined settlings ponds and one lined water quality pond. These individual ponds are divided by internal dikes within the water quality cell with crest elevations at 429.0 feet such that only one pond will fail during the "Sunny Day" scenario. A breach to the northeastern tip of the water quality cell draining Settling Pond 3 is the most likely scenario to cause damage to the SynMat Dewatering Facility.

Settling Pond 3 has a normal operating water surface elevation of 426.8 feet. Inflow to the water quality cell was neglected. A piping failure was assumed to occur along the northeastern edge of the water quality cell as shown in Figure A1 of Appendix A. The impounded water within the pond was assumed to be lost down to the bottom of the pond at elevation 418.0 feet. Figure A2 in Appendix A is a schematic cross section through the Gypsum Disposal Complex showing the "Sunny Day" failure configuration.

2.1.2 PMP Southeast Breach Scenario

The PMP Southeast Breach scenario involves the failure of two dikes in series. The first breach would occur on the southern edge of the water quality cell dike. The impounded water within the area breached was assumed to be lost down to the bottom of the pond at elevation 426.0 feet. The water would then discharge to South Cell A which has a dike crest elevation of 415.0

feet. When the water surface elevation in South Cell A reaches the dike crest elevation, the east dike was assumed to fail by overtopping. The impounded water is assumed to be lost down to an elevation of 411.1 feet. Figure A3 in Appendix A is a schematic cross section through the Gypsum Disposal Complex showing the PMP Southeast Breach failure configuration. The water surface elevation of the receiving waterway was assumed at the 100-year flood event, an elevation of 381.6 feet at the breach location.

Inflow to the pond consisted of the 6-hour PMP event precipitation (35.4 inches) obtained from the National Oceanic and Atmospheric Administration (NOAA) Hydrometeorological Report No.56 (HMR-56) (Reference 2). The SCS Type-B 6-hour hyetograph is a standard shape currently being used for spillway design at various TVA fossil plants (Reference 3).

2.2 ESTIMATION OF DAM BREACH PARAMETERS

Empirical equations have been developed from case studies to predict average breach width and breach development time based on the height of the dam, depth of the water, volume impounded, and/or type of breach. The equations developed by Von Thun and Gillette (Reference 4) were selected since they include factors to account for easily erodible material such as the material making up the Gypsum Disposal Complex. Stantec used these equations and based final breach parameters on the range of the estimates obtained and engineering judgment.

Estimates for breach development time and breach parameters for the “Sunny Day” Northeast Breach scenario are summarized below. The predicted average breach width (B_{av}) was 41.9 feet and breach development time (t_f) ranged from 0.06 hours to 0.16 hours with the average of 0.1 hours used. These estimates are based on the assumed failure conditions, height of the breach (14.0 feet), and impoundment water volume of 11.9 acre-feet in Settling Pond 3 above the breach elevation. Piping initiates at the elevation of 418.0 feet which is the bottom elevation of settling pond 3 and the top of the is the crest of the dike at 432.0 feet. A piping coefficient of value of 0.8 was used in modeling the breach.

Estimates for breach development time and breach parameters for the PMP Southeast Breach scenario are summarized below. This scenario includes the series of two breaches, first the breach of the water quality cell to the south into South Cell A, then the failure of South Cell A to the southeast into an Unnamed Stream which drains to Wells Creek. The predicted average breach width (B_{av}) of the first breach was 26.5 feet and breach development time (t_f) ranged from 0.03 hours to 0.12 hours with the average of 0.1 hours used. These estimates are based on the assumed failure conditions, height of the breach (6.0 feet), and impoundment water volume of 15.6 acre-feet in the Water Quality Cell above the breach elevation. Piping initiates at the elevation of 426.0 feet which is the bottom elevation of the water quality cell at the location of the breach and the top of the breach is the crest of the dike at 432.0 feet. A piping coefficient of value of 0.8 was used in modeling the breach. The predicted average breach width (B_{av}) of the second breach was 31.0 feet and breach development time (t_f) ranged from 0.02 hours to 0.14 hours with the average of 0.1 hours used. These estimates are based on the assumed failure conditions, height of the breach (4.4 feet), and impoundment water volume of 44.3 acre-feet in South Cell A above the breach elevation. The impoundment water volume at the time of the breach of South Cell A includes the runoff volume into the impoundment (35.4 acre-feet) as well as the volume of water entering the impoundment through the breach in the Water Quality Cell. Overtopping initiates at the elevation of 415.5 feet which is the top of the dike, proceeding linearly down to the elevation of 411.1 feet.

The empirical calculations that served as the basis for the dam breach parameters estimation are included in Figures A4, A5, and A6 of Appendix A, for the “Sunny Day” Northeast Breach and the two PMP Southeast Breaches, respectively.

2.3 “SUNNY DAY” SCENARIO HYDROLOGIC MODELING

A dam breach outflow hydrograph for the “Sunny Day” Northeast Breach scenario was estimated using the dam break capabilities of HEC-HMS version 3.4. The data required for the model included (1) an elevation-storage relationship for Settling Pond 3 impoundment, (2) starting water surface elevation, and (3) dam breach parameters. Hydrologic inputs are described as follows:

(1) The stage-storage curve, shown in Figure A7 of Appendix A, was developed using the contours from plans for the proposed configuration of the Gypsum Disposal Complex.

(2) The starting water surface was set to the normal operating water surface elevation of 426.8 feet.

(3) The dam breach parameters described in Section 2.2 were applied to the model.

The computed outflow hydrograph for the “Sunny Day” Northeast Breach scenario had a peak outflow of 1,279 cfs which occurred 4 minutes after the start of the breach. The hydrograph is included as Figure A8 of Appendix A.

2.4 PRE-FAILURE HYDROLOGIC MODEL DEVELOPMENT FOR PMP EVENT

A hydrologic model of the proposed Gypsum Disposal Complex modifications was developed during the design of the facility and summarized in the Gypsum Disposal Complex Modifications Stormwater Management Report developed by Stantec (Reference 5). Inflow hydrographs and peak water surface elevations were obtained from the previous study and utilized in the development of the breach modeling.

The computed peak PMP water surface elevation was computed as 428.6 feet in the Water Quality Cell and as 414.6 feet in South Cell A. For the Southeast Breach scenario, the peak water surface elevations in the Water Quality Cell and South Cell A were assumed to occur simultaneously.

2.5 PMP SOUTHEAST BREACH SCENARIO HYDROLOGIC MODELING

A dam breach outflow hydrograph for the PMP Southeast Breach scenario was estimated using the dam break capabilities of HEC-HMS version 3.4. The data required for the model included (1) an elevation-storage relationship for the water quality cell impoundment draining to the South Cell A during the breach and South Cell A, (2) starting water surface elevations, and (3) dam breach parameters. Hydrologic inputs are described as follows:

(1) The stage-storage curves, shown in Figure A9 of Appendix A, were developed using the contours from plans for the proposed configuration of the Gypsum Disposal Complex .

(2) The starting water surface was set to the maximum PMP water surface elevation occurring in the water quality cell impoundment draining to the South Cell A during the breach of 428.6 feet. The maximum water surface elevation occurring in South Cell A during the PMP event is 414.6 feet before failure.

(3) The dam breach parameters described in Section 2.2 were applied to the model.

(4) The inflow hydrograph for the remaining PMP event after the water surface elevation in the water quality cell reaches an elevation of 428.6 feet was obtained from the pre-failure hydrologic model for a PMP event described in Section 2.4. The inflow hydrograph for the remaining PMP event after the water surface elevation in South Cell A reaches an elevation of 414.6 feet was obtained from the pre-failure hydrologic model for a PMP event described in Section 2.4. These remaining PMP event hydrographs were included as inflows during the breach.

The computed outflow hydrograph for the PMP Southeast Breach scenario had a peak outflow of 849 cfs which occurred 34 minutes after the start of the breach in the Water Quality Cell. The hydrograph is included as Figure A10 of Appendix A.

3.0 Hydraulic Analysis

For the “Sunny Day” Northeast Breach scenario, uniform flow calculations were performed to estimate the maximum water surface elevation at the SynMat Dewatering Facility. An unsteady flow hydraulic model was developed in USACE HEC-RAS Version 4.1 software to calculate maximum water surface elevations for the postulated PMP Southeast Breach scenario near the Wallboard Plant.

3.1 “SUNNY DAY” NORMAL DEPTH

The area to the northeast of the Gypsum Disposal Complex is flat with numerous buildings, ponds and ditches. The area is not suitable for the application of a 1-dimensional hydraulic model such as HEC-RAS. Instead, the estimated water surface elevations were calculated assuming a wide rectangular ditch and uniform flow.

To determine the width of flow to be used in the normal depth calculations, it was assumed that the width of flow would increase at the rate of 1 foot outward on each side of the flood wave for every 3 feet traveled in the direction of the wave. The flood wave was assumed to flow to the northeast perpendicular to the corner of the lined settling pond closest to the SynMat Dewatering Facility. Similar assumptions are routinely made when determining areas of effective flow in open channel flow calculations. The distance measured from the midpoint of the breach to the toe of the dike is approximately 220 feet and the distance measured from the toe of the dike to the SynMat Dewatering Facility is approximately 100 feet. At the assumed spreading rate, flow is assumed to be approximately 180 feet wide at the toe of the dike and 250 feet wide at the SynMat Dewatering Facility. After the plant, flow will gradually flow to the northwest via the system of plant ditches and ponds and overland flow. This flow was not considered in this analysis.

The downstream face of the Gypsum Disposal Complex is assumed to have a slope of 3H:1V and a Manning’s coefficient of 0.03. Using Manning’s Equation, the depth, velocity and momentum of flow at the toe of the dike were estimated for the peak discharge from the breach hydrograph.

$$(Average\ Velocity) = \frac{1.49}{(Manning\ Coefficient)} \times (Hydraulic\ Radius)^{2/3} \times (Slope)^{1/2}$$

At the toe of the dike, the flow is expected to undergo a hydraulic jump from supercritical to subcritical flow as a result of the abrupt change from a steep slope to a shallow slope. This jump results in an abrupt increase in the depth of flow corresponding to reduced velocity in which momentum is conserved.

$$\frac{(Flow\ Depth\ After\ Jump)}{(Flow\ Depth\ Before\ Jump)} = \frac{1}{2} \times (\sqrt{1 + 8 \times (Froude\ Number\ Before\ Jump)^2} - 1)$$

Finally, the resulting flow after the jump is assumed to continue spreading while conserving energy until it reaches the structure of interest. The resultant depth of flow was then added to the elevation of the ground to determine the water surface elevation for comparison to the elevation of the structure of interest. Figure B1 in Appendix B summarizes normal depth calculations for the “Sunny Day” Northeast Breach.

3.2 PMP SOUTHEAST BREACH HEC-RAS UNSTEADY HYDRAULIC MODELING

3.2.1 Model Geometry

The HEC-RAS model previously developed for the approximate study (Reference 1) was used as the basis for the updated depth calculations. The HEC-RAS model was developed using cross sections with an average spacing of less than 1,000 feet for Wells Creek and the Unnamed Tributary. Cross section overbank geometry was developed from 1-foot contour interval aerial mapping provided by TVA dated March 2010 (Reference 6) where available. In areas where aerial mapping was not available, cross section information was developed from USGS 10-Meter Digital Elevation Map data (Reference 7).

3.2.2 HEC-RAS Unsteady Hydraulic Modeling

The PMP Southeast Breach was assumed to occur during a 100-year flood of Wells Creek and the Cumberland River. Detailed flood information was not available for Wells Creek. The approximate 100-year peak discharge for Wells Creek of 13,600 cfs was obtained from “Tennessee Streamstats” (Reference 8) and applied as an inflow to Wells Creek in the HEC-RAS model. Because this approximate geometry does not contain channel information below the normal water surface elevation, flows for the Unnamed Stream draining into Wells Creek were set to 100 cfs for model stability purposes.   The breach hydrograph was applied as a lateral inflow to the Unnamed Stream upstream to the southeast of the Gypsum Disposal Complex Figure A1 of Appendix A. The simulation had a 24-hour duration time and a computation interval of 30-seconds.

4.0 Results and Inundation Mapping

The primary areas of concern were the SynMat Dewatering Facility and the Temple Inland Wall Board Plant to the east of the Gypsum Disposal Complex. The peak water surface elevations at each of the structures are provided in Table 4. The impact elevation of the Wallboard Plant was based on 2-foot contours provided by TVA (Reference 6) while the impact elevation of the SynMat Dewatering Facility was provided by TVA based on a letter provided by the TVA to the President of the SynMat Dewatering Facility in 2006. The SynMat Dewatering Facility was identified within the potential impact zone of the “Sunny Day” Northeast Breach with inundation depths of approximately 1.3 feet. Neither structure was identified within the potential impact zone of the PMP Southeast Breach scenario. Figure B2 in Appendix B shows the approximate inundation limits of the “Sunny Day” Northeast Breach scenario.

Table 4. Dam Breach Modeling Impact Summary

Facility	Structure Elevation (feet)	Max. Post-Breach WSE (feet)	
		“Sunny Day” Northeast Breach	PMP Southeast Breach
SynMat Dewatering Facility	395.2	396.5	381.7
Wallboard Plant	386.0	n/a	381.7

5.0 Hazard Classification

The SynMat Dewatering Facility was identified within the dam breach impact zone where maximum computed water surface elevations exceed the defined impact elevation. However, the inundation depth is expected to reach a maximum of 1.3 feet, which, based on a review of dam safety literature regarding life loss estimation (Reference 10), would not likely present a probable threat to human life. Based on existing and proposed conditions for the operation of the Gypsum Disposal Complex, it is recommended that the hazard classification be lowered from High Hazard to Significant Hazard. If the proposed Gypsum Disposal Complex is constructed differently than shown on the proposed drawings (i.e. berm crest elevation raised) or development occurs within the impact zone, the hazard classification should be re-evaluated.

6.0 References

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3. Chow V., D. R. Maidment, and L. W. Mays. (1988). *Applied Hydrology*. McGraw Hill, Singapore, 461.

4. Von Thun, Lawrence J. and D. R. Gillette (1990). *Guidance on Breach Parameters*, unpublished internal document, USBR, Denver, Colorado, 17. (Referenced in Wahl, 1998).

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6. Tuck Mapping Solutions Inc. (2010). *Cumberland Fossil Plant Aerial Survey, February 2010*. Tuck Mapping Solutions Inc.

7. United States Geological Survey (USGS), (1999). *10-Meter Digital Elevation Maps for Cumberland City, Ellis Mills, Erin and Needmore, Tennessee, February 1999*.

8. USGS (2007). "StreamStats for Tennessee" USGS, <http://water.usgs.gov/osw/streamstats/tennessee.html> (Feb. 10, 2010).

9. Federal Emergency Management Agency (FEMA). (1991). *Flood Insurance Rate Map: Marshall County, Kentucky (Unincorporated Areas)*. FEMA, 210252 0025 B.

10. McClelland, Duane M. and David S. Bowles (2002). *Estimating Life Loss for Dam Safety Risk Assessment: A Review and New Approach*. Institute for Dam Safety Risk Management, Utah State University, Logan, Utah.

Appendix A

Breach Analysis Calculations

Geographic Information Systems

Cartographic Design By: Daniel Hoffman

FIGURE A.1

Assumed Breach Location
Cumberland Fossil Plant Dam Breach Analysis

Stantec
11687 Lebanon Rd., Cincinnati, OH 45241-2012 Phone 513.842.8200 Fax 513.842.8250 www.stantec.com

FIGURE A2 - "SUNNY DAY" NORTHEAST FAILURE CONFIGURATION SCHEMATIC

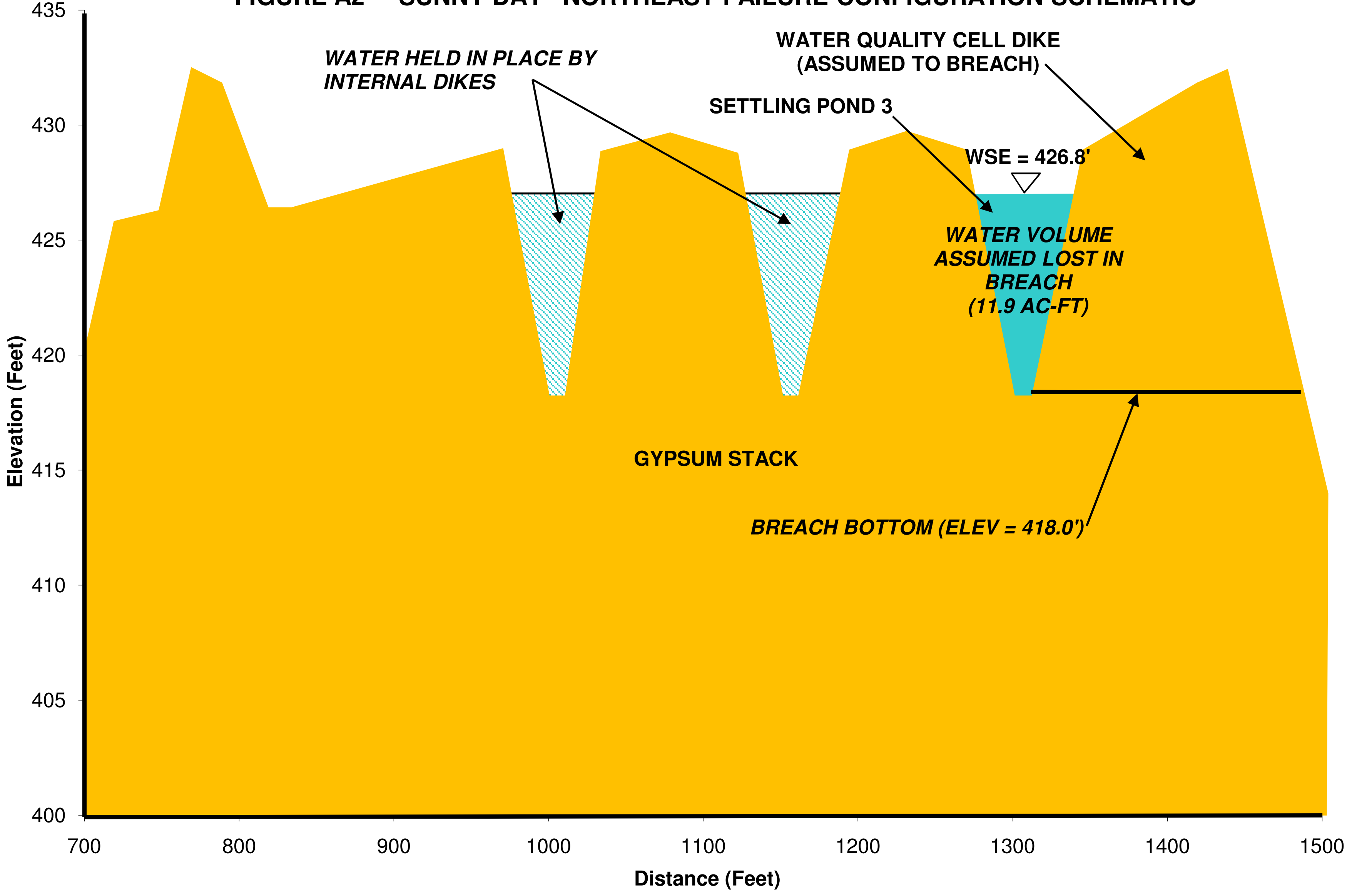


FIGURE A3 - PMP SOUTHEAST FAILURE CONFIGURATION SCHEMATIC

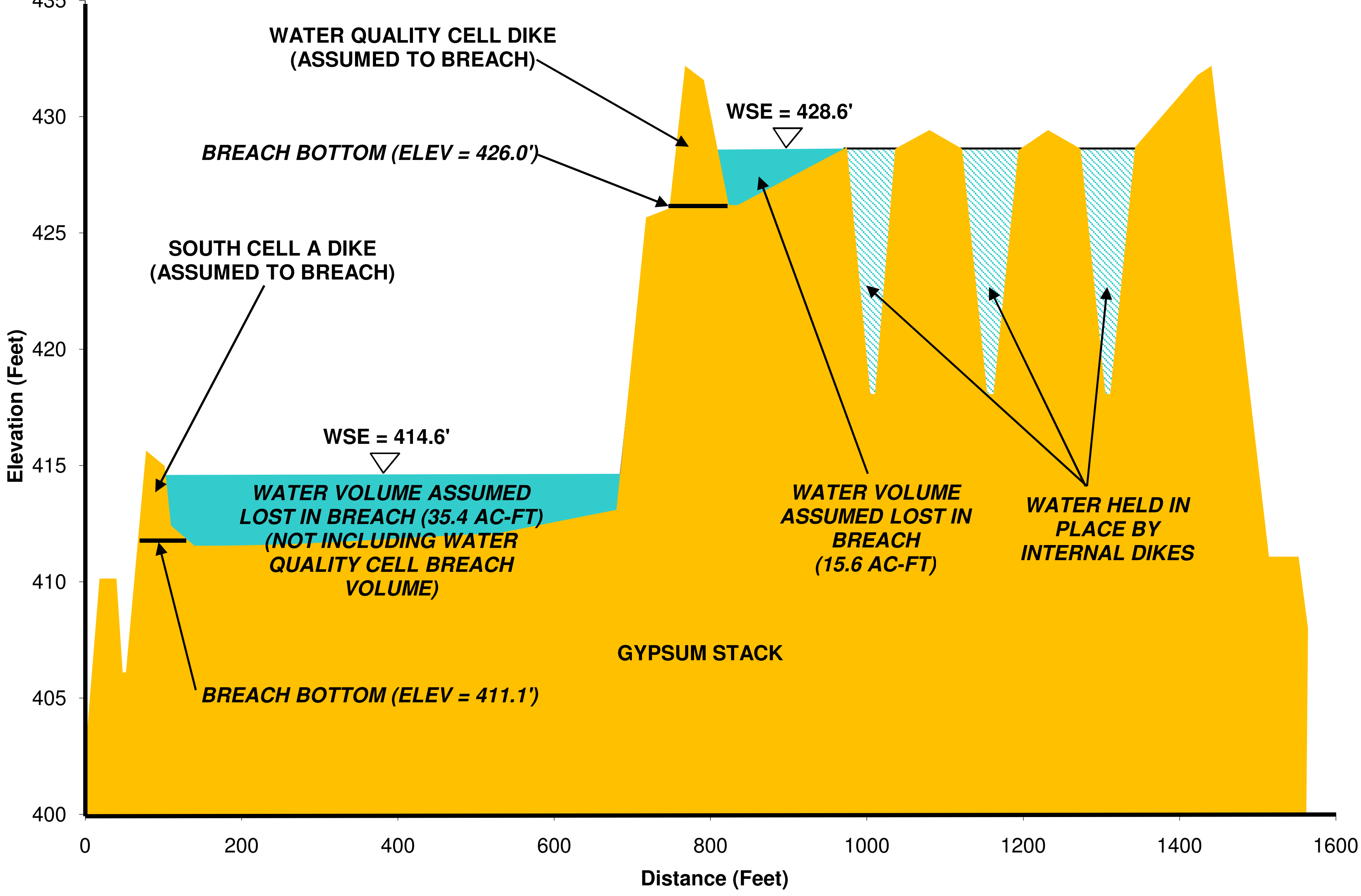


FIGURE A4 - "SUNNY DAY" NORTHEAST BREACH SCENARIO PARAMETERS

Dam Name: **Water Quality Cell - Settling Pond 3**

HEC-HMS Dam Breach Geometry and Development Time	
Breach Geometry	
Elevation of Water/Emergency Spillway Elevation (ft)	426.77
Top Elevation (ft)	432
Breach Bottom Elevation (ft)	418.0
Left Slope (xH:1V)	1
Right Slope (xH:1V)	1
Average Predicted Bottom Width (ft)	33.2
Average Predicted Width (ft)	41.9
Average Predicted Development Time (HR)	0.1

Breach Width and Time to Failure Parameters

Overtopping correction factor - 1.0 for piping failure	K_0	1
Height of dam (feet)	H_d	14.0
Hydraulic depth of water at dam failure, above breach bottom (feet)	H_w	8.8
Constant in Von Thun and Gillette breach width relation	C_b	20
Volume of water above breach invert elevation at time of breach (acre-feet)	V_w	11.9

	Breach Width	Time to Failure	
Froehlich (1987)(1)	~~21.7~~	~~0.176~~	$B_{av}=0.47*K_0*(V_w H_w)^{0.25}$ $t_f=0.59*V_w^{0.47}/H_d^{0.9}$
Froehlich (1995)(2)	~~15.4~~	~~0.111~~	$B_{av}=15*K_0*(*V_w)^{0.32}(H_w)^{0.19}$ $t_f=3.84*V_w^{0.53}/H_d^{0.9}$
USBR (1988)(3)	~~26.3~~	~~0.088~~	$B_{av}=3*H_w$ $t_f=B_{av}*0.011$
Von Thun and Gillette (1990)(4)	41.9		$B_{av}=2.5*H_w+C_b$
(based on t_f vs h_w)		~~0.064~~	*easily erodible;* $t_f=0.015*(H_w)$
(based on t_f vs h_w)		0.335	*erosion resistant;* $t_f=0.020*(H_d)+0.25$
(based on lateral erosion rates)		~~0.164~~	*easily erodible;* $t_f=B_{av}/\{4*(H_d/3.28)+61\}$
(based on lateral erosion rates)		0.749	*erosion resistant;* $t_f=B_{av}/\{4*(H_d/3.28)\}$

Chosen Values		
Bav=	41.9	feet
td=	0.1	hours
Bottom width=	33.13	feet
Width at WS=	50.67	feet
Width at Dam Top=	55.9	feet

FIGURE A5 - PMP SOUTHEAST BREACH SCENARIO PARAMETERS

Dam Name: **Water Quality Cell - Drainage Basin**

HEC-HMS Dam Breach Geometry and Development Time	
Breach Geometry	
Elevation of Water/Emergency Spillway Elevation (ft)	428.6
Top Elevation (ft)	432
Breach Bottom Elevation (ft)	426.0
Left Slope (xH:1V)	1
Right Slope (xH:1V)	1
Average Predicted Bottom Width (ft)	23.9
Average Predicted Width (ft)	26.5
Average Predicted Development Time (HR)	0.1

Breach Width and Time to Failure Parameters		
Overtopping correction factor - 1.0 for piping failure	K_0	1
Height of dam (feet)	H_d	6.0
Hydraulic depth of water at dam failure, above breach bottom (feet)	H_w	2.6
Constant in Von Thun and Gillette breach width relation	C_b	20
Volume of water above breach invert elevation at time of breach (acre-feet)	V_w	15.6

	Breach Width	Time to Failure	
Froehlich (1987)(1)	~~17.1~~	~~0.428~~	$B_{av}=0.47*K_0*(V_w H_w)^{0.25}$ $t_f=0.59*V_w^{0.47}/H_d^{0.9}$
Froehlich (1995)(2)	~~13.3~~	~~0.275~~	$B_{av}=15*K_0*(*V_w)^{0.32}(H_w)^{0.19}$ $t_f=3.84*V_w^{0.53}/H_d^{0.9}$
USBR (1988)(3)	~~7.8~~	~~0.026~~	$B_{av}=3*H_w$ $t_f=B_{av}*0.011$
Von Thun and Gillette (1990)(4)	26.5		$B_{av}=2.5*H_w+C_b$
(based on t_f vs h_w)		~~0.027~~	*easily erodible;* $t_f=0.015*(H_w)$
(based on t_f vs h_w)		0.287	*erosion resistant;* $t_f=0.020*(H_d)+0.25$
(based on lateral erosion rates)		~~0.118~~	*easily erodible;* $t_f=B_{av}/\{4*(H_d/3.28)+61\}$
(based on lateral erosion rates)		1.104	*erosion resistant;* $t_f=B_{av}/\{4*(H_d/3.28)\}$

Chosen Values		
Bav=	26.5	feet
td=	0.1	hours
Bottom width=	23.9	feet
Width at WS=	29.1	feet
Width at Dam Top=	32.5	feet

FIGURE A6 - PMP SOUTHEAST BREACH SCENARIO PARAMETERS

Dam Name: **South Cell A**

HEC-HMS Dam Breach Geometry and Development Time	
Breach Geometry	
Elevation of Water/Emergency Spillway Elevation (ft)	415.5
Top Elevation (ft)	415.5
Breach Bottom Elevation (ft)	411.1
Left Slope (xH:1V)	1
Right Slope (xH:1V)	1
Average Predicted Bottom Width (ft)	26.6
Average Predicted Width (ft)	31.0
Average Predicted Development Time (HR)	0.1

Breach Width and Time to Failure Parameters

Overtopping correction factor - 1.0 for piping failure	K_0	1.4
Height of dam (feet)	H_d	4.4
Hydraulic depth of water at dam failure, above breach bottom (feet)	H_w	4.4
Constant in Von Thun and Gillette breach width relation	C_b	20
Volume of water above breach invert elevation at time of breach (acre-feet)	V_w	44.3

	Breach Width	Time to Failure	
Froehlich (1987)(1)	~~35.5~~	~~0.924~~	$B_{av}=0.47*K_0*(V_wH_w)^{0.25}$ $t_f=0.59*V_w^{0.47}/H_d^{0.9}$
Froehlich (1995)(2)	~~28.7~~	~~0.632~~	$B_{av}=15*K_0*(*V_w)^{0.32}(H_w)^{0.19}$ $t_f=3.84*V_w^{0.53}/H_d^{0.9}$
USBR (1988)(3)	~~13.2~~	~~0.044~~	$B_{av}=3*H_w$ $t_f=B_{av}*0.011$
Von Thun and Gillette (1990)(4)	31.0		$B_{av}=2.5*H_w+C_b$
(based on t_f vs h_w)		~~0.020~~	*easily erodible;* $t_f=0.015*(H_w)$
(based on t_f vs h_w)		0.277	*erosion resistant;* $t_f=0.020*(H_d)+0.25$
(based on lateral erosion rates)		~~0.142~~	*easily erodible;* $t_f=B_{av}/\{4*(H_d/3.28)+61\}$
(based on lateral erosion rates)		1.761	*erosion resistant;* $t_f=B_{av}/\{4*(H_d/3.28)\}$

Chosen Values		
Bav=	27.5	feet
td=	0.1	hours
Bottom width=	23.1	feet
Width at WS=	31.9	feet
Width at Dam Top=	31.9	feet

FIGURE A7 - SETTLING POND 3 STAGE STORAGE CURVE

Facility Name: **Cumberland Gypsum Stack**

Elevation (ft)	Cumulative Volume (acre-ft)
418	0.0
420	1.3
422	3.4
424	6.3
426	10.1
428	14.8
430	47.7
432	114.1

NOTE: This stage-storage curve was used for the modeling of the dam breach scenario in HEC-HMS for the "Sunny Day" Northeast scenario only.

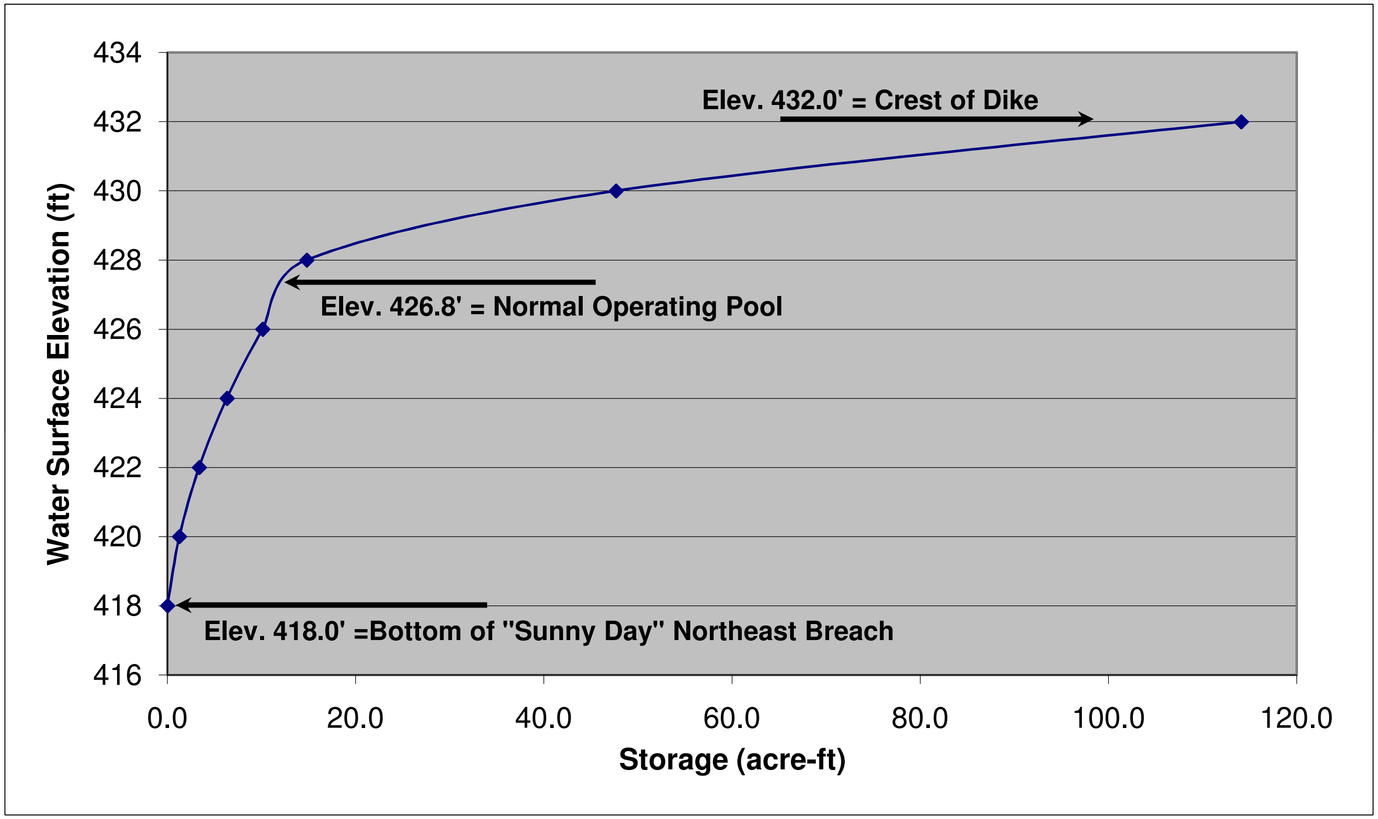


FIGURE A8 -"SUNNY DAY" NORTHEAST BREACH SCENARIO OUTFLOW HYDROGRAPH

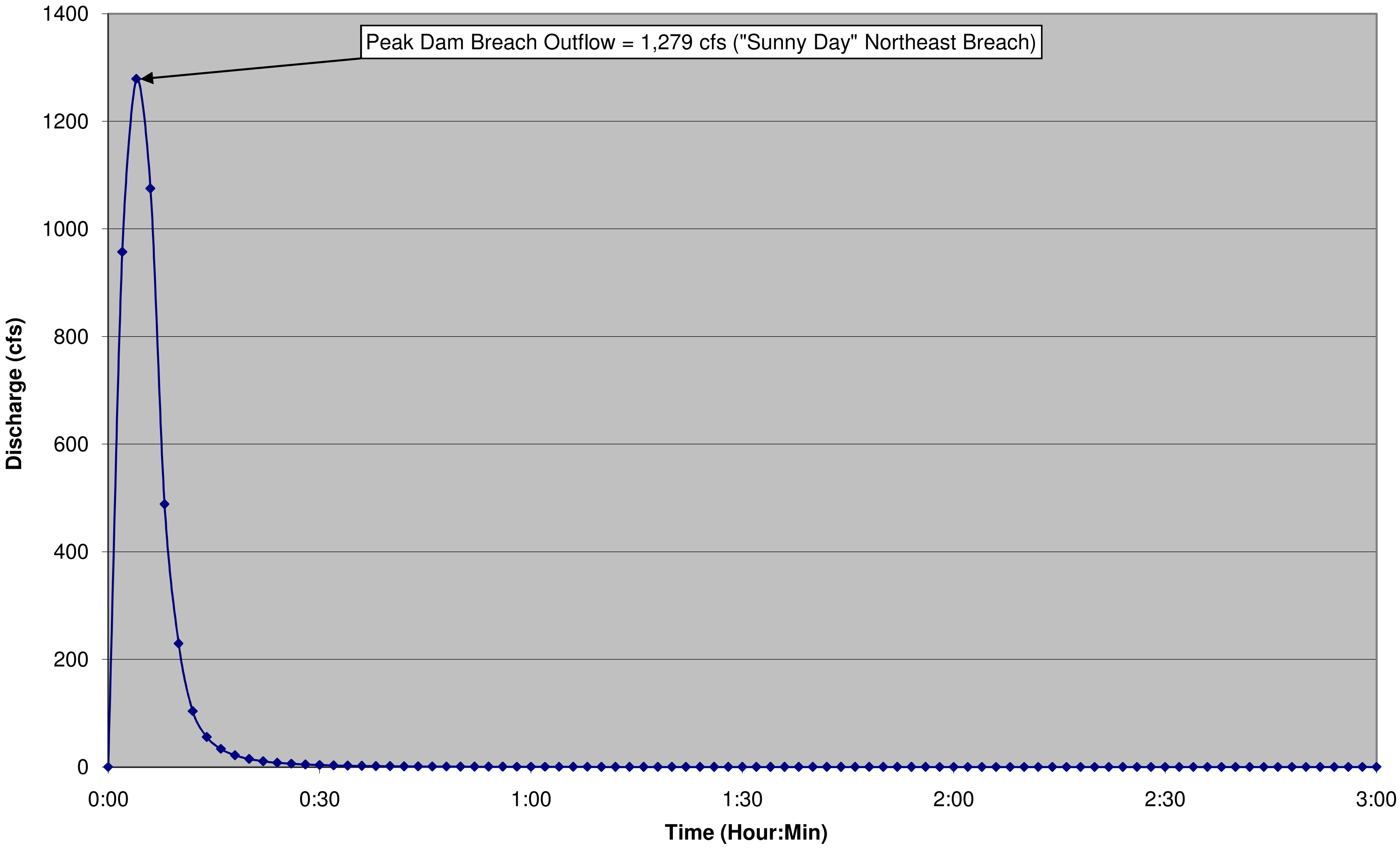


FIGURE A9 - WATER QUALITY CELL AND SOUTH CELL A STORAGE CURVES (FOR PMP SOUTHEAST BREACH HYDROLOGIC ROUTING)

Facility Name: **Water Quality Cell and South Cell A**

Water Quality Cell

Elevation (ft)	Cumulative Volume (acre-ft)
424	0.0
426	1.2
428	6.9
430	41.9
432	108.4

South Cell A

Elevation (ft)	Cumulative Volume (acre-ft)
410	0.0
410.5	1.1
411	2.2
411.5	5.0
412	7.8
412.5	12.0
413	16.3
414	28.4
415	40.5
415.5	47.1

NOTE: This stage-storage curve was used for the modeling of the dam breach scenario in HEC-HMS for the PMP Southeast Breach scenario only.

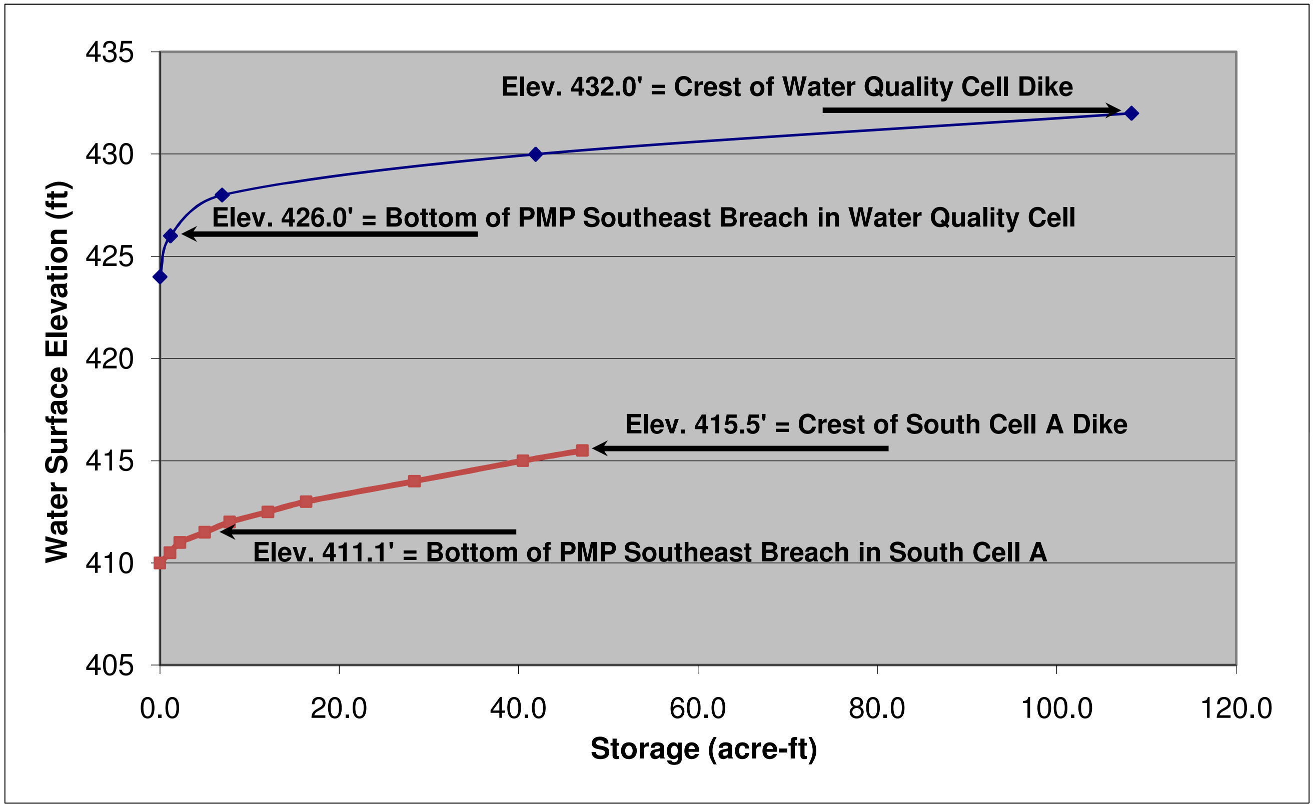
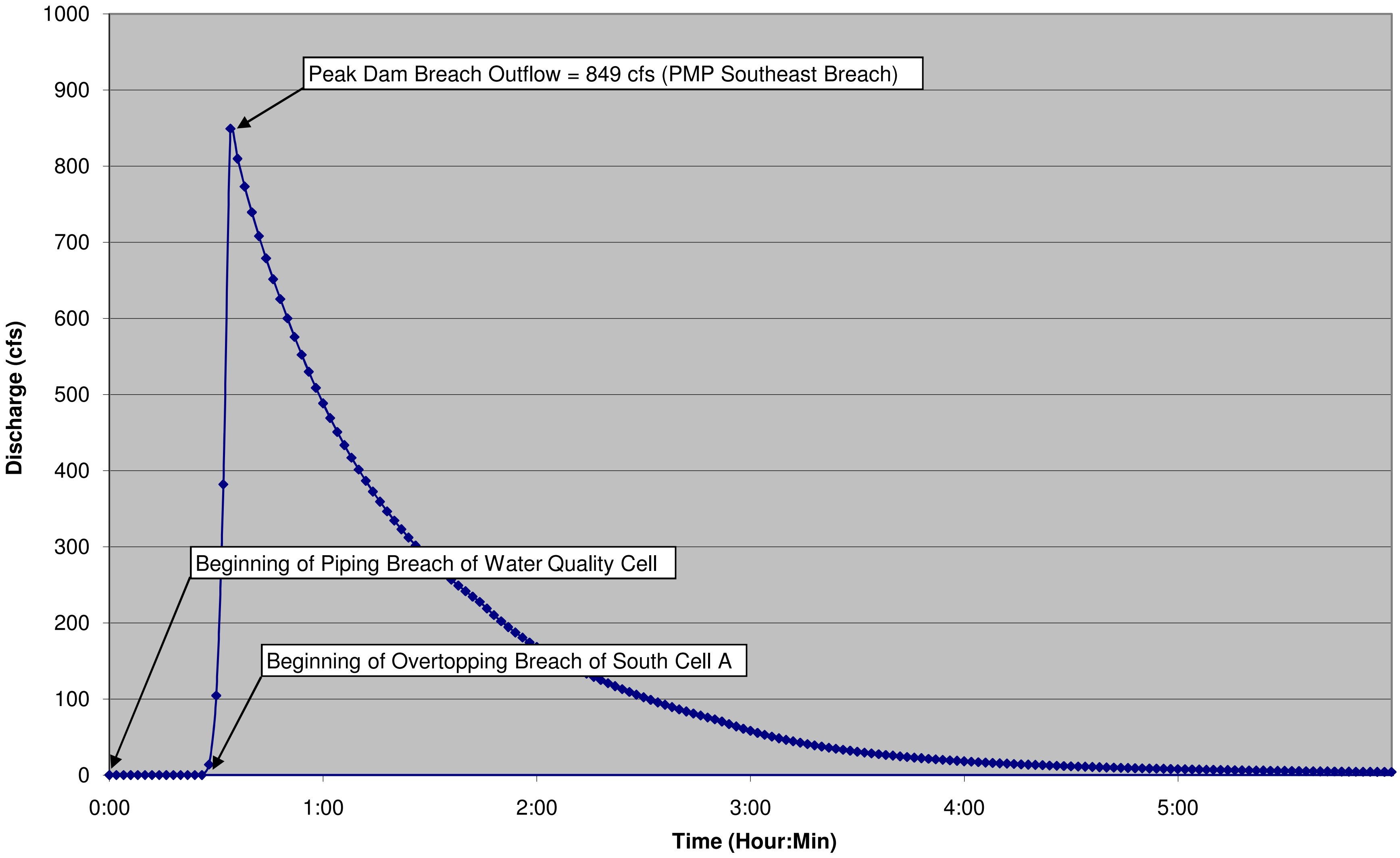


FIGURE A10 - PMP SOUTHEAST BREACH SCENARIO OUTFLOW HYDROGRAPH



Appendix B

Breach Routing Calculations

FIGURE B1 - "SUNNY DAY" NORTHEAST BREACH HYDRAULIC ANALYSIS

Known Information

Breach Bottom Width (ft)	33.2	
Breach Peak Flow Rate (cfs)	1279	
Mannings Roughness	0.03	
Outer Dike Approximate Slope (ft/ft)	0.33	
Width of Flow at Toe of Dike (ft)	180	
Width of Flow at Dewatering Plant (ft)	250	

Application of Manning's Equation

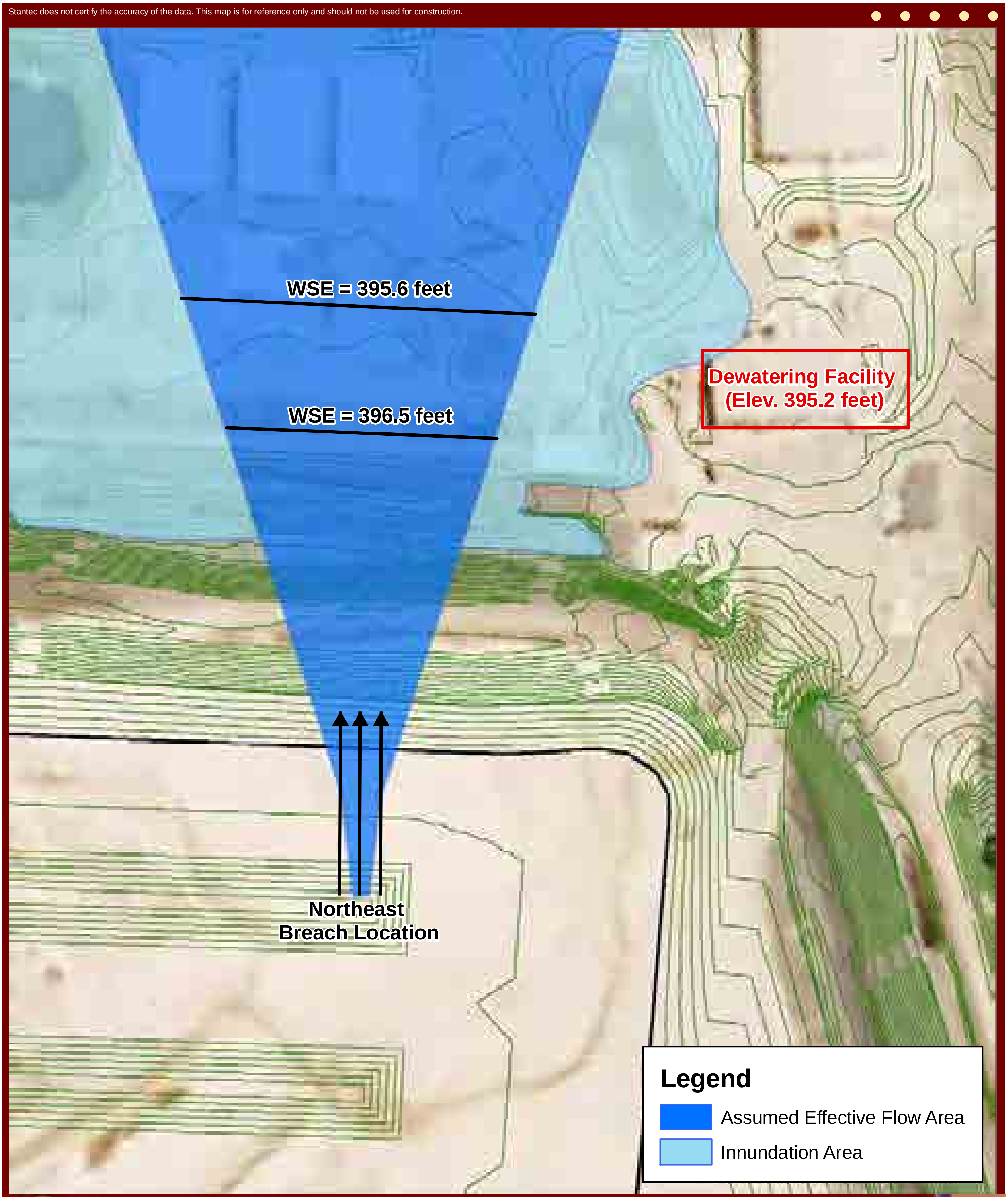
Normal Depth Before Hydraulic Jump (ft)	0.4	Determined using solver
Velocity Before Hydraulic Jump (ft/s)	16.3	
Froude Number Before Hydraulic Jump	4.4	

Flow Properties After Hydraulic Jump

Ratio of Depth After Jump to Depth Before Jump	5.7	
Normal Depth After Hydraulic Jump (ft)	2.47	
Velocity After Hydraulic Jump (ft/s)	2.9	
Specific Energy (ft)	2.6	

Flow Properties at Dewatering Plant

Specific Energy (ft)	2.6	
Normal Depth After Hydraulic Jump (ft)	2.5	Determined using solver
Velocity After Hydraulic Jump (ft/s)	2.0	



Geographic Information Systems

Cartographic Design By: Daniel Hoffman

FIGURE B.2

"Sunny Day" Northeast Breach
Cumberland Fossil Plant Dam Breach Analysis

APPENDIX A

Document 14

Dam Breach Analysis – Ash Pond, Stantec, September 2010

Stantec

Dam Breach Analysis and Inundation Mapping

Cumberland Fly Ash Pond
Cumberland Fossil Plant
Stewart County, Tennessee

September, 2010

Stantec

Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati OH 45241-2012
Tel: (513) 842-8200
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September 2, 2010
File: 175639026

Daniel G. Stephens, PE
Program Manager - CUF
Tennessee Valley Authority – CCP Engineering
1101 Market Street, LP5E-C
Chattanooga, Tennessee 37402

Reference: Cumberland Fossil Plant Ash Pond
Breach Inundation Analysis

Dear Mr. Stephens:

Enclosed is our report of the breach inundation analysis for the Cumberland Fossil Plant Ash Pond. This report summarizes Stantec Consulting Services Inc.'s analysis, methodologies, modeling results and hazard classification recommendation. We appreciate the opportunity to assist Tennessee Valley Authority on this project. If you have any questions, please call our office.

Sincerely,

STANTEC CONSULTING SERVICES INC.

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Table of Contents

1.0 Study Description

The Cumberland Fossil Plant is located at the confluence of Wells Creek and the Cumberland River in Stewart County, Tennessee. The fly ash pond has a footprint of approximately 50 acres with a dike crest elevation of approximately 394 feet.

Stantec had previously performed breach analyses of the fly ash pond at the Cumberland Fossil Plant using approximate methods. The results of this study were included in the summary titled, “Preliminary Dam Breach Approximate Limits of Impact – Methodology” and submitted to the TVA on July 24, 2009 (Reference 1).

Stantec has been requested to perform a detailed analysis using recently developed topographic data to determine the limit of impact caused by a breach of the ash pond dike. The following report summarizes the additional study of the breach impacts using HEC-HMS, a hydrologic routing software, and HEC-RAS, hydraulic modeling software capable of performing unsteady flow routing.

2.0 Breach Hydrograph Development

2.1 FAILURE SCENARIOS

Stantec developed breach hydrographs for the ash pond using the U.S. Army Corps of Engineers (USACE) HEC-HMS computer modeling software, Version 3.4. Breach analyses were performed for two failure scenarios: (1) A "Sunny Day" breach which consists of a piping failure that is assumed to occur during normal operational inflows. The impoundment water surface elevation is normally assumed to be at the top of the lowest non-clogging spillway. (2) A Probable Maximum Precipitation (PMP) event which consists of an overtopping failure during a PMP event. Specific assumptions for the two scenarios are outlined below:

For a piping failure, HEC-HMS simulates a trapezoidal breach that begins at the bottom elevation of the breach and has a gradually increasing breach orifice height and width, until the dam crest is reached. Likewise, for a PMP failure, HEC-HMS simulates a trapezoid failure that begins at the top of the embankment and has gradually increasing breach width and decreasing weir elevation until the bottom elevation is reached.

2.1.1 "Sunny Day" Scenario

Since the Cumberland Ash Pond does not have an emergency spillway, the water surface elevation at the time of the breach was assumed to be equal to the perimeter dike crest elevation of 394.0 feet. Inflow to the ash pond was neglected and the water surface elevation of the Cumberland River assumed to be 359.0 feet which is the summer normal pool of Lake Barkley (Reference 2). The resulting water surface elevation at likely breach locations along Wells Creek was estimated at 359.3 feet. Piping failures were assumed to occur along Wells Creek or the Cumberland Fossil Plant Discharge Channel as shown in Figure A1 of Appendix A. The impounded water and fly ash within the pond was assumed to be lost down to elevation 359.3 feet since the surrounding water would act as tailwater and limit outflow. Conservatively, all sluiced ash above elevation 359.3 feet was assumed to mobilize and be lost through the breach. Figure A2 in Appendix A is a schematic cross section through the ash pond showing the "Sunny Day" failure configuration.

2.1.2 PMP Scenario

The water surface in the ash pond at the beginning of the PMP event was assumed at normal pool elevation, 384.3 feet. Overtopping failures were to occur along Wells Creek or the Cumberland Fossil Plant Discharge Channel as shown in Figure A1 of Appendix A. The water surface elevation on Wells Creek and the Cumberland River was assumed at the level of the 100-year flood event, an elevation of 381.0 feet at the breach location. This assumption is reasonable since some level of flooding of the surrounding waterways would be expected during a PMP event of the ash pond but the water surface elevations of the surrounding waterways would be expected to be less than the PMP elevations since Wells Creek and the Cumberland

River have much larger drainage areas and lag times. The overtopping failure was assumed to begin when the ash pond water surface reached the crest of the dike, elevation 394.0 feet. Figure A3 in Appendix A is a schematic cross section through the ash pond showing the PMP failure configuration.

The inflow consisted of the 6-hour PMP event precipitation (35.4 inches) obtained from the National Oceanic and Atmospheric Administration (NOAA) Hydrometeorological Report No.56 (HMR-56) (Reference 3). Three different hyetograph shapes were evaluated: (1) SCS Type-B 6-hour hyetograph, (2) "Early Peak" 6-hour hyetograph, and (3) "Late Peak" 6-hour hyetograph. The SCS Type-B 6-hour hyetograph is a standard shape currently being used for spillway design at various TVA fossil plants (Reference 4). The "Early Peak" and "Late Peak" hyetographs were developed using a procedure outlined in HMR-56. The 1-, 2-, 3-, 4-, 5-, and 6-hr PMP depths were taken from Figure 16 in HMR-56 and arranged sequentially. Incremental depths were determined for each hour and then rearranged to develop the two hyetographs according to rules presented in HMR-56.

2.2 ESTIMATION OF DAM BREACH PARAMETERS

Many empirical equations have been developed from case studies to predict average breach width and breach development time based on the height of the dam, depth of the water, volume impounded, and type of breach. Since there is great uncertainty in predicting dam breach parameters, Stantec used different empirical equations and based final breach parameters on the range of the estimates obtained and engineering judgment.

Estimates for breach development time and average breach parameters for the "Sunny Day" scenario are summarized in Table 1. The predicted average breach width (B_{av}) ranged from 85.9 feet to 146.8 feet and breach development time (t_f) ranged from 0.2 hours to 1.1 hours. These estimates are based on the assumed failure conditions, height of the breach (35 feet), and impoundment water volume of 1141 acre-feet in the ash pond above the breach elevation. While the total volume of both water and sluiced ash above the breach elevation is 1762 acre-feet, for use in determination of the dam breach parameters, ash volume is excluded.

Table 1. Estimate of Dam Breach Parameters Based on "Sunny Day" Scenario

Equation Name	B_{av} (feet)	t_f (hours)
Froehlich (1987)(5)	95.8	0.7
Froehlich (1995)(6)	85.9	0.6
USBR (1988)(7)	104.1	0.3
Von Thun and Gillette (1990)(8)	146.8	0.2-1.1
Average	**108.1**	**0.5**

The selected parameters for the "Sunny Day" Scenario are summarized below:

(1) The average breach width along Wells Creek is 108.1 feet, which is the average of the breach widths from the equations referenced. For the breach along the Discharge Channel, an average breach width of 65.7 feet was selected because the lined spillway would restrict the bottom width of the breach to just 36.0 feet at this location.

(2) The breach development time is 0.5 hours.

(3) The piping initiates at the Wells Creek normal pool elevation of 359.3 feet at the location of the breach, which is also the bottom elevation of the breach, and progresses linearly. This elevation was used for both breach analyses as a conservative assumption.

(4) The top of breach is the dike crest elevation of 394.0 feet.

(5) The piping coefficient is 0.8, a common orifice coefficient value.

Estimates for breach development time and average breach parameters for the PMP event scenario are summarized in Table 2. For the overtopping failure of the PMP event scenario, only the Froehlich equations were utilized because of their incorporation of a correction factor specifically for overtopping failures. The predicted average breach width (B_{av}) ranged from 81.2 feet to 89.3 feet and breach development time (t_f) ranged from 0.1 hours to 1.2 hours. These estimates are based on the assumed failure conditions, height of the breach (13.0 feet), and impoundment volume of water of 598 acre-feet in the ash pond above the breach elevation. While the total volume of both water and sluiced ash above the breach elevation is 631 acre-feet, for use in determination of the dam breach parameters, only the water volume is used.

Table 2. Estimate of Dam Breach Parameters Based on PMP Scenario

Equation Name	B_{av} (feet)	t_f (hours)
Froehlich (1987)(5)	89.3	1.2
Froehlich (1995)(6)	81.2	0.9
USBR (1988)(7)	Not Considered	0.1
Von Thun and Gillette (1990)(8)	Not Considered	0.1-1.0
Average	**85.2**	**0.6**

The selected parameters for the PMP Scenario are summarized below:

(1) The average breach width is 85.2 feet, which is the average of the average breach widths from the equations referenced.

(2) The breach development time is 0.6 hours.

(3) The bottom elevation of the breach is at the Wells Creek 100-year flood elevation of 381.0 feet.

(4) The overtopping failure initiates at the dike crest elevation, 394.0 feet and progresses linearly.

The empirical calculations that served as the basis for the dam breach parameters estimation are included in Figures A4 and A5 of Appendix A, for the “Sunny Day” and PMP Scenarios, respectively.

2.3 “SUNNY DAY” SCENARIO HYDROLOGIC MODELING

A dam breach outflow hydrograph for the “Sunny Day” scenario was estimated using the dam break capabilities of HEC-HMS Version 3.4. The data required for the model included (1) an elevation-storage relationship for the ash pond impoundment, (2) starting water surface elevation, and (3) dam breach parameters. Hydrologic inputs are described as follows:

(1) The stage storage curve, shown in Figure A6 of Appendix A, was developed using three sources provided by TVA:

   a. Hydrographic survey dated September, 2008 (Reference 9)
   b. Aerial survey dated April, 2009 (Reference 10)
   c. Design drawings dated January,1969 (Reference11)

(2) The starting water surface was set to the dike crest elevation of 394.0 feet.

(3) The dam breach parameters described in Section 2.2 were applied to the model.

The computed outflow hydrograph for the “Sunny Day” scenario resulted in a peak outflow of 44,363 cfs which occurred 22 minutes after the start of the breach when the failure occurred along Wells Creek. The computed outflow hydrograph for the “Sunny Day” scenario resulted in a peak outflow of 22,522 cfs which occurred 24 minutes after the start of the breach when the failure occurred along the Discharge Channel. The hydrographs are included as Figure A7 of Appendix A.

2.4 PRE-FAILURE HYDROLOGIC MODEL DEVELOPMENT FOR PMP EVENT

The purpose of the pre-failure hydrologic model was to establish the time during the PMP event that the ash pond water surface would reach the top of embankment elevation and overtopping would begin to occur. Stantec used available data to develop a hydrologic model of the ash pond in HEC-HMS Version 3.4. Hydrologic information and outlet geometry information was taken from “Cumberland Fossil Plant – Design Support Calculations for Spillway Replacement Project” by Stantec dated 2010 (Reference 12). The data required for the model included (1) an elevation-storage relationship for the impoundment, (2) a starting water surface elevation, (3) an outflow rating curve, (4) watershed parameters, and (5) an inflow hydrograph. Hydrologic inputs are described as follows:

(1) The stage-storage curve, shown in Figure A8 of Appendix A, was developed for the PMP pre-failure modeling from a hydrographic survey provided by TVA and dated September, 2008 (Reference 9).

(2) The starting water surface was set to the normal pool elevation of 384.3 feet. The normal operating pool elevation was selected because it would be unlikely for the pool elevation to be at the crest elevation at the start of the PMP event.

(3) The ash pond outlet consists of four circular riser structures. A rating curve for these structures was developed based on a construction detail drawing (Reference 13) assuming inlet control for the PMP breach scenario and is included in Figure A9 of Appendix A.

(4) Watershed parameters input to the model included:

    a. Composite Curve Number = 89
    b. Lag Time = 9.2 min
    c. Watershed Area = 467 acres

(5) The inflow hydrograph was computed in HEC-HMS based on the watershed parameters and the 6-hour SCS Type-B PMP event, 6-hour “Early Peak” PMP event or 6-hour “Late Peak” PMP event. An additional inflow of 57 cfs, which is the maximum expected plant flow pumped to the pond, was also applied as a constant baseflow.

The model showed that overtopping would be expected to begin 2 hours and 40 minutes after the start of the 6-hour SCS Type-B PMP event, 1 hour and 20 minutes after the start of the 6-hour “Early Peak” PMP event and 5 hours and 26 minutes after the start of the 6-hour “Late Peak” PMP event. The computed PMP hydrographs are included in Figure A10 of Appendix A.

2.5 PMP SCENARIO HYDROLOGIC MODELING

A dam breach outflow hydrograph for the PMP scenario was calculated using the dam break capabilities of HEC-HMS Version 3.4. The simulation was run from the time of overtopping, until 24-hours after the start of the PMP. The data required for the model included (1) an elevation-storage relationship for the ash pond impoundment, (2) starting water surface elevation, (3) dam breach parameters, and (4) an inflow hydrograph for PMP event. These inputs are described below:

(1) The stage storage curve, shown in Figure A6 of Appendix A, was developed using three sources provided by TVA:

  a. Hydrographic survey dated September, 2008 (Reference 9)
  b. Aerial survey dated April, 2009 (Reference 10)
  c. Design drawings dated January, 1969 (Reference 11)

(2) The starting water surface was set to the top of embankment elevation of 394 feet.

(3) The dam breach parameters described in Section 2.2 were applied to the model.

(4) The inflow hydrograph for the remaining PMP event after the water surface elevation in the fly ash pond reaches an elevation of 394.0 feet was obtained from the pre-failure hydrologic model for a PMP event described in Section 2.4. This remaining PMP event hydrograph was included as an inflow during the breach.

The peak outflow computed for the three PMP scenarios are summarized in Table 3. The hydrographs are included as Figure A11 of Appendix A.

Table 3. Summary of Peak Outflow for PMP Breach Scenarios

PMP Event Description	Time of Peak (Hour:Min After Start of PMP Event)	Peak Outflow (cfs)
6-Hour SCS Type-B Hyetograph	3:16	12,055
6-Hour “Early Peak” Hyetograph	1:56	10,521
6-Hour “Late Peak” Hyetograph	6:02	14,381

3.0 Hydraulic Model Development

An unsteady flow hydraulic model was developed in USACE HEC-RAS Version 4.1.0 software to calculate maximum water surface elevations for the postulated breach scenarios.

3.1 MODEL GEOMETRY

The HEC-RAS model was developed using cross sections with an average spacing of less than 1000 feet for Wells Creek and an average spacing of less than 5000 feet for the Cumberland River in the vicinity of the Cumberland Fossil Plant. Cross section overbank geometry was developed from 1-foot contour interval aerial mapping provided by TVA and dated March 2010 (Reference 14) where available. Wells Creek and the Cumberland River channel geometry for the underwater portion of the cross sections was developed from a hydrographic survey of Wells Creek and the Cumberland River Channel performed by TVA in January 2010 (Reference 15). Channel geometry for the Cumberland Fossil Plant Discharge Channel underwater portion of the cross sections and structures was developed from channel design drawings provided by TVA (Reference 16)

In areas where aerial mapping along the Cumberland River was not available, cross section information was developed from USGS 10-Meter Digital Elevation Map data (Reference 17).

The Cumberland City Road bridge over Wells Creek was added to the hydraulic model based on field survey performed by TVA in January 2010 (Reference 15) and design drawings provided by the Tennessee Department of Transportation (Reference 18). The Cumberland City Road bridge over the Discharge Channel was based on design drawings provided by TVA (Reference 16)

3.2 HEC-RAS UNSTEADY HYDRAULIC MODELING

The “Sunny Day” breach was assumed to occur during a non-flood condition. The approximate baseflow for Wells Creek of 14 cfs was obtained from “Tennessee Streamstats” (Reference 19) and applied as an inflow to Wells Creek in the HEC-RAS model. Baseflow in the Discharge Channel was set at approximately 59 cfs (Reference 12). Baseflow in the Cumberland River was approximated as 24,520 cfs based on average annual flow rates recorded at USGS Gage 03437000 near Dover, Tennessee from 1938 to 1965 (Reference 20). A downstream boundary condition was applied to the Cumberland River reach such that the initial water surface elevation was 359.0 feet, which is the Cumberland River summer normal pool elevation (Reference 2). The downstream boundary condition represents a backwater effect from Lake Barkley. The appropriate “Sunny Day” breach hydrograph was applied as a lateral inflow to Wells Creek upstream of the Cumberland City Road bridge and as an inflow to the Discharge Channel at the locations shown on Figure A1 of Appendix A during separate simulations. The simulations used a 24-hour duration time and a computation interval of 20-seconds.

The PMP breach was assumed to occur during a 100-year flood of Wells Creek and the Cumberland River. Detailed flood information was not available for Wells Creek. The approximate 100-year peak discharge for Wells Creek of 13,600 cfs was obtained from “Tennessee Streamstats” (Reference 19) and applied as an inflow to Wells Creek in the HEC-RAS model. Baseflow in the Discharge Channel was approximately 59 cfs because the majority of the contributing drainage area is regulated through the ash ponds to be breached (Reference 12).The approximate 100-year peak discharge of the Cumberland River, 300,000 cfs, was obtained from a USGS gage on the Cumberland River near Dover, Tennessee, approximately 15 miles downstream from the Cumberland Fossil Plant at river mile 88 (Reference 21). A downstream boundary condition was applied to the Cumberland River reach such that the 100-year water surface elevation was 380.1 feet based on data developed by the USACE from the Cumberland River gage at Cumberland Fossil Plant at river mile 104 (Reference 22). Each of the PMP breach hydrographs was applied as a lateral inflow to Wells Creek upstream of the Cumberland City Road bridge as shown in Figure A1 of Appendix A. The simulation used a 24-hour duration time and a computation interval of 20-seconds.

3.3 BRIDGE SCOUR ANALYSIS

During the “Sunny Day” breach simulation, flow velocities beneath the Cumberland City Road bridge over Wells Creek reach a peak of 13.2 feet per second. During the “PMP” breach simulation flow velocities beneath the bridge reach a peak of 9.7 feet per second. While these flows occur only briefly, their magnitude makes failure of the bridge by scour a concern.

To estimate the depth of potential scour in the vicinity of the bridge foundation, the hydraulic design functions of the HEC-RAS software were utilized. HEC-RAS performs scour analysis based on the methodology outlined in HEC-18 (Reference 23). Bridge scour calculations were performed for only the “Sunny Day” simulation due to the higher velocities. Figure B1 and B2 of Appendix B summarize the HEC-RAS bridge scour input parameters as well as support calculations.

According to construction drawings provided by TDOT, the existing bridge abutments, extending 40 feet upstream and downstream, are protected by a riprap blanket (Reference 18). At the time of this study, the presence of scour protection along the Wells Creek channel bottom was not confirmed. As such, the channel bottom was assumed to be free of rip rap and scour projection.

For purposes of the scour analysis, the riprap was assumed to have a D50 of 150.0 mm and D95 of 300.0 mm based on field observations. For the bed material within the channel, Stantec assumed the material properties of fine sediments. The entered properties were based on lab analysis of soil boring B-49 (Reference 24) located approximately 5000 feet upstream of the bridge and taken at the estimated depth of the original stream bed. This sample was selected to provide what is thought to be a conservative estimate of the channel properties in the absence of specific data.

4.0 Results and Inundation Mapping

The inundation limits for each scenario were mapped to determine which structures/roadways would be impacted. The primary areas of concern were the Cumberland City Road bridges at the mouth of Wells Creek and crossing the Discharge Channel. The bridge impact elevations, defined as the top of deck elevation, were determined based on field survey data. The peak water surface elevations at each of the bridges are provided in Table 4. Based on the base flood elevations provided by USACE and routing model results, the Cumberland City Road bridge over Wells Creek overtops during the 100-year event. The model results indicate that the PMP breach outflows result in an increase of water surface elevation of 0.4 feet. No additional structures or bridges were identified within the potential impact zone of the “Sunny Day” or PMP scenarios. For each scenario, the breach was applied upstream of the Cumberland City Road bridges. These locations correspond to the locations at which a breach produces the most severe rise in water surface elevation at each of the bridges.

The individual PMP events modeled produced slightly different breach hydrographs. The model indicated that the 6-hour “Late Peak” PMP event produces the greatest water surface elevations along both Wells Creek and the Cumberland River. The PMP event impact elevations are based on values produced by the 6-hour “Late Peak” PMP event.

Inundation mapping was developed for each of the breach scenarios and is included as Figures B3 and B4 of Appendix B for the “Sunny Day” and PMP scenarios, respectively. The inundation limits were delineated using the hydraulic model outputs and the imagery and topographic data described in Section 3.2.

Table 4. Dam Breach Modeling Impact Summary

Facility	Base Sunny Day WS (feet)	Base 100-Year WS (feet)	Impact Elevation (feet)	Max. Post-Breach WS (feet)	
				Sunny Day Breach	PMP Breach
Cumberland City Road Bridge at Mouth of Wells Creek	359.3	380.9	380.9	363.0	381.3
Cumberland City Road Bridge Over Discharge Channel	359.3	380.6	381.2	359.6	380.7

According to model results, the combination of pier and contraction scour, at the Cumberland City Road bridge over Wells Creek, could cause scour to a depth of 322.3 feet within the channel for the grain sizes taken from the boring sample. In the areas covered by the riprap blanket, no significant scour occurred. Table 5 summarizes the maximum scour depth within the channel based on the assumed sediment properties. According to design drawings provided by the Tennessee Department of Transportation (Reference 18) the top of the pile cap within the channel is at an elevation of 326.6 feet and extends down to an elevation of 323.6 feet. The scour depth calculations assume sustained flow conditions and thus provide a conservative value for this simulation because peak flow velocities are sustained for only minutes. The maximum scour depth is below the base of the pile cap and could undermine the piers, potentially causing bridge failure.

Table 5. Dam Breach Bridge Scour Summary

	Grain Size
Channel D50 (mm)	0.009
Channel D95 (mm)	1.00
Starting Channel Elevation (ft)	344.6
Max Scour Depth (ft)	22.3
Max Scour Elevation (ft)	322.3
Impact Elevation (ft)	323.6
Difference Between Scour and Impact Elevations (ft)	-1.3

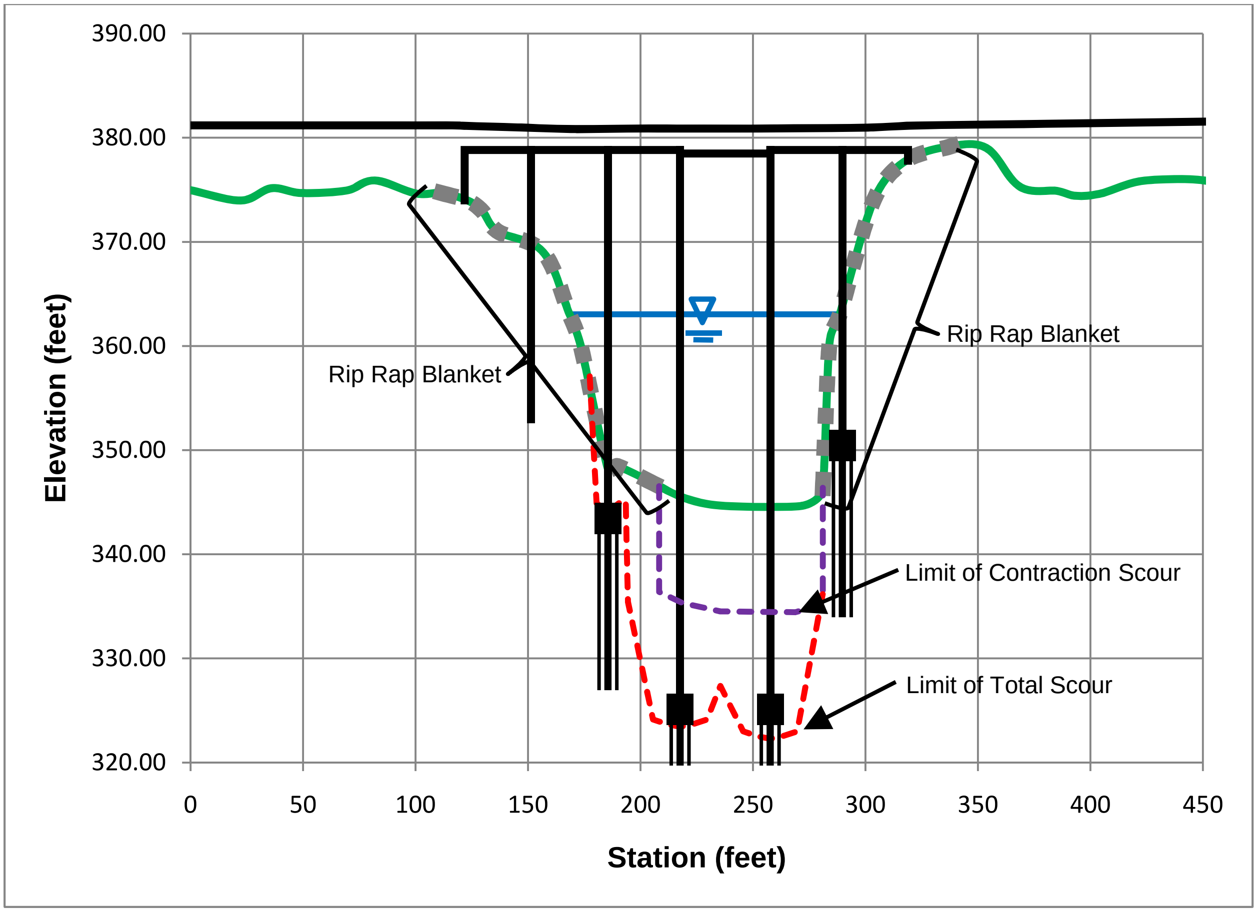

Figure 1. Bridge Scour Depth Results During "Sunny Day" Simulation

5.0 Hazard Classification

The Cumberland City Road bridge at the mouth of Wells Creek was identified within the dam breach impact zone where maximum computed water surface elevations exceed the defined impact elevation during the PMP event; however, the model indicates that the bridge overtops prior to the breach event and the subsequent rise in water surface elevations at the bridge during the PMP event is less than 0.5 feet. This small rise in water surface elevations caused by the breach event is unlikely to result in additional risk of loss of life at the bridge.

Additionally, the analysis indicates that scour is a potential risk to the Cumberland City Road bridge over Wells Creek during a dam breach event. It is recommended that the hazard classification remain at High Hazard until confirmation of existing scour protection or action is taken to protect the bridge. The confirmation of the existing presence or the placement of a riprap blanket through the bridge cross section would reduce the risk that scour poses to the Cumberland City Road bridge during a dam breach event and allow the hazard classification of the ash pond to be reduced from High Hazard to Significant Hazard.

If additional scour protection is required, the design and construction of the scour protection should be in accordance with requirements and specifications of the Tennessee Department of Transportation.

If the ash pond is modified (i.e. berm crest elevation raised) or development occurs within the impact zone, the hazard classification should be re-evaluated. Additionally, if the Cumberland City Road bridges across Wells Creek or the discharge channel are significantly modified, the hazard classification could be affected, since the maximum water surface elevations upstream of the bridge could increase.

6.0 References

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APPENDIX A

Document 15

Stantec Cumberland Piezometer Summary Report

Stantec

Cumberland Fossil Plant
815 Cumberland City Rd
Cumberland City,TN
175539009

	6/13/2009				7/16/2009				8/19/2009			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**
B-3	0.0	0.0	0.0	0.0	394.8	2.5	13.3	384.0	394.8	0.0	11.1	383.6
B-4	0.0	3.0	7.8	-4.8	393.9	3.0	11.2	385.7	393.9	2.6	11.2	385.4
B-9	394.7	0.0	17.2	377.5	394.7	0.0	17.5	377.2	394.7	0.0	17.5	377.2
B-10	0.0	0.0	0.0	0.0	397.1	3.0	21.0	379.1	397.1	2.8	20.8	379.1
B-15A	395.0	0.0	7.8	387.2	395.0	0.0	8.8	386.3	395.0	0.0	8.4	386.7
B-16	397.8	2.3	39.1	361.0	397.8	2.3	39.0	361.2	397.8	2.3	40.2	359.9
B-21	395.1	0.0	4.6	390.5	395.1	0.0	4.9	390.3	395.1	0.0	4.6	390.6
B-22	410.2	3.8	19.9	394.1	410.2	3.8	24.1	389.9	410.2	2.8	23.4	389.6
B-27	0.0	0.0	0.0	0.0	422.2	0.0	0.0	422.2	422.2	2.3	27.5	397.0
B-28	410.6	0.8	28.2	383.2	410.6	0.8	30.5	380.9	410.6	2.5	32.2	380.9
B-29	395.2	0.0	20.0	375.2	395.2	0.0	20.7	374.5	395.2	0.0	19.9	375.3
B-35	425.7	2.2	29.6	398.2	425.7	2.2	33.9	393.9	425.7	2.6	45.4	382.9
B-36	411.2	0.0	25.1	386.1	411.2	0.0	25.7	385.4	411.2	2.4	27.8	385.7
B-37	395.2	1.8	17.1	380.0	395.2	0.0	20.1	375.1	395.2	0.0	18.1	377.1
B-42	0.0	0.0	0.0	0.0	396.2	0.0	18.0	378.3	396.2	0.0	16.7	379.5
B-43	0.0	0.0	0.0	0.0	411.3	0.8	19.8	392.4	411.3	2.2	21.2	392.3
B-44	0.0	0.0	0.0	0.0	419.5	2.0	27.5	394.0	419.5	1.5	27.5	393.5
B-45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	411.6	2.5	21.1	393.0
B-46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	420.3	3.2	23.3	400.2

Change in elevation
Significant Change

Stantec

Cumberland Fossil Plant
815 Cumberland City Rd
Cumberland City,TN
175539009

	9/15/2009				10/20/2009				11/5/2009			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**
B-3	394.8	0.0	11.0	383.8	394.8	0.0	10.9	383.9	394.8	0.0	0.0	394.8
B-4	393.9	2.6	11.3	385.2	393.9	2.6	10.9	385.6	393.9	2.6	0.0	396.5
B-9	394.7	0.0	17.8	376.9	394.7	0.0	17.3	377.4	394.7	0.0	0.0	394.7
B-10	397.1	2.8	21.3	378.6	397.1	2.8	21.1	378.8	397.1	2.8	0.0	399.9
B-15A	395.0	0.0	8.7	386.3	395.0	0.0	8.4	386.7	395.0	0.0	0.0	395.0
B-16	397.8	2.3	42.1	358.1	397.8	2.3	40.6	359.5	397.8	2.3	37.5	362.7
B-21	395.1	0.0	0.0	395.1	395.1	0.0	0.0	395.1	395.1	0.0	4.4	390.7
B-22	410.2	2.8	24.0	389.0	410.2	2.8	23.5	389.5	410.2	2.8	0.0	413.0
B-27	422.2	2.3	27.7	396.7	422.2	2.3	27.5	397.0	422.2	2.3	0.0	424.5
B-28	410.6	2.5	32.4	380.7	410.6	2.5	31.8	381.3	410.6	2.5	0.0	413.1
B-29	395.2	0.0	20.1	375.1	395.2	0.0	19.5	375.7	395.2	0.0	0.0	395.2
B-35	425.7	2.6	35.6	392.6	425.7	2.6	35.5	392.8	425.7	2.6	0.0	428.3
B-36	411.2	2.4	27.8	385.7	411.2	2.4	27.6	386.0	411.2	2.4	0.0	413.5
B-37	395.2	0.0	18.1	377.1	395.2	0.0	17.7	377.5	395.2	0.0	0.0	395.2
B-42	396.2	0.0	0.0	396.2	396.2	0.0	0.0	396.2	396.2	0.0	17.1	379.1
B-43	411.3	2.2	21.6	391.9	411.3	2.2	21.2	392.3	411.3	2.2	0.0	413.5
B-44	419.5	1.5	28.0	393.0	419.5	1.5	27.7	393.2	419.5	1.5	0.0	421.0
B-45	411.6	2.5	21.3	392.8	411.6	2.5	21.3	392.8	411.6	2.5	0.0	414.1
B-46	420.3	3.2	24.3	399.2	420.3	3.2	23.4	400.1	420.3	3.2	0.0	423.5

Change in elevation
Significant Change

Cumberland Fossil Plant
815 Cumberland City Rd
Cumberland City,TN
175539009

	11/17/2009				12/7/2009				1/18/2010			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**
B-3	394.8	0.0	10.8	384.0	394.8	0.0	11.0	383.8	394.8	0.0	11.0	383.8
B-4	393.9	2.7	10.9	385.7	393.9	2.7	11.2	385.5	393.9	2.7	11.3	385.3
B-9	394.7	0.0	16.9	377.8	394.7	0.0	17.2	377.4	394.7	0.0	17.7	377.0
B-10	397.1	2.8	20.8	379.1	397.1	2.8	21.2	378.7	397.1	2.8	21.4	378.5
B-15A	395.0	0.0	8.4	386.6	395.0	0.0	8.9	386.1	395.0	0.0	9.3	385.8
B-16	397.8	2.3	41.4	358.6	397.8	2.3	41.8	358.2	397.8	2.3	41.8	358.3
B-21	395.1	0.0	4.6	390.5	395.1	0.0	5.2	389.9	395.1	0.0	5.7	389.5
B-22	410.2	2.9	23.6	389.5	410.2	2.9	24.1	389.0	410.2	2.9	24.4	388.7
B-27	422.2	3.0	27.5	397.7	422.2	3.0	27.9	397.3	422.2	3.0	28.1	397.0
B-28	410.6	2.7	31.8	381.5	410.6	2.7	32.3	381.0	410.6	2.7	32.5	380.7
B-29	395.2	0.0	19.2	376.0	395.2	0.0	19.6	375.6	395.2	0.0	19.7	375.4
B-35	425.7	2.5	35.2	392.9	425.7	2.5	35.5	392.6	425.7	2.5	36.1	392.1
B-36	411.2	2.4	27.5	386.0	411.2	2.4	27.8	385.8	411.2	2.4	27.8	385.8
B-37	395.2	0.0	17.6	377.6	395.2	0.0	18.0	377.3	395.2	0.0	17.9	377.3
B-42	396.2	0.0	17.4	378.8	396.2	0.0	17.4	378.8	396.2	0.0	18.1	378.1
B-43	411.3	2.3	21.3	392.2	411.3	2.3	21.9	391.6	411.3	2.3	22.5	391.1
B-44	419.5	1.6	27.8	393.3	419.5	1.6	28.5	392.5	419.5	1.6	29.1	392.0
B-45	411.6	2.6	21.3	392.9	411.6	2.6	21.3	392.9	411.6	2.6	21.1	393.0
B-46	420.3	3.3	23.4	400.1	420.3	3.3	23.4	400.1	420.3	3.3	23.3	400.2

Change in elevation
Significant Change

Stantec

Cumberland Fossil Plant
815 Cumberland City Rd
Cumberland City,TN
175539009

	2/11/2010				3/16/2010				4/22/2010			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement (ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**
B-3	394.8	0.0	10.9	383.8	394.8	0.0	11.3	383.5	394.8	0.0	11.1	383.7
B-4	393.9	2.7	10.6	386.0	393.9	2.7	11.2	385.4	393.9	2.7	11.4	385.2
B-9	394.7	0.0	16.7	378.0	394.7	0.0	17.7	377.0	394.7	0.0	17.6	377.1
B-10	397.1	2.8	20.4	379.5	397.1	2.8	21.8	378.1	397.1	2.8	21.3	378.6
B-15A	395.0	0.0	8.4	386.6	395.0	0.0	9.6	385.4	395.0	0.0	9.3	385.7
B-16	397.8	2.3	36.5	363.6	397.8	2.3	42.6	357.5	397.8	2.3	39.7	360.4
B-21	395.1	0.0	5.3	389.8	395.1	0.0	5.9	389.2	395.1	0.0	6.0	389.2
B-22	410.2	2.9	24.0	389.1	410.2	2.9	24.8	388.3	410.2	2.9	24.8	388.3
B-27	422.2	3.0	27.8	397.3	422.2	3.0	28.1	397.1	422.2	3.0	28.2	397.0
B-28	410.6	2.7	31.4	381.8	410.6	2.7	32.7	380.6	410.6	2.7	32.6	380.7
B-29	395.2	0.0	18.7	376.5	395.2	0.0	19.9	375.3	395.2	0.0	19.6	375.6
B-35	425.7	2.5	36.2	392.0	425.7	2.5	36.5	391.6	425.7	2.5	36.7	391.4
B-36	411.2	2.4	27.8	385.8	411.2	2.4	28.2	385.4	411.2	2.4	28.4	385.2
B-37	395.2	0.0	17.8	377.5	395.2	0.0	18.3	376.9	395.2	0.0	18.7	376.5
B-42	396.2	0.0	17.4	378.8	396.2	0.0	18.2	378.0	396.2	0.0	17.7	378.5
B-43	411.3	2.3	22.2	391.3	411.3	2.3	22.8	390.7	411.3	2.3	22.9	390.6
B-44	419.5	1.6	28.8	392.3	419.5	1.6	29.6	391.5	419.5	1.6	29.6	391.5
B-45	411.6	2.6	21.0	393.1	411.6	2.6	21.0[a]	393.1	411.6	2.6	21.0[a]	393.1
B-46	420.3	3.3	21.3	402.3	420.3	3.3	21.3[a]	402.3	420.3	3.3	21.3[a]	402.3

Change in elevation [a] Dry
Significant Change

Cumberland Fossil Plant
815 Cumberland City Rd
Cumberland City,TN
175539009

	5/18/2010				6/14/2010				7/14/2010			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**
B-3	394.8	0.0	10.9	383.9	394.8	0.0	11.0	383.8	394.8	0.0	11.0	383.8
B-4	393.9	2.7	10.4	386.2	393.9	2.7	11.0	385.6	393.9	2.7	11.0	385.6
B-9	394.7	0.0	5.8	388.9	394.7	0.0	17.7	377.0	394.7	0.0	17.9	376.8
B-10	397.1	2.8	19.6	380.3	397.1	2.8	21.2	378.7	397.1	2.8	21.4	378.5
B-15A	395.0	0.0	8.3	386.7	395.0	0.0	8.4	386.6	395.0	0.0	8.8	386.3
B-16	397.8	2.3	35.8	364.3	397.8	2.3	38.5	361.6	397.8	2.3	39.0	361.0
B-21	395.1	0.0	5.0	390.2	395.1	0.0	5.0	390.2	395.1	0.0	5.2	389.9
B-22	410.2	2.9	23.7	389.4	410.2	2.9	23.8	389.3	410.2	2.9	24.1	389.0
B-27	422.2	3.0	27.5	397.7	422.2	3.0	27.3	397.9	422.2	3.0	27.6	397.6
B-28	410.6	2.7	31.1	382.2	410.6	2.7	32.4	380.9	410.6	2.7	32.2	381.0
B-29	395.2	0.0	19.2	376.0	395.2	0.0	19.9	375.2	395.2	0.0	19.8	375.3
B-35	425.7	2.5	35.2	393.0	425.7	2.5	34.6	393.5	425.7	2.5	35.0	393.2
B-36	411.2	2.4	21.2	392.4	411.2	2.4	27.1	386.5	411.2	2.4	27.4	386.2
B-37	395.2	0.0	17.6	377.6	395.2	0.0	17.8	377.4	395.2	0.0	18.1	377.1
B-42	396.2	0.0	17.6	378.6	396.2	0.0	19.0	377.2	396.2	0.0	16.7	379.5
B-43	411.3	2.3	21.3	392.3	411.3	2.3	21.2	392.4	411.3	2.3	21.9	391.6
B-44	419.5	1.6	27.7	393.4	419.5	1.6	27.7	393.4	419.5	1.6	28.4	392.7
B-45	411.6	2.6	21.0	393.1	411.6	2.6	21.0	393.1	411.6	2.6	21.0	393.1
B-46	420.3	3.3	23.3	400.3	420.3	3.3	23.3	400.3	420.3	3.3	23.3	400.3

Change in elevation
Significant Change

Stantec

Cumberland Fossil Plant
815 Cumberland City Rd
Cumberland City,TN
175539009

	8/10/2010				9/24/2010				10/27/2010			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**
B-3	394.8	0.0	11.0	383.7	394.8	0.0	11.2	383.6	394.8	0.0	11.1	383.6
B-4	393.9	2.7	11.2	385.4	393.9	2.7	11.9	384.8	393.9	2.7	12.0	384.6
B-9	394.7	0.0	18.3	376.4	394.7	0.0	18.8	375.8	394.7	0.0	18.8	375.9
B-10	397.1	2.8	21.7	378.2	397.1	2.8	22.3	377.6	397.1	2.8	22.5	377.4
B-15A	395.0	0.0	9.1	385.9	395.0	0.0	9.6	385.4	395.0	0.0	9.7	385.3
B-16	397.8	2.3	40.3	359.7	397.8	2.3	42.4	357.6	397.8	2.3	42.8	357.3
B-21	395.1	0.0	5.4	389.8	395.1	0.0	5.8	389.4	395.1	0.0	5.6	389.5
B-22	410.2	2.9	24.2	388.9	410.2	2.9	24.6	388.5	410.2	2.9	24.6	388.5
B-27	422.2	3.0	27.4	397.8	422.2	3.0	28.1	397.0	422.2	3.0	28.4	396.8
B-28	410.6	2.7	32.6	380.7	410.6	2.7	33.2	380.1	410.6	2.7	33.6	379.7
B-29	395.2	0.0	19.9	375.2	395.2	0.0	20.5	374.7	395.2	0.0	20.8	374.4
B-35	425.7	2.5	35.2	393.0	425.7	2.5	36.1	392.1	425.7	2.5	36.5	391.6
B-36	411.2	2.4	27.6	385.9	411.2	2.4	28.2	385.4	411.2	2.4	28.3	385.3
B-37	395.2	0.0	18.4	376.8	395.2	0.0	18.5	376.7	395.2	0.0	18.8	376.4
B-42	396.2	0.0	17.2	379.0	396.2	0.0	17.3	378.9	396.2	0.0	17.6	378.6
B-43	411.3	2.3	22.3	391.3	411.3	2.3	22.8	390.8	411.3	2.3	23.1	390.4
B-44	419.5	1.6	29.2	391.9	419.5	1.6	29.4	391.7	419.5	1.6	29.9	391.1
B-45	411.6	2.6	21.0	393.1	411.6	2.6	21.3	392.9a	411.6	2.6	21.9	392.3[a]
B-46	420.3	3.3	23.3	400.3	420.3	3.3	23.3	400.3a	420.3	3.3	23.2	400.3[a]

▨	**Change in elevation**
🟥	**Significant Change**

[a] Dry

Cumberland Fossil Plant
815 Cumberland City Rd
Cumberland City,TN
175539009

	11/19/2010				12/7/2010				1/5/2011			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**
B-3	394.8	0.0	11.2	383.6	394.8	0.0	11.1	383.7	394.8	0.0	11.0	383.8
B-4	393.9	2.7	12.1	384.6	393.9	2.7	11.6	385.0	393.9	2.7	11.6	385.1
B-9	394.7	0.0	18.9	375.7	394.7	0.0	18.4	376.2	394.7	0.0	18.3	376.4
B-10	397.1	2.8	22.5	377.4	397.1	2.8	22.0	377.9	397.1	2.8	21.9	378.0
B-15A	395.0	0.0	9.9	385.2	395.0	0.0	9.4	385.6	395.0	0.0	9.2	385.8
B-16	397.8	2.3	42.5	357.5	397.8	2.3	41.6	358.5	397.8	2.3	40.8	359.2
B-21	395.1	0.0	5.6	389.6	395.1	0.0	5.5	389.6	395.1	0.0	5.3	389.9
B-22	410.2	2.9	24.5	388.6	410.2	2.9	24.5	388.6	410.2	2.9	24.2	388.9
B-27	422.2	3.0	28.5	396.7	422.2	3.0	28.4	396.7	422.2	3.0	28.1	397.0
B-28	410.6	2.7	33.6	379.6	410.6	2.7	33.0	380.3	410.6	2.7	33.0	380.3
B-29	395.2	0.0	20.8	374.4	395.2	0.0	20.0	375.2	395.2	0.0	19.9	375.3
B-35	425.7	2.5	36.7	391.4	425.7	2.5	36.6	391.6	425.7	2.5	36.4	391.8
B-36	411.2	2.4	28.3	385.3	411.2	2.4	28.1	385.4	411.2	2.4	28.4	385.2
B-37	395.2	0.0	18.8	376.5	395.2	0.0	18.3	377.0	395.2	0.0	18.1	377.1
B-42	396.2	0.0	17.5	378.7	396.2	0.0	17.3	378.9	396.2	0.0	17.4	378.8
B-43	411.3	2.3	23.0	390.6	411.3	2.3	22.7	390.8	411.3	2.3	22.5	391.0
B-44	419.5	1.6	29.8	391.3	419.5	1.6	29.4	391.7	419.5	1.6	29.0	392.1
B-45	411.6	2.6	21.1	393.1	411.6	2.6	21.1	393.1[a]	411.6	2.6	21.1	393.1[a]
B-46	420.3	3.3	23.3	400.3[a]	420.3	3.3	23.3	400.3[a]	420.3	3.3	23.2	400.3[a]

Change in elevation
Significant Change

[a] Dry

Stantec

Cumberland Fossil Plant
815 Cumberland City Rd
Cumberland City,TN
175539009

	2/4/2011				3/10/2011				4/7/2011			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**
B-3	394.8	0.0	11.1	383.7	394.8	0.0	11.1	383.7	394.8	0.0	11.0	383.8
B-4	393.9	2.7	11.6	385.0	393.9	2.7	10.5	386.1	393.9	2.7	10.6	386.1
B-9	394.7	0.0	18.2	376.5	394.7	0.0	17.0	377.7	394.7	0.0	17.2	377.5
B-10	397.1	2.8	21.9	378.0	397.1	2.8	20.8	379.1	397.1	2.8	20.9	379.0
B-15A	395.0	0.0	9.2	385.8	395.0	0.0	8.7	386.3	395.0	0.0	8.7	386.3
B-16	397.8	2.3	40.4	359.6	397.8	2.3	35.3	364.8	397.8	2.3	37.7	362.3
B-21	395.1	0.0	5.6	389.6	395.1	0.0	5.2	389.9	395.1	0.0	5.3	389.8
B-22	410.2	2.9	24.5	388.6	410.2	2.9	24.0	389.1	410.2	2.9	24.2	388.9
B-27	422.2	3.0	28.1	397.0	422.2	3.0	27.4	397.7	422.2	3.0	27.5	397.6
B-28	410.6	2.7	32.9	380.4	410.6	2.7	31.9	381.4	410.6	2.7	32.3	380.9
B-29	395.2	0.0	19.4	375.8	395.2	0.0	19.5	375.7	395.2	0.0	19.8	375.4
B-35	425.7	2.5	36.3	391.9	425.7	2.5	35.4	392.8	425.7	2.5	35.0	393.2
B-36	411.2	2.4	27.9	385.6	411.2	2.4	27.3	386.3	411.2	2.4	27.3	386.3
B-37	395.2	0.0	18.1	377.1	395.2	0.0	17.6	377.6	395.2	0.0	17.8	377.4
B-42	396.2	0.0	18.2	378.1	396.2	0.0	17.5	378.7	396.2	0.0	17.1	379.1
B-43	411.3	2.3	23.0	390.5	411.3	2.3	22.0	391.5	411.3	2.3	26.7	386.9
B-44	419.5	1.6	29.5	391.6	419.5	1.6	28.7	392.4	419.5	1.6	28.2	392.8
B-45	411.6	2.6	NA	NA[a]	411.6	2.6	21.1	393.1[a]	411.6	2.6	[a]	[a]
B-46	420.3	3.3	NA	NA[a]	420.3	3.3	23.2	400.3[a]	420.3	3.3	[a]	[a]

Change in elevation	[a] Dry
Significant Change	

Stantec

Cumberland Fossil Plant
815 Cumberland City Rd
Cumberland City,TN
175539009

	5/4/2011				6/9/2011				7/13/2011			
Location	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**	**Surface Elevation (ft)**	**Stickup (ft)**	**Depth Measurement(ft)**	**Water Elevation (ft)**
B-3	394.8	0.0	10.8	384.0	394.8	0.0	10.9	383.9	394.8	0.0	11.1	383.7
B-4	393.9	2.7	9.6	387.0	393.9	2.7	10.3	386.3	393.9	2.7	Abandoned	
B-9	394.7	0.0	14.6	380.1	394.7	0.0	17.1	377.5	394.7	0.0	17.1	377.6
B-10	397.1	2.8	18.6	381.3	397.1	2.8	20.6	379.3	397.1	2.8	Abandoned	
B-15A	395.0	0.0	7.0	388.0	395.0	0.0	8.0	387.0	395.0	0.0	8.5	386.5
B-16	397.8	2.3	25.6	374.5	397.8	2.3	38.0	362.0	397.8	2.3	Abandoned	
B-21	395.1	0.0	4.7	390.5	395.1	0.0	4.7	390.4	395.1	0.0	5.3	389.9
B-22	410.2	2.9	23.2	389.9	410.2	2.9	23.6	389.5	410.2	2.9	24.2	388.9
B-27	422.2	3.0	26.8	398.4	422.2	3.0	27.3	397.8	422.2	3.0	Abandoned	
B-28	410.6	2.7	28.6	384.6	410.6	2.7	32.5	380.7	410.6	2.7	33.0	380.3
B-29	395.2	0.0	14.8	380.4	395.2	0.0	20.5	374.7	395.2	0.0	20.5	374.7
B-35	425.7	2.5	34.1	394.0	425.7	2.5	34.6	393.5	425.7	2.5	Abandoned	
B-36	411.2	2.4	26.2	387.3	411.2	2.4	27.3	386.3	411.2	2.4	27.3	386.3
B-37	395.2	0.0	15.9	379.4	395.2	0.0	18.2	377.0	395.2	0.0	18.1	377.1
B-42	396.2	0.0	17.2	379.0	396.2	0.0	17.6	378.6	396.2	0.0	16.9	379.3
B-43	411.3	2.3	21.1	392.4	411.3	2.3	21.1	392.4	411.3	2.3	21.3	392.2
B-44	419.5	1.6	27.7	393.4	419.5	1.6	27.5	393.6	419.5	1.6	Abandoned	
B-45	411.6	2.6	[a]	[a]	411.6	2.6	[b]	[b]	411.6	2.6	Abandoned	
B-46	420.3	3.3	[a]	[a]	420.3	3.3	[a]	[a]	420.3	3.3	Abandoned	

Change in elevation
Significant Change

[a] Dry
[b] Destroyed

Stantec

Stantec Consulting Services Inc.
10509 Timberwood Circle Suite 100
Louisville, KY 40223-5301
Tel: (502) 212-5000
Fax: (502) 212-5055

February 15, 2012 ltr_001_175551015

Mr. Michael S. Turnbow
Tennessee Valley Authority
1101 Market Street, LP 2G-C
Chattanooga, Tennessee 37402-2801

Re: Results of Pseudostatic Slope Stability Analysis
Active CCP Disposal Facilities
Cumberland Fossil Plant (CUF)

Dear Mr. Turnbow:

As requested, Stantec Consulting Services Inc. (Stantec) has conducted pseudostatic slope stability analyses for ground motion levels corresponding to a return period of 2,500 years to support the U.S. Environmental Protection Agency's assessment of TVA's CCP disposal facilities. The results for Cumberland's Ash Pond and Dry Fly Ash Stack are provided in this letter.

Approach

The analyses were performed for current conditions using pseudostatic stability methods, where the added inertial load from an earthquake is assumed to be represented by a simple horizontal pseudostatic coefficient. Specifics related to the analyses/approach are as follows:

- Subsurface data was obtained from the Stantec's recent geotechnical studies performed in 2009 and 2010 time frame.
- SLOPE/W software (from GEO-SLOPE International, Inc.) was used to perform the calculations.
- One existing SLOPE/W cross-section model per disposal facility was selected from the previous studies for analysis. For the Ash Pond, the selected section represents the facility's lowest current static (long-term) factor of safety. The section selected for the Dry Fly Ash Stack is located along the north side where a failure may impact the adjacent Ash Pond. The SLOPE/W models were updated to reflect current conditions.
- Undrained shear strength parameters were used.
- A ground motion level corresponding to a return period of 2,500 years (or approximate exceedance probability of 2% in 50 years) was used for selection of a horizontal seismic coefficient. For simplicity, the horizontal seismic coefficient was selected to equal the total hazard peak ground acceleration (rock) for 2,500 year return periods as shown in Table 16

of TVA's March 28, 2011 region-specific seismic hazard study performed by AMEC Geomatrix, Inc.

- A target factor of safety (FS) of 1.0 was considered for comparing results.

Results

The results of the pseudostatic stability analyses are enclosed (summary spreadsheet, SLOPE/W cross-sections, and plan views showing cross-section locations). The results indicate factors of safety greater than or equal to the target of 1.0.

Stantec appreciates the opportunity to provide these services. If you have questions, or if we can provide additional information, please let us know.

Sincerely,

STANTEC CONSULTING SERVICES INC.

Randy L. Roberts

Randy L. Roberts, PE
Principal

Enclosures

/cdm

Pseudostatic Stability Analysis Summary - TVA Active CCP Disposal Facilities

Cumberland Fossil Plant

Plant	CCP Disposal Facility		Cross-Section	2,500 yr Return	
	Name	Type		PGA (g)	Factor of Safety
CUF	Ash Pond	Wet Stack	P	0.217	1.0
	Dry Fly Ash Stack	Stack	A		1.1 for shallower surface through divider dike; 1.0 for deeper surface beneath divider dike

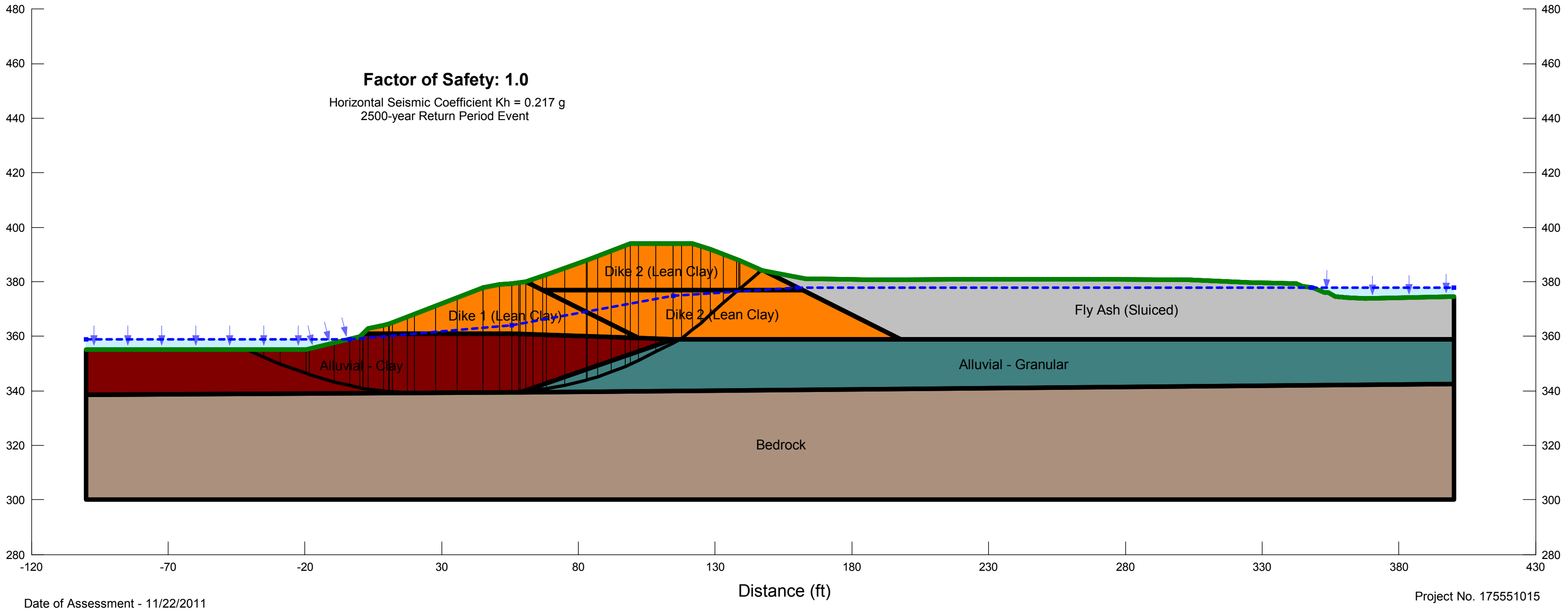
Pseudostatic Slope Stability Analysis
CCP Storage Facilities - Existing Conditions
Tennessee Valley Authority Fossil Plants

Section P - Ash Pond
Cumberland Fossil Plant
Cumberland City, Tennessee

Stantec

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	800 psf	20 °
Dike 2 (Lean Clay)	123 pcf	500 psf	21 °
Fly Ash (Sluiced)	100 pcf	140 psf	11 °
Alluvial - Clay	124 pcf	450 psf	20 °
Alluvial - Granular	130 pcf	100 psf	20 °
Bedrock			



Factor of Safety: 1.0

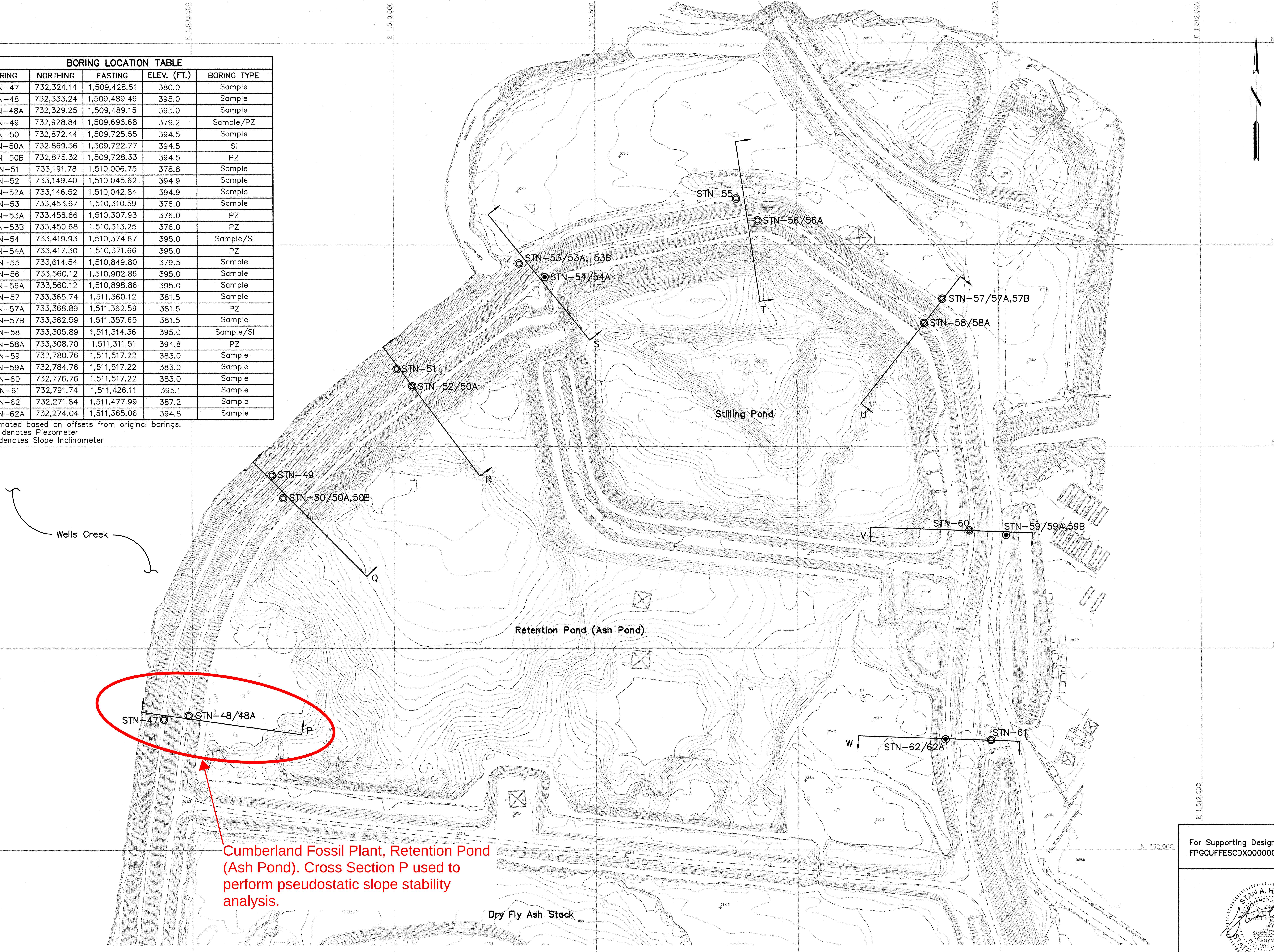
Horizontal Seismic Coefficient Kh = 0.217 g
2500-year Return Period Event

Date of Assessment - 11/22/2011

Project No. 175551015

BORING LOCATION TABLE				
BORING	NORTHING	EASTING	ELEV. (FT.)	BORING TYPE
STN-47	732,324.14	1,509,428.51	380.0	Sample
STN-48	732,333.24	1,509,489.49	395.0	Sample
*STN-48A	732,329.25	1,509,489.15	395.0	Sample
STN-49	732,928.84	1,509,696.68	379.2	Sample/PZ
STN-50	732,872.44	1,509,725.55	394.5	Sample
*STN-50A	732,869.56	1,509,722.77	394.5	SI
*STN-50B	732,875.32	1,509,728.33	394.5	PZ
STN-51	733,191.78	1,510,006.75	378.8	Sample
STN-52	733,149.40	1,510,045.62	394.9	Sample
*STN-52A	733,146.52	1,510,042.84	394.9	Sample
STN-53	733,453.67	1,510,310.59	376.0	Sample
*STN-53A	733,456.66	1,510,307.93	376.0	PZ
*STN-53B	733,450.68	1,510,313.25	376.0	PZ
STN-54	733,419.93	1,510,374.67	395.0	Sample/SI
*STN-54A	733,417.30	1,510,371.66	395.0	PZ
STN-55	733,614.54	1,510,849.80	379.5	Sample
STN-56	733,560.12	1,510,902.86	395.0	Sample
*STN-56A	733,560.12	1,510,898.86	395.0	Sample
STN-57	733,365.74	1,511,360.12	381.5	Sample
*STN-57A	733,368.89	1,511,362.59	381.5	PZ
*STN-57B	733,362.59	1,511,357.65	381.5	Sample
STN-58	733,305.89	1,511,314.36	395.0	Sample/SI
*STN-58A	733,308.70	1,511,311.51	394.8	PZ
STN-59	732,780.76	1,511,517.22	383.0	Sample
*STN-59A	732,784.76	1,511,517.22	383.0	Sample
STN-60	732,776.76	1,511,517.22	383.0	Sample
STN-61	732,791.74	1,511,426.11	395.1	Sample
STN-62	732,271.84	1,511,477.99	387.2	Sample
*STN-62A	732,274.04	1,511,365.06	394.8	Sample

*Estimated based on offsets from original borings.
"PZ" denotes Piezometer
"SI" denotes Slope Inclinometer



Cumberland Fossil Plant, Retention Pond (Ash Pond). Cross Section P used to perform pseudostatic slope stability analysis.

BORING LAYOUT

SCALE: 1"=100'

50 0 100 200 FEET
GRAPHIC SCALE: 1" = 100'
CONTOUR INTERVAL = 1'

LEGEND

◎	Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests
◉	Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests and Rock Core

NOTE:

The topographic mapping provided is based on horizontal datum NAD27 and vertical datum NGV29 using State Plane Tennessee coordinate system. The site photography was performed on 4/17/2009.

FOR INFORMATION ONLY
This Record Drawing which has been previously submitted to TVA is provided for Information Only.

RECORD DRAWING

For Supporting Design Calculations see FPGCUFFESCDX00000020100002

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R –	–	–	–	–	–	–	–	–	–	–	–
R 0	03/29/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–
RECORD DRAWING											

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=100' EXCEPT AS NOTED

YARD
RETENTION AND STILLING PONDS

GEOTECHNICAL EXPLORATION
BORING LAYOUT

STAN A. HARRIS
No. 00113308
STATE OF TENNESSEE
3/25/10

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
D. ROGERS	C. WITHERS	D. ROGERS	S. HARRIS	S. HARRIS	S. HARRIS	T. JOHNSON

Stantec Consulting Services Inc.
11687 Lebanon Rd.
Cincinnati, Ohio
45241-2012
Tel. 513.842.8200
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www.stantec.com

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000	DATE 03/29/10	46	C	10W544-01	R 0

STANTEC	0
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

PLOT DATE: 03/24/2010

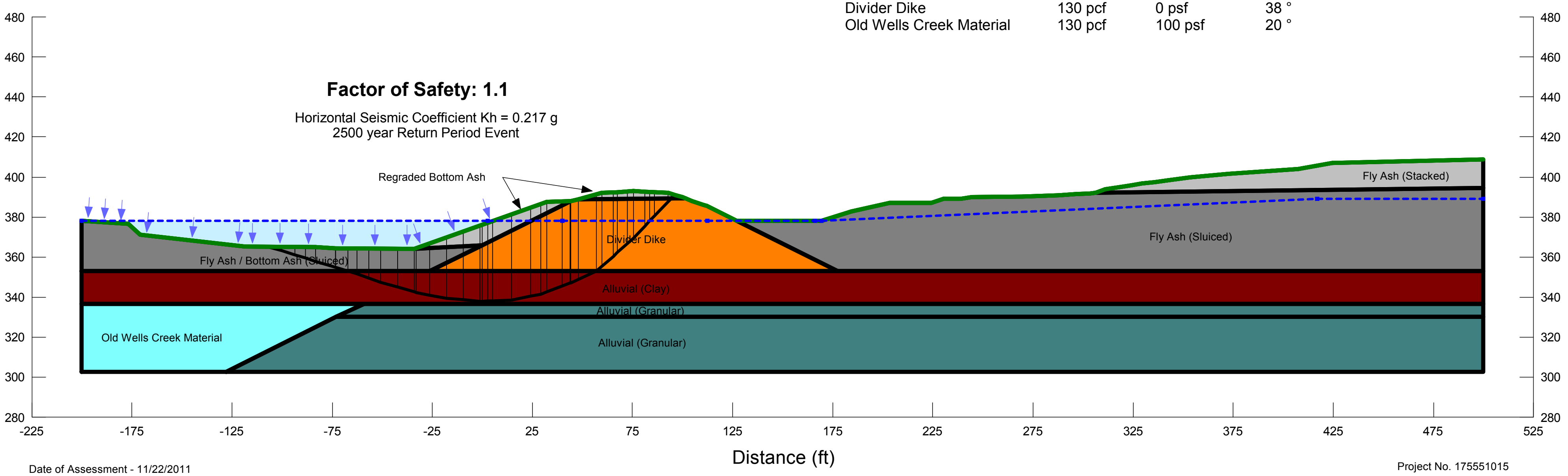
46 C 10W544-01

Psuedostatic Slope Stability Analysis
CCP Storage Facilities - Existing Conditions
Tennessee Valley Authority Fossil Plants

Section A - Dry Fly Ash Stack
Cumberland Fossil Plant
Cumberland City, Tennessee

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material Type	Unit Weight	Cohesion	Friction Angle
Alluvial (Clay)	121 pcf	450 psf	21 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
Fly Ash (Sluiced)	100 pcf	280 psf	11 °
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	25 °
Regraded Bottom Ash	105 pcf	0 psf	32 °
Divider Dike	130 pcf	0 psf	38 °
Old Wells Creek Material	130 pcf	100 psf	20 °



Date of Assessment - 11/22/2011

Project No. 175551015

Psuedostatic Slope Stability Analysis
CCP Storage Facilities - Existing Conditions
Tennessee Valley Authority Fossil Plants

Section A - Dry Fly Ash Stack
Cumberland Fossil Plant
Cumberland City, Tennessee

Stantec

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material Type	Unit Weight	Cohesion	Friction Angle
Alluvial (Clay)	121 pcf	450 psf	21 °
Alluvial (Granular)	130 pcf	0 psf	32 °
Fly Ash (Stacked)	100 pcf	0 psf	32 °
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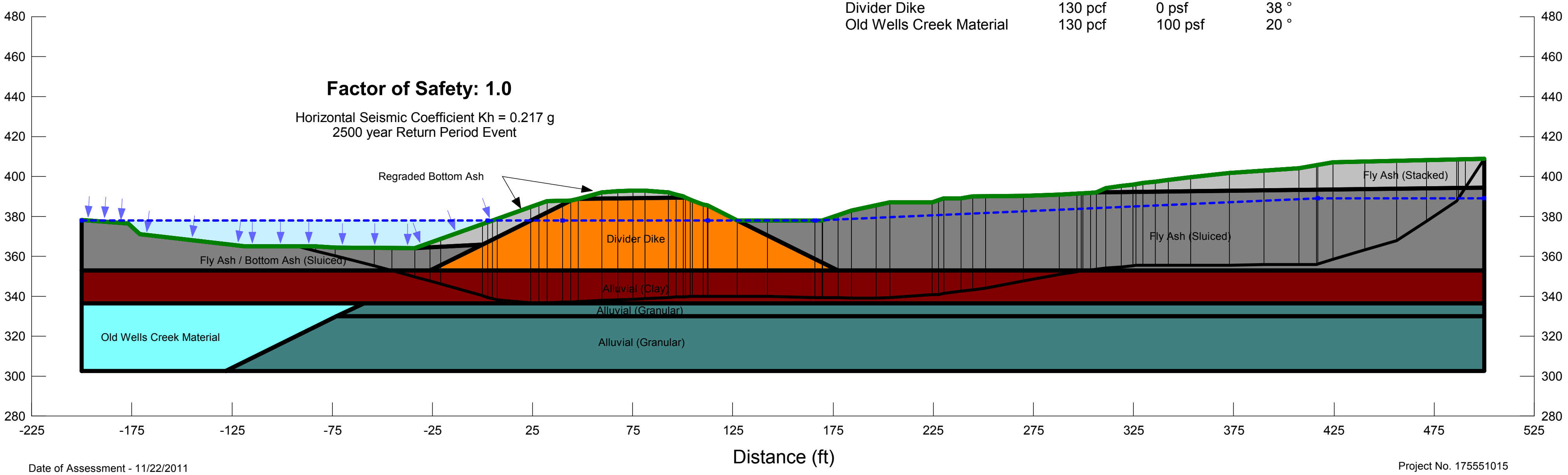
Fly Ash / Bottom Ash (Sluiced)	100 pcf	0 psf	25 °
Regraded Bottom Ash	105 pcf	0 psf	32 °
Divider Dike	130 pcf	0 psf	38 °
Old Wells Creek Material	130 pcf	100 psf	20 °

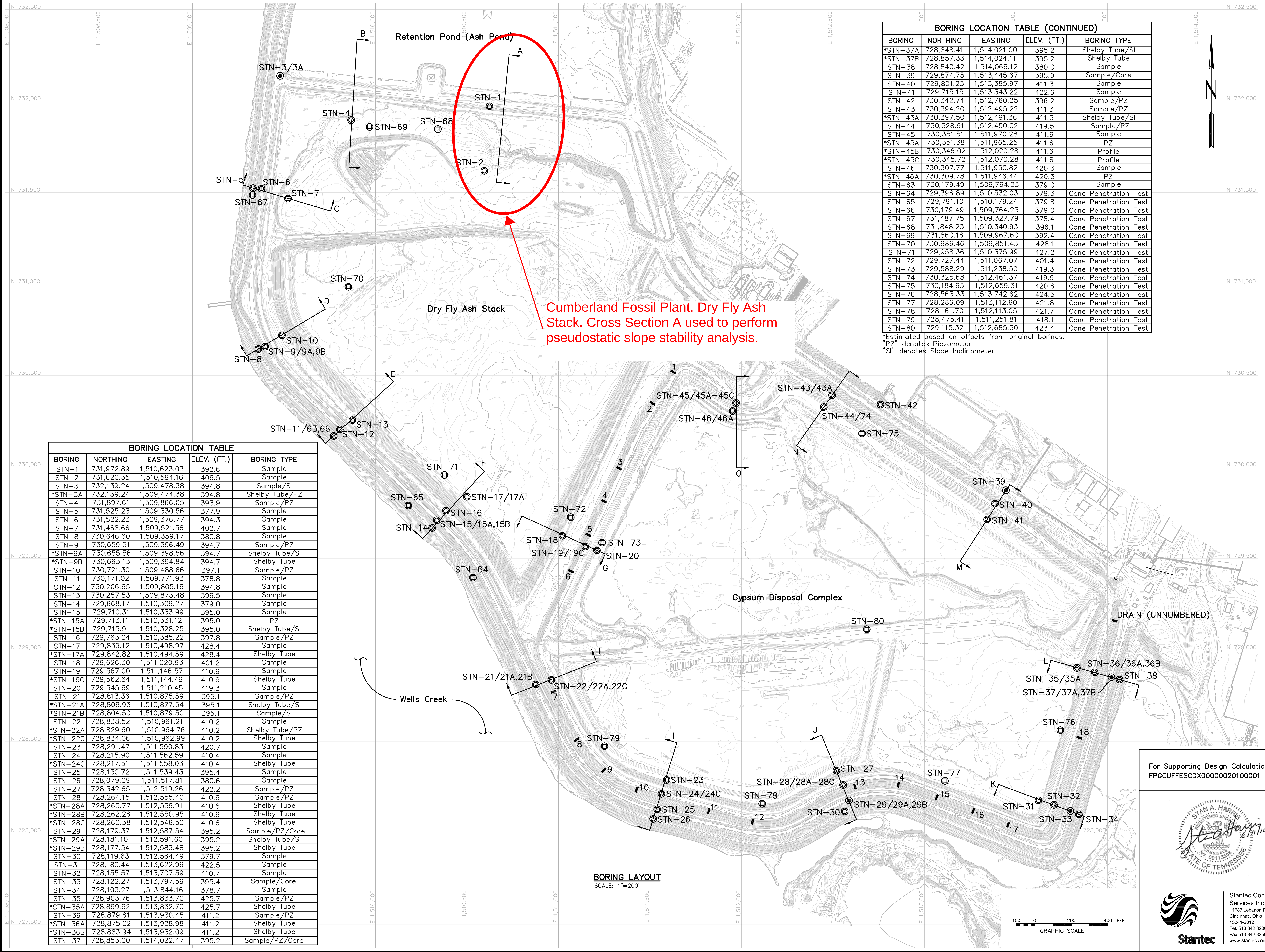


Factor of Safety: 1.0

Horizontal Seismic Coefficient Kh = 0.217 g
2500 year Return Period Event

Date of Assessment - 11/22/2011

Project No. 175551015



Cumberland Fossil Plant, Dry Fly Ash Stack. Cross Section A used to perform pseudostatic slope stability analysis.

BORING LAYOUT
SCALE: 1"=200'

BORING LOCATION TABLE

BORING	NORTHING	EASTING	ELEV. (FT.)	BORING TYPE
STN-1	731,972.89	1,510,623.03	392.6	Sample
STN-2	731,620.35	1,510,594.16	406.5	Sample
STN-3	732,139.24	1,509,478.38	394.8	Sample/SI
*STN-3A	732,139.24	1,509,474.38	394.8	Shelby Tube/PZ
STN-4	731,897.61	1,509,866.05	393.9	Sample/PZ
STN-5	731,525.23	1,509,330.56	377.9	Sample
STN-6	731,522.23	1,509,376.77	394.3	Sample
STN-7	731,468.66	1,509,521.56	402.7	Sample
STN-8	730,646.60	1,509,359.17	380.8	Sample
STN-9	730,659.51	1,509,396.49	394.7	Sample/PZ
*STN-9A	730,655.56	1,509,398.56	394.7	Shelby Tube/SI
*STN-9B	730,663.13	1,509,394.84	394.7	Shelby Tube
STN-10	730,721.30	1,509,488.66	397.1	Sample/PZ
STN-11	730,171.02	1,509,771.93	378.8	Sample
STN-12	730,206.65	1,509,805.16	394.8	Sample
STN-13	730,257.53	1,509,873.48	396.5	Sample
STN-14	729,668.17	1,510,309.27	379.0	Sample
STN-15	729,710.31	1,510,333.99	395.0	Sample
*STN-15A	729,713.11	1,510,331.12	395.0	PZ
*STN-15B	729,715.91	1,510,328.25	395.0	Shelby Tube/SI
STN-16	729,763.04	1,510,385.22	397.8	Sample/PZ
STN-17	729,839.12	1,510,498.97	428.4	Sample
*STN-17A	729,842.82	1,510,494.59	428.4	Shelby Tube
STN-18	729,626.30	1,511,020.93	401.2	Sample
STN-19	729,567.00	1,511,146.57	410.9	Sample
*STN-19C	729,562.64	1,511,144.49	410.9	Shelby Tube
STN-20	729,545.69	1,511,210.45	419.3	Sample
STN-21	728,813.36	1,510,875.59	395.1	Sample/PZ
*STN-21A	728,808.93	1,510,877.54	395.1	Shelby Tube/SI
*STN-21B	728,804.50	1,510,879.50	395.1	Sample/SI
STN-22	728,838.52	1,510,961.21	410.2	Sample
*STN-22A	728,829.60	1,510,964.76	410.2	Shelby Tube/PZ
*STN-22C	728,834.06	1,510,962.99	410.2	Shelby Tube
STN-23	728,291.47	1,511,590.83	420.7	Sample
STN-24	728,215.90	1,511,562.59	410.4	Sample
*STN-24C	728,217.51	1,511,558.03	410.4	Shelby Tube
STN-25	728,130.72	1,511,539.43	395.4	Sample
STN-26	728,079.09	1,511,517.81	380.6	Sample
STN-27	728,342.65	1,512,519.26	422.2	Sample/PZ
STN-28	728,264.15	1,512,555.40	410.6	Sample/PZ
*STN-28A	728,265.77	1,512,559.91	410.6	Shelby Tube
*STN-28B	728,262.26	1,512,550.95	410.6	Shelby Tube
*STN-28C	728,260.38	1,512,546.50	410.6	Shelby Tube
STN-29	728,179.37	1,512,587.54	395.2	Sample/PZ/Core
*STN-29A	728,181.10	1,512,591.60	395.2	Shelby Tube/SI
*STN-29B	728,177.54	1,512,583.48	395.2	Shelby Tube
STN-30	728,119.63	1,512,564.49	379.7	Sample
STN-31	728,180.44	1,513,622.99	422.5	Sample
STN-32	728,155.57	1,513,707.59	410.7	Sample
STN-33	728,122.27	1,513,797.59	395.4	Sample/Core
STN-34	728,103.27	1,513,844.16	378.7	Sample
STN-35	728,903.76	1,513,833.70	425.7	Sample/PZ
*STN-35A	728,899.92	1,513,832.70	425.7	Shelby Tube
STN-36	728,879.61	1,513,930.45	411.2	Sample/PZ
*STN-36A	728,875.02	1,513,928.98	411.2	Shelby Tube
*STN-36B	728,883.94	1,513,932.09	411.2	Shelby Tube
STN-37	728,853.00	1,514,022.47	395.2	Sample/PZ/Core

BORING LOCATION TABLE (CONTINUED)

BORING	NORTHING	EASTING	ELEV. (FT.)	BORING TYPE
*STN-37A	728,848.41	1,514,021.00	395.2	Shelby Tube/SI
*STN-37B	728,857.33	1,514,024.11	395.2	Shelby Tube
STN-38	728,840.42	1,514,066.12	380.0	Sample
STN-39	729,874.75	1,513,445.67	395.9	Sample/Core
STN-40	729,801.23	1,513,385.97	411.3	Sample
STN-41	729,715.15	1,513,343.22	422.6	Sample
STN-42	730,342.74	1,512,760.25	396.2	Sample/PZ
STN-43	730,394.20	1,512,495.22	411.3	Sample/PZ
*STN-43A	730,397.50	1,512,491.36	411.3	Shelby Tube/SI
STN-44	730,328.91	1,512,450.02	419.5	Sample/PZ
STN-45	730,351.51	1,511,970.28	411.6	Sample
*STN-45A	730,351.38	1,511,965.25	411.6	PZ
*STN-45B	730,346.02	1,512,020.28	411.6	Profile
*STN-45C	730,345.72	1,512,070.28	411.6	Profile
STN-46	730,307.77	1,511,950.82	420.3	Sample
*STN-46A	730,309.78	1,511,946.44	420.3	PZ
STN-63	730,179.49	1,509,764.23	379.0	Sample
STN-64	729,396.89	1,510,532.03	379.3	Cone Penetration Test
STN-65	729,791.10	1,510,179.24	379.8	Cone Penetration Test
STN-66	730,179.49	1,509,764.23	379.0	Cone Penetration Test
STN-67	731,487.75	1,509,327.79	378.4	Cone Penetration Test
STN-68	731,848.23	1,510,340.93	396.1	Cone Penetration Test
STN-69	731,860.16	1,509,967.60	392.4	Cone Penetration Test
STN-70	730,986.46	1,509,851.43	428.1	Cone Penetration Test
STN-71	729,958.36	1,510,375.99	427.2	Cone Penetration Test
STN-72	729,727.44	1,511,067.07	401.4	Cone Penetration Test
STN-73	729,588.29	1,511,238.50	419.3	Cone Penetration Test
STN-74	730,325.68	1,512,461.37	419.9	Cone Penetration Test
STN-75	730,184.63	1,512,659.31	420.6	Cone Penetration Test
STN-76	728,563.33	1,513,742.62	424.5	Cone Penetration Test
STN-77	728,286.09	1,513,112.60	421.8	Cone Penetration Test
STN-78	728,161.70	1,512,113.05	421.7	Cone Penetration Test
STN-79	728,475.41	1,511,251.81	418.1	Cone Penetration Test
STN-80	729,115.32	1,512,685.30	423.4	Cone Penetration Test

*Estimated based on offsets from original borings.
"PZ" denotes Piezometer
"SI" denotes Slope Inclinometer

FOR INFORMATION ONLY
This Record Drawing which has been previously submitted to TVA is provided for Information Only.

NOTE:

The topographic mapping provided is based on horizontal datum NAD27 and vertical datum NGV29 using State Plane Tennessee coordinate system. The site photography was performed on 4/17/2009.

LEGEND

◎	Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests
◉	Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests and Rock Core
⊡	Cone Penetration Test
▬	Drain, Number

RECORD DRAWING

PLOT DATE: 06/08/2010 USER: WITHERS, CHEYENNE
V:\1755\ACTIVE\175539009\GEOTECHNICAL\DRAWING\REV0_RECORD\10W543-01-R0.DWG

For Supporting Design Calculations see FPGCUFFESCDX00000020100001

STAN A. HARRIS
REGISTERED ENGINEER
No. 00113308
STATE OF TENNESSEE
6/11/10

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R –	–	–	–	–	–	–	–	–	–	–	–
–											
R 0	06/11/10	DBR	CW	DBR	SAH	SAH	SAH	TJ	–	–	–
RECORD DRAWING											

DISCIPLINE INTERFACE
1
2
3
4

SCALE: 1"=200' EXCEPT AS NOTED

YARD
DRY FLY ASH STACK AND GYPSUM DISPOSAL COMPLEX

GEOTECHNICAL EXPLORATION
BORING LAYOUT

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
D. ROGERS	C. WITHERS	D. ROGERS	S. HARRIS	S. HARRIS	S. HARRIS	T. JOHNSON

Stantec Consulting Services Inc.
11687 Lebanon Rd.
Cincinnati, Ohio
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Tel. 513.842.8200
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CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | DATE 06/11/10 | 46 | C | 10W543-01 | R 0

STANTEC	0
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

APPENDIX A

Document 16

Stantec, Results of Pseudostatic Slope Analysis, February 15, 2012

APPENDIX A

Document 17

CUF Spillway Improvement Project Letter, March 29, 2012

Stantec

Stantec Consulting Services Inc.
1859 Bowles Avenue Suite 250
St. Louis MO 63026-1944
Tel: (636) 343-3880
Fax: (636) 343-3554

March 29, 2012
File: 175609014

1101 Market Street
EB 4H-C
Chattanooga, TN 37402-2801

Dear Mr. Skelton:

Reference: CUF Spillway Improvement Project
TVA Project No. 203579

A project in-service date of March 29, 2012 was taken for the Cumberland Fossil Plant Spillway Improvement Project. The retrofitted spillways are in-service and the emergency spillway has been installed. A final walk-down will be conducted on April 10, 2012 and a punch-list of any open items will be developed and included in the final closure package.

Stantec appreciates the opportunity to assist TVA on this project. If there are any questions please feel free to contact me.

Respectfully,

STANTEC CONSULTING SERVICES INC.

Matthew Hoy, PE
Senior Project Engineer
Tel: (636) 343-3880
Fax: (636) 343-3554
Matthew.Hoy@stantec.com

MAH/ncb

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APPENDIX B

Document 18

Dam Inspection Check List Form – Ash Pond

US Environmental Protection Agency

Coal Combustion Dam Assessment Checklist Form

Site Name:	**Cumberland Fossil**	Date:	**September 7, 2011**
Unit Name:	**Ash Pond**	Operator's Name:	**Tennessee Valley Authority**
Unit I.D.:		Hazard Potential Classification:	**High** ☐ **Significant** ☒ **Low** ☐
	Inspector's Name:	Stanford/McLaren	

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No
1. Frequency of Company's Dam Inspections?	x	
2. Pool elevation (operator records)?	x	
3. Decant inlet elevation (operator records)?		x
4. Open channel spillway elevation (operator records)?	x	
5. Lowest dam crest elevation (operator records)?	x	
6. If instrumentation is present, are readings recorded (operator records)?	x	
7. Is the embankment currently under construction?		x
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?	x	
9. Trees growing on embankment? (If so, indicate largest diameter below)		x
10. Cracks or scarps on crest?		x
11. Is there significant settlement along the crest?		x
12. Are decant trashracks clear and in place?	x	
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		x
14. Clogged spillways, groin or diversion ditches?		x
15. Are spillway or ditch linings deteriorated?		x
16. Are outlets of decant or underdrains blocked?		x
17. Cracks or scarps on slopes?		x

	Yes	No
18. Sloughing or bulging on slopes?		x
19. Major erosion or slope deterioration?		x
20. Decant Pipes:		
Is water entering inlet, but not exiting outlet?		x
Is water exiting outlet, but not entering inlet?		x
Is water exiting outlet flowing clear?	x	
21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
From underdrain?		x
At isolated points on embankment slopes?	x	
At natural hillside in the embankment area?	x	
Over widespread areas?		x
From downstream foundation area?	x	
"Boils" beneath stream or ponded water?		x
Around the outside of the decant pipe?		x
22. Surface movements in valley bottom or on hillside?		x
23. Water against downstream toe?	x	
24. Were Photos taken during the dam inspection?	x	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Issue #	Comments

Coal Combustion Residuals (CCR)

Impoundment Assessment

Impoundment NPDES Permit	TN0005789	**INSPECTOR**
Date	November 30, 2007 / Expires 5-31-2010 (TVA has reapplied for permit)	
Impoundment Name	Ash Pond	
Impoundment Company	TVA-Cumberland Fossil Plant	
EPA Region	4	
State Agency	Tennessee Department of Environment and Conservation (DEC)	
(Field Office) Address	61 Forsyth Street, SW Atlanta GA 30303-1754	
Name of Impoundment	Ash Pond (Outfall 001)	

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ☐ **Update** ☒

	Yes	No
Is impoundment currently under construction? Pond is currently actively used for settling of bottom ash and storm water management for the entire CCR Complex.	☐	☒
Is water or ccw currently being pumped into the impoundment?	☒	☐

IMPOUNDMENT FUNCTION:	Settling Pond
Nearest Downstream Town Name:	Cumberland City
Distance from the impoundment:	1.7 Miles

Location:

Latitude	36	Degrees	23	Minutes	30.18	Seconds	**N**
Longitude	-87	Degrees	39	Minutes	48.96	Seconds	**W**

State Tennessee **County** Stewart

	Yes	No
Does a state agency regulate this impoundment?	☐	☒
If So Which State Agency?	No dam safety regulatory agency, but Tenn. DEC Div. of Water Pollution Control regulates discharge.	

HAZARD POTENTIAL *(In the event the impoundment should fail, the following would occur):*

☐ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

☐ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

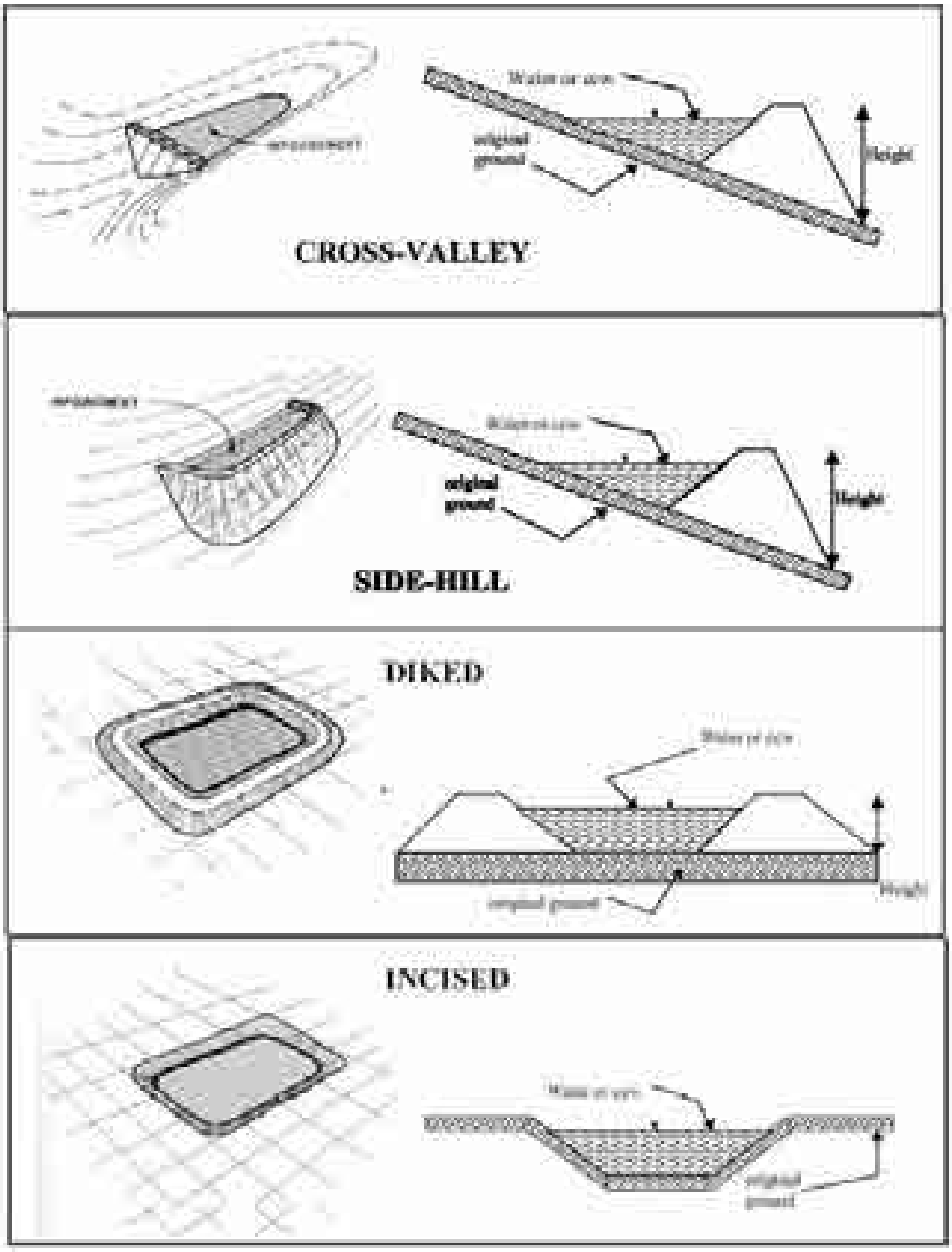
☒ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

☐ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

The Pond is considered significant hazard due to the potential for damage to the downstream state highway and bridge and due to off-site environmental damage should a failure of the impoundment occur.

CONFIGURATION:



☐ Cross-Valley ☐ Side-Hill ☒ Diked

☐ Incised (form completion optional) ☐ Combination Incised/Diked

Embankment Height (ft) 35 **Embankment Material** Clay

Pool Area (ac) 50 **Liner** No

Current Freeboard (ft) 10’ estimated **Liner Permeability** N/A

TYPE OF OUTLET (Mark all that apply)

☐ **Open Channel Spillway**

☐ Trapezoidal

☐ Triangular

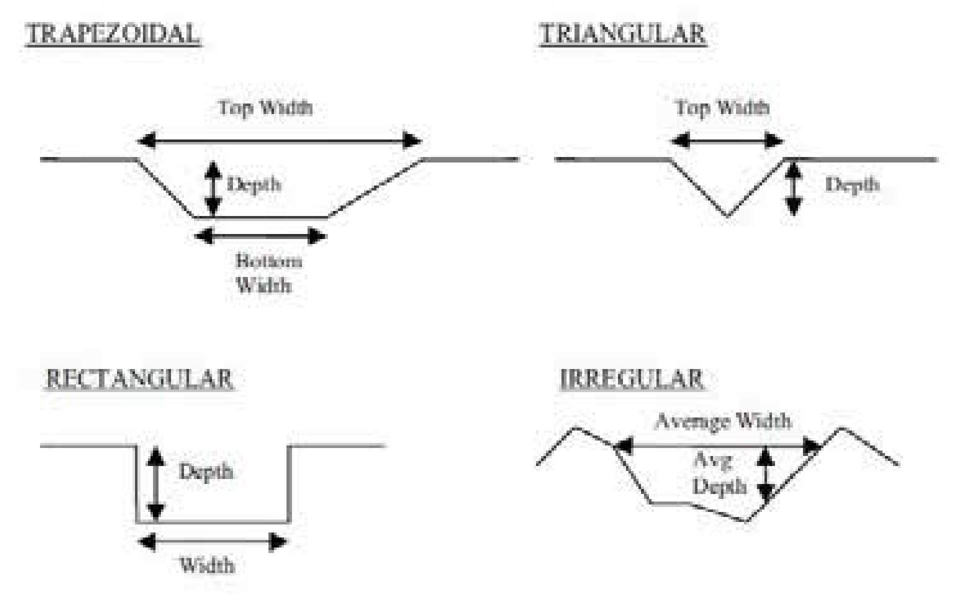
☐ Rectangular

☐ Irregular

depth (ft)

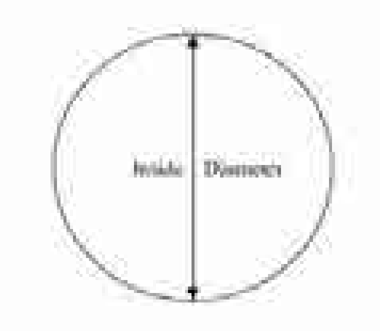
average bottom width (ft)

top width (ft)



☒ **Outlet**

4 36–inch dia. RCPs (Outfall 001)



Material

☐ corrugated metal

☐ welded steel

☒ concrete

☐ plastic (hdpe, pvc, etc.)

☐ other (specify):

	Yes	No
Is water flowing through the outlet?	☒	☐

☐ **No Outlet**

☐ **Other Type of Outlet** (specify):

The Impoundment was Designed By Not known at this time.

	Yes	No
Has there ever been a failure at this site?	☐	☒

If So When?

If So Please Describe :

No failure of dike at Ash Pond has occurred, but on 2/2/1997 bypass of the Cumberland Ash Pond Discharge Structure (Outfall 001) occurred when between one-half to one million gallons of gypsum wastewater spilled from the hydraulically connected Gypsum Disposal Area into Wells Creek. Heavy rainfall contributed to the failure of the internal gypsum dike, allowing a brief surge of wastewater to pass over the exterior dike in the Gypsum Disposal Area and enter the creek. The bypass lasted no longer than ten minutes.

	Yes	**No**
Has there ever been significant seepages at this site?	☒	☐
If So When?		

If So Please Describe :

In 1974 a seep was reported through the dike along the western side of the retention pond. A repair was performed consisting of placing a 40 foot wide clay seal on the interior of the dike. The area is monitored annually and no further seepage has been noted.

	Yes	No
Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site?	☐	☒
If so, which method (e.g., piezometers, gw pumping,...)?		

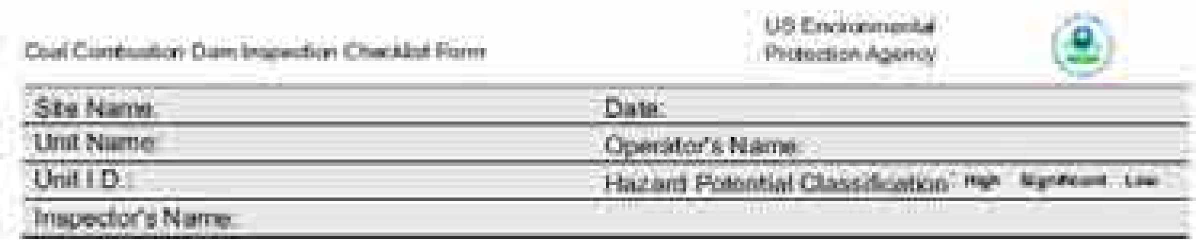
If So Please Describe :

ADDITIONAL INSPECTION QUESTIONS

Concerning the embankment foundation, was the embankment construction built over wet ash, slag, or other unsuitable materials*?* ***If there is no information just note that.*** *No construction documents are available at the time of the site visit. Current borings show that the dike raise embankments were constructed over sluiced fly ash.*

Did the dam assessor meet with, or have documentation from, the design Engineer-of-Record concerning the foundation preparation? *NO*

From the site visit or from photographic documentation, was there evidence of prior releases, failures, or patchwork on the dikes? *NO*



Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name:

Date:

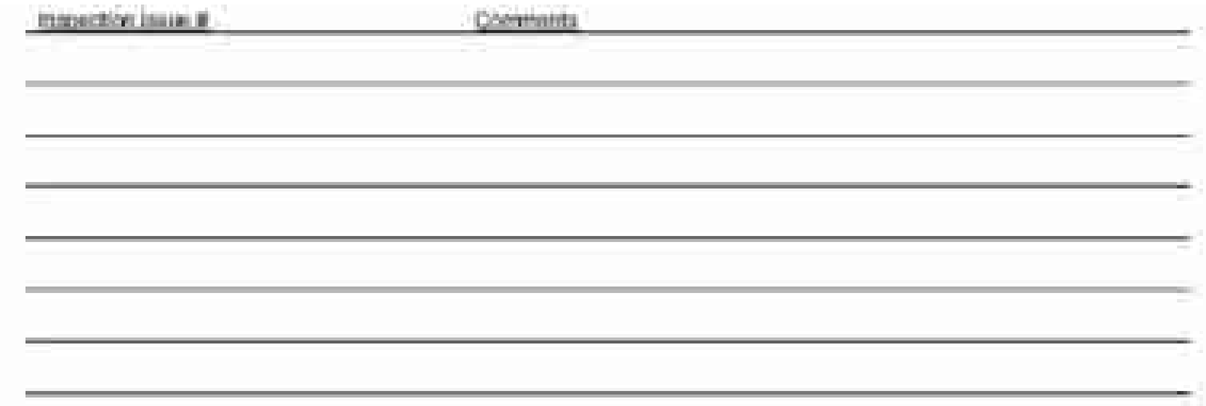
Unit Name:

Operator's Name:

Unit I.D.:

Hazard Potential Classification: High Significant Low

Inspector's Name:



Inspection Issue #

Comments

APPENDIX B

Document 19

Dam Inspection Check List Form – Dry Gypsum Storage

US Environmental Protection Agency

Coal Combustion Dam Assessment Checklist Form

Site Name:	**Cumberland Fossil**	Date:	**September 7, 2011**
Unit Name:	**Gypsum Disposal Area**	Operator's Name:	**Tennessee Valley Authority**
Unit I.D.:		Hazard Potential Classification:	**High** ☐ **Significant** ☒ **Low** ☐
	Inspector's Name:	Stanford/McLaren	

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	x		18. Sloughing or bulging on slopes?		x
2. Pool elevation (operator records)?	N/A		19. Major erosion or slope deterioration?		x
3. Decant inlet elevation (operator records)?	N/A		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?	N/A	
5. Lowest dam crest elevation (operator records)?	x		Is water exiting outlet, but not entering inlet?	N/A	
6. If instrumentation is present, are readings recorded (operator records)?	x		Is water exiting outlet flowing clear?	N/A	
7. Is the embankment currently under construction?		x	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?	x		From underdrain?		x
9. Trees growing on embankment? (If so, indicate largest diameter below)		x	At isolated points on embankment slopes?	x	
10. Cracks or scarps on crest?		x	At natural hillside in the embankment area?	x	
11. Is there significant settlement along the crest?		x	Over widespread areas?		x
12. Are decant trashracks clear and in place?	N/A		From downstream foundation area?	x	
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?	N/A		"Boils" beneath stream or ponded water?		x
14. Clogged spillways, groin or diversion ditches?		x	Around the outside of the decant pipe?	N/A	
15. Are spillway or ditch linings deteriorated?		x	22. Surface movements in valley bottom or on hillside?		x
16. Are outlets of decant or underdrains blocked?		x	23. Water against downstream toe?	x	
17. Cracks or scarps on slopes?		x	24. Were Photos taken during the dam inspection?	x	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Issue #	Comments

Coal Combustion Residuals (CCR)

Impoundment Assessment

Impoundment NPDES Permit TN0005789 **INSPECTOR**

Date November 30, 2007 / Expires 5-31-2010 (TVA has reapplied for permit)
Impoundment Name Gypsum Disposal Area

Impoundment Company TVA-Cumberland Fossil Plant
EPA Region 4

State Agency Tennessee Department of Environment and Conservation (DEC)
(Field Office) Address 61 Forsyth Street, SW Atlanta GA 30303-1754
Name of Impoundment Gypsum Disposal Area (Hydraulically connected to Outfall 001)

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ☐ **Update** ☒

	Yes	No
Is impoundment currently under construction? Area is currently actively used for dry filling of gypsum stacks and infrequent wet-sluicing of gypsum slurry only as needed.	☐	☒
Is water or ccw currently being pumped into the impoundment?	☐	☒

IMPOUNDMENT FUNCTION: Dry Gypsum Storage

Nearest Downstream Town Name: Cumberland City

Distance from the impoundment: 1.7 Miles

Location:

Latitude	36	Degrees	23	Minutes	1.80	Seconds	**N**
Longitude	-87	Degrees	39	Minutes	22.08	Seconds	**W**

State Tennessee **County** Stewart

	Yes	No
Does a state agency regulate this impoundment?	☐	☒

If So Which State Agency? No dam safety regulatory agency, but Tenn. DEC Div. of Water Pollution Control regulates discharge at Ash Pond (Outfall

001).

HAZARD POTENTIAL *(In the event the impoundment should fail, the following would occur):*

☐ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

☐ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

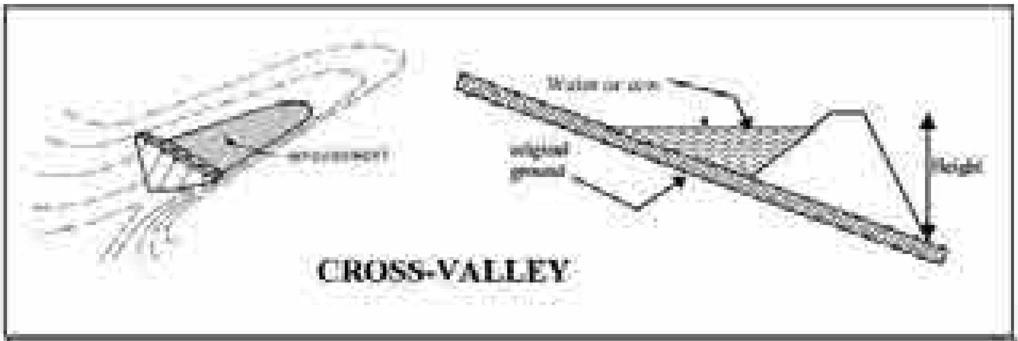
☒ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

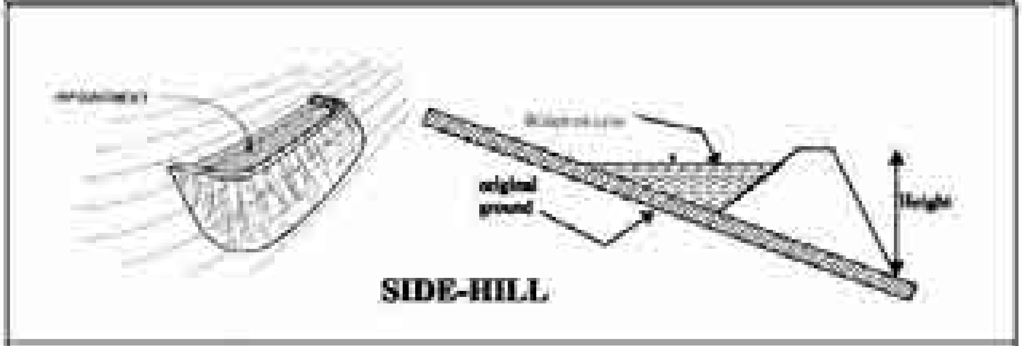
☐ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

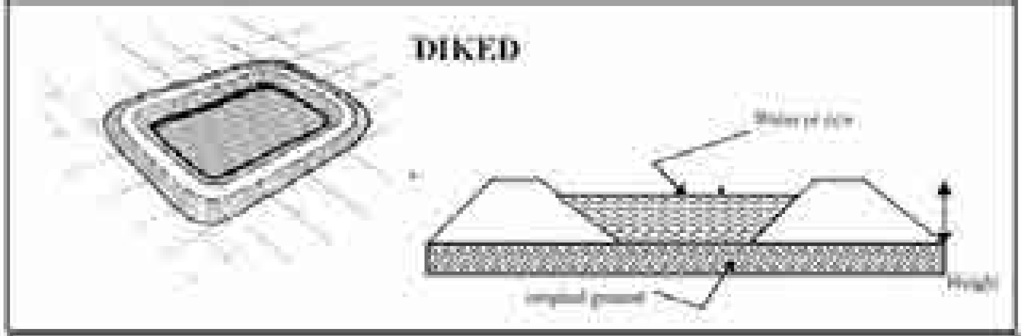
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

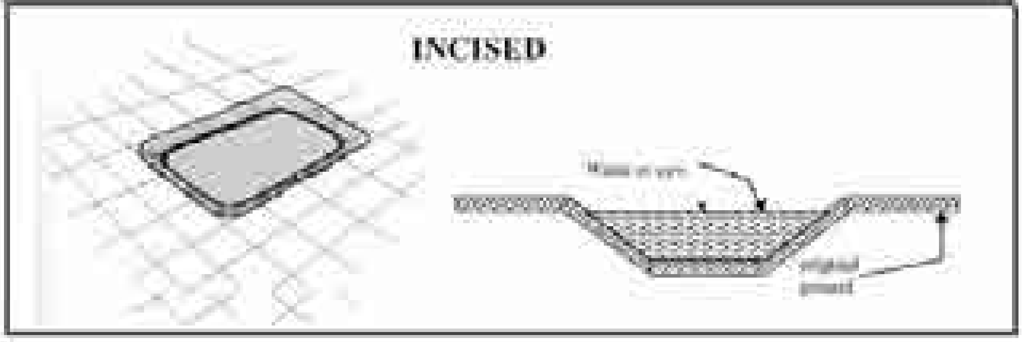
The Gypsum Disposal Area is considered significant hazard due to the potential for off-site environmental damage or damage to on-site structures should a failure of the containment dike occur.

CONFIGURATION:









☐ Cross-Valley ☐ Side-Hill ☒ Diked

☐ Incised (form completion optional) ☐ Combination Incised/Diked

Embankment Height (ft) 60 estimated **Embankment Material** Clay (Starter Dike Clayey Gravel)

Pool Area (ac)	170	**Liner**	No
Current Freeboard (ft)	N/A	**Liner Permeability**	N/A

TYPE OF OUTLET (Mark all that apply)

☐ **Open Channel Spillway**

☐ Trapezoidal

☐ Triangular

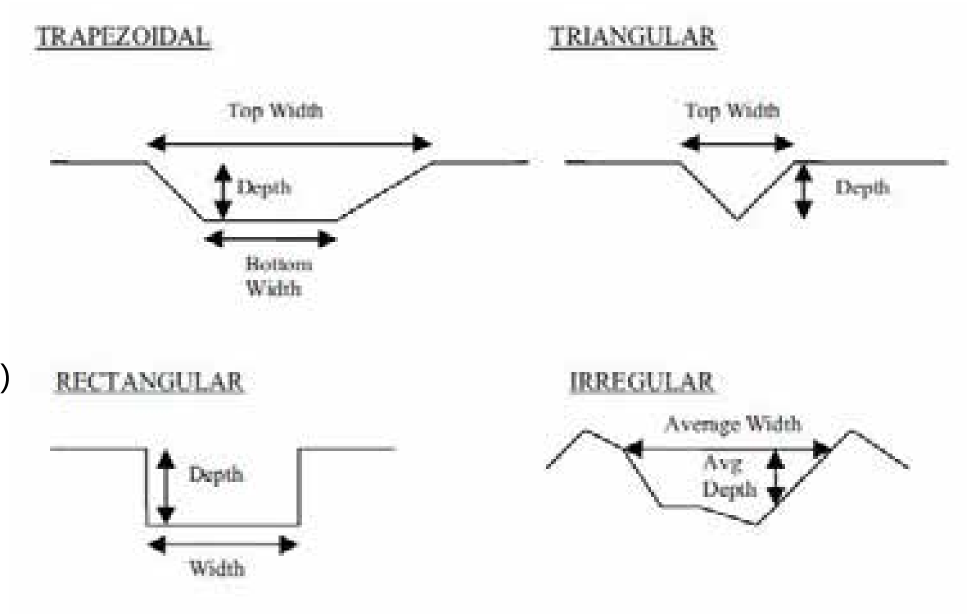
☐ Rectangular

☐ Irregular

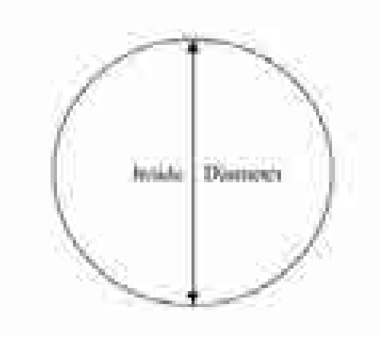
depth (ft)

average bottom width (ft)

top width (ft)



☐ **Outlet**



Material

☐ corrugated metal

☐ welded steel

☐ concrete

☐ plastic (hdpe, pvc, etc.)

☐ other (specify):

	Yes	No
Is water flowing through the outlet?	☐	☐

☒ **No Outlet (to Exterior)**

Hydraulically connected to Ash Pond via perimeter ditches and drainage pipes

☐ **Other Type of Outlet** (specify):

The Impoundment was Designed By Not Known at this time.

	Yes	No
Has there ever been a failure at this site?	☒	☐

If So When? 2/2/1997

If So Please Describe :

No structural failure of dike at Gypsum Disposal Area has occurred, but on 2/2/1997 bypass of the hydraulically connected Cumberland Ash Pond Discharge Structure (Outfall 001) occurred when between one-half to one million gallons of gypsum wastewater spilled from the Gypsum Disposal Area into Wells Creek. Heavy rainfall contributed to the failure of the internal gypsum dike, allowing a brief surge of wastewater to pass over the exterior dike in the Gypsum Disposal Area and enter the creek. The bypass lasted no longer than ten minutes.

	Yes	No
Has there ever been significant seepages at this site?	☒	☐

If So When? On-going

If So Please Describe : Seepage on the exterior side of the containment dike on the southwest side of the Gypsum Disposal Area is monitored in accordance with TVA's Seepage Action Plan

	Yes	No
Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site?	☐	☒
If so, which method (e.g., piezometers, gw pumping,...)?		

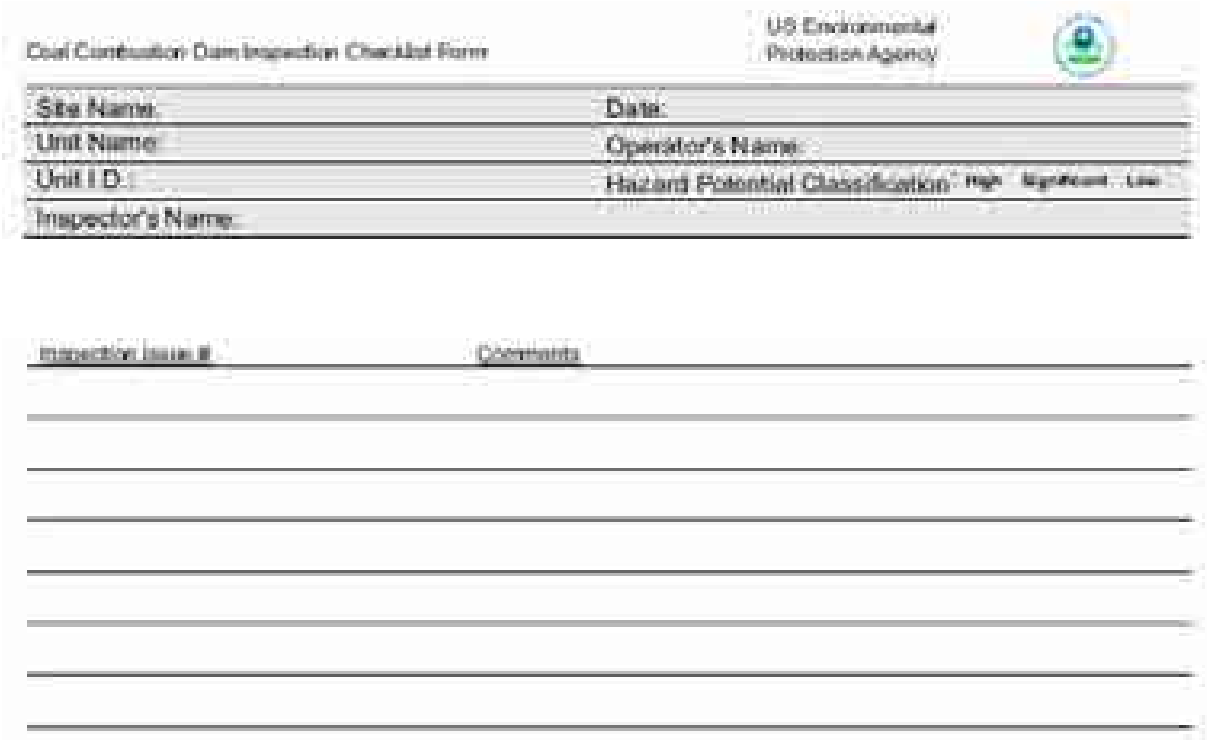
If So Please Describe :

ADDITIONAL INSPECTION QUESTIONS

Concerning the embankment foundation, was the embankment construction built over wet ash, slag, or other unsuitable materials? If there is no information just note that. *No construction documents are available at the time of the site visit. Current borings do not show that the embankments were constructed of wet ash, slag, or unsuitable materials.*

Did the dam assessor meet with, or have documentation from, the design Engineer-of-Record concerning the foundation preparation? *NO*

From the site visit or from photographic documentation, was there evidence of prior releases, failures, or patchwork on the dikes? *NO*



Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name:

Date:

Unit Name:

Operator's Name:

Unit I.D.:

Hazard Potential Classification: High Significant Low

Inspector's Name:

Inspection Issue #

Comments

APPENDIX B

Document 20

Dam Inspection Check List Form – Dry Ash Storage

US Environmental Protection Agency

Coal Combustion Dam Assessment Checklist Form

Site Name:	**Cumberland Fossil**	Date:	**September 7, 2011**
Unit Name:	**Dry Ash Stack**	Operator's Name:	**Tennessee Valley Authority**
Unit I.D.:		Hazard Potential Classification:	**High** ☐ **Significant** ☒ **Low** ☐
		Inspector's Name:	Stanford/McLaren

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	x		18. Sloughing or bulging on slopes?		x
2. Pool elevation (operator records)?	N/A		19. Major erosion or slope deterioration?		x
3. Decant inlet elevation (operator records)?	N/A		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?	N/A	
5. Lowest dam crest elevation (operator records)?	x		Is water exiting outlet, but not entering inlet?	N/A	
6. If instrumentation is present, are readings recorded (operator records)?	x		Is water exiting outlet flowing clear?	N/A	
7. Is the embankment currently under construction?		x	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?	x		From underdrain?		x
9. Trees growing on embankment? (If so, indicate largest diameter below)		x	At isolated points on embankment slopes?	x	
10. Cracks or scarps on crest?		x	At natural hillside in the embankment area?	x	
11. Is there significant settlement along the crest?		x	Over widespread areas?		x
12. Are decant trashracks clear and in place?	N/A		From downstream foundation area?	x	
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?	N/A		"Boils" beneath stream or ponded water?		x
14. Clogged spillways, groin or diversion ditches?		x	Around the outside of the decant pipe?	N/A	
15. Are spillway or ditch linings deteriorated?		x	22. Surface movements in valley bottom or on hillside?		x
16. Are outlets of decant or underdrains blocked?		x	23. Water against downstream toe?	x	
17. Cracks or scarps on slopes?		x	24. Were Photos taken during the dam inspection?	x	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Issue #	Comments

Coal Combustion Residuals (CCR)

Impoundment Assessment

Impoundment NPDES Permit TN0005789 **INSPECTOR**

Date November 30, 2007 / Expires 5-31-2010 (TVA has reapplied for permit)
Impoundment Name Dry Ash Stack

Impoundment Company TVA-Cumberland Fossil Plant
EPA Region 4

State Agency (Field Office) Address Tennessee Department of Environment and Conservation (DEC)
61 Forsyth Street, SW Atlanta GA 30303-1754
Name of Impoundment Dry Ash Stack (Hydraulically connected to Outfall 001)

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ☐ **Update** ☒

	Yes	No
Is impoundment currently under construction? Area is currently actively used for dry filling of ash in stacks.	☐	☒
Is water or ccw currently being pumped into the impoundment?	☐	☒

IMPOUNDMENT FUNCTION: Dry Ash Storage

Nearest Downstream Town Name: Cumberland City

Distance from the impoundment: 1.7 Miles

Location:

Latitude	36	Degrees	23	Minutes	15.00	Seconds	**N**
Longitude	-87	Degrees	39	Minutes	43.08	Seconds	**W**

State Tennessee **County** Stewart

	Yes	No
Does a state agency regulate this impoundment?	☐	☒

If So Which State Agency? No dam safety regulatory agency, but Tenn. DEC Div. of Water Pollution Control regulates discharge at Ash Pond (Outfall 001).

HAZARD POTENTIAL *(In the event the impoundment should fail, the following would occur):*

☐ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

☐ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

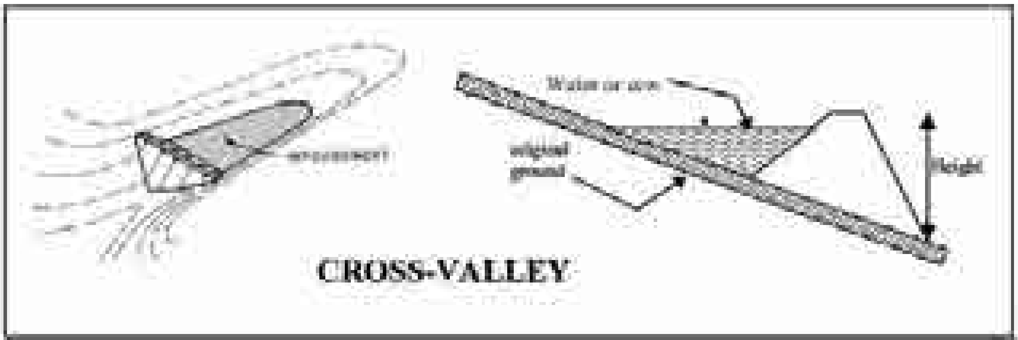
☒ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

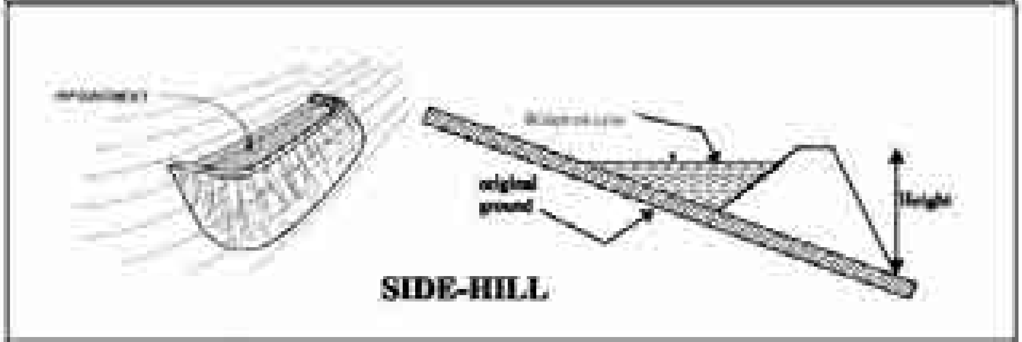
☐ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

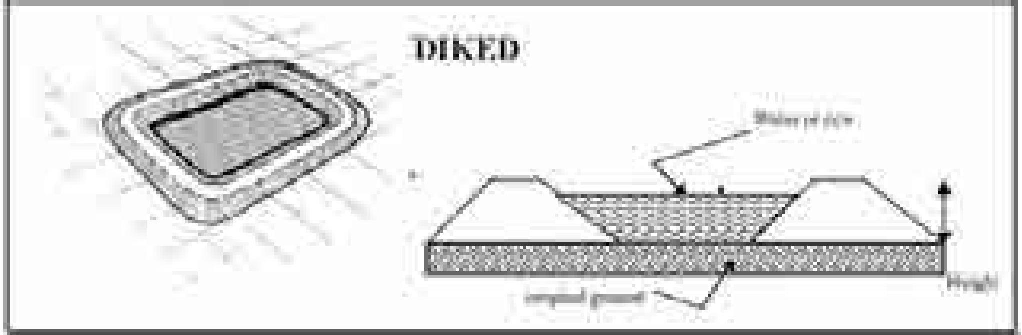
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

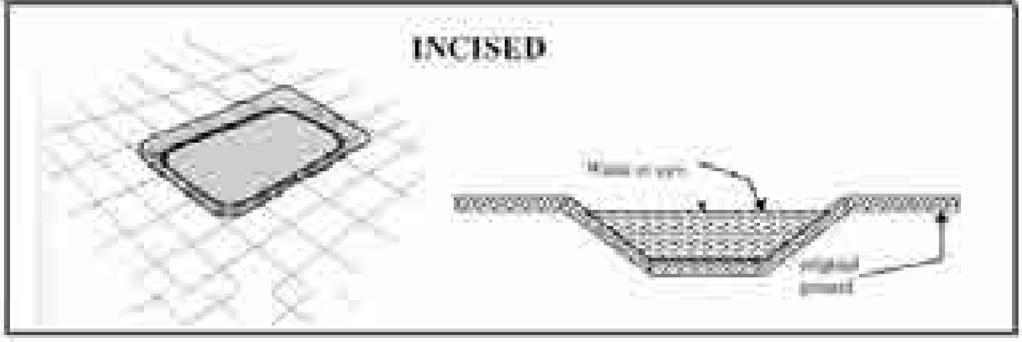
The Dry Ash Stack is considered significant hazard due to the potential for off-site environmental damage should a failure of the containment dike occur.

CONFIGURATION:









☐ Cross-Valley ☐ Side-Hill ☒ Diked

☐ Incised (form completion optional) ☐ Combination Incised/Diked

Embankment Height (ft)	35	**Embankment Material**	Clay
Pool Area (ac)	110	**Liner**	No

Current Freeboard (ft) N/A

Liner Permeability N/A

TYPE OF OUTLET (Mark all that apply)

☐ **Open Channel Spillway**

☐ Trapezoidal

☐ Triangular

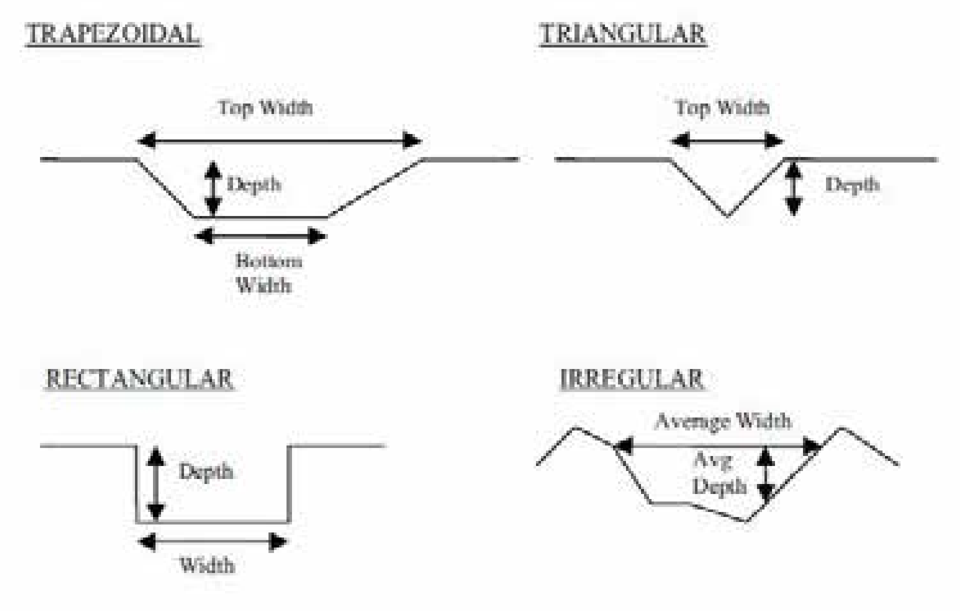
☐ Rectangular

☐ Irregular

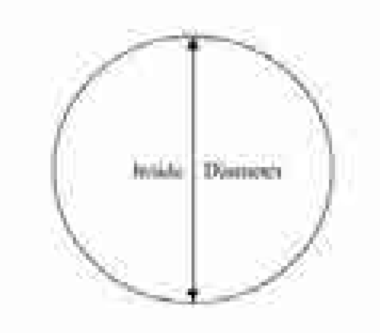
depth (ft)

average bottom width (ft)

top width (ft)



☐ **Outlet**



Material

☐ corrugated metal

☐ welded steel

☐ concrete

☐ plastic (hdpe, pvc, etc.)

☐ other (specify):

	Yes	No
Is water flowing through the outlet?	☐	☐

☒ **No Outlet (to Exterior)**

Hydraulically connected to Ash Pond via perimeter ditches and culverts

☐ **Other Type of Outlet** (specify):

The Impoundment was Designed By Not Known at this time.

	Yes	No
Has there ever been a failure at this site?	☐	☒

If So When?

If So Please Describe :

No failure of dike at Dry Ash Stack has occurred, but on 2/2/1997 bypass of the Cumberland Ash Pond Discharge Structure (Outfall 001) occurred when between one-half to one million gallons of gypsum wastewater spilled from the hydraulically connected Gypsum Disposal Area into Wells Creek. Heavy rainfall contributed to the failure of the internal gypsum dike, allowing a brief surge of wastewater to pass over the exterior dike in the Gypsum Disposal Area and enter the creek. The bypass lasted no longer than ten minutes.

	Yes	No
Has there ever been significant seepages at this site?	☒	☐
If So When?	On-going	

If So Please Describe :

Seepage on the exterior side of the containment dike on the southwest side of the Dry Ash Stack is monitored in accordance with TVA's Seepage Action Plan

	Yes	No
Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site?	☐	☒
If so, which method (e.g., piezometers, gw pumping,...)?		

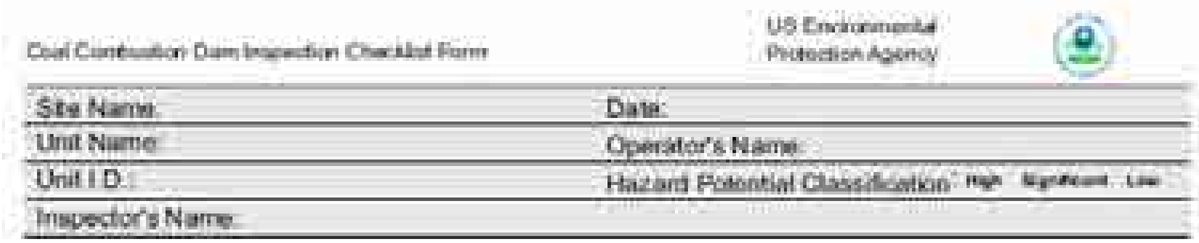
If So Please Describe :

ADDITIONAL INSPECTION QUESTIONS

Concerning the embankment foundation, was the embankment construction built over wet ash, slag, or other unsuitable materials? If there is no information just note that. *No construction documents are available at the time of the site visit. Current borings show that the dike raise embankment was constructed over sluiced fly ash.*

Did the dam assessor meet with, or have documentation from, the design Engineer-of-Record concerning the foundation preparation? *NO*

From the site visit or from photographic documentation, was there evidence of prior releases, failures, or patchwork on the dikes? *NO*



Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name:

Date:

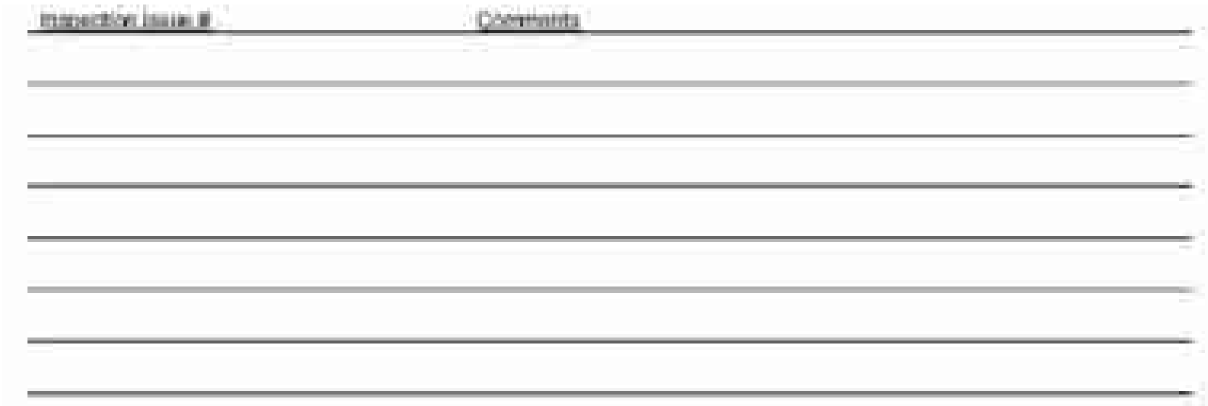
Unit Name:

Operator's Name:

Unit I.D.:

Hazard Potential Classification: High Significant Low

Inspector's Name:



Inspection Issue #	Comments

APPENDIX B

Document 21

Dewberry Memorandum dated May 25, 2012, Regarding Qualitative Assessment

Memorandum

To: Stephen Hoffman, USEPA
Through: Jerry Strauss
From: Joe Klein
Date: May 25, 2012
Re: Qualitative Assessment
Liquefaction Potential
TVA Fossil Plant CCR Impoundments
Dewberry Project No, 50047151

This memorandum provides the results of a qualitative assessment of CCR impoundment embankment susceptibility to liquefaction at eight of the TVA fossil fuel plants assessed by Dewberry. The plants are: Bull Run; Colbert; Cumberland; Gallatin; John Sevier; Johnsonville; Kingston, and Widows Creek. We have not included Watts Bar (small pond, inactive for 30 years, minimal potential ash release), and Allen (TVA continuing deformation analyses, awaiting data and report)

TVA has indicated that a formal assessment of liquefaction susceptibility is underway; a completion date has not been provided. In prior rounds of the EPA CCR program, Dewberry has provided a preliminary indication of the presence of soils susceptible to liquefaction based on the geotechnical data provided with the slope stability analysis. The purpose of this assessment is to include similar information as a component of our reports to EPA, and to provide a uniform approach to the remaining plant sites.

Generally the geotechnical review looks at the soil stratification beneath both the embankments and impoundments to identify soil types considered susceptible to liquefaction; i.e., fine to medium grain sands, and some silts with Standard Penetration Resistance, or N-Values of less than 15 blows per foot[1]. That criterion, is an accepted industry standard for first level reviews.

Because several of the embankments had been constructed to their current configuration in stages, and because the raised sections were typically constructed by extending embankments in the *upstream* direction, most of TVA raised dikes are supported in part on stored bottom ash and/or fly ash. As bottom ash and fly ash are both known to be somewhat susceptible to liquefaction, an assessment of the potential impact on loss of subgrade support to the raised dike sections is a key consideration in the assessments.

For most of the other management units I have visited, the impoundments were expanded by *building out* on the downstream side of the dikes, eliminating the situation of building on the existing ash layer. The one site that did expand inward conducted a liquefaction analysis which indicated a potential for liquefaction in the ash at certain groundwater elevations. In that case the utility combined a groundwater monitoring system and construction schedule in an effort to prevent groundwater elevation

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[1] Winterkorn, H.F., and Fang, H., *Foundation Engineering Handbook, Van Nostrand Reinhold, Ltd., New York, NY. 1975, pg. 268*

increases. If the approach proved to be unsuccessful, the utility had a drainage system design ready to be installed to stabilize the embankment against a potential liquefaction failure.

Because the assessments are qualitative rather than quantitative, I elected not to consider the results as indicative of either SATISFACTORY or UNSATISFACTORY. The assessed liquefaction condition at each impoundment is presented as either NO CONCERN or CONCERN. Each impoundment is assessed based on the natural foundation soils at the site, and the supporting material of raised dike sections. A composite rating is provided as described below.

The evaluations are based on the embankment cross-sections used in the recent (February 2012 and April 2012) pseudo static slope stability analyses conducted by Stantec Consulting Services for TVA.

Foundation Rating

Foundation soils are rated not only on the presence of liquefaction susceptible soils, but also the depth and thickness of the stratum, the slope of the base of the stratum, and whether the stratum extends beneath the base dike, or is restricted to the impoundment area. A CONCERN rating indicates the presence of soils susceptible to liquefaction at a relatively shallow depth below the embankment, and sufficiently thick to result in substantial deformations to the embankment in the event liquefaction occurs.

Dike Rating

Dikes were rated based on the presence of bottom ash, fly ash or other CCR material underlying raised dike sections. If the CCR material supported 50 percent or more of the raised dike, the dike received a CONCERN rating.

Composite Ratings

Composite ratings are based on a judgment of deformations that may occur to the embankments in the event of liquefaction of materials supporting the initial and/or raised dikes, The rating reflects the potential volume of material released in the event of an embankment failure, and the nature of the adjoining area expected to receive the outflow. In most cases, the controlling parameter for each perimeter dike is the potential failure of raised dikes supported in part by CCR material. Conversely, the controlling factor for interior dikes is the foundation rating.

Results

Table 1 presents a summary of the results of this assessment.

Plant	Impoundment	Liquefaction Stability Rating		
		Foundation	Dikes	Composite
Bull Run	Disposal Area 2A	NO CONCERN	CONCERN	**CONCERN**
	Disposal Area 2	NO CONCERN	NO CONCERN	NO CONCERN
	Bottom Ash Disposal Area 1	NO CONCERN	CONCERN	**CONCERN**
Colbert	Ash Pond 4	CONCERN	CONCERN	**CONCERN**
	Ash Pond 5	NO CONCERN	NO CONCERN	NO CONCERN
Cumberland	Ash Pond	NO CONCERN	NO CONCERN	NO CONCERN
Gallatin	Ash Pond A	NO CONCERN	CONCERN	NO CONCERN
	Ash Pond E	NO CONCERN	CONCERN	NO CONCERN
John Sevier	Bottom Ash Pond	NO CONCERN	NO CONCERN	NO CONCERN
	Ash Disposal Area J	NO CONCERN	NO CONCERN	NO CONCERN
Johnsonville	Ash Disposal Area 2	NO CONCERN	CONCERN	**CONCERN**
Kingston	Ash Pond Dike C	CONCERN	CONCERN	**CONCERN**
	Gypsum Stack	NO CONCERN	NO CONCERN	NO CONCERN
Widows Creek	Main Ash Pond Complex	NO CONCERN	CONCERN	**CONCERN**
	Gypsum Stack	NO CONCERN	NO CONCERN	NO CONCERN

The embankment composite ratings at Gallatin Fossil Plant are the exception to the general case of the dike rating being the controlling factor. Gallatin Ash Pond A embankment is an interior dike separating Ash Pond A and Stilling Pond B. Failure of the embankment due to liquefaction of the supporting ash would result in an intermingling of ash and decant water within the impoundment, a release from the impoundment would not be expected to occur.

Gallatin Ash Pond E is supported on an underlying layer of ash that extends beyond the toe of the embankment to a natural slope, expected to be the excavation limits for the original impoundment area. Failure of the Ash Pond E due to liquefaction of the underlying material is not expected to result in a significant release beyond the boundaries of the current impoundment,

Conclusions

Based on the results of this review, the stability of six impoundments is rated as CONCERN relative to potential liquefaction during a seismic event.

As previously discussed, the embankment stability ratings are based on a qualitative review of the current geotechnical data. More rigorous analytical assessments may arrive at different results. Such analyses should evaluate both the likelihood of liquefaction occurring from susceptible soils in the event of the design earthquake, and the effects of liquefaction on the embankments. The second phase of analyses is important to assess the risk posed by potential liquefaction of (or beneath) the CCR impoundment embankments.

Limitations

Our assessment of the stability of CCR impoundment embankments includes evaluation of many variables, including liquefaction potential. Most of the other variables have data developed with significantly more technical rigor than this qualitative assessment. *Therefore, I caution against using the results of this assessment as a primary determinant on the overall rating of a CCR impoundment.* Although reasonable judgment was used throughout the evaluation, uncertainties were evaluated using the most conservation assumptions.

Further, it is likely that the geotechnical data provided by TVA is "inconsistent" with the data (i.e., procedure) used in the Foundation Engineering Handbook (Footnote 1) to develop correlations with liquefaction susceptibility and N-values. That is, information in the TVA geotechnical reports indicate that the Standard Penetration Tests were conducted using an automatic hammer to drive the sampler. Research has shown that automatic hammers impart a significantly higher percentage of the theoretical maximum hammer to the drive anvil energy than achieved by traditional manual methods using a rope and cathead to raise and release the hammer. The result is that TVA's recorded N-values can be expected to be lower than those achieved by manual hammers in use at the time the industry-practice (i.e., Handbook) liquefaction correlations were developed.

Further, the sand strata encountered at TVA sites were below the ground water level. The boring logs indicated borings were advanced using a hollow stem auger. Hollow stem augers are a standard method for advancing soil borings, and comply with ASTM requirements. However, it is difficult to maintain the required hydrostatic head inside the augers while inserting and removing the sampler. If the hydrostatic head is not maintained, an upward gradient can develop at the tip of the auger which also reduces the N-value below the theoretical value.

It is for these reasons that the results of this assessment should not be used as the primary determinate of the overall rating for an embankment.