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Coal Combustion Residue Impoundment

Round 11 - Dam Assessment Report

Colbert Fossil Plant
Tennessee Valley Authority
Tuscumbia, Alabama

Prepared for:

United States Environmental Protection Agency
Office of Resource Conservation and Recovery

Prepared by:

Dewberry & Davis, LLC
Fairfax, Virginia

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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's Kingston, Tennessee facility in December 2008, which flooded more than 300 acres of land and damaged homes and property, is a wake-up call for diligence on coal combustion residue disposal units. 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 Colbert Fossil Plant's coal combustion residuals (CCR) management units is based on a review of available documents and on the site assessment conducted by Dewberry personnel on Monday, September 12, 2011. The CCR management units are referred to herein as Ash Pond 4 and Disposal Area 5 (also known as Ash Pond 5). We found the supporting technical documentation inadequate (Section 1.1.3) for Ash Pond 4, and adequate for Disposal Area 5. As detailed in Section 1.2.3, there are two recommendations based on field observations that may help to maintain a safe and trouble-free operation.

In summary, the Colbert Fossil Plant's Ash Pond 4 is **FAIR**, and Disposal Area 5 is **SATISFACTORY** for continued safe and reliable operation with no recognized management unit safety deficiencies.

PURPOSE AND SCOPE

The U.S. Environmental Protection Agency (EPA) is investigating 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 early 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)

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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 (See Appendix C).

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 Colbert Fossil Plant that were reviewed and used in preparation of this report.

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).

Note: The terms "embankment", "berm", "dike" and "dam" are used interchangeably within this report, as are the terms "pond", "basin", and "impoundment".

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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Doc 16 URS Memorandum dated September 12, 2011, “Subject: August 2011 TVA Instrumentation Readings Comments”

Doc 17 Stantec Consulting Services Inc. correspondence dated February 15, 2012, Re: Results of Pseudostatic Slope Stability Analysis, Active CCP Disposal Facilities, BRF, COF, GAF, JSF, KIF, PAF, and WCF.

APPENDIX B

Doc 18: Dam Inspection Check List Form Ash Pond 4

Doc 19: Dam Inspection Check List Form Area 5 Dry Stack

1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

Conclusions are based on visual observations from a one-day site visit, September 12, 2011, and review of technical documentation provided by Tennessee Valley Authority.

1.1.1 Conclusions Regarding the Structural Soundness of the Management Unit

The Ash Pond 4 and Disposal Area 5 embankments and spillways appear to be structurally sound based on a review of the engineering data provided by the owner's technical staff, consultants, and Dewberry engineers' observations during the site visit.

- Geotechnical analyses available at the time of the site visit indicated the calculated slope stability under static conditions of a section of Ash Pond 4 dike did not meet the minimum requirements of 1.5. Alterations and improvements were being made to the Ash Pond 4 dike at the time of the site visit. Subsequently, documentation was provided that verified the effectiveness of the improvements in raising the stability Safety Factor to greater than 1.5.

- Liquefaction analyses have not been performed for either Ash Pond 4 or Disposal Area 5. Qualitative examination of geotechnical data for Ash Pond 4 indicates the presence of loose to very loose silty sand beneath the toe of the east lower dike, and loose to very loose ash beneath the toe of the upper dike. Both conditions are prevalent along the east dike. Disposal Area 5 did not show soil conditions susceptible to liquefaction.

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

Hydrologic and hydraulic analyses, including a dam break analysis of Ash Pond 4, were provided to Dewberry for review.

The dam break analysis of Ash Pond 4 included both "sunny day" breaches and overtopping during a Probable Maximum Precipitation (PMP) event. Based on the results of the analysis, a segment of the embankment crest was lowered, and new spillway and siphon systems constructed to lower the normal pool elevation. The purpose of the work was to remove the probability of the loss of human life in the event of a failure of the embankment. Documentation provided states that lowering the crest of a section of Ash Pond 4 provides sufficient overflow capacity to prevent the remainder of the embankment from being overtopped during a PMP event.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

The supporting technical documentation is inadequate due to the absence of liquefaction analyses, particularly for Ash Pond 4.

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

The description of the management unit provided by the owner was an accurate representation 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 field observation. The visible parts of the Ash Pond 4 and Disposal Area 5 embankments and outlet structures were observed to have no signs of overstress, significant settlement or shear failure, or other signs of instability. Embankments appear structurally sound. There are no apparent indications of unsafe conditions, or conditions needing remedial action beyond current monitoring and maintenance operations.

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 Ash Pond 4 and Disposal Area 5. There was no evidence of significant embankment repairs or prior releases observed during the field inspection. TVA has identified seepage areas, performed an analysis of the seepage potential, and instituted a program of monitoring and managing the seepage.

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

The surveillance program appears to be adequate. The Ash Pond 4 and Disposal Area 5 embankments are instrumented with a network of piezometers. The piezometers are monitored regularly.

1.1.8 Classification Regarding Suitability for Continued Safe and Reliable Operation

Ash Pond 4 is rated FAIR and Disposal Area 5 CCR management units is rated SATISFACTORY for continued safe and reliable operation.

1.2 RECOMMENDATIONS

1.2.1 Recommendations Regarding the Structural Stability

No recommendations appear warranted at this time.

1.2.2 Recommendations Regarding the Hydrologic/Hydraulic Safety

No recommendations appear warranted at this time.

1.2.3 Recommendations Regarding the Supporting Technical Documentation

It is recommended that an analysis of the impact of potential liquefaction of materials within and under Ash Pond 4 be performed now rather than upon closure of the unit.

1.2.4 Recommendations Regarding Continued Safe and Reliable Operation

It is anticipated that the Ash Pond 4 management unit would be considered Satisfactory for continued safe and reliable operation upon:

A determination of the lack of liquefaction potential for soils and materials under the design seismic event

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants

Darrell Moses, TVA
Keith McMillian, TVA
Scott Turnbow, TVA
J. Chris Buttram, TVA
Michael Gean, TVA
Shane Harris, TVA
John Dizer, TVA
Brett Wyatt, TVA
Jake Booth, TVA
Mitch Gorodea, URS
Randy Roberts, Stantec
Joe Klein, Dewberry
Frank Lockridge, Dewberry

1.3.2 Acknowledgement and Signature

We acknowledge that the management unit referenced herein has been assessed on September 12, 2011.

__________________________ __________________________

Joseph P. Klein, III, P.E.
Registered, AL #25976

Frank B. Lockridge, P.E.

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

2.1 LOCATION AND GENERAL DESCRIPTION

The Colbert Fossil Plant is located on the south bank of the Tennessee River west of Tuscumbia, Colbert County, Alabama. Construction of the plant began in 1951 and the first four units were put into commercial operation in 1955. A fifth unit was authorized in 1959 and put into commercial service in 1962. The site is bordered on the south by U.S. Highway 72, on the west by timber land and on the east by agriculture. The site location and area topography is shown on Figure 2.1-1

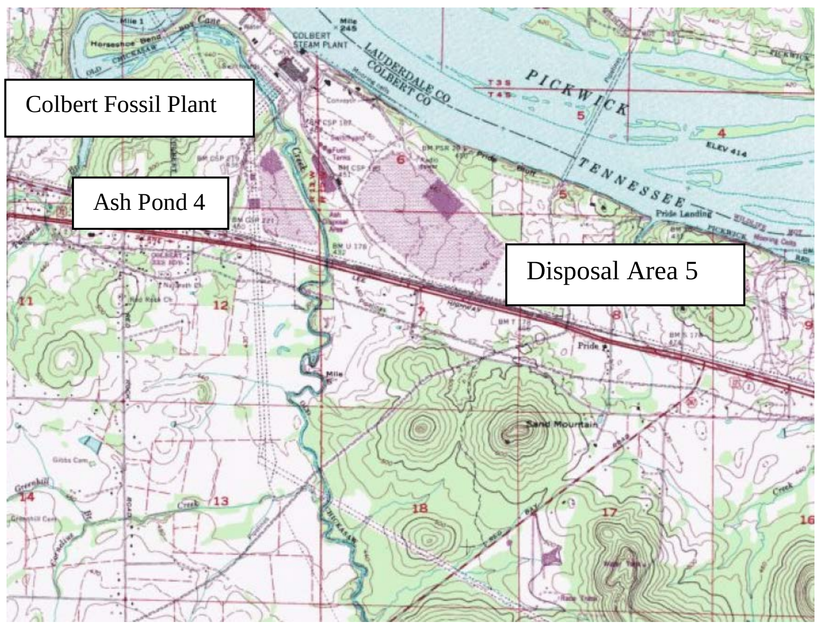

Figure 2.1-1: Colbert Fossil Plant Location

The plant has two active CCR impoundments that are receiving coal combustion residue materials: Ash Pond 4 and Disposal Area 5. Disposal Area 5 includes a Dry Stack and a Drainage Basin.

<u>Ash Pond 4</u>

Ash Pond 4 is located about 3,000 feet south of the plant's powerhouse. Ash Pond 4 is bordered by the plant access road on the west, U.S. Highway 72 on the south, and Cane Creek on the south and north and east. Ash Pond 4 encompasses about 52 acres impounded by an earth fill dike about 6,700 feet in length. The height of the embankment ranges in height from about 20 to 40 feet. Figure 2.1-2 shows the location of Ash Pond 4 on the site. Table 2.1 provides a summary of the embankment height, length and side slopes for Ash Pond 4.

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Disposal Area 5

Disposal Area 5 is located about 5,000 feet southeast of the plant's powerhouse. Disposal Area 5 is bordered by U.S. Highway 72 to the south, the Tennessee River to the north, and a water treatment facility to the southeast. Disposal Area 5 encompasses about 75 acres impounded by an earth fill dike about 7,500 feet in length. The height of the embankment ranges from about 10 to 30 feet.

Figure 2.1-2 also shows the location of Disposal Area 5 on the site.

Figure 2.1-2 Ash Pond 4 and Disposal Area 5 Locations

Table 2.1 provides a summary of the embankment height, length and side slopes the Disposal Area 5 Ash Stack and Disposal Area 5 Drainage Basin embankments.

Table 2.1: Summary of Dam Dimensions and Size[1]			
	Ash Pond 4	Disposal Area 5	
		Ash Stack Impoundment	Drainage Basin
Dam Height (ft)	20 to 40	10 to 30	15 to 20
Crest Width (ft)	20 to 25	25 to 30	20
Length (ft)	6,700	7,500	3,000
Side Slopes (upstream) H:V	2.0(H):1(V)	2.0(H):1(V)	1.5(H):1(V)
Side Slopes (downstream) H:V	2.5(H):1(V) to 3(H):1(V)	1.5(H):1(V) to 2.5(H):1(V)	2.0(H):1(V)

[1] Information from *Tennessee Valley Authority (TVA) Routine Handling Operations and Maintenance (RHO&M) Operations Support Document, Colbert Fossil Plant*, July, 2011 (See Appendix A – Doc 01)

2.2 COAL COMBUSTION RESIDUE HANDLING

Dewberry was provided general information regarding the type of equipment used in the handling, transportation and deposition of the various coal combustion residuals (Appendix A -Doc. 02).

2.2.1 Fly Ash

Equipment used for the collection, handling and disposition of fly ash at the Colbert Fossil Plant includes precipitators, precipitator hoppers, surge bins, storage silos and piping. Precipitator hoppers are located inside the plant building. Other equipment is located outside.

2.2.2 Bottom Ash

Equipment used for the collection, handling and disposition of bottom ash at Colbert Fossil Plant includes bottom ash hoppers, economizer hoppers, air heater hoppers, central ash sump, and piping. Bottom ash precipitator hoppers are located inside the plant building. Other equipment is located outside.

2.2.3 Boiler Slag

Not generated at this location,

2.2.4 Flue Gas Desulfurization Sludge

Not applicable at this location.

2.3 SIZE AND HAZARD CLASSIFICATION

Ash Pond 4

Ash Pond 4 consists of a starter dike on the east side, and north and south ends with a crest elevation of about 441 feet. The starter dike abutted a topographic rise on the west side to form a side hill impoundment. The crest elevation was increased to elevation 462 feet by adding a raised dike on all four sides creating a diked impoundment. In 2010 - 2011 a section of the crest about 900 feet long was lowered to elevation 458 feet (creating an emergency spillway on the plant facility side) as part of a program to reduce the risk hazard rating from “High” to “Significant”. The embankment height is about 37 to 40 feet on the north and northeast side and about 12 to 17 feet on the west side. Ash Pond 4, including the stilling basin at the north end, has a total storage capacity of about 230 acre-feet.

Disposal Area 5

Disposal Area 5 consists of a perimeter dike with a crest elevation ranging from about 478 feet to 488 feet. The embankment ranges in height from about 15 to 25 feet. The adjoining Drainage Basin dike has a crest elevation of about 474 feet and an average height of about 17 feet. Disposal Area 5, except for the Drainage Basin, is being used to dry stack CCR material. The elevation of the top of the CCR stack inside the impoundment is about 80 feet above the crest elevation of the embankment.

The Disposal Area 5 Drainage Basin collects surface water runoff and internal seepage from the ash stack. The Disposal Area 5 Drainage Basin (also called Ash Pond 5) has a total storage capacity of about 96 acre-feet.

The classification for size, based on the height of the embankments and the impoundment storage capacity, is “Intermediate” for Ash Pond 4 and “Small” for the Disposal Area 5 Drainage Basin according to the USACOE recommended *guidelines for safety inspection of dams*, ER 1110-2-106.

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Table 2.2a: USACE ER 1110-2-106 Size Classification		
	Impoundment	
Category	Storage (Ac-ft)	Height (ft)
Small[1]	50 and < 1,000	25 and < 40
Intermediate[2]	1,000 and < 50,000	40 and < 100
Large	> 50,000	> 100

[1] Disposal Area 5 Drainage Basin
[2] Ash Pond 4

Dewberry conducted a qualitative hazard classification based on Federal Guidelines for Dam Safety. The hazard assessment classifications are summarized in Table 2.2b.

Table 2.2b: 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 had initially classified Ash Pond 4 as a “high hazard” impoundment because of possible downstream damage in the event of a release due to a failure or misoperation of the impoundment. TVA commissioned a feasibility study to identify methods to reduce this hazard classification. The study determined that lowering the pond level and a section of the embankment would reduce the risk sufficiently to reclassify the risk as “significant”. The recommended work has been completed.

Based on the size of the impoundments and the mitigation measures taken by TVA to reduce the hazards associated with Ash Pond 4 and the size of Disposal Area 5 Drainage Basin, a failure of either Ash Pond 4 or Disposal Area 5 Drainage Basin at Colbert Fossil Plant is not expected to result in a loss of human life. Economic and environmental losses are expected due to the potential for released materials reaching the Tennessee River to the north or reaching U.S. Highway 72 to the south of the impoundments. Therefore Dewberry evaluated Ash Pond 4 and Ash Pond 5, including Ash Pond 5 Drainage Basin each as being a **Significant Hazard Potential.**

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

<table>
<tr><th colspan="4">Table 2.3: Maximum Capacity of Unit</th></tr>
<tr><th rowspan="2"></th><th rowspan="2">Ash Pond 4</th><th colspan="2">Ash Pond 5</th></tr>
<tr><th>Disposal Area 5</th><th>Drainage Basin</th></tr>
<tr><td>Surface Area (acre)[1]</td><td>52</td><td>75</td><td>12</td></tr>
<tr><td>Current Storage Capacity (cubic yards)[2]</td><td>298,852</td><td rowspan="4">N/A</td><td>154,719</td></tr>
<tr><td>Current Storage Capacity (acre-feet)</td><td>185</td><td>96</td></tr>
<tr><td>Total Storage Capacity (cubic yards)[2]</td><td>371,543</td><td>239,763</td></tr>
<tr><td>Total Storage Capacity (acre-feet)</td><td>230</td><td>185</td></tr>
<tr><td>Crest Elevation (feet)</td><td>458[2]</td><td>478 – 488</td><td>474</td></tr>
<tr><td>Normal Pond Level (feet)</td><td>453 ft.</td><td>N/A</td><td>467</td></tr>
</table>

[1] Data taken from Operations Support Document, July, 2011 (Appendix A – Doc 01)

[2] Data taken from TVA "Colbert Incremental Volumes" surveys dated August, 2011 (Appendix A – Doc 03)

2.5 PRINCIPAL PROJECT STRUCTURES

2.5.1 Earth Embankment

Ash Pond 4 – The embankment impounding Ash Pond 4 consists of an earth fill starter dike and a raised dike about 6,700 feet long. The embankment starter dike having a crest elevation of about 441 feet was constructed in 1972. A 20-foot high raised dike was added in 1984, increasing the crest elevation to 461 feet. The raised dike was constructed by extending the starter dike outside slope upward resulting in the inside potion of the raised dike being supported on stored bottom ash.

In 2011 a section of the Ash Pond 4 embankment about 900 feet long was re-graded to lower the crest to elevation of 458 feet. Lowering the north and northeastern portion of the crest was done to reduce the hazard rating of the impoundment.

The embankments vary in height from about 20 to 30 feet on the west side to about 37 to 40 feet along the east side.

Disposal Area 5

The embankment impounding Disposal Area 5 consists of an earth fill dike about 7,500 feet long. Crest elevations of the dike impounding the dry ash are about 480 feet along the stacked ash south side of the impoundment, 488 feet along the active stacking north side, and 474 feet along the Drainage Basin. The embankment is founded on native clays.

2.5.2 Outlet Structures

Ash Pond 4

Sluice bottom ash enters Ash Pond 4 near the northwest corner of the impoundment. An interior ash dike channels the sluiced water toward the southeast end of the impoundment where it discharges into the main settling area.

The Ash Pond 4 outlet system is located at the north end of the impoundment. The outlet system consists of a three pipe siphon, and a four chamber overflow spillway. The siphon consists of three 12-inch diameter HDPE pipes. The overflow spillway consists of four concrete inlet weirs each with a 27-inch diameter HDPE discharge pipe. Each weir is protected by a 96-inch diameter corrugated metal half pipe skimmer. The siphon and overflow spillway discharge into a common drainage channel that empties into Cane Creek (See Appendix A – Doc 04).

The original spillway system of four 36-inch diameter concrete pipes has been abandoned in place and the risers filled with grout.

Disposal Area 5

Storm water runoff and seepage from stacked ash interior drains in Disposal Area 5 drain to a perimeter ditch on the inside of the embankment. The ditch flows to drop inlets that discharge into the Disposal Area 5 Drainage Basin. The Disposal Area 5 Drainage Basin spillway consists of a 36-inch diameter smooth wall steel pipe decant riser protected by a 60-inch diameter corrugated metal pipe trash rack. The riser discharges through the embankment into a partially riprap-lined stream flowing north to the Tennessee River.

The Disposal Area 5 Drainage Basin also has a 30-inch diameter concrete riser located near the primary spillway riser. The riser is permanently out of service.

2.6 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

The plant area generally drains north into the bordering Tennessee River which flows eastward in the vicinity of the plant site. Land downgradient of the plant is generally agricultural or undeveloped. U.S. Highway 72 is located about 400 feet south of Ash Pond 4 and Disposal Area 5. Releases due to failure or misoperation of Ash Pond 4 and/or Disposal Area 5 Drainage Basin would likely reach the Tennessee River and possibly reach and cause a temporary closure of U.S. Highway 72.

3.0 SUMMARY OF RELEVANT REPORTS, PERMITS, AND INCIDENTS

TVA provided representative reports of 2011 daily, weekly, monthly, quarterly inspections prepared by TVA personnel for both Ash Pond 4 and Disposal Area 5 (See Appendix A – Doc 05).TVA also provided the 2011 annual inspection report prepared by Stantec Consulting Services (See Appendix A – Doc 06).

The Stantec 2011 inspection reports did not indicate findings of significance for either Ash Pond 4 or Disposal Area 5. Recommendations presented in the report were generally related to routine maintenance issues including:

- Continued monitoring of identified seepage areas
- Reseeding and erosion controls over areas lacking adequate vegetative ground cover
- Repair of minor erosion rills
- Repair of holes on embankments resulting from tree stump removal, and removal of remaining tree stumps.

The 2011 annual inspection report identified changes in Ash Pond 4 since the 2010 annual inspection. The most significant changes included:

- Installation of a new overflow spillway system and closure of the original spillway
- Installation of a new siphon system south of the new spillway
- A 900-foot section of the embankment crest was lowered to elevation 458 and the normal pool elevation was lowered to elevation 453 to reduce the hazard risk rating from “High” to “Significant”

The 2011 annual inspection report identified changes in Disposal Area 5 since the 2010 annual inspection. The most significant changes included:

- Placement of wave protection along a portion of the Disposal Area 5 Drainage Basin northwest embankment inside slope
- New Disposal Area ash stack drainage system inlet constructed to improve drainage from the ash stack to the Drainage Basin. Work to complete the system was underway at the time of Dewberry’s site visit.

3.1 SUMMARY OF LOCAL, STATE, AND FEDERAL ENVIRONMENTAL PERMITS

Alabama does not have a dam safety program; therefore there is no state permit for the embankment.

Discharge from the impoundments is regulated by the Alabama Department of Environmental Management and the impoundments have been issued a National Pollutant Discharge Eliminations Permit. Permit No. AL003867 was issued May 17, 2005 (See Appendix A – Doc 07). The permit expired on March 31, 2010. TVA reportedly submitted an application for permit renewal prior to September 20, 2009. Review of the renewal application by the Alabama Department of Environmental Management has not been completed.

3.2 SUMMARY OF SPILL/RELEASE INCIDENTS

Data reviewed by Dewberry did not indicate any spills, unpermitted releases, or other performance related problems with the embankments over the last 10 years.

4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

The original design of Colbert Fossil Plant included four 180,000 kW generating units. Construction began in 1951 and the generators placed into service in 1955. A fifth unit with a generating capacity of 500,000 kW was added in 1962.

<u>Ash Pond 4</u>

Original construction of Ash Pond 4 was accomplished in 1972 and consisted of 20-foot high clay embankments abutting a topographic bench on the west side.

<u>Disposal Area 5</u>

Original constriction of Disposal Area 5 was accomplished in 1983 and consisted on a 7,500-foot long clay embankment ranging from about 10 feet to 30 feet high.

Clay for the embankments was likely excavated from on-site sources, including from the impoundments being constructed.

4.1.2 Significant Changes/Modifications in Design since Original Construction

<u>Ash Pond 4</u>

In 1984 the Ash Pond 4 embankment was raised about 20 feet to elevation 461 by extending the outside slope upward toward the inside of the impoundment. The 6,700-foot long raised embankment changed the configuration of Ash Pond 4 to a diked impoundment. The construction method resulted in the interior portion of the extended embankment being support on previously sluiced ash.

In 2011 TVA implemented engineering recommendations to lower a 900-foot section Ash Pond 4 embankment to elevation 458, and lower the operating pool elevation to 453 feet as a step toward lowering the hazard risk rating of the impoundment from “High” to “Significant”. The lowered section of dike acts as an emergency spillway preventing topping of the dike during a Probable Maximum Precipitation Event (Appendix A – Doc 08).

Disposal Area 5

Disposal Area 5 was originally designed for use as a dredge cell, receiving dredged ash from Ash Pond 4. However in 1984, soon after the pond began operation, karst features (sinkholes) developed in the impoundment subgrade. Construction was undertaken to repair the sinkholes, but the continued presence of sinkhole development led to the termination of dredge disposal in Disposal Area 5 in 1990.

4.1.3 Significant Repairs/Rehabilitation since Original Construction

Ash Pond 4

As discussed in Section 7, a geotechnical exploration conducted in 2010 indicates a long term slope stability Safety Factor of 1.4 which is below the minimum accepted value of 1.5 (See Appendix A – Doc 09). The lower than required slope stability Safety Factor occurred along the center section of the east embankment. TVA implemented the recommendation in the geotechnical report by constructing an inverted filter drain/crushed stone buttress along the lower portion of the embankment slope. Additionally the normal pool elevation was lowered to 453 feet.

As previously discussed, the original spillway system was replaced in 2010 with a new four pipe weir, supplemented by a three pipe siphon system.

4.2 SUMMARY OF OPERATIONAL PROCEDURES

4.2.1 Original Operational Procedures

Original plant operation consisted of sluicing bottom ash to an impoundment, designated Ash Pond Disposal Area 1, located along the Tennessee River west of the plant. In 1975 that facility was taken out of service and abandoned.

Ash Pond 4

When put into service in 1972, the operation of Ash Pond 4 consisted of receiving and storing sluiced bottom ash.

Disposal Area 5

When put into service in 1983, Disposal Areas 5 received and stored bottom ash dredged from Ash Pond 4.

4.2.2 Significant Changes in Operational Procedures and Original Startup

Ash Pond 4

From 1982 to 1990 Ash Pond 4 received sluiced fly ash and bottom ash. Since 1990 the pond has received only bottom ash.

Disposal Area 5

Placing dredged ash in Disposal Area 5 was halted in 1990 due to continued issues related to controlling sinkhole development. Subsequently, Disposal Area 5 was converted to a dry stacking operation.

4.2.3 Current Operational Procedures

Ash Pond 4

Sluiced ash from the plant is discharged to the northwest corner of Ash Pond 4 and routed southward through interior ditches in the bottom ash. At the south end of the impoundment the sluiced ash is deposited into the main settling pond. Decant water is released from Ash Pond 4 through a siphon and an overflow spillway located in the northeast portion of the impoundment. Periodically bottom ash is dredged from the east side of Ash Pond 4 and stacked in the west side. Photograph 4.2.2-1 shows sluiced ash entering Ash Pond 4 and the ditches through the stacked ash.

Figure 4.2.2-1: Sluiced Ash Discharge to Ash Pond 4. South Flowing Ditches through Stacked Ash in Background

Disposal Area 5

The southwest portion of Disposal Area 5, designated Ash Stack 5, has reached capacity. Dry stacking is continuing in the northeast portion of the impoundment.

Stormwater runoff from the ash stack is collected in a perimeter ditch and routed to the Disposal Area 5 Drainage Basin on the northwest side of the active stacking cell.

5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry personnel Joseph P. Klein III, P.E. and Frank B. Lockridge, P.E. performed a site visit on September 12, 2011 in company with the participants listed in Section 1.3.1. The design engineer of record was neither present nor available to answer questions about the impoundments.

The site visit began at approximately 9:00 AM. The weather was sunny and warm. Photographs were taken of the conditions observed. Please refer to the Coal Combustion Dam Inspection Checklist in Appendix B for additional information concerning the impoundments. Selected photographs are included in the main body of this report for ease of visual reference. All pictures were taken by Dewberry personnel during the site visit and provided to TVA at the conclusion of the visit.

The overall visual assessment of the Ash Pond 4 and Disposal Area 5 impoundment embankments was that they were in satisfactory condition and no significant findings were noted.

5.2 ASH POND 4

5.2.1 Crest

The crest of the embankment impounding Ash Pond 4 is a 25-foot wide gravel roadway. There were no signs of significant depressions, tension cracks, settlement or shear failure along the crest. Photograph 5.2.1-1 shows the crest of the west embankment.

Photograph 5.2.1-2: West Dike Crest (Bottom Ash Stack on left)

5.2.2 Upstream/Inside Slope

The inside slopes of the north and east embankments of Ash Pond 4 are armored with medium rip rap to protect against wind driven wave erosion. The inside slope of the south embankment is vegetated with grass and weed. There were no signs of slumps or slides in the visible portions of the slopes and no significant erosion was noted. Photograph 5.2.2-1 shows the inside slope of the east embankment near the south end and the east end of the south embankment.

Photograph 5.2.2-1: Inside Slope of East Embankment with South Embankment in the Background.

The inside slope of the western side of the impoundment is being used for storage of dredged ash material making observation of the inside slope infeasible.

5.2.3 Downstream/Outside Slope and Toe

The outside slopes of the Ash Pond 4 impoundment are generally grassed. No signs of scarps, sloughing or other indication of distress were observed. Seepage areas have been identified and treated with inverted filter drains. A riprap filter drain/buttress has been placed along the toe of the east dike and portions of the south and west embankments. Photograph 5.2.3-1 shows representative outside slope filter drain/buttress conditions. Photograph 5.2.3-2 shows a seepage patch at the toe of the west embankment.

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Photograph 5.2.3-1: Outside Slope of East Embankment with Inverted Filter Drain and Riprap Buttress

Photograph 5.2.3-2: Seepage Blanket at Toe of West Embankment North End

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5.2.4 Abutments and Groin Areas

Initially Ash Pond 4 was a side hill configuration abutted to a topographic bench on the west side. Raising the embankments to their current configuration resulted in a fully diked impoundment. The interior groins of the east embankment are armored with riprap. The south and west interior groins are covered with dry ash material and light vegetation.

Exterior groins are vegetated. Southeast and northeast exterior groins have inverted filter toe drains and buttresses. Photograph 5.2.4- 1 shows representative conditions observed at the groins.

Photograph 5.2.4-1: Southeast Outside Groin with Inverted Filter Drain and Buttress

Significant seepage was noted in the southeast exterior groin area. The area was marked and remediation is planned for the area. Photograph 5.2.4-2 shows the observed seepage area at the southeast groin.

Photograph 5.2.4-2: Seepage Area Being Monitored near Southeast Groin

5.3 DISPOSAL AREA 5 WITH DRAINAGE BASIN

5.3.1 Crest

The crest of Disposal Area 5 consists of a compacted clay roadway. The crest shows no signs of significant depressions, tension cracks, or other indications of settlement or shear failure. Photograph 5.3.1-1 shows the crest of the embankment between the ash stack and drainage basin portions of Disposal Area 5. The photograph was taken at the crest of the west embankment.

Photograph 5.3.1-1: Disposal Area 5 Crest between Ash Stack and Drainage Basin

The crest of the Drainage Basin embankment consists of compacted clay, except that the south embankment crest has a compacted ash roadway surface shown in Photograph 5.3.2-2.

Photograph 5.3.2-2: Crest of Drainage Basin South Embankment with Compacted Ash Road Surface

5.3.2 Upstream/Inside Slope

The Disposal Area 5 ash stack area has been filled with sluiced ash to approximate elevation 480 and stacked with dry ash to a height of approximately 80 – 100 feet above the original pond embankment level. The dry stacking has been accomplished using tiered construction with benches every 20 feet of height. The inside slopes of the ash stack portion of Disposal Area 5 are no longer visible. Figure 5.3.2-1 shows the inside of the ash stack impoundment at the embankment crest elevation. Construction of a segment of the stack interior drainage system and perimeter ditch is in progress.

Photograph 5.3.2-1: Disposal Area 5 Ash Stack Perimeter Ditch Construction Along Inside of Impoundment Embankment Crest.

The inside slope of Disposal Area 5 Drainage Basin embankments is vegetated with various species of grass and weeds. Sections of the slope are armored with riprap at the water level to provide protection against wind driven wave erosion. As shown in Photograph 5.3.2-2 construction to complete slope armoring was underway during Dewberry’s site visit.

Photograph 5.3.2-2: Disposal Area 5 Drainage Basin South Embankment Inside Slope; Track Hoe Installing Riprap for Wave Erosion Protection.

5.3.3 Outside Slope and Toe

The outside slope of embankments impounding the ash stack is generally grassed. Areas under construction on the outside slope have a cover of fugitive grading soils along the outside slope near the crest. Photograph 5.3.3-1 shows a section of outside slope with soil spilled onto the embankment.

Photograph 5.3.3-1: Ash Pond 5 North Embankment Outside Slope with Fugitive Soil Adjacent to Construction along Ash Stack

The outside slopes of the north, south, and west dikes of the Drainage Basin are vegetated with various species of grass and weeds. Photograph 5.3.3-2 shows representative conditions observed during Dewberry's site visit. Some small trees were growing on the lower half of the south embankment. Photograph 5.3.3-3 shows the small trees observed along the south embankment. The east embankment separates the Drainage Basin and the ash stack unit of Disposal Area 5.

Photograph 5.3.3-2: Drainage Basin West Embankment Outside Slope

Photograph 5.3.3-3: Drainage Basin South Embankment Trees on Outside Slope

There were no indications of sloughing, erosion or other distress along the exterior slopes of the basin.

5.3.4 Groin Areas

Disposal Area 5 is a fully diked impoundment so there are no abutments.

Ash stacking operations have covered the inside groins of the Disposal Area 5 ash stack. The internal groins for the Drainage Basin are covered with medium riprap at the water level and a light cover of grass above the rip rap. Photograph 5.3.4-1 shows the groin on the interior of the Drainage Basin.

Photograph 5.3.4-1: Disposal Area 5 Drainage Basin Inside Groin at Southwest Corner

Outside groins are vegetated with various species of grass and weeds similar to the outside slopes. Photograph 5.3.4-2 shows representative conditions observed during Dewberry's site visit.

Photograph 5.3.4-2: Disposal Area 5 Drainage Basin Outside Groin at Southwest Corner

No evidence of scarps, slippage or seepage was observed at the groins.

5.4 OUTLET STRUCTURES

5.4.1 Overflow Structures

Ash Pond 4

The original decant riser spillway was replaced in 2010-2011 with a siphon and an overflow spillway.

The siphon consists of three 12-inch diameter HDPE pipes with inlets located near the northwest corner of Ash Pond 4. Each siphon pipe is equipped with a flow control gate valve.

The overflow spillway is a concrete structure with four cells about 8-feet by 4-feet in plan dimension. A 96-inch diameter corrugated metal half-pipe skimmer is attached to each spillway inlet. Photograph 5.4.1-1 shows the front of the spillway.

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Photograph 5.4.1-1 Ash Pond 4 Spillway Structure.

<u>Disposal Area 5</u>

Surface runoff from the Disposal Area 5 ash stack is captured by a perimeter ditch located inside the impounding embankment crest. The ditch conveys water to a drop inlet that discharges through pipes in the northeast groin area into the Drainage Basin. Internal drainage is also directed to the perimeter drain. Photograph 5.4.1-2 shows the ditch and inlet structure under construction.

Photograph 5.4.1-2: Ash Stack Drainage System Outlet to Disposal Area 5 Drainage Basin

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The overflow structure in the Drainage Basin consists of a 48-inch diameter reinforced concrete riser with a corrugated metal skimmer and trash rack. Photograph 5.4.1-3 shows the riser structure.

Figure 5.4.1-3: Ash Pond 5 Drainage Basin Rise Spillway

There is a second (inactive) reinforced concrete riser pipe in the Disposal Area 5 Drainage Basin. The elevation of the pipe is above the primary spillway. Photograph 5.4.1-4 shows the second riser pipe.

Photograph 5.4.1-4: Ash Pond 5 Drainage Basin Inactive Riser

5.4.2 Outlet Conduit

Ash Pond 4

The Ash Pond 4 spillway outlet is four 27-inch diameter HDPE pipes through the west embankment to a reinforced concrete headwall structure. The headwall structure is shown in Photograph 5.4.2-1.

Photograph 5.4.2-1: Ash Pond 4 Spillway Conduits and Outlet Structure

Discharge from the spillway flows into a drainage channel that empties into Cane Creek and then the Tennessee River.

The siphon system discharges into the same drainage channel a short distance downstream from the spillway headwall structure. Photograph 5.3.2-1 shows the drainage channel and the siphon pipe outlet conduits.

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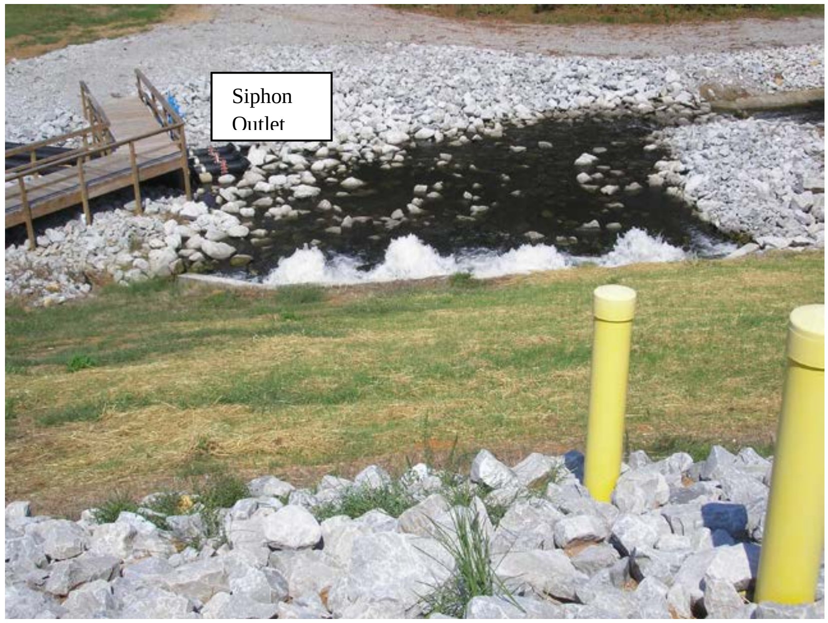

Photograph 5.4.2-2: Spillway Discharge Channel. Outlet End of Siphon Pipes to Right of Walkway in top Left Portion of Photograph.

Disposal Area 5

Discharge from the Disposal Area 5 ash stack is into the Ash Pond 5 Drainage Basin.

Discharge from the Drainage Basin spillway riser is through a 36-inch diameter reinforced concrete pipe that exits the embankment at a concrete headwall. Discharge is to a riprap drainage channel that empties into the Tennessee River.

At the time of Dewberry's site visit the Drainage Basin pool level was below the riser and no water was entering the spillway. No water was observed exiting the outlet pipe. The area around the outlet headwall was overgrown with weeds that obscured observation of the outlet and may reduce outlet flow capacity. Photograph 5.4.2-3 shows the Disposal Area 5 Drainage Basin outlet structure.

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Photograph 5.4.2-3: Disposal Area 5 Drainage Basin Spillway Structure

5.4.3 Emergency Spillway

Ash Pond 4

Ash Pond 4 does not have a designated emergency spillway. However modifications made to Ash Pond 4 to reduce the hazard risk classification from “High” to “Significant” included lowering the crest elevation of about 900 feet of the embankment from about 461 feet to 458 feet. The lowered portion of the embankment creates an emergency spillway location.

Disposal Area 5

Disposal Area 5 Drainage Basin does not have an emergency spillway.

6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Flood of Record

No documentation has been provided about the flood of record.

6.1.2 Inflow Design Flood

No documentation has been provided about the inflow design flood.

6.1.3 Downstream Flood Analysis

Ash Pond 4

TVA retained URS to perform a dam break analysis for Ash Pond 4 (See Appendix A – Doc 08). The analysis included dam failure during a Probable Maximum Precipitation (PMP) Event, and due to piping through the dike in a less than full condition. The piping failure analysis included four surface water elevation levels in the pond. The findings provided a recommendation for lowering a 900-foot long section at the northeast corner of Ash Pond 4 embankment crest to elevation 458 to provide capacity to pass the PMP without overtopping the remainder of the dike. This prevents impoundment outflow from reaching the elevation of the nearby railroad tracks. The recommendation also included managing Ash Pond 4 to control the normal pool elevation at 453 feet.

Subsequent documentation provided indicates the recommendation to lower a portion of the northern and northeastern dikes to a crest elevation 458 has been completed. Documentation also indicates the water level in Ash Pond 4 is being managed at elevation 453 feet (See Appendix A – Doc 04).

Disposal Area 5 Drainage Basin

No documentation has been provided about downstream flooding for the Disposal Area 5 Drainage Basin. However the small size (i.e., 12 acres) of the pond indicates release of any CCR from overtopping would be minimal and would be retained onsite.

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Supporting documentation reviewed by Dewberry is adequate.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

Based on the above information, the hydrologic and hydraulic safety of Ash Pond 4 and the Disposal Area 5 Drainage Basin is SATISFACTORY.

7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

In 2009, TVA retained Stantec Consulting Services to perform a geotechnical exploration and slope stability evaluation of Colbert Plant Ash Pond 4 and Disposal Area 5 (See Appendix A - Doc. 09 and Doc 11, respectively). Stantec performed field sampling, laboratory testing and static slope stability analysis of Ash Pond 4, the Disposal Area 5 ash stack, and the Drainage Basin embankment. Several cross-sections were developed and analyzed in the Ash Pond 4 and Disposal Area 5 ash stack. One cross-section was analyzed for the Disposal Area 5 Drainage Basin embankment. The results of the analyses indicated long term slope stability Safety Factors less than the minimum requirement of 1.5. Each Stantec report included conceptual design recommendations to improve the stability Safety Factors.

TVA retained URS Corporation to develop detailed designs to remedy the Safety Factor deficiencies at both Ash Pond 4 and Ash Stack 5 (See Appendix A- Docs 16 and 17, respectively).

The design improvements at Ash Pond 4 included:

- Lowering a section of dike at the north end of the impoundment to provide an emergency spillway
- Construct a new primary spillway system
- Lower the normal pool elevation
- Construct a filter blanket and trench drain at mid-slope of the east and south embankments
- Construct a crushed stone buttress near the toe of the dike

The design improvements at Ash Stack 5 included:

- Vertical extensions of the impounding embankment to act as a buttress at the base of the ash stack
- Perimeter graded filter drain and new drainage swale at base of ash stack
- Improved spillway capacity from ash stack to stilling basin.

At the time of Dewberry's site visit the improvements at Ash Pond 4 had been completed, and the improvements at Ash Stack 5 were being constructed.

The stability of the slopes was evaluated under fully drained conditions (static long-term, steady state seepage) using SLOPE/W software.

Based on discussions between TVA and EPA during the current assessment, TVA retained Stantec to conduct additional analyses to evaluate slope stability under seismic loading conditions (See Appendix A – Doc 11). Ground motion used in the initial seismic analyses was based on peak ground acceleration with an exceedance probability of 10 percent in 50 years. Based on further discussions between TVA and EPA, additional seismic analyses were conducted using a peak ground acceleration with a probability of exceedance of two percent in 50 years (See Appendix A – Doc 15).

7.1.2 Design Parameters and Dam Materials

Documentation provided to Dewberry for review indicated the stability analyses assumed six strata for Ash Pond 4, and five strata for Disposal Area 5 ash stack and Drainage Basin. The material properties used in the analysis are shown in Table 7.1. The long term, static analyses used drained soil shear strength parameters. The seismic loading analyses used undrained soil shear strength parameters.

Ash Pond 4 – Selected Strength Parameters for Stability Analyses

Table 7.1: Summary of Soil Properties Used in Stability Analyses						
Ash Pond 4						
Soil Strata	**Static Analyses**			**Seismic Analyses**[1]		
	Unit Weight γ' (pcf)	**Cohesion c' (psf)**	**Friction Angle Ø**	**Unit Weight γ (pcf)**	**Cohesion c (psf)**	**Friction Angle Ø**
Upper Dike	126	200	28	126	750	12
Lower Dike	127	200	29	127	400	14
Sluiced Ash	85	0	26	85	400	10
Native Clay/Silt	129	200	28	129	700	14
Native Sand	110	0	30	110	0	30
Stacked Ash	90	0	30			
Disposal Area 5 and Ash Stack and Drainage Basin						
Perimeter Dikes	125	100	29	125	200	19
Sluiced Ash	85	0	26	85	400	15
Stacked Ash	105	0	32	105	0	32
Native Clay	125	200	28	125	290	19
Native Silt	125	0	26			

1. Strength data for seismic analyses based on ground acceleration value with a 2 percent probability of exceedance in 50 years.

7.1.3 Uplift and/or Phreatic Surface Assumptions

The stability documentation provided to Dewberry did not specifically identify uplift forces acting on the base of the dikes.

Embankment pore pressures for the long-term static loading condition were obtained from the seepage analyses conducted as part of the geotechnical exploration (See Appendix A – Doc 09 and 10). Phreatic surface assumptions were made using the information developed by Stantec using their SEEP/W Analysis program and also the levels obtained from piezometer readings. The SEEP/W program is discussed in detail in the Stantec Geotechnical Reports of this area. The factors of safety using the SEEP/W program derived phreatic surface are generally slightly lower than those computed using the piezometer water levels.

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7.1.4 Factors of Safety and Base Stresses

The minimum safety factors computed for Ash Pond 4, and Disposal Area 5 ash stack and Drainage Basin are summarized in Table 7.2

Table 7.1.4 Factors of Safety for Colbert Fossil Plant

Location	Long Term Static Loading		Seismic Loading[1]	
	Required Safety Factor (US Army Corps of Engineers)	Computed Minimum Safety Factor	Required Safety Factor (US Army Corps of Engineers)	Computed Minimum Safety Factor
Ash Pond 4	1.5	1.54[2]	>1.0	1.0
Disposal Area 5 Ash Stack	1.5	1.77[3]	>1.0	1.1
Disposal Area 5 Drainage Basin	1.5	1.8	>1.0	1.2

[1] Factors of Safety for seismic loading based on peak ground acceleration having a two percent probability of exceedance in 50 years.
[2] Factor of Safety based in completed improvements outlined in URS Design Report (Appendix A – Doc 16). Work completed at the time of Dewberry's site visit.
[3] Factor of Safety based on improvements outlined in URS Design Report (Appendix A – Doc 17). Work was underway at time of Dewberry's site visit.

7.1.5 Liquefaction Potential

The documentation reviewed by Dewberry did not include an evaluation of liquefaction. Soils indicated in the boring logs provided in the geotechnical reports (See Appendix A – Doc 09) indicate a potential liquefaction concern at Ash Pond 4. The geotechnical data indicates the presence of loose to very loose silty sand beneath the toe of the east lower dike, and loose to very loose ash beneath the toe of the upper dike. Both conditions are prevalent along the east dike.

Soils indicated in the boring logs and geotechnical reports (Appendix A – Doc 11) do not indicate a potential liquefaction concern at Ash Stack 5.

7.1.6 Critical Geological Conditions

This site is underlain by the Tuscumbia limestone formation. This limestone is subject to solution weathering and the possible development of sinkholes. Sinkhole development has been reported to have occurred during initial development of Disposal Area 5.

The USGS National Seismic Risk Map for the Central and Eastern United States estimate the peak ground acceleration with a 2-percent probability of exceedance in 50 years of 0.1g.

Overburden soils at the plant site generally consist of residual clays with a layer of silty clay and chert fragments at the soil/rock interface. Areas of alluvial and terrace deposits occur in the area of Ash Pond 4 along Cane Creek.

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Structural stability documentation is considered adequate to support the results and conclusions provided. However, documentation for Ash Pond 4 is inadequate due to the lack of a liquefaction potential analysis, since the underlying materials for Ash Pond 4 can be characterized as being susceptible to liquefaction.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

Geotechnical explorations in early 2011 indicated a minimum Safety Factor for Ash Pond 4 that was below the required Safety Factor under static loading conditions. TVA proceeded to develop remedial designs for both Ash Pond 4 and Ash Stack 5.

The proposed remedial work had been completed at Ash Pond 4 at the time of Dewberry's site visit. Therefore, Table 7.1.4 provides the post-remediation Safety Factor. The proposed remediation work at Ash Stack 5 was underway at the time of Dewberry's site visit. Therefore, Table 7.1.4 provides the Safety Factors for both pre-and post-remediation conditions for Ash Stack 5.

As shown in Table 7.1.4, the calculated seismic loading Safety Factors meet or exceed the minimum requirements of 1.0.

Overall, the structural stability of the Ash Pond 4 dam is rated as **FAIR** based on the lack of documentation of liquefaction analyses. Disposal Area 5 (i.e., Ash Stack 5) can be rated as **Satisfactory**, because the qualitative analysis indicated the underlying materials are not susceptible to liquefaction.

8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATING PROCEDURES

The operation and maintenance procedures for the Colbert CCR impoundments are defined in the *Tennessee Valley Authority (TVA) Routine Handling Operations and Maintenance (RHO&M) Operations Support Document, Colbert Fossil Plant*, July, 2011 (See Appendix A – Doc 01)

Ash Pond 4

Ash Pond 4 receives sluiced bottom ash from pipes located in the northwestern section of the pond. Ash settles as the liquid is channeled through an internal ash ditch system, emptying into the main settling pond area. Water discharges from Ash Pond 4 through spillway risers located in a stilling pond adjacent to the north dike. The stilling pond is formed by interior ash dikes within the main pond area. Water discharges from the pond into a channel that carries it to Cane Creek and finally into the Tennessee River.

Disposal Area 5

Fly ash is transported by truck to Disposal Area 5 where it is dry stacked for permanent storage. An internal drainage system is incorporated into the dry stacking operation that results in internal and external drainage flowing to a perimeter ditch that empties into the Drainage Basin located northwest of the stacking area. An overflow riser spillway discharges water from the Drainage Basin into a channel that carries it to the Tennessee River.

8.2 MAINTENANCE OF THE DAM AND PROJECT FACILITIES

TVA has implemented a formal operation and maintenance program for Ash Pond 4 and Disposal Area 5, including the Drainage Basin (See Appendix A – Doc 01). Specifically, the document describes a detailed program regarding coal combustion residue streams, coal combustion residue handling and disposal, compliance with government regulations, and roles and responsibilities of plant personnel.

The 2011 annual inspection report reviewed by Dewberry identified seepage through Ash Pond 4 embankments as the most significant maintenance issue (See Appendix A – Doc 02). In response Colbert Fossil Plant retained Stantec to prepare a maintenance plan addressing seepage (See Appendix A – Doc 13). Dewberry was provided a copy of the plan for review.

Seepage areas identified during routine inspections were marked in the field with flags. Most of the seepage areas had been repaired by installation of inverted filter drain blankets. Scattered seepage areas were marked and are being monitored. No significant seepage areas were observed that had not been previously identified.

Ash Pond 4 and Disposal Area 5 appear to be actively maintained and are in good condition. Inspection reports provided to Dewberry for review identified seepage through the embankments as the most significant maintenance issue.

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 seemed to be adequate.

8.3.2 Adequacy of Maintenance

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

9.0 ADEQUACY OF SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

The TVA surveillance procedures for Colbert Fossil Plant CCR impoundments include written reports of daily, weekly, monthly, quarterly and annual inspections. Special inspections are required after significant storms, i.e. rain event exceeding the 10-year recurrence intensity, and after significant earthquakes (See Appendix A – Doc 12).

Reports of daily, weekly, monthly, quarterly and annual inspection for 2011 were provided to Dewberry for review (See Appendix A – Doc 03).

9.2 INSTRUMENTATION MONITORING

Piezometers have been installed at both the Ash Pond 4 and Disposal Area 5 impounding embankment. The piezometers are read regularly and the results reported by URS to TVA. The results of this program were used by Stantec in the seepage and slope stability analyses.

Reports of instrumentation data and evaluation were provided to Dewberry for review (See Appendix A – Doc 13). No significant changes in groundwater elevations or other issues were reported.

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 monitoring program is adequate.

APPENDIX A

Document 1

Tennessee Valley Authority (TVA) Routine Handling Operations and Maintenance (RHO&M) Operations Support Document, Colbert Fossil Plant, July

Tennessee Valley Authority (TVA)

Routine Handling Operations and Maintenance (RHO&M)

Operations Support Document

Colbert Fossil Plant
July 2011

Notes: Each section to be updated as required by RHO&M.

(1) **Red indicates annual updates required**

(2) **Blue indicates the contract term is currently 2 years**

Notes: Each section to be updated as required by RHO&M.

(1) **Red indicates annual updates required**

(2) **Blue indicates the contract term is currently 2 years**

1.0 OVERVIEW OF OPERATIONS SUPPORT DOCUMENT

1.1 TABLE OF CONTENTS

The table of contents is presented in **Section 100**.

1.2 OVERVIEW

The overview of the OSD is presented herein as **Section 200**.

1.2.1 OVERVIEW AND HISTORY[1]

The Colbert Steam Plant is the fifth steam-electric power plant to be constructed by TVA. The first of these, the Watts Bar plant, was built as part of an emergency power program of the World War II period. In 1949, some four years after completion of the Watts Bar plant, construction started on the first of seven large steam-electric projects to be built over a span of eight and a half years. This program included, successively, Johnsonville, Widows Creek, Shawnee, Kingston, Colbert, John Sevier, and Gallatin.

To meet area power requirements beyond the peak load expected in the winter of 1953-1954, Congress appropriated funds for a two-unit installation in August 1951 and construction of Colbert, the fifth plant built during this mammoth building program, began October 15, 1951. Rapid expansion of power facilities in TVA's service area resulted mainly from increased power demands of the Atomic Energy Commission and other federal defense agencies. Additional electric energy was required also by the expanding program of private industry and the increased needs of commercial and domestic consumers in the service area. Additional appropriations were therefore made in July 1952 to increase the size of the plant to four units. **Figure 1** shows the Colbert Steam Plant location. The powerhouse, located on a 1,500 foot wide strip of land between the Tennessee River and Cane Creek, is about one mile upstream from the point where the creek flows into the river. This arrangement permits a direct flow of river water through underground tunnels and the plant condensers to the creek, without possibility of recirculation.

Figure 1 – Colbert Plant Aerial Image (North direction to top)

Four 180,000 kW capacity generating units comprised the initial plant. The first unit was placed in commercial operation January 18, 1955, and by November 4 of the same year, three other units were operating commercially. The plant has a continuous energy capacity of 720,000 kW and a plant capability of 800,000 kW. A fifth unit for the Colbert Steam Plant was authorized March 19, 1959, and was scheduled for operation by the fall of 1962. This fifth unit, with a rated capacity (and capability) of 500,000 kW, would increase the plant capability from 800,000 to 1,300,000 kW.

COF's five coal-fired generating units consume approximately 8,900 tons of coal daily (2009 data). According to the current Long Term Disposal Plan (see **Section 1402**) COF generates approximately 251,800 dry tons dry fly ash annually that is collected in silos and transferred to an on-site 75-acre dry ash stack for disposal [Disposal Area (Stack) 5, see **Figure 1**]. Approximately 27,000 dry tons of bottom ash annually is wet-sluiced to an on-site 52-acre ash pond (Bottom Ash Pond 4, see **Figure 1**).

1.2.2 CCP STORAGE FACILITIES

1.2.3 ASH DISPOSAL AREA 1

Bottom ash was initially sluiced to an on-site pond to the west of the main plant. The pond is now abandoned (see **Figure 2**).

Figure 2 – Ash Disposal Area 1 at the Colbert Plant

1.2.4 BOTTOM ASH POND 4[1]

Bottom Ash Pond 4 occupies approximately 52 acres of land south of the power plant site as shown in **Figure 3**. In 1972, the first phase of Bottom Ash Pond 4 was constructed and put into service. Initially it was constructed of nearly 6,700 feet total length, and 20-foot tall clay dikes. In 1984 the dikes were raised 20 feet by upstream construction, wherein clay embankments were raised over previously sluiced ash. From 1982 to 1990, both fly ash and bottom ash were sluiced into Pond 4. After 1990, the pond received only sluiced bottom ash. Dewatered bottom ash is removed and stacked on its west side. This ash stacking operation began in 1999 and remains active.

Figure 3 – Wet Operations Aerial Image (North direction to top)

According to the current Long Term Disposal Plan (see **Section 1402**) currently, approximately 27,000 dry tons/year of bottom ash is wet-sluiced to Bottom Ash Pond 4, which receives an average of 5.4 million gallons per day (MGD, annualized flow) of ash sluice water.[2] Solids settle out as the sluice water moves northward, and the clarified supernatant water is decanted into Stilling Pond 4.

1.2.5 DRY FLY ASH DISPOSAL AREA (STACK) 5[1]

COF generates approximately 251,800 tons/year of dry fly ash that is collected in silos and transferred to an on-site dry ash stack for disposal [Ash Disposal Area (Stack) 5 (see **Figure 4**)]. The active Ash Disposal Area 5 is approximately 75 acres in area and is enclosed by a perimeter dike system that is approximately 7,500 feet in total length and ranges from 10 feet to 30 feet high with side slopes ranging from 1.5H:1V to 2H:1V. Slopes of the dry stack are approximately 3.5H:1V to 4H:1V, with benches located on 20-foot height intervals.

Figure 4 – Ash Disposal Area (Stack) 5 Aerial Image

The interior area was originally used as a dredge cell, receiving dredged ash from Bottom Ash Pond 4 from 1983 to 1990. Sinkholes opened up in 1984, soon after the pond operation began, prompting repairs and eventual cessation of usage.[3] In 1990 dredging was stopped and disposal methods were converted to a dry stacking operation. The stack appears fully built out in the south and west portions and currently disposal activity is on the northeast side.

As the existing dry stack reaches its final design capacity it will be closed. Partial closure construction will be completed in steps as portions of the dry stack reach their final elevation, starting in FY2010.

A perimeter drainage ditch is located between the clay perimeter dikes and the stacked ash. The ditch encircles the entire stack and collects surface water run-off from the stack area. The high point is located near the south corner and the ditch drains into rip-rap down drains that route the collected stormwater to the toe of slope stormwater ditch. The ditch routes storm water to the Ash Disposal Area 5 Drainage (Stilling) Basin located northwest of the stack. This drainage basin is approximately 12 acres in size, and has a perimeter dike totaling approximately 3,000 feet in length with a dike height of approximately 17 feet, and elevations ranging from 470 to 475.

1.2.6 ASH POND 4 STILLING POND[1]

The pond is an impoundment providing water clarification and further suspended solids reduction prior to eventual discharge of treated water from the Bottom Ash Pond 4 at COF. The pond (shown in **Figure 3**) occupies an area of approximately 6 acres. The pond is formed by perimeter dikes, comprised originally of ash to elevation 436.0, which were later raised with earth to elevation 460 in 1976.

Water flows from south to north through the pond, eventually discharging through a new (2011 construction[4]) concrete spillway that discharges through four 30-inch HDPE pipes into a discharge channel. The channel discharges approximately 8.452 MGD[(2)], annualized, into Cane Creek through the NPDES permitted outfall 001.

Accumulated bottom ash is dipped and placed on the ash stacking area (shown in **Figure 3**) on the west side within the pond perimeter.

1.2.7 REFERENCES

1. Tennessee Valley Authority, "The Colbert Steam Plant, Technical Report No. 35," 1963
2. Colbert Facility NPDES Permit No. AL0003867, June 2005
3. Tennessee Valley Authority, "TVA Colbert Fossil Plant Groundwater Assessment," Report No. WR28-1-37-110, October 1994
4. URS Corporation, "Health and Safety Plan, Coal Ash Program, Tennessee Valley Authority," Revision 2.3, October 14, 2010

1.3 ROLES AND RESPONSIBILITIES

Roles and responsibilities, **Section 300**, contains a narrative of the responsibilities for the daily operations for routine handling of CCP material. Two responsibility matrices are provided to better define all responsibilities for the routine handling group and TVA.

1.4 CONTACTS

Contacts, **Section 400**, defines contact information for RHO&M group personnel, the facility engineer, client project contacts, emergency service contacts and local hospital information.

The latest RHO&M contact list, facility engineer and client project contacts should be included in this document. This contact list should be updated as personnel change or positions are added. The contacts list should include any third party engineers.

The emergency contact list is provided as a general overview of emergency services. This emergency contact list is not intended to replace any site specific emergency action plans or emergency procedures such as the IPP Plan, Emergency Action Plan or Seepage Action Plan; it only should serve as supplemental information. Contact the site specific RHO&M or CCP personnel for additional emergency plans and procedures. In addition, phone numbers, a map and directions to the local hospital are included.

1.5 HISTORIC INFORMATION

The historical information, **Section 500**, contains the information pertaining to the history of the facility to assist the operators of the facility during inspections and construction. The following subsections are included: historical timeline, pipe inventory, instrumentation plan, seepage log and FEMA Flood Insurance Rate Maps.

1.5.1 HISTORICAL TIMELINE

The historical timeline included in **Section 501** provides an overview of the history of the CCP facilities at COF. The timeline provides historical aerial photographs and a description of the major construction events. It also notes any major failures that may have occurred.

1.5.2 PIPE INVENTORY

The pipe inventory included in **Section 502** was prepared by Stantec Consulting Services, Inc. (Stantec) in March 2010. The inventory contains a plan view showing the locations of all major spillways and pipes at the facility. Photos of each spillway (when available) are also included. The inventory should be updated as new pipes/spillways are installed and old pipes are removed/abandoned. Contact CCP Engineering for the latest inventory.

1.5.3 INSTRUMENTATION PLAN

The instrumentation plan included in **Section 503** is a plan view depicting the locations of piezometers installed at the active facility during the geotechnical investigations performed by Stantec since 2009. The instrumentation plan should be updated as new instruments are installed and old instruments are removed. Contact CCP Engineering for the latest instrumentation plan.

1.5.4 SEEPAGE LOG

The seepage log included in **Section 504** contains an executive summary of the Seepage Action Plan, followed by the latest seepage log for COF to be used as an example. The seepage log, in the COF Seepage Action Plan, is kept electronically at:

\\chapgfs2\ccp\Seepage_Action_Plans\COF.

The seepage log should be updated as new seeps are identified and/or repaired. Contact CCP Engineering for the latest seepage log.

1.5.5 FEMA FLOOD MAPS

Included in **Section 505** are FEMA Flood Insurance Rate Maps (FIRM) produced under the National Flood Insurance Program. The maps show areas subject to inundation by the 1% annual chance flood for the COF plant area.

1.6 CONTRACT

The current scope of work for the handling of coal combustion products at COF is included in **Section 600**. The scope involves the handling of 325,000 dry tons of fly ash and 30,000 dry tons of bottom ash per year.

The current scope of work should be included in the document. The routine handling contracts are typically five years in length. The contract section should be updated with the issuance of a new contract.

1.7 CONSTRUCTION PLANS

The construction plans are presented in **Section 700**. The construction plans section is intended to keep 11"x17" copies of the current drawings RHO&M utilizes for active placement of CCP materials and any 'issued for construction' status work plan drawings. In cases where construction drawings have not been developed, the permit drawings should be included, as this is the only information the contractor has for the handling and placement of CCP materials. Only the current drawings for the placement of CCP materials are included in **Section 700**. Remedial measures, unapproved drawings, permit or construction and 'issued for review' status work plan drawings are not included in this section. Refer to **Section 800** for a list of other drawings for the active facilities.

1.8 DRAWING INVENTORY LIST

The drawing inventory list is presented in **Section 800**. The purpose of the drawing inventory list is to maintain a record of pertinent drawings for the active disposal facility at the plant and any 'completed' status work plans drawings. These drawings should include the original design drawings for the initial construction of the disposal facility as well as any additional designs for changes to the disposal area, remedial measures, or additional work plans that do not directly pertain to the placement of CCP materials.

The list of design drawings is included in this section. As new drawings are developed, revised, or construction is completed the list should be updated. The list includes the TVA series number, number of sheets, revision number, date issued, facility, and a description of the drawing set.

1.9 PERMITS

The Operations Requirement Matrix (see **Section 901**) included in **Section 900** lists the various requirements that pertain to routine handling of CCP materials for the active sites. The matrix is divided based on the source of the requirement. The requirements include permit requirements, NEPA commitments, and recommended practices.

The permit section also contains a list of the active permits at the facilities. A current list of facility permits can be found at:

http://insidenet.tva.gov/org/et/environet/toolbox/tva-facility_permit_list.xls.

Additionally contact the responsible Environmental Media Specialist to obtain a copy of the current active permits. The permit list may or may not be up-to-date as new permits, modifications or renewals may occur prior to incorporating revisions to the list. This section should be updated as updates to it occur.

1.10 SURVEY DATA

The survey data is presented in **Section 1000**. TVA routinely develops topographic survey information for COF to calculate volume capacity and hydrographic survey information. RHO&M maintains a list of when the most current survey was conducted and when the next planned survey is scheduled for each plant. This section should be updated as updates to the survey schedule occur.

1.11 PROCEDURES

The current procedures for the handling of production ash and gypsum are included in **Section 1100**. As operations change, the procedures document should be updated.

The procedures section includes subsections for operations manuals, specifications, QA/QC plans, standard repair guidelines, daily field report, weekly material summary, weekly facility observation form, monthly/quarterly/special facility observation form, project start up checklist, additional work/change order form, TVA internal procedures for NEPA evaluations, RHO&M work control and clay dike restrictions. The subsections are described in the procedures document.

1.12 WORK PACKAGES

Work packages, **Section 1200**, contains a list of all work packages and a list of all remedial Work Plans at COF. The general routine handling work package is included as an example. Work packages are stored electronically at:

\\chapgfs2\ccp\Work_Packages-JSA's.

1.13 MARKETING INFORMATION

Marketing information included in **Section 1300** contains information for the marketing of CCP materials. This section should be updated as marketing information changes or every 3 to 5 years.

1.14 PLANNING

Section 1400 contains information related to the future of the active CCP facilities. Included in the planning section as subsections the following are provided; remaining life calculations, the long range plan, and the master strategy plan. These are described below.

1.14.1 REMAINING LIFE CALCULATIONS

Remaining life calculations are included in **Section 1401**. Remaining life was estimated for the Ash Disposal Area 5.

Remaining life of the facility should be re-calculated if there is a change in the design of the facility, production rates change, or every year. Topographic survey data of the site should be used to calculate the amount of material placed at the active facilities in a specific amount of time to estimate CCP production rates. This should be used to verify the assumptions made in creating the long range plans discussed below.

1.14.2 LONG RANGE PLAN

The long range plan included in **Section 1402** is developed by the TVA program manager. The plan projects future coal burn at the plant and calculates capacity needs for the storage of CCP materials.

1.14.3 MASTER STRATEGY PLAN

The master strategy plan included in **Section 1403** provides an overview presentation of CCP Integrated Planning of Closure Options for Wet CCP Disposal Facilities.

Table of Contents

1.0 OVERVIEW

The chief responsibilities of the RHO&M group are to manage and execute activities for safe and efficient transport and storage of CCP.

The RHO&M group also provides recommendations that improve the production processes for cost and safety reasons, and provides guidance and advice to others supporting organizational functions including the Maintenance, Engineering, Environmental, and Marketing groups.

Additionally, the RHO&M group is responsible for environmental compliance of the CCP facilities with support from CCP Engineering and Environmental Support groups. The need for a design/operational change should be communicated to the Environmental Support and CCP Engineering groups as soon as practicable to evaluate the impact on permitting.

A critical responsibility of CCP RHO&M group is to closely communicate and interface with the Capital Projects and Marketing functions of the CCP organization. These responsibilities include:

1. Managing capacity and predicting needs six years in advance.
2. Providing routine status updates of CCP plant performance, including operating problems, bottlenecks, or other issues inhibiting the primary mission of the group.
3. Providing routine testing (every 3 to 5 years or as required) of the CCP materials, as appropriate, and maintain a database of CCP physical and chemical characteristics.
4. Tracking free water volume and initiating projects accordingly.
5. Developing free water volume reports to the state.
6. Preparing, updating, and maintaining site-specific operation and maintenance manuals.
7. Maintaining roads for ash hauling.
8. Scheduling of CCP management facility maintenance activities.
9. The provision of routine maintenance priorities for timely repairs and providing direction during maintenance projects.
10. Recommending solutions for routine and non-routine maintenance.
11. Recommending new capital improvement projects.
12. Providing cost-reduction ideas to reduce the cost of finished products.
13. Providing safety improvement ideas.
14. Assisting the Marketing functions to promote the sales of CCP.
15. Executing purchase orders to meet contractual commitments of the Marketing group with customers.
16. Providing support on large capital projects (e.g. new landfill ash impoundment).

Additionally, RHO&M will oversee and direct any outside personnel or organizations involved in the transportation and disposal of CCP materials. These responsibilities cover the following areas:

1. Performance of all subcontractors including those involved in transportation and processing.
2. Safe and responsive operation to meet the commitments of marketing, including making and executing transportation arrangements.
3. Implementation of quality control procedures.

The primary role of CCP Marketing, a sub-group within the RHO&M group, is to place products into a wide variety of markets at a profit.

2.0 PERSONNEL RESPONSIBILITIES

The following responsibilities are listed for the daily routine handling of production CCP materials. The list does not contain all responsibilities of the parties listed. Reference is made to the responsibilities matrix included in Section 300 which define the responsibilities of each personnel group.

2.1 CONTRACTOR

1. Implement adherence to safety manual.
2. Inspection of facilities immediately following large storms or earthquakes.
3. Provide scope, estimate, and schedule for new / additional RHO&M T&M work.
4. Verify heavy equipment safety checks.
5. Maintain ancillary facilities (roads, dikes, etc.) associated with routine operations and maintenance.
6. Implement corrective maintenance work orders to repair deficiencies.
7. Manage fugitive dust associated with CCP facilities.
8. Manage cenospheres.
9. Provide quantities of materials handled on a weekly basis.
10. Provide safety and environmental statistics on a weekly basis.
11. Perform inspections on on-site fuel tanks.
12. Report on quantities of materials handled daily. Utilize RHO&M Weekly Material Summary included in **Section 1106**.
13. Report on manpower on-site daily.
14. Perform daily facility observations. Utilize RHO&M Daily Field Report included in **Section 1105**.
15. Maintain heavy equipment.
16. Perform safety and environmental observations and interventions.
17. Prepare and issue any white papers required.

2.2 FIELD SUPERVISOR (SITE SUPERVISOR)

1. Perform safety and environmental observations and interventions.
2. Initiate and approve all RHO&M T&M contracts.
3. Adhere to the TVA safety manual (JSA's, pre-job briefings, etc.)
4. Approve all RHO&M T&M invoices.
5. Manage and execute maintenance of disposal facilities and structures.
6. Manage on-site borrow pit areas.
7. Oversight of field operations for CCP disposal facilities.
8. Perform weekly inspection (implement weekly PM work orders). Utilize RHO&M Weekly Facility Observation Form in **Section 1107**.
9. QA / QC has been performed on RHO&M work.
10. Prioritize list of job jar work.
11. Supply partner oversight.
12. Supply safety oversight.
13. Plant interface with PAE and / or plant managers.
14. Identify new seeps and monitor existing.
15. Inspection of erosion and sediment controls immediately following significant precipitation events.
16. Notify plant of and any / all potential critical deficiencies.

2.3 CONSTRUCTION MANAGER

1. Implement programmatic document.
2. Perform monthly dike inspections (implement monthly PM work orders). Utilize RHO&M Monthly/Quarterly Special Facility Observation Form included in **Section 1108**.
3. Ensure all RHO&M policies and standards are being adhered to in the field.
4. Assist and support field supervisors.
5. Perform Safety and environmental observations and interventions.

2.4 PROGRAM MANAGER

1. Review projects for operability (constructability if capital project).
2. Ensure environmental requirements for CCP facilities are maintained.
3. Predict future storage needs.
4. Track and report on free water volumes.
5. Quantify burn rates vs. ash production.

6. Perform quarterly dike inspections (implement quarterly PM work orders). Utilize RHO&M Monthly/Quarterly Special Facility Observation Form included in **Section 1108**.
7. Have surveys of CCP facilities performed.
8. Manage and track CCP production and facility remaining capacities.
9. Calculate monthly CCP material volumes and quantities handled.
10. Provide plant PAEs with required CCP quantities.
11. Conduct new project design reviews for RHO&M.
12. Perform operability reviews and approval.

2.5 MANAGER OF PLANNING AND PROGRAMS

1. Attend Site Manager strategy meetings.
2. Develop and manage (TCM) contracts for routine handling of CCPs.
3. Conduct routine site visits to identify opportunities for improvements.
4. Implement programmatic document.

2.6 FIELD TECHNICIAN (QA/QC)

1. Stand in for field supervisors.
2. Verify operations are within the design footprints.
3. Verify completion of corrective maintenance work orders (repairs complete).
4. Provide locations of deficiencies.
5. Provide work packages and design drawings.
6. Verify survey results.

3.0 RESPONSIBILITY MATRICES

Two responsibility matrices are provided herein that define, in detail, each members' roles and responsibilities.

CCP Roles and Responsibilities

Activity Description	CCP Projects and Engineering				CCPM		Environmental	River Ops	Plant	Other
	CCP Engineering	CCP Projects	CCP Construction	CCP Projects & Engr. Support	RHO&M	FE				
Capital Projects										
a. Project Initiation/Justification	Structural Deficiencies	Executive Decisions (such as dry ash conversion)			RHO&M (Capacity/Marketing needs, Reductions in routine handling costs/need for borrow areas)		Regulatory Changes		Generation Needs	
b. Development of Project Planning Document	Lead	Input	Input - constructability	Input - scheduling	Input - constructability/operability	Input	Input - Regulatory compliance		Input	
c. Development/Management of Project Budget	Manage Engineering Budget	Ownership of Overall Budget	Manage Construction Budget	Support - track spending	Manage Construction Budget (if involved in construction)		Manage Environmental budget			
d. Obtain Project Approval and Supporting Documents	Support	Lead	Support	Support	Support		Support		Support	
e. Project schedule Development (schedulers work for one manager, individual schedulers assigned to each organization	Engineering Schedule	Ownership of Project Schedule	Construction Schedule	Integrated Schedule	Construction Schedule (if involved in construction)	Input	NEPA/Permitting schedule			
f. Project Design, Engineering, Management of Engr Consultants	Lead	Manage Overall Project	Input to design		Input to design	Input to design; translate design documentation into field implementation package	Input to design	Input to design (if project is a dam)	Input to design	
g. Joint Project Team (including 10/50/90% reviews) - Follow SPP 19.3 and 34; modify signature forms to indicate focus area for JPT member; emphasize that JPT is a TEAM	Participate	Lead	Participate/review for constructability	Participate - schedule	Participate/review for constructability (if involved in construction) & operability	Participate	Review for Regulatory compliance	Participate (if project involves a structured deemed to be a dam)	Participate	
h. Development of borrow areas	Lead for siting and engineering; identify need for borrow area for projects	Manage Overall Project	Lead	Support	Input for locations, lead for construction if requested; identify need for borrow areas for routine handling		NEPA and permitting		Support	
i. Perform NEPA activites in support of projects	Support	Manage Overall Project	Support	Support	Support		Lead	Support (if involved in project)	Support	
j. Obtain new environmental permits or modify existing environmental permits	Lead for engineering for permits	Manage Overall Project	Input	Input	Input (if new disposal/marketing facility)		Lead for permit negotiations	Input (if involved in project)	Support	
k. Project change control	Identify/justify need for change in area of responsibility	Lead for approval/denial of requested change	Identify/justify need for change in area of responsibility		Identify/justify need for change in area of responsibility	Identify/justify need for change in area of responsibility	Identify/justify need for change in area of responsibility	Identify/justify need for change in area of responsibility	Identify/justify need for change in area of responsibility	
l. Project Construction	Support - Technical Guidance (including pre construction check lists, identification of project risks, and identification of contingency plans for critical projects)	Manage Overall Project	Lead	Support	Lead (if requested), otherwise Support	Support	Support	Support (if project involves a structured deemed to be a dam)	Support	
m. Environmental compliance during construction	Support - Technical Guidance	Manage Overall Project	Lead		Lead (if Lead on Construction)		Establish criteria			
n. Project QA/QC; move to 1 QA contractor for fleet w/Engr as TCM	Develop project quality control plan, Lead for performance of project QA, present in field during key project QA milestones	Manage Overall Project	Lead for QC if lead on Construction		Support, Lead for QC (if Lead on Construction)		Support	Support (if involved in project)		
o. Project Testing and Turnover (Project Commissioning)	Support/sign off; Provide operating constraints/design assumptions	Support/sign off	Lead	Support	Lead (if Lead on Construction)/participate otherwise		Support/sign off		Sign off	
p. Project Acceptance for Operation					Lead (if RHO&M operation)				Lead (if plant operation)	
q. Project closure	Support	Lead	Support		Support (if Lead on Construction)		Support	Support (if involved in project)	Support	
r. Exception for small projects (typically less than $250,000)	Design/Constr Support/QA/QC plan	Keep checkbook	Construction Lead (if requested)		May serve as TCM/Lead for construction and execution of QC plan		Support			
O&M Projects										
a. Project Initiation/Justification	Structural Deficiencies	Executive Decisions (such as dry ash conversion)			Capacity needs/Marketing needs/Reductions in routine handling costs/need for borrow areas/findings from inspections	Findings from inspections	Regulatory Changes		Generation Needs	
b. Development of Project Planning Document	Lead	Input	Input - constructability (if involved in construction)		Input - constructability/operability	Input	Input - Regulatory compliance		Input	

CCP Roles and Responsibilities

Activity Description	CCP Projects and Engineering				CCPM		Environmental	River Ops	Plant	Other
	CCP Engineering	CCP Projects	CCP Construction	CCP Projects & Engr. Support	RHOM	FE				
c. Development/Management of Project Budget	Manage Engineering Budget	Manage Overall Budget as appropriate based on project	Manage Construction Budget (if requested to participate in project)	Support - track spending	Manage Construction Budget		Manage environmental budget			
d. Obtain Project Approval and Supporting Documents	Support	Lead to obtain funding for special projects	Support (if involved in construction)	Support	Support		Support		Support	
e. Project schedule Development (schedulers work for one manager, individual schedulers assigned to each organization	Engineering Schedule	Project Schedule	Construction Schedule (if involved in project)	Integrated Schedule	Develop Construction Schedule	Input	NEPA/Permitting schedule			
f. Project Design, Engineering, Management of Engr. Consultants	Lead	Manage Overall Project if requested based on "Who does work" Committee decision	Input to design (if involved in proejct)		Input to design	Input to design; translate design documentation into field implication package	Input to design	Input to design (if project is a dam)	Input to design	
g. Joint Project Team (including 10/50/90% reviews) - modify signature forms to indicate focus area for JPT member; emphasize that JPT is a TEAM	Participate	Lead	Participate/review for constructability (if involved)		Participate/review for constructability & operability	Participate	Review for Regulatory compliance	Participate (if project involves a structured deemed to be a dam)	Participate	
h. Development of borrow areas	Lead for siting and engineering; identify need for borrow area for projects	Manage Overall Project	Lead (if requested by RHO&M)	Support	Identify need and input for locations (if for routine handling), lead for construction		NEPA and permitting		Support	
i. Perform NEPA activities in support of projects	Support	Manage Overall Project	Support	Support	Support		Lead	Support (if involved in project)	Support	
j. Obtain new environmental permits or modify existing environmental permits	Support	Manage Overall Project	Support (if involved in construction)	Support	Input/Support		Lead	Support (if involved in project)	Support	
k. Project change control	Identify/justify need for change in area of responsibility	Lead for approval/denial of requested change	Identify/justify need for change in area of responsibility		Identify/justify need for change in area of responsibility	Identify/justify need for change in area of responsibility	Identify/justify need for change in area of responsibility	Identify/justify need for change in area of responsibility	Identify/justify need for change in area of responsibility	
l. Project Construction	Support - Technical Guidance (including pre construction check lists, identification of project risks, and identification of contingency plans for critical projects)	Support as appropriate based on project	Lead (if requested)	Support	Lead (may request help from other FGD&C resources based on project and work load)	Support	Support	Support (if involved in project)	Support	
m. Environmental compliance during construction	Support - Technical Guidance	Support	Lead (if Lead on construction)		Lead		Support			
n. Project QA/QC, move to 1 QA contractor for fleet w/Engr as TCM	Develop project quality control plan; Lead for performance of project QA, present in field during key project QA milestones		Support (if lead on construction)		Support, Lead for QC (if Lead on Construction)		Support	Support (if involved in project)		
o. Project Testing and Turnover (Project Commissioning)	Support/sign off; Provide operating constraints/design assumptions	Support/sign off	Lead (if Lead on Construction)		Lead		Support/sign off		Sign off	
p. Project Acceptance for Operation					Lead (if RHO&M operation)				Lead (if plant operation)	
q. Project closure	Support	Lead	Support (if Lead on Construction)		Support (if Lead on Construction)		Support	Support (if involved in project)	Support	
r. Exception for small projects (typically less than $250,000)	Design/Constr. Support/QA/QC plan	Keep checkbook	Construction Lead (if requested)		TCM/Lead for construction and execution of QA/QC plan		Support			
Routine Operations and Maintenance - CCPs										
a. Ownership of CCP disposal sites	Accountable for assigned areas of responsibility; provide RHO&M with scope/schedule information for a given site as the site owner; communicate directly with plant on details associated with on-site activities as agreed upon in JPT meetings	Accountable for assigned areas of responsibility; provide RHO&M with scope/schedule information for a given site as the site owner; communicate directly with plant on details associated with on-site activities as agreed upon in JPT meetings	Accountable for assigned areas of responsibility; provide RHO&M with scope/schedule information for a given site as the site owner; communicate directly with plant on details associated with on-site activities as agreed upon in JPT meetings	Accountable for assigned areas of responsibility; provide RHO&M with scope/schedule information for a given site as the site owner; communicate directly with plant on details associated with on-site activities as agreed upon in JPT meetings	Owner of disposal site; ongoing general knowledge of objectives, scope, and schedule of all projects/activities at site. Primary point of contact for plant until specific responsibilities are agreed upon in JPT meetings; kept informed on status of site activities or special visitors				Customer for CCP management activities and ultimate owner of site	
b. Manage capacity at disposal sites/predict new capacity needs 6 yrs in advance; track CCP production and facility remaining capacity (currently referred to as long range plans) - all ponds except coal yard run off ponds	Support - identify capacity reductions due to structural deficiencies				Lead	Support	Support		Support (Gen Plan)	

CCP Roles and Responsibilities

Activity Description	CCP Projects and Engineering: CCP Engineering	CCP Projects and Engineering: CCP Projects	CCP Projects and Engineering: CCP Construction	CCP Projects and Engineering: CCP Projects & Engr. Support	CCPM: RHOM	CCPM: FE	Environmental	River Ops	Plant	Other
c. Manage and execute operational and production activities that transport and store CCP at the intended end purpose and in accordance with engineering design drawings and parameters; manage and execute maintenance of disposal facilities and structures, including dikes and embankments, maintain pond freeboard per design (all ponds except coal yard run off pond)	Support				Lead	Prepare work instructions for maintenance activities; execute purchase orders for field materials				
d. Develop and manage contracts for routine operations and maintenance of CCPs and associated disposal facilities					Lead					
e. Maintain Environmental Compliance at CCP facilities					Lead for compliance with permit requirements					
1. Communicate Regulatory requirements							Lead			
2. Negotiate CCP related permits with State and Federal Agencies	Support				Support		Lead			
3. Maintain permit records; provide electronic/hard copies of permitting/regulatory documents	Support				Support	Support	Lead			Support
4. Serve as focal point for all regulatory contact							Lead			
5. Develop, manage, and execute groundwater monitoring program	Support	Support (through projects)	Support		Support		Lead			
6. Develop, manage, and execute air monitoring program							Programmatic Lead			
7. Perform routine environmental auditing functions					Support		Lead		Support	
8. Conduct annual Solid Waste Managment Site Environmental review					Support		Lead		Support	
9. Track free water volume, develop annual free water volume reports to state					Lead	Support	Support			
10. Manage stormwater associated with CCP/disposal facilities					Lead		Support			
11. Manage leachate associated with CCP/disposal facilities					Lead		Support			
12. Manage fugitive dust associated with CCP/disposal facilities					Lead					
13. NPDES sampling					Weir maintenance, support of compliance activities		Program lead (negotiate permits, communicate requirements, audits, etc including weir calibration)		Collect and analyze samples on specified frequencies, routine reporting to regulators	Responsibility for weir calibration returns to Environmental Support group in MS
14. Perform required NEPA activites	Support				Support		Lead		Support	
15. Wetland mitigation					Support		Lead			
16. Seepage Action Plan; Form Team to revise Seepage Action Plan	Program owner; participate in quarterly inspections; Lead to classify seeps, determine actions required & prioritize actions				Execute recommended actions based on identified priorities; monitor seeps for changes as part of routine inspections; write work orders for routine maintenance, write PERS for significant issues	Support	Identify & prioritize actions for compliance		Maintain copies in SOS office	
17. Operate facilities in compliance with permit requirements	Support				Lead		Communicate permit requirements to RHOM		Support	
f. Perform routine testing of CCP materials and maintain data base of CCP physical and chemical characteristics	Lead				Support	Support				
g. Prepare, update, and maintain site-specific operation and maintenance manuals	Support				Lead	Support				
h. Develop and deploy safe work plans for routine operations and maintenance					Execute safe work plans; provide input for development of plans	Support				Corporate Governance lead for plan development with input from Safety Staff; lead for training, communicate plan requirements to RHOM
i. Maintain heavy equipment and ancillary facilities (roads, dikes etc) associated with routine operations and maintenance of CCPs and associated disposal facilities					Lead				Support	
j. Develop & manage projects and contracts for marketing/beneficial reuse of CCPs	Support				Lead		Support		Support	
k. Manage budgets for routine operation and maintenance activities					Lead					
l. Develop engineering plan to ensure facilities are operating to the appropriate standards of safety, functionality, and environmental compliance; lead for ensuring structural stability of site	Lead				Support; ensure engineering recommendations are implemented	Assist with field documentation	Support	Support		
m. Audit routine activities for compliance with design and construction documents; perform QA for routine handling	Lead				Support; fund QA for remainder of FY	Support				
n. Provide factors of safety, load ratings, design assumptions, risks etc as needed to support routine O&M activities	Lead				Identify needs					
o. Prepare facility phaseing plans to prevent field engineering (3D drawings)	Lead				Support					

CCP Roles and Responsibilities

Activity Description	CCP Projects and Engineering: CCP Engineering	CCP Projects and Engineering: CCP Projects	CCP Projects and Engineering: CCP Construction	CCP Projects and Engineering: CCP Projects & Engr. Support	CCPM: RHOM	CCPM: FE	Environmental	River Ops	Plant	Other
p. Prepare Emergency Action Plans for CCP facilities	Lead				Support	Support				Support from Safety Staff
q. Develop and deploy CCP facility stability monitoring program	Lead				Support	Support		Support for dams		
r. Operate and Maintain stationary CCP processing equipment (silos, blowers, pumps, piping, dewatering systems, etc'					Provide input				Lead	
s. Annual review of programmatic document	Lead	Support	Support	Support	Support	Support	Support	Support		
t. Provide security for CCP processing and management facilities					Lead				Support	
u. Adherence to the TVA safety manual (JSA's, Pre-job briefings, etc)					Lead					Support from Safety Staff
v. Design changes resulting from Routine Operations	Review/approve changes				Request design changes		Modify permit as required			
w. Strategic Planning for sites	Lead (coordinate with FPG)	Input/support	Input/support	Input/support	Input/support (ensure linkage with marketing plans and remaining facility capacity	Input/support	Input/support	Input/support	Input/support	
x. Technical guidance and advice on major maintenance and process problems	Lead				Input	Support				
y. Organizational indicators for CCBP management	Support	Support	Support		Support	Lead	Support			
Inspections and monitoring										
a. Daily inspections	Develop scope				Lead - Perform and report; maintain files on site		Input to scope			
b. Weekly inspections	Develop scope				Lead - Perform and report; maintain files on site		Input to scope			
c. Unscheduled inspections	Lead				Support					
d. Quarterly inspections	Participate; prioritize corrective actions				Lead - Perform and report; maintain files on site; correct deficiencies per priorities	Support				
e. Annual inspections	Lead for inspection and reporting; prioritize corrective actions				Participate; maintain files on site; correct deficiencies per priorities	Support			Participate	
f. Annual inspections - landfill overlying an inactive pond	Participate				Participate			Lead and program oversight		
g. Ash Pond Dam Safety inspections	Participate				Participate			Lead and program oversight		
h. Inspection of erosion and sediment controls immediately following significant precipitation events	Support				Lead			Support		
i. Inspection of facilities immediately following large storms or earthquakes	Support				Lead					
j. Closed ash ponds										
1. Daily "drive by" inspection					Lead					
2. Dam safety inspection	Participate				Participate			Lead		
3. Maintenance of closed ash ponds and stacks	Support				Lead		Support	Support	Support	
k. Ash Pond monitoring										
1. Develop and deploy monitoring program	Lead							Support		
2. Read instruments on established schedule	Lead							Read during Dam Safety Inspections		
3. Establish action ranges	Lead							Support		
4. Review and interpret instrument data	Lead							Support		
5. Identify and prioritize required actions based on data	Lead							Support		
6. Implement corrective actions	Support				Lead	Support		Support		
7. Maintenance of instruments	Support					Lead		Support		
Other										
Properties and Siting Studies a. Buffer Properties, Regional Siting Studies, Landfill Siting Property Issues	Lead for scope, schedule, engineering, communications plan, coordination with Realty/Environmental/GI&E, coordinate demolition	Lead for PJ package, overall project management	Involvement as requested	Integrated schedule	Identify need, input, other involvement as requested		Lead for NEPA, permitting if required		Stay informed via JPT	GI&E - maps, surveying; Realty - parcel data, access permission, land procurement; Communication & Valley Relations - Communications plan
Properties and Siting Studies b. Fossil Property Transfers										Transfer to Fossil Engineering
Procedure development (SPPs) -	Support	Support	Support	Support	Support	Support	Support			Project Governance and Oversight is the lead
Root Cause Analysis (PER's, CAP's, etc)	Input as needed	Input as needed	Input as needed	Input as needed	Input as needed	Input as needed				Owning organization leads with oversight by Project Governance organization

CCP Roles and Responsibilities

	CCP Projects and Engineering				CCPM					
Activity Description	CCP Engineering	CCP Projects	CCP Construction	CCP Projects & Engr. Support	RHOM	FE	Environmental	River Ops	Plant	Other
DCN's for all projects capital, O&M, and routine to be performed by CCP Engineering	Input as needed	Input as needed	Input as needed	Input as needed	Input as needed	Input as needed				Owning organization leads with oversight by Project Governance organization
Work Packages for Maximo	Lead for project work packages	Support - project work packages	Support - capital project work packages		Lead for routine handling work packages; support for O&M project work packages	Support	Support			
Process deployment and audits	Input as needed	Input as needed	Input as needed	Input as needed	Input as needed	Input as needed				Project Governance and Oversight
Back up plans for off site CCP disposal	Identify need for backup off-site capacity based on remaining capacity and schedule for projects to provide additional capacity	Identify need for backup off-site capacity based on remaining capacity and schedule for projects to provide additional capacity	Identify need for backup off-site capacity based on remaining capacity and schedule for projects to provide additional capacity		Identify need for backup off-site capacity based on remaining capacity and schedule for projects to provide additional capacity. Make decision and establish contracts for backup off-site capacity when required					
Communications										
a. Monthly project review meetings (capital and O&M) at plants	Participate	Lead	Participate	Participate	Participate	Participate	Participate		Participate	

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		Sr. Manager	Manager Planning & Programs	Program Manager	Manager Construction / Field Support	Field Supervisor	Foremen	Technician (CAD Design)	General Technician	Field Technician	Business Support Rep	Manager Marketing	Specialist Marketing	Specialist Business Operations	Construction Partner	Field Engineering	Operational Support	Work Controls	Dam Safety
1	Overall Management and Execution of Operational and Production Activities that Transport and Store CCP	LEAD	Support	Support	Support	Support		Support	Support	Support					Support	Support	Support	Support	
2	Attend Site Master Strategy Meetings	Support	LEAD	Support	Support	Support										Support			
3	Develop and Manage (TCM) Contracts for Routine Handling of CCPs	Support	LEAD	Support	Support	Support		Support	Support	Support					Support				
4	Routine Site Visits to Identify Opportunities for Improvements	High Support	LEAD	Support	Support	Support													
5	Implement Programmatic Document	Support	LEAD (for technical)	Support	LEAD (for field)	Support									Support	Support			
6	Review Projects for Operability, (Constructability if Capital Project)	Support	High Support	LEAD	Support	High Support													
7	Ensure Environmental Requirements for CCP Facilities are Maintained	Support	Support	LEAD	Support	High Support									Support				
8	Predict Future Storage Area Needs	Support	High Support	LEAD				Support	Support	Support					Support		Support		Support
9	Track and Report on Free Water Volumes	Support	High Support	LEAD				Support	Support	Support	Support				Support		Support		
10	Quantify Burn Rates Verses Ash Production	Support	High Support	LEAD	Support	Support		Support	Support	Support					Support		Support		
11	Perform Quarterly Dike Inspections (Implement Quarterly PM WO's)	Support	High Support	LEAD	Support	Support	Support	Support	Support	Support					Support				
12	Have Surveys of CCP Facilities Performed	Support	Support	LEAD				High Support	Support	Support									
13	Manage and Track CCP Production and Facility Remaining Capacities	Support	Roll Up To	LEAD	Support	Support		Support	Support	Support	Support				Support		Roll Up To		
14	Calculate Monthly CCP Material Volumes and Quantities Handled	Support	Support	LEAD				Support		Support					Support		Roll Up To		
15	Provide Plant PAE's with Required CCP Quantities	Support	High Support	LEAD							Support				Support		Support		
16	New Project Design Reviews for RHO&M	Support	Support	LEAD												LEAD			
17	PPD Operability Reviews and Approval	Support	Support	LEAD		Support										High Support			
18	Perform Monthly Dike Inspections (Implement Monthly PM WO's)	Support			LEAD					Support	Support							Support	
19	Ensure all RHO&M Policies and Standards are being Adhered to in the Field	High Support	Support	Support	LEAD	High Support		Support	Support	Support					Support			Support	
20	Assist and Support Field Supervisors	Support	Support	Support	LEAD	Support		Support		Support									
21	Perform Safety & Environmental Observations & Interventions	Support	Support	Support	LEAD	LEAD									LEAD		Roll Up To		
22	Initiate & approve all RHO&M T&M Contracts	Support	Support	Support		LEAD													
23	Adherence to the TVA Safety Manual (JSA's, Pre-job briefings, etc)	Support	Support	Support	High Support	LEAD		Support	Support	Support					Support				
24	Approve all RHO&M T&M Invoices	Support	Support	High Support	Support	LEAD													

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25	Manage and Execute Maintenance of Disposal Facilities and Structures	Support				LEAD									High Support				
26	Manage Onsite Borrow Pit Areas	Support				LEAD									High Support				
27	Oversight of Field Operation for CCP Disposal Facilities	Support	Support	Support	Support	LEAD		Support	Support	Support					High Support				
28	Perform Weekly Inspection (Implement Weekly PM WO's)	Support				LEAD												Support	
29	QA / QC has been performed on RHO&M work	Support	High Support	Support		LEAD		Support	Support	Support									
30	Prioritize List of Job Jar Work	Support				LEAD													
31	Supply Partner oversight	Support				LEAD													
32	Supply Safety Oversight	Support				LEAD													
33	Plant Interface w/PAE and or Plant Managers	Support	Support	Support	Support	LEAD													
34	Identify New Seeps and Monitor Existing	Support	Support	Support	Support	LEAD	Support	Support	Support	Support						Support		Support	
35	Inspection of Erosion and Sediment Controls Immediately Following Significant Precipitation Events	Support	Support	Support	Support	LEAD	Support								Support				
36	Notify Plant of Any / All Potential Critical Deficiencies	Support	Support	Support	Support	LEAD									Support				
37	Oversee Vegetation Control Practices	Support	Support	Support	Support	Support	LEAD		Support										
38	Identify Facility Deficiencies on Aerial Maps	Support						LEAD	Support	High Support									
39	Track Facility Deficiencies and Provide Documentation for Resolved Items	Support						LEAD	Support	High Support							Roll Up To	High Support	
40	Produce Updated Facility Maps	Support	Support	Support				LEAD	Support	Support									
41	Prepare and Implement Spill Prevention / Response Plan	Support	Support	Support	Support	Support			LEAD						High Support				
42	Prepare and Issue any White Papers Required	Support	Support	Support	Support	Support			LEAD						LEAD				
43	Ensure all PER's are initiated and tracked for CCP	Support							LEAD										
44	Track for closure all Performance Evaluation Reviews (PER's) for CCP	Support	Support	Support	Support	Support		Support	LEAD	Support	Support								
45	Ensure all Corrective Action Plans are Implemented for CCP	Support							LEAD										
46	Update and Revise Safety Flashes for CCP & CCP RHO&M Lessons Learned	Support				Support			LEAD								Roll Up To		
47	Serve as Environmental Liaison for CCP and Environmental Corporate	Support				Support			LEAD										
48	Support Operations for Safety and Environmental Notifications & Issue Environmental Updates to Field Personnel	Support				Support			LEAD										

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49	Develop and Deploy all RHOM Communication "Huddle Boards" & update with JSA, Safety, Environmental, and Operations Materials	Support		Support		Support			LEAD		Support								
50	Track and Trend Corrective Actions	Support	Support	Support	Support	Support		Support	LEAD		Support	Support	Support	Support	Support		Roll Up To		Support
51	PER Dispositions	Support	Support	Support	Support	Support			LEAD								Support		
52	Stand-in for Field Supervisors									LEAD									
53	Verify Operations are with in the Design Footprints	Support	Support	Support	Support	Support		Support	Support	LEAD					Support				
54	Verify Completion of Corrective Maintenance WO's (Repairs Cpt)	Support						Support	Support	LEAD								Support	
55	Provide Locations of Deficiencies	Support						Support	Support	LEAD								Support	
56	Provide Work Packages & Design Drawings	Support	Support	Support		Support		Support		LEAD									
57	Verify Survey Results	Support	Support	Support		Support		Support	Support	LEAD	Support								
58	Provide Status and Track Completed Dike Observations/Inspections and Environmental Items	Support			Support	Support					LEAD						Roll Up To		Support
59	Maintain weekly spreadsheet of DRF (Daily Field Report) on share drive										LEAD								
60	Maintain updated contact list										LEAD								
61	Provide Meeting Minutes and Action Items for RHO&M Meetings, Including Weekly Call										LEAD								Support
62	Develop & Manage Projects and Contracts for Marketing/Beneficial Reuse of CCPs	Support	Support	Support								LEAD	Support						
63	Develop Integrated Strategy for CCP Management, Manage CCP Marketing and Beneficial Reuse	Support	Support	Support								LEAD	Support	Support					
64	Place Products into a Wide Variety of Markets											LEAD	Support	Support					
65	Prepare annual report to the State of Tennessee on beneficial use of CCPs											LEAD		Support					
66	Prepare annual report to the State of Kentucky on beneficial use of CCPs											LEAD		Support					
67	Complete American Coal Ash Association (ACAA) production and use survey annually											LEAD	Support	Support					
68	Establish R&D Priorities for Beneficial Reuse											LEAD	LEAD						
69	Develop Strategic Sales and Production Alliances											LEAD	LEAD						
70	Prepare yearly ash production and utilization report for Toxics Release Inventory (TRI)												LEAD	Support					

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71	Prepare monthly report on slag operations at PAF for Title V compliance												LEAD	Support					
72	Report of all CCP production, utilization, stockpiles, disposal and remaining capacities for DOE Energy Information Administration (EIA) annually.		Support									Support	LEAD						
73	Prepare annual report of gypsum utilization and revenue to United States Geological Survey (USGS)												LEAD	Support					
74	Manage performance and compliance of CCP marketing contracts.											Support	LEAD	Support					
75	Perform biennial physical and chemical characterization of CCPs.											Support	LEAD						
76	Track Costs, Revenues and Indicators for Marketing											Support	Support	LEAD	Support		Roll Up To		
78	Track and Report on RHO&M Routine Handling Budgets	Support	Support											LEAD	Support		Support		
79	Track and Report on RHO&M Project Budgets	Support	Support											LEAD	Support		Support		
77	Track Additional Work List													LEAD					
80	Prepare Monthly CCP Utilization and Revenue Report for FGD&C/CCPM/RHO&M dashboard												Support	LEAD					
81	Prepare report on Greenhouse Gas Emissions Reduction											Roll Up To		LEAD					
82	Prepare Quarterly Report of Utilization for Environment & Technology's Environmental Dashboard													LEAD					
83	Prepare Quarterly Revenue Accruals for Business Services											Support		LEAD					
84	Prepare Recycled CCPs Report for the Stewart-Montgomery-Robertson (SMR) Municipal Solid Waste Planning Region's Annual Solid Waste Progress Report												Support	LEAD					
85	Serve as Liaison for Business Services & Procurement													LEAD					
86	Implement Adherence to Safety Manual	Support		Support	Support	High Support									LEAD				
87	Inspection of Facilities Immediately Following Large Storms or Earthquakes	Support	Support	Support	Support	High Support		Support		Support	Support				LEAD				
88	Provide Scope, Estimate, Schedule for New / Additional RHO&M T&M Work	Support	Support	Support	Support	High Support									LEAD				

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89	Verify Heavy Equipment Safety Checks	Support				High Support									LEAD				
90	Maintain Ancillary Facilities (roads, dikes etc) Associated with Routine Operations and Maintenance	Support				High Support									LEAD				
91	Implement Corrective Maintenance WO's to Repair Deficiencies	Support				High Support									LEAD			LEAD	
92	Manage Fugitive dust Associated with CCP Facilities	Support				High Support									LEAD				
93	Manage Cenospheres	Support	Support			High Support							Support		LEAD				
94	Provide Quantities of Materials Handled on a Weekly Basis	Support			Support	Support		Support			High Support				LEAD		Roll Up To		Support
95	Provide Safety and Environmental Statistics on a Weekly Basis	Support	Support	Support	Support	Support					Support				LEAD		Roll Up To		Support
96	Perform Inspections of Onsite Fuel Tanks	Support				Support									LEAD		Support		
97	Report on Quantities of Materials Handled Daily	Support				Support					Support				LEAD		Support		Support
98	Report on Manpower Onsite Daily	Support									Support				LEAD		Support		
99	Perform Daily Facility Observations	Support									Support				LEAD		Support		
100	Maintain Heavy Equipment	Support				Support									LEAD				
101	Contract Engineering Facilitator for Phase 2 of Operational Support Effort	Support	Support	Support	Support	Support		Support	Support	Support						LEAD			
102	Capital Project Joint Team Member	Support	Support	Support	Support											LEAD			
103	Maintain Operation Support Document (O&M Manuals)	Support	Support	Support	Support	Support		Support	Support	Support					Support	LEAD			
104	Liaison Between CCP Engineering and RHO&M	Support	Support	Support				Support								LEAD			
105	Obtain Factors of Safety, Load Ratings, Design Assumptions, Risks etc as to Support Routine O&M Activities	Support														LEAD			
106	Technical Guidance and Advice on Major Maintenance and Process Problems	Support	Support	Support	Support	Support									Support	LEAD			
107	Coordinate Review of Programmatic Document for RHO&M	Support	Support	Support	Support	Support		Support	Support	Support					Support	LEAD			
108	Produce Weekly RHO&M Highlights for FGDC Report on Weekly Basis	Support	Support	Support	Support	Support					Support				Support		LEAD		Support
109	Provide Breakdown of Types of Deficiencies Found	Support						High Support	Support	Support							LEAD	Support	
110	Provide Safety Flashes	Support				Support					Support				Support		LEAD		
111	Provide Weekly Resource Counts (Head Counts)	Support			Support	Support					Support				Support		LEAD		Support
112	Produce Monthly Material Quantity Reports	Support	Support	Support	Support	Support		Support				Support			Support		LEAD		Support

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113	Produce Monthly Safety Reports	Support	Support	Support	Support	Support		Support				Support	Support		Support		LEAD		Support
114	Produce Overall RHO&M Monthly KPI's	Support	Support	Support	Support	Support		Support			Support	Support		Support	Support		LEAD	Support	Support
115	Track Safety Observations, Interventions - Input Hard Copies	Support	Support	Support	Support	Support			Support		Support						LEAD		
116	Track all Required Training	Support	Support	Support	Support	Support			Support								LEAD		
117	Produce Monthly Work Order Reports	Support	Support	Support	Support	Support		Support							Support		High Support	LEAD	Support
118	Work Controls Procedure Development (SPPs)	Support	Support	Support	Support	Support										Support		LEAD	
119	Plan Preventive Maintenance WO's for Inspections	Support																LEAD	
120	Close Completed Preventive Maintenance WO's and Vault	Support															Support	LEAD	
121	Create Corrective Maintenance WO's for Deficiencies	Support															Support	LEAD	
122	Plan Corrective Maintenance WO's for Deficiencies	Support															Support	LEAD	
123	Close Completed Corrective Maintenance WO's and Vault	Support															Support	LEAD	
124	Create Corrective Maintenance WO's Requiring Engineering Recommendations	Support															Support	LEAD	
125	Track and Report on all Work Orders for RHO&M	Support															Support	LEAD	
126	Produce Health Report on Facilities	Support	Support	Support				High Support	Support	Support							Support		LEAD
127	Prepare Emergency Action Plans for CCP facilities	Support									Support					Support			LEAD
128	Implementation of CCP Instrumentation Program	Support															Support		LEAD
129	Instrumentation Monitoring Program	Support																	LEAD
130	Dam Safety Training	Support									Support						Support		LEAD
131	Landfill Inspection Program Training	Support									Support						Support		LEAD
132	Maintenance of Instruments	Support									Support								LEAD
133	Prepare Inspection Plans for DSO	Support	Support	Support	Support	Support													LEAD
134	Prepare All Required Reports Per TVA SPP-27.3																		LEAD
135	Prepare All Required Per TVA SPP-27.4		Support					Support			Support								LEAD
136	Prepare All Required Per TVA SPP-27.5																		LEAD
137	Prepare All Required Per TVA SPP-27.6																		LEAD
138	Manage TVA Mineral Property Locations																		LEAD

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1.0 CONTACTS

2.0 RHO&M GROUP PERSONNEL

Table 1 shows the RHO&M group personnel and contact information for COF.

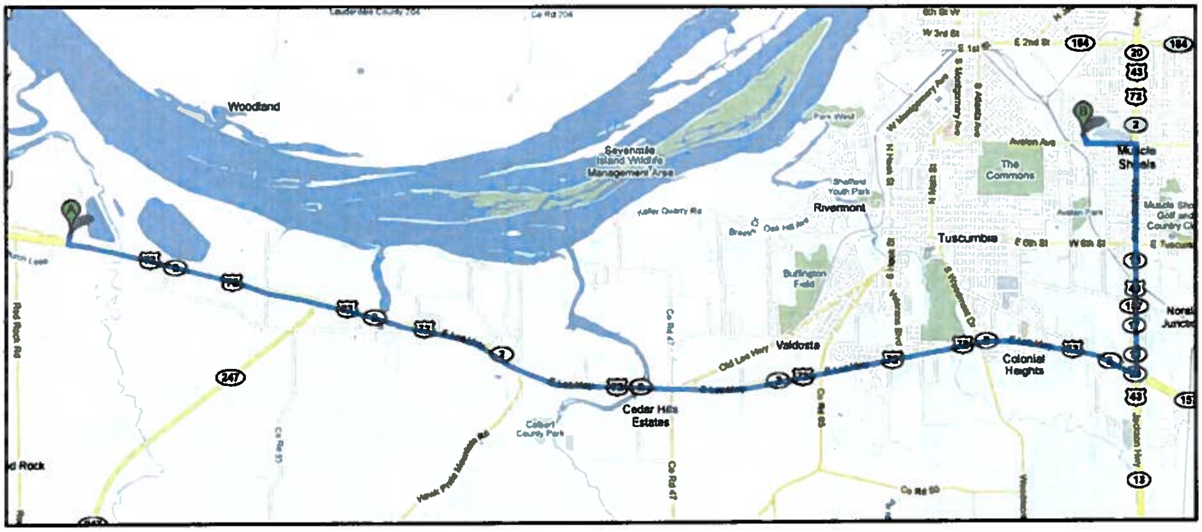
Table 1 - Contacts			
Plant SOS		(865) 945-7213	
Foreman – Trans Ash	Grayson Simmons	(513) 258-7866	gsimmons@transash.com
Field Supervisor	Shane Harris	(423) 260-9640	rsharri0@tva.gov
Const. Manager	Gary Wilford	(423) 326-7192	gwilford@tva.gov
Program Manager	Brent Wyatt	(423) 260-3144	bdwyatt@tva.gov
CCP Engineer	Chris Buttram	(423) 802-7666	jcbuttram@tva.gov
Civil Design Tech.	Jacob Booth	(423) 240-2449	jbooth@tva.gov
Program Admin.	Michael Gean	(256) 349-6463	magean@tva.gov
Stantec Spillways	Matt Hoy	(636) 448-7128	matthew.hoy@stantec.com
Stantec Engineer	Randy Roberts	(502) 212-5009	randy.roberts@stantec.com
URS Engineer	Mike Stepic	(330) 836-9111	mike_stepic@urscorp.com

3.0 EMERGENCY CONTACTS

Table 2 shows the RHO&M Emergency contact information for COF.

Table 2 – Emergency Contacts		
Shoals Hospital		(256) 386-1600
Non-Emergency – Helen Keller Hospital		(256) 386-4196
TVA Emergency Services	Facility Phone	Shift Supervisor will handle all emergency calls including environmental
TVA Facility Specific Medical Services: **Plant Nurse – 1st Floor – Left at Double Doors after entering Main Entrance**	Mobile Phone	(256) 389-7274
	Facility Phone	7274
Client Project Contacts		
TVA Project Manager: Roy Quinn	Office	(423) 718-3349
	Mobile	
TVA Site Point-of-Contact: Carolyn Malone	Office	(256) 389-7000
	Mobile	
TVA Site Alternate Point-of-Contact:	Office	
	Mobile	
URS Project Manager: Mike Stepic	Office	(330) 836-9111
	Mobile	(330) 289-0092

Map from COF to Shoals Hospital.



Directions from COF to Shoals Hospital.

Driving directions to Shoals Hospital

Suggested routes

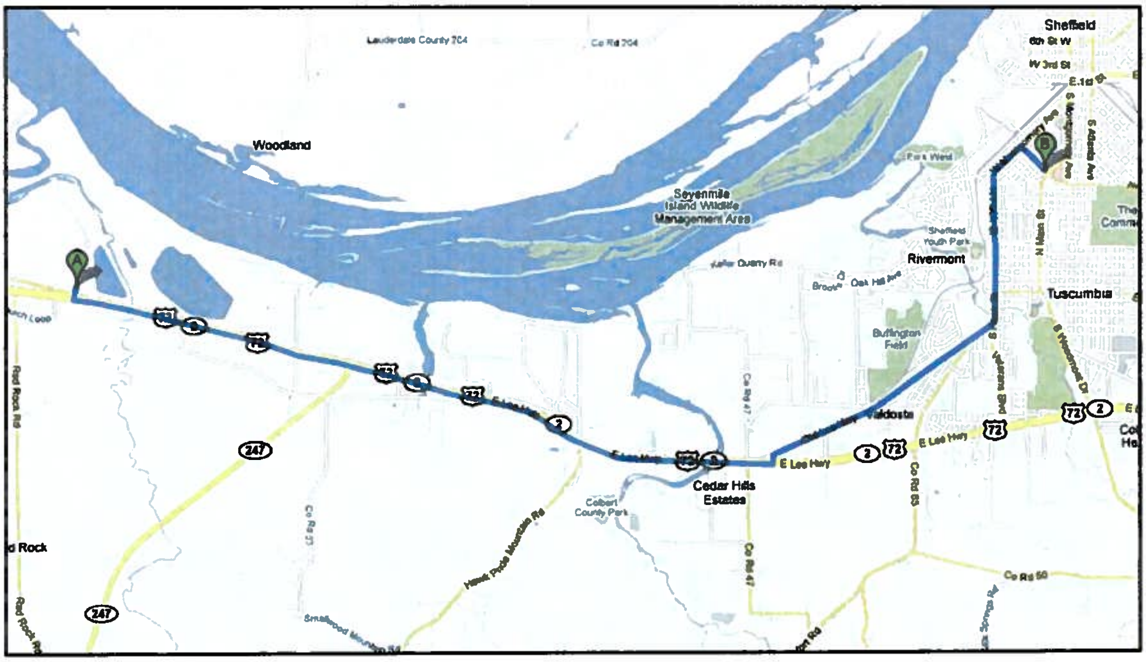
AL-2 E/US-72 E 14.1 mi	**21 mins**
AL-2 E/US-72 E and Pickwick St 13.1 mi	29 mins

Colbert Steam Plant Rd
Tuscumbia, AL 35674

1. Head **south** on **Colbert Steam Plant Rd** toward **Co Rd 20** — 0.1 mi
2. Turn **left** at **AL-2 E/US-72 E** — 11.0 mi
3. Turn **left** at **AL-13 N/AL-157 N/AL-17 N/AL-2 E/AL-20 W/US-43 N/US-72 E/Woodward Ave** — 2.3 mi
4. Turn **left** at **W Avalon Ave** — 0.5 mi
5. Turn **right** at **Billy Bowling Dr** — 0.1 mi

Shoals Hospital
201 West Avalon Avenue
Muscle Shoals, AL 35661

Map from COF to Keller Wellcare



Directions from COF to Keller Wellcare.

Driving directions to 1021 SW 11th St, Sheffield, AL 35660

Suggested routes

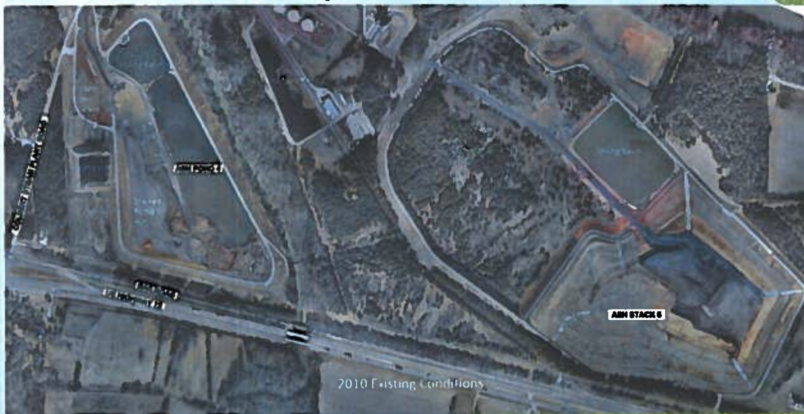
AL-2 E/US-72 E 11.0 mi	**19 mins**
AL-2 E/US-72 E and S Main St 11.9 mi	19 mins

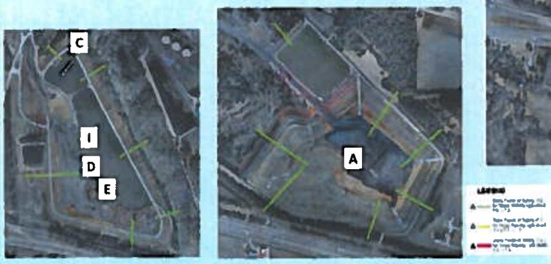
Colbert Steam Plant Rd
Tuscumbia, AL 35674

1. Head **south** on **Colbert Steam Plant Rd** toward **Co Rd 20**	0.1 mi
2. Turn **left** at **AL-2 E/US-72 E**	6.5 mi
3. Turn **left** at **Old Lee Hwy**	2.4 mi
4. Slight **left** at **S Hook St**	1.3 mi
5. Continue onto **W Montgomery Ave**	0.4 mi
6. Turn **right** at **SW 11th St** Destination will be on the right	0.3 mi

1021 SW 11th St
Sheffield, AL 35660

History of Colbert Fossil Plant
Coal Combustion Products Disposal Facilities

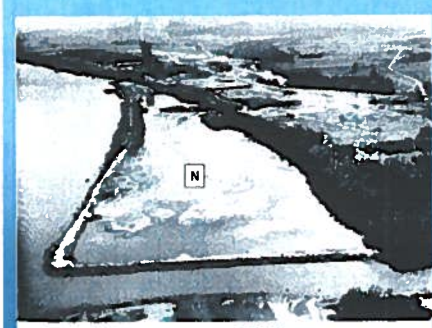




2010 Factor of Safety

2010 Ash Disposal Area 5 Perimeter Construction

1999 Aerial Photograph



Late 1950's Aerial Photograph

2011
2010
2009

A In 2010 TVA began Seepage and Drainage Remediation construction, circumnavigating Ash Stack 5 with drainage improvements and buttressing, to mitigate high seepage gradients and increase slope stability safety factors.

B Stantec's February 2010 draft geotechnical report for Ash Stack 5 identified excessive seepage gradients in the perimeter ditches and recommended improvements to increase the slope stability safety factors.

C During 2010 and 2011 Pond 4 spillways were lowered to drop the normal pool in Pond 4 and the stilling basin from +456 to +453, and the perimeter dike tops were lowered from +460 to +458 to eliminate the "high hazard" categorization.

D Stantec's 2010 Ash Pond 4 geotechnical report recommended pond modifications to increase seepage and slope stability safety factors.

E In 2009 TVA classified Ash Pond 4 as a "high hazard" impoundment.

1990

F In July 1990 TVA converted to dry fly ash handling and dredging to Disposal Area 5 ceased. Clay perimeter dikes were raised around cells 1 and 2, over previously sluiced flyash, and dry ash stacking commenced.

1984
1983

G Leaks in Pond 5 were noted in July and again in October 1984. 31-acres at the East end of Pond 5, and a 17-acre stilling basin were clay-lined, and dredging to this lined area resumed in 1986 and continued until cells 1 and 2 were filled.

H In 1984 Disposal Area 5 drainage basin (P-1), cover[illegible] 13-acres, was put into service, fitted with 2-48" diameter RCP ri[illegible] 36" diameter RCP discharge pipes. Today this pond serv[illegible] stilling basin for drainage water from Ash Stack 5.

1978

I In 1984 the Ash Pond 4 perimeter dikes were raised 20 feet to +460 over sluiced ash, using upstream construction. Seepage at the interface between the two clay dikes has persisted, especially along the east side of Pond 4.

1972

J Ash Pond 5 construction was completed in September 1983, creating a 183-acre dredge spoil receptor for Ash Pond 4.

K In 1978 the 0.5-acre Chemical treatment pond, located West of Ash Pond 4 displayed signs of leakage. Although the pond [illegible] was repaired in 1978, more than 500,000 gallons of [illegible] lost in December 1991 through a 1-meter sinkhole. The [illegible] closed and the dikes bulldozed in 1993.

L In 1972, [illegible] 4 was initially constructed with 20' high clay perim[illegible] 440. Both bottom and fly ash were wet sluiced [illegible]

1960

M On January 4, 1960 unit 5 const[illegible] commenced in late 1963.

N [illegible] 1952 to January 1953 the initial 45-acre ash disposal [illegible] using rock from the intake, downstream of the pow[illegible] confluence of Cane creek and the River.

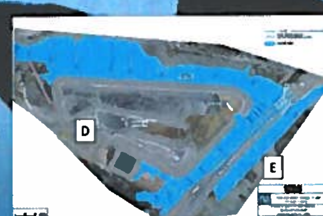
1955

O Construction on [illegible] October 15, 1951, [illegible] 3 and 4 were [illegible] November 1955.

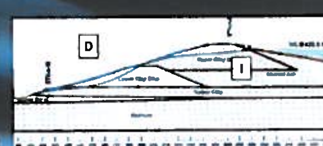
1951

Siphons installed to lower normal pool in Ash Pond 4 stilling basin during spillway reconstruction.

High gradients id[illegible] Ash Disposal 5 perimeter where c[illegible] were raised upstream over previo[illegible]

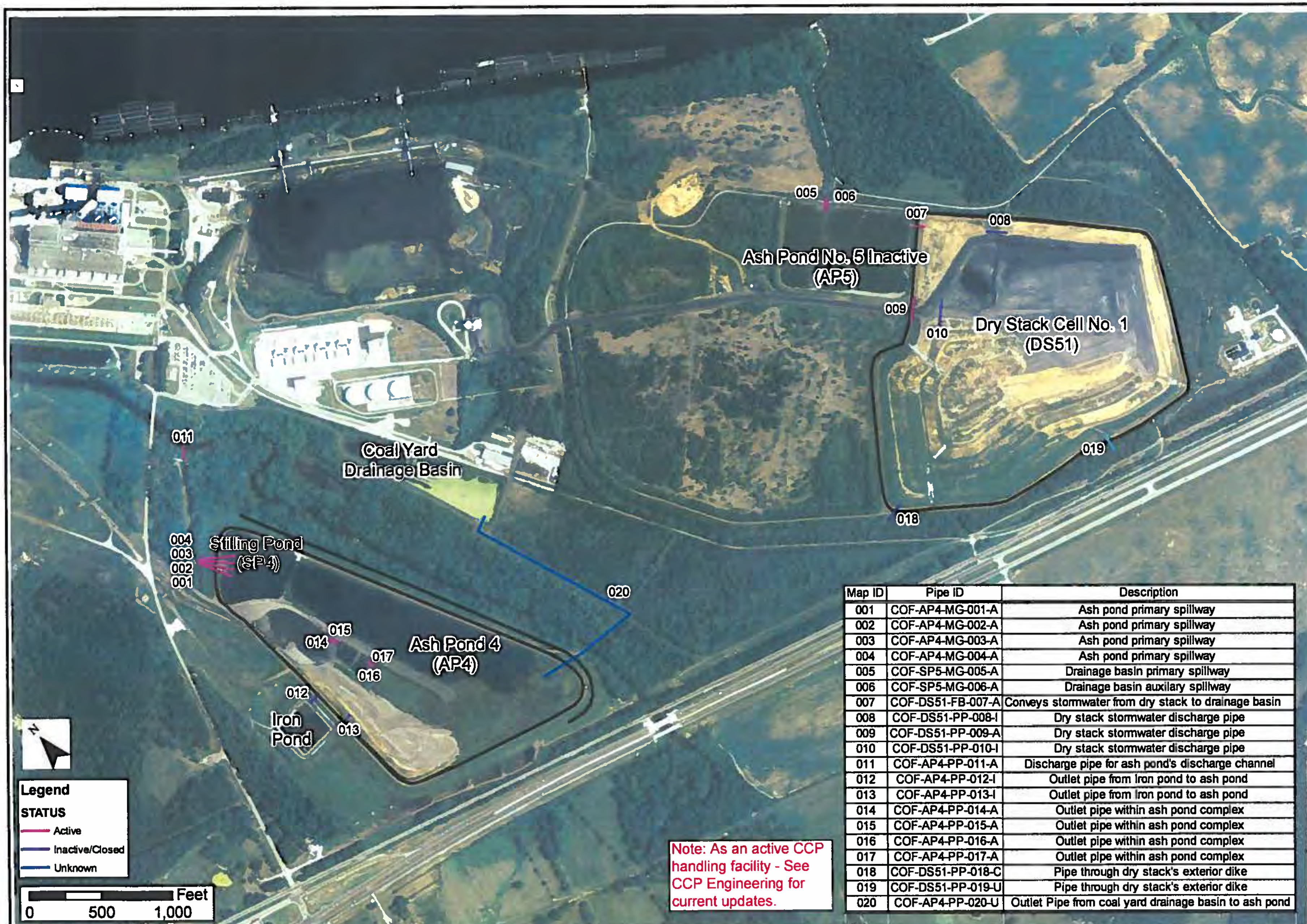


2009 Inundation Map for Ash Pond 4.



Ash Pond 4 p[illegible] 1984 [illegible]

URS



Map ID	Pipe ID	Description
001	COF-AP4-MG-001-A	Ash pond primary spillway
002	COF-AP4-MG-002-A	Ash pond primary spillway
003	COF-AP4-MG-003-A	Ash pond primary spillway
004	COF-AP4-MG-004-A	Ash pond primary spillway
005	COF-SP5-MG-005-A	Drainage basin primary spillway
006	COF-SP5-MG-006-A	Drainage basin auxiliary spillway
007	COF-DS51-FB-007-A	Conveys stormwater from dry stack to drainage basin
008	COF-DS51-PP-008-I	Dry stack stormwater discharge pipe
009	COF-DS51-PP-009-A	Dry stack stormwater discharge pipe
010	COF-DS51-PP-010-I	Dry stack stormwater discharge pipe
011	COF-AP4-PP-011-A	Discharge pipe for ash pond's discharge channel
012	COF-AP4-PP-012-I	Outlet pipe from Iron pond to ash pond
013	COF-AP4-PP-013-I	Outlet pipe from Iron pond to ash pond
014	COF-AP4-PP-014-A	Outlet pipe within ash pond complex
015	COF-AP4-PP-015-A	Outlet pipe within ash pond complex
016	COF-AP4-PP-016-A	Outlet pipe within ash pond complex
017	COF-AP4-PP-017-A	Outlet pipe within ash pond complex
018	COF-DS51-PP-018-C	Pipe through dry stack's exterior dike
019	COF-DS51-PP-019-U	Pipe through dry stack's exterior dike
020	COF-AP4-PP-020-U	Outlet Pipe from coal yard drainage basin to ash pond

Note: As an active CCP handling facility - See CCP Engineering for current updates.

Spillway/Conduit Inventory

Tennessee Valley Authority
Colbert Fossil Plant
Tuscumbia, Colbert County, Alabama

Stantec

STANTEC CONSULTING SERVICES INC.
1409 N. Forbes Rd
Lexington, Kentucky
40511-2050
859-422-3000

SHEET
1 OF 1
502-1

Photo Log		
Drawing Mark	**Comments**	
COF-AP4-MG-001-A _p1	48" Morning Glory Riser in Ash Pond 4 (1 of 4)	
COF-AP4-MG-001-A _p1	48" Morning Glory Riser in Ash Pond 4 (1 of 4)	
COF-AP4-MG-001-A _p1	48" Morning Glory Riser in Ash Pond 4 (1 of 4)	
COF-AP4-MG-001-A _p1	48" Morning Glory Riser in Ash Pond 4 (1 of 4)	
COF-AP4-MG-001-A _p2	Outlet pipes from Ash Pond 4 discharging into discharge channel	
COF-AP4-MG-001-A _p3	Outlet pipes from Ash Pond 4 discharging into discharge channel	
COF-AP4-MG-001-A _p4	Ash Pond 4's discharge channel	
COF-AP4-PP-011-A _p1	Ash Pond 4's discharge channel outlet pipe discharging into Cane Creek (inlet)	
COF-AP4-PP-011-A _p2	Ash Pond 4's discharge channel outlet pipe discharging into Cane Creek	
COF-SP5-MG-005-A _p1	Disposal Area 5 Spillway	
COF-SP5-MG-006-A _p1	Disposal Area 5 Auxiliary Spillway	
COF-SP5-MG-005-A _p2	Disposal Area 5 spillway outlet pipes	
COF-DS51-PP-007-A _p1	Disposal Area 5 outlet pipe to stilling pond (or drainage basin)	
COF-DS51-PP-007-A _p2	Disposal Area 5 outlet pipe discharging into stilling pond (or drainage basin)	
COF-DS51-PP-009-A _p1	Disposal Area 5 Dry Stack; outlet pipe underneath haul road, partly plugged	

COF-DS51-PP-009-A _p2	Disposal Area 5 Dry Stack; outlet pipe underneath haul road, partly plugged	
COF-AP4-PP-012-I _p1	Inactive steel outlet pipe from Iron Pond to west side of Ash Pond	
COF-AP4-PP-013-I _p1	Inactive PVC outlet pipe from Iron Pond to west side of ash pond	
COF-AP4-PP-014-A _p1	24" Fiberglass outlet pipes located within the ash pond complex (pipes -014 and -015)	
COF-AP4-PP-016-A _p1	24" Steel outlet pipes located within the ash pond complex (pipes -016 and -017)	
COF-DS51-PP-018-C _p1	Plugged fiberglass outlet pipe penetrating dike on west end of dry stack	
COF-DS51-PP-019-C _p1	Steel outlet pipe penetrating dike on southwest side of dry stack	

LEGEND

A — Static Factor of Safety (F.S.) for Slope Stability F.S. ≥ 1.5

A — Static Factor of Safety (F.S.) for Slope Stability 1.3 ≤ F.S. < 1.5

A — Static Factor of Safety (F.S.) for Slope Stability F.S. < 1.3

0 200 400 800
Scale in Feet

BASE MAP SOURCE:
1. Aerial survey based upon files ortho8385800_1719350 and ortho8395400_1719350, dated April 13, 2010, provided by TVA.
2. Information presented in this figure based solely on Stantec Report of Geotechnical Exploration and Slope Stability Evaluation, Ash Pond 4, Colbert Fossil Plant, Janurary 22, 2010.

TVA TENNESSEE VALLEY AUTHORITY
COLBERT FOSSIL PLANT

SUMMARY OF STABILITY RESULTS FROM STANTEC GEOTECH REPORT YARD ASH POND 4

DATE: 7/6/2011	FIGURE: 1
DRAWN BY: MPS	CHECKED BY:
URS	JOB NUMBER: 31881022

37 C 10W706-02

BORING LOCATION TABLE

BORING	NORTHING	EASTING	ELEVATION
STN-4-1	1,723,869.52	394,330.89	460.2
STN-4-2	1,723,632.72	394,208.32	438.4
STN-4-3	1,723,645.94	394,253.91	427.3
STN-4-4	1,723,316.42	394,738.76	460.4
STN-4-5	1,723,346.01	394,798.52	438.5
STN-4-6	1,723,373.16	394,864.84	418.6
STN-4-7	1,722,880.06	394,890.81	460.8
STN-4-8	1,722,943.46	395,089.90	421.6
STN-4-9	1,722,306.36	395,380.37	461.2
STN-4-10	1,722,357.06	395,401.16	420.9
STN-4-11	1,721,862.90	395,468.31	461.3
STN-4-12	1,721,504.67	395,746.27	448.2
STN-4-13	1,721,330.83	395,874.15	425.3
STN-4-14	1,721,420.06	395,715.83	461.9
STN-4-15	1,721,219.13	395,347.89	460.5
STN-4-16	1,721,128.23	395,391.96	435.1
STN-4-17	1,721,538.56	394,882.90	476.8
STN-4-18	1,721,402.10	394,539.84	461.1
STN-4-19	1,721,382.01	394,478.66	448.3
STN-4-20	1,721,887.83	394,461.02	482.3
STN-4-21	1,721,868.14	394,282.71	460.2
STN-4-22	1,721,857.70	394,065.63	438.0
STN-4-23	1,722,728.47	394,227.94	461.1
STN-4-24	1,722,623.19	394,138.84	444.3

LEGEND

- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Sampling
- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Piston Sampling, And Piezometer Installation
- Soil Boring With Continuous Standard Penetration Tests And/or Shelby Tube Sampling, Rock Core, And Piezometer Installation

NOTES

1. Topographic and survey information provided by the Tennessee Valley Authority.
2. The Boring Logs And Related Information Shown On This Drawing 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. Any Correlations Shown Between Borings Are Generally Based On Straight Line Interpolation. Actual Conditions Between Borings Are Unknown And May Differ From Those Shown.

Note: As an active CCP handling facility - See CCP Engineering for current updates.

RECORD DRAWING

GRAPHIC SCALE 1"=200'

For Supporting Design Calculations see FPCOFFESCDX000002010001

1/22/10

SCALE: 1"=200' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION
BORING AND STABILITY
CROSS-SECTION PLAN

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

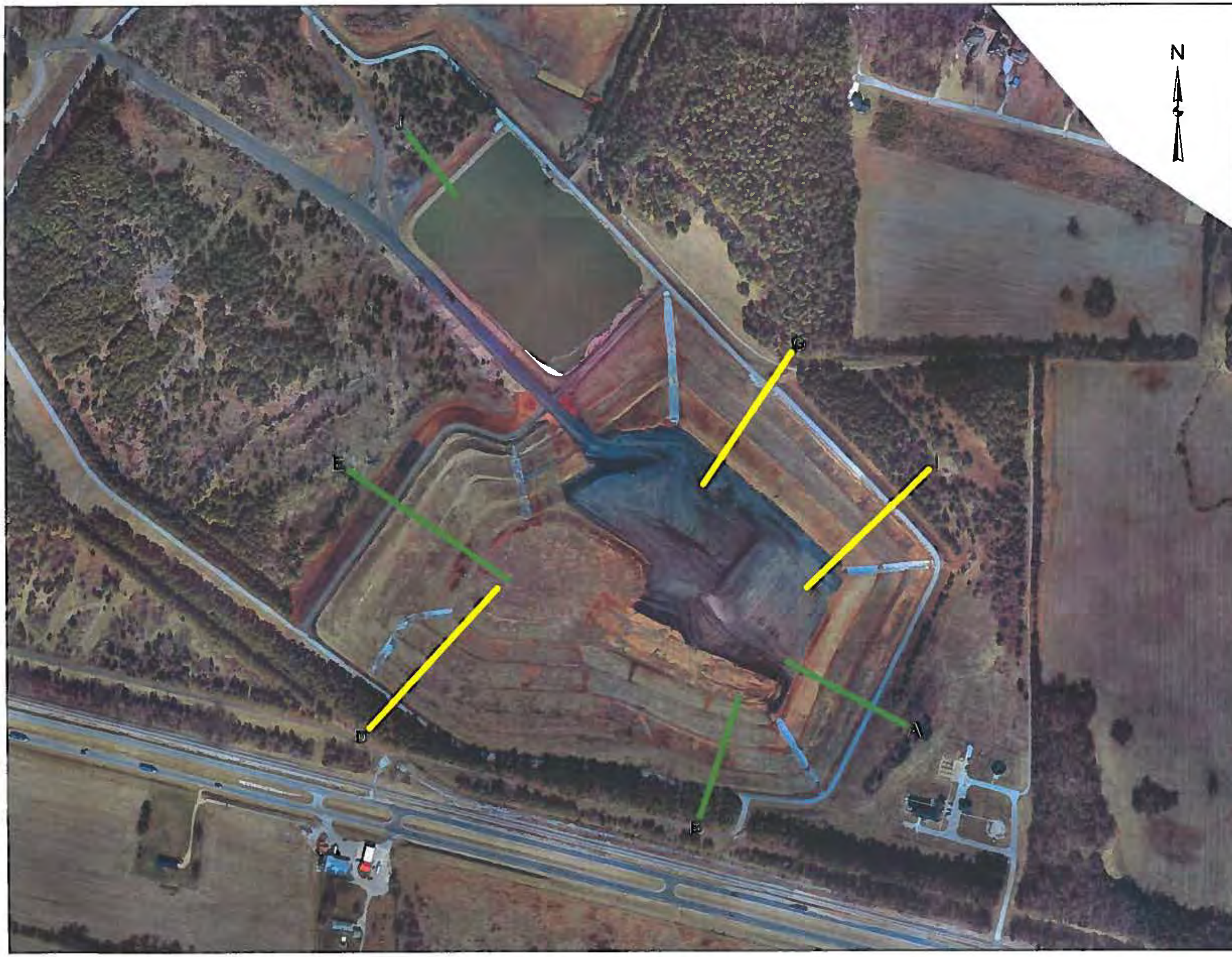
AUTOCAD R 2000 | 37 | C | 10W706-02 | R 0

STANTEC | 0
TASK COMPLETED BY | REV NO

PLOT FACTOR XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

503-2



LEGEND

A — Static Factor of Safety (F.S.) for Slope Stability (global) F.S. ≥ 1.5

A — Static Factor of Safety (F.S.) for Slope Stability (global) 1.3 ≤ F.S. < 1.5

A — Static Factor of Safety (F.S.) for Slope Stability (global) F.S. < 1.3

Note: As an active CCP handling facility - See CCP Engineering for current updates.

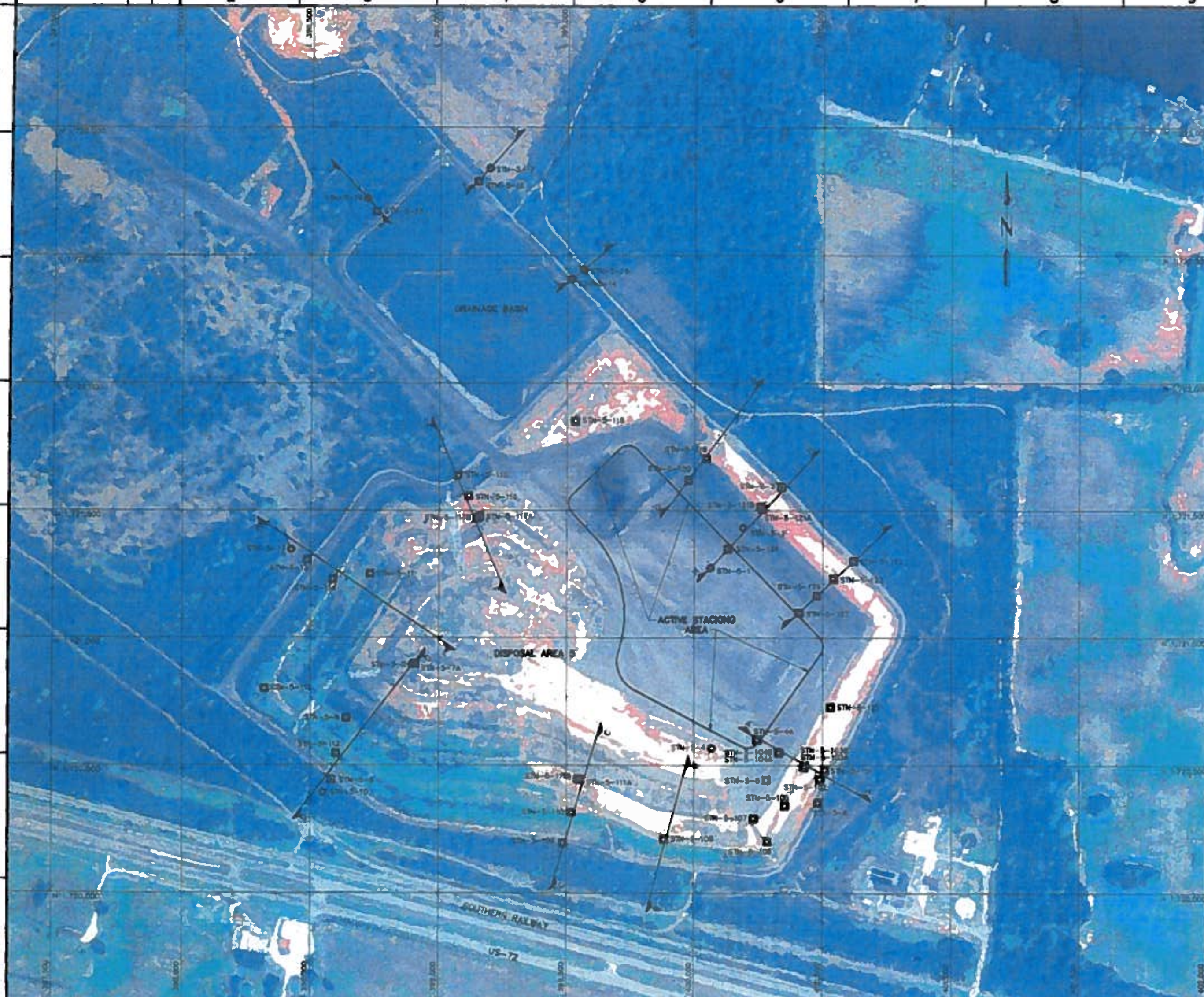
0 200 400 800
Scale in Feet

BASE MAP SOURCE
1. Aerial survey based upon files ortho8385800_1719350 and ortho8395400_1719350, dated April 13, 2010, provided by TVA.
2. Information presented in this figure based solely on Stantec Draft Report of Geotechnical Exploration and Slope Stability Evaluation, Area 5 Dry Stack, Colbert Fossil Plant, February 23, 2010.

TVA TENNESSEE VALLEY AUTHORITY
COLBERT FOSSIL PLANT

SUMMARY OF STABILITY RESULTS FROM STANTEC GEOTECH REPORT YARD DISPOSAL AREA NO. 5

DATE: 7/6/2011	FIGURE: 1
DRAWN BY: MPS	CHECKED BY:
URS	JOB NUMBER: 31881022



LEGEND

- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Sampling
- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Piston Sampling (Piezometer Installed)
- Soil Boring With Continuous Standard Penetration Tests And/or Shelby Tube Sampling, Rock Core, And Piezometer Installed
- Cross Section

BORING LOCATION TABLE

Boring	Northing	Easting	Elev. (ft.)
STN-5-1	1,721,274.40	400,063.00	552.91
STN-5-2	1,721,432.78	400,188.85	529.19
STN-5-3	1,721,592.79	400,338.67	487.54
STN-5-4	1,720,567.21	400,087.66	558.98
STN-5-4A	1,720,600.17	400,244.82	550.70
STN-5-5	1,720,441.17	400,279.80	528.71
STN-5-6	1,720,353.73	400,481.02	488.08
STN-5-7	1,720,895.57	398,898.12	564.52
STN-5-7A	1,720,897.20	398,908.71	563.34
STN-5-8	1,720,884.82	398,841.15	517.82
STN-5-9	1,720,444.22	398,582.58	480.52
STN-5-10	1,720,383.13	398,849.84	459.85
STN-5-11	1,721,251.58	398,733.51	515.53
STN-5-12	1,721,308.21	398,486.81	477.77
STN-5-13	1,721,348.27	398,424.36	452.28
STN-5-14	1,722,407.30	399,518.43	478.88
STN-5-15	1,722,443.72	399,582.30	462.85
STN-5-16	1,722,788.34	399,148.51	478.84
STN-5-17	1,722,840.75	399,188.10	458.60
STN-5-18	1,722,871.43	398,762.80	472.18
STN-5-19	1,722,721.58	398,717.11	453.41
STN-5-101	1,720,482.33	400,509.25	488.97
STN-5-102	1,720,445.72	400,489.29	486.80
STN-5-103A	1,720,483.35	400,426.84	508.95
STN-5-103B	1,720,488.42	400,429.29	508.48
STN-5-104A	1,720,546.28	400,328.22	530.48
STN-5-104B	1,720,551.74	400,330.04	530.75
STN-5-105	1,720,341.58	400,353.10	507.40
STN-5-106	1,720,202.10	400,284.88	505.40
STN-5-107	1,720,282.02	400,232.46	527.19
STN-5-108	1,720,211.08	398,882.93	509.29
STN-5-109	1,720,185.76	398,486.17	481.82
STN-5-110	1,720,315.43	398,519.58	509.44
STN-5-111A	1,720,445.15	399,553.23	528.32
STN-5-111B	1,720,448.68	399,545.11	528.34
STN-5-112	1,720,548.53	398,601.38	497.91
STN-5-113	1,720,808.24	398,321.28	499.24
STN-5-114	1,721,230.71	398,587.74	497.51
STN-5-115	1,721,836.94	399,073.55	477.77
STN-5-116	1,721,557.19	399,115.88	481.58
STN-5-117A	1,721,479.82	399,158.40	512.79
STN-5-117B	1,721,489.59	399,148.35	512.84
STN-5-118	1,721,850.73	398,533.21	489.18
STN-5-119	1,721,703.92	400,044.78	504.54
STN-5-120	1,721,819.44	399,876.15	525.76
STN-5-121A	1,721,508.28	400,264.15	508.23
STN-5-121B	1,721,514.85	400,256.18	507.94
STN-5-122	1,721,301.29	400,620.41	488.86
STN-5-123	1,721,231.75	400,542.84	508.11
STN-5-124	1,721,165.96	400,478.58	527.23
STN-5-125	1,720,727.47	400,531.28	509.03
STN-5-126	1,721,348.47	400,128.73	554.68
STN-5-127	1,721,097.71	400,407.87	550.45

Note: As an active CCP handling facility - See CCP Engineering

RECORD DRAWING

GRAPHIC SCALE 1"=150'

For Supporting Design Calculations see FPOOFFECON000000000000002

SCALE: 1"=150' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5
GEOTECHNICAL EXPLORATION
BORING AND STABILITY
CROSS SECTION PLAN

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

Stantec

AUTOCAD R 2000 | 37 | C | 10W707-02 | R 0

PLOT FACTOR:XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY | REV NO.

37 | C | 10W707-02

503-4

The Seepage Action Plan serves three primary functions: educate the inspector about potential seepage areas, assist the inspector in determining the seepage action level based on the seepage characteristics, and inform the inspector of corrective measures to take based on the seepage action level.

The Seepage Action Plan can be found at: \\chapgfs2\ccp\Seepage_Action_Plans\COF

Seepage through an impoundment can typically be found on the lower third of the slope and extending downstream beyond the toe approximately fifty feet. Other seepage areas may exist, and the field inspector should be familiar with previous inspection reports and photographed observations. The site plan(s) included in the Seepage Log are intended to document historical locations of seepage.

Three seepage action levels are identified in the plan:

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

Depending on the level of the seepage, various actions need to be taken. For Level 1, the field supervisor should document the seepage area into the seepage log by recording the date, time, size of area, location, and taking photographs.

For Level 2, the field supervisor should carefully inspect the area for outflow quantity, transported material, and take photographs. Team members should be contacted in accordance with Figure 8 of the plan, and photographs should be sent to the RHO&M Construction Manager and Program Manager for distribution. The seepage area should be documented in the log in the same manner as Level 1.

For Level 3, the Field Supervisor should inspect the area for outflow quantity and transported material and determine if piping has occurred. He should take photographs and contact team members in accordance with Figure 9 of the plan. The objective is to determine a plan of action within four hours of notification by the team consisting of the geotechnical consultant, TVA Program Manager, and CCP Engineering Manager. The seepage location and repair should be recorded in the seepage log in the same manner.

In order to be prepared for corrective actions, concrete sand, crushed stone, riprap, sandbags, and pipe for temporary culverts should be purchased and stockpiled onsite for an emergency situation. These readily available materials can be used to construct a reverse graded filter or to place sandbags around a boil to reduce piping of embankment soils. The type and quantity of required materials are defined in Table 1 of the Seepage Action Plan.

URS

CALCULATION SHEET

PROJECT	TVA COLBERT FACILITY	JOB NO.	31881012
SUBJECT	SEEP TRACKING FORM	SHEET NO.	
ORIGINATED BY	CAS	DATE	3/3/2011
CHECKED BY	JHW	DATE	3/4/2011
CALC. NO.		REV. NO.	

SEEP NO.	DATE FOUND	SITE GRID NORTH	SITE GRID EAST	LAT (N)	LONG (W)	SAP LEVEL	STATUS	ACTION DATE	UPDATE DATE	DESCRIPTION	DOCUMENTATION
1	3/9/2010	1722132.0	395432.2	34 44' 00.7"	87 50' 53.8"	2	Mitigation beginning in 2010 (Note: Stantec Seeps 1 and 6 have been consolidated)	3/9/10	3/7/2011	SEEP	Available upon request
2	3/9/2010	1723332.0	394809.5	34 44' 12.2"	87 51' 00.7"	2	Mitigation beginning in 2010	3/9/10	3/7/2011	SEEP	Available upon request
3	3/9/2010	1721411.0	395793.0	34 43' 53.4"	87 50' 48.5"	2	Mitigation beginning in 2010	3/9/10	3/7/2011	SEEP	Available upon request
4	3/9/2010	1721177.0	395246.1	34 43' 50.7"	87 50' 55.6"	2	Mitigation beginning in 2010	3/9/10	3/7/2011	SEEP	Available upon request
5	3/9/2010	TBD	TBD	TBD	TBD	1	Mitigation beginning in 2010	3/9/10	3/7/2011	REPAIRED	Available upon request

Note: This comprehensive seepage log includes all seeps identified at COF by both Stantec and URS

created: March 7, 2011
by: Allen Sharlett

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.

Note: As an active CCP handling facility - See Field Supervisor or the FDG&C Sharepoint for current updates.

LEGEND

N

Areas of Concern

Stockpile Location

Potential Seepage Zone

0 250 500 Feet

STANTEC CONSULTING SERVICES INC
1409 N Forbes Rd
Lexington, Kentucky
40511-2050
859-422-3000

Stantec

SEEPAGE ACTION PLAN

Tennessee Valley Authority
Colbert Fossil Plant
Tuscumbia, Colbert County, Alabama

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

504-4

NOTES TO USERS

STATE OF ALABAMA FIRM PANEL LOCATOR DIAGRAM

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

OTHER AREAS

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

MAP SCALE 1" = 2000'

METERS

PANEL 0300D

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

COLBERT COUNTY,
ALABAMA
AND INCORPORATED AREAS

PANEL 300 OF 550
(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

EFFECTIVE DATE FEBRUARY 17, 2010

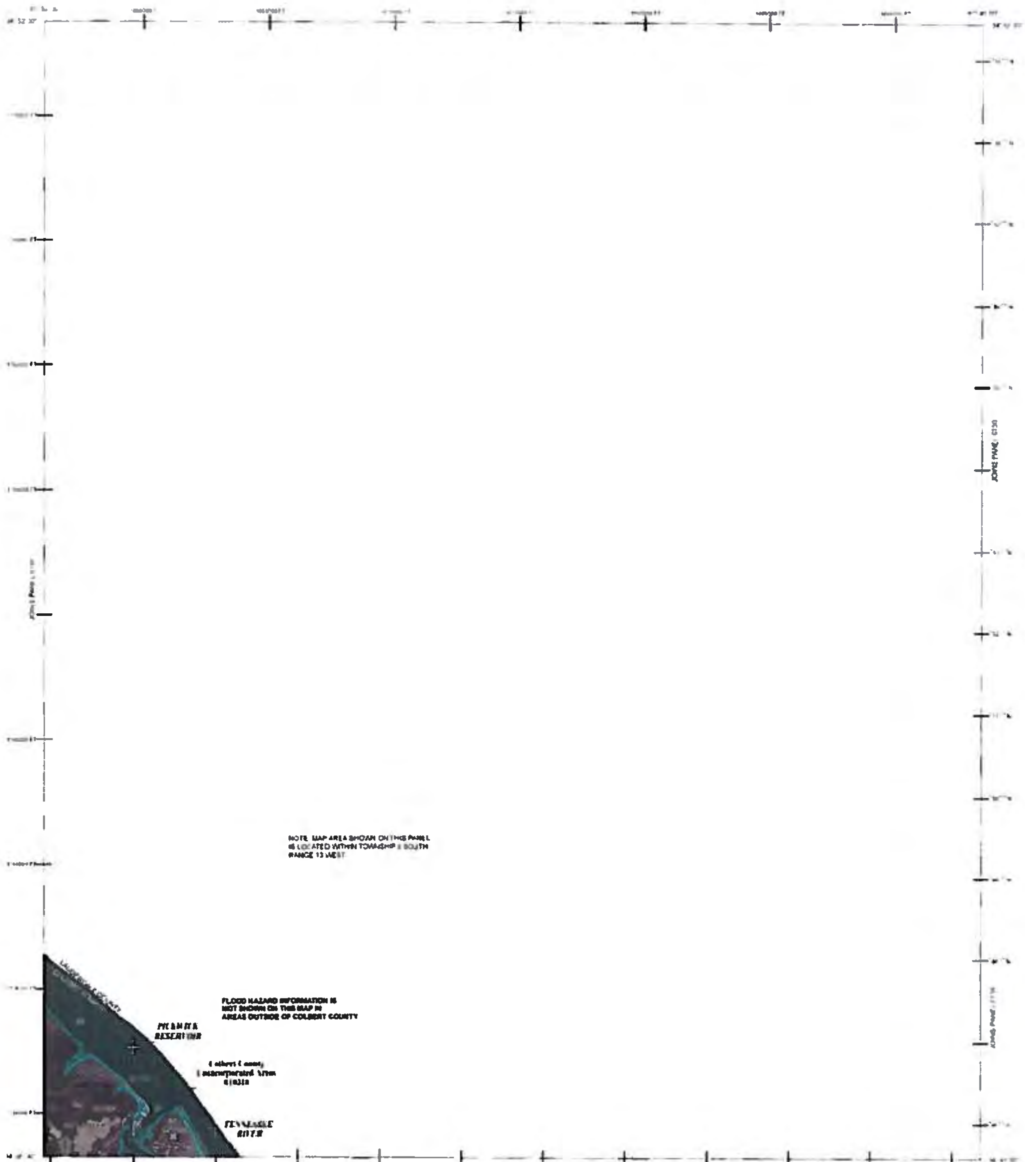
MAP NUMBER 01033C0300D

State of Alabama
Federal Emergency Management Agency

505-1

NOTES TO USERS

STATE OF ALABAMA FIRM PANEL LOCATOR DIAGRAM



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

OTHER AREAS

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

MAP SCALE 1" = 2000'

FEET

METERS

NFIP

PANEL 0125D

FIRM

FLOOD INSURANCE RATE MAP

COLBERT COUNTY, ALABAMA AND INCORPORATED AREAS

PANEL 125 OF 550

(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

NATIONAL FLOOD INSURANCE PROGRAM

EFFECTIVE DATE: FEBRUARY 17, 2010

MAP NUMBER 01033C0125D

State of Alabama

Federal Emergency Management Agency

Colbert Fossil Plant
Coal Combustion Byproduct Handling
Scope of Work/Contract

I. FLY ASH HANDLING

CONTRACTOR shall be responsible for providing all required material, equipment, and labor to haul conditioned fly ash from the plant silo and place on the dry fly ash storage stack in accordance with TVA approved design drawings/specifications & ADEM permit requirements. Colbert Yard Operations will supply personnel to operate the ash silo unloading system. Conditioned fly ash will be removed from the silo on an adequate frequency to ensure that plant operations are not impacted.

CONTRACTOR will keep the dry fly ash sediment pond cleaned out as required to prevent ash from migrating to the river. Ash removed from the sediment pond will be placed on the dry fly ash stack, which will be handled as a special project.

It is expected that CONTRACTOR will haul and place 325,000 dry tons of fly ash per year.

II. BOTTOM ASH HANDLING

CONTRACTOR's responsibility will begin at the discharge point of the sluice line from the plant. CONTRACTOR will provide all required material, equipment, and labor to reclaim bottom ash production to maintain flow. CONTRACTOR will also ensure at least four feet of freeboard in the bottom ash pond in conformance with the CCP Programmatic Document. No visible build up in the pond area will be allowed. It is expected that the channel will be cleaned out 2 to 3 times per week, with every other day being a good working guideline and also keeping the bottom ash 2' below the ash sluice lines. For final disposal, CONTRACTOR will haul and place bottom ash on the bottom ash stack in accordance with TVA approved design drawings/specifications & ADEM permit requirements. CONTRACTOR will use good practice to maintain the bottom ash stack. Slopes on the bottom ash stack will be constructed and maintained in a uniform configuration.

TVA CCP will perform an initial survey of the Ash Pond and Stilling Pond prior to commencement of the project and on at least an annual basis thereafter. If the CONTRACTOR allows more than 10% of total annual bottom ash production (approximately 3,000 cy "pond cubic yards" per year) to reach the Ash Pond and Stilling Pond, the CONTRACTOR must remove any ash over the 10% of annual production from the ponds at its own expense within three months of discovery by CCP or on a schedule determined by CCP. The removal plan must be approved by CCP Program Management. Prior to CONTRACTOR's start of activities a hydrographic survey will be performed to determine Free Water Volume (FWV).

The expected volume of bottom ash to be handled is 30,000 dry tons per year.

III. DUST CONTROL

CONTRACTOR will maintain a zero visible dust standard 24/7/365 regardless of whether the CONTRACTOR is actively performing work.

IV. FACILITY INSPECTIONS

CONTRACTOR will perform daily inspections of all ash storage facilities in accordance with the CCP Programmatic Document. CONTRACTOR will complete required forms and maintain records in onsite trailer. Seepage discovered or appearing to change during inspections will be immediately communicated with TVA Field Supervisor. Problems discovered during these routine inspections will be corrected by the contractor under a T&M pricing structure, upon written request.

V. COMMUNICATIONS

CONTRACTOR will provide daily report summarizing work item status. Each report will include amount of ash moved that day and equipment onsite. In the event an accident occurs it is the CONTRACTOR's responsibility to immediately notify the CCP Field Supervisor. In the event an accident/incident occurs the CONTRACTOR must within 24 hours develop a "White Paper" describing the event and the immediate steps to mitigate future similar events.

VI. AGREEMENT PRICE & DURATION

CONTRACTOR agrees that the work specified in this agreement can be performed for a fixed rate price of [redacted], to be paid to CONTRACTOR in twelve monthly payments as the work is performed. A onetime mobilization fee will be paid to the contractor in the amount of [redacted]. The purpose of the fixed monthly payment is to compensate the CONTRACTOR for the estimated manpower, equipment, overhead and profit to perform the work. The fixed monthly payments will be paid only during the months that the CONTRACTOR is actively operating. In the event that TVA shuts down the work, it will be TVA's sole discretion to utilize the manpower and equipment for other activities; to furlough the manpower and pay a standby charge for the equipment equal to [redacted] of the regular equipment rate; or to enact a partial termination of the contract, per Section 51 (Termination of Convenience) of the blanket contract.

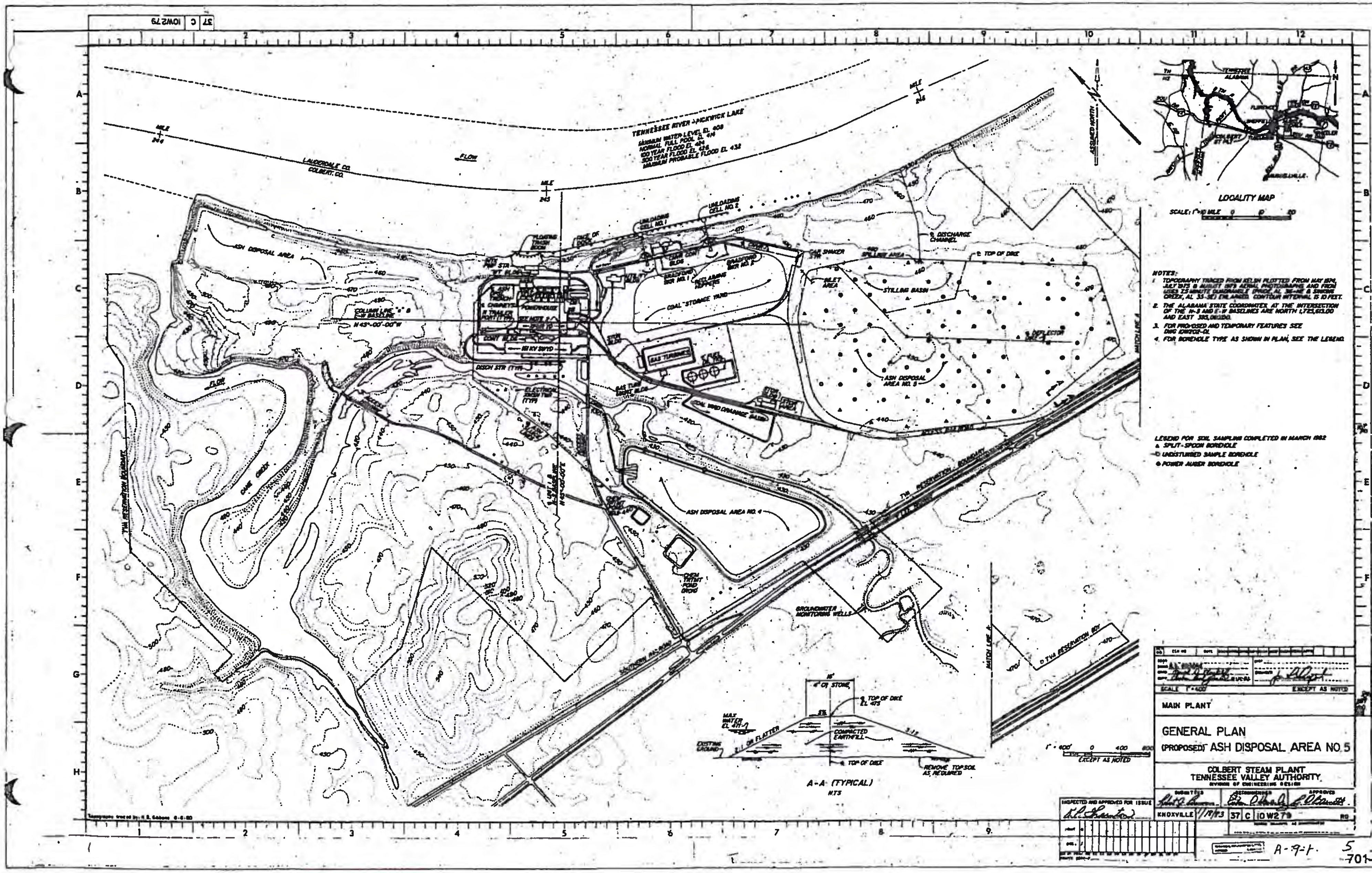
CONTRACTOR will maintain and distribute a report card to track key measures of CONTRACTOR performance. This agreement is in effect from October 1, 2010 through September 30, 2015.

VII. ADDITIONAL WORK

Additional work shall be defined as activities other than basic routine handling of ash. Additional work shall be paid for using the T&M pricing structure. Examples of additional work shall include temporary earth cover, density testing, seeding & erosion control, cenosphere management, quarterly inspection repairs, etc. Examples of activities that are not considered additional work are construction surveying, attending meetings, participation in quarterly inspections, housekeeping, etc. Work that can be performed with the existing onsite manpower and equipment, within normal work hours will be completed at no additional charge to TVA. Otherwise, the CONTRACTOR shall provide a scope, schedule and budget to perform the additional work and obtain written approval from the TCM prior to proceeding with the work.

VIII. CALCULATION OF OVERAGES

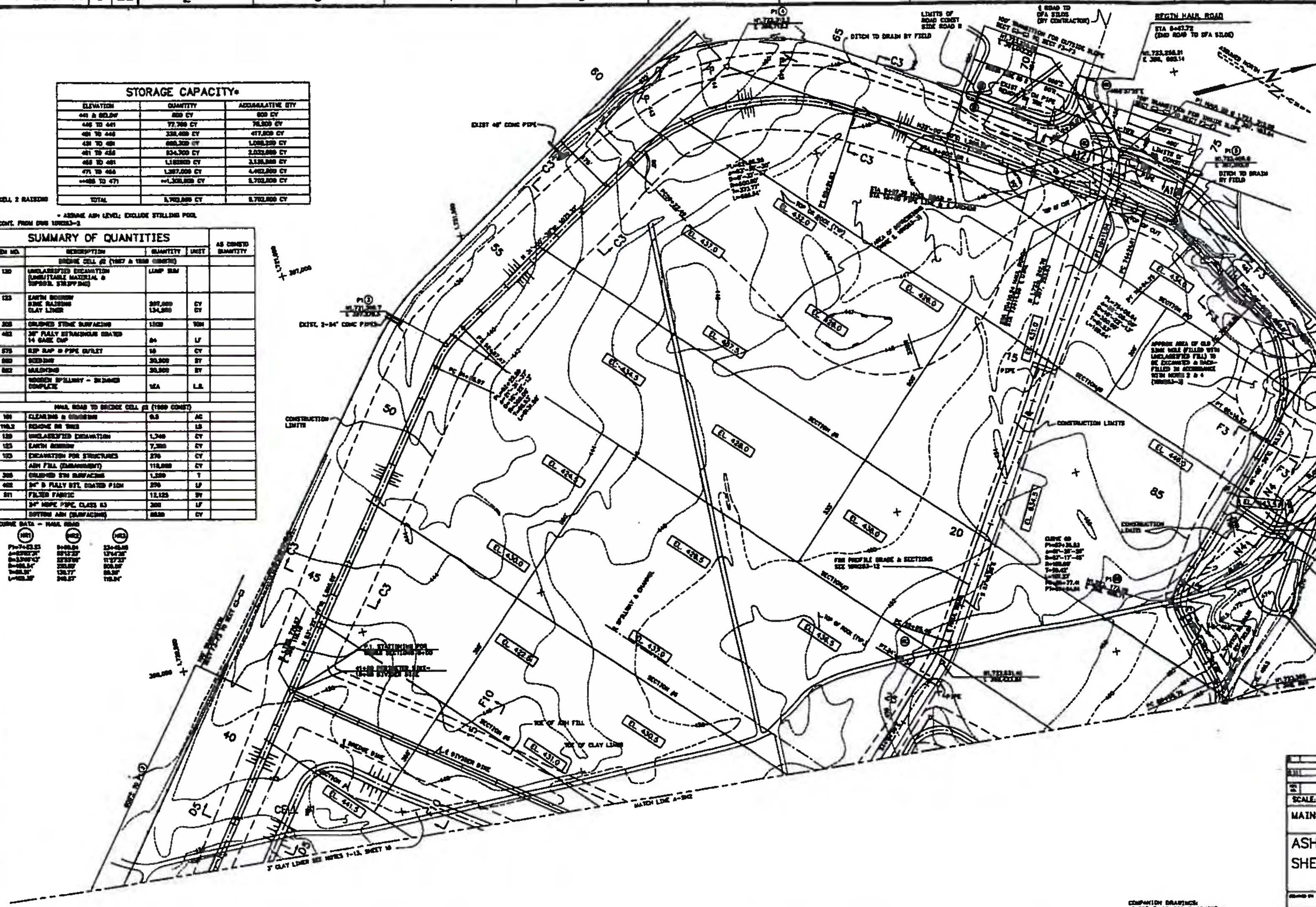
Tonnages over the annual amounts noted in this scope of work will be calculated based upon coal burn data. RHO&M and the Partners will work together in an effort to verify the annual production. The lump sum pricing stated above is good for up to 10% over the annual tonnage quantities detailed in this scope of work. The additional charge per ton to be paid for tonnage quantities greater than 10% is [redacted].

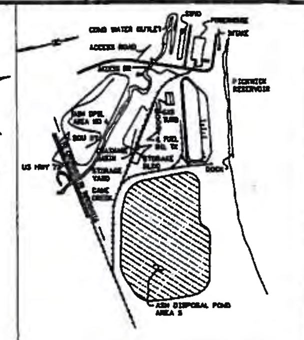


TENNESSEE RIVER - PICKWICK LAKE
MAXIMUM WATER LEVEL EL 408
NORMAL FULL POOL EL 414
100 YEAR FLOOD EL 426
500 YEAR FLOOD EL 426
MAXIMUM PROBABLE FLOOD EL 432
FLOW
LAUDERDALE CO.
COLBERT CO.
ASH DISPOSAL AREA
COAL STORAGE YARD
STILLING BASIN
ASH DISPOSAL AREA NO. 5
ASH DISPOSAL AREA NO. 4
GAS TURBINES
COAL YARD DRAINAGE BASIN
GROUNDWATER MONITORING WELLS
SOUTHERN RAILROAD
TVA RESERVATION BOUNDARY
ASSUMED NORTH
LOCALITY MAP
SCALE: 1" = 10 MILE
NOTES:
1. TOPOGRAPHY TRACED FROM KELSH PLOTTED FROM MAY 1974, JULY 1975 & AUGUST 1975 AERIAL PHOTOGRAPHS AND FROM USGS 7.5 MINUTE QUADRANGLE (PRIDE, AL 36-NE & SINKING CREEK, AL 35-SE) ENLARGED. CONTOUR INTERVAL IS 10 FEET.
2. THE ALABAMA STATE COORDINATES AT THE INTERSECTION OF THE N-S AND E-W BASELINES ARE NORTH 1,723,613.00 AND EAST 393,061.00.
3. FOR PROPOSED AND TEMPORARY FEATURES SEE DWG 10W202-01.
4. FOR BOREHOLE TYPE AS SHOWN IN PLAN, SEE THE LEGEND.
LEGEND FOR SOIL SAMPLING COMPLETED IN MARCH 1982
▲ SPLIT-SPOON BOREHOLE
UNDISTURBED SAMPLE BOREHOLE
● POWER AUGER BOREHOLE
A-A (TYPICAL)
NTS
TOP OF DIKE
COMPACTED EARTHFILL
REMOVE TOPSOIL AS REQUIRED
EXCEPT AS NOTED
SCALE 1" = 400' EXCEPT AS NOTED
MAIN PLANT
GENERAL PLAN
(PROPOSED) ASH DISPOSAL AREA NO. 5
COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
KNOXVILLE 1/18/73 37 C 10W279
37 C 10W279

A-9-1.

5
701-1





LOCATION PLAN

NTS

STORAGE CAPACITY*

ELEVATION	QUANTITY	ACCUMULATIVE QTY
441 & BELOW	800 CY	800 CY
446 TO 441	77,700 CY	78,500 CY
451 TO 446	338,400 CY	417,000 CY
456 TO 451	660,300 CY	1,080,200 CY
461 TO 456	934,300 CY	2,032,000 CY
466 TO 461	1,102,000 CY	3,135,000 CY
471 TO 466	1,267,000 CY	4,402,000 CY
**486 TO 471	**1,300,000 CY	5,702,000 CY
TOTAL	5,702,000 CY	5,702,000 CY

**CELL 2 RAISING

* ASSUME ASH LEVEL; EXCLUDE STILLING POOL

CONT. FROM DWG 10W283-3

SUMMARY OF QUANTITIES

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	AS CONSTD QUANTITY
	BRIDGE CELL #2 (1987 & 1988 CONSTR)			
120	UNCLASSIFIED EXCAVATION (UNSUITABLE MATERIAL & TOPSOIL STRIPPING)	LUMP SUM		
123	EARTH BORROW DIKE RAISING CLAY LINER	307,000 134,000	CY CY	
303	CRUSHED STONE SURFACING	1300	TON	
402	36" FULLY BITUMINOUS COATED 14 GAGE CMP	84	LF	
575	RIP RAP @ PIPE OUTLET	16	CY	
660	SEEDING	30,000	SY	
662	MULCHING	30,000	SY	
	WOODEN SPILLWAY - SKIMMER COMPLETE	1EA	L.S.	
	HAUL ROAD TO BRIDGE CELL #2 (1988 CONST)			
101	CLEARING & GRUBBING	9.5	AC	
110.2	REMOVE 88 TREES		LS	
120	UNCLASSIFIED EXCAVATION	1,740	CY	
123	EARTH BORROW	7,300	CY	
125	EXCAVATION FOR STRUCTURES	270	CY	
	ASH FILL (EMBANKMENT)	118,000	CY	
303	CRUSHED STN SURFACING	1,200	T	
402	36" Ø FULLY BIT. COATED PICM	270	LF	
511	FILTER FABRIC	12,125	SY	
	24" HDPE PIPE, CLASS 63	300	LF	
	BOTTOM ASH (SURFACING)	8820	CY	

CURVE DATA - HAUL ROAD

HR1	HR2	HR3
PI=7+23.23	9+80.84	23+45.80
Δ=53°02'30"	58°13'22"	17°14'35"
D=13°00'42"	22°23'08"	11°27'33"
R=440.34'	255.89'	500.00'
T=220.31'	139.77'	80.50'
L=403.38'	240.27'	118.24'

COMPANION DRAWINGS:
10W283-2, 10W283-3, 10W297,
10W283-4, 10W283-5, 10W235-1
10W283-5 10W284-6, 10W283-10

SCALE: 1"=100' EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA NO. 5
SHEET 1

COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

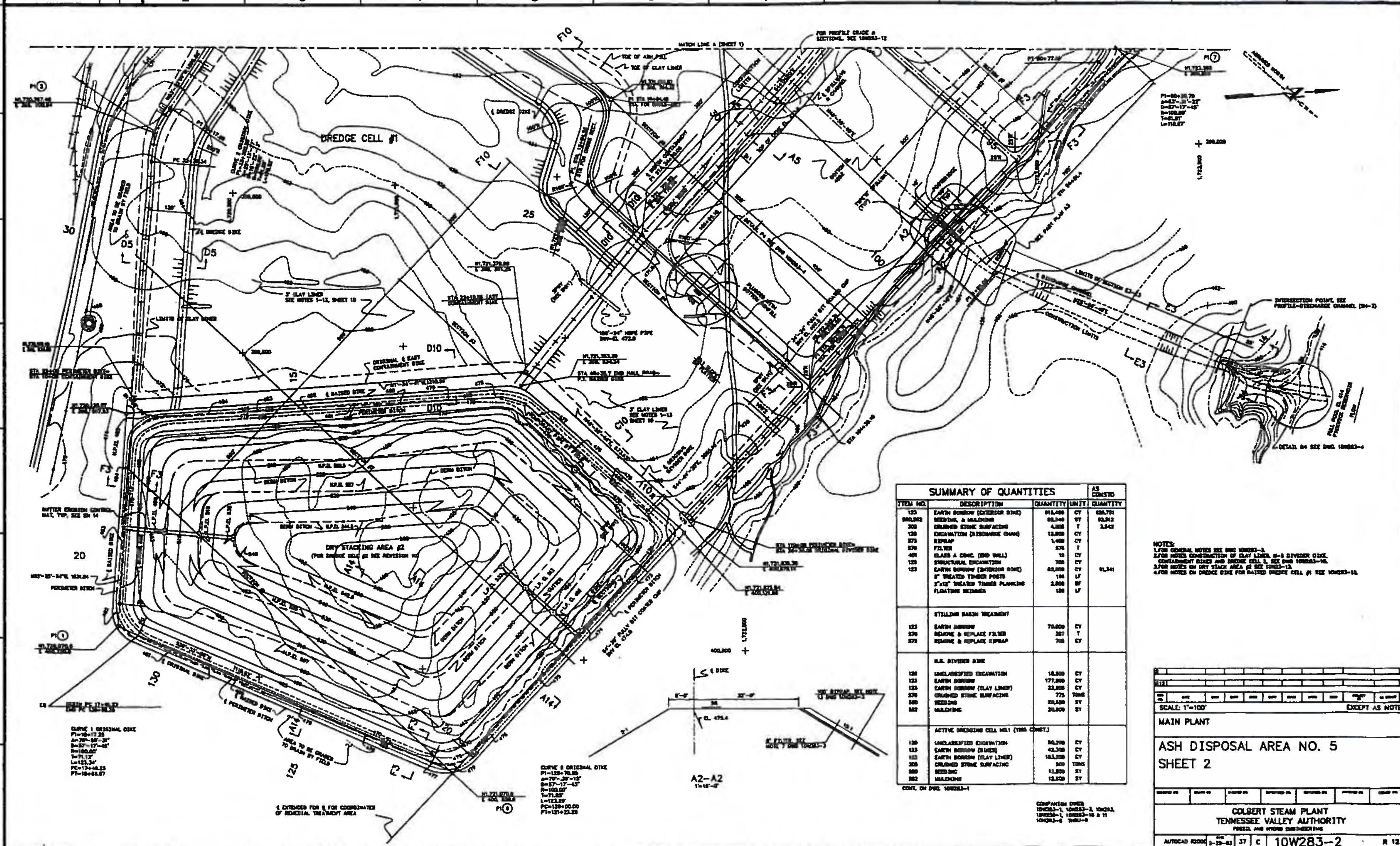
AUTOCAD R10 | 2-25-93 | 37 | C | 10W283-1 | R 11

ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN AND SUPERSEDES : (10W283-1 R10)

PLOT FACTOR:1200

C.A.D. DRAWING DO NOT ALTER MANUALLY

701-2



SUMMARY OF QUANTITIES				AS CONSTD
ITEM NO.	DESCRIPTION	QUANTITY	UNIT	QUANTITY
123	EARTH BORROW (EXTERIOR DIKE)	[illegible]	CY	[illegible]
[illegible]	SEEDING, & MULCHING	[illegible]	SY	[illegible]
305	CRUSHED STONE SURFACING	[illegible]	T	[illegible]
120	EXCAVATION (DISCHARGE CHAN)	12,000	CY	
275	RIPRAP	1,400	CY	
276	FILTER	[illegible]	T	
401	CLASS A CONC. (END WALL)	10	CY	
120	STRUCTURAL EXCAVATION	700	CY	
123	EARTH BORROW (INTERIOR DIKE)	[illegible]	CY	[illegible]
	8" TREATED TIMBER POSTS	[illegible]	LF	
	3"x12" TREATED TIMBER PLANKING	2,000	BF	
	FLOATING SKIMMER	100	LF	
	STILLING BASIN TREATMENT			
123	EARTH BORROW	70,000	CY	
276	REMOVE & REPLACE FILTER	[illegible]	T	
275	REMOVE & REPLACE RIPRAP	[illegible]	CY	
	N.E. DIVIDER DIKE			
120	UNCLASSIFIED EXCAVATION	18,000	CY	
123	EARTH BORROW	177,000	CY	
123	EARTH BORROW (CLAY LINER)	[illegible]	CY	
305	CRUSHED STONE SURFACING	775	TONS	
380	SEEDING	[illegible]	SY	
382	MULCHING	[illegible]	SY	
	ACTIVE DREDGING CELL NO.1 ([illegible] CONST.)			
120	UNCLASSIFIED EXCAVATION	[illegible]	CY	
123	EARTH BORROW (DIKES)	42,300	CY	
[illegible]	EARTH BORROW (CLAY LINER)	[illegible]	CY	
305	CRUSHED STONE SURFACING	500	TONS	
380	SEEDING	12,000	SY	
382	MULCHING	12,000	SY	

CONT. ON DWG. 10W283-1

SCALE: 1"=100' EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA NO. 5
SHEET 2

COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

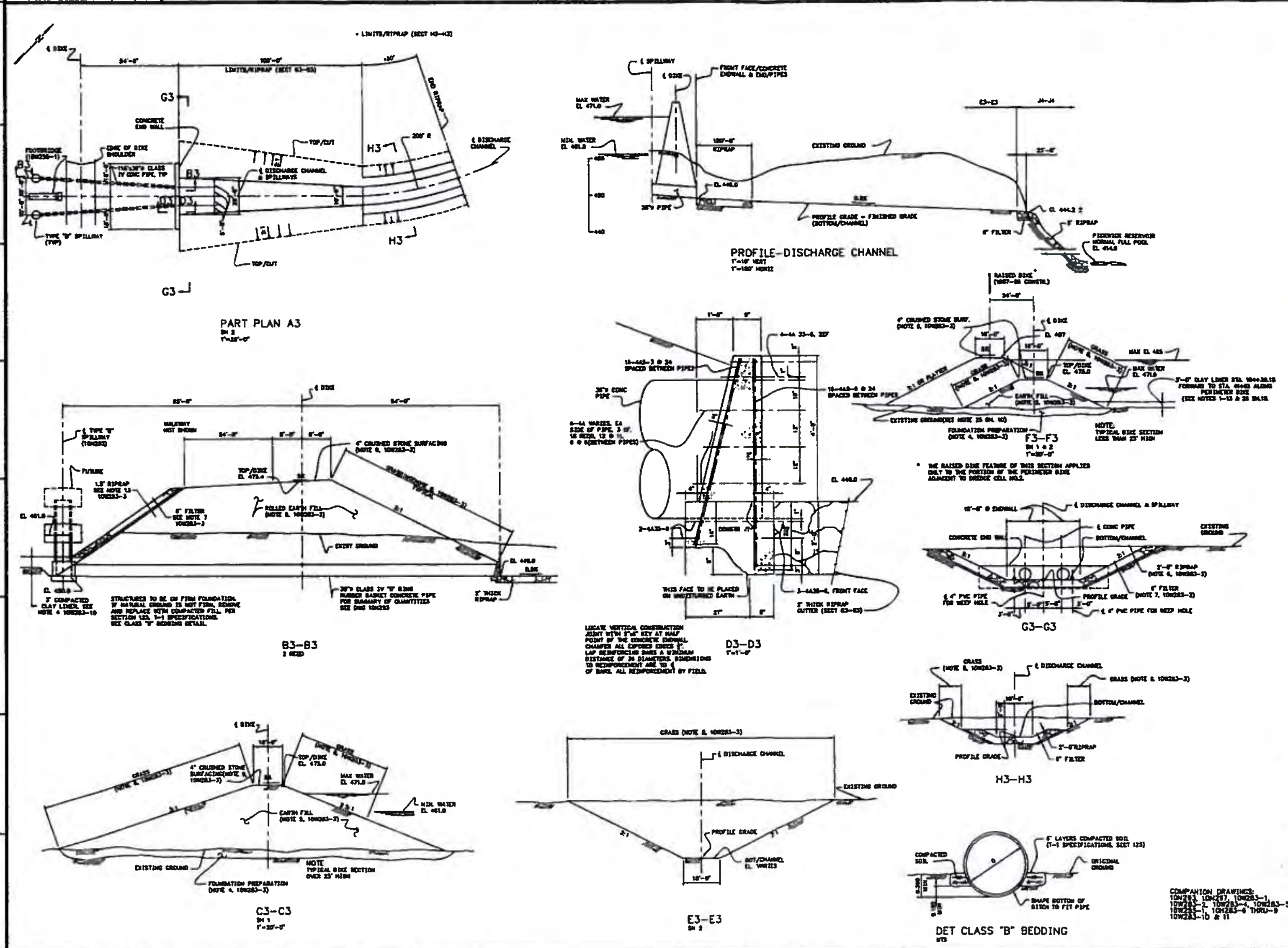
AUTOCAD R2000 | 37 | C | 10W283-2 | R 12

ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN
AND SUPERSEDES (10W283-2 R11)

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

701-3



NOTES FOR ORIGINAL CONSTRUCTION:

1. ALL WORK SHALL BE IN ACCORDANCE WITH T-1 SPECIFICATIONS, UNLESS OTHERWISE NOTED AND ALL MATERIAL TO BE BY FIELD.

2. THE DESIGNATED AREAS OF DEPRESSIONS AND SINKHOLES IN THE DISPOSAL AREA SHALL HAVE ALL TOPSOIL REMOVED AND THE AREAS BACKFILLED WITH COMPACTED FINE GRAIN EARTH FILL IN HORIZONTAL LAYERS (IN ACCORDANCE WITH NOTE 5), AND GRADED TO DRAIN WITH A 2% MINIMUM SLOPE. NO BORROW EXCAVATION IS PERMITTED IN THESE AREAS.

3. ALL EARTH BORROW SHALL BE OBTAINED FROM WITHIN DISPOSAL AREA.
(A) CUT SLOPES ADJACENT TO STRUCTURES OR EMBANKMENTS SHALL NOT BE EXCAVATED STEEPER THAN 3:1 AND TOP OF CUT SHALL BE A MINIMUM OF 25 FEET OF THE STRUCTURES OR TOE OF THE EMBANKMENT.
(B) A MINIMUM 3 FEET OF THE INSITU FINE GRAIN EARTH COVER ABOVE TOP OF ROCK SHALL BE LEFT IN PLACE INSIDE THE DISPOSAL AREA. ELEVATIONS INSIDE THE DISPOSAL AREA SHOWN THUS 425.7, INDICATE APPROXIMATE TOP OF ROCK ELEVATION AT THAT LOCATION.
(C) IF PERVIOUS MATERIAL OR ROCK IS ENCOUNTERED DURING THE DIKE FOUNDATION PREPARATION OR BORROW EXCAVATION, A BLANKET OF COMPACTED FINE GRAIN EARTH FILL WITH A MINIMUM THICKNESS OF 3 FEET, COMPACTED IN HORIZONTAL LAYERS (IN ACCORDANCE WITH NOTE 5), SHALL BE PLACED OVER THESE PERVIOUS ZONES OR TOP OF ROCK FOR PROTECTION AGAINST THE LEACHATE PERCOLATING INTO THE GROUNDWATER.
(D) THE TOP OF EARTH, AFTER BORROW EXCAVATION, SHALL BE SEALED BY ROLLING WITH RUBBER-TIRED EQUIPMENT OR SMOOTH-DRUM ROLLERS TO PROVIDE A RELATIVELY IMPERVIOUS LAYER.

4. DIKE FOUNDATION PREPARATION SHALL CONSIST OF CLEARING AND REMOVING ALL ROOTS, VEGETATION SHALL CONSIST OF CLEARING AND REMOVING ALL ROOTS, VEGETATION, AND ORGANIC TOPSOIL. THE SOFT ALLUVIAL SOILS (2 TO 3 FOOT THICK LAYERS, WHEN ENCOUNTERED DIRECTLY BENEATH THE TOPSOIL, MOST LIKELY TO OCCUR UNDER THE DIKES AT THE WEST END SOUTHWEST CORNER OF THE DISPOSAL AREA) SHALL ALSO BE REMOVED. ALL FOUNDATION AREAS SHALL BE COMPACTED BY USING SHEEP'S FOOT ROLLER FOLLOWED BY FLAT WHEELED ROLLER UNTIL DISTURBED AREA WILL SUPPORT HEAVY EQUIPMENT WITHOUT RUTTING INTO OR HEAVING THE GROUND. PRIOR TO PLACING THE FILL, THE FOUNDATION MUST BE SCARIFIED SO THERE WILL BE A GOOD BOND BETWEEN FOUNDATION AND FILL.

5. DIKE CONSTRUCTION SHALL BE IN ACCORDANCE WITH GENERAL CONSTRUCTION SPECIFICATION NO. G-9, ROLLED EARTH FILL FOR DAMS & POWER PLANTS. THE RESULTS OF THE SOIL INVESTIGATION FOR THE ASH DISPOSAL AREA DIKES ARE IN A REPORT PREPARED BY SINGLETON MATERIALS ENGINEERING LAB (SMEL) TITLED, "COLBERT STEAM PLANT, ASH DISPOSAL AREA 5, SOILS EXPLORATION & TESTING, DIKES SOILS SCHEDULE NO. 67.2." EARTH FILL COMPACTION FOR THE EXTERIOR DIKES SHALL BE AT LEAST 98% OF STANDARD MAXIMUM DRY DENSITY (ASTM D698) AS ESTABLISHED BY SMEL. FILL MOISTURE SHALL BE CONTROLLED TO ACHIEVE OPTIMUM COMPACTION. ALLOWABLE MOISTURE CONTENT DURING PLACEMENT AND COMPACTION SHALL BE BETWEEN 2% ABOVE AND 2% BELOW OPTIMUM MOISTURE CONTENT.

6. RIPRAP SHALL BE 3 FEET THICK WITH A MINIMUM OF 50% BY WEIGHT CONSISTING OF STONES AT LEAST 200 LBS. EACH, EXCEPT AS NOTED IN SECTION [illegible]. RIPRAP SHALL CONFORM TO SECTION 575.

7. FILTER BLANKET SHALL BE 6" THICK AND SHALL CONFORM TO SECTION 570.

8. CUT AND FILL SLOPES AND OTHER DISTURBED AREAS, EXCEPT THOSE INSIDE THE DISPOSAL AREA BELOW ELEVATION [illegible], SHALL BE SEEDED WITH TYPE 8 FOR FALL SEEDING OR TYPE 8 MIXTURE 1 FOR SPRING SEEDING. SEEDED AREAS ARE TO BE FERTILIZED AND MULCHED IN ACCORDANCE WITH SECTIONS 380 & 382 RESPECTIVELY.

9. CRUSHED STONE SURFACING, 4" THICK, SHALL BE APPLIED FOR THE FULL WIDTH OF THE TOP OF THE DIKE IN ACCORDANCE WITH SECTION 305.

10. THE ASH DISPOSAL AREA SHALL BE CLEARED AND GRUBBED IN ACCORDANCE WITH SECTION 101.

11. THE ENTIRE BOTTOM OF THE POND SHALL BE SEALED BY ROLLING THE TOP OF THE INPLACE CLAY WITH RUBBER-TIRED EQUIPMENT OR SMOOTH-DRUM ROLLERS.

12. FACTOR OF SAFETY FOR CONSTRUCTION CONDITION, DIKE SLOPE OF 2:1 IS GREATER THAN 2. FACTOR OF SAFETY FOR THE OPERATING CONDITION, OUTSIDE SLOPE OF 2:1 IS GREATER THAN 1.5.

13. RIPRAP SHALL BE 1.5 FEET THICK WITH A MINIMUM OF 50% BY WEIGHT CONSISTING OF STONES AT LEAST 100 LBS. EACH. RIPRAP SHALL CONFORM TO SECTION 575.

14. EARTH FILL COMPACTION FOR THE INTERIOR DIKE AND ACCESS ROAD SHALL BE AT LEAST 95% OF STANDARD MAXIMUM DRY DENSITY (ASTM D698) AS ESTABLISHED BY SMEL. FILL MOISTURE SHALL BE CONTROLLED TO ACHIEVE OPTIMUM COMPACTION. ALLOWABLE MOISTURE CONTENT DURING PLACEMENT AND COMPACTION SHALL BE BETWEEN 3% ABOVE AND 2% BELOW OPTIMUM MOISTURE CONTENT.

SCALE: 1"=10'-0" EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA NO. 5
MISC DETAILS & SECTIONS
SHEET 3

COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

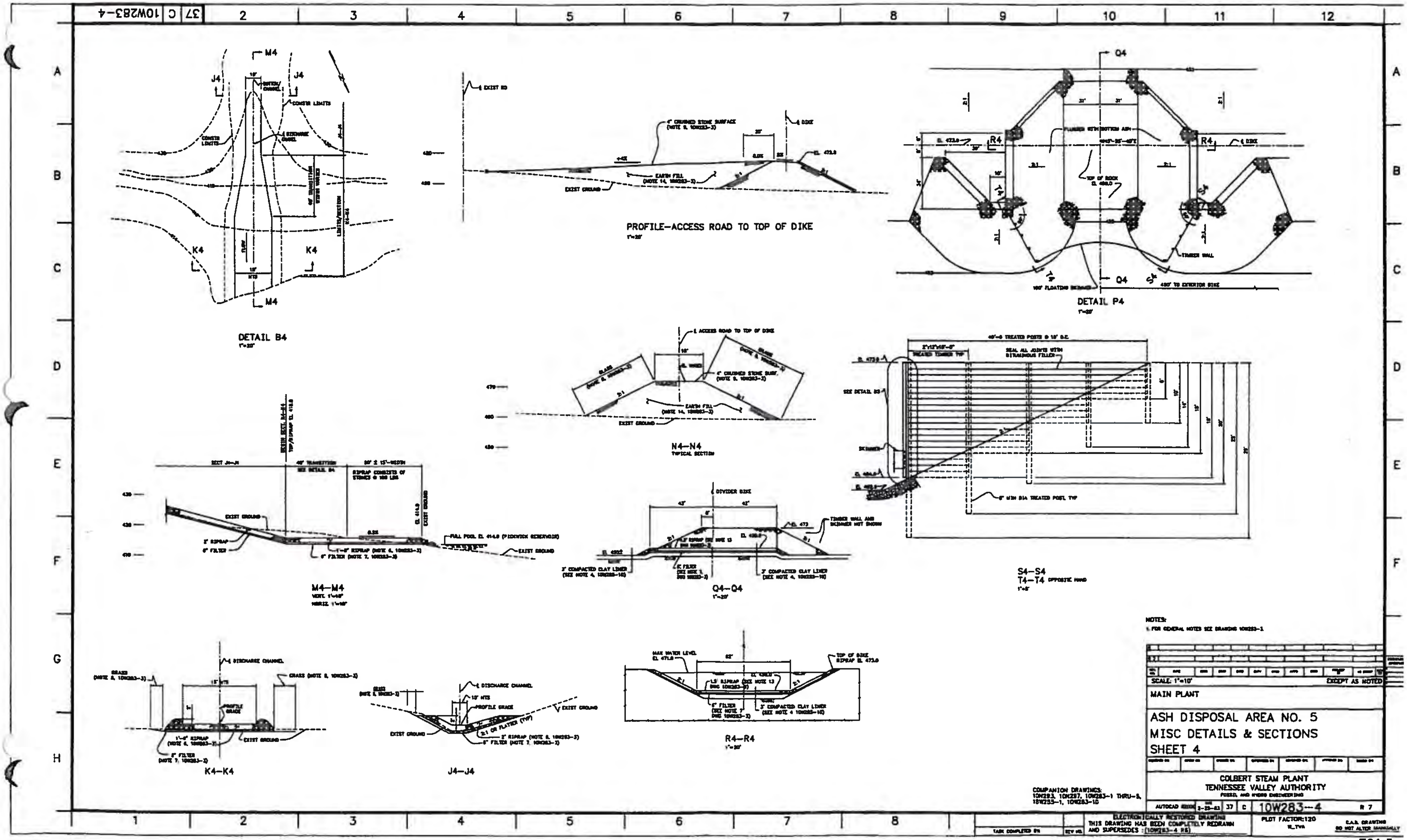
AUTOCAD R2000 | 2-25-03 | 37 | C | 10W283-3 | R 8

ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN AND SUPERSEDES :(10W283-3 R7)

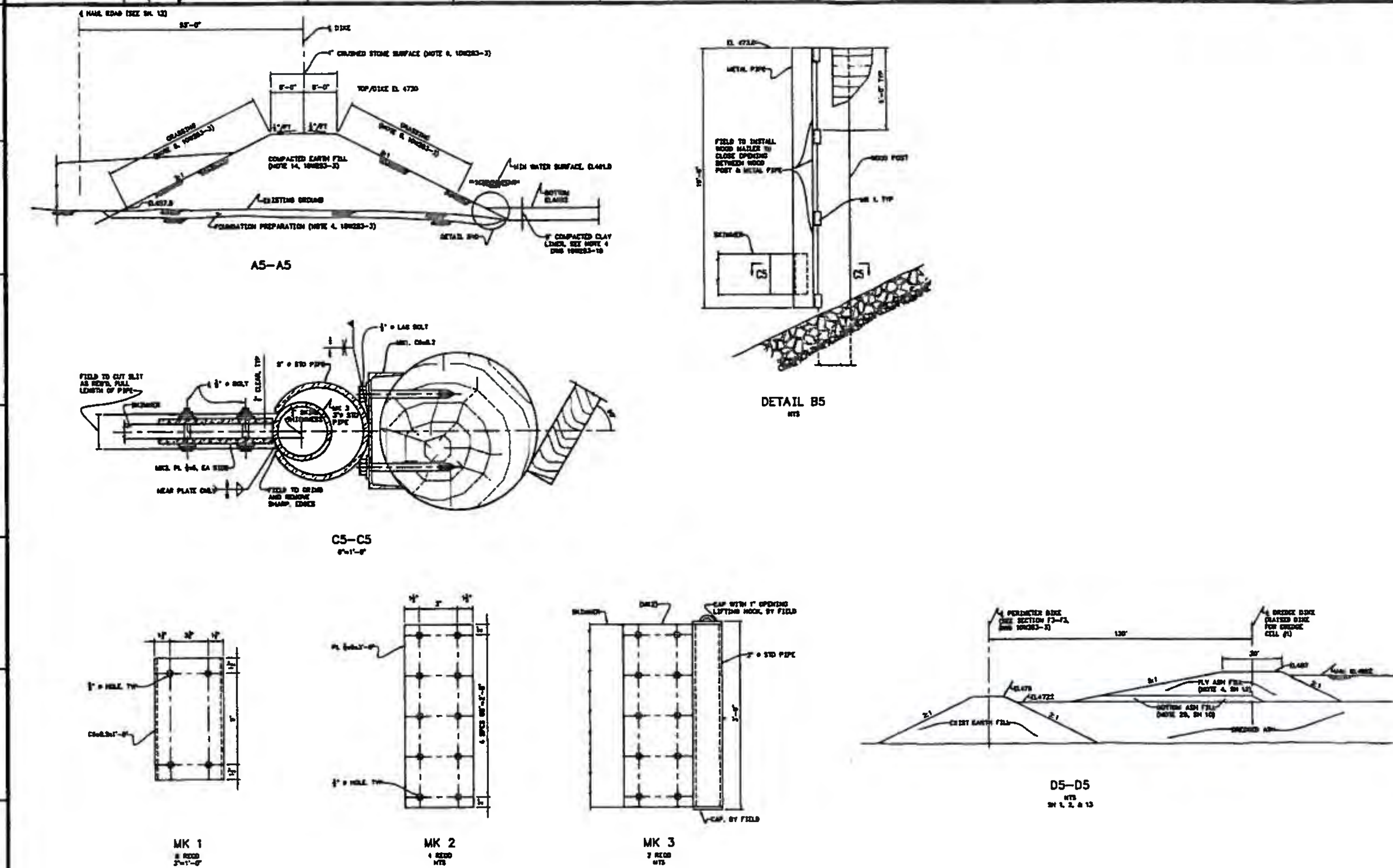
PLOT FACTOR:120

C.A.D. DRAWING
DO NOT ALTER MANUALLY

701-4


10W283-4
DETAIL B4
PROFILE-ACCESS ROAD TO TOP OF DIKE
DETAIL P4
N4-N4
TYPICAL SECTION
M4-M4
Q4-Q4
S4-S4
T4-T4 OPPOSITE HAND
K4-K4
J4-J4
R4-R4
NOTES:
COMPANION DRAWINGS:
SCALE: 1"=10'
EXCEPT AS NOTED
MAIN PLANT
ASH DISPOSAL AREA NO. 5
MISC DETAILS & SECTIONS
SHEET 4
COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING
10W283-4
R 7
PLOT FACTOR:120
ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN

701-5



NOTES:
1. FOR LIST OF ADDITIONAL NOTES SEE 10W283-3 AND 10W283-10.
2. ALL WELDS TO BE MADE WITH AWS A5.1, E70 SERIES ELECTRODES.
3. ALL WELDING AND INSPECTIONS BY TVA FIELD TO BE IN ACCORDANCE WITH TVA CONSTRUCTION SPECIFICATIONS G 29.
4. ALL WELDS BY TVA FIELD TO HAVE VISUAL INSPECTION.
5. ALL ROLLED SHAPES AND PLATES SHALL CONFORM TO ASTM A36.
6. STRUCTURAL PIPE SHALL CONFORM TO ASTM A36 OR A53, GRADE B.
7. ALL STEEL SHAPES AND PLATES TO BE HOT DIPPED GALVANIZED AFTER FABRICATION.
8. ERECTION BOLTS, FASTENERS AND FASTENING MATERIAL SHALL CONFORM TO ASTM A307, NUTS: A563, GRADE A.
9. AFTER WELDING, REPAIR THE DAMAGED GALVANIZED AREA BY COATING WITH 2 COATS OF CARBO ZINC 11 PRIMER.

COMPANION DRAWINGS:
10W283-1 THRU-4, 10W283, 10W297, 18W285-1
10W283-10.

SCALE: 1"=10' EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA NO.5
MISC DETAILS & SECTIONS
SHEET 5

COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY

AUTOCAD | 37 | C | 10W283-5 | R 4

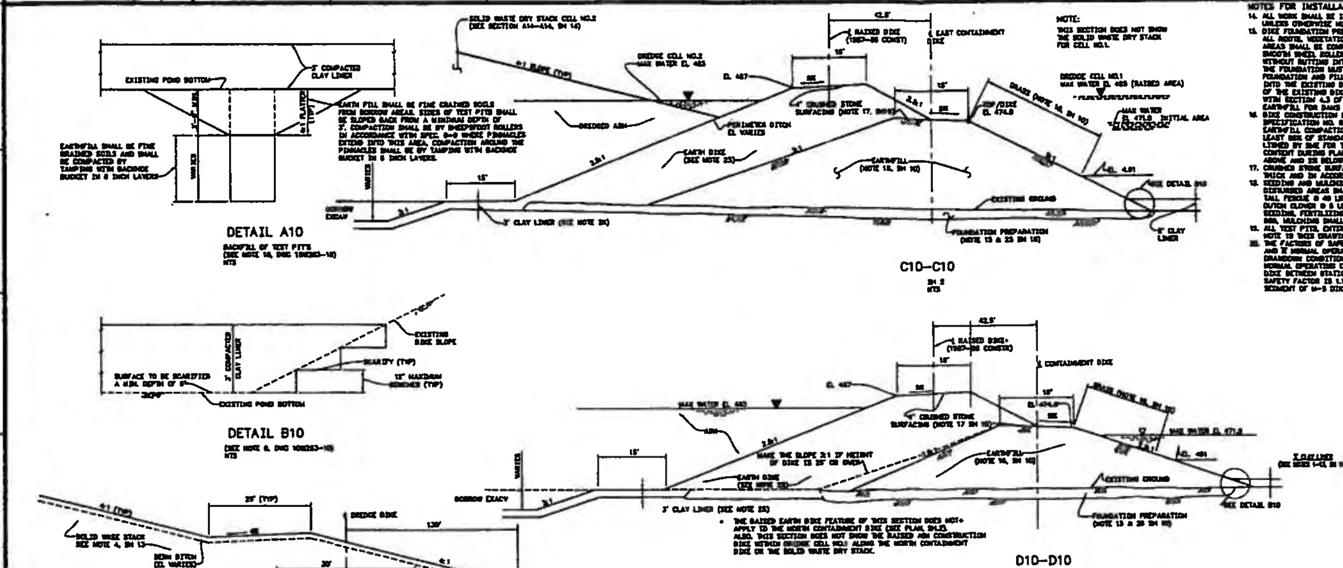
ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN
AND SUPERSEDES : (10W283-5 R3)

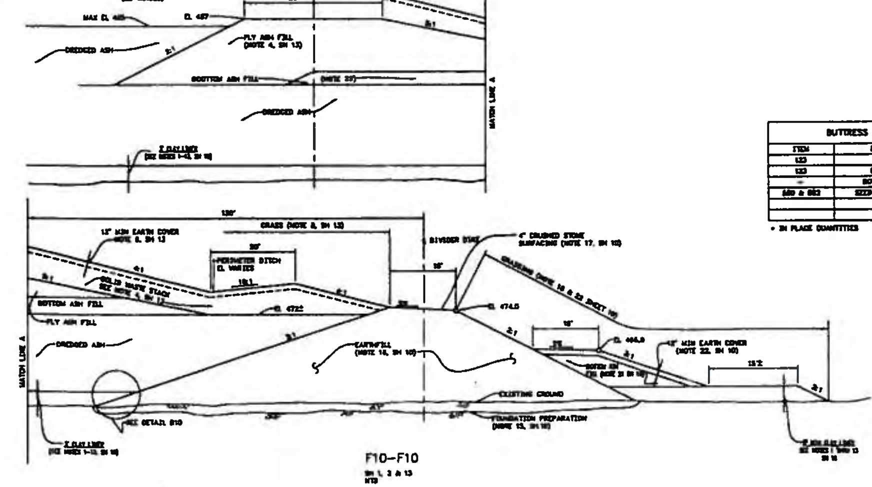
PLOT FACTOR:120

C.A.D. DRAWING
DO NOT ALTER MANUALLY

37 | C | 10W283-5

701-6





NOTES FOR INSTALLATION OF N-S DIVIDER DIKE CONTAINMENT DIKES

14. ALL WORK SHALL BE IN ACCORDANCE WITH T-1 SPECIFICATIONS UNLESS OTHERWISE NOTED.
15. DIKE FOUNDATION PREPARATION SHALL CONSIST OF CLEARING AND REMOVING ALL ROOTS, VEGETATION, ROCKS, AND ORGANIC TOPSOIL. ALL FOUNDATION AREAS SHALL BE COMPACTED BY SHEEPS FOOT ROLLER FOLLOWED BY SMOOTH WHEEL ROLLER UNTIL AREAS WILL SUPPORT HEAVY EQUIPMENT WITHOUT RUTTING INTO OR HEAVING THE GROUND. PRIOR TO PLACING THE FILL THE FOUNDATION MUST BE SCARIFIED SO THERE WILL BE A GOOD BOND BETWEEN FOUNDATION AND FILL. THE DIKES SHALL BE ADEQUATELY TIED INTO THE EXISTING DIKES. FOUNDATION PREPARATION ON THE TIE-IN AREAS OF THE EXISTING DIKES, AND OTHER REQUIREMENTS SHALL BE IN ACCORDANCE WITH SECTION 4.3 OF GENERAL CONSTRUCTION SPECIFICATION NO. G-9, ROLLED EARTHFILL FOR DAMS AND POWER PLANTS.
16. DIKE CONSTRUCTION SHALL BE IN ACCORDANCE WITH GENERAL CONSTRUCTION SPECIFICATION NO. G-9, ROLLED EARTHFILL FOR DAMS AND POWER PLANTS. EARTHFILL COMPACTION FOR THE DIKE SHALL BE AT LEAST 98% OF STANDARD MAXIMUM DRY DENSITY (ASTM D698) AS ESTABLISHED BY SME FOR THE BORROW AREA BEING USED. ALLOWABLE MOISTURE CONTENT DURING PLACEMENT AND COMPACTION SHALL BE BETWEEN 3% ABOVE AND 2% BELOW OPTIMUM MOISTURE CONTENT.
17. CRUSHED STONE SURFACE ON THE DIKE SHALL BE 4 INCHES THICK AND IN ACCORDANCE WITH SECTION 302 OF THE T-1 SPECIFICATIONS.
18. SEEDING AND MULCHING—CUT AND FILL SLOPES, TOPSOIL STOCKPILE, AND OTHER DISTURBED AREAS SHALL BE SEEDED WITH THE FOLLOWING MIXTURE: "REBEL" TALL FESCUE @ 40 LBS PER ACRE, HARD FESCUE @ 10 LBS PER, AND WHITE DUTCH CLOVER @ 5 LBS PER ACRE TOTAL MIXTURE=55 LBS PER ACRE. SEEDING, FERTILIZING, AND LIMING SHALL BE IN ACCORDANCE WITH SECTION 800, MULCHING SHALL BE IN ACCORDANCE WITH SECTION 801.
19. ALL TEST PITS, ENTIRE POND, SHALL BE BACKFILLED IN ACCORDANCE WITH NOTE 10 THIS DRAWING.
20. THE FACTORS OF SAFETY AGAINST DIKE FAILURE ARE ≥1.5 FOR THE NORMAL OPERATING CONDITION AND ≥1.2 FOR THE SUDDEN DRAWDOWN CONDITION. HOWEVER THE FACTORS OF SAFETY FOR THE NORMAL OPERATING CONDITIONS ARE ≤1.0 FOR THE SEGMENT OF THE N-S DIKE BETWEEN STATIONS 18± AND 23± (SEE SECTION F10–F10). THE SAFETY FACTOR IS 1.12 FOR A LOW POOL ELEV OF 481 FOR THIS SEGMENT OF N-S DIKE.

NOTES FOR INSTALLATION OF CLAY LINER:

1. ALL WORK SHALL BE IN ACCORDANCE WITH T-1 SPECIFICATIONS, UNLESS OTHERWISE NOTED.
2. SOILS INFORMATION MAY BE FOUND IN REPORTS PREPARED BY SINGLETON MATERIALS ENGINEERING LABORATORY (SME) (A) FARMER TO BUCHANAN CSB 780329007, DATED MARCH 27, 1978, (B) OE SOILS SCHEDULE NO.67.4 & (C) OE SOILS SCHEDULE 67.2.
3. FDN PREPARATION SHALL CONSISTS OF REMOVING ALL ORGANIC MATL, LOOSE ROCK AND OTHER DEBRIS FROM THE SURFACE OF THE AREA & ALL LOOSE PINNACLES THAT PROTRUDE THRU THE SURFACE. THE SURFACE OF THE FOUNDATION SHALL BE SCARIFIED A MINIMUM DEPTH OF SIX INCHES BEFORE PLACING THE CLAY LINER.
4. EARTH FILL FOR CONSTRUCTING THE CLAY LINER SHALL BE IN ACCORDANCE WITH GENERAL CONSTRUCTION SPECIFICATIONS NO.G-9, ROLLED EARTH FILL FOR DAMS AND POWER PLANTS. BORROW SOILS FOR USE IN CONSTRUCTING THE CLAY LINERS SHALL BE FINE GRAINED SOILS, FREE FROM ROOTS, BRUSH, MUCK, SOD, CONSTRUCTION DEBRIS OR OTHER UNSUITABLE MATERIALS. EARTH FILL SHALL BE COMPACTED IN SIX INCH HORIZONTAL LAYERS TO AT LEAST 98% OF STANDARD MAXIMUM DRY DENSITY (ASTM D 698). AS ESTABLISHED BY SME. ALLOWABLE MOISTURE CONTENT DURING PLACEMENT AND COMPACTION SHALL BE BETWEEN 3% ABOVE AND 1% BELOW OPTIMUM MOISTURE CONTENT. IN PLACE DRY DENSITY TESTS SHALL BE CONDUCTED AT THE RATE OF ONE FOR EVERY 2,000 C.Y. OF FILL. A MINIMUM OF ONE IN PLACE DRY DENSITY TEST SHALL BE CONDUCTED EACH DAY THE FILL IS PLACED.
5. EARTH FILL COMPACTION SHALL BE BY TAMPING (SHEEPSFOOT) ROLLERS. HOWEVER THE TOP SURFACE OF THE CLAY LINER SHALL BE SEALED WITH RUBBER TIRED EQUIPMENT OR SMOOTH DRUM ROLLERS.
6. EXTREME CARE SHALL BE EXERCISED WHEN TYING THE CLAY LINER INTO THE EXISTING DIKE. ALL LOOSE STONES, ANY PERVIOUS MATERIALS, AND OTHER DEBRIS SHALL BE REMOVED AND THE FACE OF THE DIKE SHALL BE BENCHED OR SCARIFIED TO INSURE A RELATIVELY IMPERVIOUS BOND BETWEEN THE EXISTING DIKE AND THE CLAY LINER. SEE DETAIL B10, THIS SHEET.
7. RIPRAP AND FILTER SHALL BE REMOVED, AS REQUIRED AND STORED UNTIL THE CLAY LINER HAS BEEN PLACED AND THEN THE RIPRAP AND FILTER SHALL BE REPLACED.
8. TO MINIMIZE TENSION CRACKING, DURING CONSTRUCTION AND BEFORE OPERATION, THE CONSTRUCTED CLAY LINER SHALL BE PROTECTED (IE COVERED BY STRAW, ASH, BLACK PLASTIC, OR BY SPRINKLING, ETC) TO PREVENT DECREASE IN ITS PLACED M.C. WHEN DEEMED NECESSARY BY OE.
9. REPRESENTATIVES FROM THE OFFICE OF ENGINEERING (OE) WILL INSPECT THE FOUNDATION (PRIOR TO FILL PLACEMENT) AND THE CONSTRUCTION OF THE CLAY LINER.
10. PRIOR TO CONSTRUCTING THE CLAY LINER, THE EXCAVATED TEST PITS WITHIN THE AREA SHALL BE BACKFILLED IN ACCORDANCE WITH DETAIL A10, THIS SHEET.
11. PRIOR TO FOUNDATION PREPARATION, THE POND BOTTOM SHALL BE VISUALLY INSPECTED FOR EVIDENCE OF UNFILLED BORINGS DRILLED DURING THE SOIL INVESTIGATION, SCHEDULE NO.67.2. THE BORINGS FOUND UNFILLED SHALL BE BACKFILLED WITH FINE GRAINED SOILS AND BE WELL COMPACTED.
12. COMPACTION OF THE CLAY LINER AT STRUCTURES SHALL BE BY HAND HELD COMPACTOR (WHACKERS) AND THE CLAY LINER SHALL BE HAND COMPACTED FOR A MINIMUM DISTANCE OF 3 FEET FROM ALL FACES OF THE STRUCTURES. THE MATERIAL SHALL BE FINE GRAINED SOILS AND SHALL BE SPREAD IN 3 TO 4 INCH LOOSE LAYERS BEFORE COMPACTION. THE COMPACTED LINER AROUND THE STRUCTURES SHALL MEET THE REQUIREMENTS OF NOTE 4.
13A. FOUNDATION PREPARATION FOR LINER CONSTRUCTION SHALL CONSIST OF REMOVING ALL ROOTS, VEGETATION, AND ORGANIC TOPSOIL. THE SURFACE AREA OF THE FOUNDATION SHALL BE SCARIFIED TO A DEPTH OF 6 INCHES BEFORE PLACING THE MATERIAL FOR THE CLAY LINER.
13B. CARE SHALL BE EXERCISED DURING BORROW EXCAVATION IN THE AREAS DESIGNATED TO RECEIVE THE CLAY LINER, TO MINIMIZE DISTURBANCE OF THE FOUNDATION MATERIAL TO AVOID ANY POSSIBILITY OF AN ADVERSE IMPACT ON THE STABILITY OF PERMEABILITY OF THE FOUNDATION. IF ROCK PINNACLES OR CHERT LAYERS ARE ENCOUNTERED EXCAVATION SHALL BE DISCONTINUED. THE EXCAVATION SLOPES SHALL NOT BE STEEPER THAN 2:1

NOTES FOR BUTTRESS OF N-S DIVIDER DIKE

21. ASH FILL SHALL BE SPREAD IN LAYERS NOT TO EXCEED 8 INCHES AND COMPACTED WITH LOADED RUBBER TIRED EARTH HAULING EQUIPMENT MAKING A MINIMUM OF 5 PASSES OVER EACH LAYER.
22. ALL EXTERIOR SURFACES OF THE ASH FILL SHALL BE COVERED WITH 12 INCHES OF EARTH. THE EARTH COVER SHALL BE PLACED ON THE EXTERIOR SLOPE AS THE FILL PROGRESSES UPWARD. THE TOP SURFACE SHALL BE COVERED WITH EARTH IMMEDIATELY FOLLOWING FINAL GRADING.
23. SEEDING AND FERTILIZING SHALL BE IN ACCORDANCE WITH NOTE 18. LIME SHALL BE APPLIED AT THE RATE OF 4 TONS PER ACRE AND SHALL BE AGRICULTURE LIMESTONE. APPLICATION SHALL BE IN ACCORDANCE WITH SECTION 802.

BUTTRESS OF N-S DIVIDER DIKE		
ITEM	DESCRIPTION	QUANTITY
123	CLAY LINER	6,700 CY *
123	EARTH COVER	3,000 CY *
—	BOTTOM ASH FILL	16,100 CY *
800 & 802	SEEDING & MULCHING	12,300 SY

* IN PLACE QUANTITIES

NOTES FOR CELL #2 CONSTRUCTION:

24. REFERENCE NOTES THIS SHEET.
   1. NOTES FOR INSTALLATION OF CLAY LINER: USE NOTES 1 THRU 6 AND 8 THRU 13B.
   2. NOTES FOR CONSTRUCTION OF N-S DIVIDER DIKE: SHEET 3, USE NOTE 14 THRU 18
   3. NOTES FOR ORIGINAL CONSTRUCTION: SHEET 3, USE NOTES 6, 7, 8 AND 11.
25. PREPARATION OF THE EMBANKMENT AREA AND EMBANKMENT CONSTRUCTION.
   (A). THE ORIGINAL GROUND SURFACE, OR ANY EMBANKMENT LAYER IN PLACE, SHALL NOT BE IN A FROZEN CONDITION, AND SHALL BE FREE FROM THE PRESENCE OF SNOW, ICE AND MUD WHEN A SUBSEQUENT LAYER OF EMBANKMENT IS TO BE PLACED THEREON.
   (B). SNOW, ICE OR FROZEN MATERIALS SHALL NOT BE PLACED IN EMBANKMENT AREAS OR INCORPORATED IN THE EMBANKMENT CONSTRUCTION.
   (C). EMBANKMENTS SHALL BE SO CONSTRUCTED THAT ADEQUATE SURFACE DRAINAGE WILL BE PROVIDED AT ALL TIMES.
26. PREPARATION OF THE EMBANKMENT AREA AND EMBANKMENT CONSTRUCTION. THE UNSUITABLE MATERIAL WILL BE REMOVED TO A FIRM FOUNDATION AND THE PREPARED TO POND BOTTOM GRADE AND ROCK WILL BE REMOVED TO GRADE AND THE ENTIRE AREA WILL BE COVERED WITH 4 FEET OF COMPACTED CLAY LINER.
27. IN AREAS WHERE EXAMINATION SHOWS QUESTIONABLE CONDITIONS, THESE AREAS WILL BE EXPLORED AT THE DIRECTIONS OF THE GEOLOGICAL SECTION, AND REPAIRED IN ACCORDANCE WITH NOTES 3 AND 4 THIS SHEET AND RECEIVE A LINER THICKNESS OF 4'-0" IN ACCORDANCE TO NOTE 26. ALL QUESTIONABLE AREAS WILL NOT BE EXPLORED BUT WILL RECEIVE A LINER THICKNESS OF 4'-0".
28. MATERIAL FOR THE DIKE AND CLAY LINER SHALL BE OBTAINED FROM BORROW AREA E AND/OR WITHIN CELL II AND CONSTRUCTED TO THE COMPACTION SPECIFICATIONS. A CONCERTED EFFORT SHALL BE MADE TO ENSURE THAT MATERIAL USED HAS A PERMEABILITY OF 10^{-7} CM/SEC. EARTH MATERIAL FROM BORROW AREA E SHALL CONFORM TO CLASS II, REFERENCE OE SOILS SCHEDULE NO.67.4 (B46890817001).

NOTE FOR DREDGE DIKE

29. BOTTOM ASH FILL FOR THE DREDGE DIKE FOUNDATION SHOULD BE COMPOSED OF THE HEAVIEST, MOST GRANULAR ASH AVAILABLE AT THE TIME OF CONSTRUCTION. AFTER PLACEMENT AND SPREADING OF THE BOTTOM ASH TO A LEVEL THAT WILL SAFELY PERMIT THE OPERATION OF A COMPACTOR, THE BOTTOM ASH FILL SHALL BE ROLLED (MINIMUM OF 4 PASSES) BY A SMOOTH SURFACE STEEL WHEEL VIBRATORY ROLLER (8 TO 10 TONS) IN LAYERS NOT EXCEEDING 12 INCH MAXIMUM LOOSE THICKNESS. BEFORE PLACEMENT OF THE COMPACTED FLY ASH FILL IS BEGUN, THE BOTTOM ASH FILL SHALL BE RAISED TO A LEVEL (3-FOOT MINIMUM ABOVE THE TOP OF THE DREDGED ASH) WHERE THE FOUNDATION WILL SUPPORT THE MOVEMENT OF LOADED ASH HAULING EQUIPMENT WITHOUT RUTTING OR PUMPING.

SCALE: NTS — EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA NO. 5
MISC DETAILS & SECTIONS
SHEET 10

COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

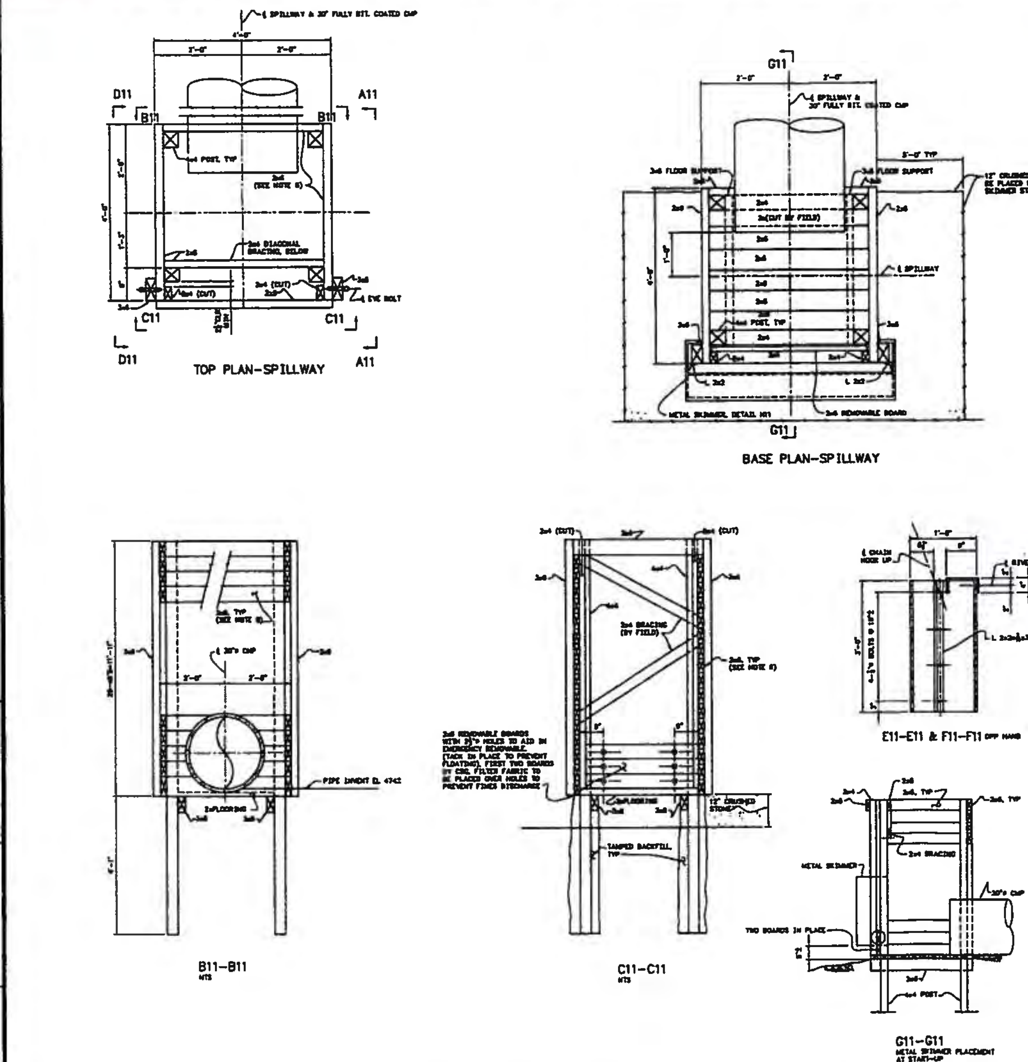
AUTOCAD R2000 | 37 | C | 10W283–10 | R 8

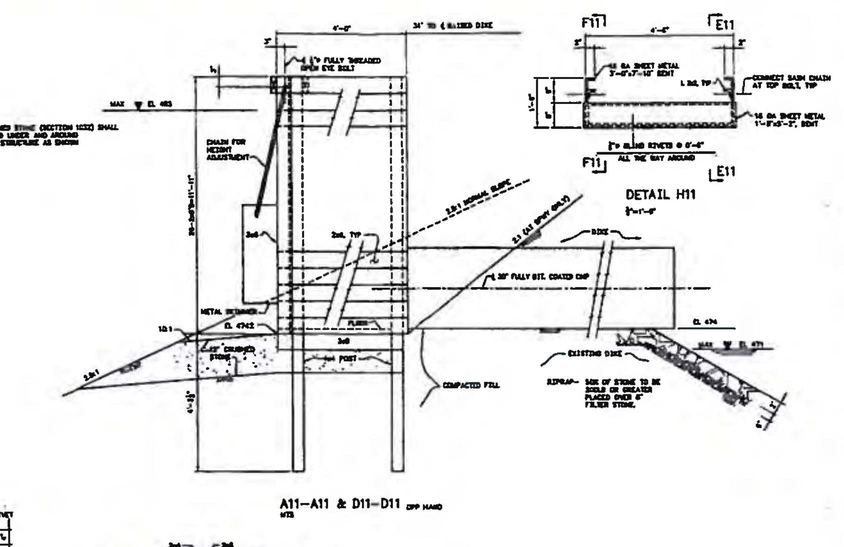
ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN AND SUPERSEDES :10W283-10 R7

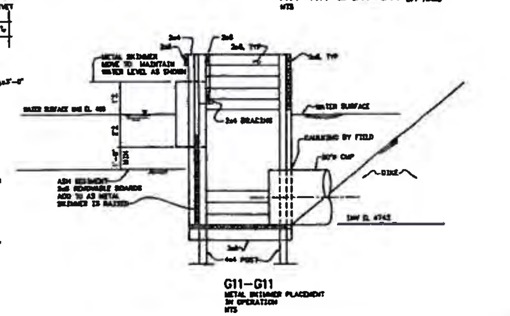
PLOT FACTOR:1

C.A.D. DRAWING DO NOT ALTER MANUALLY

701-7







TEMPORARY STRUCTURE:

1. ALL WOOD SHALL BE SOUTHERN PINE NO. 2 DENSE SELECT STRUCTURAL TIMBER.
2. ALL WOOD SHALL BE PRESSURE TREATED WITH 0.4–0.6 POUNDS OF PRESERVATIVE PER CUBIC FOOT OF WOOD. THE PRESERVATIVE SHALL BE WOLMAN PRESERVATIVE CCA BY KOPPERS OR EQUAL.
3. THE BLIND RIVETS SHALL HAVE A STEEL BODY AND STEEL STEM.
4. ALL NAILS, NUTS, WASHERS AND BOLTS SHALL BE GALVANIZED.
5. CHAIN SHALL BE GALVANIZED WITH A WORK LOAD OF 75 LBS.
6. 3/4" CONSTRUCTION GRADE PLYWOOD MAY BE SUBSTITUTED FOR THE 2x6 INCH SIDING AND FLOORING.

SUMMARY OF QUANTITIES

DESCRIPTION	QUANTITY
4"x6"x16'-6"	4
2"x4"	30 BF
2"x6"	360 BF
3"x6"	37 BF
16 GA. SHEET METAL	34.3 FT^2
L 2x2x1/4	6.0 FT
5/8"Φ BOLTS	8
3/4"Φ THREADED OPEN EYE BOLT	2
NAILS, BLIND RIVETS & CHAIN	BY FIELD
PLYWOOD OPTION (SEE NOTE 6)	3 SHEETS 3/4x4x8

SCALE: 1"=1'-0" EXCEPT AS NOTED

YARD

ASH DISPOSAL AREA NO. 5
MISC DETAILS & SECTIONS
WOODEN SPILLWAY-SKIMMER

COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R10 | 1-22-88 | 37 | C | 10W283-11 | R 2

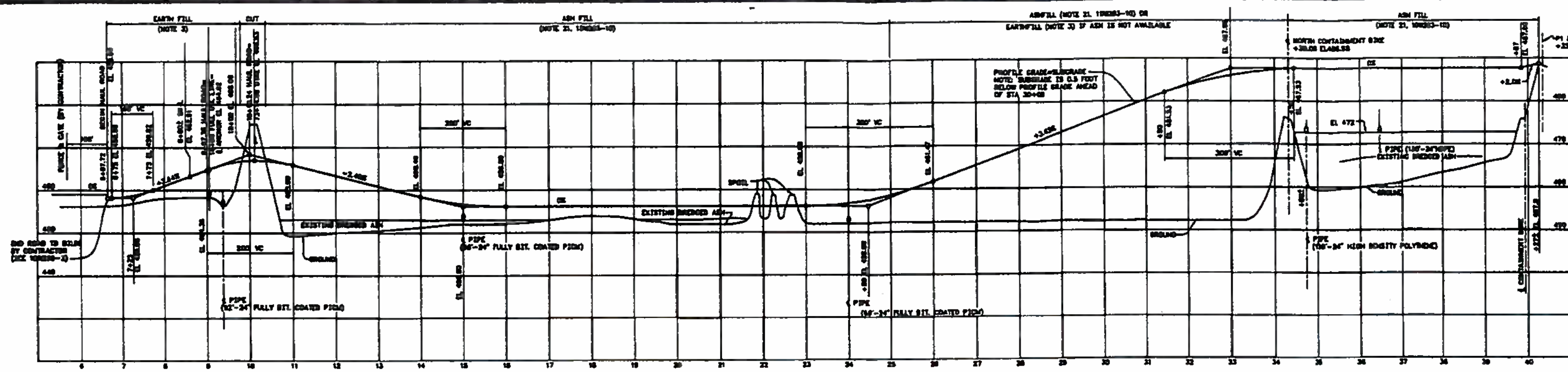
ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN AND SUPERSEDES (10W283-11 R1)

PLOT FACTOR:12

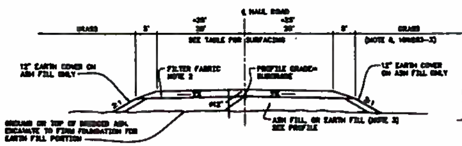
C.A.D. DRAWING DO NOT ALTER MANUALLY

37 C 10W283-11

701-8

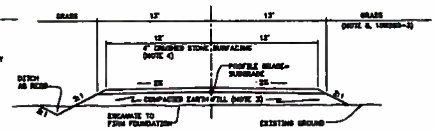


PROFILE–HAUL ROAD
1"=100' HORIZ
1"=10' VERT

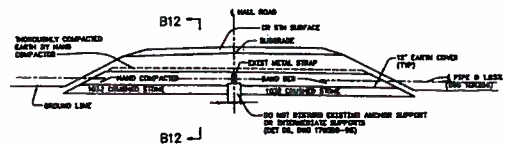


TYP SECTION–HAUL ROAD
STA 6+80± TO STA 29+00±
STA 29+80± TO STA 40+22±

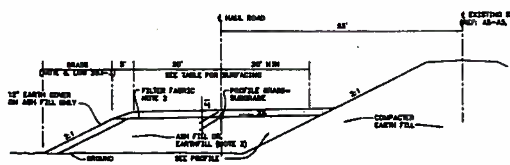
* STA 6+67 TO STA 8+50
* AREAS OF STA 20+00 SUBGRADE IS 0.5 FOOT LOWER THAN PROFILE GRADE.



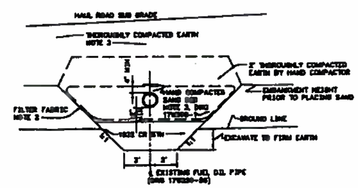
TYP SECTION–SIDE ROAD
R STA 6+67.72
L STA 8+80±
1"=5'



A12–A12
FUEL OIL PIPE BED @ HAUL ROAD CROSSING
TYP SECTION



TYP SECTION–HAUL ROAD @ DIKE
STA 29+00± TO STA 29+80±

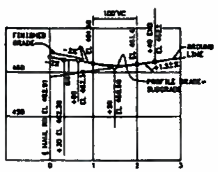


B12–B12
1"=3'

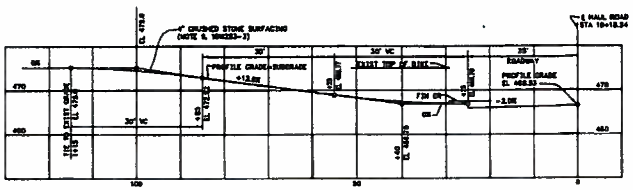
SURFACING				
FROM	TO	* TYPE	THICKNESS	COMMENTS
6+67	10+80	CRUSHED STONE	12 INCH	WITH FILTER FABRIC
10+80	20+00	BOTTOM ASH	12 INCH	WITH FILTER FABRIC
20+00	29+00	BOTTOM ASH	✱18 INCH	
29+80	40+27	BOTTOM ASH	✱18 INCH	WITH FILTER FABRIC

* SUBGRADE IS 0.5 FOOT LOWER THAN PROFILE GRADE
* SEE NOTES 4 & 5. IF BOTTOM ASH IS NOT AVAILABLE, USE 12–INCHES CRUSHED STONE WITH FILTER FABRIC PER NOTE 2.

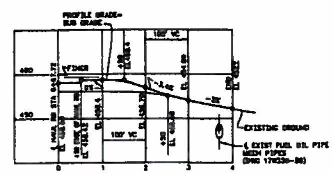
NOTES:
1. FOR GENERAL NOTES SEE DWG. 10W283-1.
2. FILTER FABRIC FOR HAUL ROAD SHALL BE A NON-WOVEN, NEEDLE PUNCHED, POLYESTER EQUAL TO TREVIRA SPUNBOND 1135, DISTRIBUTED BY HOECHST FIBERS INDUSTRIES, P.O. BOX 5887, SPARTANBURG S.C. 29304. FILTER FABRIC SHALL BE INSTALLED ACCORDING TO MFR RECOMMENDATIONS.
3. EARTHFILL COMPACTION FOR THE HAUL ROAD SHALL BE IN ACCORDANCE WITH SECTION 130.12.
4. CRUSHED STONE SURFACING SHALL BE IN ACCORDANCE WITH SECTION 308.
5. BOTTOM ASH SURFACING SHALL BE HANDLED AND PLACED IN ACCORDANCE WITH SECTION 308 EXCEPT IT MAY BE PLACED IN LOOSE LAYERS NOT EXCEEDING 9 INCHES.



PROFILE–SIDE ROAD L
STA 8+80± HAUL ROAD
1"=100' HORIZ
1"=10' VERT



PROFILE–PERIMETER DIKE RAMP TO HAUL ROAD
L & R STA 10+10.34 HAUL ROAD



PROFILE–SIDE ROAD R
STA 6+67.72 HAUL ROAD
1"=100' HORIZ
1"=10' VERT

COMPANION DRAWINGS:
10W283-1 THRU 3

SCALE: 1"=10' EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA NO. 5
MISC DETAILS & SECTIONS
SHEET 12

COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

37 C 10W283–12 R 1

ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN
AND SUPERSEDES : [10W283-12 R0]

PLOT FACTOR:120

C.A.D. DRAWING
DO NOT ALTER MANUALLY

701-9

NOTES:

1. ALL WORK SHALL BE IN ACCORDANCE WITH GENERAL CONSTRUCTION SPECIFICATION NO. 71 UNLESS OTHERWISE NOTED.
2. DASHED CONTOURS IN DRY STACKING AREA NO. 2 REPRESENT EXISTING GROUND AFTER COMPLETION OF CONSTRUCTION OF DREDGE CELL NO. 2 IN APRIL, 1988. DASHED CONTOURS IN ALL OTHER AREAS REPRESENT ORIGINAL GROUND PRIOR TO CONSTRUCTION. SOLID CONTOURS REPRESENT FINISHED GRADING OF STACKED ASH.
3. TEST COMPACTION STRIPS WITH FLY ASH FROM THE DEAF SILO WILL BE REQUIRED TO DETERMINE (A) THE ALLOWABLE RANGE FOR MOISTURE CONTENT OF THE ASH (B) THE MOST EFFICIENT LIFT THICKNESS (C) THE MINIMUM NUMBER OF PASSES REQUIRED OF THE COMPACTOR (D) THE SPEED & FREQUENCY OF VIBRATION AT WHICH THE COMPACTOR SHOULD OPERATE. ASH FILL COMPACTION SHALL BE AT LEAST 95% OF STANDARD MAXIMUM DRY DENSITY (ASTM D698).
4. ASH FILL FOR DRY STACKING PLACED PRIOR TO COMPLETION OF THE TEST COMPACTION STRIPS (SEE NOTE 3) SHALL BE PLACED AS FOLLOWS: THE ASH FILL SHALL BE PLACED AND SPREAD IN HORIZONTAL LAYERS OF 8 TO 12 INCHES WITH A 12 INCH MAXIMUM LOOSE THICKNESS AND SHALL BE TRACKED WITH A DOZER OR SUITABLE HAULING EQUIPMENT TO ALLOW THE COMPACTOR TO OPERATE MORE EFFICIENTLY. THE ASH FILL SHALL BE ROLLED WITH A MINIMUM OF 4 PASSES, IMMEDIATELY AFTER SPREADING, BY SMOOTH SURFACE STEEL WHEEL VIBRATORY ROLLERS (5 TO 10 TONS) FOR COMPACTION AND TO FORM A HARDENED SURFACE CRUST FOR DUST CONTROL. THE ABOVE PROCEDURES MAY BE MODIFIED AS NECESSARY TO COMPLY WITH THE RESULTS OBTAINED FROM THE TEST COMPACTION STRIPS.
5. THE DRY STACKED ASH FILL SHALL BE RAISED AND GRADED IN SUCH A MANNER AS TO DIRECT SHEET FLOW RUNOFF TOWARD THE SPILLWAY IN THE NORTHWEST CORNER OF DRY STACKING AREA NO. 2. PARTICULAR ATTENTION MUST BE GIVEN TO MAINTAINING GOOD SURFACE DRAINAGE (2% MINIMUM SLOPE) WITH PROPER EROSION CONTROL AT ALL TIMES. A WINDROW SHOULD BE MAINTAINED ALONG THE TOP EXTERIOR RIM, EXCEPT THE NORTH END, TO MINIMIZE EROSION OF THE OUTSIDE SLOPE DURING STACKING. ANY AREAS OF PONDING OR SURFACE WETNESS SHALL BE GRADED TO DRAIN OR THE WATER PUMPED OFF AND THEN ALLOWED TO DRY BEFORE PLACEMENT OF ASH FILL ON THAT AREA. STACKING SEQUENCE SHALL BE GENERALLY FROM SOUTH TO NORTH.
6. DRY STACKED ASH FILL PLACED AND COMPACTED TO ITS FINAL GRADE SHALL BE COVERED WITH A MINIMUM OF 12 INCHES OF MODERATELY COMPACTED EARTH FILL IMMEDIATELY FOLLOWING FINAL GRADING. LAYERING BETWEEN THE EARTH COVER AND THE ASH FILL SHALL BE PREVENTED BY PLACING APPROXIMATELY 3 INCHES OF EARTH FILL ON THE ASH FILL AND DISC HARROWING TO A DEPTH OF APPROXIMATELY 6 INCHES. A MINIMUM OF AN ADDITIONAL 9 INCHES OF EARTH FILL SHALL THEN BE PLACED OVER THE SCARIFIED SURFACE AND MODERATELY COMPACTED. EXCESSIVE COMPACTION OF THE EARTH COVER DURING PLACEMENT SHOULD BE AVOIDED.
7. THE FINISHED SLOPE OF THE DRY STACKED ASH FILL SHALL BE COVERED WITH EARTH AND SEEDED IN PROGRESSION WITH THE RAISING OF THE ASH FILL. UNCOVERED AREAS OF ASH FILL SHALL BE KEPT TO A MINIMUM. AREAS AS SMALL AS PRACTICAL SHALL BE FILLED TO FINAL GRADE, COVERED WITH EARTH, AND SEEDED (SEE NOTE 8).
8. THE EARTH COVER OF THE DRY STACKED ASH AND OTHER DISTURBED EARTH SURFACES SHALL BE FERTILIZED AND SEEDED WITH THE FOLLOWING MIXTURES IN ACCORDANCE WITH SECTION 860: FOR FALL SEEDING, TYPE 6, MIXTURE 2; FOR SPRING SEEDING, TYPE 6, MIXTURE 2. WHEN SEEDING IS REQUIRED DURING A PERIOD WHEN FALL OR SPRING SEEDING CANNOT BE USED, THEN A TEMPORARY COVER SHALL BE ESTABLISHED USING THE FOLLOWING MIXTURES: FOR WINTER SEEDING, TYPE 9; FOR SUMMER SEEDING, TYPE 10, MIXTURE 1. OVER SEEDING OF THE TEMPORARY COVER SHALL BE APPLIED DURING THE NEXT SPRING OR FALL SEASON. ALL SEEDED AREAS SHALL BE MULCHED IN ACCORDANCE WITH SECTION 860. PREVIOUSLY SEEDED AREAS WITH SPARSE VEGETATION SHALL BE RE-SEEDED, FERTILIZED AND MULCHED, USING THE APPROPRIATE MIXTURE, EACH SPRING AND FALL AS THE NEWLY COVERED AREAS ARE SEEDED.
9. TRAVEL OF ASH MOVING EQUIPMENT (PANS, TRUCKS, DOZERS, ETC.) EITHER LOADED OR UNLOADED, ON THE DIKES OF THIS DISPOSAL AREA SHALL NOT BE PERMITTED IF THERE ARE OTHER REASONABLE ALTERNATIVES.
10. EROSION CONTROL MAT SHALL BE TYPE A (SIMILAR TO ENKAMAT 7020 AS MANUFACTURED BY AMERICAN ENKA COMPANY, ENKA, N.C. 28728) PER SECTION 860. THE EROSION CONTROL MAT SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS (WE RECOMMEND THAT A REPRESENTATIVE FROM THE MANUFACTURER BE ONSITE TO PROVIDE HELP FOR THE FIRST TIME INSTALLATION OF THE EROSION CONTROL MAT) AS LONG AS THEY MEET OR EXCEED THE REQUIREMENTS OF SECTION 860.
11. GROUTED RIPRAP SHALL BE IN ACCORDANCE WITH SECTION 677.

SCALE: 1"=100'-0" EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA NO. 5
FLY ASH STACKING PLAN
SHEET 13

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R14 | 37 | C | 10W283-13 | R 1

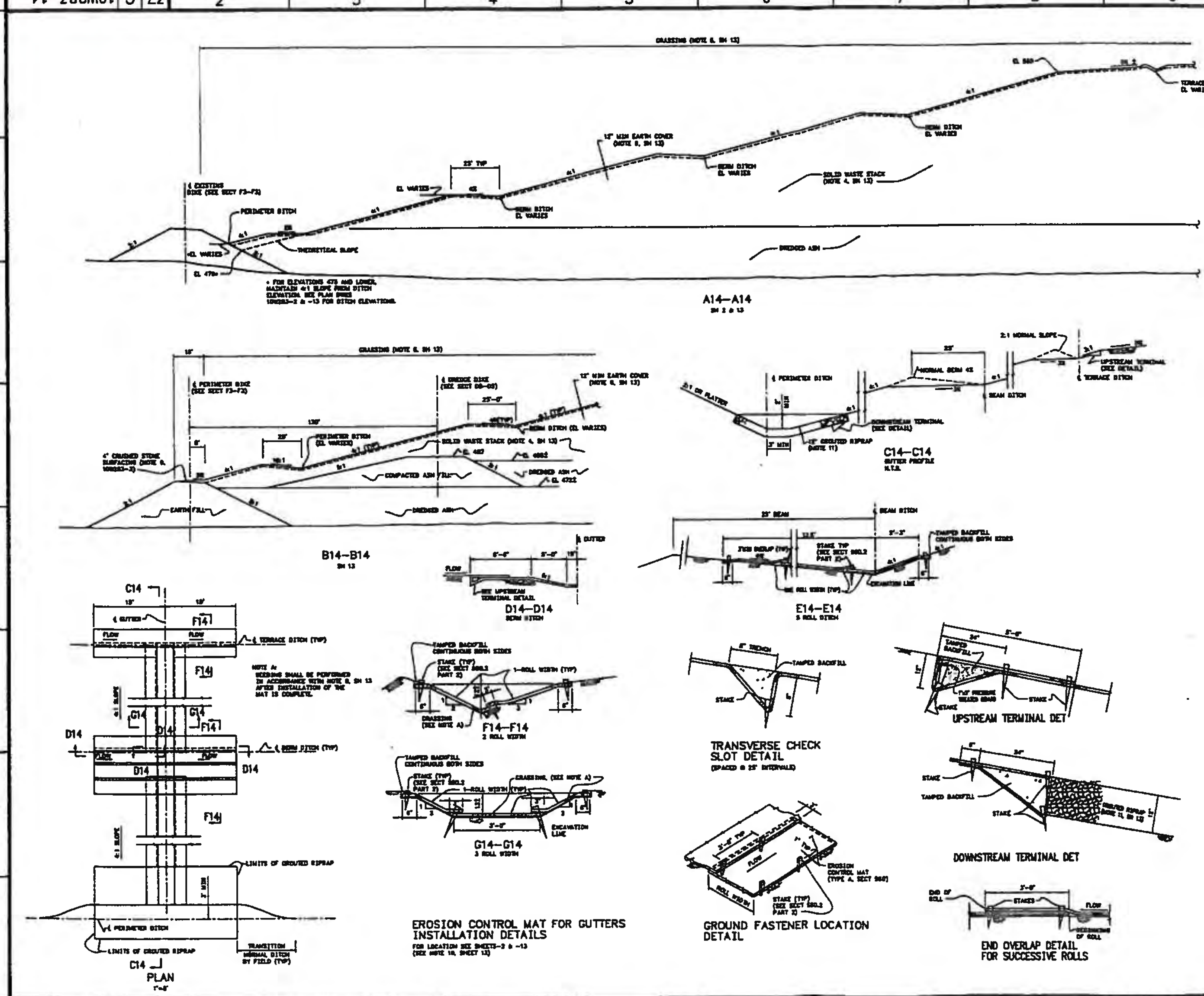
ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN
AND SUPERSEDES :[10W283-13 R0]

PLOT FACTOR:1200

C.A.D. DRAWING
DO NOT ALTER MANUALLY

37 C 10W283-13

701-10



NOTES:
1. FOR DRY STACKING NOTES SEE 10W283-13

SCALE: 1"=20' EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA NO. 5
MISC. DETAILS & SECTIONS
SHEET 14

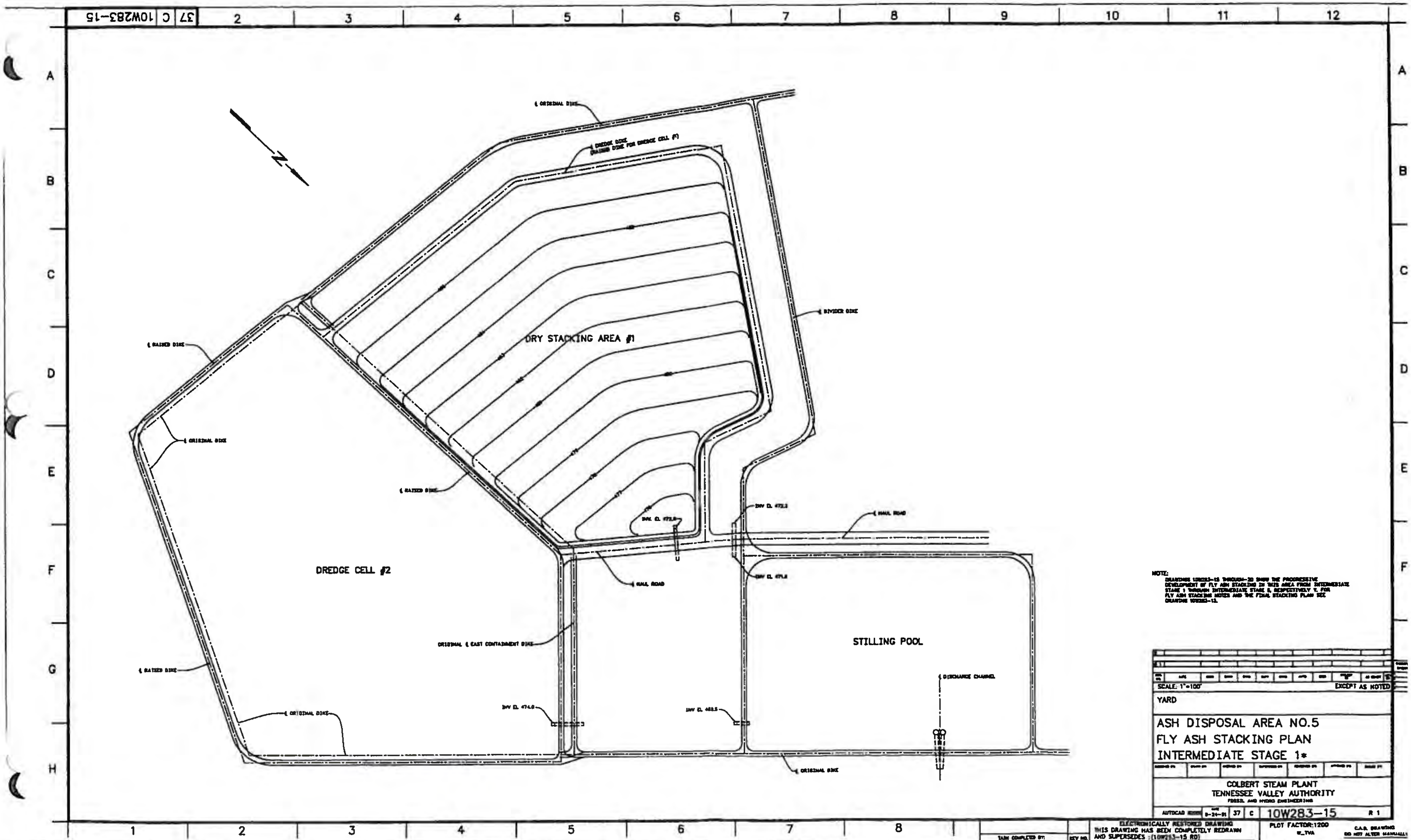
COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

37 C 10W283-14 R 1

ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN
AND SUPERSEDES : (10W283-14 R0)

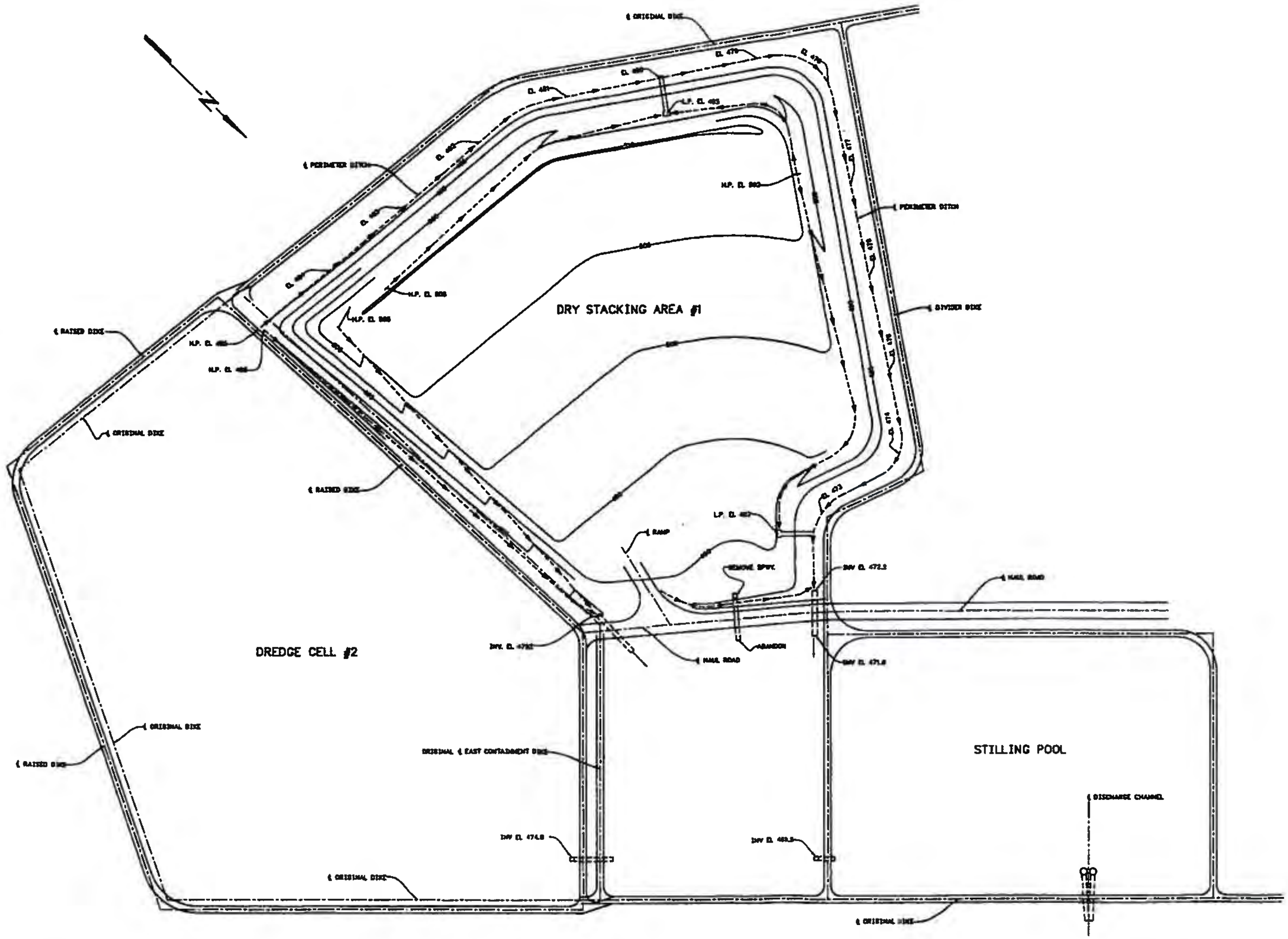
PLOT FACTOR:240

701-11



37 C 10W283-15
DRY STACKING AREA #1
DREDGE CELL #2
STILLING POOL
℄ ORIGINAL DIKE
℄ DREDGE DIKE
℄ RAISED DIKE
℄ DIVIDER DIKE
℄ HAUL ROAD
℄ DISCHARGE CHANNEL
ORIGINAL ℄ EAST CONTAINMENT DIKE
INV EL 474.0
INV EL 463.5
NOTE:
SCALE: 1"=100'
EXCEPT AS NOTED
YARD
ASH DISPOSAL AREA NO.5
FLY ASH STACKING PLAN
INTERMEDIATE STAGE 1*
COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING
AUTOCAD
37
C
10W283-15
R 1
ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN
AND SUPERSEDES : (10W283-15 R0)
PLOT FACTOR:1200
W_TVA
C.A.D. DRAWING
DO NOT ALTER MANUALLY
TASK COMPLETED BY:
REV NO.

701-12



NOTE

DRAWINGS 10W283-15 THROUGH-20 SHOW THE PROGRESSIVE DEVELOPMENT OF FLY ASH STACKING IN THIS AREA FROM INTERMEDIATE STAGE 1 THROUGH INTERMEDIATE STAGE 6, RESPECTIVELY. FOR FLY ASH STACKING NOTES AND THE FINAL STACKING PLAN SEE DRAWING 10W283-13.

SCALE: 1"=100' EXCEPT AS NOTED

YARD

ASH DISPOSAL AREA NO. 5
FLY ASH STACKING PLAN
INTERMEDIATE STAGE 1*

COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD 37 C 10W283-16 R 1

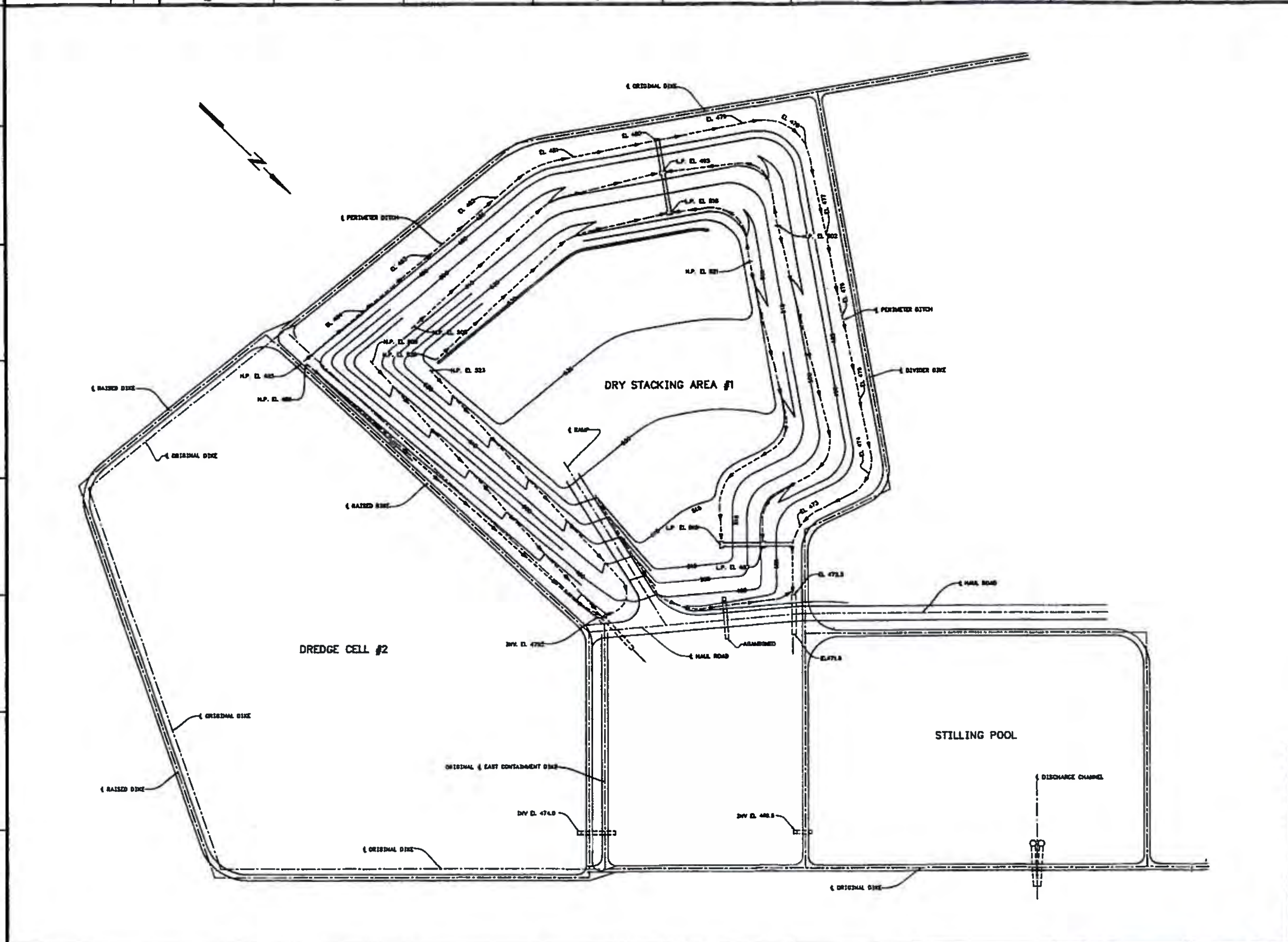
ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN AND SUPERSEDES: (10W283-16 R0)

PLOT FACTOR:1200

C.A.D. DRAWING DO NOT ALTER MANUALLY

37 C 10W283-16

701-13



NOTE:
DRAWINGS 10W283-15 THROUGH-20 SHOW THE PROGRESSIVE DEVELOPMENT OF FLY ASH STACKING IN THIS AREA FROM INTERMEDIATE STAGE 1 THROUGH INTERMEDIATE STAGE 6, RESPECTIVELY. FOR FLY ASH STACKING NOTES AND THE FINAL STACKING PLAN SEE DRAWING 10W283-13.

SCALE: 1"=100' EXCEPT AS NOTED

YARD

ASH DISPOSAL AREA NO. 5
FLY ASH STACKING PLAN
INTERMEDIATE STAGE 3*

COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

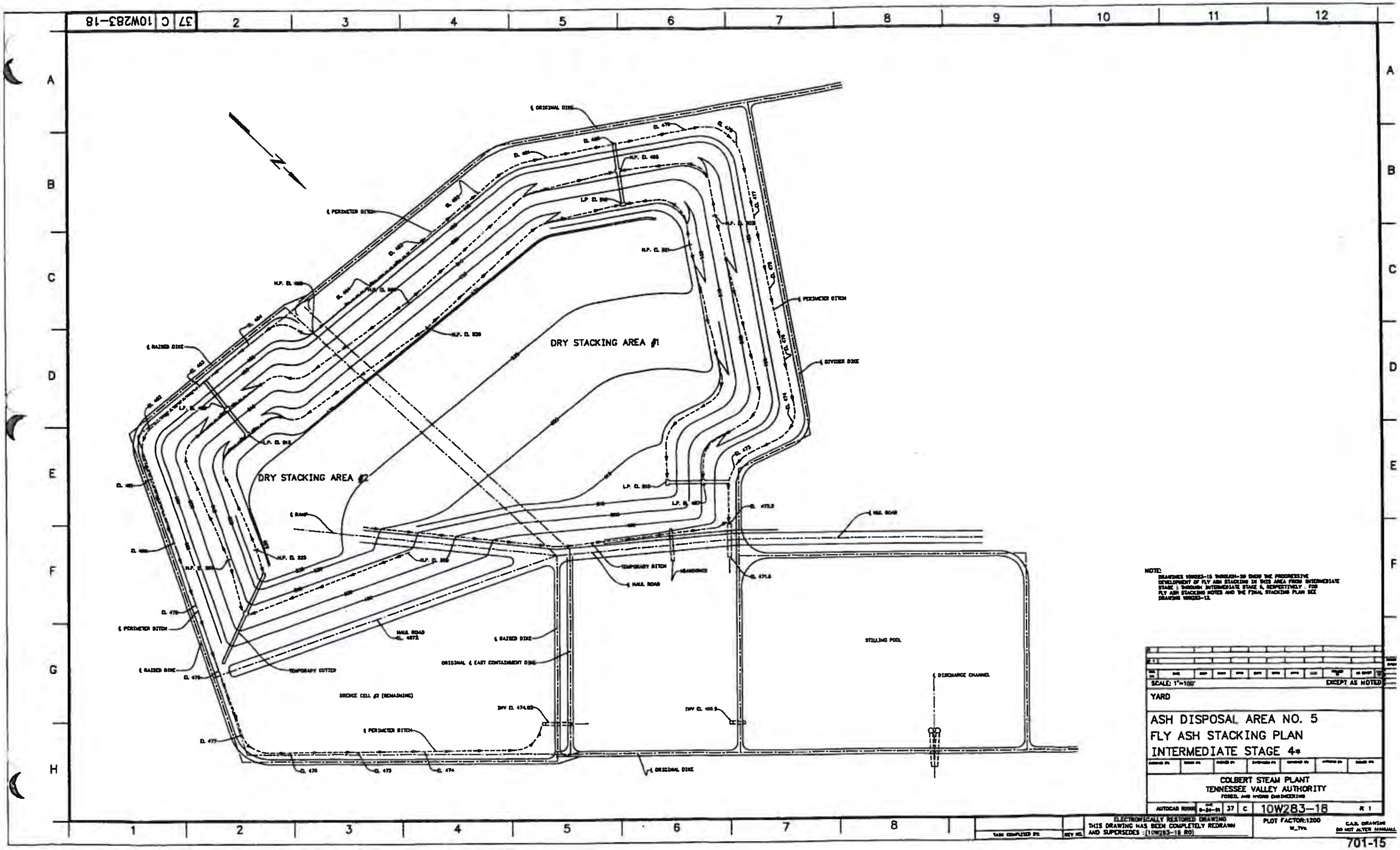
37 | C | 10W283-17 | R 1

ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN AND SUPERSEDES :(10W283-17 R0)

PLOT FACTOR:1200

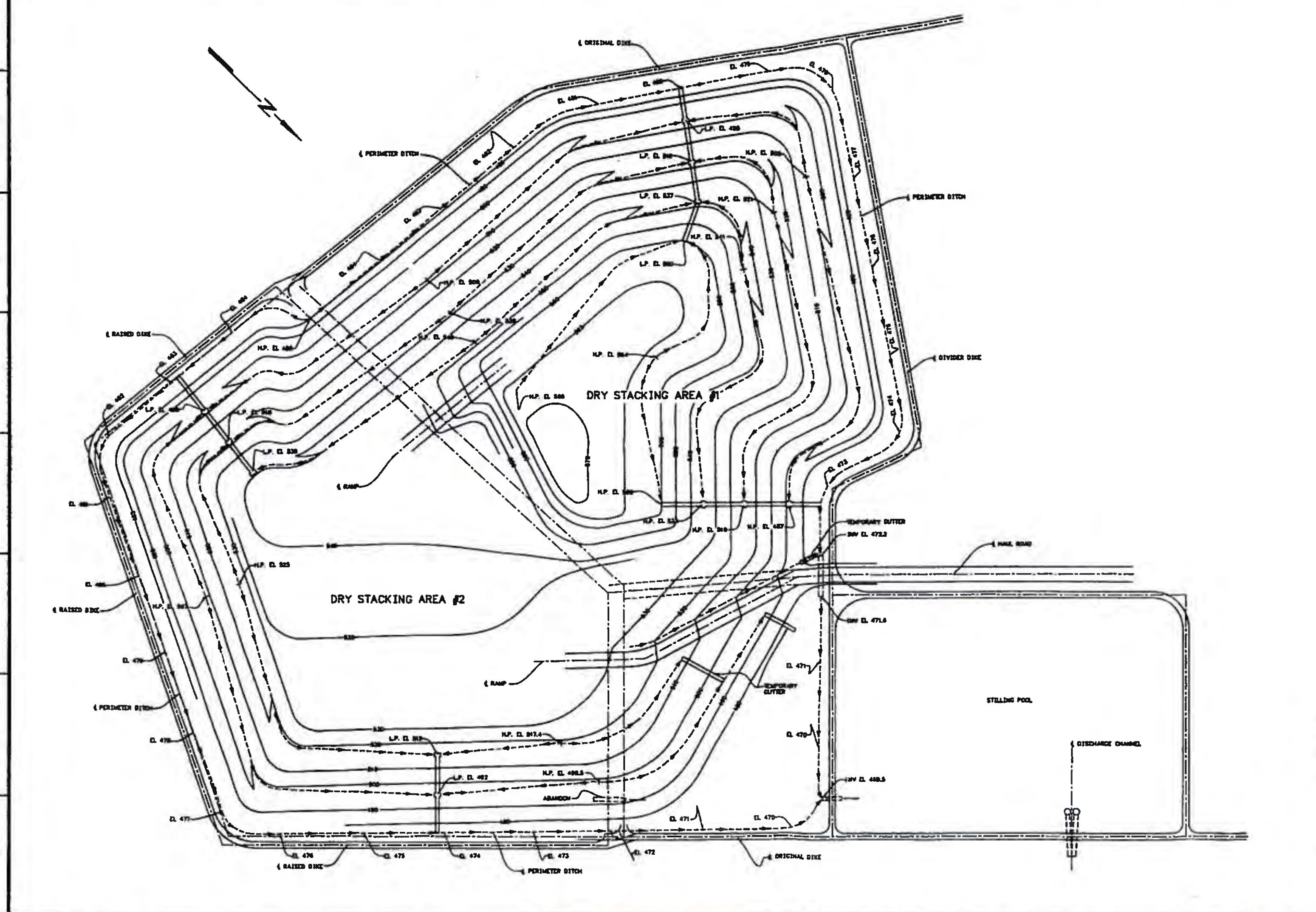
C.A.D. DRAWING DO NOT ALTER MANUALLY

37 | C | 10W283-17



37 C 10W283-18
DRY STACKING AREA #1
DRY STACKING AREA #2
STILLING POOL
HAUL ROAD
TEMPORARY DITCH
TEMPORARY GUTTER
ORIGINAL ℄ EAST CONTAINMENT DIKE
DREDGE CELL #2 (REMAINING)
℄ PERIMETER DITCH
℄ RAISED DIKE
℄ ORIGINAL DIKE
℄ DIVIDER DIKE
℄ DISCHARGE CHANNEL
NOTE:
SCALE: 1"=100'
EXCEPT AS NOTED
YARD
ASH DISPOSAL AREA NO. 5
FLY ASH STACKING PLAN
INTERMEDIATE STAGE 4*
COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
10W283-18
R 1
ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN
AND SUPERSEDES (10W283-18 R0)
PLOT FACTOR:1200
701-15

37 | C | 10W283-19



NOTE.
DRAWINGS 10W283-13 THROUGH-20 SHOW THE PROGRESSIVE DEVELOPMENT OF FLY ASH STACKING IN THIS AREA FROM INTERMEDIATE STAGE 1 THROUGH INTERMEDIATE STAGE 6, RESPECTIVELY. FOR FLY ASH STACKING NOTES AND THE FINAL STACKING PLAN SEE DRAWING 10W283-13.

SCALE: 1"=100' EXCEPT AS NOTED

YARD

ASH DISPOSAL AREA NO. 5
FLY ASH STACKING PLAN
INTERMEDIATE STAGE 5*

COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

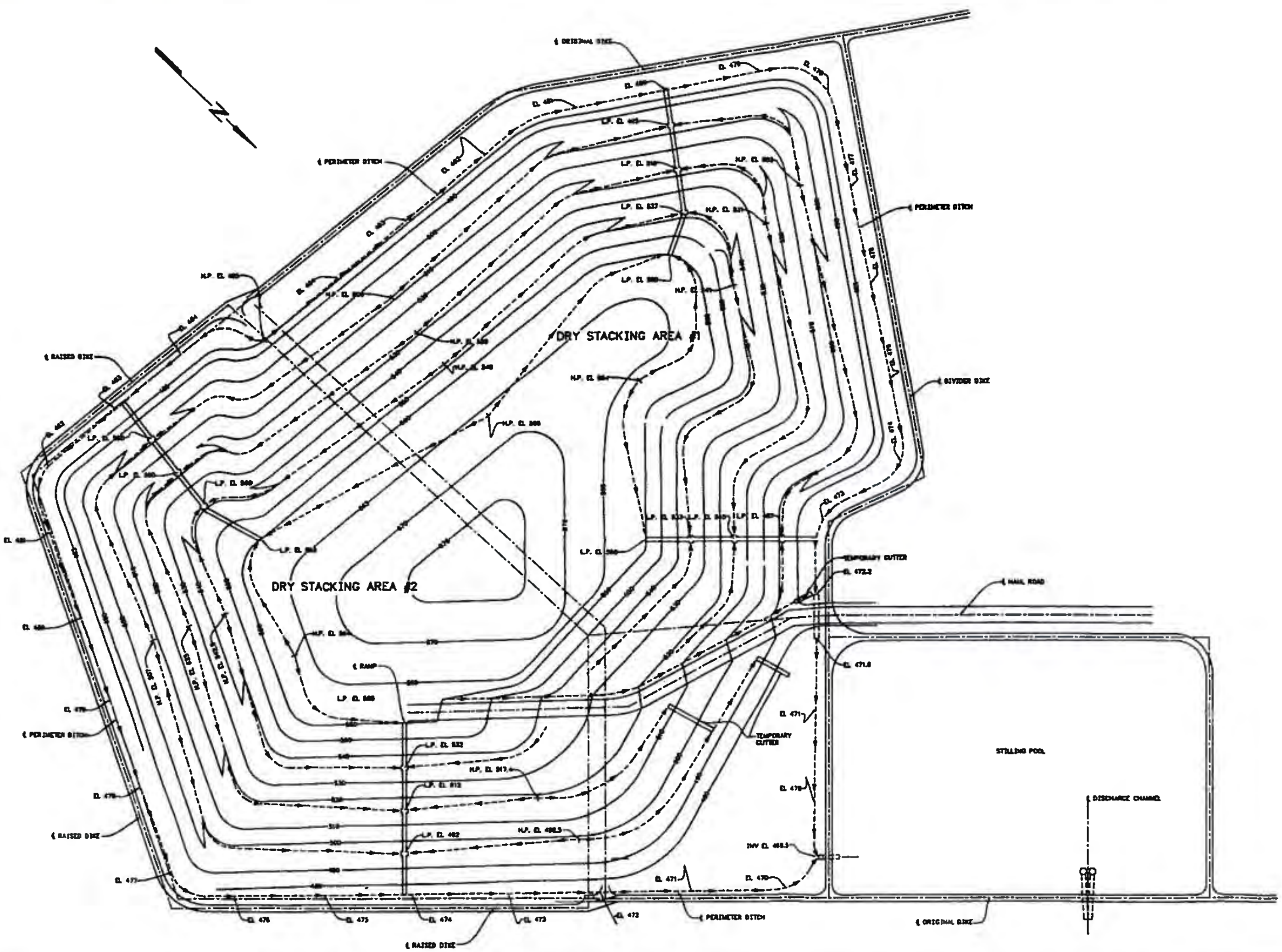
AUTOCAD | 9-24-91 | 37 | C | 10W283-19 | R 1

ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN AND SUPERSEDES (10W283-19 R0)

PLOT FACTOR:1200

C.A.D. DRAWING DO NOT ALTER MANUALLY

37 C 10W283-20



NOTE:
DRAWINGS 10W283-13 THROUGH-20 SHOW THE PROGRESSIVE DEVELOPMENT OF FLY ASH STACKING IN THIS AREA FROM INTERMEDIATE STAGE 1 THROUGH INTERMEDIATE STAGE 6, RESPECTIVELY. FOR FLY ASH STACKING NOTES AND THE FINAL STACKING PLAN SEE DRAWING 10W283-13.

SCALE: 1"=100' EXCEPT AS NOTED

YARD

ASH DISPOSAL AREA NO. 5
FLY ASH STACKING PLAN
INTERMEDIATE STAGE 6*

COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

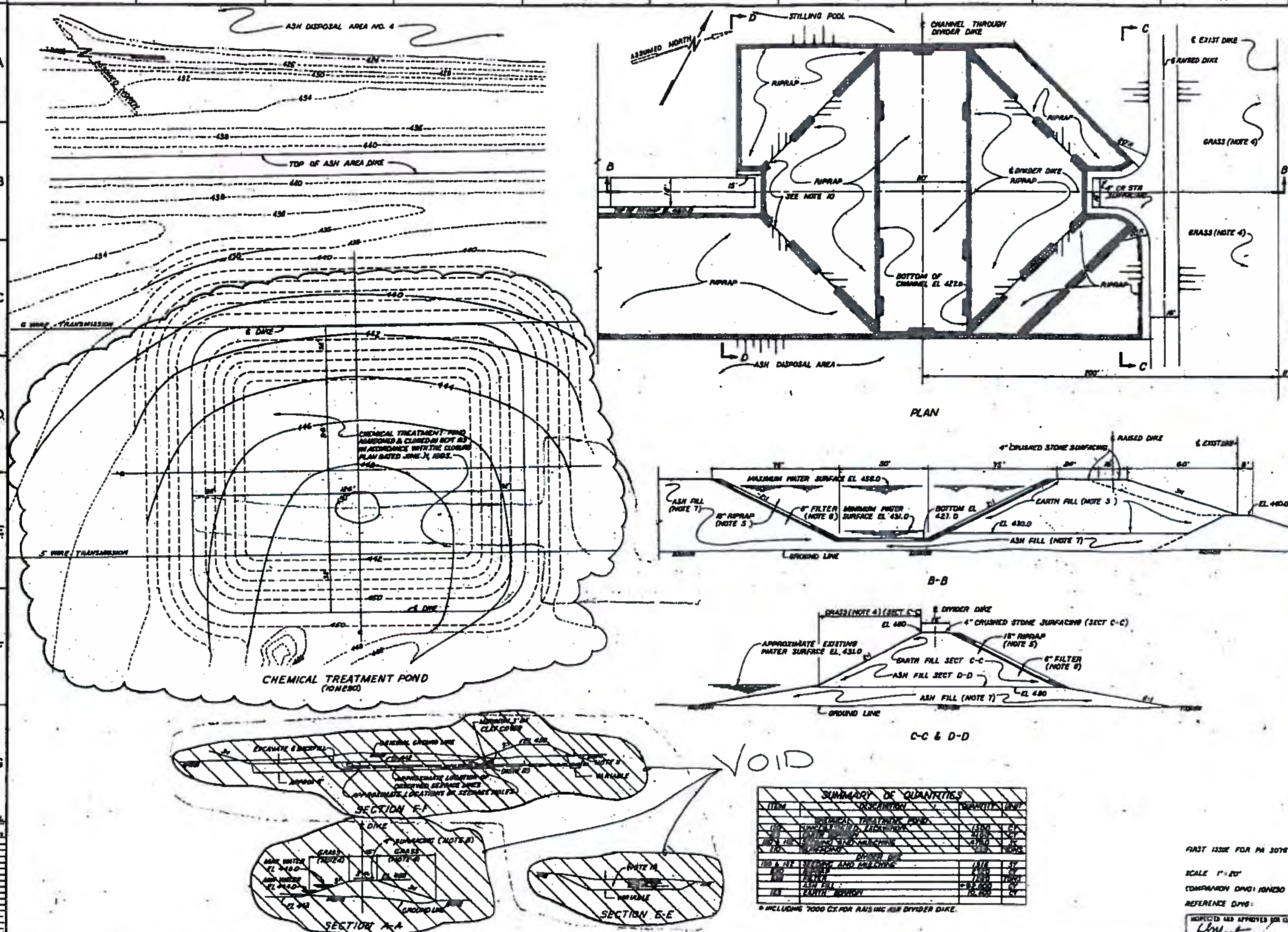
AUTOCAD R2000 | 8-24-01 | 37 | C | 10W283-20 | R 1

ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN AND SUPERSEDES (10W283-20 R0)

PLOT FACTOR:1200

C.A.D. DRAWING DO NOT ALTER MANUALLY

701-17



ITEM	DESCRIPTION	QUANTITY	UNIT
	CHEMICAL TREATMENT POND		
[illegible]	[illegible]	[illegible]	CY
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
	DIVIDER DIKE		
[illegible]	[illegible] AND MULCHING	[illegible]	SY
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
	ASH FILL	* [illegible]	[illegible]
[illegible]	EARTH BORROW	[illegible]	CY

* INCLUDING 7000 C.Y. FOR RAISING ASH DIVIDER DIKE.

NOTES:

1. ALL WORK SHALL BE IN ACCORDANCE WITH T-1 SPECIFICATIONS, EXCEPT AS NOTED.
2. DIKE FOUNDATION SHALL HAVE ALL WEAK SURFACE SOILS REMOVED TO MATERIAL THAT WILL EASILY BEAR THE WEIGHT OF LOADED RUBBER-TIRED EARTH HAULING EQUIPMENT.
3. 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.
4. 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 180 & 182 RESPECTIVELY.
5. RIPRAP ALONG THE CHANNEL THROUGH THE DIVIDER DIKE SHALL BE 18 INCHES THICK, WITH A MINIMUM OF 50%, BY WEIGHT, CONSISTING OF STONES OF AT LEAST 50 POUNDS EACH. RIPRAP SHALL CONFORM TO SECTION 830.
6. FILTER BLANKET, 6 INCHES THICK, SHALL CONFORM TO SECTION 836.
7. 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 3 INCH LAYERS AND WELL COMPACTED WITH RUBBER TIRED HAULING EQUIPMENT.
8. CRUSHED STONE SURFACING, 4" THICK, SHALL BE APPLIED FOR THE FULL WIDTH OF THE CHEMICAL TREATMENT POND DIKE IN ACCORDANCE WITH SECTION 210 OF THE T-1 SPECIFICATIONS.
9. DASHED CONTOURS REPRESENT EXISTING GROUND. SOLID CONTOURS REPRESENT FINISHED GRADE.
10. RIPRAP IS NOT TO BE PLACED IN CONE AREA OF CHANNEL UNTIL PILES ARE DRIVEN FOR FLOATING SKIMMER. FOR LOCATION OF PILES SEE DRAWING 10N281.

FIRST ISSUE FOR PA 3076

SCALE 1" = 20'

COMPANION DWG: 10N230

REFERENCE DWG:

INSPECTED AND APPROVED FOR ISSUE

4	11-8-93
	ABANDONED CHEMICAL TREATMENT POND (CHEMPOND) CLOSURE.
3	REVISED TO POND STORAGE AREAS PA 3076
2	RAISED EXISTING DIKES. WO 84-82-30973
1	REVISED CHANNEL THROUGH DIVIDER DIKE PA 3076

D.A. VALENTINE
A.A. DOMBECK - J.L. BLACK
D.A. VALENTINE
J.L. GLADDLE

K.W. Burnett

MAIN PLANT

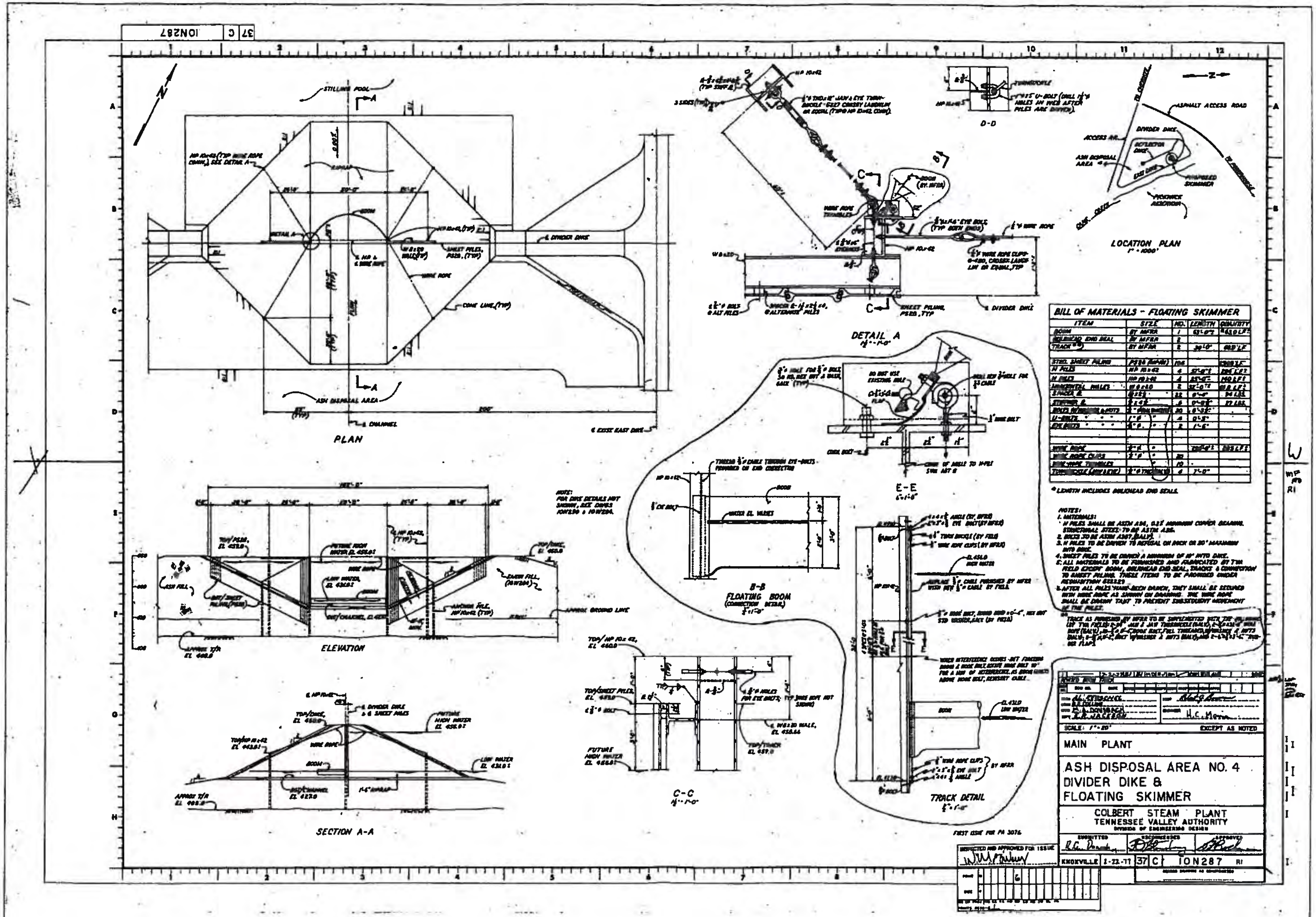
CHEMICAL TREATMENT POND & ASH POND DIVIDER DIKE PLAN AND DETAILS

COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

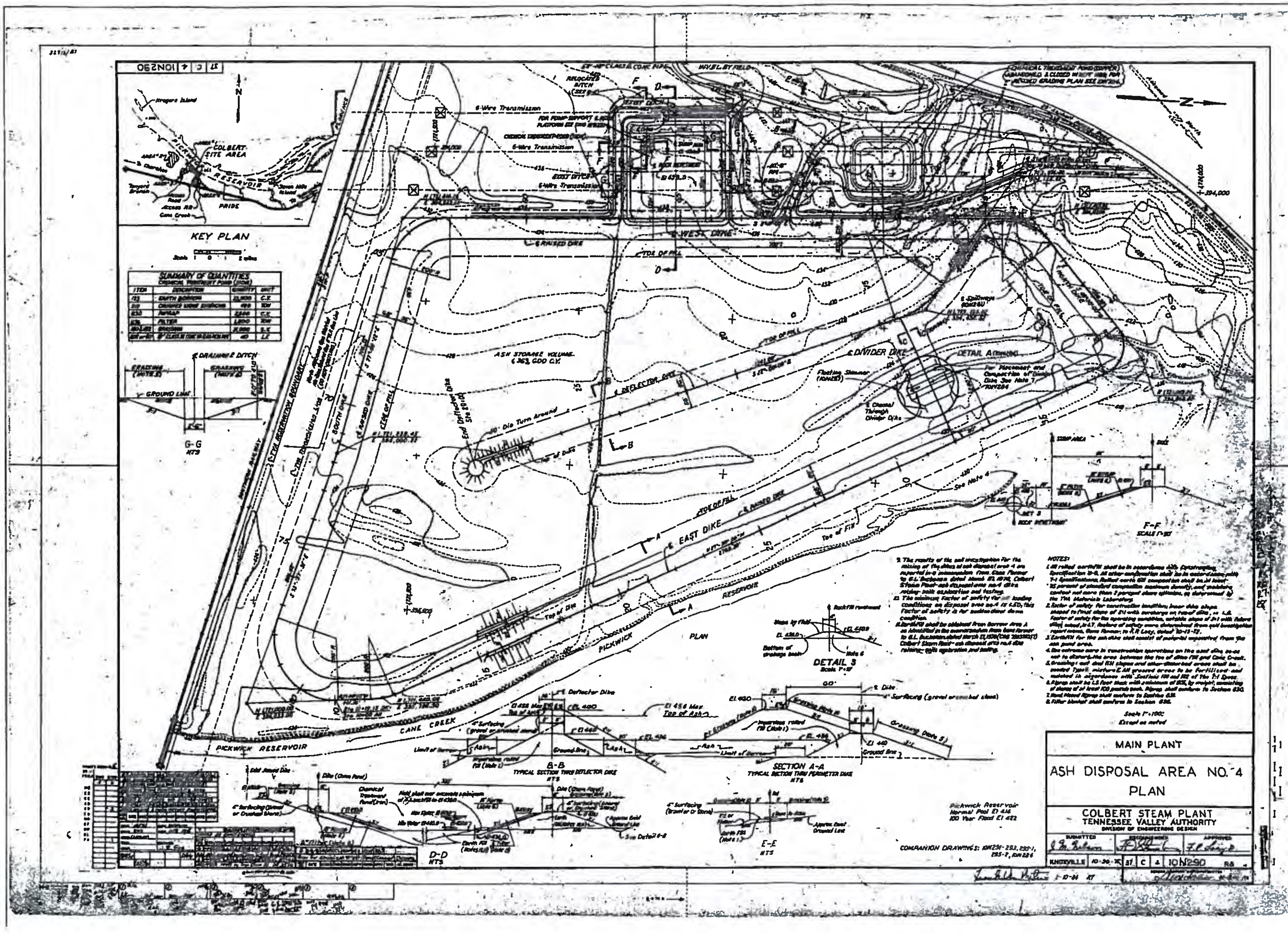
SUBMITTED | RECOMMENDED | APPROVED

KNOXVILLE | 7-19-76 | 37 | C | 10W284 | R4

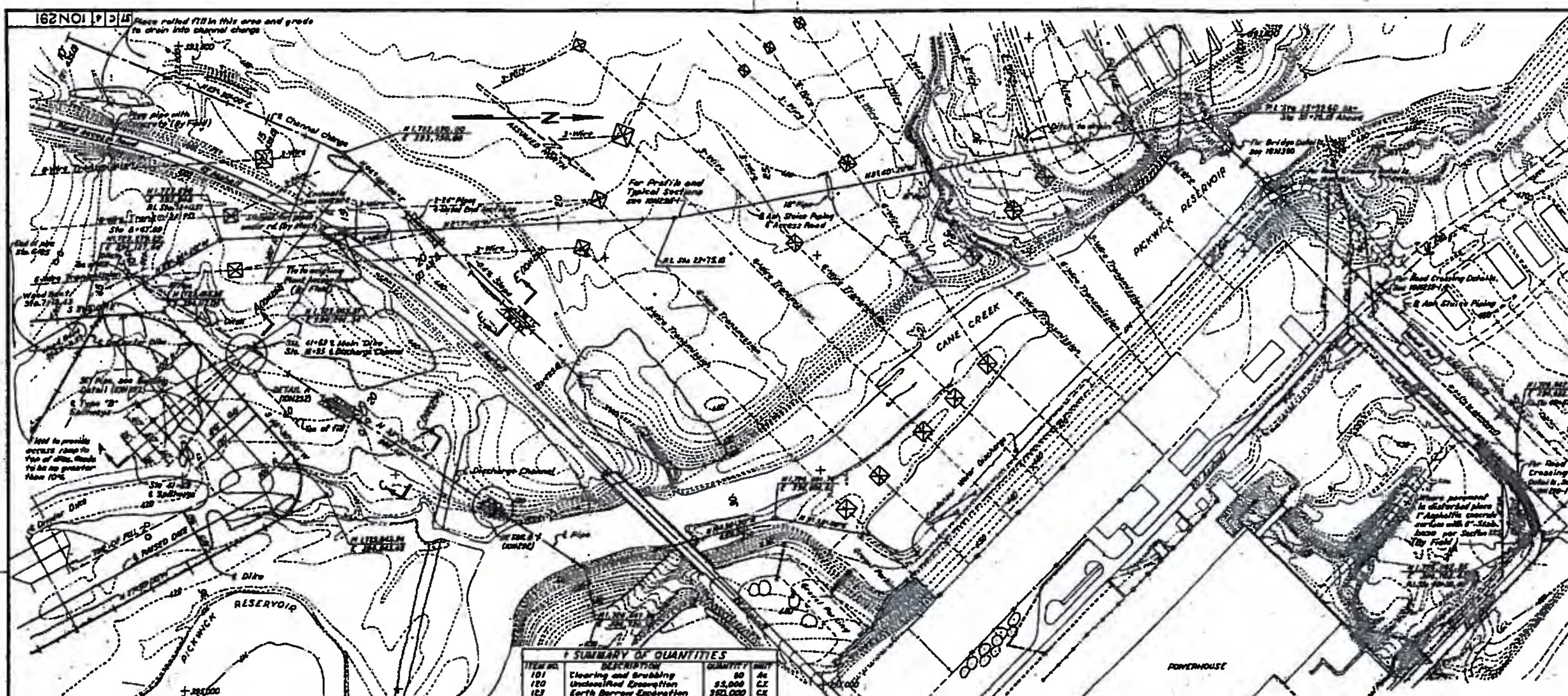
701-18



PLAN
ELEVATION
SECTION A-A
DETAIL A
LOCATION PLAN
D-D
E-E
B-B
FLOATING BOOM
C-C
TRACK DETAIL
BILL OF MATERIALS - FLOATING SKIMMER
STILLING POOL
ASH DISPOSAL AREA
DIVIDER DIKE
ASPHALT ACCESS ROAD
MAIN PLANT
ASH DISPOSAL AREA NO. 4
DIVIDER DIKE &
FLOATING SKIMMER
COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
EXCEPT AS NOTED
KNOXVILLE
37 C 10N287 R1


MAIN PLANT
ASH DISPOSAL AREA NO. 4
PLAN
COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN
KNOXVILLE
10N290
KEY PLAN
COLBERT SITE AREA
PICKWICK RESERVOIR
SUMMARY OF QUANTITIES
ASH STORAGE VOLUME 6,363,000 C.Y.
WEST DIKE
EAST DIKE
DIVIDER DIKE
DEFLECTOR DIKE
SOUTH DIKE
CANE CREEK
PICKWICK RESERVOIR
PLAN
DETAIL 3
SECTION A-A
TYPICAL SECTION THRU PERIMETER DIKE
B-B
TYPICAL SECTION THRU DEFLECTOR DIKE
D-D
E-E
F-F
G-G
NOTES:
Pickwick Reservoir
Normal Pool El 414
100 Year Flood El 432
COMPANION DRAWINGS: 10N231-293, 293-1, 293-2, 10N286

701-20



ITEM NO.	DESCRIPTION	QUANTITY	UNIT
	SUMMARY OF QUANTITIES (FOR RAISING ASH DIKE E)		
123	EARTH BORROW EXCAVATION	43,700	C.Y.
	ASH FILL	100,300*	C.Y.
180	SEEDING	100,000	S.Y.
182	MULCHING	100,000	S.Y.
210	CRUSHED STONE SURFACING	2600	TONS
830	RIPRAP	320	C.Y.
836	FILTER BLANKET	215	TONS

* INCLUDES 7000 C.Y. FOR DIVIDER DIKE

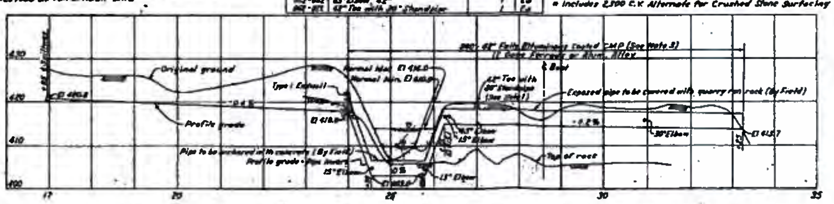
ITEM NO.	DESCRIPTION	QUANTITY	UNIT
	† SUMMARY OF QUANTITIES		
101	Clearing and Grubbing	80	Ac
120	Unclassified Excavation	53,000	C.Y.
123	Earth Borrow Excavation	350,000	C.Y.
125	Excavation for Structures	5,700	C.Y.
180	Seeding	75,000	S.Y.
182	Mulching	75,000	S.Y.
210	Crushed Stone Surfacing	2,300	C.Y.
	Ash Surfacing	* 3,600	C.Y.
392	Concrete Gutter	745	L.F.
401	Class A Concrete	70	C.Y.
418	Reinforcing Steel (By Field)	3,000	L.B.
561-681	18" Pipe	208	L.F.
561-681	24" Pipe	148	L.F.
681-681	18" Metal End Sections	4	Ea
662-682	42" Pipe	340	L.F.
800	120" Rg CMP	20	L.F.
830	Riprap	980	C.Y.
836	Filter Blanket	515	TON
125	Excav. for Structures - Rock	225	C.Y.
365	Asphaltic Conc. Surface Course	25	TON
662-682	30" Pipe	4	L.F.
	Cast Iron Frame & lid	230	L.B.
662-682	15° Elbow, 42"	3	Ea
662-682	30° Elbow, 42"	1	Ea
662-682	45° Elbow, 42"	1	Ea
662-682	42" Tee with 30" Standpipe	1	Ea

† For additional quantities see 10N293, 257

* Includes 2,300 C.Y. Alternate for Crushed Stone Surfacing

NOTES:
1. For Standpipe Cover, use NEENAH R-5100-G, or equal, light duty frame and solid lid with holes in barrel of frame for bolting to pipe.
2. Use extreme care in construction operations of ash sluice piping & stations 23+35± and 40+81± so as not to disturb existing 18" concrete storm sewer and 8" vcp sanitary outfall sewer.
3. All exposed metal, joints, elbows, and tee shall be coated with the type and kind of bitumen used in coating the pipe originally.

Scale 1"=100'



PROFILE - DISCHARGE CHANNEL & PIPE

COMPANION DRAWINGS: 10N290, 292, 293, 295-1, 295-2

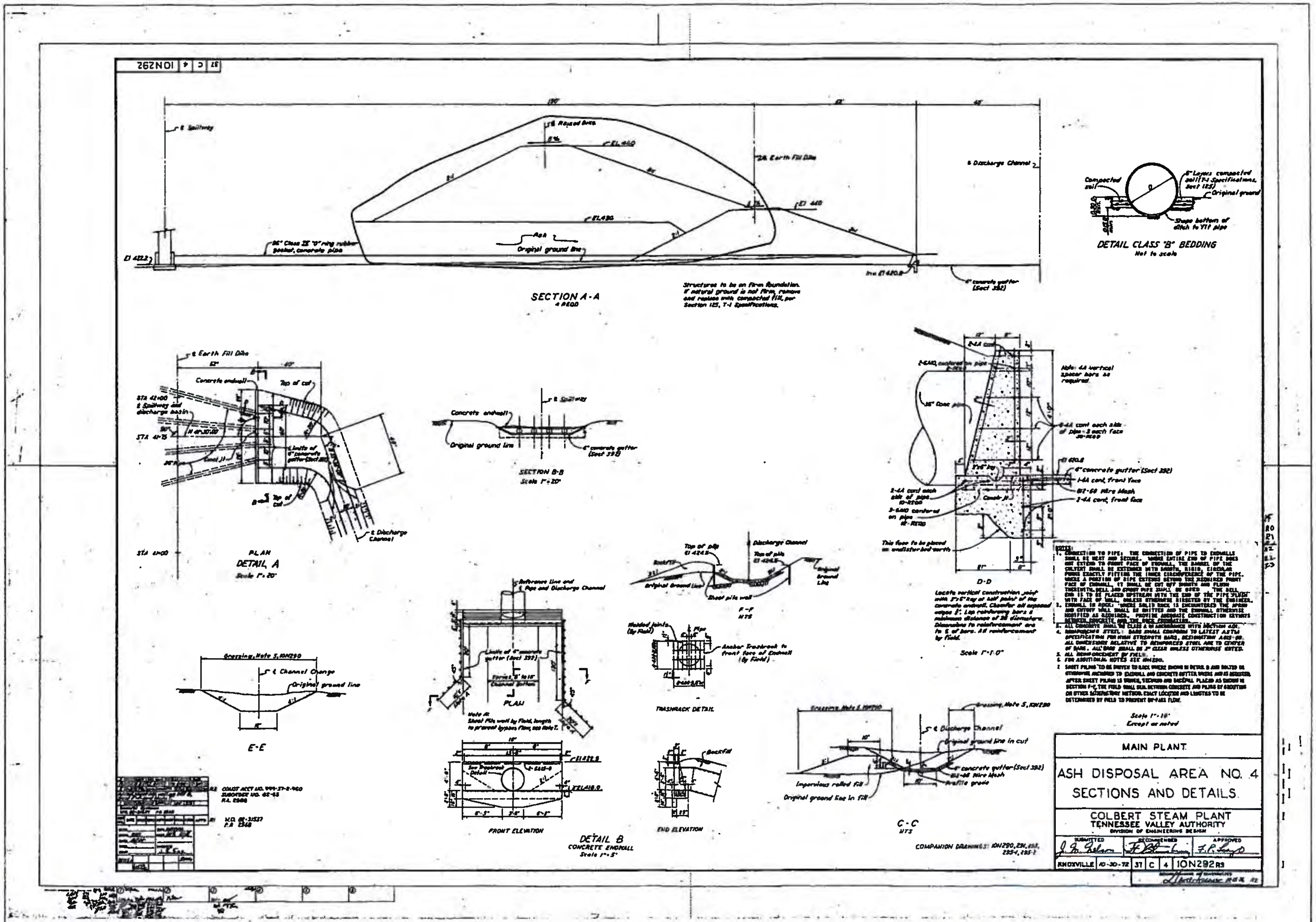
MAIN PLANT

ASH DISPOSAL AREA NO. 4
SPILLWAY & CHANNEL
PLAN

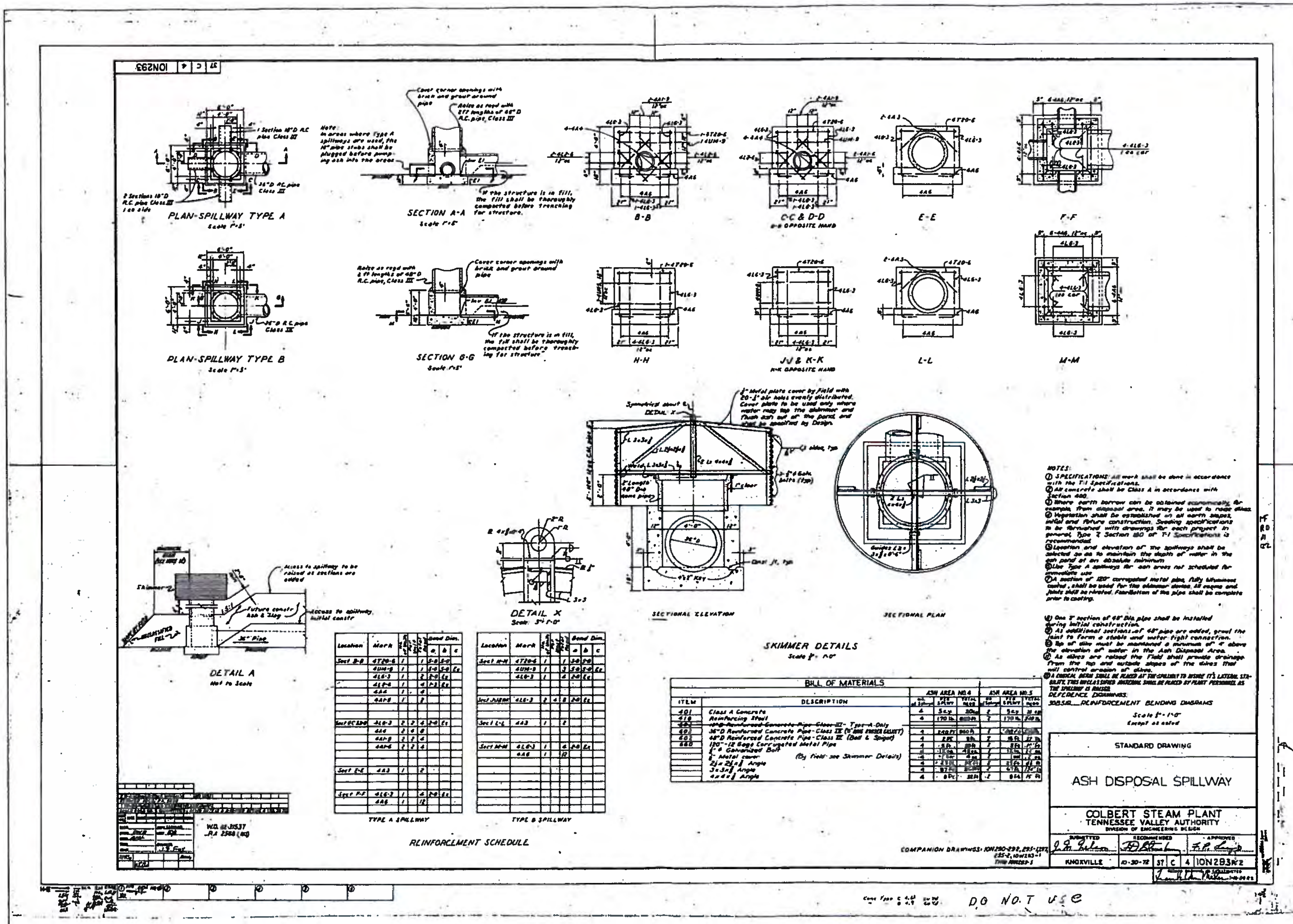
COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

KNOXVILLE 10-30-72 37 C 4 10N291

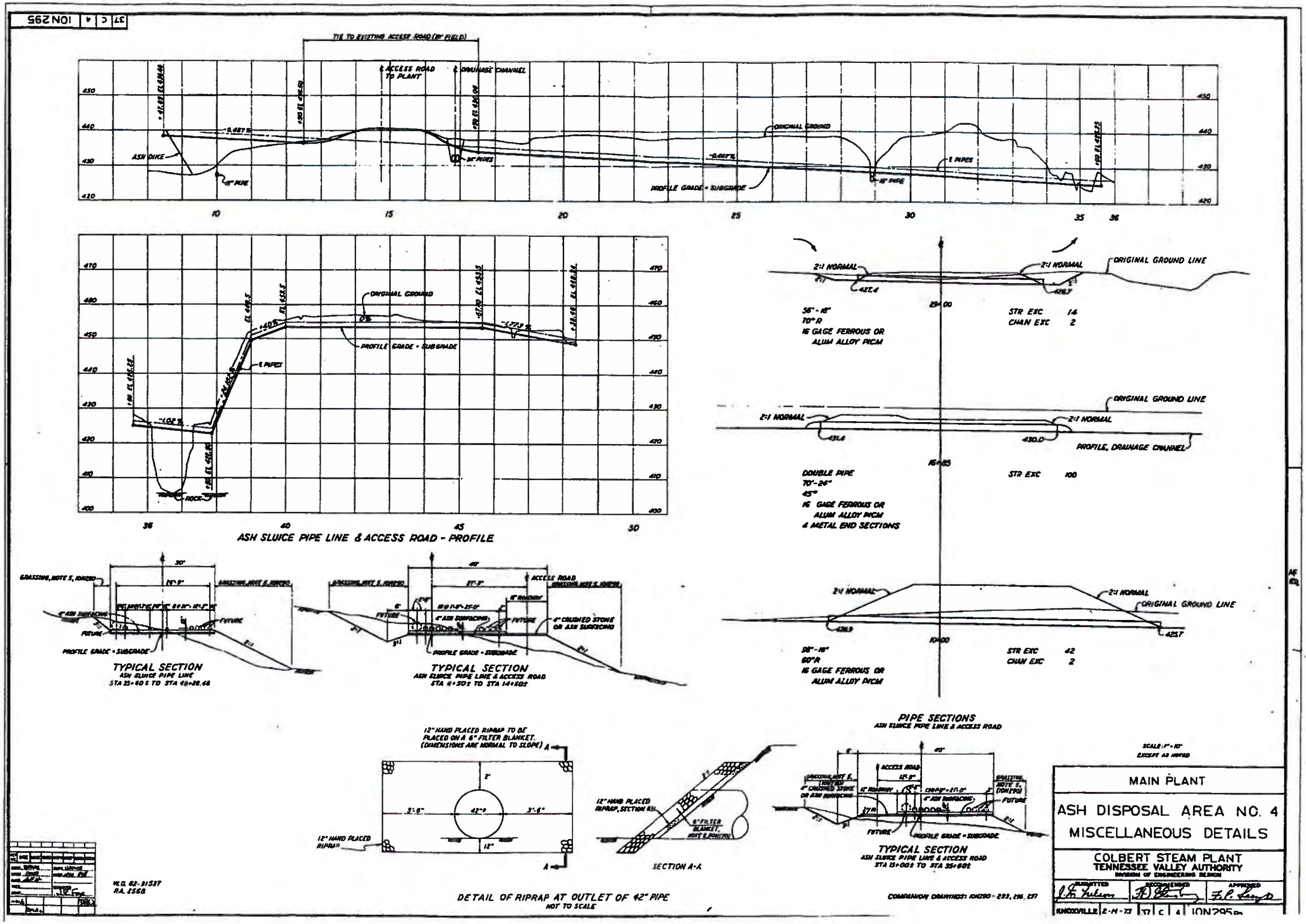
701-21


SECTION A-A
DETAIL CLASS "B" BEDDING
Not to scale
Structures to be on firm foundation. If natural ground is not firm, remove and replace with compacted fill, per Section 125, T-1 Specifications.
PLAN
DETAIL A
Scale 1"=20'
SECTION B-B
Scale 1"=20'
D-D
Scale 1"=1'-0"
E-E
F-F
NTS
TRASHRACK DETAIL
END ELEVATION
FRONT ELEVATION
DETAIL B
CONCRETE ENDWALL
Scale 1"=5'
C-C
NTS
COMPANION DRAWINGS: 10N290, 291, 233-1, 295-1
Scale 1"=10'
Except as noted
MAIN PLANT
ASH DISPOSAL AREA NO. 4
SECTIONS AND DETAILS
COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN
SUBMITTED
RECOMMENDED
APPROVED
KNOXVILLE 10-30-72 37 C 4 10N292 R3
37 C 4 10N292

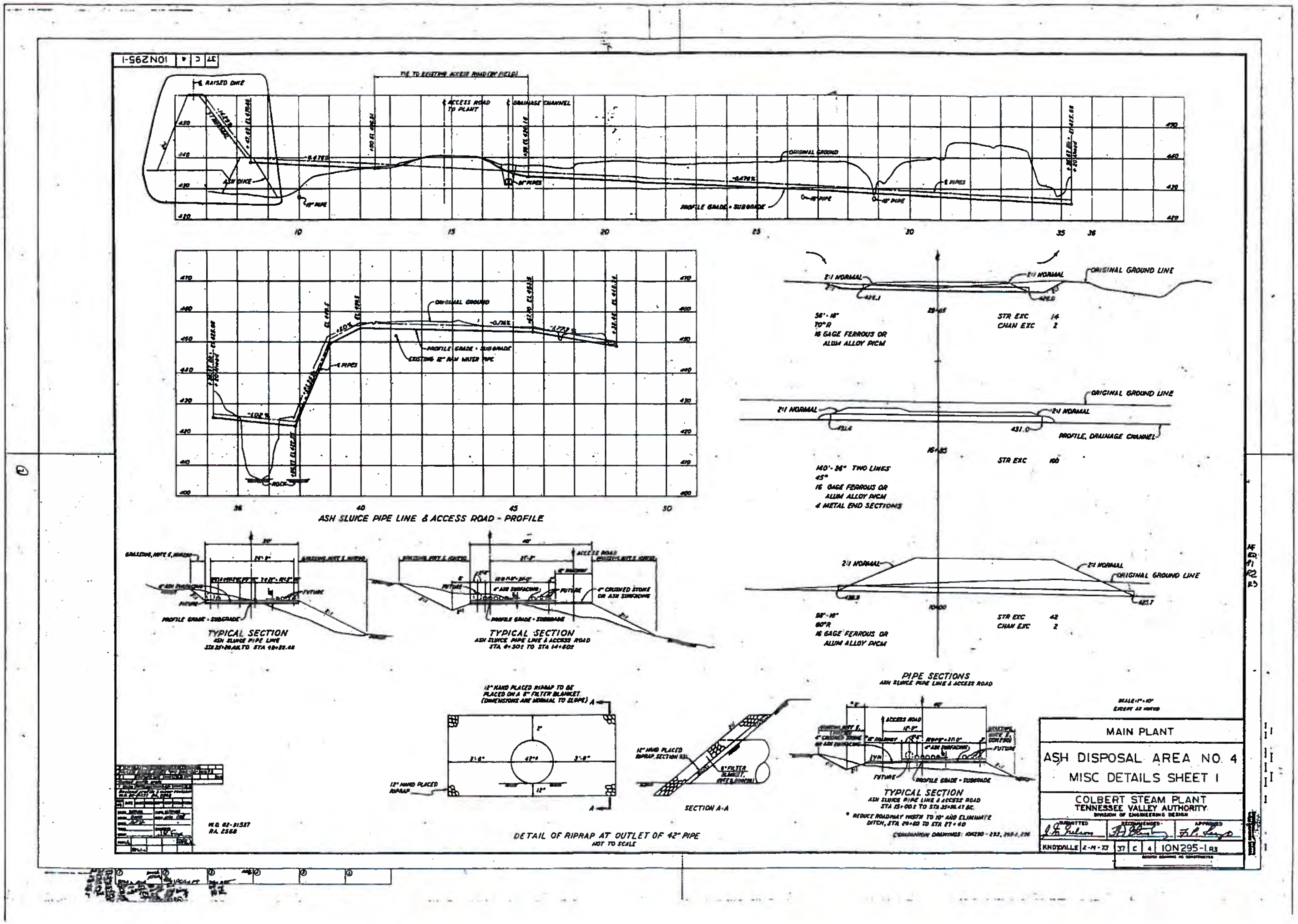
701-22



PLAN-SPILLWAY TYPE A
SECTION A-A
B-B
CC & D-D
E-E
F-F
PLAN-SPILLWAY TYPE B
SECTION G-G
H-H
JJ & K-K
L-L
M-M
DETAIL X
SECTIONAL ELEVATION
SECTIONAL PLAN
SKIMMER DETAILS
DETAIL A
Not to Scale
BILL OF MATERIALS
TYPE A SPILLWAY
TYPE B SPILLWAY
REINFORCEMENT SCHEDULE
NOTES:
STANDARD DRAWING
ASH DISPOSAL SPILLWAY
COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN
KNOXVILLE
10-30-72
10N293
DO NOT USE

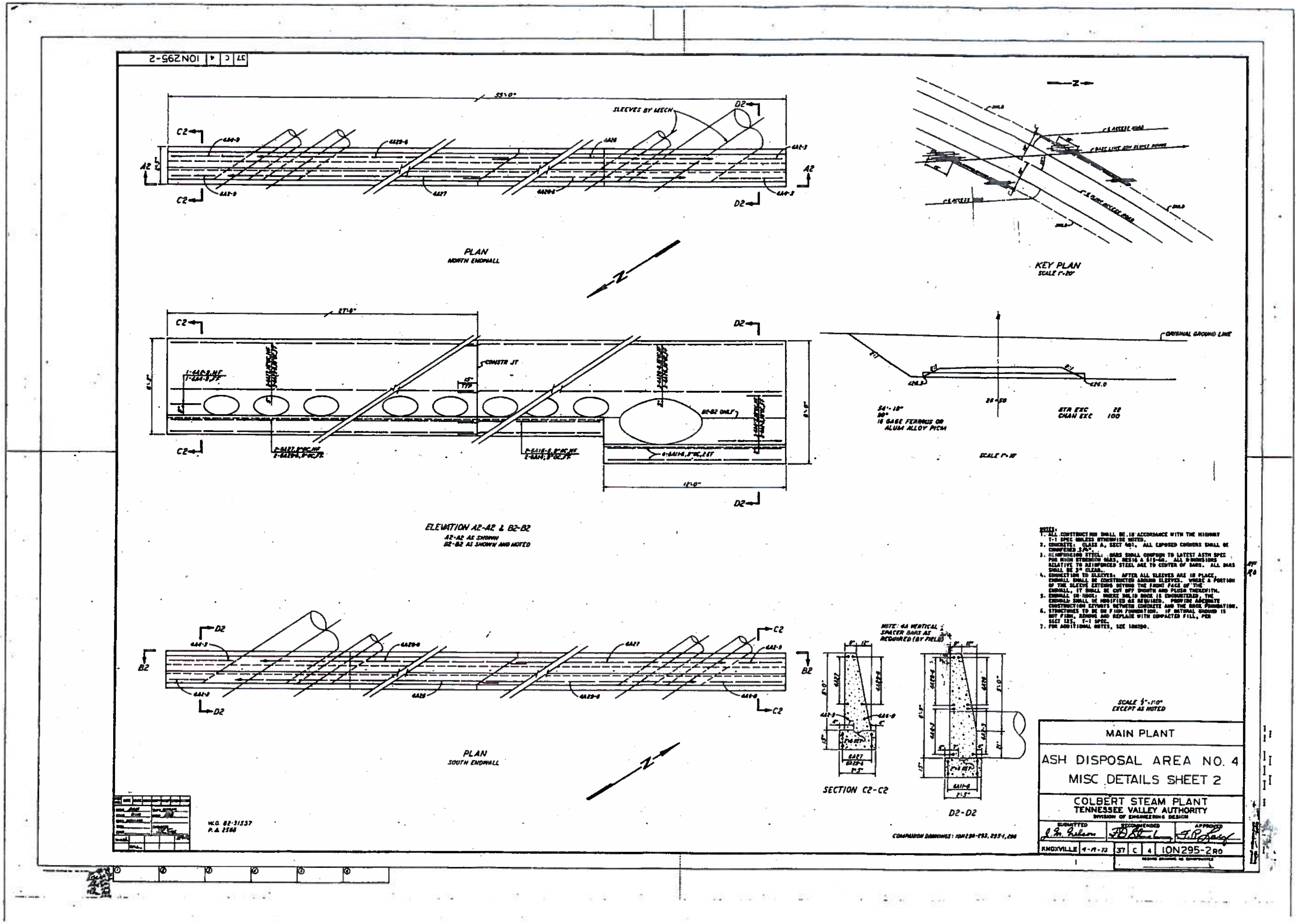


ASH SLUICE PIPE LINE & ACCESS ROAD - PROFILE
TIE TO EXISTING ACCESS ROAD (BY FIELD)
ACCESS ROAD TO PLANT
DRAINAGE CHANNEL
ORIGINAL GROUND
PROFILE GRADE • SUBGRADE
ASH DIKE
ORIGINAL GROUND LINE
2:1 NORMAL
STR EXC 14
CHAN EXC 2
DOUBLE PIPE
4 METAL END SECTIONS
STR EXC 100
PROFILE, DRAINAGE CHANNEL
STR EXC 42
CHAN EXC 2
16 GAGE FERROUS OR ALUM ALLOY PICM
PIPE SECTIONS
ASH SLUICE PIPE LINE & ACCESS ROAD
TYPICAL SECTION
ASH SLUICE PIPE LINE
STA 35+60± TO STA 48+28.46
TYPICAL SECTION
ASH SLUICE PIPE LINE & ACCESS ROAD
STA 6+30± TO STA 14+50±
TYPICAL SECTION
ASH SLUICE PIPE LINE & ACCESS ROAD
STA 15+00± TO STA 35+60±
12" HAND PLACED RIPRAP TO BE PLACED ON A 6" FILTER BLANKET. (DIMENSIONS ARE NORMAL TO SLOPE)
12" HAND PLACED RIPRAP
SECTION A-A
DETAIL OF RIPRAP AT OUTLET OF 42" PIPE
NOT TO SCALE
W.O. 82-31537
P.A. 2568
COMPANION DRAWINGS: 10N290 - 293, 216, 237
SCALE: 1" = 10'
EXCEPT AS NOTED
MAIN PLANT
ASH DISPOSAL AREA NO. 4
MISCELLANEOUS DETAILS
COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN
SUBMITTED
RECOMMENDED
APPROVED
KNOXVILLE 2-14-73
37 C 4 10N295
701-24



10N295-1
RAISED DIKE
ASH DIKE
TIE TO EXISTING ACCESS ROAD (BY FIELD)
ACCESS ROAD TO PLANT
DRAINAGE CHANNEL
ORIGINAL GROUND
PROFILE GRADE = SUBGRADE
ASH SLUICE PIPE LINE & ACCESS ROAD - PROFILE
EXISTING 12" RAW WATER PIPE
ORIGINAL GROUND LINE
2:1 NORMAL
PROFILE, DRAINAGE CHANNEL
STR EXC 14
CHAN EXC 2
STR EXC 100
STR EXC 42
CHAN EXC 2
140'-36" TWO LINES
45°
16 GAGE FERROUS OR
ALUM ALLOY PVCM
4 METAL END SECTIONS
PIPE SECTIONS
ASH SLUICE PIPE LINE & ACCESS ROAD
TYPICAL SECTION
ASH SLUICE PIPE LINE
TYPICAL SECTION
ASH SLUICE PIPE LINE & ACCESS ROAD
STA 6+50± TO STA 14+50±
4" CRUSHED STONE OR ASH SURFACING
TYPICAL SECTION
ASH SLUICE PIPE LINE & ACCESS ROAD
12" HAND PLACED RIPRAP TO BE PLACED ON A 6" FILTER BLANKET (DIMENSIONS ARE NORMAL TO SLOPE)
12" HAND PLACED RIPRAP
SECTION A-A
DETAIL OF RIPRAP AT OUTLET OF 42" PIPE
NOT TO SCALE
MAIN PLANT
ASH DISPOSAL AREA NO. 4
MISC DETAILS SHEET 1
COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
KNOXVILLE
10N295-1 R3

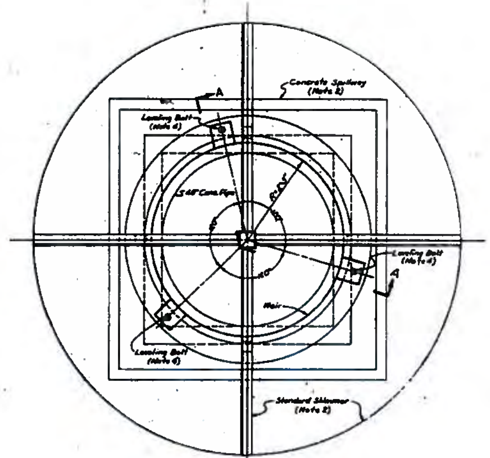
701-25



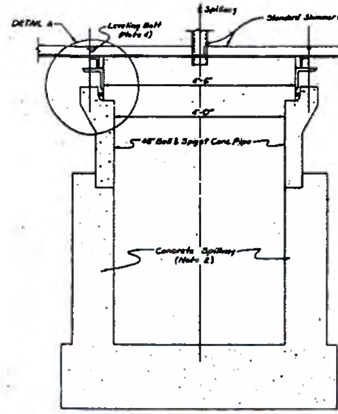
PLAN
NORTH ENDWALL
SLEEVES BY MECH
ELEVATION A2-A2 & B2-B2
A2-A2 AS SHOWN
B2-B2 AS SHOWN AND NOTED
CONSTR JT
PLAN
SOUTH ENDWALL
KEY PLAN
SCALE 1"=20'
ORIGINAL GROUND LINE
SECTION C2-C2
D2-D2
SCALE 3/4"=1'-0"
EXCEPT AS NOTED
MAIN PLANT
ASH DISPOSAL AREA NO. 4
MISC DETAILS SHEET 2
COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN
SUBMITTED
RECOMMENDED
APPROVED
KNOXVILLE
37 C 4 10N295-2 R0

701-26

37 | C | 4 | 10N297

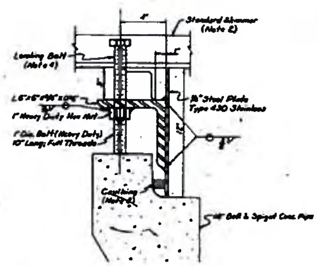


PLAN
Scale: 1"=1'



SECTION A-A
Scale: 1"=1'

WEIR DISCHARGE IN CUBIC FEET PER SECOND										
HEAD IN FEET	0.0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0	.04	.11	.21	.33	.46	.72	.89	1.20	1.34
0.1	1.54	1.73	1.97	2.20	2.46	2.70	2.96	3.24	3.52	3.87
0.2	4.11	4.41	4.72	5.04	5.36	5.69	6.04	6.38	6.73	7.10
0.3	7.47	7.85	8.23	8.62	9.00	9.41	9.82	10.2	10.6	11.1
0.4	11.5	11.9	12.4	12.8	13.3	13.7	14.2	14.7	15.1	15.6
0.5	16.1	16.6	17.1	17.6	18.1	18.6	19.1	19.6	20.1	20.7
0.6	21.2	21.7	22.3	22.8	23.4	23.9	24.5	25.0	25.6	26.2
0.7	26.7	27.3	27.9	28.3	29.1	29.7	30.3	30.9	31.5	32.1
0.8	32.7	33.4	34.0	34.6	35.2	35.9	36.5	37.2	37.8	38.5
0.9	39.1	39.8	40.4	41.1	41.8	42.5	43.1	43.8	44.5	45.2
1.0	45.9									



DETAIL A
3 REQUIRED
Scale: 3"=1'

NOTES:
1. All connections to be welded.
2. For Skimmer and Spillway details see Std Dwg. 10N293
3. Caulking shall extend completely around the weir and form a water tight seal.
4. When the weir is installed the top shall be leveled with the use of the leveling bolts.

SUMMARY OF QUANTITIES		
Item	Description	No. Req'd
Angles	6"x6"x5/16"x0'-6"	3
Bolts	1"x10" Heavy Duty (Full Thread) w/nut	3
Steel Plate	12"x14'-5", Type 430 Stainless	1
Caulking	By Field	

4 REQUIRED (AREA 4)
2 REQUIRED (AREA 5)

W.O. 82-31537
R.A. 2566

COMPANION DRAWINGS: 10N290-293, 235-1, 235-2, 10N233-1, 233-2, 233-3, 233-4, 233-5

Scale: As Noted

STANDARD DRAWING

WEIR FOR ASH DISPOSAL SPILLWAY

COLBERT STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED | RECOMMENDED | APPROVED

KNOXVILLE | 2-14-73 | 37 | C | 4 | 10N297 R2

701-27

Colbert Fossil Plant
Drawing Inventory List

Series	Sheets	Revision	Date	Facility	Description
10W279R0	-	varies	1/18/83	Ash Stack 5	Ash Disposal Area 5 general plan
10W283-1 through 5	-	varies	2/25/83	Ash Stack 5	Ash Disposal Area 5 sections and details
10W283-10 through 20	-	varies	9/24/81	Ash Stack 5	Ash Disposal Area 5 stacking plan
10W283-10 through 505	-	varies	4/25/06	Ash Stack 5	Ash Disposal Area 5 dike and stormwater plans
10N291 through 10N295	-	varies	2/14/73	Ash Pond 4	Ash Disposal Area 4 plan and details
COF-090430-WP 1	-	complete	2009	Various Facilities	Various Facilities- Tree Removal
COF-090710-WP-2	-	complete	2009	Ash Pond 4	Ash Pond 4- Wave Wash Protection
COF-091216-WP-3	-	complete	2010	Ash Stack 5	Disposal Area 5 Dry Stack- Interim Risk Reduction Measures
10W291-01 thru 10W291-09	-	complete	2010	Ash Pond 4	Ash Pond 4 - Seepage Remediation
10W284-01 thru 10W284-02	-	complete	2010	Ash Stack 5	Ash Stack 5 - Inlet Structure Grading Plan & Removal
10W503-01 thru 10W503-07	-	complete	2011	Ash Pond 4	Ash Pond 4 - Temporary Rock Buttress & Sheet Pile Wall
10W393-01 thru 10W393-10	-	complete	2010	Ash Pond 4	Ash Pond 4 - Partial Closure Phase 1
10W290-00 thru 10W290-19	-	complete	2011	Ash Pond 4	Ash Pond 4 - High Hazard Removal & Spillway Replacement
10W209-01 thru 10W209-37	-	complete	2010	Ash Stack 5	Ash Stack 5 - Seepage & Drainage Remediation

1.0 PERMITS

The list presented below is of known active permits for the Colbert Fossil Plant. It should be noted that the permit information presented herein may or may not be up-to-date as revisions and modifications to permits can occur. To obtain current permit information the TVA Environet should be referenced or contact the site specific PAE. Environet can be accessed through TVA's intranet at the following link:

http://insidenet.tva.gov/org/et/environet/toolbox/tva-facility_permit_list.xls

List of Active Permits:

- National Pollutant Discharge Elimination System (NPDES), Permit No.: AL0003867

2.0 OPERATIONS REQUIREMENT MATRIX

The Operations Requirement Matrix included as **Section 901**, lists the various requirements that pertain to routine handling of CCP materials for active facilities. The matrix is divided based on the source of the requirement. The requirements include permit requirements, NEPA commitments, and recommended practices. Additionally, presented in the matrix are the designation of the responsible party and a status of each item presented. As responsibilities, requirements, commitments alter the matrix should be revised.

3.0 NPDES FLOW SCHEMATIC

The NPDES flow schematic is presented in **Section 902**.

4.0 NEPA COMMITMENTS

If applicable, NEPA commitments are presented in **Section 903**.

Operations Requirements Matrix
Colbert Fossil Plant

Item No.	Activity	Operations Manual	QAQC Plan Requirement	NEPA Commitment	Recom. Practice	Responsible Group	Complete
	General						
1	Dust suppression is controlled by use of water trucks	X			X		
2	Vegetative cover is established and maintained over the site	X			X		
3	QA/QC performed for new construction		X		X		
4	Annual aerial topographic survey	X			X		
5	Annual free water volume certification	X					
6	NDPES outfall discharge water quality testing	X					
7	Annual NPDES discharge monitoring report	X					
8	Title V Air Monitoring for fugitive dust leaving property line	X					
9	Daily, Weekly, Monthly Inspection	X			X		
10	Quarterly Dam Safety Inspection	X					
	Bottom Ash Pond 4						
11	Maintain drainage facilities and other sedimentation/erosion controls	X			X		
12	Pond level/elevation and freeboard in feet	X			X		
13	Condition of inlet/discharge piping and structures, spillways, road surfaces and slopes	X			X		
14	Condition of outboard embankment slopes, nature of vegetation, and presence of any seeps, animal burrows or erosion	X			X		
15	Presence and condition of piezometers or similar facility monitoring devices	X			X		
16	Monthly instrumentation data collection	X			X		
17	Seepage areas observed	X			X		
	Ash Disposal Area 5 and Drainage Basin						
18	Earthwork construction completed according to RHO&M QA / QC Procedures		X				
19	Ash fill / compaction completed according to RHO&M QA / QC Procedures		X				
20	Maintain top drainage facilities and other sedimentation/erosion controls	X			X		
21	Drainage Basin level/elevation and freeboard in feet	X			X		
22	Condition of inlet/discharge piping and structures, spillways, road surfaces and slopes	X			X		
23	Condition of outboard embankment slopes, nature of vegetation, and presence of any seeps, animal burrows or erosion	X			X		
24	Presence and condition of piezometers or similar facility monitoring devices	X			X		
25	Monthly instrumentation data collection	X			X		
26	Seepage areas observed	X			X		

Item No.	Activity	Operations Manual	QAQC Plan Requirement	NEPA Commitment	Recom. Practice	Responsible Group	Complete
	NPDES Permit # AL0003867						
27	DSN001 - Number 4 ash pond discharge consisting of low volume wastes 5/, metal cleaning wastes (DNS001B), ash transport wastes, sanitary wastewater (DSN001A), non-chemical metal cleaning wastes, equipment cooling water, miscellaneous systems leakage and stormwater runoff including coal pile runoff. 6/ Such discharge shall be limited and monitored to: Oil and Grease - 9mg/L daily maximum, Oil and Grease - 7 mg/L monthly Average, Total Suspended Solids (TSS) - 55 mg/L Daily Maximum, Total Suspended Solids (TSS) - 19mg/L Monthly Average, pH - 6 SU Minimum, pH - 9 SU Maximum. **[Report responsibility of the plant and not an RHOM Responsibility. RHOM responsible for operations of the COF FGD GDA and its associated runoff and needs to be aware of plant's NPDES Permit limits.]**	Yes				Plant Operations and PA(E)	
28	Records Retention and Production - The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by the permit, and records of all data used to complete the above reports or the application for this permit, for a period of at least three years from the date of the sample measurement, report or application.	Yes				Plant Operations and PA(E)	
29	Monitoring Equipment and Instrumentation - All equipment and instrumentation used to determine compliance with the requirements of this permit shall be installed, maintained, and calibrated in accordance with the manufacturer's instructions or in accordance with accepted practices.	Yes				Plant Operations, PA(E) and RHOM or CCP	
30	Spill Prevention, Control, and Management - permittee shall provide spill prevention, control, and/or management sufficient to prevent any spills of pollutants from entering a water of the state or a publicly or privately owned treatment works. Any containment system used to implement this requirement shall be constructed of materials compatible with the substance(s) contained and which shall prevent the contamination of groundwater and such containment system shall be capable of retaining a volume equal to 110 percent of the capacity of the largest tank for which containment is provided.	Yes			Annual Training provided to Plant Operations and Maintenance and RHOM & RHOM Cntractor.	Plant Operation & Maintanance, RHOM & RHOM Contractor and PA(E)	

Operations Requirements Matrix
Colbert Fossil Plant

Item No.	Activity	Operations Manual	QAQC Plan Requirement	NEPA Commitment	Recom. Practice	Responsible Group	Complete
NPDES Permit # AL0003867							
31	Ash Pond Free Board Requirement - there shall be no discharge of plant wastes to the ash pond unless the permittee provides and maintains at all times a minimum free water volume (between the top of the sediment level and the minimum discharge elevation) equivalent to the sum of the maximum 24-hour plant discharges plus all direct runoff and all runoff flows to the pond resulting from a 10-year, 24-hour rainfall event, when using a runoff coefficient of 1.0. The permitted shall remove settled material from the pond or otherwise enlarge the available storage capacity in order to maintain the required minimum volumes at all times.	Yes				PA(E) and RHOM or CCP	

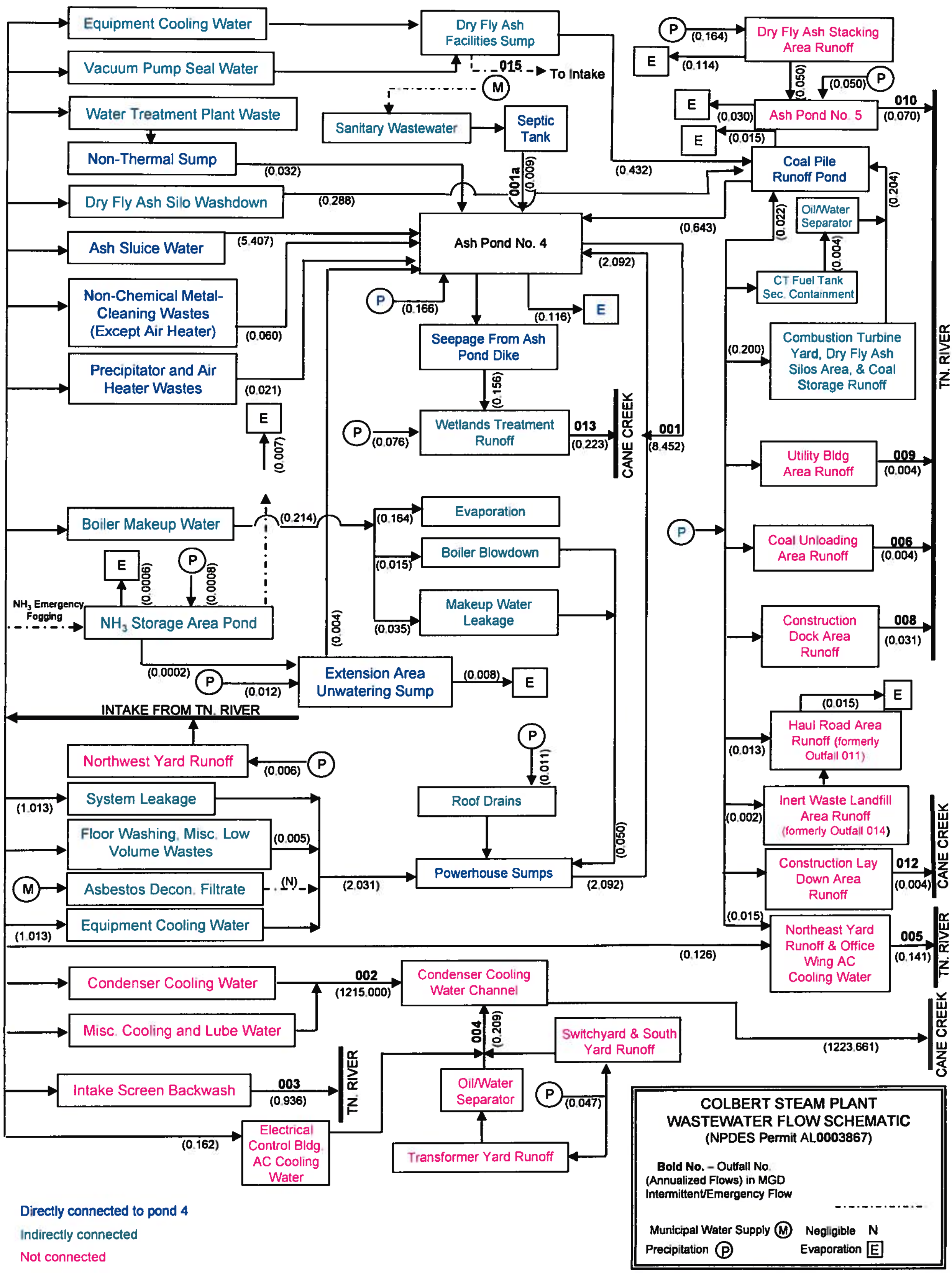
Item No.	Activity	Operations Manual	QAQC Plan Requirement	NEPA Commitment	Recom. Practice	Responsible Group	Complete
	Air Permit # 701-0010						
32	Any change in operation which could affect emission must be evaluated with respect to the permit conditions. **[Coordination with EP&C is required before it the change is implemented]**	Yes				Plant Operations & Maintenance and PA(E)	
33	Fugitive Dust - Reasonable precautions shall be taken to prevent fugitive dust emanating from plant roads, grounds, stockpiles, screens, dryers, hoppers, ductwork, etc.	Yes				Plant Operations & Maintenance and PA(E)	
34	Fugitive Dust - Plant or haul roads and grounds will be maintained in the following manner so that dust will not become airborne: (1) By the application of water any time the surface of the road is sufficiently dry to allow the creation of dust emissions by the act of wind or vehicular traffic; (2) By reducing the speed of vehicular traffic to a point below that at which dust emissions are created; (3) by paving; (4) by the application of binders to the road surface at any time the road surface is found to allow the creation of dust emissions; or (5) by any combination of the above methods which results in the prevention of dust becoming airborne from the road surface. If above methods fail, alternative methods shall be approved by the Department prior to utilization.	Yes				Plant Operations & Maintenance and PA(E)	
35	Emission Standards - The wet suppression vehicle shall be operated as necessary to minimize emissions from this area.				Yes	Plant Operations & Maintenance and PA(E)	
36	Emission Monitoring - (1) Inspection of the wet suppression vehicle will be conducted each calendar quarter to ensure proper operation of the equipment; (2) An observation of the ash handling area will be accomplished at least semi-annually to determine if fugitive emissions are present.	Yes				PA(E)	
37	Recordkeeping and Reporting Requirements - (1) Inspections and maintenance of the wet suppression vehicle will be documented and the records maintained at the facility for review for a period of at least five years; (2) Records of all observations performed for this area shall be documented and maintained in a form suitable for inspection for a period of at least five years.	Yes				PA(E)	

Operations Requirements Matrix
Colbert Fossil Plant

Item No.	Activity	Operations Manual	QAQC Plan Requirement	NEPA Commitment	Recom. Practice	Responsible Group	Complete
	Integrated Pollution Prevention (IPP) Plan						
38	Conduct Routine Inspections (Yard Ops) - Ensure routine inspections and testing assigned to the Yard Ops is performed according to required frequency.	Yes		X		Yard Operations	
39	Conduct Annual Site Compliance Evaluation (Manager Engineering) - Ensure that an annual comprehensive storm water compliance evaluation is conducted and a summary report is written & certified.	Yes				Manager Engineering	
40	Conduct Training (PSO) - Ensure prescribed training is performed.	Yes				PSO	
41	Maintain BMPs (PSO) - Ensure that Best Management Practices (BMPs) are implemented and maintained.	Yes				PSO	
42	Stormwater Monitoring (Manager Engineering) - Conduct stormwater monitoring and visual examinations.	Yes				Manager Engineering	
43	Spill Notification (Production Supervisors) - Ensure Environmental Emergency Notification according to TVA.SPP.05.17.				Yes	Production Supervisors	
44	Spill Documentation (Manager Engineering) - Maintain record of spill incidents	Yes				Manager Engineering	
45	Conduct Routine Inspections (PSO) - Ensure routine inspections and testing assigned to the PSO is performed according to required frequency.				Yes	PSO	
46	Review and Update IPP Plan (EP&C) - Ensure that the IPP plan is reviewed and updated as needed after the following: (1) Conducting annually comprehensive site compliance evaluation, (2) Conducting 5 year SPCC facility evaluation, (3) Whenever there is a change in design, construction, operation or maintenance that has a significant effect on the potential for the discharge of pollutants to the waters of the state and (4) Stormwater monitoring evaluation	Yes			X	PA(E) and EP&C	
47	Records - Manager Engineering shall ensure that environmental records identified in the IPP plan are stored in accordance with the E&T, EP&C, Environmental Records Process, UG-1.	Yes			X	Manager Engineering	
48	Haul Trucks are to be covered prior to leaving the ash loading area.				Yes	Trans Ash, RHOM and RHOM Contractor	

Item No.	Activity	Operations Manual	QAQC Plan Requirement	NEPA Commitment	Recom. Practice	Responsible Group	Complete
	Integrated Pollution Prevention (IPP) Plan						
49	Ash Haul Road shall be inspected monthly for ash accumulation at the time when ash haul trucks are using the road. A set of tracking records, such as MAXIMO, shall be used to ensure that the appropriate actions is taken in response to the inspection.				Yes	Plant Operation, Outside Contractor, PA(E) and RHOM	
50	Temporary Tanks, Mobile Tanks and other Containers - Small containers with capacities less than or equal to 5,000 gallons including drums and totes will not require integrity testing. Routine visual inspections is expected to be an adequate preventative measure if any sides can be inspected (if necessary) and no corrosion problems are expected.	Yes			Contact PAE(E), prior to tank being brought on site, for approval	RHOM and RHOM Contractor	
51	Temporary or mobile bulk storage tanks brought on site by contractors will be inspected on a routine basis by the contractor, this visual inspection includes: (1) Double wall tanks should be inspected for the presence of oil in the interstice, (2) Pipe connections to the tank should be inspected for presence of leaks, and (3) The tank should be inspected to identify any abnormalities.				Contact PAE(E), prior to tank being brought on site, for approval	RHOM and RHOM Contractor	Contact PAE(E), prior to tank being brought on site, for approval
52	The NPDES Permit requires monthly inspections of areas that may contribute contamination to stormwater run-off. The monthly inspection shall be performed by qualified plant personnel (trained in Environmental Awareness and briefed in specific areas of concern). The documentation of the monthly inspections shall be check sheet, log or by computer-based tracking system such as MAXIMO. A set of tracking or follow-up items shall be produced to ensure that appropriate actions are taken in response to the inspections. The documented inspection shall be retained onsite a minimum of three (3) years after the date of the inspection and subject to review upon request by the Environmental Protection Agency, State, and local agency with jurisdiction.	Yes				PA(E)	

Item No.	Activity	Operations Manual	QAQC Plan Requirement	NEPA Commitment	Recom. Practice	Responsible Group	Complete
	Integrated Pollution Prevention (IPP) Plan						
53	Annual Facility Inspections and plan review shall be conducted to check the accuracy of the plan and maps. The review shall determine whether measures in the plan to reduce pollutants in stormwater runoff are adequate and properly implemented or whether additional controls are needed. In addition, yearly inspections for structural integrity of material storage facilities may be incorporated into this requirement.	Yes				PA(E), RHOM & RHOMContractor	



Directly connected to pond 4
Indirectly connected
Not connected

From: Gilbert, Brian Newell
Sent: Tuesday, May 17, 2011 3:12 PM
To: Keller, J Darlene
Subject: Fossil Plant Commitments

Darlene,

Fossil Plant Commitments

Colbert Fossil Plant

Supply Dry Fly Ash for Bear Creek Dam Rehabilitation

1. Haul roads used by the fly ash tanker trucks will be watered to prevent the release of fugitive dust.
2. When a vacuum truck is used to clean out the dry fly ash silo, a water jet will be used at the vacuum intake to wet the fly so that when the truck is emptied at the ash pond, dry fly ash will not be released to the air.
3. The fly ash scales will be hosed down if the silo operator observes fly ash accumulation.

System Wide Fuel By-products Survey Schedule
Schedule For FY11

Plant	Area	FWV Reports	BSL LINK (Document ID)	Last Survey Date	Proposed Next Survey Date	Countdown Clock (Days)	Frequency	Survey Method	Comments
Allen									
Allen	East active ash pond	ALF_EASTACTIVE_FWV	38MS461K557(D)	23-Mar-11	22-Jun-11	35	Quarterly	Water	Pre and Post Dredge Surveys
Allen	East stilling pond	ALF_EASTSTILLING_FWV	38MS461K552(D)	23-Mar-11	22-Jun-11	35	Quarterly	Water	
Allen	East Dredge Cell	ALF_DREDGECELL_FWV	38MS461K557(D)	6-Oct-10	5-Jan-11	-139	As Requested	Land / Air	** Survey performed by TA
Allen	West ash pond			20-May-04	-	-	As Requested	Water / Land	
Allen	Pidgeon Industrial Park		38MS461K556(D)	30-Nov-10	1-Mar-11	-78	Quarterly	Land	
Total									
Bull Run									
Bull Run	Main ash pond w/channel	BRF_MAINASH_FWV	49MS461K553(D)	22-Feb-11	24-May-11	6	Quarterly	Water	Pre and Post Dredge Surveys
Bull Run	Main ash stilling pond	BRF_STILLING_FWV	49MS461K553(D)	22-Feb-11	24-May-11	6	Quarterly	Water	
Bull Run	Bottom ash stack (Pond 1)		49MS461K534(D)	8-Sep-10	9-Mar-11	-70	Bi-annually	Land	
Bull Run	Gypsum Storage (Pd 2A)		49MS461K549(D)	26-Jan-09	27-Jul-09	-660	Bi-annually	Land	Pre and Post Dredge Surveys
Bull Run	Fly ash stack Phase II		49MS461K533(D)	17-Feb-11	17-Feb-12	275	Bi-annually	Land	
Total									
Colbert									
Colbert	Ash pond 4	COF_MAINASH4_FWV	37MS461G556(D)	3-Mar-11	1-Sep-11	106	Bi-annually	Water	
Colbert	Ash pond 4 stilling	COF_STILLING4_FWV	37MS461G556(D)	3-Mar-11	2-Mar-12	269	Annually	Water	
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	-553	[illegible]	[illegible]	[illegible]
Colbert	Ash pond 5 complex		37MS461K550(D)	1-Nov-10	2-May-11	-16	Bi-annually	Land	
Colbert	Ash pond 5 stilling	COF STILLING5 FWV	37MS461K547(D)	23-Nov-10	23-Nov-11	189	Annually	Water	
Total									
Cumberland									
Cumberland	Retention pond	CUF_RETENTION_FWV	46MS461K542(D)	4-Nov-10	5-May-11	-13	Bi-annually	Water	
Cumberland	Stilling pond	CUF_STILLING_FWV	46MS461K542(D)	4-Nov-10	5-May-11	-13	Bi-annually	Water	
Cumberland	Gypsum stack complex		46MS461K533(D)	6-Mar-10	4-Sep-10	-256	Bi-annually	Land	
Cumberland	Dry flyash stack		CU000046	6-Mar-10	6-Mar-11	-73	Annually	Air	
Cumberland	Ash Stack			1-Jun-04	1-Jun-05	-2177	Bi-annually	Water / Land	
Total									
Gallatin									
Gallatin	Active ash pond A	ACTIVE ASH POND A FWV	39MS461K564(D)	13-Jan-11	14-Jul-11	57	Bi-annually	Water / Land	
Gallatin	Middle pond A		39MS461K564(D)		-	-	As Requested	Water / Land	
Gallatin	Stilling pond (B, C, & D)	GAF_STILLING_FWV	39MS461K567(D)	31-Aug-10	1-Mar-11	-78	Bi-annually	Water	
Gallatin	Ash pond E	GAF_ASHPONDE_FWV	39MS461K567(D)	20-Oct-10	20-Apr-11	-28	Bi-annually	Water / Land	
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	-792	[illegible]	[illegible]	[illegible]
Total									
Johnsonville									
Johnsonville	Main Ash Pond A	JOF_MAIN ASH A_FWV	30MS461K554(D)	14-Feb-11	16-May-11	-2	Quarterly	Water	
Johnsonville	Main Ash Pond B	JOF_MAIN ASH B_FWV	30MS461K554(D)	14-Feb-11	16-May-11	-2	Quarterly	Water	
Johnsonville	Stilling Pond C	JOF_STILLING C_FWV	30MS461K554(D)	14-Feb-11	16-May-11	-2	Quarterly	Water	
Johnsonville	Ash Complex (Island)			4-Apr-08	4-Jul-08	-1779	Quarterly	Land	
Total									
John Sevier									
John Sevier	Dry Fly Ash Stack		41MS461K527(D)	17-Mar-11	16-Mar-12	303	bi-annually	Land	
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	-439	[illegible]	[illegible]	
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	-439	[illegible]	[illegible]	
John Sevier	Main Ash Pd (Bottom Ash)	JSF_MAIN BOTTOM_FWV	41MS461K548(D)	21-Oct-10	21-Apr-11	-27	Bi-annually	Water	
John Sevier	Stilling Pond	JSF_STILLING_FWV	41MS461K548(D)	28-Oct-10	28-Apr-11	-20	Bi-annually	Water	
Total									
Kingston									
Kingston	Main Ash Pond	KIF_MAIN_FWV	36MS461K623(D)	14-Mar-11	13-Jun-11	28	Quarterly	Water	
Kingston	Stilling Pond	KIF_STILLING_FWV	36MS461K620(D)	11-Nov-10	10-Feb-11	-97	Quarterly	Water	
Kingston	Gypsum Pond			-		-40681	Quarterly	Water	
Total									
Paradise									
Paradise	Daniel run phase II, pond 1			26-Nov-07	25-Nov-08	-904	Annually	Air	Water too LOW to complete survey (8-9-10)
Paradise	Daniel run phase II, pond 2		64MS461K557(D)	13-Mar-07	-	-	As Requested	Water	
Paradise	Daniel run phase II, stilling pond		64MS461K557(D)	13-Mar-07	-	-	As Requested	Water	
Paradise	Daniel run phase I, stilling pond		64MS461K557(D)	13-Mar-07	-	-	As Requested	Water	
Paradise	Daniel run phase I, Cell 2		64MS461K557(D)	13-Mar-07	-	-	As Requested	Water	
Paradise	Jacobs creek ash pond			13-Mar-07	-	-	As Requested	Water	
Paradise	Jacobs creek stilling pond		64MS461K558(D)	13-Mar-07		-	As Requested	Water	
Paradise	Peabody ash pond	PAF_PEABODYASH_FWV	64MS461K576(D)	9-Jun-10	8-Dec-10	-161	Bi-annually	Water	
Paradise	Peabody stilling pond	PAF_PEABODYSTILLING_FWV	64MS461K576(D)	9-Jun-10	8-Dec-10	-161	Bi-annually	Water	
Paradise	Slag Mountain			29-Apr-10	-	-	As Requested	Water / Air	
Paradise	Slag pond 2A	PAF_SLAG2A_FWV	64MS461K579(D)	13-Oct-10	13-Apr-11	-35	Bi-annually	Water / Land	
Paradise	Slag pond 2B	PAF_SLAG2B_FWV	64MS461K579(D)	13-Oct-10	13-Apr-11	-35	Bi-annually	Water	
Paradise	Slag stilling pond		64MS461B568(D)	22-Feb-10		-	As Requested	Water	Only survey if pond is filling up
Paradise	Scrubber Sludge Complex			6-Mar-10	5-Jun-10	-347	Quarterly	Air	
Paradise	Scrubber sludge stilling pond	PAF_STILLING_FWV		28-Jun-10	27-Sep-10	-233	Quarterly	Water	
Total									
Shawnee									
Shawnee	Consolidated Ash stack		35MS461G551(D)	17-Nov-10	18-May-11	0	Bi-Annually	Land	
Shawnee	Main Ash Pond	SHF_MAINASH_FWV	35MS461K559(D)	2-Nov-10	3-May-11	-15	Bi-Annually	Water	
Shawnee	Ash Stilling Pond	SHF_STILLING_FWV	35MS461K559(D)	2-Nov-10	3-May-11	-15	Bi-Annually	Water	
Total									
Widows Creek									
Widows Creek	Main Ash Pond A	WCF_MAIN_FWV	34MS461K596(D)	4-Jan-11	5-Apr-11	-43	Quarterly	Water / Air	
Widows Creek	Upper Stilling Pond	WCF_STILLING_FWV	34MS461K593(D)	20-Apr-11	20-Jul-11	63	Quarterly	Water	
Widows Creek	Lower Stilling Pond (Pump Pd)				-	-	As Requested	Water	
Widows Creek	Old Scrubber Pond Dredge Cell		34MS461K534(D)	25-Jun-10	25-Jun-11	38	Annually	Water / Air	Fly before project starts
Widows Creek	Gypsum Stack			20-Jan-10	20-Jan-11	-118	Bi-annually	Water / Air	
Widows Creek	Gypsum Stilling Pond	WCF_GYP STILLING_FWV	34MS461K534(D)	21-Apr-11	21-Jul-11	64	Quarterly	Water	
Total									
System Total									

Last Updated: April 19, 2011
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Table of Contents

1.0 PROCEDURES

The purpose of this document is to define the procedures for handling production CCP materials at COF. This document defines the roles and responsibilities of all parties, active permits, operational requirements, required documentation, and general procedures for the daily operations at COF.

1.1 BOTTOM ASH POND 4 AND STILLING POND

Operating Requirements

The operating requirements for Bottom Ash Pond 4 are contained in the Pond and Ash operations Manual (included as **Section 1101**).

The Operational Requirements Checklist for additional activities as applicable (Checklist provided in **Section 901**) should also be reviewed. Additionally, comply with the stacking QA/QC requirements listed in **Section 1103**.

1.2 FLY ASH DISPOSAL AREA (STACK) 5

Operating Requirements

The operating requirements include the following items:

1. Compact fly ash to requirements listed in **Section 1103**.
2. Maintain spillway risers.
3. Maintain top area stormwater conveyance flow channel, dip ash as necessary.
4. Maintain the outer stack slopes and stormwater benches including mowing and / or removal of excess vegetation. Frequency should be as needed to maintain manageable growth for inspections, positive drainage off stack, and for overall good appearance.
5. Maintain rip-rap down drains.
6. Repair embankment erosion and seeps.
7. Maintain top of perimeter berm roads / surfaces.
5. Protect instrumentation from damage.

The Operational Requirements Checklist for additional activities as applicable (Checklist provided in **Section 901**) should also be reviewed.

2.0 QUALITY CONTROL MEASURES

Quality control measures and procedures for all activities at the fly ash and bottom ash disposal areas are provided in **Section 1103**. As operations change, the specifications should be updated.

3.0 GENERAL MAINTENANCE GUIDELINES

Frequently, general maintenance activities are required for such occurrences as:

1. Erosion repairs,
2. Animal burrows repairs,

3. Wave wash repairs,
4. Vehicle rutting,
5. Tree removal,
6. Mowing and Vegetation Removal, and
7. Bare Area Fertilizing and reseeding.

These general maintenance activities shall be conducted according to the guidelines provided in **Section 1104**.

4.0 ENVIRONMENTAL MANAGEMENT

Overview

This section provides an overview of environmental (stormwater / dust) management at CCP facilities. Specific to CCP ponds or impoundments, stormwater is managed within the CCP pond itself and discharged in accordance with the facility's NPDES permit. The stormwater management systems prevent stormwater run-on and are to control sedimentation / erosion and stormwater run-off.

Surface Water Run-On Control

Stormwater run-on controls consist of berms and ditches to divert and/or prevent stormwater from entering operational areas. Inspections of stormwater run-on controls shall be conducted weekly, quarterly and annually. In addition, inspections shall also occur immediately following significant storm events. Inspections following storm events are to confirm that controls have not been damaged. In some cases, repairs of items will need to be performed immediately following the post-storm inspections. In other cases, repairs may not be required, however accumulated sediment will need to be removed and/or original design volumes of sediment basins will need to be restored.

Erosion and Sediment Control

Monitoring of erosion and sediment controls shall be conducted to ensure compliance with the facility-specific erosion and sediment control permit.

Inspections of erosion and sediment controls shall be conducted weekly, quarterly and annually. In addition, inspections shall also occur immediately following significant storm events. Inspections following storm events are to confirm that controls have not been damaged. In some cases, repairs of items such as silt fencing, open channels, sediment basins, etc. will need to be performed immediately following the post-storm inspection. In other cases, repairs may not be required, however accumulated sediment will need to be removed and/or original design volumes of sediment basins will need to be restored. The items to be inspected consist of erosion and sediment control measures to limit sediment from entering into natural drainage features or surface water bodies outside the CCP impounding facilities and stilling basins.

Fugitive Dust Control

TVA shall operate facilities such that water is applied / sprayed for dust suppression to all areas susceptible to visible fugitive dust emissions. This includes access roads, waste surfaces, onsite stockpiles, staging areas, active construction areas, material hauling or storage areas, loading and unloading areas, etc.

5.0 INSPECTION REQUIREMENTS

Inspections are to be conducted by a combination of TVA's Reservoir Operations-Dam Safety (RO-DS) and RHO&M Groups, or their designee. Guidelines for inspection frequency are given in the TVA Master Programmatic Document.

Prompt corrective action should be implemented if necessary. Utilize the standardized "RHO&M Daily Field Report," provided in **Section 1105**. In addition to the standard information to be provided on the daily report, the report shall include inspection results and a summary of any corrective actions taken. Completed daily reports shall be maintained on-site by the operator in order to be available for local and/or State permitting authorities upon request.

The operator shall also inspect all facilities, on a daily basis, at a minimum, for possible impairment or damage after storms, and after the occurrence of earthquakes, vandalism, or other potentially damaging events. Documentation of these inspections shall also be provided on the standardized "RHO&M Daily Field Report," provided in **Section 1105**.

5.1 INSPECTION DEFICIENCIES

Inspection deficiencies and guidelines for correction are provided in **Section 1112**.

6.0 PROJECT MANAGEMENT

The following forms are included to assist in project management requirements.

<u>Project Startup Checklist</u>

The purpose of the project startup checklist is to define the roles and responsibilities of the various groups within TVA and to insure that the required tasks are completed during the project planning stage. It also includes the required steps to be completed at project completion. The project startup checklist is provided in **Section 1109**.

<u>RHO&M Additional Work/ Change Order Form</u>

The additional work/ change order form shall be used when the scope of work changes for the routine handling contractor. The form addresses the reason for the change, who initiated the change, who needs to be notified, and the financial impacts of the change. The additional work/ change order form is provided in **Section 1110**.

<u>Environmental Review</u> (NEPA)

TVA's NEPA procedure for conducting an environmental review prior to initiation of a new project is provided in **Section 1111**.

7.0 WORK CONTROL PROCESS

The work control process was developed to provide guidance for implementing a work control process that maximizes safety, facility reliability, work productivity, and risk assessment and management. The procedures describe the process by which maintenance and modification work activities are identified, planned, scheduled, monitored, and completed. It describes the work order process using the Maximo system. The work control process is included in Section 1112.

8.0 RECORDS

In accordance with the TVA Master Programmatic Documents, the Maximo database shall be used to track all inspection, monitoring, reporting, and maintenance recommendations. Final inspection reports and instrumentation data collection and analysis will be placed in the TVA BSL.

9.0 SUBSECTIONS

1101 Pond and Ash Operations Manual

1102 Technical Specifications

1103 RHO&M QA/QC Procedures

1104 General Maintenance Guidelines

1105 RHO&M Daily Field Report

1106 RHO&M Weekly Material Summary

1107 Weekly Facility Observation Form

1108 Monthly/Quarterly/Special Facility Observation Form

1109 Project Startup Checklist

1110 RHO&M Additional Work/Change Order Approval Form

1111 Procedures for Compliance with the National Environmental Policy Act

1112 RHO&M Work Control

1113 Clay Dike Restrictions

RHO&M Daily Field Report

Date		Plant		Partner	

Project No.		Weather Conditions :		High	Low	Rain Gauge Reading:

Daily Facility Observation; List deficiencies found beyond Routine Maint. items(Boils, Freeboard, Seeps [new or changes to existing] , Sloughs Spillways)

Who Was Notified of Deficiency:		Date & Time of Notification:	

Safety Statistics	Current	Year to Date Totals	Environmental Statistics	Current	Year to Date Totals
Near Misses			Near Misses		
First Aides			REE's		
Recordable			NOV's		
Interventions			Interventions		
Observations			Observations		

Safety / Environmental Explanation:

Silo Status

	Starting Level	Ending Level	Load Count	No. Pug Mills in Operation	Constraints / Expectation
Silo "A"					
Silo "B"					
Silo "C"					
Silo "D"					

Daily Production / Materials Handled

	No. of Loads	CY/TNS Hauled	CY/TNS Dipped	Hours	Loc 1	Loc 2	Loc 3	Comments
Bottom Ash								
Fly Ash								
Gypsum Hauled								
Gypsum Dipped								
Boiler Slag								
Coal Fine Haul								
Coal Fine Blend								
Dirt								
Sand								
Rock								
Water/Dust Cont								
Dredging								
Other								
Cenospheres								

NOTE: Loc 1 thru Loc 3 to be used to identify / breakout sub areas such as JOF cells and CUF Gypsum Shed / Pond

Materials / Equipment Delivered

Description:

Plant / Visitor Interface:		Completed By:	

Routine Handling Activities

Man Power	Hours	Equipment Description	Equipment # / Rental	Hours	Work ID

Activity Descriptions:

Approved Additional (T&M Work)

Man Power	Hours	Equipment Description	Equipment # / Rental	Hours	Work ID

Daily Activity Description:

SUMMARY PAGE

Weekly Material Summary for Week Ending : 1/6/00 PLANT: 0

	Bottom Ash				Fly Ash				Gypsum – Gypsum Hauled				Gypsum – Gypsum Dipped			
	Loads	CY/TN Haul	CY/TN Dipped	Hours	Loads	CY/TN Haul	CY/TN Dipped	Hours	Loads	CY/TN Haul	CY/TN Dipped	Hours	Loads	CY/TN Haul	CY/TN Dipped	Hours
Monday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tuesday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wednesday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thursday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Friday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saturday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Boiler Slag				Coal Fine Haul				Coal Fine Blend				Dirt			
	Loads	CY/TN Haul	CY/TN Dipped	Hours	Loads	CY/TN Haul	CY/TN Dipped	Hours	Loads	CY/TN Haul	CY/TN Dipped	Hours	Loads	CY/TN Haul	CY/TN Dipped	Hours
Monday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tuesday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wednesday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thursday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Friday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saturday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Sand				Rock				Water/Dust Cont				Dredging			
	Loads	CY/TN Haul	CY/TN Dipped	Hours	Loads	CY/TN Haul	CY/TN Dipped	Hours	Loads	CY/TN Haul	CY/TN Dipped	Hours	Loads	CY/TN Haul	CY/TN Dipped	Hours
Monday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tuesday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wednesday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thursday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Friday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saturday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunday	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Other				Cenospheres		Silo Load
	Loads	CY/TN Haul	CY/TN Dipped	Hours	Loads	CY/TN	Tons
Monday	0	0	0	0	0	0	0
Tuesday	0	0	0	0	0	0	0
Wednesday	0	0	0	0	0	0	0
Thursday	0	0	0	0	0	0	0
Friday	0	0	0	0	0	0	0
Saturday	0	0	0	0	0	0	0
Sunday	0	0	0	0	0	0	0
TOTALS	0	0	0	0	0	0	0

Safety Statics Summary

	Near Misses		First Aides		Recordables		Interventions		[illegible]	
	WK	YTD	WK	YTD	WK	YTD	WK	YTD	WK	YTD
Monday	0	0	0	0	0	0	0	0	0	0
Tuesday	0	0	0	0	0	0	0	0	0	0
Wednesday	0	0	0	0	0	0	0	0	0	0
Thursday	0	0	0	0	0	0	0	0	0	0
Friday	0	0	0	0	0	0	0	0	0	0
Saturday	0	0	0	0	0	0	0	0	0	0
Sunday	0	0	0	0	0	0	0	0	0	0
TOTALS	0	0	0	0	0	0	0	0	0	0

Environmental Statics Summary

	Near Misses		REI's		NOV's		Interventions		[illegible]	
	WK	YTD	WK	YTD	WK	YTD	WK	YTD	WK	YTD
Monday	0	0	0	0	0	0	0	0	0	0
Tuesday	0	0	0	0	0	0	0	0	0	0
Wednesday	0	0	0	0	0	0	0	0	0	0
Thursday	0	0	0	0	0	0	0	0	0	0
Friday	0	0	0	0	0	0	0	0	0	0
Saturday	0	0	0	0	0	0	0	0	0	0
Sunday	0	0	0	0	0	0	0	0	0	0
TOTALS	0	0	0	0	0	0	0	0	0	0

TVA **Weekly Facility Observation Form** **Form Date 06-01-10**

1. Site Name: ______ **2. Date & Start Time of Ot** - -

3. Operator Name: ______

4. Observation Method: ☐ Walk ☐ Ride ☐X Both

(KNOWN KEY DEFICIENCIES MUST BE INSPECTED)

5. Observer's Name(s): ______

6. Current Weather Conditions ______

7. Prior Weather Conditions, if notable ______

CHECK ALL BOXES WHERE DEFICIENCIES ARE KNOWN AND MAKE APPROPRIATE COMMENTS, OBSERVATIONS, AND/OR ACTIONS TAKEN. NOTE LOCATIONS OF DEFICIENCIES ON AERIAL PHOTO

8. Type(s) of Facilities Observed	Name of Facility	Minimum Freeboard	Current Freeboard
☐X Wet Fly Ash Pond		3 ft FT	4+ ft FT
☐ Wet Gypsum Pond		FT	FT
☐ Wet Bottom Ash Pond		FT	FT
☐ Dry Ash Stack			
☐ Dry Gypsum Stack			
☐ Other			

	YES	NO	COMMENTS
9 .Pre-Job Safety Briefing Performed			
10. Activity / Construction on/ at facility			

11. DIKE CREST	☐ Transverse or Longitudinal Cracks or bulges ☐ Settlement ☐ Displacement ☐ Rutting
12. DIKE SLOPES	☐ Erosion, ☐ Cracks or Bulges ☐ Slides/Sloughs ☐ Subsidence ☐ Seepage (clear/muddy water, new or flow increasing over time) ☐ Wet or soft spot ☐ Changes in geometry, depth and elevation ☐ Changes in freeboard ☐ Vegetation (excessive/ sparse) ☐ Animal Burrows ☐ Sinkholes ☐ Rutting ☐ Trees
13. DIKE TOE AREAS	☐ Seepage Areas ☐ Boils ☐ Equipment Rutting ☐ Perimeter Ditches Properly Draining ☐ Sinkholes
14. SPILLWAY WEIR SYSTEM (Only visibly accessible features checked)	☐ Discharge Channel Erosion ☐ Riser Vertical Alignment ☐ Riser/Outlet Pipe Joint Leakage/Separation ☐ Headwall Condition ☐ Box Weir/Skimmers Operating Properly ☐ Vegetation blocking overflow
15. SEEPAGE COLLECTION SYSTEM	☐ Check Flow and Water Clarity ☐ Check For Blockages

16. DEFICIENCIES	YES	NO	COMMENTS
A. Prior Key Deficiencies Checked			
B. New Deficiencies Identified / Flagged			
C. Immediate Actions Taken (Note Below)			
D. Photographs Taken / Attached			

17. DESCRIPTIONS OF NEWLY IDENTIFIED AND DEGRADING EXISTING KEY DEFICIENCIES/ACTIONS TAKEN/COMMENTS

18. **Who was Notified of New Key Deficiency:** (Date & Time)

19. **PA(E) Notified of New Key Deficiency:** (Date & Time)

20. **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:

RJ Rodocker 4-13-11

TVA Monthly /Quarterly/Special Facility Inspection Form — Form Date 6-01-10

1. Site Name: ___________ 2. Facility Name: ____________________ 3. Date and Start Time of Inspection: ____________________

4. Operator Name: ________________________________ 5. Inspection Method: ☐ Walk ☐ Ride ☐ Both

(KNOWN KEY DEFICIENCIES MUST BE INSPECTED)

6. Inspector's Name(s): ________________________________ 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________________________________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		Yes	No
10. Pre-Job Safety Briefing Performed			15. DIKE TOE AREAS		
11. Activity / Construction on/ at facility			A. Seepage ○ New ○ Existing		
12. DIKE CREST			○ Clear/Cloudy/Red/Muddy		
A. Settlement / Cracking			○Flow Increased / Decreased/Same		gpm
B. Rutting			○ Aquatic Vegetation Growing		
C. Lateral Displacement			○ Ash or Clay Deposits Below Seep Outlet		
D. Erosion			B. Boils ○ New ○ Existing		
13. INTERIOR / EXTERIOR DIKE SLOPES			○ Clear/Cloudy/Red/Muddy		
A. Minimum Freeboard		ft.	○ Flow Increased / Decreased/Same		gpm
B. Current Freeboard		ft.	○ Growing in Size		
C. Instabilities (Sloughs or Slides)			C. Sinkholes/Depressions ○ New ○ Existing		
D. Erosion			16. SEEPAGE COLLECTION SYSTEM		
E. Sinkholes/Depressions ○ New ○ Existing			A. Estimated Flow Measurement		gpm
F. Vegetation / Brush / Trees			B. Increased Flow		
○ Heavy/Adequate/Sparse/Bare			C. Emitting Clear or Dirty Water		
G. Animal Burrows ○ New ○ Existing			17. SPILLWAY WEIRS & OUTLETS		
H. Seepage ○ New ○ Existing			A. Decant Riser Misaligned		
○ Clear/Cloudy/Red/Muddy			B. Decant Pipe Joints		
○ Flow Increased/Decreased/Same		gpm	○ Leaking		
○ Ash or Clay Deposits Below Seep Outlet			○ Separated		
I. Seep around Drain Pipe(s)			C. Headwall In Good Condition		
○ Clear/Cloudy/Red/Muddy			18. OPERATIONS & MAINTENANCE		
14. DEFICIENCIES			A. Major Changes in Operations		
A. Prior Key Deficiencies Checked					
B. New Deficiencies Identified / Flagged					
C. Immediate Actions Taken (Note Below)					
D. Photos of deficiencies attached					

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: __________ To: __________ Signature: ________________________________ Date: __________

PROJECT START-UP

Partner Performing Work ______________________ **Attentive Start Date** ______________________

Design Engineering Firm ☐ Stantec ☐ URS ☐ CDM ☐ Other ______________

Task Description	Yes	No	Responsible Group	Verified By	Date
Design Complete			CCP Engineering		
Construction Drawings Issued			CCP Engineering		
Design Coordinates Provided			CCP Engineering		
Risk Analysis Required			Joint Project Team		
(If Yes, Analysis Performed)			CCP Engineering		
(If Yes, Contingency Plan Developed)			CCP Engineering		
Project Transitions			Joint Project Team		
Cost Estimate / Schedule			Field Supervisor		
Procurement Process Followed , Contract PO established			Procurement		
Environmental Requirements Complete			Environmental		
QA / QC Criteria Established			CCP Engineering		
QA / QC Personnel Available			Program Manager		
Maximo Work Package Developed, to include JSA			Work Control Program Manger		
Peer Review Meeting Held			Program Manager		
Project Completion / Closure	**Yes**	**No**	**Responsible Group**	**Verified By**	**Date**
Final Walkdown Completed			Joint Project Team		
Punch List Items Completed			Field Supervisor		
Redline Drawings Completed			CCP Field Engineer		
Ready to Return to Service			CCP Field Engineer		

Completed By ____ **Date** ______________________

ROUTINE HANDLING OPERATIONS & MAINTENANCE
ADDITIONAL WORK /CHANGE ORDER APPROVAL FORM

Partner / Engineering Company ______________________________

TVA Work Order No. / Work Plan ______________________________

Work Requested By ______________________________

Scope

____

____

____

Emergency Work ☐ Yes ☐ No **Scope Growth** ☐ Yes ☐ No

Project Initiation / Change (Describe Below What Initiated Work or Changed Scope)

____

____

____

Engineering Recommendation Needed? ☐ Yes ☐ No (Explain below if Yes or No)

____

____

Environmental Notification Required? ☐ Yes ☐ No (Explain below if Yes or No)

____

____

Can Work Be Performed within Monthly Rate? ☐ Yes ☐ No
If **No,** Attach Estimate & Schedule

Is Work in Existing RHO&M Budget? ☐ Yes ☐ No

If **No,** Funding to be Provided By; (capital, O&M, plant, etc.) ______________________________

P.O. / Alias # Work is to be charged ______________________________

Bond Required? ☐ Yes ☐ No If **Yes,** Cost of Bond ______________________________

Approvals	Printed Name & Signature	Date
Business Services Acknowledgement		
Field Supervisor (Up to $50K)		
Program Manager (Up to $50K)		
Construction Manager (Up to $100K)		
RHO&M MP Program Manager (Up to $100K)		
RHO&M Manager (Up to $100K)		
CCP Manager (Over $100K)		

Form Completed By ______________________________ ______________
Signature Date

TVA IS NOT OBLIGATED TO PAY FOR ANY / ALL WORK PERFORMED WITHOUT PRIOR WRITTEN APPROVAL

PROCEDURES FOR COMPLIANCE WITH THE NATIONAL ENVIRONMENTAL POLICY ACT

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1.0 Purpose

These procedures provide guidance for compliance by the Tennessee Valley Authority (TVA) with the National Environmental Policy Act (NEPA), 42 U.S.C. 4321, et seq. (1976) and other applicable guidelines, regulations, and Executive orders implementing NEPA. It is intended to incorporate concepts and implement policies in the regulations promulgated by the Council on Environmental Quality at 40 CFR, parts 1500-1508 (1981).

2.0 Policy

TVA, to the fullest extent possible, incorporates environmental considerations into its decision making processes. In carrying out this policy, these procedures ensure that actions are viewed in a manner to encourage productive and enjoyable harmony between man and the environment. Commencing at the earliest possible point and continuing through implementation, appropriate and careful consideration of the environmental aspects of proposed actions is built into the decision making process in order that adverse environmental effects may be avoided or minimized, consistent with the requirements of NEPA.

3.0 Abbreviations

3.1 CEQ - Council on Environmental Quality
3.2 EA - Environmental Assessment
3.3 EIS - Environmental Impact Statement-D-Draft; F-Final
3.4 NEPA - National Environmental Policy Act
3.5 TVA - Tennessee Valley Authority

4.0 Definitions

The following definitions shall apply throughout these procedures. All other applicable terms shall be given the same meaning as set forth in CEQ's currently effective regulations (see 40 CFR regulations, part 1508) unless otherwise inconsistent with the context in which they appear.

4.1 "Floodplain" refers to the lowland and relatively flat areas adjoining flowing inland waters and reservoirs or to those areas inundated by the unusual or rapid accumulation or runoff of surface waters from any source. Floodplain generally refers to the base floodplain, i.e., that area subject to a 1 percent or greater chance of flooding in any given year. A flood having a 1 percent chance of occurring in any given year is usually referred to as a 100-year flood.

4.2 "Natural and beneficial floodplain and wetland values" refer to such attributes as the capability of floodplains and wetlands to provide natural moderation of floodwaters, water quality maintenance, fish and wildlife habitat, plant habitat, open space, natural beauty, scientific and education study areas, and recreation.

4.3 "Practicable" refers to the capability of an action being done within existing constraints. The test of what is practicable depends on the situation involved and should include an evaluation of all pertinent factors, such as environmental impact, economic costs, technological achievability, and public benefit.

4.4 "Wetlands" are those areas inundated by surface or ground water with a frequency sufficient to support, and under normal circumstances do or would support, a prevalence of vegetation or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, mud flats, and natural ponds. Wetlands do not include temporary human-made ponds, sloughs, etc., resulting from construction activities.

4.5 "Important farmland" includes prime farmland, unique farmland, and farm land of Statewide importance as defined in 7 CFR, part 657 (1981).

5.0 Procedures

5.1 Action Formulation and NEPA Determination

Each office within TVA is responsible for integrating environmental considerations into its planning and decision making process at the earliest possible time to ensure that potential environmental effects are appropriately considered to avoid potential delays and to minimize potential conflicts. Environmental analyses are to be included in or circulated with and reviewed at the same time as other planning documents. This responsibility is to be carried out in accordance with the environmental review procedures contained herein.

The General Manager and Board of Directors are the major decision points within the agency for TVA's principal programs that are likely to have a significant effect on the quality of the human environment. Alternatives considered by the General Manager and Board of Directors shall be encompassed by the range of alternatives discussed in relevant environmental documents, and the General Manager and Board of Directors shall consider the alternatives described in relevant EISs.

At the earliest possible time, the office proposing to initiate an action will initially determine the level of environmental review required for a specific action. The level of review will be in one of the following categories:

	Procedure
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5.2 Categorical Exclusions

Categories of actions listed in this section are those which do not normally have, either individually or cumulatively, a significant impact on the quality of the human environment and require neither the preparation of an EA nor an EIS. The office proposing to initiate an action shall determine, in consultation with the Environmental Quality Staff as appropriate, whether or not the proposed action is categorically excluded. An action which would normally qualify as a categorical exclusion shall not be so classified if: (1) the proposed action could have a potentially significant impact on a threatened or endangered species, wetland or floodplain, cultural or historical resource, important farmland, or other environmentally significant resource; or (2) substantial controversy over the significance of the environmental impacts associated with the proposed action has developed or is likely to develop. Categorical exclusion actions are:

1. Routine operation, maintenance, and minor upgrading of existing TVA facilities.

2. Technical and planning assistance to State and local organizations.

3. Personnel action.

4. Procurement activities.

5. Accounting, auditing, financial reports, and disbursement of funds.

6. Contracts or agreements for the sale, purchase, or interchange of electricity.

7. Activities related to the promotion and maintenance of employee health.

8. Activities of TVA's Equal Employment Opportunity staff.

9. Administrative actions consisting solely of paperwork.

10. Communication, transportation, computer service, and other office services.

11. Property protection, law enforcement, and other legal activities.

12. Emergency preparedness.

13. Preliminary planning, studies, or reviews consisting of only paperwork.

14. Exploration for uranium, including hydrologic investigations.

15. Preliminary onsite engineering and environmental studies for future power generating plants and other energy-related facilities.

16. Establishment of environmental quality monitoring programs and field monitoring stations.

17. Transmission line relocation, tap-ins, or modifications or substation alterations due to conflicts such as new highway projects and projects requiring acquisition of minor amounts of additional substation property or transmission line right-of-way easements.

18. Construction and operation of communication facilities (i.e., powerline carrier, insulated overhead ground wire, VHF radio, and microwave).

19. Backslope agreements involving properties on which TVA holds an interest between operators and other adjacent mining companies.

20. Purchase, exchange, lease or sale, or lease purchase of stepdown facilities, transmission lines, and transmission line rights of way by distributors or customers directly served by TVA.

21. Minor research, development, and joint demonstration projects.

22. Construction of visitor reception centers.

23. Development of minor TVA public use areas and stream access points.
24. Minor non-TVA activities on TVA property authorized under contract or license, permit and covenant agreements, including utility crossings, encroachments, agricultural uses, rental of structures, and sale of miscellaneous structures and materials from TVA land.

25. Purchase, sale, abandonment or exchange of minor tracts of land, mineral rights, or landrights.

26. Approvals under Section 26a of the TVA Act of minor structures, boat docks, and shoreline facilities.

27. Any action which does not have a primary impact on the physical environment.

28. Actions which were the subject of an EA which concluded that the category of such actions should be treated as a categorical exclusion.

5.3 Environmental Assessments

5.3.1 Purpose and Scope

An EA will be prepared for any appropriate action not qualifying as a categorical exclusion to determine whether an EIS is necessary or a Finding of No Significant Impact should be reached. An EA is not necessary if it has been determined that an EIS will be prepared.

5.3.2 Public Participation in EA Preparation

The Environmental Quality Staff or the initiating office, in consultation with the Environmental Quality Staff, Citizen Action Office, and other interested offices, may request public involvement in the preparation of the EA or a revision or supplement thereof. The type of and format for public involvement would be selected as appropriate to best facilitate timely and meaningful public input to the EA process.

5.3.3 EA Preparation

The initiating office is responsible for the preparation of the EA. As soon as practical after the decision to prepare an EA is made, the initiating office in consultation with the Environmental Quality Staff shall determine the need for a coordination meeting to define (1) reasonable alternatives, (2) permit requirements, (3) coordination with other agencies, (4) environmental issues, and (5) a schedule for EA preparation.

The EA will include the identification and, as appropriate, discussion of questions and concerns raised during the public input period, if any. The EA will describe the proposed action and will include brief discussions of the need for the proposed action, reasonable alternatives, the environmental impacts of the proposed action and alternatives, measures (if any) to minimize or mitigate such impacts, and a listing of the agencies and persons consulted. A list of required permits and environmental commitments will be circulated with the EA.

The EA will briefly provide sufficient data and analysis for determining whether to prepare an EIS or a Finding of No Significant Impact. The EA will be reviewed by the Environmental Quality Staff and other interested offices. After completion of the review, the Environmental Quality Staff will, in consultation with the Office of the General Counsel, make one of the following determinations: (1) the action does not require the preparation of an EIS, (2) the action will require the preparation of an EIS, or (3) the EA is incomplete or the decision will be deferred until a later stage in the planning process. Measures (if any) to minimize or mitigate impacts committed to in the EA will be implemented as described in section 5.5 (Mitigation Commitment Identification, Auditing, and Reporting).

5.3.4 Finding of No Significant Impact

If it is concluded, based on an EA, that a proposed action does not require the preparation of an EIS, the Environmental Quality Staff, in consultation with the Office of the General Counsel and the initiating office, will prepare a Finding of No Significant Impact.

Appropriate notice of Finding of No Significant Impact shall be made available to the public by the Environmental Quality Staff.

In the following circumstances, the Environmental Quality Staff, in consultation with the Office of the General Counsel and the initiating office, will make a Finding of No Significant Impact available for public review and comment (including, if appropriate, State and regional A-95 clearinghouses or other designated State/local coordination points) for a period of time (normally 30 days) before a final determination is made as whether or not to prepare an EIS and before the proposed action may begin:

1. The proposed action is, or is closely similar to, an action listed in section 5.4.1

2. TVA has previously announced that the proposed action would be the subject of an EIS.

3. The nature of the proposed action is one without precedent.

5.3.5 Generic EAs

For any category of actions not described in section 5.2 (Categorical Exclusions), the initiating office may prepare a generic EA. The generic EA will be prepared, reviewed, and approved as would any other EA. Upon completion of review, the Environmental Quality Staff, in consultation with the Office of the General Counsel, will determine whether or not the category of actions may normally be treated as if listed in section 5.2 as a categorical exclusion.

5.3.6 Revisions and Supplements

If new information concerning action modifications, alternatives, or probable environmental effects becomes available, the initiating office, in consultation with the Environmental Quality Staff and the Office of the General Counsel, will consider preparing a revision or supplement to the EA based on the significance of the new information.

5.4 Environmental Impact Statements

5.4.1 Purpose and Scope

The following actions normally will require an environmental impact statement:

1. Large water resource development and water control projects.

2. Major power generating facilities.

3. Uranium mining and milling complexes.

4. Any major action, the environmental impact of which is expected to be highly controversial.

5. Any other major action which will have a significant effect on the quality of the human environment.

An EIS should include a description and an analysis of the proposed action; alternatives to the proposed action, including the no-action alternative; probable environmental impacts associated with the proposed action and measures (if any) to minimize impacts; and a list of the major preparers of the EIS. The scope and detail of the EIS should be reasonably related to the scope and the probable environmental impacts of the proposed action and alternative actions (see 40 CFR, parts 1502.10-1502.18).

5.4.2 Lead and Cooperating Agency Determinations

As soon as possible after the decision is made to prepare an EIS, the Environmental Quality Staff, in consultation with the initiating office and the Office of the General Counsel, shall consider requesting other Federal, State, or local agencies to participate in the preparation of the EIS as lead, joint lead (see 40 CFR 1501.5), or cooperating agencies (see 40 CFR 1501.6). If TVA is requested to participate in the preparation of another Federal agency's EIS, the General Manager will determine if TVA will become a cooperating agency.

5.4.3 Scoping Process

As soon as possible after the decision to prepare an EIS is made, the initiating office will organize a scoping committee to tentatively identify action alternatives, probable environmental issues and environmental permits, and a schedule for EIS preparation. The scoping committee will consist of representatives of the Environmental Quality Staff, the initiating office, the Office of the General Counsel, Citizen Action Office, and other interested or affected offices.

The scoping process may include interagency scoping sessions to coordinate an action with and obtain inputs from other interested agencies, and public scoping sessions to obtain input from interested members of the general public. The scoping committee will determine the need, nature, and format for the various scoping sessions. Session type and format will be selected to facilitate timely and meaningful public input into the EIS process.

As soon as practicable in the scoping process, the initiating office will prepare and the Environmental Quality Staff, in consultation with the Office of the General Counsel, will review and make available a Notice of Intent to Prepare an EIS. This notice will briefly describe the action, reasonable alternatives thereto, and potential environmental impacts associated with the action. In addition, those issues which tentatively have been determined to be insignificant and which will not be discussed in detail in the EIS may be identified. The scoping process will be described and, if a scoping meeting will be held, the notice should state where and when the meeting is to occur. The notice will identify the person in TVA who can supply additional information about the action and to whom comments should be sent. There will normally be a public input period of 30 days from the date of publication of the Notice of Intent in the *Federal Register* to allow other interested agencies and the public an opportunity to review the action alternatives and probable environmental issues identified by the scoping committee. On the basis of input received, the Environmental Quality Staff, in consultation with the scoping committee, may determine what, if any, additions or modifications in the scoping process or schedule are required and establish the scope of the EIS.

At the close of the scoping process, the Environmental Quality Staff, in consultation with the scoping committee, will identify in writing the following EIS components:

1. Key action alternatives.

2. Significant environmental issues to be addressed in detail.

3. Probable nonsignificant environmental issues that should be mentioned but not addressed in detail.

4. Lead and cooperating agency assignments, if any.

5. Related environmental documents.

6. Other environmental review and consultation requirements.

7. Delegation of DEIS work assignments to interested offices.

5.4.4 DEIS Preparation

Based on information obtained and decisions made during the scoping process, the initiating office, in consultation with the Environmental Quality Staff and other interested offices, will prepare the preliminary DEIS using an appropriate format (see 40 CFR 1502.10). In addition, a list of required permits and an environmental commitment list will be prepared and circulated with the DEIS. The preliminary DEIS will be circulated by the initiating office to the Environmental Quality Staff, the Office of the General Counsel, and other interested offices for review and comment. All reviewing offices will, as soon as practical and normally within 30 days, supply comments on the preliminary DEIS to the initiating office, the Environmental Quality Staff, and the Office of the General Counsel. These comments will include lists of agencies, A-95 contacts or other State/local coordination points, and groups and individuals (both proponents and opponents, if any, of the proposed action) who should receive a copy of the DEIS. After the preliminary DEIS is revised, the initiating office will transmit it to other interested offices for their final approval. The Environmental Quality Staff will, in consultation with the Office of the General Counsel, review the document and transmit it and the commitment list to the General Manager for approval.

5.4.5 DEIS Transmittal and Review

Upon notification of approval from the General Manager, TVA will transmit the DEIS and appropriate notices to the Environmental Protection Agency (EPA) and other interested Federal, State, and local agencies (including State and regional A-95 clearinghouses or other State/local coordination points). The Citizen Action Office will coordinate overall DEIS distribution and will maintain a master list of those to whom the DEIS is sent. The length of the DEIS public comment period, normally no less than 45 days from publication of the notice of availability in the *Federal Register*, will be determined by the scoping committee. Materials to be made available to the public shall be provided to the public without charge to the extent practicable, or at a fee which is not more than the actual costs of reproducing copies required to be sent to other Federal agencies, including CEQ.

At any time in the DEIS process, the initiating office, in consultation with the Environmental Quality Staff, the Citizen Action Office, and other interested offices, may provide for additional public involvement to supplement EIS preparation. The type of and format for public involvement will be selected as appropriate to best facilitate timely and meaningful public input into the EIS process.

5.4.6 FEIS Preparation

At the close of the DEIS public review period, the Environmental Quality Staff will, in consultation with the initiating office and other interested offices, determine what is needed for the preparation of an FEIS. If the requisite changes in the DEIS are limited to making minor factual corrections and explaining why the comments received do not warrant further response, an errata sheet containing only DEIS comments, responses, and factual corrections in the DEIS may be prepared by the initiating office. If other more extensive modifications are required, the initiating office will, in consultation with the Environmental Quality Staff and other interested offices, prepare a preliminary FEIS utilizing an appropriate format (see 40 CFR 1502.10).

The errata sheet or preliminary FEIS will be prepared and circulated by the initiating office to the Environmental Quality Staff, Office of the General Counsel, and other interested offices for review and comment. All reviewing offices will supply written comments concerning the errata sheet or preliminary FEIS to the initiating office with copies to the Environmental Quality Staff and Office of the General Counsel.

The initiating office, with the assistance of the Environmental Quality Staff, will review all comments received and modify, as appropriate, the errata sheet or the preliminary FEIS. After the errata sheet or preliminary FEIS is revised, the initiating office will transmit it to other interested offices for their final approval. The Environmental Quality Staff will, in consultation with the Office of the General Counsel, review the document and transmit it to the General Manager for approval along with a list of environmental commitments made in the EIS.

Measures (if any) to minimize or mitigate impacts committed to in the FEIS will be identified and implemented as described in section 5.5 (Mitigation Commitment Identification, Auditing, and Reporting).

5.4.7 FEIS Transmittal

Upon notification of approval from the General Manager, TVA will transmit the FEIS and appropriate notices to EPA and other Federal, State, and local agencies (including State and regional A-95 clearinghouses or other State/local coordination points) to whom copies of the DEIS were sent. The FEIS will also be sent to every person and organization to whom copies of the DEIS were sent or from whom comments were received.

5.4.8 Commencement of Action

Except in emergency circumstances, an action for which an EIS has been approved will not commence until 30 days after notice of availability of the final statement has been published in the *Federal Register* or 90 days after a notice of availability of the DEIS has been published in the *Federal Register*, whichever is later.

5.4.9 Record of Decision

After release of the FEIS, a Record of Decision shall be prepared for the General Manager by the Environmental Quality Staff, in consultation with the Office of the General Counsel and the initiating office. The record will normally include the following: (1) what the decision was; (2) what alternatives were considered; (3) which alternative(s) was considered to be environmentally preferable; (4) the alternatives' associated environmental considerations (which may include a discussion of measures to be taken to mitigate or minimize adverse environmental impacts (see 40 CFR 1505.2); and (5) what monitoring, reporting, and administrative arrangements have been made (see 40 CFR 1505.2). Records of decision will be made available to the public.

5.4.10 Revisions and Supplements

If significant new information concerning action modifications, alternatives, or probable environmental effects becomes available, TVA will make such information available to the public. The initiating office shall consider preparing a revision or a supplement to the EIS. The Environmental Quality Staff will, in consultation with the initiating office, Office of the General Counsel, Citizen Action Office, and other interested offices, determine the method of making such information available to the public.

5.4.11 EIS Adoption

TVA may adopt as its final EIS another EIS or any portion thereof whether or not TVA participated in its preparation. The Environmental Quality Staff and the Office of the General Counsel, in consultation with the initiating office, will determine if the EIS proposed for adoption adequately assesses the TVA action and is still generally available to the public.

If it is determined that the EIS proposed for adoption or the relevant portion thereof is adequate and still available, TVA will circulate its written finding of this determination and advise that copies of the EIS will be sent to any person or agency requesting it. If the EIS is not available, TVA will then circulate, along with its written finding, the adopted EIS (or relevant portion) or a summary thereof (see 40 CFR 1502.12; 40 CFR 1502.19 (d)).

If the EIS is generally available and TVA determines that significant supplementary information is needed, TVA will prepare and circulate a supplement to the EIS and advise that copies of the adopted EIS will be sent to any person or agency requesting it. If the EIS is not generally available, TVA will circulate its supplement along with either the adopted EIS or a summary thereof (see 40 CFR 1502.12; 40 CFR 1502.19 (d)). The above findings or documents shall be approved and circulated in accordance with section 5.4.5 or 5.4.7, as appropriate.

5.5 Mitigation Commitment Identification, Auditing and Reporting

All significant measures planned to minimize or mitigate expected environmental impacts shall be identified in the EA or EIS (or, as appropriate, in a memorandum documenting the Environmental Quality Staff's determination or concurrence that a proposed action is a categorical exclusion) and compiled in a commitment list. The commitment list will include, to the extent practicable, the estimated cost of each commitment. The commitment list is prepared for both the draft and final EA or EIS and should be developed in cooperation with the Environmental Quality Staff and all interested offices.

Each such commitment in the commitment list will be tentatively assigned by the initiating office to the appropriate responsible office and such assignments shall be transmitted to the Environmental Quality Staff and affected offices at the time the draft EA or EIS is sent out for review. The initiating office should consult with the assigned offices to resolve assignment conflicts, identify supporting offices, and determine commitment schedules. Prior to finalization of the commitment list, the initiating office shall obtain Environmental Quality Staff concurrence that commitments can be monitored for compliance. At the time of finalizing the EA or EIS, the initiating office shall submit to the Environmental Quality Staff a finalized commitment list.

The initiating office shall report, periodically and upon request to the Environmental Quality Staff, the status of a commitment. The Environmental Quality Staff will ensure that commitments are met and will, as it deems appropriate, audit commitment progress. Circumstances may arise which warrant modifying or deleting previously made commitments. When such circumstances occur, the office desiring the change shall submit to the Environmental Quality Staff and the initiating office a request which shall include the basis for changing or deleting the commitment and an evaluation of the environmental significance of the requested change. The decision to modify or delete the commitment will be made by the Environmental Quality Staff in consultation with the Office of the General Counsel and the initiating office.

5.6 Emergency Action

Because of unforeseen situations or emergencies, or through inadvertence, or for other reasons, some of the steps outlined in these procedures may be consolidated, modified, or omitted. The Environmental Quality Staff and the Office of the General Counsel shall be promptly notified and asked to approve any such consolidation, modification, or omission, and may do so if such change would conform to legal requirements and substantially comply with the intent of these procedures. The Environmental Quality Staff, in consultation with the Office of the General Counsel, will consult with CEQ when appropriate before such changes are approved.

5.7 Floodplains and Wetlands

5.7.1 Purpose and Scope

Consistent with Executive Order Nos. 11988 (Floodplain Management) and 11990 (Protection of Wetlands), and TVA Code under IX FLOODPLAIN MANAGEMENT AND PROTECTION OF WETLANDS, the review of a proposed action undertaken in accordance with sections 5.2, 5.3, or 5.4 of these procedures that potentially may affect floodplains or wetlands shall include a floodplain or wetlands evaluation as required by this section. A wetland evaluation is not required for (1) the issuance of permits, licenses, or allocations to private parties for activities involving wetlands on non-Federal lands; (2) projects or programs under construction or in operation as of May 24, 1977; (3) projects for which all funds were appropriated through June 1977; or (4) projects for which a draft or final EIS was filed before October 1, 1977. Moreover, no reevaluation of floodplain or wetland impacts is required for projects, programs, and policies approved by TVA before July 23, 1979.

5.7.2 Evaluation Process

5.7.2.1 Area of Impact

If a proposed action will potentially occur in or affect wetlands or floodplains, the initiating office, as soon as practicable in the planning process, will request the Office of Natural Resources to determine whether the proposed action will occur in or affect a wetland or floodplain and the level of impact, if any, on the wetland or floodplain. If the Office of Natural Resources determines that the proposed action (1) is outside the floodplain or wetland, (2) has no identifiable impacts on a floodplain or wetland, and (3) does not directly or indirectly support floodplain development or wetland alteration, further floodplain or wetland evaluation shall be unnecessary.

5.7.2.2 Actions That Will Affect Floodplains or Wetlands

When a proposed action can otherwise be categorically excluded under section 5.2, no additional floodplain or wetland evaluation is required if (1) the initiating office determines that there is no practicable alternative that will avoid affecting floodplains or wetlands and that all practical measures to minimize impacts to floodplains or wetlands are incorporated and (2) the Office of Natural Resources determines that impacts on the floodplain or wetland would be minor.

If the action requires an EA or an EIS, the ensuing evaluation shall consider (1) the effect of the proposed action on natural and beneficial floodplain and wetland values and (2) alternatives that would eliminate or minimize such effects. The initiating office shall determine if there is no practicable alternative to siting in a floodplain or constructing in a wetland. If the Environmental Quality Staff in consultation with the Office of the General Counsel concurs, this determination shall be final. If a determination of no practicable alternative is made, all practical measures to minimize impacts on the floodplain or wetland shall be implemented.

If at any time prior to commencement of the action it is determined that there is a practicable alternative that will avoid affecting floodplains or wetlands, the proposed action shall not proceed.

5.7.2.3 Public Notice

Public notice of actions affecting floodplains or wetlands is not required if the action is categorically excluded under section 5.2. If an EA or EIS is prepared and a determination of no practicable alternative is made in accordance with section 5.7.2.2, the initiating office shall notify the public of a proposed action's potential impact on the floodplain or wetland.

Public notice of actions affecting floodplains or wetlands may be combined with any notice published by TVA or another Federal agency if such a notice generally meets the minimum requirements set forth in this section. Issuance of a draft or final EA or EIS for public review and comment will satisfy this notice requirement.

Public notices shall at a minimum (1) briefly describe the proposed action and the potential impact on the floodplain or wetland; (2) briefly identify alternative actions considered and explain why a determination of no practicable alternative has been proposed; (3) briefly discuss measures that would be taken to minimize or mitigate floodplain or wetland impacts; (4) state when appropriate whether the action conforms to applicable State or local floodplain protection standards; (5) specify a reasonable period of time within which the public can comment on the proposal; and (6) identify the TVA official who can provide additional information on the proposed action and to whom comments should be sent.

Such notices shall be issued in a manner designed to bring the proposed action to the attention of those members of the public likely to be interested in or affected by the action's potential impact on the floodplain or wetland. The initiating office, in consultation with the Environmental Quality Staff and the Citizen Action Office, shall determine the manner in which the notice will be made available to the public. Typical ways of providing public notice include direct mailing, posting in appropriate places in the vicinity of the proposed action, publication in the *Federal Register,* or publication in newspapers of general circulation in the area of the proposed action. If a floodplain public notice is required, a copy of such notice shall be included in information sent to State and regional clearinghouses for those actions subject to Office of Management and Budget Circular A-95 or other State/local coordination points.

TVA shall consider all relevant comments received in response to a notice and shall reevaluate the action as appropriate to take such comments into consideration. The Environmental Quality Staff, in consultation with the initiating office, shall determine if response is necessary and the initiating office, in coordination with other interested offices, shall prepare comment responses. The Environmental Quality Staff, in consultation with the Office of the General Counsel, shall approve all comment responses before release.

A proposed action may not be implemented before publication of any required public notice and appropriate consideration of any relevant comments received in a timely manner.

5.7.2.4 Disposition of Real Property

When TVA property in a floodplain or wetland is proposed for lease, easement, license, right of way, or disposal to non-Federal public or private parties and the action will not result in disturbance of the floodplain or wetland, floodplain or wetland evaluation is not required. The conveyance document, however, shall specify:

1. Applicable restricted uses under Federal, State or local floodplain and wetland regulations.

2. Other appropriate restrictions to minimize destruction, loss, or degradation of floodplains and wetlands and to preserve and enhance their natural and beneficial values, except when prohibited by law or unenforceable by TVA or, otherwise, the property shall be withheld from conveyance or use.

If the disposition of TVA property rights in a floodplain or wetland potentially will result in disturbance to the floodplain or wetland, the proposed action shall be reviewed in accordance with sections 5.7.2.1 - 5.7.2.3.

5.8 Miscellaneous Procedures

5.8.1 Proposals for Legislation

Proposals for congressional legislation significantly affecting the quality of the human environment will require the preparation of an EIS (see 40 CFR 1506.8).

5.8.2 Private Applicants

In those cases when private applicants or other non-Federal entities propose to undertake an action that will require TVA's approval or involvement and fall within the scope of these procedures, the contacted office will as soon as possible notify the Environmental Quality Staff.

Each office will maintain information to advise potential applicants of studies or other data that may be required in connection with applications and will take reasonable steps to publicize accessibility of such information. The office charged with initiating action, upon the applicant's request, will in consultation with the Environmental Quality Staff when practicable advise the applicant of the information or studies (including the preparation of environmental documents, if necessary) that will be required in order to fulfill its responsibilities hereunder. The applicant must provide TVA sufficient information to allow an accurate determination of the environmental impacts of the proposed action. TVA may require that this information be submitted in the form of a written environmental report. If TVA is required to make investigations or otherwise incur additional expenses, the applicant may be charged for TVA's service. The Environmental Quality Staff, in consultation with the Office of the General Counsel, will also determine the need to consult early with appropriate Federal, State, and local agencies (including State and regional A-95 clearinghouses or their State/local coordination points); Indian tribes; and other interested persons regarding TVA's involvement in or approval of the applicant's proposed action and, where appropriate, should commence such consultation at the earliest practicable time.

5.8.3 Non-TVA EISs

The Environmental Quality Staff, in consultation with other interested offices, will coordinate the review of EISs provided to TVA for review by other Federal agencies. The Environmental Quality Staff, in consultation with the Office of the General Counsel, will prepare comments on such EISs and transmit any TVA comments to the initiating agency (see 40 CFR 1503.2 - 1503.3).

5.8.4 Supplemental Instruction

The Environmental Quality Staff, in consultation with interested offices and with concurrence of the Office of the General Counsel, may issue supplemental or explanatory instructions to these procedures.

5.8.5 Modifications of These Procedures

The assignments to offices in these procedures can be modified by agreement of the offices involved or by instructions from the General Manager.

5.8.6 Tiering

An initiating office may consider tiering the environmental review of a proposed action. Tiering involves coverage of general matters in broader environmental documents, and subsequent narrower analyses need only incorporate by reference the broader analyses (see 40 CFR 1508.28).

5.8.7 Combining Documents

Any environmental document may be combined with any other document to reduce duplication and paperwork.

5.8.8 Applicability to Ongoing Actions

These procedures shall not apply to those actions which have been approved under applicable procedures prior to the effective date of these procedures or for which an EA or a DEIS has already been prepared. No environmental documents need be redone by reason of the adoption of these revised procedures.

5.8.9 Consolidation of Reviews

Review of proposed actions under these procedures may be consolidated with other reviews where such consolidation would reduce duplication or increase efficiency.

5.8.10 Documents

The Environmental Quality Staff shall keep on file all final and approved environmental documents.

5.8.11 Substantial Compliance

Minor deviations from these procedures will be permitted, but in all respects substantial compliance must be achieved. Flexibility is the key to implementing these procedures and reviewing proposed actions.

5.8.12 Reducing Paperwork and Delay

These procedures are to be interpreted and applied with the aim of reducing paperwork and the delay associated with both assessment and implementation of a proposed action. In this regard, data and analyses shall be commensurate with the importance of associated impacts. Less important material should be summarized, consolidated, or referenced.

5.8.13 Office Responsible for NEPA Compliance Efforts

The Director of Environmental Quality is designated as that person responsible for overall NEPA compliance.

5.8.14 Status Reports

Information or status reports on EISs and other related NEPA compliance activities and documents may be obtained by writing to the Director of Environmental Quality, Tennessee Valley Authority, Knoxville, Tennessee 37902.

5.8.15 Public Participation

TVA's policy is to encourage public participation in all of its decision making. This policy is implemented through various mechanisms. TVA has open meetings of the Board of Directors. These Board meetings are widely publicized and include a question and answer session between the public and Board of Directors. TVA has established a Citizen Action Office whose responsibility is to maximize to the extent practicable the interchange of ideas between TVA and the public in the full range of TVA activities. In addition, TVA has set up a "Citizen Action Line" which allows members of the public to call in on toll-free lines to ask questions and make suggestions or comments to TVA. In line with TVA's broad policies, TVA intends to encourage and actively seek public participation in its NEPA review process. The type of and format for public participation will be selected as appropriate to best facilitate timely and meaningful public input into the review process.

TVA FGDC Standard Programs and Processes	CCP RHO&M Work Control	FGDC-SPP-07.007 Rev. 0000 Page 1 of 14
		Validation Date 04-13-2011 Review Frequency 2 years Validated By Julie Bryant
		Effective Date 05-04-2011

Prepared by: Julie Bryant

Approved by:

Electronic signature functionality is currently unavailable for use within the TVA Procedure templates. Replace this message with a TIF image of the applicable signature. General Manager, Coal Combustion Products	

Revision Log

Revision or Change Number	Effective Date	Affected Page Numbers	Description of Revision/Change
0	TBD	All	Initial issue.

Table of Contents

1.0 PURPOSE

This procedure specifies the general requirements and standard programmatic controls for the work controls process. The purpose of this procedure is to provide guidance for implementing a work control process that will maximize personnel safety, facility reliability, work productivity, assess, and manage facility risk. Work management is the process by which maintenance and modification work activities are identified, planned, scheduled, monitored and completed. Work control participants must recognize that work control is a fundamental, cross-functional process with a direct impact on facility condition.

NOTE

For the purpose of this procedure the term facility refers to storage containment facilities such as wet ponds / impoundments and dry stacks / landfills under the governance of the Coal Combustion Products group.

2.0 SCOPE

This procedure applies to all work activities that affect or have the potential to affect a Coal Combustion Products (CCP) asset. This procedure is responsible for ensuring that CCP, as a matter of policy and practice, makes every reasonable effort to maintain and enhance the safety of all facilities that are owned and operated by TVA. Key elements in this procedure include the work flow from identification of new work through recording, document close out and archiving. This procedure applies to all CCP facilities. This procedure designates Maximo as the work management tool for FGD&C. All Maximo tasks discussed herein shall be performed in accordance with the FGD&C Maximo Training Guide.

3.0 PROCESS

3.1 Roles and Responsibilities

RHO&M Foreman (TVA or Partner)

Reports facility deficiencies to the Routine Handling Operations & Maintenance (RHO&M) Field Supervisor when found. Provides peer reviews of planned work, communicates problems or recommendations about the work. Supplies required equipment and personnel to perform the work as planned.

RHO&M Field Supervisors

Responsible for the execution of all work conducted on-site. Ensure work is properly planned and reinforces the integration of employee feedback and continuous improvement. Monitor worker safety performance and continually model and reinforce the practices laid out in the TVA Safety Manual. Interface with the TVA Partners to ensure resources are available to work the schedule. Communicate with Work Control Program Manager when new work orders need to be written and, upon completion of work, ensure that Field Technicians have emailed the Program Manager, Work Control with all information needed to close the work package.

3.1 Roles and Responsibilities (continued)

<u>RHO&M Construction Managers</u>

Review the schedule to determine the impacts and ensure work can be implemented as planned. Perform constructability reviews on work orders prior to issuance to the field for implementation. Control emergent work decisions. The Construction Manager or his designee is responsible for sending weekly schedule updates to the Work Control Program Manager no later than Friday noon, at a minimum. More frequent updates are encouraged.

<u>RHO&M Program Managers</u>

Own the corrective backlog for assigned sites. Obtain scope, schedule and budget requirements for new work from sub contractor. Act as a focal point for work package preparation and problem resolution. Identify and prepare all permits, requests, etc. for any conditions. When requested, provides work plans to Work Control Program Manager for entry into Maximo. Identifies problems with implementation of work, provides updates as work activities complete or fail to complete, and when schedule threats are identified.

<u>Program Manager, Work Control</u>

Responsible for development and maintenance of work control procedures. Chairs weekly work control meetings. Develops and tracks work control indicators, and assigns corrective actions to address gaps. Responsible for training personnel in work control procedures and tools. Creates work orders and enters all documentation needed for document closeout. Archives work orders in the vault. Provides system health information to CCP Engineering. Prepares the schedule and updates the schedule based on input from responsible work groups. Prepares hard copies of the schedule for weekly review and supports the Program Managers and individual work groups with any needed schedule reports or other schedule information.

<u>Field Technicians</u>

Identify and document deficient areas noted during inspections. Perform walk downs of all completed work, verifying work was completed as planned. Upon work completion, notify Program Manager, Work Control of work order number, dates work began and was completed, condition as found, as left and details of work performed, along with any other relevant data such as lessons learned or suggestions for work package improvement. If needed, photographs of repairs may also be sent for entry into Maximo.

<u>CCP Engineering Personnel</u>

Work with program managers to set priorities for new corrective work. Provide technical support needed to troubleshoot and implement required work. Identify and supply technical support with implementation of work orders. Evaluates the overall performance on each facility and recommends any changes needed in the maintenance and repair. Work with Program Manager, Work Control to initiate work orders for all recommendations and designs issued from engineering and third party engineers.

<u>Independent Third Party Engineering Company</u>

3.1 Roles and Responsibilities (continued)

Issue design recommendations and provides technical support needed to troubleshoot and implement work orders. Provide QA/QC requirements and construction monitoring support for field implementation.

3.2 Program Elements

3.2.1 Planning and Scheduling Guidelines

A. Emergency Work

Emergency work may begin immediately, with only a verbal pre-job briefing. Work will continue until the situation has stabilized, at which time a work order will be issued and a work plan developed for the remaining work. Emergency work is defined as work required to mitigate a situation which is causing an immediate safety or environmental hazard.

B. Sponsored Work

Sponsored work is work which, while not an emergency, must be performed during the current work week (T-0). Prior to beginning sponsored work, a work order must be initiated and planned to the minimum requirements per FGDC Work Package Development.

C. Tool Pouch Maintenance

1. No work order or written documentation is needed for deficiencies which meet the following qualifications:

   a. The problem and its correction are self-evident and require no documentation or planning to initiate the work.

   b. Work can be completed within the current shift.

   c. No safety or environmental issues exist with performing the work.

   d. Work will not interrupt or otherwise affect scheduled activities.

   e. Work does not require that equipment to be de-energized or isolated.

   f. Work will not result in the potential for uncontrolled release of hazardous waste.

   g. Only minor or consumable parts are needed.

   h. No records are required for any part of the activity.

2. If, at any point during the performance of tool pouch maintenance, conditions change and the situation no longer meets the qualifications of tool pouch maintenance, work should immediately cease and a work order/work plan should be created.

3.2.1 Planning and Scheduling Guidelines (continued)

D. Minor Maintenance

1. Work which meets the below criteria is considered minor maintenance work and requires a simple one-page Maximo work order. No work package is required.
   a. No safety or environmental issues exist with performing the work.
   b. Work does not require that equipment to be de-energized or isolated.
   c. Work will not result in the potential for uncontrolled release of hazardous waste.
   d. No safety or environmental issues exist with performing the work.
   e. Work will not affect operation of the plant or systems.
   f. The work is limited in scope and within the skill set of the craftsman.
   g. Work does not require coordination between groups.
   h. Generic procedures can be used.
2. If at any point during the performance of minor maintenance conditions change and the situation no longer meets the qualifications of minor maintenance, work should immediately cease and a work plan should be developed. Minor maintenance is treated as job jar work and is not scheduled.

E. Deficiency Monitoring

Some deficiencies discovered during inspections or in the course of routine maintenance will not require immediate repair, but must be monitored on an ongoing basis. Deficiencies of this nature shall be documented in Maximo as "Other" work orders with a work type of "OTH". These work orders will not be included in the corrective work order backlog count, but will be provided to personnel during dike inspections for follow up. If conditions should change, the change should be documented in the log section of the Maximo work order, and photographs should be attached to the Maximo work order through the BSL. If the change is of a nature such that repairs have become necessary, the issue should be elevated to the CCP Construction Supervisor for consideration as emergent work. If the issue is not urgent and can be scheduled for work at a later date, the CCP Construction Supervisor should notify the RHO&M Program Manager to change the work type to corrective maintenance and re-introduce the work order at the weekly work order review meeting for prioritization and placement in the schedule.

F. Complex Corrective Maintenance

Work which does not fall into the above categories is considered a complex corrective maintenance and will require a Maximo work order and a full work package. This work will be scheduled. These jobs may:

1. Require coordination from more than one crew.

3.2.1 Planning and Scheduling Guidelines (continued)

2. Require special permits or clearances.

3. Require special tools or equipment which are not normally kept on site.

4. Have high safety or environmental risks involved in performing the work.

5. Involve a complicated work plan or tasks which are beyond the normal skill range of the worker in the field.

6. Require in-depth planning or coordination with another group's scheduled activities.

3.2.2 Weekly Work Order Review Group

A. A work order review group shall meet once weekly to review new work orders. The meeting will be chaired by Program Manager, Work Control or designee. The group shall review all new work orders and return to the originating organization any that do not contain sufficient detail to adequately define the problem. Additional meetings may be called if needed.

B. The weekly review team will be responsible for performing the following duties:

1. Review and categorize all work orders generated since the last review group meeting (with the exception of auto-generated PM work orders) based upon the expertise and experience of the team members.

2. Cancel duplicate and unnecessary work orders. Determine if work fits criteria for minor maintenance. If not, assign the appropriate sub-priority, job details, and scheduling codes (to include planner and target schedule dates) to new work orders

3. Determine whether service request initiator has correctly checked the "Recommend PER" box and the "Recommend DCN"

4. Determine and set in motion any compensatory actions needed to ensure that CCP equipment / assets could safely operate until repaired if it is to remain available or in service. If compensatory actions are assigned, they will be entered into the log section of the appropriate work order by the Work Control Program Manager.

   a. Attendees:

   b. RHO&M Construction Manager(s) - Optional

   c. RHO&M Program Manager(s) - Optional

   d. RHO&M PER Coordinator - Required

   e. CCP Engineering Personnel - Required

   f. Program Manager, Work Control - Required

3.2.2 **Weekly Work Order Review Group (continued)**

3.2.3 Work Order Planning

Work Orders shall be planned in accordance with FGDC Work Package Development. If work orders cannot be planned and executed in accordance with the target schedule date assigned in the daily review group meeting, the responsible program manager should notify the Program Manager, Work Control.

3.2.4 Schedule Review and Job Walkdown

A copy of the schedule and hard copies of any required work packages shall be provided to the Field Supervisor and Foreman no later than Monday of T-1. (The week prior to schedule execution.) The Field Supervisor and Foreman should walk down the jobs and review the work packages, and reply to their respective RHO&M Program Manager and Construction Manager with concurrence or identified issues no later than Thursday of T-1. The Program Manager, Work Control, should be copied on the response from the Field Supervisor/Foreman. If issues cannot be resolved by Thursday afternoon of T-1, the work shall be removed from the schedule and rescheduled for a later date. If any work is determined to be generation sensitive, FGD&C personnel will refer to FPG Control of Generation Sensitive Activities and will coordinate with the plant accordingly.

3.2.5 Work Execution

All work shall be performed in accordance with "TVA Plan Work Safely". The performing organization shall, within one week of work completion, email notes on the work order to describe the condition as found, as left, and all work performed. The performing organization will notify the Work Control Program Manager of any corrective work orders which need to be entered on new deficiencies discovered during the course of the work which cannot be worked under the existing work scope. The Construction Manager or his designee is responsible for sending weekly schedule updates to the Work Control Program Manager no later than Friday noon, at a minimum. More frequent schedule updates are encouraged

4.0 RECORDS

4.1 QA Records

None

4.2 Non-QA Records

Any records generated as a result of this procedure are to be filed and retained in accordance with the Fossil Generation Development & Construction (FGD&C) Comprehensive Records Schedule (CRS)

5.0 DEFINITIONS

Long - Term Maintenance Plan (Rolling Schedule) A twelve week rolling maintenance schedule will be maintained, the backbone of which is the preventive maintenance process. All corrective work shall be documented on a Maximo corrective work order unless the work is specifically exempted as tool pouch in the attached appendix. These work orders shall be scheduled per the weekly review committee determination.

Emergent Work - Any unscheduled activity that must be performed to maintain operations or to sustain the integrated CCP schedule.

Emergency Work - Emergency work that poses an immediate threat to personnel safety, environment, and unit operation.

Maximo - The computerized maintenance management system.

Work Order - A sequentially numbered document generated in the MAXIMO system for the purpose of initiating a work activity.

Work Package - A single work order or a series of work orders linked to a master document for the purpose of packaging or sourcing all the data/instructions/information necessary to perform an item of work.

6.0 REFERENCES

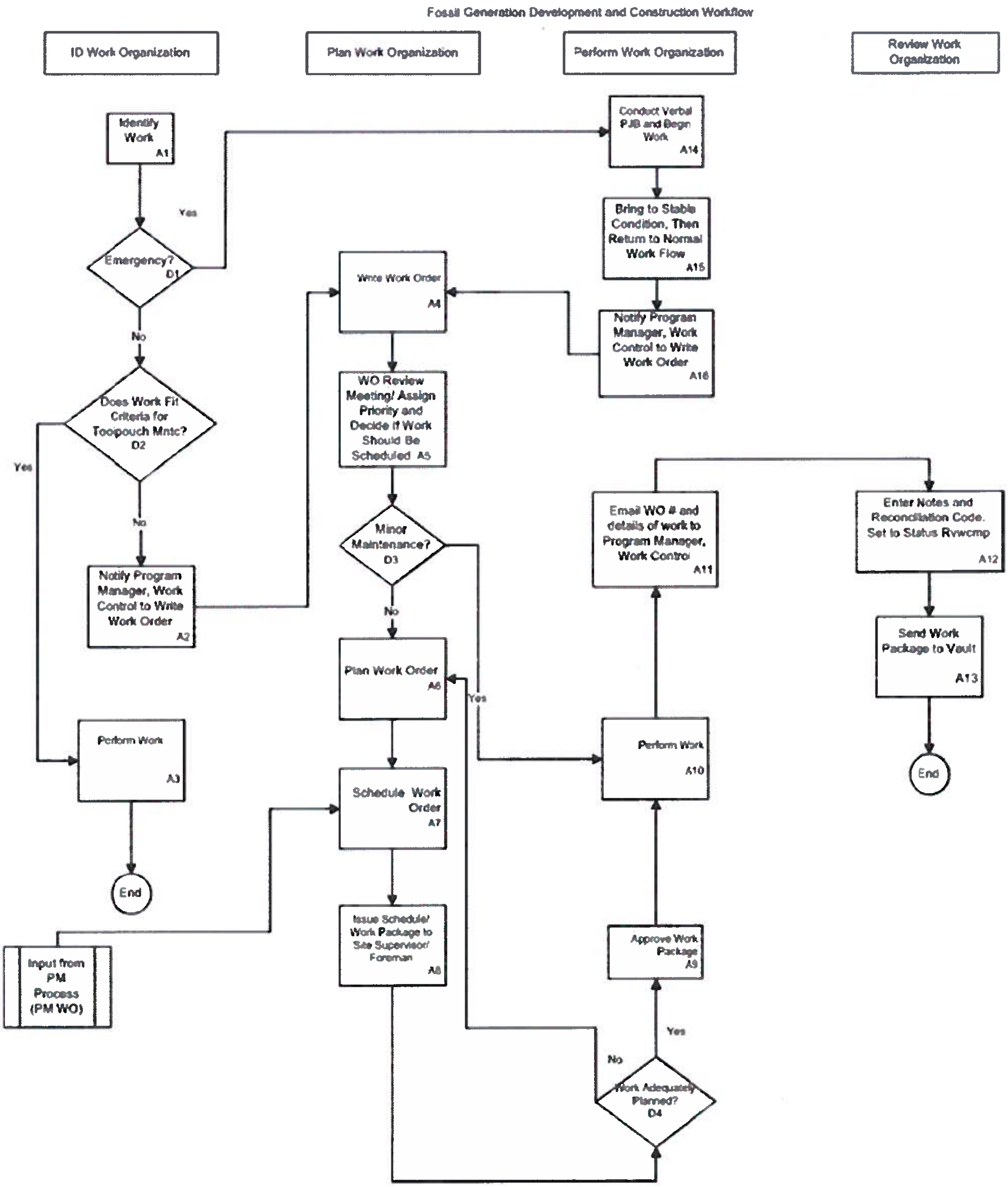
A. FGDC Work Package Development (Under Development)

B. FGD&C Maximo Training Guide (Under Development)

C. TVA Plan Jobs Safely

Appendix A
(Page 1 of 3)

Process Flowchart



Appendix A
(Page 2 of 3)

Process Flowchart

A. **Activity Box A1:** Identify Work - Personnel typically responsible for authorizing work package initiation are designated by the Department Managers.

B. **Decision Block D1** - Does identified work fit the criteria for emergency work? If yes, continue to Activity Box A14. If no, continue to Decision Block D2.

C. **Activity Box A14:** Conduct verbal pre-job briefing and begin work. This work may only continue to the point that the situation is stable and an immediate safety/environmental hazard no longer exists.

D. **Activity Box A15:** After situation is stable, return to normal workflow.

E. **Activity Box A16:** Notify Program Manager, Work Control to create work order.

F. **Decision Block D2:** Does work qualify as Toolpouch Maintenance? If so, continue to Activity Block A3. If no, continue to Activity Box A2.

G. **Activity Box A2:** Notify Program Manager, Work Control to write a work order.

H. **Activity Box A4**: Write work order to TVA standard.

I. **Activity Box A5:** Present work order in weekly review meeting. Assign priority by consensus and determine if work order should be scheduled.

J. **Activity Box A6:** Plan work order per FGDC Work Package Development.

K. **Activity Box A7:** Populate Maximo Schedule Start Date. Schedule date will pass through interface to correct date on the scheduling tool. This schedule will be provided to CCP scheduler for integrated schedule.

L. **Activity Box A8:** Issue work package/ schedule to for approval.

M. **Decision Block D4:** Determine if job is properly planned. If no, work package is returned to the preparer. (Activity Block A6.) If yes, continue to Activity Block A9.

N. **Activity Box A9:** Communicate approval of schedule/work package to RHO&M Construction Manager and Program Manager, Work Controls.

O. **Activity Box A10:** Perform Work.

Appendix A
(Page 3 of 3)

Process Flowchart

P. **Activity Box A11:** Email WO# to Program Manager, Work Control with data regarding condition as found, as left and all work performed, to include methods of post maintenance testing and any data derived from it. Email should additionally include the below items:

1. All Process and Configurations changes must be properly documented and communicated.

2. Problems specific to this work package discovered while performing this work should be captured and analyzed. The problem and analysis may be captured in the feedback tab of the Maximo Work Order before closing the work order and tracked automatically thru the feedback application in Maximo.

3. Deficiencies in the work plan/ work package must be reviewed to identify process improvements, which can be incorporated into future work packages of similar scope throughout TVA. This should be captured thru the Feedback application in Maximo.

4. There may be information developed or discovered during the performance of work, which needs to be captured for the benefit of others who may perform this work at some future time.

Q. **Activity Block A12:** Program Manager, Work Control enters notes on Maximo work order, enters any other needed information, and reviews package for completeness and accuracy of notes/documentation. Place work order in Review Complete (Revwcmp) status.

R. **Activity Block A15**: Program Manager, Work Control sends work package to vault.

Source Notes
(Page 1 of 1)

Requirements Statement	Source Document	Implementing Statement
This document does not contain internal or external commitments or requirements.	N/A	N/A

1200 Work Packages

The following work packages are available for Colbert Fossil Plant:

1. 24 Inch Pipe Removal at No. 4 Ash Pond
2. COF #5 Ash Stack Perimeter Ditch Seepage Mitigation
3. COF CYRO Pond Clean-out Plan
4. COF Wooden Weir Removal Work Plan
5. Colbert Fossil Plant 350 Articulating Dump Truck
6. Colbert 637 Pan Scraper
7. Colbert #4 Ash Pond Dike Vegetation Removal
8. Colbert Drainage Ditch Clean-out Work Plan
9. Colbert Coal Breaker Area Drainage Ditch Refurbishment
10. Colbert Dry Ash Stacking Plan R-1
11. Colbert Dry Ash Stacking Plan
12. Colbert New Land Fill Study Plan
13. Colbert Silo Road Expansion
14. Colbert Stack 5 Stilling Pond Wave Wash Repair Work Plan
15. Colbert Weed, Brush, and Vegetation Cutting

Fossil By Products
Work Package Cover Sheet

Location: Colbert Fossil Plant
Project Supervisor:

Work Order No:
Date:

Work Package Desc: Colbert General Site Support Work Plan

	YES	NO	N/A	Component / Step
1	X			*STEP TEXT (REQUIRED)*
2	X			*SAFETY ANALYSIS (JSA) (REQUIRED)*
3	X			*PERMIT LIST / HOLD ORDER BOUNDARIES (REQUIRED)*
4	X			*PRE-JOB BRIEFING CHECKLIST (REQUIRED)*
5			X	POTENTIAL PROBLEM ANALYSIS (PPA)
5	X			ENVIRONMENTAL ANALYSIS (CEC)
6	X			MATERIAL LIST
7	X			DRAWINGS / SPECIFICATIONS / MANUALS
8			X	CONFIGURATION MANAGEMENT
9			X	PMT REQUIREMENTS
10			X	GSA
11			X	FME
12	X			TURNOVER CHECKLIST

Purpose / Problem Description:
A general site support work plan for Colbert Fossil Plant is required to provide a basic plan to safely and efficiently address various routine site repairs and for rapid response to requests by COF plant personnel. This plan shall address the need to perform routine work on site in order to maintain roads, drainage ditches, etc. and to remove undesirable brush, vegetation, etc. as requested or identified as needed. Many requests are small in nature and require rapid response to address the issues at hand.

Scope of Work:
Perform routine required maintenance to site roads, haul roads, drainage ditches, etc. as requested or as needed to repair site travel paths. Remove undesired brush, tall grasses, and other indentified vegetation as needed. Comply with COF plant personnel's request for the performance of requested tasks that are small in nature and usually short in duration. Requested work that is deemed by the Site Supervisor as extensive in manpower and time required, shall require a work package be developed to address such requests.

Prepared By: Bob Gilchrist
Revised By: Judith "Wanda" Sumerel
Reviewed By:

Approved By:
Date:

Meet all Work Package Requirements: YES [X] NO [ ]
If No, why?

Optional Supplementary Documentation (References):

	Yes	NO	N/A	Component / Step	File / Location
1	X			Project Funding Approvals	File Server
2	X			Scope Documents	
3	X			Authorizations	
4	X			Estimate Details	
5	X			Schedule	
6	X			Experience Review / Lessons Learned	

17814 [1-2004]

1200 General Site Support Work Plan COF 7-5-11
Step Text
7/20/2011

Location: Colbert Fossil Plant

Work Order No: 0 **Date:** 1/0/00

Work Package Desc: Colbert General Site Support Work Plan

Note 1		Perform daily (minimum) pre-job briefings with crew. Each employee will have a pre-job briefing before each assignment, detailing the scope of the assigned task, the possible hazards, and steps to mitigate the identified hazards. Should the employee's daily assigned task be changed, a subsequent pre-job briefing will be given. Document briefings with signatures, and file in this Work Package.
Note2		Anytime the work package is found to have a change in the plan, or a deficient area of instruction, work will be stopped and the document shall be revised and approved by all managers / engineering involved prior to re-start of the work. There will be no exceptions.
Note3		This step text is arranged in sequence but is not intended for strict compliance. The site supervisor and foreman may change the sequence in which the work is performed, providing the sequence change has no negative impact on job safety or work quality.
Note4		A new "Material Load and Unload Checklist" has been added to this work plan. The checklist is located in the page tab named "Material Load Unload Checklist". Due to previous critical incidents at other sites while unloading materials, ensure that this checklist is used before loading or unloading materials at Colbert Fossil Plant.
Step No.	**Initial & Date As Steps Are Completed**	**Work Description**
1		Each person assigned a task is to participate in/sign the prejob briefing and use the 2 minute rule in all processes before starting the task. Ask: How do I need to do it? Do I have the proper PPE? What is the procedure? New employees assigned to the job site, including contractors working beneath Supervisor or Forman's oversight, must have new personnel orientation.
2		Mobilize equipment and/or tools required to safely and efficiently perform the assigned task. Use the Material Loading/Unloading checklist before all loading or unloading activities. Due to recent incidents involving overhead power sources and support guide wires, Managers, Supervisors, and/or Foreman shall walk down their worksite to identify any potential Power Line/Guide Wire Hazard. View and discuss the electrical minimum safe working distance charts located in the "Safety Notes" tab of this work plan.
3		Employees must inspect their equipment and/or tools before work begins to ensure all are ready to perform as designed and can be operated safely. Personnel assigned to operate equipment must be qualified and familiar with the equipment they are required to use. Equipment checklists must be completed before equipment operation begins.
4		All personnel assigned to operate ATV's on Colbert Fossil Plant projects must review the operator's manuals and TVA Safety Procedure 601 "All Terrain Vehicles". (TSP 601 is included in the "Safety Notes" tab of this work plan). ATV's shall not exceed safe speeds on all dikes, berms, and dike roadways. No radio or cell phone communications may be used while the vehicle is in operation. Personal cell phone use is absolutely prohibited while operating ATV's on Colbert projects. Review and adhere to additional related information for safe ATV operation contained in the JSA of this work plan.
5		Haul and access roads on site are to be inspected daily by the CCP Site Supervisor/Foreman. All haul roads to and from spoils areas, site ponds, material staging areas, site dike improvement project areas, etc. shall be inspected and repaired as needed. When required, use grader, dozer, etc. to cut the road surfaces to remove washes, pot holes, soft spots, or other rough road imperfections. The graded materials may be spread evenly over the road's surface and compacted to provide a uniform surface for travel. As needed, and when deemed necessary by Site Supervisor, additional crushed stone or similar materials shall be hauled and spread to provide additional cover to provide improved road surfaces.
6		Drainage/run-off ditches will require the use of an excavator or equivalent piece of equipment to remove sediment materials in order for the ditches to perform as designed. Make repairs to eroded areas, wash-outs, etc. as required or when requested. Install or add rip rap stone as needed in eroded areas as needed to deter excessive materials migration. Materials removed during clean-out of ditches, run-offs, sediment ponds, etc. shall be loaded into dump trucks to be carried to the applicable spoils area for disposal.

1200 General Site Support Work Plan COF 7-5-11
Step Text
7/20/2011

Location: Colbert Fossil Plant

Work Order No: 0 **Date:** 1/0/00

Work Package Desc: Colbert General Site Support Work Plan

Note 1		Perform daily (minimum) pre-job briefings with crew. Each employee will have a pre-job briefing before each assignment, detailing the scope of the assigned task, the possible hazards, and steps to mitigate the identified hazards. Should the employee's daily assigned task be changed, a subsequent pre-job briefing will be given. Document briefings with signatures, and file in this Work Package.
Note2		Anytime the work package is found to have a change in the plan, or a deficient area of instruction, work will be stopped and the document shall be revised and approved by all managers / engineering involved prior to re-start of the work. There will be no exceptions.
Note3		This step text is arranged in sequence but is not intended for strict compliance. The site supervisor and foreman may change the sequence in which the work is performed, providing the sequence change has no negative impact on job safety or work quality.
Note4		A new "Material Load and Unload Checklist" has been added to this work plan. The checklist is located in the page tab named "Material Load Unload Checklist". Due to previous critical incidents at other sites while unloading materials, ensure that this checklist is used before loading or unloading materials at Colbert Fossil Plant.
Step No.	**Initial & Date As Steps Are Completed**	**Work Description**
7		When required and/or directed by the Site Supervisor, make temporary repairs using SWPP BMP's such as silt fence repair, placing of straw bales, straw eels, check dams, and/or addition of riprap in ditches periodically. These potential repairs are required for proper erosion control and to limit material migration. Details for erosion and sediment control features are covered in General Construction Specification T-1. Should new or additional silt fencing be required, ensure plant personnel are contacted in order to inquire for an excavation permit should one be required in the area.
8		Cut undesired vegetation on site as required or requested. Walk down and inspect all areas requiring vegetation removal before any cutting activities begin. Identify and flag areas in the proposed vegetation removal area that are deemed hazardous to the cutting operation, such as holes, scrap materials, stumps, etc. Ensure that personnel assigned to walk down the areas to be cut wear all appropriate required PPE. For larger areas of vegetation cutting, use a tractor with bush hog attachment. Use a side boom cutter to cut vegetation in areas where the machine can be located on flat, stable ground but the slope area is too steep for other equipment travel. Such areas include inside slopes of ponds, roadways, and other areas identified by the Site Supervisor. Utilize a spotter during these cutting operations, ensuring the spotter remains a minimum of 200 feet from the cutting operations. All operations must stop when on coming traffic approaches. Operations may resume after traffic has passed 200 feet from area being cut.
9		In areas that cannot be safely reached by equipment and/or areas deemed too small to involve larger equipment, all vegetation cutting will be performed manually by personnel using power pruners, weed/brush cutters, hedge trimmers, chain saws, etc. Personnel shall walk down the area before cutting begins to identify and flag potential hazard areas, such as holes, soft spots, areas of slick/poor footing, etc. All required PPE shall be worn at all times during vegetation removal, including hard hats, gloves, goggles/face shields, protective leggings, etc. During warm weather operations, snake boots and snake leggings shall be worn. All employees operating chainsaws must have received the training course "Chain Saw Safety", ATIS Number 00059105.
10		All fuel handling safety processes and procedures must be used when providing fuel for general site support projects equipment. Ensure a spill kit is on hand and available during all fueling operations. The foreman's truck with fuel tank located in the truck bed may be used for fueling operations when fueling in the field is required.
11		Perform erosion control tasks as required or requested by promoting vegetative cover growth in identified areas. Restore the area cover by spreading seed and fertilizer and then covering with soil erosion reduction materials, such as hay, straw, curlex, or other suitable products used in erosion stabilization. Attention to details is advantageous when working on all sloped areas in order to avoid slipping, tripping, or falling during the distribution of the materials over the surface.

1200 General Site Support Work Plan COF 7-5-11
Step Text
7/20/2011

Location: Colbert Fossil Plant

Work Order No: 0 **Date:** 1/0/00

Work Package Desc: Colbert General Site Support Work Plan

Note 1		Perform daily (minimum) pre-job briefings with crew. Each employee will have a pre-job briefing before each assignment, detailing the scope of the assigned task, the possible hazards, and steps to mitigate the identified hazards. Should the employee's daily assigned task be changed, a subsequent pre-job briefing will be given. Document briefings with signatures, and file in this Work Package.
Note2		Anytime the work package is found to have a change in the plan, or a deficient area of instruction, work will be stopped and the document shall be revised and approved by all managers / engineering involved prior to re-start of the work. There will be no exceptions.
Note3		This step text is arranged in sequence but is not intended for strict compliance. The site supervisor and foreman may change the sequence in which the work is performed, providing the sequence change has no negative impact on job safety or work quality.
Note4		A new "Material Load and Unload Checklist" has been added to this work plan. The checklist is located in the page tab named "Material Load Unload Checklist". Due to previous critical incidents at other sites while unloading materials, ensure that this checklist is used before loading or unloading materials at Colbert Fossil Plant.
Step No.	**Initial & Date As Steps Are Completed**	**Work Description**
12		The project area should be picked up daily. Equipment cabs should be free of scrap paper, rags, etc. All debris and job related waste should be disposed of in a manner acceptable to the Colbert Site Environmental Representative.
13		Conduct a post job briefing at the end of each shift, or at the end of the assigned task. Encourage employees to provide input during the briefings to provide added opportunity to improve safety and performance processes and procedures.

1200 General Site Support Work Plan COF 7-5-11
JSA
7/21/2011

Date:	1/0/00	Project Supervisor/Foreman:	0
Location:	Colbert Fossil Plant		
Work Order No:	0		
Work Package Desc:	Colbert General Site Support Work Plan		
Prepared By:	Bob Gilchrist		
Reviewed By:	0	Approved By:	0
Skills Required:	Qualified Operators and Teamsters, Skilled Laborers		
Required Personal Protective Equipment:	Hard Hats, Safety Glasses, Face Shield, Safety Vest, Gloves, Hearing Protection, Adequate Footwear For Foot Protection, Snake Boots/Snake Leggings When Applicable		
Tools and Equipment Required:	See Attached Tool and Equipment List		
Job Preparation:	Operators must be qualified for the equipment assigned to operate and have current S-5 Medical exam. Osha 10 training required for craft and contract personnel. All chain saw operators must have received the training course "Chain Saw Safety", ATIS Number 00059105.		
Hazardous Materials:	None		

Type In White Cells Only

Step Number	Sequence of Basic Job Steps	Potential Accidents or Hazards	Recommended Safe Job Procedures
Note 1	Perform daily (minimum) pre-job briefings with crew. Each employee will have a pre-job briefing before each assignment, detailing the scope of the assigned task, the possible hazards, and steps to mitigate the identified hazards. Should the employee's daily assigned task be changed, a subsequent pre-job briefing will be given. Document briefings with signatures, and file in this Work Package.		
Note 2	Anytime the work package is found to have a change in the plan, or a deficient area of instruction, work will be stopped and the document shall be revised and approved by all managers / engineering involved prior to re-start of the work. There will be no exceptions.		
1	Each person assigned a task is to participate in/sign the prejob briefing and use the 2 minute rule in all processes before starting the task. Ask: How do I need to do it? Do I have the proper PPE? What is the procedure? New employees assigned to the job site, including contractors working beneath Supervisor or Forman's oversight, must have new personnel orientation.	New employees will not be familiar with assembly points, evacuation routes, accountability procedures, etc, causing increased exposure to new employees. Rule or knowledge based errors could lead to a variety of accidents or injuries.	If performing personnel are new to the job site, conduct new personnel orientation. Discuss emergency alarms, evacuation routes, location of assembly points, personnel accountability procedures, route to local hospital and or Medical Facility. Report all incidents and injuries to Supervisor, no matter how minor they are. View additional safety notes located on the "Notes" page of this work plan that are applicable to this assigned work.

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JSA
7/21/2011

Date:	1/0/00	Project Supervisor/Foreman:	0
Location:	Colbert Fossil Plant		
Work Order No:	0		
Work Package Desc:	Colbert General Site Support Work Plan		
Prepared By:	Bob Gilchrist		
Reviewed By:	0	Approved By:	0
Skills Required:	Qualified Operators and Teamsters, Skilled Laborers		
Required Personal Protective Equipment:	Hard Hats, Safety Glasses, Face Shield, Safety Vest, Gloves, Hearing Protection, Adequate Footwear For Foot Protection, Snake Boots/Snake Leggings When Applicable		
Tools and Equipment Required:	See Attached Tool and Equipment List		
Job Preparation:	Operators must be qualified for the equipment assigned to operate and have current S-5 Medical exam. Osha 10 training required for craft and contract personnel. All chain saw operators must have received the training course "Chain Saw Safety", ATIS Number 00059105.		
Hazardous Materials:	None		

Type In White Cells Only

Step Number	Sequence of Basic Job Steps	Potential Accidents or Hazards	Recommended Safe Job Procedures
2	Mobilize equipment and/or tools required to safely and efficiently perform the assigned task. Use the Material Loading/Unloading checklist before all loading or unloading activities. Due to recent incidents involving overhead power sources and support guide wires, Managers, Supervisors, and/or Foreman shall walk down their worksite to identify any potential Power Line/Guide Wire Hazard. View and discuss the electrical minimum safe working distance charts located in the "Safety Notes" tab of this work plan.	Equipment activity and movement could result in strike and contact type accidents. Equipment could overturn while off loading from trucks or trailers. Operators could fall getting into or out of equipment. Personnel in area could be injured if struck or contacted by equipment. Equipment could be damaged and/or personnel could be injured by equipment striking surrounding structures, power poles, etc during unloading and staging of equipment.	Flagman/spotter shall be used as needed while equipment is being unloaded and staged. Workers must wear all appropriate PPE during loading and unloading processes, including high visibility fluorescent vests. Operators must be familiar with and qualified to operate the assigned equipment. All personnel not immediately involved in the equipment unloading and staging must remain clear of this area.
3	Employees must inspect their equipment and/or tools before work begins to ensure all are ready to perform as designed and can be operated safely. Personnel assigned to operate equipment must be qualified and familiar with the equipment they are required to use. Equipment checklists must be completed before equipment operation begins.	Contact with pinch points during inspections. Employees contacted by sharp objects, metal burrs, etc. causing puncture wounds. Fingers/hands caught between equipment cabs and doors, etc. Falls to below, Foot level fall.	Read and understand the instructions in the manufacturer's operating manual for each tool or equipment to be used. All equipment/tool protective guards must be in place. Tools or equipment with deficiencies that affect safe operations shall not be operated until corrected. Operators must be qualified for the equipment assigned to operate per TVA Safety Procedure 711, "Heavy Equipment Operations." Employees must wear all appropriate PPE during equipment/tool inspections.

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Required Personal Protective Equipment:	Hard Hats, Safety Glasses, Face Shield, Safety Vest, Gloves, Hearing Protection, Adequate Footwear For Foot Protection, Snake Boots/Snake Leggings When Applicable		
Tools and Equipment Required:	See Attached Tool and Equipment List		
Job Preparation:	Operators must be qualified for the equipment assigned to operate and have current S-5 Medical exam. Osha 10 training required for craft and contract personnel. All chain saw operators must have received the training course "Chain Saw Safety", ATIS Number 00059105.		
Hazardous Materials:	None		

Type In White Cells Only

Step Number	Sequence of Basic Job Steps	Potential Accidents or Hazards	Recommended Safe Job Procedures
4	All personnel assigned to operate ATV's on Colbert Fossil Plant projects must review the operator's manuals and TVA Safety Procedure 601 "All Terrain Vehicles". (TSP 601 is included in the "Safety Notes" tab of this work plan). ATV's shall not exceed safe speeds on all dikes, berms, and dike roadways. No radio or cell phone communications may be used while the vehicle is in operation. Personal cell phone use is absolutely prohibited while operating ATV's on Colbert projects. Review and adhere to additional related information for safe ATV operation contained in the JSA of this work plan.	ATV's being struck by other equipment. Tipping, or lose of control of ATV, causing equipment damage or personnel injury. Running off embankments/Rolling over. Striking against other workers. Striking other equipment. Falling out of ATV.	Seat belts must be fastened at all times when ATV is in transit. All appropriate PPE must be worn and self checking shall be applied. Pre-trip inspections must be completed. Absolutely no communication radio or cell phone use is allowed during ATV movement. All personal cell phone use is prohibited. Review TSP 601 for ATV operations. Operators must be aware of their surroundings at all times and yield to pedestrians and crosswalk requirements to stop. Passengers shall only be permitted when the vehicle is equipped with the manufacturers approved seating for passengers. ATV operators shall not exceed safe operating speeds on all dikes, berms, and dike roadways. Equipment must not be operated under the influence of drugs, alcohol, or impairing medications.

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Date:	1/0/00	Project Supervisor/Foreman:	0
Location:	Colbert Fossil Plant		
Work Order No:	0		
Work Package Desc:	Colbert General Site Support Work Plan		
Prepared By:	Bob Gilchrist		
Reviewed By:	0	Approved By:	0
Skills Required:	Qualified Operators and Teamsters, Skilled Laborers		
Required Personal Protective Equipment:	Hard Hats, Safety Glasses, Face Shield, Safety Vest, Gloves, Hearing Protection, Adequate Footwear For Foot Protection, Snake Boots/Snake Leggings When Applicable		
Tools and Equipment Required:	See Attached Tool and Equipment List		
Job Preparation:	Operators must be qualified for the equipment assigned to operate and have current S-5 Medical exam. Osha 10 training required for craft and contract personnel. All chain saw operators must have received the training course "Chain Saw Safety", ATIS Number 00059105.		
Hazardous Materials:	None		

Type In White Cells Only

Step Number	Sequence of Basic Job Steps	Potential Accidents or Hazards	Recommended Safe Job Procedures
5	Haul and access roads on site are to be inspected daily by the CCP Site Supervisor/Foreman. All haul roads to and from spoils areas, site ponds, material staging areas, site dike improvement project areas, etc. shall be inspected and repaired as needed. When required, use grader, dozer, etc. to cut the road surfaces to remove washes, pot holes, soft spots, or other rough road imperfections. The graded materials may be spread evenly over the road's surface and compacted to provide a uniform surface for travel. As needed, and when deemed necessary by Site Supervisor, additional crushed stone or similar materials shall be hauled and spread to provide additional cover to provide improved road surfaces.	Personnel in the vicinity could be struck by equipment or materials. Equipment could strike other equipment or other vehicles on road, causing injury to personnel and/or equipment damage. The operator when getting on and off the equipment could be subject to: Fall to below, foot level fall. Operating equipment on uneven ground subject the equipment and operator to tipping, lose of control of equipment, and/or damage to equipment.	Keep equipment steps and rails free of mud, grease, and other slick materials that may contribute to falls when entering or exiting equipment. Always use flagman, warning indicators, barricades, etc. as necessary when making repairs in close proximity to other work and on roads with vehicle and/or equipment traffic. Be aware of all obstructions above ground and any detected below ground. Operators shall use side mirrors while backing and also use flag person if needed for direction. While loading trucks, or other equipment load from driver's side of vehicle or from rear if at all possible. Read and understand operators' manual for each type of equipment to be operated. Equipment with deficiencies that affect safe operations shall not be operated until corrected. Use right machine for job. Operators shall be trained and qualified for the equipment they are to operate. TVA Safety Procedures 711 " Heavy Equipment Operations" is applicable and provides detailed instructions.

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JSA
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Date:	1/0/00	Project Supervisor/Foreman:	0
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Work Package Desc:	Colbert General Site Support Work Plan		
Prepared By:	Bob Gilchrist		
Reviewed By:	0	Approved By:	0
Skills Required:	Qualified Operators and Teamsters, Skilled Laborers		
Required Personal Protective Equipment:	Hard Hats, Safety Glasses, Face Shield, Safety Vest, Gloves, Hearing Protection, Adequate Footwear For Foot Protection, Snake Boots/Snake Leggings When Applicable		
Tools and Equipment Required:	See Attached Tool and Equipment List		
Job Preparation:	Operators must be qualified for the equipment assigned to operate and have current S-5 Medical exam. Osha 10 training required for craft and contract personnel. All chain saw operators must have received the training course "Chain Saw Safety", ATIS Number 00059105.		
Hazardous Materials:	None		

Type In White Cells Only

Step Number	Sequence of Basic Job Steps	Potential Accidents or Hazards	Recommended Safe Job Procedures
6	Drainage/run-off ditches will require the use of an excavator or equivalent piece of equipment to remove sediment materials in order for the ditches to perform as designed. Make repairs to eroded areas, wash-outs, etc. as required or when requested. Install or add rip rap stone as needed in eroded areas as needed to deter excessive materials migration. Materials removed during clean-out of ditches, run-offs, sediment ponds, etc. shall be loaded into dump trucks to be carried to the applicable spoils area for disposal.	The operator when getting on and off the equipment could be subject to: Fall to below, foot level fall. Operating equipment on uneven ground subject the equipment and operator to tipping, lose of control of equipment, and/or damage to equipment. Personnel in the vicinity could be struck by equipment or materials. Equipment could strike other equipment or other vehicles on road, causing injury to personnel and/or equipment damage.	Always use flagman, warning indicators, barricades, etc. as necessary when making repairs in close proximity to other work and on roads with vehicle and/or equipment traffic. Read and understand operators' manual for each type of equipment to be operated. Equipment with deficiencies that affect safe operations shall not be operated until corrected. Use right machine for job. Operators shall be trained and qualified for the equipment they are to operate. TVA Safety Procedures 711 " Heavy Equipment Operations" is applicable and provides detailed instructions. Be aware of all obstructions above ground and any detected below ground. When using a track hoe, always excavate between the tracks, not over the side. Operators shall use side mirrors while backing and also use flag person if needed for direction. While loading trucks, or other equipment load from driver's side of vehicle or from rear if at all possible.

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Reviewed By:	0	Approved By:	0
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Required Personal Protective Equipment:	Hard Hats, Safety Glasses, Face Shield, Safety Vest, Gloves, Hearing Protection, Adequate Footwear For Foot Protection, Snake Boots/Snake Leggings When Applicable		
Tools and Equipment Required:	See Attached Tool and Equipment List		
Job Preparation:	Operators must be qualified for the equipment assigned to operate and have current S-5 Medical exam. Osha 10 training required for craft and contract personnel. All chain saw operators must have received the training course "Chain Saw Safety", ATIS Number 00059105.		
Hazardous Materials:	None		

Type In White Cells Only

Step Number	Sequence of Basic Job Steps	Potential Accidents or Hazards	Recommended Safe Job Procedures
7	When required and/or directed by the Site Supervisor, make temporary repairs using SWPP BMP's such as silt fence repair, placing of straw bales, straw eels, check dams, and/or addition of riprap in ditches periodically. These potential repairs are required for proper erosion control and to limit material migration. Details for erosion and sediment control features are covered in General Construction Specification T-1. Should new or additional silt fencing be required, ensure plant personnel are contacted in order to inquire for an excavation permit should one be required in the area.	Employees being struck by equipment or materials. Equipment striking against other equipment. Strains/Sprains or pinch points while placing straw, eels, silt fencing, etc. Falls to below. Foot level falls. Tipping, lose of control of equipment.	Proper PPE must be worn by all employees at all times when work is in progress. All personnel should be familiar with TVA Safety Procedures that pertain to the assigned task: TVA Safety Procedures 304-Eye & Face, 307-Feet, 308 -Hand, 309-Head, and 310-Hearing Protection all apply. Operators shall be familiar with and qualified to operate the assigned equipment. All equipment checks must be completed to ensure the equipment can be operated as designed and safely. Operators must be aware of all other employees working in the immediate area. Employees working on silt fence, straw eels, straw etc, shall remain aware of pinch points and shall use good ergonomic positioning to deter strains and sprains. All personnel must stay aware of their surroundings and maintain good footing at all times.

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Prepared By:	Bob Gilchrist		
Reviewed By:	0	Approved By:	0
Skills Required:	Qualified Operators and Teamsters, Skilled Laborers		
Required Personal Protective Equipment:	Hard Hats, Safety Glasses, Face Shield, Safety Vest, Gloves, Hearing Protection, Adequate Footwear For Foot Protection, Snake Boots/Snake Leggings When Applicable		
Tools and Equipment Required:	See Attached Tool and Equipment List		
Job Preparation:	Operators must be qualified for the equipment assigned to operate and have current S-5 Medical exam. Osha 10 training required for craft and contract personnel. All chain saw operators must have received the training course "Chain Saw Safety", ATIS Number 00059105.		
Hazardous Materials:	None		

Type In White Cells Only

Step Number	Sequence of Basic Job Steps	Potential Accidents or Hazards	Recommended Safe Job Procedures
8	Cut undesired vegetation on site as required or requested. Walk down and inspect all areas requiring vegetation removal before any cutting activities begin. Identify and flag areas in the proposed vegetation removal area that are deemed hazardous to the cutting operation, such as holes, scrap materials, stumps, etc. Ensure that personnel assigned to walk down the areas to be cut wear all appropriate required PPE. For larger areas of vegetation cutting, use a tractor with bush hog attachment. Use a side boom cutter to cut vegetation in areas where the machine can be located on flat, stable ground but the slope area is too steep for other equipment travel. Such areas include inside slopes of ponds, roadways, and other areas identified by the Site Supervisor. Utilize a spotter during these cutting operations, ensuring the spotter remains a minimum of 200 feet from the cutting operations. All operations must stop when on coming traffic approaches. Operations may resume after traffic has passed 200 feet from area being cut.	Equipment or personnel being struck by other equipment working in or near cutting area, causing personal injury and/or equipment damage. Tipping or loss of control of equipment. Struck by flying debris from the cutting operation. Moving equipment or equipment parts striking against employees. Contact with moving traffic. Snake bites. Slips, trips, same level falls. Falls to below. Inclement weather events. Equipment fires.	TVA Safety Procedures 703 and 715 apply to these operations and shall be reviewed. Safety goggles/glasses, hearing protection, hard hat, and all required PPE must be worn during cutting operations. Pick up any trash or debris that can become airborne before removing vegetation. Before operating the tractor & bush hog, the operator shall be familiar with the operation manual, including speed, braking, and slope & steering capabilities of the equipment. Equipment shall have a fire extinguisher available should equipment fires occur. Walk around and inspect grass cutting equipment before each use. Before beginning operations, and before resuming cutting operations after meal period, inspect equipment for possible loose or missing wheel lug nuts. Should either missing or loose lug nuts be observed, the equipment shall not be operated until corrective repairs have been made. Tractors shall not mow horizontally on slopes greater than 3:1 . Use seat belt and ensure roll bar is in place. Disengage bush hog when traveling . Any embedded encroachments i.e. wells, drains, landmarks will be marked and identified to all operators. Snake boots/leggings shall be worn when needed for protection from possible snake bites. During lightning or other severe weather events, operations must stop and workers shall seek protective shelter.

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Work Package Desc:	Colbert General Site Support Work Plan		
Prepared By:	Bob Gilchrist		
Reviewed By:	0	Approved By:	0
Skills Required:	Qualified Operators and Teamsters, Skilled Laborers		
Required Personal Protective Equipment:	Hard Hats, Safety Glasses, Face Shield, Safety Vest, Gloves, Hearing Protection, Adequate Footwear For Foot Protection, Snake Boots/Snake Leggings When Applicable		
Tools and Equipment Required:	See Attached Tool and Equipment List		
Job Preparation:	Operators must be qualified for the equipment assigned to operate and have current S-5 Medical exam. Osha 10 training required for craft and contract personnel. All chain saw operators must have received the training course "Chain Saw Safety", ATIS Number 00059105.		
Hazardous Materials:	None		

Type In White Cells Only

Step Number	Sequence of Basic Job Steps	Potential Accidents or Hazards	Recommended Safe Job Procedures
9	In areas that cannot be safely reached by equipment and/or areas deemed too small to involve larger equipment, all vegetation cutting will be performed manually by personnel using power pruners, weed/brush cutters, hedge trimmers, chain saws, etc. Personnel shall walk down the area before cutting begins to identify and flag potential hazard areas, such as holes, soft spots, areas of slick/poor footing, etc. All required PPE shall be worn at all times during vegetation removal, including hard hats, gloves, goggles/face shields, protective leggings, etc. During warm weather operations, snake boots and snake leggings shall be worn. All employees operating chainsaws must have received the training course "Chain Saw Safety", ATIS Number 00059105.	Struck by brush, segments of vegetation being cut, or other materials hurled into operator during cutting activities. Coming in contact with cutting chain or cutting areas of tools, such as power pruners, brush cutters, chain saws, etc. Slips, falls to below while working on sloped surfaces. Contact by other equipment when working in close proximity to ongoing projects. Slips, trips, same level falls. Lightning or other inclement weather events. Strains, overexertion. (During warm weather operations, hazards will include: Insect bites. Snake bites. Heat stress.)	All proper PPE must be worn at all times during vegetative cutting operations including gloves, chaps or other approved leg protection, heavy duty footwear with cut-resistant material, hearing protection, eye protection, and hard hat. Stay aware of surroundings at all times and maintain good footing while using cutting tools and equipment. Use good ergonomic positioning to deter strains/sprains. Use a spotter and maintain a minimum of 20 feet distance between cutting operators. Stop all work during periods of lightning or extreme weather activity and take shelter. All chain saw operators must be trained and have received the training course "Chain Saw Safety", ATIS Number 00059105. Operators should read, understand, and follow TVA Safety Procedure 704 "Chain Saw Operations". (During warm season operations, snake leggings and boots shall be worn. Insect repellant shall be provided and worn as needed. During high heat periods, drink plenty of fluids and take breaks in the shade as needed.)

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Prepared By:	Bob Gilchrist		
Reviewed By:	0	Approved By:	0
Skills Required:	Qualified Operators and Teamsters, Skilled Laborers		
Required Personal Protective Equipment:	Hard Hats, Safety Glasses, Face Shield, Safety Vest, Gloves, Hearing Protection, Adequate Footwear For Foot Protection, Snake Boots/Snake Leggings When Applicable		
Tools and Equipment Required:	See Attached Tool and Equipment List		
Job Preparation:	Operators must be qualified for the equipment assigned to operate and have current S-5 Medical exam. Osha 10 training required for craft and contract personnel. All chain saw operators must have received the training course "Chain Saw Safety", ATIS Number 00059105.		
Hazardous Materials:	None		

Type In White Cells Only

Step Number	Sequence of Basic Job Steps	Potential Accidents or Hazards	Recommended Safe Job Procedures
10	Use the plant fuel truck to provide fuel for general site support projects equipment. Should any equipment requiring fueling be positioned where the fuel truck cannot access it safely, then the foreman's truck with fuel tank can be used for this application.	Spills or leaks of oil, fuel, antifreeze, etc. Static electricity. Foot level falls. Exposure to fuels. Falls to below. Fires and/or explosions	Approved and required PPE to be used during fueling operations. Follow all site specific fueling transfer processes and TVA Safety Procedures. Use drip pans, oil absorbent pads established under leaks as spill prevention. Turn off equipment before refueling starts. Connect bonding cable /grounding cables to receiving equipment at a suitable grounding point during refueling. Ensure that the nozzle is in contact with receiving filler opening before transfer begins. Check all valves for proper settings and leaks. Ensure that all flame or spark producing activities are away from refueling operations. Keep a fire extinguisher available at all times. A spill kit and spill clean-up materials will be on site and in clear location at all times.

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Required Personal Protective Equipment:	Hard Hats, Safety Glasses, Face Shield, Safety Vest, Gloves, Hearing Protection, Adequate Footwear For Foot Protection, Snake Boots/Snake Leggings When Applicable		
Tools and Equipment Required:	See Attached Tool and Equipment List		
Job Preparation:	Operators must be qualified for the equipment assigned to operate and have current S-5 Medical exam. Osha 10 training required for craft and contract personnel. All chain saw operators must have received the training course "Chain Saw Safety", ATIS Number 00059105.		
Hazardous Materials:	None		

Type In White Cells Only

Step Number	Sequence of Basic Job Steps	Potential Accidents or Hazards	Recommended Safe Job Procedures
11	Perform erosion control tasks as required or requested by promoting vegetative cover growth in identified areas. Restore the area cover by spreading seed and fertilizer and then covering with soil erosion reduction materials, such as hay, straw, curlex, or other suitable products used in erosion stabilization. Attention to details is advantageous when working on all sloped areas in order to avoid slipping, tripping, or falling during the distribution of the materials over the surface.	Struck by truck delivering erosion control materials. Striking against rip rap material and/or other surface objects while placing ground cover materials around the edges of repaired areas. Contact by or contact with erosion control materials in eyes, nose, etc. Caught in positions to cause sprains and strains while handling and distributing materials. Fall to below and/or foot level falls while working on slopped surfaces, Tipping, lose of control of equipment, causing injury to personnel and/or damage to equipment.	Always use proper PPE and follow all TVA Safety Procedures applicable for the job being done. Be aware of surroundings at all times and use extra caution when working on uneven and/or sloped surfaces. Workers should be familiar with sections 307 (Foot Protection), 308 (Hand Protection), and 609 (Lifting/Handling Materials) from the TVA Safety Manual. Employees should use good ergonomic positioning to deter possible strains and sprains during material handling. Dust masks shall be provided and worn should conditions warrant during spreading of seed, fertilizer, straw, etc.
12	The project area should be picked up daily. Equipment cabs should be free of scrap paper, rags, etc. All debris and job related waste should be disposed of in a manner acceptable to the Colbert Site Environmental Representative.	Sprains, strains, etc. while moving materials for disposal. Struck by equipment working in close proximity. Possible pinch points between materials or between materials and equipment. Slips, trips, or falls to below. Same foot level falls.	Employees should be familiar with TVA Safety Procedures 304-Eye & Face, 307-Foot, 308 -Hand, 309-Head, and 310-Hearing Protection for this task. Supportive boots with slip resistant soles should be worn. TSP 609 "Lifting and Handling Materials in applicable to this task. Be observant for possible pinch points and wear protective work gloves to defend against possible puncture wounds during the handling of material for loading and disposal. If the material to be lifted is too heavy, stop and ask for help to avoid strains, sprains, and pulls.

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Work Package Desc:	Colbert General Site Support Work Plan		
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Skills Required:	Qualified Operators and Teamsters, Skilled Laborers		
Required Personal Protective Equipment:	Hard Hats, Safety Glasses, Face Shield, Safety Vest, Gloves, Hearing Protection, Adequate Footwear For Foot Protection, Snake Boots/Snake Leggings When Applicable		
Tools and Equipment Required:	See Attached Tool and Equipment List		
Job Preparation:	Operators must be qualified for the equipment assigned to operate and have current S-5 Medical exam. Osha 10 training required for craft and contract personnel. All chain saw operators must have received the training course "Chain Saw Safety", ATIS Number 00059105.		
Hazardous Materials:	None		

Type In White Cells Only

Step Number	Sequence of Basic Job Steps	Potential Accidents or Hazards	Recommended Safe Job Procedures
13	Conduct a post job briefing at the end of each shift, or at the end of the assigned task. Encourage employees to provide input during the briefings to provide added opportunity to improve safety and performance processes and procedures.	N/A	N/A

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Tools & Special Equip List
7/20/2011

Location: Colbert Fossil Plant

Work Order No: 0 **Date:** 1/0/00

Work Package Desc: Colbert General Site Support Work Plan

ITEM	Qty	Description
1	1	Tractor/Bush-Hog
2	1	Tractor/Side Boom Cutter
3	1	ATV
4	1	R/T Backhoe
5	1	Dump Trucks
6	1	Track hoe
7	Various	Power Pruners, Weed Trimmers, Hedge Trimmers, Chain Saw
8	1	Grader
9	1	Dozer
10	1	Water Truck

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CEC
7/20/2011

Location:	Colbert Fossil Plant		
Work Order No:	0	Date:	1/0/00
Work Package Desc:	Colbert General Site Support Work Plan		

On File in Primary Project Files

1200 General Site Support Work Plan COF 7-5-11
Permit List
7/20/2011

Location: Colbert Fossil Plant

Work Order No: 0 **Date:** 1/0/00

Work Package Desc: Colbert General Site Support Work Plan

PERMIT	REQUIRED YES	REQUIRED NO	PERMIT NUMBER	COMMENTS
Permit				
Hold Order		X		
Operating		X		
Welding		X		
Excavation				Excavation Permit As Required
Temporary Alteration		X		
Scaffold		X		
Confined Space		X		
Caution		X		
Ground Tags		X		

Notes

Location: Colbert Fossil Plant

Work Order No: 0 **Date:** 1/0/00

Work Package Desc: Colbert General Site Support Work Plan

General Safety: Utilize proper PPE for each specific task identified. TVA Safety Procedures 304-Eye & Face, 307-Foot, 308 -Hand, 309-Head, and 310-Hearing Protection are applicable. Utilize florescent green safety vests and hard hats for all personnel in the work area at all times. Maintain adequate Body/Hand Clearances to prevent pinch points. All personnel will participate in Pre-Job and Post-job Briefings. Discuss emergency alarms, evacuation routes, location of assembly points, personnel accountability procedures, route to local hospital/medical facility; discuss applicable lessons learned, if any. Use peer and self checking to identify any hazards that may exist, and consult the site supervisor if doubt arises . Report all incidents and injuries to Supervisor, no matter how minor they are. Work areas shall be barricaded/flagged etc. as necessary.

Weather: Stay alert to changing weather conditions. If electrical storms, heavy rain, icing, high winds, or other hazards exist, stop outside work and notify supervisor. Foremen and Supervisors shall monitor working conditions and require actions to be taken to protect personnel. Areas for employee protection shall be provided for such conditions (rain, snow, warmer or cooler etc.)
Implement heat stress/cold weather prevention methods listed in TVA safety manual. Rotate workers as needed to limit exposure. Use the buddy system to monitor each other, notify supervision if any type of stress is detected. PPE will be evaluated to meet all conditions that arise.
Inspect work areas for infestation of insects, rodents, snakes, etc. and eradicate where possible. Infested areas should be avoided where possible. Provide and instruct in the use of repellants. Insect repellant should be used as needed. Notify supervisor or any known allergies, prior to work activities. Co-workers must be aware of such allergies and be prepared to respond in an emergency situation.

Equipment Operation Safety Precautions: Read and understand operators' manual for each type of equipment to be operated. Always wear seat belt. Use the three points of contact approach while mounting and dismounting equipment. Keep steps and platforms clear of mud and debris. Equipment checklist to be filled out on each piece of equipment at the start of each shift. Equipment with deficiencies that affect safe operations shall not be operated until corrected. Notify supervisor to resolve discrepancies. Be aware of all surroundings and personnel. Do not come between equipment, facilities, or other pinch points. Use flag person/ spotter as needed to safely maneuver equipment in constricted areas. Use right machine for job. Operators shall be trained for the equipment they are to operate. TVA Safety Procedures 805 "Forklift Operations" and TVA SP 711" Heavy Equipment Operations" and 715 "Mowers" are applicable and provide detailed instructions. Operators will always focus their attention to the direction of travel. All ground personnel and persons involved in this activity will make eye contact with the equipment operators when entering work area.

TVA Safety Procedure Number 601 All Terrain Vehicles Revision 0 January 6, 2003

1. Purpose

1.1. The purpose of this procedure is to establish requirements for the use of All-terrain Vehicles (ATVs).

2. Requirements

2.1. ATVs equipped with a single front tire shall not be used on transmission line rights-of-way.

2.2. ATVs shall be equipped with roll over protection, bench seat, and seat belts for each passenger.

2.3. Personal Protective Equipment (PPE) shall include a hard hat and safety eyewear.

2.4. ATVs are for off-road operations and should not be driven on public streets and roads.

2.5. When tools or equipment are transported, they should be properly secured on the vehicle.

2.6. A personal flotation device should be worn when fording streams that could cause the tires to float.

2.7. ATVs are intended to be operated at safe speeds, depending on terrain and conditions. At no time should an ATV be operated in an unsafe manner or used for purposes other than its intended use.

2.8. Passengers shall only be permitted when the vehicle is equipped with the manufacturer approved seating for passengers except in the event of a medical emergency.

3. Definitions

3.1. All-terrain vehicles are vehicles that are operated off the road are not licensed vehicles and include such as Gators, Mules.

4. Training

4.1. Employees who operate ATVs shall receive the safety training course "All Terrain Vehicle (ATV) Safety", ATIS Number 00059102.

Safe Equipment Working Distances From Electrical Lines. Contact the responsible supervisor for assistance.

TABLE 1

REQUIRED CLEARANCE FOR OPERATIONS NEAR HIGH-VOLTAGE POWER LINES
AND FOR OPERATIONS IN TRANSIT WITH NO LOAD AND ROOM FOR
MAST LOWERED

Normal Voltage, kV (Phase-to-Phase)	Minimum Required Clearance, ft
Operation Near High-Voltage Power Lines	
0 to 50	10
Over 50 to 200	15
Over 200 to 350	20
Over 350 to 500	25
Over 500 to 750	35
Over 750 to 1000	45
Operation in Transit With No load and Boom or Mast Lowered	
0 to 0.75	4
Over 0.75 to 50	6
Over 50 to 343	10
Over 345 to 750	16
Over 750 to 1000	20

Fossil Generation, Development & Construction
(Civil Projects / Coal Combustion Products)
PRE-JOB BRIEF (PJB)

Turn in to Site Manager or Safety Department at end of day or completion of task.

The PJB shall be completed daily and for each high hazard task. PJBs shall be completed when the scope of work changes or when a new task has been assigned.

Plant/Site: ______

TVA ☐ Contractor: ______

Foreman: ______

Person conducting the PJB: ______

Date: ______

Location of Task: ______

Task Description: ______

Does this task require special training? Yes ☐ No ☐

If yes, what type? ______

General Information/Considerations/Reminders

1. Is there a work package for this task? Do you have the necessary drawings, procedures or verbal instruction to proceed?
2. Should a safety professional be involved in the planning of this job?
3. Do you have materials staged or available and the proper tools in good working order to complete the work?
4. Does everyone have the training/qualifications to perform the work?
5. Verify safe working standards for all work.
6. Are you conducting routine or non-routine tasks? Non-routine tasks require more planning / awareness. Do you have a contingency plan?
7. Take two extra minutes when arriving at the work area/look for changes/items that impact your work.
8. YOU ARE AUTHORIZED AND RESPONSIBLE FOR STOPPING AT-RISK WORK FOR SAFETY, HEALTH, OR ENVIRONMENTAL REASONS.
9. Has a JSA been completed/reviewed for this task? Yes ☐ No ☐ N/A ☐
10. Observe the Two Minute Rule before starting work.

A check mark below indicates the item applies to this work activity and precautions were discussed during this PJB or was not applicable to the job.

Trucks and Heavy Equipment

11. Equipment inspection check lists on all required equipment. Yes ☐ N/A ☐
12. 3-Points of contact used for climbing on/off equipment. Yes ☐ N/A ☐
13. All personnel wearing bright colored safety vest. Yes ☐ N/A ☐
14. Trucks required to back long distances. Yes ☐ N/A ☐
15. Flag/Signal person required for this job. Yes ☐ No ☐
16. Control of vehicle and pedestrian traffic patterns. Yes ☐ N/A ☐
17. Personnel clear of equipment swing radius, eye contact w/Operator before approaching equipment. Yes ☐ N/A ☐
18. Crane operations near overhead power lines. Yes ☐ N/A ☐

Terrain Stability

19. Dikes/dams/embankments evaluated for stability for heavy equipment and analysis complete. Yes ☐ N/A ☐
20. Personnel prohibited from walking on ash/gypsum ponds. Yes ☐ N/A ☐

Trenching & Excavation Work

21. All personnel entering a trench or excavation trained. Yes ☐ N/A ☐
22. A trained Competent Person is available to inspect and approve entry. Yes ☐ N/A ☐
23. Barricade and safe access maintained. Yes ☐ N/A ☐

Material Handling

24. 50lb manual lifting limit; obtain if needed; use equipment instead of heavy manual lifting; eyes on path when carrying; one hand free for handrails on steps/stairs; load swing path clear; softeners used for sharp edges. Yes ☐ N/A ☐

Personal Protective Equipment (PPE)

25. PPE selected, inspected and available (hand, eye, head, foot, hearing, PFD). Yes ☐ N/A ☐

Rigging

26. Rigging plan developed. Yes ☐ N/A ☐
27. Personnel performing rigging are trained. Yes ☐ N/A ☐

Person-in-Charge of rigging: ______

Housekeeping

28. Housekeeping maintained safe / acceptable in the work area; all flammable/combustible materials properly stored and proper containment around storage area. Yes ☐ N/A ☐

Hazardous Materials

29. The work activity has potential to expose employees to the hazards of lead, arsenic, cadmium or other hazardous substances or materials. Yes ☐ N/A ☐
30. Requirements for training, sampling monitoring, PPE. Yes ☐ N/A ☐

Emergency Planning

31. List below the location of the nearest fire extinguisher, spill kits, communications source, emergency phone number(s), and assembly area. Yes ☐ N/A ☐

______

______

Applicable Permits

32.	Hot Work	Yes ☐	No ☐
	Clearance	Yes ☐	No ☐
	Excavation	Yes ☐	No ☐
	Signs/Barricades	Yes ☐	No ☐
	Confined Space	Yes ☐	No ☐
	Crane Lift	Yes ☐	No ☐
	Scaffolds	Yes ☐	No ☐
	Other: ______	Yes ☐	No ☐

Additional Comment & Precautions Discussed

______

______

______

______

TVA 20518 [03-08-2011]

1200-22

Fossil Generation, Development & Construction
(Civil Projects / Coal Combustion Products)
PRE-JOB BRIEF (PJB)

Signature of all Pre-job Briefing Participants

Post-Job Review

For any issues identified during this review, provide comments below the question, including any actions taken already. PER written (document PER#), etc.

Equipment inspection check lists on all required equipment. Yes ☐ No ☐

If a JSA was used in the pre-job briefing, did it adequately cover all of the hazards and control measures? Yes ☐ No ☐

If a JSA was not used in the pre-job briefing, did the checklist cover all of the hazards and control measures? Yes ☐ No ☐

Was there any change in work scope requiring re-briefing of workers? Yes ☐ No ☐

If a JSA was not used in the pre-job briefing should a JSA be developed for this job? Yes ☐ No ☐

Are there recommended changes to the work that could have improved the safety or efficiency of the work, i.e., PPE, work environment, tools, materials, equipment, etc.? Yes ☐ No ☐

Were there any unexpected aspects or occurrences including accidents, injuries or near-miss incidents? Yes ☐ No ☐

Was the task accomplished with expected results? Yes ☐ No ☐

Is any enhancement to plant documentation warranted, i.e., were procedures/step text complete and accurate, any print or schematic discrepancies, etc? Yes ☐ No ☐

Was planning and scheduling optimized to reduce the potential for human error? Yes ☐ No ☐

Was preparation adequate? Yes ☐ No ☐

Were lessons learned that change the way the job should be performed, recorded, passed on to others, and entered into Maximo as appropriate? Yes ☐ No ☐

Were Lessons Learned entered into the FGD&C Lessons Learned website? Yes ☐ No ☐

Did supervision provide the needed support and appropriate guidance when necessary? Yes ☐ No ☐

Did you notice any human factors issues, improper or missing labels, or any significant physical hindrances to the performance of the work? Yes ☐ No ☐

Was training for the job appropriate and effective? Yes ☐ No ☐

Was work area cleanup/housekeeping adequate? Yes ☐ No ☐

Did all involved with the work understand their individual responsibilities? Yes ☐ No ☐

Is additional follow up required from this Post-job Review? Yes ☐ No ☐

If YES, then the Foreman/Supervisor/Lead Performer is responsible to provide this feedback to the responsible group for action.

Signature of all Pre-job Briefing Participants

Foreman/Supv/Employee

Date of Review:

Note: This form must be retained for 30 days or until work order/package is closed.

TVA 20516 [03-08-2011]

PRE-JOB BRIEF SIGNATURE FORM
FOR JOBS CONTINUING ACROSS MULTIPLE SHIFTS

By my signature below I acknowledge instructions regarding this PJB prior to my job task / work shift.

TASK:

DATE: ____________________ **TIME:**____________________

SIGNATURES:

______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________

DATE: ____________________ **TIME:**____________________

SIGNATURES:

______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________

DATE: ____________________ **TIME:**____________________

SIGNATURES:

______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________

TVA – PROJECTS DEVELOPMENT
MATERIAL LOADING/UNLOADING CHECK LIST

Check completed items.
Write N/A where necessary.
If no is checked on any box, STOP
and contact Supervisor

	YES	NO	N/A
TRUCK ON LEVEL SURFACE			
DRIVER HAS PROPER PPE			
PRE-JOB MEETING COMPLETED			
STRAPS SECURED ON LOAD			
LOAD ON DUNNAGE SECURE			
OPERATOR AND DRIVER INSPECTED LOAD			
BLIND SIDE OF LOAD CLEAR			
SPOTTER/FLAGGER IS PRESENT			
OPERATOR CERTIFIED ON EQUIPMENT			
RIGGER CERTIFIED PER TSP #721A			
WEIGHT KNOWN			
DOES JSA ADEQUATELY COVER THIS WORK			

Offloading/Loading Reminders

1) OPERATOR SHALL MAINTAIN VISUAL CONTACT WITH SPOTTER AT ALL TIMES.
2) ALWAYS HAVE FOOT ON BRAKE WHEN SHIFTING MACHINE IN GEAR. (IF NEEDED SET PARKING BRAKE)
3) SPOT LOAD AS WHERE IT IS ON LEVEL GROUND ALWAYS.
4) DRIVER MUST LEAVE STRAPS ON LOAD UNTIL FOREMAN AND CREW ARE SET AND ONLY REMOVE AS DIRECTED. (BY UNLOADING CREW)
5) WHERE NEEDED, STANCHIONS, STANDARDS OR OTHER MEANS PRACTICAL SHALL SECURE LOADS FROM FALLING OFF TRUCK PRIOR TO REMOVING STRAPS.
6) AT NO TIME SHALL ANYONE BE ALLOWED ON THE OPPOSITE SIDE OF LOAD AS IT IS BEING LOADED OR OFFLOADED.
7) SPOTTERS MUST HAVE VISUAL CONTACT W/ HAND SIGNALS OF OPERATOR AT ALL TIMES.
8) SPOTTER ON GROUND SHALL MAKE SURE NO ONE IS ALLOWED TO BE AROUND BASE OF TRUCK. MAINTAIN 10' CLEARENCE OF LOAD PERIMETER.
9) ONCE LOAD CLEARS TRUCK IT MUST BE LOWERED AS CLOSE TO GROUND AS POSSIBLE BEFORE MOVING.
10) KEEP LOAD AS CLOSE TO THE GROUND AS POSSIBLE AT ALL TIMES.
11) MAINTAIN PERIMETER BETWEEN CREW AND LOAD WHEN RELOCATING LOAD.
12) ALWAYS INSPECT AREA FOR SEASONAL WEATHER CONDITIONS (I.E. ICE, FROST, MUD, STANDING WATER.)
13) REFERENCE SAFETY MANUAL PROCEDURE #610 AND #616 FOR ADDITIONAL INFORMATION.

DATE: _________ LOCATION: ________________________________

MATERIAL:_____________________________________

FOREMAN SIGNATURE:_______________________________________

1.0 MARKETING

Colbert Fossil Plant (COF) produces Class F fly ash and bottom ash.

1.1 FLY ASH MARKETING

CY 2010 tons produced: 206,374
CY 2010 tons marketed: 0 – none marketed

COF produces a dry, high carbon Class F fly ash. Its high carbon content excludes the material from any current markets causing the plant to incur disposal costs by transporting and working the ash at an on-site dry fly ash landfill.

At this time there are no plans to market COF's fly ash.

1.2 BOTTOM ASH MARKETING

CY 2010 tons produced: 22,930
CY 2010 tons marketed: 0 – none marketed

COF produced 22,930 tons, none of which was utilized into any type of market.

COF ASH DISPOSAL AREA 5 AIRSPACE CONSUMPTION RATE CALCULATION CONFIRMATION

2008-2009 Fill Volumes

Contour	Contour Spacing (feet)	End Area (sq. feet)	Average End Area (sq. feet)	Volume (cubic ft)	Volume (cyds)	Cumulative Volume (cyds)
498		1675				
	2		3214	6427	238	238
500		4752				
	10		63166	631655	23395	23633
510		121579				
	4		136763	547050	20261	43894
514		151946				
	6		160317	961899	35626	79520
520		168687				
	10		174897	1748965	64776	144296
530		181106				
	10		264590	2645895	97996	242292
540		348073				
	6		179238	1075425	39831	282123
546		10402				
	2		5201	10402	385	
548		0				
	20		0	0	0	
0		0				
					TOTAL	**282,508**

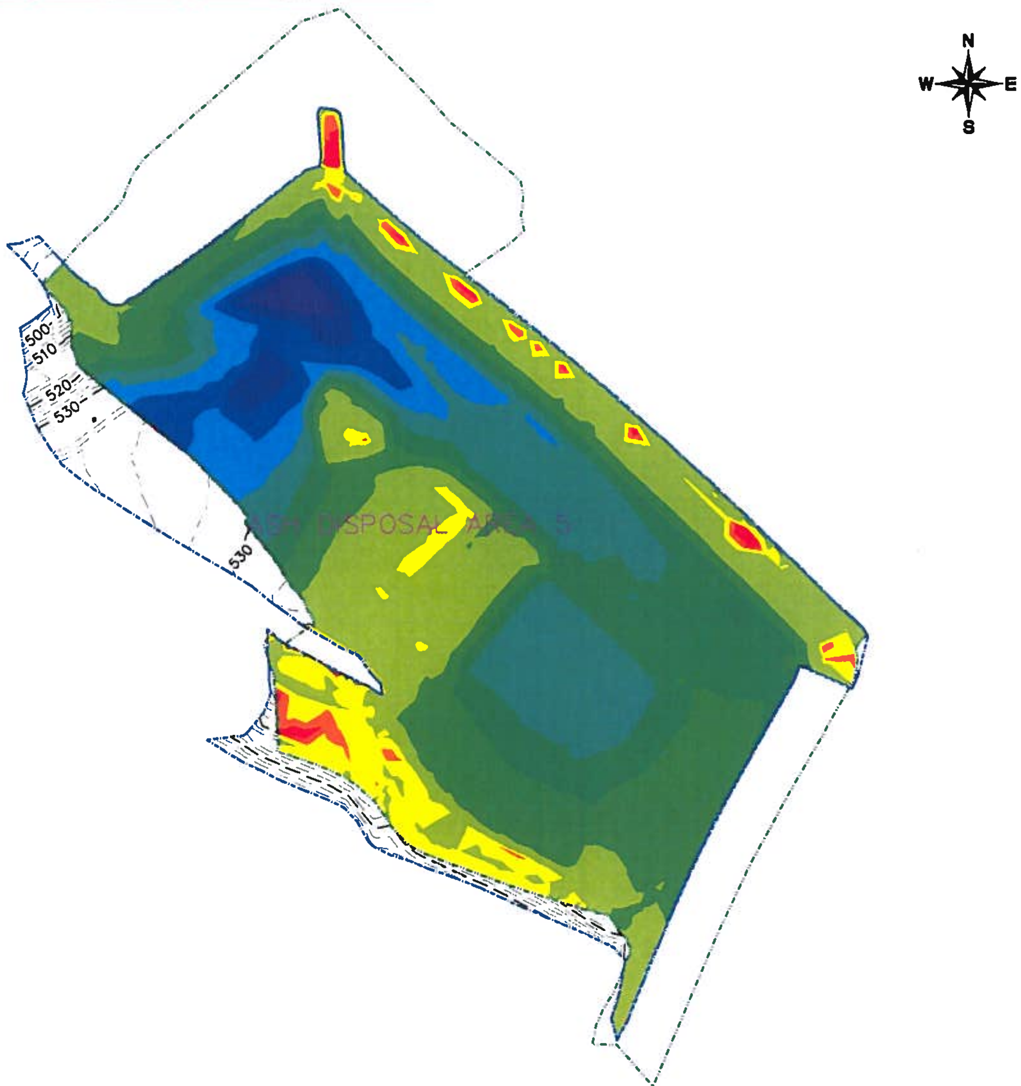
2008 TOPO SURVEY DATE = 5/14/2008
2009 TOPO SURVEY DATE = 5/13/2009
DAYS BETWEEN SURVEYS = 364
DAILY FILL RATE = 776 CYDS/DAY
ANNUALIZED FILL RATE = **283,284** CYDS/YR

2009-2010 Fill Volumes

Contour	Contour Spacing (feet)	End Area (sq. feet)	Average End Area (sq. feet)	Volume (cubic ft)	Volume (cyds)	Cumulative Volume (cyds)
514		1125				
	6		4539	27231	1009	1009
520		7952				
	10		52123	521225	19305	20313
530		96293				
	10		126149	1261485	46722	67035
540		156004				
	10		143786	1437855	53254	120289
550		131567				
	2		89398	178796	6622	126911
552		47229				
	2		25292	50584	1873	128784
554		3355				
	1		1678	1678	62	128846
555		0				
	2		0	0	0	
		0				
	20		0	0	0	
0		0				
					TOTAL	**128,846**

2009 TOPO SURVEY DATE = 5/13/2009
2010 TOPO SURVEY DATE = 1/27/2010
DAYS BETWEEN SURVEYS = 259
DAILY FILL RATE = 497 CYDS/DAY
ANNUALIZED FILL RATE = **181,579** CYDS/YR

TOTAL AIRSPACE CONSUMED = 411,355 CYDS
TIME INTERVAL = 623 DAYS
AVERAGE DAILY FILL RATE = 660 CYDS/DAY
AVERAGE ANNUALIZED FILL RATE = **241,002** CYDS/YR



Elevations Table

Number	Minimum Elevation (ft)	Maximum Elevation (ft)	Area (sf)	Volume (cy)	Color
1	-3.70	-2.00	2610	42	
2	-2.00	-1.00	10587	243	
3	-1.00	0.00	56931	1250	
4	0.00	5.00	215287	116135	
5	5.00	10.00	164448	86732	
6	10.00	15.00	142640	60312	
7	15.00	20.00	135994	31777	
8	20.00	25.00	55427	15426	
9	25.00	30.00	35611	6842	
10	30.00	35.00	15482	2305	
11	35.00	40.60	6218	648	

LEGEND

- EXISTING 2009 GRADES (MAJOR CONTOURS)
- EXISTING 2009 GRADES (MINOR CONTOURS)
- APPROXIMATE 2008 GROUND SURVEY LIMIT
- APPROXIMATE 2009 GROUND SURVEY LIMIT
- TO CUT AREA
- TO FILL AREA

REFERENCES

1. TOPOGRAPHIC SURVEY OF THE SITE IS BASED ON DATA COMPILED FROM TVA GROUND SURVEY DATA: MTH511.xyz, SURVEYED ON MAY 13–15, 2008, AND RCB519.xyz, SURVEYED ON MAY 12–13, 2009.

DRAFT

ISSUED FOR APPROVAL
NOT FOR CONSTRUCTION

200 0 100 200
SCALE IN FEET

ASH DISPOSAL AREA 5
ASH PLACEMENT
FROM MAY 2008 TO MAY 2009

URS

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

4/13/11

DRAWING NO. 1

1401-2

XXXMXX X XX

P:\Jobs_Projects\TVA\Operations\COF\CAD Drawings and Figures\April 2011 Volume\COF Area 5 Fill Rate - 2008-2009.dwg User:paul_zhang Apr 13, 2011 - 9:11am

URS DRAFT	PROJECT TVA:COF ASH DISPOSAL AREA 5		SHEET 1	REV. NO.
	SUBJECT ANNUAL ASH FILL RATE ESTIMATES		CLIENT PROJECT #	URS JOB NO. 31881022
	ACTIVITY ASH PLACEMENT ESTIMATE	LAST UPDATED BY: PZ	DATE LAST MODIFIED 4/13/2011	REVIEWED BY: RL

TABLE 1: ACTIVE FILLING AREA
ASH PLACEMENT FROM MAY 2008 TO MAY 2009

Shaded Area Number (1)	Comparative Thickness Interval(2)		Calculated Area at Thickness Interval (sf)	Calculated Volume at Thickness Interval (cy)	Shaded Area Color(1)	Notes
	Minimum (ft)	Maximum (ft)				
1	-3.7	-2	2,610	42	●	Cut Volume
2	-2	-1	10,587	243	●	
3	-1	0	56,931	1,250	●	
4	0	5	215,267	118,135	●	Fill Volume
5	5	10	164,449	86,732	●	
6	10	15	142,640	60,312	●	
7	15	20	135,994	31,777	●	
8	20	25	55,427	15,426	●	
9	25	30	35,811	6,842	●	
10	30	35	15,482	2,305	●	
11	35	40.6	6,218	648	●	
		TOTAL CUT VOL. (cy)		1,535		
		TOTAL FILL VOL. (cy)		322,177		
		EST. ANNUAL FILL RATE (cy/yr) (3)		322,177		

Notes:

(1) Shaded area numbers and colors refer to URS Drawing No. 1. Additional notes and details are also provided on same drawing.

(2) Comparative thickness intervals calculated using AutoCAD Civil 3D and represent the difference between May 13, 2009 grades and Jan. 27, 2010 grades in the active filling area. Negative (-) numbers indicate cut and positive numbers indicate fill.

(3) Estimated annual ash fill rate was calculated as the total fill volume placed between May 13, 2008 and May 13, 2009. Interim grading procedures for benching and stormwater management were not considered.

Elevations Table					
Number	Minimum Elevation (ft)	Maximum Elevation (ft)	Area (sf)	Volume (cy)	Color
1	-4.76	-3.00	64	1	
2	-3.00	-2.00	688	12	
3	-2.00	-1.00	9423	146	
4	-1.00	0.00	221406	2591	
5	0.00	5.00	491762	57982	
6	5.00	10.00	76080	35763	
7	10.00	15.00	134047	6924	
8	15.00	20.00	4433	1906	
9	20.00	25.00	4673	1086	
10	25.00	27.30	3464	153	

LEGEND

540 EXISTING 2010 GRADES (MAJOR CONTOURS)

EXISTING 2010 GRADES (MINOR CONTOURS)

APPROXIMATE 2009-2010 ACTIVE FILLING AREA

TO CUT AREA

TO FILL AREA

REFERENCES

1. TOPOGRAPHIC SURVEY OF THE SITE IS BASED ON DATA COMPILED FROM TUCK MAPPING SOLUTIONS AERIAL SURVEY DATA, FLOWN ON JANUARY 27, 2010, AND TVA GROUND SURVEY DATA:RCB519.xyz, SURVEYED ON MAY 12-13, 2009.

DRAFT

ISSUED FOR APPROVAL
NOT FOR CONSTRUCTION

200 0 100 200
SCALE IN FEET

URS

ASH DISPOSAL AREA 5
ASH PLACEMENT
FROM MAY 2009 TO JAN. 2010

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

DRAWING NO. 2

1401-4

XXXMXX X XX

P:\Jobs4_Projects\TVA\Operations\COF\CAD Drawings and Figures\April 2011 Volume\COF Area 5 Fill Rate 2009-2010.dwg User:paul_zhang Apr 13, 2011 - 9:22am

URS DRAFT	PROJECT: TVA:COF ASH DISPOSAL AREA 5		SHEET: 2	REV. NO.
	SUBJECT: ANNUAL ASH FILL RATE ESTIMATES		CLIENT PROJECT #	URS JOB NO. 31881022
	ACTIVITY: ASH PLACEMENT ESTIMATE	LAST UPDATED BY: PZ	DATE LAST MODIFIED 4/13/2011	REVIEWED BY: RL

TABLE 2: ACTIVE FILLING AREA
ASH PLACEMENT FROM MAY 2009 TO JAN. 2010

Shaded Area Number [1]	Comparative Thickness Interval[2]		Calculated Area at Thickness Interval (sf)	Calculated Volume at Thickness Interval (cy)	Shaded Area Color[1]	Notes
	Minimum (ft)	Maximum (ft)				
1	-4.76	-3	64	1	●	Cut Volume
2	-3	-2	888	12	●	
3	-2	-1	9,423	146	●	
4	-1	0	221,406	2,591	●	
5	0	5	491,782	57,982	●	Fill Volume
6	5	10	76,080	35,763	●	
7	10	15	134,047	8,924	●	
8	15	20	4,433	1,906	●	
9	20	25	4,673	1,086	●	
10	25	27.3	3,464	153	●	
			TOTAL CUT VOL. (cy)	**2,750**		
			TOTAL FILL VOL. (cy)	**105,814**		
			EST. AVE. MONTHLY FILL RATE (cy/mon) [3]	**12,449**		
			EST. ANNUAL FILL RATE (cy/yr)	**149,384**		

Notes:

(1) Shaded area numbers and colors refer to URS Drawing No. 1. Additional notes and details are also provided on same drawing.

(2) Comparative thickness intervals calculated using AutoCAD Civil 3D and represent the difference between May 13, 2009 grades and Jan. 27, 2010 grades in the active filling area. Negative (-) numbers indicate cut and positive numbers indicate fill.

(3) Estimated average monthly ash fill rate was calculated by dividing the total fill volume placed between May 13, 2009 and Jan. 27, 2010 by eight and half months. Interim grading procedures for benching and stormwater management were not considered.

URS	PROJECT				JOB NO.
	Colbert				31881022.85130
	SUBJECT				SHEET NO.
	Ash Stack Density Tests and Proctors				
CALCULATION SHEET	ORIGINATED B	DATE	CHECKED BY	DATE	CALC. NO.	REV. NO.
	Rich Lowe	4/11/2011				

Test Date	Max Dry D (pcf)	Opt WC (%)	As-Rec'd WC (%)
8/20/2010	77.0	31.0	25.3
8/31/2010	80.0	27.1	25.8
9/9/2010	81.1	26.5	26.5
9/15/2010	84.5	23.3	27.4
9/24/2010	85.4	22.0	22
10/1/2010	83.2	24.8	21.5
10/7/2010	79.7	28.2	25
10/13/2010	79.1	28.1	28.1
10/20/2010	82.9	25.2	28.2
11/5/2010	84.4	22.1	19.8
11/19/2010	87.2	21.9	
12/14/2010	85.5	26.2	22.6
2/10/2011	79.0	23.5	22.8
Ave	82.2	25.4	24.6
Max	87.2	31.0	28.2
Min	77.0	21.9	19.8
Count	13	13	12

January 3, 2011

TVA
1101 Market Street, LP 5G-C
Chattanooga, Tennessee 37402

Attention: Mr. Stuart Harris, P.E.

Subject: Field Density Testing
Colbert Steam Plant
Barton, Colbert County, Alabama
S&ME Job Number 1823-05-0582

Dear Mr. Harris:

S&ME has completed a portion of the construction testing services at the referenced project. Services referenced in this report include field density testing of the ash pile material. These services were provided on December 14, 2010.

A total of 3 field density tests were performed at the referenced project. The tests were performed on an on call basis. The test results, percent compaction and approximate locations are provided on the attached sheet. The Proctor curve used to calculate the percent compaction is attached for your review and records.

The test results represent only the relative compaction at the locations specified. Mr. Rex McNeese of TVA advised S&ME that GPS coordinates of test locations and elevations would be performed by the TVA.

S&ME appreciates the opportunity to provide these services to you. Should you have questions pertaining to this report, or if we may be of further assistance, please contact either of the undersigned.

Sincerely,

S&ME, Inc.

W. Zack Young
Construction Services Manager

Jeffrey C. Pepper, P.E.
Senior Engineer

Attachments: Field Density Tests
Proctor No. 7

S&ME, INC. / 399 Executive Drive / Huntsville, AL 35816 / p 256.837.8882 f 256.837.6931 / www.smeinc.com

S&ME

FIELD DENSITY TEST REPORT

399 Executive Drive / Huntsville, Alabama 35816 / 256-837-8882

Date:	December 14, 2010	Technician:	Collin Hays	Standard-ASTM 698	X
Job No:	1823-05-0582	Weather:	Sunny/Very Cold	Modified-ASTM 1557	
Project:	Colbert Fossil Plant	Client:	TVA	AASHTO T99	
Location:	Colbert County, AL	Contractor:		AASHTO T180	

DRIVE CYLINDER METHOD FOR IN-PLACE FIELD DENSITIES

Test No.	In-Place Wet Density (Ft^3)	In-Place Dry Density (Ft^3)	Field Moisture Percent	Compaction Percent Attained	Compaction Percent Required	Depth Below Grade (Feet)	Lab. Max Density (Ft^3)	Pass Fail	Location
1	92.0	74.6	23.3	94	-	n/a	79.6	-	Ash Pile 150 Ft. E, 150 Ft. S of the NW Corner
2	98.8	79.2	24.7	99	-	n/a	79.6	-	Ash Pile 150 Ft. W, 150 Ft. S of the NE Corner
3	96.8	73.4	31.9	92	-	n/a	79.6	-	Ash Pile 200 Ft. E, 100 Ft. S of the NW Corner

NOTE: Test locations were obtained by the technician and are approximate. The percent compaction for in place density testing is based on laboratory Moisture/Density Relations Tests.

NOTE: S&ME did not monitor fill placement.

Lab No.	Maximum Dry Density	Optimum Moisture Content	Material Description
7	79.6	26.0	Dark Gray FLY ASH

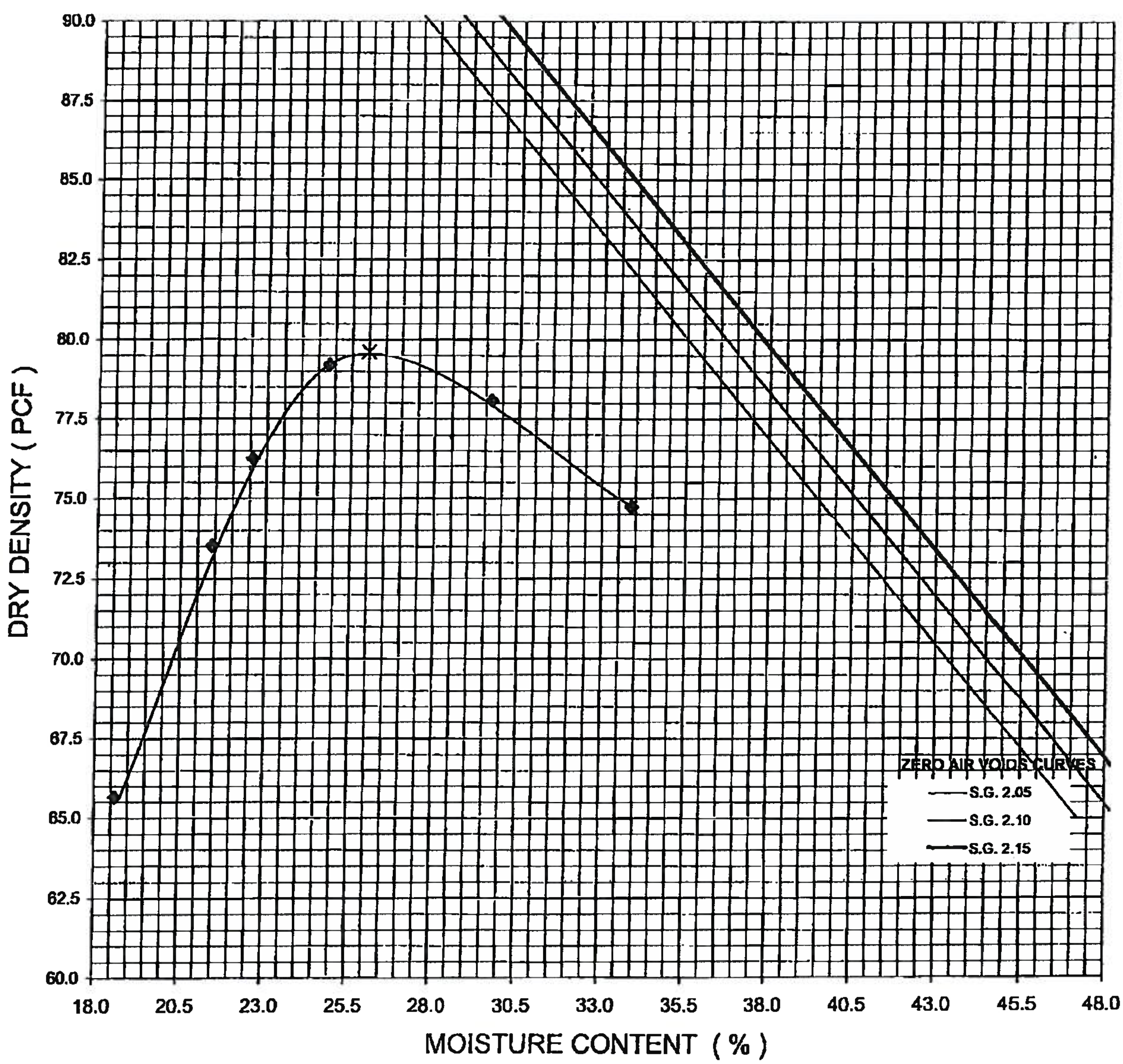
I

S&ME

MOISTURE / DENSITY RELATIONSHIPS OF SOIL
(ASTM D 1557)

PROJECT :	Colbert Co. Steam Plant - Fly Ash			REVIEWED BY :	JT
CLIENT :	TVA	DATE SAMPLED :	12/15/10	SAMPLED BY :	C. Hays
JOB NO. :	1823-05-0582	*SAMPLE NO. :*	7	TEST DATE :	12/16/10
SAMPLE LOCATION :	In place, upper ash pile, 150' E x 150' S of NW corner			*IN-SITU M.C., % :*	
SOIL DESCRIPTION :	Dark Gray FLY ASH			*SPECIFIC GRAVITY :*	-
PROCTOR TYPE :	*STANDARD ASTM D-698*	PROCEDURE :	A	+ 3 / 4 " , % :	-
LIQUID LIMIT, % :	NON-PLASTIC -	FINES, % :	-	USCS : -	AASHTO : -

UNCORRECTED		*CORRECTED*	
MAXIMUM DRY DENSITY, PCF :	*79.6*	*MAXIMUM DRY DENSITY, PCF :*	*79.6*
OPTIMUM MOISTURE CONTENT, % :	*26.0*	*OPTIMUM MOISTURE CONTENT, % :*	*26.0*



COPIES TO : TVA

COLBERT FOSSIL PLANT - LONG TERM DISPOSAL PLAN

March 24, 2011

FISCAL YEAR ENDING	PROJECTED COAL BURN (TONS)	FLY ASH PRODUCTION (DRY TONS)	BOTTOM ASH PRODUCTION (DRY TONS)	DRY STACK CAPACITY (CY)	ASH POND 4 CAPACITY (CY)	BA STACK CAPACITY (CY)	CAPITAL COSTS ($)	O & M COSTS ($)	TOTAL COSTS ($)	NET PRESENT COSTS ($)
2011	2,950,034	251,817	26,609	520,454	242,430	636,256	0	2,022,897	2,022,897	2,022,897
2012	3,190,781	272,368	28,781	211,889	235,748	617,543	0	2,073,469	2,073,469	2,073,469
2013	2,957,331	252,440	21,548	4,089,441	230,745	603,532	0	2,125,306	2,125,306	1,848,166
2014	2,543,509	217,116	18,533	3,809,484	226,442	591,481	0	2,178,439	2,178,439	1,894,370
2015	2,194,630	187,335	19,796	3,563,266	221,846	578,610	0	2,232,900	2,232,900	1,688,296
2016	1,819,260	155,293	16,410	2,820,885	218,036	567,940	0	2,288,722	2,288,722	1,504,835
2017	2,073,951	177,034	18,707	2,053,875	213,693	555,777	0	2,345,940	2,345,940	1,341,409
2018	1,899,976	162,183	17,138	1,303,689	209,714	544,634	0	2,404,589	2,404,589	1,195,562
2019	1,802,615	153,873	16,260	562,918	205,939	534,062	0	2,464,704	2,464,704	1,065,491
2020	1,920,085	163,900	17,319		201,918	522,801	0	2,526,321	2,526,321	949,644
2021	1,740,087	148,535	15,696		198,274	512,595	0	2,589,479	2,589,479	846,501
2022	1,699,845	145,100	15,333		194,714	502,626	0	2,654,216	2,654,216	754,594
2023	1,823,902	155,690	16,452		190,894	491,929	0	2,720,572	2,720,572	672,525
2024	1,752,672	149,609	15,809		187,224	481,650	0	2,788,586	2,788,586	599,267
2025	1,874,089	159,974	16,904		183,299	470,659	0	2,858,301	2,858,301	534,216
2026	1,916,594	163,602	17,288		179,286	459,418	0	2,929,758	2,929,758	476,086
2027	1,936,178	165,274	17,464		175,231	448,063	0	3,003,002	3,003,002	424,324
						TOTAL =	0	42,207,201	42,207,201	19,891,652

Assumptions:
1) Ash production is based on the January 2011, Budget Case Coal Burn Forecast.
2) Ash content is 9.02% plus 5.15% unburned carbon, based upon past 3 year average.
3) 90% of the total ash is fly ash, the remaining 10% is bottom ash.
4) 79% of the bottom ash is stacked, the remaining 21% flows out into Pond 4, based upon recent survey data.
5) Fly ash dry stack capacity allows for 30% moisture and 85 lb/c.f. density.
6) Stacked bottom ash density is 90 lb/c.f. Ponded ash density is 67 lb/c.f.
7) The remaining capacity in Pond 4 allows for the free water volume requirement of 129,828 c.y.
8) O&M costs are based on the routine ash handling agreement plus any O&M projects.
9) Inflation rate = 2.5%.
10) The net present values are based on a 15% discount rate.
11) Assumes Scrubbers come online in 2016 at an annual rate of 470K tons.
12) Assumes temporary landfill is designed for 6 years capacity.
13) Temporary landfill accepts FA, BA, and Gypsum.
14) Currently no available information on permanent landfill.

3/24/11

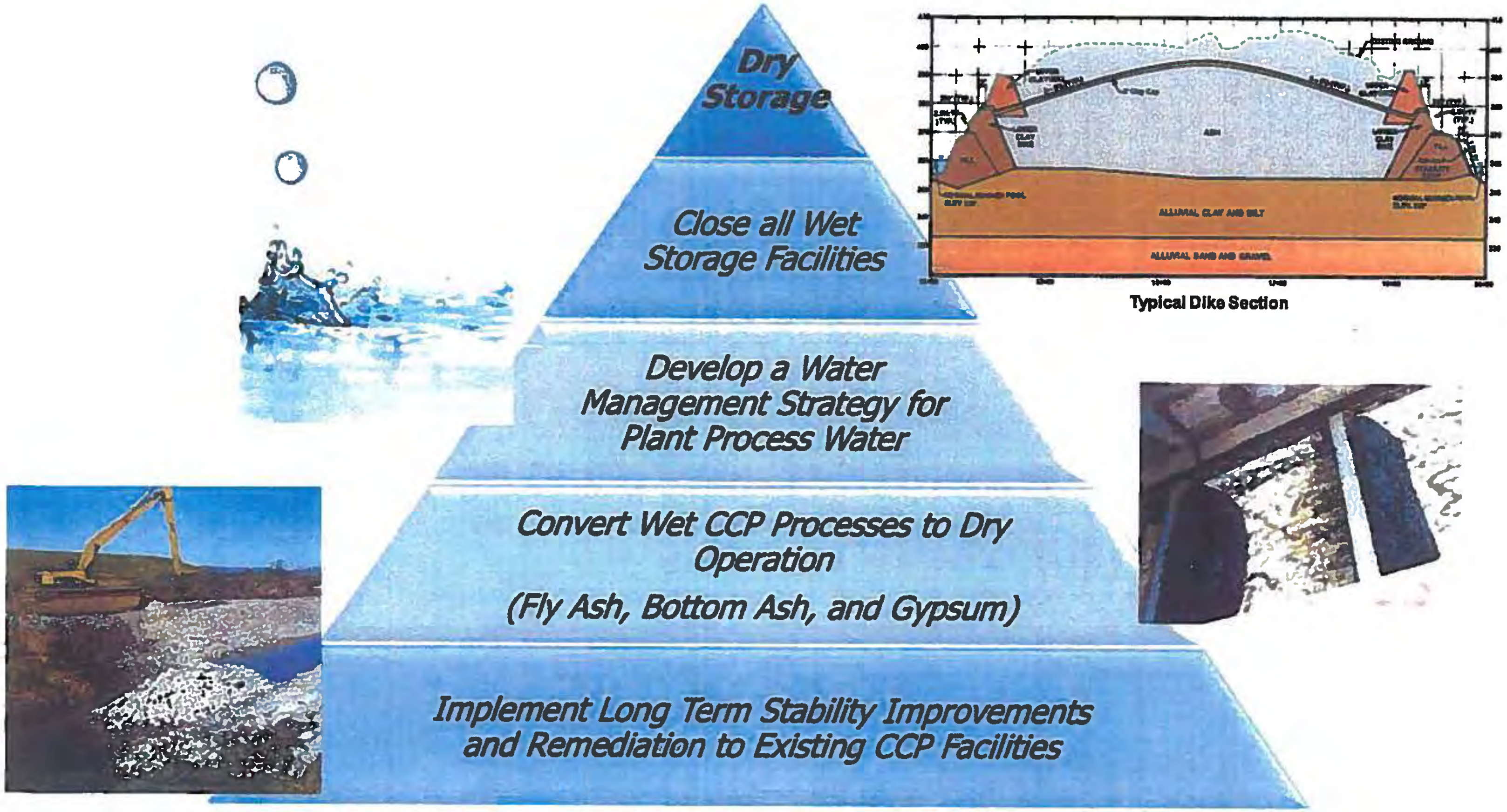
1402-1

Coal Combustion Products Master Strategy Review

April 2011

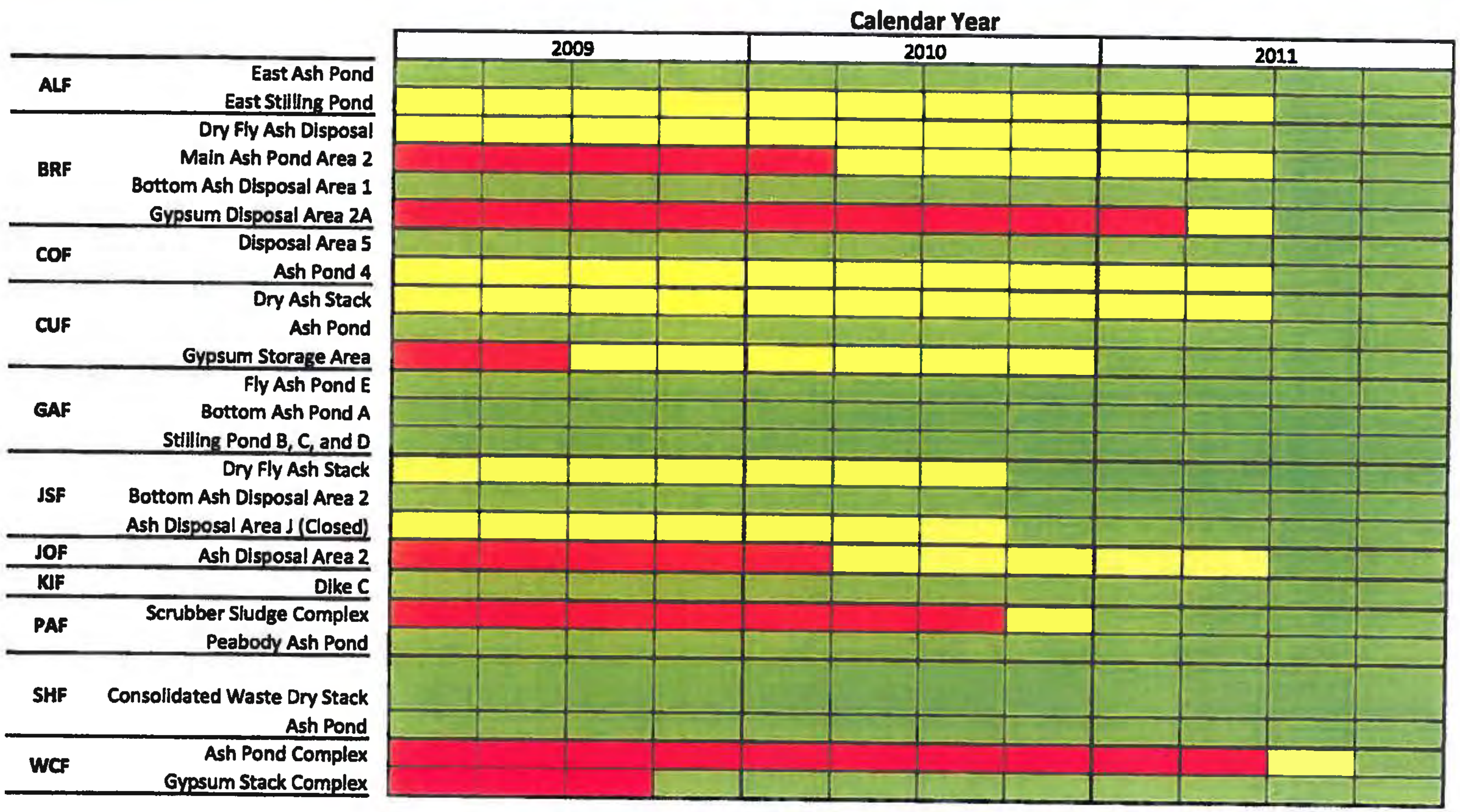
Note: As an active CCP handling facility - See CCP Engineer for current updates.

Coal Combustion Products Engineering
Programmatic Pyramid



Coal Combustion Products – Projects and Engineering

Global Stability



Global Stability	As-Found	Current	Jun-2011
1.5 or Greater	12	17	25
1.3 to 1.5	6	6	0
Less than 1.3	7	2	0

04/04/2011

Coal Combustion Products – Projects and Engineering

CCP Score Card

TVA Fossil Plants	Facility	Global Stability	Target to Clear	Non-Global Stability	Target to Clear	Hazard Classification	Target to Clear	Spillways Priority	Schedule
Allen	Ash Disposal		Jun-11		Jun-18		Close		
Bull Run	Ash Pond		Jun-11		Jun-11		Close		
	Gypsum		Jun-11		Dec-11				
Colbert	Dry Stack				May-16	N/A	N/A	N/A	N/A
	Bottom Ash		Jun-11				Close		
Cumberland	Ash Pond						Aug-11	In-Progress	Aug-11
	Dry Stack		Jun-11		Jul-17	N/A	N/A	N/A	N/A
	Gypsum				Jul-17		Close		
Gallatin	Ash Disposal				Sep-17		Close		
John Sevier	Dry Stack				Sep-15	N/A	N/A	N/A	N/A
	Bottom Ash						Close		
Johnsonville	Ash Disposal		Mar-11				Close	In-Progress	Sep-11
Kingston	Dike C				Sep-11		Close		
Paradise	Ash Pond								
	Scrubber Complex				Oct-18				
Shawnee	Dry Stack					N/A	N/A	N/A	N/A
	Ash Pond				Sep-11		Close	In-Progress	May-11
Widows Creek	Ash pond		Sep-11		Sep-12		Close	In-Progress	Jul-12
	Gypsum				Sep-11		Close		

Global Stability	Target to Clear	Non-Global Stability	Target to Clear	Hazard Classification	Target to Clear	Spillways Priority	Schedule
<1.3	Behind Sch	<1.3	Behind Sch	High	Behind Sch	Work Immediately	Behind Sch
1.3 - 1.5	At Risk	1.3 - 1.5	At Risk	Signficant	At Risk	Reduce Risk	At Risk
	On Sch		On Sch	Low	On Sch	Pond Closure	On Sch

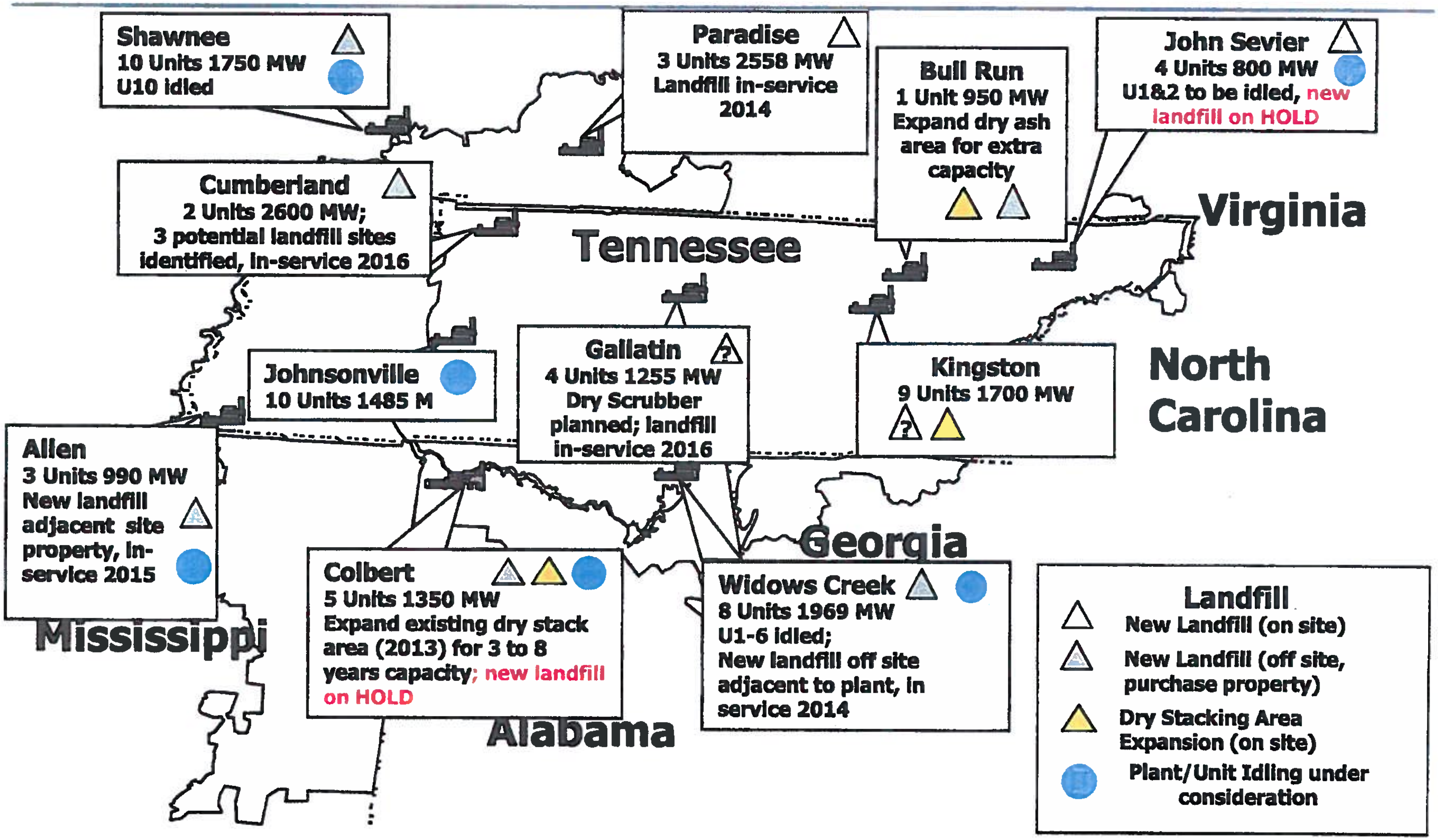
Engineering Overview

Annual Inspection Plan – 5 Year Plan

2011 Annual Inspection - 5 Year Plan					
	2011	2012	2013	2014	2015
Allen	February	June	September	November	March
Bull Run	August	November	February	May	August
Colbert	July	October	January	April	July
Cumberland	June	September	December	March	June
Gallatin	November	February	May	August	November
Kingston	September	December	March	June	September
John Sevier	November	March	June	September	November
Johnsonville	June	September	December	March	June
Paradise	September	December	March	June	September
Shawnee	September	December	June	February	May
Widows Creek	June	September	December	May	February

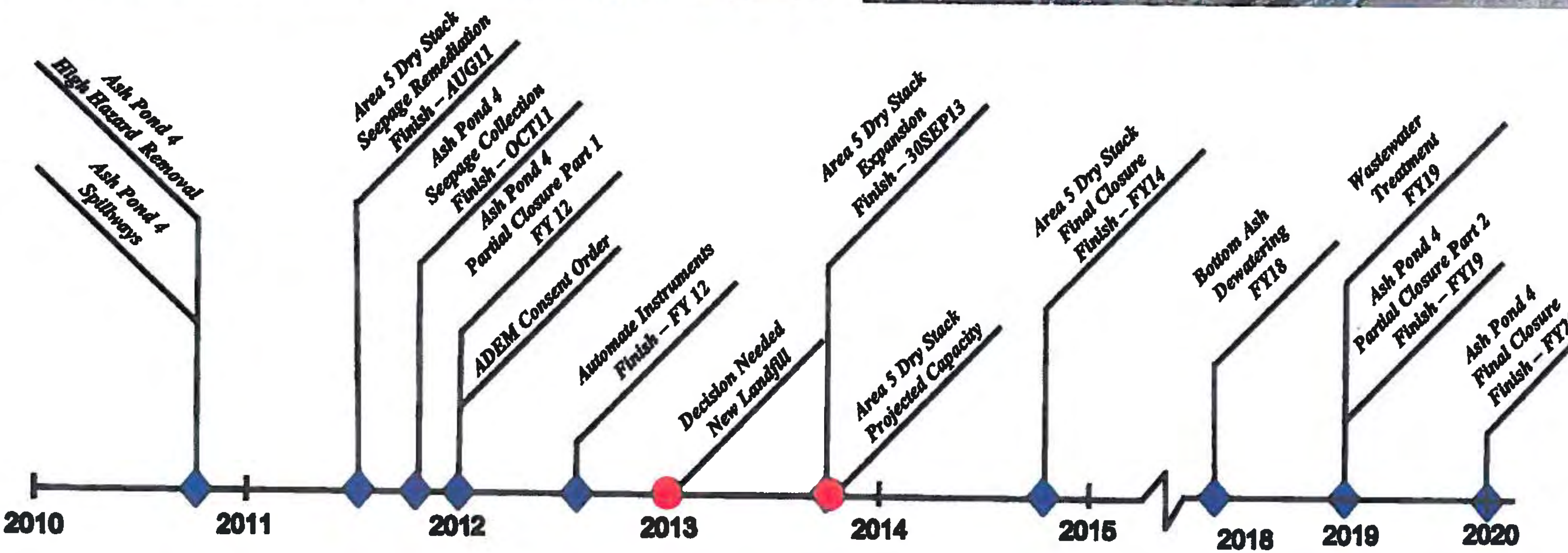
Coal Combustion Products – Projects and Engineering

Projects Overview – Landfill Valley Map



04/04/2011

Coal Combustion Products – Projects and Engineering
Colbert Fossil Plant



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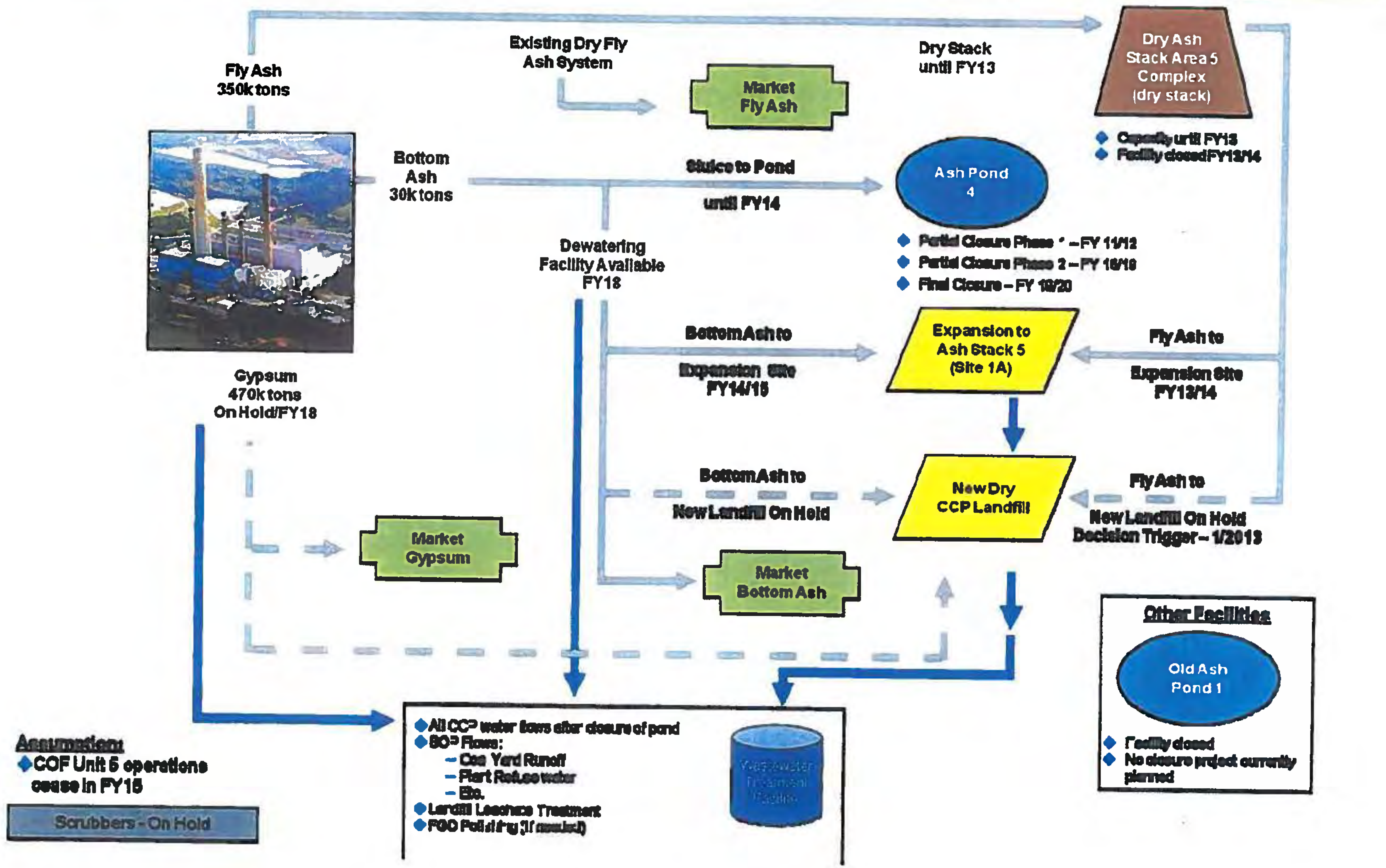
Coal Combustion Products – Projects and Engineering

Colbert Fossil Plant – Master Strategy



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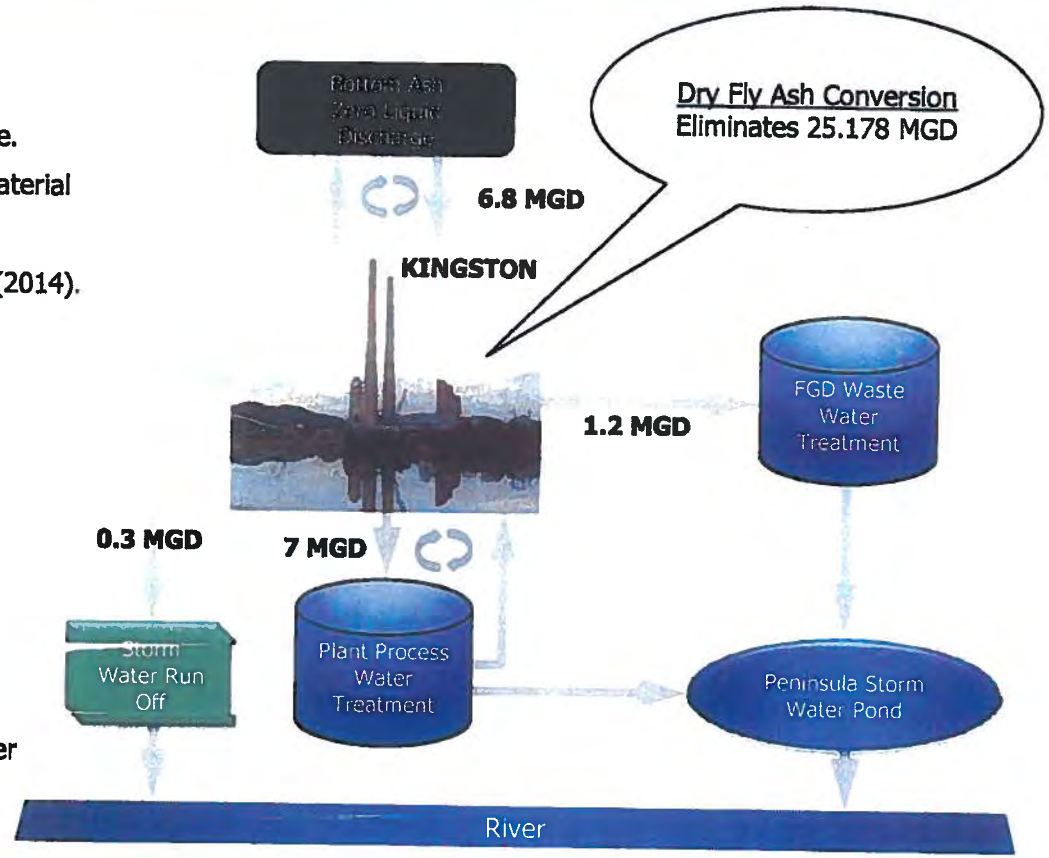
Coal Combustion Products – Projects and Engineering

Water Management

Regulatory Drivers

- Closing all CCP Ponds/Impoundments.
- Regulator Changes will force Stilling Ponds to close.
- Dewatering Facilities will be built to handle CCP Material and discharge at current NPDES Discharge Limits.
- NEW Stringent EPA Effluent Limitation Guidelines (2014).
  - Eliminate Fly Ash Transport Water.
  - Selenium, Mercury, and Arsenic.
  - Expect EPA will require Bottom Ash ZLD.
  - Do not expect ZLD requirement on FGD.



TVA Team Approach

- Organized a team of FPG, FGDC (lead), E&T.
- Researched Industry and Manufactures of WWT.
- Performed Water Characterization Study of all water streams at BRF, KIF, and WCF.
- Developed Pilot Strategy for KIF.
- Will be the core JPT for all WWT Projects.
- Current Estimate of $80M-$160M per fossil facility.

04/04/2011

APPENDIX A

Document 2

TVA Spreadsheet "CCR Generation and Handling," dated September 27, 2011

CCR Generation and Handling Questions:	Allen	Bull Run	Colbert	Cumberland	Gallatin	John Sevier	Johnsonville
1. Does the utility have drawings showing the CCR generation/handling/storage train for:							
a. Fly Ash	Yes	Yes	Yes	Yes	Yes	Yes	Yes
b. Bottom Ash	Yes	Yes	Yes	Yes	Yes	Yes	Yes
c. Boiler Slag	Yes	Yes	Yes	Yes	Yes	Yes	Yes
d. FGD wastes	N/A	Yes	N/A	Yes	N/A	N/A	N/A
2. What specific equipment is used to collect, handle, and store CCR material? For:							
a. Fly Ash	Precipitator Hoppers, hydroveyor, air separator tank, jet pump, piping,. Ash Pond	Precipitator Hoppers, hydroveyor, air separator tank, silo, piping, ash pond	Precipitator Hoppers, Surge bins, piping, silos	SCR Hoppers, Precipitator Hoppers, Surge Bins, piping, silos, ash pond	Air Heater Hoppers, Economizer Hoppers, Precipitator Hoppers, Hydroveyors, Air separator tank,piping, ash pond	Economizer Hoppers, Mechanical Collector Hoppers, Precipitator Hoppers,Surge Bins, piping, Silos	Economizer Hoppers, Mechanical Collector Hoppers, Precipitator Hoppers, Hydroveyors, Air Separartor Tanks, piping, Ash Pond
b. Bottom Ash	N/A	Bottom Ash Hoppers, jet pumps, ash transfer tanks, piping, bottom ash pond	Bottom Ash Hoppers, economizer hoppers, air heater hoppers, central ash sump, slurry pumps, piping, bottom ash pond	Economizer Hoppers, Hydroveyor, Air separator tank, bottom ash hoppers, jet pumps, piping, bottom ash reclaim pit	Bottom Ash Hoppers, jet pumps, piping, bottom ash pond	Bottom Ash Hoppers, Central Ash Sump, Slurry Pumps, piping, Ash Pond	Wet Bottom, jet pumps, piping, ash pond
c. Boiler Slag	Slag Tank, sluice system, piping, ash pond	N/A	N/A	N/A	N/A	N/A	N/A
d. FGD wastes	N/A	Limestone preparation facilities, absorbers, recycle pumps, piping, FGD pond	N/A	Limestone preparation facilities, absorbers, recycle pumps, piping, FGD pond	N/A	N/A	N/A
3. Is there design information on the handling and transport equipment?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
a. Example:size and length of pipe for sluicing the CCR	Yes	Yes	Yes	Yes	Yes	Yes	Yes

b. Is equipment within a secondary containment or just sitting on the ground?	Slag tanks are enclosed. All other equipment and piping are outside	Precip Hoppers and Bottom Ash hoppers are inside a building. Other ash equipment is outside. Limestone preparation is done inside a building, the absorbers are inside along with recycle pumps. Some piping is inside the remainder outside going to the pond.	Precip Hoppers and Bottom Ash Hoppers are inside a building. Other Ash equipment and piping are outside.	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.	Air Heater Hoppers, Economizer Hoppers, Precipitator Hoppers are inside a building. Hydroveyors, Air separator tank,piping and ash pond are outside.	Economizer Hoppers, Mechanical Collector Hoppers are inside a building, Precipitator Hoppers,Surge Bins, piping, and Silos are outside.	Economizer Hoppers, Mechanical Collector Hoppers are inside a building. Precipitator Hoppers, Hydroveyors, Air Separator Tanks, piping, Ash Pond are outside.
c. Volume of storage silo	N/A	1500 Tons	5000 Tons	32000 Tons	1200 Tons	4000 Tons	N/A
4. What equipment is outside versus enclosed?	Precipitator Hoppers and slag tank are enclosed. All other equipment outside	Precip Hoppers and Bottom Ash hoppers are inside a building. Other ash equipment is outside. Limestone preparation is done inside a building, the absorbers are inside along with recycle pumps. Some piping is inside the remainder outside going to the pond.	Precip Hoppers and Bottom Ash Hoppers are inside a building. Other Ash equipment and piping are outside.	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.	Air Heater Hoppers, Economizer Hoppers, Precipitator Hoppers are inside a building. Hydroveyors, Air separator tank,piping and ash pond are outside.	Economizer Hoppers, Mechanical Collector Hoppers are inside a building, Precipitator Hoppers,Surge Bins, piping, and Silos are outside.	Economizer Hoppers, Mechanical Collector Hoppers are inside a building. Precipitator Hoppers, Hydroveyors, Air Separator Tanks, piping, Ash Pond are outside.
5. Has there ever been a release of CCR to the environment from the collection/handling/disposal system?	Yes, small releases due to piping gasket leaks	Yes, small releases due to FGD piping gasket leaks and one occasion of overflow of an ash collection system	Yes, release due to piping rupture and sump overflowing	Yes, release of gypsum wastewater into Wells Creek	Yes, small flyash line leak and overflow of ash separator tank	Yes, sluice line leaks and piping rupture	Yes, Cenosphere release, ash piping release

6. How much CCR per hour are they handling in each system, actual and design?	TVA Provided this information in the EPA Questionnaire for the Steam Electric Power Generating Effluent Guidelines submitted October, 2010, Section B, FGD and Section C, Ash Handling						

Kingston	Paradise	Shawnee	Widows Creek
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
Yes	Yes	N/A	Yes
SCR Hoppers, Economizer Hoppers, Precipitator Hoppers, jet pumps, hydroveyors, air separator tanks, piping, ash pond	Air Preheater Hoppers, Economizer Hoppers, SCR Hoppers, hydroveyors, Air separator tanks, piping, Ash Pond	Mechanical Collectors, Baghouse, Transfer Silos, piping, Silos	Economizer Hoppers, Precipitator Hoppers,SCR Hoppers, Hydroveyors, Air Separator Tanks, piping, Ash Pond
Bottom Ash Hoppers, jet pumps, piping, ash pond	N/A	Wet Bottoms, jet pumps, Hydroveyor, piping, Ash Pond	Wet Bottom, Jet pumps, Hydroveyor, piping, Ash Pond
N/A	Economizer slurry Bowl, Slag Tanks, jet pumps, piping, Slag Pond	N/A	N/A
Limestone preparation facilities, absorbors, recycle pumps, area sump, piping, FGD pond	Limestone preparation facilities, absorbers, recycle pumps, piping, FGD pond	N/A	Limestone preparation facilities, absorbers, tanks, pumps, piping, FGD pond
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes

SCR Hoppers, Economizer Hoppers, Precipitator Hoppers and bottom ash hoppers are inside a building. Jet pumps, hydroveyors, air separator tanks, piping, ash pond	Air Preheater Hoppers, Economizer Hoppers and slag tanks are inside a building, SCR Hoppers, hydroveyors, Air separator tanks, piping, and Ash Pond are outside. Limstone preparation is done inside a building. Absorber tanks are outside the building on Units 1 & 2, but inside a building on U3.	Mechanical Collectors, Baghouse and wet bottoms are inside a building, Transfer Silos, piping,& Silos are outside.	Economizer Hoppers, wet bottoms and limestone preparation are inside a building. Precipitator Hoppers,SCR Hoppers, Hydroveyors, Air Separator Tanks,absorbers, piping, scrubber tanks and Ponds are outside.
5265 Tons	N/A	5000 Tons	N/A
SCR Hoppers, Economizer Hoppers, Precipitator Hoppers and bottom ash hoppers are inside a building. Jet pumps, hydroveyors, air separator tanks, piping, ash pond	Air Preheater Hoppers, Economizer Hoppers and slag tanks are inside a building, SCR Hoppers, hydroveyors, Air separator tanks, piping, and Ash Pond are outside. Limstone preparation is done inside a building. Absorber tanks are outside the building on Units 1 & 2, but inside a building on U3.	Mechanical Collectors, Baghouse and wet bottoms are inside a building, Transfer Silos, piping,& Silos are outside.	Economizer Hoppers, wet bottoms and limestone preparation are inside a building. Precipitator Hoppers,SCR Hoppers, Hydroveyors, Air Separator Tanks,absorbers, piping, scrubber tanks and Ponds are outside.
Yes, hydroveyor release to sump, ash lines parted at coupling	Yes, small amount of scrubber slurry went into river	No	Yes, Cenosphere release, gypsum piping leaks, ash line leaks, scrubber slurry tank overflow

APPENDIX A

Document 3

TVA Spreadsheet "Free Water Volume Report," dated September 28, 2011

Tennessee Valley Authority
Transmission/Power Supply
Surveying & Project Services

Project: Colbert
Ash Pond 4
Incremental Volumes

Survey Date: 2/9/10
Project: co000090

	Elevation (US Survey Feet)	Volume (Cubic Yards)	Volume (US Gallons)
*	462.9	588,600	118,873,575
	462.0	555,464	112,181,429
	461.0	520,123	105,044,001
	460.0	485,283	98,007,835
	459.0	450,973	91,078,406
	458.0	417,678	84,354,309
**	457.3	396,872	80,152,249
	457.0	388,321	78,425,309
***	456.6	377,679	76,276,071
	456.0	364,339	73,581,864
	455.0	340,930	68,854,304
	454.0	317,986	64,220,453
	453.0	295,462	59,671,445
	452.0	273,352	55,206,210
	451.0	251,700	50,833,413
	450.0	230,547	46,561,252
	449.0	209,914	42,394,130
	448.0	189,830	38,337,966
	447.0	170,341	34,402,048
	446.0	151,599	30,616,974
	445.0	133,548	26,971,435
	444.0	116,108	23,449,192
	443.0	99,306	20,055,759
	442.0	83,194	16,801,800
	441.0	67,866	13,706,137
	440.0	53,443	10,793,308
	439.0	40,111	8,100,757
	438.0	28,177	5,690,546
	437.0	17,873	3,609,631
	436.0	9,470	1,912,480
	435.0	3,487	704,154
	434.0	549	110,856
	433.0	12	2,444
****	432.1	0	0

Note: 201.96 gallons/cubic yard

* = Average top of dike
** = Elevation at lowest top of dike
*** = Free Standing Water Volume
**** = Lowest elevation at time of survey

Water surface elevation on 2/9/10 = 456.86 ft.
containing 14.89 acres.

Tennessee Valley Authority
Transmission/Power Supply
Surveying & Project Services

Project: Colbert
Stilling Pond 4
Incremental Volumes

Survey Date: 2/9/10
Project: co000090

	Elevation (US Survey Feet)	Volume (Cubic Yards)	Volume (US Gallons)
*	461.4	133,479	26,957,318
	461.0	130,482	26,352,104
**	460.1	122,725	24,785,541
	460.0	122,158	24,671,110
	459.0	114,323	23,088,693
	458.0	106,715	21,552,161
	457.0	99,246	20,043,783
***	456.6	96,001	19,388,342
	456.0	91,900	18,560,104
	455.0	84,659	17,097,711
	454.0	77,525	15,657,030
	453.0	70,508	14,239,715
	452.0	63,649	12,854,512
	451.0	56,963	11,504,308
	450.0	50,511	10,201,242
	449.0	44,327	8,952,301
	448.0	38,433	7,761,888
	447.0	32,844	6,633,215
	446.0	27,595	5,573,046
	445.0	22,741	4,592,793
	444.0	18,295	3,694,838
	443.0	14,285	2,884,938
	442.0	10,699	2,160,831
	441.0	7,565	1,527,747
	440.0	4,919	993,340
	439.0	2,914	588,572
	438.0	1,630	329,215
	437.0	855	172,736
	436.0	311	62,810
	435.0	39	7,856
	434.0	0	0
****	433.9	0	0

Note: 201.96 gallons/cubic yard

* = Average top of dike
** = Elevation at lowest top of dike
*** = Free Standing Water Volume
**** = Lowest elevation at time of survey

Water surface elevation on 2/9/10 = 456.86 ft.
containing 4.57 acres.

APPENDIX A

Document 4

"Tennessee Valley Authority Colbert Fossil Plant – Ash Pond 4, High Hazard Removal & Spillway Replacement," Construction Drawings Number 10W290-00 to 10W290-19, Prepared by URS, Dated June 17, 2010

TENNESSEE VALLEY AUTHORITY
COLBERT FOSSIL PLANT - ASH POND 4
HIGH HAZARD REMOVAL & SPILLWAY REPLACEMENT

COLBERT COUNTY, ALABAMA

SITE VICINITY MAP

0 6000 12000
SCALE: 1"=6000'

DWG. NO.	DWG. DESCRIPTION
10W290-00	TITLE SHEET
10W290-01	GENERAL NOTES
10W290-02	GENERAL NOTES
10W290-03	OVERALL SITE PLAN AND HAUL ROUTE
10W290-04	DIKE LOWERING, SIPHON, AND SPILLWAY PLAN
10W290-05	DIKE LOWERING PLAN AND PROFILE
10W290-06	TYPICAL DIKE SECTIONS AND DETAILS
10W290-07	SIPHON PLAN AND PROFILE
10W290-08	SPILLWAY PLAN AND PROFILE
10W290-09	SIPHON PIPE SECTION AND DETAILS
10W290-10	SPILLWAY STRUCTURE DETAILS
10W290-11	OUTLET HEADWALL DETAILS
10W290-12	FILTER DIAPHRAGM DETAILS
10W290-13	SPILLWAY ABANDONMENT PLAN
10W290-14	DOWNSTREAM IMPROVEMENTS PLAN AND PROFILE
10W290-15	SURVEY CONTROL PLAN
10W290-16	CBMPP-OVERALL SITE
10W290-17	CBMPP-POND 4 IMPROVEMENTS
10W290-18	CBMPP-DETAILS 1
10W290-19	CBMPP-DETAILS 2

2 WORKING DAYS
BEFORE YOU DIG
205-353-2636
ALABAMA UTILITIES PROTECTION SERVICE

PREPARED FOR:

TENNESSEE VALLEY AUTHORITY
1101 MARKET STREET
CHATTANOOGA, TN 37402-2801

PREPARED BY:

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ISSUED FOR CONSTRUCTION

URS

SCALE: NONE — EXCEPT AS NOTED

TITLE SHEET

ASH POND 4 –
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD 2010 | 6/17/10 | 47 | C | 10W290-00 | R 0

PLOT FACTOR XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

10W290-00 | C | 47

WORK TO BE DONE

THE WORK DESCRIBED IN THIS DRAWING SET CONSISTS OF CONSTRUCTION OF PERMANENT SIPHON AND SPILLWAY STRUCTURES, ABANDONMENT OF THE EXISTING SPILLWAY STRUCTURES, AND LOWERING THE NORMAL POOL ELEVATION AND A PORTION OF THE EXISTING DIKE TO REMOVE THE HIGH HAZARD CLASSIFICATION AT ASH POND 4 AT TVA'S COLBERT FOSSIL PLANT. SIPHONS WILL BE INSTALLED TO TEMPORARILY LOWER THE POOL OF THE STILLING POND AND CONVEY THE DAILY PROCESS FLOW DURING CONSTRUCTION AND ALLOW THE NEW PERMANENT SPILLWAY CONSTRUCTION TO TAKE PLACE IN THE DRY. FOLLOWING CONSTRUCTION AND OPERATION OF THE NEW PERMANENT SPILLWAYS, THE EXISTING SPILLWAY STRUCTURES WILL BE ABANDONED BY GROUTING THE OUTLET PIPES AND 10 VERTICAL FEET OF THE RISER.

GENERAL PROVISIONS

1. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH OSHA SAFETY STANDARDS AND IN ACCORDANCE WITH ALL APPLICABLE LOCAL, STATE, AND FEDERAL LAWS AND TVA REQUIREMENTS.
2. ENGINEER REFERS TO URS CORPORATION, WHICH HAS BEEN CONTRACTED BY TVA FOR CONSTRUCTION QUALITY ASSURANCE FOR THE DURATION OF THE PROJECT.
3. WHENEVER REFERENCE IS MADE TO THE ALABAMA DEPARTMENT OF TRANSPORTATION (ALDOT) STANDARD SPECIFICATIONS, AMERICAN CONCRETE INSTITUTE(ACI), AMERICAN WATER WORKS ASSOCIATION, AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM) AND OTHER PUBLISHED STANDARDS OR SPECIFICATIONS, IT SHALL MEAN THE LATEST VERSION IN ITS ENTRY.
4. THE CONTRACTOR SHALL SECURE THE LATEST EDITION OF ALABAMA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS WHEN PERFORMING WORK WHICH IS PRESCRIBED HEREIN. COPIES MAY BE OBTAINED FROM:

   PROPOSALS ENGINEER
   ALABAMA DEPARTMENT OF TRANSPORTATION
   1409 COLISEUM BOULEVARD
   MONTGOMERY, ALABAMA 36130-3050

5. HORIZONTAL AND VERTICAL SURVEY CONTROL EXISTS AT THE SITE. IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO PROVIDE CONTROL POINT INFORMATION TO THE CONTRACTOR. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL SURVEYING AND STAKING NECESSARY FOR LAYOUT AND CONSTRUCTION OF THE PROJECT.
6. ACCEPTABLE CONSTRUCTION TOLERANCES FROM PLAN DIMENSIONS, ELEVATIONS, AND GRADES SHALL BE AS FOLLOWS:
   - EXCAVATIONS AND FINAL GRADES FOR EARTH SURFACES AND SLOPES: ±0.25 FEET VERTICAL, ±1 FT IN A HORIZONTAL PLANE.
   - RIP RAP: FINAL GRADE ±0.5 FEET, THICKNESS ZERO TO +0.5 FEET; ±1 FT IN A HORIZONTAL PLANE.
   - FINAL GRADE TOP OF DIKE: ZERO TO +0.25 FEET VERTICAL, ±1 FT IN A HORIZONTAL PLANE.
   - CONCRETE SPILLWAY STRUCTURES: ±0.10 FEET, AND ALL STRUCTURES WITHIN 1/2" OF THE SAME ELEVATION. ALL OTHER MEASUREMENTS WITHIN 1/2" OF PLAN DIMENSIONS.
   - STOP LOGS: ALL WITHIN 1/2" OF SAME ELEVATION AND NO MORE THAN 1/8" VARIATION (LEVELNESS) ACROSS A SINGLE STOP LOG.
   - PIPES AND APPURTENANCES: ± 0.10 FEET OF PLAN ELEVATION.
6. NO DEVIATIONS FROM THE PLANS OR APPROVED SHOP DRAWINGS SHALL BE MADE WITHOUT PRIOR APPROVAL FROM THE ENGINEER. THE CONTRACTOR SHALL KEEP A RECORD OF ALL DEVIATIONS OF ANY INSTALLATION FROM THAT SHOWN ON THE PLANS, AND ANY DEVIATIONS IN INSTALLATIONS FROM APPROVED SHOP DRAWINGS AND PROVIDE COPIES OF THESE RECORDS TO ENGINEER. AT COMPLETION OF THE PROJECT A SET OF FINAL RECORD DRAWINGS SHALL BE PREPARED BY THE ENGINEER TO ENSURE THAT THE OWNER HAS A PERMANENT RECORD OF THE PROJECT AS IT WAS CONSTRUCTED. CONTRACTOR SHALL ASSIST THE ENGINEER WITH ANY MEASUREMENTS OR INTERPRETATIONS NECESSARY FOR PREPARATION OF THE FINAL RECORD DRAWINGS.
7. EXISTING SPILLWAY STRUCTURE SHALL BE KEPT INTACT AND IN AN OPERABLE CONDITIONS UNTIL CONSTRUCTION OF THE NEW SPILLWAY SYSTEM IS COMPLETE. THE CONTRACTOR SHALL CONDUCT ALL WORK IN SUCH A MANNER AS TO PREVENT DAMAGE TO THE EXISTING SPILLWAY STRUCTURE DURING CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE TO THE SPILLWAY CAUSED BY THEIR OPERATIONS.
8. UNLESS OTHERWISE INDICATED, THESE DRAWINGS WERE COMPILED USING SURVEY INFORMATION PROVIDED BY TVA. THE MAPPING IS BASED ON HORIZONTAL NORTH AMERICAN DATUM 27 USING THE ALABAMA WEST COORDINATE SYSTEM AND NATIONAL GEODETIC VERTICAL DATUM 29.
9. THE ENGINEER WILL PROVIDE QUALITY ASSURANCE TESTING AND WILL OBSERVE CONSTRUCTION ACTIVITIES, IN ACCORDANCE WITH THE PROJECT-WIDE QUALITY ASSURANCE/QUALITY CONTROL PLAN.

GENERAL SITEWORK REQUIREMENTS

1. ACCESS INTO THE WORK AREA FOR DELIVERY OF EQUIPMENT, MATERIALS AND WORKFORCE SHALL BE REVIEWED DAILY BY THE CONTRACTOR, AND CONTROLLED AS NEEDED TO PREVENT ANY DAMAGE TO THE CREST OR SLOPES OF THE DIKES SURROUNDING THE ASH PONDS. IF EQUIPMENT OR MATERIAL HAULING CAUSES DAMAGE, THE DAMAGE SHALL BE IMMEDIATELY REPAIRED BY THE CONTRACTOR, AND THE METHODS FOR HAULING SHALL BE ALTERED TO PREVENT FURTHER DAMAGE. THE CONTRACTOR SHALL NOT MAKE ANY UNPLANNED EXCAVATIONS INTO THE DIKE WITHOUT THE APPROVAL OF THE OWNER OR THE ENGINEER. DURING CONSTRUCTION THE CONTRACTOR IS RESPONSIBLE FOR PRECAUTIONS REQUIRED TO PROTECT THE INTEGRITY OF THE DIKES, EXISTING SPILLWAY SYSTEM AND APPURTENANCES NEEDED FOR THE SAFE OPERATION OF THE ASH POND.
2. CONTRACTOR SHALL TAKE EVERY PRECAUTION TO ENSURE THAT THERE ARE NO OIL EXCURSIONS INTO THE ASH POND DURING CONSTRUCTION. CONTRACTOR SHALL HAVE OIL CONTROL EQUIPMENT (ABSORBENT BOOMS, ETC) ON SITE AT ALL TIMES. IF OIL IS RELEASED OR OBSERVED DURING CONSTRUCTION, CONTRACTOR SHALL IMMEDIATELY NOTIFY THE PLANT AND DEPLOY OIL CONTROL EQUIPMENT. CONTRACTOR SHALL COORDINATE WITH ENGINEER AND OWNER ON OIL CLEANUP, AS NECESSARY.
3. THE CONTRACTOR SHALL INSTALL, MAINTAIN AND INSPECT SILT FENCE AND OTHER EROSION CONTROL FEATURES AS REQUIRED IN THE CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN (CBMPP). EROSION CONTROL FEATURES SHALL BE INSTALLED PRIOR TO BEGINNING ANY EARTHMOVING ACTIVITIES.
4. WEEKLY DELIVERIES OF CARBON DIOXIDE ARE MADE BY TANKER TRUCK TO THE CO2 SYSTEM LOCATED ON THE EAST DIKE. FULL ACCESS TO DELIVERY VEHICLES MUST BE MAINTAINED THROUGHOUT THE DURATION OF SPILLWAY CONSTRUCTION.
5. OWNER WILL MONITOR PH AND WATER QUALITY AT DISCHARGE TO CANE CREEK THROUGHOUT CONSTRUCTION. CONTRACTOR MAY NEED TO ADJUST CONSTRUCTION PRACTICES IF WATER QUALITY ISSUES ARISE. CONTRACTOR TO COORDINATE WITH TVA AND ENGINEER.
6. APPROXIMATE LOCATIONS FOR STAGING AND STOCKPILE AREAS ARE SHOWN ON THESE DRAWINGS AND IN THE CONSTRUCTION BEST MANAGEMENT PLAN DRAWINGS. HOWEVER, THE CONTRACTOR SHALL COORDINATE WITH THE OWNER TO DETERMINE THE FINAL LOCATION OF STAGING AREAS FOR EQUIPMENT OR MATERIAL STORAGE AND FOR OTHER CONSTRUCTION LAY DOWN ACTIVITY.

POND LEVEL MONITORING AND EMERGENCY PROCEDURES

1. THE OUTLETS OF THE EXISTING SPILLWAYS ARE A PERMITTED DISCHARGE, "OUTFALL 001", FOR ALABAMA NPDES DISCHARGE PERMIT AL0003867. DURING CONSTRUCTION, WORK IN THE ASH POND MAY CAUSE CHANGES IN PERMITTED EFFLUENT CHARACTERISTICS. THE CONTRACTOR SHALL EXERCISE EVERY REASONABLE PRECAUTION AT ALL TIMES TO PREVENT WATER POLLUTION BY DEPOSITION OF SEDIMENT INTO THE ASH POND.
2. PRIOR TO ACTIVATION OF SIPHONS, THE CONTRACTOR SHALL INSTALL A STAFF GAUGE ON THE EXISTING SPILLWAY TO MONITOR WATER LEVELS. STAFF GAUGE SHALL HAVE CLEARLY IDENTIFIABLE MARKS AT 0.1 FT INTERVALS, AND WHOLE FOOT CALLOUTS GIVING THE ELEVATION OF THE POND. THE GAUGE SHALL BE LOCATED AND CONSTRUCTED SUCH THAT THE POND WATER LEVEL CAN BE OBSERVED FROM A VEHICLE PARKED AT THE PARKING AREA.
3. INITIAL LOWERING OF STILLING POND. THE WATER LEVEL IN THE STILLING POND SHALL BE INITIALLY LOWERED USING THE SIPHONS. SIPHON DISCHARGE SHALL BE ADJUSTED SUCH THAT THE POND LEVEL IS LOWERED AT A RATE OF NO MORE THAN 1 FT PER DAY TO A FINAL ELEVATION OF 447.0 FT. THE INTERIOR SLOPES OF THE POND DIKES SHALL BE MONITORED DURING THE INITIAL LOWERING. IF SIGNS OF INSTABILITY OF THE POND DIKES ARE OBSERVED, POND LOWERING SHALL BE HALTED IMMEDIATELY AND THE ENGINEER SHALL BE NOTIFIED.
4. AFTER INITIAL LOWERING, CONTRACTOR SHALL MONITOR POND LEVEL USING THE STAFF GAUGE CONTINUOUSLY DURING CONSTRUCTION. THE SIPHON DISCHARGE RATE SHALL BE CONTINUOUSLY ADJUSTED TO ACCOUNT FOR POND INFLOWS, SUCH THAT THE WATER LEVEL IN THE STILLING POND REMAINS WITHIN +/- 0.5 FT OF THE CONSTRUCTION OPERATING ELEVATION OF 447.0 FT.

POND LEVEL MONITORING AND EMERGENCY PROCEDURES (CONT'D)

5. THE CONTRACTOR SHALL CONTINUOUSLY MONITOR WEATHER CONDITIONS AND FORECASTS DURING CONSTRUCTION. WHEN SEVERE STORMS ARE PREDICTED, WORKMEN AND EQUIPMENT SHALL BE MOVED OUT OF THE WORK AREAS, AND THE SITE SHALL BE PREPARED AND PROTECTED FOR THE STORM EVENT. THE SITE CREW WILL KEEP AND MAINTAIN A DAILY LOG OF POND LEVEL READINGS DURING AND AFTER STORM EVENTS UNTIL STEADY STATE WATER LEVELS HAVE BEEN REACHED. WATER LEVELS WILL THEN BE MONITORED AT MAXIMUM OF 2 TO 3 HOUR INTERVALS THEREAFTER. THE SIPHON DISCHARGE RATE SHALL BE ADJUSTED TO MAINTAIN WATER LEVEL IN THE STILLING POND WITHIN THE ALLOWED TOLERANCE. MONITORING SHALL BE IMPLEMENTED IN SUCH A MANNER AS TO MAINTAIN SAFETY OF WORKMEN (SUCH AS FROM A VEHICLE PARKED AT THE TOP OF THE POND DIKE).
6. IF MONITORING AND ADJUSTMENT OF SIPHONS CANNOT BE SAFELY PERFORMED DURING VERY LARGE STORM EVENTS, THE WATER LEVEL IN THE STILLING POND MAY RISE TO THE LEVEL OF THE EXISTING MORNING GLORY SPILLWAYS. THESE SPILLWAYS WILL PREVENT OVERTOPPING OF THE POND DIKES. HOWEVER, IN THIS CASE ELEMENTS UNDER CONSTRUCTION MAY BE DAMAGED OR LOST.

EARTHWORK NOTES

1. AREAS WHICH WILL BE EXCAVATED SHALL BE CLEARED OF TREES, STUMPS, BRUSH, PROJECTING ROOTS, WEEDS, LOGS AND OTHER PROTRUDING OBSTRUCTIONS. ALL TREES, STUMPS, BRUSH, PROJECTING ROOTS, WEEDS LOGS, AND PROTRUDING OBSTRUCTIONS SHALL BE CUT TO WITHIN 3 INCHES OF EXISTING GROUND. THE AREA SHALL BE GRUBBED TO A DEPTH OF 6 INCHES TO REMOVE GRASS, ROOTS AND OTHER ORGANIC MATERIAL. ALL CLEARED AND GRUBBED MATERIAL SHALL BE REMOVED FROM THE SITE AND DISPOSED OF AT AN APPROVED DISPOSAL SITE AND IN ACCORDANCE WITH APPLICABLE LAWS. IF ENCOUNTERED, TOPSOIL SHALL BE STRIPPED TO A DEPTH OF 4 INCHES. TOPSOIL SHALL BE STORED AT THE DESIGNATED STOCKPILE AREA AS NOTED IN THE CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN (CBMPP) AND AS ALLOWED BY THE OWNER.
2. ALL EXCAVATIONS SHALL BE SLOPED, BENCHED, OR SHORED TO PERMIT SAFE WORKING CONDITIONS PER OSHA REQUIREMENTS FOR PROTECTIVE SYSTEMS (29 CFR 1926.652). EXISTING DIKE MATERIALS SHALL BE CONSIDERED OSHA TYPE C MATERIALS.
3. MAJOR EXCAVATIONS IMPLEMENTED ALONG THE SLOPES OF THE EXISTING DIKE (SUCH AS REQUIRED TO INSTALL THE INLET AND OUTLET STRUCTURES), AND ANY MISCELLANEOUS EXCAVATIONS GREATER THAN 4 FT IN DEPTH THAT WILL REMAIN OPEN FOR A PERIOD OF GREATER THAN 1 WEEK SHALL BE SLOPED AT NO GREATER THAN 2H:1V, UNLESS OTHERWISE ALLOWED BY THE ENGINEER.
4. THE CONTRACTOR IS RESPONSIBLE FOR PROVIDING DRAINAGEWAYS, SUMP PITS AND PUMPS, OR OTHER METHODS AND PRACTICES TO KEEP EXCAVATIONS IN A DRAINED CONDITION AT ALL TIMES. SURFACES ABOVE EXCAVATIONS SHALL BE GRADED OR PROTECTED SUCH THAT SURFACE RUNOFF IS DIRECTED AWAY FROM OPEN EXCAVATIONS.
5. PRIOR TO PLACING FILLS AGAINST THE INSIDE AND OUTSIDE SLOPES OF THE DIKE, THE BOTTOM SHALL BE BENCHED LEVEL TO PROVIDE A LEVEL SURFACE TO BEGIN THE FILLING ACTIVITIES. SLOPING SURFACES AGAINST WHICH FILL MATERIAL WILL BE PLACED SHALL BE DISCED, BENCHED OR SERRATED, TO ENHANCE BONDING OF THE FILL TO THE EXCAVATION FACE.
6. SUITABLE FILL MATERIALS. SOIL MATERIALS TO BE PLACED AS BACKFILL AGAINST EITHER THE OUTSIDE SLOPE OF THE DIKE, OR TO BACKFILL EXCAVATIONS WITHIN THE DIKE, SHALL CONSIST OF CLAY SOILS THAT EXHIBIT A CLASSIFICATION OF CL, CL-ML, CL-CH, OR CH IN ACCORDANCE WITH ASTM D-2487. THE MATERIAL SHALL BE FREE OF ORGANIC MATTER, TOPSOIL, RUBBISH, DEBRIS, WASTE MATERIALS, AND ROCK PIECES GREATER THAN 3 INCHES (MAXIMUM DIMENSION) IN SIZE, AND SHALL BE AT A MOISTURE CONTENT THAT IS SUITABLE FOR ACCEPTABLE COMPACTION, AS REQUIRED HEREIN. EXISTING SOILS REMOVED FROM THE EXCAVATIONS MAY BE REUSED AS FILL, TO THE EXTENT THAT THEY MEET THE REQUIREMENTS GIVEN HEREIN.
7. NO MATERIAL SHALL BE PLACED IN ANY SECTION OF THE EMBANKMENT UNTIL THE FOUNDATION FOR THAT SECTION H AS BEEN APPROVED BY THE ENGINEER. THE CONTRACTOR SHALL KEEP THE FOUNDATION AND SUBGRADE FREE FROM WATER OR UNACCEPTABLE MATERIALS AFTER FILL OPERATIONS HAVE STARTED.
8. NEW FILL SHALL NOT BE PLACED ON SUBGRADES OF EXISTING SOILS OR PREVIOUSLY PLACED FILL LAYERS, IF IN THE OPINION OF THE ENGINEER THE SUBGRADE IS UNSUITABLE. SUBGRADE SHALL BE REWORKED OR REPLACED TO THE SATISFACTION OF THE ENGINEER, PRIOR TO PLACEMENT OF ADDITIONAL FILLS.
9. COMPACTION REQUIREMENTS. FILL MATERIALS SHALL BE PLACED AND SPREAD IN HORIZONTAL LOOSE LIFTS THAT DO NOT EXCEED 8 INCHES IN THICKNESS. EACH LIFT SHALL BE THOROUGHLY COMPACTED TO ACHIEVE A MINIMUM DENSITY OF 98% OF ITS MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D-698 (CONTRACTOR TO PERFORM PROCTOR TESTING AND SUBMIT RESULTS TO ENGINEER). THE MOISTURE CONTENT DURING COMPACTION SHALL BE WITHIN A RANGE OF 0 TO +3 PERCENT OF THE OPTIMUM MOISTURE CONTENT AS DETERMINED BY ASTM D-698. FIELD COMPACTION TESTS, BY THE ENGINEER, SHALL BE PERFORMED ON EACH LIFT TO VERIFY THAT SPECIFIED LEVELS OF COMPACTION ARE ACHIEVED.
10. MATERIAL THAT IS PLACED ADJACENT TO AND LESS THAN 3 FEET ABOVE THE TOP OF SPILLWAY PIPES SHALL BE COMPACTED USING LIGHTWEIGHT COMPACTORS. COMPACTION OF FILLS WITHIN 5 FT OF ANY STRUCTURE (WALLS, SLABS, ETC) SHALL BE PERFORMED WITH LIGHTWEIGHT COMPACTION EQUIPMENT.
11. RIP-RAP. RIPRAP SHALL COMPLY WITH SECTION 610 OF THE ALDOT SPECIFICATIONS. THE CONTRACTOR SHALL INSTALL LOOSE RIPRAP OF THE TYPE AND QUANTITY SPECIFIED, AT THE LOCATIONS SHOWN IN THE PLANS.
12. DIKE CREST TREATMENT. WITHIN THE AREA OF THE SPILLWAY AND DIKE LOWERING, THE FINAL TOP OF DIKE SHALL BE SURFACED ACROSS THE ENTIRE CREST WIDTH USING A LAYER OF COMPACTED NO. 57 STONE AGGREGATE BASE MEETING REQUIREMENTS OF SECTION 430 OF THE ALDOT STANDARD SPECIFICATIONS. PRIOR TO PLACEMENT OF THE AGGREGATE BASE, THE SURFACE OF THE SUBGRADE SHALL BE PROOFROLLED USING A DUMP TRUCK OR OTHER PNEUMATIC-TIRED PIECE OF EQUIPMENT WEIGHING A MINIMUM OF 25 TONS AND WITH MINIMUM TIRE PRESSURE OF 90 PSI. THE ENGINEER WILL OBSERVE THE PROOFROLL. AREAS OF SUBGRADE THAT ARE DEEMED DEFICIENT BY THE ENGINEER SHALL BE REPAIRED PRIOR TO PLACEMENT OF THE STONE BASE, AS REQUIRED IN THESE DRAWINGS.
13. AREAS OF THE DOWNSTREAM DIKE SLOPE THAT ARE DISTURBED DURING CONSTRUCTION SHALL BE FINISHED TO PRECONSTRUCTION GRADES AND TO A SMOOTH AND COMPACT SURFACE AND REVEGETATED. SEEDBED PREPARATION, FERTILIZING, SEEDING, AND MULCHING SHALL BE IN ACCORDANCE WITH TVA'S T-1 CONSTRUCTION SPECIFICATIONS.
14. EXISTING TOPSOIL THAT IS REMOVED AND STOCKPILED SHALL BE REUSED TO THE EXTENT POSSIBLE.
15. RIPRAP SHALL BE PLACED BY MECHANICAL MEANS USING AN EXCAVATOR OR LOADER. THE MAXIMUM ALLOWABLE DROP HEIGHT FOR RIPRAP PLACEMENT IS 2 FEET (1 FT WHEN DROPPING DIRECTLY ONTO A GEOTEXTILE). THE ROCK SHALL BE PLACED TO THE DEPTHS AND EXTENTS SHOWN IN THE DRAWINGS. THE SURFACE OF THE LINING, UPON COMPLETION, SHALL BE GRADED AS PRACTICABLE INTO FINAL POSITION TO ENSURE PROPER THICKNESS AND A UNIFORM SURFACE. LARGER ROCKS SHALL BE UNIFORMLY DISTRIBUTED WITH THE SMALL ROCKS AND SPALLS FILLING THE VOIDS BETWEEN THE LARGER ROCKS.

SIPHON SPILLWAYS

1. CONTRACTOR IS RESPONSIBLE FOR SELECTING AND PROVIDING A SUITABLE PUMP TO PRIME THE SIPHON SYSTEM. THE PUMP SHALL BE AVAILABLE ON SITE FOR THE DURATION OF CONSTRUCTION.
2. CONTRACTOR TO PROVIDE SHOP DRAWINGS FOR SIPHON SUPPORT STRUCTURES AND OBTAIN ENGINEER APPROVAL PRIOR TO CONSTRUCTION.
3. PRESSURE TEST ALL SIPHON PIPING AS DESCRIBED IN SECTION ENTITLED "HDPE PIPE".
4. SIPHON PIPING AT DOWNSTREAM END (DISCHARGE INTO EXISTING CONCRETE CHANNEL TO CANE CREEK) WILL BE TEMPORARILY EXTENDED DURING CONSTRUCTION PERIOD. AFTER CONSTRUCTION, REMOVE PORTIONS OF SIPHONS INDICATED IN THESE DRAWINGS. REMAINDER OF SIPHON SYSTEM TO REMAIN IN PLACE PERMANENTLY AFTER CONSTRUCTION.
5. SPECIFICATIONS FOR GATE VALVES.
6. GATE OPERATORS SHALL BE HAND WHEEL TYPE OPERATORS AND LOCATED ADJACENT TO THE PLATFORM FOR EASE OF OPERATION.

CONCRETE STRUCTURE CONSTRUCTION

1. THE SPILLWAY AND HEADWALL STRUCTURES SHALL BE CAST-IN-PLACE CONCRETE IN ACCORDANCE WITH THE SPECIFICATIONS BELOW.
2. CONNECTION OF 27" HDPE PIPE TO CONCRETE STRUCTURES SHALL BE MADE USING CAST-IN CONNECTOR, CAST-A-SEAL 802 FROM PRESS-SEAL CORPORATION, OR APPROVED EQUAL. CONTRACTOR TO FOLLOW ALL MANUFACTURER INSTRUCTIONS AND SPECIFICATIONS WHEN INSTALLING.
3. WHERE ANCHOR BOLTS ARE SPECIFIED TO ATTACH METAL ELEMENTS TO CONCRETE, ANCHORS SHALL BE GALVANIZED STEEL ADHESIVE TYPE CONCRETE ANCHORS THAT ARE INSTALLED INTO HOLES DRILLED AFTER THE UNIT IS CAST. MINIMUM EMBEDMENT SHALL BE 6 INCHES. DRILL HOLES SHALL BE OF THE DIAMETER RECOMMENDED BY THE MANUFACTURER AND SHALL BE THOROUGHLY CLEANED PRIOR TO INSTALLING ANCHORS AND ANCHORS SHALL BE INSTALLED PER MANUFACTURER'S DIRECTIONS.
4. IT IS INTENDED TO KEEP THE EXISTING SPILLWAYS SERVICEABLE FOR THE LONGEST TIME POSSIBLE DURING CONSTRUCTION. EXCAVATIONS MADE FOR THE NEW SPILLWAY STRUCTURE SHALL BE CONFIGURED SUCH THAT THE SOUTH EDGE OF EXCAVATION REMAINS AT LEAST 30 FT AWAY FROM THE EXISTING SPILLWAYS. EXCAVATION FOR AND INSTALLATION OF THE RIP-RAP APPROACH CHANNEL TO THE NEW SPILLWAY SHALL BE IMPLEMENTED AFTER THE END OF SPILLWAY STRUCTURE CONSTRUCTION AND BACKFILL.

STOP LOGS

1. THE CONTRACTOR SHALL FURNISH FIBERGLASS REINFORCED PLASTIC (FRP) STOP LOGS DESIGNED TO WITHSTAND A MAXIMUM DIFFERENTIAL HEAD OF 6 FEET.
2. STOP LOGS LEAK RATE SHALL BE IN ACCORDANCE WITH AWWA C563 DURING THE WARRANTY PERIOD (2 YEARS).
3. THE STOP LOG SUPPLIER SHALL PROVIDE TWO SETS OF SHOP DRAWINGS FOR APPROVAL PRIOR TO FABRICATION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING DIMENSIONS.
4. STOP LOGS AND GUIDE FRAMES SHOWN ON THESE PLANS ARE FOR CONCEPTUAL PURPOSE. THE CONTRACTOR WILL BE REQUIRED TO FURNISH FIBERGLASS REINFORCED PLASTIC (FRP) STOP LOGS DESIGNED TO WITHSTAND A MAXIMUM DIFFERENTIAL HEAD OF 6 FEET. STOPLOGS SHALL BE AS MANUFACTURED BY PLASTI-FAB OR ENGINEER APPROVED EQUIVALENT.
5. THE STOP LOG COVER SHALL BE FABRICATED SO AS TO TOTALLY SURROUND THE INTERNAL STRUCTURAL MATRIX AND PROTECT IT AGAINST CORROSION FROM MOISTURE OR CHEMICAL DETERIORATION. STOP LOGS SHALL BE DESIGNED SO THAT THE MAXIMUM FIBER STRESS (ULTIMATE OR YIELD, WHICHEVER APPLIES) DOES NO EXCEED 2.5 TIMES THE WORKING STRESS. STOP LOGS SHALL BE SUITABLY REINFORCED TO WITHSTAND THE MAXIMUM SEATING HEAD WITH A DEFLECTION LESS THAN ½ INCH. STOP LOG COVERS THAT ARE FABRICATED FROM PRESSED OR LAMINATED SHEET MATERIAL AND GLUED TO A SUBSTRUCTURE SHALL NOT BE ACCEPTABLE.
6. ALL STOP LOGS SHALL BE FLAT AND LEVEL. WARPAGE THROUGHOUT THE ENTIRE STOP LOG SHALL NOT PRODUCE A CROWN OF MORE THAN 1/16 INCH IN ANY DIRECTION. VISUAL INSPECTION FOR DEFECTS SHALL BE MADE WITHOUT THE AID OF MAGNIFICATION. DEFECTS SHALL BE CLASSIFIED AS TO TYPE AND LEVEL AS SHOWN IN TABLE 1 OF ANSI / ASTM D2563-0, APPROVED 1977, OR ANY SUBSEQUENT REVISION.
7. THE STOP LOGS SHALL BE EQUIPPED WITH ELASTOMERIC BOTTOM SEALS TO SEAL BETWEEN THE LOGS. A SPECIAL LABYRINTH SEAL SHALL ALSO BE FASTENED TO THE GUIDE TO FORM A WATERTIGHT JOINT WITH THE STOP LOGS. SEALS SHALL BE MADE OF MOLDED OR EXTRUDE VIRGIN NEOPRENE HAVING A HARDNESS OF 55 - 65 SHORE A DUROMETER, CONFORMING TO ASTM D-2000, WITH A MAXIMUM COMPRESSION SET OF 25% AND LOW TEMPERATURE BRITTLENESS TO MEET SUFFIX F-17 (-40 DEGREES F). GUIDES SHALL BE STYLED FOR WALL MOUNTING AS SHOWN ON THESE PLANS. GUIDES SHALL BE FABRICATED FROM T-304 STAINLESS STEEL OR FIBERGLASS AND SHALL HAVE A SLOT SUITABLE FOR MATING WITH THE STOP LOG. GUIDES TO BE BOLTED TO THE HEAD WALL SHALL BE EQUIPPED WITH HEAVY DUTY MOUNTING ANGLE FOR EASE OF MOUNTING TO THE CHANNEL WALL BY MEANS OF T-304 STAINLESS STEEL ANCHOR BOLTS.
8. GUIDES SHALL BE FITTED WITH A NEOPRENE SEAL HAVING TWO RAISED SEATING POINTS FASTENED TO THE GUIDE WITH A UNIMI CLAMPING BAR AND STAINLESS STEEL FLAT HEAD MACHINE SCREWS. SEALS SHALL BE ON EACH SIDE OF THE GUIDE GROOVE.
9. STOP LOG LEAK SHALL NOT EXCEED 0.20 GPM / FT OF WETTED PERIMETER DURING THE WARRANTY PERIOD (2 YEARS).
10. THE STOP LOG SUPPLIER SHALL PROVIDE TWO SETS OF SHOP DRAWING FOR CONTRACTOR AND ENGINEER APPROVAL PRIOR TO FABRICATION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING ALL DIMENSIONS. PRIOR TO DELIVERY, THE CONTRACTOR SHALL SUBMIT DOCUMENTATION FROM THE SUPPLIER REGARDING ACCEPTABILITY OF THE SUBJECT MATERIALS FOR THE PROJECT TO THE QC MANAGER AND THAT THE SUPPLIED STOPLOGS MEET THE LEAKAGE RATE SPECIFICATIONS IN THE CONSTRUCTION PLANS.
11. AS THE POOL LEVEL IS RAISED TO AN ELEVATION JUST BELOW THE TOP STOPLOG CREST, THE CONTRACTOR SHALL CONFIRM THAT THE STOPLOGS MEET THE LEAKAGE RATE SPECIFICATION BY CONDUCTING LEAKAGE TESTING OF INSTALLED STOPLOGS. ANY OPENINGS NOT MEETING THE LEAKAGE RATE SPECIFICATIONS SHALL BE REPAIRED BY THE SUPPLIER. THE CONTRACTOR SHALL PROVIDE FOUR (4) ADDITIONAL STOPLOGS IN ADDITION TO THE 18 DEPICTED ON THESE PLANS THAT WILL REMAIN ONSITE FOLLOWING CONSTRUCTION TO BE USED FOR TEMPORARILY SHUTTING OFF FLOW TO SELECTED STRUCTURES FOR INSPECTION AND MAINTENANCE PURPOSES.

STRUCTURAL GENERAL NOTES

1. IT IS SOLELY THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE ERECTION PROCEDURE AND SEQUENCE TO INSURE THE SAFETY OF THE STRUCTURE, ITS COMPONENT PARTS, AND WORKMEN AND EQUIPMENT DURING ERECTION. THIS INCLUDES, BUT IS NOT LIMITED TO, THE ADDITION OF WHATEVER TEMPORARY BRACING, GUYS OR TIE-DOWNS MAY BE NECESSARY. SUCH MATERIAL SHALL BE REMOVED AND SHALL REMAIN THE PROPERTY OF THE CONTRACTOR AFTER COMPLETION OF THE PROJECT.
2. ALL DIMENSIONS AND ELEVATIONS SHOWN ON THE STRUCTURAL DRAWINGS SHALL BE VERIFIED BY THE CONTRACTOR.
3. NO STRUCTURAL CHANGES FROM THE APPROVED PLANS SHALL BE MADE IN THE FIELD UNLESS, PRIOR TO MAKING CHANGES, WRITTEN APPROVAL IS OBTAINED FROM THE ENGINEER. IF CHANGES ARE MADE WITHOUT WRITTEN APPROVAL, SUCH CHANGES SHALL BE THE LEGAL AND FINANCIAL RESPONSIBILITY OF THE PARTY MAKING THE CHANGE.
4. STRUCTURAL DESIGN SHOWN ON THESE PLANS DO NOT INCLUDE CONSTRUCTION LOADINGS. IF THE CONTRACTOR'S MEANS AND METHODS WILL APPLY SIGNIFICANT SURCHARGE LOADS, IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO INFORM THE ENGINEER AHEAD OF TIME AND OBTAIN APPROVAL PRIOR TO USING SUCH MEANS AND METHODS.

CAST-IN-PLACE CONCRETE

1. CAST-IN-PLACE CONCRETE WORK SHALL CONFORM TO THE AMERICAN CONCRETE INSTITUTE CODES AND STANDARDS ACI 301_08 "STANDARD SPECIFICATIONS FOR STRUCTURAL CONCRETE" & HEREBY MADE A PART OF THESE DRAWINGS. ALL CONCRETE CONSTRUCTION SHALL CONFORM TO ACI 301_80, EXCEPT AS EXPLICITLY MODIFIED HEREIN.
2. ALL CONCRETE WORK SHALL BE IN ACCORDANCE WITH ACI 318-08, THE BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE.
3. CONCRETE SHALL HAVE THE FOLLOWING MINIMUM COMPRESSIVE STRENGTHS AT 28 DAYS.
   A. 4000 PSI WITH AN ENTRAINED AIR ADMIXTURE CONFORMING WITH ASTM C260 FOR ALL CONCRETE. THE AMOUNT OF ENTRAINED AIR SHALL BE 6% ± 1%.
4. SLUMP OF CONCRETE AT THE POINT OF PLACEMENT SHALL BE 4" +/- 1".
5. REINFORCING BARS TO BE ASTM A615, GRADE 60 KSI YIELD STRENGTH.
6. TACK WELDING OF THE REINFORCING SHALL NOT BE PERMITTED.
7. CALCIUM CHLORIDE SHALL NOT BE PERMITTED NOR SHALL ANY ADMIXTURE CONTAINING CALCIUM CHLORIDE BE PERMITTED.

CAST-IN-PLACE CONCRETE (CONT'D)

8. ALL CONCRETE SHALL CONTAIN A WATER REDUCING ADMIXTURE CONFORMING TO ASTM C494, TYPE A, F OR G.
9. ALUMINUM PIPE SHALL NOT BE USED WITH CONCRETE PUMPS.
10. CONCRETE SHALL BE DISCHARGED AT THE SITE WITHIN 1_1/2 HOURS AFTER WATER HAS BEEN ADDED TO THE CEMENT AND AGGREGATES. ADDITION OF WATER TO THE MIX AT THE PROJECT SITE WILL NOT BE ALLOWED. ALL WATER MUST BE ADDED AT THE BATCH PLANT.
11. REINFORCING BARS REQUIRED FOR PROPER SUPPORT OF PRINCIPAL REINFORCING SHALL BE DETAILED AND SUPPLIED BY THE CONTRACTOR WHETHER OR NOT THEY ARE INDICATED ON THE DRAWINGS. THE MINIMUM BAR SIZE SHALL BE #4 AND MAXIMUM SPACING SHALL BE 36" ON CENTER. WELDED WIRE FABRIC SHALL NOT BE USED FOR THE SUPPORT OF PRINCIPAL REINFORCING. CONCRETE CUBES OR SAND PLATED CHAIRS SHALL BE USED FOR THE SUPPORT OF REINFORCING ON GRADE.
12. THERE SHALL BE NO CONSTRUCTION JOINTS IN BASE SLABS AND FLOORS OF THE SPILLWAY OR HEADWALL STRUCTURES – CONCRETE SHALL BE PLACED IN A SINGLE POUR AND ALL REINFORCEMENT SHALL BE CONTINUOUS.
13. WHERE CONSTRUCTION JOINTS ARE REQUIRED IN WALLS AND ARE NOT INDICATED ON THE DRAWINGS, THEY SHALL BE LOCATED AT MIDSPAN OF WALL, AND SHALL BE SUBJECT TO REVIEW AND APPROVAL BY THE ENGINEER. UNLESS OTHERWISE NOTED OR SHOWN ON THE DRAWINGS, PROVIDE A CONTINUOUS SHEAR KEY AT JOINTS BETWEEN SLABS AND WALLS. THE MINIMUM KEY SIZE SHALL BE 1-1/2" DEEP BY 1/3 THE DEPTH OR WIDTH OF THE MEMBER.
14. OPENINGS.
   A. OPENINGS SHALL NOT BE PROVIDED IN SLABS AND WALLS UNLESS SHOWN ON STRUCTURAL DRAWINGS. IF ANY OPENING NOT SHOWN ON THE PLANS IS REQUIRED, SECURE APPROVAL OF THE ENGINEER BEFORE PROCEEDING.
   B. PROVIDE ½ NUMBER OF BARS INTERRUPTED PLUS ONE TYPICAL EACH FACE OF OPENING. PROVIDE TWO #5 BARS AROUND ALL SLAB AND WALL OPENINGS, EXTENDING 2' BEYOND OPENING IN EVERY DIRECTION UNLESS NOTED. OPENINGS NOT EXCEEDING 18" X 14" MAY BE SLEEVED AS REQUIRED BY WORKING THE REINFORCING STEEL AROUND THEM.
14. CHAMFER EXPOSED EDGES OF CONCRETE 3/4", UNLESS NOTED OTHERWISE.
15. REINFORCING BAR LAP SPLICES AND ANCHORAGE LENGTH SHALL CONFORM WITH ACI 318 REQUIREMENTS.
16. FOOTINGS, COLUMNS, WALLS.
   A. DOWELS IN BASE SLABS AND FOOTINGS TO MATCH VERTICAL WALL REINFORCING.
   B. PROVIDE CORNER BARS AT WALL AND FOOTING CORNERS TO MATCH HORIZONTAL REINFORCING. MINIMUM LENGTH OF EACH LEG TO BE – 2'-0" UNLESS SHOWN OTHERWISE.
   C. PROVIDE LEAN CONCRETE (f'c= 1500 PSI) UNDER FOUNDATIONS OR SLABS FOR ACCIDENTAL OVER-EXCAVATION, SOFT SPOTS AND TRENCHES.
17. DETERMINE SIZE AND LOCATION OF EQUIPMENT AND EMBEDDED STRUCTURES, AND MAKE PROVISIONS FOR BOLTS, SLEEVES, PADS, ETC, IN ACCORDANCE WITH THE MANUFACTURER'S CERTIFIED DRAWINGS.
19. EXPOSED EDGES SHALL BE CHAMFERED 3/4 INCH. EXPOSED, FORMED SURFACES SHALL RECEIVE A CLASS 1, ORDINARY SURFACE FINISH. EXPOSED, UNFORMED (HORIZONTAL SURFACES) SHALL RECEIVE A CLASS 3, FLOAT FINISH SURFACES.
20. NO CONCRETE SHALL BE PLACED IN ANY SECTION OF THE STRUCTURE UNTIL THE BEARING SURFACE/SUBGRADE FOR THAT STRUCTURE HAS BEEN APPROVED BY THE ENGINEER. UNSUITABLE BEARING SURFACES SHALL BE UNDERCUT AND REPLACED OR OTHERWISE IMPROVED TO THE SATISFACTION OF THE ENGINEER.
21. ALL CONCRETE AND/OR STEEL REINFORCEMENT SHALL BE HANDLED AND STORED IN SUCH MANNER AS TO AVOID DAMAGE OR CORROSION. IF CORROSION OR DAMAGE IS OBSERVED, REPLACEMENT MATERIALS MAY BE REQUIRED.
22. CONCRETE FIELD QUALITY CONTROL.
   A. THE ENGINEER WILL PERFORM CONCRETE TESTING, WHICH WILL INCLUDE PREPARATION OF TEST CONCRETE CYLINDERS, SLUMP TESTS, TESTS FOR AIR CONTENT, AND STRENGTH TESTS IN ACCORDANCE WITH ASTM C39.
   B. MINIMUM OF FOUR CYLINDERS WILL BE TAKEN FOR EACH 50 CU YD OF CONCRETE OR FRACTION THEREOF OR PER STRUCTURE FOR EACH STRENGTH AND TYPE OF CONCRETE BEING CAST THAT DAY. CONTRACTOR WILL ASSIST ENGINEER IN PREPARATION OF CONCRETE CYLINDERS AS APPROPRIATE.
   C. NO CONCRETE SHALL BE PLACED THAT DOES NOT MEET SLUMP OR AIR CONTENT REQUIREMENTS. ALL TESTS FOR AIR CONTENT SHALL BE MADE BY THE PRESSURE METHOD. SLUMP TESTS WILL BE TAKEN AT EACH 20 CU YD OF CONCRETE BEING PLACED.
   D. SLUMP EXCEEDING THE SPECIFIED MAXIMUM, WHEN OCCURRING IN 2 CONSECUTIVE TESTS MADE ON DIFFERENT PORTIONS OF THE SAME SAMPLE, WILL BE CAUSE FOR REJECTION OF THAT TRUCKLOAD.
   E. CONCRETE NOT MEETING THE REQUIREMENTS GIVEN HEREIN SHALL BE REMOVED AND REPLACED.
21. MINIMUM CONCRETE COVER: MINIMUM REBAR COVER SHALL BE 3", UNLESS SHOWN OTHERWISE ON THESE PLANS.

HDPE PIPE

1. HDPE PIPE SUPPLIED FOR THE WORK SHALL BE MANUFACTURED FROM VERY HIGH MOLECULAR WEIGHT HIGH DENSITY POLYETHYLENE RESIN RECOMMENDED BY THE PLASTIC PIPE INSTITUTE FOR AN 800 PSI HYDROSTATIC DESIGN STRESS RATING AT 140 DEGREES FAHRENHEIT, AND SHALL HAVE A PLASTIC PIPE INSTITUTE MATERIAL DESIGNATION OF PE 3408 AND A CELL CLASSIFICATION OF PE 345430 AS DETERMINED BY ASTM D3350.
2. THE STANDARD DIMENSION RATIO (SDR) RATING OF INDIVIDUAL HDPE SIPHON AND PRIMARY SPILLWAY PIPE AND FITTINGS SHALL CONFORM TO SDR 17.
3. JOINTS SHALL BE BUTT FUSED JOINTS WHICH MEET THE REQUIREMENTS ASTM D 3261 "STANDARD SPECIFICATION FOR BUTT HEAT FUSION POLYETHYLENE PLASTIC PIPE AND TUBING".
4. FOLLOWING BUTT FUSION AND FABRICATION OF SIPHON AND SPILLWAY PIPE RUNS, EACH RUN SHALL BE PRESSURE TESTED BY THE CONTRACTOR IN ACCORDANCE WITH ASTM F 1417. ANY PIPE RUNS NOT MEETING TEST REQUIREMENTS SHALL BE REPAIRED OR REBUILT UNTIL A PASSING TEST IS ACHIEVED.
5. HIGH DENSITY POLYETHYLENE PIPE (HDPE) AND FITTINGS FOR THE FILTER DIAPHRAGM LATERAL OUTLETS SHALL MEET THE REQUIREMENTS OF AASHTO M 252, TYPE C AND SHALL BE ADS N-12 WT/IB (GASKETED WATERTIGHT) OR APPROVED EQUIVALENT.
6. HDPE PIPE FOR THE FILTER DIAPHRAGM COLLECTION PIPE SHALL BE PERFORATED WITH A MAXIMUM SLOT WIDTH OF 0.120" AND MAXIMUM SLOT LENGTH OF 0.875" WITH 3" SPACING, AS SHOWN IN THESE PLANS.

For Supporting Design Calculations see
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STRUCTURAL STEEL

1. DETAIL, FABRICATE AND ERECT STRUCTURAL STEEL IN ACCORDANCE WITH THE LATEST AISC MANUAL OF STEEL CONSTRUCTION (ASD), AWS D1.1, AND OTHER CODES, STANDARDS, AND SPECIFICATIONS EXCEPT AS EXPLICITLY MODIFIED HEREIN.
2. CONTRACTOR RESPONSIBLE FOR ALL MISCELLANEOUS/ORNAMENTAL STEEL NOT SHOWN ON STRUCTURAL DRAWINGS.
3. STRUCTURAL STEEL MATERIALS:
   ROLLED STEEL PLATES, SHAPES, BARS, AND ROD: ASTM A36.
   STEEL PIPE: ASTM A53, TYPE E OR S, GRADE B.
   CORRUGATED METAL PIPE: ASTM A760, TYPE I
4. BOLTS: ASTM A307, HOT-DIP GALVANIZED, 3/4" DIAMETER MINIMUM, UNLESS NOTED OTHERWISE. ASTM A36 FOR ALL ANCHOR BOLTS.
5. COORDINATE STRUCTURAL DRAWINGS WITH ALL OTHER DRAWINGS FOR CLEARANCES, ATTACHMENTS, ETC.
6. ALL STEEL EXPOSED TO THE EXTERIOR SHALL BE HOT DIP GALVANIZED.
7. WELDING:
   PREPARATION OF BASE METAL PRIOR TO WELDING SHALL BE PERFORMED IN ACCORDANCE WITH AWS D1.1
   ALL WELDING SHALL BE DONE BY THE SHIELDED METAL ARC WELDING (SMAW) PROCESS.
   WELDING OPERATORS SHALL BE QUALIFIED IN ACCORDANCE WITH AWS STANDARD QUALIFICATION PROCEDURES. CERTIFICATIONS SHOWING THAT WELDERS EMPLOYED IN THE WORK HAVE SATISFACTORILY PASSED AWS QUALIFICATION TEST WITHIN THE PREVIOUS 12 MONTHS SHALL BE PROVIDED PRIOR TO BEGINNING SUCH WORK.

WOOD-FRAME WALKWAY CONSTRUCTION

1. CONTRACTOR SHALL CONSTRUCT A WALKWAY GENERALLY AS INDICATED ON PLANS. THE WALKWAY SHALL BE CONSTRUCTED OF TREATED LUMBER AND SHALL CONSIST OF A LANDING, STEPS AND PLATFORMS ALONG WITH ASSOCIATED FOUNDATION(S), RAILING(S), THREADS(S), POSTS(S), JOISTS(S) AND DECKING MEETING THE MINIMUM LOCAL BUILDING CODE REQUIREMENTS FOR COLBERT COUNTY, ALABAMA FOR EXTERIOR DECK CONSTRUCTION. ALL WOOD COMPONENTS SHALL BE TREATED DIMENSIONAL LUMBER WITH A COMPOSITE DECK PLANK OPTION ON THE WALKWAY SURFACES. ALL WALKWAYS INCLUDING LANDINGS, STEPS AND PLATFORMS SHALL HAVE RAILINGS. CONTRACTOR SHALL FOLLOW ALL OSHA REQUIREMENTS.
2. THE PURPOSE OF THE WALKWAY STRUCTURE IS TO PROVIDE ACCESS FROM THE TOP OF THE DIKE TO THE GATE VALVE OPERATORS ON THE SIPHON SPILLWAY PIPES. THE PLATFORM AT THE GATE OPERATORS SHALL BE 30" TO 36" BELOW THE ACTUAL GATE OPERATORS. ALL WALKWAYS SHALL BE A MINIMUM OF 6 FEET WIDE (CLEAR DISTANCE BETWEEN SIDE RAILS).

EXISTING SPILLWAY PIPE CLEANING

1. PRIOR TO PLACEMENT OF GROUT, ALL HORIZONTAL SPILLWAY PIPES SHALL BE CLEANED OF ALL SAND, DIRT, AND OTHER SOLID OR SEMI-SOLID MATERIALS. CLEANING WILL BE ACCOMPLISHED BY UTILIZING A HIGH PRESSURE, HYDRAULIC SEWER PIPELINE CLEANER. THE CLEANING OPERATION SHALL BE SUFFICIENT TO ALLOW THE CCTV CAMERA INSPECTION TO OBSERVE ANY STRUCTURAL DEFECTS, JOINT SEPARATION, MISALIGNMENT, ETC.
2. CLEANING SHALL INCLUDE TRAPPING AND REMOVAL OF ALL SEDIMENTS AND RESIDUAL WASTE INCLUDING RINSE WATER FROM THE SPILLWAY PIPES. THE CONTRACTOR SHALL DISPOSE OF RESIDUAL WASTE AT A LOCATION DESIGNATED BY TVA. WATER DECANTED FROM SUCTION TRUCKS SHALL BE PUMPED TO AN ACTIVE ASH POND OR HAULED OFF SITE AND DISPOSED OF IN ACCORDANCE WITH LOCAL AND STATE REGULATIONS.
3. POTABLE WATER REQUIRED FOR CLEANING WILL BE THE RESPONSIBILITY OF THE CONTRACTOR.

ISSUED FOR CONSTRUCTION

SCALE: NONE — EXCEPT AS NOTED

GENERAL NOTES

ASH POND 4 –
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

URS

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PLOT FACTOR: NTS

C.A.D. DRAWING DO NOT ALTER MANUALLY

GRADED FILTER/FILTER DIAPHRAGM

1. FILTERS SHALL BE INSTALLED AS SOON AS PRACTICABLE FOLLOWING GROUTING OPERATIONS, AND AS DESCRIBED USING THE CONSTRUCTION SEQUENCE OUTLINED ON THESE DRAWINGS.
2. FILTER GRAVEL MATERIAL USED AT THE SPILLWAY OUTLET PIPES SHALL MEET ALDOT NO. 327.02 MIX NO. 1 FILTER GRAVEL SPECIFICATIONS.

CLOSED CIRCUIT TELEVISION (CCTV)

1. AFTER CLEANING AND PRIOR TO FILLING THE EXISTING SPILLWAY PIPES WITH GROUT, THE SPILLWAY PIPES ARE TO BE INSPECTED VIA A CLOSED CIRCUIT TELEVISION (CCTV). THE INSPECTION SHALL BE CONDUCTED IN SUCH A MANNER AS TO DETERMINE THAT THE LINE IS CLEAN AND TO LOCATE LEAKING JOINTS, BREAKS, AND FAULTS IN THE PIPE. TELEVISION CAMERA MOVEMENT SHALL BE HALTED AT EACH VISIBLE POINT SOURCE OF INFILTRATION/INFLOW.
2. IF AT ANYTIME THE PIPE IS FOUND TO NOT BE CLEAN, THE CCTV WILL BE REMOVED AND THE CONTRACTOR SHALL RE-CLEAN THE PIPE UNTIL VIDEO FOOTAGE SHOWS THAT IT HAD BEEN ADEQUATELY CLEANED.
3. MINIMUM CCTV SPEED SHALL BE 10 FEET PER MINUTE.
4. THE CCTV TRUCK SHALL HAVE CERTIFIED PIPELINE ASSESSMENT AND CERTIFICATION PROGRAM (PACP) SOFTWARE (CURRENT VERSION IS 4.4 OR NEWER). THE CAMERA OPERATOR SHALL ALSO BE CERTIFIED.
5. THE PIPE INSPECTIONS PERFORMED SHALL BE CAPTURED AND SUBMITTED TO TVA IN A MOVING PICTURE EXPERT GROUP (MPEG) FORMAT. A SEPARATE MPEG FILE SHALL BE PRODUCED FOR EACH PIPE INSPECTED. MPEG FILE NAMES SHALL BE THE SAME AS THE SPILLWAY PIPE NAMES ON THESE DRAWINGS (I.E. SPILLWAY PIPE 4, ETC.). THE MPEG FILES SHALL BE DELIVERED TO TVA ON DVD DISCS OR AN EXTERNAL HARD DRIVE (USB 2.0).
6. DURING THE ENTIRE VIDEO OF THE PIPELINE, THE FOLLOWING INFORMATION SHALL BE CONTINUOUSLY DISPLAYED:
   a. AUTOMATIC UPDATE OF THE CAMERA'S FOOTAGE POSITION IN THE PIPELINE FROM ADJUSTED ZERO (ZERO BEING THE POINT OF ENTRY OF PIPE)
   b. PIPE DIMENSION IN INCHES
   c. SPILLWAY PIPE NAME
   d. DATE AND TIME OF VIDEO

   THE SIZE AND POSITION OF THE DATA DISPLAY SHALL BE SUCH AS NOT TO INTERFERE WITH THE MAIN SUBJECT OF THE PICTURE.
7. THE ENGINEER SHALL BE PRESENT DURING THE INTERNAL TELEVISION INSPECTION AND SHALL MONITOR THE LIVE VIDEO FEED DURING FILMING. NO INSPECTION SHALL BE PERFORMED WITHOUT THE ENGINEER PRESENT.

GEOTEXTILE

1. GEOTEXTILE USED BENEATH STONE SHALL BE A NON-WOVEN, POLYESTER OR POLYPROPYLENE FABRIC MEETING THE FOLLOWING MINIMUM PHYSICAL PROPERTIES: BURST STRENGTH – 300 PSI, TENSILE STRENGTH – 180 PSI, PUNCTURE STRENGTH – 45 LBS., PERMEABILITY – 2X10-1 CM/SEC, APPARENT OPENING SIZE – 0.15 MM – 0.21 MM, FABRIC WEIGHT – 8 OZ / SQ. YD. AN ACCEPTABLE PRODUCT IS MIRAFI 180N.
2. DURING ALL PERIODS OF SHIPMENT AND STORAGE, THE GEOTEXTILE SHALL BE PROTECTED FROM DIRECT SUNLIGHT, ULTRA-VIOLET RAYS, TEMPERATURE GREATER THAN 140 DEGREES FAHRENHEIT, MUD, DIRT, DUST AND DEBRIS. TO THE EXTENT POSSIBLE, THE GEOTEXTILE SHALL BE MAINTAINED WRAPPED IN A HEAVY DUTY PROTECTIVE COVERING.
3. THE CONTRACTOR SHALL ADHERE TO THE MANUFACTURER'S RECOMMENDATIONS AND THESE SPECIFICATIONS DURING INSTALLATION OF THE GEOTEXTILE.
4. THE SURFACE TO RECEIVE GEOTEXTILE SHALL BE PREPARED TO A RELATIVELY SMOOTH CONDITION FREE OF OBSTRUCTIONS, DEPRESSIONS, DEBRIS, AND SOFT OR LOW DENSITY POCKETS OF MATERIAL.
5. THE GEOTEXTILE SHALL BE PLACED WITH THE LONG DIMENSION PARALLEL WITH THE CENTERLINE OF THE DITCH, EMBANKMENT, OR ROAD AND SHALL BE LAID SMOOTH, AND FREE OF TENSION, STRESS, FOLDS, WRINKLES, OR CREASES.
6. GEOTEXTILE SHALL BE COVERED WITHIN 15 DAYS OF DEPLOYMENT. ANY GEOTEXTILE EXPOSED FOR MORE THAN 15 DAYS SHALL BE REMOVED AND REPLACED AT NO COST TO THE OWNER.

GROUT FOR EXISTING SPILLWAY ABANDONMENT

1. THE GROUT MIX SHALL BE DETERMINED BY THE CONTRACTOR. GROUT MAY BE COMPOSED OF PORTLAND CEMENT, FINE AGGREGATE (SAND) WATER, AND OTHER ADMIXTURES. THE USE OF ADMIXTURES SHALL BE APPROVED IN WRITING BY THE ENGINEER. THE DESIGN OF THE GROUT MIXTURE SHALL BE BASED ON THE WATER-CEMENT RATIO NECESSARY TO SECURE (1) A PLASTIC, FLOWABLE MIXTURE SUITABLE FOR THE SPECIFIC CONDITION OF PLACEMENT, (2) PROVIDE LESS THAN ONE-HALF PERCENT SHRINKAGE AND NO MORE THAN ONE-HALF PERCENT EXPANSION, AND (3) RETARD THE SETTING TIME TO AT LEAST THE TIME REQUIRED BY THE CONTRACTOR TO COMPLETE FILLING OF THE PIPE IN ONE, UNINTERRUPTED OPERATION. THE GROUT MIXTURE SHALL BE DESIGNED SO THAT IT WILL PRODUCE A MINIMUM LABORATORY COMPRESSIVE STRENGTH OF 1000 PSI OR GREATER AT 28 DAYS. THE GROUT SHALL BE CHEMICALLY COMPATIBLE WITH THE PIPE MATERIALS.
2. PORTLAND CEMENT SHALL MEET THE REQUIREMENTS OF ASTM C-150 FOR THE TYPE OF CEMENT SPECIFIED. PROVIDE TYPE 1 CEMENT UNLESS OTHERWISE DIRECTED BY THE ENGINEER. CEMENT SHALL BE PROPERLY STORED AND PROTECTED FROM WEATHER, DAMPNESS, OR OTHER DESTRUCTIVE AGENTS. ANY CEMENT WHICH IS DAMAGED WILL BE REJECTED AND NOT PERMITTED TO BE USED IN THE WORK. PORTLAND CEMENT SHALL BE SUBJECT TO SAMPLING AND TESTING IN ACCORDANCE WITH ASTM C-150.
3. WATER USED IN MIXING GROUT SHALL BE POTABLE WATER IN ACCORDANCE WITH ASTM C-94.
4. GROUTING SHALL COMMENCE USING THE PRIMARY PIPE. GAUGES TO MONITOR GROUT PRESSURE SHALL BE INSTALLED INTO THE INJECTION PIPING AND IMMEDIATELY ADJACENT TO THE CONCRETE BLOCK. THE GAUGES SHALL CONFORM TO AN ACCURACY OF NO MORE THAN ONE-HALF PERCENT ERROR OVER THE FULL RANGE, AND THE FULL RANGE SHALL NOT BE MORE THAN 100 PERCENT GREATER THAN THE MAXIMUM DESIGN PRESSURE. PRESSURE GAUGES SHALL BE INSTRUMENT OIL-FILLED, AND ATTACHED TO A SADDLE-TYPE DIAPHRAGM SEAL (GAUGE SAVER) TO PREVENT CLOGGING WITH GROUT. GAUGES SHALL BE CERTIFIED AND CALIBRATED IN ACCORDANCE WITH ANSI B40, GRADE 2A.
5. PRIOR TO FIRST PLACEMENT, A TEST BATCH OF GROUT DELIVERED TO OR PREPARED ON SITE SHALL BE SAMPLED AND TESTED BY THE ENGINEER TO CHECK FOR ADEQUATE FLUIDITY, SHRINKAGE, STRENGTH CHARACTERISTICS, AND INITIAL SET TIME. CONTRACTOR SHALL ASSIST THE ENGINEER AS REQUIRED TO PERFORM THIS TESTING.
6. GROUT SHALL BE INJECTED THROUGH THE PRIMARY PORT, WHICH DISCHARGES INTO THE SPILLWAY PIPE JUST UPSTREAM OF THE CONCRETE BLOCK. DURING GOUT INJECTION THE GROUT PRESSURE SHALL BE MONITORED. IF ELEVATED PRESSURES ARE DETECTED INDICATING THAT THE PRIMARY PORT HAS CLOGGED, THEN THE GROUT INJECTION SHALL BE DIVERTED AND CONTINUED THROUGH THE SECONDARY PIPE. GROUT PRESSURE SHALL NOT EXCEED 25 PSI. GROUT INJECTION SHALL BE TERMINATED WHEN GROUT FILLS THE RISER AT LEAST 10 FEET ABOVE THE INVERT OF THE RISER PIPE.
7. EACH SPILLWAY PIPE SHALL BE FILLED IN ONE CONTINUOUS, UNINTERRUPTED OPERATION. EQUIPMENT USED TO MIX, DELIVER, AND PLACE THE GROUT SHALL BE OF SUFFICIENT SIZE AND CAPACITY TO IMPLEMENT THIS REQUIREMENT.
8. THE CONTRACTOR SHALL MONITOR THE SLOPES AROUND AND ABOVE THE SPILLWAY PIPE. GROUND HEAVE OR DISTURBANCE WILL INDICATE THAT THE PIPING HAS BEEN BREACHED. IF HEAVE OCCURS DURING OPERATION OF THE PRIMARY GROUT PIPE, GROUTING OPERATIONS SHALL IMMEDIATELY BE SWITCHED TO THE SECONDARY PIPE.
9. THE GROUTING EQUIPMENT SHALL BE EQUIPPED WITH GAUGES OR FLOWMETERS THAT ALLOW CONTINUOUS MEASUREMENT OF THE GROUT TAKE DURING OPERATION.

SUBMITTALS

THE CONTRACTOR SHALL MAKE THE FOLLOWING SUBMITTALS FOR REVIEW AND APPROVAL BY THE ENGINEER UNLESS NOTED OTHERWISE. SUBMITTALS SHALL BE MADE A MINIMUM OF TWO WEEKS PRIOR TO MOBILIZATION. WORK ON ANY COMPONENT OF THE PROJECT SHALL NOT BEGIN UNTIL THE SUBMITTAL(S) CORRESPONDING TO THAT WORK HAVE BEEN APPROVED:

1. A DETAILED CONSTRUCTION PLAN OUTLINING:
   • SPECIFIC EQUIPMENT TO BE USED AND ITS PURPOSE.
   • METHODS TO BE USED TO IMPLEMENT DAM LOWERING, INCLUDING CONTRACTOR'S PROPOSED HAUL ROUTES.
   • LOCATION OF STAGING AREAS
   • METHODS FOR DELIVERING CONCRETE AND GROUT TO ITS DISCHARGE POINT
   • METHODS OF DELIVERING CONSTRUCTION MATERIALS TO THEIR PROPOSED LOCATIONS
   • PROPOSED METHOD OF CONTROLLING POND WATER LEVEL USING SIPHONS.
   • A DETAILED CONSTRUCTION SCHEDULE AND SEQUENCE
2. WELDING CERTIFICATIONS FOR PERSONNEL THAT WILL PERFORM WELDING ON THIS PROJECT.
3. MANUFACTURERS CUT SHEETS AND CERTIFICATION FOR ALL PIPING TO BE DELIVERED TO THE SITE (SIPHONS, 27-INCH PIPING, PVC DRAINS, ETC).
4. SUPPLIER CERTIFICATION FOR ALL CRUSHED STONE AND RIP-RAP TO BE DELIVERED TO THE SITE. CERTIFICATION SHOULD INDICATE THAT THE MATERIAL MEETS THE CORRESPONDING ALDOT REQUIREMENTS.
5. MIX DESIGN AND AT LEAST THREE (3) UNCONFINED COMPRESSIVE STRENGTH TEST RESULTS AT 28-DAYS FOR THE CONCRETE PROPOSED FOR USE. ALSO INCLUDE ADDRESS/LOCATION OF THE CONCRETE PLANT THAT THE MATERIAL WILL BE COMING FROM.
6. MANUFACTURER'S PRODUCT DATA FOR PROPOSED CONCRETE ADHESIVE ANCHORS.
7. DETAILED GROUTING PLAN DESCRIBING CONTRACTOR'S MEANS AND METHODS FOR GROUTING AND ABANDONING THE EXISTING SPILLWAYS. PLAN SHALL ALSO INCLUDE THE MIX DESIGN AND THREE (3) SAMPLE 28-DAY COMPRESSION TEST RESULTS FOR THE GROUT TO BE DELIVERED ON SITE.
8. SHOP DRAWINGS FOR ALL PROPOSED CAST-IN-PLACE CONCRETE STRUCTURES, SHOWING REINFORCEMENT PLACEMENT, TIES, CHAIRS, LOCATION OF ANCHORS AND EMBEDMENTS, ETC.
9. SHOP DRAWINGS AND PRODUCT DATA FOR METAL PEDESTRIAN GRATING AT SPILLWAY STRUCTURE – INCLUDE LOAD RATING.
10. SHOP DRAWINGS AND MANUFACTURER INFORMATION FOR FRP STOP LOGS.
11. SHOP DRAWINGS AND RELATED PRODUCT DATA FOR SIPHON SUPPORT STRUCTURES.
12. SHOP DRAWINGS FOR THE PROPOSED WOOD FRAME STAIRWAY/WALKWAY.
13. MATERIAL CHARACTERIZATION TESTING FOR ALL ON-SITE SOIL MATERIALS TO BE RECOMPACTED TO BACKFILL EXCAVATIONS. CHARACTERIZATION TESTING SHALL INCLUDE STANDARD PROCTOR TEST (ASTM D 698). MATERIAL SUBMITTED FOR TESTING SHOULD BE A REPRESENTATIVE SAMPLE, AND TEST RESULTS SHALL BE SUBMITTED TO ENGINEER A MINIMUM OF 48 HOURS PRIOR TO THE START OF FILL PLACEMENT.
14. IF IMPORTED FILL IS TO BE USED, SOILS CHARACTERIZATION TEST RESULTS OF THE FILL MATERIAL, INCLUDING MOISTURE CONTENT (ASTM D 2216), ATTERBERG LIMITS ANALYSIS (ASTM D 4318), PARTICLE SIZE ANALYSIS (ASTM D 422), AND STANDARD PROCTOR TEST RESULTS (ASTM D 698) SHALL BE SUBMITTED TO THE ENGINEER. SEPARATE CHARACTERIZATION TESTING SHALL BE DONE FOR EACH SEPARATE BORROW SOURCE THAT IS PROPOSED BY THE CONTRACTOR. TEST RESULTS SHALL BE SUBMITTED TO ENGINEER A MINIMUM OF 48 HOURS PRIOR TO THE START OF FILL PLACEMENT.

QUANITY LIST

THE FOLLOWING IS A LIST OF ITEMS TO BE COMPLETED FOR THIS PROJECT. SPECIFICATION NUMBERS ARE BASED ON THE ALABAMA DEPARTMENT OF TRANSPORTATION'S STANDARD SPECIFICATIONS, UNLESS OTHERWISE NOTED AS "SPECIAL". SPECIFICATIONS FOR ITEMS THAT ARE NOTED AS "SPECIAL" ARE DESCRIBED WITHIN THESE PLANS.

SPEC	DESCRIPTION	QUANTITY
610	RIPRAP, CLASS 1	130 CY
610	RIPRAP, CLASS 3	350 CY
430	AGGREGATE SURFACING (NO. 1 AND 2 STONE)	200 CY
533	27" HDPE CONDUIT	520 LF
533	18" HDPE CONDUIT	100 LF
533	12" HDPE CONDUIT FOR SIPHONS	1370 LF
533	4" PVC CONDUIT	200 LF
534	CLEANING EXISTING PIPE, 48" OR UNDER	1000 LF
430	AGGREGATE SURFACING (NO. 57 STONE)	1100 CY
501	STRUCTURAL PORTLAND CEMENT CONCRETE	
	SIPHON HEADWALL	2 CY
	SPILLWAY OUTLET HEADWALL	42 CY
	SPILLWAY STRUCTURE	30 CY
501	STRUCTURAL PORTLAND CEMENT CONCRETE	
	CONDUIT ENCASEMENT	100 CY
	THRUST BLOCKS	11 CY
SPECIAL	CONCRETE FOR SPILLWAY ABANDONMENT (GROUT)	300 CY
509	TREATED TIMBER (FOR WALKWAY)	1 LUMP
502	STEEL REINFORCEMENT	1 LUMP
508	STRUCTURAL STEEL AND MISCELLANEOUS METALS	1 LUMP
SPECIAL	30" FLOAT BALL	6 EACH
SPECIAL	CLEVIS HANGER	6 EACH
SPECIAL	TORPEDO STRAINERS	3 EACH
201	CLEARING AND GRUBBING	1 LUMP
205	REMOVAL AND RELOCATION OF STRUCTURES (FOOTBRIDGE, DOCKS)	2 EACH
600	MOBILIZATION	1 LUMP
603	ENGINEER'S FIELD OFFICE	1 LUMP
650	TOPSOIL	1210 CY
651	GROUND PREPARATION	1.5 ACRES
651	COMMERCIAL FERTILIZER	1 TON
652	SEEDING	1.5 ACRES
662	MOWING	1.5 ACRES
656	MULCHING	1.5 ACRES
665	SILT FENCE	3057 LF
665	SAND BAGS	1 LUMP
SPECIAL	DIVERSION BERM, AS PER PLAN	1200 LF
SPECIAL	CONSTRUCTION ENTRANCE, AS PER PLAN	2 EACH
SPECIAL	VACUUM FILL PORT	3 EACH
SPECIAL	TURBIDITY CURTAINS	1 LUMP
SPECIAL	FILTER DIAPHRAGM	1 EACH
	No. 7 STONE	10 CY
	C-33 SAND	60 CY
	4" PERFORATED PVC CONDUIT, SCH. 40	60 LF
SPECIAL	8" VENT TEE MANIFOLD	1 LUMP
	SADDLE TEE	4 EACH
	8" HDPE CONDUIT	60 LF
	6" GALVANIZED PIPE BOLLARDS	6 EACH
	CLASS C CONCRETE	3 CY
SPECIAL	CLOSED CIRCUIT TELEVISION	1 LUMP
SPECIAL	STOP LOGS WITH GUIDE FRAMING	4 EACH
SPECIAL	GALVANIZED 96" CMP SKIMMERS	4 EACH
SPECIAL	TRASH RACK	1 EACH
SPECIAL	DAVIT CRANE	2 EACH
SPECIAL	HANDRAIL	
	1-1/2" SCH 40 GALV STEEL RAIL	74 LF
	1-1/2" SCH 40 GALV STEEL POST	16 LF
	4" SCH 40 PIPE SLEEVE	4 EACH

ISSUED FOR CONSTRUCTION

For Supporting Design Calculations see

SCALE: NONE EXCEPT AS NOTED

GENERAL NOTES

ASH POND 4 –
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT

URS

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

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PLOT FACTOR: NTS

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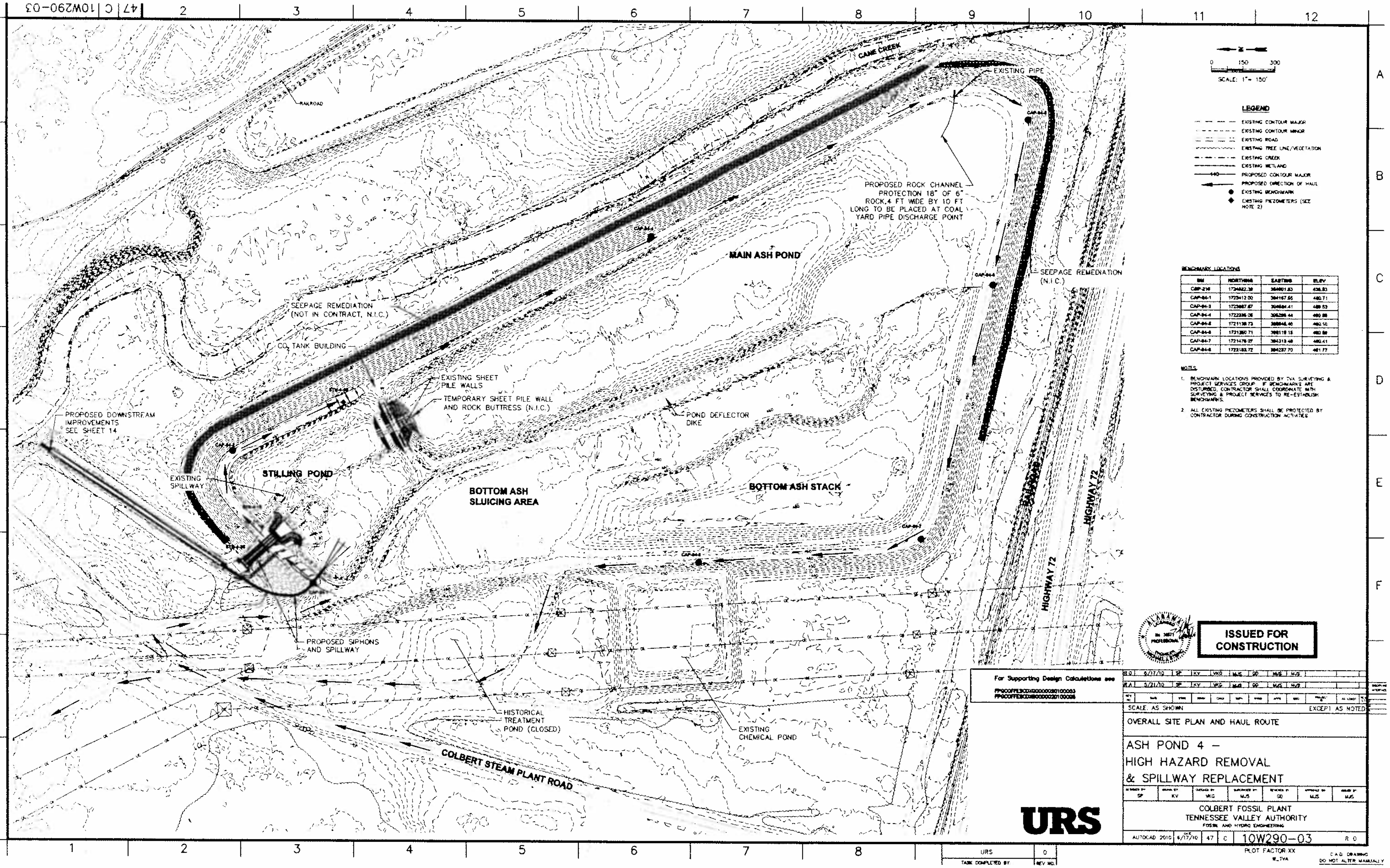
ISSUED FOR CONSTRUCTION
LEGEND
EXISTING CONTOUR MAJOR
EXISTING CONTOUR MINOR
EXISTING ROAD
EXISTING TREE LINE/VEGETATION
EXISTING CREEK
EXISTING WETLAND
PROPOSED CONTOUR MAJOR
PROPOSED DIRECTION OF HAUL
EXISTING BENCHMARK
EXISTING PIEZOMETERS (SEE NOTE 2)
SCALE: 1"= 150'
BENCHMARK LOCATIONS
BM
NORTHING
EASTING
ELEV
NOTES
1. BENCHMARK LOCATIONS PROVIDED BY TVA SURVEYING & PROJECT SERVICES GROUP. IF BENCHMARKS ARE DISTURBED, CONTRACTOR SHALL COORDINATE WITH SURVEYING & PROJECT SERVICES TO RE-ESTABLISH BENCHMARKS.
2. ALL EXISTING PIEZOMETERS SHALL BE PROTECTED BY CONTRACTOR DURING CONSTRUCTION ACTIVITIES.
CANE CREEK
RAILROAD
EXISTING PIPE
PROPOSED ROCK CHANNEL PROTECTION 18" OF 6" ROCK,4 FT WIDE BY 10 FT LONG TO BE PLACED AT COAL YARD PIPE DISCHARGE POINT
MAIN ASH POND
SEEPAGE REMEDIATION (N.I.C.)
SEEPAGE REMEDIATION (NOT IN CONTRACT, N.I.C.)
CO_2 TANK BUILDING
EXISTING SHEET PILE WALLS
TEMPORARY SHEET PILE WALL AND ROCK BUTTRESS (N.I.C.)
POND DEFLECTOR DIKE
PROPOSED DOWNSTREAM IMPROVEMENTS SEE SHEET 14
EXISTING SPILLWAY
STILLING POND
BOTTOM ASH SLUICING AREA
BOTTOM ASH STACK
HIGHWAY 72
PROPOSED SIPHONS AND SPILLWAY
HISTORICAL TREATMENT POND (CLOSED)
EXISTING CHEMICAL POND
COLBERT STEAM PLANT ROAD
For Supporting Design Calculations see
SCALE AS SHOWN
EXCEPT AS NOTED
OVERALL SITE PLAN AND HAUL ROUTE
ASH POND 4 –
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING
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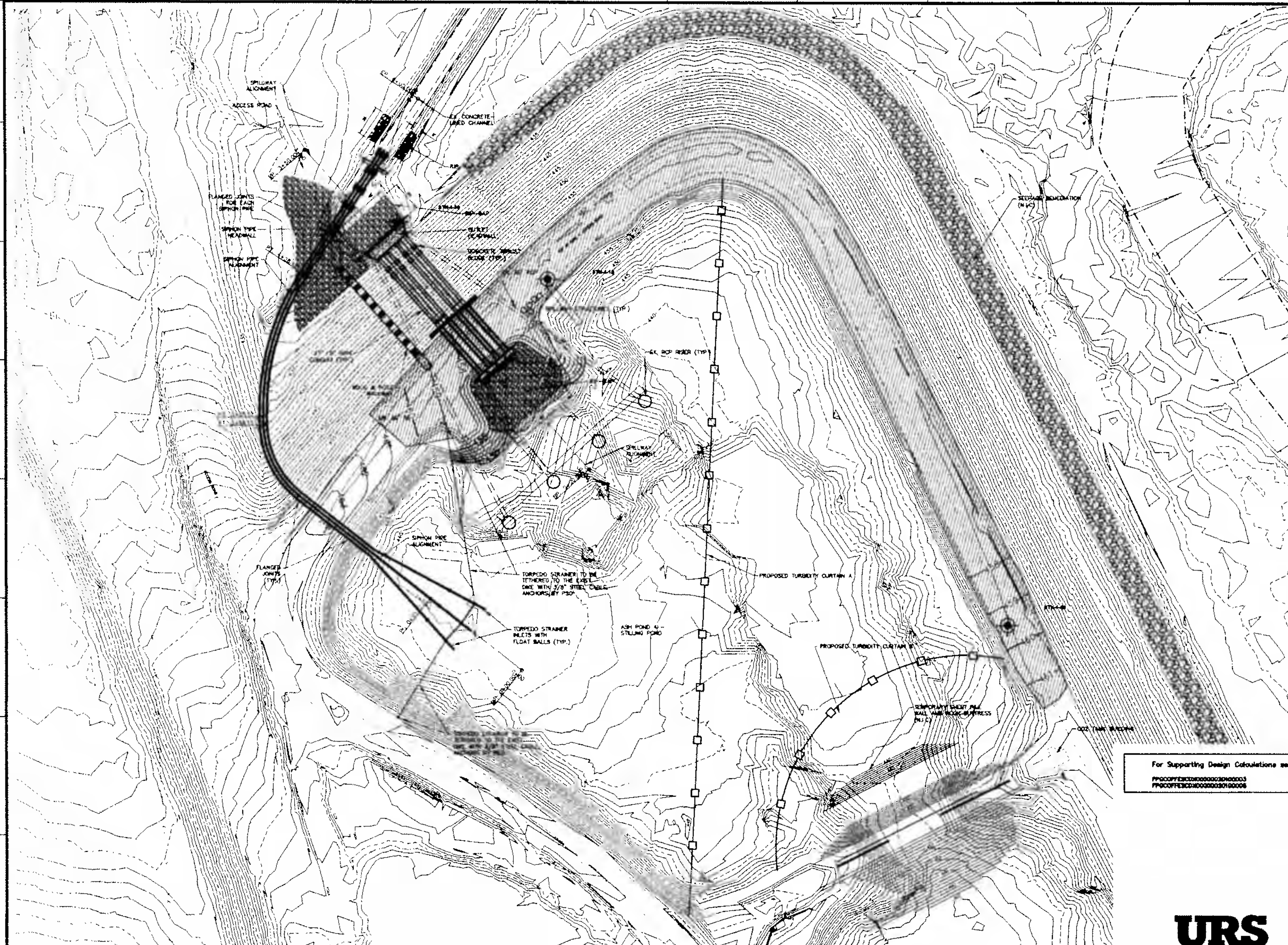
TASK COMPLETED BY
REV NO.
47 C 10W290-03



LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- EXISTING SHEET PILE WALL
- EXISTING ROAD
- PROPOSED RIP RAP
- EXISTING TREE-LINE/VEGETATION
- PROPOSED DIKE LOWERING
- EXISTING PIEZOMETERS

SCALE: 1"=30'

PROPOSED CONSTRUCTION SEQUENCE

1. INSTALL TURBIDITY CURTAIN "A" NORTH OF FINGER DIKE AREA AND CURTAIN "B" UPSTREAM OF THE SPILLWAY AND SIPHON WORK AREA. TURBIDITY CURTAIN "A" DIAGONALLY THROUGH THE STILLING POND AND CURTAIN "B" NORTH OF THE FINGER DIKE AREA WILL BE IN PLACE FROM PREVIOUS CONTRACT WORK. THE CURTAINS SHALL BE INSPECTED AND REPAIRED AS NECESSARY TO MAKE THEM SERVICEABLE FOR THIS CONTRACT WORK.
2. CONSTRUCT TEMPORARY BUTTRESS AND SHEET PILING (SEE SEPARATE WORK PLAN).
3. INSTALL OTHER CONTROLS PER CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN (CBMPP) - CAN BE DONE SIMULTANEOUSLY WITH BUTTRESS CONSTRUCTION.
4. PREPARE ACCESS TO BASE OF DIKE AT DISCHARGE CHANNEL.
5. START CONSTRUCTING DOWN-SLOPE PORTION OF SIPHON PIPES.
6. AFTER COMPLETION OF TEMPORARY BUTTRESS AND SHEET PILE, MOVE TURBIDITY CURTAIN "A" TO SOUTH OF NEW BUTTRESS/SHEETPILING.
7. FINISH CONSTRUCTING SIPHONS AND PERFORM VERIFICATION TESTING.
8. UPON COMPLETION OF THE REQUIRED BUTTRESS PRELOAD PERIOD (SEE BUTTRESS AND SHEET PILE WORK PLAN), DEWATER STILLING BASIN TO ELEVATION 447.0' USING SIPHONS. MAINTAIN WATER LEVEL IN STILLING BASIN WITH SIPHONS CONTINUOUSLY THROUGHOUT REMAINDER OF CONSTRUCTION UNTIL NEW SPILLWAY SYSTEM IS PUT INTO SERVICE.
9. IMPLEMENT DIKE LOWERING AS REQUIRED IN THESE PLANS.
10. PLACE SANDBAGS ACROSS THE CONCRETE CHANNEL, UPSTREAM FROM THE SIPHON OUTLETS, TO ALLOW INSPECTION OF EXISTING OUTLET PIPES AND RISERS IN THE DRY.
11. CLEAN AND INSPECT EXISTING OUTLET PIPES AND RISERS USING CCTV METHOD.
12. EXCAVATE AND INSTALL NEW HEADWALL STRUCTURE FOR OUTLET PIPES.
13. EXCAVATE AND INSTALL NEW SPILLWAY STRUCTURE IN THE NORTH FACE OF THE DIKE.
14. INSTALL NEW SPILLWAY PIPES, CONNECTING SPILLWAY STRUCTURE TO HEADWALL STRUCTURE AND INSTALL FILTER DIAPHRAGM AND PIPES. STUBS FOR SEEPAGE COLLECTION PIPING (SEE SEPARATE WORK PLAN) SHALL ALSO BE PROVIDED IN THE HEADWALL AT THIS TIME.
15. WHEN CURING OF CAST-IN-PLACE CONCRETE STRUCTURES IS COMPLETE (CONCRETE HAS REACHED DESIGN STRENGTH), BACKFILL BOTH SPILLWAY AND HEADWALL STRUCTURES TO FINAL GRADE.
16. REGRADE AND INSTALL NEW RIPRAP UPSTREAM OF SPILLWAY STRUCTURE AND DOWNSTREAM OF HEADWALL STRUCTURE.
17. CLEAN, GROUT AND ABANDON THE EXISTING SPILLWAY PIPES AND RISERS AS REQUIRED HEREIN.
18. IMPLEMENT CUTTING AND LOWERING OF CENTER SECTION OF TEMPORARY BUTTRESS AND SHEET PILE TO EL. 462 (SEE SEPARATE WORK PLAN).
19. THROTTLE BACK SIPHONS TO ALLOW WATER LEVEL TO COME BACK UP IN STILLING POND.
20. REMOVE SANDBAGS AT MOST OPPORTUNE TIME - SHUT OFF SIPHONS SLIGHTLY BEFORE WATER STARTS SPILLING OVER NEW SPILLWAYS TO REMOVE THE SANDBAGS IN THE DRY.
21. WHEN STILLING POND REACHES EL. 463, THE NEW SPILLWAY WILL BE IN SERVICE AND WILL BE THE NEW CONTROL FOR THE POND SYSTEM.
22. MOVE TURBIDITY CURTAIN "B" TO FRONT OF NEW ENTRANCE CHANNEL.
23. REMOVE EXTENDED SECTIONS OF SIPHON PIPES AND INSTALL TURN-UP ENDS TO DISCHARGE INTO RIPRAP AREA OF BASIN.
24. REMOVE SWPPP CONTROLS.

ISSUED FOR CONSTRUCTION

For Supporting Design Calculations see
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FPGCOFFESCDX000000030100006

REV	DATE						
R 0	6/17/10	SW/SP TJG	GD/VG MJS	GD	MJS	MJS	
R A	5/21/10	SW/SP TJG	GD/VG MJS	GD	MJS	MJS	

SCALE: 1" = 30' EXCEPT AS NOTED

DIKE LOWERING, SIPHON AND SPILLWAY PLAN

ASH POND 4 -
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
SW/SP	TJG	GD/VG	MJS	GD	MJS	MJS

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

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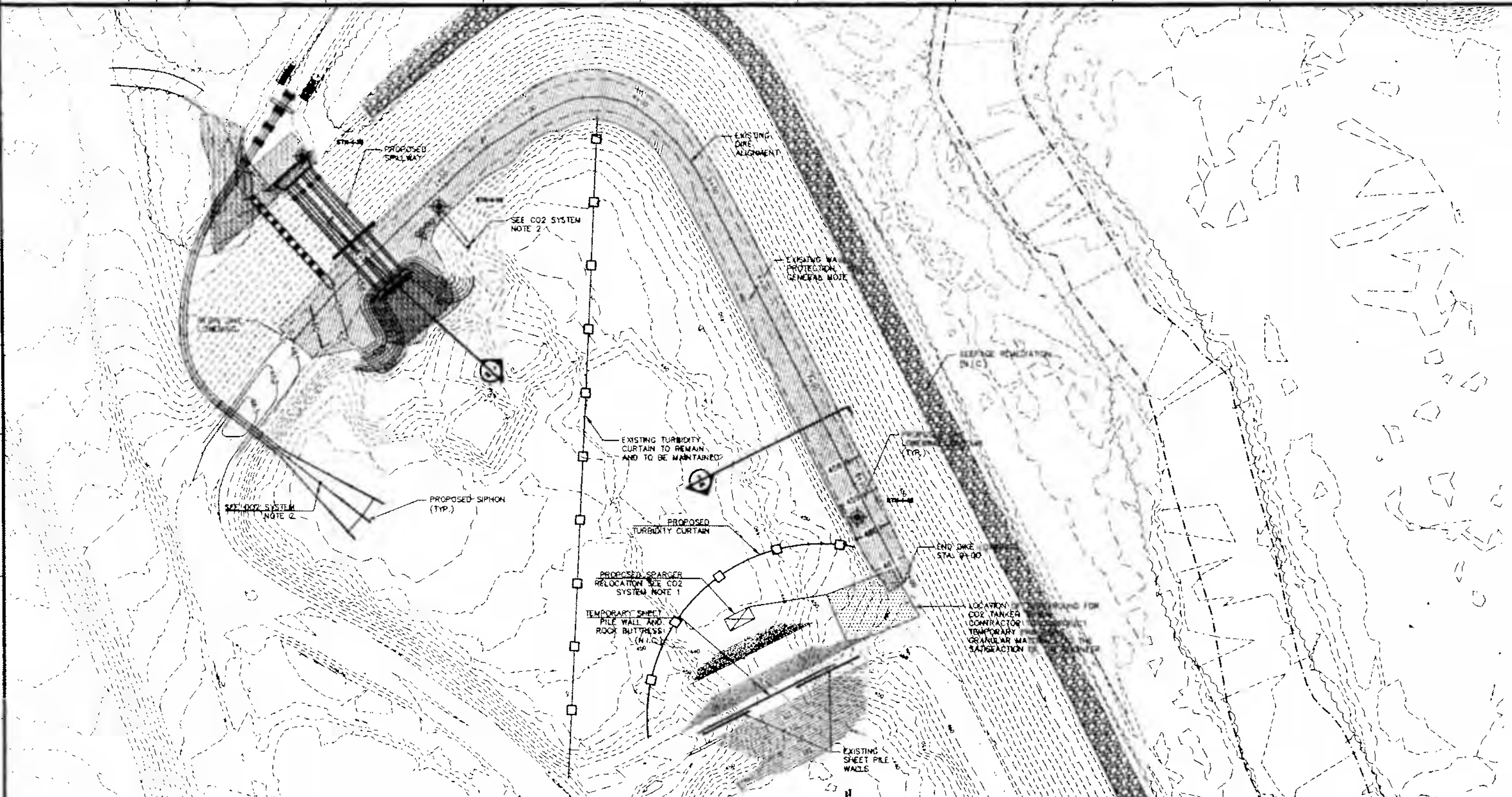
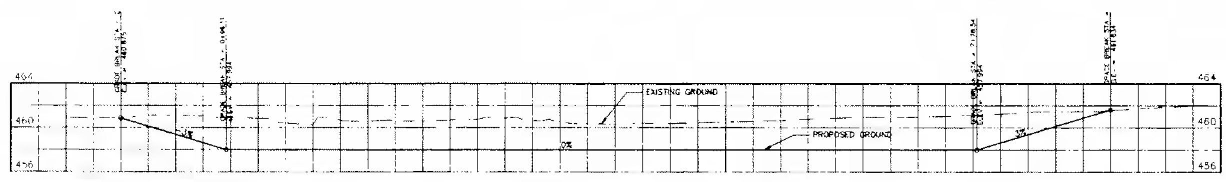


PLAN VIEW

0 40 80
SCALE: 1" = 40'



PROFILE VIEW ALONG CENTERLINE OF LOWERED SECTION OF DIKE

HORIZONTAL SCALE: 1" = 40'
VERTICAL EXAGERATION = 10x

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- EXISTING ROAD
- PROPOSED CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- CROSS SECTION LOCATION (SECTION NUMBER/SHEET NUMBER WHERE IT IS DRAWN)
- PROPOSED DIKE LOWERING
- EXISTING PIEZOMETERS (SEE GENERAL NOTE 2)

GENERAL NOTES

1. EXISTING WAVE EROSION PROTECTION ABOVE EL. 458 TO BE REMOVED AND REPLACED IN SAME CONFIGURATION BELOW THE LOWEST ELEVATION OF EXISTING PROTECTION.
2. ALL EXISTING PIEZOMETERS SHALL BE PROTECTED BY CONTRACTOR DURING CONSTRUCTION ACTIVITIES.

CO2 SYSTEM NOTES

1. PLANT WILL PROVIDE ADDITIONAL BRAIDED STAINLESS STEEL CABLE AS NECESSARY TO SECURE CO2 SPARGER.
2. PH SENSOR CURRENTLY LOCATED AT DOCK STRUCTURE TO BE MOVED TO MIDDLE TORPEDO STRAINER. RELOCATION SHALL OCCUR PRIOR TO LOWERING OF WATER LEVEL. PLANT TO PROVIDE ADDITIONAL CABLE AS NECESSARY TO CONNECT TO CONTROL SYSTEM.
3. FINAL LOCATION OF PH SENSOR TO BE AT NEW SPILLWAY.

For Supporting Design Calculations see FPGCOFFEBCOM0000000020100006

ISSUED FOR CONSTRUCTION

SCALE AS SHOWN — EXCEPT AS NOTED

DIKE LOWERING PLAN AND PROFILE

ASH POND 4 –
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

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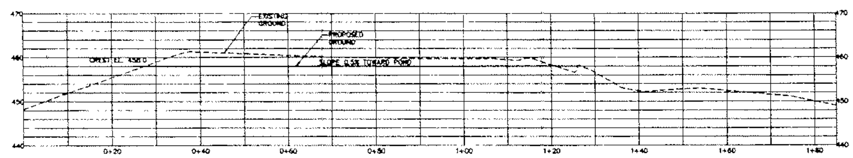
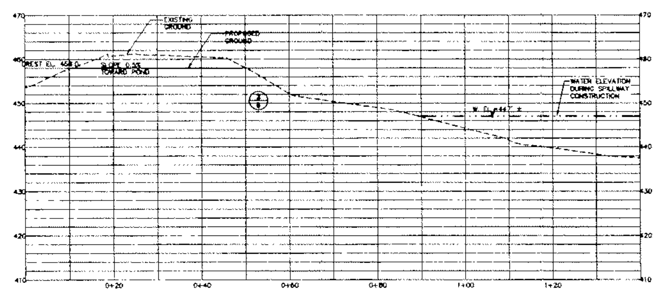
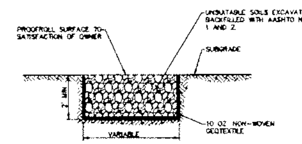


DIKE CROSS SECTION AT SPILLWAY- SECTION 1 - SHEET 5
HORIZONTAL SCALE: 1"=10'
VERTICAL EXAGERATION = NONE

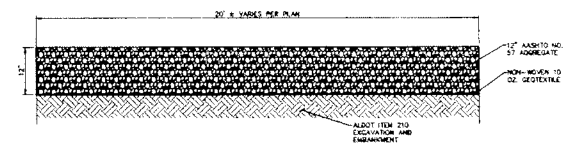


TYPICAL DIKE CROSS SECTION 2 - SHEET 5
HORIZONTAL SCALE: 1"=10'
VERTICAL EXAGERATION = NONE

0 10 20
SCALE: 1"= 10'



SUBGRADE REPAIR
N.T.S.



TYPICAL PAVEMENT DETAIL
N.T.S.

Detail No
Sheet Where Shown
REFERENCE KEY

ISSUED FOR CONSTRUCTION

For Supporting Design Calculations see

SCALE: AS SHOWN — EXCEPT AS NOTED

TYPICAL DIKE SECTIONS AND DETAILS

ASH POND 4 –
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT

SEP	KV	VKG	GD	MJS	MJS	MJS

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FOSSIL AND HYDRO ENGINEERING

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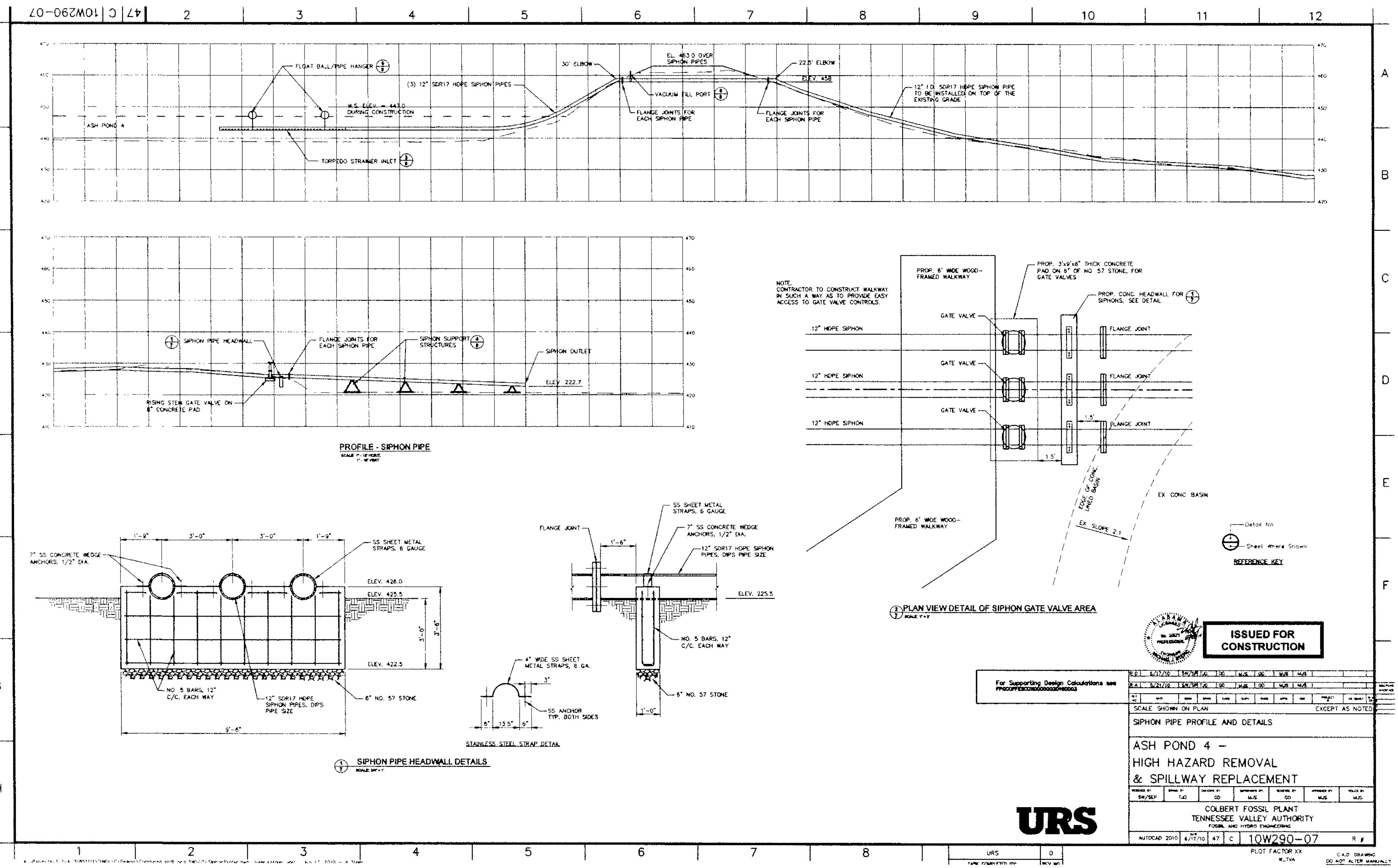

FLOAT BALL/PIPE HANGER
(3) 12" SDR17 HDPE SIPHON PIPES
W.S. ELEV. = 447.0 DURING CONSTRUCTION
ASH POND 4
TORPEDO STRAINER INLET
30° ELBOW
EL. 463.0 OVER SIPHON PIPES
VACUUM FILL PORT
FLANGE JOINTS FOR EACH SIPHON PIPE
22.5° ELBOW
ELEV. 458
12" I.D. SDR17 HDPE SIPHON PIPE TO BE INSTALLED ON TOP OF THE EXISTING GRADE
SIPHON PIPE HEADWALL
SIPHON SUPPORT STRUCTURES
SIPHON OUTLET
ELEV. 222.7
RISING STEM GATE VALVE ON 6" CONCRETE PAD
PROFILE - SIPHON PIPE
NOTE: CONTRACTOR TO CONSTRUCT WALKWAY IN SUCH A WAY AS TO PROVIDE EASY ACCESS TO GATE VALVE CONTROLS.
PROP. 6' WIDE WOOD-FRAMED WALKWAY
PROP. 3'x9'x8" THICK CONCRETE PAD ON 6" OF NO. 57 STONE, FOR GATE VALVES
PROP. CONC. HEADWALL FOR SIPHONS, SEE DETAIL
GATE VALVE
12" HDPE SIPHON
FLANGE JOINT
EDGE OF CONC. LINED BASIN
EX. SLOPE 2:1
EX. CONC BASIN
PLAN VIEW DETAIL OF SIPHON GATE VALVE AREA
Detail No.
Sheet Where Shown
REFERENCE KEY
7" SS CONCRETE WEDGE ANCHORS, 1/2" DIA.
SS SHEET METAL STRAPS, 6 GAUGE
ELEV. 426.0
ELEV. 425.5
ELEV. 422.5
NO. 5 BARS, 12" C/C, EACH WAY
12" SDR17 HDPE SIPHON PIPES, DIPS PIPE SIZE
6" NO. 57 STONE
1'-9"
3'-0"
9'-6"
3'-6"
SIPHON PIPE HEADWALL DETAILS
4" WIDE SS SHEET METAL STRAPS, 6 GA.
SS ANCHOR TYP. BOTH SIDES
13.5"
STAINLESS STEEL STRAP DETAIL
1'-6"
ELEV. 225.5
1'-0"
ISSUED FOR CONSTRUCTION
For Supporting Design Calculations see
SCALE SHOWN ON PLAN
EXCEPT AS NOTED
SIPHON PIPE PROFILE AND DETAILS
ASH POND 4 –
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT
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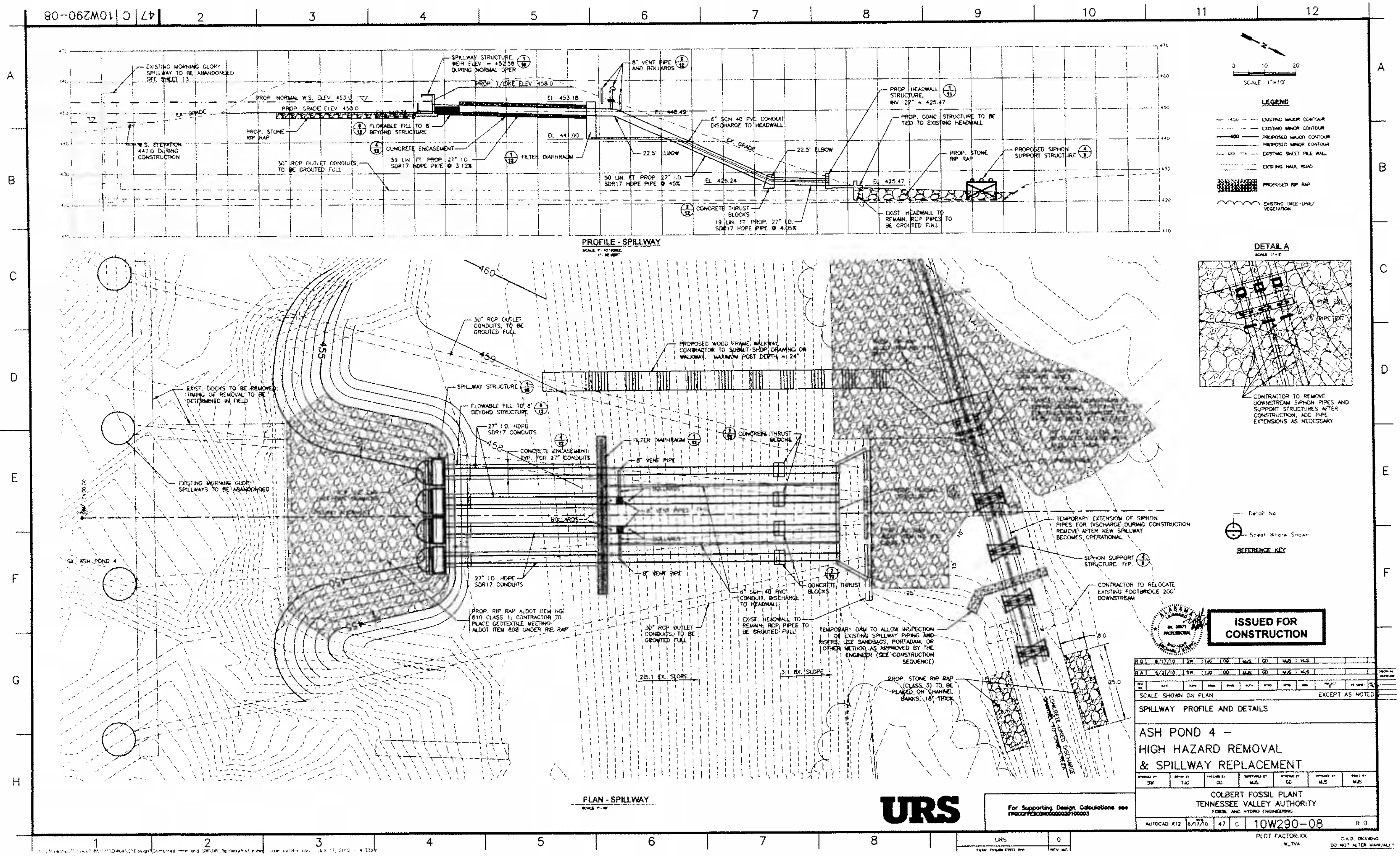
PROFILE - SPILLWAY
PLAN - SPILLWAY
DETAIL A
LEGEND
REFERENCE KEY
ISSUED FOR CONSTRUCTION
EXISTING MORNING GLORY SPILLWAY TO BE ABANDONED SEE SHEET 13
SPILLWAY STRUCTURE WEIR ELEV = 452.58 DURING NORMAL OPER
8" VENT PIPE AND BOLLARDS
PROP. NORMAL W.S. ELEV. 453.0
PROP. GRADE ELEV. 453.0
EX. GRADE
PROP. STONE RIP RAP
W.S. ELEVATION 447.0 DURING CONSTRUCTION
30" RCP OUTLET CONDUITS TO BE GROUTED FULL
FLOWABLE FILL TO 8' BEYOND STRUCTURE
CONCRETE ENCASEMENT
59 LIN. FT. PROP. 27" I.D. SDR17 HDPE PIPE @ 3.12%
FILTER DIAPHRAGM
EL. 453.18
EL. 448.49
EL. 441.00
6" SCH 40 PVC CONDUIT DISCHARGE TO HEADWALL
22.5° ELBOW
50 LIN. FT. PROP. 27" I.D. SDR17 HDPE PIPE @ 45%
EL. 426.24
CONCRETE THRUST BLOCKS
19 LIN. FT. PROP. 27" I.D. SDR17 HDPE PIPE @ 4.05%
PROP. HEADWALL STRUCTURE, INV. 27" = 425.47
PROP. CONC. STRUCTURE TO BE TIED TO EXISTING HEADWALL
EL. 425.47
EXIST. HEADWALL TO REMAIN, RCP PIPES TO BE GROUTED FULL
PROPOSED SIPHON SUPPORT STRUCTURE
PROPOSED WOOD FRAME WALKWAY. CONTRACTOR TO SUBMIT SHOP DRAWING ON WALKWAY. MAXIMUM POST DEPTH = 24"
EXIST. DOCKS TO BE REMOVED. TIMING OF REMOVAL TO BE DETERMINED IN FIELD
EXISTING MORNING GLORY SPILLWAYS TO BE ABANDONED
27" I.D. HDPE SDR17 CONDUITS
PROP. RIP RAP ALDOT ITEM NO. 610 CLASS 1; CONTRACTOR TO PLACE GEOTEXTILE MEETING ALDOT ITEM 608 UNDER RIP RAP
TEMPORARY DAM TO ALLOW INSPECTION OF EXISTING SPILLWAY PIPING AND RISERS. USE SANDBAGS, PORTADAM, OR OTHER METHOD AS APPROVED BY THE ENGINEER (SEE CONSTRUCTION SEQUENCE)
PROP. STONE RIP RAP (CLASS 3) TO BE PLACED ON CHANNEL BANKS, 18" THICK
CONCRETE LINED DISCHARGE CHANNEL TO CANE CREEK
TEMPORARY EXTENSION OF SIPHON PIPES FOR DISCHARGE DURING CONSTRUCTION REMOVED AFTER NEW SPILLWAY BECOMES OPERATIONAL
SIPHON SUPPORT STRUCTURE, TYP.
CONTRACTOR TO RELOCATE EXISTING FOOTBRIDGE 200' DOWNSTREAM
CONTRACTOR TO REMOVE DOWNSTREAM SIPHON PIPES AND SUPPORT STRUCTURES AFTER CONSTRUCTION. ADD PIPE EXTENSIONS AS NECESSARY
215:1 EX. SLOPE
3:1 EX. SLOPE
EX. ASH POND 4
SCALE: SHOWN ON PLAN
EXCEPT AS NOTED
SPILLWAY PROFILE AND DETAILS
ASH POND 4 –
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING
URS
For Supporting Design Calculations see
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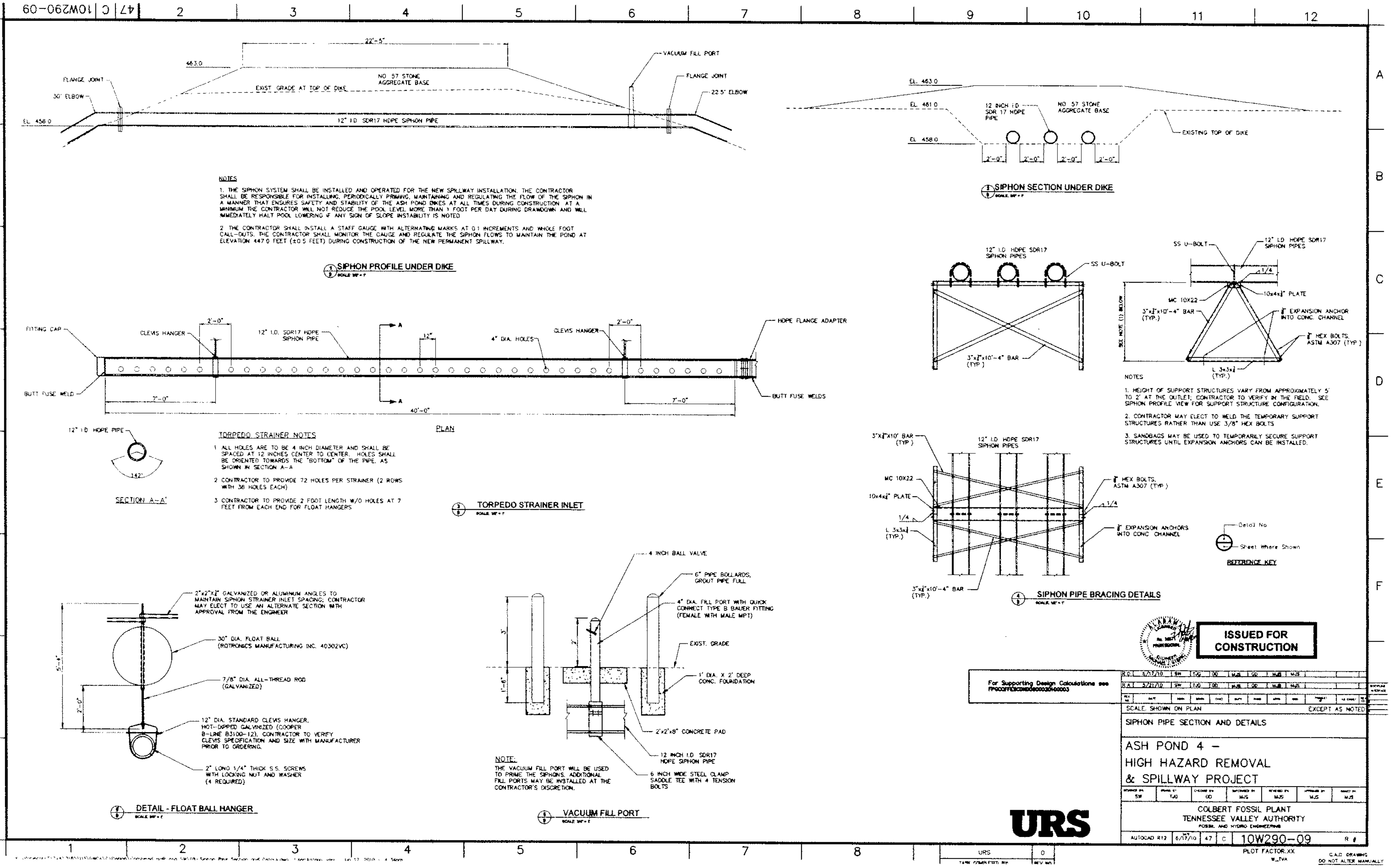
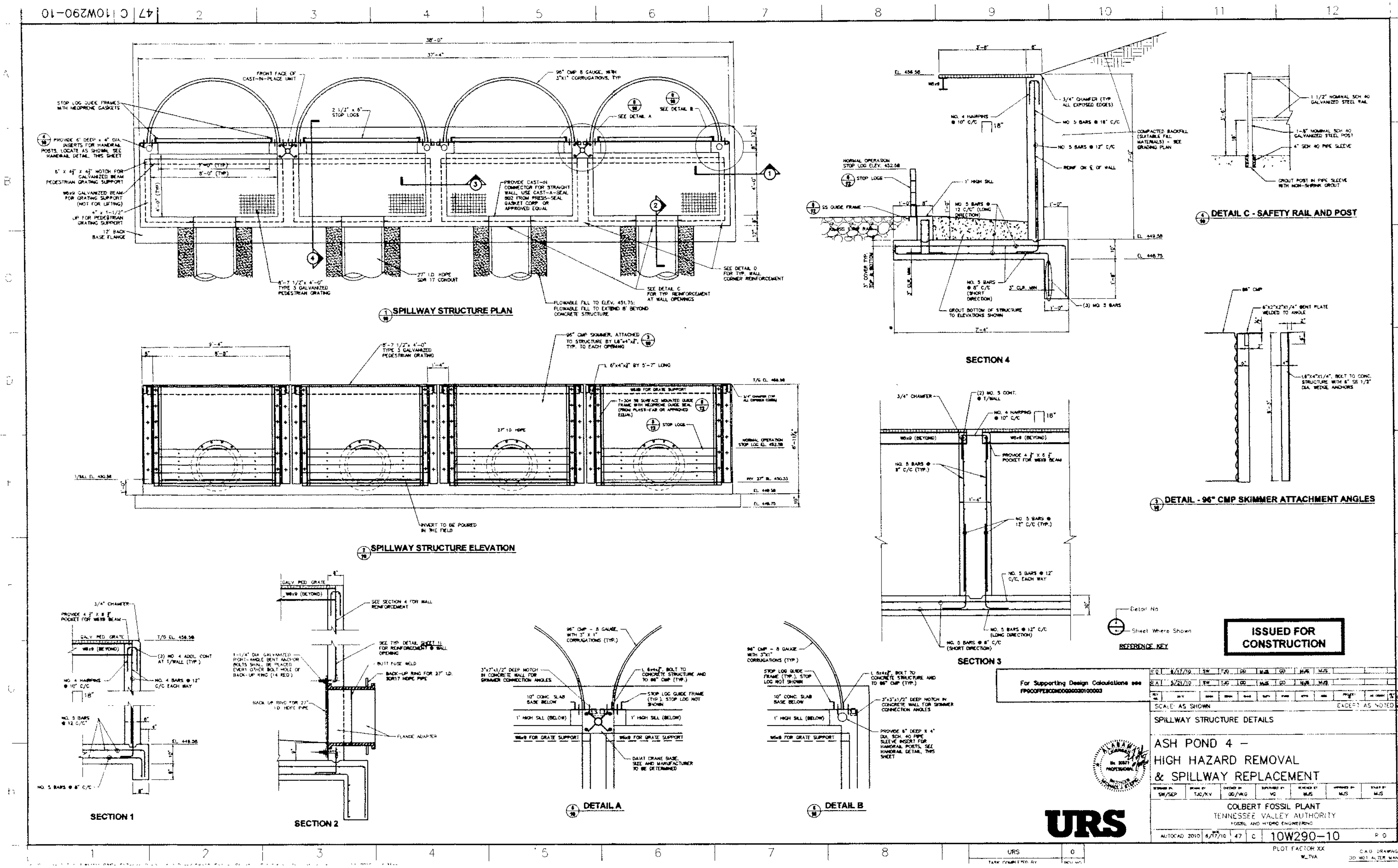
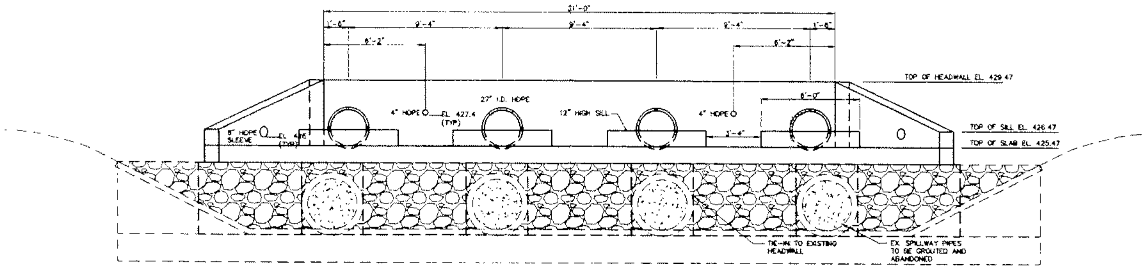
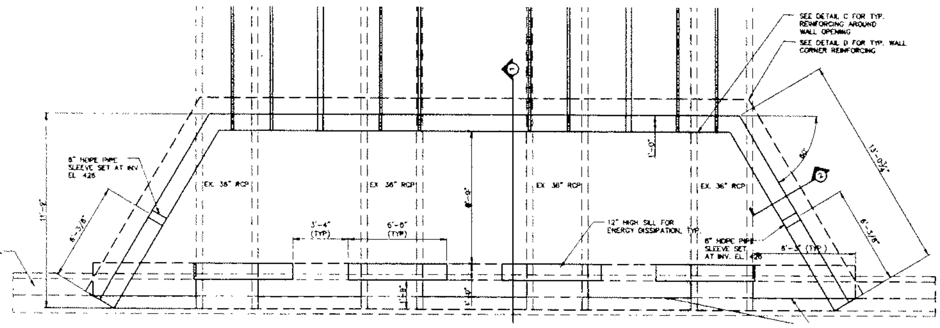


47 C 10W290-09
22'-5"
463.0
FLANGE JOINT
30' ELBOW
EL. 458.0
EXIST. GRADE AT TOP OF DIKE
NO. 57 STONE AGGREGATE BASE
12" I.D. SDR17 HDPE SIPHON PIPE
VACUUM FILL PORT
FLANGE JOINT
22.5' ELBOW
NOTES
1. THE SIPHON SYSTEM SHALL BE INSTALLED AND OPERATED FOR THE NEW SPILLWAY INSTALLATION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR INSTALLING, PERIODICALLY PRIMING, MAINTAINING AND REGULATING THE FLOW OF THE SIPHON IN A MANNER THAT ENSURES SAFETY AND STABILITY OF THE ASH POND DIKES AT ALL TIMES DURING CONSTRUCTION. AT A MINIMUM THE CONTRACTOR WILL NOT REDUCE THE POOL LEVEL MORE THAN 1 FOOT PER DAY DURING DRAWDOWN AND WILL IMMEDIATELY HALT POOL LOWERING IF ANY SIGN OF SLOPE INSTABILITY IS NOTED.
2. THE CONTRACTOR SHALL INSTALL A STAFF GAUGE WITH ALTERNATING MARKS AT 0.1 INCREMENTS AND WHOLE FOOT CALL-OUTS. THE CONTRACTOR SHALL MONITOR THE GAUGE AND REGULATE THE SIPHON FLOWS TO MAINTAIN THE POND AT ELEVATION 447.0 FEET (±0.5 FEET) DURING CONSTRUCTION OF THE NEW PERMANENT SPILLWAY.
SIPHON PROFILE UNDER DIKE
EL. 463.0
EL. 461.0
EL. 458.0
12 INCH I.D. SDR 17 HDPE PIPE
NO. 57 STONE AGGREGATE BASE
EXISTING TOP OF DIKE
2'-0"
SIPHON SECTION UNDER DIKE
FITTING CAP
BUTT FUSE WELD
CLEVIS HANGER
2'-0"
12" I.D. SDR17 HDPE SIPHON PIPE
12"
4" DIA. HOLES
HDPE FLANGE ADAPTER
BUTT FUSE WELDS
7'-0"
40'-0"
PLAN
12" I.D. HDPE PIPE
142°
SECTION A-A'
TORPEDO STRAINER NOTES
1. ALL HOLES ARE TO BE 4 INCH DIAMETER AND SHALL BE SPACED AT 12 INCHES CENTER TO CENTER. HOLES SHALL BE ORIENTED TOWARDS THE "BOTTOM" OF THE PIPE, AS SHOWN IN SECTION A-A.
2. CONTRACTOR TO PROVIDE 72 HOLES PER STRAINER (2 ROWS WITH 36 HOLES EACH)
3. CONTRACTOR TO PROVIDE 2 FOOT LENGTH W/O HOLES AT 7 FEET FROM EACH END FOR FLOAT HANGERS.
TORPEDO STRAINER INLET
12" I.D. HDPE SDR17 SIPHON PIPES
SS U-BOLT
3"x1/4"x10'-4" BAR (TYP.)
MC 10X22
10x4x1/2" PLATE
3/8" EXPANSION ANCHOR INTO CONC. CHANNEL
3/8" HEX BOLTS, ASTM A307 (TYP.)
L 3x3x1/4 (TYP.)
SEE NOTE (1) BELOW
NOTES
1. HEIGHT OF SUPPORT STRUCTURES VARY FROM APPROXIMATELY 5' TO 2' AT THE OUTLET; CONTRACTOR TO VERIFY IN THE FIELD. SEE SIPHON PROFILE VIEW FOR SUPPORT STRUCTURE CONFIGURATION.
2. CONTRACTOR MAY ELECT TO WELD THE TEMPORARY SUPPORT STRUCTURES RATHER THAN USE 3/8" HEX BOLTS.
3. SANDBAGS MAY BE USED TO TEMPORARILY SECURE SUPPORT STRUCTURES UNTIL EXPANSION ANCHORS CAN BE INSTALLED.
3"x1/4"x10' BAR (TYP.)
3/8" EXPANSION ANCHORS INTO CONC. CHANNEL
3"x1/4"x10'-4" BAR (TYP.)
SIPHON PIPE BRACING DETAILS
Detail No.
Sheet Where Shown
REFERENCE KEY
2"x2"x1/4" GALVANIZED OR ALUMINUM ANGLES TO MAINTAIN SIPHON STRAINER INLET SPACING; CONTRACTOR MAY ELECT TO USE AN ALTERNATE SECTION WITH APPROVAL FROM THE ENGINEER
30" DIA. FLOAT BALL (ROTRONICS MANUFACTURING INC. 40302VC)
7/8" DIA. ALL-THREAD ROD (GALVANIZED)
12" DIA. STANDARD CLEVIS HANGER, HOT-DIPPED GALVANIZED (COOPER B-LINE B3100-12), CONTRACTOR TO VERIFY CLEVIS SPECIFICATION AND SIZE WITH MANUFACTURER PRIOR TO ORDERING.
2" LONG 1/4" THICK S.S. SCREWS WITH LOCKING NUT AND WASHER (4 REQUIRED)
5'-4"
2'-0"
DETAIL - FLOAT BALL HANGER
4 INCH BALL VALVE
6" PIPE BOLLARDS, GROUT PIPE FULL
4" DIA. FILL PORT WITH QUICK CONNECT TYPE B BAUER FITTING (FEMALE WITH MALE MPT)
EXIST. GRADE
1' DIA. X 2' DEEP CONC. FOUNDATION
2'x2'x8" CONCRETE PAD
12 INCH I.D. SDR17 HDPE SIPHON PIPE
6 INCH WIDE STEEL CLAMP SADDLE TEE WITH 4 TENSION BOLTS
NOTE:
THE VACUUM FILL PORT WILL BE USED TO PRIME THE SIPHONS. ADDITIONAL FILL PORTS MAY BE INSTALLED AT THE CONTRACTOR'S DISCRETION.
VACUUM FILL PORT
ISSUED FOR CONSTRUCTION
For Supporting Design Calculations see
SCALE: SHOWN ON PLAN
EXCEPT AS NOTED
SIPHON PIPE SECTION AND DETAILS
ASH POND 4 –
HIGH HAZARD REMOVAL
& SPILLWAY PROJECT
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING
URS
AUTOCAD R12
6/17/10
47
C
10W290-09
PLOT FACTOR:XX
C.A.D. DRAWING DO NOT ALTER MANUALLY

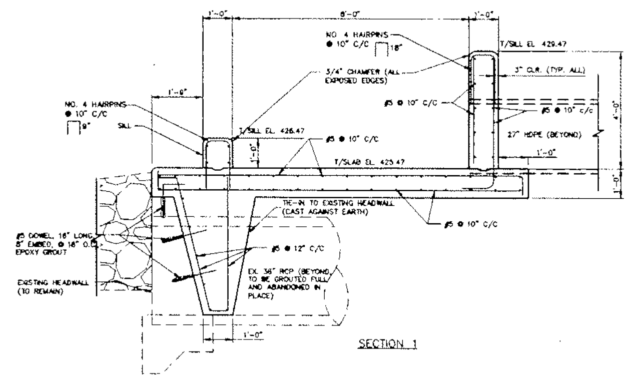

SPILLWAY STRUCTURE PLAN
SPILLWAY STRUCTURE ELEVATION
SECTION 1
SECTION 2
SECTION 3
SECTION 4
DETAIL A
DETAIL B
DETAIL C - SAFETY RAIL AND POST
DETAIL - 96" CMP SKIMMER ATTACHMENT ANGLES
REFERENCE KEY
ISSUED FOR CONSTRUCTION
SCALE: AS SHOWN
EXCEPT AS NOTED
SPILLWAY STRUCTURE DETAILS
ASH POND 4 -
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING
URS
10W290-10
47 C 10W290-10



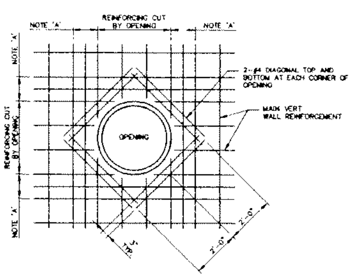
1/11 ELEVATION - OUTLET HEADWALL DETAILS



2/11 PLAN - OUTLET HEADWALL DETAILS

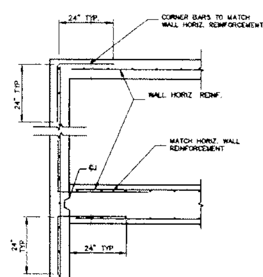


SECTION 1

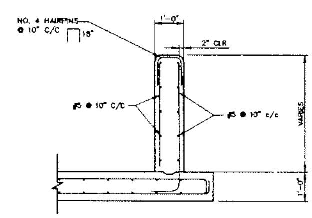


NOTE 'A':
ALL REINFORCING, TOP AND BOTTOM WHICH IS CUT BY THE OPENING SHALL BE ADDED EQUALLY TO EACH SIDE OF THE OPENING AND PLACED BETWEEN NORMAL SLAB REINFORCING. THE ADDED REINFORCING SHALL BE THE SAME LENGTH AS THE NORMAL REINFORCING.

DETAIL C
TYPICAL REINFORCING AROUND OPENING IN FLAT SLAB/WALL



DETAIL D
TYPICAL CONCRETE WALL CORNER REINFORCING



SECTION 2

Detail No
Sheet Where Shown
REFERENCE KEY

ISSUED FOR CONSTRUCTION

For Supporting Design Calculations see

SCALE: AS SHOWN EXCEPT AS NOTED

OUTLET HEADWALL DETAILS

ASH POND 4 –
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT

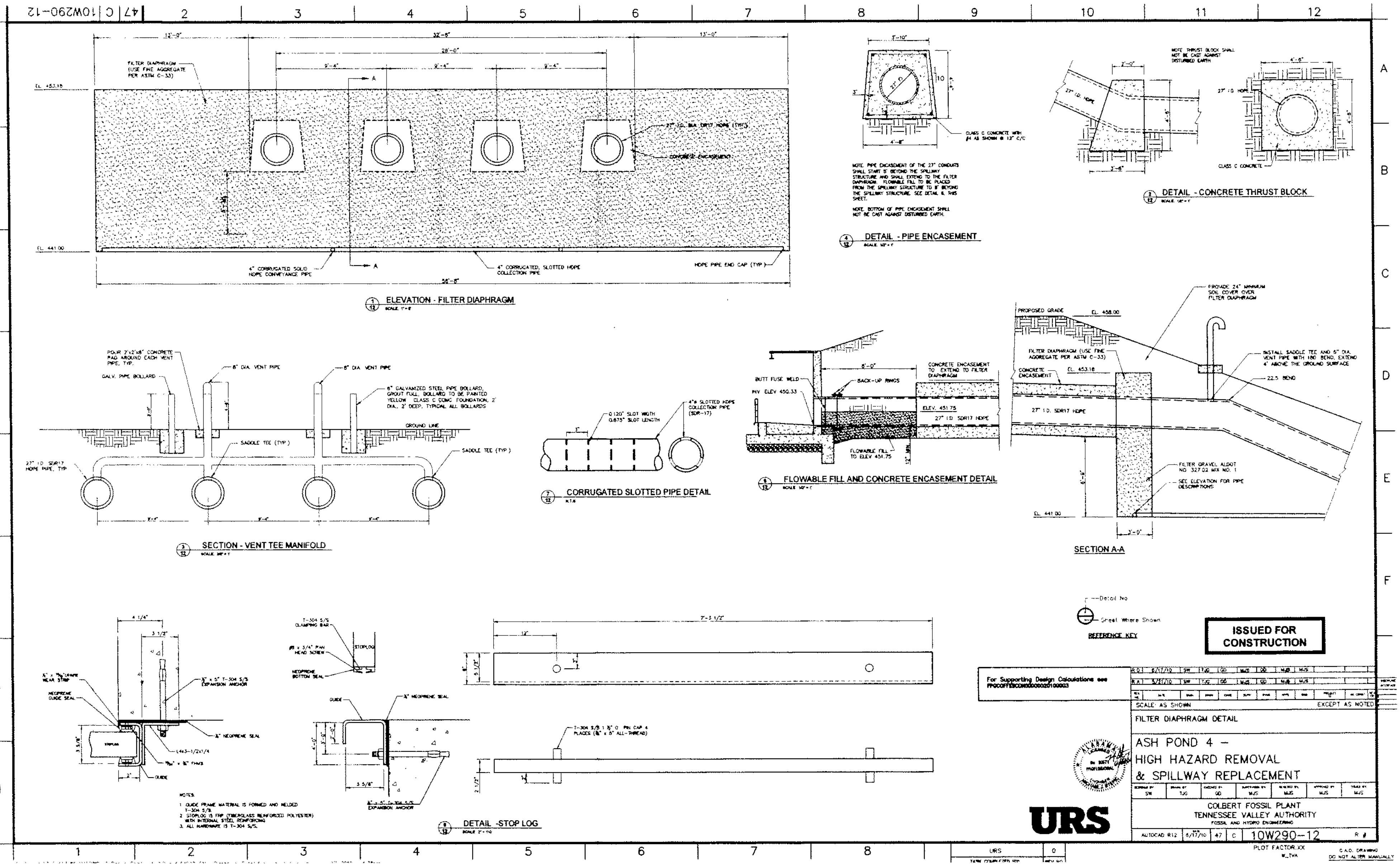
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

URS

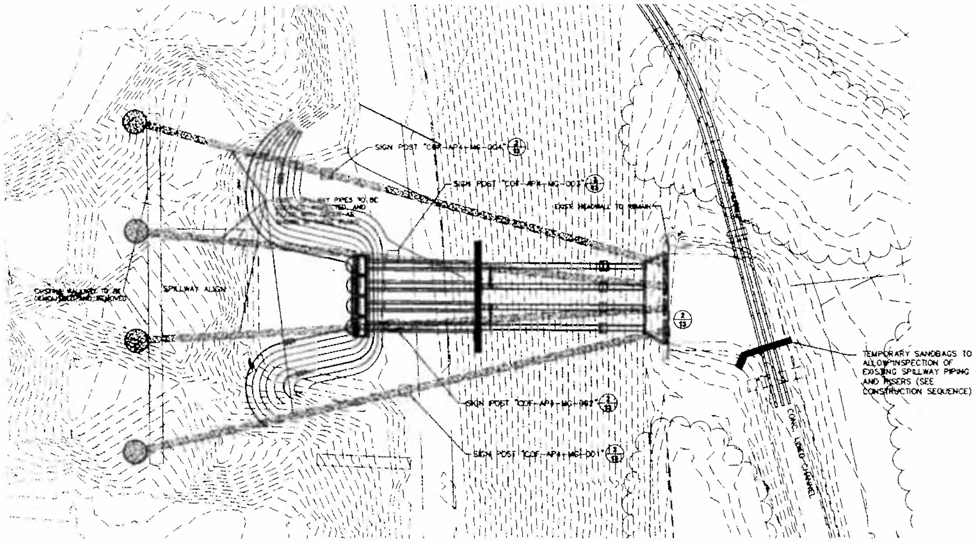
AUTOCAD R12 | 6/17/10 | 47 | C | 10W290-11

PLOT FACTOR:XX

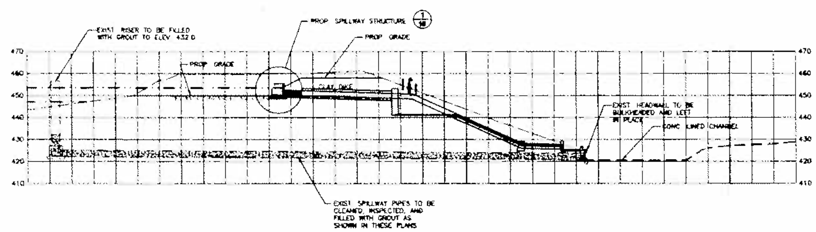
C.A.D. DRAWING DO NOT ALTER MANUALLY



ELEVATION - FILTER DIAPHRAGM
FILTER DIAPHRAGM (USE FINE AGGREGATE PER ASTM C-33)
27" I.D. DIA. DR17 HDPE (TYP.)
CONCRETE ENCASEMENT
4" CORRUGATED SOLID HDPE CONVEYANCE PIPE
4" CORRUGATED, SLOTTED HDPE COLLECTION PIPE
HDPE PIPE END CAP (TYP.)
EL. 453.18
EL. 441.00
DETAIL - PIPE ENCASEMENT
CLASS C CONCRETE WITH #4 AS SHOWN @ 12" C/C
DETAIL - CONCRETE THRUST BLOCK
NOTE: THRUST BLOCK SHALL NOT BE CAST AGAINST DISTURBED EARTH.
CLASS C CONCRETE
27" I.D. HDPE
SECTION - VENT TEE MANIFOLD
8" DIA. VENT PIPE
GALV. PIPE BOLLARD
SADDLE TEE (TYP.)
GROUND LINE
27" I.D. SDR17 HDPE PIPE, TYP.
CORRUGATED SLOTTED PIPE DETAIL
0.120" SLOT WIDTH
0.875" SLOT LENGTH
FLOWABLE FILL AND CONCRETE ENCASEMENT DETAIL
BUTT FUSE WELD
INV. ELEV. 450.33
BACK-UP RINGS
CONCRETE ENCASEMENT TO EXTEND TO FILTER DIAPHRAGM
ELEV. 451.75
27" I.D. SDR17 HDPE
FLOWABLE FILL TO ELEV 451.75
SECTION A-A
PROPOSED GRADE
EL. 458.00
EL. 453.18
EL. 441.00
22.5 BEND
FILTER GRAVEL ALDOT NO. 327.02 MIX NO. 1
SEE ELEVATION FOR PIPE DESCRIPTIONS
DETAIL - STOP LOG
GUIDE
NEOPRENE SEAL
STOPLOG
NOTES:
1. GUIDE FRAME MATERIAL IS FORMED AND WELDED T-304 S/S.
2. STOPLOG IS FRP (FIBERGLASS REINFORCED POLYESTER) WITH INTERNAL STEEL REINFORCING.
3. ALL HARDWARE IS T-304 S/S.
REFERENCE KEY
Detail No
Sheet Where Shown
ISSUED FOR CONSTRUCTION
For Supporting Design Calculations see
SCALE: AS SHOWN
EXCEPT AS NOTED
FILTER DIAPHRAGM DETAIL
ASH POND 4 –
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING
URS
AUTOCAD R12
6/17/10
47
C
10W290-12
PLOT FACTOR XX
C.A.D. DRAWING
DO NOT ALTER MANUALLY



PLAN - SPILLWAY ABANDONMENT



PROFILE - SPILLWAY ABANDONMENT

ABANDONMENT SEQUENCING

1. PROPOSED SPILLWAY STRUCTURE TO BE OPERATIONAL FOR NO LESS THAN 7 DAYS PRIOR TO BEGINNING ANY ABANDONMENT ACTIVITIES.

2. INSTALL BERM (SANDBAGS) FOR SEDIMENT CONTROL WITHIN DOWNSTREAM CHANNEL.

3. CLEAN PIPES IN ACCORDANCE WITH THE GENERAL NOTES.

4. INSPECT PIPES IN ACCORDANCE WITH THE GENERAL NOTES.

5. INSTALL INJECTION PIPES AS SHOWN IN THESE PLANS.

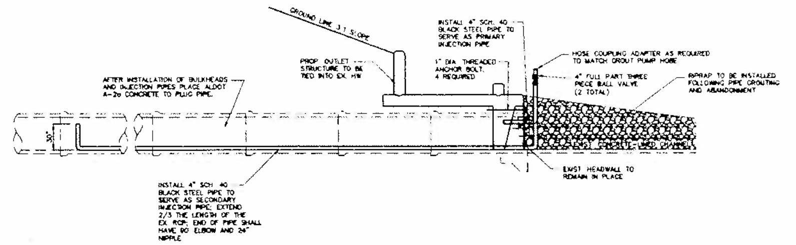
6. INSTALL STEEL BULKHEAD.

7. INJECT GROUT TO FILL REMAINING PIPES. FILL RISER TO NO GREATER THAN 10' FROM THE INVERT OF THE RISER.

8. REMOVE STEEL SKIMMER STRUCTURES AND WALKWAY.

9. REMOVE TEMPORARY EQUIPMENT AND MATERIALS.

10. INSTALL POST WITH STEEL PLATE DOCUMENTING SPILLWAY ABANDONMENT.



SECTION - BULKHEAD AND PIPE ABANDONMENT

COF-XXX-MG-00X

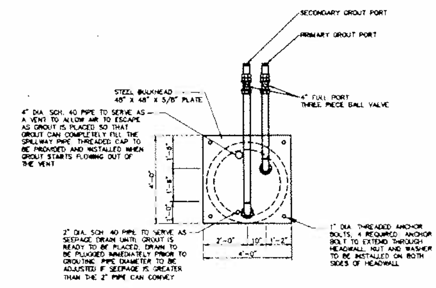
ABANDONED ON XX/XX/XXXX

IN ACCORDANCE WITH COF-XXXXXX-WP-X

NOTES:
DETAILS FOR "X" LABELS TO BE PROVIDED BY URS/TVA DURING CONSTRUCTION

CONTRACTOR TO PROVIDE SIGN POST INDICATING SPILLWAY IDENTIFICATION AS SHOWN FOLLOWING ABANDONMENT. SIGN POST IN ACCORDANCE WITH TVA STANDARD DRAWING 1050855 – MODEL NO. 1

DETAIL - SIGNAGE LAYOUT



ELEVATION - STEEL BULKHEAD

Detail No
Sheet Where Shown
REFERENCE KEY

ISSUED FOR CONSTRUCTION

For Supporting Design Calculations see

SCALE: AS SHOWN — EXCEPT AS NOTED

SPILLWAY ABANDONMENT PLAN

ASH POND 4 –
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

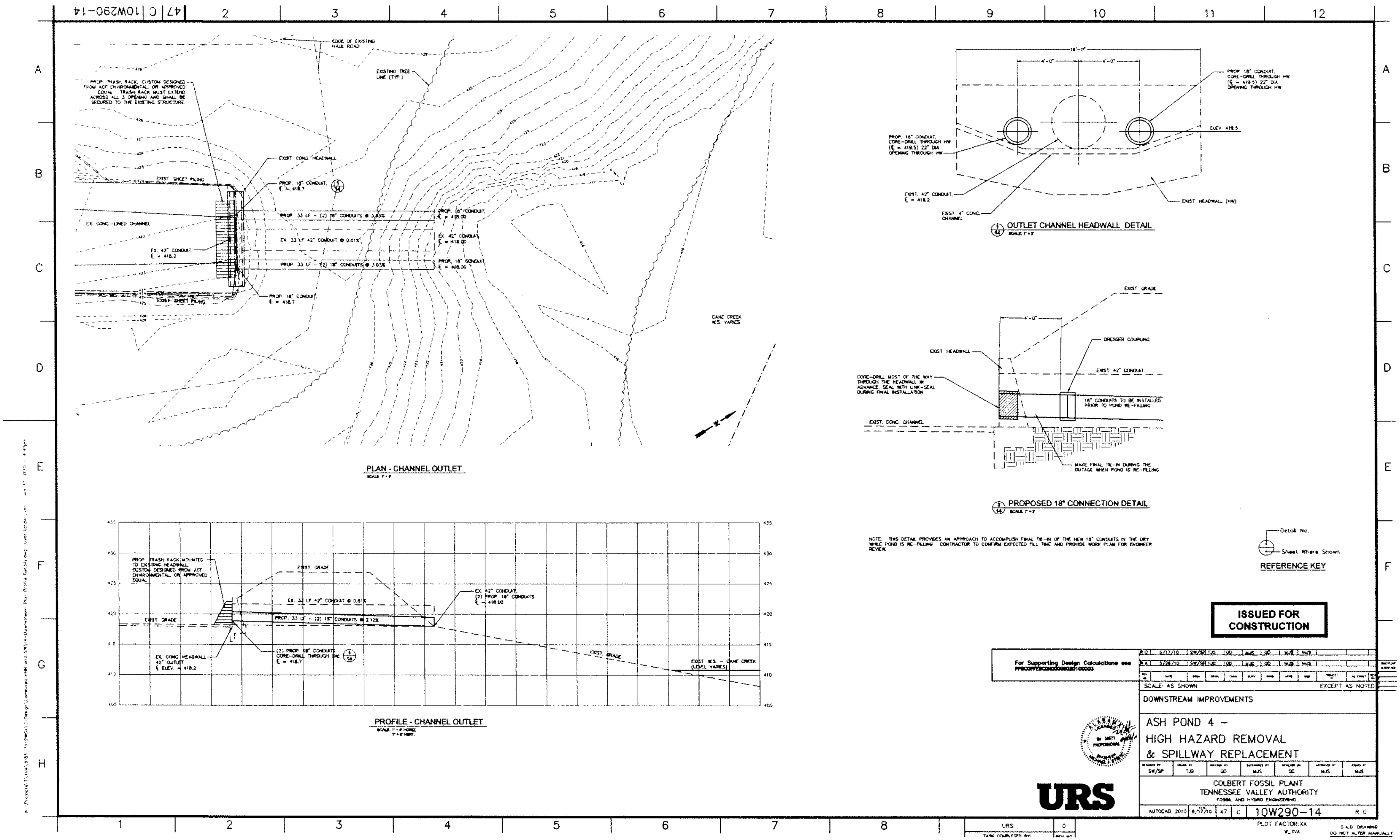
URS

AUTOCAD R12 | 6/17/10 | 47 | C | 10W290-13

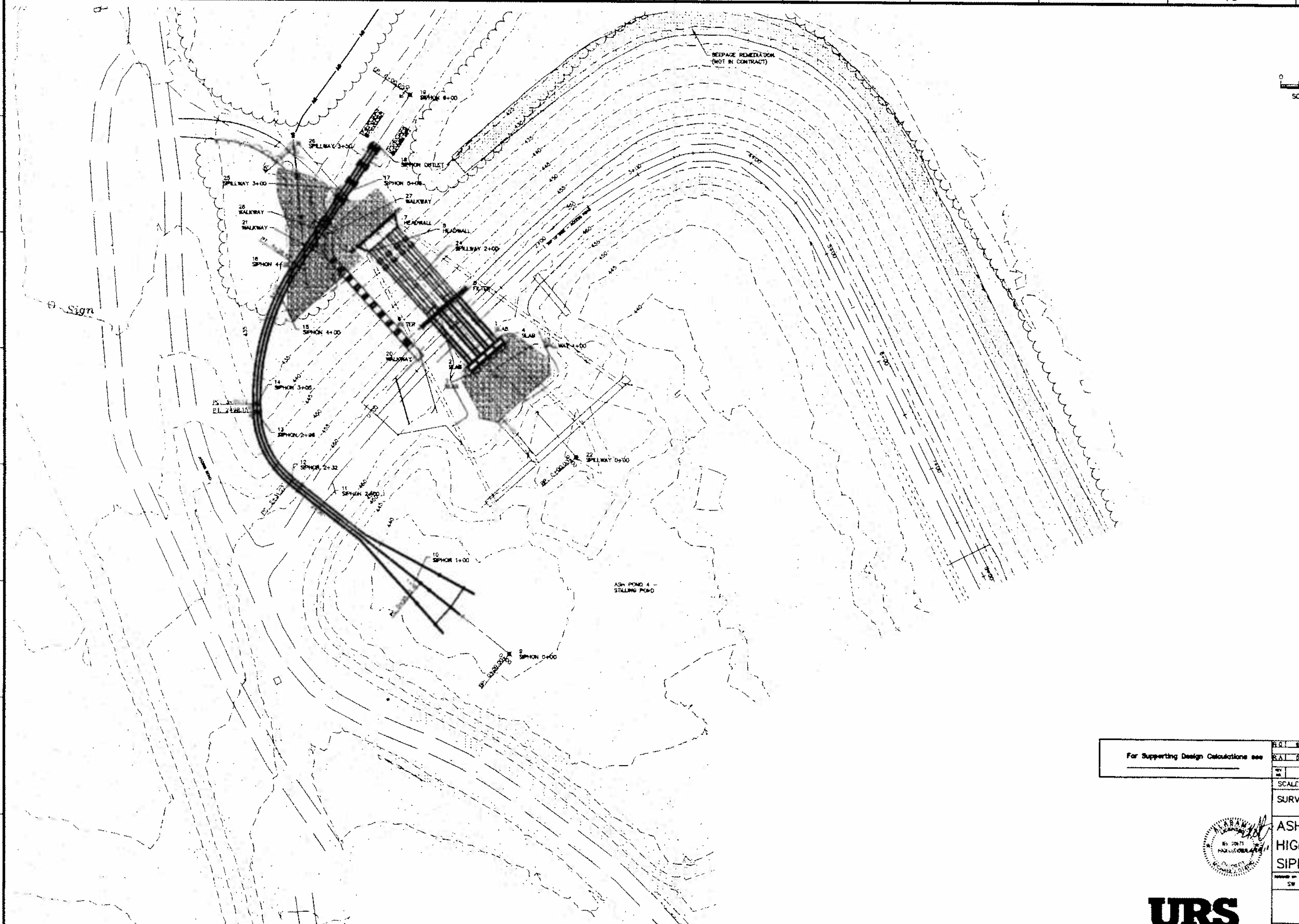
PLOT FACTOR:XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

47 | C | 10W290-13



PLAN - CHANNEL OUTLET
PROFILE - CHANNEL OUTLET
OUTLET CHANNEL HEADWALL DETAIL
PROPOSED 18" CONNECTION DETAIL
REFERENCE KEY
ISSUED FOR CONSTRUCTION
SCALE: AS SHOWN
EXCEPT AS NOTED
DOWNSTREAM IMPROVEMENTS
ASH POND 4 -
HIGH HAZARD REMOVAL
& SPILLWAY REPLACEMENT
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
URS
10W290-14
PLOT FACTOR:XX



LEGEND

- 450 — EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- 460 — PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- EXISTING SHEET PILE WALL
- EXISTING HAUL ROAD
- PROPOSED RIP RAP
- EXISTING TREE-LINE/ VEGETATION

N

SCALE: 1"=30' (0, 30, 60)

Point Table				
Point #	Elevation	Northing	Easting	Description
1	448.75	1723543.90	394329.25	SLAB
2	448.75	1723519.08	394301.36	SLAB
3	448.75	1723513.61	394308.23	SLAB
4	448.75	1723538.42	394334.13	SLAB
5	443.25	1723585.37	394301.18	FILTER
6	443.25	1723551.61	394263.44	FILTER
7		1723635.72	394244.12	HEADWALL
8		1723614.42	394220.18	HEADWALL
9		1723276.85	394337.64	SIPHON 0+00
10		1723340.64	394259.09	SIPHON 1+00
11		1723402.43	394180.64	SIPHON 2+00
12		1723422.22	394165.43	SIPHON 2+32
13		1723479.49	394126.88	SIPHON 2+86
14		1723486.44	394126.50	SIPHON 3+05
15		1723578.47	394145.81	SIPHON 4+00
16		1723603.25	394169.68	SIPHON 4+28
17		1723663.10	394198.94	SIPHON 5+00
18		1723704.81	394226.36	SIPHON OUTLET
19		1723748.72	394253.79	SIPHON 6+00
20		1723523.98	394260.56	WALKWAY
21		1723610.71	394163.30	WALKWAY
22		1723443.43	394383.83	SPILLWAY 0+00
23		1723518.15	394327.17	SPILLWAY 1+00
24		1723582.87	394280.71	SPILLWAY 2+00
25		1723667.59	394194.25	SPILLWAY 3+00
26		1723704.95	394161.02	SPILLWAY 3+50
27		1723627.80	394183.27	WALKWAY
28		1723635.89	394170.93	WALKWAY

ISSUED FOR CONSTRUCTION

For Supporting Design Calculations see

SCALE: 1" = 30' EXCEPT AS NOTED

SURVEY CONTROL PLAN

ASH POND 4 –
HIGH HAZARD, DIKE LOWERING,
SIPHON, AND SPILLWAY PLAN

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

URS

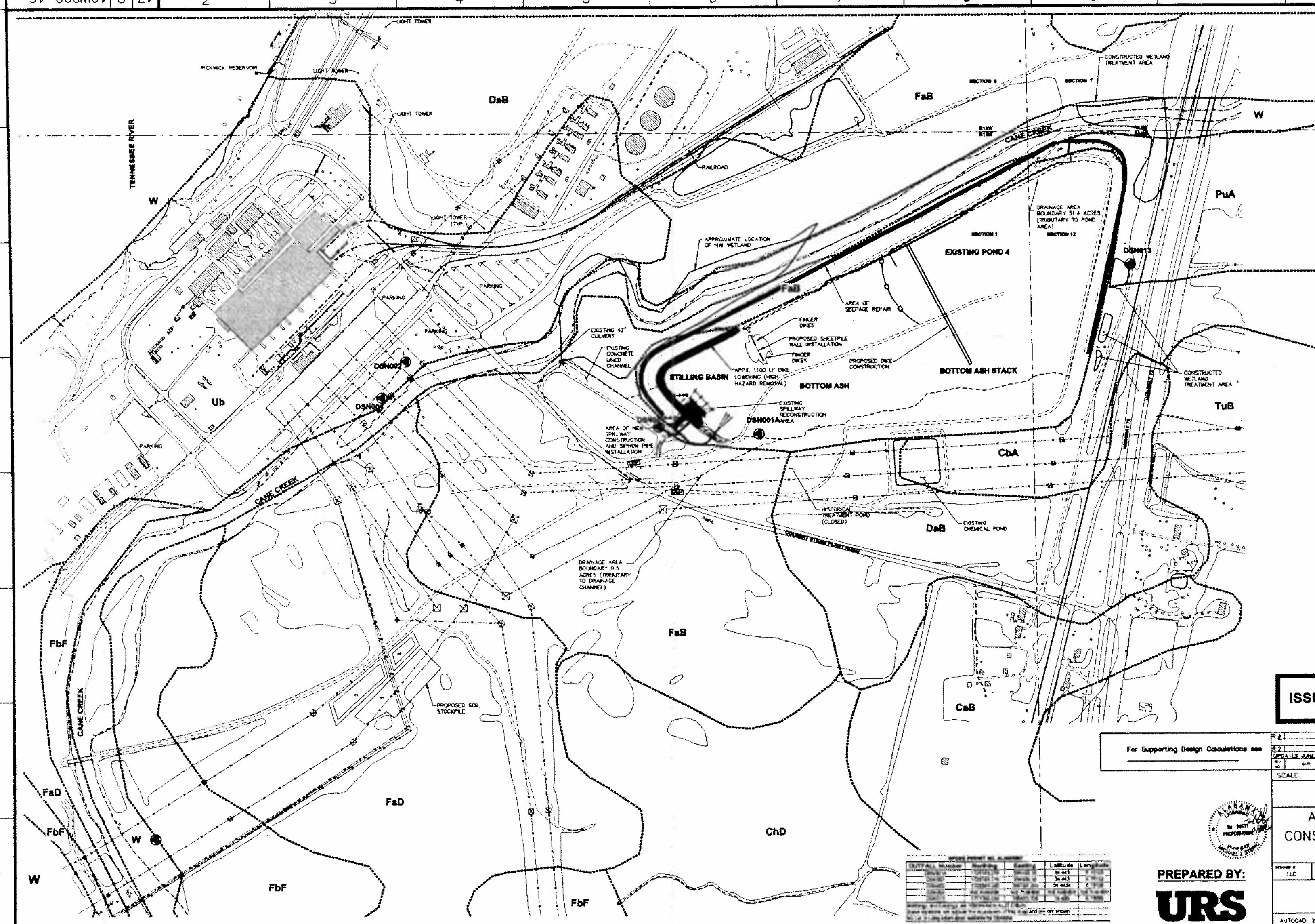
AUTOCAD R10 | 6/10/10 | 47 | C | 10W290-15 | R 0

PLOT FACTOR:XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

URS | 0
TASK COMPLETED BY | REV NO.

47 C 10W290-15



SCALE: 1"=200'

TENNESSEE VALLEY AUTHORITY
COLBERT STEAM PLANT
COLBERT COUNTY
MAP AREA SHOWN ON THIS DRAWING IS LOCATED WITHIN TOWNSHIP 4 SOUTH, RANGE 13 WEST AND TOWNSHIP 4 SOUTH, RANGE 12 WEST, SECTIONS 1, 6, 12, AND 7
URS CORPORATION
DATE OF INITIAL ISSUE: 2/25/2010
REVISION DATE: 6/3/2010

LEGEND

- EXISTING VEGETATION
- EXISTING FENCE
- EXISTING OVERHEAD ELECTRIC LINE
- EXISTING HAUL ROAD
- PROPERTY LINE
- EXISTING RAILROAD
- TRANSMISSION TOWER
- PERMITTED DISCHARGE LOCATION
- SECTION BREAK

NOTES

1. EXACT LOCATION OF EXISTING UTILITIES TO BE VERIFIED
2. WORK AREAS ARE IN FLOOD ZONE A ACCORDING TO FEMA, COLBERT COUNTY PANEL 300 OF 550. POND AREAS ARE IN FLOOD ZONE X.
3. THERE ARE NO CONTAMINATED SITES, THREATENED OR ENDANGERED SPECIES, OR CULTURAL RESOURCES WITHIN THE LIMITS OF CONSTRUCTION
4. CONTRACTOR TO BE CAREFUL WORKING IN RIPARIAN CORRIDOR ASSOCIATED WITH CANE CREEK. WORK AT ELEVATION 420 OR LOWER SHOULD BE AVOIDED. CONTACT TVA BEFORE WORKING IN THESE AREAS

SOIL SYMBOLS

- CaB CAPSHAW SILT LOAM, 2 TO 6 PERCENT SLOPES
- CbA CHENNEBY SILT LOAM, 0 TO 2 PERCENT SLOPES, OCCASIONALLY FLOODED
- ChD CHISCA LOAM, 8 TO 15 PERCENT SLOPES
- DaB DECATUR SILT LOAM, 6 TO 10 PERCENT SLOPES, ERODED
- FaB FULLERTON CHERTY SILT LOAM, 6 TO 15 PERCENT SLOPES
- FaD FULLERTON CHERTY SILT LOAM, 8 TO 15 PERCENT SLOPES
- FbF FULLERTON-BODINE COMPLEX, 15 TO 45 PERCENT SLOPES
- PuA PRUITTON AND SULLIVAN SILT LOAMS, 0 TO 2 PERCENT SLOPES, OCCASIONALLY FLOODED
- TuB TUPELO-COLBERT COMPLEX, 0 TO 4 PERCENT SLOPES
- Ub URBAN LAND
- W WATER

ISSUED FOR CONSTRUCTION

For Supporting Design Calculations see

UPDATES JUNE 2010

SCALE: EXCEPT AS NOTED

PREPARED BY: URS

ASH POND 4-OVERALL SITE
CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN

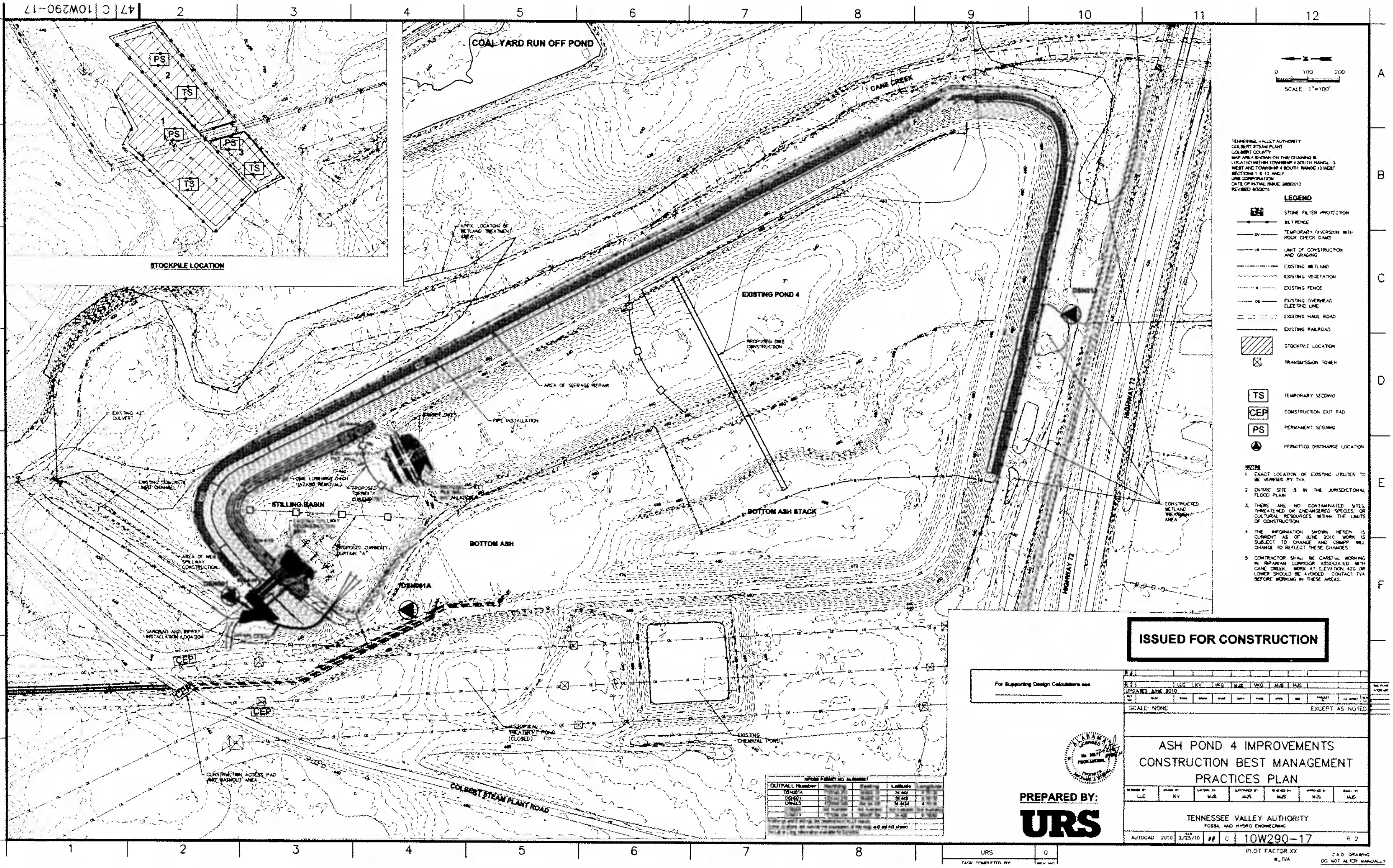
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD 2010 | 2/25/10 | 47 | C | 10W290-16 | R 2

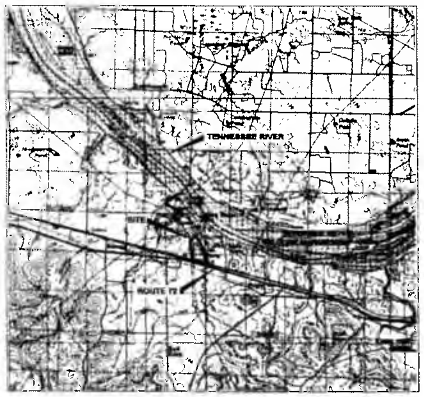
PLOT FACTOR XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

47 C 10W290-16



47 C 10W290-17
COAL YARD RUN OFF POND
CANE CREEK
STOCKPILE LOCATION
EXISTING POND 4
BOTTOM ASH STACK
BOTTOM ASH
STILLING BASIN
AREA OF SEEPAGE REPAIR
PIPE INSTALLATION
HIGHWAY 72
COLBERT STEAM PLANT ROAD
EXISTING CHEMICAL POND
CONSTRUCTED WETLAND TREATMENT AREA
CONSTRUCTION ACCESS PAD AND WASHOUT AREA
EXISTING 42" CULVERT
SCALE 1"=100'
TENNESSEE VALLEY AUTHORITY
COLBERT STEAM PLANT
COLBERT COUNTY
MAP AREA SHOWN ON THIS DRAWING IS LOCATED WITHIN TOWNSHIP 4 SOUTH RANGE 13 WEST AND TOWNSHIP 4 SOUTH, RANGE 12 WEST SECTIONS 1, 6, 12, AND 7
URS CORPORATION
LEGEND
STONE FILTER PROTECTION
SILT FENCE
TEMPORARY DIVERSION WITH ROCK CHECK DAMS
LIMIT OF CONSTRUCTION AND GRADING
EXISTING WETLAND
EXISTING VEGETATION
EXISTING FENCE
EXISTING OVERHEAD ELECTRIC LINE
EXISTING HAUL ROAD
EXISTING RAILROAD
STOCKPILE LOCATION
TRANSMISSION TOWER
TS TEMPORARY SEEDING
CEP CONSTRUCTION EXIT PAD
PS PERMANENT SEEDING
PERMITTED DISCHARGE LOCATION
NOTES
1. EXACT LOCATION OF EXISTING UTILITIES TO BE VERIFIED BY TVA.
2. ENTIRE SITE IS IN THE JURISDICTIONAL FLOOD PLAIN.
3. THERE ARE NO CONTAMINATED SITES, THREATENED OR ENDANGERED SPECIES, OR CULTURAL RESOURCES WITHIN THE LIMITS OF CONSTRUCTION.
4. THE INFORMATION SHOWN HEREIN IS CURRENT AS OF JUNE 2010. WORK IS SUBJECT TO CHANGE AND CBMPP WILL CHANGE TO REFLECT THESE CHANGES.
5. CONTRACTOR SHALL BE CAREFUL WORKING IN RIPARIAN CORRIDOR ASSOCIATED WITH CANE CREEK. WORK AT ELEVATION 420 OR LOWER SHOULD BE AVOIDED. CONTACT TVA BEFORE WORKING IN THESE AREAS.
ISSUED FOR CONSTRUCTION
For Supporting Design Calculations see
SCALE: NONE
EXCEPT AS NOTED
PREPARED BY:
URS
ASH POND 4 IMPROVEMENTS
CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING
AUTOCAD 2010
10W290-17
R 2
PLOT FACTOR XX
C.A.D. DRAWING DO NOT ALTER MANUALLY



PRODUCED BY TENNESSEE VALLEY AUTHORITY IN COOPERATION WITH UNITED STATES GEOLOGICAL SURVEY
NAD 27
AERIAL PHOTOGRAPHS TAKEN 1981
MAP EDITED 1985
CONTOUR INTERVAL 10 METERS

0 2000 4000
SCALE IN METERS

N

CBMPP REQUIREMENTS

PROJECT NAME AND LOCATION

COLBERT FOSSIL PLANT
900 COLBERT STEAM PLANT ROAD
TUSCUMBIA, AL 35674-6806

OWNER NAME AND ADDRESS

TENNESSEE VALLEY AUTHORITY (TVA)
1101 MARKET STREET
CHATTANOOGA, TN 37402-2801

GENERAL NOTES:

1. A NOTICE OF REGISTRATION (NOR) HAS BEEN SUBMITTED FOR THIS PROJECT.
2. ALL CONSTRUCTION ACTIVITIES MUST COMPLY WITH STATE OF ALABAMA AND COLBERT COUNTY REGULATIONS.
3. ALL EROSION AND SEDIMENT CONTROL PRACTICES MUST MEET THE STANDARDS AND SPECIFICATIONS OF THE ALABAMA HANDBOOK FOR EROSION CONTROL, SEDIMENT CONTROL, AND STORMWATER MANAGEMENT ON CONSTRUCTION SITES AND URBAN AREAS.
4. ALL STORM INLETS/CATCH BASINS THAT ARE MADE OPERATIONAL DURING CONSTRUCTION SHALL BE PROTECTED SO THAT SEDIMENT-LADEN WATER WILL NOT ENTER THE CONVEYANCE SYSTEM WITHOUT FIRST BEING FILTERED OR OTHERWISE TREATED TO REMOVE SEDIMENT.
5. PERIMETER SEDIMENT CONTROLS SHALL BE IMPLEMENTED AS THE FIRST STEP OF GRADING AND WITHIN 7 DAYS FROM THE START OF GRUBBING. THESE SHALL CONTINUE TO FUNCTION UNTIL DISTURBED AREAS ARE RE-STABILIZED.
6. MINIMIZE TRACKING OF SEDIMENTS BY VEHICLES BY UTILIZING THE CONSTRUCTION ENTRANCES AS THE ONLY ENTRANCES FOR VEHICLES. MAINTAIN THIS ENTRANCES WITH STONE AS NEEDED TO PREVENT DIRT AND MUD FROM TRACKING ONTO THE ROADWAY. REGULAR SWEEPING OF THE ROADWAY MAY BE NECESSARY TO ENSURE ROADWAY DOES NOT BUILD UP WITH SEDIMENTS.
7. OTHER EROSION AND SEDIMENT CONTROL ITEMS MAY BE NECESSARY DUE TO ENVIRONMENTAL CONDITIONS AND MAY BE REQUIRED AT THE DISCRETION OF THE COLBERT COUNTY ENGINEER'S OFFICE.
8. NO SOLID OR LIQUID WASTE SHALL BE DISCHARGED INTO STORM WATER RUNOFF. (THIS INCLUDES WASHING OUT OF CEMENT TRUCKS.) WASH PIT AREAS SHALL BE APPROVED BY OWNER, AWAY FROM AREAS OF STORM WATER RUNOFF.
9. SITE STABILIZATION OTHER PERMANENT OR TEMPORARY MUST FOLLOW THE REQUIREMENTS AS APPLICABLE ON THE CHARTS ON CBMPP PLAN SHEETS.

OFFSITE VEHICLE / SEDIMENT TRACKING

A STABILIZED CONSTRUCTION ENTRANCE SHALL BE PROVIDED TO HELP REDUCE VEHICLE TRACKING OF SEDIMENTS. ALL PAVED STREETS ADJACENT TO THE SITE ARE BE SWEPT DAILY TO REMOVE ANY EXCESS MATERIAL TRACKED FROM THE SITE. A TIRE WASH IS TO BE INSTALLED AT NO ADDITIONAL COST TO THE PROJECT IF DEEMED NECESSARY BY LOCAL OFFICIALS. DUMP TRUCKS HAULING MATERIAL FROM THE CONSTRUCTION SITE MUST TO BE COVERED WITH A TARPAULIN.

TIMING OF CONTROLS / MEASURES

AS INDICATED IN THE SCHEDULE OF CONSTRUCTION ACTIVITIES, STABILIZED CONSTRUCTION ENTRANCE AND SILT FENCE WILL BE CONSTRUCTED PRIOR TO CLEARING OR GRADING OF ANY OTHER PORTIONS OF THE SITE. AREAS WHERE CONSTRUCTION ACTIVITY TEMPORARILY CEASES FOR MORE THAN 14 DAYS WILL BE STABILIZED WITH A TEMPORARY SEED AND MULCH WITHIN 7 DAYS OF THE LAST DISTURBANCE. ONCE CONSTRUCTION ACTIVITY CEASES PERMANENTLY IN AN AREA, THAT AREA WILL BE STABILIZED WITH PERMANENT SEED AND MULCH.

SOIL PROTECTION CHART

STABILIZATION TYPE	J	F	M	A	M	J	J	A	S	O	N	D
[illegible]			●	●	●	*	*	*	●	●		
[illegible]	●	●	●							●	●	●
[illegible]			●	●	●	*	*	*	●	●		
[illegible]			**	**	**	**	**	**				
[illegible]	●	●	●	●	●	●	●	●	●	●	●	●

* – IRRIGATION NEEDED

** – IRRIGATION NEEDED FOR 2–3 WEEKS AFTER SOD IS APPLIED

PRODUCT SPECIFIC PRACTICES

THE FOLLOWING PRODUCT SPECIFIC PRACTICES SHALL BE FOLLOWED WHILE ONSITE.

PETROLEUM PRODUCTS – ALL ONSITE VEHICLES WILL BE MONITORED FOR LEAKS AND RECEIVE REGULAR PREVENTIVE MAINTENANCE TO REDUCE THE CHANCE OF LEAKAGE. PETROLEUM PRODUCTS MUST BE STORED IN APPROVED SEALED CONTAINERS WHICH ARE CLEARLY LABELED. ANY ASPHALT SUBSTANCES USED ONSITE ARE TO BE APPLIED ACCORDING TO THE MANUFACTURER'S RECOMMENDATIONS.

FERTILIZERS – FERTILIZERS USED SHALL BE APPLIED IN THE MINIMUM AMOUNTS RECOMMENDED BY THE MANUFACTURER. ONCE APPLIED, FERTILIZER WILL BE WORKED INTO THE SOIL TO LIMIT EXPOSURE TO STORM WATER. STORAGE OF ALL MATERIAL SHALL BE IN A COVERED SHED. THE CONTENTS OF ANY PARTIALLY USED BAGS OF FERTILIZER MUST BE TRANSFERRED TO A SEALABLE CONTAINER, MADE OF A SUITABLE MATERIAL TO PREVENT SPILLS.

PAINTS – ALL CONTAINERS SHALL BE TIGHTLY SEALED AND PROPERLY STORED WHEN NOT IN USE. EXCESS PAINT IS NOT BE DISCHARGED TO THE STORM SEWER SYSTEM, BUT PROPERLY DISPOSED OF ACCORDING TO MANUFACTURERS' INSTRUCTIONS OR STATE, LOCAL, OR FEDERAL REGULATIONS.

FINAL STABILIZATION

A SITE IS CONSIDERED STABILIZED WHEN ALL OF THE FOLLOWING CRITERIA ARE MET:

- A PERENNIAL VEGETATED COVER (OR OTHER PERMANENT STABILIZATION PRACTICE) HAS GROWN TO A 70% DENSITY THROUGHOUT THE ENTIRE DISTURBED AREA.
- ALL TEMPORARY EROSION AND SEDIMENT CONTROLS HAVE BEEN REMOVED AND DISPOSED OF PROPERLY.
- ALL TRAPPED SEDIMENT HAS BEEN PERMANENTLY STABILIZED TO PREVENT FURTHER EROSION OR RE-SUSPENSION.
- ALL CONSTRUCTION ACTIVITIES HAVE CEASED

ANTICIPATED SEQUENCE OF CONSTRUCTION

1. INSTALL TURBIDITY CURTAIN TO PROTECT EXISTING SPILLWAY.
2. INSTALL TURBIDITY CURTAIN NORTH OF FINGER DIKE AREA.
3. INSTALL OTHER CONTROLS PER SWPPP.
4. PREPARE ACCESS TO BASE OF DIKE AT DISCHARGE CHANNEL.
5. DRIVE SHEETING AT FINGER DIKES
6. START CONSTRUCTING DOWN-SLOPE PORTION OF SIPHON PIPES.
7. AFTER DRIVING OF SHEETPILING IS COMPLETE, MOVE TURBIDITY CURTAIN SOUTH OF NEW SHEETPILING.
8. CUT DOWN TOP OF DIKE TO ELEVATION 458.0' ALONG NORTH AND EAST SIDES OF THE STILLING BASIN.
9. FINISH CONSTRUCTING THE POND-SIDE PORTION OF THE SIPHONS.
10. MOVE TURBIDITY CURTAIN FROM IN FRONT OF EXISTING SPILLWAYS TO THE NORTHWEST CORNER OF THE STILLING BASIN TO PROTECT DURING SIPHON OPERATION.
11. DEWATER POND AND STILLING BASIN TO ELEVATION 453.0' AT MAIN POND AND 447.0' IN THE STILLING BASIN AREA.
12. SANDBAG INLET FROM OUTLET BASIN TO OUTLET CHANNEL.
13. INSPECT EXISTING OUTLET PIPES AND RISERS.
14. EXCAVATE AND INSTALL NEW SPILLWAY STRUCTURE IN THE NORTH FACE OF THE DIKE.
15. CONSTRUCT NEW HEADWALL FOR OUTLET PIPES.
16. INSTALL NEW SPILLWAY PIPES, CONNECTING SPILLWAY STRUCTURE TO HEADWALL.
17. ABANDON THE EXISTING SPILLWAY PIPES AND RISERS.
18. EXCAVATE AND RIPRAP NEW APPROACH CHANNEL TO THE SPILLWAYS.
19. FILL DISCHARGE BASIN WITH RIPRAP.
20. RAISE WATER LEVEL TO COME BACK UP TO ELEVATION 453.0' AND START OPERATING THROUGH THE NEW SPILLWAYS.
21. REMOVE SANDBAGS.
22. MOVE TURBIDITY CURTAIN TO FRONT OF NEW ENTRANCE CHANNEL.
23. REMOVE EXTENDED SECTIONS OF SIPHON PIPES AND INSTALL TURN-UP ENDS TO DISCHARGE INTO RIPRAP AREA OF BASIN.
24. REMOVE NO LONGER NEEDED CONTROLS.

ISSUED FOR CONSTRUCTION

For Supporting Design Calculations see

R 2 | LLC | KY | VKG | MJS | MJS | MJS | WDH
UPDATED JUNE 2010

SCALE: NONE EXCEPT AS NOTED

PREPARED BY:
URS

ASH POND 4 – NOTES AND DETAILS
CONSTRUCTION BEST MANAGEMENT
PRACTICES PLAN

LLC	KY	MJS	MJS	MJS	MJS	MJS

TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD 2010 | 2/26/10 | 47 | C | 10W290-18 | R 2

URS | 0
TASK COMPLETED BY: | REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

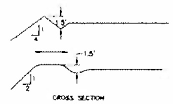
47 | C | 10W290-19

TEMPORARY DIVERSION

DESCRIPTION

A TEMPORARY DIVERSION IS A DIKE AND/OR CHANNEL CONSTRUCTED TO:

- DIRECT SEDIMENT-LADEN RUNOFF TO A SETTLING POND.
- ROUTE CLEAN RUNOFF AWAY FROM DISTURBED AREAS.
- DIVERT RUNOFF TO REDUCE THE EFFECTIVE LENGTH OF THE SLOPE.
- DIRECT RUNOFF AWAY FROM STEEP CUT OR FILL SLOPES.



CROSS SECTION

SPECIFICATIONS FOR TEMPORARY DIVERSION

1. DRAINAGE AREA SHOULD NOT EXCEED 10 ACRES. LARGER AREAS REQUIRE A MORE EXTENSIVE DESIGN.
2. THE CHANNEL CROSS SECTION MAY BE PARABOLIC OR TRAPEZOIDAL. DISK THE BASE OF THE DIKE BEFORE PLACING FILL. BUILD THE DIKE 10% HIGHER THAN DESIGNED FOR SETTLEMENT. THE DIKE SHALL BE COMPACTED BY TRAVERSING WITH TRACKED EARTH-MOVING EQUIPMENT.
3. THE MINIMUM CROSS SECTION OF THE LEVEE OR DIKE WILL BE AS FOLLOWS. (MINIMUM DESIGN FREEBOARD SHALL BE 0.3 FOOT.) WHERE CONSTRUCTION TRAFFIC WILL CROSS, THE TOP WIDTH MAY BE MADE WIDER AND THE SIDE SLOPES FLATTER THAN SPECIFIED ABOVE.

DIKE TOP WIDTH (FT.)	HEIGHT (FT.)	SIDE SLOPES	SHAPE
0	1.5	4:1	TRAPEZOIDAL
4	1.5	2:1	PARABOLIC

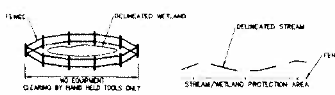
4. THE GRADE MAY BE VARIABLE DEPENDING UPON THE TOPOGRAPHY, BUT MUST HAVE A POSITIVE DRAINAGE TO THE OUTLET AND BE STABILIZED TO BE NON-EROSIVE.
5. DIVERT OUTLET RUNOFF ONTO A STABILIZED AREA, INTO A PROPERLY DESIGNED WATERWAY, GRADE STABILIZATION STRUCTURE, OR SEDIMENT TRAPPING FACILITY.
6. DIVERSIONS SHALL BE SEEDED AND MULCHED, IN ACCORDANCE WITH THE REQUIREMENTS FOR TEMPORARY SEEDING (OR PERMANENT SEEDING) AND MULCHING, AS SOON AS THEY ARE CONSTRUCTED IN ORDER TO PRESERVE DIKE HEIGHT AND REDUCE MAINTENANCE.

TEMPORARY DIVERSION STABILIZATION TREATMENT			
DIVERSION SLOPE	< 2 ac	2 - 5 ac	5 - 10 ac
0 - 3%	SEED AND STRAW	SEED AND STRAW	SEED AND STRAW
3 - 5%	SEED AND STRAW	SEED AND STRAW	MATTING
5 - 8%	SEED AND STRAW	MATTING	MATTING
8 - 20%	SEED AND STRAW	MATTING	ENGINEERED

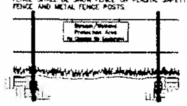
WETLAND PROTECTION

DESCRIPTION

WETLANDS THAT EXIST ON-SITE PRIOR TO DEVELOPMENT MAY BE PROTECTED SO THAT WILL CONTINUE TO SURVIVE AFTER CONSTRUCTION.



FENCE SHALL BE SNOW FENCE OR PLASTIC SAFETY FENCE AND METAL FENCE POSTS



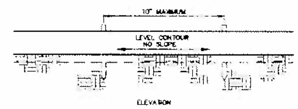
SPECIFICATIONS FOR WETLAND PRESERVATION AREA

1. PRESERVATION AREAS SHALL BE FENCED PRIOR TO BEGINNING CLEARING OPERATIONS.
2. FENCE MATERIALS SHALL BE METAL FENCE POSTS WITH PLASTIC SAFETY FENCE OR SNOW FENCE.
3. SIGNAGE SHALL CLEARLY IDENTIFY THE STREAM/WETLAND PROTECTION AREA AND STATE THAT NO CLEARING OR EQUIPMENT IS ALLOWED WITHIN IT.
4. FENCE SHALL REMAIN AROUND THE PROTECTION AREAS UNTIL AFTER FINAL GRADING HAS BEEN COMPLETED.
5. FENCE SHALL BE PLACED AS SHOWN ON PLANS.
6. IF ANY CLEARING IS DONE AROUND THE PROTECTED AREAS IT SHALL BE DONE BY CUTTING AT GROUND LEVEL WITH HAND HELD TOOLS AND SHALL NOT BE GRUBBED OR PULLED OUT.

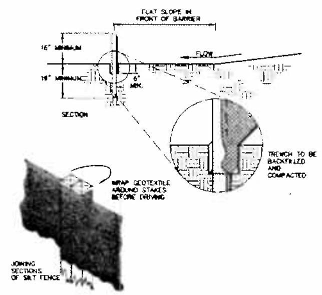
SILT FENCE

DESCRIPTION

SILT FENCE IS A SEDIMENT-TRAPPING PRACTICE UTILIZING A GEOTEXTILE FENCE, TOPOGRAPHY AND VEGETATION TO CAUSE SEDIMENT DEPOSITION. SILT FENCE REDUCES RUNOFF'S ABILITY TO TRANSPORT SEDIMENT BY PONDING RUNOFF AND DISSIPATING SMALL RILLS OF CONCENTRATED FLOW INTO UNIFORM SHEET FLOW.



ELEVATION



SECTION

SPECIFICATIONS FOR SILT FENCE

1. SILT FENCE SHALL BE CONSTRUCTED BEFORE UPSLOPE LAND DISTURBANCE BEGINS.
2. ALL SILT FENCE SHALL BE PLACED AS CLOSE TO THE CONTOUR AS POSSIBLE SO THAT WATER WILL NOT CONCENTRATE AT LOW POINTS IN THE FENCE AND SO THAT SMALL SWALES OR DEPRESSIONS WHICH MAY CARRY SMALL CONCENTRATED FLOWS TO THE SILT FENCE ARE DISSIPATED ALONG ITS LENGTH.
3. TO PREVENT WATER PONDED BY THE SILT FENCE FROM FLOWING AROUND THE ENDS, EACH END SHALL BE CONSTRUCTED UPSLOPE SO THAT THE ENDS ARE AT A HIGHER ELEVATION.
4. WHERE POSSIBLE, SILT FENCE SHALL BE PLACED ON THE FLATTEST AREA AVAILABLE.
5. WHERE POSSIBLE, VEGETATION SHALL BE PRESERVED FOR 5 FEET (OR AS MUCH AS POSSIBLE) UPSLOPE FROM THE SILT FENCE. IF VEGETATION IS REMOVED, IT SHALL BE REESTABLISHED WITHIN 7 DAYS FROM THE INSTALLATION OF THE SILT FENCE.
6. THE HEIGHT OF THE SILT FENCE SHALL BE A MINIMUM OF 16 INCHES ABOVE THE ORIGINAL GROUND SURFACE.
7. THE SILT FENCE SHALL BE PLACED IN A TRENCH CUT A MINIMUM OF 6 INCHES DEEP. THE TRENCH SHALL BE CUT WITH A TRENCHER, CABLE LAYING MACHINE, OR OTHER SUITABLE DEVICE WHICH WILL ENSURE AN ADEQUATELY UNIFORM TRENCH DEPTH.
8. THE SILT FENCE SHALL BE PLACED WITH THE STAKES ON THE DOWNSLOPE SIDE OF THE GEOTEXTILE AND SO THAT 8 INCHES OF CLOTH ARE BELOW THE GROUND SURFACE. EXCESS MATERIAL SHALL LAY ON THE BOTTOM OF THE 6 INCH DEEP TRENCH. THE TRENCH SHALL BE BACKFILLED AND COMPACTED.
9. SEAMS BETWEEN SECTION OF SILT FENCE SHALL BE OVERLAPPED WITH THE END STAKES OF EACH SECTION WRAPPED TOGETHER BEFORE DRIVING INTO THE GROUND.
10. MAINTENANCE--SILT FENCE SHALL ALLOW RUNOFF TO PASS ONLY AS DIFFUSE FLOW THROUGH THE GEOTEXTILE. IF RUNOFF OVERTOPS THE SILT FENCE, FLOWS UNDER OR AROUND THE ENDS, OR IN ANY OTHER WAY BECOMES A CONCENTRATED FLOW, ONE OF THE FOLLOWING SHALL BE PERFORMED, AS APPROPRIATE.
    - THE LAYOUT OF THE SILT FENCE SHALL BE CHANGED,
    - ACCUMULATED SEDIMENT SHALL BE REMOVED, OR
    - OTHER PRACTICES SHALL BE INSTALLED.

CRITERIA FOR SILT FENCE MATERIALS.

1. FENCE POSTS--THE LENGTH SHALL BE A MINIMUM OF 32 INCHES LONG. WOOD POSTS WILL BE 2-BY-2 INCH HARDWOOD OF SOUND QUALITY. THE MAXIMUM SPACING BETWEEN POSTS SHALL BE 10 FEET.
2. SILT FENCE FABRIC (SEE CHART BELOW).

Fabric Properties	Values	Test Method
Grab Tensile Strength	90 lb. minimum	ASTM D 1682
Mullen Burst Strength	190 psi minimum	ASTM D 3786
Slurry Flow Rate	0.3 gal./min./ft^2 maximum	
Equivalent Opening Size	40-80	US Std. sieve CW-02215
Ultraviolet Radiation Stability	90% minimum	ASTM-G-26

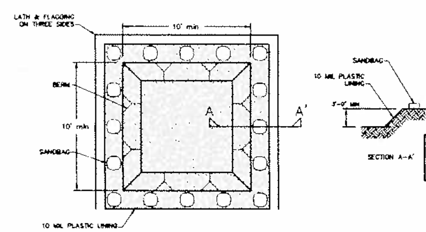
CONCRETE WASHOUT AREA

DESCRIPTION

A CONCRETE WASH OUT AREA IS A STABILIZED LINED COLLECTION AREA WHERE TRUCKS, PANS AND TOOLS CAN BE WASHED OFF AFTER WORKING WITH CONCRETE.

SPECIFICATIONS FOR CONCRETE WASHOUT AREA

1. FINAL LOCATION AND SIZE TO BE DETERMINED IN THE FIELD.
2. A CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FEET OF THE TEMPORARY CONCRETE WASHOUT FACILITY. THE SIGN SHALL BE A MIN. OF 24"X24" WITH 4" MIN LETTER HEIGHT MOUNTED 72" MIN. ABOVE GRADE.



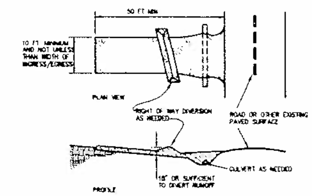
PLAN

SECTION A-A'

CONSTRUCTION ENTRANCE

DESCRIPTION

A CONSTRUCTION ENTRANCE IS A STABILIZED PAD OF AGGREGATE OVER A GEOTEXTILE BASE AND IS USED TO REDUCE THE AMOUNT OF MUD TRACKED OFF-SITE WITH CONSTRUCTION TRAFFIC.



SPECIFICATIONS FOR CONSTRUCTION ENTRANCE

1. STONE SIZE--TWO-INCH WASHED STONE SHALL BE USED, OR RECYCLED CONCRETE EQUIVALENT.
2. LENGTH--THE CONSTRUCTION ENTRANCE SHALL BE AS LONG AS REQUIRED TO STABILIZE HIGH TRAFFIC AREAS BUT NOT LESS THAN 50 FEET.
3. THICKNESS--THE STONE LAYER SHALL BE AT LEAST 6 INCHES THICK.
4. WIDTH--THE ENTRANCE SHALL BE AT LEAST 10 FEET WIDE, BUT NOT LESS THAN THE FULL WIDTH AT POINTS WHERE INGRESS OR EGRESS OCCURS.
5. BEDDING--A NON-WOVEN 10 OZ. GEOTEXTILE SHALL BE PLACED OVER THE ENTIRE AREA PRIOR TO PLACING STONE. IT SHALL HAVE A GRAB TENSILE STRENGTH OF AT LEAST 200 LB. AND A MULLEN BURST STRENGTH OF AT LEAST 190 LB.
6. CULVERT--A PIPE OR CULVERT SHALL BE CONSTRUCTED UNDER THE ENTRANCE IF NEEDED TO PREVENT SURFACE WATER FLOWING ACROSS THE ENTRANCE FROM BEING DIRECTED OUT ONTO PAVED SURFACES.
7. WATER BAR--A WATER BAR SHALL BE CONSTRUCTED AS PART OF THE CONSTRUCTION ENTRANCE IF NEEDED TO PREVENT SURFACE RUNOFF FROM FLOWING THE LENGTH OF THE CONSTRUCTION ENTRANCE AND OUT ONTO PAVED SURFACES.
8. MAINTENANCE--TOP DRESSING OF ADDITIONAL STONE SHALL BE APPLIED AS CONDITIONS DEMAND. MUD SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC ROADS, OR ANY SURFACE WHERE RUNOFF IS NOT CHECKED BY SEDIMENT CONTROLS, SHALL BE REMOVED IMMEDIATELY. REMOVAL SHALL BE ACCOMPLISHED BY SCRAPING OR SWEEPING.
9. CONSTRUCTION ENTRANCES SHALL NOT BE RELIED UPON TO REMOVE MUD FROM VEHICLES AND PREVENT OFF-SITE TRACKING. VEHICLES THAT ENTER AND LEAVE THE CONSTRUCTION SITE SHALL BE RESTRICTED FROM MUDDY AREAS.

GENERAL NOTE:

1. TEMPORARY CONSTRUCTION ENTRANCES MUST BE INSTALLED AT EACH CONSTRUCTION TRAFFIC ENTRANCE / EXIT. THESE LOCATIONS WILL BE COORDINATED BY THE CONSTRUCTION MANAGER.
2. CONTRACTOR TO WASH OFF WHEELS IN GRAVEL CONSTRUCTION ENTRANCE PRIOR TO ENTERING CITY STREETS. IF MUD ACCUMULATES IN STREETS, THEN THE CONTRACTOR SHALL BE RESPONSIBLE TO CLEAN STREETS AS REQUESTED BY THE CITY OR CONSTRUCTION MANAGER.

ISSUED FOR CONSTRUCTION

For Supporting Design Calculations see

R 2 | LLC | KY | MJS | MJS | MJS | MJS
UPDATES JUNE 2010

SCALE: NONE — EXCEPT AS NOTED

ASH POND 4 – DETAILS-2
CONSTRUCTION BEST MANAGEMENT
PRACTICES PLAN

LLC	KY	MJS	MJS	MJS	MJS	MJS

PREPARED BY:
URS

TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD 2010 | 2/25/10 | 47 | C | 10W290-19 | R 2

PLOT FACTOR: NTS
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

URS | 0
TASK COMPLETED BY | REV NO

APPENDIX A

Document 5

TVA Monthly Inspections Reports for July - August

TVA Monthly /Quarterly/Special Facility Inspection Form — Form Date 6-01-10

1. Site Name: COF 2. Facility Name: Fly Ash Complex 3. Date and Start Time of Inspection: 12/1/10 9:55 Am CST

4. Operator Name: 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 SUNNY, WINDY 36°F RAIN PREV. DAY 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		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	WET, NOT FLOWING	
○ 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	WET	
○ 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	N/A	
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: 12/3/10

LOCATION: Colbert Fossil Plant - **Fly Ash Stack 5 Inspection** - 1st Quarter FY2011 Dike Inspection
WEATHER: 35 degrees F, Sunny, Rained previous day
INSPECTION BY: Stuart Harris, Jacob Horton, Jake Booth, Mike Hulslander, Bronson Reed, Shane Harris, Ken Dunay, Tim Trousedale, Curtis Beckwith, Virgil Gean, Jason Hill, and Chris Buttram
DATE: 12/01/2010

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	COMMENT
1	Erosion on roadside at pipe	625	1008	1721634.54	399248.33	Repair in accordance with General Guidelines
2	Erosion	626	1010	1720555.57	399322.51	Repair in accordance with General Guidelines
3	Erosion	627	1012	1720294.50	400076.30	Repair in accordance with General Guidelines
4	Erosion (20' wide, top to toe)	582	2009	1721660.32	399070.23	Repair in accordance with General Guidelines
5	Seep/very soft area	583	2010	1721445.01	398504.53	Previously Identified (4th quarter, PT# 2012)Monitor seep, ensure it is identified in Seepage Action Log.
6	Monitoring Well - no cover	584	2011	1721306.52	398487.04	Notify Stantec and CCP Engineering to get a replacement cap.
7	Soft area/possible seep (5' dia area)	585	2012	1720889.63	398107.98	**Engineering is this a seep? What action should RHO&M take?**
8	Abandoned dredge pipe has erosion from leak	586	2013	1720750.94	398105.47	Previously identified (4th quarter, PT# 1011), will be addressed by Stack 5 Seepage & Drainage Mitigation Project
9	Erosion (20' x 100')	587-588	2014	1720530.72	398400.19	Repair in accordance with General Guidelines
10	Old post - bent and twisted	589	2015	1720186.74	399312.77	Remove and dispose of
11	Animal burrow (1' dia x 2' deep)	590	2016	1721124.50	400834.03	Repair in accordance with General Guidelines
12	Animal burrow (0.5' dia x 1.5' deep)	591	2017	1721277.32	400701.23	Repair in accordance with General Guidelines
13	Seep (small seep at toe)	592	2018	1721570.15	400342.41	Previously identified (4th quarter, PT# 2028), will be addressed by Stack 5 Seepage & Drainage Mitigation Project
14	Erosion (100' long x 1' deep)	1587	3006	1721689.14	399299.23	Repair in accordance with General Guidelines
15	Erosion/multiple rills (100' long x 1' deep)	1588	3007	1721273.84	400511.03	Repair erosion in accordance with the General Guidelines for Rill and Gully Erosion Repair at TVA Fossil Plants.
16	Exposed ash in rock chute (15' x 15' area)	1589	3008	1721051.96	400577.77	Repair rock chute
17	Erosion/multiple rills (0.5' deep)	1590	3009	1720696.28	400582.29	Will be addressed by Stack 5 Seepage & Drainage Mitigation Project
18	Erosion/multiple rills (0.5' deep)	1591	3010	1720637.01	400548.30	Will be addressed by Stack 5 Seepage & Drainage Mitigation Project
19	No vegetation/exposed ash	1592	3011	1720841.54	399495.40	Repair in accordance with General Guidelines
20	Slough (5' long)	1593	3012	1721998.51	399025.17	Repair in accordance with General Guidelines
21	Hole	1594	3013	1722035.61	398985.86	Repair in accordance with General Guidelines
22	Animal burrow (1.5' deep)	1595	3014	1722118.67	398913.04	Repair in accordance with General Guidelines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IMG_1589.jpg


3014
3012
3013
3006
2009
1008
2018
2010
2011
3007
2017
2016
3008
2012
3011
2013
3009
3010
AREA NOT INSPECTED
DUE TO CONSTRUCTION
1010
2014
1012
2015

TVA Monthly /Quarterly/Special Facility Inspection Form — Form Date 6-01-10

1. Site Name: COF 2. Facility Name: Bottom Ash Complex 3. Date and Start Time of Inspection: 12/1/10 8:10Am EST

4. Operator Name: 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 Sunny 35°F, Rain Prev. Day 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		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 In places		
G. Animal Burrows ○ New ○ Existing	✓	
H. Seepage ○ New ○ Existing	✓	
○ Clear/Cloudy/Red/Muddy Some red water/wet spot		
○ 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 Some red water	Some wet spots	
○ 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	In process of replacing	
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: 12/3/10

LOCATION: Colbert Fossil Plant - **Bottom Ash Stack Inspection** - 1st Quarter FY2011 Dike Inspection
WEATHER: 35 degrees F, Sunny, Rained previous day
INSPECTION BY: Stuart Harris, Jacob Horton, Jake Booth, Mike Hulslander, Bronson Reed, Shane Harris, Ken Dunay, Tim Trousedale, Curtis Beckwith, Virgil Gean, Jason Hill, and Chris Buttram
DATE: 12/01/2010

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	COMMENT
23	Standing water in pipe, outfall was covered up when road was widened	617	1000	1723637.58	394038.39	Previously Identified (3rd quarter, PT# 3001)Uncover outfall and repair/extend outfall pipes
24	Erosion (0.5' x 12')	618	1001	1723481.65	393931.44	Repair in accordance with General Guidelines
25	Animal burrow	619	1002	1722964.58	394116.90	Repair in accordance with General Guidelines
26	Possible seep	620	1003	1722575.71	394174.83	Monitor wet spot to determine if it is a actual seep. If it is a seep notify CCP Engineering and add to Seepage Action Log.
27	Possible seep	621	1004	1722472.36	394148.88	Monitor wet spot to determine if it is a actual seep. If it is a seep notify CCP Engineering and add to Seepage Action Log.
28	Animal burrow	622	1005	1721245.39	394979.33	Will be addressed by Pond 4 Seepage Remediation Project
29	Animal burrow	623	1006	1721054.36	395480.98	Will be addressed by Pond 4 Seepage Remediation Project
30	Animal burrow	624	1007	1721254.61	395802.46	Will be addressed by Pond 4 Seepage Remediation Project
31	Erosion	575	2000	1723418.17	393968.11	Repair in accordance with General Guidelines
32	Animal burrow (0.5' dia, 3' deep)	576	2001	1723077.55	394125.10	Repair in accordance with General Guidelines
33	Pipe filling with sediment	577	2002	1721515.75	394312.73	Pipe previously cleaned out has silted up again. Install check dam or other means to keep pipe clear of sediment.
34	Seep	578	2003	1721181.45	395246.50	Will be addressed by Pond 4 Seepage Remediation Project
35	Animal burrow (1' dia, 2' deep)	579	2004	1721130.08	395583.42	Repair in accordance with General Guidelines
36	Red water seep	580	2005	1721094.53	395696.12	Previously identifed, will be addressed by Pond 4 Seepage Remediation Project
37	Red water seep	581	2006	1721166.63	395780.16	
38	Seep (beginning)	1582	3000	1721720.26	395662.38	
39	Seep (end)	1583	3001	1722000.15	395513.38	
40	Seep	1584	3002	1722328.34	395341.05	
41	Seep	1585	3003	1722560.39	395218.35	
42	Seep (beginning)	-	3004	1723366.24	394798.553	
43	Seep (end)	1586	3005	1723099.76	394939.379	
44	Hole (8in dia)	1096	5000	1721761.81	395680.08	Will be addressed by Pond 4 Seepage Remediation Project
45	Animal burrow (10in dia)	1097	5001	1721940.71	395497.624	Repair in accordance with General Guidelines
46	Animal burrow (8in dia)	1098	5002	1722229.2	395371.258	Will be addressed by Pond 4 Seepage Remediation Project
47	Hole (8in dia)	1099	5003	1722534.04	395226.118	Will be addressed by Pond 4 Seepage Remediation Project
48	Hole (8in dia)	1100	5004	1722594.3	395234.223	Will be addressed by Pond 4 Seepage Remediation Project
49	Animal burrow (10in dia)	1101	5005	1722616.02	395141.541	Repair in accordance with General Guidelines
50	Animal burrow (10in dia)	1102	5006	1722779.61	395081.891	Will be addressed by Pond 4 Seepage Remediation Project
51	Animal burrow (10in dia)	1103	5007	1723107.41	394916.634	Will be addressed by Pond 4 Seepage Remediation Project
52	Animal burrow (10in dia)	1104	5008	1723168.05	394884.335	Will be addressed by Pond 4 Seepage Remediation Project
53	Animal burrow (10in dia)	1105	5009	1723183.91	394873.91	Will be addressed by Pond 4 Seepage Remediation Project
54	Animal burrow (10in dia)	1106	5010	1723304.03	394831.419	Will be addressed by Pond 4 Seepage Remediation Project


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3002
5002
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5001
5000
3000
AREA NOT INSPECTED
DUE TO CONSTRUCTION
2002
1005
2003
1007
2006
2004
1006
2005

TVA Monthly /Quarterly/Special Facility Inspection Form

Form Date 6-01-10

1. Site Name: COF 2. Facility Name: Fly Ash Complex 3. Date and Start Time of Inspection: 3/7/11 9:15AM CST

4. Operator Name: Trans Ash 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 CLOUDY, 41°F Prior Conditions, if notable 2" RAIN PREVIOUS DAY

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		Yes	No
10. Pre-Job Safety Briefing Performed	✓		15. DIKE TOE AREAS		
11. Activity / Construction on/ at facility	✓		A. Seepage ○ New ○ Existing		✓
12. DIKE CREST			○ Clear/Cloudy/Red/Muddy		
A. Settlement / Cracking		✓	○ Flow Increased / Decreased/Same		gpm
B. Rutting			○ Aquatic Vegetation Growing		
C. Lateral Displacement			○ Ash or Clay Deposits Below Seep Outlet		
D. Erosion			B. Boils ○ New ○ Existing		✓
13. INTERIOR / EXTERIOR DIKE SLOPES			○ Clear/Cloudy/Red/Muddy		
A. Minimum Freeboard		ft.	○ Flow Increased / Decreased/Same		gpm
B. Current Freeboard		ft.	○ Growing in Size		
C. Instabilities (Sloughs or Slides)			C. Sinkholes/Depressions ○ New ○ Existing		✓
D. Erosion	✓		16. SEEPAGE COLLECTION SYSTEM		
E. Sinkholes/Depressions ○ New ○ Existing		✓	A. Estimated Flow Measurement	NA	gpm
F. Vegetation / Brush / Trees			B. Increased Flow		
○ Heavy/Adequate/Sparse/Bare			C. Emitting Clear or Dirty Water		
G. Animal Burrows ○ New ○ Existing	✓		17. SPILLWAY WEIRS & OUTLETS		
H. Seepage ○ New ○ Existing		✓	A. Decant Riser Misaligned	NA	
○ Clear/Cloudy/Red/Muddy			B. Decant Pipe Joints		
○ Flow Increased/Decreased/Same		gpm	○ Leaking		
○ Ash or Clay Deposits Below Seep Outlet			○ Separated		
I. Seep around Drain Pipe(s)		✓	C. Headwall In Good Condition		
○ Clear/Cloudy/Red/Muddy	NA		18. OPERATIONS & MAINTENANCE		
14. DEFICIENCIES			A. Major Changes in Operations		✓
A. Prior Key Deficiencies Checked	✓				
B. New Deficiencies Identified / Flagged	✓				
C. Immediate Actions Taken (Note Below)		✓			
D. Photos of deficiencies attached	✓				

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: ________ To: MAR 2011 Signature: Stuart Harris Date: 3/7/11

LOCATION: Colbert Fossil Plant - **Fly Ash Stack 5 Inspection** - 2nd Quarter FY2011 Dike Inspection
WEATHER: 41 degrees F, Sunny, Approximately 2" of rain was received prior to inspection
INSPECTION BY: Stuart Harris, Jacob Horton, Jake Booth, Mike Hulslander, Bronson Reed, Shane Harris, Griffin Lifsey, Danny Stephens, Grayson Simmons, Alan Shariett, Robert Bagwell, Mitch Paige, Rocky West, Micheal Rainer
DATE: 03/07/2011

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	COMMENT
1	Erosion/rills alongside and into rock chute	843	1004	1721940.83	399749.14	Repair in accordance with General Guidelines
2	Erosion - exposed ash	844	1005	1721794.01	400007.96	Ash Stack 5 Seepage and Drainage Remediation Project will address
3	Erosion - exposed ash	845	1006	1721837.07	399990.03	Ash Stack 5 Seepage and Drainage Remediation Project will address
4	Erosion - 3 areas in need of repair	846	1007	1721791.91	400052.64	Ash Stack 5 Seepage and Drainage Remediation Project will address
5	Erosion/rills (100'x25')	847	1008	1721708.95	400145.72	Ash Stack 5 Seepage and Drainage Remediation Project will address
6	Erosion - ash draining along the bottom	848	1009	1721319.55	400533.29	Repair in accordance with General Guidelines
7	Erosion/rills (20'x50')	809	2002	1721653.68	399407.47	Repair in accordance with General Guidelines
8	Area with no vegetation/ground cover present	810	2003	1721735.07	399778.06	Repair in accordance with General Guidelines
9	Area with no vegetation/ground cover present (100'x50'). Needs new topsoil	-	2004	1720995.88	400637.35	Repair in accordance with General Guidelines
10	Area with no vegetation/ground cover present (100'x50'). Needs new topsoil	-	2005	1720737.54	400477.14	Repair in accordance with General Guidelines
11	Erosion - exposed ash (2'x20')	813	2006	1720579.16	400421.37	Repair in accordance with General Guidelines
12	End of slope area with no vegetation/ground cover present	814	2007	1720346.97	400206.74	Repair in accordance with General Guidelines
13	Low area holding standing water (300'x20')	815	2008	1720621.54	399581.2	Fill low spot to correct drainage
14	Erosion/rills (50'L X 1.5'W X 1'D)	816	2009	1720627.66	399534.22	Repair in accordance with General Guidelines
15	Animal Burrow (2'-2" deep)	1939	3004	1720487.72	399089.74	Repair in accordance with General Guidelines
16	Animal Burrow (3'+ deep)	1940	3005	1720463.66	399310.89	Repair in accordance with General Guidelines
17	Low area on Bench Drain.	1941	3006	1720256.84	400176.05	Fill low spot to correct drainage
18	Area with no vegetation/ground cover present (100' X 100')	1942	3008	1720814.1	399475.18	Previously Identified. (FY11 1st Quarter - PT#3011) Repair in accordance with General Guidelines
19	Animal Burrow (18" Ø)	2476	5003	1720946.86	398590.84	Repair in accordance with General Guidelines
20	Low area holding standing water (50'x10')	2477	5004	1720369.52	400088.18	Fill low spot to correct drainage
21	Erosion - washout (10' X 50')	2478	5005	1720360.69	400082.38	Repair in accordance with General Guidelines


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TVA Monthly /Quarterly/Special Facility Inspection Form — Form Date 6-01-10

1. Site Name: COF 2. Facility Name: Bottom Ash Complex 3. Date and Start Time of Inspection: 3/7/11 9AM CST

4. Operator Name: Trans Ash 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 CLOUDY, 41°F Prior Conditions, if notable RAIN PREVIOUS DAY 2"

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	NA	
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	NA	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. 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: ________ To: MAR 2011 Signature: Stuart Harris Date: 3/7/11

LOCATION: Colbert Fossil Plant - **Bottom Ash Stack Inspection** - 2nd Quarter FY2011 Dike Inspection
WEATHER: 41 degrees F, Sunny, Approximately 2" of rain was received prior to inspection
INSPECTION BY: Stuart Harris, Jacob Horton, Jake Booth, Mike Hulslander, Bronson Reed, Shane Harris, Griffin Lifsey, Danny Stephens, Grayson Simmons, Alan Shariett, Robert Bagwell, Mitch Paige, Rocky West, Micheal Rainer
DATE: 03/07/2011

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	COMMENT
22	Erosion/rills (2'x5')	839	1000	1723333.15	394009.13	Repair in accordance with General Guidelines
23	Erosion/rills along pipe	840	1001	1722434.78	394222.24	Repair in accordance with General Guidelines then rip rap should be placed around the discharge of the pipe to help dissipate and spread out the water
24	Area with no vegetation/ground cover present	841	1002	1721955.78	394276.21	Repair in accordance with General Guidelines
25	Animal Burrow	842	1003	1721163.36	395427.28	Repair in accordance with General Guidelines
26	Unknown 12" Ø Steel Pipe found	807	2000	1723348.38	394085.9	Further investigation is needed per CCP Engineering
27	Area with no vegetation/ground cover present (50'x100')	808	2001	1723555.78	394207.73	Repair in accordance with General Guidelines
28	Erosion/rills (1'D X 10'L)	1935	3000	1723339.17	394105.76	Repair in accordance with General Guidelines
29	Erosion/rills - multiple areas (1'D X 10"L)	1936	3001	1723406.93	394072.58	Repair in accordance with General Guidelines
30	Animal Burrow (2' deep)	1937	3002	1721796.12	395561.88	Repair in accordance with General Guidelines
31	Animal Burrow (2'-2" deep)	1938	3003	1721420.24	395706.14	Repair in accordance with General Guidelines
32	Erosion/rills (40' area)	2472	5000	1723452.58	393945.61	Repair in accordance with General Guidelines
33	Animal Burrow (8" Ø)	2473	5001	1721054.17	395480.69	Repair in accordance with General Guidelines
34	Possible Seep (50' long)	2474-2475	5002	1721070.97	395747.74	Monitor wet spot to determine if it is a actual seep per Allen Shariett (URS). If it continues to be wet notify CCP Engineering and add to Seepage Action Log.


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TVA Monthly /Quarterly/Special Facility Inspection Form — Form Date 6-01-10

1. Site Name: COF 2. Facility Name: BA Complex 3. Date and Start Time of Inspection: 6/22/11 - 1 pm (cst)

4. Operator Name: Trans-Ash 5. Inspection Method: ☒ Walk ☐ Ride ☐ Both

(KNOWN KEY DEFICIENCIES MUST BE INSPECTED)

6. Inspector's Name(s): Brett Wyatt, Roy Quinn, Chris Buttram, Jake Booth, Jacob Horton, Bronson Reed, Shane Harris, Robert Bagwell, Mitch Paige, Johnny Ables 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 81°, Cloudy Prior Conditions, if notable Approx. 1.5" of rain previous day

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		Yes	No
10. Pre-Job Safety Briefing Performed	X		**15. DIKE TOE AREAS**		
11. Activity / Construction on/ at facility	X		A. Seepage ○ New ☒ Existing	X	
12. DIKE CREST			○ Clear/Cloudy/Red/Muddy	Clear	
A. Settlement / Cracking		X	○ Flow Increased / Decreased/Same	Same	gpm
B. Rutting		X	○ Aquatic Vegetation Growing		X
C. Lateral Displacement		X	○ Ash or Clay Deposits Below Seep Outlet		X
D. Erosion		X	B. Boils ○ New ○ Existing		X
13. INTERIOR / EXTERIOR DIKE SLOPES			○ Clear/Cloudy/Red/Muddy	N/A	
A. Minimum Freeboard	4'	ft.	○ Flow Increased / Decreased/Same	N/A	gpm
B. Current Freeboard	>4'	ft.	○ Growing in Size	N/A	
C. Instabilities (Sloughs or Slides)		X	C. Sinkholes/Depressions ○ New ○ Existing		X
D. Erosion	X		**16. SEEPAGE COLLECTION SYSTEM**		
E. Sinkholes/Depressions ☒ New ○ Existing	X		A. Estimated Flow Measurement	N/A	gpm
F. Vegetation / Brush / Trees			B. Increased Flow	N/A	
○ Heavy/Adequate/Sparse/Bare	Adequate		C. Emitting Clear or Dirty Water	N/A	
G. Animal Burrows ☒ New ○ Existing	X		**17. SPILLWAY WEIRS & OUTLETS**		
H. Seepage ○ New ☒ Existing	X		A. Decant Riser Misaligned		X
○ Clear/Cloudy/Red/Muddy	Red/Muddy		B. Decant Pipe Joints		X
○ Flow Increased/Decreased/Same	Same	gpm	○ Leaking		X
○ Ash or Clay Deposits Below Seep Outlet		X	○ Separated		X
I. Seep around Drain Pipe(s)		X	C. Headwall In Good Condition	X	
○ Clear/Cloudy/Red/Muddy	N/A		**18. OPERATIONS & MAINTENANCE**		
14. DEFICIENCIES			A. Routine O&M Performed	X	
A. Prior Key Deficiencies Checked	X		B. Weekly Observations Performed	X	
B. New Deficiencies Identified / Flagged	X		C. Any Changes in Operations	X	
C. Immediate Actions Taken (Note Below)		X			
D. Photos of deficiencies attached	X				

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: June 2011 Signature: Brett Wyatt Date: 7/18/11

LOCATION: Colbert Fossil Plant - **Bottom Ash Stack Inspection** - 3rd Quarter FY2011 Dike Inspection
WEATHER: 81 degrees F, Cloudy
INSPECTION BY: Brett Wyatt, Roy Quinn, Chris Buttram, Jake Booth, Jacob Horton, Bronson Reed, Shane Harris, Robert Bagwell, Mitch Paige, Johnny Ables
DATE: 06/22/2011

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	COMMENT
10	Trees at toe of slope (beginning)	1183	1000	1721390.91	394293.35	Repair in accordance with General Guidelines
11	Trees at toe of slope (end)/animal burrow	1184	1002	1721649.5	394200.75	Repair in accordance with General Guidelines
12	Rutting/standing water	1185	1003	1722033.37	394283.27	Fill low spot to correct drainage
13	Tree stump	1186	1004	1722581.53	394205.37	Repair in accordance with General Guidelines
14	Hole - undercutting slope	1187	1005	1722862.2	394172.63	Repair in accordance with General Guidelines
15	Hole (from tree removal)	1188	1006	1722890.58	394167.55	Repair in accordance with General Guidelines
16	Animal burrow	1189	1007	1723018.16	394156.62	Repair in accordance with General Guidelines
17	High vegetation full length of toe	1190	1008	1723209.48	394920.61	Cut vegetation in accordance with correct requirements


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1000

TVA Monthly /Quarterly/Special Facility Inspection Form — Form Date 6-01-10

1. Site Name: COF 2. Facility Name: FA Stack 3. Date and Start Time of Inspection: 6/22/11 - 1 pm (cst)

4. Operator Name: Trans-Ash 5. Inspection Method: ☒ Walk ☐ Ride ☐ Both (KNOWN KEY DEFICIENCIES MUST BE INSPECTED)

6. Inspector's Name(s): Brett Wyatt, Roy Quinn, Chris Buttram, Jake Booth, Jacob Horton, Bronson Reed, Shane Harris, Robert Bagwell, Mitch Paige, Johnny Ables 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 81°, Cloudy Prior Conditions, if notable Approx. 1.5" of rain previous day

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		Yes	No
10. Pre-Job Safety Briefing Performed	x		**15. DIKE TOE AREAS**		
11. Activity / Construction on/ at facility	x		A. Seepage ○ New ○ Existing		x
12. DIKE CREST			○ Clear/Cloudy/Red/Muddy	N/A	
A. Settlement / Cracking		x	○ Flow Increased / Decreased/Same	N/A	gpm
B. Rutting		x	○ Aquatic Vegetation Growing	N/A	
C. Lateral Displacement		x	○ Ash or Clay Deposits Below Seep Outlet	N/A	
D. Erosion		x	B. Boils ○ New ○ Existing		x
13. INTERIOR / EXTERIOR DIKE SLOPES			○ Clear/Cloudy/Red/Muddy	N/A	
A. Minimum Freeboard	N/A ft.		○ Flow Increased / Decreased/Same	N/A	gpm
B. Current Freeboard	N/A ft.		○ Growing in Size	N/A	
C. Instabilities (Sloughs or Slides)		x	C. Sinkholes/Depressions ○ New ○ Existing		x
D. Erosion	x		**16. SEEPAGE COLLECTION SYSTEM**		
E. Sinkholes/Depressions ○ New ○ Existing		x	A. Estimated Flow Measurement	N/A	gpm
F. Vegetation / Brush / Trees			B. Increased Flow	N/A	
○ Heavy/Adequate/Sparse/Bare	Sparse		C. Emitting Clear or Dirty Water	N/A	
G. Animal Burrows ☒ New ○ Existing	x		**17. SPILLWAY WEIRS & OUTLETS**		
H. Seepage ○ New ○ Existing		x	A. Decant Riser Misaligned	N/A	
○ Clear/Cloudy/Red/Muddy	N/A		B. Decant Pipe Joints	N/A	
○ Flow Increased/Decreased/Same	N/A	gpm	○ Leaking	N/A	
○ Ash or Clay Deposits Below Seep Outlet	N/A		○ Separated	N/A	
I. Seep around Drain Pipe(s)	N/A		C. Headwall In Good Condition	N/A	
○ Clear/Cloudy/Red/Muddy	N/A		**18. OPERATIONS & MAINTENANCE**		
14. DEFICIENCIES			A. Routine O&M Performed	x	
A. Prior Key Deficiencies Checked	x		B. Weekly Observations Performed	x	
B. New Deficiencies Identified / Flagged	x		C. Any Changes in Operations		x
C. Immediate Actions Taken (Note Below)		x			
D. Photos of deficiencies attached	x				

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: June 2011 Signature: Brett Wyatt Date: 7/18/11

LOCATION: Colbert Fossil Plant - **Fly Ash Stack 5 Inspection** - 3rd Quarter FY2011 Dike Inspection
WEATHER: 81 degrees F, Cloudy
INSPECTION BY: Brett Wyatt, Roy Quinn, Chris Buttram, Jake Booth, Jacob Horton, Bronson Reed, Shane Harris, Robert Bagwell, Mitch Paige, Johnny Ables
DATE: 06/22/2011

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	COMMENT
1	Erosion (20' x 1.5'D)	2402	3000	1721172.45	400766.71	Repair in accordance with General Guidelines
2	Low area/standing water	2404	3001	1721016.89	400690.51	Fill low spot to correct drainage
3	Low area/standing water	2405	3002	1720457.14	400080.93	Fill low spot to correct drainage
4	Low area/standing water	2406	3003	1720557.09	399726.47	Fill low spot to correct drainage
5	Low area/standing water	2407	3004	1721286.48	399140.2	Fill low spot to correct drainage
6	Low area/standing water	2408	3005	1721348.79	399120.61	Fill low spot to correct drainage
7	Beached area in Stilling Pond	2409-2410	3006	1721860.33	399275.88	Monitor beached area with regards to Free Water Volume requirements
8	Low area/poor drainage	5713	5000	1721477.69	398762.34	Fill low spot to correct drainage
9	Large animal burrow	5714	5001	1720670.94	398742.62	Repair in accordance with General Guidelines


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APPENDIX A

Document 6

2011 Annual Inspection of CCP Facilities and Ponds, Colbert Fossil Plant, Tuscumbia, Alabama, Stantec Consulting Services, August 30, 2011

Stantec

2011 Annual Inspection of CCP Facilities and Ponds

Colbert Fossil Plant
Tuscumbia, Alabama

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

August 30, 2011

Stantec

Stantec Consulting Services Inc.
10509 Timberwood Circle, Suite 100
Louisville, KY 40223-5301
Tel: (502) 212-5000
Fax: (502) 212-5055

August 30, 2011 rpt_001_175551007

Mr. Michael S. Turnbow, PE
Tennessee Valley Authority
1101 Market Street
LP 2G-C
Chattanooga, Tennessee 37402

Re: 2011 Annual Inspection of CCP Facilities and Ponds
Colbert Fossil Plant
Tuscumbia, Alabama

Dear Mr. Turnbow:

Stantec Consulting Services Inc. (Stantec) has completed the 2011 annual inspections for CCP facilities and ponds at the Colbert Fossil Plant. Facilities reviewed included:

- Ash Pond 4
- Disposal Area 5 Dry Stack
- Disposal Area 5 Drainage Basin
- Closed Disposal Area 1
- Coal Yard Drainage Basin

The field work was executed on July 25 and 26, 2011. The results of the work along with facility-specific recommendations for maintenance or other activities are included on the enclosed documents. In addition, the following general plant-wide recommendations and comments area offered:

- It is recommended that vegetation maintenance continue, including mowing and clearing tall grass/cattail growth at regular intervals. 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.

- 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 newly implemented 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.

Mark L. Jones

Mark L. Jones, PE
Project Engineer

Randy L. Roberts

Randy L. Roberts, PE
Principal

Enclosures:

A – Ash Pond 4
B – Disposal Area 5 Dry Stack
C – Disposal Area 5 Drainage Basin
D – Closed Disposal Area 1
E – Coal Yard Drainage Basin
F – General Guidelines for Rutting Repair
G – General Guidelines for Rill and Gully Erosion Repair
H – General Guidelines for Wave Wash Erosion Repair and Riprap Protection
I – General Guidelines for Tree Removal on Slopes
J – Dam Safety Priorities
K – TVA 3rd Quarter FY 2011 Dike Inspection – Colbert Fossil Plant
L – Stantec Annual Inspection Item List – Colbert Fossil Plant

Executive Summary

Stantec Consulting Services Inc. (Stantec) has completed an Annual Inspection of the five facilities at the Colbert Fossil Plant (COF). The facilities reviewed include: Ash Pond 4, Disposal Area 5 Dry Stack, Disposal Area 5 Drainage Basin, Closed Disposal Area 1, and the Coal Yard Drainage Basin. This inspection was performed to evaluate the current conditions of the disposal facilities, document improvements since the last annual inspection, and to provide recommendations for additional improvements and maintenance.

Each facility was reviewed by a team of three individuals (two Stantec engineers and one TVA surveyor). The team walked the perimeter of each facility to review for the presence of seepage, instabilities, erosion features and other inconsistencies that may affect the stability of the facilities. Once the inspection was complete, the notes, photographs and location coordinates of each item of concern were compiled for each facility and are presented in the following report. The inspection forms include historical and operational information, field observations, repairs or construction activities since the last annual inspection, and recommendations for repairs or maintenance activities.

Mitigation construction and maintenance activities that were noted to have been completed since the last annual inspection, are ongoing, or are planned include:

- High Hazard Removal and Spillway Replacement, Ash Pond 4 (complete)
- Seepage Remediation, Ash Pond 4 (ongoing)
- Seepage and Drainage Remediation, Ash Stack 5 (ongoing)
- Closure of Chemical Pond (completed).
- Various maintenance activities at all facilities, including cutting and maintaining vegetation, some tree removal, and repairs of animal burrows and erosion.

During the inspection, Stantec's field team did not observe any critical deficiencies at any of the five facilities reviewed, such as slope instabilities, severe seepage conditions, boils, insufficient freeboard, piping, sinkholes, dike settlement, or spillway blockage.

A number of non-critical maintenance-type items were observed at various locations, including erosion features, animal burrows, and sparse vegetation. Specific locations and recommendations for repairs can be found on the individual inspection forms within the enclosures.

Enclosure A

Ash Pond 4

1. General Facility Information

Facility Status:	Active	**NID Identification:**	Not Available
Surface Area (inside dikes):	52 acres	**TVA Hazard Classification:**	Significant
Maximum Height (toe to top of dike):	46 feet	**Dike Length:**	6,700 ft.
Plant Discharge to Facility:	11.5 MGD	**Current Pool Elevation:**	El. 452.9 ft.

2. Site Visit Information

Stantec Inspection Team:	Mark Jones, PE and Brad Allgeier, EIT.
TVA Staff Present:	Jacob Booth and Scott Barrentine.
Field Inspection Date:	July 26, 2011.
Weather/Site Conditions:	Sunny, low 90's, humid, and dry conditions.

3. History/Current and Future Operations

History:	Ash Pond 4 was initially constructed in 1972 with clay starter dikes. The dikes were raised 20 feet using an upstream method with new clay dikes in 1984.
Current Operations:	Approximately 30,000 tons per year of bottom ash is wet sluiced to Ash Pond 4. Dried bottom ash is being excavated, dewatered, and stacked within the west side of the pond. Outlet is through four new 24-inch spillway pipes which discharge into the original drainage channel which is lined with riprap protection.
Future Planned Operational Changes:	URS Corporation recently designed modifications for Ash Pond 4 to reduce the "high" hazard classification and to improve other operational conditions. Operational improvements consisted of spillway replacement and lowering of north/northeast dikes and pool level in the vicinity of the stilling basin. Installation of a seepage collection system along the east-southeast dike (working platform in place) is planned.

4. Stantec Field Observations

See attached Photos and Site Plan Drawing.

4.1. Interior Slopes

Vegetation:	Little to none on majority of slope faces due to riprap protection in place (Photo 1). However, some vegetation was present along the waterline across southern portions of the east interior dike (Photo 4). Sparse vegetation was observed on silted/stacked ash material within the southern portions of the ash pond.
Trees:	None observed.
Wave Wash Protection:	Yes, along the north and east sides.
Erosion:	None observed.
Instabilities:	No issues observed.
Animal Burrows:	None observed.
Freeboard:	Approximately 5.1 feet on north side; 8.1 feet on southeast side.
Encroachments:	Bottom ash stacking has occurred on southwest side.
Slope:	2H:1V to 1.5H:1V (as measured in 2009 TVA survey used for Stantec geotechnical evaluation of Pond 4).

4.2. Crest

Crest Cover and Slope:	Crushed stone with good coverage sloped toward interior.
Erosion:	None observed.
Alignment:	No issues observed.
Settlement/Cracking:	None observed.
Bare Spots/Rutting:	None observed.
Width:	25 ft.

4.3. Exterior Slopes

Vegetation: Grasses, generally good coverage. Vegetation was yet to take root sufficiently where regrading was completed over the new spillways (Photo 3). At the toe of the slope and extending to the bank of Cane Creek, vegetation was thick and overgrown (Photo 9). Vegetation was not yet established at the site of a recent test trench on the south side of the pond (Photo 14). Recent regrading efforts in relation to the chemical pond closure also showed sparse vegetation extending onto the west slope (Photo 21).

Trees: Two tree stumps were observed near the crest of the exterior slope on the west side of the pond (Photo 22).

Erosion: Rutting was observed from mowing equipment in and around seepage areas on the east and southeast sides (Photos 6, 8, 13, 17) but no significant erosion gullies and/or rills were observed that appeared to be associated with seepage on the dike slopes. Minor erosion of gravel on the segment of access road that crosses the slope face near the southeast corner (Photo 11) was observed. Some eroded material was deposited on the rock working platform at Seep 4 (Photo 16). One significant erosion gully was noted adjacent to the chemical pond closure on the west side of the dike (Photo 21).

Instabilities: None observed.

Uniform Appearance: Yes.

Seepage: Seepage has been ongoing reportedly since 1984 on the east and south dike slopes and was observed during this inspection as well. Seeps have been labeled 1 through 4 by TVA and are monitored regularly. Flow appears to remain minimal with clear water. Seepage was observed on the slopes (Photos 6, 8, 10, 11, 12, and 16) and at the toe of the perimeter dike (Photos 7, 13, and 17). Previously noted seepage along the bank of Cane Creek was not observed/located on this inspection due to overgrown vegetation.

Benches: A crushed stone working platform is in place around the east and south sides in preparation for seepage collection construction (Photos 5 and 15).

Foundation Drains, and Seepage Collection Systems:	No foundation drains on seepage collection systems exist. A seepage collection system is planned for the east side.
Instrumentation:	Twenty-one piezometers were installed by Stantec in 2009 as part of the dike slope stability and seepage evaluation.
Animal Burrows:	None observed.
Slope:	2.75H:1V to 3H:1V (as measured in 2009 TVA survey used for Stantec geotechnical evaluation of Pond 4).
Height:	Approximately 46 feet maximum on northeast side; reduces to approximately 20 feet on west side.

4.4. Spillway Weirs/Riser Inlets

Number:	Four new primary spillway inlet weirs, located in stilling pond area at north side. Three siphon spillway pipes located southwest of the primary spillway weirs.
Size, Type and Material:	27-inch inside diameter HDPE pipes with 96-inch CMP half-pipe steel skimmers. Siphon spillway pipes are 12-inch diameter dredge pipe hooked to float balls.
Height of Riser Inlets:	N/A.
Access:	Tops of spillways accessible via grated platform from north dike crest.
Joints:	None. New pipe sections are welded or mechanically restrained flanged joints.
Mis-Alignment:	None reported, unable to observe.
Closed/Abandoned Conduits:	The former spillways have been abandoned by grouting the pipes. Original inlet risers were left in place in the north stilling area of the pond. Risers were grouted to no greater than 10 feet above the invert according to construction notes on URS drawing No. 10W290-08.

4.5. Outlet Pipes

Number:	Four pipes for the primary spillway. Three pipes for the emergency siphon spillway.

Size, Type and Material:	27-inch HDPE.
Headwall:	Yes, appeared to be in good condition. The former headwall remained in place with the new headwall structure tied into the top according to URS construction drawing No. 10W290-08 but was not visible.
Joint Separations:	None reported, unable to observe beyond headwall.
Mis-Alignment:	None reported, unable to observe beyond headwall.
Closed/Abandoned Conduits:	The four old 36-inch RCP spillway pipes have been sealed with bulkheads and abandoned in place by filling with grout.

5. Repairs/Mitigation/New Construction Activities Since Last Annual Inspection

The following maintenance activities and improvements have been performed at Ash Pond 4 since the last annual inspection.

- A new primary spillway system has been constructed and is currently in use. It consists of four 27-inch pipes with new inlets and a new headwall outlet structure. Additional crushed stone crest coverage and interior slope riprap protection was placed and appeared to be in excellent condition. The former spillway system was abandoned in place and filled with grout.
- The dike crests and pool elevation were lowered within the stilling pond to remove the previous high hazard designation.
- A new siphon system was constructed using three 12-inch diameter dredge pipes (torpedo strainer inlets) with float balls tethered to the existing dike within the pond to the south of the new main spillway inlet. The pipes outlet into the stormwater drainage channel just upstream of the main spillway outlets (Photo 23).
- Two new pipes with riprap lining have been constructed through a divider dike coming into the main ash pond on the south side.
- Vegetation coverage has been established and maintained near the southeast access road where the previous dredge pipe exposure had been backfilled and regraded, and along the toe of the west dike (with the exception of the recent closure activity for the former chemical pond).
- Improvements were made to storm water drainage at the northwest side of the pond by lining the drainage channel alongside the access road with riprap (Photo 24).
- A working platform along the east slope consisting of crushed stone has been placed

in preparation for construction of a new seepage collection system.

- General maintenance activities (mowing, erosion repair, etc.) appear to have been performed.

6. Recommendations

The following maintenance recommendations are offered for Ash Pond 4. Priority codes are included in parentheses and are described in Enclosure J. The listing of areas to be repaired is included in Enclosure L.

- The seepage along the east and southeast sides should continue to be monitored in accordance with the seepage action plan for COF.
- A few areas lacking adequate vegetation coverage were noted in this inspection. These include the area regraded over the new spillways and the test trench on the southeast corner. These areas should be re-seeded and covered with erosion control blankets to re-establish vegetation coverage. (Items 3 and 14 in Enclosure L, Priority 4)
- It is recommended that a layer of ALDOT Class 2 riprap be placed directly below the outlet end of the drain pipe located along the west dike adjacent to the chemical pond closure area (Photo 21). This pipe crosses beneath the perimeter dike crest and drains surface water onto unprotected soil. Repair of the erosion gullies beyond this pipe should be in accordance with the "General Guidelines for Rill and Gully Erosion Repair at TVA Fossil Plants" document included in Enclosure G. In addition, continued efforts should be made to enhance vegetation coverage at the closed chemical pond area by seeding as needed. (Item 20 and 21 in Enclosure L, Priority 4)
- The tree stumps located on the west side should be removed in accordance with the "General Guidelines for Tree Removal on Slopes" included in Enclosure I. (Item 22 in Enclosure L, Priority 4)

Photo 1

View of interior wave wash protection from northern corner.

Photo 2

New spillways.

Photo 3

Refilled and regraded dike face over new spillway pipes. Vegetation not yet fully established.

Photo 4

View of vegetation on silted material below wave wash protection approaching the southeast corner.

Photo 5

Typical view of good vegetation coverage and rock working platform along east side perimeter dike.

Photo 6

Rutting and standing water at Seep 2.

Photo 7

Standing water below the rock platform downslope of Seep 2.

Photo 8

Continued standing water in rutting of Seep 2.

Photo 9

Typical view of overgrown vegetation at toe of perimeter dike and rock platform along east side of ash pond.

Photo 10

Water from Seep 3 flowing onto access road ditch.

Photo 11

Seepage from Seep 3.

Photo 12

Seepage onto rock platform at southeast corner of dike. TVA survey point #3034.

Photo 13

Soft, wet, and rutted ground downslope of seep observed in Photo 12.

Photo 14

Refilled and regraded site of test dig on southeast corner alongside seep observed in Photo 12. Vegetation not yet established.

Photo 15

Typical view of rock working platform along south side of ash pond.

Photo 16

Seep 4.

Photo 17

Soft, wet, and rutted ground downslope of Seep 4 observed in Photo 16.

Photo 18

Recently trimmed vegetation along toe at southwestern edge of perimeter dike.

Photo 19

Typical view of good vegetation coverage along west side of ash point.

Photo 20

Closed chemical pond.

Photo 21

Sparse vegetative coverage and erosion into chemical pond closure from drainage pipe in ash pond dike. TVA survey point #3035.

Photo 22

Tree stumps along west side of ash pond. TVA survey point #3036.

Photo 23

View of dredge pipes being used as emergency spillway system. Pipes outlet into spillway drainage channel to the right of the photo, south and upstream of the main spillways.

Photo 24

New riprap lined stormwater drainage channel alongside the access roadway.

Plan View - COF 2011 Annual Inspection - Ash Pond 4

Tennessee Valley Authority
Colbert Fossil Plant
Tuscumbia, Colbert County, Alabama

Stantec

STANTEC CONSULTING SERVICES INC
10509 Timberwood Circle
Suite 100
Louisville, Kentucky
40223-5301
502-212-5000

SHEET 1 OF 1

Enclosure B

Disposal Area 5 Dry Stack

TVA 2011 Annual Inspection Program
Colbert Fossil Plant (COF)
Disposal Area 5 Dry Stack

1. General Facility Information

Facility Status: Active

Surface Area:	75 acres	**Maximum Height (toe to top of stack):**	Approx. 120 ft. (from top to toe of perimeter dike)

2. Site Visit Information

Stantec Inspection Team: Mark Jones, PE and Brad Allgeier, EIT.

TVA Staff Present: Jacob Booth and Scott Barrentine.

Field Inspection Date: July 26, 2011.

Weather/Site Conditions: Sunny, mid- to upper-80's, humid, and dry conditions.

3. History/Current and Future Operations

History: Disposal Area 5 perimeter dikes were constructed in 1984. The disposal area was initially utilized as an ash pond. From the mid-1980's until 1990, ash was dredged in slurry fashion from Ash Pond 4 to Area 5 dredge cells 1 and 2. In 1990, dredging was stopped and disposal methods were converted to a dry stacking operation. Dry disposal operation is following a stacking plan developed in the early 1990's. Ultimate height of stack will range from 100 to 120 feet from top to toe of original perimeter dikes. Stacked fly ash is being constructed on approximate 4H:1V slopes, with benches every 20 feet in height.

Current Operations: Stacking operations are continuing, with primary activity located in the relative central region of Disposal Area 5. The stack is built up to 3 to 4 benches above the perimeter dike as of the time of this inspection. Perimeter ditch improvements to mitigate slope stability and toe seepage and better facilitate drainage to the Area 5 Drainage Basin are ongoing.

Future Planned Operational Changes: No significant operational changes are planned. The stack is nearing capacity, and URS Corporation is conducting closure designs. A phased closure approach will be implemented.

4. Stantec Field Observations

See attached Photos and Site Plan Drawing.

4.1. Exterior Slopes and Benches

Vegetation:	Thick grasses/brush in areas that have not yet been subject to regrading during current construction, including the northeast perimeter dike (Photo 4) and south perimeter dike (Photo 22). Other areas of the perimeter dike lacked vegetation coverage at the time of this inspection due to ongoing construction, including the southeast area (Photo 1). The west side of the perimeter dike generally exhibited poor coverage (Photos 17 and 18), particularly in the bend just south of the main haul road. This area of poor coverage extended up the stack (Photos 14 and 15). Grass coverage was generally fair extending farther south along the west perimeter dike (Photo 21). Above the perimeter dike, grass coverage was generally good in most areas (Photos 11 and 24). Areas of sparse to poor coverage were noted sporadically across the stack slopes and benches in other areas (Photos 12, 23, 25, 27, and 30 for typical examples).
Trees:	None observed.
Erosion:	Numerous areas of erosion were observed. Erosion rills and gullies were especially prevalent in the "bend" area extending from the perimeter dike up to the first bench south of the main haul road (Photos 14 through 19). Other instances of erosion were noted on the northern corner of the first bench (Photos 28 and 29) and on the second bench near the southeast down-drain (Photo 32).
Instabilities:	None observed.
Uniform Appearance	Yes.
Benches:	Yes, on approximate 20-foot foot height intervals, approximately 25 feet wide and sloped toward the stack.
Slope:	Approximately 2H:1V for perimeter dike; approximately 3H:1V to 4H:1V for dry stack slopes (as measured in 2009 TVA survey used for Stantec geotechnical evaluation).
Height:	Approximately 120 ft. (from top to toe of perimeter dike).
Other:	During this inspection, seepage areas were observed near the toe of the perimeter dike along the west side of the stack approaching the southwest corner (Photos 19, 20, and 21). TVA personnel reported that this area has exhibited seepage and wet ground conditions for some time. The area exhibited wet ground conditions and no discernable flow was detected.

4.2. Perimeter Drainage Ditches and Down-Drains

Vegetation: Sparse to no vegetation in down-drains. No vegetation in perimeter ditches under construction.

Rip-Rap Channel Lining: Riprap protection coverage was generally good in the down-drains.

Erosion: Down-drain erosion noted at two locations within the east down-drain between the perimeter dike and first bench (Photo 7) and between the second and third benches (Photo 31). Eroded/silted material had covered crushed stone present at the first bench of the north down-drain (Photo 29).

Sedimentation in Ditches: No sedimentation observed - perimeter ditch improvements under construction at time of this inspection. See Photos 2 and 3 for typical views of ongoing construction.

Standing Water in Ditches or on Benches: Standing water was observed at a few locations along the northeast and southeast spans of the perimeter ditch (Photos 5, 6, 8, and 9). This appeared to be a result of seepage occurring as construction was ongoing.

Silted/Impeded Drainage Pipes: None observed, although reportedly some areas of the perimeter ditch regrading had been overfilled by the contractor which impeded drainage (Photo 8).

Other: Seepage boils which had been noted in the perimeter ditch in past inspections were not observed during this inspection. Construction to mitigate this issue was ongoing at the time of inspection. Some seepage was observed within the perimeter ditch along the northeast and southeast areas, as described above.

5. Repairs/Mitigation/New Construction Activities Since Last Annual Inspection

The following maintenance activities and improvements have been performed at the Disposal Area 5 Dry Stack since the last annual inspection:

- New riprap down-drains have been constructed at the north and east corners.
- Perimeter ditch seepage and drainage mitigation construction activities have commenced. In addition, new inlet and outlet headwalls for two 36-inch pipes beneath the haul road have been constructed with riprap protection in place around

the north headwall.

- A stormwater drainage system has been constructed in addition to regrading efforts at the top of the stack in the active staking area prior to the 2010 inspections. This system consists of three pipes held in place atop the stack with riprap which discharge into the perimeter ditch just south of the main haul road (Photos 34 and 35).
- Previous areas of erosion observed during the 2010 inspections have been mitigated, but vegetation coverage is still lacking (Photos 25 and 30).
- A new inlet structure to the Area 5 Drainage Basin has been constructed and improvements are underway to the drainage ditch leading to the inlet box.

6. Recommendations

The following maintenance recommendations are offered for the Disposal Area 5 Dry Stack. Priority codes are included in parentheses and are described in Enclosure J. The listing of areas to be repaired is included in Enclosure L.

- Some areas lacking adequate vegetation coverage were noted in this inspection away from current construction work (Items 36, 49, 51, and 56 of Enclosure L). Re-seeding of these areas should be performed to re-establish vegetation. Erosion control blankets should be placed following seeding. TVA personnel should continue to monitor the stack for sufficient vegetation coverage and re-seed areas as necessary until adequate coverage is achieved. (Priority 4)
- Widespread minor to moderate erosion rills and gullies were prevalent on the west side of the perimeter dike and first bench and at a few other areas (Items 34, 38 through 43, 54, and 58 of Enclosure L). It is recommended that these occurrences of erosion be repaired in accordance with the "General Guidelines for Rill and Gully Erosion Repair at TVA Fossil Plants" included in Enclosure G. (Priority 4)
- Apparent new seepage areas were discovered during this inspection along the toe of the perimeter dike on the northwest side (Items 43 through 47 of Enclosure L). The areas were saturated, but no discernable flow was observed. The areas should be added to the COF Seepage Action Plan for monitoring. Future mitigation may be required if conditions become worse or if expansion of stack occurs to northwest.
- A few areas of minor seepage and seepage collection were observed along the ongoing perimeter ditch reconstruction along the northeast and southeast areas (Items 29, 30, 32, and 33 of Enclosure L). The areas should be reviewed to determine if any modifications to the ongoing construction are needed for mitigation.
- Erosion gullies and/or eroded material were noted in the riprap down-drains at the northeast corner (Photos 7, 29, and 31). It is recommended that the erosion be repaired by cleaning sedimentation and placing new ALDOT Class 2 riprap to re-establish coverage. (Items 31, 55, and 57 of Enclosure L, Priority 4)

Photo 1

Typical view of southeast slope of perimeter dike, looking northeast (construction ongoing).

Photo 2

Perimeter ditch improvements construction along south side, looking west.

Photo 3

Perimeter ditch regrading along southeast side of stack, looking northeast.

Photo 4

Typical view of vegetation on perimeter dike from toe of northeast side of stack.

Photo 5

Seepage beginning to appear along perimeter ditch regrading near south/southeast corner. TVA survey point #3016.

Photo 6

Seepage beginning to appear along perimeter ditch near south/southeast corner.

Photo 7

Slough and erosion in downdrain at northeastern corner between perimeter dike and first bench. TVA survey point #3019.

Photo 8

Seepage collection along perimeter ditch underneath construction road near northeast corner.

Photo 9

Seeps continuing within perimeter ditch along northeast side of stack. TVA survey point #3018.

Photo 10

Erosion rills below first bench along northeast side of stack. TVA survey point #3017

Photo 11

Typical view of good vegetation coverage on slope below first bench along northeast side of stack.

Photo 12

Sparse vegetation near northern corner below first bench. TVA survey point #3021.

Photo 13

Perimeter ditch regrading/excavation underway on northwest side of stack alongside drainage basin.

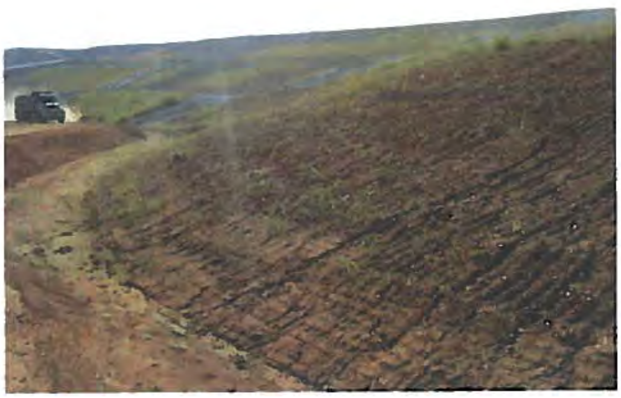

Photo 14

Typical bare ground and erosion rills above perimeter ditch on northwest side of stack (construction ongoing).

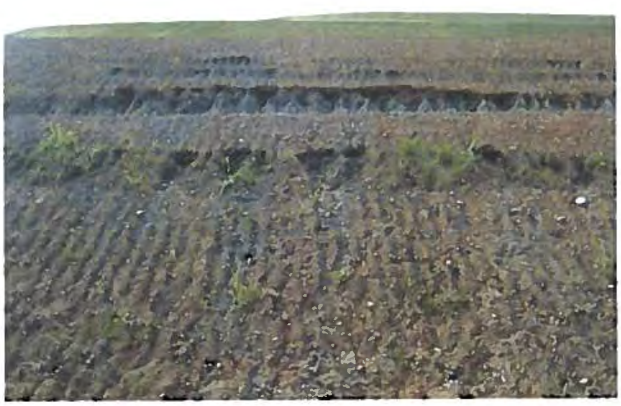

Photo 15

More extensive erosion gullies on northwest side of stack above perimeter ditch (construction ongoing). TVA survey point #3023.

Photo 16

Close-up of erosion gullies from Photo 15.

Photo 17

Typical sparse vegetation and erosion gullies along slopes of perimeter dike, northwest side of stack. TVA survey point #3022.

Photo 18

Additional erosion rills and sparse vegetation on perimeter dike along northwest side of stack.

Photo 19

Seepage and erosion of perimeter dike near southwest corner. TVA survey point #3027.

Photo 20

"Start point" of seepage observed at toe of perimeter dike on northwest side. Minimal flow with clear water noted. TVA survey point #3024.

Photo 21

"End point" of seep beginning in Photo 20, approximately 91 feet southwest. TVA survey point #3025.

Photo 22

Typical view of vegetation from toe of perimeter dike along south side of stack.

Photo 23

Sparse to no vegetation coverage on second bench of stack, looking west from southeast corner.

Photo 24

Typical view of good vegetation coverage on slope between first and second benches along south side of stack.

Photo 25

Previous erosion repair area, vegetation not yet established. TVA survey point #3029.

Photo 26

Regrading and fill material observed around boring STN-117A on second bench (construction ongoing).

Photo 27

Sparse to no vegetation alongside downdrain on northwest side of stack between first and second benches (construction ongoing). TVA survey point #3030.

Photo 28

Bare soil and erosion on first bench approaching northern downdrain. TVA survey point #3020.

Photo 29

Eroded material from Photo 28 in downdrain and lack of rock coverage on first bench. Adjacent to TVA point #3020.

Photo 30

Large area of previous erosion repair between second and third benches on northeast side of stack; vegetation not yet established. TVA survey point #3032.

Photo 31

Localized erosion in downdrain on northeast corner between first and second benches. TVA survey point #3033.

Photo 32

Erosion on second bench near southeast downdrain. TVA survey point #3034.

Photo 33

Recent ash placement at top of stack. View from fourth bench on northwestern side. Note pipes from new stormwater drainage system in background.

Photo 34

Stormwater drainage pipes with riprap protection on top of stack in current active stacking area.

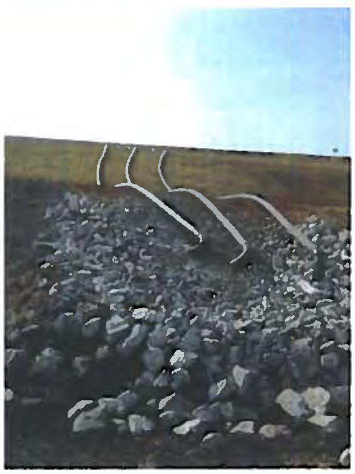

Photo 35

Discharge location of stormwater drainage from top of stack into perimeter ditch.

Plan View - COF 2011 Annual Inspection - Disposal Area 5 Dry Stack

Tennessee Valley Authority
Colbert Fossil Plant
Tuscumbia, Colbert County, Alabama

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PROJECT NO.	175551007
DATE	AUGUST 2011
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Enclosure C

Disposal Area 5 Drainage Basin

Stantec

TVA 2011 Annual Inspection Program
Colbert Fossil Plant (COF)
Disposal Area 5 Drainage Basin

1. General Facility Information

Facility Status:	Active	**NID Identification:**	Not Available.
Surface Area (inside dikes):	12 acres	**TVA Hazard Classification:**	Not Rated
Maximum Height (toe to top of dike):	17 ft.	**Dike Length:**	3,000 ft. (estimated)
Plant Discharge to Facility:	N/A	**Current Pool Elevation:**	El. 466.7 ft.

2. Site Visit Information

Stantec Inspection Team:	Mark Jones, PE and Brad Allgeier, EIT.
TVA Staff Present:	Jacob Booth and Scott Barrentine.
Field Inspection Date:	July 26, 2011.
Weather/Site Conditions:	Partly cloudy to sunny, low- to mid-80's, very humid.

3. History/Current and Future Operations

History:	The Disposal Area 5 Drainage Basin was constructed in the early 1980's with initial development of this disposal area. The basin receives storm water runoff from the adjacent Disposal Area 5 Dry Stack. Storm water enters the basin at the southeast corner. Outlet is through two 48-inch RCP riser pipe/weirs that discharge through two 36-inch RCP sections.
Current Operations:	Receives storm water runoff from adjacent fly ash dry stack, as described above.
Future Planned Operational Changes:	No significant operational changes planned. The basin will continue to receive runoff from the stack area.

4. Stantec Field Observations

See attached Photos and Site Plan Drawing.

4.1. Interior Slopes

Vegetation: Grass to overgrown brush. Grass coverage generally adequate with occasional areas of sparse coverage (Photos 2 and 7). Construction was ongoing at the time of this inspection with regraded material not yet vegetated on the southeast dike near the new inlet (Photo 13). Overgrown brush was present on the interior slopes and silted material along the southeast dike to the south of the new inlet construction (Photo 16).

Trees: A tree stump on the interior side of the crest had not been properly removed (Photo 10).

Wave Wash Protection: Riprap protection was observed along northwest dike (Photos 3 and 7).

Erosion: Minor wave wash erosion was generally present at the waterline along much the southwest dike. A small sough was also observed along the southwest dike as well (Photo 1). Occasional sparse vegetation with minor erosion rills was observed (Photo 2, typical).

Instabilities: None observed.

Animal Burrows: None observed.

Freeboard: 5.5 feet measured from the northwest dike.

Encroachments: None observed.

Slope: 1.5H:1V to 2H:1V (from TVA 2009 survey for Stantec geotechnical exploration of Area 5).

4.2. Crest

Crest Cover and Slope: Access road along the northwest and southwest dike generally exhibited grass coverage outside of wheel paths (upper corners of Photos 2 and 7). Crushed stone coverage on northeast side was generally good. Cover on the southeast dike crest was generally bare from ongoing construction.

Erosion: Minor erosion noted alongside access road near northern corner (Photo 2).

Alignment: No issues observed.

Settlement/Cracking:	None observed.
Bare Spots/Rutting:	Occasional sparse vegetation as observed in Photo 7. Areas of the southeast dike were part of ongoing construction at the time of this inspection and were bare of vegetation. No rutting was observed.
Width:	16 to 19 ft. in most areas, 32 ft. at outlet area.

4.3. Exterior Slopes

Vegetation:	Grass, generally fair to adequate coverage across the majority of the southwest and northwest dike (Photos 4 and 5) with occasional areas of sparse coverage (Photo 6). Coverage along the northeast dike was generally sparse and exhibited track marks from dozer activity (Photos 8 and 11). Vegetation was overgrown along the southernmost 100 feet of the northeast dike (Photo 12).
Trees:	An apparent tree removal cavity on the face of the northeast dike over the spillway area was observed (Photo 9).
Erosion:	Minor erosion observed sporadically in areas of poor coverage as noted above (Photos 4, 5, and 6). No large erosion rills or gullies were observed.
Instabilities:	None observed.
Uniform Appearance:	Yes.
Seepage:	None observed.
Benches:	None observed.
Foundation Drains and Seepage Collection Systems:	None exist.
Instrumentation:	Two piezometers were installed by Stantec in 2009 as part of the geotechnical exploration.
Animal Burrows:	None observed.
Slope:	Generally on the order of 2H:1V (from TVA 2009 survey for Stantec geotechnical exploration of Area 5) for northwest and southwest dike. Portions of the northeast

	dike south of the spillway were observed to be steeper than 2H:1V after initial regrading from apparent tree removal efforts (Photo 11).
Height:	17 ft. maximum.

4.4. Spillway Weirs/Riser Inlets

Number:	Two (southeast weir is above pool and inactive) located at northeast side of basin.
Size, Type and Material:	48-inch RCP push-together riser sections with standard TVA steel skimmers.
Height of Riser Inlets:	23 feet (estimated from TVA Drawing 10W283-3).
Access:	Spillways are accessed via walkway between spillways.
Joints:	No leakage visible in upper portion of southeast weir, which is above pool and inactive. Unable to observe below inlet level at active northwest weir.
Mis-Alignment:	None observed.
Closed/Abandoned Conduits:	None reported or observed.

4.5. Outlet Pipes

Number:	Two.
Size, Type and Material:	36-inch RCP.
Headwall:	Yes, appears to be in good shape. No significant defects noted.
Joint Separations:	Unknown, could not observe. None reported.
Mis-Alignment:	Unknown, could not observe. None reported.
Closed/Abandoned Conduits:	None reported or observed.

5. Repairs/Mitigation/New Construction Activities Since Last Annual Inspection

The following maintenance activities and improvements have been performed for the Disposal Area 5 Drainage Basin since the last annual inspection.

- Wave wash protection has been placed along the interior of the northwest dike.
- Vegetation coverage along the northwest exterior dike face has been improved.
- Previously observed animal burrows appear to have been filled in and no new animal burrows were noted.
- A new inlet system has been constructed on the southeast side. Construction and earthwork are ongoing to facilitate better drainage from Dry Stack 5 to the Area 5 Drainage basin.

6. Recommendations

The following maintenance recommendations are offered for the Disposal Area 5 Drainage Basin. Priority codes are included in parentheses and are described in Enclosure J. The listing of areas to be repaired is included in Enclosure L.

- A few minor erosion features were noted (Items 66 and 67 of Enclosure L). It is recommended that minor erosion rills be repaired in accordance with the "General Guidelines for Rill and Gully Erosion Repair at TVA Fossil Plants" in Enclosure G. (Priority 4)
- It is recommended that the area of internal slope erosion (Item 62 of Enclosure L) be repaired in accordance with the "General Guidelines for Wave Wash Repair and Riprap Protection at TVA Fossil Plants" document in Enclosure H. (Priority 4)
- Sparse vegetation was observed at several locations (Items 63, 65, 68, 69, and 72 of Enclosure L). It is recommended that additional efforts be made to re-establish vegetation by placing seed and erosion control blankets. (Priority 4)
- A tree removal cavity and old tree stump were observed along the northeast dike (Items 70 and 71 of Enclosure L). The cavity should be filled and the tree stump removed in accordance with the "General Guidelines for Removal of Trees on Slopes at TVA Fossil Plants" document in Enclosure I. (Priority 4).

Photo 1

Minor erosion/sloughing on interior dike slope. TVA survey point #3007.

Photo 2

Sparse vegetation coverage, typical along portions of northwest dike interior slope and edge of crest. TVA survey point #3009.

Photo 3

Wave wash protection present on interior of northwest dike.

Photo 4

Typical vegetation on northwest exterior slope. TVA survey point #3008.

Photo 5

Additional minor points of sparse vegetation with minor erosion rills on exterior of northwest dike. TVA survey point #3010.

Photo 6

Minor erosion and sparse vegetation from previous regrading efforts. Exterior slope of northwest dike near north corner. TVA survey point #3011.

Photo 7

Area of sparse vegetation near northern corner. TVA survey point #3012.

Photo 8

Typical sparse vegetation conditions along exterior side of northeast dike from tree removal and regrading efforts.

Photo 9

Apparent tree removal cavity. TVA survey point #3013.

Photo 10

Tree stump not removed. Interior side of northeast dike. TVA survey point #3014.

Photo 11

Typical conditions of sparse vegetation along majority of exterior side of northeast dike after tree removal.

Photo 12

Typical overgrown conditions along easternmost 100 feet (approx.) of northeast dike exterior slope. Overgrown area continued southeast towards Dry Stack 5 area.

Photo 13

Bare ground immediately left/northeast of new inlet along interior slope of southwest dike (construction ongoing). TVA survey point #3015.

Photo 14

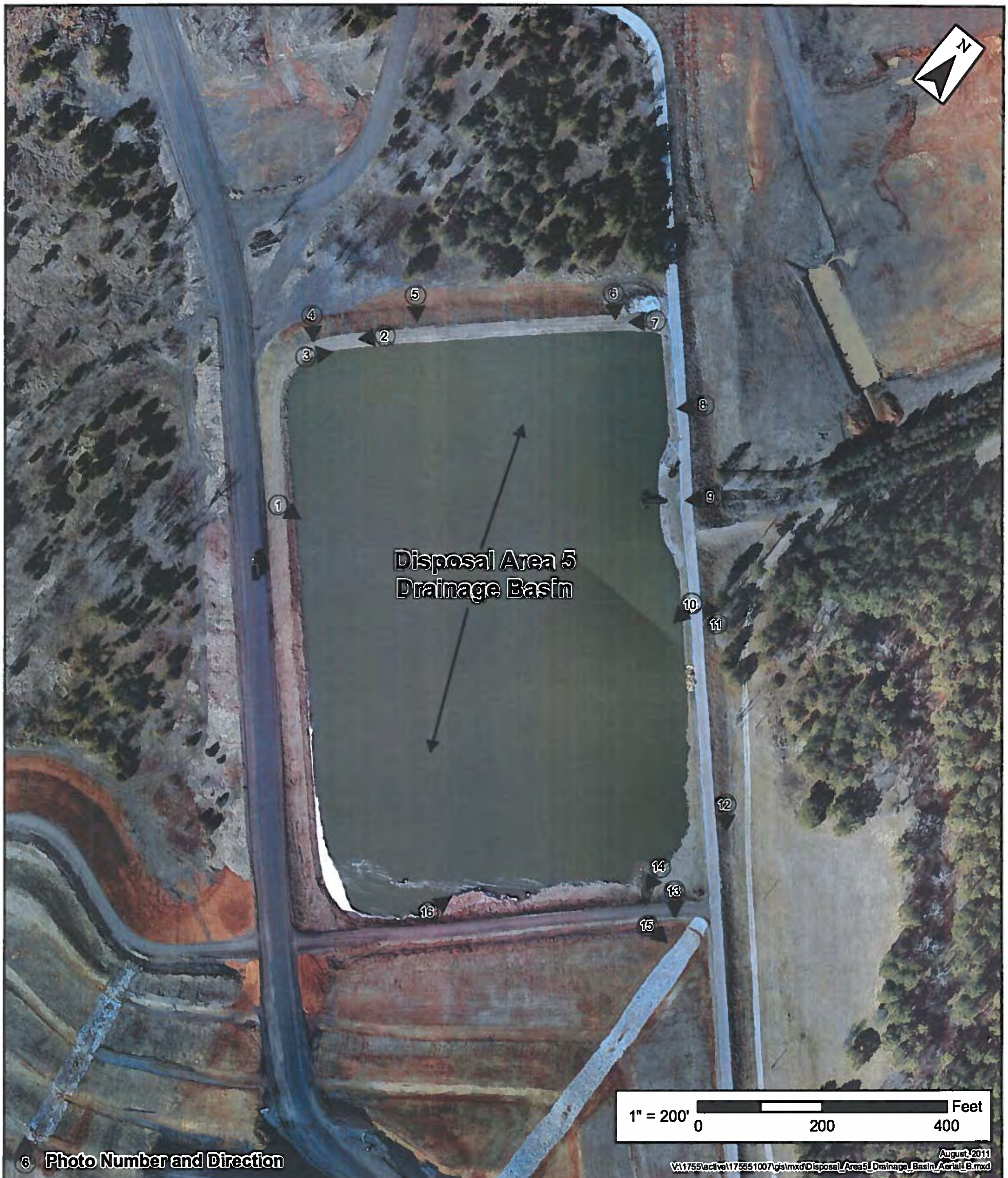
New inlet from Dry Stack 5. Three 36-inch pipes with riprap protection around headwall.

Photo 15

New inlet box (construction ongoing).

Photo 16

Overgrown area along interior of southeast dike.



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Tennessee Valley Authority
Colbert Fossil Plant
Tuscumbia, Colbert County, Alabama
COF 2011 Annual Inspection

1 OF 1

Plan View - COF 2011 Annual Inspection - Disposal Area 5 Drainage Basin

Enclosure D

Closed Disposal Area 1

TVA 2011 Annual Inspection Program
Colbert Fossil Plant (COF)
Closed Disposal Area 1

1. General Facility Information

Facility Status:	Closed	**NID Identification:**	Not Available
Surface Area (inside dikes):	40 acres (estimated)	**TVA Hazard Classification:**	Not Rated
Maximum Height (toe to top of dike):	40 ft. (estimated)	**Dike Length:**	3,000 ft. (estimated)
Plant Discharge to Facility:	None. Disposal area is closed.	**Current Pool Elevation:**	N/A

2. Site Visit Information

Stantec Inspection Team:	Mark Jones, PE and Brad Allgeier, EIT.
TVA Staff Present:	Jacob Booth and Scott Barrentine.
Field Inspection Date:	July 25, 2011.
Weather/Site Conditions:	Sunny, hot, and humid with dry conditions.

3. History/Current and Future Operations

History:	This disposal area was the first ash pond constructed at COF. Ash has not been sluiced to this area since 1975. A reclamation/final grading plan was developed in 1976 for final grading and storm water management. The plant reportedly periodically dry-stacked ash in this area from Ash Pond 4 between 1982 and 1990. The area is currently heavily vegetated and wooded.
Current Operations:	Area is closed and not in use.
Future Planned Operational Changes:	Area will remain closed.

4. Stantec Field Observations

See attached Photos and Site Plan Drawing.

4.1. Interior Slopes

Vegetation:	N/A, interior portion of closed disposal area has been filled/graded and contains thick vegetation and wooded areas.
Trees:	N/A
Wave Wash Protection:	N/A
Erosion:	N/A
Instabilities:	N/A
Animal Burrows:	N/A
Freeboard:	N/A
Encroachments:	N/A
Slope:	N/A

4.2. Crest

Crest Cover and Slope:	The access roadway crest contains a mixture of fly ash in some areas and bottom ash in others with sparse grass cover (Photo 4).
Erosion:	Minor erosion was noted along the access road in the southwestern area of the crest (Photo 5).
Alignment:	No issues observed.
Settlement/Cracking:	None observed.
Bare Spots/Rutting:	None observed.
Width:	25 ft.

4.3. Exterior Slopes

Vegetation:	Thick vegetation throughout with mature trees and dense undergrowth.
Trees:	Yes. Extensive tree growth observed.
Erosion:	Some wave wash erosion was observed along the shoreline (Photo 3). Erosion upslope from the shoreline

	was not observed. Riprap protection--although noted during the 2010 inspections--was unable to be observed at the time of this inspection due to increased pool elevation during fieldwork.
Instabilities:	None observed.
Uniform Appearance:	Good.
Seepage:	None observed.
Benches:	One bench is located approximately halfway down the exterior slope. Width varies between approximately 20 to 40 feet.
Foundations Drains, and Seepage Collection Systems:	No provisions for drainage or seepage collection.
Instrumentation:	None observed.
Animal Burrows:	None observed.
Slope:	Approximately 2H:1V to 3H:1V.
Height:	Approximately 40 feet from dike crest to edge of river, as estimated from old TVA drawings.

4.4. Spillway Weirs/Riser Inlets

Number:	N/A, disposal area is closed.
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:	Old TVA Drawing 10N213 shows two spillway inlets: one at northwest portion and one at southeast. Northwest inlet is visible and open, with no apparent abandonment or closure procedure observed. Inlet consists of 48" RCP riser and is approximately 41 feet deep (estimated from old data). See Photo 1. The southeast inlet and outlet were not observed.

4.5. Outlet Pipes

Number: N/A, disposal area is closed.

Size, Type and Material: N/A

Headwall: N/A

Joint Separations: N/A

Mis-Alignment: N/A

Closed/Abandoned Conduits: Old TVA Drawing 10N213 shows two pipe outlets, one at northwest portion and one at southeast. Only the northwest pipe outlet end was found at the toe of the slope during this inspection due to higher water levels. It was observed to be a 30" diameter RCP section. The pipe outlet was open and no apparent abandonment or closure procedures were observed. A small flow of clear water was observed draining from the southeast outlet. See Photo 2.

5. Repairs/Mitigation/New Construction Activities Since Last Annual Inspection

No known repairs or construction activities have been performed on Closed Disposal Area 1 since the last annual inspection.

6. Recommendations

The following recommendations are offered for Closed Disposal Area 1. Priority codes are included in parentheses and are described in Enclosure J. The listing of areas to be repaired is included in Enclosure L.

- It is recommended that a closure design be developed and executed for the two abandoned spillway outlets associated with this facility. (Priority 5)
- The old dike crest should continue to be maintained. Areas of erosion (as noted in Item 82 of Enclosure L) should be mitigated as outlined in the "General Guideline for Rill and Gully Erosion Repair at TVA Plants" document in Enclosure G. (Priority 5)
- Riprap protection along the shoreline was not observed due to higher water levels. Status of riprap protection should be periodically observed once water levels are lower to ascertain any potential instabilities or erosion issues. (Priority 5)

Photo 1

Former northwest spillway inlet.

Photo 2

Former northwest spillway outlet pipe.

Photo 3

Typical condition at toe of bank with minor erosion.

Photo 4

Typical view of access roadway along crest of closed area.

Photo 5

Minor erosion on access road in southwestern stretch of closed area.

Photo 6

Typical view of boulders on exterior slopes.

Plan View - COF 2011 Annual Inspection - Closed Disposal Area 1

Tennessee Valley Authority
Colbert Fossil Plant
Tuscumbia, Colbert County, Alabama

Stantec

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Enclosure E

Coal Yard Drainage Basin

TVA 2011 Annual Inspection Program
Colbert Fossil Plant (COF)
Coal Yard Drainage Basin

1. General Facility Information

Facility Status:	Active	**NID Identification:**	Not Available
Surface Area (inside dikes):	5 acres	**TVA Hazard Classification:**	Not Rated
Maximum Height (toe to top of dike):	12 to 15 ft.	**Dike Length:**	1,300 ft. (est.)
Plant Discharge to Facility:	N/A	**Current Pool Elevation:**	El. 438.9 ft.

2. Site Visit Information

Stantec Inspection Team:	Mark Jones, PE and Brad Allgeier, EIT.
TVA Staff Present:	Jacob Booth and Scott Barrentine.
Field Inspection Date:	July 25, 2011.
Weather/Site Conditions:	Sunny, hot, and humid with dry conditions.

3. History/Current and Future Operations

History:	The coal yard drainage basin was constructed in approximately 1977. The basin receives runoff from the coal yard. Runoff enters the basin on the northeast side. The basin was formed by excavating into the hillside to the northeast and constructing a clay dike to the west. Outlet is via three pumps which operate on an automatic floating switch basis.
Current Operations:	The basin receives storm water runoff from the adjacent coal yard. Runoff enters the basin on the northeast side.
Future Planned Operational Changes:	No significant operational changes planned. The basin will continue to receive runoff from the coal yard.

4. Stantec Field Observations

See attached Photos and Site Plan Drawing.

4.1. Interior Slopes

Vegetation:	Grass with good coverage to overgrown brush (Photo 1).
Trees:	None observed.
Wave Wash Protection:	None observed.
Erosion:	Minor erosion rills observed along majority of southwest slope. See Photo 3 for typical example.
Instabilities:	None observed.
Animal Burrows:	None observed.
Freeboard:	5.4 feet measured from approximate midpoint of west dike.
Encroachments:	None observed.
Slope:	1.5H:1V to 2H:1V.

4.2. Crest

Crest Cover and Slope:	Gravel (crushed stone) access road with good coverage. Sloped toward interior.
Erosion:	None observed.
Alignment:	No issues observed.
Settlement/Cracking:	None observed.
Bare Spots/Rutting:	None observed.
Width:	26 ft.

4.3. Exterior Slopes

Vegetation:	Grass with some areas of sparse to no coverage along the west dike (Photos 7 and 9).
Trees:	None observed.
Erosion:	Instances of minor erosion and/or rutting were observed Photos 5, 6, 8, and 11). Erosion rills were generally shallow and minor on the west dike. Some eroded material has accumulated at the toe of the slope (Photo

	10). An erosion gully has begun to form at the toe of the dike in a north/northwest direction (Photos 7 and 8).
Instabilities:	None observed.
Uniform Appearance:	Yes.
Seepage:	None observed.
Benches:	None.
Foundations Drains, and Seepage Collection Systems:	No provisions for seepage collection.
Instrumentation:	None.
Animal Burrows:	None observed.
Slope:	2.6H:1V (as measured by Stantec's 2010 inspection)
Height:	12 to 15 ft. (estimated)

4.4. Spillway Weirs/Riser Inlets

Number:	This basin does not have spillway weirs. The outlet system is via 3 pumps which operate on an automatic float switch basis. Operation can also be switched to manual. The pumps are mounted on an elevated platform at the southwest corner (Photo 12).
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:	None reported or observed.

4.5. Outlet Pipes

Number:	See 4.4 for description of pump outlet system. Basin water pumped to Ash Pond 4 when pumps are activated.
Size, Type and Material:	N/A

Headwall: N/A

Joint Separations: N/A

Mis-Alignment: N/A

Closed/Abandoned Conduits: None reported or observed.

5. Repairs/Mitigation/New Construction Activities Since Last Annual Inspection

The following maintenance and construction activities have been performed for the Coal Yard Drainage Basin since the last annual inspection.

- Crest cover has been well maintained. Mowing along the exterior dike slopes has been performed.
- The pond has been dredged to maintain storage capacity.

6. Recommendations

The following maintenance recommendations are offered for the Coal Yard Drainage Basin. Priority codes are included in parentheses and are described in Enclosure J. The listing of areas to be repaired is included in Enclosure L.

- It is recommended that TVA personnel monitor the storage capacity of the basin and perform dredging as-needed to maintain sufficient capacity. (Priority 5)
- Areas of erosion were observed along the majority of the interior dike slope along the northwest side. Photo 3 (Item 86 of Enclosure L) illustrates a typical location. Efforts for repairs should be made following the "General Guidelines for Rill and Gully Erosion Repair at TVA Fossil Plants" document in Enclosure G. However, the erosion appears to be recurring, and TVA should consider placement of wave wash protection for a more permanent repair. (Priority 4)
- Instances of erosion rills on the exterior slope face (Items 88 and 90 of Enclosure L) should be mitigated according to procedures outlined in the "General Guidelines for Rill and Gully Erosion repair at TVA Fossil Plants" included in Enclosure G. (Priority 4)
- Areas exhibiting rutting (Items 89 and 94 of Enclosure L) should be mitigated according to procedures outlined in the "General Guidelines for Rutting Repair at TVA Fossil Plants" included in Enclosure F. (Priority 4)
- It is recommended that the eroded gully shown in Photo 8 (Item 91 in Enclosure L) be repaired by cleaning loose/eroded material and placing ALDOT Class 2 riprap to

provide erosion protection. (Priority 4)

- Areas with sparse to no vegetation coverage on the face of the exterior slope (Item 92 in Enclosure L) should be re-seeded and protected with an erosion control blanket to re-establish vegetation. The accumulated eroded material at the toe (Item 93 in Enclosure L) should be removed and/or regraded and the area seeded and protected with an erosion control blanket to facilitate re-establishing of vegetation. (Priority 4)
- It is recommended that the pump outlet system be checked periodically for proper operation. Maintenance should be performed as needed. (Priority 5)

Photo 1

Typical view of crest and interior slope looking northwest.

Photo 2

Typical view of exterior slope looking northwest.

Photo 3

Typical minor erosion along interior slope. Erosion evident along majority of interior northwest slope. TVA survey point #3000.

Photo 4

View of influent pipes.

Photo 5

Minor erosion rill on exterior slope. TVA survey point #3004.

Photo 6

Rutting in soft, relatively damp area. TVA survey point #3006.

Photo 7

Minor erosion and rutting in poorly vegetated area along exterior slope. TVA survey point #3001.

Photo 8

Continuation of erosion downslope and to the north/northwest of Photo 7. TVA survey point #3002.

Photo 9

Large area on exterior slope lacking vegetation. TVA survey point #3003.

Photo 10

Accumulated eroded material immediately downslope at toe of bare area in Photo 9.

Photo 11

Typical rutting along toe of exterior slope. TVA survey point #3005.

Photo 12

Pump structure in basin.

Stantec

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www.stantec.com

Tennessee Valley Authority
Colbert Fossil Plant
Tuscumbia, Colbert County, Alabama
COF 2011 Annual Inspection

1 OF 1

Plan View - COF 2011 Annual Inspection - Coal Yard Drainage Basin

Enclosure F

General Guidelines for 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 G

General Guidelines for 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 H

General Guidelines for Wave Wash Erosion Repair and 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.

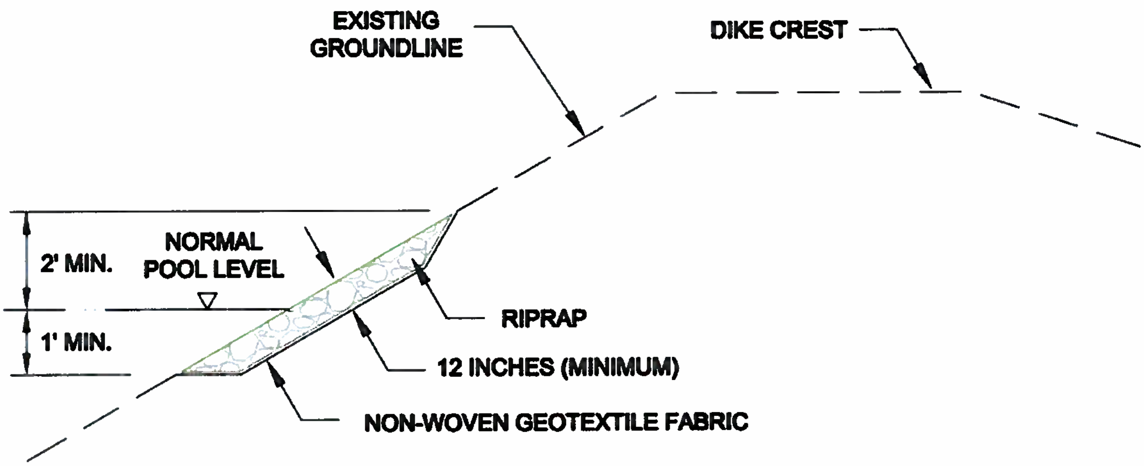
Kentucky Plants -	KYTC Type I Geotextile Fabric
Tennessee Plants -	TDOT Type III Geotextile Fabric
Alabama Plants -	Fabric conforming to Section 608 of ALDOT Standard Specifications

- 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 I

General Guidelines for Tree Removal on Slopes

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 J

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 K

TVA 3rd Quarter FY 2011 Dike Inspection – Colbert Fossil Plant

TVA Monthly /Quarterly/Special Facility Inspection Form

Form Date 6-01-10

1. Site Name: COF **2. Facility Name:** BA Complex **3. Date and Start Time of Inspection:** 6/22/11 - 1 pm (cst)

4. Operator Name: Trans-Ash **5. Inspection Method:** ☒ Walk ☐ Ride ☐ Both

(KNOWN KEY DEFICIENCIES MUST BE INSPECTED)

6. Inspector's Name(s) Brett Wyatt, Roy Quinn, Chris Buttram, Jake Booth, Jacob Horton, Bronson Reed, Shane Harris, Robert Bagwell, Mitch Paige, Johnny Ables **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 81°, Cloudy **Prior Conditions, if notable** Approx. 1.5" of rain previous day

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	x	
11. Activity / Construction on/ at facility	x	
12. DIKE CREST		
A. Settlement / Cracking		x
B. Rutting		x
C. Lateral Displacement		x
D. Erosion		x
13. INTERIOR / EXTERIOR DIKE SLOPES		
A. Minimum Freeboard	4' ft.	
B. Current Freeboard	>4' ft.	
C. Instabilities (Sloughs or Slides)		x
D. Erosion	x	
E. Sinkholes/Depressions ☒ New o Existing	x	
F. Vegetation / Brush / Trees		
o Heavy/Adequate/Sparse/Bare	Adequate	
G. Animal Burrows ☒ New o Existing	x	
H. Seepage o New ☒ Existing	x	
o Clear/Cloudy/Red/Muddy	Red/Muddy	
o Flow Increased/Decreased/Same	Same gpm	
o Ash or Clay Deposits Below Seep Outlet		x
I. Seep around Drain Pipe(s)		x
o Clear/Cloudy/Red/Muddy	N/A	
14. DEFICIENCIES		
A. Prior Key Deficiencies Checked	x	
B. New Deficiencies Identified / Flagged	x	
C. Immediate Actions Taken (Note Below)		x
D. Photos of deficiencies attached	x	

	Yes	No
15. DIKE TOE AREAS		
A. Seepage o New ☒ Existing	x	
o Clear/Cloudy/Red/Muddy	Clear	
o Flow Increased / Decreased/Same	Same gpm	
o Aquatic Vegetation Growing		x
o Ash or Clay Deposits Below Seep Outlet		x
B. Boils o New o Existing		x
o Clear/Cloudy/Red/Muddy	N/A	
o Flow Increased / Decreased/Same	N/A gpm	
o Growing in Size	N/A	
C. Sinkholes/Depressions o New o Existing		x
16. SEEPAGE COLLECTION SYSTEM		
A. Estimated Flow Measurement	N/A gpm	
B. Increased Flow	N/A	
C. Emitting Clear or Dirty Water	N/A	
17. SPILLWAY WEIRS & OUTLETS		
A. Decant Riser Misaligned		x
B. Decant Pipe Joints		x
o Leaking		x
o Separated		x
C. Headwall In Good Condition	x	
18. OPERATIONS & MAINTENANCE		
A. Routine O&M Performed	x	
B. Weekly Observations Performed	x	
C. Any Changes in Operations	x	

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: __________ To: __________ Signature: ____________________ Date: __________

LOCATION: Colbert Fossil Plant - **Bottom Ash Stack Inspection** - 3rd Quarter FY2011 Dike Inspection
WEATHER: 81 degrees F, Cloudy
INSPECTION BY: Brett Wyatt, Roy Quinn, Chris Buttram, Jake Booth, Jacob Horton, Bronson Reed, Shane Harris, Robert Bagwell, Mitch Paige, Johnny Ables
DATE: 06/22/2011

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	COMMENT
10	Trees at toe of slope (beginning)	1183	1000	1721390.91	394293.35	Repair in accordance with General Guidelines
11	Trees at toe of slope (end)/animal burrow	1184	1002	1721649.5	394200.75	Repair in accordance with General Guidelines
12	Rutting/standing water	1185	1003	1722033.37	394283.27	Fill low spot to correct drainage
13	Tree stump	1186	1004	1722581.53	394205.37	Repair in accordance with General Guidelines
14	Hole - undercutting slope	1187	1005	1722862.2	394172.63	Repair in accordance with General Guidelines
15	Hole (from tree removal)	1188	1006	1722890.58	394167.55	Repair in accordance with General Guidelines
16	Animal burrow	1189	1007	1723018.16	394156.62	Repair in accordance with General Guidelines
17	High vegetation full length of toe	1190	1008	1723209.48	394920.61	Cut vegetation in accordance with correct requirements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TVA **Monthly /Quarterly/Special Facility Inspection Form** **Form Date 6-01-10**

1. Site Name: COF **2. Facility Name:** FA Stack **3. Date and Start Time of Inspection:** 6/22/11 - 1 pm (cst)

4. Operator Name: Trans-Ash **5. Inspection Method:** ☒ Walk ☐ Ride ☐ Both

(KNOWN KEY DEFICIENCIES MUST BE INSPECTED)

6. Inspector's Name(s) Brett Wyatt, Roy Quinn, Chris Buttram, Jake Booth, Jacob Horton, Bronson Reed, Shane Harris, Robert Bagwell, Mitch Paige, Johnny Ables **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 81°, Cloudy **Prior Conditions, if notable** Approx. 1.5" of rain previous day

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	x	
11. Activity / Construction on/ at facility	x	
12. DIKE CREST		
A. Settlement / Cracking		x
B. Rutting		x
C. Lateral Displacement		x
D. Erosion		x
13. INTERIOR / EXTERIOR DIKE SLOPES		
A. Minimum Freeboard	N/A ft.	
B. Current Freeboard	N/A ft.	
C. Instabilities (Sloughs or Slides)		x
D. Erosion	x	
E. Sinkholes/Depressions ○ New ○ Existing		x
F. Vegetation / Brush / Trees		
○ Heavy/Adequate/Sparse/Bare	Sparse	
G. Animal Burrows ☒ New ○ Existing	x	
H. Seepage ○ New ○ Existing		x
○ Clear/Cloudy/Red/Muddy	N/A	
○ Flow Increased/Decreased/Same	N/A gpm	
○ Ash or Clay Deposits Below Seep Outlet	N/A	
I. Seep around Drain Pipe(s)	N/A	
○ Clear/Cloudy/Red/Muddy	N/A	
14. DEFICIENCIES		
A. Prior Key Deficiencies Checked	x	
B. New Deficiencies Identified / Flagged	x	
C. Immediate Actions Taken (Note Below)		x
D. Photos of deficiencies attached	x	

	Yes	No
15. DIKE TOE AREAS		
A. Seepage ○ New ○ Existing		x
○ Clear/Cloudy/Red/Muddy	N/A	
○ Flow Increased / Decreased/Same	N/A gpm	
○ Aquatic Vegetation Growing	N/A	
○ Ash or Clay Deposits Below Seep Outlet	N/A	
B. Boils ○ New ○ Existing		x
○ Clear/Cloudy/Red/Muddy	N/A	
○ Flow Increased / Decreased/Same	N/A gpm	
○ Growing in Size	N/A	
C. Sinkholes/Depressions ○ New ○ Existing		x
16. SEEPAGE COLLECTION SYSTEM		
A. Estimated Flow Measurement	N/A gpm	
B. Increased Flow	N/A	
C. Emitting Clear or Dirty Water	N/A	
17. SPILLWAY WEIRS & OUTLETS		
A. Decant Riser Misaligned	N/A	
B. Decant Pipe Joints	N/A	
○ Leaking	N/A	
○ Separated	N/A	
C. Headwall In Good Condition	N/A	
18. OPERATIONS & MAINTENANCE		
A. Routine O&M Performed	x	
B. Weekly Observations Performed	x	
C. Any Changes in Operations		x

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: ________ **To:** ________ **Signature:** ____________________ **Date:** ________

LOCATION: Colbert Fossil Plant - Fly Ash Stack 5 Inspection - 3rd Quarter FY2011 Dike Inspection
WEATHER: 81 degrees F, Cloudy
INSPECTION BY: Brett Wyatt, Roy Quinn, Chris Buttram, Jake Booth, Jacob Horton, Bronson Reed, Shane Harris, Robert Bagwell, Mitch Paige, Johnny Ables
DATE: 06/22/2011

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	COMMENT
1	Erosion (20' x 1.5'D)	2402	3000	1721172.45	400766.71	Repair in accordance with General Guidelines
2	Low area/standing water	2404	3001	1721016.89	400690.51	Fill low spot to correct drainage
3	Low area/standing water	2405	3002	1720457.14	400080.93	Fill low spot to correct drainage
4	Low area/standing water	2406	3003	1720557.09	399726.47	Fill low spot to correct drainage
5	Low area/standing water	2407	3004	1721286.48	399140.2	Fill low spot to correct drainage
6	Low area/standing water	2408	3005	1721348.79	399120.61	Fill low spot to correct drainage
7	Beached area in Stilling Pond	2409-2410	3006	1721860.33	399275.88	Monitor beached area with regards to Free Water Volume requirements
8	Low area/poor drainage	5713	5000	1721477.69	398762.34	Fill low spot to correct drainage
9	Large animal burrow	5714	5001	1720670.94	398742.62	Repair in accordance with General Guidelines


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Enclosure L

Stantec Annual Inspection Item List – Colbert Fossil Plant

LOCATION: Colbert Fossil Plant - Annual Inspection
WEATHER: 80's to 90's degrees F, Sunny
INSPECTION BY: Mark Jones, Brad Allgeier, Jacob Booth, Scott Barrentine
DATE: 7/25/2011 and 7/26/2011

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	RECOMMENDATION
Annual Inspection - Ash Pond 4						
1	Wave wash protection	1				Information purposes only. No recommendation/repair necessary.
2	New spillways	2				Information purposes only. No recommendation/repair necessary.
3	Lack of vegetation on exterior slope over spillways	3				Re-establish vegetation
4	Wave wash protection and vegetation in interior slope	4				Information purposes only. No recommendation/repair necessary.
5	Vegetation and rock bench, exterior slope	5				Information purposes only. No recommendation/repair necessary.
6	Seep #2	6				Continue to monitor
7	Seep #2	7				Continue to monitor
8	Seep #2	8				Continue to monitor
9	Overgrown vegetation at along east toe	9				Maintain vegetation
10	Seep #3	10				Continue to monitor
11	Seep #3 (looking below)	11				Continue to monitor
12	Seepage	12	3034	1721137.41	395740.55	Continue to monitor
13	Seepage	13				Re-establish vegetation
14	Test Trench - lack of vegetation	14				Repair in accordance with General Guidelines
15	Vegetation and rock bench, exterior slope	15				Information purposes only. No recommendation/repair necessary.
16	Seep #4	16				Continue to monitor
17	Seep #4	17				Continue to monitor
18	Vegetation - good coverage	18				Information purposes only. No recommendation/repair necessary.
19	Vegetation - good coverage, recently trimmed	19				Information purposes only. No recommendation/repair necessary.
20	Closed chemical pond	20				Continue efforts to re-establish vegetation
21	Erosion	21	3035	1722433.36	394191.05	Repair in accordance with General Guidelines and place riprap
22	Tree stumps	22	3036	1722795.84	394189.82	Remove in accordance with General Guidelines
23	Riprap protection	23				Information purposes only. No recommendation/repair necessary.
24	Riprap protection	24				Information purposes only. No recommendation/repair necessary.
Annual Inspection - Disposal Area 5 Dry Stack						
25	Southeast slope - ongoing construction	1				Information purposes only. No recommendation/repair necessary.
26	Perimeter ditch - ongoing construction	2				Information purposes only. No recommendation/repair necessary.
27	Perimeter ditch - ongoing construction	3				Information purposes only. No recommendation/repair necessary.
28	Vegetation - overgrown	4				Maintain vegetation
29	Perimeter ditch seepage	5	3016	1720294.34	400404.55	Continue to monitor through construction - make adjustments if necessary
30	Perimeter ditch seepage	6				Continue to monitor through construction - make adjustments if necessary
31	Erosion	7	3019	1721054.09	400735.99	Clean eroded material and place riprap
32	Perimeter ditch seepage	8				Continue to monitor through construction - make adjustments if necessary
33	Perimeter ditch seepage	9	3018	1721309.11	400570.50	Continue to monitor through construction - make adjustments if necessary
34	Erosion	10	3017	1721305.60	400535.22	Repair in accordance with General Guidelines
35	Vegetation - good coverage	11				Information purposes only. No recommendation/repair necessary.
36	Vegetation - sparse coverage	12	3021	1722033.14	399650.41	Re-establish vegetation
37	Perimeter ditch - ongoing construction	13				Information purposes only. No recommendation/repair necessary.
38	Erosion, sparse vegetation	14				Repair in accordance with General Guidelines
39	Erosion, sparse vegetation	15	3023	1721476.21	398704.70	Repair in accordance with General Guidelines
40	Erosion	16				Repair in accordance with General Guidelines
41	Erosion, sparse vegetation	17	3022	1721649.96	399029.50	Repair in accordance with General Guidelines
42	Erosion, sparse vegetation	18				Repair in accordance with General Guidelines
43	Seepage, erosion	19	3027	1720975.21	398161.41	Repair in accordance with General Guidelines and monitor seepage
44	Seepage	20	3024	1721370.89	398433.38	Continue to monitor
45	Seepage	21	3025	1721295.89	398380.37	Continue to monitor

Note: The accompanying aerial layout displaying the location of the surveyed points is included in each facilities respective enclosure within the annual inspection.

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	RECOMMENDATION
Annual Inspection - Disposal Area 5 Dry Stack						
46	Seepage	No photo	3026	1721260.12	398356.37	Continue to monitor
47	Seepage	No photo	3028	1721029.97	398208.46	Continue to monitor
48	Vegetation - overgrown	22				Maintain vegetation
49	Vegetation - sparse coverage	23				Establish vegetation
50	Vegetation - good coverage	24				Information purposes only. No recommendation/repair necessary.
51	Vegetation - sparse coverage (erosion repair)	25	3029	1720636.14	398857.97	Establish vegetation
52	Ongoing construction	26				Information purposes only. No recommendation/repair necessary.
53	Vegetation - sparse coverage (ongoing construction)	27	3030	1721454.72	399079.75	Information purposes only. No recommendation/repair necessary.
54	Erosion, sparse vegetation	28	3020	1721959.31	399722.67	Repair in accordance with General Guidelines
55	Erosion, lack of riprap	29				Repair in accordance with General Guidelines and place riprap
56	Vegetation - sparse coverage	30	3032	1721632.42	399903.23	Establish vegetation
57	Erosion	31	3033	1721044.03	400624.10	Clean eroded material and place riprap
58	Erosion	32				Repair in accordance with General Guidelines
59	Active stacking area	33				Information purposes only. No recommendation/repair necessary.
60	Storm drain pipe (inlet)	34				Information purposes only. No recommendation/repair necessary.
61	Storm drain pipe (outlet)	35				Information purposes only. No recommendation/repair necessary.
Annual Inspection - Disposal Area 5 Drainage Basin						
62	Erosion/sloughing	1	3007	1722296.19	398747.19	Repair in accordance with General Guidelines
63	Vegetation - sparse coverage	2	3009	1722646.47	398734.05	Re-establish vegetation
64	Wave wash protection	3				Information purposes only. No recommendation/repair necessary.
65	Vegetation - sparse coverage	4	3008	1722514.75	398565.89	Re-establish vegetation
66	Vegetation - sparse coverage, minor erosion	5	3010	1722658.04	398681.36	Repair in accordance with General Guidelines
67	Vegetation - sparse coverage, minor erosion	6	3011	1722870.12	398910.38	Repair in accordance with General Guidelines
68	Vegetation - sparse coverage	7	3012	1722898.44	399002.42	Re-establish vegetation
69	Vegetation - sparse coverage	8				Re-establish vegetation
70	Tree removal cavity not backfilled	9	3013	1722739.97	399248.28	Repair in accordance with General Guidelines
71	Tree stump	10	3014	1722610.39	399313.46	Remove stump in accordance with General Guidelines
72	Vegetation - sparse coverage	11				Establish vegetation
73	Vegetation - overgrown	12				Maintain vegetation
74	Bare ground (ongoing construction)	13	3015	1722196.25	399616.17	Information purposes only. No recommendation/repair necessary.
75	New inlet headwall	14				Information purposes only. No recommendation/repair necessary.
76	New box inlet	15				Information purposes only. No recommendation/repair necessary.
77	Vegetation - overgrown	16				Maintain vegetation
Annual Inspection - Closed Disposal Area 1						
78	Former spillway inlet	1				Develop and execute closure design.
79	Former spillway outlet	2				Develop and execute closure design.
80	Erosion (wave wash)	3				Continue to monitor
81	Access road	4				Information purposes only. No recommendation/repair necessary.
82	Erosion	5				Repair in accordance with General Guidelines
83	Riprap protection	6				Information purposes only. No recommendation/repair necessary.
Annual Inspection - Coal Yard Drainage Basin						
84	Crest and interior slope	1				Information purposes only. No recommendation/repair necessary.
85	Exterior slope	2				Information purposes only. No recommendation/repair necessary.
86	Erosion	3	3000	1722955.96	395756.18	Repair in accordance with General Guidelines
87	Influent pipes	4				Information purposes only. No recommendation/repair necessary.
88	Erosion	5	3004	1723433.65	395489.84	Repair in accordance with General Guidelines
89	Rutting, damp area	6	3006	1723251.64	395543.06	Repair in accordance with General Guidelines
90	Erosion, rutting	7	3001	1722793.36	395765.19	Repair in accordance with General Guidelines
91	Erosion	8	3002	1722955.45	395681.81	Place riprap protection
92	Vegetation - sparse coverage	9	3003	1723221.07	395593.13	Re-establish vegetation
93	Eroded material	10				Remove/regrade accumulated eroded material, re-establish vegetation

Note: The accompanying aerial layout displaying the location of the surveyed points is included in each facilities respective enclosure within the annual inspection.

ITEM NO.	DESCRIPTION	PICTURE NO.	POINT NO.	NORTHING	EASTING	RECOMMENDATION
Annual Inspection - Coal Yard Drainage Basin						
94	Rutting	11	3005	1723310.50	395525.12	Repair in accordance with General Guidelines, continue to monitor
95	Pump structure	12				Information purposes only. No recommendation/repair necessary.

Note: The accompanying aerial layout displaying the location of the surveyed points is included in each facilities respective enclosure within the annual inspection.

APPENDIX A

Document 7

TVA Colbert Fossil Plant NPDES Permit No. AL003867

ADEM

ALABAMA
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT

PERMITTEE:	TENNESSEE VALLEY AUTHORITY COLBERT FOSSIL PLANT
FACILITY LOCATION:	900 COLBERT STEAM PLANT ROAD TUSCUMBIA, AL
PERMIT NUMBER:	AL 0003867
RECEIVING WATERS:	DSN001, DSN002, DSN004, DSN012, and DSN013: CANE CREEK DSN003, DSN005, DSN006, DSN008 – DSN010: TENNESSEE RIVER

*In accordance with and subject to the provisions of the Federal Water Pollution Control Act, as amended, 33 U.S.C. §§1251-1378 (the "FWPCA"), the Alabama Water Pollution Control Act, as amended, **Code of Alabama 1975**, §§ 22-22-1 to 22-22-14 (the "AWPCA"), the Alabama Environmental Management Act, as amended, **Code of Alabama 1975**, §§22-22A-1 to 22-22A-15, and rules and regulations adopted thereunder, and subject further to the terms and conditions set forth in this permit, the Permittee is hereby authorized to discharge into the above-named receiving waters.*

ISSUANCE DATE:	MAY 17, 2005
EFFECTIVE DATE:	JUNE 1, 2005
EXPIRATION DATE:	MAY 31, 2010

Alabama Department of Environmental Management

APPENDIX A

Document 8

URS Memorandum Dated September 24, 2010, Re: Colbert Fossil Plant – Bottom Ash 4 High Hazard Designation Removal Documentation

November 29, 2010
(Original sent September 26, 2010)

Memo No: COF10-0001

Dam Safety Officer, Michael T. Scott, LP 3D-C

COLBERT ASH POND 4 - HAZARD CLASSIFICATION "SIGNIFICANT"

The Colbert Fossil Plant is located on the south bank of Pickwick Reservoir along the Tennessee River in Colbert County, Alabama. The existing Ash Pond 4 has a footprint of approximately 52 acres.

In the Spring of 2009, TVA performed a preliminary evaluation of the Colbert Ash Pond 4, classifying it as a "High Hazard" structure. This was based on the consequences of failure in terms of probable loss of human life in the event of a failure.

On November 20, 2009, URS and TVA conducted a meeting to determine the method for removal of the "High Hazard." The meeting resulted in an approach of lowering a portion of the Ash Pond 4 dike. An analysis was performed by URS for two basic failure scenarios: (1) A "Sunny Day" dam break inundation analysis to determine the elevation of pond water that would result in no loss of life in the event of a dam break. This evaluation resulted in a design elevation of El. 458 and an operating pool of El. 453.; and (2) A "Probable Maximum Precipitation (PMP) Event" consisting of an overtopping failure during a PMP event. Under the new spillway design, the dikes would not be overtopped at EL 458. Therefore, the design is sufficient to pass the PMP. Upon implementation of the dike lowering design, the hazard designation of Pond 4 could be reduced to "Significant Hazard," reflecting no probable loss of life in the event of a failure.

Dike lowering activities began in August 2010 and were completed on September 3, 2010. The final "as constructed" survey data, obtained on September 21, 2010, verified the as-built dike crest elevation at El. 458. Thus, the attached URS memo recommends that the hazard classification be lowered from "High Hazard" to "Significant Hazard."

TVA CCP Engineering, along with River Operations, have reviewed the report and concur with the methodology of analysis and the subsequent results. Based on the report and reviews, CCP Engineering is sending this memo to Dam Safety to document the lowering of the Hazard Classification of the Colbert Ash Pond 4 to "Significant."

Scott Turnbow

Scott Turnbow
Senior Manager, CCP Engineering
LP 5E-C

MST:MST
Attachment: URS Memo - "Colbert Fossil Plant – Bottom Ash Pond 4
High Hazard Designation Removal Documentation"
cc (Attachment):

J. C. Kammeyer, LP 5D-C
R. W. Tompkins, LP 3D-C
J. C. Buttram, LP 5E-C

Coal Combustion Products Engineering

September 26, 2010 *Memo No: COF10-0001*

Dam Safety Officer, Michael T. Scott, LP 3D-C

COLBERT ASH POND 4 - HAZARD CLASSIFICATION "SIGNIFICANT"

The Colbert Fossil Plant is located on the south bank of Pickwick Reservoir along the Tennessee River in Colbert County, Alabama. The existing Ash Pond 4 has a footprint of approximately 52 acres.

In the Spring of 2009, TVA performed a preliminary evaluation of the Colbert Ash Pond 4, classifying it as a "High Hazard" structure. This was based on the consequences of failure in terms of probable loss of human life in the event of a failure.

On November 20, 2009, URS and TVA conducted a meeting to determine the method for removal of the "High Hazard." The meeting resulted in an approach of lowering a portion of the Ash Pond 4 dike. Upon implementation of the dike lowering design, the hazard designation of Pond 4 would be reduced to "Significant Hazard," reflecting no probable loss of life in the event of a failure. URS performed dam break inundation analysis to establish the extent of the dike lowering, resulting in a design elevation of El. 458 and an operating pool of El. 453.

Dike lowering activities began in August 2010 and were completed on September 3, 2010. The final "as constructed" survey data, obtained on September 21, 2010, verified the as-built dike crest elevation at El. 458. Thus, the attached URS memo recommends that the hazard classification be lowered from "High Hazard" to "Significant Hazard."

TVA CCP Engineering, along with River Operations, have reviewed the report and concur with the methodology of analysis and the subsequent results. Based on the report and reviews, CCP Engineering is sending this memo to Dam Safety to document the lowering of the Hazard Classification of the Colbert Ash Pond 4 to "Significant."

ORIGINAL ISSUE

Scott Turnbow

Scott Turnbow
Senior Manager, CCP Engineering
LP 5E-C

MST:MST
Attachment: URS Memo - "Colbert Fossil Plant – Bottom Ash Pond 4 High Hazard Designation Removal Documentation"
cc (Attachment):
J. C. Kammeyer, LP 5D-C
R. W. Tompkins, LP 3D-C
J. C. Buttram, LP 5E-C
C. M. Anderson, LP 5D-C

URS
1375 Euclid Avenue
Cleveland, OH 44115-1808
Tel: 216.622-2400

MEMORANDUM

TO:	Ron Skelton – TVA	DATE:	September 24, 2010
BY:	Michael Stepic, P.E. - URS	PROJECT:	TVA Colbert Fossil Plant (COF)
CC:	Chris Buttram – TVA Jeff Ward – TVA Brandt Rutledge – TVA Keith McMillion - TVA Larry Chintella – URS Sherry Potoma – URS Keith Mast - URS	JOB NO.:	31851111

RE: Colbert Fossil Plant – Bottom Ash Pond 4
High Hazard Designation Removal Documentation

The purpose of this memorandum is to document the removal of the High Hazard designation at Colbert Fossil Plant (COF) Bottom Ash Pond 4 (Pond 4).

HIGH HAZARD DESIGNATION

In the spring of 2009, TVA performed a preliminary evaluation of existing impoundment structures in general accordance with FEMA's Hazard Potential of Dams (FEMA, 2004). Following expedited assessment of site conditions, TVA classified Pond 4 as a "High Hazard" structure. The High Hazard classification was based on the consequences (not probability) of failure in terms of probable loss of human life if failure was to occur. This classification was based on the proximity of the south dike of Pond 4 to State Route 2/US Route 72/Lee Highway, a railroad, and an existing inhabited structure to the east and west side of Colbert Steam Plant Road.

HIGH HAZARD REMOVAL DESIGN

URS and TVA conducted a meeting on November 20, 2009 to choose the method of high hazard removal. During this meeting and subsequent telephone conversations, the concept of lowering a portion of the Pond 4 dike was the chosen method to remove the High Hazard designation. Upon implementation of the dike lowering design, the hazard designation of Pond 4 will then be "Significant" Hazard, reflecting no probable loss of life in the event of a failure. However, under the Significant Hazard designation, environmental impacts, economic losses, and infrastructure damage may occur.

URS performed dam break inundation analysis to establish the extent of dike lowering. Iterative analyses were performed, in which the dike top elevation and the maximum pool of the pond (i.e., a pool elevation corresponding to the top of dike) was varied. The dam break analysis is described in Attachment 1. The maximum pool level that would not result in overtopping of the downstream highway and railroad structures in the event of a breach was determined. Based on the results of the analyses, dam breach flood inundation will be contained below the level of the railroad, highway, and adjacent residence if the dike crest elevation is reduced to El. 458 and the normal operating pool is set at El. 453. The extent of dike lowering was limited to 800 feet along the north and east sides of the stilling pond to minimize impact to plant operations while still eliminating the high hazard.

The extent of the high hazard removal is shown in drawings 10W290-05 and 10W290-06 of the Ash Pond 4- High Hazard Removal & Spillway Replacement (construction set, dated June 17, 2010) Work Plan Drawings.

HIGH HAZARD REMOVAL CONSTRUCTION

Dike lowering activities began in August 2010 and were completed on September 3, 2010. The Work Plan included removal of the existing roadway and excavation of the existing dike to a nominal elevation of 457 ft msl. The top of the dike was then proof rolled to verify that the subgrade was appropriately prepared and established prior to reconstruction of the new road consisting of 12 inches of ALDOT No. 410 aggregate. During construction and following establishment of the final road cross-section, TVA performed a final as constructed survey. Survey data obtained on September 21, 2010 verify the as-built dike crest elevation at El. 458.

Based upon the confirmation via survey, URS has concluded that the as constructed modifications to Pond 4 have been completed in accordance with the design drawings. Based upon the hydraulic modeling previously completed, the High Hazard classification for Pond 4 has been eliminated. Pond 4 is now classified as a Significant Hazard due to potential damage to COF property and potential environmental impacts.

ATTACHMENT 1
Dam Break Analysis

DAM BREAK ANALYSIS

TVA COLBERT FOSSIL PLANT
TUSCUMBIA, ALABAMA
HIGH HAZARD REMOVAL

Prepared for

Tennessee Valley Authority
1101 Market Street
Chattanooga, TN 37402

May 26, 2010

URS

1375 Euclid Avenue
Cleveland, Ohio 44115
216-622-2400
Project No. 31851111.42000

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The Tennessee Valley Authority (TVA) has directed URS Corporation (URS) to confirm feasibility and develop final design of the conceptual alternative selected by TVA to eliminate the high hazard dam designation at the Colbert Fossil Plant Facility (COF), Ash Disposal Pond 4 (Pond 4). The selected alternative consists of lowering the dike crest and operating pool elevation by several feet such that potential dam failure will no longer inundate inhabited areas.

Previous dam break analyses and inundation mapping (Stantec, 2009) indicated that under existing conditions failure of the dikes would inundate parts of the railroad tracks and US Highway 72 south of Pond 4, confirming TVA's decision to classify Pond 4 as high hazard. URS was directed to further evaluate the existing conditions of Pond 4, perform dam break analyses and hydraulic calculations to confirm previous findings, and to perform an iterative series of dam break simulations to determine the required dike height reduction to eliminate the high hazard classification.

1.1 BACKGROUND

URS has prepared the following Basis of Design report that presents all pertinent engineering analyses, site investigations, surveys, references, standards and backup calculations associated with preparation of the final design and technical specifications for the high hazard removal at COF Pond 4.

URS performed existing conditions modeling which confirmed that Pond 4, under its current operating conditions and incorporating conservative assumptions, is appropriately classified as high hazard. URS has provided this document to illustrate a clear understanding of the current conditions of the coal ash pond, while supplying the technical basis for design modifications to remove the high hazard classification.

All elevations in this document are expressed in feet, and referenced to the Alabama West, North American Vertical Datum (NAVD) of 1929. The final design, feasibility studies and supporting analyses were prepared using aerial photograph based topographic mapping provided by TVA early in the project.

1.2 REVIEW OF PREVIOUS ANALYSIS

A previous dam failure inundation study was performed in 2009 that substantiated TVA's preliminary assessment to assign the High Hazard classification to COF Ash Pond 4 and is listed below:

1. Colbert Fossil Plant Bottom Ash Pond, Impact Reduction Analysis - October 22, 2009, by Stantec Consulting Services Inc., Cincinnati, OH.

After reviewing this document and incorporating common practice methods, URS was able to establish modeling parameters as a basis for the dam break analysis. Structures inundated through this exercise were located to the south of the pond, and included a railroad, US Highway 72, and a single family residence. Since the railroad is the lowest structure at elevation 434.0, it governs the analysis.

2.1 METHODOLOGY

The US Army Corps of Engineers Hydrologic Engineering Center's Analysis System (HEC-RAS) v4.0 was used to model the current conditions of Ash Pond 4 and the potential dike failures. An unsteady-state model was developed to predict the flooding conditions downstream as the embankment failures progressed through time. The top (crest) of the existing dike surrounding Ash Pond 4 ranges from elevation 460.0 to 462.9. Analysis began with an assumption that in the event of an overtopping failure, it would start at elevation 460.0. This failure scenario represents the existing conditions of Pond 4. The assumed failure trigger would be a water surface elevation in the pond which exceeds that of the embankments, causing an overtopping failure of the dike.

ArcGIS 9.3 and HEC-GeoRAS 4.0 were used in conjunction with a topographic map, developed from aerial photographs and land surveying, to develop geo referenced cross-sections used in the HEC-RAS models to store and route water during the event of a breach. The same software package was used to determine the limits of flooding based on the results of the dam failure models. URS determined that breach events occurring at the south end of the pond should be considered worst case due to their proximity to the railroad, highway and residence; all dike breach failure models for existing conditions followed this assumption.

An existing breach failure model was also developed by URS for a breach event located to the east; however results illustrated that the structures located to the south of the pond were not inundated. All failure scenarios were simulated assuming static (non-seismic) conditions.

Failures caused by overtopping are assumed to be the worst case scenario because they initiate with the pool at its highest level. Water elevations in the pond were set to the respective level for the breach scenario being modeled. The model was then set to begin breach behavior as soon as the dike began to be overtopped, and progressed as time elapsed. Once the breach failure model was initiated, the failure progressed until the entire section of the dike failed. The model allowed for the breach water to pass through the failed dike and then routed it downstream based on the geo referenced geometry created from the topographic maps. The dam breach continued to expand until the storage within the pond was exhausted.

Modeling scenarios began at elevation 460.0 to match existing conditions, and then were reduced incrementally to find the level to which the dike must be lowered to preclude dam breach inundation of the railroad, highway and residence, i.e., remove the high hazard classification. Modeling efforts persisted from elevation 460.0 through elevation 457.0, resulting in a range of breach outflow quantities, and downstream flood water surface elevations.

URS also performed multiple modeling scenarios for non-overtopping failure modes, such as piping. These efforts incorporated bottom ash and fly ash properties and their flow characteristics into the breach modeling. This analysis is described in detail in a technical memorandum located in **Appendix D**.

2.2 DAM BREAK PARAMETERS AND ASSUMPTIONS

URS checked the breach parameters and assumptions used in the 2009 analyses as part of this project. We found that the Stantec model assumed a large portion of the eastern side of ash Pond 4 would contain only clear water prior to the start of a dam failure event. This approach was used based on conservative information available at the time suggesting that ash might be removed from the pond in the future. The 2009 analysis therefore represented the "full volume" of clear water in the eastern side of the pond as approximately 960 acre-feet, or about 1,547,000 cubic yards (CY). It has since become evident that TVA intends to keep the existing sluiced ash in the pond permanently, and that according to surveys the actual clear water volume is only 273 acre-feet (~440,000 CY), or about 28% of the volume assumed in the 2009 analysis.

URS treated the sedimented ash in two ways in its dam breach analyses:

- Overtopping analyses modeled the outflow of clear water from the current pool elevation down to the top of sluiced ash (El. 436) as indicated by survey/soundings. To remain conservative a large portion of the sluiced ash was also modeled to flow as if it was clear water. This volume was calculated by cutting the saturated ash with a theoretical plane that slopes from the bottom of breach (El. 422) up to El. 436 at an angle of repose of 30 degrees this approach is considered to be conservative.

- Non-overtopping dam breach analyses modeled the breach outflow as clear water down to the top of sedimented ash, and then as a viscous fluid down to the bottom of breach. The flow characteristics of saturated fly ash and bottom ash were estimated from laboratory tests performed on Colbert Plant samples, using equations described in the technical memorandum located in **Appendix D**.

As to be expected, results between the two assumptions were quite similar; having the water models yield slightly higher downstream elevations.

2.2.1 Overtopping Analyses

Common practice for breach parameters have been compiled by Bill Irwin in *Workshop on Issues, Resolutions, and Research Needs Related to Dam Failure Analysis* and were followed in this analysis. The breach parameters and assumptions for the embankment failure analysis were taken from the Bureau of Reclamation (BOR) "*Guidelines for Estimating Dam Breach Parameters,*" the journal of Hydraulic Engineering "*Breach Characteristics of Dam Failures,*" and others. The two major input parameters for breach modeling are average breach width and breach development time. Earth embankment dams historically have been found to have average breach widths of 1 to 5 times the hydraulic height of the dam and breach development times between 6 and 60 minutes. Average breach width and breach development times were calculated for each failure scenario based on equations derived by MacDonald & Langridge-Monopolis reported in *Washington State Dept of Ecology's Dam Safety Guidelines Technical Note 1* as well as equations derived by Von Thun & Gillette as seen in *Prediction of Embankment Dam Breach Parameters*. The calculated values that correlated best with widely accepted common practice values were used in the breach models. URS added a level of conservatism in areas of concern, mainly the average breach width, and breach development time. Breach side slopes were set at 1H:1V since cohesive fill dikes typically fail at slopes this steep or steeper, and the hydraulic embankment height was taken as the difference between the reservoir starting water surface elevation and the elevation at the base of the embankment, 422.0.

The following tables illustrate the suggested parameters associated with common practice widely accepted values, and the actual parameters URS used for the modeling efforts.

Table 1 – Widely Accepted Dam Breach Parameters

Dike Elevation (ft.)	Dam Breach Parameter					
	Average Breach Width (ft.)	Breach Development Time (hr)	Breach Side Slopes (H:V)	Hydraulic Embankment Height* (ft)	Water Volume (ac-ft)	Down Stream Channel Slope (ft/ft)
460.0	38.0	0.86	1:1	38.0	431.0	0.001
459.0	37.0	0.84	1:1	37.0	408.0	0.001
458.0	37.0	0.82	1:1	36.0	386.0	0.001
457.0	36.0	0.80	1:1	35.0	362.0	0.001

*Invert elevation assumed to be 422.0

Table 2 – URS Adjusted Dam Breach Parameters

Dike Elevation (ft.)	Dam Breach Parameter					
	Average Breach Width (ft.)	Breach Development Time (hr)	Breach Side Slopes (H:V)	Hydraulic Embankment Height* (ft)	Water Volume (ac-ft)	Down Stream Channel Slope (ft/ft)
460.0	70.0	0.50	1:1	38.0	431.0	0.001
459.0	68.0	0.50	1:1	37.0	408.0	0.001
458.0	68.0	0.50	1:1	36.0	386.0	0.001
457.0	68.0	0.50	1:1	35.0	362.0	0.001

*Invert elevation assumed to be 422.0

In addition to breach parameters, estimated breach outflow discharges help determine proper model execution. The table below contains estimates of dam break peak discharges for overtopping failures of earthen embankments made of predominately erosion resistant materials. These estimates were calculated from equations derived by David Froehlich in *Peak Outflow from Breached Embankment Dam.*

Table 3 - Estimated Dam Breach Peak Discharge for Embankments or Erosion Resistant Materials

Dam Height (Feet)	Dam Breach Peak Discharge (cfs)									
	Reservoir Surface Area (acres)									
	4	7	10	15	20	30	40	60	80	100
6	440	660	860	1,170	1,450	1,970	2,440	3,330	4,140	4,910
8	620	930	1,210	1,630	2,020	2,740	3,400	4,620	5,740	6,800
10	810	1,200	1,560	2,100	2,600	3,510	4,350	5,900	7,330	8,680
12	1,010	1,490	1,920	2,570	3,170	4,280	5,300	7,180	8,910	10,540
14	1,210	1,770	2,280	3,040	3,750	5,050	6,250	8,450	10,470	12,380
16	1,420	2,060	2,640	3,520	4,330	5,810	7,180	9,690	12,010	14,190
18	1,630	2,360	3,010	4,000	4,900	6,570	8,110	10,930	13,530	15,970
20	1,850	2,660	3,380	4,470	5,480	7,320	9,020	124,140	15,020	17,720
25	2,530	3,410	4,300	5,660	6,900	9,180	11,270	15,120	18,650	21,980
30	3,340	4,160	5,230	6,830	8,300	10,990	13,460	17,990	22,160	26,070
35	4,030	5,140	6,140	7,990	9,680	12,760*	15,590	20,770	25,530	30,000
40	4,550	6,140	7,120	9,110	11,020	14,480*	17,660	23,460	28,790	33,790
45	4,860	6,960	8,330	10,210	12,320	16,150	19,660	26,060	31,920	37,430
50	5,000	7,570	9,350	11,360	13,570	17,760	21,590	28,560	34,940	40,930

*URS estimates the outflow discharge would be between 12,760 and 14,480 cfs, with Pond #4 having a dam height between 35-40 feet and approximately 30 acres of surface area.

2.2.2 Non-Overtopping Analyses

The non-overflow analyses evaluate the viscous flow characteristics of saturated bottom ash, fly ash and earth embankment materials as a result of static, non-overflow dam failure. Predictions are made of the aerial extent, maximum flood elevations and timing of propagation of a flood wave resulting from such failure.

Four scenarios were analyzed in this study:

1) Piping failure of the dam down to the bottom of the Bottom Ash for initial water surface elevations of 460 in the pond;
2) Piping failure of the dam down to the bottom of the Bottom Ash for initial water surface elevations of 458 in the pond;
3) Piping failure of the dam down to the bottom of the fly ash with initial water surface elevations of 460 in the pond; and
4) Piping failure of the dam down to the bottom of the fly ash with initial water surface elevations of 458 in the pond

In addition, an analysis was done to evaluate if the bottom ash would be eroded once the piping breach reach the top of the bottom ash. A set of inundation maps for all scenarios have been prepared from the study.

The National Weather Service DAMBRK program was used to calculate the outflow hydrograph from each breach scenario. The 2-dimensional hydrodynamic mudflow model, FLO-2D developed by FLO-2D Software, Inc. was used for routing the outflow hydrograph from the breach location to downstream drainages. DAMBRK is a standard dam breach program used world-wide and is supported by regulatory agencies. FLO-2D is also a program that is supported by regulatory agencies, especially FEMA, for flood inundation mapping purposes. FLO-2D is especially suitable for flood waters with high concentrations of sediment (hyperconcentrated flow or mud/debris flows), which might behave differently than traditional Newtonian fluid characteristics for clear water. A rheological model for the fly ash-water mixture was tested in the laboratory based on samples collected from the Colbert site. These laboratory results were used in the subsequent FLO-2D analysis.

The National Weather Service dam break simulation program, BOSS DAMBRK, simulates the breach of a dam based on the following breach parameters: bottom breach width, time to failure, pool elevation at time of failure, breach side slope, and the breach development exponent. DAMBRK assumes a trapezoidal breach that enlarges with time. Federal Energy Regulatory Commission (FERC) guidelines state that the breach side slope for an engineered, compacted, earthen dam can range from 0.25:1 to 1:1 (H:V). A conservative breach side slope of 1:1 was utilized in this study.

Because the TVA Pond 4 dam is an engineered and compacted earthen dam, the dam breach bottom width and time of failure were estimated by applying the Froehilch’s (1995) equations and Von Thun and Gillette’s (1990) equations, which are two of the most popularly used methods for earthen dams.

A detailed discussion of the assumptions, methodology and results of the non-overflow dam failure simulations is provided in **Appendix D**.

3.1 EAST

Modeling efforts for existing conditions started at a maximum water surface elevation of 460.0 in relation to the existing lowest dike elevation along the eastern perimeter of Pond 4. A dam breach model was generated for a breach event that would occur to the east of the pond, discharge waters routing into Cane Creek. Embankment failures were modeled using an unsteady state analysis of the flood wave out of the pond.

Two models were set up to accurately predict the behavior of a breach event occurring on the east dike at Pond 4. The first model generated the outflow hydrograph of the breach, while the second model used the outflow hydrograph from the first and routed the breach discharge laterally into Cane Creek at the same location. The breach outflow hydrograph supplied URS with maximum discharge rates, while the Cane Creek routing model provided maximum water surface elevation with the same discharge. The HEC RAS modeling report may be found in **Appendix A.** The following table illustrates the results from the east dam breach, water surface elevations were safely below the control structure elevation, and therefore URS assumed that no further breach modeling in this direction was needed.

Table – 4 East Dam Breach Results

Dike Elevation (ft.)	Dam Breach Analysis Results			
	Maximum Breach Outflow (cfs)	Maximum Outflow Velocity (ft/s)	Maximum Downstream Water Surface Elevation (ft)	Upstream Railroad Elevation (ft)
460.0	13,970	6.0	423.8	434.0

3.2 SOUTH

Modeling efforts for existing conditions started at maximum water surface elevations in relation to dike elevations. The analysis began with a dike elevation set at 460.0, and persisted through elevation 457.0, in increments of one foot. Dam breach models were built and analyzed for corresponding dike elevations. Embankment failures were modeled using an unsteady state analysis of the flood wave out of the pond.

The receiving downstream area is comprised of a valley containing a series of wetlands that drain east into Cane Creek. Much like the method used for the east models, maximum outflow discharge hydrographs for each scenario were generated from the breach event. Then, the breach outflow hydrographs from each scenario were inserted laterally into the second model containing the geometry of the receiving downstream waters. Again, the breach models provided URS with maximum breach outflow discharge rates, while the downstream model provided the maximum water surface elevation. The following table illustrates the results from the south breach models.

Table – 5 South Dam Breach Results

Dike Elevation (ft.)	Dam Breach Analysis Results			
	Maximum Breach Outflow (cfs)	Maximum Outflow Velocity (ft/s)	Maximum Downstream Water Surface Elevation (ft)	Downstream Railroad Elevation (ft)
460.0	17,390	13.6	434.7	434.0
459.0	16,280	13.4	434.4	434.0
458.0	15,560	13.3	434.1	434.0
457.0	14,825	13.2	433.8	434.0

*Dam breach flood waters that exceed the elevation of the railroad tracks by less than 1.0 foot are not considered hazardous to human life, and therefore do not trigger the High Hazard definition.

The HEC RAS modeling reports corresponding to dike elevations 460.0 and 458.0 may be found in **Appendix B and C.**

4.1 CONCLUSIONS

URS has reached the following conclusions as a result of the above described analyses:

- Dam breach flood inundation will be contained below the level of the railroad, highway and residence if the dike crest elevation is reduced to 458.0 and the normal operating pool is set at El. 453.0.

- Theoretical dam breaches involving water only are the worst case scenario, traveling further and flooding higher than breaches involving the flow of soil/ash/water mixtures.

- Dam breach simulations at the south dike involving soil/ash/water mixtures do not endanger the railroad, highway or residence. This result indicates that saturated ash in the southern part of the pond, whether in its existing condition or under a future cap/closure, is not expected to endanger human life at the railroad, highway or residence in the event of failure at the south dike.

- These results suggest that a full hydraulic barrier to separate free water volume in the northern part of the pond from capped saturated ash at the southern part of the pond is not necessary for high hazard elimination at Pond 4.

4.2 RECOMMENDATIONS

It is recommended that the existing dike be reduced to elevation 458.0, along the northern and northeastern dike sections of the stilling basin. Operational water levels shall not exceed elevation 453.0, in agreement with the five foot freeboard requirement in the programmatic document. URS has chosen this recommendation on the basis that it satisfies the goal of high hazard elimination while supporting other parts of the overall project to improve conditions at Ash Pond #4.

4.2.1 Updated Topographic Mapping

Updated topographic mapping became available late in the development of this high hazard removal design, and has not been thoroughly evaluated by URS at this time. Preliminary assessments of the new mapping appear to confirm the analytical results and final design of the selected alternative, and suggest that they are conservative.

Irwin, Bill. *Workshop on Issues, Resolutions, and Research Needs Related to Dam Failure Analysis*. Natural Resources Conservation Service. October 1993.

Wahl, Tony L. Water Resources Research Laboratory. *Prediction of Embankment Dam Breach Parameters: A Literature Review and Needs Assessment*. U.S. Department of the interior, Bureau of Dam Reclamation, Dam Safety Office. July 1998.

Washington State Department of Ecology. *Dam Break Inundation Analysis and Downstream Hazard Classification*. Dam Safety Guidelines: Technical Note 1. July 1992.

Froehlich, David C. *Peak Outflow from Breached Embankment Dam*. ASCE Journal of Water Resources Planning and Management, vol. 121 no. 1, p. 90-97, 1995.

Bureau of Reclamation (BOR), "*Guidelines for Estimating Dam Breach Parameters*"

Journal of Hydraulic Engineering, "*Breaching Characteristics of Dam Failures*"

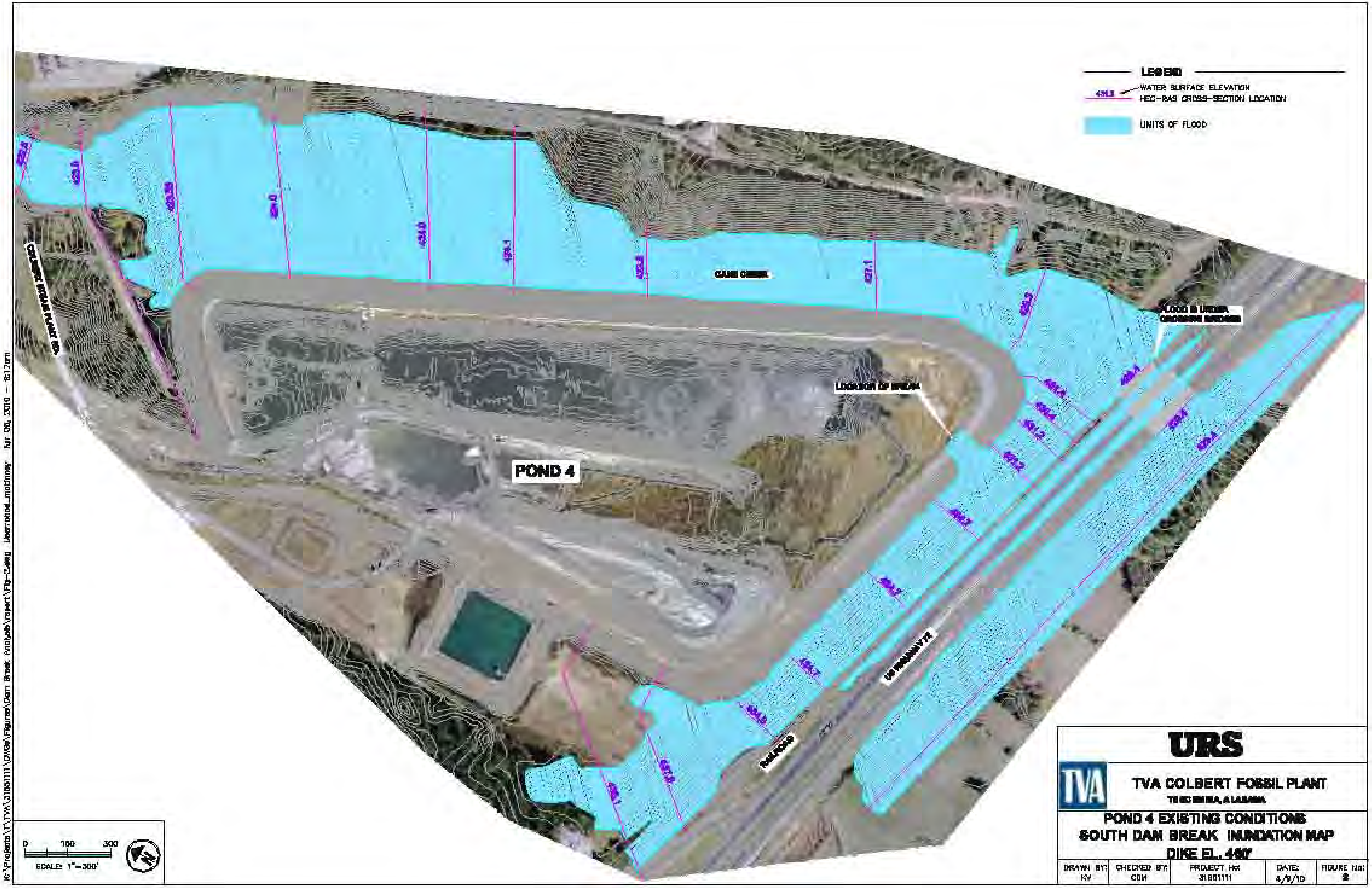
K:\Projects\T\TVA\31851111\DWGs\Figures\Dam Break Analysis\report\Fig-1.dwg User:chad_mckinney Apr 08, 2010 - 8:14am

URS

TVA COLBERT FOSSIL PLANT
TUSCUMBIA, ALABAMA

POND 4 EXISTING CONDITIONS
EAST DAM BREAK INUNDATION MAP
DIKE EL. 460'

DRAWN BY:	CHECKED BY:	PROJECT No:	DATE:	FIGURE No:
KV	CDN	31851111	4/8/10	1


LEGEND
WATER SURFACE ELEVATION
HEC-RAS CROSS-SECTION LOCATION
LIMITS OF FLOOD
POND 4
CANE CREEK
LOCATION OF BREAK
US HIGHWAY 72
RAILROAD
SCALE: 1"=300'
URS
TVA
TVA COLBERT FOSSIL PLANT
POND 4 EXISTING CONDITIONS
SOUTH DAM BREAK INUNDATION MAP
DIKE EL. 460'
DRAWN BY: KV
CHECKED BY: CDH
PROJECT NO: 31801111
DATE: 4/9/10
FIGURE NO: 2

LEGEND
WATER SURFACE ELEVATION
HEC-RAS CROSS-SECTION LOCATION
LIMITS OF FLOOD
POND 4
LOCATION OF BREAK
0 150 300
SCALE: 1"=300'
URS
TVA
TVA COLBERT FOSSIL PLANT
TUSCUMBIA, ALABAMA
POND 4 SOUTH DAM BREAK
INUNDATION MAP
DESIGN DIKE EL 458'
DRAWN BY: KY
CHECKED BY: CDM
PROJECT No: 31881111
DATE: 4/9/10

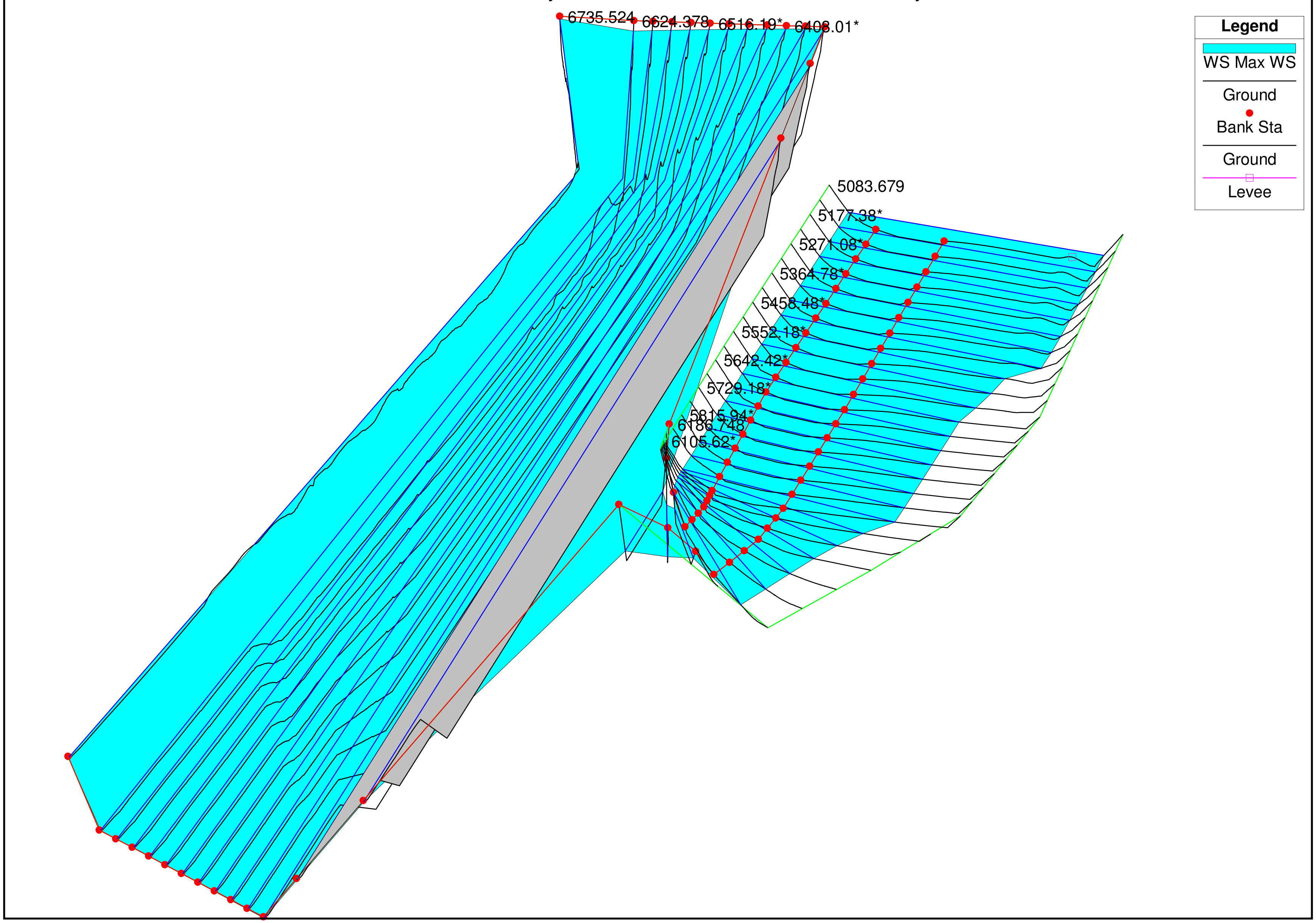
Appendix A

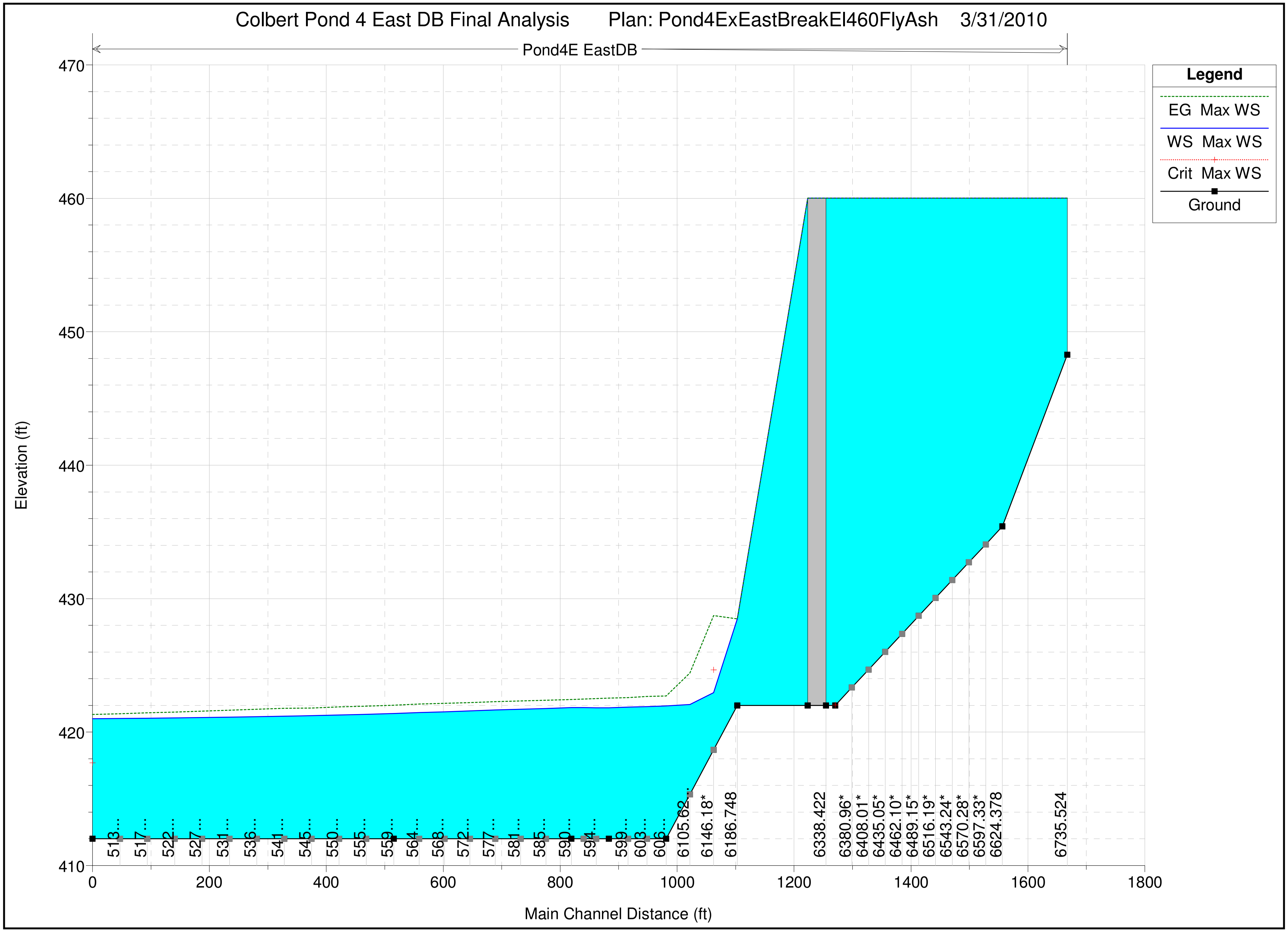
COF Pond 4 Existing Conditions
East Dam Break Analysis
Dike Elevation 460.0

Pond 4 East Dam Break HEC-RAS Model
Dike Elevation 460.0

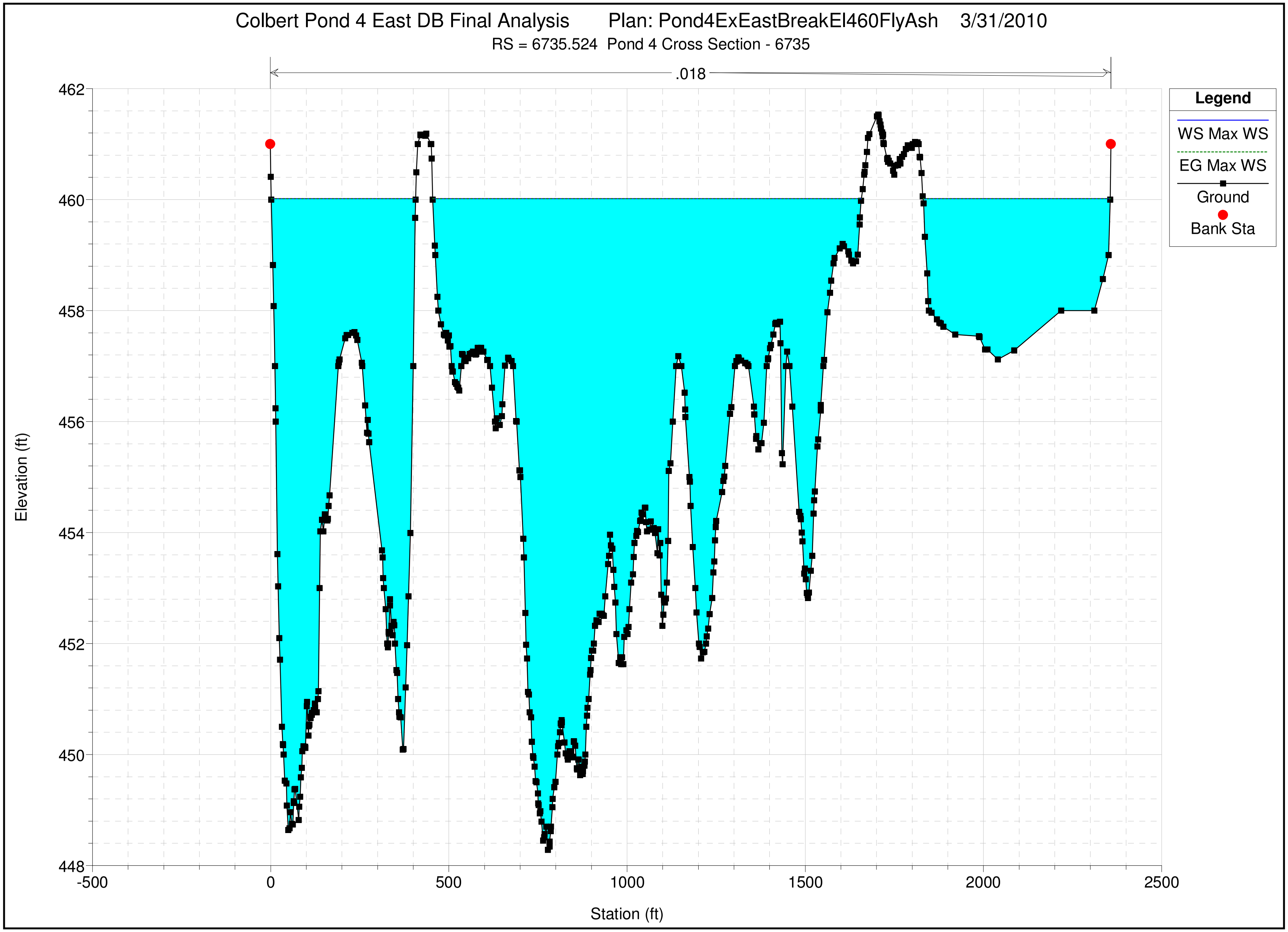
1 in Horiz. = 800 ft   1 in Vert. = 400 ft

Colbert Pond 4 East DB Final Analysis   Plan: Pond4ExEastBreakEl460FlyAsh   3/31/2010





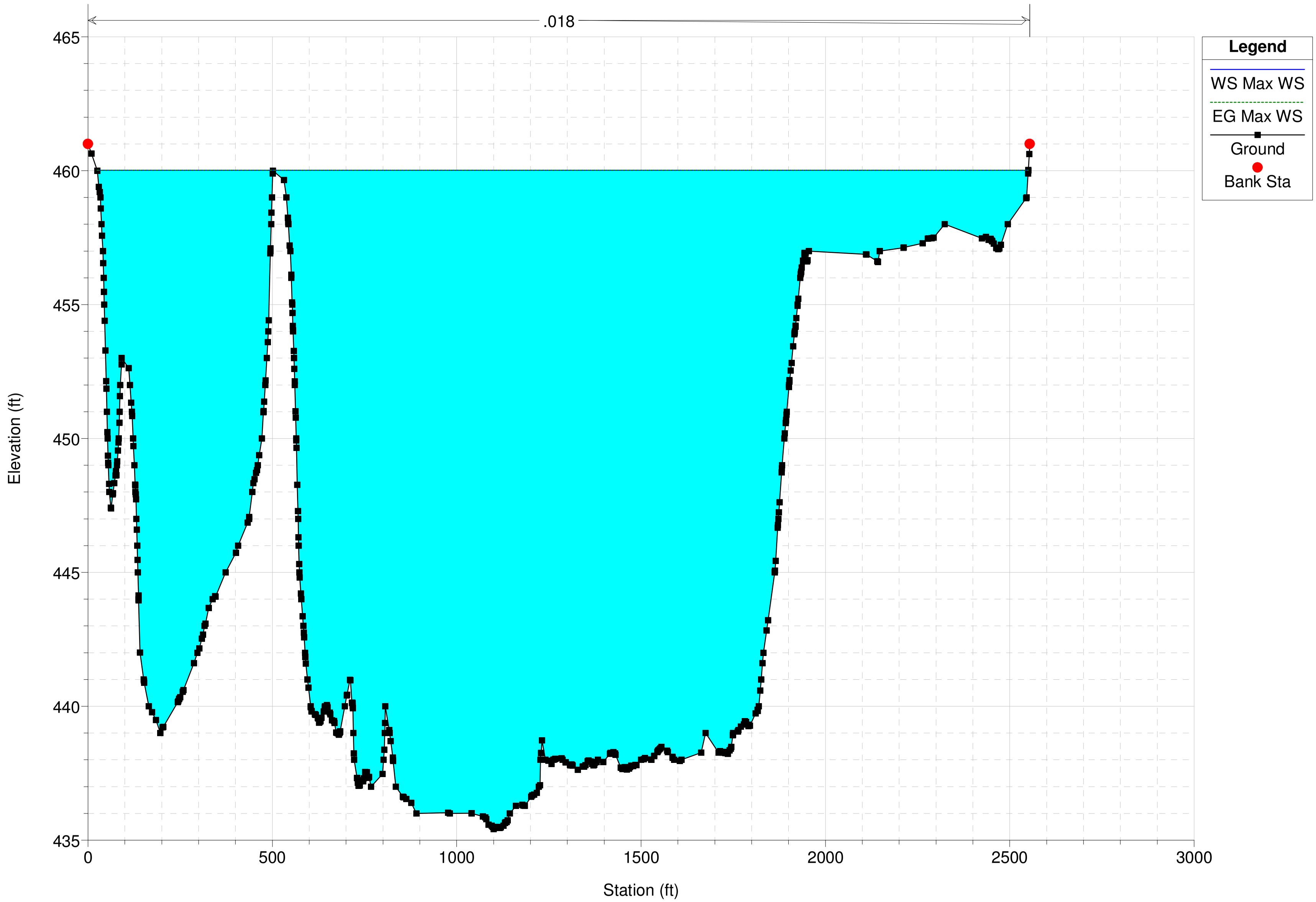
Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh 3/31/2010
Pond4E EastDB
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Elevation (ft)
Main Channel Distance (ft)
470
460
450
440
430
420
410
0
200
400
600
800
1000
1200
1400
1600
1800
6105.62
6146.18*
6186.748
6338.422
6380.96*
6408.01*
6435.05*
6462.10*
6489.15*
6516.19*
6543.24*
6570.28*
6597.33*
6624.378
6735.524

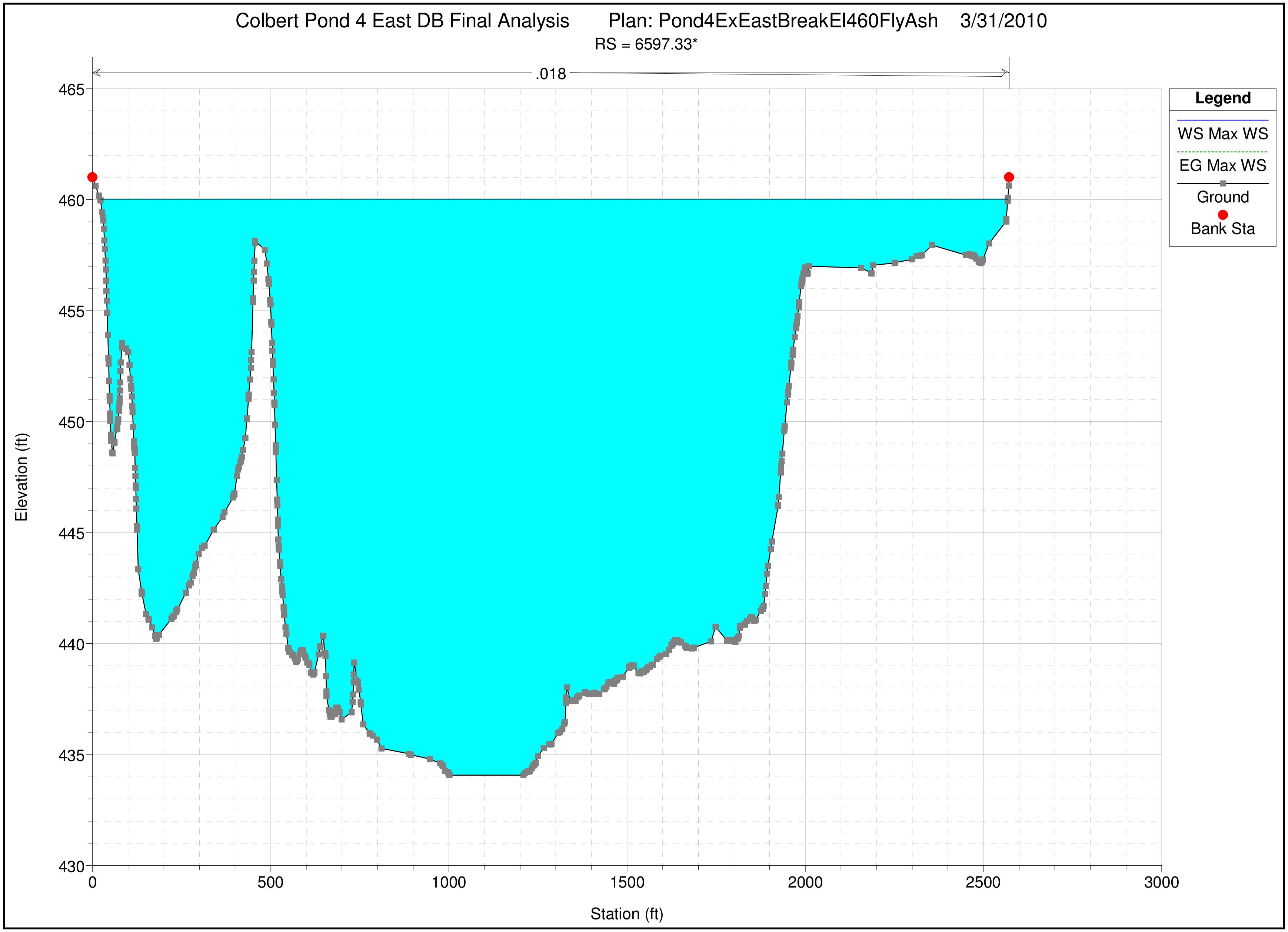


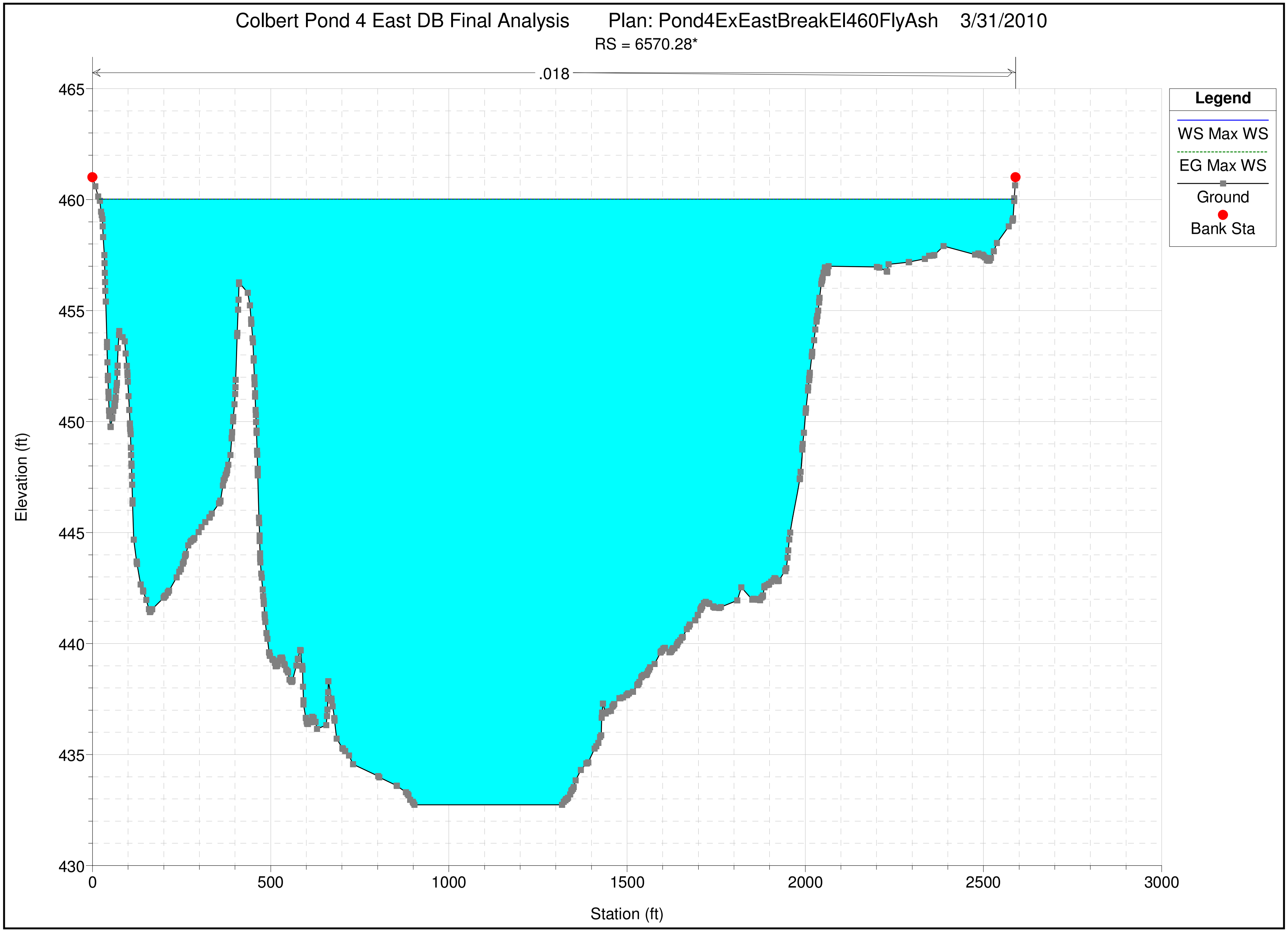
Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh 3/31/2010
RS = 6735.524 Pond 4 Cross Section - 6735
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
462
460
458
456
454
452
450
448
-500
0
500
1000
1500
2000
2500

Colbert Pond 4 East DB Final Analysis   Plan: Pond4ExEastBreakEl460FlyAsh   3/31/2010

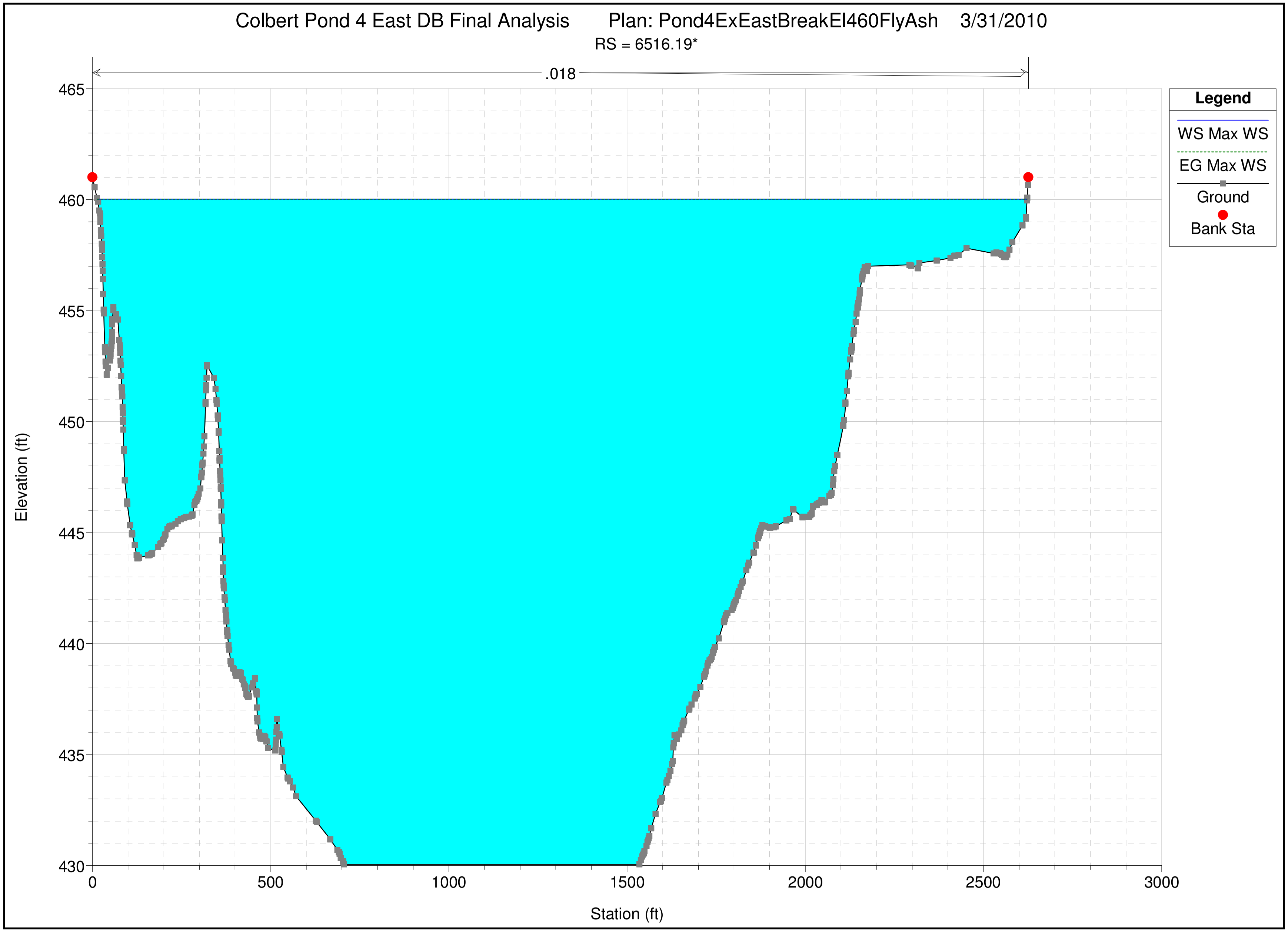
RS = 6624.378 Pond 4 Cross Section - 6624



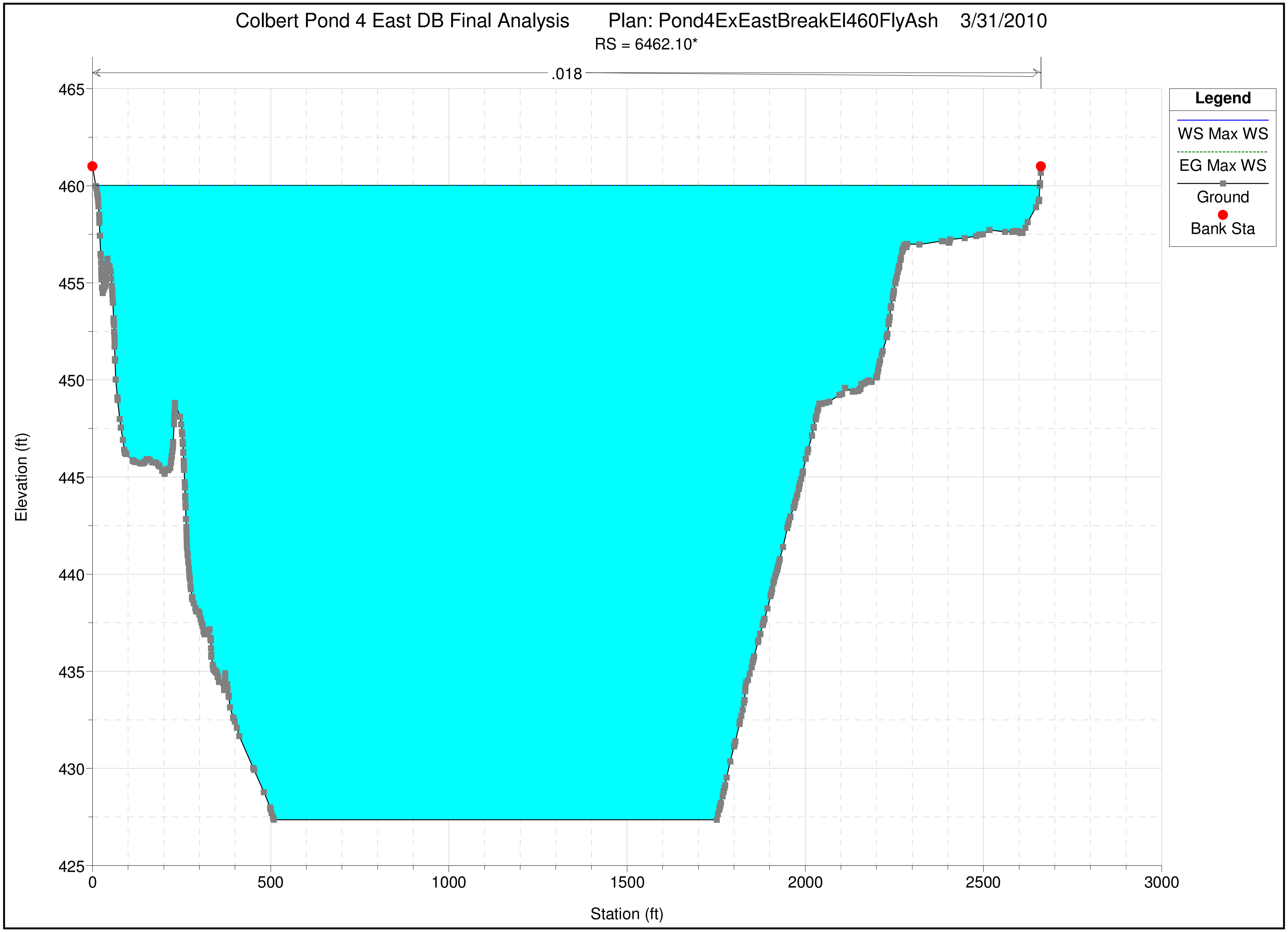

Colbert Pond 4 East DB Final Analysis
Plan: Pond4ExEastBreakEl460FlyAsh
3/31/2010
RS = 6597.33*
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
465
460
455
450
445
440
435
430
0
500
1000
1500
2000
2500
3000

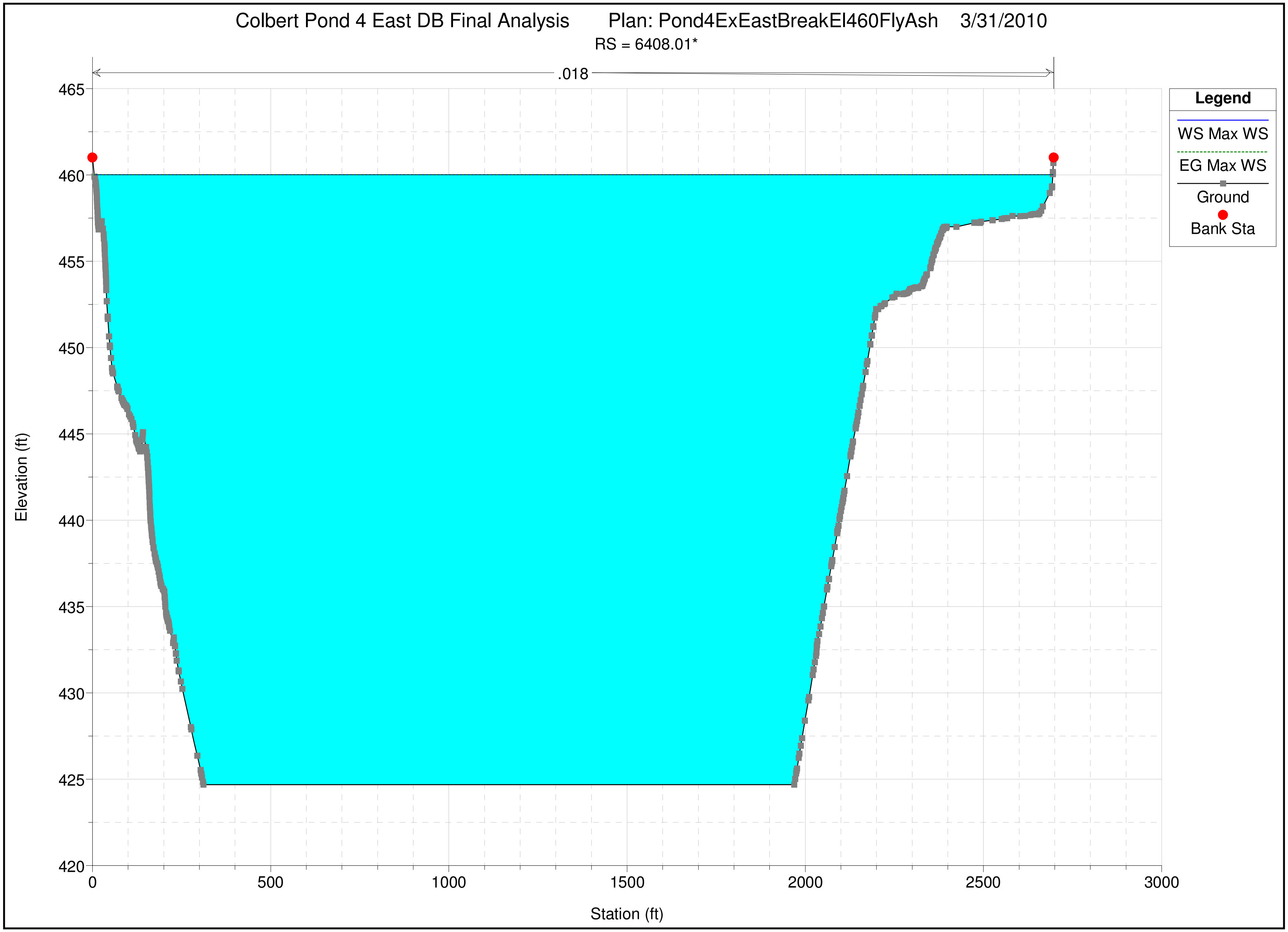


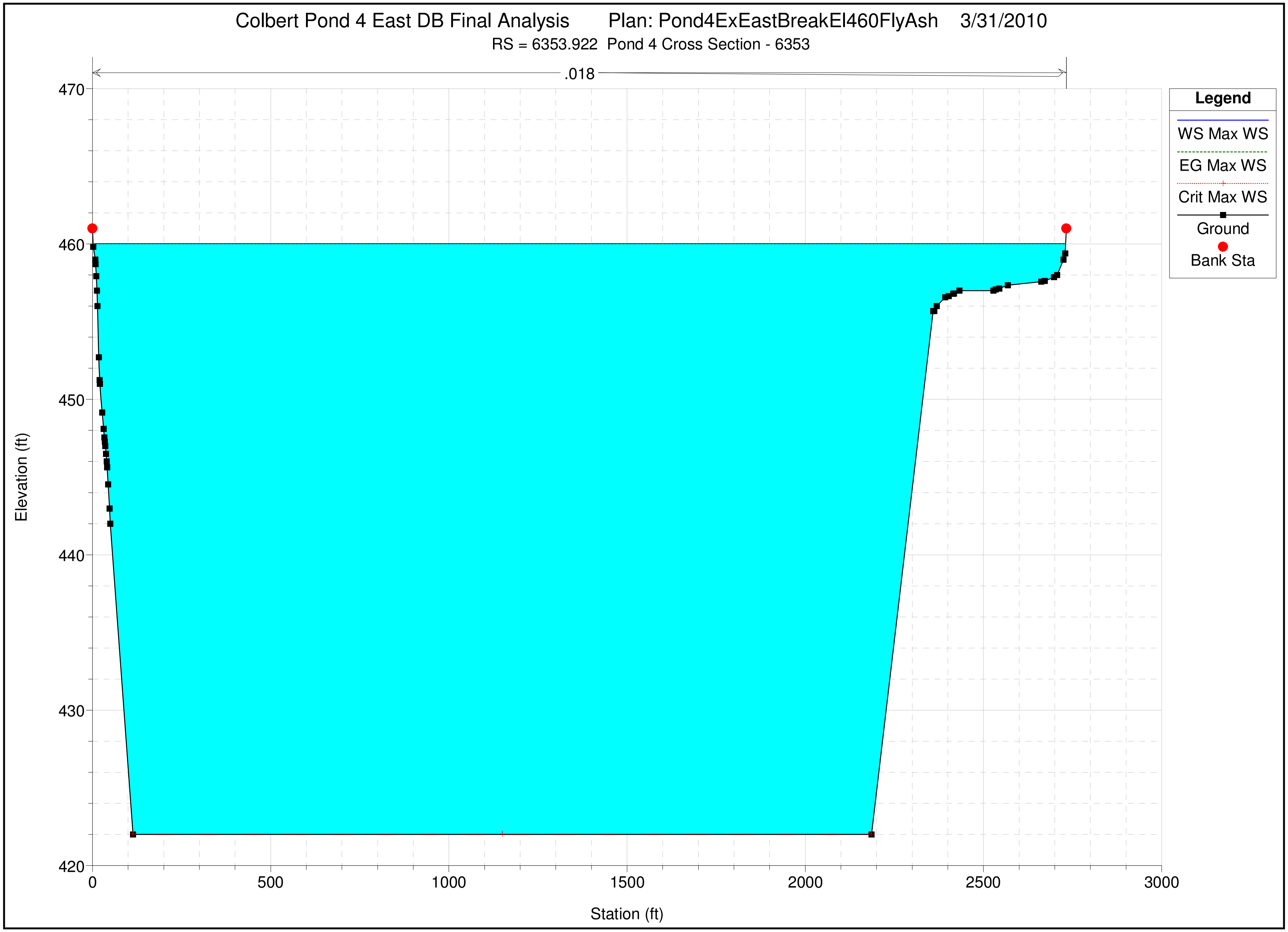
Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh 3/31/2010
RS = 6570.28*
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
465
460
455
450
445
440
435
430
0
500
1000
1500
2000
2500
3000
Station (ft)



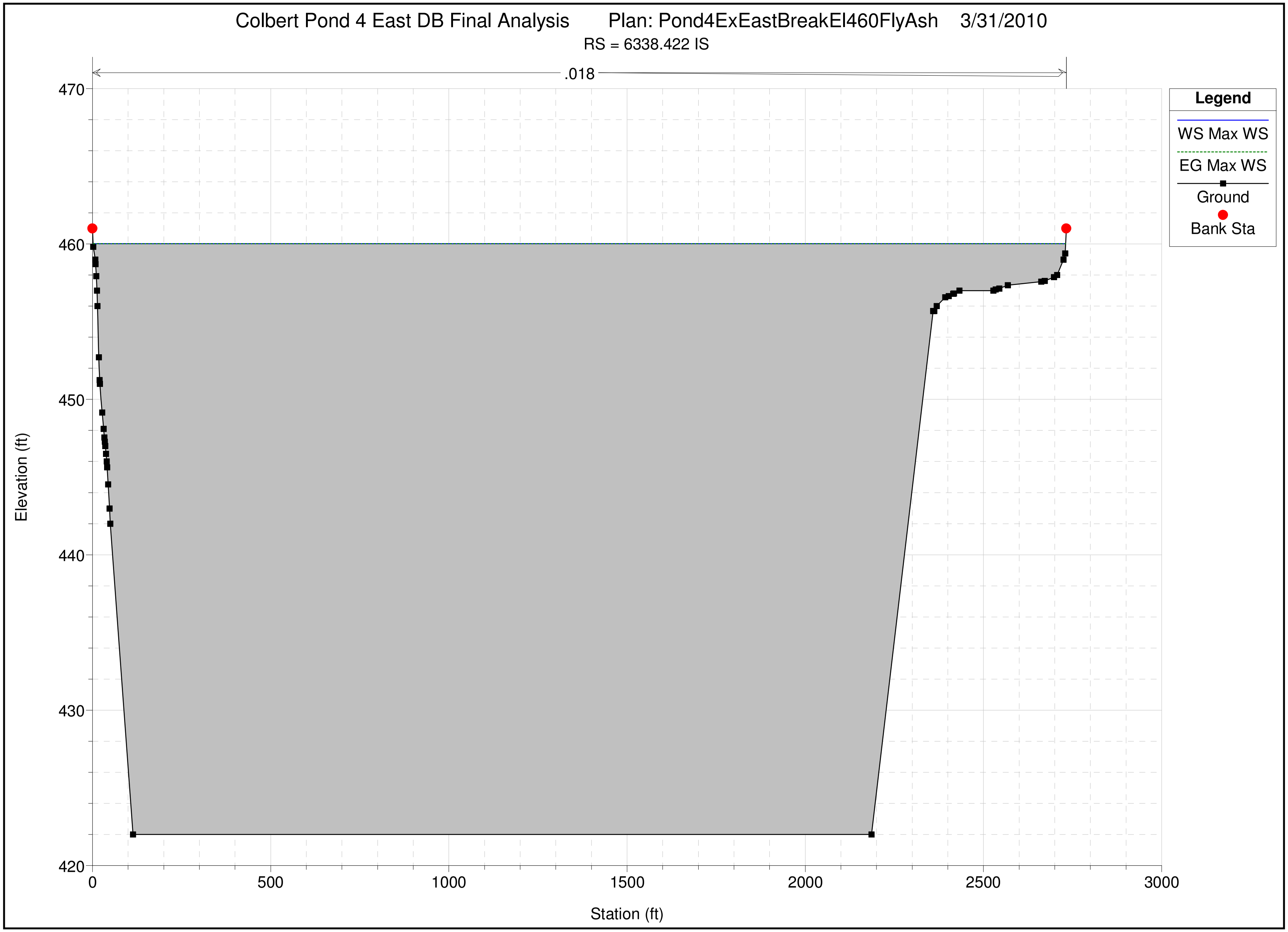
Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh 3/31/2010
RS = 6516.19*
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
465
460
455
450
445
440
435
430
0
500
1000
1500
2000
2500
3000
Station (ft)


Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh 3/31/2010
RS = 6462.10*
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
465
460
455
450
445
440
435
430
425
0
500
1000
1500
2000
2500
3000
Station (ft)

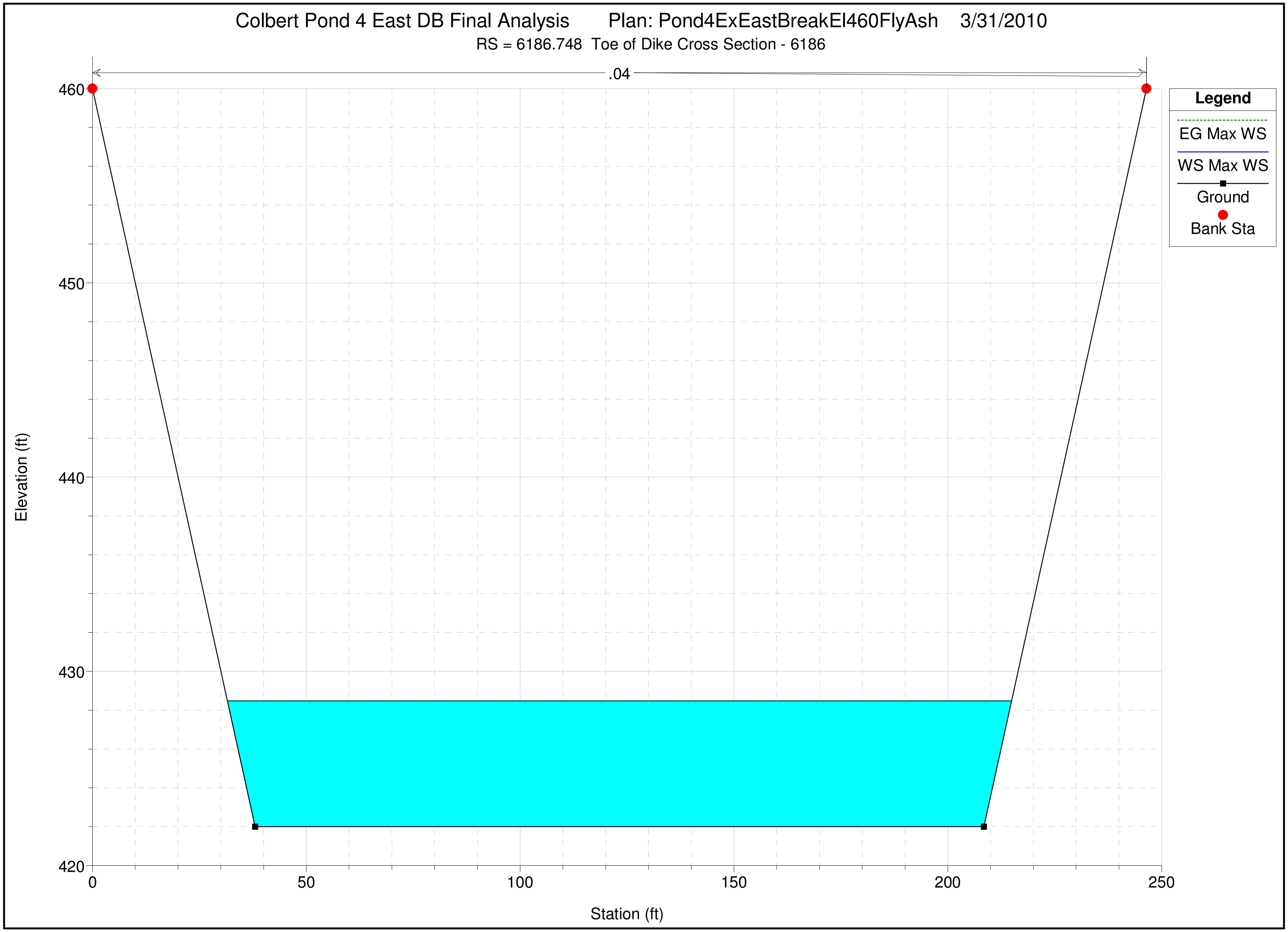

Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh 3/31/2010
RS = 6408.01*
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
465
460
455
450
445
440
435
430
425
420
0
500
1000
1500
2000
2500
3000

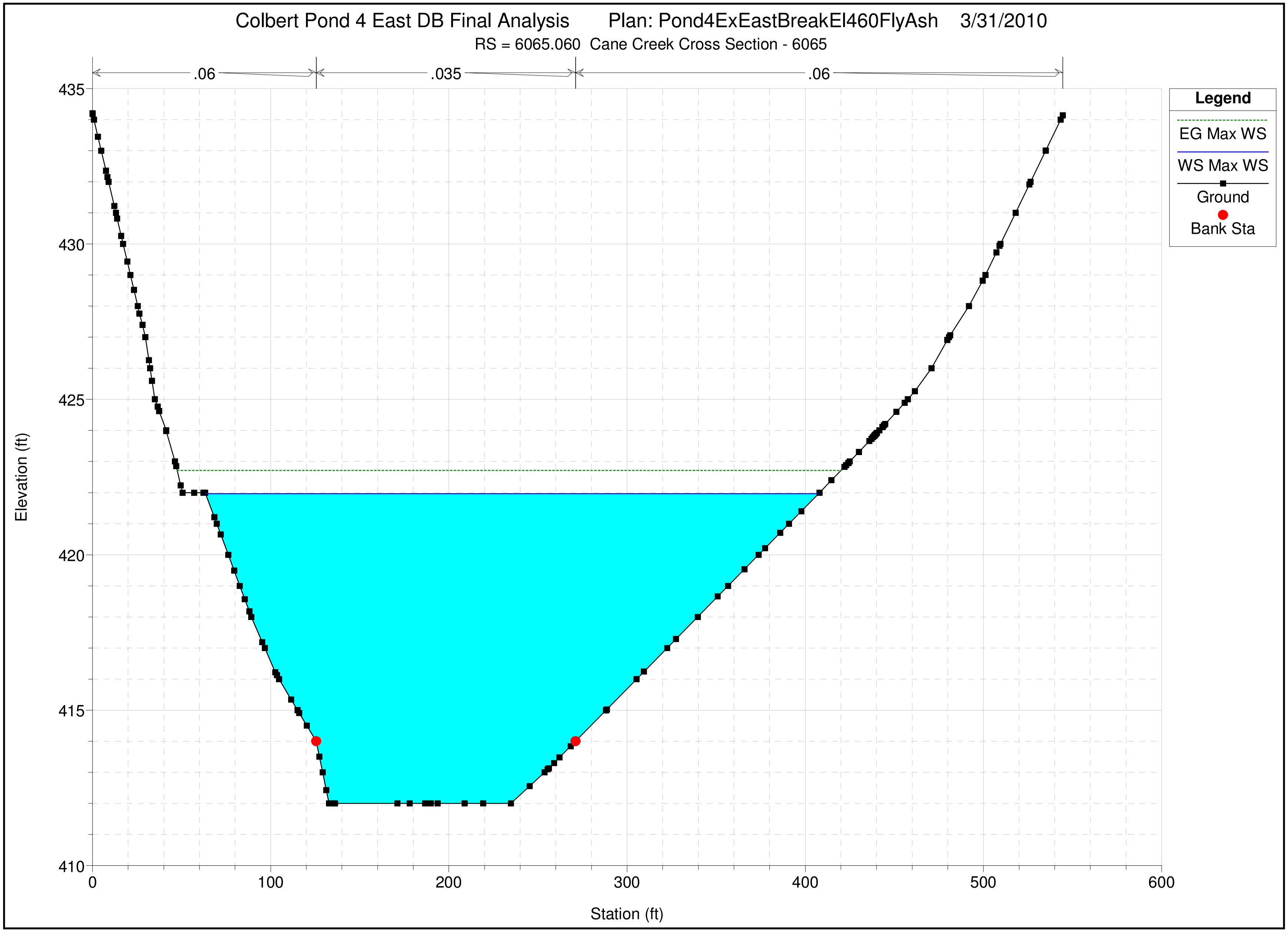


Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh 3/31/2010
RS = 6353.922 Pond 4 Cross Section - 6353
.018
Legend
WS Max WS
EG Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
470
460
450
440
430
420
0
500
1000
1500
2000
2500
3000
Station (ft)



Colbert Pond 4 East DB Final Analysis   Plan: Pond4ExEastBreakEl460FlyAsh   3/31/2010
RS = 6338.422 IS
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
470
460
450
440
430
420
Station (ft)
0
500
1000
1500
2000
2500
3000


Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh 3/31/2010
RS = 6186.748 Toe of Dike Cross Section - 6186
.04
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
460
450
440
430
420
Station (ft)
0
50
100
150
200
250



Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh 3/31/2010
RS = 6065.060 Cane Creek Cross Section - 6065
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
435
430
425
420
415
410
0
100
200
300
400
500
600
Station (ft)

HEC-RAS Plan: EB460UnFA River: Pond4E Reach: EastDB Profile: Max WS

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft)	
EastDB	6735.524	Max WS	5.00	448.28	460.02		460.02	0.000000	0.00	2133.21	0.00
EastDB	6624.378	Max WS	7.76	435.41	460.02		460.02	0.000000	0.00	2525.63	0.00
EastDB	6597.33*	Max WS	8.54	434.07	460.02		460.02	0.000000	0.00	2546.55	0.00
EastDB	6570.28*	Max WS	9.35	432.73	460.02		460.02	0.000000	0.00	2567.29	0.00
EastDB	6543.24*	Max WS	10.16	431.39	460.02		460.02	0.000000	0.00	2588.12	0.00
EastDB	6516.19*	Max WS	10.97	430.05	460.02		460.02	0.000000	0.00	2608.79	0.00
EastDB	6489.15*	Max WS	11.82	428.71	460.02		460.02	0.000000	0.00	2629.46	0.00
EastDB	6462.10*	Max WS	12.68	427.36	460.02		460.02	0.000000	0.00	2649.66	0.00
EastDB	6435.05*	Max WS	13.55	426.02	460.02		460.02	0.000000	0.00	2669.71	0.00
EastDB	6408.01*	Max WS	14.45	424.68	460.02		460.02	0.000000	0.00	2689.60	0.00
EastDB	6380.96*	Max WS	15.36	423.34	460.02		460.02	0.000000	0.00	2709.38	0.00
EastDB	6353.922	Max WS	16.29	422.00	460.02	422.03	460.02	0.000000	0.00	2729.05	0.00
EastDB	6338.422		Inl Struct								
EastDB	6186.748	Max WS	-829.99	422.00	428.48		428.48	0.000034	-0.72	183.38	0.05
EastDB	6146.18*	Max WS	12658.41	418.67	422.96	424.66	428.73	0.037446	19.28	158.38	1.67
EastDB	6105.62*	Max WS	11468.08	415.33	422.08		424.43	0.008606	12.32	151.06	0.88
EastDB	6065.060	Max WS	12586.89	412.00	421.97		422.71	0.001520	7.50	343.93	0.43
EastDB	6032.31*	Max WS	12543.16	412.00	421.91		422.67	0.001584	7.60	348.20	0.43
EastDB	5999.56*	Max WS	12179.34	412.00	421.87		422.59	0.001546	7.44	346.28	0.43
EastDB	5966.822	Max WS	12175.01	412.00	421.82		422.54	0.001595	7.50	345.95	0.43
EastDB	5945.44*	Max WS	12170.63	412.00	421.83		422.51	0.001518	7.32	369.22	0.42
EastDB	5924.07*	Max WS	12164.97	412.00	421.83		422.47	0.001438	7.14	396.30	0.41
EastDB	5902.704	Max WS	12157.88	412.00	421.83		422.44	0.001362	6.95	434.03	0.40
EastDB	5859.32*	Max WS	12139.76	412.00	421.77		422.38	0.001376	6.96	434.66	0.40
EastDB	5815.94*	Max WS	12117.47	412.00	421.71		422.33	0.001391	6.97	435.16	0.40
EastDB	5772.56*	Max WS	12091.38	412.00	421.65		422.27	0.001407	6.98	435.68	0.41
EastDB	5729.18*	Max WS	12061.81	412.00	421.59		422.22	0.001424	6.98	436.29	0.41
EastDB	5685.8*	Max WS	12029.52	412.00	421.52		422.16	0.001442	6.99	436.72	0.41
EastDB	5642.42*	Max WS	11995.91	412.00	421.46		422.10	0.001463	7.01	437.44	0.41
EastDB	5599.039	Max WS	11670.67	412.00	421.39		422.01	0.001412	6.85	437.72	0.40
EastDB	5552.18*	Max WS	11668.03	412.00	421.33		421.95	0.001438	6.89	451.41	0.41
EastDB	5505.33*	Max WS	11661.02	412.00	421.28		421.89	0.001450	6.90	462.14	0.41
EastDB	5458.48*	Max WS	11382.39	412.00	421.23		421.80	0.001386	6.72	469.30	0.40
EastDB	5411.63*	Max WS	11634.47	412.00	421.18		421.78	0.001480	6.93	521.70	0.41
EastDB	5364.78*	Max WS	11614.71	412.00	421.15		421.70	0.001425	6.79	521.48	0.40
EastDB	5317.93*	Max WS	11591.74	412.00	421.12		421.63	0.001357	6.61	520.08	0.39

HEC-RAS Plan: EB460UnFA River: Pond4E Reach: EastDB Profile: Max WS (Continued)

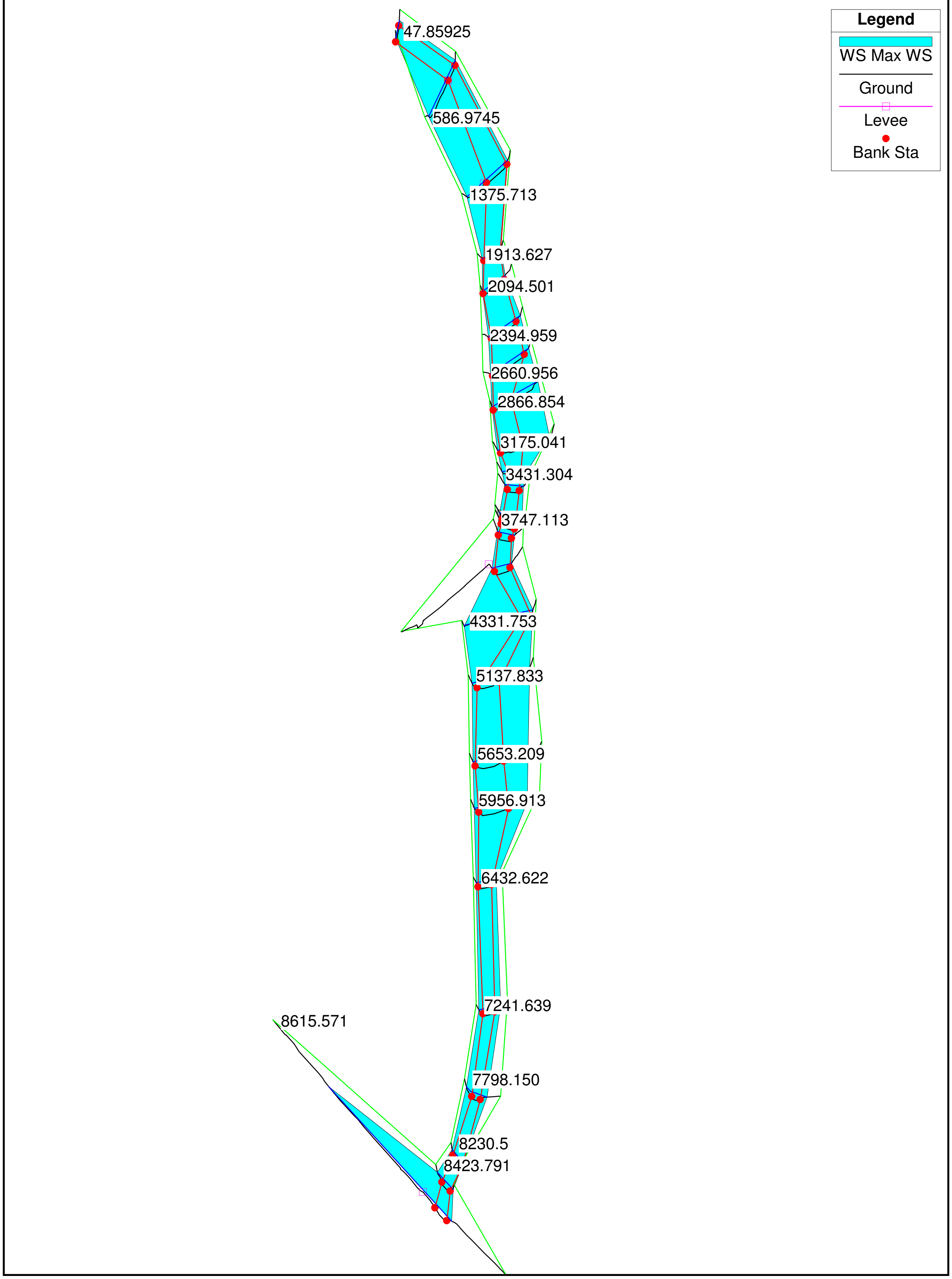
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft)	
EastDB	5271.08*	Max WS	11566.73	412.00	421.09		421.57	0.001286	6.43	517.97	0.38
EastDB	5224.23*	Max WS	11540.14	412.00	421.07		421.50	0.001214	6.24	515.38	0.37
EastDB	5177.38*	Max WS	11512.39	412.00	421.05		421.44	0.001142	6.05	512.31	0.36
EastDB	5130.53*	Max WS	11483.90	412.00	421.02		421.38	0.001072	5.85	508.96	0.35
EastDB	5083.679	Max WS	11455.07	412.00	421.00	417.70	421.32	0.001006	5.66	505.33	0.34

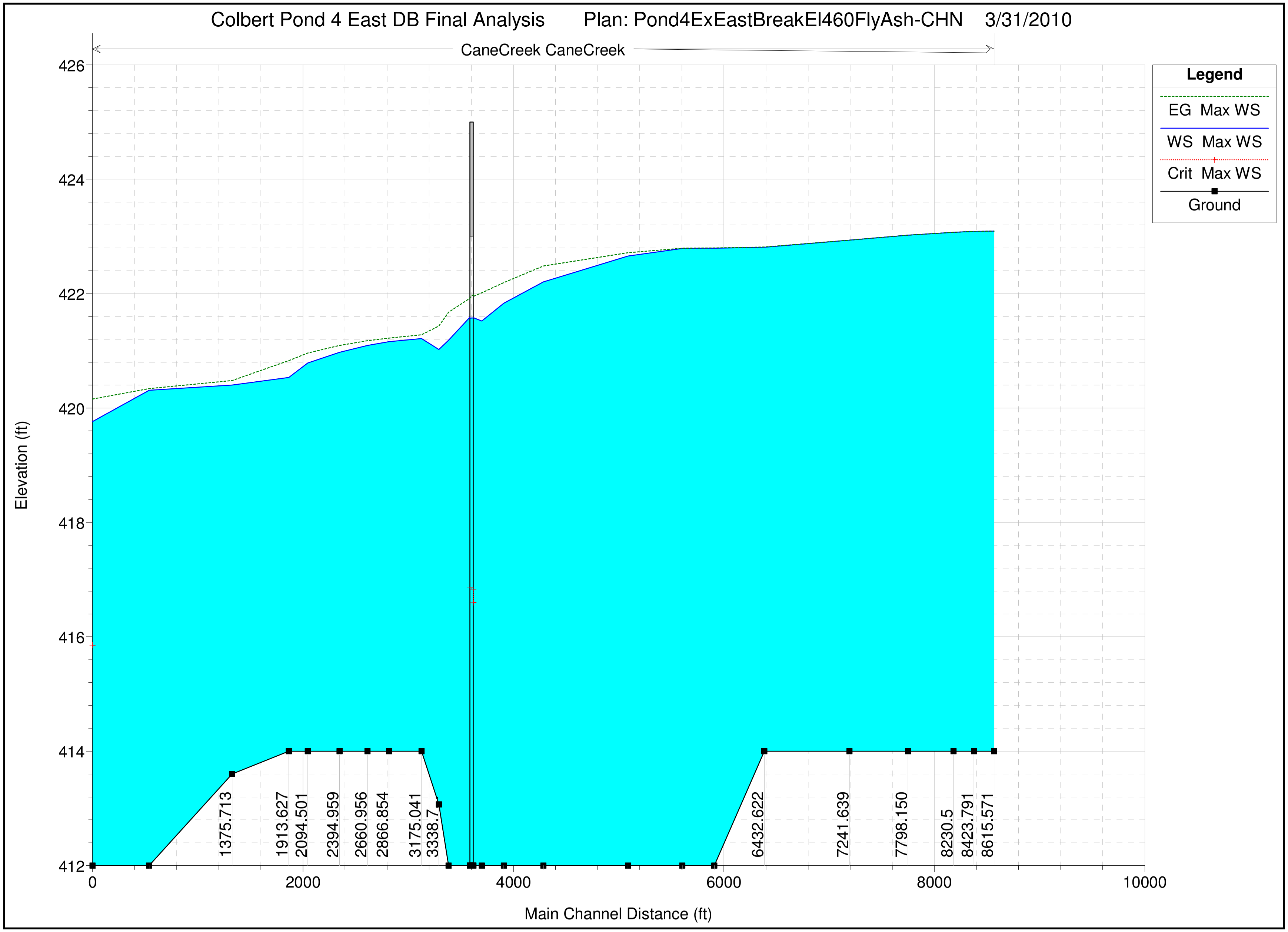
Cane Creek East Dam Break HEC-RAS Model
Dike Elevation 460.0

2 of the 25 XS's are not Geo-Referenced (Geo-Ref user entered XS , Geo-Ref interpolated XS , Non Geo-Ref user entered XS , Non Geo-Ref interpolated XS)

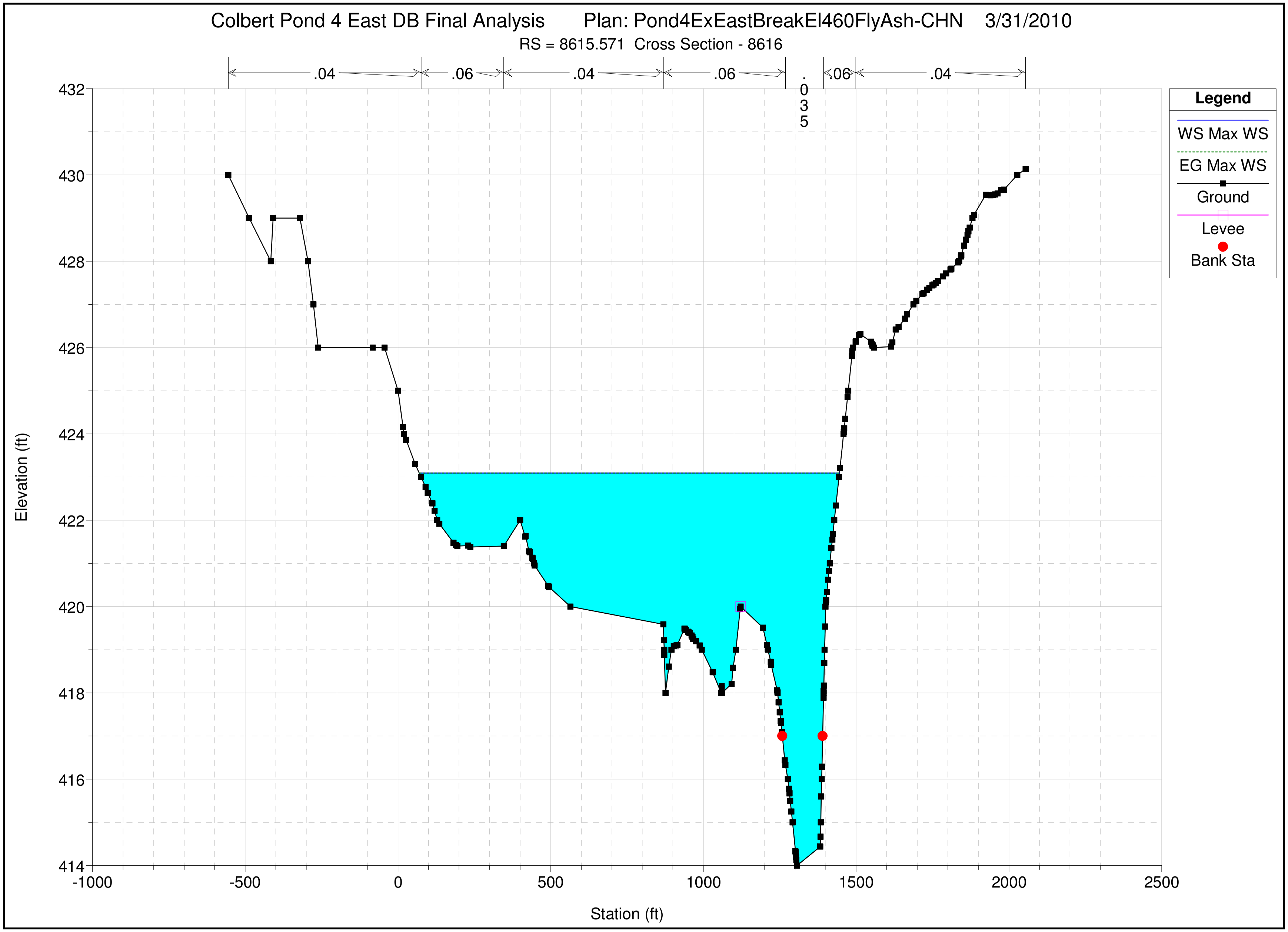
1 in Horiz. = 1800 ft 1 in Vert. = 800 ft

Colbert Pond 4 East DB Final Analysis   Plan: Pond4ExEastBreakEl460FlyAsh-CHN   3/31/2010

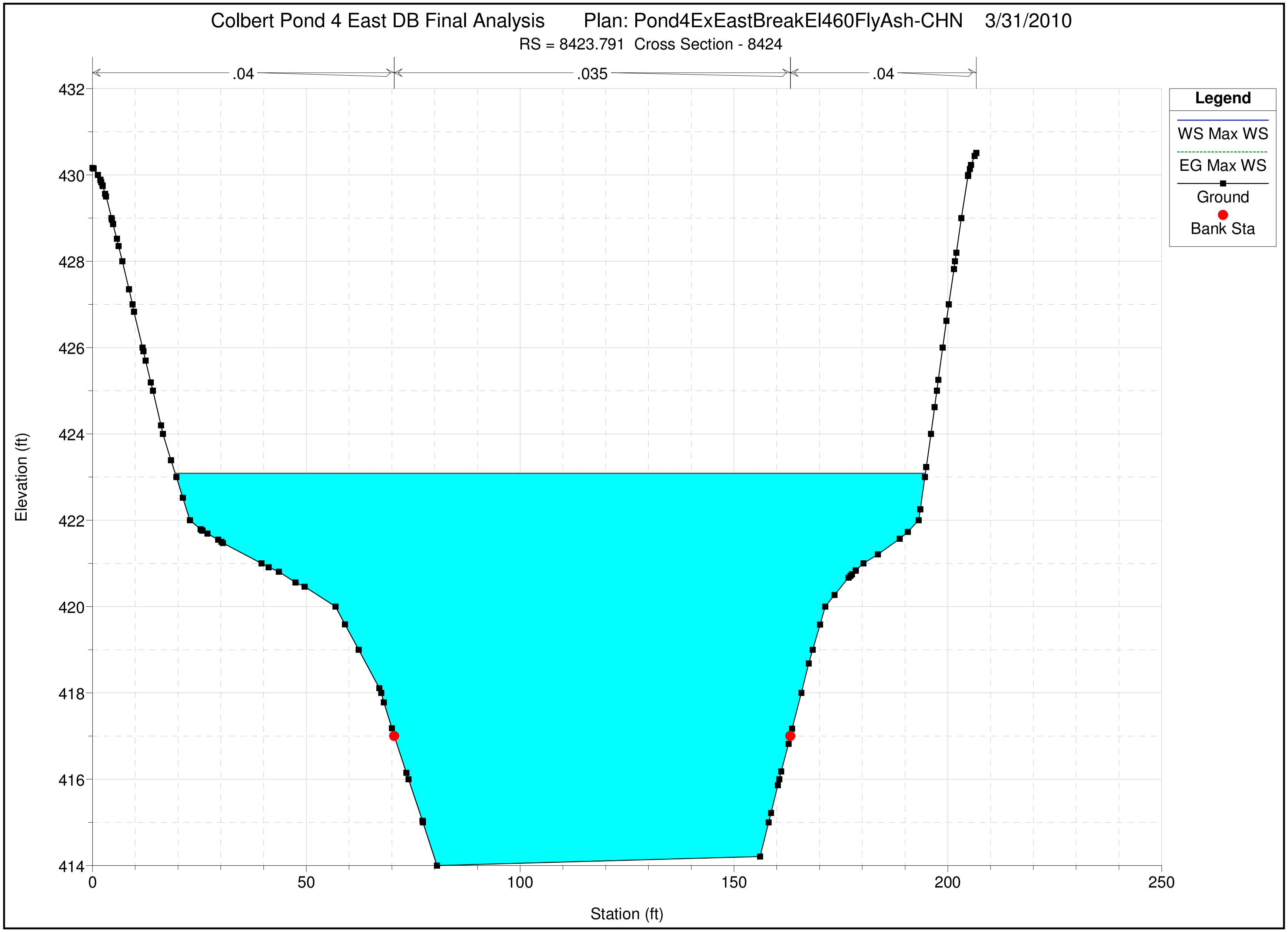


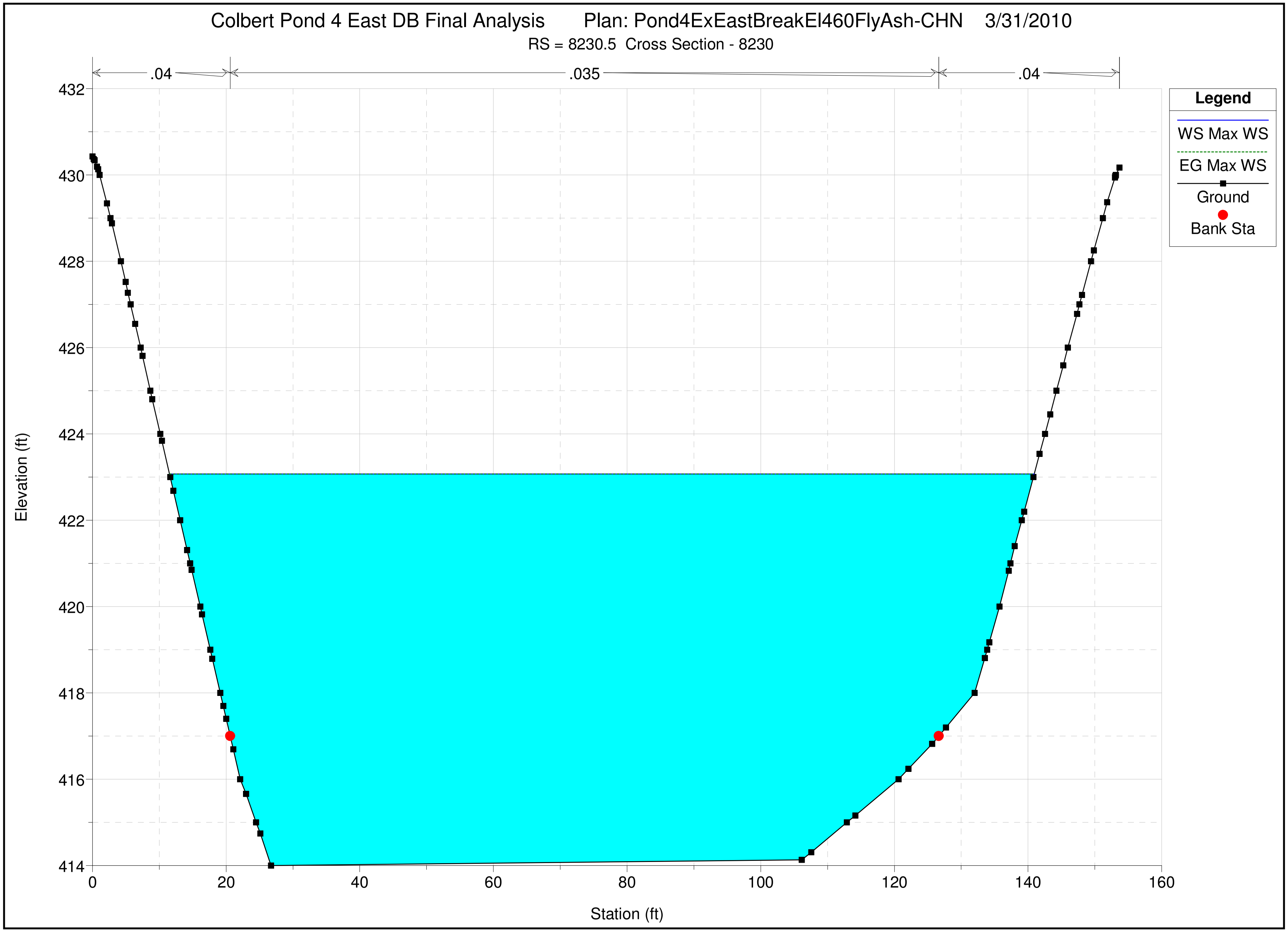


Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
CaneCreek CaneCreek
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Elevation (ft)
426
424
422
420
418
416
414
412
0
2000
4000
6000
8000
10000
Main Channel Distance (ft)
1375.713
1913.627
2094.501
2394.959
2660.956
2866.854
3175.041
3338.7
6432.622
7241.639
7798.150
8230.5
8423.791
8615.571

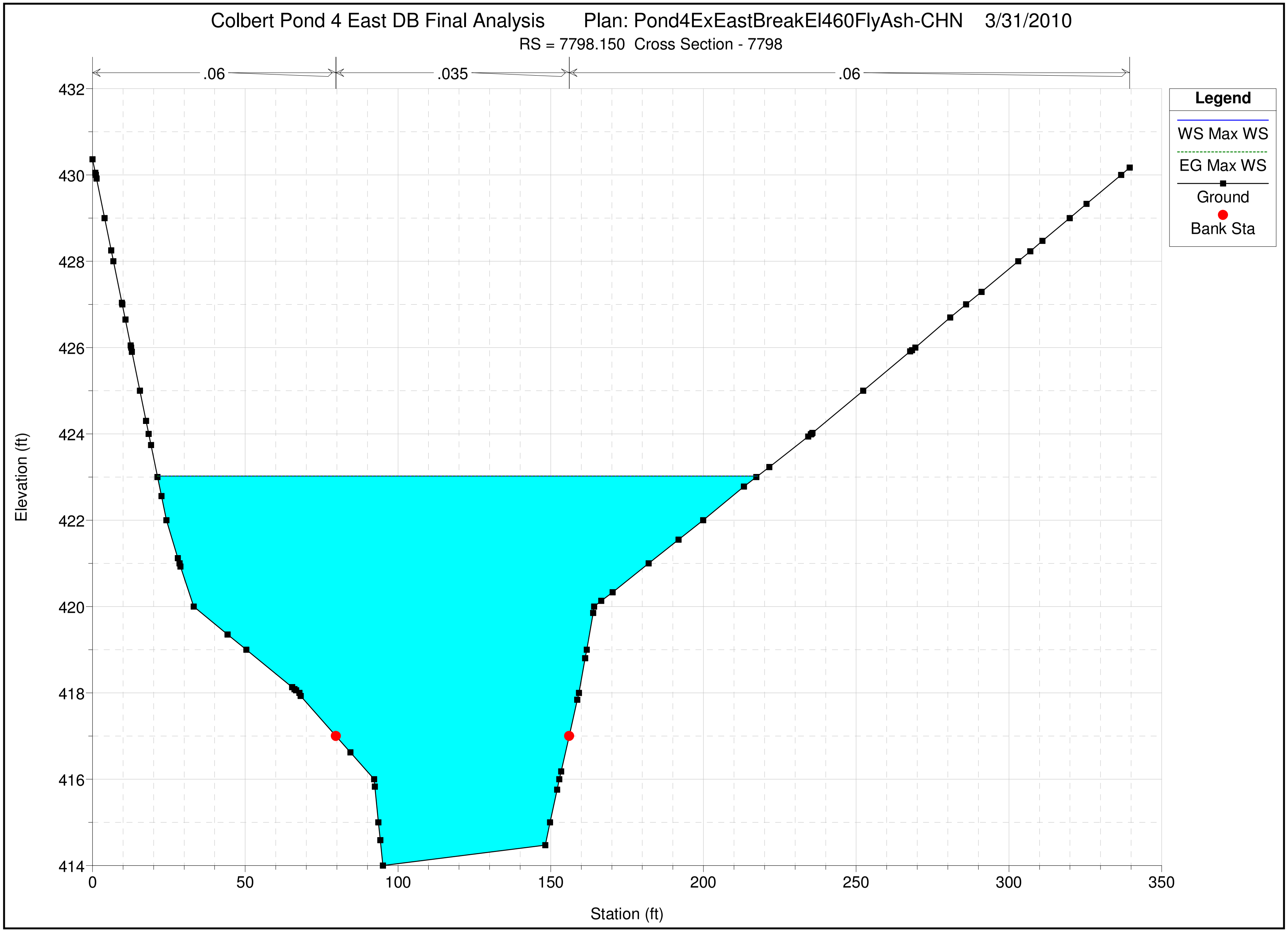


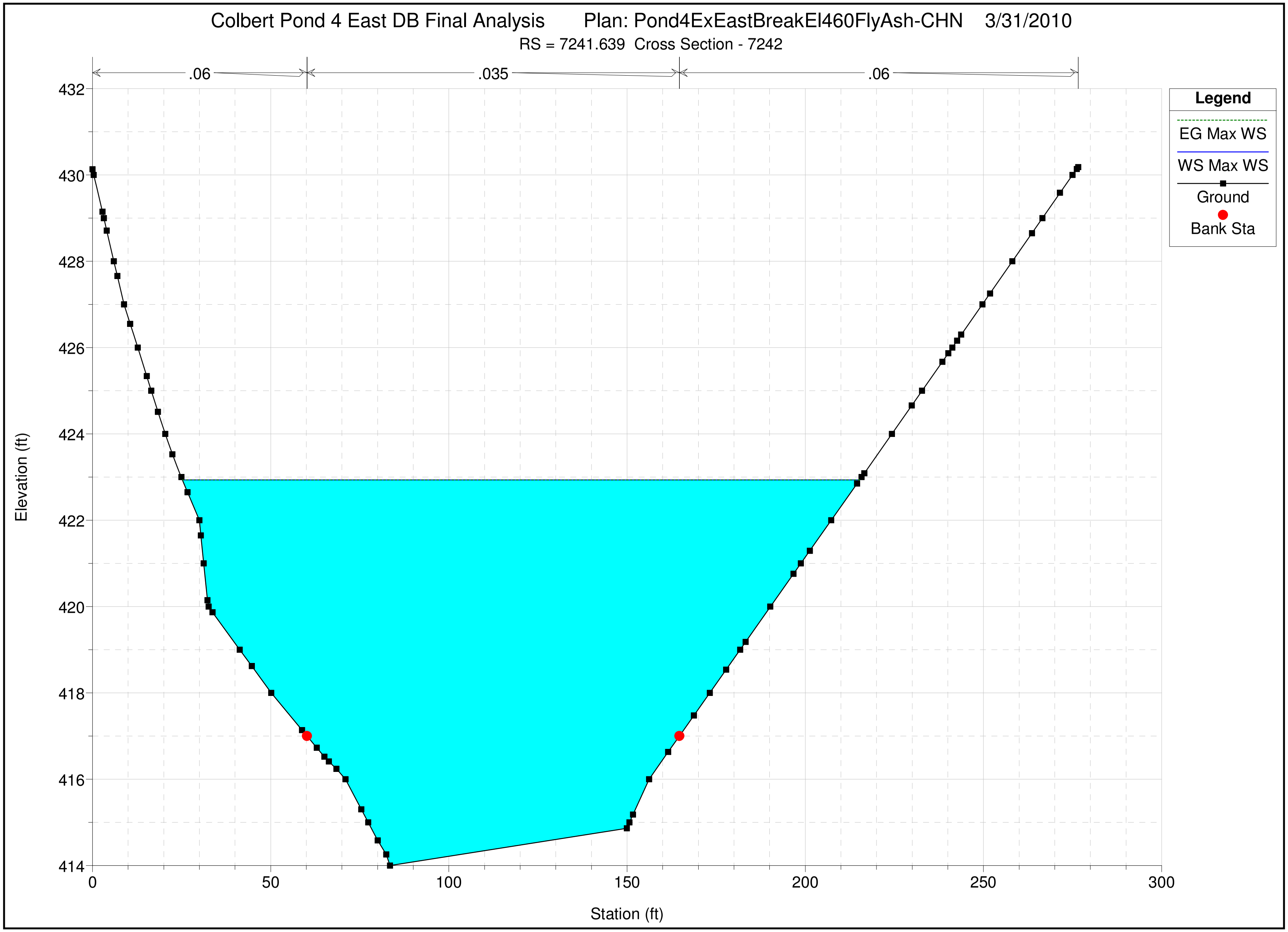
Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 8615.571 Cross Section - 8616
.04
.06
.04
.06
.035
.06
.04
Legend
WS Max WS
EG Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
432
430
428
426
424
422
420
418
416
414
-1000
-500
0
500
1000
1500
2000
2500

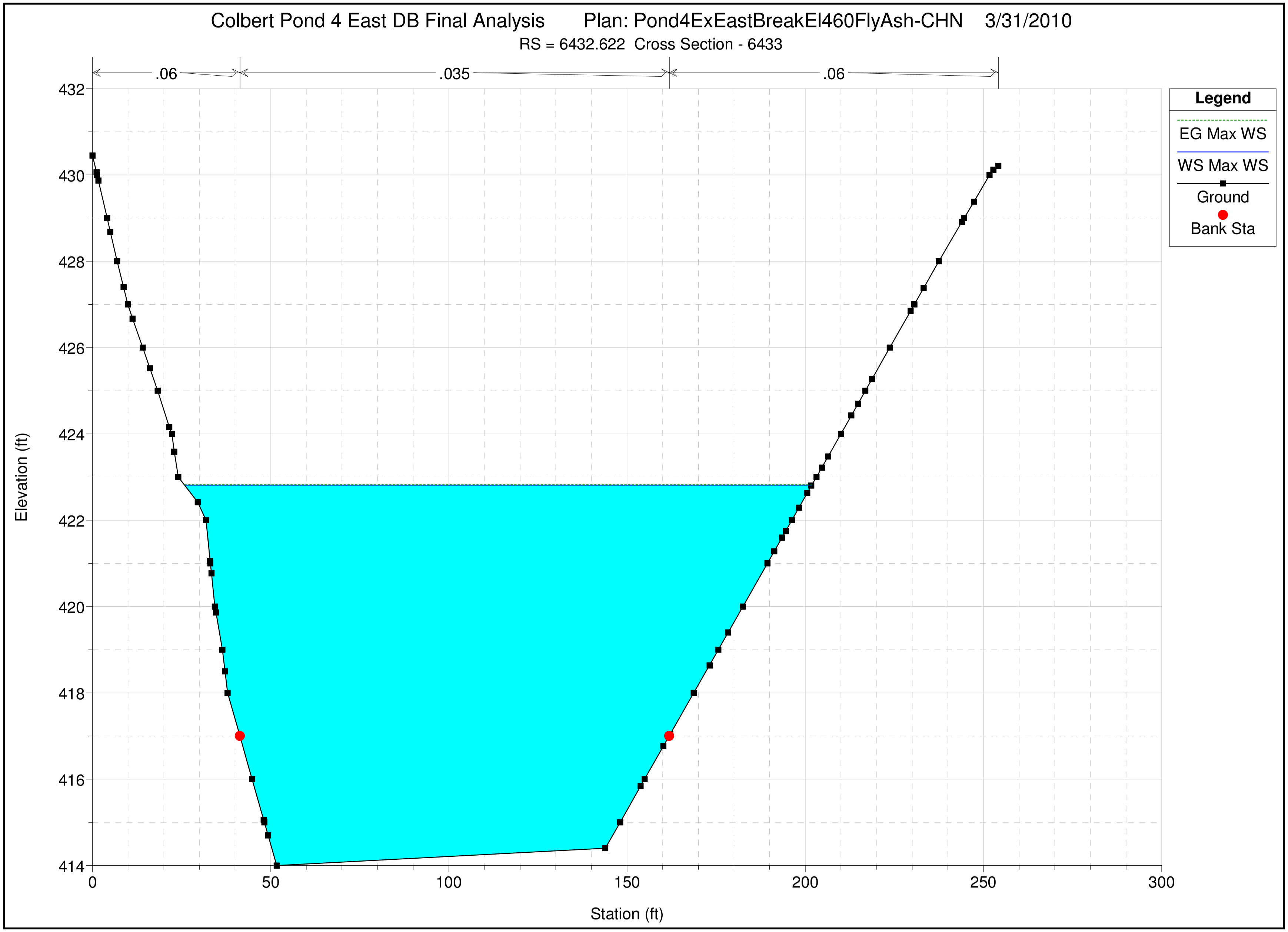

Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 8423.791 Cross Section - 8424
.04
.035
.04
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
432
430
428
426
424
422
420
418
416
414
0
50
100
150
200
250
Station (ft)

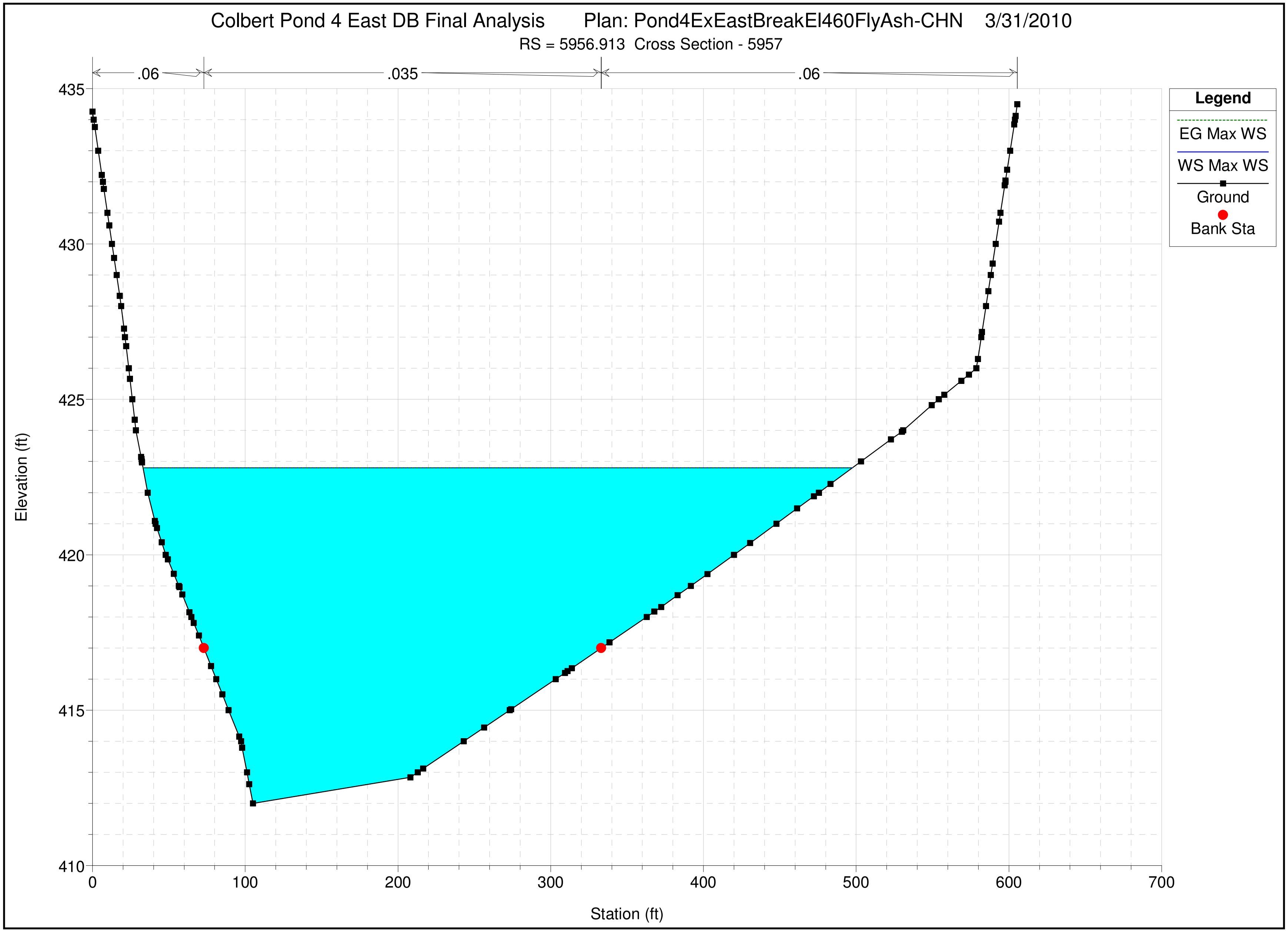


Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 8230.5 Cross Section - 8230
.04
.035
.04
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
432
430
428
426
424
422
420
418
416
414
0
20
40
60
80
100
120
140
160
Station (ft)


Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 7798.150 Cross Section - 7798
.06
.035
.06
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
432
430
428
426
424
422
420
418
416
414
0
50
100
150
200
250
300
350
Station (ft)


Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 7241.639 Cross Section - 7242
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
432
430
428
426
424
422
420
418
416
414
0
50
100
150
200
250
300
Station (ft)

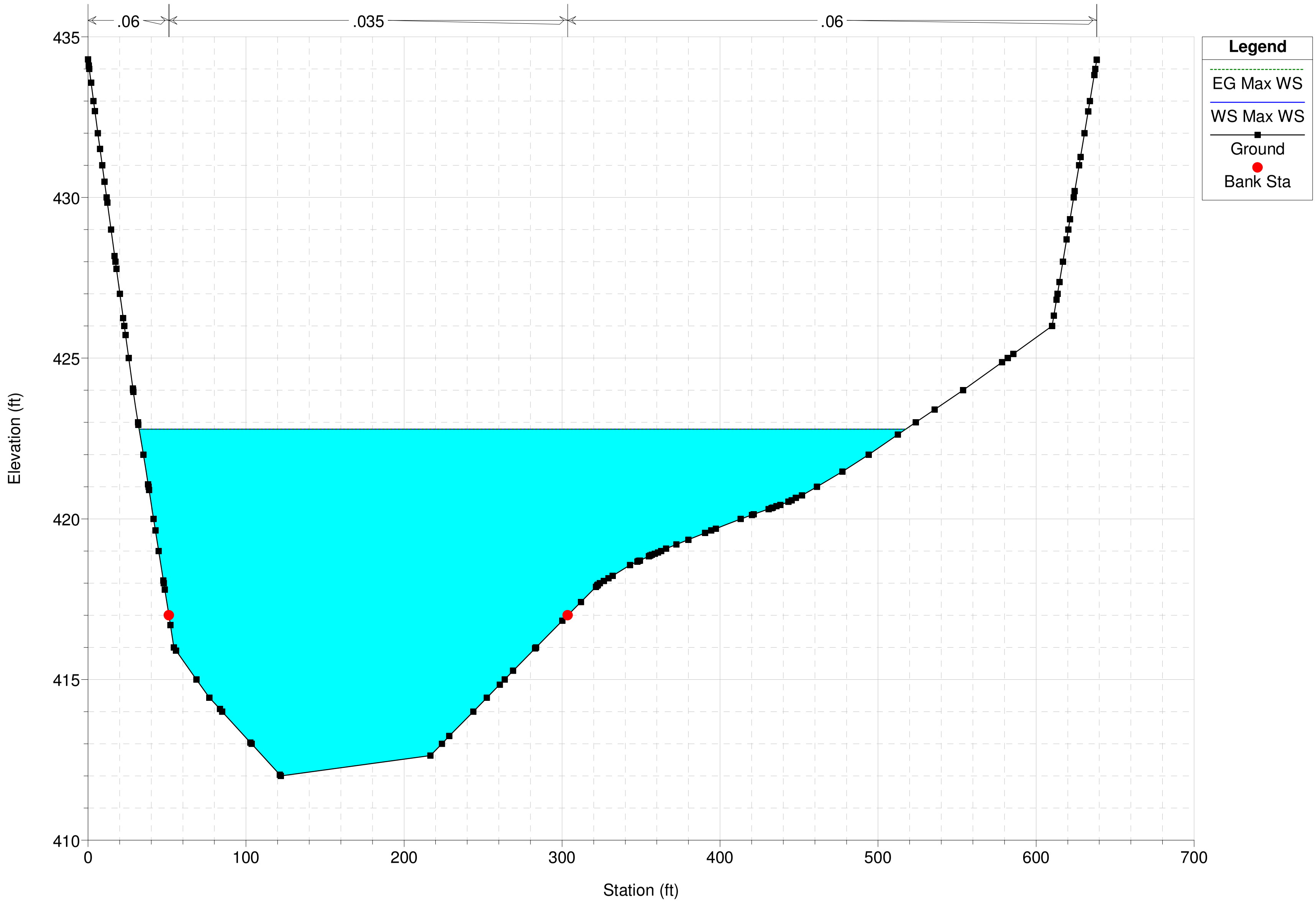

Colbert Pond 4 East DB Final Analysis
Plan: Pond4ExEastBreakEl460FlyAsh-CHN
3/31/2010
RS = 6432.622 Cross Section - 6433
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
432
430
428
426
424
422
420
418
416
414
0
50
100
150
200
250
300

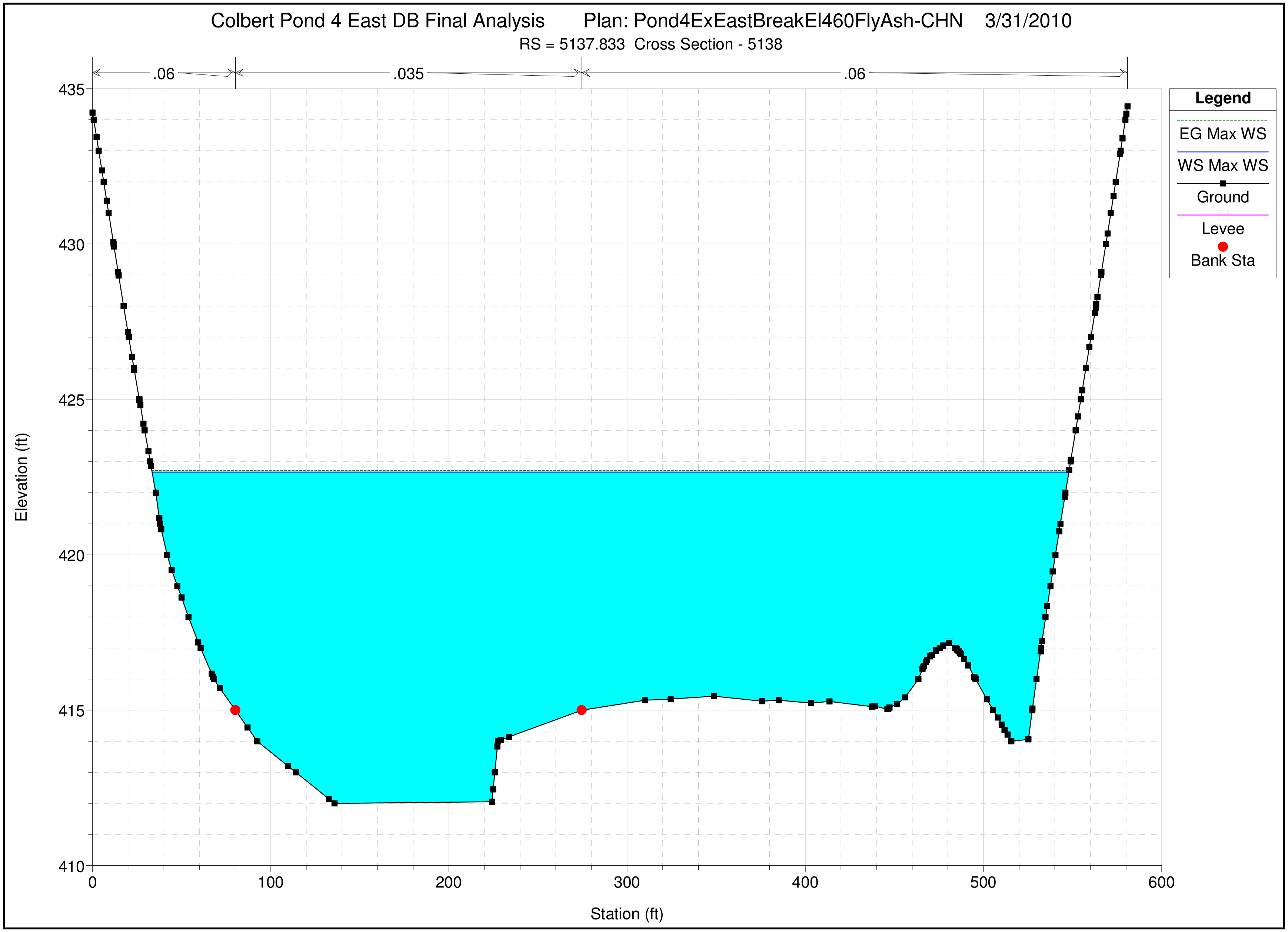


Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 5956.913 Cross Section - 5957
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
435
430
425
420
415
410
0
100
200
300
400
500
600
700

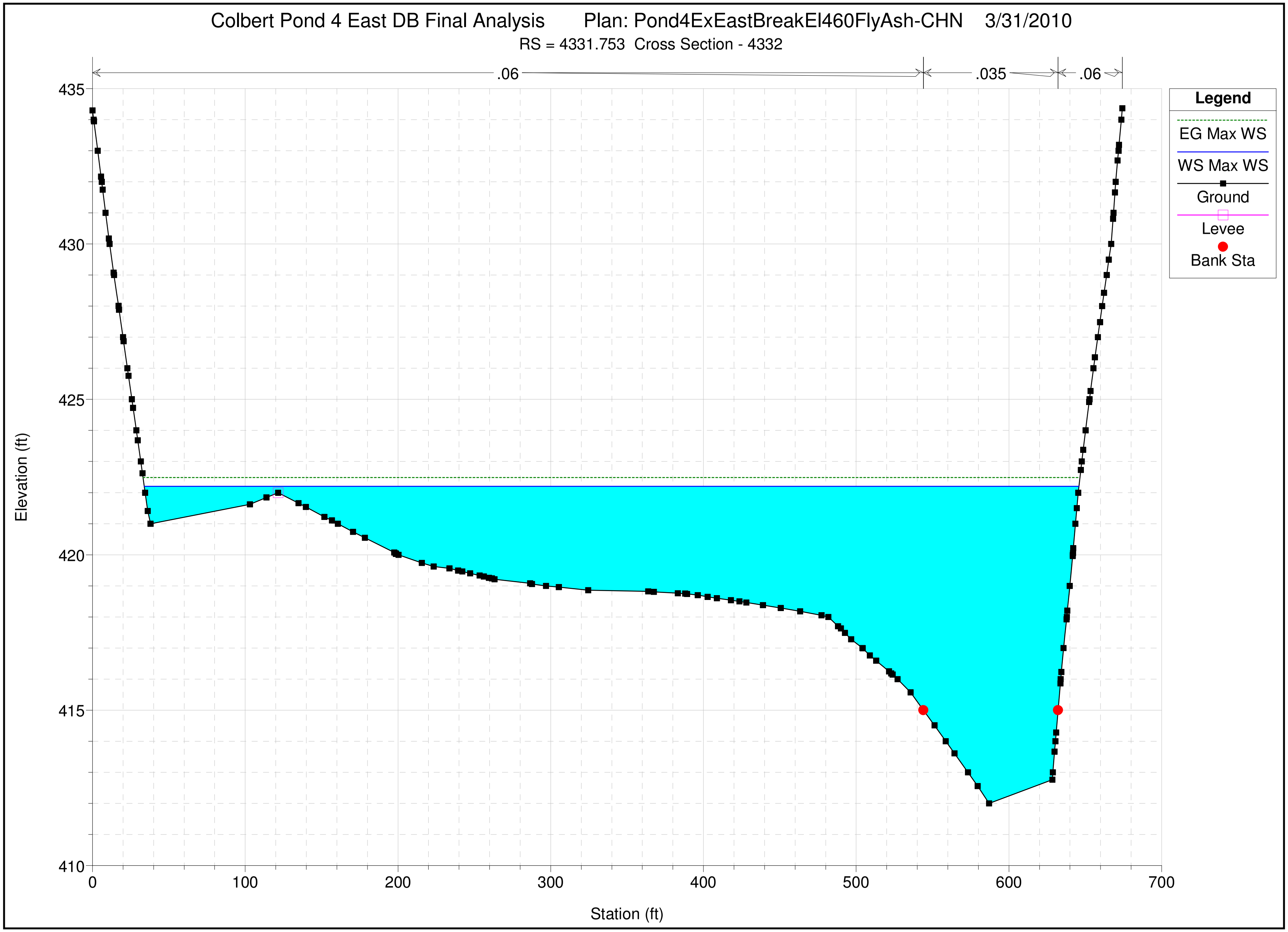
Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010

RS = 5653.209 Cross Section - 5653

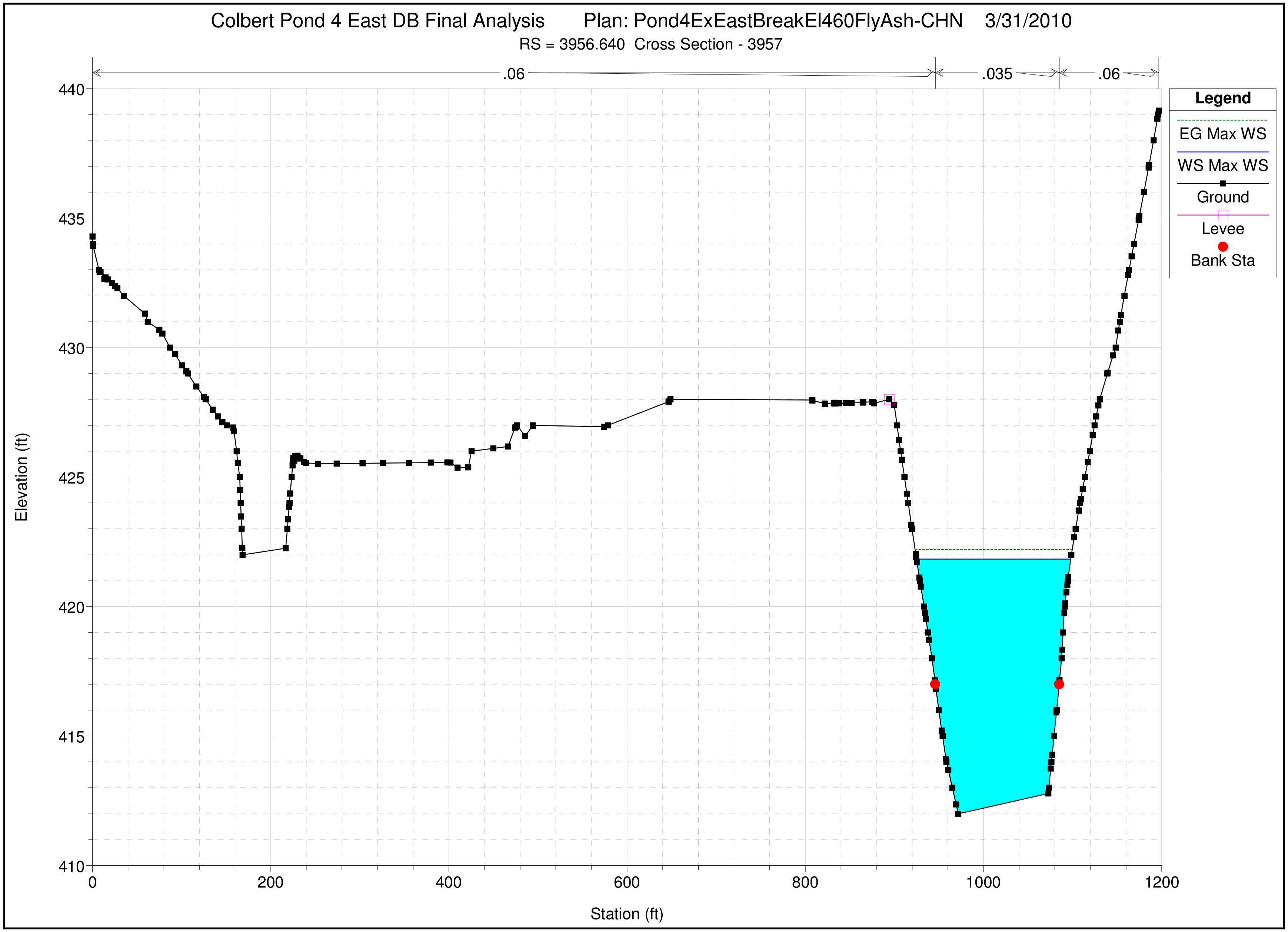


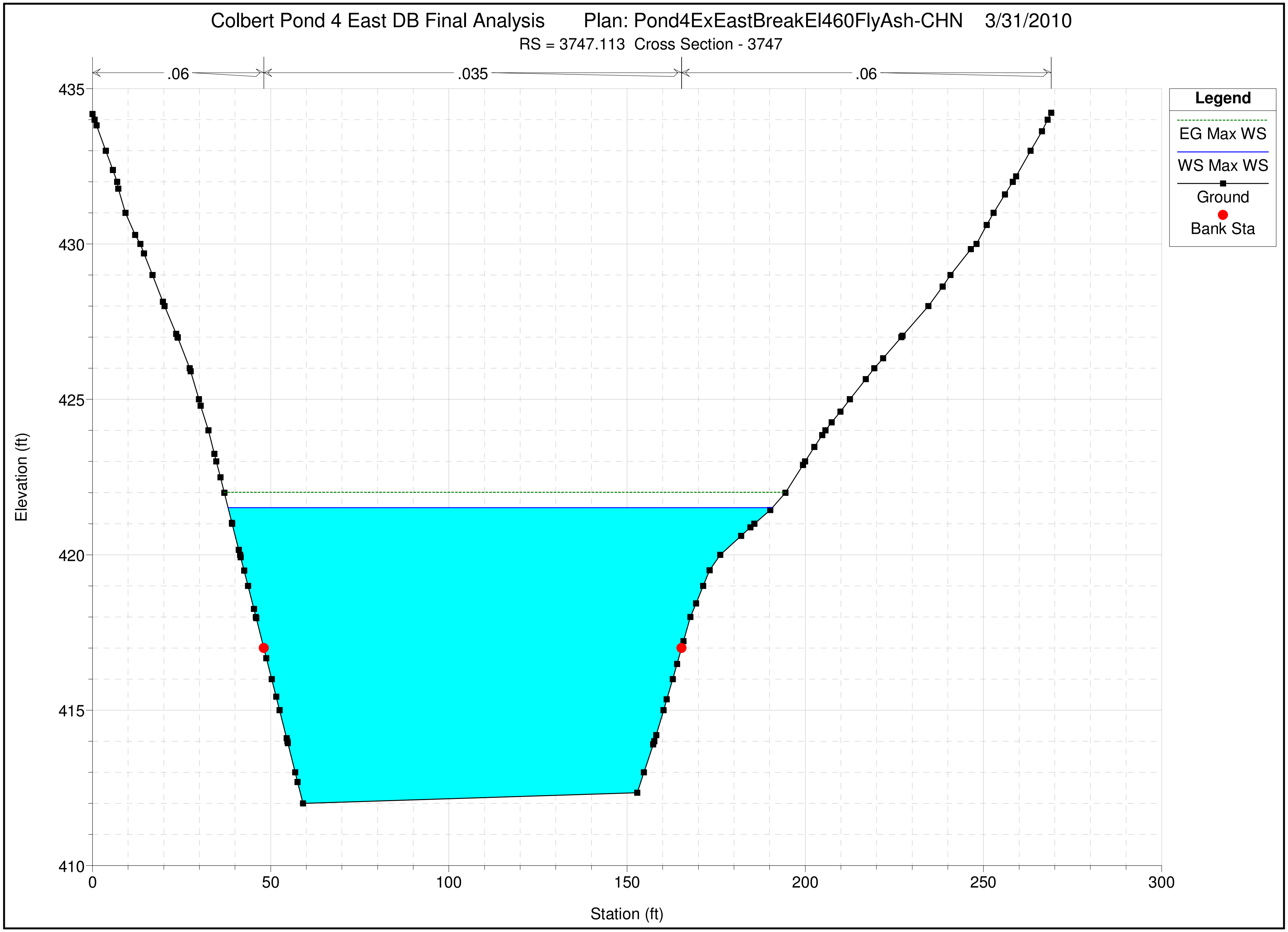


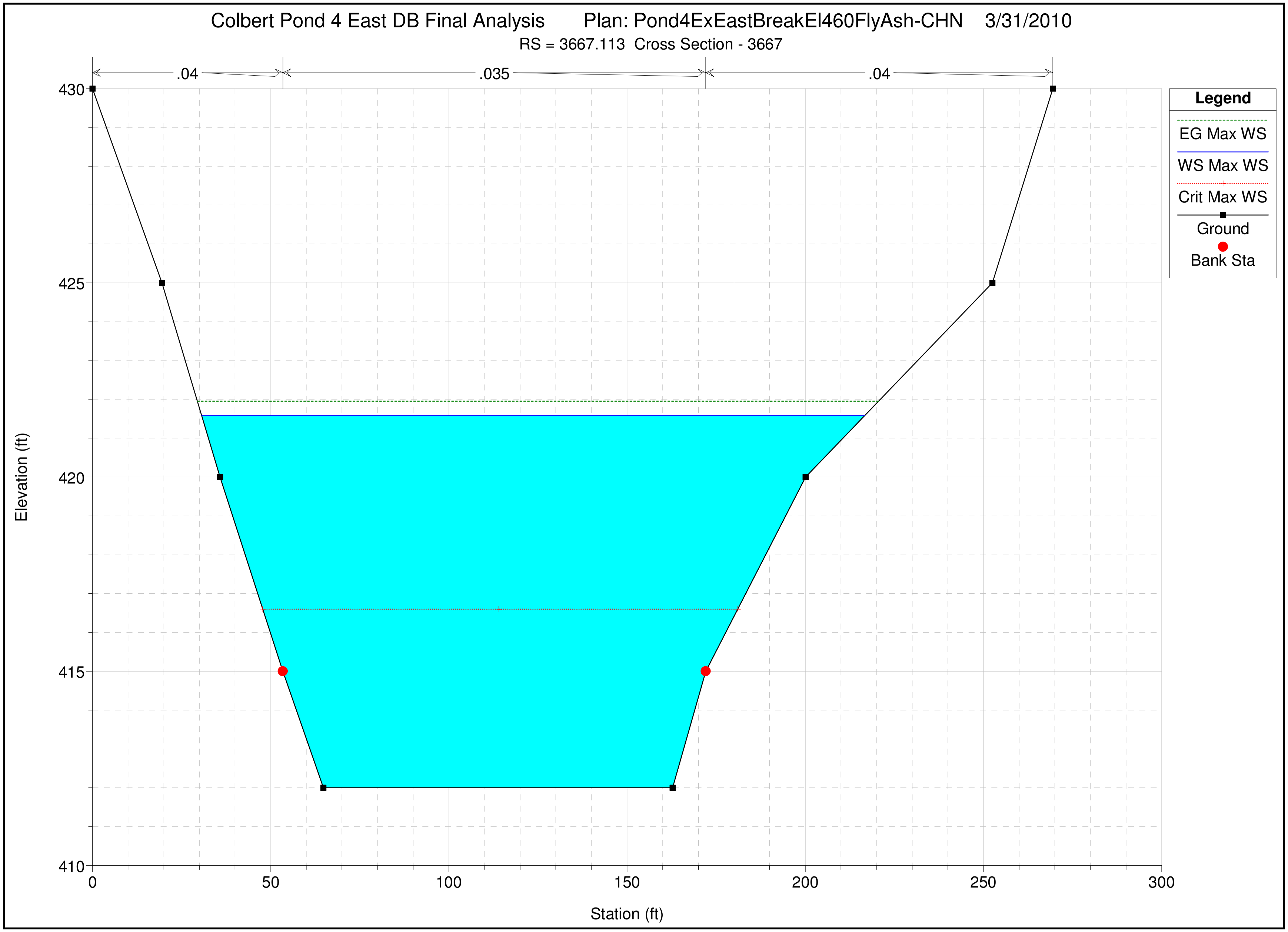
Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 5137.833 Cross Section - 5138
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
435
430
425
420
415
410
0
100
200
300
400
500
600

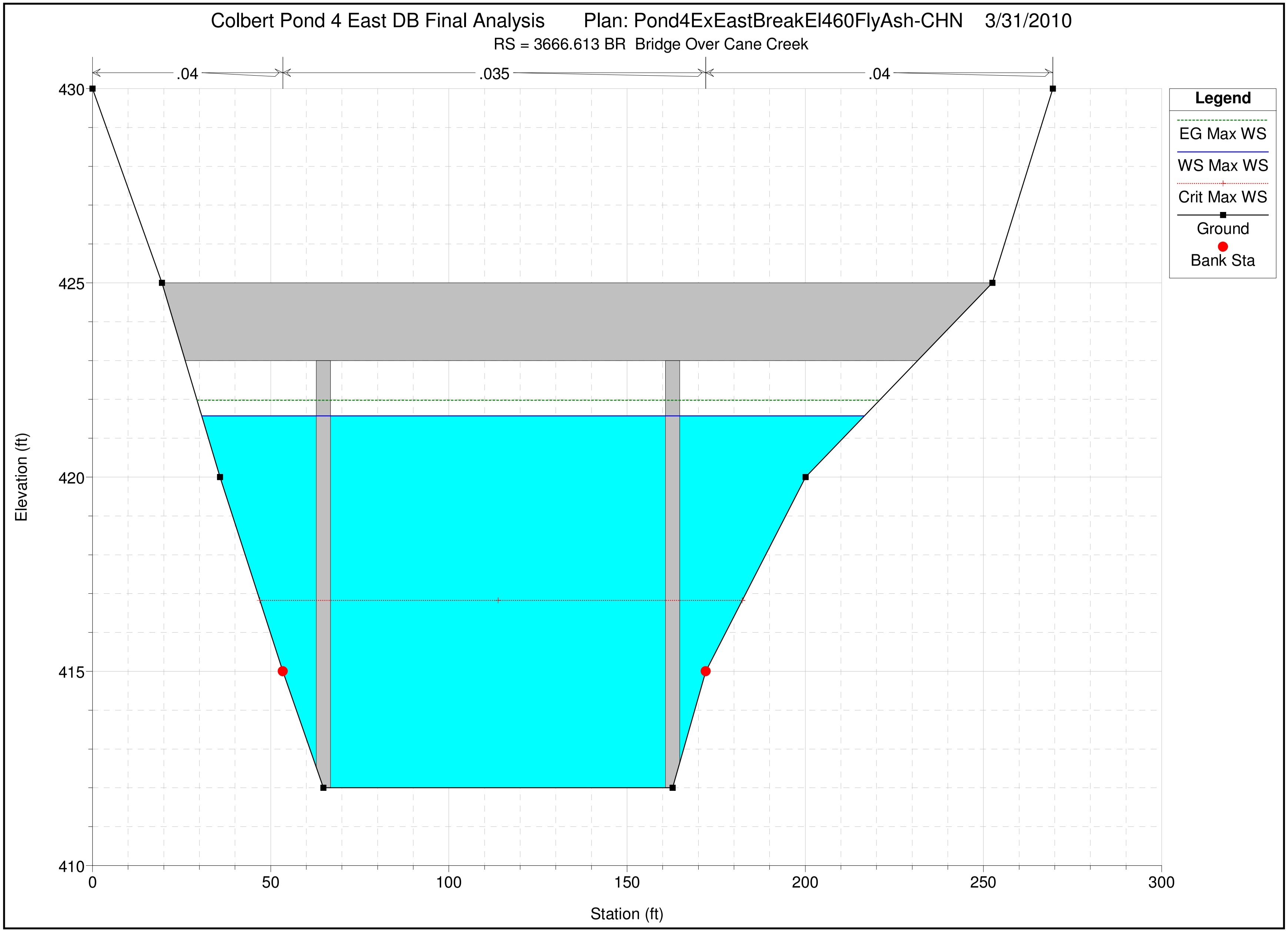


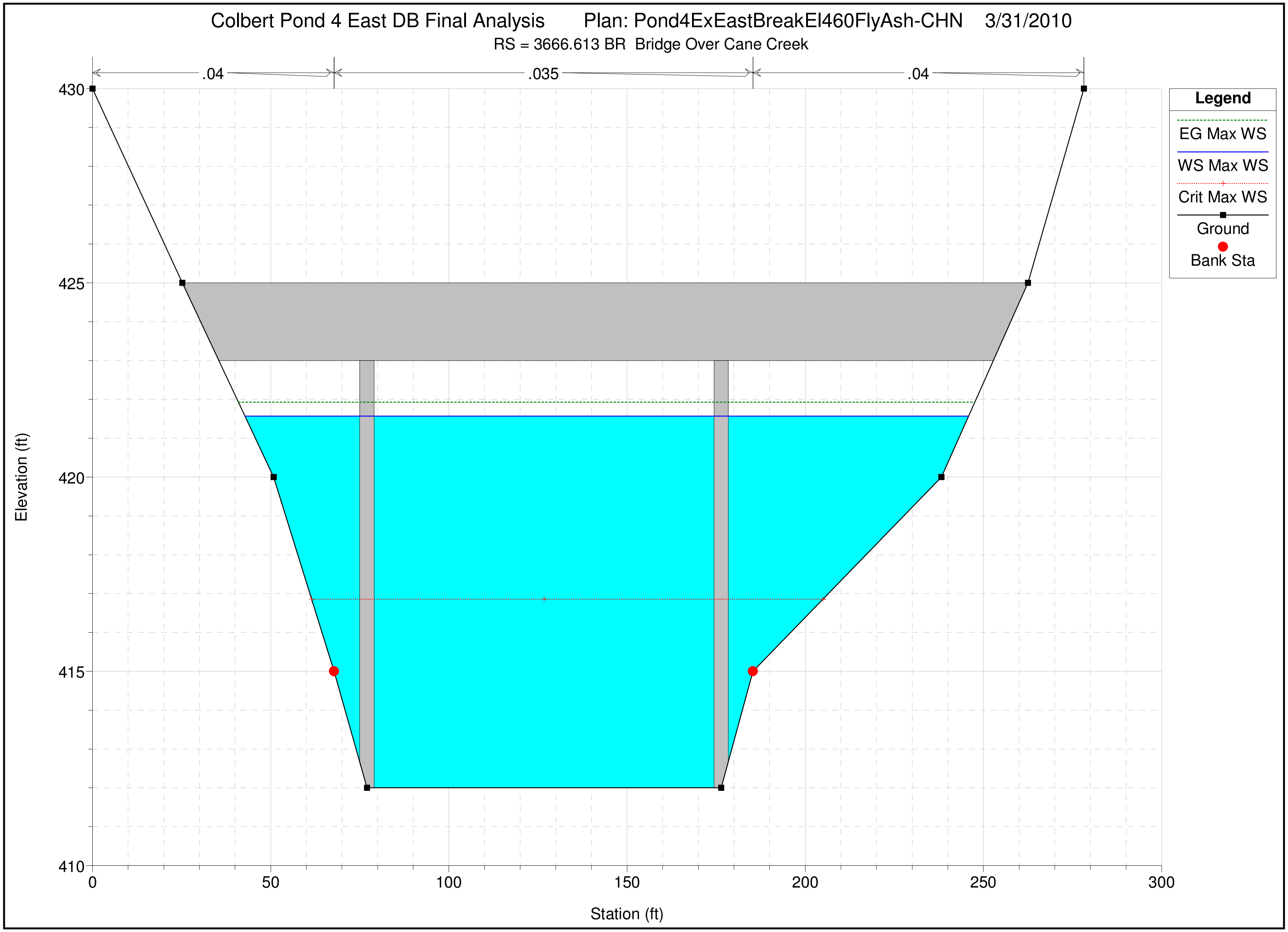
Colbert Pond 4 East DB Final Analysis   Plan: Pond4ExEastBreakEl460FlyAsh-CHN   3/31/2010
RS = 4331.753 Cross Section - 4332
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
435
430
425
420
415
410
0
100
200
300
400
500
600
700
Station (ft)

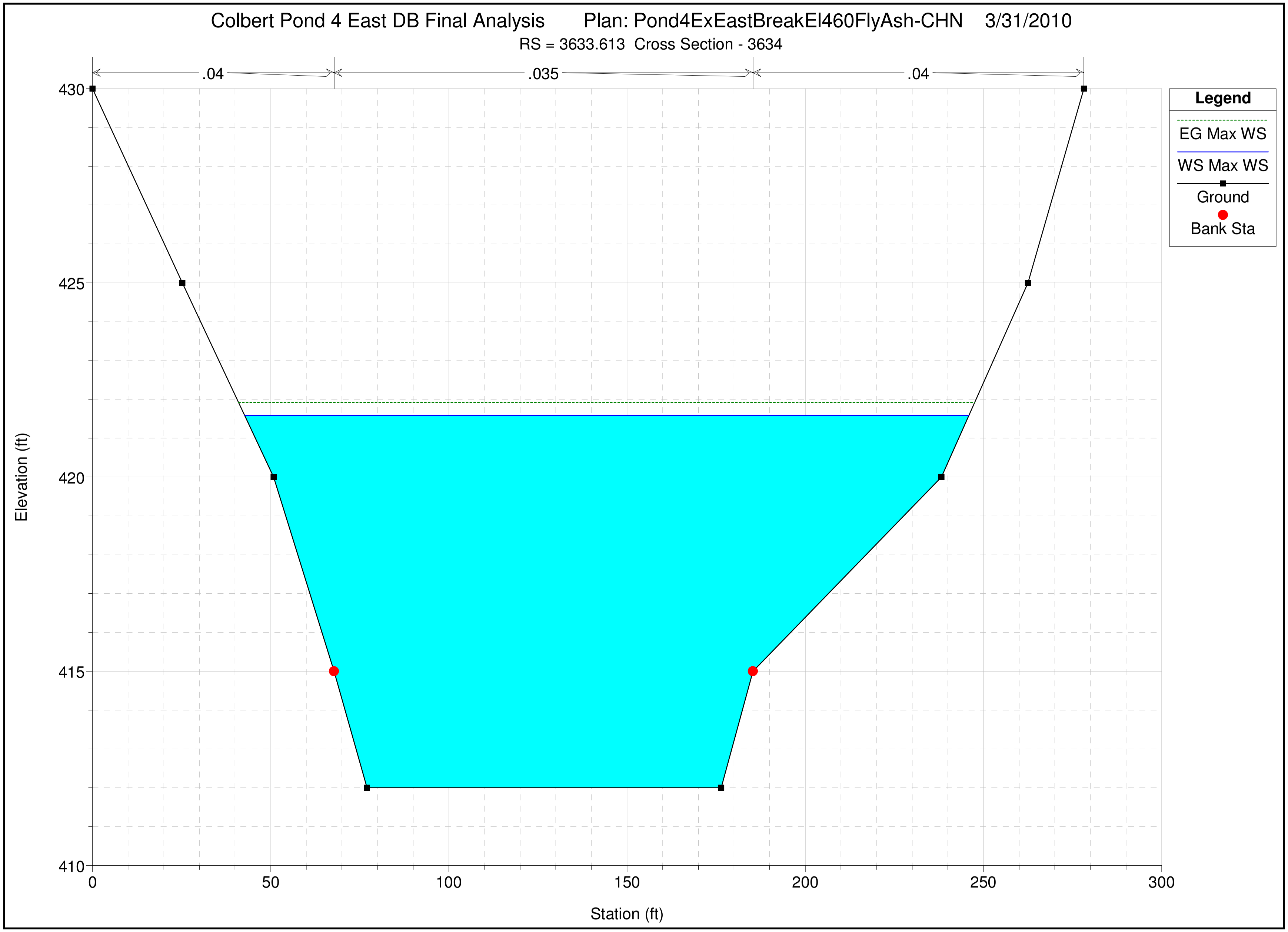

Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 3956.640 Cross Section - 3957
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
440
435
430
425
420
415
410
0
200
400
600
800
1000
1200
Station (ft)

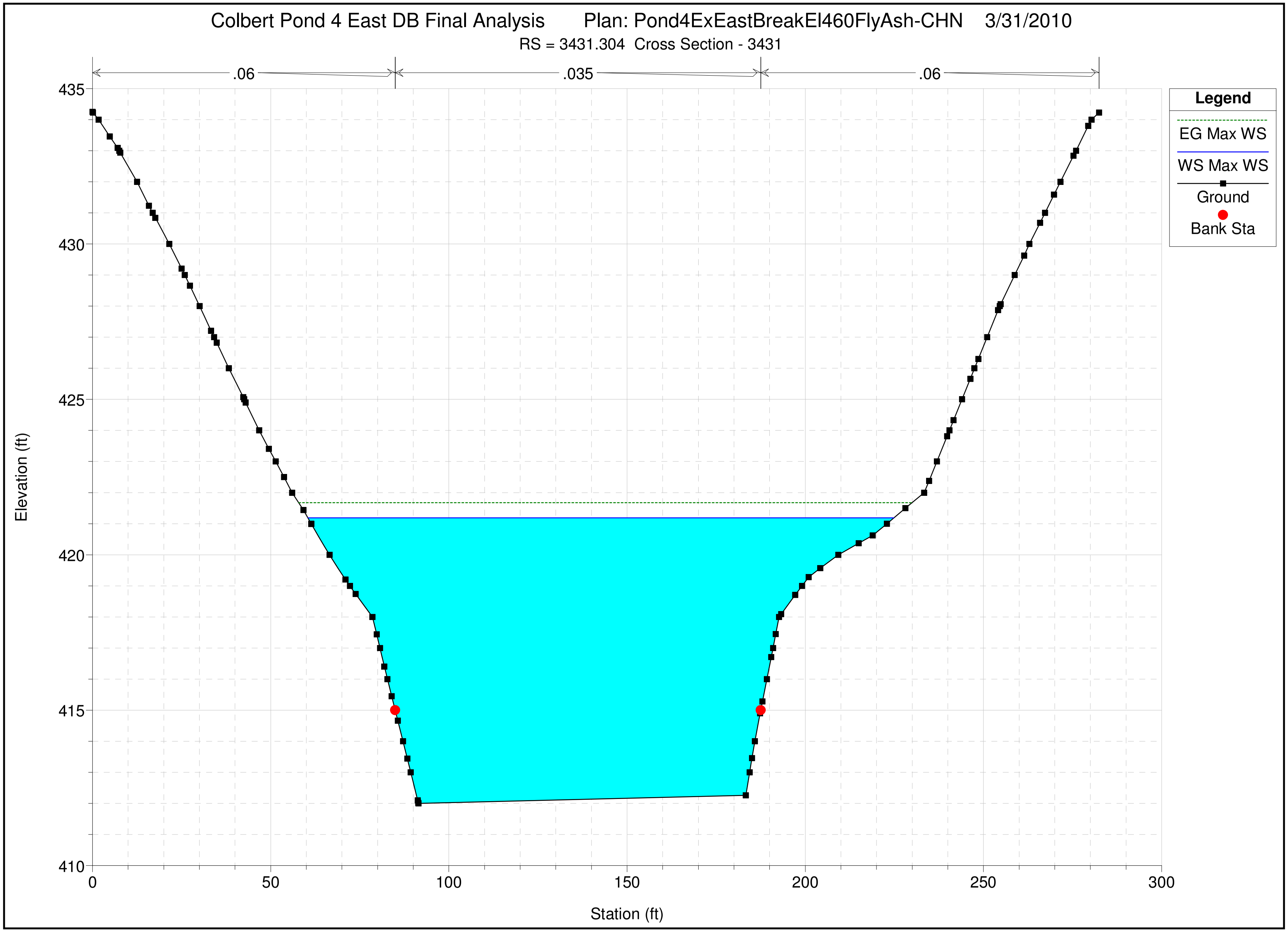

Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 3747.113 Cross Section - 3747
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
435
430
425
420
415
410
0
50
100
150
200
250
300
Station (ft)

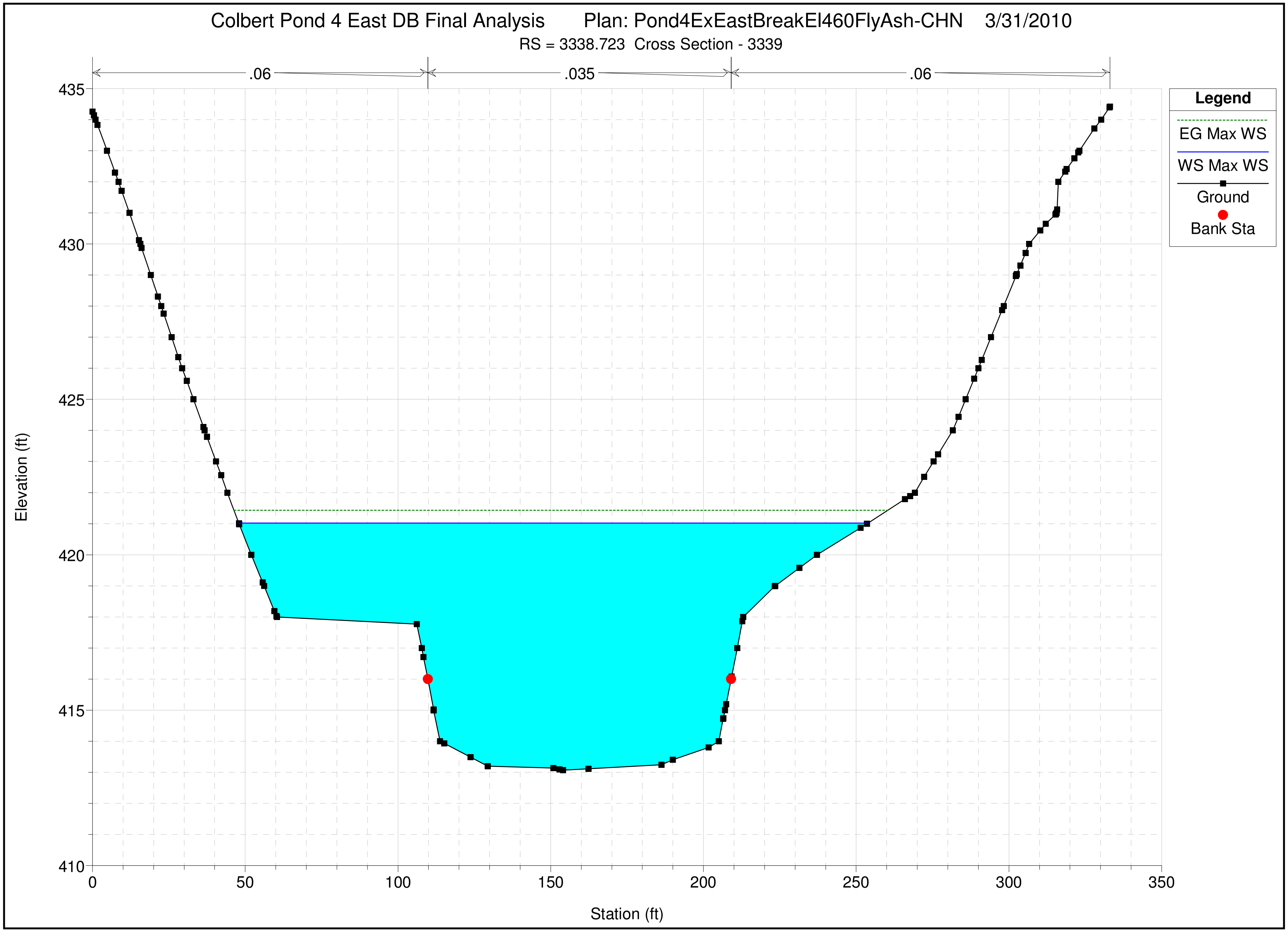

Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 3667.113 Cross Section - 3667
.04
.035
.04
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
430
425
420
415
410
0
50
100
150
200
250
300
Station (ft)

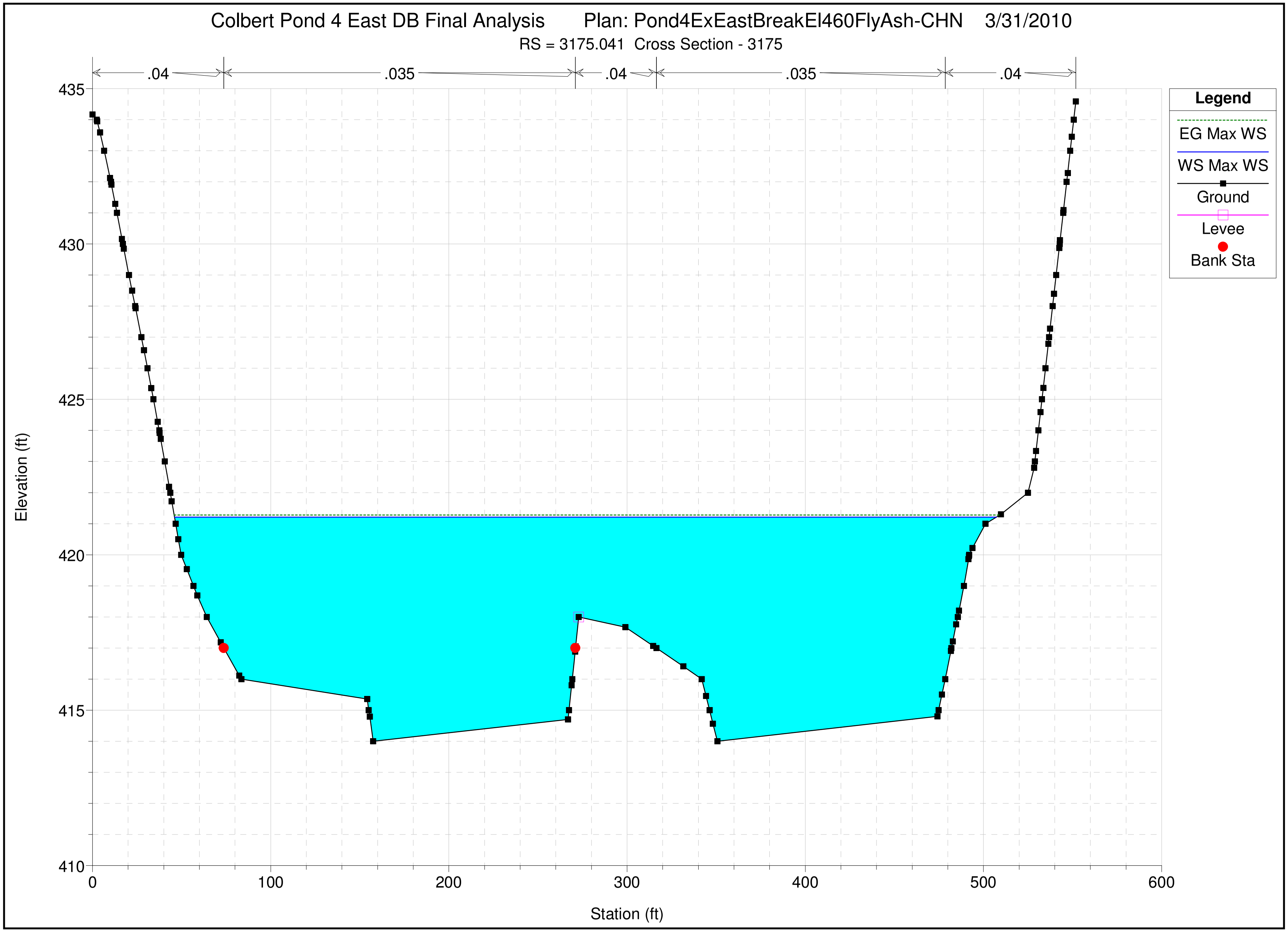

Colbert Pond 4 East DB Final Analysis   Plan: Pond4ExEastBreakEl460FlyAsh-CHN   3/31/2010
RS = 3666.613 BR Bridge Over Cane Creek
.04
.035
.04
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
430
425
420
415
410
0
50
100
150
200
250
300
Station (ft)


Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 3666.613 BR Bridge Over Cane Creek
.04
.035
.04
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
430
425
420
415
410
0
50
100
150
200
250
300
Station (ft)

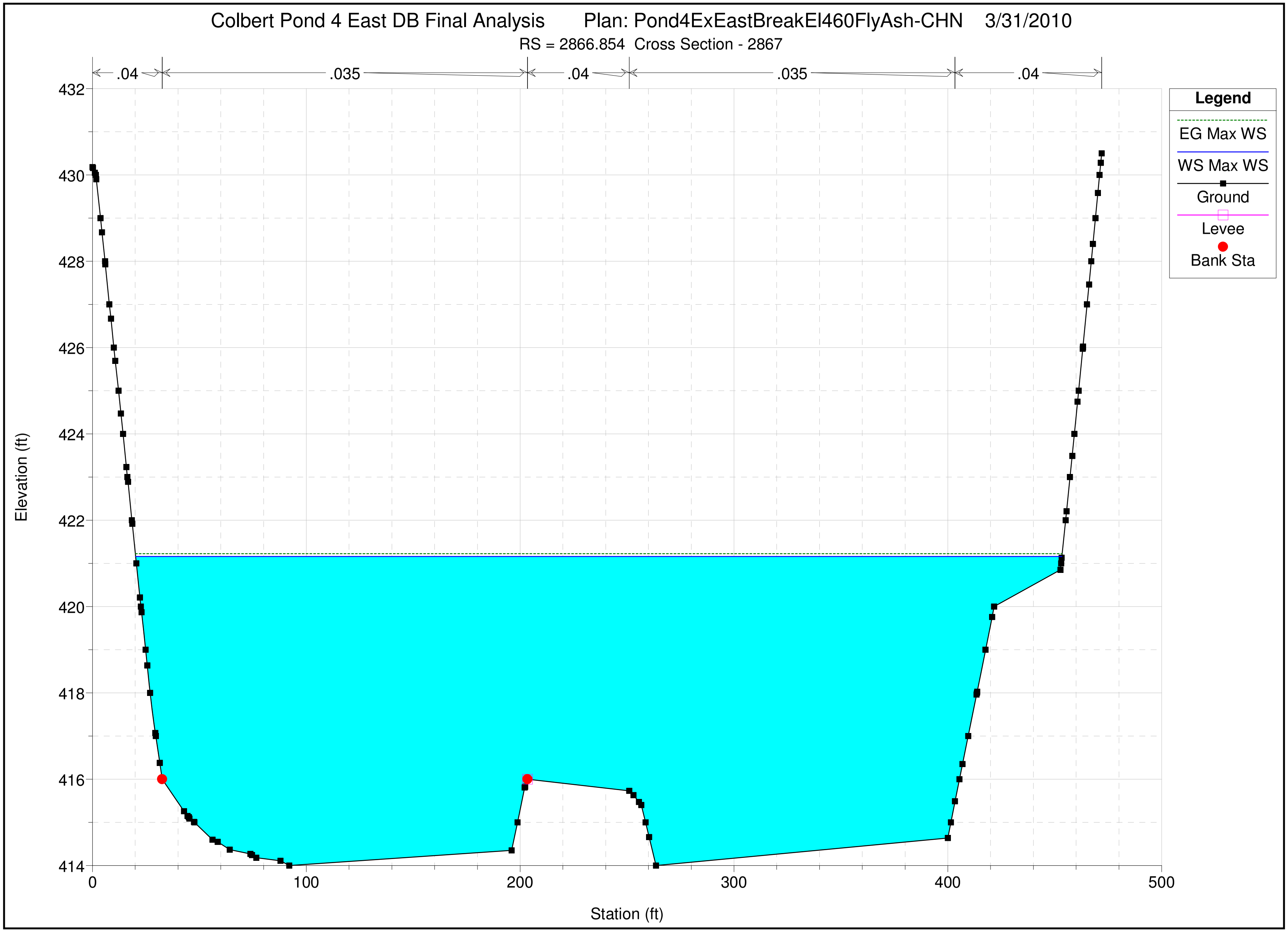

Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 3633.613 Cross Section - 3634
.04
.035
.04
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
430
425
420
415
410
0
50
100
150
200
250
300
Station (ft)


Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 3431.304 Cross Section - 3431
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
435
430
425
420
415
410
0
50
100
150
200
250
300

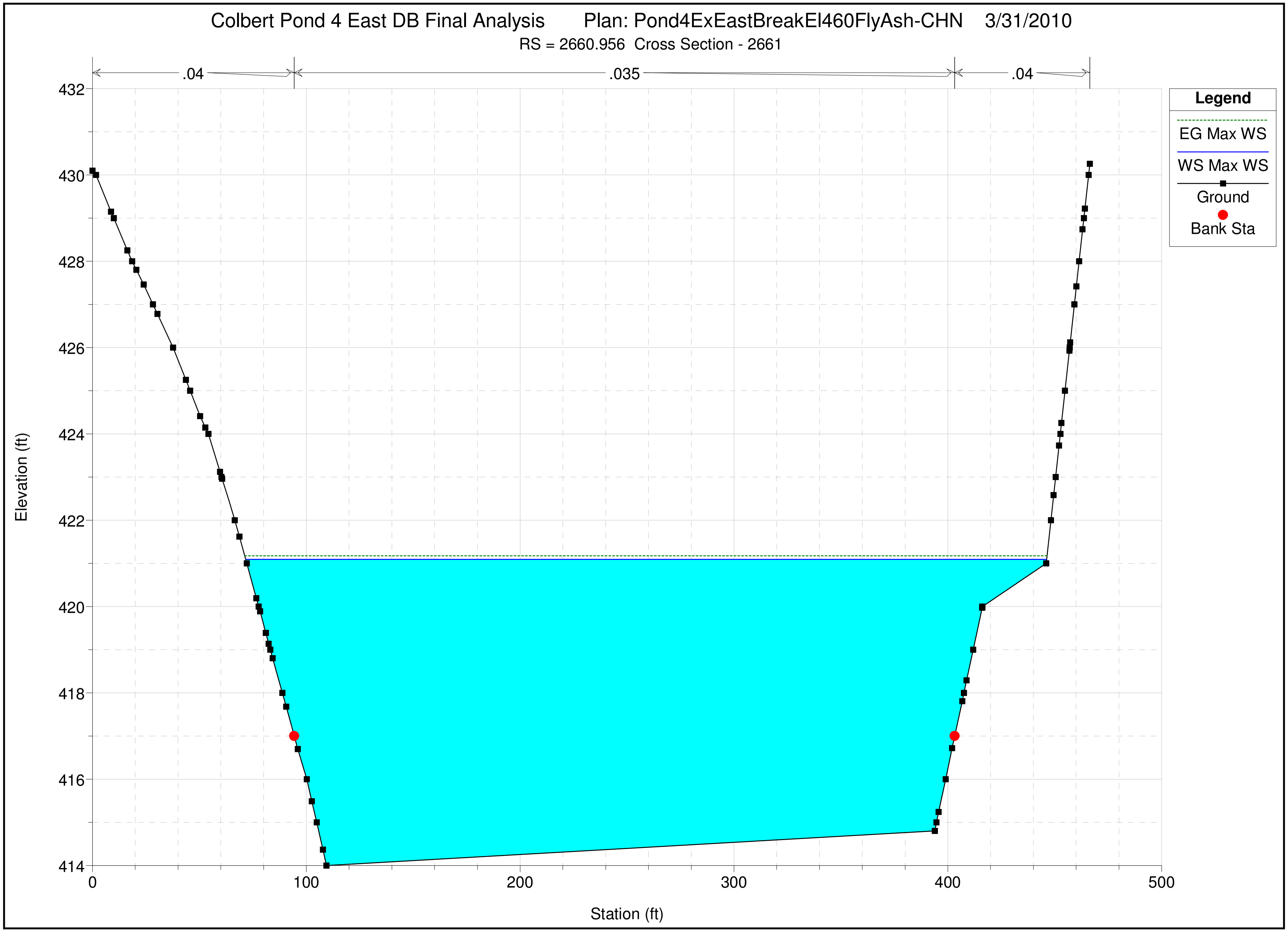

Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 3338.723 Cross Section - 3339
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
435
430
425
420
415
410
Station (ft)
0
50
100
150
200
250
300
350



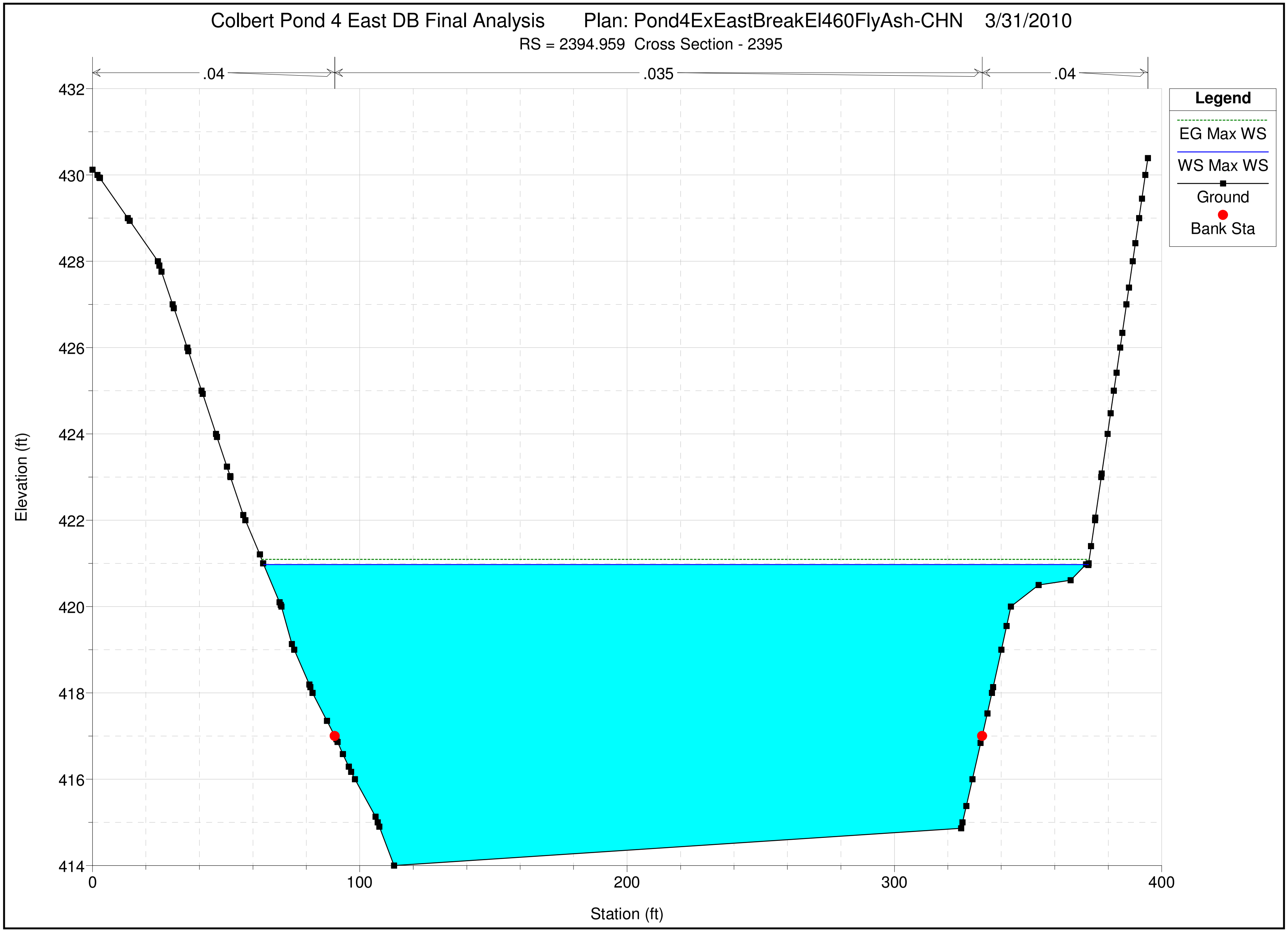
Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 3175.041 Cross Section - 3175
.04
.035
.04
.035
.04
435
430
425
420
415
410
Elevation (ft)
0
100
200
300
400
500
600
Station (ft)
Legend
EG Max WS
WS Max WS
Ground
Levee
Bank Sta

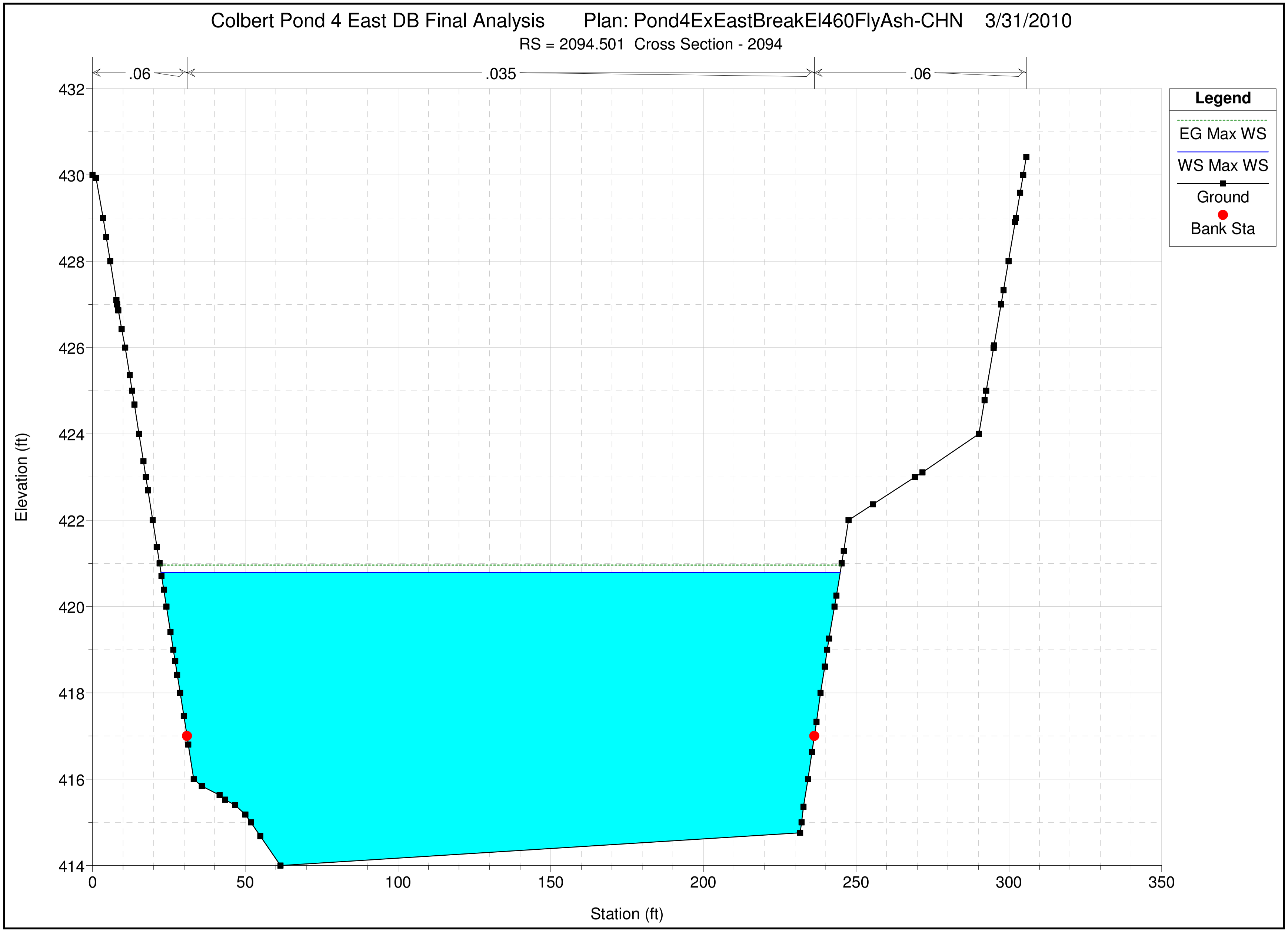


Colbert Pond 4 East DB Final Analysis
Plan: Pond4ExEastBreakEl460FlyAsh-CHN
3/31/2010
RS = 2866.854 Cross Section - 2867
.04
.035
.04
.035
.04
Legend
EG Max WS
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
432
430
428
426
424
422
420
418
416
414
0
100
200
300
400
500

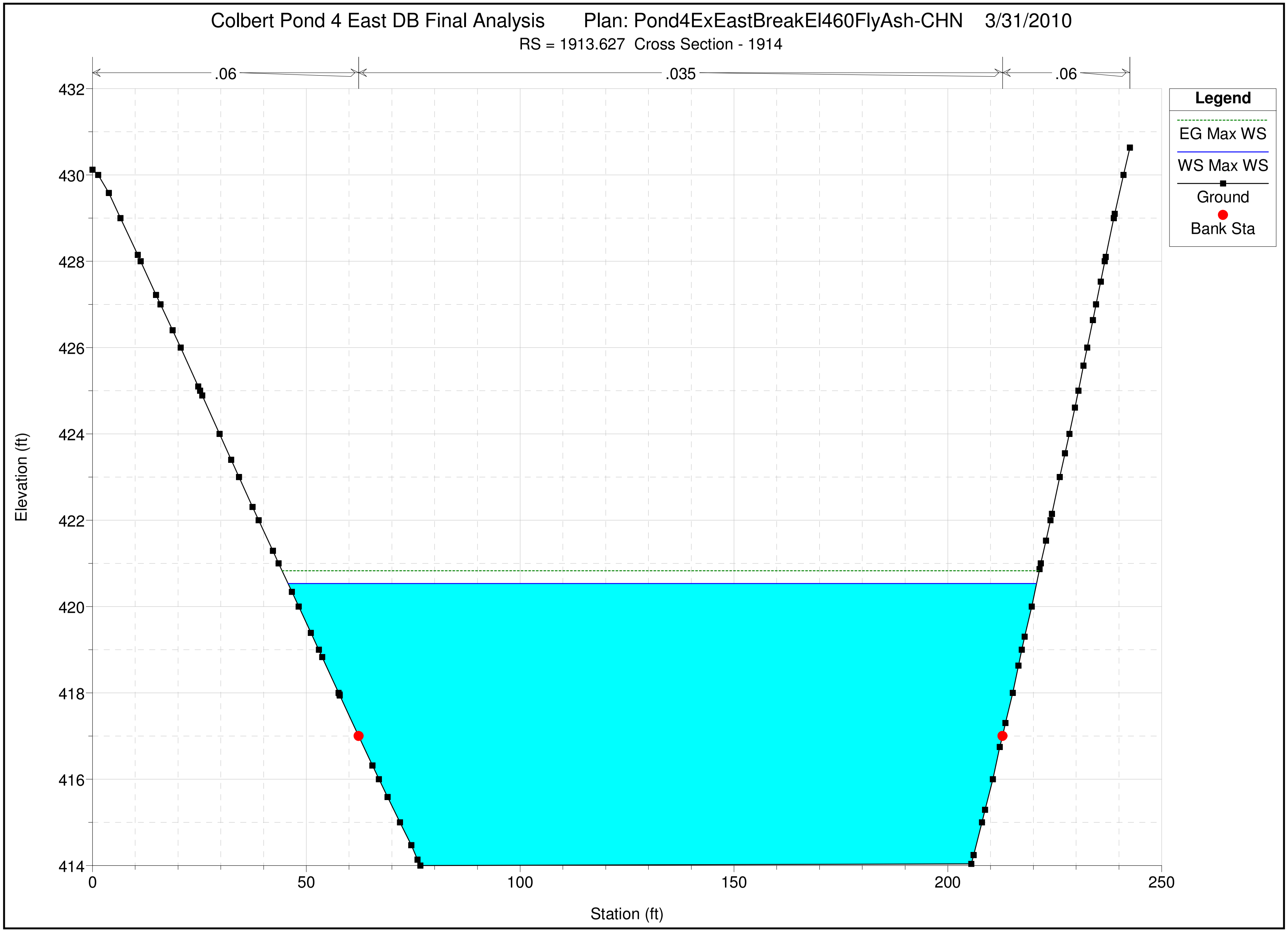


Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 2660.956 Cross Section - 2661
.04
.035
.04
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
432
430
428
426
424
422
420
418
416
414
0
100
200
300
400
500

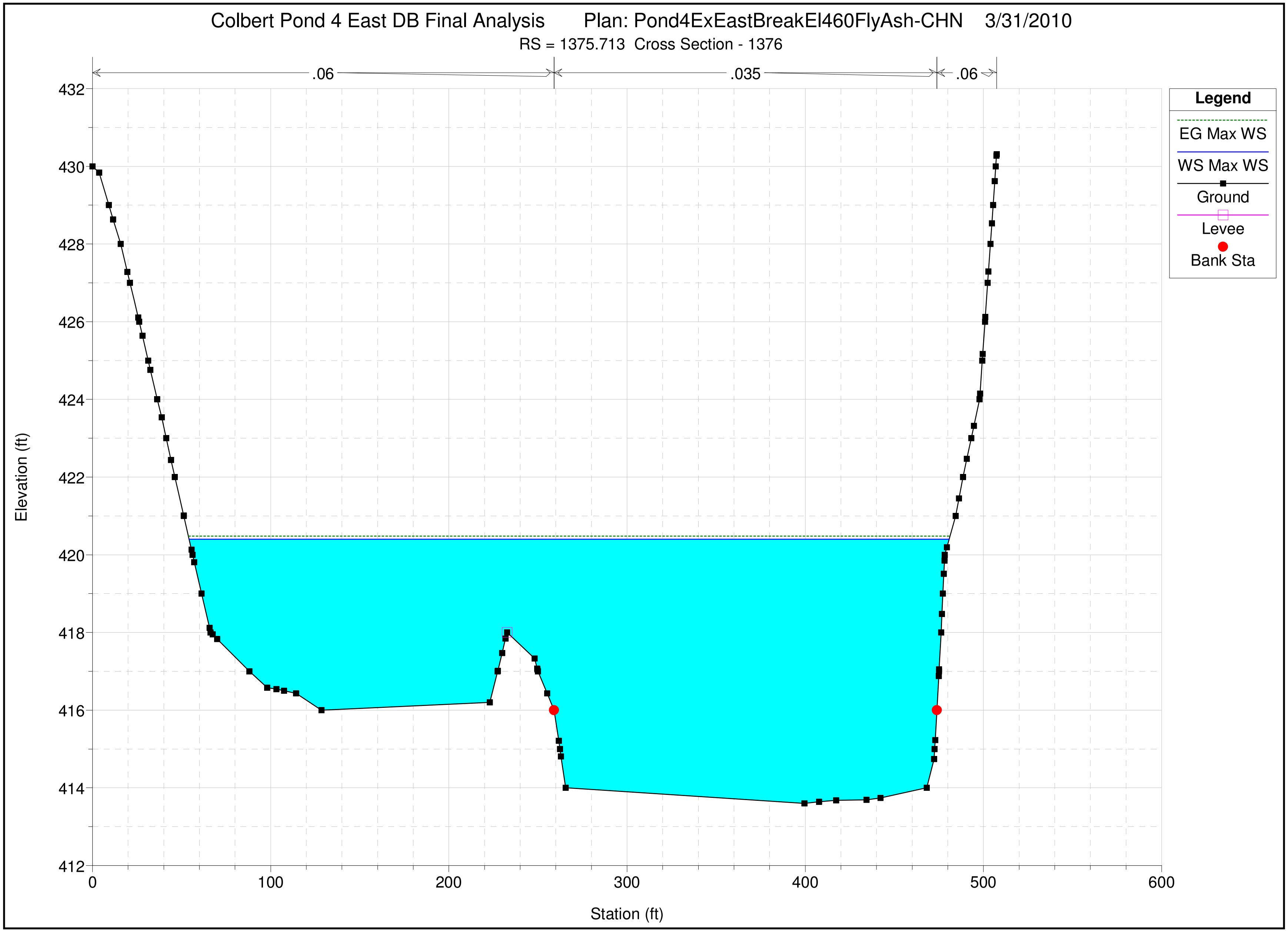

Colbert Pond 4 East DB Final Analysis
Plan: Pond4ExEastBreakEl460FlyAsh-CHN
3/31/2010
RS = 2394.959 Cross Section - 2395
.04
.035
.04
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
432
430
428
426
424
422
420
418
416
414
0
100
200
300
400
Station (ft)



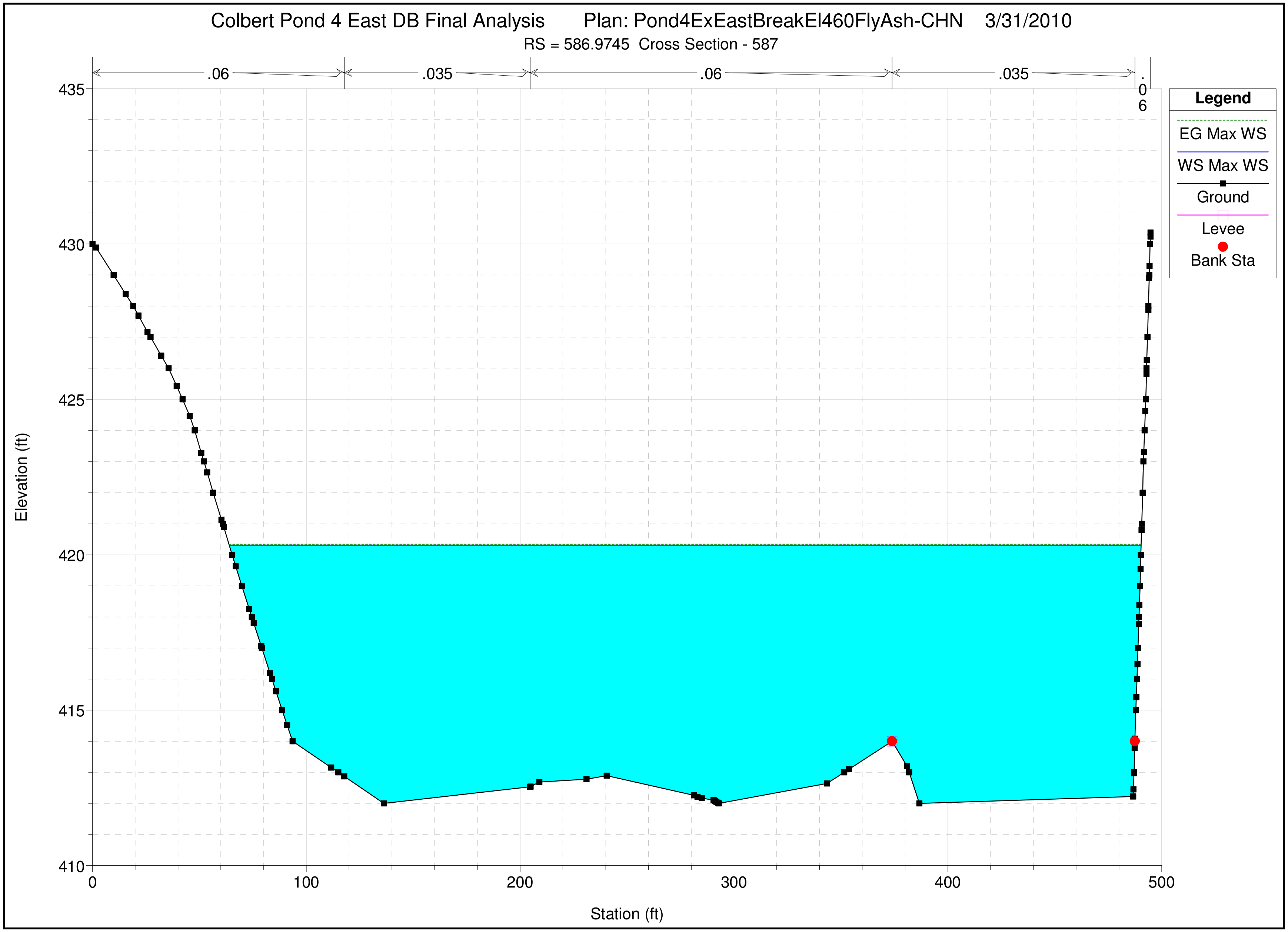
Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 2094.501 Cross Section - 2094
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
432
430
428
426
424
422
420
418
416
414
0
50
100
150
200
250
300
350
Station (ft)

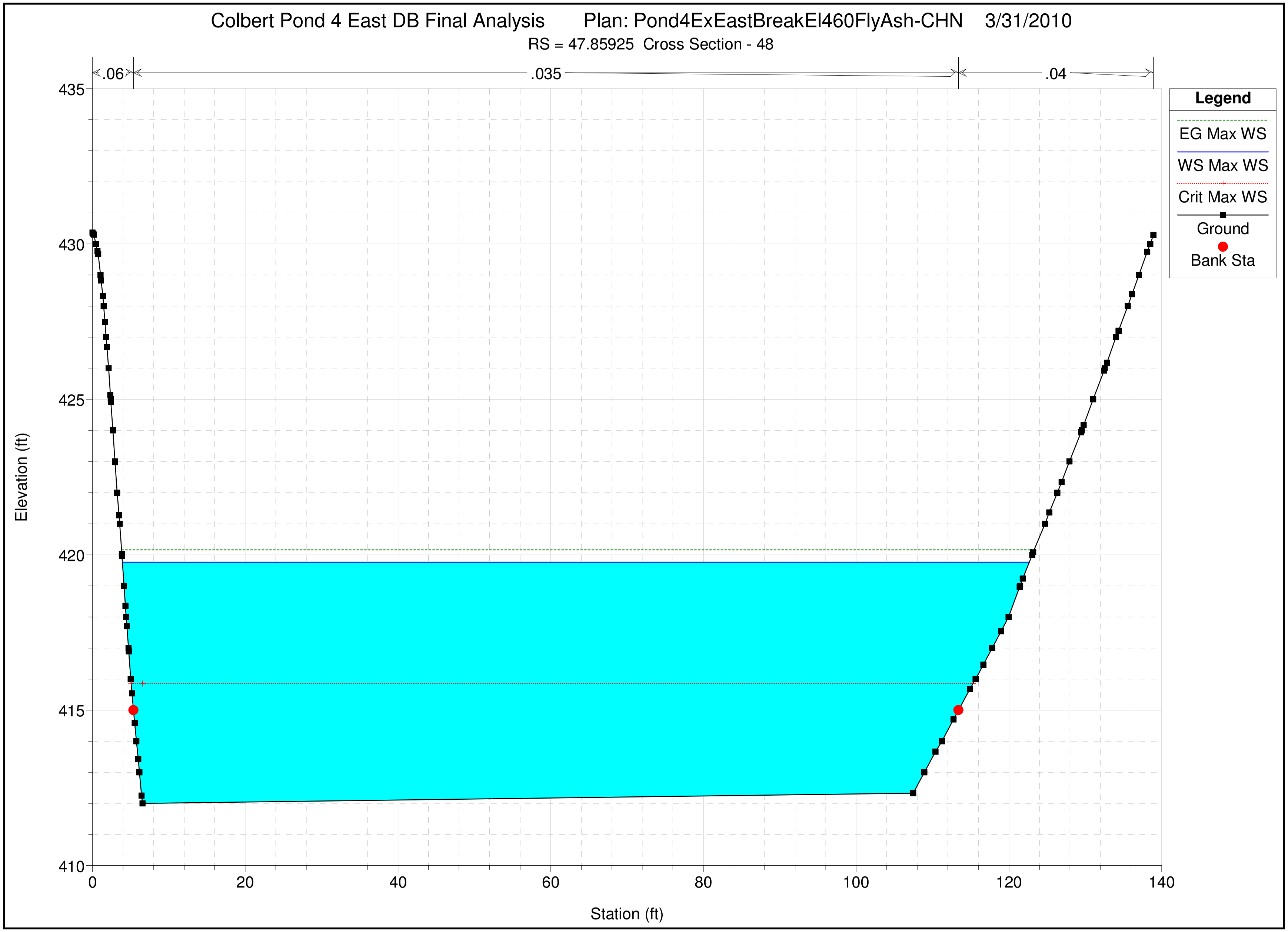


Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 1913.627 Cross Section - 1914
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
432
430
428
426
424
422
420
418
416
414
0
50
100
150
200
250
Station (ft)



Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 1375.713 Cross Section - 1376
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
432
430
428
426
424
422
420
418
416
414
412
0
100
200
300
400
500
600
Station (ft)


Colbert Pond 4 East DB Final Analysis
Plan: Pond4ExEastBreakEl460FlyAsh-CHN
3/31/2010
RS = 586.9745 Cross Section - 587
.06
.035
.06
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
435
430
425
420
415
410
0
100
200
300
400
500



Colbert Pond 4 East DB Final Analysis Plan: Pond4ExEastBreakEl460FlyAsh-CHN 3/31/2010
RS = 47.85925 Cross Section - 48
.06
.035
.04
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
435
430
425
420
415
410
0
20
40
60
80
100
120
140

HEC-RAS Plan: EB460UnFACHN River: CaneCreek Reach: CaneCreek Profile: Max WS

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft)	
CaneCreek	8615.571	Max WS	5.00	414.00	423.09		423.09	0.000000	0.00	1375.05	0.00
CaneCreek	8423.791	Max WS	-1.41	414.00	423.09		423.09	0.000000	0.00	175.45	0.00
CaneCreek	8230.5	Max WS	-2.52	414.00	423.07		423.07	0.000000	0.00	129.40	0.00
CaneCreek	7798.150	Max WS	-5.52	414.00	423.02		423.02	0.000000	-0.01	196.49	0.00
CaneCreek	7241.639	Max WS	38.49	414.00	422.94		422.94	0.000000	0.04	189.96	0.00
CaneCreek	6432.622	Max WS	561.43	414.00	422.81		422.82	0.000010	0.54	175.97	0.03
CaneCreek	5956.913	Max WS	672.05	412.00	422.80		422.80	0.000002	0.27	464.43	0.02
CaneCreek	5653.209	Max WS	701.69	412.00	422.79		422.79	0.000002	0.28	485.30	0.02
CaneCreek	5137.833	Max WS	6358.45	412.00	422.66		422.72	0.000135	2.23	514.51	0.13
CaneCreek	4331.753	Max WS	6162.15	412.00	422.21		422.48	0.000753	5.09	611.93	0.30
CaneCreek	3956.640	Max WS	6093.36	412.00	421.83		422.19	0.000721	4.86	173.06	0.29
CaneCreek	3747.113	Max WS	5974.52	412.00	421.52		422.01	0.000994	5.67	152.73	0.34
CaneCreek	3667.113	Max WS	5995.78	412.00	421.58	416.60	421.95	0.000726	5.04	186.01	0.29
CaneCreek	3666.613		Bridge								
CaneCreek	3633.613	Max WS	5995.78	412.00	421.59		421.92	0.000671	4.86	203.23	0.28
CaneCreek	3431.304	Max WS	5361.26	412.00	421.19		421.68	0.000992	5.69	164.40	0.34
CaneCreek	3338.723	Max WS	4392.12	413.07	421.02		421.43	0.001086	5.36	206.01	0.34
CaneCreek	3175.041	Max WS	5220.65	414.00	421.21		421.28	0.000221	2.14	461.29	0.15
CaneCreek	2866.854	Max WS	5064.77	414.00	421.16		421.22	0.000190	2.09	433.14	0.14
CaneCreek	2660.956	Max WS	4805.74	414.00	421.09		421.18	0.000243	2.32	374.56	0.16
CaneCreek	2394.959	Max WS	4453.41	414.00	420.97		421.09	0.000372	2.82	308.16	0.20
CaneCreek	2094.501	Max WS	4311.89	414.00	420.79		420.96	0.000544	3.35	222.32	0.24
CaneCreek	1913.627	Max WS	4208.15	414.00	420.53		420.83	0.000925	4.39	175.03	0.31
CaneCreek	1375.713	Max WS	4167.93	413.60	420.40		420.48	0.000268	2.43	426.59	0.17
CaneCreek	586.9745	Max WS	4159.52	412.00	420.31		420.34	0.000099	1.69	426.45	0.10
CaneCreek	47.85925	Max WS	4158.27	412.00	419.76	415.85	420.16	0.001002	5.07	118.76	0.33

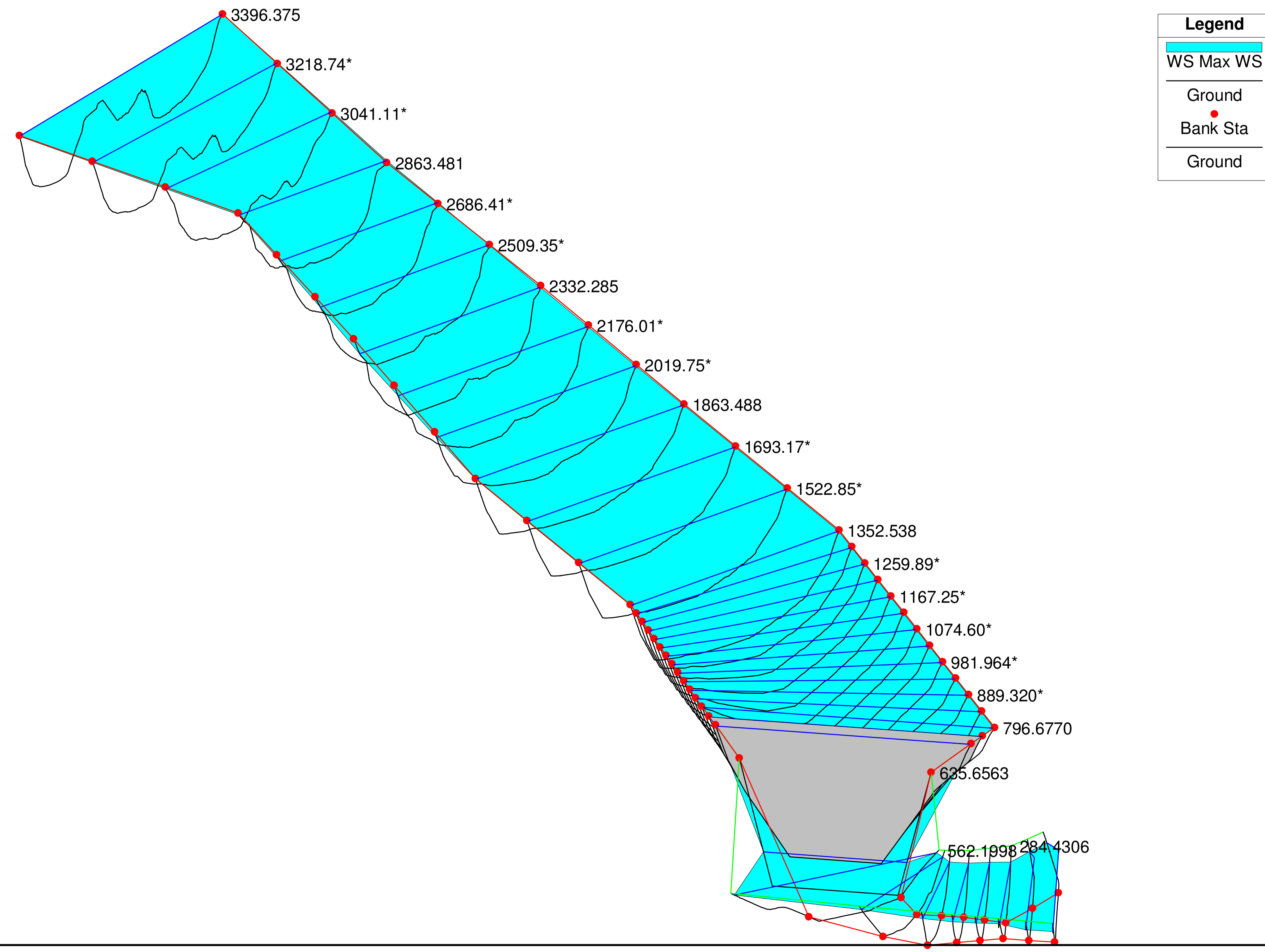
Appendix B

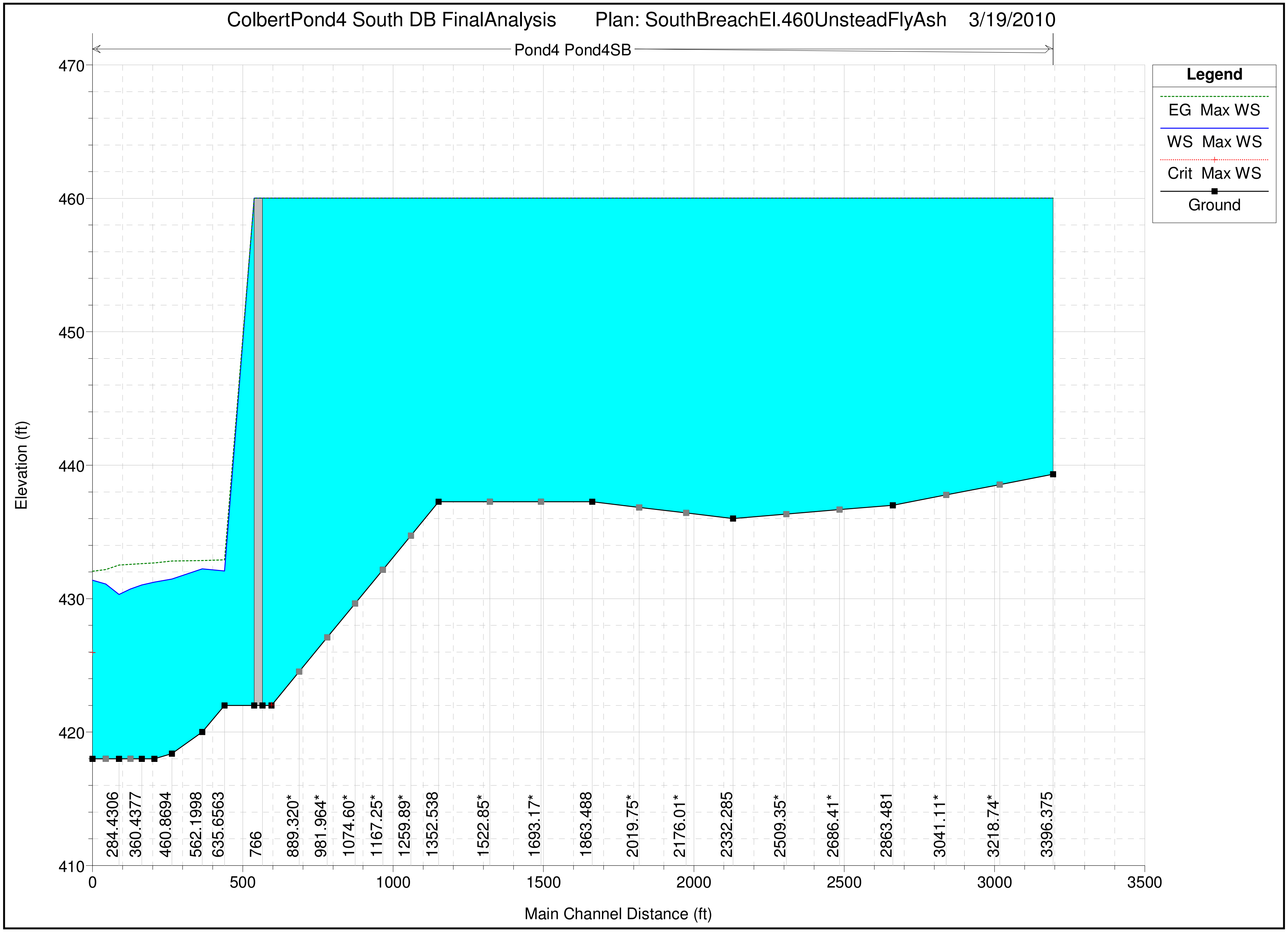
COF Pond 4 Existing Conditions
South Dam Break Analysis
Dike Elevation 460.0

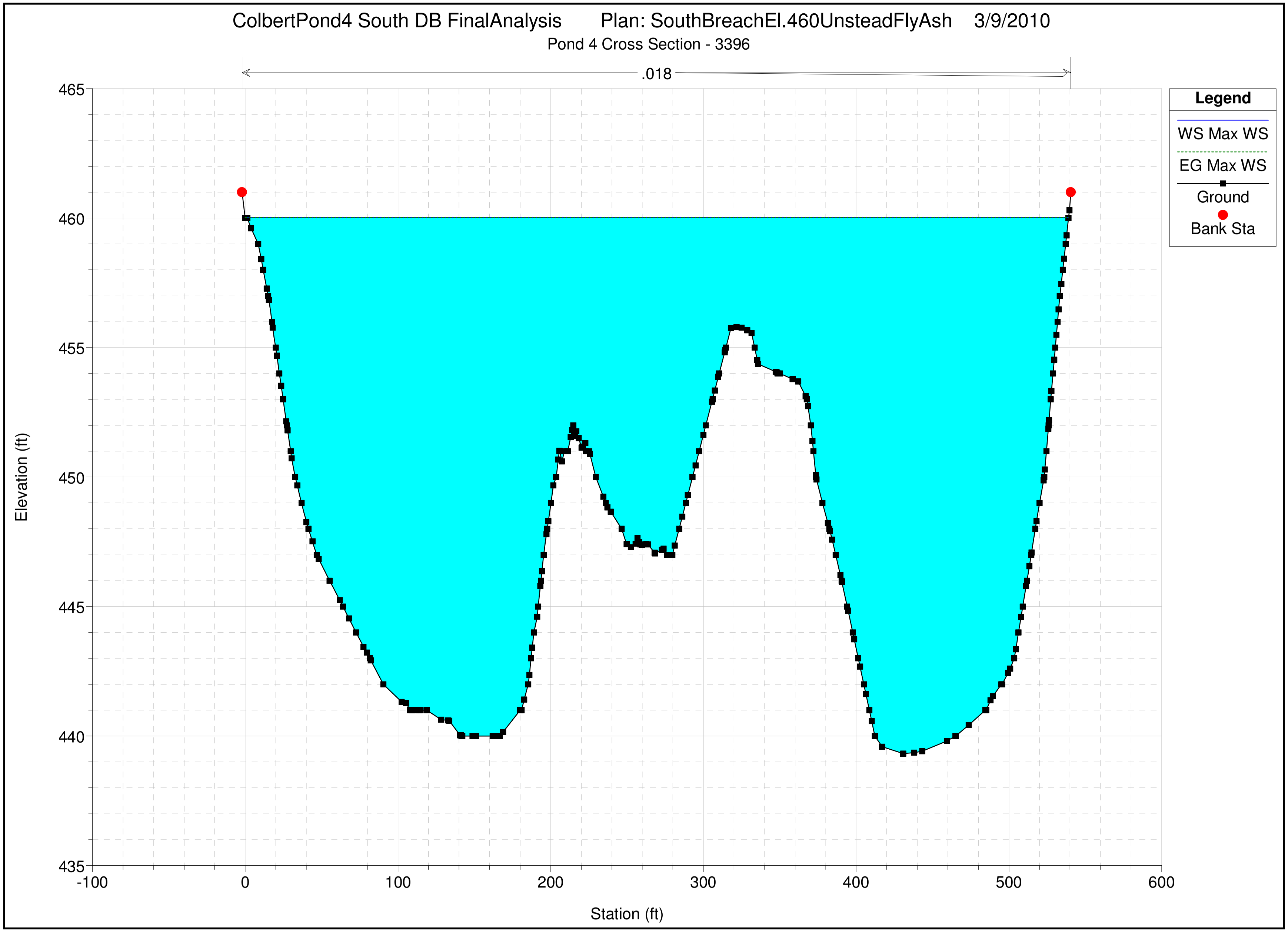
Pond 4 South Dam Break HEC-RAS Model
Dike Elevation 460.0


3396.375
3218.74*
3041.11*
2863.481
2686.41*
2509.35*
Pond4SB
Pond4
2332.285
2176.01*
2019.75*
1863.488
1693.17*
1522.85*
1352.538
1259.89*
1167.25*
1074.60*
981.964*
889.320*
796.6770
635.6563

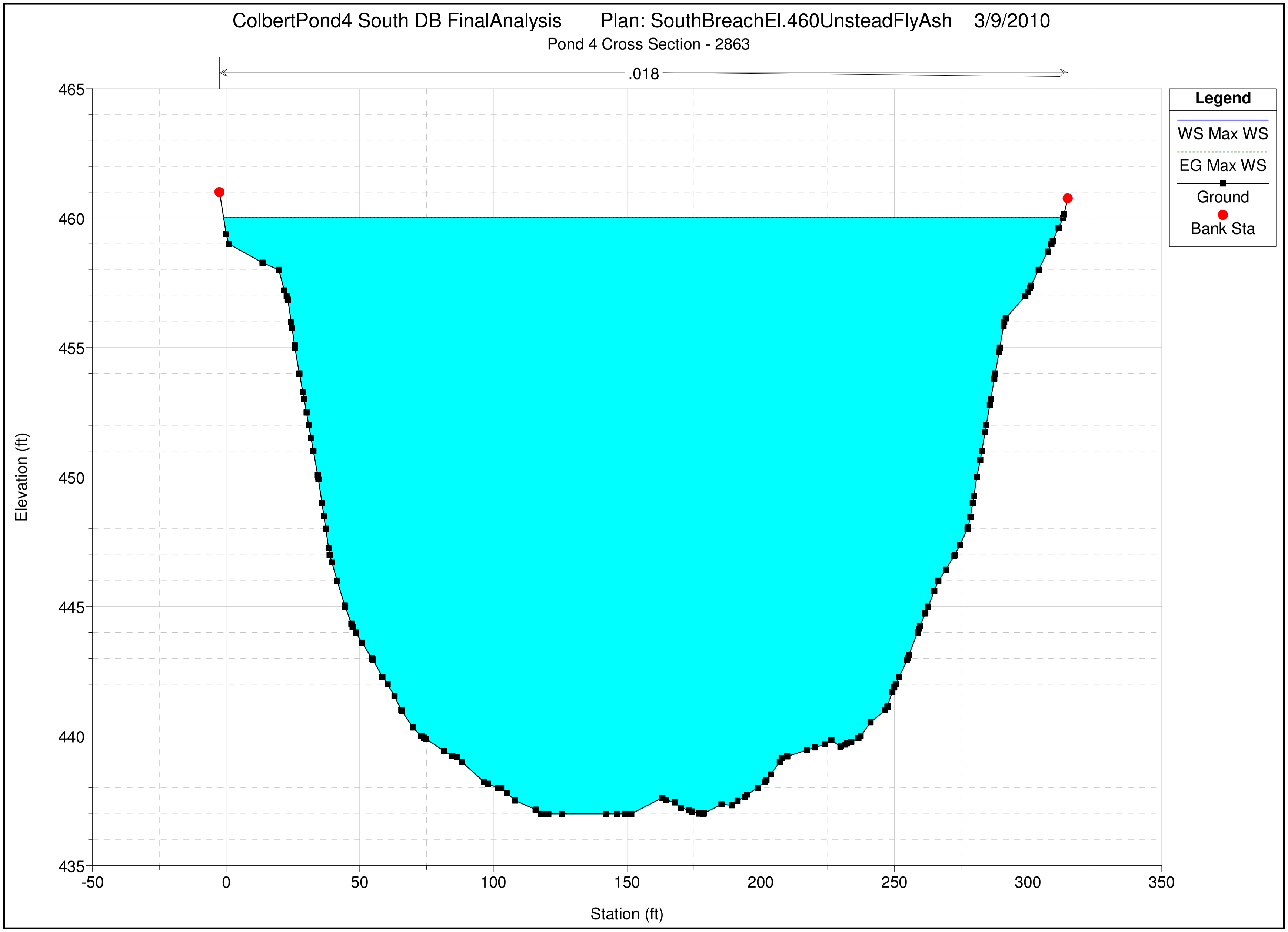
ColbertPond4 South DB FinalAnalysis   Plan: SouthBreachEl.460UnsteadFlyAsh   3/9/2010



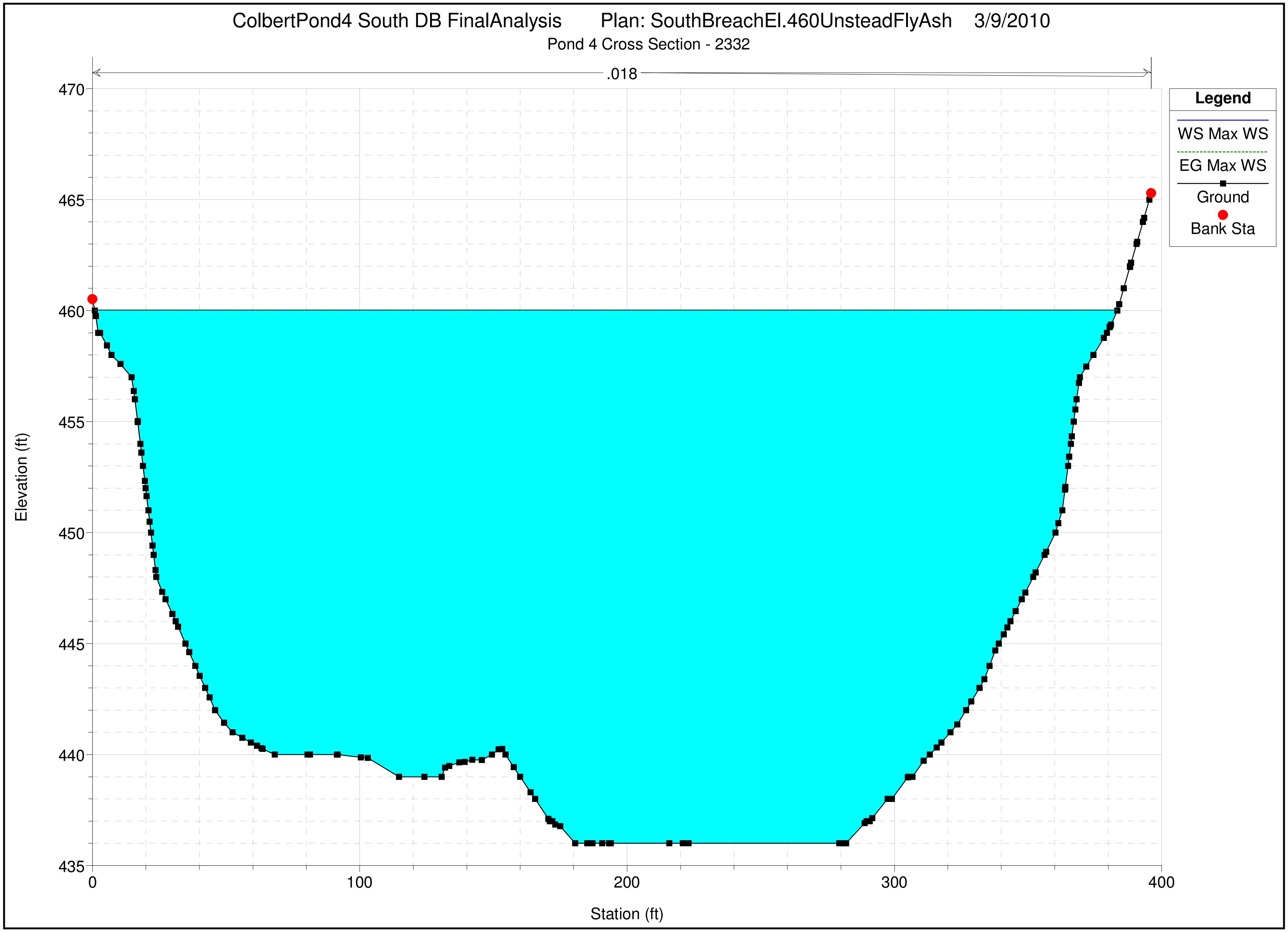

ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.460UnsteadFlyAsh 3/19/2010
Pond4 Pond4SB
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Elevation (ft)
470
460
450
440
430
420
410
284.4306
360.4377
460.8694
562.1998
635.6563
766
889.320*
981.964*
1074.60*
1167.25*
1259.89*
1352.538
1522.85*
1693.17*
1863.488
2019.75*
2176.01*
2332.285
2509.35*
2686.41*
2863.481
3041.11*
3218.74*
3396.375
0
500
1000
1500
2000
2500
3000
3500
Main Channel Distance (ft)



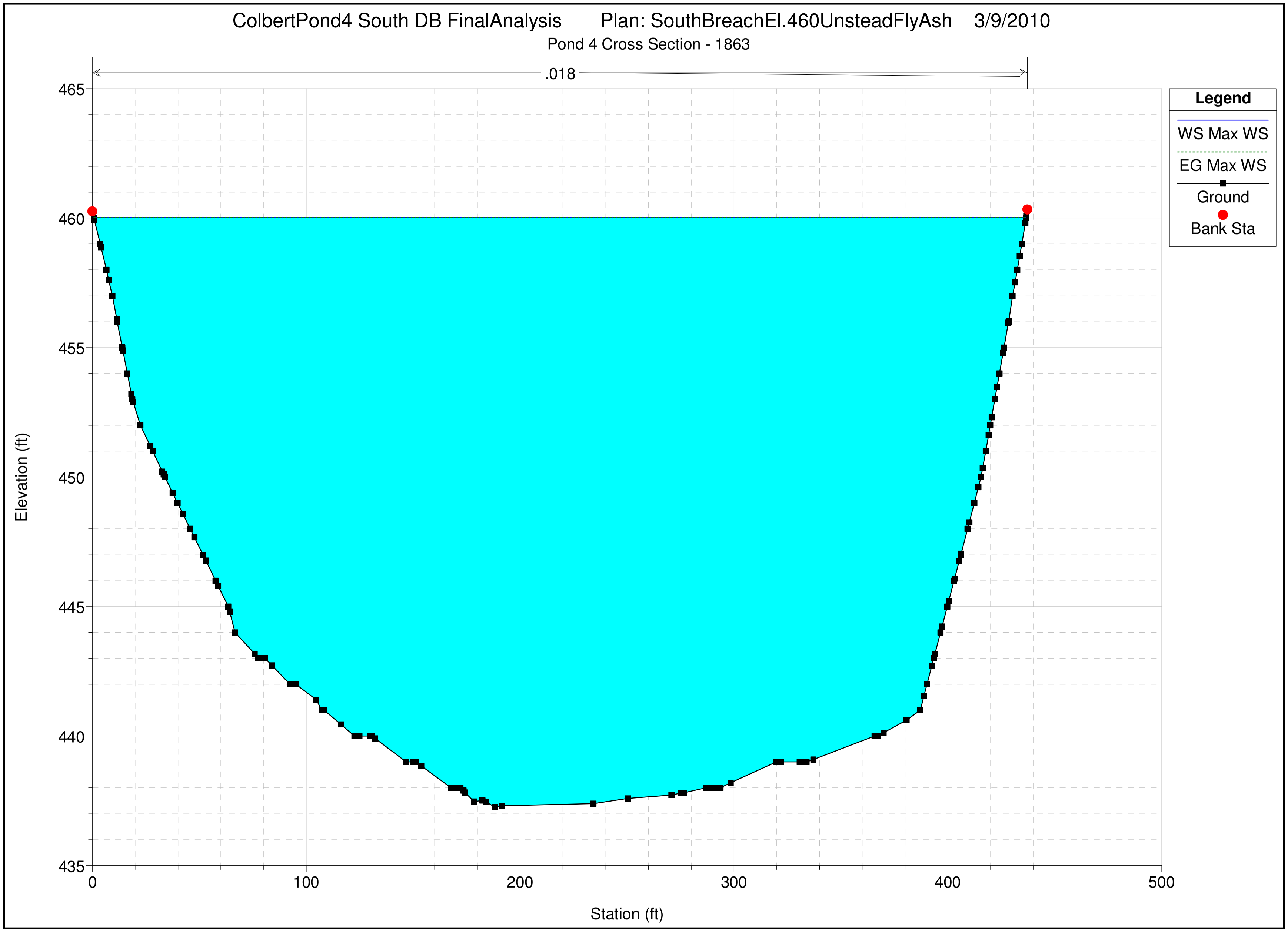
ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.460UnsteadFlyAsh 3/9/2010
Pond 4 Cross Section - 3396
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
465
460
455
450
445
440
435
-100
0
100
200
300
400
500
600
Station (ft)

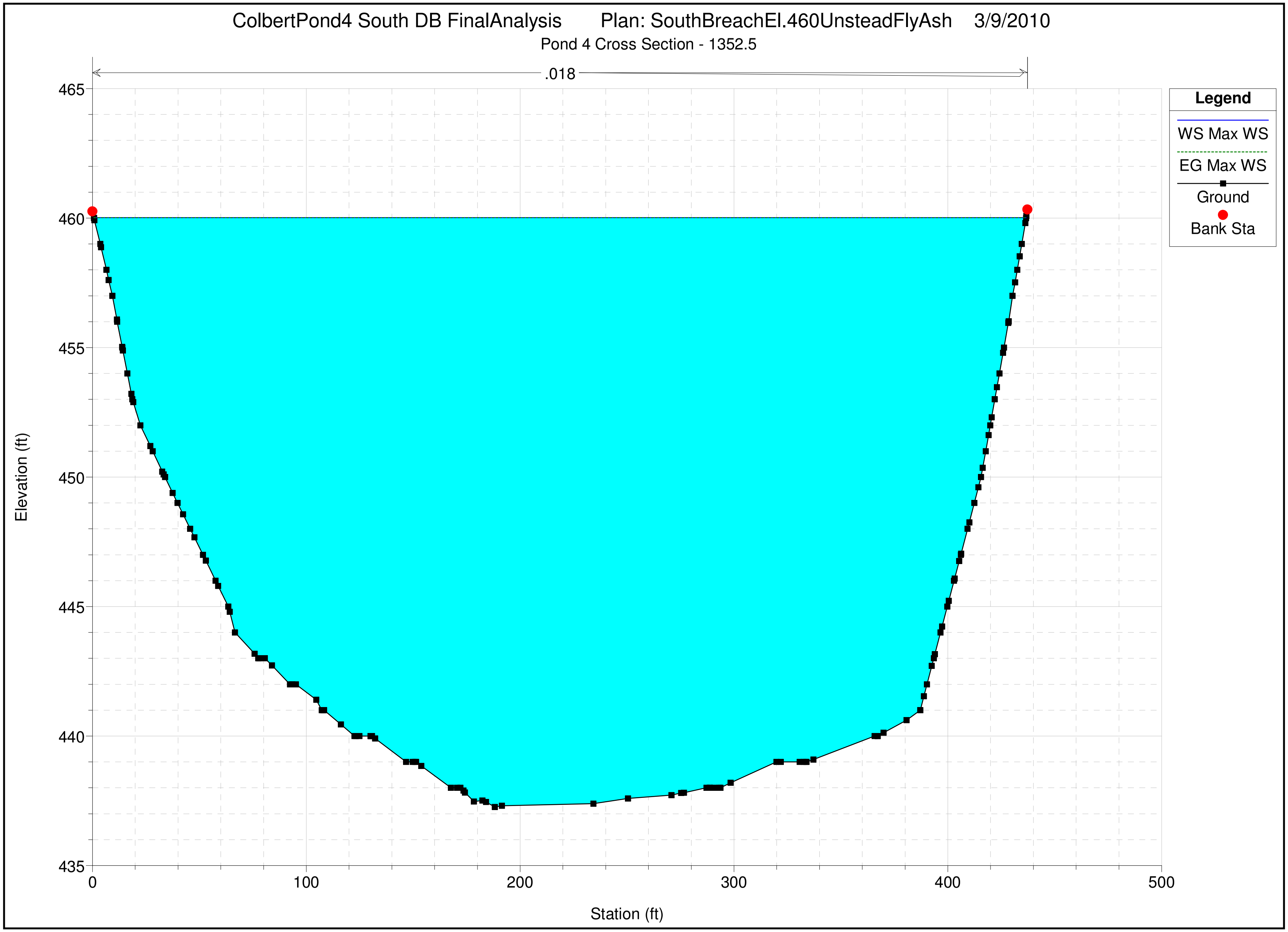


ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.460UnsteadFlyAsh 3/9/2010
Pond 4 Cross Section - 2863
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
465
460
455
450
445
440
435
-50
0
50
100
150
200
250
300
350

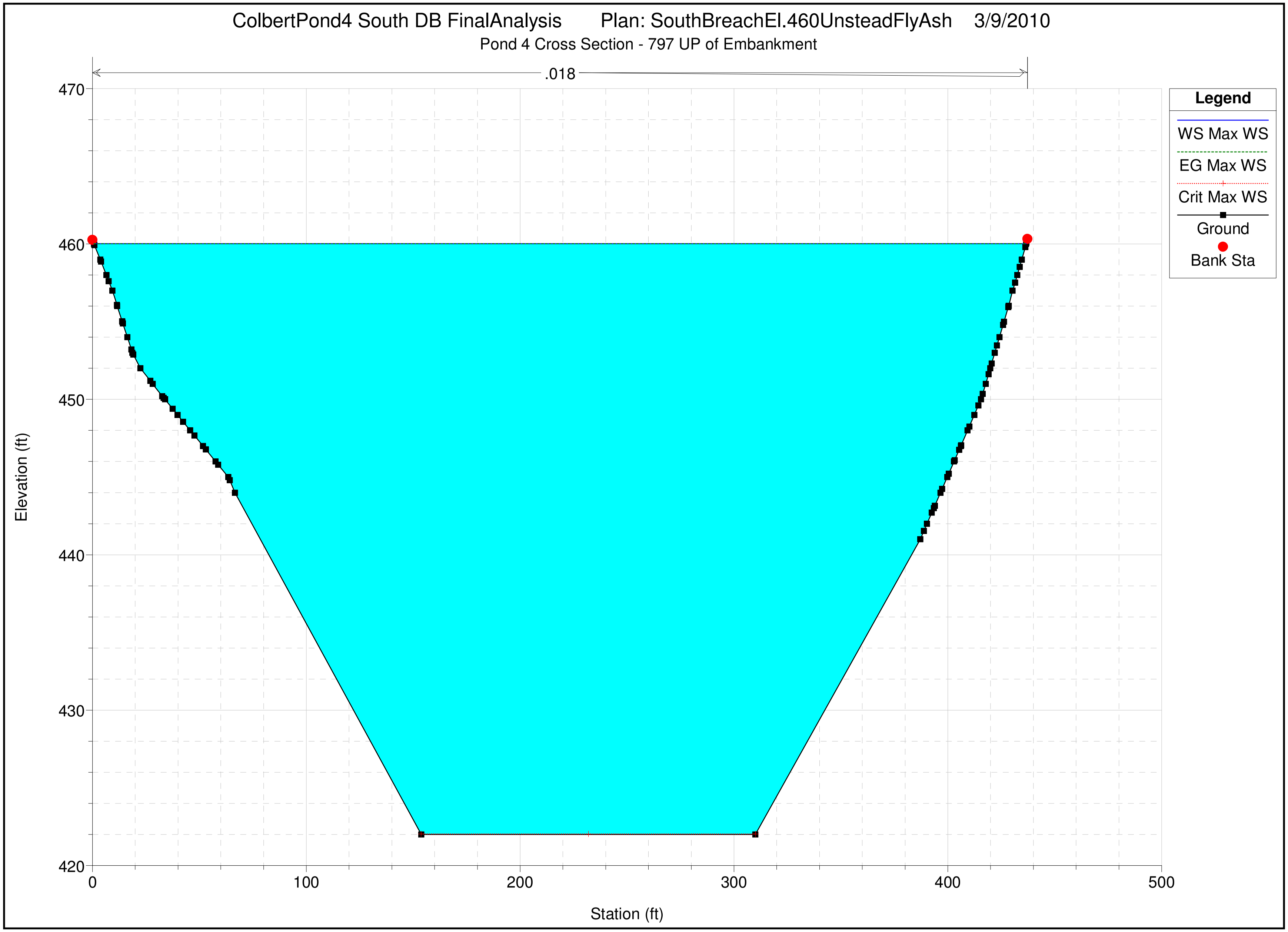


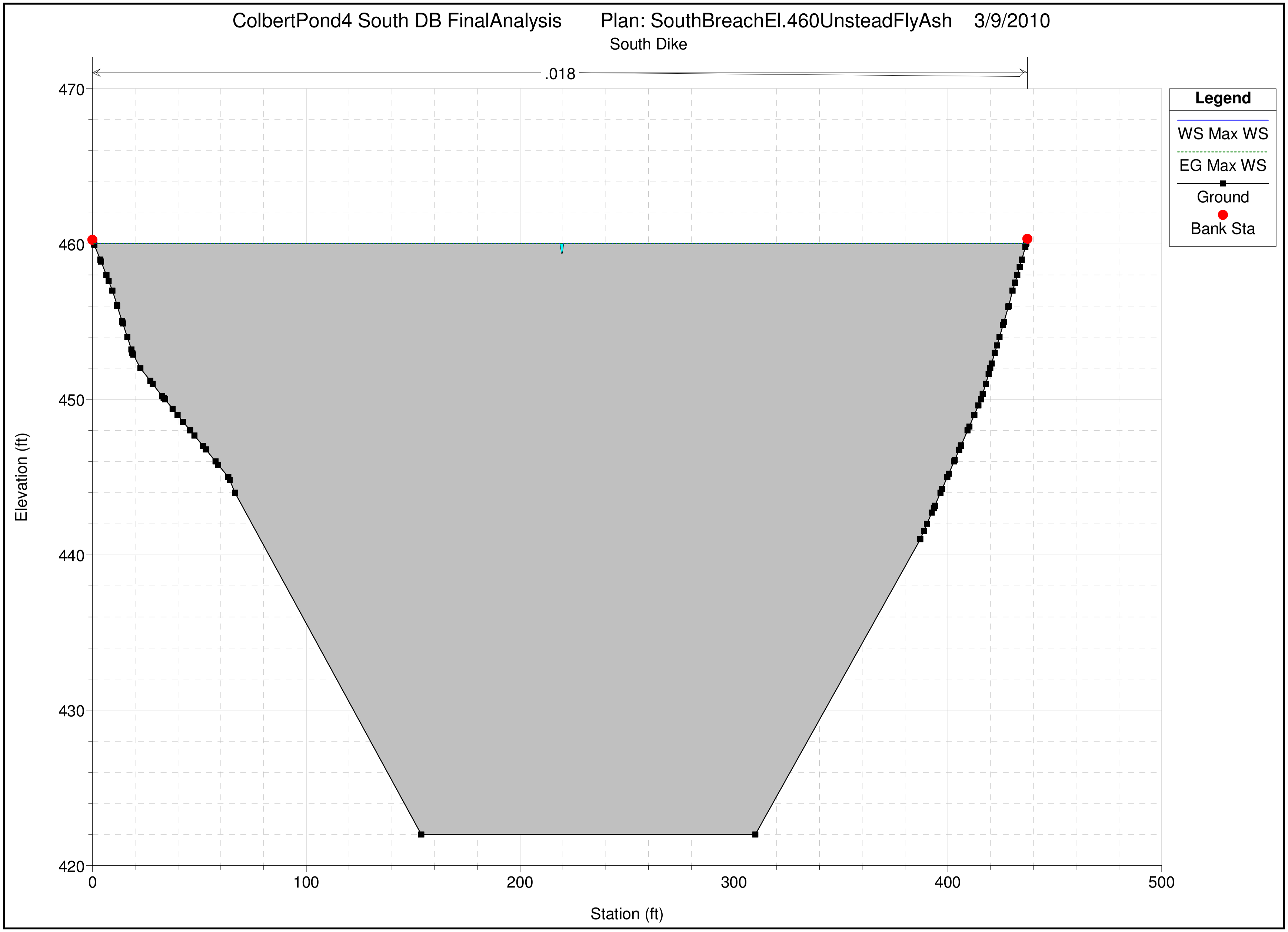
ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.460UnsteadFlyAsh 3/9/2010
Pond 4 Cross Section - 2332
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
470
465
460
455
450
445
440
435
0
100
200
300
400
Station (ft)


ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.460UnsteadFlyAsh 3/9/2010
Pond 4 Cross Section - 1863
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
465
460
455
450
445
440
435
Station (ft)
0
100
200
300
400
500



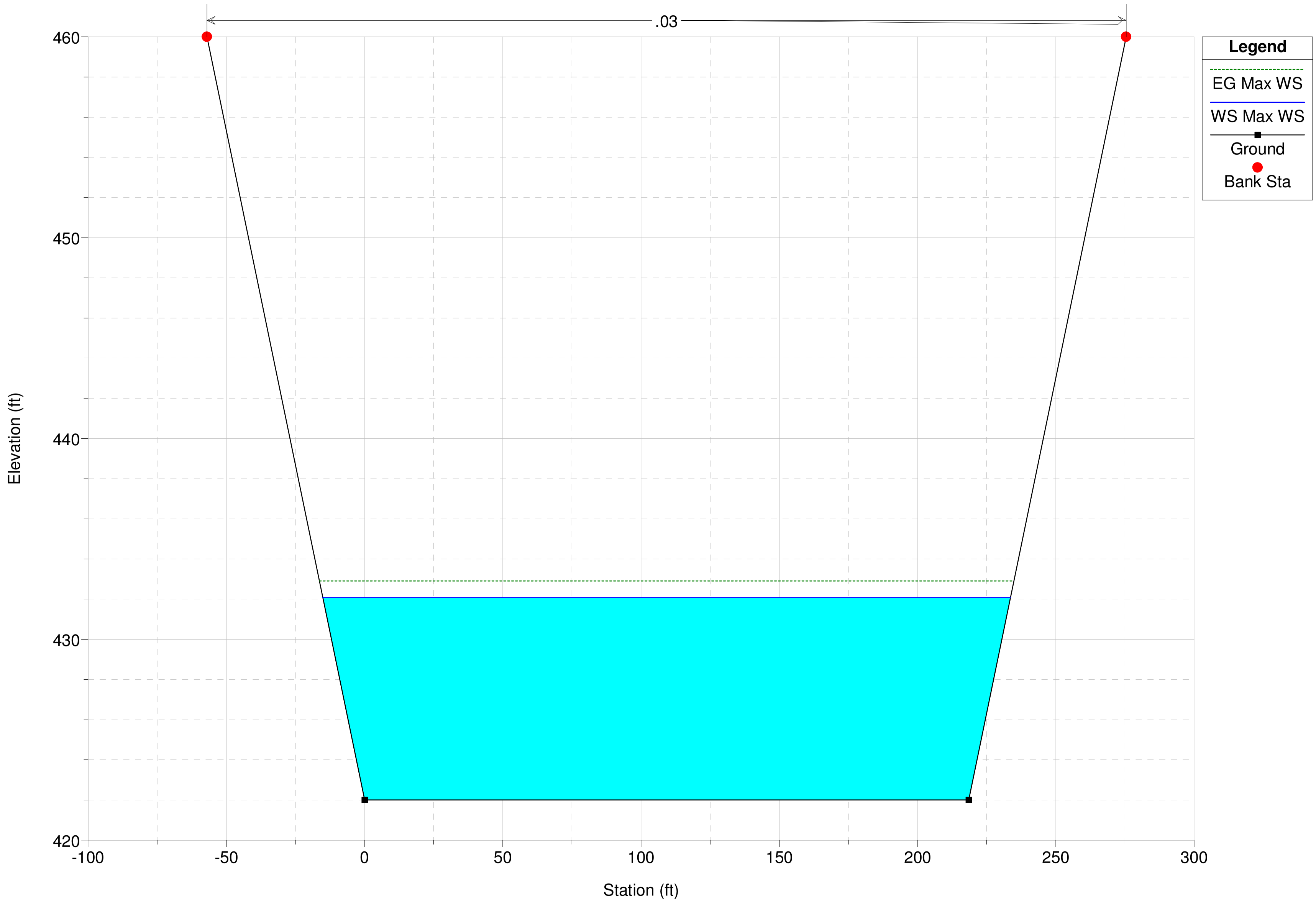
ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.460UnsteadFlyAsh 3/9/2010
Pond 4 Cross Section - 1352.5
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
465
460
455
450
445
440
435
Station (ft)
0
100
200
300
400
500

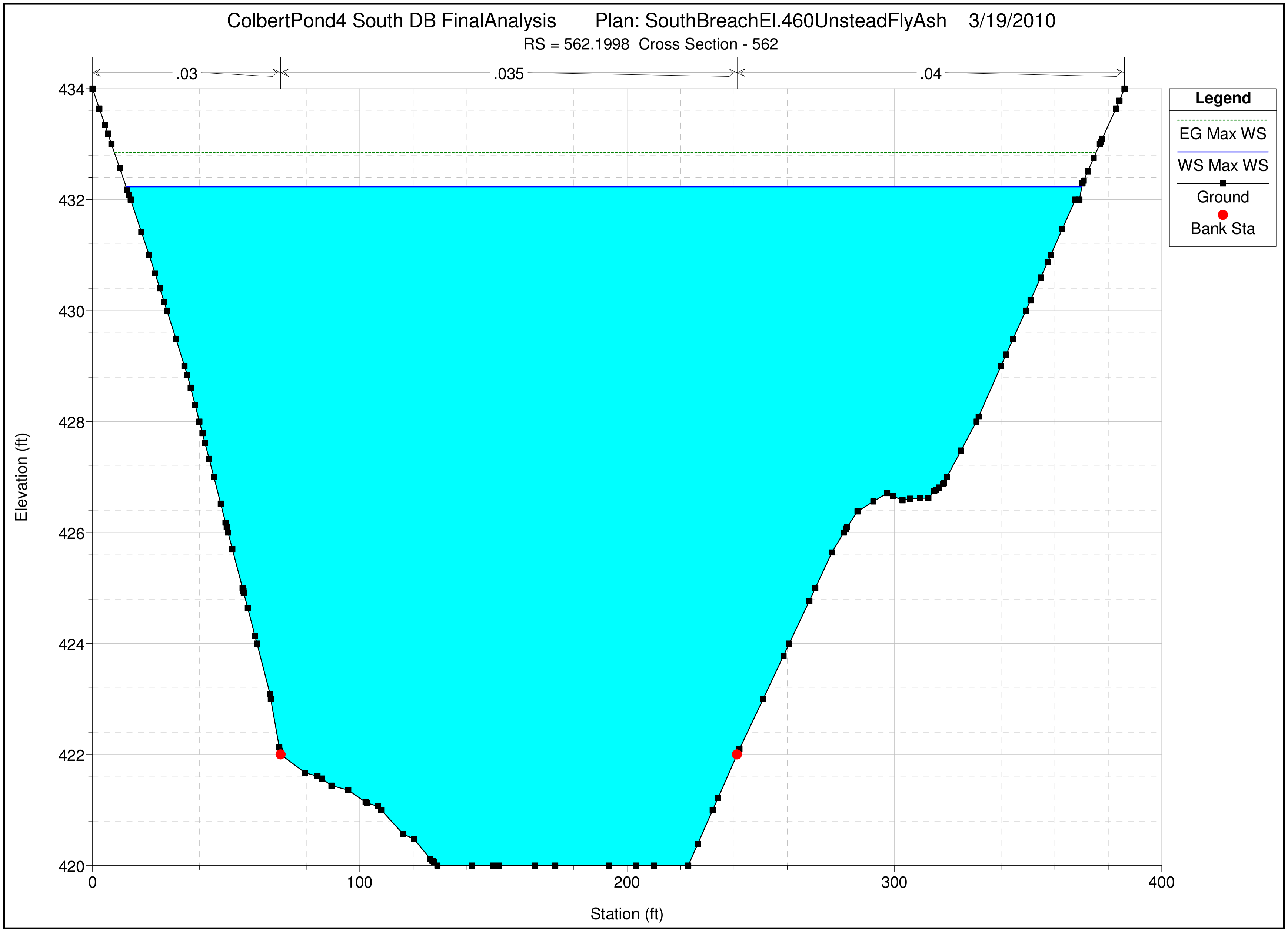

ColbertPond4 South DB FinalAnalysis
Plan: SouthBreachEl.460UnsteadFlyAsh
3/9/2010
Pond 4 Cross Section - 797 UP of Embankment
.018
Elevation (ft)
Station (ft)
470
460
450
440
430
420
0
100
200
300
400
500
Legend
WS Max WS
EG Max WS
Crit Max WS
Ground
Bank Sta


ColbertPond4 South DB FinalAnalysis
Plan: SouthBreachEl.460UnsteadFlyAsh 3/9/2010
South Dike
.018
Elevation (ft)
470
460
450
440
430
420
Station (ft)
0
100
200
300
400
500
Legend
WS Max WS
EG Max WS
Ground
Bank Sta

ColbertPond4 South DB FinalAnalysis   Plan: SouthBreachEl.460UnsteadFlyAsh   3/19/2010

RS = 635.6563 Cross Section - 635 1st XS Downstream of Dam



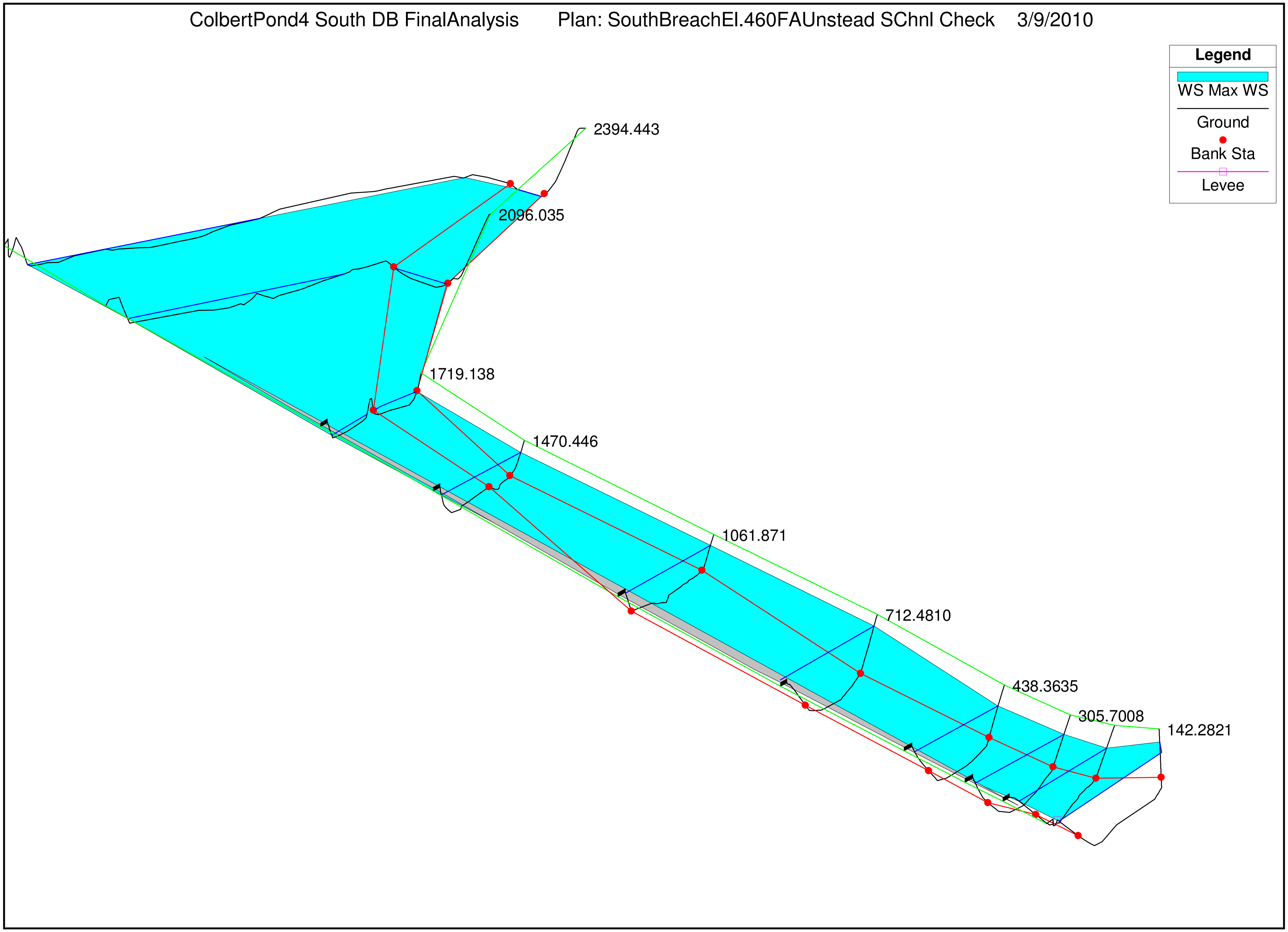

ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.460UnsteadFlyAsh 3/19/2010
RS = 562.1998 Cross Section - 562
.03
.035
.04
434
432
430
428
426
424
422
420
Elevation (ft)
0
100
200
300
400
Station (ft)
Legend
EG Max WS
WS Max WS
Ground
Bank Sta

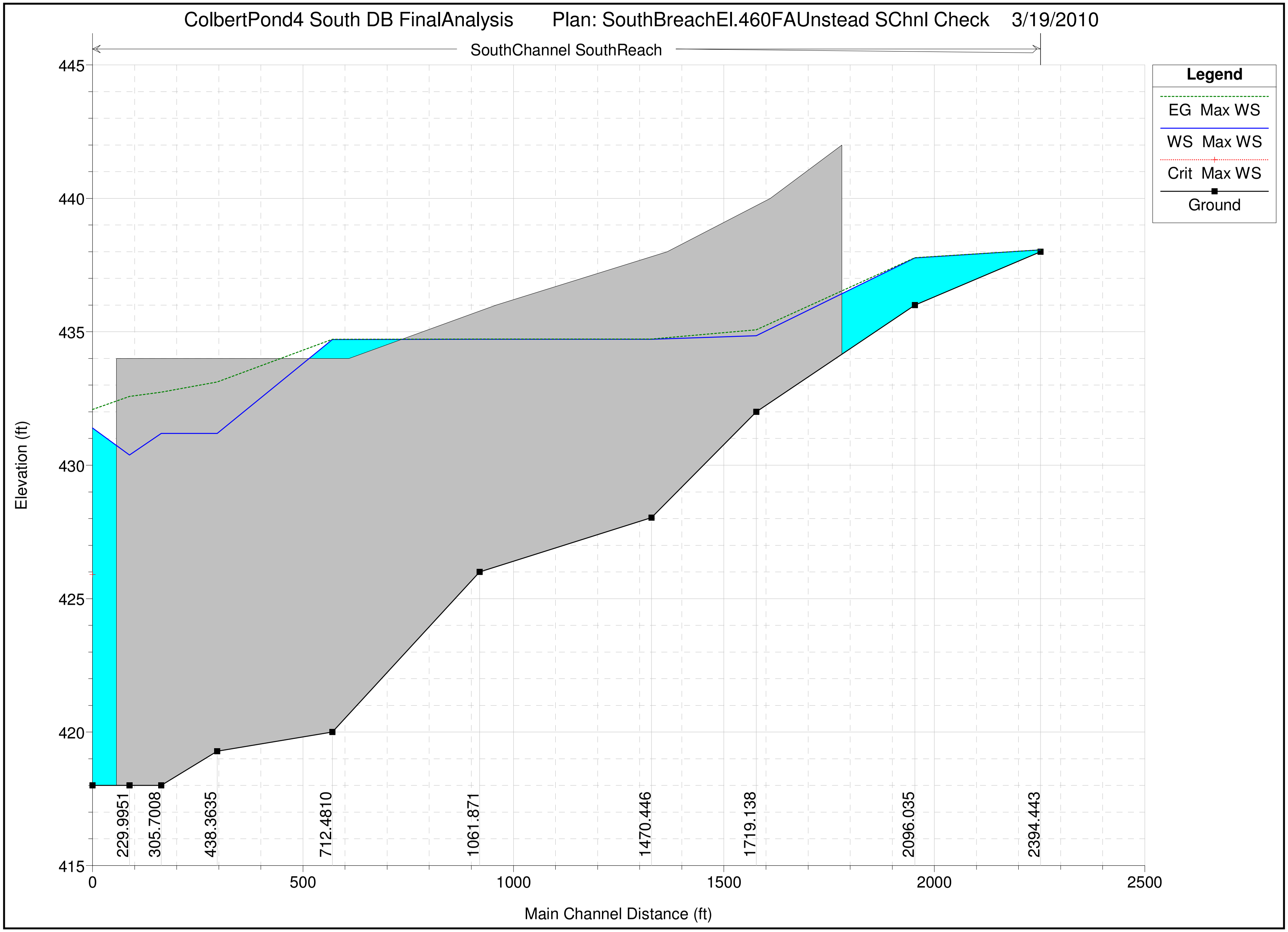
HEC-RAS Plan: SB460UnFA River: Pond4 Reach: Pond4SB Profile: Max WS

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft)	
Pond4SB	3396.375	Max WS	5.00	439.32	460.02		460.02	0.000000	0.00	539.05	0.00
Pond4SB	3218.74*	Max WS	4.85	438.55	460.02		460.02	0.000000	0.00	464.22	0.00
Pond4SB	3041.11*	Max WS	4.72	437.77	460.02		460.02	0.000000	0.00	389.24	0.00
Pond4SB	2863.481	Max WS	4.62	437.00	460.02		460.02	0.000000	0.00	314.11	0.00
Pond4SB	2686.41*	Max WS	4.55	436.67	460.02		460.02	0.000000	0.00	335.07	0.00
Pond4SB	2509.35*	Max WS	4.40	436.33	460.02		460.02	0.000000	0.00	357.90	0.00
Pond4SB	2332.285	Max WS	4.47	436.00	460.02		460.02	0.000000	0.00	382.61	0.00
Pond4SB	2176.01*	Max WS	4.17	436.42	460.02		460.02	0.000000	0.00	400.97	0.00
Pond4SB	2019.75*	Max WS	4.46	436.84	460.02		460.02	0.000000	0.00	418.70	0.00
Pond4SB	1863.488	Max WS	4.04	437.26	460.02		460.02	0.000000	0.00	435.94	0.00
Pond4SB	1693.17*	Max WS	3.94	437.26	460.02		460.02	0.000000	0.00	435.94	0.00
Pond4SB	1522.85*	Max WS	3.89	437.26	460.02		460.02	0.000000	0.00	435.94	0.00
Pond4SB	1352.538	Max WS	3.94	437.26	460.02		460.02	0.000000	0.00	435.94	0.00
Pond4SB	1259.89*	Max WS	3.63	434.72	460.02		460.02	0.000000	0.00	435.92	0.00
Pond4SB	1167.25*	Max WS	3.90	432.17	460.02		460.02	0.000000	0.00	435.93	0.00
Pond4SB	1074.60*	Max WS	3.46	429.63	460.02		460.02	0.000000	0.00	435.96	0.00
Pond4SB	981.964*	Max WS	3.37	427.09	460.02		460.02	0.000000	0.00	435.94	0.00
Pond4SB	889.320*	Max WS	3.27	424.54	460.02		460.02	0.000000	0.00	435.94	0.00
Pond4SB	796.6770	Max WS	3.18	422.00	460.02	422.03	460.02	0.000000	0.00	435.94	0.00
Pond4SB	766		Inl Struct								
Pond4SB	635.6563	Max WS	17184.91	422.00	432.08		432.91	0.001120	7.30	248.71	0.42
Pond4SB	562.1998	Max WS	17175.46	420.00	432.23		432.85	0.000966	6.81	357.50	0.35
Pond4SB	460.8694	Max WS	17162.17	418.38	431.46		432.81	0.001996	10.12	218.05	0.51
Pond4SB	402.9081	Max WS	17155.12	418.00	431.25		432.68	0.002011	10.22	195.30	0.51
Pond4SB	360.4377	Max WS	17149.97	418.00	431.02		432.62	0.002383	11.06	198.52	0.55
Pond4SB	322.434*	Max WS	17144.87	418.00	430.73		432.57	0.002965	12.13	205.37	0.62
Pond4SB	284.4306	Max WS	17138.87	418.00	430.31		432.52	0.003925	13.61	207.86	0.70
Pond4SB	240.433*	Max WS	17131.05	418.00	431.09		432.17	0.001671	9.08	257.54	0.46
Pond4SB	196.4367	Max WS	17122.65	418.00	431.38	425.96	432.06	0.001001	7.00	298.43	0.36

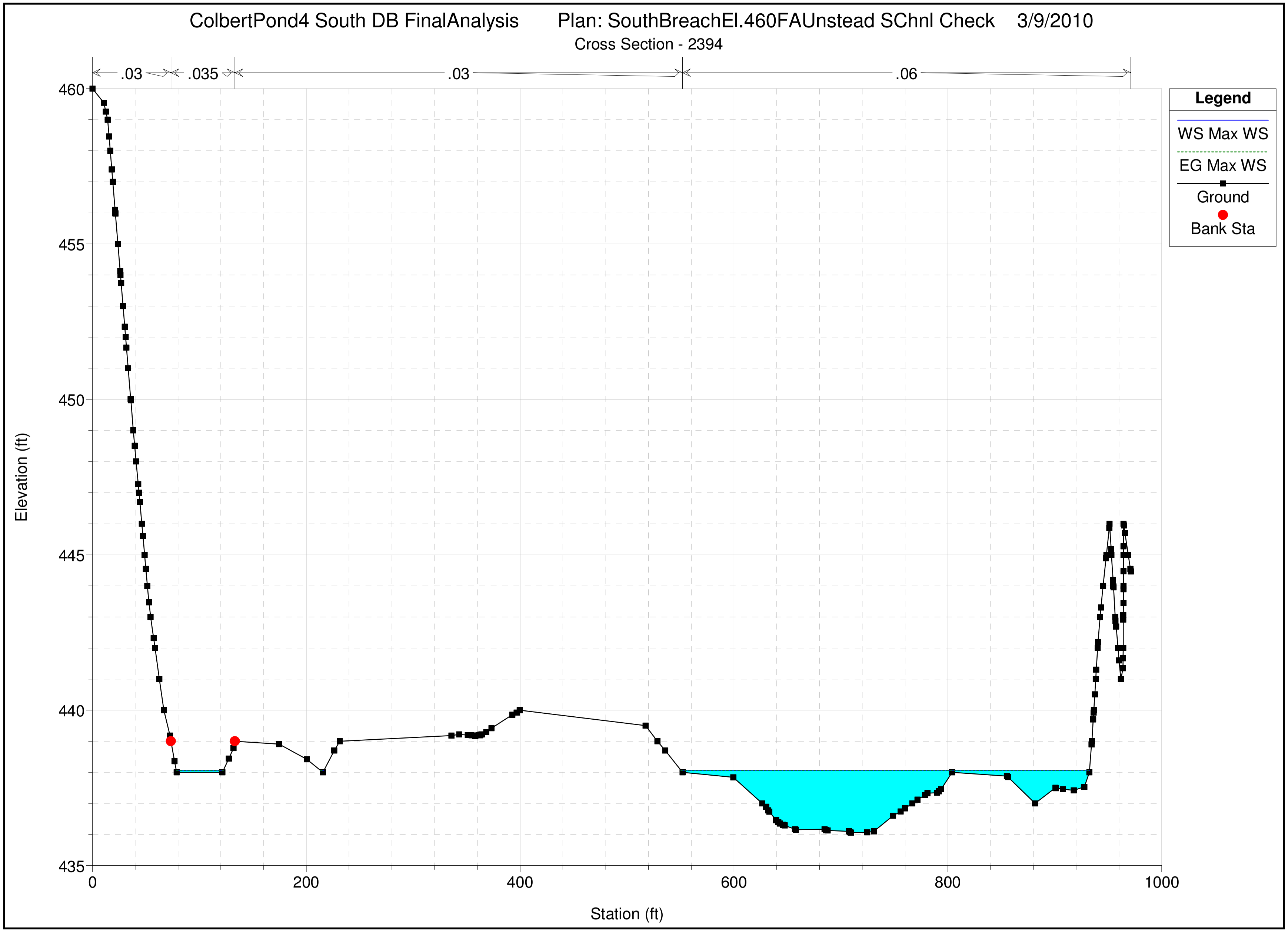
Pond 4 South Dam Break
South Channel HEC-RAS Model
Dike Elevation 460.0

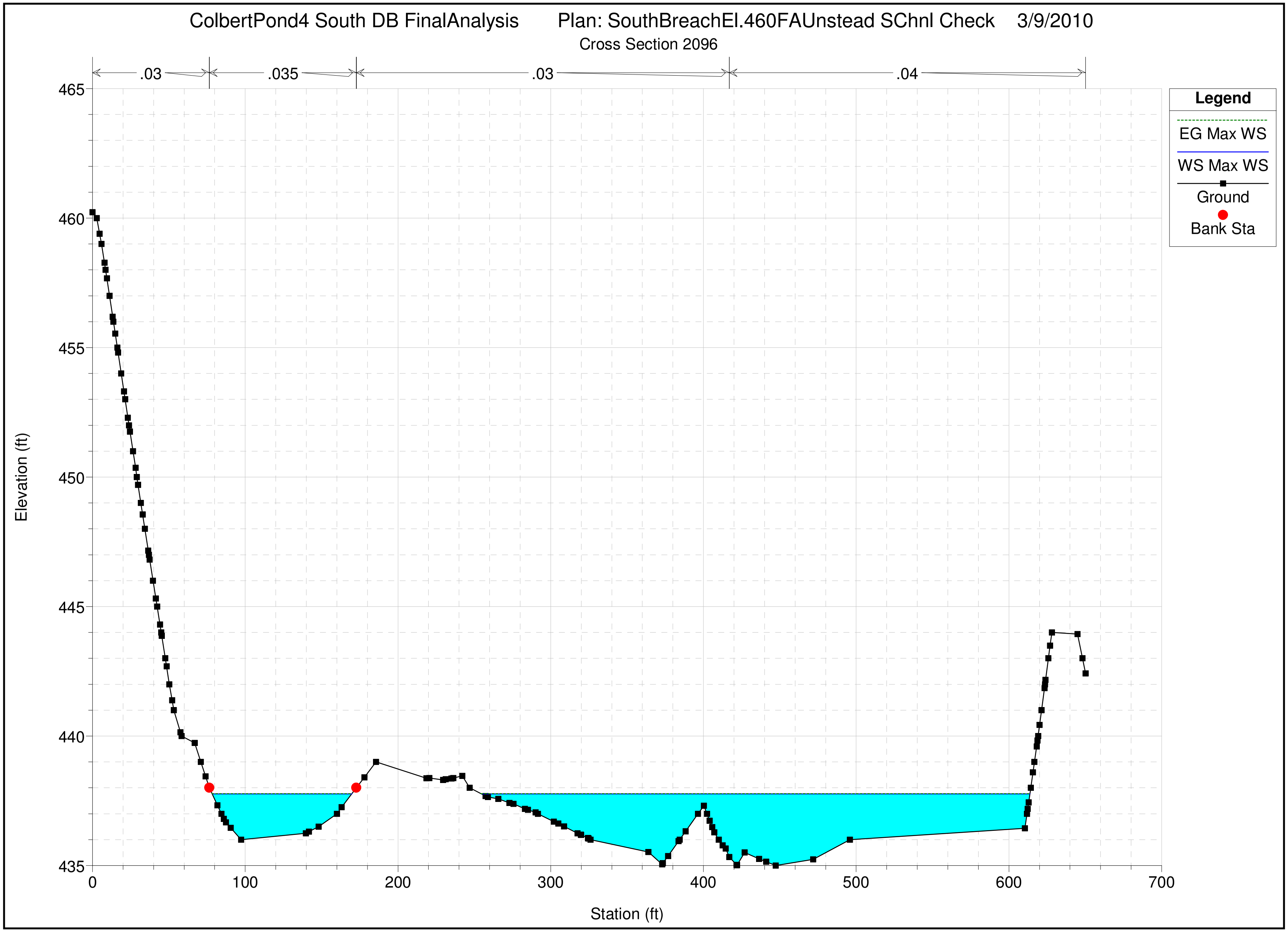
2394.443
2096.035
SouthReach
1719.138
SouthChannel
1470.446
1907.586
1061.871
712.4810
438.3635
305.7008
142.2821


ColbertPond4 South DB FinalAnalysis
Plan: SouthBreachEl.460FAUnstead SChnl Check
3/9/2010
Legend
WS Max WS
Ground
Bank Sta
Levee
2394.443
2096.035
1719.138
1470.446
1061.871
712.4810
438.3635
305.7008
142.2821

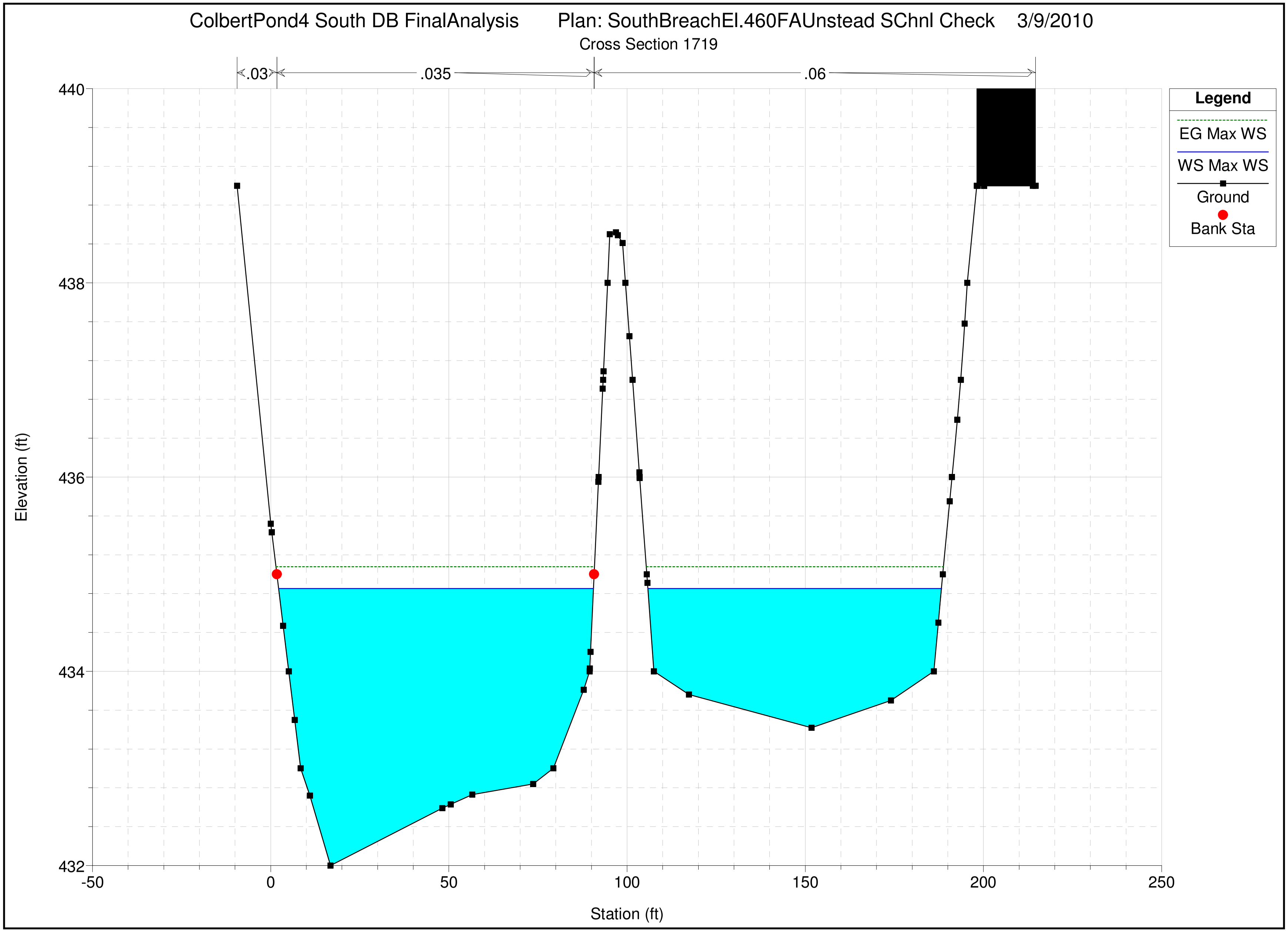


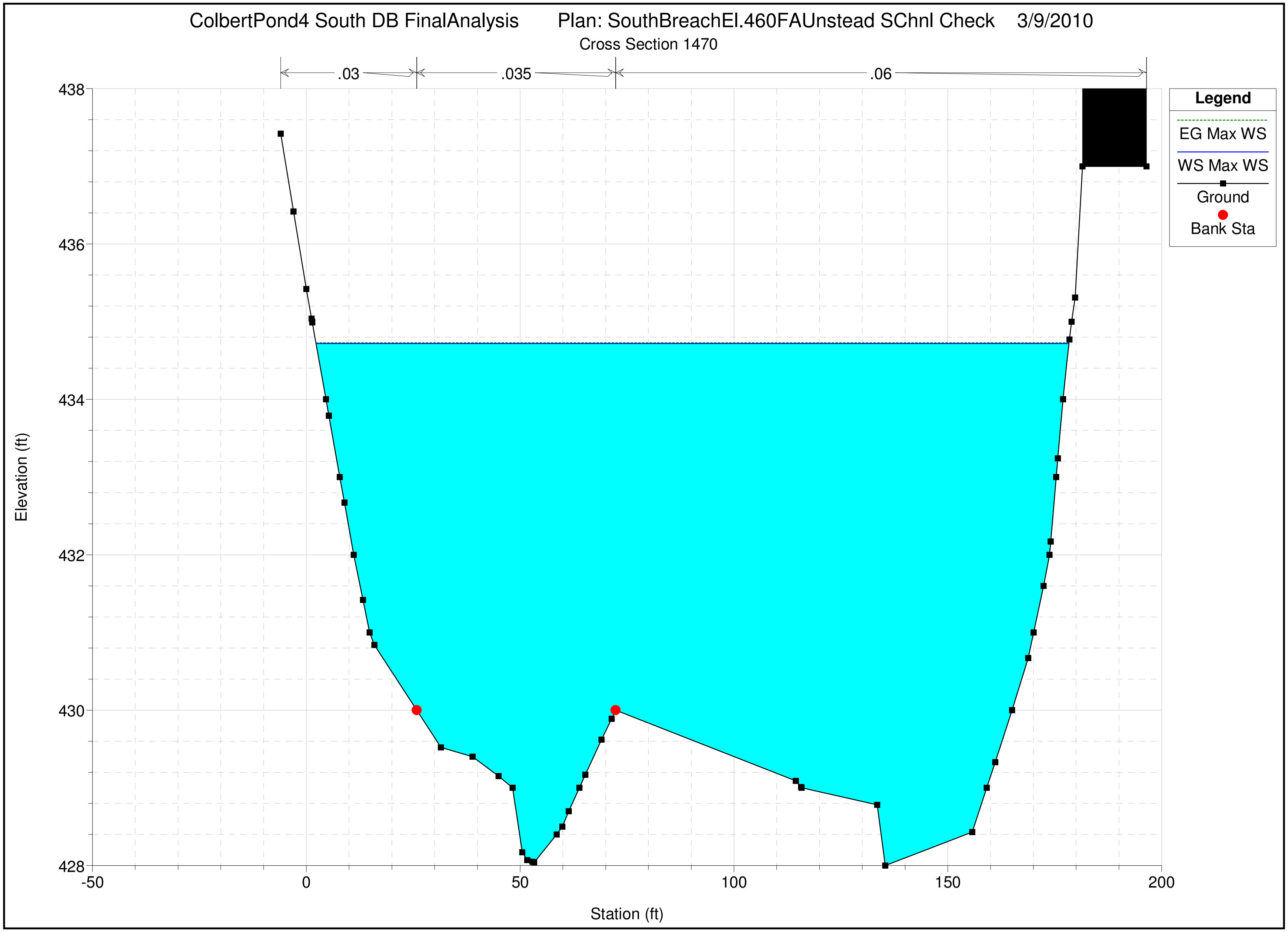
ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.460FAUnstead SChnl Check 3/19/2010
SouthChannel SouthReach
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Elevation (ft)
445
440
435
430
425
420
415
229.9951
305.7008
438.3635
712.4810
1061.871
1470.446
1719.138
2096.035
2394.443
0
500
1000
1500
2000
2500
Main Channel Distance (ft)


ColbertPond4 South DB FinalAnalysis
Plan: SouthBreachEl.460FAUnstead SChnl Check
3/9/2010
Cross Section - 2394
.03
.035
.03
.06
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
460
455
450
445
440
435
0
200
400
600
800
1000

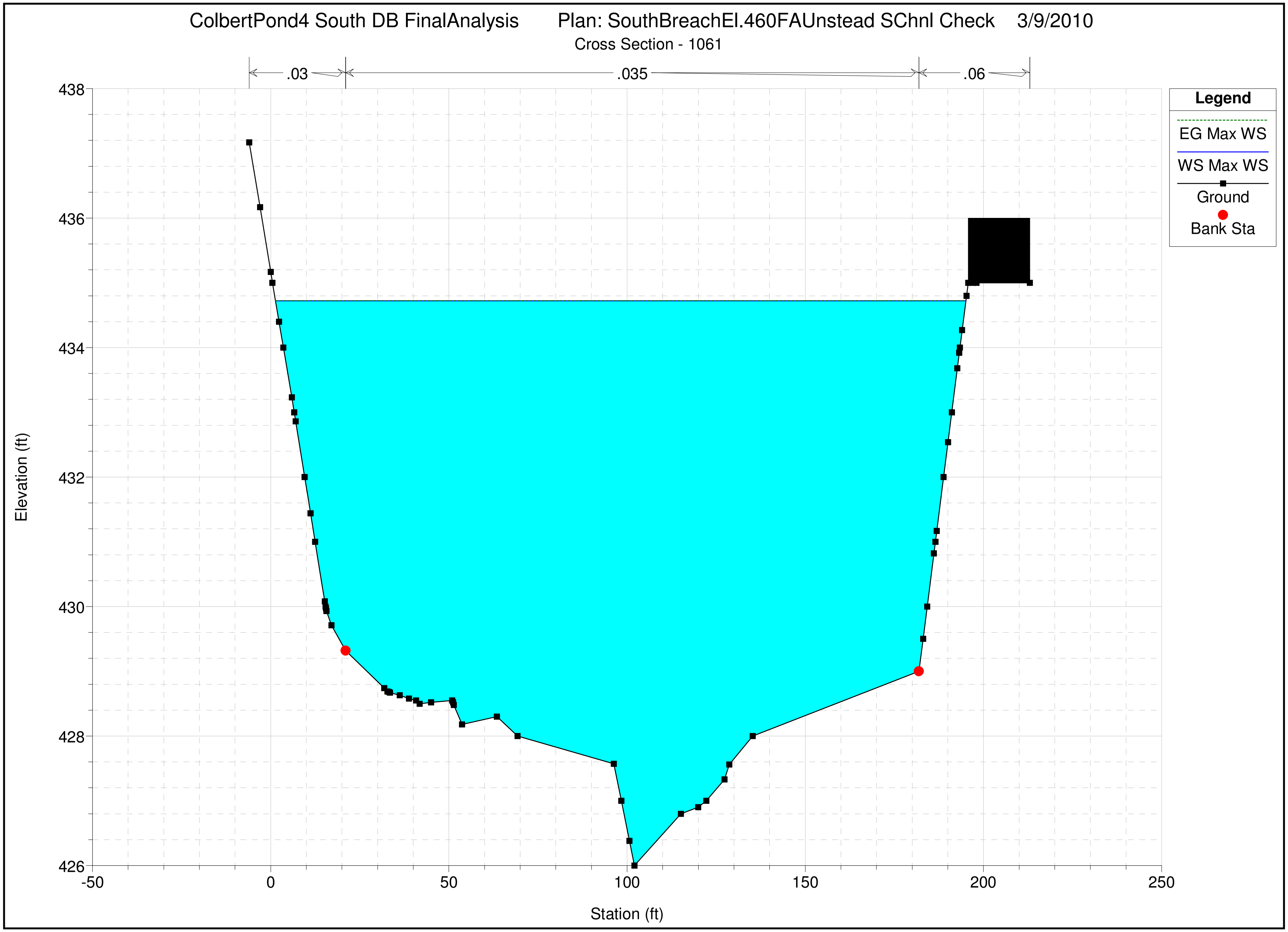


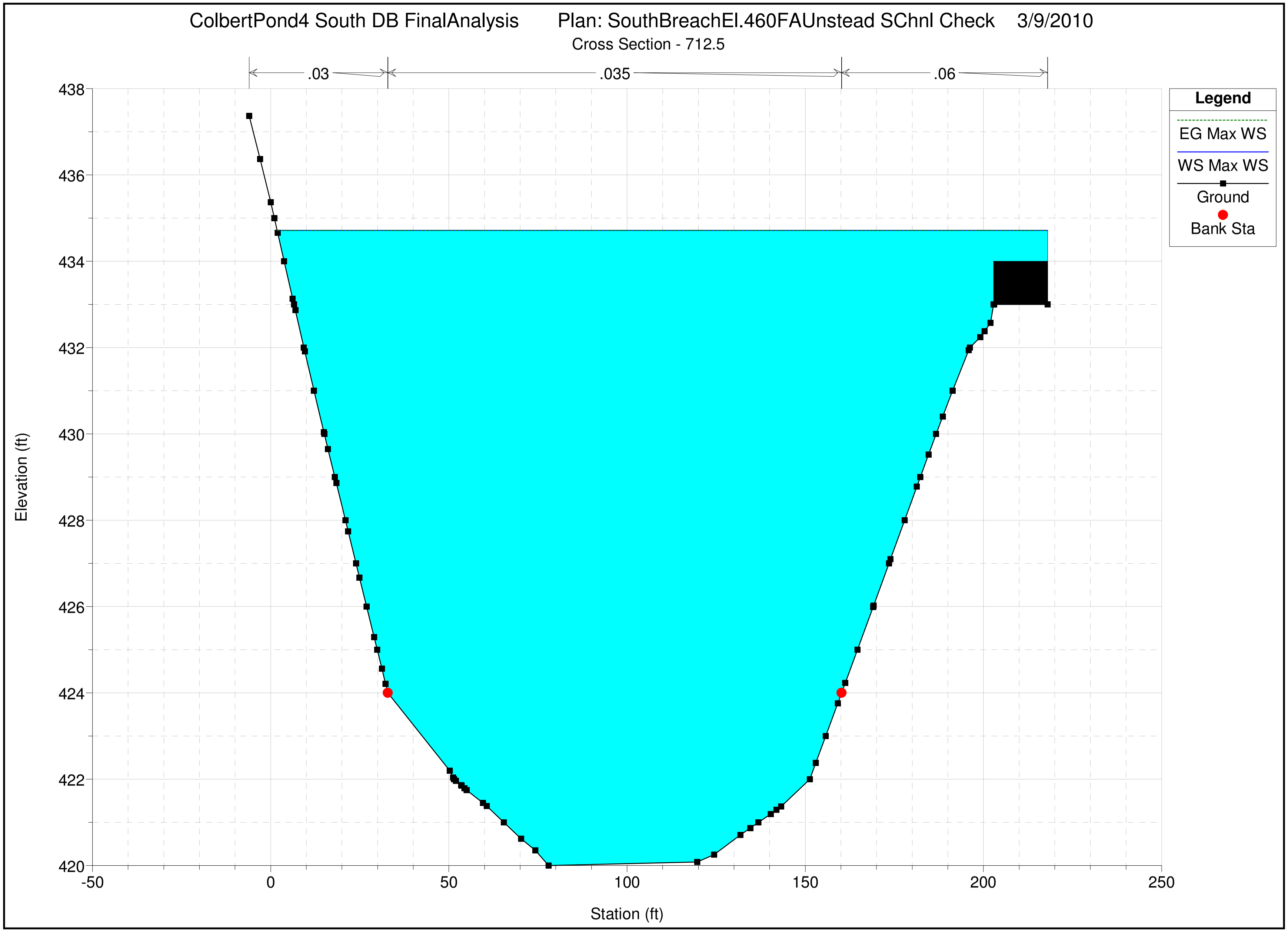
ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.460FAUnstead SChnl Check 3/9/2010
Cross Section 2096
.03
.035
.03
.04
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
465
460
455
450
445
440
435
Station (ft)
0
100
200
300
400
500
600
700


ColbertPond4 South DB FinalAnalysis
Plan: SouthBreachEl.460FAUnstead SChnl Check
3/9/2010
Cross Section 1719
.03
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
440
438
436
434
432
-50
0
50
100
150
200
250
Station (ft)



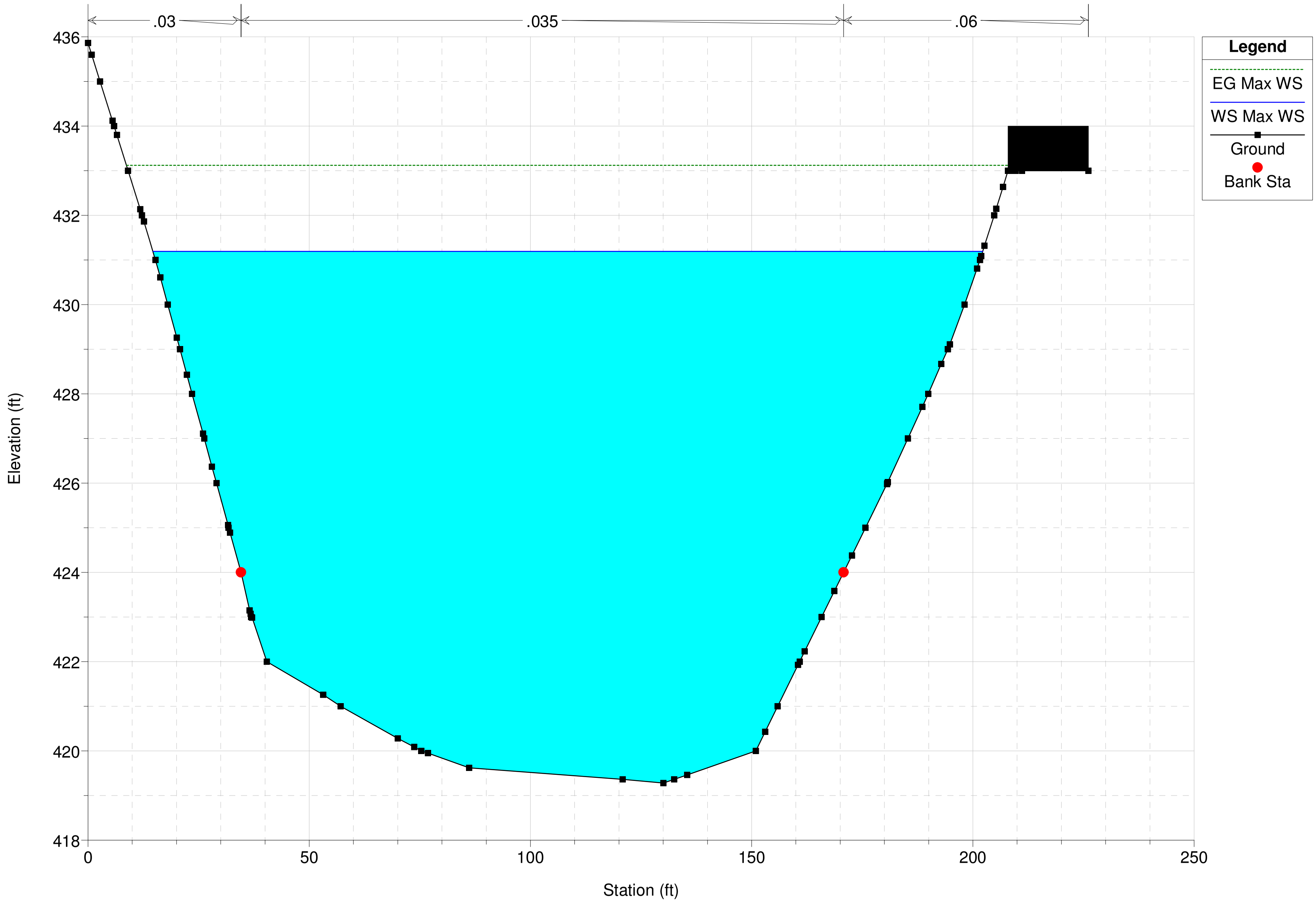
ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.460FAUnstead SChnl Check 3/9/2010
Cross Section 1470
.03
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
438
436
434
432
430
428
-50
0
50
100
150
200
Station (ft)

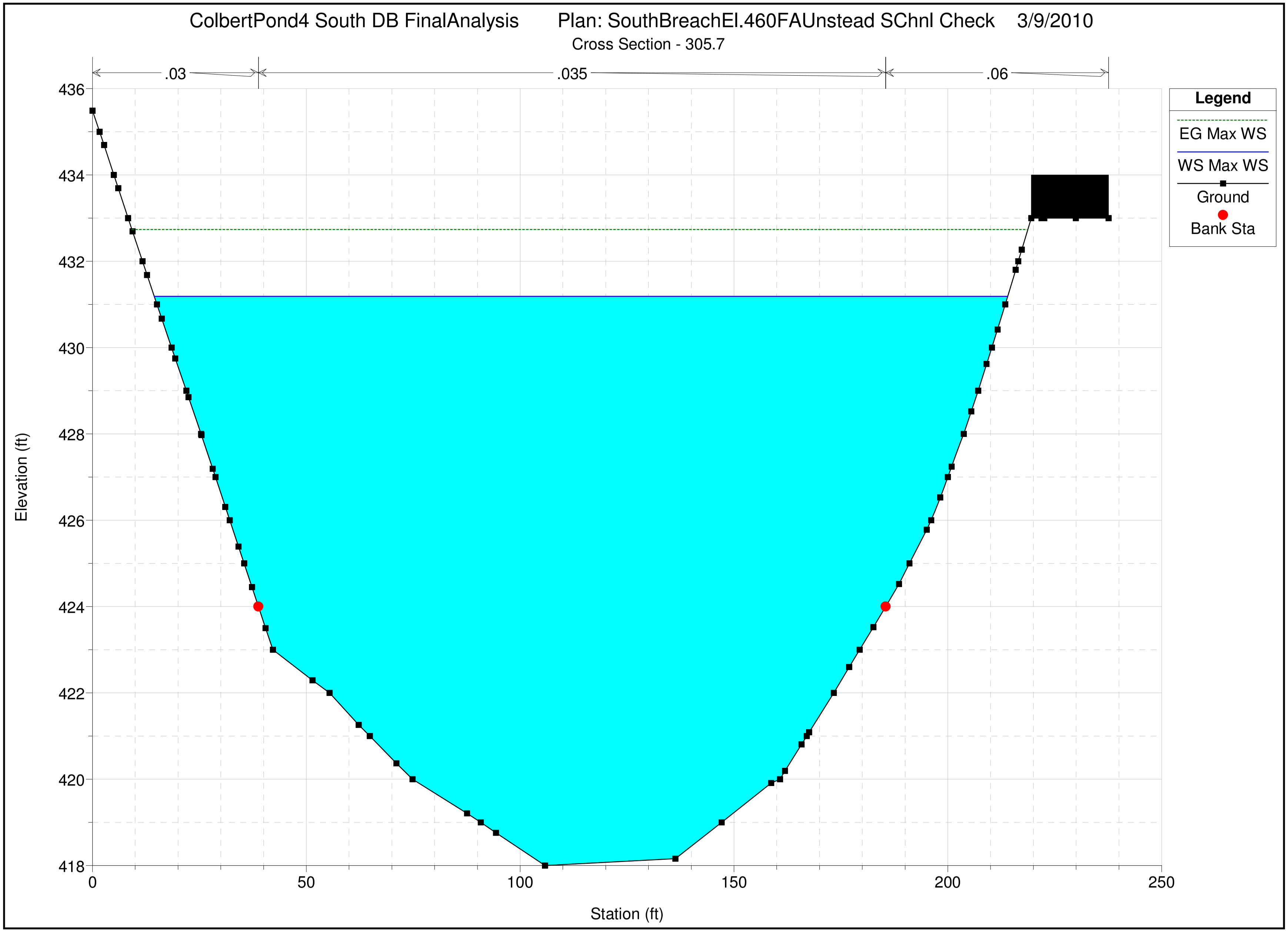

ColbertPond4 South DB FinalAnalysis
Plan: SouthBreachEl.460FAUnstead SChnl Check
3/9/2010
Cross Section - 1061
.03
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
438
436
434
432
430
428
426
Station (ft)
-50
0
50
100
150
200
250

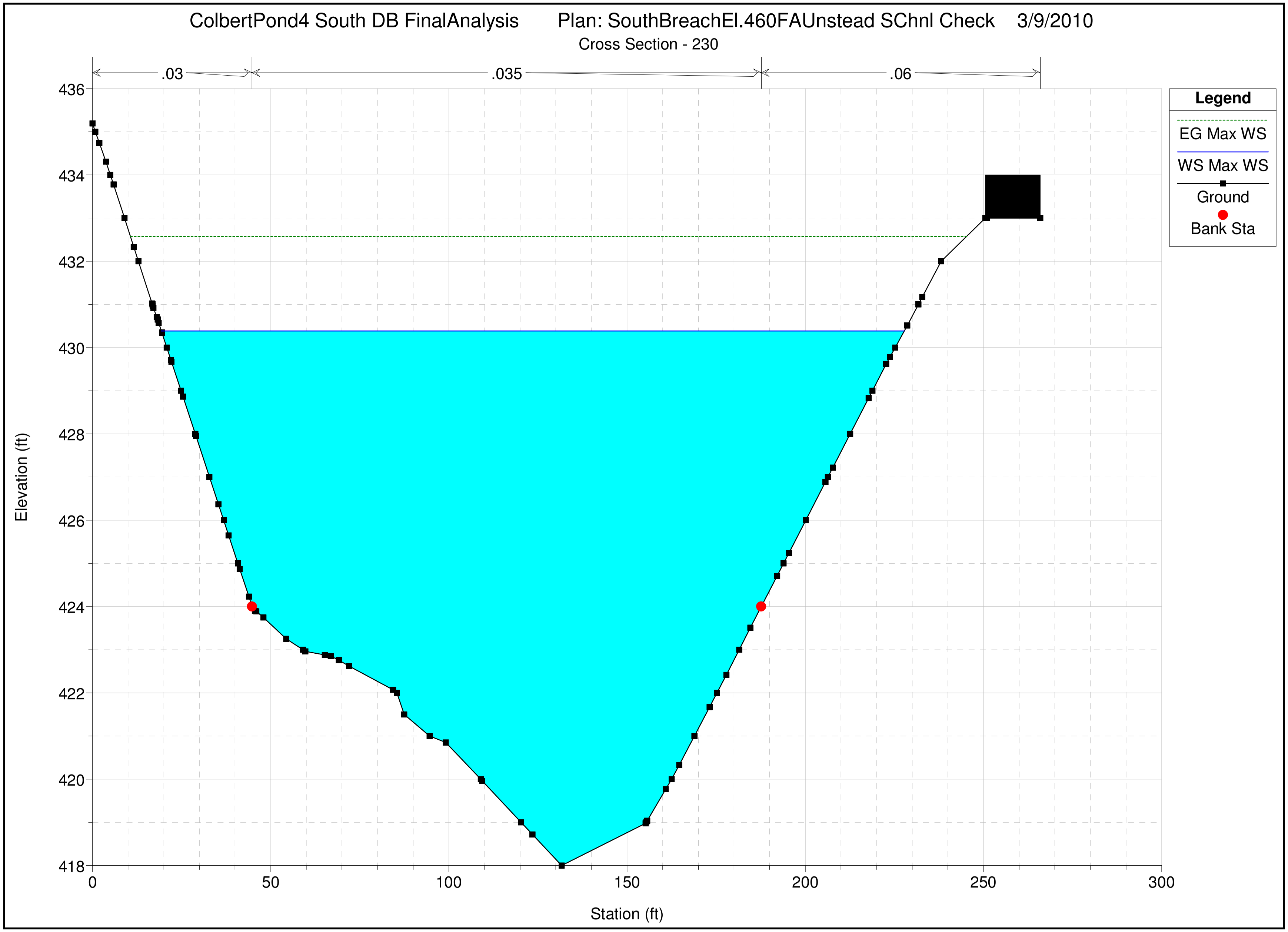

ColbertPond4 South DB FinalAnalysis
Plan: SouthBreachEl.460FAUnstead SChnl Check
3/9/2010
Cross Section - 712.5
.03
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
438
436
434
432
430
428
426
424
422
420
-50
0
50
100
150
200
250

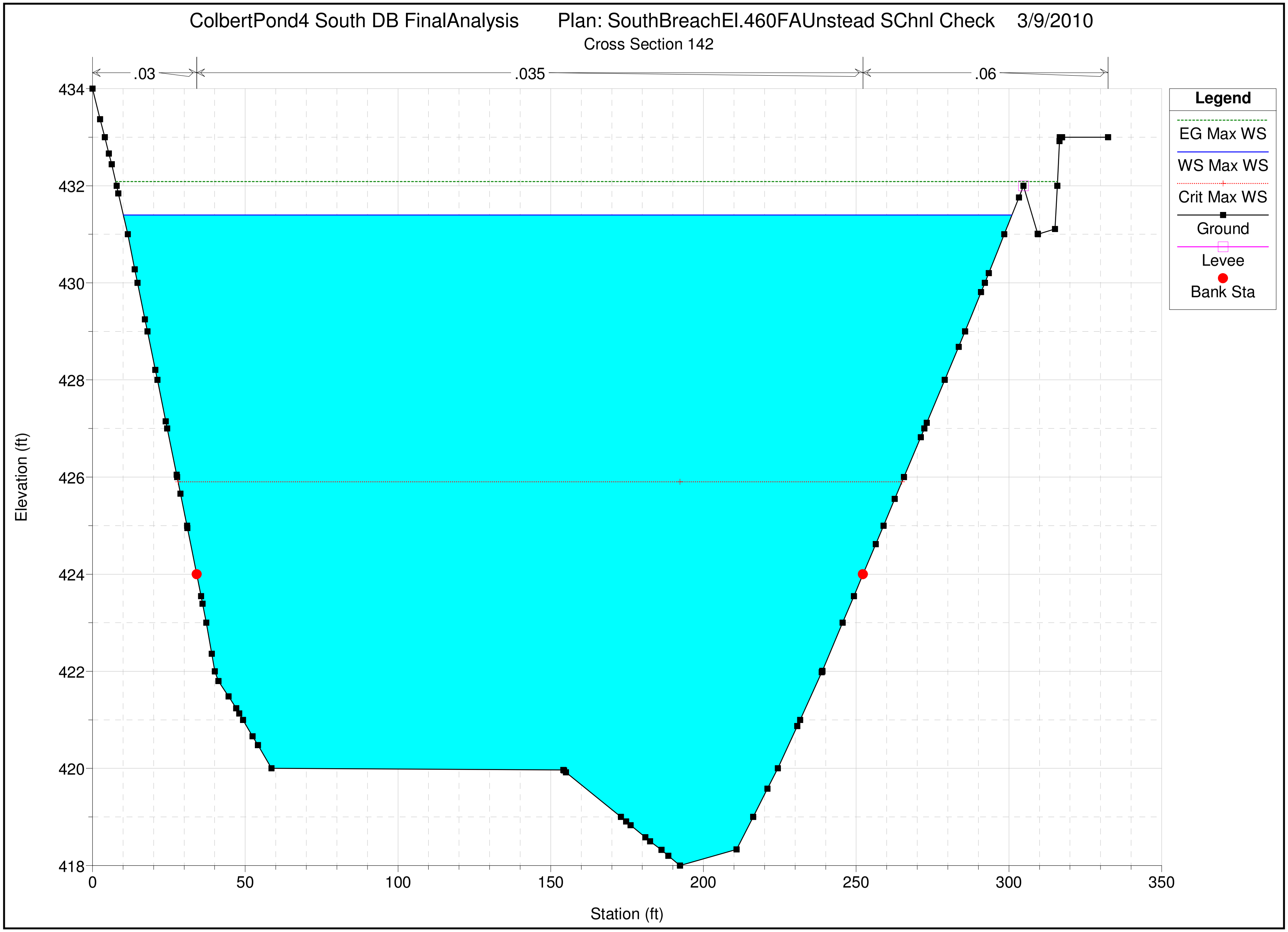
ColbertPond4 South DB FinalAnalysis   Plan: SouthBreachEl.460FAUnstead SChnl Check   3/9/2010

Cross Section - 438




ColbertPond4 South DB FinalAnalysis
Plan: SouthBreachEl.460FAUnstead SChnl Check
3/9/2010
Cross Section - 305.7
.03
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
436
434
432
430
428
426
424
422
420
418
Station (ft)
0
50
100
150
200
250


ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.460FAUnstead SChnl Check 3/9/2010
Cross Section - 230
.03
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
436
434
432
430
428
426
424
422
420
418
0
50
100
150
200
250
300
Station (ft)


ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.460FAUnstead SChnl Check 3/9/2010
Cross Section 142
.03
.035
.06
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Levee
Bank Sta
Elevation (ft)
434
432
430
428
426
424
422
420
418
Station (ft)
0
50
100
150
200
250
300
350

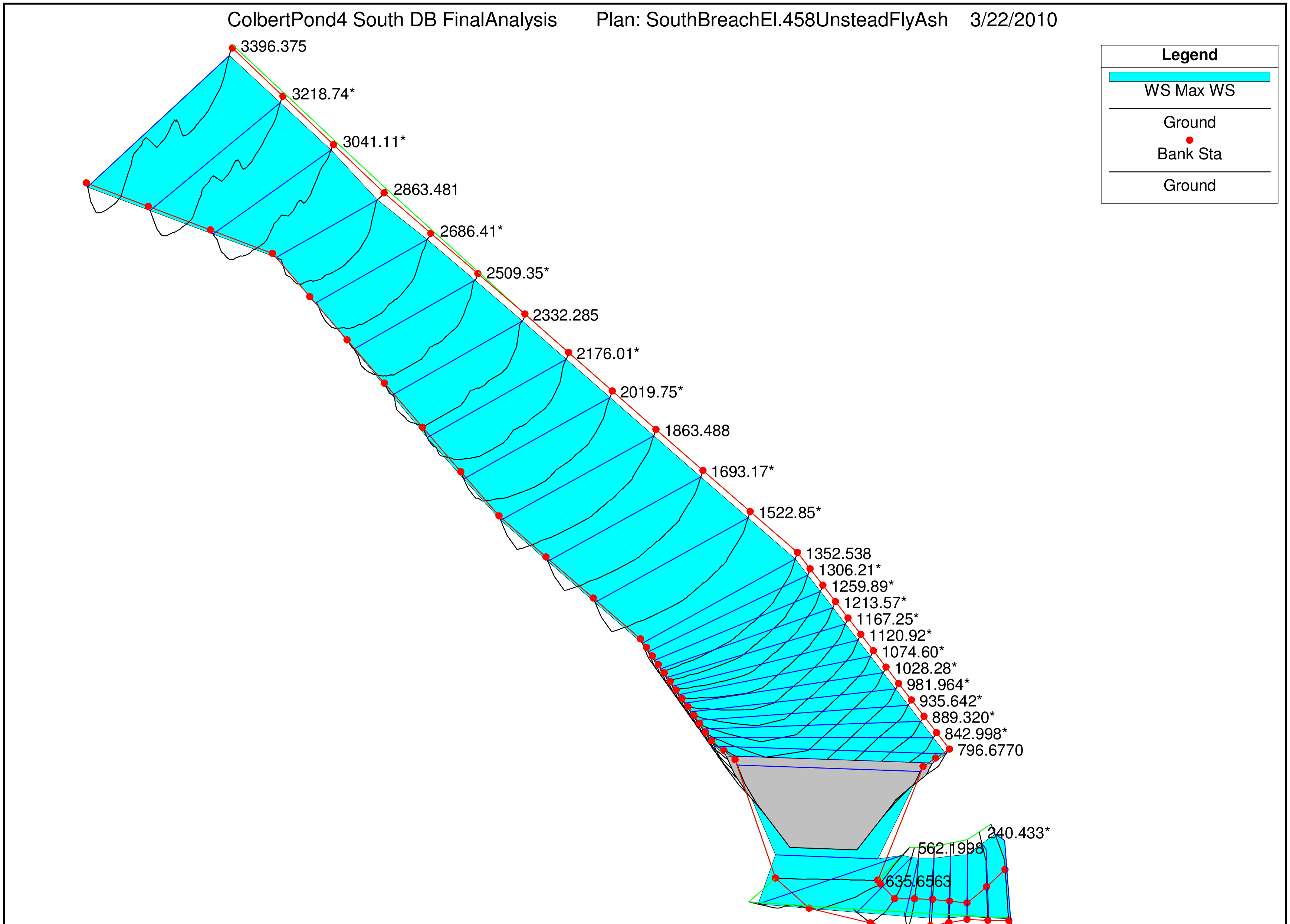
HEC-RAS Plan: SB460FASChk River: SouthChannel Reach: SouthReach Profile: Max WS

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft)	
SouthReach	2394.443	Max WS	5.00	438.00	438.06		438.06	0.000000	0.00	429.39	0.00
SouthReach	2096.035	Max WS	599.82	436.00	437.76		437.77	0.000218	0.73	450.38	0.11
SouthReach	1907.586		Lat Struct								
SouthReach	1719.138	Max WS	915.82	432.00	434.85		435.08	0.003565	4.12	170.79	0.50
SouthReach	1470.446	Max WS	554.63	428.04	434.72		434.73	0.000043	0.88	176.07	0.07
SouthReach	1061.871	Max WS	540.38	426.00	434.72		434.72	0.000010	0.48	193.68	0.03
SouthReach	712.4810	Max WS	366.64	420.00	434.71		434.71	0.000001	0.19	216.16	0.01
SouthReach	438.3635	Max WS	17503.52	419.28	431.19		433.12	0.003038	11.37	187.52	0.61
SouthReach	305.7008	Max WS	17488.00	418.00	431.19		432.74	0.002316	10.18	199.55	0.54
SouthReach	229.9951	Max WS	17479.13	418.00	430.39		432.58	0.004097	12.15	208.46	0.69
SouthReach	142.2821	Max WS	17466.59	418.00	431.40	425.90	432.09	0.001001	6.78	290.86	0.35

Appendix C

COF Pond 4
South Dam Break Analysis
Dike Elevation 458.0
Basis of Dike Lowering Design

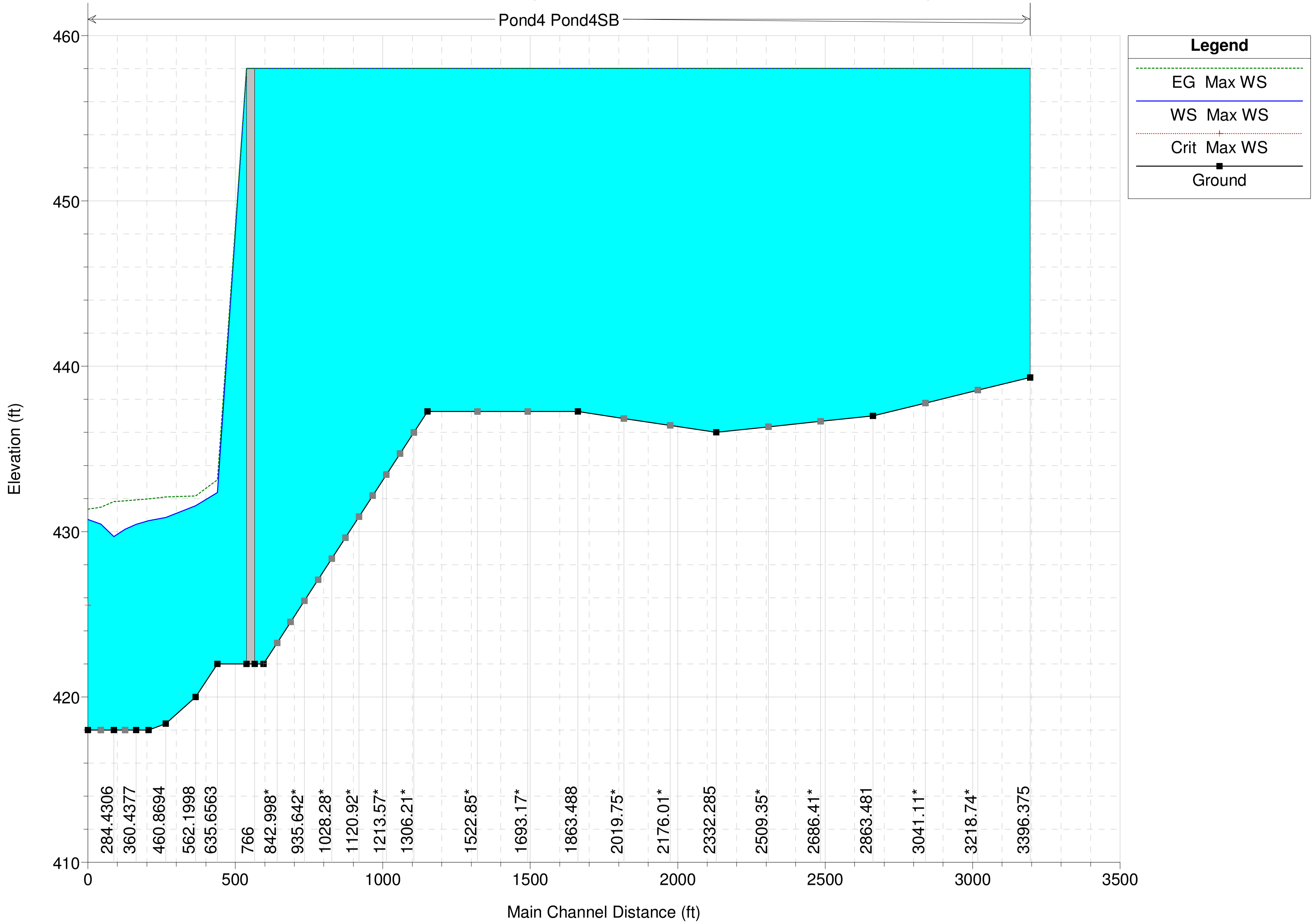
Pond 4 South Dam Break HEC-RAS Model
Dike Elevation 458.0

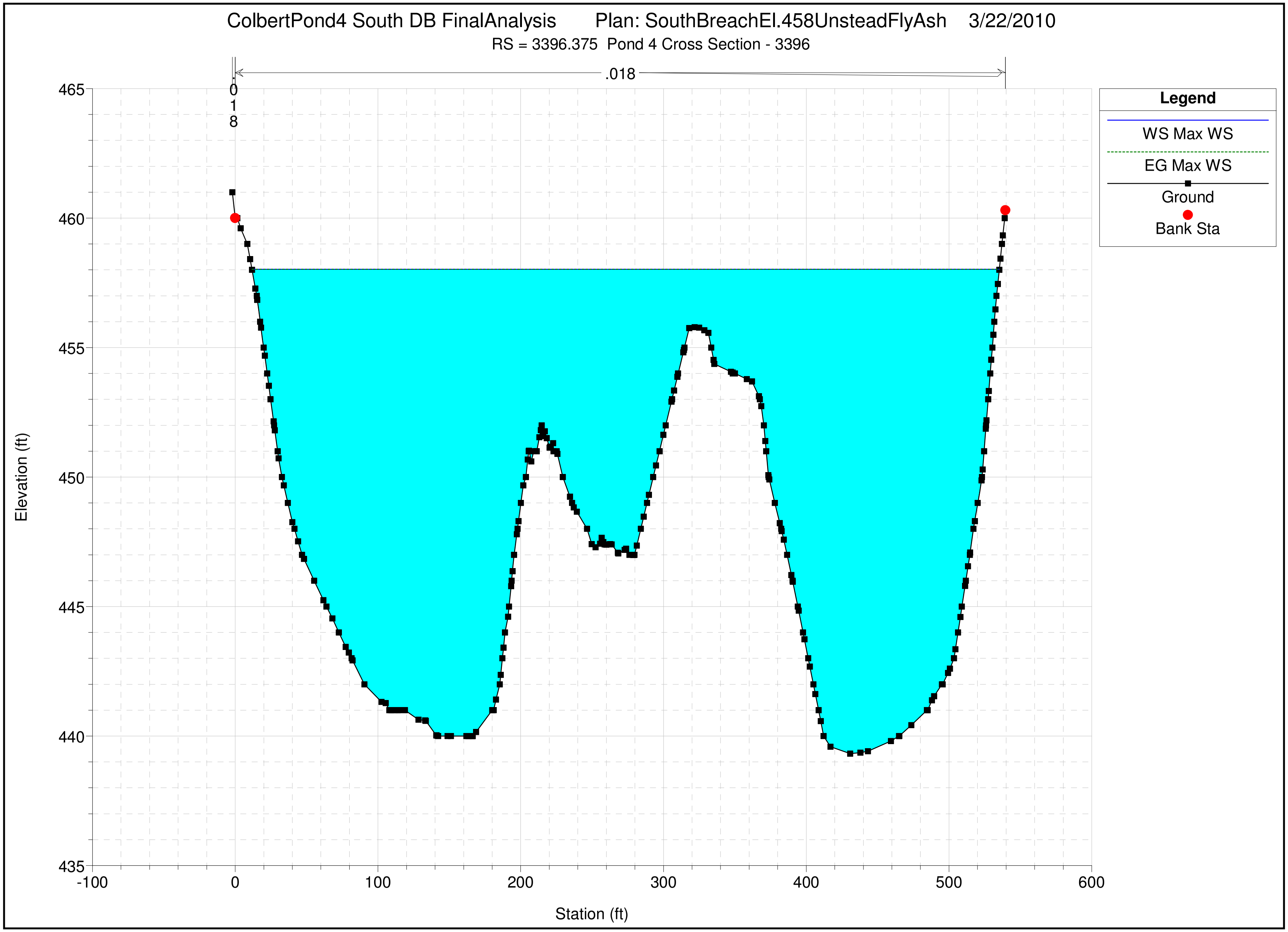


ColbertPond4 South DB FinalAnalysis
Plan: SouthBreachEl.458UnsteadFlyAsh
3/22/2010
Legend
WS Max WS
Ground
Bank Sta
Ground
3396.375
3218.74*
3041.11*
2863.481
2686.41*
2509.35*
2332.285
2176.01*
2019.75*
1863.488
1693.17*
1522.85*
1352.538
1306.21*
1259.89*
1213.57*
1167.25*
1120.92*
1074.60*
1028.28*
981.964*
935.642*
889.320*
842.998*
796.6770
562.1998
635.6563
240.433*

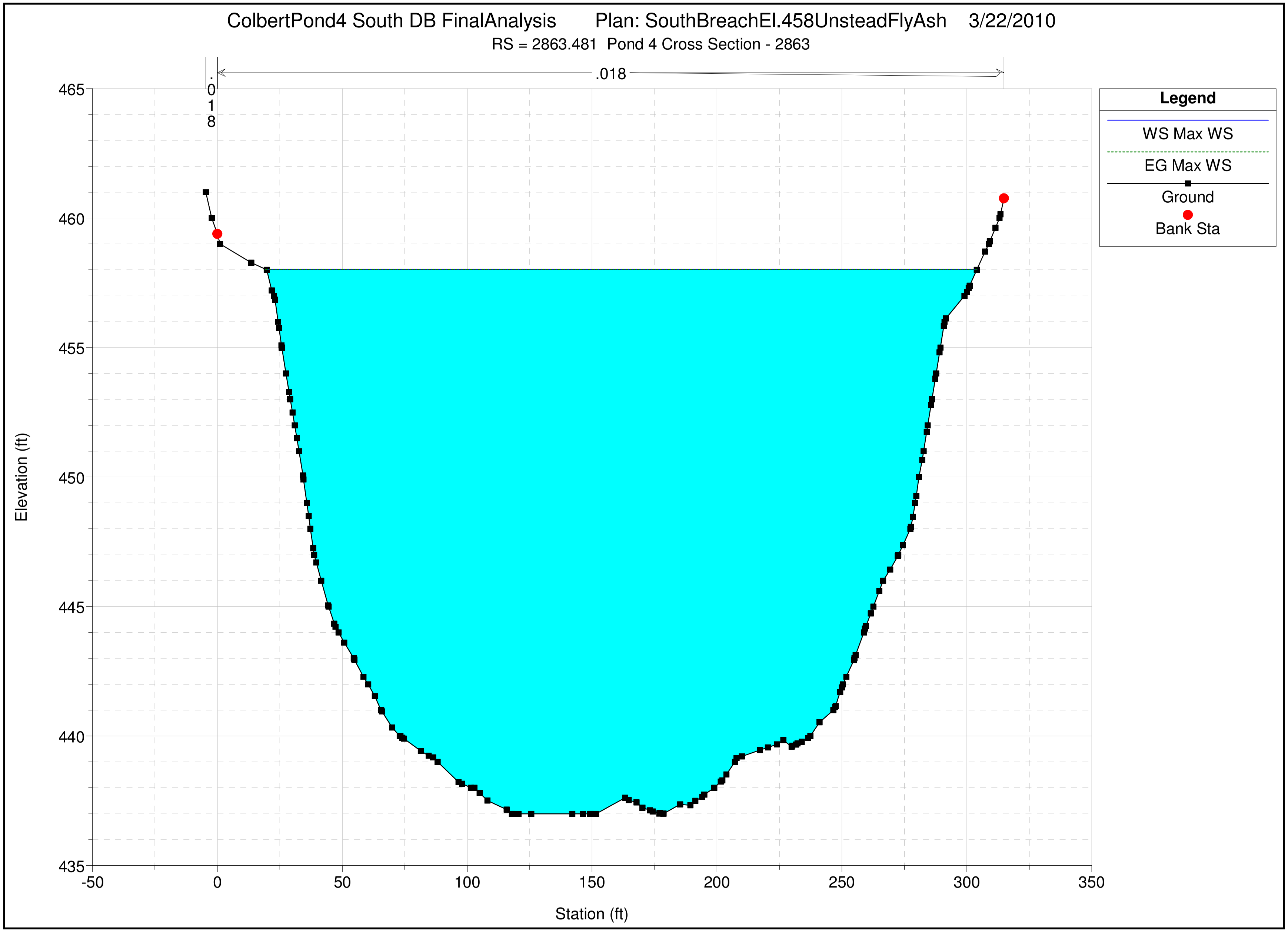
1 in Horiz. = 800 ft   1 in Vert. = 400 ft

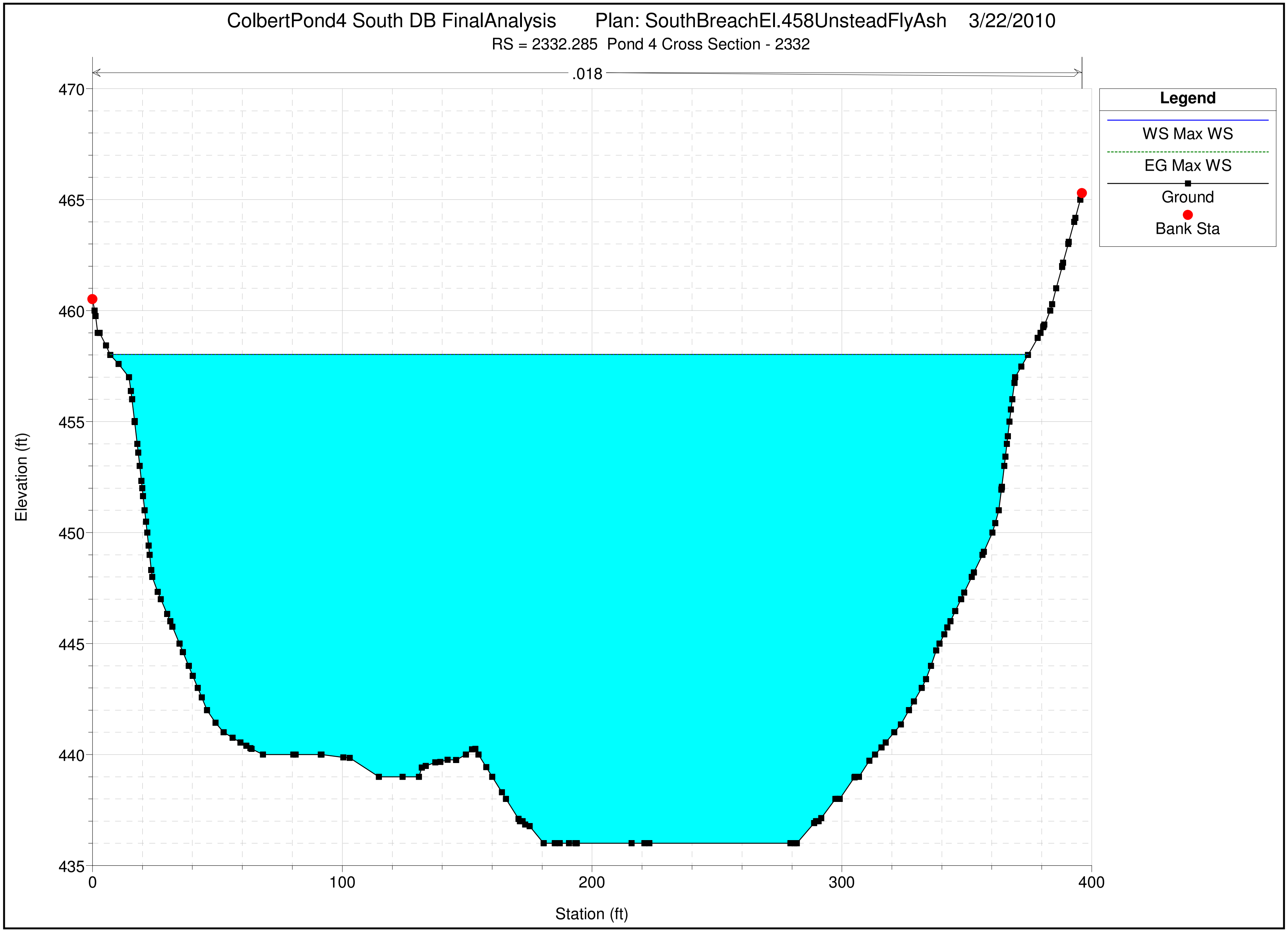
ColbertPond4 South DB FinalAnalysis   Plan: SouthBreachEl.458UnsteadFlyAsh   3/22/2010



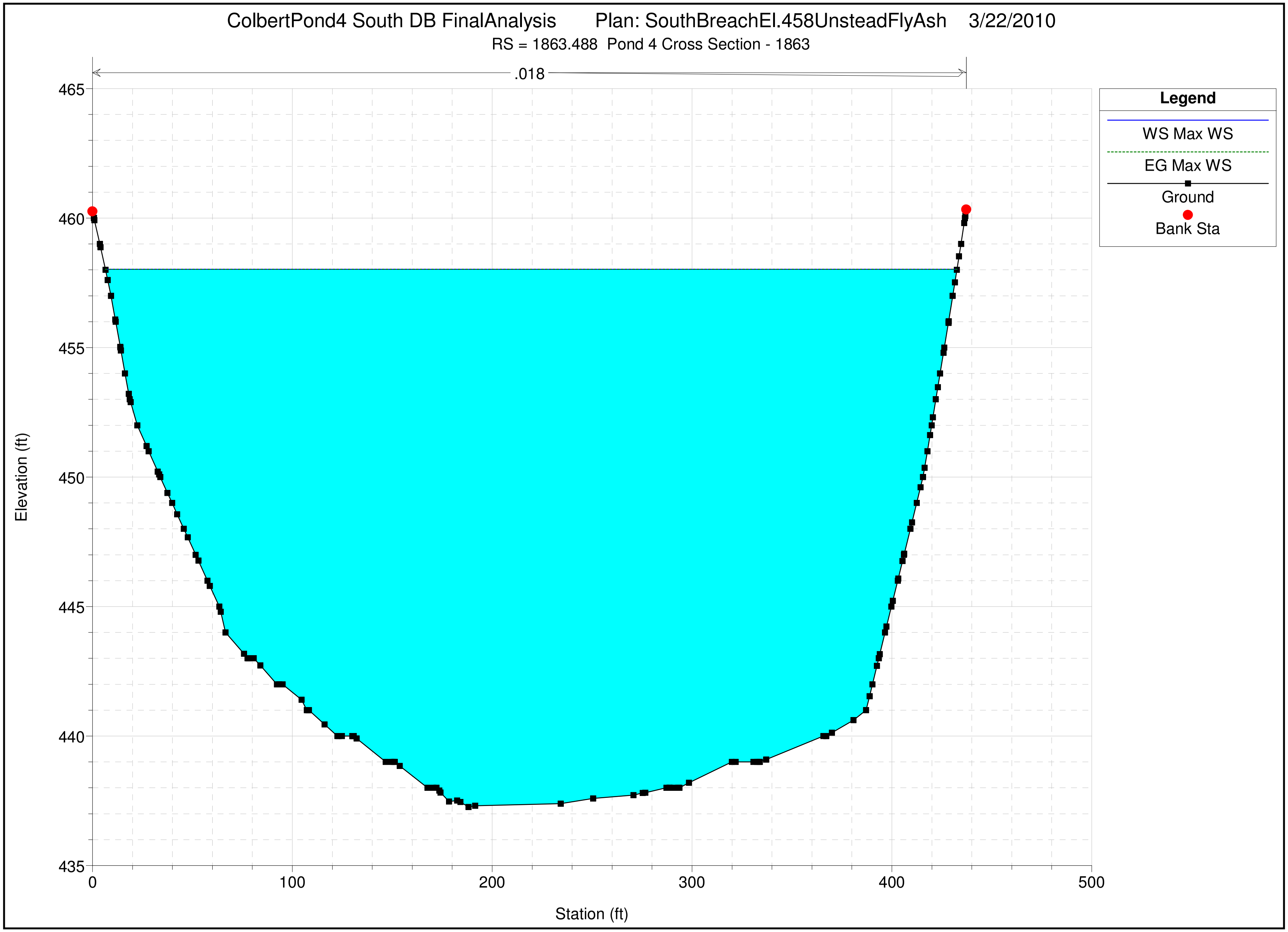


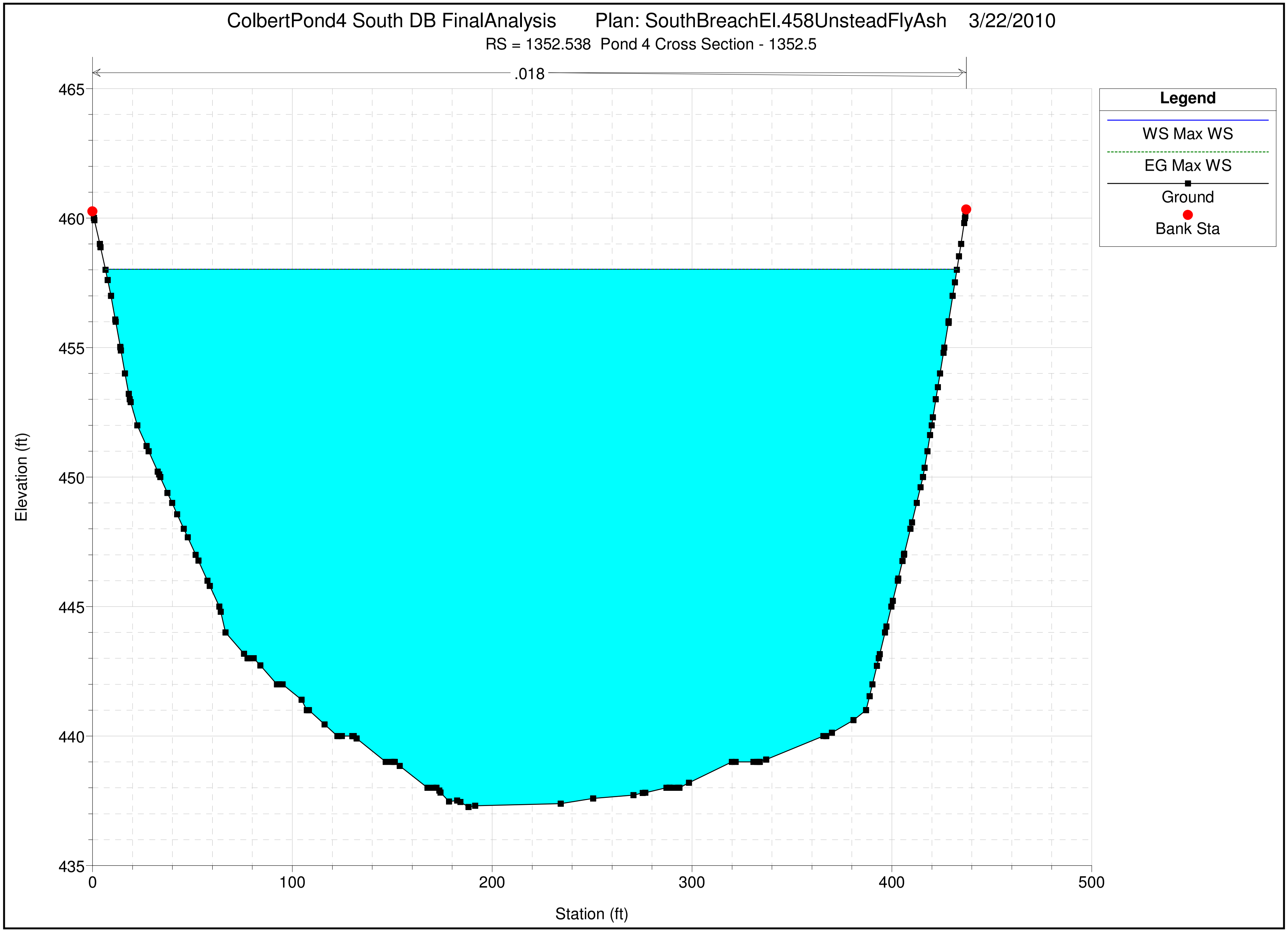
ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458UnsteadFlyAsh 3/22/2010
RS = 3396.375 Pond 4 Cross Section - 3396
.018
0
1
8
465
460
455
450
445
440
435
-100
0
100
200
300
400
500
600
Elevation (ft)
Station (ft)
Legend
WS Max WS
EG Max WS
Ground
Bank Sta

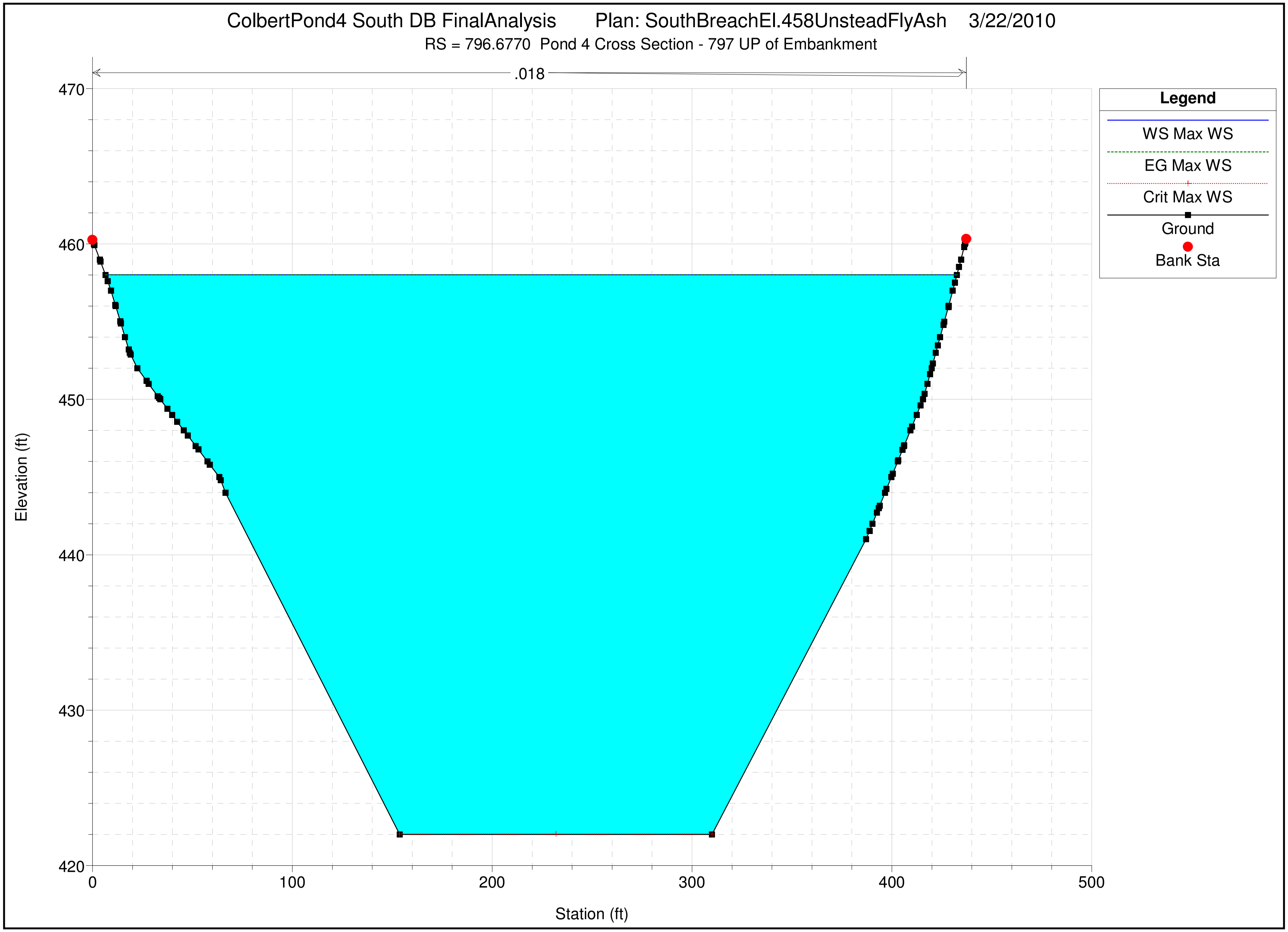

ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458UnsteadFlyAsh 3/22/2010
RS = 2863.481 Pond 4 Cross Section - 2863
.018
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
465
460
455
450
445
440
435
-50
0
50
100
150
200
250
300
350
Station (ft)



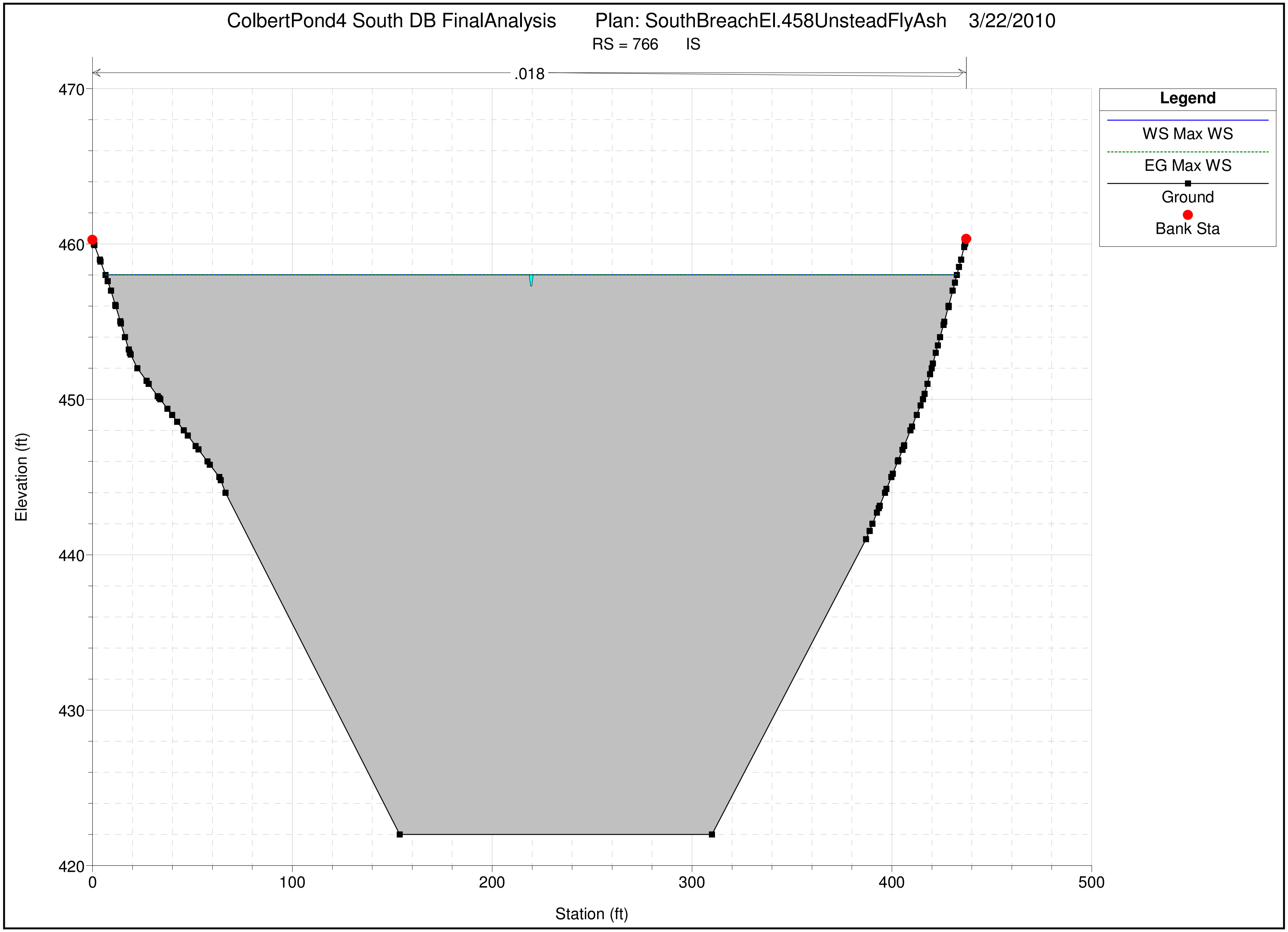
ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458UnsteadFlyAsh 3/22/2010
RS = 2332.285 Pond 4 Cross Section - 2332
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
470
465
460
455
450
445
440
435
0
100
200
300
400
Station (ft)

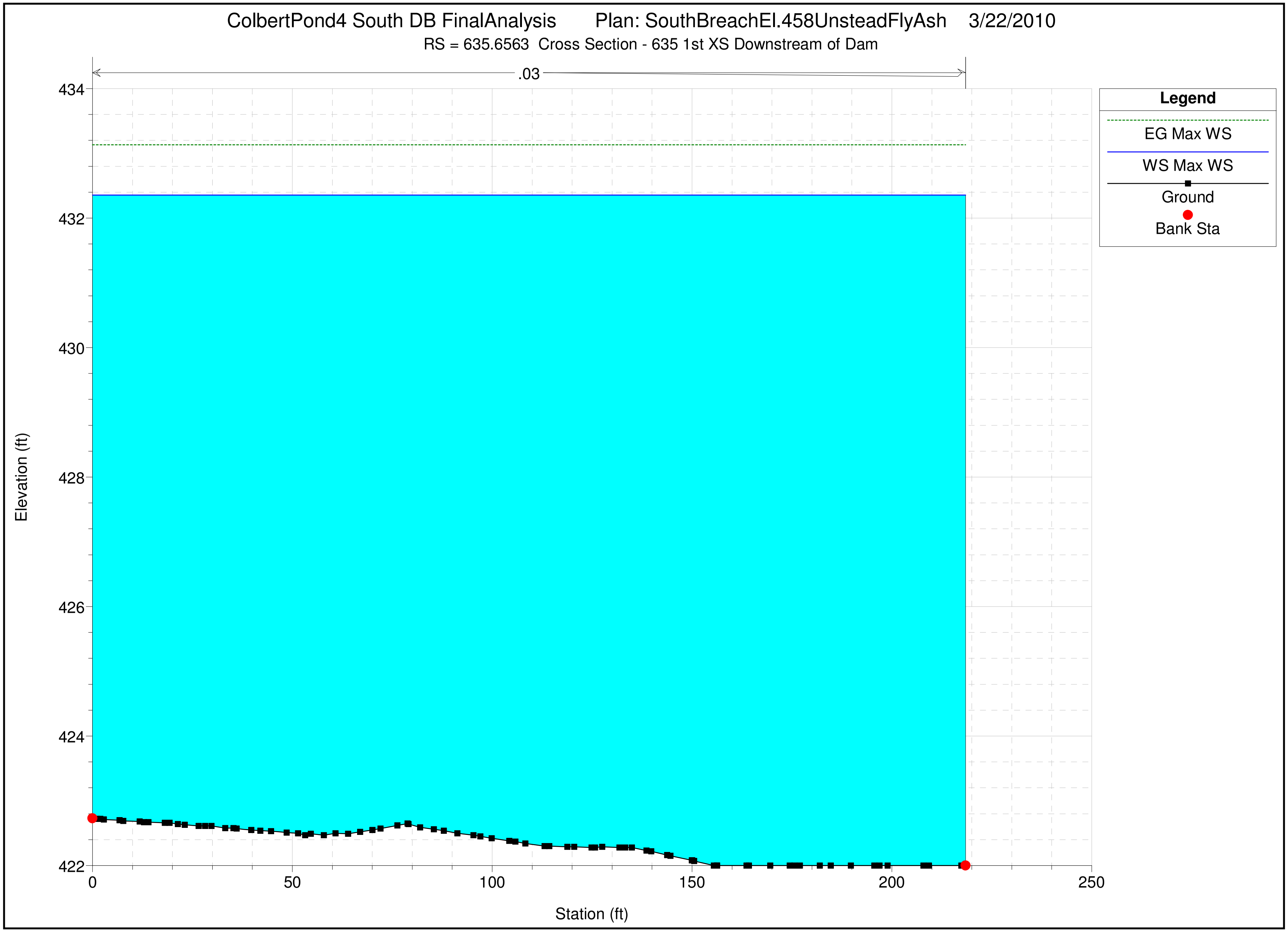

ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458UnsteadFlyAsh 3/22/2010
RS = 1863.488 Pond 4 Cross Section - 1863
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
465
460
455
450
445
440
435
0
100
200
300
400
500


ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458UnsteadFlyAsh 3/22/2010
RS = 1352.538 Pond 4 Cross Section - 1352.5
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
465
460
455
450
445
440
435
0
100
200
300
400
500

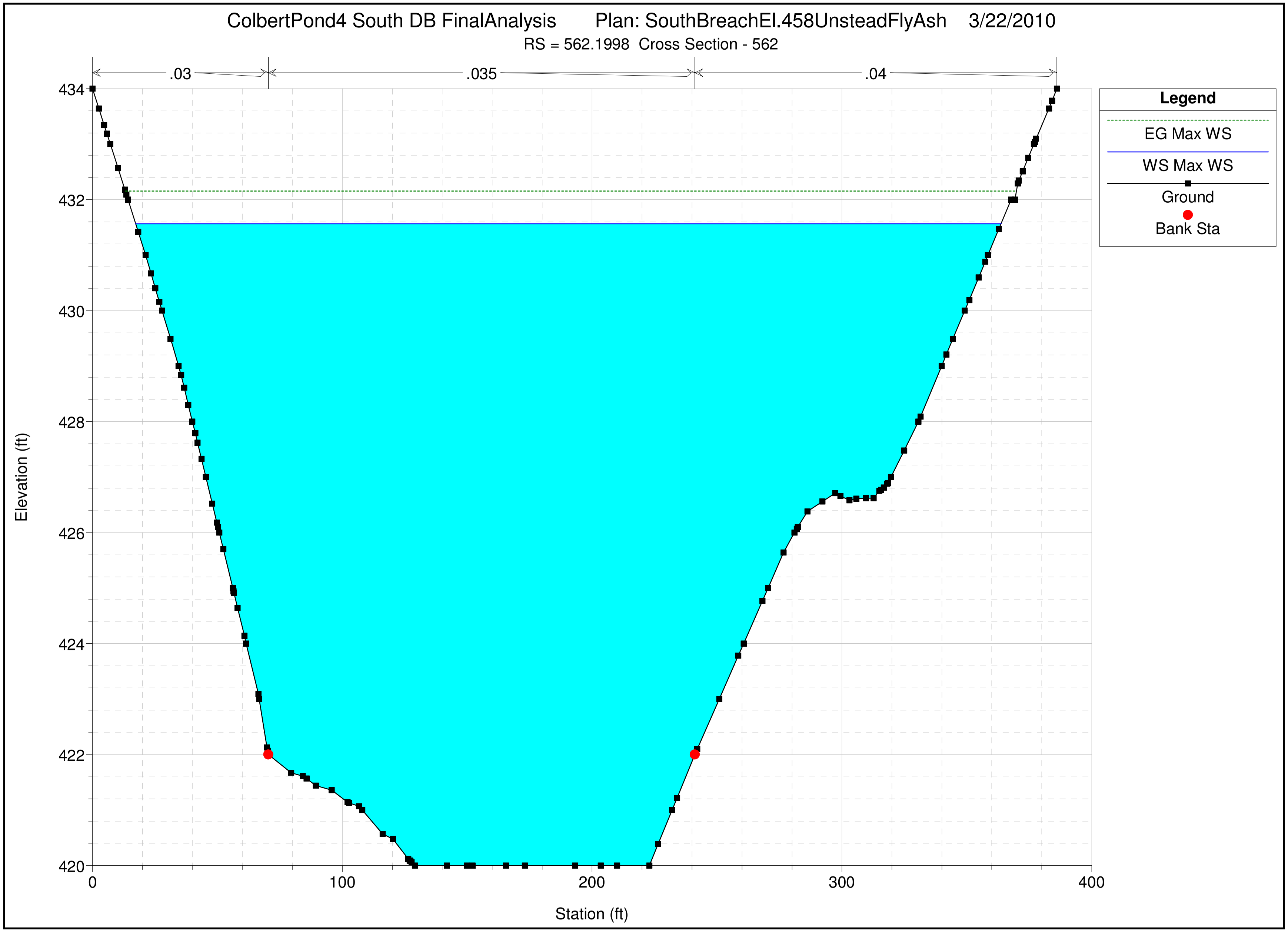


ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458UnsteadFlyAsh 3/22/2010
RS = 796.6770 Pond 4 Cross Section - 797 UP of Embankment
.018
Legend
WS Max WS
EG Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
470
460
450
440
430
420
0
100
200
300
400
500


ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458UnsteadFlyAsh 3/22/2010
RS = 766 IS
.018
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
470
460
450
440
430
420
Station (ft)
0
100
200
300
400
500



ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458UnsteadFlyAsh 3/22/2010
RS = 635.6563 Cross Section - 635 1st XS Downstream of Dam
.03
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
434
432
430
428
426
424
422
Station (ft)
0
50
100
150
200
250


ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458UnsteadFlyAsh 3/22/2010
RS = 562.1998 Cross Section - 562
.03
.035
.04
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
434
432
430
428
426
424
422
420
0
100
200
300
400
Station (ft)

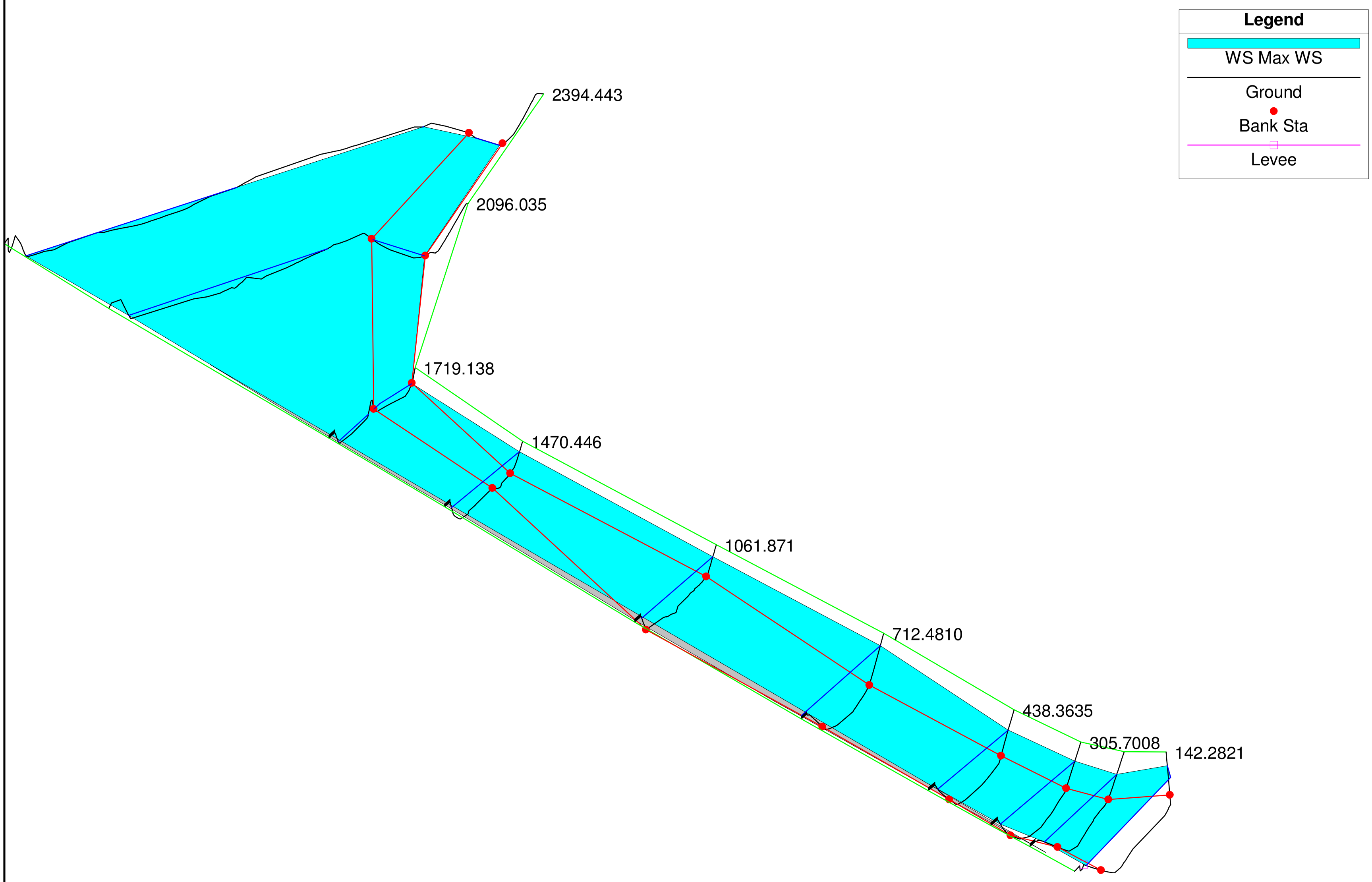
HEC-RAS Plan: SB458UnFA   River: Pond4   Reach: Pond4SB   Profile: Max WS

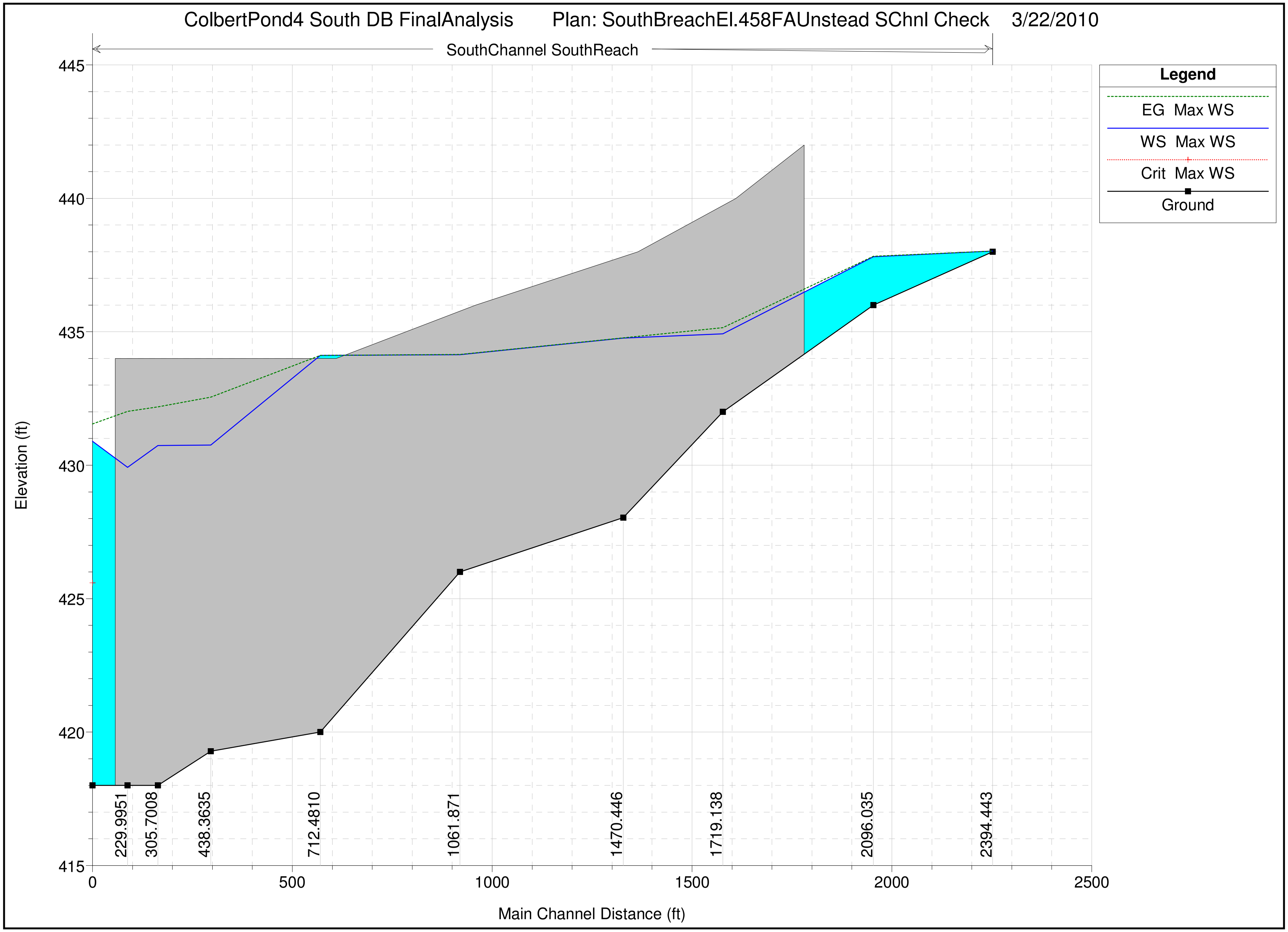
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft)	
Pond4SB	3396.375	Max WS	5.00	439.32	458.02		458.02	0.000000	0.00	523.56	0.00
Pond4SB	3218.74*	Max WS	4.83	438.55	458.02		458.02	0.000000	0.00	449.05	0.00
Pond4SB	3041.11*	Max WS	4.40	437.77	458.02		458.02	0.000000	0.00	373.47	0.00
Pond4SB	2863.481	Max WS	4.81	437.00	458.02		458.02	0.000000	0.00	284.74	0.00
Pond4SB	2686.41*	Max WS	4.60	436.67	458.02		458.02	0.000000	0.00	315.52	0.00
Pond4SB	2509.35*	Max WS	4.01	436.33	458.02		458.02	0.000000	0.00	341.47	0.00
Pond4SB	2332.285	Max WS	3.90	436.00	458.02		458.02	0.000000	0.00	367.52	0.00
Pond4SB	2176.01*	Max WS	4.48	436.42	458.02		458.02	0.000000	0.00	390.51	0.00
Pond4SB	2019.75*	Max WS	4.08	436.84	458.02		458.02	0.000000	0.00	408.58	0.00
Pond4SB	1863.488	Max WS	4.85	437.26	458.02		458.02	0.000000	0.00	426.12	0.00
Pond4SB	1693.17*	Max WS	4.70	437.26	458.02		458.02	0.000000	0.00	426.12	0.00
Pond4SB	1522.85*	Max WS	4.32	437.26	458.02		458.02	0.000000	0.00	426.12	0.00
Pond4SB	1352.538	Max WS	4.23	437.26	458.02		458.02	0.000000	0.00	426.12	0.00
Pond4SB	1306.21*	Max WS	4.35	435.99	458.02		458.02	0.000000	0.00	426.13	0.00
Pond4SB	1259.89*	Max WS	4.29	434.72	458.02		458.02	0.000000	0.00	426.12	0.00
Pond4SB	1213.57*	Max WS	4.22	433.45	458.02		458.02	0.000000	0.00	426.13	0.00
Pond4SB	1167.25*	Max WS	4.23	432.17	458.02		458.02	0.000000	0.00	426.13	0.00
Pond4SB	1120.92*	Max WS	4.12	430.90	458.02		458.02	0.000000	0.00	426.14	0.00
Pond4SB	1074.60*	Max WS	4.07	429.63	458.02		458.02	0.000000	0.00	426.11	0.00
Pond4SB	1028.28*	Max WS	4.02	428.36	458.02		458.02	0.000000	0.00	426.08	0.00
Pond4SB	981.964*	Max WS	4.23	427.09	458.02		458.02	0.000000	0.00	426.08	0.00
Pond4SB	935.642*	Max WS	3.92	425.82	458.02		458.02	0.000000	0.00	426.11	0.00
Pond4SB	889.320*	Max WS	4.23	424.54	458.02		458.02	0.000000	0.00	426.12	0.00
Pond4SB	842.998*	Max WS	3.84	423.27	458.02		458.02	0.000000	0.00	426.10	0.00
Pond4SB	796.6770	Max WS	4.25	422.00	458.02	422.03	458.02	0.000000	0.00	426.12	0.00
Pond4SB	766		Inl Struct								
Pond4SB	635.6563	Max WS	15498.04	422.00	432.36		433.13	0.001059	7.07	218.47	0.39
Pond4SB	562.1998	Max WS	15455.36	420.00	431.57		432.15	0.000984	6.61	346.43	0.35
Pond4SB	460.8694	Max WS	15453.02	418.38	430.85		432.10	0.001972	9.73	212.86	0.50
Pond4SB	402.9081	Max WS	15451.17	418.00	430.66		431.97	0.001955	9.76	191.55	0.50
Pond4SB	360.4377	Max WS	15449.81	418.00	430.44		431.91	0.002335	10.60	194.73	0.54
Pond4SB	322.434*	Max WS	15448.21	418.00	430.14		431.86	0.002960	11.72	200.44	0.61
Pond4SB	284.4306	Max WS	15446.08	418.00	429.69		431.82	0.004030	13.30	201.29	0.71
Pond4SB	240.433*	Max WS	15443.95	418.00	430.45		431.47	0.001679	8.78	245.31	0.46
Pond4SB	196.4367	Max WS	15442.62	418.00	430.73	425.55	431.36	0.001001	6.74	284.43	0.35

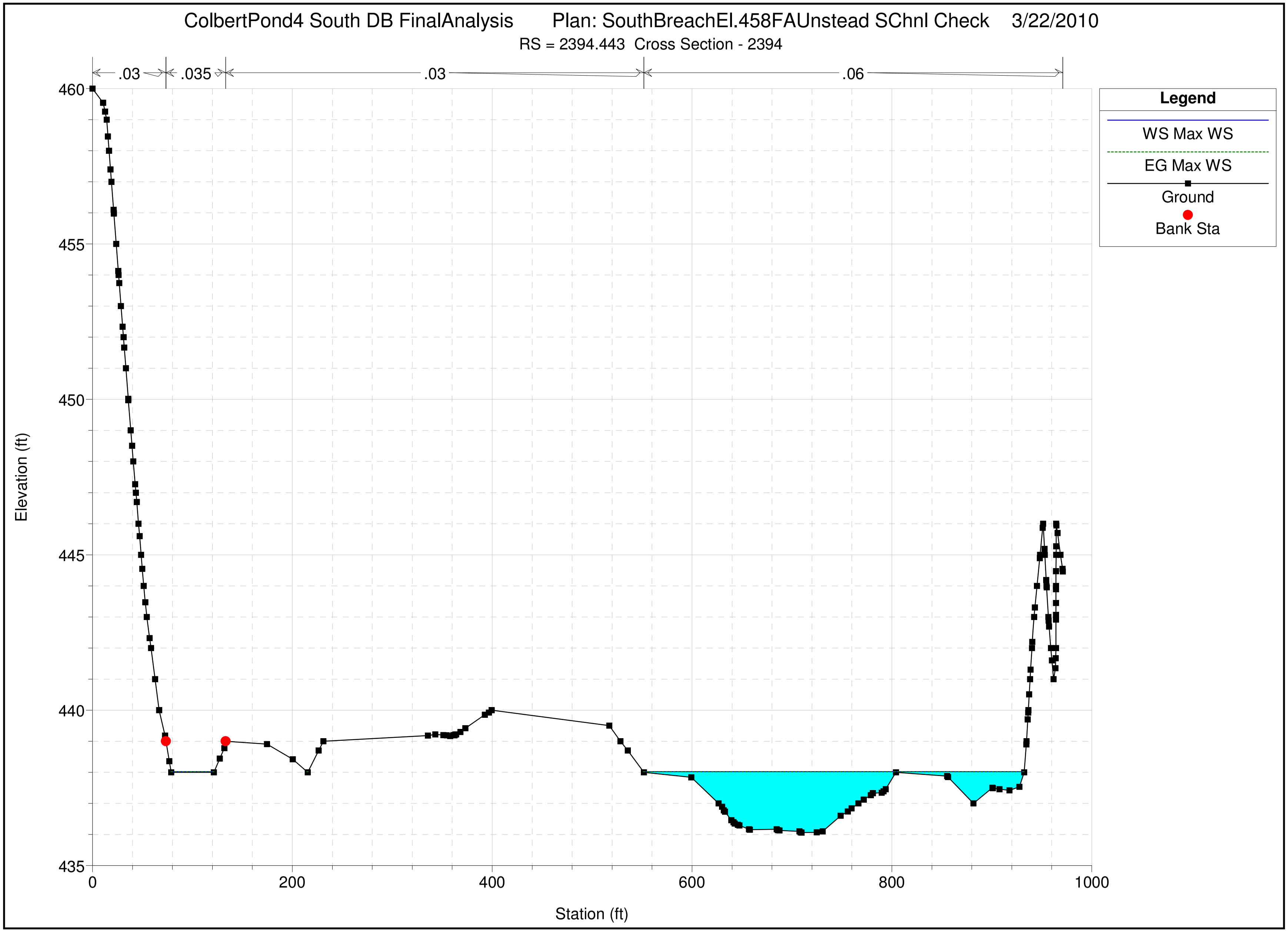
Pond 4 South Dam Break
South Channel HEC-RAS Model
Dike Elevation 458.0

1 in Horiz. = 500 ft   1 in Vert. = 500 ft

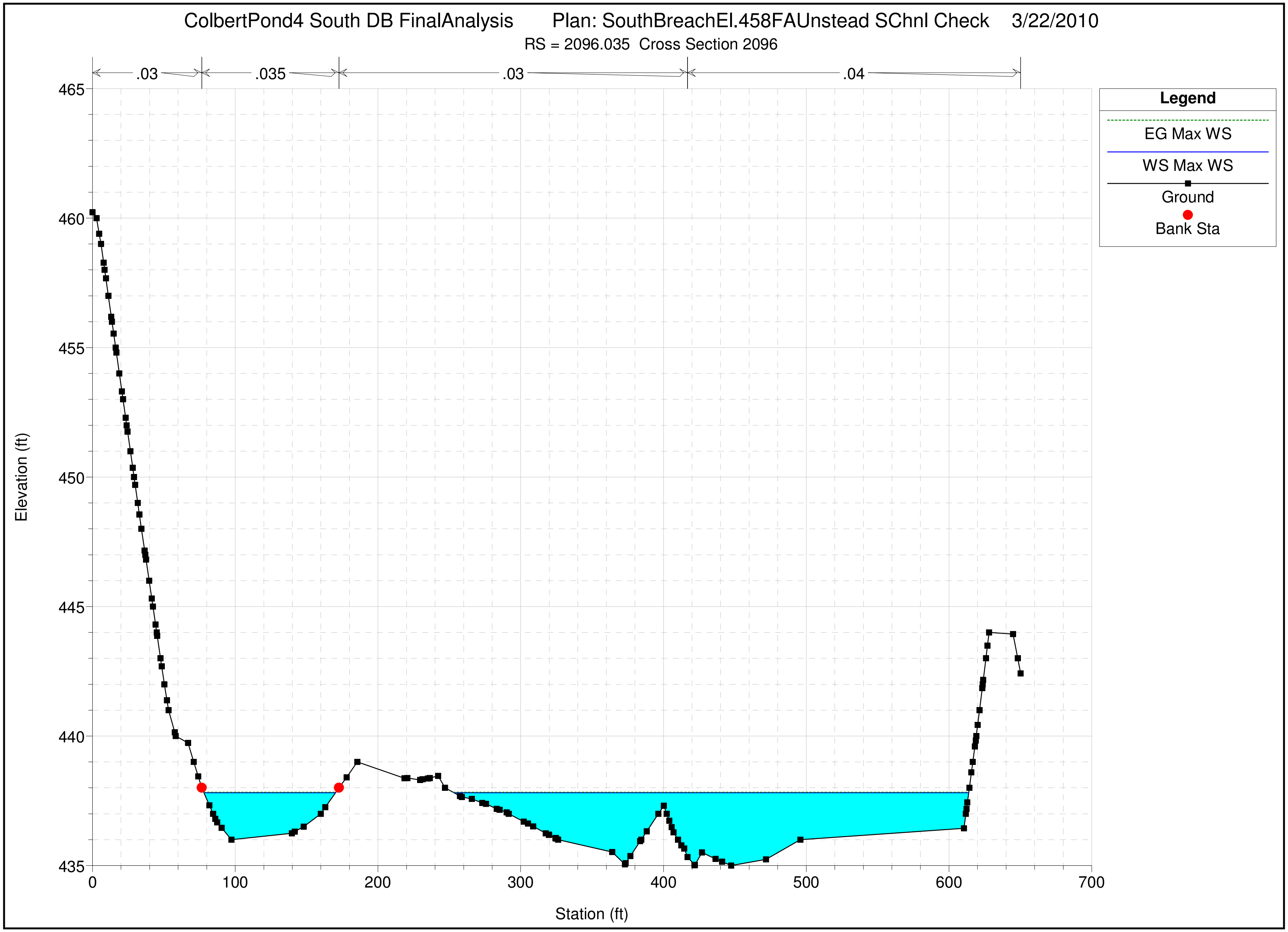
ColbertPond4 South DB FinalAnalysis   Plan: SouthBreachEl.458FAUnstead SChnl Check   3/22/2010



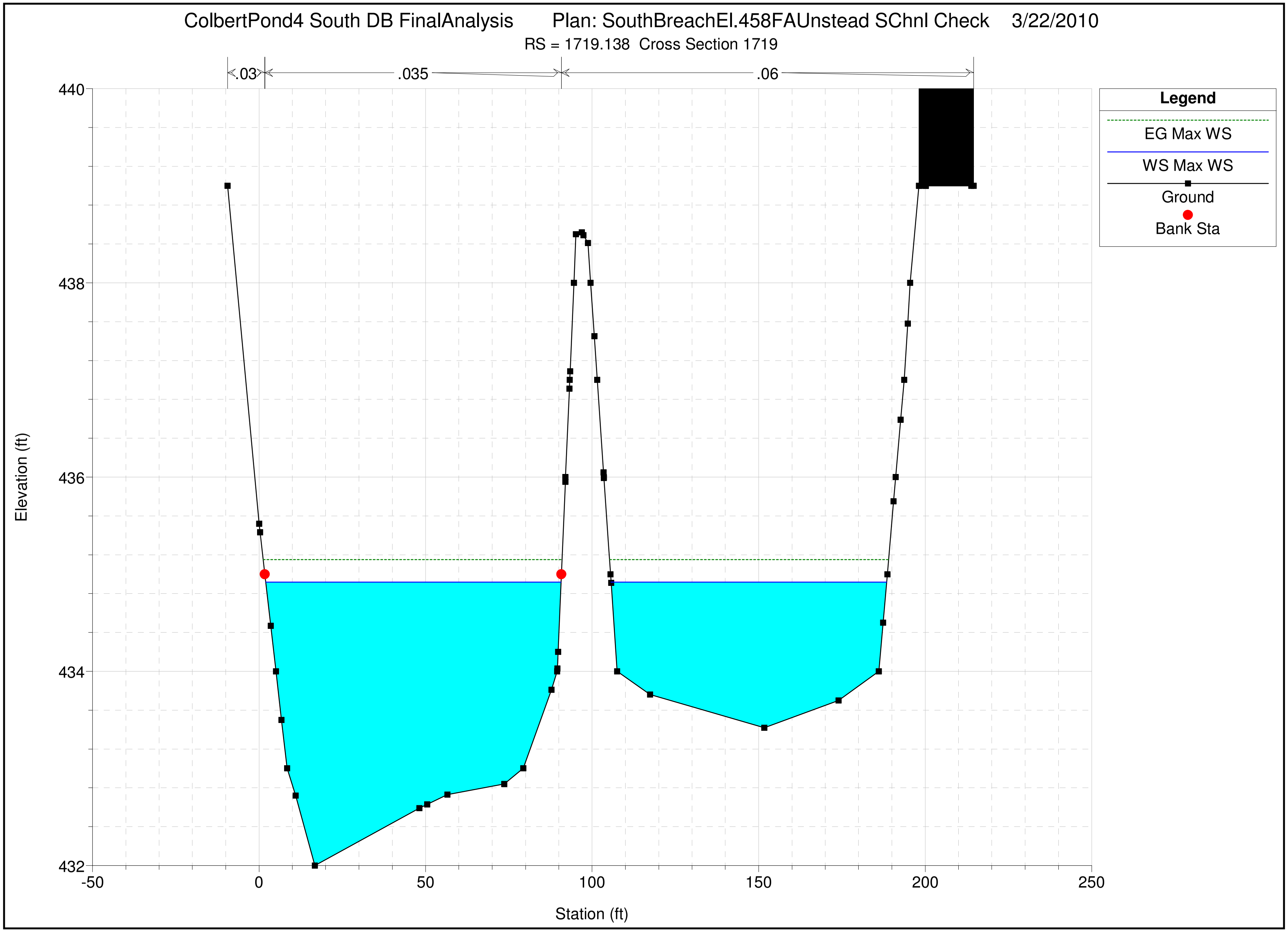

ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458FAUnstead SChnl Check 3/22/2010
SouthChannel SouthReach
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Elevation (ft)
445
440
435
430
425
420
415
229.9951
305.7008
438.3635
712.4810
1061.871
1470.446
1719.138
2096.035
2394.443
0
500
1000
1500
2000
2500
Main Channel Distance (ft)



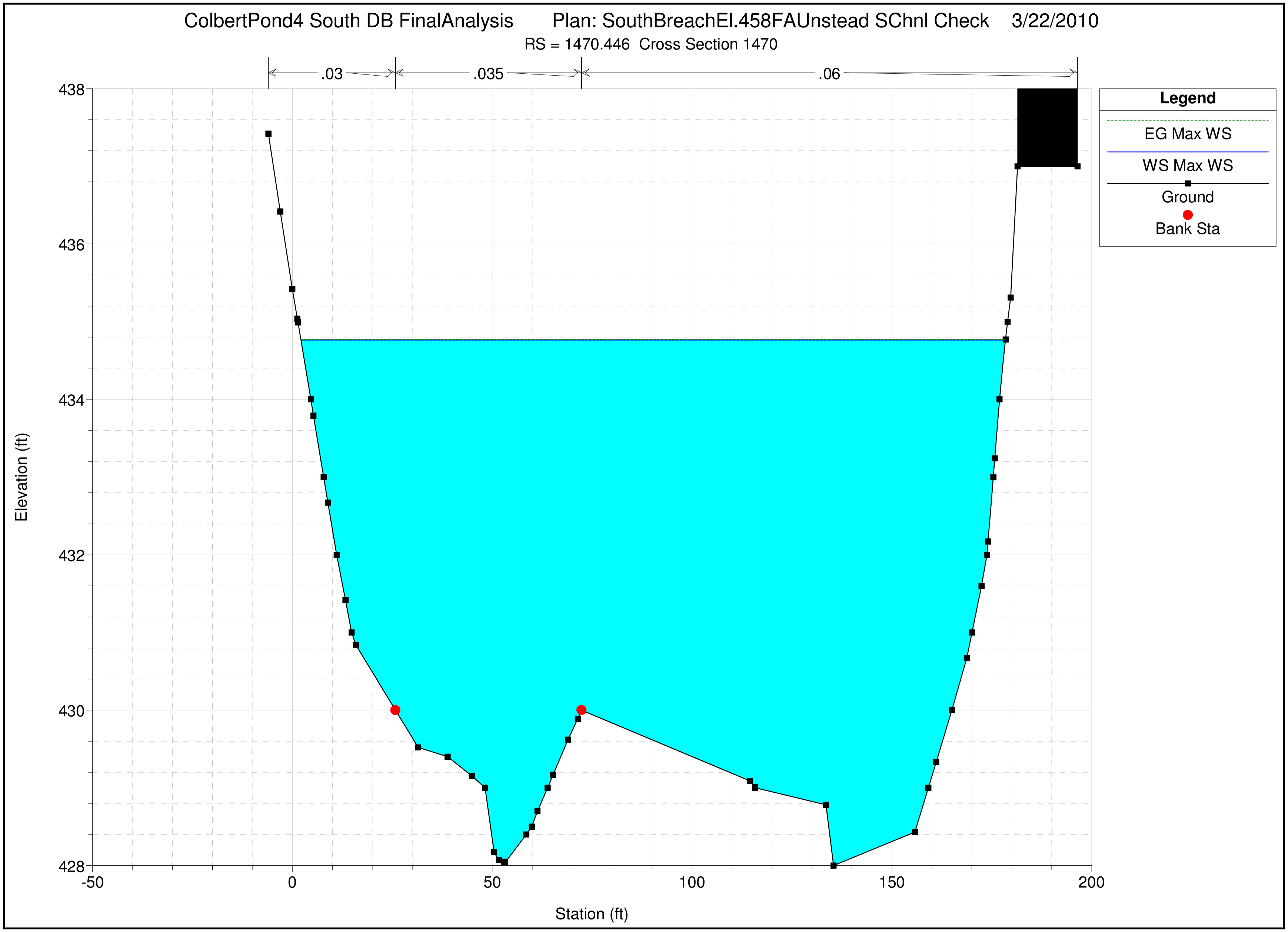
ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458FAUnstead SChnl Check 3/22/2010
RS = 2394.443 Cross Section - 2394
.03
.035
.03
.06
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
460
455
450
445
440
435
0
200
400
600
800
1000



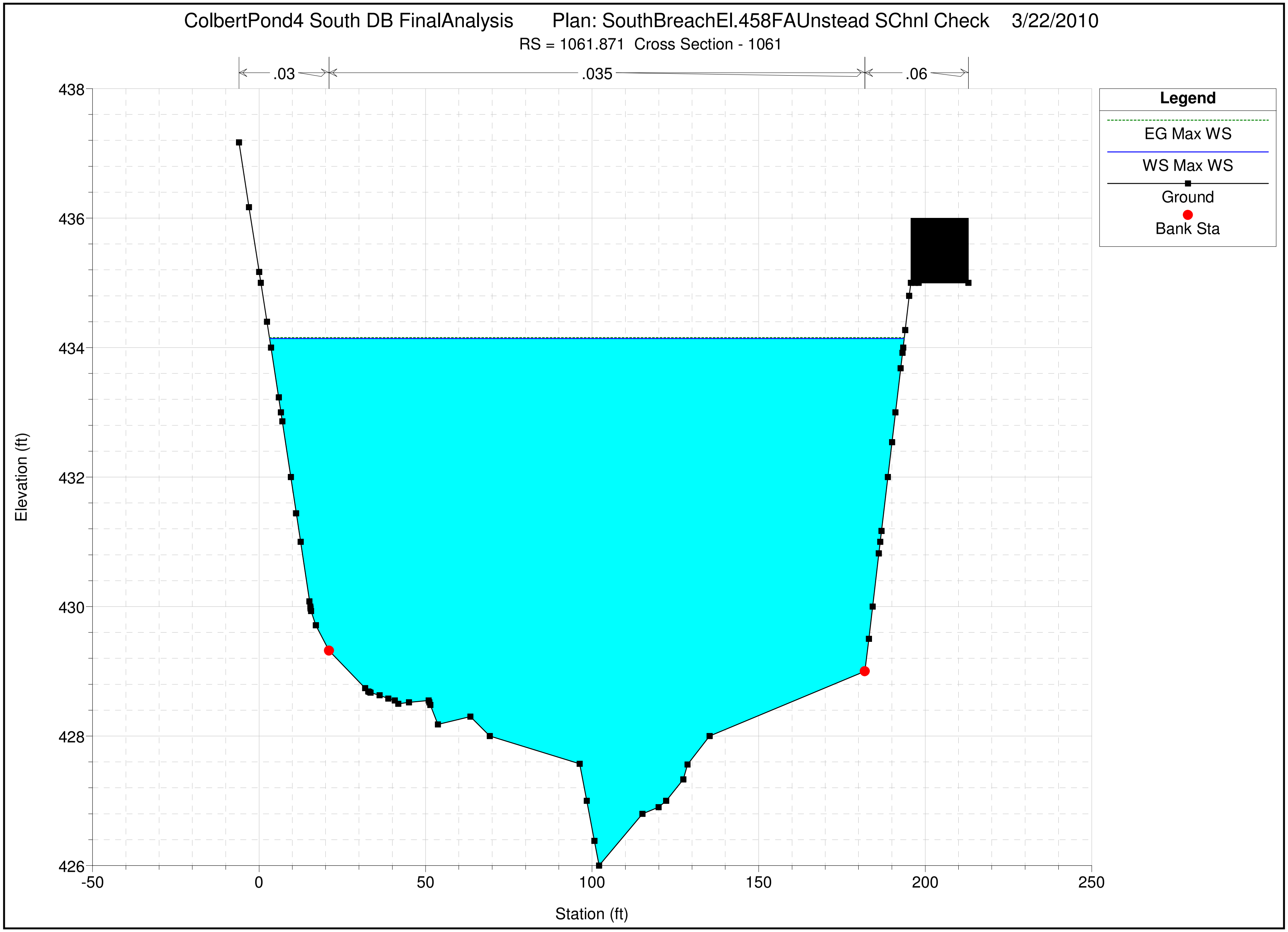
ColbertPond4 South DB FinalAnalysis
Plan: SouthBreachEl.458FAUnstead SChnl Check
3/22/2010
RS = 2096.035 Cross Section 2096
.03
.035
.03
.04
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
465
460
455
450
445
440
435
0
100
200
300
400
500
600
700
Station (ft)

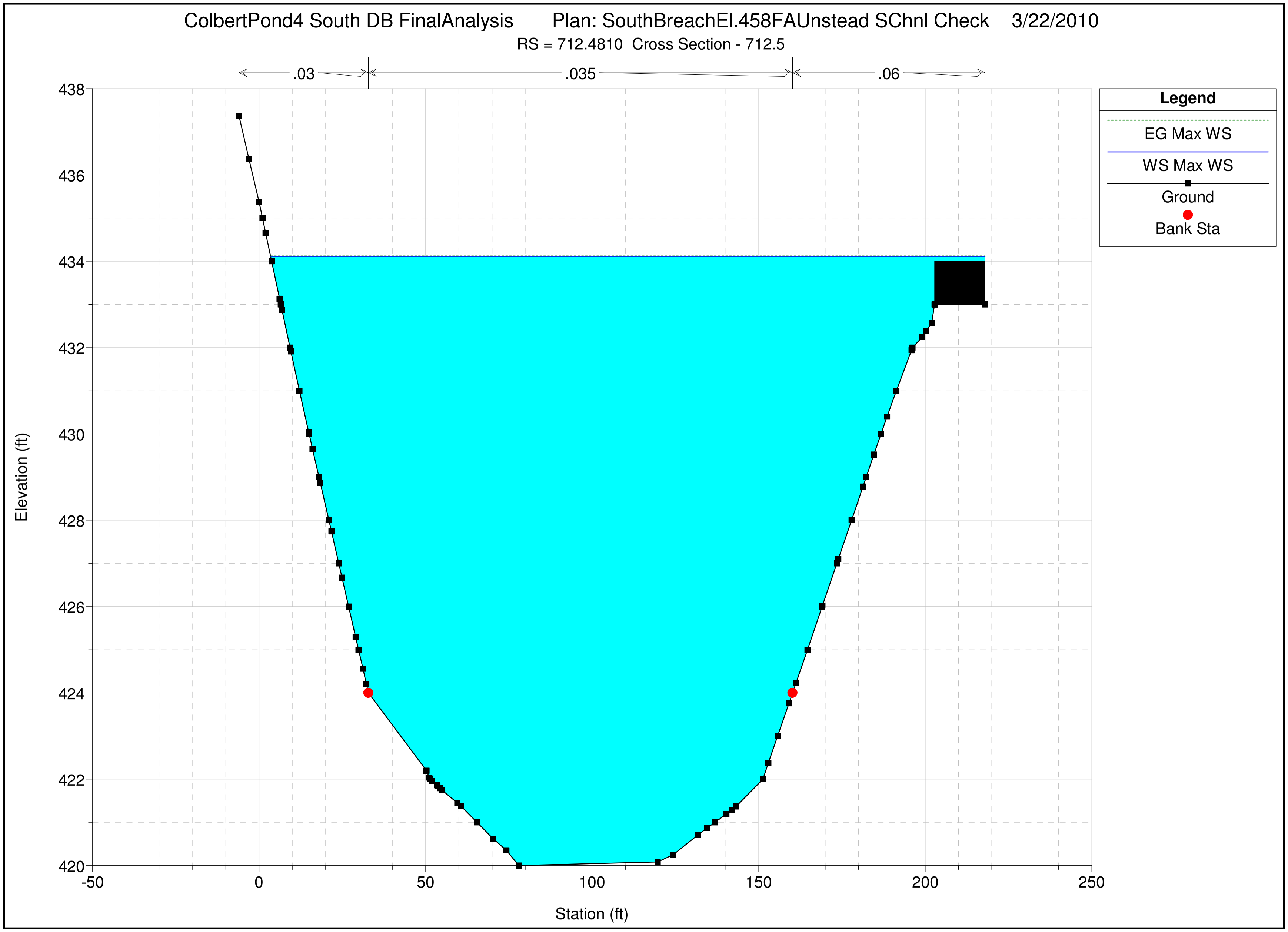


ColbertPond4 South DB FinalAnalysis
Plan: SouthBreachEl.458FAUnstead SChnl Check
3/22/2010
RS = 1719.138 Cross Section 1719
.03
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
440
438
436
434
432
Station (ft)
-50
0
50
100
150
200
250

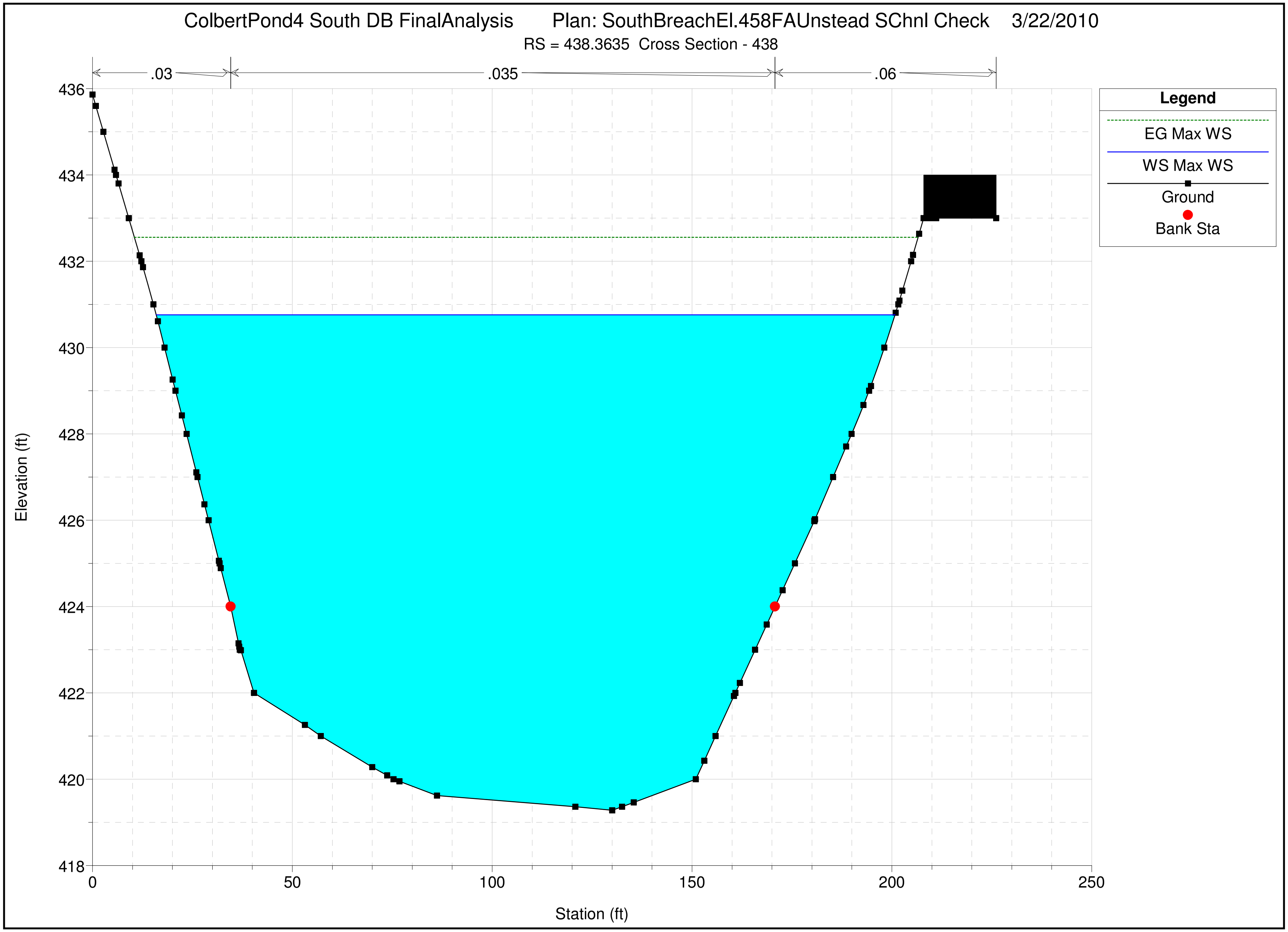


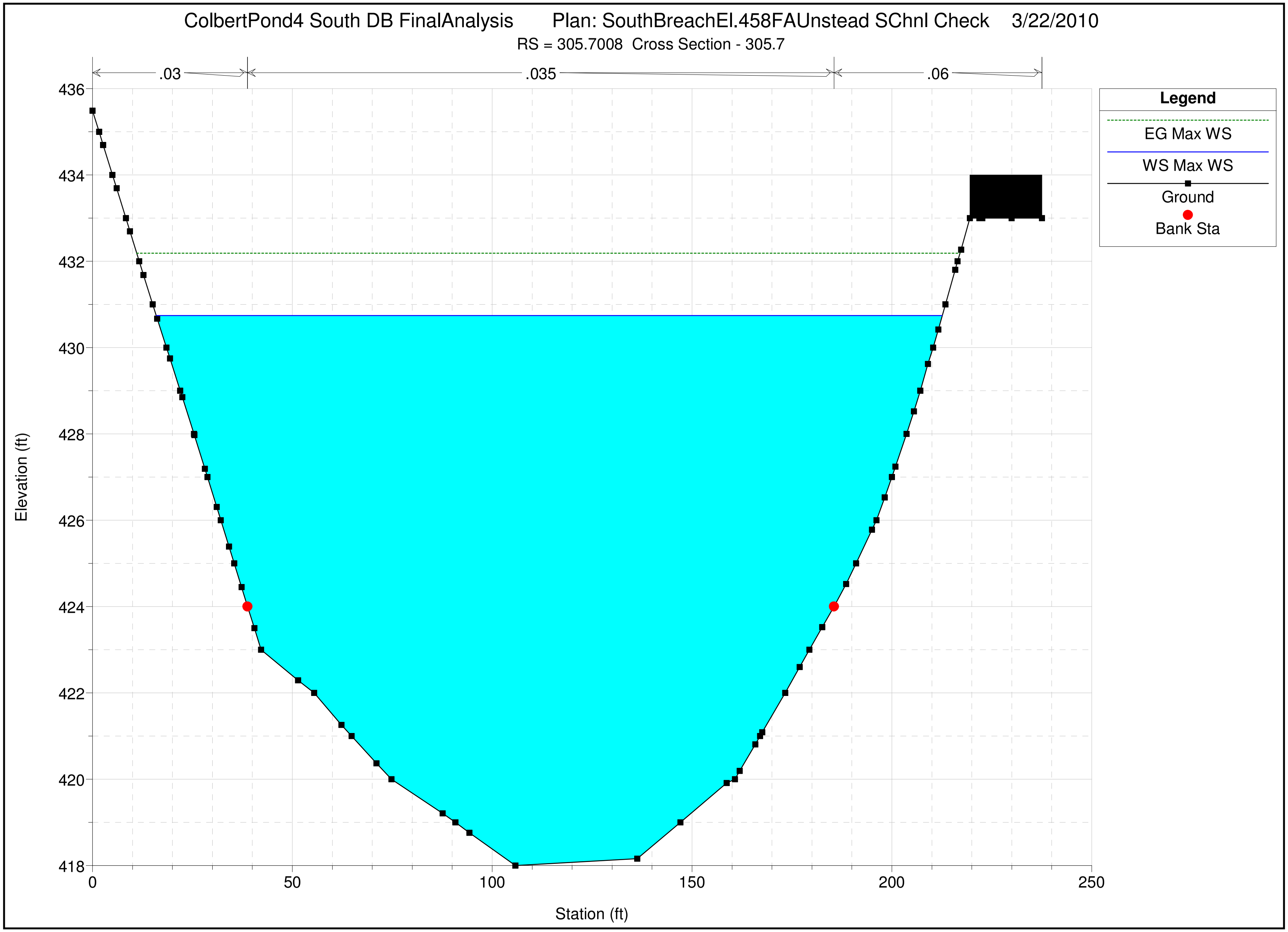
ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458FAUnstead SChnl Check 3/22/2010
RS = 1470.446 Cross Section 1470
.03
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
438
436
434
432
430
428
Elevation (ft)
-50
0
50
100
150
200
Station (ft)

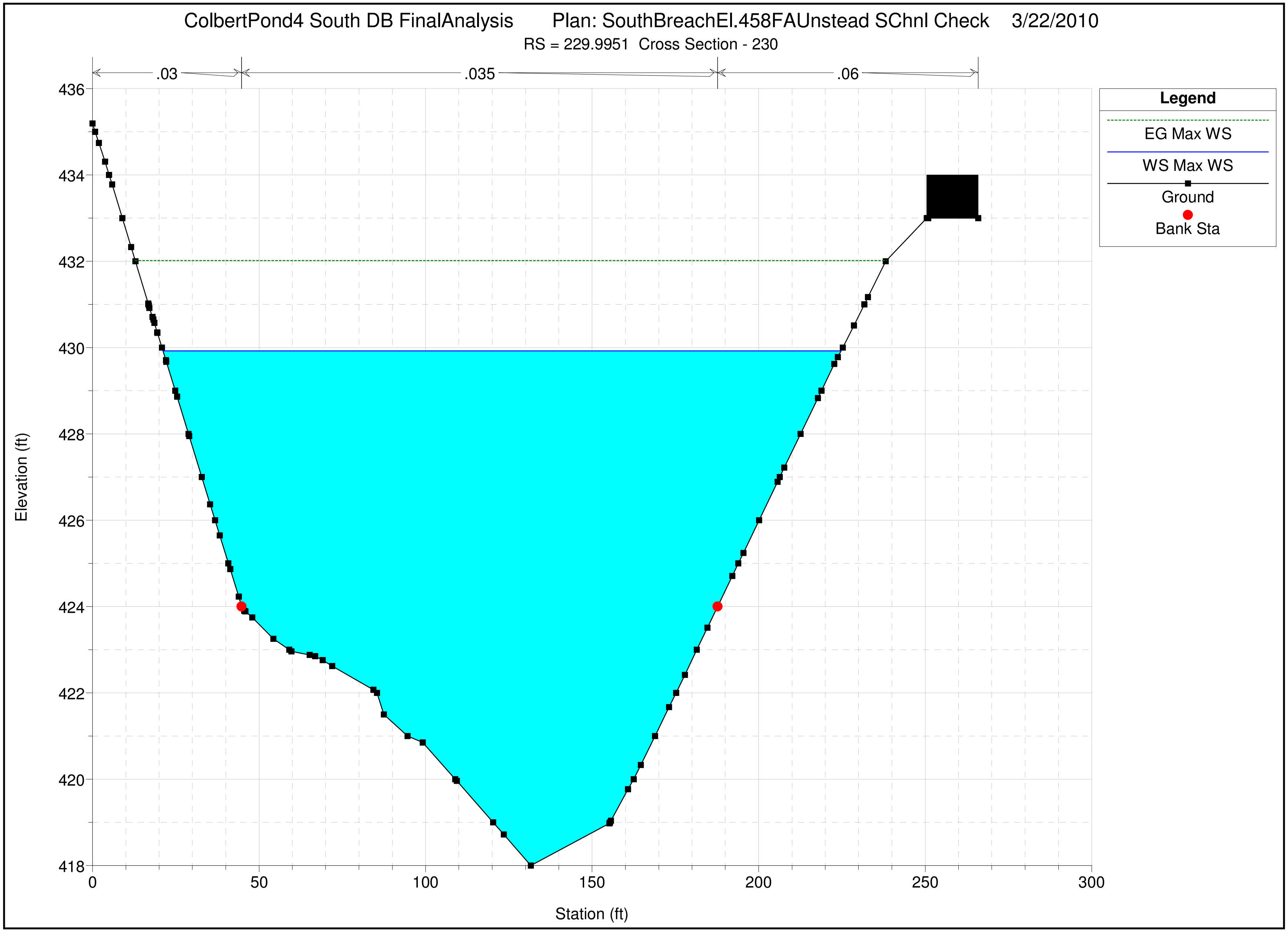

ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458FAUnstead SChnl Check 3/22/2010
RS = 1061.871 Cross Section - 1061
.03
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
438
436
434
432
430
428
426
-50
0
50
100
150
200
250



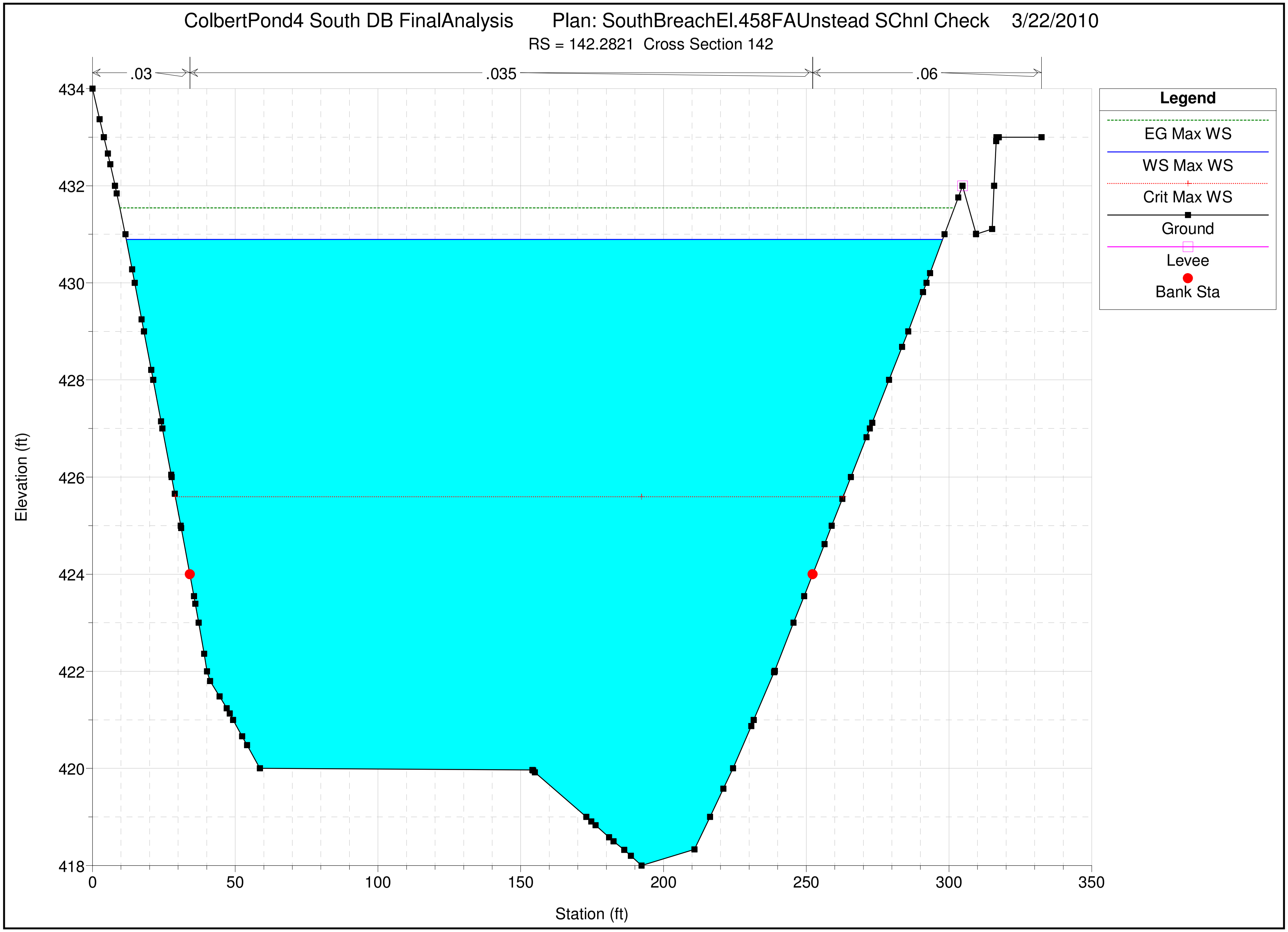
ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458FAUnstead SChnl Check 3/22/2010
RS = 712.4810 Cross Section - 712.5
.03
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
438
436
434
432
430
428
426
424
422
420
-50
0
50
100
150
200
250


ColbertPond4 South DB FinalAnalysis
Plan: SouthBreachEl.458FAUnstead SChnl Check
3/22/2010
RS = 438.3635 Cross Section - 438
.03
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
436
434
432
430
428
426
424
422
420
418
0
50
100
150
200
250
Station (ft)


ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458FAUnstead SChnl Check 3/22/2010
RS = 305.7008 Cross Section - 305.7
.03
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
436
434
432
430
428
426
424
422
420
418
0
50
100
150
200
250
Station (ft)



ColbertPond4 South DB FinalAnalysis Plan: SouthBreachEl.458FAUnstead SChnl Check 3/22/2010
RS = 229.9951 Cross Section - 230
.03
.035
.06
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
436
434
432
430
428
426
424
422
420
418
0
50
100
150
200
250
300



ColbertPond4 South DB FinalAnalysis
Plan: SouthBreachEl.458FAUnstead SChnl Check
3/22/2010
RS = 142.2821 Cross Section 142
.03
.035
.06
Elevation (ft)
434
432
430
428
426
424
422
420
418
0
50
100
150
200
250
300
350
Station (ft)
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Levee
Bank Sta

HEC-RAS Plan: SB458FAChk   River: SouthChannel   Reach: SouthReach   Profile: Max WS

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft)	
SouthReach	2394.443	Max WS	5.00	438.00	438.03		438.03	0.000000	0.00	425.65	0.00
SouthReach	2096.035	Max WS	667.84	436.00	437.81		437.83	0.000246	0.79	453.12	0.12
SouthReach	1907.586		Lat Struct								
SouthReach	1719.138	Max WS	964.31	432.00	434.92		435.15	0.003522	4.17	171.40	0.50
SouthReach	1470.446	Max WS	538.96	428.04	434.76		434.77	0.000040	0.85	176.31	0.06
SouthReach	1061.871	Max WS	974.92	426.00	434.14		434.15	0.000044	0.95	190.57	0.07
SouthReach	712.4810	Max WS	947.38	420.00	434.11		434.12	0.000005	0.52	214.51	0.03
SouthReach	438.3635	Max WS	16125.93	419.28	430.76		432.55	0.002983	10.96	184.81	0.60
SouthReach	305.7008	Max WS	16145.56	418.00	430.74		432.19	0.002283	9.83	196.65	0.53
SouthReach	229.9951	Max WS	16125.56	418.00	429.92		432.02	0.004169	11.86	203.56	0.70
SouthReach	142.2821	Max WS	16130.29	418.00	430.89	425.60	431.55	0.001001	6.57	285.90	0.35

Date: March 31, 2010

To: Mike Stepic

From: Frank Lan, Ph.D., P.E., and Max Shih, Ph.D.

Subject: **Summary of Dam Breach Analysis, TVA Colbert Fossil Plant Pond 4**

Introduction

This technical memorandum was prepared to summarize the results from a dam breach and flood inundation analysis for the tailings dam at TVA Colbert Fossil Plant Pond No. 4 (TVA Pond 4). The purpose of this analysis is to provide reasonable flood inundation mapping for classifying the dam hazard in case of an unexpected dam failure under static conditions, such as piping.

Four scenarios were analyzed in this study: 1) piping failure of the dam down to the bottom of the Bottom Ash for initial water surface elevations of 460’ and 458’ in the pond; and 2) piping failure of the dam down to the bottom of the Fly Ash with initial water surface elevations of 460’ and 458’ in the pond. In addition, an analysis was done to evaluate if the Bottom Ash could be eroded once the piping breach reach the top of the Bottom Ash. A set of inundation maps for all scenarios are prepared from the study.

The National Weather Services DAMBRK program was used to calculate the outflow hydrograph from each breach scenario. The 2-dimensional hydrodynamic mudflow model, FLO-2D developed by FLO-2D Software, Inc. was used for routing the outflow hydrograph from the breach location to downstream drainages. DAMBRK is a standard dam breach program used world-wide and is supported by regulatory agencies. FLO-2D is also a program that is supported by regulatory agencies especially FEMA for flood inundation mapping purposes. FLO-2D is suitable especially for flood with high concentration of sediment (hyperconcentrated flow or mud/debris flows), which might behave differently from traditional Newtonian fluid characteristics for clear water. The rheological model for the fly ash-water mixture was tested in the laboratory based on samples collected from the site. The results from the laboratory were used in the subsequent FLO-2D analysis.

To facilitate the dam breach and inundation mapping, digital elevation models were prepared based on the field survey. Particle characteristics of Fly Ash and Bottom Ash were assumed based on the geotechnical investigation by Law Engineering Inc. (Law) in 1995, and the additional boring samples taken by Stantec Consulting Services Inc. (Stantec) in January 2010.

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- USACE, HEC-RAS computer program (version 4.0)

Attachments

Appendix A.	Reference Materials
Appendix B.	Laboratory Rheological Test Results of Tailing Ash - Water Mixture
Appendix C.	Dam Breach Parameters Calculation
Appendix D.	Mudflow Properties Estimation
Appendix E.	
	Map 1. Dam Breach Inundation Map – Scenario I
	Map 2. Dam Breach Inundation Map – Scenario II
	Map 3. Dam Breach Inundation Map – Scenario III
	Map 4. Dam Breach Inundation Map – Scenario IV

Existing Condition and Field Information

The geotechnical report by Stantec (2010) was used to interpret the current conditions for the dike embankment and reservoir tailing material. Figure 1 illustrates the existing profile within TVA Pond 4 at the maximum embankment section. The top elevation of tailing on the upstream face of the embankment is approximately 457 ft. The pond water level at full storage is about 460 ft. The lower portion of the embankment is stacked ash including 9.5 ft bottom ash and 9.0 ft fly ash. The bottom ash is composed of mainly coarse sand while the fly ash is composed of mainly medium silt.

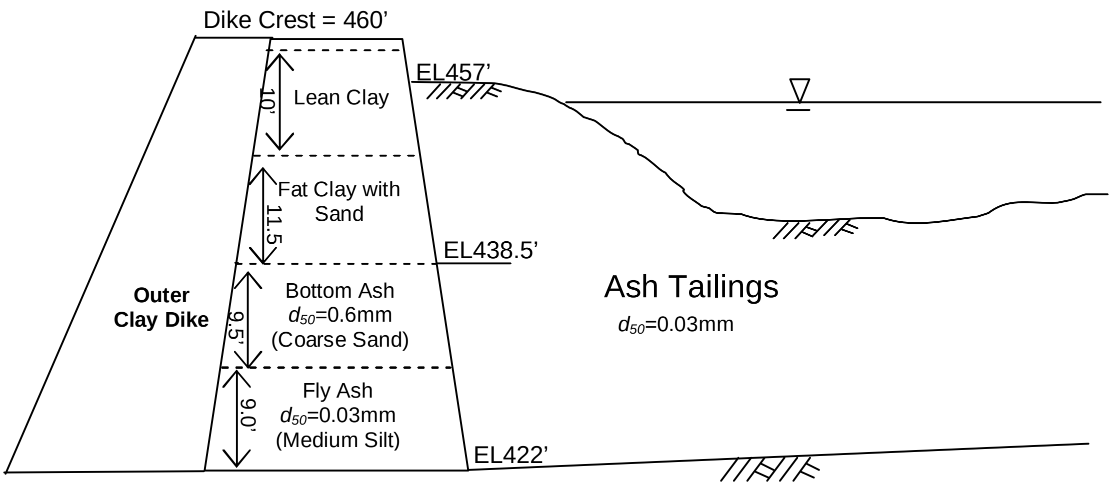


Figure 1. Existing N-S Profile of TVA Pond 4 at Boring No. STN-4-15 (For details**,** see boring log and profile in Appendix A**)**

The dam breach analysis for TVA Pond 4 was based on sunny-day conditions. The breach location selected in this analysis was on the south dike near the southeast corner of the pond. A failure of the dike at this location would potentially give the worse flooding scenario for the railroad just south of the pond. Potential seepage was identified in the geotechnical report (Stantec, 2010) at elevation 457 ft at which the top of the existing tailing ash is in the pond, based on current conditions. Consequently, all breach scenarios in this study assumed an initial piping elevation of 457 ft.

For the purpose of this analysis, the embankment and fly ash tailings were assumed to be saturated at the time of the hypothetical failure scenarios.

Dam Break Scenarios

Four dam breach scenarios were investigated for the purpose of this analysis and they are defined below.

Scenario I – Failure to Bottom Ash with an Initial Water Surface at 460':

Under this scenario, the failure was assumed to begin at the piping elevation of 457 and continue to the top of the Bottom Ash. The bottom ash layer, which is composed of coarse sand, was assumed to be able to withhold the erosive force from the initial breach and not to fail. The failure would subsequently stop at the top of the bottom ash layer (elevation = 438.5'). The dam was assumed to fail from piping at elevation 457 ft with the upstream water level at elevation 460 ft. The sediment-water mixture from tailing ash, eroded embankment, and pond water discharges through the breach opening to downstream drainage areas, and then eventually into Cane Creek. The rheological parameters of the sediment-water mixture were utilized in the subsequent flood routing analysis. In addition, the erosivity of the breached sediment-water mixture through the breach opening was estimated to evaluate if the bottom ash could be eroded subsequently.

Scenario II – Failure to Bottom of Fly Ash with an Initial Water Surface at 460':

In this scenario, the piping failure was assumed to reach the bottom of the fly ash in the embankment, assuming that the bottom ash material is not able to withhold the erosive force from the initial breach. The final breach bottom would reach the original reservoir bottom at elevation 422 ft. This scenario assumes that the dam fails from piping at elevation 457 ft with the upstream water level at elevation 460 ft and no inflow to the pond. The sediment-water mixture from tailing ash, eroded embankment, and pond water discharges through the breach opening to downstream drainage areas, and then eventually into Cane Creek. Upstream of the breach opening, a final breach channel/cone with a 3% slope, which is slightly smaller than the friction slope of saturated ash, was assumed to estimate the amount of ash that could be flushed out during the hypothetical breach, and subsequently the pond storage. In this scenario, there is a greater breach flow with higher sediment concentration than in Scenario I because of the greatest failure height and greatest water volume. This scenario is considered as the worst flood hazard scenario. The rheological parameters of the sediment-water mixture were utilized in the subsequent flood routing analysis.

Scenario III – Failure to Bottom Ash with an Initial Water Surface at 458':

This scenario is similar to Scenario I except the initial water level in the pond was assumed to be at 458 ft instead of 460 ft, which is 2 feet below the current dam crest. Due to a lower initial water level, the sediment concentration in the outflow is higher, and the breach width is narrower than in Scenario I. The rheological parameters of the sediment-water mixture were utilized in the subsequent flood routing analysis. In addition, the erosivity of the breached sediment-water mixture through the breach opening was estimated to evaluate if the bottom ash could be subsequently eroded.

Scenario IV – Failure to Bottom of Fly Ash with an Initial Water Surface at 458':

This scenario is similar to Scenario II except that the water level at the start of the breach was assumed to be at 458 ft, which is 2 feet below the current dam crest. The breach was assumed to reach the bottom of the dam at elevation 422 ft. Due to a lower initial water level, the breach width is less than in Scenario II. Upstream of the breach opening, a final breach channel/cone with a 3% slope was assumed to estimate the amount of ash that could be flushed out during the hypothetical breach, and subsequently the pond storage. The rheological parameters of the sediment-water mixture were utilized in the subsequent flood routing analysis.

Breach Volumes

For the four identified scenarios, the accumulated volumes of decant water and flushed ash tailing due to dam break were determined based on the site contours by using AutoCAD 2010. The calculated stage-volume relationships of TVA Pond 4 for failures to elevations 438.5 ft and 422 ft are illustrated in Table 1 and Figure 2. The soil properties were taken from Law (1995) and Stantec's (2010) studies. For this analysis, the soil was assumed saturated.

Table 1. Stage vs volume relationship of TVA Pond 4.

Elevation (ft)	Existing Pond Accumulated Water Volume (ac-ft)	Post-Breach Pond Accumulated Volume* (ac-ft)	Accumulated Ash Tailing Volume to be Breached (ac-ft)
460	362.0	553.2	191.2
458	303.6	494.8	191.2
456	259.6	440.8	181.2
454	222.1	388.2	166.1
452	186.3	336.9	150.6
450	152.4	287.2	134.8
448	120.8	239.6	118.9
446	91.7	194.3	102.6
444	65.2	151.3	86.1
442	41.7	111.0	69.3
440	22.3	74.4	52.1
438	7.9	43.7	35.8
436	0.1	29.8	29.7
435	0.0	27.2	27.2
434	-	24.7	24.7
432	-	16.0	16.0
430	-	9.4	9.4
428	-	4.7	4.7
426	-	1.7	1.7
424	-	0.3	0.3
422	-	0.0	0.0

*An accumulated pond volume was estimated based on an assumed breach profile slope of 3% at the final breach bottom (EL=422).

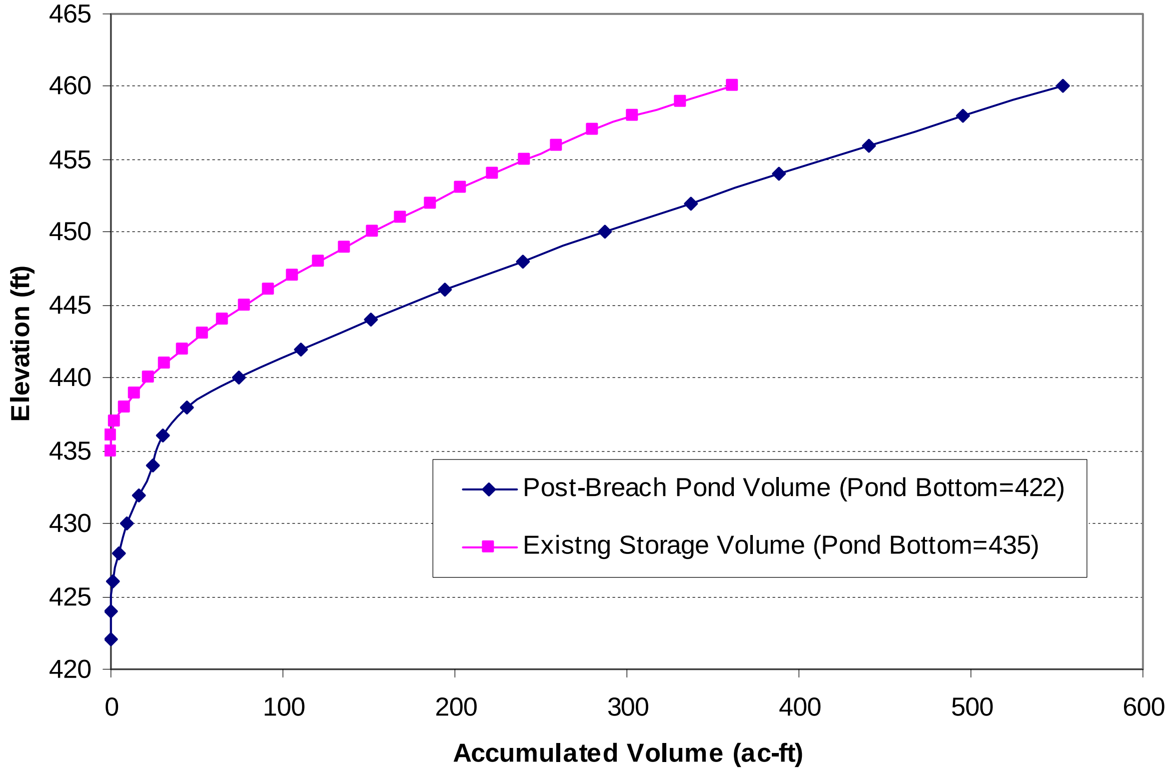


Figure 2. Stage vs Volume Curves of TVA Pond 4.

Dry soil volume can be estimated by using the following equation, based on the observed moisture content of field samples;

$$V_s = \frac{V_T}{(G_s \cdot \theta - 1)} \tag{1}$$

where V_s is the volume of dry soil; V_T is total saturated soil volume; G_s is the specific weight of dry soil and was assumed as 2.5; θ is the moisture content.

Determination of Dam Breach Parameters

The National Weather Services dam break simulation program, BOSS DAMBRK, simulates the breach of a dam based on the following breach parameters: bottom breach width, time to failure, pool elevation at time of failure, breach side slope, and the breach development exponent. DAMBRK assumes a trapezoidal breach that enlarges with time. The Federal Energy Regulatory Commission (FERC) guidelines state that the breach side slope for an engineered, compacted, earthen dam can range from 0.25:1 to 1:1 (H:V). A conservative breach side slope of 1:1 was utilized in this study.

Because the TVA Pond 4 dam is an engineered and compacted earthen dam, the dam breach parameters (breach bottom width and time of failure) were estimated by applying the Froehilch's

(1995) equations and Von Thun and Gillette's (1990) equations, two of the most popularly used methods for earthen dams. Table 2 shows the comparison of predicted dam breach parameters.

Table 2. Comparison of Predicted Dam Breach Parameters using Froehilch's (1995) and Von Thun and Gillette (1990) Equations

Scenario	Failure Height (ft)	Breach Side Slope	Froehlich (1995)		Von Thun & Gillette (1990)	
			Average Breach Width (ft)	Failure Time (hr)	Average Breach Width (ft)	Failure Time (*) (hr)
I	21.5	1(V):1(H)	57.8	0.5	74.0	0.9
II	38		65.7	0.3	115.0	0.8
III	21.5		55.2	0.5	69.0	0.9
IV	38		63.6	0.3	110.0	0.8

*) For erosion resistant material.

Practically, an average breach width in a range of 1 to 5 times of failure height is suggested for earthen dams for storage reservoirs by government agencies such as FERC (1998), USBR (1982), and COE (1980). For a tailings dam such as the TVA Pond 4, due to the massive tailing ash deposited on the upstream side of the dam, a longer failure time than predicted by the aforementioned empirical equations is more likely to happen. A long failure time produces a low peak breach flow. For conservativeness, however, the breach parameters using Froehilch's (1995) equations were selected, which produced the highest peak outflows. These predicted breach parameters were then used in the BOSS DAMBRK to determine the breach outflow hydrographs for the four selected scenarios. The selected parameters are summarized in Table 3. The dam breach parameters calculation sheets were attached in Appendix C.

Table 3. Selected Dam Breach Parameters based on Froehilch's (1990) Equation

Scenario	Initial WS (ft)	Breach Invert (ft)	Breach Side Slope	Average Breach Width (ft)	Failure Time (hr)	Embankment Failure Volume (ft^3)
I	460	438.5	1(V):1(H)	57.8	0.5	61,823
II		422		65.7	0.3	140,101
III	458	438.5		55.2	0.5	57,950
IV		422		63.6	0.3	131,074

Since breach flow is highly turbulent flow, the eroded soil and water were assumed to be completely mixed, and uniform sediment concentration was utilized for the subsequent mudflow modeling downstream of the dam. The eroded soil volume was counted as the total volumes of tailing ash and embankment failure above the breach bottom. The volumes and sediment concentrations of each scenario are listed in Table 4.

Table 4. Volumes of Water and Soil for all Breach Scenarios, and Average Sediment Concentration of Breach Flow.

Scenario	Initial W.S. (ft)	Final Breach Bottom (ft)	Water Volume (ft^3)	Dry Soil Vol. (ft^3)	Sed. Concentration, C_v
I	460	438.5	19,125,683	2,832,466	0.13
II		422	20,396,422	3,787,898	0.16
III	458	438.5	16,580,029	2,830,083	0.15
IV		422	18,392,251	3,240,860	0.15

Dam Breach Hydrograph Estimation Using BOSS DAMBRK Model

The above analysis indicates that assumed hypothetical breach would result in high concentration of more than 10%. In general, this type of sediment-water mixture would behave differently than clear water, and most likely is a Bingham Plastic Fluid (O'Brien and Julien, 1988). A Bingham plastic fluid could be characterized by sediment concentration, yield shear stress, and fluid dynamic viscosity:

$$\tau = \tau_y + \mu_m \frac{du}{dz} \qquad (2)$$

where τ is the shear stress, τ_y is the yield shear stress at which the mixture starts to move, μ_m is the dynamic viscosity, and (*du/dz*) is the shear rate normal to the flow direction.

The yield shear stress, τ_y, and dynamic viscosity, μ_m, are empirically expressed as exponential functions as shown (FLO-2D, 2007):

$$\tau_y = \alpha_2 e^{\beta_2 C_v} \qquad (3)$$

$$\mu_m = \alpha_1 e^{\beta_1 C_v} \qquad (4)$$

where τ_y is yield shear stress in dynes/cm^2; μ_m is dynamic viscosity of mixture in poises; $\alpha_1, \beta_1, \alpha_2$, and β_2 are empirical coefficients; and C_v is the sediment volumetric concentration.

Assuming a Bingham plastic fluid for the fly ash-water mixture, the yield stress and dynamic viscosity were determined in a separate laboratory test based on samples collected from TVA Pond 4 site. The lab test results are provided in Appendix B. The results are summarized in Table 5.

Table 5. Empirical Coefficients of Fly Ash-Water Mixture for TVA Pond 4

Sediment Source	Yield shear stress $\tau_y = \alpha_2 e^{\beta_2 C_v}$ (dynes/cm^2)		Dynamic viscosity of mixture $v_m = \alpha_1 e^{\beta_1 C_v}$ (poises)	
	α_1	β_1	α_2	β_2
TVA Pond 4 Ash Tailing	0.9778	8.148	0.00057	11.257

The predicted dam breach parameters, storage volumes, sediment concentrations of the mixtures, and related properties (Table 6) were then applied in the DAMBRK models to determine the breach outflow hydrographs. The calculation sheets for mudflow properties were given in Appendix D.

Four dam break models based on the selected scenarios were created using BOSS DAMBRK. The models extend from the upstream (northern) end of the tailing pond to a short distance downstream of the breach opening. In this study, the Manning's roughness, n, was assumed to be 0.035 for channel, 0.055 for overbank area, 0.02 for highway surface. A value of 0.05 was used in the DAMBRK models. The downstream boundary condition occurs in Can Creek and is based on normal depth calculation with a channel slope of 0.1%.

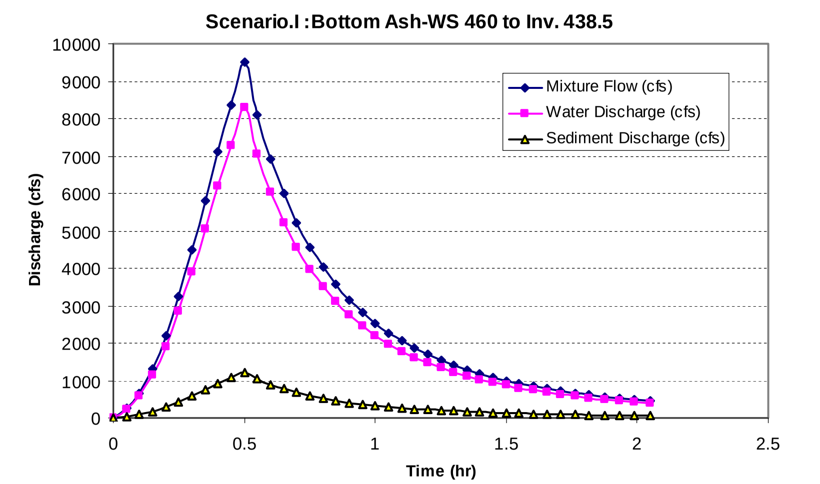
Table 6. Sediment-Water Mixture Properties for All Breach Scenarios

Scenario	C_v	Mudflow Dynamic Viscosity (lb-sec/ft^2)	Yield Stress (lb/ft^2)	Unit Weight (lb/ft^3)
I - (Bottom Ash)	0.13	0.000051	0.0058	74.5
II - (Fly Ash)	0.16	0.000069	0.0073	77.0
III - (Bottom Ash)	0.15	0.000061	0.0067	76.0
IV - (Fly Ash)	0.15	0.000064	0.0069	76.4

The simulated hydrographs are shown in Figure 3 and the computed peak discharges are listed in Table 7. The maximum peak discharge, 24,120 cfs, occurs under Scenario II with the failure to the bottom of the Fly Ash (elev. 422') at an initial water surface of 460 ft.

Table 7. DAMBRK Simulated Peak Breach Discharges

Scenario	Peak Outflow Discharge (cfs)
I - (Bottom Ash)	9,520
II - (Fly Ash)	24,120
III - (Bottom Ash)	8,150
IV - (Fly Ash)	22,870



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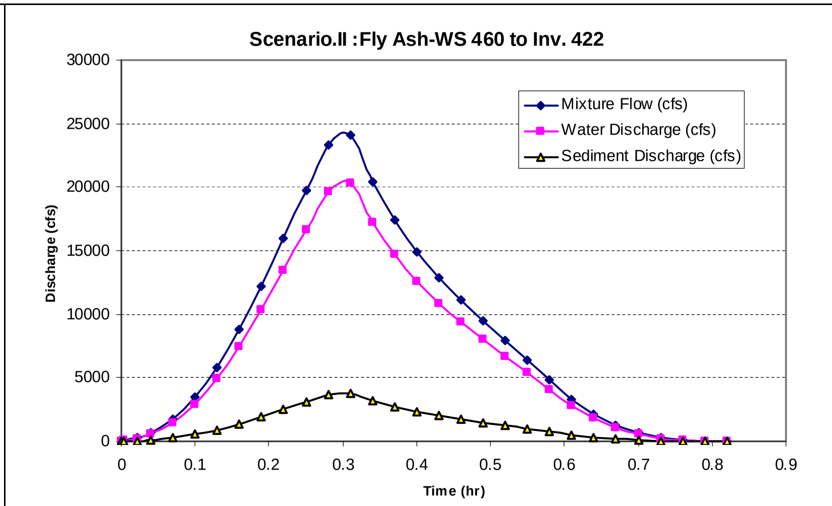

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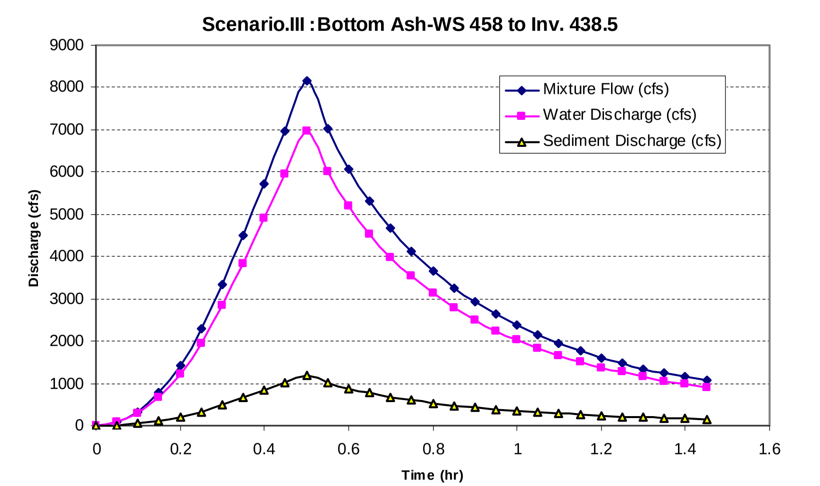

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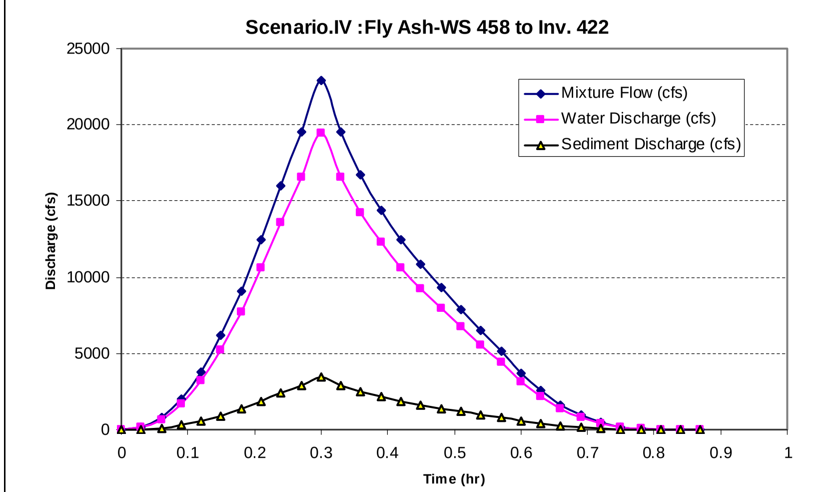

d.

Figure 3. Dam Breach Outflow Hydrographs for all Breach Scenarios

Estimation of Breach Flow Erosivity above the Bottom Ash Layer

The relatively coarse material in the Bottom Ash in the embankment raises the question if failure of the dam from the top layer (Scenarios I and III) would subsequently cause failure of the bottom ash. The following analysis evaluates whether the bottom ash could erode when the breach reaches this material.

The erodibility of the bottom ash was determined by comparing the resistance of the material to the erosivity of the breach outflow. Erosivity is the soil loss potential caused by flow. The hydraulic parameters during dam break were taken from BOSS DAMBRK models, which assume broad crested weir flow at the breach opening. Based on this assumption, a critical flow condition was adopted to determine the shear stress on the bottom ash at the dam embankment. The detailed calculations of critical flow are presented in Appendix D. The shear stresses acted by clear water and sediment-water mixture were both considered in this study. For clear water, the shear stress is expressed by

$$\tau_w = \gamma_w h S \tag{5}$$

where τ_w is shear stress acted by clear water; γ_w is specific weight of water and is 62.4 lb/ft^3; h is flow depth equal to the critical depth at the breach opening; and S is energy slope equal to the critical slope at the breach location. The computed clear water shear stresses are shown in Table 7.

The total fluid shear stress in hyperconcentrated sediment flow (or mud/debris flow) was expressed by the following quadratic rheological model (O'Brien and Julien, 1988).

$$\tau_m = \tau_y + \mu_m \frac{du}{dy} + \xi\left(\frac{du}{dy}\right)^2 \tag{6}$$

where τ_m is the shear stress of the fluid mixture; τ_y is the yield shear stress of the mixture; μ_m is the dynamic viscosity of the mixture; $\frac{du}{dy}$ is the velocity gradient normal to the flow direction; and ξ is an inertial shear stress coefficient. The calculation sheets for the total fluid shear stress are provided in Appendix D.

Once the shear stress is greater than the critical shear stress of particle incipient motion, bed particles will be moved from their original locations. The shear stress acting on bed particles can be expressed using the dimensionless Shields parameter τ_* (Julien, 1998);

$$\tau_* = \frac{\tau_m}{(\gamma_s - \gamma_m)d_s} \tag{7}$$

where γ_s is the specific weight of bottom sediment particles; γ_m is the specific weight of the fluid mixture, d_s is particle size; and τ_m is shear stress of mixture fluid near the bed. The mean particle size of the bottom ash is coarse sand (d_{50}=0.6mm). Assuming that the bottom ash is cohesiveless, the critical Shield parameter for the bottom ash particles is approximately 0.06 (Julien, 1998). A comparison of the flow shear stress and the critical shear stress in terms of the Shields parameter is provided in Table 7.

Table 7. Mix Flow Erosivity on the Embankment Bottom Ash

W.S. (ft)	τ_{water} (lb/ft^2)	$\tau_{mixture}$ (lb/ft^2)	Calculated Flow Shields Parameter τ_*		Critical Shields Parameter τ_{*c}
458	14.7	296	1874	>>	0.06
460	15.2	307	1909	>>	0.06

The computation indicates that the Shield parameter of mixture flow is much greater than the critical Shield parameter of coarse sand, under both initial starting water levels. The shear stress of mixture flow is more than one order of magnitude higher than that of clear water. The results indicate that the mixture flow is very erosive to the bottom ash. The bottom ash layer would be highly erodible and could be washed out easily during a dam break. Therefore, Scenarios II and IV were recommended to evaluate the potential hazard due to a dam break for TVA Pond 4.

Mudflow Inundation Area Delineation using FLO-2D

FLO-2D version 2007.6 was used to model the outflow hydrograph down the drainages away from the pond. The model was built on the digital elevation model (DEM) that was generated from survey contours to a raster data using ESRI ArcMap 9.3. The cell size of the raster surface is 10 feet by 10 feet. The outflow hydrographs of the four scenarios obtained from DAMBRK models were utilized as inflows to the FLO-2D model immediately downstream from the dam breach opening. The yield shear stress and dynamic viscosity were referred to the results from the lab tests. In addition, a bankfull flow, 134cfs, was considered as a base flow in Can Creek, based on normal flow at bank stage. The most downstream boundary condition in Can Creek is free outflow.

The inundation maps are attached in Appendix E.

Results and Conclusions

The analysis presented in this memorandum showed a relatively high erosive ability for the initially breach flow to scour the embankment to the bottom of the pond. Scenario II and IV, having breach depths reaching the bottom of the pond, were recommended to evaluate the potential hazard of TVA Pond 4 in the event of a dam failure.

The delineated inundation area maps, based on stimulated mudflood in all scenarios, indicate that only the overbank area in Cane Creek is flooded. The rail road and Highway 72 are not overtopped during any scenarios.

The hydraulic models using DAMBRK and FLO-2D are attached in Appendix F.

Attachments – A

Reference Materials

Stantec

Report of Geotechnical Exploration and Slope Stability Evaluation

Ash Pond 4
Colbert Fossil Plant
Tuscumbia, Alabama

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Prepared for
Tennessee Valley Authority
Chattanooga, Tennessee

January 22, 2010

- *Hydraulically Placed (sluiced) Ash:* This represents sluiced bottom ash/fly ash that is contained by the upper and lower dikes.

7.3. Seepage Analysis

7.3.1. SEEP/W Model

An analysis of steady state seepage through the Ash Pond 4 dikes was performed 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). The numerical seepage models for COF Ash Pond 4 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-section. 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.

Six dike cross-sections through Ash Pond 4 were modeled with SEEP/W, and then were subsequently evaluated for slope stability (Section 7.4). For the numerical analysis, each cross-section was subdivided into a mesh of elements, consisting of first-order quadrilateral and triangular finite elements. For seepage problems, where the primary unknown (hydraulic head) is a scalar quantity, first-order elements provide for efficient, effective modeling. Given appropriate hydraulic conductivity properties and applied boundary conditions, the finite element method (as implemented in the SEEP/W code) was then used to simulate steady seepage across the mesh. The total hydraulic head is computed at each nodal location, from which pore water pressures and seepage gradients can be determined.

7.3.2. Boundary Conditions

Piping failure elevation 457

Steady-state seepage was assumed for the analysis, with the static pool level placed at approximate El. 457 feet (based on TVA provided survey data).

Boundary conditions for the SEEP/W analysis were assumed as follows. Along the vertical, upstream edge of the model, the hydraulic head at each node was constant with depth and equal to the pool elevation. A total head equal to the pool level was also applied to all submerged nodes along the ground surface of the upstream side (submerged sluiced ash and interior upper dike). Along the vertical, downstream edge of the model, the hydraulic head at each node was constant with depth and equal to the Cane Creek elevation or piezometer reading closest to the edge, depending on cross-section location. 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 earthquake or other dynamic loads). For these conditions, soil unit weights and drained strength parameters (c' and ϕ') are needed.

The drained shear strength parameters used for the clay dikes and clay foundation materials were derived using results of laboratory triaxial tests, along with consideration given to standard penetration test data and laboratory classification test data. In addition, the strength parameters selected were further refined or confirmed by comparisons with the strength parameters listed in the TVA-provided historical reports. Representative strengths for each horizon were selected using the methodology outlined in the US Army Corps of Engineers Engineer Manual EM 1110-2-1902 as a guide. Results of triaxial testing were evaluated and effective stress p' versus q scatter plots were prepared of all of the data points. The maximum effective principal stress ratio was used to determine failure criteria for selection of these values within Stantec's laboratory test results. Once the p' versus q plots were prepared, a failure envelope was then selected such that two thirds of the plotted values were above the envelope. The p' versus q plots and selection of the failure envelope are shown for each horizon on the graphs presented in Appendix D. The strength parameters were rounded to the nearest degree with regards to ϕ'. The cohesion intercept point (c') was limited to a maximum of 200 pounds per square foot.

For non-cohesive native sands, shear strength parameters were estimated using published relationships which correlate SPT N-values with relative density, specific soil types and angles of internal friction.

In addition to the dike and foundation soils, both stacked and sluiced ash materials are present within Ash Pond 4. Shear strength parameters for ash materials were estimated using historical data, typical values, and published correlations using SPT N-values.

The following table provides a summary of the effective stress shear strengths selected for use in the slope stability analyses.

Table 7.3. Selected Strength Parameters for Stability Analyses

Soil Horizon	Unit Weight (pcf)	Effective Stress Strength Parameters	
		c' (psf)	Ø' (degrees)
Upper Dike	126	200	28
Lower Dike	127	200	29
Sluiced Ash	85	0	26
Native Clay/Silt	129	200	28
Native Sand	110	0	30
Stacked Ash	90	0	30

7.4.5. Results of Slope Stability Analysis

Using the strength parameters (c' and ϕ') listed in Table 7.3, in conjunction with the results of the seepage analyses and piezometer data, the existing dike configurations were analyzed at the six selected cross-sections. Geo-Slope's Slope/W computer program was used for the analyses with pore pressures imported from the seepage analyses. Separate analysis was also performed using the piezometer data instead of seepage model pore pressures for

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Dike Embankment Material

SUBSURFACE LOG

Project No.	175559016	Location	N 1721219.13, E 395347.89 (NAD27)
Project Name	Colbert Fossil Plant - TVA	Boring No.	STN-4-15 Total Depth 50.0 ft
Location	Colbert County, Alabama	Surface Elevation	460.5 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	7/27/09 Completed 7/27/09
Supervisor	Paul Cooper Driller S. Wilks	Depth to Water	19.0 ft Date/Time 7/27/09
Logged By	Greg Budd	Automatic Hammer ☒ Safety Hammer ☐ Other ☐	

Alt I,II @ 460

@ 458 Alt III, IV

Top of Tailings 457

initial piping failure elevation 457

Breach Scenarios : Bottom Ash

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft / Rec. Ft	Blows / Rec. %	Mois Cont. % / Run Depth	Remarks
460.5'	0.0'	Top of Hole							
~~460.0'~~	0.5'	Bottom Ash Road Surface		SPT-1	0.0 - 1.5	1.3	3-3-4	23	Boring advanced using 3 1/4" Hollow Stem Augers
		LEAN CLAY (upper dike), reddish brown to brown, moist, medium to very stiff, trace chert fragments and manganese concentrations		SPT-2	1.5 - 3.0	1.0	7-11-21	22	
				SPT-3	3.0 - 4.5	0.0	20-14-10	--	
				SPT-4	4.5 - 6.0	0.3	5-8-9	25	
				SPT-5	6.0 - 7.5	0.2	9-12-11	24	
				SPT-6	7.5 - 9.0	1.1	9-7-10	22	
450.0'	10.5'			SPT-7	9.0 - 10.5	1.3	4-5-5	26	
		FAT CLAY with Sand (uper dike), reddish brown and tan mottled gray, moist, stiff, trace chert fragments and manganese concentrations		SPT-8	10.5 - 12.0	1.4	5-5-6	23	
				SPT-9	12.0 - 13.5	1.5	6-7-9	21	
				SPT-10	13.5 - 15.0	1.5	2-3-3	25	
				SPT-11	15.0 - 16.5	1.5	4-6-7	34	
				SPT-12	16.5 - 18.0	1.5	5-6-6	26	
				SPT-13	18.0 - 19.5	0.5	2-2-2	30	
				SPT-14	19.5 - 21.0	1.5	1-2-2	27	
438.5'	22.0'			SPT-15	21.0 - 22.5	1.5	2-3-8	19	
		BOTTOM ASH, black, wet, very loose to loose		SPT-16	22.5 - 24.0	1.1	5-4-3	18	
		coarse sand $d_{50} = 0.6$ mm		SPT-17	24.0 - 25.5	1.0	4-2-2	24	
				SPT-18	25.5 - 27.0	1.0	2-1-1	23	
				SPT-19	27.0 - 28.5	0.4	2-2-2	20	
				SPT-20	28.5 - 30.0	1.0	2-4-2	22	
429.0'	31.5'			SPT-21	30.0 - 31.5	1.3	2-3-2	16	
		FLY ASH, black, wet, soft to medium		SPT-22	31.5 - 33.0	1.5	3-4-7	47	
				SPT-23	33.0 - 34.5	0.5	4-3-2	46	
				SPT-24	34.5 - 36.0	0.5	4-3-2	52	
				SPT-25	36.0 - 37.5	1.0	4-4-5	39	
				SPT-26	37.5 - 39.0	1.0	6-5-4	25	
420.0'	40.5'			SPT-27	39.0 - 40.5	1.1	2-3-3	21	
				SPT-28	40.5 - 42.0	1.0	2-2-1	21	
				SPT-29	42.0 - 43.5	0.8	1-1-1	23	

FHWA_LEGACY 175559016 BORINGS.GPJ FMSM.GDT 1/4/10

Stantec Tailing Fly Ash

SUBSURFACE LOG

Project No.	175559016	Location	N 1721539.59, E 394582.90 (NAD27)
Project Name	Colbert Fossil Plant - TVA	Boring No.	STN-4-17 Total Depth 58.9 ft
Location	Colbert County, Alabama	Surface Elevation	476.8 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	7/25/09 Completed 7/25/09
Supervisor	Paul Cooper Driller S. Wilks	Depth to Water	19.0 ft Date/Time 7/25/09
Logged By	Greg Budd	Automatic Hammer ☒	Safety Hammer ☐ Other ☐

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
476.8'	0.0'	Top of Hole							
476.3'	0.5'	Bottom Ash Road Surface		SPT-1	0.0 - 1.5	1.5	5-6-6	15	Boring advanced using 3 1/4" Hollow Stem Augers.
		BOTTOM ASH, black and gray, moist to wet, very loose to medium dense		SPT-2	1.5 - 3.0	1.4	8-9-9	41	
				SPT-3	3.0 - 4.5	1.5	7-9-9	20	
				SPT-4	4.5 - 6.0	1.0	8-8-8	13	
				SPT-5	6.0 - 7.5	1.0	9-11-12	27	
				SPT-6	7.5 - 9.0	1.2	10-12-12	16	
				SPT-7	9.0 - 10.5	1.5	5-6-4	22	
				SPT-8	10.5 - 12.0	1.5	4-3-6	23	
				SPT-9	12.0 - 13.5	1.3	7-8-8	18	
				SPT-10	13.5 - 15.0	1.5	4-5-6	39	
				SPT-11	15.0 - 16.5	1.5	5-8-8	24	
				SPT-12	16.5 - 18.0	1.2	4-4-3	27	
				SPT-13	18.0 - 19.5	1.5	2-2-2	35	
				SPT-14	19.5 - 21.0	1.2	2-2-1	43	
				SPT-15	21.0 - 22.5	0.6	1-1-1	35	
				SPT-16	22.5 - 24.0	0.7	1-1-1	38	
				SPT-17	24.0 - 25.5	1.5	WOH-1-1	70	
449.8'	27.0'			SPT-18	25.5 - 27.0	1.4	1-1-1	66	
		FLY ASH, black, wet, very soft		SPT-19	27.0 - 28.5	1.5	1-1-1	77	
				SPT-20	28.5 - 30.0	1.0	WOH-WOH-WOH	51	
				SPT-21	30.0 - 31.5	1.5	WOH-WOH-WOH	51	
				SPT-22	31.5 - 33.0	1.5	WOH-WOH-1	59	
				SPT-23	33.0 - 34.5	1.5	1-1-2	58	
		- Rod dropped 7.4' through fine fly ash from 34.5' to 41.9'		SPT-24	34.5 - 36.0	1.5	WOR-WOR-WOR	55	
		Tailing Deposition							
				SPT-25	42.0 - 43.5	1.5	1-2-2	34	

1/4/10

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SUBSURFACE LOG

Project No.	175559016	Location	N 1721539.59, E 394582.90 (NAD27)
Project Name	Colbert Fossil Plant - TVA	Boring No.	STN-4-17 Total Depth 58.9 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft	Blows	Mois.Cont %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft	Rec. %	Run Depth	Remarks
		FLY ASH, black, wet, very soft. *(Continued)* Tailing Deposition		SPT-26	43.5 - 45.0	1.5	1-1-1	41	
				SPT-27	45.0 - 46.5	1.3	WOH-WOH-WOH	33	
				SPT-28	46.5 - 48.0	1.5	WOH-WOH-WOH	40	
				SPT-29	48.0 - 49.5	1.5	WOH-WOH-1	39	
		- Rod dropped 6.0' through fine fly ash from 49.5' to 55.5'		SPT-30	49.5 - 51.0	1.5	WOR-WOR-WOR	36	
Breach Scenarios - fly ash 422		original Pond Bottom							
420.8'	56.0'								
		SANDY LEAN CLAY, dark orange brown, wet, very stiff, some fine to coarse sand		SPT-31	55.5 - 57.0	0.8	8-23-11	37	
				SPT-32	57.0 - 58.5	0.9	12-13-13	37	
417.9'	58.9'			SPT-33	58.5 - 58.9	0.4	50/0.4	26	
		Auger Refusal / Bottom of Hole Top of Rock = 58.9' Elevation (417.9')							Boring backfilled with bentonite grout from 0.0 ft. to 58.9 ft.

10-XXXMXX | 0 | 27

BORING LOCATION TABLE			
BORING	NORTHING	EASTING	ELEVATION
STN-4-1	1723599.5[illegible]	394[illegible]	460.2
STN-4-2	1723632.72	394[illegible].32	439.4
STN-4-3	1723645.94	394253.91	[illegible]
STN-4-4	[illegible]	39473[illegible]	460.4
STN-4-5	1723365.01	394798.52	439.5
STN-4-6	172[illegible]73.16	394864.54	[illegible]
STN-4-7	172[illegible]0.06	394960.[illegible]	460.8
STN-4-8	1722943.49	395089.90	421.6
STN-4-9	172[illegible]5.36	39[illegible].37	461.2
STN-4-10	[illegible]	395401.10	420.9
STN-4-11	[illegible]188[illegible]	3954[illegible]	[illegible]
STN-4-12	1721504.87	39574[illegible].27	[illegible]
STN-4-13	172133[illegible]	3956[illegible]	[illegible]
STN-4-14	1721420.08	39[illegible]3	461.[illegible]
STN-4-15	1721219.13	395347.8[illegible]	[illegible]
STN-4-16	[illegible]126.23	39[illegible]	[illegible]
STN-4-17	172[illegible]539.59	[illegible]4582.[illegible]	[illegible]
STN-4-18	[illegible]721402.1[illegible]	[illegible]	[illegible]
STN-4-19	172[illegible]	39[illegible]75.66	[illegible]
STN-4-20	[illegible]	[illegible]	[illegible]
STN-4-21	172[illegible]5.1[illegible]	394262.71	[illegible]
STN-4-22	1721957.70	394065.63	[illegible]0
STN-4-23	[illegible]22728.4[illegible]	[illegible]7.94	[illegible]
STN-4-24	1722823.1[illegible]	394138.84	444.5

LEGEND

- SOIL BORING WITH CONTINUOUS STANDARD PENETRATION TESTS AND/OR SHELBY TUBE SAMPLING
- SOIL BORING WITH CONTINUOUS STANDARD PENETRATION TESTS AND/OR SHELBY TUBE PISTON SAMPLING, AND PIEZOMETER INSTALLATION
- SOIL BORING WITH CONTINUOUS STANDARD PENETRATION TESTS AND/OR SHELBY TUBE SAMPLING, ROCK CORE AND PIEZOMETER INSTALLATION

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

PROJECT REVISION HISTORY

SCALE: 1"=100' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION
BORING AND STABILITY
CROSS-SECTION PLAN

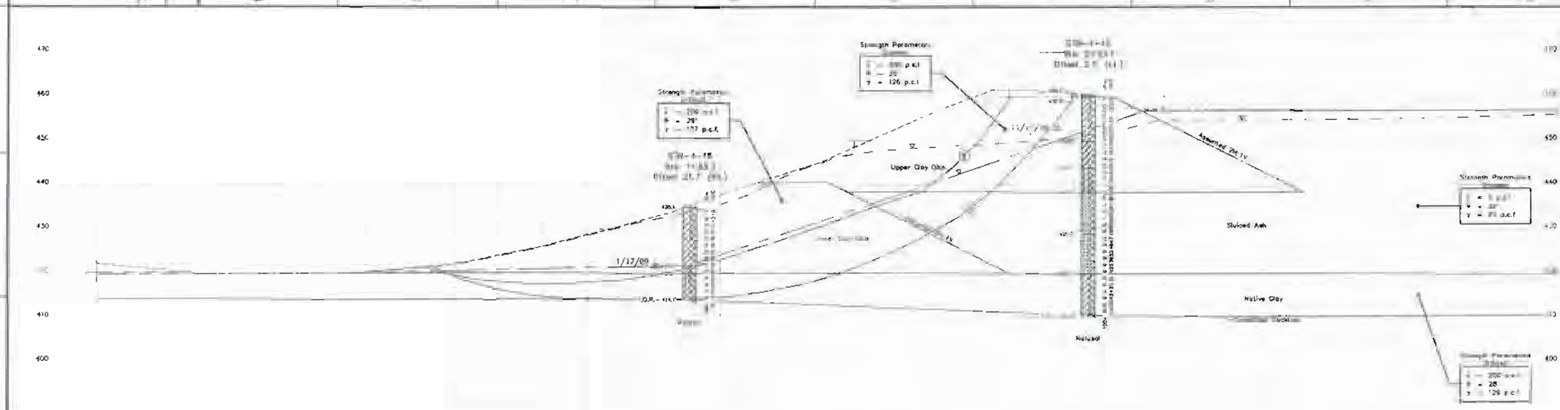
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Stantec

XXWXXX-01

PLOT FACTOR XX

STANTEC



LEGEND

- Lean Clay, Sandy Lean Clay, Lean Clay with Sand
- Silty, Clayey Sand
- Fat Clay, Fat Clay with Sand
- Overburden
- Silty Clay
- Poorly Graded Sand
- Silty Sand
- Silt, Sandy Silt, Silt with Sand
- Limestone
- Fly Ash
- Bottom Ash

WH Weight of Hammer
WR Weight of Rods
Standard Penetration Test Interval
Undisturbed Thin-walled (Shelby) Tube Sample
Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C. Natural Moisture Content (%)
Unit Weight Wet (lbs./cu.ft.)
Unit Weight Dry (lbs./cu.ft.)
U.C./U.U. Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/08 Piezometer Water Level Reading and Date Recorded
Phreatic Surface from PZ Data
Phreatic Surface from Seepage Model
T.O.R. – Top of Rock (indicates the beginning of rock-like resistance to the advancement of the auger. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
Begin Rock Core
Rock Quality Designation (%)
Recovery (%)
Refusal Auger Refusal using a carbide tipped tooth auger bit
No Refusal No Refusal Encountered
• Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer to boring log.

CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Location	[illegible]		
Depth	5.0'-5.9'	[illegible]	[illegible]
Φ	[illegible]		
C	[illegible]		
Location	[illegible]		
Depth	[illegible]	[illegible]	[illegible]
Φ	[illegible]		
C	[illegible]		

SUMMARY OF OFFSET BORINGS

Boring #	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION

Failure Surface	Failure Mode	Factor of Safety
A	[illegible]	[illegible]
B	[illegible]	[illegible]

Section G-G'

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

PROJECT REVISION HISTORY

SCALE: 1"=10' EXCEPT AS NOTED

ASH POND A

GEOTECHNICAL EXPLORATION
STABILITY SECTION G-G'

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

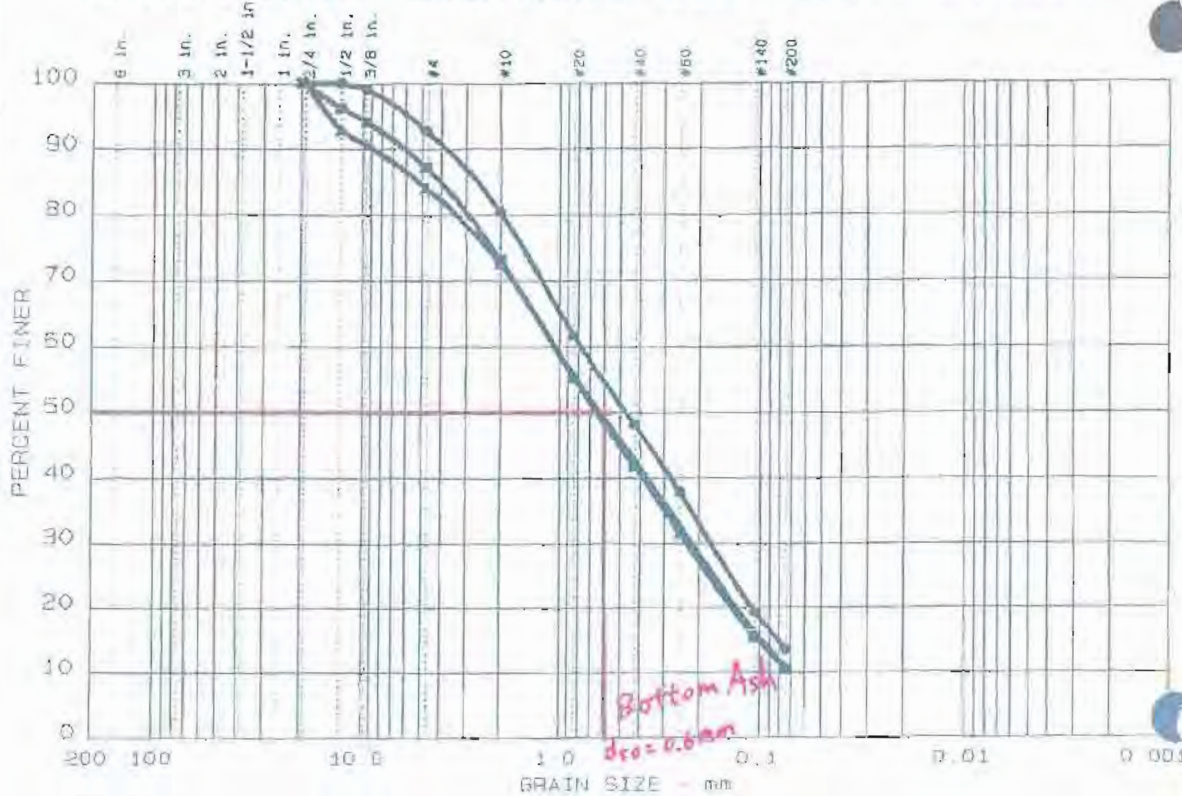
XXWXXX-08

STANTEC

C.A.D. DRAWING
DO NOT ALTER MANUALLY

37 C XXWXXX-08

GRAIN SIZE DISTRIBUTION TEST REPORT



Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
● 12	0.0	7.2	79.2	13.6	
▲ 13	0.0	15.9	73.3	10.8	
■ 14	0.0	12.8	76.7	10.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	2.60	0.78	0.46	0.176	0.0804			
▲	NL	NP	5.13	1.04	0.62	0.219	0.0966			
■	NL	NP	4.03	1.08	0.65	0.232	0.1012			

	MATERIAL DESCRIPTION	USCS	AASHTO
●		SM	A-1-b
▲		SP-SM	A-1-b
■		SP-SM	A-1-b

Project No.: 5810860101
Project: TVA - Colbert
● Location: Bottom Ash A & B
▲ Location: Bottom Ash C & D
■ Location: Bottom Ash E & F
Date: July 18, 1995

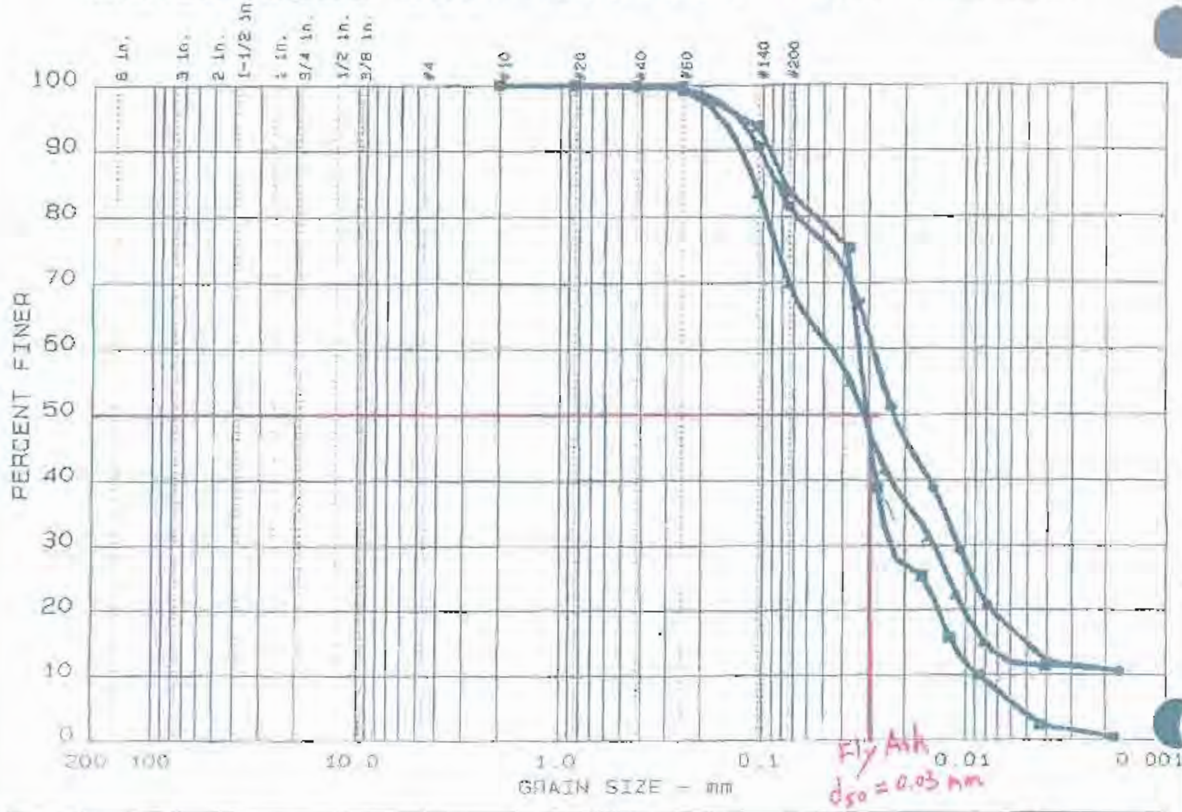
Remarks:
Tested by: JOE
Reviewed by: HJ

GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING, INC.

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	9	0.0	0.0	18.4	66.7	14.9
▲	10	0.0	0.0	30.1	58.4	11.5
■	11	0.0	0.0	16.4	79.7	3.9

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	0.09		0.02	0.011	0.0050			
▲	NL	NP	0.11		0.03	0.014	0.0080			
■	NL	NP	0.08		0.03	0.024	0.0116	0.0086	1.93	3.9

	MATERIAL DESCRIPTION	USCS	AASHTO
●	Units 1-4	ML	A-4(0.0)
▲	Units 1-4	ML	A-4(0.0)
■	Units 1-4	ML	A-4(0.0)

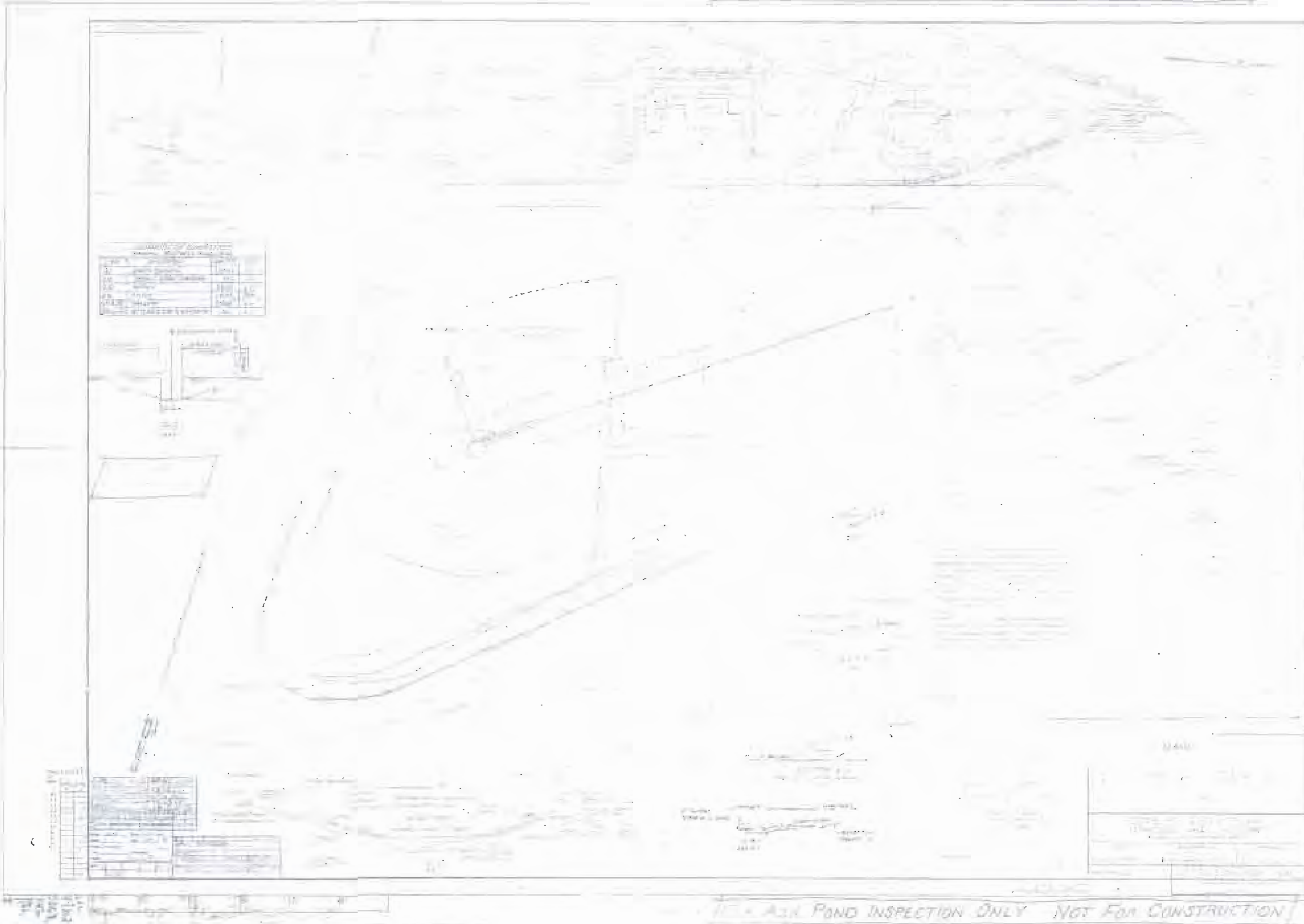
Project No. 5810860101
Project: TVA - Colbert
● Location: Dry Fly Ash A & B
▲ Location: Dry Fly Ash C & D
■ Location: Dry Fly Ash E & F
Date: July 18, 1995

Remarks:
Tested by: JOR
Reviewed by: [illegible]

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

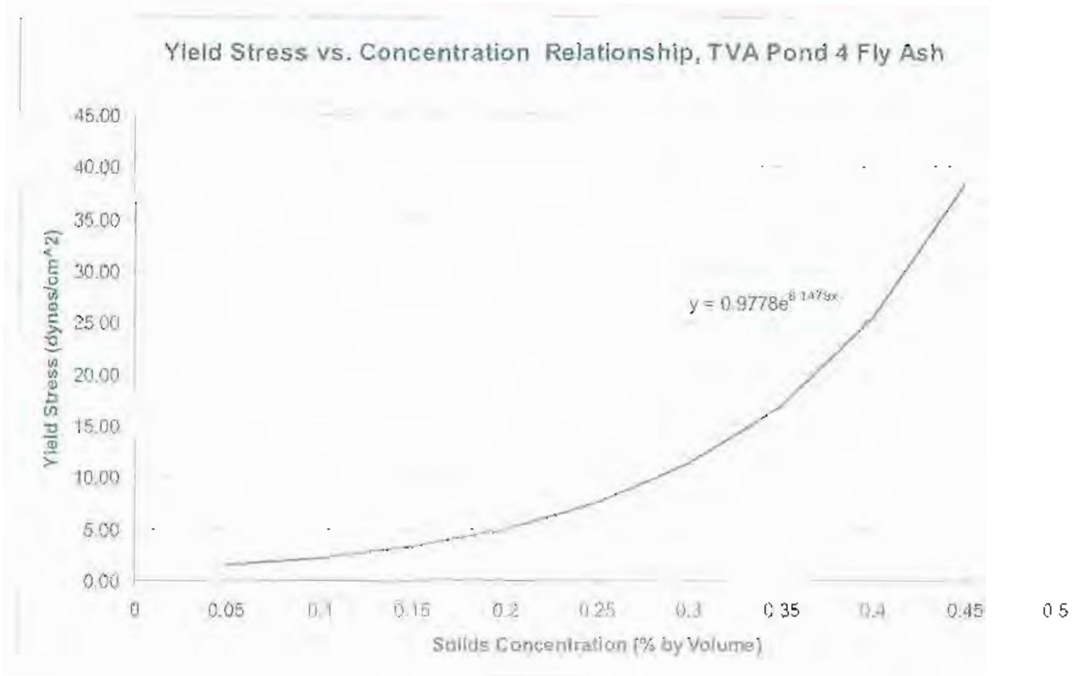
FOR ASH POND INSPECTION ONLY - NOT FOR CONSTRUCTION



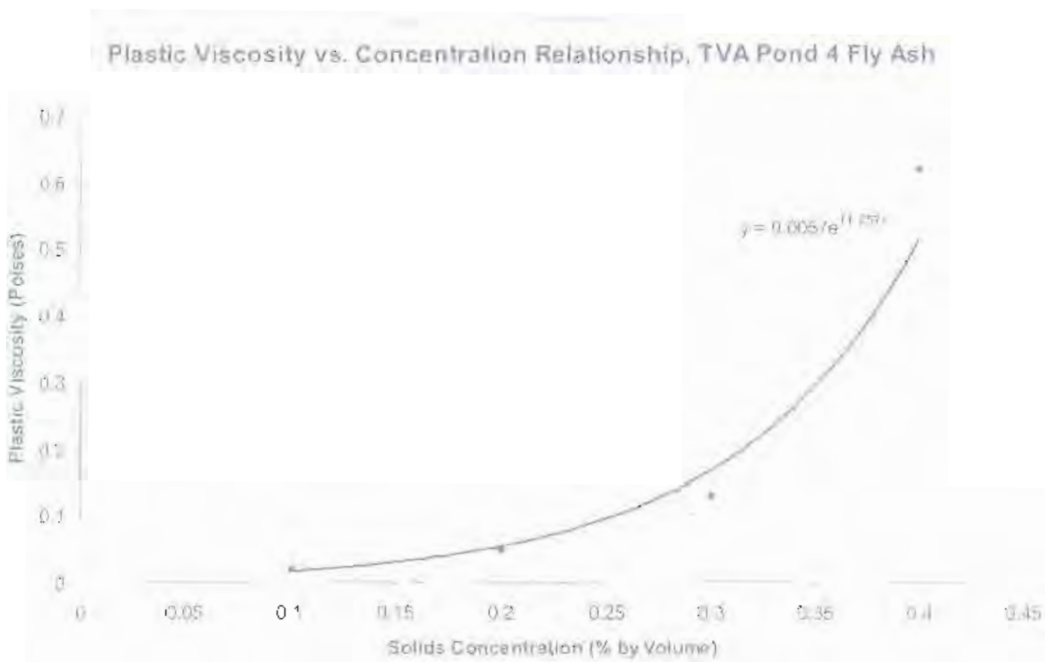
FOR ASH POND INSPECTION ONLY - NOT FOR CONSTRUCTION

Attachments – B

Mixture of Tailing Ash and Water
Laboratory Test Results



Yield Stress vs. Concentration Relationship, TVA Pond 4 Fly Ash
Yield Stress (dynes/cm^2)
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
y = 0.9778e^8.1479x
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
Solids Concentration (% by Volume)



Plastic Viscosity vs. Concentration Relationship, TVA Pond 4 Fly Ash
Plastic Viscosity (Poises)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
y = 0.0057e
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
Solids Concentration (% by Volume)

BENTONITE COMPATIBILITY
API RP 13A & 13B

Client Name: URS Corporation

Job No :2093-225

Type of Bentonite:Fly Ash
Leachate Description:Tap Water
Project Description: TVA COF Pond4

Date Sampled:–
Date Tested:02/11/10 DPM
Project #: 318511

Rheometer Readings

Sample ID	Temp °C	300 rpm (cp)	600 rpm (cp)	Gel Strength (lb/100 ft²)		Plastic Viscosity (cp)	Yield Point (lb/100ft²)	Yield Point/Plastic Viscosity	Apparent Viscosity (cp)
				10 sec	10 min				
10% Fly Ash	22.4	3	5	0	0	2	1	0.5	2.5
20% Fly Ash	22.4	6	11	1	2	5	1	0.2	5.5
30% Fly Ash	22.5	15	28	6	6	13	2	0.15	14
40% Fly Ash	22.5	68	130	17	20	62	6	0.09	65
50% Fly Ash	---	---	---	---	---	---	---	---	---

Notes: The 10% sample started settling within seconds of the initial mixing being stopped.
The 20% sample settled during the testing.
The 50% sample was too thick to test. It did not contain enough water to achieve a fluid like state.
Per client instructions, the samples were mixed volumetrically. A Specific Gravity of 2.31g/cc was used in the calculations.

DATA ENTERED BY: DPM DATE: 02/24/10
DATA CHECKED BY: KR DATE: 2/24/10
FILENAME: WCBCFA13

ATT

Attachments – C

Dam Breach Parameters
Calculation

DAM BREACH PARAMETER CALCULATION

Froehlich Breach Predictor Equations (1995)

Project Name: TVA - Colbert Fossil Plant Pond 4

Description: Estimate breach parameters with a breach invert of 438.5 where the top of bottom ash. (Initial WS= 460) - Scenario I

Job No.: 31851118.41

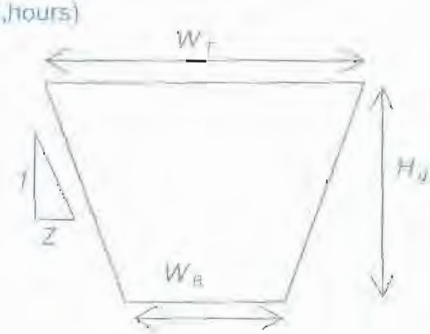
Data: 03.09.2010

Constant, K=	1	ft (1.4 for overtopping failure and 1.0 for piping failure)
Top of Dam Crest=	460	ft
Stored Water Volume, V_w=	19125683	ft^3
Breach Invert=	438.5	ft
Breath Slope, Z=	1	H:1V
Crest Length, W=	16	ft
DamFront Face Slope, Zf=	3	H:1V
Dam Back Face Slope, Zb=	2	H:1V
Failure Depth, H_d=	21.5	ft
Average Breath Width, b=	57.8	ft
Time of Failure, t_f=	0.5	hr
Breach Top Width, W_T=	79.3	ft
Breach Bottom Width, W_B=	36.3	ft
Dam Breach Volume=	61,823	ft^3

Froehlich Breach Predictor Equations (1995) in SI units (meters, m3/s,hours)

$$B = 0.1803\, K V_w^{0.32} h_d^{0.19}$$

$$t_f = 0.00254 V_w^{0.53} h_d^{-0.9}$$



Reference:

1. Froehlich, D. C. 1995(a). "Peak Outflow from Breached Embankment Dam," Water Resources Engineering Proceedings of the 1995 ASCE Conference on Water Resources Engineering, San Antonio, Texas, August 14-18, 1995, 887-891.

2. Froehlich, D. C. 1995(b). "Embankment Dam Breach Parameters Revisited," Journal of Water Resources Planning and Management, 121(1), 90-97.

Prepared by Hui-Ming (Max) Shih, Ph.D., CFM

DAM BREACH PARAMETER CALCULATION

Froehlich Breach Predictor Equations (1995)

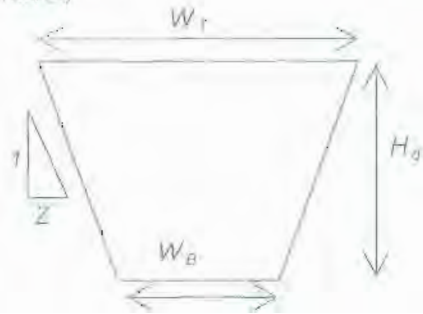
Project Name: TVA - Colbert Fossil Plant Pond 4
Description: Estimate breach parameters with a breach invert of 422 where the original invert of TVA Pond 4. (Initial WS= 460)- Scenario II
Job No.: 31851118.41
Data: 03.09.2010

Constant, K=	1	ft (1.4 for overtopping failure and 1.0 for piping failure)
Top of Dam Crest=	460	ft
Stored Water Volume, V_w=	20396422	ft^3
Breach Invert=	422	ft
Breath Slope, Z=	1	H:1V
Crest Length, W=	16	ft
DamFront Face Slope, Zf=	3	H:1V
Dam Back Face Slope, Zb=	2	H:1V
Failure Depth, H_d=	38	ft
Average Breath Width, b=	65.7	ft
Time of Failure, t_f=	0.3	hr
Breach Top Width, W_T=	103.7	ft
Breach Bottom Width, W_B=	27.7	ft
Dam Breach Volume=	140,101	ft^3

Froehlich Breach Predictor Equations (1995) in SI units (meters, m3/s,hours)

$$B = 0.1803\, K V_w^{0.32} h_d^{0.19}$$

$$t_f = 0.00254 V_w^{0.53} h_d^{-0.9}$$



Reference:

1. Froehlich, D. C. 1995(a). "Peak Outflow from Breached Embankment Dam," Water Resources Engineering, Proceedings of the 1995 ASCE Conference on Water Resources Engineering, San Antonio, Texas, August 14-18, 1995, 887-891

2. Froehlich, D. C. 1995(b). "Embankment Dam Breach Parameters Revisited," Journal of Water Resources Planning and Management, 121(1), 90-97.

Prepared by Hui-Ming (Max) Shih, Ph.D., CFM

DAM BREACH PARAMETER CALCULATION

Froehlich Breach Predictor Equations (1995)

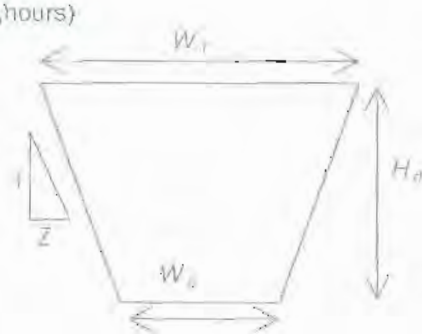
Project Name: TVA - Colbert Fossil Plant Pond 4
Description: Estimate breach parameters with a breach invert of 438.5 where the top of bottom ash. (Initial WS= 458) Scenario III
Job No.: 31851118.41
Data: 03.09.2010

Constant, K=	1	ft (1.4 for overtopping failure and 1.0 for piping failure)
Top of Dam Crest=	460	ft
Stored Water Volume, V_w=	16580029	ft^3
Breach Invert=	438.5	ft
Breath Slope, Z=	1	H:1V
Crest Length, W=	16	ft
DamFront Face Slope, Zf=	3	H:1V
Dam Back Face Slope, Zb=	2	H:1V
Failure Depth, H_B=	21.5	ft
Average Breath Width, b=	55.2	ft
Time of Failure, t_f=	0.5	hr
Breach Top Width, W_T=	76.7	ft
Breach Bottom Width, W_B=	33.7	ft
Dam Breach Volume=	57,950	ft^3

Froehlich Breach Predictor Equations (1995) in SI units (meters, m3/s,hours)

$$B = 0.1803\, K V_w^{0.32} h_d^{0.19}$$

$$t_f = 0.00254 V_w^{0.53} h_d^{-0.9}$$



Reference:

1. Froehlich, D. C. 1995(a). "Peak Outflow from Breached Embankment Dam," Water Resources Engineering, Proceedings of the 1995 ASCE Conference on Water Resources Engineering, San Antonio, Texas, August 14-18, 1995, 887-891.

2. Froehlich, D. C. 1995(b). "Embankment Dam Breach Parameters Revisited," Journal of Water Resources Planning and Management, 121(1), 90-97.

Prepared by Hui-Ming (Max) Shih, Ph.D., CFM

DAM BREACH PARAMETER CALCULATION

Froehlich Breach Predictor Equations (1995)

Project Name: TVA - Colbert Fossil Plant Pond 4
Description: Estimate breach parameters with a breach invert of 422 where the original invert of TVA Pond 4. (Initial WS= 458) - Scenario IV
Job No.: 31851118.41
Data: 03.09.2010

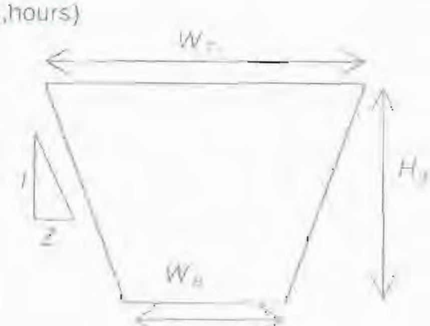
Constant, K=	1	ft (1.4 for overtopping failure and 1.0 for piping failure)
Top of Dam Crest=	460	ft
Stored Water Volume, V_w=	18392251	ft^3
Breach Invert=	422	ft
Breath Slope, Z=	1	H:1V
Crest Length, W=	16	ft
DamFront Face Slope, Zf=	3	H:1V
Dam Back Face Slope, Zb=	2	H:1V

Failure Depth, H_d=	38	ft
Average Breath Width, b=	63.6	ft
Time of Failure, t_f=	0.3	hr
Breach Top Width, W_T=	101.6	ft
Breach Bottom Width, W_B=	25.6	ft
Dam Breach Volume=	131,074	ft^3

Froehlich Breach Predictor Equations (1995) in SI units (meters, m3/s,hours)

$$B = 0.1803\, K V_w^{0.32} h_d^{0.19}$$

$$t_f = 0.00254 V_w^{0.53} h_d^{-0.9}$$



Reference:

1. Froehlich, D. C. 1995(a). "Peak Outflow from Breached Embankment Dam," Water Resources Engineering, Proceedings of the 1995 ASCE Conference on Water Resources Engineering, San Antonio, Texas, August 14-18, 1995, 887-891

2. Froehlich, D. C. 1995(b).

Prepared by Hui-Ming (Max) Shih, Ph.D., CFM

DAM BREACH PARAMETER CALCULATION

Von Thun & Gillette Breach Predictor Equations (1990)

Project Name: TVA - Colbert Fossil Plant Pond 4
Description: Estimate breach parameters with a breach invert of 438.5 where the top of bottom ash. (Initial WS= 460)- Scenario I
Job No.: 31851118.41
Data: 03.09.2010

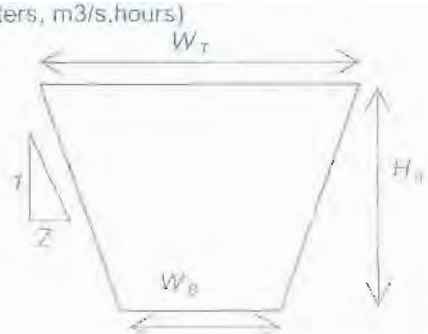
Constant, C_b =	20	ft (refer to the below table)
Top of Dam Crest=	460	ft
Initial WS of Dam Breach=	460	ft
Breach Invert=	438.5	ft
Breath Slope, Z=	1	H:1V
Crest Length, W=	16	ft
DamFront Face Slope, Zf=	3	H:1V
Dam Back Face Slope, Zb=	2	H:1V

Failure Depth, H_d=	21.5 ft	
Height of Water, H_w=	21.5 ft above Breach Invert	
Average Breath Width, b=	73.8 ft	
Time of Failure, t_f=	0.9 hr	Erosion Resistant (considered as static condition)
	0.3 hr	Highly Erodible (considered as seismic consition)

Breach Top Width, W_T=	95.3 ft
Breach Bottom Width, W_B=	52.3 ft
Dam Breach Volume=	85,751 ft^3

Von Thun & Gillette Breach Predictor Equations (1990) in SI units (meters, m3/s,hours)

$$b = 2.5 \times H_w + C_b$$
$$t_f = b / 4H_w$$
$$t_f = b/(4H_w + 61)$$



C_b (m)	C_b (ft)		Pond Volume (ac-ft)
6.1	20	When	<1000
18.3	60		1000~5000
42.7	140		5000~10000
54.9	180		>10000

Reference:

Von Thun, J. L., and Gillette, D. R. ~1990! "Guidance on breach parameters." Internal Memorandum, U.S. Dept of the Interior, Bureau of Reclamation, Denver, 17.

Prepared by Hui-Ming (Max) Shih, Ph.D., CFM

DAM BREACH PARAMETER CALCULATION

Von Thun & Gillette Breach Predictor Equations (1990)

Project Name: TVA - Colbert Fossil Plant Pond 4
Description: Estimate breach parameters with a breach invert of 422 where the original invert of TVA Pond 4. (Initial WS= 460)- Scenario II
Job No.: 31851118.41
Data: 03.09.2010

Constant, C_b=	20	ft (refer to the below table)
Top of Dam Crest=	460	ft
Initial WS of Dam Breach=	460	ft
Breach Invert=	422	ft
Breath Slope, Z=	1	H:1V
Crest Length, W=	16	ft
DamFront Face Slope, Zf=	3	H:1V
Dam Back Face Slope, Zb=	2	H:1V

Failure Depth, H_d=	38 ft	
Height of Water, H_w=	38 ft	above Breach Invert
Average Breath Width, b=	115.0 ft	
Time of Failure, t_f=	0.8 hr	Erosion Resistant (considered as static condition)
	0.3 hr	Highly Erodible (considered as seismic consition)

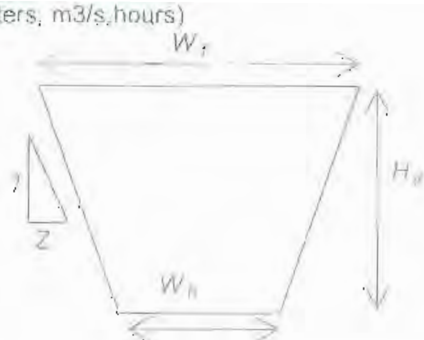
Breach Top Width, W_T=	153.0 ft
Breach Bottom Width, W_B=	77.0 ft
Dam Breach Volume=	347,890 ft^3

Von Thun & Gillette Breach Predictor Equations (1990) in SI units (meters, m3/s,hours)

$$b = 2.5 \times H_w + C_b$$

$$t_f = b / 4 H_w$$

$$t_f = b / (4 H_w + 61)$$



C_b (m)	C_b (ft)		Pond Volume (ac-ft)
6.1	20	When	<1000
18.3	60		1000~5000
42.7	140		5000~10000
54.9	180		>10000

Reference:

Von Thun, J. L., and Gillette, D. R. -1990!. "Guidance on breach parameters." Internal Memorandum, U.S. Dept. of the Interior, Bureau of Reclamation, Denver, 17.

DAM BREACH PARAMETER CALCULATION

Von Thun & Gillette Breach Predictor Equations (1990)

Project Name: TVA - Colbert Fossil Plant Pond 4

Description: Estimate breach parameters with a breach invert of 438.5 where the top of bottom ash. (Initial WS= 458)- Scenario III

Job No.: 31851118.41

Data: 03.09.2010

Constant, C_b =	20	ft (refer to the below table)
Top of Dam Crest=	460	ft
Initial WS of Dam Breach=	458	ft
Breach Invert=	438.5	ft
Breath Slope, Z=	1	H:1V
Crest Length, W=	16	ft
DamFront Face Slope, Zf=	3	H:1V
Dam Back Face Slope, Zb=	2	H:1V

Failure Depth, H_d =	21.5 ft	
Height of Water, H_w =	19.5 ft above Breach Invert	
Average Breath Width, b =	68.8 ft	
Time of Failure, t_f =	0.9 hr	Erosion Resistant (considered as static condition)
	0.2 hr	Highly Erodible (considered as seismic consition)

Breach Top Width, W_T =	90.3 ft
Breach Bottom Width, W_B =	47.3 ft
Dam Breach Volume=	78,253 ft^3

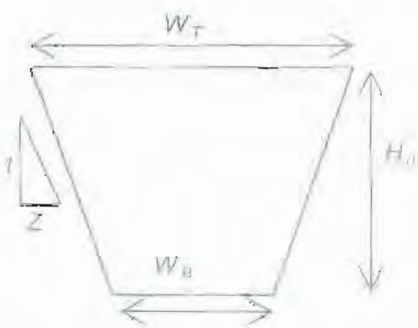
Von Thun & Gillette Breach Predictor Equations (1990) in SI units (meters, m3/s,hours)

$$t_f = b / 4H_w$$

$$b = 2.5 \times H_w + C_b$$

$$t_f = b / (4H_w + 61)$$

C_b (m)	C_B (ft)		Pond Volume (ac-ft)
6.1	20	When	<1000
18.3	60		1000~5000
42.7	140		5000~10000
54.9	180		>10000



Reference:

Von Thun, J. L., and Gillette, D. R. ~1990. "Guidance on breach parameters." Internal Memorandum, U.S. Dept. of the Interior, Bureau of Reclamation, Denver, 17.

Prepared by Hui-Ming (Max) Shih, Ph.D., CFM

DAM BREACH PARAMETER CALCULATION

Von Thun & Gillette Breach Predictor Equations (1990)

Project Name: TVA - Colbert Fossil Plant Pond 4

Description: Estimate breach parameters with a breach invert of 422 where the original invert of TVA Pond 4. (Initial WS= 458)- Scenario IV

Job No.: 31851118.41

Data: 03.09.2010

Constant, C_b =	20	ft (refer to the below table)
Top of Dam Crest=	460	ft
Initial WS of Dam Breach=	458	ft
Breach Invert=	422	ft
Breath Slope, Z=	1	H:1V
Crest Length, W=	16	ft
DamFront Face Slope, Zf=	3	H:1V
Dam Back Face Slope, Zb=	2	H:1V

Failure Depth, H_d =	38 ft	
Height of Water, H_w =	36 ft	above Breach Invert
Average Breath Width, b =	110.0 ft	
Time of Failure, t_f =	0.8 hr	Erosion Resistant (considered as static condition)
	0.3 hr	Highly Erodible (considered as seismic consition)

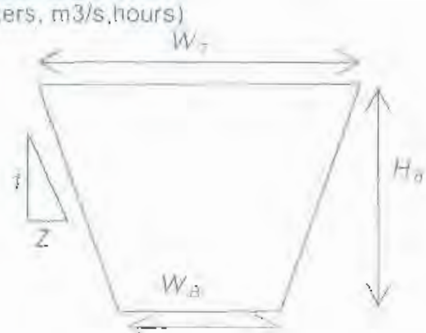
Breach Top Width, W_T =	148.0 ft
Breach Bottom Width, W_B =	72.0 ft
Dam Breach Volume=	326,800 ft^3

Von Thun & Gillette Breach Predictor Equations (1990) in SI units (meters, m3/s,hours)

$$b = 2.5 \times H_w + C_b$$

$$t_f = b / 4H_w$$

$$t_f = b / (4H_w + 61)$$



C_b (m)	C_b (ft)		Pond Volume (ac-ft)
6.1	20	When	<1000
18.3	60		1000~5000
42.7	140		5000~10000
54.9	180		>10000

Reference:

Von Thun, J. L. and Gillette, D. R. ~1990! "Guidance on breach parameters." Internal Memorandum, U.S. Dept. of the Interior, Bureau of Reclamation, Denver, 17.

Prepared by Hui-Ming (Max) Shih, Ph.D., CFM

Attachments – D

Mudflow Properties Estimation

HYPER-CONCENTRATED SEDIMENT FLOW ANALYSIS

Tailing Dam Breach

Project Name: TVA - Colbert Fossil Plant Pond 4

Description: Estimate mudflow erosivity when breach bottom at 438.5 where the top of bottom ash (Initial WS=460)- Scenario I

Job No. 31851118.41

Data: 03.09.2010

Current Pond Volume=	15,283,354	ft^3
Pond Volume after Dam Breach=	21,920,104	ft^3
Moisture Content of Tailing Ash (%)=	55.0	% by weight
Embankment Breach Volume=	61,823	ft^3 (Saturated Soil)
Moisture Content of Embankment (%)=	25.0	% by weight
Mean Particle Size of Reservoir Siltation, *ds* =	0.03	mm= 0.000098 ft
Flow Depth of Breach Flow, *h* =	11.52	ft
Breach Flow Velocity, *u* =	17.28	ft/sec
Dry Soil Specific Gravity, Gs=	2.5	

Wet Tailing Ash Volume=	6,636,750	ft^3 (Saturated Soil)
Dry Tailing Ash Volume=	2,794,421	ft^3
Released Water Volume=	19,125,683	ft^3
Dry Embankment Soil Volume=	38,045	ft^3
Total Dry Particle Volume=	2,832,466	ft^3

Particle Density, ρ_s =	4.9	slug/ft^3
Mixture Density, ρ_m =	2.3	slug/ft^3

Total Shear Stress of Mixture Fluid τ_m:

$$\tau_m = \tau_y + \mu_m \frac{du}{dy} + \xi \left(\frac{du}{dy} \right)^2$$

$$\xi \cong 0.16 \rho_m h^2 + 0.01 \rho_s \lambda^2 d_s^2$$

Mixture Flow Properties:

$$\mu_m = \alpha_1 e^{\beta_1 C_v}$$

α_1 =	0.0057	Poise
β_1 =	11.257	

$$\tau_y = \alpha_2 e^{\beta_2 C_v}$$

α_2 =	0.9778	dynes/cm^2
β_2 =	8.148	

Sed. Concentration,Cv	Mixture Flow Dynamic Viscosity, ν_m		Mixture Flow Yield Stress, τ_c		Unit Weight
	Poise	lb-sec/ft^2	dynes/cm^2	lb/ft^2	lb/ft^3
0.13	0.024	**0.000051**	2.794	**0.005835**	**74.5**

$\lambda=$ 1.46

$\xi=$ 49.11 slug/ft

$du/dy=$ 2.50 1/sec $= \frac{\bar{u}}{0.6H}$

$\tau_m=$ **306.95 lb/ft^2**

Mixture Flow Erosivity to Bed Material:

Bed Particle Size, d_{bed}=	**0.6**	mm	0.001968504 ft
Angle of Repose of a Particle=	**30.00**	degree=	0.5774 ft/ft

Crtical Shields Parameter τ_{*c} of Submerged Incipient Motion:

Shear Velocity, u_*= 11.52 ft/sec

Shear Parameter, τ_*= 1909

$$u_* = \sqrt{\frac{\tau_m}{\rho_m}} \qquad \tau_* = \frac{\tau_m}{(\gamma_s - \gamma_m) d_{bed}}$$

Grain shear Reynolds Number, Re*= 22.33

$$\mathrm{Re}_* = \frac{u_* d_s}{\nu_m}$$

Dimensionless Particle Diameter, d_*= 5.23

$$d_* = d_{bed}\left[\frac{(G-1)g}{\nu_m^2}\right]^{1/3}$$

Cririal Shields Parameter, τ_{*c}

	τ_{*c}=	0.2887	for d*<0.3
τ*>>	τ_{*c}=	0.0535	for 0.3<d*<19
	τ_{*c}=	0.0145	for 19<d*<50
	τ_{*c}=	0.0346	for d*>50

References:

1. Julien, Pierre Y., 1998, EROSION AND SEDIMENTATION, Cambridge University Press, New York, USA.

2. Julien, P.Y. and Lan, Y., 1991,"Rheology of Hyperconcentrations", J. of Hydraulic Engineering, Vol. 117, No.3, pp.346-353.

Worksheet for S-I 460 to 438.5 - Critical Condition (Qp=9,520cfs)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050	
Channel Slope	0.02115	ft/ft
Left Side Slope	1.00	ft/ft (H:V)
Right Side Slope	1.00	ft/ft (H:V)
Bottom Width	36.30	ft
Discharge	9520.00	ft³/s

Results

Normal Depth	11.52	ft
Flow Area	550.82	ft²
Wetted Perimeter	68.88	ft
Hydraulic Radius	8.00	ft
Top Width	59.34	ft
Critical Depth	11.52	ft
Critical Slope	0.02115	ft/ft
Velocity	17.28	ft/s
Velocity Head	4.64	ft
Specific Energy	16.16	ft
Froude Number	1.00	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	11.52	ft
Critical Depth	11.52	ft
Channel Slope	0.02115	ft/ft

Worksheet for S-I 460 to 438.5 - Critical Condition (Qp=9,520cfs)

GVF Output Data

Critical Slope	0.02115	ft/ft

Messages

Notes

Initial W.S=460'
Breach flow (Critical Weir Flow, Fr=1.0) at top of the bottom ash in static condition
The peak flow (9,520 cfs) and breach geometry was taken from DAMBRK modal

HYPER-CONCENTRATED SEDIMENT FLOW ANALYSIS

Tailing Dam Breach

Project Name: TVA - Colbert Fossil Plant Pond 4
Description: Estimate mudflow erosivity with a breach invert of 422 where the original pond invert (Initial WS=460)- Scenario II
Job No.: 31851118.41
Date: 03.09.2010

Current Pond Volume=	15769319.8	ft^3	
Pond Volume after Dam Breach=	24098103.5	ft^3	
Moisture Content of Tailing Ash (%)=	50.0	% by weight	
Embankment Breach Volume=	140,101	ft^3 (Saturated Soil)	
Moisture Content of Embankment (%)=	25.0	% by weight	
Mean Particle Size of Reservoir Siltation, ds =	0.03	mm=	0.000098 ft
Dry Soil Specific Gravity, Gs=	2.5		

Wet Tailing Ash Volume=	8,328,784	ft^3 (Saturated Soil)
Dry Tailing Ash Volume=	3,701,682	ft^3
Released Water Volume=	20,396,422	ft^3
Dry Embankment Soil Volume=	86,216	ft^3
Total Dry Particle Volume=	3,787,898	ft^3

Particle Density, ρ_s = 4.9 slug/ft^3

Mixture Density, ρ_m = 2.4 slug/ft^3

Mixture Flow Properties:

$$v_m = \alpha_1 e^{\beta_1 C_v}$$

α_1= 0.0057 Poise

β_1= 11.257

$$\tau_y = \alpha_2 e^{\beta_2 C_v}$$

α_2= 0.9778 dynes/cm^2

β_2= 8.148

Sed. Concentration,Cv	Mixture Flow Dynamic Viscosity, v_m		Mixture Flow Yield Stress, τ_y		Unit Weight
	Poise	lb-sec/ft^2	dynes/cm^2	lb/ft^2	lb/ft^3
0.16	0.033	0.000069	3.493	0.007296	77.0

References:

1. Julien, Pierre Y., 1998, EROSION AND SEDIMENTATION, Cambridge University Press, New York, USA

2. Julien, P.Y. and Lan, Y., 1991,"Rheology of Hyperconcentrations", J. of Hydraulic Engineering, Vol. 117, No.3, pp.346-353.

Prepared by Hui-Ming (Max) Shih, Ph.D., CFM

HYPER-CONCENTRATED SEDIMENT FLOW ANALYSIS

Tailing Dam Breach

Project Name: TVA - Colbert Fossil Plant Pond 4
Description: Estimate mudflow erosivity when breach bottom at 438.5 where the top of bottom ash (Initial WS=458)- Scenario III
Job No.: 31851118.41
Data: 03.09.2010

Current Pond Volume=	12,737,700	ft^3	
Pond Volume after Dam Breach=	19,374,450	ft^3	
Moisture Content of Tailing Ash (%)=	55.0	% by weight	
Embankment Breach Volume=	57,950	ft^3 (Saturated Soil)	
Moisture Content of Embankment (%)=	25.0	% by weight	
Mean Particle Size of Reservoir Siltation, *ds* =	0.03	mm=	0.000098 ft
Flow Depth of Breach Flow, *h* =	10.89	ft	
Breach Flow Velocity, *u* =	16.78	ft/sec	
Dry Soil Specific Gravity, Gs=	2.5		

Wet Tailing Ash Volume=	6,636,750	ft^3 (Saturated Soil)
Dry Tailing Ash Volume=	2,794,421	ft^3
Released Water Volume=	16,580,029	ft^3
Dry Embankment Soil Volume=	35,662	ft^3
Total Dry Particle Volume=	2,830,083	ft^3
Particle Density, ρ_s=	4.9	slug/ft^3
Mixture Density, ρ_m=	2.4	slug/ft^3

Total Shear Stress of Mixture Fluid τ_m:

$$\tau_m = \tau_y + \nu_m \frac{du}{dy} + \xi \left(\frac{du}{dy} \right)^2$$

$$\xi \cong 0.16 \rho_m h^2 + 0.01 \rho_s \lambda^2 d_s^2$$

Mixture Flow Properties:

$$\nu_m = \alpha_1 e^{\beta_1 C_v}$$

α_1=	0.0057	Poise
β_1=	11.257	

$$\tau_y = \alpha_2 e^{\beta_2 C_v}$$

α_2=	0.9778	dynes/cm^2
β_2=	8.148	

Sed Concentration,Cv	Mixture Flow Dynamic Viscosity, v_m		Mixture Flow Yield Stress, τ_c		Unit Weight
	Poise	lb-sec/ft^2	dynes/cm^2	lb/ft^2	lb/ft^3
0.15	0.029	**0.000061**	3.203	**0.006690**	**76.0**

λ= 1.62

ξ= 44.81 slug/ft

du/dy = 2.57 1/sec

τ_m= **295.54 lb/ft^2**

Mixture Flow Erosivity to Bed Material:

Bed Particle Size, d_{bed}=	**0.6**	mm	0.001968504 ft
Angle of Repose of a Particle=	**30.00**	degree=	0.5774 ft/ft

Crtical Shields Parameter τ_{*c} of Submerged Incipient Motion:

Shear Velocity, u_*= 11.19 ft/sec

Shear Parameter, τ_*= 1874

$$u_* = \sqrt{\frac{\tau_m}{\rho_m}} \qquad \tau_* = \frac{\tau_m}{(\gamma_s - \gamma_m)d_{bed}}$$

Grain shear Reynolds Number, Re*= 17.95

$$\mathrm{Re}_* = \frac{u_* d_s}{\nu_m}$$

Dimensionless Particle Diameter, d_*= 4.61

$$d_* = d_{bed}\left[\frac{(G-1)g}{\nu_m^2}\right]^{1/3}$$

Crirical Shields Parameter, τ_{*c}

	τ_{*c}=	0.2887	for d*<0.3
τ*>>	τ_{*c}=	0.0577	for 0.3<d*<19
	τ_{*c}=	0.0138	for 19<d*<50
	τ_{*c}=	0.0346	for d*>50

References:

1. Julien, Pierre Y., 1998, EROSION AND SEDIMENTATION, Cambridge University Press, New York, USA.

2. Julien, P.Y. and Lan, Y., 1991,"Rheology of Hyperconcentrations", J. of Hydraulic Engineering, Vol. 117, No.3, pp.346-353.

Worksheet for S-III 458 to 438.5 - Critical Condition (Qp=8,150cfs)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050	
Channel Slope	0.02161	ft/ft
Left Side Slope	1.00	ft/ft (H:V)
Right Side Slope	1.00	ft/ft (H:V)
Bottom Width	33.70	ft
Discharge	8150.00	ft³/s

Results

Normal Depth	10.89	ft
Flow Area	485.64	ft²
Wetted Perimeter	64.50	ft
Hydraulic Radius	7.53	ft
Top Width	55.48	ft
Critical Depth	10.89	ft
Critical Slope	0.02161	ft/ft
Velocity	16.78	ft/s
Velocity Head	4.38	ft
Specific Energy	15.27	ft
Froude Number	1.00	
Flow Type	Critical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	10.89	ft
Critical Depth	10.89	ft
Channel Slope	0.02161	ft/ft

Worksheet for S-III 458 to 438.5 - Critical Condition (Qp=8,150cfs)

GVF Output Data

Critical Slope	0.02161	ft/ft

Messages

Notes

Initial W S=458'
Breach flow (Critical Weir Flow, Fr=1.0) at top of the bottom ash (EL=438.5) in static condition.
The peak flow (8,150 cfs) and breach geometry was taken from DAMBRK model.

HYPER-CONCENTRATED SEDIMENT FLOW ANALYSIS

Tailing Dam Breach

Project Name: TVA - Colbert Fossil Plant Pond 4
Description: Estimate mudflow erosivity with a breach invert of 422 where the original pond invert (Initial WS=458)- Scenario IV
Job No.: 31851118.41
Data: 03.09.2010

Current Pond Volume=	14442002.4	ft^3	
Pond Volume after Dam Breach=	21,552,450	ft^3	
Moisture Content of Tailing Ash (%)=	50.0	% by weight	
Embankment Breach Volume=	131,074	ft^3 (Saturated Soil)	
Moisture Content of Embankment (%)=	25.0	% by weight	
Mean Particle Size of Reservoir Siltation, *ds* =	0.03	mm=	0.000098 ft
Dry Soil Specific Gravity Gs=	2.5		

Wet Tailing Ash Volume=	7,110,448	ft^3 (Saturated Soil)
Dry Tailing Ash Volume=	3,160,199	ft^3
Released Water Volume=	18,392,251	ft^3
Dry Embankment Soil Volume=	80,661	ft^3
Total Dry Particle Volume=	3,240,860	ft^3

Particle Density, ρ_s= 4.9 slug/ft^3

Mixture Density, ρ_m= 2.4 slug/ft^3

Mixture Flow Properties:

$$V_m = \alpha_1 e^{\beta_1 C_v}$$

α_1= 0.0057 Poise

β_1= 11.257

$$\tau_y = \alpha_2 e^{\beta_2 C_v}$$

α_2= 0.9778 dynes/cm^2

β_2= 8.148

Sed. Concentration,Cv	Mixture Flow Dynamic Viscosity, v_m		Mixture Flow Yield Stress, τ_c		Unit Weight
	Poise	lb-sec/ft^2	dynes/cm^2	lb/ft^2	lb/ft^3
0.15	0.031	0.000064	3.305	0.006902	76.4

References:

1. Julien, Pierre Y., 1998, EROSION AND SEDIMENTATION, Cambridge University Press, New York, USA

2. Julien, P.Y. and Lan, Y., 1991,"Rheology of Hyperconcentrations", J. of Hydraulic Engineering, Vol. 117, No 3, pp 346-353.

Prepared by Hui-Ming (Max) Shih, Ph.D., CFM

Attachments – E

Inundation Maps

URS

N W E S

Scenario I- Failure to Top of Bottom Ash with an Initial W.S. at 460'
Final Breach Bottom=438 5 ft
Peak Breach Flow= 9,520 cfs

0 100 200 400 Feet

Note: Due to the method, procedures, and assumptions used to develop the flooded areas, the limits of the flooding shown and wave travel times are approximate and should be used only as a guideline for establishing evacuation zones. Actual areas inundated will depend on actual failure conditions and may differ from the areas shown on this map.

TVA ASH POND 4

Dam Failure Flood Inundation Map
Scenario I

Date: 3/30/2010 | Map I

URS

N
W E
S

Scenario II- Failure to Bottom of Fly Ash with an Initial W.S. at 460 ft
Final Breach Bottom=422 ft
Peak Breach Flow= 24,120 cfs

0 100 200 400 Feet

Note: Due to the method, procedures, and assumptions used to develop the flooded areas, the limits of the flooding shown and wave travel times are approximate and should be used only as a guideline for establishing evacuation zones. Actual areas inundated will depend on actual failure conditions and may differ from the areas shown on this map.

TVA ASH POND 4

Dam Failure Flood Inundation Map
Scenario II

Date: 3/30/2010 | Map II

URS

Scenario III- Failure to Top of Bottom Ash with an Initial W.S. at 458 ft
Final Breach Bottom=438 5 ft
Peak Breach Flow= 8,150 cfs

Note: Due to the method, procedures, and assumptions used to develop the flooded areas, the limits of the flooding shown and wave travel times are approximate and should be used only as a guideline for establishing evacuation zones. Actual areas inundated will depend on actual failure conditions and may differ from the areas shown on this map.

TVA ASH POND 4

Dam Failure Flood Inundation Map
Scenario III

Date: 3/30/2010 | Map III

Turnbow, Michael S

From: Buttram, James C
Sent: Tuesday, October 12, 2010 10:33 AM
To: Turnbow, Michael S
Subject: FW: Colbert 4

Scott,

Please see URS' response below regarding PMP calculations for the COF Ash Pond 4 High Hazard Removal.

Thanks,

J. Chris Buttram, PE

'Confidential and Pre-decisional Deliberative Document'

From: Michael_Stepic@URSCorp.com [mailto:Michael_Stepic@URSCorp.com]
Sent: Monday, October 11, 2010 12:51 PM
To: Buttram, James C
Cc: Vik_Gautam@URSCorp.com; keith_mast@URSCorp.com; Glen Dieterle; Chad_McKinney@URSCorp.com; Michael_Shore@URSCorp.com
Subject: Re: FW: Colbert 4

Chris -

I follow up with my design team and offer the following:

1. The Pond 4 Dam-Break analysis was performed to determine the elevation of pond water that would result in no loss of life, etc if a dam break occurs (during a sunny-day condition) - this was calculated to be El. 458 and so we set the top of dike at this elevation.

2. URS analyzed a PMP event under our spillway design and showed that, under the PMP, the dike would not be overtopped (the water level in the pond does not exceed 458). Therefore, the design is sufficient to pass the PMP.

3. A failure with the pond filled to the top would cause worse flooding downstream than would a failure under the PMF scenario. The hazard classification is due to the probable loss of life should there be a failure regardless of the tailwater condition.

4. A dike failure during the PMF does not appear to make the eminent flooding downstream much worse and is therefore a critical flood. To check sensitivity, we did run an estimated 100-year tailwater in the Cane Creek to see how its backwater affected the dam wave, and it did not appear to change the results.

thank you

Mike

Michael J. Stepic, PE, RS, BCEE
Senior Environmental Project Manager

URS Corporation
564 White Pond Dr
Akron, OH 44320
Website | Map

Main: 330.836.9111

Direct: 330-800-2725
Mobile: 330-289-0092
Fax: 330-836-9115
Email: michael_stepic@urscorp.com

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"Buttram, James C" <jcbuttram@tva.gov>

"Buttram, James C" <jcbuttram@tva.gov>

10/08/2010 09:52 AM

To<Michael_Stepic@URSCorp.com>

cc<Vik_Gautam@URSCorp.com>

SubjectFW: Colbert 4

Mike,

Can you help me give an explanation to the question below? My question is, why would you check it for PMP? If we have freeboard and the spillways are designed for a ½ PMP event, seems like it would take a much larger storm to fill the Pond up.

Thanks for the help,
J. Chris Buttram, PE
'Confidential and Pre-decisional Deliberative Document'
From: Turnbow, Michael S
Sent: Friday, October 08, 2010 9:25 AM
To: Buttram, James C
Subject: Fw: Colbert 4

Chris,

Can you respond to Rusty's question and include me on the response? I would think that Stantec did the PMP?

Scott

From: Tompkins, Russell W
To: Turnbow, Michael S
Sent: Fri Oct 08 08:50:06 2010
Subject: Colbert 4
URS did not do any PMP scenarios on the hazard classification for Colbert ash pond 4. This there a reason?

Russell (Rusty) W. Tompkins, PE
Manager, Dam Safety Inspections

TVA - Dam Safety Governance
1101 Market Street (LP 3D - C)
Chattanooga, TN 37402
Work Number 423-751-6111
Cell Number **423-582-0137 (new Blackberry**)
email **rwtompkins1@tva.gov**

URS

N
W E
S

Scenario IV- Failure to Bottom of Fly Ash with an Initial W.S. at 458 ft
Final Breach Bottom=422 ft
Peak Breach Flow= 22,870 cfs

0 100 200 400 Feet

Note: Due to the method, procedures, and assumptions used to develop the flooded areas, the limits of the flooding shown and wave travel times are approximate and should be used only as a guideline for establishing evacuation zones. Actual areas inundated will depend on actual failure conditions and may differ from the areas shown on this map.

TVA ASH POND 4

Dam Failure Flood Inundation Map
Scenario IV

Date: 3/30/2010 | Map IV

APPENDIX A

Document 9

Report of Geotechnical Exploration and Slope Stability Evaluation, Ash Pond 4, Colbert Fossil Plant, Tuscumbia, Alabama, Stantec Consulting Services, January 22, 2010

Stantec

Report of Geotechnical Exploration and Slope Stability Evaluation

Ash Pond 4
Colbert Fossil Plant
Tuscumbia, Alabama

Stantec Consulting Services Inc.
One Team. Infinite Solutions
1901 Nelson Miller Parkway
Louisville KY 40223-2177
Tel: (502) 212-5000 • Fax: 502) 212-5055
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Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

January 22, 2010

Stantec

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January 22, 2010

rpt_001_175559016

Mr. Barry Snider, PE
Tennessee Valley Authority
1101 Market Street
LP 2N
Chattanooga, Tennessee 37402

Re: Report of Geotechnical Exploration and Slope Stability Evaluation
Ash Pond 4
Colbert Fossil Plant
Tuscumbia, Alabama

Dear Mr. Snider:

As requested, Stantec Consulting Services Inc. (Stantec) has completed our Geotechnical Exploration and Slope Stability Evaluation for Ash Pond No. 4 at the Colbert Fossil Plant. The report documents the subsurface conditions, results of laboratory testing, findings from the historical document reviews, results of our analyses and evaluation, and recommendations for 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, feel free to contact our office.

Sincerely,

STANTEC CONSULTING SERVICES INC.

Paul Cooper

Paul J. Cooper, EIT
Project Engineer

Randy L. Roberts

Randy L. Roberts, PE
Senior Associate

ALABAMA LICENSED No. 30563 PROFESSIONAL ENGINEER RANDY LEE ROBERTS

Enclosures

Report of Geotechnical Exploration and Slope Stability Evaluation

Ash Pond 4
Colbert Fossil Plant
Tuscumbia, Alabama

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

January 22, 2010

Report of Geotechnical Exploration and Slope Stability Evaluation

Ash Pond 4
Colbert Fossil Plant
Tuscumbia, Alabama

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Executive Summary

Stantec Consulting Services Inc. (Stantec) has completed the Geotechnical Exploration and Slope Stability Evaluation at Colbert Fossil Plant's Ash Pond 4. This study was performed to evaluate slope stability and seepage for the pond's existing conditions.

Background Information

Ash Pond 4 is approximately 52 acres in area, and is enclosed by a perimeter dike system that is approximately 6,700 feet in total length. In 1972, the first phase of Ash Pond 4, consisting of dikes constructed to a crest of El. 440 feet, was constructed and put into service. In 1984, the dikes were raised 20 feet using upstream construction methods (constructing inwardly over sluiced ash). The overall constructed height of the perimeter dike system now varies from approximately 20 to 30 feet on the west side, to about 40 feet on the east side, adjacent to Cane Creek. Dike slopes are approximately 2.5H:1V to 3H:1V.

TVA has recently classified Ash Pond 4 as a "high hazard" impoundment because of the consequences of failure relative to potential damage downstream. Currently, URS Corporation is conducting a feasibility study to address potential operational modifications to Ash Pond 4 so the hazard classification might possibly be reduced. Pond modifications being considered include reducing the size of the pond or perhaps pond closure.

Historical geotechnical issues include seepage areas located along the east and southeast sides of the pond. The seepage outbreaks are typically located near the contact of the upper and lower dikes. Recently, Stantec discovered additional seepage outbreaks along the south and west sides of the ponds near the same dike elevations, but these are much less pronounced and less widespread compared to conditions on the east and southeast sides. The seepage areas are wet and soft, but there is typically no, to minimal, flow of water and no visible piping of dike materials. The historical documents reviewed for Ash Pond 4 do not indicate a history of slope instability. In addition, signs of slope instability have not been observed in the field during this study.

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 24 locations. Piezometers were installed at 21 locations. Drilling locations were positioned along ten cross-sections around the pond. The laboratory testing program included moisture content, classification, permeability and shear strength testing to establish key index properties and strength parameters.

Results of Exploration and Engineering Analyses

The results from the geotechnical exploration indicate that the upper and lower perimeter dike system for Ash Pond 4 is constructed of clay materials. The capacity of the pond was expanded in 1984 by constructing the upper dikes inwardly over sluiced ash. The exploration program did confirm the presence of sluiced ash beneath the upper dike. The dikes are underlain by native clays, silts, and sands, and then by limestone bedrock.

Following the drilling and laboratory testing program, slope stability and seepage 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. The analysis focused on six cross-sections that were selected to represent typical conditions around the pond.

To evaluate the seepage conditions within the dikes, a finite element model was developed for each of the six cross-sections. On most cross-sections, the model predicts the potential for seepage outbreaks to occur on the exterior dike slopes just above the upper-lower dike interface (toe of the upper dike), and at lower areas along, or beyond, the dike toes. This prediction correlates well with field observations. This condition could create the potential to initiate soil piping if exit gradients are high enough. To judge whether or not a tendency for piping is possible, factors of safety can be calculated using the vertical exit gradients as predicted by the seepage models. For Ash Pond 4, the highest vertical exit gradients where minimum factors of safety against piping occur are located at points along the dike toes or just beyond. The minimum factor of safety values range from 1.6, to greater than 3. Based on the U.S. Army Corps of Engineers (USACE) design criteria for dams, Stantec reccomends a value of 3 as a minimum target factor of safety against piping for the evaluation of Ash Pond 4. Thus, the results indicate the seepage criterion is not currently being met at the toe areas of four out of the six cross-sections analyzed for Pond 4. The lowest factors of safety are along cross-sections that represent the east side of the pond adjacent to Cane Creek.

The slope stability of the Ash Pond 4 dikes was also evaluated. Factors of safety for slope stability were computed using Spencer's method of analysis, circular slip surfaces, and search routines that help to identify the critical (minimum factor of safety) failure surface. The slope stability models were evaluated using both pore pressures predicted with the seepage models and data from the piezometer readings. The results of the steady-state seepage and long-term slope stability analysis demonstrate that the factors of safety range from approximately 1.4 to greater than 1.5. TVA has adopted a minimum target factor of safety of 1.5 against slope stability based on USACE criteria. The results indicate that only one cross-section (Section D-D') has a safety factor less than the target. This cross-section is generally representing the east side of the pond along Cane Creek.

In conclusion, there are some locations where the current configuration of Ash Pond 4 exhibits deficient factors of safety against slope stability and piping. The lowest factors of safety occur along the east side of the pond adjacent to Cane Creek. This does not imply that the dike is in immediate danger of failure, but TVA should undertake mitigation efforts to improve long-term stability and seepage conditions. Improvements could be incorporated into upcoming design of pond modifications/closure, or a separate interim mitigation program could be implemented, depending on timing and as decided by TVA.

Report of Geotechnical Exploration and Slope Stability Evaluation
Ash Pond 4
Colbert Fossil Plant
Tuscumbia, Alabama

1. Introduction

In January 2009, the Tennessee Valley Authority (TVA) requested Stantec Consulting Services Inc. (Stantec) conduct assessments of its coal combustion product (CCP) disposal facilities at one closed, and eleven active, fossil plants. The plants are located in the states of Kentucky, Tennessee and Alabama. The assessments were performed for the purpose of determining if conditions were present to indicate an unstable condition that could possibly cause a release of CCP's into the environment.

Stantec's scope of services for the assessments was developed within the framework of current dam safety practice, and was performed in phases. Phase 1 included review of available documentation, site reconnaissance, field measurements, and providing recommendations for interim corrective measures, improvements, and further engineering studies. The Report of Phase 1 Facility Assessment for Coal Combustion Product Impoundments and Disposal Facilities for the two Alabama plants was completed on June 24, 2009. The conclusions and recommendations for Ash Pond 4 at the Colbert Fossil plant (COF) are included in that Phase 1 report. In addition to issues that require maintenance-type remedial activities, the Phase 1 recommendations included conducting a Phase 2 geotechnical exploration to evaluate slope stability and seepage for Ash Pond 4 at COF. As a result, the following geotechnical evaluation was authorized by TVA under Engineering Services Request ESR/TAO 894. This report documents the scope and results of the study and contains Stantec's conclusions and recommendations concerning slope stability and seepage for Ash Pond 4.

2. Site Description and Geology

2.1. Location and Description

The Colbert Fossil Plant is located in Tuscumbia, Colbert County, Alabama on the south bank of Pickwick Reservoir along the Tennessee River, approximately 50 miles west of Decatur in northwest Alabama. Ash Pond 4 is situated approximately 3,000 feet south of the plant's powerhouse. This disposal area is bordered by the plant access road to the west, US Highway 72 to the south, and Cane Creek to the north and east. Figure 2.1 on the following page provides a plan view of the Colbert Ash Pond 4 area.

Ash Pond 4 is approximately 52 acres in area, and is enclosed by a perimeter dike system that is approximately 6,700 feet in total length. The dike crest supports a gravel access road and is currently at an approximate elevation of 460 to 461 feet. The overall constructed height of the perimeter dike system varies from approximately 20 to 30 feet on the west side to about 40 feet on the east side, adjacent to Cane Creek.

Colbert Fossil Plant, Ash Pond 4 **Tuscumbia, Alabama** Stantec	**Figure 2.1. Colbert Ash Pond 4 Overview**

Dike slopes are approximately 2.5:1V to 3H:1V. The slopes are vegetated with thick grasses. A few trees once existed at various locations around the ponds (primarily along the toe of the north dike slope). These trees were removed in April, 2009. Currently, approximately 30,000 tons per year of bottom ash is wet-sluiced to Ash Pond 4. Dewatered bottom ash is removed from Ash Pond 4 and stacked within its west side. This stacking operation began in 1999 and is active, but is progressing slowly.

TVA has recently classified Ash Pond 4 as a "high hazard" impoundment because of the consequences of failure relative to potential damage downstream. Currently, URS Corporation is conducting a feasibility study to address potential operational modifications to Ash Pond 4 so the hazard classification might possibly be reduced. Pond modifications being considered include reducing the size of the pond or perhaps pond closure. Stantec has assisted TVA with this effort by performing inundation mapping.

2.2. Geology

According to the Geologic Map of Alabama, compiled by the Geological Survey of Alabama, the Colbert Fossil Plant is underlain by the Tuscumbia Limestone formation. The Tuscumbia Limestone is of Mississippian age and consists of light gray, bioclastic limestone that is fine to very coarse grained and partly oolitic near the top. Light gray chert nodules are scattered throughout the formation and locally abundant. Given the limestone's karst features and differential dissolution of the carbonate in the unit, thickness varies throughout the region. Strike/dip joints are well developed in Tuscumbia Limestone with numerous outcrops along the southern bluff of the Tennessee River. The limestone has shown no discernable signs of faulting in the area, although weathered joints are likely, given the karstic nature of the formation.

Overburden consists primarily of residual clays. Silty clays are present at shallow depths, with moderate to high plasticity clays predominant at intermediate depths. Atop the soil/bedrock interface, a layer of silty clay with extensive chert fragments is present as a result of extensive weathering of the karstic limestone. Some alluvial and terrace deposits are present along the banks of Cane Creek within the location of Ash Pond 4, to an average depth of about 10 feet.

As mentioned above, the Tuscumbia Limestone is known for karst activity, with the formation of sinkholes, irregular bedrock surfaces, and varying solutioning/weathering being possible. Two known sinkhole collapses have occurred in the past at COF; one in the now abandoned/unused area of Disposal Area 5, and one at the area of the closed chemical pond adjacent to Ash Pond 4. However, the historical documentation reviewed by Stantec shows no known karst-related problems reported for Ash Pond 4.

3. Review of Available Information

3.1. General

During the Phase 1 Facility Assessment, Stantec's engineers reviewed documents provided by TVA pertaining to Ash Pond 4. The main objective of the document review was to develop a historical knowledge base of the impoundment. The documents reviewed included record drawings, cross-sections of dikes, old contour maps, annual dike stability reports, and old geotechnical reports. A complete listing of the reviewed documents is included in the Phase 1 report.

Of particular interest and use in this study are the following documents and drawings:

- Colbert Steam Plant – Proposed Ash Disposal Area No. 4 – Dikes – Soil Investigation, Memorandum from Gene Farmer to F.P. Lacy, October 13, 1972.

- Colbert Steam Plant – Ash Disposal Area No. 4 Dike Raising – Soils Exploration and Testing – En Des Soils Schedule No. 67, Memorandum from Gene Farmer to G.L. Buchanan, March 27, 1978.

- Geology of the Colbert Steam Plant, Charles P. Bensiger, TVA Division of Water Control Planning, Geologic Branch, November, 1951.

- TVA Drawing Numbers 10N290, 291, 292, 293, 294-1 through 294-7, 287.

- TVA Annual Inspection Reports, 1993 to 2008.

These documents included site plans, cross-sections, boring plans, boring logs, results of laboratory tests, and geologic information. The information gained was evaluated and used to supplement the information obtained during Stantec's geotechnical exploration.

3.2. Site History

Construction began at Colbert Fossil Plant in 1951 and was completed in 1965. Colbert currently contains five coal-fired generating units and burns approximately 8,900 tons of coal per day.

Initially, ash materials were sluiced into Ash Disposal Area 1, located to the northwest of the powerhouse along the river. The pond was constructed by building dikes on the north and east side of the existing river shoreline. Sluicing to this area stopped in 1975. Dried, reclaimed ash from Ash Pond 4 was stacked in this area from 1982 until 1990. The area is now closed and no longer in use.

In 1972, the first phase of Ash Pond 4 was constructed and put into service. The first phase consisted of construction of 20-foot tall dikes to a crest of El. 440 feet. The majority of the initial dike construction occurred along the north, south, and east sides where the original ground elevations were lower. On the west side, the existing ground elevations were very close to or approximate at El. 440 feet and the initial pond appears to have been formed partially by excavating on this side. In 1984, the dikes were raised 20 feet using upstream construction methods (constructing inwardly over sluiced ash). From 1982 until 1990, both fly ash and bottom ash were sluiced into Ash Pond 4. After 1990, the pond began to receive only sluiced bottom ash. At present, approximately 30,000 tons per year of bottom ash is wet-sluiced to Ash Pond 4. Dewatered bottom ash is removed from Ash Pond 4 and stacked within its west side. This stacking operation began in 1999 and remains active, but is progressing slowly.

The most recent ash disposal area to be developed on the Colbert reservation is Disposal Area 5 located southeast of the plant's powerhouse. The disposal area was initially intended to be an ash pond, but a sinkhole failure occurred in the northwest portion upon initial filling.

The sinkhole was reportedly treated and capped and the entire north and northwest portions of Disposal Area 5 were abandoned. Operations then shifted to disposal into two dredge cells (Cells 1 and 2) that were constructed in the south and southeast portions of Area 5. This operation continued from the mid 1980's until 1990 when dredging was stopped and disposal methods were converted to a dry stacking operation. Dry disposal is following a stacking plan developed in the early 1990's. The ultimate height of the stack will range from 100 to 120 feet from top to toe of original perimeter dikes. Stacked fly ash is being constructed on approximately 4H:1V slopes, with benches every 20 feet in height. The stack appears fully built-out in the south and west portions. The current disposal activity is on the east side. At present, approximately 350,000 tons of dry fly ash is collected in silos each year and hauled to this disposal area. The report addressing the geotechnical exploration and slope stability evaluation for the Disposal Area 5 Dry Stack will be provided in the future under separate cover.

3.3. Historical Geotechnical Issues

As discussed in Section 1, the Phase 1 work included review of historical documents. A few primary issues that were found from the documents for Ash Pond 4 are discussed in the following paragraphs.

3.3.1. Seepage and Slope Stability

Historical documentation indicates that seepage has been occurring at various intervals along the mid-slope of the east and southeast dikes since 1984, when the pond was expanded by raising the dikes. In general, the seepage is occurring just above the interface elevation of the upper-lower dikes and appears to extend downslope. The seepage has been monitored by TVA with little or no change being reported through the years. In addition, Stantec has also noticed minimal change in seepage conditions at these locations since January, 2009. Currently, there is minimal to no flow occurring, and clear water is being emitted from the seepage areas. In 2007, TVA retained a geotechnical consultant to investigate the seepage. The investigation identified a seepage zone between the two phases of dike construction where a thin zone of bottom ash and organic material was found. The report recommended to continue monitoring the seepage and to install a collection system below the seeps.

A much smaller area of seepage is located at the dike toe along the northwest side of the pond below the sluice line piping. This area was discovered after vegetation was cleared earlier in 2009. Colbert maintenance personnel placed rip-rap over this seepage area.

Additional areas of seepage were also recently found by Stantec in November, 2009. These are located at various intervals around the south, southwest, and west sides of the pond. They are located near the toe of the upper dike (similar location as the east side), but are much less pronounced and less widespread than the seepage areas on the east and southeast sides. In fact, these areas were not noted until recently when ground conditions were drier and vegetation was lower. These areas have probably existed for some time, but have likely been obscured by tall vegetation or wet ground conditions after rain.

The documents reviewed for Ash Pond 4 do not indicate a history of slope instability. Additionally, no signs of slope instability have been observed in the field by Stantec throughout the course of this work.

3.3.2. Spillway Outlets

The outlet system for Ash Pond 4 consists of four 48-inch diameter reinforced concrete pipe (RCP) riser sections that discharge through four 36-inch RCP sections into a discharge channel. Over recent years, the historical documentation reports that some leakage of riser pipe joints has been occurring and annual sealing of joints within the top 12 feet or so is performed with oakum. The spillway system for Ash Pond 4 is planned to be evaluated by URS Corporation for possible replacement.

4. Scope of Exploration

The field portion of the geotechnical exploration was performed July 14 through August 8, 2009. These services were performed in general accordance with various Corps of Engineers procedures, along with standard procedures for geotechnical engineering practice.

Stantec personnel advanced 24 conventional sample borings using a combination of track-mounted and truck-mounted drill rigs. In general, the borings were positioned at the dike crest, toe, and mid-slope areas along ten cross-sections. All borings were advanced to apparent bedrock, with two borings being advanced ten feet into bedrock using NQ-sized (approximately two-inch diameter) rock coring equipment. The rock core borings were advanced to confirm bedrock depths. The locations of the borings are shown on the Boring Layout Plan in Appendix E. At completion of the drilling, TVA's survey crew located the borings and profiled the ground lines at the ten cross-sections.

The subsurface exploration was performed using 3¼- and 4¼-inch (ID) hollow stem augers equipped with a carbide-tipped tooth bit. Standard Penetration Testing (SPT) was performed in all 24 of the conventional sample borings at continuous intervals. A standard penetration test consists of dropping a 140-pound hammer to drive a split-spoon sampler 18 inches. The consistency or relative density of soil is estimated by the number of blows it takes to drive the spoon the last 12 inches. This method is typically used to obtain soil samples, estimate the consistency or relative density of the soil, and also to estimate the vertical limits of the subsurface soil horizons. In addition, undisturbed samples (Shelby tubes) were obtained in offset borings using a fixed head piston sampler from selected depth intervals within the cohesive materials to provide samples for subsequent laboratory strength testing. After completion of the drilling and sampling procedures, the boreholes were checked for subsurface water and backfilled with bentonite grout.

Stantec installed 21 piezometers within the upper and lower dikes in offset borings as a part of the overall stability evaluation to provide data on piezometric levels within the existing dikes and native foundation soils. Piezometer construction consisted of one-inch diameter Schedule 40 PVC, well screen (ten feet) and riser pipe. The annular backfill consisted of a sand filter pack to some distance above the screened interval followed by a bentonite seal. After allowing the bentonite to hydrate, the remaining annulus was backfilled with bentonite grout tremmied into place. Flush-mounted or riser-type protective covers were set in concrete to protect the piezometers. These instruments are scheduled to be monitored by Stantec until June 2010.

An engineer/geologist was present with each drill crew throughout the drilling operations. The engineer/geologist directed the drill crews, logged the subsurface materials encountered during the exploration, and collected samples. Particular attention was given to the material's color, texture, moisture content, and consistency or relative density. The samples extracted from the borings were transported to Stantec laboratories for testing.

In the laboratory, standard penetration test (SPT) samples were subjected to natural moisture content determination in accordance with ASTM D 2216. Selected SPT samples were also combined and subjected to soil classification tests that included Atterberg limits testing (ASTM D 4318), specific gravity tests (ASTM D 854) and sieve and hydrometer analyses (ASTM D 422). Select bulk samples were also collected and subjected to standard moisture-density (Proctor) testing (ASTM D 698). Undisturbed samples were extruded and subjected to unit weight determination, falling head permeability testing (ASTM D 5084), and consolidated undrained triaxial compression testing with pore pressure measurements (ASTM D 4767).

The results of the field and laboratory testing services were used to develop cross-sections for slope stability and seepage analysis. Based on the results of the field exploration, cross-section geometry, and the preliminary slope stability analyses, Stantec selected six cross-sections to analyze.

5. Results of Geotechnical Exploration

5.1. Summary of Borings

Stantec developed a boring plan for the field exploration for Ash Pond 4 after a review of historical information and existing site conditions. TVA survey personnel established boring locations and elevations after drilling was completed. The boring layout plan is contained in Appendix E and boring logs are presented in Appendix A. A summary of the boring information is presented in Table 5.1 (all measurements are expressed in feet).

Table 5.1. Summary of Borings

Boring No.	Surface Elevation	Northing	Easting	Top of Rock** Depth	Top of Rock** Elevation	Boring Termination Depth	Bottom of Hole Elevation
STN-4-1	460.2	1723599.52	394359.89	53.0	407.2	54.0	406.2
STN-4-1S	460.2	1723599.52	394359.89	--	--	27.0	433.2
STN-4-2	439.4	1723632.72	394289.32	29.2	410.2	29.2	410.2
STN-4-3	427.3	1723645.94	394253.91	13.8	413.5	13.8	413.5
STN-4-3S	427.3	1723645.94	394253.91	18.0	409.3	18.0	409.3
STN-4-4	460.4	1723316.42	394738.76	66.3	394.1	66.3	394.1
STN-4-4S	460.4	1723316.42	394738.76	--	--	27.0	433.4
STN-4-5	439.5	1723366.01	394798.52	31.1	408.4	31.1	408.4
STN-4-5S	439.5	1723366.01	394798.52	--	--	23.5	416.0
STN-4-6	419.8	1723373.16	394864.54	13.2	406.6	13.2	406.6
STN-4-7	460.8	1722880.08	394960.81	54.1	406.7	54.1	406.7
STN-4-7S	460.8	1722880.08	394960.81	--	--	27.0	433.8
STN-4-8	421.6	1722943.49	395089.90	18.0	403.6	21.0	400.6
STN-4-9	461.2	1722306.36	395260.37	51.0	410.2	51.0	410.2
STN-4-9S	461.2	1722306.36	395260.37	--	--	42.0	419.2
STN-4-10	420.9	1722357.09	395401.10	14.5	406.4	14.5	406.4
STN-4-11	461.3	1721882.96	395485.31	50.8	410.5	50.8	410.5
STN-4-11S	461.3	1721882.96	395485.31	--	--	24.0	437.3

Table 5.1. Summary of Borings, continued

Boring No.	Surface Elevation	Northing	Easting	Top of Rock** Depth	Top of Rock** Elevation	Boring Termination Depth	Bottom of Hole Elevation
STN-4-12	446.2	1721504.87	395746.27	37.5	408.7	37.5	408.7
STN-4-12S	446.2	1721504.87	395746.27	--	--	22.0	424.2
STN-4-13*	425.3	1721330.83	395874.15	17.1	408.2	27.1	398.2
STN-4-14	461.9	1721420.08	395715.53	52.7	409.2	52.7	409.2
STN-4-14S	461.9	1721420.08	395715.53	--	--	41.0	420.9
STN-4-15	460.5	1721219.13	395347.89	50.0	410.5	50.0	410.5
STN-4-15S	460.5	1721219.13	395347.89	--	--	41.0	419.5
STN-4-16	435.1	1721126.23	395351.96	21.0	414.1	21.1	414.0
STN-4-16S	435.1	1721126.23	395351.96	21.0	414.1	21.0	414.1
STN-4-17	476.8	1721539.59	394582.90	58.9	417.9	58.9	417.9
STN-4-17	476.8	1721539.59	394582.90	--	--	22.0	454.8
STN-4-18	461.1	1721402.10	394555.64	43.1	418.0	43.1	418.0
STN-4-18S	461.1	1721402.10	394555.64	--	--	41.0	420.1
STN-4-19	440.3	1721352.01	394475.66	26.1	414.2	26.1	414.2
STN-4-19S	440.3	1721352.01	394475.66	26.0	414.3	26.0	414.3
STN-4-20	482.3	1721987.93	394461.02	61.5	420.8	61.7	420.6
STN-4-20S	482.3	1721987.93	394461.02	--	--	22.0	460.3
STN-4-21	460.2	1721985.14	394262.71	44.0	416.2	44.0	416.2
STN-4-22	438.0	1721957.70	394065.63	24.5	413.5	24.5	413.5
STN-4-22S	438.0	1721957.70	394065.63	24.0	414.0	24.0	414.0
STN-4-23	461.1	1722728.47	394227.94	41.2	419.9	41.2	419.9
STN-4-23S	461.1	1722728.47	394227.94	--	--	17.0	444.1
STN-4-24*	444.5	1722823.19	394138.84	32.3	412.2	42.4	402.1

* *Boring advanced into bedrock.*

** *Top of Rock, as used herein, refers to rock-like resistance to the advancement of the augers using a carbide-tipped-tooth bit. This may indicate the beginning of weathered bedrock, boulders, or rock remnants. An exact determination cannot be made without performing rock coring.*

5.2. Subsurface Conditions

5.2.1. Soil

Using the boring logs and laboratory tests from this geotechnical exploration, the boring information contained in previous geotechnical studies at the facility, TVA design drawings, old contour maps, and other historical information, Stantec developed a general profile for each stability cross-section at Ash Pond 4. The general profiles depict five major material horizons (or "layers") that are described below in sequence of descending lithology. The stability sections contained in Appendix E show these layers in graphical manner. In addition, the graphical logs shown on the stability sections also depict the material Unified Soil Classification System (USCS) classifications. The classifications are based on a combination of laboratory test results and visual observations where samples were not selected for such testing.

The "Upper Dike" extends upwardly from approximate El. 440 feet (crest of initial starter dike) to approximate El. 460 feet (current crest) and represents the most recent dike raising which occurred in 1984. The upper dike materials are clay soils with USCS classifications of CL and CH, and with textural descriptions of lean clay with sand and fat clay with sand. The clays are moist in moisture content and predominately reddish brown in color, with occasional brown and tan mottling. Based on SPT N-values and laboratory strength testing, the upper dike clays have strength consistencies ranging from medium to very stiff.

The "Lower Dike" extends upwardly from original native ground to approximate El. 440 feet (crest of the initial dike construction) and is located on the north, east, and south sides of the pond. It appears that an initial lower dike was not needed on some portions of the west side because of higher ground elevations. The lower dike materials are clay soils with USCS classifications of CL and textural descriptions of sandy lean clay and lean clay with sand. The clays are mostly moist in moisture content with some isolated wet zones encountered and predominantly reddish brown to brown in color. Based on SPT N-values and laboratory strength testing, the lower dike clays have strength consistencies ranging mostly from medium to stiff, with a few isolated instances of soft to medium consistencies.

Below the "Lower Dike" material, "Native Clay" and/or "Native Clay and Silt" was encountered extending downwardly to or near apparent top of bedrock. Based on laboratory tests and on visual classifications, the "Native Clay" has USCS classifications of CL or CH and primary textural descriptions of lean clay or fat clay. The "Native Clay and Silt" has classifications of CL, CL-ML, or ML with primary textural descriptions of lean clay with sand, sandy lean clay, silty clay, and sandy silt. The "Native Clay and Silt" is typically less predominant. These horizons are typically dark brown, reddish brown or brown in color (with occasional tan, gray, and/or orange-brown mottling), and moist in moisture content with some isolated wet zones. Based on SPT N-values and laboratory strength testing, the clays and silts have strength consistencies ranging mostly from soft to stiff.

Below the "Native Clay" horizon, "Native Sand" was encountered in a few borings, specifically STN-4-1, 4-5, 4-7, 4-10, and 4-13 on the Cane Creek side of the pond. The native sand has USCS classifications of SM and SC-SM and textural descriptions of silty clayey sand and silty sand. The native sand is mostly described as brown to gray in color and wet in moisture content. Based on SPT N-values, the native silt/sand has relative densities ranging mostly from very loose to medium dense.

The thicknesses of the native soils above bedrock across the pond range from as little as approximately 3 feet to as much as about 30 feet. Most thicknesses are from about 10 to 20 feet. The lesser thicknesses were encountered in Borings STN-4-17 and 20 which were drilled within stacked materials along the interior of the pond (historical documents indicate that native materials were excavated from the pond interior and used as borrow to construct the initial perimeter dike). The thickest materials occur in borings drilled on the west side of the pond.

Hydraulically placed (sluiced) fly ash and bottom ash was also encountered beneath the upper dike in borings drilled through the crest. The ash was typically encountered at a depth of about 25 feet beneath the crest and extended to a depth of approximately 40 feet for an average thickness of about 15 feet. The borings typically encountered sluiced bottom ash overlying a lesser thickness of sluiced fly ash. Historical documents indicate that the pond was also used for disposal of fly ash in the past, in addition to the current bottom ash disposal. Classification testing performed on selected bottom ash samples resulted in USCS classifications of SW-SM with a textural description of well-graded sand with silt and gravel. Classification testing performed on selected fly ash samples resulted in a USCS classification of ML with a textural description of sandy silt and silt with sand. The ash materials are black in color and wet in moisture content. SPT N-values indicate loose to medium relative densities for the bottom ash, and very soft to soft strength consistencies for the fly ash.

It should be noted that materials matching the "slime layer" as described in AECOM's findings relative to the failure at the Kingston Fossil Plant were not encountered during this study. These "slime" materials (as described by AECOM) are typically thin laminated layers of silt and fly ash that contain unusual index properties such as very high moisture contents and very high liquidity indices.

The subsurface logs presented in Appendix A include more detailed descriptions of the materials encountered at the specific boring locations.

5.2.2. Bedrock

Elevations of apparent bedrock across the pond site, as indicated by auger refusal, show a general trend of descending from west to east. On the west side, bedrock elevations typically range from about El. 415 to El. 420 feet. On the east side, the bedrock elevations are mostly in the range of El. 407 to El. 415 feet. There were two instances of irregularities where bedrock is deeper than these trends. One occurs at Boring STN-4-24 on the west side where bedrock is at El. 412 feet. The other is at Boring STN-4-4 on the east side where bedrock was encountered at El. 394 feet. These variations are typical for limestone bedrock formations where surface weathering and solutioning can create abrupt changes in the rock surface over relatively short distances.

Approximately 10 feet of rock coring was performed at two borings (STN-4-13 and 24) to confirm the presence of bedrock, and to gain general information on the underlying limestone. The rock cores were logged in terms of rock type, color, bedding characteristics, and other notable features. The limestone bedrock encountered, correlates well with the geologic mapping; i.e. Tuscumbia Limestone formation. The rock core specimens are generally described as limestone, light gray to light brown, fine to coarse grained, hard, thin bedded, and fossiliferous. No notable karst features such as voids or clay seams were encountered. Rock core recoveries were measured to be between 92% and 96%, and the measured Rock Quality Designations (RQD) is 79% to 82%. These values are indicative of competent bedrock.

5.3. Phreatic Conditions

At select boring locations, piezometers were installed to measure pore water pressures. In general, initial piezometer readings were taken at approximate two week intervals, and then extended to monthly intervals. It is anticipated that Stantec will continue to take readings until June 2010. Refer to Appendix B for piezometer installation details and readings (up to most recent set of readings). The most recent readings are also shown on graphical logs shown on the stability cross-sections in Appendix E. Piezometer locations and tip elevations are summarized in Table 5.2 below.

Table 5.2. **Summary of Piezometers**

Boring No.	Concrete Pad Elevation (Feet)	Piezometer Tip Elevation (Feet)
STN-4-1s	460.2	435.7 (upper dike)
STN-4-3s	427.3	409.3 (native clay)
STN-4-4s	460.4	435.4 (upper dike)
STN-4-5s	439.5	415.5 (native clay/lower dike)
STN-4-6s	419.8	406.3 (native clay)
STN-4-7s	460.8	435.8 (upper dike)
STN-4-8s	421.6	401.6 (native clay/sand)
STN-4-9s	461.2	437.7 (upper dike)
STN-4-10s	420.9	406.4 (native clay/sand)
STN-4-11s	461.3	439.3 (upper dike)
STN-4-12s	446.2	426.2 (lower dike)
STN-4-13s	425.3	409.3 (native sand)
STN-4-14s	461.9	436.9 (upper dike)
STN-4-15s	460.5	439.5 (upper dike)
STN-4-16s	435.1	414.1 (native clay/lower dike)
STN-4-18s	461.1	437.1 (upper dike)
STN-4-19s	440.3	414.3 (native clay)
STN-4-21s	460.2	440.2 (upper dike)
STN-4-22s	438.0	414.0 (native clay)
STN-4-23s	461.1	444.1 (upper dike)
STN-4-24s	444.5	411.5 (native clay)

In general, the series of readings to date have shown that water levels have remained fairly consistent, with only slight fluctuations being observed (usually only a few tenths of a foot to about one foot). These fluctuations are likely attributed to equalization of the water level within the piezometers over time. However, it should be noted that water levels can also fluctuate due to the seasons, precipitation events, and other factors.

6. Laboratory Testing

6.1. General

The results of laboratory testing performed are included within the appendices. ASTM testing specifications were observed. In particular, natural moisture content test results are shown on the attached boring logs in Appendix A and are also shown on the drafted stability sections in Appendix E. The results of the classification testing and shear strength testing performed on selected samples are included in Appendix C. The USCS classifications associated with each horizon are also discussed in Section 5.2 above. No further discussion relative to the results of moisture content and classification testing are provided in this section. The discussion that follows is limited to the laboratory testing associated with evaluation of the dike compaction characteristics and shear strengths of the cohesive soil horizons.

6.2. Cohesive Soils/Undisturbed (Shelby) Tube Samples

The borings drilled for Ash Pond 4 included 3-inch diameter undisturbed (Shelby) tube sampling within cohesive soil horizons. Stantec's soils laboratory extruded the tubes and trimmed 6-inch long specimens. Lab personnel determined visual classifications, unit weights (wet and dry), and natural moisture for each 6-inch specimen prior to submitting a summary of the extruded specimens to a geotechnical engineer for assignment of lab testing. Select 6-inch specimens extruded from Shelby tubes were then subjected to consolidated-undrained (CU) triaxial testing and permeability testing. The results of these tests are included in Appendix C and discussed below.

6.2.1. Consolidated Undrained (CU) Triaxial Testing

Stantec performed CU triaxial testing with pore pressure measurements on selected 6-inch long specimens extruded from 3-inch diameter Shelby tubes obtained during drilling. CU testing provides indicators of effective-stress shear strength parameters for slope stability analyses. The results of the CU triaxial tests are presented on the stability sections in Appendix E, and are summarized in Table 6.1. The stress path envelopes derived from CU triaxial testing are also presented in Appendix C.

Table 6.1. Summary of Consolidated – Undrained Triaxial Testing

Boring No.	Sample Interval (feet)	Soil Horizon	CU Triaxial Strength	
			c' (psf)	ϕ' (degrees)
STN-4-1	2.5 – 3.0	Upper Clay Dike	860	24.1
	5.1 – 5.6			
	10.0 – 10.5			
STN-4-2	4.0 – 4.5	Lower Clay Dike	2	33.4
	8.0 – 8.5			
STN-4-5	9.0 – 9.5			
STN-4-3	2.5 – 3.0	Native Clay	356	27.1
	6.5 – 7.0			
	10.0 – 10.5			
STN-4-4	2.8 – 3.3	Upper Clay Dike	497	28.9
	5.0 – 5.5			
	5.6 – 6.1			
STN-4-5	17.0 – 17.5	Lower Clay Dike/Native Clay	229	32.4
	17.6 – 18.1			
	22.3 – 22.8			
STN-4-11	5.0 – 5.5	Upper Clay Dike	600	29.2
	5.5 – 6.0			
	10.0 – 10.5			
STN-4-12	8.0 – 8.5	Lower Clay Dike	261	29.5
	8.6 – 9.1			
	15.0 – 15.5			
STN-4-15	5.4 – 5.9	Upper Clay dike	701	21.2
	10.1 – 10.6			
	15.5 – 16.1			
STN-4-16	4.0 – 4.5	Lower Clay Dike	641	29.2
	4.6 – 5.1			
	9.6 – 10.1			
STN-4-19	14.1 – 14.6	Native Clay	384	28.2
	19.1 – 19.6			
	19.7 – 20.2			
STN-4-19	14.1 – 14.6	Native Clay	0	36.0
STN-4-22	4.0 – 4.5			
	4.6 – 5.1			
STN-4-23	4.1 – 4.6	Upper Clay Dike	658	23.1
	9.3 – 9.8			

6.2.2. Permeability Testing

The following table summarizes the testing results from the falling head permeability testing. Permeability values are used in seepage analyses.

Table 6.2. Summary of Falling Head Permeability Testing

Boring No.	Sample Interval (feet)	Soil Horizon	Permeability (cm/sec)
STN-4-1	15.4-16.0	Upper Clay Dike	4.1 E-08
STN-4-7	15.0-15.5	Upper Clay Dike	2.4 E-08
STN-4-12	5.2-5.7	Lower Clay Dike	2.8 E-08
STN-4-14	11.0-11.5	Upper Clay Dike	6.1 E-08
STN-4-19	5.2-5.7	Lower Clay Dike	4.4 E-08
STN-4-23	9.9-10.4	Upper Clay Dike	6.5 E-08

6.3. Moisture-Density Relationships

Bag samples were obtained of materials associated with the upper and lower clay dikes. The results of the standard moisture-density tests performed on these samples are summarized in Table 6.3.

Table 6.3. Standard Moisture-Density (Proctor) Test Results

Sample Location	Sample Depth Interval (feet)	Dike Location	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
STN-4-2	0.0' – 5.0'	Lower Dike	106.2	18.2
STN-4-7	15.0' – 17.0'	Upper Dike	109.4	16.3
STN-4-11	20.0' – 22.0'	Upper Dike	107.6	18.5
STN-4-14	20.0' – 22.0'	Upper Dike	107.6	18.4

Following completion of the moisture-density testing, undisturbed samples taken within dike materials were extruded and unit weight and moisture content determinations were made in association with triaxial shear strength testing. The results of the unit weight and moisture content determinations for triaxial test samples are shown in Table 6.4. A comparison between the moisture-density test results and the unit weight determinations obtained from the undisturbed samples are also included. The comparison was made by using the moisture density test results that were nearest to the undisturbed sample locations (and which also had like classifications) to estimate relative compaction.

Table 6.4. Comparison Between Undisturbed Sample Conditions and Moisture-Density Test Results

Boring Location	Sample Depth Interval (feet)	Dike Location	Unit Weight Dry (pcf)	Moisture Content (%)	Maximum Dry Density (pcf)	Percent Maximum Dry Density (%)	Optimum Moisture Content (%)	Moisture Content Variation (%)
STN-4-1	2.5-3.0	Upper	108.4	19.9	109.4	99.1	16.3	+3.6
STN-4-1	5.1-5.6	Upper	103.5	21.6	109.4	94.6	16.3	+5.3
STN-4-1	10.0-10.5	Upper	96.9	25.3	109.4	88.6	16.3	+9.0
STN-4-2	4.0-4.5	Lower	103.7	21.5	106.2	97.6	18.2	+3.3
STN-4-2	8.0-8.5	Lower	101.2	20.4	106.2	95.3	18.2	+2.2
STN-4-5	9.0-9.5	Lower	107.6	20.4	106.2	101.3	18.2	+2.2
STN-4-4	2.8-3.3	Upper	102.5	20.1	107.6	95.3	18.5	+1.6
STN-4-4	5.0-5.5	Upper	102.8	20.8	107.6	95.5	18.5	+2.3
STN-4-4	5.6-6.1	Upper	99.0	22.0	107.6	92.0	18.5	+3.5
STN-4-5	17.0-17.5	Lower	108.0	16.8	106.2	101.7	18.2	-1.4
STN-4-5	17.6-18.1	Lower	107.9	16.2	106.2	101.6	18.2	-2.0
STN-4-11	5.0-5.5	Upper	102.9	22.1	107.6	95.6	18.5	+3.6
STN-4-11	5.5-6.0	Upper	110.4	18.0	107.6	102.6	18.5	-0.5
STN-4-11	10.0-10.5	Upper	105.8	20.2	107.6	98.3	18.5	+1.7
STN-4-12	8.0-8.5	Lower	96.8	22.8	106.2	91.1	18.2	+4.6
STN-4-12	8.6-9.1	Lower	110.2	16.8	106.2	103.8	18.2	-1.4
STN-4-12	15.0-15.5	Lower	108.4	20.0	106.2	102.1	18.2	+1.8
STN-4-16	4.0-4.5	Lower	107.9	20.1	106.2	101.6	18.2	+1.9
STN-4-16	4.6-5.1	Lower	110.4	18.9	106.2	104.0	18.2	+0.7
STN-4-16	9.6-10.1	Lower	107.4	20.3	106.2	101.1	18.2	+2.1

The existing in-situ dry densities of the dike materials were determined to range from about 91 percent to 104 percent of the standard Proctor dry densities, with most being greater than 95 percent. This data indicates that the dike materials appear to have been compacted in a controlled manner when compared to typically accepted target densities of 95 percent or greater for compacted clay soils in an earth dike. However, it should be noted that no construction documentation has been provided to confirm this comparison. The corresponding moisture values were mostly in the range of about 1 to 5 percent above the optimum moisture value. This is likely attributed to the dike materials being saturated by long-term steady-state seepage conditions.

6.4. Standard Penetration Test Samples

Recovered soil specimens from SPT sampling were subjected to natural moisture content determinations and select samples were combined for engineering classification testing. The engineering classification testing consisted of Atterberg limits, specific gravity, and sieve and hydrometer analyses. The results of the classification testing were used in conjunction with the N-values from SPT's to estimate soil strength based on published correlations of such data. The results of the moisture content tests and classification testing are included on the boring logs and stability section drawings in Appendixes A and E, respectively.

7. Engineering Analysis

7.1. General

Geotechnical engineering analyses included evaluations of strength and permeability parameters, seepage analyses, and slope stability analyses. Prior to beginning the analyses, the geotechnical data and cross-sections were combined and the geometry of the existing dikes and soil horizons were approximated using current and historical information. Once the geometry of the sections was approximated, each section was reviewed and evaluated to determine the critical cross-section for analyses. Selection of critical sections was based on the steepness of slopes, heights of dikes, geometry of the sections, phreatic surface, seepage conditions, and subsurface conditions. Based on this evaluation, six representative cross-sections were selected for analyses (Sections A-A', B-B', D-D', F-F', G-G', and I-I'). The locations of the sections are shown on the layout drawing presented in Appendix E. Results of the analyses and evaluations are summarized in the following paragraphs, and are shown on drawings/computer output provided in Appendices F and G.

It should be noted that construction records indicating the methods used to construct dikes, as-built dike configurations, etc. were not available for review. As a result, assumptions and generalizations in soil parameters and dike geometry were needed to construct the seepage and stability models.

7.2. Soil Horizons

Based on the results of the drilling, laboratory testing, historical documentation, and drawings, the materials on site were divided into five different soil layers for seepage and stability analyses. Refer to the stability sections in Appendix E for locations of the soil horizons. The soil horizons are briefly described as follows (refer to Section 5.2.1 for further descriptions):

- *Lower Dike:* This represents the material used for construction of the initial perimeter dike constructed in 1972. Historical data shows that this dike was constructed to a crest of El. 440 feet, with interior side slopes of 2H:1V and exterior side slopes of about 3H:1V. The dike is located primarily on the north, east, and south sides of the pond where native ground elevations were the lowest. It is present only in low heights on the southwest to west side.

- *Upper Dike:* This represents the material used for the 1984 construction of the raised dikes. Historical data shows that this dike was constructed to a crest of El. 460 feet above the initial "lower dike" and outwardly over sluiced ash. Historical data also shows that this dike was constructed with interior side slopes of 2H:1V and exterior side slopes of 3H:1V.

- *Native Clay and/or Native Clay and Silt:* This represents the uppermost layers of native clay and/or silty materials beneath the perimeter dikes and pond.

- *Native Sand:* This represents horizons of alluvial silty and clayey sand that were encountered in some instances below the native clay/silt materials.

- *Hydraulically Placed (sluiced) Ash:* This represents sluiced bottom ash/fly ash that is contained by the upper and lower dikes.

7.3. Seepage Analysis

7.3.1. SEEP/W Model

An analysis of steady state seepage through the Ash Pond 4 dikes was performed 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). The numerical seepage models for COF Ash Pond 4 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-section. 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.

Six dike cross-sections through Ash Pond 4 were modeled with SEEP/W, and then were subsequently evaluated for slope stability (Section 7.4). For the numerical analysis, each cross-section was subdivided into a mesh of elements, consisting of first-order quadrilateral and triangular finite elements. For seepage problems, where the primary unknown (hydraulic head) is a scalar quantity, first-order elements provide for efficient, effective modeling. Given appropriate hydraulic conductivity properties and applied boundary conditions, the finite element method (as implemented in the SEEP/W code) was then used to simulate steady seepage across the mesh. The total hydraulic head is computed at each nodal location, from which pore water pressures and seepage gradients can be determined.

7.3.2. Boundary Conditions

Steady-state seepage was assumed for the analysis, with the static pool level placed at approximate El. 457 feet (based on TVA provided survey data).

Boundary conditions for the SEEP/W analysis were assumed as follows. Along the vertical, upstream edge of the model, the hydraulic head at each node was constant with depth and equal to the pool elevation. A total head equal to the pool level was also applied to all submerged nodes along the ground surface of the upstream side (submerged sluiced ash and interior upper dike). Along the vertical, downstream edge of the model, the hydraulic head at each node was constant with depth and equal to the Cane Creek elevation or piezometer reading closest to the edge, depending on cross-section location. 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.

7.3.3. Seepage Properties

For each modeled cross-section, a representative subsurface profile was compiled based on boring logs, available record drawings, and the known project history. Material properties were estimated based on available laboratory data, correlations with classification data, and on typical values for similar materials. Material properties used in the seepage analysis are summarized in Table 7.1.

Table 7.1. 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 Saturated (%)	Volumetric Water Content Residual (%)	Basis
Lower Dike	1.0e-7 to 1.0e-8	1 to 5	2.74	0.58	37	2	Available Laboratory Data and Correlation w/ Typical Values
Upper Dike	1.0e-7 to 1.0e-8	1 to 5	2.72	0.66	40	2	Available Laboratory Data and Correlation w/ Typical Values
Hydraulically Placed (Sluiced) Ash	1.0e-4 to 4e-5	10 to 35	2.30	0.85	46	1	Available Laboratory Data and Correlation w/ Typical Values
Native Clay / Native Clay and Silt	1.0e-4 to 1.0e-5	10 to 35	2.71	0.58	37	1	Available Laboratory Data and Correlation w/ Typical Values
Native Sand	1.0e-3 to 1.0e-4	30 to 50	2.72	0.84	46	1	Available Laboratory Data and Correlation w/ Typical Values
Limestone Bedrock	1.0e-3	10	2.60	0.14	12	1	Correlation w/ Typical Values

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

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 Ash Pond 4, an iterative process of parametric calibration (Section 7.3.4) was used to arrive at final estimates of the seepage properties. Results from trial simulations were compared to field data (measured piezometric levels and observed seepage) and the material parameters were then varied until the solutions reasonably matched the field data. The final set of parameters (Table 7.1) resulted in the comparisons presented in Section 7.3.4.

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 Ash Pond 4, 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 Ash Pond 4, 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 are not sensitive to the selection of these values.

7.3.4. Comparison to Field Observations

After the initial seepage parameters were estimated, results from the SEEP/W model were compared to pore water pressures measured in piezometers installed within Ash Pond 4. Data from the 21 piezometers were used in this evaluation. Nodes were placed in the model at the same location as the piezometer tip was installed in the field 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 3 feet below to 5 feet above the readings obtained in the piezometers installed within the dike crest. For the dike toe areas and mid-slope areas, the seepage model consistently predicted the water table position to be from about 3 to 10 feet above actual toe piezometer readings (or closer to the ground surface). Actual field conditions at toe/midslope piezometers were more difficult to match within the seepage model. For all locations, the maximum difference between the predictions and measurements is about 12 feet, while most differ by less than 3 to 6 feet. These differences are judged to be acceptable given the limited information available and unknown conditions between the modeled cross-sections and borings.

The results from the seepage model can also be compared to field observations of seepage. For Ash Pond 4, historical seepage has been present along the majority of the east and southeast dikes. Also, Stantec recently found less pronounced and less widespread seepage areas along the south, southwest, and west sides. The outbreak of the observed seepage typically begins a few feet above the toe of the upper dike. These observations correlate well with the seepage models for the cross-sections which generally show the shape of the predicted phreatic surface extending to the slope face just above the lower dike.

In summary, the seepage models appear to give a reasonable prediction of the phreatic surface location when compared to field observations and piezometer measurements.

7.3.5. 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.

$$FS_{piping} = \frac{i_{crit}}{i} \qquad \textbf{Eqn. 7.1}$$

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:

$$i_{crit} = \frac{\gamma_{sub}}{\gamma_w} = \frac{G_s - 1}{1 + e} \qquad \textbf{Eqn. 7.2}$$

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.

7.3.6. Results of Seepage Analysis

Plots from the SEEP/W analyses of the six cross-sections through the Ash Pond 4 dikes are presented in Appendix F. The plots show the finite element mesh, material zones, and boundary conditions used in each analysis. The results are depicted in contour plots of total head, pore water pressure, and seepage gradients. For the slope stability analyses (Section 7.4), the pore water pressures along the considered slip surfaces were determined by interpolation between the nodal pore pressures predicted with the SEEP/W model. The seepage gradients were assessed for maximum exit gradients and the potential for soil piping.

On each modeled cross-section, examination of the output (predicted phreatic surface and vertical gradients) can be made to look 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 7.3.5. First, contour plots of vertical gradient (Appendix F) 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 toe of the lower 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 7.2. They range from 1.6 to 3.1, with one value being relatively high (Section F-F') because a critical exit point was not predicted by the model. Stantec recommends a target factor of safety against piping of 3 for the evalution of Ash Pond 4, based on information contained in United States Army Corps of Engineers (USACE) manual EM 1110-2-1901. Hence, on four of the six cross sections modeled, Ash Pond 4 does not meet the recommended target factor of safety for piping at the critical seepage exit points located at or beyond the dike toes. The lowest factors of safety occur at cross-sections that represent the east side of the pond along Cane Creek.

Table 7.2. Summary of Computed Exit Gradients and Minimum Factors of Safety against Piping

Cross Section*	Vertical Gradient (i_v) at Critical Exit Point	Location of Critical Exit Point	Material	Critical Gradient (i_{crit})	FS_{piping}
A-A'	0.42	Toe	Native Clay	1.08	2.6
B-B'	0.69	Toe/Creek	Native Clay	1.08	1.6
D-D'	0.56	Toe/Creek	Native Sand	0.93	1.7
F-F'	Critical Exit Point Not Identified by Model	N/A	N/A	N/A	> 3
G-G'	0.44	Toe	Native Clay	1.08	2.5
I-I'	0.35	Toe	Native Clay	1.08	3.1

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

7.4. Slope Stability Analyses

7.4.1. SLOPE/W Model

The stability of the Ash Pond 4 dikes were evaluated using limit equilibrium methods as implemented in the SLOPE/W software, which is available from GEO-SLOPE International, Ltd., of Calgary, Alberta, Canada (www.geo-slope.com). Analyses were completed for static, long-term conditions with steady-state. SLOPE/W is a special-purpose computer code 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 mapped directly from a SEEP/W solution. In this study, steady-state pore pressures were obtained from the SEEP/W models described in Section 7.3. Stability analyses were also performed using data obtained from piezometer readings for comparison purposes.

7.4.2. Limit Equilibrium Methods in SLOPE/W

Limit equilibrium methods for evaluating slope stability consider 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 first divided into vertical slices, then stresses are evaluated along the sides and base of each slice. The factor of safety against a slope failure (FSslope) is defined as:

$$FS_{slope} = \frac{\text{shear strength of soil}}{\text{shear stress required for equilibrium}} \qquad \textbf{Eqn. 7.3}$$

where the strengths and stresses are computed along a defined failure surface located at the base of the vertical slices. The shearing resistance along the potential slip surface is 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 FSslope for an assumed failure surface. A search must be made to find the critical slip surface corresponding to the lowest FSslope. Both circular and noncircular potential failure surfaces can be evaluated.

7.4.3. Analysis Approach for Pond 4

The slope stability analyses for Ash Pond 4 were performed using SLOPE/W 2007 on the downstream (exterior) faces of the dikes. SLOPE/W incorporates various search routines to locate the critical slip surface. For the analyses presented here, the "Grid and Radius" method and the "Entrance and Exit" method were employed. Center points for the trial circles were confined to a specified range above the slope surface, while the trial radii were varied based on tangent horizontal lines within the soil. The minimum and maximum range for the center points and tangent lines were parametrically varied over a wide range to determine the likely solution region for the critical circle. In subsequent runs, the search was refined by narrowing the range and spacing for the candidate center points. The phreatic surface and distribution of pore water pressures obtained from the SEEP/W model were used in the analysis. For comparison, separate slope stability models were also prepared using the phreatic surface as obtained from the piezometer readings.

7.4.4. Selection of Shear Strength Parameters

The lower dikes for Ash Pond 4 were originally constructed in 1972, and the upper dikes were constructed in 1984. These dikes have existed in their current cross sectional geometry (slopes and crest elevation) for at least 25 years. Hence, excess pore pressures generated in the underlying soil during construction have had sufficient time to dissipate and steady state seepage conditions have developed within the dikes. The stability analyses presented in this report will focus only on static steady state seepage conditions (no earthquake or other dynamic loads). For these conditions, soil unit weights and drained strength parameters (c' and ϕ') are needed.

The drained shear strength parameters used for the clay dikes and clay foundation materials were derived using results of laboratory triaxial tests, along with consideration given to standard penetration test data and laboratory classification test data. In addition, the strength parameters selected were further refined or confirmed by comparisons with the strength parameters listed in the TVA-provided historical reports. Representative strengths for each horizon were selected using the methodology outlined in the US Army Corps of Engineers Engineer Manual EM 1110-2-1902 as a guide. Results of triaxial testing were evaluated and effective stress p' versus q scatter plots were prepared of all of the data points. The maximum effective principal stress ratio was used to determine failure criteria for selection of these values within Stantec's laboratory test results. Once the p' versus q plots were prepared, a failure envelope was then selected such that two thirds of the plotted values were above the envelope. The p' versus q plots and selection of the failure envelope are shown for each horizon on the graphs presented in Appendix D. The strength parameters were rounded to the nearest degree with regards to ϕ'. The cohesion intercept point (c') was limited to a maximum of 200 pounds per square foot.

For non-cohesive native sands, shear strength parameters were estimated using published relationships which correlate SPT N-values with relative density, specific soil types and angles of internal friction.

In addition to the dike and foundation soils, both stacked and sluiced ash materials are present within Ash Pond 4. Shear strength parameters for ash materials were estimated using historical data, typical values, and published correlations using SPT N-values.

The following table provides a summary of the effective stress shear strengths selected for use in the slope stability analyses.

Table 7.3. Selected Strength Parameters for Stability Analyses

Soil Horizon	Unit Weight (pcf)	Effective Stress Strength Parameters	
		c' (psf)	Ø' (degrees)
Upper Dike	126	200	28
Lower Dike	127	200	29
Sluiced Ash	85	0	26
Native Clay/Silt	129	200	28
Native Sand	110	0	30
Stacked Ash	90	0	30

7.4.5. Results of Slope Stability Analysis

Using the strength parameters (c' and ϕ') listed in Table 7.3, in conjunction with the results of the seepage analyses and piezometer data, the existing dike configurations were analyzed at the six selected cross-sections. Geo-Slope's Slope/W computer program was used for the analyses with pore pressures imported from the seepage analyses. Separate analysis was also performed using the piezometer data instead of seepage model pore pressures for comparison. Long term (effective stress) steady state seepage conditions were analyzed using Spencer's method. For the Spencer's method analyses, circular failure surfaces with optimization were conducted.

The stability analyses focused on the potential for failure along the exterior dike face. SLOPE/W failure surfaces from these analyses are presented on the drafted sheets in Appendix E. The results are summarized in Table 7.4 below.

Table 7.4. Summary of Minimum Computed Factors of Safety for Slope Stability

Cross-Section*	Minimum FS (using piezometer data)	Minimum FS (using pore water pressures from SEEP/W)
A-A'	2.10	1.50
B-B'	1.80	1.54
D-D'	1.40	1.42
F-F'	1.49	1.77
G-G'	1.95	1.50
I-I'	2.19	1.92

*Refer to Appendix E for plan view of cross-section locations.

Based on discussions with TVA and to be in accordance with current prevailing geotechnical practice, a minimum target factor of safety of 1.5 was established for long term conditions using the guidelines presented in USACE Manual EM 1110-2-1902 "Slope Stability". There is no formal dam safety program, regulations, or design criteria for dams in the state of Alabama.

The results of the slope stability analyses demonstrate that the factors of safety against long-term, steady state seepage slope stability range from about 1.4 to greater than 1.5. The results indicate that only one cross-section (Section D-D') has a safety factor less than the target. This cross-section is generally representing the east side of the pond along Cane Creek. The trends of safety factors determined from the analyses using the piezometer data versus the pore water pressures from the seepage model are fairly comparable, with the values using the seepage model tending to be a little lower. In each case, the critical slip surfaces extend into the dike to affect the crest and represent more of a global failure surface. The critical slip surfaces are depicted in Appendix E.

There was no indication in the slope stability analyses that a noncircular failure surface would give a factor of safety lower than that obtained for circular 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 optimization scheme available within SLOPE/W was used to consider noncircular, curved slip surfaces. The results presented in Table 7.4 and in Appendix E represent factors of safety computed from the optimized, circular slip surface routine.

8. Conclusions and Recommendations

The conclusions and recommendations that follow are based on Stantec's understanding of Ash Pond 4, as outlined in this report, and on TVA's plans for future modifications to downsize or possibly close the pond. This understanding has been developed from review of historical information, discussions with TVA personnel, and from the results of this geotechnical exploration. In addition, Stantec understands that TVA has tasked URS Corporation with conducting a feasibility study to address potential operational modifications to Ash Pond 4 so that the hazard classification could possibly be reduced. Pond modifications being considered by TVA and URS include reducing the size of the pond or perhaps pond closure.

8.1. 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. On most cross-sections, the model predicts the potential for seepage outbreaks to occur on the exterior dike slopes just above the upper-lower dike interface (toe of the upper dike), and at lower areas along or beyond the dike toes. These results are generally confirmed by the observation of intermittent seepage areas around the pond typically beginning as high as a few feet above the upper dike toe and extending downslope (most predominantly on the east side). The seepage analyses also showed that maximum vertical exit gradients typically occur at or just beyond the dike toe areas. Factors of safety against piping in these toe areas where the maximum exit gradients are predicted range from 1.6 to 2.6 for Sections A-A', B-B', D-D', and G-G', which is less than the recommended target of 3. The factors of safety against piping for Sections F-F' and I-I are greater than 3. Thus, for four of the six cross-sections analyzed, the factors of safety against piping at locations of the maximum exit gradients are less than the recommended target value. The lowest factors of safety occur at the toes of cross-sections that represent the east side of the pond along Cane Creek.

8.2. The results of the slope stability analyses indicate that factors of safety against long-term slope stability failure are mostly greater than the target value of 1.5, except for Section D-D' where a factor of safety of about 1.4 was calculated from the model. This section represents the east side of the pond adjacent to Cane Creek.

8.3. To improve the long-term stability and seepage conditions, it is recommended that TVA implement a mitigation design and construction program for Ash Pond 4 to improve factors of safety against slope stability and piping in areas where deficiencies are identified. These improvements could be incorporated into URS Corporation's design of pond modifications/closure, or a separate short-term interim mitigation program could be implemented, depending on timing and as decided by TVA. Final mitigation design should increase factors of safety to at least 1.5 for long term slope stability, and to at least 3 for piping.

8.4. If TVA decides to perform mitigation coincident with URS design of pond modifications/closure, then features for improvements should include a combination of stabilizing beams, flattening of dike slopes, and provisions for collecting and controlling seepage. Lowering the pool level will also help to improve slope stability and seepage conditions, and should be considered by URS in their evaluation of operational changes to Ash Pond 4. If stabilizing berms are used and are placed over areas subject to exit seepage, the gradation of the berm should be selected to filter the seepage water and to prevent piping.

8.5. If implementation of a short-term interim mitigation program is selected, then improvements should focus on the east and southeast sides of the pond where lower factors of safety against slope stability and piping have been calculated, and where the most predominant historical seepage conditions exist. Short term improvements should consist of placement of a stabilizing berm. Since this berm would be placed over seepage areas, it should contain appropriate material zones and gradations to filter seepage water and to prevent piping.

8.6. It is recommended that URS Corporation's design of modifications/closure include an instrumentation monitoring program (including calculation of "alert" piezometric levels which would result in slope stability factors of safety falling below 1.5). Until mitigation/operational changes can be made that will improve stability/seepage, it is also recommended that TVA continue dike inspections/monitoring to look for changes or conditions that might affect dike integrity. The frequency of inspections should be daily (Site Foreman or PAE), weekly (Field Supervisor) and monthly (Construction Manager). This is consistent with the TVA's new programmatic inspection schedule.

8.7. Ash Pond 4 is underlain by limestone bedrock that can be susceptible to solutioning and the development of karst features, such as voids, solution channels, and sinkholes in the soil overburden and/or the underlying bedrock. Construction and operation in such areas is always accompanied by risk that internal soil erosion and ground subsidence could affect constructed facilities. It is not possible to completely investigate a site or design a facility to eliminate karst-related problems. However, throughout this study Stantec did not observe ground features nor detect unusual subsurface conditions at the boring locations that would indicate that karst-related issues are affecting Ash Pond 4.

9. Closure and Limitations of Study

9.1. The scope of this evaluation was limited to consider only the potential risks of the Ash Pond 4 dikes due to excessive seepage and slope instability 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 embankment (including the buried spillway pipes).

9.2. These conclusions and recommendations are based on data and subsurface conditions from the borings advanced during this investigation using that degree of care and skill ordinarily exercised under similar circumstances by competent members of the engineering profession. No warranties can be made regarding the continuity of conditions between borings.

9.3. 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.

10. References

The following is a list of documents that were the main references for gaining historical information used to evaluate Ash Pond No. 4 and prepare this report:

- Colbert Steam Plant – Proposed Ash Disposal Area No. 4 – Dikes – Soil Investigation, Memorandum from Gene Farmer to F.P. Lacy, October 13, 1972.

- Colbert Steam Plant – Ash Disposal Area No. 4 Dike Raising – Soils Exploration and Testing – En Des Soils Schedule No. 67, Memorandum from Gene Farmer to G.L. Buchanan, March 27, 1978.

- Geology of the Colbert Steam Plant, Charles P. Bensiger, TVA Division of Water Control Planning, Geologic Branch, November, 1951.

- TVA Drawing Numbers 10N290, 291, 292, 293, 294-1 through 294-7, 213, 287.

- TVA Annual Inspection Reports, 1993 to 2008.

Additional reference documents:

- Slope Stability, Department of the Army, US Army Corps of Engineers, Engineering Manual EM 1110-2-1902, October 31, 2003.

- Seepage Analysis and Control for Dams, Department of the Army, US Army Corps of Engineers, Engineering Manual EM 1110-2-1901, April 30, 1993.

- Geotechnical Investigations, Department of the Army, US Army Corps of Engineers, Engineering Manual EM 1110-1-1804, January 1, 2001.

- GeoStudio, Computer Software. GEO-Slope International Ltd. Ver. 7.14, 2007.

- Soil Mechanics Design Manual 7.1, Department of the Navy – Navy Facilities Engineering Command, May 1982.

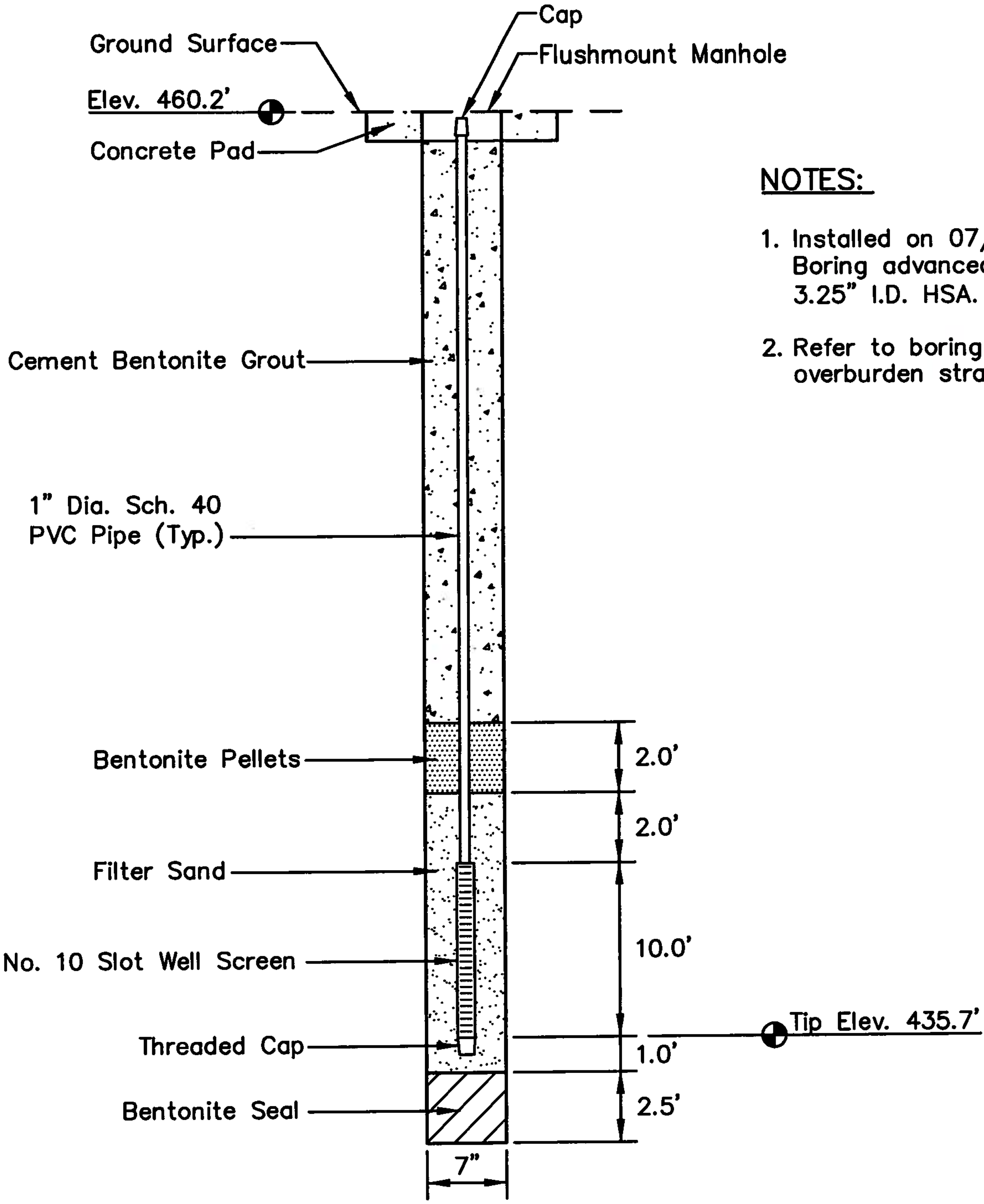
- Terzaghi, K., Peck, R.B., and Gholamreza, M., Soil Mechanics in Engineering Practice, 3rd Edition, New York, John Wiley and Sons, 1996.

Appendix A

Typed Boring Logs

Appendix B

Piezometer Installation Details and Readings



NOTES:

1. Installed on 07/15/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/01/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-1.DWG

LOCATION

Northing: 1723599.52
Easting: 394359.89
Ground Elevation: 460.2

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-1S
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
ASH POND 4

Stantec

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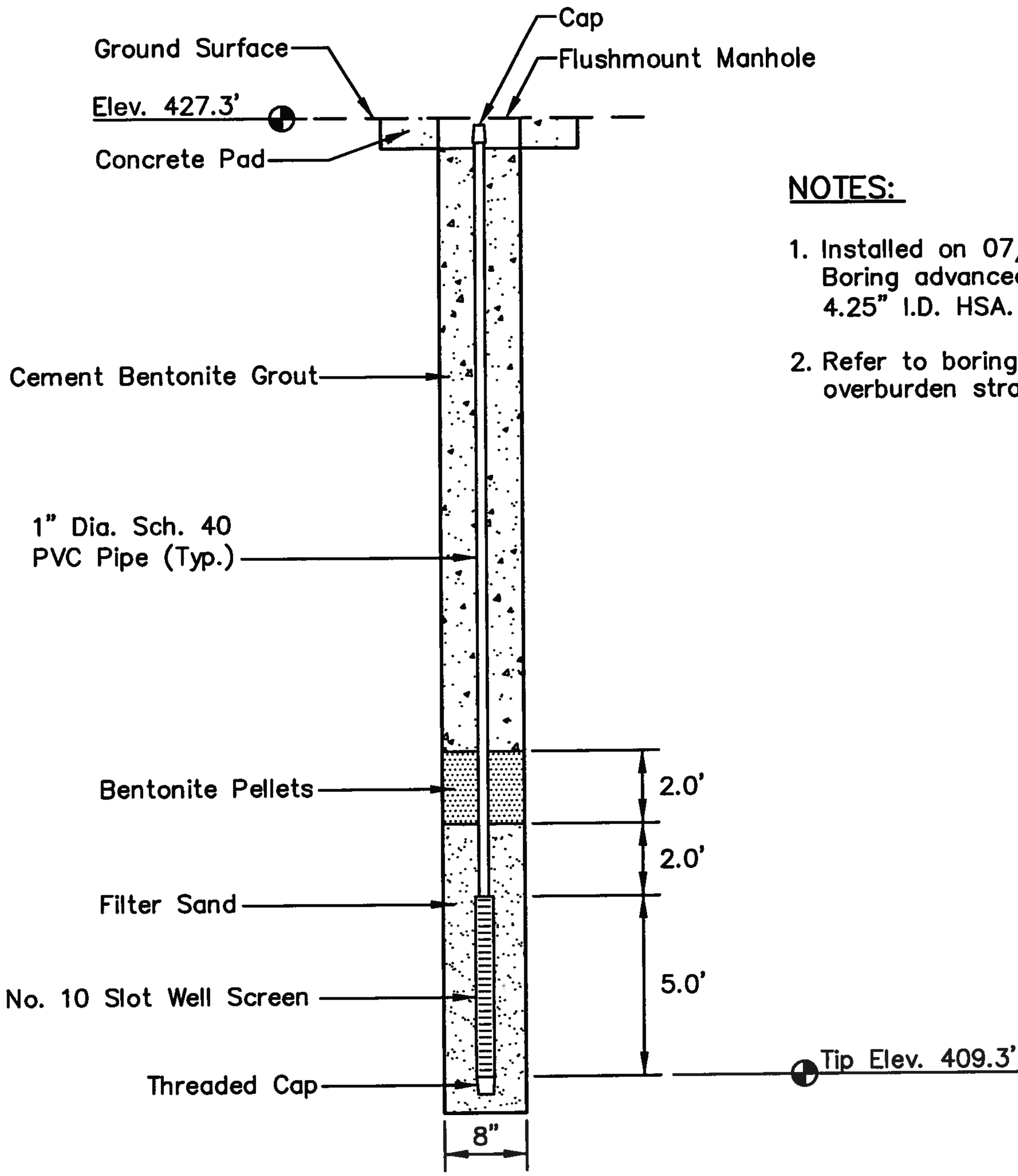
www.stantec.com

DRAWN BY	RRP	DATE	SEPT., 2009	REVISED			SHEET
CHECKED BY	PJC	PROJ. NO.	175559016	1.	3.		1 OF 21
CHECKED BY	RLR	SCALE	NTS	2.	4.		



NOTES:

1. Installed on 07/21/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 09/25/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-3.DWG

LOCATION

Northing: 1723645.94
Easting: 394253.91
Ground Elevation: 427.3

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-3S
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
ASH POND 4

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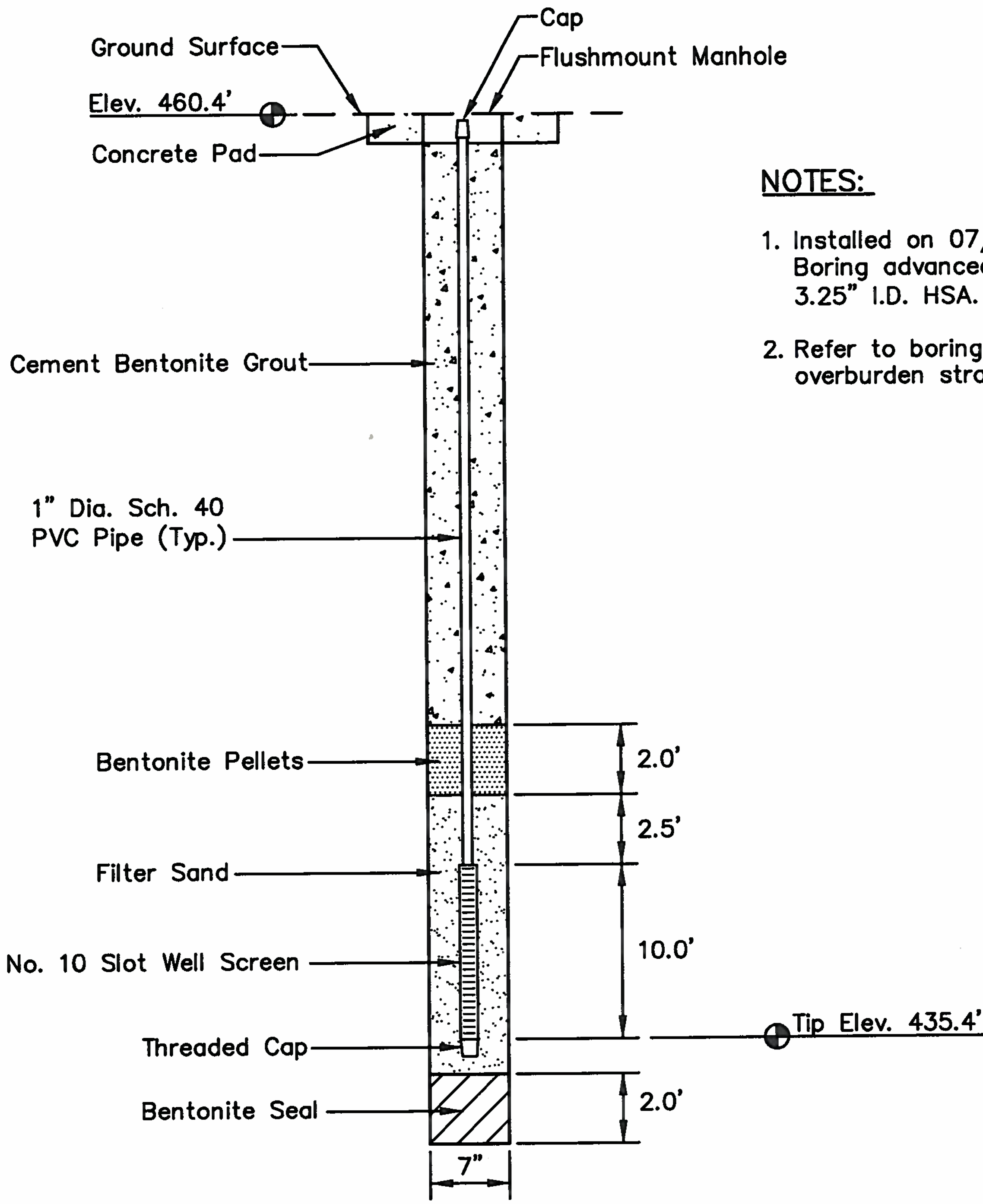
CHECKED BY	PJC	PROJ. NO.	175559016	1.	3.	2 OF 21
CHECKED BY	RLR	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 07/21/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/01/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-4.DWG

LOCATION

Northing: 1723316.42
Easting: 394738.76
Ground Elevation: 460.4

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-4S
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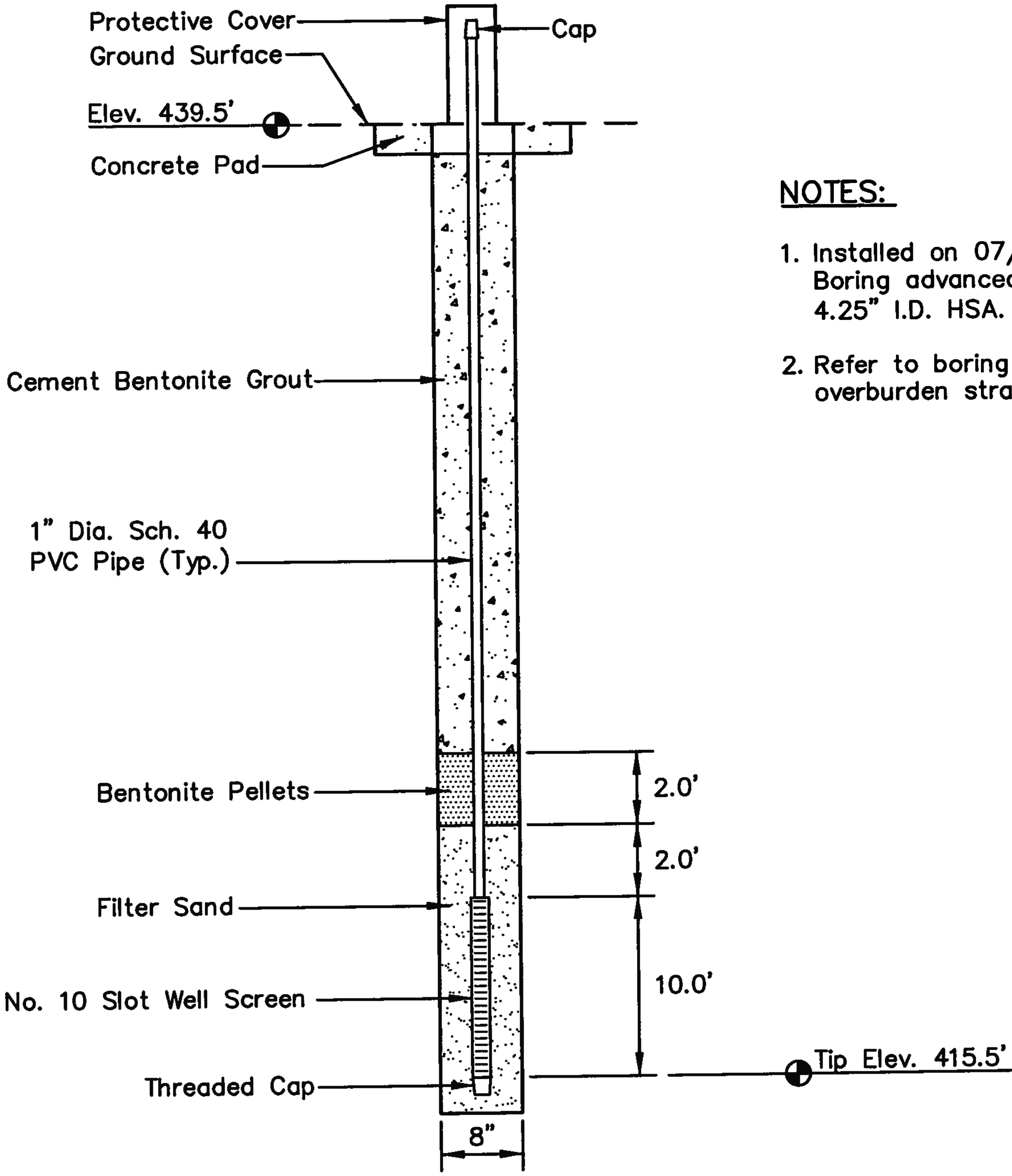
CHECKED BY	PJC	PROJ. NO.	175559016	1.	3.	3 OF 21
CHECKED BY	RLR	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 07/25/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 09/25/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-5.DWG

LOCATION

Northing: 1723366.01
Easting: 394798.52
Ground Elevation: 439.5

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-5S
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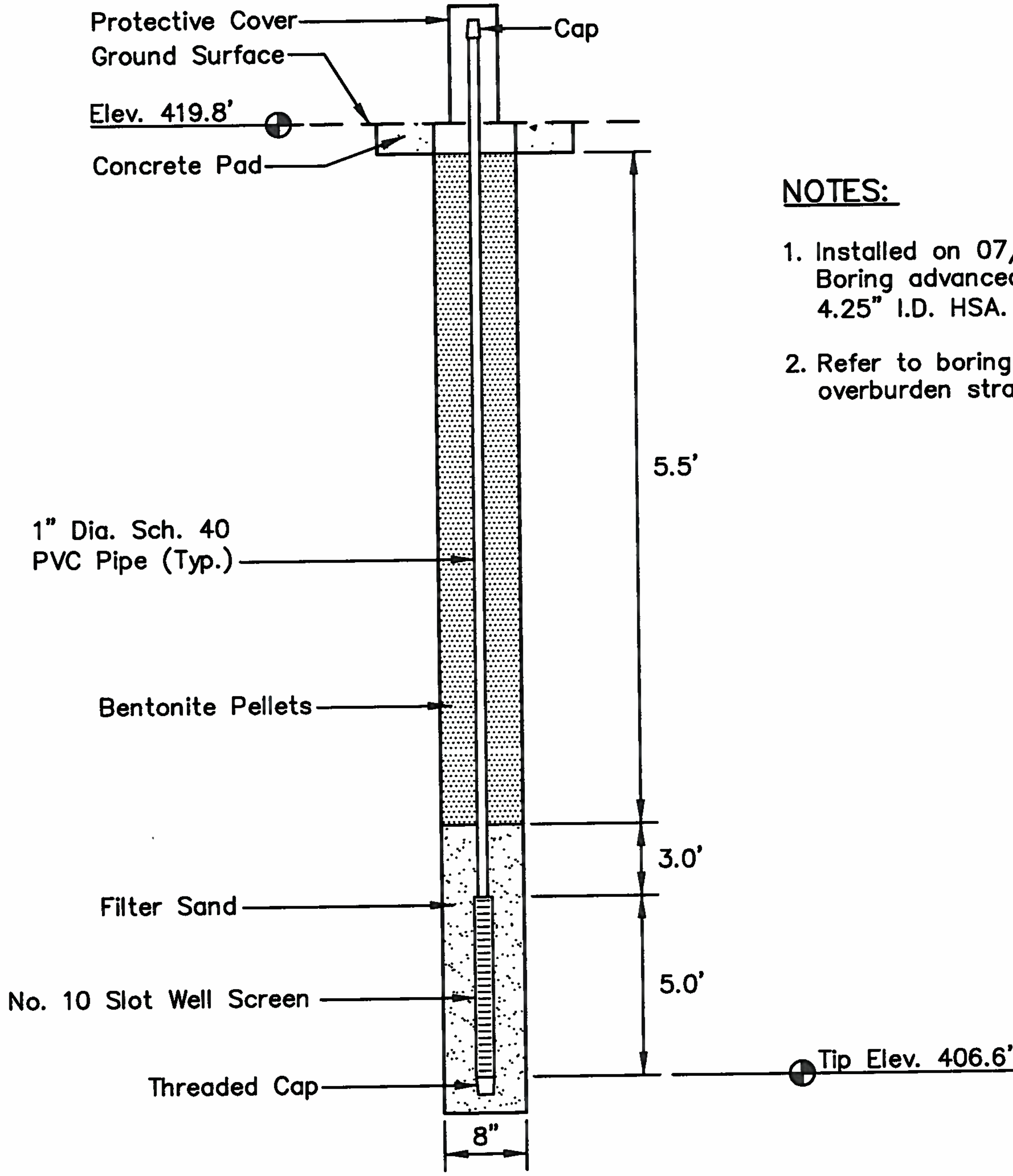
CHECKED BY	PJC	PROJ. NO. 175559016	1.	3.		4 OF 21
CHECKED BY	RLR	SCALE NTS	2.	4.		



NOTES:

1. Installed on 07/24/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 11/11/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-6.DWG

LOCATION

Northing: 1723373.16
Easting: 394864.54
Ground Elevation: 419.8

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-6S
PIEZOMETER INSTALLATION DETAIL
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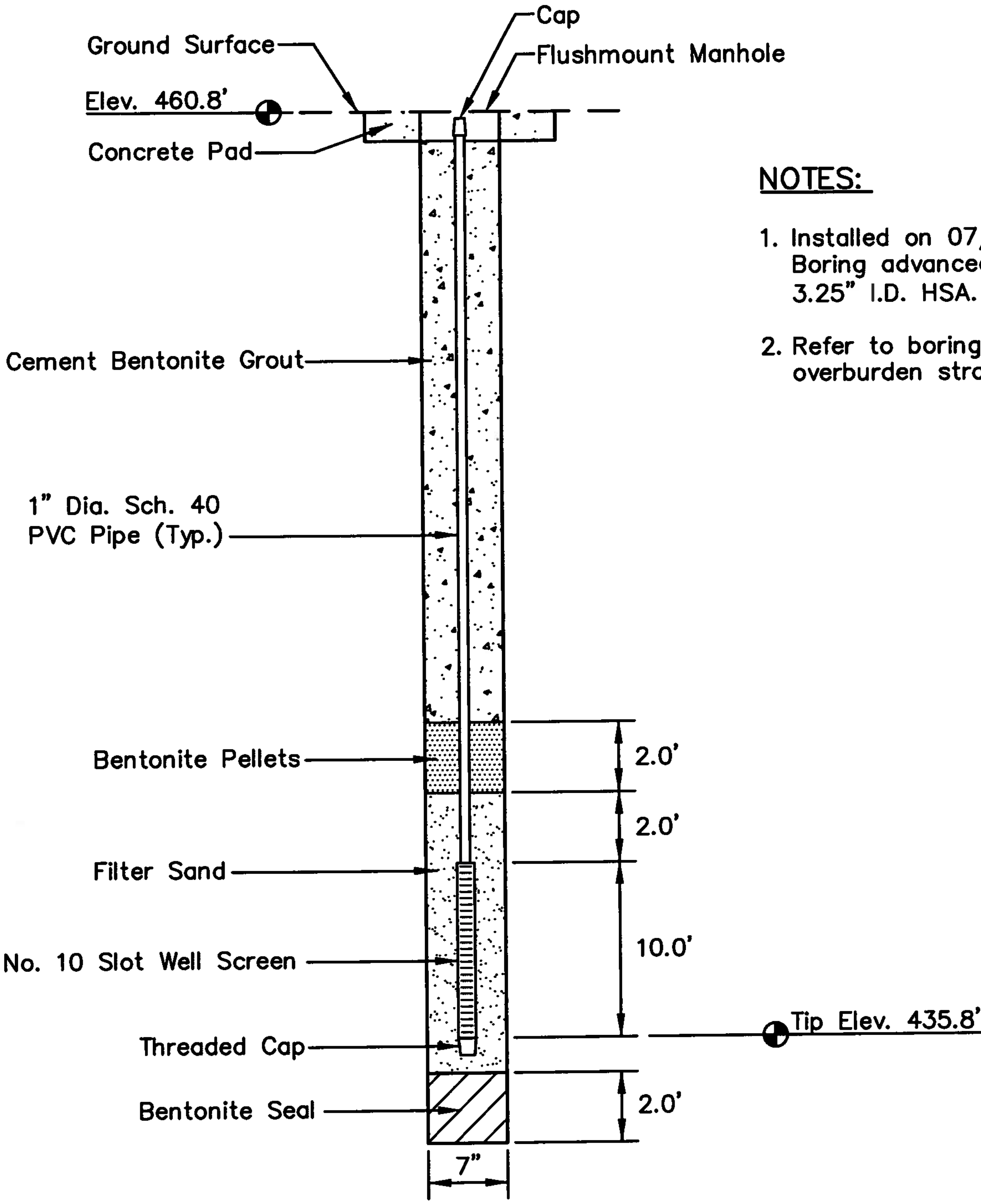
CHECKED BY	PJC	PROJ. NO.	175559016	1.	3.	5 OF 21
CHECKED BY	RLR	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 07/22/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/01/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-7.DWG

LOCATION

Northing: 1722880.08
Easting: 394960.81
Ground Elevation: 460.8

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-7S
PIEZOMETER INSTALLATION DETAIL
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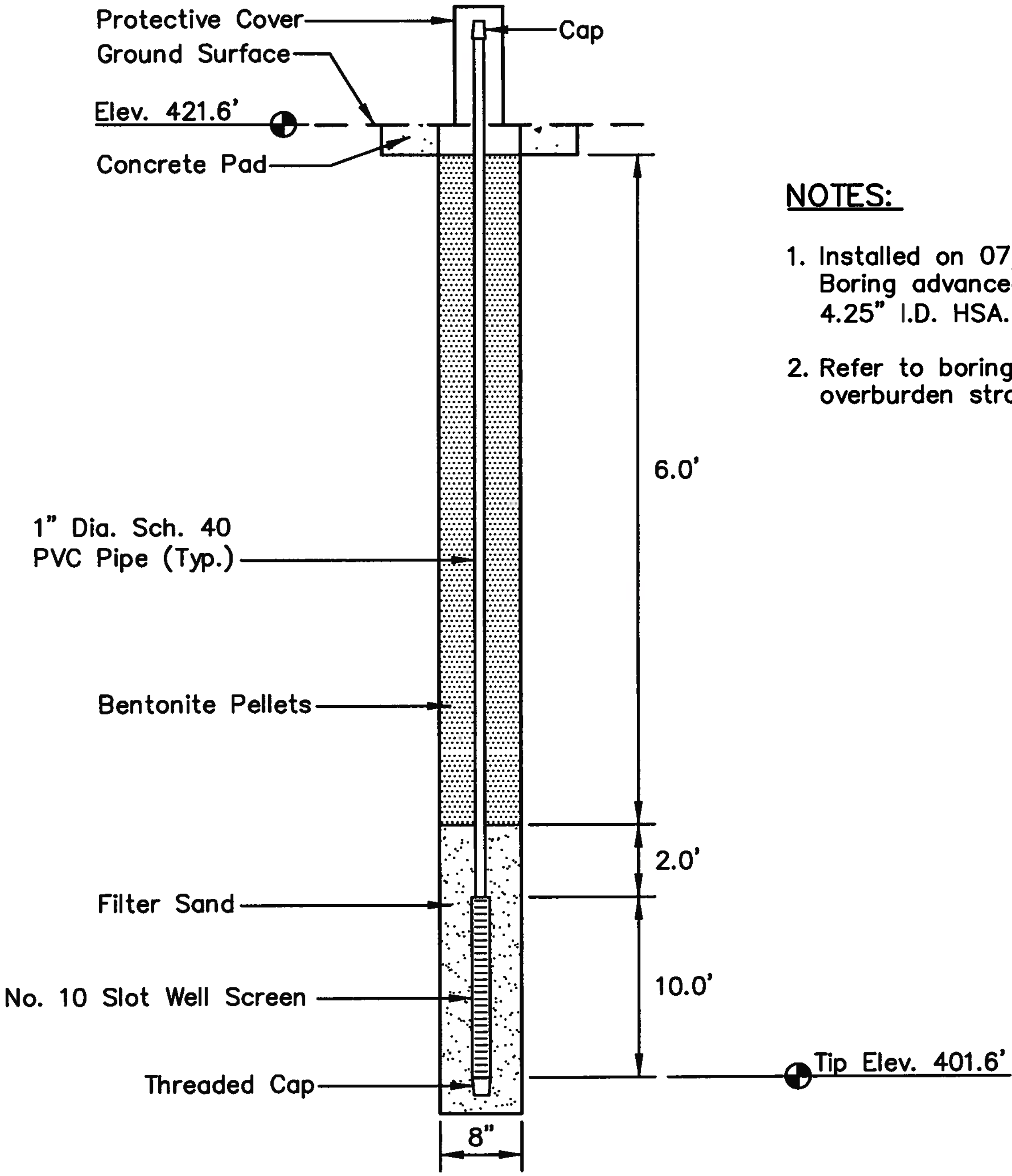
CHECKED BY	PJC	PROJ. NO.	175559016	1.	3.		6 OF 21
CHECKED BY	RLR	SCALE	NTS	2.	4.		



NOTES:

1. Installed on 07/25/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 09/25/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-8.DWG

LOCATION

Northing: 1722943.49
Easting: 395089.90
Ground Elevation: 421.6

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-8S
PIEZOMETER INSTALLATION DETAIL
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CHECKED BY	PJC	PROJ. NO. 175559016	1.	3.	7 OF 21	
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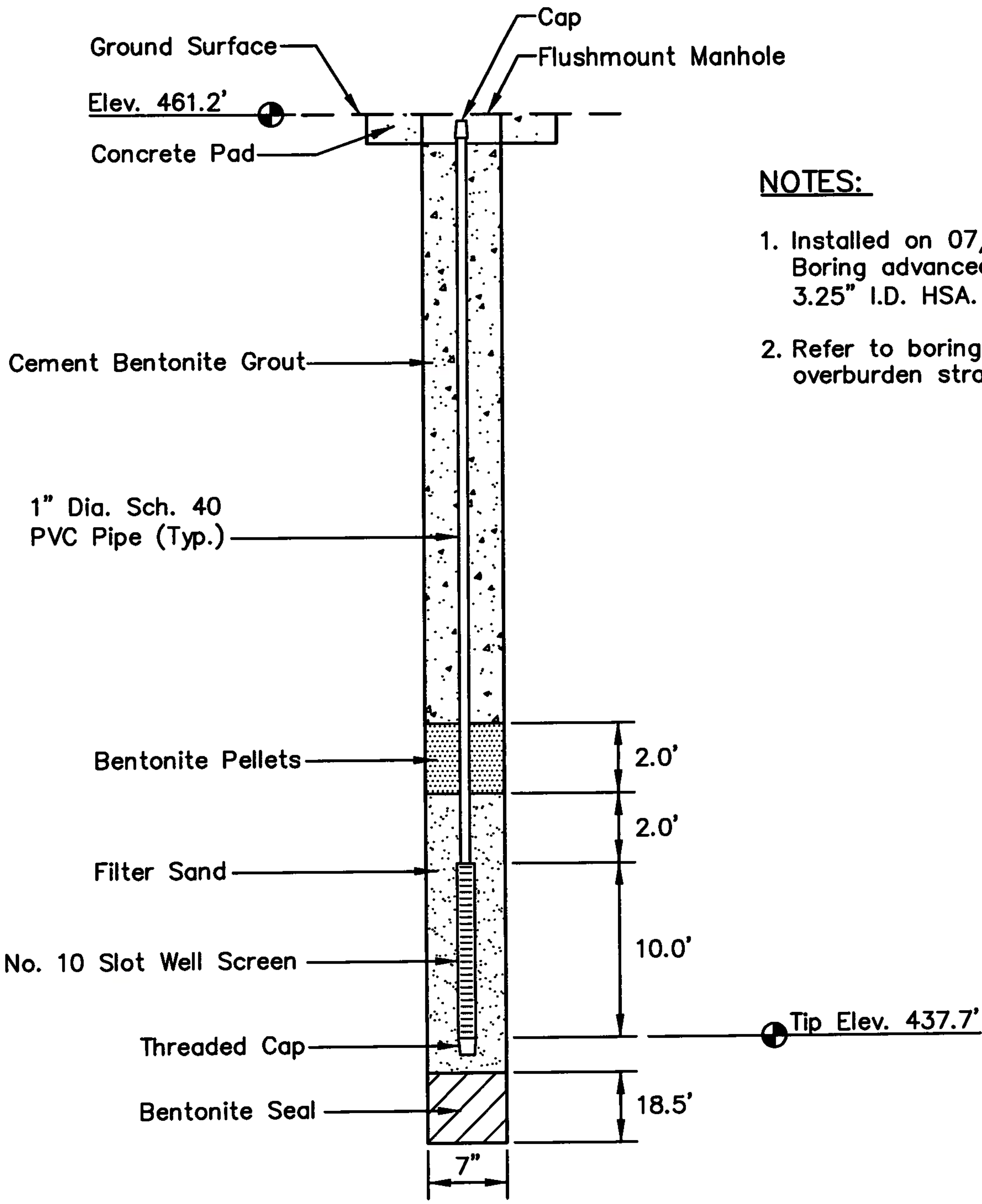

NOTES:

1. Installed on 07/23/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/01/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-9.DWG

LOCATION

Northing: 1722306.36
Easting: 395260.37
Ground Elevation: 461.2

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-9S
PIEZOMETER INSTALLATION DETAIL
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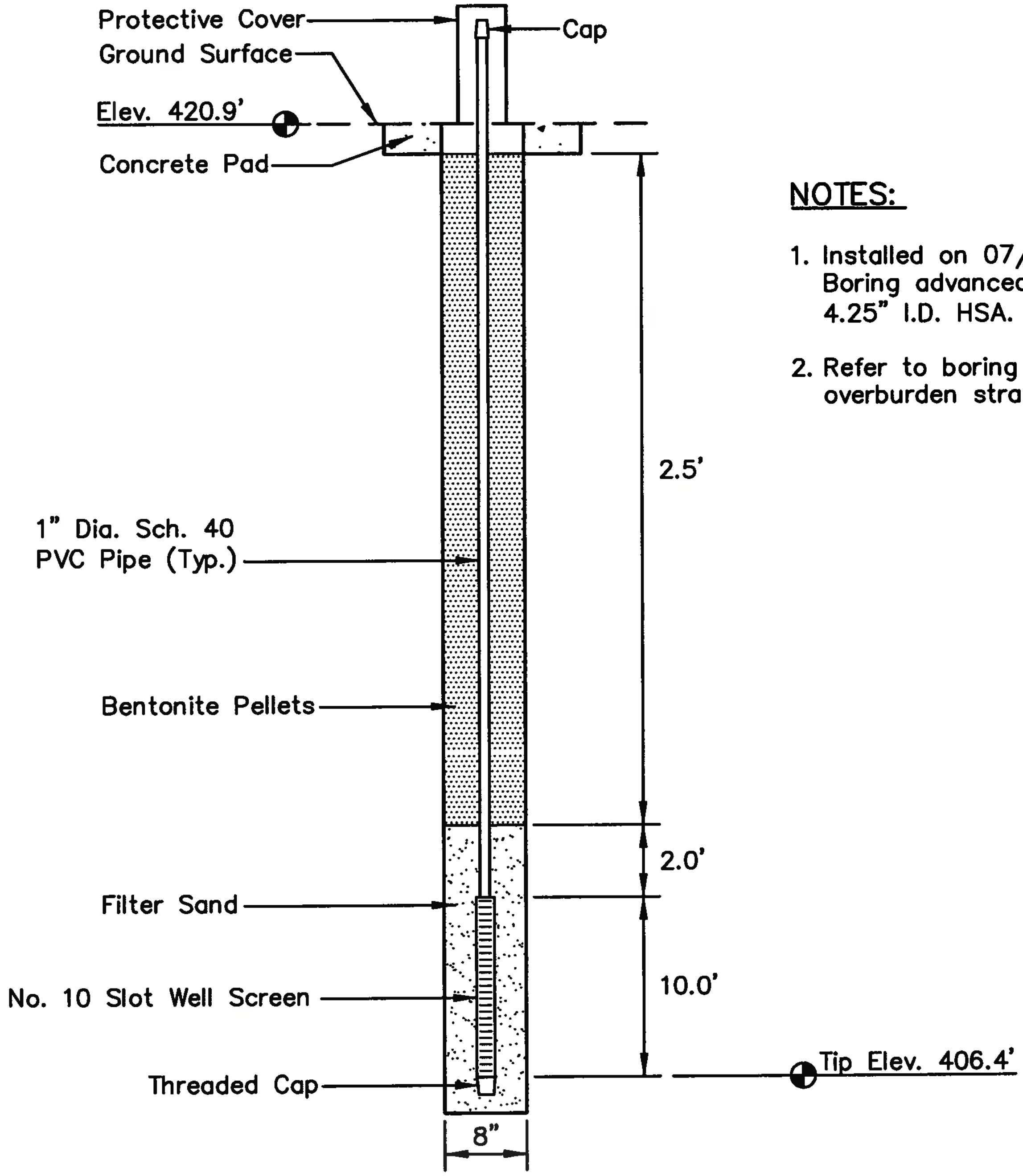
CHECKED BY	RLR	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 07/25/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 09/25/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-10.DWG

LOCATION

Northing: 1722357.09
Easting: 395401.10
Ground Elevation: 420.9

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-10S
PIEZOMETER INSTALLATION DETAIL
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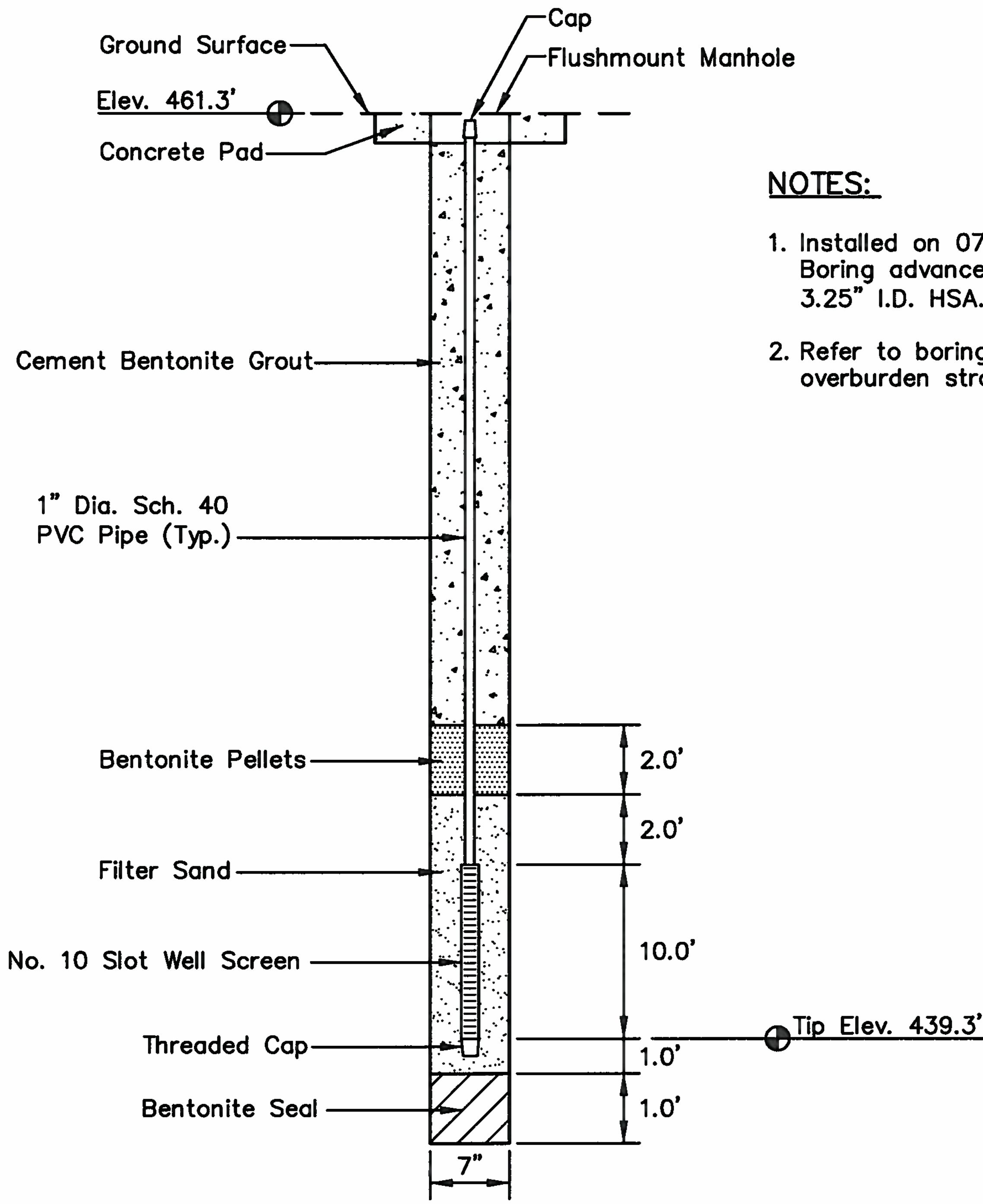

NOTES:

1. Installed on 07/16/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 11/02/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-11.DWG

LOCATION

Northing: 1721882.96
Easting: 395485.31
Ground Elevation: 461.3

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-11S
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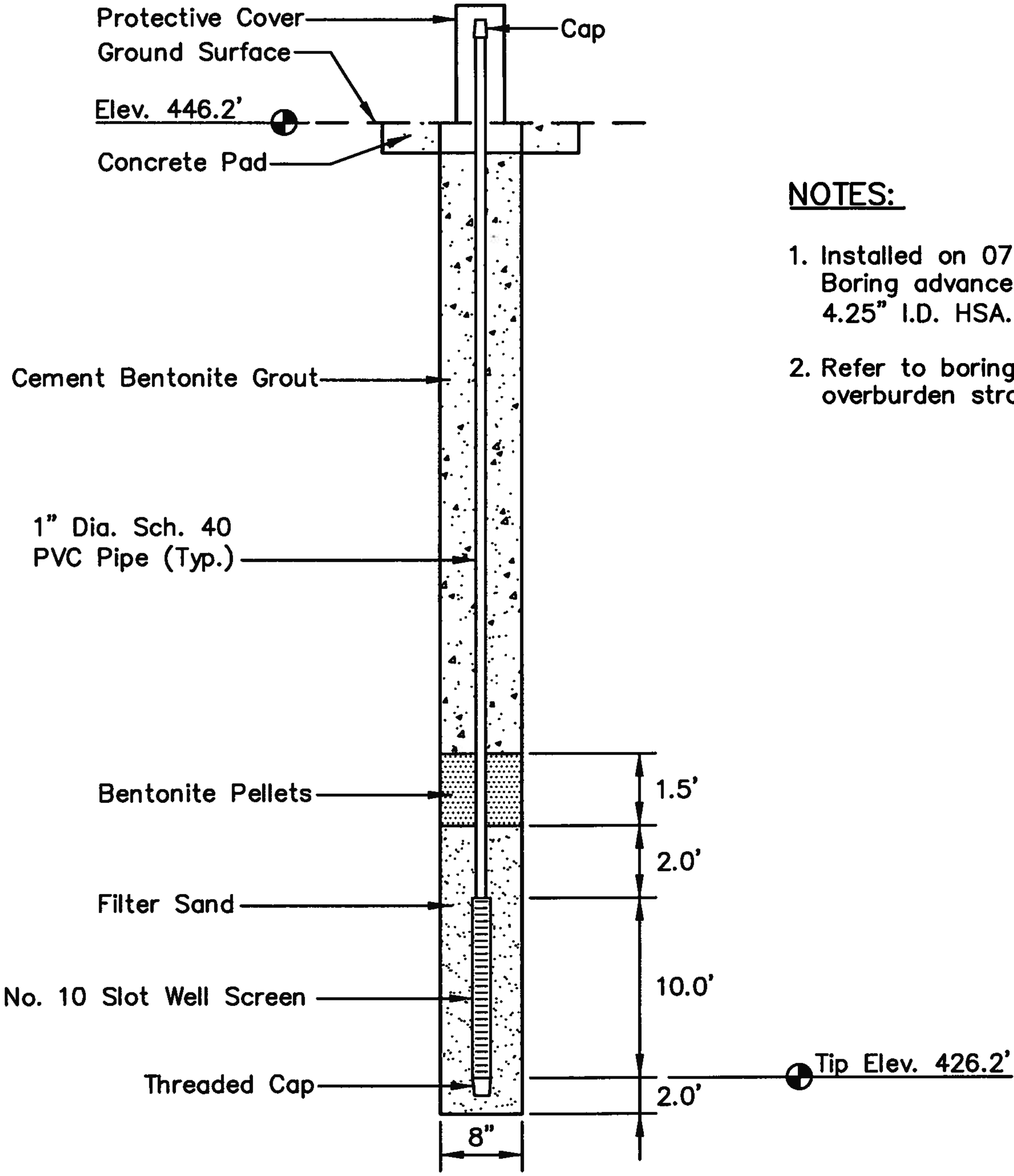
CHECKED BY	RLR	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 07/23/09. Boring advanced with 4.25" I.D. HSA.

2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 09/25/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-12.DWG

LOCATION

Northing: 1721504.87
Easting: 395746.27
Ground Elevation: 446.2

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-12S
PIEZOMETER INSTALLATION DETAIL
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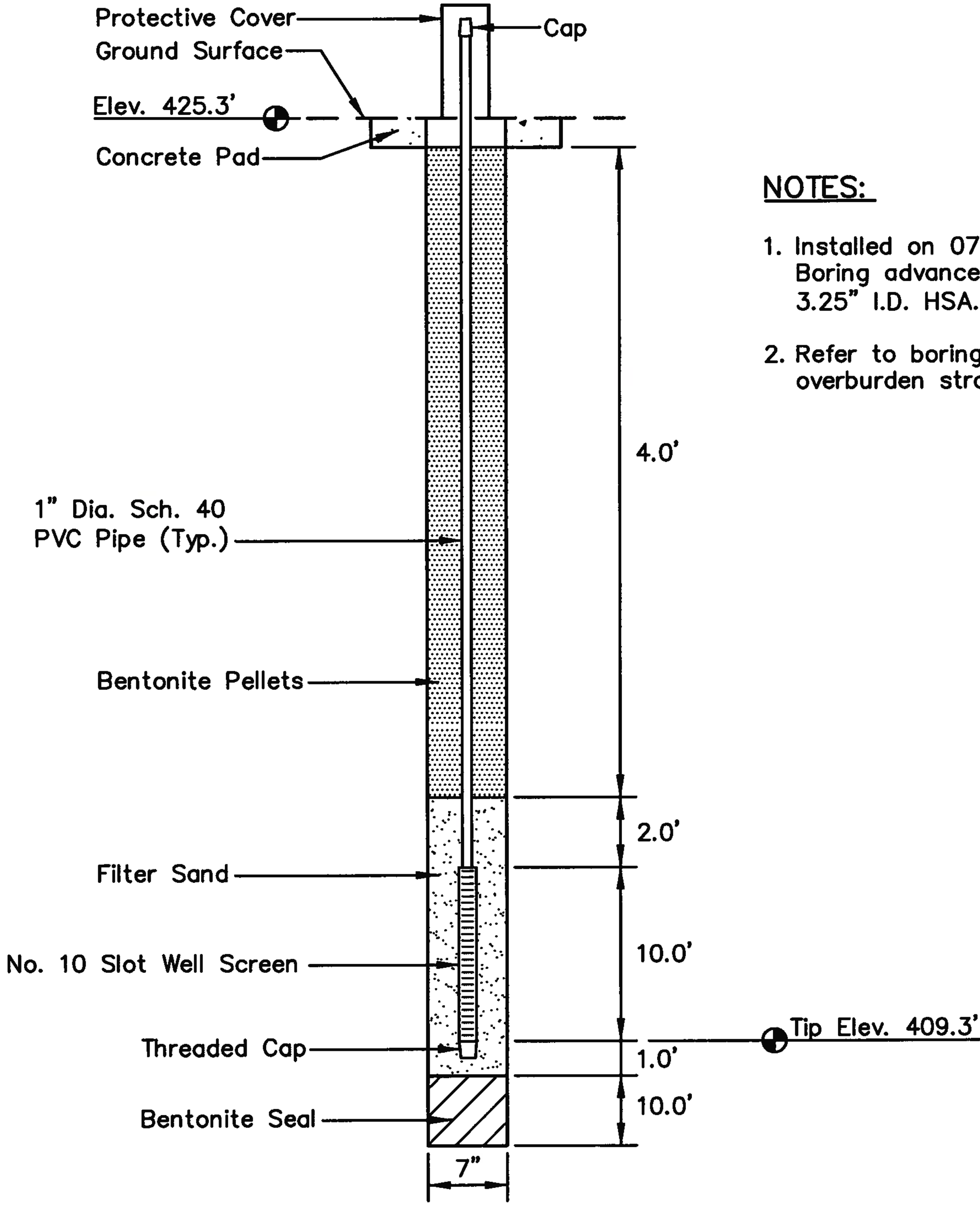

NOTES:

1. Installed on 07/29/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/01/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-13.DWG

LOCATION

Northing: 1721330.83
Easting: 395874.15
Ground Elevation: 425.3

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-13S
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
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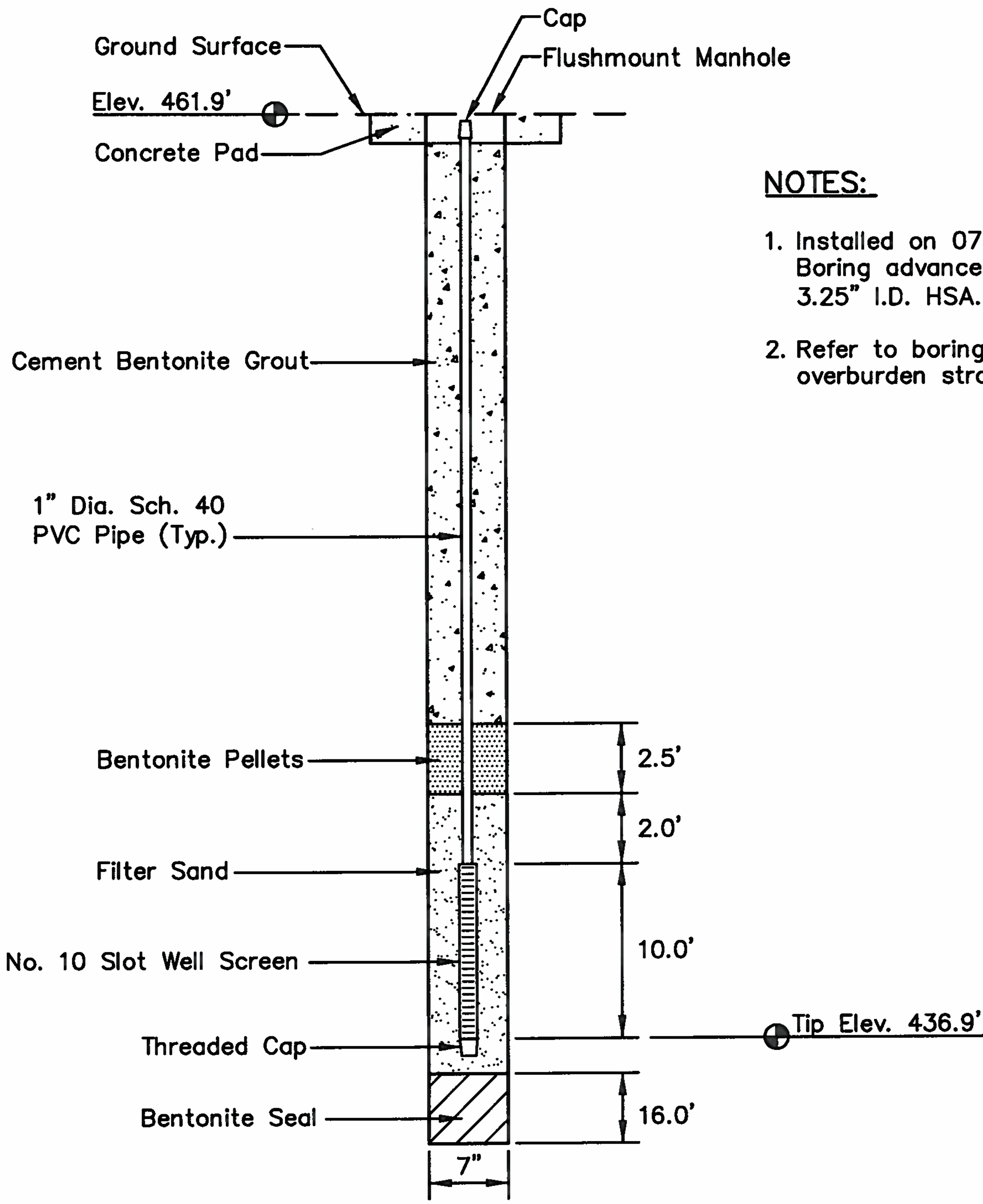

NOTES:

1. Installed on 07/25/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/01/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-14.DWG

LOCATION

Northing: 1721420.08
Easting: 395715.53
Ground Elevation: 461.9

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-14S
PIEZOMETER INSTALLATION DETAIL
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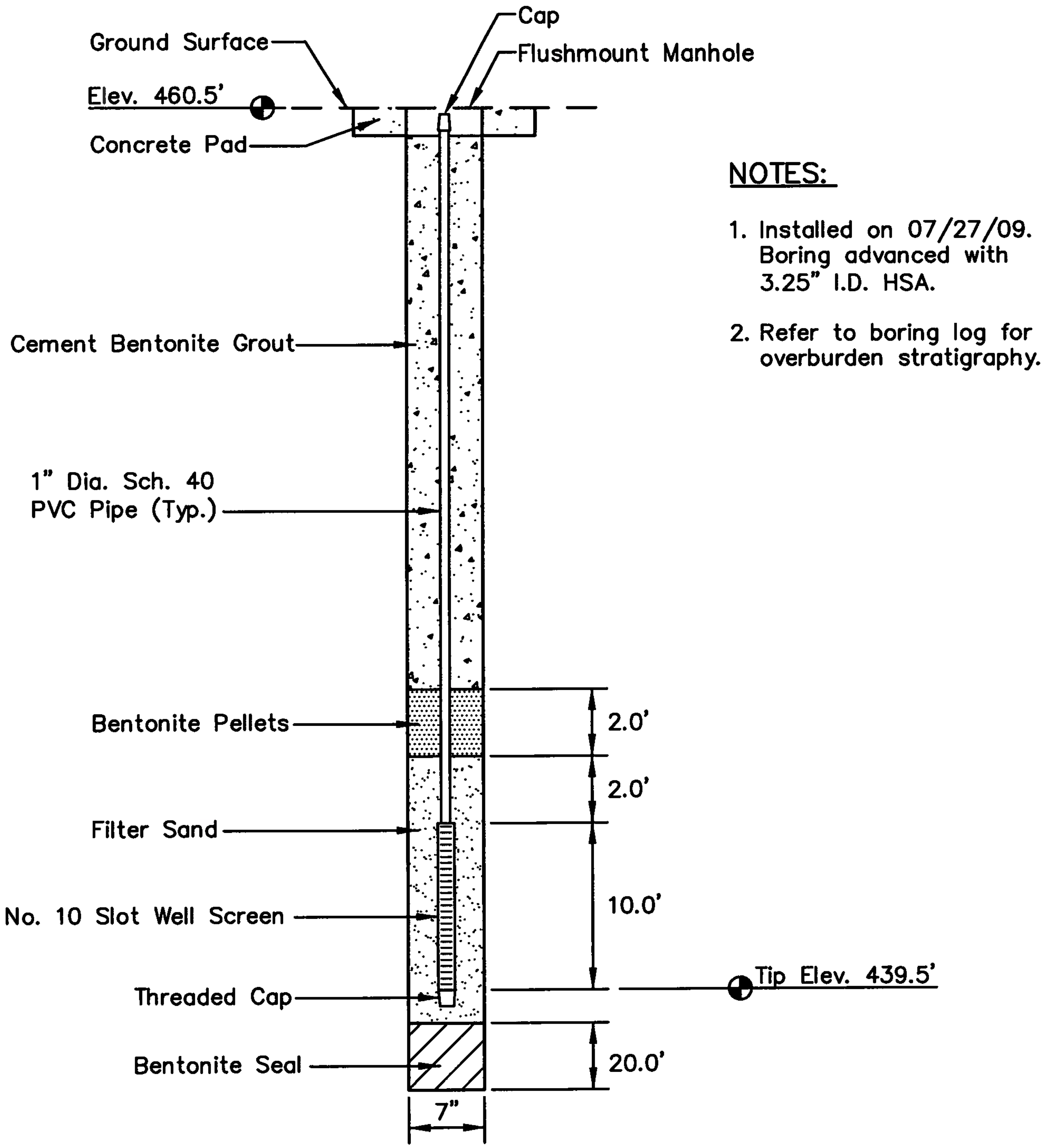

NOTES:

1. Installed on 07/27/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/01/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-15.DWG

LOCATION

Northing: 1721219.13
Easting: 395347.89
Ground Elevation: 460.5

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-15S
PIEZOMETER INSTALLATION DETAIL
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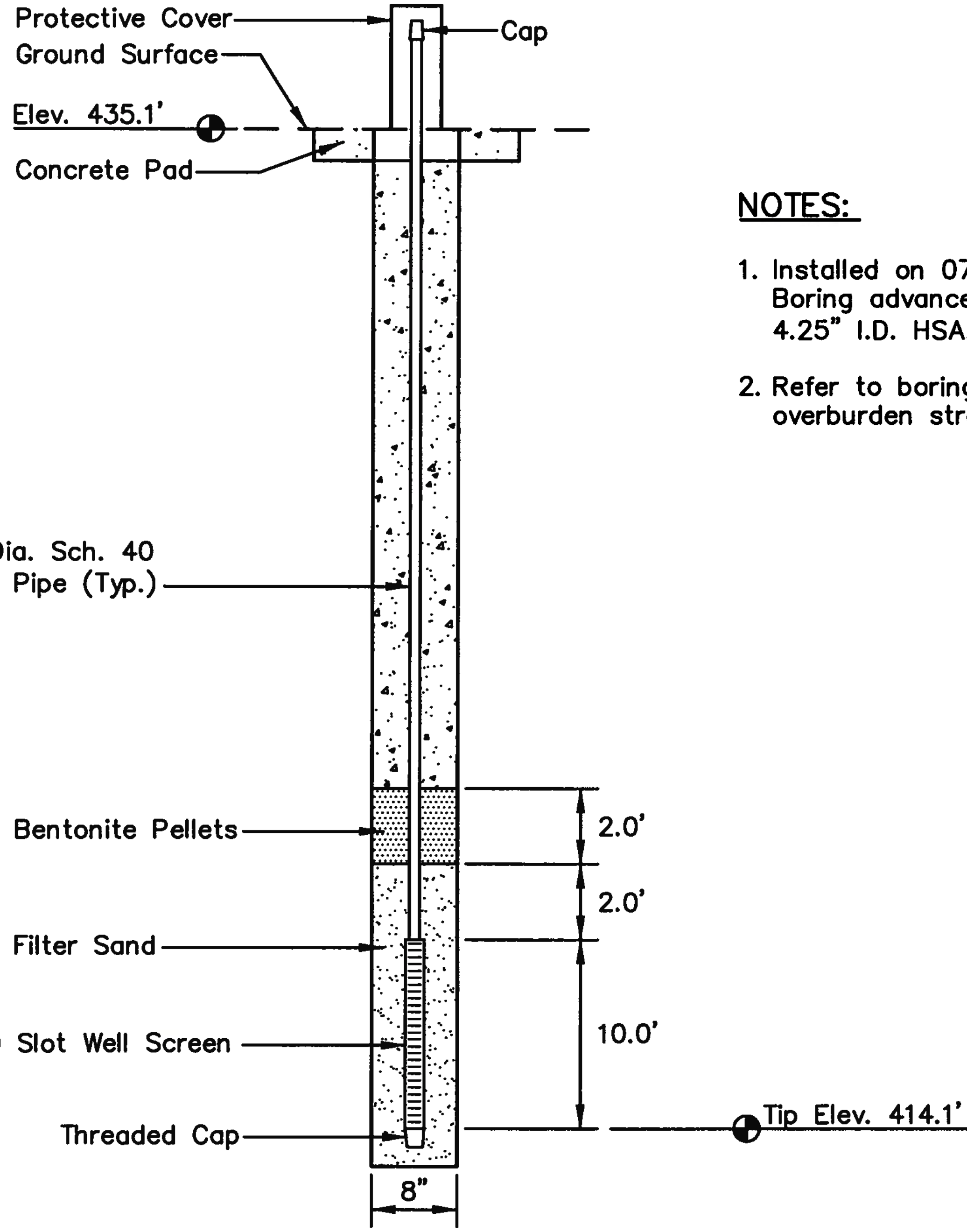

NOTES:

1. Installed on 07/26/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 09/25/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-16.DWG

LOCATION

Northing: 1721126.23
Easting: 395351.96
Ground Elevation: 435.1

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-16S
PIEZOMETER INSTALLATION DETAIL
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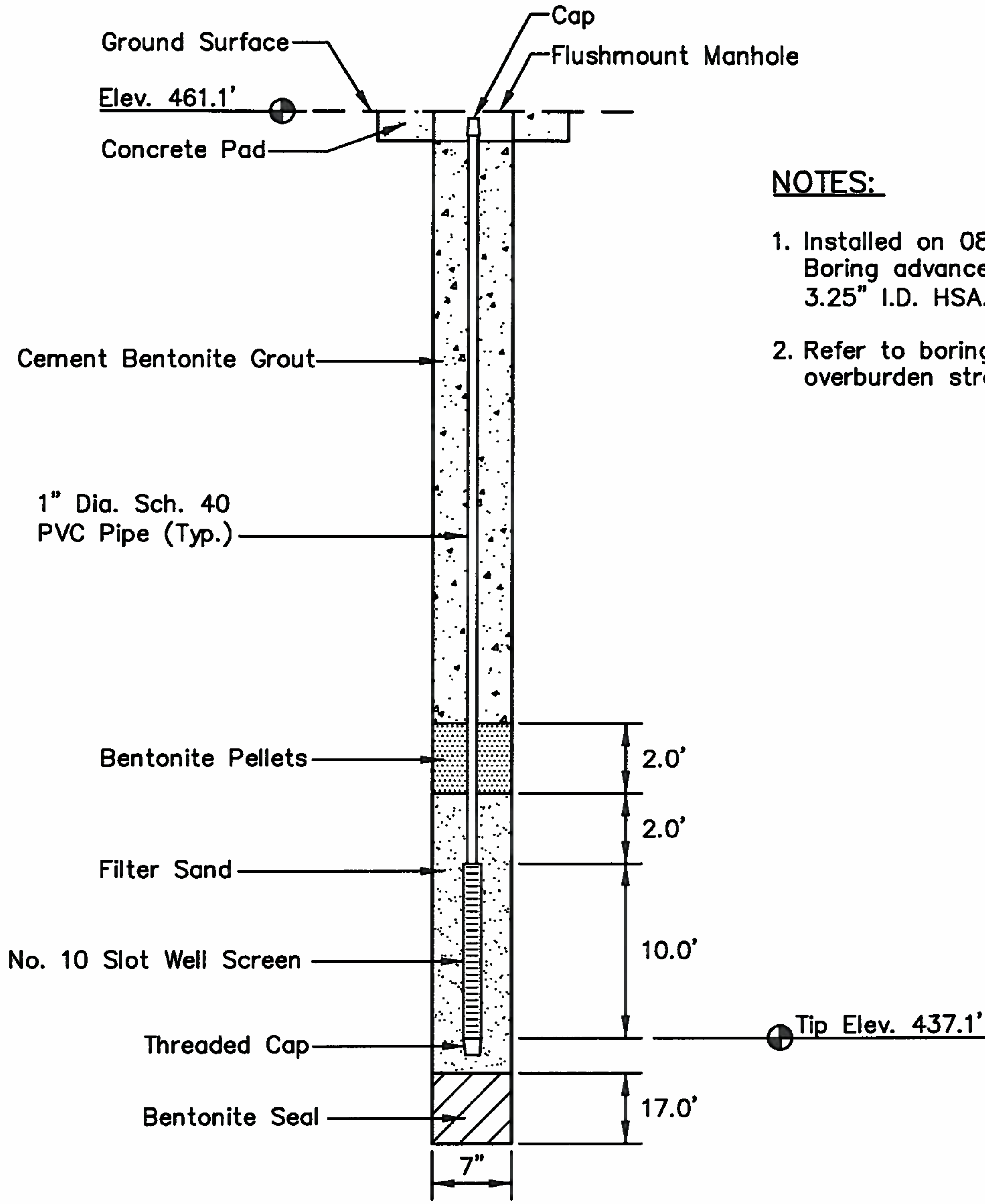
CHECKED BY	RLR	SCALE NTS	2.	4.		



NOTES:

1. Installed on 08/08/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 11/02/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-18.DWG

LOCATION

Northing: 1721402.10
Easting: 394555.64
Ground Elevation: 461.1

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-18S
PIEZOMETER INSTALLATION DETAIL
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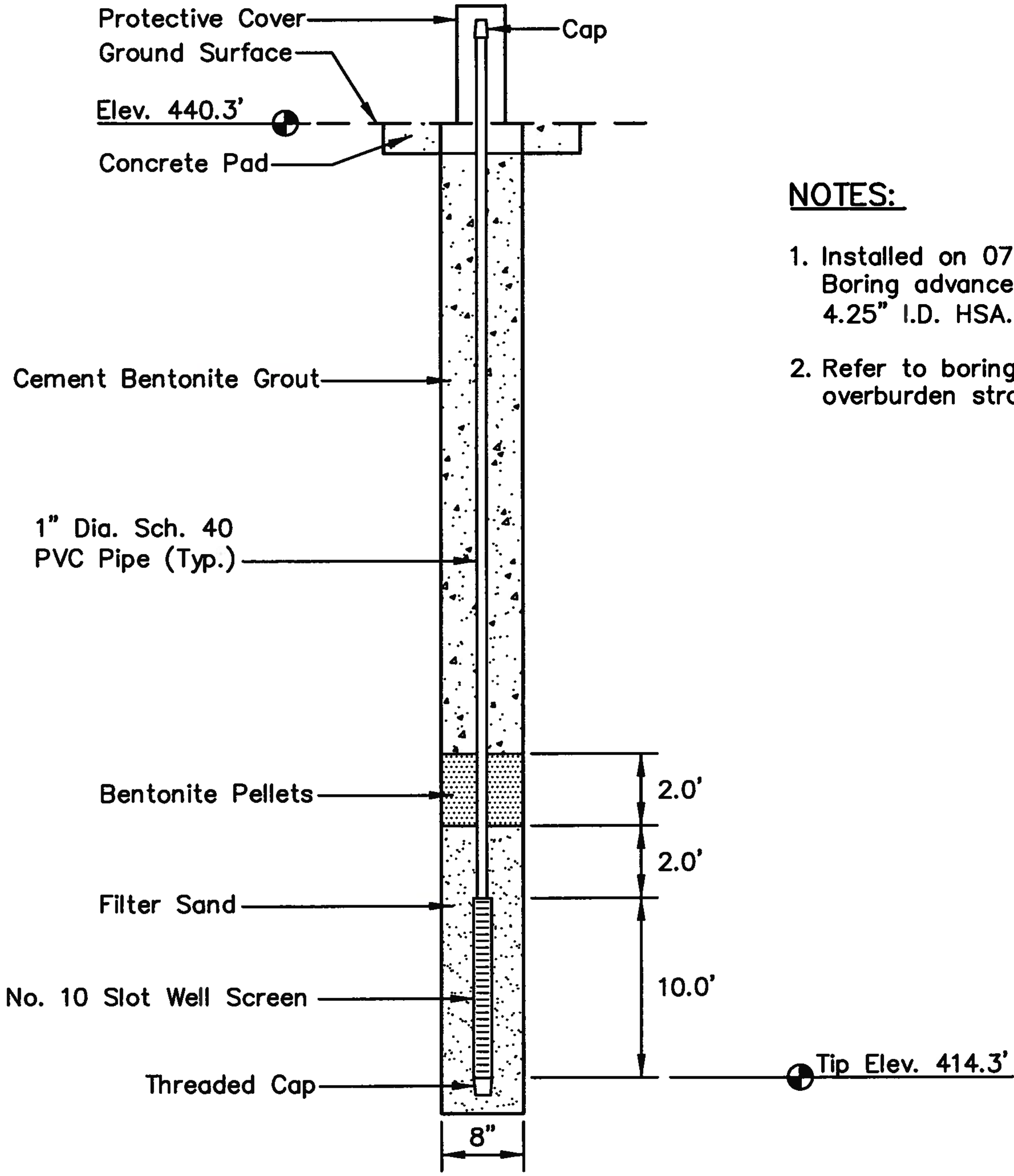

NOTES:

1. Installed on 07/26/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 09/25/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-19.DWG

LOCATION

Northing: 1721352.01
Easting: 394475.66
Ground Elevation: 440.3

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-19S
PIEZOMETER INSTALLATION DETAIL
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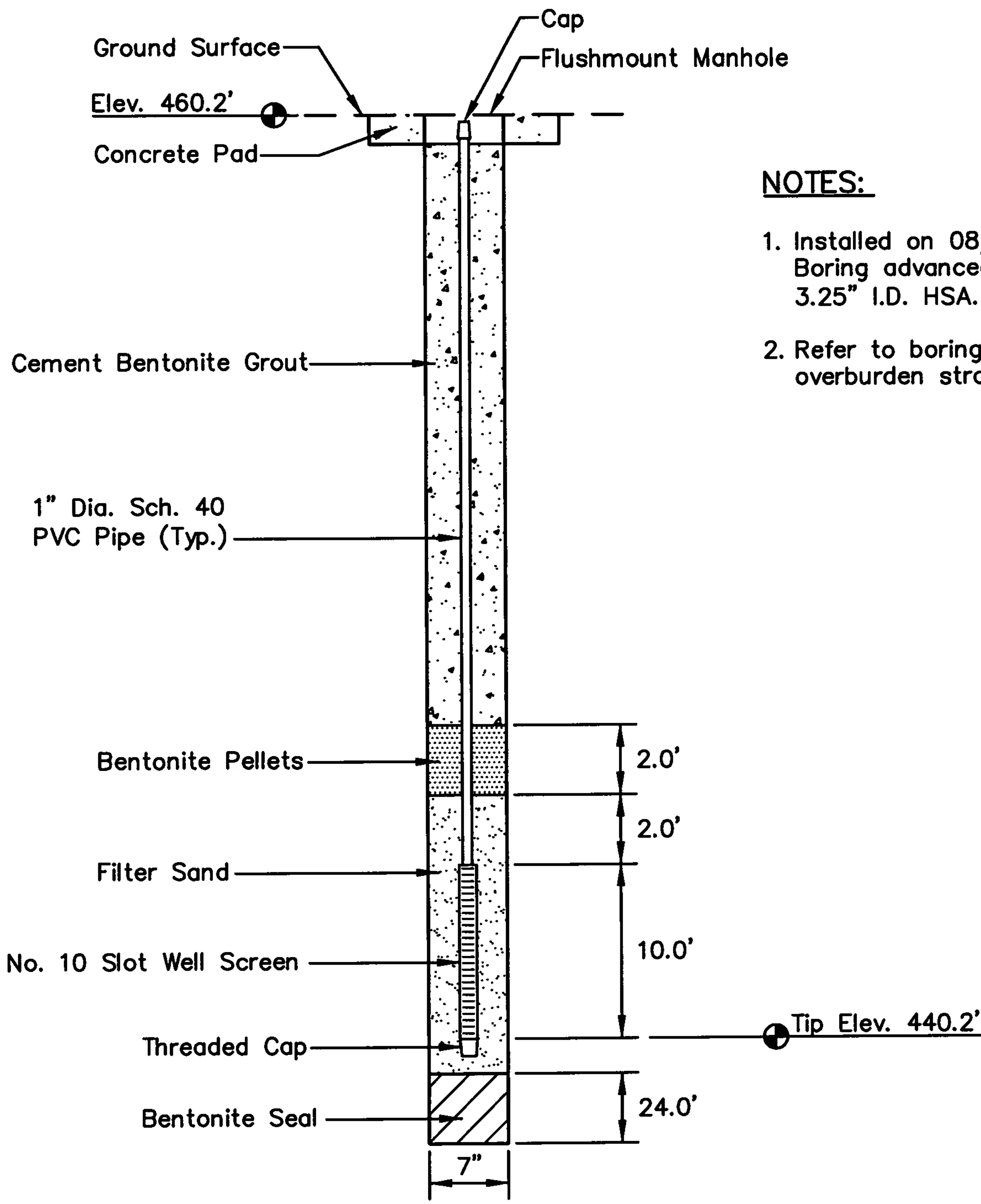
CHECKED BY	RLR	SCALE NTS	2.	4.		



NOTES:

1. Installed on 08/09/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 09/25/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-21.DWG

LOCATION

Northing: 1721985.14
Easting: 394262.71
Ground Elevation: 460.2

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-21S
PIEZOMETER INSTALLATION DETAIL
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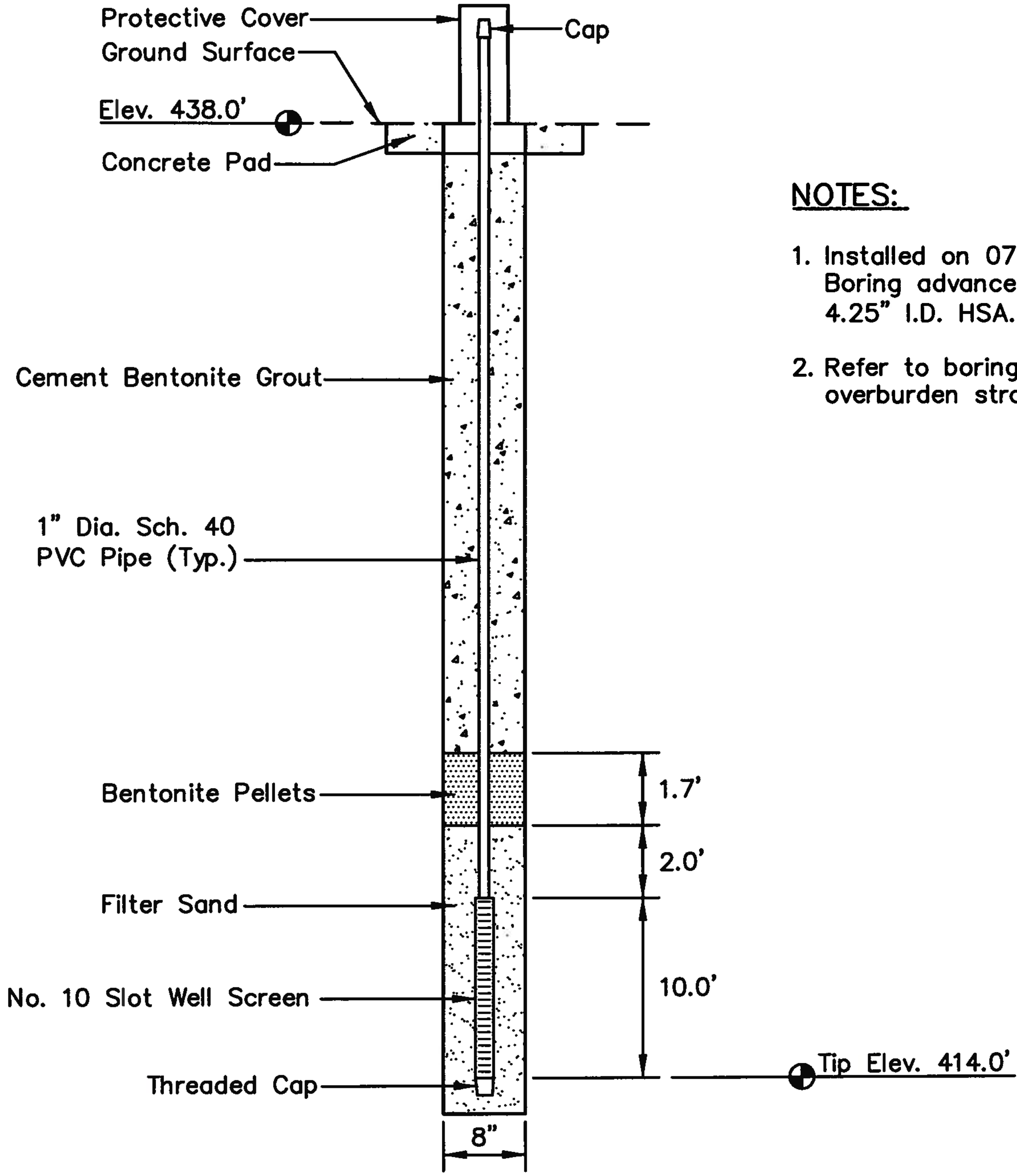
CHECKED BY	RLR	SCALE	NTS	2.	4.		



NOTES:

1. Installed on 07/22/09. Boring advanced with 4.25" I.D. HSA.

2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 09/25/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-22.DWG

LOCATION

Northing: 1721957.70
Easting: 394065.63
Ground Elevation: 438.0

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-22S
PIEZOMETER INSTALLATION DETAIL
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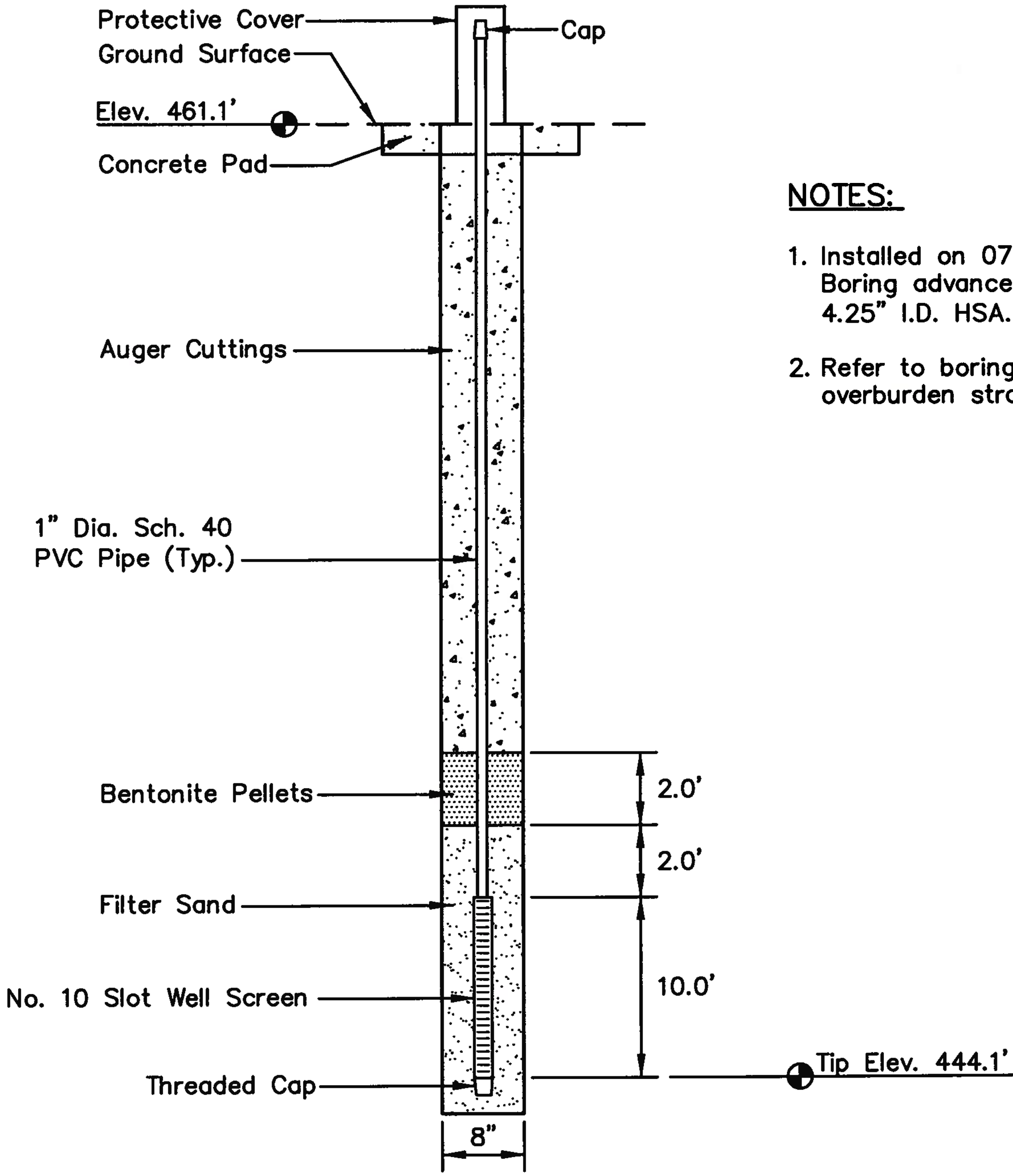
CHECKED BY PJC	PROJ. NO. 175559016	1.	3.	19 OF 21
CHECKED BY RLR	SCALE NTS	2.	4.	



NOTES:

1. Installed on 07/28/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 09/25/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-23.DWG

LOCATION

Northing: 1722728.47
Easting: 394227.94
Ground Elevation: 461.1

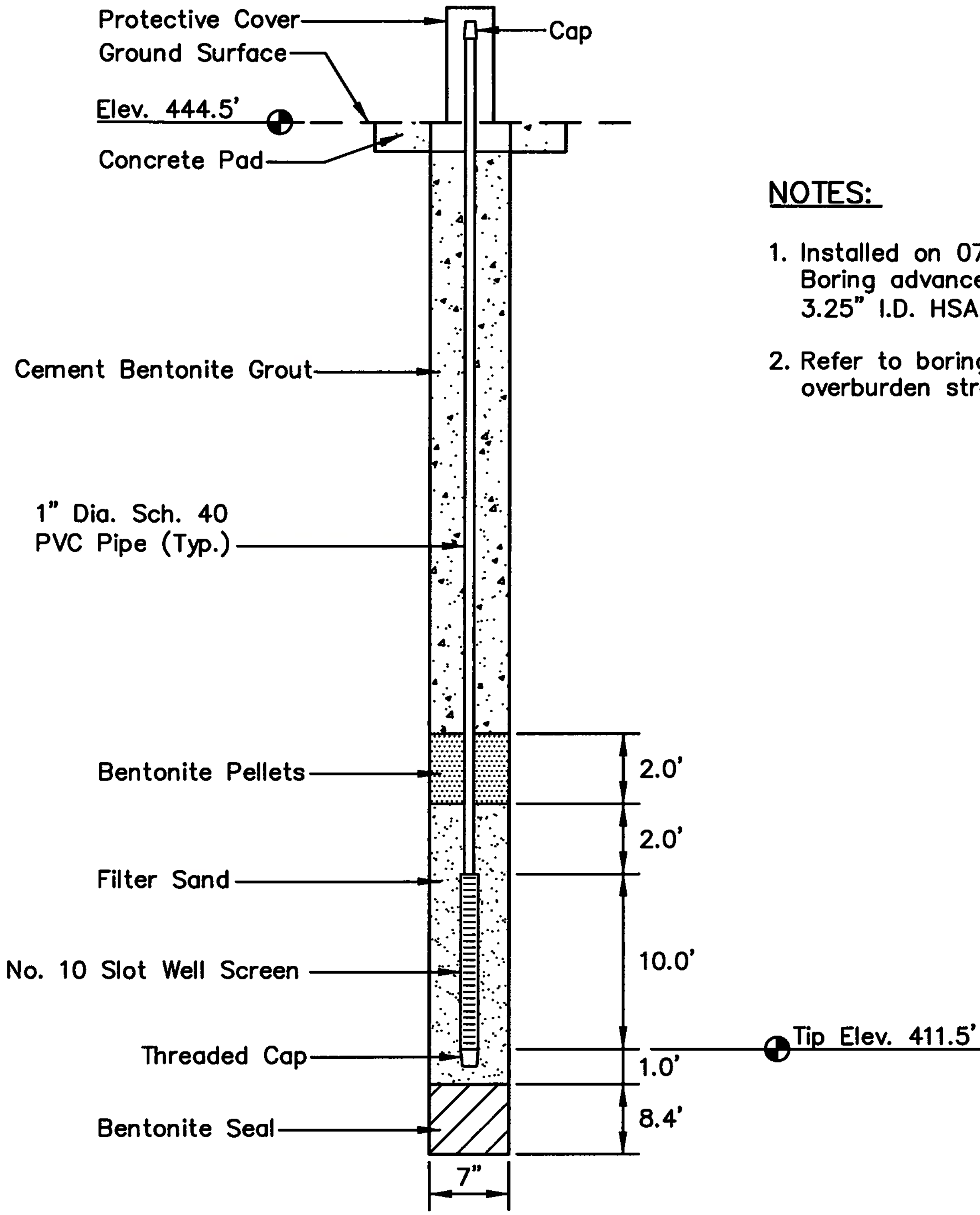
Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-23S
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
ASH POND 4

Stantec

Stantec Consulting Services Inc.
1901 Nelson Miller Parkway
Louisville, Kentucky
40223-2177
502-212-5000
www.stantec.com

DRAWN BY RRP	DATE SEPT., 2009	REVISED		SHEET	
CHECKED BY PJC	PROJ. NO. 175559016	1.	3.	20 OF 21	
CHECKED BY RLR	SCALE NTS	2.	4.		



NOTES:

1. Installed on 07/29/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/01/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559016\GEOTECHNICAL\DRAWING\PZ_DETAILS\59016PZ-4-24.DWG

LOCATION

Northing: 1722823.19
Easting: 394138.84
Ground Elevation: 444.5

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-4-24S
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
ASH POND 4

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502-212-5000
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DRAWN BY	RRP	DATE	SEPT., 2009	REVISED		SHEET
CHECKED BY	PJC	PROJ. NO.	175559016	1.	3.	21 OF 21
CHECKED BY	RLR	SCALE	NTS	2.	4.	

COLBERT FOSSIL PLANT
ASH POND 4
Piezometer Readings

	Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring	
	STN-4-1		STN-4-3		STN-4-4		STN-4-5		STN-4-6		STN-4-7		STN-4-8		STN-4-9		STN-4-10		STN-4-11		STN-4-12	
	Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.	
	460.2		427.3		460.4		439.5		419.8		460.8		421.6		461.2		420.9		461.3		446.2	
	Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation	
	435.7		409.3		435.4		415.5		406.3		435.8		401.6		437.7		406.4		439.3		426.2	
Date	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
1-Sep-09																						
2-Sep-09	8.6	451.6	3.6	423.7	4.9	455.5	18.1	421.4	3.8	416.0	5.1	455.7	6.3	415.3	8.8	452.4	5.7	415.2	9.0	452.3	-0.4	446.6
10-Sep-09	8.2	452.0	3.4	423.9	4.7	455.7	18.1	421.4	4.6	415.2	5.9	454.9	6.3	415.3	8.7	452.6	6.2	414.7	7.6	453.7	-0.4	446.6
23-Sep-09	8.2	452.0	3.2	424.1	4.8	455.6	15.8	423.7	1.0	418.8	5.7	455.1	2.2	419.4	8.7	452.5	4.0	416.9	7.7	453.6	-0.3	446.5
8-Oct-09	8.1	452.1	2.9	424.4	4.8	455.6	16.6	422.9	2.9	416.9	5.8	455.0	3.8	417.8	8.6	452.6	5.3	415.6	7.6	453.7	1.8	444.4
22-Oct-09	7.8	452.4	2.5	424.8	4.8	455.6	17.2	422.3	3.0	416.8	5.7	455.1	5.1	416.5	8.5	452.7	6.4	414.5	7.5	453.8	-1.4	447.6
5-Nov-09	7.8	452.5	2.5	424.8	4.8	455.6	17.2	422.3	3.0	416.8	5.7	455.1	5.1	416.5	8.5	452.7	6.4	414.5	7.5	453.8	-1.4	447.6
17-Nov-09	8.1	452.1	2.5	424.8	4.7	455.7	17.2	422.3	2.7	417.1	5.6	455.2	5.2	416.4	8.6	452.6	5.9	415.0	7.6	453.7	-1.1	447.3
16-Dec-09	8.2	452.0	2.1	425.2	4.7	455.7	16.7	422.8	2.4	417.4	5.9	454.9	4.3	417.3	8.9	452.3	4.9	416.0	7.8	453.5	-0.5	446.7

	Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring	
	STN-4-13		STN-4-14		STN-4-15		STN-4-16		STN-4-18		STN-4-19		STN-4-21		STN-4-22		STN-4-23		STN-4-24	
	Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.	
	425.3		461.9		460.5		435.1		461.1		440.3		460.2		438.0		461.1		444.5	
	Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation	
	409.3		436.9		439.5		414.1		437.1		414.3		440.2		414.0		444.1		411.5	
Date	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
1-Sep-09				461.9	8.2	452.3	14.1	421.0			7.1	433.2	18.4	441.8	1.0	437.0	7.8	453.3	7.2	437.3
2-Sep-09	10.6	414.7	8.6	453.3					11.5	449.6										
10-Sep-09	10.8	414.6	8.4	453.5	8.2	452.3	14.1	421.0	11.6	449.5	6.9	433.4	18.4	441.8	0.1	438.0	3.6	457.5	7.2	437.4
23-Sep-09	9.5	415.8	8.5	453.4	8.2	452.3	13.3	421.8	11.3	449.8	6.4	433.9	17.9	442.3	-0.4	438.4	3.0	458.1	5.3	439.2
8-Oct-09	9.4	415.9	8.4	453.5	8.1	452.4	13.8	421.3	11.3	449.8	6.6	433.7	17.6	442.6	1.7	436.3	2.9	458.2	5.3	439.2
22-Oct-09	9.8	415.5	8.4	453.5	8.1	452.4	14.0	421.1	11.2	449.9	6.7	433.6	17.2	443.0	1.9	436.1	3.0	458.1	5.8	438.7
5-Nov-09	9.8	415.6	8.4	453.6	8.1	452.4	14.0	421.1	11.2	449.9	6.7	433.6	17.2	443.0	1.9	436.1	3.0	458.2	5.8	438.7
17-Nov-09	9.9	415.4	8.3	453.6	8.0	452.5	13.8	421.3	11.2	449.9	6.7	433.6	17.5	442.7	-0.2	438.2	2.4	458.7	6.3	438.2
16-Dec-09	8.9	416.4	8.4	453.5	8.3	452.2	13.7	421.4	11.3	449.8	6.6	433.7	17.1	443.1	-0.6	438.6	2.8	458.3	6.5	438.0

Appendix C

Laboratory Test Results

Stantec

Summary of Soil Tests

Project Name	Colbert Fossil Plant (COF) - Ash Pond 4	Project Number	175559016
Source	STN-4-1, 12.0'-13.5', 13.5'-15.0', 15.0'-16.5'	Lab ID	678
County	Colbert	Date Received	9-3-09
Sample Type	SPT Comp	Date Reported	9-24-09

Test Results

Natural Moisture Content

Test Not Performed

Moisture Content (%): N/A

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	98.6
No. 4	4.75	98.0
No. 10	2	97.2
No. 40	0.425	94.3
No. 200	0.075	75.9
	0.02	63.5
	0.005	42.4
	0.002	36.7
estimated	0.001	35.6

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	2.0	2.8
Coarse Sand	0.8	2.9
Medium Sand	2.9	—
Fine Sand	18.4	18.4
Silt	33.5	39.2
Clay	42.4	36.7

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry

Liquid Limit: 46
Plastic Limit: 18
Plasticity Index: 28
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: 2.69

Classification

Unified Group Symbol: CL
Group Name: Lean clay with sand

AASHTO Classification: A-7-6 (20)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name: Colbert Fossil Plant (COF) - Ash Pond 4
Source: STN-4-1, 12.0'-13.5', 13.5'-15.0', 15.0'-16.5'

Project Number: 175559016
Lab ID: 678

Sieve analysis for the Portion Coarser than the No□□□ Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Rounded and Angular
Particle Hardness: Hard and Durable

Tested By: RHB
Test Date: 09-10-2009
Date Received: 09-03-2009

Maximum Particle size: 3/4" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	100.0
3/8"	98.6
No. 4	98.0
No. 10	97.2

Analysis for the portion □iner than the No□□□ Sieve

Analysis Based on: Total Sample

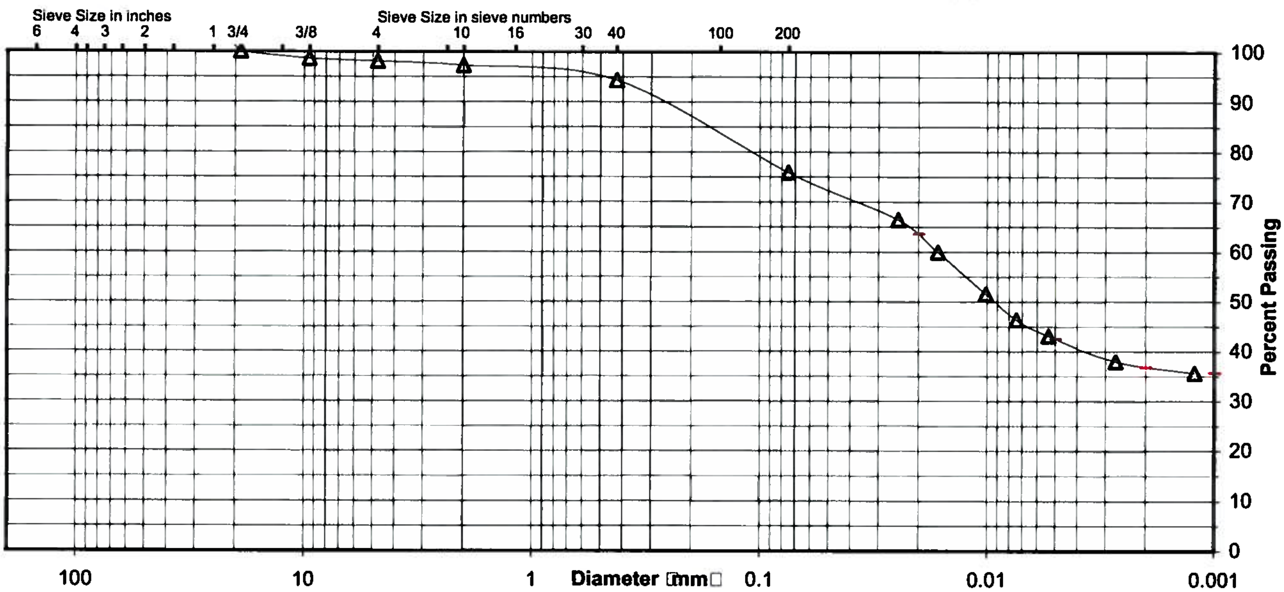
Specific Gravity: 2.69

Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	94.3
No. 200	75.9
0.02 mm	63.5
0.005 mm	42.4
0.002 mm	36.7
0.001 mm	35.6

Particle Size Distribution

ASTM	Coarse Gravel 0.0	Fine Gravel 2.0	C. Sand 0.8	Medium Sand 2.9	Fine Sand 18.4	Silt 33.5	Clay 42.4
AASHTO	Gravel 2.8			Coarse Sand 2.9	Fine Sand 18.4	Silt 39.2	Clay 36.7



Comments

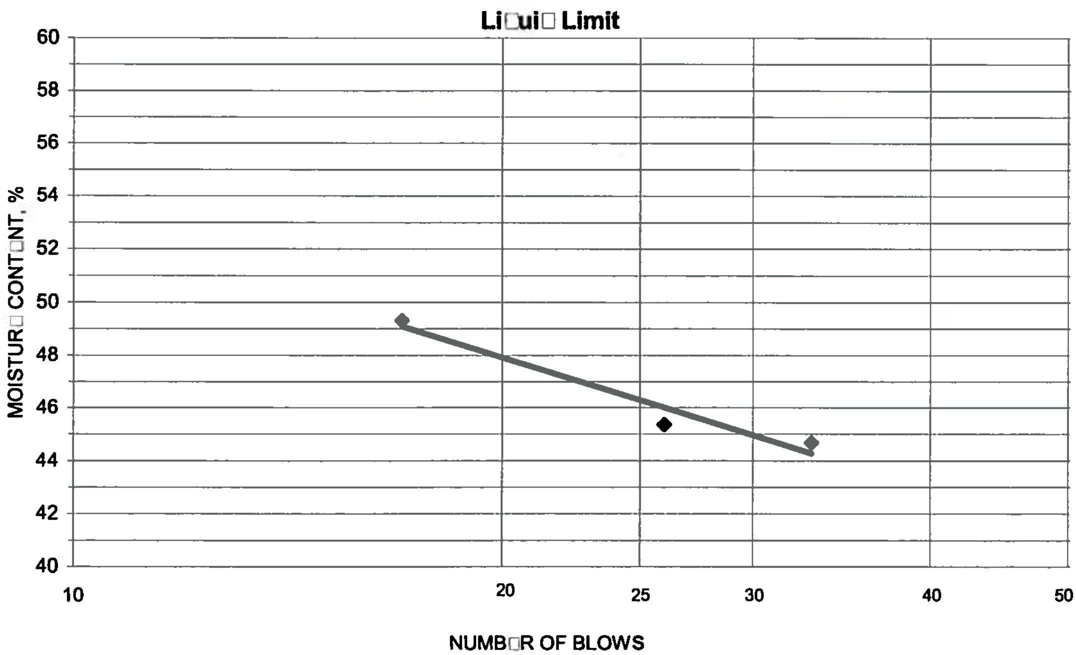
Reviewed By RHB

Stantec

ATT□RB□RG L□M□TS

Project	Colbert Fossil Plant (COF) - Ash Pond 4	Project No.	175559016
Source	STN-4-1, 12.0'-13.5', 13.5'-15.0', 15.0'-16.5'	Lab ID	678
		% □ No. 40	6
Tested By	CLH	Test Method	ASTM D 4318 Method A
Date Received	09-03-2009		
Test Date	09-11-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
14.23	11.17	4.32	33	44.7	46
14.96	11.63	4.29	26	45.4	
15.33	11.70	4.34	17	49.3	



PLASTIC LIMIT AND PLASTICITY IND□□

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
10.21	9.34	4.36	17.5	18	28
10.29	9.37	4.31	18.2		

Remarks:

Reviewed By RHB

Stantec

Summary of Soil Tests

Project Name: Colbert Fossil Plant (COF) - Ash Pond 4
Project Number: 175559016
Source: STN-4-1, 27.0'-28.5', 28.5'-30.0', 30.0'-31.5'
Lab ID: 682

County: Colbert
Date Received: 9-3-09
Sample Type: SPT Comp
Date Reported: 9-25-09

Test Results

Natural Moisture Content

Test Not Performed

Moisture Content (%): N/A

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	98.3
3/8"	9.5	89.6
No. 4	4.75	72.9
No. 10	2	53.0
No. 40	0.425	30.1
No. 200	0.075	11.8
	0.02	3.8
	0.005	2.0
	0.002	1.6
estimated	0.001	1.6

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	27.1	47.0
Coarse Sand	19.9	22.9
Medium Sand	22.9	---
Fine Sand	18.3	18.3
Silt	9.8	10.2
Clay	2.0	1.6

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: 2.72

Classification

Unified Group Symbol: SW-SM
Group Name: Well-graded sand with silt and gravel

AASHTO Classification: A-1-b (0)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Colbert Fossil Plant (COF) - Ash Pond 4	Project Number	175559016
Source	STN-4-1, 27.0'-28.5', 28.5'-30.0', 30.0'-31.5'	Lab ID	682

Sieve analysis for the Portion Coarser than the No□□□ Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: CLH
Test Date: 09-16-2009
Date Received 09-03-2009

Maximum Particle size: 1" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	100.0
3/4"	98.3
3/8"	89.6
No. 4	72.9
No. 10	53.0

Analysis for the portion □iner than the No□□□ Sieve

Analysis Based on: Total Sample

Specific Gravity 2.72

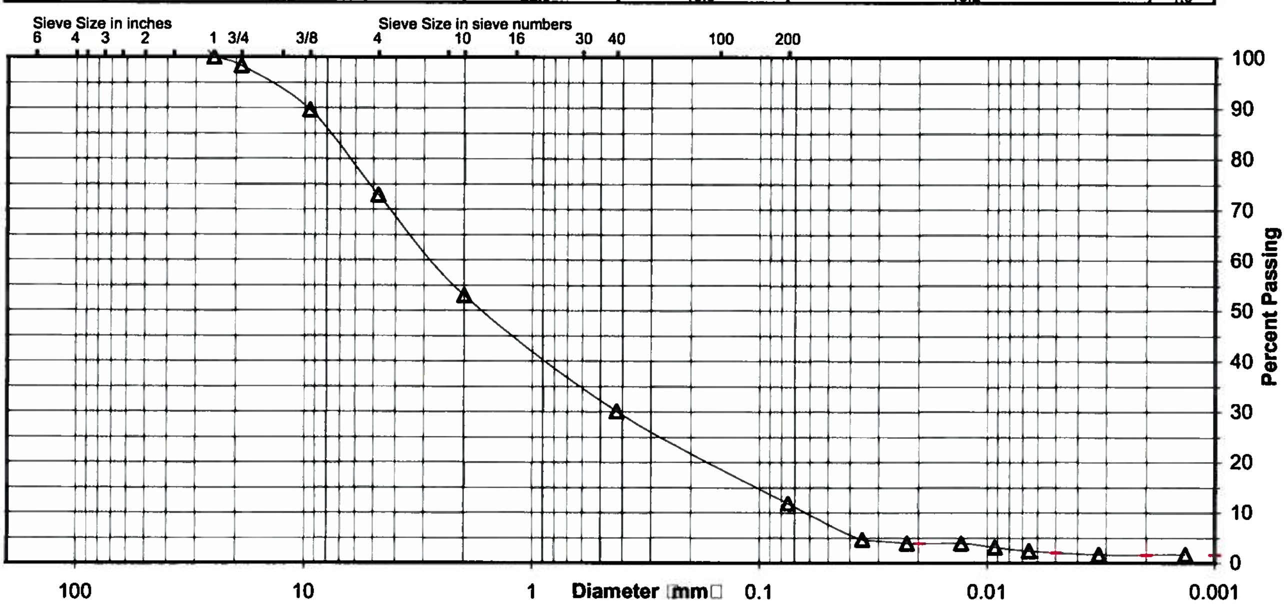
Dispersed using: Apparatus A - Mechanical, for 1 minute

Sieve Size	% Passing
No. 40	30.1
No. 200	11.8
0.02 mm	3.8
0.005 mm	2.0
0.002 mm	1.6
0.001 mm	1.6

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	1.7	25.4	19.9	22.9	18.3	9.8	2.0

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	47.0	22.9	18.3	10.2	1.6



Comments

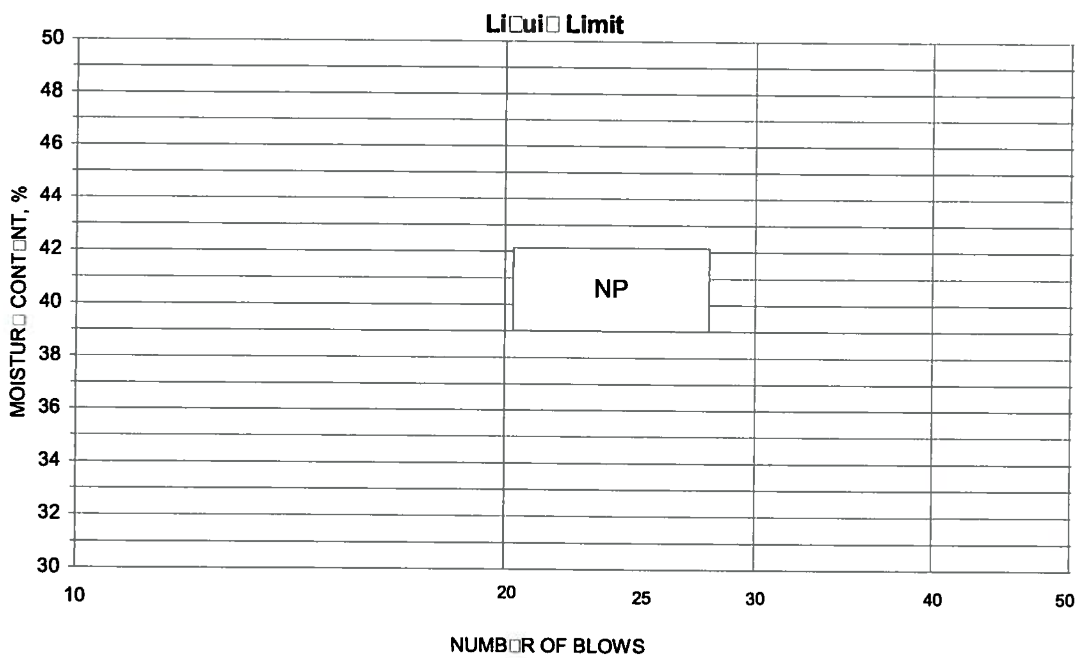
Reviewed By RHB

Stantec

ATTERBERG LIMITS

Project	Colbert Fossil Plant (COF) - Ash Pond 4	Project No.	175559016
Source	STN-4-1, 27.0'-28.5', 28.5'-30.0', 30.0'-31.5'	Lab ID	682
		% No. 40	70
Tested By	RHB	Test Method	ASTM D 4318 Method A
Date Received	09-03-2009		
Test Date	09-23-2009	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

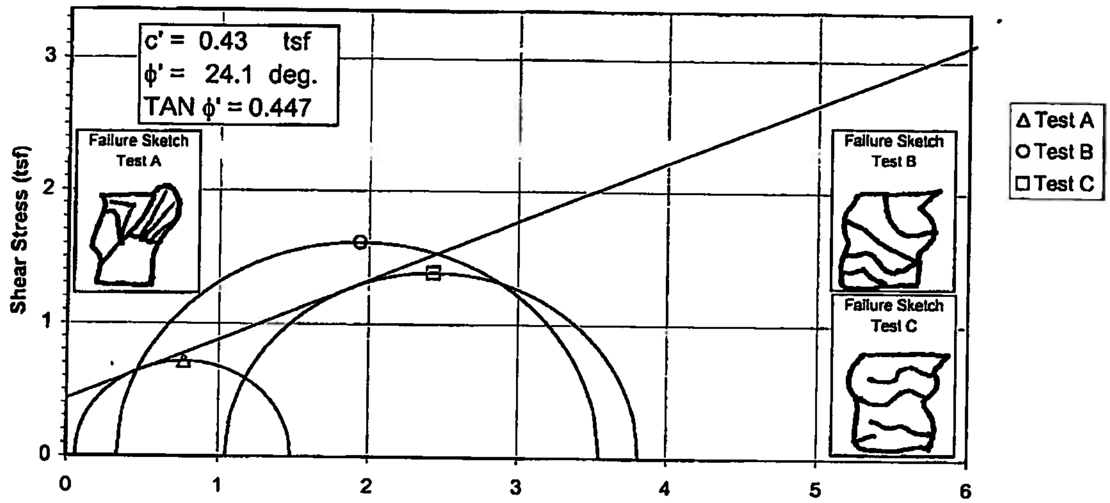
Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks:

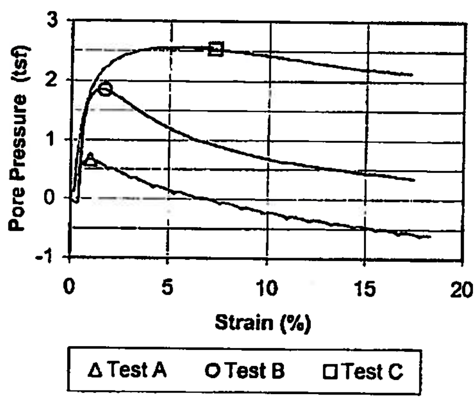
Reviewed By RHB

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	19.9	21.6	25.3	
	Dry Density PCF	γ_{d_o}	108.4	103.5	96.9	
	Saturation %	S_o	97.4	93.1	92.7	
	Void Ratio	e_o	0.548	0.623	0.733	
After Shear	Water content %	W_f	20.6	22.2	23.4	
	Dry Density PCF	γ_{d_f}	108.1	105.2	103.1	
	Saturation %	S_f	100.0	100.0	100.0	
	Void Ratio	e_f	0.554	0.597	0.628	
	Final Back Pressure TSF	u_c	5.76	4.32	2.88	
Minor Principal Stress TSF @ failure		$\sigma_3'f$	0.06	0.33	1.05	
Maximum Deviator Stress (tsf) @ failure		$(\sigma_1'-\sigma_3')_{max}$	1.43	3.23	2.74	
Time to (σ1'-σ3')max min.		t_f	9.6	7.4	312.8	
Ultimate Deviator Stress, t/sq ft		$(\sigma 1'-\sigma 3')_{ult}$	n/a	n/a	n/a	
Initial Diameter, in.		D_o	2.852	2.881	2.876	
Initial Height, in.		H_o	5.938	5.981	5.887	

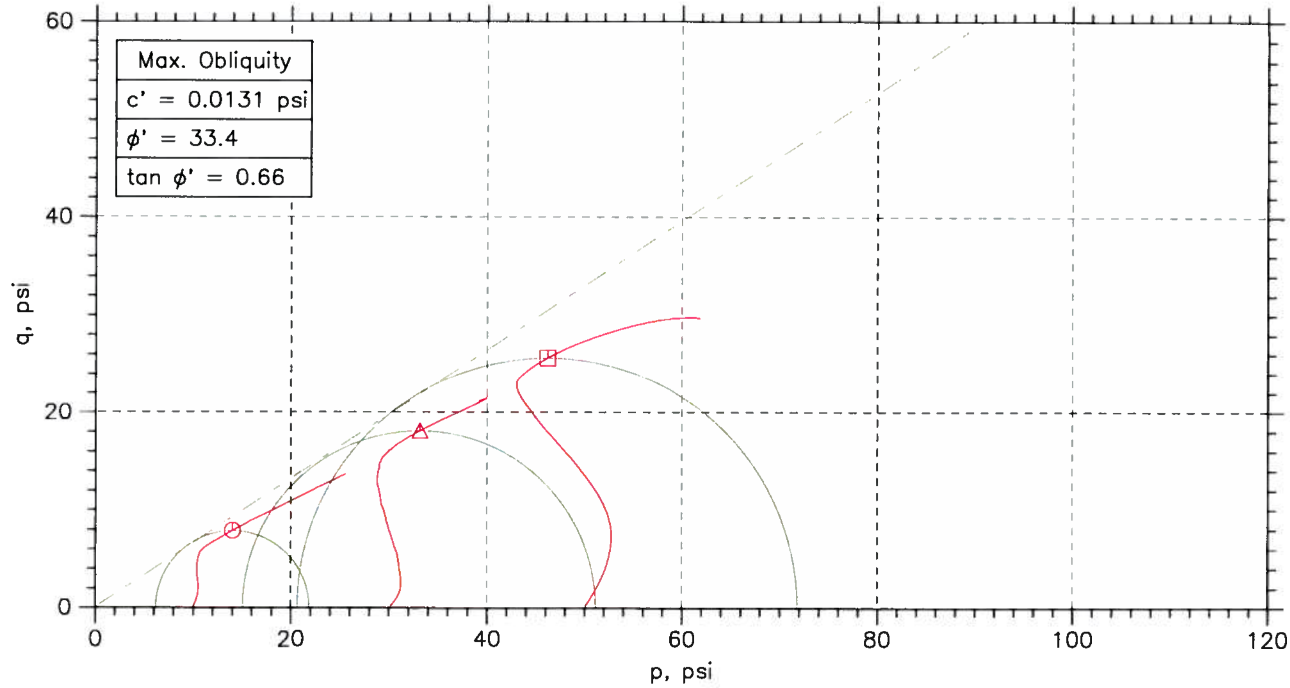
Controlled - Strain Test			
Description of Specimens	Fat Clay with Gravel (CH), red brown, moist, firm		
	Type of Specimen	Undisturbed	Type of test $\bar{R}$
LL PL PI Gs 2.69	Project	Colbert Fossil Plant (COF) - Ash Pond 4	
Remarks:			
	Boring No.	STN-4-1	Sample No. 1
	Depth Elev.	2.5'-3.0', 5.1'-5.6', 10.0'-10.5'	
	Laboratory	Stantec	Date 8-26-09
	TRIAXIAL COMPRESSION TEST REPORT		

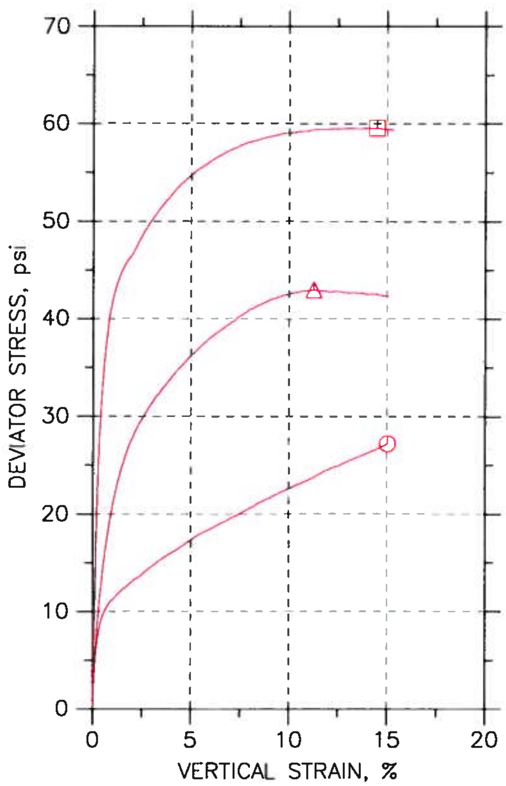
File: 175559016_cu_1 Sheet: CE_Final-E
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		593	594	599	
Test No.		3.1	3.2	3.3	
Depth		4-4.5'	8-8.5 ft	9-9.5'	
Initial	Diameter, in	2.846	2.835	2.865	
	Height, in	6.019	6.009	6.044	
	Water Content, %	21.5	20.4	20.4	
	Dry Density, pcf	103.7	101.2	107.6	
	Saturation, %	92.7	83.0	97.2	
	Void Ratio	0.625	0.665	0.566	
Before Shear	Water Content, %	22.6	21.0	20.1	
	Dry Density, pcf	104.6	107.6	109.3	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.611	0.566	0.543	
	Back Press., psi	91.8	83.22	65.25	
Ver. Eff. Cons. Stress, psi		9.957	30.01	49.98	
Shear Strength, psi		13.6	21.46	29.75	
Strain at Failure, %		15	11.3	14.5	
Strain Rate, %/min		0.016	0.016	0.016	
B-Value		0.96	0.96	0.95	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

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Project: Colbert Fossil Plant
Location: Ash Pond 4
Project No.: GTX-1495
Boring No.: STN-4-2
Sample Type: UD
Description: Brown Silty lean clay with gravel
Remarks: Note: Sample 599 from Boring STN-4-5

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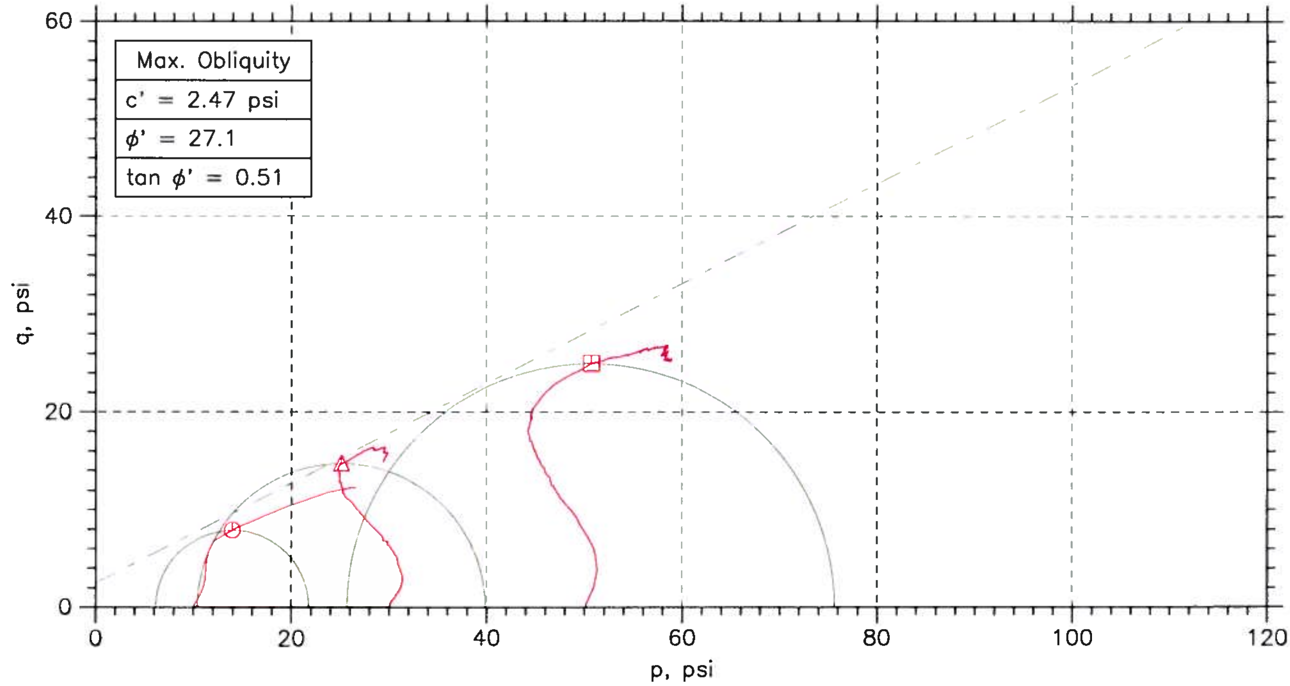
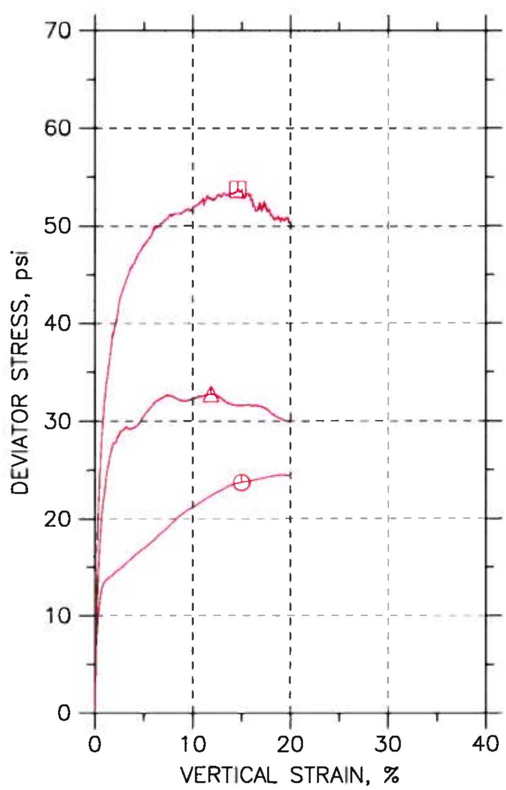
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		595	596	597	
Test No.		CU-1-1	CU-1-2	CU-1-3	
Depth		2.5-3.0	6.5-7.0	10-10.5	
Initial	Diameter, in	2	2	2.01	
	Height, in	4.05	4.1	4.21	
	Water Content, %	19.5	20.3	20.5	
	Dry Density, pcf	108.3	107.2	102.3	
	Saturation, %	94.3	95.9	85.6	
	Void Ratio	0.557	0.572	0.647	
Before Shear	Water Content, %	21.2	19.7	20.7	
	Dry Density, pcf	107.2	110.1	108.2	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.572	0.532	0.558	
	Back Press., psi	103	79	104.9	
Ver. Eff. Cons. Stress, psi		9.998	29.99	49.99	
Shear Strength, psi		11.84	16.37	26.83	
Strain at Failure, %		15	11.9	14.6	
Strain Rate, %/min		0.016	0.016	0.016	
B-Value		0.96	0.96	0.95	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

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Project: Colbert Fossil Plant	
Location: ASh Pond 4	
Project No.: GTX-9344	
Boring No.: STN-4-3	
Sample Type: UD	
Description: Moist, reddish brown clay with gravel	
Remarks: System 0	

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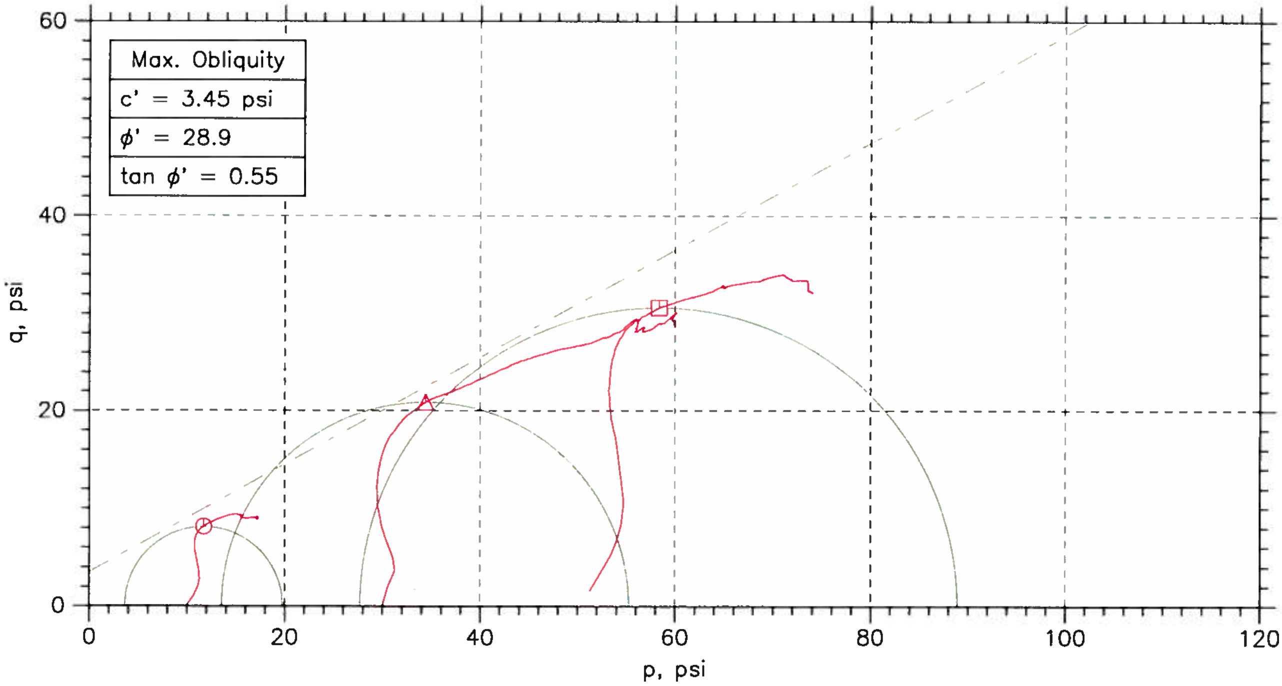
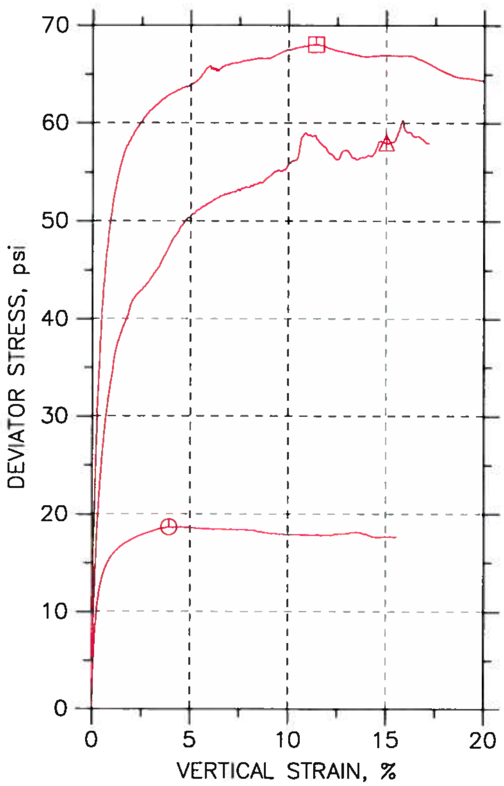
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





		⏀	△	⊡	
Symbol		⏀	△	⊡	
Sample No.		663A	662B	663B	
Test No.		CU-4-1	CU-4-2	CU-4-3	
Depth		5.0-5.5	2.8-3.3	5.6-6.1	
Initial	Diameter, in	2	2	2	
	Height, in	3.98	4.13	4.11	
	Water Content, %	20.1	20.8	22.0	
	Dry Density, pcf	102.5	102.8	99.04	
	Saturation, %	84.4	88.0	84.7	
	Void Ratio	0.644	0.639	0.702	
Before Shear	Water Content, %	23.2	21.3	22.9	
	Dry Density, pcf	103.6	106.9	104.1	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.627	0.576	0.619	
	Back Press., psi	29	128.9	67.26	
Ver. Eff. Cons. Stress, psi		9.998	29.99	49.73	
Shear Strength, psi		9.323	28.96	33.99	
Strain at Failure, %		3.93	15	11.4	
Strain Rate, %/min		0.016	0.016	0.016	
B-Value		0.96	0.95	0.96	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

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Project: Colbert Fossil Plant
Location: Ash Pond 4
Project No.: GTX-9344
Boring No.: STN-4-4
Sample Type: UD
Description: Moist, red, brown and yellow clay with sand and gravel
Remarks:

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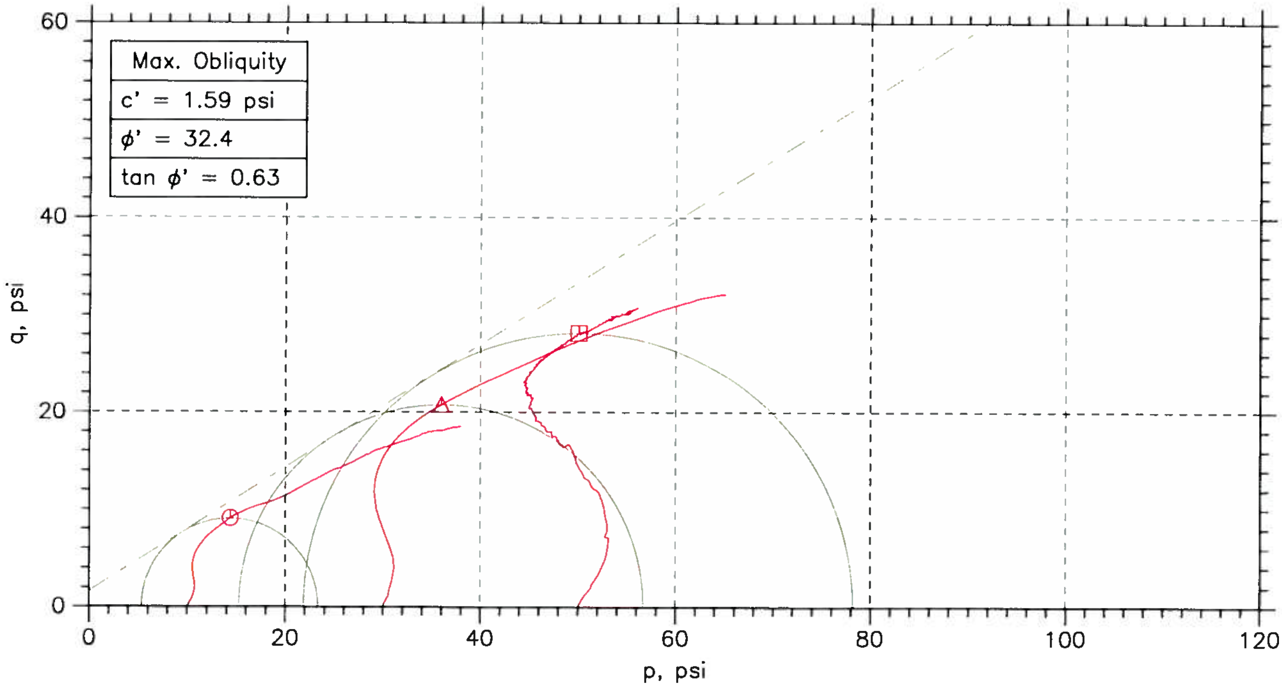
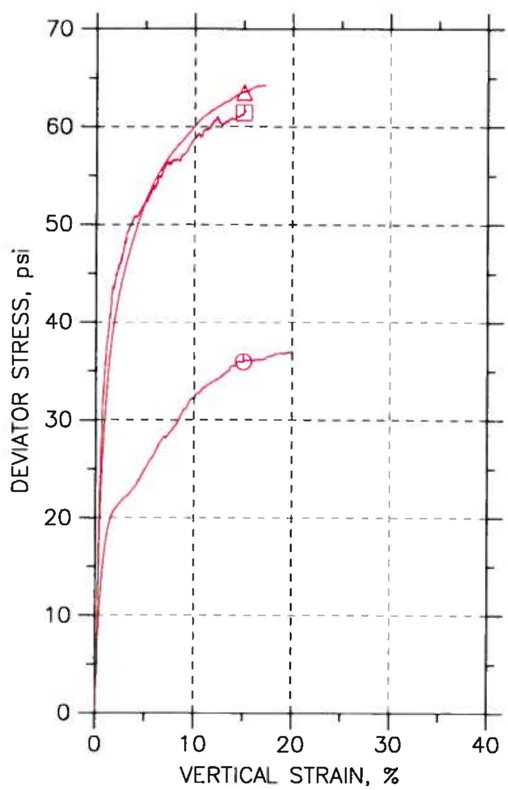
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		⏀	△	◫	
Sample No.		601B	601A	602	
Test No.		CU-3-1	CU-3-2	CU-3-3	
Depth		17.6-18.1	17-17.5	22.3-22.8	
Initial	Diameter, in	2	2.01	2	
	Height, in	4.13	4.04	4.16	
	Water Content, %	16.2	16.8	16.8	
	Dry Density, pcf	107.9	108.	109.1	
	Saturation, %	77.7	81.0	83.4	
	Void Ratio	0.562	0.56	0.544	
Before Shear	Water Content, %	17.5	17.0	15.9	
	Dry Density, pcf	114.5	115.4	117.9	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.473	0.46	0.43	
	Back Press., psi	134.9	106.9	101	
Ver. Eff. Cons. Stress, psi		9.988	29.98	50	
Shear Strength, psi		17.96	31.73	30.68	
Strain at Failure, %		15	15	15	
Strain Rate, %/min		0.016	0.016	0.016	
B-Value		0.95	0.95	0.96	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

GeoTesting express a subsidiary of Geocomp Corporation	Project: Colbert Fossil Plant
	Location: Ash Pond 4
	Project No.: GTX-9344
	Boring No.: STN-4-5
	Sample Type: UD
	Description: Moist, yellow brown and red sandy clay with gravel
	Remarks:

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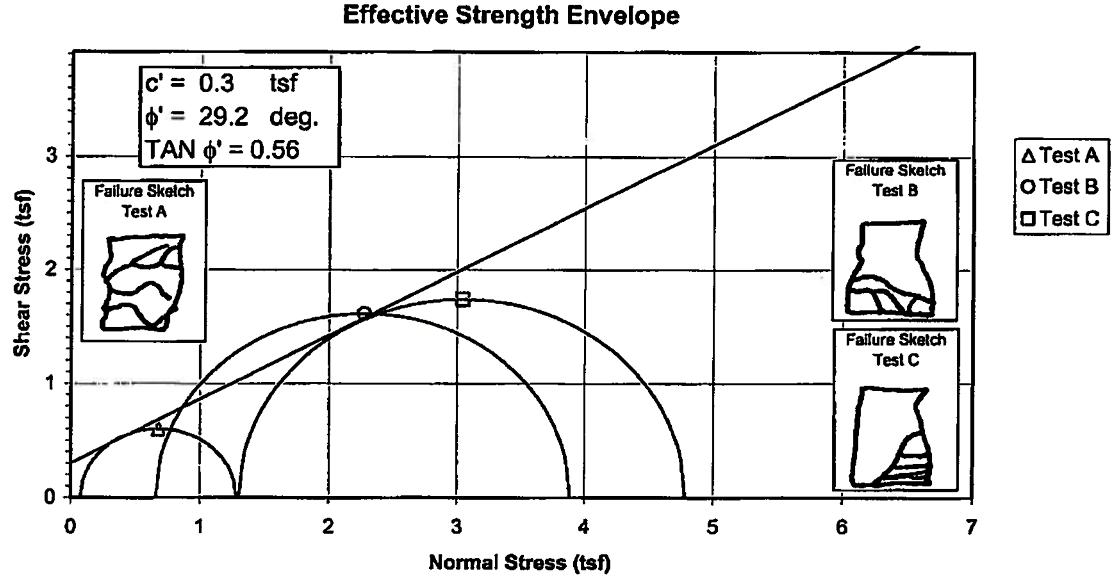
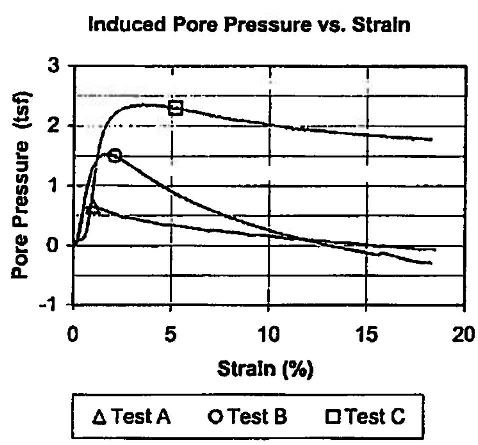
Failure Criterion: Maximum Effective Principal Stress Ratio





Specimen No.			A	B	C	
Initial Data	Water content %	W_o	22.1	18.0	20.2	
	Dry Density PCF	γ_{d_o}	102.9	110.4	105.8	
	Saturation %	S_o	94.3	92.9	92.5	
	Void Ratio	e_o	0.632	0.521	0.587	
After Shear	Water content %	W_f	23.3	18.3	20.0	
	Dry Density PCF	γ_{d_f}	103.3	112.5	109.1	
	Saturation %	S_f	100.0	100.0	100.0	
	Void Ratio	e_f	0.626	0.493	0.539	
	Final Back Pressure TSF	u_c	5.76	4.32	2.88	
Minor Principal Stress TSF @ failure		$\sigma_3'f$	0.08	0.66	1.30	
Maximum Deviator Stress (tsf) @ failure		$(\sigma_1'-\sigma_3')_{max}$	1.20	3.22	3.48	
Time to (σ1'-σ3')max min.		t_f	5.3	67.5	150.9	
Ultimate Deviator Stress, t/sq ft		$(\sigma 1'-\sigma 3')_{ult}$	n/a	n/a	n/a	
Initial Diameter, in.		D_o	2.881	2.884	2.884	
Initial Height, in.		H_o	5.989	6.057	6.028	

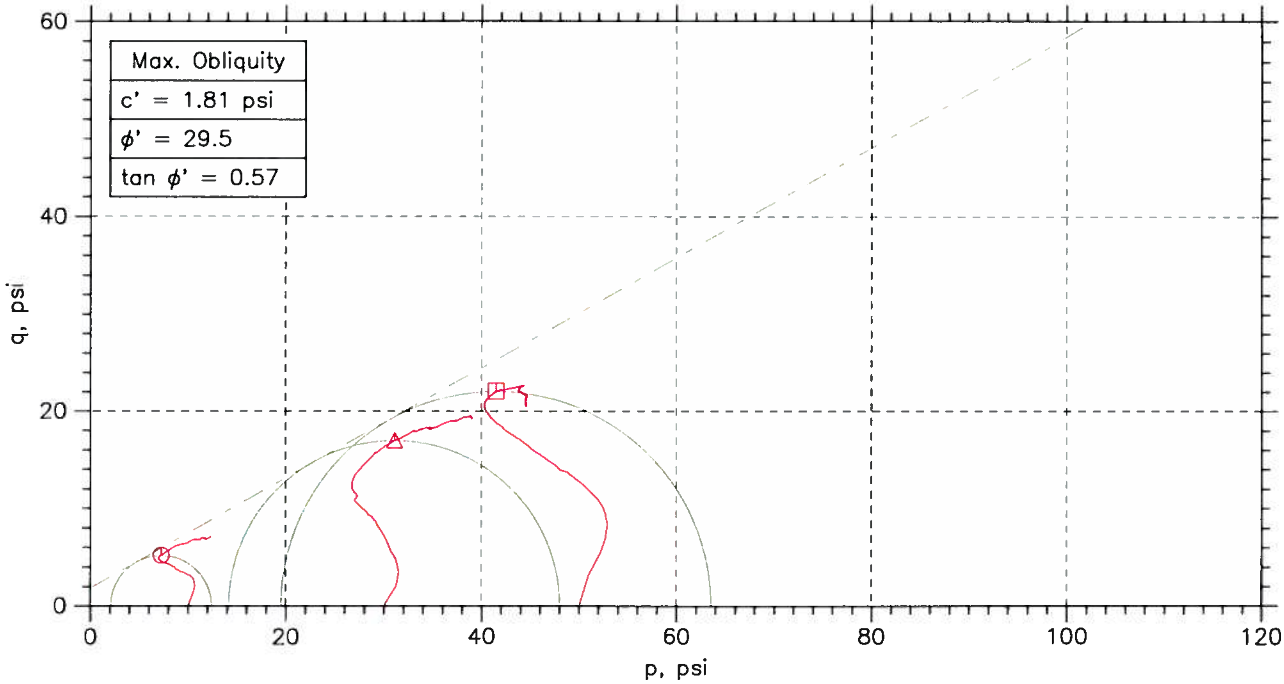
Controlled - Strain Test					
Description of Specimens	Fat Clay with Gravel (CH), red brown, moist, firm				
	Type of Specimen	Undisturbed		Type of test	$\bar{R}$
LL / PL / PI / Gs 2.69	Project	Colbert Fossil Plant (COF) - Ash Pond 4			
Remarks:					
	Boring No.	STN-4-11		Sample No.	8
	Depth Elev.	5.0'-5.5', 5.5'-6.0', 10.0'-10.5'			
	Laboratory	Stantec		Date	8-27-09
	TRIAXIAL COMPRESSION TEST REPORT				

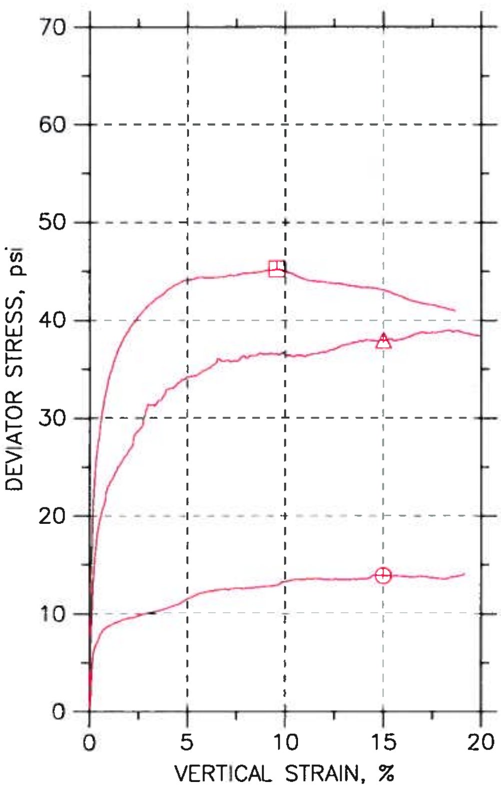
File: 175559016_cu_8 Sheet: CE_Final-E
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: MW
Approved BY: TLK

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		621A	622	621B	
Test No.		CU-2-1	CU-2-2	CU-2-3	
Depth		8.0-8.5	15-15.5	8.6-9.1	
Initial	Diameter, in	2.01	2.01	2	
	Height, in	4.2	4.3	4.2	
	Water Content, %	22.8	16.8	20.0	
	Dry Density, pcf	96.79	110.2	108.4	
	Saturation, %	83.0	85.6	97.5	
	Void Ratio	0.741	0.529	0.555	
Before Shear	Water Content, %	23.0	16.7	19.6	
	Dry Density, pcf	104.	116.3	110.2	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.621	0.45	0.53	
	Back Press., psi	101	125	107	
Ver. Eff. Cons. Stress, psi		10	30	49.99	
Shear Strength, psi		6.935	18.95	22.6	
Strain at Failure, %		15	15	9.56	
Strain Rate, %/min		0.016	0.016	0.016	
B-Value		0.95	0.96	0.95	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

GeoTesting express a subsidiary of Geocomp Corporation	Project: Colbert Fossil Plant
	Location: Ash Pond 4
	Project No.: GTX-9344
	Boring No.: STN-4-12
	Sample Type: UD
	Description: Moist, dark reddish brown clay
	Remarks:

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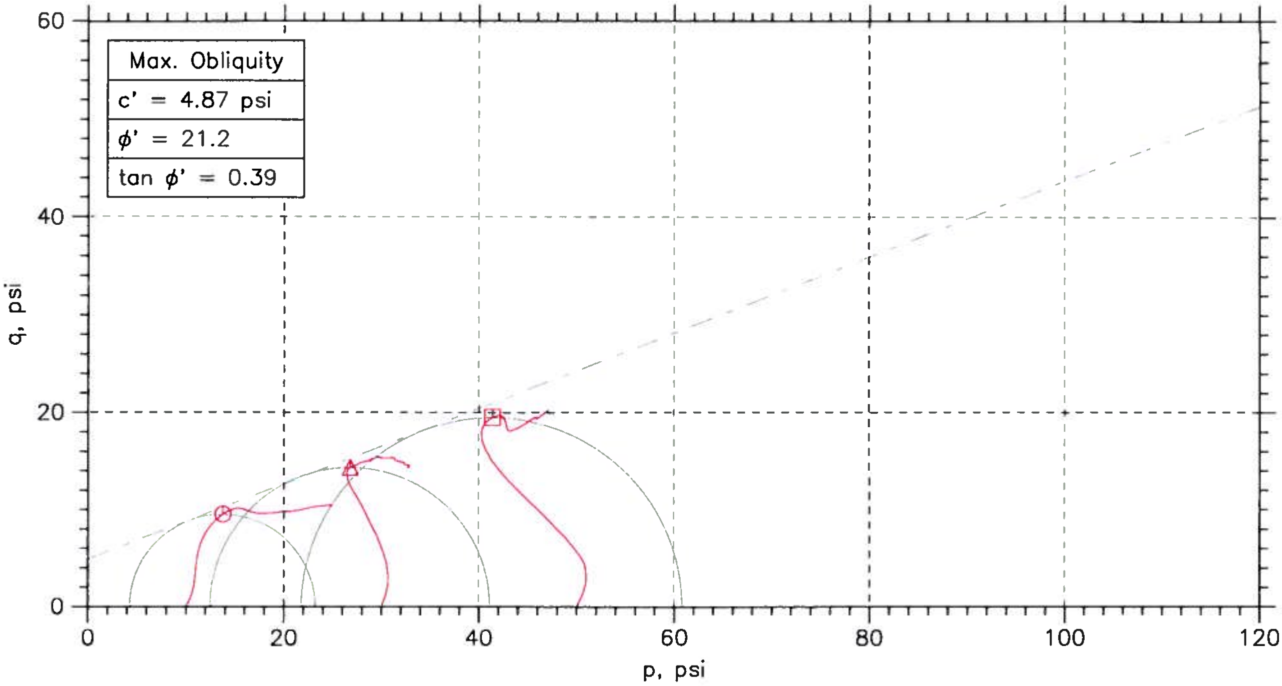
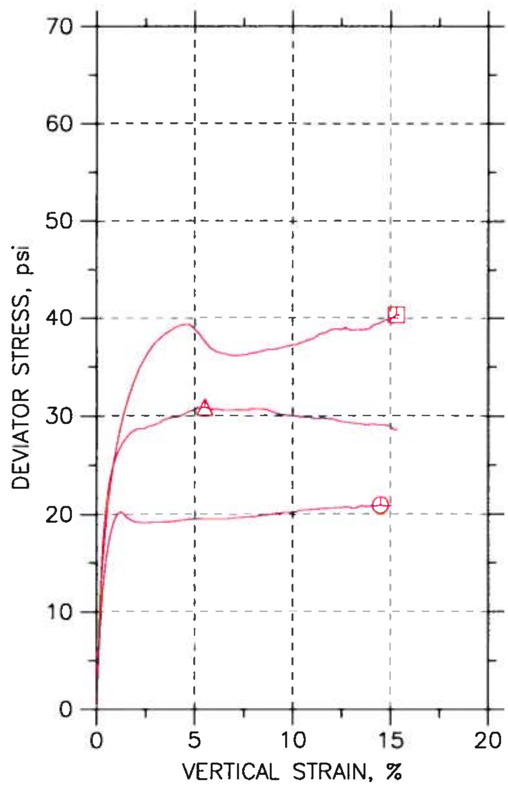
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		645	646	647	
Test No.		10.1	10.2	10.3	
Depth		5.4-5.9	10.1-10.6	15.5-16.1	
Initial	Diameter, in	2.876	2.892	2.883	
	Height, in	5.981	5.995	5.938	
	Water Content, %	27.9	23.9	26.9	
	Dry Density, pcf	94.68	98.72	94.97	
	Saturation, %	96.7	91.1	93.8	
	Void Ratio	0.78	0.707	0.775	
Before Shear	Water Content, %	29.2	24.4	0.0	
	Dry Density, pcf	94.22	101.6	168.6	
	Saturation*, %	100.0	100.0	0.0	
	Void Ratio	0.789	0.66	0	
	Back Press., psi	62.29	121.6	101	
Ver. Eff. Cons. Stress, psi		9.936	29.93	49.98	
Shear Strength, psi		10.44	15.43	20.15	
Strain at Failure, %		14.5	5.5	15.3	
Strain Rate, %/min		0.016	0.016	0.016	
B-Value		0.95	0.96	0.95	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

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Project: Colbert Fossil Plant
Location: Ash Pond 4
Project No.: GTX-1495
Boring No.: STN-4-15
Sample Type: UD
Description: Brown Lean clay
Remarks: 2054

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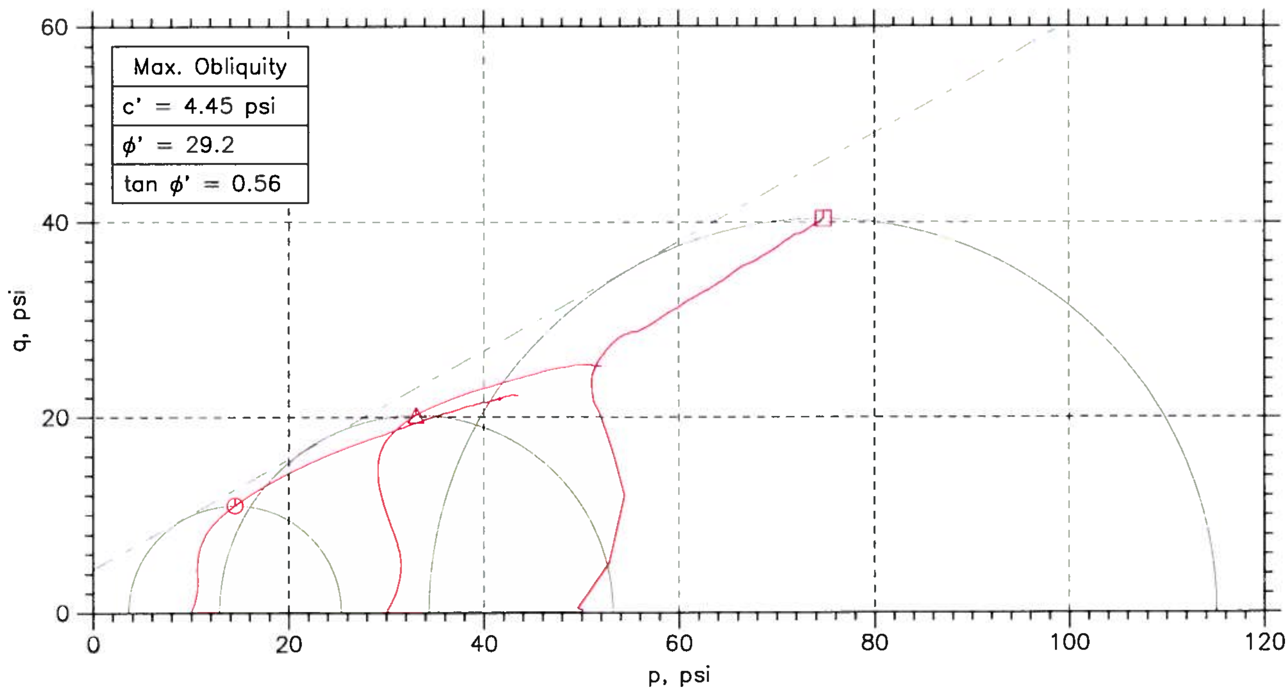
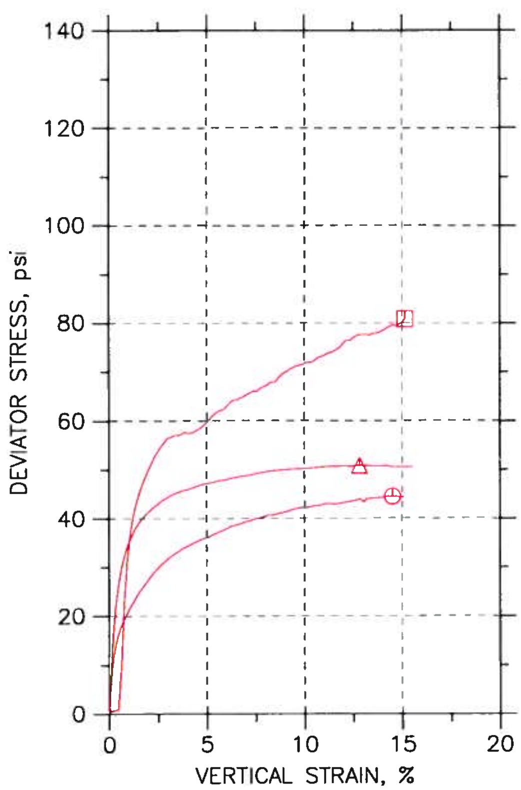
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		633A	634	633A	
Test No.		1.1	1.2	1.3	
Depth		4-4.5 ft	9.6-10.1'	4.6-5.1'	
Initial	Diameter, in	2.872	2.865	2.879	
	Height, in	6.027	5.923	6.032	
	Water Content, %	20.1	18.9	20.3	
	Dry Density, pcf	107.9	110.4	107.4	
	Saturation, %	96.5	97.0	96.0	
	Void Ratio	0.562	0.527	0.57	
Before Shear	Water Content, %	21.1	19.3	20.6	
	Dry Density, pcf	107.4	110.8	108.3	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.569	0.521	0.557	
	Back Press., psi	140	119	102	
Ver. Eff. Cons. Stress, psi		9.961	29.96	49.99	
Shear Strength, psi		22.21	25.38	40.35	
Strain at Failure, %		14.5	12.8	15.1	
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		---	---	---	
Plastic Limit		---	---	---	

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Project: Colbert Fossil Plant	
Location: Ash Pond 4	
Project No.: GTX-1495	
Boring No.: STN-4-16	
Sample Type: UD	
Description: Brown lean clay with sand	
Remarks: System 1062	

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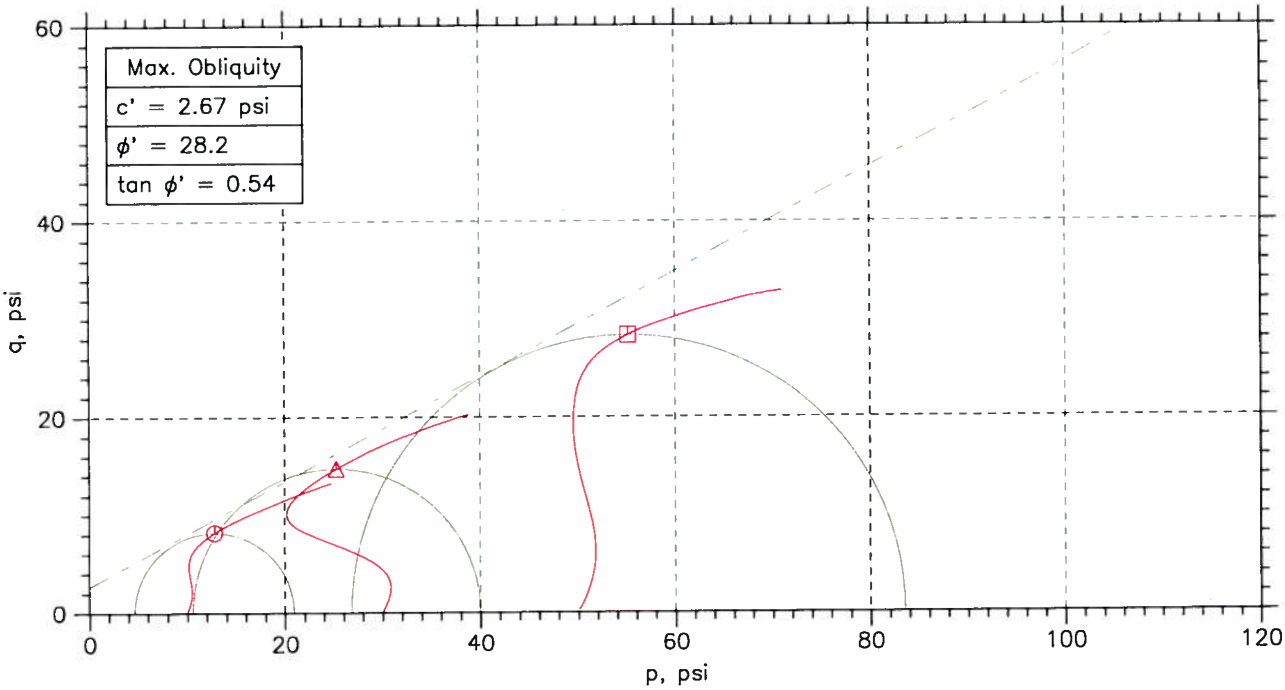
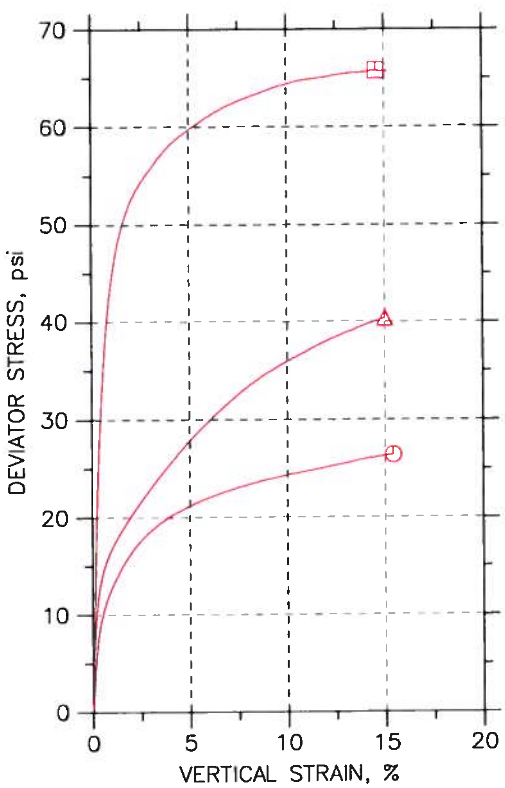
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





		Symbol	○	△	□	
		Sample No.	639A	638A	639B	
		Test No.	2.1	4.2	2.3	
		Depth	19.1-19.6'	14.1-14.6'	19.7-20.2'	
Initial		Diameter, in	2.863	2.857	2.867	
		Height, in	5.958	5.985	5.997	
		Water Content, %	22.3	18.1	20.8	
		Dry Density, pcf	105.3	111.7	107.2	
		Saturation, %	100.2	95.7	98.3	
		Void Ratio	0.601	0.509	0.572	
Before Shear		Water Content, %	22.6	17.5	20.6	
		Dry Density, pcf	104.7	114.5	108.3	
		Saturation*, %	100.0	100.0	100.0	
		Void Ratio	0.61	0.472	0.556	
		Back Press., psi	53.23	62.04	98.03	
		Ver. Eff. Cons. Stress, psi	9.984	29.97	49.96	
		Shear Strength, psi	13.18	20.14	32.85	
		Strain at Failure, %	15.4	15	14.6	
		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	---	---	---	
		Plastic Limit	---	---	---	

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Project: Colbert Fossil Plant
Location: Ash pond 4
Project No.: GTX-1495
Boring No.: STN-4-19
Sample Type: UD
Description: Brown Lean clay
Remarks: 2054

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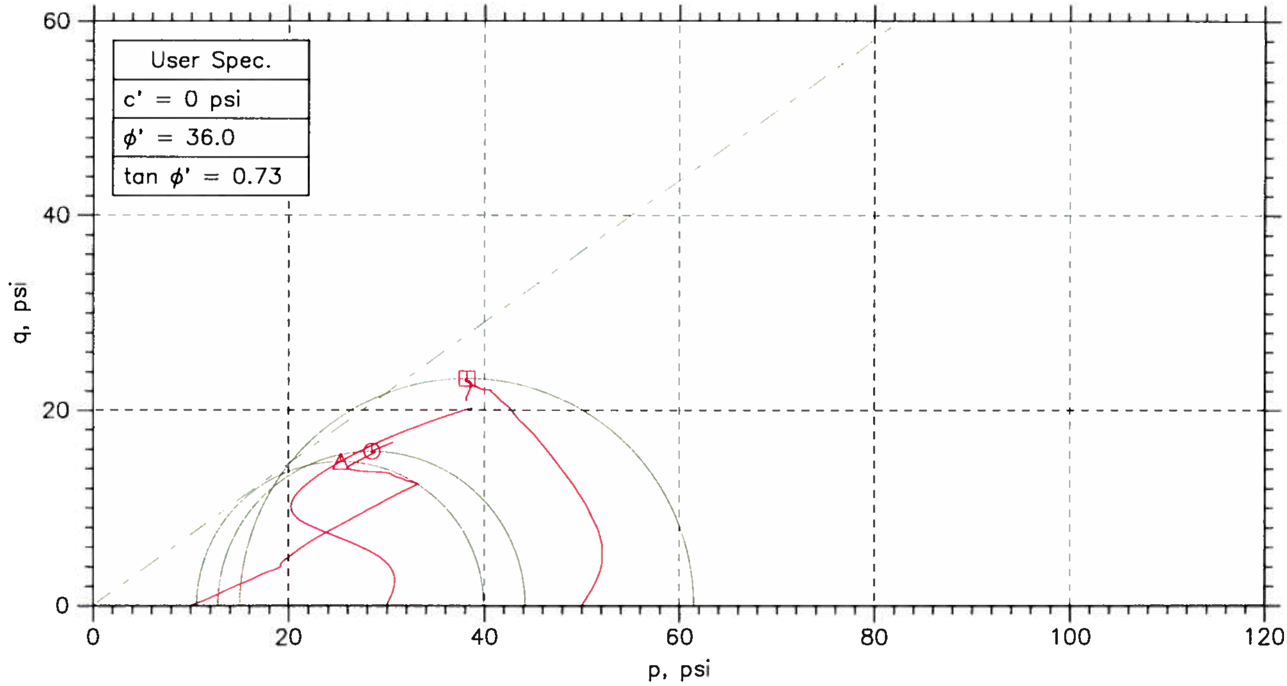
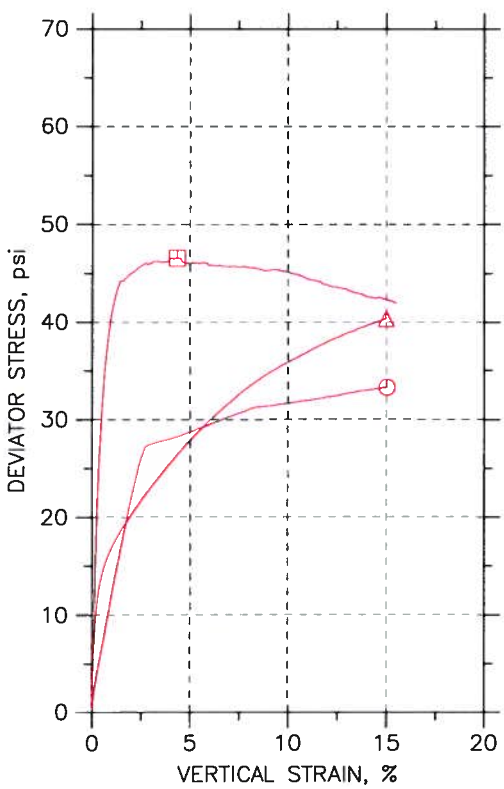
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		640A	638A	640B	
Test No.		4.1	4.2	4.3	
Depth		4-4.5'	14.1-14.6'	4.6-5.1'	
Initial	Diameter, in	2.861	2.857	2.85	
	Height, in	5.951	5.985	6.069	
	Water Content, %	21.4	18.1	22.6	
	Dry Density, pcf	106.6	111.7	103.8	
	Saturation, %	99.5	95.7	97.6	
	Void Ratio	0.581	0.509	0.624	
Before Shear	Water Content, %	20.4	17.5	21.0	
	Dry Density, pcf	108.7	114.5	107.6	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.55	0.472	0.567	
	Back Press., psi	113.1	62.04	102	
Ver. Eff. Cons. Stress, psi		10.11	29.97	49.97	
Shear Strength, psi		16.63	20.14	23.25	
Strain at Failure, %		15	15	4.33	
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		---	---	---	

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Project: Colbert Fossil Plant
Location: Ash Pond 4
Project No.: GTX-1495
Boring No.: STN-4-22
Sample Type: UD
Description: moist, brown clay
Remarks: Note: Sample 638A from Boring STN-4-19

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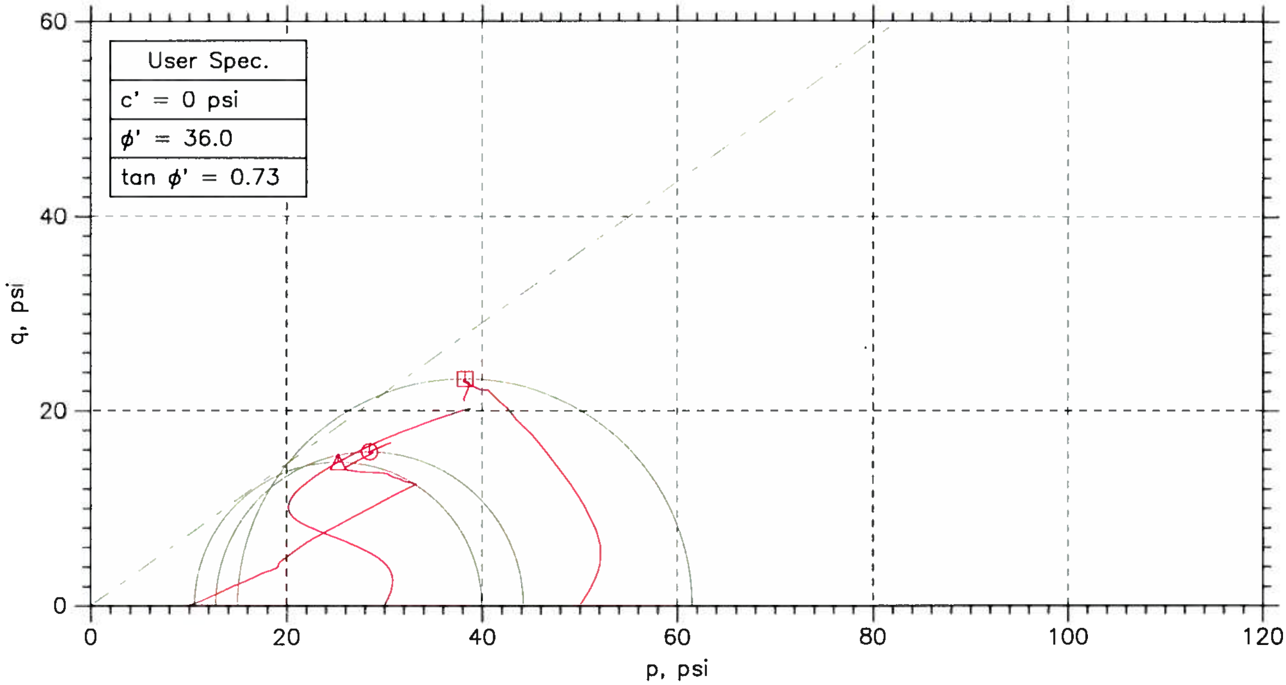
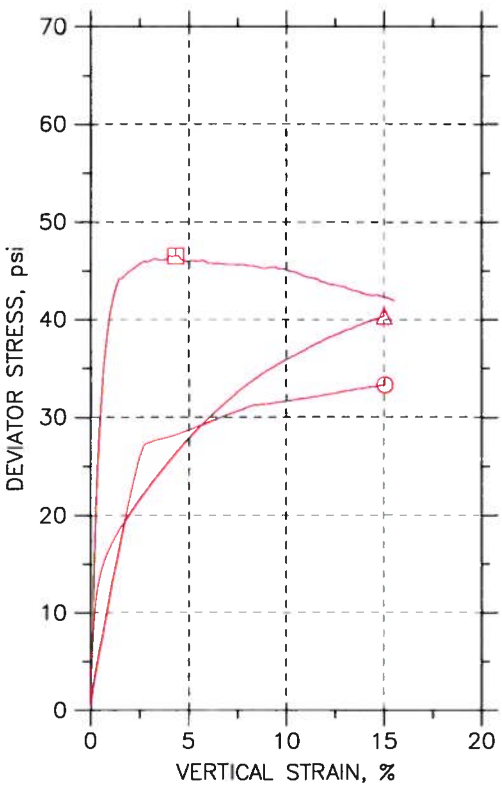
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





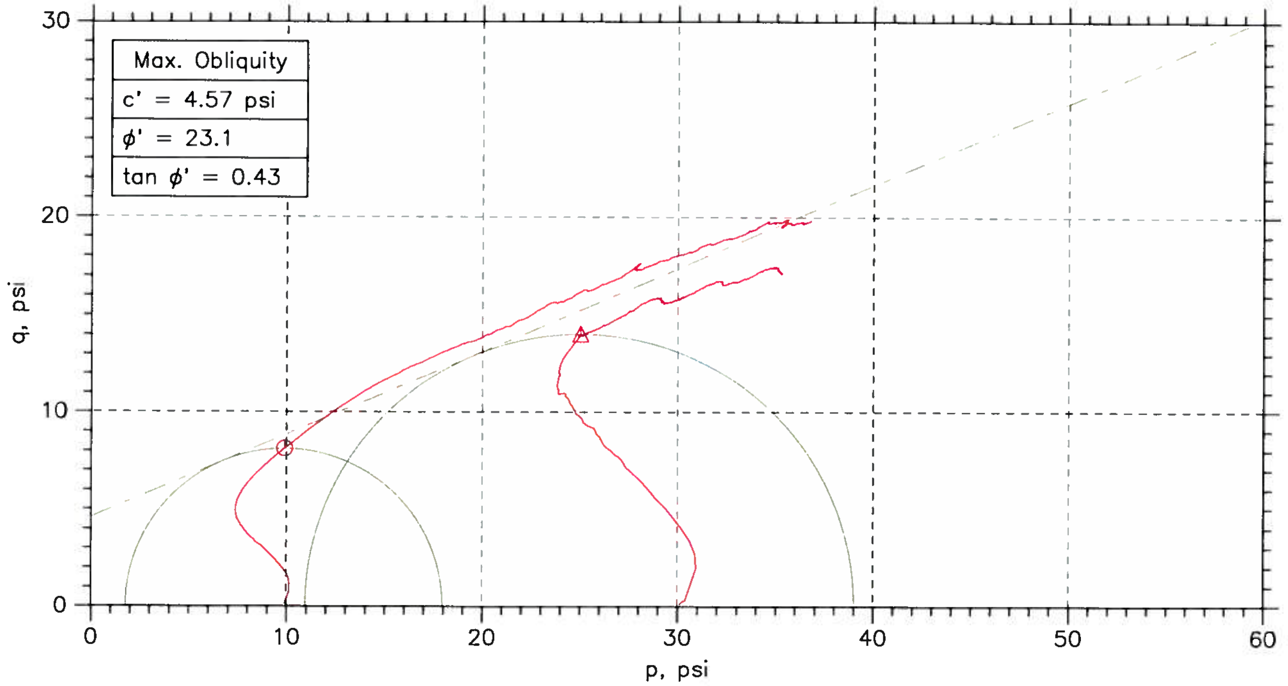
	Symbol	○	△	□	
	Sample No.	640A	638A	640B	
	Test No.	4.1	4.2	4.3	
	Depth	4-4.5'	14.1-14.6'	4.6-5.1'	
Initial	Diameter, in	2.861	2.857	2.85	
Initial	Height, in	5.951	5.985	6.069	
Initial	Water Content, %	21.4	18.1	22.6	
Initial	Dry Density, pcf	106.6	111.7	103.8	
Initial	Saturation, %	99.5	95.7	97.6	
Initial	Void Ratio	0.581	0.509	0.624	
Before Shear	Water Content, %	20.4	17.5	21.0	
Before Shear	Dry Density, pcf	108.7	114.5	107.6	
Before Shear	Saturation*, %	100.0	100.0	100.0	
Before Shear	Void Ratio	0.55	0.472	0.567	
Before Shear	Back Press., psi	113.1	62.04	102	
	Ver. Eff. Cons. Stress, psi	10.11	29.97	49.97	
	Shear Strength, psi	16.63	20.14	23.25	
	Strain at Failure, %	15	15	4.33	
	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	---	---	---	

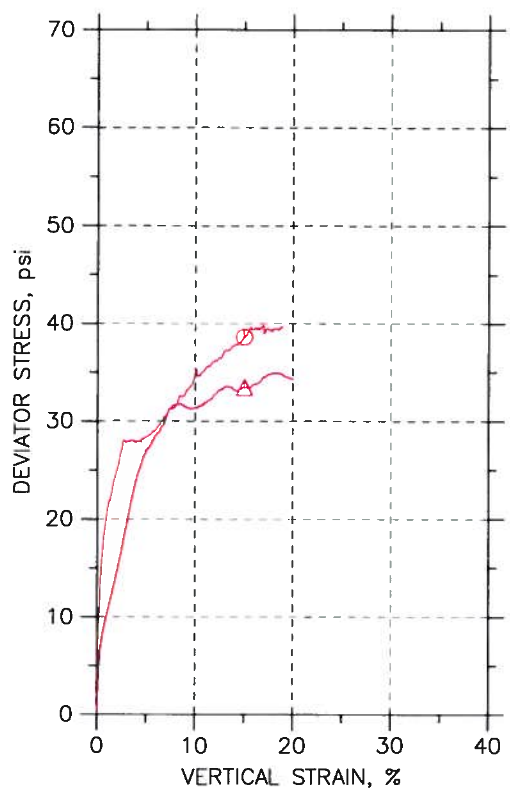
GeoTesting express
a subsidiary of Geocomp Corporation

Project: Colbert Fossil Plant
Location: Ash Pond 4
Project No.: GTX-1495
Boring No.: STN-4-22
Sample Type: UD
Description: moist, brown clay
Remarks: Note: Sample 638A from Boring STN-4-19

Fri, 16-OCT-2009 08:08:50

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		⊙	△		
Sample No.		642A	643A		
Test No.		CU-5-1	CU-5-2		
Depth		4.1-4.6	9.3-9.8		
Initial	Diameter, in	2.01	2.01		
	Height, in	4.08	4.08		
	Water Content, %	18.3	21.5		
	Dry Density, pcf	108.4	95.5		
	Saturation, %	89.2	76.0		
	Void Ratio	0.555	0.765		
Before Shear	Water Content, %	18.3	21.5		
	Dry Density, pcf	112.7	106.6		
	Saturation*, %	100.0	100.0		
	Void Ratio	0.495	0.581		
	Back Press., psi	113	100.9		
Ver. Eff. Cons. Stress, psi		9.995	30		
Shear Strength, psi		19.28	16.71		
Strain at Failure, %		15	15		
Strain Rate, %/min		0.016	0.016		
B-Value		0.96	0.96		
Estimated Specific Gravity		2.7	2.7		
Liquid Limit		---	---		
Plastic Limit		---	---		

GeoTesting express
a subsidiary of Geocomp Corporation

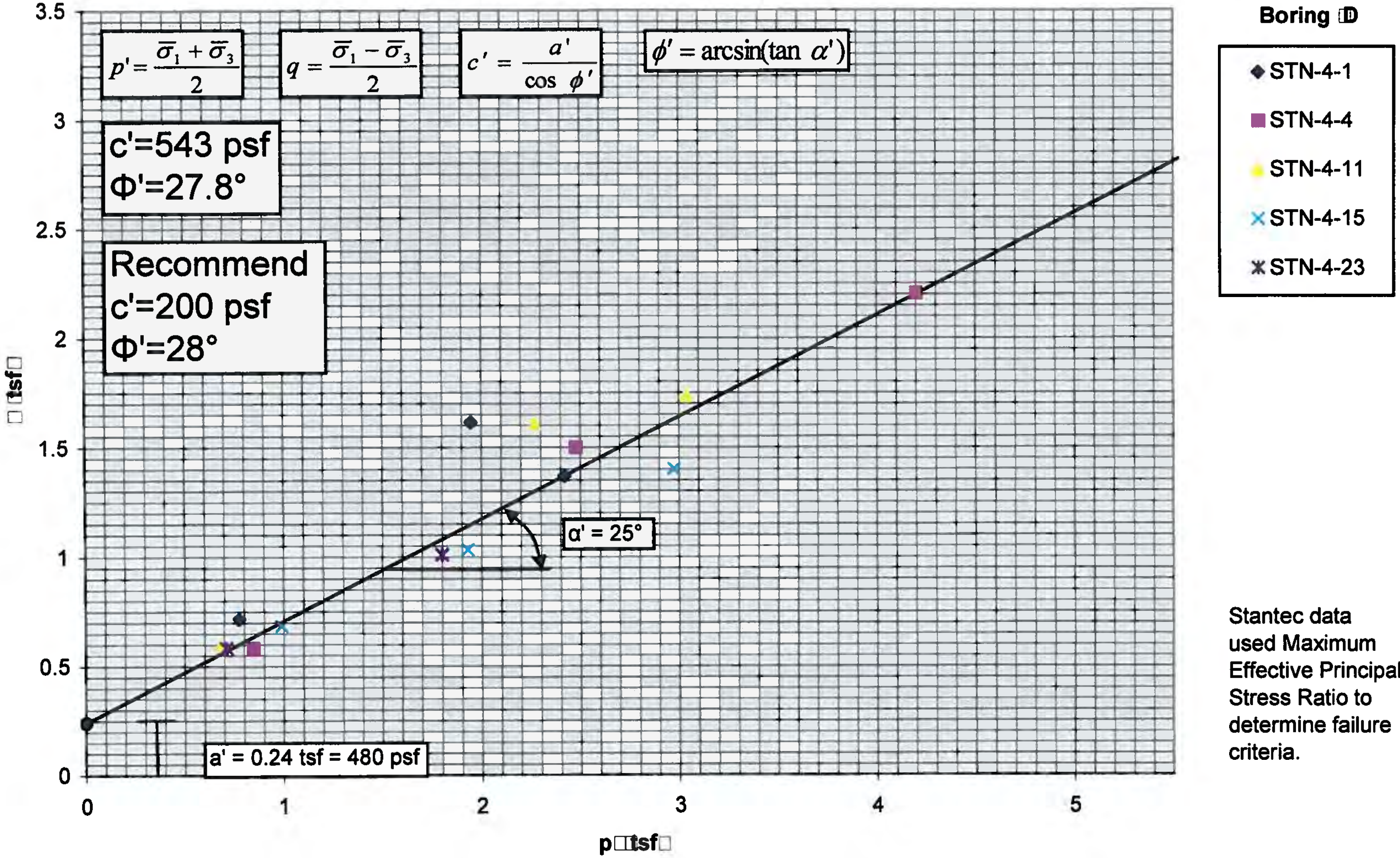
Project: Colbert Fossil Plant	
Location: Ash Pond 4	
Project No.: GTX-9344	
Boring No.: STN-4-23	
Sample Type: UD	
Description: Moist, mottled, red, yellow, brown , and gray sandy clay	
Remarks:	

Fri, 16-OCT-2009 08:39:34

Appendix D

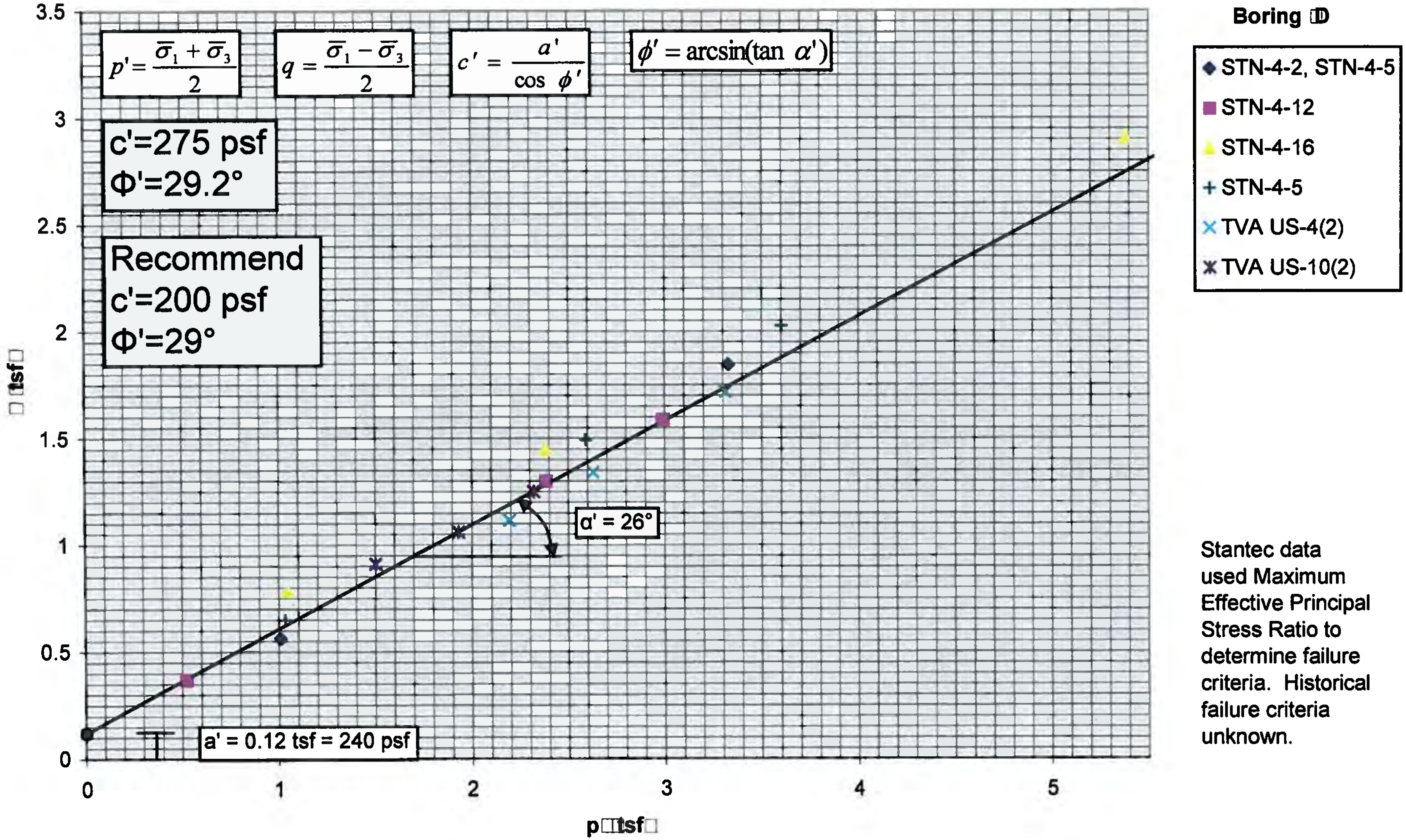
Strength Parameter Selection

Upper Clay Dike
Effective Stress From CU Triaxial Tests



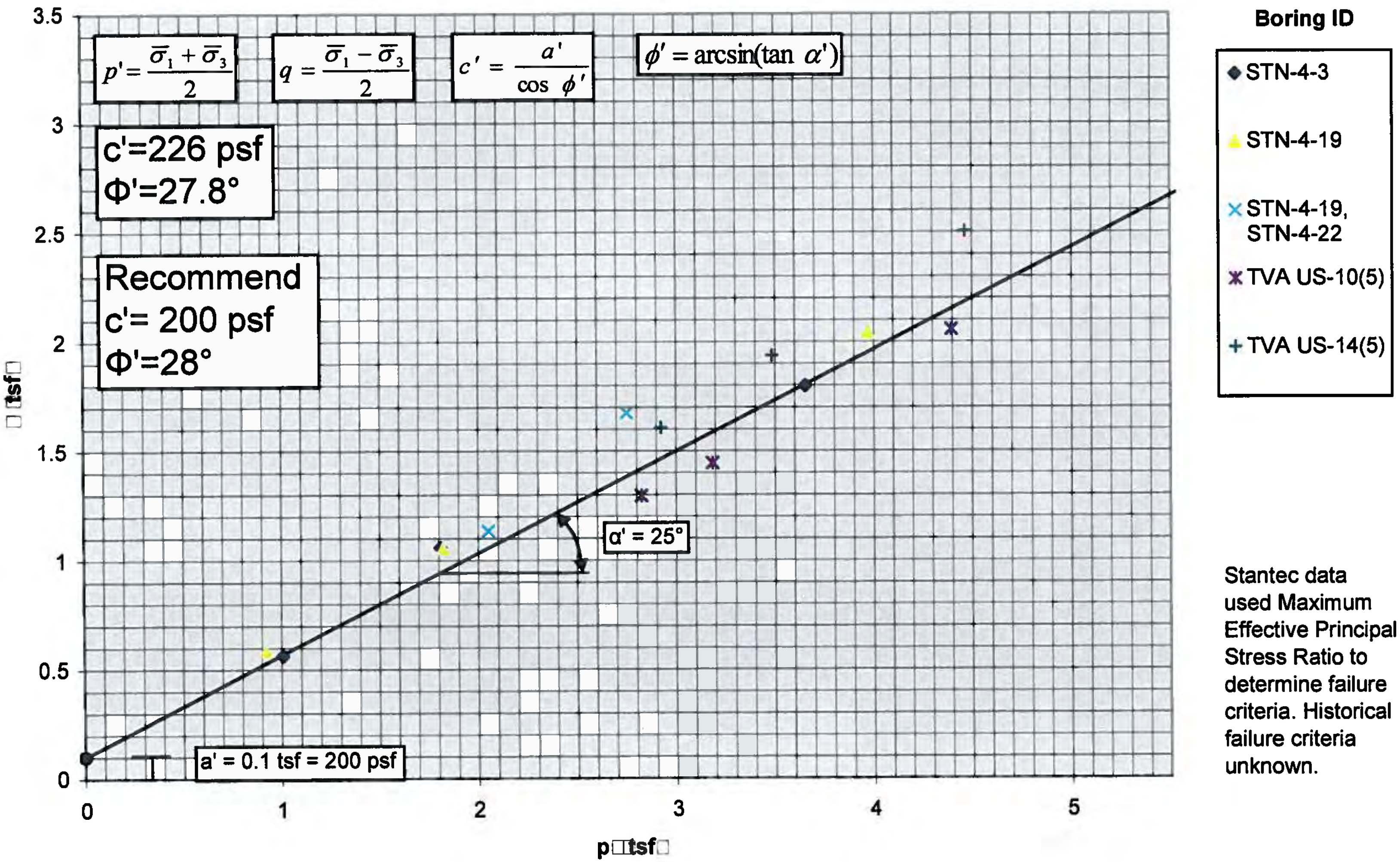
Stantec data used Maximum Effective Principal Stress Ratio to determine failure criteria.

Lower Clay Dike
Effective Stress from CU Triaxial Tests



Stantec data used Maximum Effective Principal Stress Ratio to determine failure criteria. Historical failure criteria unknown.

Native Clay
□ffective Stress □rom C□ Tria□ial Tests



Stantec data used Maximum Effective Principal Stress Ratio to determine failure criteria. Historical failure criteria unknown.

Appendix E

Geotechnical Drawings

GEOTECHNICAL EXPLORATION
ASH POND 4
COLBERT FOSSIL PLANT
TUSCUMBIA, COLBERT COUNTY, ALABAMA

PREPARED FOR

TENNESSEE VALLEY AUTHORITY

PREPARED BY

Stantec

Stantec Consulting Services Inc.
1901 Nelson Miller Parkway
Louisville, Kentucky
40223-2177
Tel. 502.212.5000
Fax 502.212.5055
www.stantec.com

VICINITY MAP

INDEX OF SHEETS

1. COVER SHEET
2. BORING AND STABILITY CROSS-SECTION PLAN
3. STABILITY SECTION A-A'
4. STABILITY SECTION B-B'
5. STABILITY SECTION C-C'
6. STABILITY SECTION D-D'
7. STABILITY SECTION E-E'
8. STABILITY SECTION F-F'
9. STABILITY SECTION G-G'
10. STABILITY SECTION H-H'
11. STABILITY SECTION I-I'
12. STABILITY SECTION J-J'

RECORD DRAWING

SCALE: NONE EXCEPT AS NOTED

YARD
ASH POND 4
GEOTECHNICAL EXPLORATION
COVER SHEET

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W706-01 | R 0

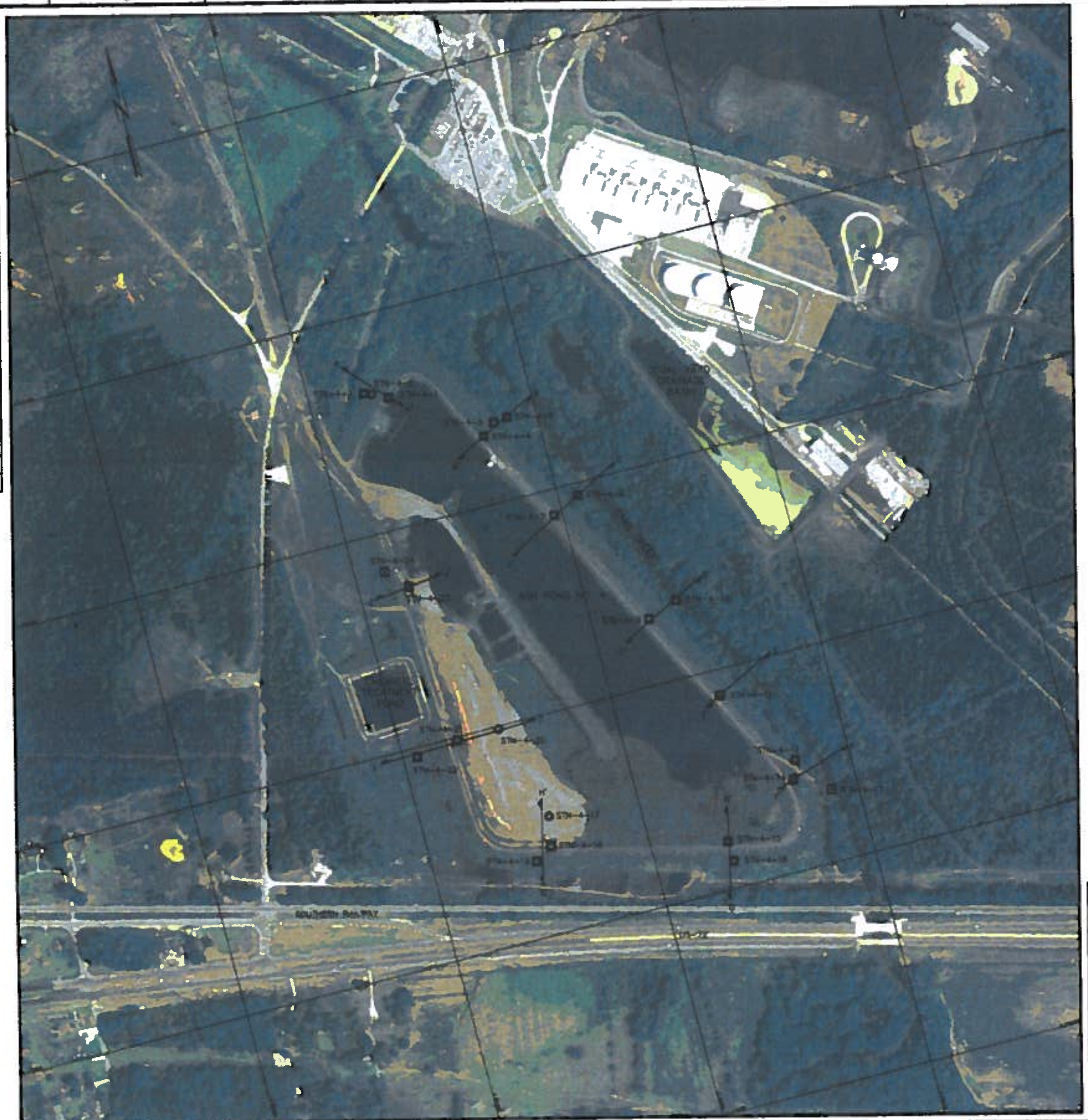
PLOT FACTOR:XX

C.A.D. DRAWING

37 C 10W706-01

37 | C | 10W706-02

BORING LOCATION TABLE			
BORING	NORTHING	EASTING	ELEVATION
STN-4-1	1,723,669.52	394,350.89	460.2
STN-4-2	1,723,632.72	394,288.32	439.4
STN-4-3	1,723,645.94	394,253.91	427.3
STN-4-4	1,723,316.42	394,738.76	460.4
STN-4-5	1,723,386.01	394,798.52	439.5
STN-4-6	1,723,373.18	394,884.54	419.8
STN-4-7	1,722,880.08	394,960.81	460.8
STN-4-8	1,722,943.49	385,068.90	421.8
STN-4-9	1,722,306.36	385,280.37	461.2
STN-4-10	1,722,357.09	385,401.10	420.9
STN-4-11	1,721,682.96	385,485.31	461.3
STN-4-12	1,721,504.87	385,748.27	446.2
STN-4-13	1,721,330.83	385,874.15	425.3
STN-4-14	1,721,420.08	385,715.53	481.9
STN-4-15	1,721,219.13	385,347.[illegible]	460.5
STN-4-16	1,721,126.23	385,351.[illegible]	435.1
STN-4-17	1,721,539.59	384,582.90	476.8
STN-4-18	1,721,402.10	384,555.64	461.1
STN-4-19	1,721,352.01	384,475.68	440.3
STN-4-20	1,721,987.93	384,481.02	482.3
STN-4-21	1,721,985.14	384,262.71	460.2
STN-4-22	1,721,857.70	384,085.63	438.0
STN-4-23	1,722,728.47	384,227.84	461.1
STN-4-24	1,722,823.19	384,138.84	444.5



LEGEND

- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Sampling
- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Piston Sampling, And Piezometer Installation
- Soil Boring With Continuous Standard Penetration Tests And/or Shelby Tube Sampling, Rock Core, And Piezometer Installation

NOTES

1. Topographic and survey information provided by the Tennessee Valley Authority.
2. The Boring Logs And Related Information Shown On This Drawing 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. Any Correlations Shown Between Borings Are Generally Based On Straight Line Interpolation. Actual Conditions Between Borings Are Unknown And May Differ From Those Shown.

RECORD DRAWING

GRAPHIC SCALE: 1"=200'

For Supporting Design Calculations see FPGCOFFESCDN000002010001

1/22/10

SCALE: 1"=200' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION
BORING AND STABILITY
CROSS-SECTION PLAN

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

Stantec

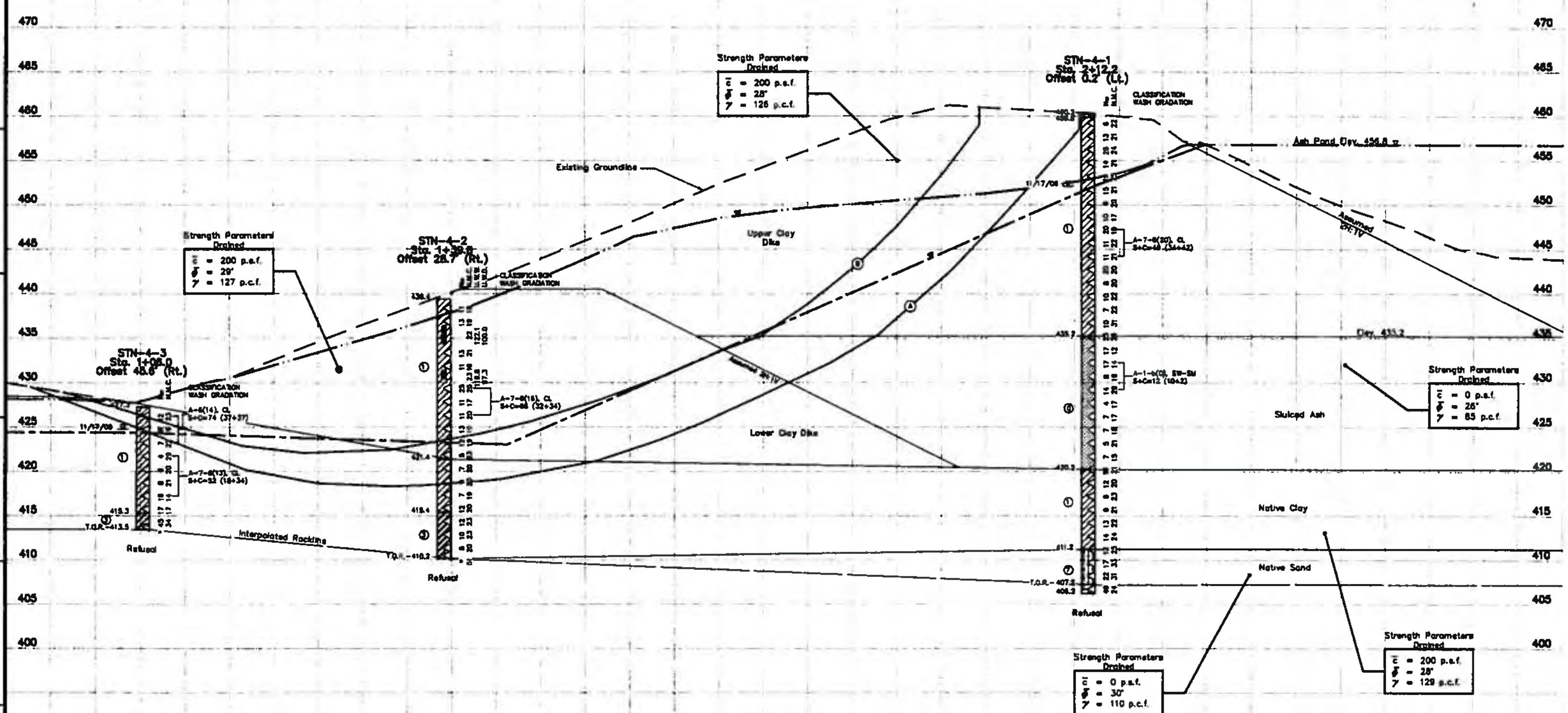
AUTOCAD R 2000 | 37 | C | 10W706-02 | R 0

STANTEC | 0

TASK COMPLETED BY: | REV NO.

PLOT FACTOR: XX

C.A.D. DRAWING DO NOT ALTER MANUALLY



LEGEND

1. Lean Clay, Sandy Lean Clay, Lean Clay with Sand
2. Silty, Clayey Sand
3. Fat Clay, Fat Clay with Sand
4. Overburden
5. Silty Clay
6. Poorly Graded Sand
7. Silty Sand
8. Silt, Sandy Silt, Silt with Sand
- Limestone
9. Fly Ash
10. Bottom Ash

WH	Weight of Hammer
WR	Weight of Rods
	Standard Penetration Test Interval
	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09	Piezometer Water Level Reading and Date Recorded
	Phreatic Surface from PZ Data
	Phreatic Surface from Seepage Model
T.O.R. –	Top of Rock (indicates the beginning of rock-like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
B.C. –	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal using a carbide-tipped tooth auger bit
No Refusal	No Refusal Encountered
•	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer to typed boring log.

NOTE:

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CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Location	STN-4-1		
Depth	2.5'-3.0'	5.1'-5.6'	10.0'-10.5'
$\bar{\phi}$	24.1°		
$\bar{c}$	880 p.s.f.		
Location	STN-4-3		
Depth	2.5'-3.0'	6.5'-7.0'	10.0'-10.5'
$\bar{\phi}$	27.1°		
$\bar{c}$	356 p.s.f.		
Location	STN-4-2		STN-4-5
Depth	4.0'-4.5'	8.0'-8.5'	9.0-9.5'
$\bar{\phi}$	33.4°		
$\bar{c}$	2 p.s.f.		

SUMMARY OF OFFSET BORINGS

BORING NO.	SURFACE ELEV.	BOTTOM OF HOLE DEPTH	PIEZOMETER SCREENED INTERVAL	UNDISTURBED "SHELBY" TUBE SAMPLE INTERVALS
STN-4-1S	460.2'	27.0'	14.5'-24.5'	2.0'-4.0' 5.0'-7.0' 10.0'-12.0' 15.0'-17.0' 20.0'-22.0' 25.0'-27.0'
STN-4-3S	427.3'	18.0'	13.0'-18.0'	2.0'-4.0' 6.0'-8.0' 10.0'-12.0'

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION

Failure Surface	Failure Mode	Factor of Safety
A	Circular Optimized With Phreatic Surface From PZ Data	2.10
B	Circular Optimized With Phreatic Surface From Seepage Model	1.50

100 150 200 250

SECTION A-A'

RECORD DRAWING

For Supporting Design Calculations see FPCOFFESCDX000002010001

1/22/10

Stantec Consulting Services Inc.

SCALE: 1"=5' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION
STABILITY SECTION A-A'

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

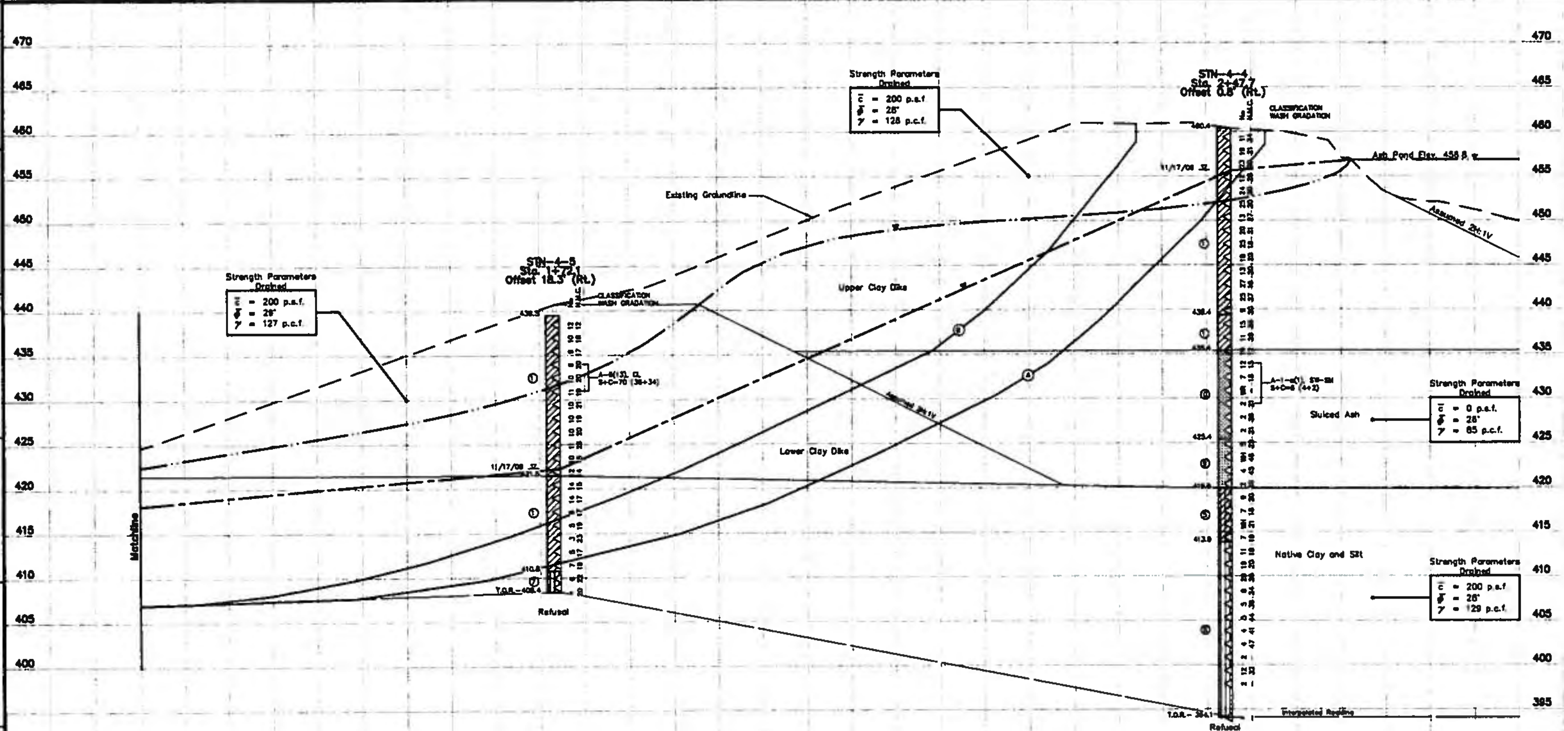
AUTOCAD R 2000 | 37 | C | 10W706-03 | R 0

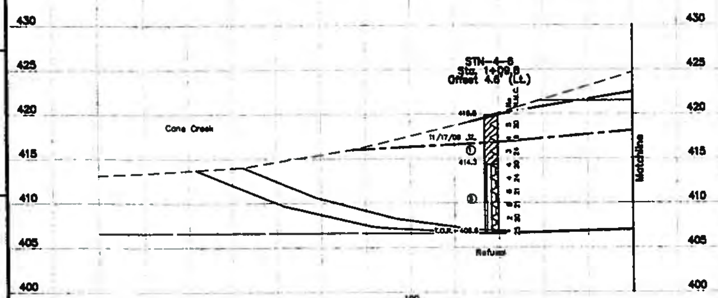
PLOT FACTOR: XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY | REV NO.

37 C 10W706-03





SECTION B-B'

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
A	Circular Optimized With Phreatic Surface From PZ Data	1.80
B	Circular Optimized With Phreatic Surface From Seepage Model	1.54

CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Location	STN-4-2		STN-4-5
Depth	4.0'-4.5'	8.0'-8.5'	9.0'-9.5'
$\bar{\phi}$	33.4°		
$\bar{c}$	2 p.s.f		
Location	STN-4-4		
Depth	5.0'-5.5'	2.8'-3.3'	5.8'-6.1'
$\bar{\phi}$	28.9°		
$\bar{c}$	497 p.s.f.		
Location	STN-4-5		
Depth	17.6'-18.1'	17.0'-17.5'	22.3'-22.8'
$\bar{\phi}$	32.4°		
$\bar{c}$	229 p.s.f.		

SUMMARY OF OFFSET BORINGS

BORING NO.	SURFACE ELEV	BOTTOM OF HOLE DEPTH	PIEZOMETER SCREENED INTERVAL	UNDISTURBED "SHELBY" TUBE SAMPLE INTERVALS
STN-4-4S	460.4	27.0'	15.0'-25.0'	2.0'-4.0' 5.0'-7.0' 10.0'-12.0' 15.0'-17.0' 20.0'-22.0' 25.0'-27.0'
STN-4-5S	439.5'	24.0'	14.0'-24.0'	4.0'-6.0' 9.0'-11.0' 14.0'-16.0' 17.0'-19.0' 21.5'-23.5'
STN-4-6	419.8'	13.2'	8.2'-13.2'	No Samples

LEGEND

- ① Lean Clay, Sandy Lean Clay, Lean Clay with Sand
- ② Silty, Clayey Sand
- ③ Fat Clay, Fat Clay with Sand
- ④ Overburden
- ⑤ Silty Clay
- ⑥ Poorly Graded Sand
- ⑦ Silty Sand
- ⑧ Silt, Sandy Silt, Silt with Sand
- Limestone
- ⑨ Fly Ash
- ⑩ Bottom Ash

WH Weight of Hammer
WR Weight of Rods
◁ Standard Penetration Test Interval
● Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60} Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60} Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C. Natural Moisture Content (%)
U.W.W. Unit Weight Wet (lbs./cu.ft.)
U.W.D. Unit Weight Dry (lbs./cu.ft.)
U.C./U.U. Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09 Piezometer Water Level Reading and Date Recorded
Phreatic Surface from PZ Data
Phreatic Surface from Seepage Model
T.O.R.- Top of Rock (Indicates the beginning of rock-like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
B.C.- Begin Rock Core
R.Q.D. Rock Quality Designation (%)
REC. Recovery (%)
Refusal Auger Refusal using a carbide-tipped tooth auger bit
No Refusal No Refusal Encountered
* Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer to typed boring log.

NOTE:

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RECORD DRAWING

For Supporting Design Calculations see FPGCOFFESCDX0000002010001

SCALE: 1"=5' EXCEPT AS NOTED

YARD
ASH POND 4
GEOTECHNICAL EXPLORATION
STABILITY SECTION B-B'

1/22/10

Stantec

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

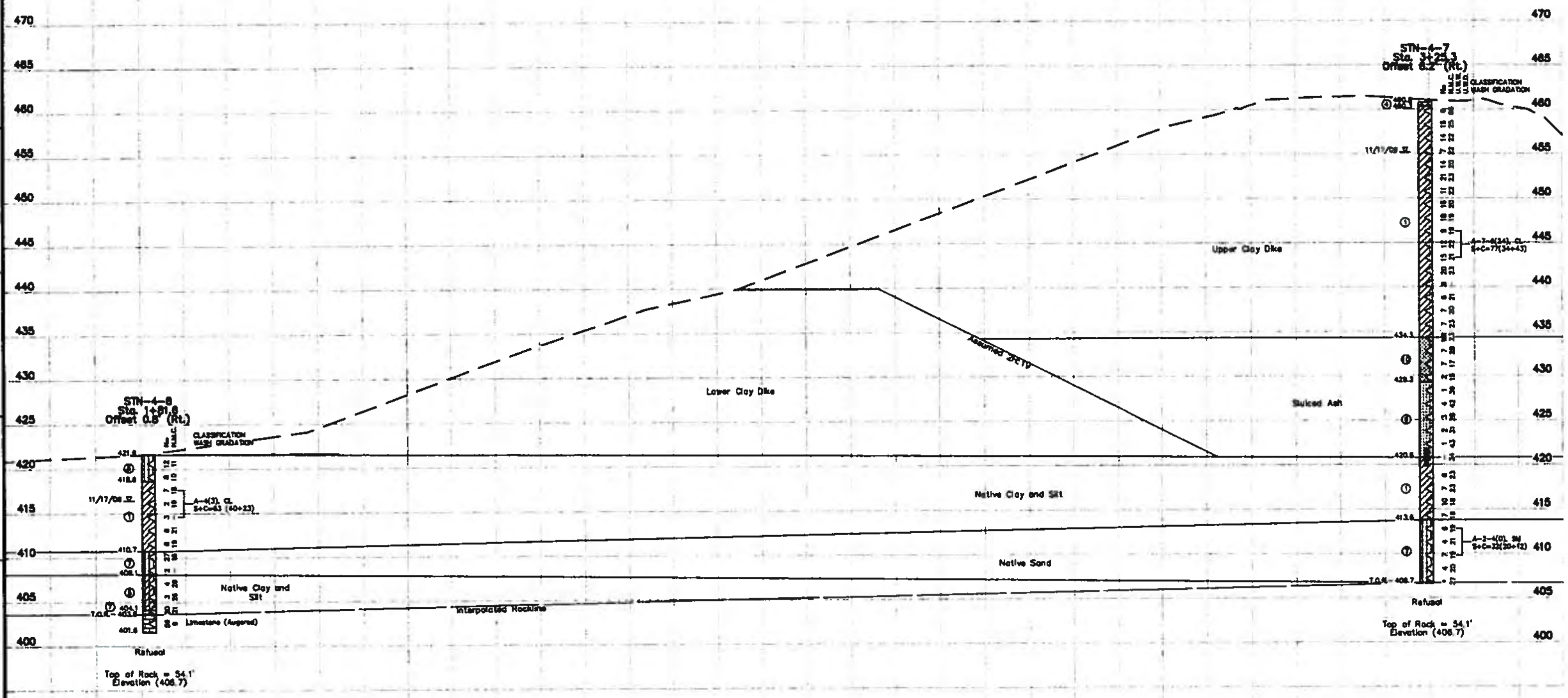
AUTOCAD R 2000 | 37 | C | 10W706-04 | R 0

STANTEC | 0
TASK COMPLETED BY | REV NO.

PLOT FACTOR:XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

37 C 10W706-04



LEGEND

①		Lean Clay, Sandy Lean Clay, Lean Clay with Sand
②		Silty, Clayey Sand
③		Fat Clay, Fat Clay with Sand
④		Overburden
⑤		Silty Clay
⑥		Poorly Graded Sand
⑦		Silty Sand
⑧		Silt, Sandy Silt, Silt with Sand
		Limestone
⑨		Fly Ash
⑩		Bottom Ash

WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
●	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09	Piezometer Water Level Reading and Date Recorded
T.O.R.-	Top of Rock (indicates the beginning of rock-like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
B.C.-	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal using a carbide-tipped tooth auger bit
No Refusal	No Refusal Encountered
*	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer to typed boring log.

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SUMMARY OF OFFSET BORINGS

BORING NO.	SURFACE ELEV.	BOTTOM OF HOLE DEPTH	PIEZOMETER SCREENED INTERVAL	UNDISTURBED "SHELBY" TUBE SAMPLE INTERVALS
STN-4-7S	460.8'	27.0'	15.0'-25.0'	2.0'-4.0' 5.0'-7.0' 10.0'-12.0' 15.0'-17.0' 20.0'-22.0' 25.0'-27.0'
STN-4-8S	421.6'	20.0'	10.0'-20.0'	No Samples

200 250 300

SECTION C-C'

RECORD DRAWING

For Supporting Design Calculations see FPOCOFFESCOX0000002010001

Stantec Consulting Services Inc.

SCALE: 1"=5' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION
STABILITY SECTION C-C'

P. COOPER

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

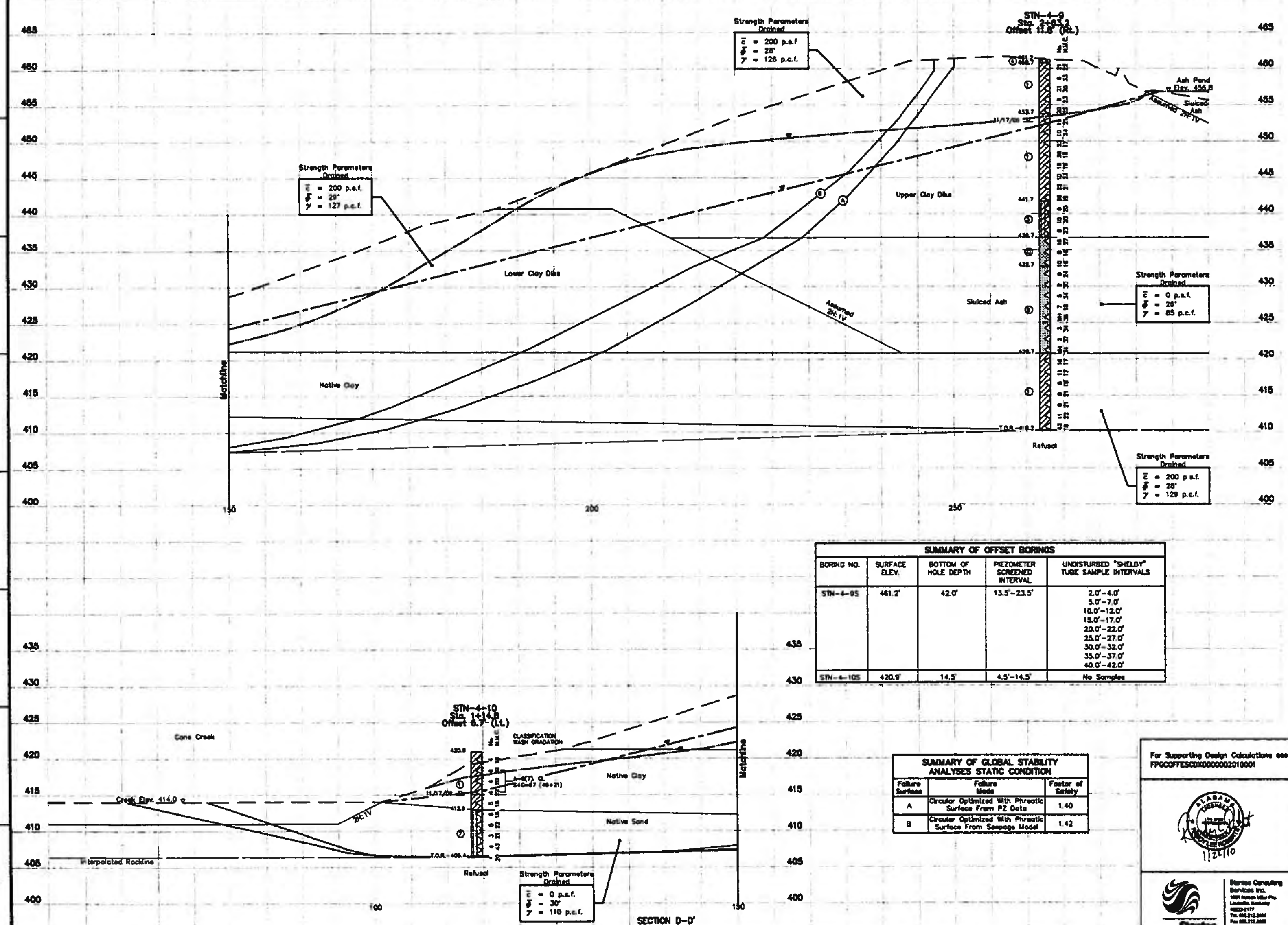
AUTOCAD R 2000 | 37 | C | 10W706-05 | R 0

PLOT FACTOR: XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY | REV NO.

37 C 10W706-05



LEGEND

①	Lean Clay, Sandy Lean Clay, Lean Clay with Sand
②	Silty, Clayey Sand
③	Fat Clay, Fat Clay with Sand
④	Overburden
⑤	Silty Clay
⑥	Poorly Graded Sand
⑦	Silty Sand
⑧	Silt, Sandy Silt, Silt with Sand
	Limestone
⑨	Fly Ash
⑩	Bottom Ash
WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
■	Undisturbed Thin-Walled (Shelby) Tube Sample
N	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09	Piezometer Water Level Reading and Date Recorded
	Phreatic Surface from PZ Data
	Phreatic Surface from Seepage Model
T.O.R.-	Top of Rock (Indicates the beginning of rock-like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
B.C.-	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal using a carbide-tipped tooth auger bit
No Refusal	No Refusal Encountered
•	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer to typed boring log.

NOTE:

The geotechnical information and data furnished herein are not intended as representation or warranties but are furnished for information only. It shall be distinctly understood that the Owner or Engineer will not be responsible for any deduction, interpretation or conclusion drawn therefrom. The information is made available in order that the Contractor may have ready access to the same information available to the Owner and the Engineer and is not part of this contract.

SUMMARY OF OFFSET BORINGS

BORING NO.	SURFACE ELEV.	BOTTOM OF HOLE DEPTH	PIEZOMETER SCREENED INTERVAL	UNDISTURBED "SHELBY" TUBE SAMPLE INTERVALS
STN-4-9S	461.2'	42.0'	13.5'-23.5'	2.0'-4.0' 5.0'-7.0' 10.0'-12.0' 15.0'-17.0' 20.0'-22.0' 25.0'-27.0' 30.0'-32.0' 35.0'-37.0' 40.0'-42.0'
STN-4-10S	420.9'	14.5'	4.5'-14.5'	No Samples

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION

Failure Surface	Failure Mode	Factor of Safety
A	Circular Optimized With Phreatic Surface From PZ Data	1.40
B	Circular Optimized With Phreatic Surface From Seepage Model	1.42

RECORD DRAWING

For Supporting Design Calculations see FPGCOFFESCDX000000002010001

1/22/10

SCALE: 1"=5' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION
STABILITY SECTION D-D'

Stantec Consulting Services Inc.

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

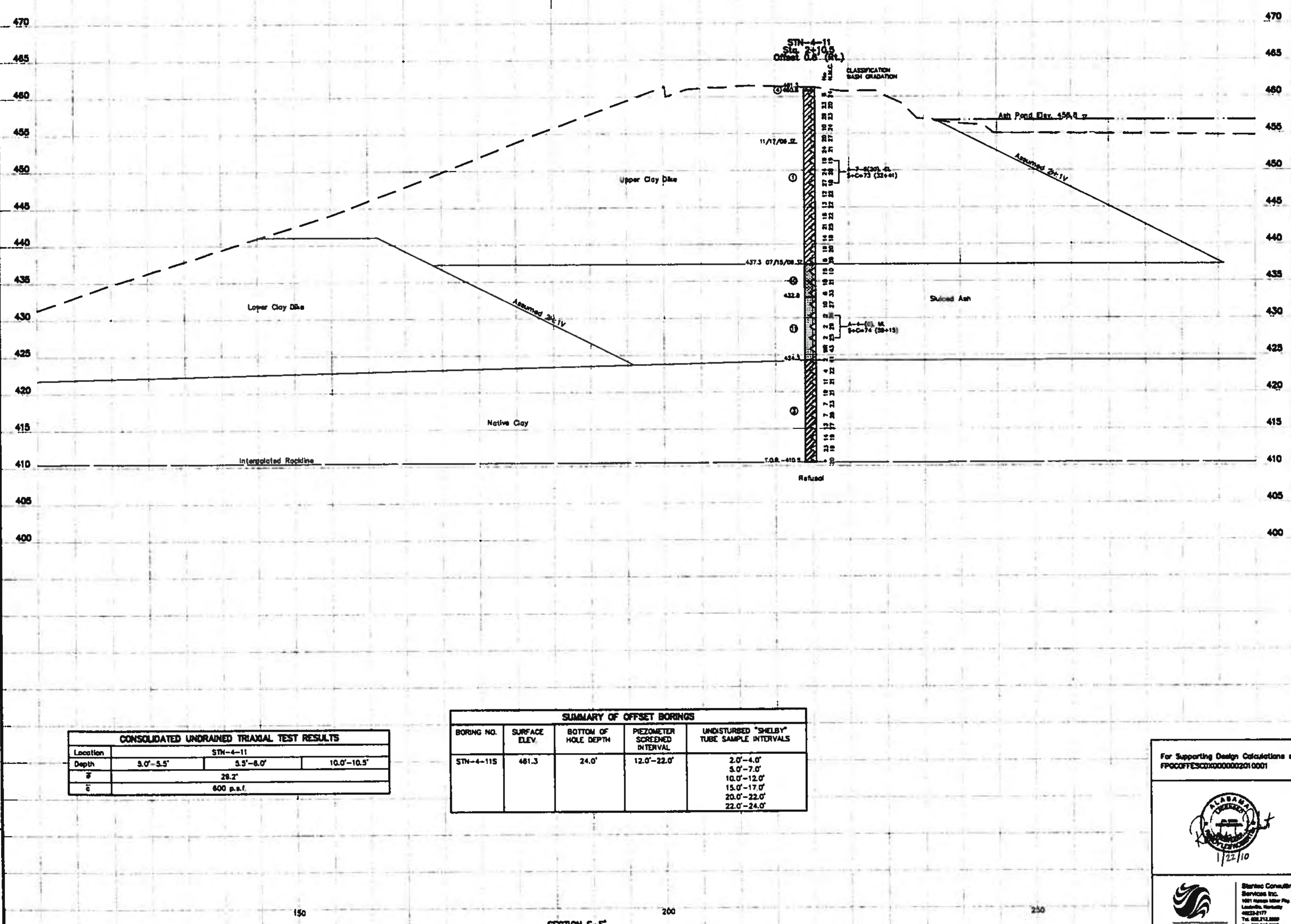
AUTOCAD R 2000 | 37 | C | 10W706-06 | R 0

PLOT FACTOR: XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC	0
TASK COMPLETED BY:	REV NO.

37 C 10W706-06



LEGEND

1. Lean Clay, Sandy Lean Clay, Lean Clay with Sand
2. Silty, Clayey Sand
3. Fat Clay, Fat Clay with Sand
4. Overburden
5. Silty Clay
6. Poorly Graded Sand
7. Silty Sand
8. Silt, Sandy Silt, Silt with Sand
- Limestone
9. Fly Ash
10. Bottom Ash

- WH — Weight of Hammer
- WR — Weight of Rods
- ◁ — Standard Penetration Test Interval
- ▪ — Undisturbed Thin-Walled (Shelby) Tube Sample
- N_{60} — Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
- N_{60} — Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
- N.M.C. — Natural Moisture Content (%)
- U.W.W. — Unit Weight Wet (lbs./cu.ft.)
- U.W.D. — Unit Weight Dry (lbs./cu.ft.)
- U.C./U.U. — Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
- 03/31/09 — Piezometer Water Level Reading and Date Recorded
- T.O.R.- — Top of Rock (indicates the beginning of rock-like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
- B.C.- — Begin Rock Core
- R.Q.D. — Rock Quality Designation (%)
- REC. — Recovery (%)
- Refusal — Auger Refusal using a carbide-tipped tooth auger bit
- No Refusal — No Refusal Encountered
- • — Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer to typed boring log.

NOTE:

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CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Location	STN-4-11		
Depth	5.0'-5.5'	5.5'-6.0'	10.0'-10.5'
$\bar{\phi}$	29.2°		
$\bar{c}$	600 p.s.f.		

SUMMARY OF OFFSET BORINGS

BORING NO.	SURFACE ELEV.	BOTTOM OF HOLE DEPTH	PIEZOMETER SCREENED INTERVAL	UNDISTURBED "SHELBY" TUBE SAMPLE INTERVALS
STN-4-11S	481.3	24.0'	12.0'-22.0'	2.0'-4.0' 5.0'-7.0' 10.0'-12.0' 15.0'-17.0' 20.0'-22.0' 22.0'-24.0'

RECORD DRAWING

For Supporting Design Calculations see FPGCOFFESC0X0000002010001

1/22/10

Stantec Consulting Services Inc.

SCALE: 1"=5' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION
STABILITY SECTION E-E'

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

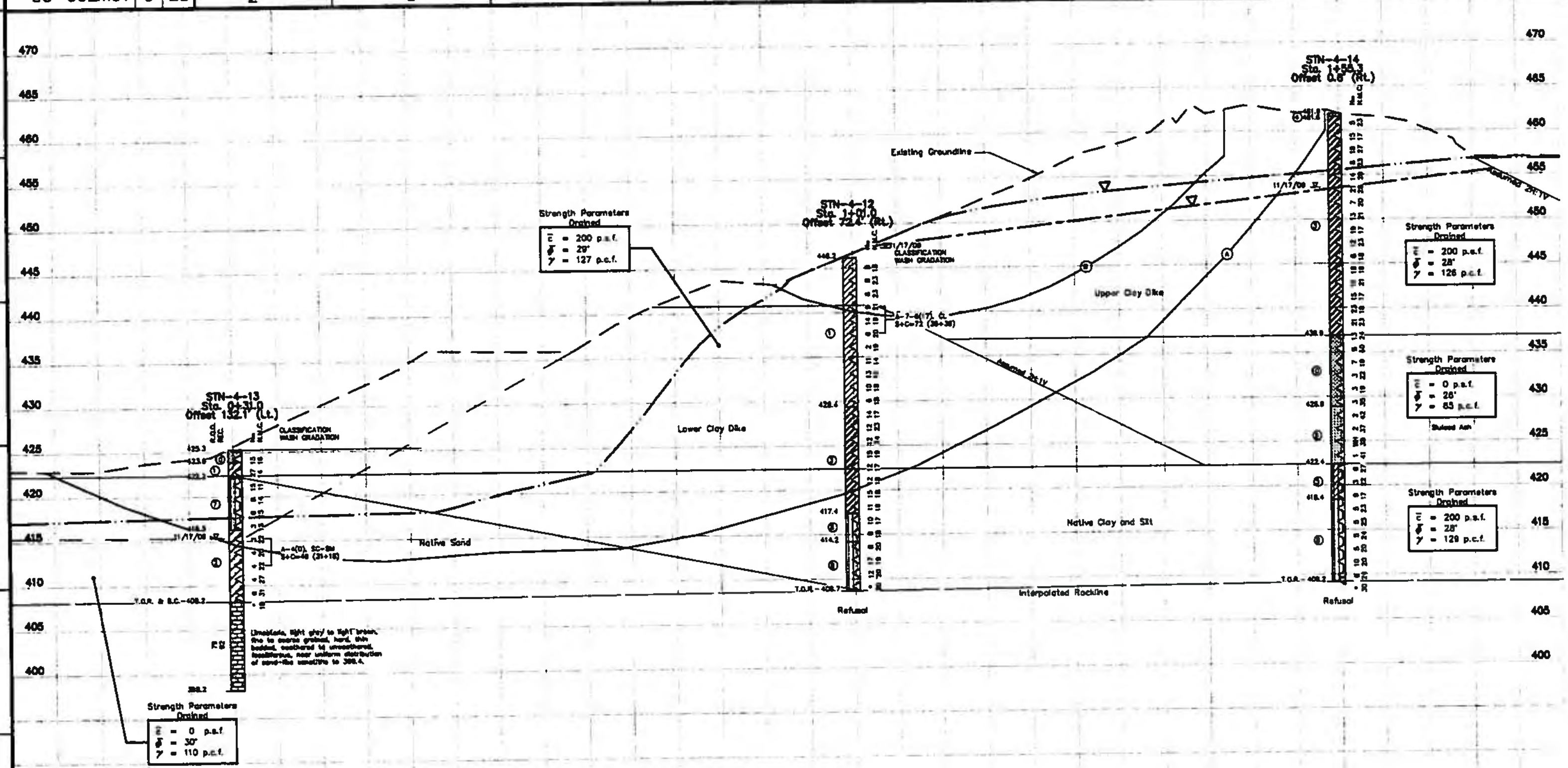
AUTOCAD R 2000 | 37 | C | 10W706-07 | R 0

STANTEC | 0

PLOT FACTOR: XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

37 C 10W706-07



LEGEND

①	Lean Clay, Sandy Lean Clay, Lean Clay with Sand
②	Silty, Clayey Sand
③	Fat Clay, Fat Clay with Sand
④	Overburden
⑤	Silty Clay
⑥	Poorly Graded Sand
⑦	Silty Sand
⑧	Silt, Sandy Silt, Silt with Sand
	Limestone
⑨	Fly Ash
⑩	Bottom Ash
WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
■	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{SH}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{AH}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09	Piezometer Water Level Reading and Date Recorded
	Phreatic Surface from PZ Data
	Phreatic Surface from Seepage Model
T.O.R.-	Top of Rock (indicates the beginning of rock-like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
B.C.-	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal using a carbide-tipped tooth auger bit
No Refusal	No Refusal Encountered
*	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer to typed boring log.

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CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Location	STN-4-12		
Depth	8.0'-8.5'	15.0'-15.5'	8.6'-9.1'
$\bar{\phi}$	29.5°		
$\bar{c}$	261 p.s.f.		

SUMMARY OF OFFSET BORINGS

BORING NO	SURFACE ELEV.	BOTTOM OF HOLE DEPTH	PIEZOMETER SCREENED INTERVAL	UNDISTURBED "SHELBY" TUBE SAMPLE INTERVALS
STN-4-12S	446.2'	22.0'	10.0'-20.0'	2.0'-4.0' 5.0'-7.0' 8.0'-10.0' 15.0'-17.0' 20.0'-22.0'
STN-4-13S	425.3'	27.0'	6.0'-16.0'	No Samples
STN-4-14S	461.9'	41.0'	15.0'-25.0'	2.0'-4.0' 5.0'-7.0' 10.0'-12.0' 15.0'-17.0' 20.0'-22.0' 25.0'-27.0' 32.0'-34.0' 35.0'-37.0' 39.0'-41.0'

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION

Failure Surface	Failure Mode	Factor of Safety
A	Circular Optimized With Phreatic Surface From PZ Data	1.49
B	Circular Optimized With Phreatic Surface From Seepage Model	1.77

RECORD DRAWING

For Supporting Design Calculations see FPGCOFFESCDXD000002010001

SCALE: 1"=5' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION
STABILITY SECTION F-F'

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

Stantec Consulting Services Inc.

1/22/10

AUTOCAD R 2000 | 37 | C | 10W706-08 | R 0

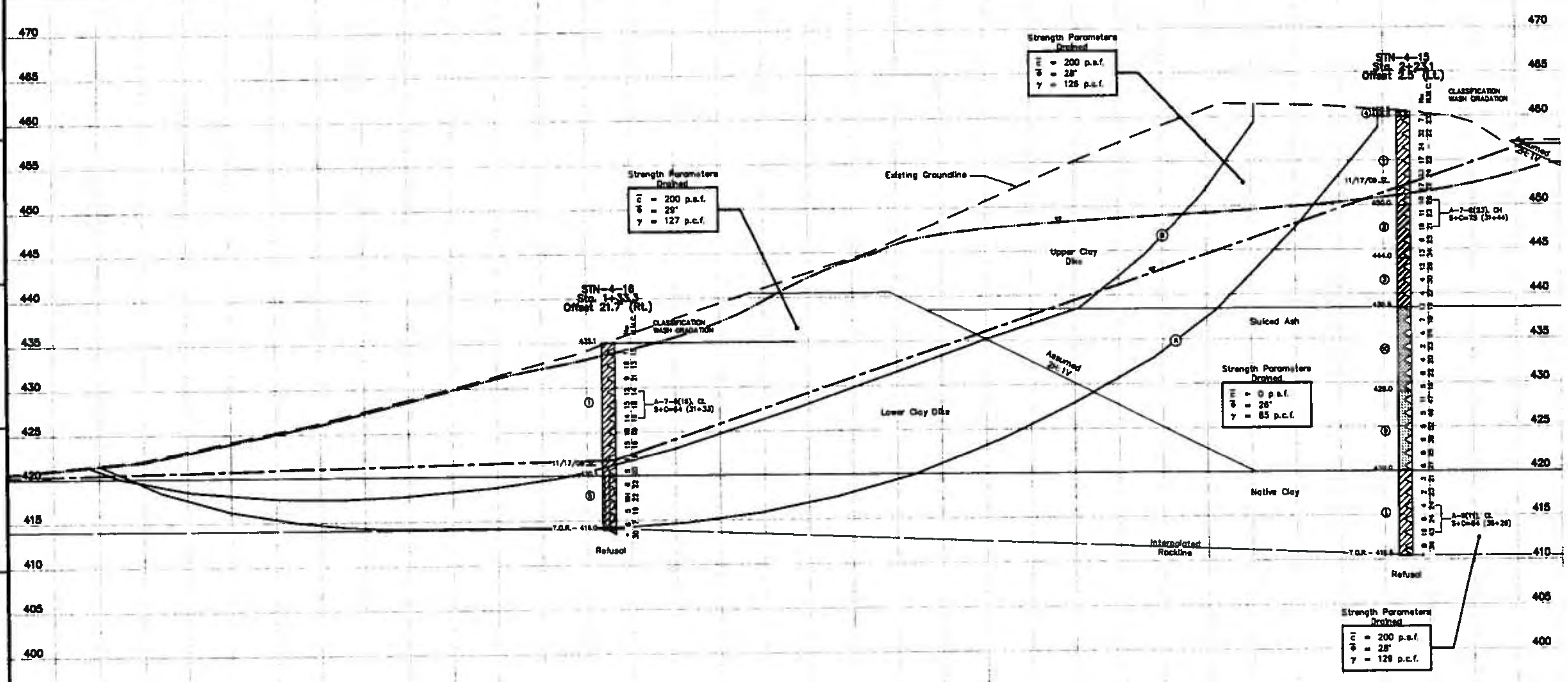
PLOT FACTOR XX

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC	0
TASK COMPLETED BY:	REV NO.

37 C 10W706-08

37 C 10W706-09



LEGEND

- ① Lean Clay, Sandy Lean Clay, Lean Clay with Sand
- ② Silty, Clayey Sand
- ③ Fat Clay, Fat Clay with Sand
- ④ Overburden
- ⑤ Silty Clay
- ⑥ Poorly Graded Sand
- ⑦ Silty Sand
- ⑧ Silt, Sandy Silt, Silt with Sand
- Limestone
- ⑨ Fly Ash
- ⑩ Bottom Ash

WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
●	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09	Piezometer Water Level Reading and Date Recorded
	Phreatic Surface from PZ Data
	Phreatic Surface from Seepage Model
T.O.R. –	Top of Rock (Indicates the beginning of rock-like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
B.C. –	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal using a carbide-tipped tooth auger bit
No Refusal	No Refusal Encountered
*	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer to typed boring log.

NOTE:

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CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Location	STN-4-15		
Depth	5.4'-5.9'	10.1'-10.6'	15.5'-16.1'
φ̄	21.2°		
c̄	701 p.s.f.		
Location	STN-4-18		
Depth	4.0'-4.5'	9.6'-10.1'	4.6'-5.1'
φ̄	29.2°		
c̄	641 p.s.f.		

SUMMARY OF OFFSET BORINGS

BORING NO.	SURFACE ELEV.	BOTTOM OF HOLE DEPTH	PIEZOMETER SCREENED INTERVAL	UNDISTURBED "SHELBY" TUBE SAMPLE INTERVALS
STN-4-15S	460.5'	41.0'	11.0'-21.0'	2.0'-4.0' 5.0'-7.0' 10.0'-12.0' 15.0'-17.0' 20.0'-22.0' 33.0'-35.0' 35.0'-37.0' 39.0'-41.0'
STN-4-18S	435.1'	21.0'	11.0'-21.0'	4.0'-6.0' 9.0'-11.0' 13.5'-15.5'

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION

Failure Surface	Failure Mode	Factor of Safety
A	Circular Optimized With Phreatic Surface From PZ Data	1.95
B	Circular Optimized With Phreatic Surface From Seepage Model	1.50

RECORD DRAWING

For Supporting Design Calculations see FPCCOFFESCDX00000002010001

1/22/10

Stantec Consulting Services Inc.

SCALE: 1"=5' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION STABILITY SECTION G-G'

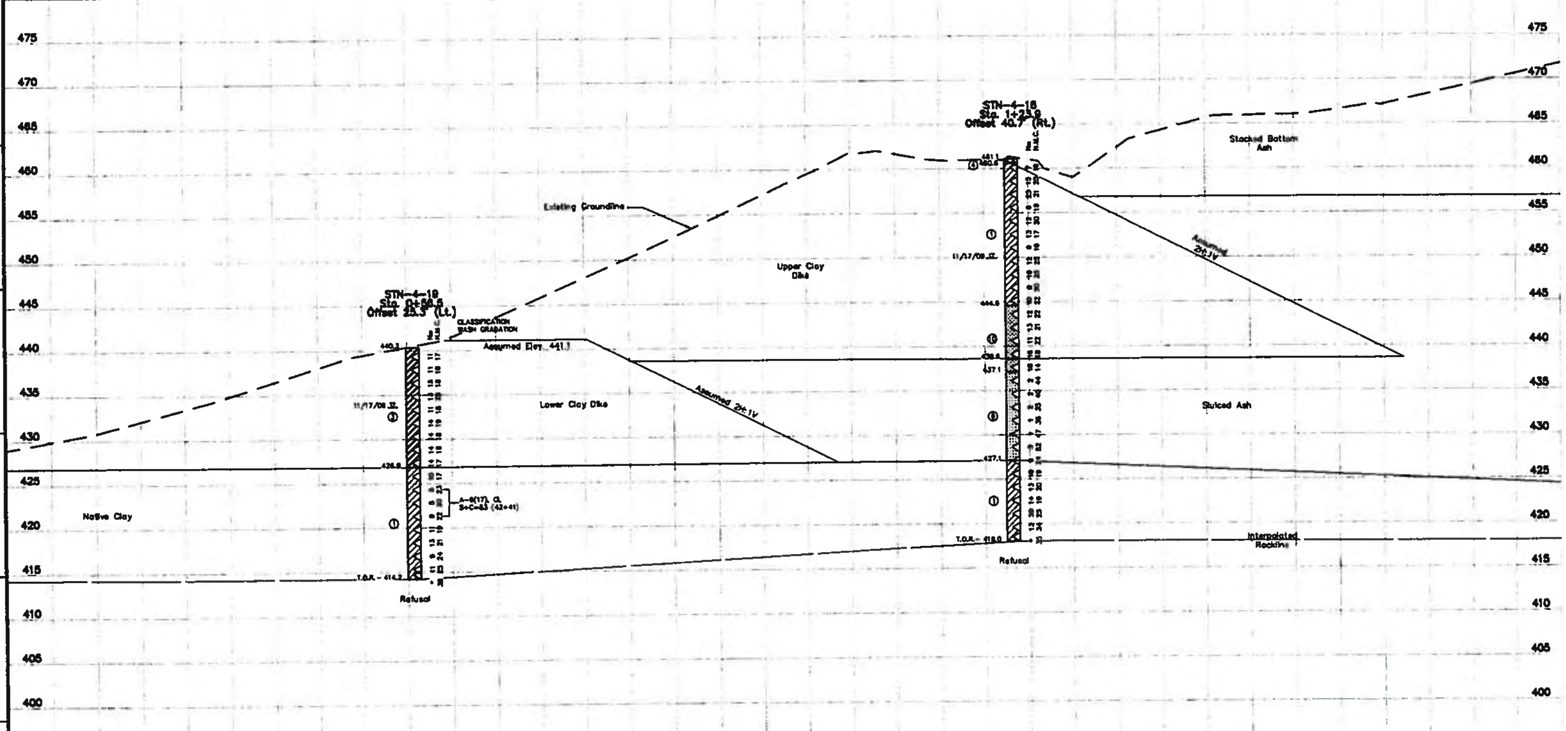
P. COOPER | S. BRADSHAW | P. COOPER | R. ROBERTS | R. ROBERTS | R. ROBERTS | T. JOHNSON

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 01/22/10 | 37 | C | 10W706-09 | R 0

PLOT FACTOR: XX
C.A.D. DRAWING DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY | REV NO.



LEGEND

- ① Lean Clay, Sandy Lean Clay, Lean Clay with Sand
- ② Silty, Clayey Sand
- ③ Fat Clay, Fat Clay with Sand
- ④ Overburden
- ⑤ Silty Clay
- ⑥ Poorly Graded Sand
- ⑦ Silty Sand
- ⑧ Silt, Sandy Silt, Silt with Sand
- Limestone
- ⑨ Fly Ash
- ⑩ Bottom Ash

WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
■	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{ss}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{au}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09.SL	Piezometer Water Level Reading and Date Recorded
T.O.R.-	Top of Rock (Indicates the beginning of rock-like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
B.C.-	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal using a carbide-tipped tooth auger bit
No Refusal	No Refusal Encountered
•	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer to typed boring log.

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CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Location	STN-4-19		
Depth	19.1'-19.6'	14.1'-14.6'	19.7'-20.2'
$\bar{\phi}$	28.2°		
$\bar{c}$	385 p.s.f.		
Location	STN-4-19	STN-4-22	
Depth	14.1'-14.6'	4.0'-4.5'	4.6'-5.1'
$\bar{\phi}$	36.0°		
$\bar{c}$	0 p.s.f.		

SUMMARY OF OFFSET BORINGS

BORING NO.	SURFACE ELEV.	BOTTOM OF HOLE DEPTH	PIEZOMETER SCREENED INTERVAL	UNDISTURBED "SHELBY" TUBE SAMPLE INTERVALS
STN-4-17S	478.8'	22.0'	N/A	2.0'-4.0' 5.0'-7.0' 10.0'-12.0' 15.0'-17.0' 20.0'-22.0'
STN-4-18S	461.1'	41.0'	14.0'-24.0'	2.0'-4.0' 5.0'-7.0' 10.0'-12.0' 15.0'-17.0' 20.0'-22.0' 25.0'-27.0' 39.0'-41.0'
STN-4-19S	440.3'	26.0'	16.0'-26.0'	4.0'-6.0' 9.0'-11.0' 14.0'-16.0' 19.0'-21.0'

RECORD DRAWING

For Supporting Design Calculations see FPGCOFFESCDX000002010001

1/22/10

Stantec Consulting Services Inc.

R 0 01/22/10 PC SB PC SLR RLR RLR TJ
RECORD DRAWING

SCALE: 1"=5' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION STABILITY SECTION H-H'

P. COOPER | S. BRADSHAW | P. COOPER | R. ROBERTS | R. ROBERTS | R. ROBERTS | T. JOHNSON

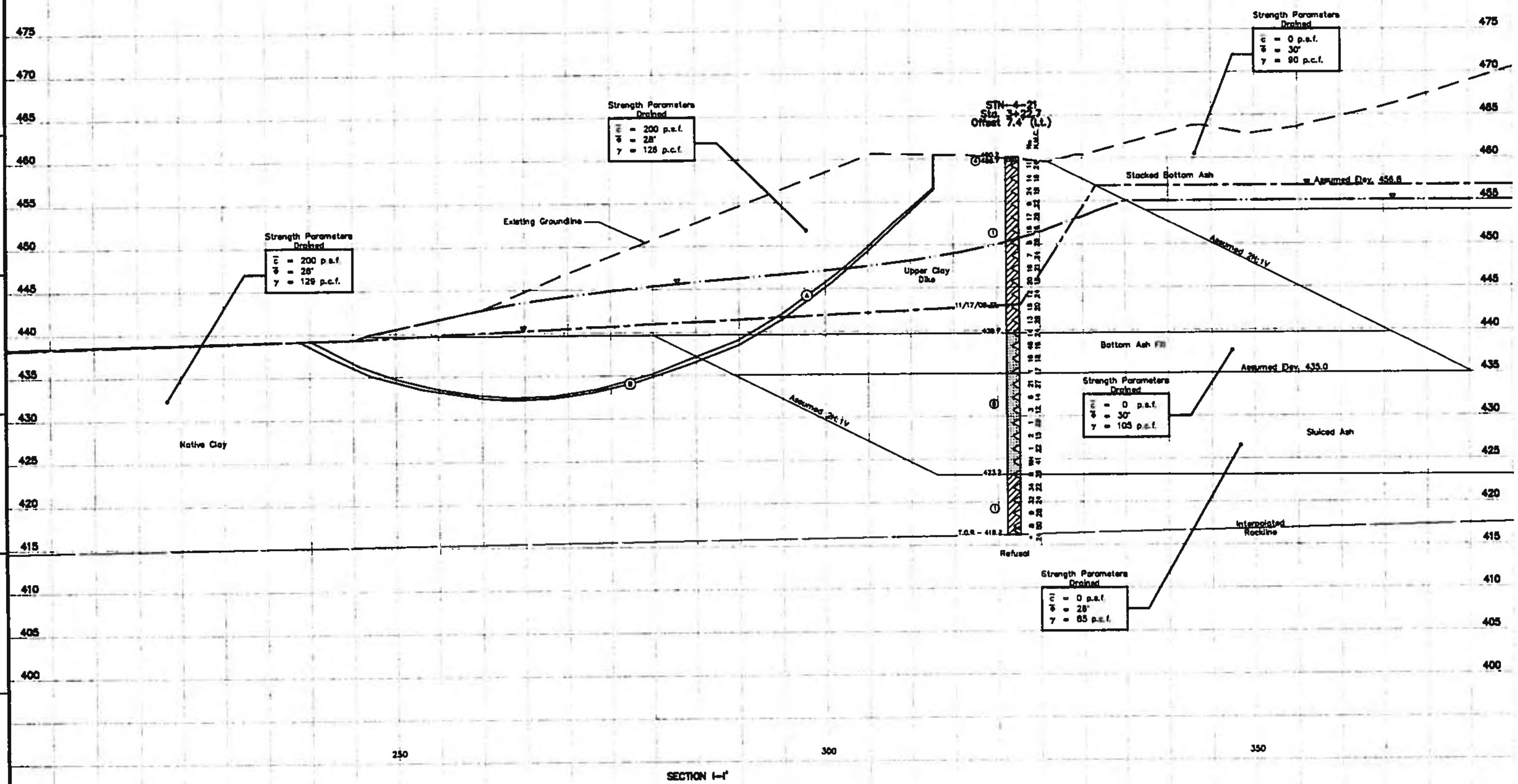
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W706-10 | R 0

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY

STANTEC	0
TASK COMPLETED BY	REV NO.



SECTION I-I'

LEGEND

1. Lean Clay, Sandy Lean Clay, Lean Clay with Sand
2. Silty, Clayey Sand
3. Fat Clay, Fat Clay with Sand
4. Overburden
5. Silty Clay
6. Poorly Graded Sand
7. Silty Sand
8. Silt, Sandy Silt, Silt with Sand
- Limestone
9. Fly Ash
10. Bottom Ash

WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
■	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09	Piezometer Water Level Reading and Date Recorded
	Phreatic Surface from PZ Data
	Phreatic Surface from Seepage Model
T.O.R.-	Top of Rock (Indicates the beginning of rock-like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
B.C.-	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal using a carbide-tipped tooth auger bit
No Refusal	No Refusal Encountered
*	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer to typed boring log.

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RECORD DRAWING

CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Location	STN-4-19	STN-4-22	
Depth	14.1'-14.6'	4.0'-4.5'	4.6'-5.1'
φ̄	36.0°		
c̄	0 p.s.f.		

SUMMARY OF OFFSET BORINGS

BORING NO.	SURFACE ELEV.	BOTTOM OF HOLE DEPTH	PIEZOMETER SCREENED INTERVAL	UNDISTURBED "SHELBY" TUBE SAMPLE INTERVALS
STN-4-20S	482.3'	22.0'	N/A	2.0'-4.0' 5.0'-7.0' 10.0'-12.0' 15.0'-17.0' 20.0'-22.0'
STN-4-21	460.2'	44.0'	10.0'-20.0'	No Samples
STN-4-22S	438.0'	24.0'	14.0'-24.0'	4.0'-6.0' 12.0'-14.0'

SUMMARY OF GLOBAL STABILITY ANALYSES STATIC CONDITION

Failure Surface	Failure Mode	Factor of Safety
A	Circular Optimized With Phreatic Surface From PZ Data	2.19
B	Circular Optimized With Phreatic Surface From Seepage Model	1.92

For Supporting Design Calculations see FPGCOFFESCDX0000002010001

ALABAMA

1/22/10

Stantec Consulting Services Inc.

0 | 01/22/10 | RECORD DRAWING

SCALE: 1"=5' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION
STABILITY SECTION I-I'

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

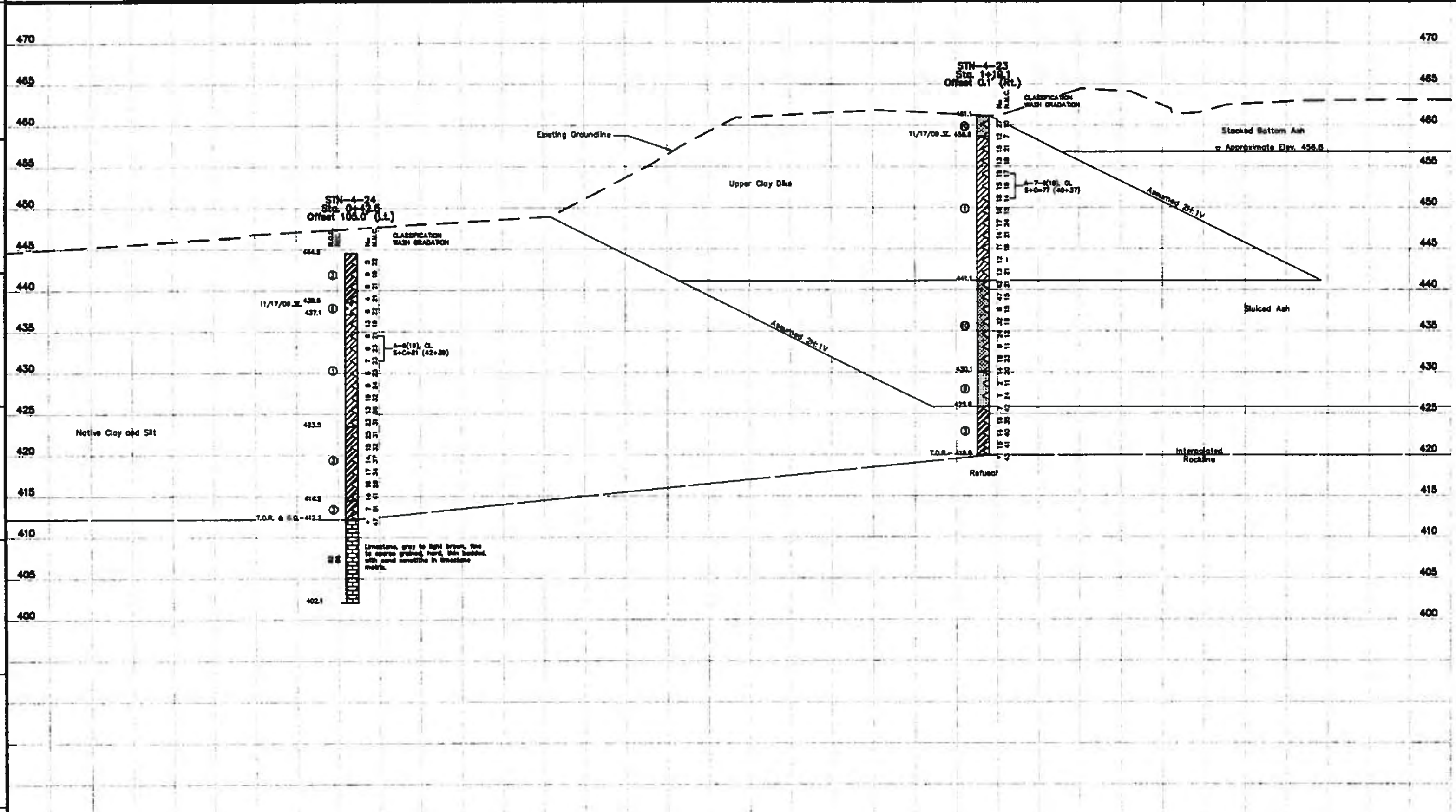
AUTOCAD R 2000 | 37 | C | 10W706-11 | R 0

STANTEC | 0
TASK COMPLETED BY: | REV NO.

PLOT FACTOR: XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

37 C 10W706-11



LEGEND

- ① Lean Clay, Sandy Lean Clay, Lean Clay with Sand
- ② Silty, Clayey Sand
- ③ Fat Clay, Fat Clay with Sand, Sandy Fat Clay
- ④ Overburden
- ⑤ Silty Clay
- ⑥ Poorly Graded Sand
- ⑦ Silty Sand
- ⑧ Silt, Sandy Silt, Silt with Sand
- Limestone
- ⑨ Fly Ash
- ⑩ Bottom Ash

WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
■	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09	Piezometer Water Level Reading and Date Recorded
T.O.R.-	Top of Rock (Indicates the beginning of rock-like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
B.C.-	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal using a carbide-tipped tooth auger bit
No Refusal	No Refusal Encountered
•	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer to typed boring log.

NOTE:

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CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Location	STN-4-23	
Depth	4.1'-4.6'	9.3'-9.8'
$\bar{\phi}$	23.1°	
$\bar{c}$	658 p.s.f.	

SUMMARY OF OFFSET BORINGS

BORING NO.	SURFACE ELEV.	BOTTOM OF HOLE DEPTH	PIEZOMETER SCREENED INTERVAL	UNDISTURBED "SHELBY" TUBE SAMPLE INTERVALS
STN-4-23S	461.1'	17.0'	7.0'-17.0'	4.0'-6.0' 9.0'-11.0'
STN-4-24	444.5'	42.4'	23.0'-33.0'	No Samples

SECTION J-J'

RECORD DRAWING

For Supporting Design Calculations see FPOCOFFESCOX0000002010001

Stantec Consulting Services Inc.

SCALE: 1"=5' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION
STABILITY SECTION J-J'

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W706-12 | R 0

STANTEC | 0
TASK COMPLETED BY: | REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY

Appendix F

Seepage Analyses Results

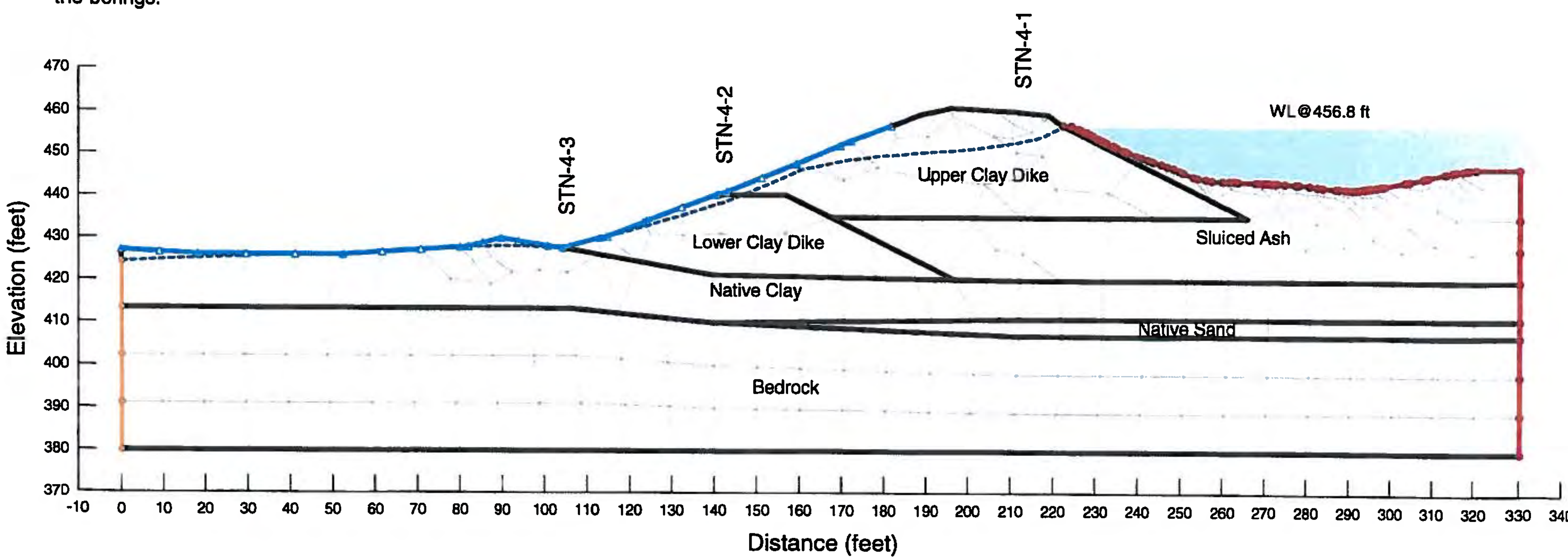
Slope Stability Section A-A'
Ash Pond 4

Boundary Conditions with Mesh

Colbert Fossil Plant
Tennessee Valley Authority

November 2009
Method: Steady-State
File Name: COFAP4_SectionA_seep.gsz

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.



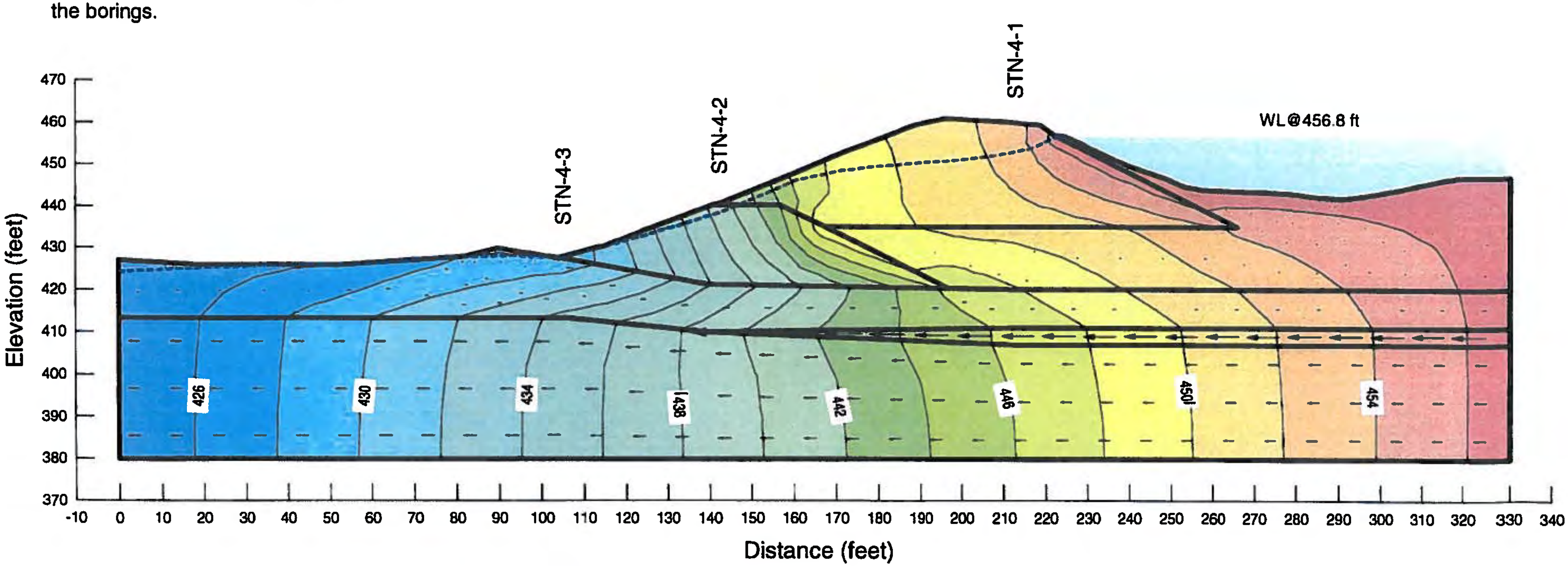
Slope Stability Section A-A'
Ash Pond 4

Total Head with Flow Vectors

Colbert Fossil Plant
Tennessee Valley Authority

November 2009
Method: Steady-State
File Name: COFAP4_SectionA_seep.gsz

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.



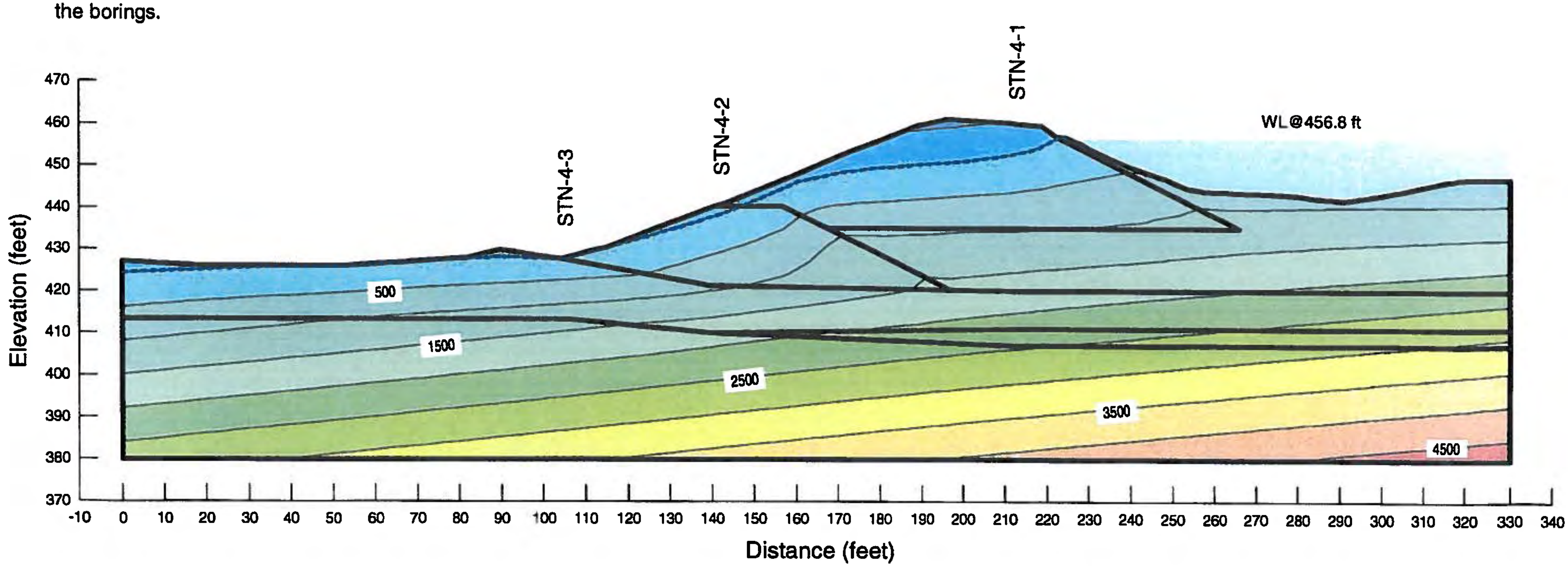
Slope Stability Section A-A'
Ash Pond 4

Pore Water Pressure (psf)

Colbert Fossil Plant
Tennessee Valley Authority

November 2009
Method: Steady-State
File Name: COFAP4_SectionA_seep.gsz

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.



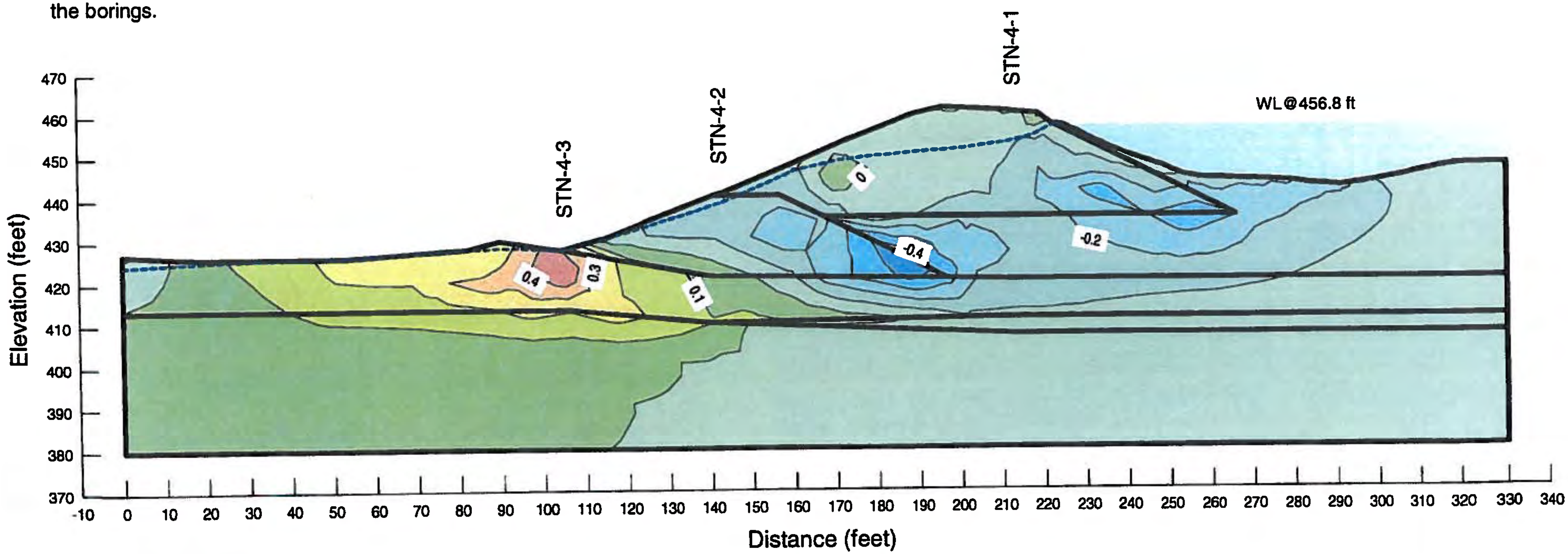
Slope Stability Section A-A'
Ash Pond 4

Vertical Gradient

Colbert Fossil Plant
Tennessee Valley Authority

November 2009
Method: Steady-State
File Name: COFAP4_SectionA_seep.gsz

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.



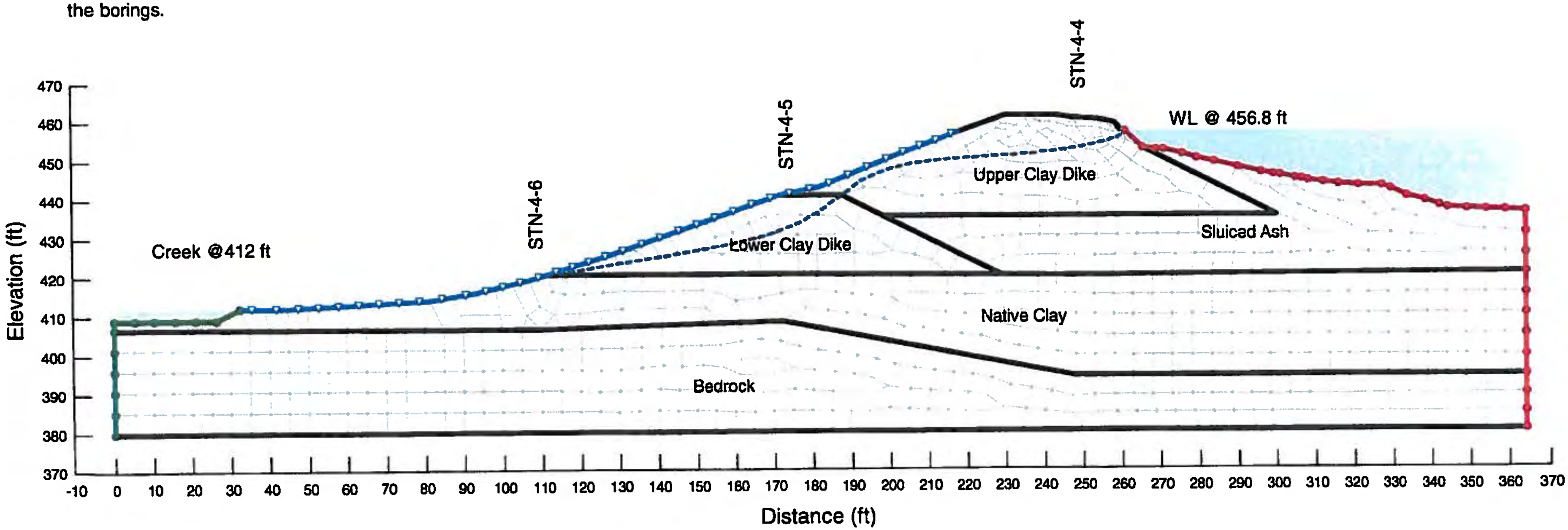
Slope Stability Section B-B'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

Boundary Conditions with Mesh

November 2009
Method: Steady-State
File Name: COFAP4_SectionB_Seep.gsz

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.



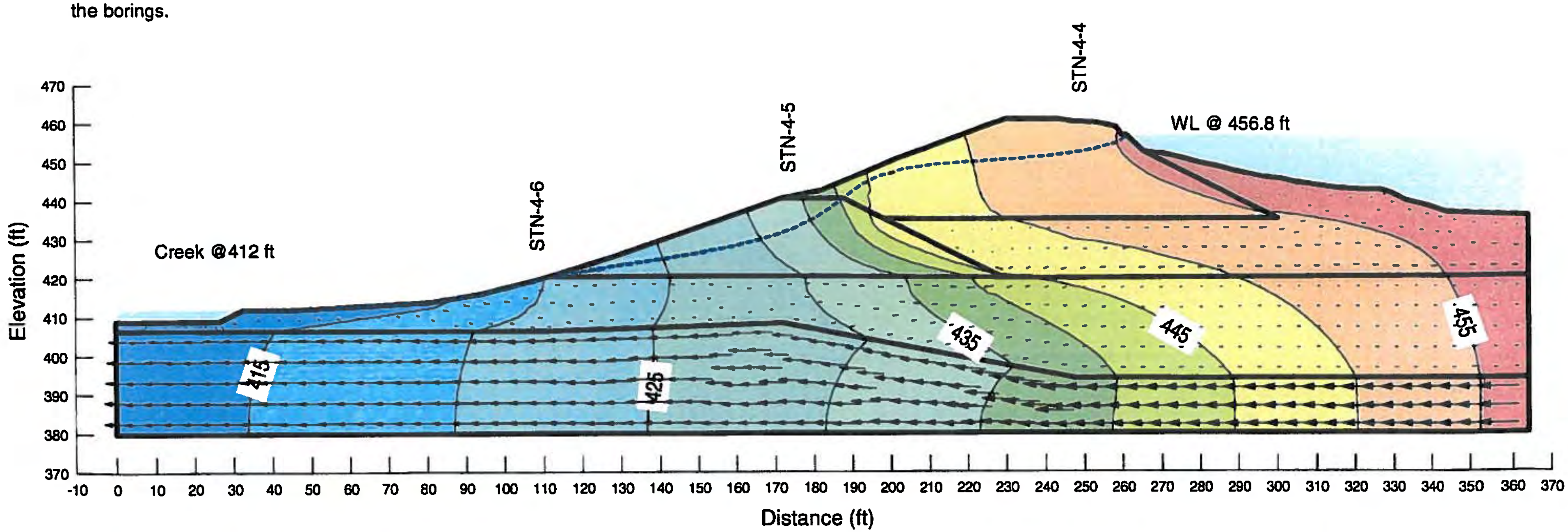
Slope Stability Section B-B'
Ash Pond 4

Total Head with Flow Vectors

Colbert Fossil Plant
Tennessee Valley Authority

November 2009
Method: Steady-State
File Name: COFAP4_SectionB_Seep.gsz

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.



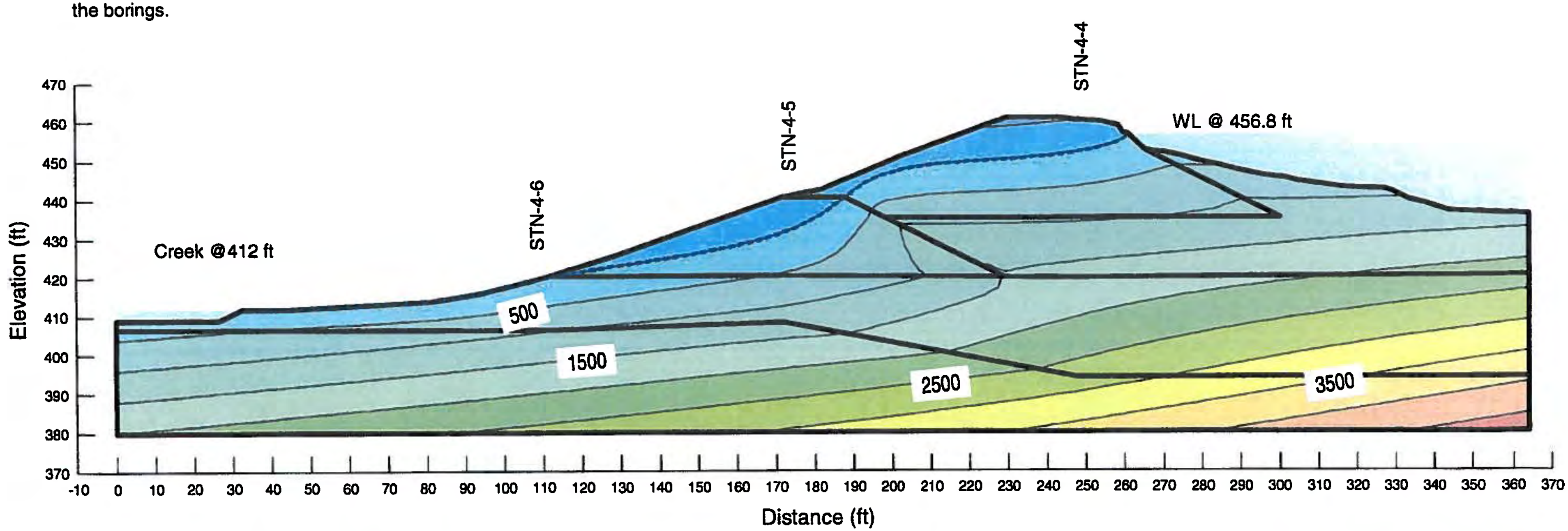
Slope Stability Section B-B'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

Pore Water Pressure (psf)

November 2009
Method: Steady-State
File Name: COFAP4_SectionB_Seep.gsz

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.



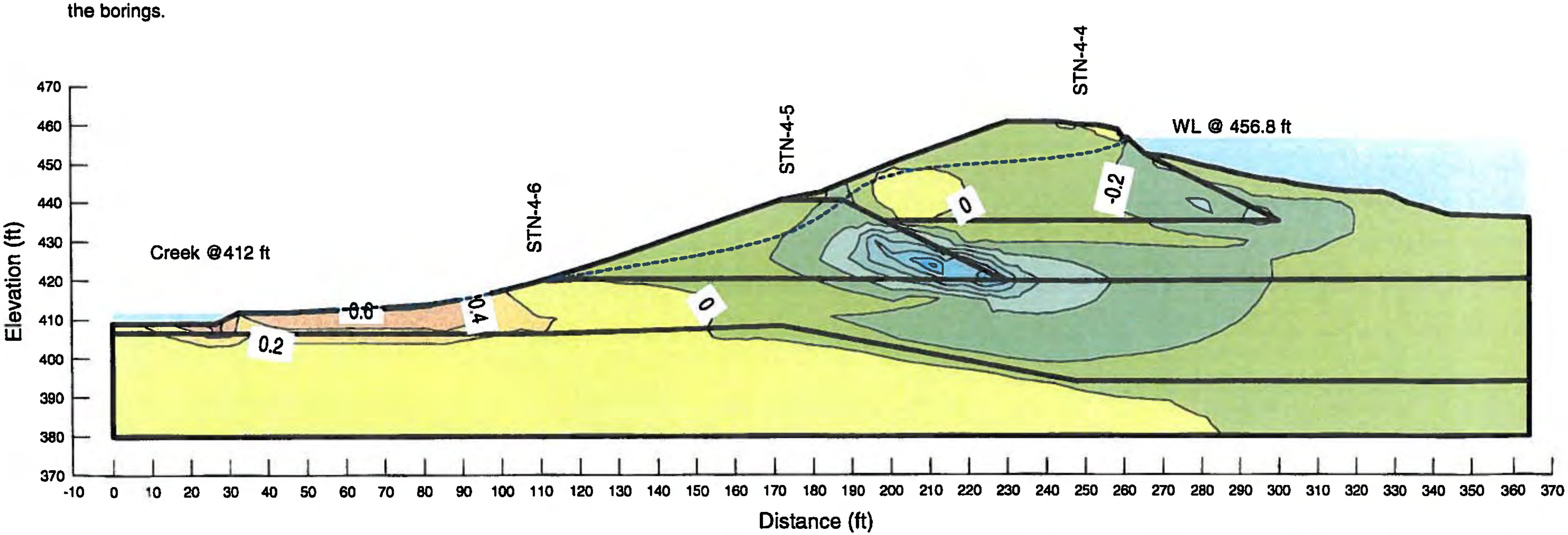
Slope Stability Section B-B'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

Vertical Gradient

November 2009
Method: Steady-State
File Name: COFAP4_SectionB_Seep.gsz

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.



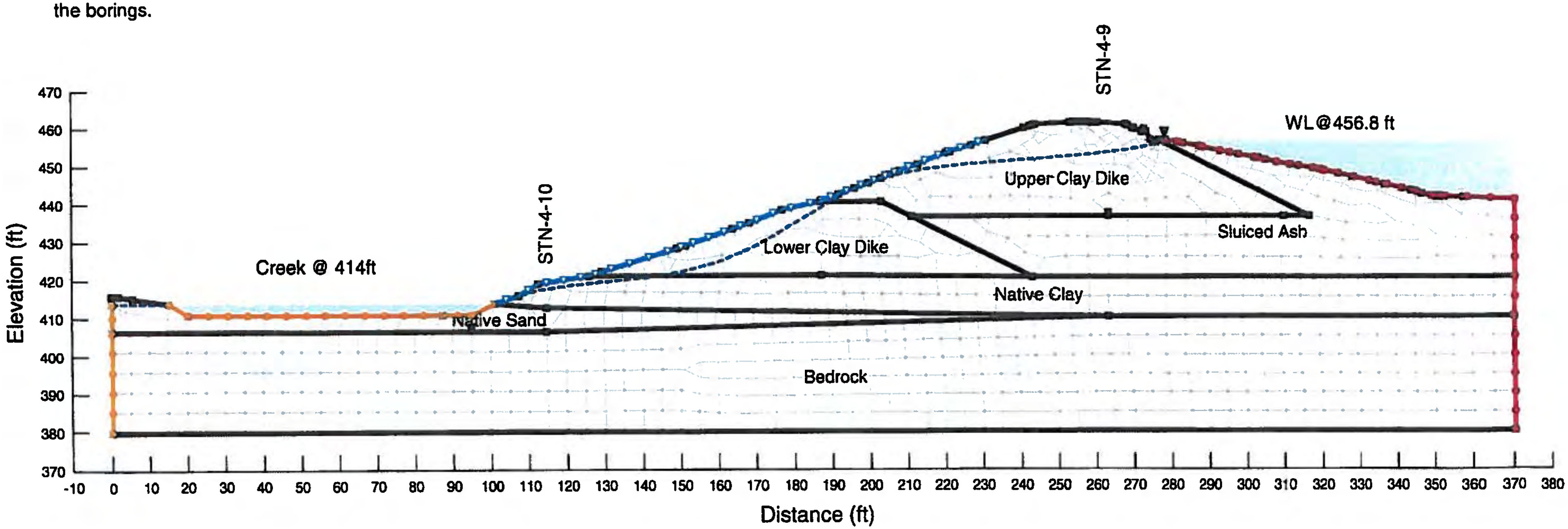
Slope Stability Section D-D'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

Boundary Conditions with Mesh

November 2009
Method: Steady-State
File Name: COFAP4_SectionD_seep.gsz

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.



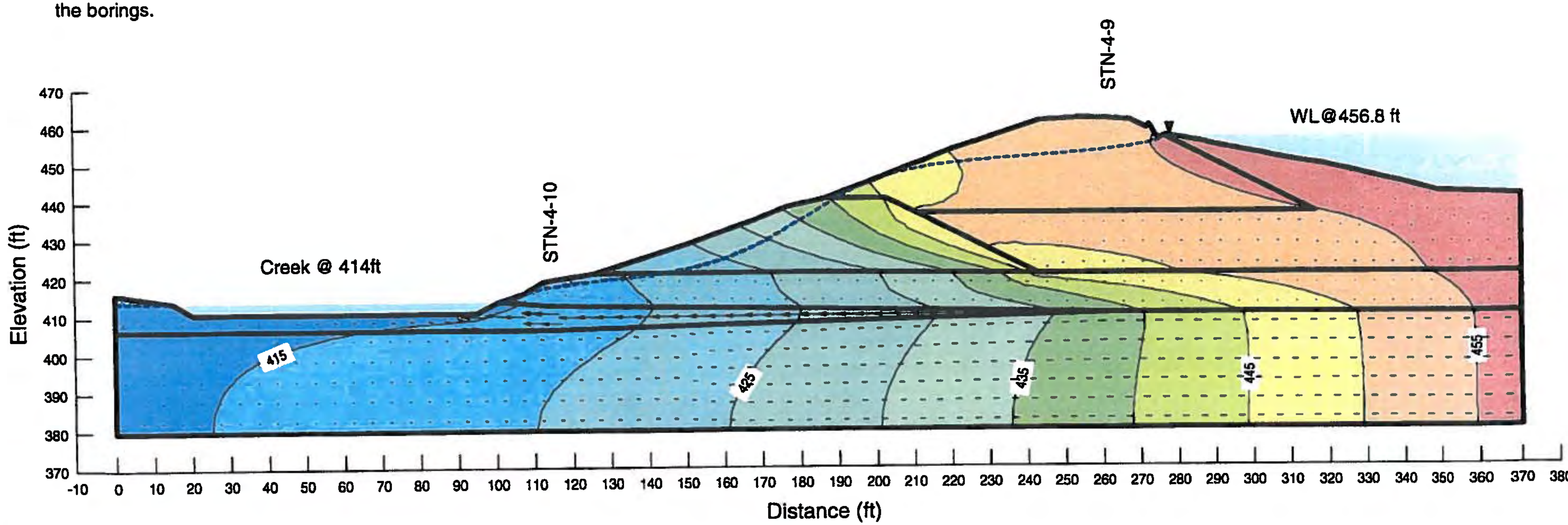
Slope Stability Section D-D'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

Total Head with Flow Vectors

November 2009
Method: Steady-State
File Name: COFAP4_SectionD_seep.gsz

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.



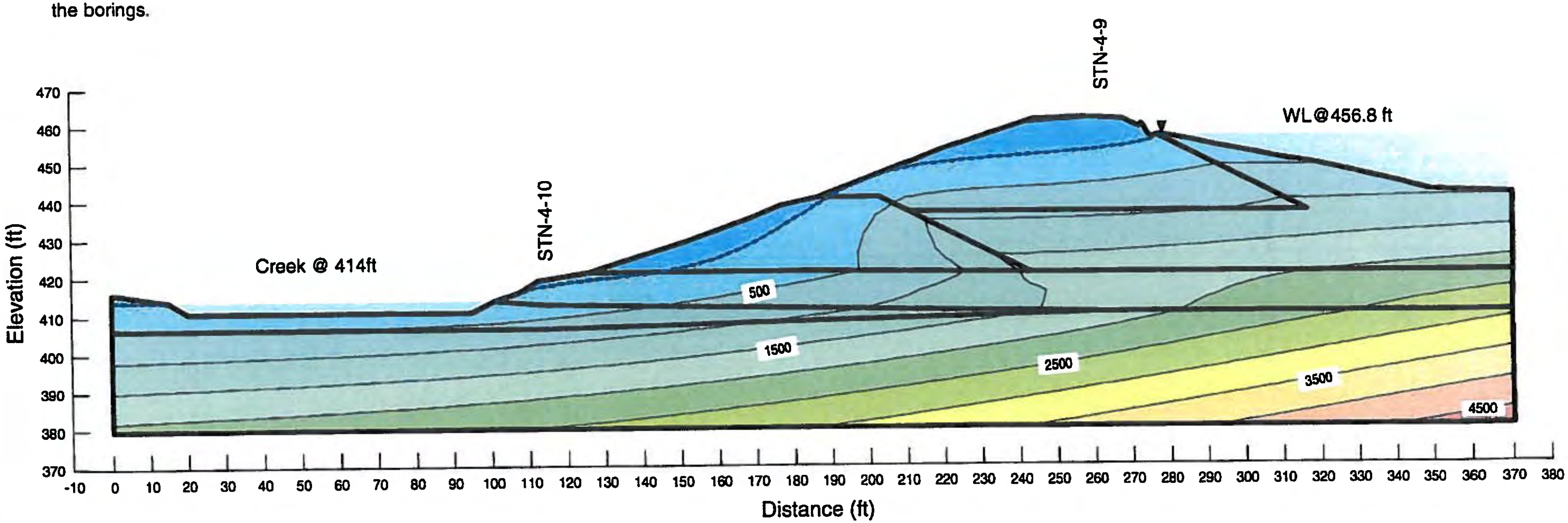
Slope Stability Section D-D'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

November 2009
Method: Steady-State
File Name: COFAP4_SectionD_seep.gsz

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.

Pore Water Pressure (psf)



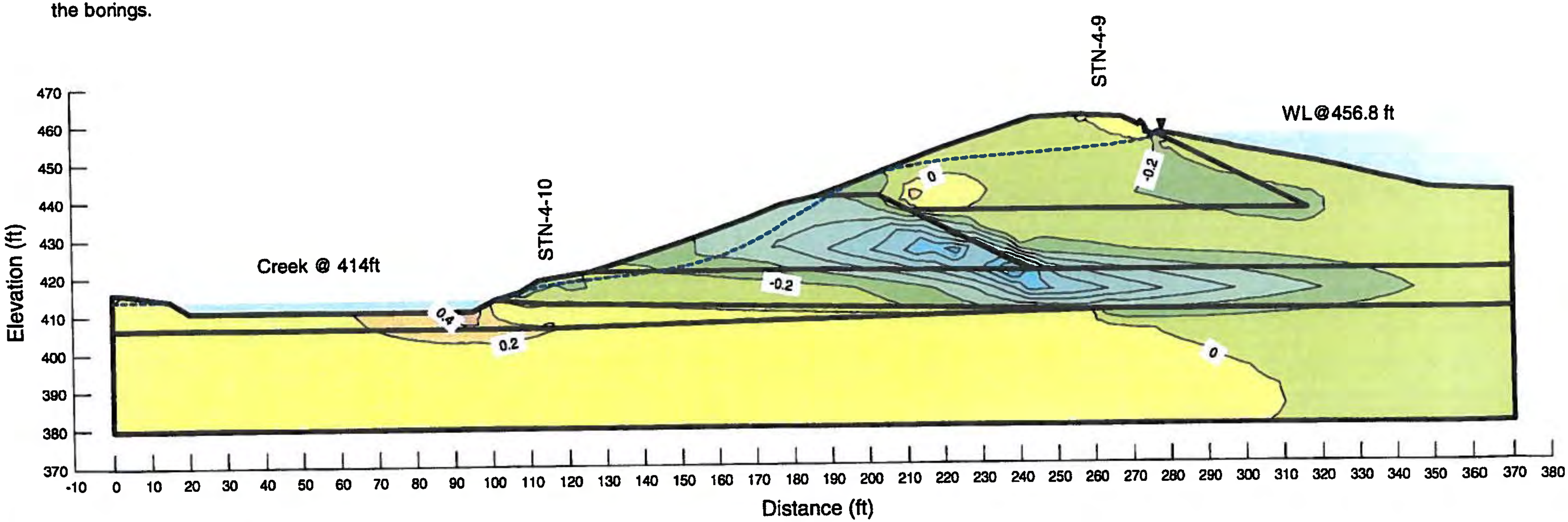
Slope Stability Section D-D'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

Vertical Gradient

November 2009
Method: Steady-State
File Name: COFAP4_SectionD_seep.gsz

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.



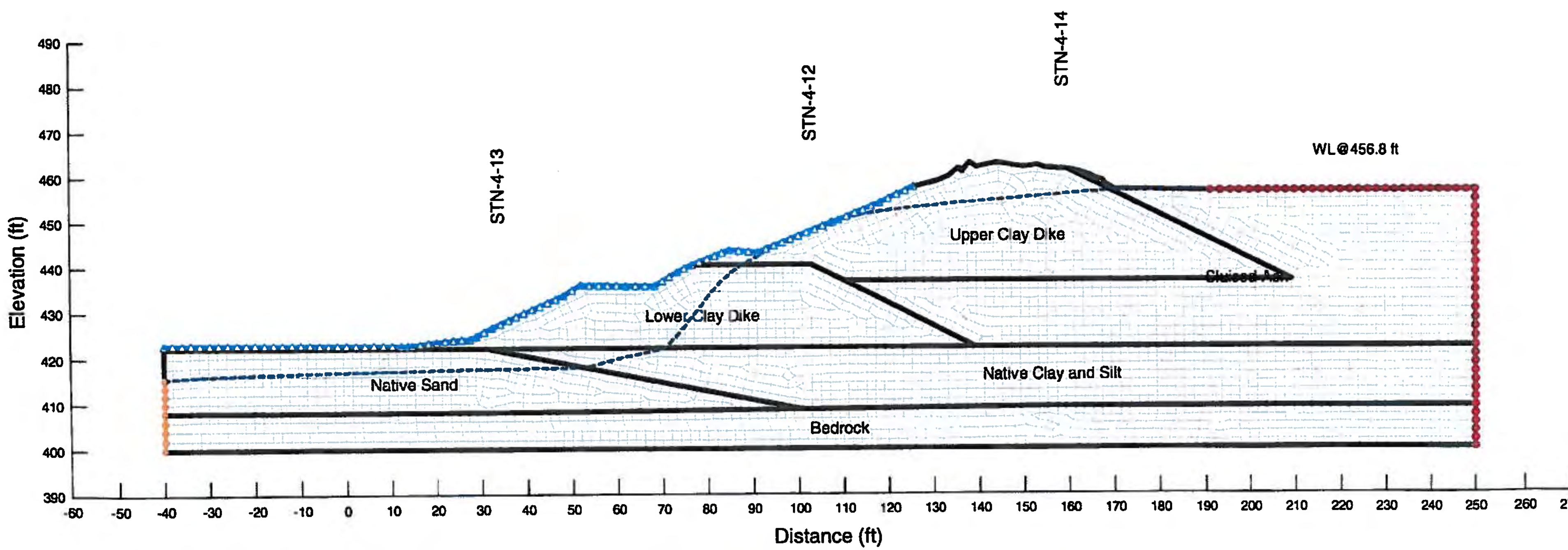
Slope Stability Section F-F'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

Boundary Conditions with Mesh

November 2009
Method: Steady-State
File Name: COFAP4_SEctionF_seep.gsz

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.



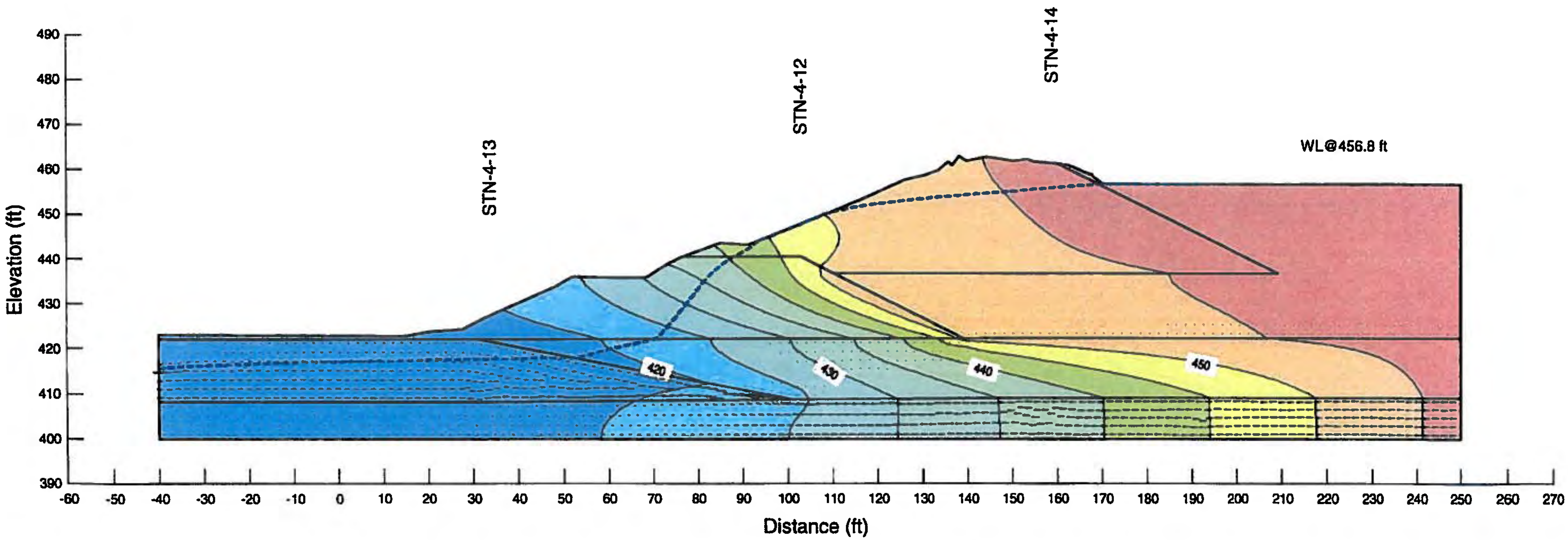
Slope Stability Section F-F'
Ash Pond 4

Total Head with Flow Vectors

Colbert Fossil Plant
Tennessee Valley Authority

November 2009
Method: Steady-State
File Name: COFAP4_SEctionF_seep.gsz

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.



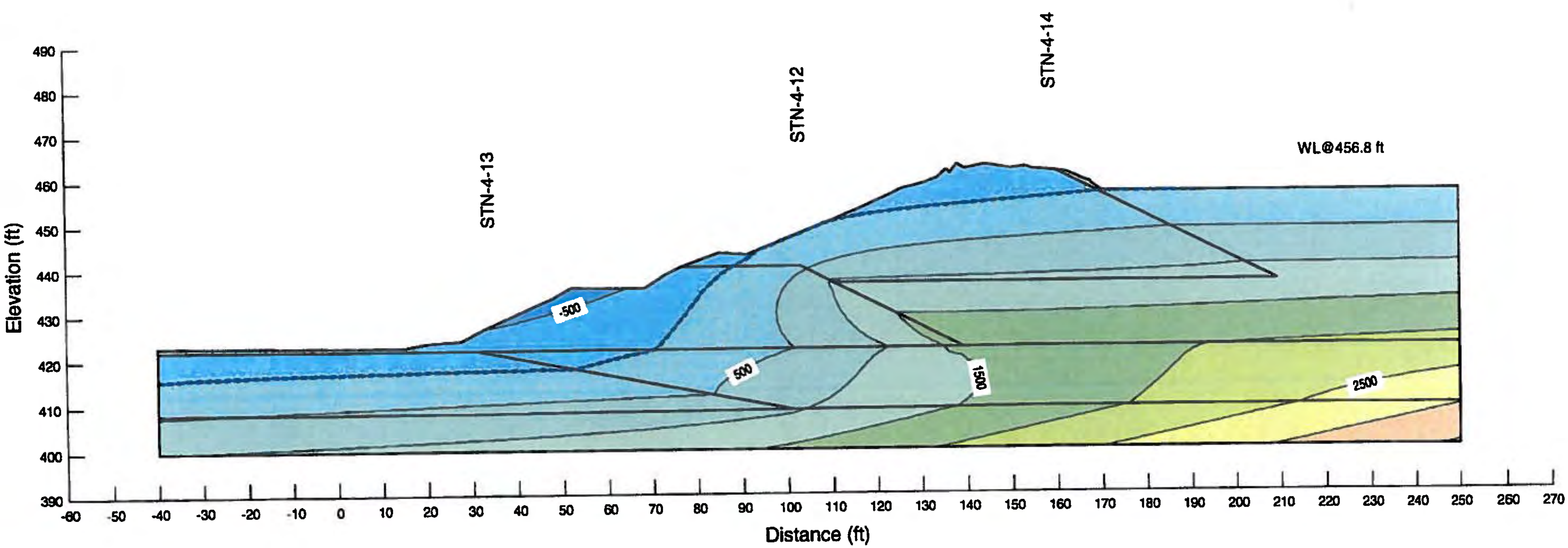
Slope Stability Section F-F'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

November 2009
Method: Steady-State
File Name: COFAP4_SEctionF_seep.gsz

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.

Pore Water Pressure (psf)



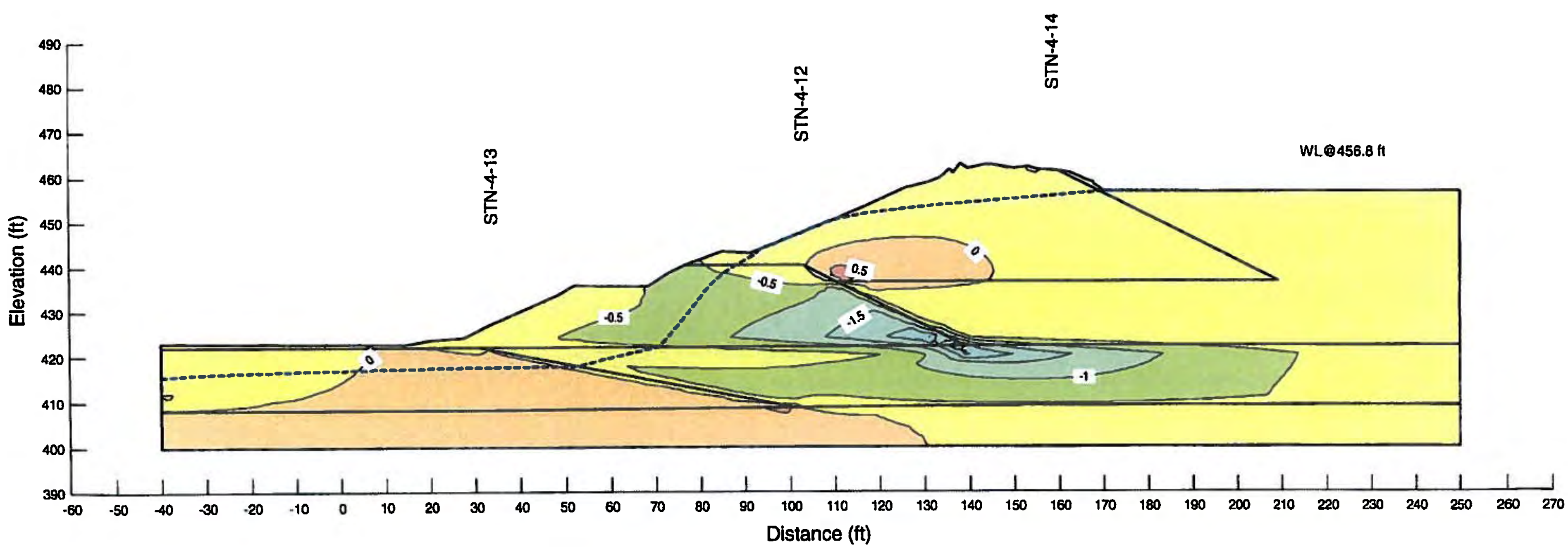
Slope Stability Section F-F'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

Vertical Gradient

November 2009
Method: Steady-State
File Name: COFAP4_SEctionF_seep.gsz

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.



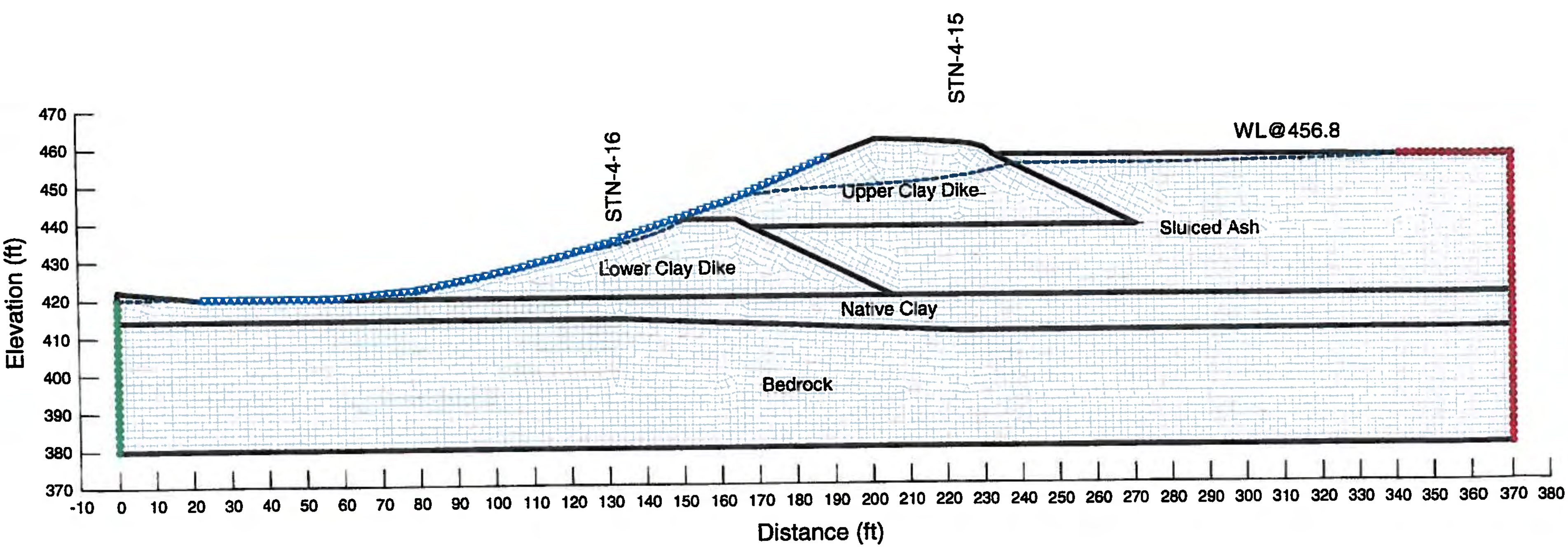
Slope Stability Section G-G'
Ash Pond 4

Boundary Conditions with Mesh

Colbert Fossil Plant
Tennessee Valley Authority

November 2009
Method: Steady-State
File Name: COFAP4_SectionG_seep.gsz

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.



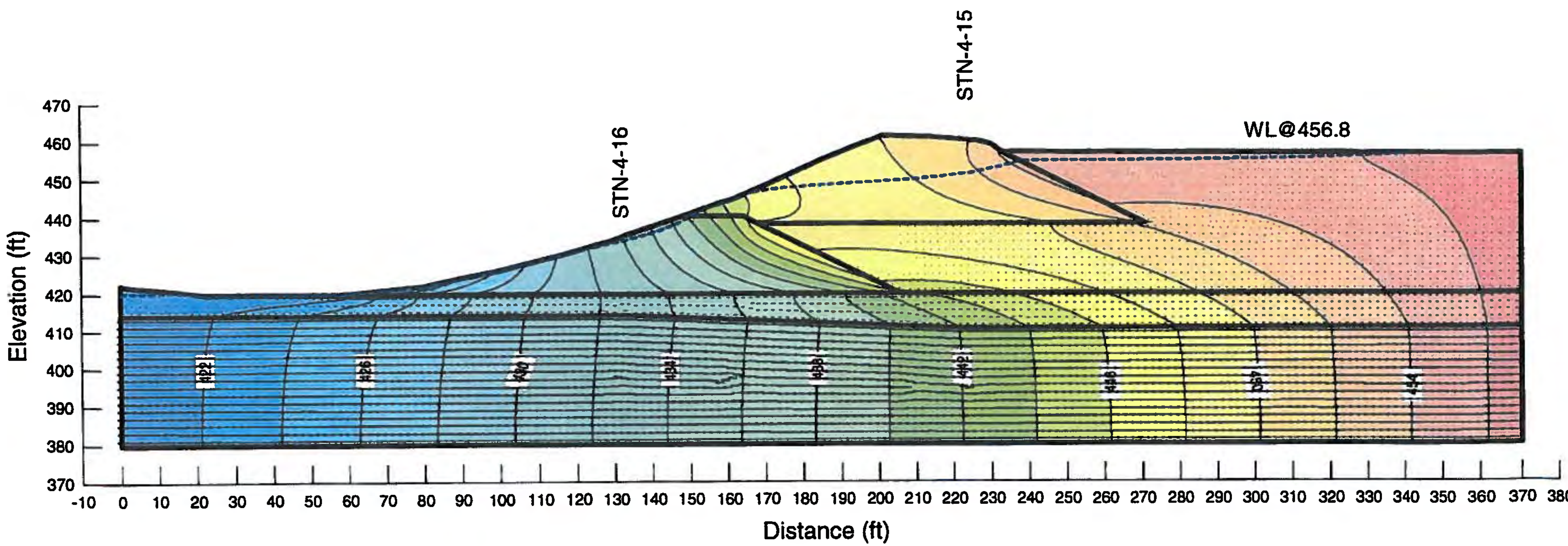
Slope Stability Section G-G'
Ash Pond 4

Total Head with Flow Vectors

Colbert Fossil Plant
Tennessee Valley Authority

November 2009
Method: Steady-State
File Name: COFAP4_SectionG_seep.gsz

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.



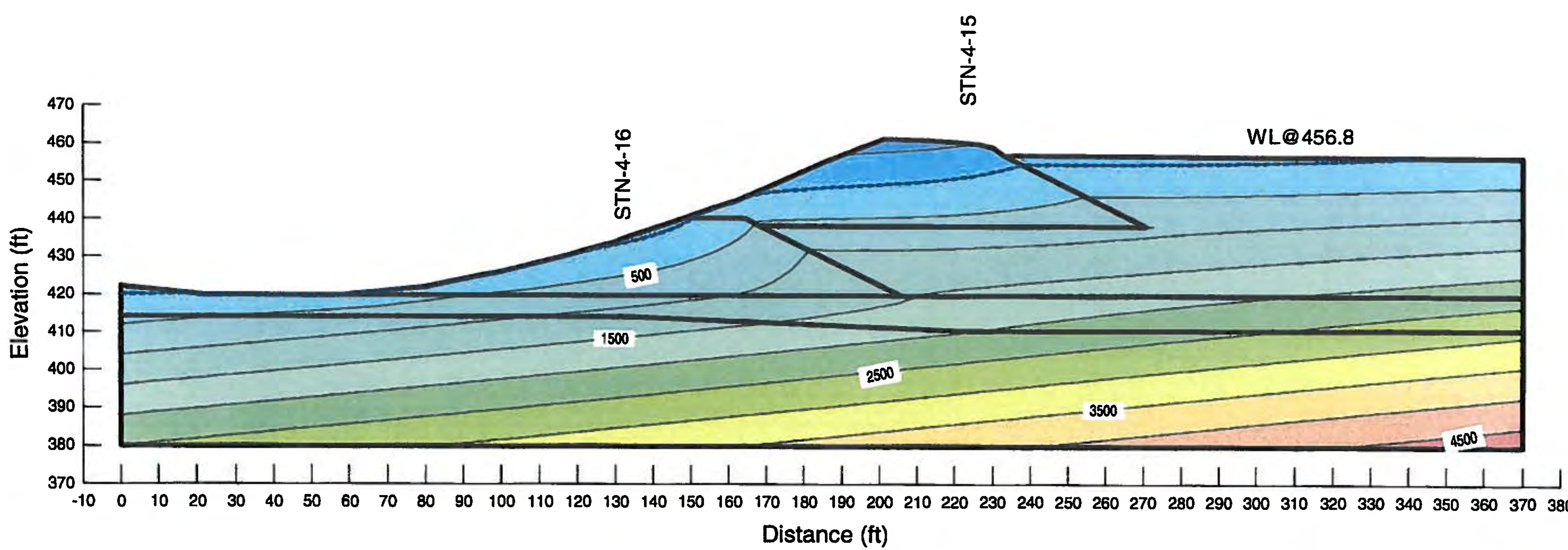
Slope Stability Section G-G'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

Pore Water Pressure (psf)

November 2009
Method: Steady-State
File Name: COFAP4_SectionG_seep.gsz

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.



Slope Stability Section G-G'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

Vertical Gradient

November 2009
Method: Steady-State
File Name: COFAP4_SectionG_seep.gsz

Note:
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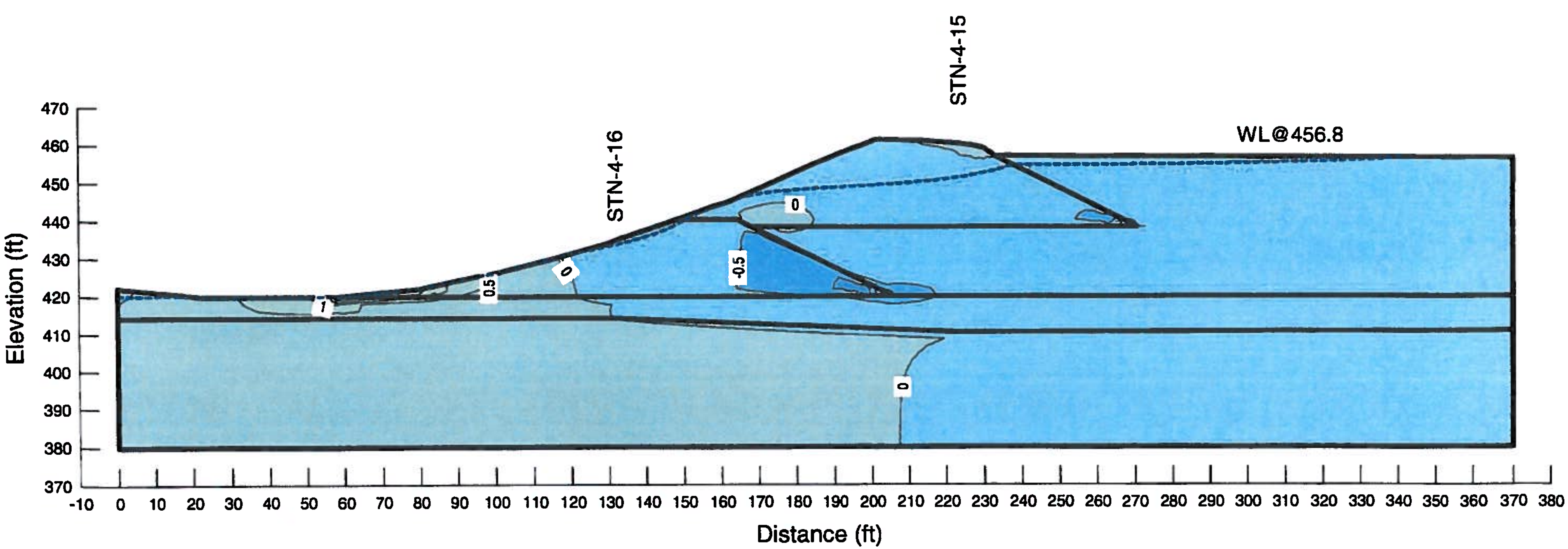


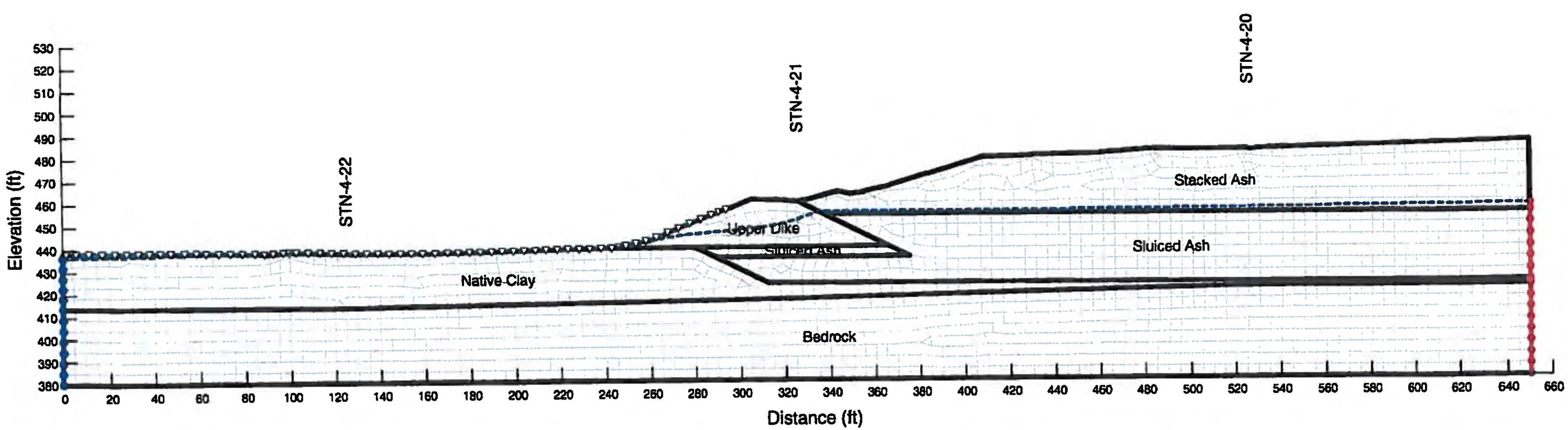
Slope Stability Section I-I'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

Boundary Conditions with Mesh

November 2009
Method: Steady-State
File Name: COFAP4_SectionI_seep.gsz

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.



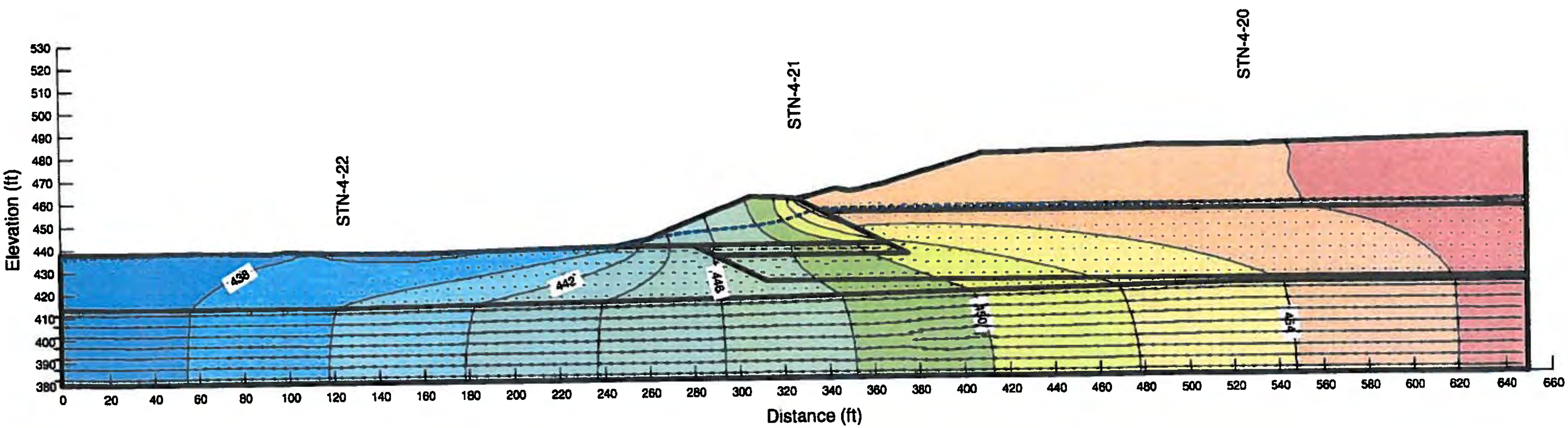
Slope Stability Section I-I'
Ash Pond 4

Total Head with Flow Vectors

Colbert Fossil Plant
Tennessee Valley Authority

November 2009
Method: Steady-State
File Name: COFAP4_SectionI_seep.gsz

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.



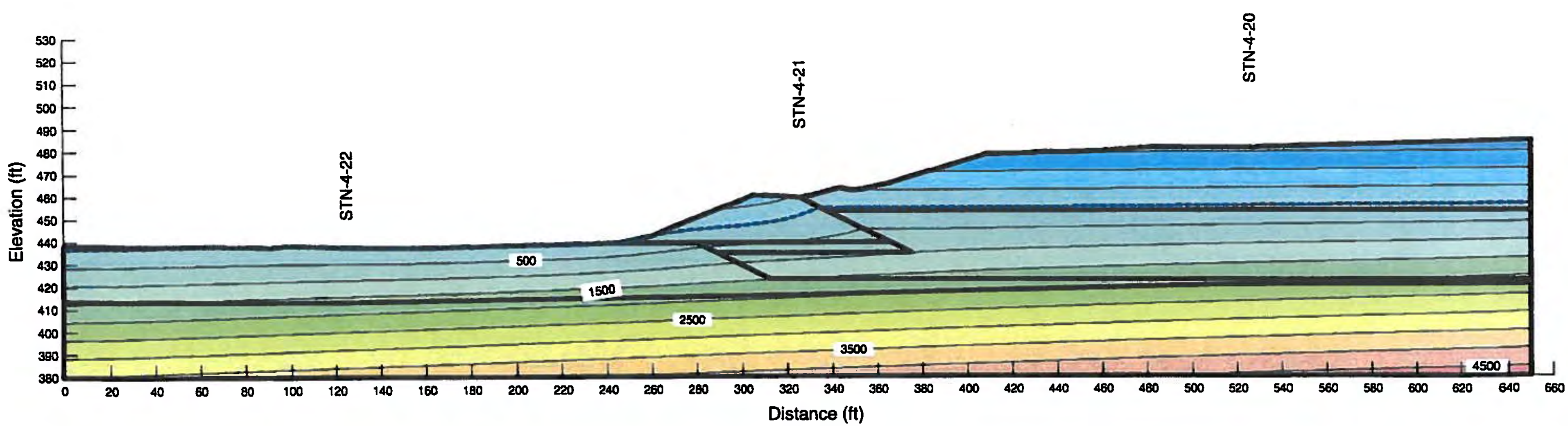
Slope Stability Section I-I'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

Pore Water Pressure (psf)

November 2009
Method: Steady-State
File Name: COFAP4_SectionI_seep.gsz

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.



Slope Stability Section I-I'
Ash Pond 4

Colbert Fossil Plant
Tennessee Valley Authority

Vertical Gradient

November 2009
Method: Steady-State
File Name: COFAP4_SectionI_seep.gsz

Note:
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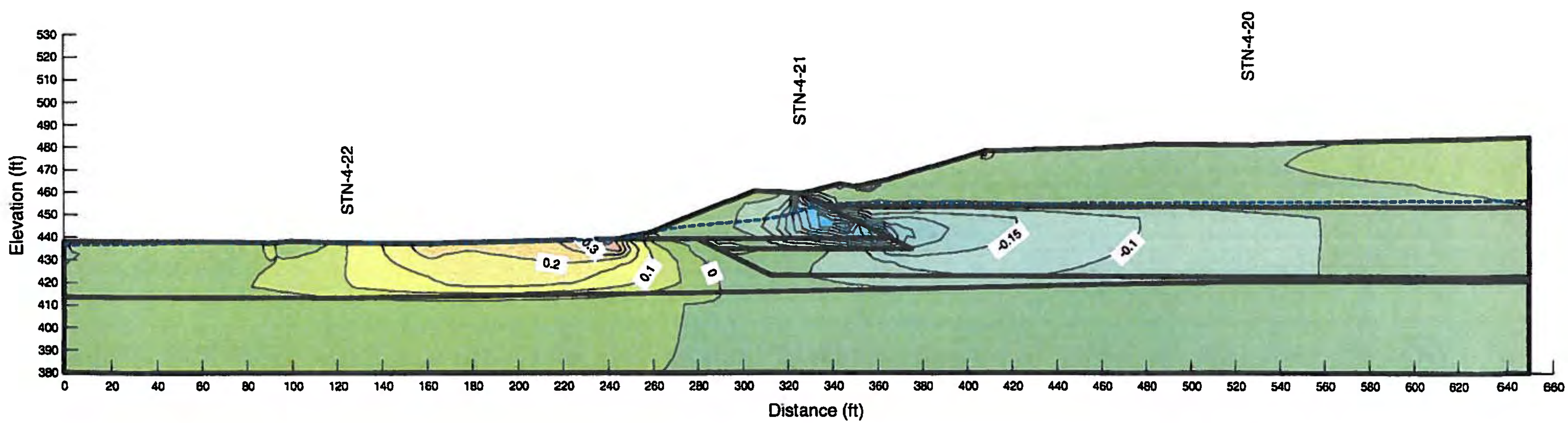


APPENDIX A

Document 10

TVA Colbert Fossil Plant, Ash Pond 4, Basis of Design Report, Proposed Improvements and partial Closure Phase 1, October 29, 2010, Prepared by URS

BASIS OF DESIGN REPORT

TVA COLBERT FOSSIL PLANT
ASH DISPOSAL POND NO. 4

PROPOSED IMPROVEMENTS & PARTIAL CLOSURE PHASE 1

Prepared for:

Tennessee Valley Authority
1101 Market St.
Chattanooga, TN 37402-2801

October 29, 2010

URS

1375 Euclid Avenue
Cleveland, Ohio 44115
216-622-2400
Project No. 31851131

Figures

Appendices

This Basis of Design (BOD) Report was prepared in accordance with URS Corporation's (URS') understanding of the projects as discussed in a meeting with TVA on November 20, 2009, and described in Change Order No 1 (submitted December 11, 2009) and the Spillway Replacement Proposal (submitted December 11, 2009). The projects have been further refined during subsequent meetings with TVA. This BOD report documents the design criteria and minimum standards utilized for the proposed projects. The document is prepared in general accordance with TVA's Master Programmatic Document.

1.1 PROJECT DESCRIPTION

The projects are located at Ash Disposal Pond No. 4 (Pond 4), part of the TVA Colbert Fossil Plant (COF) in Tuscumbia, Alabama.

1.2 EXISTING CONDITIONS

Existing conditions at Pond 4 are shown in Figure 1. Currently Pond 4 is used for disposal of coal combustion bottom ash and treatment of several wastewater streams at the COF facility, including effluent from the coal yard run-off pond, various collection sumps, and septic tanks.

Pond 4 is an upground reservoir that is approximately 52 acres in surface area, and is enclosed by earthen perimeter dikes having a total length of approximately 6,700 feet and side slopes of approximately 2.5H:1V to 3H:1V. The pond is bounded by Cane Creek on the east side, railroad tracks and US Route 72 on the south side. A former chemical treatment pond is located on higher ground west of the pond, and wooded areas and the power plant yard lie to the north.

The pond was originally constructed in 1972 with dikes that were approximately 20 feet high on the north, east and south sides, and somewhat shorter at the west side of the pond. The crest elevation was nominally El. 440. In 1984, the dikes were raised approximately 20 feet using the upstream method, with fill material being placed on the inboard side on top of ash deposits, resulting in an average crest elevation of El. 460. According to TVA's 2010 aerial survey, the average crest elevation is El. 462.9.

Pond 4 currently operates at a pool elevation of El. 456.6, which corresponds to a free water volume of 440,829 cubic yards, or 89,036,007 gallons. A minimum free water volume of 129,828 cubic yards, or 26,220,000 gallons is required by the current NPDES Permit (Permit No. AL 0003867).

1.2.1 High Hazard Designation

Prior to the start of the project, TVA performed a preliminary evaluation of existing impoundment structures in general accordance with FEMA's Hazard Potential of Dams (FEMA, 2004). Following expedited assessment of site conditions, TVA classified Pond 4 as a "High Hazard" structure. The High Hazard classification was based on consequences (not probability) of failure in terms of probable loss of human life. This was based on the proximity of the south dike of Pond 4 to State Route 2/US Route 72/Lee Highway and a railroad, and existing structures to the east and west side of Colbert Steam Plant Road.

1.2.2 Seepage

The Pond 4 perimeter dikes have a history of seepage along the east and southeast outboard sides, with the majority of seepage believed to originate near the contact of the original dike and new fill area, approximate El. 445. The seepage may indicate the presence of a permeable hydraulic connection from the interior of Pond 4 to the contact of the original dike and new fill.

1.2.3 Spillway Structures

Pond 4 discharges through four "morning glory" spillway structures located at the north end of the stilling basin. The morning glory spillways are constructed of four 48-inch risers set on a concrete base with a 36-inch outlet pipe leading to the concrete discharge channel.

As part of a comprehensive Phase I Facility Assessment prepared by Stantec (2009) for all the TVA fossil facilities, and subsequent studies, the Pond 4 spillway structure was identified as having higher risk for failure than other spillways in the TVA system. The existing spillways present a potential hazard to the ash pond system due to their age and possible instability. As such, these spillways were given higher priority for expedited replacement.

1.3 PROPOSED IMPROVEMENTS & PROJECTS

Proposed improvements to Pond 4 include the removal of the high hazard designation, replacement of the existing spillway system, including installation of siphons, and remediation of the observed seepage on the outboard dikes. Additionally, both the high hazard removal and spillway improvements will be facilitated by the initial construction of a temporary rock buttress and sheet pile wall across the boundary between the stilling pond and the main pond. The proposed Pond 4 improvements are shown in Figure 2.

The temporary rock buttress and sheet pile wall are described in Section 2. The removal of the high hazard designation will be accomplished by lowering a portion of the dike at the north end of Pond 4to El. 458, and is further described in Section 3. The spillway improvements include constructing a new spillway and permanent siphon, and abandonment of the existing spillway structures. The spillway improvements are described in Section 4. The seepage remediation consists of construction of a seepage collection drain, conveyance line, and a stone buttress, located at the eastern and southern pond dikes. Seepage remediation design components are described in Section 5.

Lastly, URS understands that it is the intent of TVA to close Pond 4 to bottom ash sluicing operations. For the initial phase of closure, Partial Closure - Phase 1, a separator embankment will be built in the existing main pond, and the area south of the separator dike filled in with bottom ash from the existing bottom ash stack located in the southwestern corner of the pond footprint. Partial Closure is described in Section 6, and graphically depicted in Figure 3.

The Pond 4 improvements and Partial Closure Phase 1 have been designed in accordance with TVA's Master Programmatic Document (Revision 1.0). Additionally, the improvements have been designed to meet regulatory and operational requirements for dam safety, ongoing ash disposal, wastewater treatment and discharge, and plant operations requirements, as indicated by TVA.

1.4 DOCUMENT ORGANIZATION

The document is organized into sections corresponding to design/work plans submitted to TVA. The work plans submitted to date consist of the following:

- The Ash Pond 4- Temporary Rock Buttress & Sheet Pile Wall (construction set, 06/03/10) Work Plan Drawings 10W503-01 through 07

- Ash Pond 4- High Hazard Removal & Spillway Replacement (construction set, 06/17/10) Work Plan Drawings 10W290-00 through 19

- Ash Pond 4- Seepage Remediation (construction set, 05/20/10) Work Plan Drawings 10W291-01 through 09

- Ash Pond 4- Partial Closure Phase 1 (draft set, 06/14/10) Work Plan Drawings 10W393-01 through 10

Each section provides a summary of the proposed designs and improvements. Detailed calculations are included in the corresponding Appendices. The BOD generally follows the organization described in Section 2.1 of TVA's Master Programmatic Document (Revision 1.0). However, the following sections referenced in the Master Programmatic Document are not applicable for the following reason:

- Construction Cost Estimate and Schedule- The cost estimate and schedule is not applicable to design of the proposed improvements. A general cost estimate and schedule was provided in the Project Planning Document (PPD), submitted in draft form on May 14, 2010. URS understands that cost estimates and construction schedules have been solicited from the applicable contractors for each project, and provided to TVA. Those estimates and schedules are not included herein.

- Permits- A Construction Best Management Practice Plan (CBMPP), was required to construct the proposed improvements. The CBMPP was submitted to TVA for approval by the Alabama Department of Environmental Management (ADEM) on March 2, 2010. Approval was received from ADEM on May 11, 2010. While URS provided some support for obtaining other environmental permits, TVA submitted the required permit documents.

- Construction or Implementation Plan- Construction or implementation plans for this project are being prepared and submitted by TVA's internal contractors and are therefore not included herein. Detailed design of the improvements are provided in the Work Plans for each Project. Long lead items (including sheet piling, and turbidity curtains) were discussed with TVA concurrent with design development.

A temporary rock buttress and sheet pile wall will be constructed across the pond in the area near the finger dikes. Figure 2 shows the location of the temporary buttress and sheet pile wall. The purpose of the temporary buttress and sheet pile wall is to divide the stilling pond (north) from the main pond (south), so that the stilling pond may be temporarily lowered to facilitate construction of the new spillway system while keeping the free water volume of the main pond roughly equal with pre-construction conditions. Construction of the temporary buttress and sheet pile wall allows for temporary lowering of the water in the stilling pond to El. 447 for construction of the new Pond 4 spillway, while operating the rest of the pond at normal pool elevation (El.456.6). A sheet pile wall will be driven down the center of the buttress after fill placement is completed, and will provide hydraulic separation to allow for dewatering of the north pond. A lowered center opening section will be provided through the crest of the buttress. Inflows coming into the pond during construction will pass over this lowered section, across the buttress and into the stilling pond, ultimately being discharged to Cane Creek via the siphons.

2.1 DESIGN PROCESS

2.1.1 Design Criteria

Design criteria are described in Appendices 1 and 2.

2.1.2 Design Exceptions

There were no deviations from recommended minimum standards in design of the temporary buttress and sheet pile wall.

2.1.3 Design Narrative

Detailed narratives are provided for the hydraulic design and slope stability analysis in Appendix 2, and are summarized herein. The detailed narratives further describe assumptions made, data utilized and calculations performed to design the temporary buttress and sheet pile wall.

<u>Slope Stability Analysis</u> – A slope stability analysis was performed to establish the design geometry of the temporary buttress.

Existing geometry, stratigraphy, and material properties utilized in the design were based on: 1) TVA' Pond 4 bathymetric survey (August 2009); 2) data given in Stantec's geotechnical investigation report for Pond 4, dated January 22, 2010; and, 3) some material properties (specifically for sluiced fly ash in the pond) are based on site-specific lab test data obtained by URS, and/or published technical data.

Slope stability analyses were performed with the SLOPE/W software by Geo-Slope International. Based on the results of the analysis, the buttress will have a maximum of 2.5H:1V southern slope, a broken (separated by a 20 ft wide bench) 1.5H:1.5V north slope, and consist of crushed gravel, sizes No. 1 through No. 4.

Hydraulic Design – For the hydraulic design, broad crested weir equations were used in conjunction with the probable maximum precipitation (PMP) event of 900 cubic feet per second (cfs) to size the opening in the center of the buttress. Results of the analyses are as follows:

- Center Opening Length (for both construction and final configurations): 60 ft
- Invert Elevation for Construction Condition = El.456
- Invert Elevation for Final Condition = El.452

2.2 OPERATIONAL FEATURES

Operational features and controls are not applicable for inclusion in the BOD for this project.

The high hazard classification will be removed by lowering a portion of the dikes to El. 458 and lowering the long-term operating pool in Pond 4 to El. 453. Figure 2 shows the location of the dike lowering.

3.1 DESIGN PROCESS

3.1.1 Design Criteria

Design criteria are described in Appendices 1 and 3.

3.1.2 Design Exceptions

There were no deviations from recommended minimum standards in design and verification of the high hazard removal.

3.1.3 Design Narrative

Detailed narratives are provided for the inundation mapping and the viscous flow modeling in Appendix 3, and are summarized herein. The detailed narratives further describe assumptions made, data utilized and calculations performed to calibrate the depth of dike lowering and verify the high hazard removal.

Dam Break Inundation Analysis - Inundations that would result if a dam-break failure occurs were analyzed. Iterative analyses were performed, in which dike top elevation and the maximum pool of the pond (i.e., a pool elevation corresponding to the top of dike) was varied. The maximum pool level that would not result in overtopping of the downstream highway and railroad structures in the event of a breach was determined.

The sedimented fly ash in the base of Pond 4 was treated two ways in the dam breach analyses:

- Overtopping analyses modeled the outflow of clear water from the current pool elevation down to the top of sluiced ash (El. 436) as indicated by bathymetric survey data (August 2009). For conservatism, a large portion of the sluiced ash was also modeled to flow as clear water. This volume of ash was conservatively calculated by cutting the saturated ash with a theoretical plane that slopes from the bottom of breach (El. 422) up to El. 436 at an angle of repose of 30 degrees.

- Non-overtopping dam breach analyses modeled the breach outflow as clear water down to the top of sedimented ash, and then as a non-Newtonian, viscous fluid down to the bottom of breach. The flow characteristics of saturated fly ash and bottom ash were estimated from laboratory tests performed on ash samples.

Both assumptions yielded similar results, with the water models having slightly higher downstream elevations.

Based on the results of the analyses, dam breach flood inundation will be contained below the level of the railroad, highway and adjacent residence if the dike crest elevation is reduced to El. 458 and the normal operating pool is set at El. 453. The extent of dike lowering was limited to 800 feet along the north and east sides of the stilling pond to minimize impact to plant operations while still eliminating the high hazard.

Slope Stability - Following the results of the inundation mapping, slope stability and seepage analyses were performed to model the proposed lowered dike. Detailed narratives are provided for the slope stability and seepage modeling in Appendix 1. The detailed narratives further describe assumptions made, data utilized and calculations performed to verify the stability of the lowered dike.

3.2 OPERATIONAL FEATURES

Operational water levels shall not exceed El. 453, in agreement with the five-foot freeboard requirement in TVA's Master Programmatic Document.

The new spillway was designed to replace the existing morning glory spillways. Construction of a new spillway will allow TVA to grout full and abandon the old spillways, thereby eliminating the potential for negative environmental impacts and potential property damage and loss of life should one or more of the old morning glory spillways fail. Siphons will be installed to draw down the water level to El.447 in the stilling pond for construction of the new spillway, while the water level in the main pond will be maintained near El. 456 by the temporary buttress and sheet pile. The siphons will remain in-place for emergency usage. Figure 2 shows the location of the proposed spillway and siphons.

4.1 DESIGN PROCESS

4.1.1 Design Criteria

The Johnsonville Fossil Plant spillway design was selected by TVA to be the prototype for future replacement spillways. URS has been provided with construction drawings for the Johnsonville installation and also observed some aspects of the final stage of construction in the field. These documents and observations were used as guidelines for design of the new spillway structure at Pond 4.

Additional design criteria are described in Appendices 1 and 4.

4.1.2 Design Exceptions

There were no deviations from recommended minimum standards in design of the permanent siphons and spillway structures.

4.1.3 Design Narrative

Detailed narratives are provided for the hydraulic and structural design of the spillway and hydraulic design of the siphons in Appendix 4, and are summarized herein. The detailed narratives further describe assumptions made, data utilized and calculations performed to verify the adequacy of the design configuration.

<u>Spillway Hydraulic Design</u> –The hydraulic design of the spillway (using Johnsonville spillway as an initial guideline) verified the configuration described below.

- The spillway will be a concrete structure incorporating four (4) seven-foot long stop-log weirs and four (4) 30-inch nominal-diameter HDPE conduits draining to the trapezoidal concrete lined channel north of the pond. The structure is separated into four identical chambers, and the flow is evenly split between these chambers.

Additionally, the design of the new spillway allows for adjustments in water level with the use of plastic stop logs, which can be lifted and moved with a davit crane mounted to the concrete structure. The design also takes into account the high hazard removal, in that the controlled water surface will allow the required 5 feet of freeboard, and can be manipulated up to 2 feet in either direction as necessary. The proposed spillway will also be stable, will pass the 6-hour PMP, and will maintain the desired water level during normal flow operations.

Spillway Structural Design –The structural design of the spillway (using Johnsonville spillway as an initial guideline) was verified for general accordance with the American Concrete Institute's ACI 318 code. Some minor revisions to the Johnsonville Spillway structural design have been incorporated.

Siphon Hydraulic Design –The proposed siphons were designed to keep the stilling pond lowered under normal plant flow during construction, and to drain the pond to El.447 at a rate not to exceed 1 foot per day. Based on the design, 12-inch SDR17 HDPE pipes were calculated as adequate to manage the flow. Additionally, gate valves were added to regulate the rate of drawdown in the stilling pond. Torpedo strainers were also designed for the siphon system to minimize the likelihood of disturbing ash from the base of the pond.

Slope Stability – Although the rate of drawdown in the stilling pond during spillway construction will be limited to no more than 1 ft per day, a slope stability and seepage (rapid drawdown) analyses were performed to model the proposed lowered dike. The analysis was conservatively performed as a rapid drawdown analysis. Detailed narratives are provided for the slope stability and seepage modeling in Appendix 1. The detailed narratives further describe assumptions made, data utilized and calculations performed to verify the stability of the pond dike under drawdown conditions.

4.2 OPERATIONAL FEATURES

Spillway operation and maintenance requirements may include the following:

- Regular inspection of the stop logs to verify operation, confirm minimal deflection and/or warping, and to confirm no accumulation of algae or other deposits.
- Periodic inspection to ensure that the individual logs can be lifted with the davit crane.
- Inspect the stainless steel, hardware and connections for wear and deterioration.

- At a minimum, annually inspect stop log frames, CMP skimmers, davit crane and davit crane base, and interior pipe connections

- Inspect all spillway appurtenances, including tees, bollards, vents, outlets, and concrete structures for wear, rust, spalling, or other deterioration.

Siphon operation and maintenance requirements include the following:

- At a minimum, annually inspect HDPE pipe, joints, flanged connections, float balls, and gate valves for signs of deterioration

- Periodic opening of the gate valves (every 3 to 4 months) for occasional flushing of siphons.

The seepage remediation system consists of a seepage collection drain, lateral piping, conveyance line, and stone buttress to mitigate seepage along the eastern and southern sides of the Pond 4 dikes. The seepage collection drain is designed to intercept the seepage near the interface of the upper and lower dikes (between El. 445 and 440). Seepage will then be carried via lateral pipes to the seepage conveyance line, which will subsequently convey seepage flows to the new headwall structure to the north of Pond 4 (seepage from the east dike), and to the treatment wetlands to the south of Pond 4 (seepage from the south dike). The stone buttress will provide a working surface for construction of the conveyance line and is also intended to increase global stability of the Pond 4 east dike.

5.1 DESIGN PROCESS

5.1.1 Design Criteria

Design criteria are described in Appendices 1 and 5.

5.1.2 Design Exceptions

There were no deviations from minimum standards in design of seepage remediation system.

5.1.3 Design Narrative

Detailed narratives are provided for the design of the seepage remediation components in Appendix 5, and are summarized herein. The detailed narratives further describe assumptions made, data utilized and calculations performed to verify the adequacy of the design configuration and components. Additionally, slope stability and seepage analysis supporting this design are provided in Appendix 1.

Slope Stability Analyses: Slope stability analysis of the east dike, accounting for the stabilizing effect of the stone buttress and reduced phreatic surface with the seepage collection system in place, was performed using the SLOPE/W computer program. Existing geometry, stratigraphy, and material properties utilized in the design were based on: 1) TVA' Pond 4 topographic and bathymetric survey (August 2009); 2) data given in Stantec's geotechnical investigation report for Pond 4, dated January 22, 2010; and, 3) some material properties (specifically for sluiced fly ash in the pond) are based on site-specific lab test data obtained by URS, and/or published technical data.

Seepage Analyses: Seepage analysis with the finite element computer program SEEP/W (by Geo-Slope International, Inc) was utilized to estimate both the reduced phreatic surface resulting from the seepage collection system and to estimate the maximum rate of seepage to be collected by the system. Seepage models created by Stantec and included as part of their January 22, 2010 report were utilized as starting points, but were modified by URS to include conditions that will exist after installation of the new spillway, high hazard removal and lowering of the permanent operating pool of Pond 4 to El. 453. Additional details regarding the model are provided in Appendix 5.

Seepage Collection Pipe Design – Bentley Flow Master version 8.0 software was used for all seepage collection system pipe calculations. Based on the calculations, the seepage collection drain will consist of a 6-inch perforated HDPE pipe placed in a trench cut into the sideslope bench and backfilled with pervious filter material; and, a blanket drainage layer constructed over the bench cut and over the dike subgrade exposed by the backslope cut. The blanket drainage layer will be a minimum of 1 ft thick and was designed to intercept seepage flow that may be coming through the clay dike embankment above the interface of the upper and lower dikes.

Conveyance Line Design - The conveyance line will consist of a 6-inch solid wall, gasketed HDPE pipe and will be trenched into the dike at varying elevation below the elevation of the collection drain. The conveyance line and trench will have a constant slope designed to provide adequate discharge capacity for the estimated amount of seepage. Solid HDPE lateral pipes will be installed at 200 ft spacing along the drain alignment, and will connect the collection drain pipe to the conveyance pipe. The east dike conveyance line will discharge through the spillway outlet headwall, and the south conveyance line will discharge through a small outlet structure to be installed just above the existing treatment wetlands. An animal guard screen will be provided at each outlet point.

Stone Buttress Design - A stone buttress consisting of No. 1 and 2 crushed stone will be constructed on the face of the south and east dike. The crest of the stone buttress will vary with location to match the elevation of the conveyance pipe trench and will be at least 10 ft wide. The front slope of the buttress will be maximum 1.5H:1V.

Partial Closure Phase 1 consists of closing the southern area of Pond 4 to inflows from the plant, and partially filling the southern area with bottom ash from the existing bottom ash stack. A new separator embankment/dike will be constructed in the southern portion of the main pond, spanning between the existing east pond dike and the existing deflector dike. The new separator embankment will consist of a bottom ash core with rock protection at the surface. A lowered weir section will be left in the embankment, to allow water displaced as part of the filling operation to pass into the open portion of Pond 4 north of the separator embankment. A new inlet configuration will also be constructed for plant inflows that enter Pond 4 via the sluicing area located west of the existing divider dike. The new inlet will be located north of the new separator embankment and will consist of a rip-rap lined open channel and a rip-rap lined weir through the existing deflector dike. Lastly, the coal yard runoff pipe will be extended from its current outlet point, to a new point north of the proposed separator embankment, and an air release valve will be added to the pipe. Figure 3 illustrates Partial Closure Phase 1.

6.1 DESIGN PROCESS

6.1.1 Design Criteria

Design criteria are described in Appendix 6

6.1.2 Design Exceptions

There were no deviations from minimum standards in design of Partial Closure Phase 1.

6.1.3 Design Narrative

Detailed narratives are provided for Partial Closure Phase 1 hydraulic design and slope stability analysis in Appendix 6, and are summarized herein. The detailed narratives further describe assumptions made, data utilized and calculations performed to design the separator dike, the sluice channel, and the modifications to the coal yard runoff pipe.

<u>Location of Separator Embankment</u> - Prior to designing the configuration of the separator embankment, the location of the embankment was selected. Three options were initially considered for the location, and are shown in Figure 4:

- The southern-most location allows the current bottom ash stack to be 'pushed' in to the southern portion of the pond and filled to ELE 460. Additionally approximately 4 years (38,000 tons/yr) of bottom ash will be stored on top of this to accommodate the period before going to dry ash handling. This line allows for approximately 1.7 times the required free water volume (FWV).

- The middle location represents the FWV for current bathometry (August 2009) and future operating water level 453 ft (based on lowest dike elevation of 458 ft).

- The northern-most location represents the required water volume based on total suspended solids evaluation. Considerations were based on mass balance information derived from flow rates in the NPDES application flow diagram, as well as constituent analyses of water samples taken in February 2010. Analyses of the constituents indicated that metals treatment is a function of solids settling, and the solids sent to the pond are mainly bottom ash particulates, which according to Stokes' Law calculations and settling tests, have a quick settling time. The required minimum free water volume of 23.51 million gallons is larger than the approximately 19.5 million gallons minimum treatment volume recommended for solids settling criteria.

The three options were presented to TVA during a conference call on May 12, 2007 (A record of the call is included in Appendix 6). URS received direction from TVA to proceed with the southern most location for the separator embankment design.

Slope Stability Analysis – A slope stability analysis was performed to establish the design geometry of the separator embankment.

Existing geometry, stratigraphy, and material properties utilized in the design were based on: 1) TVA' Pond 4 bathymetric survey (August 2009); 2) data given in Stantec's geotechnical investigation report for Pond 4, dated January 22, 2010; and, 3) some material properties (specifically for sluiced fly ash in the pond) are based on site-specific lab test data obtained by URS, and/or published technical data.

Slope stability analyses were performed with the SLOPE/W software by Geo-Slope International. Based on the results of the analysis, a uniform 2.5H:1V south slope, and a uniform 3:1 north slope were designed. Additionally, the north side will be buttressed with gravel to improve stability and mitigate potential erosion of the bottom ash material.

Coal Yard Runoff Pipe Modification – Currently water is conveyed from the Coal Yard Coal Yard Drainage Basin (CYDB) to Pond 4 across Cane Creek. The pipe currently discharges to Pond 4 in the south-eastern portion of the pond. As part of Partial Closure Phase 1, this area of the pond will be filled with bottom ash. As a result, the pipe will need to be extended approximately 1250 feet to discharge into the remaining open portion of the pond.

Based on existing system configuration and the proposed pipe extension, a combination air release valve (CAV) is necessary due to the potential of accumulation of air pockets. The air pockets can cause the pump to operate at a higher head to overcome the constricted flow. The CAV was sized based on existing system configurations as given in TVA drawings 10W285-1,2, 17W412-1, 2,3, (1976), Colbert Coal Yard Drainage Basin Study and associated pump curves (1991-1994). The design was performed using the design 16-inch high density polyethylene pipe and the APCO Manufacturer APSLIDE sizing program.

The design CAV recommended is a 4-inch APCO Model 149c or approved equal.

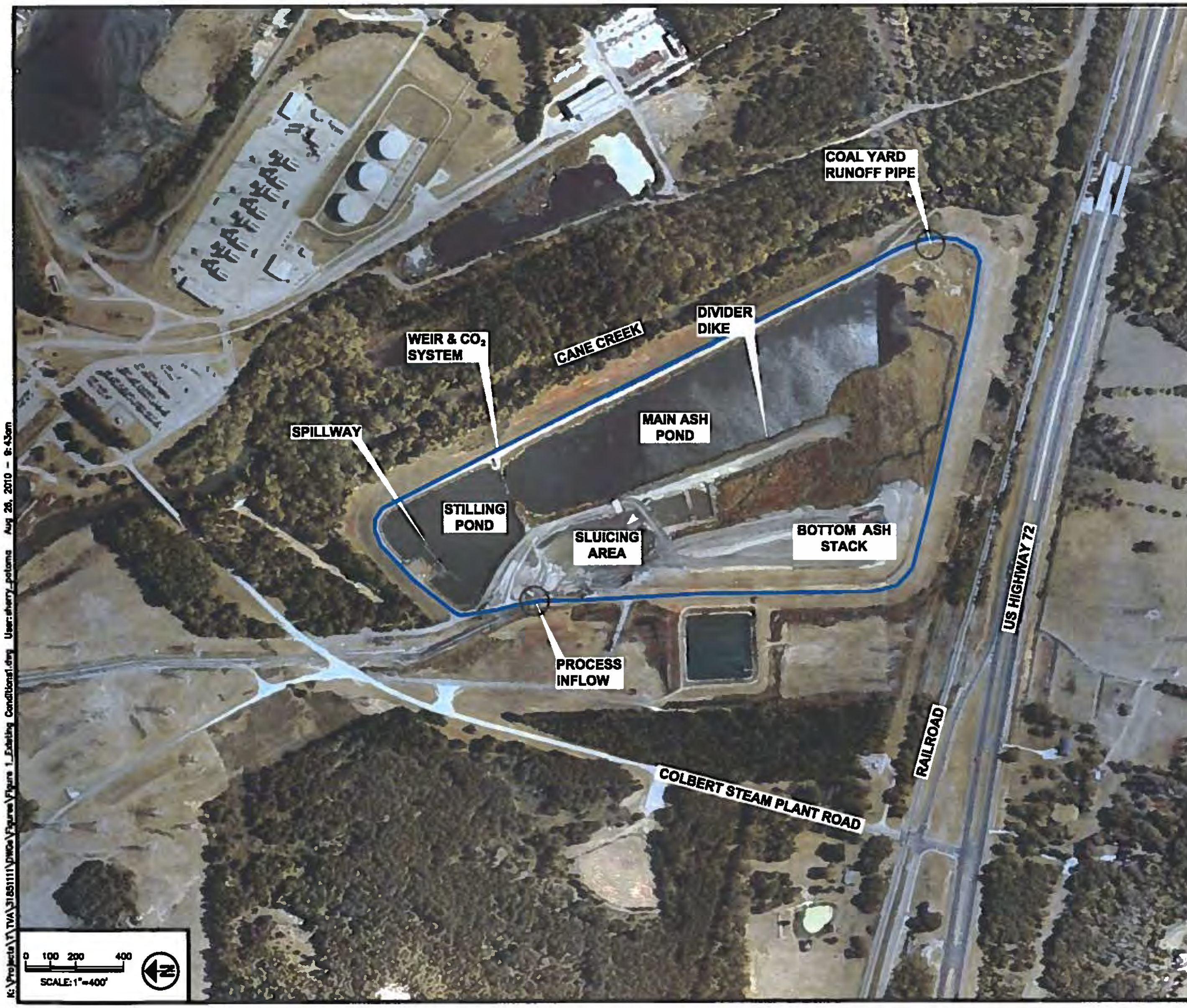
Sluice Channel Hydraulic Analysis –. Hydraulic Analysis of the new sluice channel was designed using standard methods (Manning's Equation) for open channels, and anticipated plant inflows. Based on this analysis, a trapezoidal channel with minimum depth of 2 ft and minimum base width of 2 feet will be adequate to manage flows.

The conclusions and recommendations presented in the Basis of Design report are based on the assumptions that our understanding of the existing site conditions and the scope of the project do not change substantially from what is described herein. It is recommended that communication be maintained with URS in order to ensure that the designs described herein are properly interpreted and incorporated into construction.

In the event that changes are made to the nature, design, or location of the proposed improvements, the designs presented herein should not be considered valid, unless URS has reviewed the changes and addresses their impact in the recommendations provided.

The design presented in this report should not be used for other projects or purposes. Conclusions or recommendations made from these data by others are their responsibility. Our services were provided in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation is intended.

FIGURES



URS

TVA

TVA COLBERT FOSSIL PLANT
TUSCUMBIA, ALABAMA

EXISTING CONDITIONS

DRAWN BY:	CHECKED BY:	PROJECT No:	DATE:	FIGURE No:
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LEGEND

SEEP REPAIR LOCATION

AREA OF DIKE LOWERING

URS

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TVA COLBERT FOSSIL PLANT
TUSCUMBIA, ALABAMA

PROPOSED IMPROVEMENTS

DRAWN BY:	CHECKED BY:	PROJECT No:	DATE:	FIGURE No:
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LEGEND

PARTIAL CLOSURE PHASE 1

NOTES:

1. PARTIAL CLOSURE PHASE 1 - CONSISTS OF BUILDING A NEW SEPARATOR DIKE ACROSS THE EXISTING POND TO ISOLATE THE SOUTHERN PART. THE INFLUENT WILL BE DIRECTED TO THE REMAINING OPEN END OF THE POND. THE STOCKPILED BOTTOM ASH WILL BE SPREAD EASTWARD TO BEGIN FILLING IN THE ISOLATED SOUTHERN PORTION OF THE POND.

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TVA COLBERT FOSSIL PLANT
TUSCUMBIA, ALABAMA

PARTIAL CLOSURE PHASE 1

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SEP	MJS	31851131	06/04/10	3

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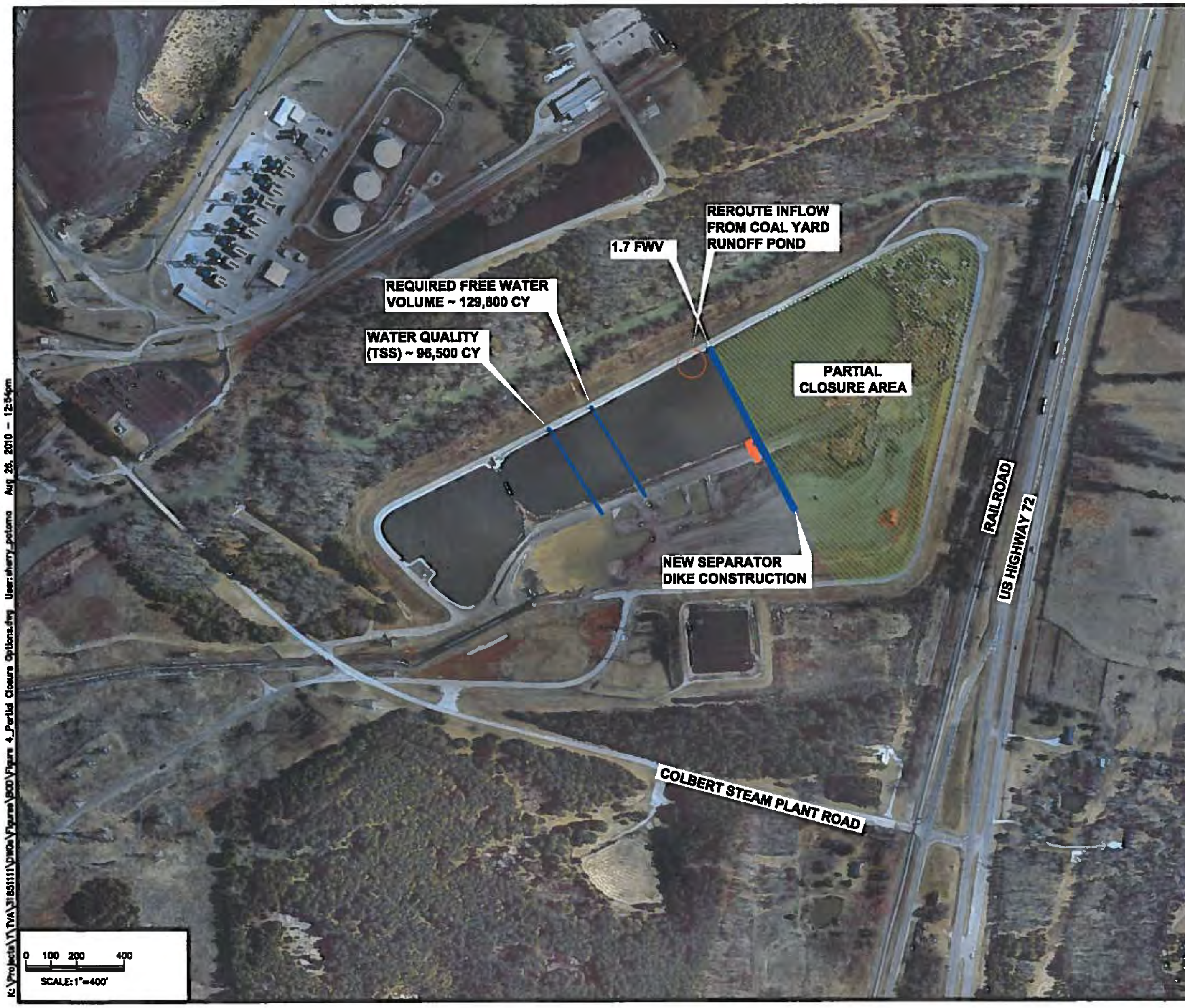

LEGEND

PARTIAL CLOSURE

NEW WIER THROUGH SPLITTER DIKE

NOTES:

1. VOLUMES WERE CALCULATED ASSUMING WATER AT EL 453.
2. FREE WATER VOLUME SHOWN IS BASED ON CURRENT PERMIT REQUIREMENTS.
3. PARTIAL CLOSURE - PHASE 1- CONSISTS OF BUILDING A NEW SEPARATOR DIKE ACROSS THE EXISTING POND TO ISOLATE THE SOUTHERN PART. THE INFLUENT WILL BE DIRECTED TO THE REMAINING OPEN END OF THE POND. THE STOCKPILED BOTTOM ASH WILL BE SPREAD EASTWARD TO BEGIN FILLING IN THE ISOLATED SOUTHERN PORTION OF THE POND
4. PARTIAL CLOSURE PHASE 2 - THE BOTTOM ASH GENERATED DURING THE PERIOD BETWEEN PARTIAL CLOSURE AND TERMINATION OF BOTTOM ASH FLOW WILL BE PLACED IN THE PARTIAL CLOSURE AREA AND GRADED TO PROVIDE POSITIVE DRAINAGE TO POND 4. GRADE AND CAP THE REMAINDER OF THE SOUTH END OF THE POND WHEN FLOW OF BOTTOM ASH TO THE POND CEASES, OR AS DEEMED NECESSARY BY TVA. CONTINUE TO OPERATE THE NORTHERN END OF POND 4

URS

TVA

TVA COLBERT FOSSIL PLANT
TUSCUMBIA, ALABAMA

PARTIAL CLOSURE OPTIONS

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SEP	MJS	31851131	05/11/10	4

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APPENDICES

APPENDIX 1

I. Purpose: **This summarizes URS's slope stability analyses for COF Pond 4, including analyses performed for proposed long-term conditions and analyses performed to check interim conditions that may exist during construction.**

II. Overview

Previous Slope Stability Evaluation By Others

- Stantec performed slope stability and seepage analyses for several cross-sections along the Pond 4 dike system – as shown in Figure 1. Assumptions, methodology, and results of Stantec's analyses are presented in their report entitled "Report of Geotechnical Exploration and Slope Stability Evaluation, Ash Pond 4, Colbert Fossil Plant, Tuscumbia, Alabama", by Stantec, Inc. and dated January 21, 2010. Stantec's analyses were for existing (pre-construction) conditions and were based on effective strengths only.
- Stantec used SEEP/W to establish porewater pressures within the dike and foundation soils, which were then imported into SLOPE/W for use in the stability analyses. SEEP/W was also used to evaluate vertical exit gradients at the toe of the dike and the area beyond the toe. Stantec used an iterative procedure in which seepage properties of the dike materials (hydraulic conductivity, hydraulic conductivity ratio) were varied within pre-established ranges until a reasonable match between the results of the SEEP/W analysis and actual piezometers measurements was obtained. Generally, Stantec installed piezometers at the crest and at or closer to the toe of the dike at each cross-section that they analyzed. Midslope piezometers were also installed at a number of locations.
- The Stantec work identified that most cross-sections of the dike had factors of safety exceeding 1.50 for effective strength conditions (the value required by the TVA Programmatic Document). The lowest factors of safety were computed at locations along the east dike. Specifically, at Section B-B (near the junction of the Stilling Pond and Main Pond) and Section D-D (near the midlength of the east dike at the Main Pond). Section D-D had FS of roughly 1.45, the lowest computed value.

Proposed Improvements At Pond 4

The following changes to Pond 4 are proposed as part of the High Hazard Removal (HHR), Spillway, and Seepage Remediation Projects:

<u>Permanent Changes and Reconfiguration:</u>

- As part of the HHR and Spillway projects, the normal operating pool of the pond will be lowered from current El. 456.6 to new El. 453. The dike will be lowered by approximately 3 ft on average to El. 458, along the north slope and part of the east slope.
- As part of the Seepage Remediation Project, a seepage collection system consisting of a filtered blanket and trench drain will be installed near the midslope of the east and south

dikes (drain El. 438.5). The drain is designed to lower the phreatic surface within the dike to El. 438.5 at the drain location, and to collect and convey seepage via a closed pipe to Cane Creek at the north end of the pond. Additionally, a small stone buttress will be installed at or near the toe of the dike, along the entire length of the collection system. The buttress will have a 10 ft crest width and a 1.5:1 sideslope. The buttress will provide access for equipment during construction of the system, and will also provide some stabilizing weight to the toe of the dike.

Temporary Configurations During Construction:

- Construction of the seepage collection drain at the midslope will require a temporary cut into the dike, which is specified at a maximum slope angle of 2H:1V. The cut is specified to be made in 100-ft increments, to minimize the amount of slope that is opened at any one time and in consideration of stability concerns.
- Construction of the new spillway will require temporary lowering of the Stilling Pond to El. 447 for several months. This will be accomplished by first installing a temporary stone buttress with embedded sheet pile cut-off wall across the junction of the Stilling Pond and Main Pond, and then lowering the water level in the Stilling Pond using siphons, while maintaining the Main Pond. With regard to slope stability, the following temporary conditions are of interest:
    - o Slope stability of the temporary stone buttress – this is covered in a separate calculation package – TVA #FPGCOFFESCDX000000201000006.
    - o Rapid drawdown stability on the pond side of the portion of the dike that supports the Stilling Pond.
    - o Stability of the east dike in the area under construction surcharge loads (both pond side and slope side). This may include dozer and excavator equipment working on the dikes, truck loads from material deliveries, and the weight of a crane that may be positioned on the east dike in order to install the sheet pile cut-off wall.

The long term configurations resulting from the proposed construction will tend to increase factors of safety against slope stability of the dike, while the temporary surcharges and configurations that occur during construction will tend to lower factors of safety. The analyses herein address specific long term and temporary construction cases and check results for comparison against the Programmatic Document requirements.

III. Cross-Sections Selected For URS Analysis

For slope stability evaluations, URS has chosen to use Stantec Cross-Sections B-B and D-D, for the following reasons:

- These sections had the lowest factors of safety in the Stantec analyses, and are thus identified to be most critical.
- Furthermore, B-B is a representative cross-section through the east dike near the divide between the stilling pond and the main pond. A number of temporary construction

configurations within this area need to be analyzed, so Section B-B provides a good representative cross-section.

IV. Review and Back-Check of Stantec Analyses

URS's approach is to use as much of the existing Stantec data as possible in order to perform the stability analyses. As such, URS performed a detailed review of Stantec's geotechnical report and data, assumptions, and stability analyses, prior to adopting any of the information into its own analyses. The following review and back checks were made:

- ***Topography and Stratigraphy:*** Where Stantec cross-sections were utilized in URS analyses, URS checked the topography shown in Stantec sections against available survey data from TVA. URS also back-checked stratigraphy shown in the Stantec sections against the information given in Stantec's boring logs. The following discrepancies were identified and corrected for the URS stability analyses:
    - At Section B-B, the surface topography of the area east of the toe of the Pond 4 dike shown in Stantec's cross-section did not match the available survey data. This was corrected to match the survey data in URS's analyses.
    - Stantec did not differentiate between sluiced bottom ash and sluiced fly ash in their stability analyses – both materials were lumped into a single deposit called "sluiced ash". Stantec's borings clearly delineate bottom ash and fly ash, however. URS's stability analyses differentiate between the two materials, with the stratigraphy in each particular cross-section based on the appropriate Stantec boring log descriptions.
- ***Shear Strength Parameters:*** Stantec's selection of shear strength parameters for analysis were verified against the triaxial testing data and other data given in Stantec's geotechnical report. Specifically, URS verified the assigned shear strengths for the upper and lower dike clays as well as the native clay/silt deposit against available triaxial data using the "Modified" Mohr-Coulomb Diagram (p-q) approach given in USACE EM-1110-2-1902, Appendix D. For other strata, including the native sand deposit and sluiced ash deposit (for which triaxial data were not available), URS back-checked Stantec's shear strength assignments based on engineering judgment or in the case of sluiced ash, based on URS triaxial testing of reconstituted fly ash and bottom ash samples. URS's back-checks verified that Stantec's effective shear strength parameters (as given in Table 7.3 in Section 7.4.4) of their report were reasonable and conservative. URS has thus adopted these same parameter values in its analyses.

    One addition is the shear strength parameters assigned to bottom ash (which Stantec did not include):

Layer	Total Unit Weight (pcf)	Eff. Friction Angle (deg)	Eff. Cohesion (psf)
Bottom Ash	95	32	0

These values are based on conservative interpretation of URS triaxial test data performed on reconstituted samples of bottom ash.

- ***Slope Stability Analyses:*** Stantec utilized Spencer's Method, and incorporated a tension crack assumption at the crest of the dike in their SLOPE/W analyses. This methodology is considered adequate and is utilized in URS's analyses also.

- ***Seepage Analyses:*** Stantec's approach to SEEP/W modeling (i.e., assigning pre-determined ranges of hydraulic parameters to each separate stratigraphic unit and then varying the parameters within those ranges until a reasonable match between the SEEP/W phreatic surface and actual piezometers readings is obtained) is considered to be a valid approach, and URS has incorporated it into its own analyses. However, a number of changes to the details of Stantec's models were incorporated into URS's analyses, as summarized below:

  Note: Table 7.1 in Section 7.3.3 of Stantec's geotechnical report presents the hydraulic parameter assumptions that Stantec used in their SEEP/W analyses. The comments made below refer to those parameters.

  - In URS's opinion, Stantec has assigned a very high permeability to the limestone bedrock unit in its analyses. URS has chosen to model the bedrock layer as a hydraulic barrier – a "No-Flow" boundary condition is applied to the unit.

  - URS agrees with some of the hydraulic parameter ranges used by Stantec in their analyses, but disagrees with some others. Specifically, the ratios of horizontal to vertical permeability used by Stantec for the native soils and ash materials are unreasonably high in URS's opinion. URS's models use the following hydraulic parameter ranges, which may be compared to Table 7.1 in Stantec's report (significant differences relative to Stantec values are shaded in the table below).

Table 1 – Material Properties For SEEP/W Analyses

(URS Values)

Layer	Saturated k_V (cm/s)	k_H/k_V
Upper Clay Dike	$1x10^{-7}$ to $1x10^{-8}$	1 to 4
Lower Clay Dike	$1x10^{-7}$ to $1x10^{-8}$	1 to 4
Sluiced Fly Ash	$1x10^{-4}$ to $5x10^{-5}$	4 to 10
Sluiced Bottom Ash	$1x10^{-3}$	4 to 10
Native Silt (ML classification)	$1x10^{-4}$ to $1x10^{-5}$	4 to 10
Native Clay (CL or CH classification)	$5x10^{-5}$ to $1x10^{-6}$	4 to 10
Native Sand	$1x10^{-3}$ to $1x10^{-4}$	4 to 10

- Stantec's values for specific gravity, void ratio, and saturated and residual water content were verified to be reasonable.
- URS chose to utilize the pre-programmed volumetric water content functions in SEEP/W, as opposed to grain size data (as utilized by Stantec).
- Stantec's SEEP/W models do not extend to sufficient distance away from the dike both in the right and left ends of the problem. The left (Cane Creek side) far-field boundary in URS's models has been extended several hundred feet beyond Stantec's model limits. The right (Pond side) boundary has been extended to roughly the center of the Main Pond in URS's models. This is done to ensure that the far-field boundaries do not skew the SEEP/W results within the area of interest, and in order to properly model the far-field boundary conditions (see below).
- The right (pond-side) far-field boundary condition given in Stantec's model is incorrect. The proper boundary condition is a no-flow boundary condition applied along the right vertical edge of the model, which as mentioned above is set to correspond roughly to the centerline of the Main Pond.
- The left (Cane Creek side) far-field boundary condition (along the vertical left edge of the model) is set to El. 414, which roughly corresponds to the normal

water level in the Tennessee River. The water level within Cane Creek is given a head boundary condition of El. 414, as in Stantec's models. All surface nodes between the toe of the dike and the Creek and between the Creek and the left far-field boundary are given no-flow boundary conditions with potential seepage face review.

- URS chooses to use a denser mesh for regions making up the dike and at areas adjacent to the dike – URS models use a 1 ft x 1 ft element length in the mesh at these areas.
- Stantec installed a number of piezometers at elevations corresponding to the midslope area of the dikes, at various locations along the dike alignment. Water levels in the these midslope piezometers varied, depending on location. In most cases, midslope piezometers indicated groundwater at or close to the ground surface (from 0 to 7 ft of the ground surface). However, there were a few outlier locations (one of which is at Section B-B) where the groundwater level in the piezometers was far lower than the ground surface (15-20 ft +). Given the observations of seepage occurring along the midslope in several areas of the dike alignment, and taking into account that the majority of midslope piezometers showed water levels close to the ground surface, URS's interpretation is that the phreatic surface in the dike passes close to the ground surface in the midslope area. Therefore, SEEP/W results which indicate this are considered valid, even if the actual piezometer corresponding to the cross-section shows a lower groundwater level. This is a conservative interpretation.

V. Description of Cases Analyzed

Analysis 1: Existing Conditions Analysis (1A - Section B-B; 1B - Section D-D): This consists only of seepage analyses with SEEP/W. The existing conditions are analyzed to calibrate the SEEP/W models using the same iterative approach that Stantec used. In these analyses, Pond 4 is modeled at its current operating pool El. 456.6, and no seepage collection features (drains, stone buttress, etc) are included. The SEEP/W results are checked against the Stantec Piezometer readings and the hydraulic conductivity and conductivity ratio of each stratum are varied within the revised predetermined ranges given in Table 1 until a reasonable match between the SEEP/W phreatic line and the piezometers readings is established. The hydraulic parameter values resulting at the end of the iterative procedure are then utilized in all subsequent analyses.

Analysis 2: Long-Term Proposed Conditions Analysis (2A - Section B-B; 2B - Section D-D): These analyses model the long-term modifications to the dike system, and include the following features:

- The normal operating pool level in Pond 4 is set to El. 453.

- The seepage collection system is included in the analysis. It is included by incorporating a head boundary condition equal to El. 438.5 (the elevation of the midslope seepage collection drain) along nodes internal to the upper and lower dike stratum along the configuration of the proposed seepage collection trench and blanket layer.
- The stone buttress at the toe of the dike (part of the seepage remediation project) is included as a vertical surcharge load weighing 120 pcf in the model.
- The hydraulic parameters established in Analysis 1 are utilized for the SEEP/W runs.
- Effective shear strength parameters are used in the SLOPE/W runs, as revised in Section IV above.

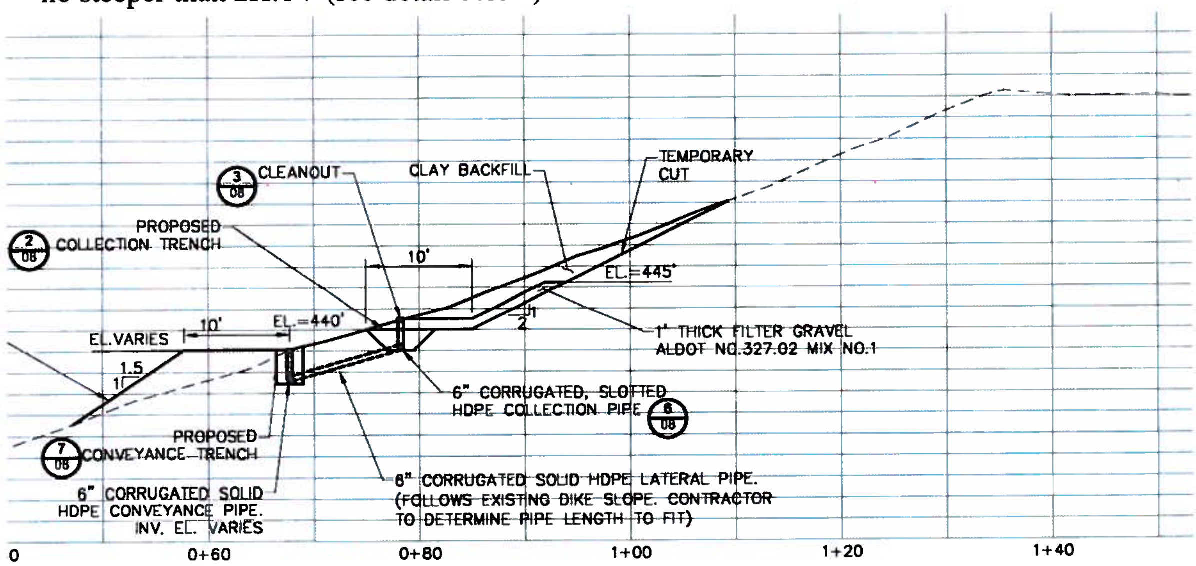
SEEP/W is first run to establish the phreatic line and internal porewater pressures under the conditions summarized above. The SEEP/W results are then imported into SLOPE/W, which is used to determine the factor of safety against slope stability. A wide range of failure geometries are analyzed in SLOPE/W, using the Entry and Exit and Auto-Locate features in SLOPE/W. All critical failure surfaces are optimized, using the built-in routine in the program.

Analysis 3: Proposed Maximum Pool Conditions Analysis (3A - Section B-B; 3B - Section D-D): These analyses model a worst-case condition in which the pool level in Pond 4 has risen to the top of the lowered dike (El. 458, as set by the High Hazard Removal Project). The analyses include the following features:

- The proposed Seepage Collection System is included in this analysis, as described above for Case 2.
- The pond is assumed to be at El 458, and it is conservatively assumed that corresponding steady-state seepage has been established within the dike.
- The stone buttress at the toe of the dike (part of the seepage remediation project) is included as a vertical surcharge load weighing 120 pcf in the model.
- The hydraulic parameters established in Analysis 1 are utilized for the SEEP/W runs.
- Effective shear strength parameters are used in the SLOPE/W runs, as revised in Section IV above.

As with Analysis 2, SEEP/W is first run to establish porewater conditions, and the results are imported into SLOPE/W.

Analysis 4: Temporary Cut At Midslope – Seepage Collection Construction (4A - Section B-B; 4B - Section D-D): These analyses model a temporary condition that will exist during construction of the seepage collection system. Specifically, when installing the seepage collection drain (at El. 438.5) and blanket layer (to El. 445), the Contractor will need to excavate into the outside face of the pond dike to expose the subgrade for the drain and blanket. The Seepage Remediation Workplan specifies that this excavation be laid back at no steeper than 2H:1V (see detail below).



Analysis 4 models this temporary configuration, to verify safety of the dike during construction.

- The phreatic line corresponding to existing normal pool El. 456.6 is used in this analysis (as established in Analysis 1).
- The stone buttress/construction access road is included in this analysis, since construction of that feature is specified to occur prior to installation of the seepage collection work at the midslope.
- A surcharge load of 4000 lbs/ft is included in the analysis at the temporary bench created at El. 440 – this models the weight of small to medium excavator working on the cut (50,000 # weight over a 12 ft base). A 400 psf surcharge, 10 ft wide is also placed at the crest of the dike above the work area – modeling a fully loaded dump truck or other vehicle.
- Effective strength parameters are conservatively used.
- Failure surface geometries bounded by the crest of the dike and the temporary cut are analyzed in this analysis.

Analysis 5: Temporary Construction Surcharge At Crest of Dike – Temporary Buttress/Sheet Pile Construction (5A – failure toward inside dike face; 5B – failure toward outside dike face): Construction of the temporary buttress and sheet pile will require equipment to be positioned and operated at the crest of the pond dike. Equipment may include excavators, dozer, and a crane, the latter considered as being the most substantial surcharge. The design of the temporary buttress itself includes an equipment surcharge (see separate calculation package - TVA #FPGCOFFESCDX000000201000006). However, means and methods of the Contractor may dictate placement of the crane on the east dike crest, rather than on the buttress itself. Analysis 5 addresses this possibility.

- Since Section B-B is very close to the area in question, it is used directly for Analyses 5A and 5B.
- The phreatic line corresponding to existing normal pool El. 456.6 is used in this analysis (as established in Analysis 1A) – pond will not have been lowered while crane operations are taking place.
- The crane surcharge is modeled as a 520 psf uniform load, 22 ft wide in the cross-section. This is based on estimated loading for a 100-ton crane– see Attachment A for surcharge calculations and basis. The crane is positioned on the crest, perpendicular to the dike alignment and immediately at the inside crest edge.
- Effective strength parameters are used.

It should be noted that the type and weight of equipment surcharges that will be applied to the dikes during construction is not known at the time of this report – final means and methods for construction are to be determined by the Contractor. Surcharge loads used in the analyses are estimated/assumed, based on typical construction practices. The assumptions should be verified once detailed construction plans have been made by the Contractor.

Analysis 6: Rapid Drawdown Conditions During Lowering of Stilling Pond For Spillway Construction: Construction of the new spillway will require temporarily lowering the water level in the stilling pond to El. 447, or roughly 10 ft lower than current normal pool. Per the plans, this is to be implemented at a rate of no more than 1 ft per day. The proposed drawdown rate is conservatively assumed to be a rapid drawdown condition and Analysis 6 evaluates slope stability for rapid drawdown of the stilling pond.

- Section B-B is representative of the stilling pond dike, and is thus used for this analysis.
- Drawdown analysis is performed for failures occurring along the inside face of the dike only.
- Rapid drawdown analysis is performed in general accordance with the multi-stage procedure given in Duncan, J. M., Wright, S. G., and Wong, K. S. 1990. “Slope

Stability During Rapid Drawdown,"H. Bolton Seed Symposium, Vol. 2, University of California at Berkeley, pp 253-272, as presented in USACE Engineer Manual EM-1110-2-1902 "Slope Stability", Appendix E. SLOPE/W 2007 has a built-in routine to perform this procedure, based on user-input phreatic surfaces for the pre-drawdown and post-drawdown equilibrium conditions.

- In accordance with the multi-stage procedure, the steady-state phreatic surfaces are determined for both the pre-drawdown and post-drawdown pool. These are established using SEEP/W, by adjusting the right head boundary condition. Note that the pre-drawdown phreatic line is as determined in Analysis 1A.
- The multi-stage procedure requires total strength properties for all layers that are not considered to be free-draining materials. For the purposes of the analysis, the Upper and Lower Clay dike, Native Clay, and Sluiced Ash strata are not considered to be free draining materials. For Analysis 6, URS evaluated total strength properties for the dike and native clay materials using the available triaxial test data from Stantec, and using the "Modified" Mohr-Coulomb Diagram (p-q) approach given in USACE EM-1110-2-1902, Appendix D. For the sluiced ash materials, total strength properties were established using the URS triaxial testing data, in conjunction with the USACE p-q approach.

  Total strength properties used in Analysis 6 are given in Table 2 below:

Table 2 – Total Strength Material Properties Used in Analysis 6

Layer	Total Unit Weight (pcf)	Total Friction Angle (deg)	Total Cohesion (psf)
Upper Clay Dike	126	13	700
Lower Clay Dike	127	17	850
Native Clay	129	17	700
Sluiced Ash	85	25	125

VI. Results Of Analysis

SEEP/W and SLOPE/W output files for each analysis are provided in Attachment B. Critical factors of safety corresponding to each analysis (other than Analysis 1, which is strictly a seepage analysis) are provided in Table 3 below:

Table 3 – Results of Slope Stability Analyses

Analysis	Analysis Description	Critical Factor of Safety
Analysis 2A	Long-Term Proposed Condition – Section B-B	1.55
Analysis 2B	Long-Term Proposed Condition – Section D-D	1.54
Analysis 3A	Proposed Maximum Pool Condition – Section B-B	1.41
Analysis 3B	Proposed Maximum Pool Condition – Section D-D	1.44
Analysis 4A	Temporary Excavation For Seepage Remediation – Section B-B	1.56
Analysis 4B	Temporary Excavation For Seepage Remediation – Section D-D	1.36
Analysis 5A	Construction Surcharge At Dike Crest – Section B-B (Inward Failure)	1.84
Analysis 5B	Construction Surcharge At Dike Crest – Section B-B (Outward Failure)	1.41
Analysis 6	Construction Rapid Drawdown Analysis – Section B-B	1.53

The TVA Programmatic Document requires the following minimum factors of safety:

- For Long-term proposed conditions (Analyses 2A and 2B): 1.50
- For maximum surcharge pool conditions (Analyses 3A and 3B): 1.40
- For temporary construction configurations (Analyses 4A, 4B, and 5): 1.30
- For rapid drawdown conditions (Analysis 6): 1.30

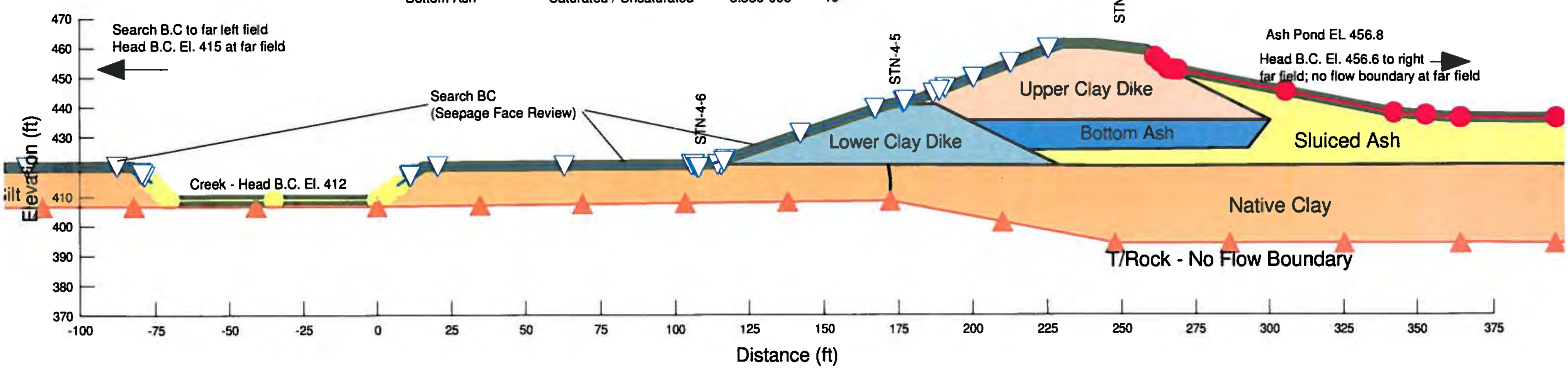
Comparison of the critical factors of safety given in Table 3 to the above values indicates that the dike system meets the requirements of the Programmatic Document for all cases considered.

Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 1A - Existing Conditions
Cross-Section B-B

FEM Model Configuration

Material Layer	Model	Kv (cm/s)	Kh/Kv
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Upper Clay Dike	Saturated / Unsaturated	3.3e-009	4
Native Clay and Silt	Saturated / Unsaturated	8e-006	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10

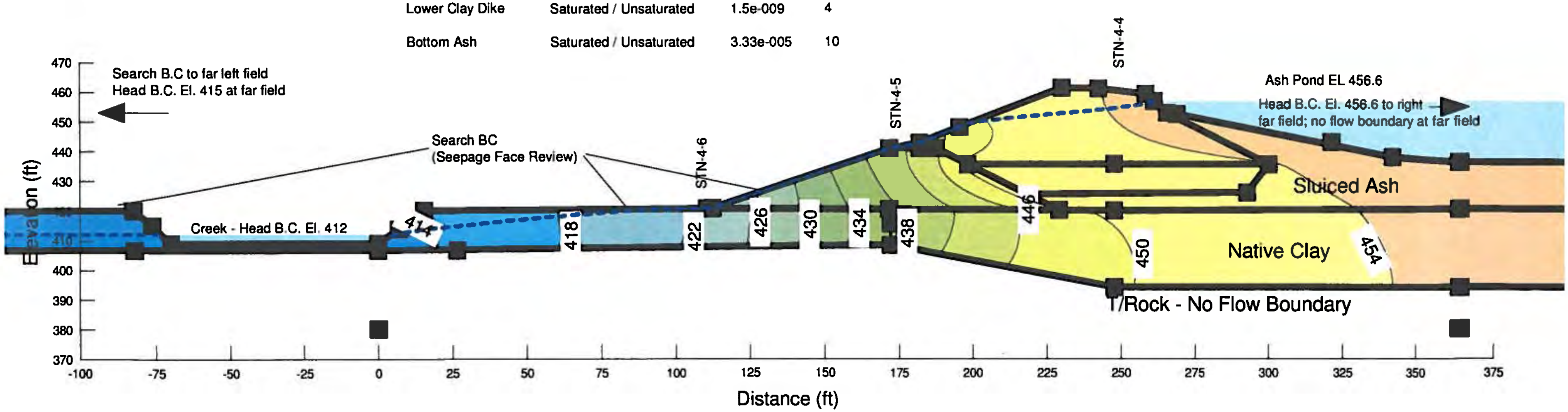


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 1A - Existing Conditions
Cross-Section B-B

Phreatic Surface and Total Head Contours

Material Layer	Model	Kv (cm/s)	Kh/Kv
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Upper Clay Dike	Saturated / Unsaturated	3.3e-009	4
Native Clay and Silt	Saturated / Unsaturated	8e-006	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10

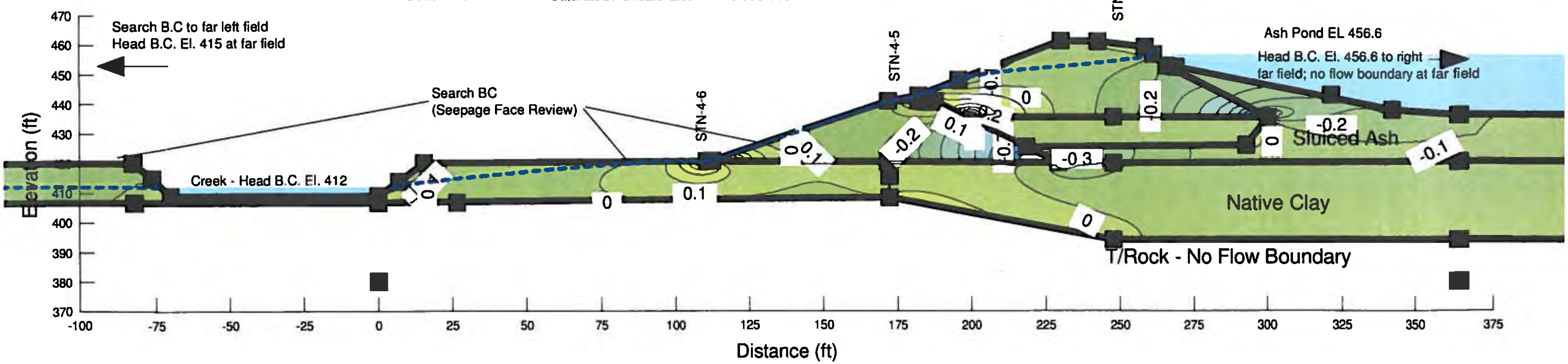


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 1A - Existing Conditions
Cross-Section B-B

Phreatic Surface and Vertical Gradient Contours

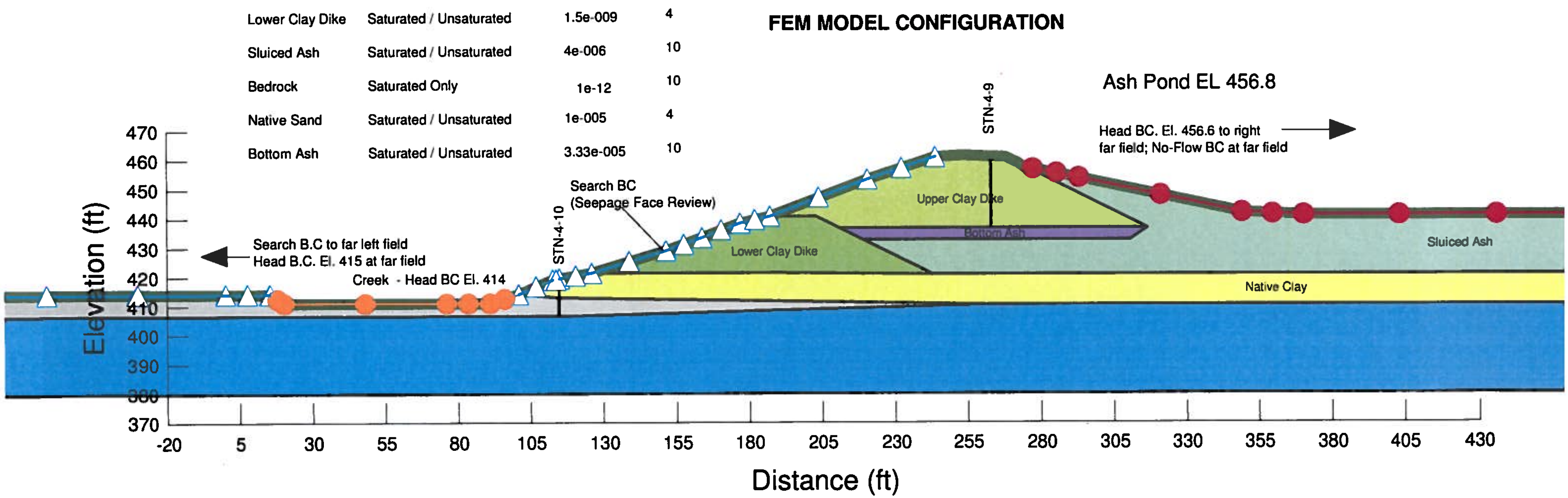
Material Layer	Model	Kv (cm/s)	Kh/Kv
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Upper Clay Dike	Saturated / Unsaturated	3.3e-009	4
Native Clay and Silt	Saturated / Unsaturated	8e-006	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10



Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 1B - Existing Conditions
Cross-Section D-D

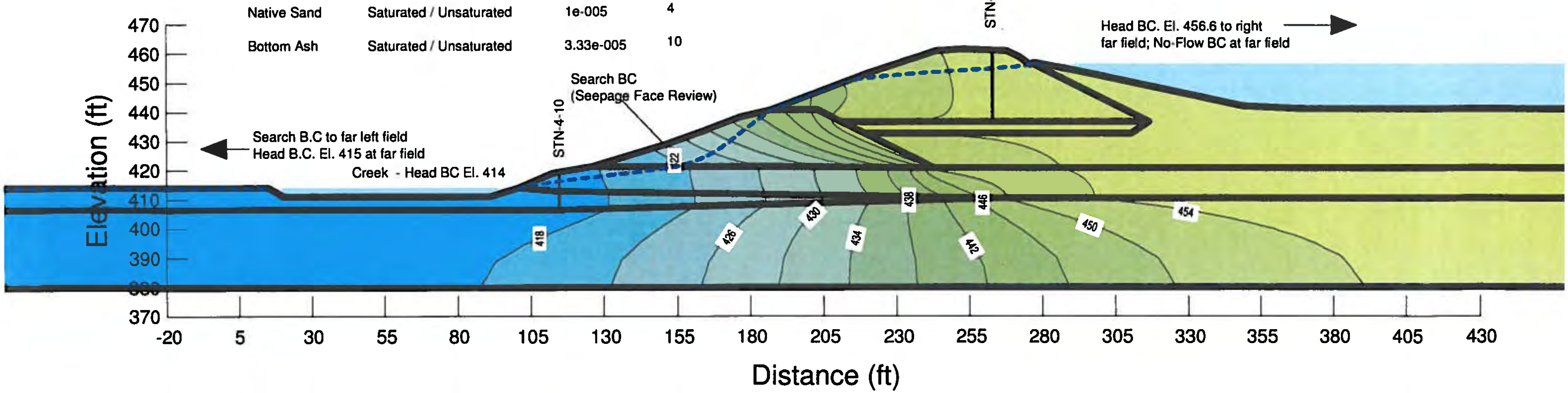
Material	Model	Kv (ft/s)	Kh/Kv
Native Clay	Saturated / Unsaturated	8e-007	4
Upper Clay Dike	Saturated / Unsaturated	3e-009	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Bedrock	Saturated Only	1e-12	10
Native Sand	Saturated / Unsaturated	1e-005	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10



Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 1B - Existing Conditions
Cross-Section D-D

Material	Model	Kv (ft/s)	Kh/Kv
Native Clay	Saturated / Unsaturated	8e-007	4
Upper Clay Dike	Saturated / Unsaturated	3e-009	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Bedrock	Saturated Only	1e-12	10
Native Sand	Saturated / Unsaturated	1e-005	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10

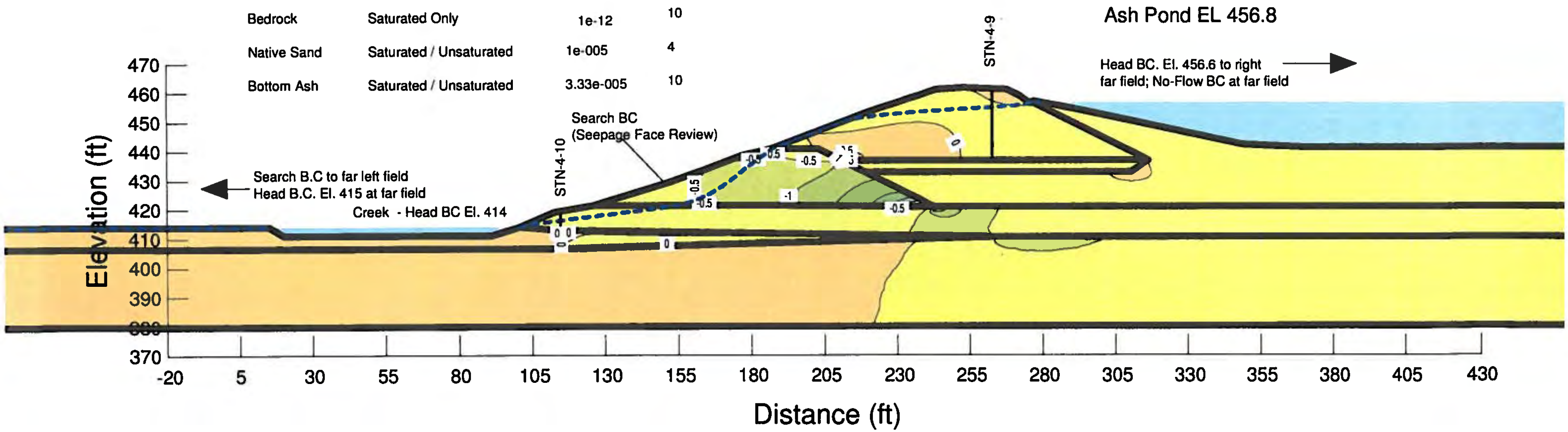


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 1B - Existing Conditions
Cross-Section D-D

Material	Model	Kv (ft/s)	Kh/Kv
Native Clay	Saturated / Unsaturated	8e-007	4
Upper Clay Dike	Saturated / Unsaturated	3e-009	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Bedrock	Saturated Only	1e-12	10
Native Sand	Saturated / Unsaturated	1e-005	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10

PHREATIC LINE WITH VERTICAL GRADIENT CONTOURS

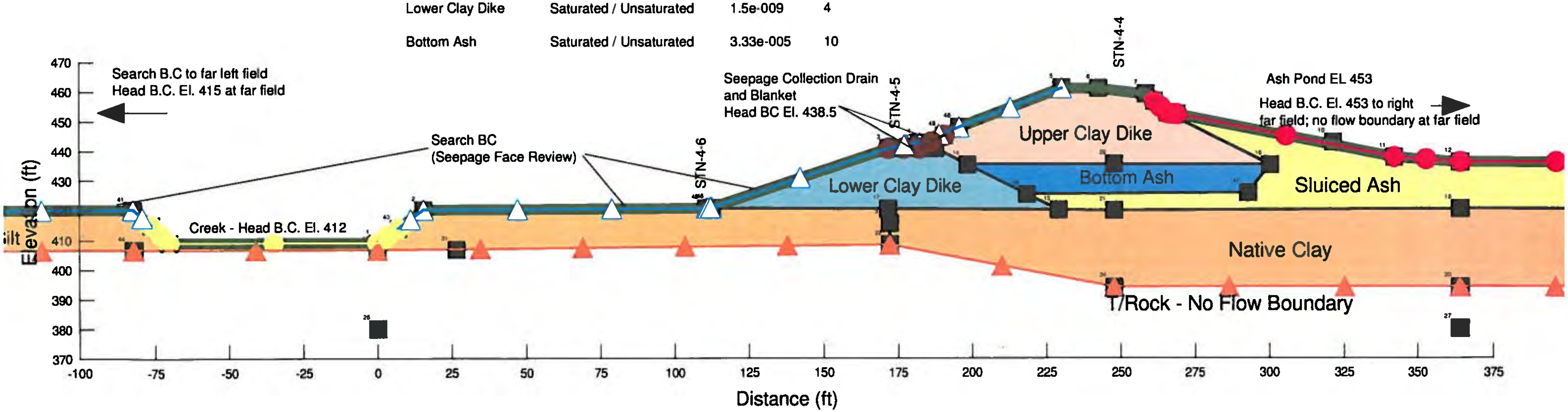


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 2A - Long Term Proposed Conditions
Cross-Section B-B

FEM Model Configuration

Material Layer	Model	Kv (cm/s)	Kh/Kv
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Upper Clay Dike	Saturated / Unsaturated	3.3e-009	4
Native Clay and Silt	Saturated / Unsaturated	8e-006	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10

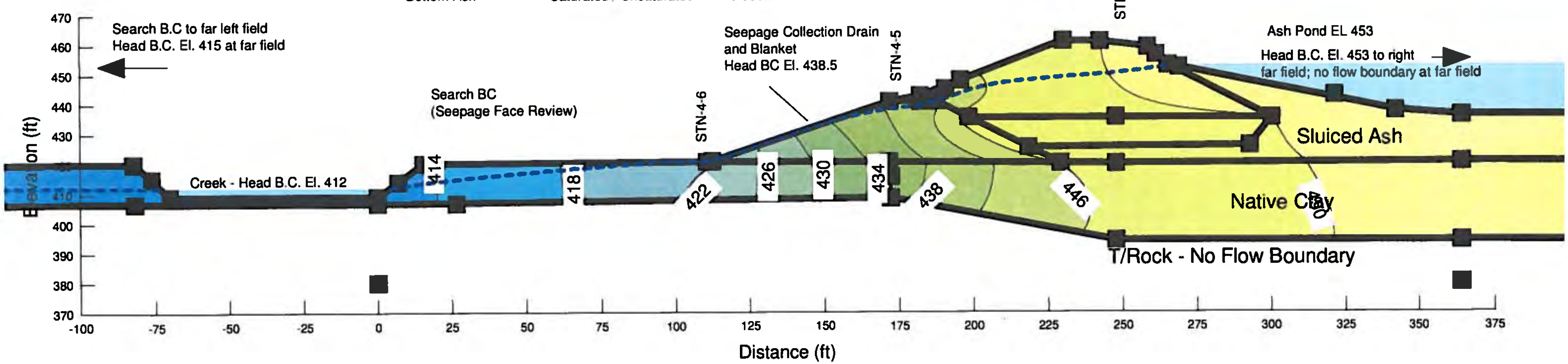


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 2A - Long Term Proposed Conditions
Cross-Section B-B

Phreatic Surface and Total Head Contours

Material Layer	Model	Kv (cm/s)	Kh/Kv
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Upper Clay Dike	Saturated / Unsaturated	3.3e-009	4
Native Clay and Silt	Saturated / Unsaturated	8e-006	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10

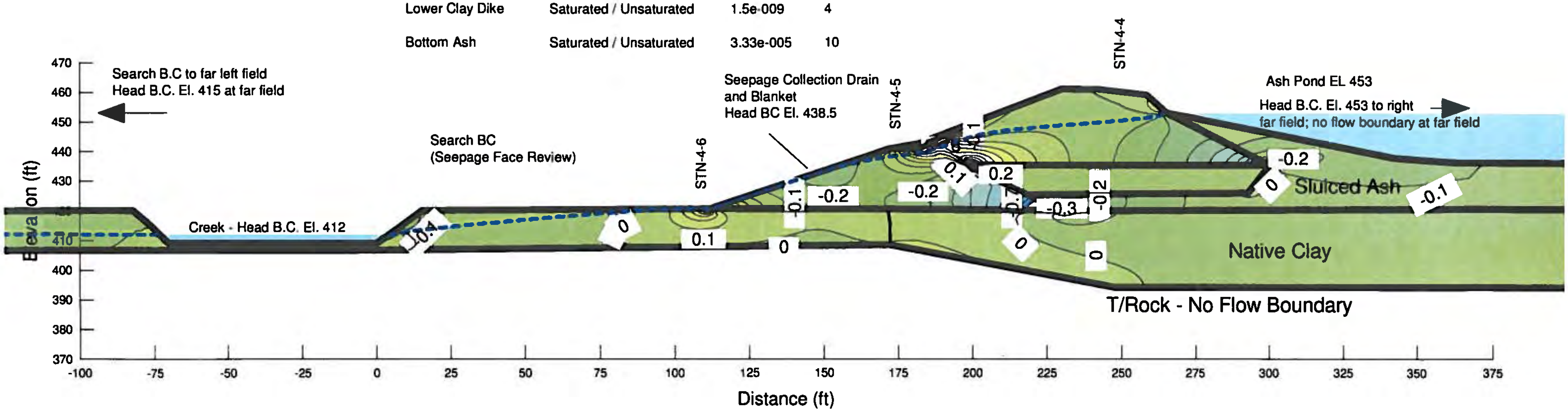


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 2A - Long Term Proposed Conditions
Cross-Section B-B

Phreatic Surface and Vertical Gradient Contours

Material Layer	Model	Kv (cm/s)	Kh/Kv
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Upper Clay Dike	Saturated / Unsaturated	3.3e-009	4
Native Clay and Silt	Saturated / Unsaturated	8e-006	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10



Slope Stability Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 2A - Long Term Proposed Conditions
Cross-Section B-B

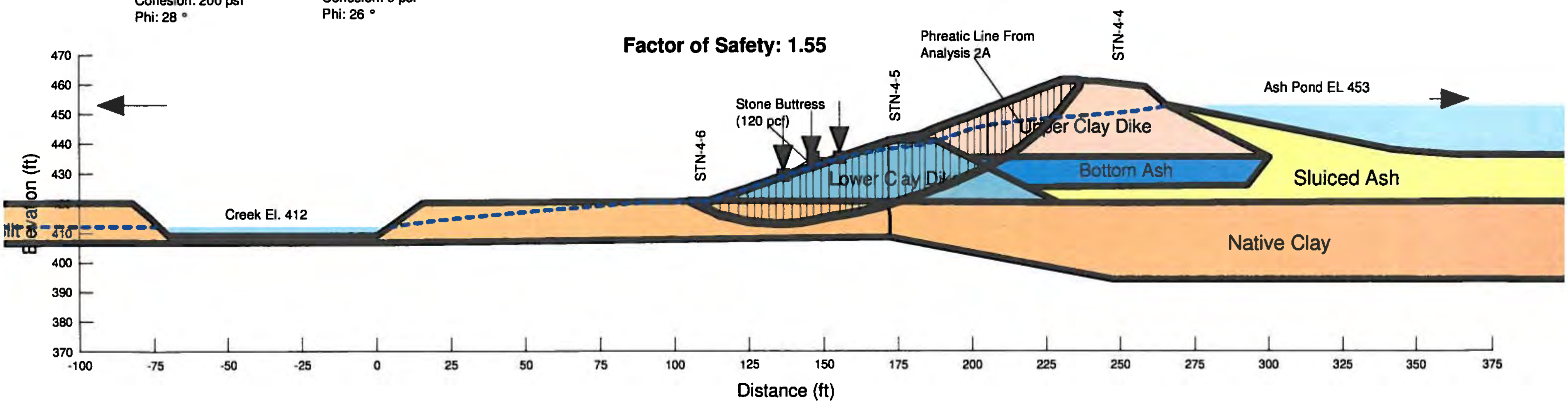
Name: Lower Clay Dike
Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 29 °

Name: Upper Clay Dike
Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 200 psf
Phi: 28 °

Name: Bottom Ash
Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion: 0 psf
Phi: 34 °

Name: Native Clay and Silt
Model: Mohr-Coulomb
Unit Weight: 129 pcf
Cohesion: 200 psf
Phi: 28 °

Name: Sluiced Ash
Model: Mohr-Coulomb
Unit Weight: 85 pcf
Cohesion: 0 psf
Phi: 26 °

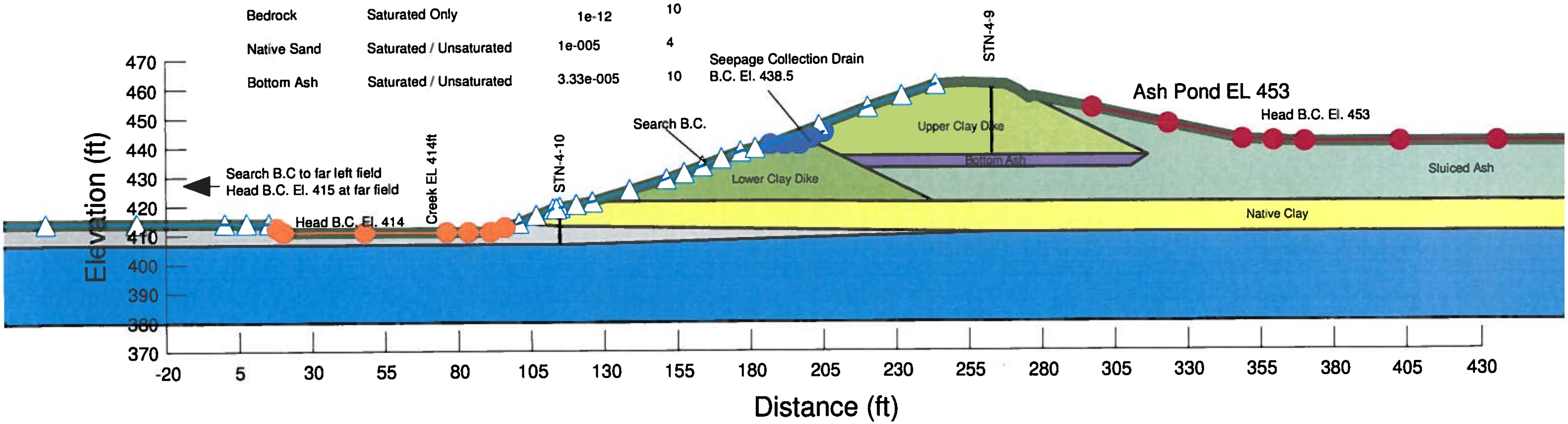


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 2B - Long-Term Proposed Conditions
Cross-Section D-D

Material	Model	Kv (ft/s)	Kh/Kv
Native Clay	Saturated / Unsaturated	8e-007	4
Upper Clay Dike	Saturated / Unsaturated	3e-009	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Bedrock	Saturated Only	1e-12	10
Native Sand	Saturated / Unsaturated	1e-005	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10

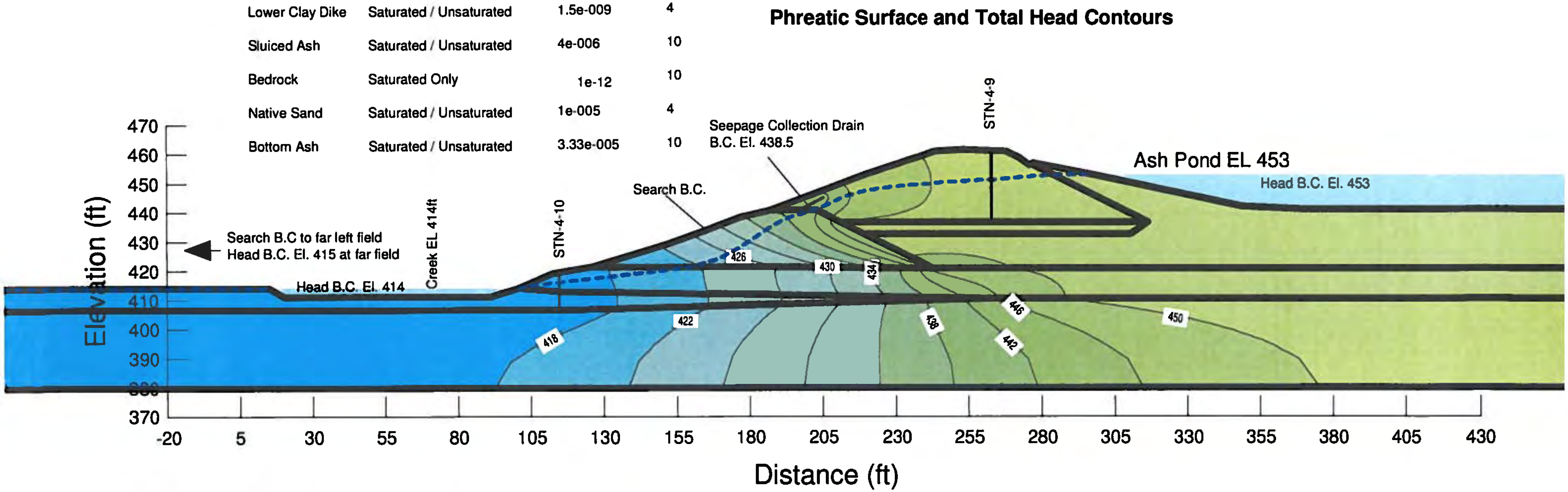
FEM Model Setup



Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 2B - Long-Term Proposed Conditions
Cross-Section D-D

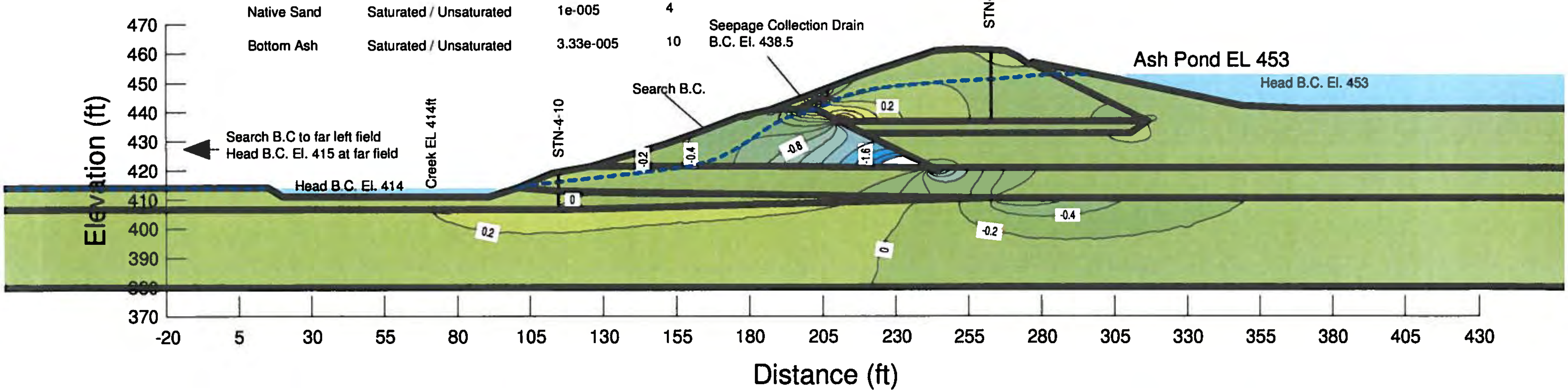
Material	Model	Kv (ft/s)	Kh/Kv
Native Clay	Saturated / Unsaturated	8e-007	4
Upper Clay Dike	Saturated / Unsaturated	3e-009	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Bedrock	Saturated Only	1e-12	10
Native Sand	Saturated / Unsaturated	1e-005	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10



Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 2B - Long-Term Proposed Conditions
Cross-Section D-D

Material	Model	Kv (ft/s)	Kh/Kv
Native Clay	Saturated / Unsaturated	8e-007	4
Upper Clay Dike	Saturated / Unsaturated	3e-009	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Bedrock	Saturated Only	1e-12	10
Native Sand	Saturated / Unsaturated	1e-005	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10



Slope Stability Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 2B - Long-Term Proposed Conditions
Cross-Section D-D

Name: Lower Clay Dike
Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 29 °

Name: Upper Clay Dike
Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 200 psf
Phi: 28 °

Name: Sluiced Ash
Model: Mohr-Coulomb
Unit Weight: 85 pcf
Cohesion: 0 psf
Phi: 26 °

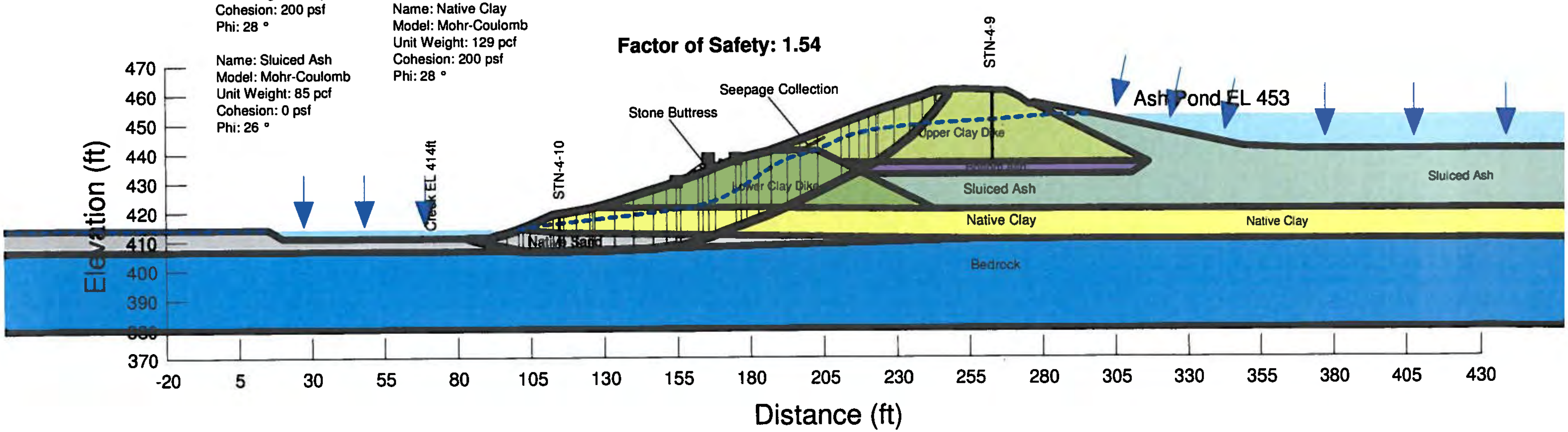
Name: Bedrock
Model: Bedrock (Impenetrable)

Name: Native Sand
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 30 °

Name: Native Clay
Model: Mohr-Coulomb
Unit Weight: 129 pcf
Cohesion: 200 psf
Phi: 28 °

Name: Bottom Ash
Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion: 0 psf
Phi: 34 °

Factor of Safety: 1.54

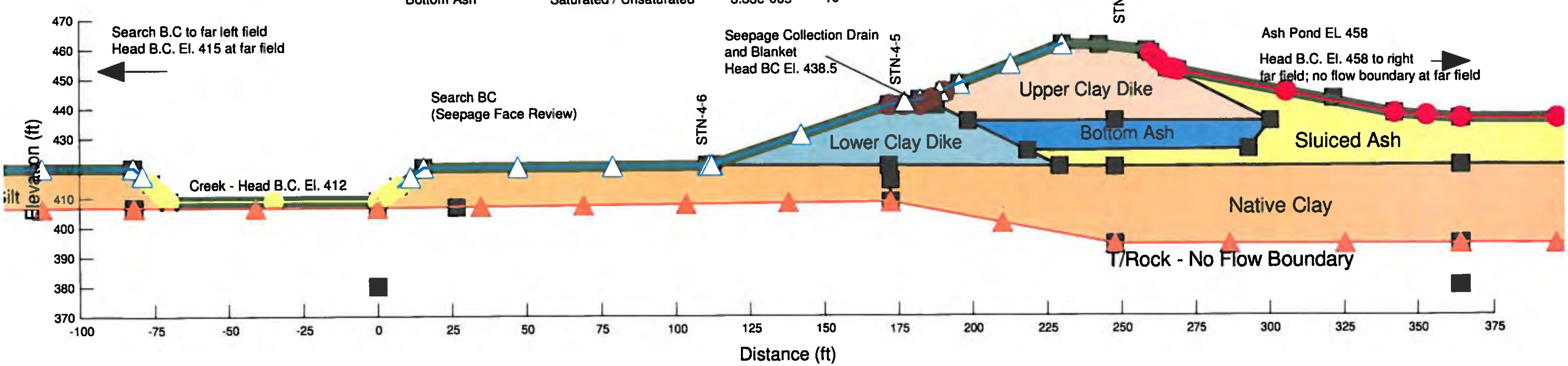


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 3A - Maximum Pool Conditions
Cross-Section B-B

FEM Model Configuration

Material Layer	Model	Kv (cm/s)	Kh/Kv
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Upper Clay Dike	Saturated / Unsaturated	3.3e-009	4
Native Clay and Silt	Saturated / Unsaturated	8e-006	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10

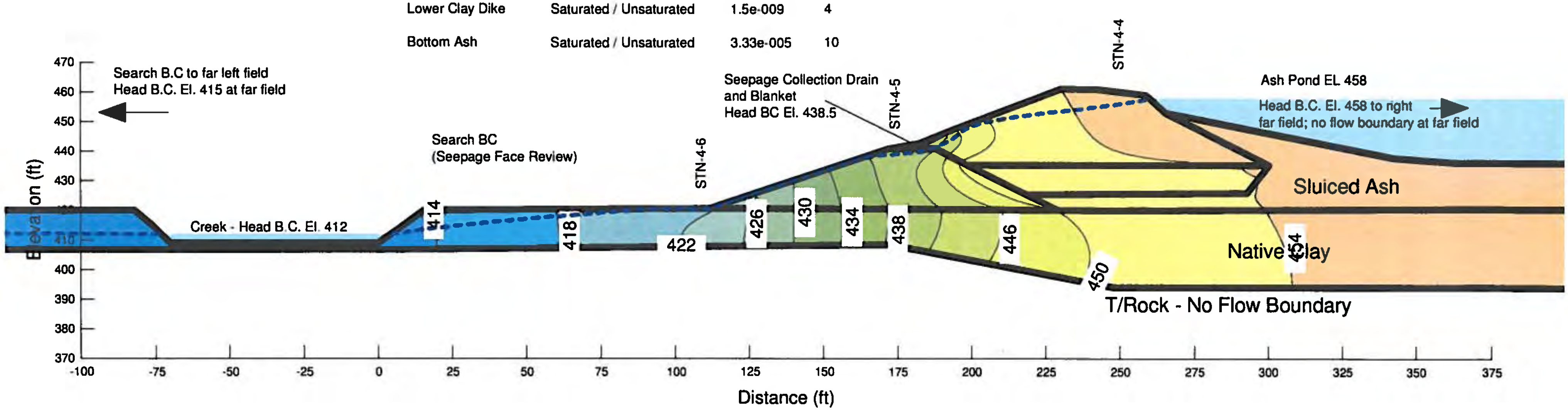


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 3A - Maximum Pool Conditions
Cross-Section B-B

Phreatic Line and Total Head Contours

Material Layer	Model	Kv (cm/s)	Kh/Kv
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Upper Clay Dike	Saturated / Unsaturated	3.3e-009	4
Native Clay and Silt	Saturated / Unsaturated	8e-006	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10

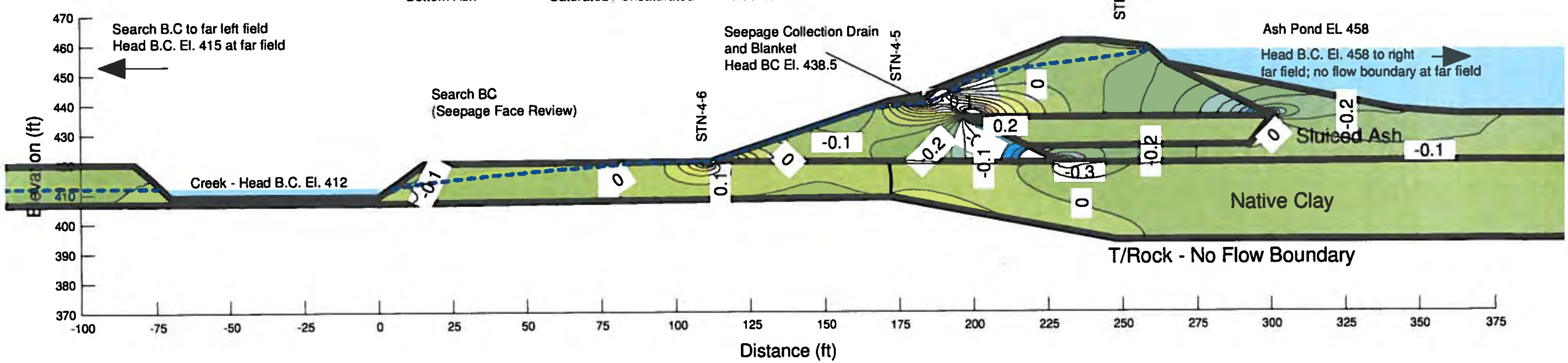


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 3A - Maximum Pool Conditions
Cross-Section B-B

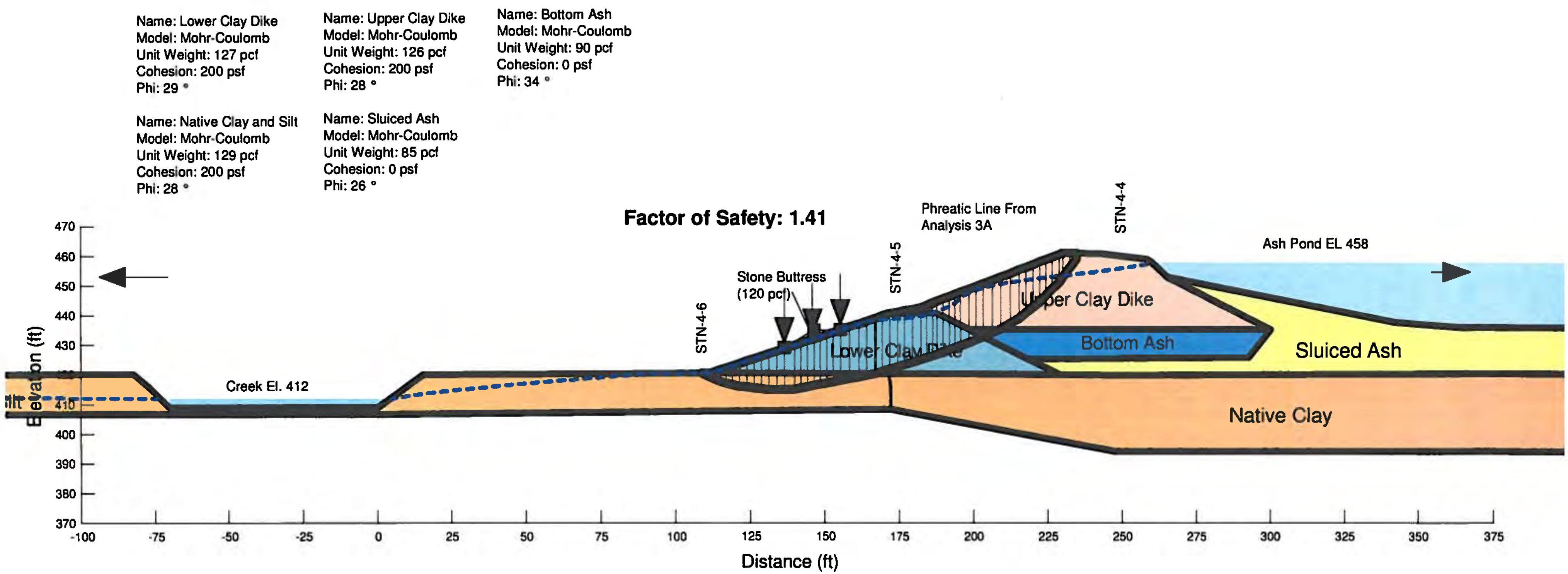
Phreatic Line and Vertical Gradient Contours

Material Layer	Model	Kv (cm/s)	Kh/Kv
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Upper Clay Dike	Saturated / Unsaturated	3.3e-009	4
Native Clay and Silt	Saturated / Unsaturated	8e-006	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10



Slope Stability Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 3A - Maximum Pool Conditions
Cross-Section B-B

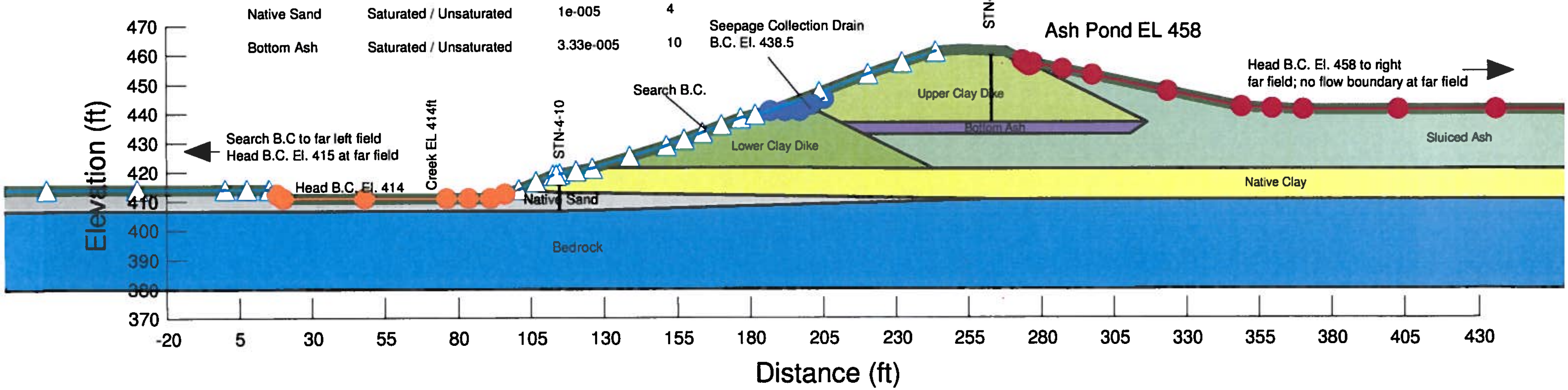


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 3B - Maximum Pool Conditions
Cross-Section D-D

Material	Model	Kv (ft/s)	Kh/Kv
Native Clay	Saturated / Unsaturated	8e-007	4
Upper Clay Dike	Saturated / Unsaturated	3e-009	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Bedrock	Saturated Only	1e-12	10
Native Sand	Saturated / Unsaturated	1e-005	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10

FEM Model Configuration

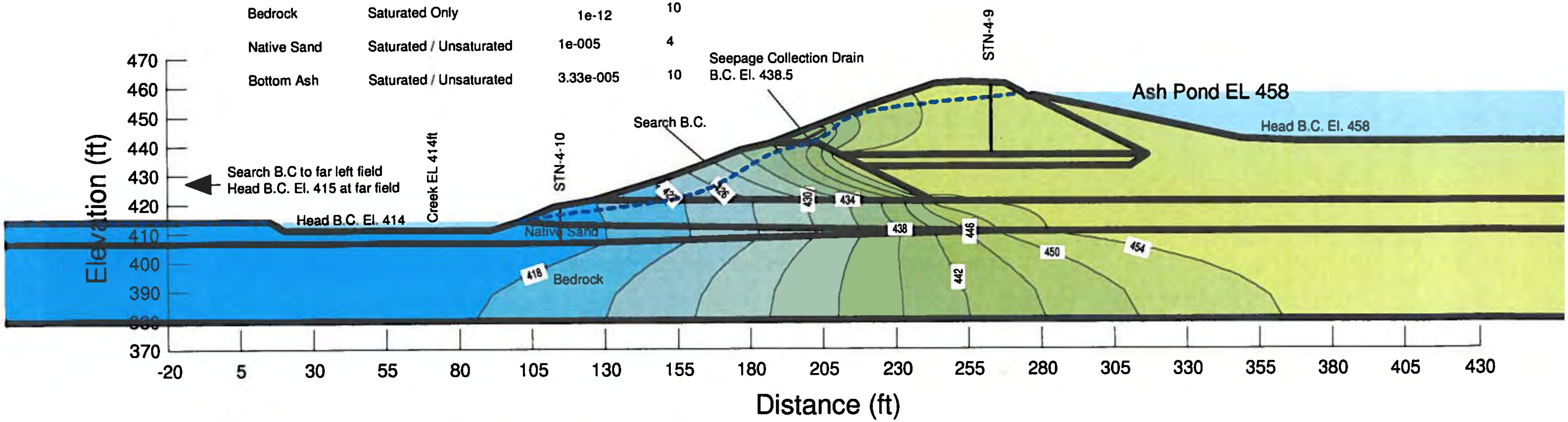


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 3B - Maximum Pool Conditions
Cross-Section D-D

Material	Model	Kv (ft/s)	Kh/Kv
Native Clay	Saturated / Unsaturated	8e-007	4
Upper Clay Dike	Saturated / Unsaturated	3e-009	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Bedrock	Saturated Only	1e-12	10
Native Sand	Saturated / Unsaturated	1e-005	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10

Phreatic Line With Total Head Contours

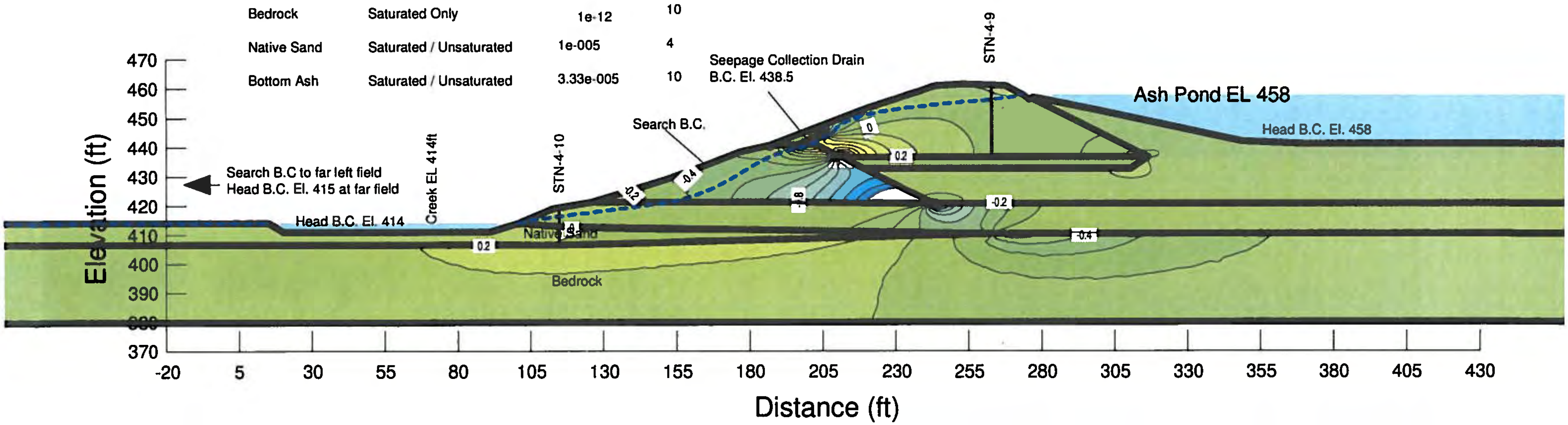


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 3B - Maximum Pool Conditions
Cross-Section D-D

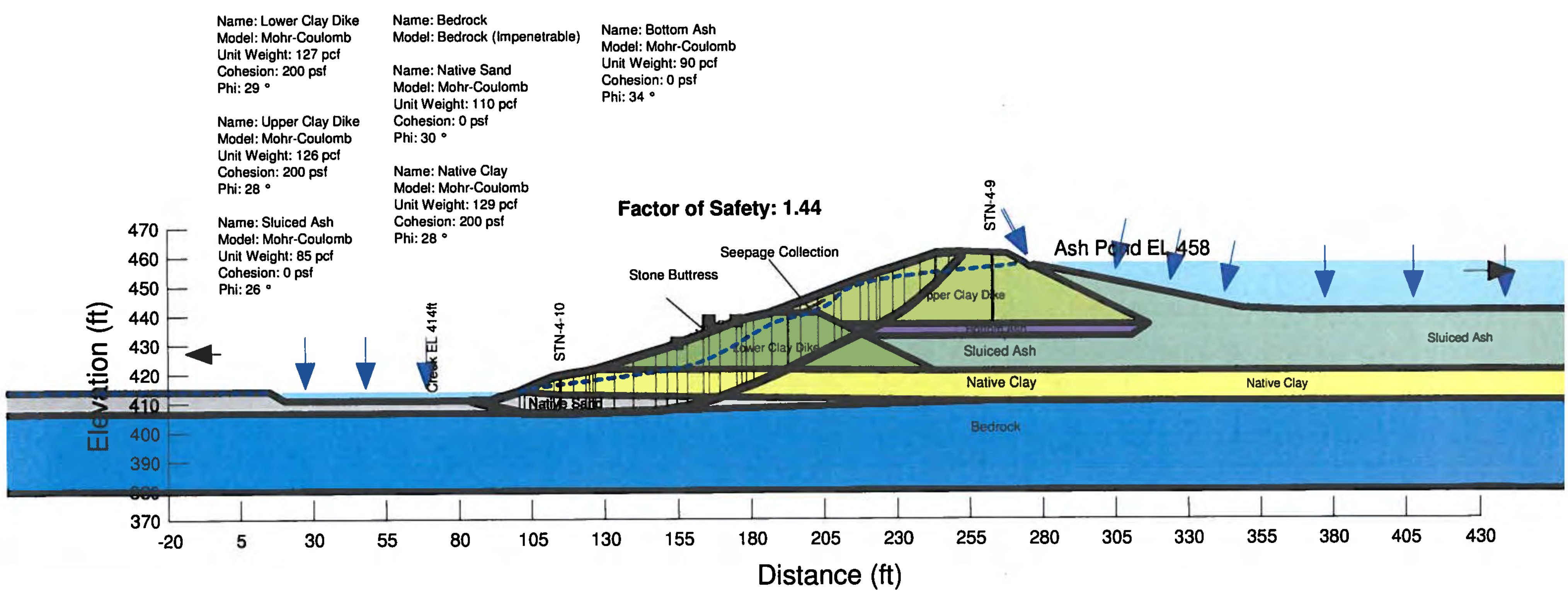
Material	Model	Kv (ft/s)	Kh/Kv
Native Clay	Saturated / Unsaturated	8e-007	4
Upper Clay Dike	Saturated / Unsaturated	3e-009	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Bedrock	Saturated Only	1e-12	10
Native Sand	Saturated / Unsaturated	1e-005	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10

Phreatic Line With Y-Gradient Contours



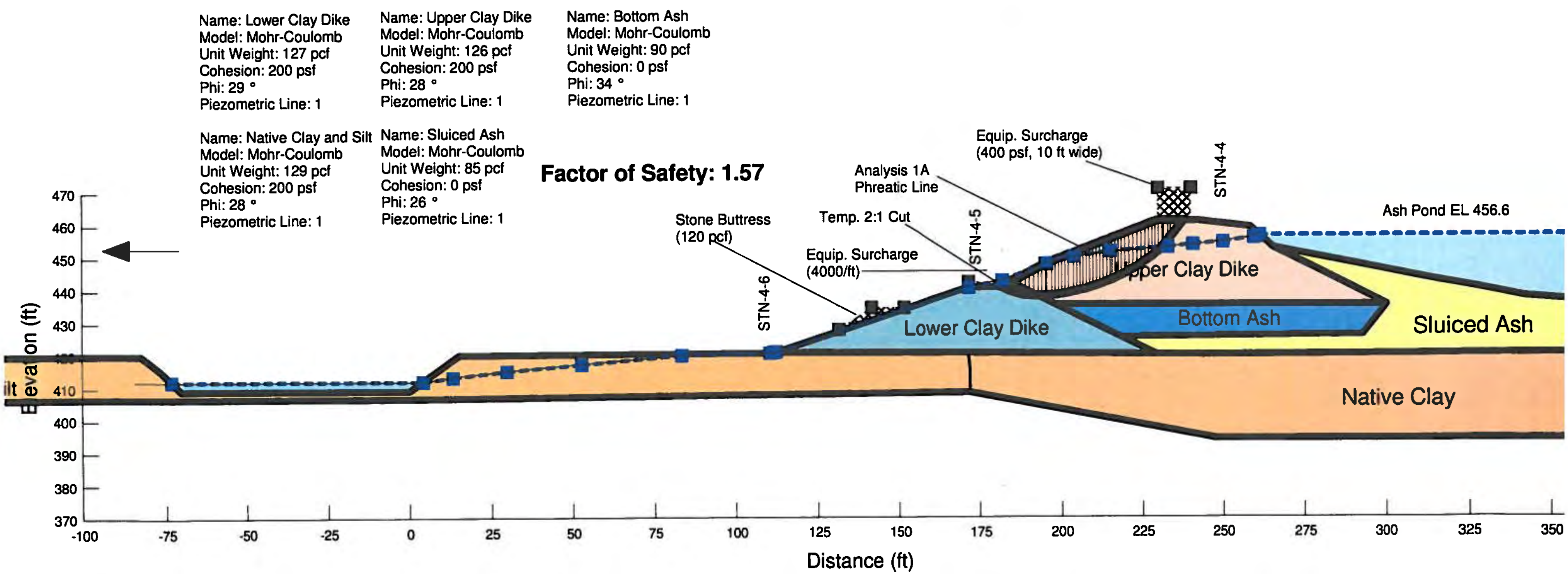
Slope Stability Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 3B - Maximum Pool Conditions
Cross-Section D-D



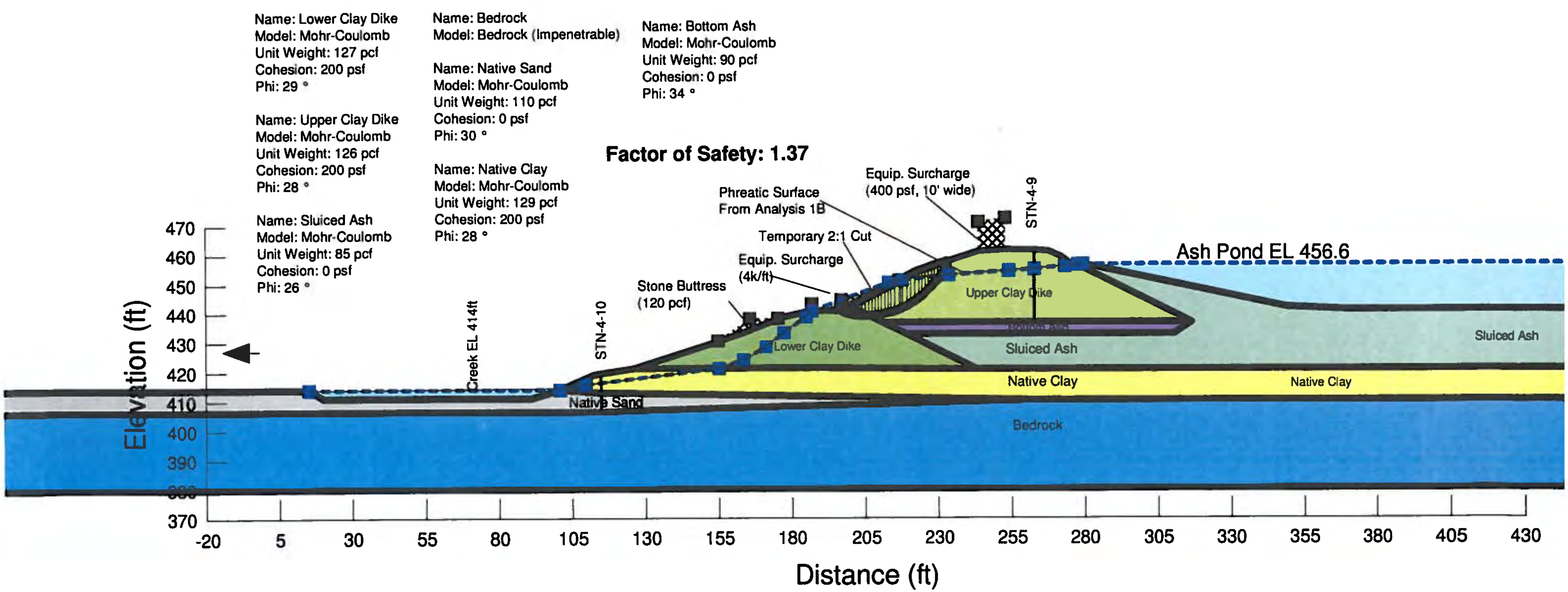
Slope Stability Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 4A - Temporary Cut At Midslope - Seepage Remediation
Cross-Section B-B



Slope Stability Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 4B - Temp. Cut At Midslope - Seepage Remediation
Cross-Section D-D



Slope Stability Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 5A - Crane Surcharge At Crest - Temp. Buttress Construction
Cross-Section B-B - Inward Failure

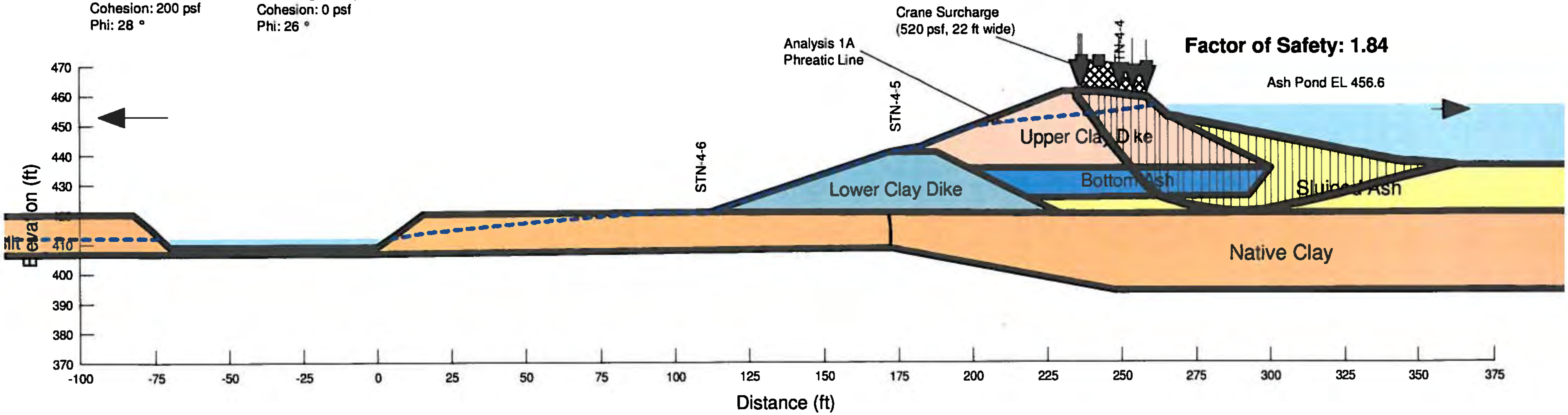
Name: Lower Clay Dike
Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 29 °

Name: Upper Clay Dike
Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 200 psf
Phi: 28 °

Name: Bottom Ash
Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion: 0 psf
Phi: 34 °

Name: Native Clay and Silt
Model: Mohr-Coulomb
Unit Weight: 129 pcf
Cohesion: 200 psf
Phi: 28 °

Name: Sluiced Ash
Model: Mohr-Coulomb
Unit Weight: 85 pcf
Cohesion: 0 psf
Phi: 26 °



Slope Stability Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 5B - Crane Surcharge At Crest - Temp. Buttress Construction
Cross-Section B-B - Outward Failure

Name: Lower Clay Dike
Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 29 °

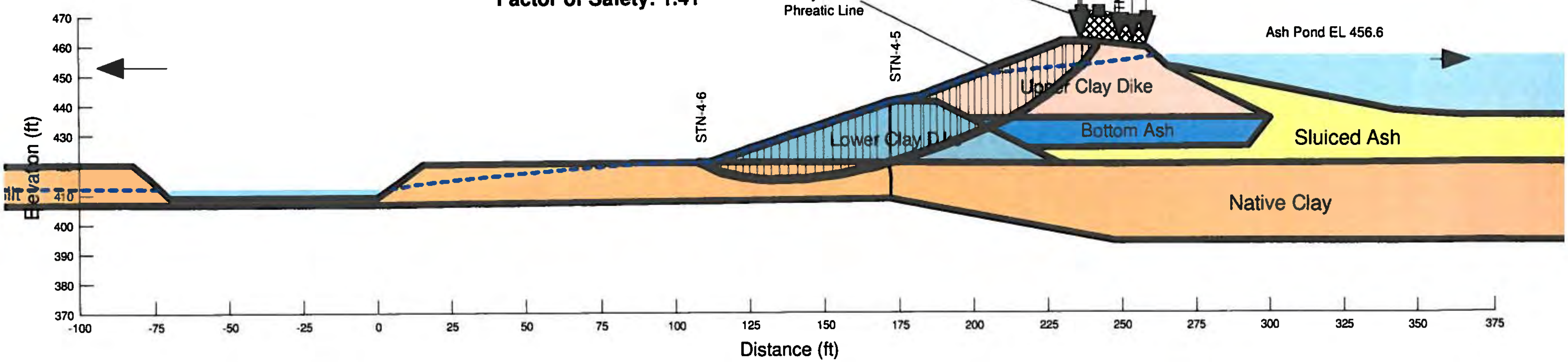
Name: Upper Clay Dike
Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 200 psf
Phi: 28 °

Name: Bottom Ash
Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion: 0 psf
Phi: 34 °

Name: Native Clay and Silt
Model: Mohr-Coulomb
Unit Weight: 129 pcf
Cohesion: 200 psf
Phi: 28 °

Name: Sluiced Ash
Model: Mohr-Coulomb
Unit Weight: 85 pcf
Cohesion: 0 psf
Phi: 26 °

Factor of Safety: 1.41

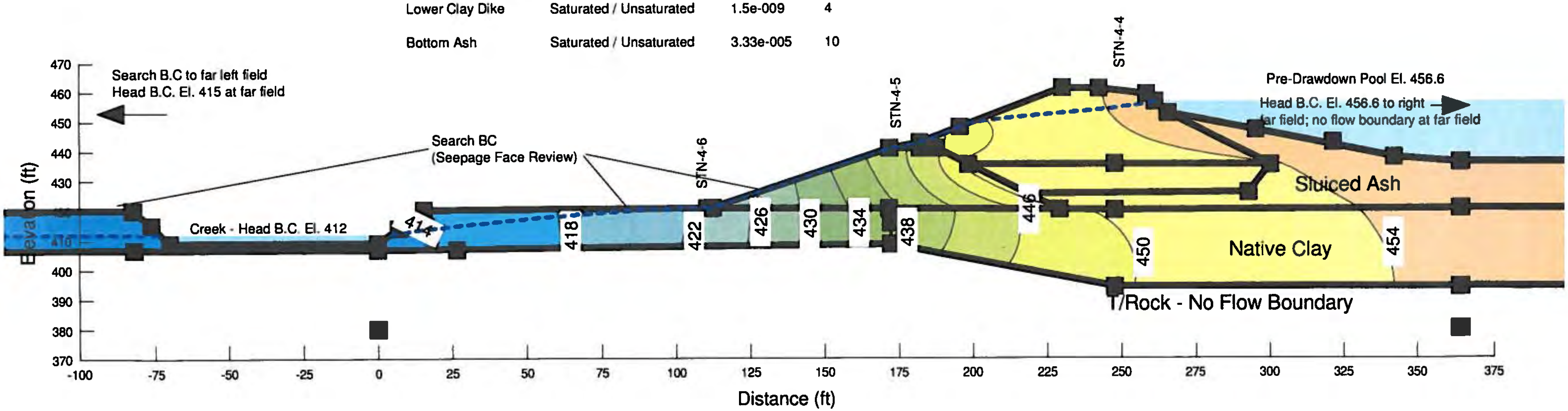


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 6 - Construction Rapid Drawdown Analysis
Cross-Section B-B

Phreatic Surface and Total Head Contours
Steady State at Pool El. 456.6 (Prior to Drawdown)

Material Layer	Model	Kv (cm/s)	Kh/Kv
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Upper Clay Dike	Saturated / Unsaturated	3.3e-009	4
Native Clay and Silt	Saturated / Unsaturated	8e-006	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10

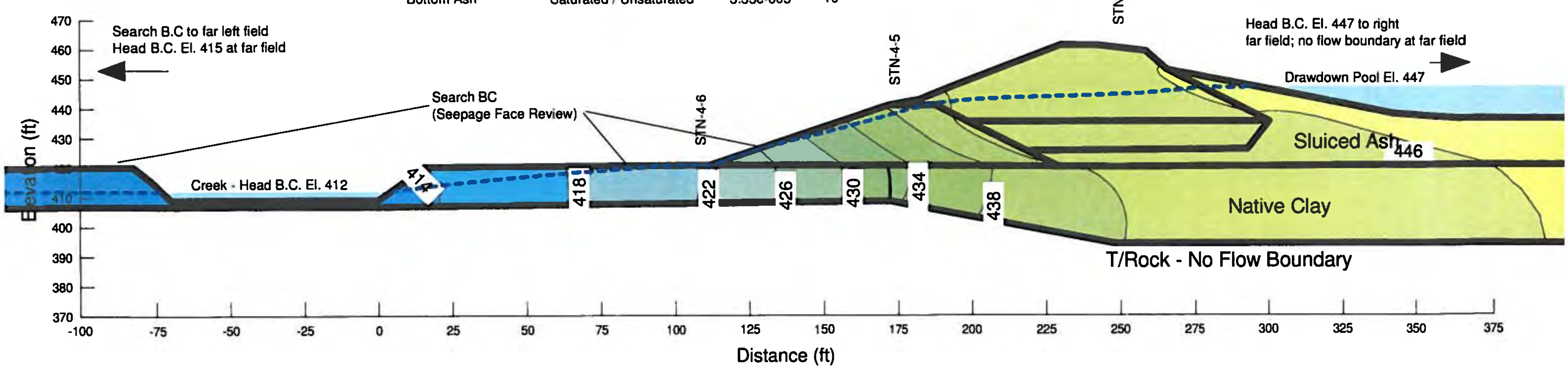


Seepage Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 6 - Construction Rapid Drawdown Analysis
Cross-Section B-B

Phreatic Surface and Total Head Contours
Steady State at Pool El. 447 (After Drawdown)

Material Layer	Model	Kv (cm/s)	Kh/Kv
Sluiced Ash	Saturated / Unsaturated	4e-006	10
Upper Clay Dike	Saturated / Unsaturated	3.3e-009	4
Native Clay and Silt	Saturated / Unsaturated	8e-006	4
Lower Clay Dike	Saturated / Unsaturated	1.5e-009	4
Bottom Ash	Saturated / Unsaturated	3.33e-005	10



Slope Stability Analysis
Ash Pond 4 Colbert Fossil Plant Tennessee Valley Authority

Analysis 6 - Construction Rapid Drawdown
Cross-Section B-B

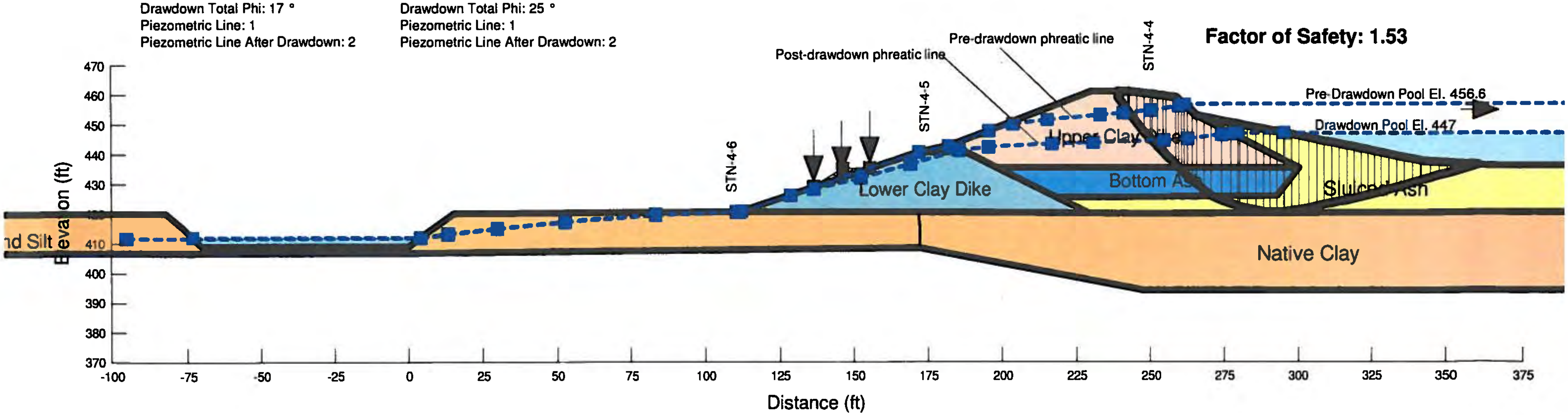
Name: Lower Clay Dike
Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 200 psf
Phi: 29 °
Drawdown Total Cohesion: 850 psf
Drawdown Total Phi: 17 °
Piezometric Line: 1
Piezometric Line After Drawdown: 2

Name: Upper Clay Dike
Model: Mohr-Coulomb
Unit Weight: 126 pcf
Cohesion: 200 psf
Phi: 28 °
Drawdown Total Cohesion: 700 psf
Drawdown Total Phi: 13 °
Piezometric Line: 1
Piezometric Line After Drawdown: 2

Name: Bottom Ash
Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion: 0 psf
Phi: 34 °
Drawdown Total Cohesion: 0 psf
Drawdown Total Phi: 0 °
Piezometric Line: 1
Piezometric Line After Drawdown: 2

Name: Native Clay and Silt
Model: Mohr-Coulomb
Unit Weight: 129 pcf
Cohesion: 200 psf
Phi: 28 °
Drawdown Total Cohesion: 700 psf
Drawdown Total Phi: 17 °
Piezometric Line: 1
Piezometric Line After Drawdown: 2

Name: Sluiced Ash
Model: Mohr-Coulomb
Unit Weight: 85 pcf
Cohesion: 0 psf
Phi: 26 °
Drawdown Total Cohesion: 125 psf
Drawdown Total Phi: 25 °
Piezometric Line: 1
Piezometric Line After Drawdown: 2



APPENDIX A

Document 11

Report of Geotechnical Exploration and Slope Stability Evaluation, Disposal Area 5 Dry Stack and Drainage Basin, Colbert Fossil Plant, Tuscumbia, Alabama, Stantec Consulting Services, March 26, 2010

Stantec

Report of Geotechnical Exploration and Slope Stability Evaluation

Disposal Area 5 Dry Stack and Drainage Basin
Colbert Fossil Plant
Tuscumbia, Alabama

Stantec Consulting Services Inc.
One Team. Infinite Solutions.
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Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

March 26, 2010

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March 26, 2010

rpt_001_175559019

Mr. Barry Snider, PE
Tennessee Valley Authority
1101 Market Street
LP 2N
Chattanooga, Tennessee 37402

Re: Report of Geotechnical Exploration and Slope Stability Evaluation
Disposal Area 5 Dry Stack and Drainage Basin
Colbert Fossil Plant
Tuscumbia, Alabama

Dear Mr. Snider:

As requested, Stantec Consulting Services Inc. (Stantec) has completed our Geotechnical Exploration and Slope Stability Evaluation for the Disposal Area 5 at the Colbert Fossil Plant. The report documents the subsurface conditions, results of laboratory testing, findings from the historical document reviews, results of our analyses and evaluation, and recommendations for 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, feel free to contact our office.

Sincerely,

STANTEC CONSULTING SERVICES INC.

Paul J. Cooper, PE
Project Engineer

Randy L. Roberts, PE
Senior Associate

/day

Enclosures

Report of Geotechnical Exploration and Slope Stability Evaluation

Disposal Area 5 Dry Stack and Drainage Basin
Colbert Fossil Plant
Tuscumbia, Alabama

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

March 26, 2010

Report of Geotechnical Exploration and Slope Stability Evaluation

Disposal Area 5 Dry Stack and Drainage Basin
Colbert Fossil Plant
Tuscumbia, Alabama

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Appendix

Executive Summary

Stantec Consulting Services Inc. (Stantec) has completed the Geotechnical Exploration and Slope Stability Evaluation at Colbert Fossil Plant's (COF) Disposal Area 5 Dry Stack and Drainage Basin. This study was performed to evaluate slope stability and seepage for the existing conditions.

Background Information

The Disposal Area 5 Dry Stack is approximately 75 acres in area, and is enclosed by a perimeter dike system that is approximately 7,500 feet in total length. The disposal area was originally used as a dredge cell, receiving dredged ash material from Ash Pond 4. In 1990 dredging was stopped and disposal methods were converted to dry stacking. Slopes of the dry stack are approximately 3H:1V to 4H:1V, with benches located on 20-foot height intervals. The stack height is approaching about 90 to 100 feet. A perimeter drainage ditch is located between the perimeter dikes and the stacked ash. The ditch conveys surface water runoff from the stack area to a drainage basin located to the northwest. The dry stack is nearing capacity, and URS Corporation is conducting a siting study for a new fly ash landfill on the COF reservation. URS will also be preparing a closure design for the existing dry stack.

Historical geotechnical issues include the occurrence of seepage boils from time to time in the perimeter ditch in the vicinity of the southeast corner of the stack. On August 27, 2009 COF personnel discovered a new seepage boil in the perimeter ditch along the southeast side of the stack. Two additional seepage boils were also discovered about one month later along the northwest. As a result, Stantec prepared a construction Work Plan for interim mitigation. It included placement of rock protection/weighted filter systems at the two intervals where the boils occurred. The historical documents reviewed do not indicate a history of slope instability or seepage along the exterior of the perimeter dikes. In addition, signs of slope instability or external seepage have not been observed in the field by Stantec throughout the course of this work. Other issues include poor drainage characteristics and sedimentation accumulation within the perimeter drainage ditch.

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 46 locations. In addition, 44 piezometers were installed to monitor groundwater levels. Drilling locations were positioned along 12 cross-sections. The laboratory testing program included moisture content, classification, permeability and shear strength testing to establish key index properties and strength parameters.

Results of Exploration and Engineering Analyses

The results from the geotechnical exploration indicate that the perimeter dike systems for both the stack and basin consist primarily of clay. Inside the dikes surrounding the stack, the exploration detected sluiced ash ranging from about 15 to 25 feet thick, overlain by dry stacked fly ash. The disposal area is underlain by native clays and then by limestone bedrock.

Following the drilling and laboratory testing program, slope stability and seepage analyses were performed to quantify factors of safety for existing conditions. The analysis focused on seven cross-sections that were selected to represent typical conditions for the facility. Six sections were selected for the stack and one was selected for the drainage basin.

To evaluate the seepage conditions, a finite element model was developed for three cross-sections. Two cross-sections were selected along the dry stack to represent the areas where recent seepage boils had occurred, and one section was selected to represent the drainage basin. The main purpose of the seepage analysis of the stack was to check for model prediction of a critical vertical exit gradient at the locations of the seepage boils to reconcile field observations. No further seepage analysis was performed for the stack since it is not impounding water. To judge whether or not a tendency for piping is possible, factors of safety can be calculated using the vertical exit gradients as predicted by the seepage models. For the two sections analyzed for the stack, the seepage models do predict the potential for seepage outbreaks within the perimeter ditch, as shown by the predicted shape of the phreatic surface. The seepage models also show maximum vertical exit gradients occurring within the perimeter ditch, along with corresponding factors of safety against piping near one. These results are consistent with the observation of recurring seepage boils at the areas represented by the cross-sections. Based on the U.S. Army Corps of Engineers (USACE) design criteria for dams, Stantec recommends a value of three as a minimum target factor of safety against piping. For the cross-section representing the adjacent drainage basin, the seepage analyses did not predict a critical vertical gradient exit point and the resulting factor of safety against piping for the drainage basin is much greater than the target value of three.

Slope stability of the dry stack and adjacent drainage basin was also evaluated. Factors of safety for slope stability were computed using Spencer's method of analysis, circular and non-circular slip surfaces, and search routines that help to identify the critical (minimum factor of safety) failure surface. The results of the static, drained slope stability analysis demonstrate that the factors of safety range from approximately 1.3 to greater than 1.5. TVA has adopted a minimum target factor of safety of 1.5 against drained slope stability based on USACE criteria. The deficient factors of safety occur on three of the seven cross-sections and represent failure surfaces that are along the toe of the dry stack just above the perimeter ditch, below the first bench, and that are contained within the perimeter dike system. Stantec also analyzed additional potential failure surfaces that extend farther into the stack and to greater depths to check factors of safety for more global-type failures. Factors of safety for these deeper, surfaces are all greater than the target value of 1.5. The results of the slope stability analyses performed for two cross-sections representing static, undrained loading conditions indicate factors of safety ranging from 1.3 to greater than 2. These are greater than the target minmum factors of safety for undrained conditions.

In conclusion, it is recommended that mitigation procedures be implemented to address the static, drained slope stability and perimeter ditch seepage issues identified. Stantec understands that mitigation features will be incorporated into a phased closure design to be performed by URS Corporation. Mitigation features should include means for collecting toe seepage, regrading and/or buttressing of the stack toe area, and other stormwater management improvements.

Report of Geotechnical Exploration and Slope Stability Evaluation

Disposal Area 5 Dry Stack and Drainage Basin
Colbert Fossil Plant
Tuscumbia, Alabama

1. Introduction

In January 2009, the Tennessee Valley Authority (TVA) requested that Stantec Consulting Services Inc. (Stantec) conduct assessments of its coal combustion product (CCP) disposal facilities at one closed, and eleven active, fossil plants. The plants are located in the states of Kentucky, Tennessee and Alabama. The assessments were performed for the purpose of determining if conditions were present to indicate an unstable condition that could possibly cause a release of CCP's into the environment.

Stantec's scope of services for the assessments was developed within the framework of current dam safety practice, and was performed in phases. Phase 1 included review of available documentation, site reconnaissance, field measurements, and providing recommendations for interim corrective measures, improvements, and further engineering studies. The Report of Phase 1 Facility Assessment for Coal Combustion Product Impoundments and Disposal Facilities for the two Alabama plants was completed on June 24, 2009. The conclusions and recommendations for the Disposal Area 5 at the Colbert Fossil Plant (COF) are included in that Phase 1 report. In addition to issues that require maintenance-type remedial activities, the Phase 1 recommendations included conducting a Phase 2 geotechnical exploration to evaluate slope stability for the Disposal Area 5 at COF. As a result, the following geotechnical evaluation was authorized by TVA under Engineering Services Request ESR/TAO 894. This report documents the scope and results of the study and contains Stantec's conclusions and recommendations concerning existing slope stability for the Disposal Area 5 Dry Stack and Drainage Basin.

2. Site Description and Geology

2.1. Location and Description

The Colbert Fossil Plant is located in Tuscumbia, Colbert County, Alabama on the south bank of Pickwick Reservoir along the Tennessee River, approximately 50 miles west of Decatur in northwest Alabama. Disposal Area 5 is situated approximately 5,000 feet southeast of the plant's powerhouse. This disposal area is bordered by US Highway 72 to the south, the Tennessee River to the north, and a water treatment facility to the southeast. Figure 2.1 on the following page provides a plan view of Colbert's Disposal Area 5.

The Disposal Area 5 Dry Stack is approximately 75 acres in area, and is enclosed by a perimeter dike system that is approximately 7,500 feet in total length. The dike crest supports a gravel access road and is currently at an approximate elevation of 480 to 490 feet. The overall constructed height of the perimeter dike system varies from approximately 10 feet on the southwest side to about 30 feet at other locations. Dike slopes range from

Colbert Fossil Plant, Disposal Area 5 **Tuscumbia, Alabama**	**Figure 2.1. Disposal Area 5 Overview**
Stantec	

approximately 1.5:1V to 2.5H:1V. The slopes are typically vegetated with thick grasses. Trees once existed at various locations around the stack (primarily along the northwest and southwest exterior dike faces), but these have been removed. The interior area was originally used as a dredge cell, receiving dredged ash material from Ash Pond 4. In 1990 dredging was stopped, and disposal methods were converted to a dry stacking operation. Dry fly ash has been placed over the old dredge cells, and is now approaching 90 to 100 feet in height. Slopes of the dry stack are approximately 3.5H:1V to 4H:1V, with benches located on 20-foot height intervals. A perimeter drainage ditch is located between the perimeter dikes and the stacked ash. The ditch encompasses the entire stack and collects surface water runoff from the stack area. The high point is located near the south corner and the ditch drains to the Disposal Area 5 Drainage Basin located northwest of the stack. This drainage basin is approximately 12 acres in size, and has a perimeter dike totaling approximately 3,000 feet in length with a maximum dike height of about 17 feet.

The Disposal Area 5 Dry Stack is nearing capacity, and URS Corporation is conducting a siting study for a new fly ash landfill on the COF reservation. URS will also be designing a closure plan for the existing dry stack in the near future. A phased closure approach will likely be implemented.

2.2. Geology

According to the Geologic Map of Alabama, compiled by the Geological Survey of Alabama, the Colbert Fossil Plant is underlain by the Tuscumbia Limestone formation. The Tuscumbia Limestone is of Mississippian age and consists of light gray, bioclastic limestone that is fine to very coarse grained and partly oolitic near the top. Light gray chert nodules are scattered throughout the formation and locally abundant. Given the limestone's karst features and differential dissolution of the carbonate in the unit, thickness varies throughout the region. Strike/dip joints are well developed in Tuscumbia Limestone with numerous outcrops along the southern bluff of the Tennessee River. The limestone has shown no discernable signs of faulting in the area, although weathered joints are likely, given the karstic nature of the formation.

Overburden consists primarily of residual clays. Silty clays are present at shallow depths, with moderate to high plasticity clays predominant at intermediate depths. Atop the soil/bedrock interface, a layer of silty clay with extensive chert fragments is present as a result of extensive weathering of the karstic limestone. Some alluvial and terrace deposits are present along the banks of Cane Creek to the west, to an average depth of about 10 feet.

As mentioned above, the Tuscumbia Limestone is known for karst activity, with the formation of sinkholes, irregular bedrock surfaces, and varying solutioning/weathering being possible. Two known sinkhole collapses have occurred in the past at COF; one in the now abandoned/unused area of Disposal Area 5, and one at the area of the closed chemical pond adjacent to Ash Pond 4. However, the historical documentation reviewed by Stantec shows no known karst-related problems reported for the current stack and basin area.

3. Review of Available Information

3.1. General

During the Phase 1 Facility Assessment, Stantec's engineers reviewed documents provided by TVA pertaining to Disposal Area 5. The main objective of the document review was to help Stantec develop a historical knowledge base of the disposal area. The documents reviewed included design/construction drawings, cross-sections of dikes, old contour maps, annual dike stability reports, and old geotechnical reports. A complete listing of the reviewed documents is included in the Phase 1 report.

Of particular interest and use in this study are the following documents and drawings:

- Colbert Steam Plant – Ash Pond 5 – Field Permeability Tests, Memorandum from John A. Raulston to O. P. Thornton, December 14, 1984.
- Report of Hydrogeological and Geophysical Investigation, Colbert Steam Plant, LAW Environmental, Inc. August 15, 1989.
- Report of Geotechnical Exploration, Ash Stack – Area 5, Colbert Fossil Plant, MACTEC Engineering and Consulting, March 19, 2004.
- Colbert Steam Plant – Leakage in Ash Pond 5, Memorandum from R. E. Harris and H. W. Harris to Fossil Engineering Projects Files, November 30, 1984.
- Colbert Steam Plant – Additional Ash Disposal Area No. 5 – Engineering Report, Memorandum from M. N. Sprouse to H. S. Fox, December 21, 1982.
- Geology of the Colbert Steam Plant, Charles P. Bensiger, TVA Division of Water Control Planning, Geologic Branch, November, 1951.
- TVA Drawing Numbers 10W279, 10W283-1 through 5, 10W283-10 through 20.
- TVA Annual Inspection Reports, 1993 to 2008.

3.2. Site History

Construction began at Colbert Fossil Plant in 1951 and was completed in 1965. Colbert currently contains five coal-fired generating units and burns approximately 8,900 tons of coal per day.

Initially, ash materials were sluiced into Ash Disposal Area 1, located to the northwest of the powerhouse along the river. This pond was constructed by building dikes on the north and east side of the existing river shoreline. Sluicing to this area stopped in 1975. Dried, reclaimed ash from Ash Pond 4 was stacked in this area from 1982 until 1990. The area is now closed and no longer in use.

In 1972, the first phase of Ash Pond 4 was constructed and placed into service. The first phase consisted of construction of 20-foot tall dikes to a crest of El. 440 feet. In 1984, the dikes were raised 20 feet using upstream construction methods (constructing inwardly over sluiced ash). At present, approximately 30,000 tons per year of bottom ash is wet-sluiced to Ash Pond 4. Dewatered bottom ash is removed from Ash Pond 4 and stacked within its west side. This stacking operation began in 1999 and remains active, but is progressing slowly. The report addressing the geotechnical exploration and slope stability evaluation for Ash Pond 4 was submitted under separate cover.

The most recent ash disposal area to be developed on the Colbert reservation is Disposal Area 5 located southeast of the plant's powerhouse, which is the subject of this report. The disposal area was initially intended to be an ash pond, but a sinkhole failure occurred in the northwest portion upon initial filling. The sinkhole was reportedly treated and capped and the entire north and northwest portions of Disposal Area 5 were abandoned. Operations then shifted to disposal into two dredge cells (Cells 1 and 2) that were constructed in the south and southeast portions of Disposal Area 5. This operation continued from the mid 1980's until 1990 when dredging was stopped and disposal methods were converted to a dry stacking operation. The dry fly ash then began to be placed over the inactive dredge cells. Dry disposal is following a stacking plan developed in the early 1990's and the ultimate height of the stack will range from 100 to 120 feet from top to toe of original perimeter dikes. Stacked fly ash is being constructed on approximately 3.5H:1V to 4H:1V slopes, with benches every 20 feet in height. The stack appears fully built-out in the south and west portions. The current disposal activity is on the northeast side, but this area is also close to being fully built out. At present, approximately 350,000 tons of dry fly ash is collected in silos each year and hauled to this disposal area.

3.3. Historical Geotechnical Issues

As discussed in Section 1, the Phase 1 work included review of historical documents. A few primary issues that were found from the documents for Disposal Area 5 are discussed in the following paragraphs.

3.3.1. Seepage and Slope Stability

Historical documentation indicates that small seepage boils have been occurring from time to time in the perimeter ditch in the vicinity of the southeast corner of the stack. The ditch is located between the stack toe area and the exterior perimeter dike system. During Stantec's initial work efforts for Disposal Area 5, such seepage boils were not observed. However, on August 27, 2009 COF personnel discovered the occurrence of a new seepage boil in the perimeter ditch along the southeast side of the stack. The discovery of this boil resulted in Stantec re-mobilizing drill rigs to install additional instrumentation to monitor groundwater conditions within the stack. Two additional seepage boils were also discovered about one month later along the northwest side of the stack, and Stantec has also noted small points of seepage in the perimeter ditch at areas along the northeast side as well. It should be noted that rainfall for late summer and early fall of 2009 was above normal in the Tuscumbia, Alabama area. As a result of the recurring seepage boils, Stantec prepared a construction Work Plan in December, 2009 for interim mitigation. It included placement of rock protection/weighted filter systems at the two intervals where the recent boils occurred in 2009. For reference, a copy of the "Issued for Construction" work plan drawings is included in this report in Appendix G.

Indications of seepage along the exterior faces of the perimeter dikes or dike toes was not reported in the historical documentation, nor was any seepage actually observed by Stantec in these exterior areas during this work.

Last, the documents reviewed do not indicate a history of slope instability. Additionally, no signs of slope instability have been observed in the field by Stantec throughout the course of this work.

3.3.2. Karst Activity

Documentation reviewed indicates that a sinkhole collapse occurred in a now-abandoned area of Disposal Area 5 located northwest and away from the active dry stack and drainage basin. The collapse occurred in 1984 shortly after the new disposal area was placed into service. Disposal Area 5 was initially intended to be an ash pond. After discovery of the sinkhole, the area was drained and the sinkhole was reportedly capped. Disposal operations then shifted to the southeast where the current active stack is located.

Disposal Area 5 has not experienced any reported additional karst-related problems in recent years. Additionally, no signs of karst-related activity have been observed in the field by Stantec during the course of this work.

3.3.3. Stormwater Drainage

During the course of Stantec's work, it was noted that the perimeter ditch around the stack exhibits poor drainage characteristics. The causes appear to be insufficient channel slope (causing standing water), vegetation overgrowth, and sedimentation accumulation. The worst area appears to be along the northwest side of the stack. Stantec also observed areas of standing water and apparent poor drainage along the intermediate benches along the stack, which can contribute to increased stormwater infiltration. These issues will need to be mitigated to improve overall stormwater management for closure of the stack. Improved stormwater management will also help to enhance slope stability and seepage issues as well.

4. Scope of Exploration

The field portion of the geotechnical exploration was performed July 30 through August 19, 2009 and from August 31 to September 8, 2009. These services were performed in general accordance with various Corps of Engineers procedures, along with standard procedures for geotechnical engineering practice. The second period of drilling was performed as a result of the seepage boil that was discovered in the perimeter ditch on August 27, 2009. This second phase primarily included installation of additional piezometers.

Stantec personnel advanced sample borings at 46 locations using a combination of track-mounted and truck-mounted drill rigs. In general, the borings were positioned along the stack and drainage basin perimeter dike crests, perimeter dike toes, various bench levels of the dry stack, and at the seepage boil on the southeast side of the stack. Borings were positioned along 12 cross-sections. Nine sections are located along the dry stack and three are positioned along the adjacent drainage basin. All borings were advanced to apparent bedrock, with two borings being advanced ten feet into bedrock using NQ-sized (approximately two-inch diameter) rock coring equipment. The rock core borings were advanced to confirm bedrock depths and to gain additional bedrock information. The locations of the borings are shown on the Boring Layout Plan in Appendix E. At completion of the drilling, TVA's survey crew located the borings and profiled the ground lines at the 12 cross-sections.

The subsurface exploration was performed using 3¼- and 4¼-inch (ID) hollow stem augers equipped with a carbide-tipped tooth bit. Standard Penetration Testing (SPT) was performed in the conventional sample borings. A standard penetration test consists of dropping a 140-pound hammer to drive a split-spoon sampler 18 inches. The consistency or relative density of soil is estimated by the number of blows it takes to drive the spoon the last 12 inches. This method is typically used to obtain soil samples, estimate the consistency or relative density of the soil, and also to estimate the vertical limits of the subsurface soil horizons. In addition, undisturbed samples (Shelby tubes) were obtained from selected depth intervals in offset borings using a fixed head piston sampler within the cohesive materials to provide samples for subsequent laboratory strength testing. After completion of the drilling and sampling procedures, the boreholes were checked for subsurface water and backfilled with cement-bentonite grout.

Stantec installed 44 piezometers at various target elevations in offset borings as a part of the overall stability evaluation to provide data on piezometric levels within the sluiced ash beneath the dry stack, existing dikes and native foundation soils. Piezometer construction consisted of one-inch diameter Schedule 40 PVC, well screen (ten feet) and riser pipe. The annular backfill consisted of a sand filter pack to some distance above the screened interval followed by a bentonite seal. After allowing the bentonite to hydrate, the remaining annulus was backfilled with cement-bentonite grout tremmied into place. Flush-mounted or riser-type protective covers were set in concrete to protect the piezometers. These instruments are scheduled to be monitored by Stantec until June 2010.

An engineer/geologist was present with each drill crew throughout the drilling operations. The engineer/geologist directed the drill crews, logged the subsurface materials encountered during the exploration, and collected samples. Particular attention was given to the material's color, texture, moisture content, and consistency or relative density. The samples extracted from the borings were transported to Stantec laboratories for testing.

In the laboratory, standard penetration test (SPT) samples were subjected to natural moisture content determination in accordance with ASTM D 2216. Selected SPT samples were also combined and subjected to soil classification tests that included Atterberg limits testing (ASTM D 4318), specific gravity tests (ASTM D 854) and sieve and hydrometer analyses (ASTM D 422). Select bulk samples were also collected and subjected to standard moisture-density (Proctor) testing (ASTM D 698). Undisturbed samples were extruded and subjected to unit weight determination, falling head permeability testing (ASTM D 5084), and consolidated undrained triaxial compression testing with pore pressure measurements (ASTM D 4767).

The results of the field and laboratory testing services were used to develop cross-sections for slope stability and seepage analysis. Based on the results of the field exploration, cross-section geometry, and the preliminary slope stability analyses, Stantec selected seven cross-sections to analyze.

5. Results of Geotechnical Exploration

5.1. Summary of Borings

Stantec developed a boring plan for the field exploration after a review of historical information and existing site conditions. TVA survey personnel established boring locations and elevations after drilling was completed. The boring layout plan is contained in Appendix E and boring logs are presented in Appendix A. A summary of the boring information is presented in Table 5.1 (all measurements are expressed in feet).

Table 5.1. Summary of Borings

Boring No.	Surface Elevation	Northing	Easting	Top of Rock** Depth	Top of Rock** Elevation	Boring Termination Depth	Bottom of Hole Elevation
STN-5-1	552.9	1721274.40	400063.00	--	--	60.0	492.9
STN-5-2	529.2	1721432.78	400188.85	--	--	90.0	439.2
STN-5-2S	529.2	1721432.78	400188.85	--	--	46.0	483.2
STN-5-3*	487.5	1721592.79	400338.67	86.9	400.6	100.5	387.0
STN-5-3S	487.5	1721592.79	400338.67	--	--	39.0	448.5
STN-5-4	560.0	1720567.21	400067.66	--	--	60.0	500.0
STN-5-4A	550.7	1720600.17	400244.82	--	--	92.5	458.2
STN-5-5	529.7	1720441.17	400279.90	71.0	458.7	71.0	458.7
STN-5-5S	529.7	1720441.17	400279.90	69.8	459.9	69.8	459.9
STN-5-6	488.1	1720353.73	400481.02	26.3	461.8	26.3	461.8
STN-5-6S	488.1	1720353.73	400481.02	--	--	27.0	461.1
STN-5-7	564.5	1720895.57	398896.12	--	--	60.0	504.5
STN-5-7A	565.3	1720897.20	398906.71	--	--	115.0	450.3
STN-5-8	517.9	1720684.92	398641.15	--	--	90.0	427.9
STN-5-8S	517.9	1720684.92	398641.15	--	--	66.0	451.9
STN-5-9*	480.5	1720444.22	398582.58	52.2	428.3	63.0	417.5
STN-5-9S	480.5	1720444.22	398582.58	--	--	42.0	438.5
STN-5-10	459.7	1720393.13	398549.64	16.1	443.6	16.1	443.6
STN-5-10S	459.7	1720393.13	398549.64	--	--	7.0	452.7
STN-5-11	515.5	1721251.58	398733.51	75.9	439.6	75.9	439.6
STN-5-11S	515.5	1721251.58	398733.51	--	--	65.0	450.5
STN-5-12	477.8	1721306.21	398486.91	49.5	428.3	49.5	428.3
STN-5-12S	477.8	1721306.21	398486.91	--	--	25.0	452.8
STN-5-13	452.3	1721346.27	398424.36	15.9	436.4	16.4	435.9
STN-5-13S	452.3	1721346.27	398424.36	16.4	435.9	16.4	435.9
STN-5-13S-1	452.3	1721346.27	398424.36	--	--	7.0	445.3
STN-5-14	475.9	1722407.30	399518.43	--	--	45.0	430.9
STN-5-15	462.9	1722443.72	399562.30	59.0	403.9	59.0	403.9
STN-5-16	475.8	1722788.34	399149.51	38.6	437.2	38.6	437.2
STN-5-16S	475.8	1722788.34	399149.51	38.6	437.2	38.6	437.2
STN-5-17	458.6	1722840.75	399195.10	29.0	429.6	29.0	429.6
STN-5-18	472.2	1722671.43	398752.90	--	--	45.0	427.2
STN-5-19	453.4	1722721.58	398717.11	29.0	424.4	29.0	424.4
STN-5-101	487.0	1720482.33	400509.25	--	--	15.0	472.0
STN-5-102	486.8	1720445.72	400489.29	--	--	15.0	471.8
STN-5-103A	509.0	1720493.35	400426.84	--	--	40.0	469.0
STN-5-103B	509.5	1720498.42	400429.29	--	--	60.0	449.5
STN-5-104A	530.5	1720548.28	400328.22	--	--	62.5	468.0
STN-5-104B	530.8	1720551.74	400330.04	82.0	448.8	82.5	448.3
STN-5-105	507.4	1720341.58	400353.20	--	--	45.0	462.4
STN-5-106	505.4	1720202.10	400284.88	--	--	47.5	457.9
STN-5-107	527.2	1720292.02	400232.46	--	--	71.5	455.7
STN-5-108	509.3	1720211.06	399882.93	--	--	48.5	460.8

Table 5.1. Summary of Borings *(cont.)*

Boring No.	Surface Elevation	Northing	Easting	Top of Rock** Depth	Top of Rock** Elevation	Boring Termination Depth	Bottom of Hole Elevation
STN-5-109	481.8	1720195.76	399486.17	46.5	435.3	46.5	435.3
STN-5-110	509.4	1720315.43	399519.59	--	--	50.0	459.4
STN-5-111A	529.3	1720445.15	399553.23	--	--	60.0	469.3
STN-5-111B	529.3	1720446.66	399545.11	--	--	82.0	447.3
STN-5-112	497.9	1720546.53	398601.38	--	--	45.0	452.9
STN-5-113	499.2	1720800.24	398321.28	--	--	50.0	449.2
STN-5-114	497.5	1721230.71	398587.74	--	--	50.0	447.5
STN-5-115	477.8	1721636.94	399073.55	47.5	430.3	48.5	429.3
STN-5-116	491.6	1721557.19	399115.86	--	--	32.5	459.1
STN-5-117A	512.8	1721475.92	399159.40	--	--	50.0	462.8
STN-5-117B	512.8	1721469.59	399148.35	--	--	67.0	445.8
STN-5-118	499.2	1721850.73	399533.21	--	--	43.5	455.7
STN-5-119	504.5	1721703.92	400044.78	--	--	36.0	468.5
STN-5-120A	525.8	1721619.44	399976.15	--	--	57.5	468.3
STN-5-120B	525.8	1721619.44	399976.15	--	--	71.0	454.8
STN-5-121A	508.2	1721506.28	400264.15	--	--	45.0	463.2
STN-5-121B	507.9	1721514.55	400256.18	--	--	63.5	444.4
STN-5-122	486.9	1721301.29	400620.41	--	--	60.0	426.9
STN-5-123	508.1	1721231.75	400542.54	--	--	46.5	461.6
STN-5-124	527.2	1721165.96	400476.56	--	--	66.0	461.2
STN-5-125	509.0	1720727.47	400531.28	--	--	47.5	461.5
STN-5-126	554.7	1721349.47	400129.73	--	--	100.0	454.7
STN-5-127	550.5	1721097.71	400407.87	--	--	90.0	460.5

* *Boring advanced into bedrock.*

** *Top of Rock, as used herein, refers to rock-like resistance to the advancement of the augers using a carbide-tipped-tooth bit. This may indicate the beginning of weathered bedrock, boulders, or rock remnants. An exact determination cannot be made without performing rock coring.*

5.2. Subsurface Conditions

5.2.1. Soil

Using the boring logs and laboratory tests, the boring information contained in previous geotechnical studies at the facility, TVA design drawings, old contour maps, and other historical information, Stantec developed a general profile for each stability cross-section. The general profiles depict four primary material horizons (or "layers") that are described below. The stability sections contained in Appendix E show these layers in graphical manner. In addition, the graphical logs shown on the stability sections also depict the material Unified Soil Classification System (USCS) classifications. The classifications are based on a combination of laboratory test results and visual observations where samples were not selected for such testing.

"Stacked Fly Ash" represents landfilled dry fly ash that has been placed within the limits of the perimeter dikes above the sluiced ash (sluiced ash initially deposited in this area until 1990). The bottom of the stacked fly ash is located at about El. 475 to El. 485, and the top is currently at about El. 570 at the highest point along the northwest side. The stacked fly ash has a USCS classification of ML, with textural descriptions of silt and silt with sand. The ash materials are black in color and moist into wet in moisture content. The moisture content typically increases near the bottom of the stacked ash near the top of the sluiced ash where the phreatic surface is typically elevated above the sluiced ash. Based on SPT N-values, the stacked fly ash has strength consistencies typically ranging primarily from medium to very stiff, with some zones of lesser strength consistencies also being encountered.

The "Perimeter Dike" materials represent the materials used to construct the perimeter dike systems for both the dry stack area and the adjacent drainage basin. The dikes extend upwardly from original native ground to approximate El. 480 to El. 490 feet for the dry stack perimeter dikes, and to a crest of about El. 472 to El. 477 feet for the basin. The dike materials are clay soils with USCS classifications of CL and CH, and textural descriptions of lean clay with sand, lean clay with gravel, gravelly lean clay with sand, gravelly fat clay with sand, and fat clay with sand. The clays are typically moist in moisture content with some isolated wet zones encountered and predominantly reddish brown to brown in color. Based on SPT N-values, the dike clays have strength consistencies ranging mostly from medium to very stiff, with a few isolated instances of soft consistencies.

"Hydraulically Placed (sluiced) Fly Ash" was encountered beneath the stacked fly ash inside the perimeter dike system. The ash was placed during the 1980's when the disposal area originally operated as a dredge cell. The sluiced ash was typically encountered at approximate EL. 475 to EL. 485 feet, and is mostly about 15 to 25 feet thick. Classification testing performed on selected fly ash samples resulted in a USCS classification of ML with a textural description of silt. The ash materials are black in color and wet in moisture content. SPT N-values indicate very soft to soft strength consistencies.

Below the perimeter dikes and ash materials, "Native Soil" materials were encountered. Based on laboratory tests and on visual classifications, the "Native Soil" has USCS classifications primarily of CL or CH with textural descriptions of lean clay, lean clay with sand, fat clay, fat clay with sand, and gravelly fat clay. Other lesser occurring material classifications include ML, GM, and GC with corresponding textural descriptions of sandy silt, silty gravel with sand, and clayey gravel. These horizons are typically reddish brown (with other shades of brown also being present), and moist to wet in moisture content. Based on SPT N-values, the native soils have strength consistencies ranging mostly from medium stiff to very stiff, with some zones of very soft to soft consistencies also being present.

The thicknesses of the native soils above bedrock across Disposal Area 5 range from as little as approximately 5 feet to as much as about 64 feet. Most thicknesses are from about 15 to 30 feet. The lesser thicknesses occur in the vicinity of the southeast side of the stack while the thickest materials typically occur in borings drilled along the northeast side of the stack and at the drainage basin area.

It should be noted that materials matching the "slime layer" as described in AECOM's findings relative to the failure at the Kingston Fossil Plant were not encountered during this study. These "slime" materials (as described by AECOM) are typically thin laminated layers of silt and fly ash that contain unusual index properties such as very high moisture contents and very high liquidity indices.

The subsurface logs presented in Appendix A include more detailed descriptions of the materials encountered at the specific boring locations.

5.2.2. Bedrock

Elevations of apparent bedrock across the site, as indicated by auger refusal, show a general trend of descending from southeast to northwest. On the southeast side of the stack, bedrock elevations are as high as about El. 460 feet. Moving to the northwest, the bedrock elevations show a trend of decreasing to approximately El. 430 to El. 440 feet. There were two instances of irregularities on the north-northwest sides where the top of apparent bedrock is substantially deeper than these trends. One occurs at Boring STN-5-3 where bedrock is at approximate El. 401 feet. The other is at Boring STN-5-15 where bedrock was encountered at El. 404 feet. These variations are typical for limestone bedrock formations where surface weathering and solutioning can create abrupt changes in the rock surface over relatively short distances. The soils immediately above bedrock at both of these locations consist of soft clays/silts, which could be indicative of soil-filled weathered crevices or slots occurring within the bedrock.

Rock coring was performed at two borings (STN-5-3 and STN-5-9) to confirm the presence of bedrock, and to gain general information on the underlying limestone. The rock cores were logged in terms of rock type, color, bedding characteristics, and other notable features. The limestone bedrock encountered correlates well with the geologic mapping; i.e. the Tuscumbia Limestone formation. The rock core specimens are generally described as limestone, light gray to light brown, microcrystalline to coarse grained, hard, and thin bedded. Rock core recoveries were measured to be between 58% and 99%, and the measured Rock Quality Designations (RQD) were measured to be from 73% to 86%. The lower recovery value of 58% was encountered at Boring STN-5-3 where an irregular depth to bedrock is present. The lower recovery is possibly indicative of weathered zones/clay zones that were washed away during the coring process. These types of weathered/clay-filled zones can be common because of the karst nature of the bedrock.

5.3. Phreatic Conditions

At several selected boring locations, piezometers were installed to measure the groundwater level/pore water pressures. Piezometer tips were targeted to be installed within the lower sluiced ash, native clay, and perimeter dike materials. Most piezometer tips were installed within the lower sluiced ash material after the appearance of the seepage boil in August, 2009. In general, initial piezometer readings were taken at approximately one to two week intervals because of the seepage boils that occurred within the perimeter ditch. Currently, Stantec is taking readings on a monthly basis. It is anticipated that Stantec will continue to take readings until June, 2010. Refer to Appendix B for piezometer installation details and readings (up to most recent set of readings). The most recent readings are also shown on graphical logs shown on the stability cross-sections in Appendix E. Piezometer locations and tip elevations are summarized in Table 5.2.

Table 5.2. Summary of Piezometers

Boring No.	Concrete Pad Elevation (Feet)	Piezometer Tip Elevation (Feet)
STN-5-3S	487.5	448.5 (native clay)
STN-5-4A	550.7	461.7 (sluiced ash)
STN-5-5S	529.7	465.0 (sluiced ash)
STN-5-6S	488.1	468.1(native clay/perimeter dike)
STN-5-7A	565.3	455.3 (sluiced ash)
STN-5-8S	517.9	457.9 (sluiced ash)
STN-5-9	480.5	428.5 (native clay)
STN-5-11S	515.5	470.0 (sluiced ash)
STN-5-12	477.8	428.8 (native clay)
STN-5-16S	475.8	455.8 (native clay/perimeter dike)
STN-5-18	472.2	447.2 (native clay/perimeter dike)
STN-101	487.0	475.0 (sluiced ash)
STN-5-102	486.8	475.3 (sluiced ash)
STN-5-103A	509.0	469.0 (sluiced ash)
STN-5-103B	509.5	449.5 (native clay)
STN-5-104A	530.5	470.0 (sluiced ash)
STN-5-104B	530.8	449.3 (native clay)
STN-5-105	507.4	467.4 (sluiced ash)
STN-5-106	505.4	464.4 (sluiced ash)
STN-5-107	527.2	463.2 (sluiced ash)
STN-5-108	509.3	464.3 (sluiced ash)
STN-5-109	481.1	436.3 (native clay)
STN-5-110	509.4	463.4 (sluiced ash)
STN-5-111A	529.3	469.3 (sluiced ash)
STN-5-111B	529.3	447.3 (native clay)
STN-5-112	497.9	457.1 (sluiced ash)

Table 5.2. Summary of Piezometers (*cont.*)

Boring No.	Concrete Pad Elevation (Feet)	Piezometer Tip Elevation (Feet)
STN-5-113	499.2	453.7 (sluiced ash)
STN-5-114	497.5	452.5 (sluiced ash)
STN-5-115	477.8	429.3 (native clay)
STN-5-116	491.6	463.1 (sluiced ash)
STN-5-117A	512.8	465.8 (sluiced ash)
STN-5-117B	512.8	446.8 (native clay)
STN-5-118	499.2	457.2 (sluiced ash)
STN-5-119	504.5	477.5 (native clay/sluiced ash)
STN-5-120A	525.8	473.8 (sluiced ash)
STN-5-120B	525.8	454.8 (native clay)
STN-5-121A	508.2	463.2 (sluiced ash)
STN-5-121B	507.9	444.4 (native clay)
STN-5-122	486.9	427.9 (native clay)
STN-5-123	508.1	463.1 (sluiced ash)
STN-5-124	527.2	462.2 (sluiced ash)
STN-5-125	509.0	464.5 (sluiced ash)
STN-5-126	554.7	459.7 (sluiced ash)
STN-4-127	550.5	465.5 (sluiced ash)

Several sets of piezometer readings have been obtained and reviewed throughout the course of this geotechnical evaluation. Readings were initially obtained on approximate one week intervals or after rain events because of the initial concerns related to the seepage boils that had appeared in the perimeter ditch. Based on piezometer data and on observations of seepage/boils, the following trends and observations can be made regarding groundwater within the dry stack.

- Phreatic levels indicated by readings from piezometers installed within the sluiced ash beneath the stack are typically much higher than readings taken from piezometers that have been installed within native materials. This suggests that groundwater within the sluiced/stacked fly ash is "trapped" or "perched" and does not appear to be hydraulically connected to groundwater outside the dikes or below within native materials.

- Phreatic levels are located a few feet to as much as about 10 feet above the top of the sluiced ash within the dry stack. The readings also suggest that the phreatic surface is mounded within the stack.

- The phreatic levels appear to be directly responsive to the amount of prevailing precipitation conditions and resulting stormwater infiltration. After significant rain events, the phreatic surface will typically rise by a few tenths to as much as one-foot or more, and increased seepage points or even boils may appear in the perimeter ditch (as described in Section 3.3.1). As conditions dry, phreatic surfaces will typically fall somewhat and perimeter ditch seepage will normally diminish.

6. Laboratory Testing

6.1. General

The results of laboratory testing performed are included within the appendices. ASTM testing specifications were observed. In particular, natural moisture content test results are shown on the attached boring logs in Appendix A and are also shown on the drafted stability sections in Appendix E. The results of the classification testing, shear strength testing, and permeability testing are included in Appendix C. The USCS classifications associated with each horizon are also discussed in Section 5.2 above. No further discussion relative to the results of moisture content and classification testing are provided in this section. The discussion that follows is limited to the laboratory testing associated with evaluation of the dike compaction characteristics and shear strengths of the cohesive soil horizons and fly ash materials.

6.2. Cohesive Soils/Undisturbed (Shelby) Tube Samples

The borings drilled for this exploration included 3-inch diameter undisturbed (Shelby) tube sampling within cohesive soil horizons and within stacked and sluiced fly ash. Stantec's soils laboratory extruded the tube samples and trimmed 6-inch long specimens. Lab personnel determined visual classifications, unit weights (wet and dry), and natural moisture for each 6-inch specimen prior to submitting a summary of the extruded specimens to a geotechnical engineer for assignment of laboratory testing. Select 6-inch specimens extruded from Shelby tubes were then subjected to consolidated-undrained (CU) triaxial testing and permeability testing. The results of these tests are included in Appendix C and are discussed below.

6.2.1. Consolidated-Undrained (CU) Triaxial Testing

Stantec performed CU triaxial testing with pore pressure measurements on selected 6-inch long specimens extruded from Shelby tube samples. CU testing provides indicators of effective-stress shear strength parameters for slope stability analyses. The results of the CU triaxial tests are presented on the stability sections in Appendix E, and are summarized in Table 6.1. The stress path envelopes derived from CU triaxial testing are also presented in Appendix D.

Table 6.1. Summary of Consolidated – Undrained Triaxial Testing

Boring No.	Sample Interval (feet)	Soil Horizon	CU Triaxial Strength	
			c' (psf)	ϕ' (degrees)
STN-5-2S	39.8 – 40.4 44.0 – 44.8	Stacked Fly Ash	315	31.2
STN-5-3S	2.6 – 3.2 3.2 – 3.8 10.4 – 11.2	Clay Dike	300	25.9
STN-5-5S	59.4 – 59.9 64.0 – 64.8 65.4 – 66.0	Sluiced Fly Ash	422	34.6
STN-5-8S	39.8 – 40.4 40.4 – 41.0	Sluiced Fly Ash	238	32.9
STN-5-9S	20.0 – 20.6 20.6 – 21.2	Clay Dike	7	36.1
STN-5-10S STN-5-3S STN-5-9S	3.4 – 4.0 35.6 – 36.2 35.6 – 36.2	Native Clay	357	31.1
STN-5-11S	39.1 – 39.7 44.8 – 45.4 54.8 – 55.4	Sluiced Fly Ash	16	37.1
STN-5-12S	5.4 – 6.2 15.8 – 16.4 20.8 – 21.2	Clay Dike	0	35.0
STN-5-11S STN-5-13S	64.8 – 65.4 10.8 – 11.4 11.4 – 12.0	Native Clay	39	36.4
STN-5-16S	2.8 – 3.4 3.4 – 4.0 11.0 -11.4	Clay Dike	639	23.3
STN-5-18S	10.8 – 11.4 15.8 – 16.4	Clay Dike	111	37.6

6.2.2. Permeability Testing

The following table summarizes the testing results from the falling head permeability testing. Permeability values are used in seepage analyses.

Table 6.2. Summary of Falling Head Permeability Testing

Boring No.	Sample Interval (feet)	Soil Horizon	Permeability (cm/sec)
STN-5-2S	40.6 – 40.9	Stacked Fly Ash	1.2e-06
STN-5-3S	11.3 – 11.6	Clay Dike	6.5e-08
STN-5-5S	60.0 – 60.3	Sluiced Fly Ash	3.8e-06

Table 6.2. Summary of Falling Head Permeability Testing (*cont.*)

Boring No.	Sample Interval (feet)	Soil Horizon	Permeability (cm/sec)
STN-5-6S	11.6 – 11.9	Clay Dike	4.8e-08
STN-5-6S	21.7 – 22.0	Native Clay	5.4e-08
STN5-5-8S	35.5 – 35.8	Stacked Fly Ash	6.1e-07
STN-5-9S	21.3 – 21.6	Clay Dike	5.7e-08
STN-5-9S	26.7 – 27.0	Native Clay	6.3e-08
STN-5-11S	45.6 – 45.9	Sluiced Fly Ash	1.2e-06
STN-5-11S	64.5 – 64.8	Native Clay	2.3e-08
STN-5-12S	21.4 – 21.7	Clay Dike	5.0e-08
STN-5-13S	10.2 – 10.8	Native Clay	2.6e-08
STN-5-18S	11.6 – 11.9	Clay Dike	2.2e-08

6.3. Moisture-Density Relationships

Bag samples were obtained to represent materials associated with the clay dikes of the dry stack and drainage basin. The results of the standard moisture-density tests performed on these samples are summarized in Table 6.3.

Table 6.3. Standard Moisture-Density (Proctor) Test Results

Sample Location	Sample Depth Interval (feet)	Soil Horizon	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
STN-5-3	1.0 - 10.0	Stack Perimeter Dike	98.7	22.2
STN-5-9	1.0 – 10.0	Stack Perimeter Dike	106.9	17.9

Following completion of the moisture-density testing, undisturbed samples taken within dike materials were extruded and unit weight and moisture content determinations were made in association with triaxial shear strength testing. The results of the unit weight and moisture content determinations for triaxial test samples are shown in Table 6.4. A comparison between the moisture-density test results and the unit weight determinations obtained from the undisturbed samples are also included. The comparison was made by using the moisture density test results that were nearest to the undisturbed sample locations (and which also had like classifications) to estimate relative compaction.

Table 6.4. Comparison Between Undisturbed Sample Conditions and Moisture-Density Test Results

Boring Location	Sample Depth Interval (feet)	Dike Location	Unit Weight Dry (pcf)	Moisture Content (%)	Maximum Dry Density (pcf)	Percent Maximum Dry Density (%)	Optimum Moisture Content (%)	Moisture Content Variation (%)
STN-5-3S	2.6-3.2	Perim. Dike	93.5	20.9	98.7	95	22.2	-1.3
STN-5-3S	3.2-3.8	Perim. Dike	98.4	24.7	98.7	100	22.2	+2.5
STN-5-3S	10.4-11.2	Perim. Dike	97.3	23.6	98.7	99	22.2	+1.4
STN-5-9S	20.0-20.6	Perim. Dike	96.4	26.3	98.7	98	22.2	+4.1
STN-5-9S	20.6-21.2	Perim. Dike	97.2	24.5	98.7	98	22.2	+2.3
STN-5-12S	5.4-6.2	Perim. Dike	94.7	24.9	98.7	96	22.2	+2.7
STN-5-12S	15.8-16.4	Perim. Dike	100.9	21.3	106.9	94	17.9	+3.4
STN-5-12S	20.8-21.2	Perim. Dike	103.5	17.6	106.9	97	17.9	-0.3
STN-5-16S	2.8-3.4	Basin Dike	88.1	30.2	98.7	89	22.2	+8.0
STN-5-16S	3.4-4.0	Basin Dike	103.7	22.8	98.7	105	22.2	+0.6
STN-5-16S	11.0-11.4	Basin Dike	89.2	30.7	98.7	90	22.2	+8.5
STN-5-18S	10.8-11.4	Basin Dike	98.6	20.9	106.9	92	17.9	+3.0
STN-5-18S	15.8-16.4	Basin Dike	110.3	19.6	106.9	103	17.9	+1.7

The existing in-situ dry densities of the dike materials were determined to range from about 89 percent to 105 percent of the standard Proctor dry densities, with most being greater than 95 percent. This data indicates that the dike materials appear to have been compacted in a controlled manner when compared to typically accepted target densities of 95 percent or greater for compacted clay soils in an earth dike. However, it should be noted that no construction documentation has been provided to confirm this comparison. The corresponding moisture values were mostly in the range of about 1 to 5 percent above the optimum moisture value.

6.4. Standard Penetration Test Samples

Recovered soil specimens from SPT sampling were subjected to natural moisture content determinations and select samples were combined for engineering classification testing. The engineering classification testing consisted of Atterberg limits, specific gravity, and sieve and hydrometer analyses. The results of the classification testing were used in conjunction with the N-values from SPT's to estimate soil strength based on published correlations of such data. The results of the moisture content tests and classification testing are included on the boring logs and stability section drawings in Appendices A and E, respectively. Soil classification summaries are also provided in Appendix C.

7. Engineering Analysis

7.1. General

Geotechnical engineering analyses included evaluations of strength and permeability parameters, slope stability analyses, and limited seepage analyses. Prior to beginning the analyses, the geotechnical data and cross-sections were combined and the geometry of the existing perimeter dikes, dry stack and soil horizons were approximated using current and historical information. Once the geometry of the sections was approximated, each section was reviewed and evaluated to select critical cross-sections for analyses. Selection of critical sections was based on the steepness of slopes, heights of dikes, geometry of the sections, phreatic surface, seepage conditions, and subsurface conditions. Based on this evaluation, six representative cross-sections were selected for slope stability analyses along the stack area (Sections A, B, D, E, G, and I), and one was selected at the drainage basin (Section J). Two cross-sections were selected for seepage analysis (Sections A and E) along the dry stack. These two sections represent the areas where seepage boils have recently occurred in the perimeter ditch. The main purpose of the seepage analysis of the stack was to check for model prediction of a critical vertical exit gradient in the perimeter ditch at the locations of the seepage boils to reconcile field observations. No further seepage analysis was performed for the stack since the disposal facility is not impounding water. One section (Section J) was selected for seepage analysis along the drainage basin. The locations of the sections are shown on the layout drawing presented in Appendix E. Results of the analyses and evaluations are summarized in the following paragraphs, and are shown on drawings/computer output provided in Appendices E and F.

It should be noted that construction records indicating the methods used for construction, as-built dike configurations, etc. were not available for review. As a result, assumptions and generalizations in soil parameters and section geometry were needed to construct the seepage and stability models.

7.2. Soil Horizons

Based on the results of the drilling, laboratory testing, historical documentation, and drawings, the materials on site were divided into four primary soil layers for seepage and stability analyses. Refer to the stability sections in Appendix E for locations of the soil horizons. The soil horizons are briefly described as follows (refer to Section 5.2.1 for further descriptions):

- *Stacked Fly Ash:* This represents landfilled dry fly ash that has been placed within the limits of the perimeter dikes above the sluiced ash (sluiced ash initially deposited in this area until 1990). The bottom of the stacked fly ash is located at about El. 475 to El. 485, and the top is currently at about El. 570 at the highest point along the northwest side. Side slopes are approximately 3.5H:1V to 4H:1V, with benches located at approximate 20-foot height intervals.

- *Perimeter Dike:* This represents the materials within the perimeter dike systems for both the dry stack area and the adjacent drainage basin. The dikes extend upwardly from original native ground to approximate El. 480 to El. 490 feet for the dry stack, and to a crest of about El. 472 to El. 477 feet for the basin. Exterior side slopes are primarily 2.5H:1V to 2H:1V, or steeper in some cases.

- *Native Soil:* This represents the layers of native clay and/or silty materials beneath the site. Native soils are primarily clays, with lesser occurrences of silt and gravel.

- *Hydraulically Placed (sluiced) Ash:* This represents sluiced ash that is contained by the perimeter dikes beneath the stacked ash.

7.3. Seepage Analysis

7.3.1. SEEP/W Model

Analysis of steady state seepage through the perimeter dikes and dry stack was performed 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 specifically at the drainage basin). The numerical seepage models were developed using SEEP/W 2007 (Version 7.15), a finite element code tailored for modeling groundwater seepage in soil and rock. The finite element method is used to simulate steady-state seepage across the mesh. The total hydraulic head is computed at each nodal location, from which pore water pressures and seepage gradients can be determined. SEEP/W is distributed by GEO-SLOPE International, Ltd, of Calgary, Alberta, Canada (www.geo-slope.com).

Two cross-sections were selected for seepage analysis (Sections A and E) along the dry stack. These two sections represent the areas where seepage boils have recently occurred in the perimeter ditch. The main purpose of the seepage analysis of the stack was simply to check for model prediction of a critical vertical exit gradient in the perimeter ditch at the locations of the seepage boils to reconcile field observations. No further seepage analysis was performed for the stack since the disposal facility is not impounding water. One section (Section J) was selected for seepage analysis along the drainage basin.

7.3.2. Boundary Conditions

Boundary conditions for the SEEP/W analysis were assumed as follows. For the drainage basin, the hydraulic head at each node along the interior side was constant with depth and set equal to the pool elevation. A total head equal to the pool level was also applied to all submerged nodes along the ground surface of the upstream side. Along the vertical, external edge of the basin model, the hydraulic head at each node was constant with depth and was set equal to the toe piezometer reading at the model cross-section. For the stack, the hydraulic head at nodes along the interior and exterior boundaries were set equal to the nearest piezometer readings at the modeled cross-sections. Other nodes along the ground surface in each model 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 analyses.

7.3.3. Seepage Properties

For the modeled cross-sections, a representative subsurface profile was compiled based on boring logs, available record drawings, and the known project history. Material properties were estimated based on available laboratory data, correlations with classification data, and on typical values for similar materials. Material properties used in the seepage analysis are summarized in Table 7.1.

Table 7.1. Material Properties for SEEP/W Analysis

Soil Horizon	Saturated k_v (cm/s)	Ratio k_h / k_v	Volumetric Water Content Saturated (%)	Volumetric Water Content Residual (%)	Basis
Stacked Fly Ash	1.0e-6	10	46	1	Available Laboratory Data and Correlation w/ Typical Values
Perimeter Dikes	1.0e-8	1 to 5	37	2	Available Laboratory Data and Correlation w/ Typical Values
Hydraulically Placed (Sluiced) Fly Ash	2.5e-6	20	46	1	Available Laboratory Data and Correlation w/ Typical Values
Native Clay/Silts	1.0e-8	10	37	1	Available Laboratory Data and Correlation w/ Typical Values

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

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 study, an iterative process of parametric calibration was used to arrive at final estimates of the seepage properties. Results from trial simulations were compared to field data (measured piezometric levels and observed seepage) and the material parameters were then varied until the solutions reasonably matched the field data. The final set of parameters (Table 7.1) resulted in the comparisons presented in Section 7.3.4.

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 Disposal Area 5, higher ranges of ratios were used for sluiced ash and native materials, whereas a lower range of ratios was assumed for compacted materials.

The governing equations in SEEP/W are formulated to consider seepage through unsaturated soils. This formulation is used to locate the phreatic surface for unconfined seepage. 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 are not sensitive to the selection of these values.

7.3.4. Comparison to Field Observations

After the initial seepage parameters were estimated, results from the SEEP/W model were compared to pore water pressures measured in the piezometers installed. Nodes were placed in the modeled cross-sections at the same locations 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 2 feet above to about 4 feet below the readings obtained in the actual piezometers installed. The exception to this is at STN-5-18 at Section J (drainage basin) where the model predicted the groundwater table to be about 14 feet higher than the actual piezometer reading. The results from the seepage model can also be compared to field observations of seepage conditions. This specifically applies to the past observations of seepage and boils within the perimeter ditch of the dry stack. For the two dry stack sections analyzed, the seepage model does in fact predict the potential for seepage outbreaks to occur within the perimeter ditch, as shown by the predicted shape of the phreatic surface. The seepage models also show that the maximum vertical exit gradients occur within the perimeter ditch. For Section J (drainage basin), the model predicts the phreatic surface to be buried with no prediction of a critical exit gradient point, which is consistent with the reported lack of historical seepage issues along the drainage basin dikes.

In summary, the seepage models appear to give a reasonable prediction of the phreatic surface and seepage locations when compared to field observations and piezometer measurements.

7.3.5. 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.

$$FS_{piping} = \frac{i_{crit}}{i} \quad \textbf{Eqn. 7.1}$$

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:

$$i_{crit} = \frac{\gamma_{sub}}{\gamma_w} = \frac{G_s - 1}{1 + e} \qquad \textbf{Eqn. 7.2}$$

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.

7.3.6. Results of Seepage Analysis

Plots from the SEEP/W analyses of the three cross-sections analyzed are presented in Appendix F. The plots show the finite element mesh, material zones, and boundary conditions used in each analysis. The results are depicted in contour plots of total head, pore water pressure, and seepage gradients.

On each modeled cross-section, examination of the output (predicted phreatic surface and vertical gradients) can be made to look 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 7.3.5. First, contour plots of vertical gradient were examined to determine the general location of the maximum vertical exit gradient. On the modeled cross-sections for the dry stack, the maximum upward gradients occur within the perimeter ditch. For the factor of safety calculations, vertical gradients from these locations were then used along with the critical gradients determined from the soil properties. A critical exit point for Section J along the drainage basin was not predicted by the model.

The calculated factors of safety against piping are summarized in Table 7.2. They range from near 1 for dry stack Sections A and E to greater than 3 for the drainage basin Section J. Stantec recommends a target factor of safety against piping of 3, based on information contained in United States Army Corps of Engineers (USACE) manual EM 1110-2-1901. Hence, the results indicate that Section J, which is representative of the drainage basin dikes, meets this factor of safety criteria. The calculated piping factor of safety of about 1 for Sections A and E is less than the target, and offers a very good correlation with actual field observations.

Table 7.2. Summary of Computed Exit Gradients and Minimum Factors of Safety against Piping

Cross Section*	Vertical Gradient (i_v) at Critical Exit Point	Location of Critical Exit Point	Material	Critical Gradient (i_{crit})	FS_{piping}
A (Stack)	0.45	Perimeter Ditch	Sluiced Ash	0.58	1.3
E (Stack)	0.60	Perimeter Ditch	Sluiced Ash	0.55	0.9
J (Basin)	Critical Exit Point Not Identified by Model	N/A	N/A	N/A	> 3

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

7.4. Slope Stability Analyses

7.4.1. SLOPE/W and UTEXAS4 Models

The existing stability of the dry stack and drainage basin dike slopes was evaluated under fully drained conditions (static long-term, steady state seepage) using limit equilibrium methods as implemented in the SLOPE/W software. Additional static analysis was also performed using the UTEXAS4 software to evaluate existing slope stability of the dry stack in the event of the sudden development of an undrained loading condition 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). Undrained analysis was also performed for the ultimate buildout of the stack where undrained conditions can be induced by additional placement of ash.

The SLOPE/W software is available from GEO-SLOPE International, Ltd., of Calgary, Alberta, Canada (www.geo-slope.com). SLOPE/W is a special-purpose computer code designed to analyze the stability of earth slopes using two-dimensional, limit equilibrium methods. Stability analyses for the dry stack were performed using data obtained from piezometer readings for modeling of groundwater conditions. For Section J (drainage basin), the phreatic conditions/steady-state pore pressures obtained from the SEEP/W model were used.

The UTEXAS4 software was developed by Dr. Stephen G. Wright and is available from Shinoak Software, Austin, Texas. The undrained analysis is based on a three-stage stability assessment of the potential for an undrained failure developed by Duncan, Wright, and Wong and as outlined in EM 1110-2-1902 (USACE).

7.4.2. Limit Equilibrium Methods

Limit equilibrium methods for evaluating slope stability consider 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 first divided into vertical slices, then stresses are evaluated along the sides and base of each slice. The factor of safety against a slope failure (FSslope) is defined as:

$$FS_{slope} = \frac{\text{shear strength of soil}}{\text{shear stress required for equilibrium}} \qquad \textbf{Eqn. 7.3}$$

where the strengths and stresses are computed along a defined failure surface located at the base of the vertical slices. The shearing resistance along the potential slip surface is 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 FSslope for an assumed failure surface. A search must be made to find the critical slip surface corresponding to the lowest FSslope. Both circular and noncircular potential failure surfaces can be evaluated.

7.4.3. Analysis Approach

The slope stability analysis for the Disposal Area 5 was performed on the exterior faces of the slopes. SLOPE/W and UTEXAS4 incorporate various search routines to locate critical slip surfaces. For the analysis of the stack, deep (global) and shallow (non-global) failure surfaces were considered. Stability analyses for the dry stack were performed using data obtained from piezometer readings for modeling of groundwater conditions. For section J (drainage basin), the phreatic conditions/steady-state pore pressures obtained from the SEEP/W model were used. SLOPE/W software was used to evaluate static, long-term (fully drained) loading conditions, while the UTEXAS4 software was used to evaluate slope stability for static undrained loading conditions within the saturated ash.

7.4.4. Selection of Shear Strength Parameters

For Disposal Area 5, static slope stability was evaluated for both drained and undrained loading conditions. Drained conditions represent long-term loading conditions where excess pore pressures have had sufficient time to dissipate and steady state conditions prevail. For these conditions, soil unit weights and effective stress strength parameters (c' and ϕ') are needed. For the three-stage undrained analysis, determination of the shear strength along a potential failure plane is based on two limiting strength envelopes representing both the fully drained (effective stress) strength and the undrained (total stress) strength. For the undrained analysis of the dry stack, this approach is applied to the portion of the fly ash that is saturated (or located below the water table). Thus, the total stress (undrained) strength parameters (c and ϕ) are needed for the saturated ash in addition to the effective stress parameters.

The drained shear strength parameters used for the ash, clay dikes and clay foundation materials were derived using results of laboratory triaxial tests, along with consideration given to standard penetration test data (and published correlations) and laboratory classification test data. Representative strengths for each horizon were selected using the methodology outlined in the US Army Corps of Engineers Engineer Manual EM 1110-2-1902 as a guide. Results of triaxial testing were evaluated and effective stress p' versus q scatter plots were prepared for all of the data points. The maximum effective principal stress ratio was used to determine failure criteria for selection of these values within the laboratory test results. Once the p' versus q plots were prepared, a failure envelope was then selected such that at least two thirds of the plotted values were above the envelope. The drained strength parameters were rounded to the nearest degree with regards to ϕ'. The cohesion intercept point (c') was limited to a maximum of 200 pounds per square foot (psf). The undrained shear strength parameters for the saturated ash were similarly derived, also using results of triaxial testing. The p' versus q plots and selection of the failure envelopes are shown for each horizon on the graphs presented in Appendix D.

The following table provides a summary of the effective stress (drained) shear strengths selected for use in the long-term slope stability analyses.

Table 7.3. Selected Strength Parameters for Stability Analyses

Soil Horizon	Unit Weight (pcf)	Effective Stress Strength Parameters	
		c' (psf)	Ø' (degrees)
Perimeter Dikes	125	100	29
Sluiced Ash	85	0	26
Stacked Ash	105	0	32
Native Clay	125	200	28
Native Silt	125	0	26

For the three-stage undrained analysis, Stantec selected c = 400 psf and ϕ = 10 degrees for the total stress (undrained) shear strength parameters for the saturated portion of the fly ash.

7.4.5. Results of Slope Stability Analysis

Using the strength parameters listed above, in conjunction with the results of the seepage analyses and piezometer data, the existing dike configurations were analyzed at the seven selected cross-sections. Long term, steady state seepage conditions (fully drained loading conditions) were analyzed with SLOPE/W at each of the seven cross-sections. Undrained loading conditions were evaluated with UTEXAS4 at dry stack Sections G and I where the lowest factors of safety were calculated for the long-term analyses. These two cross sections also represent the side of the stack where additional ash material will be placed to achieve final buildout. The stability analyses focused on the potential for failure along the exterior faces of the dikes and stack. Failure surfaces from these analyses are presented on the drafted sheets in Appendix E. The results of the analyses are presented in the following discussion.

A summary of factors of safety for the fully drained loading conditions for the existing "as found" stack configuration is presented below. Stantec considered potential failure surfaces located at the toe (shallow) and extending deeper into the stack.

Table 7.4. Summary of Factors of Safety for Slope Stability for Drained Conditions, Existing Configuration

Cross-Section*	Minimum FS_d	Deep Surface FS_d	Global FS_d
A (Stack)	1.5	1.7	2.1
B (Stack)	1.7	2.0	2.0
D (Stack)	1.4	2.0	2.3
E (Stack)	1.5	2.0	2.3
G (Stack)	1.4	1.8	2.7
I (Stack)	1.3	1.6	2.4
J (Basin)	1.8	N/A	N/A

*Refer to Appendix E for plan view of cross-section locations.

The results of the slope stability analyses demonstrate that the factors of safety against long-term, steady state slope instability (fully drained conditions) for the existing configuration range from about 1.3 to greater than 1.5. Based on discussions with TVA and to be in accordance with current prevailing geotechnical practice, a minimum target factor of safety (FS_d) of 1.5 was established for this loading condition using the guidelines presented in USACE Manual EM 1110-2-1902 "Slope Stability". The results indicate that three cross-sections (Sections D, G, and I) have minimum safety factors less than the target. These minimum factors of safety occur along potential failure surfaces that are along the toe of the dry stack just above the perimeter ditch, below the first bench, and which are also contained within the perimeter dike system. Stantec also analyzed additional potential failure surfaces that extend farther into the stack and to greater depths to check factors of safety for more global-type failures. Factors of safety for these deeper slip surfaces are all greater than the target value of 1.5.

A summary of factors of safety for the undrained analysis of the existing stack configuration performed at Sections G and I is presented below. Stantec also considered potential failure surfaces located at the toe (shallow) and extending deeper into the stack for this loading condition.

Table 7.5. Summary of Factors of Safety for Slope Stability for Undrained Conditions, Existing Configuration

Cross-Section*	Shallow Surface (Stack Toe) FS_u	Deep Surface FS_u
G (Stack)	1.4	2.0 to 2.6
I (Stack)	1.3	1.5 to 2.2

*Refer to Appendix E for plan view of cross-section locations.

The results of the slope stability analyses demonstrate that the factors of safety against undrained slope stability failure for the existing configuration are all equal to or greater than 1.3. Based on discussions with TVA, Stantec recommends a minimum target factor of safety of 1.3 for undrained loading conditions of existing facilities (FS_u). Hence, the results indicate that these factors of safety are acceptable.

Last, Stantec performed undrained analysis for deep-seated failure surfaces at Sections G and I to represent loading conditions that will be induced during remaining ash placement to reach the final build-out configuration. The summary of factors of safety for this condition is presented below (FS_{ul}).

Table 7.6. Summary of Factors of Safety for Slope Stability for Undrained Conditions, Ultimate Buildout

Cross-Section*	Deep Surface FS_{ul}
G (stack)	2.3
I (stack)	1.9

*Refer to Appendix E for plan view of cross-section locations.

The undrained analysis representing the final build-out produced factors of safety ranging from 1.9 to 2.3. The acceptability of this loading condition is judged by calculating the target factor of safety using the following calculation:

$$\text{Target } FS_{ul} = \frac{2 \times FS_u}{1 + FS_u} \qquad \textbf{Eqn. 7.4.}$$

Based on this, the target factor of safety for undrained loading conditions of the final buildout is approximately 1.4 for the deep-seated surfaces at Sections G and I. Hence, these resulting factors of safety are acceptable.

8. Conclusions and Recommendations

The conclusions and recommendations that follow are based on Stantec's understanding of the history of Disposal Area 5, as outlined in this report. This understanding has been developed from review of historical information, discussions with TVA personnel, and from the results of this geotechnical exploration. In addition, Stantec understands that TVA has tasked URS Corporation with conducting a siting study for a new fly ash landfill on the COF reservation. URS will also be designing a closure plan for the existing dry stack in the near future since the existing stack is close to capacity. Phased closure approach will likely be implemented.

8.1. For the Disposal Area 5 Dry Stack, seepage analysis was conducted at two cross-sections (Sections A and E) for the purpose of confirming field observations of seepage boils and piping that have occurred from time to time in the perimeter ditch. For these two sections, the seepage model does in fact predict the potential for seepage outbreaks to occur within the perimeter ditch, as shown by the predicted shape of the phreatic surface. The seepage models also show that the maximum vertical exit gradients occur within the perimeter ditch with corresponding factors of safety against piping near 1. These results are consistent with the observation of recurring seepage boils at the areas represented by Sections A and E.

Based on the information gained throughout this study, it is Stantec's conclusion that seepage into the perimeter ditch is a result of trapped water within the stack, rainfall infiltration into the stack, along with no provisions being provided for internal drainage. After significant rain events, the phreatic surface will typically rise by a few tenths to as much as one-foot or more, and increased seepage points or even boils may appear in the perimeter ditch. As conditions dry, phreatic surfaces will typically fall somewhat and perimeter ditch seepage will normally diminish. Rainfall for late summer and early fall of 2009 was above normal, which resulted in more notable seepage into the ditch and the recurrence of new seepage boils.

As discussed previously, Stantec prepared a construction Work Plan in December, 2009 for interim mitigation of the seepage boils. It included placement of rock protection/weighted filter systems at two intervals where the boils occurred in 2009. For reference, a copy of the "Issued for Construction" work plan drawings is included in this report in Appendix G. Additional permanent mitigation will be needed for closure. Until then, seepage boils will continue to appear from time to time and some continued maintenance activities may be needed.

8.2. The results of the seepage analyses for Section J (which represents the adjacent drainage basin) were reviewed to identify conditions where seepage and possible piping may occur. The seepage analyses did not predict a critical vertical gradient exit point and the resulting factor of safety against piping for the drainage basin is much greater than the target value of 3.

8.3. The results of the slope stability analyses indicate that factors of safety against long-term (fully drained loading conditions) slope stability failure are mostly greater than the target value of 1.5, except for Sections D, G and I where factors of safety are from about 1.3 to 1.4. These minimum factors of safety occur along potential failure surfaces that are along the toe of the dry stack just above the perimeter ditch, are below the first bench, and are also contained within the perimeter dike system. Stantec also analyzed additional potential failure surfaces that extend farther into the stack and to greater depths to check factors of safety for more global-type failures. Factors of safety for these deeper, more global slip surfaces are all greater than the target value of 1.5.

8.4. The results of the slope stability analyses indicate that factors of safety against undrained loading slope stability failure are greater than the target values of 1.3 to 1.4.

8.5. It is recommended that improvements to address the long-term undrained slope stability and perimeter ditch seepage issues described within this report be designed and implemented. Stantec understands that such improvements will be designed by URS Corporation and implemented during a phased closure approach. Design features should include means for collecting toe seepage, and regrading and/or buttressing of the stack toe area. In addition, it is also recommended that stormwater management improvements be included, which will also help to improve stability and seepage issues. This includes regrading/reconfiguration of the perimeter ditch, regrading of intermediate benches, and proper placement/maintenance of final cover material to help reduce stormwater infiltration. Final closure design should increase factors of safety to at least 1.5 for long term (drained) slope stability at the stack toe, and to at least 3 for piping in the perimeter ditch. Closure design should also include provisions for flattening perimeter dike exterior slopes in those areas where slopes are relatively steep. It is also recommended that URS Corporation's closure design include an instrumentation monitoring program (including calculation of "alert" piezometric levels which would result in slope stability factors of safety falling below 1.5).

8.6. Until improvements can be made that will permanently improve stability, seepage and stormwater management conditions, it is recommended that TVA continue inspections/monitoring to look for changes or conditions that might affect the integrity of the stack and adjacent drainage basin. The frequency of inspections should be consistent with the TVA's new programmatic inspection schedule.

8.7. The Disposal Area 5 site is underlain by limestone bedrock that can be susceptible to solutioning and the development of karst features, such as voids, solution channels, and sinkholes in the soil overburden and/or the underlying bedrock. Construction and operation in such areas is always accompanied by risk that internal soil erosion and ground subsidence could affect constructed facilities. It is not possible to completely investigate a site or design a facility to eliminate karst-related problems. However, throughout this study Stantec did not observe ground features nor detect significant karst subsurface conditions at the boring locations that would indicate that karst-related issues are affecting the existing facility.

9. Closure and Limitations of Study

9.1. The scope of this evaluation was limited to consider only the potential risks of the Disposal Area 5 Dry Stack and Drainage Basin dikes due to excessive seepage and slope instability under static long-term, drained (steady-state) and undrained loading conditions. This assessment did not consider potential failure modes related to spillway capacity and overtopping or seepage along penetrations through the dikes (including the buried spillway pipes).

9.2. These conclusions and recommendations are based on data and subsurface conditions from the borings advanced during this investigation using that degree of care and skill ordinarily exercised under similar circumstances by competent members of the engineering profession. No warranties can be made regarding the continuity of conditions between borings.

9.3. 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.

10. References

The following is a list of documents that were the main references for gaining historical information used to evaluate the Disposal Area 5 Dry Stack and Drainage Basin and to prepare this report:

- Colbert Steam Plant – Ash Pond 5 – Filed Permeability Tests, Memorandum from John A. Raulston to O. P. Thornton, December 14, 1984.
- Report of Hydrogeological and Geophysical Investigation, Colbert Steam Plant, LAW Environmental, Inc. August 15, 1989.
- Report of Geotechnical Exploration, Ash Stack – Area 5, Colbert Fossil Plant, MACTEC Engineering and Consulting, March 19, 2004.

- Colbert Steam Plant – Leakage in Ash Pond 5, Memorandum from R. E. Harris and H. W. Harris to Fossil Engineering Projects Files, November 30, 1984.
- Colbert Steam Plant – Additional Ash Disposal Area No. 5 – Engineering Report, Memorandum from M. N. Sprouse to H. S. Fox, December 21, 1982.
- Geology of the Colbert Steam Plant, Charles P. Bensiger, TVA Division of Water Control Planning, Geologic Branch, November, 1951.
- TVA Drawing Numbers 10W279, 10W283-1 through 5, 10W283-10 through 20.
- TVA Annual Inspection Reports, 1993 to 2008.

Additional reference documents are listed below:

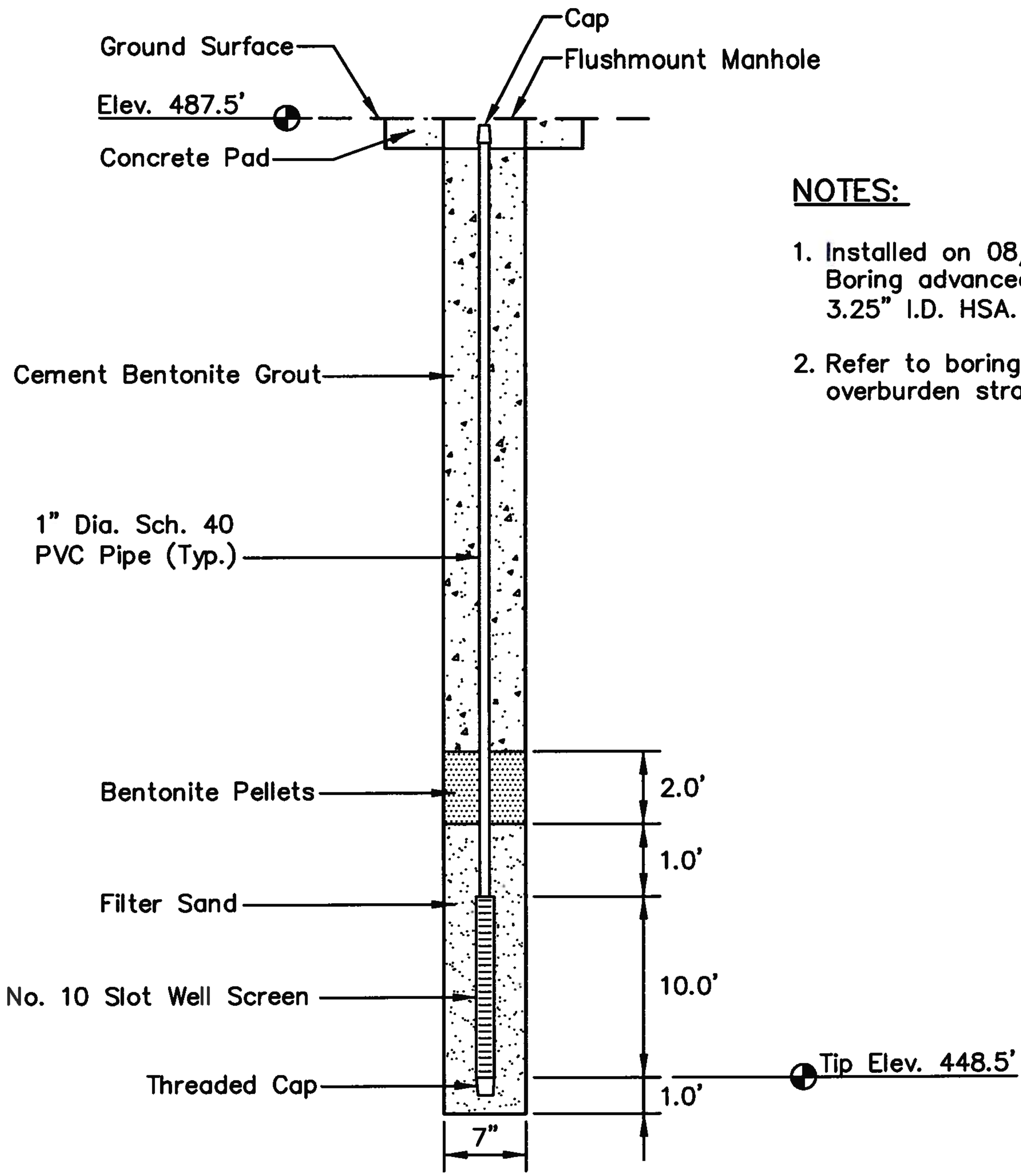
- Slope Stability, Department of the Army, US Army Corps of Engineers, Engineering Manual EM 1110-2-1902, October 31, 2003.
- Seepage Analysis and Control for Dams, Department of the Army, US Army Corps of Engineers, Engineering Manual EM 1110-2-1901, April 30, 1993.
- Geotechnical Investigations, Department of the Army, US Army Corps of Engineers, Engineering Manual EM 1110-1-1804, January 1, 2001.
- GeoStudio, Computer Software. GEO-Slope International Ltd. Ver. 7.15, 2007.
- Soil Mechanics Design Manual 7.1, Department of the Navy – Navy Facilities Engineering Command, May 1982.
- Terzaghi, K., Peck, R.B., and Gholamreza, M., Soil Mechanics in Engineering Practice, 3rd Edition, New York, John Wiley and Sons, 1996.
- UTEXAS 4, Computer Software. Stephen G. Wright, University of Texas at Austin. Ver. 4.1.0.3

Appendix A

Typed Boring Logs

Appendix B

Piezometer Installation Details and Readings



NOTES:

1. Installed on 08/03/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 01/21/2010 USER: MCKINNEY, JIMMY
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_JFR\59019PZ-STN-5-3.DWG

LOCATION

Northing: 1721592.79
Easting: 400338.67
Ground Elevation: 487.5

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-3S
PIEZOMETER INSTALLATION DETAIL
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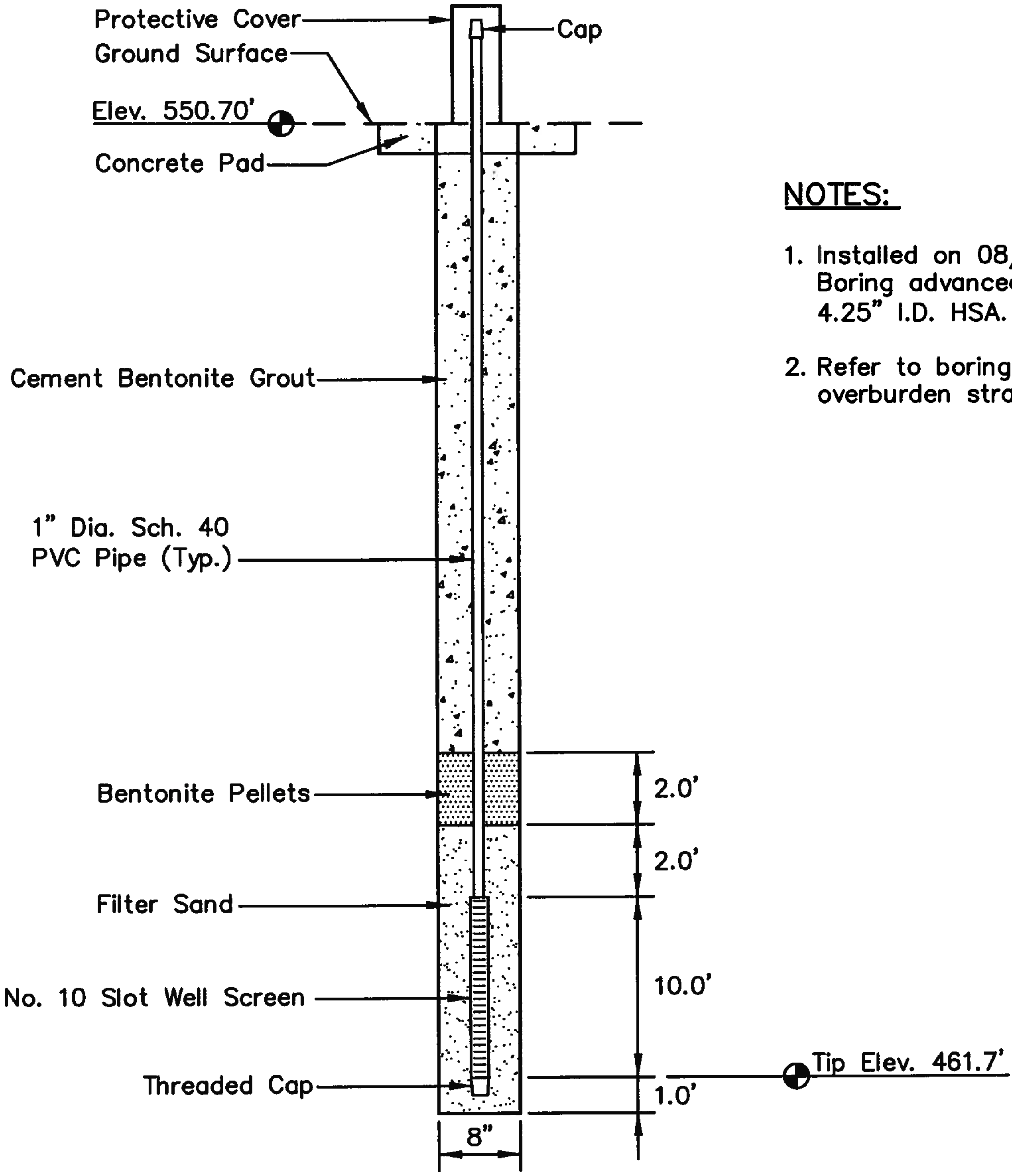
CHECKED BY	SHB	SCALE NTS	2.	4.	



NOTES:

1. Installed on 08/31/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/07/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-4A.DWG

LOCATION

Northing: 1720600.17
Easting: 400244.82
Ground Elevation: 550.7

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-4A
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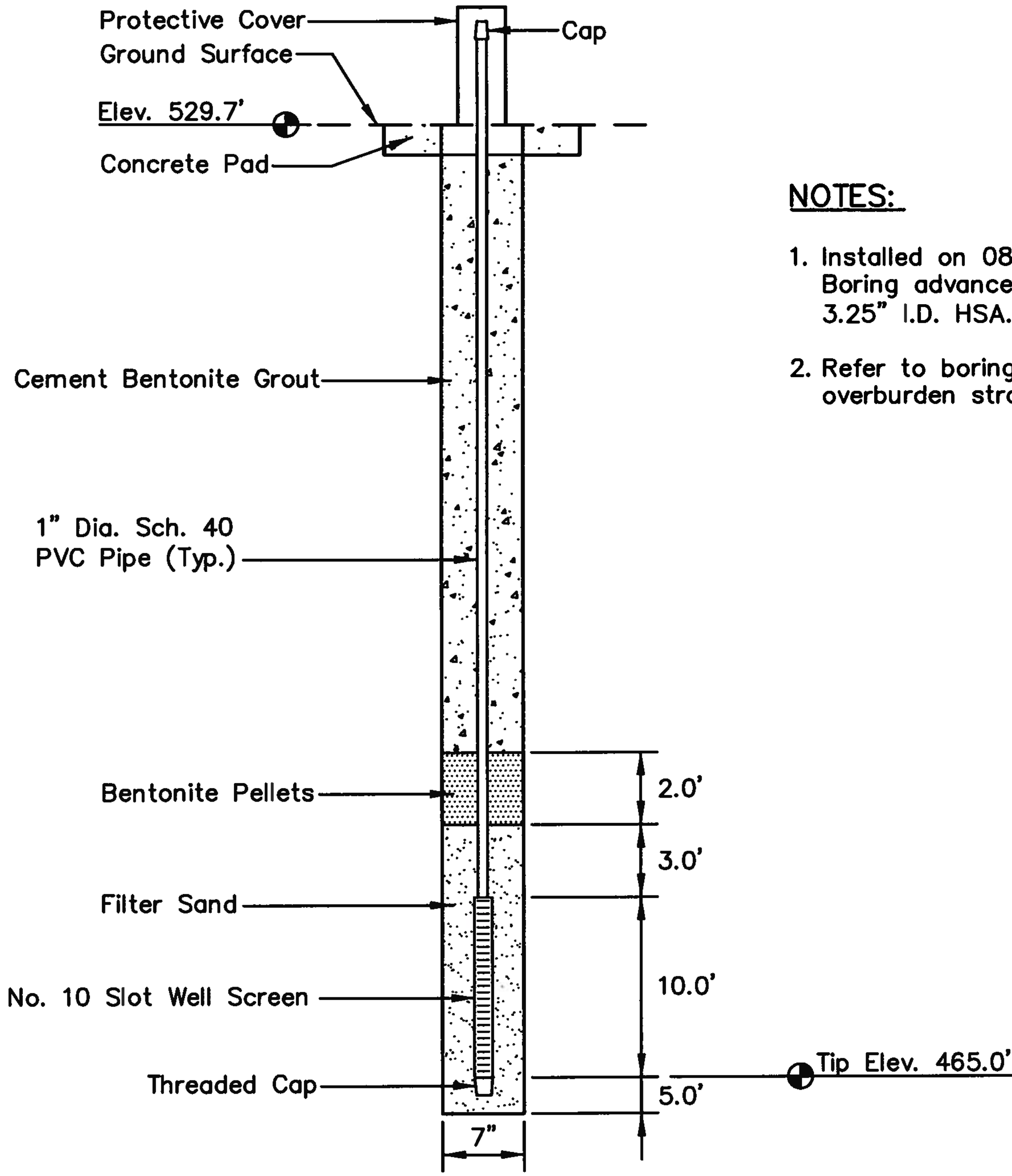

NOTES:

1. Installed on 08/06/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

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V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-5.DWG

LOCATION

Northing: 1720441.17
Easting: 400279.90
Ground Elevation: 529.7

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-5S
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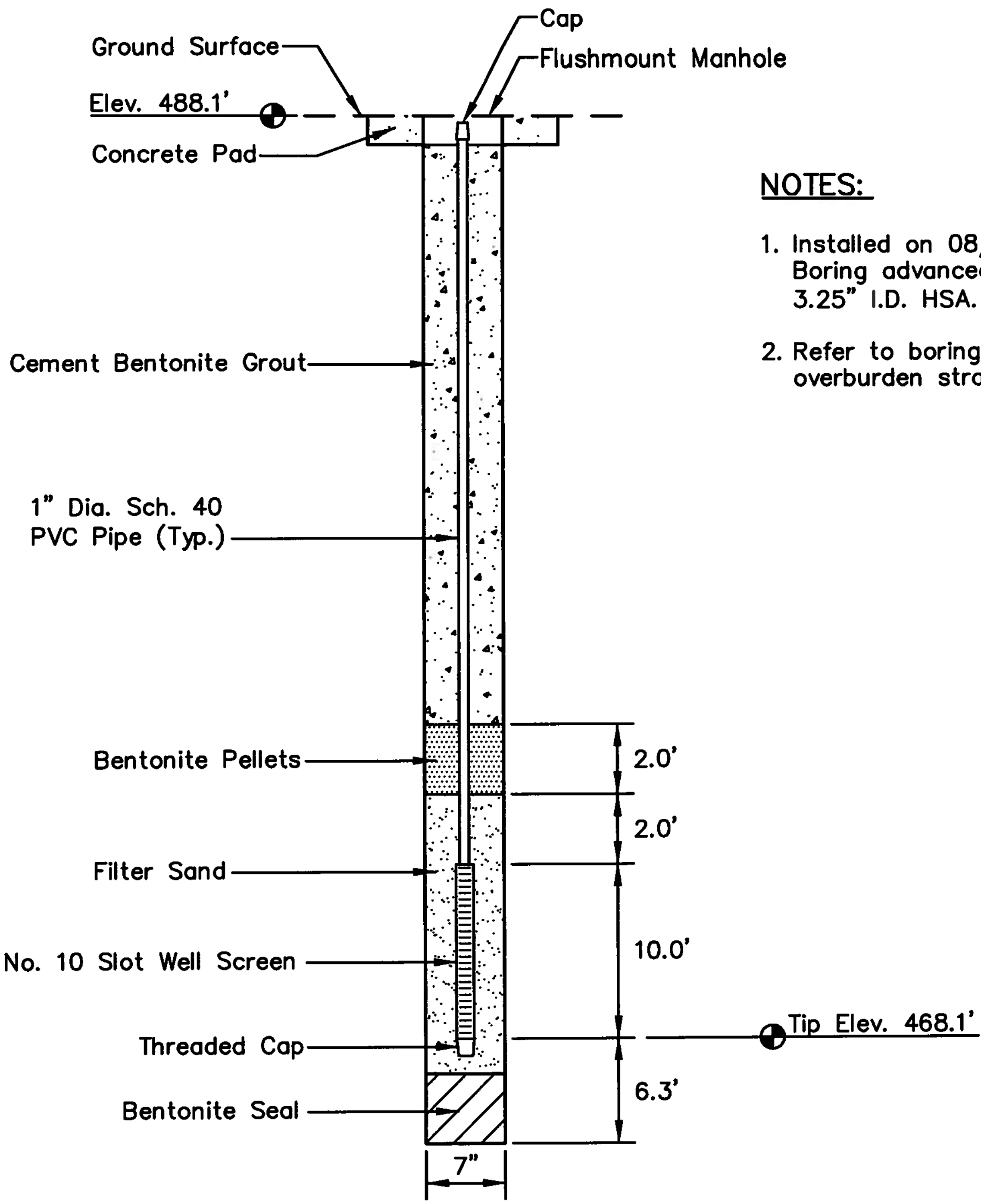

NOTES:

1. Installed on 08/11/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

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V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-6.DWG

LOCATION

Northing: 1720353.73
Easting: 400481.02
Ground Elevation: 488.1

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

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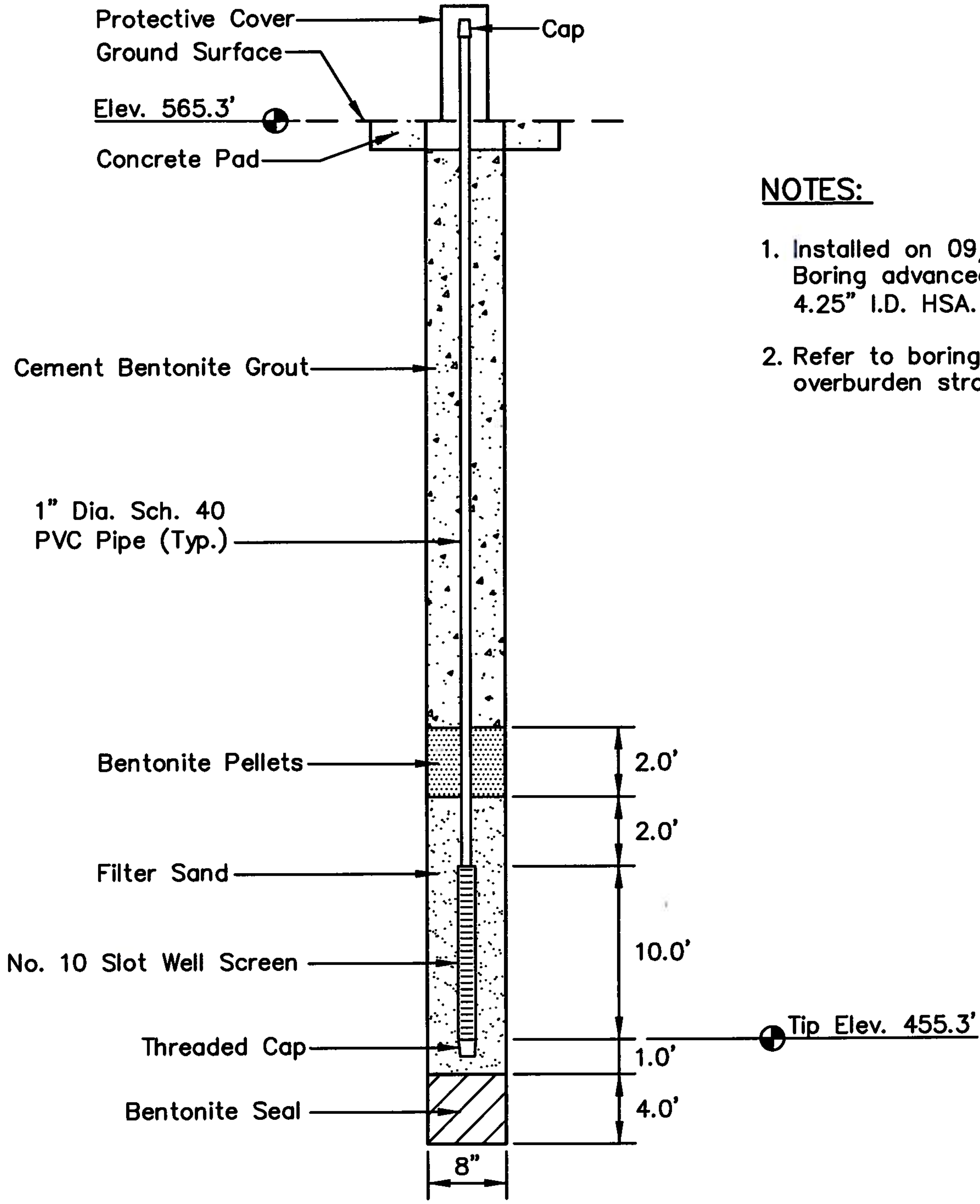

NOTES:

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2. Refer to boring log for overburden stratigraphy.

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LOCATION

Northing: 1720897.20
Easting: 398906.71
Ground Elevation: 565.3

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-7A
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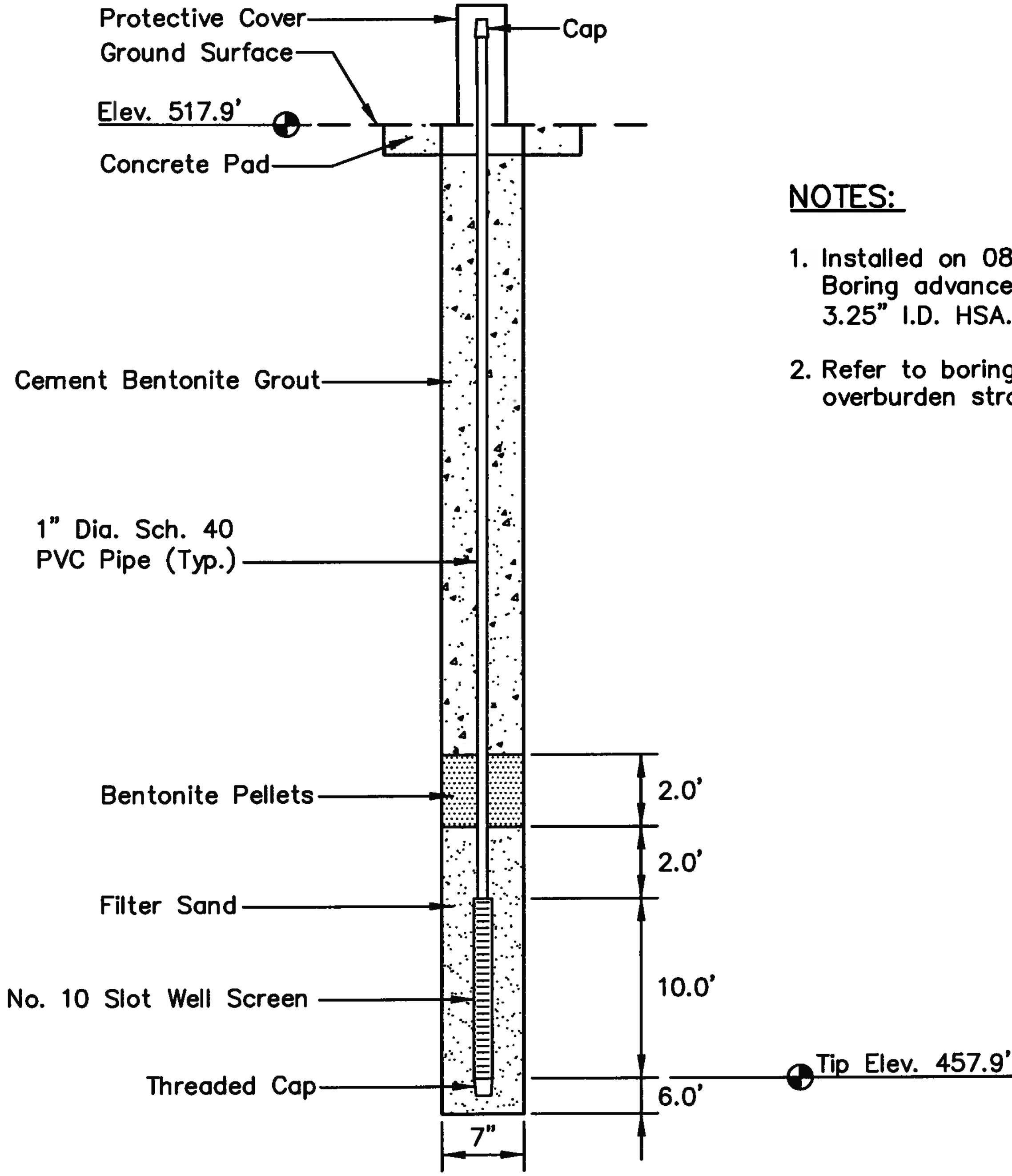

NOTES:

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V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-8.DWG

LOCATION

Northing: 1720684.92
Easting: 698641.15
Ground Elevation: 517.9

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

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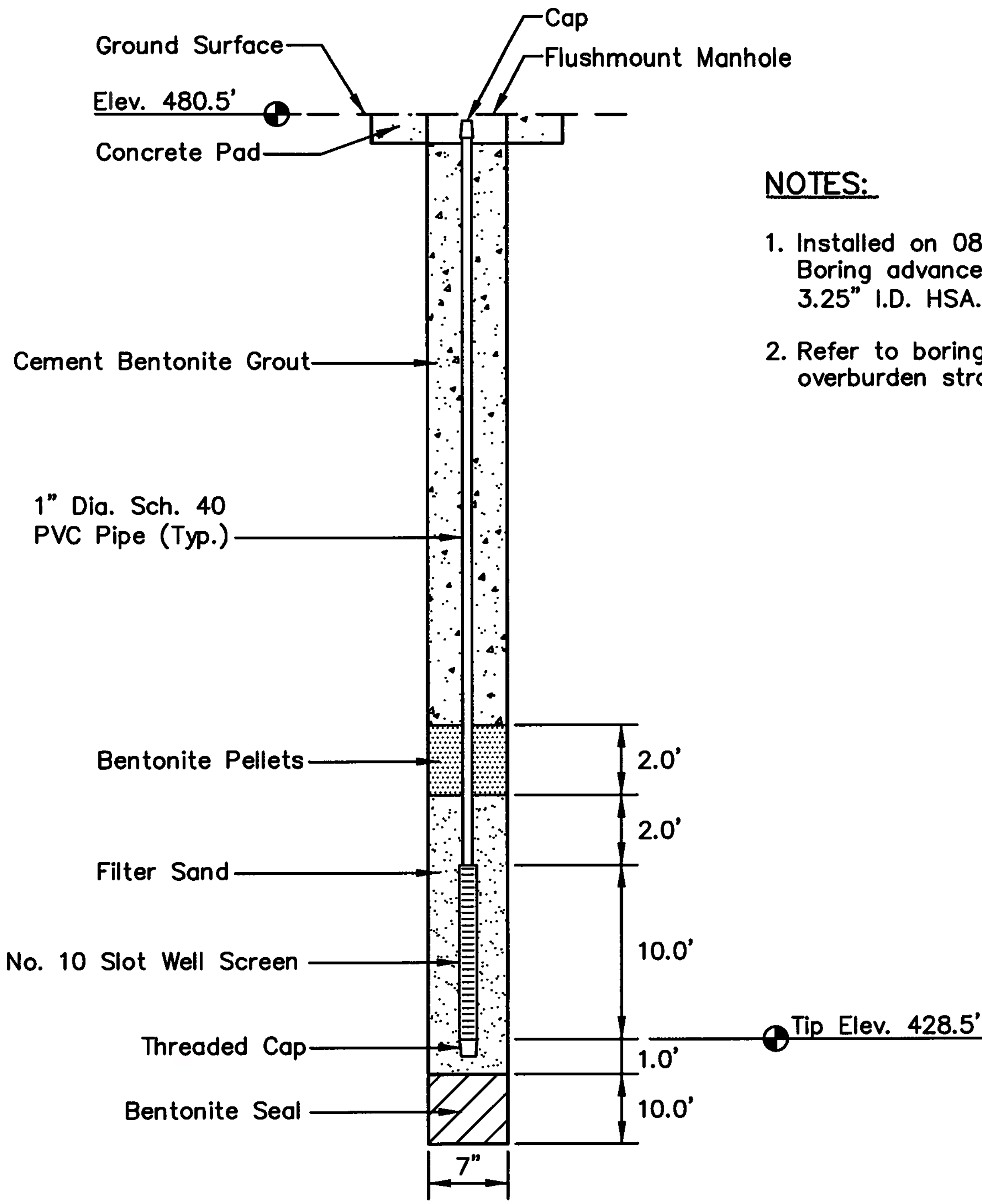

NOTES:

1. Installed on 08/04/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

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V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REVO_JFR\59019PZ-STN-5-9.DWG

LOCATION

Northing: 1720444.22
Easting: 398582.58
Ground Elevation: 480.5

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

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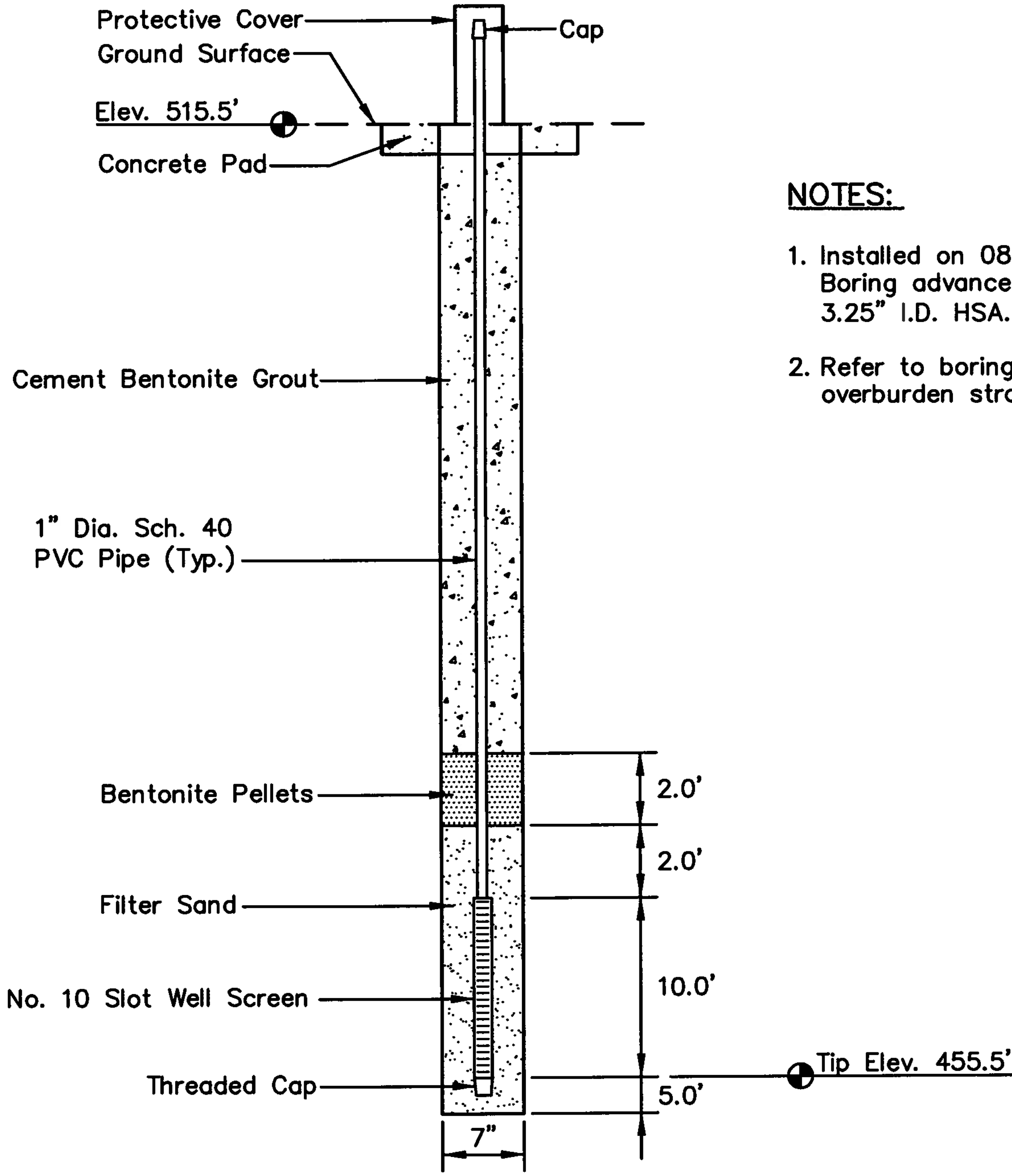

NOTES:

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2. Refer to boring log for overburden stratigraphy.

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LOCATION

Northing: 1721251.58
Easting: 398733.51
Ground Elevation: 515.5

Locations to be provided by TVA,
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Surveying and Project Services.
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Vertical Datum: NGVD29

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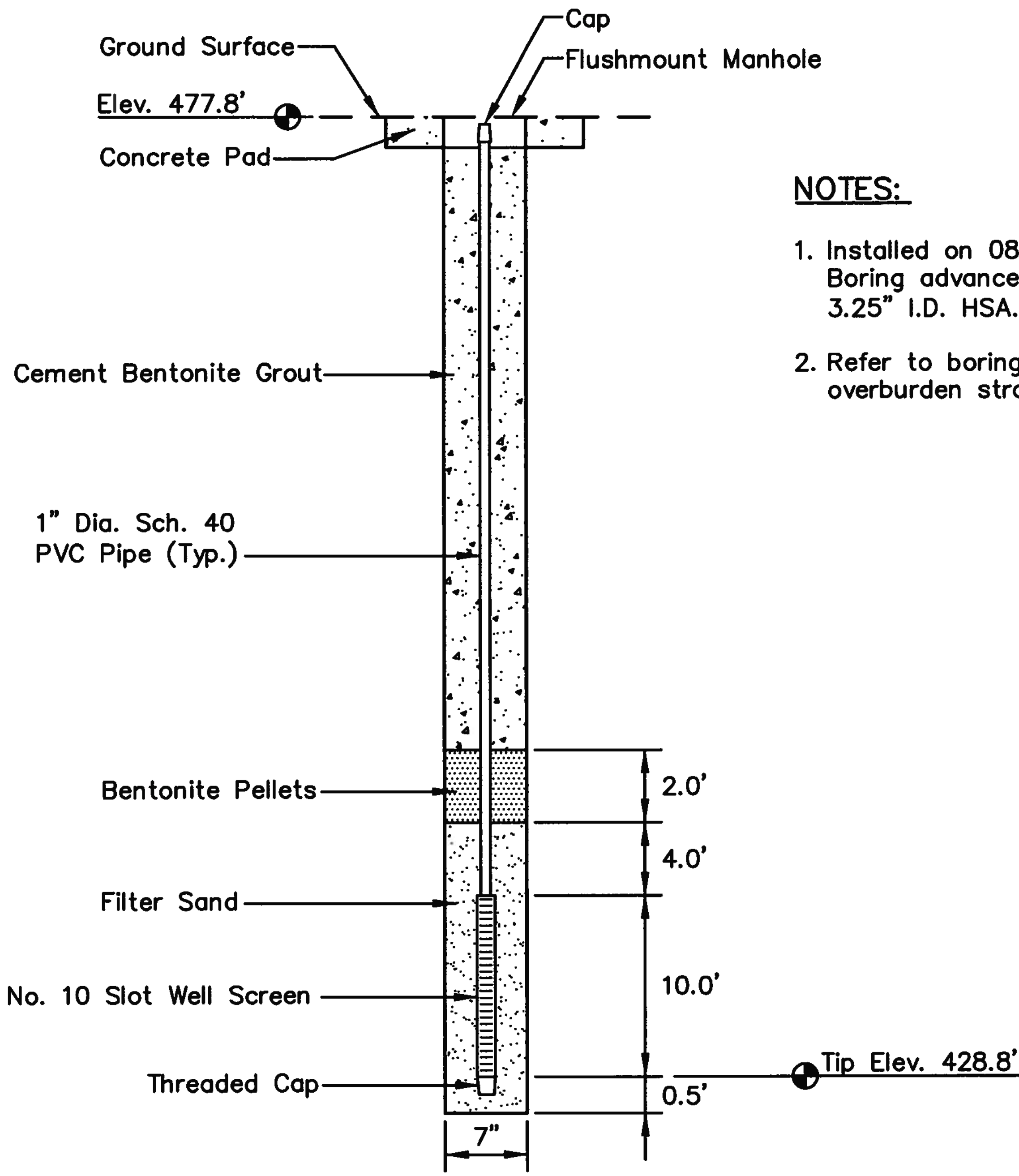

NOTES:

1. Installed on 08/18/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

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V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REVO_IFR\59019PZ-STN-5-12.DWG

LOCATION

Northing: 1721306.21
Easting: 398486.91
Ground Elevation: 477.8

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-12
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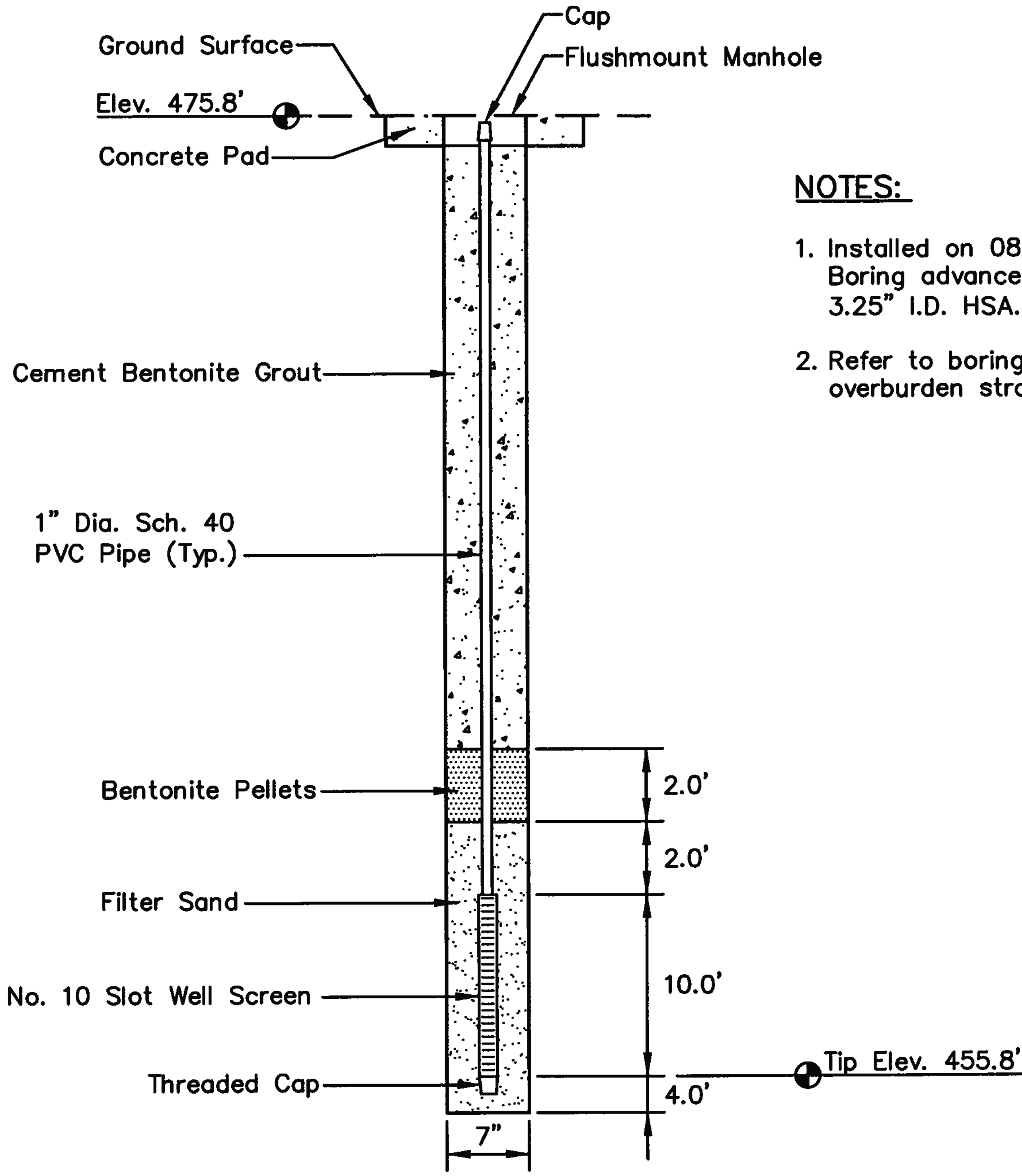

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2. Refer to boring log for overburden stratigraphy.

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V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REVO_IFR\59019PZ-STN-5-16.DWG

LOCATION

Northing: 1722788.34
Easting: 399149.51
Ground Elevation: 475.8

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

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PIEZOMETER INSTALLATION DETAIL
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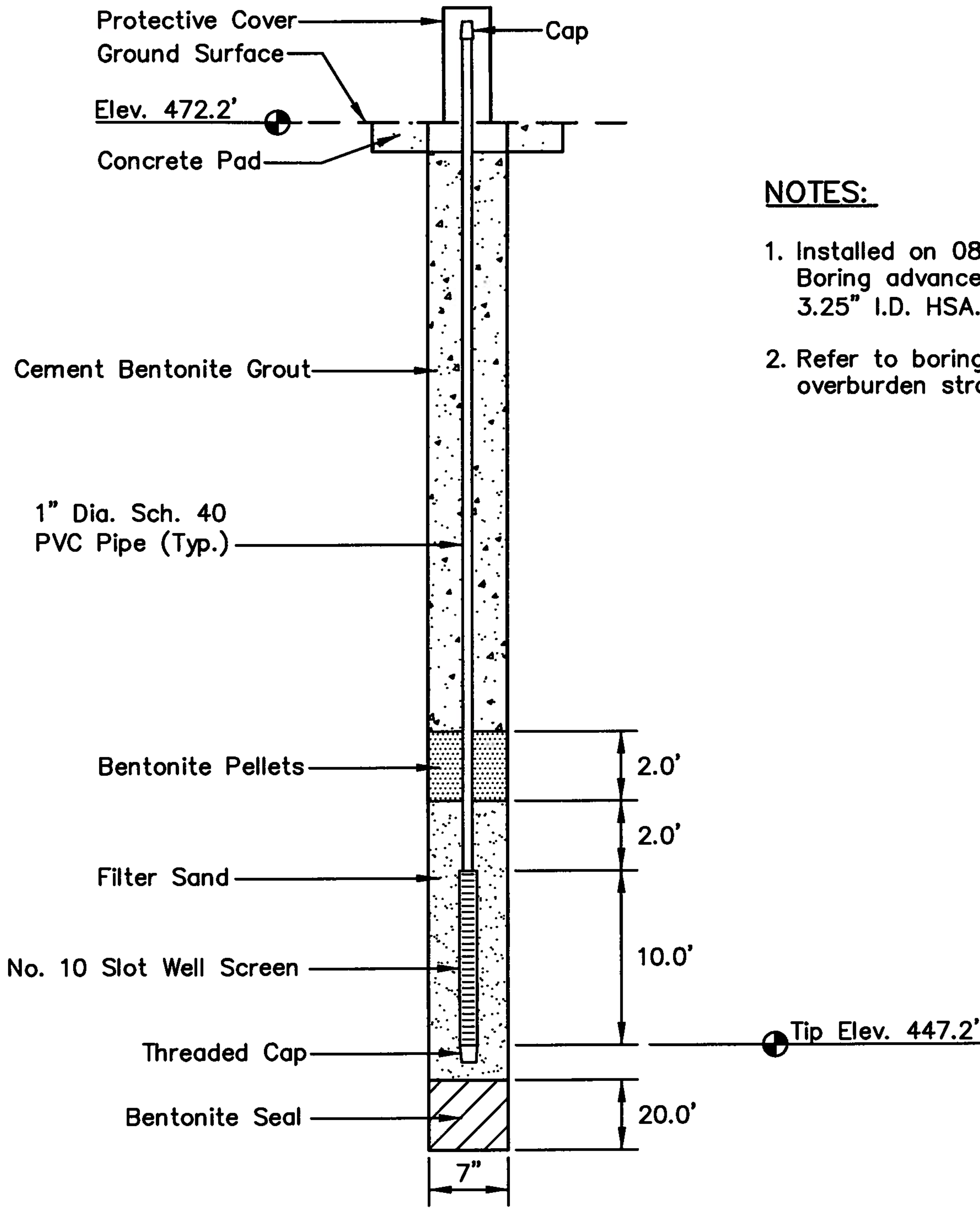

NOTES:

1. Installed on 08/10/09. Boring advanced with 3.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

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LOCATION

Northing: 1722671.43
Easting: 398752.9
Ground Elevation: 472.2

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-18
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
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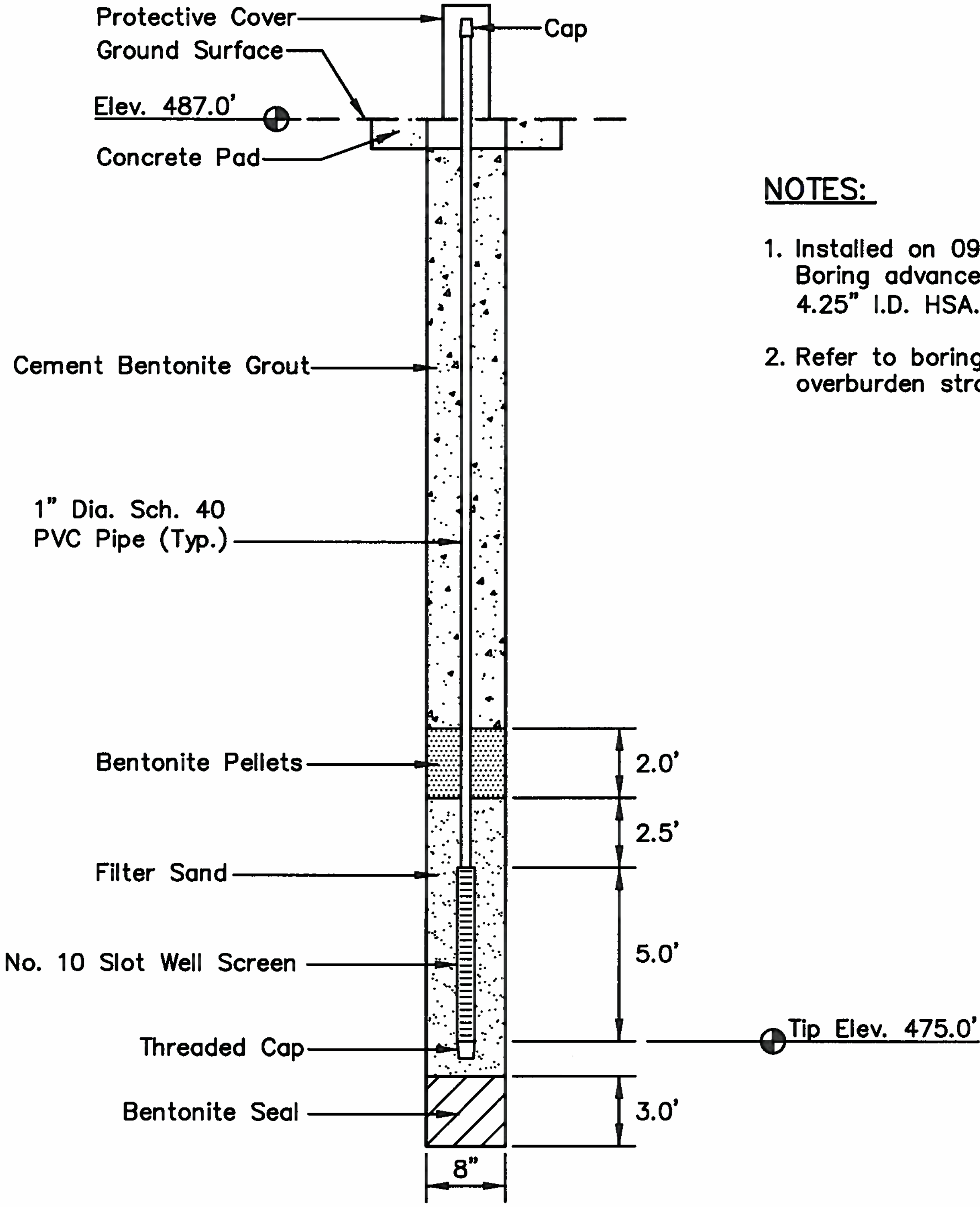

NOTES:

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2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/07/2009 USER: PETTY, RICHARD
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LOCATION

Northing: 1720482.33
Easting: 400509.25
Ground Elevation: 487.0

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-101
PIEZOMETER INSTALLATION DETAIL
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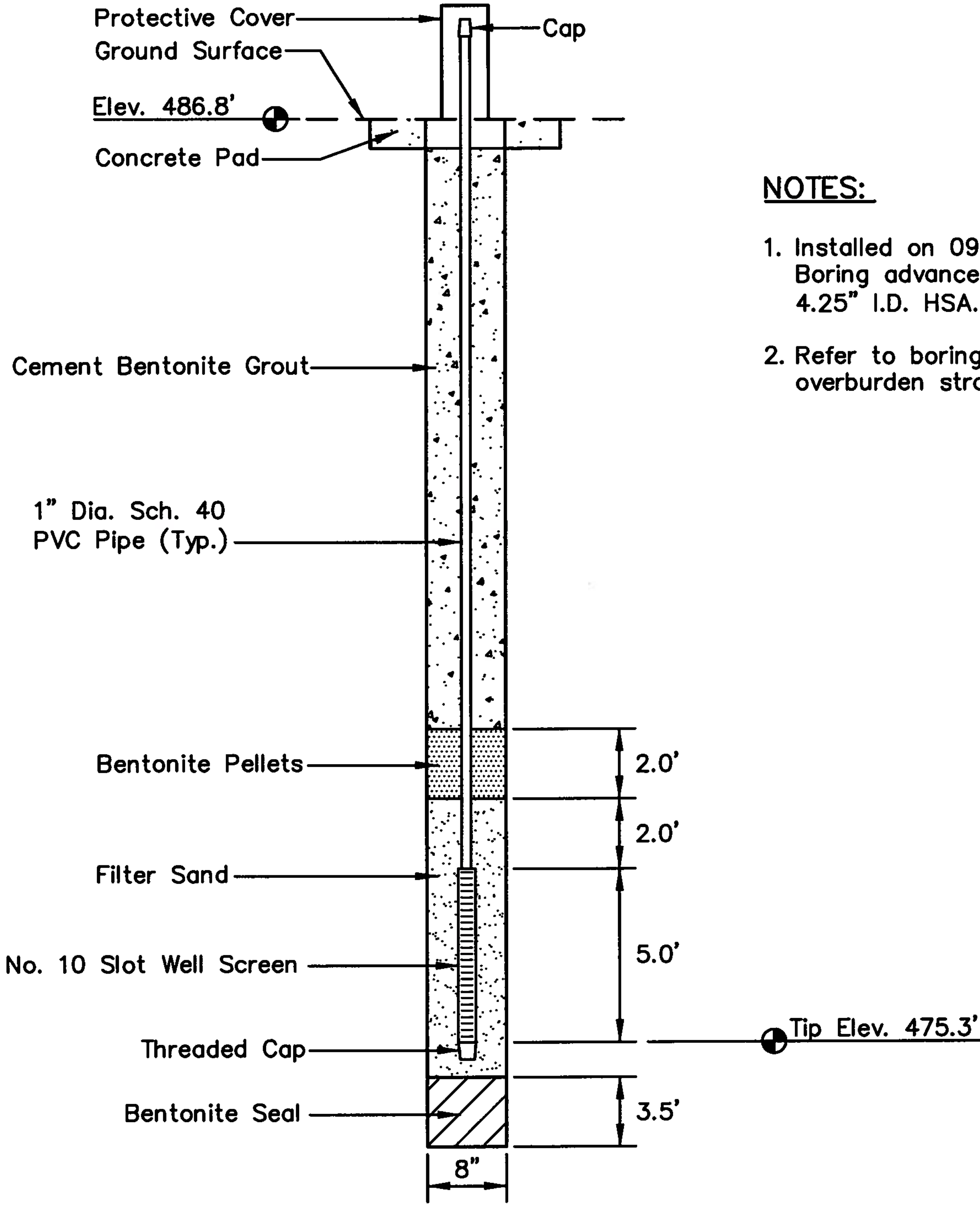

NOTES:

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2. Refer to boring log for overburden stratigraphy.

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LOCATION

Northing: 1720445.72
Easting: 400489.29
Ground Elevation: 486.8

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-102
PIEZOMETER INSTALLATION DETAIL
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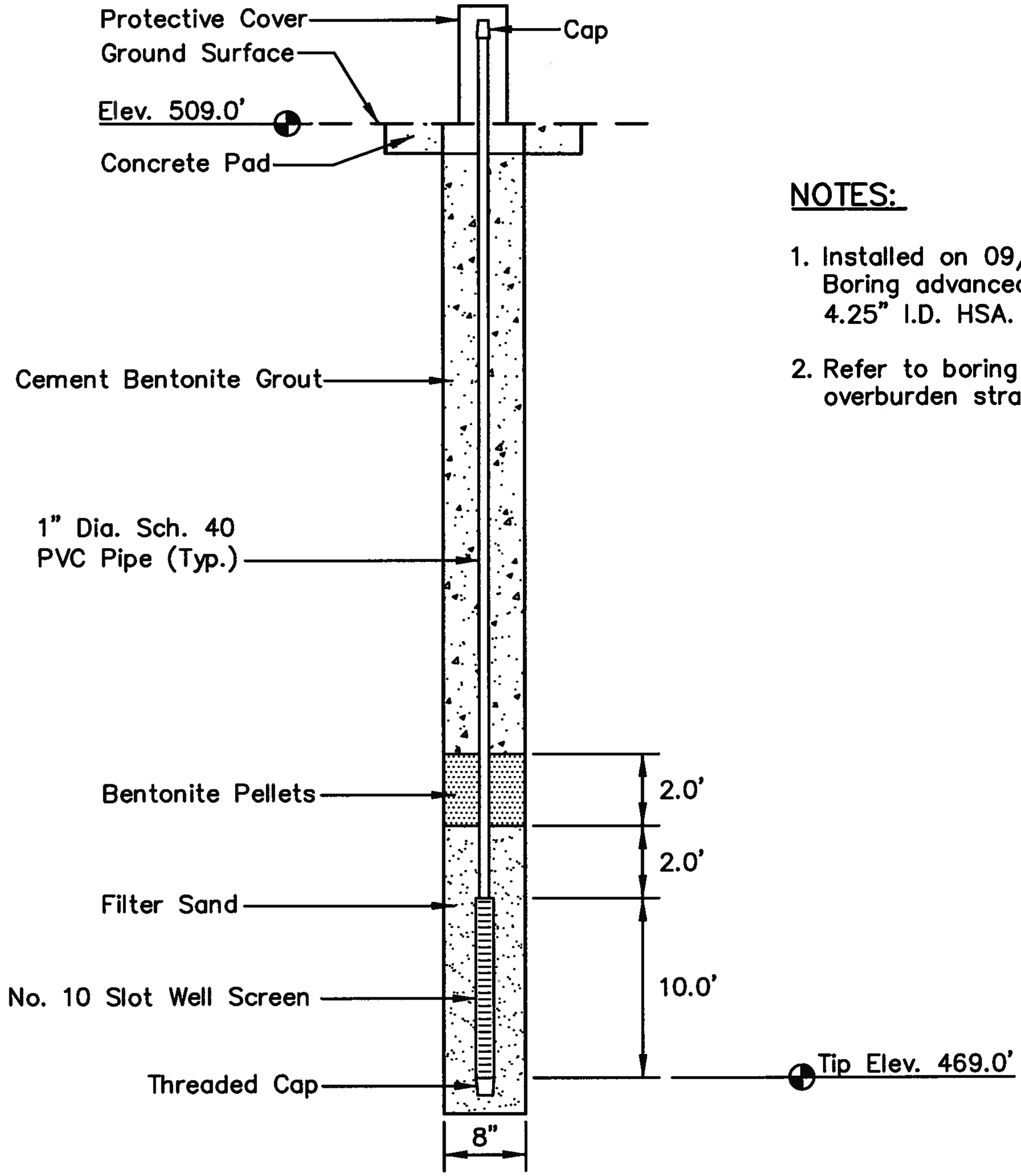
DRAWN BY	SB	DATE	OCT., 2009	REVISED		SHEET
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	13 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/01/09. Boring advanced with 4.25" I.D. HSA.

2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/07/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REVO_JFR\59019PZ-STN-5-103A.DWG

LOCATION

Northing: 1720493.35
Easting: 400426.84
Ground Elevation: 509.0

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-103A
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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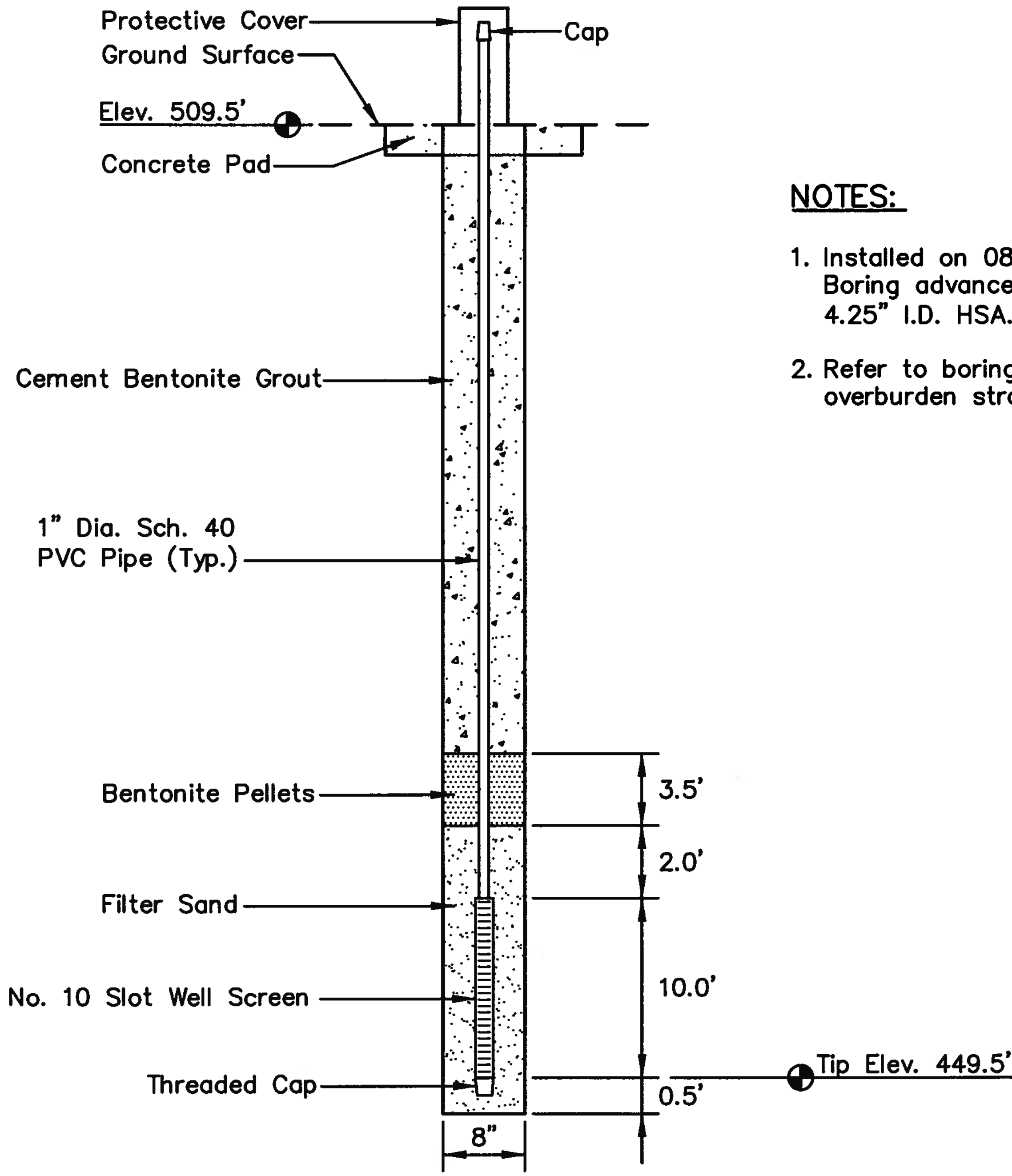
CHECKED BY PJC	PROJ. NO. 175559019	1.	3.	14 OF 44
CHECKED BY SHB	SCALE NTS	2.	4.	



NOTES:

1. Installed on 08/31/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/07/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REVO_IFR\59019PZ-STN-5-103B.DWG

LOCATION

Northing: 1720498.42
Easting: 400429.29
Ground Elevation: 509.5

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-103B
PIEZOMETER INSTALLATION DETAIL
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DISPOSAL AREA 5

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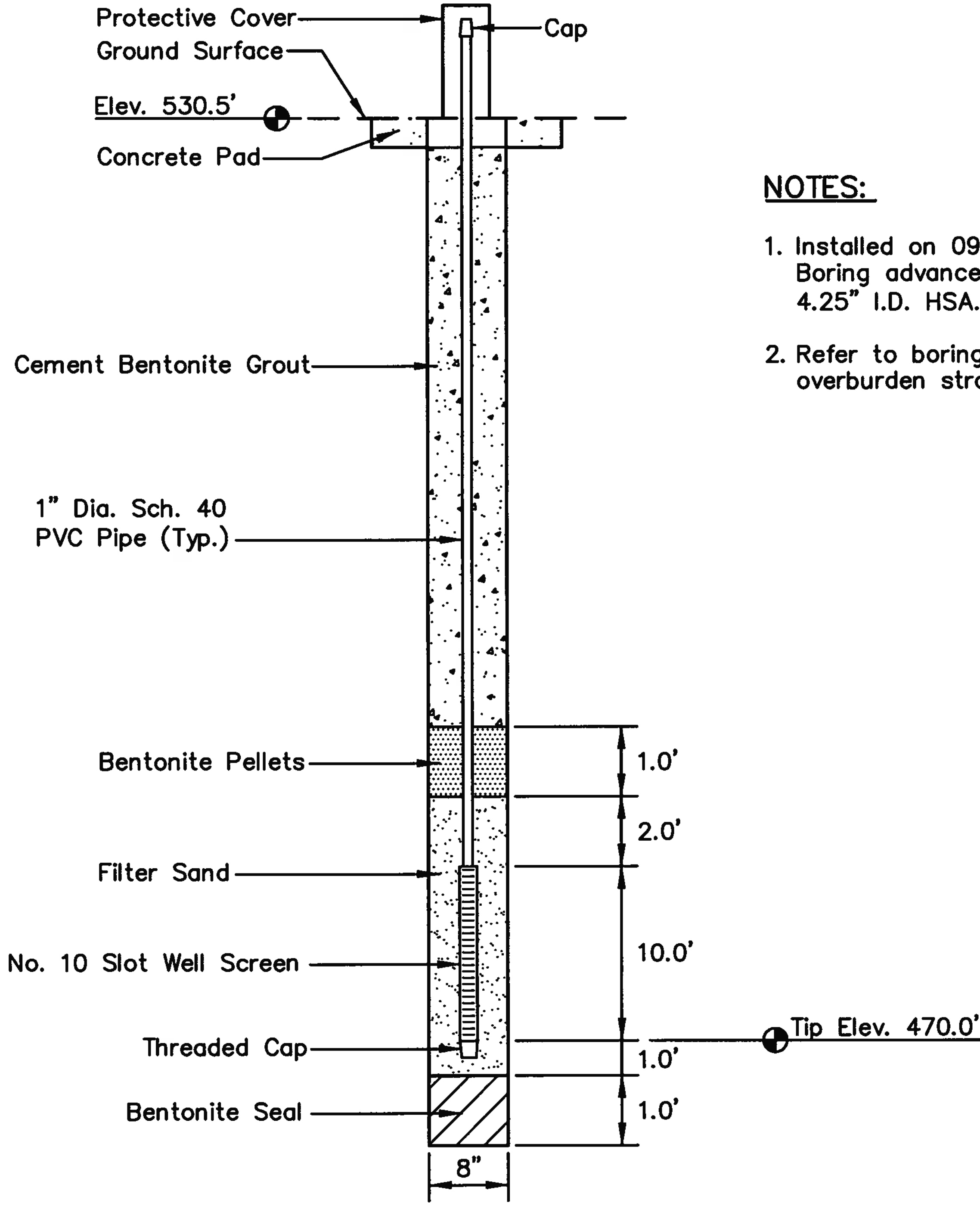
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.		15 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.		



NOTES:

1. Installed on 09/01/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 01/21/2010 USER: MCKINNEY, JIMMY
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REVO_IFR\59019PZ-STN-5-104A.DWG

LOCATION

Northing: 1720548.28
Easting: 400328.22
Ground Elevation: 530.5

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-104A
PIEZOMETER INSTALLATION DETAIL
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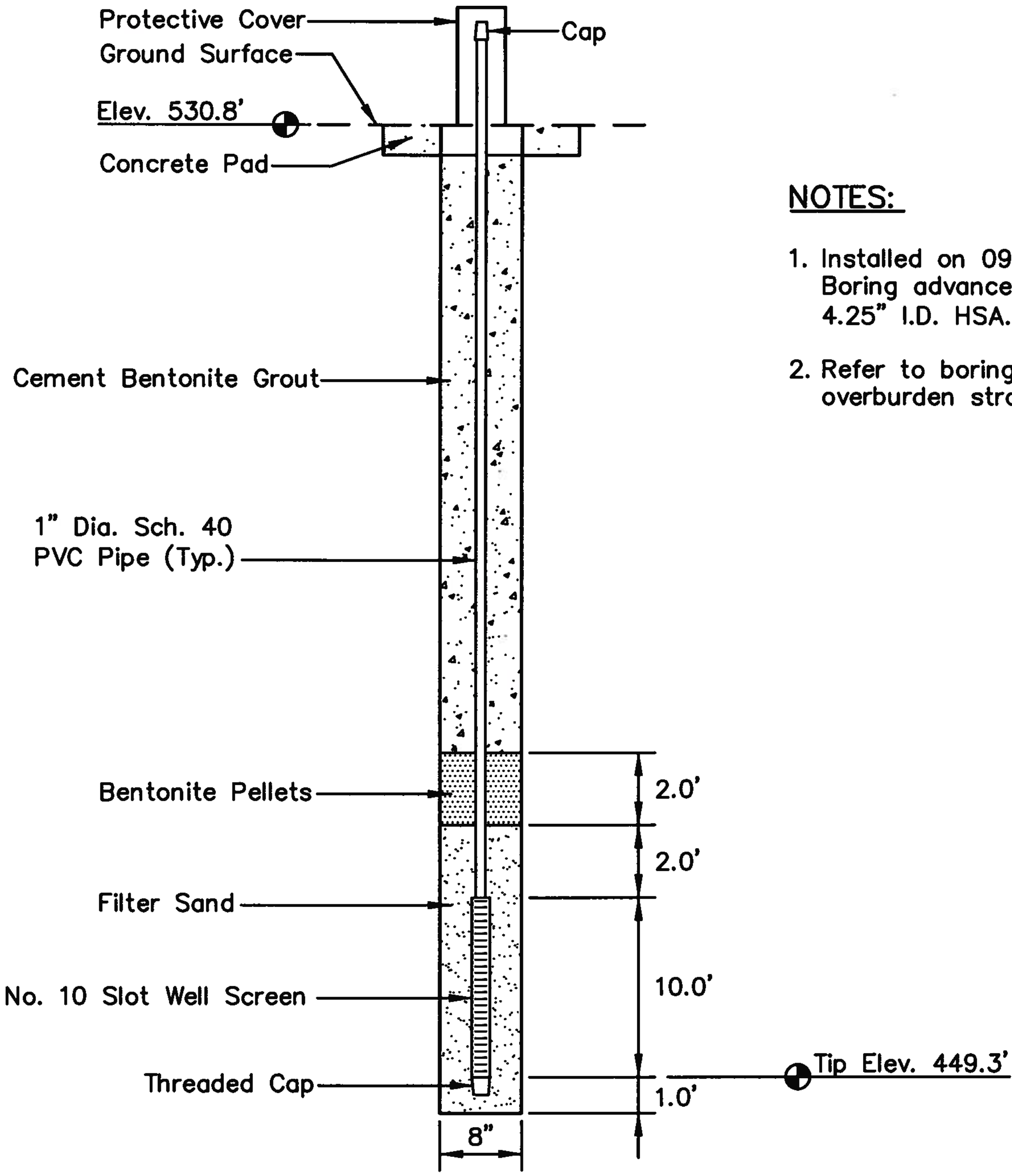
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	16 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/01/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/07/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-104B.DWG

LOCATION

Northing: 1720551.74
Easting: 400330.04
Ground Elevation: 530.8

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-104B
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
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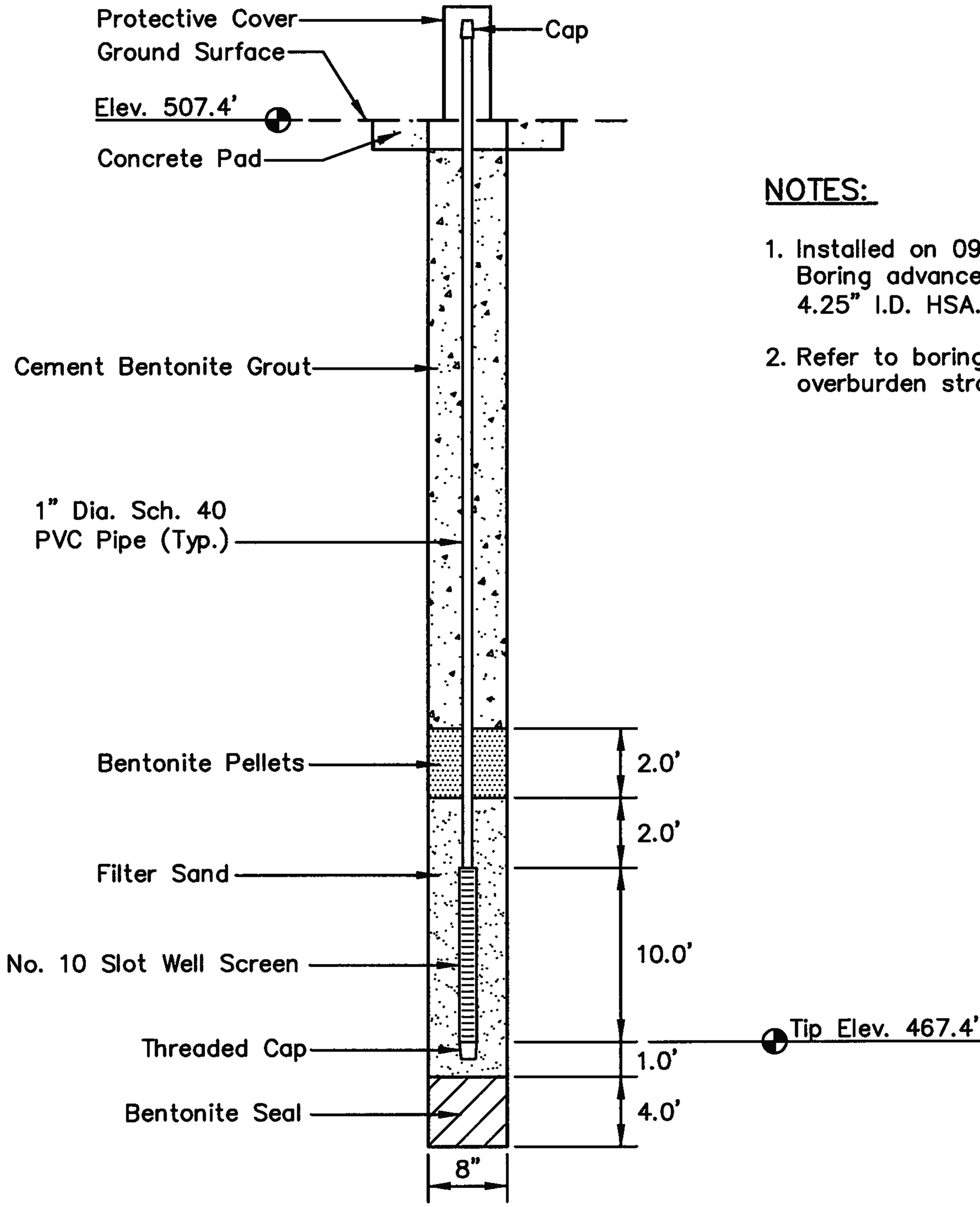
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	17 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/02/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/07/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REVO_JFR\59019PZ-STN-5-105.DWG

LOCATION

Northing: 1720341.58
Easting: 400353.20
Ground Elevation: 507.4

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-105
PIEZOMETER INSTALLATION DETAIL
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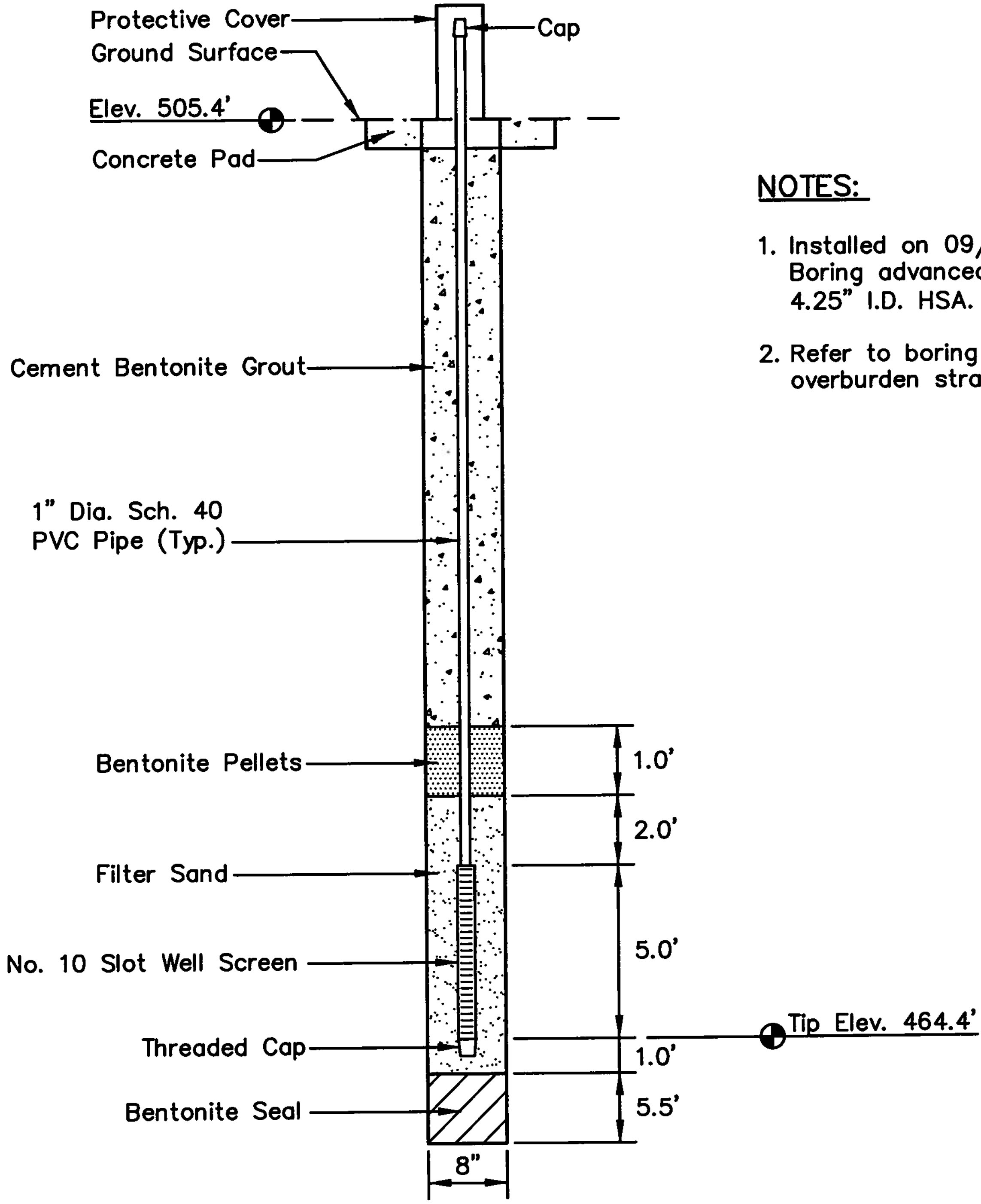
CHECKED BY PJC	PROJ. NO. 175559019	1.	3.		18 OF 44
CHECKED BY SHB	SCALE NTS	2.	4.		



NOTES:

1. Installed on 09/02/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/07/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_JFR\59019PZ-STN-5-106.DWG

LOCATION

Northing: 1720202.10
Easting: 400284.88
Ground Elevation: 505.4

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-106
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
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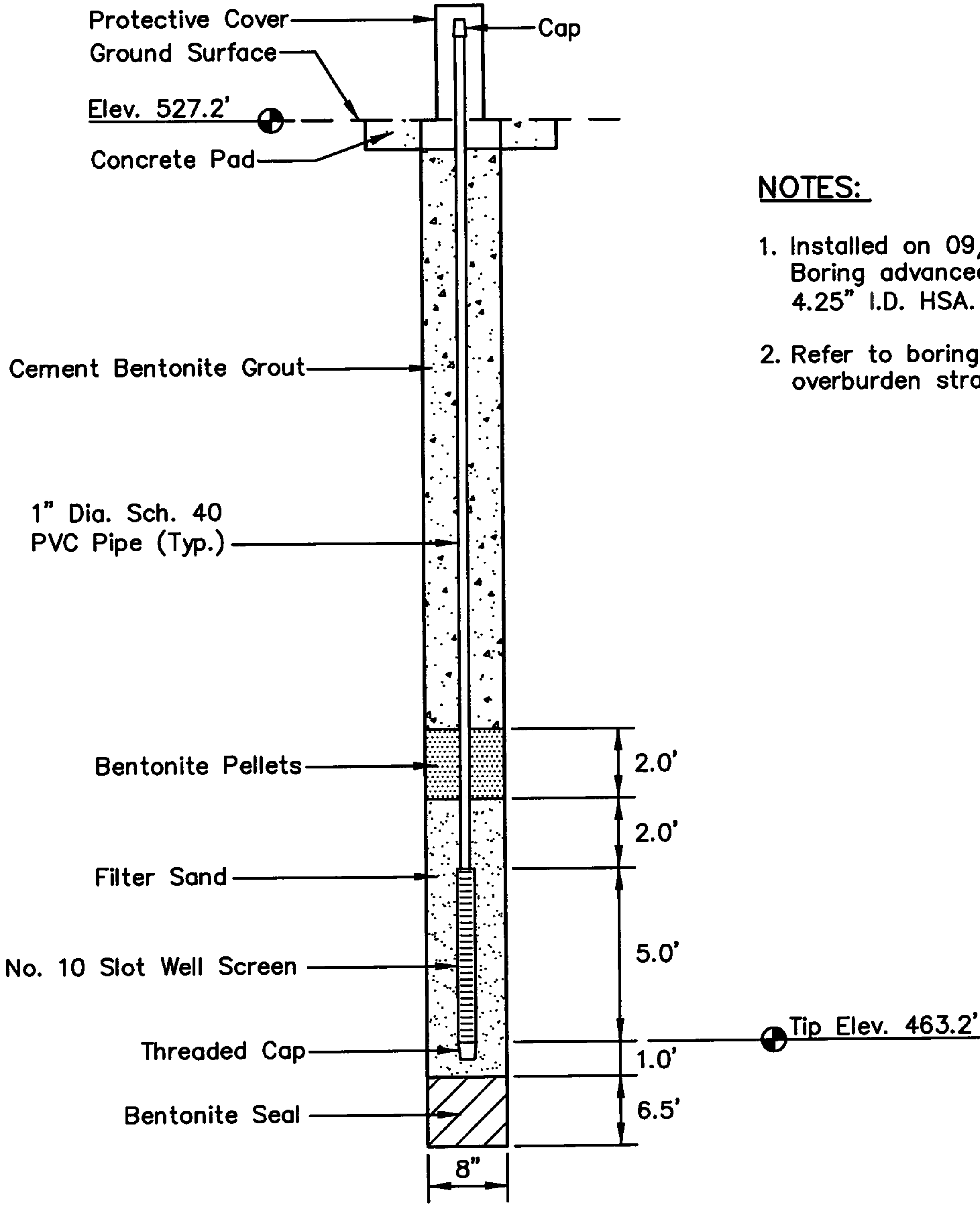
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	19 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/02/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/07/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-107.DWG

LOCATION

Northing: 1720292.02
Easting: 400232.46
Ground Elevation: 527.2

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-107
PIEZOMETER INSTALLATION DETAIL
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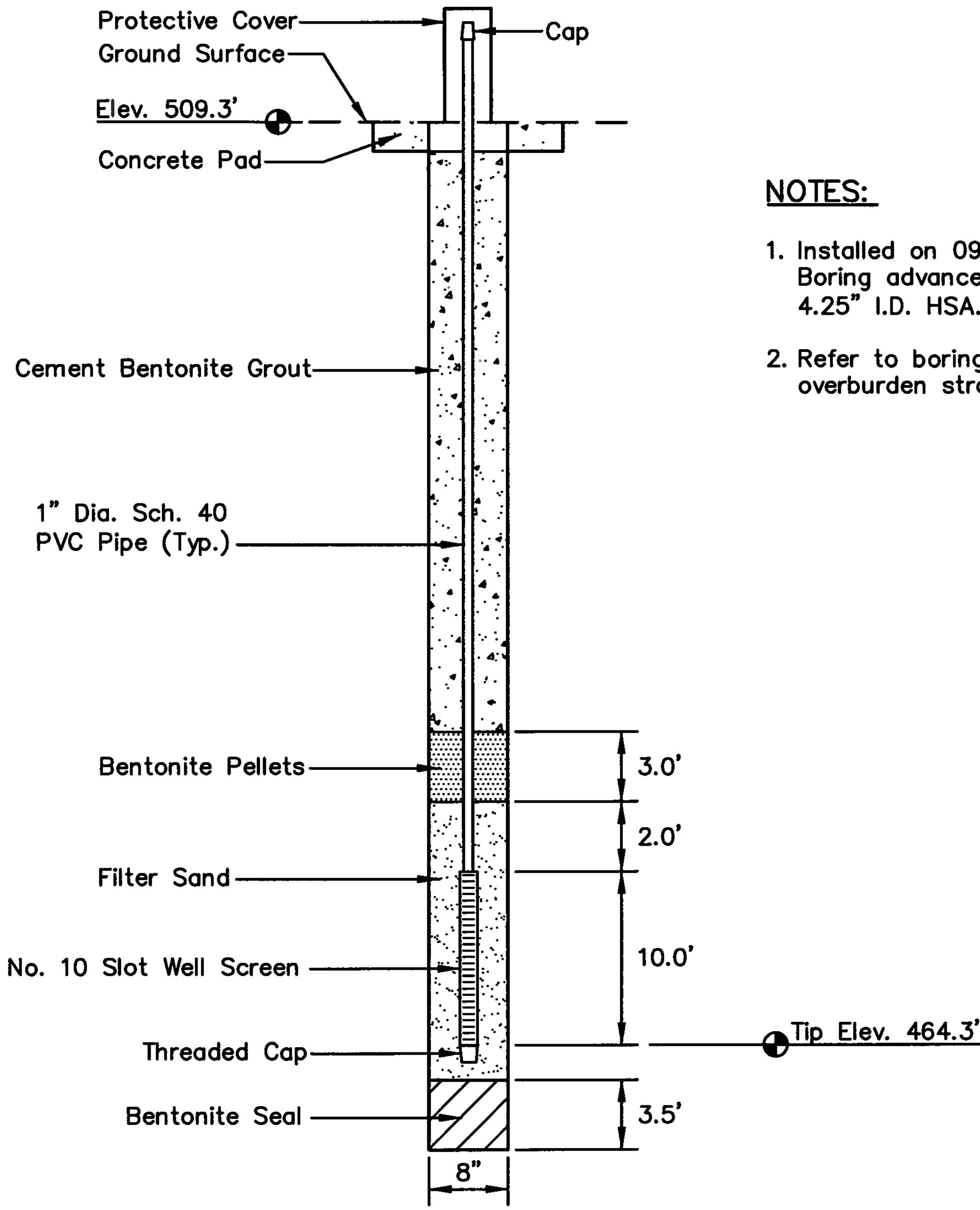
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	20 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/09/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/07/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-108.DWG

LOCATION

Northing: 1720211.06
Easting: 399882.93
Ground Elevation: 509.3

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-108
PIEZOMETER INSTALLATION DETAIL
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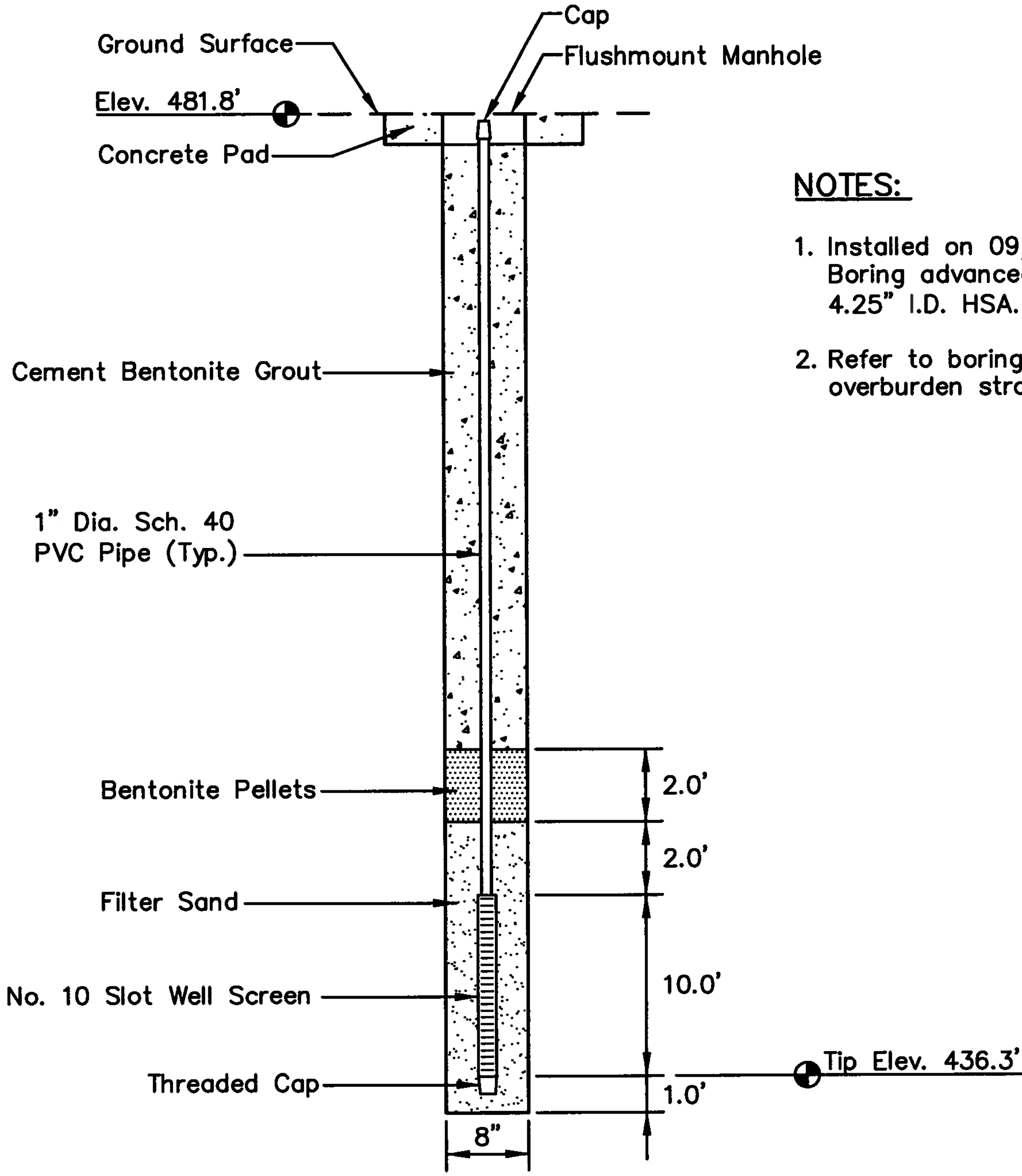
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	21 OF 44	
CHECKED BY	SHB	SCALE	NTS	2.	4.		



NOTES:

1. Installed on 09/07/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/07/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REVO_IFR\59019PZ-STN-5-109.DWG

LOCATION

Northing: 1720195.76
Easting: 399486.17
Ground Elevation: 481.8

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-109
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
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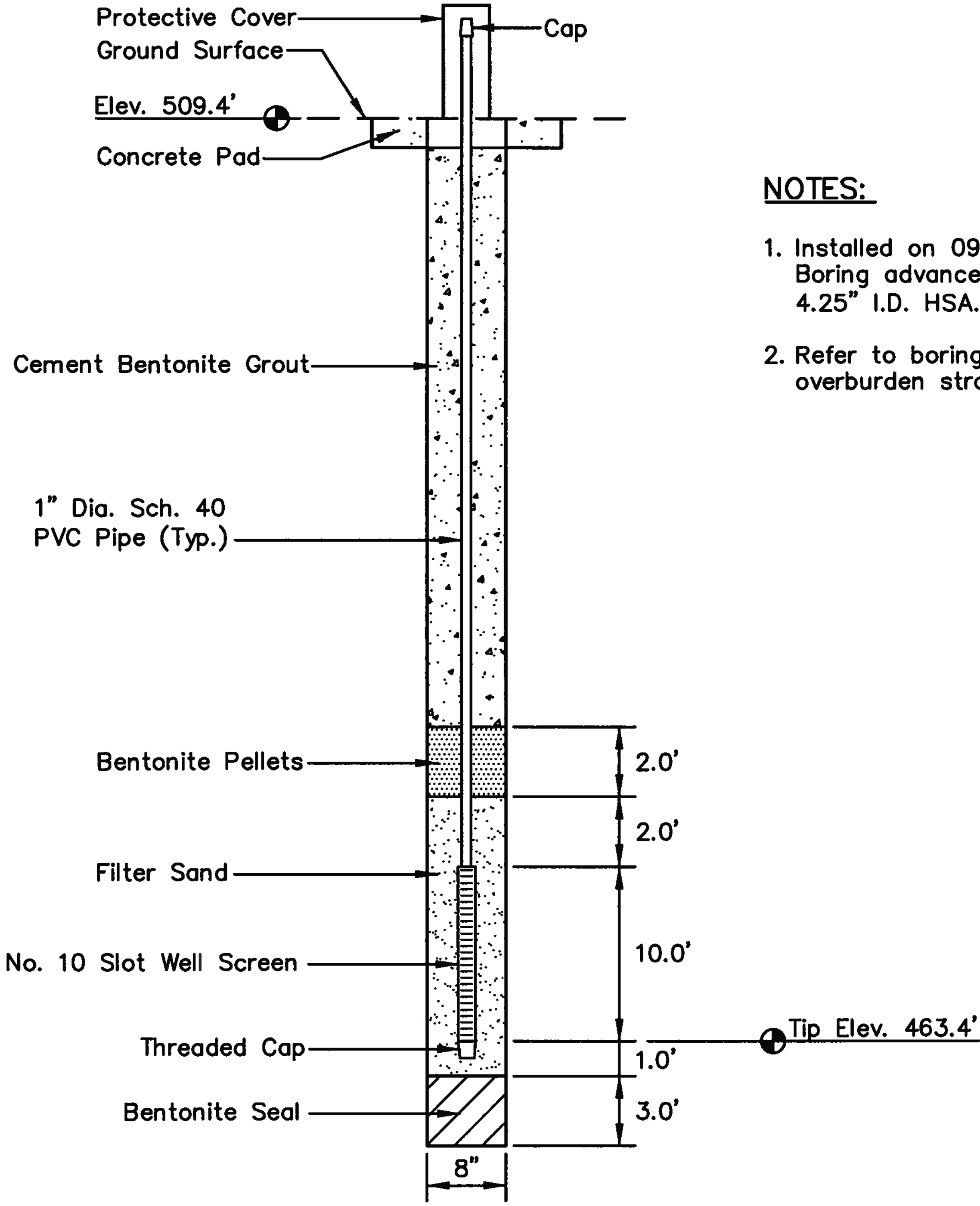
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	22 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/07/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_JFR\59019PZ-STN-5-110.DWG

LOCATION

Northing: 1720315.43
Easting: 399519.59
Ground Elevation: 509.4

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-110
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
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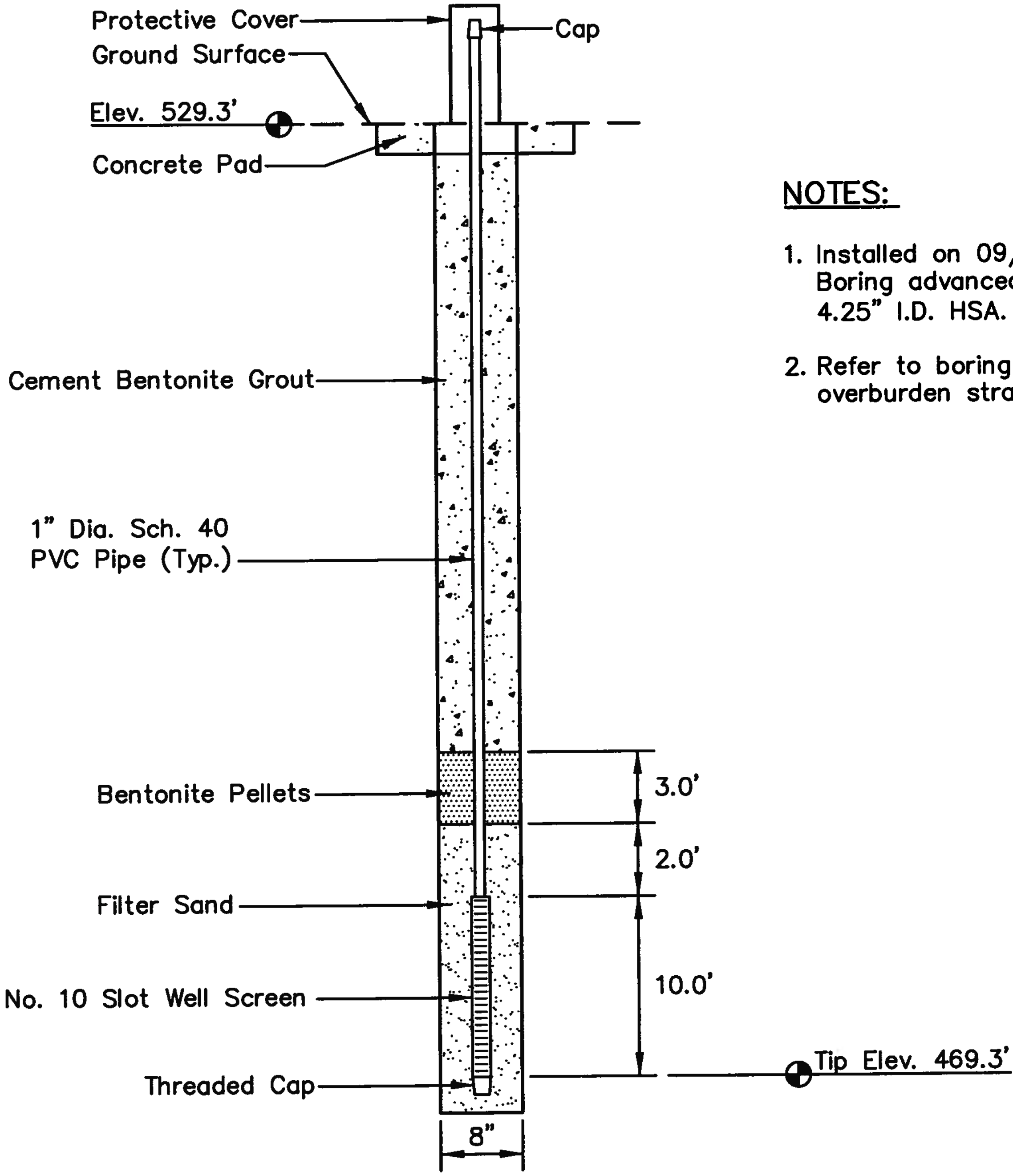
CHECKED BY PJC	PROJ. NO. 175559019	1.	3.		23 OF 44
CHECKED BY SHB	SCALE NTS	2.	4.		



NOTES:

1. Installed on 09/08/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-111A.DWG

LOCATION

Northing: 1720445.15
Easting: 399553.23
Ground Elevation: 529.3

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-111A
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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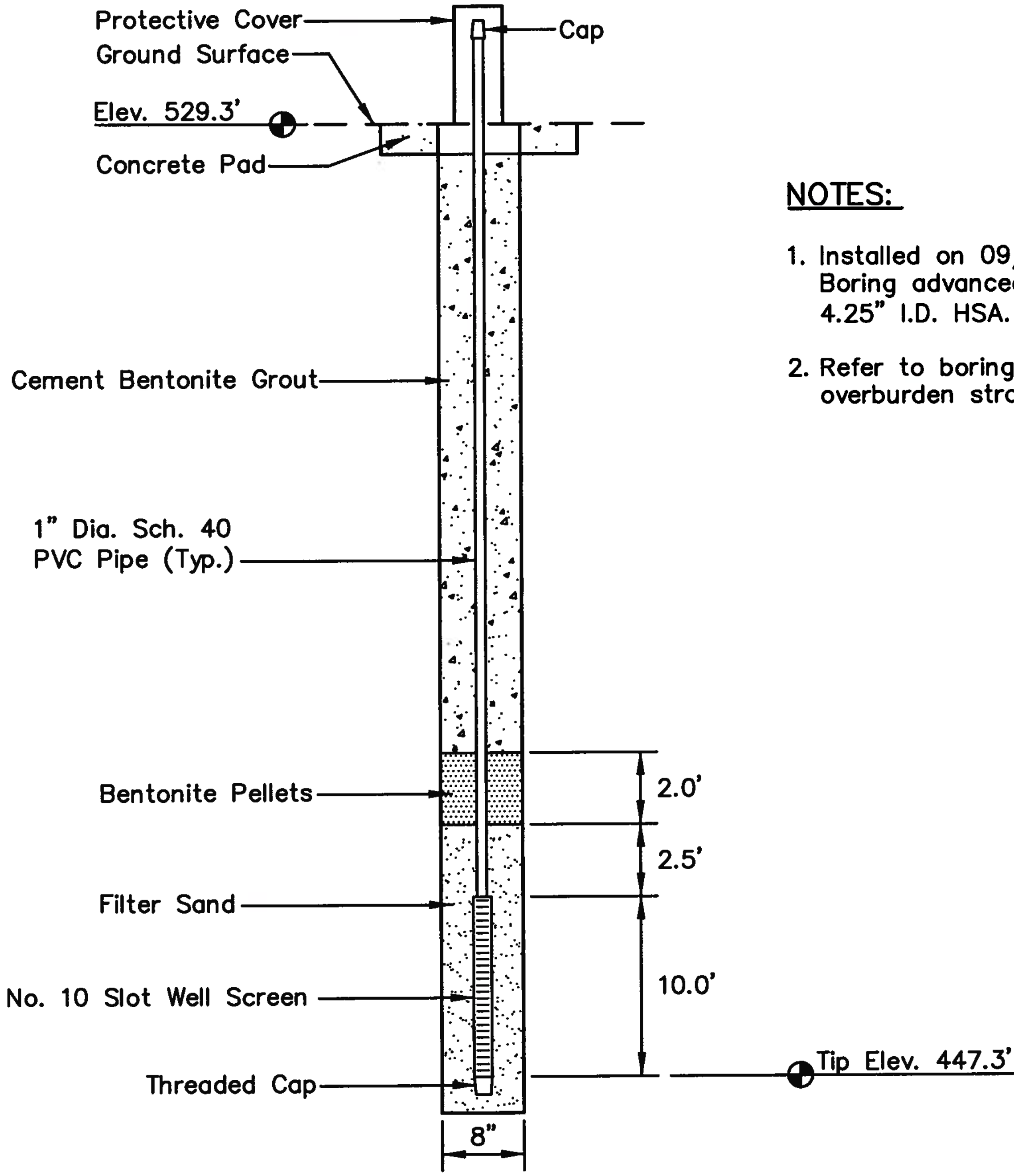
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	24 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/07/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_JFR\59019PZ-STN-5-111B.DWG

LOCATION

Northing: 1720446.66
Easting: 399545.11
Ground Elevation: 529.3

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-111B
PIEZOMETER INSTALLATION DETAIL
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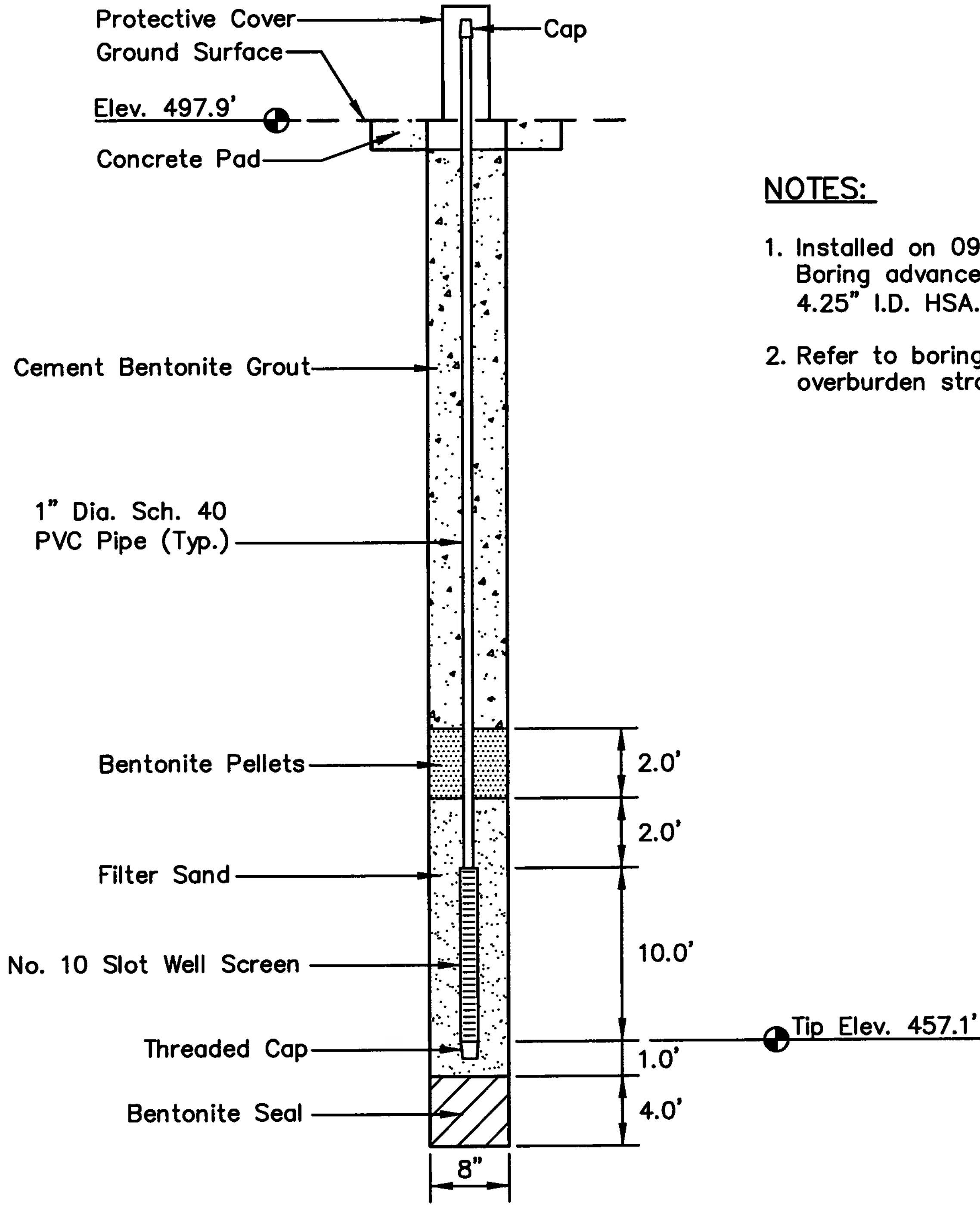
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/07/09. Boring advanced with 4.25" I.D. HSA.

2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 01/21/2010 USER: MCKINNEY, JIMMY
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_JFR\59019PZ-STN-5-112.DWG

LOCATION

Northing: 1720546.53
Easting: 398601.38
Ground Elevation: 497.9

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-112
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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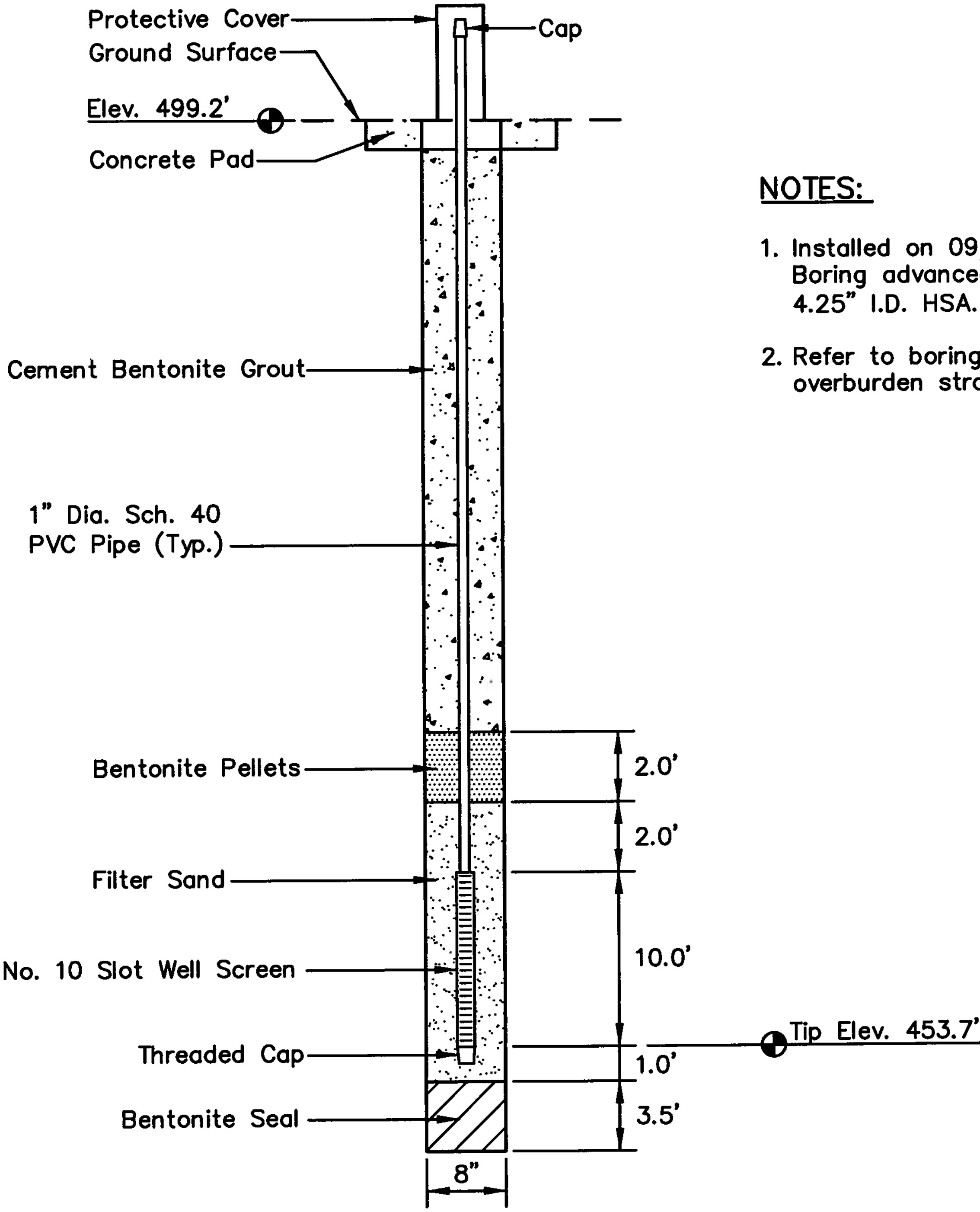

NOTES:

1. Installed on 09/08/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 01/21/2010 USER: MCKINNEY, JIMMY
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REVO_JFR\59019PZ-STN-5-113.DWG

LOCATION

Northing: 1720800.24
Easting: 398321.28
Ground Elevation: 499.2

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-113
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
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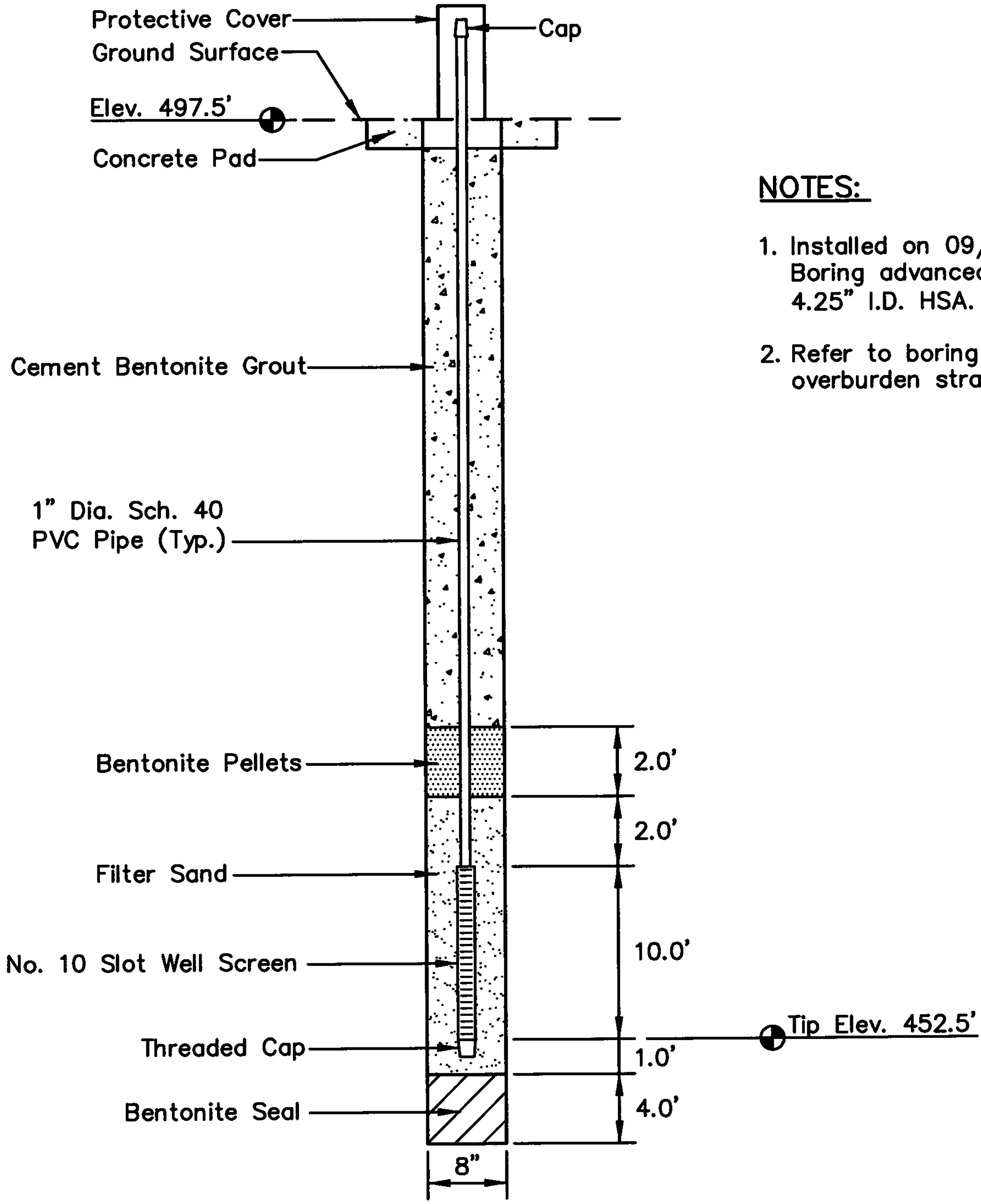
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	27 OF 44	
CHECKED BY	SHB	SCALE	NTS	2.	4.		



NOTES:

1. Installed on 09/08/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REVO_IFR\59019PZ-STN-5-114.DWG

LOCATION

Northing: 1721230.71
Easting: 398587.74
Ground Elevation: 497.5

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-114
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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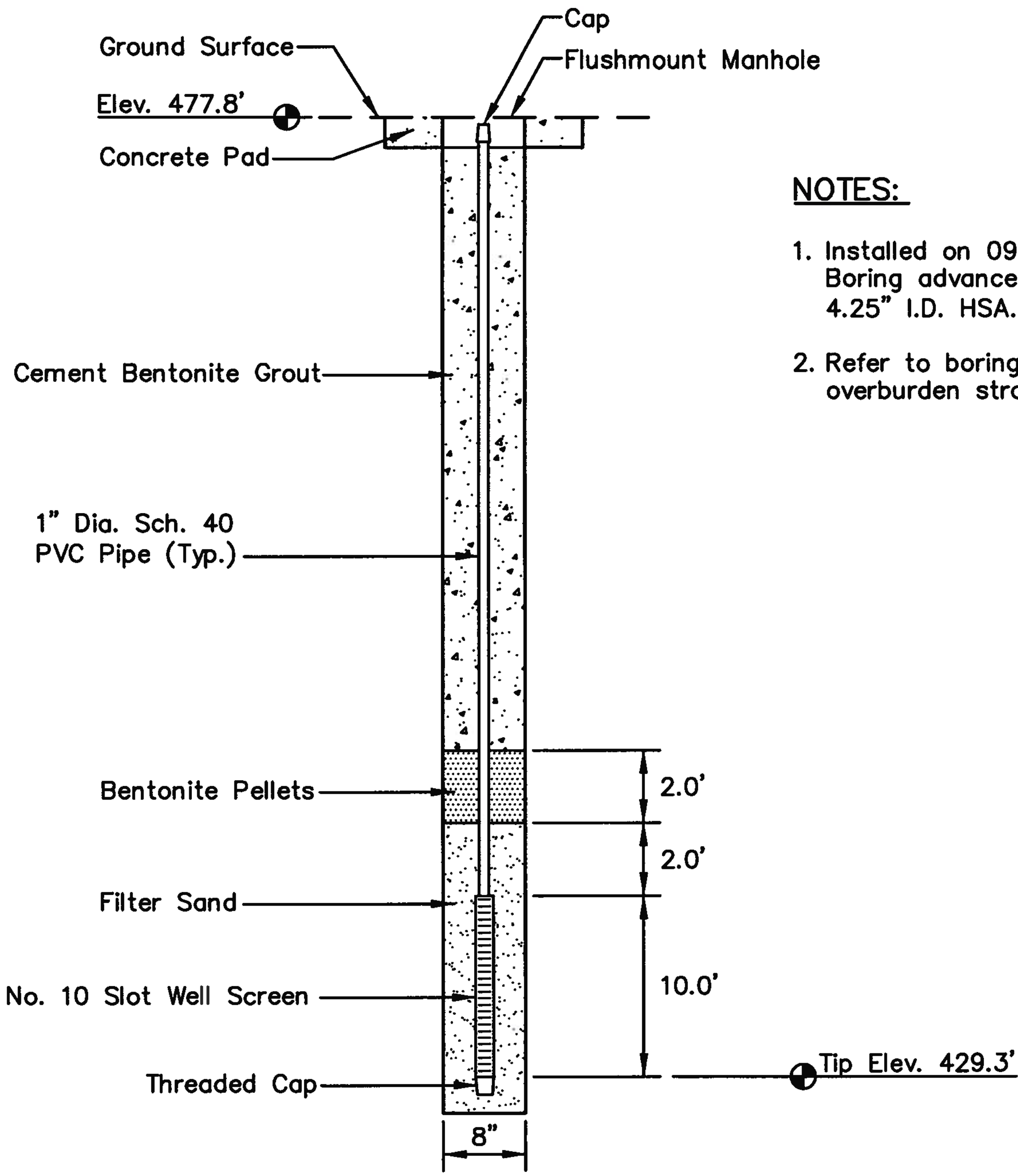
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/06/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_JFR\59019PZ-STN-5-115.DWG

LOCATION

Northing: 1721636.94
Easting: 399073.55
Ground Elevation: 477.8

Locations to be provided by TVA,
Power Systems Operations,
Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-115
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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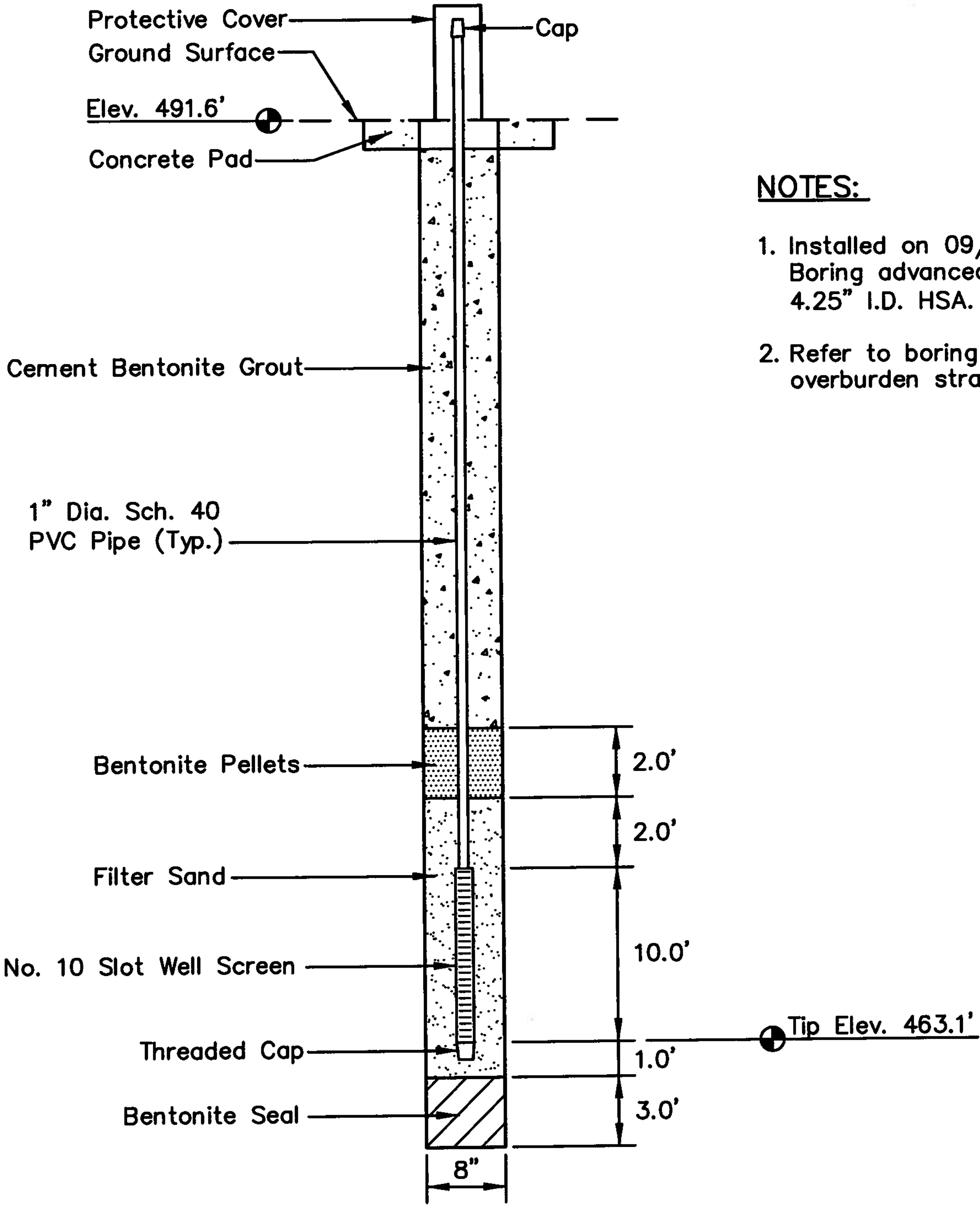
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	29 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/06/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-116.DWG

LOCATION

Northing: 1721557.19
Easting: 399115.86
Ground Elevation: 491.6

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-116
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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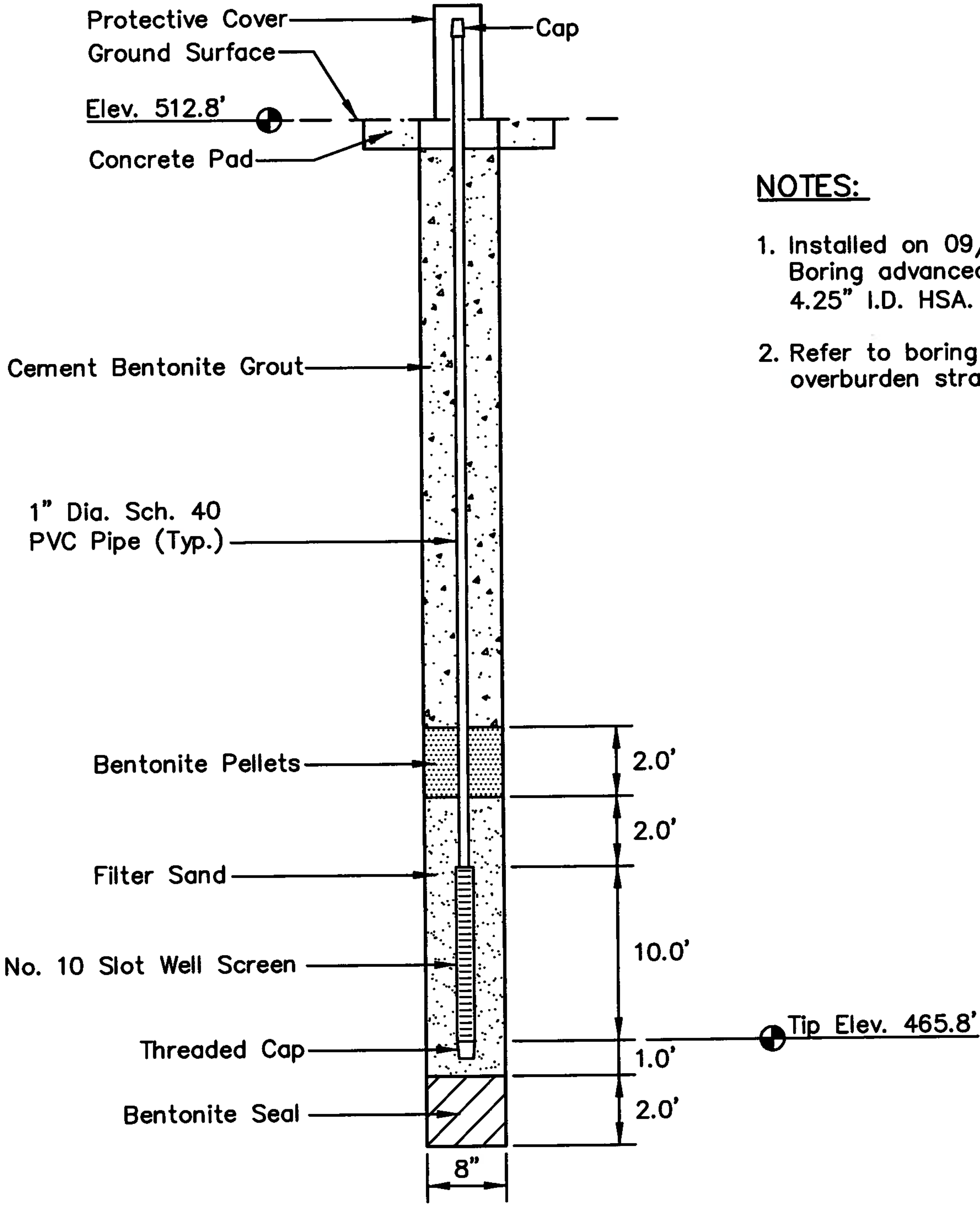
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	30 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/05/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-117A.DWG

LOCATION

Northing: 1721475.92
Easting: 399159.40
Ground Elevation: 512.8

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-117A
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

Stantec

Stantec Consulting Services Inc.
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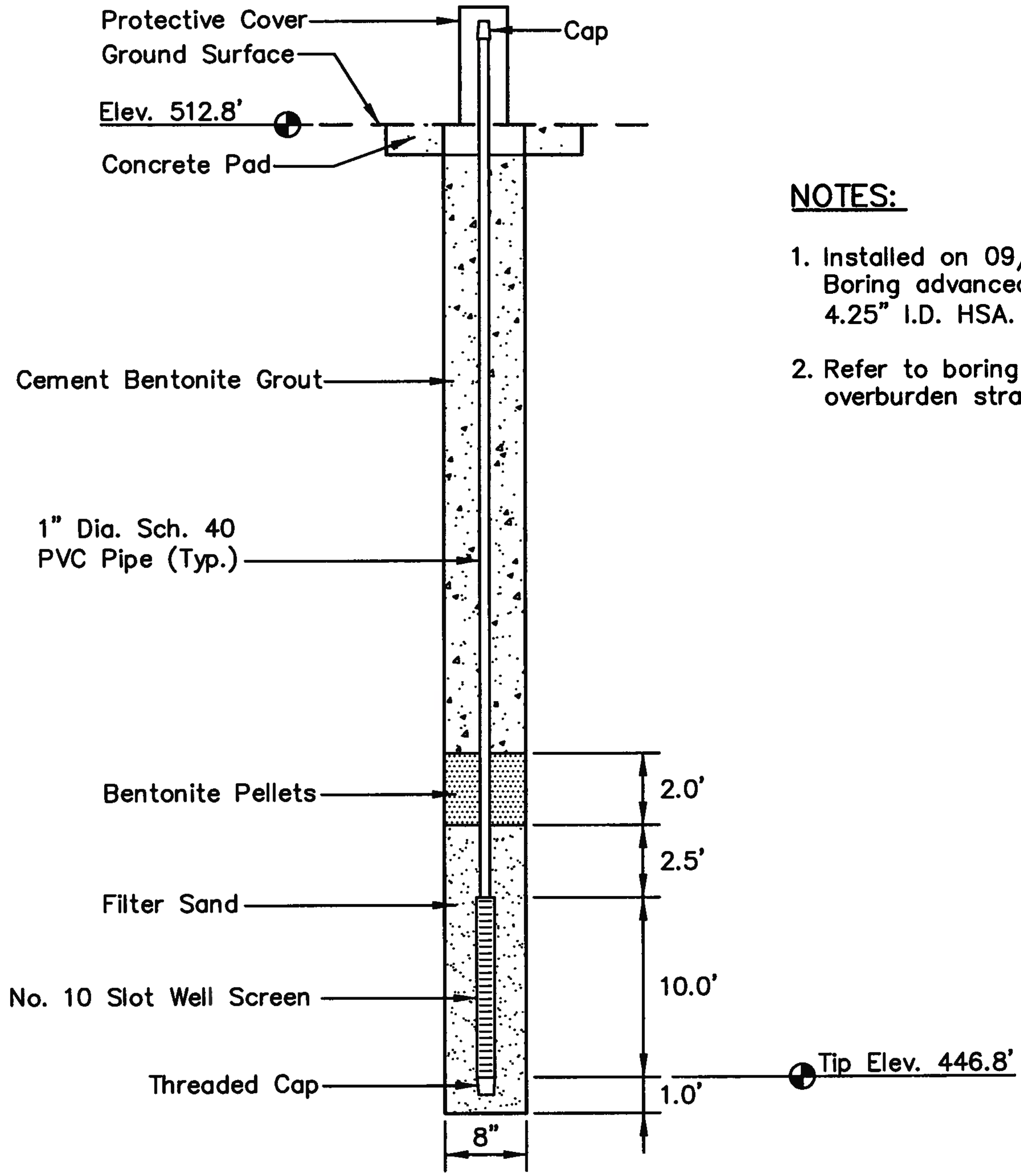
Louisville, Kentucky
40223-2177
502-212-5000
www.stantec.com

DRAWN BY	SB	DATE	OCT., 2009	REVISED		SHEET
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	31 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/05/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 01/21/2010 USER: MCKINNEY, JIMMY
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REVO_IFR\59019PZ-STN-5-117B.DWG

LOCATION

Northing: 1721469.59
Easting: 399148.35
Ground Elevation: 512.8

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-117B
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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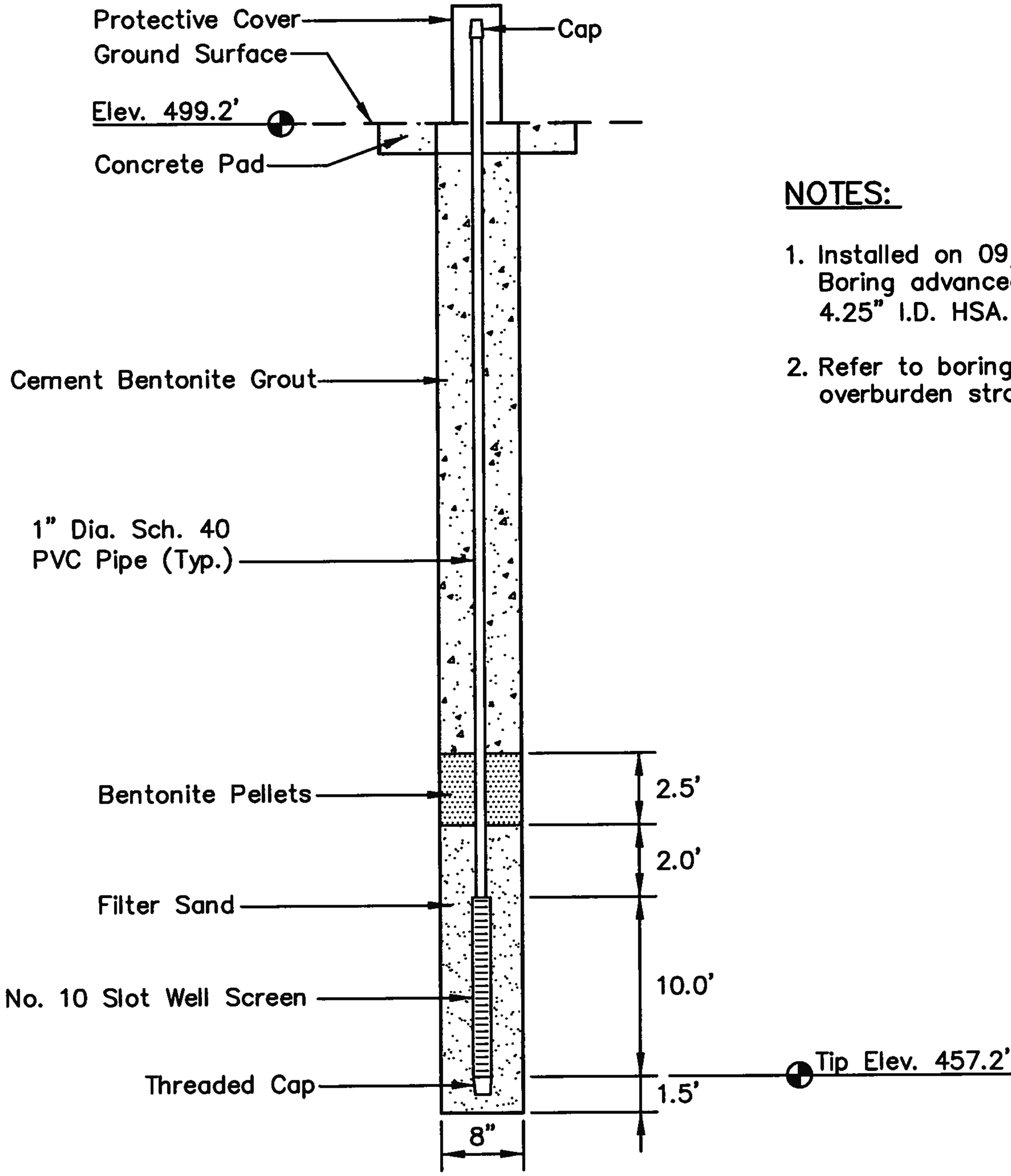
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	32 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/06/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REVO_JFR\59019PZ-STN-5-118.DWG

LOCATION

Northing: 1721850.73
Easting: 399533.21
Ground Elevation: 499.2

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-118
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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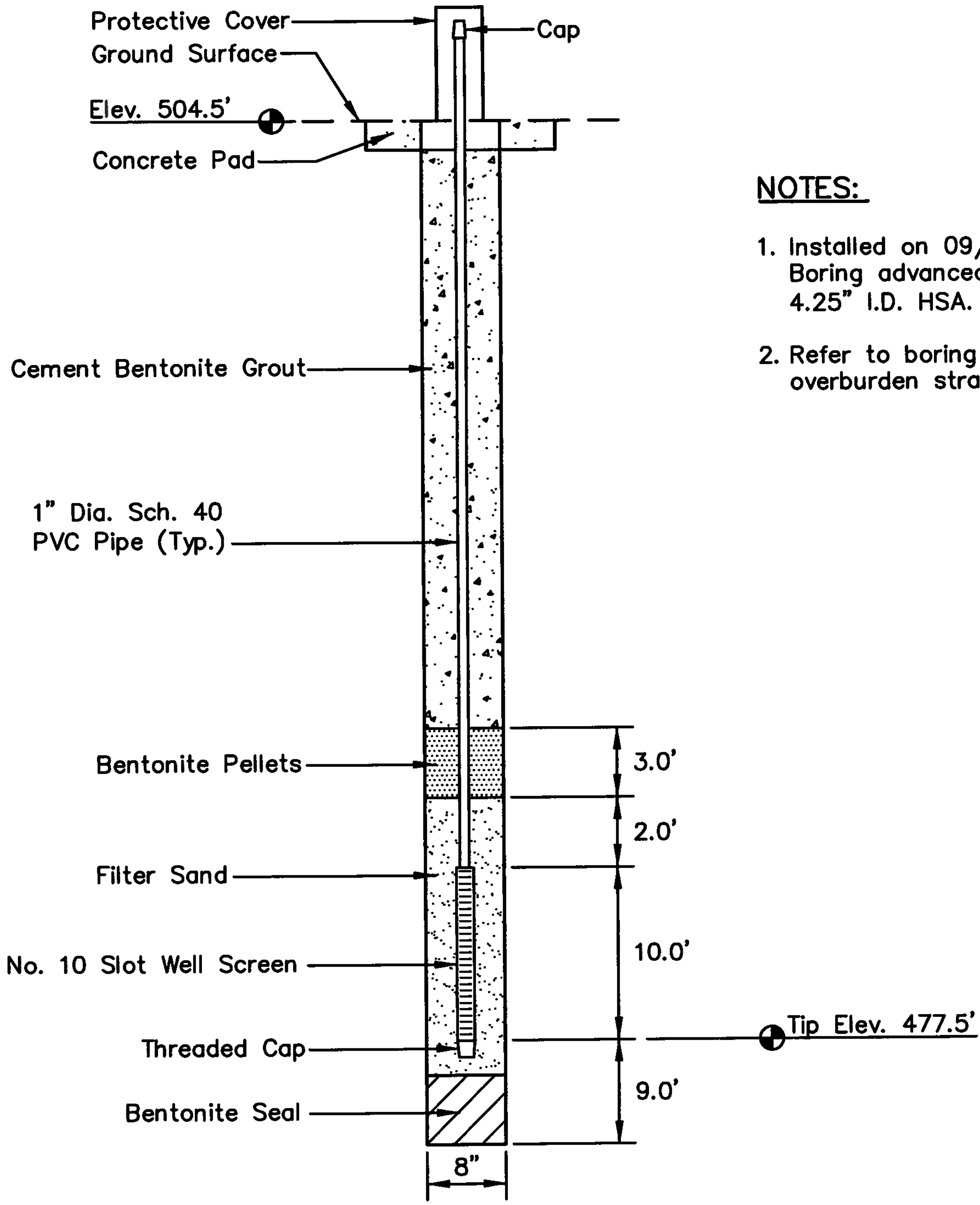
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	33 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/05/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_JFR\59019PZ-STN-5-119.DWG

LOCATION

Northing: 1721703.92
Easting: 400044.78
Ground Elevation: 504.5

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-119
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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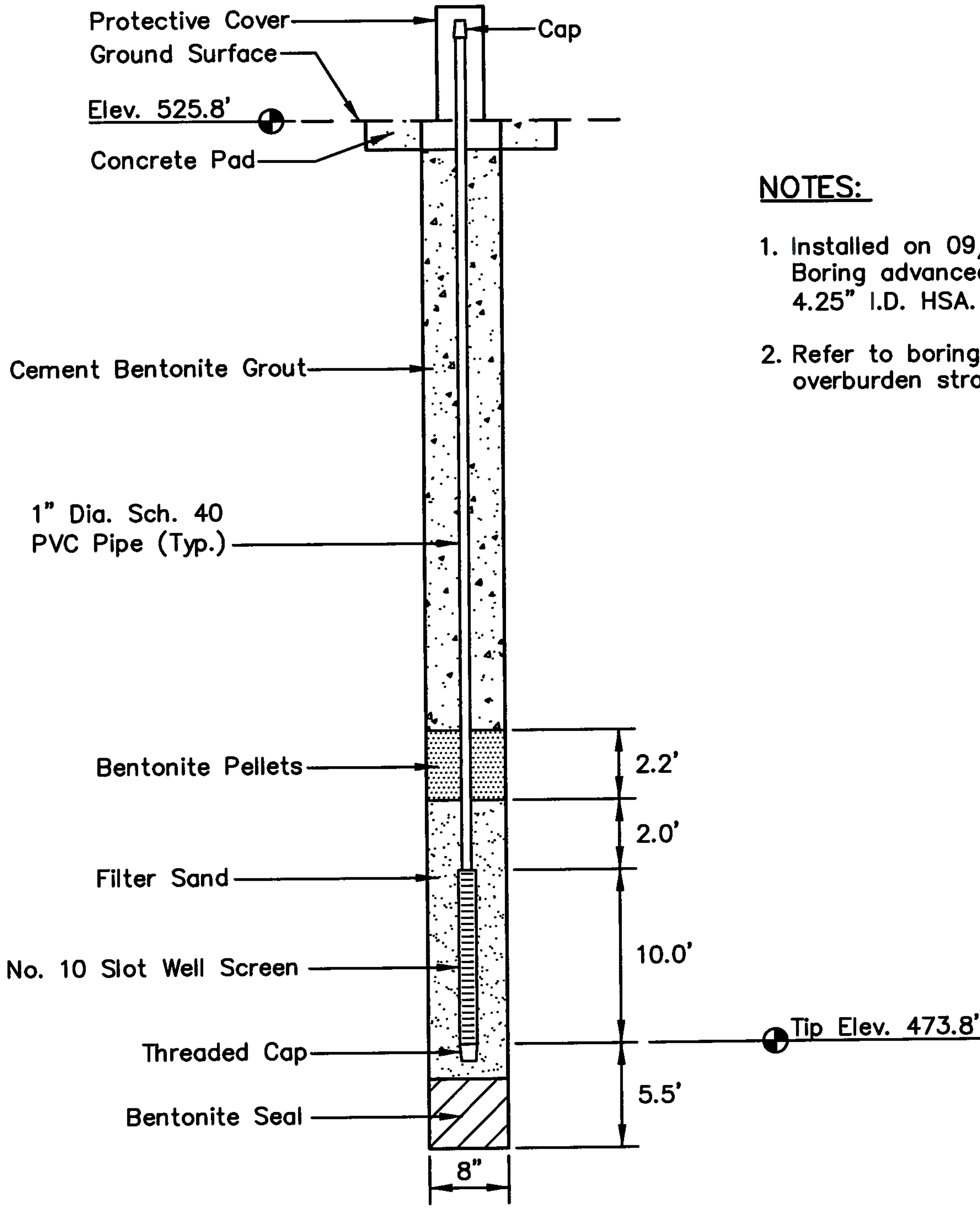
DRAWN BY	SB	DATE	OCT., 2009	REVISED		SHEET
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	34 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/06/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-120A.DWG

LOCATION

Northing: 1721619.44
Easting: 399976.15
Ground Elevation: 525.8

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-120A
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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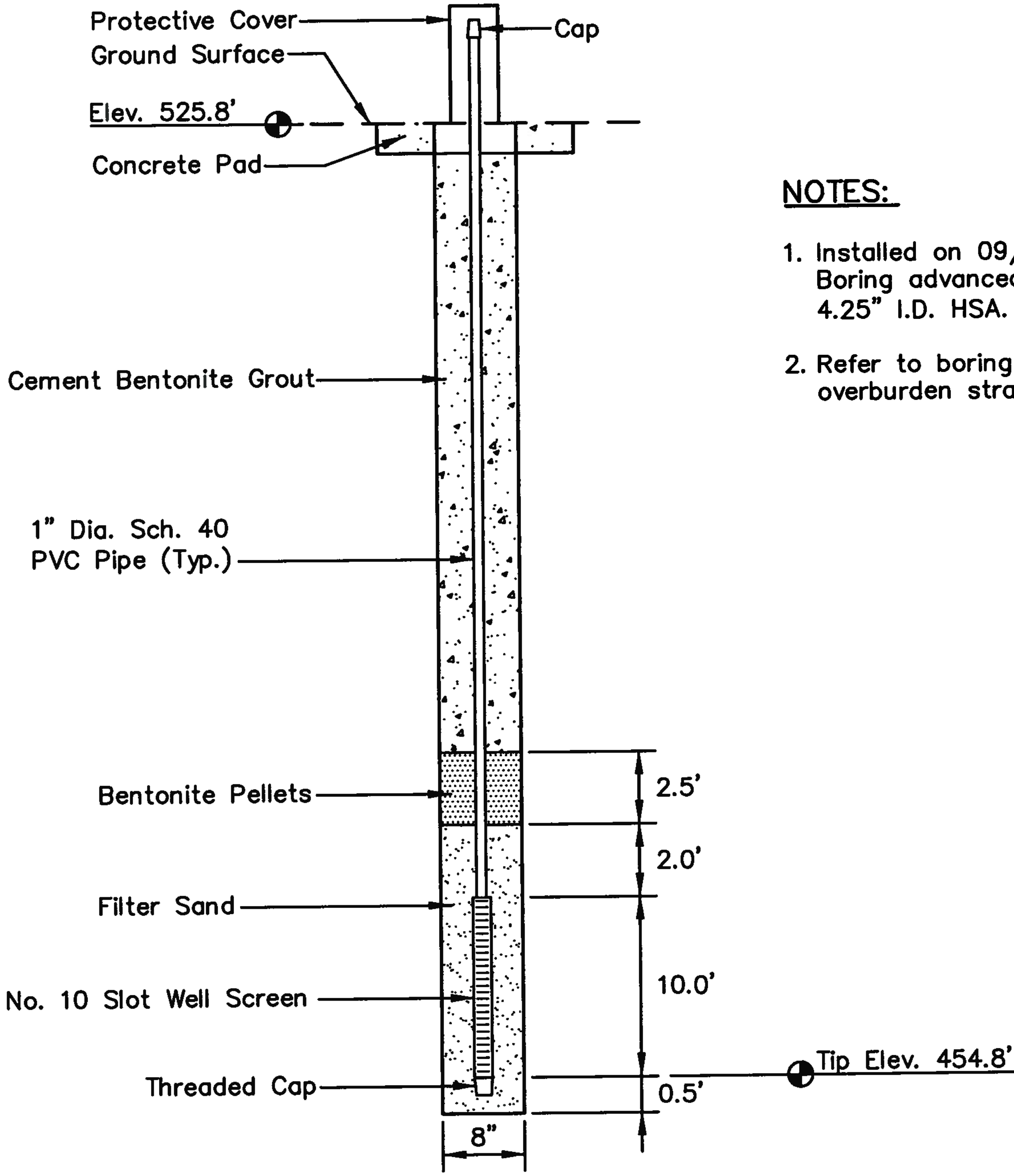
DRAWN BY	SB	DATE OCT., 2009	REVISED			SHEET
CHECKED BY	PJC	PROJ. NO. 175559019	1.	3.		35 OF 44
CHECKED BY	SHB	SCALE NTS	2.	4.		



NOTES:

1. Installed on 09/07/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 01/21/2010 USER: MCKINNEY, JIMMY
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-120B.DWG

LOCATION

Northing: 1721619.44
Easting: 399976.15
Ground Elevation: 525.8

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-120B
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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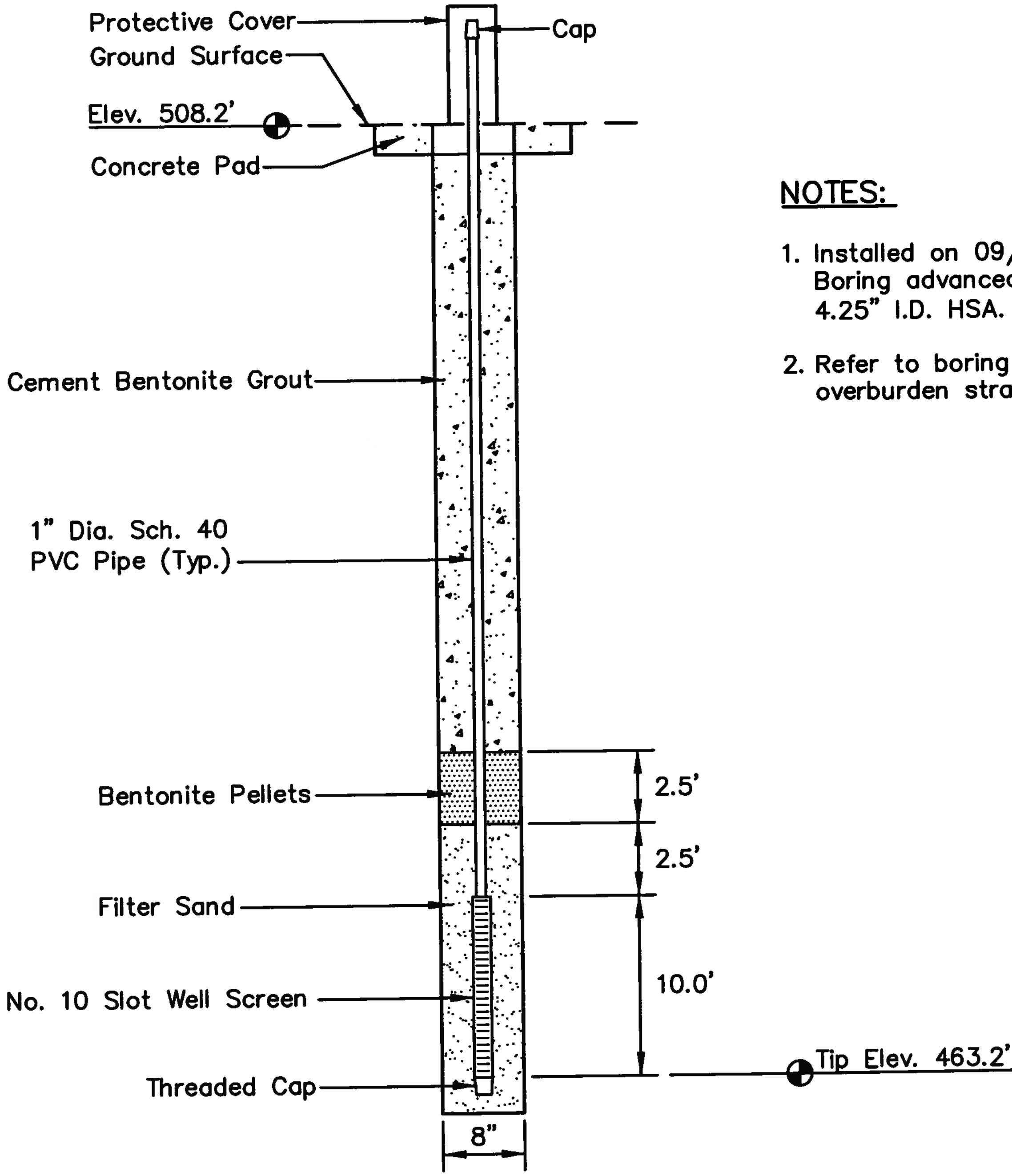
DRAWN BY	SB	DATE	OCT., 2009	REVISED		SHEET
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	36 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/04/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_JFR\59019PZ-STN-5-121A.DWG

LOCATION

Northing: 1721506.28
Easting: 400264.15
Ground Elevation: 508.2

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-121A
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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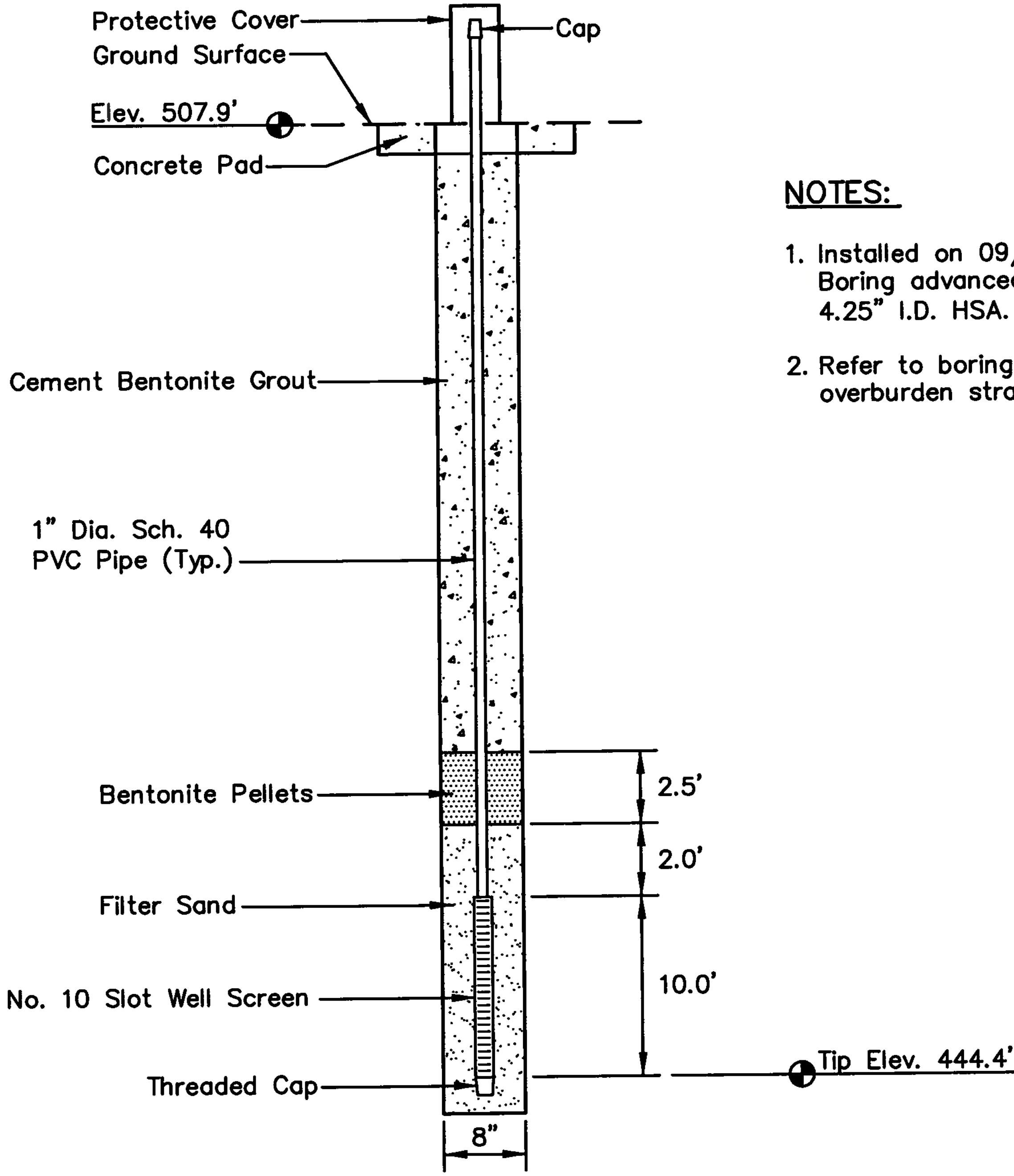
DRAWN BY	SB	DATE	OCT., 2009	REVISED		SHEET
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	37 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/04/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_FR\59019PZ-STN-5-121B.DWG

LOCATION

Northing: 1721514.55
Easting: 400256.18
Ground Elevation: 507.9

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-121B
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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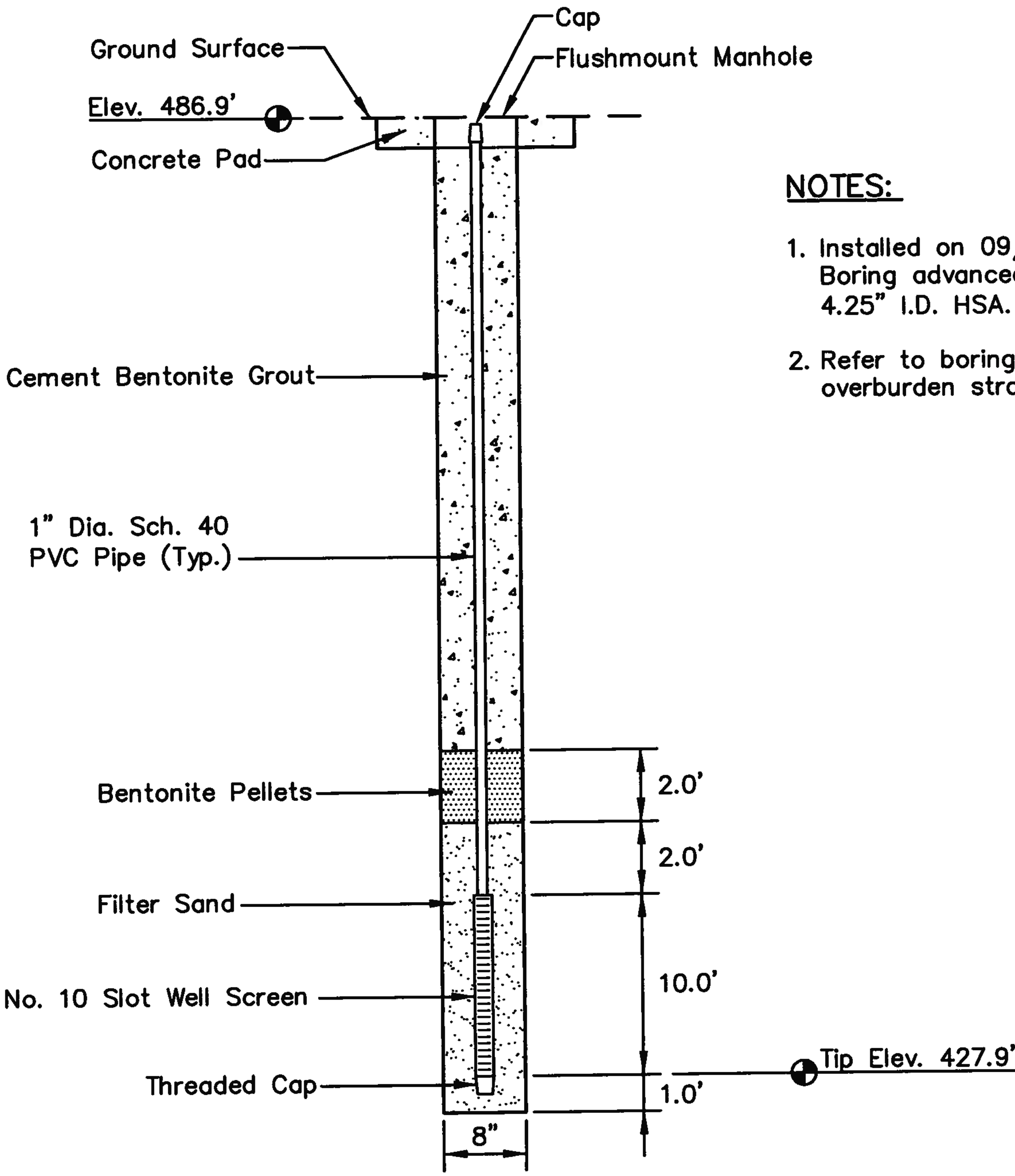
DRAWN BY	SB	DATE	OCT., 2009	REVISED		SHEET
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	38 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/08/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-122.DWG

LOCATION

Northing: 1721301.29
Easting: 400620.41
Ground Elevation: 486.9

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-122
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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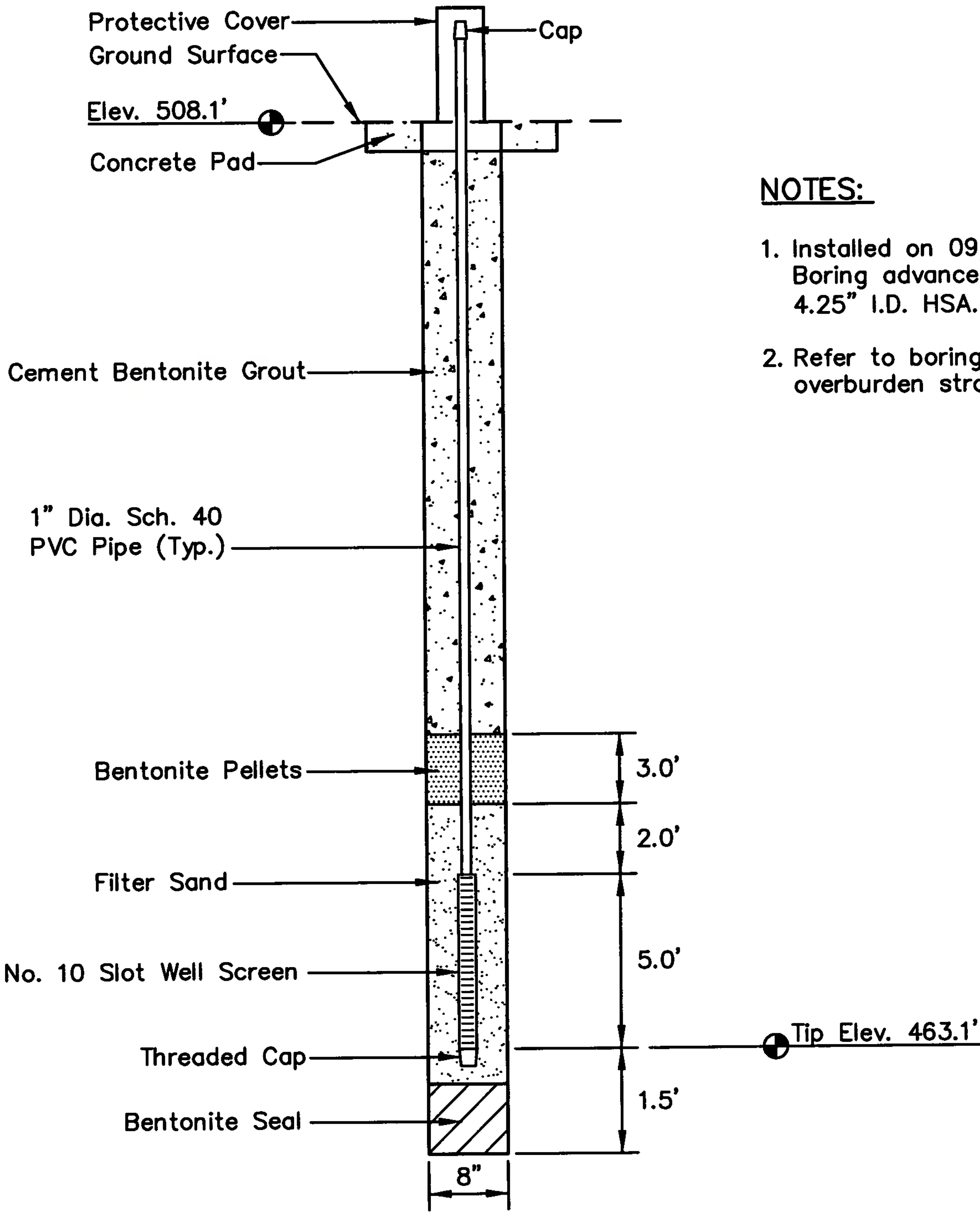
DRAWN BY	SB	DATE	OCT., 2009	REVISED		SHEET
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	39 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/03/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_JFR\59019PZ-STN-5-123.DWG

LOCATION

Northing: 1721231.75
Easting: 400542.54
Ground Elevation: 508.1

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-123
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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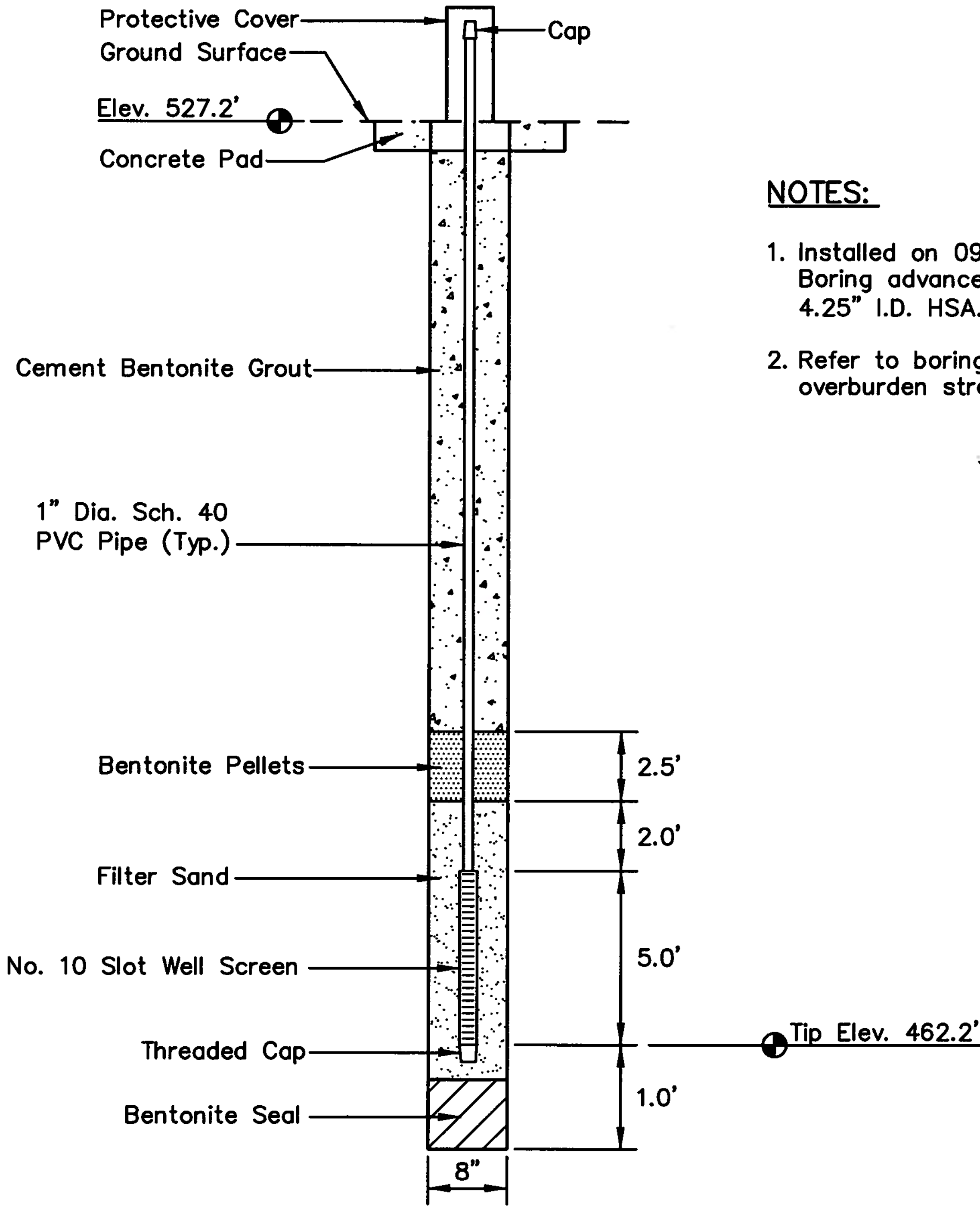
DRAWN BY SB	DATE OCT., 2009	REVISED		SHEET	
CHECKED BY PJC	PROJ. NO. 175559019	1.	3.	40 OF 44	
CHECKED BY SHB	SCALE NTS	2.	4.		



NOTES:

1. Installed on 09/02/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-124.DWG

LOCATION

Northing: 1721165.96
Easting: 400476.56
Ground Elevation: 527.2

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-124
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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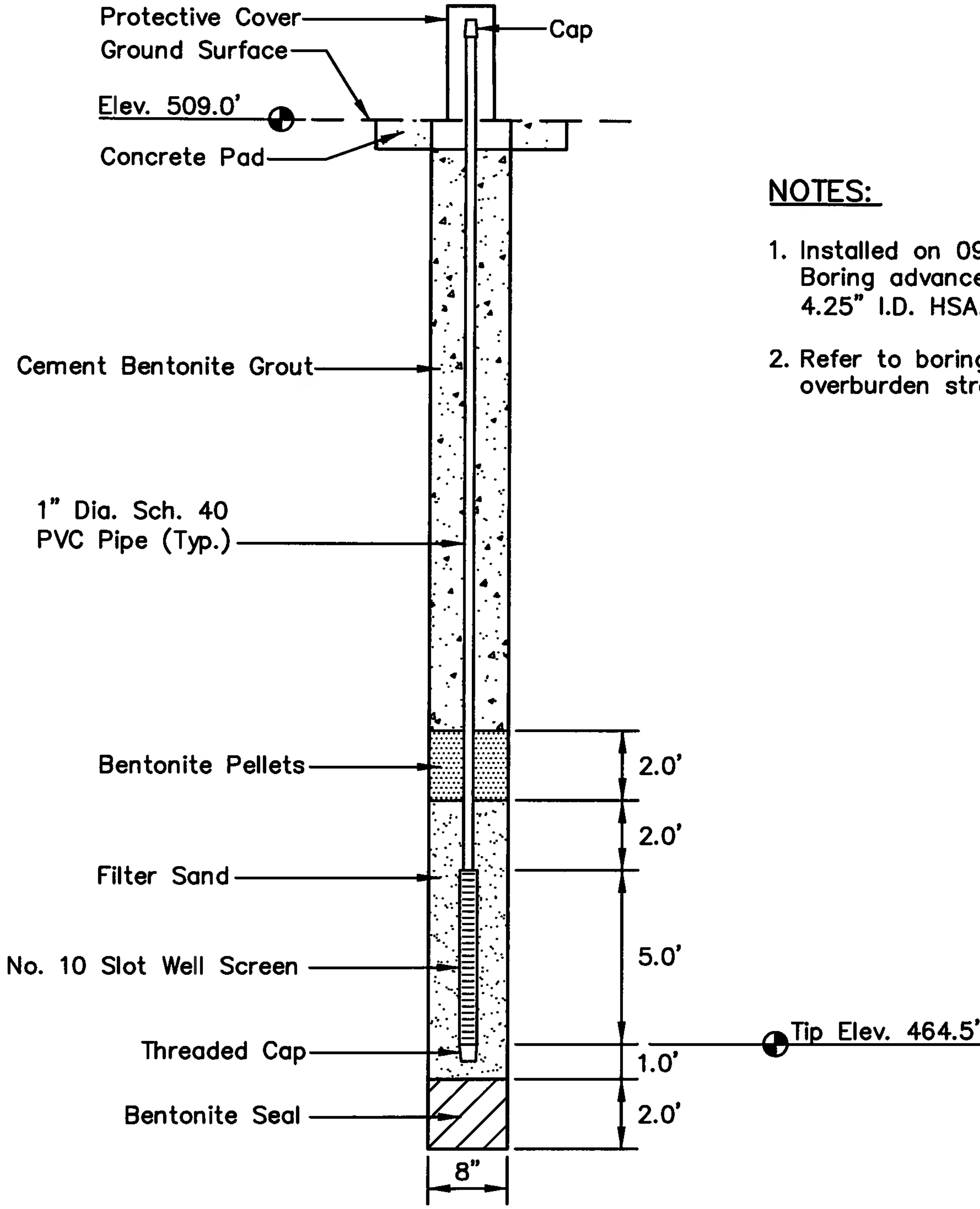
DRAWN BY SB	DATE OCT., 2009	REVISED		SHEET
CHECKED BY PJC	PROJ. NO. 175559019	1.	3.	41 OF 44
CHECKED BY SHB	SCALE NTS	2.	4.	



NOTES:

1. Installed on 09/02/09. Boring advanced with 4.25" I.D. HSA.

2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 11/24/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_JFR\59019PZ-STN-5-125.DWG

LOCATION

Northing: 1720727.47
Easting: 400531.28
Ground Elevation: 509.0

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-125
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

Stantec

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40223-2177
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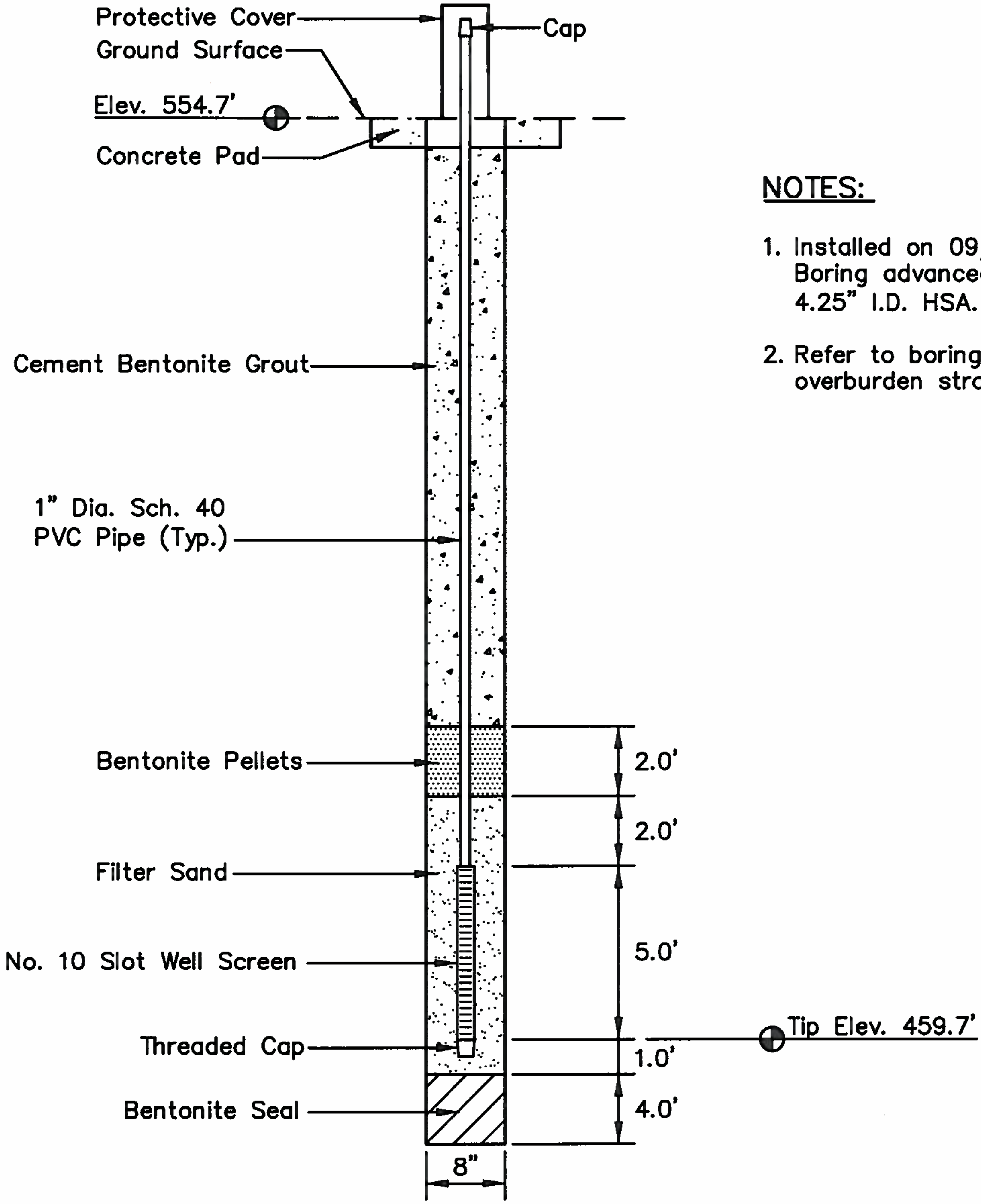
DRAWN BY RP	DATE NOV., 2009	REVISED		SHEET
CHECKED BY PJC	PROJ. NO. 175559019	1.	3.	42 OF 44
CHECKED BY SHB	SCALE NTS	2.	4.	



NOTES:

1. Installed on 09/03/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_JFR\59019PZ-STN-5-126.DWG

LOCATION

Northing: 1721349.47
Easting: 400129.73
Ground Elevation: 554.7

Locations to be provided by TVA,
Power Systems Operations,
Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-126
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

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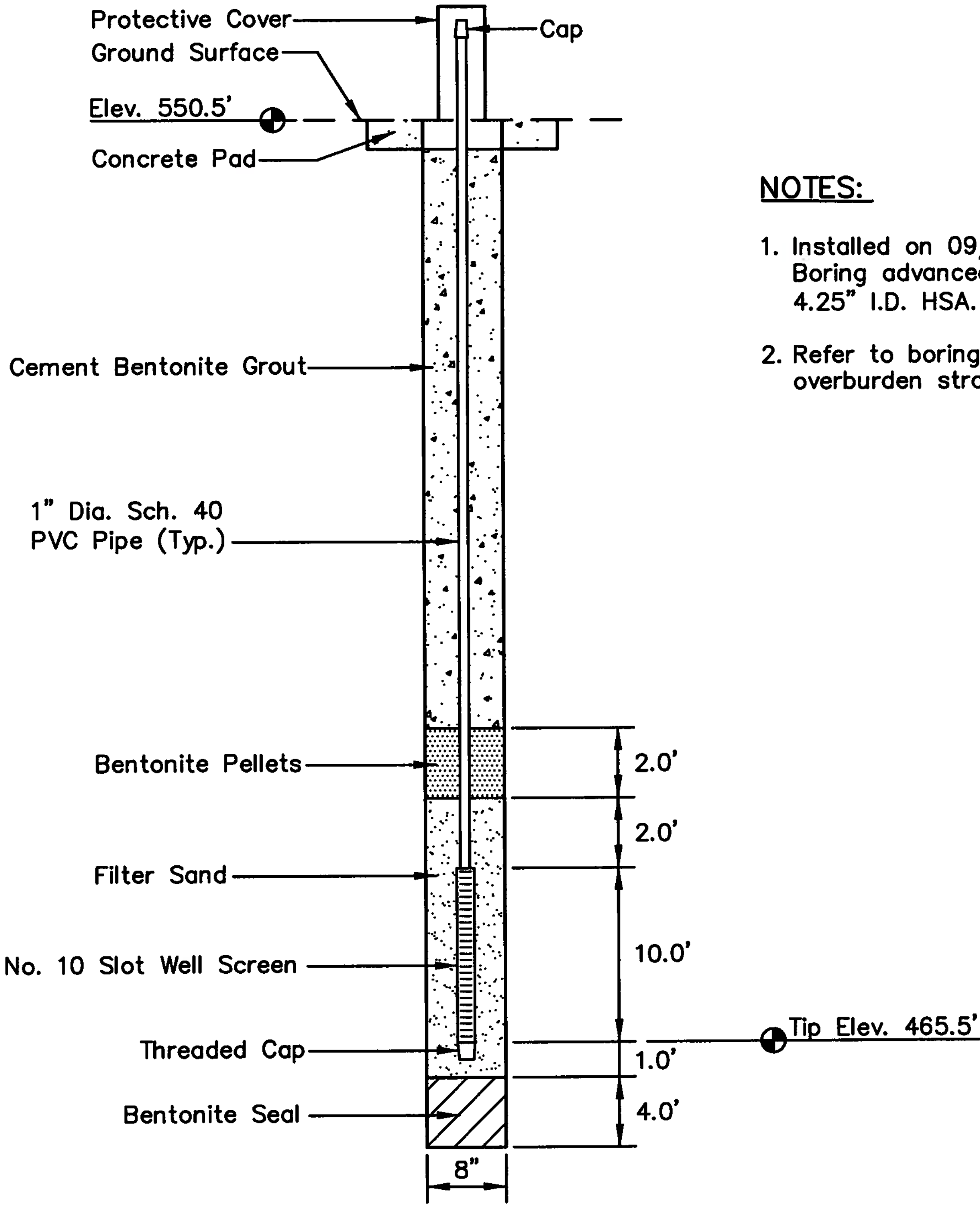
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	43 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 09/04/09. Boring advanced with 4.25" I.D. HSA.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 10/13/2009 USER: PETTY, RICHARD
V:\1755\ACTIVE\175559019\GEOTECHNICAL\DRAWING\PZ_DETAILS\REV0_IFR\59019PZ-STN-5-127.DWG

LOCATION

Northing: 1721097.71
Easting: 400407.87
Ground Elevation: 550.5

Locations to be provided by TVA, Power Systems Operations, Surveying and Project Services.
Horizontal Datum: NAD 27
Vertical Datum: NGVD29

STN-5-127
PIEZOMETER INSTALLATION DETAIL
COLBERT FOSSIL PLANT
DISPOSAL AREA 5

Stantec

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				REVISED		SHEET
DRAWN BY	SB	DATE	OCT., 2009			
CHECKED BY	PJC	PROJ. NO.	175559019	1.	3.	44 OF 44
CHECKED BY	SHB	SCALE	NTS	2.	4.	

Colbert Fossil Plant Disposal Area 5
Piezometer Readings

	Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring	
	STN-5-3		STN-5-5		STN-5-6		STN-5-8		STN-5-9		STN-5-11		STN-5-12		STN-5-16	
	Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.	
	487.5		529.7		488.1		517.9		480.5		515.5		477.8		475.8	
	Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation	
	448.5		483.2		468.1		457.9		428.5		455.5		428.8		455.8	
Date	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
1-Sep-09	Dry	Dry	36.9	492.8	Dry	Dry	28.5	489.4	Dry	Dry	28.0	487.5	Dry	Dry	Dry	Dry
2-Sep-09			37.2	492.5												
3-Sep-09			37.1	492.6												
4-Sep-09																
5-Sep-09	36.8	450.7	36.8	492.9	Dry	Dry	28.4	489.5	Dry	Dry	26.9	488.6				
6-Sep-09	Dry	Dry	37.4	492.3	Dry	Dry	28.6	489.3	Dry	Dry	27.3	488.2	Dry	Dry		
7-Sep-09	Dry	Dry	39.0	490.7	Dry	Dry	28.9	489.0	Dry	Dry	27.6	487.9	Dry	Dry		
9-Sep-09	Dry	Dry	37.0	492.7	Dry	Dry	29.1	488.9	Dry	Dry	26.9	488.7	Dry	Dry		
10-Sep-09															Dry	Dry
15-Sep-09	Dry	Dry	36.9	492.8	Dry	Dry	28.8	489.1	Dry	Dry	27.3	488.2	Dry	Dry	Dry	Dry
24-Sep-09	Dry	Dry	37.0	492.7	Dry	Dry	29.0	488.9	Dry	Dry	27.0	488.5	Dry	Dry	Dry	Dry
26-Sep-09			37.0	492.7			29.0	488.9			26.6	488.9				
1-Oct-09			36.7	493.0			28.5	489.4			26.3	489.2				
8-Oct-09	Dry	Dry	36.7	493.0	Dry	Dry	28.8	489.1	Dry	Dry	26.0	489.5	Dry	Dry	Dry	Dry
15-Oct-09	Dry	Dry	36.3	493.4	Dry	Dry	28.4	489.5	Dry	Dry	25.3	490.2	Dry	Dry	Dry	Dry
22-Oct-09	Dry	Dry	36.3	493.4	Dry	Dry	28.1	489.8	Dry	Dry	25.2	490.3	Dry	Dry	Dry	Dry
5-Nov-09	Dry	Dry	36.8	492.9	Dry	Dry	27.7	490.2	Dry	Dry	25.3	490.2	Dry	Dry	Dry	Dry
17-Nov-09	Dry	Dry	36.3	493.4	Dry	Dry	27.4	490.5	Dry	Dry	25.1	490.4	Dry	Dry	Dry	Dry
16-Dec-09	Dry	Dry	36.7	493.0	Dry	Dry	27.7	490.2	Dry	Dry	25.6	489.9	Dry	Dry	Dry	Dry
20-Jan-10	Dry	Dry	35.9	493.8	Dry	Dry	27.4	490.5	Dry	Dry	24.9	490.6	Dry	Dry	Dry	Dry
17-Feb-10	Dry	Dry	35.8	493.9	Dry	Dry	26.5	491.4	Dry	Dry	24.2	491.3	Dry	Dry	Dry	Dry

Colbert Fossil Plant Disposal Area 5
Piezometer Readings

	Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring	
	STN-5-18		STN-5-101		STN-5-102		STN-5-103A		STN-5-103B		STN-5-104A		STN-5-104B		STN-5-4A		STN-5-105	
	Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.	
	472.2		487.0		486.8		509.0		509.5		530.5		530.8		550.7		507.4	
	Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation	
	447.2		475.0		475.3		469.0		449.5		470.0		449.3		461.7		467.4	
Date	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
1-Sep-09	Dry	Dry													56.0	494.7		
2-Sep-09			-0.2	487.2	-0.5	487.3	18.6	490.4	Dry	Dry	37.2	493.3	Dry	Dry	76.2	474.5		
3-Sep-09			-0.5	487.5	-0.5	487.3					37.7	492.8	Dry	Dry	56.0	494.7		
4-Sep-09							18.9	490.1	Dry	Dry							16.9	490.5
5-Sep-09			-0.1	487.1	-0.2	487.0	18.7	490.3	Dry	Dry	37.1	493.4	Dry	Dry	56.7	494.0	16.7	490.7
6-Sep-09			-0.9	487.9	-0.9	487.7	18.6	490.4	Dry	Dry	37.8	492.7	Dry	Dry	56.8	493.9	16.9	490.5
7-Sep-09			-0.9	487.9	-0.8	487.6	18.8	490.2	Dry	Dry	37.3	493.2	Dry	Dry	56.6	494.1	16.9	490.5
9-Sep-09			-0.3	487.3	-0.2	487.0	18.9	490.2	Dry	Dry	37.9	492.7	Dry	Dry	56.5	494.3	17.6	489.8
10-Sep-09	Dry	Dry																
15-Sep-09	Dry	Dry	-0.5	487.5	-0.5	487.3	18.8	490.2	Dry	Dry	37.9	492.6	Dry	Dry	56.4	494.3	17.4	490.0
24-Sep-09	Dry	Dry	-0.8	487.8	-0.8	487.6	18.5	490.5	Dry	Dry	38.0	492.5	Dry	Dry	56.5	494.2	17.3	490.1
26-Sep-09			-0.9	487.9	-0.9	487.7	18.3	490.7	Dry	Dry	38.0	492.5	Dry	Dry	56.5	494.2	17.0	490.4
1-Oct-09			-0.9	487.9	-0.9	487.7	18.3	490.7	Dry	Dry	37.8	492.7	Dry	Dry	56.3	494.4	17.1	490.3
8-Oct-09	Dry	Dry	-0.9	487.9	-1.1	487.9	18.1	490.9	Dry	Dry	37.8	492.7	Dry	Dry	56.4	494.3	16.9	490.5
15-Oct-09	Dry	Dry	-0.7	487.7	-0.8	487.6	17.8	491.2	Dry	Dry	36.2	494.3	Dry	Dry	56.0	494.7	16.5	490.9
22-Oct-09	Dry	Dry	-0.6	487.6	-0.5	487.3	17.9	491.1	Dry	Dry	37.5	493.0	Dry	Dry	56.1	494.6	16.6	490.8
5-Nov-09	Dry	Dry	-0.4	487.4	-0.5	487.3	18.2	490.8	Dry	Dry	37.9	492.6	Dry	Dry	56.5	494.2	17.0	490.4
17-Nov-09	Dry	Dry	-0.5	487.5	-0.6	487.4	18.0	491.0	Dry	Dry	37.5	493.0	Dry	Dry	56.0	494.7	16.7	490.7
16-Dec-09	Dry	Dry	-0.5	487.5	-0.8	487.6	18.3	490.7	Dry	Dry	37.8	492.7	Dry	Dry	56.4	494.3	17.0	490.4
20-Jan-10	Dry	Dry	-0.4	487.4	-1.4	488.2	17.6	491.4	Dry	Dry	37.0	493.5	Dry	Dry	55.5	495.2	16.4	491.0
17-Feb-10	Dry	Dry	-0.8	487.8	-1.0	487.8	17.3	491.7	Dry	Dry	36.8	493.7	Dry	Dry	55.5	495.2	16.1	491.3

Colbert Fossil Plant Disposal Area 5
Piezometer Readings

	Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring	
	STN-5-106		STN-5-107		STN-5-108		STN-5-109		STN-5-110		STN-5-111A		STN-5-111B		STN-5-112		STN-5-113	
	Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.	
	505.4		527.2		509.3		481.8		509.4		529.3		529.3		497.9		499.2	
	Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation	
	464.4		463.2		464.3		436.3		463.4		469.3		447.3		457.9		453.7	
Date	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
1-Sep-09																		
2-Sep-09																		
3-Sep-09			35.9	491.3														
4-Sep-09	16.3	489.1																
5-Sep-09	16.0	489.4	35.2	492.0														
6-Sep-09	16.1	489.3	36.2	491.0														
7-Sep-09	16.9	488.5	36.6	490.6			Dry	Dry										
9-Sep-09	16.8	488.7	38.4	488.9	18.7	490.7	Dry	Dry	16.8	492.7	27.2	502.2	61.3	468.0	14.0	484.0	18.6	480.7
10-Sep-09																		
15-Sep-09	16.8	488.6	36.6	490.6	18.5	490.8	Dry	Dry	16.3	493.1	27.6	501.7	70.5	458.8	14.1	483.8	18.6	480.6
24-Sep-09	16.0	489.4	36.6	490.6	18.5	490.8	44.9	436.9	15.8	493.6	28.0	501.3	70.7	458.6	12.8	485.2	17.1	482.1
26-Sep-09	15.8	489.6	36.4	490.8	17.4	491.9	--	--	15.4	494.0	28.0	501.3	71.0	458.3	12.4	485.5	16.5	482.7
1-Oct-09	15.9	489.5	--	--	18.4	490.9	--	--	15.1	494.3	27.6	501.7	70.7	458.6	12.5	485.4	16.4	482.8
8-Oct-09	15.6	489.8	36.3	490.9	18.3	491.0	Dry	Dry	14.9	494.5	27.3	502.0	70.9	458.4	12.2	485.7	16.1	483.1
15-Oct-09	15.1	490.3	36.0	491.2	18.0	491.3	Dry	Dry	14.1	495.3	26.6	502.7	70.8	458.5	11.4	486.5	15.2	484.0
22-Oct-09	15.4	490.0	35.9	491.3	18.0	491.3	Dry	Dry	14.0	495.4	26.3	503.0	70.8	458.5	11.8	486.1	15.5	483.7
5-Nov-09	15.5	489.9	36.2	491.0	18.3	491.0	Dry	Dry	14.2	495.2	26.1	503.2	71.1	458.2	11.9	486.0	15.7	483.5
17-Nov-09	15.5	489.9	35.8	491.4	18.0	491.3	Dry	Dry	14.0	495.4	25.3	504.0	71.2	458.1	12.7	485.2	16.6	482.6
16-Dec-09	15.8	489.6	36.0	491.2	18.3	491.0	Dry	Dry	14.4	495.0	25.6	503.7	71.9	457.4	12.9	485.0	17.0	482.2
20-Jan-10	15.2	490.2	35.7	491.5	17.7	491.6	Dry	Dry	13.6	495.8	25.6	503.7	72.2	457.1	12.3	485.6	16.5	482.7
17-Feb-10	15.0	490.4	35.3	491.9	17.7	491.6	Dry	Dry	12.9	496.5	23.9	505.4	72.4	456.9	11.9	486.0	15.7	483.5

Colbert Fossil Plant Disposal Area 5
Piezometer Readings

	Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring	
	STN-5-7A		STN-5-114		STN-5-115		STN-5-116		STN-5-117A		STN-5-117B		STN-5-118		STN-5-119		STN-5-120A	
	Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.	
	565.3		497.5		477.8		491.6		512.8		512.8		499.2		504.5		525.8	
	Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation	
	455.3		452.5		429.3		463.1		465.8		446.8		457.2		477.5		473.8	
Date	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
1-Sep-09																		
2-Sep-09																		
3-Sep-09																		
4-Sep-09																		
5-Sep-09	53.0	512.3																
6-Sep-09	54.6	510.7							24.6	488.2	48.9	463.9			17.9	486.6		
7-Sep-09	56.0	509.3			Dry	Dry	10.2	481.4	25.3	487.5	50.4	462.4	17.8	481.4	17.8	486.7		
9-Sep-09	57.4	508.0	14.9	482.6			10.8	480.8	25.3	487.5	49.7	463.1	18.0	481.2	18.1	486.4	35.5	490.4
10-Sep-09																		
15-Sep-09	60.3	505.0	15.1	482.4	Dry	Dry	10.7	480.9	25.2	487.6	48.5	464.3	18.2	481.0	17.7	486.8	35.6	490.2
24-Sep-09	63.0	502.4	14.2	483.4	48.1	429.7	10.6	481.0	25.2	487.6	47.9	465.0	17.2	482.1	17.6	486.9	35.7	490.2
26-Sep-09	63.3	502.0	13.7	483.8			10.6	481.0	25.1	487.7	48.0	464.8	17.1	482.1	17.4	487.1	35.7	490.1
1-Oct-09	64.2	501.1	13.6	483.9			11.0	480.6	25.1	487.7	47.8	465.0	17.7	481.5	17.1	487.4	35.5	490.3
8-Oct-09	67.2	498.1	13.3	484.2	Dry	Dry	10.6	481.1	25.0	487.8	47.7	465.1	17.5	481.7	16.6	487.9	35.4	490.4
15-Oct-09	67.7	497.6	15.1	482.4	Dry	Dry	10.2	481.4	24.5	488.3	47.4	465.4	17.2	482.0	15.9	488.6	35.2	490.6
22-Oct-09	68.0	497.3	15.5	482.0	Dry	Dry	10.6	481.0	24.7	488.1	47.4	465.4	17.0	482.2	15.8	488.7	35.1	490.7
5-Nov-09	68.2	497.1	15.7	481.8	Dry	Dry	N/A	N/A	24.8	488.0	47.7	465.1	16.8	482.4	15.9	488.6	35.2	490.6
17-Nov-09	68.1	497.2	16.3	481.2	Dry	Dry	11.1	480.5	24.8	488.0	47.7	465.1	16.7	482.5	15.6	488.9	34.8	491.0
16-Dec-09	68.0	497.3	16.5	481.0	Dry	Dry	11.6	480.0	25.1	487.7	48.8	464.0	16.8	482.4	15.7	488.8	34.7	491.1
20-Jan-10	67.7	497.6	16.0	481.5	Dry	Dry	11.1	480.5	24.5	488.3	49.2	463.6	16.3	482.9	15.1	489.4	33.9	491.9
17-Feb-10	65.0	500.3	15.5	482.0	Dry	Dry	11.1	480.5	24.3	488.5	49.7	463.1	15.5	483.7	14.4	490.1	33.7	492.1

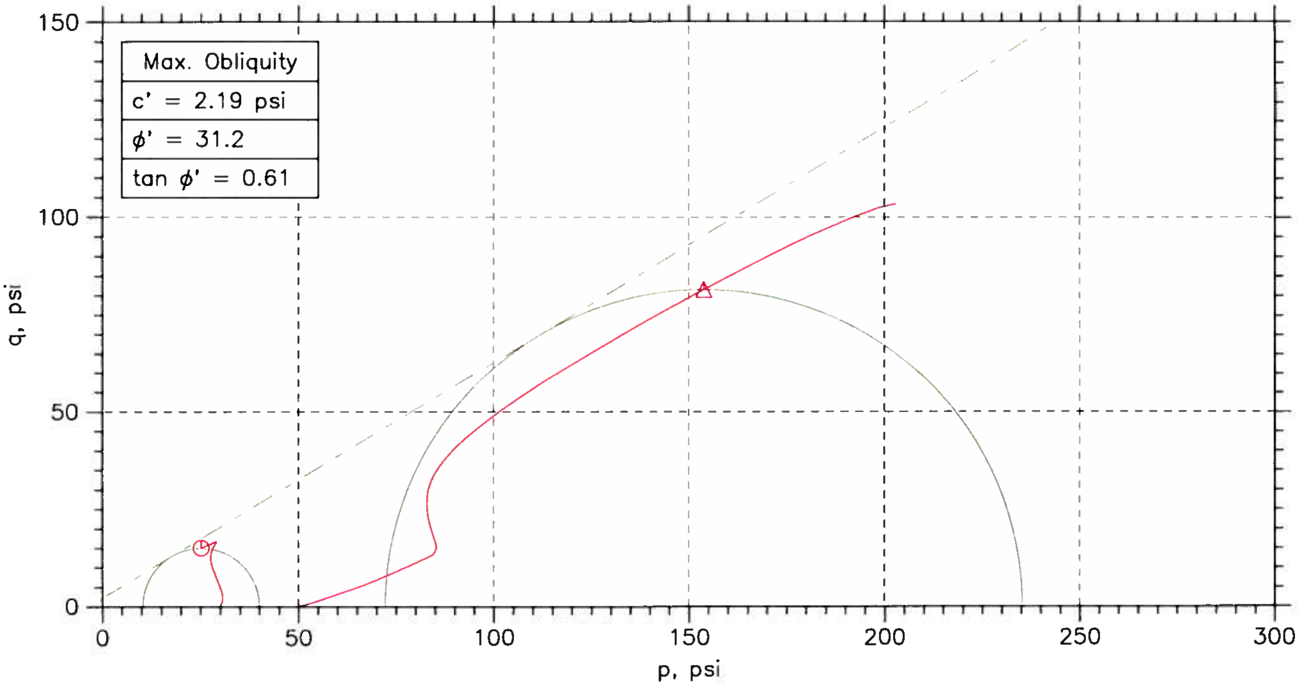
Colbert Fossil Plant Disposal Area 5
Piezometer Readings

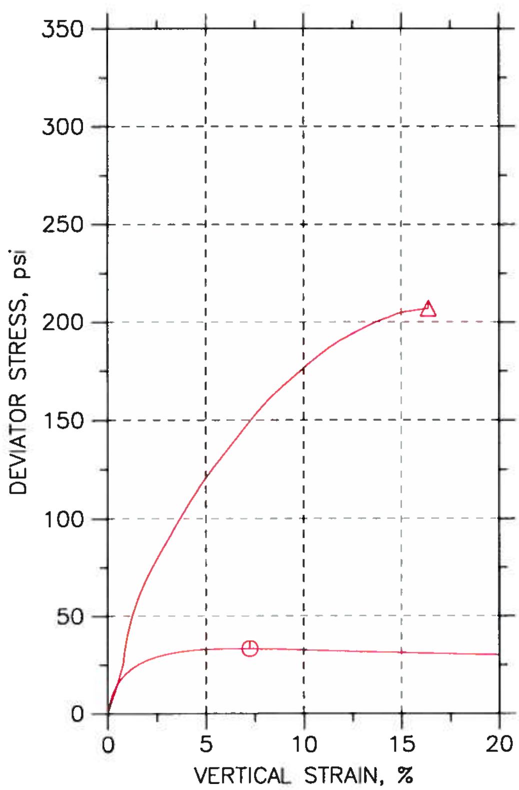
	Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring		Boring	
	STN-5-120B		STN-5-121A		STN-5-121B		STN-5-122		STN-5-123		STN-5-124		STN-5-125		STN-5-126		STN-5-127	
	Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.		Surface Elev.	
	525.8		508.2		507.9		486.9		508.1		527.2		509.0		554.7		550.5	
	Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation		Tip Elevation	
	454.8		463.2		444.4		427.9		463.1		462.2		464.0		459.7		465.5	
Date	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
1-Sep-09																		
2-Sep-09																		
3-Sep-09															39.4	515.3		
4-Sep-09													17.4	491.6				
5-Sep-09			19.1	489.1					20.2	487.9	35.6	491.6	19.2	489.8	39.3	515.4	56.0	494.5
6-Sep-09			19.3	488.9	Dry	Dry			19.8	488.3	37.8	489.4	17.6	491.4	41.4	513.3	56.3	494.2
7-Sep-09			19.3	488.9	Dry	Dry			19.2	488.9	35.9	491.3	17.8	491.2	42.6	512.1	56.8	493.7
9-Sep-09	43.5	482.3	19.4	488.9	Dry	Dry			18.0	490.2	37.9	489.3	18.2	490.9	44.3	510.5	56.8	493.8
10-Sep-09																		
15-Sep-09	42.8	483.0	19.2	489.0	Dry	Dry	58.3	428.6	19.4	488.7	35.6	491.6	18.1	490.9	48.4	506.3	56.7	493.8
24-Sep-09	44.1	481.7	18.8	489.4	63.3	444.6	Dry	Dry	19.2	488.9	35.6	491.6	17.6	491.5	52.6	502.1	56.7	493.8
26-Sep-09	44.1	481.7	18.6	489.6	Dry	Dry			19.0	489.1	35.7	491.5	17.4	491.6	53.2	501.5	56.6	493.9
1-Oct-09	44.4	481.4	18.8	489.4	Dry	Dry			19.0	489.1	35.5	491.7	17.5	491.5	54.7	500.0	56.6	493.9
8-Oct-09	44.5	481.3	18.6	489.6	Dry	Dry	Dry	Dry	18.9	489.2	35.5	491.7	17.3	491.7	56.2	498.5	56.6	493.9
15-Oct-09	44.5	481.3	18.3	489.9	Dry	Dry	Dry	Dry	18.7	489.4	35.3	491.9	17.1	491.9	57.1	497.6	56.3	494.2
22-Oct-09	44.5	481.3	18.4	489.8	Dry	Dry	Dry	Dry	18.7	489.4	35.3	491.9	17.1	491.9	57.8	496.9	56.4	494.1
5-Nov-09	44.6	481.2	18.7	489.5	Dry	Dry	Dry	Dry	18.6	489.5	35.3	491.9	17.3	491.7	58.4	496.3	56.6	493.9
17-Nov-09	44.1	481.7	18.4	489.8	Dry	Dry	Dry	Dry	18.5	489.6	35.1	492.1	17.2	491.8	58.6	496.1	56.3	494.2
16-Dec-09	44.2	481.6	18.3	489.9	Dry	Dry	Dry	Dry	18.5	489.6	35.0	492.2	17.3	491.7	58.7	496.0	56.4	494.1
20-Jan-10	43.9	481.9	17.6	490.6	Dry	Dry	Dry	Dry	18.3	489.8	35.5	491.7	16.5	492.5	58.5	496.2	55.7	494.8
17-Feb-10	43.7	482.1	17.5	490.7	Dry	Dry	Dry	Dry	17.9	490.2	34.2	493.0	15.9	493.1	58.2	496.5	55.5	495.0

Appendix C

Laboratory Test Results

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





		⦶	△		
Symbol		⦶	△		
Sample No.		ST-8	ST-9		
Test No.		10.2	10.3		
Depth		39.8-40.4	44.0-44.8		
Initial	Diameter, in	2.808	2.808		
	Height, in	6.077	6.017		
	Water Content, %	76.2	51.1		
	Dry Density, pcf	48.03	66.05		
	Saturation, %	81.9	88.9		
	Void Ratio	2.51	1.55		
Before Shear	Water Content, %	78.9	46.6		
	Dry Density, pcf	53.87	74.66		
	Saturation*, %	100.0	100.0		
	Void Ratio	2.13	1.26		
	Back Press., psi	74.42	94.8		
Ver. Eff. Cons. Stress, psi		29.89	50.2		
Shear Strength, psi		16.57	103.4		
Strain at Failure, %		7.25	16.4		
Strain Rate, %/min		0.08	0.08		
B-Value		0.95	0.96		
Estimated Specific Gravity		2.7	2.7		
Liquid Limit		---	---		
Plastic Limit		---	---		

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Project: Colbert Fossil Plant
Location: ---
Project No.: GTX-1499
Boring No.: STN-5-2S
Sample Type: UD
Description: Gray-Ash
Remarks: 2054

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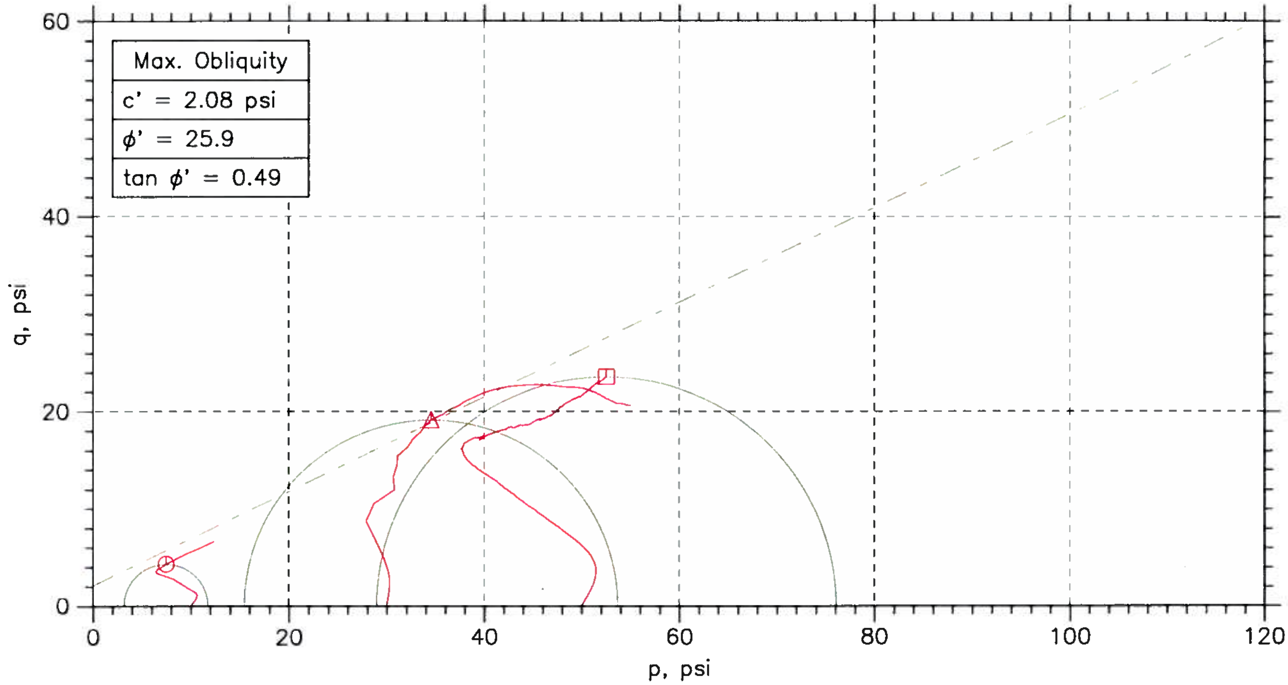
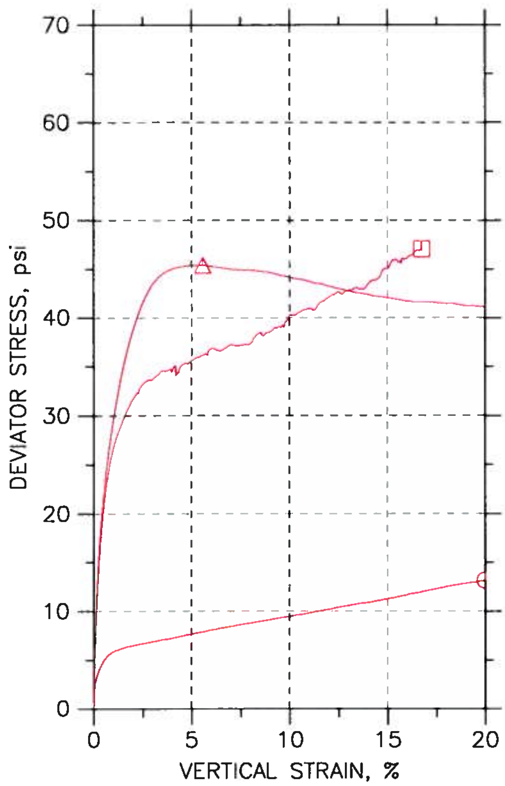
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





		Symbol	○	△	□	
		Sample No.	ST-1	ST-1	ST-3	
		Test No.	11.1	11.2	11.3	
		Depth	2.6-3.2	3.2-3.8	10.4-11.2	
Initial		Diameter, in	2.87	2.84	2.853	
		Height, in	6.199	6.641	6.412	
		Water Content, %	20.9	24.7	23.6	
		Dry Density, pcf	93.51	98.37	97.27	
		Saturation, %	70.4	93.4	87.0	
		Void Ratio	0.802	0.713	0.733	
Before Shear		Water Content, %	24.6	26.3	24.6	
		Dry Density, pcf	101.3	98.6	101.3	
		Saturation*, %	100.0	100.0	100.0	
		Void Ratio	0.664	0.709	0.663	
		Back Press., psi	77.62	116.1	95.02	
		Ver. Eff. Cons. Stress, psi	9.995	29.94	49.97	
		Shear Strength, psi	6.572	22.69	23.53	
		Strain at Failure, %	20	5.56	16.8	
		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	---	---	---	
		Plastic Limit	---	---	---	

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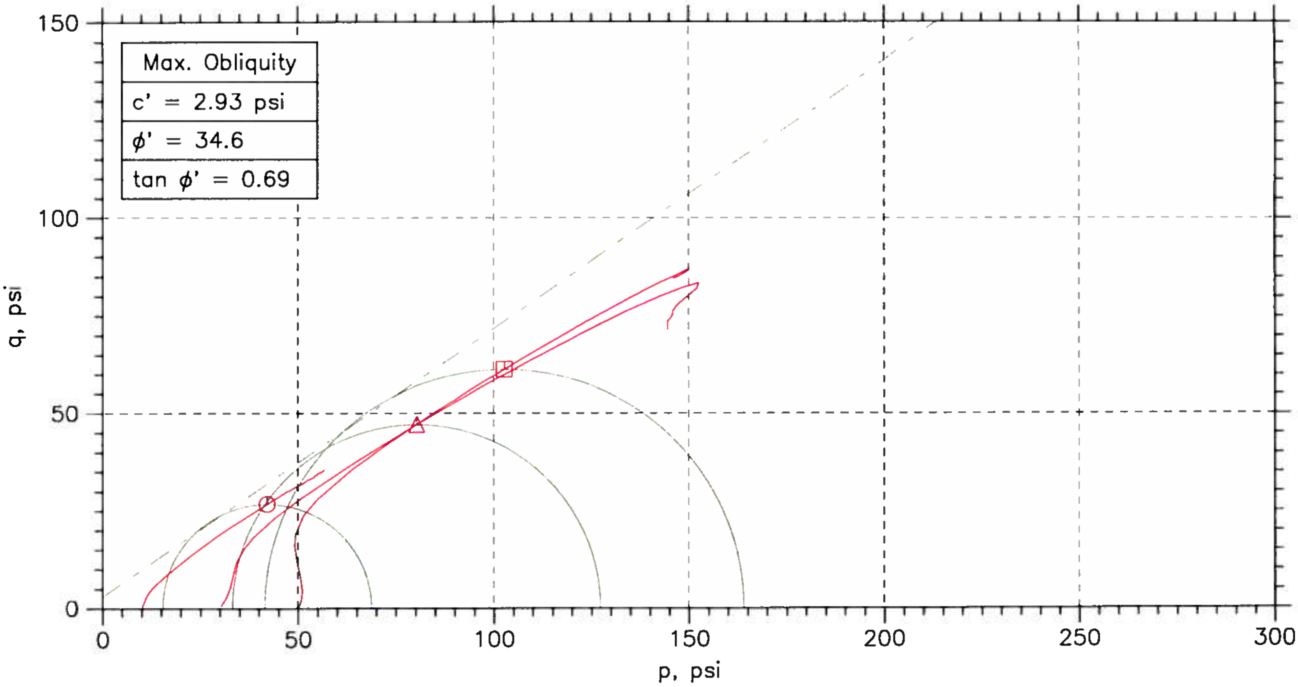
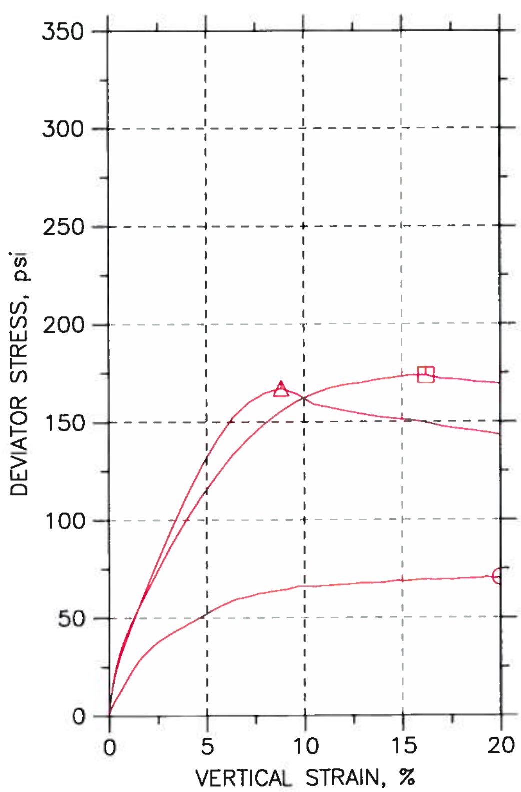
Project: Colbert Fossil Plant	
Location: ---	
Project No.: GTX-1499	
Boring No.: STN-5-3S	
Sample Type: UD	
Description: Reddish Brown Lean clay	
Remarks: 2054	

Wed, 30-DEC-2009 13:58:56

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		ST12	ST-13	ST-13	
Test No.		6.1	6.2	6.3	
Depth		59.4-59.9	64.0-64.8	65.4-66.0	
Initial	Diameter, in	2.797	2.733	2.836	
	Height, in	5.885	5.854	5.74	
	Water Content, %	56.5	37.8	43.1	
	Dry Density, pcf	62.24	80.55	69.54	
	Saturation, %	89.3	93.4	81.7	
	Void Ratio	1.71	1.09	1.42	
Before Shear	Water Content, %	54.1	36.2	40.7	
	Dry Density, pcf	68.52	85.2	80.31	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	1.46	0.978	1.1	
	Back Press., psi	68.07	116.1	95.13	
Ver. Eff. Cons. Stress, psi		9.923	29.86	49.86	
Shear Strength, psi		35.28	83.44	86.75	
Strain at Failure, %		20	8.8	16.2	
Strain Rate, %/min		0.08	0.08	0.08	
B-Value		0.95	0.96	0.95	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

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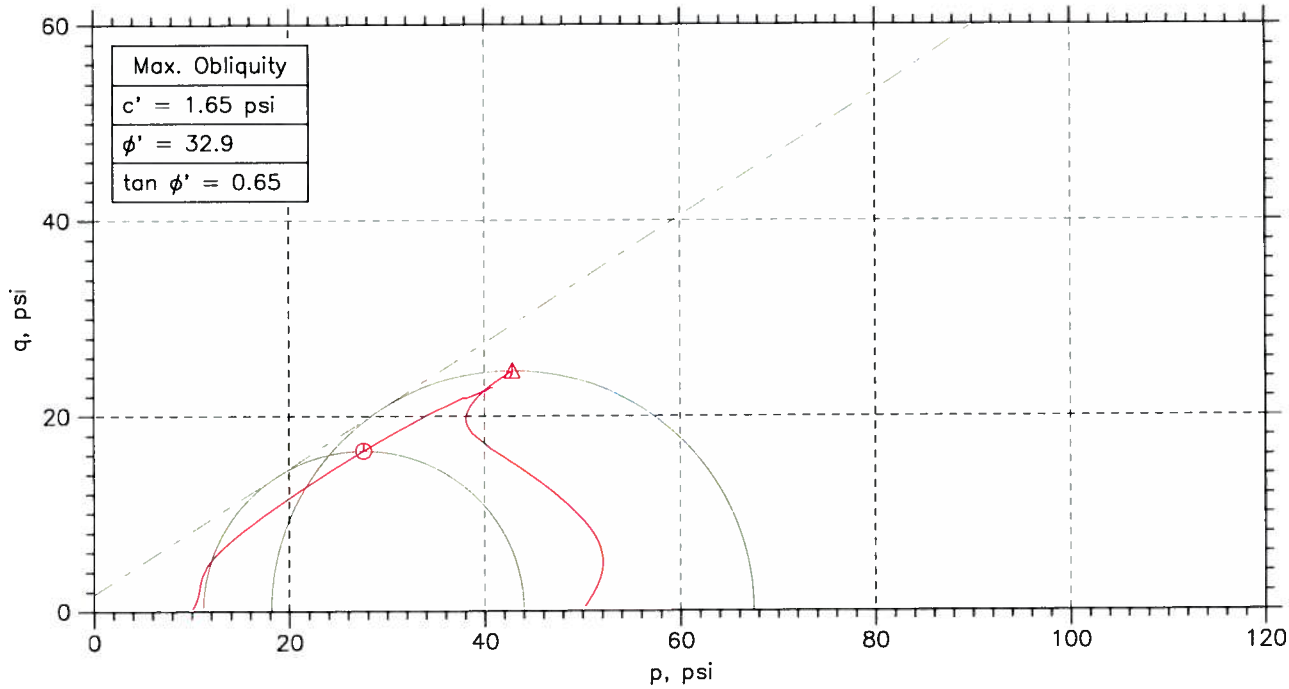
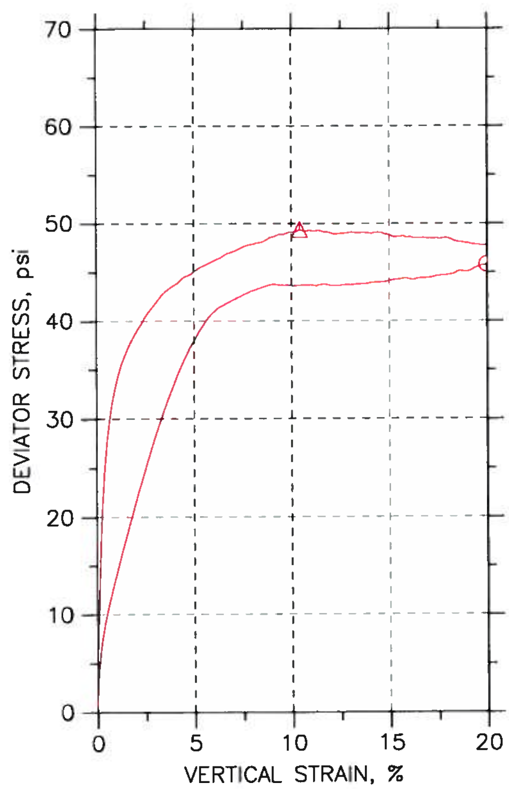
a subsidiary of Geocomp Corporation

Project: Colbert Fossil Plant
Location: ---
Project No.: GTX-1499
Boring No.: STN-5-5S
Sample Type: UD
Description: Gray Ash
Remarks: System 1057

Wed, 30-DEC-2009 14:07:57

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		⊙	△		
Sample No.		ST-8	ST-8		
Test No.		7.1	7.3		
Depth		39.0-39.8	40.4-41.0		
Initial	Diameter, in	2.796	2.829		
	Height, in	6.334	5.973		
	Water Content, %	42.2	41.9		
	Dry Density, pcf	73.4	69.26		
	Saturation, %	87.8	78.9		
	Void Ratio	1.3	1.43		
Before Shear	Water Content, %	43.0	43.1		
	Dry Density, pcf	78.04	77.9		
	Saturation*, %	100.0	100.0		
	Void Ratio	1.16	1.16		
	Back Press., psi	80.34	95.14		
Ver. Eff. Cons. Stress, psi		9.904	49.85		
Shear Strength, psi		22.88	24.66		
Strain at Failure, %		20	10.4		
Strain Rate, %/min		0.08	0.08		
B-Value		0.95	0.95		
Estimated Specific Gravity		2.7	2.7		
Liquid Limit		---	---		
Plastic Limit		---	---		

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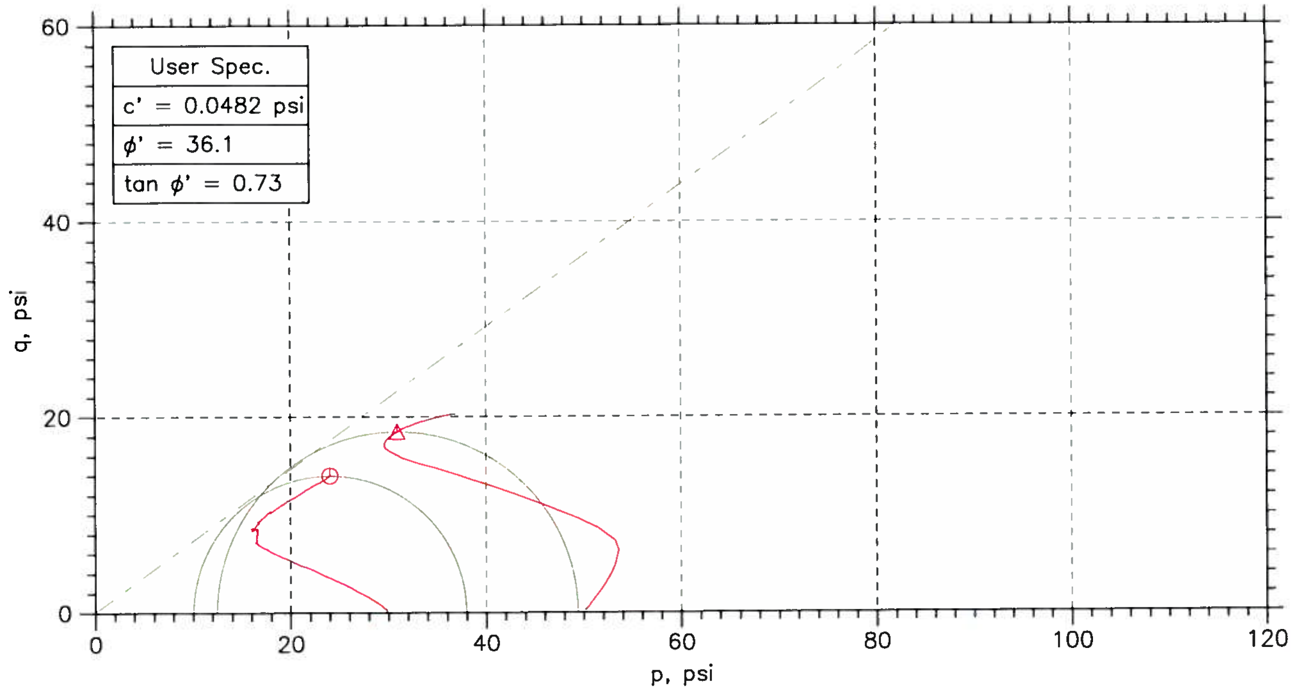
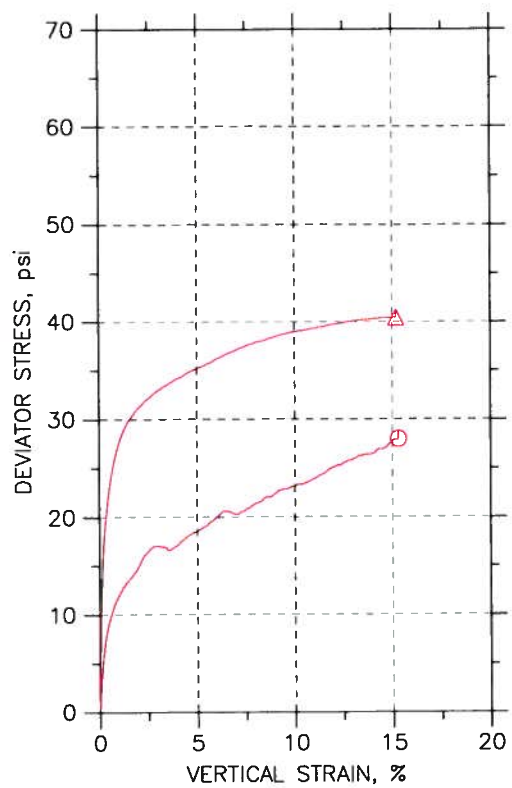
Project: Colbert Fossil Plant
Location: ---
Project No.: GTX-1499
Boring No.: STN-5-8S
Sample Type: UD
Description: Gray Ash-Note Sample 7.2 (30 psi) crumbled during trimming no test)
Remarks: 2054

Wed, 30-DEC-2009 14:09:25

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		⦶	△		
Sample No.		ST-4	ST-4		
Test No.		8.2	8.3		
Depth		20.0-20.6	20.6-21.2		
Initial	Diameter, in	2.797	2.818		
	Height, in	5.947	5.842		
	Water Content, %	26.3	24.5		
	Dry Density, pcf	96.43	97.17		
	Saturation, %	95.0	89.9		
	Void Ratio	0.748	0.735		
Before Shear	Water Content, %	24.0	21.4		
	Dry Density, pcf	102.2	106.8		
	Saturation*, %	100.0	100.0		
	Void Ratio	0.649	0.578		
	Back Press., psi	89.22	95.01		
Ver. Eff. Cons. Stress, psi		29.76	49.98		
Shear Strength, psi		13.97	20.19		
Strain at Failure, %		15.3	15.2		
Strain Rate, %/min		0.016	0.016		
B-Value		0.96	0.95		
Estimated Specific Gravity		2.7	2.7		
Liquid Limit		---	---		
Plastic Limit		---	---		

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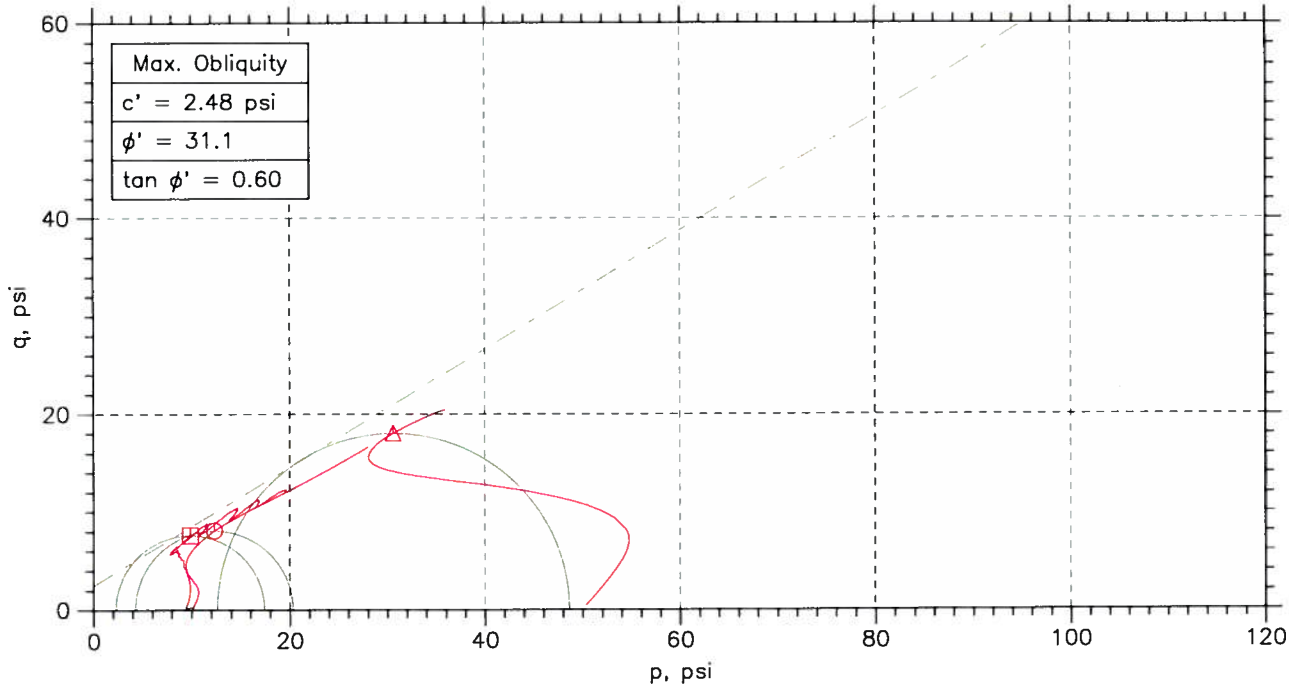
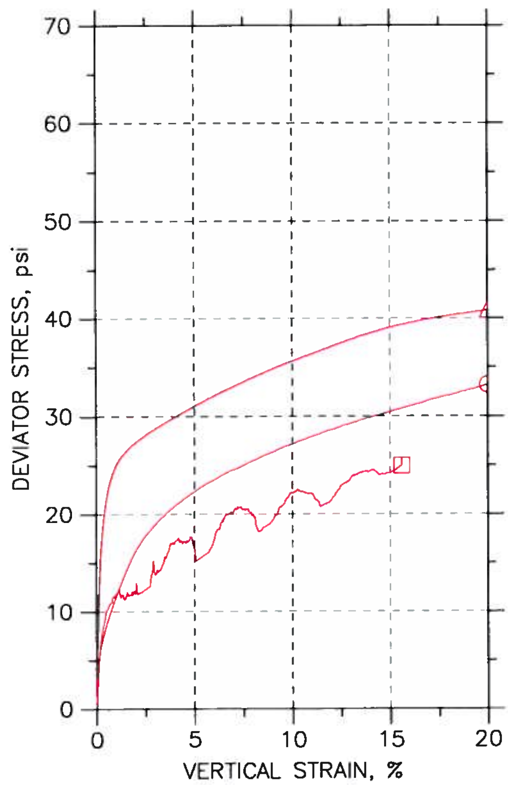
Project: Colbert Fossil Plant	
Location: ---	
Project No.: GTX-1499	
Boring No.: STN-5-9S	
Sample Type: UD	
Description: Light Brown lean clay with sand	
Remarks: System 1057	

Wed, 30-DEC-2009 14:12:29

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





		○	△	□	
Symbol		○	△	□	
Sample No.		ST-1	ST-6	---	
Test No.		9.1	9.3	12.1	
Depth		3.4-4 ft	35.6-36.2	35.6-36.2	
Initial	Diameter, in	2.841	2.846	2.835	
	Height, in	6.496	6.049	6.451	
	Water Content, %	22.0	25.1	24.8	
	Dry Density, pcf	101.8	99.74	95.57	
	Saturation, %	90.7	98.2	87.5	
	Void Ratio	0.655	0.69	0.764	
Before Shear	Water Content, %	24.1	21.0	27.4	
	Dry Density, pcf	102.1	107.6	96.95	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.651	0.566	0.739	
	Back Press., psi	137.1	50.47	140	
Ver. Eff. Cons. Stress, psi		9.851	49.97	9.997	
Shear Strength, psi		16.58	20.41	12.46	
Strain at Failure, %		20	20	15.6	
Strain Rate, %/min		0.08	0.08	0.016	
B-Value		0.95	0.96	0.95	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

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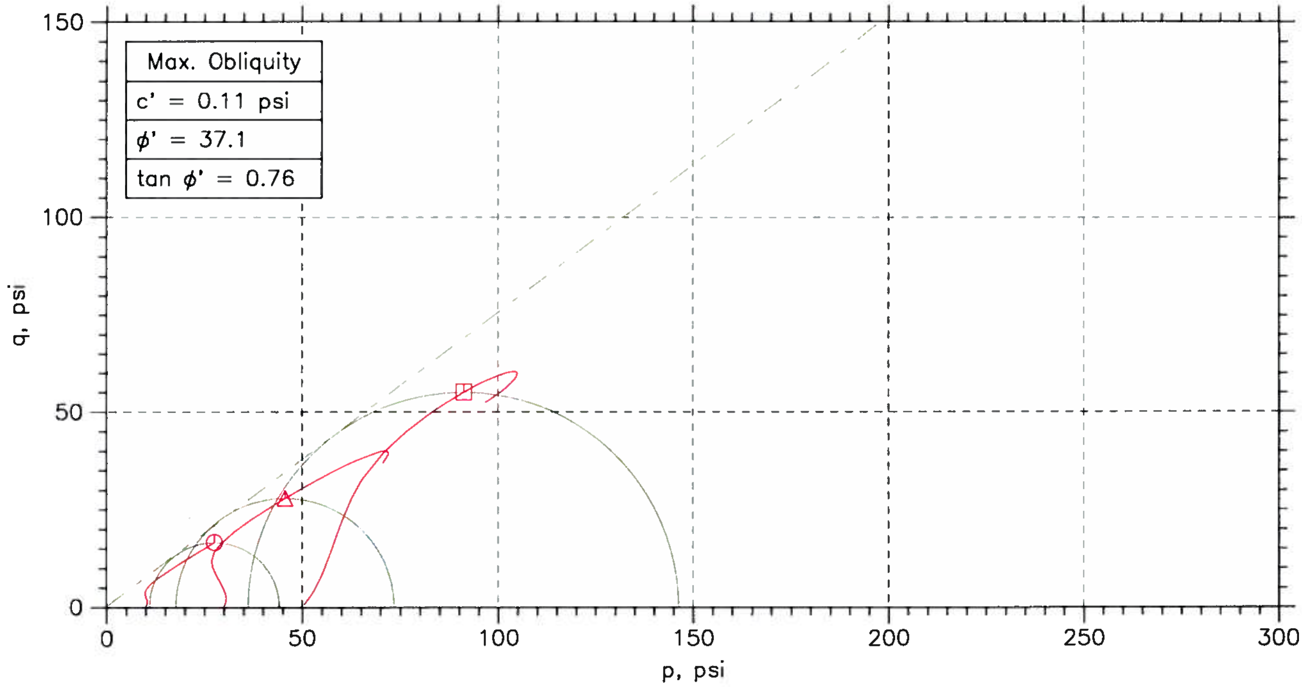
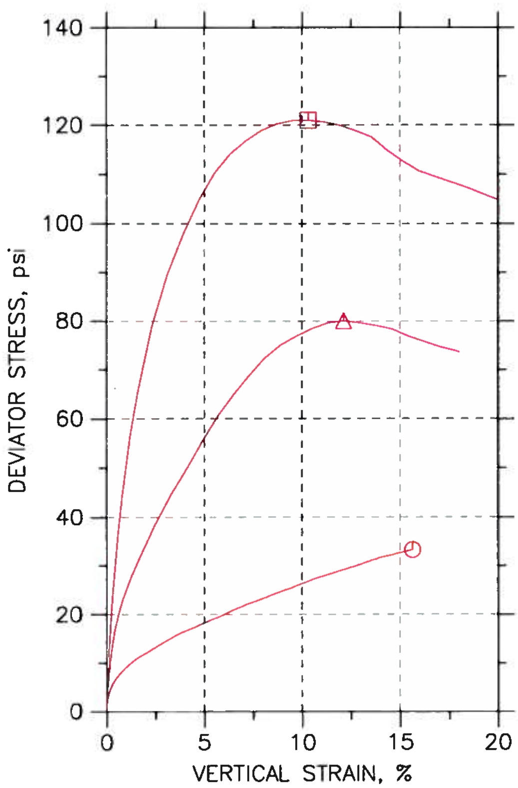
Project: Colbert Fossil Plant
Location: ---
Project No.: GTX-1499
Boring No.: See Remarks
Sample Type: UD
Description: Brown Lean clay with sand
Remarks: Test 9.1-Boring STN-5-10S, Test 9.3-Boring STN-5-9S, Test 12.1-Boring STN-5S

Wed, 30-DEC-2009 14:05:58

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



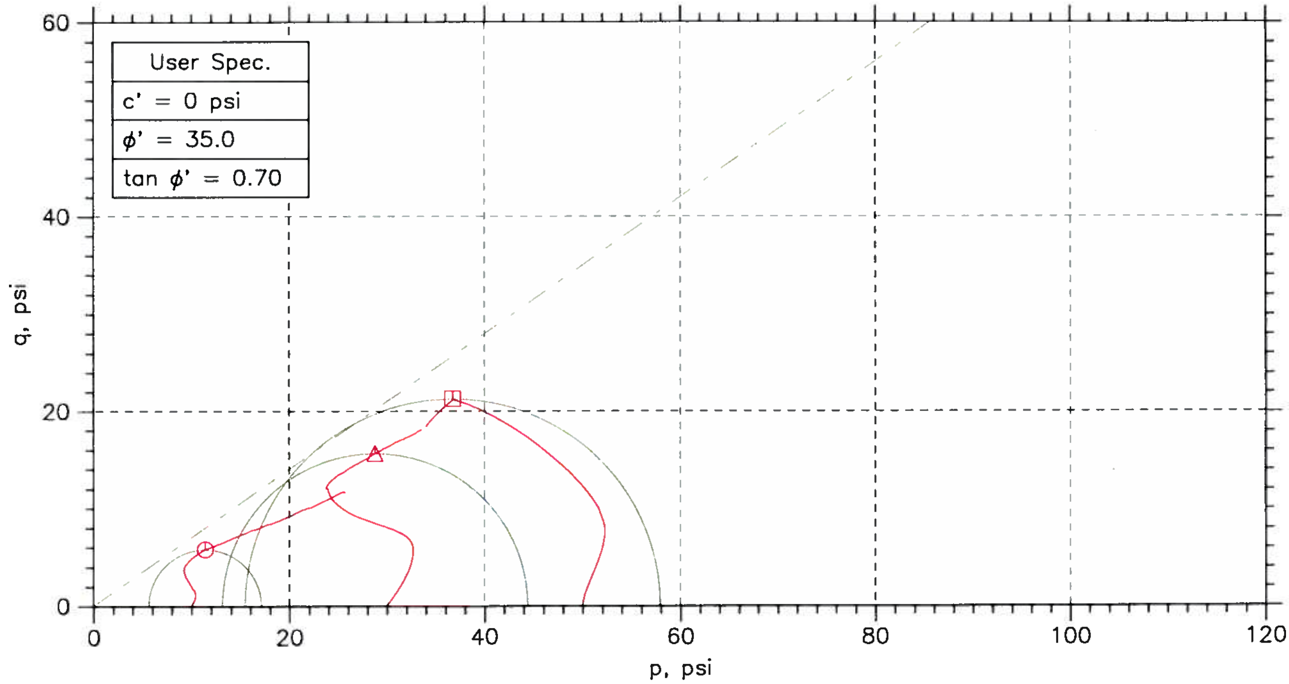


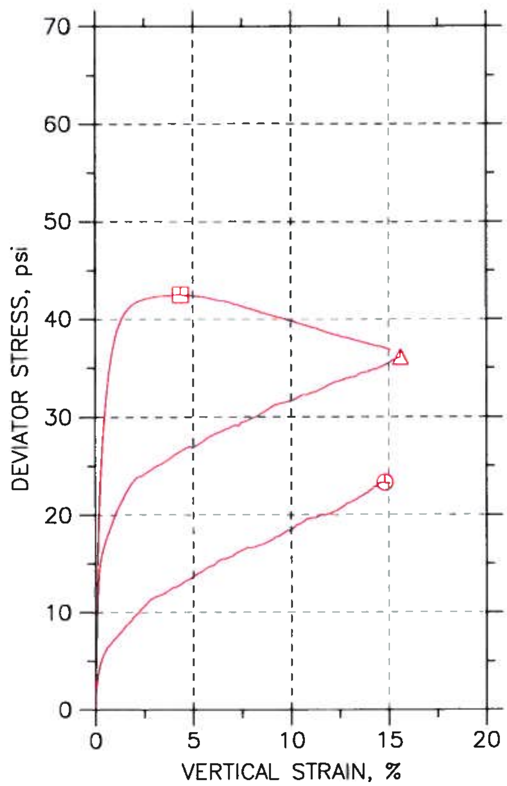
Symbol		○	△	□	
Sample No.		ST-8	ST-9	ST-11	
Test No.		3.1	3.2	3.3	
Depth		39.1-39.7'	44.8-45.4'	54.8-55.4'	
Initial	Diameter, in	2.757	2.841	1.398	
	Height, in	5.972	6.01	2.949	
	Water Content, %	56.0	46.4	52.0	
	Dry Density, pcf	59.36	68.65	64.61	
	Saturation, %	82.2	86.1	87.3	
	Void Ratio	1.84	1.46	1.61	
Before Shear	Water Content, %	57.5	45.2	47.3	
	Dry Density, pcf	66.05	75.89	73.98	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	1.55	1.22	1.28	
	Back Press., psi	94.94	106.8	90.95	
Ver. Eff. Cons. Stress, psi		9.908	29.99	49.89	
Shear Strength, psi		16.6	39.98	60.42	
Strain at Failure, %		15.6	12.1	10.3	
Strain Rate, %/min		0.08	0.08	0.08	
B-Value		0.95	0.96	0.97	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

GeoTesting express, a subsidiary of Geocomp Corporation	
	Project: Colbert Fossil Plant
	Location: ---
	Project No.: GTX-1499
	Boring No.: STN-5-11S
	Sample Type: UD
	Description: Gray-Ash
	Remarks: System 1057

Wed, 30-DEC-2009 14:18:20

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		---	---	st-5	
Test No.		4.1	4.2	4.3	
Depth		5.4-6.2	15.8-16.4	20.8-21.3	
Initial	Diameter, in	2.821	2.832	2.849	
	Height, in	5.779	6.455	5.771	
	Water Content, %	24.9	21.3	17.6	
	Dry Density, pcf	94.65	100.9	103.5	
	Saturation, %	86.0	85.8	75.9	
	Void Ratio	0.781	0.671	0.628	
Before Shear	Water Content, %	26.8	22.5	21.1	
	Dry Density, pcf	97.82	104.9	107.3	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.723	0.607	0.571	
	Back Press., psi	134	113	77.01	
Ver. Eff. Cons. Stress, psi		9.989	29.99	49.9	
Shear Strength, psi		11.63	18.02	21.23	
Strain at Failure, %		14.8	15.6	4.37	
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		---	---	---	
Plastic Limit		---	---	---	

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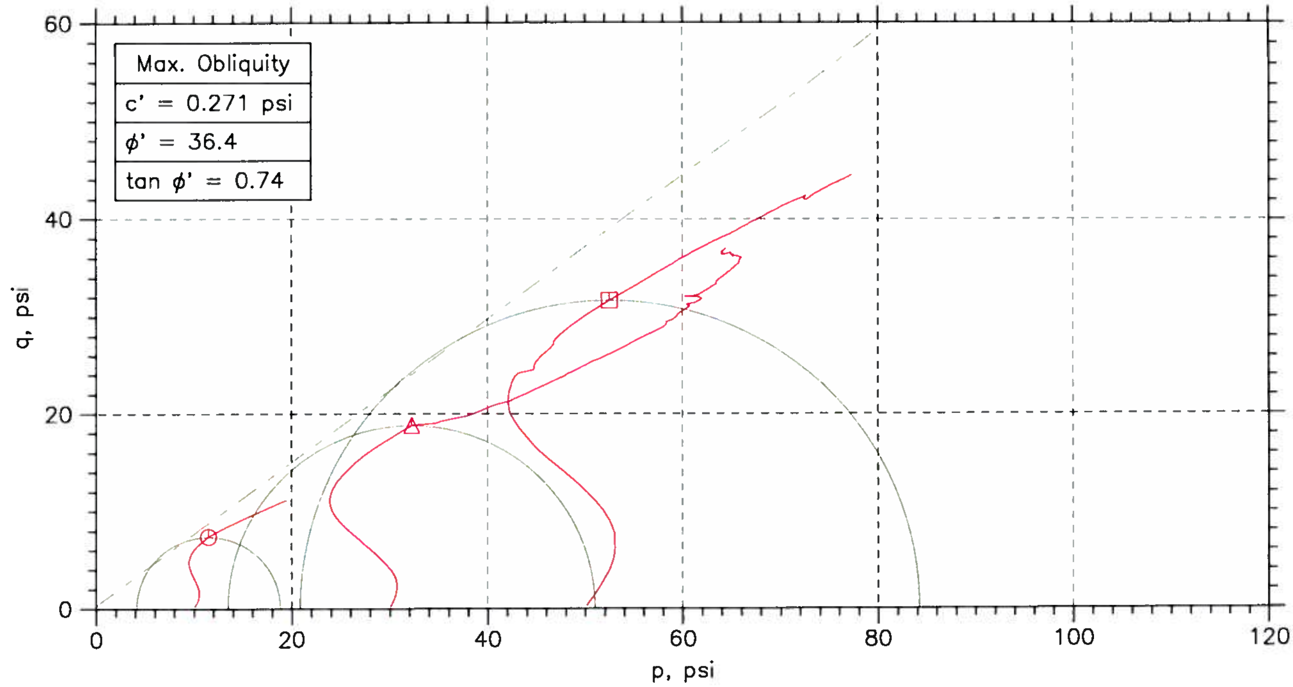
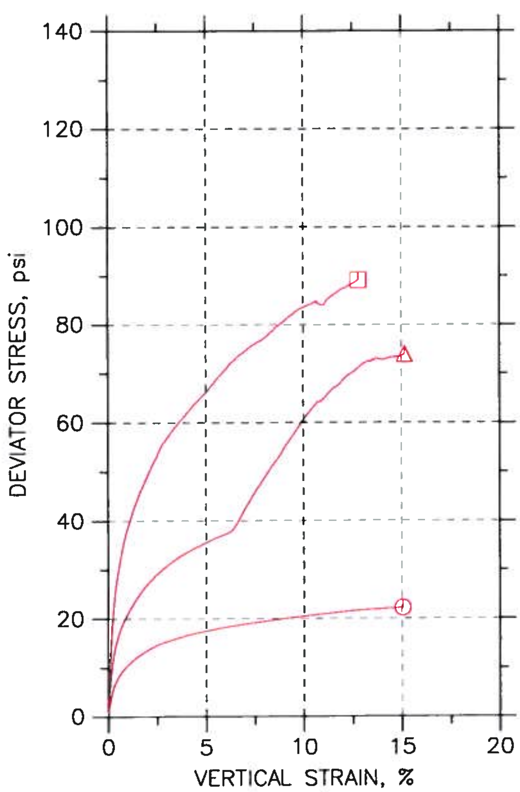
Project: Colbert Fossil Plant	
Location: ---	
Project No.: GTX-1499	
Boring No.: STN-5-12s	
Sample Type: UD	
Description: brown sandy	
Remarks: System 1057	

Tue, 15-DEC-2009 17:14:55

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





		ST-3 (○)	ST-3 (△)	ST-13 (□)	
Symbol		○	△	□	
Sample No.		ST-3	ST-3	ST-13	
Test No.		5.1	5.2	5.3	
Depth		10.8-11.4	11.4-12.0	64.8-65.4	
Initial	Diameter, in	2.805	2.83	2.842	
	Height, in	5.97	6.348	6.367	
	Water Content, %	22.5	23.5	19.2	
	Dry Density, pcf	102.9	101.9	110.3	
	Saturation, %	95.3	97.0	98.1	
	Void Ratio	0.638	0.654	0.528	
Before Shear	Water Content, %	22.8	21.6	18.5	
	Dry Density, pcf	104.3	106.5	112.4	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.617	0.583	0.5	
	Back Press., psi	47.29	116.1	95.06	
Ver. Eff. Cons. Stress, psi		9.961	29.92	49.94	
Shear Strength, psi		11.07	36.93	44.51	
Strain at Failure, %		15	15.1	12.8	
Strain Rate, %/min		0.04	0.04	0.04	
B-Value		0.96	0.95	0.95	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

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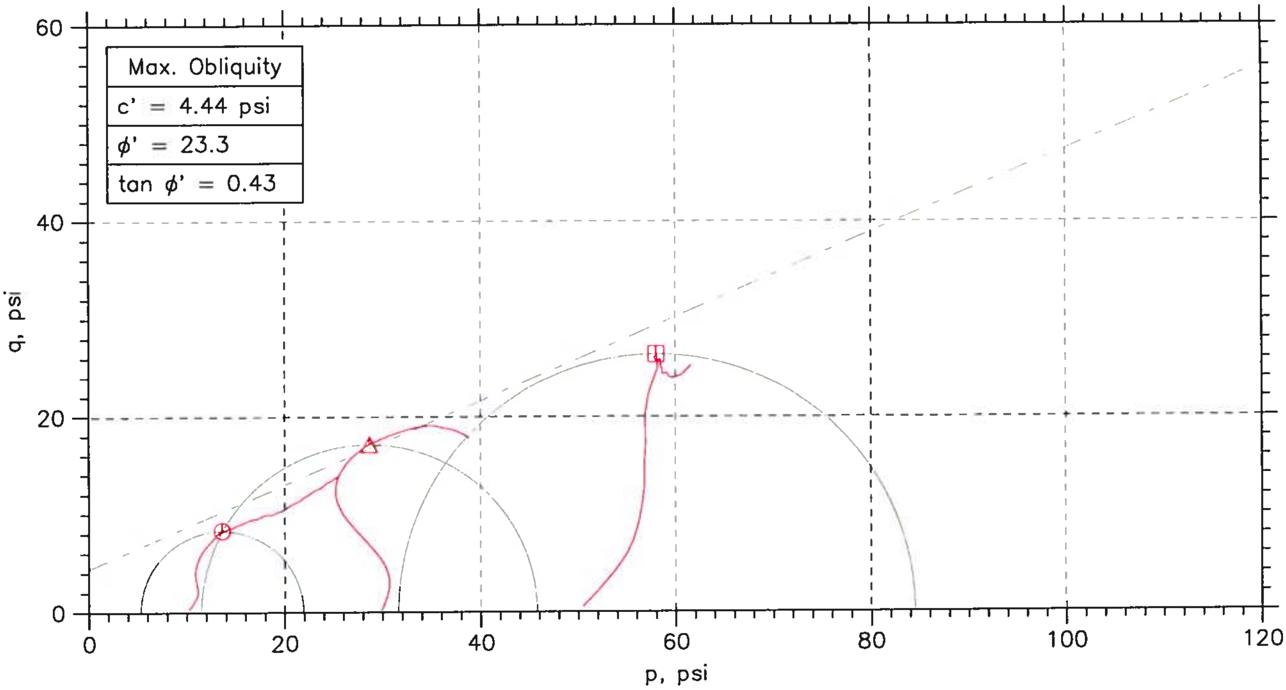
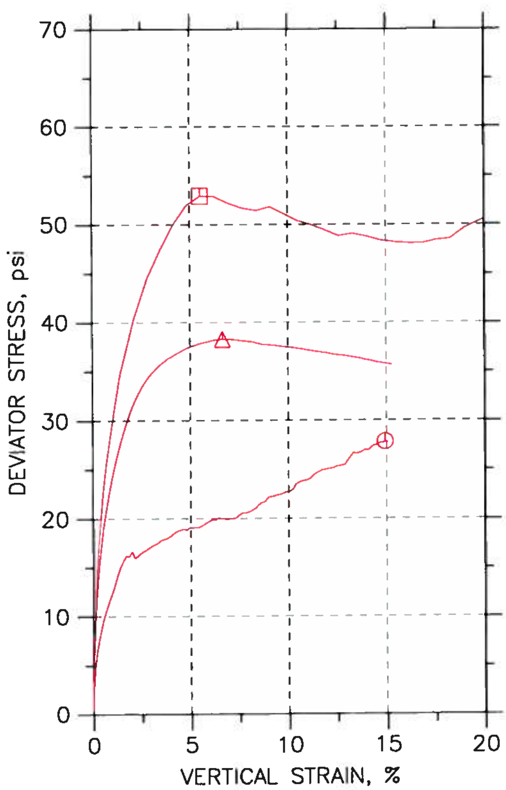
Project: Colbert Fossil Plant
Location: ---
Project No.: GTX-1499
Boring No.: STN-5-13S
Sample Type: UD
Description: Brown lean clay with sand
Remarks: Tests 5.1 & 5.2-Boring STN-5-13S, Test 5.3-Boring STN-5-11S

Wed, 30-DEC-2009 14:22:02

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



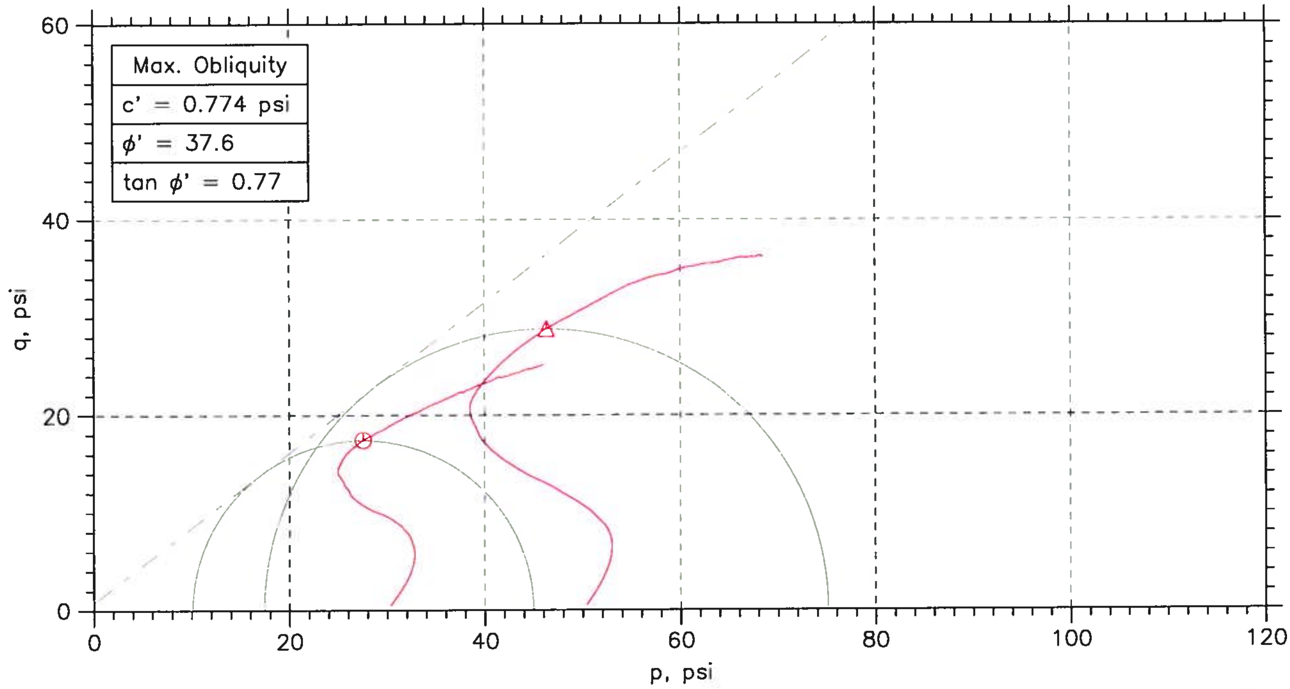


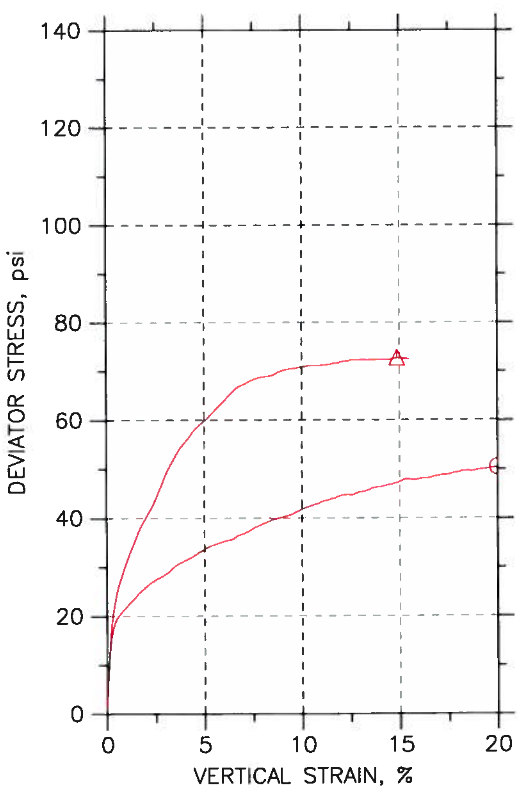
Symbol		○	△	□	
Sample No.		ST-1	ST-1	ST-3	
Test No.		1.1	1.2	1.3	
Depth		2.8-3.4	3.4-4.0'	11.0-11.5'	
Initial	Diameter, in	2.845	2.839	1.374	
	Height, in	6.977	6.221	3.1	
	Water Content, %	30.2	22.8	30.7	
	Dry Density, pcf	88.13	103.7	89.2	
	Saturation, %	89.3	98.2	93.3	
	Void Ratio	0.912	0.626	0.89	
Before Shear	Water Content, %	31.0	23.1	32.2	
	Dry Density, pcf	91.81	103.7	90.23	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.836	0.625	0.868	
	Back Press., psi	101	95.22	94	
Ver. Eff. Cons. Stress, psi		9.924	29.69	49.98	
Shear Strength, psi		13.89	19.1	26.43	
Strain at Failure, %		14.9	6.64	5.51	
Strain Rate, %/min		0.07	0.07	0.07	
B-Value		0.95	0.95	0.96	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

GeoTesting express a subsidiary of Geocomp Corporation	Project: Colbert Fossil Plant
	Location: ---
	Project No.: GTX-1499
	Boring No.: STN-5-16S
	Sample Type: UD
	Description: Gray Lean clay with sand
	Remarks: System 1057

Wed, 30-DEC-2009 14:24:05

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△		
Sample No.		ST-3	ST-4		
Test No.		2.2	2.3		
Depth		10.8-11.4	15.8-16.4		
Initial	Diameter, in	2.845	2.807		
	Height, in	6.087	6.158		
	Water Content, %	20.9	19.4		
	Dry Density, pcf	98.64	110.5		
	Saturation, %	79.5	99.8		
	Void Ratio	0.709	0.526		
Before Shear	Water Content, %	22.6	19.8		
	Dry Density, pcf	104.7	109.9		
	Saturation*, %	100.0	100.0		
	Void Ratio	0.609	0.534		
	Back Press., psi	116.1	95.13		
Ver. Eff. Cons. Stress, psi		29.91	49.86		
Shear Strength, psi		25.17	36.28		
Strain at Failure, %		20	14.9		
Strain Rate, %/min		0.08	0.08		
B-Value		0.95	0.96		
Estimated Specific Gravity		2.7	2.7		
Liquid Limit		---	---		
Plastic Limit		---	---		

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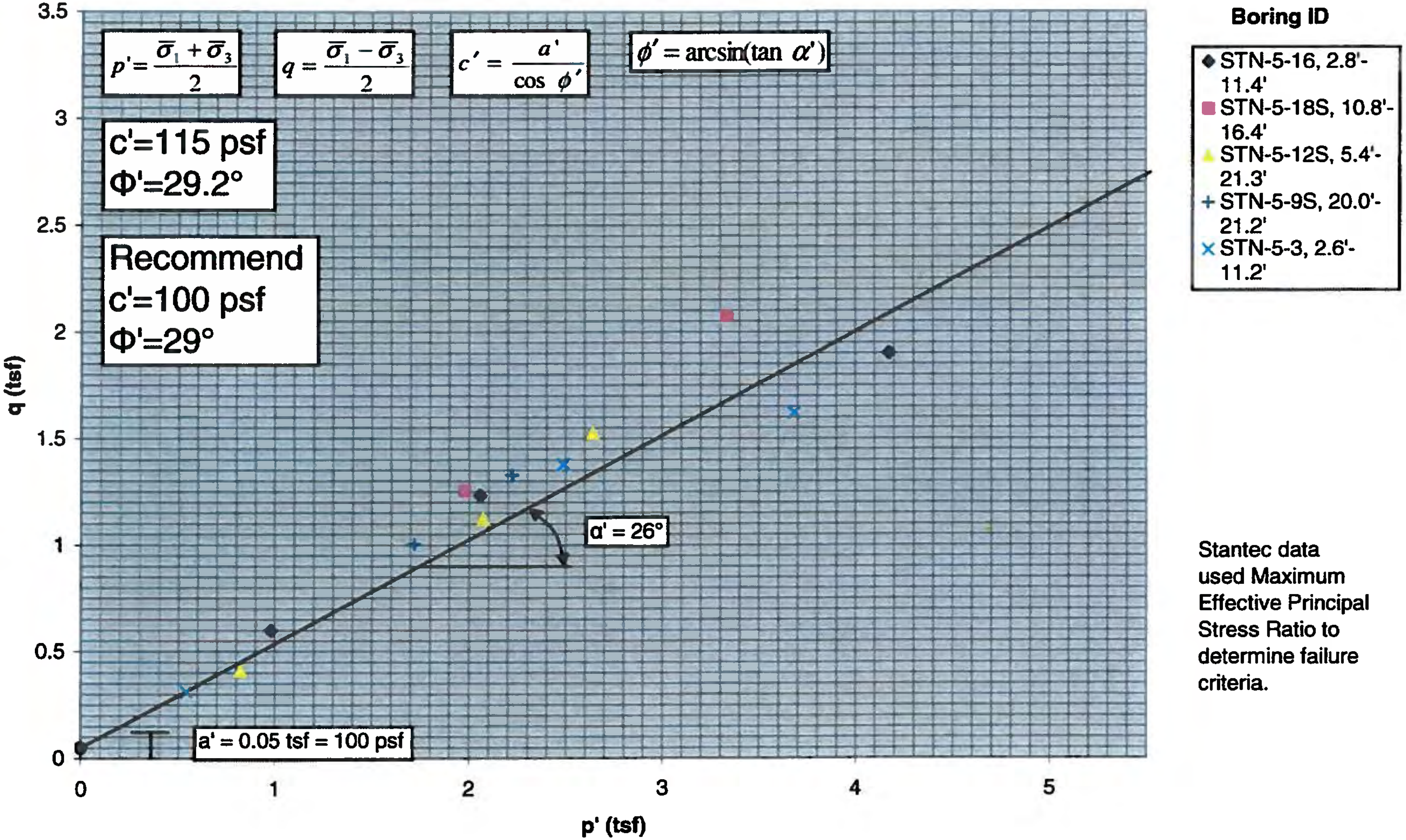
Project: Colbert Fossil Plant
Location: ---
Project No.: GTX-1499
Boring No.: STN-5-18s
Sample Type: UD
Description: Red-Brown sandy lean clay
Remarks: System 1057

Tue, 05-JAN-2010 14:49:42

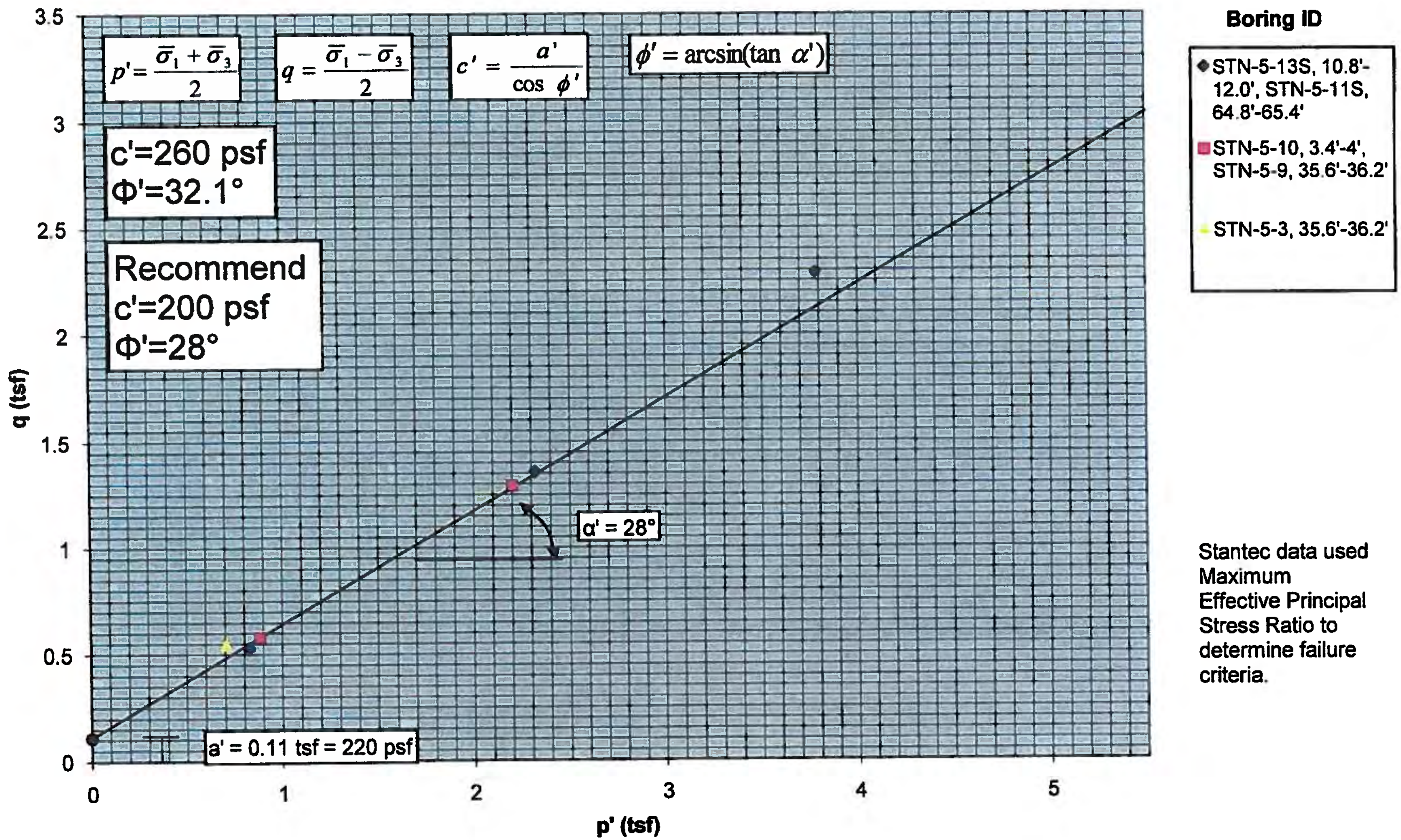
Appendix D

Strength Parameter Selection

Clay Dike
Effective Stress From CU Triaxial Tests

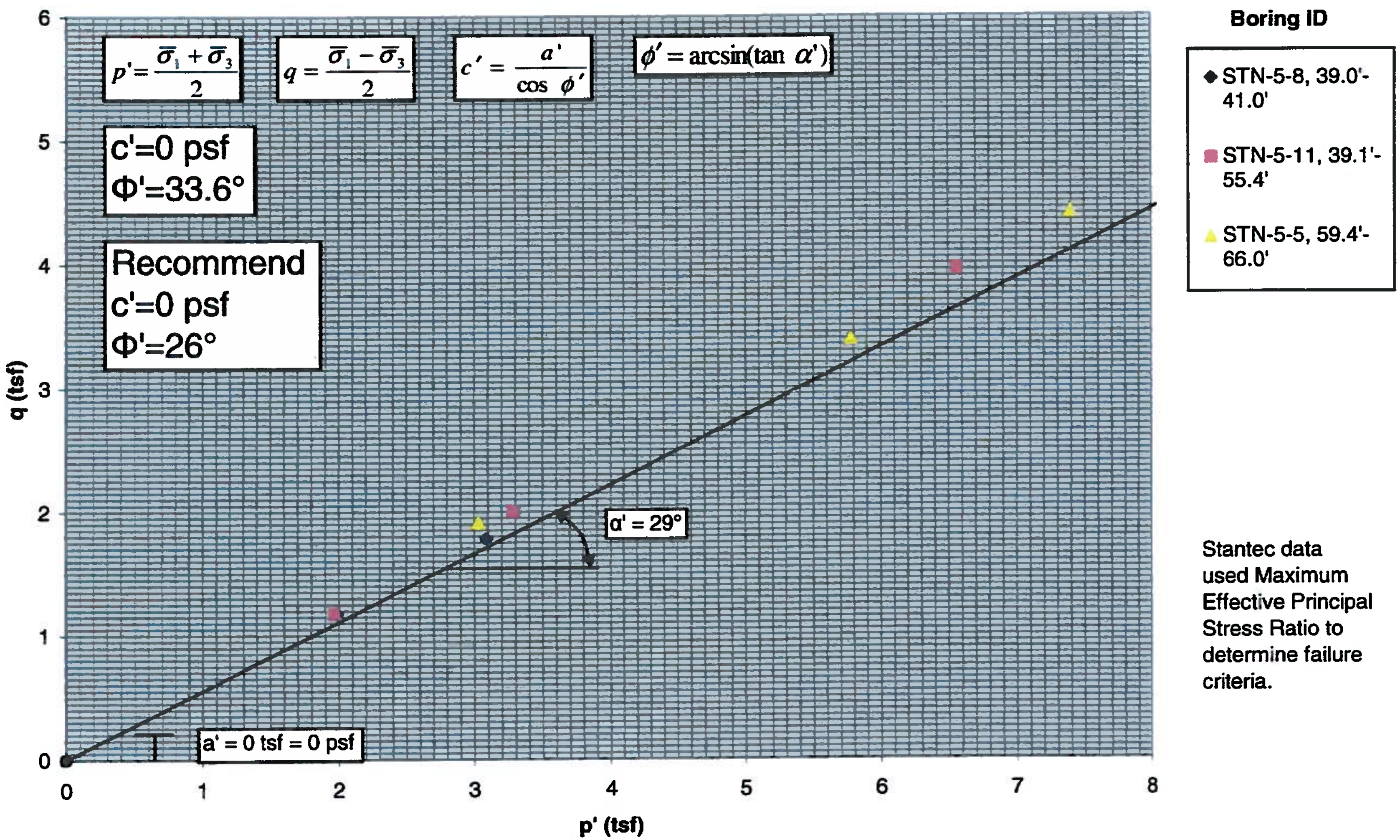


Native Clay
Effective Stress From CU Triaxial Tests



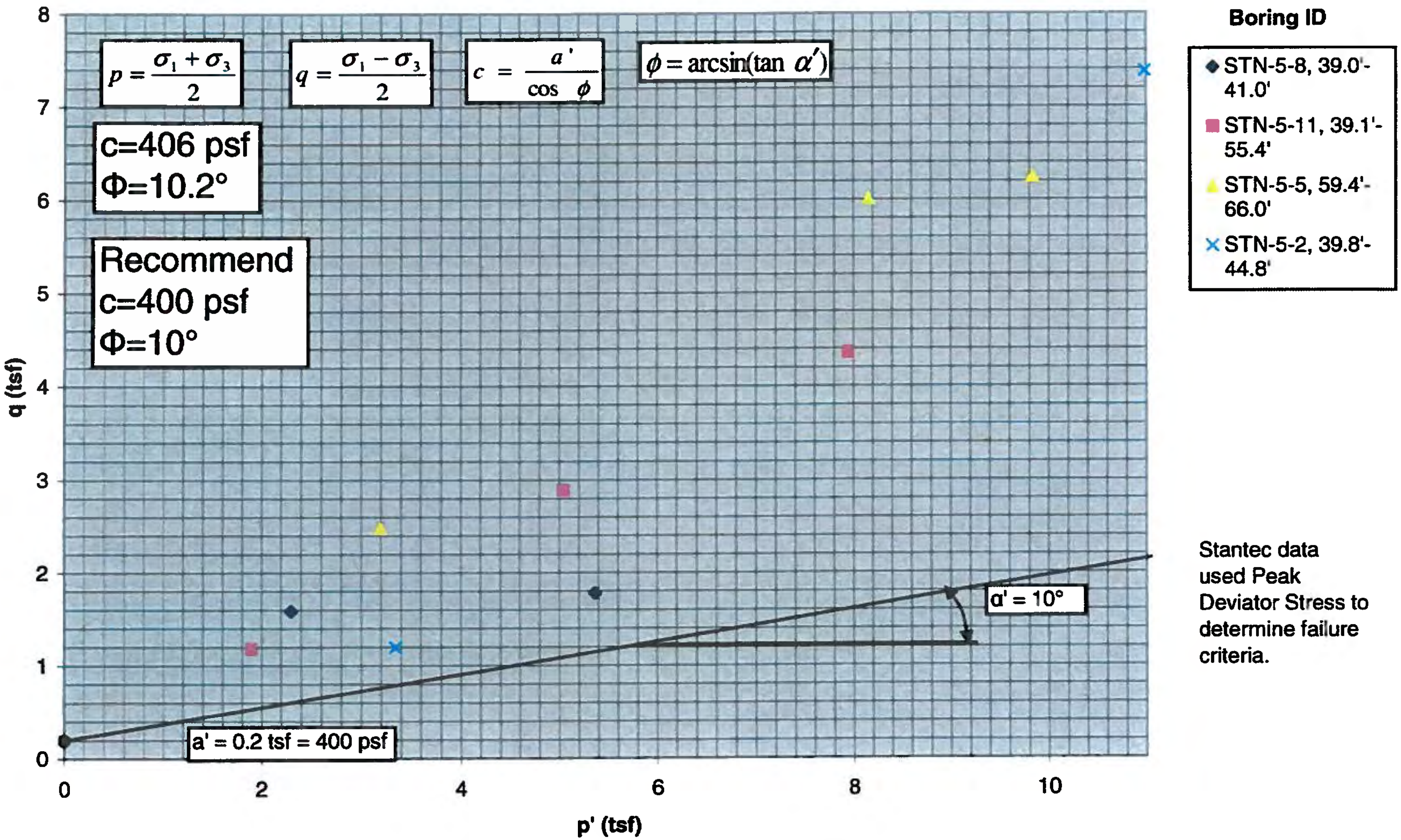
Stantec data used Maximum Effective Principal Stress Ratio to determine failure criteria.

Sluiced Ash
Effective Stress From CU Triaxial Tests



Stantec data used Maximum Effective Principal Stress Ratio to determine failure criteria.

Saturated Ash
Total Stress From CU Triaxial Tests



Appendix E

Geotechnical Drawings

GEOTECHNICAL EXPLORATION
DISPOSAL AREA NO. 5
COLBERT FOSSIL PLANT
TUSCUMBIA, COLBERT COUNTY, ALABAMA

PREPARED FOR

TENNESSEE VALLEY AUTHORITY

PREPARED BY

Stantec

Stantec Consulting Services Inc.
1901 Nelson Miller Parkway
Louisville, Kentucky
40223-2177
Tel. 502.212.5000
Fax 502.212.5055
www.stantec.com

VICINITY MAP

INDEX OF SHEETS

RECORD DRAWING

For Supporting Design Calculations see FPOOFFESCDX00000031100002

SCALE: AS SHOWN — EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5
GEOTECHNICAL EXPLORATION
COVER SHEET

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

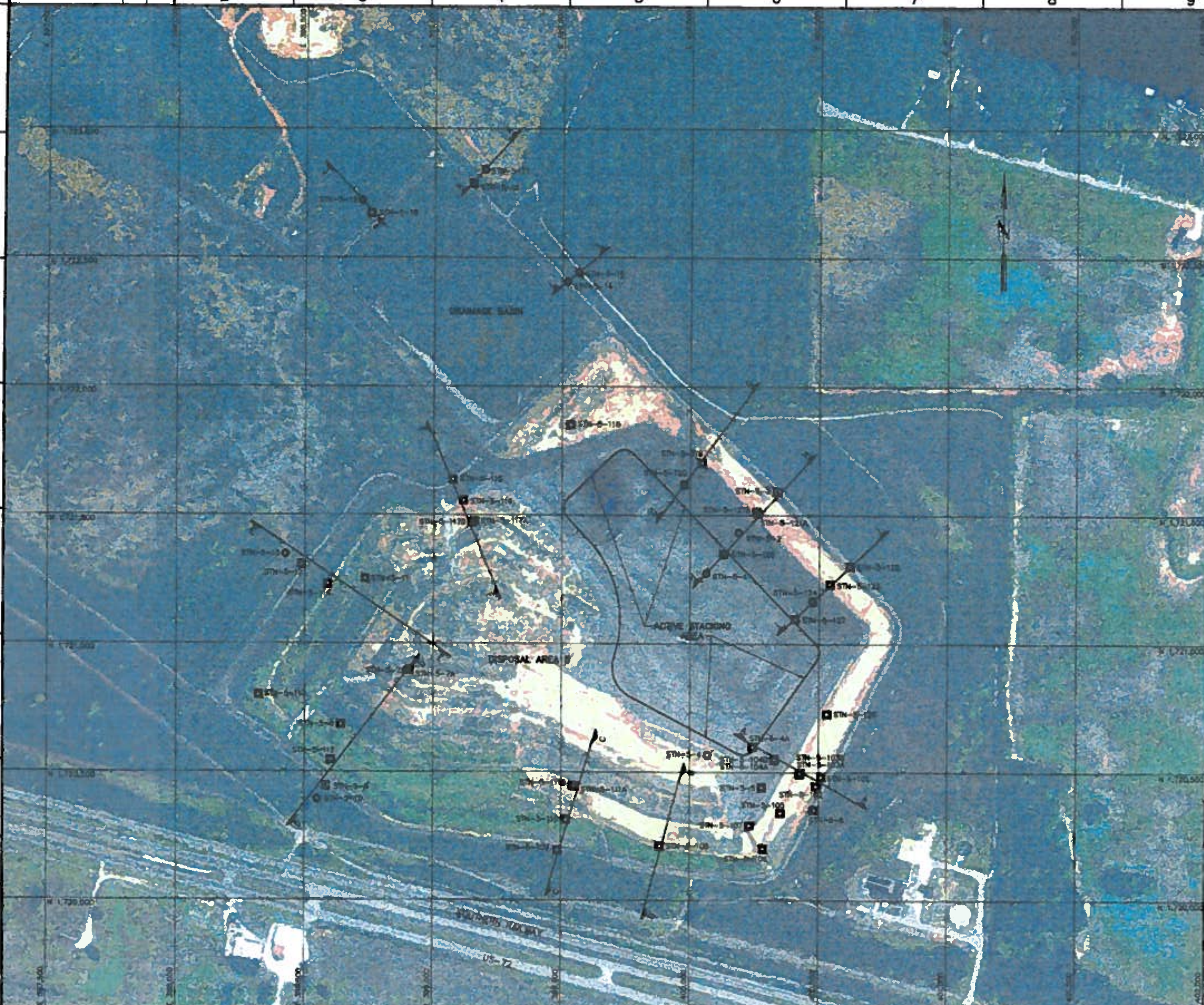
AUTOCAD R 2000 | 37 | C | 10W707—01 | R 0

PLOT FACTOR XX

STANTEC | 0
TASK COMPLETED BY | REV NO.

C.A.D. DRAWING DO NOT ALTER MANUALLY

37 C 10W707-01



37 C 10W707-02

LEGEND

- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Sampling
- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Piston Sampling (Piezometer Installed)
- Soil Boring With Continuous Standard Penetration Tests And/or Shelby Tube Sampling, Rock Core, And Piezometer Installed
- Cross Section

BORING LOCATION TABLE			
Boring	Northing	Easting	Elev. (ft.)
STN-5-1	1,721,274.40	400,083.00	552.91
STN-5-2	1,721,432.78	400,188.85	529.19
STN-5-3	1,721,592.79	400,338.67	487.54
STN-5-4	1,720,567.21	400,067.66	559.98
STN-5-4A	1,720,600.17	400,244.82	550.70
STN-5-5	1,720,441.17	400,279.90	529.71
STN-5-6	1,720,353.73	400,481.02	488.06
STN-5-7	1,720,896.57	398,896.12	564.52
STN-5-7A	1,720,897.20	398,906.71	565.34
STN-5-8	1,720,684.92	398,641.15	517.92
STN-5-9	1,720,444.22	398,582.58	480.52
STN-5-10	1,720,393.13	398,549.84	459.85
STN-5-11	1,721,251.58	398,733.51	515.53
STN-5-12	1,721,308.21	398,486.91	477.77
STN-5-13	1,721,346.27	398,424.38	452.28
STN-5-14	1,722,407.30	399,518.43	475.88
STN-5-15	1,722,443.72	399,582.30	482.85
STN-5-16	1,722,788.34	399,149.51	475.84
STN-5-17	1,722,840.75	399,195.10	458.60
STN-5-18	1,722,671.43	398,752.90	472.18
STN-5-19	1,722,721.58	398,717.11	453.41
STN-5-101	1,720,482.33	400,508.25	486.97
STN-5-102	1,720,445.72	400,489.29	486.80
STN-5-103A	1,720,493.35	400,426.84	508.95
STN-5-103B	1,720,498.42	400,429.29	509.48
STN-5-104A	1,720,548.28	400,328.22	530.48
STN-5-104B	1,720,551.74	400,330.04	530.75
STN-5-105	1,720,341.58	400,353.20	507.40
STN-5-106	1,720,202.10	400,284.88	505.40
STN-5-107	1,720,282.02	400,232.48	527.19
STN-5-108	1,720,211.06	399,882.93	509.29
STN-5-109	1,720,185.76	399,488.17	481.82
STN-5-110	1,720,315.43	399,518.59	508.44
STN-5-111A	1,720,443.15	399,553.23	529.32
STN-5-111B	1,720,446.66	399,545.11	528.34
STN-5-112	1,720,546.53	398,601.38	497.91
STN-5-113	1,720,800.24	398,321.28	489.24
STN-5-114	1,721,230.71	398,587.74	487.61
STN-5-115	1,721,836.94	399,073.86	477.77
STN-5-116	1,721,587.19	399,118.86	491.58
STN-5-117A	1,721,475.92	399,139.40	512.79
STN-5-117B	1,721,489.59	399,148.35	512.84
STN-5-118	1,721,850.73	399,533.21	499.18
STN-5-119	1,721,703.82	400,044.78	504.34
STN-5-120	1,721,819.44	399,976.15	525.76
STN-5-121A	1,721,506.28	400,264.15	508.23
STN-5-121B	1,721,514.55	400,256.18	507.94
STN-5-122	1,721,301.29	400,620.41	488.86
STN-5-123	1,721,231.75	400,542.54	508.11
STN-5-124	1,721,185.86	400,478.56	527.23
STN-5-125	1,720,727.47	400,531.28	509.03
STN-5-126	1,721,349.47	400,129.73	554.68
STN-5-127	1,721,097.71	400,407.87	550.45

RECORD DRAWING

GRAPHIC SCALE 1"=150'

For Supporting Design Calculations see FPGCOFTESCDX00000020100002

SCALE: 1"=150' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
BORING AND STABILITY
CROSS SECTION PLAN

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W707-02 | R 0

PLOT FACTOR XX

STANTEC	0
TASK COMPLETED BY	REV NO.

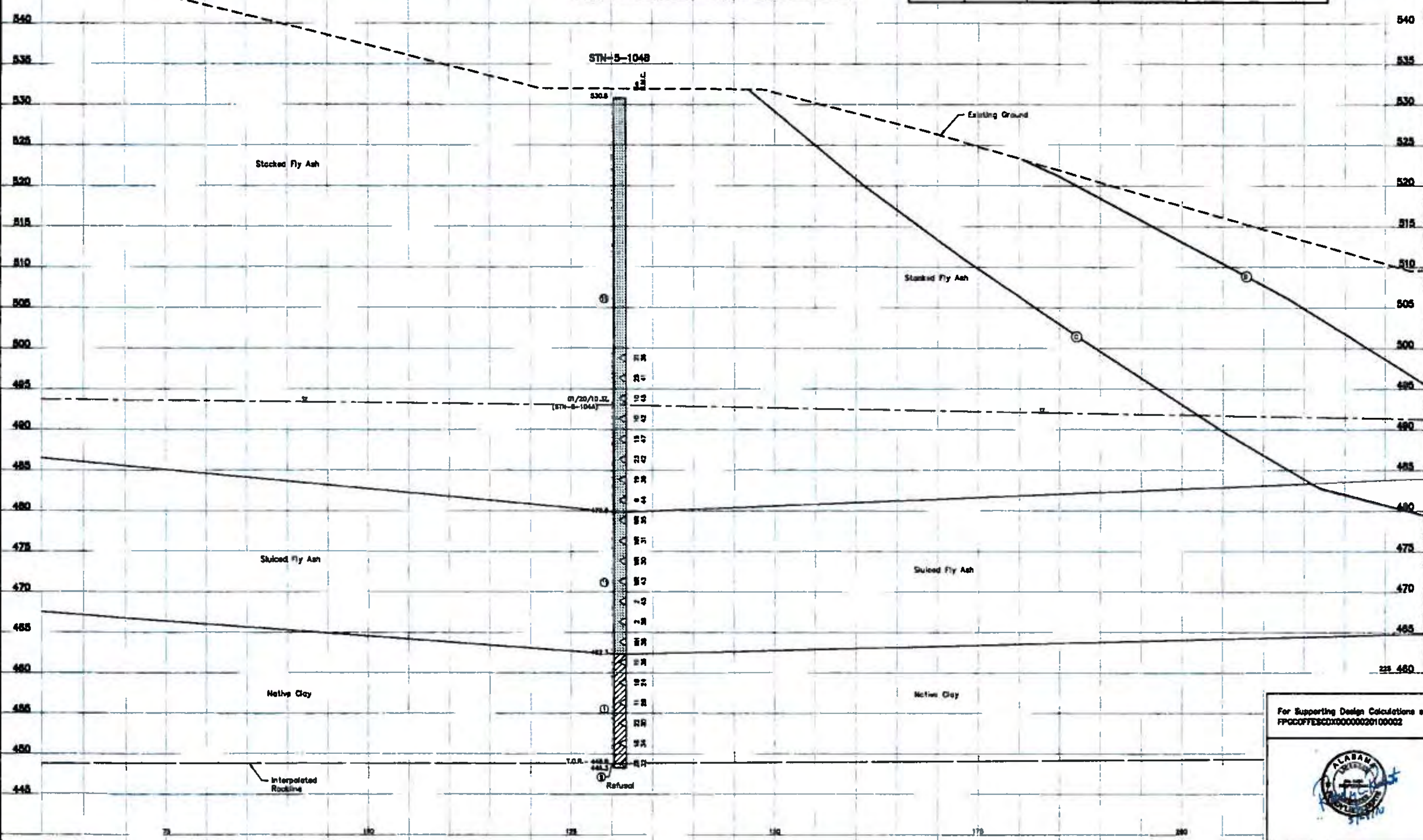
C.A.D. DRAWING DO NOT ALTER MANUALLY

SUMMARY OF STABILITY ANALYSES STATIC CONDITION

Failure Surface	Summary Of Stability Analyses Static Condition	Analysis Type	Factor of Safety
A	Minimum, Shallower Circle With Optimized Surface from PZ Data	Drained	1.5
B	Deeper Circle With Optim'zed Surface From PZ Data	Drained	1.7
C	Global Circle With Optimized Surface From PZ Data	Drained	2.1

SUMMARY OF OFFSET BORINGS

Boring Number	Surface Elevation (Ft.)	Bottom Of Hole Depth (ft.)	Piezometer Screened Interval (Ft.)	Undisturbed "Shelby" Tube Sample Intervals (Ft.)
STN-5-6S	486.1	27.0	10.0–20.0	2.0–4.0, 5.0–7.0, 10.0–12.0, 15.0–17.0, 20.0–22.0, 25.0–27.0
STN-5-103A	509.0	40.0	30.0–40.0	No Samples
STN-5-104A	530.5	82.5	50.5–60.5	No Samples



LEGEND

1. Lean Clay, Sandy Lean Clay, Lean Clay With Sand
2. Silty, Clayey Sand
3. Fat Clay, Fat Clay With Sand
4. Overburden
5. Silty Clay
6. Poorly Graded Sand
7. Silty Sand
8. Silt, Sandy Silt, Silt With Sand
9. Limestone
10. Well Graded Sand With Silt
11. Fly Ash
12. Bottom Ash
13. Clayey Gravel
14. Silty Gravel With Sand

- WH — Weight of Hammer
- WR — Weight of Rods
- ◁ — Standard Penetration Test Interval
- ● — Undisturbed Thin-Walled (Shelby) Tube Sample
- N_{60} — Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
- N_{80} — Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
- N.M.C. — Natural Moisture Content (%)
- U.W.W. — Unit Weight Wet (lbs./cu.ft.)
- U.W.D. — Unit Weight Dry (lbs./cu.ft.)
- U.C./U.U. — Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
- 03/31/09 — Water Level and Date Recorded
- —— — Phreatic Surface From Pz Data
- T.O.R. — Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
- B.C. — Begin Rock Core
- R.Q.D. — Rock Quality Designation (%)
- REC. — Recovery (%)
- Refusal — Auger Refusal Using A Carbide-tipped Tooth Auger Bit
- No Refusal — No Refusal Encountered
- * — Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

For Supporting Design Calculations see FPGCOFFESCDX00000020100022

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5
GEOTECHNICAL EXPLORATION
STABILITY SECTION A

Stantec Consulting Services Inc.

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W707-03 | R 0

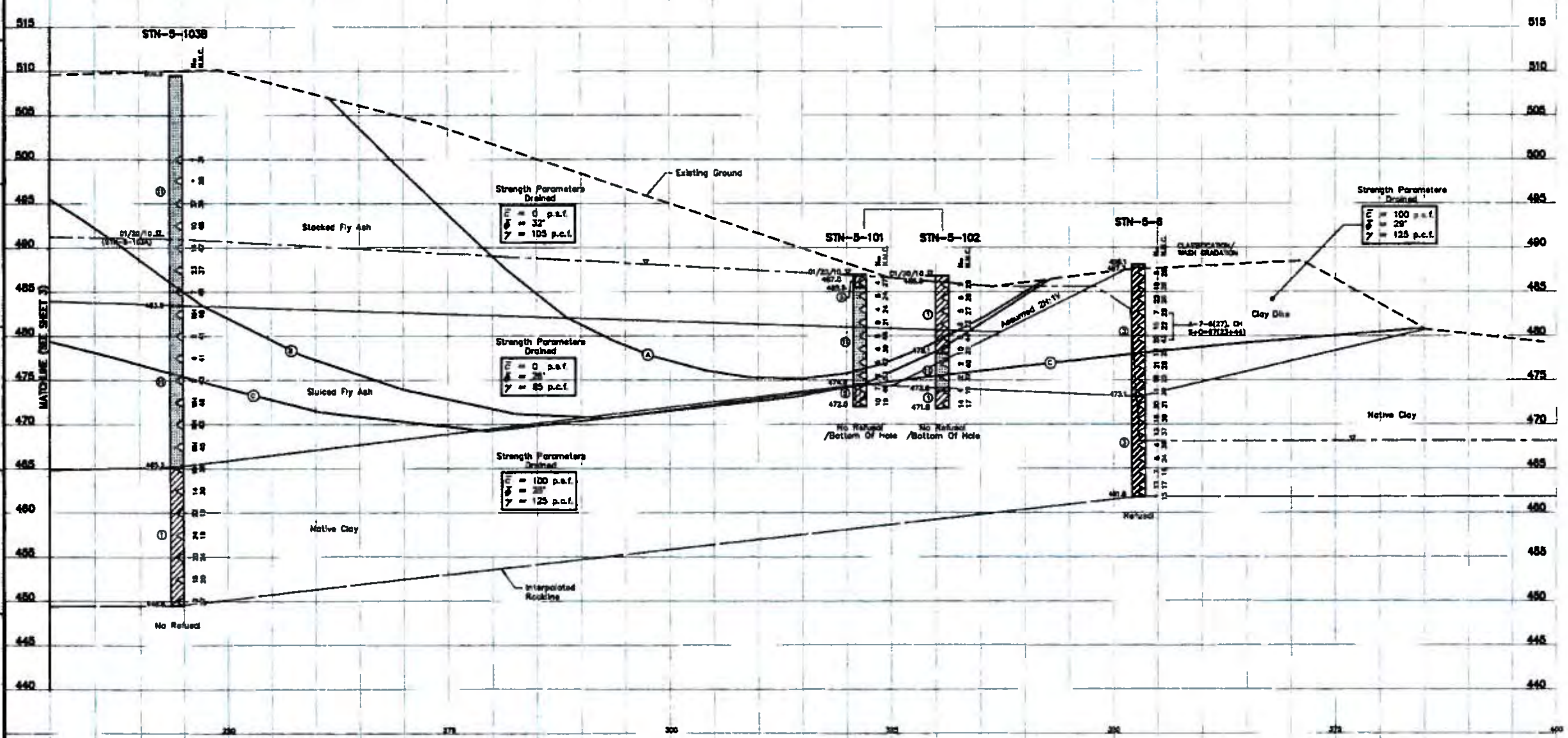
PLOT FACTOR XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY | REV NO.

37 | C | 10W707-03

37 | C | 10W707-04



LEGEND

①	Lean Clay, Sandy Lean Clay, Lean Clay With Sand
②	Silty, Clayey Sand
③	Fat Clay, Fat Clay With Sand
④	Overburden
⑤	Silty Clay
⑥	Poorly Graded Sand
⑦	Silty Sand
⑧	Silt, Sandy Silt, Silt With Sand
⑨	Limestone
⑩	Well Graded Sand With Silt
⑪	Fly Ash
⑫	Bottom Ash
⑬	Clayey Gravel
⑭	Silty Gravel With Sand
WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
■	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09 ⊻	Water Level and Date Recorded
—— ⊻ ——	Phreatic Surface From Pz Data
T.O.R.–	Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
B.C.–	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal Using A Carbide-tipped Tooth Auger Bit
No Refusal	No Refusal Encountered
*	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

SUMMARY OF STABILITY ANALYSES STATIC CONDITION			
Failure Surface	Summary Of Stability Analyses Static Condition	Analysis Type	Factor of Safety
A	Minimum, Shallower Circle With Optimized Surface from PZ Data	Drained	1.5
B	Deeper Circle With Optimized Surface From PZ Data	Drained	1.7
C	Global Circle With Optimized Surface From PZ Data	Drained	2.1

SUMMARY OF OFFSET BORINGS				
Boring Number	Surface Elevation (Ft.)	Bottom Of Hole Depth (Ft.)	Piezometer Screened Interval (Ft.)	Undisturbed "Shelby" Tube Sample Intervals (Ft.)
STN-5-6S	488.1	27.0	10.0–20.0	2.0–4.0, 5.0–7.0, 10.0–12.0 15.0–17.0, 20.0–22.0, 25.0–27.0
STN-5-103A	509.0	40.0	30.0–40.0	No Samples
STN-5-104A	530.5	62.5	50.5–60.5	No Samples

For Supporting Design Calculations see FPGCOFFESCDX00000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
STABILITY SECTION A

P. COOPER | R. PETTY | P. COOPER | A. ROBERTS | R. ROBERTS | R. ROBERTS | T. JOHNSON

Stantec Consulting Services Inc.

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

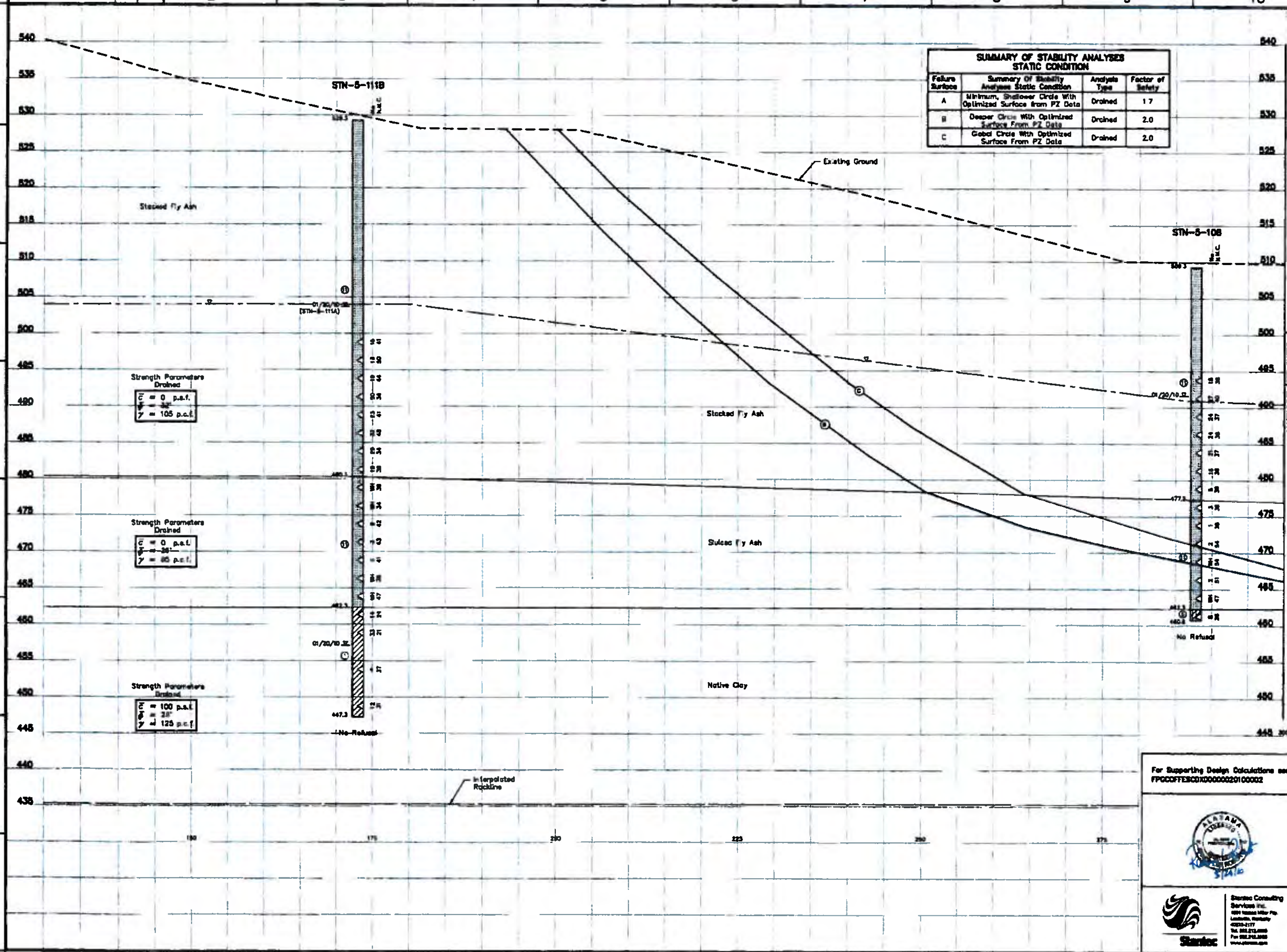
AUTOCAD R 2000 | 37 | C | 10W707–04 | R 0

PLOT FACTOR XX
W_TVA

CAD DRAWING DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY | REV NO.

37 | C | 10W707-05



SUMMARY OF STABILITY ANALYSES STATIC CONDITION

Failure Surface	Summary Of Stability Analyses Static Condition	Analysis Type	Factor of Safety
A	Minimum, Shallower Circle With Optimized Surface from PZ Data	Drained	1.7
B	Deeper Circle With Optimized Surface From PZ Data	Drained	2.0
C	Global Circle With Optimized Surface From PZ Data	Drained	2.0

LEGEND

1. Lean Clay, Sandy Lean Clay, Lean Clay With Sand
2. Silty, Clayey Sand
3. Fat Clay, Fat Clay With Sand
4. Overburden
5. Silty Clay
6. Poorly Graded Sand
7. Silty Sand
8. Silt, Sandy Silt, Silt With Sand
9. Limestone
10. Well Graded Sand With Silt
11. Fly Ash
12. Bottom Ash
13. Clayey Gravel
14. Silty Gravel With Sand

- WH — Weight of Hammer
- WR — Weight of Rods
- ◁ — Standard Penetration Test Interval
- ■ — Undisturbed Thin-Walled (Shelby) Tube Sample
- N_{60} — Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
- N_{60} — Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
- N.M.C. — Natural Moisture Content (%)
- U.W.W. — Unit Weight Wet (lbs./cu.ft.)
- U.W.D. — Unit Weight Dry (lbs./cu.ft.)
- U.C./U.U. — Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
- 03/31/09 — Water Level and Date Recorded
- Phreatic Surface From Pz Data
- T.O.R. — Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
- B.C. — Begin Rock Core
- R.Q.D. — Rock Quality Designation (%)
- REC. — Recovery (%)
- Refusal — Auger Refusal Using A Carbide-tipped Tooth Auger Bit
- No Refusal — No Refusal Encountered
- * — Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

For Supporting Design Calculations see FPGCOFFESC0X0000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
STABILITY SECTION B

Stantec Consulting Services Inc.

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

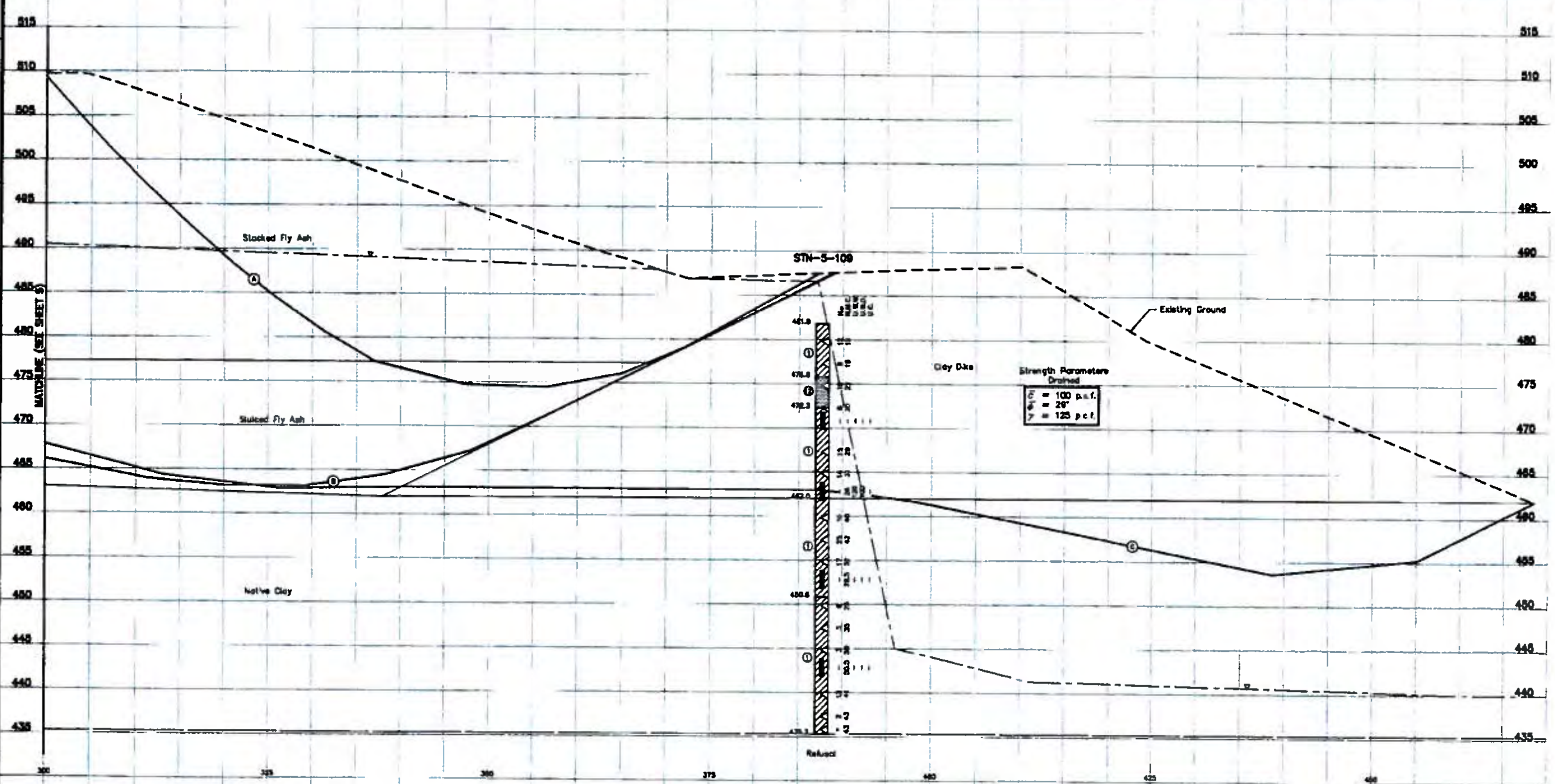
AUTOCAD R 2000 | 37 | C | 10W707-05 | R 0

STANTEC | 0
TASK COMPLETED BY | REV NO.

PLOT FACTOR: XX
W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY

37 | C | 10W707-06



LEGEND

- ① Lean Clay, Sandy Lean Clay, Lean Clay With Sand
- ② Silty, Clayey Sand
- ③ Fat Clay, Fat Clay With Sand
- ④ Overburden
- ⑤ Silty Clay
- ⑥ Poorly Graded Sand
- ⑦ Silty Sand
- ⑧ Silt, Sandy Silt, Silt With Sand
- ⑨ Limestone
- ⑩ Well Graded Sand With Silt
- ⑪ Fly Ash
- ⑫ Bottom Ash
- ⑬ Clayey Gravel
- ⑭ Silty Gravel With Sand

WH — Weight of Hammer
WR — Weight of Rods
◁ — Standard Penetration Test Interval
■ — Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60} — Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60} — Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C. — Natural Moisture Content (%)
U.W.W. — Unit Weight Wet (lbs./cu.ft.)
U.W.D — Unit Weight Dry (lbs./cu.ft.)
U.C./U.U. — Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09 — Water Level and Date Recorded
— — Phreatic Surface From Pz Data
T.O.R.— Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
B.C.— Begin Rock Core
R.Q.D. — Rock Quality Designation (%)
REC. — Recovery (%)
Refusal — Auger Refusal Using A Carbide-tipped Tooth Auger Bit
No Refusal — No Refusal Encountered
* — Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

SUMMARY OF STABILITY ANALYSES
STATIC CONDITION

Failure Surface	Summary Of Stability Analyses Static Condition	Analysis Type	Factor of Safety
A	Minimum, Shallower Circle With Optimized Surface from PZ Data	Drained	1.7
B	Deeper Circle With Optimized Surface From PZ Data	Drained	2.0
C	Global Circle With Optimized Surface From PZ Data	Drained	2.0

For Supporting Design Calculations see FPGCOFFESCDX0000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
STABILITY SECTION B

Stantec Consulting Services Inc.

P. COOPER | B. PETTY | P. COOPER | [illegible] | [illegible] | [illegible] | [illegible]

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

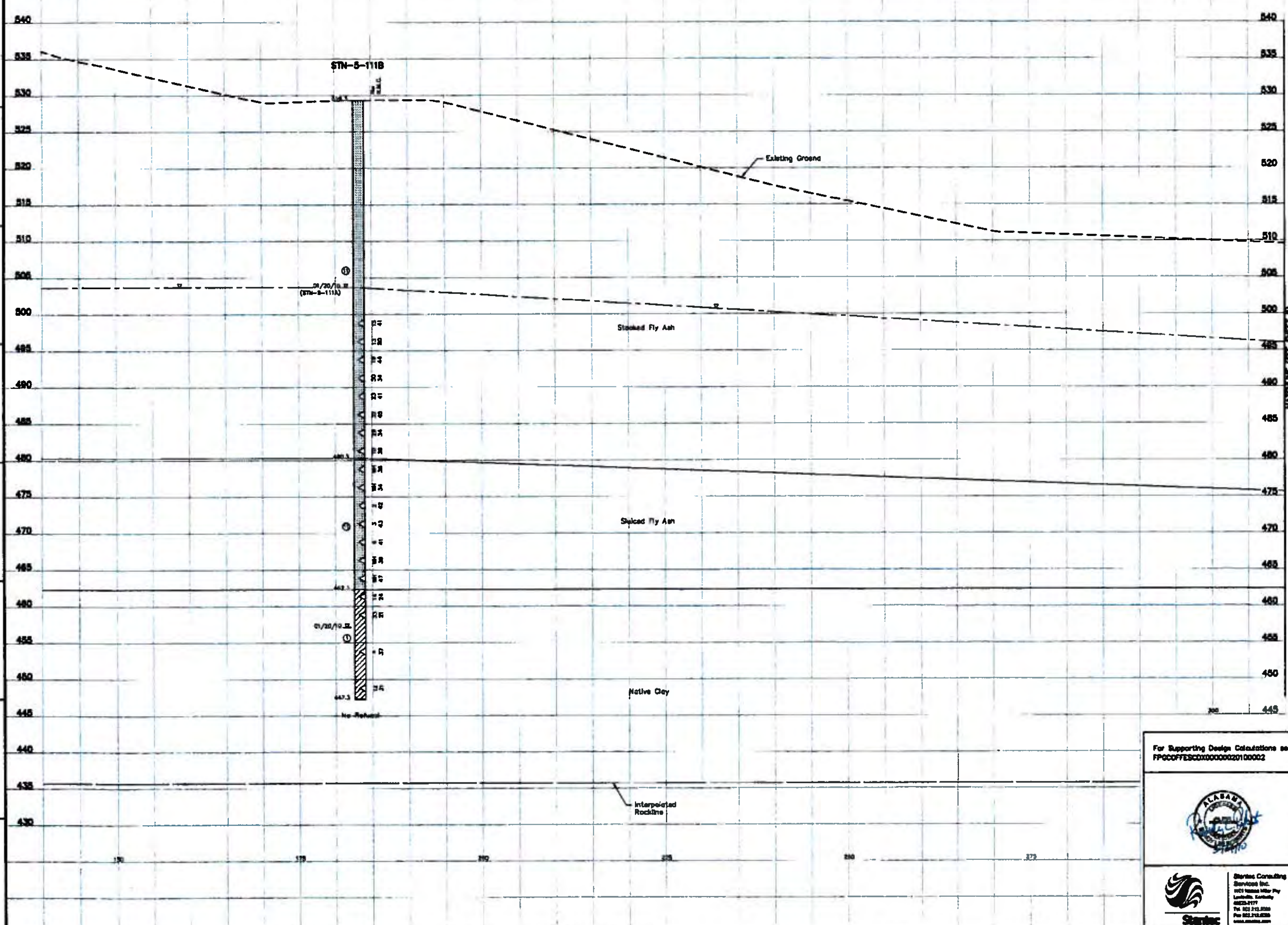
AUTOCAD R 2000 | [illegible] | 37 | C | 10W707-06 | R 0

STANTEC | 0
TASK COMPLETED BY: | REV NO.

PLOT FACTOR XX
R_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

37 | C | 10W707-07



LEGEND

①		Lean Clay, Sandy Lean Clay, Lean Clay With Sand
②		Silty, Clayey Sand
③		Fat Clay, Fat Clay With Sand
④		Overburden
⑤		Silty Clay
⑥		Poorly Graded Sand
⑦		Silty Sand
⑧		Silt, Sandy Silt, Silt With Sand
⑨		Limestone
⑩		Well Graded Sand With Silt
⑪		Fly Ash
⑫		Bottom Ash
⑬		Clayey Gravel
⑭		Silty Gravel With Sand
	WH	Weight of Hammer
	WR	Weight of Rods
	◁	Standard Penetration Test Interval
	■	Undisturbed Thin-Walled (Shelby) Tube Sample
	N_{60}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
	N_{80}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
	N.M.C.	Natural Moisture Content (%)
	U.W.W.	Unit Weight Wet (lbs./cu.ft.)
	U.W.D.	Unit Weight Dry (lbs./cu.ft.)
	U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
	03/31/09 ▽	Water Level and Date Recorded
	▽	Phreatic Surface From Pz Data
	T.O.R.–	Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
	B.C.–	Begin Rock Core
	R.Q.D.	Rock Quality Designation (%)
	REC.	Recovery (%)
	Refusal	Auger Refusal Using A Carbide-Tipped Tooth Auger Bit
	No Refusal	No Refusal Encountered
	•	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

For Supporting Design Calculations see FPGCOFFESCDX00000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
STABILITY SECTION C

Stantec Consulting Services Inc.

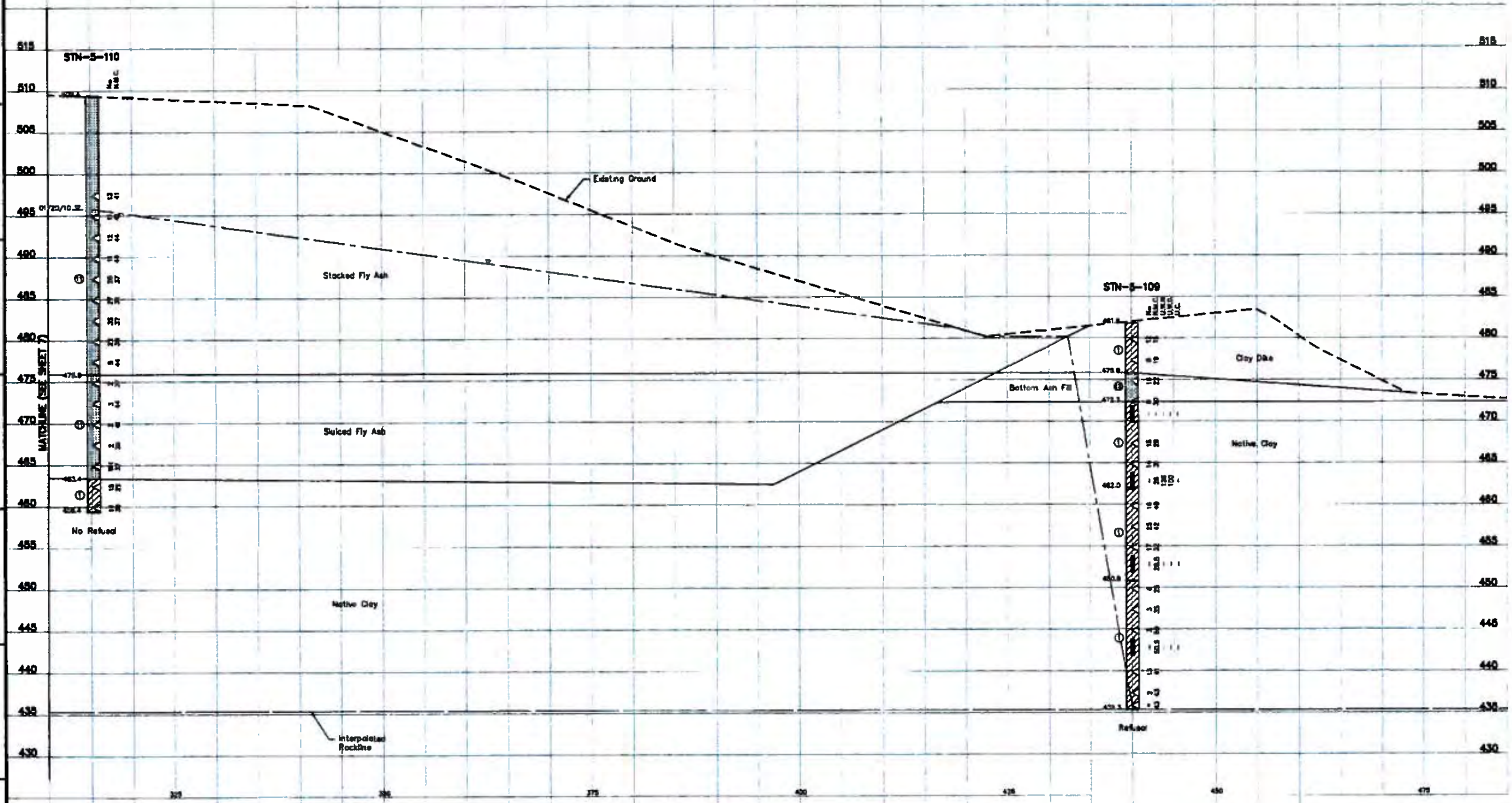
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W707-07 | R 0

PLOT FACTOR XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC	0
TASK COMPLETED BY:	REV NO



LEGEND

- ① Lean Clay, Sandy Lean Clay, Lean Clay With Sand
- ② Silty, Clayey Sand
- ③ Fat Clay, Fat Clay With Sand
- ④ Overburden
- ⑤ Silty Clay
- ⑥ Poorly Graded Sand
- ⑦ Silty Sand
- ⑧ Silt, Sandy Silt, Silt With Sand
- ⑨ Limestone
- ⑩ Well Graded Sand With Silt
- ⑪ Fly Ash
- ⑫ Bottom Ash
- ⑬ Clayey Gravel
- ⑭ Silty Gravel With Sand

WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
■	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{se}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{ae}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09 ⊻	Water Level and Date Recorded
— ⊻ —	Phreatic Surface From Pz Data
T.O.R.–	Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
B.C.–	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal Using A Carbide-tipped Tooth Auger Bit
No Refusal	No Refusal Encountered
•	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

For Supporting Design Calculations see FPGCOFFESCDX000000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
STABILITY SECTION C

Stantec Consulting Services Inc.

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

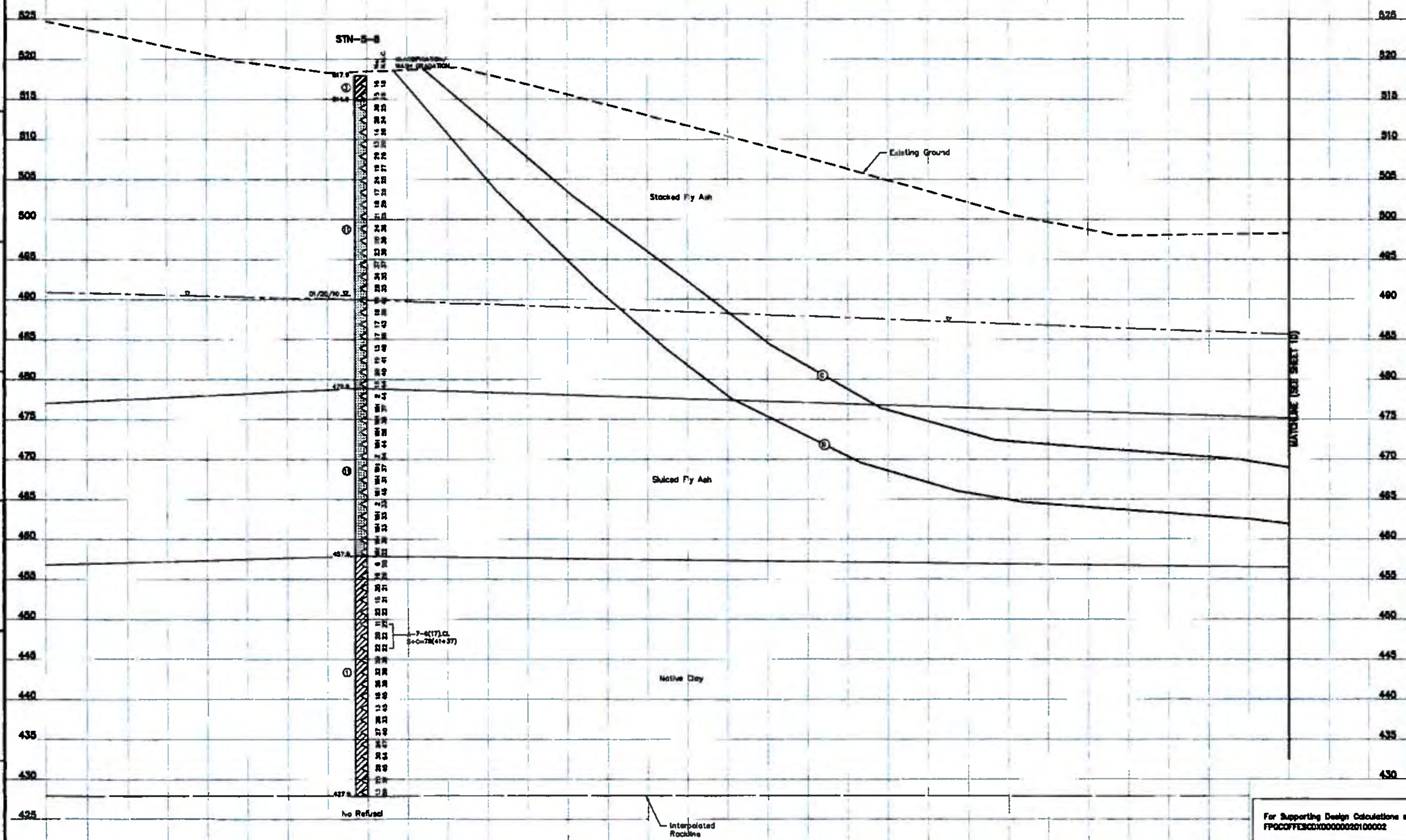
AUTOCAD 4 2000 | 37 | C | 10W707–08 | R 0

STANTEC | 0
TASK COMPLETED BY: | REV NO.

PLOT FACTOR XX
W_TVA

C.A.D DRAWING
DO NOT ALTER MANUALLY

37 C 10W707-09



LEGEND

1. Lean Clay, Sandy Lean Clay, Lean Clay With Sand
2. Silty, Clayey Sand
3. Fat Clay, Fat Clay With Sand
4. Overburden
5. Silty Clay
6. Poorly Graded Sand
7. Silty Sand
8. Silt, Sandy Silt, Silt With Sand
9. Limestone
10. Well Graded Sand With Silt
11. Fly Ash
12. Bottom Ash
13. Clayey Gravel
14. Silty Gravel With Sand

- WH Weight of Hammer
- WR Weight of Rods
- Standard Penetration Test Interval
- Undisturbed Thin-Walled (Shelby) Tube Sample
- N_{60} Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
- N_{60} Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
- N.M.C. Natural Moisture Content (%)
- U.W.W. Unit Weight Wet (lbs./cu.ft.)
- U.W.D. Unit Weight Dry (lbs./cu.ft.)
- U.C./U.U. Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
- 03/31/09 Water Level and Date Recorded
- Phreatic Surface From Pz Data
- T.O.R.– Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
- B.C. Begin Rock Core
- R.Q.D. Rock Quality Designation (%)
- REC. Recovery (%)
- Refusal Auger Refusal Using A Carbide-tipped Tooth Auger Bit
- No Refusal No Refusal Encountered
- * Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

SUMMARY OF STABILITY ANALYSES STATIC CONDITION

Failure Surface	Summary Of Stability Analyses Static Condition	Analysis Type	Factor of Safety
A	Minimum, Shallower Circle With Optimized Surface from PZ Data	Drained	1.4
B	Deeper Circle With Optimized Surface From PZ Data	Drained	2.0
C	Global Circle With Optimized Surface From PZ Data	Drained	2.3

For Supporting Design Calculations see FPGCOFFEBCDX00000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5
GEOTECHNICAL EXPLORATION
STABILITY SECTION D

Stantec Consulting Services Inc.

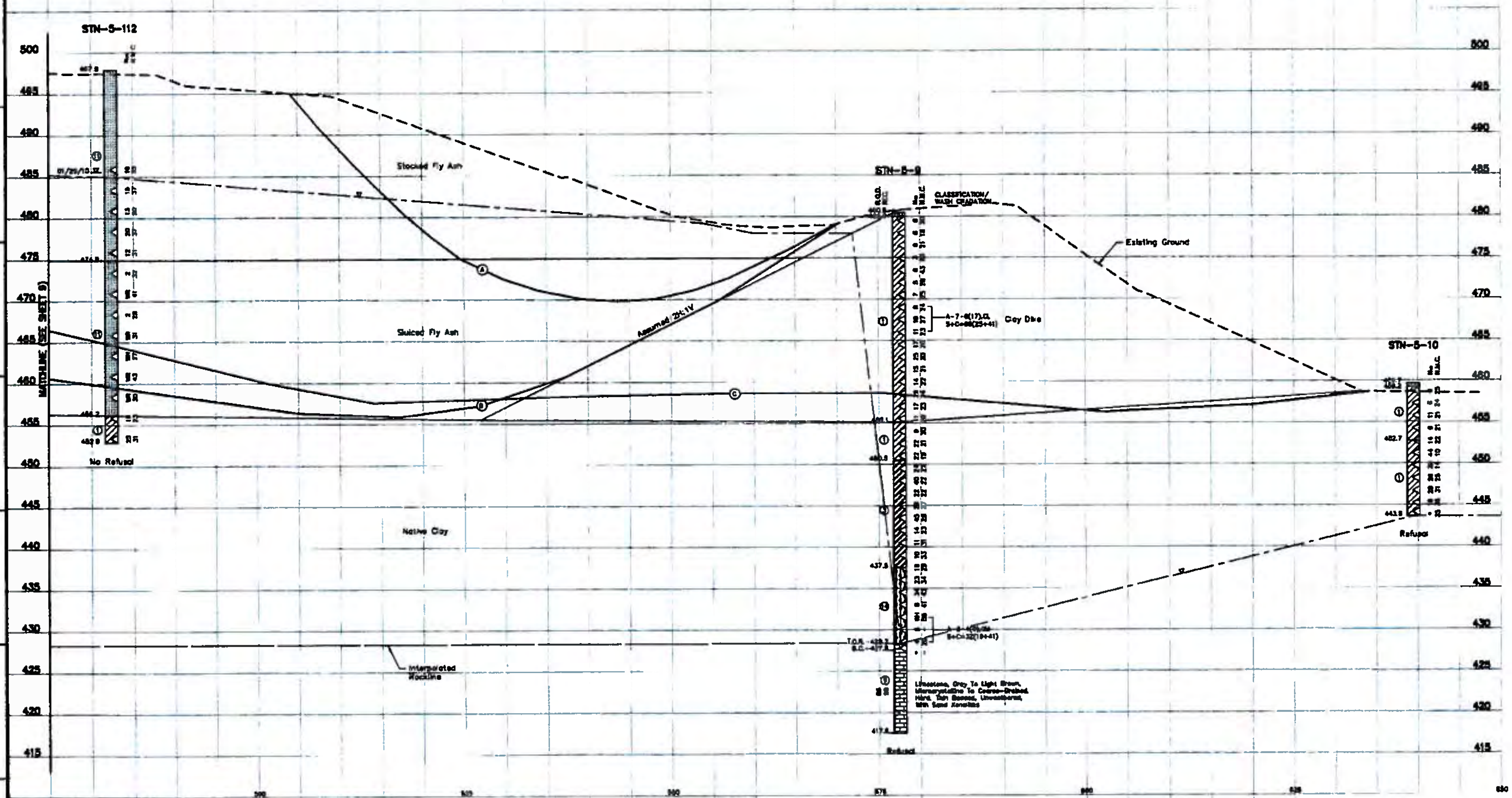
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W707-09 | R 0

PLOT FACTOR XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY: | REV NO.



LEGEND

1 Lean Clay, Sandy Lean Clay, Lean Clay With Sand
2 Silty, Clayey Sand
3 Fat Clay, Fat Clay With Sand
4 Overburden
5 Silty Clay
6 Poorly Graded Sand
7 Silty Sand
8 Silt, Sandy Silt, Silt With Sand
9 Limestone
10 Well Graded Sand With Silt
11 Fly Ash
12 Bottom Ash
13 Clayey Gravel
14 Silty Gravel With Sand

WH Weight of Hammer
WR Weight of Rods
Standard Penetration Test Interval
Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60} Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60} Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C. Natural Moisture Content (%)
U.W.W. Unit Weight Wet (lbs./cu.ft.)
U.W.D. Unit Weight Dry (lbs./cu.ft.)
U.C./U.U. Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09 Water Level and Date Recorded
Phreatic Surface From Pz Data
T.O.R.– Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
B.C.– Begin Rock Core
R.Q.D. Rock Quality Designation (%)
REC. Recovery (%)
Refusal Auger Refusal Using A Carbide-tipped Tooth Auger Bit
No Refusal No Refusal Encountered
* Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

NOTE:
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RECORD DRAWING

SUMMARY OF STABILITY ANALYSES STATIC CONDITION

Failure Surface	Summary Of Stability Analyses Static Condition	Analysis Type	Factor of Safety
A	Minimum, Shallower Circle With Optimized Surface from PZ Data	Drained	1.4
B	Deeper Circle With Optimized Surface From PZ Data	Drained	2.0
C	Global Circle With Optimized Surface From PZ Data	Drained	2.3

For Supporting Design Calculations see FPOCOFFESCDX000000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5
GEOTECHNICAL EXPLORATION
STABILITY SECTION D

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W707-10 | R 0

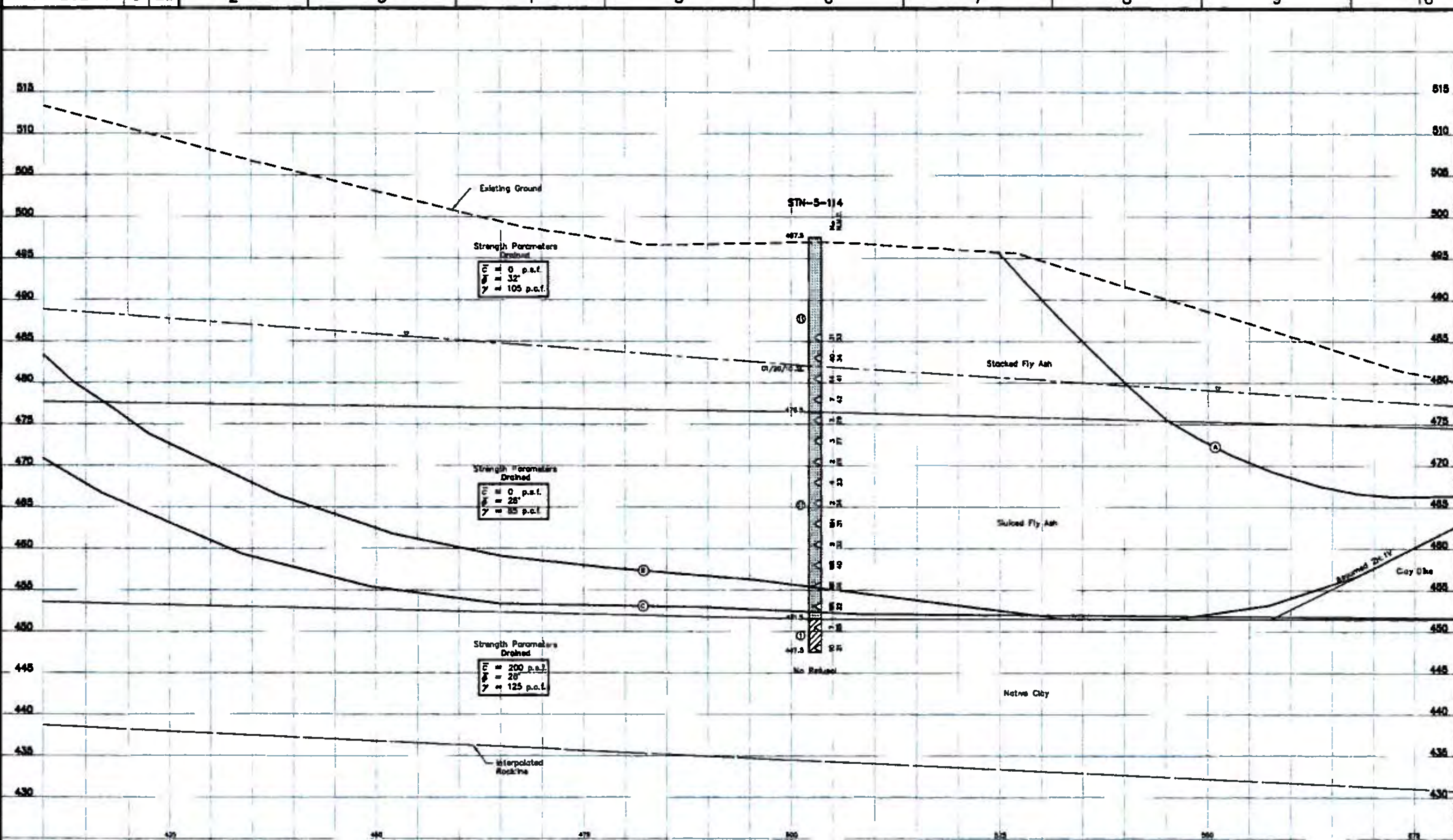
PLOT FACTOR XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

STANTEC | 0

Stantec Consulting Services Inc.

37 | C | 10W707-10



LEGEND

1. Lean Clay, Sandy Lean Clay, Lean Clay With Sand
2. Silty, Clayey Sand
3. Fat Clay, Fat Clay With Sand
4. Overburden
5. Silty Clay
6. Poorly Graded Sand
7. Silty Sand
8. Silt, Sandy Silt, Silt With Sand
9. Limestone
10. Well Graded Sand With Silt
11. Fly Ash
12. Bottom Ash
13. Clayey Gravel
14. Silty Gravel With Sand

- WH — Weight of Hammer
- WR — Weight of Rods
- Standard Penetration Test Interval
- Undisturbed Thin-Walled (Shelby) Tube Sample
- N_{60} — Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
- N_{60} — Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
- N.M.C. — Natural Moisture Content (%)
- U.W.W. — Unit Weight Wet (lbs./cu.ft.)
- U.W.D. — Unit Weight Dry (lbs./cu.ft.)
- U.C./U.U. — Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
- 03/31/09 — Water Level and Date Recorded
- Phreatic Surface From Pz Data
- T.O.R. — Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers.This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
- B.C. — Begin Rock Core
- R.Q.D. — Rock Quality Designation (%)
- REC. — Recovery (%)
- Refusal — Auger Refusal Using A Carbide-tipped Teeth Auger Bit
- No Refusal — No Refusal Encountered
- * — Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

NOTE:
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RECORD DRAWING

SUMMARY OF STABILITY ANALYSES STATIC CONDITION

Failure Surface	Summary Of Stability Analyses Static Condition	Analysis Type	Factor of Safety
A	Minimum, Shallower Circle With Optimized Surface from PZ Data	Drained	1.5
B	Deeper Circle With Optimized Surface From PZ Data	Drained	2.0
C	Global Circle With Optimized Surface From PZ Data	Drained	2.3

For Supporting Design Calculations see FPGCOFFESCOX000000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5
GEOTECHNICAL EXPLORATION
STABILITY SECTION E

Stantec Consulting Services Inc.

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

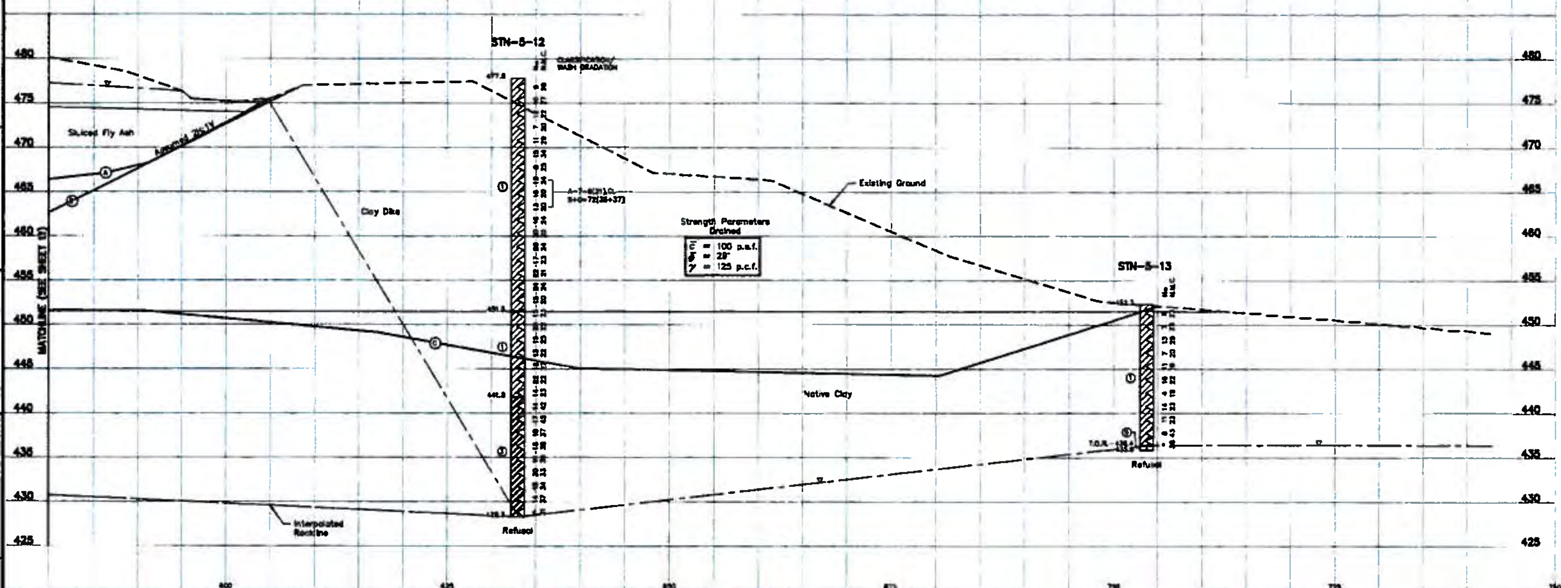
AUTOCAD R 2000 | 37 | C | 10W707-11 | R 0

PLOT FACTOR XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

37 C 10W707-11

37 C 10W707-12



SUMMARY OF OFFSET BORINGS				
Boring Number	Surface Elevation (Ft.)	Bottom Of Hole Depth (ft.)	Piezometer Screened Interval (Ft.)	Undisturbed "Shelby" Tube Sample Intervals (Ft.)
STN-5-11S	515.5	65.0	35.5-45.5	4.0-6.0, 9.0-11.0, 14.0-16.0, 19.0-21.0, 24.0-26.0, 29.0-31.0, 34.0-36.0, 39.0-41.0, 44.0-46.0, 49.0-51.0, 54.0-56.0, 59.0-61.0, 64.0-65.0
STN-5-12S	477.8	25.0	39.0-49.0	2.0-4.0, 5.0-7.0, 10.0-12.0, 15.0-17.0, 20.0-22.0
STN-5-13S	452.3	16.4	N/A	2.0-4.0, 5.0-7.0, 10.0-12.0, 15.0-16.4

CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS			
Location	STN-5-11S		
Depth	39.1'-39.7'	44.8'-46.4'	54.8'-56.4'
$\bar{\phi}$	37.1°		
$\bar{c}$	16 p.s.f.		
Location	STN-5-12S		
Depth	5.4'-6.2'	15.8'-16.4'	20.8'-21.2'
$\bar{\phi}$	35.0°		
$\bar{c}$	0 p.s.f.		
Location	STN-5-11S	STN-5-13S	
Depth	64.8'-65.4'	10.8'-11.4'	11.4'-12.0'
$\bar{\phi}$	38.4°		
$\bar{c}$	39 p.s.f		

SUMMARY OF STABILITY ANALYSES STATIC CONDITION			
Failure Surface	Summary Of Stability Analyses Static Condition	Analysis Type	Factor of Safety
A	Minimum, Shallower Circle With Optimized Surface from PZ Data	Drained	1.6
B	Deeper Circle With Optimized Surface From PZ Data	Drained	2.0
C	Global Circle With Optimized Surface From PZ Data	Drained	2.3

LEGEND

- ① Lean Clay, Sandy Lean Clay, Lean Clay With Sand
- ② Silty, Clayey Sand
- ③ Fat Clay, Fat Clay With Sand
- ④ Overburden
- ⑤ Silty Clay
- ⑥ Poorly Graded Sand
- ⑦ Silty Sand
- ⑧ Silt, Sandy Silt, Silt With Sand
- ⑨ Limestone
- ⑩ Well Graded Sand With Silt
- ⑪ Fly Ash
- ⑫ Bottom Ash
- ⑬ Clayey Gravel
- ⑭ Silty Gravel With Sand

WH — Weight of Hammer
WR — Weight of Rods
◁ — Standard Penetration Test Interval
▪ — Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60} — Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60} — Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C. — Natural Moisture Content (%)
U.W.W. — Unit Weight Wet (lbs./cu.ft.)
U.W.D. — Unit Weight Dry (lbs./cu.ft.)
U.C./U.U. — Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09 ▽ — Water Level and Date Recorded
—▽— Phreatic Surface From Pz Data
T.O.R.— Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
B.C.— Begin Rock Core
R.Q.D. Rock Quality Designation (%)
REC. Recovery (%)
Refusal — Auger Refusal Using A Carbide-tipped Tooth Auger Bit
No Refusal — No Refusal Encountered
* Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

For Supporting Design Calculations see FPGCOFFESCDX0000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
STABILITY SECTION E

Stantec Consulting Services Inc.

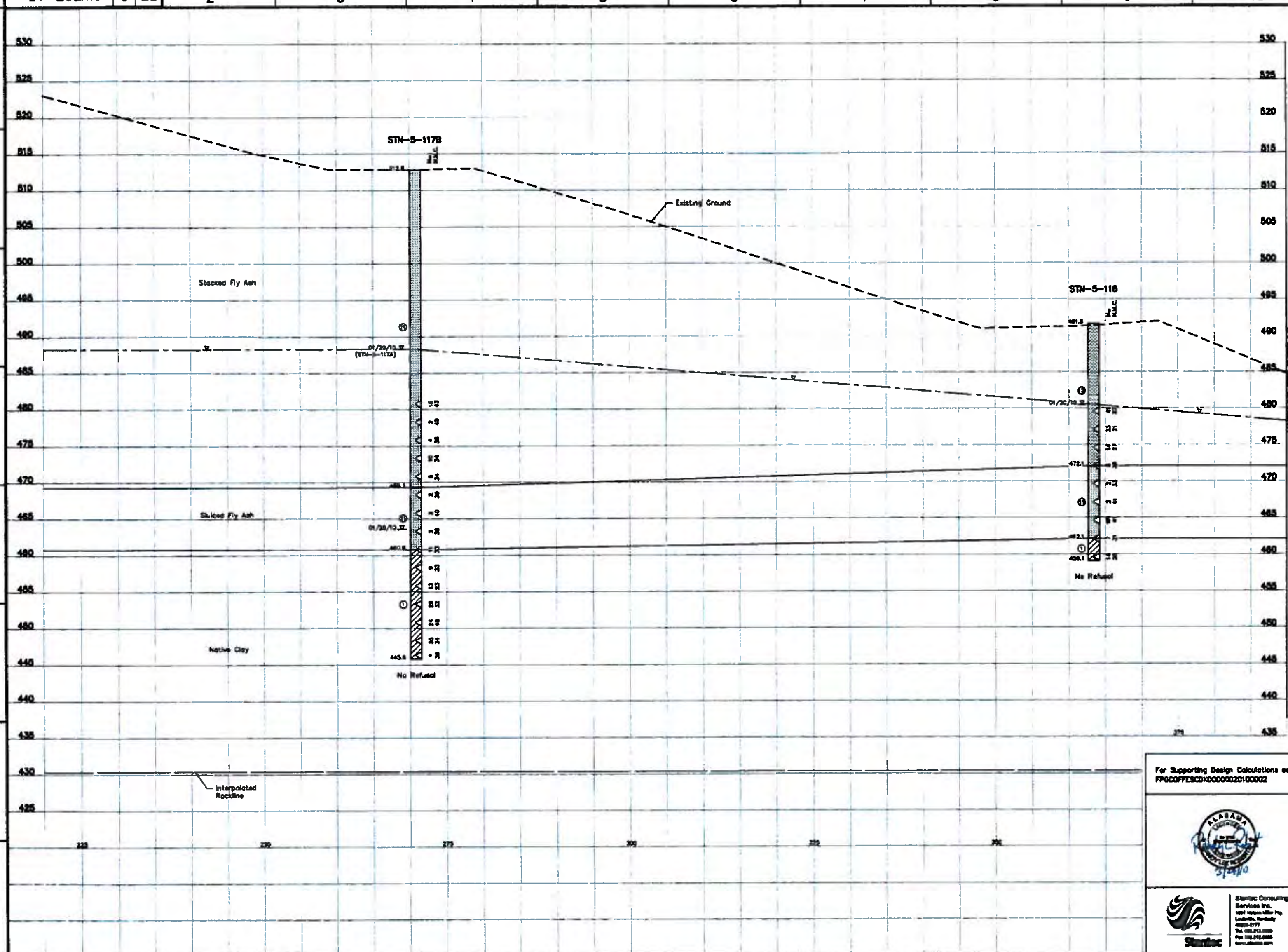
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W707-12 | R C

STANTEC | 0
TASK COMPLETED BY | REV NO.

PLOT FACTOR XX
R_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY



LEGEND

1. Lean Clay, Sandy Lean Clay, Lean Clay With Sand
2. Silty, Clayey Sand
3. Fat Clay, Fat Clay With Sand
4. Overburden
5. Silty Clay
6. Poorly Graded Sand
7. Silty Sand
8. Silt, Sandy Silt, Silt With Sand
9. Limestone
10. Well Graded Sand With Silt
11. Fly Ash
12. Bottom Ash
13. Clayey Gravel
14. Silty Gravel With Sand

WH	Weight of Hammer
WR	Weight of Rods
	Standard Penetration Test Interval
	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09	Water Level and Date Recorded
	Phreatic Surface From Pz Data
T.O.R.-	Top Of Rock (Indicates The Beginning Of Rock-Like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
B.C.-	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal Using A Carbide-Tipped Tooth Auger Bit
No Refusal	No Refusal Encountered
*	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

For Supporting Design Calculations see FPOCOFFESCDX00000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
STABILITY SECTION F

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

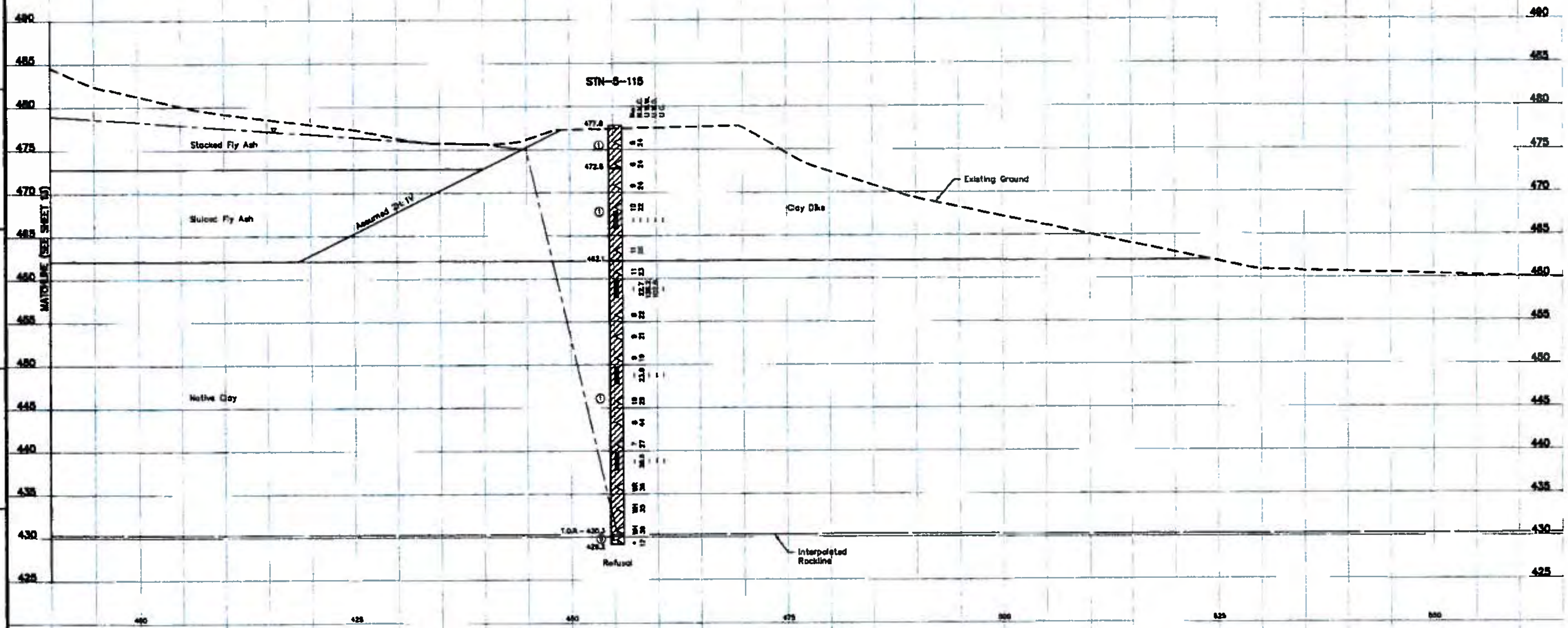
Stantec Consulting Services Inc.

AUTOCAD R 2000 | 37 | C | 10W707-13 | R 0

PLOT FACTOR XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

STANTEC | TASK COMPLETED BY | 0 | REV NO.



LEGEND

①	Lean Clay, Sandy Lean Clay, Lean Clay With Sand
②	Silty, Clayey Sand
③	Fat Clay, Fat Clay With Sand
④	Overburden
⑤	Silty Clay
⑥	Poorly Graded Sand
⑦	Silty Sand
⑧	Silt, Sandy Silt, Silt With Sand
⑨	Limestone
⑩	Well Graded Sand With Silt
⑪	Fly Ash
⑫	Bottom Ash
⑬	Clayey Gravel
⑭	Silty Gravel With Sand
WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
▪	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09 ⊻	Water Level and Date Recorded
—— ⊻ ——	Phreatic Surface From Pz Data
T.O.R.-	Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
B.C.-	Begin Rock Core
R.Q.D	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal Using A Carbide-tipped Tooth Auger Bit
No Refusal	No Refusal Encountered
*	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

For Supporting Design Calculations see FPGCOFFESCDX00000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
STABILITY SECTION F

Stantec Consulting Services Inc.

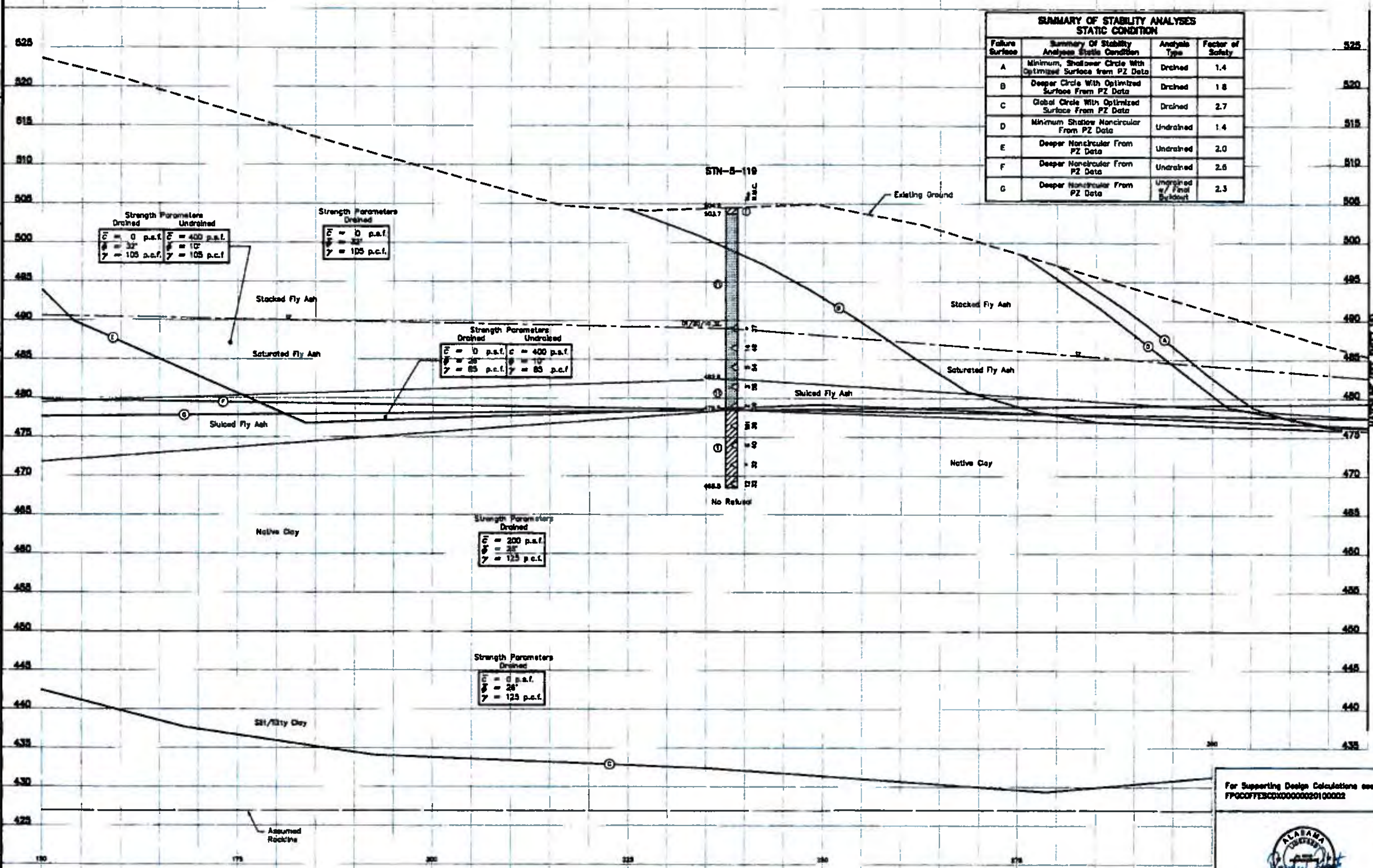
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W707-14 | R 0

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY: | REV NO.



SUMMARY OF STABILITY ANALYSES STATIC CONDITION

Failure Surface	Summary Of Stability Analyses Static Condition	Analysis Type	Factor of Safety
A	Minimum, Shallower Circle With Optimized Surface from PZ Data	Drained	1.4
B	Deeper Circle With Optimized Surface From PZ Data	Drained	1.8
C	Global Circle With Optimized Surface From PZ Data	Drained	2.7
D	Minimum Shallow Noncircular From PZ Data	Undrained	1.4
E	Deeper Noncircular From PZ Data	Undrained	2.0
F	Deeper Noncircular From PZ Data	Undrained	2.6
G	Deeper Noncircular From PZ Data	Undrained w/ Final Buildout	2.3

LEGEND

1. Lean Clay, Sandy Lean Clay, Lean Clay With Sand
2. Silty, Clayey Sand
3. Fat Clay, Fat Clay With Sand
4. Overburden
5. Silty Clay
6. Poorly Graded Sand
7. Silty Sand
8. Silt, Sandy Silt, Silt With Sand
9. Limestone
10. Well Graded Sand With Silt
11. Fly Ash
12. Bottom Ash
13. Clayey Gravel
14. Silty Gravel With Sand

- WH — Weight of Hammer
- WR — Weight of Rods
- Standard Penetration Test Interval
- Undisturbed Thin-Walled (Shelby) Tube Sample
- N_{60} — Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
- N_{60} — Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
- N.M.C. — Natural Moisture Content (%)
- U.W.W. — Unit Weight Wet (lbs./cu.ft.)
- U.W.D. — Unit Weight Dry (lbs./cu.ft.)
- U.C./U.U. — Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
- 03/31/08 — Water Level and Date Recorded
- Phreatic Surface From Pz Data
- T.O.R. — Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
- B.C. — Begin Rock Core
- R.Q.D. — Rock Quality Designation (%)
- REC. — Recovery (%)
- Refusal — Auger Refusal Using A Carbide-tipped Tooth Auger Bit
- No Refusal — No Refusal Encountered
- * — Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

For Supporting Design Calculations see FPGCOFFESCDX00000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
STABILITY SECTION G

3/24/10

Stantec Consulting Services Inc.

Stantec

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W707-15 | R 0

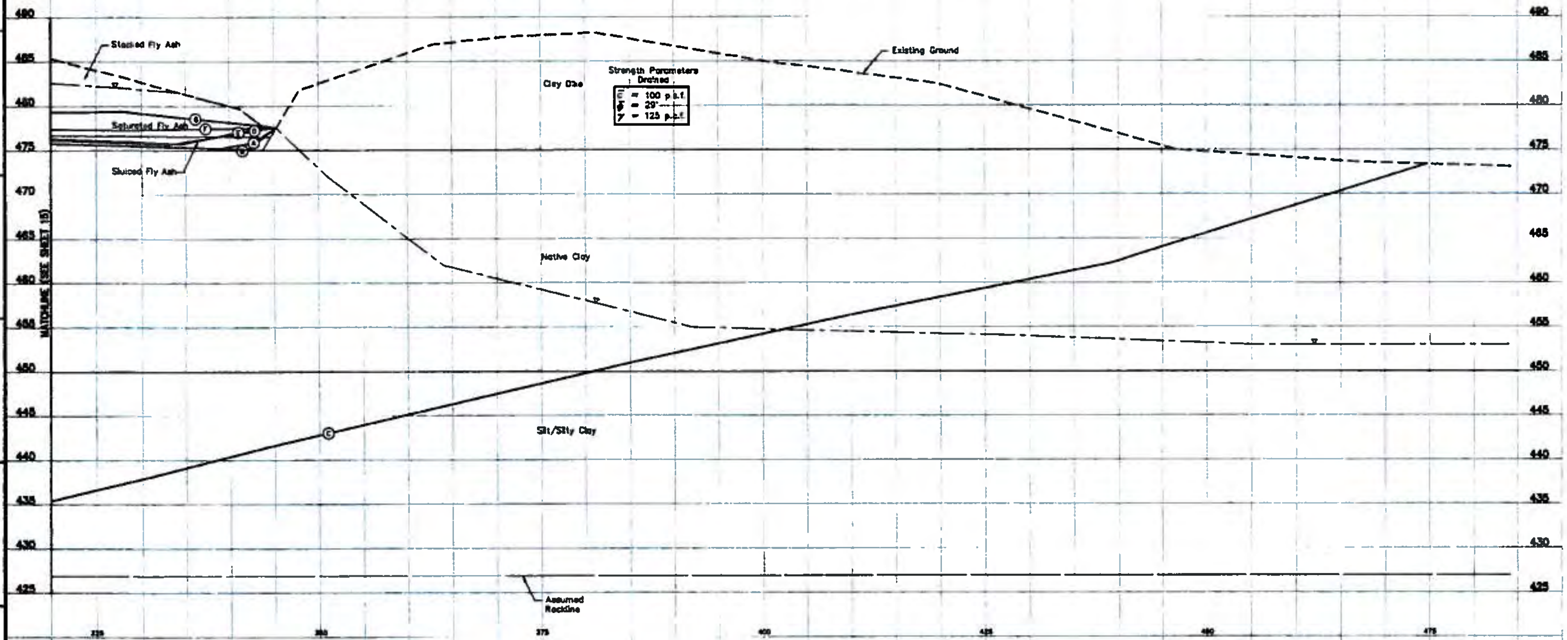
PLOT FACTOR XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY | REV NO.

37 C 10W707-15

37 C 10W707-16



LEGEND

①	Lean Clay, Sandy Lean Clay, Lean Clay With Sand
②	Silty, Clayey Sand
③	Fat Clay, Fat Clay With Sand
④	Overburden
⑤	Silty Clay
⑥	Poorly Graded Sand
⑦	Silty Sand
⑧	Silt, Sandy Silt, Silt With Sand
⑨	Limestone
⑩	Well Graded Sand With Silt
⑪	Fly Ash
⑫	Bottom Ash
⑬	Clayey Gravel
⑭	Silty Gravel With Sand
WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
■	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{SH}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{AH}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09 ∇	Water Level and Date Recorded
— ∇ —	Phreatic Surface From Pz Data
T.O.R.-	Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
B.C.-	Begin Rock Core
R.Q.D	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal Using A Carbide-tipped Tooth Auger Bit
No Refusal	No Refusal Encountered
*	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

SUMMARY OF OFFSET BORINGS

Boring Number	Surface Elevation (Ft.)	Bottom Of Hole Depth (Ft.)	Piezometer Screened Interval (Ft.)	Undisturbed "Shelby" Tube Sample Intervals (Ft.)
STN-S-120B	525.8	71.0	61.0-71.0	No Samples

SUMMARY OF STABILITY ANALYSES STATIC CONDITION

Failure Surface	Summary Of Stability Analyses Static Condition	Analysis Type	Factor of Safety
A	Minimum, Shallower Circle With Optimized Surface from PZ Data	Drained	1.4
B	Deeper Circle With Optimized Surface From PZ Data	Drained	1.8
C	Global Circle With Optimized Surface From PZ Data	Drained	2.7
D	Minimum Shallow Noncircular From PZ Data	Undrained	1.4
E	Deeper Noncircular From PZ Data	Undrained	2.0
F	Deeper Noncircular From PZ Data	Undrained	2.6
G	Deeper Noncircular From PZ Data	Undrained w/ Final Buildout	2.3

For Supporting Design Calculations see FPGCOFFEXCDX000000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5
GEOTECHNICAL EXPLORATION
STABILITY SECTION G

Stantec Consulting Services Inc.

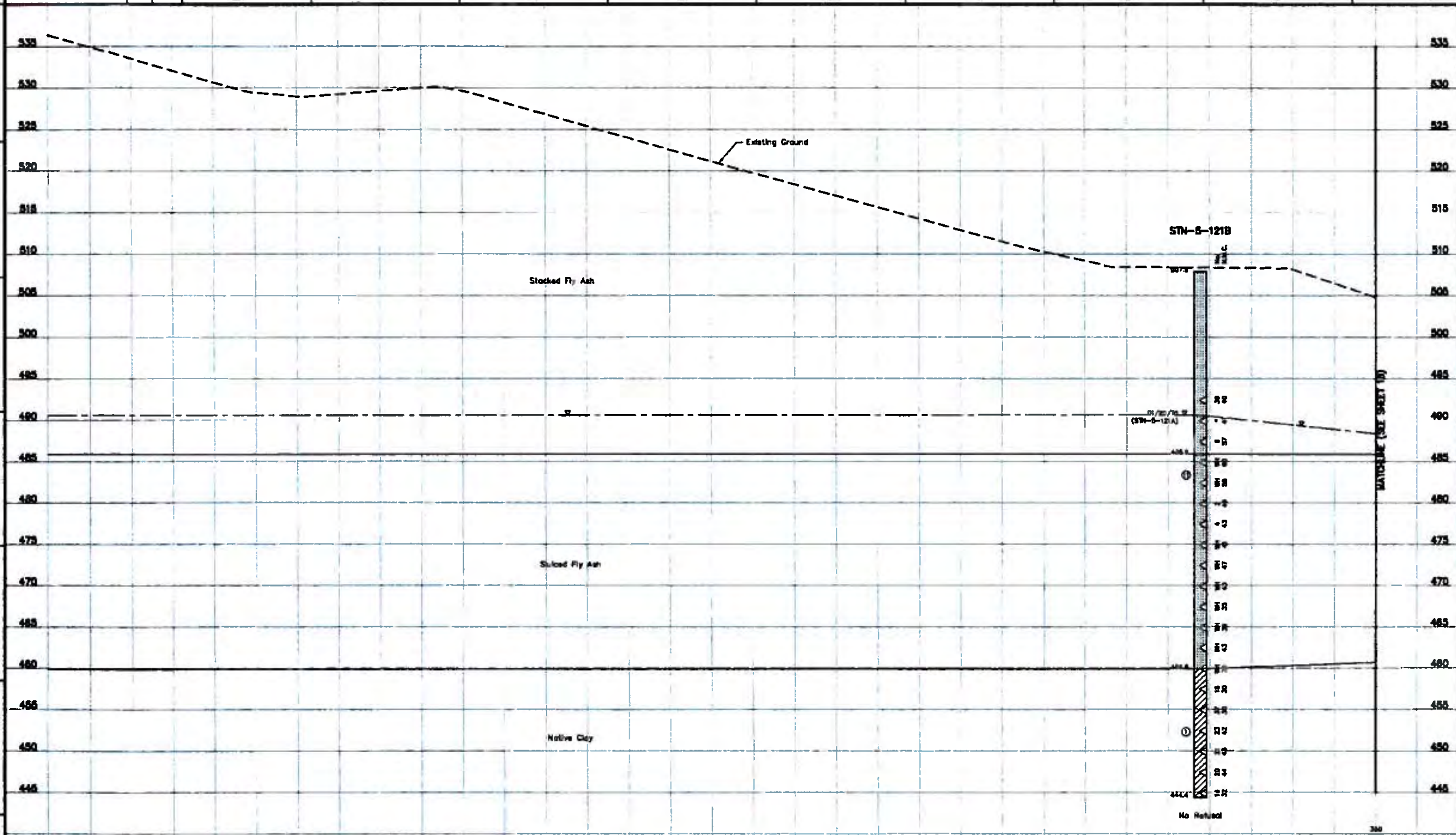
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W707-16 | R 0

PLOT FACTOR: XX

STANTEC | 0
TASK COMPLETED BY | REV NO.

C.A.D. DRAWING DO NOT ALTER MANUALLY



LEGEND

①		Lean Clay, Sandy Lean Clay, Lean Clay With Sand
②		Silty, Clayey Sand
③		Fat Clay, Fat Clay With Sand
④		Overburden
⑤		Silty Clay
⑥		Poorly Graded Sand
⑦		Silty Sand
⑧		Silt, Sandy Silt, Silt With Sand
⑨		Limestone
⑩		Well Graded Sand With Silt
⑪		Fly Ash
⑫		Bottom Ash
⑬		Clayey Gravel
⑭		Silty Gravel With Sand

WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
■	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09	Water Level and Date Recorded
	Phreatic Surface From Pz Data
T.O.R.–	Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
B.C.–	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal Using A Carbide-tipped Tooth Auger Bit
No Refusal	No Refusal Encountered
*	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

For Supporting Design Calculations see FPCOFFESCDX000000020100002

Stantec Consulting Services Inc.

SCALE 1"=5 EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
STABILITY SECTION H

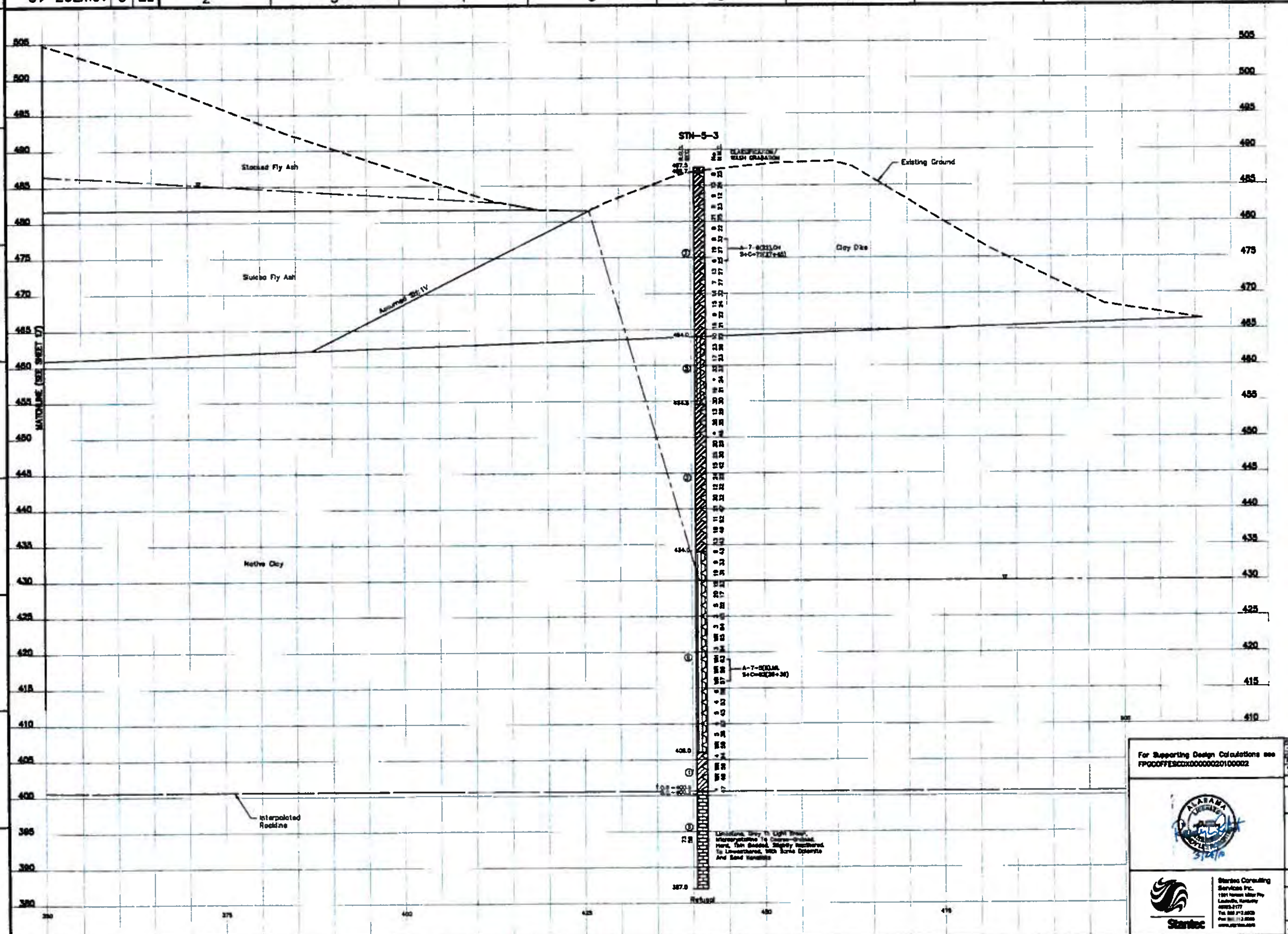
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W707-17 | R C

PLOT FACTOR: XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY | REV NO.



LEGEND

- ① Lean Clay, Sandy Lean Clay, Lean Clay With Sand
- ② Silty, Clayey Sand
- ③ Fat Clay, Fat Clay With Sand
- ④ Overburden
- ⑤ Silty Clay
- ⑥ Poorly Graded Sand
- ⑦ Silty Sand
- ⑧ Silt, Sandy Silt, Silt With Sand
- ⑨ Limestone
- ⑩ Well Graded Sand With Silt
- ⑪ Fly Ash
- ⑫ Bottom Ash
- ⑬ Clayey Gravel
- ⑭ Silty Gravel With Sand

WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
▪	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09	Water Level and Date Recorded
—	Phreatic Surface From Pz Data
T.O.R.–	Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
B.C.–	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal Using A Carbide-tipped Tooth Auger Bit
No Refusal	No Refusal Encountered
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RECORD DRAWING

For Supporting Design Calculations see FPOCOFFESCDX000000020100002

SCALE 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5
GEOTECHNICAL EXPLORATION
STABILITY SECTION H

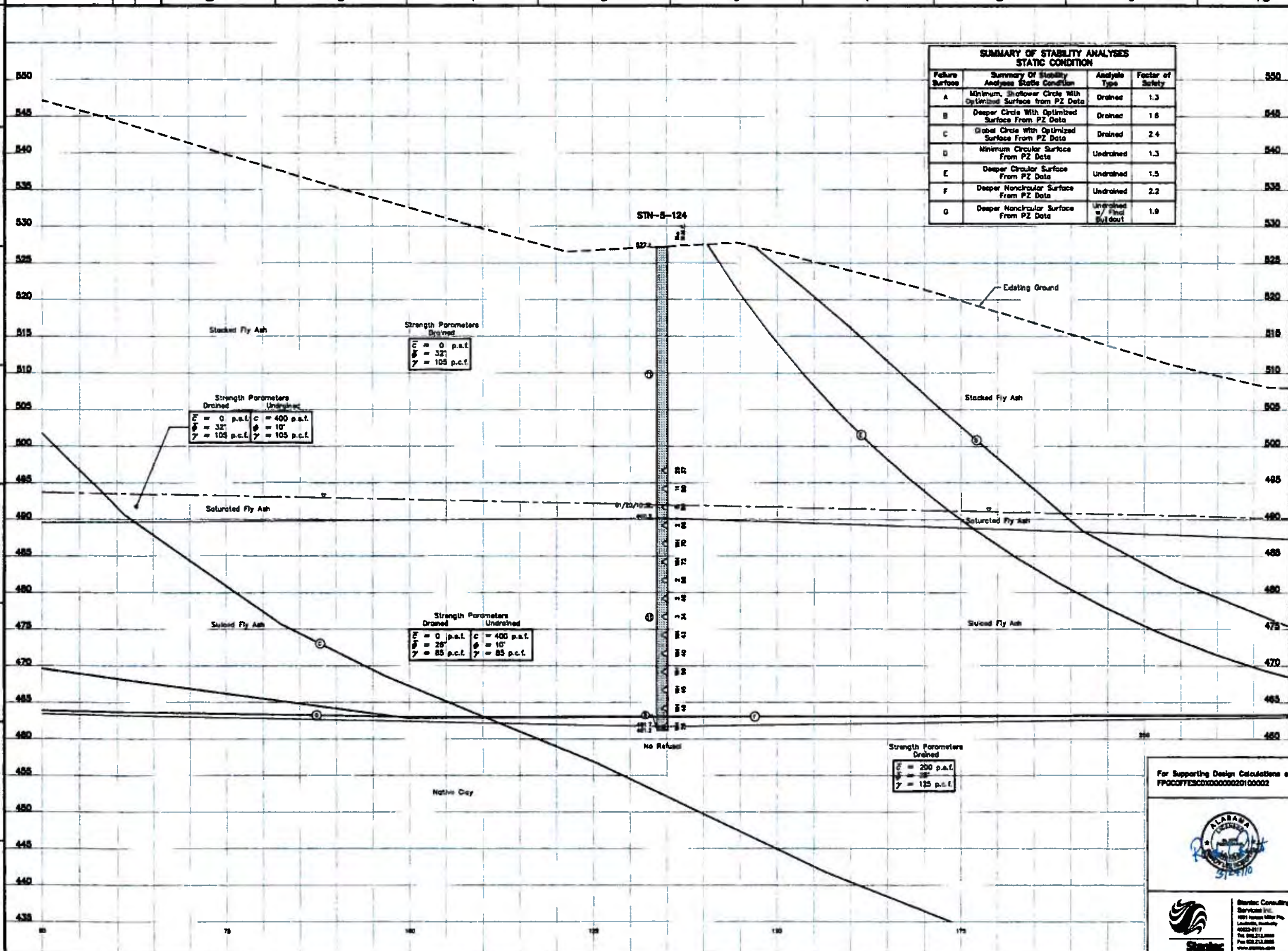
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

Stantec Consulting Services Inc.

AUTOCAD R 2000 | 37 | C | 10W707-18 | R 0

STANTEC | 0
TASK COMPLETED BY | REV NO.

PLOT FACTOR:XX
C.A.D. DRAWING
DO NOT ALTER MANUALLY



SUMMARY OF STABILITY ANALYSES STATIC CONDITION

Failure Surface	Summary Of Stability Analyses Static Condition	Analysis Type	Factor of Safety
A	Minimum, Shallower Circle With Optimized Surface from PZ Data	Drained	1.3
B	Deeper Circle With Optimized Surface From PZ Data	Drained	1.6
C	Global Circle With Optimized Surface From PZ Data	Drained	2.4
D	Minimum Circular Surface From PZ Data	Undrained	1.3
E	Deeper Circular Surface From PZ Data	Undrained	1.5
F	Deeper Noncircular Surface From PZ Data	Undrained	2.2
G	Deeper Noncircular Surface From PZ Data	Undrained w/ Final Buildout	1.9

LEGEND

1. Lean Clay, Sandy Lean Clay, Lean Clay With Sand
2. Silty, Clayey Sand
3. Fat Clay, Fat Clay With Sand
4. Overburden
5. Silty Clay
6. Poorly Graded Sand
7. Silty Sand
8. Silt, Sandy Silt, Silt With Sand
9. Limestone
10. Well Graded Sand With Silt
11. Fly Ash
12. Bottom Ash
13. Clayey Gravel
14. Silty Gravel With Sand

- WH — Weight of Hammer
- WR — Weight of Rods
- Standard Penetration Test Interval
- Undisturbed Thin-Walled (Shelby) Tube Sample
- N_{60} — Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
- N_{60} — Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
- N.M.C. — Natural Moisture Content (%)
- U.W.W. — Unit Weight Wet (lbs./cu.ft.)
- U.W.D. — Unit Weight Dry (lbs./cu.ft.)
- U.C./U.U. — Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
- 03/31/09 — Water Level and Date Recorded
- Phreatic Surface From Pz Data
- T.O.R. — Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
- B.C. — Begin Rock Core
- R.Q.D. — Rock Quality Designation (%)
- REC. — Recovery (%)
- Refusal — Auger Refusal Using A Carbide-tipped Teeth Auger Bit
- No Refusal — No Refusal Encountered
- * — Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

For Supporting Design Calculations see FPOCOFFESCOX000000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5
GEOTECHNICAL EXPLORATION
STABILITY SECTION I

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

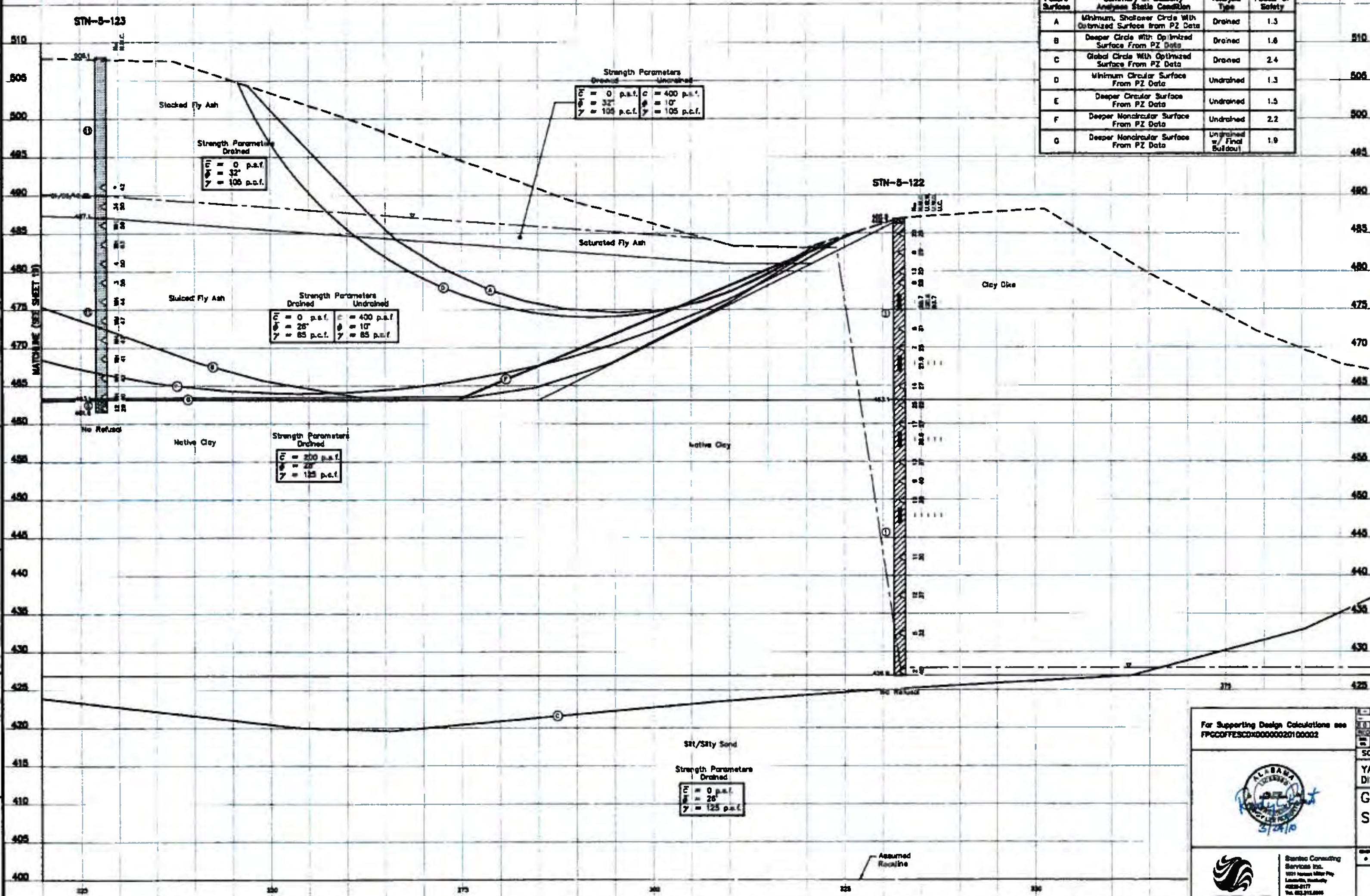
AUTOCAD R 2000 | 37 | C | 10W707-19 | R 0

PLOT FACTOR: XX
C.A.D. DRAWING DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY: | REV NO.

37 C 10W707-19

37 C 10W707-20



SUMMARY OF STABILITY ANALYSES STATIC CONDITION

Failure Surface	Summary Of Stability Analyses Static Condition	Analysis Type	Factor of Safety
A	Minimum, Shallower Circle With Optimized Surface from PZ Data	Drained	1.3
B	Deeper Circle With Optimized Surface From PZ Data	Drained	1.6
C	Global Circle With Optimized Surface From PZ Data	Drained	2.4
D	Minimum Circular Surface From PZ Data	Undrained	1.3
E	Deeper Circular Surface From PZ Data	Undrained	1.5
F	Deeper Noncircular Surface From PZ Data	Undrained	2.2
G	Deeper Noncircular Surface From PZ Data	Undrained w/ Final Buildout	1.9

LEGEND

1. Lean Clay, Sandy Lean Clay, Lean Clay With Sand
2. Silty Clayey Sand
3. Fat Clay, Fat Clay With Sand
4. Overburden
5. Silty Clay
6. Poorly Graded Sand
7. Silty Sand
8. Silt, Sandy Silt, Silt With Sand
9. Limestone
10. Well Graded Sand With Silt
11. Fly Ash
12. Bottom Ash
13. Clayey Gravel
14. Silty Gravel With Sand

WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
■	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{SH}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{AH}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09	Water Level and Date Recorded
— ▽ —	Phreatic Surface From Pz Data
— ▼ —	Phreatic Surface From Seepage Model
T.O.R.–	Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
B.C.–	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal Using A Carbide-tipped Tooth Auger Bit
No Refusal	No Refusal Encountered
•	Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

For Supporting Design Calculations see FPCCOFFESCOX000000020100002

3/24/10

Stantec Consulting Services Inc.

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
STABILITY SECTION I

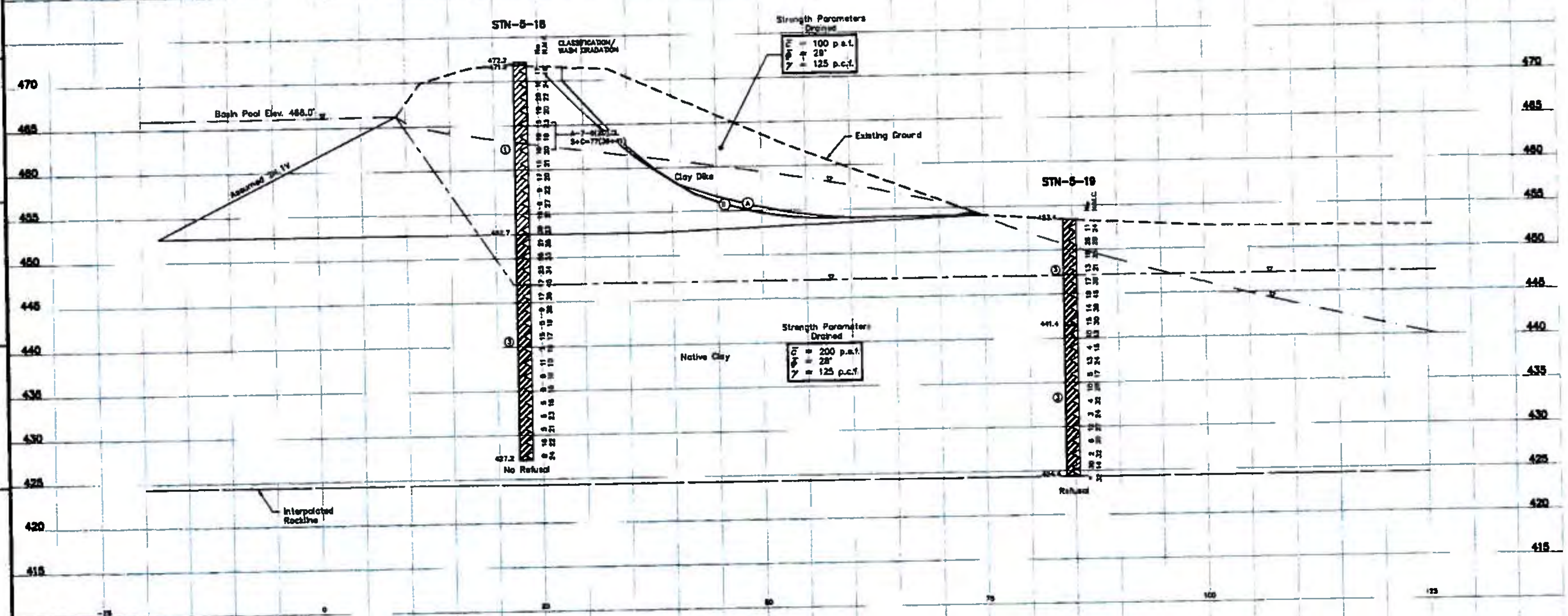
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD ® 2000 | 37 | C | 10W707-20 | R 0

PLOT FACTOR XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC	0
TASK COMPLETED BY:	REV NO.



LEGEND

- ① Lean Clay, Sandy Lean Clay, Lean Clay With Sand
- ② Silty, Clayey Sand
- ③ Fat Clay, Fat Clay With Sand
- ④ Overburden
- ⑤ Silty Clay
- ⑥ Poorly Graded Sand
- ⑦ Silty Sand
- ⑧ Silt, Sandy Silt, Silt With Sand
- ⑨ Limestone
- ⑩ Well Graded Sand With Silt
- ⑪ Fly Ash
- ⑫ Bottom Ash
- ⑬ Clayey Gravel
- ⑭ Silty Gravel With Sand

- WH Weight of Hammer
- WR Weight of Rods
- Standard Penetration Test Interval
- Undisturbed Thin-Walled (Shelby) Tube Sample
- N_{60} Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
- N_{60} Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
- N.M.C. Natural Moisture Content (%)
- U.W.W. Unit Weight Wet (lbs./cu.ft.)
- U.W.D. Unit Weight Dry (lbs./cu.ft.)
- U.C./U.U. Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
- 03/31/09 Water Level and Date Recorded
- Phreatic Surface From Pz Data
- Phreatic Surface From Seepage Model
- T.O.R.– Top Of Rock (indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
- B.C.– Begin Rock Core
- R.Q.D. Rock Quality Designation (%)
- REC. Recovery (%)
- Refusal Auger Refusal Using A Carbide-Tipped Tooth Auger Bit
- No Refusal No Refusal Encountered
- Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

SUMMARY OF STABILITY ANALYSES STATIC CONDITION

Failure Surface	Summary Of Stability Analyses Static Condition	Analysis Type	Factor of Safety
A	Minimum, Shallower Circle With Optimized Surface from PZ Data	Drained	2.2
B	Minimum, Shallower Circle With Optimized Surface from Seepage Model	Drained	1.8

CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Location	STN-5-18S	
Depth	10.8'–11.4'	15.8'–16.4'
φ	37.6°	
c	111 p.s.f.	

For Supporting Design Calculations see FPGCOFFESC0X000000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5
GEOTECHNICAL EXPLORATION
STABILITY SECTION J

Stantec Consulting Services Inc.

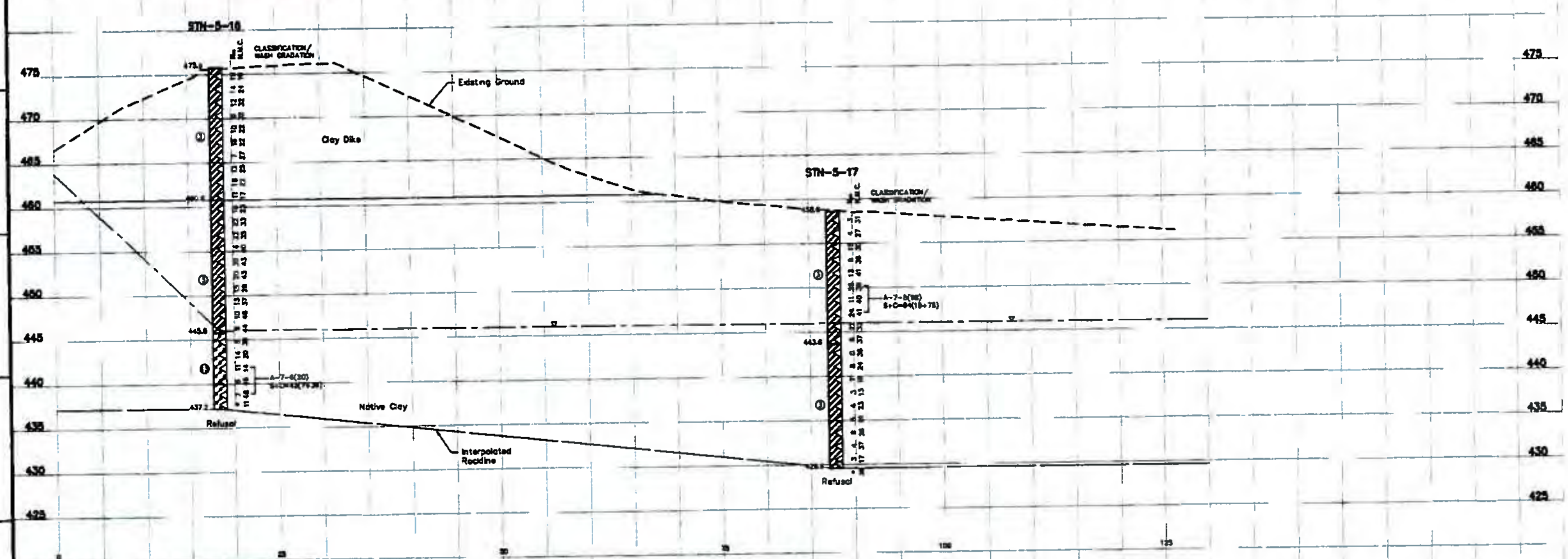
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W707–21 | R0

PLOT FACTOR:XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY | REV NO.



LEGEND

1. Lean Clay, Sandy Lean Clay, Lean Clay With Sand
2. Silty, Clayey Sand
3. Fat Clay, Fat Clay With Sand
4. Overburden
5. Silty Clay
6. Poorly Graded Sand
7. Silty Sand
8. Silt, Sandy Silt, Silt With Sand
9. Limestone
10. Well Graded Sand With Silt
11. Fly Ash
12. Bottom Ash
13. Clayey Gravel
14. Silty Gravel With Sand

- WH — Weight of Hammer
- WR — Weight of Rods
- Standard Penetration Test Interval
- Undisturbed Thin-Walled (Shelby) Tube Sample
- N_{60} — Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
- N_{80} — Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
- N.M.C. — Natural Moisture Content (%)
- U.W.W. — Unit Weight Wet (lbs./cu.ft.)
- U.W.D. — Unit Weight Dry (lbs./cu.ft.)
- U.C./U.U. — Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
- 03/31/09 — Water Level and Date Recorded
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- T.O.R.— Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
- B.C.— Begin Rock Core
- R.Q.D. — Rock Quality Designation (%)
- REC. — Recovery (%)
- Refusal — Auger Refusal Using A Carbide-tipped Tooth Auger Bit
- No Refusal — No Refusal Encountered
- * — Standard Penetration Test (SPT) terminated per ASTM D 1586-99. Refer To Typed Boring Log.

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RECORD DRAWING

For Supporting Design Calculations see FPGCOFFESCDX00000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5
GEOTECHNICAL EXPLORATION
STABILITY SECTION K

Stantec Consulting Services Inc.

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

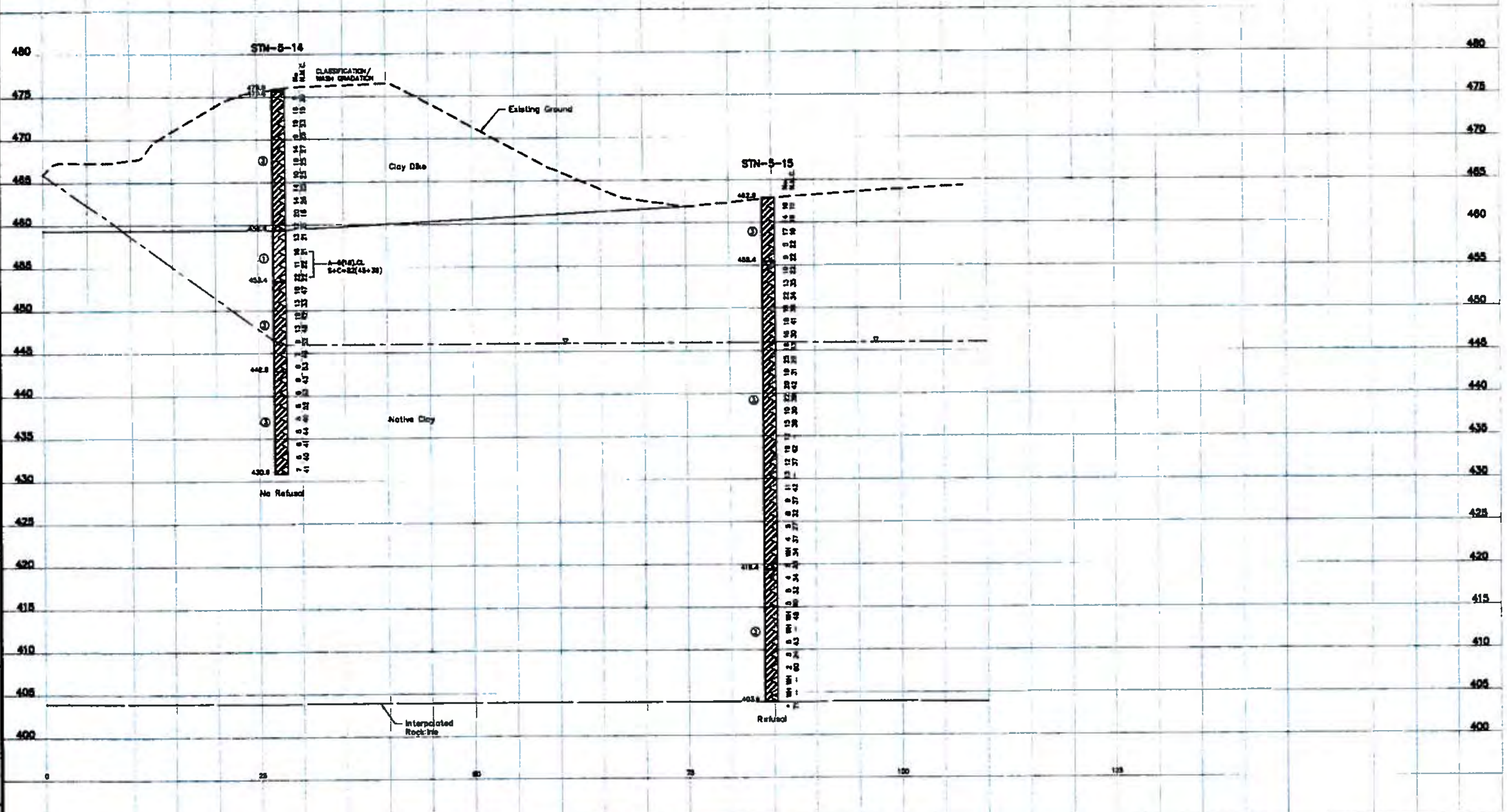
AUTOCAD R 2000 | 37 | C | 10W707-22 | R 0

PLOT FACTOR XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

STANTEC | 0

37 C 10W707-22



LEGEND

- ① Lean Clay, Sandy Lean Clay, Lean Clay With Sand
- ② Silty, Clayey Sand
- ③ Fat Clay, Fat Clay With Sand
- ④ Overburden
- ⑤ Silty Clay
- ⑥ Poorly Graded Sand
- ⑦ Silty Sand
- ⑧ Silt, Sandy Silt, Silt With Sand
- ⑨ Limestone
- ⑩ Well Graded Sand With Silt
- ⑪ Fly Ash
- ⑫ Bottom Ash
- ⑬ Clayey Gravel
- ⑭ Silty Gravel With Sand

WH	Weight of Hammer
WR	Weight of Rods
◁	Standard Penetration Test Interval
▪	Undisturbed Thin-Walled (Shelby) Tube Sample
N_{60}	Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
N_{60}	Standard Penetration Test Blow Count with a 140 lb Automatic Hammer (blows/ft.)
N.M.C.	Natural Moisture Content (%)
U.W.W.	Unit Weight Wet (lbs./cu.ft.)
U.W.D.	Unit Weight Dry (lbs./cu.ft.)
U.C./U.U.	Unconfined Compressive Strength (psf)/ Unconsolidated Undrained Triaxial Test (psf)
03/31/09	Water Level and Date Recorded
—	Phreatic Surface From Pz Data
T.O.R.—	Top Of Rock (Indicates The Beginning Of Rock-like Resistance To The Advancement Of The Augers. This May Indicate The Beginning Of Weathered Bedrock, Boulders Or Rock Remnants. An Exact Determination Cannot Be Made Without Performing Rock Coring.)
B.C.—	Begin Rock Core
R.Q.D.	Rock Quality Designation (%)
REC.	Recovery (%)
Refusal	Auger Refusal Using A Carbide-tipped Tooth Auger Bit
No Refusal	No Refusal Encountered
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RECORD DRAWING

For Supporting Design Calculations see FPOCOFFESC0X00000020100002

SCALE: 1"=5' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5
GEOTECHNICAL EXPLORATION
STABILITY SECTION L

P. COOPER | B. PETTY | P. COOPER | R. ROBERTS | R. ROBERTS | R. ROBERTS | T. JOHNSEN

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W707-23 | R 0

PLOT FACTOR XX
W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY

Stantec

STANTEC | 0
TASK COMPLETED BY: | REV NO.

37 C 10W707-23

Appendix F

Seepage Analyses Results

Slope Stability Section A
Dry Stack 5 - Seepage Analysis

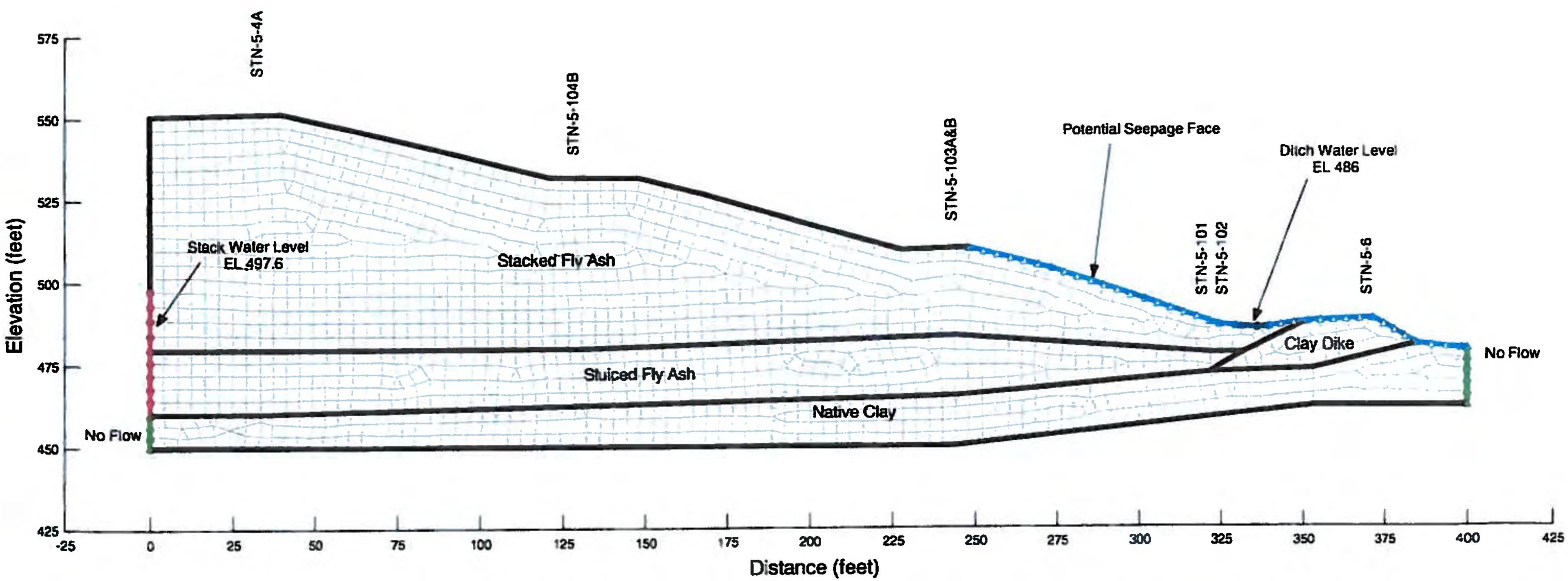
Boundary Conditions and Mesh

Colbert Fossil Plant
Tennessee Valley Authority

January 2010
Method: Steady-State
File Name: Section A seepage.gsz

Note:
The results and 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	Ksat (ft/sec)	Kratio (Kh/Kv)	Wsat
Stacked Fly Ash	3.28e-008	0.1	0.46
Sluiced Fly Ash	8.2e-008	0.05	0.46
Native Clay	3.28e-010	0.1	0.37
Clay Dike	3.28e-010	0.2	0.37



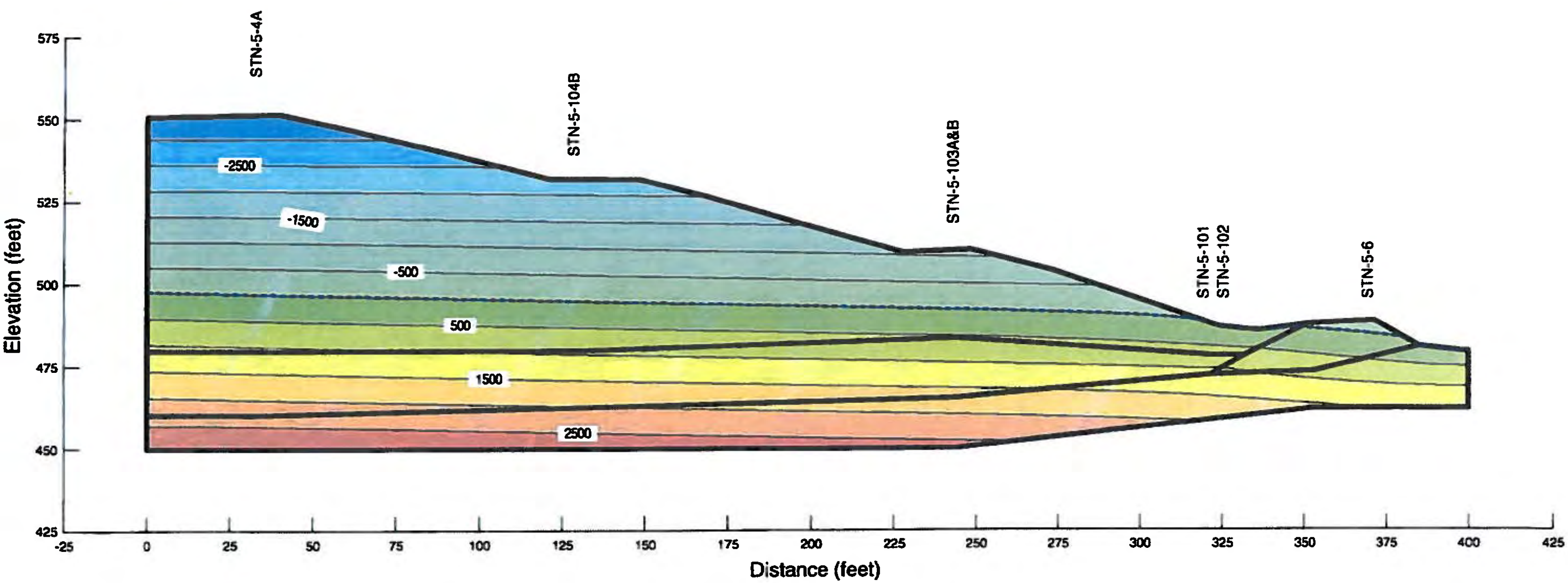
Slope Stability Section A
Dry Stack 5 - Seepage Analysis

Colbert Fossil Plant
Tennessee Valley Authority

January 2010
Method: Steady-State
File Name: Section A seepage.gsz

Pore Water Pressure (psf)

Note:
The results and 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.



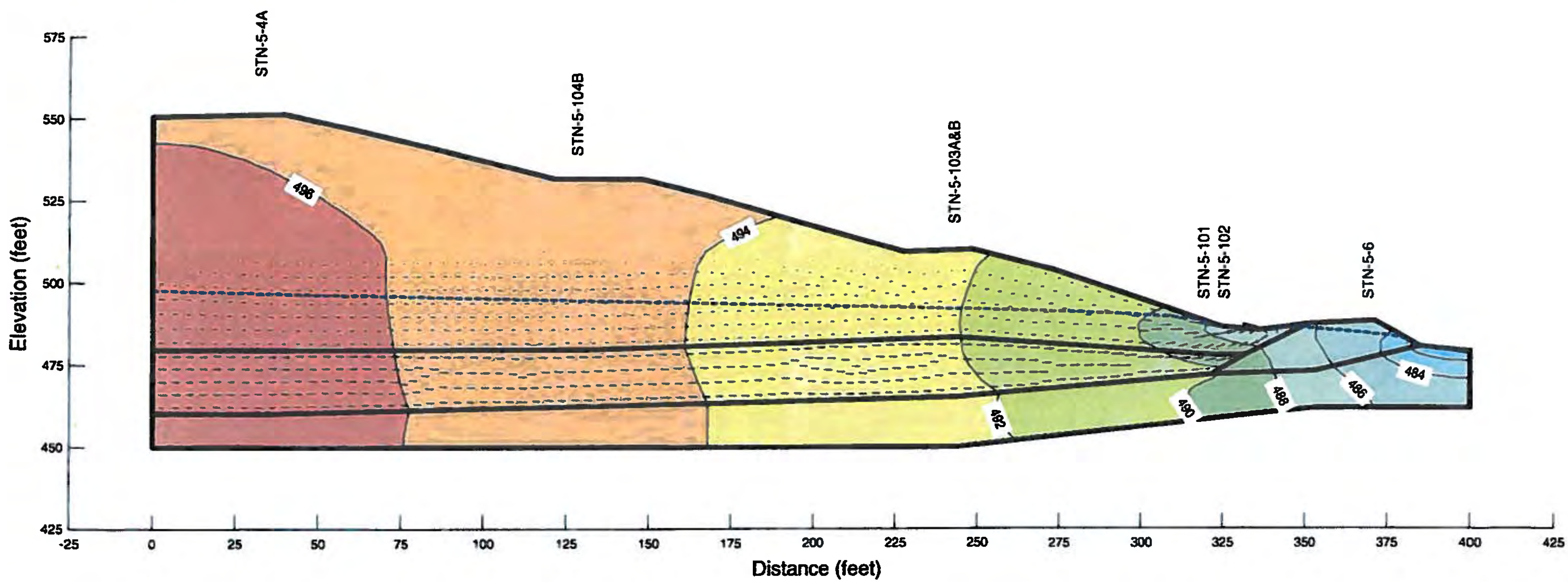
Slope Stability Section A
Dry Stack 5 - Seepage Analysis

Colbert Fossil Plant
Tennessee Valley Authority

Total Head with Flow Vectors

January 2010
Method: Steady-State
File Name: Section A seepage.gsz

Note:
The results and 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.



Slope Stability Section A
Dry Stack 5 - Seepage Analysis

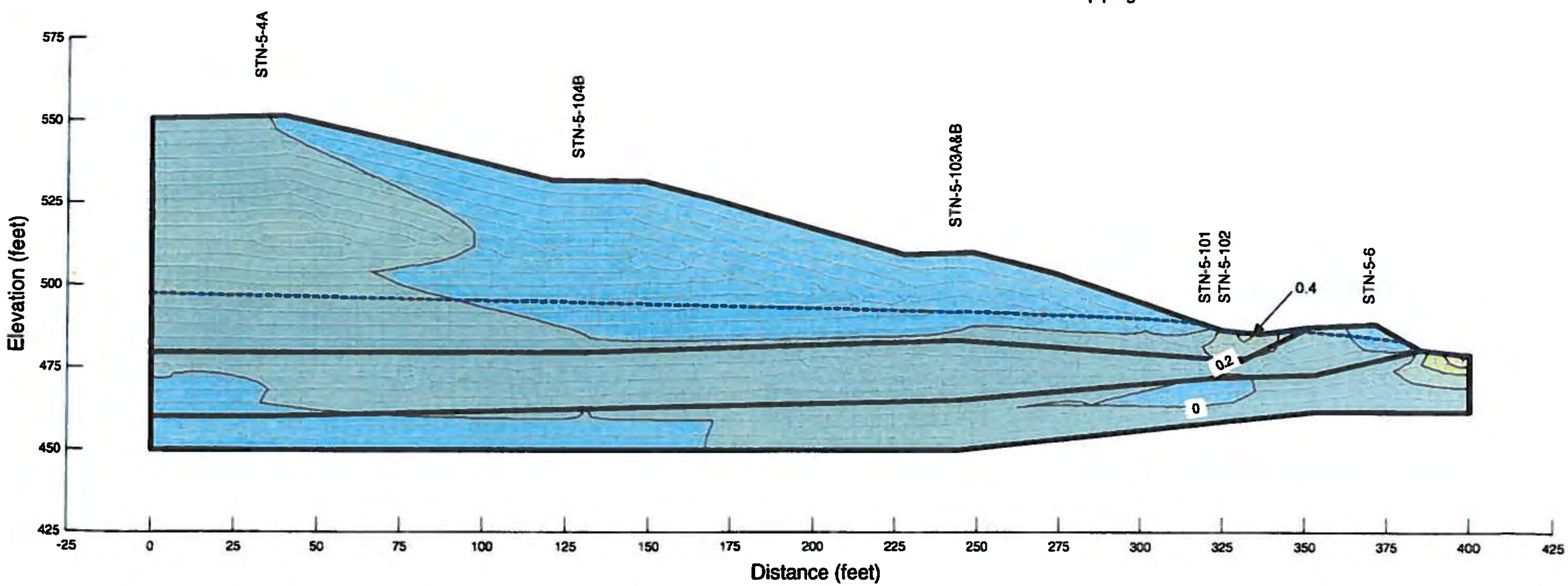
Vertical Gradient

Colbert Fossil Plant
Tennessee Valley Authority

January 2010
Method: Steady-State
File Name: Section A seepage.gsz

Note:
The results and 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.

Piping Potential
Maximum occurs at (331.55, 486)
Total Head = 486 ft
At (331.46, 482.85)
Total Head = 487.42 ft
dH = 1.42 ft   dL = 3.15
i = 0.45   i(criticial) = 0.58
FSpiping = 1.28



Slope Stability Section E
Dry Stack 5 - Seepage Analysis

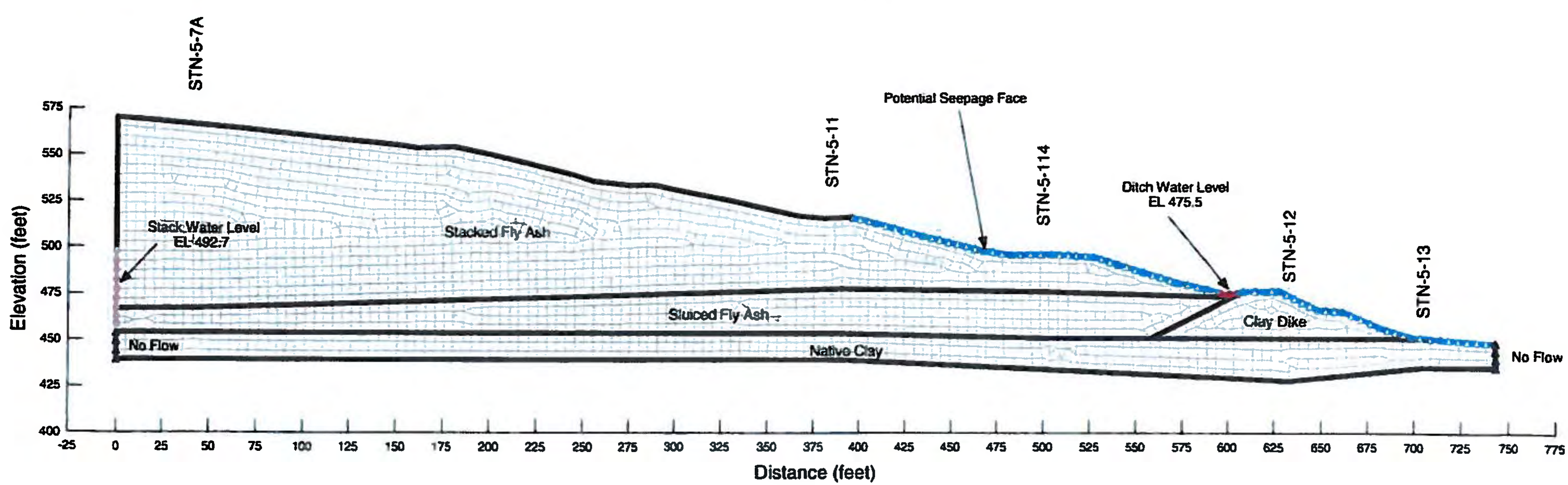
Boundary Conditions and Mesh

Colbert Fossil Plant
Tennessee Valley Authority

January 2010
Method: Steady-State
File Name: Section E seepage.gsz

Note:
The results and 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	Ksat (ft/sec)	Kratio (Kh/Kv)	Wsat
Stacked Fly Ash	3.28e-008	0.1	0.46
Sluiced Fly Ash	8.2e-008	0.05	0.46
Native Clay	3.28e-010	0.1	0.37
Clay Dike	3.28e-010	0.2	0.37



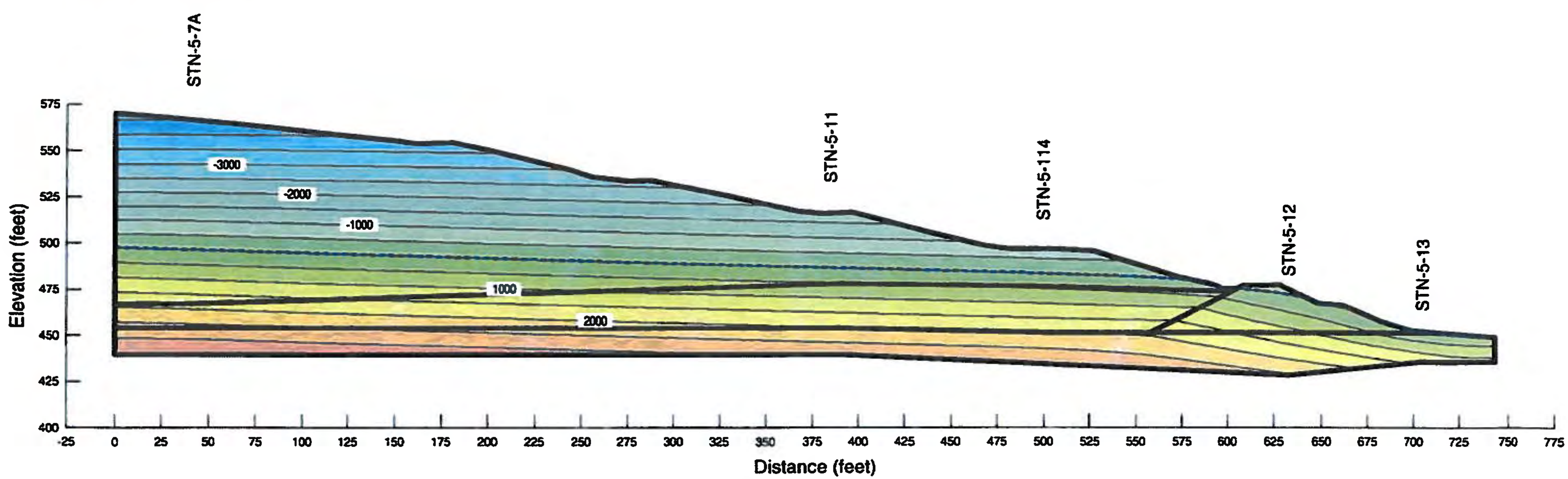
Slope Stability Section E
Dry Stack 5 - Seepage Analysis

Colbert Fossil Plant
Tennessee Valley Authority

January 2010
Method: Steady-State
File Name: Section E seepage.gsz

Note:
The results and 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.

Pore Water Pressure (psf)



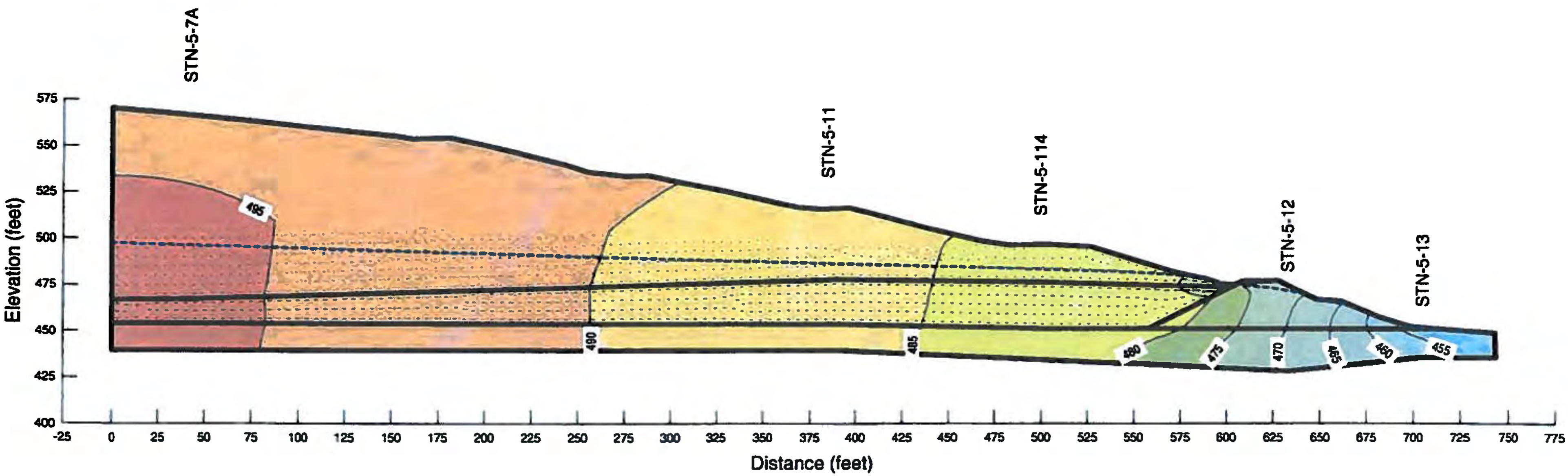
Slope Stability Section E
Dry Stack 5 - Seepage Analysis

Total Head with Flow Vectors

Colbert Fossil Plant
Tennessee Valley Authority

January 2010
Method: Steady-State
File Name: Section E seepage.gsz

Note:
The results and 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.



Slope Stability Section E
Dry Stack 5 - Seepage Analysis

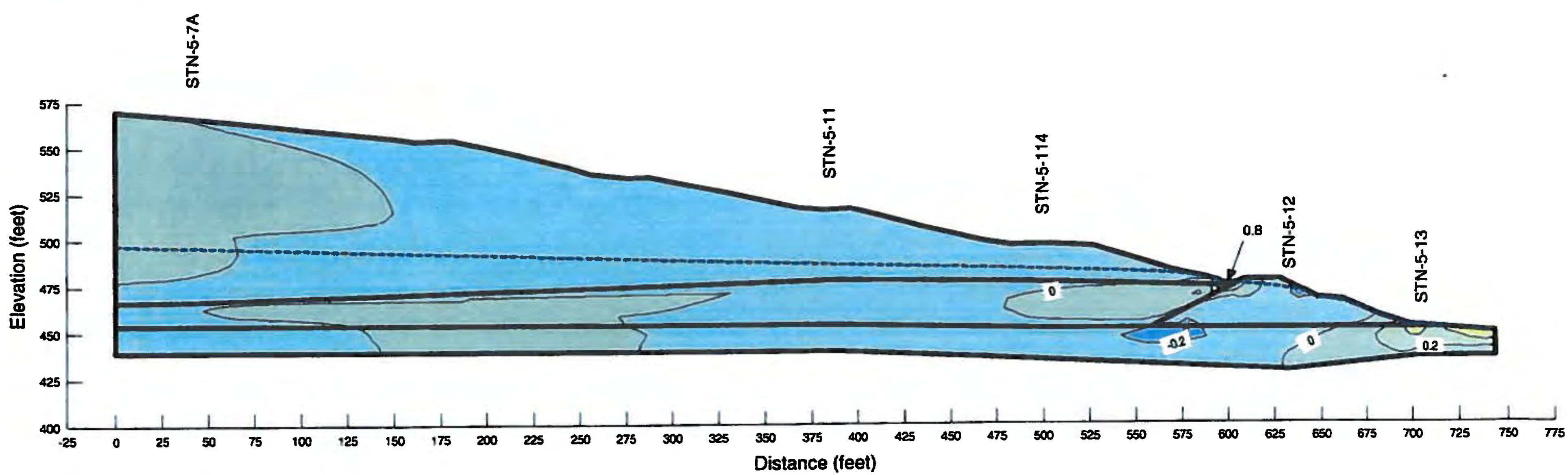
Vertical Gradient

Colbert Fossil Plant
Tennessee Valley Authority

January 2010
Method: Steady-State
File Name: Section E seepage.gsz

Note:
The results and 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.

Piping Potential
Maximum occurs at (601.03, 475.16)
Total Head = 475.51 ft
At (598.2, 471.75)
Total Head = 478.17 ft
dH = 2.66 ft   dL = 4.43
i = 0.60   i(criticial) = 0.55
FSpiping = 0.92



Slope Stability Section J
Dry Stack 5 - Seepage Analysis

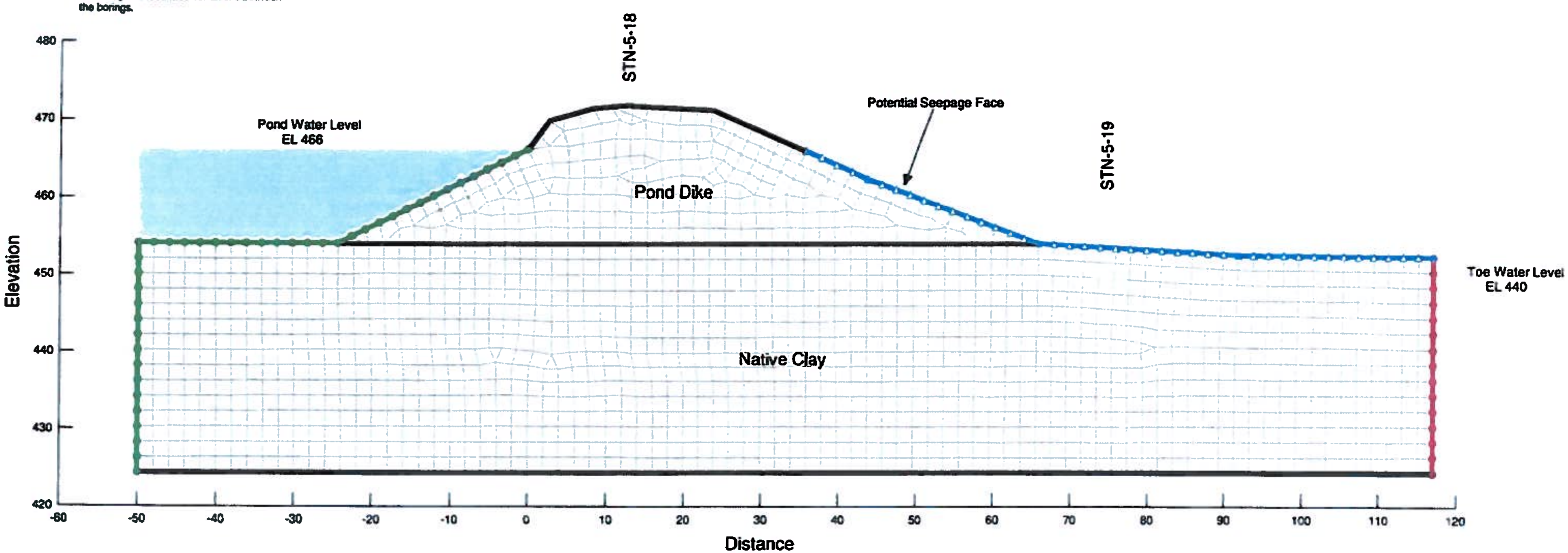
Boundary Conditions and Mesh

Colbert Fossil Plant
Tennessee Valley Authority

January 2010
Method: Steady-State
File Name: Section J seepage.gsz

Material Type	Ksat (ft/sec)	Kratio (Kh/Kv)	Wsat
Native Clay	3.28e-010	0.1	0.37
Pond Dike	3.28e-010	1	0.37

Note:
The results and 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.



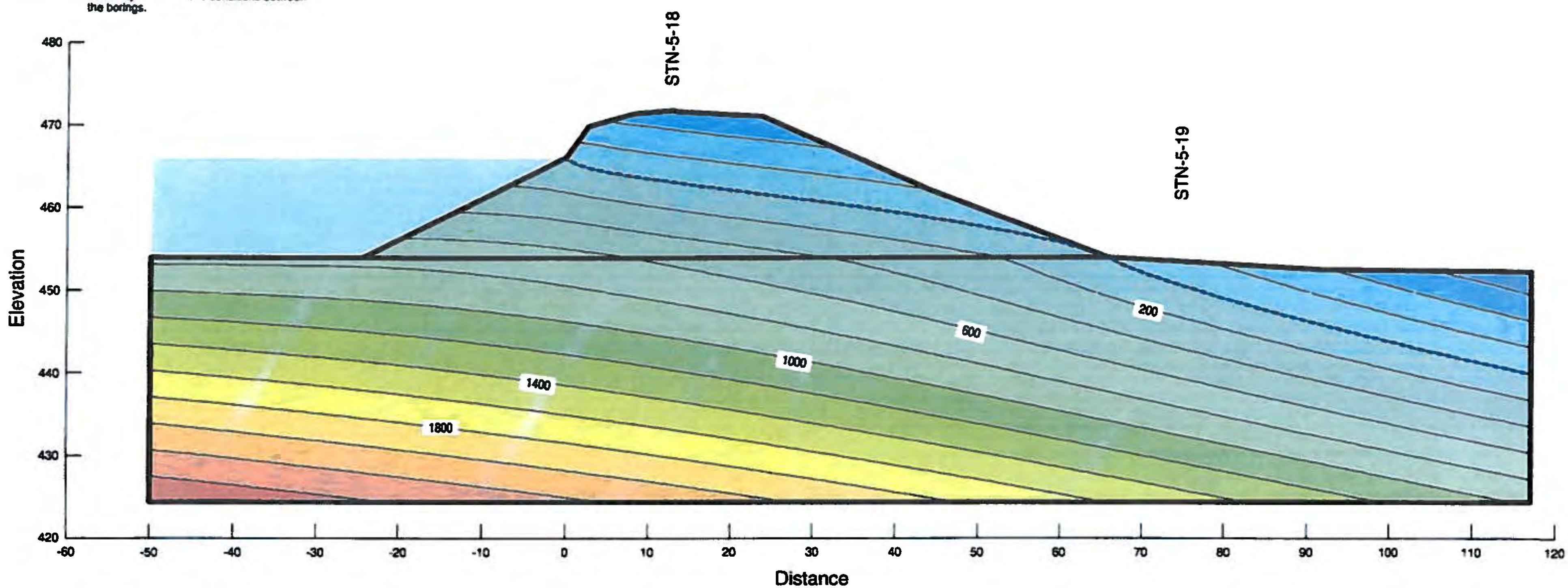
Slope Stability Section J
Dry Stack 5 - Seepage Analysis

Colbert Fossil Plant
Tennessee Valley Authority

Pore Water Pressure (psf)

January 2010
Method: Steady-State
File Name: Section J seepage.gsz

Note:
The results and 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.



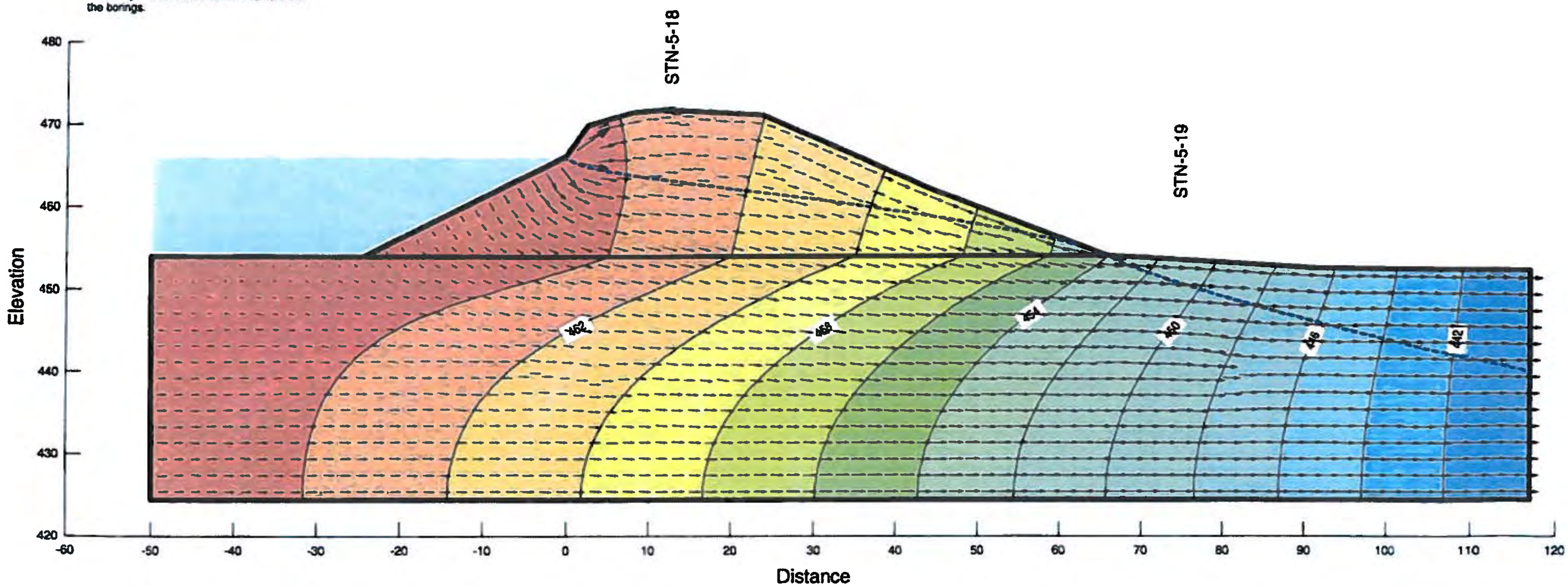
Slope Stability Section J
Dry Stack 5 - Seepage Analysis

Total Head with Flow Vectors

Colbert Fossil Plant
Tennessee Valley Authority

January 2010
Method: Steady-State
File Name: Section J seepage.gsz

Note:
The results and 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.



Slope Stability Section J
Dry Stack 5 - Seepage Analysis

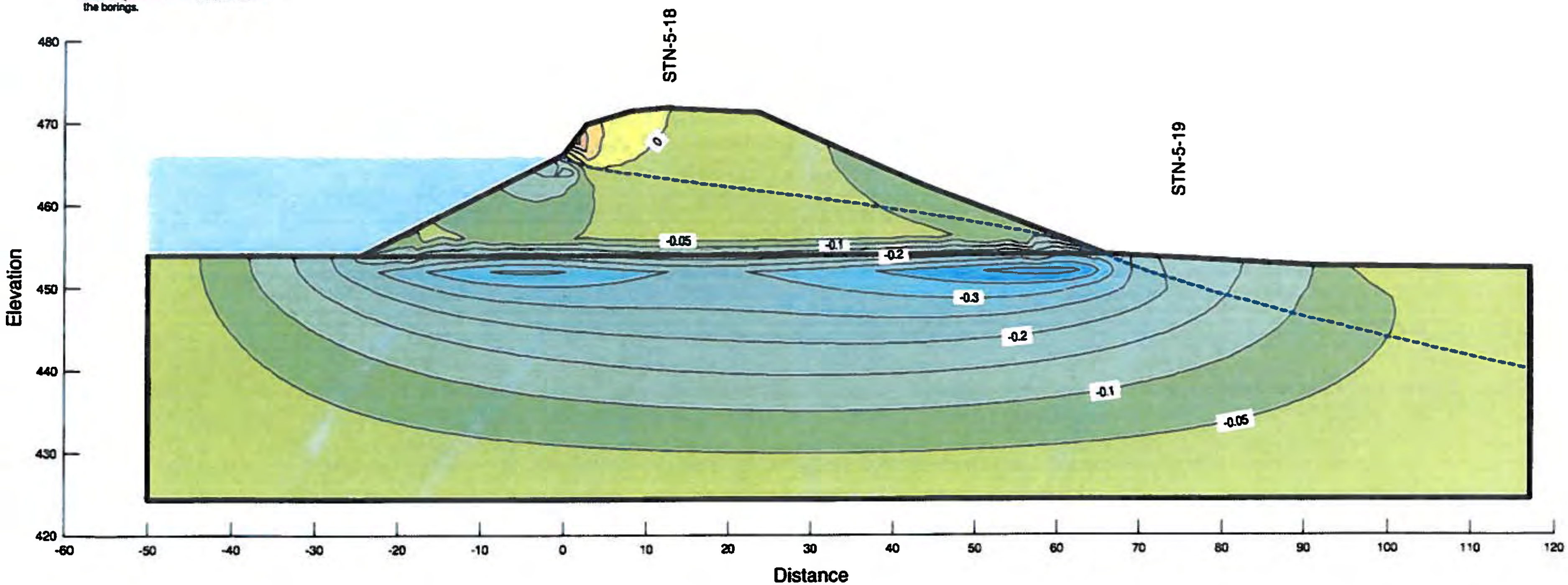
Vertical Gradient

Colbert Fossil Plant
Tennessee Valley Authority

January 2010
Method: Steady-State
File Name: Section J seepage.gsz

Piping Potential: No critical gradient identified by Seepage model.

Note:
The results and 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.



Appendix G

Work Plan Drawings for Seepage Boil Interim Mitigation

PLANS FOR CONSTRUCTION

PERIMETER DITCH ROCK PROTECTION AND INTERIM SEEPAGE MITIGATION DISPOSAL AREA 5 DRY STACK COLBERT FOSSIL PLANT

TUSCUMBIA, COLBERT COUNTY, ALABAMA

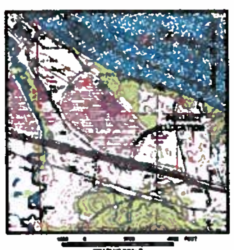
PREPARED FOR

TENNESSEE VALLEY AUTHORITY

PREPARED BY

Stantec

Stantec Consulting Services Inc.
1901 Nelson Miller Pky.
Louisville, Kentucky
40223-2177
Tel. 502.212.5000
Fax 502.212.5055
www.stantec.com



VICINITY MAP

INDEX OF SHEETS

ISSUED FOR CONSTRUCTION

For Supporting Design Calculations see FPGCOFFESCDX00000020080002

SCALE: NONE — EXCEPT AS NOTED

YARD
DISPOSAL AREA 5 DRY STACK
PERIMETER DITCH ROCK PROTECTION
AND INTERIM SEEPAGE MITIGATION
COVER SHEET

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

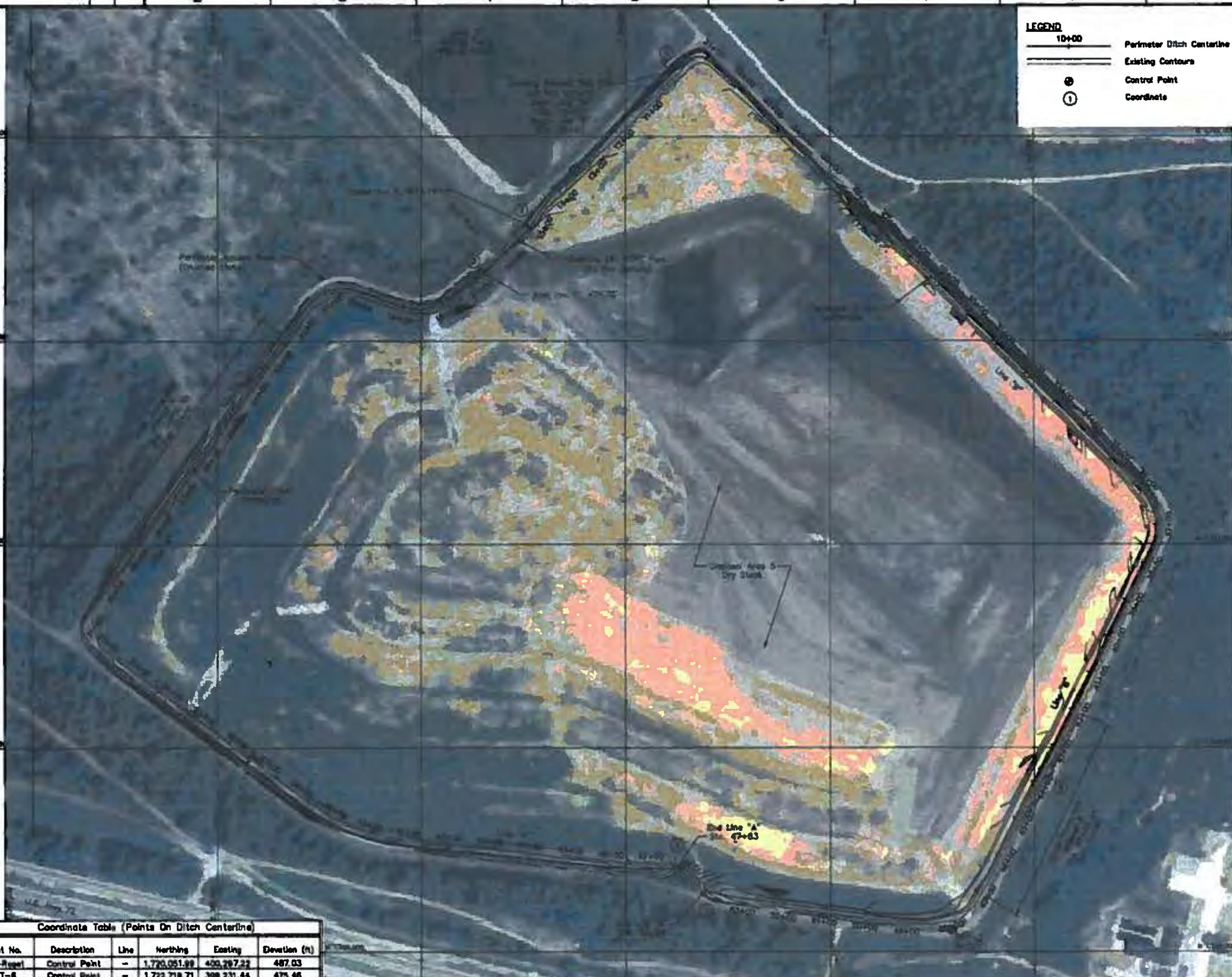
AUTOCAD R 2000 | 37 | C | 10W705-01 | R 0

PLOT FACTOR XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY: | REV NO.

37 | C | 10W705-01



Coordinate Table (Points On Ditch Centerline)

Point No.	Description	Line	Northing	Easting	Elevation (ft)
PP3-Reset	Control Point	-	1,720,051.99	400,287.22	487.03
PPT-6	Control Point	-	1,722,719.71	399,231.44	475.46
1	Wooden Weir Box	-	1,722,159.43	399,810.13	488.33
2	24" Pipe, Outlet	A	1,721,780.17	399,269.51	473.44
3	24" Pipe, Inlet	A	1,721,688.85	399,184.53	474.73
4	Cross Section A	A	1,721,318.73	398,828.57	-
5	End Line "A"	A	1,720,203.53	399,823.68	-
6	Cross Section D	B	1,720,465.20	400,918.25	-
7	End Line "B"	B	1,720,150.14	399,693.52	-

Notes

DESCRIPTION OF WORK

The improvements shown on these drawings include the placement of rock protection and weighted filter at two intervals along the existing perimeter ditch at TVA's Colbert Fossil Plant Disposal Area #5 located in Tuscumbia Alabama. The rock filter will be installed for interim mitigation efforts due to the recent discovery of seepage boils within the perimeter ditch of the dry stack. The two intervals to receive rock protection / weighted filter include:

Interval A - Sta. 22+50 to Sta. 28+00, Line A
Interval B - Sta. 42+00 to Sta. 47+00, Line B

The project tasks in the above project description are provided for general purposes only. This description is not intended to be an all-inclusive list of project tasks.

SURVEY/AERIAL PHOTO

Topographic information shown along the perimeter ditch is from a survey conducted by TVA in June of 2009. The contractor is responsible for checking that conditions in the field during time of construction have not changed from the time of the survey.

The control points and coordinates shown are referenced horizontally to NAD 27, Alabama Mercator West, and vertically to NGVD 29.

The aerial photo was taken in 2006 and does not reflect current site conditions. The image is shown for reference only and is not to be considered at scale.

HEALTH AND SAFETY

The contractor shall be responsible for the health and safety of its personnel and shall meet industry standard requirements. The contractor shall adhere to state, local, and federal regulations for construction. OSHA standards for construction shall be met as well as site specific owner requirements.

DIVERSION OF STORM WATER

The contractor is responsible for site drainage throughout construction and shall install temporary drainage structures/ditches or pump water as necessary to prevent interference with the work. Such temporary drainage features shall be performed in accordance with the requirements of environmental permits.

CONSTRUCTION SEQUENCING

The contractor is to execute work in such a manner as to only disturb manageable sections of the ditch at a time.

Any disturbed areas along the slope of the stack and adjacent perimeter access road shall be covered with a minimum of 6" of soil cover, seeded, and protected with erosion control blankets. Blankets shall be placed in accordance with the manufacturer's recommendations.

PROJECT RECORD DRAWINGS

Field adjustments are expected with this project and the contractor shall maintain a complete and accurate record of adjustments, changes or deviations from the plans indicating the work as actually installed.

SPECIFICATIONS

Site Preparation

Site preparation shall include the removal of sediment and vegetation within the areas planned for placement of the rock protection. This site preparation shall comply with the construction sequencing above and only disturb manageable sections at a time.

Stone

Stone for the weighted filter and rock protection shall comply with ALDOT Standard Specifications for Highway Construction. Approved stone is ALDOT Class 1 Riprap, ALDOT No. 2 Stone, and ALDOT No. 57 Stone.

Sand Filter

Sand for the weighted filter shall comply with ALDOT Standard Specifications for Highway Construction. ALDOT No. 100 Sand shall be used for the bottom layer of the weighted filter to create a separation layer between the ditch bottom and stone.

Section or Detail No.
Sheet Where Shown
REFERENCE KEY

For Supporting Design Calculations see FPGCOFFEXCD0000002009002

ISSUED FOR CONSTRUCTION

SCALE: 1"=100' EXCEPT AS NOTED

YARD
DISPOSAL AREA 5 DRY STACK

PERIMETER DITCH ROCK PROTECTION
AND INTERIM SEEPAGE MITIGATION
SITE LAYOUT

Stantec

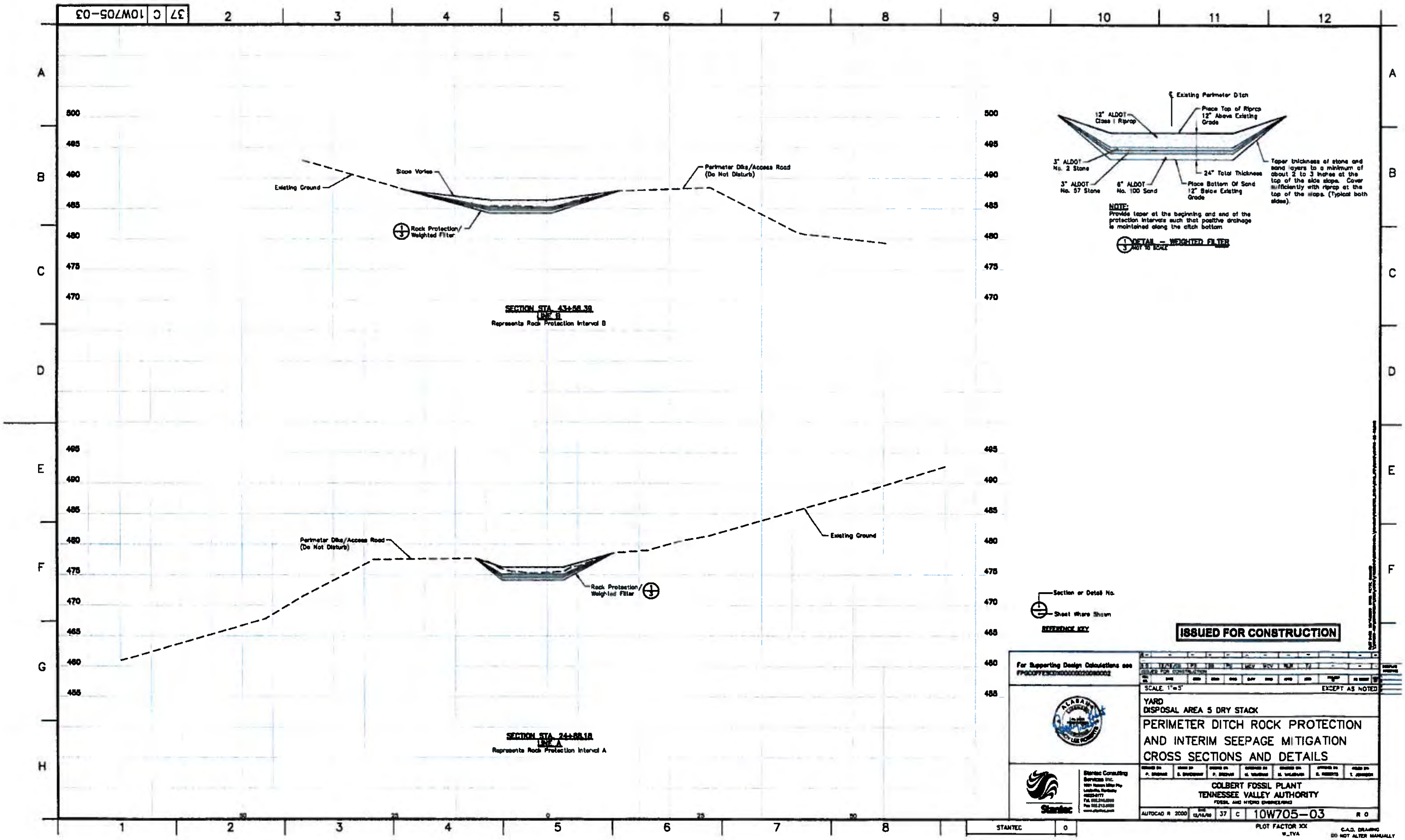
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 12/16/09 | 37 | C | 10W705-02 | R 0

STANTEC | 0
TASK COMPLETED BY | REV NO.

PLOT FACTOR XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY



SECTION STA. 43+58.38
LINE B
Represents Rock Protection Interval B
Existing Ground
Slope Vortex
Rock Protection/ Weighted Filter
Perimeter Dike/Access Road (Do Not Disturb)
SECTION STA. 24+88.18
LINE A
Represents Rock Protection Interval A
Existing Perimeter Ditch
Place Top of Riprap 12" Above Existing Grade
12" ALDOT Class I Riprap
3" ALDOT No. 2 Stone
3" ALDOT No. 57 Stone
6" ALDOT No. 100 Sand
24" Total Thickness
Place Bottom Of Sand 12" Below Existing Grade
Taper thickness of stone and sand layers to a minimum of about 2 to 3 inches at the top of the side slope. Cover sufficiently with riprap at the top of the slope. (Typical both sides).
NOTE:
Provide taper at the beginning and end of the protection intervals such that positive drainage is maintained along the ditch bottom
DETAIL - WEIGHTED FILTER
NOT TO SCALE
Section or Detail No.
Sheet Where Shown
REFERENCE KEY
ISSUED FOR CONSTRUCTION
For Supporting Design Calculations see
SCALE 1"=5'
EXCEPT AS NOTED
YARD
DISPOSAL AREA 5 DRY STACK
PERIMETER DITCH ROCK PROTECTION
AND INTERIM SEEPAGE MITIGATION
CROSS SECTIONS AND DETAILS
COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING
Stantec
AUTOCAD R 2000
37 C 10W705-03 R 0
PLOT FACTOR XX
C.A.D. DRAWING DO NOT ALTER MANUALLY

APPENDIX A

Document 12

TVA Colbert Fossil Plant, Ash Stack 5, Seepage and Drainage Remediation, December 22, 2010, prepared by URS

B A S I S   O F   D E S I G N

TVA COLBERT FOSSIL PLANT
ASH STACK 5

SEEPAGE AND DRAINAGE REMEDIATION
REV. 0

Prepared for:

Tennessee Valley Authority
1101 Market St.
Chattanooga, TN 37402-2801

December 22, 2010

URS

1375 Euclid Avenue
Cleveland, Ohio 44115
216-622-2400
Project No. 31851121

Figures

Appendices

This document presents the engineering basis used to implement the design of the Seepage and Drainage Remediation of the Colbert Fossil Plant (COF) Ash Stack 5. Design assumptions and methodology are summarized and important results of the analyses are presented and attached. This report documents the design criteria and minimum standards utilized for the proposed improvements.

1.1 PROJECT DESCRIPTION

The Tennessee Valley Authority (TVA) currently operates wet Coal Combustion Products (CCP) disposal systems at all eleven (11) of its' coal burning plants. TVA decided that all ash will be handled in a dry state. In the case of the Colbert Fossil Plant, the conversion process to dry disposal includes the closure of Ash Stack 5, Ash Disposal Pond 4 and construction of a dry CCP landfill. COF currently places dry fly ash in Ash Stack 5; however, there are areas at the ash stack that have reached design grades and are inactive.

The eventual closure of Ash Stack 5 will consist of installing an impermeable cap system over the ash stack, upon exhaustion of the available disposal volume. The cap system currently assumes a flexible membrane liner, a geosynthetic drainage layer, 24 inches of cap cover soil, and vegetation. The closure of Ash Stack 5 is anticipated to be conducted in phases, thus enabling TVA to cap the finished portions of the ash stack while continuing to dispose of ash in the areas that have yet to reach final grade.

The initial phase of closure of Ash Stack 5 includes stability mitigation, seepage remediation, surface/storm water improvements, and the Stilling Basin inlet structure replacement. A stability analyses performed for the site by Stantec Consulting Services (Stantec) identified several areas of the Ash Stack that had a factor of safety below the acceptable limit of 1.5 established by the TVA Coal Combustion Products Management Program Master Programmatic Document Revision 1.0 dated December 7, 2009 (Programmatic Document). In addition, seepage has been observed in the perimeter ditch. A graded filter drain system is proposed to be installed in the bottom of the existing ditch to remediate the seepage issues. The graded filter drain is designed to collect existing seeps and direct them to the Stilling Basin. A soil buttress will be constructed over the existing dike and perimeter ditch to increase the passive pressures at the toe of the slope and increase the factor of safety above the target value of 1.5. The phased closure will also address storm water issues including the existing terraces on Ash Stack 5 which have inadequate slopes and letdowns that are insufficient to handle the anticipated flows after final closure of the ash stack. The perimeter ditch will be reconstructed as part of the stability mitigation to handle the storm water flows and direct them to the Stilling Basin. The temporary Stilling Basin inlet structure will need to be replaced due to the anticipated increased flows to the Stilling Basin upon closure.

1.2 EXISTING CONDITIONS

Ash Stack 5 is approximately 75 acres in area, and enclosed by a perimeter dike system that is approximately 7,500 feet in total length. The dike crest supports a gravel access road and is currently at an approximate elevation of 480 to 490 feet. The overall constructed height of the perimeter dike system varies from approximately 10 feet on the southwest side to about 30 feet at other locations. Dike slopes range from approximately 1.5H:1V to 2.5H:1V. Figure 1 shows the current conditions at Ash Stack 5.

Slopes of the dry stack are approximately 2.5H:1V to 4H:1V and are now approaching 90 to 100 feet in height with terraces located on approximately 20-foot height intervals. A perimeter drainage ditch is located between the perimeter dike and the stacked ash. The ditch surrounds the entire ash stack and collects surface water runoff from the stack area. The high point is located near the south corner and the ditch drains to the existing Stilling Basin inlet structure (also known as the wooden weir replacement structure) and into the Area 5 Stilling Basin located northwest of the ash stack. This Stilling Basin is approximately 12 acres in size, and has a perimeter dike totaling approximately 3,000 feet in length with a maximum dike height of about 17 feet.

Dry disposal is following a stacking plan developed in the early 1990's and the ultimate height of the stack will range from 100 to 120 feet from top to toe of original perimeter dikes. Stacked fly ash is being constructed on approximately 2.5H:1V to 4H:1V slopes, with terraces every 20 feet in height. The stack appears fully built-out in the south and west portions. The current disposal activity is on the northeast side, but this area is also close to being fully built-out. Based on information provided by TVA, approximately 350,000 tons of dry fly ash is collected in silos each year and hauled to this disposal area. Based on this disposal rate, Ash Stack 5 is anticipated to have approximately three years of expected life remaining and expects to run out of disposal volume in the third quarter of 2013. In addition to the exhaustion of the capacity of Ash Stack 5 in 2013, stability analyses performed for the site yielded several areas of Ash Stack 5 that had a factor of safety less than the target value of 1.5. This low factor of safety was determined to be primarily due to a loose ash layer and high water levels below Ash Stack 5 from when the site was utilized as an ash pond/dredge cell. This may also be contributing to the seepage issues that have been identified in the existing perimeter ditch.

An evaluation of the surface water drainage found that the perimeter ditch contains inadequate slopes with large portions at or near 0% grade. Similarly, many of the terraces built into Ash Stack 5 also have inadequate slopes with portions of them sloping away from the storm water letdowns that convey the water from the terraces to the perimeter ditch.

Another concern at Ash Stack 5 is the replacement of the current Area 5 Stilling Basin (Stilling Basin) inlet structure, which allows water to flow from the Ash Stack 5 perimeter ditch to the Stilling Basin. The original structure was the remnants of the weir structure that controlled water level in the Ash Disposal Area 5 prior to the construction of the ash stack. The inlet structure was in relatively poor condition and there was significant concern that the structure may collapse, potentially blocking the entrance to the Stilling Basin. In July 2010, TVA replaced the wooden weir structure with a temporary solution consisting of a 24-inch corrugated metal pipe and riprap protection. The temporary structure will need to be replaced with a permanent structure to allow water to flow from the perimeter ditch of Ash Stack 5 to the Stilling Basin.

1.3 PROPOSED IMPROVEMENTS

Proposed improvements to Ash Stack 5 include the construction of a soil buttress, installation of a toe drain to control seepage, installation of an impermeable cap system, modifications to the surface water management system, and the replacement of the temporary Stilling Basin inlet structure.

- The Stability Mitigation Project involves installation of a soil buttress around the perimeter of Ash Stack 5. The buttress is designed to be installed as a vertical extension of the clay dike and extend laterally over the perimeter ditch to the toe of the ash stack. The soil buttress increases the Factors of Safety above TVA's target value of 1.5 per the Programmatic Document. The junction of the soil buttress and the stacked ash is designed to create a new, elevated perimeter ditch as discussed below.

- The Seepage and Drainage Remediation Project consists of a perimeter graded filter drain and the creation of a new drainage swale. The perimeter graded filter drain (graded stone filter with a perforated pipe) is being installed beneath the soil buttress, at the bottom of the existing perimeter ditch, to maintain the phreatic surface and control seepage. Any water that permeates from the ash stack through the existing ditch is designed to be collected and conveyed to the Stilling Basin. The junction of the buttress and the stacked ash is designed to create a new, elevated perimeter ditch that is graded to flow to the Stilling Basin and promote positive drainage.

- The Ash Stack 5 Partial Cap design consists of implementing the closure of Ash Stack 5 starting from approximately the outside edge of the new perimeter road and working up the slopes of the ash stack from the base of the stack towards the first terrace. The cap system for the partial closure will consist of the same components as the final closure, the "alternate closure cap system" presented in the Programmatic Document.

- The Stilling Basin inlet structure replacement design consists of removing the existing inlet structure and replacing it with a more sound structure capable of handling the anticipated increased flows as a result of the closure of the ash stack.

1.4 DOCUMENT ORGANIZATION

The document is organized into sections corresponding to design/work plans submitted to TVA. The work plans submitted to date consist of the following:

- Ash Stack 5- Seepage and Drainage Remediation (construction set, 06/29/10) Work Plan Drawings 10W209-01 through 37

Each section provides a summary of the proposed designs and improvements. Detailed calculations are included in the corresponding Appendices. The BOD generally follows the organization described in Section 2.1 of the Programmatic Document. However, the following sections referenced in the Programmatic Document are not applicable for the following reason:

- Construction Cost Estimate and Schedule- The cost estimate and schedule are not applicable to design of the proposed improvements. A general cost estimate and schedule were provided in the Project Planning Document (PPD), submitted in draft form on June 1, 2010.

- Permits- A Construction Best Management Practice Plan (CBMPP), is required to implement the proposed improvements. A CBMPP was developed for the Ash Stack 5 projects and a Notice of Registration (NOR) was submitted to the Alabama Department of Environmental Management (ADEM) on June 2, 2010 and approved on June 23, 2010.

- Construction or Implementation Plan- A construction or implementation plan containing details regarding implementation of the improvements is not provided as part of the BOD.

- Operational features – Similar to the construction and implementation plan, operations and maintenance requirements are not part of the BOD.

The purpose of the Seepage and Drainage Remediation project is to begin the partial closure of Ash Stack 5 in areas that have reached final grades and to correct several maintenance and stability related issues discovered during an evaluation of the ash stack. In addition to the exhaustion of the capacity of Ash Stack 5 in 2013, stability analyses performed for the site yielded several areas of the Ash Stack that had a Factor of Safety less than the TVA target value of 1.5 as defined by the Programmatic Document. An evaluation of the surface water drainage found that the perimeter ditch contains inadequate slopes and many of the terraces built into Ash Stack 5 also have slopes that do not perform as designed. The Seepage and Drainage Remediation work plan addresses the correct measures for these maintenance and stability related issues.

2.1 DESIGN PROCESS

2.1.1 Design Criteria

2.1.1.1 Stability Analysis

A stability analysis was performed on Ash Stack 5 based on cross sectional data and parameters provided by Stantec in The Geotechnical Exploration and Slope Stability Evaluation for Ash Stack 5 issued to TVA on February 23, 2010. URS imported the cross-sections provided by Stantec into the 2007 Slope/W Program and evaluated the stability of Ash Stack 5 with a soil buttress applied to the toe of the slope. The soil buttress was designed to increase stability above the target Factor of Safety of 1.5 as defined by the Programmatic Document. The minimum thickness of soil buttress was determined for each of the cross sections that Stantec concluded to have a Factor of Safety less than 1.5. Based on the results of the stability analysis, it was determined that a 3-foot soil buttress would raise the Factor of Safety for the areas examined above 1.5. Note that a thicker buttress was required for ditch grading. The procedures, calculations, and results of the Stability Analysis are located in Appendix 1.

2.1.1.2 Selection of Graded Filter Drainage Media

The graded filter design was developed using methods published by the US Army Corps of Engineers in their engineering manual EM-1110-2-2300, General Design and Construction Considerations for Earth and Rock-Fill Dams, Appendix B, Filter Design. The design procedure began by identifying the base soil through which seepage is occurring, soil which must be protected from internal erosion by the proposed filter. Sieve analysis data was examined, from which a grain size gradation curve was drawn for the base soil. Statistical grain size parameters important to the design were obtained from the gradation curve, such as d_{15} (the grain size at which only 15 percent of the base soil sample consists of smaller particles), d_{85}, d_{90}, d_{10} and others. Design equations were applied to the grain size parameters to evaluate the suitability of proposed filter material for use with the base soil, with respect to stability, permeability, and resistance to segregation during construction.

The design procedure produced a range of grain size characteristic of materials that are suitable filters for the given base soil. This was plotted on the gradation curve of the base soil as a band that represents the proposed filter. Gradation curves for sand and gravel mixtures were plotted to determine if they conform to the proposed filter material. After applying these procedures, it was determined that both a standard Alabama Department of Transportation (ALDOT) No. 100 sand and No. 8910 stone were found to satisfy Filter #1 criteria and are specified for use on the project. In addition, AASHTO No. 57 and No. 4 stone were found to be acceptable materials to be used as Filter #2. Filter #2 is to act as a screen for the Filter #1 material to prevent the Filter #1 material from entering the slots in the slotted pipe. The same procedure for determining the acceptability of proposed Filter #1 materials was utilized to determine the acceptability of proposed materials for Filter #2. The design procedure, calculations and grain size plots are presented in Appendix 2.

2.1.1.3 Design/Selection of Drain Pipe for Graded Filter Drain

The majority of the graded filter drain will be installed with low to moderate burial depths. Depths for the majority of the length of the drainage pipe range from three feet to fourteen feet. For this, conventional corrugated pipe with a smooth inside (ADS N-12 or similar) is adequate. Based on ADS Technical Note TN 2.01 for a 6 inch corrugated N-12 maximum burial depth using compacted Type 1 (granular) backfill, the maximum recommended burial depth for this pipe is 44 feet. A copy of this technical note is located in Appendix 3.

Currently TVA and URS are investigating the area adjacent Ash Stack 5, south of the Ash Stack 5 Stilling Basin for potential storage of future CCP materials (referred to as Site 1A). As part of this project, future CCP storage may include a vertical expansion onto the adjacent western slope of Ash Stack 5. This area encompasses approximately Station 5+00 to Station 22+00 of the west filter drain pipe (See Seepage and Drainage Remediation work plan dwg. 10W209-05 & 06, Rev. 1). With the added height of the Site 1A vertical expansion, the height of fill will exceed 44 feet. For these locations, a stiffer, thick-walled SDR17 HDPE pipe will be utilized.

The proposed SDR17 HDPE pipe has been analyzed in accordance with the Pipe Strength Calculations section of the Programmatic Document (Revision 1.0). These calculations show that for both the live load and static load associated with the potential piggyback of Site 1A onto

Ash Stack 5, the proposed SDR17 HDPE pipe is adequate. A detailed pipe strength calculation is included in Appendix 3

2.1.1.4 Surface Water Management

The proposed design for surface water controls at the TVA Ash Stack 5 meets the requirements of the Programmatic Document. Specifically, Volume 2 of the Programmatic Document requires that all permanent and temporary surface water control structures be designed to accommodate the peak flow from the 25-year/24-hour storm event. HydroCAD version 8.0 was used to model the proposed surface water design for the facility. HydroCAD version 8.0 is a program designed to model small watersheds and incorporates methodology developed in Technical Release 55 (TR-55) Urban Hydrology for Small Watersheds.

The design for the surface water management upgrades for Ash Stack 5 consisted of evaluating the current configuration of Ash Stack 5 and the proposed final conditions. Contours of the existing conditions were obtained from an aerial survey provided by TVA. These contours were merged with the future final grades drawing to estimate the final conditions of Ash Stack 5 upon reaching the final grades. Although the entire Ash Stack 5 facility was analyzed as part of this analysis, this evaluation is only valid for the site features constructed as part of the Seepage and Drainage Mitigation project.

Ash Stack 5 was divided into drainage areas based on the location of the rock channel letdowns. Flow from the letdowns was then routed into the perimeter ditch and associated drainage structures. The perimeter ditch elevation is controlled by the elevation of the soil buttress. The ditch outlet at the Stilling Basin was set by the minimum thickness (approximately 3 feet) of the soil buttress at the outlet. The perimeter ditch invert elevation was designed from the downstream to upstream direction at a 0.5% grade per the Programmatic Document. The HydroCad report for the surface water management design is located in Appendix 4.

2.1.1.5 Stilling Basin Inlet Structure

The design for the Stilling Basin inlet structure was based on the flows generated for the perimeter ditch during the surface water management design. The flows for the perimeter ditch were modeled in HydroCad 8.0 for sizing the catch basin, grate, and outlet pipes to the Stilling Basin. The Stilling Basin was not evaluated as part of this analysis.

2.1.1.6 Partial Cap

The partial cap system for Ash Stack 5 was designed based on the "alternate closure cap system" presented in the Programmatic Document. The components of the cap system include a membrane, a geocomposite drainage layer, 24-inches of cover soil, and vegetation. A shallow translational failure analysis was performed in order to evaluate the stability of the soil buttress with respect to the layers of the cap system where a mechanism of failure may occur.

A shallow translational failure analysis was performed to establish the factors of safety against failure for the proposed partial cap system design. The analysis consists of finding strength parameters (friction angle, and cohesion, c) for a given interface, to meet required factors of safety against translational failure. Each interface (geosynthetic-to-geosynthetic or geosynthetic-to-soil) is tested to determine the minimum strength parameters. Proposed materials for the partial cap construction are to be tested during construction and the results are to be compared against the shallow translational failure analysis results to determine if the material properties are suitable for the proposed design. The results of the partial cap shallow translational failure analysis can be found in Appendix 4.

2.1.2 Design Exceptions

The only component of the Seepage and Drainage Remediation Plan that fails to meet the requirements set forth in the Programmatic Document is the graded filter drain. While the graded filter drain itself is in compliance with typical design standards, the grade at which the graded filter drain is designed to be installed is less than the minimum 0.5% grade. This toe drain system is not designed to improve stability in the existing ash stack, but rather to collect surface water and prevent it from seeping out from the proposed buttress. The slope of this drain is shallow in portions (approximately 0.2% in portions) and cleanouts have been designed to allow the pipes to be cleaned as necessary to prevent clogging of the pipe.

2.1.3 Design Narrative

Stability Analysis – Corrective measures include the installation of a soil buttress around the perimeter of Ash Stack 5. The buttress is designed to be installed as a vertical extension of the clay dike and extend over the perimeter ditch to the toe of the ash stack. The junction of the buttress and the stacked ash is designed to create a new, elevated perimeter ditch that is graded to flow to the Stilling Basin. The soil buttress increases the Factors of Safety above TVA's target value Factor of Safety of 1.5 as defined by the Programmatic Document and the new perimeter ditch promotes positive drainage. The design criteria for the soil buttress was based on the minimum thickness of the buttress required to raise the Factor of Safety above the target value of 1.5. The minimum height of the buttress (3 feet) was determined by preliminary analyses. This minimum height was set at the location of the discharge point of the newly created perimeter ditch into the Stilling Basin. The ditch was then graded backward in both directions around the ash stack to the high point at a 0.5% grade. Subsequently, the thickness of the soil buttress increased from three feet at the discharge point to approximately fourteen feet at the high point of the buttress. Note that for all stability analyses, a seismic analysis was not performed as directed by TVA. The Stability Analysis for the soil buttress is located in Appendix 1.

Seepage Remediation - The seepage collection system consists of a perimeter graded filter drain (graded stone filter with a perforated pipe) installed beneath the proposed soil buttress, in the existing perimeter ditch, to maintain the phreatic surface inside the ash stack and control seepage through the existing clay dikes. The graded filter should collect water that permeates through the ash stack and into the existing ditch and convey it to the Stilling Basin. The graded filter is designed to follow the grade of the existing ditch from the high point of the ash stack to the discharge point into the Stilling Basin. The calculations for the graded filter are located in Appendix 2.

The graded filter drainpipe is designed at a grade ranging from approximately 1% to 0.2%. It was determined that if the pipe was sloped to a preferred minimum slope of around 0.5%, it would roughly parallel the proposed buttress, allowing water to elevate locally to within a few feet of the top of the buttress. This could lead to seeps through the buttress soil. By leaving the pipe lower in the profile, this pipe should act as the preferred pathway for seepage water to flow instead of seeping out of the buttress soil. Cleanouts have been added at roughly 1,000 feet intervals to allow conventional cleaning equipment (which can typically reach greater than 500 feet in each direction) to clear any potential sediment that may form in the pipe and impede flow.

Surface Water Management - improvements will be made to the surface water management system. The existing surface water management system consists of a series of sideslope terraces, rock channel letdowns, and a perimeter ditch. The existing perimeter ditch is poorly draining with portions of the ditch being at or near 0% grade. The new perimeter ditch is designed to be graded to a minimum 0.5% slope as recommended by the Programmatic Document. In addition, the ditch geometry and channel lining was designed for the flows from the 25-year/24-hour storm event.

All temporary and permanent storm water culverts, catch basins, and other similar storm water structures was sized to manage the calculated flow from the 25-year/24-hour storm event. The

HydroCad output reports used during the design of the surface water management system are located in Appendix 3.

Stilling Basin Inlet Structure – the temporary inlet structure will be replaced with a new permanent inlet structure. The new inlet structure will be composed of a catch basin structure with multiple culvert pipes leading to the existing Stilling Basin. The outlet of the culvert pipes will be stabilized with a pre-cast concrete headwall. The new Stilling Basin inlet structure, culvert pipes, and headwall structure was designed to manage the anticipated flow from the 25-year/24-hour storm event. The HydroCad files used for designing the surface water management system are located in Appendix 3.

Partial Cap - The cap system to be utilized for the partial closure of Ash Stack 5 is the "alternate closure cap system" presented in the Programmatic Document. The alternate closure cap system consists of from bottom to top:

- 40-mil textured polyethylene or 30-mil PVC geomembrane
- Double-sided geocomposite drainage layer
- 24-inch cap cover soil with the upper 6-inches capable of supporting vegetation (topsoil or amended cap cover soil)
- Dense, non-woody, vegetation

The alternate closure cap system can be deployed directly over the existing cover soils once the existing vegetation is removed, requires considerably less construction equipment effort, can be installed more rapidly than the standard cap system, and has straight forward construction quality testing/quality assurance procedures. The alternate closure cap system can be constructed more quickly than the standard cap system and has been shown to have a greater reduction in infiltration into the ash mass in comparison to the standard cap system. The partial cap shallow translational stability analysis is located in Appendix 5.

The conclusions and recommendations presented in the Basis of Design report are based on the assumptions that our understanding of the existing site conditions and the scope of the project do not change substantially from what is described herein. It is recommended that communication be maintained with URS in order to ensure that the designs described herein are properly interpreted and incorporated into construction.

In the event that changes are made to the nature, design, or location of the proposed improvements, the designs presented herein should not be considered valid, unless URS has reviewed the changes and addresses their impact in the recommendations provided.

The design presented in this report should not be used for other projects or purposes. Conclusions or recommendations made from these data by others are their responsibility. Our services were provided in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation is intended.

Appendices

Appendix 1
Stability Analysis

I. Purpose: The purpose of this analysis is to re-evaluate slope stability of Ash Stack 5 of the TVA Colbert Facility after the construction of a soil buttress.

A slope stability analysis was performed for select cross sections of Ash Stack 5 based on the results of models previously analyzed by Stantec. These models represent the same cross-section configurations analyzed by Stantec for Ash Stack 5 with the addition of the proposed soil buttress. The following sections summarize the methodology, assumptions, and results of the analysis.

All analyses were performed using the 2007 SLOPE/W computer program. The program uses limit equilibrium theory and standard procedures (e.g. Spencer's, Bishop, Janbu, etc.) to determine factors of safety for circular and translational failure surface geometries. The program searches for critical factors of safety based on user-input grids of slip centers and radius lines. Additional information on the program is available at http://www.geo-slope.com/.

II. Model Development

The models that were evaluated for the slope stability analysis were developed by Stantec as part of their Report of Geotechnical Exploration and Slope Stability Evaluation dated March 26, 2010. URS added a proposed soil buttress and re-analyzed the models to evaluate the effect of the soil buttress on the slope stability and verify that the Factor of Safety after construction of the soil buttress would exceed 1.5 which is the target value as established by TVA's Programmatic Document. A toe seepage collection drain is to be installed to collect groundwater, maintain the phreatic surface elevation, and keep water from infiltrating into the soil buttress. The various parameters used to construct the slope stability models are as follows:

- Model geometry - including subsurface conditions and stratigraphy
- Material Properties – including strength and unit weight properties for each material
- Water Table Elevations – including estimated groundwater levels based on piezometric data obtained by Stantec between September 2009 and December 2009.

Model Geometry

The cross-sections selected for analysis were Sections D, G, and I from the Stantec Slope Stability Analysis. These are the cross sections that had a Factor of Safety of less than 1.5 based on Stantec's evaluation. These cross sections were analyzed using the same geometry as the Stantec model with the exception of the proposed buttress that was added. URS exercised due diligence by performing a spot check of data included in the Stantec models. URS compared topographic data from the Stantec models against new topography obtained through an aerial performed in January 2010. URS also compared water elevations and stratigraphy data from the Stantec models versus the boring logs included in the Stantec Report.

Summary of Subsurface Conditions

Subsurface conditions were provided in the Stantec Report. Based on Stantec's geotechnical exploration, the perimeter dike systems for the stack consist primarily of clay. Inside the dikes surrounding the stack, the exploration detected sluiced ash ranging from about 15 to 25 feet thick, overlain by dry stacked fly ash. The disposal area is underlain by native clays and then by limestone bedrock.

Stratigraphy

The stratigraphy for the cross-sections was provided by the models performed by Stantec. Stantec performed a geotechnical investigation along the alignment of the cross sections that were evaluated for slope stability. Lab testing was performed to obtain the characteristics of the existing stratigraphic layers. The following stratigraphic layers were included in the slope stability models included in the Stantec Report:

1. *Proposed Buttress and Cap* – This stratum represents a geosynthetic cap system installed over the final ash grades and a soil layer ranging in thickness from 3 feet to 15 feet placed on top of the existing dike. The soil buttress will be specified to consist of clayey soils very similar in nature to the clay dike materials. The soil buttress will be placed and compacted in a controlled manner.
2. *Clay Dike* – The dike materials are clay soils with USCS classifications of CL and CH, and textural descriptions of lean clay with sand, lean clay with gravel, gravelly lean clay with sand, gravelly fat clay with sand, and fat clay with sand. The clays are typically moist in moisture content with some isolated wet zones encountered and predominantly reddish brown to brown in color. Based on SPT N-values, the dike clays have strength consistencies ranging mostly from medium to very stiff, with a few isolated instances of soft consistencies.
3. *Stacked Ash* – The stacked fly ash has a USCS classification of ML, with textural descriptions of silt and silt with sand. Based on SPT N-values, the stacked fly ash has strength consistencies typically ranging primarily from medium to very stiff, with some zones of lesser strength consistencies also being encountered.
4. *Sluiced Ash*– Classification testing performed on selected fly ash samples resulted in a USCS classification of ML with a textural description of silt. The ash materials are black in color and wet in moisture content. SPT N-values indicate very soft to soft strength consistencies.
5. *Native Clay*- Below the clay dike and ash materials, native clay materials were encountered. Based on laboratory tests and on visual classifications, the native clay has USCS classifications primarily of CL or CH with textural descriptions of lean clay, lean clay with sand, fat clay, fat clay with sand, and gravelly fat clay. Other lesser occurring material classifications include ML, GM, and GC with corresponding textural descriptions of sandy silt, silty gravel with sand, and clayey gravel. These horizons are typically reddish brown (with other shades of brown also being present), and moist to wet in moisture content. Based on SPT N-values, the native soils have strength consistencies

ranging mostly from medium stiff to very stiff, with some zones of very soft to soft consistencies also being present.

Material Properties

The analyses were performed using effective stress conditions, which represent long-term drained conditions. The ash has been in-place for several years; as a result, effective stress conditions are considered appropriate.

The material properties used in the model include the total unit weight, , and effective strength parameters , friction angle, and *c*, cohesion. Material parameters used in all slope stability analyses were as follows:

Layer	***Unit Weight* (lb/ft^3)**	**(deg)**	***c* (psf)**
Native Clay	125	29	200
Sluiced Ash	85	26	0
Stacked Ash	105	32	0
Clay Dike	125	28	100
Buttress	120	28	250

URS utilized the unit weights, friction angles, and cohesion values provided by Stantec for the native clay, sluiced ash, stacked ash, and clay dike. URS used typical values for the soil buttress.

Water Table

Groundwater data provided in the Stantec cross sections was utilized for the URS models. The groundwater elevations were obtained through piezometer readings. Stantec installed piezometers at several selected boring locations to measure the groundwater level/pore water pressures. Piezometer tips were installed within the lower sluiced ash, native clay, and perimeter dike materials. Most piezometer tips were installed within the lower sluiced ash material.

A toe drain system is proposed for installation under the buttress around the perimeter of the ash stack. This toe drain system is not being installed to improve stability in the existing ash stack, but rather to collect surface water and prevent it from seeping out from the newly constructed buttress. The slope of this drain is shallow in portions (approximately 0.2% in portions) and cleanouts have been designed to allow the pipes to be cleaned as necessary to prevent clogging of the pipe. To illustrate that adequate stability will be achieved even if this pipe becomes temporarily clogged, the phreatic surface has been articially increased for each of the critical sections to approximately equal to the elevation of the bottom of the proposed cap system. This mimics a theoretical condition where the pipe becomes temporarily clogged during a period of large infiltration of the ash stack and the phreatic water surface rises locally near these critical sections. This is assumed to be a temporary condition and therefore this water table is not applied to the existing clay dike material.

III. Methodology

A failure surface geometry was considered for each cross-section, for the static condition. SLOPE/W searches for and finds the critical (i.e. with lowest factor of safety) failure surface for circular failure geometries.

A description of the failure surface considered for the cross-sections, as well as general commentary on the analysis methodology is provided below. The description given is the general geometry for the surfaces being considered.

Potential Failure Geometry:

Circular Failure: This analysis included circular failure geometry, passing through the ash stack, dike, buttress, and underlying soils. It should be noted that while running the model for this case, only the critical failure surfaces were considered.

IV. Results of Analysis

As stated previously, the required factor of safety as determined in the Programmatic Document is 1.50. This value is used to assess the results of the analysis which are given below

Potential Failure Geometry	Cross-Sections		
	D	G	I
	Factor of Safety	Factor of Safety	Factor of Safety
Circular	1.84	2.04	1.89
Circular – Temporary High Water Table	1.77	2.04	1.80

From the above table, safety factors for all three of the cross-sections are at or above the target value of 1.50 for the Factor of Safety as established by TVA's Programmatic Document.

V. Conclusions

In order to evaluate the stability of Ash Stack 5 with respect to its configuration, URS performed a slope stability analysis of the three cross sections that Stantec identified as having factors of safety less than 1.50. For completeness, URS also examined the geometries of other cross sections in between the ones presented here. These cross sections were found to have similar geometries to the cross sections that were evaluated and presented.

The results of the analysis indicate that factors of safety against failures meet or exceed the target value of 1.50 as established by the Programmatic Document. The installation of the proposed toe drain to maintain the phreatic surface level and the proposed soil buttress will improve the stability of Ash Stack 5. Thus, the configuration of the facility, as proposed, should be acceptable with regard to slope stability considerations.

Slope Stability Section D
Ash Stack 5

Colbert Fossil Plant
Tennessee Valley Authority

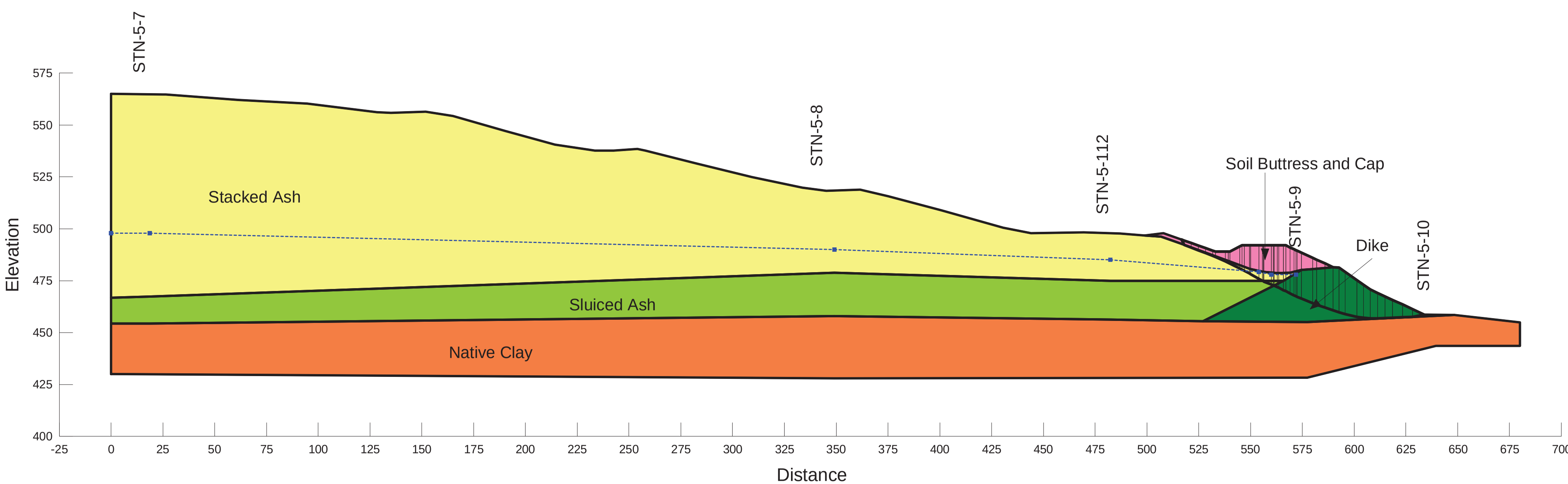
May 2010
Method: Spencer
File Name: AS5_SectionD_with Buttcap.gsz

Note:
The results and analysis shown here are based on subsurface information, laboratory test results, and approximate soil properties provided by Stantec. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 1.89

Minimum Slip Surface Depth: 10 ft

Material Type	Unit Weight	Cohesion	Friction Angle
Stacked Fly Ash	105 pcf	0 psf	32 °
Sluiced Fly Ash	85 pcf	0 psf	26 °
Native Clay	125 pcf	200 psf	28 °
Clay Dike	125 pcf	100 psf	29 °
Buttress and Cap	120 pcf	250 psf	28 °



Slope Stability Section D - with Temp High Water Level
Ash Stack 5

Colbert Fossil Plant
Tennessee Valley Authority

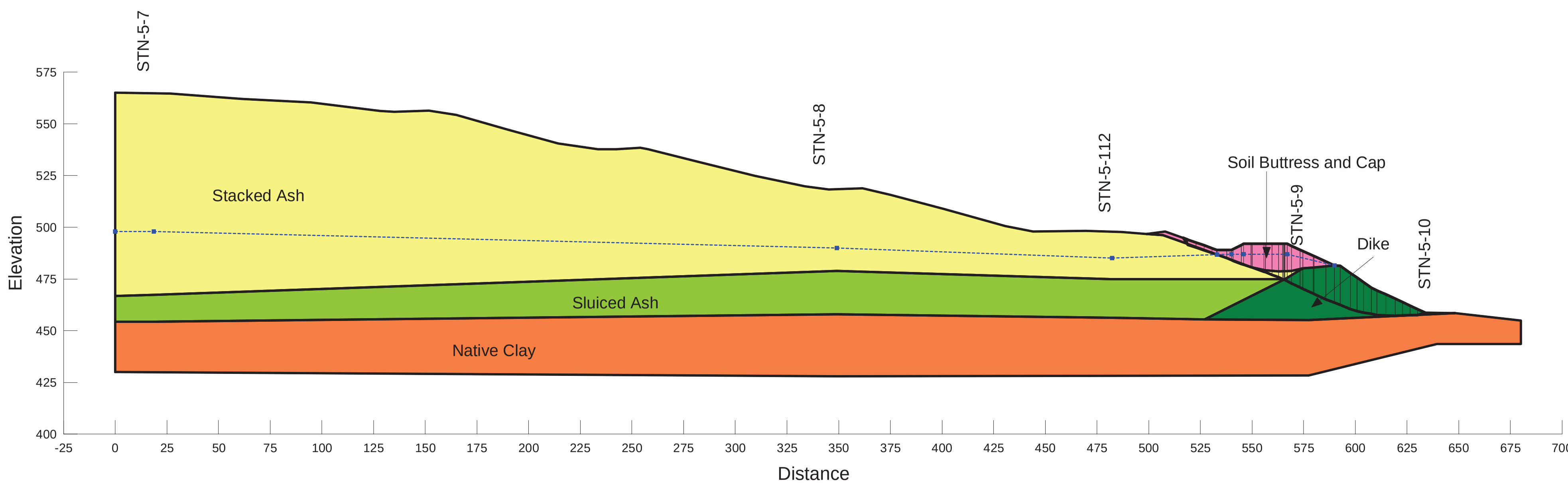
Factor of Safety: 1.77

Minimum Slip Surface Depth: 10 ft

May 2010
Method: Spencer
File Name: AS5_SectionD_with Buttcap-HighWaterLevel.gsz

Material Type	Unit Weight	Cohesion	Friction Angle
Stacked Fly Ash	105 pcf	0 psf	32 °
Sluiced Fly Ash	85 pcf	0 psf	26 °
Native Clay	125 pcf	200 psf	28 °
Clay Dike	125 pcf	100 psf	29 °
Buttress and Cap	120 pcf	250 psf	28 °

Note:
The results and analysis shown here are based on subsurface information, laboratory test results, and approximate soil properties provided by Stantec. No warranties can be made regarding the continuity of subsurface conditions between the borings.



Slope Stability Section G
Ash Stack 5

Colbert Fossil Plant
Tennessee Valley Authority

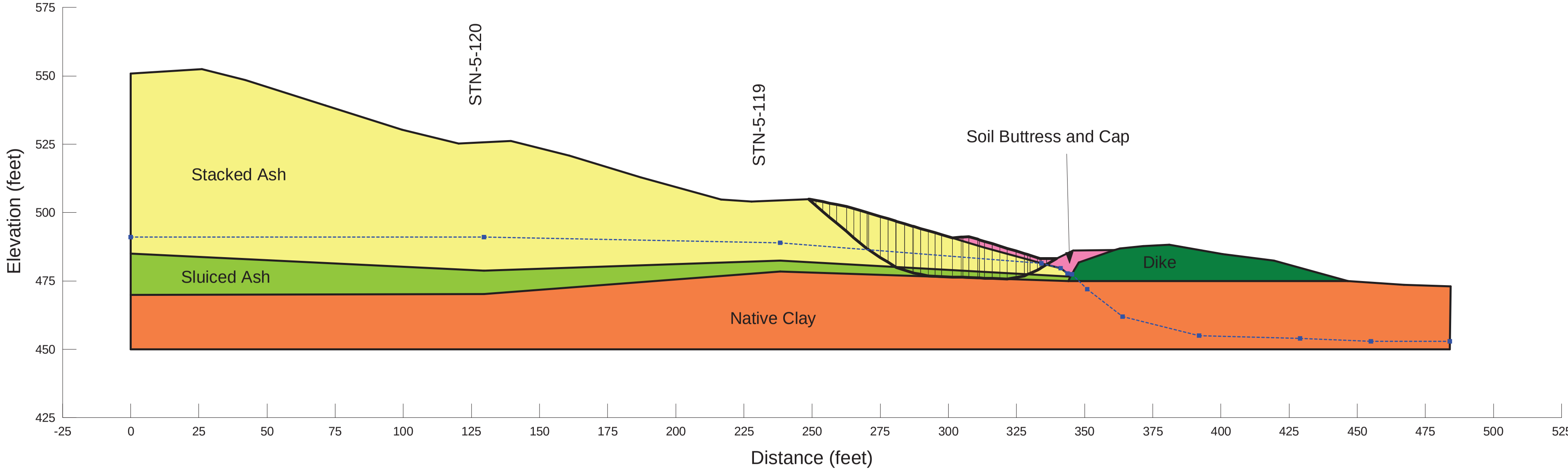
May 2010
Method: Spencer
File Name: AS5_SectionG_with Buttcap.gsz

Note:
The results and analysis shown here are based on subsurface information, laboratory test results, and approximate soil properties provided by Stantec. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 2.09

Minimum Slip Surface Depth: 10 ft

Material Type	Unit Weight	Cohesion	Friction Angle
Stacked Fly Ash	105 pcf	0 psf	32 °
Sluiced Fly Ash	85 pcf	0 psf	26 °
Native Clay	125 pcf	200 psf	28 °
Clay Dike	125 pcf	100 psf	29 °
Buttress and Cap	120 pcf	250 psf	28 °



Slope Stability Section G - with Temp High Water Level
Ash Stack 5

Colbert Fossil Plant
Tennessee Valley Authority

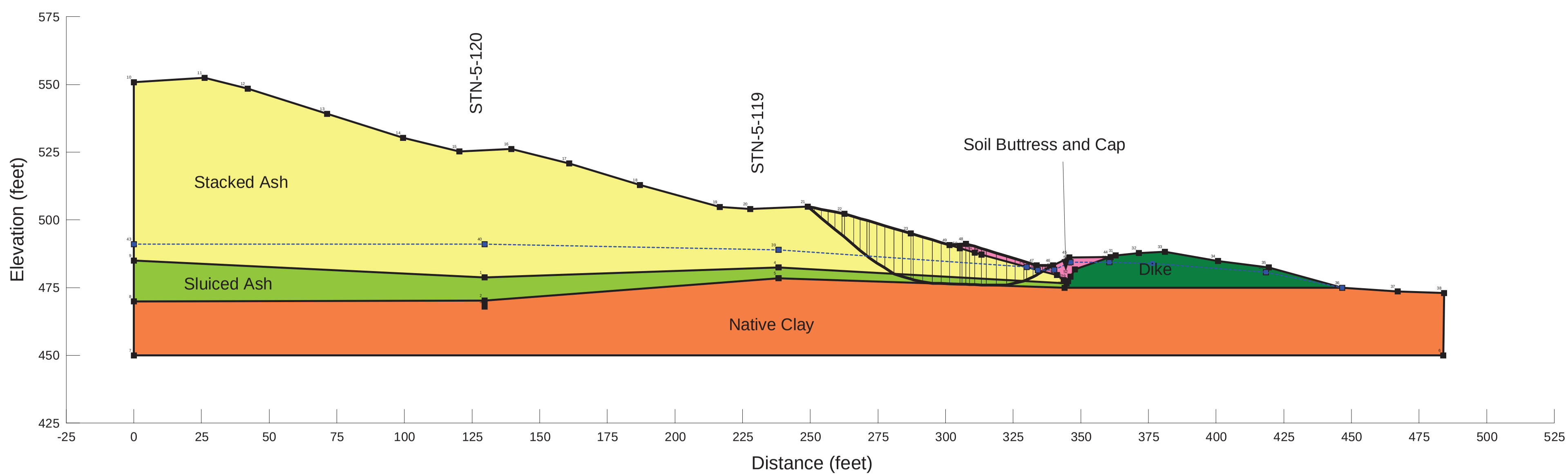
May 2010
Method: Spencer
File Name: AS5_SectionG_with Buttcap-HighWaterLevel.gsz

Note:
The results and analysis shown here are based on subsurface information, laboratory test results, and approximate soil properties provided by Stantec. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 2.04

Minimum Slip Surface Depth: 10 ft

Material Type	Unit Weight	Cohesion	Friction Angle
Stacked Fly Ash	105 pcf	0 psf	32 °
Sluiced Fly Ash	85 pcf	0 psf	26 °
Native Clay	125 pcf	200 psf	28 °
Clay Dike	125 pcf	100 psf	29 °
Buttress and Cap	120 pcf	250 psf	28 °



Slope Stability Section I
Dry Stack 5

Colbert Fossil Plant
Tennessee Valley Authority

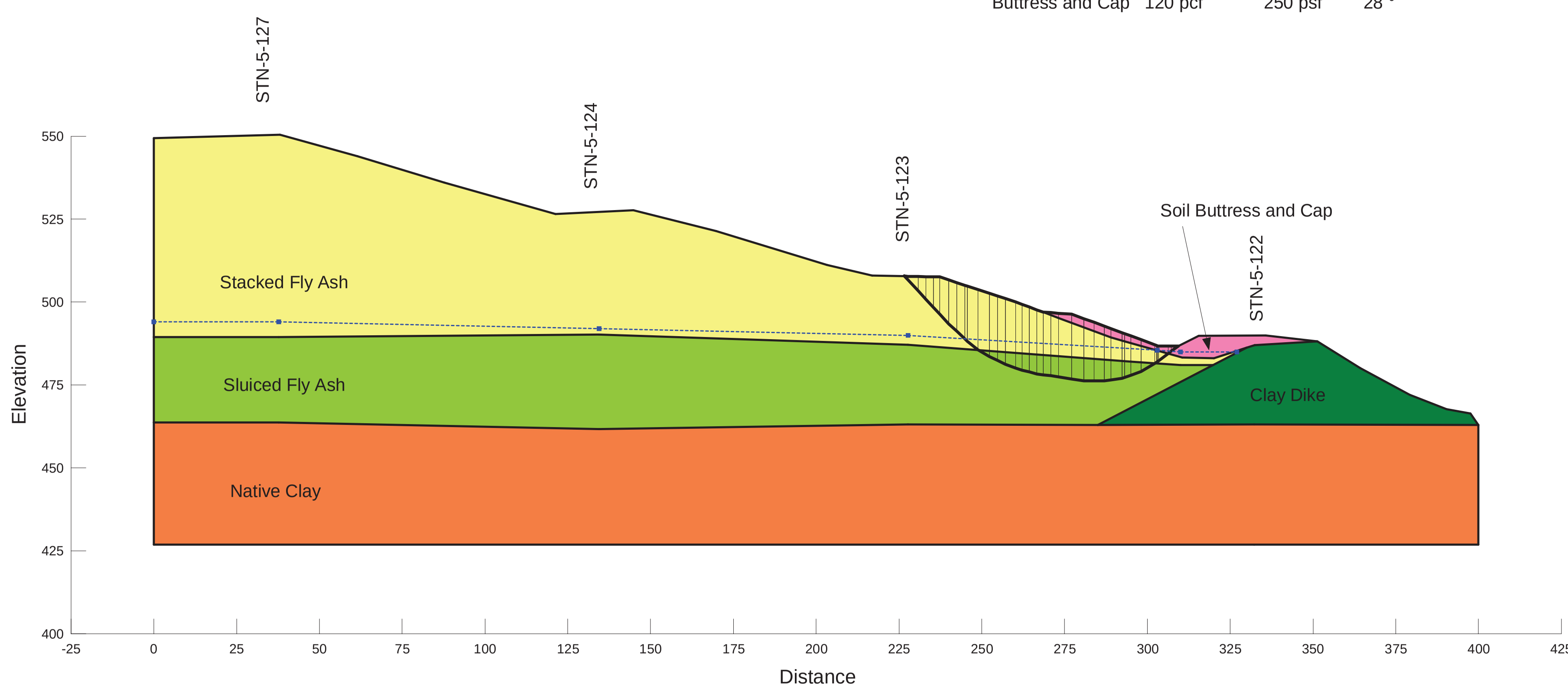
May 2010
Method: Spencer
File Name: AS5_SectionI_with Buttcap.gsz

Note:
The results and analysis shown here are based on subsurface information, laboratory test results, and approximate soil properties provided by Stantec. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 1.90

Minimum Slip Surface Depth: 10 ft

Material Type	Unit Weight	Cohesion	Friction Angle
Stacked Fly Ash	105 pcf	0 psf	32 °
Sluiced Fly Ash	85 pcf	0 psf	26 °
Native Clay	125 pcf	200 psf	28 °
Clay Dike	125 pcf	100 psf	29 °
Buttress and Cap	120 pcf	250 psf	28 °



Slope Stability Section I - with Temp High Water Level
Dry Stack 5

Colbert Fossil Plant
Tennessee Valley Authority

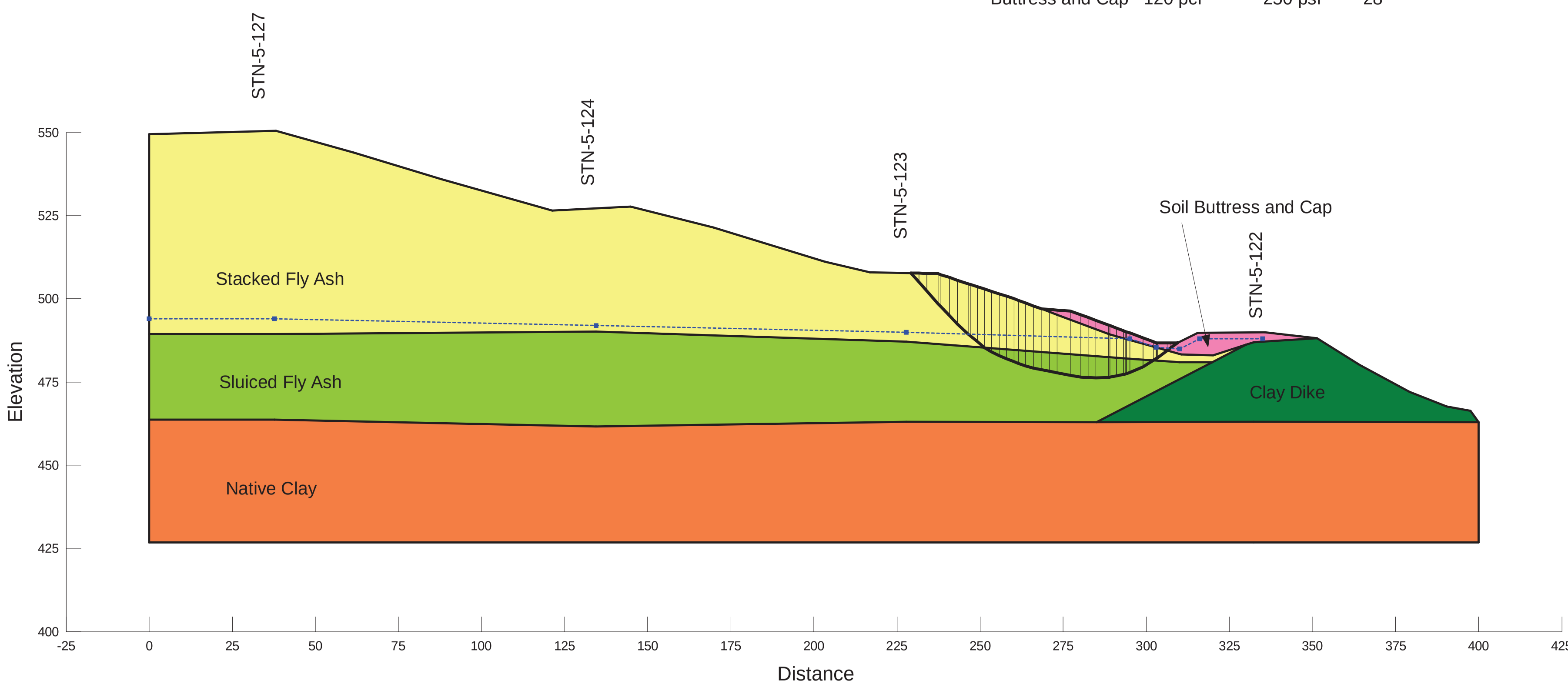
May 2010
Method: Spencer
File Name: AS5_SectionI_with Buttcap-HighWaterLevel.gsz

Note:
The results and analysis shown here are based on subsurface information, laboratory test results, and approximate soil properties provided by Stantec. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 1.80

Minimum Slip Surface Depth: 10 ft

Material Type	Unit Weight	Cohesion	Friction Angle
Stacked Fly Ash	105 pcf	0 psf	32 °
Sluiced Fly Ash	85 pcf	0 psf	26 °
Native Clay	125 pcf	200 psf	28 °
Clay Dike	125 pcf	100 psf	29 °
Buttress and Cap	120 pcf	250 psf	28 °



APPENDIX A

Document 13

Stantec Consulting Services Correspondence Dated September 27, 2011, Re: Results of Seismic Slope Stability Analysis

Stantec

Stantec Consulting Services Inc.
10509 Timberwood Circle Suite 100
Louisville, KY 40223-5301
Tel: (502) 212-5000
Fax: (502) 212-5055

September 27, 2011 ltr_004_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
Colbert 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 Colbert Fossil Plant (COF) 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 COF's active disposal facilities, which include Area 5 Dry Stack/Stilling Basin and Ash Pond 4.

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 COF, completion of closure for Area 5 Dry Stack is currently planned for 2014, and closure of Ash Pond 4 is currently planned for 2020.

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; Disposal Area 5 Dry Stack and Drainage Basin; Colbert Fossil Plant, Tuscumbia, Alabama; March 26, 2010.
    - Report of Geotechnical Exploration and Slope Stability Evaluation; Ash Pond 4; Colbert Fossil Plant, Tuscumbia, Alabama; January 22, 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. One section was also selected for the Area 5 stilling pond. 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 changes 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". Tennessee dam safety regulations were selected for reference since Alabama does not have such regulations. The peak ground acceleration (or seismic coefficient) for a 500 year return period was selected from Table 15 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 indicate the following factors of safety:

- Area 5 Dry Stack – 1.2
- Area 5 Stilling Basin – 1.3
- Ash Pond 4 – 1.3

These are greater than the target value of 1.0.

Enclosure B contains a summary spreadsheet, SLOPE/W cross-sections, and plan views showing cross-section locations.

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

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URS Corporation

Gonzalo Castro
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 4/22/09

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

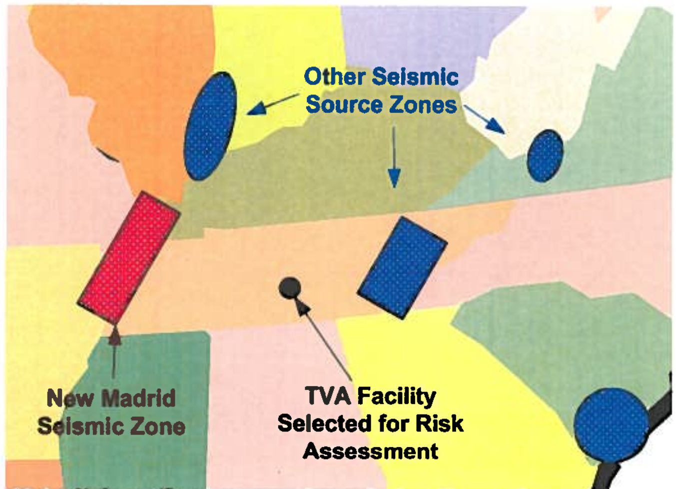
TVA Risk Event Probability Rating Scale		
Score	**Rating**	**Description**
5	Virtually Certain	95% probability that the event will occur in the next 3 years /10 years
4	Very Likely	75% probability that the event will occur in the next 3 years/10 years
3	Even Odds	50% probability that the event will occur 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 1,000 500 250 100	0.0004 0.001 0.002 0.004 0.01	*Values to be determined from the seismic hazard curves*	*Values to be determined from the hazard de-aggregation data**
All Other Seismic Sources	2,500 1,000 500 250 100	0.0004 0.001 0.002 0.004 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

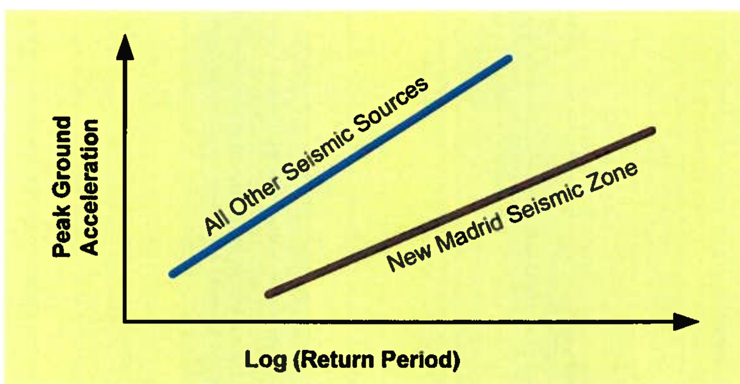


Figure 2. Typical Seismic Hazard Curves for Proposed Probabilistic Assessment of TVA Facilities

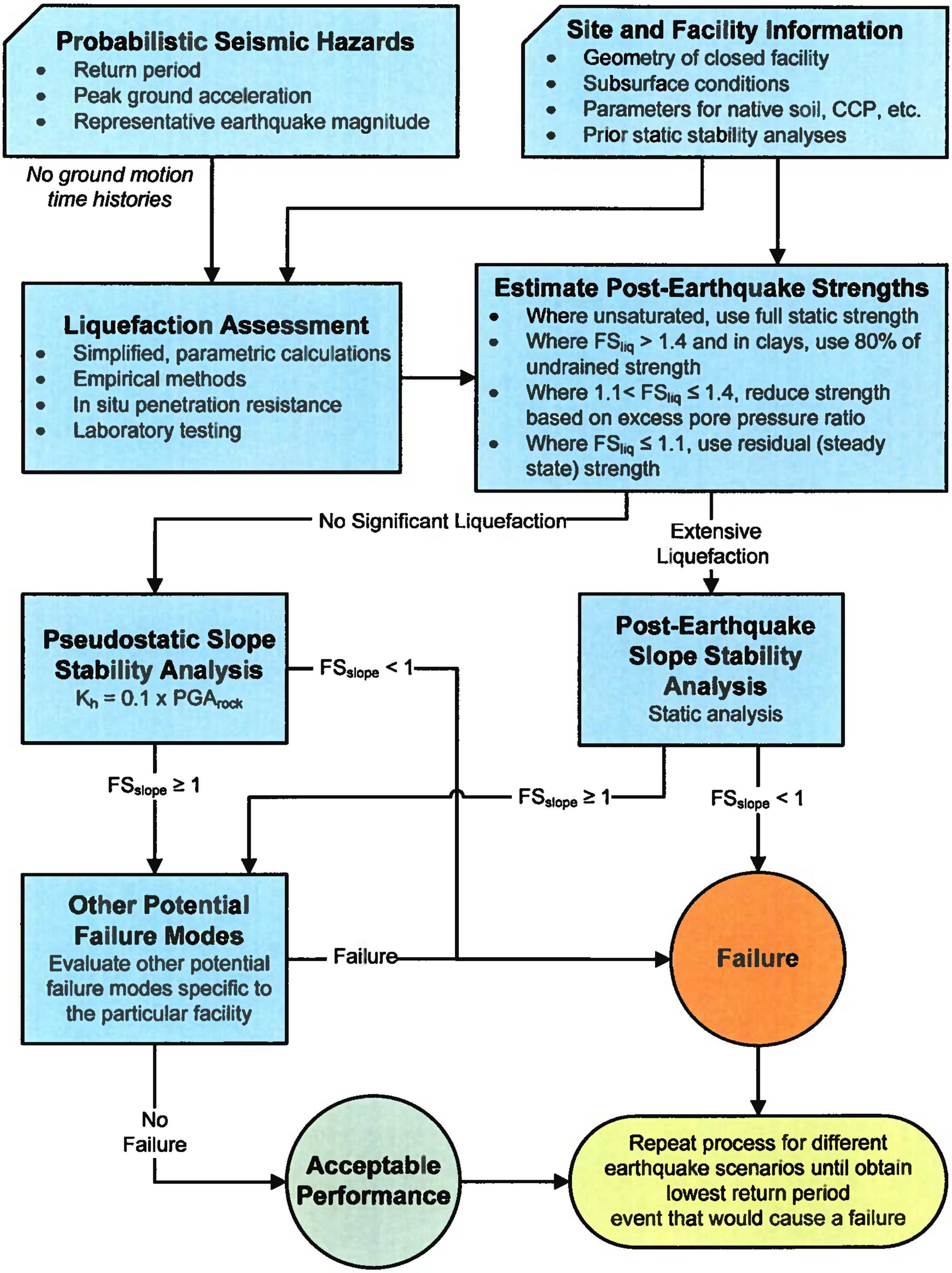


Figure 3. Simplified Flowchart for Assessing Facility Performance During a Probabilistic Seismic Event in Phase A

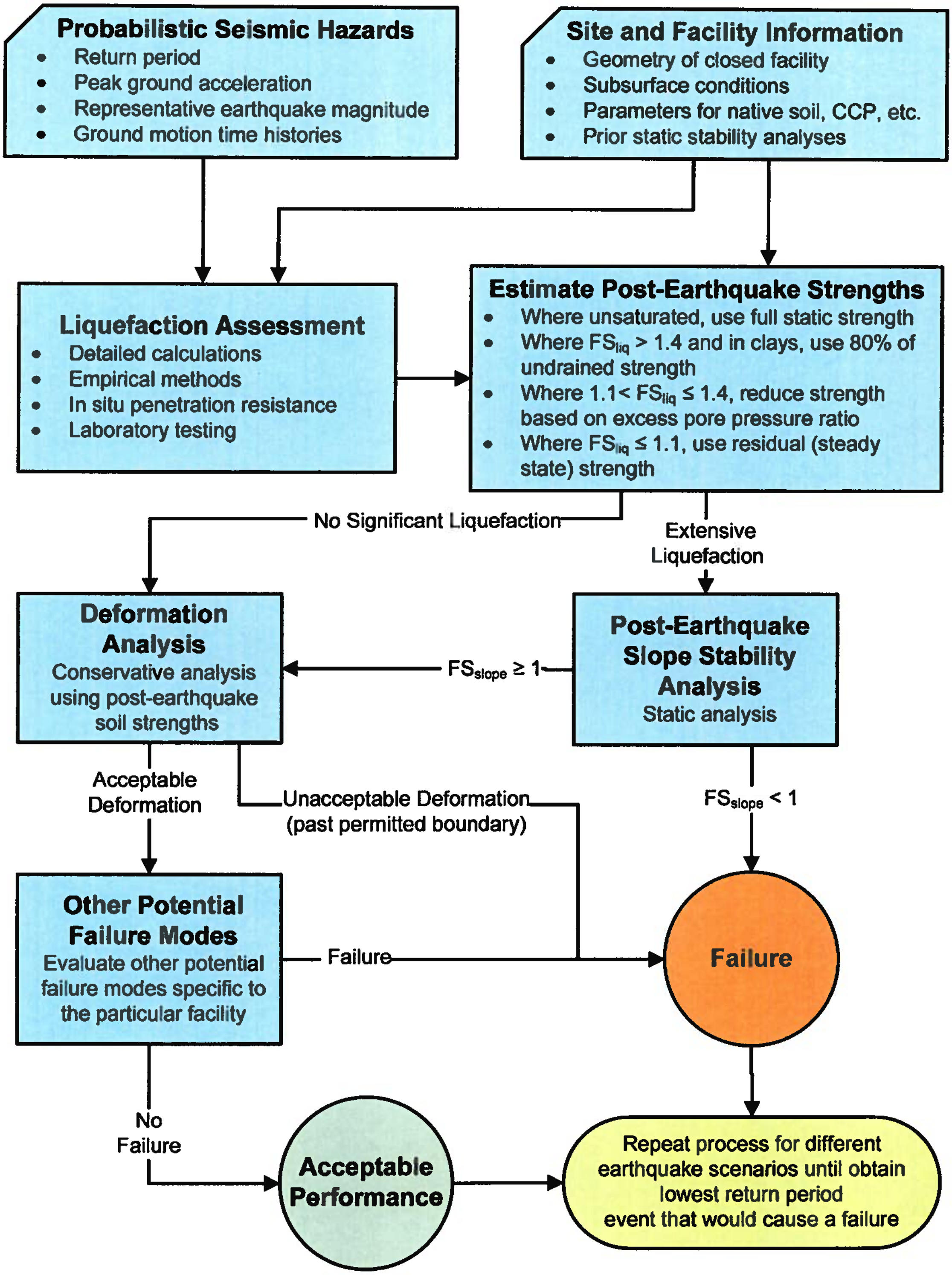


Figure 4. Simplified Flowchart for Assessing Facility Performance During a Probabilistic Seismic Event in Phase B

Enclosure B

Pseudostatic Analysis Results

Colbert Fossil Plant - Pseudostatic Stability Analysis Summary

CCP Disposal Facility		Cross-Section Information		500 yr Return		Mitigation and Improvement Activities Since January 2009 As-Found Conditions
Name	Type	Section Analyzed	Section Location	PGA (g) for COF	Factor of Safety	
Area 5 Dry Stack	Stack	I	Northwest Side	0.053	1.2	Construction activities are currently on-going to improve static stability, stormwater drainage, and seepage conditions. This includes raising of perimeter clay dike, constructing a new perimeter ditch, and installing a seepage collection system. Section I represents these mitigations.
Area 5 Stilling Basin	Impoundment	J	Northeast Dike		1.3	No mitigation activities were necessary at Area 5 stilling pond. As-found static FS was sufficient. Section J represents current and as-found conditions.
Ash Pond 4	Impoundment	D	East Dike		1.3	Mitigation activities to Ash Pond 4 include: spillway replacement (complete), lowering of pool (complete) and lowering of dike in stilling pond area (complete). A mid-slope seepage collection system is also currently under construction along north, east and south sides. Section D slope stability model has been updated to reflect the completed improvements.

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 I - Disposal Area 5
Colbert Fossil Plant
Tuscumbia, Alabama

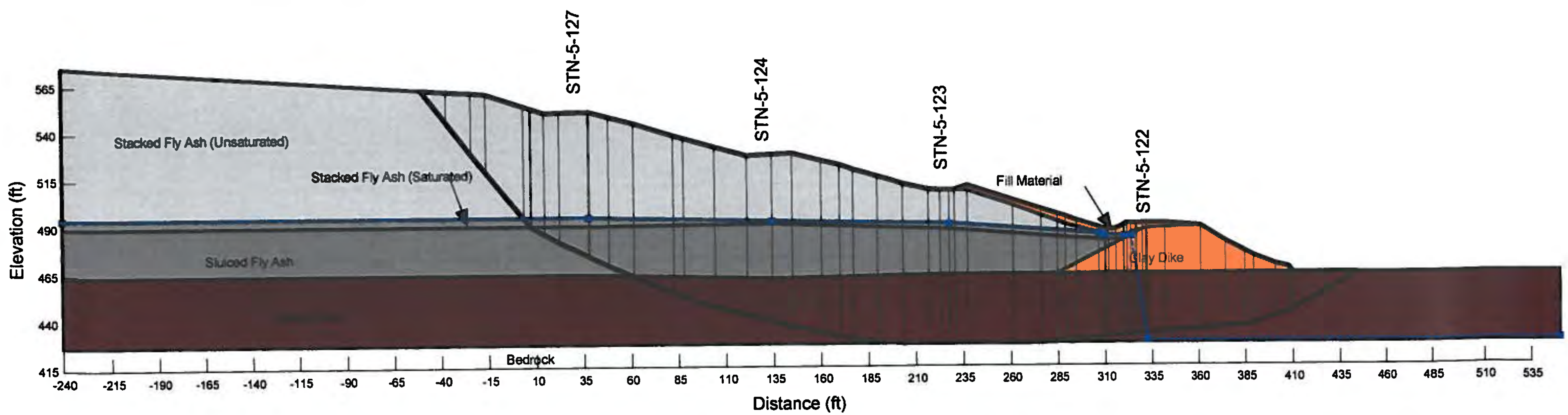
Material Type	Unit Weight	Cohesion	Friction Angle
Stacked Fly Ash (Unsaturated)	105 pcf	0 psf	32 °
Stacked Fly Ash (Saturated)	105 pcf	0 psf	32 °
Sluiced Fly Ash	85 pcf	400 psf	10 °
Fill Material	125 pcf	200 psf	15 °
Clay Dike	125 pcf	200 psf	15 °
Native Clay	125 pcf	289 psf	14.4 °

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.

Additional remediation measures taken from URS plans dated 7/09/2010.

Factor of Safety: 1.15

Horizontal Sesmic Coefficient Kh = 0.053 g
500-year Return Period Event



Date of Assessment - 09/09/2011

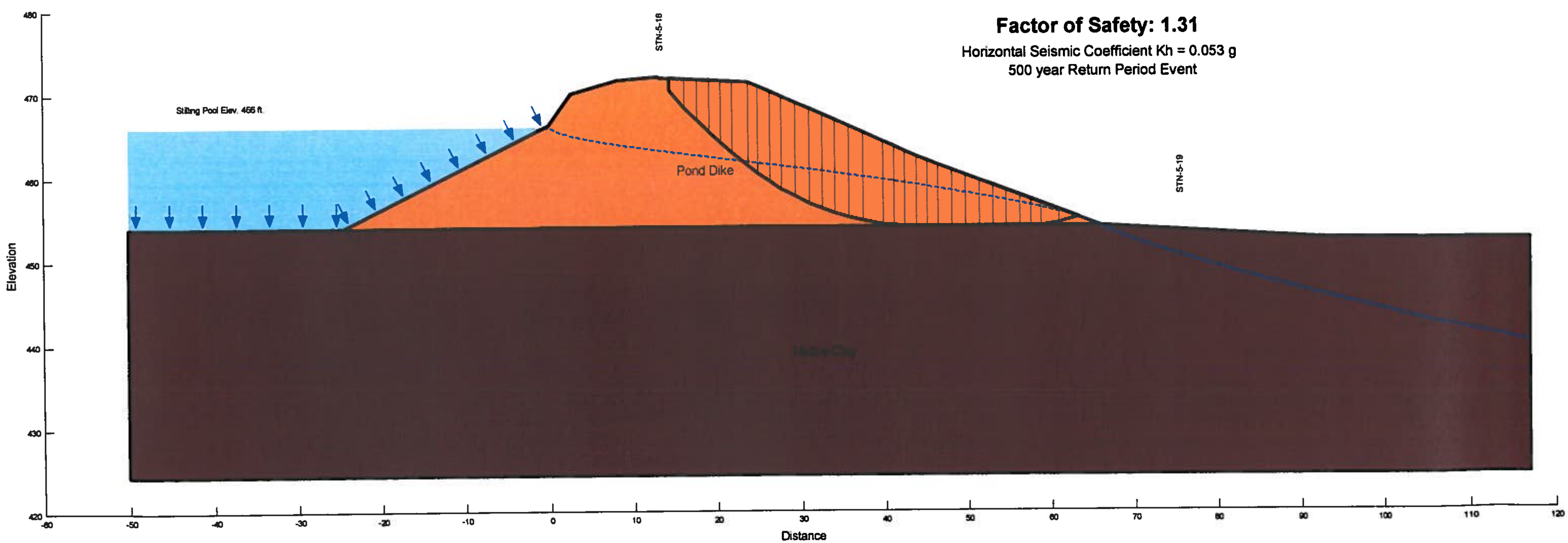
Project No. 175551015

Pseudostatic Slope Stability Analysis
CCP Storage Facilities - Existing Conditions
Tennessee Valley Authority Fossil Plants

Section J - Disposal Area 5 Stilling Basin
Colbert Fossil Plant
Tuscumbia, Alabama

Note:
The results and 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
Native Clay	125 pcf	289 psf	14.4 °
Pond Dike	125 pcf	200 psf	15 °



Project No. 175551015

Date of Assessment - 09/14/2011

Pseudostatic Slope Stability Analysis
CCP Storage Facilities - Existing Conditions
Tennessee Valley Authority Fossil Plants

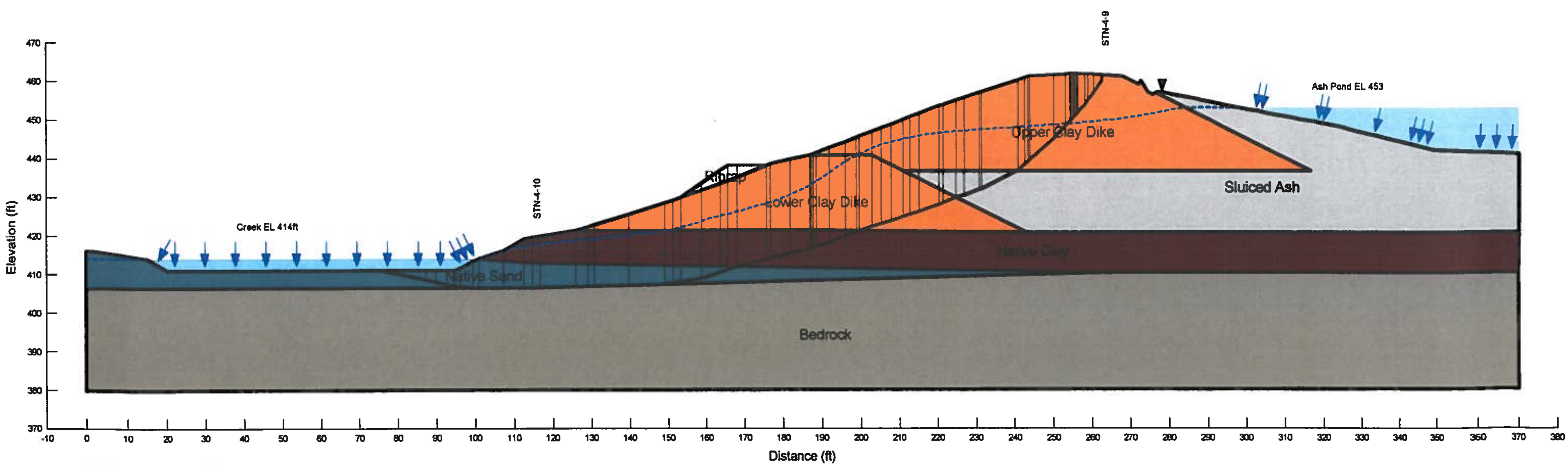
Section D - Ash Pond 4
Colbert Fossil Plant
Tennessee Valley Authority

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.

Additional remediation measures taken from URS plans dated 05/20/2010.

Material Type	Unit Weight	Cohesion	Friction Angle
Native Clay	129 pcf	700 psf	14 °
Upper Clay Dike	126 pcf	750 psf	12 °
Lower Clay Dike	127 pcf	400 psf	14 °
Sluiced Ash	85 pcf	400 psf	10 °
Native Sand	110 pcf	0 psf	30 °

Factor of Safety: 1.25
Horizontal Seismic Coefficient Kh = 0.053 g
500-year Return Period Event



Date of Assessment - 09/09/2011

Project No. 175551015

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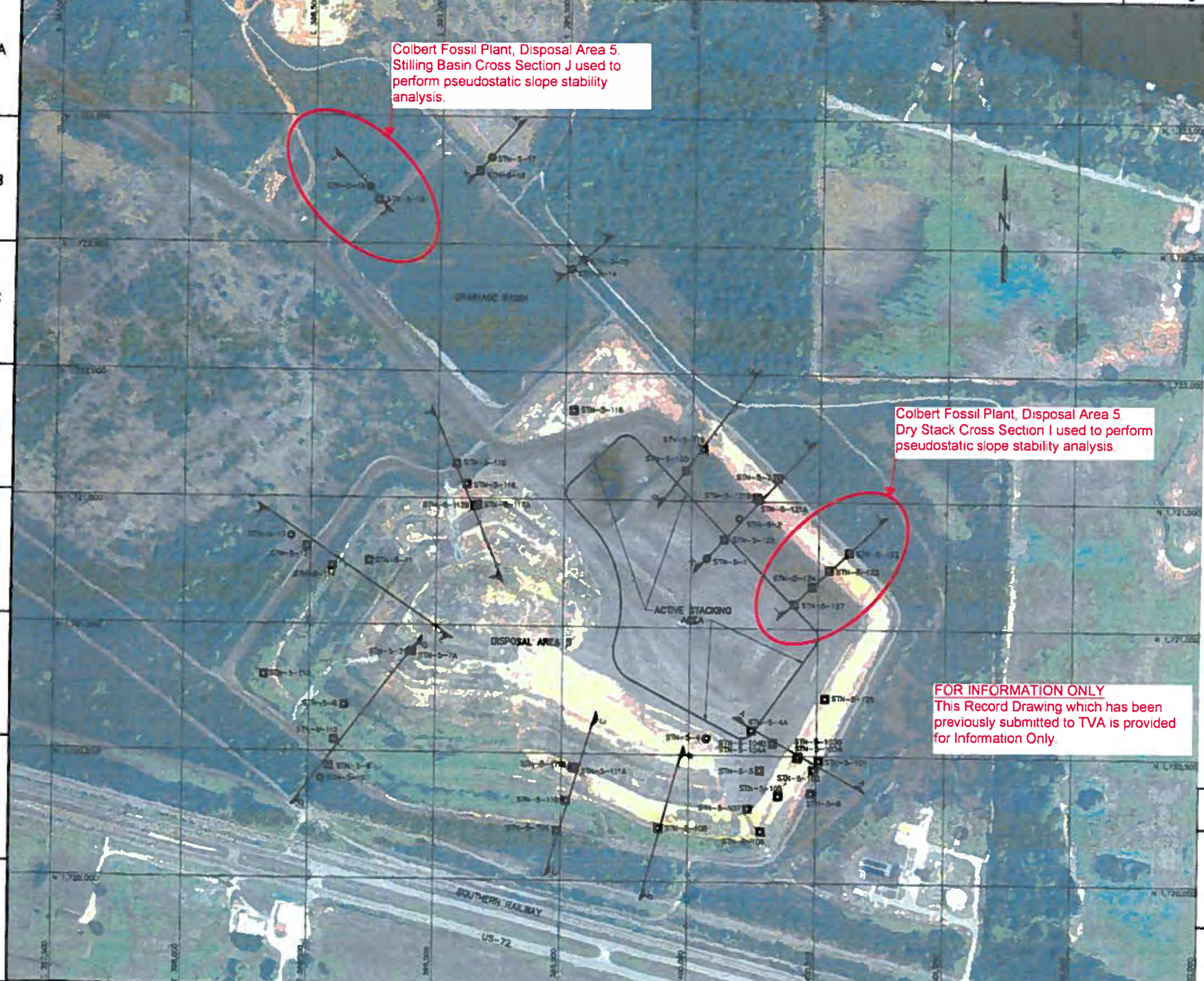

LEGEND

- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Sampling
- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Piston Sampling (Piezometer Installed)
- Soil Boring With Continuous Standard Penetration Tests And/or Shelby Tube Sampling Rock Core, And Piezometer Installed
- Cross Section

BORING LOCATION TABLE

Boring	Northing	Easting	Elev. (ft.)
STN-5-1	1,721,274.40	400,063.00	552.91
STN-5-2	1,721,432.78	400,188.85	529.19
STN-5-3	1,721,582.79	400,338.67	487.54
STN-5-4	1,720,567.21	400,067.86	559.96
STN-5-4A	1,720,600.17	400,244.82	550.70
STN-5-5	1,720,441.17	400,279.90	528.71
STN-5-6	1,720,353.73	400,481.02	488.06
STN-5-7	1,720,895.57	398,898.12	564.52
STN-5-7A	1,720,897.20	398,906.71	565.34
STN-5-8	1,720,684.92	398,641.15	517.92
STN-5-9	1,720,444.22	398,582.56	480.52
STN-5-10	1,720,393.13	398,546.84	459.65
STN-5-11	1,721,251.58	398,733.51	515.53
STN-5-12	1,721,306.21	398,486.81	477.77
STN-5-13	1,721,346.27	398,424.38	452.28
STN-5-14	1,722,407.30	399,518.43	475.88
STN-5-15	1,722,443.72	399,562.30	462.85
STN-5-16	1,722,788.34	399,148.51	475.84
STN-5-17	1,722,840.75	399,195.10	456.60
STN-5-18	1,722,671.43	398,752.90	472.18
STN-5-19	1,722,721.98	398,717.11	453.41
STN-5-101	1,720,482.33	400,509.25	486.97
STN-5-102	1,720,445.72	400,489.29	486.80
STN-5-103A	1,720,493.35	400,426.84	508.95
STN-5-103B	1,720,498.42	400,429.29	508.48
STN-5-104A	1,720,548.28	400,328.22	530.46
STN-5-104B	1,720,551.74	400,330.04	530.75
STN-5-105	1,720,341.58	400,353.20	507.40
STN-5-106	1,720,202.10	400,284.85	505.40
STN-5-107	1,720,282.02	400,232.46	527.19
STN-5-108	1,720,211.06	399,882.93	509.29
STN-5-109	1,720,195.78	399,486.17	481.82
STN-5-110	1,720,315.43	399,518.59	508.44
STN-5-111A	1,720,445.15	399,553.23	529.32
STN-5-111B	1,720,446.66	399,545.11	529.34
STN-5-112	1,720,548.53	398,601.38	497.91
STN-5-113	1,720,800.24	398,321.28	489.24
STN-5-114	1,721,230.71	398,587.74	487.51
STN-5-115	1,721,636.94	399,073.55	477.77
STN-5-116	1,721,557.19	399,115.86	491.58
STN-5-117A	1,721,475.92	399,158.40	512.79
STN-5-117B	1,721,469.58	399,148.35	512.84
STN-5-118	1,721,850.73	399,533.21	499.18
STN-5-119	1,721,703.92	400,044.78	504.54
STN-5-120	1,721,619.44	399,976.15	525.78
STN-5-121A	1,721,506.28	400,264.15	508.23
STN-5-121B	1,721,514.85	400,256.18	507.94
STN-5-122	1,721,301.29	400,620.41	486.66
STN-5-123	1,721,231.75	400,542.54	508.11
STN-5-124	1,721,165.98	400,476.56	527.23
STN-5-125	1,720,727.47	400,531.28	509.03
STN-5-126	1,721,349.47	400,129.73	554.68
STN-5-127	1,721,097.71	400,407.87	550.45

RECORD DRAWING

GRAPHIC SCALE: 1"=150'

For Supporting Design Calculations see FPOCOFFESCXX0000020100002

SCALE: 1"=150'

EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
BORING AND STABILITY
CROSS SECTION PLAN

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

Stantec

AUTOCAD R 2000 | 37 | C | 10W707-02 | R 0

STANTEC | 0
TASK COMPLETED BY | REV NO

PLOT FACTOR XX

C.A.D. DRAWING DO NOT ALTER MANUALLY

37 | C | 10W706-02

BORING LOCATION TABLE			
BORING	NORTHING	EASTING	ELEVATION
STN-4-1	1,723,580.52	384,390.69	460.2
STN-4-2	1,723,632.72	384,288.32	430.4
STN-4-3	1,723,645.94	384,253.91	427.3
STN-4-4	1,723,316.42	384,738.76	460.4
STN-4-5	1,723,388.01	384,798.52	430.5
STN-4-6	1,723,373.16	384,864.54	419.8
STN-4-7	1,722,880.08	384,960.81	460.8
STN-4-8	1,722,943.48	385,089.80	421.8
STN-4-9	1,722,306.36	385,280.37	461.2
STN-4-10	1,722,357.08	385,401.10	420.8
STN-4-11	1,721,882.96	385,485.31	461.3
STN-4-12	1,721,504.87	385,748.27	448.2
STN-4-13	1,721,330.83	385,874.15	425.3
STN-4-14	1,721,420.08	386,715.63	461.9
STN-4-15	1,721,219.13	385,347.89	460.5
STN-4-16	1,721,128.23	385,351.06	435.1
STN-4-17	1,721,539.58	384,582.90	478.8
STN-4-18	1,721,402.10	384,555.64	461.1
STN-4-19	1,721,352.01	384,475.88	440.3
STN-4-20	1,721,987.83	384,461.02	462.3
STN-4-21	1,721,985.14	384,282.71	460.2
STN-4-22	1,721,857.70	384,085.63	438.0
STN-4-23	1,722,728.47	384,227.94	461.1
STN-4-24	1,722,823.19	384,138.84	444.5

Colbert Fossil Plant, Ash Pond □.
Cross Section D used to perform pseudostatic slope stability analysis.

LEGEND

- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Sampling
- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Piston Sampling, And Piezometer Installation
- Soil Boring With Continuous Standard Penetration Tests And/or Shelby Tube Sampling, Rock Core, And Piezometer Installation

NOTES

1. Topographic and survey information provided by the Tennessee Valley Authority.
2. The Boring Logs And Related Information Shown On This Drawing 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. Any Correlations Shown Between Borings Are Generally Based On Straight Line Interpolation. Actual Conditions Between Borings Are Unknown And May Differ From Those Shown.

FOR INFORMATION ONLY
This Record Drawing which has been previously submitted to TVA is provided for Information Only.

RECORD DRAWING

GRAPHIC SCALE: 1"=200'

For Supporting Design Calculations see FPGCOFFESCOX000002010001

1/22/10

Stantec

SCALE: 1"=200' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION
BORING AND STABILITY
CROSS-SECTION PLAN

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W706-02 | 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 14

TVA Coal Combustion Products Management Program, Master Programmatic Document Vol. 2 Facilities Design and Construction Requirements, December 9, 2009, Prepared by URS

VOLUME 2 OF 3:
FACILITIES DESIGN AND CONSTRUCTION REQUIREMENTS

TVA COAL COMBUSTION PRODUCTS MANAGEMENT PROGRAM

MASTER PROGRAMMATIC DOCUMENT

(REVISION 1.0)

Prepared for:

Tennessee Valley Authority (TVA)
1101 Market Street
Chattanooga, TN 37402-2801

December 7, 2009

URS

1375 Euclid Avenue
Cleveland, Ohio 44115
216-622-2400
Project No. 13813279

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Master List of Acronyms

ACAA	American Coal Ash Association
ADEM	Alabama Department of Environmental Management
ALF	Allen Fossil Plant
AOS	Apparent Opening Size
ARAP	Aquatic Resources Alteration Permit
ARPA	Archaeological Resources Preservation Act
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
BMP	Best Management Practice
BOD	Basis of Design
BRF	Bull Run Fossil Plant
BSL	Business Support Library
C&DD	Construction and Demolition Debris
C2P2	Coal Combustion Products Partnership
CBMPP	Construction Best Management Practices Plan
CBR	California Bearing Ration
CCP	Coal Combustion By Product
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CGP	Construction General Permit
COF	Colbert Fossil Plant
CPT	Cone Penetration Testing
CQA	Construction Quality Assurance
CS&PD	Clean Strategies & Project Development
CUF	Cumberland Fossil Plant
DEP	Department of Environmental Protection
DOT	Department of Transportation
DSWM	Division of Solid Waste Management
E&S	Erosion and Sediment
EA	Environmental Assessment
EAP	Emergency Action Plan
ECM	Erosion Control Matting

EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FERC	Federal Regulatory Energy Commission
FGD	Flue Gas Desulfurization
FHWA	Federal Highway Administration
FML	Flexible Membrane Liner
FOIA	Freedom of Information
FOTG	Field Office Technical Guide
GAF	Gallatin Fossil Plant
GAI-LAP	Geosynthetic Accreditation Institute Laboratory Accreditation Program
GVW	Gross Vehicle Weight
HASP	Health and Safety Plan
HDPE	High Density Polyethylene
HELP	Hydrologic Evaluation of Landfill Performance
HRIM	Haul Road Inspection Manual
IDW	Investigative derived wastes
IW	Industrial Waste
JOF	Johnsonville Fossil Plant
JSA	Job safety analysis
JSF	John Sevier Fossil Plant
KAR	Kentucky Administrative Regulations
KDEP	Kentucky Department of Environmental Protection
KIF	Kingston Fossil Plant
KPDES	Kentucky Pollutant Discharge Elimination System
KRS	Kentucky Revised Statutes
LLDPE	linear low density polyethylene
MS4	Municipal Separate Storm Sewer Systems
MSHA	Mine Safety and Health Administration
MSW	Municipal Solid Waste
MSWL	Municipal Solid Waste Landfill
NAVFAC	Naval Facilities Engineering Command

NDSP	National Dam Safety Program
NEHRP	National Earthquake Hazards Reduction Program
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NOT	Notice of Termination
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
O&M	Operation and Maintenance
O.C.	On Center
OEPA	Ohio Environmental Protection Agency
ONRW	Outstanding National Resource Water
OSHA	Occupational Safety and Health Administration
PAE	Program Administrator of Environmental
PAF	Paradise Fossil Plant
P.E.	Professional Engineer
PGA	Peak Ground Acceleration
PMP	Probable Maximum Precipitation
PPE	Personal Protective Equipment
PRB	Powder River Basin
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
QCP	Qualified Credentialed Professional
RCRA	Resource Conservation and Recovery Act
RFP	Request for Proposal
RHO&M	Routine Handling, Operations, and Maintenance
RLS	Registered Land Surveyor
RO-DS	Reservoir Operations, Dam Safety
RSL	Recompacted Soil Liner
RUSLE	Revised Universal Soil Loss Equation
SAF	Shawnee Fossil Plant
SCD	Soil Conservation District

SCS	Soil Conservation Service
SEM	Scanning Electron Microscope
SPT	Standard Penetration Test
SSD	Stopping sight distance
SWCC	Soil and Water Conservation Committee
SWPPP	Stormwater Pollution Prevention Plan
T&O	Technology and Operations
TADS	Training Aids for Dam Safety
TCA	Tennessee Code Annotated
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation
TDH	Total Dynamic Head
TPE	Third Party Engineering
TR	Technical Release
TRM	Turf Reinforced Matrix
TSS	Total Suspended Solids
TVA	Tennessee Valley Authority
UIP	Underground Injection Permit
USEPA	United States Environmental Protection Agency
USACE	United States Army Corps of Engineers
USCS	United Soil Classification System
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USET	United Southeastern Tribes
USGS	U.S. Geological Survey
USWAG	Utility Solid Waste Activities Group
VOC	Volatile Organic Compound
WCF	Widows Creek Fossil Plant

The Programmatic Document was designed as a management tool to provide guidance for the effective management and planning of Coal Combustion By Product (CCP) streams generated by Tennessee Valley Authority (TVA). The Document addresses engineering design, environmental compliance, safety, training, data management, procedural requirements for construction, inspection, monitoring, and operation of CCP facilities, and applies to all CCP materials generated by TVA. Existing facilities where these materials are managed includes ash ponds (or impoundments), wet stacks, dry landfills, surface water ponds, and chemical ponds. New facilities will include ash ponds, dry landfills, surface water ponds, leachate ponds, and chemical ponds. The Programmatic Document only applies to chemical ponds with respect to structural integrity.

Volume 2 of the Programmatic Document establishes design criteria for all elements of CCP facilities, and includes a Master and Abbreviated version. This volume of the Programmatic Document, **Master Volume 2**, is generally organized to:

1. Define CCP facility types;

2. Define key design elements of CCP facilities;

3. Present minimum state and federal standards and identify industry standards associated with each design element ; and,

4. Provide a selected design standard for each design element.

Similarly, the Abbreviated Volume 2 contains the same information as the Master Version with the omission of the minimum state and federal standards, thereby providing the selected standard for each topic. The Programmatic Document shall be periodically reviewed to reflect the most current CCP streams, design references, regulations and management protocols. The Document should be considered current as of the revision date and number provided on the Document cover.

1.1 FACILITY TYPES

This section describes the facility types discussed in Volume 2 including landfills, ash impoundments, surface water ponds, and leachate storage facilities.

1.1.1 Landfills

Definition

Landfills are defined for the purpose of this Document as an area of land or an excavation in which wastes are placed for disposal or temporary storage and that is not a land application unit, surface impoundment, injection well, or waste pile (any non-containerized accumulation of solid, non-flowing waste that is used for treatment or storage). For TVA purposes, landfills will be used for deposition of CCPs in solid form. Landfills for CCP can be used for permanent disposal or temporary deposition. When landfills are used for temporary deposition, it is to enable beneficial reuse of the CCP upon its removal.

There are several design and construction components to landfills considered standard across the solid waste management industry. These generally include a bottom liner system, leachate collection system, leachate conveyance system, leachate storage or treatment system, waste disposal area, final closure cap system, surface water management system, haul and service roads, groundwater management system, and operational and service infrastructure. The design requirements for each of these components are described in more detail in Volume 2 Section 1 of this Document. A generalized schematic of a landfill, which illustrates these key components, is presented in Figure 1.1.1-1.

Landfill Regulations

Following the Ruling on the Bevil Amendment in 1980, large volume wastes generated from the combustion of coal were determined to be exempt from federal hazardous waste regulations under Subtitle C of RCRA section 3001(b)(3)(C). CCPs are not currently regulated at the federal level and therefore, regulations for disposal of CCPs are administered at the State level.

As of the date of this Document, USEPA is in the process of establishing/negotiating an appropriate classification and regulatory designation for CCP including Federal regulations for management. It is anticipated that the regulations for management of CCPs at the Federal level will be put in-place and will require more stringent regulation of CCPs at the State level. This Document is limited to the current status of the regulations, and does not speculate on the content of the future Federal and state-specific regulations.

<u>Alabama</u>: In Alabama, CCPs are specifically exempted from the definitions of "solid waste" and "industrial waste". Bottom ash and fly ash are defined as a "Special Waste" per Alabama Department of Environmental Management (ADEM) 335-13-1-.03(134). However, ashes from combustion of fossil fuels at electric or steam generating facilities are excluded per ADEM 335-

13-1-.03(13). Therefore, there is no landfill permitting requirements for CCP materials in Alabama.

Kentucky: CCPs are defined as a "Special Waste" per KRS Chapter 224.50-760(1)(a) and are therefore treated separately than solid wastes. The requirements for management and disposal of special wastes are presented in 401 KAR Chapter 45 and the technical and operating requirements for special waste landfills are specified in 401 KAR 45:110. There are very limited requirements specified in 401 KAR 45:110 with respect to specific design, construction and/or operational requirements for Special Waste landfills. Specifics regarding new facility permitting are provided in 401 KAR 45:30.

Tennessee: Disposal of CCPs is permitted in Class II (non-hazardous industrial wastes, commercial wastes and fill) Disposal Facilities, as defined in TDEC 1200-1-7-.01(3). Management of CCP is specifically regulated in Tennessee as presented in TDEC 1200-1-7-.04, which has specific design, permitting, construction and operation requirements for Class II Disposal Facilities.

1.1.2 Ash Impoundments

Definition

Ash impoundment can be defined as a collection of water, wastewater, or liquid-borne materials that is contained by an artificial structure (dam), into which CCPs are placed for disposal or temporary storage. All ash impoundments shall be managed by the TVA Dam Safety Program.

For reference, Table 1.1.2-1 compares the state and federal definitions of dams. Table1.1.2-2 compares the state and federal hazard classifications.

Table 1.1.2-1
Comparison of State and Federal Regulations: Definition of "Dam"

<table>
<tr><th>Criteria</th><th>Alabama</th><th>Kentucky</th><th>Tennessee</th><th>Federal[2]</th></tr>
<tr><td>Any artificial barrier that impounds water</td><td>Yes</td><td>Yes</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Impounds wastewater or liquid-borne materials</td><td>Yes</td><td>No</td><td>No</td><td>See tailings dams, below</td></tr>
<tr><td>Height[3]</td><td>≥25 feet</td><td>≥25 feet</td><td>≥20 feet</td><td>≥25 feet</td></tr>
<tr><td>Storage Volume[4]</td><td>≥50 acre-feet</td><td>≥50 acre-feet</td><td>≥30 acre-feet</td><td>≥50 acre-feet</td></tr>
<tr><td rowspan="2">Other criteria that trigger classification as a dam:</td><td>Probable loss of human life due to failure or improper operation regardless of height or storage volume</td><td>N/A</td><td>N/A</td><td rowspan="2">This lower size limitation should be waived if there is potentially significant downstream hazard. In addition to conventional structures, this definition specifically includes "tailings dams", embankments built by waste products disposal and retaining a disposal pond.</td></tr>
<tr><td>Probable loss of critical infrastructure due to failure or improper operation regardless of height or storage volume [1]</td><td>N/A</td><td>N/A</td></tr>
</table>

Note 1: If the dam and/or the appurtenant utility and ash handling facilities are considered to be critical infrastructure, then any artificial barrier that impounds water, wastewater or liquid-borne materials meets the definition of a dam.
Note 2: Federal criteria referenced from the Federal Guidelines for Dam Safety, prepared by the Interagency Committee on Dam Safety, U.S. Department of Homeland Security, Federal Emergency Management Agency, June 1979, Reprinted April 2004.
Note 3: Federal and state guidelines measure height of dam from the top of the dam crest to the lowest point where the original streambed intersects the downstream toe, or the lowest point along the toe.
Note 4: Federal and state guidelines measure storage capacity at the top of the dam crest, i.e., the maximum possible impounded capacity, irrespective of the elevation of spillways or outlet works.

Table 1.1.2-2
Comparison of State and Federal Regulations: Dam Hazard Classifications

Category	Alabama[1]	Kentucky[1]	Tennessee[1]	Federal
High Hazard	High Hazard Potential Dam: Failure or improper operation will cause probable loss of human life.	Class C: Failure would cause loss of life or serious damage to homes, commercial buildings, utilities, highways or railroads.	Category 1 : Failure would probably result in: loss of human life; excessive economic loss due to damage to downstream properties; excessive economic loss, public hazard, or public inconvenience due to loss of impoundment and/or damage to roads or any public or private utilities.	High Hazard Potential Dam: Failure or misoperation will probably cause loss of human life.
Moderate Hazard	Moderate Hazard Potential Dam: Failure or improper operation results in no probable loss of human life but will cause probable loss of critical infrastructure.	Class B: Failure would cause significant damage to property and project operation, but loss of life is not envisioned.	Category 2 : Failure may damage downstream private or public property, but such damage would be relatively minor and within the general financial capabilities of the dam owner. Public hazard or inconvenience due to loss of roads or any public or private utilities would be minor and of short duration. Chances of loss of life would be possible but remote.	Significant Hazard Potential Dam: Failure or improper operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.
Low Hazard	Low Hazard Potential Dam: A dam not assigned the moderate or high hazard potential classification.	Class A: Failure results in loss of structure itself but little or no additional damage to other property.	Category 3: Failure may damage uninhabitable structures or land but such damage would probably be confined to the dam owner's property. No loss of human life would be expected.	Low Hazard Potential: Failure or improper operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

1. According to the TVA Dam Safety Program, state dam safety regulations do not apply. Rather, the TVA Dam Safety Program follows Federal programs in these regards. The following sections for each state are therefore provided for reference only.

TVA operates coal-fired power plants in Alabama, Kentucky and Tennessee. Dam safety regulations define a "dam" similarly in all three states and federal programs. Once an ash impoundment is closed (in accordance with the provisions herein), it is no longer considered a possible dam structure.

TVA Ash Impoundment Inventory

CCP Engineering will use the TVA Ash Impoundment Inventory Sheet (Appendix 1) to collect information on all wet CCP disposal impoundments, such as location, power plant served, the name of stream impounded (if applicable), USGS quadrangle sheet that shows the site location, original designer, construction contractor, year constructed, height, length, impoundment capacity and related information. Completed inventory sheets will be forwarded to the TVA Reservoir Operations, Dam Safety Group, who will use the information to determine:

- Does the impoundment meet the definition of a dam?
- What is its probable hazard category?
- Should the structure be managed in accordance with the TVA Dam Safety Program?

As appropriate, TVA Reservoir Operations, Dam Safety will accept the facility into its ongoing dam safety program, and will decide what if any investigations or analyses such as dam break inundation mapping are needed to definitively establish the hazard category of the dam.

TVA Reservoir Operations, Dam Safety will assume responsibility for dam safety activities for the ash impoundment classified as a dam, including scheduling of an initial dam inspection, scheduling and frequency of future dam inspections, and the nature and extent of additional investigations that may be required. This may include items such as spillway capacity evaluations, slope stability analyses, seismic evaluations, seepage analyses or other technical activities that are found to be necessary. TVA Reservoir Operations, Dam Safety will also assume responsibility for making repairs, improvements or modifications to the dam as required to promote continued safe operation of the impoundment.

Ash Impoundment Regulations

According to the TVA Dam Safety Program, state dam safety regulations do not apply. Rather, the TVA Dam Safety Program follows Federal programs in these regards. The following sections for each state are therefore provided for reference only,

Alabama: Alabama currently has no dam safety regulations. However, a bill entitled “Alabama Dam Inventory and Classification Act” is under consideration of the state legislature as of February 2008.

Kentucky: Dam safety regulations are in KAR Chapter 4, Title 401, Water Resources, last amended in 1990.

Tennessee: Regulations for dam safety are found in the TDEC, Division of Water Supply, Chapter 1200-5-7, effective February 2001.

Federal: Guidelines for dam safety are found in Federal Guidelines for Dam Safety, prepared by the Interagency Committee on Dam Safety, U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA), June 1979. Water quality from ash impoundment discharges is regulated under the NPDES regulations, under the terms of the facility's NPDES permit.

1.1.3 Surface Water Ponds

Definition

Surface water ponds related to management of stormwater discharges from landfills can be defined as earthen structures used to temporarily retain and/or detain surface water (non-contact water) away from the limits of the landfill or other disturbed area (clean earth disturbances) within the landfill facility. This non-contact water is surface water that has not come into contact with the waste materials and therefore is not considered leachate. Surface water ponds are used for temporarily retaining and/or detaining flows from active construction areas to allow for sediment to settle out of the surface water prior to discharge. In this case, surface water ponds are also referred to as sediment basins. Surface water ponds are also used as permanent stormwater management control structures for stormwater conveyed from a final closure or post-construction area.

Surface water ponds generally consist of an excavated area surrounded by a containment berm that may be formed by either excavated soils (cut) or embankment soils (fill). Inlets and outlets for surface water ponds can be via inlet ditches or piped structures, both typically operating by gravity flow. Riser structures may be used to control the rate and quantity of discharge from the ponds. Typically, surface water ponds are not constructed with bottom liner systems, since the surface water is not contaminated and should not pose a risk to groundwater. Design requirements for surface water ponds are discussed in Volume 2, Section 1 of this Document

Surface Water Pond Facility Regulations

State/Federal: The requirements for the design, use, and monitoring of surface water ponds will be based on the requirements included in the approved site-specific NPDES permit administered by the state regulatory agency (ADEM, KDEP or TDEC). The specified state regulatory agency is responsible for administering the state NPDES and stormwater management program, which may closely follow the federal NPDES requirements. The state NPDES programs regulate the surface water discharge limits from contact water (leachate) and non-contact water (stormwater), or a combined flow of leachate and stormwater.

The design guidance provided in either state specific guidance manuals (available in Alabama and Tennessee, but not in Kentucky), or in the federal Natural Resources Conservation Service (NRCS) standards of the *Field Office Technical Guide* (FOTG) – *Section IV – Practice Standards and Specifications*, are used as the basis for developing surface water pond practices, as well as other best management practices (BMP), for inclusion in the site-specific stormwater pollution prevention plan (SWPPP). The development and submittal of the SWPPP is a regulatory requirement of the general construction permit under state NPDES programs.

Sediment control basins, along with other erosion and sediment (E&S) controls are also regulated at the state level via the state's NPDES program. However, many counties have their own Soil Conservation Districts (SCDs), which are overseen by the NRCS of the United States Department of Agriculture (USDA). The County SCDs also typically offer technical guidance in the development of stormwater and E&S control design and associated planning. Unless granted regulatory or enforcement authority by the State or County, the SCDs and their technical guidance documents do not have the force of law, rather provide guidance for preventing or minimizing the related problems of stormwater management and E&S control.

While regulations for stormwater management are administered at the state level, certain counties or municipalities – typically ones that are closest to or more directly affect significant or sensitive water bodies or locations defined within Municipal Separate Storm Sewer Systems (MS4) regions – may have additional stormwater or E&S requirements. Some of these additional requirements may include detailed design submittals, increased requirements for use of various BMPs, different design storm events, etc. For this reason, it is necessary that the design engineer/consultant preparing the permitting and design documents check with the applicable county or municipality where the facility is sited to determine if there are additional regulatory requirements specific to the facility location.

1.1.4 Leachate Storage Facilities

Definition

Leachate storage facilities are those facilities that temporarily store leachate produced in the landfill or ash impoundment prior to final treatment or disposal. Leachate is liquid that is generated when the materials (CCPs) are compressed. The liquid originates from the material itself, or when surface water infiltrates through the landfill cover materials and/or CCPs. In addition, any surface water that comes in contact with the CCPs is also considered leachate and shall be treated as such. Of the three states, only Kentucky has defined leachate. Kentucky defines leachate as any liquid, including any suspended components in the liquid that has percolated through or drained from waste materials.

Leachate storage facilities typically consist of either an above or below ground leachate storage tank or a leachate storage pond. Leachate can be conveyed to the storage facility by gravity or by forcemains from the operational cells of the landfill.

Key Components of Leachate Storage Facilities

Leachate storage tanks are typically constructed of specialized plastics, fiberglass or metallic with specially treated internal coatings or glass lining to limit corrosion and be compatible (nonreactive) with the chemicals in the leachate. The storage tanks can be single-walled or double-walled. If the tank is single-walled, it is required that a system for secondary containment is included (vault for below grade tanks or perimeter containment for above ground tanks) to reduce the potential for groundwater contamination. The storage tank typically consists of an inlet conveying leachate from a collection manhole with control valving, and an outlet. Leachate is typically pumped from the leachate storage tank to a loadout facility (for truck hauling), treatment system, or connection to a sanitary sewer.

Leachate storage ponds are excavated ponds constructed with a bottom liner system and groundwater monitoring wells to enable monitoring of any potential leaks through from the liner system. The storage pond typically consists of an inlet conveying leachate from a collection manhole with control valving. Leachate is typically pumped or otherwise conveyed from the leachate storage pond to a loadout facility (for truck hauling), treatment system, connection to a sanitary sewer, or a receiving surface water body under an NPDES permit.

Leachate Storage Facility Regulations

As discussed in the Landfill Regulations section (Section 1.1.1), Federal regulations do not govern the design and construction of leachate storage facilities. The State regulations for leachate storage facilities are the same as specified in Section 1.1.1.

1.2 REFERENCES AND SOURCES

References are provided in Appendix 3.

1.3 GENERAL DESIGN CRITERIA

1.3.1 Siting Criteria

Definition

Siting criteria are the exclusionary requirements/guidance to regulate the permitting and ultimate construction of a facility. Siting criteria often include items such as prohibited areas and buffer zones/distances that are to be maintained with respect to the location of a landfill.

Minimum Design Standards

Alabama: In Alabama, CCPs are specifically exempted from the definition of solid waste and industrial waste. Bottom ash and fly ash are defined as a "Special Waste" per Alabama Department of Environmental Management (ADEM) 335-13-1-.03(134). However, ashes from combustion of fossil fuels at electric or steam generating facilities are excluded per ADEM 335-13-1-.03(13). As such, there are no has no specific siting criteria requirements associated with CCP materials

Kentucky: In Kentucky, CCP wastes are considered special wastes, regulated under 401 KAR 45. 401 KAR 45:130 provides siting requirements for new special waste landfills and horizontal expansions to permitted waste boundaries. Requirements include maintaining buffer zones, restricting disposal in floodplain areas, and conforming to site suitability criteria. Site suitability criteria includes satisfying upper aquifer monitoring and corrective action requirements.

Tennessee: Siting criteria requirements for Class I and II facility are provided in TDEC Rule 1200-1-7-.04(2). Siting criteria to be considered includes impact to endangered species, floodplain location, wetland restrictions, karst terrain, seismic impact zones, unstable areas, and maintaining buffer zones.

Selected Design Standards

For a new landfill, all applicable state regulatory siting criteria shall apply. However, in states where specific siting criteria is not defined, landfills shall be located in compliance with the following items:

- Facilities shall not be located in a manner that contributes loss of endangered species, or adverse modification of their habitat.
- Facilities must not be located in a 100-year floodplain unless it can be proven that the location will not restrict the flow of the 100-year flood nor reduce temporary floodplain storage capacity, and the facility is designed, constructed, operated, and maintained to prevent washout of any waste.
- Facilities shall not be located in wetlands, unless the applicant can demonstrate under USEPA Clean Water Act, Section 404, that a practical alternative does not exist. Additionally, the applicant shall demonstrate that construction of the landfill will not cause or contribute to violations of any applicable state water quality standard; or, violate any applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act. The applicant shall also demonstrate that the facility will not cause or contribute to significant degradation of wetlands by establishing the integrity of the landfill and the ability to protect ecological resources. Lastly, as required under Section 404 of the Clean Water Act the applicant shall show that steps have been taken to attempt to achieve no net loss of wetlands.
- For a facility proposed in an area of highly developed karst terrain, the applicant must demonstrate that there is no significant potential for surface collapse, and the location will not cause any significant degradation to the local ground water resources.
- Facilities shall not be located within 200 feet of a fault that has had displacement in Holocene time, unless the applicant demonstrates that an alternative setback distance of less than 200 feet will prevent damage to the structural integrity of the landfill unit and will be protective of human health and the environment.
- Facilities shall not be located in seismic impact zones, unless the applicant demonstrates that all containment structures, including liners, leachate collection systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth materials.
- Facilities proposed for locations in an unstable area must demonstrate that engineering measures have been incorporated to ensure integrity of landfill components. The demonstration shall consider the following factors: soil conditions that may result in significant differential settling; geologic or geomorphologic features; and man-made features or events (both surface and subsurface).
- Additionally, the following buffer distances/zones shall be maintained when siting a landfill:
    - 100 feet from all property lines;
    - 500 feet from all residences, unless the owner of the residential property agrees in writing to a shorter distance;

- 500 feet from all wells determined to be downgradient and used as a source of drinking water by humans or livestock;
- 200 feet from the normal boundaries of springs, streams and lakes; and
- 50 feet from the property line for all constructed appurtenances.

1.3.2 Site Investigations

Site investigations for landfill and impoundment systems shall include geotechnical and hydrogeological explorations. These investigations include exploratory drilling and sampling, field testing, and laboratory testing, and are necessary to establish the subsurface soil, rock, and groundwater conditions to support the facility design. Often, similar drilling and sampling tasks are required for both types of investigations. Costs and schedule can usually be optimized if both investigations are coordinated in conjunction with one another, so that duplication of tasks is eliminated or minimized. The Engineer should be cognizant of this during planning of these investigations.

1.3.2.1 Geotechnical Investigations

Definition

The objective of the geotechnical investigation is to collect sufficient information to define the subsurface conditions at a site as it relates to facility design and construction, and use this information to provide recommendations and perform geotechnical analyses to support the facility design. Important aspects of the geotechnical investigation include defining the stratigraphy, extent and engineering properties of subsurface soils and rock influenced by the facility, groundwater conditions on the site, and the nature and extent of any geologic hazards (such as karst formations and mining activity) that exist on the site as they may influence facility construction and operation.

Minimum Design Standards

Minimum design standards for landfills and ash impoundments on a state-by-state and federal level are described below.

<u>Alabama:</u> Alabama has no specific requirements for geotechnical investigations associated with landfills.

Alabama provides no specific requirements for geotechnical investigations related to impoundment systems.

<u>Kentucky:</u> In Kentucky, CCPs are generally considered special wastes, which are regulated under 401 KAR 45. There are no specific requirements for geotechnical investigations supporting special waste facilities, other than a general statement in 401 KAR 45:110, Section 1 (5) which states that the engineering design for a special waste landfill shall consider the properties of the soil underlying the facility. Requirements for geotechnical investigations for new municipal solid waste facilities (contained wastes) are given in 401 KAR 47:170, Section 3. The requirements for geotechnical investigations for contained waste facilities include a

minimum of nine soil borings per 1000 ft x 1000 ft area of the facility (roughly one boring per 2.5 acres), and a minimum of four rock core borings per facility, with the requirement of an additional rock core boring for each 25 acre increment for facilities whose area is greater than 50 acres. Requirements for reporting information obtained from geotechnical investigations are given in 401 KAR 47:180, Section 6.

Kentucky provides no specific requirements for geotechnical investigations related to impoundment systems.

Tennessee: Tennessee has no specific requirements for geotechnical investigations associated with landfills. Requirements for hydrogeologic investigations are given in 1200-1-7-.04(9)(a).

Tennessee provides guidance for hydrogeologic investigations in its Technical Guidance Document 001, "Hydrogeologic Investigation Guidance Document", January 1, 1993. This document does not make specific reference to geotechnical investigations. Major requirements listed in the document include:

- Borings shall be drilled on an equivalent triangular grid pattern having 200 foot spacing between holes. Holes are to be drilled to a depth of 20 feet below the bottom of the clay liner or to the top of rock, whichever is shallower.
- At least one boring per site or per ten acres of the site shall be drilled to a depth of at least 70 feet below the top of the proposed clay liner or at least 20 feet into bedrock, whichever is shallower. Continuous bedrock cores are required in these borings.
- A complete grain size analysis, natural moisture content, and Atterberg limit tests, shall be performed on a representative sample from each significant stratum encountered.
- For each three acres proposed for landfilling a minimum of one hydraulic conductivity test (ASTMD D5084) shall be conducted on a Shelby tube sample at a random sampling interval approved by the Division. The samples shall be taken from within the proposed geologic buffer.

Tennessee provides no specific requirements for geotechnical investigations related to impoundment systems.

Selected Design Standard

The geotechnical investigation shall be performed prior to detailed design and construction of the landfill or impoundment site and shall be planned and conducted by or under the supervision of a professional engineer specializing in geotechnical engineering. In general, the investigation shall include the following tasks and considerations:

- A study of the general geologic setting of the site area shall be made during planning of the investigation. Publicly available information such as bedrock geology and topographic maps, karst maps, groundwater resource maps and reports, mine maps and soil surveys should be consulted. This study should be used to gain an understanding of the local geology and to identify potential geologic hazards that may be present in the area of the site. Additionally, a thorough search of existing documents, records, plan drawings, etc related to the site should be performed, including research into the past history and use of the site.

- For all sites, a site reconnaissance shall be performed prior to beginning the geotechnical investigation. Areas with karst formations or mining activity should be evaluated by qualified geologists knowledgeable in the identification of karstic/mine subsidence features. Subsidence features (such as caves, sinkholes, losing streams, etc) on site should be thoroughly described and mapped as part of the reconnaissance. Consideration should be given to performing special investigations to delineate the location, extent, and most appropriate mitigation techniques for subsidence features as deemed appropriate by the Geotechnical Engineer. Such investigations may include the use of geophysical and/or electromagnetic surveys, dye tracing, etc.
- Consideration should be given to performing a preliminary investigation prior to implementing the full geotechnical investigation. The preliminary investigation may consist of several borings performed across the site, to establish the basic characteristics of the subsurface. Information gained from this investigation can be used in planning for the main geotechnical investigation that is to follow – such as boring locations and depth, location and characteristics of geologic strata of interest, etc.
- The scope of the geotechnical investigation should include, at a minimum: soil sampling using the Standard Penetration Test (SPT) method, per ASTM D 1586; collection of undisturbed samples when soft, cohesive soils are encountered per ASTM D 1587; and, where bedrock is encountered within a depth corresponding to 50 ft below the base of the facility, rock coring should be performed per ASTM D 2113. In areas with karst or mining activity, rock coring may be required to depths exceeding 50 ft. If the site conditions warrant and if deemed appropriate by the Geotechnical Engineer, other sampling and field testing methods, such as Cone Penetration Testing (CPT), dilatometer or pressuremeter testing, and shear vane testing, may also be considered in addition to the above testing methods. Appropriate observation of groundwater levels during and after drilling should be performed. Monitoring wells or piezometers should be installed and monitored as necessary to establish the position of the water table, as necessary to support the geotechnical design of the facility.
- Soil borings should be drilled at the following minimum frequency:

  Landfills: Minimum of one boring per four acres, unless a greater frequency is specifically required by the state or if subsurface conditions such as karst or mining activity dictate otherwise. To the extent practicable, borings should be located on a uniform grid pattern across the area of the site within the limits of proposed CCP placement. Additional borings should be drilled at locations of proposed structure foundations, haul roads, or other site features, at the discretion of the Geotechnical Engineer.

  Impoundment Systems: Borings should be drilled at a minimum spacing of 200 ft on center (O.C.) along the centerline of the alignment of the impoundment structure (i.e., earth dam, dike, etc.). For impoundment structures with a total base width exceeding 100 ft, sets of two borings shall be drilled at each 200 ft interval along the centerline. One boring shall be located normal to the centerline on the downstream side and one boring shall be located normal to the centerline on the upstream side. The two borings should be roughly equidistant from the centerline. Borings sufficient to characterize the soil deposits underlying the area within the impoundment should also be performed, at the discretion of the Geotechnical Engineer.

- Soil borings should be drilled to sufficient depth to identify and characterize critical subsurface materials that will be influenced by the facility or may affect the stability of the facility. The final depth of borings will depend on site-specific conditions, and should be determined by the Geotechnical Engineer. Minimal guidelines for soil boring depths are as follows:

  Landfills: Borings should extend to the top of competent bedrock or other competent material that will resist substantial settlement and has enough strength to preclude shear failure through it.. The investigation should further include an appropriate amount of bedrock coring to characterize the strength and other engineering properties of the competent bedrock and assess karst/mining activity.

  Impoundments: Borings should extend to the top of competent bedrock or other competent material that will resist substantial settlement and has enough strength to preclude shear failure through it. Borings shall also extend to a stratum that is considered to be impervious or minimally pervious with respect to seepage beneath the impoundment. Where bedrock is encountered, the investigation should further include an appropriate amount of rock coring to characterize the strength and other engineering properties of the competent bedrock and assess karst/mining activity.

- For projects where high seismicity is a controlling aspect of design, additional field testing to determine dynamic properties of the foundation soils may be warranted. This may include downhole seismic testing per ASTM D 7400, crosshole testing per ASTM D 4428, or seismic CPT. Such testing should be performed under the guidance and supervision of an experienced geotechnical engineer or geophysicist.

- For impoundment projects, where the seepage characteristics of the foundation soils are required, field tests to determine permeability in-situ such as pump tests, slug tests, or piezocone testing may be warranted. Such testing should be performed under the guidance and supervision of an experienced hydrogeologist or geotechnical engineer.

- Laboratory Testing Program: The geotechnical investigation should include a laboratory testing program performed on soil and rock samples collected from the borings, as well as on materials scheduled for use in constructing the facility. The laboratory testing program should be designed to define the index and engineering properties (including at a minimum, soil unit weights, shear strength parameters, compressibility parameters, and permeability) of all distinct soil and rock units encountered within the borings. This data will be essential in supporting assumptions made in the geotechnical analyses performed for the facility. A sufficient number of tests should be specified to define the range of material characteristics that may be anticipated within each critical soil and rock unit. A list of test procedures for soil and rock materials that should be considered for use is provided in Table 1.3.1-1 as follows:

Table 1.3.1-1
Laboratory Soil and Rock Test Procedures

Test Procedures	**Test Standard**
Index Properties	
Water Content	ASTM D 2216
Atterberg Limits	ASTM D 4318
Particle Size Analysis	ASTM D 422
Specific Gravity of Soils	ASTM D 854
Determination of Shear Strength	
Direct Shear Test of Soils	ASTM D 3080
Triaxial Test (U-U)	ASTM D 2850
Triaxial Test (C-U)	ASTM D 4767
Unconfined Compression	ASTM D 2166
Moisture-Density Relationships (Compaction Testing)	
Standard Proctor Test	ASTM D 698
Modified Proctor Test	ASTM D 1557
Compressibility Testing:	
1-D Consolidation Test	ASTM D 2435
Hydraulic Conductivity:	
Permeability Test	ASTM D 2434

Characterization of Strength of Geosynthetic Interfaces: A laboratory testing program establishing the shear strengths of the various interfaces to be used in the design of the cap and liner systems of the facility (soil and geosynthetics) should be performed as part of the construction sequencing, but when determined to be appropriate by the Geotechnical Engineer due to site conditions or design constraints, laboratory testing can be incorporated into the scope of the geotechnical investigation, if the specific materials to be used are known during the design phase. Testing should consist of, at a minimum, 3-point direct shear tests performed per ASTM D 5321 and with a recommended maximum strain rate of 0.04 in/min for all interfacing involving a clay or GCL. Strain rates of up to 0.2 in/min may be used for geosynthetic to geosynthetic interfaces that are not expected to build up pore water pressure during the laboratory test such as a geomembrane to geotextile interface. The tests should determine both peak and residual shear strength parameters (friction angle and adhesion) for each interface being examined. Care should be taken when a non-linear shear strength envelope is apparent, such is common with many geosynthetic interfaces, especially those involving a GCL or some clay materials. The Engineer may consider additional testing points in the range of anticipated normal stresses to further characterize the interface shear strength.

Characterization of Earthen Materials to Be Used In Embankment Systems: For projects including embankment systems, appropriate laboratory testing should be performed to characterize the index, strength, consolidation and compaction characteristics of the earthen materials used to construct the embankments and associated features. The list of testing presented above is generally applicable for these systems. Other tests may also be performed based on project-specific requirements and as determined to be appropriate by the Engineer.

Characterization of CCP Materials: Physical and chemical properties of the CCP materials to be disposed of at the facility should be determined, as described in the Ash Characterization Section (Section 1.3.2), and as appropriate for the project. The results of this characterization will be used to establish input parameters related to the CCP materials for use in the stability analyses and other engineering analyses that support the landfill or ash pond design.

1.3.2.2 Hydrogeologic Studies

Definition

Hydrogeologic studies are required by regulatory guidance to evaluate the suitability of proposed landfill sites with respect to the subsurface environment. A suitable subsurface environment is typically one in which the near-surface materials (soils) can be used or otherwise managed to help create the landfill containment (liner and/or capping materials), and in which the uppermost saturated zone (aquifer) can be readily monitored to detect the presence or absence of a potential release from the landfill. Other factors in the evaluation include the character of the aquifer and its use or potential for use as a water supply.

Minimum Design Standards

Each state stipulates the minimum content and order for the hydrogeological report. The most current version of this form should be obtained from the appropriate state at the initiation of the project.

The hydrogeologic report summarizing the investigation methods and results may be required for regulatory review and comment prior to the engineering design.

Specific requirements for the specific state should be reviewed prior to initiating an investigation since there are unique requirements for each state. An overview of requirements for the subject states is provided below.

Alabama: Hydrogeologic investigation requirements for siting coal ash facilities are not explicitly identified in Alabama environmental regulations. Rather, they defer to the intent of the administrative code as determined by ADEM. As a conservative guide, ADEM Form 439, Solid Waste Disposal Permit Application, page 11, provides a detailed list of data that ADEM requires to be submitted with a permit application. These requirements should be incorporated into the investigation at the onset. The following are unique requirements to the state of Alabama:

- The applicant may be required to pay ADEM to conduct an independent site investigation.
- A minimum of three borings converted to piezometers will be required for site characterization.
- ADEM must approve boring locations prior to installation.

Kentucky: Unique requirements for Special Waste Landfills in Kentucky stipulate the following:

- Baseline groundwater characterization requires monitoring for a CCP specific list of constituents provided 401KAR45:160 Section 71.
- Cannot be located within 250 feet of a sinkhole or other karst feature suggesting rapid transmission of water to the water table.
- Cannot be located within the 100-year floodplain.
- Operations must be capable of monitoring the uppermost aquifer in a manner that will detect the targeted constituents. Furthermore, the operator must be able to demonstrate that corrective action of the uppermost aquifer is capable of being performed in accordance with 401 KAR 45:160, or propose an equivalent statistical procedure that provides reasonable confidence that the migration of leachate from the site is capable of being detected.

Tennessee: The hydrogeologic report requirements are provided in 1200-1-7-.04(9)(a) of the TDEC Rules. The hydrogeological investigation and report must include the following:

- If the facility will be placed in a karst terrain, the investigation must demonstrate that:
  - There is no significant potential for collapse.
  - That the groundwater flow mechanism is not conduit flow.
  - The facility will not degrade local groundwater resources.
  - Piezometers, geophysical survey, or dye trace studies will be installed/performed as required by TDEC.
- If a fault is located within 200 ft of the proposed location that underwent displacement in Holocene time, it will be necessary to prove the facility will be safe from seismic issues.
- Bottom clay must be 1x10-5 cm/s and 10 ft, or 1x10-6 cm/s and 5 ft, above seasonal high water level (unconfined) or the top of a confined aquifer.
- The quantity of all sample sets must be consistent with the appropriate statistical procedures.

Selected Design Standard

Investigation

Hydrogeologic studies for landfill siting shall be conducted in two phases. The first phase involves desktop studies, a minimal site investigation to support a fatal flaw analysis. The second phase involves site-specific field studies to generate data in support of the evaluation and potentially an extended fatal flaw analysis.

The elements of the investigation process are as follows:

1. Literature review (typically Phase 1 only)
2. Work Plan Development
3. Site Investigation
4. Data Analysis and Reporting

The investigation process is iterative until sufficient data is collected to determine if the site is suitable for a landfill.

Literature Review

The objective of the literature review is to gather and evaluate the available site specific, local, and regional hydrogeologic data including:

- Existing site information from previous studies. For developed properties this may include geotechnical and groundwater investigations.
- Published material regarding
    - Geology. Geologic reports from the U.S. Geological Survey (USGS) or the applicable state geological survey.
    - Hydrogeology. USGS water resource investigations, state-generated groundwater resource maps, and other special reports.
    - Topography. USGS topographic maps and any local or site-specific maps.
    - Flood insurance maps. Obtained from the FEMA National Flood Insurance Program.
    - Aerial photographs. Obtained from state transportation and agricultural departments (National Agricultural Imagery Program), public-domain internet services, and private services.
    - Soil maps. Obtained from the U.S. Department of Agriculture local Soil Conservation Service extension.
    - Applicable regulations
    - Permits for nearby facilities. Obtained through www.epa.gov/enviro/ or a Freedom of Information (FOIA) request.

- A well inventory to identify all private, commercial and agricultural wells within at least one mile of the site. This information is available on-line for some states and can only be obtained through direct contact in others.

Following completion of the literature review, there may be sufficient information to conduct an initial fatal flaw analysis. Elimination as a result of a fatal flaw analysis at this stage should be based on readily apparent criteria such as regulatory prohibitions or grossly unsuitable physical characteristics.

Work Plan Development

The findings of the literature review or the summary report from the previous investigation shall be used to develop a work plan for onsite investigations. The following provides an overview of the items included in a work plan:

- Soil borings to inspect subsurface conditions.
- Conversion of site borings to monitoring wells or piezometers with which to test the uppermost aquifer conditions.
- Groundwater monitoring for a sufficient period of time to provide a statistically defensible background data set, which is often four to eight monitoring events.
- Groundwater elevation measurements to establish the seasonal high water table and/or the range of groundwater flow conditions.
- Aquifer testing to characterize the aquifer transmissivity, permeability, and other elements required to characterize the direction, rate and mechanism of flow within the aquifer.
- Laboratory testing may be required to document soil permeability and other characteristics.

The work plan document should clearly identify the data to be collected, how it will be collected, and where it will be collected. The components of the work plan include:

- Identification of data gaps
- Identification of investigative methods to be implemented.
- Identification of investigation locations

Data gaps shall be identified prior to selecting the investigative methods to be used. The appropriate investigative methods to provide the targeted data should be included in the work plan. Potentially applicable investigative methods are listed on Table 1.3.1-2.

Table 1.3.1-2
Investigation Methods and Implementation Considerations

Investigative Method	Implementation Considerations
Photogrammetric Study	Aerial photos- preferably from multiple years, stereo pairs, taken in winter and prior to development are preferred
Test Pits	Utility clearance
Geophysical Survey	Survey lines must be cleared to allow vehicle access
Borehole Geophysics	Methods will be limited based on the type of casing used to hold open the formation, if required
Soil borings & Monitoring Well Installation	▪ Investigative derived waste (IDW) plan ▪ Backfill as stipulated by State ▪ Use appropriately licensed contractor ▪ Register borings/monitoring wells with state if required ▪ Utility clearance
Soil sampling	▪ QA/QC samples should be collected according to the work plan or QAPP ▪ Sample protocol should be provided in workplan ▪ Contracted lab should provide appropriate sample jars
Groundwater Elevation Survey	Measure depth of water from top of casing (TOC) to the 1/10th of foot
Groundwater Sampling	▪ QA/QC samples should be collected according to the work plan or QAPP ▪ Sample protocol should be provided in workplan ▪ Contracted lab should provide appropriate sample jars
Slug Test	
Pumping Test	
Packer Test	
Dye Trace Study	UIC permit required
In-Situ Flow Direction	Method is time-intensive if well recover slowly
Surface Water Elevation Survey	All wells and piezometers must be surveyed to the nearest 0.01 ft.
Surface Water Sampling	▪ QA/QC samples should be collected according to the work plan or QAPP ▪ Sample protocol should be provided in workplan ▪ Contracted lab should provide appropriate sample jars

After the investigative methods have been selected, the final step is selection of the investigative locations. In Phase 1 investigations locations may be biased to identify potential fatal flaws such as sinkholes. Phase 2 investigation locations shall be spatially unbiased to document the homogeneity or heterogeneity of the site.

The work plan, particularly a Phase 2 work plan, may require review by the regulatory agency prior to implementation. Proceeding without regulatory buy-in may result in an additional mobilization to collect specific data required by the agency.

Hydrogeologic investigations must be tailored to the specifics of the site, disposal unit, permit requirements, geology, and regulatory agency. Hydrogeologic investigations are typically required to be conducted directly by or under the supervision of a registered or licensed geologist, or otherwise qualified professional.

A boring plan must be included in the work plan. The boring plan shall identify proposed boring locations, drilling methods, sampling frequency and sampling method. A justification for the location and depth of each boring shall be provided. General guidelines on boring frequency and depth are described below.

The frequency of borings is dependent upon the phase of the investigation, the site size, and hydrogeologic complexity. Five soil borings are typically sufficient for a Phase 1 investigation to confirm the regional and local hydrogeological setting. Phase 2 investigations require a greater spatial density of borings (up to one boring per 10 acres) to ensure the homogeneity of the strata and aquifer beneath the site.

All borings must be advanced a minimum of 25 feet below ground surface. Increasing the boring depth for one or all borings may be necessary if groundwater or bedrock has not been encountered. If groundwater is reached prior to bedrock and bedrock is not expected within 25 feet of the groundwater elevation, then the boring can be halted otherwise it should be advanced to the bedrock interface.

Two downgradient and one upgradient monitoring well installations are typically sufficient for a Phase 1 investigation. As with soil borings, a greater spatial density of wells will be required to ensure the homogeneity or define the heterogeneity of the site in Phase 2. The following information must be considered before installing a monitoring well:

- Data to be obtained.
- Well must be located in an area or of a construction type that will not be damaged during site operations.
- Well construction methods must prevent downward migration of surface water.
- If a confining unit is present, surface casing must be installed into the confining unit and the well drilled through the casing to termination.
- Wells that are not necessary to the investigation should be abandoned according to state-specific procedures as soon as possible to reduce the risk of possible contamination to the aquifer. Abandonment may require state regulatory approval.

Aquifer characterization is typically performed only in Phase 2 investigations. Characterization includes testing by slug tests, pumping tests or packer tests to obtain information on transmissivity, storativity, and permeability. In areas of high secondary porosity such as karst or fractured rock, a dye trace study may be required.

Modifications to the work plan should be expected if site conditions deviate from those anticipated.

Site Work/Data Collection

Work plan implementation begins with the non-invasive methods first, then investigation of overburden, followed by (or simultaneously with) investigations of the uppermost aquifer. The following outlines the typical progression of site work for Phase 2 of a project:

1. Perform surface geophysical survey.

2. Confirm boring and monitoring well locations based on geophysical survey.

3. Install soil borings.

4. Convert soil borings to monitoring wells or piezometers. All borings that will not be converted to monitoring wells or piezometers should be abandoned upon completion.

5. Survey monitoring wells and piezometers to ± 0.01 ft.

6. Collect water level measurements at least twice ten days apart.

7. Perform pumping tests or other appropriate aquifer characterization methods.

All site work shall be thoroughly documented in serialized, bound logbooks or equivalent. Errors should be lined through once, dated and initialed. Lines should not be skipped. Once a page, is complete it shall be signed and dated. Boring logs and monitoring well diagrams are frequently recorded on forms specifically designed for this purpose. Critical information from these forms shall also be included in the bound logbook:

- boring or monitoring well name
- location relative to fixed landmarks or coordinates using a handheld GPS unit
- total depth drilled
- drilling and sampling method
- reason for ending the boring
- well construction information, including:
  - total depth of monitoring well
  - length of screened interval, specifically the distance from highest and lowest slots to the bottom of the well
  - well material type and diameter
  - filter pack type and amount
  - annular seal type and amount
  - grout seal and amount type
  - type of surface completion

Investigative derived wastes (IDW) will be generated during most intrusive investigations. The IDW should be handled/disposed of appropriately. For greenfield sites, this may simply be spreading drill cuttings and discharging groundwater on ground surface. For other sites, wastes shall be handled in a manner consistent with local, state and federal regulations, as dictated by a waste characterization analysis. The TVA Environmental group should be contacted regarding IDW prior to initiation of field activities.

Data Analysis and Reporting

It is critical to evaluate data as it is collected for the following reasons:

- To ensure that the data has been collected in an appropriate manner such that the data is representative and reproducible.
- To verify that the data collected will increase the accuracy of the developing conceptual site model. If the data is not required by regulation and it does not increase the accuracy of the developing conceptual site model (CSM) then it may be appropriate to cease that data collection method in lieu of a more appropriate method.
- To continuously evaluate of the CSM, allowing for modifications to the field program when unexpected data is encountered.
- To collect additional data while personnel and equipment are still mobilized, if the data set is determined to be inadequate

Conceptual Site Model (CSM)

The hydrogeologic study results are used to develop a CSM. The CSM synthesizes the data into a graphical representation of the geology, geologic structure, and groundwater flow at the site. The CSM is a dynamic model that starts on a broad basis and evolves as more information is generated.

The CSM should characterize groundwater conditions on site as they may apply to the design and operation of the proposed facility such as:

- The character of the unsaturated zone (soil, rock or other) between the facility and the underlying saturated zone.
- The character and identity of the geologic materials in which the uppermost saturated zone (aquifer) and potentially interconnected aquifers occur on site.
- The ability of the aquifer to transmit groundwater and the character of that flow (whether diffuse or discrete).
- The path of groundwater flow from upgradient (recharge) to downgradient (discharge) areas.
- The gradient and rate of groundwater flow through the uppermost aquifer.
- The local use of groundwater for water supply.

The amount of information needed to develop a sufficient CSM to the support site selection will depend on the complexity of the site. Table 1.3.1-3 provides a generalized representation of how the site complexity increases the amount of data required to develop the CSM. All sites must be evaluated at the regional (~100 mile radius), local (facility) and the site specific scale.

Table 1.3.1-3
Generalized Representation of Relationship Between Site Complexity and Data Required

Investigative and Data Analysis Methods	Least Complex	Moderately Complex	Highly Complex
	Shallow, unconfined overburden aquifer	Confined overburden aquifer above bedrock	Bedrock aquifer with fractures, jointing and high secondary porosity
	homogenous isotropic	→ →	heterogeneous anisotropic
Cross Sections	2	2	2
Piezometers	3	3 per geologic unit	3 per geologic unit
Soil Borings	3	8	15
Monitoring Wells	1	5	15
Hydraulic Conductivity	slug tests	pumping test	pumping tests
Potentiometric Surface Maps	2 at least 2 wks apart	quarterly for 1/2 year	quarterly for 1 yr
Stratigraphic Maps	yes	yes	yes
Flow Nets		1	multiple
Borehole Geophysics		yes	yes
Geological Mapping of Bedrock and Structure		yes	yes
Surface Geophysics		yes	yes
3-D Geology/Lab Testing			yes
Conceptual Models			yes
Core Drilling			yes
Geochemical Groundwater Comparisons			yes
In-Situ Flow Direction			yes
Dye Trace Studies			yes
Groundwater Modeling			yes
Fracture Trace Analysis			yes
Fault Mapping			yes

1.3.3 Ash Characterization

1.3.3.1 Chemical Characterization

Definition

Chemical characterization of CCP materials can be conducted to evaluate regulatory classification, leachate treatment requirements, chemical compatibility with landfill components, etc. The chemical characteristics of CCP materials will vary based on factors including coal source, coal processing mechanism, scrubbing technology, boiler type, other emissions control technologies, and conveyance type (especially wet sluice versus dry conveyance). Chemical characterization can include more conventional leach testing such as synthetic precipitation leaching procedure (SPLP), and toxicity leaching characteristic procedure (TCLP), column leaching) and totals analysis (digestion), but could include other analyses such as x-ray diffraction, x-ray fluorescence, scanning electron microscope (SEM), etc. depending on the purpose of the characterization.

The TCLP procedure is commonly used and utilizes an extraction fluid designed to mimic the environment of a typical municipal solid waste landfill. The TCLP method may yield higher concentrations of heavy metals compared with other methods that may more represent a CCP disposal facility such as the SPLP method (SW-846 Method 1312) or a deionized (DI) water leach (e.g. ASTM D3987). If chemical compatibility or prediction of heavy metal concentrations for treatment evaluation and/or fate and transport modeling are of critical importance methods using a more representative extraction fluid may be warranted.

All TCLP extracts should be analyzed for the 8 RCRA Metals listed in 40 CFR §261.24 (Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver). In addition, TCLP samples should be analyzed for other constituents commonly found in CCP materials, including Chloride, Sulfate, Aluminum, Antimony, Beryllium, Boron, Calcium, Cobalt, Copper, Iron, Magnesium, Manganese, Nickel, Thallium, Titanium, Vanadium, and Zinc. Organic compounds are not typically found in CCP materials, but should be evaluated if there is reason to believe they may be present.

Minimum Design Standards

<u>Alabama</u>: In Alabama, “ashes” are defined as the solid residue from the burning of wood, coal, coke or combustible material used for heating or burning or incineration of solid waste. The terms “solid waste”, garbage”, and “ash”, as defined in ADEM solid waste rules, do not include ash resulting from the combustion of coal at electric or steam generating plants. Therefore, no specific testing requirements or frequency of testing is specified in the state of Alabama.

<u>Kentucky</u>: In Kentucky, CCPs are generally considered special wastes, which are regulated under 401 KAR 45. There are few specific requirements for chemical characterization of special wastes. 401 KAR 45:110, Section 1 (1) states that the engineering design of a special waste facility should consider the physical and chemical characteristics of the waste, including compatibility with the liner system, cap system, and water that comes into contact with the waste. In addition, 401 KAR 45:210 Section 3 (2) states that the special waste material must not be a hazardous waste material as defined in 401 KAR Chapter 31. Determination of the special

waste material as hazardous/non-hazardous is done through the TCLP procedure and comparison with the hazardous levels in 40 CFR §261.24. No frequency of testing is specified.

Tennessee: The existing TVA CCP facilities in Tennessee are permitted as Class II Industrial Waste Landfills. It is assumed that future solid waste landfills will also be constructed as Class II facilities. The definition of Industrial Wastes states that the material cannot be deemed hazardous as regulated under Subtitle C of RCRA. This implies that TCLP analysis of the material cannot yield constituent levels greater than those listed in 40 CFR §261.24. Rule 1200-1-7-04 (a)(4) requires that a potential alternative liner system must be chemically compatible with the leachate generated by the waste. Similarly, Rule 1200-1-7-04 (a)(5) states that the leachate collection system must be chemically resistant to the leachate produced by the waste material. No specific testing requirements or frequency of testing is specified.

Federal: No specific chemical characterization of the material is required.

Selected Design Standard

With respect to chemical characterization, the characteristic that is of most importance to the design and maintenance of a containment facility is the leachable constituents of the ash, and in particular leachable heavy metals and salts. The chemical characteristics for each CCP material should be evaluated as follows:

- The primary goals for chemical analysis of the CCP material is to evaluate if the material leaches constituents in concentrations that exceed state or federal regulations (in particular levels greater than those listed in 40 CFR §261.24) and to evaluate chemical compatibility with containment facility components. In order to allow comparison with 40 CFR §261.24 limits for hazardous waste, a TCLP procedure (EPA SW-846 Method 1311) should be performed.
- If no historic data exists for the CCP material, samples should be collected and analyzed using TCLP on enough individual samples to allow for statistical significance (typically eight samples). Thereafter, samples should be collected and analyzed at least annually or when any significant fuel source change (i.e. change from eastern coal to PRB coal), after a significant process modification including, but not limited to, the addition/modification of pollution control equipment, boiler modification, coal processing modification, etc. State regulations and/or permit conditions may require more frequent sampling events.
- An annual analysis of an undiluted leachate sample may be performed in lieu of a TCLP analysis on the CCP material if there have been no other significant process changes to the generating facility, coal source, etc.
- Other types of testing can be performed as required for various projects. For example, column tests, sequential batch tests, batch testing with various solid to liquid ratios, etc. may be more useful for groundwater modeling projects than a TCLP or SPLP test.

1.3.3.2 Physical Characterization

Definition

Determination of the physical characteristics of the CCP material may include material strength, grain size distribution, Atterberg Limits, material compaction characteristics, material density, moisture content requirements for handling and compaction, compressibility, dynamic property evaluation, and hydraulic conductivity. The importance of these parameters will vary depending on the parameter's importance to the design of the facility.

Minimum Design Standards

Alabama: No specific physical characterization of the material is required.

Kentucky: No specific physical characterization of the material is required.

Tennessee: No specific physical characterization of the material is required.

Federal: No specific physical characterization of the material is required.

Selected Design Standard

Required testing of CCP materials for physical properties is to be determined by the design Engineer. It is the design Engineer's responsibility to determine what physical characteristics are important for a specific facility.

Frequency of testing shall also be determined by the Engineer. It is recommended that all tests for critical parameters be completed in duplicate on distinct samples. It is also recommended that critical physical properties of CCPs, as determined by the Engineer, be repeated upon significant change in fuel source or after a significant process modification including, but not limited to, the addition/modification of pollution control equipment, boiler modification, coal processing modification, etc.

TVA has a database of physical properties of its CCP materials in a report by Law Engineering entitled "Fly Ash, Bottom Ash, and Scrubber Gypsum Study" (Contract No. TV-92657V, Phase 1) completed in 1995 (referred to herein as "TVA CCP Database"). This source may provide an adequate basis for material properties. It is the Designer's responsibility to evaluate whether system changes since 1995 may have altered properties of the CCP material or whether the data is adequate and representative. It is of particular importance to ensure that strength testing data performed as part of this study were performed over the range of normal stresses that represent the design of a new facility for critical applications.

If the results from the TVA CCP Database are to be used for design, it is recommended that index testing such as grain size distribution and standard compaction testing be performed to establish whether the materials are similar enough in basic physical characteristics to use other physical characteristics shown in the database such as shear strength.

The following tests are recommended for CCP materials if the material properties are deemed important to the design:

Grain Size Distribution

- All CCP materials should be tested in accordance with ASTM D422. For more coarse grained CCPs, sieve alone may provide adequate data for the design. For other design applications, the designer may want to perform sieve with hydrometer to better classify the fine material.

Hydraulic Conductivity

- Materials should be evaluated for hydraulic conductivity under the conditions (density, moisture content, gradient, etc.) that the material will be placed during construction of the intended design.
- Gypsum, and fly ash (ponded and dry) should be tested for hydraulic conductivity using ASTM D5084.
- Bottom ash should be tested for hydraulic conductivity using ASTM D2434
- Other non-gypsum scrubber byproducts should be tested for hydraulic conductivity using ASTM D5084 if they are generally fine-grained and are anticipated to have a permeability of less than 1×10^{-5} cm/s. If the non-gypsum scrubber material is granular in nature, samples should be tested using ASTM D2434.
- Materials that are pozzolonic (self-cementing) in nature should be prepared and allowed to cure prior to testing (typically 7 to 30+ days). Depending on the nature of the material, curing time may or may not affect the hydraulic conductivity of the material, but allowance for curing time will be more representative of the long-term properties of the material.

Shear Strength

- Shear strength for all CCPs should be determined at the lowest density and highest moisture content that are anticipated for the project.
- In general, effective stress shear strengths for all CCP materials should be determined by the direct shear method (ASTM D3080), or by triaxial testing with pore pressure measurements (ASTM D 4767). Other test methods, such as the direct simple shear test (ASTM D 6528) may also be used, at the discretion of the Geotechnical Engineer and as appropriate. Total stress shear strengths should be determined using triaxial testing (ASTM D 4767).
- Materials that are pozzolonic (self-cementing) in nature should be prepared and allowed to cure prior to testing (typically 7 to 30+ days). Depending on the nature of the material, curing time may or may not affect the shear strength of the material, but allowance for curing time will be more representative of the long-term properties of the material.

Atterberg Limits

CCP materials are generally non-plastic. If Atterberg Limits are desired by the design engineer, they should be performed as per ASTM D4318

Compaction and Density Testing

In general, compaction testing for all CCP materials should be conducted using standard effort (ASTM D698) unless the project warrants the material to be compacted at higher densities with greater effort during construction.

- The compaction characteristics of coarse grained material such as bottom ash and boiler slag may be determined using a one-point proctor test using standard effort at the discretion of the design engineer. Compaction curves for bottom ash and boiler slag with low fines content are typically "flat". Bottom ash should be compacted moist, at its typical as-received moisture content (e.g. bottom ash from pond, freely drained) or at a value established by historical data.
- Care must be taken when oven drying CCP materials containing hydrated water, such as gypsum and non-gypsum FGD material. ASTM 2216 recommends that materials that contain hydrated water be dried at 60 degrees Celsius or using a desiccator at room temperature. Regardless if low temperature or room temperature drying techniques are used, care must be taken to ensure that free water content is being determined in relation to compaction testing and not total water content (which would include hydrated water).

Consolidation Testing

- Most CCP materials exhibit low consolidation coefficients (<0.1) for moderate to well compacted CCP materials and is generally not a critical concern for most applications. If the designer desires consolidation data for CCP materials, it should be performed per ASTM 2435. The sample should be prepared in a manner that represents the moisture content and density of the condition being evaluated. This is of particular consequence when evaluating the compressive behavior of ponded fly ash material.

Other Testing

Other material testing for design purposes should be determined by the design engineer.

1.3.4 Liner and Cap System

1.3.4.1 Liner System

Definition

A liner refers to a continuous layer of natural or man-made materials, beneath and/or on the sides of a surface impoundment, landfill, or landfill cell, which restricts the downward or lateral escape of wastes, waste constituents, or leachate. Liners for disposal facilities are typically composite systems constructed of one or more layers of a low permeability synthetic material such as high density polyethylene (HDPE), linear low density polyethylene (LLDPE), or polyvinyl chloride (PVC) and a low permeability compacted clayey soil.

Minimum Design Standards

Alabama: There are no known minimum design standards for liners for CCP facilities in Alabama. Design requirements for liners of Municipal Solid Waste (MSW) facilities are given in 335-13-4-.18. MSW facilities are to be equipped with a composite liner system consisting of two components; the upper component must consist of a minimum 40 mil (60 mil if using HDPE) flexible membrane liner (FML), and the lower component must consist of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 1 x 10^{-7} cm/sec. The FML component must be installed in direct and uniform contact with the compacted soil component.

Alabama has an additional requirement of a leachate collection system. A leachate collection system shall be required that is designed and constructed to maintain less than a 12-inch depth of leachate over the liner. Refer to Section 1.5 for leachate management system design standards.

Kentucky: There are no known minimum design standards for liners used for special waste facilities in Kentucky. Minimum design standards for liners of contained facilities for other types of waste are given in 401 KAR 48:080. For contained facilities a primary and secondary composite liner system is required. The primary liner system shall consist, at a minimum, (from bottom to top): a 36 inch clay layer with a permeability of 1 x 10^{-7} cm/sec; a primary synthetic liner with a demonstrated hydraulic conductivity less than 1 x 10^{-12} cm/sec and a thickness of at least 60 mils; a 12 inch drainage layer with permeability of 1 x 10^{-2} cm/sec or a layer of equivalent performance; and a filter fabric. The secondary liner system shall consist of (from bottom to top): a 12 inch soil layer with a permeability of 1 x 10^{-7} cm/ sec; a secondary synthetic liner as specified above for the primary liner; a 12 inch drainage layer with a permeability of 1 x 10^{-2} cm/ sec; and a filter fabric. The secondary soil and synthetic components may be replaced with an existing naturally occurring soil material meeting the requirements given in 401 KAR 48:080, Section 1(2).

Additional requirements in Kentucky:

- Liner subgrade shall be sufficiently dry, compacted and structurally sound to ensure that the first lift and all succeeding lifts of soil placed over the landfill subgrade can be adequately compacted to the design requirements. Proofrolling of the subgrade is required, with a minimum 100,000 pound loaded four tire scraper (20 cubic yard size) or equivalent procedure and equipment approved by the cabinet.
- Strains in all geosynthetic components are required to be maintained at less than 10%;
- The slope of liner components shall be no less than 3% percent toward the main leachate collection line, 1% along the main leachate collection line, and no greater than 50% at any point.

Tennessee: Liners for Class II facilities in Tennessee are required to meet minimum design requirements for liners of Class I facilities, which are given in 1200-1-7-.04(4)(a)(1), unless otherwise approved by the State. In summary, a composite liner system is required, consisting of two components: the upper component must consist of a minimum 30-mil (60-mil for HDPE) geosynthetic FML, and the lower component must consist of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 1.0 x 10^{-7} cm/sec. The FML component must be installed in direct and uniform contact with the compacted soil component. Liners shall be sloped such that, excluding excavation side slopes, the slope of the liner shall not exceed 25%.

Additional requirements in Tennessee:

- Geologic Buffer: The liner system shall be placed on top of a geologic buffer which has a maximum hydraulic conductivity of 1.0 x 10^{-5} cm/sec and measures at least ten feet from the bottom of the liner (or have a maximum hydraulic conductivity of 1 x 10^{-6} cm/sec and measures at least 5 ft from the bottom of the liner) to the seasonal high water table of the uppermost unconfined aquifer or the top of the formation of a confined aquifer.
- Leachate Collection System: A leachate collection and removal system is required immediately above the liner that is designed, constructed, maintained, and operated to collect and remove leachate from the facility. Refer to Section 1.5 for leachate management system design standards.

Federal: No liner system is specified for CCP facilities.

Selected Design Standard

The design of liner systems shall based on the following standards, which have been determined based on the state requirements given above. Alternate and equivalent systems may also be applicable, if acceptable to the regulators:

Thickness and Materials: Where specific State requirements are given for CCP facilities (such as in Tennessee), the liner system should be designed to meet those specific requirements. Where no specific requirements are given, the basic liner system design should consist of (from top to bottom) a drainage layer; an FML; and a recompacted soil liner (RSL). These layers should meet the following minimum guidelines:

Drainage Layer: Should consist of a minimum 12-inch thick layer of granular soil, a geocomposite material with an equivalent transmissivity, or a combination of geocomposite and granular soil materials designed to maintain less than a 30 centimeter (12 inch) depth of leachate above the liner system. A geotextile separator, or graded granular filter, should be included between the top of the drainage layer and the emplaced CCP. Refer to Section 1.5 for leachate management system design standards.

FML: FMLs should have a minimum thickness of 30 mils (60-mils if HDPE). As an industry standard, typically HDPE or PVC materials are used in liner system FML applications. The FML should be physically and chemically resistant to chemical attack by the waste, leachate, or other materials to which it may come into contact. The FML should be placed in direct contact with the RSL layer. The FML should be protected from the drainage layer by an appropriate cushion, such as a geotextile fabric.

RSL: RSL should consist of at least 24-inches of material meeting classifications of CL, CH, or CL-ML per the United Soil Classification System (USCS). It should be demonstrated by appropriate laboratory testing that the material has a maximum permeability of 1 x 10^{-7} cm/sec under moisture and density conditions consistent with those under which it will be placed in the field. RSL should be free from organic and other deleterious materials, and sharp materials which may pose puncture hazards to the FML.

A generalized schematic of this basic liner system, which illustrates the key components, is presented in Figure 1.3.3-1.

Additional design considerations include:

Geologic Buffer: If specifically required by the state, the landfill design shall include a geologic buffer between the liner system and groundwater. Buffer materials may consist of or include the existing soil materials below the facility, if these materials meet the state requirements. If the existing materials do not meet the requirements, compacted fill materials meeting the requirements shall be included in the design to act as the geologic buffer.

Liner Slope: Unless specific state requirements are more stringent, the facility should be designed such that the liner system has a minimum slope of at least 2% toward leachate collection piping and a minimum of 0.5% along leachate collection piping, after including the effects of estimated facility settlements. Where state requirements are more stringent, those requirements should be incorporated into the design.

Anchor Trenches: In general, anchor trenches for geosynthetic components of the liner system should be provided around the entire perimeter of the landfill facility. Anchor trenches should be designed to provide resistance against pullout of the materials. Anchor trenches should be designed per Section 1.4.5.

Shear Strength: The liner design should include the determination of combinations of peak and residual shear strength properties (friction angle and cohesion) which satisfy requirements for global slope stability of the facility, as described in Section 1.4.

Working Strain: The facility should be designed such that the maximum predicted strain induced in any FML components is less than 5%, under all or part of the weight of the facility, and considering the predicted settlements under the facility, unless specific data from the synthetic manufacturer allows for a higher strain.

1.3.4.2 Cap System

Definition

The cap system, also referred to as the final cover system, is the cover material and components that are spread and compacted on the top and side slopes of a facility which will be permanently exposed to the environment. The cap system is placed at the end of the life of the facility and is designed to inhibit and control the movement of CCP, dust, water, and gases both into and out of the emplaced CCP. Caps are typically composite systems constructed of one or more layers of: a vegetative cover, protective soil material, a drainage layer, and a low permeability layer of recompacted soil or a geosynthetic material (such as HDPE).

Minimum Design Standards

<u>Alabama:</u> There are no known minimum design standards for caps of CCP waste facilities in Alabama. Design requirements for caps of MSW facilities are given in 335-13-4-.20. In summary, the MSW requirements state: The final cover system must be comprised of an erosion layer(s) underlain by an infiltration layer(s). The infiltration layer must be comprised of a

minimum of 18 inches of earthen material and/or a synthetic layer that has a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 x 10^{-5} cm/sec, whichever is less. The erosion layer must consist of a minimum 6 inches of earthen material that is capable of sustaining native plant growth.

Kentucky: There are no minimum design standards for caps used for special waste facilities. Minimum design standards for caps of contained facilities are given in 401 KAR 48:080, Section 8. In summary, the contained facilities requirements state: At a minimum the final cap shall consist of a layered system. Each layer shall have the same slope of between five and twenty-five (25) percent. The components, listed from bottom to top, are: a filter fabric or other material approved by the cabinet; a 12 inch sand gas venting system with a minimum hydraulic permeability of 1 x 10^{-3} (a layer that is not needed in a CCP landfill as it does not generate gases); a filter fabric or other material approved by the cabinet; an 18 inch clay layer with a maximum permeability of 1 x 10^{-7} cm/sec; for areas of the final cap with a slope of less than 15 percent, a 12 inch drainage layer with a minimum permeability of 1 x 10^{-3} cm/sec; and a 36 inch vegetative soil layer.

Tennessee: Unless otherwise approved by the State, caps for Class II facilities in Tennessee are required to meet minimum design requirements for caps of Class I facilities, which are given in 1200-1-7-.04(4)(a)(6) and 1200-1-7-.04(8)(a)(1). Section 1200-1-7-.04(8)(a)(1) states: "The depth of final cover system shall be at least 36 inches of soil of which a minimum of 12 inches shall be for the support of vegetative cover. The design of the final cover system shall be such that the infiltration volume of water will be equal to or less than the percolation volume through the bottom liner system or a design which includes a compacted soil layer of at least 24 inches which has a permeability no greater than 1 x 10^{-7} cm/sec, whichever is less. This design shall be supported by the use of the Hydrologic Evaluation of Landfill Performance (HELP) model or other equivalent method approved by the Commissioner".

Federal: No cap system is specified for CCP facilities.

Selected Design Standard

The design of cap systems should be based on the following standards, which have been determined based on the state requirements given above. Alternate and equivalent systems may also be applicable, if acceptable to the regulators:

Thickness and Materials: Where specific state requirements are given for CCP facilities (such as in Tennessee), cap design should follow those requirements. Otherwise, the basic cap system should consist of the following layers, at a minimum (from top to bottom): A layer of cover soil material, with a total thickness that is equal to or greater than the local frost penetration depth and of which the upper 6-inches is capable of supporting vegetation (topsoil); A minimum 24-inch thick layer of recompacted soil with a permeability of less than 1 x 10^{-7} cm/sec and meeting USCS soil classifications of CL, CL-ML, or CH should be placed below the cover soil. Additionally, dense vegetative (non-woody) growth at the surface of the cap shall be specifically included in the design.

An alternate cap system may be considered, if clay materials are unavailable or difficult to obtain. The alternate system should consist of the following layers, from top to bottom: Minimum 24-inches of cover soil, of which the upper 6-inches is capable of supporting vegetation (topsoil); a nonwoven geotextile separator, or graded granular filter,; a drainage layer consisting of either 12-inches of granular soil materials or a geocomposite material; a nonwoven geotextile separator (if a geocomposite drainage layer is selected, the geotextile separator may be omitted); and a FML with a minimum thickness of 30-mils (40 mils if LLDPE or HDPE). As an industry standard, typically LLDPE or PVC materials are used in cap system FML applications. The FML should be physically and chemically resistant to chemical attack by the CCP, leachate, or other materials to which it may come into contact. The FML should be placed directly on top of a prepared, compacted subgrade that is free from sharp materials that pose a puncture hazard to the FML. Additionally, dense vegetative (non-woody) growth at the surface of the cap shall be specifically included in the design. A generalized schematic of this alternate cap system, which illustrates the key components, is presented in Figure 1.3.3-2.

Infiltration Analysis: The cap system should be designed to restrict infiltration of surface water into the facility such that all requirements for operating head on the leachate collection system at the base of the facility are met. This design should be evaluated by use of the HELP model. HELP Model analysis is described in Section 1.5.1.

Cap Slope: Where specific requirements on maximum slope are given by a state (such for facilities in Alabama), the design should follow those requirements. If there are no specific requirements, the slope of all cap system layers should not exceed 3 Horizontal to 1 Vertical (3H:1V), unless it is explicitly demonstrated by analysis that all cap system components and the underlying CCP subgrade will be stable at a steeper slope.

Stability: If geosynthetics are to be used in the cap, the cap design should include the determination of combinations of peak and residual shear strength properties (friction angle and cohesion) which satisfy minimum guidelines for shallow translational slope stability, as described in Section 1.4.4. Additionally, anchor trenches should be provided for geosynthetic components as required to provide resistance against pullout of the materials. Anchor trenches should be designed per Section 1.4.5.

Surface Water Management and Soil and Erosion Control: In general, benches/terraces should be provided in the design of the cap system, to limit surface erosion and convey stormwater off of the landfill cap system. The spacing of benches shall be designed in accordance with soil and erosion control requirements described in Section 1.6.1. The design requirements for surface water management structures, including benches/terraces, are described in Section 1.6.2. The design requirements for sediment basins are described in Section 1.6.3.

1.3.5 Volume and Life Calculations

Definition

Volume and life calculations are performed to determine the disposal volume, operational lifetime, and soil balance for the overall facility, as well as for interim phases within the facility. These calculations are based on estimates of CCP generation rates, in-place CCP density, and the geometry and areal limits of phases within the facility design. The calculations provide a basis to measure disposal rates and to schedule construction to provide for additional disposal capacity.

Minimum Design Standards

Alabama: There are no minimum design standards for volume and life calculations for special waste facilities or MSW facilities in Alabama.

Kentucky: There are no minimum design standards for volume and life calculations for special waste facilities in Kentucky. However, 401 KAR 47:190 Section 2 requires submission of phasing plans within the application for the proposed facility. Development of these plans will inherently require an analysis of volume and life.

Tennessee: For Class I, II, and III facilities that require a permit, 1200-1-7-.04(9)(c)(9) and (10) require narrative descriptions to be provided of the volume and type of waste to be disposed of in the facility, as well as the total acreage to be filled in each phase.

Federal: There are no minimum design standards for volume and life calculations for CCP facilities.

Selected Design Standard

The landfill design shall include specific volume and life calculations and a technical memo summarizing these calculations.

Volume and life calculation standards for new facilities should be based on the following considerations:

- The desired working life of the facility. Regarding facility life, TVA has the following internal goals:
    - Facilities are to be designed for a minimum 20 year working life, if possible.
    - Facility planning should be such that design of new facilities should begin a minimum of six years prior to the end of the working life of the previous facility.
- Estimates of annual CCP generation rates, as well as potential for future increases/decreases in these rates during the lifetime of the facility.
- Estimates of the in-place volume of the CCP within the facility. These should be based on prior experience as well as results of the ash characterization program.
- In general, separate volume and life calculations should be performed for each construction phase of the facility.
- The volume of any required cover, soil liners and caps, berms, etc. should be accounted for in the available volume and life calculations of any phase within the facility.

To obtain accurate results, it is recommended that available phase and facility volumes be computed using computer-aided design and drafting techniques and software packages, rather than via hand calculations.

1.4 STABILITY ANALYSIS

The following criteria have been developed to define performance standards and an overview of methods of engineering evaluation for the construction of new dry ash landfills. Analyses and evaluations are currently being performed by others for wet ash landfills and will be incorporated at a later date.

1.4.1 Hydrostatic Uplift Analysis

Definition

Soils, geosynthetics, or CCP materials that are placed underneath a temporary or permanent phreatic surface may be subject to hydrostatic forces, especially when the phreatic surface lies above materials or components with low permeability, such as the base liner system. If the driving force of the hydrostatic pressure at the base of a facility component exceeds the resisting force, primarily provided by the weight of the component and any soils placed over it, the component may be physically uplifted or deformed. Other effects such as heave or instability of the subgrade or excessive groundwater infiltration at the facility base may also occur. The hydrostatic uplift analysis evaluates the driving and resisting forces and determines a factor of safety against uplift, defined as the ratio of the resisting to the driving forces.

Minimum Design Standards

Alabama: There are no minimum design standards for hydrostatic uplift analysis in Alabama.

Kentucky: There are no minimum design standards for hydrostatic uplift analysis in Kentucky.

Tennessee: There are no minimum design standards for hydrostatic uplift analysis in Tennessee.

Federal: There are no federal minimum design standards for hydrostatic uplift analysis.

Selected Design Standard

The selected design standard includes the following components:

- Contours defining the highest temporal phreatic and potentiometric (confined or pressurized water table) surfaces on site shall be established based on the results of the hydrogeological and geotechnical investigations.

- Using the design base grades of the facility and the contours of the phreatic and potentiometric surfaces, an elementary hydrostatic uplift analyses should be performed. Methods of elementary analysis are presented in the Ohio EPA's "Geotechnical and Stability Analyses for Ohio Waste Containment Facilities", Chapter 7. In summary, this analysis involves computing the hydrostatic uplift at the base of a facility component or at the base of a confining subsurface layer (based on the elevation of the phreatic or potentiometric surface relative to the elevation of the base of the component or confining layer), and comparing it with the total vertical stress acting at the base of the component or layer. The factor of safety, defined as the ratio of the total vertical stress and the hydrostatic uplift pressure, should be greater than 1.4. The elementary analysis should include cases which consider all interim or permanent configurations of the facility and subsurface soils that may be prone to hydrostatic uplift (such as a point in time during landfill construction at which the liner has been placed and minimal or no cover is present over the liner) and should delineate areas of the facility footprint exhibiting factors of safety less than the design criteria presented above. If such areas are identified through the elementary analysis, an effort should be made to adjust the design of the facility's base grades to yield a safety factor satisfying the above recommended design criteria.

- If redesign to satisfy the design criteria established by the elementary analysis is not feasible, then more rigorous analyses may be performed to demonstrate that the factors of safety are higher than predicted by the elementary analysis. Such analyses may include steady state or transient seepage analyses that predict the magnitude of hydrostatic uplift forces on the liner system, or other analyses deemed appropriate by the Geotechnical Engineer.
- In the case that the factor of safety requirement for uplift cannot be met with more rigorous analyses or by redesign of the facility's base grades, then specific engineering modifications to lower the phreatic or potentiometric surfaces, such as underdrain systems, pumping wells, etc., may be incorporated into the design, to raise the factor of safety against hydrostatic uplift. If required, these systems should remain active until such time as the weight of materials placed over the component or layer of concern is sufficient to counteract the hydrostatic uplift forces with a factor of safety of 1.4.

1.4.2 Slope Stability Analysis

1.4.2.1 Deep-Seated Failure Analysis (Static)

Definition

Deep seated failure analyses evaluate the potential for mass slope instabilities. Qualitatively, failure geometries with a maximum thickness greater than 10 ft may be considered to be deep-seated. Deep-seated failures may involve the CCP alone, or pass through the CCPs and into the underlying foundation materials, and are generally analyzed as being rotational (having a circular geometry) or translational (having a block-like geometry). The potential for deep-seated instability is dependent on factors such as slope geometry, shear strength of the CCPs, foundation materials, liner materials, and groundwater conditions. The analysis of deep-seated instabilities is performed using computer slope stability analysis software, which generally use limit equilibrium analysis and the method of slices.

Analyses under static conditions evaluate the potential for deep-seated instabilities under normal, service conditions of the facility, either during its construction or post closure.

Minimum Design Standards

Alabama: There are no known minimum design standards for deep-seated stability analyses in Alabama.

Kentucky: There are no specific minimum design standards for deep-seated stability analyses for special waste facilities or for contained waste facilities in Kentucky. However, for contained waste facilities, 401 KAR 48:080 Section 3 (1) makes the following generalized requirement pertaining to the subgrade soils below a proposed landfill: The landfill subgrade material shall be free of organic material and consist of bedrock, on-site soils, or any select fill with the structural ability to support the landfill maximum load with a factor of safety of two (2.0).

Tennessee: There are no known specific minimum design standards for deep-seated stability analyses for Class II or Class I facilities in Tennessee.

Federal: There are no federal minimum design standards for deep-seated stability analyses for CCP facilities.

Selected Design Standard

Static, deep-seated stability analyses shall be performed based on the following recommendations. Guidance for these types of analyses is provided in [NAVFAC, 1986] and [OEPA, 2004]. The recommendations presented herein are based in part on these documents. A deep-seated stability analysis should include the following:

- Critical slope geometries under interim and long term configurations. Interim conditions are defined as any configuration of the facility that is of a temporary nature (such as a temporary internal slope that exists at close of one cell and prior to start of construction of the adjacent cell) that will be present for a period of less than one year. A long term configuration refers to any configuration that is not classified as interim (for example, post-closure geometries, or semi-temporary conditions that may exist for longer than one year during construction).
- Cross-sections of the facility which represent critical (worst-case) geometries or configurations. Prior to beginning the stability calculations, a screening analysis should be performed in order to identify these critical cross-sections considering both long term and interim facility configurations (such as height of fill over existing grade, sideslope geometry, etc.), properties of the foundation materials (including strength and consistency of the foundation materials, depths to competent material, etc.), and groundwater conditions. It will likely be necessary to analyze more than one section in a given project if a single critical section cannot be identified by inspection.
- Both circular and block-type failure surface geometries, as well as geometries involving failures along internal slopes and along liners featuring geosynthetic interfaces. Failure surface geometries of a wide range of sizes should be considered in the analyses, in order to identify the critical failure surface geometry.

- The results of the geotechnical investigation and laboratory testing should be utilized to establish shear strength and unit weight parameters for the foundation soils and to establish groundwater elevations for input into the stability analyses.
- All static slope stability analyses should be based on effective stress strength parameters. Peak shear strength parameters should be assigned to earthen materials. For analyses of block failure surfaces which pass through a multilayer base liner system, shear strengths representing the liner should correspond to the weakest interface within the liner system. The Geotechnical Engineer should consider the amount of displacement that is anticipated along the liner system during service when selecting shear strengths for use in the analyses. Low anticipated deformations warrant the use of peak shear strength parameters, while high anticipated deformations would warrant the use of residual shear strength parameters. If the specific materials that are to comprise the liner system are known at the time of the stability modeling, the strengths assigned should be based on the results of laboratory direct shear testing that are representative of the materials and interfaces to be used in the design. If the specific materials that are to comprise the liner system are unknown at the time of the stability modeling, the modeling should be used to establish an envelope of friction angle and adhesion combinations, which together satisfy the design criteria minimum safety factors (see below) for all design cases. This envelope should be made part of a performance specification for the liner materials in conjunction with similar requirements determined from the seismic deep-seated stability analyses (Section 1.4.2.2) and the shallow translational stability analyses (Section 1.4.4).
- Landfill construction involves incremental placement of fill materials over a relatively long period of time. Thus increases in porewater pressures induced by each increment of loading will generally have time to come to equilibrium with the applied loads, prior to application of the next increment – i.e., effective strength conditions will prevail in the foundation. However, soft, cohesive materials with low permeability that underlie the facility may not adequately drain in response to one load increment before the next increment is applied. Such layers may be prone to stability failures under undrained conditions. In such situations, stability analyses should include a check of slope stability utilizing total strength parameters for the soft, cohesive layers.

  The Geotechnical Engineer should determine if a facility is prone to failure in a total strength mode, on a case-by-case basis. The following guidance is provided for total strength stability analyses:

  - Total strength stability analyses should be considered if soil materials with undrained shear strength of less than 1,000 pounds per square foot (psf) and permeability of $1x10^{-7}$ cm/sec are present within or underneath the facility.
  - Implementation of total strength analyses must consider the estimated rate of fill placement within the facility, and the value of the undrained shear strength that is available in each soft, cohesive layer at any time during the landfilling process. The undrained shear strength of these materials will change over time, depending on the amount of consolidation that has occurred under the load that has already been applied. Analyses representing a number of points in time during the landfilling process will usually be required.

- o The rate of consolidation and the undrained shear strength available after a particular amount of consolidation has occurred under a given load should be determined based on laboratory consolidation and triaxial testing.

- A minimum factor of safety of 1.5 shall be used for static analysis of deep-seated stability for post-closure slopes or slopes that are not classified as interim slopes. Interim slopes shall be designed for a factor of safety of 1.3. These factors of safety pertain to both effective strength and total strength analyses. Facilities that do not meet these criteria will need to be redesigned. If the facility meets the criteria under effective strength analyses but not under total strength analyses, consideration should be given to incorporating controlled loading rates (staged construction), vertical subdrainage (wick drains) or other methods of ground improvement. These techniques should be clearly incorporated into the plans and specifications for the facility.

- At a minimum, all slope stability analyses should be performed using 2-dimensional limit equilibrium analysis based on the method of slices and capable of determining minimum (critical) factors of safety based on a search of a wide range of potential circular and block failure geometries. An analysis methodology satisfying both force and moment equilibrium and incorporating the effects of interslice forces should be utilized – such as Spencer's Method or the Morgenstern-Price Method. Hand calculations and computer analyses are acceptable for this purpose. In certain situations, finite element or finite difference methods may also be used in conjunction with the limit equilibrium procedures, at the discretion of the Geotechnical Engineer.

1.4.2.2 Deep Seated Failure Analysis (Seismic)

1.4.2.2.1 Design Seismic Event

Definition

The design seismic event is defined as the event producing the maximum horizontal acceleration at the base of the facility for which the facility and its components must be designed to remain stable. This maximum horizontal acceleration is used as input in evaluating the liquefaction potential and seismically influenced global stability analyses.

Minimum Design Standards

Alabama: There are no minimum design standards for the design seismic event for special waste facilities. For municipal solid waste facilities 335-13-4-.01 (1) (d) gives requirements that are essentially identical to those in Tennessee (see below).

Kentucky: There are no specific minimum design standards for special waste facilities. For contained waste facilities, 401 KAR 48:070 Section 3 states: At a new contained solid waste landfill unit located in a seismic impact zone, all containment structures, including liners, leachate collection systems, and surface water control systems shall be designed to resist the maximum anticipated horizontal acceleration in lithified material for the site.

Tennessee: 1200-1-7-.04(2)(v) states that Class I and II disposal facilities shall not be located in seismic impact zones, unless the owner or operator demonstrates that all containment structures, including liners, leachate collection systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site. The owner or operator must place the demonstration in the Narrative Description of the Facility and Operations Manual. The state provides the following definitions with regard to this regulation:

> "Seismic impact zone" means an area with a ten percent or greater probability that the maximum horizontal acceleration in lithified earth materials, expressed as a fraction of the earth's gravitational pull will exceed 0.10g in 250 years.
>
> "Maximum horizontal acceleration in lithified earth material" means the maximum expected horizontal acceleration depicted on a seismic hazard map, with a 90 percent or greater probability that the acceleration will not be exceeded in 250 years, or the maximum expected horizontal acceleration based on a site-specific seismic risk assessment.

Selected Design Standard

Seismic design of facilities shall be performed based on an event which produces a maximum horizontal acceleration in lithified earth materials with a probability of exceedance of 2% in 50 years (the design event). This corresponds to an event with a return period of approximately 2,500 years, and is approximately equivalent to the requirements for Class I and II facilities in Tennessee and MSW facilities in Alabama.

The following information should be obtained/established, prior to performing seismic stability analyses:

- The seismic site class should be determined using the NEHRP site class definitions and based on the results of the geotechnical investigation. Sites that include ponded or sluiced fly ash materials or fly ash materials below the water table should be given Site Class F designation, by inspection.
- The peak ground acceleration in lithified earth at the site and corresponding to the design event should be selected based on data from the United States Geological Survey's (USGS) Seismic Hazard maps (currently available online at http://gldims.cr.usgs.gov/nshmp2008/viewer.htm and/or from the data in TVA's region-specific study performed by AMEC GeoMatrix.

  The peak acceleration obtained as above is referred to herein as PGA_{rock}.

- Most sites will include overburden soils and geomaterials lying above bedrock. In these cases, the parameter PGA_{rock} should be corrected to account for the characteristics of the overburden (i.e., potential for amplification of the rock motions through the overburden materials), to obtain the peak horizontal acceleration at the ground surface at the site (i.e., at the base of the facility), referred to herein as PGA_{design}.. The parameter $\mathrm{PGA}_{\mathrm{design}}$ will be used as input in several of the seismic stability analyses described in the subsequent sections.

The following minimum level of effort should be implemented to determine PGA_{design}::

For sites classified as Class A or B (rock sites), PGA_{rock} can be used as PGA_{design}. A site-specific response analysis (as described below) may also be used to determine PGA_{design}

Sites for which PGA_{rock} is less than 0.20g and the seismic site classification is C through E, PGA_{design} may be determined by multiplying PGA_{rock} by published amplification ratios to account for amplification of rock motions through the soil profile at the site. References containing amplification ratios include [Idriss, 1991]. A site-specific response analysis (as described below) may also be used to determine PGA_{design}.

Sites that have PGA_{rock} greater than 0.20g and are designated Site Classes C through E, or Class F sites with any value of PGA_{rock} warrant further study to obtain PGA_{design}. A site-specific response analysis is recommended for such sites. The site response analysis should include a seismological evaluation to establish the design moment magnitude, M_{design} (as described below) and to develop time histories at bedrock that are representative of the design event. The response analysis should also include a 1-D nonlinear or equivalent-linear ground response analyses which accounts for propagation of the rock motions through the soil column and to the ground surface. This analysis should be used to establish $PGA_{design.}$

- The mean moment magnitude for the event at the location of the site should be selected using USGS deaggregation data (currently available online at http://eqint.cr.usgs.gov/deaggint/2008/) and/or from the data in TVA's region-specific study performed by AMEC GeoMatrix (most current study at the time of writing of this document is dated 2004).

  The moment magnitude obtained in this fashion is referred to herein as M_{design}. This moment magnitude should be used as input to the seismic stability analyses described in subsequent sections.

1.4.2.2.2 Liquefaction Analysis

Definition

Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. Liquefaction generally occurs in saturated fine to medium sands, silts, or similar cohesionless soils, in response to increases in pore pressures and associated loss of shear strength created by seismically induced ground motion. Liquefaction analyses are performed with the objectives of evaluating the potential for liquefaction of each subsurface deposit underlying a facility, and if liquefaction potential exists, predicting the extent of deformation that may occur due to liquefaction. This section describes minimum design guidelines for liquefaction analyses.

Minimum Design Standards

Alabama: There are no minimum design standards for liquefaction analyses for CCP facilities. For municipal solid waste facilities, regulations which are indirectly related to liquefaction include: 335-13-4-.01 (1) (d) which presents requirements for facilities located in seismic impact zones. The requirements are essentially identical to those in Tennessee (see above).

Kentucky: There are no minimum design standards for liquefaction analysis for special waste facilities and contained waste facilities.

Regulations which are indirectly related to liquefaction include:

> 401 KAR 48:070 Section 3 states: At a new contained solid waste landfill unit located in a seismic impact zone, all containment structures, including liners, leachate collection systems, and surface water control systems shall be designed to resist the maximum anticipated horizontal acceleration in lithified material for the site.
>
> 401 KAR 48:070 Section 4 for contained facilities which require that the facility design address stability of the facility components if constructing in unstable areas.

Tennessee: Tennessee addresses liquefaction analyses in a document published by the Division of Solid Waste Management and entitled “Earthquake Evaluation Guidance Document”. This guidance references a procedure for evaluating liquefaction potential of foundation soils presented in [Seed and Idriss, 1971] (see references below).

Regulations which are indirectly related to liquefaction include:

> 1200-1-7-.04(2)(v) Class I and II disposal facilities shall not be located in seismic impact zones, unless the owner or operator demonstrates that all containment structures, including liners, leachate collection systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site. The owner or operator must place the demonstration in the Narrative Description of the Facility and Operations Manual. The state provides the following definition with regard to this regulation:
>
> “Seismic impact zone” means an area with a ten percent or greater probability that the maximum horizontal acceleration in lithified earth materials, expressed as a fraction of the earth’s gravitational pull will exceed 0.10g in 250 years.
>
> “Maximum horizontal acceleration in lithified earth material” means the maximum expected horizontal acceleration depicted on a seismic hazard map, with a 90 percent or greater probability that the acceleration will not be exceeded in 250 years, or the maximum expected horizontal acceleration based on a site-specific seismic risk assessment.

Selected Design Standard

- Soil units defined by the geotechnical investigation should be separated into materials that may subject to classical liquefaction and those that may be subject to softening and substantial reduction in strength during and after earthquake shaking. Separate evaluations will be required for each type of material.

Soil layers susceptible to classical liquefaction should be identified as follows: Layers classified as sands or gravels, per USCS (all S- and G- classes); Layers classified as silts or clays (M- and C- classes) that have plasticity index less than 7. These soil layers are defined as Category 1 materials herein.

Natural silt, clay, or organic soils (M- and C- and O- classes) that have plasticity index greater than or equal to 7 though not susceptible to classic liquefaction, may be prone to softening under cyclic loads. These soil layers are defined as Category 2 materials herein.

Soils not fitting within the definitions of Categories 1 and 2 as defined above are considered special soils and are defined as Category 3 materials. Category 3 materials include fly ash and other CCPs, or other unnatural soil materials. Category 3 soils may be prone to classic liquefaction or cyclic softening, but their liquefaction (or softening) behavior is not well established in the literature and needs to be specifically addressed by the Geotechnical Engineer.

Evaluation of Soils With Potential For Classical Liquefaction (Category 1)

- All soil layers that fall under Category 1 as described above should be evaluated for the potential for liquefaction.
- Analysis of liquefaction potential should be performed in general accordance with the methods given in [You'd et al., 2001]. This methodology is an update to the methodology presented in the Tennessee guidance document referred above. This is a semi-empirical procedure which relates the soil's resistance to liquefaction based on typical field data that is obtained during the geotechnical investigation (SPT N values, CPT resistances, etc). The liquefaction analysis shall have the design seismic event (defined in Section 1.4.2.2.1) as its basis. Material properties for each layer used as input to the analyses should be established based on the results of the geotechnical investigation and site-specific laboratory testing.
- The result of the liquefaction analyses will be a factor of safety against liquefaction, where the factor of safety is defined as follows:

  $$FS_{liq} = \frac{CRR}{CSR}$$

  Where CRR = Cyclic Resistance Ratio, corresponding to the design event

  CSR = Cyclic Stress Ratio, corresponding to the design event.

  The factor of safety against liquefaction of each subsurface layer within Category 1 should be determined.
- Interpretation of the computed factors of safety is performed as part of the seismic slope stability analyses and seismic deformation analyses, as defined in Sections 1.4.2.2.3 and 1.4.2.2.4 below.
- If appropriate and at the discretion of the Geotechnical Engineer, the cyclic resistance of soils may be determined through the use of project-specific laboratory testing. Project-specific laboratory testing is recommended to establish cyclic resistance of highly

sensitive clay soils falling within Category 2 (sensitivity greater than 6) or soils which reach peak undrained strength at low strains (less than 5% strain).

Evaluation of Soils With Potential For Cyclic Softening (Category 2)

- All soil layers that fall under Category 2 as described above should be evaluated for the potential for softening under cyclic loading.
- Analysis of the potential for cyclic softening should be evaluated according to [Idriss and Boulanger, 2008]. This is a semi-empirical procedure which relates the soil's resistance to cyclic softening based on data that is obtained during the geotechnical investigation (undrained shear strength and overconsolidation ratio). The analysis should have the design seismic event (defined in Section 1.4.2.2.1) as its basis. Material properties for each layer used as input to the analyses should be established based on the results of the geotechnical investigation and site-specific laboratory testing.
- The result of the liquefaction analyses will be a factor of safety against cyclic softening for each layer within Category 2. The factor of safety is defined as follows:

  $$FS_{cs} = \frac{CRR}{CSR}$$

  Where CRR = Cyclic Resistance Ratio, corresponding to the design event

  CSR = Cyclic Stress Ratio, corresponding to the design event.
- Interpretation of the computed factors of safety is performed as part of the seismic slope stability analyses and seismic deformation analyses, as defined in Sections 1.4.2.2.3 and 1.4.2.2.4 below.
- If appropriate and at the discretion of the Geotechnical Engineer, the cyclic resistance of soils may be determined through the use of project-specific laboratory testing.

Evaluation of Special Soils (Category 3)

- Since the seismic response of Category 3 materials may differ from that of natural or typical soils, the methods for determining the potential for liquefaction or cyclic softening recommended for Category 1 and 2 soils above may or may not be applicable. Analysis of liquefaction or softening potential of Category 3 materials should be at the discretion of the Geotechnical Engineer and should be based on material and site-specific laboratory testing data, and on the design event. The Geotechnical Engineer should provide detailed description, assumptions, and supporting data to substantiate the methods that are selected to analyze Category 3 materials.

1.4.2.2.3 Seismic Slope Stability Analysis

Definition

Deep seated stability analyses evaluate the potential for mass slope instabilities, as defined above in Section 1.4.2.1.

Analyses under seismic conditions evaluate the potential for deep-seated instabilities under the action of the design seismic event and after the end of this event. This analysis also seeks to estimate the amount of permanent deformation that may occur within the facility due to the seismic action, so that facility components can be appropriately designed.

Minimum Design Standards

Alabama: Regulations and guidance pertaining to seismic stability analyses are as given for the liquefaction analyses, see Section 1.4.2.2.2.

Kentucky: Regulations and guidance pertaining to seismic stability analyses are as given for the liquefaction analyses, see Section 1.4.2.2.2.

Tennessee: Regulations and guidance pertaining to seismic stability analyses are as given for the liquefaction analyses, see Section 1.4.2.2.2.

Selected Design Standard

Seismic slope stability evaluations should, at a minimum, include the following:

1. Determination of critical cross-sections and failure geometries for analysis.
2. An interpretation of the results of the liquefaction analyses (described in Section 1.4.2.2.2).
3. Evaluation of post-earthquake shear strengths.
4. Post-earthquake residual conditions slope stability analyses.

Recommendations and guidelines for each of these components are as follows:

Determination of Critical Cross-Sections and Failure Geometries For Analysis

- The recommendations related to selection of critical cross-sections, failure surface geometries to be considered and slope stability analysis methods given in Section 1.4.2.1 for static stability analyses may also be applied to the seismic stability analyses. At a minimum, cross-sections and failure geometries considered in the seismic stability analyses should include all post-closure configurations and all configurations not classified as interim conditions, as defined for the static stability analyses (Section 1.4.2.1).

Interpretation of Liquefaction Analysis

- Prior to performing slope stability and deformation analyses, the liquefaction analyses presented in Section 1.4.2.2.2 should be performed, to identify those deposits within and underneath the facility that are prone to liquefaction or significant strength loss during the design seismic event. As described previously, the results of the analyses of 1.4.2.2.2 are the factors of safety against liquefaction (FS_{liq})or against cyclic softening (FS_{cs}) for each major soil layer. The potential for liquefaction of each layer should be interpreted based on the computed factors of safety, as follows:

  For soils susceptible to classical liquefaction (Category 1 as defined in Section 1.4.2.2.2):

  $FS_{liq} <= 1.10$ Assume layer liquefies under design event

  $1.1 < FS_{liq} <= 1.4$ Assume partial liquefaction and strength loss in layer

  $FS_{liq} > 1.4$ Assume no liquefaction

For soils susceptible to cyclic softening (Category 2 as defined in Section 1.4.2.2.2):

FS_{cs} <= 1.4	Assume cyclic softening occurs as a result of design event.
FS_{cs} > 1.4	Assume no cyclic softening occurs.

Evaluation of Post-Earthquake Shear Strengths

The shear strength of soils that have liquefied or softened and liner and cap components that have displaced substantially in response to the design earthquake may be substantially smaller than the static shear strength of these materials.

The first estimate of post-earthquake shear strengths should be evaluated as follows. It may be appropriate in some cases to establish post-earthquake shear strengths in a manner other than that presented below. In such a case, the Geotechnical Engineer shall provide thorough written documentation of the procedures and methodology used to establish the post-earthquake shear strengths assigned.

- For soils susceptible to classical liquefaction (Category 1 as defined in Section 1.4.2.2.2), shear strengths should be taken no higher than as follows:

If FS_{liq}<=1.10	Assume layer is liquefied following the design event and assign post-liquefaction residual strength to the layer.
If 1.1<FS_{liq}<=1.4	Determine the strength for the layer by interpolation based on the computed safety factor against liquefaction. Interpolate between the post-liquefaction residual strength at FS = 1.10, and the full peak strength of the material at FS = 1.40.
If FS_{liq}> 1.4	Assign the full static drained strength of the layer for soils classified as sands or gravels (G- or S- classes); Assign the full static undrained strength for soils classified as silts or clays (M- and C- classes).

  The post-liquefaction residual strengths may be determined using published empirical methods, such as given in Seed, et. al, (2003) and Idriss and Boulanger, (2008) or using project-specific laboratory testing performed under the supervision of the Geotechnical Engineer.

- For soils susceptible to softening under cyclic loads (Category 2 as defined in Section 1.4.2.2.2), shear strengths should be taken as follows:

FS_{cs} <= 1.4	Assign shear strength equal to 80% of the peak undrained shear strength under static conditions.
FS_{cs} > 1.4	Assign shear strength equal to 100% of the peak undrained shear strength under static conditions.
Special Cases	For highly sensitive clay soils falling within Category 2 (sensitivity of 6 or greater) or soils which reach peak undrained strength at low strains, FS_{cs} may be interpreted as given above, but it is recommended that the post-

earthquake shear strength be established using project-specific laboratory testing.

- For special soils (Category 3), post-earthquake shear strengths should be established by material and site-specific laboratory testing, and at the discretion of the Geotechnical Engineer.
- For liner interfaces containing geosynthetics, assign residual shear strengths. Residual strength properties used in the analyses should correspond to the weakest interface within the liner system. If the specific materials that are to comprise the liner system are known at the time of the stability modeling, the strengths assigned should be based on the results of laboratory direct shear testing on the materials and interfaces to be used in the design. If the specific materials that are to comprise the liner system are unknown at the time of the analysis, the analysis should be used to establish an envelope of friction angle and adhesion combinations, which together satisfy the design criteria minimum safety factors (see below) for all design cases. This envelope should be made part of a performance specification for the liner materials, in conjunction with similar requirements determined from the static deep-seated stability analyses (Section 1.4.2.1) and the shallow translational stability analyses (Section 1.4.4).

Post-Earthquake Residual Conditions Slope Stability Analysis

- This analysis consists of limit-equilibrium slope stability evaluations under post-earthquake conditions. It analyzes the susceptibility of the facility to slope failures occurring after the end of the design seismic event. The analysis should be performed using the post-earthquake shear strengths established as recommended above. Separate analyses should be performed for each critical cross-section and failure surface geometry. Acceptable limit equilibrium analysis procedures for this analysis are the same as those presented for the static stability analyses (Section 1.4.2.1).

  If the factor of safety at any cross-section under this analysis is less than 1.0, the facility is prone to large scale failure after the end of the seismic event, and redesign of the facility is warranted.

1.4.2.2.4 Seismic Deformation Analyses

Definition

Seismic deformation analyses are used to estimate the amount of permanent deformations (horizontal and vertical) that may occur within the facility in response to the design seismic event, as defined above in Section 1.4.2.2.1. The results of this analysis are used to evaluate the potential for damage of facility components due to seismically induced deformations.

Minimum Design Standards

Alabama: Regulations and guidance pertaining to seismic stability analyses are as given for the liquefaction analyses, see Section 1.4.2.2.2.

Kentucky: Regulations and guidance pertaining to seismic stability analyses are as given for the liquefaction analyses, see Section 1.4.2.2.2.

Tennessee: Regulations and guidance pertaining to seismic stability analyses are as given for the liquefaction analyses, see Section 1.4.2.2.2.

Selected Design Standard

At a minimum, seismic deformation analyses shall include the following:

1. Newmark-type Sliding Block Analysis to determine accumulated displacements that occur during earthquake shaking.
2. For sites at which liquefaction is predicted in Category 1 soils (as defined in Section 1.4.2.2.2) and that also include incised by stream channels or other open face channels, or that are sites constructed on sloping ground, an evaluation of lateral spreading-type displacements should be performed.
3. An analysis of vertical deformations (settlements) induced by earthquake shaking.

Displacements Occurring During Earthquake (Newmark-Type Sliding Block Analyses)

Displacements accumulating during earthquake shaking should be performed using Newmark-type Sliding Block Analyses that explicitly accounts for propagation and amplification of the acceleration at the ground surface at the base of the facility (PGA_{design}), through the CCP mass above. The analysis should include the following:

- A separate Newmark Sliding Block analysis should be performed for each individual critical cross-section and failure geometry considered in the Post-Earthquake Residual Conditions Slope Stability Analysis (see Section 1.4.2.2.3 above).
- The analysis should be implemented such that an estimated magnitude of displacement within the CCP mass, along liner and cap systems, and at the location of any major facility components (underdrainage, leachate collection piping, etc) are obtained.
- Newmark Sliding Block analyses of each cross-section and failure geometry should begin by performing a pseudostatic limit equilibrium slope stability analysis, to establish the yield acceleration, k_y – defined as the magnitude of the pseudostatic seismic coefficient required to obtain a factor of safety of 1.0. Limit equilibrium analyses should be performed using the same methods and assumptions on shear strength as were used for the Post-Earthquake Residual Conditions Slope Stability Analyses (see Section 1.4.2.2.3).
- Using k_y determined as above, and using the geometric and stratigraphic configuration of the cross-section, perform a Newmark-type analysis to obtain seismically induced displacements.

  For Sites classified as Seismic Site Class A and B, or for sites classified as Site Classes C through E that have maximum horizontal acceleration (MHA) < 0.20g (as determined in Section 1.4.2.2.1), the sliding block analysis may be implemented using a simplified procedure such as given in Makdisi and Seed (1978) or Bray, (2007).

  Per the requirements of Section 1.4.2.2.1, a site response analysis will have been performed for sites classified as Site Class F, or for sites classified as C through E that have MHA>0.20g. The site response analysis would include development of site-specific earthquake time histories. For such sites, the Newmark-type sliding block calculations should be performed based on these time histories.

- More rigorous methods such as finite element or finite difference methods may be utilized to estimate accumulated displacements during earthquake shaking, if warranted and at the discretion of the Geotechnical Engineer.

Deformations Occurring Due to Liquefaction-Induced Lateral Spreads

If the results of the liquefaction analysis of Section 1.4.2.2.2 indicate a factor of safety against classical liquefaction (FS_{liq}) less than 1.10 for any Category 1 soil layers, an evaluation of liquefaction-induced lateral spread displacements should be performed. Lateral spread displacements should be evaluated for each pertinent critical cross-section.

Lateral spread displacements may be computed using semi-empirical procedures, such as given in Bartlett and Youd (1995), and updated in Youd, et. al (2002), or by finite element or finite difference methods, at the discretion of the Geotechnical Engineer.

Earthquake-Induced Vertical Deformations (Settlement)

The buildup and subsequent dissipation of pore pressures induced by earthquake shaking may result in volumetric strains and corresponding settlements of unsaturated and saturated sand soils. The potential and magnitude for such settlements should be evaluated as part of the seismic deformation analyses. Earthquake-induced settlement analyses should be based on published and widely accepted empirical procedures, such as Tokimatsu and Seed, (1987).

Evaluation of earthquake-induced settlements should be performed for each individual critical section considered in the seismic deformation analyses. Additional analyses should also be performed to estimate settlements underneath subdrainage infrastructure, such as leachate collection piping and other facility components that may be sensitive to settlement. .

Deformation Performance Criteria

- *Displacement Criteria:* If applicable, displacement estimates from the Newmark-type Sliding Block analysis should be added to the estimates of lateral spread displacements. The resulting total displacement should then be compared to the following allowable displacements given in Table 1.4.2-1 from Kavazanjian (1999):

Table 1.4.2-1
Allowable Displacement

Component	Allowable Calculated Displacement	Comment
Liner System	150 to 300 mm	Actual expected deformation is very small.
Cover System	300 mm to 1 m	Damage is repairable.
Waste Mass	1 m	For displacement not impacting cover or liner.
Roadways, Embankments	1 m	Conventional geotechnical criteria.
Surface Water Controls	1 m	Conventional geotechnical criteria.
Gas Collection System	No Limit	Breakage common under normal operating conditions.

If the predicted displacements exceed the allowable values, redesign of the facility is warranted.

The values given in Table 1.4.2-1 correspond to allowable displacements within the CCP mass and for materials and systems typically included in the design of landfill systems. For sites that include other structures or systems not covered by the above table, the Geotechnical Engineer should select appropriate displacement tolerances for these structures or systems.

- *Settlement Criteria:* Differential settlements under the liner and leachate collection systems will tend to reduce the constructed slope of these systems, and can affect their capacity to drain and manage leachate. The facility should be designed such that the minimum post-settlement slopes of the liner between leachate collection pipes is 2% and that the minimum post-settlement slope of leachate collection piping is 0.5 to 1 %. Differential settlements of piping should be limited to allowable values as established by the pipe manufacturer.

  Differential settlement of the liner system may induce strains in the geosynthetic components. The results of the settlement analysis should be used to estimate the maximum strain in the liner geosynthetic components. The facility should be designed to limit the strain to 5%. The strain across two points on the liner system that settle differentially with respect to each other may be computed using the following equation:

  $$E_T(\%) = \frac{L_f - L_0}{L_0} * 100 \quad \text{where,}$$

  E_T = Tensile strain

  L_f = Original distance separating two location points

  L_0 = Final distance separating the same two points after settlement is complete

1.4.3 Settlement Analysis and Liner Strain Evaluation

Definition

Settlement analyses predict total and differential subsurface deformations underneath critical elements of the facility, such as the liner system, leachate collection system, and cap system. Settlements are induced by the loads imposed by the facility, the self weight of facility components and the CCP materials, acting on the foundation soils below the facility. Settlement analyses are used to evaluate the effects of the subsurface deformations on the integrity and operation of the facility components and to design appropriate strategies to mitigate these effects in order to maintain serviceability and stability of the facility.

Minimum Design Standards

Alabama: There are no minimum design standards for settlement analyses for CCP facilities in Alabama. For municipal solid waste facilities, settlement concerns are generally addressed in 335-13-4-.01 (1) (5) (i), which requires that the design of the facility address on-site or local soil conditions that may result in significant differential settling.

Kentucky: There are no minimum design standards for settlement analysis for special waste facilities in Kentucky. There are also no specific standards for settlement analyses for contained waste facilities. However, 401 KAR 48:070 Section 4 (1) for contained facilities generally addresses settlement concerns by requiring that the facility design address on-site or local soil conditions that may result in significant differential settling.

Tennessee: For Class II facilities, 1200-1-7-.04(2)(w)(1) generally addresses settlement concerns by requiring that the facility design demonstrate that measures have been incorporated to ensure the integrity of the facility under the effects of on-site or local soil conditions that may result in significant differential settling. This demonstration is to be made in the design narrative for the facility which is submitted as part of the facility permit application. For Class II facilities, 1200-1-7-.04(4)(a)(1)(iii) states that the liner system be "Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift". 1200-1-7-.04(4)(a)(4)(iv) makes an equivalent statement for the cap system.

Federal: There are no federal minimum design standards for settlement analyses for CCP facilities.

Selected Design Standard

Settlement analyses shall be performed as part of the facility design and shall be documented for inclusion with the design narrative for the facility. The settlement analyses should include the following components:

- The geotechnical investigation should include laboratory testing that establishes the compressibility characteristics of all critical subsurface layers that are expected to undergo settlements under the facility. At a minimum, the laboratory testing plan should include one-dimensional consolidation tests per ASTM D 2435. A minimum of two tests per critical layer should be specified, to establish a range of values for the compressibility parameters in each layer.
- Settlement analyses should be focused on critical cross-sections of the facility, such as those sections featuring the highest fill, largest variations in the heights of fill, and underneath subdrainage infrastructure, such as leachate collection piping. The settlement analyses should generally be based on the maximum proposed grades for the facility.
- Settlement Analysis Methods: Settlement analyses for normally or over-consolidated fine-grained soils may be based on classical methods as presented in McCarthy, (1998). Settlement analyses for coarse-grained materials may be performed using the Hough Method, see FHWA, (2002). In lieu of, or complementary to, the classical analyses presented above, more rigorous analyses of settlement, such as by finite element or finite difference techniques, may also be performed, if warranted. Constitutive models and corresponding input parameters should be selected based on the characteristics of the materials being analyzed for settlement, and should be based on appropriate laboratory testing.

  Settlement analyses should also include an evaluation of secondary compression and creep of critical layers, as determined appropriate by the Geotechnical Engineer.

- Because typical facilities will feature large area fills, the load of the facility will generally be transmitted to significant depths below the landfill base. The settlement analysis should account for compression of all soil layers within the subsurface profile to the top of competent bedrock. Settlement of competent bedrock materials can generally be neglected, unless determined otherwise by the Geotechnical Engineer.
- *Seismically Induced Settlements:* Settlement occurs when liquefaction and attendant pore pressure dissipation causes densification of the liquefied layer. The magnitude of settlement (volumetric strain) can be estimated from charts developed in Tokimatsu and Seed (1987) based on the average cyclic shear stress ratio induced by the earthquake and the density of the soil in question. Settlement may result in damage to the liner and/or internal drainage systems. The effects of seismically induced settlements should be considered in the design, at the discretion of the Geotechnical Engineer.
- *Areas of Karstic Terrain and Former Mining Activity:* Where a facility is to be constructed on karstic terrain or former mined areas, appropriate field investigations should be made to identify any underground voids that may exist (geophysical surveys, etc). Near-surface voids or open sinkholes, should be appropriately treated and filled to prevent subsidence underneath the constructed facility. If deep voids are present, further study of the overlying materials should be performed to evaluate the potential for subsidence and its effects on the facility.
- Results of the settlement analyses should be used to estimate differential settlements underneath the liner system collection piping and other components prone to settlement-related distress. The facility should be designed to limit total and differential settlements under these components to allowable values as established by the manufacturer.
- Settlements under the facility will occur after construction of the base liner and leachate collection systems, and during/after filling operations. Differential settlements under the liner and leachate collection systems will tend to reduce the constructed slope of these systems, and can affect their capacity to drain and manage leachate. The facility should be designed such that the minimum post-settlement slopes of the liner between leachate collection pipes is 2% and that the minimum post-settlement slope of leachate collection piping is 0.5 to 1 %. Differential settlements of piping should be limited to allowable values as established by the pipe manufacturer.
- Differential settlement of the liner system may induce strains in the geosynthetic components. The results of the settlement analysis should be used to estimate the maximum strain in the liner geosynthetic components. The facility should be designed to limit the strain to 5%. The strain across two points on the liner system that settle differentially with respect to each other may be computed using the following equation:

  $$E_T(\%) = \frac{L_f - L_0}{L_0} * 100$$ where,

  E_T = Tensile strain

  L_f = Original distance separating two location points

  L_0 = Final distance separating the same two points after settlement is complete

1.4.4 Shallow Translational Failure Analysis

Definition

Shallow translational failures are failures involving sloped interfaces within the cap or liner systems constructed near the surface of a proposed facility. Generally, failures involving interfaces that are within 10 ft of the surface of a permanent or interim slope may be considered shallow translational failures. Critical interfaces for shallow translational failures typically include interfaces involving geosynthetic to soil contact or geosynthetic to geosynthetic contact. Forces driving shallow translational failures include the gravity load (weight) of the cap or liner system (i.e., the component of the weight aligned parallel to the interface slope), seismic forces, and hydrostatic forces due to subsurface water collecting within the interfaces. Forces resisting shallow translational failures include friction and adhesion between the materials at the critical interfaces, and passive earth forces at the base of a run of the cap or liner system. Shallow translational stability analyses quantify the driving and resisting forces along each critical interface, and establish the factor of safety against failure, defined as the ratio of the resisting forces to the driving forces.

Minimum Design Standards

Alabama: There are no specific minimum design standards for shallow translational stability analyses for CCP or MSW facilities. Regulations which are indirectly related to shallow translational stability include: 335-13-4-.20(2)(c)(2), which requires that final slopes for MSW landfill covers not exceed 25%.

Kentucky: There are no specific minimum design standards for shallow translational stability analyses for special waste facilities. For contained waste facilities, general requirements for structural stability of cap and liner systems are given in 401 KAR 48:080 Section 10, which states the following: "The design engineer shall analyze the structural integrity of the site, the subbase, each component of the composite liner, each component of the final cover, the composite liner system and the final cap as a system. Modifications to the design shall be provided where necessary, to achieve a minimum factor of safety of two (2) for the subbase, one and one-fourth (1.25) for the structural design of the facility liner components, and one and one-half (1.5) for the final cover system. Synthetic liner material and structural synthetic materials shall be designed for a maximum elongation of ten (10) percent."

The requirement does not present any specific analysis methodologies or assumptions to be used in evaluating the factors of safety.

Tennessee: There are no specific minimum design standards for shallow translational stability analyses for Class I or II landfills. Regulations which are indirectly related to shallow translational stability include: 1200-1-7-.04(4)(a)(1) which requires that slopes for landfill liners not exceed 25%.

Tennessee provides guidance for seismic stability design of landfill covers in a document published by the Division of Solid Waste Management and entitled "Earthquake Evaluation Guidance Document". This guidance presents a procedure for evaluating seismic displacements of landfill caps, based on that given in [Makidisi and Seed, 1978].

Federal: There are no specific federal minimum design standards for shallow translational stability analyses for CCP facilities.

Selected Design Standard

Final design of cap and liner materials shall conform to state standards on maximum slopes. Shallow translational stability analyses shall be performed for each critical interface within the final cap system, and should be considered for interim configurations of the liner system (i.e., prior to CCP placement or during the early stages of CCP placement) where liner slopes exceed 10%. The analyses should be performed for the most steeply sloped sections of the proposed cap or liner.

If the specific materials to be used for the cap and liner system components are known during the design phase, a program of direct shear testing should be implemented on all critical interfaces of the design. The resulting shear strength parameters should be used as input within the shallow translational stability analyses.

If the specific materials to be used in construction of the liner and cap system are not known during the design phase, the shallow translational stability analyses should be utilized to develop an envelope of friction angle and adhesion combinations, which together satisfy the minimum factors of safety presented below, for all design cases. This envelope should be made part of a performance specification for the liner and cap materials.

As a minimum design standard, the following conditions should be considered in the shallow translational stability analyses:

1) Static, Drained Conditions: This condition consists of the typical, service conditions to be experienced at the facility. This analysis does not account for the effects of seepage or groundwater, nor those of seismic events.
2) Static, Saturated Conditions: This condition adds the effects of seepage forces on the critical interfaces to the assumptions for the static drained conditions described above. Seepage forces may build within the cap system if the drainage layer becomes clogged or its capacity is exceeded during a high intensity storm event.
3) Seismic Conditions: This condition should consist of the basic conditions assumed for the static, drained analysis, with the addition of a seismic factor corresponding to the design seismic event, as described in Section 1.4.2.2.1. The seismic factor used as input into the analysis should correspond to the ground acceleration at the level of the system being analyzed (cap or liner), after accounting for amplification of ground motions through the materials underlying the system.
4) Static, Residual Strength Conditions: This condition analyzes the susceptibility of the facility to a large scale shallow translational failure, occurring after an unanticipated, short duration event that produces large displacements within the cap system (such as an earthquake). Though the critical interface may survive the initial event, the displacements that are experienced may exceed the peak

strength of the interface and create a lower strength, residual strength condition afterward. If the residual strength is too low, large scale failure may result after the end of the initial event.

5) Other Conditions: Other project-specific conditions should be considered at the discretion of the Geotechnical Engineer. These may include conditions incorporating surcharges such as construction equipment, temporary slopes or configurations that may exist at some point in the construction or service of the facility, or special conditions such as gas pressures acting on the cap or liner systems.

The analyses should be based on limit equilibrium methodologies, using a slope stability analysis computer program or using suitable closed form solutions such as those presented in the Ohio EPA's "Geotechnical and Stability Analyses for Ohio Waste Containment Facilities" (2004), or in Soong, and Koerner (1996).

In general, peak shear strength parameters may be utilized as input into the shallow translational stability analyses with exception of the following: the static, residual strength condition, and liquefaction at the toe of slope, for which residual strength parameters should be utilized. In addition, the tensile capacity of geosynthetics should be neglected in analyses of shallow translational stability.

The buildup of head at interfaces involving the drainage layer component of cap or liner systems should be limited to the thickness of the drainage layer or less, in order to minimize the effects of hydrostatic uplift forces at this interface for the static, saturated analysis condition. It is recommended that the design be based on procedures given in OEPA (2004).

Recommended minimum factors of safety for each condition are as follows:

1) Static, Drained Conditions: 1.5
2) Static, Saturated Conditions: 1.1
3) Seismic Conditions: >1.0
4) Static, Residual Strength Condition: 1.1
5) Other Conditions: Project-specific and determined by the Geotechnical Engineer.

- These minimum factors of safety assume that strength parameters for the critical interfaces have been established using rigorous, project-specific laboratory testing, and that the analysis is for a typical CCP facility. Uncertainties in strength characteristics of the critical interfaces or in the use or configuration of the facility, or other special project considerations may dictate the use of higher factors of safety in design.
- If the factor of safety under seismic conditions (computed using the limit equilibrium methods described above) is less than 1.0 for the permanent cap system, an analysis of permanent, seismically induced deformations of the cap should be made. As a minimum design standard, a Newmark-type Sliding Block analysis, as described in Section 1.4.2.2.3 should be utilized to estimate deformations. The facility should be designed such that the predicted deformation under the design seismic event is no greater than

listed in Table .1.4.2.1, and/or not in excess of allowable deformations as established by the manufacturer.

1.4.5 Anchor Trench Analysis

Definition

The terminus of geosynthetic components of liner and cap systems consists of a horizontal runout length and vertical embedment into an excavated anchor trench. The dimensions and configuration of this anchor trench is based on the tensile forces applied to the geosynthetic materials during temporary loading conditions in conjunction with the allowable tensile stresses for these materials.

Minimum Design Standards

Alabama: There are no known minimum design standards for the design of anchor trenches in Alabama.

Kentucky: There are no known minimum design standards for the design of anchor trenches for special waste facilities or contained waste facilities in Kentucky.

Tennessee: There are no known minimum design standards for the design of anchor trenches for Class I or Class II facilities in Tennessee.

Federal: There are no minimum federal design standards for the design of anchor trenches for CCP facilities.

Selected Design Standard

Anchorage shall be designed for a worst-case temporary scenario occurring during construction, such as a condition that may exist while earthmoving equipment is placing cover soil over geosynthetic components of the facility. The loading applied to the geosynthetic components should consider the weight of the soil present over these components, as well as the surcharge loads applied by the construction equipment.

Anchor trench design should be in general accordance with the methodology given in Qian, Koerner, and Gray (2002).

The resistance provided by runout length and anchor trench combinations should not be so great as to induce yield or tensile failure of the geosynthetic material prior to pullout. It is recommended that the resistance provided not exceed 2/3 of the geosynthetic material's yield strength (if the material has a definable yield strength) or ½ of the material's tensile strength.

Regardless of the results of analysis, a minimal anchor trench or combination runout section and anchor trench should be specified in the facility design, to provide resistance against unforeseen loadings such as wind. The minimal design should develop a stress in the geoynthetics that is no greater than ½ of the material's tensile strength.

1.5 LEACHATE MANAGEMENT SYSTEM

This section presents engineering design and performance standards associated with the effective management of leachate. The leachate management system includes components for collection and extraction of leachate from the landfill, as well as conveyance, storage, and treatment of the leachate. Design standards are provided in this section to estimate leachate generation, design leachate collection system piping and drainage layers, properly size leachate extraction and conveyance systems, and provide adequate leachate storage facilities.

1.5.1 Leachate Generation Calculations

Definition

Leachate generation calculations are conducted to estimate the volume of leachate that will be produced during various phases of the landfill life. The calculations are used for design of the leachate management system, including leachate collection pipe sizing, pipe spacing, leachate collection layer design, leachate extraction system design (pump sizing or gravity outlets), and leachate storage facility volumes.

Minimum Design Standards

Alabama: There are no minimum design standards for leachate generation calculations for CCP waste facilities. There are also no minimum design standards for leachate generation calculations for municipal solid waste (MSW), industrial waste (IW), and construction and demolition debris (C&DD) landfills.

Kentucky: There are no minimum design standards for leachate generation calculations for special waste facilities. There are also no minimum design standards for leachate generation calculations for contained landfills (i.e., MSW).

Tennessee: The minimum design standard for Class II disposal facilities are specified in TDEC 1200-1-7-.04(7). These standards specify that the leachate generation calculations are to be based on the infiltration volume of the 25-year 24-hour storm through the intermediate cover.

Selected Design Standard

The standard to be used for calculating leachate generation shall be based on the Tennessee regulation (TDEC 1200-1-7-.04(7)). More specifically, the Hydrologic Evaluation of Landfill Performance (HELP) model shall be used to calculate leachate generation. The HELP model was developed by the U.S. Army Engineer Waterways Experiment Station under a cooperative agreement with the U.S. Environmental Protection Agency (EPA) and is recommended by the USEPA, widely accepted in industry, and required by many States for evaluating waste management facilities. The HELP model is a computer program that computes estimates of water balances for land disposal systems. As of the date of this Document, the most recent model version is Version 3.07, which can be downloaded free on the Internet at the following website: http://el.erdc.usace.army.mil/products.cfm?Topic=model&Type=landfill.

At a minimum, the following scenarios should be analyzed by the HELP model to determine leachate generation rates:

- Scenario 1 – Initial Conditions: This scenario should assume one 10-ft lift of CCP material has been placed in the landfill, with 12-inches of intermediate cover soils placed over the CCP material. This scenario provides the peak expected leachate generation rate for the facility, which is typically utilized for sizing leachate extraction and conveyance systems (Section 1.5.4) and leachate storage facilities (Section 1.5.3). In addition, leachate collection pipe spacing and minimum required leachate collection layer permeability should be designed using this HELP model analysis (Section 1.5.2). Site specific design for the minimum liner system grades and maximum leachate flow length to the leachate collection piping should be utilized in the HELP model.

- Scenario 2 - Intermediate Conditions: This scenario assumes half of the permitted CCP height has been placed in the landfill. The CCP material is assumed to be covered with 12-inches of intermediate cover soils. This scenario provides the average leachate generation rates over the active life of the landfill.

- Scenario 3 - Closed Conditions: This scenario assumes the full height of CCP has been placed in the landfill and the final closure cap system has been constructed. This scenario estimates leachate generation rates during the post-closure period and provides cap system infiltration estimates for use in the design of cap system drainage layers.

Each scenario should be simulated by the HELP model for a minimum thirty (30) year time period to verify that all scenarios are modeled for all reasonably expected climactic conditions. Synthetic weather and solar radiation data may be generated using the HELP model for the specific project location. However, the designer must verify that synthetically generated rainfall data provides a peak daily rainfall amount greater than or equal to the 25-year, 24-hour storm event. Current weather data, such as the National Oceanic and Atmospheric Administration (NOAA) shall be referenced to determine the 25-year, 24-hour storm event. If the 25-year, 24-hour storm event is not provided, the designer should manually input this storm event into the HELP model simulation.

As the operation of the first phase of the landfill progresses, actual site-specific leachate generation data may be available based on volumes collected in the leachate management system. If this data is available, the design of the future leachate management system should be evaluated and compared to the HELP model results. Using site specific data as opposed to data obtained from the HELP model will likely require regulatory approval prior to acceptance of any design modifications.

1.5.2 Pipe Sizing and Spacing and Leachate Drainage Layer

Definition

Calculations for establishing the design requirements of the leachate collection drainage layer and the sizing and spacing of leachate collection piping are required to evaluate whether the leachate collection system is adequately designed to maintain leachate depth (head) above the liner system below the regulatory-required depth. The maximum depth of leachate head above the liner system is limited to 12-inches per federal regulations 40CFR258 Subtitle D. The leachate collection system, which includes the collection piping and drainage layer, is used to collect the leachate produced in the landfill to prevent the buildup of leachate head on the liner, and to drain leachate to a leachate extraction system. Leachate collection piping is typically constructed of a system of perforated PVC or HDPE pipe. The leachate drainage layer can be constructed of natural material (sand or gravel), geosynthetic materials (geonet or geocomposite synthetic drainage layers), or a combination of natural and geosynthetic materials. Geocomposite drainage layers can accommodate significantly larger flow rates compared with natural drainage layers.

Minimum Design Standards

Alabama: There are no minimum design standards for size and spacing of leachate collection piping and the leachate drainage layer calculations for CCP facilities. There are, however, minimum design standards for MSW, IW, and C&DD landfills as specified in ADEM 335-13-4-.18, which states that the leachate collection system shall be designed and constructed to maintain less than 1-foot of leachate head over the liner.

Kentucky: There are no minimum design standards for size and spacing of leachate collection piping or the leachate drainage layer calculations for special waste facilities. There are, however, minimum component requirements for contained landfills (MSW) as specified in 401 KAR 48:080(6)(4a), which states that a 12 inch drainage layer with a minimum permeability of 1×10^{-2} cm/sec or a layer of equivalent performance shall be designed and constructed to maintain less than one foot of leachate head over the liner. A filter fabric is required above the drainage layer. The slope of leachate collection piping shall be no less than 1% along the main leachate collection line, and no greater than 50% at any point. All leachate collection pipes shall be designed and constructed to a minimum slope of 1%, and no greater than 50% at any point. Main leachate collection lines shall have a minimum diameter of eight (8) inches, and lateral leachate collection pipes shall have a minimum diameter of four (4) inches.

Tennessee: The minimum design standards for size and spacing of leachate collection piping and the leachate drainage layer calculations for Class II disposal facilities are specified in TDEC 1200-1-7-.04(7)(i) and (ii). This regulation states that the leachate collection system must be designed, constructed, operated, and maintained such that the leachate depth over the liner does not exceed 1-foot of leachate head over the liner as calculated referencing the infiltration volume of the 25-year 24-hour storm through the intermediate cover. The regulation further states that leachate interception surfaces and associated piping must be designed, constructed, operated, and maintained to function without clogging throughout the scheduled post-closure care period.

Selected Design Standard

In all cases, the leachate collection system shall be designed to maintain less than 1-foot of leachate head over the liner. The decision on which type of leachate drainage layer to use, either natural materials, geosynthetic materials, or a combination of natural and geosynthetic materials is largely based on material availability and their comparative cost and shall be evaluated on a case-by-case basis.

Natural Drainage Layer Design: For natural (sand or gravel) leachate collection layers, the minimum spacing of leachate collection piping and minimum required permeability for the leachate collection drainage layer should be evaluated using the HELP model (Scenario 1 as described in Section 1.5.1). The maximum pipe spacing (leachate flow length along the liner system to the leachate collection piping) and minimum required permeability of the granular drainage layer should be designed such that the peak head on the liner system provided in the HELP model output is less than 12 inches. Site specific design for the minimum liner system grades and maximum leachate flow length to the leachate collection piping should be utilized in the HELP model. All natural drainage layers shall include a non-woven geotextile, or graded granular filter, above the leachate drainage layer.

Geosynthetic Drainage Layer Design: The HELP model does not accurately calculate the head on the liner system when modeling geosynthetic drainage layers. The standard method for designing geosynthetic drainage layers, commonly known as the Giroud equation, is provided in Giroud et al. (2000). The Giroud equation calculates the ultimate transmissivity of drainage layers taking into account reduction factors for intrusion, creep, chemical clogging, and biological clogging. Geosynthetic drainage layers should generally be designed to carry the peak leachate inflow rate from the HELP model (Scenario 1 as described in Section 1.5.1) entirely within the geocomposite drainage layer (leachate head should not exceed the thickness of the geocomposite drainage layer). Site specific design for the minimum liner system grades and maximum leachate flow length to the leachate collection piping should be utilized when evaluating geocomposite drainage layers using the Giroud equation.

Natural and Geosynthetic Drainage Layer Design: If the proposed leachate collection system consists of a geosynthetic drainage layer with an overlying natural drainage material, it is recommended that the Giroud equation be used to verify that the peak leachate inflow rate from the HELP model (Scenario 1 as described in Section 1.5.1) can be carried entirely within the geocomposite drainage layer. If leachate cannot be maintained within the thickness of the specified geocomposite, another, larger geocomposite should be specified or additional calculations should be performed to show that the geocomposite combined with the overlying natural drainage layer is adequate to manage the leachate under the peak conditions while maintaining less than 1-foot of head over the liner system using conservative, but reasonable assumptions. The methodology for designing a leachate collection system consisting of a geosynthetic drainage layer and a natural drainage layer is described in Giroud et al. (2004).

Pipe Sizing: The Mannings equation shall be used to verify the size of leachate collection piping using the minimum leachate collection pipe grades and peak daily leachate generation rate from the HELP model (Scenario 1 as described in Section 1.5.1). The Mannings equation is an empirical equation that applies to uniform flow in open channels and pipes and is a function of the velocity, flow area and slope of these systems. This methodology is supported by Quain, Koerner and Gray (2002), and Chevron Phillips Chemical Company (1985).

Pipe Slope: Unless specific state requirements are more stringent, the facility should be designed such that the leachate collection piping has a minimum grade of at least 0.5%, after including the effects of estimated facility settlements. Where state requirements are more stringent, those requirements should be incorporated into the design.

Additional design considerations for the leachate collection system include the following:

- Designed to function without clogging throughout the scheduled post-closure care period. Clogging shall be considered for both collection pipe perforations as well as clogging (also referred to as "blinding") of the geotextile component of a geosynthetic drainage layer. To minimize clogging of pipe perforations, the size of the perforation needs to be considered when selecting a granular material to surround the collection piping. To minimize clogging of the geotextile component of a geosynthetic drainage layer, the particle size/gradation of the overlying buffer material or CCP must be determined to be compatible with the apparent opening size (AOS) of the geotextile. Design methodology for this is provided in Quain, Koerner and Gray (2002). Alternatively, a graded granular filter (sand, aggregate, etc.) can be used in place of the geotextile to minimize clogging.

- Configure the leachate collection piping system to allow internal inspection, cleaning and maintenance.

1.5.3 Leachate Storage Facility Sizing

Definition

Leachate storage facilities, whether a leachate storage tank, or a leachate storage pond, must be sized to accommodate storage of the anticipated leachate generated at the landfill for an established time period. Sizing of leachate storage facilities is typically conducted using leachate generation calculations to estimate the volume of leachate that will be produced during various phases of the landfill life (as previously discussed in Section 1.5.1). The capacity of the leachate storage facility typically varies from site-to-site, since it is dependent on the type of treatment facilities that are available and the maximum allowable discharge rate to the treatment facility. This is further discussed in the Leachate Loadout, Treatment and Disposal section (Section 1.5.7) of this Document.

Minimum Design Standards

Alabama: There are no minimum design standards for leachate storage facility sizing for CCP facilities. There are also no minimum design standards for leachate storage facility sizing for MSW, IW, and C&DD landfills.

Kentucky: There are no minimum design standards for leachate storage facility sizing for special waste facilities. There are, however, minimum design standards for contained landfills (MSW) as specified in 401 KAR 48:080(6)(4f), which states the leachate collection tanks shall be a minimum of 1,000 gallons and that additional capacity shall be provided to store leachate for a minimum of 15 days production at peak production rates during operation and closure.

Tennessee: The minimum design standard for leachate storage facility sizing for Class II disposal facilities are specified in TDEC 1200-1-7-.04(7)(iii). This regulation states that leachate collection reservoirs must have sufficient capacity to store the volume of leachate expected to be generated in 30 days, or other adequate provisions approved by the Commissioner.

Selected Design Standard

As previously stated, the capacity of the holding tank will depend on the type of treatment facilities that are available and the maximum allowable discharge rate to the treatment facility. If leachate is to be recirculated onto the landfill, a smaller storage volume may be adequate since storage will be retained within the CCP material. For the purposes of this Document, leachate recirculation refers to the reintroduction of collected leachate into the CCP mass (within the lined areas of the landfill) for purposes of dust control and to aid in material compaction. To a limited extent in CCP landfills, leachate recirculation also allows for temporary storage of leachate within the landfill, thereby delaying overall leachate generation rate into the leachate collection system at the bottom of the landfill. If leachate will be hauled by tanker truck from the storage facility, sufficient volume should be provided to allow for tanker truck down-time, long weekends or allowable discharge rates at the treatment plant. If leachate is to be treated on-site prior to disposal, the volume of the storage facility will be dependent on the flow limitations of the treatment system. If leachate will be conveyed to a connection to a sanitary sewer line, the storage facility size will be governed by the allowable discharge rate to the treatment plant. Note that discharge to a local sewer would need to be coordinated with the appropriate agencies for their specific requirements. Pretreatment and flow control may be necessary prior to its discharge.

Regardless of the multiple scenarios that are typically site-specific, the design standard shall include first calculating leachate generation rates using the HELP model as discussed previously in the Leachate Generation Calculations section (Section 1.5.1). Based on the leachate generation rates, the minimum storage volume for the leachate storage facility shall be one (1) to three (3) days of leachate production during the peak daily leachate production period as specified by the design engineer and recommended in the following reference: "Integrated Solid Waste Management, Engineering Principles and Management Issues", G. Tchobanolglous, H. Theisen, S. Vigil, 1993, pp. 439-440. As stated previously, site specific means of leachate treatment and disposal shall be considered when determining the leachate storage requirements of a facility. If leachate for the facility is being hauled by truck for disposal, three days of peak leachate production is recommended to allow for leachate build-up during such events as long weekends, temporary reductions in hauling capacity due to mechanic problems, weather, etc., and to allow for adequate storage in the event that a significant rainfall event comes while the leachate tanks or ponds have not been fully emptied.

If the facility drains to a gravity sewer or gravity drains to the plant's treatment system, then reduced storage requirements (one day of peak leachate production) may be reasonable for the site.

Additional considerations for the leachate storage facility include the following:

- If the leachate storage facility is a pond, it shall be constructed with a bottom composite (compacted clay and geosynthetic membrane) liner system and groundwater monitoring wells to enable monitoring of any potential leaks through the liner system.
- If the leachate storage facility is a storage tank, whether above ground or below ground, the tank shall be constructed of materials compatible (nonreactive) with the chemicals in the leachate. Storage tanks are typically constructed of specialized plastics, fiberglass, or metal

with specially treated internal coatings or glass lining. Leachate storage tanks can be single- or double-walled, however double-walled tanks are preferred because of the added safety.

- The leachate storage facility should have a reliable and convenient means of detecting the volume of collected leachate in the facility and of sampling such leachate.
- It is standard industry practice and therefore a design standard requirement of this document that a secondary containment system be constructed around the leachate storage facility in the event of leakage or catastrophic failure of the system. In accordance with the federal secondary containment requirements for oil storage (40 CFR 112.8(c)(2) - Spill Prevention, Control, and Countermeasure Plan Requirements), the secondary containment system shall be constructed to provide containment for the entire capacity of the largest single container and sufficient freeboard to contain precipitation. For leachate storage tanks, the typical industry standard volume provided by the secondary containment system is 110% of the total volume contained in the largest storage tank within the leachate storage facility. It is therefore required that the volume of the secondary containment system be designed to provide the larger of either the entire capacity of the largest single container and sufficient freeboard to contain precipitation or 110% of the total volume contained in the largest storage tank within the leachate storage facility.
- The leachate storage facility shall include an early warning high-level alarm (audible and visual) and automatic shut-down of the supply forcemain or pumps to prevent leachate overflows.

1.5.4 Leachate Extraction System Sizing

Definition

The leachate extraction system includes the means to withdraw or convey leachate collected within the limits of the landfill/CCP boundary to the external leachate conveyance system, which ultimately conveys the leachate to the storage system typically located outside the limits of the landfill/CCP boundary. Leachate extraction systems, in general, consist of either gravity flow extraction systems or pumped extraction systems. In either system, the leachate is collected via the leachate collection system (collection piping and drainage layer) and conveyed to the leachate collection sump(s), which are located in low points within the landfill cell liner system. Gravity extraction systems convey the leachate by gravity from the leachate collection sump, through the liner system of the sideslope berm or bottom sump of the landfill, to the external leachate conveyance system and storage system. Pumped extraction systems similarly collect the leachate in a collection sump. However, pumped extraction systems use a pumping system (typically a side-slope riser pumping system) to lift the leachate from the collection sump into the external leachate conveyance system and storage system. Appropriate sizing of the leachate extraction system is important to avoid leachate backups in the landfill cell and to maintain less than one foot of leachate head over the liner system.

Minimum Design Standards

Alabama: There are no minimum design standards for leachate extraction system sizing for CCP facilities. There are also no minimum design standards for leachate extraction system sizing for MSW, IW, and C&DD landfills.

Kentucky: There are no minimum design standards for leachate extraction system sizing for special waste facilities. There are also no minimum design standards for leachate extraction system sizing for contained landfills (MSW).

Tennessee: There are no minimum design standards for leachate extraction system sizing for Class II disposal facilities. There are also no minimum design standards for leachate extraction system sizing for Class I disposal facilities (i.e., MSW).

Selected Design Standard

The leachate extraction system shall be sized based on the peak daily leachate generation rates calculated using the HELP Model (Scenario 1 as described in Section 1.5.1). The peak leachate generation rate shall be calculated based on the landfill area draining to each leachate collection sump. Based on the leachate generation rates anticipated in each collection sump, the extraction system sizing shall be calculated.

For a gravity flow extraction system, the size of the leachate extraction pipe shall be determined using the daily maximum rate of leachate generation to the collection sump from the HELP model in conjunction with the Manning's equation. As a separate note, for gravity flow extraction systems where the pipe penetrates the liner system of the sideslope berm or bottom sump of the landfill, great care must be taken to ensure that the seal where the pipe penetrates the landfill liner is sound.

For a pumped extraction system, the leachate extraction pumps shall be sized to ensure removal of leachate at the daily maximum rate of leachate generation from the collection sump according to the HELP model. The pumps shall have sufficient operating head to lift the leachate from the base of the leachate collection sump to the access port. Typically, submersible pumps are utilized in pumped extraction systems. The pump "off" level switches shall be set at an appropriate elevation to maintain a sufficient leachate level covering the submersible pump to prevent the pump from burning out. The pump "on" switch shall be set at an appropriate elevation to activate the lead pump to allow for efficient pumping cycles (typically 10 to 12 minutes between cycles). The pump cycle is dependent on the flow capacity of the pump, the peak leachate flow rate into the sump, and the leachate storage volume of the depressed sump area where the pumps are located. This methodology is supported Quain, Koerner and Gray (2002).

It is recommended that a two pump system, operating in a lead-lag configuration be utilized for each side slope riser pumping system. A two pump system provides the ability for intermittent pumping during varied low and medium flow conditions, while also providing for a back-up during pump maintenance and dividing the wear between the two pumps. In addition, in situations where high rates of leachate are being produced, both pumps can operate simultaneously to extract leachate. It is further recommended that a pumped extraction system be provided with a visual alarm system at the pump panel to alert operators when the pumping system is not operational or leachate levels are higher than the pump set points. It is recommended that an auto dialer function be utilized to alert operations personnel, a site supervisor at the landfill, or appropriate personnel in a control room at the power plant. The pumps should also be controlled automatically by an automatic shut-off relay from the leachate storage facility prior to the storage facility experiencing overflow levels.

1.5.5 Pipe Strength Calculations

Definition

Leachate collection piping internal to the landfill cells and conveyance piping external to the landfill cells are subject to both dynamic and static loadings capable of damaging (crushing) the piping systems. Significant static and/or dynamic loading may also cause pipe deflection resulting in changes in the underlying pipe slope, as well as its alignment and elevation, and therefore affect the function of the piping system. Static loadings on the piping system are produced from deposited CCP material and/or soil overburden above the piping system. Dynamic loadings on the piping system are produced from equipment or vehicles traversing the area above the piping system. Pipe strength and deflection calculations should verify that the pipe material type, burial depth, and bedding material are adequate to prevent pipe crushing and/or significant deflection.

Minimum Design Standards

Alabama: There are no minimum design standards to withstand for pipe strength to withstand crushing and deflection for CCP facilities. There are also no minimum design standards for pipe strength to withstand crushing and deflection for MSW, IW, and C&DD landfills.

Kentucky: There are no minimum design standards for pipe strength to withstand crushing and deflection for special waste facilities. There are, however, minimum design requirements for contained landfills (MSW) as specified in 401 KAR 48:080(6)(4a), which states that piping shall be designed to withstand static and dynamic loads that may be encountered.

Tennessee: The minimum design standard for pipe strength to withstand crushing and deflection for Class II disposal facilities are specified in TDEC 1200-1-7-.04(5)(i)(II). This regulation states that the leachate collection and removal system be constructed of materials that are of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying CCPs, cover materials and by any equipment used at the facility.

Selected Design Standard

Pipe strength and deflection calculations shall be conducted for both static and dynamic conditions. Pipe strength calculations shall include resistance to pipe deflection and critical buckling pressure.

It is recommended that pipe deflection for the static case be calculated using the Modified Iowa Formula. It is further recommended that the static pipe strength analysis be conducted based on the external soil/CCP pressure and that the piping system's critical buckling pressure is taken into account. Deflection less than five percent (5%) is considered acceptable, as recommended by the Plastic Pipe Institute. Consideration must be given to perforated versus solid wall piping. A factor of safety greater than 2.0 shall be acceptable for pipe strength. The calculation methodology for both static pipe deflection and static pipe strength is supported by Quain, Koerner and Gray (2002).

It is recommended that pipe deflection and pipe strength for the dynamic case be calculated using the Boussinesq Point Load Equation and that the PLEXCALC II computer program be used (developed by Performance Pipe, a division of Chevron Phillips Chemical Company LP). The PLEXCALC II program is utilized to calculate factors of safety against wall crushing, wall buckling, and short-term and long-term deflection. This methodology is presented in the Performance Pipe Engineering Manual, Book 2, Chevron Phillips Chemical Company LP (2003). Consideration must be given to perforated versus solid wall piping. Deflection less than five percent (5%) is considered acceptable, as recommended by the Plastic Pipe Institute. A factor of safety greater than 2.0 shall be acceptable for pipe strength.

In addition to the requirements stated above, the soil frost depth shall be considered such that the top of the piping is at least as deep as the local frost depth. Frost depths can be found by consulting the local (typically County) building codes.

1.5.6 Leachate Conveyance

Definition

Leachate conveyance piping, also sometimes referred to as transmission piping, includes piping that transfers the leachate collected within the limits of the landfill/CCP boundary from the leachate extraction system to the leachate storage system located outside the limits of the landfill/CCP boundary. Leachate conveyance piping can function as a gravity flow pipe or as a force main (under pressure). Leachate conveyance piping is typically constructed of PVC or HDPE materials. This section will discuss the design standards to be used for these conveyance piping systems.

Minimum Design Standards

Alabama: There are no minimum design standards for leachate conveyance piping for CCP facilities. There are also no minimum design standards for leachate conveyance piping for MSW, IW, and C&DD landfills.

Kentucky: There are no minimum design standards for leachate conveyance piping for special waste facilities. There are also no minimum design standards for leachate conveyance piping for contained landfills (MSW).

Tennessee: There are no minimum design standards for leachate conveyance piping for Class II disposal facilities, other than requiring that the system be chemically resistant to the leachate expected to be generated, per TDEC 1200-1-7-.04(5)(i)(I). There are no further design standards for leachate conveyance piping for Class I disposal facilities (MSW).

Selected Design Standard

The decision whether the leachate conveyance piping will be a gravity flow system or a force main is largely dictated by the topography of the site perimeter, the location of the leachate storage or treatment system, as well as owner preference.

The design standard for gravity flow leachate conveyance piping is that it shall be sized to carry the anticipated peak daily flows from upgradient landfill cells based on the leachate generation calculations (HELP model Scenario 1, as described in Section 1.5.1). The size of gravity piping can be designed using the Manning's equation. It is recommended that manholes be included at approximately 500-foot intervals or other intervals as specified by local code, as well as in locations where significant changes in direction, both horizontal and vertical, to enable the gravity line segments to be isolated for repair and maintenance. If necessary, gravity flow leachate conveyance piping shall be equipped with air release valves and vacuum break valves or a combination air release/vacuum break valve in the appropriate locations to avoid air blockage and/or to provide a vacuum break. These typically will not be necessary if the conveyance piping is operating at a continuous downward slope with manholes, as referenced above, such that the manholes will also act to release air and provide a vacuum break. In addition, for gravity flow systems, consideration must be given to provide a means to stop the flow of leachate through the conveyance piping to the leachate storage facility in the event that the leachate storage facility is full or needs to be shut down for maintenance or other reasons. Flow is typically regulated through the use of manual or automatic valves located near the limits of the landfill/CCP boundary, where the conveyance piping connects to the leachate extraction system.

The design standard for a leachate conveyance force main shall be based on calculations conducted whereby the total system head loss is balanced with the operating range(s) of the pump(s). This methodology, which is outlined below, is supported by US Army Corps of Engineers Guidance Manual TM 5-814-2 (1985). The following methodology shall be used:

- Based on the leachate generation calculations (Section 1.5.1) and leachate extraction system sizing calculations conducted (Section 1.5.4), the anticipated leachate flow shall be established.
- An iterative approach using the Hazen-Williams formula with a variety of internal pipe diameters (4-inch, 6-inch, 8-inch, etc.) should be used to calculate the friction losses for each scenario. The Hazen-Williams formula utilizes roughness coefficients (C-values) which correspond to the force main piping material to be utilized. Alternately, head losses due to friction can be calculated using the Darcy formula. Friction factors used in the Darcy formula can be determined using the Moody friction factor curves.
- Minor losses through bends, fittings, and valves should be accounted for in the overall friction loss. This can be done using the equivalent length method or by calculating the head loss coefficient (K) for each bend or fitting. Typical values for each method are tabulated in the Cameron Hydraulics handbook for various pipe materials and pipe diameters. For the equivalent length method, the tabulated equivalent length for each fitting is added to the actual pipe length and substituted back into the Hazen-Williams or Darcy equations to calculate the overall friction loss. When using the head loss coefficient method, the K value is multiplied by the velocity head yielding the head loss

through that fitting in feet. Those losses are then added to the friction loss through the pipe.

- The velocity of the leachate through the leachate conveyance force main is affected by the friction factor and pipe diameter; therefore these variables must be balanced during the design of the leachate conveyance force main. Flow rate velocity shall be maintained at a minimum of two (2) feet/second to avoid settling of particulates and a maximum of ten (10) feet/second to avoid pipe scouring, as referenced in USACE TM 5-814-2 (1985).
- Static head, the difference in elevation between the pump suction level and the highest proposed point in the leachate conveyance force main, should be calculated. The total dynamic head (TDH), the summation of the friction loss and the static head, should be calculated. The Hazen-Williams calculation provides results for different friction head losses at varying flow rates, while the static head loss is independent of the flow rate.
- Using the design flow rate and the total dynamic head, a pump size should be selected based on manufacturer-specified pump curves. This process is an iterative approach to select the leachate conveyance force main size to balance overall friction loss through the pipe while maintaining operations within design range.
- If multiple pumps are included in the design, as is typical with a multi-cell landfill configuration, each different pumping scenario shall be considered in sizing the pumps and the leachate conveyance force main.
- The velocity of the leachate through the leachate conveyance force main is affected by the friction factor and pipe diameter; therefore these variables must be balanced during the design of the leachate conveyance force main.
- It is recommended that cleanouts be included in the leachate conveyance force main in areas of significant low spots in elevation along the force main profile. Shut-off valves (gate valves or plug valves) should be included at approximately 1000-foot intervals, or other interval as specified by local code, to enable leachate conveyance force main segments to be isolated for repair and maintenance.
- Leachate conveyance force mains should be equipped with air release valves and vacuum break valves or a combination air release/vacuum break valves in the appropriate locations to avoid air blockage and/or to provide a vacuum break.
- It is recommended that a double-walled conveyance pipe should be used whenever leachate is transported outside the limits of the lined landfill area. This applies to gravity flow and force main systems. Use of double-walled leachate conveyance piping is an industry standard, is required in various states, as well as recommended in Bolton, (1995). Although it is recommended that double-contained piping be utilized, the designer may wish to further discuss the alternate use of single-wall piping with the appropriate regulatory authority.

1.5.7 Leachate Loadout, Treatment, and Disposal

Definition

The landfill leachate loadout, treatment, and disposal system includes the means by which the leachate is loaded or extracted from the leachate storage system into a final treatment and disposal system. Leachate loadout areas may consist of a tanker-truck loading area if discharging leachate at an off-site treatment plant or using trucks for leachate recirculation. Leachate recirculation is defined in Section 1.5.3. The loadout area may also consist of a monitored connection or pump station to convey the leachate into an on-site treatment system, for direct discharge to a sanitary sewer, or for direct discharge to a receiving surface water body under an NPDES permit.

Leachate treatment and disposal system options depend on site-specific conditions and may include the following: on-site treatment and discharge to surface water in compliance with a site-specific NPDES permit, direct discharge to a sanitary sewer, truck hauling to a wastewater treatment plant, leachate recirculation into the landfill, or a combination of these approaches. An additional approach that is commonly used by CCP landfills is to return the leachate to the powerplant for use as plant process water.

Minimum Design Standards

<u>Alabama:</u> There are no minimum design standards for leachate loadout, treatment and disposal for CCP facilities. There are also no minimum design standards for leachate loadout, treatment and disposal for MSW, IW, and C&DD landfills.

<u>Kentucky:</u> There are no minimum design standards for leachate loadout, treatment and disposal for special waste facilities. There are, however, minimum component requirements for leachate loadout, treatment, and disposal for contained landfills (MSW) as specified in 401 KAR 48:080(6)(4g). This regulation generally states that when leachate is discharged to a sediment basin structure, or leachate is treated using an on-site wastewater treatment plant, or other method of discharge is proposed, a KPDES permit shall reflect this provision. When an off-site wastewater treatment plant is used, written documentation shall be provided showing the acceptance of the leachate, including the criteria for disposal at the wastewater treatment plant. The regulation also states that the system shall have a method to measure the quantity of leachate managed at the site.

<u>Tennessee:</u> The minimum design standard for leachate loadout, treatment, and disposal for Class II disposal facilities are specified in TDEC 1200-1-7-.04(4)(a).8. This regulation generally states that collected leachate must be managed in accordance with any other applicable state and local regulations, that the leachate must be sampled and analyzed, and that leachate recirculation into the emplaced waste is acceptable.

Selected Design Standard

The selection of the leachate loadout, treatment, and disposal system is based on site-specific conditions. All potential loadout, treatment, and disposal options should be considered and evaluated on a site-specific basis. The evaluation shall include, but not be limited to, the system's technical feasibility, permitting requirements, and relative costs. TVA should make a decision regarding the treatment and disposal methodology best suited for the specific site based on this evaluation.

If discharging to a sanitary sewer or wastewater treatment plant, plant capacity and the potential chemical overload of the treatment plant must be considered. Coordination with the wastewater treatment plant is imperative, including anticipated flows and chemical constituents, which will need to be agreed upon prior to allowing this discharge. Additional discharge permits will most likely be required, governed by state and possibly county-specific regulations. Prior to discharge of the leachate to the sewer or treatment plant, flow control or pretreatment may be required. Other concerns that the sewer or treatment plants may have include pH, corrosivity, odor, retention time, and potential for chemical reaction with sewer system components, among others.

In all cases, the leachate loadout, treatment, and disposal system shall have a method to measure the quantity of leachate managed at the site and the leachate must be sampled and analyzed in accordance with the requirements of the site-specific discharge permits. In addition, the leachate loadout area shall be contained within a secondary containment area to avoid releases while transferring leachate from the conveyance system to the loadout system. Design of the leachate loadout system shall also take into account any applicable Occupational Safety and Health Administration (OSHA) regulations, as well as methods to enable the system to be user-friendly for operators, leachate truck haulers, etc.

1.6 SURFACE WATER RUN-OFF AND EROSION CONTROL

This section discusses the engineering design and performance standards associated with the management of surface water and sediment and erosion control measures. Factors considered with respect to surface water run-off include the design of surface water management structures and sediment basins to convey and manage expected stormwater flows from the landfill.

Factors considered with respect to erosion control measures include minimizing the volume of anticipated soil loss and providing sediment basins and BMPs to manage erosion during construction and development of the landfill.

1.6.1 Soil Erosion Calculations

Definition

Soil erosion calculations for landfill design and for pond closures (in above-grade facilities where the CCPs are emplaced above the perimeter berm, i.e., wet-stacking necessitating a sloped closure system) are performed for three essential reasons. The first reason is to estimate the amount of soil loss from the upper soil component of a landfill closure cap system. A second reason is to understand the quantity of sediment that may accumulate in a sediment basin to estimate maintenance and sediment removal activities. The third reason is to provide erosion and sediment controls construction periods at the landfill and to manage sediment and erosion from soil stockpiles used in the operation of the landfill.

Soil erosion can become a significant problem on landfill embankments and closure cap systems. If significant soil erosion occurs, the structural integrity of an embankment may become compromised. In addition, soil erosion in the upper soil component of a closure cap system may cause the underlying closure cap layers (clay or geosynthetics) to become uncovered or exposed which may result in slope instabilities and potential releases of CCPs to the environment. In areas where only soil cover is placed above the CCP material, erosion may cause the CCP to become uncovered in areas, resulting in exposed material, additional leachate production, and significant maintenance issues.

Minimum Design Standards

Alabama: There are no minimum design standards for soil erosion calculations for CCP facilities. There are, however, minimum design standards for MSW, IW, and C&DD landfills as specified in ADEM 335-13-4-.20, which states that slopes longer than 25 feet shall require horizontal terraces, of sufficient width for equipment operation, for every 20 feet rise in elevation or utilize other approved erosion control measures.

The Alabama Soil and Water Conservation Committee (SWCC) published a guidance manual, *The Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas* (2003). This guidance manual, while not having the force of law, provides guidance for preventing or minimized the related problems of erosion, sediment and stormwater. It provides a basis for developing sound plans and implementing appropriate measures (BMPs). This handbook is available via the internet at: http://swcc.alabama.gov/pdf/Handbooks&Guides/ASWCC_June_2003_Alabama_Handbook_Construction_E&S_Control.pdf

In addition, the National Resource Conservation Service (NRCS) has state-specific and county-specific technical guides, referred to as Field Office Technical Guides (FOTGs). The FOTGs contain technical information provided by the Alabama NRCS about the conservation of soil, water, air, and related plant and animal resources. The FOTGs are localized so that they apply specifically to the geographic area for which they are prepared. The FOTGs specific to Alabama are available via the Internet at: http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=AL. Referring to Section IV - Practice Standards and Specifications, provides specific details, specifications, detailed requirements and practices for erosion and sediment control, as well as other practices specific to the state. The design guidance provided in these documents are used as the basis for developing sound erosion and sediment control practices for inclusion in the site-specific SWPPP, which is a regulatory requirement of the general construction permit under the state's NPDES program administered by ADEM.

Kentucky: There are no minimum design standards for soil erosion calculations for special waste facilities. There are, however, minimum design standards for surface water calculations for contained landfills (MSW) as specified in 401 KAR 48:080. This regulation generally requires berms of at least one foot in height or two feet in width be placed at various specified intervals for varying slopes to prevent erosion.

Currently there are no state or county-specific technical guidance manuals published for Kentucky. However, the NRCS has state-specific and county-specific technical guides, referred to as Field Office Technical Guides (FOTGs). The FOTGs contain technical information provided by the Kentucky NRCS about the conservation of soil, water, air, and related plant and animal resources. The FOTGs are localized so that they apply specifically to the geographic area for which they are prepared. The FOTGs specific to Kentucky are available via the Internet at: http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=KY. Referring to Section IV - Practice Standards and Specifications, provides specific details, specifications, detailed requirements and practices for erosion and sediment control, as well as other practices specific to the state. The design guidance provided in this document can be used as the basis for developing sound erosion and sediment control practices for inclusion in the site-specific stormwater pollution prevention plan (SWPPP), which is a regulatory requirement of the general construction permit under the state's KPDES program.

Tennessee: The minimum design standard for soil erosion calculations for Class II disposal facilities are specified in TDEC 1200-1-7-.04(8)(c).4. This regulation does not provide a specific design standard for these calculations, rather provides general requirements that the final surface of the disposal facility or disposal facility parcel shall be graded and/or provided with drainage facilities in a manner that:

- Minimizes erosion of cover material (e.g., no steep slopes);

- In order to minimize soil erosion, as soon as practicable after final grading, the operator shall take steps as necessary to establish a protective vegetative cover of acceptable grasses over disturbed areas of the site. These steps shall include seeding, mulching, and any necessary fertilization at a minimum, and may include additional activities such as sodding of steeper slopes and drainage ways if such are necessary.

- In addition to the drainage and grading requirements and vegetative cover requirements, the operator shall take other measures as may be necessary to minimize and control erosion and sedimentation (e.g., soil stabilization, sediment ponds) at the site.

TDEC has published the *Tennessee Erosion and Sediment Control Handbook*, (2002), which is designed to provide information to planners, developers, engineers, and contractors on the proper selection, installation, and maintenance of BMPs. The handbook is intended for use during the design and construction of projects that require erosion and sediment controls to protect waters of the state. This handbook is available via the internet at:

http://www.state.tn.us/environment/wpc/sed_ero_controlhandbook/eschandbook.pdf

In addition, the NRCS has state-specific and county-specific technical guides, referred to as Field Office Technical Guides (FOTGs). The FOTGs contain technical information provided by the Tennessee NRCS about the conservation of soil, water, air, and related plant and animal resources. The FOTGs are localized so that they apply specifically to the geographic area for which they are prepared. The FOTGs specific to Tennessee are available via the Internet at: http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=TN. Referring to Section IV - Practice Standards and Specifications, provides specific details, specifications, detailed requirements and practices for erosion and sediment control, as well as other practices specific to the state. The design guidance provided in these documents are used as the basis for developing sound erosion and sediment control practices for inclusion in the site-specific SWPPP, which is a regulatory requirement of the general construction permit under the state's NPDES program administered by TDEC.

Selected Design Standard

Cap System Erosion Control: The Revised Universal Soil Loss Equation (RUSLE) shall be used to predict maximum soil loss from the final cap system. The RUSLE was developed by the USDA Agricultural Research Service and takes into account all the factors known to affect rainfall erosion, including climate, soil, topography and vegetation. The allowable soil loss from the cap system, based on calculations with the RUSLE, shall be 2 tons per acre per year. It is recommended that benches or terraces be designed on the cap system to limit erosion such that it is below the maximum soil loss requirement of 2 tons per acre per year. Factors that will affect the erosion rate from the cap system include the slope of the cap system, the drainage length between benches or terraces, and the properties of the cap system cover soil and vegetation. In states that provide specific guidance on the spacing and design of cap system erosion control benches or berms, the specific state design standards shall be followed, and RUSLE shall be used to confirm adequate erosion control is provided. The surface water design criteria for benches on the cap system are discussed in the Surface Water Calculations Section (Section 1.6.2). The 2 ton/acre/year allowable erosion value is provided by the USDA and many state regulations. This is also referenced in Section 11.4 of Qian, Koerner, and Gray (2002).

Erosion Control During Construction: Sediment and erosion control BMPs shall be provided during all construction activities, and to manage sediment from the landfill area and stockpiles during operations. The methodology or BMPs used to provide erosion control shall be based on the details and specifications provided on a state and county basis as presented in the NRCS FOTGs as well as any state or county technical guidance manuals or handbooks specified for the specific states as referenced in the Minimum Design Standards paragraphs of this section.

1.6.2 Surface Water Calculations

Definition

Surface water runoff (non-contact water) that has not come in contact with the CCP materials must be planned for by developing surface water management controls within the site. Sloped areas within the landfill will cause large volumes and higher peak runoff flows from the site than would occur naturally. The surface water runoff should be directed into channels that are capable of carrying most storm loads without overflowing or flooding adjacent areas. Generally, surface water drainage structures are designed based on calculations that take into account a specific design storm event for the particular region. Diversion channels consisting of benches, berms or swales on the side slopes of the landfill are used to intercept runoff before it has a chance to accumulate, flood areas and/or cut erosion gullies. Structures such as riprap letdowns or pipe slope drains are also used to convey runoff (surface water) from the diversion channels to the toe of slope of the landfill where a perimeter surface water collection channel is typically located. The perimeter surface water collection channels convey the surface water to the sedimentation basins to retain any collected sediment prior to discharge of the flow, as controlled by the site-specific NPDES permit.

Minimum Design Standards

Alabama: There are no minimum design standards for surface water calculations for CCP facilities. There are, however, minimum design standards for surface water calculations for MSW, ILF, C&DD landfills as specified in 335-13-4-.17 - Drainage. This regulation generally requires a run-on and run-off control system for the active and/or closed portions of the landfill during a 24-hour, 25-year storm event. Additionally, on-site drainage structures are required to carry incident precipitation from the disposal site so as to minimize the generation of leachate, erosion and sedimentation.

In addition, as discussed in more detail in the Minimum Design Standards section for design of erosion and sediment controls, the *Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas* (2003), provides guidance for preventing or minimizing the related problems of erosion, sediment and stormwater. Also, the NRCS FOTGs for Alabama provide BMPs for surface water management.

Kentucky: There are no minimum design standards for surface water calculations for special waste facilities. There are, however, minimum design standards for surface water calculations for contained landfills (MSW) as specified in 401 KAR 48:080. This regulation states that surface run-on and run-off ditches pass the 100-year, 24-hour, 100-year storm event, and that all designs shall be verified by the unit hydrograph method of calculation unless another method is approved. Also, the NRCS FOTGs for Kentucky provide BMPs for surface water management.

Tennessee: The minimum design standard for surface water calculations for Class II disposal facilities are specified in TDEC 1200-1-7-.04(2)(i). This regulation generally requires that the run-on and run-off control system be designed, constructed, operated, and maintained such that it is capable of preventing flow onto the active portion of the facility for all flow up to and including peak discharge from a 24-hour, 25-year storm.

In addition, as discussed in more detail in the Soil Erosion Calculations Section (Section 1.6.1), the *Tennessee Erosion and Sediment Control Handbook* (2002), provides information on the proper selection, installation, and maintenance of BMPs. Also, the NRCS FOTGs for Tennessee provide BMPs for surface water management.

Selected Design Standard

Surface water calculations shall be prepared using the Soil Conservation Service (SCS) method (previously by the USDA Soil Conservation Service, now by the Natural Resources Conservation Service (NRCS)). This includes using rainfall frequency curves provided by the NRCS and precipitation data provided by National Oceanic and Atmospheric Administration (NOAA) for the specific region where designing. The calculated surface water runoff will be based on peak flow SCS method, which entails conducting hydraulic modeling using Technical Release 55 (TR-55) method. The TR-55 method was developed by the USDA NRCS Conservation Engineering Division. TR-55 presents procedures to calculate storm runoff volume, peak rate of discharge, hydrographs, and storage volumes required for stormwater reservoirs. TR-55 can be used in conjunction with the Mannings equation to determine the design dimensions, maximum water elevations and flow velocities of the conveyance structure;

including open channels, culverts, letdowns, etc. Numerous computer software applications are available that assist in surface water calculations using these methods.

All surface water drainage structures, including channels, culverts, and benches on the landfill cap system shall be designed to carry expected flows based on the 24-hour, 25-year storm event for the particular region. This is supported by the Tennessee Class II disposal facility regulations (TDEC 1200-1-7-.04(2)(i)), as well as Federal regulations 40CFR258 Subtitle D. If specific state requirements provide more stringent design standards, the state design requirements shall be followed.

In addition, it shall be required (and is in accordance with Federal regulations 40CFR258 Subtitle D), that run-on controls be utilized to control drainage into and out of the landfill working face (area where CCP is currently being placed). Run-off from the active and/or closed portions of the landfill unit must also be controlled and shall be conveyed to a settling basin or other sedimentation control structure in accordance with the state's NPDES program

The following additional design elements shall be considered during the design of the surface water system:

- Velocity of the surface water flow through the surface water drainage structures must be calculated as referenced above. The velocity must be coordinated with the lining material used for the structure. For example, grass-lined channels are sufficient for low velocity flows, erosion control matting (ECM) or turf reinforced matrix (TRM) is used for medium to high velocity flows, while riprap and hard-liner materials (i.e., concrete, grouted riprap, and fabriform) are used for very high velocities. Specific velocity limits for each of these materials can be obtained in the NRCS FOTGs, state-specific design guidance manuals and/or from the material vendors.

- The dimensions and slope of the surface water drainage structure, as well as the maximum design water level in the structure, must be calculated as referenced above. The dimension of the conveyance structure must also allow for a free-board distance above the maximum design water level. A minimum of 6-inches of freeboard is recommended, or as otherwise specified in the NRCS FOTGs. A minimum grade of 2% shall be used for benches or berms conveying surface water off of the landfill cap system. A 0.5% minimum grade is required for perimeter surface water structures outside of the landfill cap system. However, shallow slopes shall be implemented at the discretion of the design engineer. Slopes of 1% or greater are desirable to achieve maintained positive drainage and provide surface water structures that are constructible.

- Energy dissipation devices, such as riprap protection placed at inlets and outlets to culverts, channels or letdowns; check-dams within channels; gabion baskets or other structural reinforcement at sharp channel bends; etc. must be considered to avoid excessive erosion and scouring.

- The use of non-mechanical gravity-flow surface water conveyance structures is most desirable and recommended. Mechanical conveyance (pumping) of surface water is not typically desired, and in some cases not permitted by the regulatory authorities. This is because since the control and conveyance of surface water that is generated by storm events at quantities, durations and times that cannot be well predicted, a system reliant on a mechanical means (pumps) that are susceptible to malfunction and power outages would not be reliable.

Lastly, the methodology or BMPs used to meet the referenced surface water management requirements shall be based on the details and specifications provided on a state and county basis as presented in the NRCS FOTGs as well as the technical guidance manuals or handbooks specified for the specific states as referenced in the Minimum Design Standards paragraphs of this section.

1.6.3 Sedimentation Basin Design

Definition

A sediment basin is a temporary holding pond created by construction of a barrier across a drainageway or by excavating a basin or by a combination of both. The purpose of the sediment basin is to detain sediment-laden runoff from disturbed areas in storage long enough for most of the sediment to settle out of the runoff and be deposited in the basin. This practice applies where erosion control measures are insufficient to prevent excessive off-site sedimentation. The design of the sediment basin is largely based on the storage volume and detention time required to settle out the sediment from the runoff. Also taken into consideration is the amount of sedimentation anticipated during the construction activities.

Minimum Design Standards

Alabama: There are no minimum design standards for sedimentation basin analysis for CCP facilities. There are, however, general requirements for sedimentation basins for MSW, ILF, C&DD landfills as specified in 335-13-4-.17(3). This regulation generally requires that run-off from the active and/or closed portions of the landfill unit must be handled in accordance with NPDES and shall be routed to a settling basin or other sedimentation control structure.

In addition, as discussed in more detail in the Soil Erosion Calculations Section (Section 1.6.1), the *Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas* (2003) provides guidance for preventing or minimizing the related problems of erosion, sediment and stormwater. Specifically, the design of sediment basins is presented on page 295 in the Handbook. Also, the NRCS FOTGs for Alabama provide details on the design of sediment basins.

Kentucky: There are no minimum design standards for sedimentation basin analysis for special waste facilities. There are, however, minimum design standards for sedimentation basin analysis for contained landfills (MSW) as specified in 401 KAR 48:070(2)(4). This regulation generally requires that sediment basins be designed such that the storage volume and principal spillway do not cause the emergency spillway to discharge during the 25-year, 24-hour storm event. Additional requirements include that the emergency spillway is capable of passing a 100 year, 24 hour storm even with no flow overtopping the structure and that the minimum sediment storage volume be provided for 1-year prior to requiring maintenance to restore the design volume.

Also, the NRCS FOTGs for Kentucky provide details on the design of sediment basins.

Tennessee: The minimum design standard for sedimentation basin analysis for Class II disposal facilities is specified in TDEC 1200-1-7-.04(2)(i). This regulation generally requires the following:

- Sediment basins associated with run-on and run-off control systems must be designed to detain at least the water volume resulting from a 24-hour, 25-year storm and to divert through emergency spillways at least the peak flow resulting from a 24-hour, 100-year storm.

- Sedimentation basins must be emptied or otherwise managed expeditiously after storms to maintain design capacity of the system.

- Run-on and run-off must be managed separately from leachate unless otherwise approved by the Commissioner.

In addition, as discussed in more detail in the Soil Erosion Calculations Section (Section 1.6.1), the *Tennessee Erosion and Sediment Control Handbook* (2002) provides information on the proper selection, installation, and maintenance of BMPs, including sedimentation basins. Specifically, the design of sediment basins is presented on page SB-1 in the Handbook.

Also, the NRCS FOTGs for Tennessee provide details on the design of sediment basins.

Selected Design Standard

The design standard, which is also the Industry standard, is to calculate the surface water runoff based on the peak flow SCS method. For conducting a sediment basin design, this entails conducting hydraulic modeling using TR-55 and Technical Release 20 (TR-20) methods. TR-55 has already been discussed in the Surface Water Calculations section. TR-20 was developed by the USDA NRCS Hydrology Branch and is now available as a WinTR20 version. TR-20 provides a hydrologic analysis of a watershed under present conditions. Output consists of peaks and/or storm hydrographs. Subarea surface runoff hydrographs are developed from storm rainfall using the hydrograph, drainage areas, times of concentration, and SCS runoff curve numbers. Instructions to develop, route, add, store, divert, or divide hydrographs are established to convey floodwater from the headwaters to the watershed outlet or in this case a sedimentation basin. Other computer programs, for example HydroCAD, can be used to incorporate TR-55 and TR-20 modeling.

The hydraulic modeling shall be conducted to design the sediment basin to detain at least the surface water volume resulting from a 24-hour, 25-year storm and to divert through the emergency spillways at least the peak flow resulting from a 24-hour, 100-year storm.

Additional and specific design features for sediment basins, including inlet and outlet structures, shall be based on the state-specific and county-specific requirements (if applicable). Relevant details provided in the NRCS FOTGs may also be used for design guidance.

1.7 IMPOUNDMENT SYSTEMS

As stated in the Ash Impoundments Section (Section 1.1.2), ash impoundment can be defined as a collection of water, wastewater, or liquid-borne materials that is contained by an artificial structure (dam), into which CCPs are placed for disposal or temporary storage. This section discusses seepage analysis design standards for impoundments.

1.7.1 Seepage Analysis

Definition

The movement of water through and underneath impoundments for water or saturated earthen materials is referred to as seepage. All such structures are subject to seepage through and underneath the impoundment and foundation. Seepage can impact the operation and stability of impoundment systems, and seepage control is generally necessary in these systems to prevent excessive uplift pressures, instability of slopes, piping through the impoundment and foundation, and erosion of material by loss into open joints or pore spaces in the foundation.

Minimum Design Standards

Alabama: There are currently no specific minimum design standards for seepage analyses of impoundment systems at waste facilities. However, dam safety regulations are in the process of being developed.

Kentucky: There are no specific minimum design standards for seepage analyses of impoundment systems at waste facilities.

Kentucky regulates dams and dam safety in the state via 401 KAR 4:030, and provides design requirements in Division of Water Engineering Memorandum No. 5 (2-1-75). There are no specific requirements for seepage analyses in these documents.

Tennessee: There are no specific minimum design standards for seepage analyses of impoundment systems at waste facilities.

However, Tennessee provides general requirements for seepage in its dam safety regulations, Chapter 1200-5-7, "Rules and Regulations Applied to the Safe Dams Act of 1973". Requirements related to seepage in this document include:

> 1200-5-7-.07 (5) (d) states: "All dams shall be designed and constructed to prevent the development of instability due to excessive seepage forces, uplift forces, or loss of materials in the impoundment, abutments, spillway areas, or foundation. Seepage analysis for design and inspection during construction shall be in sufficient detail to prevent the occurrence of critical seepage gradients. All dams permanently impounding water shall be constructed with an impoundment toe drain with drain pipes installed to discharge the seepage."

1200-5-7-.08 (5) (f) requires that seepage control features be presented in the plans for dams projects.

Selected Design Standard

Appropriate seepage analyses shall be performed to estimate the quantity of seepage both through and underneath the impoundment, and to estimate the distribution of pore pressures and seepage velocities within and beneath the impoundment

Seepage analyses should be implemented using appropriate 2-D or 3-D finite element or finite difference computer programs or by manual techniques such as drawing flow nets. It is recommended that seepage analyses be performed by computer analysis. The analyses should be performed by a qualified Geotechnical Engineer or Hydrogeologist with substantial experience in seepage modeling.

Input parameters to the seepage analysis, such as hydraulic conductivity of impoundment and foundation materials, should be based on the judgment of an experienced Geotechnical Engineer or Hydrogeologist and on the results of field and laboratory testing performed as part of the geotechnical investigation and judged to be sufficient by the qualified and experienced Geotechnical Engineer responsible for the analysis.

The following points shall be considered for seepage underneath and through impoundments and associated embankments:

- Impoundments and associated embankments shall be configured to mitigate all detrimental effects of seepage underneath and through the structure, such as excessive uplift pressures, piping (internal erosion), instability, sloughing, or removal of material by dissolution or erosion.
- All potential modes of piping and/or uplift for a given embankment should be considered in the evaluation on a case by case basis. These modes include , but are not necessarily limited to the following:

  (1) Upward seepage emerging at the downstream or exterior toe.

  (2) Heave where a low-permeability layer overlies a more pervious stratum.

  (3) Seepage emerging along the downstream or exterior slope or along some other sloping downstream surface.
- The evaluation of piping potential for the assessment or design of an impoundment or associated embankment should be conducted by an experienced engineer and consider several factors including, but not limited to: subsurface conditions and soil types/characteristics, embankment geometry and materials zoning, and exit gradients. There is not a universally accepted criteria for assessing the factor of safety against piping, and piping should be considered on a case by case basis.
- For piping mode (1), upward seepage emerging at the downstream or exterior toe, the critical gradient factor of safety method is commonly used whereby the factor of safety is computed as follows:

$$FS_{eg} = \frac{i_{cr}}{i_e} \quad \text{where,}$$

FS_{eg} = factor of safety for vertical exit gradient

i_e = maximum exit gradient computed from seepage modeling

i_c = critical gradient causing flotation of the impoundment foundation material.

$$i_c = \frac{G_s - 1}{1 + e}$$

G_s = specific gravity of foundation soils

e = void ratio of foundation soils

USACE Engineering Manual EM 1110-2-1901 (1993, p. 4-24 states: "Investigators have recommended ranges for factor of safety for escape gradient, FSg = i_{cr}/i_e from 1.5 and [sic] 15, depending on knowledge of soil and possible seepage conditions. Generally, factors of safety in the range of 4-5 (Harr 1962 and 1977) or 2.3-3 (Cedergren 1977) have been proposed." The U.S. Bureau of Reclamation (USBR) Design Standard No. 13, Chapter 8, page 8.8 provides more specific guidance as follows: "The heterogeneity of soils in nature, the progressive and hidden deterioration that can occur from seepage flow, and the sparse data base from appropriate testing justify a conservative safety factor (SF=4) for design of exit gradient protective features."

Selection of an acceptable minimum FSeg against piping should be on a case by case basis at the discretion of an experienced engineer. Based on the literature, a FS_{eg} greater than or equal to 4 should provide reasonable guidance as an acceptable minimum factor of safety for this piping mode, providing it is used in conjunction with other factors and sound engineering judgment. Subsurface conditions and piping susceptibility of soils must be taken into account when assessing the adequate factor of safety. Highly piping susceptible soils such as nonplastic cohesionless silts and fine sands, poorly graded, or gap-graded soils, and dispersive clays may justify a higher minimum factor of safety. Conversely if the engineer has adequate and reliable information that the soils and site conditions have a low susceptibility to piping, the engineer may decide to accept a lower FSeg value

- For piping mode (2), heave where a low-permeability layer overlies a more pervious stratum, the Natural Resources Conservation Service (NRCS) Soil Mechanics Note No. 7 (1979) states: :"To be safe against uplift or blowout a suitable factor of safety is needed. A value of 1.5 to 2 is suggested with the higher values to be used on the more piping prone materials. Using an effective stress analysis the FS_h value should be computed as:

$$FS_h = \frac{Z\gamma b}{(ho - htw)\gamma w} \quad \text{where,}$$

$FS_h =$ factor of safety against heave

Z = thickness of upper low-permeability layer

γb = buoyant unit weight of soil

ho = piezometric head in lower pervious layer at toe

htw = tailwater head at toe

- For piping mode (3), seepage emerging along the downstream or exterior slope or along some other sloping downstream surface, there is no generally accepted guidance for evaluating the minimum factor of safety against piping and each case must be evaluated individually by an experienced engineer..
- Where the above factor of safety cannot be met, engineering features (e.g. filters) meant specifically to control exit gradients and their detrimental effects shall be incorporated into the impoundment design. The state of the practice for design of new water retention embankments includes such engineering features in any embankment which woulf jeopardize human life it if was to fail.

The following points shall be considered for seepage underneath and through impoundments and associated embankments:

- The impoundment/embankment cross-section shall not be configured such that the predicted phreatic surface exits at a point along the downstream slope of the impoundment in an uncontrolled manner. The design of all impoundments should include pervious drainage features (such as toe drains, inclined or chimney drains, rockfill toes, etc.) meant specifically to collect and manage seepage flows passing through the impoundment structure's cross-section and discharge these flows safely away from the structure. Appropriate filtering media or features shall be provided between the embankment fill materials and/or foundation materials, and the pervious drainage features to preclude piping or migration (internal erosion) of soil particles.
- Design of seepage control features and filter media should be in general accordance with recommendations given USACE EM 1110-2-2300 General Design and Construction Considerations for Earth and Rock-fill Dams, Appendix B, (2004) or other similar references. Filter media shall be designed such that all interfaces between embankment soils, foundation materials, filter material, and drain material across which water can flow are filter-compatible. Discharge capacities of seepage control features should be established based on the maximum steady-state seepage rates estimated in the analysis

multiplied times a factor of safety, tyoically between 3 and 1o, depending on the confidence in the analysis..

- In addition to pervious seepage control features, planning and design of all impoundments/embankments should also formally consider the applicability of using impervious structures meant to control, limit, or direct seepage – such as cores, cut-off walls, grout curtains, etc. The results of these considerations should be reported in the design documentation.

1.7.2 Impoundment Stability Analysis

1.7.2.1 Deep-Seated Stability Analyses (Static)

Definition

The definition of deep-seated stability analyses as it applies to impoundment systems is generally the same as for landfill systems, as described in the Slope Stability Analysis Section (Section 1.4.2).

Minimum Design Standards

There are no specific minimum design standards for static stability analyses of impoundment systems at waste facilities in any of the three states. Related guidance and regulations for landfill facilities were described in the Slope Stability Analysis Section (Section 1.4.2), and could generally also apply to impoundment systems.

Some states have dam safety regulations, which may also apply to impoundment systems. Requirements are summarized below:

Alabama: Alabama currently does not have any dam safety regulations. However, regulations are in the process of being developed.

Kentucky: Kentucky regulates dams and dam safety in the state via 401 KAR 4:030, and provides design requirements in Division of Water Engineering Memorandum No. 5 (2-1-75). There are no specific requirements for stability analyses in these documents.

Tennessee: Tennessee provides its dam safety regulations in Chapter 1200-5-7, "Rules and Regulations Applied to the Safe Dams Act of 1973". There are no specific requirements for stability analyses for new dams in this document. For existing dams 1200-5-7-.06 (1) states: "All dams shall be stable. There shall not be excessive cracks, sloughing, seepage or other signs of instability or deterioration. In cases where the stability of the dam is questionable, it shall be the responsibility of the owner to either demonstrate to the Commissioner that the dam is stable or drain the reservoir and remedy the unstable condition prior to refilling the reservoir."

Selected Design Standard

Due to the nature of their construction and use, the stability of impoundment systems should be evaluated using analysis cases and criteria that are accepted for the design of dams. For static stability evaluations of impoundment systems, methodologies, guidance on use of total or effective strength parameters, and minimum factors of safety for design given in the USACE EM-1110-2-1902 (2003) should be utilized.

The stability analysis cases to be considered should include, at a minimum:

1. Construction and End of Construction Conditions: This analysis considers the newly completed impoundment and/or one or more critical configurations of the impoundment during construction. The analysis assumes that the impoundment has been constructed such that pore pressures in low permeability materials both within and underneath the impoundment have not had sufficient time to come to equilibrium. Thus, drained (effective) strengths are input into this analysis for free-draining materials (typically those with permeability of $1x10^{-4}$ cm/sec or higher) and undrained (total) strengths are input into this analysis for materials that drain slowly (typically those with permeability less than $1x10^{-7}$ cm/sec). For materials with permeability intermediate to these values, analysis should be implemented using both undrained and drained strengths, and the more conservative assumption should be used for design. The effects of staged impoundment construction or any other special drainage enhancing features (such as wick drains) should be included in this analysis, as and if appropriate.

2. Long-Term Stability Conditions: This analysis considers the impoundment under normal operating conditions that will exist a sufficient length of time after construction. It is assumed that pore pressures have had sufficient time to reach equilibrium both within and underneath the impoundment and steady-state seepage and/or hydrostatic conditions corresponding to the normal operating pool have developed. The steady state seepage and pore water pressure distributions determined in the Seepage Analysis Section (Section 1.7.1) should be used in this analysis. Drained (effective) shear strengths should be used for all materials.

3. Sudden Drawdown Conditions: This analysis considers a condition in which the impoundment has been under a long term stability condition for some time and then is subjected to a sudden lowering of the pool elevation. This condition represents a critical scenario for the upstream slope of the impoundment, due to loss of stabilizing hydrostatic pressure from the reservoir that has been drawn down. It should be assumed that drawdown is very fast, and no drainage occurs in materials with low permeability. Materials with values of permeability greater than $1x10^{-4}$ cm/s can be assumed to drain during drawdown, and drained strengths are used for these materials. The three-stage methods and procedures given in Appendix G of USACE EM-110-2-1902 should be used for implementing stability analyses for this condition.

   If the impoundment structure being designed is to be situated adjacent to or in close proximity to another impoundment, consideration shall also be given to the effects of sudden drawdown of the adjacent impoundment on the structure being designed.

Table 1.7.2-1 (reproduced from EM-1110-2-1902, 2003) provides additional summary information for the static stability analysis conditions described above.

Table 1.7.2-1
Cases to be analyzed for static stability of impoundment systems
(Taken from USACE EM-1110-2-1902 "Slope Stability", Table 2-1, 2003)

Shear Strengths and Pore Pressures for Static Design Conditions

Design Condition	Shear Strength	Pore Water Pressure
During Construction and End-of-Construction	Free draining soils – use drained shear strengths related to effective stresses[1]	Free draining soils – Pore water pressures can be estimated using analytical techniques such as hydrostatic pressure computations if there is no flow, or using steady seepage analysis techniques (flow nets or finite element analyses).
	Low-permeability soils – use undrained strengths related to total stresses[2]	Low-permeability soils – Total stresses are used; pore water pressures are set to zero in the slope stability computations.
Steady-State Seepage Conditions	Use drained shear strengths related to effective stresses.	Pore water pressures from field measurements, hydrostatic pressure computations for no-flow conditions, or steady seepage analysis techniques (flow nets, finite element analyses, or finite difference analyses).
Sudden Drawdown Conditions	Free draining soils – use drained shear strengths related to effective stresses.	Free draining soils – First-stage computations (before drawdown) – steady seepage pore pressures as for steady seepage condition. Second- and third-stage computations (after drawdown) – pore water pressures estimated using same techniques as for steady seepage, except with lowered water level.
	Low-permeability soils – Three-stage computations: First stage--use drained shear strength related to effective stresses; second stage--use undrained shear strengths related to consolidation pressures from the first stage; third stage--use drained strengths related to effective stresses, or undrained strengths related to consolidation pressures from the first stage, depending on which strength is lower – this will vary along the assumed shear surface.	Low-permeability soils – First-stage computations--steady-state seepage pore pressures as described for steady seepage condition. Second-stage computations – total stresses are used; pore water pressures are set to zero. Third-stage computations -- same pore pressures as free draining soils if drained strengths are used; pore water pressures are set to zero where undrained strengths are used.

Minimum Factors of Safety: Impoundment systems should be designed to meet the factors of safety given in Table 1.7.2-2 below.

Table 1.7.2-2

Minimum Factors of Safety for Static Stability Analyses of Cases for Impoundment Systems.

(Taken from USACE EM-1110-2-1902 "Slope Stability", Table 3-1, 2003)

Minimum Required Factors of Safety: New Earth and Rock-Fill Dams

Analysis Condition[1]	Required Minimum Factor of Safety	Slope
End-of-Construction (including staged construction)[2]	1.3	Upstream and Downstream
Long-term (Steady seepage, maximum storage pool, spillway crest or top of gates)	1.5	Downstream
Maximum surcharge pool[3]	1.4	Downstream
Rapid drawdown	1.1-1.3[4,5]	Upstream

[1] For earthquake loading, see ER 1110-2-1806 for guidance. An Engineer Circular, "Dynamic Analysis of Embankment Dams," is still in preparation.

[2] For embankments over 50 feet high on soft foundations and for embankments that will be subjected to pool loading during construction, a higher minimum end-of-construction factor of safety may be appropriate.

[3] Pool thrust from maximum surcharge level. Pore pressures are usually taken as those developed under steady-state seepage at maximum storage pool. However, for pervious foundations with no positive cutoff steady-state seepage may develop under maximum surcharge pool.

[4] Factor of safety (FS) to be used with improved method of analysis described in Appendix G.

[5] FS = 1.1 applies to drawdown from maximum surcharge pool; FS = 1.3 applies to drawdown from maximum storage pool.

For dams used in pump storage schemes or similar applications where rapid drawdown is a routine operating condition, higher factors of safety, e.g., 1.4-1.5, are appropriate. If consequences of an upstream failure are great, such as blockage of the outlet works resulting in a potential catastrophic failure, higher factors of safety should be considered.

The standards related to selection of material parameters, critical cross-sections, and slope stability analysis methods given in Section 1.4.2 for static stability analyses of landfill systems also apply to static stability analysis for impoundment systems. Additional considerations for impoundment systems are listed below

- Failure surface geometries considered in the analysis should include toe, basal geometries passing through the impoundment foundation and block failure geometries. Consideration should be given to preferential sliding planes such as along drainage layers or along interfaces anticipated to have weaker shear strength than the general impoundment fill.
- Earthen structural components of impoundment systems (such as perimeter dikes) are generally expected to be of lower height and extent than earthen components of landfills. Therefore, the properties of the foundation materials underneath impoundments may have greater influence on stability analyses. Careful consideration of variations of the foundation materials along the alignment of impoundments should be included when selecting critical cross-sections for stability analysis.
- Total and effective stress shear strength properties for stability analyses of impoundment systems should be established based on site specific field and laboratory testing, as described in the Site Investigation Section (Section 1.3.1).

1.7.2.2 Seismic Stability Analyses

Definition

Seismic stability analysis for impoundment systems includes evaluation of liquefaction potential and seismic deep-seated stability. These terms were defined previously for landfill systems in Sections 1.4.2.2, and these definitions also generally carry over to impoundment systems.

Minimum Design Standards

There are no specific minimum design standards for seismic stability analyses of impoundment systems at waste facilities in any of the three states. Related guidance and regulations for landfill facilities were described in Section 1.4.2.2, and could generally apply to impoundment systems.

Some states have dam safety regulations, which may also apply to impoundment systems. Requirements are summarized below:

<u>Alabama:</u> Alabama currently does not have any dam safety regulations. However, regulations are in the process of being developed.

<u>Kentucky:</u> Kentucky regulates dams and dam safety in the state via 401 KAR 4:030, and provides design requirements in Division of Water Engineering Memorandum No. 5 (2-1-75). There are no specific requirements for seismic stability analyses in these documents.

<u>Tennessee:</u> Tennessee provides its dam safety regulations in Chapter 1200-5-7, “Rules and Regulations Applied to the Safe Dams Act of 1973”. There are no specific requirements for seismic stability analyses for new dams in this document.

Regarding seismic design of dams, 1200-5-7-.07 (1) (b) states: “All structures other than Category 3 dams constructed before 2008 shall be designed to withstand seismic accelerations of the following intensities: Zone 1 = 0.025g, Zone 2 = 0.05g, Zone 3 = 0.15g. Zones refer to *Geologic Hazards Map of Tennessee* (Miller, 1978). All dams constructed during or after 2008 shall be designed to withstand the peak ground acceleration for an earthquake with a 10% probability of exceedance in 50 years as determined by the United States Geological Survey at the time the construction permit is issued. A different peak ground acceleration may be used if site specific studies using accepted engineering practices determine that a different value is appropriate.

The above magnitude of peak ground acceleration corresponds to an event with an approximate 475-year return period. This is a substantially smaller event than the 2,400-yr return period event that the state requires for design of new landfill facilities, and much lower than the 3,000 to 10,000 year return periods typically used for dams (,more specifically, high hazard dams).

Selected Design Standard

The design seismic event for impoundment systems shall be the same as that described in Section 1.4.2.2.1 for landfill systems and consistent with the design structure.

Liquefaction analyses as described in Section 1.4.2.2.2 for landfill systems should also be performed for impoundment systems.

The seismic slope stability analyses and seismic deformation analyses presented in Section 1.4.2.2.3 for landfill systems are also applicable to impoundment systems. The seismic analyses should be performed assuming that the fluid level existing within the impoundment at the time of the design seismic event corresponds to the coincident pool elevation, defined as the elevation at which the impounded fluid is expected to be at or below for half of the time during each year.

1.7.3 Settlement Evaluations

Definition

Settlement analysis consists of predicting of total and differential subsurface deformations underneath impoundments and critical structures associated with impoundments (such as drainage features, seepage collection features, etc). Settlements are induced primarily by the self weight of the impoundment and the materials retained by the impoundment.

Minimum Design Standards

There are no specific minimum design standards for settlement analyses of impoundment systems at CCP facilities in any of the three states. Related guidance and regulations described in Section 1.4.3, under landfill systems may generally apply to impoundment systems as well.

Similarly, there are no minimum design standards for settlement analysis in any of the three states within their dam safety regulations.

Selected Design Standard

The recommended methodologies for settlement analyses given in Section 1.4.3 for landfill systems shall also apply to impoundment systems. For impoundment systems, the following additional guidelines are applicable:

- Impoundments shall be designed such that all freeboard requirements are met assuming the maximum computed static settlements. The design should be implemented such that freeboard of at least 2 ft is predicted after including seismic deformations corresponding to the design seismic event.
- Analyses focused specifically on determining settlement profiles underneath drainage structures, piping, spillways and outlet works, and other structures should be performed, and these components should be designed to accommodate the estimated settlements.

1.8 SPILLWAY / DRAINAGE SYSTEMS

Definition

A spillway is an open or closed channel, or both, used to convey water from a reservoir. It may contain gates, either manually or automatically controlled, to regulate the discharge of water. A principal spillway is the first discharge system designed to begin operation after the normal design storage capacity is exceeded. An emergency spillway is a discharge system designed to operate at an elevation above the principal spillway to safely convey discharges that exceed the principal spillway's capacity without jeopardizing the safety of the dam.

Minimum Design Standards

State and federal regulations for minimum spillway design flow requirements are given in Table 1.9-1.

Table 1.9-1
Comparison of State and Federal Regulations: Spillway Design Flow Requirements

Hazard Category of Dam	Alabama	Kentucky	Tennessee[2]	Federal
High Hazard	N/A	Class C Dams: $P_C = PMP^1$	Small Dams: 1/2 PMP Intermediate Size Dams: PMP Large Dams: PMP	High Hazard Potential[3]
Moderate Hazard	N/A	Class B Dams: $P_B = P_{100} + 0.40 \times (PMP - P_{100})^1$	Small Dams: 1/3 PMP Intermediate Size Dams: 1/2 PMP Large Dams: PMP	Significant Hazard Potential[3]
Low Hazard	N/A	Class A Dams: $P_A = P_{100} + 0.12 \times (PMP – P_{100})^1$	Small Dams: 100-Year Flood Intermediate Size Dams: 1/3 PMP Large Dams: 1/2 PMP	Low Hazard Potential[3]

Note 1: Criteria are for Freeboard Hydrograph. P denotes 6-hour design precipitation, P_{100} refers to 6-hour, 100-year precipitation, and PMP represents 6-hour Probable Maximum Precipitation.
Note 2: Tennessee dam size classifications:

Category	Storage (acre-feet)	Height (ft.)
Small	30 – 999	20 - 40
Intermediate	1000 – 50,000	41 - 100
Large	50,000+	100+

Note 3: For Federal inflow criteria refer to Federal Guidelines for Dam Safety: Selecting and Accommodating Inflow Design Floods for Dams, U.S. Department of Homeland Security, Federal Emergency Management Agency, October 1998, Reprinted April 2004

Selected Design Standard

Flood and freeboard spillway criteria are provided in Table 1.9-2. The remainder of the section presents additional spillway design standards.

Table 1.9-2
TVA Spillway Criteria for Wet Ash Disposal Impoundments

Federal Hazard Category	Spillway Design Flood[1,2]	Minimum Freeboard During Normal Operating Conditions	
		Dam[2]	Upground Reservoir
High	100% Probable maximum flood (PMF) unless a flood inflow condition is identified such that a failure at that flow or larger flows (up to the PMF) will no longer result in unacceptable additional consequences.	Sufficient freeboard shall be provided to prevent overtopping of the top of the dam the design flood and factors such as wind, wave action, ice, ..etc. reservoir.	5 feet
Significant			5 feet
Low			3feet

Note 1: Hydrologic and hydraulic calculations must prove that the combined spillway capacity is sufficient to safely pass the inflow design flood without overtopping the dam. The inflow hydrograph shall be calculated as the flow resulting from the design flood storm event falling on the watershed upstream of the impoundment and the impoundment itself during a 6-hour period.
Note 2: For inflow design flood and freeboard requirements use procedures outlined in Federal Guidelines for Dam Safety: Selecting and Accommodating Inflow Design Floods for Dams, U.S. Department of Homeland Security, Federal Emergency Management Agency, October 1998, Reprinted April 2004.

Spillway structures shall consist of reinforced concrete or steel construction with proper foundations, engineered to withstand with a minimum Factor of Safety of 2.0 for all wind, water, ice, debris and other loads that can reasonably be expected to impinge on the structure during its service life.

Spillways should consist of a single outlet structure serving as both principal spillway and emergency spillway, a principal spillway and a dedicated emergency spillway, or two or more spillways having combined flow capacity sufficient to safely pass the design flood. Spillways consisting of a poorly founded vertical or near vertical outlet pipe with an open end at the desired pool level should be avoided unless they can satisfy all required design criteria.

Outlet works design should adhere to currently accepted engineering practice, and should consider design issues including but not limited to:

- Settlement along conduit profile
- Pipe joint requirements (pipe joint separation)
- Seepage control associated with conduits
- Proper application of spillway materials deemed appropriate with respect to embankment depth, foundation conditions, etc.
- Pipe bedding, cradling and/or encasement
- Energy dissipation and erosion control
- Corrosion protection for ductile iron or other metal pipe

All spillway structures shall be equipped with a means to shut off flow, such as by emplacing stop-logs, or by actuating a gate or valve. Such control features should be located at or near the upstream end of the discharge pipe, near the spillway structure, so that pressurizing the outlet pipe is avoided when valve is closed.

Principal spillways shall be equipped with trash racks designed and built to provide positive protection from clogging of the spillway at any point. The average velocity of flow through a clean trash rack shall not exceed 2 ft/sec with the water elevation in the reservoir 5 feet above the top of the trash rack or at the crest of the emergency spillway, whichever is lower. Velocity will be computed on the basis of net area of opening through the rack.

All spillway structures shall be equipped with personnel access devices meeting pertinent OSHA safety requirements. These may consist of fixed or floating walkways and platforms capable of safely holding a minimum of 1,000 pounds of personnel and equipment without sinking or otherwise becoming unstable. Walkway loadings shall be incorporated into the design of the structure. Guardrails shall be provided to prevent falls into the ash impoundment or the spillway structure.

Whenever possible, discharge conduits should be founded in natural foundation soil at the base of the impoundment dam/dike or at an abutment, and not through the embankment itself. If the conduit must be placed through the dam/dike embankment the design shall include seepage control features such as cutoffs, collars and filter drains. Discharge conduits may not be made of corrugated metal pipe.

Chutes or channels conveying water from the outlet end of discharge conduits should be located in natural ground to the extent possible. Chutes and outlet channels located on the dam embankment should include robust erosion control features such as filters and riprap between them and the surface of the dam to prevent or minimize erosion due to water leakage or spillover.

Pipe conduits shall be of such design as to safely support the total external loads and shall convey flow without rupture or leakage. All pipes shall have the ability to resist corrosion from surrounding soils and impounded materials based on current acceptable testing standards. All pipe conduits shall convey flow at the maximum design velocity without damage to the interior surface.

Up-ground or off stream reservoirs shall be equipped with a passive overflow prevention device that limits the maximum water level by discharging excess water. It shall have sufficient flow capacity to exceed by a minimum of 10% the sum of all pumped inflows plus precipitation runoff to the reservoir. Upground or off stream reservoirs shall be equipped with water level monitoring instruments. If practical, instruments that can be read from a remote location, such as a control panel at the power plant, are recommended. At a minimum, upground reservoirs should be equipped with a staff gage that can be read conveniently from locations readily accessible to power plant personnel.

1.9 ASH STORAGE POND AND LINER DESIGN CRITERIA

This section describes ash storage ponds and liner materials. Selected design standards are presented for dike construction, vertical separation distance, liner systems, protective drainage cover, liner penetrations, discharge structures, splitter dikes, pond sizing and future dam raising, as they relate to the of design ash storage ponds and liners.

When designing new dams, dikes and appurtenances for wet ash disposal facilities, the designer should refer to published design manuals such as the US Army Corps of Engineers EM-series manuals including EM-1110-2-2300, *Engineering and Design - General Design and Construction Considerations for Earth and Rock-Fill Dams* (2004), and related manuals.

Definition

An ash storage pond is defined as an impoundment formed by earthen dams/dikes built above the pre-existing ground surface, excavation into the existing ground surface, or a combination thereof that is used for temporary or permanent storage of wet-sluiced coal combustion products.

The liner is defined as an impervious or low-permeability layer of soil or man-made geomembrane that separates the saturated wet-sluiced coal combustion products and transport water from the soils and groundwater below and outside of the ash storage pond.

1.9.1 Recommendations for Dike Construction

Construction of the dikes should proceed as zoned earthen embankments, with a low permeability (clay) layer comprising the upstream or shoreline side. Material behind and below the impervious material should be selected to meet filter criteria with respect to the low permeability liner material. On the downstream toe of the dike, a graded filter and toe drain to control seepage is recommended. Filter criteria and filter drain design should adhere to USACE EM 1110-2-2300, Appendix B, Filter Design (2004). The slopes should be no steeper than 3H:1V, providing a factor of safety consistent with the parameters presented in this Document.

The crest of the dike should be wide enough to accommodate a two-way road, corresponding to a 25 to 30 ft wide crest. The road should include geotextile in its base and at least 6 to 9 inches of aggregate (“road stone”) so that medium weight service trucks can use the road without damage.

The impervious core of the dikes, built on the upstream slope, should be thicker at the bottom and thinner at the top, with a minimum of 3-foot thickness at the top. Thickness at the bottom should be determined by geotechnical engineering analysis, but in general the clay thickness should not be less than 1/3 the depth of the water to be stored above.

1.9.2 Vertical Separation Distance above Groundwater

A geologic buffer should be present between the base of the ash pond and the underlying groundwater system. In lieu of geologic buffers to maintain a groundwater separation distance, artificial groundwater controls via gravity draining underdrain systems, capable of lowering the groundwater to create separation between the liner and the seasonal high ground water table may be proposed. Such an underdrain system would need to be monitored, sampled, and tested as part of the facility monitoring program, similar to groundwater or surface water monitoring.

1.9.3 Liner System

A composite liner system should be present along the base of the sideslopes of the ash pond. The composite system should be comprised of a synthetic geomembrane in direct contact with a low permeability soil. More specifically, an impervious clay layer (permeability less than 1 X 10^{-7} cm/sec) should be constructed at the bottom of the pond such that the thickness is a minimum of 3 feet, or 1/6 the depth of the water to be stored above it. This ratio can be adjusted/refined using geotechnical engineering analysis. Overlying the clay liner, an HDPE, 60 mil geomembrane (or approved equivalent is recommended based on adequate design and testing for stability during construction and operation.

In general, the bottom of the pond should promote positive drainage to the outlet structure. Pond bottom slopes should be 2% minimum in the direction of liquid flow, with minimum 0.5% slopes in the direction of drainage pipes placed at regular intervals within the protective cover layer above the liner (discussed below).

1.9.4 Protective Drainage Cover

Overlying the composite liner, a protective cover system should be installed to protect the liner during construction and operation as well as facilitate a drainage path below the deposited ash. A drainage blanket of fine to medium sand (or possibly bottom ash/boiler slag) meeting filter criteria with respect to the fly ash, can be constructed at the bottom of the pond, just above the impervious blanket. Slotted or perforated drainage pipe can be embedded in it to drain transport water from the fly ash. The following are generally criteria to achieve this component:

- Protective cover at the pond bottom should be at least 24 inches in thickness, and comprised of a two-layered system.

- The bottom layer should be at least 12 inches thick. The bottom layer of the protective cover should be overlain by a continuously sewn geotextile having an AOS compatible with the upper component of the protective cover.

- The upper layer of the protective cover should be at least 12 inches in thickness. The upper layer of the protective cover should be capable of resisting the erosion force of sluice water as the pond is initially filled. Bottom ash may be used for either component of the protective cover layer, and may be placed at a greater thickness if desired to provide adequate erosion resistance to sluice water anticipated at initial pond filling.

- Protective cover on the pond slopes should satisfy the requirements listed for the pond bottom with the following exceptions:
    - The shoreline of the pond should have erosion protection such as crushed stone or riprap. Size requirements can be determined using wave-fetch design methods.

The erosion protection material should be bedded on granular filter material or a geotextile fabric.

- In areas where future bottom ash removal can be reasonably anticipated the minimum 24-inch thick protective cover should be overlain with riprap to serve as a physical barrier to excavating equipment. A geotextile separation layer may be needed beneath the rip rap layer.
- Beneath any permanent inlet pipe, having its discharge end lying above any portion of the pond slope, a minimum rip rap thickness of 24 inches of suitably sized rock extending the entire slope length, and a minimum distance of 50 feet out onto the pond bottom is recommended. A geotextile separation layer may be needed beneath the rip rap layer. Alternatively, a concrete slab, consisting of at least a 4-inch thick mesh reinforce concrete slab, having the same surface dimensions recommended for the riprap armoring layer, may be substituted for the riprap.
- All pond slopes should satisfy the shallow translational stability analysis (veneer stability calculation) for the selected liner and protective systems as described elsewhere in this document.

1.9.5 Liner Penetrations

Concrete outfall structures with stop log adjustable outlets should be used in regulating water levels in the pond. Geosynthetic liner materials should be mechanically fastened to the concrete surface using stainless steel flat bars with anchor bolts spaced at 12 inch centers. Alternatively, specially designed HDPE embedment strips may be cast in the concrete surface onto which the HDPE liner component may be continuously welded. No pipe penetrations of the liner are anticipated.

1.9.6 Pond Discharge Structure

The pond discharge should be comprised of a long shallow trough that drains to a central discharge structure. The trough should be designed to reduce flow velocities within the pond and reduce the occurrence of concentrated flow (“short-circuiting”). The main discharge structure should be equipped with water level control facilities such as stop-logs so that the pond water level can be raised as it fills with ash over time. While no specific recommendation is provided for the configuration and/or material selection as this is an element of design, due to problems with corrosion and design life, corrugated metal pipe is not recommended.

1.9.7 Splitter Dikes

If desired, splitter dikes can be constructed within the pond using bottom ash, boiler slag or earth materials to partition the pond into two or more sections. Each section should have sufficient surface area to satisfy settling requirements for the coal combustion product to be disposed of in the pond.

In the event that different water elevations are to be considered for either side of the splitter dike, the dike should be designed prior to construction.

1.9.8 Pond Size/Configuration

The surface area of the pond should be large in comparison to its depth. Settling equations should be used for pond sizing, using particle size and specific gravity values that are representative of the coal combustion product to be disposed of.

1.9.9 Future Dam Raisings

The potential impacts of future embankment raisings should be considered when planning the geotechnical aspects of ash pond design, such as predicted foundation settlement, slope stability, embankment zoning and geometry, and pipe material selection. When the possibility of future raisings cannot be ruled out, the design of new ash disposal ponds should be sufficiently conservative to support future raising(s).

1.10 VISIBILITY

While there are no specific State or Federal regulations regarding visibility, the following discussion is provided as a recommendation, especially when facilities are sited in locations where they will operate within clear view of residential areas.

It is standard procedure to locate landfills in areas where they are less visible to the surrounding public. Landfills must be designed and situated in accordance with the applicable siting regulations, which typically require a specified buffer distance between the limits of CCP and the property line, as well as from surrounding domiciles. The following is recommended to minimize visibility to the surrounding public:

- Visibility from outside the landfill property in the direction of all sides of the landfill should be obstructed using either constructed berm, landscaping or tall vegetation, to the extent possible;
- Haul roads, stockpiles, operational areas and staging areas should be screened either using a constructed berm, landscaping or tall vegetation, to the extent possible;
- Evaluations such as a line-of-sight study or balloon test should be conducted in the earliest stages of site planning.

Note that it may not be possible to completely obstruct the view of the landfill, especially as the landfill increases in height. The surrounding topography and existing vegetation can sometimes be used to the designer's advantage. Three-dimensional line-of-sight evaluations can be conducted to determine at what point or phase in the landfill life it will become visible to the surrounding community. Other methods, such as balloon testing, may be conducted to determine at what elevation the landfill will be visible to the surrounding community. In some cases, the ultimate height of the landfill will need to be negotiated with the surrounding community, depending on the level of community opposition to the project.

1.11 ACCESS, PERIMETER, HAUL, & SERVICE ROADS

General Definitions

There are four primary types of roadways that are used in CCP Facilities

The following text defines the design requirements for Access, Perimeter, Haul, and Service Roads as they pertain to CCP facilities.

1.11.1 Access Roads

Definition

Access roads are roads that are used to enter the facility, generally from a public road.

Minimum Design Standards

State/Local: There is no specific state standards in Alabama, Kentucky or Tennessee associated with private roads. Contact the local authorities for specific requirements that may need to be incorporated to the design.

The design standards listed below are based upon the Mine Safety and Health Administration (MSHA) Haul Road Inspection Manual (HRIM) 1999, United States Department of Labor, Mine Safety and Health Administration and Design of Surface Mine Haulage Roads. References to the respective State's Department of Transportation (DOT) design guidance for pavements are included as well.

Selected Design Standard

Road design is based upon factors that must be determined for the specifics of each individual facility. These factors include the following items:

- Vehicle Types-Vehicles that may be utilizing the road should be determined prior to the commencement of design.
- Gross Vehicle Weight (GVW)-GVW shall be established prior to design.
- Traffic Volumes-Projected traffic volumes should be established prior to design commencement.
- Design Speed –Typical Access Road design speeds range from 10 mph to 30 mph. A design speed should be selected and used for design iterations, and adjusted as necessary.
- Road Surface-The desired road surface (pavement, aggregate, etc.) should be established so that a friction factor can be selected for design.
- Road Widths – Haul roads widths should be 3.5 x widest vehicle width for a 2-lane road. See MSHA (HRIM), for recommended road widths based upon the number of traffic lanes and vehicle widths. Additional pavement widening may required around sharp curves. See MSHA (HRIM), Table 15 for widening based upon the curve radius dimension and the GVW.

Once these criteria are established, the following criteria shall be observed:

- Stopping Sight Distance (SSD) – The SSD may vary between 50 ft to 1700 ft based upon design speed, GVW, road surface friction factor and gradient.
- Vertical Alignment - Maximum grade is restricted to 10% with grades to 15% permitted only for short distances. There are no minimum grade restrictions.
- Horizontal Alignment- The following guidelines pertain to horizontal alignments:
    - Minimum horizontal curve is 130 ft (20mph design speed)
    - Minimum horizontal curve is 300 ft (30mph design speed)
    - Super-elevation is required for curves with a radius less than or equal to 1000 ft.
    - Intersection Sight Distance varies between 225' to 375' depending upon design speeds ranging from 15 mph to 30mph.
- Pavement Design – There are no minimum pavement design standards. State specific DOT design guidelines should be utilized. Soil types should be evaluated and considered for pavement design.
- Cross Section – Pavement cross slope to range between 2% and 4%.
- Drainage Design Criteria
    - Roadside Drainage Ditches – 10-year storm for flow capacity of V-ditch.
    - Roadway Culverts – No minimum requirements are listed for culvert design. Use local DOT guidelines or 10-year storm design, whichever is greater.
    - Culvert Outlet Protection – recommended with no standard listed. Use State specific DOT guidelines.
- Runaway Vehicle Provision – No Minimum Requirements
- Guardrail or Earthen Berms-Required for 2:1 foreslope on adjacent ditches or a fill height of 10 feet or greater.
- Storm Water Pollution Prevention Plan (SWP3) – Specific State and Local requirements for construction and post- construction storm water management should be incorporated into the design.
- Right-of-Way Permits-A permit for constructing an entrance within the public right-of-way may be required. Coordinate with the State specific DOT or locality for more information and for more information regarding this permit.
- Signage-Signs indicating speed, direction of movement (right-of-way), use of headlights, railroad crossings, and hazardous conditions must be readily visible and legible.
- Clearance from overhead power lines- Overhead high-voltage power lines are required to be installed no less than 15 feet above grade. Booms and masts of equipment shall not be operated within 10 feet of an energized overhead power line. For more information see chapter 12 of the HRIM.

1.11.2 Perimeter Roads

Definition

Perimeter roads are roads to facilitate the operation of the facility, located around and outside of the limits of CCP placement.

Minimum Design Standards

State/Local: There is no specific state standards in Alabama, Kentucky or Tennessee associated with perimeter roads.

Selected Design Standard

Perimeter Road design is based upon factors that must be determined for the specifics of each individual facility. To some degree, the perimeter road design will be governed by the landfill design standards. See Section 1.10.1 "Recommendations for Dike Construction" for further detail. Additionally the following guidelines are recommended for good engineering practice.

- Vehicle Types-Generally these facilities are designed for medium-weight service trucks however be sure to confirm this with the operations personnel.
- Traffic Volumes-Projected traffic volumes should be established prior to design commencement. These roads are generally very low volume.
- Road Surface and Composition- These roads are generally aggregate, varying in thickness from 6 to 12 inches. A 6 inch base material should underlay the aggregate, with a non-woven geotextile placed in between the two layers (10 oz. is typical). All materials should be well compacted according to specification. Soil types should be evaluated and considered for pavement design.
- Road Widths – Perimeter roads typically allow for 2-way traffic, however, one-way traffic may be permitted if frequently spaced turn-arounds are provided and space is of concern. Each lane should be no less than 12 feet wide.
- Cross Section – Pavement cross slope to range between 2% and 4%.
- Drainage Design Criteria-Drainage criteria should match that for the landfill surface drainage requirements.
- Guardrail or Earthen Berms-Required for 2:1 foreslope on adjacent ditches or a fill height of 10 feet or greater.
- Clearance from overhead power lines- Overhead high-voltage power lines are required to be installed no less than 15 feet above grade. Booms and masts of equipment shall not be operated within 10 feet of an energized overhead power line. For more information see chapter 12 of the HRIM.

1.11.3 Haul Roads

Definition

Haul Roads are roads that are designed to accommodate large trucks with a payload at a design speed with consistent daily (hourly) traffic. Haul roads are used within the footprint of a landfill, used for delivery of material to the working face. These roads are not for public use.

Minimum Design Standards

State/Local: There is no specific state standards in Alabama, Kentucky or Tennessee associated with private haul roads. They are generally the responsibility of the landfill operator to design, build, and maintain.

Selected Design Standard

The Haul Roads used within the footprint of the landfill are the responsibility of the Operator to design, build, and maintain. The design may be based upon the minimum design standards in accordance with MSHA. The Operator may be required to submit the typical Haul Road section to TVA for evaluation, however, ultimately, it is their responsibility to ensure its integrity and functionality. The Haul Road design should be based on the following criteria at a minimum:

- Vehicle Types
- Gross Vehicle Weight (GVW)
- Traffic Projections
- Desired Design Speed
- Road surface-Soil types should be evaluated and considered for pavement design.

Vehicle types, GVW including payloads and traffic projections should be selected to optimize hauling efficiency. Road surface design should consider costs, dust control, vehicle tires and friction factors.

1.11.4 Service Roads

Definition

Service Roads are roads that allow maintenance vehicles to access certain facilities on a periodic basis. Service Roads are not intended to carry payloads within the facility.

Minimum Design Standards

State/Local: There are no specific minimum design standards for private service road designs in any of the three states.

Selected Design Standards

Road design is based upon factors that must be determined for the specifics of each individual facility. These factors include the following items:

- Vehicle Types-Service Roads shall be designed for maintenance vehicles (pickup trucks, gators, etc.)
- GVW-Gross Vehicle Weight shall be established prior to design.
- Traffic Volumes-Projected traffic volumes should be established prior to design commencement. Volumes on Service Roads are assumed to be extremely low.
- Design Speed –Typical Service Road design speeds range from 10 mph to 30 mph. A design speed should be selected and used for design iterations, and adjusted as necessary.
- Road Surface-The desired road surface (pavement, aggregate, etc.) should be established so that a friction factor can be selected for design. Generally, Service Roads are aggregate, dirt, or reinforced grass.
- Service Road Widths – One lane service roads shall be 9 feet wide (min), or equal to the maximum vehicle width. Two lane service roads shall be 18 feet wide (min).

Once these criteria are established, the following criteria shall be observed:

- Stopping Sight Distance (SSD) – The SSD may vary between 50 ft to 1700 ft based upon design speed, GVW, road surface friction factor and gradient.
- Vertical Alignment - Maximum grade should be restricted to 10% with grades up to 15% only for short distances. There are no minimum grade restrictions.
- Horizontal Alignment- The following guidelines pertain to horizontal alignments:
    - Minimum horizontal curve is 50 feet.
    - Super-elevation is not required.
    - Minimum Intersection Sight Distance varies between 225' to 375' depending upon design speeds ranging from 15 mph to 30mph. These values should be compared to the State DOT standards and designed based upon the most stringent requirements.
- Pavement Design – There are no minimum requirements for pavement design. A geotechnical evaluation of the pavement subgrade is recommended to determine the bearing capacity referred to as the CBR. The pavement section should be a minimum section based on soil conditions (CBR value), groundwater, and level of maintenance desired by TVA.
- Cross Section and Drainage Design – Allow for positive drainage.
- Guardrail or Earthen Berms-Required for 2:1 foreslope on adjacent ditches or a fill height of 10 feet or greater.
- Storm Water Pollution Prevention Plan (SWP3) – Specific State and Local requirements for construction and post- construction storm water management should be incorporated into the design. If the road is hard-surfaced, it will be considered
- Signage-Signs indicating speed, direction of movement (right-of-way), use of headlights, railroad crossings, and hazardous conditions must be readily visible and legible.
- Clearance from overhead power lines- Overhead high-voltage power lines are required to be installed no less than 15 feet above grade. Booms and masts of equipment shall not be

operated within 10 feet of an energized overhead power line. For more information see chapter 12 of the HRIM.

1.12 SURVEYING

Definition

Land surveying is the detailed study or inspection, as by gathering information through observations, measurements in the field, verbal or written inquiry, or research of legal instruments, and data analysis in the support of planning, designing, and establishing of property boundaries. It involves the re-establishment of cadastral surveys and land boundaries based on documents of record and historical evidence, as well as certifying surveys (as required by statute or local ordinance) of subdivision plats/maps, registered land surveys, judicial surveys, and space delineation. Land surveying can include associated services such as mapping and related data accumulation, construction layout surveys, precision measurements of length, angle, elevation, area, and volume, as well as horizontal and vertical control surveys, and the analysis and utilization of land survey data. Expectations prior to commencement of surveying are established in regards to accuracy, datum, field equipment, hardware and software and other related requirements. These expectations can vary from project to project, state to state or within surveying sub disciplines.

Surveying and Mapping for Design and Plan Development

Field survey data shall be used to create mapping or supplement existing mapping. When applicable, determinations regarding level of supplemental survey shall be established prior to project start. Criteria shall be determined prior to map creation regarding the level of detail required. Detail shall meet or exceed minimum criteria requirements. Supervisory control of all survey and map efforts shall be by a registered professional surveyor in the State in which surveys are performed and maps created. Quality assurance / quality control measures shall be in place to ensure proper map development procedures are in use.

Key Components of Surveying Control

Key components of surveying are the establishment of control in which all future survey data will be based. Control points shall be durable in the environment they are set and uniquely and easily identified. Control points shall have specific northing, easting and elevation information attributes. From these control points, data is gathered and a data base is created. Supervisory control of all survey efforts shall be by a registered professional surveyor in the State in which surveys are performed. Quality assurance / quality control measures shall be in place to ensure proper field and office procedures.

Minimum Surveying Standards

Alabama: As indicated by statute, or as established prior to project start.

Kentucky: As indicated by statute or as established prior to project start.

Tennessee: As indicated by statute or as established prior to project start.

Accuracy Requirements & Measurement Specifications

Every determination of distance shall be made either directly or indirectly in such a manner that the linear error in the distance between any two points (not necessarily adjacent points) shall not exceed the reported distance divided by ten thousand (allowable linear error = reported distance divided by ten thousand) and every angular measurement shall be made in such a manner that the allowable (directional) error, in radians, shall not exceed the allowable linear error divided by the reported distance (allowable (directional) error = allowable linear error divided by reported distance). When the reported distance is less than two hundred feet, the linear error shall not exceed 0.02 feet. The reported distance is the distance established by the survey. The lengths and directions of the lines shall be specified so that the mathematical error in closure of the property boundary does not exceed 0.02 feet in latitudes and 0.02 feet in departure. Surveys performed using metric measurements shall utilize the metric equivalents based upon the U.S. survey foot conversion factor.

2.1 BASIS OF DESIGN REPORT

2.1.1 Definition

The Basis of Design (BOD) Report shall be developed for each specific design related project and is intended to supplement the Construction Documents. The BOD report is intended to document the design criteria and minimum standards utilized for each specific project. This guidance document shall be utilized as the initial basis for the BOD but contains only the specific standards and assumptions related to each specific project. The BOD report shall also provide relevant calculations utilized in the design.

The BOD report shall at a minimum include the following:

1. Project Description – defining the scope of work, the location and types of the facilities, purpose or intentions of the proposed improvements and the general design criteria established (i.e. TVA Guidance Document, Federal Guidelines, State or Local Guidelines)

2. Existing Site Conditions – description of the existing site and facility(s) conditions involved in the project and the associated problems necessitating the required improvements.

3. Proposed Improvements – description of the proposed improvements to each facility within the project.

4. Design Criteria – listing of the established design criteria and assumptions utilized in the design of the proposed improvements. The list should be separated into facility types or design components (i.e. Stability Analysis, Surface Water Run-off and Erosion Control, etc.) and identify the sources of each criteria listed.

5. Design Exceptions or deviations from the recommended minimum standards. This should also include an explanation or justification of the deviations from the minimum standards. Note: These should be identified as early as possible or red flagged and discussed with TVA prior to design development.

6. Design Narratives – a description or brief narrative of each design related component including the following as they pertain to the proposed improvements:

    a. Stability Analysis

    b. Leachate Management System

    c. Surface Water Run-off and Erosion Control

    d. Embankment systems

    e. Spillway / Drainage Systems

f. Haul and Service Roads

g. Special Factors

Note: Spcific calculations should be referenced and included in Appendices.

7. Construction Cost Estimate and Schedule

8. Permits – A listing of the required design and construction permits necessary for the project completion.

9. Construction or Implementation Plan - a brief description of the major construction components and a brief implementation plan identifying services or facilities that are required to be maintained during construction. Also include a list of long lead time procurement items.

10. Operational features - a brief of the operating and maintenance requirements of the proposed facilities.

11. Appendix – Supplemental Reports (i.e. Geotechnical Report**)**, Detailed Calculations or modeling output, Catalogue Cuts of proposed equipment or materials specified in the design and pertinent correspondence with TVA or regulatory agencies.

2.2 CALCULATION DOCUMENTATION

The following section describes the preparation and documentation of calculations. All calculations shall be prepared and submitted to TVA using the following guidelines:

- General Information - Be neat and legible. Use a standard computation pad if performing hand-calculations and include a calculation cover sheet and table of contents. A heading should be included on all pages to reflect project, consultant name, name of person performing calculation, reviewer's name, and date. All calculations should be grouped together for various portions of a project and submitted electronically to TVA.
- Objectives - Briefly state the description and purpose of the calculation and where the result is used (e.g., drawings, specifications, equipment structure). Use sketches for clarity.
- References – List the references (reports, technical papers, codes, textbooks, etc.) on which the calculation(s) is based.
- Inputs **-** Define all parameters used in the calculation. This includes items such as geometry, material properties, and symbols not commonly used. Give references for values, properties and coefficients used.
- Assumptions **-** List all pertinent engineering assumptions made, and the basis for these assumptions.

- Methodology – Provide a narrative explaining the methodology used to implement the calculation. Show sources or derivations of equations not commonly used. Give references for methods applied. Include the name, source and revision of any technical software used to assist in performing the calculation. State the criteria for judging results, including regulatory approaches.

- Results – Provide all results pertinent to the calculation. Explain the results in a clear manner. Compare results to minimum acceptable standards, codes or commonly applied design practice.

- Conclusions – Provide a narrative interpreting the results with respect to their end-use. All recommendations concluded from the calculations should be stated in a separate report.

2.3 TRIGGER POINT MEMORANDUM

Definition

Trigger Points are design elements considered critical to a facility's integrity. Any element or specific design criteria of an engineering project considered critical to the stability or function of the facility shall be identified as a trigger point. The following section outlines a TVA strategy to identify and provide the extra attention required to manage trigger points at all TVA CCP facilities.

Selected Standard

For all major capital projects at CCP facilities, including all major permitting and construction projects, the design engineer shall develop and submit a trigger point evaluation document to TVA in the form of a brief technical memorandum. At a minimum, the trigger point memorandum shall include:

1. An introduction of the project;
2. The definition and identification of trigger points specific to the project; and,
3. Recommendations for each identified trigger point. Recommendations shall include:
    - Additional measures that may be taken to verify construction in accordance with the design specifications;
    - Recommendations to be incorporated into the inspection or maintenance programs of each identified trigger point;
    - Identification of potential problems for each trigger point; and,
    - Development of an action plan to mitigate the trigger point if potential problems are identified.

When necessary, figures or specific references to the design documents (drawings or specifications) shall be provided to aid in the identification and discussion of each trigger point. The trigger point memorandum shall be provided to TVA at the conclusion of the engineering design process and be revisited at the close of permitting and construction activities. A meeting should be held between TVA and the design engineer to discuss and clarify the findings of the trigger point memorandum as needed.

Typical trigger points for CCP facilities include, but are not limited to:

- **Material strength or construction requirements**, such as compaction or minimum material interface shear values required for the stability of the facility.
- **Critical design assumptions** that should be confirmed during construction or revisited in future design projects.
- **Systems designed to stabilize the facility**, including wick drains or underdrain systems which must function properly over the life of the facility.
- **Design elements that may be impacted by potential settlement**, such as liner and leachate collection systems, final cap systems, and structural foundations.
- **Specific areas of concern**, such as spillways or critical embankment areas.
- **Design elements requiring critical maintenance or inspection**, such as piping systems, pumping systems, embankments, or spillways critical for the facility to function as designed.

2.4 PERMIT REGULATORY REQUIREMENTS SUMMARY

A Permit Regulatory Requirements Summary shall be provided on a permit-by-permit basis by the Engineer preparing the specific permit. The Permit Regulatory Requirements Summary shall consist of the following at a minimum:

- a compilation table or summary of the key regulatory requirements by the permit,
- a description of inspections/monitoring requirements,
- a description of documentation and reporting requirements, and
- a reporting schedule.

This Permit Regulatory Requirements Summary shall be prepared by the design engineer upon receipt of the final permit. The Permit Regulatory Requirements Summary is provided for internal use by TVA and shall be regularly reviewed and updated.

2.5 OTHER RELATED DOCUMENTATION

In the preparation of design and permit documents, additional requirements are necessary. As such, the following additional plans, calculations, and reports shall be required:

1. For all permits, the following plans shall be prepared and submitted to TVA as required by regulations or in addition to:

    a. QA/QC Plan: A plan documenting the quality control items and acceptable values.

b. Waste Characterization Plan: A plan documenting the chemical characteristics of the CCP materials included in the permit as well as testing procedures and frequency.

c. Operations Plan: A plan documenting the key aspects of the operation of the facility such that the operation remains in compliance with the permit.

d. Groundwater Monitoring Plan: A plan documenting the method, frequency, data collection and processing, reporting, etc. related to groundwater quality assessment. This plan shall be prepared with the Environmental Support Group.

2. For all construction documents, the following documents shall be prepared and submitted to TVA as required by regulations, contract, or in addition to:

    a. CQA requirements: Within the technical specifications for the project, construction quality assurance testing requirements shall be provided with the understanding that these items will be monitored and recorded during the construction.

This section lists the requirements of the regulations. In general, the specific requirements are not identified; and a reference to the full text of the regulation is presented instead

3.1 ENGINEERING CERTIFICATION

This section defines the certification requirements for dry ash landfills and wet ash ponds for each of the three states where TVA facilities are located. During the design, permitting, construction and operation of both permitted ash landfills and ash impoundments there are specific instances whereby a state licensed engineer is required to provide written certifications. This section provides information relative to what certifications are required in each of the states.

3.1.1 Dry Ash Landfills

Minimum Design Standards

Alabama: General design standards for solid waste disposal facilities are contained in the ADEM administrative code §335-13-4-.11 that references §§335-13-4-.12 through 335-13-4-.20 as well as §335-13-5-.02(1). These regulations require that all plans, specifications, operational procedures, letters of final construction certification and other technical data for the construction and operation of a permitted facility be prepared by a professional engineer registered in the State of Alabama. The seal or signature and registration number of the design engineer shall be affixed to the plans, specifications and reports. All legal property descriptions and survey plats shall be by a registered land surveyor (RLS) with the seal or signature and registration number of the land surveyor affixed. Landfill closure must be certified by a registered professional engineer or registered land surveyor. Alabama currently does not require CCP to be disposed on in permitted landfills. Therefore, there are no specific disposal requirements other than what is deemed necessary by the agency on a case-by-case basis. Therefore, the above certifications apply if CCP is disposed of in a permitted landfill.

Kentucky: The landfill permitting law is found in the Kentucky Revised Statutes (KRS) Chapter 224 and the regulations are in 401 Kentucky Administrative Regulations (KAR) Chapters 30, 40, 45, 47, 48, and 49. Generally the landfill application for contained landfills, construction/demolition debris landfills, and residual landfills is in three phases: the Notice of Intent, the Administrative Application, and the Technical Application; however, in Kentucky, CCP is considered a special waste. The special waste landfill application is a single phase with its own public notice requirements. The special waste requirements are found in 401 KAR Chapter 45. This regulation requires that all plans, reports, phasing, closure and post-closure plans be prepared by a professional engineer registered in the State of Kentucky.

Tennessee: Under the TDEC rules, Chapter 1200-1-7-.04 provides specific requirements for Class I, II, III and IV disposal facilities. A professional engineer registered in the State of Tennessee must plan, design, and inspect the construction of any of these facilities; also a registered professional engineer must assist in the start-up and outlining of correct operating procedures for any new or altered facility. In Tennessee, CCP's must be disposed of in either a

Class I or Class II landfill. A landfill in Tennessee for which only CCP waste is disposed would be subject to the Class II standards.

Federal: 40 CFR 258 establishes the design criteria for new nonhazardous waste disposal facilities and lateral expansions of existing facilities. However, a plan approved by the division director of an approved state will meet the specifications of this rule. Since each of the three states is an approved state, there are no additional federal requirements.

Selected Standard

For all projects governed by regulations that require engineering certification, these activities shall be completed and submitted to the Agency accordingly.

For projects not governed by regulations that require engineering certification, these activities shall be completed and submitted to TVA for project documentation. In this way, the information shall be available for these projects upon request.

3.1.2 Wet Ash Ponds (Impoundments and Dams)

None of the states or the federal regulations specifically address engineering certification of non-hazardous waste impoundments. However, if the structure provides treatment prior to discharge through a permitted outfall, a professional engineer certification may be required. Additionally, if the structure has a dam, as defined by the applicable regulations (1200-5-7), certification would be required in each state. However, according to the TVA Dam Safety Program, state dam safety regulations do not apply. Rather, the TVA Dam Safety Program follows Federal programs in these regards. The following sections for each state are therefore provided for reference only,

Alabama: The ADEM Water Division – Industrial Section provides Construction Guidelines for Industrial Wastewater Impoundments (Rev. 03/00). These guidelines state that a professional engineer should supervise construction and verify that engineering requirements and best engineering construction practices are met during construction. The guidelines further state that after construction is complete, a professional engineer should submit a letter of certification stating that the impoundment was built in conformity with the engineering requirements listed above or alternate requirements determined acceptable by the Department, any stipulations specified by the Department, and the initial submittal. If the impoundment differs from the initial submittal, 'as built' drawings should be submitted.

Kentucky: Certification of KPDES permit applications and reports are defined in 401 KAR 5.060 Section 9. However, this certification is not required to be stamped by a professional engineer. Additionally, there are no specific engineering certification requirements for impoundments other than those required for dam safety. All plans and specifications submitted for consideration of a dam must bear the seal and signature of the responsible engineer as defined in KRS 322.010(2), except officers and employees of the United States government while engaged in engineering for the government. Each sheet of the drawings shall bear the seal and signature of the engineer or engineers responsible for its preparation (Title 401 Chapter 4, Section 030).

Tennessee: Whenever any new construction or change in existing construction in a wastewater treatment facility is performed, a registered engineer must plan, design, and inspect the construction of such works (TN Rule 1200-4-2-.01). The certified plans must be submitted to TDEC as part of the application for a NPDES permit. Additionally, should the structure require a dam, as defined in TN Rule 1200-5-7-.02(10), a qualified professional engineer must prepare design and specification and supervise the construction. An application for an operating certificate must be submitted to TDEC.

Federal: Since all three of the states in which TVA has facilities are approved states under the NPDES program (40CFR123), no additional certification to the USEPA is required. The federal government does not have governing dam safety certifications.

3.2 BORROW SOURCE REQUIREMENTS

This section will present the applicable regulatory requirements for investigation and testing of soil borrow material sources and provide recommendations on the related procedures. The purpose of borrow material testing is to prequalify the proposed soils intended for use as natural liner or closure materials for landfill or pond constructions. Prequalification is conducted so that the engineer and/or construction contractor have advance knowledge of whether the planned borrow source materials will most likely meet the required design specifications for use as natural liner or closure materials. Potential borrow source materials should be inspected, sampled, and tested prior to their use under the direction of a qualified, geotechnical or landfill engineer. The following subsections discuss sampling, testing and stockpile management in relation to soil borrow source materials.

3.2.1 Sampling

Several methods exist for sampling proposed soil borrow sources. Samples can be obtained by drilling soil borings and recovering samples of the soil from the borings or excavating test pits into the borrow source and collecting bulk samples from the exposed cuts. Excavating test pits in the borrow source provides greater information about the variability of the soils and potential stratigraphic changes than viewing small soil samples recovered from soil borings and is therefore the preferred method.

Qualified field personnel, typically a representative of the design engineer firm or third party QA/QC firm, should be present during sampling to ensure the collection of high quality samples, and to provide an accurate representation of the soil conditions. Samples of approximately 50 pounds should be collected from specified depth intervals at each test pit location and stored in a clean 5-gallon sample bucket. Samples should be collected at specified depth intervals as appropriate to ensure complete coverage of the borrow source and to satisfy the sampling frequency. Small samples of the soil should be placed in a sealed plastic bag to determine the in-situ moisture content of the soil. The sealed plastic bag should be placed inside of the 5-gallon bucket for shipping. Samples should be shipped at the end of the sampling process to a qualified geotechnical laboratory for analysis.

3.2.2 Testing

Samples taken from the borrow source should be tested to ensure conformance with specifications for parameters defined in the design documents such as percent fines and plasticity index. The soil samples will undergo preliminary testing referred to as index testing. Index or characterization testing will determine if the borrow source samples meet the minimum criteria to be considered as natural liner or closure materials for landfills or ponds. Index testing includes Moisture Content, Atterberg Limits, Particle Size Analysis, and Standard or Modified Proctor Tests. Hydraulic Conductivity testing is performed on borrow source materials that are determined to meet the minimum specifications through index testing. Hydraulic conductivity tests are performed on soils to verify that the potential soil liner or cap material can be compacted to achieve the required low hydraulic conductivity determined by the design engineer.

Minimum Design Standard

Alabama: There are no state regulatory requirements governing the frequency of testing of soil borrow sources for the state of Alabama.

Kentucky: There are no state regulatory requirements governing the frequency of testing of soil borrow sources for Special Waste Landfills. There are, however, minimum requirements for contained landfills (MSW) as specified in 401 KAR 48:80 Section 4, which provides the following testing frequencies for proposed natural liner and cap soils. Table 2.2.2-1 provides American Society for Testing and Materials (ASTM) specifications and recommended frequencies for soil borrow source material investigations in Kentucky.

Table 3.2.2-1

ASTM Specifications and Recommended Frequencies for Soil Borrow Source Material Investigations in Kentucky

Test	Frequency	ASTM Standard
Moisture Content	1 / 2,000 cubic yards	ASTM D 2216
Particle Size Analysis / Soil Classification	1 / 2,000 cubic yards	ASTM D 422
Atterberg Limits	1 / 2,000 cubic yards	ASTM D 4318
Standard or Modified Proctor Test	1 / 20,000 cubic yards	ASTM D 698 ASTM D 1557
Hydraulic Conductivity	1 / 20,000 cubic yards	ASTM D 5084

Tennessee: There are no state regulatory requirements governing the testing of soil borrow sources for the state of Tennessee.

Selected Design Standard

Table 2.2.2-2 provides ASTM specifications and recommended frequencies for soil borrow source material investigations.

Table 3.2.2-2

ASTM Specifications and Recommended Frequencies for Soil Borrow Source Material Investigations

Test	Frequency	ASTM Standard
Moisture Content	1 / 2,000 cubic yards	ASTM D 2216
Particle Size Analysis / Soil Classification	1 / 2,000 cubic yards	ASTM D 422
Atterberg Limit Determination	1 / 2,000 cubic yards	ASTM D 4318
Standard Proctor Test or Modified Proctor Test	1 / 10,000 cubic yards	ASTM D 698 ASTM D 1557
Hydraulic Conductivity	1 / 10,000 cubic yards	ASTM D 5084

3.2.3 Stockpile Management

Soil borrow materials that have been pre-qualified via the testing and analysis program (and are thus determined to meet the criteria for soil liner or cap material) shall be excavated and stockpiled on-site. Stockpiles should be constructed in accordance with these recommended guidelines:

- Locate stockpiles in a strategic location to minimize haul distance and double handling;
- Do not stockpile soils in a location which will interfere with the natural drainage tendencies of the surrounding areas;
- Stockpile soils a minimum of 50-feet away from concentrated flows of stormwater, drainage courses, and inlets;
- Slope stockpile to promote drainage;
- Protect soil stockpiles from stormwater run-on with temporary perimeter barriers such as berms, dikes, silt fencing, or hay bales; and

- Provide temporary seeding in accordance with erosion and sediment control regulations as discussed in the Soil Erosion Section (Section 1.6.1) of this Volume.

3.3 AGENCY NOTIFICATIONS AND RESTRICTIONS

Definition

Agency notifications by way of applications, correspondence, etc are required for permitted facilities in accordance with several state and federal regulations. This section summarizes general notification requirements for the states and government and then provides a reference to the notification requirements. Additionally, in order to do significant work affecting federally controlled properties (i.e. work in which federal funds are used, work requiring federally issued permits such as USA COE Section 10 and Section 404 permits or TVA Section 26a permits) a number of federal agencies must be notified. These agencies, notified as part of the NEPA process, are listed in the sections which follow.

3.3.1 Dry Ash Landfill

Alabama**:** The notification process for a permitted landfill in Alabama requires notification to ADEM through the application process (ADEM Rule 333-13-5). However, prior to ADEM's beginning review of a new permit application the local government with jurisdiction over the proposed landfill site must approve the location, after involving the public in the siting process (Code of Alabama 1975, §22-27-48). A pre-application conference with the technical staff of the Land Division and the applicant's representatives to discuss specific requirements for the application is recommended. Specific processing steps and time periods are provided so that the applicant can include these tasks in the overall planning of the project development. In some instances, all necessary media-specific permit applications can be processed on parallel tracks. Applications for construction or modification of an existing landfill should be made at least 180 days in advance of start of construction.

Since construction of a landfill by TVA would involve federally owned property or federal funding, an environmental assessment (EA) of the project would be reviewed through the NEPA process. Numerous state and federal agencies are included in the scoping and coordination of the NEPA process. In Alabama these include: Alabama Historical Commission, ADEM Division of Water Quality, Division of Solid Waste, Division of Air, Alabama Department of Conservation and Natural Resources, Division of Wildlife and Freshwater Fisheries, Alabama National Floodplain Insurance Program, as well as numerous other state, local, and federal agencies.

Kentucky: Prior to submitting an application for a special waste landfill permit, as required by 401 KAR 45:030, a meeting should be scheduled with the Division of Waste Management concerning the location of the site and to review the potential need of additional permits that might be necessary for the project, such as KPDES discharge permits, floodplain permit, transportation permit, etc. The division has a list of agencies and points of contacts for these other permits. Division staff is also available to discuss the permitting and public notification process. Once an application is deemed complete, the state's timeline for issuing a preliminary decision to deny the permit is 180 calendar days. If the decision is made to issue the permit, a draft permit is prepared and 30-day public notice is published. Depending on the comments received, the construction permit may be issued soon after the comment periods, or if more concerns are identified, it may take several months.

As with Alabama, construction of a landfill in Kentucky would involve federally owned property or federal funding, and an EA of the project would be reviewed through the NEPA process. Coordination would be required with the State Historic Preservation Officer, Kentucky Department of Environmental Protection (Air, Water and Solid Waste), State Fish and Game agencies, Forest Service, Economic and Community Development, Agriculture Transportation and others. Federal agency coordination is described below.

Tennessee**:** The notification process for a landfill in Tennessee requires notification to the Division of Solid Waste Management through the local field office. In accordance with TDEC Rule 1200-1-7-.02(2), a Part I and Part II application, along with the application fee, must be submitted before the application is deemed complete. The Part I application (Form CN-1036) which includes the name, address and phone numbers of the owner(s); proposed activities to be conducted at the facility; a statement regarding whether the facility is subject to local approval (TCA § 68-211-701) and county approval if necessary, a topographic map and disclosure statement. The Part II includes: a hydrogeologic assessment of the potential site; facility design plans and operations manual; financial assurance demonstrating the financial responsibility for closure and post-closure care; and other specific requirements for Class I, II, III, and IV disposal facilities.

After the Part I application is received and reviewed for completeness, a preliminary public notice is issued. The state archeologist reviews the site for the existence of burial grounds. The Part II items are then submitted to the Division and are reviewed by a committee. When all documents and approvals have been met, a second public notice of intent to issue a permit is issued. Public response to this second notice may generate another public notice to hold a public hearing. If requested, the Division may give notice of a public hearing concurrently with the second public notice of intent to issue a permit. After review of the public comments, a final public notice with the permit decision is issued. The entire permit process may take from 12 months or longer, depending on the type of facility, public interest, public hearings, revisions, appeals, and site preparation.

Since construction of the landfill would involve federally owned property or federal funding, an EA of the project would be reviewed through the NEPA process. Within the state of Tennessee there are a total of six departments that must be notified prior to construction if any of the following issue categories are pertinent to the NEPA review. These departments and their divisions that should be included in the review process if there are issues pertinent to that division include:

- TN Department of Environment and Conservation (TDEC) Divisions: Threatened and Endangered Species and Wild/Scenic Rivers; State Parks; Public Recreation; Water; Air;

Surface/subsurface Drinking Water Sources; Septic Systems; Superfund; Underground Storage Tanks; Solid/Hazardous Waste; and Radiological Health.

- TDEC Tennessee Historical Commission
- Tennessee Department of Agriculture
- Tennessee Department of Transportation
- Tennessee Wildlife Resources Agency
- Tennessee Department of Economic and Community Development.

Federal**:** Construction of a landfill in any of the three states would involve federally owned property or federal funding; therefore an EA of the project would be reviewed through the NEPA process. Federal agencies that are included in the NEPA process include:

- US Fish and Wildlife Service
- US Forest Service
- Natural Resources Conservation Service
- Native American Tribes (United Southeastern Tribes – USET)
- US Army Corps of Engineers
- US Environmental Protection Agency
- Tennessee Valley Authority

3.3.2 Wet Ash Ponds (Impoundments and Dams)

According to the TVA Dam Safety Program, state dam safety regulations do not apply. Rather, the TVA Dam Safety Program follows Federal programs in these regards. The following sections for each state are therefore provided for reference only.

Alabama: ADEM regulations do not specifically address wet ash impoundments or dams. Prior to any construction of a new wet ash impoundment or modification to an existing impoundment whereby water may be discharged, an application to ADEM's Water Division must be made in accordance with rules provided in Chapters 335-6-6. The application must include technical components of the control structures, BMPs, etc.

Kentucky: The Kentucky DEP regulations do not specifically address wet ash impoundments. Prior to any construction of a new wet ash impoundment or modification to an existing impoundment whereby water may be discharged, an application to KDEP in accordance with 401 KAR 5:060 must be submitted and a permit issued. The technical and administrative requirements are similar to other states, such as Alabama (above) that have permit programs approved by the EPA, with the exception that the Dam Safety Section and Floodplain Compliance Section requirements for dam construction would be part of the submittal package. Regulations relating to dam safety are in Kentucky Administrative Regulations Chapter 4, Title 401, Water Resources.

Tennessee: TDEC regulations do not specifically address wet ash impoundments. However, prior to any construction of a new wet ash impoundment or modification to an existing impoundment whereby water may be discharged, an application to TDEC Division of Water Pollution Control must be made in accordance with TDEC Rule 1200-4-5-.05. The technical and administrative requirements are similar to other states, such as Alabama (above) that have permit programs approved by EPA.

Federal: Since all three of the states in which TVA has facilities are approved states under the NPDES program (40 CFR 122), no additional notification to USEPA are required. In the case of new land disturbances or federal properties, the NEPA notification for wet ash ponds is the same as for dry ash landfills (Section 3.3.1).

3.4 GENERAL CONSTRUCTION PERMITS (LOCAL, STATE, AND FEDERAL)

Definition

If a facility plans to clear, grade, or excavate an area of one or more acres, a stormwater construction permit is required by all states in the TVA region. This section outlines the general requirement necessary for obtaining such permits

3.4.1 Dry Ash Landfills

Alabama: The rules for storm water construction permits require an operator/owner to register construction activities and associated areas one acre or greater in size. Construction activities less than one acre in size that are part of or associated with a larger plan of development or sale that might eventually exceed one acre, must register. In addition, construction activities less than one acre in size that are determined by ADEM to have significant potential to cause or contribute to water quality impairment, may be required to register.

These rules require that a Construction Best Management Practices Plan (CBMPP), prepared by a qualified credentialed professional (QCP), and designed to minimize pollutant discharges in stormwater runoff to the maximum extent practicable during land disturbance activities, be fully implemented and effectively maintained. A CBMPP is required to be submitted with the request for registration for proposed discharges to a Tier 1 waterbody(s), proposed discharges to an Outstanding National Resource Water (ONRW) designated waterbody, and for projects involving waterbody relocation or significant alteration. NPDES registration coverage must be retained until all disturbed areas have been reclaimed and/or effective storm water quality remediation has been achieved.

Kentucky: The storm water construction permit requires any agency, company or individual planning construction activity in Kentucky disturbing one acre or more to:

- Develop and implement a "Storm Water Best Management Practices Plan." Among the requirements of this plan is that there be provisions for inspections every seven days and after each rain of one-half inch or more.

- Submit a signed Notice of Intent (NOI) form to Kentucky Division of Water at least 7 day before construction begins (if filed electronically and 30 days if paper filled.

- Submit a copy of the NOI to the municipal operator of any municipal separate storm sewer system (MS4) the site discharges into. Note that a NOI is now not required on activities at a facility that is covered under an NPDES permit.

- Submit a signed Notice of Termination (NOT) form to the Kentucky Division of Water after construction activity has ceased and the site has been finally stabilized.

Tennessee: Applicants must submit the following information for a Storm Water Construction Permit:

- A completed and signed NOI for Construction Activity - Storm Water Discharges. The NOI must include a map on 8 ½ inch by 11 inch paper with boundaries 1-2 miles outside the site property with the site and construction area outlined and the receiving water or receiving storm sewer highlighted and identified. It is preferable for this map to be the appropriate portion of a USGS 7.5-minute quadrangle map.

- A site-specific SWPPP must be developed and submitted with the NOI. The SWPPP must be developed, implemented, and updated according to Part 3 of the Construction General Permit (CGP).

Federal: Construction permits follow state regulations in all states of the TVA Region. The NEPA process must be followed for any construction that involves significant work affecting federally controlled properties. Certain project activities can trigger the need for an EA under NEPA. Pursuant to the Council on Environmental Quality (CEQ) regulations (40 CFR 1500-1508) for implementing the procedural provisions of the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.), an EA of potential environmental effects associated with federally funded projects is required. Other federal permits include Section 404 (for activities that impact waters of the United States) and/or Section 10 (for activities that impact navigation) with Joint Section 26a TVA permits. Where there are results of an EA warrant, an environmental impact statement (EIS) may be required. In industrial development type projects, an EA and possibly an EIS may be triggered by:

- Significant work affecting federally controlled properties. In Tennessee this is most often work on properties controlled by the Corps of Engineers or TVA;

- Work requiring federally issued permits such as Corps Section 10 and 404 permits or TVA Section 26a permits;

- Project work for which federal funds are used.

See Section 3.3 for agencies which require notification. The lead agency is identified by the category of impact. If a 404 permit is required, the USACE is the lead reviewing agency. Following notification to the agencies, an EA will be prepared by, or on behalf of the applicant.

3.4.2 Wet Ash Ponds (Impoundments and Dams)

The storm water general construction permitting requirements for dry ash landfills would be applicable to wet ash impoundments as well. The rule is based on the one acre disturbance and requirement of a storm water construction permit. In addition, to the storm water construction permit, and subsequent NEPA process, impoundments are subject to Dam Safety Compliance. According to the TVA Dam Safety Program, state dam safety regulations do not apply. Rather, the TVA Dam Safety Program follows Federal programs in these regards. The following sections for each state are therefore provided for reference only.

Alabama**:** see Section 3.3.2

Kentucky: see Section 3.3.2

Tennessee: see Section 3.3.2

Federal: see Section 3.3.2

This section addresses the various elements of managing construction projects within TVA. There are no references to specific regulations as these do not apply, but rather, the information presented herein is consistent with TVA's procedural and organizational approaches to management of construction project with either TVA or a Consultant in the roles defined.

4.1 OVERVIEW OF BID, EVALUATION, AND CONTRACT AWARD PROCESS

Bidding is the procurement of goods or services through a process of open and free competition. There are generally two types of bid processes, Request for Proposal and Competitive Bidding using Sealed Bids. Bids are evaluated and awarded based on a system of assessment criteria.

Prior to the bid process, the first step to successfully bidding a project for construction is to have a clearly defined project. An engineering firm or TVA depending on size/type of project should develop a complete set of design documents including drawings and specifications. This construction package should be reviewed and approved by the Owner prior to being issued for bid. It is from this construction package that a RFP will be developed.

The bid process begins through the development of the scope of work (SOW) statement (description of services) or specifications (description of goods), proposal evaluation criteria, and a recommended sources list. These are submitted to the Purchasing Department, which takes this SOW or specifications and develops a complete RFP including standard contract clauses, special clauses, instructions to prospective bidders, and any requisite technical exhibits or attachments. The RFP states a specific date and time deadline for proposal receipt and often has mandatory pre-bid meetings for bidders to attend. This meeting offers the opportunity to ask questions and gives the Owner a chance to determine whether any changes (addenda) need to be issued to the RFP. This is also an excellent time to conduct any requisite site visits to familiarize bidders with the project site(s).

After proposals are received, they are evaluated against the criteria stipulated in the RFP. After evaluating the proposals, the Owner chooses the awarded firm. Once approved, a purchase order and/or contract are processed. The following sections provide a general discussion of the bidding, evaluation, and contract award process.

4.1.1 Developing the Scope of Work

A well-written scope of work is critical to the success of a contract. A good scope of work is clear, complete, and logical enough to be understood by the bidder and Owner. Because it describes the details of performance, it is the yardstick against which the bidder's performance is measured. The structure of the document is meant to organize a bidder's response. It may be helpful to organize the RFP document in numbered sections, and require the bidders to use this same numbering/sectioning format in their responses. This ensures clarity and consistency in the RFP and in the bidders' responses, and will make the evaluation and selection process easier.

- Suggested Content - Introduction and general information, task description, constraints on the contractor, contractor personnel requirements, Owner responsibilities, special conditions, and evaluation criteria.

4.1.2 Developing a List of Bidders

A list of bidders should be developed in order to solicit bids from qualified contractors. The number of bidders can vary depending upon the size of the scope, corporate requirements, and availability of qualified bidders. The bidders listed will receive a construction document package including the RFP, construction documents, and drawings. The list of bidders should be limited to contractors that meet a series of defined criteria. Contractors should be "pre-qualified" prior to being included on the bidders list. The development of bidder's qualifications will limit the list of bidders to contractors that possess the ability, manpower, equipment, performance reputation, and experience to perform the work defined in the RFP. A list of qualifications should be developed and demonstrated by potential bidders.

- Suggested list of bidder qualifications (experience, minority requirements, safety record (OSHA), and union requirements)

4.1.3 Bidding

A pre-bid meeting is typically held to issue the RFP and a set of Contract Documents to the qualified bidders. The pre-bid meeting provides the Owner an opportunity to describe the project scope, introduce the engineer and key project personnel, define roles and responsibilities, and answer questions. Bidders are typically given the opportunity to request additional information or clarifications in writing prior to the bid submittal date. In addition, the Owner will notify the bidders of the specific date and time for bids to be submitted as well as the expected award date. Bidders may also be given the opportunity to visit the project site(s).

4.1.4 Developing Proposal Evaluation Criteria

A prerequisite for award is that the bidder must be responsible and must submit a responsive offer. To be responsible means the bidder has the requisite business integrity, as well as financial and organizational capacities, to ensure good-faith performance. To be responsive, an offer must conform in all material respects to the RFP or at least offer valid alternatives such that all aspects of the RFP are addressed. Nonresponsive offers, those bids that do not address all aspects of the RFP nor detail valid alternatives, will not be considered. Beyond these two basic criteria, the proposal evaluation criteria, which are published in the RFP aid in the selection of the bidder.

A comparative analyses of different bidder's proposals must be defensible and objective. This makes the drafting of reasonable and definitive evaluation criteria very important to the RFP and source selection process.

Some evaluation criteria to consider for inclusion in the RFP are as follows: (1) performance record of the contractor, (2) safety record, (3) relevant experience in providing comparable services on projects of similar size and scope, (4) overall quality of proposal, and (5) pricing.

The RFP should contain a cost proposal format that allows the bidders to explicitly identify their charges for the deliverables identified in the project. Deliverables must be well defined so that all bidders can respond to the same deliverables thus allowing the Owner to make comparative analyses of the bidder's costs.

4.1.5 Evaluating the Proposal

After the Purchasing Department has reviewed each bidder's proposal to determine that they are complete, the proposals are then forwarded to the department and/or committee members for evaluation. During the period of evaluation and prior to award, possession of proposals and accompanying information is limited to personnel responsible for participating in the evaluation. Any communications with bidders must be approved in advance through the purchasing agent handling the bid process.

Recommendation for award must be in written form and must address how each bidder has met or failed to meet the evaluation criteria stated in the RFP. All areas of non-conformity with any terms, conditions, or listed specifications shall be clearly stated in the evaluation.

To assist those individuals responsible for evaluating proposals, the Purchasing Department creates an evaluation matrix, based upon evaluation factors listed in the RFP. This matrix is a tool to assist those evaluating the proposals.

4.1.6 Awarding the Contract

Based on the evaluation process, a clear choice should present itself. The contract is awarded to the bidder that best meets the evaluation criteria. The Owner will issue a Letter of Intent to the apparent winning bidder and contract negotiations will follow. The Owner and winning bidder will enter into a contract and a Notice to Proceed will be issued.

4.2 CONSTRUCTION MANAGEMENT

Construction Managers are often contracted by the owner to oversee a project's completion. The American Society of Civil Engineers (ASCE) Committee on Construction Management accepts the concept of construction management being performed by the firm responsible for the design. However, construction management is typically conducted by a third party firm not involved in the design or construction of the project.

4.2.1 Construction Manager – TVA Employee

The role of the construction manager is solely dependent on the needs and preferences of the owner. Comprehensive construction managers provide a wide range of services and can be involved in both the design and construction phases of a project. In general, a construction manager provides leadership to the construction team, and coordinates between the owner, engineer, and contractor to plan and oversee the completion of a project. Responsibilities of the construction manager may include:

- Performing constructability analysis and reviews of design submittals and contract documents during the design phase of the project.
- Bid opening and evaluation, and assistance in contractor selection.
- Managing the project budget for the owner.
- Monitoring construction progress and maintaining the project schedule.
- Advising on and coordinating the procurement of materials and equipment.
- Coordinating between the owner, engineer, and contractor to resolve design and construction issues.
- Providing general construction oversight to monitor conformity with construction requirements.
- Contract administration.
- Senior site representative leading progress meetings.
- Acting as a day to day liaison between the Owner, Construction Quality Assurance (CQA) Consultant, and the Contractor
- Interpreting construction plans, specifications, and contracts.
- Overseeing day to day activities and generating progress reports.
- Maintaining the logs, data, files, and correspondence for the field records.

4.2.2 Resident Engineer – TVA Employee / Third Party

The CQA Resident Engineer acts as the engineering site representative for the inspection of contractor construction activities. The CQA Resident Engineer is generally responsible for:

- Planning, organizing, and executing resident engineering activities.
- Review submittals for compliance with engineering design.
- Coordinating between the Owner, Engineer, and Contractor to resolve design issues.
- Coordinating responses to RFI's and other technical issues with design engineers.
- Providing engineering oversight and assuring compliance with the engineered design.

4.3 CQA CONSULTANT – THIRD PARTY

The CQA Consultant is responsible for making observations and performing field tests to ensure that a facility is constructed in accordance with the applicable plans, and specifications and QA/QC Plan. The following section provides a description of the typical CQA Consultant team, including each member's roles and responsibilities.

4.3.1 Certifying Engineer

The CQA Certifying Engineer is responsible for certifying to the Owner and the permitting agency that the facility has been constructed in accordance with the plans, drawings, and the approved CQA Plan. The certifying engineer serves as the Professional Engineer for the project and properly certifies the as-built construction certification report.

4.3.2 Project Engineer

The CQA Project Engineer is responsible for providing engineering and technical support to the field CQA team throughout the construction process. The Project Engineer works closely with the Construction Manager to assist with calculations and complete take-offs in support of as-built quantities for payment. The Project Engineer also responds to contractor RFIs, reviews and maintains QA/QC data and coordinates all supplementary laboratory testing of geosynthetics and soils.

4.3.3 Field Technicians

Field Technicians provide general inspection of materials, equipment, and workmanship under the direction of the CQA Resident Engineer. Specific duties include conducting in-situ nuclear density testing and in-place geosynthetic testing, field testing and verifying compliance with standards. Field technicians are also responsible for maintaining testing data logs and daily reports.

4.3.4 Scheduler / Administrative Personnel

The scheduler / administrator is responsible for file management, invoicing and billing, and maintaining the schedule. The scheduler assembles documentation from the project team and maintains the files. The scheduler is responsible for reviewing and incorporating monthly invoices into tracking forms, and issuing payments for services and materials.

4.3.5 Soils / Geosynthetics Laboratory

Soils and Geosynthetic Laboratories are responsible for performing specific tests on materials submitted for testing. The laboratories are responsible for ensuring that tests are performed in accordance with applicable standards, following internal QC procedures, maintaining chain-of-custody records, and accurately reporting data. The testing lab should be accredited. For geosynthetic material testing, such an accreditation is available through the Geosynthetic Accreditation Institute Laboratory Accreditation Program (GAI-LAP).

4.4 CONSTRUCTION DOCUMENTATION PREPARATION

Definition

A Construction Certification Report (Certification Report) is a report that documents construction activities and provides record of a project's completion in accordance with applicable design drawings, specifications, and CQA Plan.

Minimum Standards

The minimum regulatory requirements for providing construction certification reports are outlined below:

Alabama: There are no specific requirements related to the preparation or submittal of construction certification documents in Alabama.

Kentucky: As stated in 401 KAR 45:030 Section 9(11), prior to receiving a construction/operation permit from the Kentucky DEP, a certification must be submitted by a registered engineer that the liner system, if required, and other features have been constructed in accordance with the approved plans a specifications.

Tennessee: Rule 1200-1-7-.04(1)(c) requires that a registered engineer must inspect the construction of any Class I, II, III, or IV disposal facility, but does not appear to require the submittal of construction inspection documentation. However, the requirement to submit construction QA/QC documentation may be a specific condition of the TDEC permit.

Depending on the nature and scope of the project, the Construction Certification Report may need to be submitted to the governing regulatory agency for review. The governing regulatory agency should be notified during the design phase of all construction projects to determine what, if any, construction documentation is required to be submitted for approval.

Selected Standard

It is recommended that a Construction Certification Report be prepared by the CQA Consultant for all major construction activities. At a minimum, the Certification Report shall include the following elements:

- Introduction: An introduction and description of the construction project, including tasks to be completed, a timeline of construction activities, and any applicable permits authorizing the construction activity.

- Personnel: A listing of all personnel associated with the construction, including TVA Construction Managers, Resident Engineers, CQA Consultant, and all Contractors associated with the construction.

- Alterations to the Design: Should the design be modified during construction activities, a description of each specific design alteration shall be discussed.

- Impacts to Construction: A general discussion of impacts to the construction project, such as any weather delays or mechanical failure of construction equipment shall be included.

- Construction Narrative: The construction narrative provides the main body of the Certification Report. A narrative description of each construction activity shall be included to describe the construction activities performed such that an outside party could review and adequately understand the construction. The narrative shall include, at a minimum, the duration and dates of completion for each construction activity and should reference all CQA testing and documentation procedures performed as part of each construction activity.

- Daily Reports: The CQA Consultant shall complete daily reports of construction activities to document the construction and aid in the completion of the Certification Report.

- Photo Logs: In addition to daily reports, a log of photographs shall be maintained by the CQA Consultant and included in the Certification Report.

- CQA Test Results: The results of all CQA testing required in the CQA Plan shall be included in the Certification Report.

- Other CQA Documentation: Each construction activity may require the completion of specific CQA documentation. Examples of such documentation include subgrade acceptance forms and geosynthetic seam and repair logs. Required CQA documentation shall be described in the CQA Plan and completed documentation shall be included in the Certification Report to verify that the construction has been completed in accordance with the CQA Plan.

- Record (As-Built) Drawings: A package of Record Drawings shall be completed for each construction project. Typically, the record drawings include as-built surveys for each construction milestone. The CQA Plan shall provide specific instruction related to the record surveys required, and the specific elements to be included in each record drawing.

  Record surveys are to be completed by the Contractor and provided to TVA and the CQA Consultant to verify that the construction milestone has been completed in accordance with the applicable Design Drawings and Specifications. For example, in the construction of a new facility, a record survey of the excavation or subgrade may be required prior to the construction of the facility liner system. Once the record survey has been completed and submitted to the CQA Consultant, the Certifying Engineer will review the survey and either accept the record survey, or reject the record survey and provide guidance on the remedies or alterations required. The construction milestone should be considered complete only after the CQA Consultant provides approval of the record survey. Record Survey data will be submitted to TVA and documented in the TVA surveying system. TVA reserves the right to perform the Record Survey in lieu of the contractor.

In addition to record surveys, the Resident Engineer shall maintain a set of the Design Drawings and make note of any changes to the design. These as-built notations shall be combined with the record surveys by the CQA Consultant into a final package of Record Drawings.

- Notarized Statement of Accuracy: The Certification Report shall include a statement that the documentation provided in the Certification Report is true and accurate. The statement shall be notarized and signed and by the Certifying Engineer and TVA management personnel.

5.1 CLOSURE REQUIREMENTS

This section identifies regulatory requirements for closure of dry ash landfills and wet ash impoundments in each of the three states in which TVA has facilities.

Definitions

Alabama: In Alabama, closure is the process by which a landfill unit permanently ceases to accept waste, to include those actions taken by the permittee or owner of the facility to prepare the site for post-closure monitoring and maintenance or to make it suitable for other uses.

Kentucky: In Kentucky, closure means the time at which a waste treatment, storage, or disposal facility permanently ceases to accept wastes, and includes those actions taken by the owner or operator of the facility to prepare the site for post-closure monitoring and maintenance or to make it suitable for other uses (KRS 224.01-010(4).

Tennessee: In Tennessee, closure means taking the actions at the termination of a disposal operation that are necessary to finally close the disposal facility or disposal facility parcel.

5.1.1 Dry Ash Landfills

Alabama: The closure requirements for a permitted landfill facility are contained in the ADEM administrative code §335-13-4-.20. The closure plan must be submitted as part of the permit application to the Department. This plan must address specific elements of the cover system, which for municipal and industrial waste landfills includes an infiltration layer equal to the permeability of the bottom liner system or 1 X 10^{-5} cm/sec, whichever is less, and an erosion layer on minimum of 6 inches of earthen material capable of sustaining native plant growth. For permitted special waste landfills, the cover system must be constructed in a manner deemed necessary by the Department on a case by case basis. The length of time necessary for post-closure care is established by the Department.

Kentucky: The closure requirements for a special waste landfill are contained in 401 KAR 45:110 Section 5. As part of the initial permit application, the applicant must submit a closure plan for approval that specifies the design of the final cover including functionality, erodibility, stability, etc. The closure plan design shall comply with 401 KAR 30:031 performance standards including, but not limited to, no discharge of pollutants into the waters of the state no release to underground drinking water source beyond the point of compliance in excess of maximum contaminant levels (MCL's).

Tennessee: The closure requirements for a permitted landfill facility are contained in Tennessee Division of Solid Waste Management Rule 1200-1-7-.04. The closure plan must be submitted as part of the permit application to the Department. This plan must address specific elements of the cover system, which for Class II landfills includes a 24 inch compacted soil layer with a permeability equal to that of the bottom liner system or 1 X 10^{-7} cm/sec, whichever is less, and a vegetative layer of a minimum thickness of 12 inches. By regulation the agency can approve an alternate cover if it can be demonstrated to provide equivalent or superior performance. The length of time necessary for post-closure care is 30 years unless alternate period is established by the Department.

Federal: Tennessee, Alabama and Kentucky have developed and implemented a Subtitle D permit program and therefore, provided USEPA does not determine in the future that their programs are inadequate; there will be no additional federal requirements.

5.1.2 Wet Ash Ponds (Impoundments)

According to the TVA Dam Safety Program, state dam safety regulations do not apply. Rather, the TVA Dam Safety Program follows Federal programs in these regards. The following sections for each state are therefore provided for reference only.

Alabama: Although there are no regulations that specifically address the closure of wastewater impoundments, ADEM has promulgated guidance. This document, titled The ADEM Water Division – Industrial Section provides Closure Guidelines for Industrial Wastewater Impoundments (Rev. 03/00), requires the submittal of a site specific closure plan. This plan must be certified by a professional engineer if it involves the practice of engineering and certified by a professional geologist if it involves the public practice of geology. The only regulatory citation in the guidelines has to do with the cap design meeting the requirements of ADEM Solid Waste Rule 335-13-4-.20(2). Alabama currently has no dam safety legislation or formal dam safety program. Currently the Alabama Dam Security and Safety Initiative has been created to establish dam safety laws and regulations in Alabama.

Kentucky: Kentucky does not have any specific regulations relative to closure of nonhazardous wastewater impoundments nor does it provide formal closure and post-closure guidelines for impoundments. The Kentucky Water Quality Control Act prohibits the discharge of any substance into the waters of the state that could cause damages or pollution to such waters. Therefore, each impoundment must be properly closed to eliminate discharge of pollutant to both the surface water and ground water. Although not specifically addressed in the Groundwater Protection Plan required by 401 KAR 5:037, it is recommended that this plan address proper closure of all wastewater impoundments to ensure protection of all current and future uses of groundwater and to prevent groundwater pollution. Both the Kentucky Division of Waste Management and Division of Water should be notified of intent to close an impoundment in order to get approval of proposed procedure.

Tennessee: Tennessee does not have any specific regulations relative to closure of nonhazardous wastewater impoundments nor does it provide formal closure and post-closure guidelines for impoundments. The Tennessee Water Quality Control Act prohibits the discharge of any substance into the waters of the state that could cause damages or pollution to such waters. Therefore, each impoundment must be properly closed to eliminate discharge of pollutant to both the surface water and ground water. Both the Tennessee Division of Solid Waste and Division of Water Pollution Control should be notified of intent to close an impoundment to obtain approval of proposed procedure.

Federal**:** There are no specific federal requirements for wastewater impoundment enclosures.

6.1 POST-CLOSURE REQUIREMENTS

This section identifies state and federal regulatory requirements for post-closure for each type of facility.

Definition

Post-closure requirements are requirements that must be met following the closure of a landfill or an impoundment.

6.1.1 Dry Ash Landfills

Minimum Standards

Alabama: Code Section 335-13-4-.20(3) – For municipal and industrial landfills, the operator must maintain post-closure care for a minimum 30 years; however, length may be decreased by the Department if owner/operator can demonstrate that a shorter post-closure period can be justified [335-13-4-.20(3) (b)]. For CCP, which is a nonregulated waste, this period, would be set by the department at the time of a permit application, depending on the type of permit applied for.

Kentucky: Per 401 KAR 45:110 Section 5(3), the landfill operator must maintain post-closure for a minimum 5 years.

Tennessee**:** Rule 1200-1-7-.04(8) post-closure care requirements 8(d) & (e) is for 30 years for Class I and II landfills, 2 years for Class III and IV landfills. CCP landfills are Class II landfills and therefore require 30 years of post-closure care.

Federal**:** Tennessee, Alabama and Kentucky have developed and implemented a Subtitle D permit program and therefore, provided EPA does not determine in the future that their programs are inadequate; there will be no additional federal requirements.

6.1.2 Wet Ash Impoundments

According to the TVA Dam Safety Program, state dam safety regulations do not apply. Rather, the TVA Dam Safety Program follows Federal programs in these regards. The following sections for each state are therefore provided for reference only.

Minimum Standards

Alabama: The ADEM Water Division – Industrial Section provides Closure Guidelines for Industrial Wastewater Impoundments (Rev. 03/00). There are no post-closure guidelines.

Kentucky: No Post Closure Care rules are provided in Kentucky. Closure and Post Closure Care Rules may be adapted from 401 KAR 45:110 Section 5(3) – See 2.4.1.2.

Tennessee: No Post Closure Care rules are provided in Tennessee. Closure and Post Closure Care Rules may be adapted from Division of Solid Waste Rule for Landfills or NRCS Rules for waste impoundments, See 2.4.1.3

Federal**:** Tennessee, Alabama and Kentucky have developed and implemented a Subtitle D permit program and therefore, there will be no additional federal requirements.

Industrial and commercial facilities that store waste materials should prepare a response or contingency plan to respond to emergencies involving the accidental release of these substances into the environment. Response plans should identify potential hazards, develop systems for preventing accidents, provide appropriate mechanisms for minimizing risk, loss and damage resulting from such incidents and provide an incident management structure to guide response activities.

In this section, the Document details the steps necessary to identify potential emergency situations and verify that a system of emergency procedures and directions, and general standard responses for possible emergency situations, are in place prior to facility operation, and that those procedures are sufficient to meet applicable regulatory standards.

7.1 EMERGENCY OPERATIONS AND CONTIGENCIES

Definitions

In the context of this industry involving both CCP dry disposal facilities (landfills) and wet impoundments (ponds, wet stacks), an emergency is any unexpected or accidental, serious occurrence or situation involving the release or imminent release of CCPs that could result in adverse effects on human health or the environment that requires immediate action. Items to be considered will include natural disasters (hurricanes, tornadoes, floods, earthquakes, etc.); operational failures (power outages, equipment breakdown, etc.); and, accidents (fire, vehicular or machinery accidents, etc.). It may also be necessary to consider terrorist attacks.

For the purpose of this Document, risk assessment means identifying those components of CCP landfills and impoundments that could lead to operational conditions or emergencies that may need immediate attention. Operational risk can be managed by development of administrative and operational programs designed to reduce the risk of these emergencies. Such programs include design standards discussed previously in this document. However, in this section, the applicable information is intended for the operational life of the facilities and can include standard operating procedures, equipment and facility preventive maintenance, and employee training, all in the context of emergency planning.

A contingency is an uncertainty, such as when things are left to chance, which can lead to accidents and otherwise preventable emergency situations. In order to reduce the risks associated with CCP landfills and impoundments and to avoid emergencies to the extent possible, facilities are designed, constructed and operated in accordance with strict guidelines that are imposed as a result of regulation, an engineer's recommendations, or the owner's preferences, typically whichever is most protective. Because emergencies do occur and require immediate attention when they happen, an Emergency Operations and Contingency Planning document, also know as an Emergency Action Plan (EAP) is recommended to adequately plan for emergency situations and to train employees to address them before they occur.

Minimum Standards

Alabama: In Alabama, CCPs are specifically exempted from the definition of "solid waste" and "industrial waste." Therefore, no specific requirements for CCPs are presented in this section.

Alabama currently does not have any dam safety regulations. However, regulations are in the process of being developed.

Kentucky: In Kentucky, CCPs are managed as special wastes with limited requirements with respect to specific design, construction and/or operational requirements. Minimum standards for solid waste facilities are given in 401 KAR Chapter 48, which defines contingency plan. "Contingency plan means a document setting out an organized, planned and coordinated course of action to be followed in the event of a fire, explosion, or release of waste or waste constituents into the environment which has the potential for endangering human health and the environment. Financial planning to identify resources for initiation of such action is a part of contingency plan development. Kentucky 401 KAR 48.070, design requirements for contained landfills includes a Safety and Communication Plan – The landfill safety and communication plan shall contain:

- Safe operating and maintenance procedures for heavy equipment;
- Procedures to protect employees in a manner complying with the Kentucky Labor Cabinet OSHA requirements;
- A description of equipment to achieve emergency communication. At a minimum, the applicant shall specify an on-site telephone or a two-way radio connection to an off-site telephone. The radio base station shall be monitored during landfill operations.
- A fire fighting contingency plan containing a topographic map denoting the location of the landfill, a site map and an emergency contact. The operator shall mail a copy of the safety and communications plan to the local fire chief. The plan shall include the location of fire fighting water sources, roads, and major site features. Note: the potential for fire at a contained landfill, which can include municipal solid waste (with large percentages of flammable wastes such as paper and plastic) or flammable industrial wastes is greater than for a special waste CCP facility and, as such, the requirement for a fire fighting contingency plan is made.

Kentucky regulates dams and dam safety in the state via 401 KAR 4:030, and provides design requirements in Division of Water Engineering Memorandum No. 5 (2-1-75). There are no specifics provided regarding contingency planning.

Tennessee: In Tennessee, management of CCPs is specifically regulated as presented in TDEC 1200-1-7-.04. Section two refers to General Facility Standards, which include:

- Overall Performance Standard - The facility must be located, designed, constructed, operated, maintained, closed, and cared for after closure in such a manner as to minimize to the extent practicable:
  - The potential for explosions or uncontrolled fires.
  - The potential for releases of solid wastes, solid waste constituents, or other potentially harmful materials to the environment except in a manner authorized by state and local

air pollution control, water pollution control, and/or waste management control agencies.

- The exposure of the public to potential health and safety hazards through uncontrolled or unauthorized public access.

- Fire Safety:
  - The facility must have, on-site and continuously available, properly maintained fire suppression equipment in sufficient quantities to control accidental surface fires that may occur, or arrangements must be made with the local fire protection agency to provide immediate fire fighting services when needed.
- Communications - The facility must have operating and effective communications devices (e.g., telephone, 2-way radio) capable of summoning emergency assistance on-site and available to facility personnel at all times the facility is in operation.

Tennessee provides its dam safety regulations in Chapter 1200-5-7, “Rules and Regulations Applied to the Safe Dams Act of 1973”. They include:

- Inspection Process
  - State - The public safety and welfare requiring it, the commissioner shall conduct a program of regular inspections of dams, reservoirs, and downstream floodplains within the state. The frequency of such inspections shall be as determined by the commissioner, who may establish different inspection intervals for dams based on their hazard categories. An inspection frequency table is not in the laws or regulations, but a permit cannot be issued for more than five years.
  - Owner - Owner inspections are not specified in the rules and laws. Also, it is not mentioned if owner inspections are required to be conducted by an engineer.

- Emergencies

  The owner is responsible for taking emergency action when necessary but, when the owner fails to take satisfactory action where, in the judgment of the commissioner, the danger to life or property will not permit delay, the commissioner shall request that a state of emergency be declared by the governor, and upon such declaration, shall take such action as he deems necessary to render the dam or reservoir safe.

  The regulations require that new dams with a high-hazard potential rating submit EAPs to the commissioner. The regulations list what should be included in the EAP (1200-5-7-.10).

Selected Design Standard

Because all CCP identified dams in the TVA operations can be addressed by the comprehensive Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners (FEMA 64) guidelines, which encourages strict safety standards in the practices and procedures employed by federal agencies or required of dam owners regulated by the federal agencies, this guide shall be used for EAP planning purposes for both types of TVA CCP disposal and impoundment facilities. The Guidelines address management practices and procedures, but do not attempt to establish technical standards. They provide the most complete and authoritative statement available of the desired management practices for promoting dam safety and the welfare of the public. The individual facility EAPs must also address any specific requirements of state guidance, such as those set forth in Tennessee as discussed above.

TVA facilities will also prepare and have readily available contingency plans for operational issues. Contingency plans should include protocol to temporarily replace necessary equipment, such as pumps, generators, loaders, etc. to ensure operations can continue without disruption in the event of unexpected events that could affect plant operations. Alternate disposal management planning shall also be included to effectively redirect the CCP materials to an alternate site/location in the event the current disposal plan can no longer operate (e.g., alternate landfill locations, etc.). Planning should include a written plan summarizing possible events that may warrant a shift to a contingency plan, a list and description of alternate disposal options, potential costs and driving factors in the decision process, and any general contact information and/or contract agreements.

FEMA 64 contains guidelines for preparing or revising EAPs for all high and significant hazard potential dams. These guidelines shall also be applied to landfills. Ownership and development of the floodplain downstream from dams and downslope of landfills varies; therefore, the potential for damage to the environment or loss of life as a result of failure or operation of a dam or landfill will also vary. Every EAP must be tailored to site-specific conditions**.**

EAPs generally contain six basic elements described in the next section, including:

- Notification Flowchart (Information provided by TVA appears to list many of the emergency contacts for each facility.)
- Emergency Detection, Evaluation, and Classification
- Responsibilities
- Preparedness
- Inundation Maps
- Appendices

All of these elements should be included in a complete EAP. TVA shall be responsible for the development of the EAP, specific to each facility. However, the development or revision of an EAP shall be done in coordination with those having emergency management responsibilities at the state and local levels as well as familiarity with the facility. Therefore, for new facilities, comprehensive EAPs shall be prepared as part of the permitting process so that they are complete and available at the time of operation. Emergency management agencies will use the information in a dam owner's EAP to facilitate the implementation of their responsibilities. State and local emergency management authorities will generally have some type of plan in place, either a Local Emergency Operations Plan or a Warning and Evacuation Plan.

The Six Basic Elements of an EAP

The requirements of these elements are discussed in detail in Chapter II of FEMA 64, which presents a recommended format for uniformity among EAPs. Although intended for use with dams, this document adapts the FEMA EAP format for use at landfills.

1. Notification Flowchart. A notification flowchart shows who is to be notified, by whom, and in what priority. The information on the notification flowchart is necessary for the timely notification of persons responsible for taking emergency actions.

2. Emergency Detection, Evaluation, and Classification. Early detection and evaluation of the situation(s) or triggering event(s) that initiate or require an emergency action are crucial. The establishment of procedures for reliable and **timely** classification of an emergency situation is imperative to ensure that the appropriate course of action is taken based on the urgency of the situation. It is better to activate the EAP while confirming the extent of the emergency than to wait for the emergency to occur.

3. Responsibilities. A determination of responsibility for EAP-related tasks must be made during the development of the plan. Owners (such as TVA) are responsible for developing, maintaining, and implementing the EAP. State and local emergency management officials having statutory obligation are responsible for warning and evacuation within affected areas of dams. The EAP must clearly specify the Owner's responsibilities to ensure effective, timely action is taken should an emergency occur at the dam. The EAP must be site-specific because conditions at the dam and downstream of all dams are different.

> Landfills: With landfills, state and local emergency management officials have little or no obligation to address most occurrences associated with landfills. The most prevalent emergency is fire; however, landfill fires are most commonly associated with municipal solid wastes or industrial waste facilities and the need for involvement by local fire officials at a TVA facility is unlikely.

4. Preparedness. Preparedness actions are taken to moderate or alleviate the effects of a failure or operational release and to facilitate response to emergencies. This section identifies actions to be taken before any emergency.

5. Inundation Maps. An inundation map should delineate the areas that would be flooded as a result of a dam failure. Inundation maps are used both by the dam owner and emergency management officials to facilitate timely notification and evacuation of areas affected by a dam failure or flood condition. These maps greatly facilitate notification by graphically displaying flooded areas and showing travel times for wave front and flood peaks at critical locations. Mapping of adjacent properties and knowledge of neighbors may be appropriate for some of the TVA dry disposal facilities as well. Similarly, the possible impact to adjacent areas from a landfill emergency shall be defined in the EAP.

> Landfills: Mapping of adjacent properties and knowledge of neighbors may be appropriate for some of the TVA dry disposal facilities as well. Similarly, the

possible impact to adjacent areas from a landfill emergency shall be defined in the EAP.

6. Appendices. The contain information that supports and supplements the material used in the development and maintenance of the EAP.

General Procedures to Address Potential Emergencies

In the event a potential emergency is identified (boil, slough, seep, fire, slope failure, etc.), the following general procedures shall be followed:

- Notify the designated shift/ unit supervisor.

- Make an initial assessment as to the severity of the potential emergency and address immediately if possible (i.e. use fire extinguisher to extinguish small, contained fire). For all other situations that cannot be addressed immediately by plant personnel, make appropriate contacts to those on the EAP contact list
  - 911/ Police/ Fire for immediate danger situations;
  - Qualified geotechnical engineer for identified earthen or otherwise man-made impoundments and fills (slope failure, seeps, etc.); and,
  - Appropriate plant personnel for plant and personnel related conditions (e.g. a broken weld on a catwalk should be cordoned off until fixed and approved by plant maintenance).

- Those specialists contacted in certain situations, such as the geotechnical engineer brought in to evaluate a slope failure, may also raise the level of awareness/ severity as necessary, and thereby contact local officials to evacuate in extreme cases, or to otherwise address situations as may be necessary.

- In the vast majority of these cases, the more likely scenario after visit by the engineer will include
  - Fully describe and document the conditions observed (size, shape, severity, volume, color, date, time, time elapsed since first noticed, condition stable/ worsening, etc.)
  - Interview appropriate plant personnel
  - Obtain relevant data (water levels in ponds, adjacent wells/ piezometers, survey data)
  - Make recommendations and implement additional data gathering needs (borings, wells, document review, calculations, drawings, engineering analyses, etc.)
  - Develop a remedial work plan to address the situation
  - Implement the approved remedial plan

The following sections address specific triggering events or emergencies that should be addressed in Section 2 of the EAP: Emergency Detection, Evaluation, and Classification. If local conditions warrant, other potential triggering events should be identified.

7.1.1 Fire

Fires are common at some landfill sites from a variety of sources. Although not anticipated to be common at TVA facilities due to the type of waste products being disposed, fires are still a possibility, especially when considering heavy equipment use and probable fuel storage. Whatever the cause, it is important that those involved stay calm and have an accessible plan for managing the fire, personnel and neighbors.

Identifying an appropriate fire suppression source (i.e. water, fire extinguishers, etc.) is one of the most critical components of an EAP to address fires. TVA shall identify and coordinate with the respective local fire departments to develop a plan for managing fires, establish evacuation protocols, and to train all pertinent personnel.

7.1.2 Power Outage

A power outage at a facility may result from inclement weather, lightning strikes, capacity or grid problems, or other reasons. Without power, any facility that uses conveyance systems to transport waste may be required to employ alternative power sources or transport wastes for a specified period of time by truck.

At all facilities with non-gravity drained leachate or stormwater systems, the transfer of leachate and stormwater to the appropriate storage or treatment and disposal facilities cannot occur in the event of a power outage unless alternative power sources are available. Depending on the period of power outage, alternative means of power or of liquid transfer may be required. Such contingency plans shall be specified in the EAP.

7.1.3 Leachate Outbreaks

Leachate outbreaks may occur from exterior landfill slopes during operations and even after closure. When an outbreak occurs, the proper steps should be taken to mitigate the situation. This includes the following steps:

- Contain and properly mange the leachate outbreak
- Minimize, control, or eliminate the conditions that are contributing to additional leachate production
- Collect and transport leachate to the appropriate containment or disposal facility

In some instances, the state or local regulatory official will also need to be notified. The appropriate steps for managing a leachate outbreak shall be outlined in the EAP.

7.1.4 Inclement Weather

Inclement weather can occur throughout the calendar year. It may impede operations at TVA facilities and create unsafe conditions. CCP landfills and disposal impoundments are designed to be in continuous operation. Provisions should be in place to address in the EAP for inclement weather conditions including methods to allow for the receipt and compaction of incoming CCPs and/or temporary storage, as appropriate. Access roads and facilities that are part of the operations should be maintained during inclement weather. If weather creates a situation in which compliance is compromised, the operator may need to contact regulatory officials.

7.1.5 Spills and Releases

This section of the EAP should outline operational methods to manage an accidental spill or release, and the location, capability, and limitations of equipment to be used to contain or remediate the spill. The Response Plan should not provide detailed descriptions, but refer to separate standard operating procedures or detailed technical documents need to specify which plans the reader should be accessing that apply to spill response operations.

The plan should list available on-site and off-site equipment, how it is to be accessed and who has the responsibility for it. The plan should also describe how people and equipment will get to the site, how they will be supported during the crisis, how security and safety will be maintained and how crews will be supplied for the duration of the incident.

7.1.6 Local Transportation Issues

For any site that will require over-the-road transport of CCP materials or leachate for disposal, a plan shall be developed for secondary carriers in the case of equipment breakdown, contractor failure to perform, work stoppages, etc. Also, the plan shall address alternate routes for transport in case of route closures due to reduced load limits on roadways, storm/ washouts of roadways, regular highway maintenance, etc.

On-site transportation issues shall be addressed by the Operator and will include provisions to rent more equipment from outside vendors as the need may arise. All onsite access roads and issues associated with them are the responsibility of TVA or their designated operator, so route issues will be addressed on an as-needed basis.

7.1.7 Other Emergencies

Whether classified as other emergencies or rare operational issues that need to be addressed quickly, there are several other potential problems that may need to be addressed in the individual plant EAPs.

In landfills, waste settlement and/or slope failure of the waste and/ or interior sideslopes, or final existing cover soils, can occur during construction, during operation, or after closure. Waste settlement or slope failure may expose waste and require timely, if not emergency, repairs. In rare instances, large displacement failures may also jeopardize operations or human health and the environment. Settlement in a CCP landfill should be minimal if waste is properly placed and compacted due to the uniformity of CCPs, but may be caused by consolidation of waste or foundation materials under the weight of waste material and cap. Possible consequences of settlement include instability in the waste or cover soil, which can damage the cap, and disruption of storm water drainage.

The weight of the new cap can be significant enough to cause additional waste settlement and compaction. The effect of this additional weight may initiate differential settlement across the cap, thus compromising the integrity of the cap, or create stability problems such as slippage failures in the waste and/or existing cover system. Differential settlement occurs when one area of waste settles more readily than another because of differences in moisture content, waste compaction, or waste composition. Settlement, and especially differential settlement, may create cracks in the cap and allow rainwater to reach the waste. Changes in the topography of the landfill because of settlement may also create areas on the cap surface where rainwater can pond. These conditions, if left unchecked, can lead to bigger issues of slope instability and failure, and leachate generation.

The following list provides other typical types of landfill facility emergencies requiring emergency actions be taken:

- Slope Failures and Settlement

  Slope failures, cracks or sloughing in constructed earthen slopes should be fixed immediately as part of construction. The facility design, construction specifications, construction procedures, construction oversight, or all of these possible reasons should be investigated to determine the cause of the failure and to prevent re-occurrence of slope failures during construction. The observance and notation of these types of failures resides with the construction contractor and CQA oversight firm.

  During operation, slope failures or ponding water should be addressed immediately as part of operations by regrading waste to eliminate ponding and to repair any failed waste slopes. Operational procedures, grade control, compaction control, moisture control, and record-keeping should all be investigated to determine the cause of internal waste slope failures or settlement and to prevent any recurrence.

  Although settlement and moreover differential settlement should be minimal in these types of residual waste landfills, any obvious settlement of the CCPs should be addressed as part of operation the landfill to maintain positive surface water drainage. Differential settlement is typically addressed by the addition of more waste (if feasible in an active waste placement area of the landfill) or the by the addition of intermediate or final cover soil, depending on where the settlement occurs. Additional fill should be added to return the grades to the necessary design grades to promote proper drainage.

In above-grade ponds, impoundments or wet stacks, emergency issues may involve the movement of water through the dike (seeps), beneath the dike (boils) or over the dike (overflows) which may lead to significant erosion leading to dike failure. The movement of water, when left unchecked, leads to erosion of the earthen structure until failure occurs. TVA dam safety will be reviewing all the ash disposal impoundments and will decide which will be considered to be dams. Those that are will be brought under the TVA Reservoir Operations, Dam Safety Inspection and Maintenance program. Emergency responses for dams are covered by EAPs administered by that program. For all of these earthen structures, regular inspections will be made to look for specific indications of pending problems. If encountered, the EAPs will identify the contacts to be made and the procedures to be enacted, such as follow.

- Once noted on an inspection form, notation of seeps and boils should require the inspection by a qualified engineer. Depending on the advice of the engineer, measures may be taken to stop or slow the water flow by placement of sandbags or additional earthen material, followed by a period of planned investigation into the cause of the outbreak. Once the cause is determined, an engineered fix can be designed an implemented to stop the flow and reduce the hydrostatic head pressure.

- Overtopping of any impoundment should be prevented through regular inspection procedures however can occur for several reasons (significant storm events, plugged pipes or drains, etc.) The EAP for all impoundments shall provided measures for quickly lowering water levels or redirecting overflows should they occur.

7.2 COMMUNICATION PROCEDURES

During an emergency, effective and reliable electronic communications equipment and procedures are vital. This section of the plan should detail the types of communication equipment to be used by personnel during an emergency response. Since normal means of communication can break down in an emergency, alternative means must be considered. Cellular telephones, public address systems, two-way radios and messengers should be used.

Training and arrangements may be necessary to ensure that telephone services are available for official calls during an emergency and that unauthorized calls will not be placed. Within an Incident Command Post, telephone circuits may quickly become jammed with calls. Direct hot lines that are not available to outside lines may be considered for critical communications. Use of 1-800 numbers for public inquires is another option to manage external calls.

FIGURES

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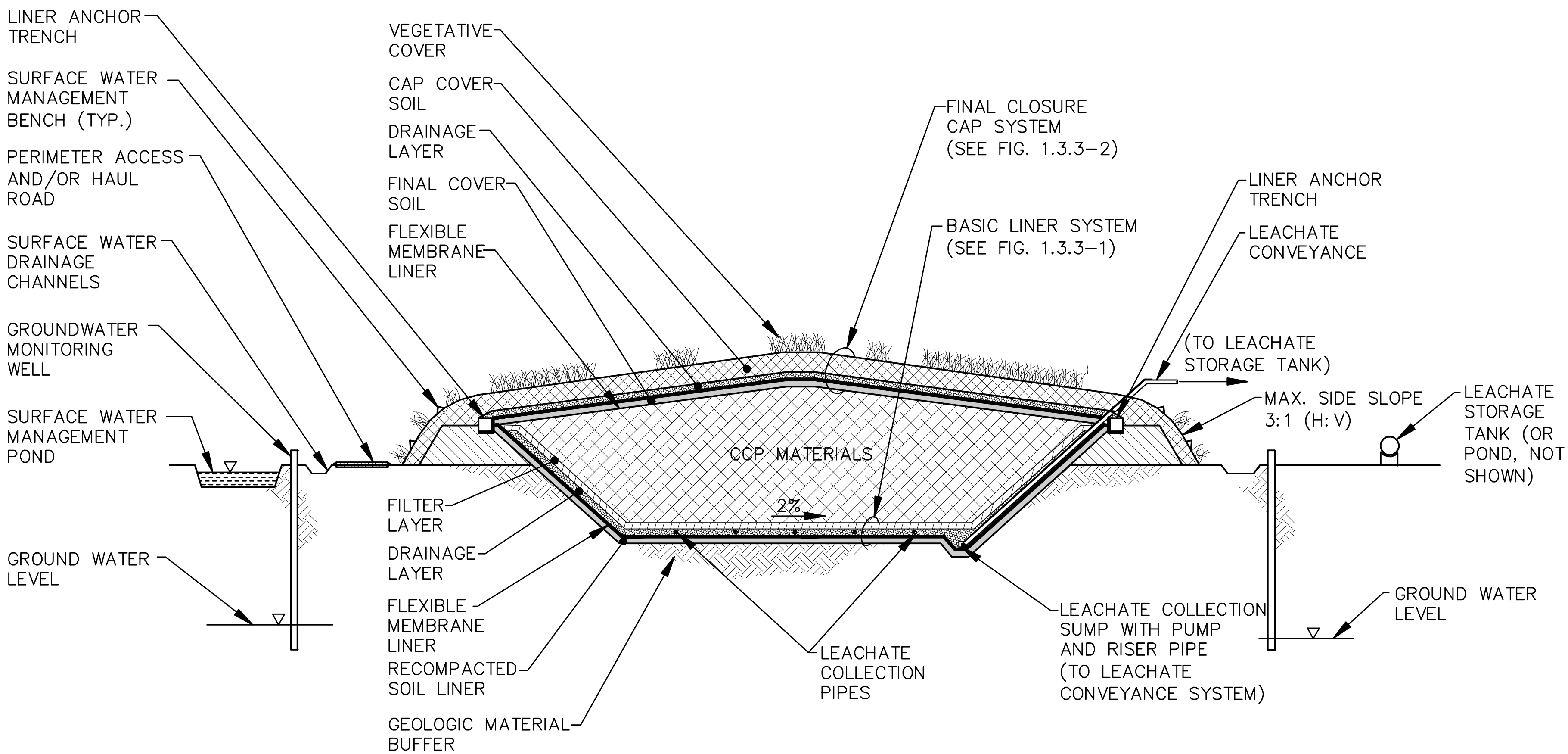

NOTE:
THIS FIGURE ILLUSTRATES A PUMPED LEACHATE EXTRACTION SYSTEM AS OPPOSED TO A GRAVITY FLOW EXTRACTION SYSTEM.

COAL COMBUSTION PRODUCT LANDFILL

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TVA

TVA COAL COMBUSTION PRODUCTS MANAGEMENT PROGRAM
PROGRAMMATIC DOCUMENT - VOL. 2

COAL COMBUSTION PRODUCT LANDFILL TYPICAL CROSS-SECTION

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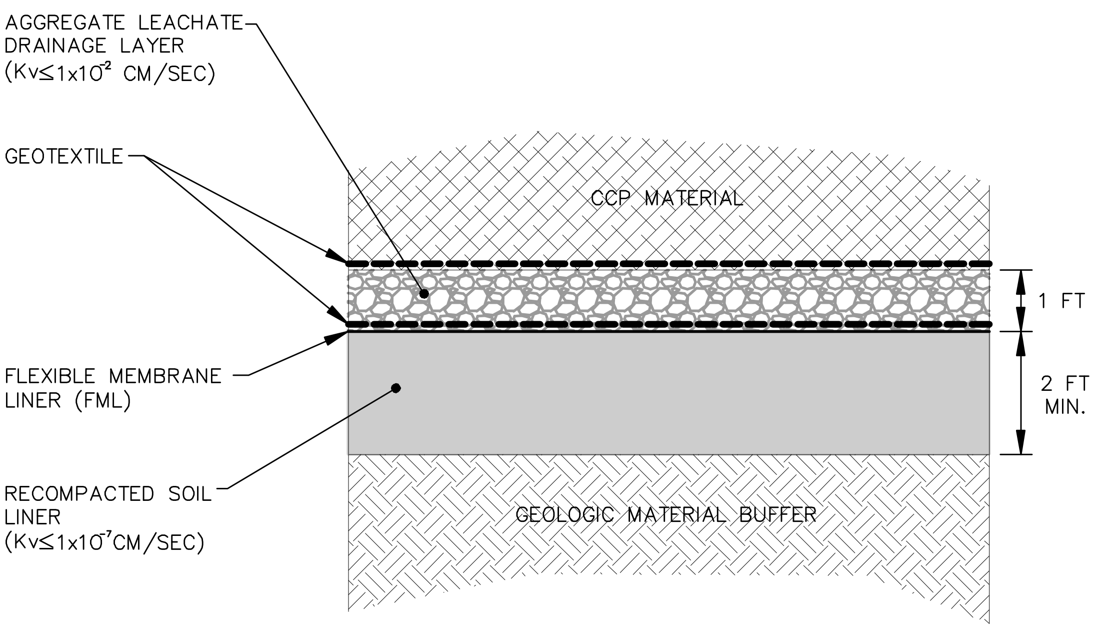

NOTE:
A GEOCOMPOSITE LEACHATE DRAINAGE LAYER MAY BE CONSIDERED AS AN ALTERNATE TO THE AGGREGATE LEACHATE DRAINAGE LAYER.

LINER SYSTEM
NOT TO SCALE

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TVA

TVA COAL COMBUSTION PRODUCTS MANAGEMENT PROGRAM
PROGRAMMATIC DOCUMENT - VOL. 2

LINER SYSTEM TYPICAL CROSS-SECTION

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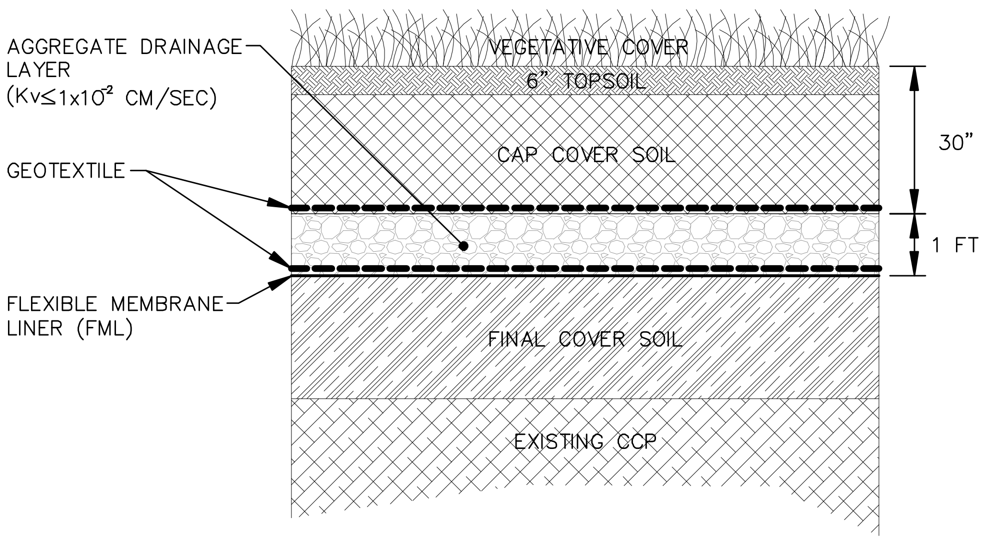

NOTE:
A GEOCOMPOSITE LEACHATE DRAINAGE LAYER MAY BE CONSIDERED AS AN ALTERNATE TO THE AGGREGATE DRAINAGE LAYER.

ALTERNATE CLOSURE CAP SYSTEM
NOT TO SCALE

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TVA

TVA COAL COMBUSTION PRODUCTS MANAGEMENT PROGRAM
PROGRAMMATIC DOCUMENT - VOL. 2

ALTERNATE CLOSURE CAP SYSTEM TYPICAL CROSS-SECTION

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APPENDIX 1

DRAFT, 10/07/09

TVA Ash Impoundment Inventory Sheet

General Information							
Name of Dam:							
Reservoir Name:							
Power Plant Name:							
Street Address:							
City:		State:		Zip:			
Contact Person:		Phone No:					
Location Information							
County:		Latitude Deg.:		Min.:		Sec.:	
Township:		Longitude Deg.:		Min.:		Sec.:	
Stream:							
Nearest Affected Community:							
Community's Distance from Dam (miles):							
USGS Quad:		USGS Basin No.:					
Design/Construction Information							
Designed By:							
Constructed By:							
Year Completed:		Plans Available? Y N		At:			
Failure/Incident/Breach:							
Structure Information							
Purpose:							
Type of Structure:							
Drainage Area (Sq. Miles):		Or (Acres):					
Length of Dam (Ft.)		Upstream Slope (H:V):					
Height of Dam (Ft.)		Downstream Slope (H:V):					
Top Width (Ft.):		Volume of Fill (Cubic Yds.):					

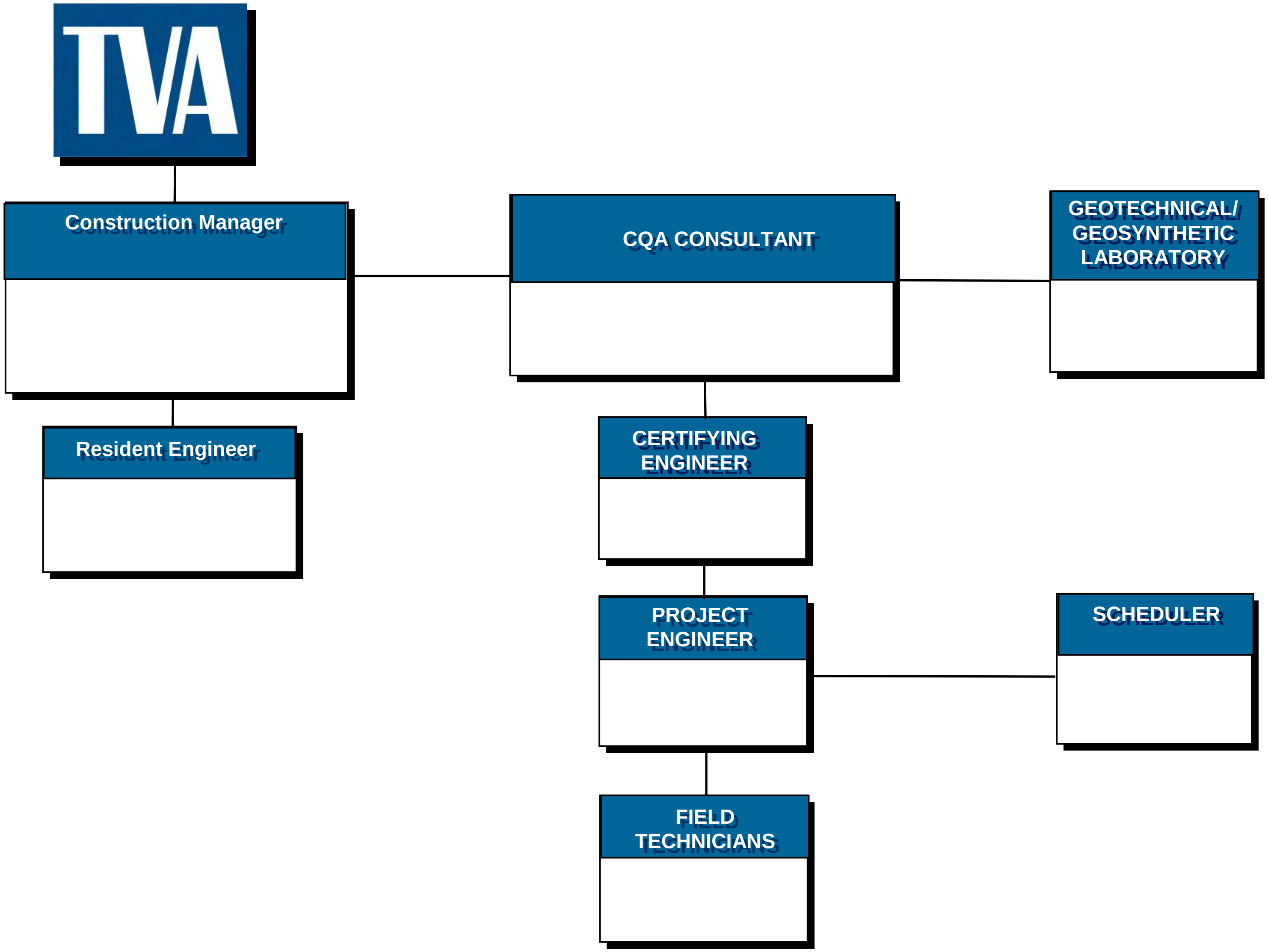
Principal Spillway:					
Emergency Spillway:					
Maximum Spillway Discharge (combined), cfs			Design Flood:		

Dam Reservoir Data:	**Elevation (Ft., MSL)**	**Area, (Acres):**	**Storage, (Acre-Ft.)**
Top of Dam:			
Emergency Spillway:			
Principal Spillway:			
Streambed at D/S Toe			

Notes & Comments

APPENDIX 2

Construction Site Organization Chart



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APPENDIX 3

Note: All regulations/standards are current as of the date of the Document, unless otherwise noted.

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ADEM Admin. Code r. 335-13-4.

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APPENDIX A

Document 15

Seepage Action Plan (SAP), Colbert Fossil Plant, Tuscumbia, Alabama, Stantec Consulting Services, Inc. June 25, 2010

Seepage Action Plan (SAP)

Colbert Fossil Plant
Tuscumbia, Alabama

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Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

June 25, 2010

Seepage Action Plan (SAP)

Colbert Fossil Plant
Tuscumbia, Alabama

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Seepage Action Plan (SAP)

Colbert Fossil Plant
Tuscumbia, Alabama

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Seepage Action Plan (SAP)

Colbert Fossil Plant
Tuscumbia, Alabama

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 Ash Pond 4. 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.

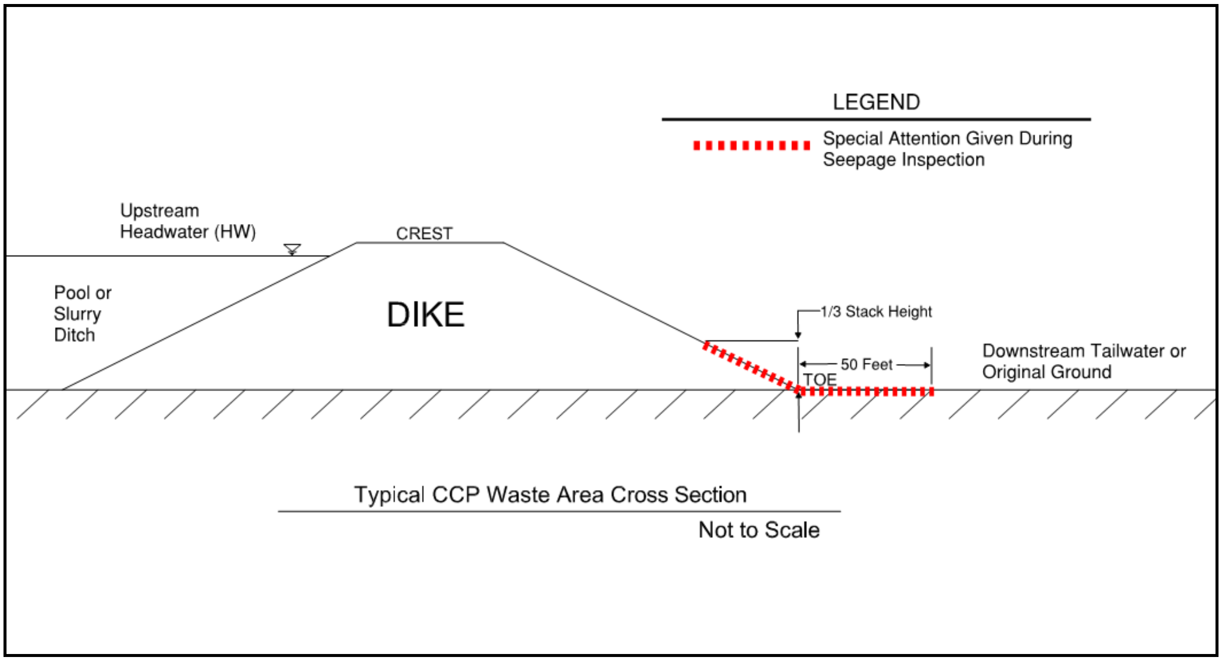


Figure 1. Seepage Inspection Location

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 Colbert Fossil Plant serve as an impoundment for ash slurry, it is imperative to maintain the embankments and prevent any possible failure from occurring. If a failure were to occur, the ash slurry could potentially contaminate Colbert Fossil Plant and the Tennessee River.

2.3. Primary Responsibility and Frequency of Dike Safety Inspections

1. TVA RHO&M Field Supervisor for Colbert Fossil Plant (**Field Supervisor**)

2. TVA RHO&M East Region Construction Manager

3. TVA RHO&M Program Manager for Colbert 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 wet 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

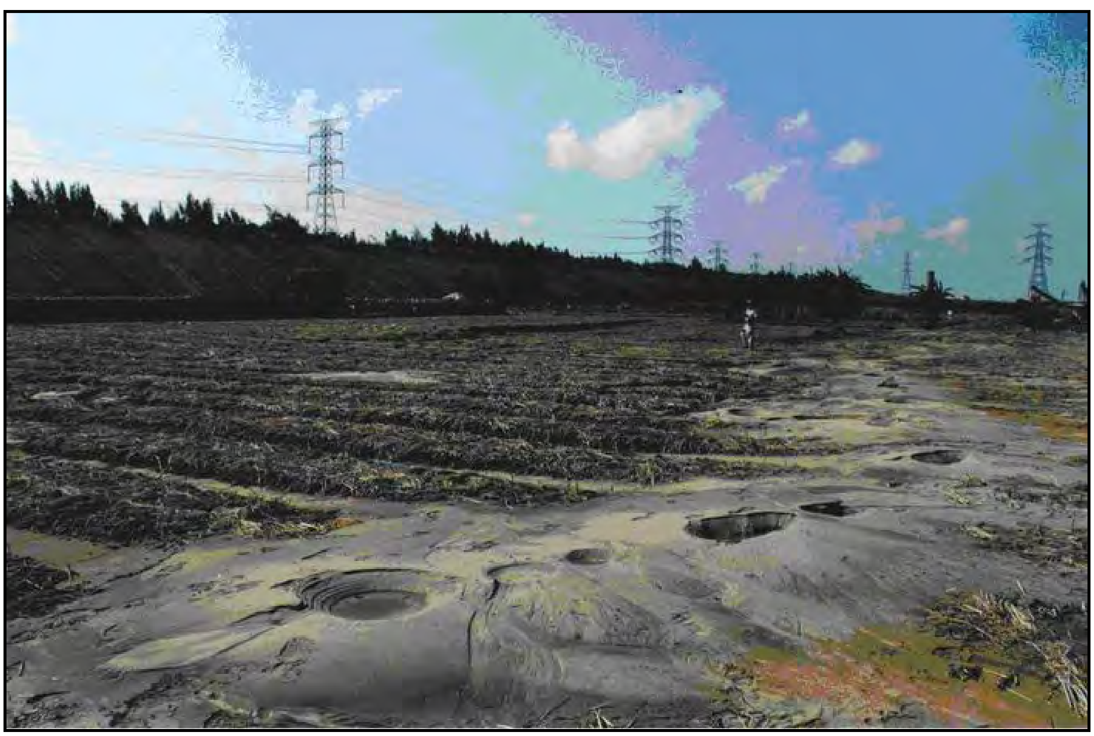


Figure 5. Example of Action Level 3 – Deposition of Sediment from Dike

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 (ALDOT Concrete Sand)
  - One foot of ALDOT No. 89 Stone
  - Two feet of ALDOT Class I Rip-Rap
  - 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
ALDOT No. 89 Stone	90	60
ALDOT Class I Rip-Rap	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 on the east side of the Coal Yard Drainage Basin across the road. 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 Colbert 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 COF 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 COF 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.

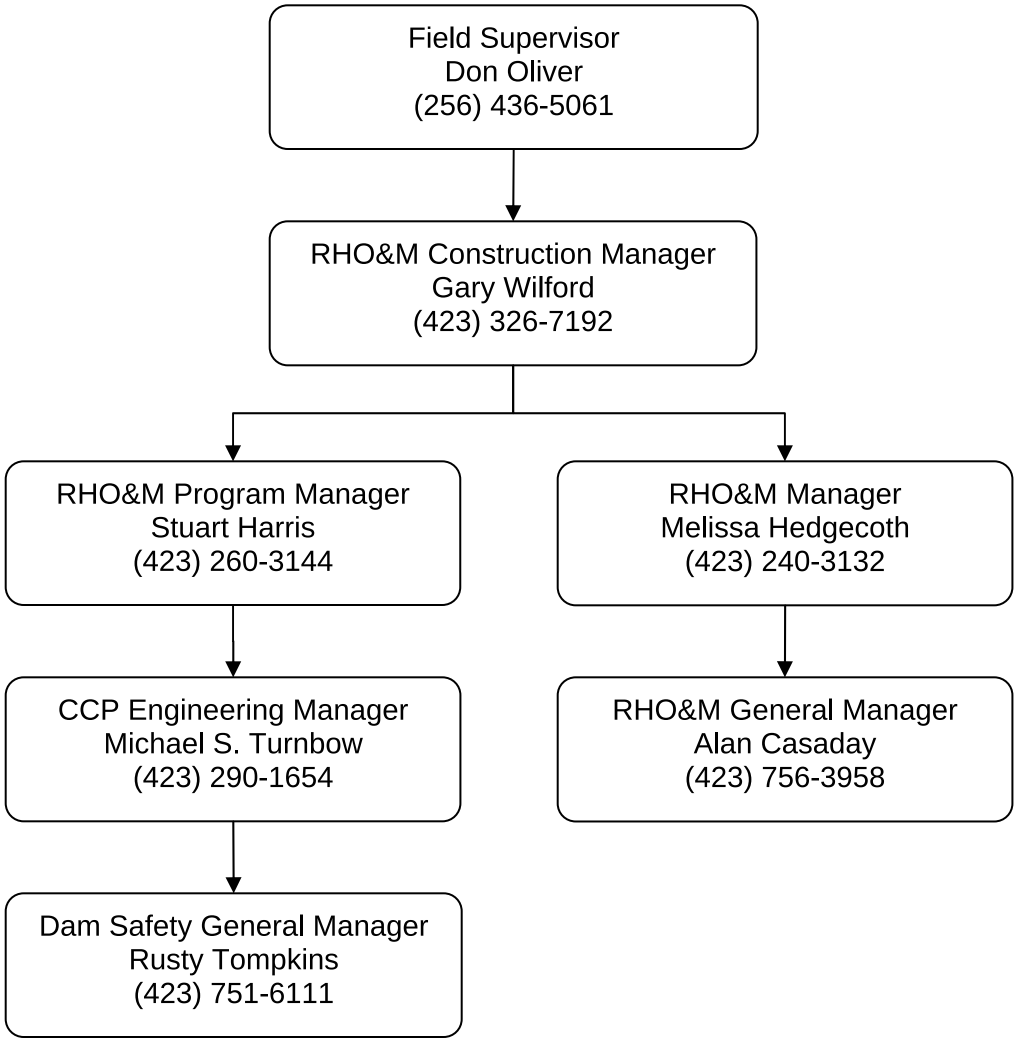


Figure 8. Level 2 Emergency Contact Flowchart

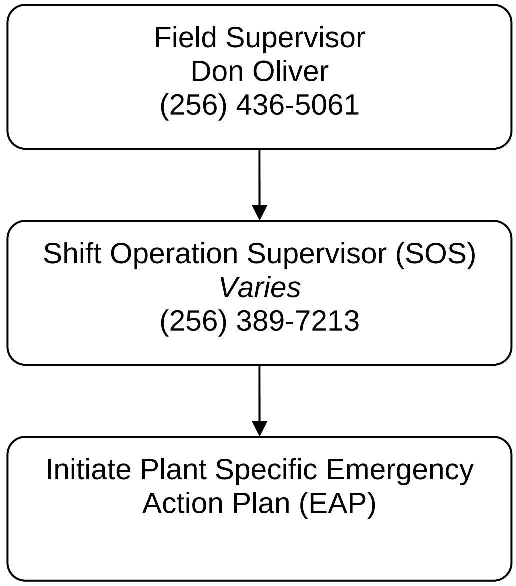


Figure 9. Level 3 Emergency Contact Flowchart

Appendix A

Ash Pond 4 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

0 250 500 Feet

STANTEC CONSULTING SERVICES INC.
1409 N. Forbes Rd.
Lexington, Kentucky
40511-2050
859-422-3000

Stantec

SEEPAGE ACTION PLAN

Tennessee Valley Authority
Colbert Fossil Plant
Tuscumbia, Colbert County, Alabama

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.	

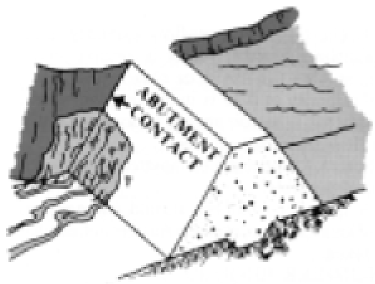
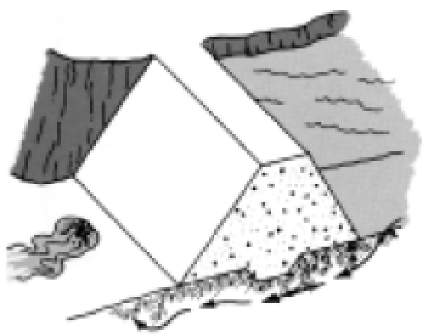
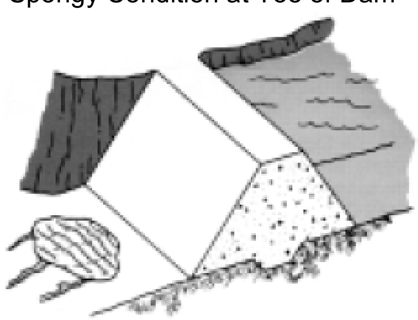
SHEET

1 OF 1

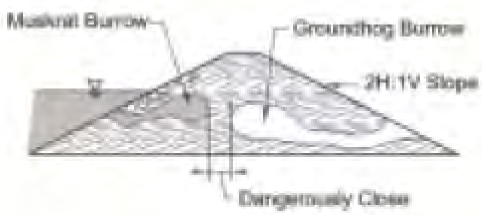
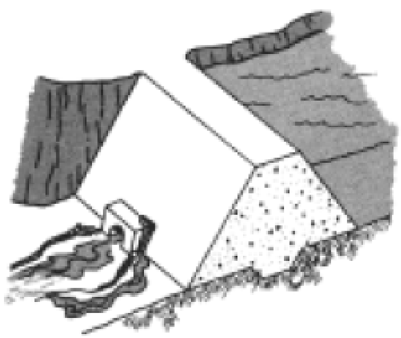
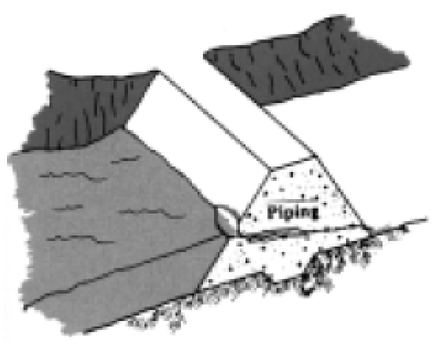
Appendix B

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

COF Seepage Log

Colbert Fossil Plant
Tuscumbia, Alabama
Updated June 22, 2010 Rev. 1

Area of Concern	Coordinate Location (Northing/Easting)		Date Initially Observed	Time	Approximate Size (Linear Feet)	SAP Level	Description	Mitigation Status/ Future Plans
1	1722427.25	395306.15	3/9/2010	N/A	Not Noted	2	Noted Seep area from Phase 1&2 - seepage has been occuring along the mid-slope to lower portions of the east to southeast dikes since 1984. Areas typically exhibit wet/saturated ground conditions. Seepage flow has been	Mitigation beginning in 2010 designed by URS and will likely include seepage collection and/or graded filters.
2	1723332.21	394809.47	3/9/2010	N/A	Not Noted	2	Noted Seep area from Phase 1&2 - seepage has been occuring along the mid-slope to lower portions of the east to southeast dikes since 1984. Areas typically exhibit wet/saturated ground conditions. Seepage flow has been	Mitigation beginning in 2010 designed by URS and will likely include seepage collection and/or graded filters.
3	1721410.81	395792.98	3/9/2010	N/A	Not Noted	2	Noted Seep area from Phase 1&2 - seepage has been occuring along the mid-slope to lower portions of the east to southeast dikes since 1984. Areas typically exhibit wet/saturated ground conditions. Seepage flow has been	Mitigation beginning in 2010 designed by URS and will likely include seepage collection and/or graded filters.
4	1721183.28	395174.54	3/9/2010	N/A	Not Noted	2	Noted Seep area from Phase 1&2 - seepage has been occuring along the mid-slope to lower portions of the east to southeast dikes since 1984. Areas typically exhibit wet/saturated ground conditions. Seepage flow has been	Mitigation beginning in 2010 designed by URS and will likely include seepage collection and/or graded filters.
5	Survey Requested		3/9/2010	N/A	Not Noted	1	Noted Seep area from Phase 1&2 - seepage locations along the west, southwest and south dike areas are much less pronounced and widespread. These lesser areas typically show moist to wet conditions with no flow and can	Mitigation beginning in 2010 designed by URS and will likely include seepage collection and/or graded filters.
6	1722427.25	395306.15	3/9/2010	N/A	Not Noted	2	Noted seep area from 2010 Annual Inspection - small red-water seep located along southeast dike area at the bank of Cane Creek, minimal flow, clear water.	Mitigation beginning in 2010 designed by URS and will likely include seepage collection and/or graded filters.

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

3/9/2010 –East Dike
Typical seep area exhibiting wet/saturated ground conditions along Ash Pond 4. Photo is representative of east dike. SAP Level 2 for east side.

Area of Concern 2

3/9/2010 – East Dike
Typical seep area exhibiting wet/saturated ground conditions along Ash Pond 4. Photo is representative of east dike. SAP Level 2 for east side.

Area of Concern 3

3/9/2010 – Southeast Corner
Typical seep area exhibiting wet/saturated ground conditions along Ash Pond 4. Photo is representative of southeast area. SAP Level 2 for southeast side.

Area of Concern 4

3/9/2010 - Southeast Corner
Typical seep area exhibiting wet/saturated ground conditions along Ash Pond 4. Photo is representative of southeast area. SAP Level 2 for southeast side.

Area of Concern 5

3/9/2010 – West Dike
Typical seep area, exhibits less pronounced and widespread seepage along Ash Pond 4. Photo is representative of west dike. SAP Level 1 for west side.

Area of Concern 6

3/9/2010 – East Dike
Typical seepage area along Ash Pond 4. Photo is representative of new red water seep at southeast area at bank of Cane Creek discovered during 2010 annual inspection. SAP Level 2 for east/southeast side.

Appendix D

COF CCP Emergency Action Plan

APPENDIX A

Document 16

URS Memorandum dated September 12, 2011, "Subject: August 2011 TVA Instrumentation Readings Comments"

Memorandum

Date: September 12, 2011

To: Email Distribution Recipients

From: Jeff Wild, P.E.

Subject: **August 2011 TVA Instrumentation Readings Comments**

This memorandum and attachments present the August 2011 RHO&M instrumentation readings performed by URS for WCF, JSF, BRF, and COF TVA facilities. This memorandum is commenting only on obvious inclinometer movement and piezometric level changes of more than approximately 1 foot, or readings outside the historical data range. URS' assigned RHO&M work scope does not include interpretation of what constitutes a critical or actionable quantity of inclinometer movement or a trigger level, critical, or actionable water level elevation change in any piezometer. URS submits this data in an organized manner to facilitate review and interpretation by others that deemed the inclinometer and piezometer installations, and ongoing monitoring, necessary to assess pond and ash stack stability.

To assist in review of the piezometer data, plots of the water level readings are included with this memorandum. Because of the plots, and to improve clarity and reduce document/file size, we are only including the last set of piezometer water level tables for each site (generally the last three to five months' worth of readings), with the exception of COF. It should be noted that, again for presentation clarity, we had already been pairing-down the inclinometer readings to include only the last six data sets. The August 2011 inclinometer readings included with this memorandum continue this data reporting methodology.

Important Note: As a result of a detailed review of the current piezometers location and elevation data for determining the trigger points at each of the piezometers, URS found that several of the piezometer riser pipes have been modified over the last year because of construction. It is likely that recent water level measurements referenced incorrect stick-up heights, and resulted in our reporting inaccurate water level elevations (see August 2011 WCF data). During September data collection URS will measure well riser heights relative to the referenced ground surface elevation at BRF, COF, JSF and WCF and report all of the piezometer stick-up heights with the September 2011 data.

Because of the substantial investment TVA will make in having URS establish trigger elevations for piezometer water levels, it makes sense that well elevations should be confirmed. Therefore, URS requests TVA survey the piezometers at the four facilities for horizontal and vertical location at ground level and at the top of the piezometer pipe. The elevations should be measured using a surveyor's level, not the roving GPS units the RHO&M field technicians commonly work with. These GPS units may not be accurate enough for vertical control.

Widows Creek (WCF)

1. **Piezometers:** As a result of a detailed review of the current piezometers location and elevation data, URS has measured the stick-up heights of the piezometers during the August 2011 readings event on-site. Several of the heights are currently different from the historical heights being utilized for reporting water level elevations. These are shown in red text in the readings table attached.

With the resulting calculated water levels in the piezometers based on the revised stick-up heights, a comparison to historical data prior to the August readings is not practical. URS will resume comparisons to historical data during and after the September 2011 readings event.

2. **Inclinometers:** SI-31 continues to show displacement consistent with Gypsum Stack settlement. To-date, this inclinometer exhibits a total cumulative displacement of approximately ¾-inch, but shows negligible additional displacement since the previous month's readings.

URS has requested TVA surveyors measure the elevation of the top of inclinometer casing (TOC) monthly (current measurements shown below). This data will be reviewed to assess downward change (indicating settlement) at SI-31 to compare with the inclinometer displacement. The elevation measurements collected to-date are summarized below:

Date of Elevation Measurement	TOC Elevation (ft., NGVD)	Elevation Change (ft.)
6/2/2011	674.93	-
6/24/2011	674.86	-0.07

The other inclinometers show little to nearly no additional displacement.

<u>John Sevier (JSF)</u>

1. **Piezomete**rs: The majority of piezometer water levels decreased during August 2011.

21 of the piezometer water levels remained level, or decreased only slightly (< 1 ft.) during the month.

None of the piezometer water levels increased during the month.

No obvious concerns are noted with the monthly readings.

2. **Inclinometers:** SI-31 located on the upper bench, immediately north of the active fill area continues to display signs of displacement consistent with settlement of the stack, and also likely due to ongoing stacking adjacent to this inclinometer. However, the cumulative displacement graph for SI-31 does not show any additional movement since last month.

URS has requested TVA surveyors measure the elevation of the top of inclinometer casing (TOC) monthly (current measurements shown below). This data is being reviewed to assess downward change (indicating settlement) at SI-31. The elevation measurements collected to-date are summarized below:

Date of Elevation Measurement	TOC Elevation (ft., NGVD)	Elevation Change (ft.)
2/23/2011	1156.07	-
3/1/2011	1155.88	-0.19
3/22/2011	1155.78	-0.10
4/26/2011	1155.92	+0.14
5/25/2011	1155.91	-0.01
6/23/2011	1155.91	0.00

The remaining inclinometers show little to nearly no displacement since last month.

No obvious concerns are noted with the monthly readings.

Bull Run (BRF)

1. **Piezometers:** The majority of piezometer water levels (33) remained level, or increased or decreased only slightly (< 1 ft.) during the month.

   Piezometers STN-77 and STN-85 decreased in water level more than 1 ft. over the month.

   22 of the piezometer water levels remained level, or decreased only slightly (< 1 ft.) during the month.

   11 of the piezometer water levels remained level, or increased only slightly (< 1 ft.) during the month.

   Piezometers PZ-5, PZ-33, PZ-39 and PZ-47 were dry this month.

   No obvious concerns are noted with the monthly readings.

   Inclinometers: The inclinometers show negligible displacement since last month.

   No other obvious concerns are noted with the monthly readings.

Colbert (COF)

1. **Piezometers:** Ash Disposal Area 5 – The majority of piezometer water levels decreased during August 2011.

   All of the piezometer water levels remained level, or increased or decreased only slightly (< 1 ft.) during the month.

   24 piezometer water levels decreased during the month, with none decreasing more than 1 ft.

   4 piezometer water levels increased during the month, with none increasing more than 1 ft.

   Piezometers STN-5-12, STN-5-18, STN-103B, STN-109, STN-5-121B, and STN-122 were dry this month.

   No obvious concerns are noted with the monthly readings.

   Ash Pond 4 – The majority of piezometer water levels decreased during August 2011. 19 of the piezometer water levels remained level, or increased or decreased only slightly (< 1 ft.) during the month.

   6 piezometers increased in water level, with none increasing more than 1 ft.

   13 piezometer water levels decreased during the month, with none decreasing more than 1 ft.

No obvious concerns are noted with the monthly readings.

Gallatin (GAF)

1. **Piezometers:** No automated piezometer water level readings (all are automated) were transmitted to URS from TVA for the month of August.

APPENDIX A

Document 17

Stantec Consulting Services Inc. Correspondence Dated February 15, 2012, Re: Results of Pseudostatic Slope Stability Analysis, Active CCP Disposal Facilities, BRF, COF, GAF, JSF, KIF, PAF, and WCF

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_002_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
BRF, COF, GAF, JSF, JOF, KIF, PAF, and WCF

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 Bull Run (BFR), Colbert (COF), Gallatin (GAF), John Sevier (JSF), Johnsonville (JOF), Kingston (KIF), Paradise (PAF), and Widows Creek (WCF) 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 simplicity and conservatism, the selected sections represent the facility's lowest current static (long-term) factor of safety. The SLOPE/W models were updated to reflect any significant mitigations or operational changes that have occurred since completion of Stantec's geotechnical studies.
- Undrained shear strength parameters were used.
- Ground motion levels 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 plant-

specific tables (Tables 13 through 23) 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

BRF, COF, GAF, JSF, JOF, KIF, PAF, WCF

Plant	CCP Disposal Facility		Cross-Section	2,500 yr Return	
	Name	Type		PGA (g)	Factor of Safety
BRF	Gypsum Disposal Area 2A	Wet Stack	I	0.131	1.0
	Fly Ash Disposal Area 2	Impoundment	S		1.4
	Bottom Ash Disposal Area 1	Stack	D		1.1
COF	Disposal Area 5 Stack	Stack	I	0.138	1.0
	Disposal Area 5 Stilling Basin	Impoundment	J		1.2
	Ash Pond 4	Impoundment	D		1.0
GAF	Ash Pond A	Impoundment	K	0.108	1.0
	Ash Pond E	Impoundment	B		1.3
JSF	Bottom Ash Pond	Impoundment	I	0.115	2.2
JOF	Ash Disposal Area 2	Impoundment	K	0.254	1.0
KIF	Stilling Pond	Impoundment	132+37	0.115	1.0
PAF	Slag Ponds 2A and 2B	Impoundment	Typical	0.157	1.1
	Scrubber Sludge Complex	Impoundment	G		1.0
	Peabody Ash Pond	Impoundment	A		1.0
WCF	Gypsum Stack	Wet Stack	F	0.1	1.5
	Dredge Cell (Old Scrubber Sludge Pond)	Impoundment	D		1.1
	Main Ash Pond	Impoundment	J		1.4

Colbert Fossil Plant
(COF)

Pseudostatic Slope Stability Analysis
CCP Storage Facilities - Existing Conditions
Tennessee Valley Authority Fossil Plants

Section I - Disposal Area 5
Colbert Fossil Plant
Tuscumbia, Alabama

Material Type	Unit Weight	Cohesion	Friction Angle
Stacked Fly Ash (Unsaturated)	105 pcf	0 psf	32 °
Stacked Fly Ash (Saturated)	105 pcf	0 psf	32 °
Sluiced Fly Ash	85 pcf	400 psf	15 °
Fill Material	125 pcf	200 psf	19 °
Clay Dike	125 pcf	200 psf	19 °
Native Clay	125 pcf	290 psf	19 °

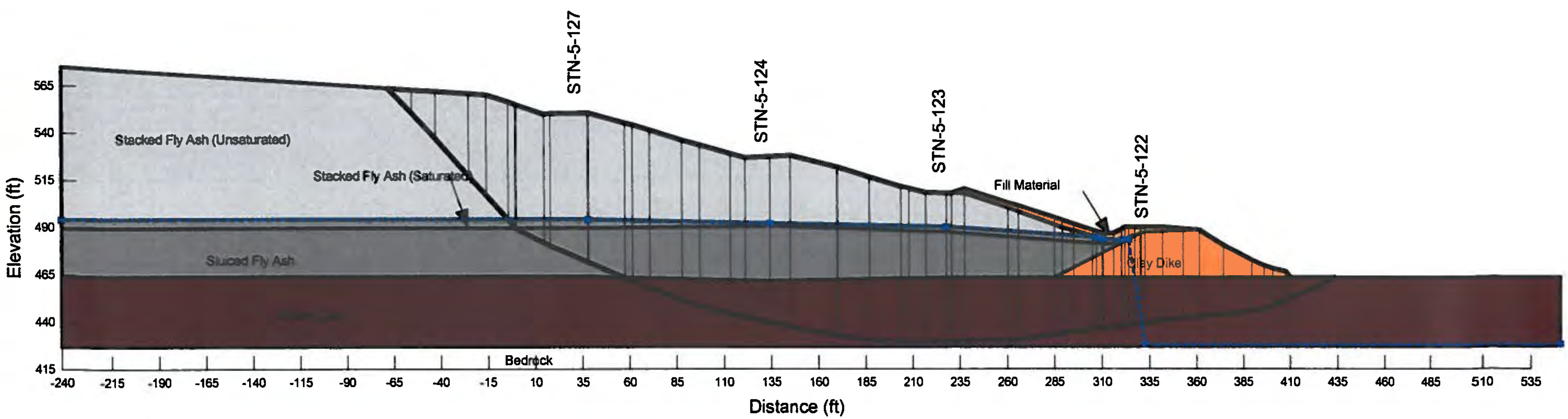
Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Additional remediation measures taken from URS plans dated 7/09/2010.

Factor of Safety: 1.0

Horizontal Sesmic Coefficient Kh = 0.138 g

2500-year Return Period Event



Date of Assessment - 11/22/2011

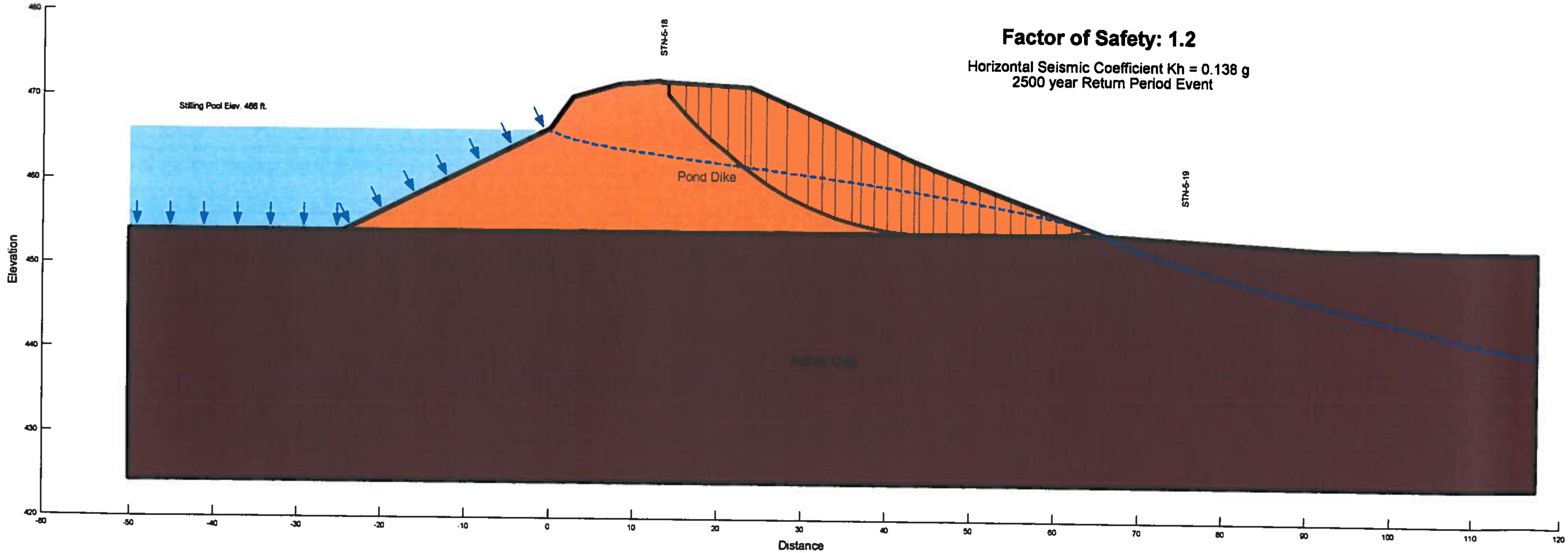
Project No. 175551015

Pseudostatic Slope Stability Analysis
CCP Storage Facilities - Existing Conditions
Tennessee Valley Authority Fossil Plants

Section J - Disposal Area 5 Stilling Basin
Colbert Fossil Plant
Tuscumbia, Alabama

Note:
The results and 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
Native Clay	125 pcf	290 psf	19 °
Pond Dike	125 pcf	200 psf	19 °



Date of Assessment - 11/28/2011

Project No. 175551015

Pseudostatic Slope Stability Analysis
CCP Storage Facilities - Existing Conditions
Tennessee Valley Authority Fossil Plants

Section D - Ash Pond 4
Colbert Fossil Plant
Tennessee Valley Authority

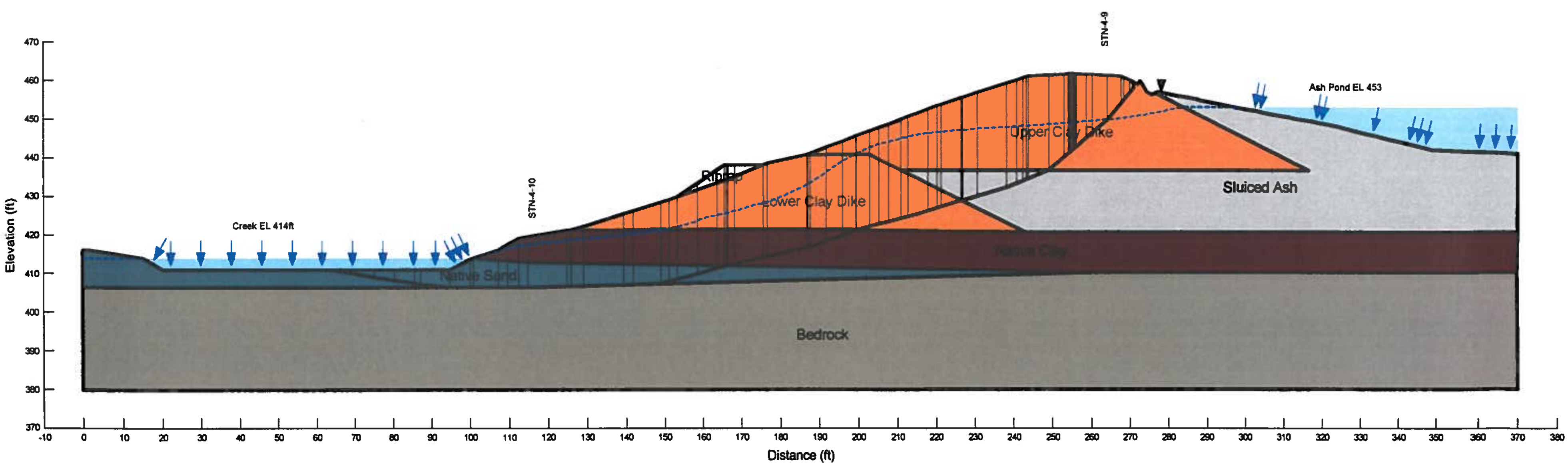
Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Additional remediation measures taken from URS plans dated 05/20/2010.

Material Type	Unit Weight	Cohesion	Friction Angle
Native Clay	129 pcf	700 psf	14 °
Upper Clay Dike	126 pcf	750 psf	12 °
Lower Clay Dike	127 pcf	400 psf	14 °
Sluiced Ash	85 pcf	400 psf	10 °
Native Sand	110 pcf	0 psf	30 °

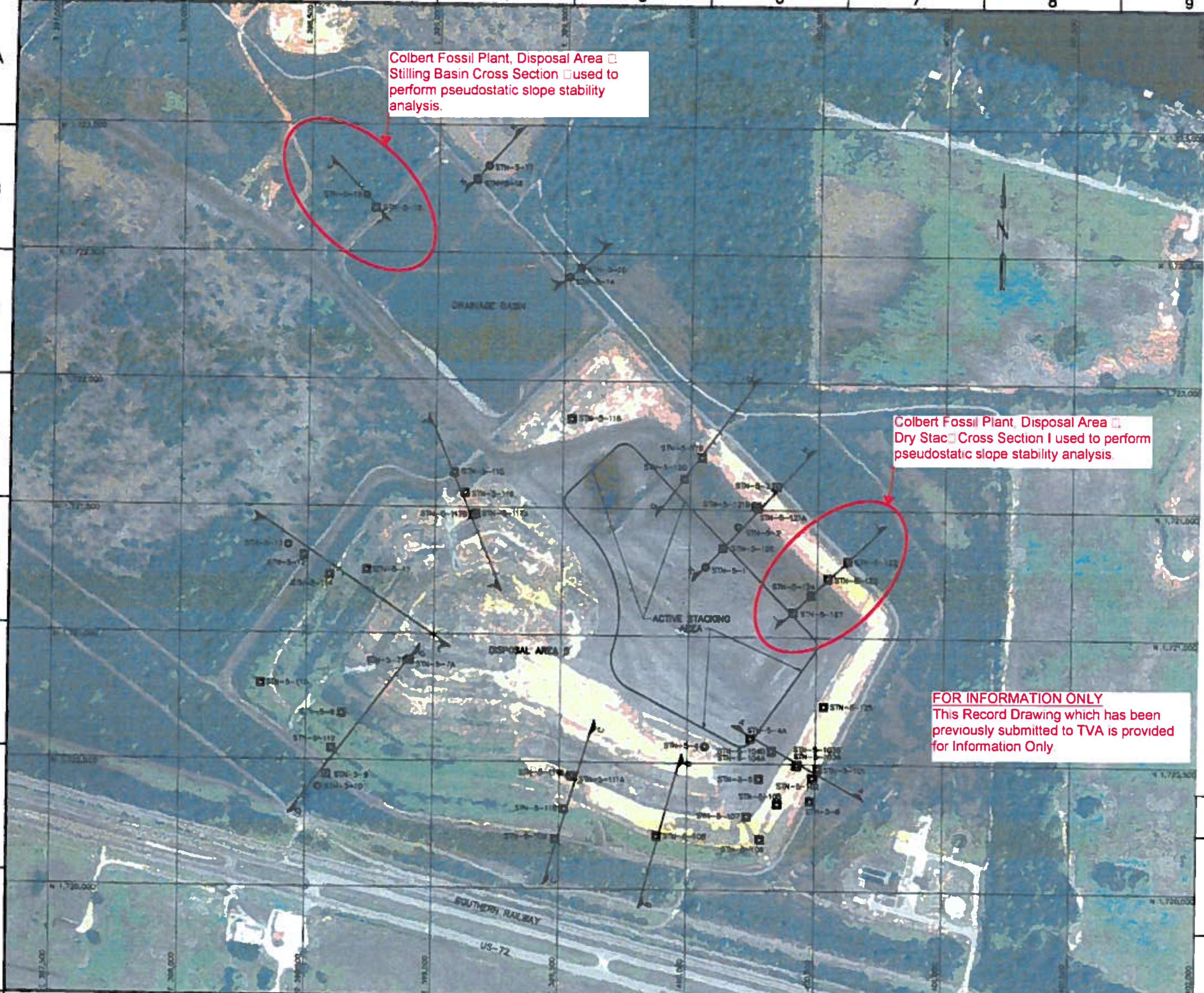
Factor of Safety: 1.0

Horizontal Seismic Coefficient Kh = 0.138 g
2500-year Return Period Event



Date of Assessment - 11/4/2011

Project No. 175551015



LEGEND

- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Sampling
- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Piston Sampling (Piezometer Installed)
- Soil Boring With Continuous Standard Penetration Tests And/or Shelby Tube Sampling, Rock Core, And Piezometer Installed
- Cross Section

BORING LOCATION TABLE

Boring	Northing	Easting	Elev. (ft.)
STN-5-1	1,721,274.40	400,063.00	552.91
STN-5-2	1,721,432.78	400,188.65	529.19
STN-5-3	1,721,592.79	400,338.67	487.54
STN-5-4	1,720,567.21	400,087.66	559.98
STN-5-4A	1,720,600.17	400,244.82	550.70
STN-5-5	1,720,441.17	400,279.90	528.71
STN-5-6	1,720,353.73	400,481.02	488.06
STN-5-7	1,720,885.57	398,898.12	564.52
STN-5-7A	1,720,897.20	398,906.71	563.34
STN-5-8	1,720,684.82	398,641.15	517.92
STN-5-9	1,720,444.22	398,582.58	480.52
STN-5-10	1,720,393.13	398,549.64	459.85
STN-5-11	1,721,251.58	398,733.51	515.53
STN-5-12	1,721,306.21	398,488.91	477.77
STN-5-13	1,721,346.27	398,424.38	452.26
STN-5-14	1,722,407.30	399,518.43	475.88
STN-5-15	1,722,443.72	399,582.30	482.65
STN-5-16	1,722,788.34	399,148.51	475.84
STN-5-17	1,722,840.75	399,195.10	456.60
STN-5-18	1,722,671.43	398,752.90	472.16
STN-5-19	1,722,721.58	398,717.11	453.41
STN-5-101	1,720,482.33	400,509.25	486.97
STN-5-102	1,720,445.72	400,489.29	488.80
STN-5-103A	1,720,493.35	400,426.84	508.95
STN-5-103B	1,720,498.42	400,429.29	509.48
STN-5-104A	1,720,548.28	400,328.22	530.48
STN-5-104B	1,720,551.74	400,330.04	530.75
STN-5-105	1,720,341.58	400,353.20	507.40
STN-5-106	1,720,202.10	400,284.88	505.40
STN-5-107	1,720,292.02	400,232.48	527.19
STN-5-108	1,720,211.08	399,882.93	509.29
STN-5-109	1,720,195.78	399,488.17	481.82
STN-5-110	1,720,315.43	399,519.59	509.44
STN-5-111A	1,720,445.15	399,553.23	529.32
STN-5-111B	1,720,446.66	399,545.11	528.34
STN-5-112	1,720,546.53	398,601.38	497.91
STN-5-113	1,720,800.24	398,321.28	499.24
STN-5-114	1,721,230.71	398,587.74	497.51
STN-5-115	1,721,636.94	399,073.55	477.77
STN-5-116	1,721,557.19	399,115.88	491.58
STN-5-117A	1,721,475.92	399,158.40	512.79
STN-5-117B	1,721,469.59	399,148.35	512.84
STN-5-118	1,721,650.73	399,533.21	499.18
STN-5-119	1,721,703.92	400,044.78	504.54
STN-5-120	1,721,619.44	399,976.15	525.76
STN-5-121A	1,721,506.28	400,264.15	506.23
STN-5-121B	1,721,514.55	400,256.18	507.94
STN-5-122	1,721,301.29	400,620.41	486.86
STN-5-123	1,721,231.75	400,542.54	506.11
STN-5-124	1,721,165.66	400,476.56	527.23
STN-5-125	1,720,727.47	400,531.28	509.03
STN-5-126	1,721,349.47	400,129.73	554.68
STN-5-127	1,721,097.71	400,407.67	550.45

RECORD DRAWING

GRAPHIC SCALE: 1"=150'

For Supporting Design Calculations see FPGCOFFESCDI000000020100002

SCALE: 1"=150' EXCEPT AS NOTED

YARD
DISPOSAL AREA NO. 5

GEOTECHNICAL EXPLORATION
BORING AND STABILITY
CROSS SECTION PLAN

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

Stantec

AUTOCAD R 2000 | 37 | C | 10W707—02 | R 0

STANTEC | 0
TASK COMPLETED BY: | REV NO.

PLOT FACTOR XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

37 | C | 10W707—02

37 | C | 10W706-02

BORING LOCATION TABLE

BORING	NORTHING	EASTING	ELEVATION
STN-4-1	1,723,698.52	394,356.89	460.2
STN-4-2	1,723,632.72	394,288.32	438.4
STN-4-3	1,723,845.94	394,293.91	427.3
STN-4-4	1,723,318.42	394,738.76	460.4
STN-4-5	1,723,368.01	394,798.52	438.5
STN-4-6	1,723,373.18	394,884.54	418.8
STN-4-7	1,722,880.06	394,990.81	460.8
STN-4-8	1,722,843.46	395,088.90	421.6
STN-4-9	1,722,306.36	395,280.37	461.2
STN-4-10	1,722,357.06	395,401.10	420.9
STN-4-11	1,721,882.96	395,485.31	461.3
STN-4-12	1,721,804.87	395,746.27	440.2
STN-4-13	1,721,330.83	395,874.15	425.3
STN-4-14	1,721,420.08	395,715.53	461.9
STN-4-15	1,721,219.13	395,347.89	460.5
STN-4-16	1,721,126.23	395,351.96	435.1
STN-4-17	1,721,538.59	394,582.90	476.8
STN-4-18	1,721,402.10	394,555.64	461.1
STN-4-19	1,721,352.01	394,475.68	440.3
STN-4-20	1,721,987.93	394,461.02	462.3
STN-4-21	1,721,985.14	394,262.71	460.2
STN-4-22	1,721,957.70	394,065.63	438.0
STN-4-23	1,722,728.47	394,227.94	461.1
STN-4-24	1,722,823.18	394,138.84	444.5

LEGEND

- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Sampling
- Soil Boring With Continuous Standard Penetration Tests And/Or Shelby Tube Piston Sampling, And Piezometer Installation
- Soil Boring With Continuous Standard Penetration Tests And/or Shelby Tube Sampling, Rock Core, And Piezometer Installation

NOTES

1. Topographic and survey information provided by the Tennessee Valley Authority.
2. The Boring Logs And Related Information Shown On This Drawing 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. Any Correlations Shown Between Borings Are Generally Based On Straight Line Interpolation. Actual Conditions Between Borings Are Unknown And May Differ From Those Shown.

FOR INFORMATION ONLY
This Record Drawing which has been previously submitted to TVA is provided for Information Only.

RECORD DRAWING

GRAPHIC SCALE 1"=200'

For Supporting Design Calculations see FPGCOFFESCDX00000002010001

1/22/10

Stantec

SCALE: 1"=200' EXCEPT AS NOTED

YARD
ASH POND 4

GEOTECHNICAL EXPLORATION
BORING AND STABILITY
CROSS-SECTION PLAN

COLBERT FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 37 | C | 10W706-02 | R 0

PLOT FACTOR: XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY | REV NO.

APPENDIX B

Document 18

Dam Inspection Check List Form Ash Pond 4

Site Name:	Colbert Fossil Plant	Date:	12 Sept. 2011
Unit Name:	Ash Pond 4	Operator's Name:	TVA
Unit I.D.:	Ash Pond 4	Hazard Potential Classification:	High ☐ Significant ☒ Low ☐
	Inspector's Name:	Joseph P. Klein III & Frank B. Lockridge	

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)?	453 ft.		19. Major erosion or slope deterioration?		x
3. Decant inlet elevation (operator records)?	452.5 ft.		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	425.5 ft.		Is water entering inlet, but not exiting outlet?		x
5. Lowest dam crest elevation (operator records)?	458 ft.		Is water exiting outlet, but not entering inlet?		x
6. If instrumentation is present, are readings recorded (operator records)?	x		Is water exiting outlet flowing clear?		x
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)?	N/A		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?		x	From downstream foundation area?		x
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		x	"Boils" beneath stream or ponded water?		x
14. Clogged spillways, groin or diversion ditches?		x	Around the outside of the decant pipe?		x
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
1	Daily by staff, weekly, monthly, semi-annual and annual. (Documentation to be provided)

Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit AL0003867 **INSPECTOR** J.P.Klein III & F.B. Lockridge

Date 12 Sept. 2011
Impoundment Name Colbert Fossil Plant, Ash Pond 4

Impoundment Company Tennessee Valley Authority
EPA Region 4

State Agency Alabama Department of Environmental Management
(Field Office) Address 1400 Coliseum Blvd. , Montgomery, AL 38110
Name of Impoundment Ash Pond 4

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ☒ **Update** ☐

	Yes	**No**
Is impoundment currently under construction?	☐	☒
Is water or ccw currently being pumped into the impoundment?	☒	☐

IMPOUNDMENT FUNCTION: Storage of sluiced material from coal combustion process.

Nearest Downstream Town Name: Cherokee, AL

Distance from the impoundment: 5 miles

Location:

Latitude	34	Degrees	44	Minutes	01.11	Seconds	**N**
Longitude	87	Degrees	50	Minutes	59.15	Seconds	**W**

State Alabama **County** Colbert

	Yes	No
Does a state agency regulate this impoundment?	☒	☐

If So Which State Agency? Ala. Dept. of Environmental Management

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.

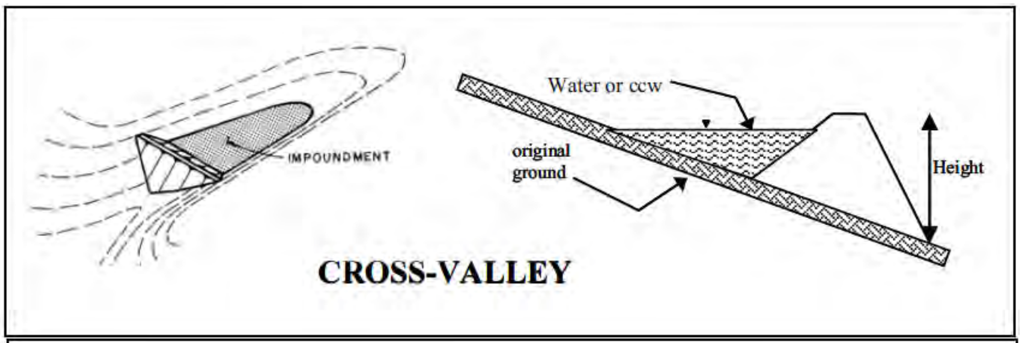
☒ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. 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.

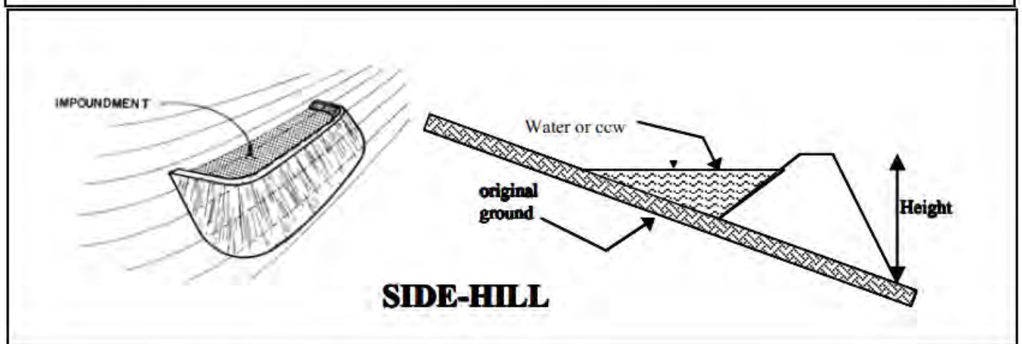
☐ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

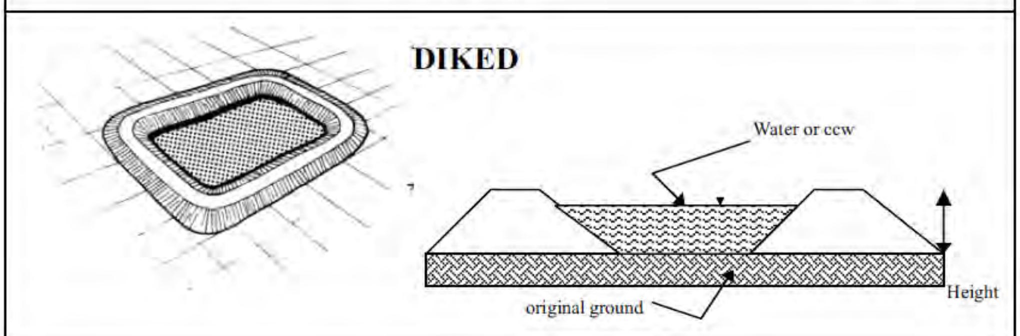
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

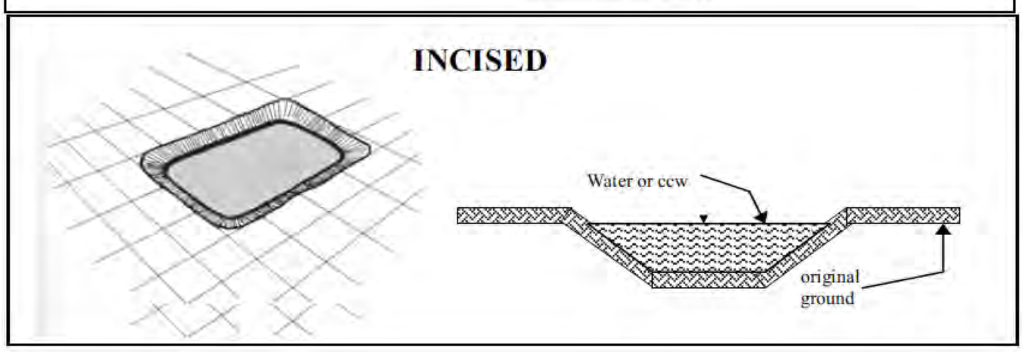
Dam break analysis reported to indicate no potential loss of human life and no inundation of habitable structures potentially impacted in the event of an embankment failure or misoperation. Dam break analysis report being provided.

CONFIGURATION:









☐ Cross-Valley ☐ Side-Hill ☒ Diked

☐ Incised (form completion optional) ☐ Combination Incised/Diked

Embankment Height (ft)	40ft. max. E side	**Embankment Material**	Clay
Pool Area (ac)	52	**Liner**	N/A
Current Freeboard (ft)	5	**Liner Permeability**	

TYPE OF OUTLET (Mark all that apply)

☐ **Open Channel Spillway**

☐ Trapezoidal

☐ Triangular

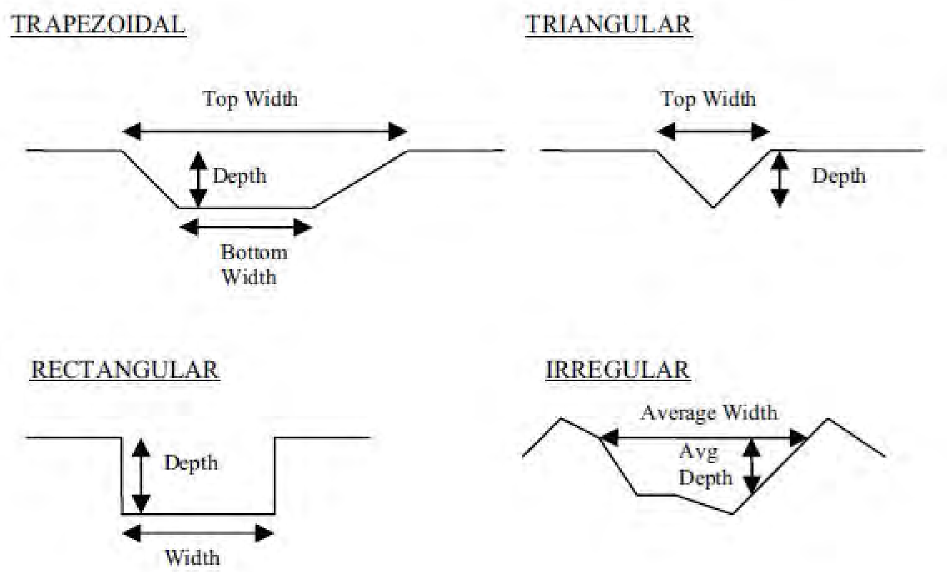
☐ Rectangular

☐ Irregular

depth (ft)

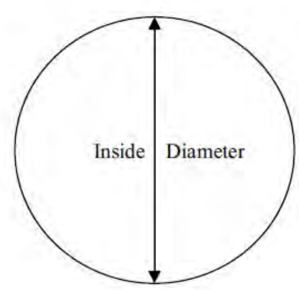
average bottom width (ft)

top width (ft)



☒ **Outlet**

27” inside diameter (4 pipes)



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

	Yes	No
Has there ever been a failure at this site?	☐	☒
If So When?		

If So Please Describe :

	Yes	No
Has there ever been significant seepages at this site?	☒	☐
If So When?	Current	

If So Please Describe : Exterior seepage drainage blankets have been installed to control seepage. Crushed stone buttress installed at bottom of downstream embankment to enhance stability in seepage areas.

	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,...)?	Piezometers	

If So Please Describe : Piezometers installed and monitored

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 information available

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 evidence of failures or patchwork due to slope movement. Dike has seepage blankets added to control observed seepage. Seepage and embankment water levels are monitored.

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 Area 5 Dry Stack

Site Name:	**Colbert Fossil Plant**	**Date:**	**12 Sept. 2011**
Unit Name:	**Disposal Area 5** **Dry Stack**	**Operator's Name:**	**TVA**
Unit I.D.:	**Dry Stack**	**Hazard Potential Classification:**	**High** ☐ **Significant** ☐ **Low** ☒
		Inspector's Name:	**J.P.Klein III and F. B. Lockridge**

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)?	* 456		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?		X
5. Lowest dam crest elevation (operator records)?	480		Is water exiting outlet, but not entering inlet?		X
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)?	N/A		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?	N/A	
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?	** X		From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?		X	Around the outside of the decant pipe?		X
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
*	Pool elevation in Drainage Basin
**	Drop Inlet system
***	No water exiting due to low pool level

Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit AL 0003867 **INSPECTOR** Klein/Lockridge

Date 12 Sept. 2011
Impoundment Name Colbert Fossil Plant

Impoundment Company TVA
EPA Region 4

State Agency Alabama Dept of Environmental Management
(Field Office) Address 1400 Coliseum Blvd., Montgomery,AL 38110
Name of Impoundment Disposal Area 5 Dry Stack Storage

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ☒ **Update** ☐

	Yes	**No**
Is impoundment currently under construction?	☐	☒
Is water or ccw currently being pumped into the impoundment?	☐	☒

IMPOUNDMENT FUNCTION: Storage of dry stacked fly ash

Nearest Downstream Town Name: Cherokee, AL

Distance from the impoundment: 5 miles

Location:

Latitude	34	Degrees	43	Minutes	55.52	Seconds	**N**
Longitude	87	Degrees	50	Minutes	08.62	Seconds	**W**

State Alabama **County** Colbert

	Yes	No
Does a state agency regulate this impoundment?	☒	☐

If So Which State Agency? Alabama Dept. of Environmental Management

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.

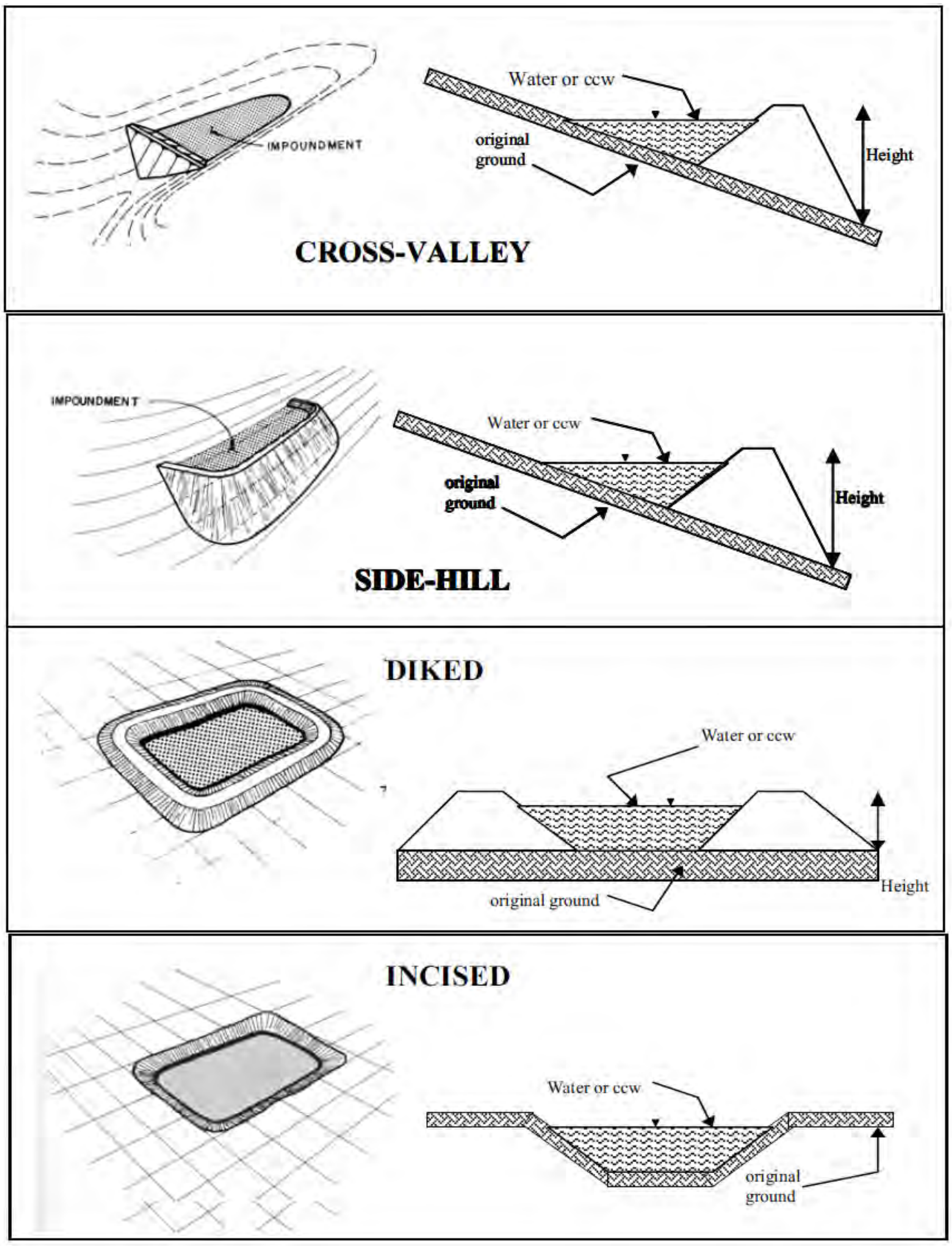
☐ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. 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:

Any failure will probably not result in a loss of life and impact only the owner's property. The drainage pool is storing only storm water and some drainage from the dry stack.

CONFIGURATION:



☐ Cross-Valley ☐ Side-Hill ☒ Diked

☐ Incised (form completion optional) ☐ Combination Incised/Diked

Embankment Height (ft)	Max. 30 ft.	**Embankment Material**	Clay
Pool Area (ac)	75 acres & 12 acres	**Liner**	None
Current Freeboard (ft)	6’ pool area	**Liner Permeability**	N/A

TYPE OF OUTLET (Mark all that apply)

☐ **Open Channel Spillway**

☐ Trapezoidal

☐ Triangular

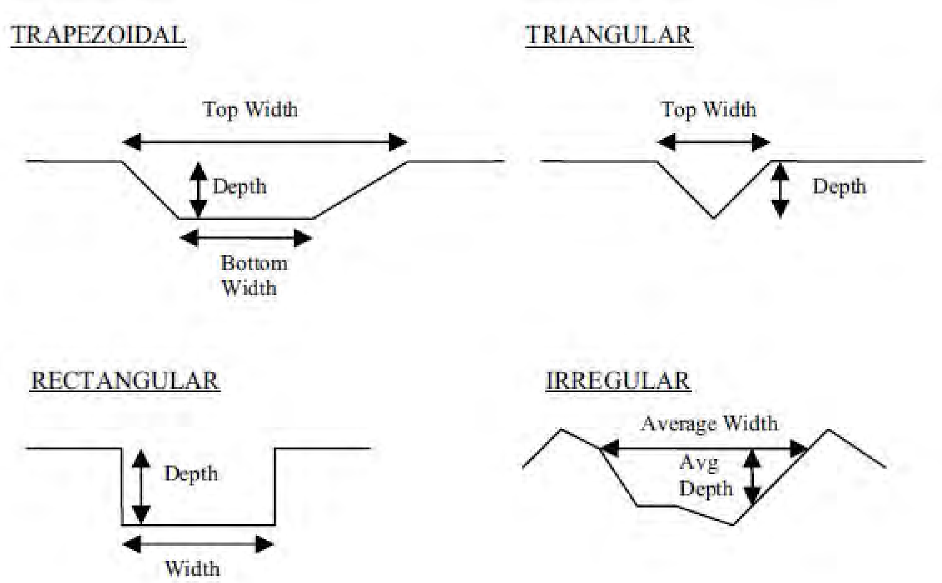
☐ Rectangular

☐ Irregular

depth (ft)

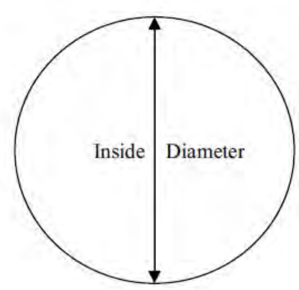
average bottom width (ft)

top width (ft)



☒ **Outlet**

36” inside diameter



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): Drop inlet; water level low.

The Impoundment was Designed By **AEP – in house personnel**

	Yes	No
Has there ever been a failure at this site?	☐	☒
If So When?		

If So Please Describe :

	Yes	No
Has there ever been significant seepages at this site?	☐	☒
If So When?		

If So Please Describe :

	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,...)? Piezometers installed in 2009.

If So Please Describe : Stantec Consulting was retained by the owner to evaluate the condition of the impoundment and installed piezometers during the course of their study.

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.

Information not available.

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