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Coal Combustion Residue Impoundment
Round 9 - Dam Assessment Report

Clinch River Power Plant

Ash Pond Management Units
Appalachian Power
d/b/a American Electric Power
Carbo, VA

Prepared for:

United States Environmental Protection Agency
Office of Resource Conservation and Recovery

Prepared by:

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Fairfax, Virginia

Under Contract Number: EP-09W001727
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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 Clinch River Power Station Ash Pond Management Units (Bottom Ash Pond 1A/1B and Bottom Ash Pond 2) is based on a review of available documents and a site assessment conducted by Dewberry personnel on February 17, 2011. In general, we found the supporting technical documentation provided to be adequate for preparation of this report (Section 1.1.3). For the purpose of this report, Bottom Ash Pond 1A/1B is defined as Ash Pond 1 and Bottom Ash Pond 2 is defined as Ash Pond 2. In summary, Ash Pond 1 is rated FAIR and Ash Pond 2 is rated POOR for continued safe and reliable operation.

An engineer from the Virginia Department of Conservation and Recreation, Dam Safety and Floodplain Management (DCR DSFM) has indicated that the Commonwealth of Virginia plans to take action in 2012 to investigate potential hydrologic and structural stability issues with both Ash Ponds 1 and 2.

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

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dispose of coal combustion residue. This letter was issued under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 104(e), to assist the Agency in assessing the structural stability and functionality of such management units, including which facilities should be visited to perform a safety assessment of the berms, dikes, and dams used in the construction of these impoundments.

EPA requested that utility companies identify all management units including surface impoundments or similar diked or bermed management units or management units designated as landfills that receive liquid-borne material used for the storage or disposal of residuals or by-products from the combustion of coal, including, but not limited to, fly ash, bottom ash, boiler slag, or flue gas emission control residuals. Utility companies provided information on the size, design, age and the amount of material placed in the units (See Appendix C).

The purpose of this report is **to evaluate the condition and potential of residue release from management units for 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 (Appalachian Power d/b/a American Electric Power). Also, after the field visit, additional information was received by Dewberry & Davis LLC from the Owner about the Clinch River Ash Pond Management Units. The additional information was reviewed and also 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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Document 3: DCR Inspection Email to AEP, 2008
Document 4: Dam Safety Inspection Report, by Woodward-Clyde Consultants
Document 5: Ash Pond 1 Stability Analysis, By AEP
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Document 7: Ash Pond 1 Construction of Cutoff Wall, by AEP
Document 8: Clinch River Plant, Dike Inspection Checklist 2008
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Document 14: Clinch River Plant Aerial Survey, Ash Pond 1
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Document 16: Draft Letter, Virginia Department of Conservation and Recreation, Dam Safety Region 4, dated December 29, 2011, #16703 (Flyash Dam No. 1)
Document 17: Draft Letter, Virginia Department of Conservation and Recreation, Dam Safety Region 4, dated December 29, 2011, #16702 (Flyash Dam No. 2)

APPENDIX B

Document 18: Ash Pond 1, Dam Inspection Check List Form
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1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

Conclusions are based on visual observations from a one-day site visit, February 17, 2011, and review of technical documentation provided by the Owner, which is provided in Appendix A.

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

Ash Pond 1 and Ash Pond 2 did not show any areas of significant structural concern during the one-day site visit. The stability analysis report for Ash Pond 1 was prepared, signed and sealed by the Owner's engineers and indicates that the main perimeter dike for Ash Pond 1 is structurally sound. The stability analysis report for Ash Pond 2 was prepared, signed and sealed by BBC&M engineers and indicates that the main perimeter dike for Ash Pond 2 is structurally sound. However the stability analysis report for Ash Pond 2 assumed that only the ash in contact with the existing water table was saturated and not saturated to the top of the ash in the impoundment. This was assumed because at the time the Owner was considering a closure permit for Ash Pond 2 and that it would be capped and would function as a landfill. The Owner submitted the closure plan for Ash Pond 2 for regulatory approval in 2009 but has since retracted the plan.

We note that the Virginia DCR DSFM has not accepted the structural analysis. The reasons for not accepting the analysis include: the analysis was not sealed by a Virginia PE; the analysis does not address large quantities of shale that the State has indicated were illegally dumped on the North end of Pond #2; and the analysis misrepresents saturation conditions because there are no spillways from the ponds. (See Appendix A – Docs 16 and 17)

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

Hydrologic/Hydraulic calculations were not provided for Ash Pond 1 or Ash Pond 2 so conclusions regarding hydrologic/hydraulic safety cannot be made at this time.

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The Virginia DCR DSFM believes that the utility has misrepresented the drainage areas for the ponds and plans to request additional hydrologic analyses in 2012.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

The supporting technical documentation provided is adequate for preparation of this report. Data reviewed by Dewberry did not contain hydrologic/hydraulic calculations. Technical documentation reviewed in preparation of this report is provided in Appendix A.

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

The description of Ash Pond 1 and Ash Pond 2 provided by the Owner was an accurate representation of what Dewberry observed in the field. We note that Virginia DCR DSFM does not believe that accurate information concerning drainage conditions at the site has been provided by the Owner. (See Appendix A – Docs 16 and 17)

1.1.5 Conclusions Regarding the Field Observations

Dewberry staff was provided adequate access to Ash Pond 1 and Ash Pond 2 to complete the field assessment. The visual assessment of the perimeter dikes for both ponds showed no significant signs of erosion, settlement or instability. Seepage was observed along the down slope of Ash Pond 1 but was well controlled with monitoring weirs. No seepage was observed at Ash Pond 2. The spillway for Ash Pond 1 appeared to be functioning properly. The spillway for Ash Pond 2 is currently not active.

During the field assessment it was noted that a large boulder had dislodged from the adjacent hillside and impacted one of the slurry pipes that conveys bottom ash to Ash Pond 1. This pipe showed no visible signs of leakage. Dewberry understands that the boulder would be removed and the pipe repaired as appropriate. No other indications of unsafe conditions or conditions needing immediate remedial action were noted during the one-day site visit.

However, subsequent to the site visit the Regional Engineer, DCR DSFM, who participated in the site visit, indicated considerable concern about the safety of both ash ponds. Based upon observations made during the site

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visit the Virginia DCR DSFM plans to take action in 2012 that could require AEP to analyze and, if necessary, remediate both ash ponds.

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation

Current operation and maintenance procedures appear adequate for Ash Pond 1. Operation and maintenance procedures were discontinued at Ash Pond 2 when it became inactive in 1998.

Virginia DSC DSFM has indicated that woody vegetation control on both dams does not comply with state regulations. (Appendix A – Docs 16 and 17)

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

Current surveillance and monitoring program procedures appear adequate for Ash Pond 1. Although Ash Pond 2 became inactive in 1998, surveillance and monitoring procedures for the pond are still in effect. Ash Pond 2 is monitored at the same time monitoring procedures for Ash Pond 1 are conducted. However, a written record of monitoring results for Ash Pond 2 is not kept.

1.1.8 Classification Regarding Suitability for Continued Safe and Reliable Operation

Clinch River Ash Pond 1 is rated FAIR with acceptable performance expected under static and seismic loading conditions in accordance with applicable safety regulatory criteria. Ash Pond 2 is rated POOR due to use of potentially non-representative assumptions in the structural stability analysis and the lack of hydrologic data addressing drainage to the pond. A hydrologic and hydraulic analysis is required for both units to demonstrate adequate hydrologic loading conditions. The classifications are based on the one-day visual assessment performed by Dewberry and supporting technical documentation provided in Appendix A of this report.

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We note that the Regional Engineer, Virginia DSC DSFM, has indicated that in 2012 the State will require additional hydrology-related action be taken by the utility for Ash Ponds 1 and 2, and that additional structural analyses will be required for Ash Pond 2. (see Appendix A – Docs 16 and 17)

1.2 RECOMMENDATIONS

1.2.1 Recommendations Regarding the Structural Stability

Perform a structural stability analysis of Ash Pond 2 that is representative of ash saturation conditions in the pond.

1.2.2 Recommendations Regarding the Hydrologic/Hydraulic Safety

A hydrologic and hydraulic analysis should be performed to evaluate the hydrologic/hydraulic safety of Ash Pond 1 and Ash Pond 2. The analysis should consider off-site drainage to Ash Pond 1 and Ash Pond 2 and should be in accordance with all requirements for such analyses as required by Virginia Department of Conservation and Recreation (VA DCR), Division of Dam Safety and Floodplain Management, including spillway capacity.

This recommendation is consistent with our understanding of the State's planned actions in 2012.

1.2.3 Recommendations Regarding the Maintenance and Methods of Operation

It is recommended that the facility maintain frequent inspections of Ash Pond 1 and resume recording monitoring results for inspections of Ash Pond 2 in accordance with Owner's current inspection program until such time that the facility is formally closed and the closure is approved by the state.

It is recommended that all underbrush and trees be removed from the Ash Pond 2 perimeter dike in accordance with VA DCR DSFM requirements.

It is recommended that all animal burrows located along the perimeter dike of Ash Pond 1 and Ash Pond 2 be backfilled in accordance with standard geotechnical engineering practices for dams, and monitored for future reoccurrence.

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It is recommended that the Owner perform an interior inspection of all outfall pipes from the Ash Pond 1 & 2 outlet structures to the reclaim pond as well as an interior inspection of the pipe systems that bypass off-site drainage through Ash Pond 1. Interior inspections should focus on the structural integrity of the pipes as well as seepage paths into and out of the pipes. The inspection report should summarize findings and remedial action required, if any.

1.2.4 Recommendations Regarding Continued Safe and Reliable Operation

No recommendations, other than the above studies and maintenance activities, appear warranted at this time.

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants:

- Gary Zych, American Electric Power, S*enior Engineer, Civil Engineering*
- Behrad Zand, American Electric Power, *Engineer II, Geotechnical Engineering*
- Jim Saunders, American Electric Power, *Glen Lynn Plant Director*
- Richard Chatin, American Electric Power
- Edwin Shelton, American Electric Power
- Thomas I. Roberts, PE, CFM, VA Dept. of Conservation & Recreation, D*am Safety Regional Engineer*
- Jim Kohler, United States Environmental Protection Agency, *LCDR, Public Health Services*
- Patrick Kelly, United States Environmental Protection Agency
- Scott Clarke, P.E., Dewberry, *Associate, Water Resources*
- Lorainne Ramos Nieves, P.E., CFM, Dewberry, *Engineer III, Water Resources*

1.3.2 Acknowledgement and Signature

We acknowledge that the management units referenced herein was assessed on February 17, 2011.

COMMONWEALTH OF VIRGINIA
SCOTT C. CLARKE
Lic. No. 033417
9.13.11
PROFESSIONAL ENGINEER

Scott Clarke, P.E.

Lorainne Ramos Nieves, P.E.,CFM

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

2.1 LOCATION AND GENERAL DESCRIPTION

The Clinch River Power Plant, owned and operated by Appalachian Power d/b/a American Electric Power, is located on the Clinch River in Russell County, Virginia off Route 665 near the town of Carbo, see Figure 2.1-1, Location Map and Figure 2.1-2, Aerial Photograph. The Plant functions as a coal-fired electric power station, operating since 1958, and consists of three 235 megawatt generator units.

The Plant contains two management units for storing CCR: Ash Pond 1 and Ash Pond 2. Ash Pond 1 is a multi-cell pond composed of Pond 1A and Pond 1B. Ash Pond 2 is a single-cell pond that is currently inactive and does not receive CCR. Table 2.1 provides some general dimensions of both Ash Ponds.

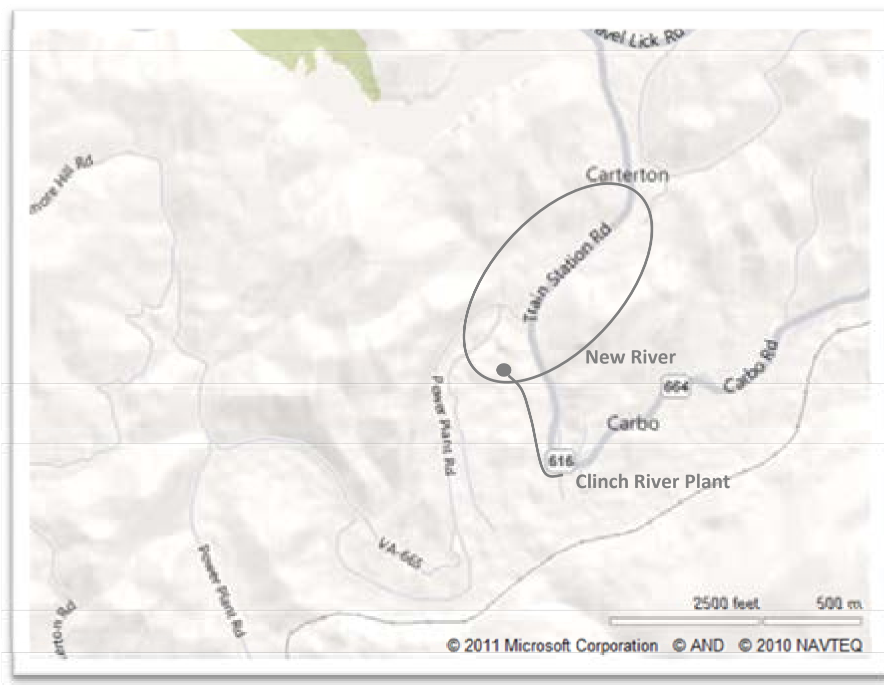

Figure 2.1-1: Location Map

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Figure 2.1-2: Aerial Photograph

Table 2.1: Summary of Approximate Dimensions and Size of Ash Ponds 1 & 2		
	Ash Pond 1 (Pond 1A/Pond 1B)	**Ash Pond 2**
Dam Height (ft)	65[1]	56[2]
Crest Width (ft)	35	20
Length (ft)	3150	1650
Side Slopes (upstream) H:V	1.75:1	3:1
Side Slopes (downstream) H:V	2:1	3:1

[1] Per Owner, however Appendix A, Document 2A: VA DCR, Division of Dam Safety and Floodplain Management inventory reports indicates a dam height of 55 ft.

[2] Per Owner, however Appendix A, Document 2A: VA DCR, Division of Dam Safety & Floodplain Management inventory report indicates a dam height of 65 ft.

2.2 COAL COMBUSTION RESIDUE HANDLING

2.2.1 Fly Ash

Fly ash generated inside boilers at this facility is collected by electrostatic precipitators (ESPs) and moved by forced draft air fans through ducts and into hoppers. Any fly ash remaining on the ESP charged plates is removed through applied vibrations and knocking of the plates. Vacuum

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lines then carry dry ash collected inside hoppers to a concrete fly ash silo. The concrete silos at the plant are approximately 100 ft tall and 30 ft in diameter; each rests on a concrete pad. No secondary containment exists for either the hopper or concrete silos. Once in the silos, fly ash is conditioned with water to prevent dust emissions as well as to facilitate in transportation. Wet fly ash residuals are either sold for beneficial use or hauled in trucks for disposal at an approved offsite landfill.

2.2.2 Bottom Ash

Bottom ash and clinkers from boiler tubes are collected inside hoppers below the boilers. Once residuals reach the hopper, they are watered down and ground into slurry that falls into a sump. From this sump it is pumped to a tank. This tank is used to help equalize and control the solid content of the slurry. Slurry is pumped periodically through basalt-lined iron pipes to Ash Pond 1, a distance of about 1500 ft. Slurry pipes are primarily located above ground and have no secondary containment.

2.3 SIZE AND HAZARD CLASSIFICATION

According to the VA DCR DSFM, inventory reports (Appendix A, Document 2A) Ash Pond 1 has a maximum capacity of 1,240 acre-feet with a maximum design height for storage of 55 feet. Ash Pond 2 has a maximum capacity of approximately 126 acre-feet with a maximum design height of 56 feet (Appendix A, Document 2B). (As noted in Table 2.1, the Owner indicated dam heights of 65 feet and 56 feet, respectively) Based on Table 2.2a, Ash Pond 1 and Ash Pond 2 are classified as intermediate size impoundments since dam height is the controlling factor for both Ash Ponds.

Table 2.2a: USACE ER 1110-2-106
Size Classification

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

Ash Pond 1 and Ash Pond 2 are classified as **Significant** Hazard facilities, see Table 2.2b. If Ash Pond 1 and/or Ash Pond 2 were to fail, it is anticipated that there would be significant environmental losses along Clinch River and Dumps Creek. In addition, it is suspected that there would be damage to State Route 616, State Route

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665 and potentially the Norfolk & Western railway. While loss of human life would not be expected, economic losses would be expected.

We note that State records currently indicate the ponds are listed as Low Hazard dams, but that the State is re-considering the classification (to Significant). (See Appendix A – Docs 16 and 17)

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)

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

The volume of CCRs stored in Ash Pond 1 and Ash Pond 2 at the time of the one-day field assessment was not available by the Owner. Table 2.3 summarizes the storage capacity for Ash Pond 1 and Ash Pond 2.

Table 2.3: Approximate Maximum Capacity of Ash Ponds 1 & 2		
	Ash Pond 1 (Pond 1A/Pond 1B)	**Ash Pond 2**
Maximum Pool Surface Area (acre)	21.0	12.5[1]
Maximum Capacity (cubic yards)	2,000,534	203,280
Maximum Capacity (acre-feet)	1240	126
EL Top Dam, min (ft)	1570	1565
Normal Pool (ft)	1568/1556	1557[1]

[1]Ash Pond 2 is currently inactive and there is no free-standing water. Value corresponds to when the pond was active.

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2.5 PRINCIPAL PROJECT STRUCTURES

2.5.1 Earth Embankment

Ash Pond 1

According to the Dam Safety Inspection Report dated July 18, 1978 (Appendix A, Document 4), Ash Pond 1 was originally built as one large pond; a side hill dike creating an embankment that runs parallel to both Route 616 and Route 665. Subsequently, a splitter dike was constructed that divided the pond into Pond 1A and Pond 1B. The earthen embankment, built in 1955, was originally constructed of silty clay soil with a mixture of shale and sandstone fragments to an elevation of approximately 1540 feet. The original dike has been raised several times since, using the upstream method, to reach its current crest elevation of 1570 feet. The first raise of the dike was composed of fly ash and bottom ash material. All subsequent lifts to the dike have used shale rock (Appendix A, Document 5).

Ash Pond 2

The design summary for the proposed final closure of Ash Pond 2, by BBC&M Engineering, indicates the original pond embankment was constructed in 1954 (Appendix A, Document 6). The embankment has since become a three-tiered dike system consisting of a lower, middle and upper dike. According to soil borings completed in 2006 and 2008, the dikes consist of shale fragments, silty clays, clayey silt and sand. The top of the upper dike has a crest elevation of 1565, although a portion of the dike was removed in 1998 to eliminate the potential of ponding water. The middle and lower dikes remain; each is filled with compacted ash to crest elevations of 1570 and 1559, respectively (per Owner).

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2.5.2 Outlet Structures

Ash Pond 1

The outlet structure for Ash Pond 1 is located in the north corner of cell Pond 1B. The outlet structure consists of an overflow drainage shaft and a 36-inch reinforced concrete pipe that directs water to a catch basin at the toe of the perimeter dike where it then flows through a 30-inch reinforced concrete pipe to an existing reclaim pond adjacent to Clinch River. The outlet structure serves as the principal and emergency spillway for Ash Pond 1.

Virginia DCR DSFM believes this outlet structure is inadequate to handle drainage to the pond (see Appendix A – Doc 16).

Ash Pond 2

The outlet structure for Ash Pond 2 is located at the northeast side of the facility and is currently inactive. The outlet structure consists of an overflow drainage shaft and a 30-inch reinforced concrete pipe. The pipe previously conveyed flow over Dumps Creek via a pipe bridge and below State Route 616 and an existing railroad before combining with outflow from Ash Pond 1 in the existing reclaim pond adjacent to Clinch River. When it was active the outlet structure served as the principal and emergency spillway for Ash Pond 2.

2.6 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

Immediately downstream of Ash Pond 1 and Ash Pond 2 is the Clinch River Power Plant on the opposite side of Clinch River as well as State Routes 616 and 665 and Norfolk & Western railway. The nearest downstream town is approximately 6 miles away at St. Paul, Virginia.

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3.0 SUMMARY OF RELEVANT REPORTS, PERMITS, AND INCIDENTS

3.1 SUMMARY OF LOCAL, STATE, AND FEDERAL ENVIRONMENTAL PERMITS

Virginia DCR – Dam Safety Program

VA DCR has a dam safety program under which Ash Pond 1(Inventory Number 16703) and Ash Pond 2 (Inventory Number 16702) are state-regulated. Each pond was issued a six-year Regular Class III Operation and Maintenance Certificate on March 20, 2008 (Appendix A, Document 2A and Document 2B). Under the dam safety program, AEP is required to submit annual inspection reports to DCR as well as an engineer's inventory report and a renewal certification application at the conclusion of each six year term. Permitting is administered by DCR, dependent on information provided by AEP regarding basic inventory of each pond, an emergency action plan and an operation and maintenance review.

Virginia DEQ – NPDES Permits

Seepage and discharges generated from Ash Pond 1 outfall into a reclaim pond which circulates to a treatment facility that recycles the water for use on site. As there is no direct pond discharge to a neighboring body of water, an NPDES Permit from Virginia Department of Environmental Quality (VA DEQ) is not required for Ash Pond 1. Ash Pond 2, however, is permitted by VA DEQ. The seepage collected at the toe of perimeter dike is discharged directly into Dumps Creek. Seepage discharge is currently listed as Outfall 015 under the NPDES Permit No. VA0001015, issued September 15, 2009. Under this NPDES Permit, AEP is required to submit monthly Discharge Monitoring Reports (DMR) to VA DEQ for this permitted outfall.

3.2 SUMMARY OF SPILL/RELEASE INCIDENTS

Ash Pond 1

No documented spill/release incidents to the best of Dewberry's knowledge.

Ash Pond 2

In 1967, a failure of the lower dike of Ash Pond 2 occurred. SourceWatch documented that approximately 130 million gallons of coal ash slurry spilled into Dumps Creek; however, this figure could not be confirmed by the Owner.

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It is alleged that the spill affected fish and benthic fauna on Dumps Creek and Clinch River as well as aquatic insects, snails and mussel populations. Dewberry requested information from the Owner regarding the failure but after further research by the Owner, no additional documentation was found regarding the incident.

The cause of the failure or the extent of damages to the Plant, roads and railroad has not been documented to the best of Dewberry's knowledge. At the time of failure, the middle and upper dikes had not yet been built. Damage to the lower dike was repaired and Ash Pond 2 was put back in service.

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4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

Ash Pond 1

Ash Pond 1 was built in 1955 as one facility consisting of one continuous side-hill dike.

Ash Pond 2

Ash Pond 2 was built in 1954 as one facility consisting of one continuous side-hill dike located in the old river valley of Dumps Creek, which required re-routing the creek to its current alignment (Appendix A, Document 6). The portion of the dike adjacent to Dumps Creek was armored with rip-rap along the toe of slope.

4.1.2 Significant Changes/Modifications in Design since Original Construction

Ash Pond 1

A splitter dike was constructed in Ash Pond 1, dividing the pond into cells identified by the Owner as Pond 1A and Pond 1B. The original perimeter dike has been raised several times by placement of material directly over the crest of the dike. Toe drains (10-inch perforated pipes encased in gravel backfill) have been installed along the toe of the embankment to control seepage. Seepage discharge collects in a sump pump and in v-notched weirs at the toe of the embankment. All seepage flow is conveyed to the outfall pipe and into the reclaim pond adjacent to Clinch River.

During the period of November through December 1990 a cement-bentonite-fly ash (CBFA) cutoff wall was constructed within the perimeter dike of Ash Pond 1. The cutoff wall served to block potential seepage paths in the dike to improve downstream stability. The cutoff is approximately 2.5 ft wide, 2,150 ft long and reaches a depth of approximately 65 ft. It was installed along the entire length of the perimeter dike and keyed into both abutments as well as the original dike material. Construction of the cutoff wall crossing the existing 68-ft deep, 36-inch diameter outfall pipe was limited to 60 ft deep and 10 ft on both sides of the estimated outfall pipe centerline (Appendix A, Document 7).

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Ash Pond 2

The original Ash Pond 2 dike has been raised several times since it was first constructed in 1954. Since then the original dike has become a three-tiered system, consisting of a lower, middle and upper dike. The original dike was raised by constructing new dikes upslope of subsequently lower dikes and on top of existing fly ash fill. A 12-inch toe drain system encased in gravel was installed along the toe of the middle dike (Appendix A, Document 4). Seepage discharges via one outfall from the toe of the lower dike into Dumps Creek in accordance with an NPDES General Permit.

4.1.3 Significant Repairs/Rehabilitation since Original Construction

Ash Pond 1

There are seepage concerns from the dikes surrounding Ponds 1A and 1B (see more detailed discussion in Section 7.3). In 2006, the Owner commenced with a seepage control project that consisted of placing inverted filters with rip-rap cover along most of the downstream face of the perimeter dike of Ash Pond 1. This project was completed in 2009; however, the Owner has indicated that there are plans to extend the limits of the project to provide near-complete coverage to the downstream face.

Ash Pond 2

No significant repairs/rehabilitation since original construction except for repairs of the dike when it failed in 1967. No additional information was found regarding the repairs that resulted from this event. Section 3.2 elaborates further on the 1967 failure.

4.2 SUMMARY OF OPERATIONAL PROCEDURES

4.2.1 Original Operational Procedures

Data reviewed by Dewberry did not contain the original operational procedures for Ash Pond 1 or Ash Pond 2.

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4.2.2 Significant Changes in Operational Procedures and Original Startup

Significant changes in operation procedures and original startup cannot be confirmed based on the data reviewed by Dewberry.

4.2.3 Current Operational Procedures

Ash Pond 1 is the only active management unit at the Clinch River Power Plant. Ash Pond 2 is currently inactive and has been inactive since 1998. Ash Pond 1 is primarily used for handling all bottom ash residuals generated by plant operations. Fly ash residuals may also be sluiced to Ash Pond 1, though AEP has stated that this is on rare occasions, since nearly 100% of fly ash residuals are hauled off-site to an approved landfill or sold for other beneficial use. Ash Pond 1 is periodically dredged, residuals allowed to dry, and the CCR is trucked off-site to an approved landfill or for other beneficial use.

4.2.4 Other Notable Events since Original Startup

No additional information was provided to Dewberry concerning other notable events, except the 1967 failure of Ash Pond 2, that have impacted the operation of either ash pond.

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5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry personnel, Scott Clarke, P.E. and Lorainne Ramos Nieves, P.E., CFM, performed a site visit on February 17, 2011 in company with the participants listed under Section 1.3.1.

The site visit began at 8:30 AM. The weather was clear and sunny. Photographs were taken of conditions observed and selected photographs are included in this report for visual reference. All pictures were taken by Dewberry personnel during the site visit. Appendix B includes two Coal Combustion Dam Inspection Checklist Forms, one for Ash Pond 1 and one for Ash Pond 2. These checklists provide a good summary and inventory of the items assessed during the site visit.

5.2 ASH POND 1

5.2.1 Crest

The crest of the perimeter dike had no significant signs of depressions, tension cracks or other indications of settlement or shear failure. Figure 5.2.1-1 and Figure 5.2.1-2 shows the typical crest conditions along the perimeter dike.

Figure 5.2.1-1: Crest, West. Clinch River Power Plant to left not seen in this figure.

Figure 5.2.1-2: Crest, Northeast. Route 616 and railroad to right.

5.2.2 Upstream/Inside Slope

The visible upstream slope of the perimeter dike, including all groins, had adequate and well maintained cover of grasses/weeds. The upstream slope below the permanent pool was not observed. There were no obvious signs of scarps, bulging cracks, depressions or other indications of slope instability. Rip-rap armoring was observed at operating pool elevations to mitigate wave erosion. Figure 5.2.2 shows a representative upstream slope section of the perimeter dike looking south.

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Figure 5.2.2: Upstream slope, South. Plant shown in background.

5.2.3 Downstream/Outside Slope and Toe

The visible downstream slope of the perimeter dike had adequate and well maintained cover of grasses/weeds as well as rip-rap armoring and inverted filter. A paved access road from Route 665 runs up the downstream slope of the perimeter dike to its crest. An animal burrow was observed along the downstream slope of the perimeter dike. The burrow hole was small in size and near the crest. No scarps, sloughs, bulging, cracks, depressions or other indications of slope instability were observed along the downstream slope. Figures 5.2.3-1 thru 5.2.3-3 show representative downstream slope sections of the perimeter dike.

Figure 5.2.3-1: Downstream slope near access road entrance off Route 665. Note animal burrow near the crest.

Figure 5.2.3-2: Downstream slope along paved access road, Southwest. Note reclaim beyond the toe of the perimeter dike.

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Figure 5.2.3-3: Downstream slope, Southwest. The embankment runs parallel to Route 616. Note transit pipes along edge of riprap. Transit pipes carry offsite runoff through the pond's splitter dike and out to Dumps Creek.

5.2.4 Abutments and Groin Areas

The perimeter dike has two abutments; the south and north abutments. Both abutment contacts consist of a drainage ditch. The south ditch shows some signs of erosion due to wet weather flow runoff from the adjacent hillside. The north ditch appeared in better condition with some stone and a v-notch weir that is used to monitor seepage, which was present on the day of the assessment. Apart from some minor erosion along the south abutment ditch, both abutments were well maintained. There were no observed scarps, sloughs, bulging, cracks, depressions or other indications of slope instability. Figures 5.2.4-1 and 5.2.4-2 show south and north abutment contacts.

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Figure 5.2.4-1: North abutment ditch. Note upstream riprap and v-notch weir used to monitor seepage.

Figure 5.2.4-2: South abutment ditch. Note downstream slope rip-rap used for seepage control and abutment ditch used to convey hillside drainage.

5.3 ASH POND 2

5.3.1 Crest

Portions of the upper dike have been removed and some re-grading has been completed near the crest of the middle dike. A small sized animal burrow was observed along the crest of the middle dike. No depressions, tension cracks or other indications of settlement or shear failure were observed on the crest of the middle or lower dike. Figure 5.3.1-1 and Figure 5.3.1-2 show typical crest conditions along the dike.

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Figure 5.3.1-1: Lower dike crest, South.

Figure 5.3.1-2: Middle dike crest, South. Note removed portions of upper dike and re-grading near crest of the middle dike.

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5.3.2 Upstream/Inside Slope

Upstream slopes for the middle and lower dikes of the embankment are not visible due to placement of fill material. The upstream slopes of the upper dike were visible. No slope maintenance appears to be in place (pond is currently inactive). Slopes are covered with sparse grass/weeds.

5.3.3 Downstream/Outside Slope and Toe

The downstream slopes of the dikes are covered in high grass/weeds. The upper dike had some areas of tree growth. Significant tree growth between the toe of the lower dike and Dumps Creek made visual observations difficult. Based on what could be observed there were no scarps, sloughs, bulging, cracks, depressions or other indications of slope instability along any portion of the dikes. Figures 5.3.3-1 thru 5.3.3-3 show representative sections of the downstream slopes and toe.

Figure 5.3.3-1: Remaining portion of upper dike, Southeast. Note tree growth on downstream slope.

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Figure 5.3.3-2: Downstream slope of lower dike, Southeast. Note significant tree growth along Dumps Creeks.

Figure 5.3.3-3: Downstream toe of lower dike. Note significant tree growth and rip-rap adjacent to Dumps Creek.

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5.3.4 Abutments and Groin Areas

There were no observed scarps, sloughs, bulging, cracks, depressions or other indications of slope instability at dike abutments and groin areas of upper dike. Significant tree growth was observed along south abutment as shown in Figure 5.3.4.

Figure 5.3.4: South abutment. Note tree growth to the right along hillside; Ash Pond 2 is to the left.

5.4 OUTLET STRUCTURES

5.4.1 Overflow Structure

Ash Pond 1

The overflow spillway structure for Ash Pond 1 is located in the north corner of the facility (Figure 5.4.1-1). The structure appeared to be in satisfactory condition and operating as designed. There were no obvious signs of trash and/or debris around the intake. Water was observed entering the spillway but could not be seen exiting the spillway as the outfall pipe consists of a long storm sewer that outfalls into the existing reclaim pond below its permanent pool.

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Figure 5.4.1-1: Overflow spillway structure

Ash Pond 2

The overflow spillway structure for Ash Pond 2 is located at the eastern midpoint of the facility (Figure 5.4.1-2). The structure appeared to be in poor condition with obvious signs of corrosion and encroaching vegetation. The spillway is currently inactive. Fissures/cracks were observed immediately west of the spillway where it appeared runoff had been migrating into existing ash residuals. The overflow spillway structure is located at an elevation significantly higher than the current finished grade around it. Discharge through the structure and outfall pipes is not possible at this time.

The Virginia DCR representative who participated in the onsite visit indicated particular concern that, as noted above, runoff is migrating into the ash residuals and there is no corresponding outlet for accumulating water.

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Figure 5.4.1-2: Ash Pond 2 overflow structure.

5.4.2 Outlet Conduit

Ash Pond 1

The spillway outlet conduit for Ash Pond 1 consists of a 36-inch reinforced concrete pipe leading to a catch basin that subsequently outfalls to a 30-inch reinforced concrete pipe that drains to the existing reclaim pond. The 30-inch outfall was not visible as it is completely submerged below the permanent pool of the reclaim pond (Figure 5.4.2-1).

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Figure 5.4.2-1: Outlet conduit outfall, reclaim pond at intersection of Route 616 and 665.

<u>Ash Pond 2</u>

The spillway outlet conduit for Ash Pond 2 consists of a 30-inch reinforced concrete pipe. The conduit connects to the same 30-inch reinforced concrete pipe as Ash Pond 1 prior to reaching the reclaim pond. The outlet conduit was not visible at the time of the site assessment.

6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Flood of Record

No documentation was provided to Dewberry regarding local flood records. USGS river gage (USGS 03524000) for the Clinch River, located approximately 4 miles upstream of the plant, shows the largest peak flows occurred during 1957 and 1977. These peak flows are comparable to the Clinch River 1% annual chance (100-year) flood discharges found in the Russell County FIS Study. Therefore, the flood of record is comparable to the base flood elevation. The Russell County FEMA FIRM dated September 29, 2010, Map Number 51167C0215C and the FIRM dated September 29, 2010, Map Number 51167C0205C are provided for reference (See Appendix A, Document 1, Exhibits 1 - 4).

6.1.2 Inflow Design Flood

Data reviewed by Dewberry did not contain Inflow Design Flood information. It should be noted that Ash Pond 1 has the potential of receiving run-off from three areas west of the pond, see Figure 6.1.2-1. Run-off is controlled from entering the pond in Areas 1 & 2 through the use of run-off diversion dams with open headwall culverts that channel flow to an outlet at the eastern edge of the pond. During the site visit these culverts appeared to be joined by a series of manhole structures prior to crossing through the Ash Pond 1 internal dike and outfalling. It was unclear how offsite run-off was controlled from Area 3. Additionally, no controls were observed for offsite run-off draining to Ash Pond 2.

Virginia DCR DSFM plans in 2012 to direct the Owner to further investigate runoff control to and from these ash ponds (see Appendix A – Docs 16 and 17).

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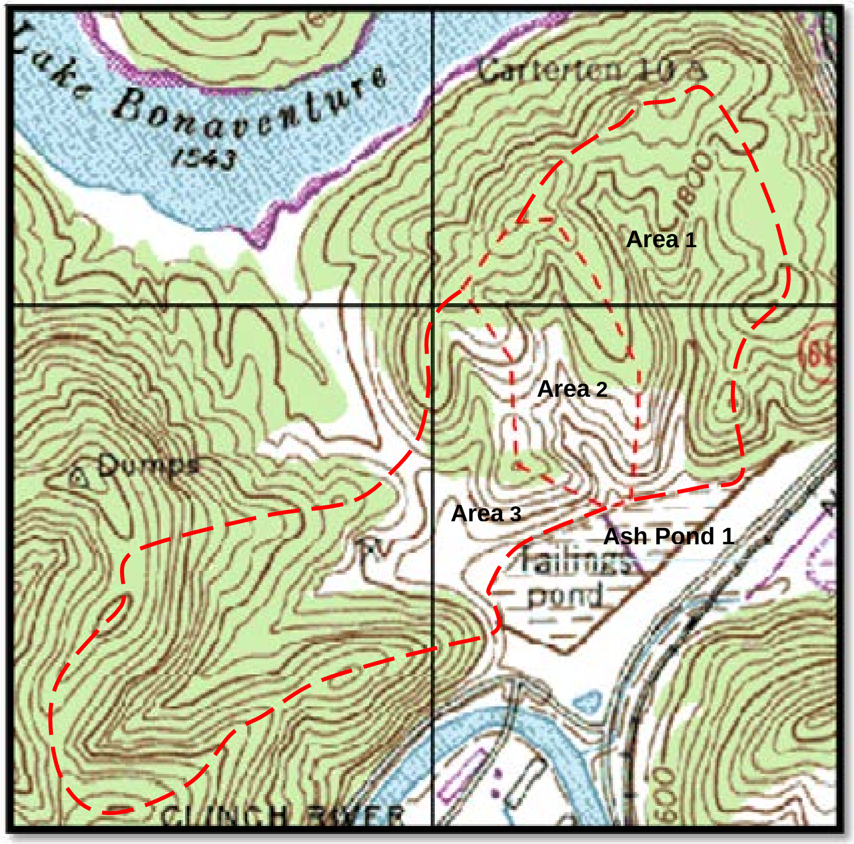

Figure 6.1.2-1: Offsite run-off draining to Ash Pond 1.

6.1.3 Spillway Rating

Data reviewed by Dewberry did not contain Spillway Rating information.

6.1.4 Downstream Flood Analysis

Data reviewed by Dewberry did not contain a detailed technical downstream flood analysis; however, according to the owner, the Emergency Action Plan for the facility contains copies of flood inundation maps and a dam break analysis summary.

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6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Data reviewed by Dewberry did not contain the necessary documentation to make a proper determination on adequacy of hydrologic and hydraulic safety factors. There is also no information on whether hydrologic safety factors were considered in the design of Ash Pond 1 or Ash Pond 2.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

An assessment of Hydrologic/Hydraulic Safety cannot be made at this time.

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7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

Ash Pond 1

A stability analysis report was provided for Ash Pond 1 (Appendix A, Document 5). The stability analysis is based on geotechnical investigations completed by MACTEC in 2009 as well as various instrumentation reading summaries acquired from plant records. The slope stability analysis of the perimeter dike considered static and seismic conditions under steady-state seepage.

Ash Pond 2

A design summary was provided for final closure of Ash Pond 2 (Appendix A, Document 6). With this summary a stability analysis was included. However, this analysis was completed assuming the ash was saturated up to existing groundwater levels and not to the top of the existing ash.

7.1.2 Design Parameters and Dam Materials

Ash Pond 1

A total of 12 boring logs were completed in 2009 by MACTEC. It was determined that the dike material for Ash Pond 1 was primarily composed of shale rock, with the exception of fly ash and bottom ash material that was found in a lower portion of the dike at a depth coincidental to the first raised section of the dike. Refer to Appendix A, Document 5 for more detail regarding design parameters considered in the slope stability analysis.

Ash Pond 2

A total of 8 boring logs were completed in 2008 by BBC&M Engineering and the Owner. It was determined that the dike material consisted of shale fragments, silty clays, clayey silt and sand.

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7.1.3 Uplift and/or Phreatic Surface Assumptions

Ash Pond 1

As part of the 2009 geotechnical investigation, eight new piezometers were installed to complement twelve existing piezometers along the perimeter dike. Piezometers were used to determine phreatic surface elevations at the crest and toe for use in the slope stability analysis.

Ash Pond 2

Groundwater observations were made at the beginning and completion of the eight borings drilled in 2008. Groundwater elevations were noted to generally decrease at borings located closer to Dumps Creek.

7.1.4 Factors of Safety and Base Stresses

Ash Pond 1

Three critical sections were used in the slope stability analysis completed for Ash Pond 1. Seepage conditions at the pond were considered in determining phreatic water surfaces and hydraulic gradients along each section. Each section was analyzed considering steady state seepage using effective shear strength parameters.

Different failure modes were considered for each section under static loading. Analysis of slope stability under seismic conditions considered both drained and undrained shear strength for each section. A summary of the calculated safety factors is included in Table 7.1.4.

Table 7.1.4: Factors of Safety for Clinch River Plant, Ash Pond 1

Section	Static Loading Safety Factor per Failure Mode			Required Safety Factor (US Army Corp of Engineers)	Seismic Loading Safety Factor per Analysis Type		Required Safety Factor (US Army Corp of Engineers)
	Deep Failure	Outer Shell Failure	Block Failure		Drained Shear Strength	Undrained Shear Strength	
A	1.8	1.5	1.9	1.5	1.3	1.3	1.2
B	1.7	1.7	2.0	1.5	1.3	1.4	1.2
C	1.6	1.8		1.5	1.3	1.2	1.2

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Ash Pond 2

As discussed in Section 7.1.1, safety factors from the slope stability analysis completed by BBC&M Engineering cannot be used for the purpose of this report based on design parameters used and assumptions concerning saturated ash levels. Specifically, the BBC&M study fails to analyze margins of safety under total saturation of the ash pond materials.

7.1.5 Liquefaction Potential

Ash Pond 1

Appendix A, Document 5 states that a liquefaction potential analysis was not performed for Ash Pond 1 but that based on other studies performed for similar facilities, including Ash Pond 2, that Ash Pond 1 is believed to have no potential for liquefaction under probable earthquakes that may occur in the region because the magnitude associated with them are not strong enough to impose cyclic stress ratios high enough to cause liquefaction.

Ash Pond 2

Appendix A, Document 6 states that a liquefaction potential analysis was performed for Ash Pond 2 assuming saturated fly ash conditions under long term conditions after closure of the facility. Under these conditions, the analysis concluded that liquefaction would not occur during the applied earthquake load, which was based on a synthetic seismograph record for the location of Ash Pond 2.

7.1.6 Critical Geological Conditions

Clinch River Power Plant is located on Lower Paleozoic sedimentary rock and near the vicinity of a thrust fault.

The Owner's stability analysis referenced a seismic force of 0.16 g at the Clinch River Power Plant, which matches well with the 2008 USGS Seismic-Hazard Maps for Central/Eastern United States, considering peak ground acceleration with a 2-percent probability of exceedance in 50-years (See Appendix A, Document 1, Exhibit 5).

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Bedrock was encountered during bore drilling at Ash Pond 1 and Ash Pond 2. Based on descriptions obtained from the samples, bedrock was classified as very-soft to soft gray shale and hard gray limestone, exhibiting massive bedding with many diagonal fractures. The top of rock was determined to be relatively flat.

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

The supporting technical documentation submitted to support the structural stability of Ash Pond 1 appears to be adequate.

The supporting technical documentation submitted to support the structural stability of Ash Pond 2 is not adequate. A structural stability loading that assumes full saturation of all ash in Ash Pond 2 should be evaluated in addition to the condition that was analyzed (i.e., assumed saturation of the ash up to the existing groundwater table).

7.3 ASSESSMENT OF STRUCTURAL STABILITY

Ash Pond 1

The overall structural stability of the perimeter dike for Ash Pond 1 appears to be **FAIR**, based on a visual site assessment and review of documentation provided. The fair rating reflects continuing concerns of seepage from the pond dikes.

Signs of significant seepage have been recorded as far back as 1975. In 1980, seepage and a wet area were observed along a 150 ft stretch of the perimeter dike adjacent to the cell, Pond 1B, about 22 ft from the toe of the dike (Appendix A, Document 5). Conditions in this location did not notably change after the construction of the cutoff wall along the embankment in 1990. A boil at the toe of the perimeter dike adjacent to the cell, Pond 1A, just above the reclaim pond was also noted to remain after construction of the cutoff wall. Recent inspections in 2008 and 2009 indicate continual wet spots and seeps at different locations along the perimeter dike adjacent to the cell, Pond 1A (Appendix A, Documents 8-10). Based on the one-day site assessment it was evident that seepage is heavily monitored and controlled by the Owner. Close monitoring of seepage at this facility is strongly encouraged as it is necessary in identifying any drastic change in seepage patterns that could potentially affect the structural stability of the perimeter dike.

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Ash Pond 2

Based on a visual site assessment and review of documentation provided, the overall structural stability of the perimeter dikes for Ash Pond 2 appears to be **POOR**. The rating reflects the inappropriate assumptions regarding groundwater elevations in the slope stability analysis and the previous dike failure. It is noted that there was no standing water in this inactive pond. No documented signs of significant erosion damage, cracks, sloughs or releases of materials could be found. The facility was retired in 1998; however, it is encouraged that more frequent inspections and maintenance of the facility continue in accordance VA DCR, Division of Dam Safety regulations and requirements.

The Appendix A - Document 17 draft letter from Virginia DCR reflects the same concerns about the inadequacy of the structural stability analysis of Ash Pond 2.

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8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATING PROCEDURES

Operating procedures are described in Section 4.2.3.

8.2 MAINTENANCE OF THE DAM AND PROJECT FACILITIES

In 1983, the Owner adopted a Dam and Dike Inspection and Maintenance Program (DIMP), where all earthen dams and dikes used for ash storage or disposal, waste water ponds, and large cooling water storage facilities under the Owner's management are routinely inspected, documented, and monitored. Under this program, there are four separate levels of inspection. First is to routinely make inspections by plant personnel to monitor visible changes; second is to make formal 'checklist type' inspections completed by plant personnel on a quarterly basis; third is to routinely schedule engineering inspections supervised by a professional engineer according to the risk classification of the dam; and, fourth are non routine inspections completed after heavy rains, seismic activity or other major events. The inspection and maintenance program continues today for Ash Pond 1. Although Ash Pond 2 became inactive in 1998, inspection and maintenance program for the pond are still in effect, however, a written record of procedures for Ash Pond 2 is not kept.

8.3 ASSESSMENT OF MAINTENANCE AND METHODS OF OPERATIONS

8.3.1 Adequacy of Operating Procedures

Operating procedures reviewed appear adequate for Ash Pond 1. This is also true for Ash Pond 2 before it became inactive in 1998.

8.3.2 Adequacy of Maintenance

Maintenance procedures reviewed appear adequate for Ash Pond 1. Though currently inactive, further consideration to maintaining vegetation and tree growth on Ash Pond 2's upstream and downstream slopes should be addressed until the facility is formally closed through VA DCR, Division of Dam Safety and Floodplain Management, and VA DEQ.

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9.0 ADEQUACY OF SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

Appendix A, Documents 3, 4, 8, 9, 10, 11 and 13 show sample inspections reports and summaries submitted by the Owner in accordance with their adopted Dam and Dike Inspection and Maintenance Program as described under Section 8.2.

9.2 INSTRUMENTATION MONITORING

Ash Pond 1 and Ash Pond 2 are both instrumented. Ash Pond 1 has twenty working piezometers and staff gage present in each cell (Pond 1A and Pond 1B). Ash Pond 2 has approximately fourteen piezometers; however, a continuous record of readings has not been kept at Ash Pond 2 since it became inactive in 1998. Documentation provided by the Owner included reading summaries for Ash Pond 1 piezometers. Data collected from Ash Pond 1 and Ash Pond 2 piezometers was used to monitor phreatic surfaces and prepare stability analysis reports.

9.3 ASSESSMENT OF SURVEILLANCE AND MONITORING PROGRAM

9.3.1 Adequacy of Inspection Program

Based on the data reviewed by Dewberry, including the observations during the site visit, the inspection program appears to be adequate, though inspections should resume for Pond 2 until the facility is formally closed through VA DCR, Division of Dam Safety and VA DEQ.

9.3.2 Adequacy of Instrumentation Monitoring Program

Based on the data reviewed by Dewberry, including the observations during the site visit, the monitoring program appears to be adequate.

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APPENDIX A

Document 1

Exhibits 1 - 5

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Exhibit 1: USGS Peak Streamflow, USGS 03524000 Clinch River at Cleveland, VA

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Data Category: Surface Water   Geographic Area: Virginia   GO

News updated March, 2011

Peak Streamflow for Virginia

- Additional information:
  - Annual Water Data Reports: Water Years 2002-09
  - Historical instantaneous flow data for Virginia: Instantaneous Data Archive - IDA
  - National Weather Service Advanced Hydrologic Prediction Service: River forecasts

USGS 03524000 CLINCH RIVER AT CLEVELAND, VA

Available data for this site   Surface-water: Peak streamflow   GO

Russell County, Virginia
Hydrologic Unit Code 06010205
Latitude 36°56'41", Longitude 82° 09'18" NAD27
Drainage area 533 square miles
Gage datum 1,500.24 feet above NGVD29

Output formats

- Table
- Graph
- Tab-separated file
- peakfq (watstore) format
- Reselect output format

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1862	Feb. 1862	22.80	27,500[7,8]
1902	Mar. 01, 1902	20.30	22,300[7]
1907	Jun. 14, 1907	20.30	22,300[7]
1918	Jan. 29, 1918	19.90[3]	21,500[7]
1921	Jan. 15, 1921	9.80[3]	6,860
1922	Mar. 10, 1922	12.00[3]	9,640
1923	Jun. 13, 1923	17.20[3]	16,400
1924	Jan. 01, 1924	13.00[3]	11,400

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1963	Mar. 12, 1963	22.70	27,200
1964	Mar. 05, 1964	10.03	6,900
1965	Mar. 27, 1965	14.00	11,700
1966	May 02, 1966	10.27	7,260
1967	Mar. 07, 1967	16.75	13,700
1968	Dec. 22, 1967	10.57	6,570
1969	Feb. 02, 1969	8.55	4,600
1970	Dec. 31, 1969	18.63	16,100

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1925	Dec. 09, 1924	10.70[3]	8,480
1926	Feb. 15, 1926	11.00[3]	8,340
1927	Dec. 22, 1926	20.10[3]	20,400
1928	Apr. 30, 1928	8.43[3]	5,200
1929	Mar. 06, 1929	11.40[3]	8,860
1930	Feb. 03, 1930	8.70[3]	5,540
1931	Apr. 04, 1931	11.00[3]	8,340
1932	Jan. 30, 1932	14.38	11,700
1933	Dec. 28, 1932	11.82	8,830
1934	Mar. 03, 1934	11.62	8,610
1935	Apr. 01, 1935	14.12	11,400
1936	Jan. 19, 1936	12.48	10,400
1937	Feb. 09, 1937	11.24	8,750
1938	Oct. 28, 1937	13.38	11,500
1939	Feb. 03, 1939	12.58	10,500
1940	Aug. 14, 1940	20.60	22,500
1941	Mar. 12, 1941	8.92	6,000
1942	Aug. 09, 1942	9.92	7,190
1943	Dec. 30, 1942	12.01	9,710
1944	Feb. 18, 1944	17.95	18,200
1945	Feb. 18, 1945	12.43	9,920
1946	Jan. 08, 1946	16.30	15,400
1947	Jan. 16, 1947	16.10	15,200
1948	Feb. 14, 1948	15.10	13,600
1949	Dec. 04, 1948	12.26	9,360
1950	Feb. 02, 1950	16.53	15,600
1951	Dec. 08, 1950	9.74	6,050
1952	Mar. 11, 1952	10.30	6,740
1953	May 20, 1953	16.66	16,000
1954	Jan. 23, 1954	10.47	6,980
1955	Mar. 07, 1955	16.35	15,500
1956	Apr. 16, 1956	15.38	14,000
1957	Jan. 30, 1957	24.40	31,000
1958	May 06, 1958	15.58	13,900
1959	Jan. 22, 1959	11.20	7,840
1960	Nov. 25, 1959	9.71	6,170
1961	Feb. 26, 1961	15.82	14,300
1962	Dec. 18, 1961	13.45	11,000
1971	May 07, 1971	18.82	16,400
1972	Apr. 15, 1972	16.77	13,700
1973	Mar. 17, 1973	19.94	20,500
1974	Dec. 26, 1973	15.25	12,200
1975	Mar. 30, 1975	18.88	18,400
1976	Jan. 01, 1976	9.68	5,680
1977	Apr. 05, 1977	26.40	34,500
1978	Jan. 26, 1978	20.87	21,200
1979	Jan. 21, 1979	17.85	16,200
1980	Jan. 23, 1980	10.19	6,190
1981	May 29, 1981	8.66	4,700
1982	Feb. 04, 1982	11.90	8,100
1983	Dec. 16, 1982	8.64	5,060
1984	May 07, 1984	19.46	18,700
1985	Feb. 02, 1985	13.66	10,000
1986	Nov. 29, 1985	9.22	5,500
1987	Apr. 17, 1987	16.10	13,300
1988	Feb. 05, 1988	5.61	2,430
1989	May 06, 1989	13.01	9,290
1990	Feb. 10, 1990	11.40	7,590
1991	Mar. 30, 1991	10.56	6,770
1992	Dec. 02, 1991	13.66	10,000
1993	Mar. 24, 1993	14.04	10,400
1994	Feb. 11, 1994	18.54	17,100
1995	Jan. 16, 1995	12.97	9,240
1996	Jan. 27, 1996	15.21	12,100
1997	Mar. 03, 1997	13.43	9,750
1998	Apr. 17, 1998	16.19	13,800
1999	Jan. 24, 1999	8.24	5,010
2000	Jul. 06, 2000	6.61	3,580
2001	Jul. 30, 2001	17.28	15,500
2002	Mar. 18, 2002	21.81	24,300
2003	Feb. 16, 2003	16.07	13,600
2004	Nov. 20, 2003	17.85	16,500
2005	Dec. 10, 2004	10.76	7,490
2006	Apr. 08, 2006	10.46	7,180
2007	Apr. 15, 2007	7.58	4,410
2008	Mar. 05, 2008	10.46	7,180
2009	Jun. 18, 2009	11.49	8,650

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Exhibit 2: FEMA Russell County FIS Study, Table 2-Summary of Discharges.

TABLE 2 – SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA* (sq. miles)	PEAK DISCHARGES (cfs) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
BIG CEDAR CREEK					
At mile 6.68	50.1	3,340	3,950	4,180	4,710
At mile 7.08, upstream of confluence of Roaring Spring Branch	46.7	3,140	3,720	3,940	4,450
At mile 8.55, downstream of confluence of Burgess Creek	46.3	3,140	3,720	3,940	4,450
BIG CEDAR CREEK, Cont.					
At mile 9.04	39.2	2,700	3,210	3,410	3,870
CLINCH RIVER					
At mile 256.0	528.3	22,000	33,000	37,000	51,000
At mile 271.0	468.5	19,500	29,000	33,500	45,500
At mile 273.0	463.7	19,500	29,000	33,500	45,500
GRAVEL LICK CREEK					
At confluence with Lick Creek	2.80	490	790	930	1,340
At mile 1.30	1.90	370	610	730	1,050

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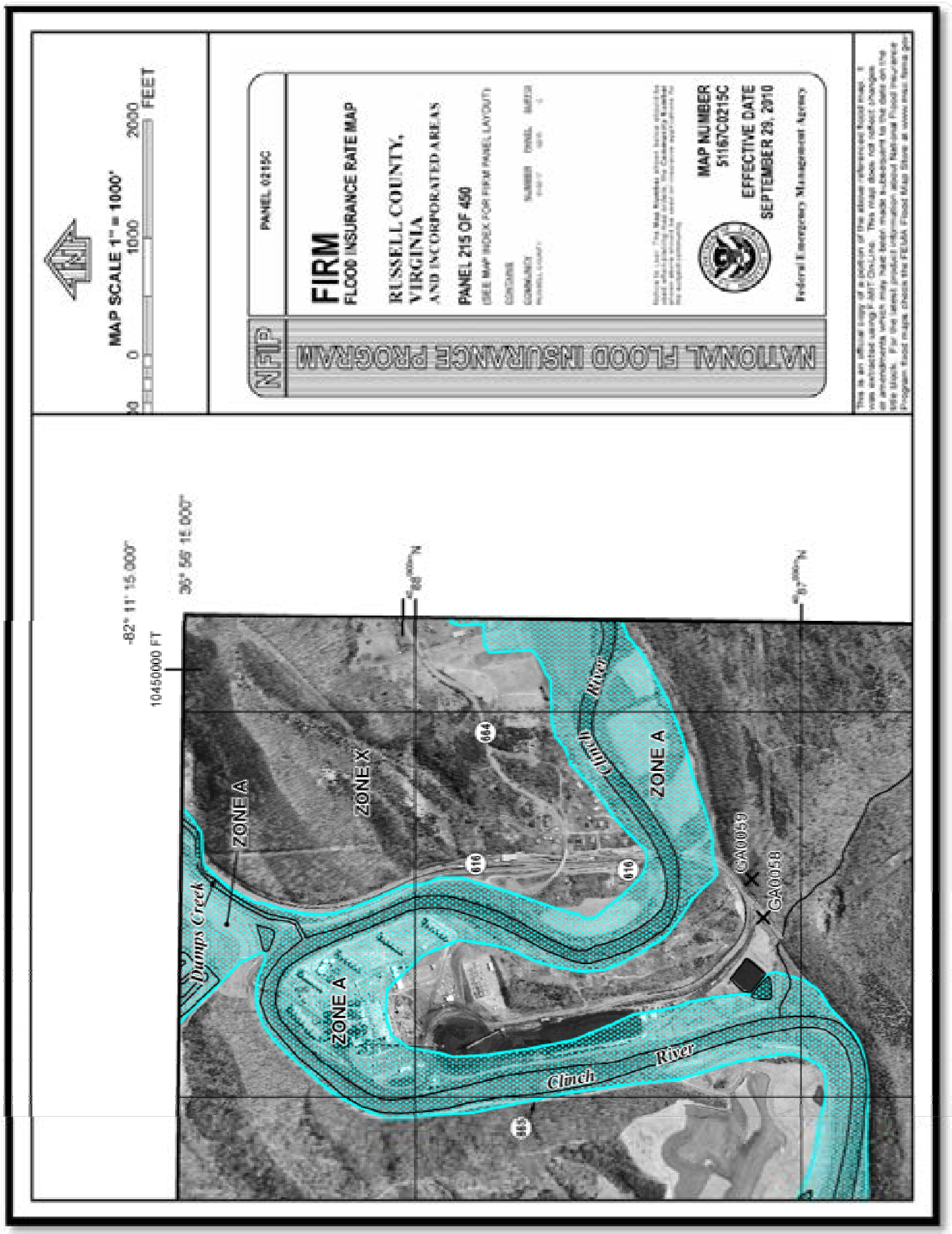
Exhibit 3: FEMA Russell County FIRM, Map Number 51167C0215C



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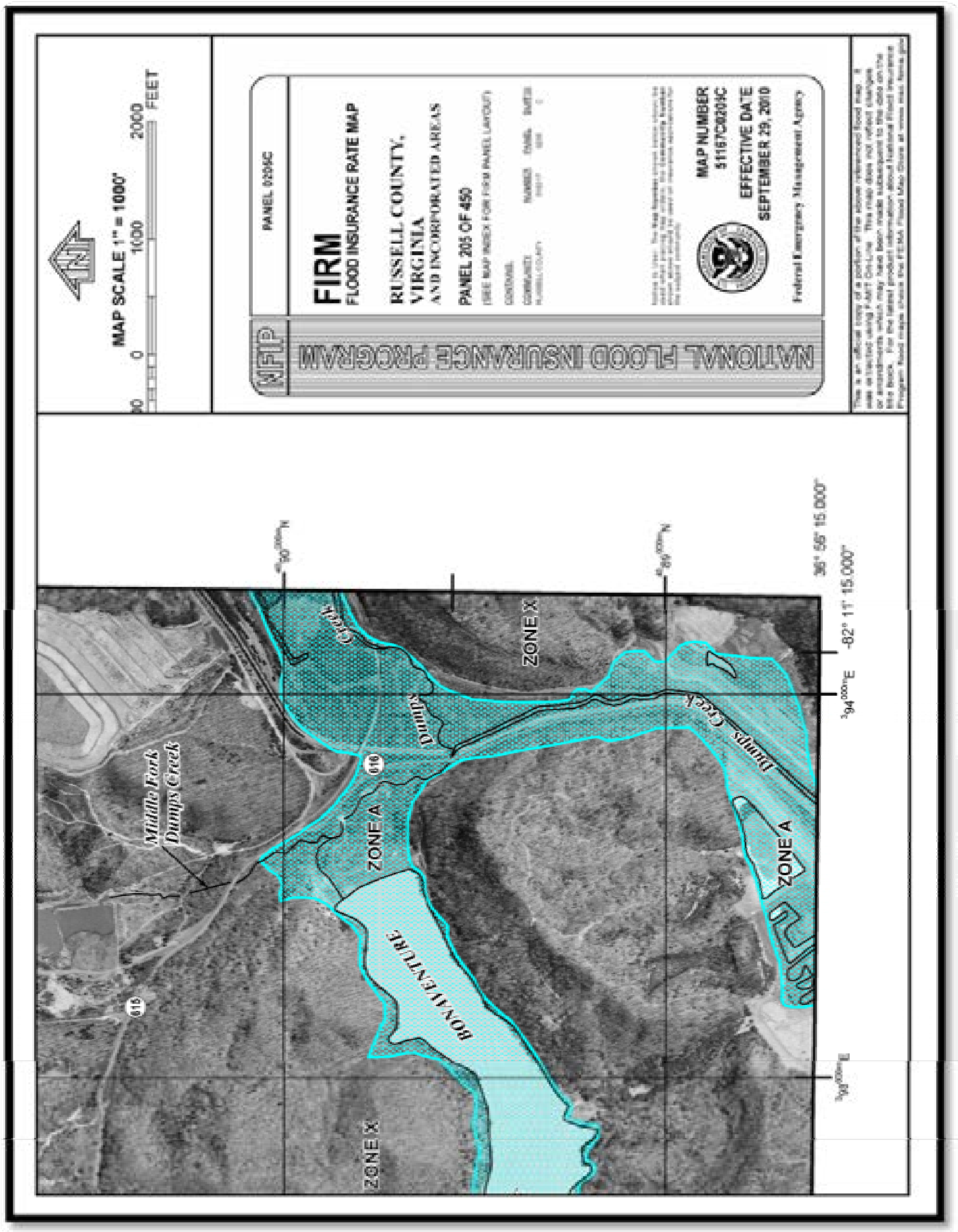
FINAL

Exhibit 4: FEMA Russell County FIRM, Map Number 51167C0205C



US EPA ARCHIVE DOCUMENT

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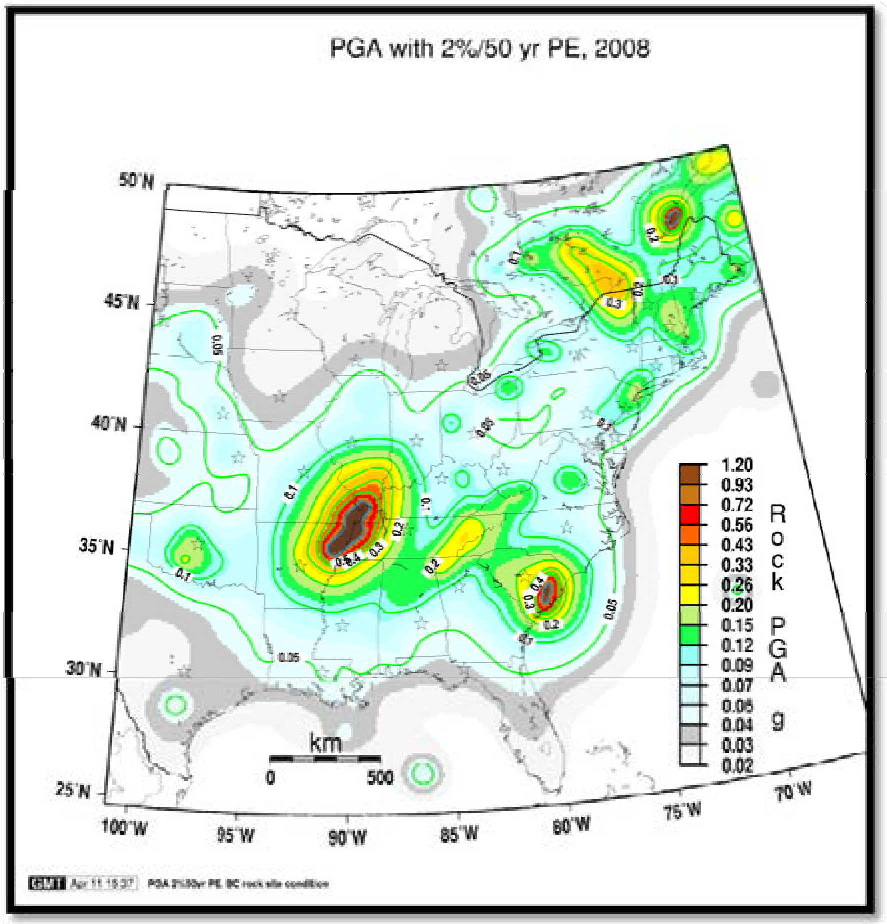
Exhibit 5: USGS Seismic-Hazard Map for Central/Eastern US, 2%/50Years, 2008



US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

APPENDIX A

Document 2A

Virginia DCR Inventory Number 16703 Certificate, Inventory Report and Operation & Maintenance Program

L. Preston Bryant, Jr
Secretary of Natural Resources

Joseph H. Maroon
Director

COMMONWEALTH of VIRGINIA
DEPARTMENT OF CONSERVATION AND RECREATION

203 Governor Street, Suite 206
Richmond, Virginia 23219-2010
(804) 371-6095 Fax (804) 371-2630

April 4, 2008

Appalachian Power Company
Attn: William Smith
Post Office Box 2021
Roanoke, VA 24022

RE: Clinch River Fly Ash Dam #1, Inventory Number 16703

Dear Mr. Smith:

The Operation and Maintenance Certificate Application for Clinch River Fly Ash Dam #1, Inventory Number 16703, and the required supporting documents have been reviewed for compliance with the provisions of the Code of Virginia, Dam Safety Act, (Section 10.1-604 et. seq.) and the regulations promulgated by the Virginia Soil and Water Conservation Board (Board). Based on this information, on March 20, 2008, the Board issued a six-year (03/20/2008 - 3/31/2014) Regular Class III Operation and Maintenance Certificate (Certificate). The Certificate and other pertinent data are enclosed.

The Dam Safety Act requires dam owners to maintain their dam in a condition to prevent unreasonable threats to life and property of others. The classification of your dam and the Certificate issued were based on the current known downstream hazard potential from upstream characteristics, a re-inspection report, operation and maintenance application, and an emergency action plan. The actions contained in the documents accompanying your Certificate Application must be adhered to for the duration of the terms contained in the Certificate. To assist you in adhering to the terms of the Certificate, the following table provides a schedule of dates to submit required documents.

US EPA ARCHIVE DOCUMENT

Annual Owner's Inspection Report	Owner's Engineer Inventory Report	Renewal Certification Six Year Application by Owner and Owner's Engineer
03/31/2009		
03/31/2010		
03/31/2011		
03/31/2012		
03/31/2013	12/31/2013	12/31/2013

Should you have questions, please direct them to Thomas I. Roberts, P.E., Dam Safety Regional Engineer, Department of Conservation and Recreation, Dam Safety and Floodplain Management Division, 8 Radford Street, Suite 203. Christiansburg, VA 24073, telephone 540-394-2550 or via e-mail at Thomas.Roberts@dcr.virginia.gov.

Sincerely,

William G. Browning
Director, Dam Safety & Floodplain Management Division

Enclosures as stated:

c: James M. Robinson, P.E., Dam Safety Program Manager
Thomas I. Roberts, P.E. Dam Safety Regional Engineer

US EPA ARCHIVE DOCUMENT

DATA SHEET - OPERATION AND MAINTENANCE CERTIFICATE

Department of Conservation & Recreation
Division of Dam Safety & Floodplain Management
203 Governor Street, Suite 206
Richmond, VA 23219-2094

Name of Dam: **Clinch River Fly Ash Dam No. 1**	Inventory Number **16703**
Location: **Offstream Dam Near New River**	City/County: **Russell**
Owner: **Appalachian Power Company** **Attn: William Smith** Address: **40 Franklin Road, P.O. Box 2021** City/Town/Zip: **Roanoke, VA 24022-2121**	Designed by **Casa Grande Consultants** Constructed by. **Unknown** Year Constructed **1964**
Type of Dam: **Rockfill**	Purpose: **Sediment-Fly Ash**
Drainage Area (Sq. Mi.): **0.03**	Type of Watershed: **N/A**
Total Height (Ft.): **55**	Elevation: **1570**
Normal Pool Height (Ft.): **53**	Elevation: **1568**
Maximum Capacity (Acre Ft.): **1240**	Maximum Area (Acres): **21**
Normal Capacity (Acre Ft.): **1200**	Normal Area (Acres): **20**
Size Classification: **Medium**	Hazard Classification: **III**
Required Spillway Design Flood: **22% PMF**	Available Spillway Design Flood: **Impounds PMF**
Type of Spillway: **N/A**	*(Note if Section 130)*

Operation and Maintenance Plans & Schedule by: **AEP/Pedro Jose Amaya-Trujillo, VA PE #036174**
() Reinspection or (**X**) Inventory Report by: **AEP/Pedro Jose Amaya-Trujillo, VA PE #036174**

Emergency Action Plan filed with:
(**X**) Virginia Dept. of Emergency Management
(**X**) Local Coordinator of Emergency Services City/County. **Russell County**

Application Reviewed and Recommended for **Six-Year Regular O & M Certificate (3/20/2008-3/31/2014)**

By: **Thomas I Roberts, PE # 19966** Date: **March 17, 2008**

Concurrence with the Recommendation:

By: **William G. Browning, Director** Date **March 19, 2008**

US EPA ARCHIVE DOCUMENT

AEPCR000112

US EPA ARCHIVE DOCUMENT

COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND RECREATION
DIVISION OF DAM SAFETY
VIRGINIA SOIL AND WATER CONSERVATION BOARD

DAM SAFETY CERTIFICATE
REGULAR
CLASS III OPERATION & MAINTENANCE CERTIFICATE NUMBER 16703

Appalachian Power Company, owner of Clinch River Fly As Dam #1 in Russell County, is entitled to operate and maintain this dam pursuant to the provisions of the Dam Safety Act (Section 10.1-604 et seq., Code of Virginia) and Regulations promulgated thereunder.

This certificate is for a term of six years. It becomes effective March 20, 2008 and expires March 31, 2014. In accordance with §4VAC50-20-100F of the Regulations, the owner shall apply for a new certificate 90 days prior to its expiration.

Joseph H. Maroon

DCR

Department of Conservation & Recreation

EMERGENCY ACTION PLAN FOR CLASS I, CLASS II AND CLASS III IMPOUNDING STRUCTURES

Reference: Impounding Structure Regulations, 4VAC52-20-00 et seq., Virginia Soil and Water Conservation Board

1. Name of Impounding Structure: Clinch River Fly Ash Dike No. 1

   Inventory Number: 16703

   Other Name (if any): Ash Area 1A & 1B

2. Hazard Potential Classification from Table I, Virginia Dam Safety Regulations:

   Class I   Class II   Class III (Underline One)

3. Name of Owner: Appalachian Power Company

   Address: 40 Franklin Road, PO Box 2021, Roanoke, VA 24022-2121

   Telephone: (Business)(800) 956-4237 (Residential)(____)

4. Name of Dam Operator: Appalachian Power Company / Clinch River Plant

   Address: PO Box 370, Cleveland, VA 24225

   Telephone: (Business)(276) 889-1540 (Residential)(____)

   Name of Alternate Operator: Operators are at the plant 24 hours per day

   Telephone: (Business)(____) SAME (Residential)(____)

5. Name of Rainfall or Staff Gage Observer for Dam: Team Leader

   Address: c/o Clinch River Plant - address as above.

   Telephone: (Business)(____) (Residential)(____)

   Name of Alternate Observer: N/A

   Telephone: (Business)(____) (Residential)(____)

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6. 24-Hour Dispatch Center Nearest Dam-Police/Fire/Sheriff's

Departments: Russell County Sheriff's Department

Address: Lebanon, VA 24266

Telephone: (Business)(276) 889-8033 (Residential)( )

7. Name of City/County Emergency Management Coordinator(s): Naomi Honaker

Address: 656 Clydesway Drive

P.O. Box 997

Lebanon, VA 24266

Telephone: (Business)(276) 889 8247 (Residential)(276) 873-4508

8. Name, address and telephone number of all occupied dwellings that would be affected in the event of a dam failure, and/or inundation mapping of affected areas.

Name	Address	Telephone Number
NO occupied dwellings would be effected in the event of a dam failure.		

US EPA ARCHIVE DOCUMENT

9. Name, address and telephone numbers of owners of all commercial or recreational establishments that would be affected in the event of dam failure, and/or an inundation mapping of affected areas.

Name	Address	Telephone Number
Failure would effect only Virginia Department of Highways - See Item 11		

10. Name, address and telephone number of owners of property, land and unoccupied buildings that would be affected in the event of a dam failure, and/or an inundation mapping of the affected area.

Name	Address	Telephone Number
See Attachment (Same as 15).		

US EPA ARCHIVE DOCUMENT

11. If there are public roads downstream from the impounding structure, identify by highway number and distance below dam:

Route # 616 , 0 Miles; Route # 665 , 0 Miles;
Route # ___, ___ Miles; Route # ___, ___ Miles.

Provide name of resident engineer, VA Dept. of Transportation, (or City/County engineer)

Mike Branham

Address: Virginia Department of Highways, Lebanon, VA 24266

Telephone: (Business)(276) 889-3131 (Residential)(276) 794-7235

NOTE: Items 12 and 13 should be provided from the Operation and Maintenance Application.

Definitions:

Stage I Condition -- A flood watch, or heavy continuous rain or excessive flow of water from ice or snow melt.

Stage II Condition – A flood warning; or emergency spillway activated or dam overtopping/ breach may be possible.

Stage III Condition – Emergency spillway activated, dam overtopping or imminent failure is probable.

12. Amount of rainfall that will initiate a:

Stage II Condition	See Attachment	inches per 6 hrs.
	See Attachment	inches per 12 hrs.
	See Attachment	inches per 24 hrs.
Stage III Condition	See Attachment	inches per 6 hrs.
	See Attachment	inches per 12 hrs.
	See Attachemnt	inches per 24 hrs.

And/or the amount of flow in the emergency spillway that will initiate a:

Stage II Condition	N/A	feet (depth of flow)
Stage III Condition	N/A	feet (depth of flow)

Total depth of emergency spillway available before crest of dam is overtopped: N/A feet.

13. Frequency of observations by rainfall/staff gage observer during a:
Stage I Condition N/A Stage II N/A
Stage III N/A (recommend continuous)
Please identify access route and means of travel during flood conditions.
N/A

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Note: It is recommended that the Observer remain on post until pool elevation starts to recede.

14. Surveillance and Notification

a. The dam owner/operator **IS RESPONSIBLE** for notifying local government of any problem or potential problem at the dam site.

b. The dam owner/operator **WILL INITIATE** dam surveillance under Stage I conditions, ie, when a flood watch is issued.

c. The dam owner/operator **WILL NOTIFY** the 24-hour dispatch center and the local Emergency Services Coordinator when Stage II conditions are met in order to alert them to review actions that may be required for the safety and protection of people and property.

d. The dam owner/operator **WILL NOTIFY** the 24-hour dispatch center and the local Emergency Services Coordinator to initiate warning of residents when Stage III conditions or imminent dam failure are probable.

e. The owner/operator **WILL BE RESPONSIBLE** for operating such devices as spillway gates and low level outlets such as to cause the dam to function effectively. Attach narrative if required.

f. 24-hour dispatch center should prepare Standard Operating Procedures (SOP's) to implement dam overtopping/failure evacuation plans.

15. Evacuation Procedures:

Note: The dam owner/operator should notify the City/County 24-hour Dispatch Center, as required in paragraph 14d above. Phone # should be listed in [a (1)].

Note: Once the local government has been notified of any problem at a dam site, it should take appropriate protective measures in accordance with the local Emergency Operations Plan and accompanying Emergency Action Plan and Standing Operations Procedures. Other local government actions might include:

(1) Notify the individuals who are directly downstream and in immediate danger. A list of the names, addresses, and telephone numbers of these individuals should be listed in [a (2)].
(2) Monitoring the situation and, if time permits, review of evacuation plans.
(3) Begin Alert, Notification, and Warning
(4) Immediately evacuating the inundation areas, if conditions warrant.
(5) Expanding Direction and Control as well as beginning Emergency Public Information and operating shelters.
(6) Provide Situation Reports to the State Emergency Operations Center (804-674-2400 or 800-468-8892)

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a. Once the local government has been notified of a condition requiring evacuation, the dam owner/operator and local government are mutually responsible for effecting evacuation.

(1) The dam owner/operator will: Notify the Russell County 24-hour Dispatch Center, Telephone (276) 889-8033 and the Emergency Management Coordinator, Telephone (276) 889-8247 home(276) 889-4508 or cell (276) 971-7147.

(2) Local government will: Monitor the situation, begin alert notification and warnings. Immediatly evacutate the inundation areas, if conditions warrant. Expand directions and control as well as beginning Emergency Public Information. Provide situation reports to the State Emergency Operations Center. (804) 674-2400 OR (800) 468-8892.

Individuals who are directly downstream and in immediate danger include:

NAME	ADDRESS	TELEPHONE
See Attachment		

b. Methods for notification and warning to evacuate include:

Check appropriate method(s)

- x (1) Telephone
- x (2) Police/fire/sheriff radio dispatch vehicles with loudspeakers, bullhorns, etc.
- ___ (3) Personal runners for door-to-door alerting
- ___ (4) Radio/television broadcasts for area involved

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16. Certification of Coordination between Owner/Operator and Local Government

Certification by Owner/Operator

I certify that procedures for implementation of this plan have been coordinated with

Russell County ~~(City~~/County) and the local Emergency Management Coordinator. Also, that a copy of this Form has been filed with the State Department of Emergency Management; that this plan shall be adhered to during the life of the project; and that the information contained herein is current and correct to the best of my knowledge.

______________________ (Signature of Owner/Operator)

This 6th day of February, 20 08.

Printed Name Ricky Chafin

Certification by Local Government

I certify that procedures for the warning and evacuation of Russell County (City/County) residents as required in the event of actual or impending failure of the

Clinch River Fly Ash Dike No. 1 (name of dam) have been coordinated with the dam owner/operator.

Naomi Hunaker

(Signature of City/County Official)

This February day of 11th, 20 08.

Printed Name Naomi Honaker

Position HAzmat/E.M. Coordinator

Please fill out and mail to:

Virginia Department of Emergency Management
Emergency Services
10501 Trade Ct.
Richmond, Virginia 23236-3713

Dept. of Conservation and Recreation
Division of Dam Safety
203 Governor Street
Richmond, Virginia 23219-2094

US EPA ARCHIVE DOCUMENT

EMERGENCY ACTION PLAN WORK/DATA SHEET

1. Name of Impounding Structure: Clinch River Fly Ash Dike No. 1

2. Inventory #: 16703 Other Name (if any): Ash Storage area 1A & 1B

3. Total Height: 55' feet (Measured vertically from top of structure to streambed at downstream toe).

4. Total Impoundment Capacity at top of structure: 1240 acre-feet.

5. Size Classification (Circle one): Large Medium (Small)

6. Hazard Classification (Circle one): Class I Class II (Class III)

7. Spillway Design (Circle one): PMF ½PMF 100-YR 50-YR

8. Downstream Inundation Area determined by (Mark one):

   x (1) Judgement

   ___ (2) Empirical Formulas Type used: ____________

   ___ (3) Computer Programs Type used: ____________

9. Critical Conditions used for structure failure (Mark one):

   ___ (1) Failure due to overtopping using:

   ___ PMF

   ___ % PMF

   ___ 100-YR

   ___ Other

   x (2) Failure not due to flooding

   Describe: Embankment instability or failure due to piping or erosion.

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AEPCR000060

Attachment I

Item No. 12

The ash ponds do not receive large quantities of stormwater runoff; therefore, storm event would not result in an overtopping. Water falling directly on the pond will not generate flows which will overtop the structures unless the discharge and emergency overflow systems are not operating simultaneously.

Item No. 15

City of St. Paul Water Plant P.O. Box 66 St. Paul, Virginia 24283	Earl Carter Office: (276) 762-9683 Home: (276) 762-7161
St. Paul Police Department 16531 Russell Street St. Paul, Virginia 24283	Office: (276) 762-5022
Wise County PSA Waterworks * Carfax Plant Rt. 3, Box 7368 Coeburn, Virginia 24230	Roy Markham Office: (276) 762-0159 Home: (276) 359-5880
Virginia Department of Environmental Quality P.O. Box 976 Abingdon, Virginia 24210	Michael Overstreet Office: (276) 676-4800
Southeast Railroad Contractors, Inc. 1235 Ohio Avenue Salem, Virginia 24153	James P. Aldridge Office: (540) 387-1620

* If unable to contact Wise County PSA Waterworks, please contact the Wise County Sheriff's Department at (276) 328-3566

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DCR

Department of Conservation & Recreation

CONSERVING VIRGINIA'S NATURAL & RECREATIONAL RESOURCES

INVENTORY REPORT FOR CLASS III AND CLASS IV IMPOUNDING STRUCTURES

Reference: Impounding Structure Regulations, 4VAC50-20-00 et seq., Virginia Soil and Water Conservation Board

1. Project Information:
   - a. Name of Impounding Structure Clinch River Fly Ash Dike No. 1
   - b. Inventory Number 16703 Other Name (if any) ---
   - c. Name of Reservoir Clinch River Plant Bottom Ponds 1A & 1B
   - d. Purpose of Reservoir Sedimentation of Bottom Ash

2. Location of Impounding Structure:
   - a. City/County Russell County Magisterial District Cleveland
   - b. Located adjacent to ~~feet/miles upstream/downstream of~~ Highway, No. 665
   - c. Name of River or Stream Does not impound, but is near Clinch River
   - d. Latitude N36 55' 30" Longitude W82 11'20"

3. Ownership:
   - a. Owner's Name Appalachian Power Company
   - b. Mailing Address 40 Franklin Road; P.O. Box 2021

     Roanoke, VA 24022-2121
   - c. Telephone (800) 956-4237

4. Owner's Engineer:
   - a. Engineering Firm/Engineer American Electric Power Service Corporation
   - b. Professional Engineer Virginia Number Pedro Jose Amaya-Trujillo, VA#036174
   - c. Mailing Address 1 Riverside Plaza; Columbus, OH 43215
   - d. Telephone (614) 223-1000 OR (614) 223-2926

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5. Impounding Structure Data (All elevations NGVD unless noted):

a. Type of Material earth __X__ concrete ___ masonry ___

Other ___

	Design Configuration	
b. Top of Dam	1570	Elev. (if known)
c. Downstream Toe (Lowest)	1515	Elev. (if known)
d. Height of Dam	55	Feet
e. Crest Length (Exclusive of Spillway)	3150	Feet
f. Crest Width	35	Feet
g. Upstream Slope	1.75 H: 1	V
h. Downstream Slope	2 H: 1	V

6. Reservoir Data

	Design Configuration	
a. Maximum Capacity	1240	Acre-feet
b. Maximum Pool	1568	Elev. (if known)
c. Maximum Pool Surface Area	21	Acres
d. Normal Capacity	1115	Acre-feet
e. Normal Pool	1A 1568; 1B 1556	Elev. (if known)
f. Normal Pool Surface Area	16	Acres
g. Freeboard (Normal Pool to Top)	1A 3ft; 1B 14	Feet
h. Freeboard (Normal Pool to Emergency)	N/A	Feet

7. Spillway Data

	Type	Construction Material	Maximum Capacity
a. Low Level Drain	N/A	---	---
b. Principal Spillway	Variable Weir	Steel	180 cfs
c. Emergency Spillway	N/A	---	---

	Design Configuration	
d. Low Level Drain	None	Elev. (if known)
e. Principal Spillway	variable 1555-1568	Elev. (if known)
f. Emergency Spillway	None	Elev. (if known)

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AEPCR000063

g. Briefly describe the low level drain and principal spillway to include dimensions, materials of construction, trash guards, location in reservoir and through dam, and orientation of intake and discharge to dam if looking downstream: There is no low level drain because it would become clogged with bottom ash or would discharge bottom ash. Principal spillway is a variable elevation side hill structure with remote control gate valve.

h. Describe the emergency spillway to include dimensions, whether the spillway is an earth channel or other construction, spillway surface protection, and orientation to dam if looking downstream: None - This is an upground reservoir which is filled by pumping.

8. Watershed Data (Class III only):

a. Drainage Area 22 acres (including pond surface) 0R .034 Sq. Miles

b. Type and Extent of Watershed Development ---

c. Time of Concentration ______ Method ______

d. Spillway Design Flood used (mark appropriate box)

____ PMF, source ______

____ 1/2 PMF, source ______

____ 100 Year, source ______

____ 50 Year, source ______

X Other, source Not Applicable - upground reservoir

e. Design inflow hydrograph: Volume --- acre-feet;

Peak inflow --- C.F.S.;

Rainfall duration of design inflow hydrograph --- hours

f. Freeboard during passage of spillway design flood --- feet

9. Impounding Structure History

a. Date construction completed 1964, modified 1971

b. Design by Casagrande Consultants Date: unknown

c. Built by Unknown Date: 1964

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d. Inspection dates 1978, 1980, 1982, annually from 1984-2005 and 2007

e. Inspections by Woodward-Clyd Consultants, AEP and Geosytec Consultants

f. Description of repairs Toe drain rebuilt in 1988. Drainage blanket constructed on d/s slope in 1984. Slurry trench cutoff wall in 1993. North end of toe drain rebuilt in 1991. Drainage blanket to cover most sections of the slope started in 2005.

g. Has the impounding structure ever been overtopped? ____ Yes x No

10. Impounding Structure Assessment:

a. Provide brief descriptions for each item:

i. Condition of the impounding structure Good

ii. Condition of the reservoir Good

iii. Condition of the upstream area Good

iv. Condition of the downstream area Good

b. Provide a narrative describing any recent changes in the impounding structure, reservoir, upstream area, and downstream area: Continue placement of drainage blanket on d/s slope until the low third is entirely covered.

c. Recommendations for remedial measures: continue routine brush cutting and piezometer readings; fill gullies and rodent burrows if they develop; maintain proper operation of seepage control features.

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11. Provide a sketch of the impounding structure.

See Attached Sketch.

CERTIFICATION BY OWNER'S ENGINEER (Class III only)

I hereby certify that the information provided in this Inventory Report has been examined by me and found to be true and correct in my professional judgment.

Signed Pedro J. Amaya
(Professional Engineer)

Virginia Number 036174

This 19th day of February, 2008

CERTIFICATION BY OWNER (Class IV only)

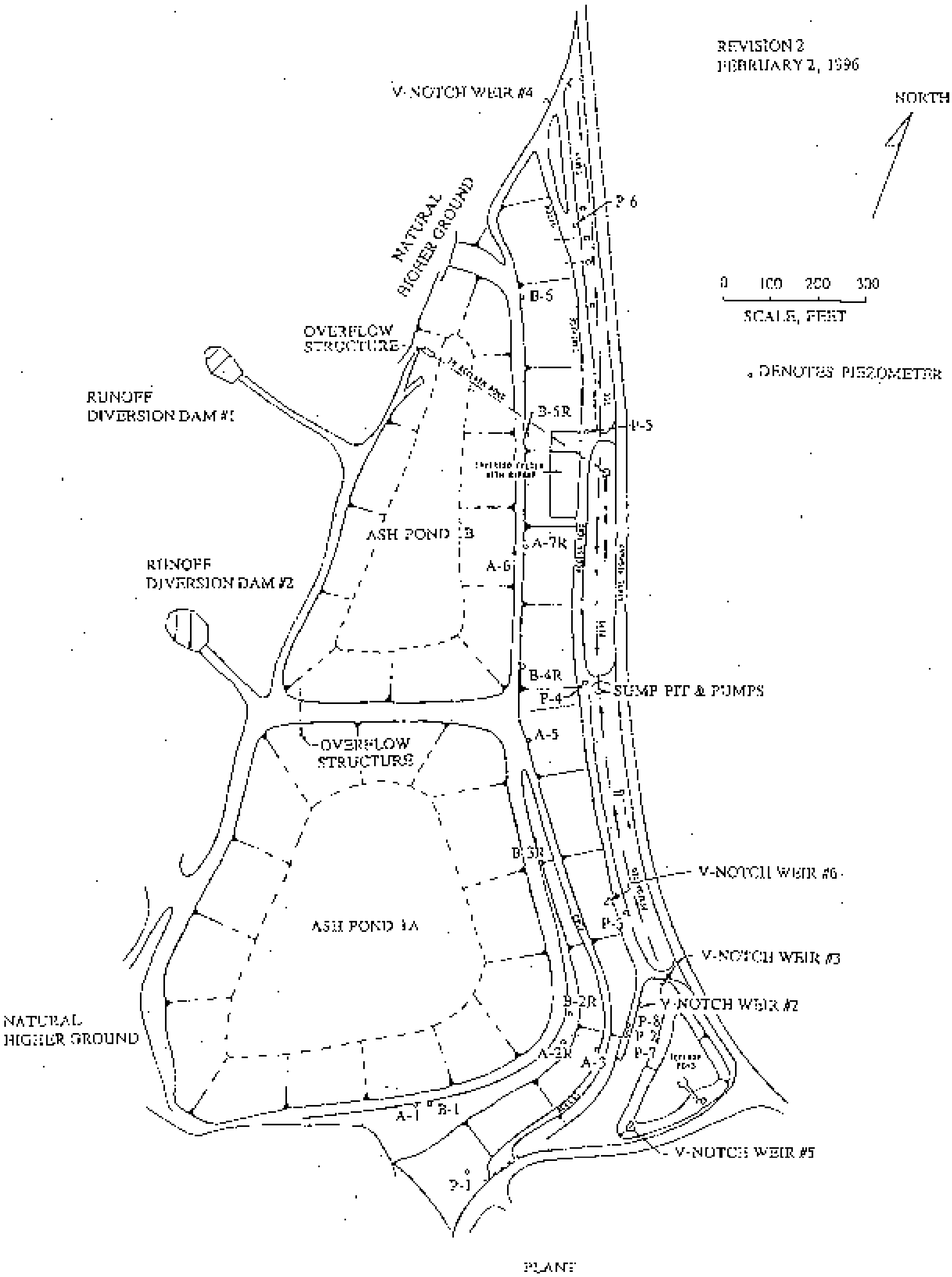
I hereby certify that the information provided in this Inventory Report is true and correct.

Signed ____________
(Owner)

This 1st day of February, 20 08

Please fill out and mail to:
Department of Conservation and Recreation
Division of Dam Safety
203 Governor Street
Richmond, Virginia 232192094

US EPA ARCHIVE DOCUMENT



CLINCH RIVER PLANT - ASH AREA 1 DIKE INSPECTION LOCATION PLAN

US EPA ARCHIVE DOCUMENT

DCR

OPERATION AND MAINTENANCE APPLICATION
CLASS I, II AND III IMPOUNDING STRUCTURES

Reference: Impounding Structures Regulations, 4VAC 50-20-00 et seq., Virginia Soil and Water Conservation Board

1. Name of Impounding Structure: Clinch River Fly Ash Dike No. 1

   Inventory Number: 16703 Other Name (if any) Ash Storage Area 1A & 1B

2. Hazard Potential Classification from Table 1, Impounding Structure Regulations:

   (Circle One) Class I Class II **(Class III)**

3. Name of Owner: Appalachian Power Company

   Address: 40 Franklin Road, P.O. Box 2021, Roanoke, VA 24022-2121

   Telephone: (Business) (800) 956-4237 (Residential) ( )

4. Operating Plan and Schedule.
   Provide a narrative for each item:

   a. Operation of control gates and spillways. See Attachment I

   b. Operation of Reservoir Drain (not to exceed ½ foot drawdown per day on embankment dams). See Attachment I

5. Maintenance Plan and Schedule
   Provide a narrative for each item:

   a. Embankment Dams:
      (1) embankment: See Attachment I
      (2) principal spillway: See Attachment I
      (3) emergency spillway: See Attachment I
      (4) low level outlet: See Attachment I
      (5) reservoir area: See Attachment I
      (6) downstream channel: See Attachment I
      (7) other: See Attachment I

   b. Concrete dams (including masonry and others):
      (1) upstream face: Not Applicable

US EPA ARCHIVE DOCUMENT

(2) downstream face: N/A

(3) crest: N/A

(4) galleries: N/A

(5) tunnels, etc.: N/A

(6) abutments: N/A

(7) spillways: N/A

(8) gates and outlets: N/A

(9) other: N/A

6. Inspection schedule (attach schedule and checklist):

(1) operator inspection (daily, weekly, etc.) Weekly - No Checklist

(2) maintenance inspection (monthly, quarterly, semi-annual, annual) Quarterly - Checklist Attached

(3) technical safety reinspection by a professional engineer. (required for certification update: Class I dams every two years, Class II dams every three years. All dams inspected after overtopping).

Inspected annually by a professional engineer and submitted to the state.

7. Emergency Action Plan Schedule.

Provide the information that initiates the Emergency Action Plan:

a. rainfall amounts and/or: This is an upground reservoir with little or no drainage area beyond its own perimeter.

b. spillway flows: water in-flow is controlled by pumping of ash/water slurry. EAP would be triggered by embankment instability or failure due to piping or erosion.

c. frequency of observation:

8. For a newly constructed impounding structure, provide certification from a Professional Engineer who has inspected the impounding structure during construction that, to the best of the engineer's judgment, knowledge and belief, the impounding structure and all appurtenances have been constructed in conformance with the plans, specifications and drawings submitted to the Department of Conservation and Recreation.

Not Applicable

US EPA ARCHIVE DOCUMENT

AEPCR000069

OPERATION AND MAINTENANCE PERMIT APPLICATION

OPERATION AND MAINTENANCE SCHEDULES
CERTIFICATION BY OWNER

I hereby certify that the operation and maintenance plans and schedules provided herewith will be adhered to during the life of the project except in cases of unanticipated emergency requiring departure therefrom in order to mitigate hazards to life and property, at which time my engineer and the Department of Conservation and Recreation will be notified.

Signed: ____ (Owner)

This 1st day of February, 20 08

CERTIFICATE BY OWNER'S ENGINEER

I hereby certify that the information provided in this form has been examined by me and found in my professional judgment to be appropriate to operation and maintenance considerations for this dam.

Signed: Pedro J. Amaya (Professional Engineer) Virginia Number: 036174

This 19th day of February, 20 08

Remarks: This upground reservoir has been operated successfully for many years for the purpose of sedimentation of bottom ash. We intend to continue our program of careful operation with frequent periodic inspections and we will continue to perform remedial repairs and maintenance as required by field conditions.

Please fill out and mail this form to:
Department of Conservation and Recreation
Division of Dam Safety
203 Governor Street
Richmond, Virginia 23219-2094

COMMONWEALTH OF VIRGINIA
PROFESSIONAL ENGINEER
2/02/2008

US EPA ARCHIVE DOCUMENT

AEPCR000070

Attachment I

4a. Operation of control gates and spillways: The discharge structure for this pond consists of a variable elevation vertical drainage shaft connected to a 36-inch diameter reinforced concrete pipe. The overflow elevation of the spillway may be changed by inserting or removing steel plates. Flow is controlled by a pneumatic piston activated slide gate which responds to water level sensors at the recirculation pond. Freeboard is sufficient to store the Probable Maximum Flood.

4b. Operation of Reservoir Drain: There is no reservoir drain of this facility because such a drain would either become clogged with bottom ash or would discharge it from the pond. The pond can be drained by pumping, if desired.

5a. (1) Embankment: The upstream and downstream slopes are visually inspected by plant personnel several times each week. Items checked for include signs of instability, seepage, rodent burrows, erosion features and vegetative cover. Grass, brush and tree cutting is done as needed. Rodent burrows and erosion gullies are filled in when they are found.

(2) Principal Spillway: The principal spillway for this upground reservoir consists of a variable elevation side-hill overflow structure connected to a 30-inch diameter discharge pipe. It is inspected visually by plant personnel several times each week, and would be repaired promptly by plant personnel or contract forces if necessary.

(3) Emergency Spillway: Not applicable – see 4a above.

(4) Low Level Outlet: Not Applicable

(5) Reservoir Area: Since this is an upground reservoir, the reservoir area is checked when the upstream slopes are inspected.

(6) Downstream Channel: The pond's 36-inch diameter discharge pipe terminates at a concrete sump box, where the discharge waters are collected and pumped to a recirculation pond.

(7) Other: No comment.

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CLINCH RIVER PLANT
DIKE INSPECTION CHECKLIST

1. GENERAL INFORMATION

Date of Inspection ______________________

Inspected by ______________________

Weather ______________________

Temperature ______________________

Rainfall During Past 7 Days ______________________

Reservoir elevations at time of inspection:

Pond 1A ______________________

Pond 1B ______________________

Pond 2 ______________________

2. EMBANKMENT CONDITION AT PONDS 1A & 1B

Please refer to the Ash Area 1 Dike Inspection Location Plan which is found on Page 8. Place a number and a descriptive sketch on the location plan at each problem area. Place the same number(s) next to the appropriate description(s) below.

DESCRIPTION	LOCATION NUMBERS
Cracks	______________________
Bulges	______________________
Sliding	______________________
Erosion	______________________
Soft Soil	______________________

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Leaking Pipe	________
Seepage/Wetness	________
Vegetative Cover	________
Trees on Slope	________
Hillside Runoff Drain #1	________
Hillside Runoff Drain #2	________
Rodent Burrows	________
Other (Please Specify)	________

3. PIEZOMETERS READINGS AT PONDS 1A & 1B

PIEZ. NO.	ELEV., TOP OF TUBE	DEPTH TO WATER FROM TOP OF TUBE	WATER ELEVATION	COMMENTS
A-1	1571.0			
A-2R	1569.5			
A-3	1535.0			
A-5	1572.2			
A-6	1571.3			
A-7R	1572.0			
B-1	1571.2			
B-2R	1571.1			
B-3R	1570.9			
B-4R	1571.1			
B-5R	1571.4			
B-6	1571.8			
P-1	1529.9			

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P-2	1520.6	________	________	________
P-3	1519.9	________	________	________
P-4	1518.6	________	________	________
P-5	1512.6	________	________	________
P-6	1517.0	________	________	________
P-7	1523.2	________	________	________
P-8	1521.2	________	________	________

4. V-NOTCH WEIRS

Please determine the flow rate in gallons per minute for each of the V-notch weirs. This can be done by measuring the head H of water above the apex of the V-notch to the nearest 1/4 inch and comparing it to the chart below.

HEAD, H, INCHES	FLOW RATE, GPM 90° WEIR	FLOW RATE, GPM 22½° WEIR	HEAD, H, INCHES	FLOW RATE, GPM 90° WEIR	FLOW RATE, GPM 22½° WEIR
1	2	0.75	3	37	7.2
1 1/4	4	1	3 1/4	45	8.9
1 1/2	6	1.4	3 1/2	53	10.8
1 3/4	9	1.9	3 3/4	65	12.5
2	12	2.6	4	76	14.5
2 1/4	17	3.4	4 1/4	88	16.8
2 1/2	24	4.6	4 1/2	100	19
2 3/4	30	5.9	4 3/4	114	21.6

V-notch Weir #1: ________________ gallons per minute
V-notch Weir #2: ________________ gallons per minute
V-notch Weir #3: ________________ gallons per minute
V-notch Weir #4: ________________ gallons per minute
V-notch Weir #5: ________________ gallons per minute
V-notch Weir #6: ________________ gallons per minute

5. SEEPAGE COLLECTION SUMP

Please determine the flow rate, in gallons per minute, of the two branches of the French drain at the 8 foot diameter seepage collection sump. This can be done by measuring how much the water

US EPA ARCHIVE DOCUMENT

level rises while recording the time during a period when both pumps are off. Flow rate is given by the following formula:

$$\text{FLOW RATE,} = \frac{(3.1416)(16)(7.48)(60)H}{t}$$

in which H = rise of water level in feet during the unpumped time interval t, in seconds.

FLOW RATE = ______________________ GALLONS PER MINUTE

6. DISCHARGE STRUCTURE AT POND 1B

Please note the conditions with regard to the following:

Condition of concrete ______________________

Are stoplogs available? ______________________

Obstructions ______________________

Foreign object in pond? ______________________

Pedestrian access O.K.? ______________________

Erosion Problems ______________________

Other (Please specify) ______________________

7. MISCELLANEOUS AT PONDS 1A & 1B

Is seepage repair area O.K.? ______________________

____

What is condition of French drain? Is white precipitate building up impeding drainage?______________________

____

What is the overall condition of the discharge structure from Pond 1A to Pond 1B?

____

US EPA ARCHIVE DOCUMENT

Are seepage sump pumps O.K.? ______________________

____

Is entrance to 24"φ seepage overflow pipe clear of obstructions? ______________________

____

8. PONDS 1A & 1B NOTES AND COMMENTS INCLUDING JOB ORDERS WRITTEN AND REPAIRS/MAINTENANCE SINCE LAST INSPECTION:

____

____

____

____

____

9. EMBANKMENT CONDITION AT POND 2 AREA

Please refer to the Ash Area 2 Dike Inspection Location Plan which is found on Page 9. Place a number and a descriptive sketch on the location plan at each problem area. Place the same number(s) next to the appropriate description(s) below.

DESCRIPTION	LOCATION NUMBERS
Cracks	______
Bulges	______
Sliding	______
Erosion	______
Soft Soil	______
Leaking Pipe	______
Seepage/Wetness	______

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DESCRIPTION	LOCATION NUMBERS
Vegetative Cover	
Trees on Slope	
Rodent Burrows	
Other (Please Specify)	

10. PIEZOMETER READINGS AT POND 2 AREA

PIEZ. NO.	ELEV., TOP OF TUBE	DEPTH TO WATER FROM TOP OF TUBE	WATER ELEVATION	COMMENTS
P-1	1557.0			
P-2	1555.8			
P-3	1556.7			
P-4	1557.4			
P-5	1557.7			
P-6	1557.4			
P-7	1557.9			
P-8	1557.4			
P-9	1558.2			
U-1	1560.0			
U-2	1561.1			
U-3	1560.0			
U-4	1560.0			
L-5	1532.0			
L-6	1532.0			
L-7	1535.3			
L-8	1534.7			

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11. IS PERFORATED DRAIN PIPE BETWEEN LOWER LEVEL AND MIDDLE LEVEL DIKES WORKING PROPERLY AND IN GOOD CONDITION?

____

____

____

12. DISCHARGE STRUCTURE AT POND 2

Please note the conditions with regard to the following:

Condition of concrete ____________________

Gates/valves operational? ____________________

Obstructions ____________________

Is access clear? ____________________

Erosion problems ____________________

Other (Please specify) ____________________

13. POND 2: NOTES AND COMMENTS INCLUDING JOB ORDERS WRITTEN AND REMEDIAL WORK DONE SINCE LAST INSPECTION

____

____

____

____

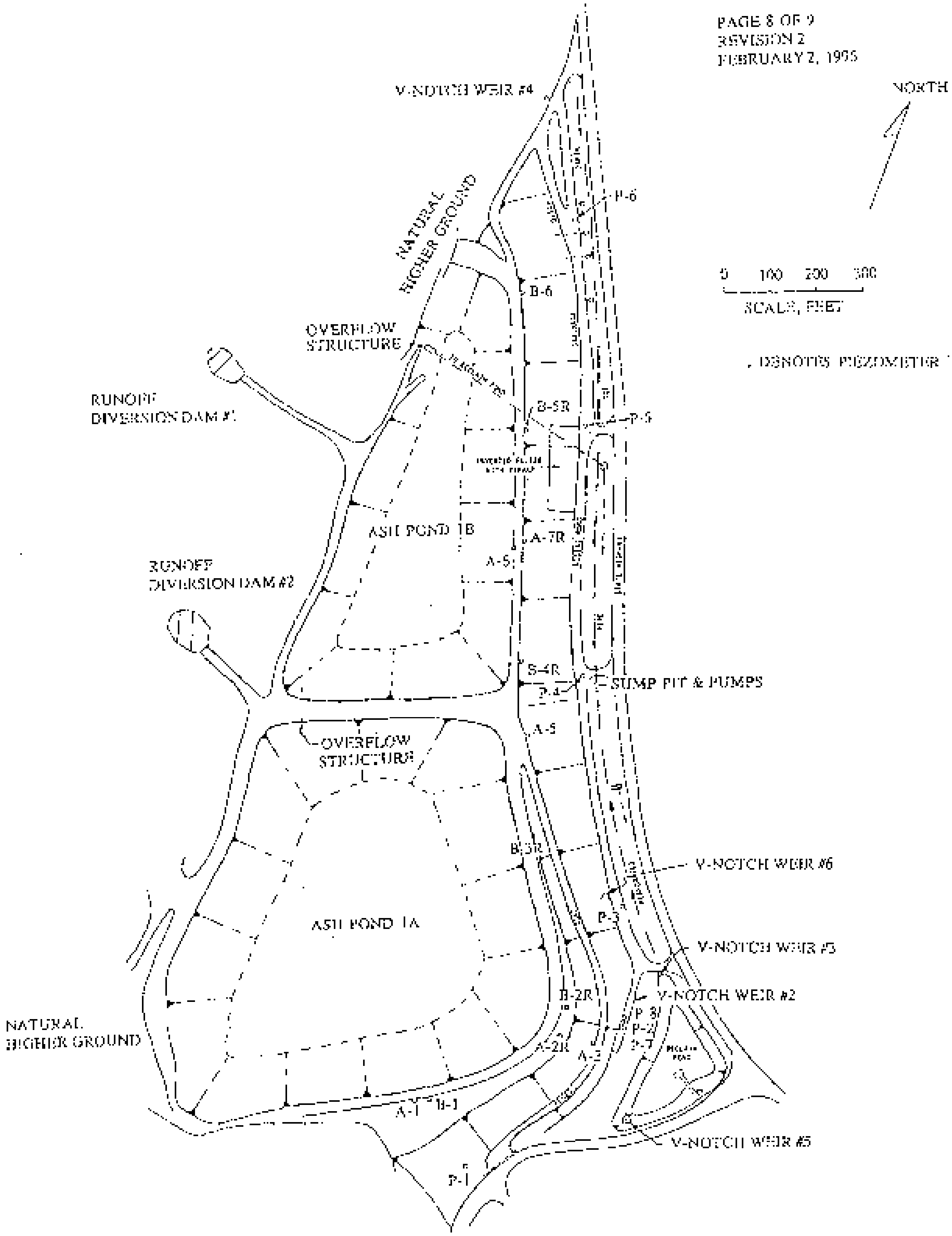
____

____

____

____

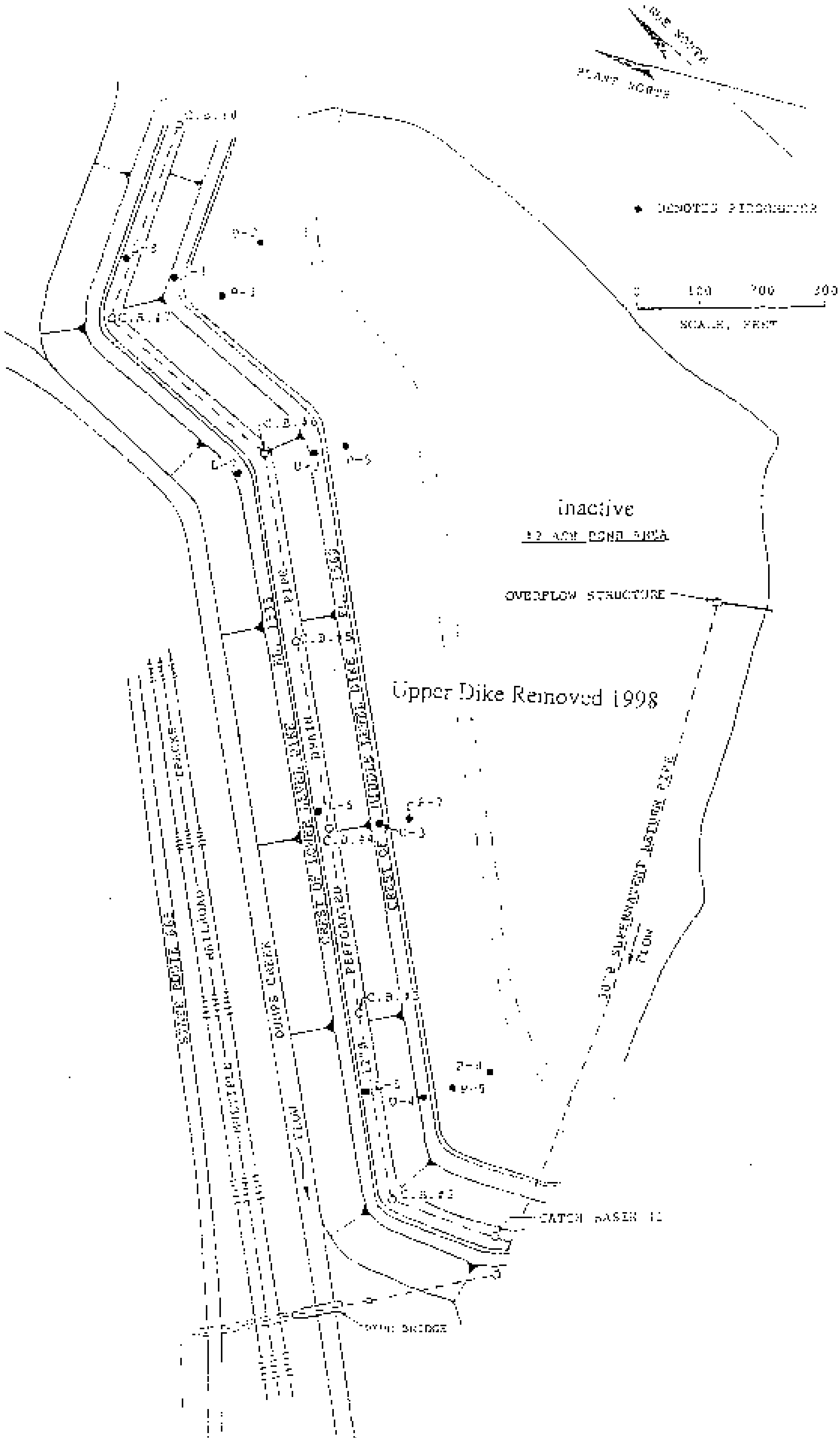
US EPA ARCHIVE DOCUMENT



CLINCH RIVER PLANT: ASH AREA 1 DIKE INSPECTION LOCATION PLAN

US EPA ARCHIVE DOCUMENT

Revised 4/29/98



CLINCH RIVER PLANT: ASH AREA 2 DIKE INSPECTION LOCATION PLAN

US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

APPENDIX A

Document 2B

Virginia DCR Inventory Number 16702
Certificate, Inventory Report and Operation & Maintenance Program

L. Preston Bryant, Jr
Secretary of Natural Resources

Joseph H. Maroon
Director

COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND RECREATION

203 Governor Street, Suite 206
Richmond, Virginia 23219-2010
(804) 371-6095 Fax (804) 371-2630

April 4, 2008

Appalachian Power Company
Attn: William Smith
Post Office Box 2021
Roanoke, VA 24022

RE: Clinch River Fly Ash Dam #2, Inventory Number 16702

Dear Mr. Smith:

The Operation and Maintenance Certificate Application for Clinch River Fly Ash Dam #2, Inventory Number 16702, and the required supporting documents have been reviewed for compliance with the provisions of the Code of Virginia, Dam Safety Act, (Section 10.1-604 et. seq.) and the regulations promulgated by the Virginia Soil and Water Conservation Board (Board). Based on this information, on March 20, 2008, the Board issued a six-year (03/20/2008 - 3/31/2014) Regular Class III Operation and Maintenance Certificate (Certificate). The Certificate and other pertinent data are enclosed.

The Dam Safety Act requires dam owners to maintain their dam in a condition to prevent unreasonable threats to life and property of others. The classification of your dam and the Certificate issued were based on the current known downstream hazard potential from upstream characteristics, a re-inspection report, operation and maintenance application, and an emergency action plan. The actions contained in the documents accompanying your Certificate Application must be adhered to for the duration of the terms contained in the Certificate. To assist you in adhering to the terms of the Certificate, the following table provides a schedule of dates to submit required documents.

US EPA ARCHIVE DOCUMENT

Annual Owner's Inspection Report	Owner's Engineer Inventory Report	Renewal Certification Six Year Application by Owner and Owner's Engineer
03/31/2009		
03/31/2010		
03/31/2011		
03/31/2012		
03/31/2013	12/31/2013	12/31/2013

Should you have questions, please direct them to Thomas I. Roberts, P.E., Dam Safety Regional Engineer, Department of Conservation and Recreation, Dam Safety and Floodplain Management Division, 8 Radford Street, Suite 203. Christiansburg, VA 24073, telephone 540-394-2550 or via e-mail at Thomas.Roberts@dcr.virginia.gov.

Sincerely,

William G. Browning
Director, Dam Safety & Floodplain Management Division

Enclosures as stated:

c: James M. Robinson, P.E., Dam Safety Program Manager
Thomas I. Roberts, P.E. Dam Safety Regional Engineer

US EPA ARCHIVE DOCUMENT

DATA SHEET - OPERATION AND MAINTENANCE CERTIFICATE

Department of Conservation & Recreation
Division of Dam Safety & Floodplain Management
203 Governor Street, Suite 206
Richmond, VA 23219-2094

Name of Dam **Clinch River Fly Ash Dam No. 2**	Inventory Number **16702**
Location **Offstream Dam Near New River**	City/County **Russell**
Owner **Appalachian Power Company** **Attn: William Smith** Address **40 Franklin Road, P.O. Box 2021** City/Town/Zip **Roanoke, VA 24022-2121**	Designed by **Casa Grande Consultants** Constructed by **Unknown** Year Constructed **1964**
Type of Dam **Rockfill**	Purpose **Sediment-Fly Ash**
Drainage Area (Sq. Mi.) **0.02**	Type of Watershed **N/A**
Total Height (Ft.) **65**	Elevation **1560**
Normal Pool Height (Ft.) **62**	Elevation **1557**
Maximum Capacity (Acre Ft.) **157**	Maximum Area (Acres) **11**
Normal Capacity (Acre Ft.) **82**	Normal Area (Acres) **10**
Size Classification **Medium**	Hazard Classification **III**
Required Spillway Design Flood **28% PMF**	Available Spillway Design Flood **Impounds PMF**
Type of Spillway **N/A**	*(Note if Section 130)*

Operation and Maintenance Plans & Schedule by — AEP/Pedro Jose Amaya-Trujillo, VA PE #036174
( ) Reinspection or (X) Inventory Report by — AEP/Pedro Jose Amaya-Trujillo, VA PE #036174

Emergency Action Plan filed with
(X) Virginia Dept. of Emergency Management
(X) Local Coordinator of Emergency Services — City/County: **Russell County**

Application Reviewed and Recommended for: **Six-Year Regular O & M Certificate (3/20/2008-3/31/2014)**

By: **Thomas I Roberts, PE # 19966** Date: **March 18, 2008**

Concurrence with the Recommendation:

By: **William G. Browning, Director** Date: **March 19, 2008**

US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND RECREATION
DIVISION OF DAM SAFETY
VIRGINIA SOIL AND WATER CONSERVATION BOARD

DAM SAFETY CERTIFICATE
REGULAR
CLASS III OPERATION & MAINTENANCE CERTIFICATE NUMBER 16702

Appalachian Power Company, owner of Clinch River Fly Ash Dam #2 in Russell County, is entitled to operate and maintain this dam pursuant to the provisions of the Dam Safety Act (Section 10.1-604 et seq., Code of Virginia) and Regulations promulgated thereunder.

This certificate is for a term of six years. It becomes effective March 20, 2008 and expires March 31, 2014. In accordance with §4VAC50-20-100F of the Regulations, the owner shall apply for a new certificate 90 days prior to its expiration.

Joseph H. Maroon

DCR

Department of Conservation & Recreation

EMERGENCY ACTION PLAN FOR CLASS I, CLASS II AND CLASS III IMPOUNDING STRUCTURES

Reference: Impounding Structure Regulations, 4VAC52-20-00 et seq , Virginia Soil and Water Conservation Board

1. Name of Impounding Structure: Clinch River Fly Ash Dike No. 2

   Inventory Number: 16702

   Other Name (if any): Ash Area #2

2. Hazard Potential Classification from Table I, Virginia Dam Safety Regulations:
   Class I Class II Class III (Underline One)

3. Name of Owner: Appalachian Power Company

   Address: 40 Franklin Road; PO Box 2021, Roanoke, VA 24022 2121

   Telephone: (Business)(800) 956-4237 (Residential)( )

4. Name of Dam Operator: Appalachian Power Company / Clinch River Plant

   Address: PO Box 370, Cleveland, VA 24225

   Telephone: (Business)(276) 889-1540 (Residential)( )

   Name of Alternate Operator: Operators are at the plant 24 hours per day

   Telephone: (Business)( ) Same (Residential)( )

5. Name of Rainfall or Staff Gage Observer for Dam: Team Leader

   Address: c/o Clinch River Plant - address as above.

   Telephone: (Business)( ) (Residential)( )

   Name of Alternate Observer: N/A

   Telephone: (Business)( ) (Residential)( )

US EPA ARCHIVE DOCUMENT

6 24-Hour Dispatch Center Nearest Dam-Police/Fire/Sheriff's

Departments: Russell County Sheriff's Department

Address: Lebanon, VA 24266

Telephone: (Business)(276) 889-8033 (Residential)( )

7. Name of City/County Emergency Management Coordinator(s): Naomi Honaker

Address: 556 Clydesway Drive Suite A

P.O. Box 997

Lebanon, VA 24266

Telephone: (Business)(276) 889-8247 (Residential)(276) 873-4509

8. Name, address and telephone number of all occupied dwellings that would be affected in the event of a dam failure, and/or inundation mapping of affected areas

Name Address Telephone Number

NO occupied dwellings would be effected in the event of a dam failure.

US EPA ARCHIVE DOCUMENT

AEPCR000082

9 Name, address and telephone numbers of owners of all commercial or recreational establishments that would be affected in the event of dam failure, and/or an inundation mapping of affected areas

Name	Address	Telephone Number
Failure would effect only Virginia Department of Highways - See Item 11		

10. Name, address and telephone number of owners of property, land and unoccupied buildings that would be affected in the event of a dam failure, and/or an inundation mapping of the affected area.

Name	Address	Telephone Number
See Attachment (Same as 15).		

US EPA ARCHIVE DOCUMENT

AEPCR000083

11. If there are public roads downstream from the impounding structure, identify by highway number and distance below dam:

Route # 616, 0 Miles; Route # 555, 0.25 Miles;
Route # ______, ______ Miles; Route # ______, ______ Miles

Provide name of resident engineer, VA Dept. of Transportation, (or City/County engineer)

Mike Bratbum

Address: Virginia Department of Highways, Lebanon, VA 24266

Telephone: (Business)(276) 889 3131 (Residential)(276) 794-7235

NOTE: Items 12 and 13 should be provided from the Operation and Maintenance Application.

Definitions:
Stage I Condition - A flood watch, or heavy continuous rain or excessive flow of water from ice or snow melt.

Stage II Condition – A flood warning; or emergency spillway activated or dam overtopping/ breach may be possible

Stage III Condition – Emergency spillway activated, dam overtopping or imminent failure is probable.

12 Amount of rainfall that will initiate a:

Stage II Condition	See Attachment	inches per 6 hrs
	See Attachment	inches per 12 hrs
	See Attachment	inches per 24 hrs
Stage III Condition	See Attachment	inches per 6 hrs.
	See Attachment	inches per 12 hrs
	See Attachment	inches per 24 hrs

And/or the amount of flow in the emergency spillway that will initiate a:

Stage II Condition N/A feet (depth of flow)
Stage III Condition N/A feet (depth of flow)

Total depth of emergency spillway available before crest of dam is overtopped:
N/A feet

13 Frequency of observations by rainfall/staff gage observer during a:
Stage I Condition N/A, Stage II N/A
Stage III N/A (recommend continuous)
Please identify access route and means of travel during flood conditions
N/A

US EPA ARCHIVE DOCUMENT

AEPCR000084

Note: It is recommended that the Observer remain on post until pool elevation starts to recede

14. Surveillance and Notification

a. The dam owner/operator **IS RESPONSIBLE** for notifying local government of any problem or potential problem at the dam site

b. The dam owner/operator **WILL INITIATE** dam surveillance under Stage I conditions, ie, when a flood watch is issued

c. The dam owner/operator **WILL NOTIFY** the 24-hour dispatch center and the local Emergency Services Coordinator when Stage II conditions are met in order to alert them to review actions that may be required for the safety and protection of people and property

d. The dam owner/operator **WILL NOTIFY** the 24-hour dispatch center and the local Emergency Services Coordinator to initiate warning of residents when Stage III conditions or imminent dam failure are probable.

e. The owner/operator **WILL BE RESPONSIBLE** for operating such devices as spillway gates and low level outlets such as to cause the dam to function effectively Attach narrative if required

f. 24-hour dispatch center should prepare Standard Operating Procedures (SOP's) to implement dam overtopping/failure evacuation plans.

15. Evacuation Procedures:

Note: The dam owner/operator should notify the City/County 24-hour Dispatch Center, as required in paragraph 14d above Phone # should be listed in [a (1)].

Note: Once the local government has been notified of any problem at a dam site, it should take appropriate protective measures in accordance with the local Emergency Operations Plan and accompanying Emergency Action Plan and Standing Operations Procedures. Other local government actions might include:

(1) Notify the individuals who are directly downstream and in immediate danger A list of the names, addresses, and telephone numbers of these individuals should be listed in [a (2)]
(2) Monitoring the situation and, if time permits, review of evacuation plans
(3) Begin Alert, Notification, and Warning
(4) Immediately evacuating the inundation areas, if conditions warrant.
(5) Expanding Direction and Control as well as beginning Emergency Public Information and operating shelters.
(6) Provide Situation Reports to the State Emergency Operations Center (804-674-2400 or 800-468-8892)

US EPA ARCHIVE DOCUMENT

a. Once the local government has been notified of a condition requiring evacuation, the dam owner/operator and local government are mutually responsible for effecting evacuation.

(1) The dam owner/operator will: Notify the Russell County 24-hour Dispatch Center, Telephone (276) 889-8033 and the Emergency Management Coordinator, Telephone (276) 889-8247 home (276) 889-1508 or cell (276) 971-7147

(2) Local government will: Monitor the situation, begin alert notification and warnings. Immediately evacuate the inundation areas, if conditions warrant. Expand directions and control as well as beginning Emergency Public Information. Provide situation reports to the State Emergency Operations Center. (804) 674-2400 OR (800) 468-8892.

Individuals who are directly downstream and in immediate danger include:

NAME	ADDRESS	TELEPHONE
See Attachment		

b. Methods for notification and warning to evacuate include:

Check appropriate method(s)

x (1) Telephone

x (2) Police/fire/sheriff radio dispatch vehicles with loudspeakers, bullhorns, etc.

___ (3) Personal runners for door-to-door alerting

___ (4) Radio/television broadcasts for area involved

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AEPCR000086

16. Certification of Coordination between Owner/Operator and Local Government

Certification by Owner/Operator

I certify that procedures for implementation of this plan have been coordinated with

Russell County (~~City/County~~) and the local Emergency Management Coordinator

Also, that a copy of this Form has been filed with the State Department of Emergency Management; that this plan shall be adhered to during the life of the project; and that the information contained herein is current and correct to the best of my knowledge

______________ (Signature of Owner/Operator)

This 6th day of February 20 08

Printed Name Ricky Chattin

Certification by Local Government

I certify that procedures for the warning and evacuation of Russell County (City/County) residents as required in the event of actual or impending failure of the Clinch River Fly Ash Dike No. 2 (name of dam) have been coordinated with the dam owner/operator

Naomi Hanaker (Signature of City/County Official)

This February day of 11th, 20 08

Printed Name Naomi Hanaker

Position HAZMAT/E.M. Coordinator

Please fill out and mail to:

Virginia Department of Emergency Management
Emergency Services
10501 Trade Ct.
Richmond, Virginia 23236-3713

Dept. of Conservation and Recreation
Division of Dam Safety
203 Governor Street
Richmond, Virginia 23219-2094

US EPA ARCHIVE DOCUMENT

EMERGENCY ACTION PLAN WORK/DATA SHEET

1. Name of Impounding Structure: Clinch River Fly Ash Dike ______________

2. Inventory #: 16702 ______________ Other Name (if any): Ash storage area #2 (inactive)

3. Total Height: ______ 56' ______ feet (Measured vertically from top of structure to streambed at downstream toe)

4. Total Impoundment Capacity at top of structure: ___ 326 ______ acre-feet

5. Size Classification (Circle one): Large Medium (Small)

6. Hazard Classification (Circle one): Class I Class II (Class III)

7. Spillway Design (Circle one): PMF ½PMF 100-YR 50-YR

8. Downstream Inundation Area determined by (Mark one):

   x (1) Judgement

   __ (2) Empirical Formulas Type used: ______ ______ ____

   ______ (3) Computer Programs Type used: ______ ______ ______

9. Critical Conditions used for structure failure (Mark one):

   ______ (1) Failure due to overtopping using:

   ______ PMF

   ______ % PMF

   ______ 100-YR

   ___ Other

   x (2) Failure not due to flooding

   Describe: Embankment instability or failure due to piping or erosion.

   ______________ ______________ ______ ____

   ______________ ______________ ______

   ______ ______________ ______________

AEPCR000088

US EPA ARCHIVE DOCUMENT

Clinch River Flyash Dike No. 2 **Inventory Number 16702**

Attachment I

Item No. 12

The ash ponds do not receive large quantities of stormwater runoff, therefore, storm event would not result in an overtopping. Water falling directly on the pond will not generate flows which will overtop the structures unless the discharge and emergency overflow systems are not operating simultaneously. The facility has been inactive since November 1995. The upper Dike wad removed in 1998 with permission from the Department of Conservation & Recreation – Dam Safety.

Item No. 15

City of St. Paul Water Plant P.O. Box 66 St. Paul, Virginia 24283	Earl Carter Office: (276) 762-9683 Home: (276) 762-7161
St. Paul Police Department 16531 Russell Street St. Paul, Virginia 24283	Office: (276) 762-5022
Wise County PSA Waterworks * Carfax Plant Rt. 3, Box 7368 Coeburn, Virginia 24230	Roy Markham Office: (276) 762-0159 Home: (276) 359-5880
Virginia Department of Environmental Quality P.O. Box 976 Abingdon, Virginia 24210	Michael Overstreet Office: (276) 676-4800
Southeast Railroad Contractors, Inc. 1235 Ohio Avenue Salem, Virginia 24153	James P. Aldridge Office: (540) 387-1620

* If unable to contact Wise County PSA Waterworks, please contact the Wise County Sheriff's Department at (276) 328-3566

Emergency Action Plan

US EPA ARCHIVE DOCUMENT

DCR
Department of Conservation & Recreation

OPERATION AND MAINTENANCE APPLICATION
CLASS I, II AND III IMPOUNDING STRUCTURES

Reference: Impounding Structures Regulations, 4VAC 50-20-00 et seq., Virginia Soil and Water Conservation Board

1. Name of Impounding Structure: Clinch River Fly Ash Dike No. 2
   Inventory Number: 16702 Other Name (if any): ---

2. Hazard Potential Classification from Table 1, Impounding Structure Regulations:
   (Circle One) Class I Class II (Class III)

3. Name of Owner: Appalachian Power Company
   Address: 40 Franklin Road, P.O. Box 2021, Roanoke, VA 24022-2121
   Telephone: (Business) (304) 336-4237 (Residential) (___)

4. Operating Plan and Schedule
   Provide a narrative for each item:
   a. Operation of control gates and spillways: See Attachment I
   b. Operation of Reservoir Drain (not to exceed ½ foot drawdown per day on embankment dams): See Attachment I

5. Maintenance Plan and Schedule
   Provide a narrative for each item:
   a. Embankment Dams:
      (1) embankment: See Attachment I
      (2) principal spillway: See Attachment I
      (3) emergency spillway: See Attachment I
      (4) low level outlet: See Attachment I
      (5) reservoir area: See Attachment I
      (6) downstream channel: See Attachment I
      (7) other: See Attachment I
   b. Concrete dams (including masonry and others):
      (1) upstream face: Not Applicable

(DCR 199-099) (12/01)

AEPCR000090

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(2) downstream face: N/A

(3) crest: N/A

(4) galleries: N/A

(5) tunnels, etc.: N/A

(6) abutments: N/A

(7) spillways: N/A

(8) gates and outlets: N/A

(9) other: N/A

6. Inspection schedule (attach schedule and checklist):

(1) operator inspection (daily, weekly, etc.) Weekly - No Checklist

(2) maintenance inspection (monthly, quarterly, semi-annual, annual) Quarterly - Checklist Attached

(3) technical safety reinspection by a professional engineer. (required for certification update: Class I dams every two years, Class II dams every three years. All dams inspected after overtopping)
Inspected annually by a professional engineer and submitted to the state.

7. Emergency Action Plan Schedule
Provide the information that initiates the Emergency Action Plan:

a. rainfall amounts and/or: This is an onground reservoir with little or no drainage area beyond its own perimeter

b. spillway flows: water in-flow is controlled by pumping of ash/water slurry. EAP would be triggered by embankment instability or failure due to piping or erosion

c. frequency of observation:

8. For a newly constructed impounding structure, provide certification from a Professional Engineer who has inspected the impounding structure during construction that, to the best of the engineer's judgment, knowledge and belief, the impounding structure and all appurtenances have been constructed in conformance with the plans, specifications and drawings submitted to the Department of Conservation and Recreation

AEPCR000091

US EPA ARCHIVE DOCUMENT

OPERATION AND MAINTENANCE PERMIT APPLICATION

OPERATION AND MAINTENANCE SCHEDULES
CERTIFICATION BY OWNER

I hereby certify that the operation and maintenance plans and schedules provided herewith will be adhered to during the life of the project except in cases of unanticipated emergency requiring departure therefrom in order to mitigate hazards to life and property, at which time my engineer and the Department of Conservation and Recreation will be notified

Signed: ________________________ (Owner)

This 1st day of February, 20 08

CERTIFICATE BY OWNER'S ENGINEER

I hereby certify that the information provided in this form has been examined by me and found in my professional judgment to be appropriate to operation and maintenance considerations for this dam

Signed: ________________________ Professional Engineer   Virginia Number: 036174

This 19th day of February, 20 08

Remarks: This onground reservoir has been operated successfully for many years for the purpose of sedimentation of bottom ash. We intend to continue our program of careful operation with frequent periodic inspections and we will continue to perform remedial repairs and maintainance as required by field conditions. This facility has been inactive since 1995

Please fill out and mail this form to:
Department of Conservation and Recreation
Division of Dam Safety
203 Governor Street
Richmond, Virginia 23219-2094

COMMONWEALTH OF VIRGINIA
PEDRO JOSE
PROFESSIONAL ENGINEER
19/02/2008

US EPA ARCHIVE DOCUMENT

Attachment I

4a Operation of control gates and spillways: Clinch River Plant last used Pond No. 2 in November, 1995 the discharge for this pond consists of a variable elevation side-hill drainage shaft connected to a 30-inch diameter reinforced concrete pipe. The overflow elevation of the spillway may be changed by inserting or removing steel plates. Flow is controlled by a pneumatic piston activated slide gate which responds to water level sensors at the recirculation pond. Freeboard is sufficient to store the Probable Maximum Flood.

4b Operation of Reservoir Drain: There is no reservoir drain of this facility because such drain would either become clogged with bottom ash or would discharge it from the pond.

5a. (1) Embankment: the upstream and downstream slopes are visually inspected by plant personnel. Items checked for include signs of invisibility, seepage, rodent burrows, erosion features and vegetative cover. Grass, brush and tree cutting is done as needed. Rodent burrows and erosion gullies are filled in when they are filled in when they are found.

(2) Principal Spillway: The principal spillway for this upground reservoir consists of a variable elevation side-hill overflow structure connected to a 30-inch diameter discharge pipe.

(3) Emergency Spillway: Not Applicable – See 4a above

(4) Low Level Outlet: Not Applicable

(5) Reservoir Area: Since this is an upground reservoir, the reservoir area is checked when the upstream slopes are inspected.

(6) Downstream Channel: The pond's 30-inch diameter discharge pipe terminates at a concrete sump box. where the discharge waters are directed to a recirculation pond.

(7) Other: No Comment.

Since the pond has not operated since 1995, a thorough inspection would be necessary before the pond is returned to service.

US EPA ARCHIVE DOCUMENT

CLINCH RIVER PLANT
DIKE INSPECTION CHECKLIST

1. GENERAL INFORMATION

Date of Inspection ______________________

Inspected by ______________________

Weather ______________________

Temperature ______________________

Rainfall During Past 7 Days ______________________

Reservoir elevations at time of inspection:

Pond 1A ______________________

Pond 1B ______________________

Pond 2 ______________________

2 EMBANKMENT CONDITION AT PONDS 1A & 1B

Please refer to the Ash Area 1 Dike Inspection Location Plan which is found on Page 3. Place a number and a descriptive sketch on the location plan at each problem area. Place the same number(s) next to the appropriate description(s) below.

DESCRIPTION	LOCATION NUMBERS
Cracks	______________________
Bulges	______________________
Sliding	______________________
Erosion	______________________
Soft Soil	______________________

US EPA ARCHIVE DOCUMENT

Leaking Pipe ______________

Seepage/Wetness ______________

Vegetative Cover ______________

Trees on Slope ______________

Hillside Runoff Drain #1 ______________

Hillside Runoff Drain #2 ______________

Rodent Burrows ______________

Other (Please Specify) ______________

3. PIEZOMETERS READINGS AT PONDS 1A & 1B

PIEZ. NO.	ELEV., TOP OF TUBE	DEPTH TO WATER FROM TOP OF TUBE	WATER ELEVATION	COMMENTS
A-1	1571.0			
A-2R	1569.5			
A-3	1535.0			
A-5	1572.2			
A-6	1571.3			
A-7R	1572.0			
B-1	1571.2			
B-2R	1571.1			
B-3R	1570.9			
B-4R	1571.1			
B-5R	1571.4			
B-6	1571.8			
F-1	1529.9			

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P-2	1520.6	________	________	________
P-3	1519.9	________	________	________
P-4	1518.6	________	________	________
P-5	1512.6	________	________	________
P-6	1517.0	________	________	________
P-7	1523.2	________	________	________
P-8	1521.2	________	________	________

4. V-NOTCH WEIRS

Please determine the flow rate in gallons per minute for each of the V-notch weirs. This can be done by measuring the head H of water above the apex of the V-notch to the nearest 1/4 inch and comparing it to the chart below.

HEAD, H, INCHES	FLOW RATE, GPM 90° WEIR	FLOW RATE, GPM 22½° WEIR	HEAD, H, INCHES	FLOW RATE, GPM 90° WEIR	FLOW RATE, GPM 22½° WEIR
1	2	0.75	3	37	7.2
1 1/4	4	1	3 1/4	45	8.9
1 1/2	6	1.4	3 1/2	53	10.8
1 3/4	9	1.9	3 3/4	65	12.5
2	12	2.6	4	76	14.5
2 1/4	17	3.4	4 1/4	88	16.8
2 1/2	24	4.5	4 1/2	100	19
2 3/4	30	5.9	4 3/4	114	21.6

V-notch Weir #1: ____________________ gallons per minute
V-notch Weir #2: ____________________ gallons per minute
V-notch Weir #3: ____________________ gallons per minute
V-notch Weir #4: ____________________ gallons per minute
V-notch Weir #5: ____________________ gallons per minute
V-notch Weir #6: ____________________ gallons per minute

5. SEEPAGE COLLECTION SUMP

Please determine the flow rate, in gallons per minute, of the two branches of the French drain at the 8 foot diameter seepage collection sump. This can be done by measuring how much the water

level rises while recording the time during a period when both pumps are off. Flow rate is given by the following formula:

FLOW RATE, = $\frac{(3.1416)(16)(7.48)(60)H}{t}$

in which H = rise of water level in feet during the unpumped time interval t, in seconds.

FLOW RATE = ________________________ GALLONS PER MINUTE

6. DISCHARGE STRUCTURE AT POND 1B

Please note the conditions with regard to the following:

Condition of concrete ____________________

Are stoplogs available? ____________________

Obstructions ____________________

Foreign object in pond? ____________________

Pedestrian access O.K.? ____________________

Erosion Problems ____________________

Other (Please specify) ____________________

7. MISCELLANEOUS AT PONDS 1A & 1B

Is seepage repair area O.K.? ____________________

____

What is condition of French drain? Is white precipitate building up impeding drainage? ____________________

____

What is the overall condition of the discharge structure from Pond 1A to Pond 1B?

____

US EPA ARCHIVE DOCUMENT

Are seepage sump pumps O.K.? ____________________

____

Is entrance to 24" seepage overflow pipe clear of obstructions? ____________________

____

8. PONDS 1A & 1B NOTES AND COMMENTS INCLUDING JOB ORDERS WRITTEN AND REPAIRS/MAINTENANCE SINCE LAST INSPECTION:

____

____

____

____

____

9. EMBANKMENT CONDITION AT POND 2 AREA

Please refer to the Ash Area 2 Dike Inspection Location Plan which is found on Page 9. Place a number and a descriptive sketch on the location plan at each problem area. Place the same number(s) next to the appropriate description(s) below.

DESCRIPTION	LOCATION NUMBERS
Cracks	____________
Bulges	____________
Sliding	____________
Erosion	____________
Soft Soil	____________
Leaking Pipe	____________
Seepage/Wetness	____________

US EPA ARCHIVE DOCUMENT

DESCRIPTION	LOCATION NUMBERS
Vegetative Cover	
Trees on Slope	
Rodent Burrows	
Other (Please Specify)	

10. PIEZOMETER READINGS AT POND 2 AREA

PIEZ. NO.	ELEV., TOP OF TUBE	DEPTH TO WATER FROM TOP OF TUBE	WATER ELEVATION	COMMENTS
P-1	1557.0			
P-2	1555.8			
P-3	1556.7			
P-4	1557.4			
P-5	1557.7			
P-6	1557.4			
P-7	1557.9			
P-8	1557.4			
P-9	1558.2			
U-1	1560.0			
U-2	1561.1			
U-3	1560.0			
U-4	1560.0			
L-5	1532.0			
L-6	1532.0			
L-7	1535.3			
L-8	1534.7			

US EPA ARCHIVE DOCUMENT

11. IS PERFORATED DRAIN PIPE BETWEEN LOWER LEVEL AND MIDDLE LEVEL DIKES WORKING PROPERLY AND IN GOOD CONDITION?

____

____

____

12. DISCHARGE STRUCTURE AT POND 2

Please note the conditions with regard to the following:

Condition of concrete ____________________

Gates/valves operational? ____________________

Obstructions ____________________

Is access clear? ____________________

Erosion problems ____________________

Other (Please specify) ____________________

13. POND 2: NOTES AND COMMENTS INCLUDING JOB ORDERS WRITTEN AND REMEDIAL WORK DONE SINCE LAST INSPECTION

____

____

____

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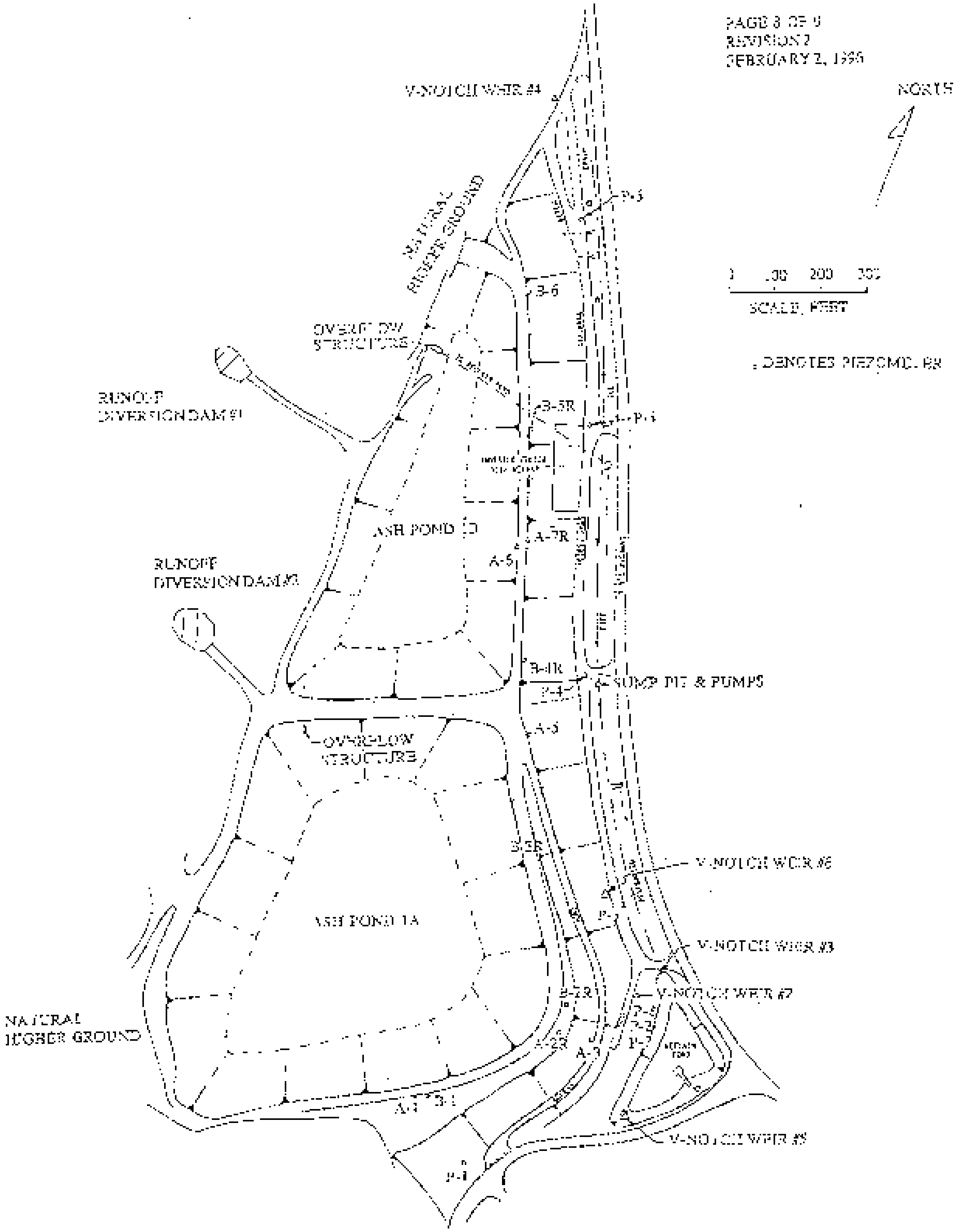
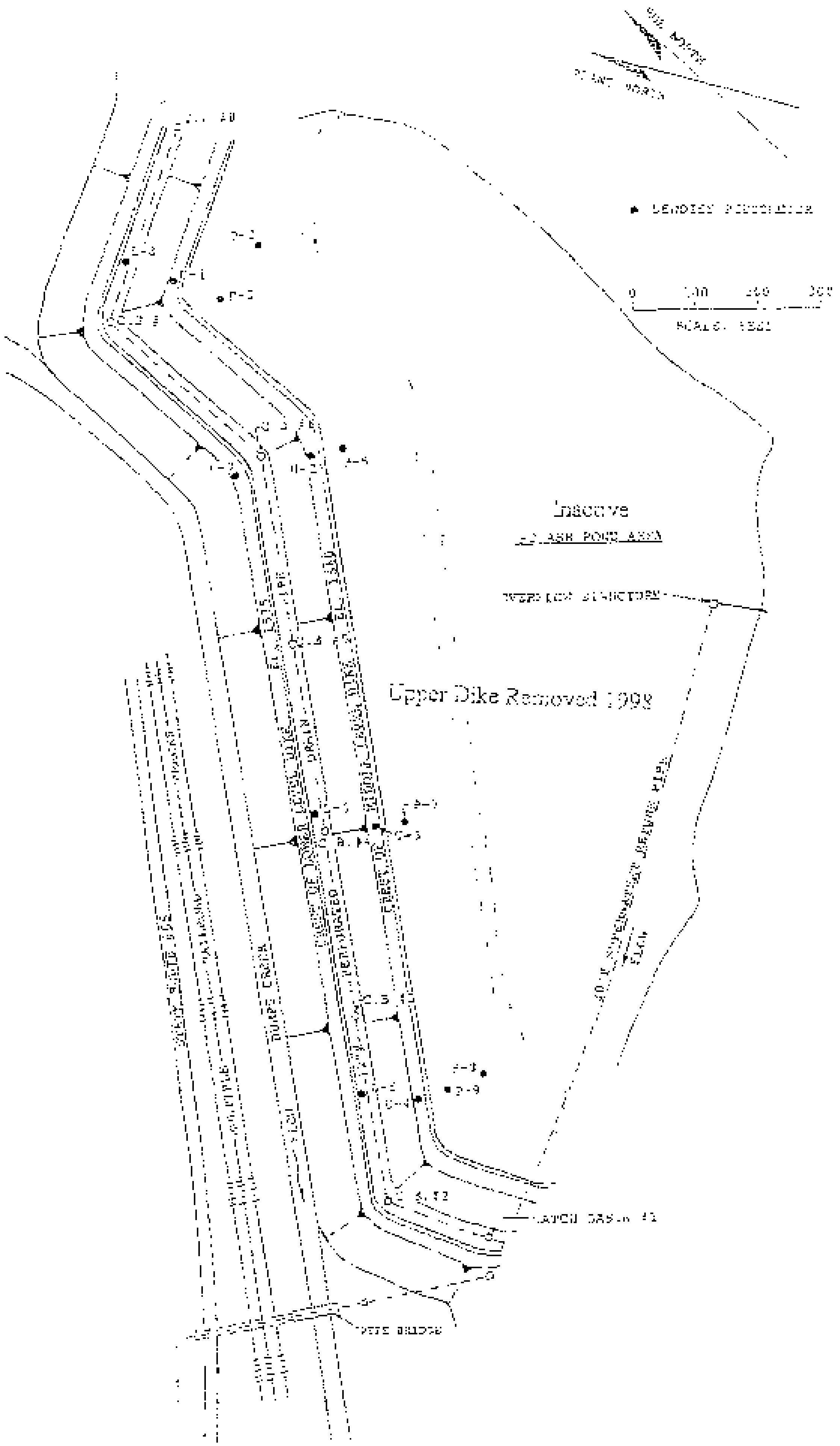
US EPA ARCHIVE DOCUMENT



PLANT

CLINCH RIVER PLANT - ASH AREA 1 DIKE INSPECTION LOCATION PLAN

Revised 4/29/98



CLINCH RIVER PLANT: ASH AREA 2 DIKE INSPECTION LOCATION PLAN

US EPA ARCHIVE DOCUMENT

DCR
Department of Conservation & Recreation

INVENTORY REPORT FOR CLASS III AND CLASS IV IMPOUNDING STRUCTURES

Reference: Impounding Structure Regulations, 4VAC50-20-00 et seq., Virginia Soil and Water Conservation Board

1. Project Information:
   a. Name of Impounding Structure Clinch River Fly Ash Dike No. 2
   b. Inventory Number 16702 Other Name (if any) ---
   c. Name of Reservoir Clinch River Plant Bottom Ponds #2
   d. Purpose of Reservoir Sedimentation of Bottom Ash

2. Location of Impounding Structure:
   a. City/County Russell Magisterial District Cleveland
   b. Located 300 feet/~~miles~~ upstream/~~downstream~~ of Highway No. 616
   c. Name of River or Stream Does not impound, but is near Dumps Creek tributary of the Clinch River
   d. Latitude N36 55' 30" Longitude W82 11'22"

3. Ownership:
   a. Owner's Name Appalachian Power Company
   b. Mailing Address 40 Franklin Road; P.O. Box 2021 Roanoke, VA 24022-2121
   c. Telephone (540) 985-2237

4. Owner's Engineer:
   a. Engineering Firm/Engineer American Electric Power Service Corporation
   b. Professional Engineer Virginia Number Pedro Jose Amaya-Trujillo, VA#036174
   c. Mailing Address 1 Riverside Plaza; Columbus, OH 43215
   d. Telephone (614) 223-1000 OR (614) 223-2926

(DCR 199-104) (12/01)

US EPA ARCHIVE DOCUMENT

5 Impounding Structure Data (All elevations NGVD unless noted):

a. Type of Material earth X concrete ___ masonry ___

Other ___

	Design Configuration	
b. Top of Dam	1595	Elev. (if known)
c. Downstream Toe (Lowest)	1509	Elev. (if known)
d. Height of Dam	86	Feet
e. Crest Length (Exclusive of Spillway)	1650	Feet
f. Crest Width	20	Feet
g. Upstream Slope	3 H: 1	V
h. Downstream Slope	3 H: 1	V

*This Facility consists of 2 dikes impoundments arranged as terraces. This facility has been inactive since 1995. Downstream toe elevation given for lowest point of lowest dike. (See Diagram)

6 Reservoir Data

	Design Configuration	
a. Maximum Capacity	125	Acre-feet
b. Maximum Pool	1569	Elev. (if known)
c. Maximum Pool Surface Area	12.5	Acres
d. Normal Capacity	82	Acre feet
e. Normal Pool	1567	Elev. (if known)
f. Normal Pool Surface Area	11.7	Acres
g. Freeboard (Normal Pool to Top)	3	Feet
h. Freeboard (Normal Pool to Emergency)	N/A	Feet

7. Spillway Data

Spillway Data	Type	Construction Material	Maximum Capacity
a. Low Level Drain	N/A	---	---
b. Principal Spillway	Variable Weir	Steel	200 cfs
c. Emergency Spillway	N/A	---	---

	Design Configuration	
d. Low Level Drain	None	Elev. (if known)
e. Principal Spillway	1557	Elev. (if known)
f. Emergency Spillway	None	Elev. (if known)

US EPA ARCHIVE DOCUMENT

g. Briefly describe the low level drain and principal spillway to include dimensions, materials of construction, trash guards, location in reservoir and through dam, and orientation of intake and discharge to dam if looking downstream: There is no low level drain because it would become clogged with bottom ash or would discharge bottom ash. Principal spillway is a variable elevation side hill structure with remote control gate valve.

h. Describe the emergency spillway to include dimensions, whether the spillway is an earth channel or other construction, spillway surface protection, and orientation to dam if looking downstream: None - this is an upground reservoir which is filled by pumping

8 Watershed Data (Class III only):

a. Drainage Area .020 Sq. Miles 13 acres (including pond surface)

b. Type and Extent of Watershed Development ---

c. Time of Concentration --- Method -

d. Spillway Design Flood used (mark appropriate box)

__ PMF, source

__ 1/2 PMF, source

__ 100 Year, source

__ 50 Year, source

X Other, source Not Applicable - upground reservoir

e. Design inflow hydrograph: Volume --- acre-feet;

Peak inflow --- C.F.S.;

Rainfall duration of design inflow hydrograph --- hours

f. Freeboard during passage of spillway design flood --- feet

9. Impounding Structure History

a. Date construction completed 1964, modified 1970 & 1975

b. Design by Casagrande Consultants Date: 1963

c. Built by Unknown Date: 1964

US EPA ARCHIVE DOCUMENT

AEPCR000105

d. Inspection dates: 1978, 1980, 1982, and annually from 1984-2001

e. Inspections by Woodward-Clyd Consultants, AEP and Geosytec Consultants

f. Description of repairs: A 75-ft length of this dike breached in 1957; repairs included placement of additional filler material and rip rap at d/s toe. Since then, routine maintenance based on recommendations from annual inspections.

g. Has the impounding structure ever been overtopped? ___ Yes x No

10. Impounding Structure Assessment:

a. Provide brief descriptions for each item:

i. Condition of the impounding structure: Good

ii. Condition of the reservoir: Good

iii. Condition of the upstream area: Good

iv. Condition of the downstream area: Good

b. Provide a narrative describing any recent changes in the impounding structure, reservoir, upstream area, and downstream area: In 1998, the upper dike was removed in order to reclaim the bottom ash for sales. Permission was received from Duncan Mcgregor for the Division of Dam Safety prior to beginning.

c. Recommendations for remedial measures: continue routine brush cutting and piezometer readings; fill gullies and rodent burrows if they develop; maintian porper operation of seepage control features.

US EPA ARCHIVE DOCUMENT

AEPCR000106

11 Provide a sketch of the impounding structure

See Attached Sketch

CERTIFICATION BY OWNER'S ENGINEER (Class III only)

I hereby certify that the information provided in this Inventory Report has been examined by me and found 19/02/2008 to be true and correct in my professional judgment.

Signed Pedro J Amaya
(Professional Engineer)

Virginia Number 036174

This 19th day of February, 2008

CERTIFICATION BY OWNER (Class IV only)

I hereby certify that the information provided in this Inventory Report is true and correct

Signed ________________
(Owner)

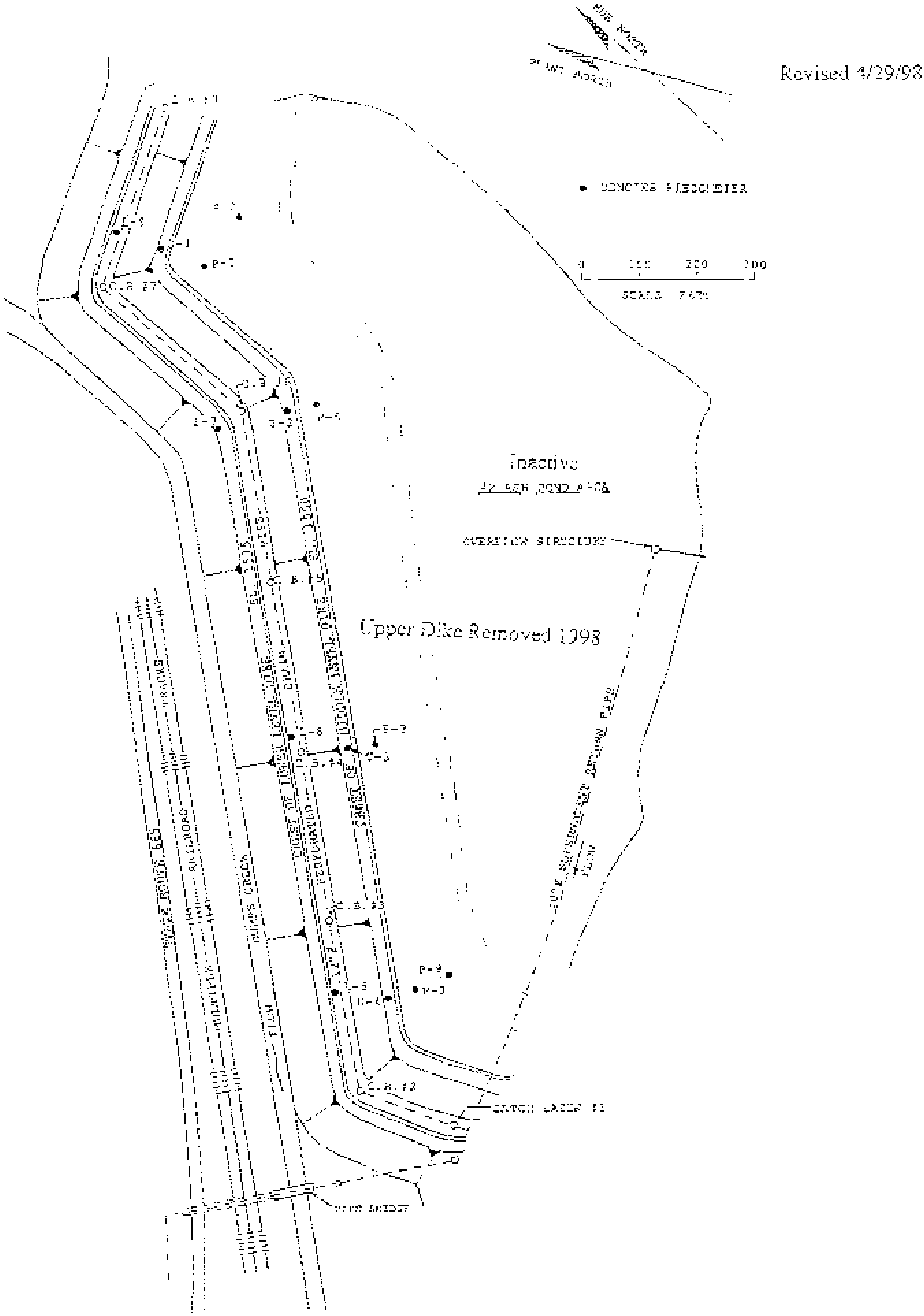
This 1st day of February, 20 08

Please fill out and mail to:
Department of Conservation and Recreation
Division of Dam Safety
203 Governor Street
Richmond, Virginia 232192094

US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

Revised 4/29/98



CLINCH RIVER PLANT: ASH AREA 2 DIKE INSPECTION LOCATION PLAN

US EPA ARCHIVE DOCUMENT

APPENDIX A

Document 3

DCR Inspection Email to AEP, 2008

"Thomas Roberts" <Thomas Roberts@dcr virginia gov>

03/20/2008 05:37 PM

To <wrsmith@aep com>

cc <rapeppler@aep com>, "Thomas Roberts" <Thomas Roberts@dcr virginia gov>

bcc

Subject 16702 Clinch River Flyash Dam #2, 16703 Clinch River Flyash Dam #1

History: This message has been forwarded.

Mr Smith-

Visited the AEP site in Carbo yesterday with Rex A Peppler and Monty D Guy A couple of quick observations:

1. It does not look like the data provided on the "Inventory Report" was up to date on the Clinch River Flyash Dam #2, for volume of normal pool and maximum pool, for normal surface area etc. Looks like the numbers provided are 15 years or more out of date. When convenient, please revise the numbers (ie normal pool = 0 acre feet) and send me a corrected copy for the file
2. It appears that there is no dam here at all made for the impounding of water, just a plateau with a few berms here and there By the vegetation it appears that there is not even ponding during heavy rainfall events As far as I could tell, this area has not been used for many years. You might consider having your engineer review this to determine if you have the volume needed (at least 15 acre feet for dams over 25' high) to justify keeping this as a regulated dam If you determine that it is no long of a size to be regulated, please forward a letter from your Proffessional Engineer indicating the reasons and we will close out this dam as a regulated dam.
3. If #2 is still a dam and is still continue to be regulated, all brush on the dams and within 25' of the dams must be removed and maintained This dam does not appear to be a hazard class other than Class III
4. The same information needs to be updated on the Inventory Report for Dam #1
5. Dam #1 looks like it has been devided with a permanent dike road through the former dam volume. The the dike road is at the same elevation as the top of the dam Effectively the area to the South West of the dike road has a separate volume from the area to the North East With some measurements, I think it is possible for your engineer to show that neither of these volumes exceed 15 acre feet of water + ash to be removed
6. If Dam #1 does turn out to still be regulatable, then you will need to have your engineer review the hazard class with respect to the roadway just below the dam. Essentially, if the dam did fail, would it wash over the road If so, it is likely that this is a Class II hazard dam rather than a class I
7. If Dam #1 does turn out to still be regulatable, then all trees and brush within 25' of the dam embankment, toe, top, etc, must be removed Mr. Peppler indicated that he would be taking care of removing the trees.

There is no rush on the above items, but they should be addressed in the next 6 months. I left both of these dams on the list for Regular Certificates

Please call me if you have questions or comments

Tom Roberts

Thomas I Roberts P.E - Regional Engineer - Dam Safety
Virginia Department of Conservation and Recreation
Dam Safety and Floodplain Management
8 Radford Street, Suite 201
Christiansburg, Virginia 24073 - 3341
Phone - 540 394 2550

US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

APPENDIX A

Document 4

Dam Safety Inspection Report, by Woodward-Clyde Consultants

DAM SAFETY INSPECTION
POND 1 AND POND 2
1978

US EPA ARCHIVE DOCUMENT

Report On

Dam Safety Inspection

ASH PONDS 1,1A, & 2

CLINCH RIVER POWER PLANT

Carbo, Virginia

Prepared by

Woodward-Clyde Consultants

Clifton, New Jersey

For

AMERICAN ELECTRIC POWER SERVICE CORPORATION

Two Broadway

New York, New York

18 July 1978

77C110

AEPCR000216

TABLE OF CONTENTS

CLINCH RIVER POWER PLANT

1.0 INTRODUCTION

The results of a dam safety inspection of Ash Ponds No. 1A, 1B and 2 at the Clinch River Power Plant are presented in this report. The purposes of the investigation were to gather and evaluate available data on the design and construction of the dams at the power plant and to complete a visual inspection of the integrity of the dikes so that an evaluation could be made of the need for additional investigation and/or remedial action.

The investigation was performed in accordance with our proposal dated 11 October 1977. It consisted of review of data concerning the Clinch River Dikes available in AEP's files, field inspection of the dikes, engineering evaluation and the preparation of this report. The field inspection was performed on 2 June 1978 by Messrs. John H. Frederick, Jr. and Ray Lambert.

2.0 PROJECT DESCRIPTION

The location of the Clinch River Power Plant is shown in Figure 1. There are two diked areas (Ponds No. 1 and No. 2) for mixed ash storage (fly ash and bottom ash combined) currently in service at the Clinch River Power Plant. Pond No. 1 is located north of Dumps Creek and Pond No. 2 is located south of Dumps Creek Pond No. 1, originally built as one large impoundment, was subsequently divided into two separate ponds, 1A and 1B.

The dikes were designed by Casagrande Consultants and constructed in 1964. Since the initial construction, the dikes of Ponds 1A, 1B and 2 have been raised a number of times. The sequence of construction as determined from AEP Drawing No. 13-10585-3107-4 dated 9/19/69 and from conversations with plant personnel at the Clinch River Plant, it shown in Table 1.

2.1 DIKE SECTIONS

The dikes are constructed primarily of compacted rock, shale and earth fill obtained from locally available borrow sources. At Ponds 1A and 1B, compacted fly ash and bottom ash were used for one of the additions to the crest of the dikes. Subsequent additions are indicated on the drawings to be composed of locally available shale material.

The dikes forming Ponds 1A and 1B were raised by placing additional material on the crest of the existing dike. At Pond 2 however, increased storage capacity was achieved by constructing new dikes on top of the flyash sediment. There are currently three tiers of dikes referred to herein as the lower, middle and upper level dikes. The layout of the dikes and typical cross sections for Ponds 1A, 1B and 2 are shown on Drawing No. 13-10585-3107-4, reproduced as Figure 2.

As shown on Figure 2 the crest of the dikes surrounding Ponds 1A, 1B and 2 is at approximately el 1570 ft.*

*USGS DATUM

The face of the dikes is sloped typically at 2H:1V. However, the upper level dike of Pond 2 is sloped at 3H:1V. The downstream slope of the lower level dike of Pond 2 is protected by riprap.

In 1967 a sudden failure of the lower dike of Pond 2 was reported as having occurred. At that time, the middle and upper level dikes were not yet built. The failure was repaired and the dike placed back in service.

2.2 OUTLET WORKS

The piping network at Clinch River serves three functions:

1. Removal of overflow water from within the pond areas
2. Seepage control;
3. Control of surface run-off from sloped areas to the north of Ponds 1A, 1B.

2.2.1 POND OVERFLOW

Overflow structures are located at the northeast corner of Pond 1A, the northwest corner of Pond 1B and the southern portion of Pond No. 2 at a point approximately midway between the two abutments. Overflow from Pond 1A passes through a 30 inch diam pipe to Pond 1B. Water overflow from Ponds 1B and 2 discharges into a common 30 inch reinforced concrete pipe through which it flows to the recirculating basin.

2.2.2 SEEPAGE CONTROL

All three ponds have had a history of obvious seepage at the downstream toe of the dikes.

Toe drains, consisting of perforated pipe within gravel backfill, have been installed along the toe of dikes 1A and 1B (10 inch pipe) and at the toe of the middle level dike in Pond 2 (12 inch pipe). Water flowing to the toe drains is collected in a sump and pumped into the 30 inch RCP which carries the pond overflow to the recirculating basin.

Despite the toe drains, seepage is still occurring. Approximately three years ago, a boil was noted near the downstream toe of Pond 1B. At the recommendation of Mr. D. Casagrande of Casagrande Consultants, an inverted filter was placed over the boil. Also at the recommendation of Casagrande Consultants, a number of piezometers were installed in the area of Pond 2 and along the downstream slope of Pond 1A. Readings of water levels in some of these piezometers were obtained during our site inspection and are described later in this report.

Seeps observed during our inspection are described in Section 5.0.

2.2.3 RUN-OFF CONTROL

Surface run-off from the steeply sloped borrow area north of Ponds 1A and 1B is channeled into an 18 inch transite pipe and is discharged into Dumps Creek.

3.0 SITE GEOLOGY

The Clinch River Steam Plant is located in the Appalachian Mountain section of the Valley and Ridge physiographic province. Bedrock consists of shale, sandstone and minor dolomite of the Rome formation of Cambrian age. The area is characterized by northeast-southwest trending folds. The course of the Clinch River is within the Rome formation.

Bedrock exposed in the area was seen to be fractured. If the slurry contained in Ash Ponds 1A, 1B and 2 has communication with the underlying bedrock, seepage would be expected to occur through the fractured rock. However, none of our observations suggest that this is in fact occurring.

4.0 SUMMARY OF ENGINEERING DATA AVAILABLE

The drawings made available to us by AEP for use in this investigation are listed in Table 2. Reference is made on these drawings to other drawings containing additional details on the dikes. However, the referenced drawings were not available at AEP's office.

The design data found in the AEP files is summarized on the data collection form contained in Appendix C of this report. There were no design calculations available in AEP's Clinch River file.

5.0 RESULTS OF VISUAL INSPECTION

The inspection consisted of a visual survey of the dikes and outlet structures. The results of the visual inspection of Ponds 1A, 1B and 2 are described in the Visual Inspection Check List contained in Appendix B and are summarized below. Photos of the dikes are presented in Appendix A .

5.1 PONDS 1A AND 1B

1. At the time of the inspection, Pond 1A was filled to within one foot of the crest and Pond 1B was filled to within 12 feet of the crest. We were told that Ponds 1A and 1B have been out of service since some time in April 1978. They are currently used only for emergencies; most of the ash from the plant is now handled dry and is sent to a landfill area located near the plant.

2. No evidence of surface cracks or of unusual movement at or beyond the toe of the dikes was found during the inspection. The vertical and horizontal

alignment of the crest appeared to the eye to be normal. Exposed portions of the slopes appeared stable with no evidence of sloughing or erosion.

3. There is an abundant growth of straw grass and weeds on the downstream slopes of Ponds 1A and 1B. This growth suggests ready access to moisture.

4. Two seeps, producing a concentrated wet area (but no free water) were noted at the downstream toe of the dike of Pond 1A at a point near the plant entrance.

5. Water collected by the toe drainage pipes was observed entering the sump pit. The water appeared to be clear. There was no evidence of sediment build-up at the bottom of the sump.

5.2 POND 2

1. At the time of the inspection, Ash Pond 2 formed by the upper level dike was in active service. The pool level in the pond was almost at the level of the crest.

2. No evidence of surface cracks or of unusual movement at or beyond the toe was found during the inspection. The vertical and horizontal alignment of the crest appeared to the eye to be normal. There was no evidence of instability, sloughing or erosion on the slopes of the dike.

3. Riprap at the downstream toe of the dike adjacent to Dumps Creek appeared in good condition.

4. There was no evidence of seepage in any of the dikes comprising Ash Pond 2.

5. Near the right abutment, the area north of the downstream toe appeared to be in a swampy condition. The established growth of swamp reeds and cat-tails suggests that this condition is long-standing. No concentrated flow was observed. Ponded water was also noted on the dried fly ash at the middle level of the storage pond near the right abutment area.

5.3 PIEZOMETER READINGS

The locations of the piezometers in which water level readings were obtained are shown in Figure 3. At each location, the depth of water below the ground surface is shown.

Readings were not obtained in the piezometers installed in the downstream slope of Pond 1A. As seen in Figure 3, readings in the piezometers located in the right abutment area indicate water levels 7 to 15 feet below the surface of the ash compared to 20 to 25 feet near the left abutment area. The cause of the relatively high water levels in the right abutment area is not known.

6.0 OPERATIONAL PROCEDURES

6.1 MAINTENANCE AND OPERATION

We understand that a plant engineer, Mr. Marshall Stevenson, is assigned full-time to operation and maintenance of the ash ponds. However, there are no documented operation or maintenance procedures established for the ash pond storage areas.

6.2 MONITORING AND WARNING SYSTEM

As mentioned earlier, piezometers have been installed in the downstream slopes of both Ponds 1A and 2. The original purpose of the piezometer installation was to obtain information on the nature of the seepage problem so that remedial measures could be designed. Initially, readings were taken on a regular basis. However, we understand that, prior to our site inspection, the piezometers had not been read for a number of years. In view of the history of seeps at these ash ponds, it is our opinion that piezometer readings should be obtained and evaluated on a regular basis. The frequency of the readings should be adjusted to reflect the plant operations in progress at the time. For example, readings should be obtained at more frequent intervals at the beginning of each filling cycle than later in the cycle.

Although plant personnel inspect the dikes daily to review their condition, there is no documentation of procedures for response to damage or deterioration of the dikes. In the past, without documentation, response to emergency conditions has consisted of immediately notifying Casagrande Consultants and requesting their evaluation.

7.0 HYDROLOGIC AND HYDRAULIC EVALUATION

7.1 HYDROLOGY

The ash ponds are enclosed impoundments. As such there is no natural drainage into the reservior. Flow is piped in under controlled conditions. The only source of in-flow, other than the piped in slurry, is rainfall. The maximum one hour precipitation for the 100 year storm in this portion of Virginia is approximately 3 1/2 inches.

7.2 HYDRAULIC CONSIDERATIONS

The AEP Directory indicates that the discharge capacity for the overflow structures is 180 cfs to 200 cfs. It is unlikely that flows even from a large rainstorm will exceed this capacity. Even if the overflow structure were not present, the 100 yr storm would result in only a small increase in pool level.

8.0 OVERALL EVALUATION

The dikes which comprise Ponds 1A, 1B and 2 appear to be in good condition with no evidence of sloughing, lateral displacement or settlement. Although the dikes appear visually to be adequate, there are a number of aspects of their construction and performance for which further evaluation is warranted.

8.1 DIKE STABILITY

The method of construction of portions of the dikes of Ponds 1 and 2 is illustrated in the sections shown in Figure 3. This technique is known as the upstream method. As seen in Figure 3 the alignment of the downstream face of the dam is maintained and the addition to the dam is constructed in the upstream direction. Part of the addition to the dam rests on the sedimented ash. As indicated in Table 1, the dikes were raised a number of times over a period of 8 years. Although some of the dike extensions are shown in Figure 3 to have been constructed in the downstream direction, most of the extensions were in the upstream direction.

As the dike is raised using the upstream method, an increasingly larger portion of the dike is underlain by sedimented ash and the strength properties of the sedimented ash become increasingly important for the overall stability of the dike. The effect of earthquake conditions on the strength of the sedimented ash also becomes an important consideration.

Although the stability of the dikes at the Clinch River plant appears adequate, (based on the visual inspections) we have not made nor reviewed any calculations of dike stability. We believe it would be prudent to evaluate the stability of the dikes. The evaluation should consider the stability of the dikes for both static and reasonable earthquake conditions.

8.2 SEEPAGE CONDITIONS

8.2.1 POND 1

The seeps observed on the downstream face of the dike forming Pond 1A were described in subsection 5.0. In our judgement, the presence of these seeps suggests that piping may be occurring. We recognize that failure has not occurred and that the overall impression of the dikes is one of stability. Nevertheless, we believe an evaluation of the seepage condition should be made.

Although the pond is currently not in repair service, we understand it is used for emergencies.

8.2.2 POND 2

The cause of the relatively high water levels measured in the piezometers located near the right (east) abutment of Pond 2 needs to be evaluated. The possibility of a relationship between these water levels and the wet condition present at the downstream toe near the right abutment should be investigated.

TABLE 1

SEQUENCE OF DIKE CONSTRUCTION

CLINCH RIVER POWER PLANT

PONDS 1A & 1B

DATE	ELEVATION OF TOP OF DIKE
1964	1540
Unknown	1550
Unknown	1560
1971	1570

POND 2

1964	1525
1968	1535
Unknown	1545
1970	1560
1972 - 1973 (not certain)	1575

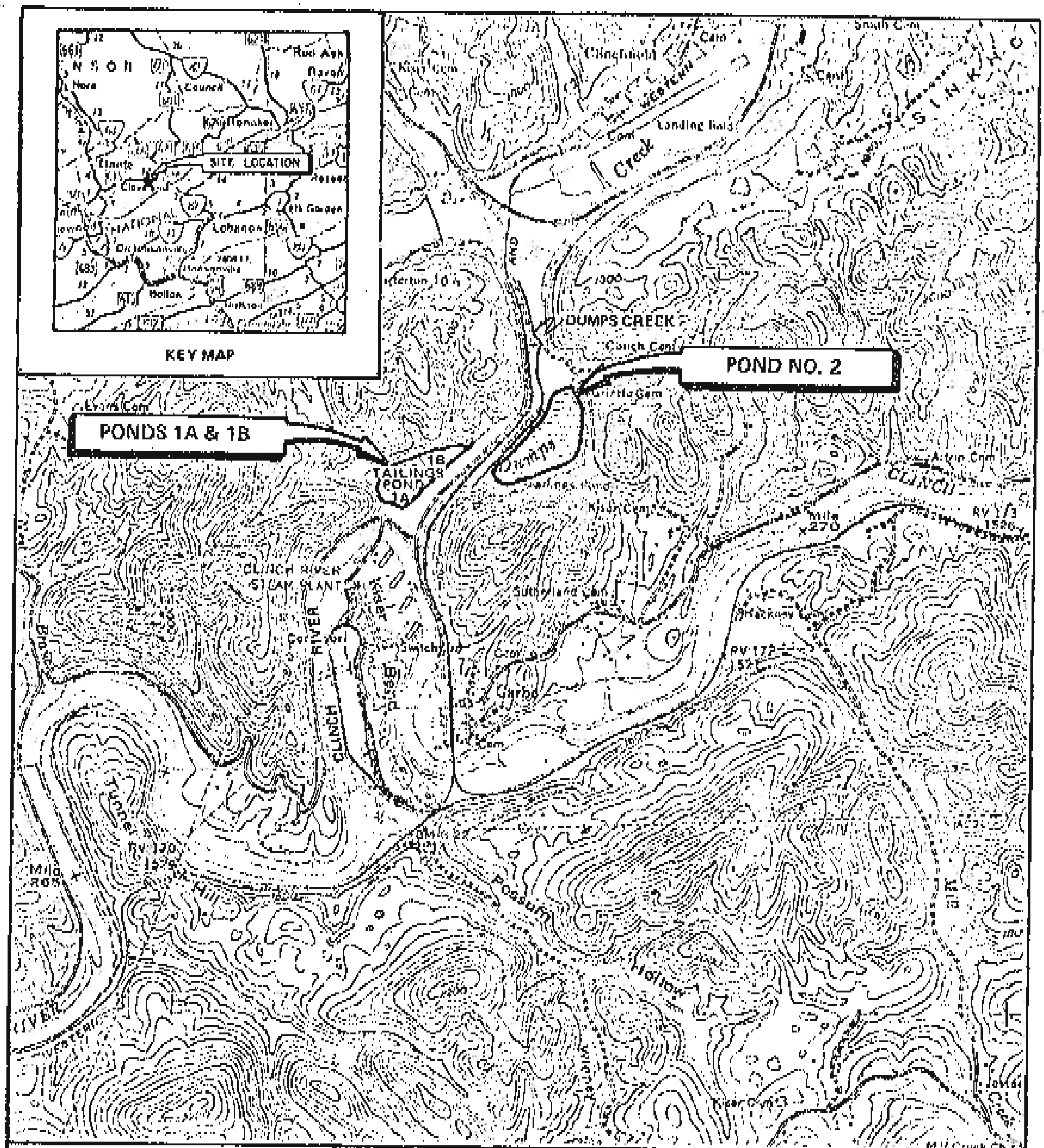
TABLE 2

LIST OF DRAWINGS AVAILABLE FROM AEP

CLINCH RIVER POWER PLANT

MIXED ASH STORAGE PONDS

DRAWING NO.	DATE	DATE OF LAST REVISION	TITLE
13-10796-3107A-2	6/14/71	9/16/77	General Plan and Sections Ash Storage Area
13-10796-3107C	6/14/71	- - -	No. 13 Ash Dike Extension
13-10585-3107-4	9/19/69	11/21/73	Ash Storage Areas
13-10733-3106-3	9/3/70	9/16/77	Ash Storage Areas - Manholes
13-11355-3107D-1	9/16/77	9/23/77	Ash Storage Areas - Sections & Details



REFERENCE DRAWINGS

1. MAP SOURCE FOR KEY MAP IS COMMONWEALTH OF VIRGINIA HIGHWAY MAP, DATED 1976
2. MAP SOURCE FOR SITE LOCATION MAP IS USGS 7.5 MINUTE SERIES (TOPOGRAPHIC) CARBO QUADRANGLE, CARBO, VA., 1969 EDITION

SITE LOCATION PLAN
CLINCH RIVER POWER PLANT
PONDS NO. 1A, 1B AND 2

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
CLIFTON, NEW JERSEY

DR. BY:	ORS	SCALE:	1" = 2000'	PROJ. NO.:	77C110
CK'D. BY:	SAL	DATE:	5 JULY 1978	FIG. NO.:	1

AEPCR000232

APPENDIX A

Document 5

Ash Pond 1 Stability Analysis, By AEP

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CLINCH RIVER POWER PLANT

BOTTOM ASH DISPOSAL FACILITY

Pond 1

Stability Analysis

December 2010

AMERICAN ELECTRIC POWER

American Electric Power Service Corporate
1 Riverside Plaza
Columbus, Ohio 43215

US EPA ARCHIVE DOCUMENT

STABILITY ASSESSMENT REPORT

BOTTOM ASH POND

CLINCH RIVER POWER STATION
CARBO, VA

PREPARED BY Behrad Zand, Engineer **Date** 12/6/2010

REVIEWED BY Pedro J. Amaya, P.E. **Date** 12/6/2010

APPROVED BY Gary F. Zych, P.E.
Section Manager – Geotechnical Engineering **Date** 12/6/2010

QA/QC DOCUMENT NO.
GERS-10-023

COMMONWEALTH OF VIRGINIA
PEDRO JOSE AMAYA-[illegible]
NO. [illegible]
PROFESSIONAL ENGINEER
12/6/10

PROFESSIONAL ENGINEER

SEAL & SIGNATURE

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AMERICAN ELECTRIC POWER

American Electric Power

1. SUMMARY

An assessment of the stability of the main dams that form the bottom ash disposal areas Pond 1 at the Clinch River Power Station is presented in this report. In 2009 a geotechnical investigations was conducted by MACTEC in behalf of AEP to investigate subsurface conditions of the dike and its foundation. This study included drilling of 12 borings to identify soil strata, perform standard proctor test, and extrude split spoon and Shelby tube samples for laboratory testing. The laboratory testing program included eight 3-point triaxial compression (consolidated undrained), four 2-point triaxial compression, twelve hydraulic conductivity, three consolidation, twenty gradation, twenty Atterburg limits, and 25 moisture content tests.

Three idealized sections were developed for the numerical analysis to represent the existing condition of the main dike that forms the 1A and 1B ponds. Seepage through each dike section was analyzed to numerically determine phreatic water surfaces and the maximum hydraulic gradients across each section. Hydraulic properties of the material were evaluated through field explorations and laboratory testing of undisturbed samples recovered from several boreholes, as well as back analyses of the recorded water levels in the piezometer that exists around the facility. Stability analyses were performed for downstream slopes of each section under static and earthquake (quasi-static) conditions with steady-state seepage. The subsurface earthen zones of each dike construction were determined based on available design drawings and subsurface investigations. Material properties used in the stability analyses were selected based on the findings of geotechnical investigations (N-value and index properties) as well as laboratory testing. The calculated factors of safety were found to be 1.5 or higher under static conditions and 1.2 or higher under seismic conditions. The calculated hydraulic gradients at the toe of the three sections were determined to be within acceptable range. As such, the facility is believed to be in safe and stable condition.

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2. INTRODUCTION

The Clinch River Plant is located in Russell county Virginia off of Route 664 and near the town of Carbo. The plant has three units with the total generation capacity of 705 MW. Units 1 and 2 started operation in 1958 and unit three in 1961.

The ash disposal facilities at the plans consist of a bottom ash pond and a fly ash landfill. Bottom ash material produced in the three units of the plant is sluiced into the bottom ash pond facility near and to the East of the plant. While most of the fly ash produced by the plant is placed dry in the landfill, occasionally some fly ash is sluiced into the bottom ash pond. The pond facilities at the Clinch River plant, constructed between 1955 and 1956, consist of two separate ponds, named Pond 1 and Pond 2. Pond 2 was dewatered in 1998 and has been out of service since then, thus it has not been included in this study. Ash ponds 1A and 1B are located at the intersection of Dump Creek and the Clinch River. They are separated by a splitter dike as shown in the facility lay-out plan (Appendix 1). The main dike that forms ponds 1A and 1B has been raised several times between 1955 and 1971. The current crest elevation of the main dike is approximately 1570 ft.

The original 1955 dike was made of relatively impervious silty clay soil with a mixture of shale and sandstone fragments to a crest elevation of 1540 ft. A mixture of fly ash and bottom ash material was used in the first raising to a crest elevation of 1550 ft. Shale rock fill was used in subsequence raisings to the current crest elevation 1570. The second and third dikes (first and second raises) were constructed above and behind the original dike following the upstream construction method. The last raising was constructed on the downstream side of the previous dike raisings with a downstream slope graded to 2 horizontal to 1 vertical. In a letter from Casagrande Consultants on July 14, 1973, the ash mixture used for the first raising and the shale fill used for the raising of the dikes up to the elevation of 1560 ft were evaluated to have a low permeability, while the shale fill beyond elevation 1560 ft was estimated to have a relatively high permeability.

The operating pool levels at Pond 1A and Pond 1B are 1565 ft and 1558 ft respectively. The ash mixture is currently being sluiced into Pond 1A and overflow water flows from Pond 1A to Pond

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1B through a decant structure and a 30 in diameter spillway pipe. The overflow from Pond 1B is directed to a catch basin at the toe of the dike through a 36 in spillway pipe, from which it flows by gravity to a Reclaim Pond. Pond 1A is used to sluice and excavate the ash produced at the plant, while Pond 1B primarily functions as a clear water pond. Both the ponds are dredged on a regular basis and the excavated ash is hauled to a landfill near the plant.

Ponds 1A and 1B had a history of seepage and boils at the toe area and on the downstream face since before 1978. To control these seeps a toe drain, consisting of 10 in diameter perforated pipe buried in a gravel blanket, was installed along the toe in the 1980s. In the late 80s a new seepage and saturated area was reported along a 150 ft long region on the downstream face of Pond 1B at approximate elevation of 1533 ft (about 22 ft above the toe). A stability study performed in 1990 [1] by AEP geotechnical engineering revealed low safety factors for the main dike (1.16). It was recommended that a cut-off wall be installed at the crest and be extended to the foundation soil. As such, in 1991 a 65 ft deep bentonite slurry cut-off wall was installed along the crest of the dike and into the abutments [2]. The cut-off wall was extended into the original 1955 dike that possesses a low permeability. In 2009 an inverted filter with a riprap revetment was placed on the lower half of the downstream slope to control seepage and provide protection against piping.

3. Previous Study and Subsurface Conditions

AEP Geotechnical Engineering conducted a stability analysis in 1990, before the construction of the cut-off wall, to study the condition of the slopes of Pond 1 and Pond 2 [1]. This study included drilling of 7 exploratory borings on the main dike, some of which were continued into the bedrock to explore the conditions of the foundation soil. Shelby tube samples were obtained from the soil layers and direct shear tests as well as triaxial compression tests were conducted to evaluate shear strength of the material. Phreatic water surface was estimated based on the available data from the piezometers and the observed seepage on the downstream slope at elevation of 1533 ft. A set of stability analyses were performed to calculate safety factors against slope instability for the dikes and minimum factors of safety of 1.17 and 1.16 were calculated at the time for Pond 1A and Pond 1B, respectively.

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The 1990 report recommended that a cut-off wall be installed along the crest of Pond 1A and Pond 1B to lower the phreatic water levels and improve the stability of the dikes. It was predicted that a cut-off wall would increase the safety factors to at least 1.45 by dissipating the phreatic level. A cement-bentonite-fly ash cut-off wall, 65 feet deep, was installed throughout the crest in the winter of 1991. Readings from the piezometer A-7R located on the downstream of the wall (Appendix 2), indicate that the maximum recorded water level dropped by about 8ft after the installation of the wall, while the water levels recorded at piezometer A-6, located on the upstream side of the wall, increased by about 10 feet. These readings confirm that the cut-off wall has been performing as intended; to decrease the phreatic level on the downstream side of the wall. Nonetheless, subsequent site inspections revealed that the seepage has been steady at the elevation of 1533 ft on the downstream slope of Pond 1B. Furthermore, water level in piezometer A-7 has consistently been recorded at about elevation of 1533 ft, the same level at which seepage is observed on the slope of Pond 1B.

The detailed construction report of the cut-off wall by Woodward-Clyde Consultant [2] states that, on the basis of visual inspection, seepage quantities decreased after the wall was placed. One boil area at the downstream toe near the reclaim pond was reported to be continued after the construction. This area was covered with a riprap over fabric blanket to minimize piping potential and it appears to have remained stable since then.

In 2009, a geotechnical investigation was conducted by MACTEC. In this study 12 borings were drilled on the crest and toe area of the dike at three sections to explore subsurface conditions and extrude split spoon and Shelby tube samples for laboratory testing. A boring location plan is provided in the Geotechnical Data Report (Appendix 2). Eight new piezometers, namely P-0901S, P-0901D, P0902, P0904, P0906, P-0908S, P-0908D, and P-0909 were installed in the boreholes to complement the exiting piezometers. The new piezometers were installed in the crest and the toe area of the dikes to monitor water levels in the embankment, the foundation soil, and the bedrock. Details of the subsurface investigation and laboratory testing program are included in Appendix 2.

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4. IDENTIFICATION OF SOIL LAYERS AND MATERIAL PROPERTIES

Locations of the three sections selected for this study are presented in Appendix 1. The geometry of each section was based on the 2006 Photography Map presented in Appendix 1. The earthen zones of the dike at the selected section were based on AEP's drawing 13-10585-3107-4 and the 2009 boring logs (Appendix 2). Figures 1 through 3 present the idealized section developed for the seepage and stability analyses. Shear strength parameters (friction angle and cohesion) and hydraulic conductivity for each zone were primarily determined through field and laboratory testing (Appendix 2). Hydraulic conductivities of the material were adjusted to match the calculated phreatic levels with the measured piezometric levels before and after the installation of the slurry wall. Review of historical piezometric data (Appendix 3) shows that the water levels in the piezometers generally exhibit minor fluctuations that are the result of changes in the pool level, seasonal variations in the ground water regime, and measurement errors. Hydraulic conductivities were back-calculated by conservatively using the maximum recorded water levels in each piezometer. Tables 1 through 3 present material properties for the three sections, respectively.

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1. Silty Sand with Shale Fragments – last raising
2. Silty Sand – second raising
3. Compacted Ash – fist raising
4. Clay with Gravel – original dike
5. Clayey Silty Gravel with Sand
6. Sluiced Fly Ash – Bottom Ash Mix
7. Sandy Lean Clay- original dike
8. Clayey Silt - foundation
9. Silty Sand – foundation
10. Sandy silt - foundation
11. Lean clay with sand - foundation
12. Weathered Shale
13. Bed Rock
14. Cutoff Wall

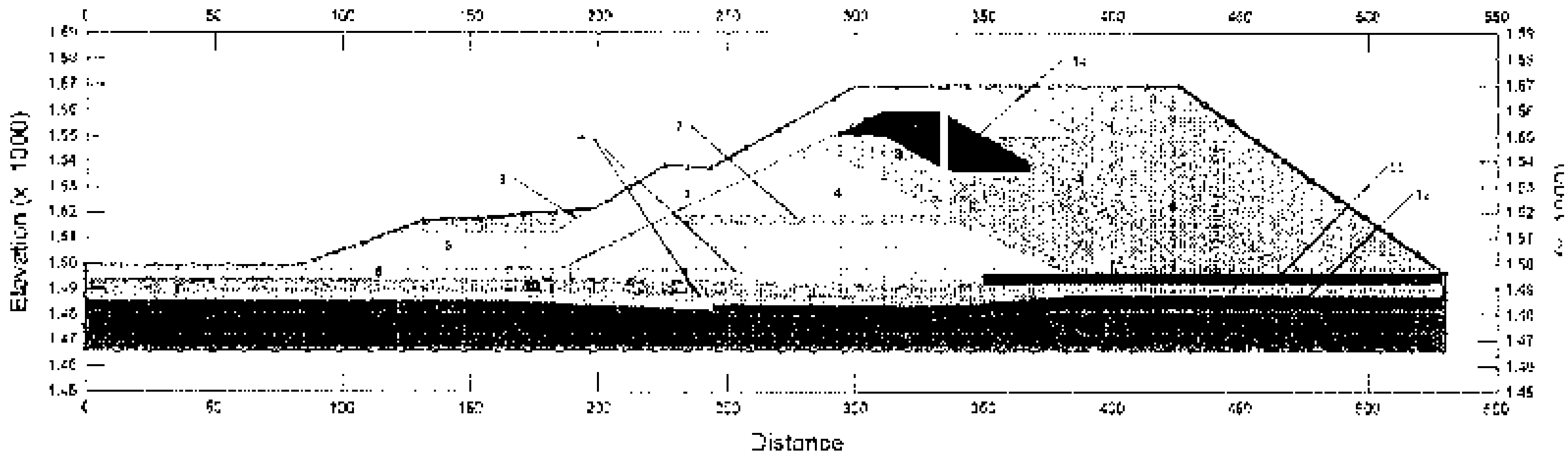

Figure 1. Idealized dike section A of Pond 1A.

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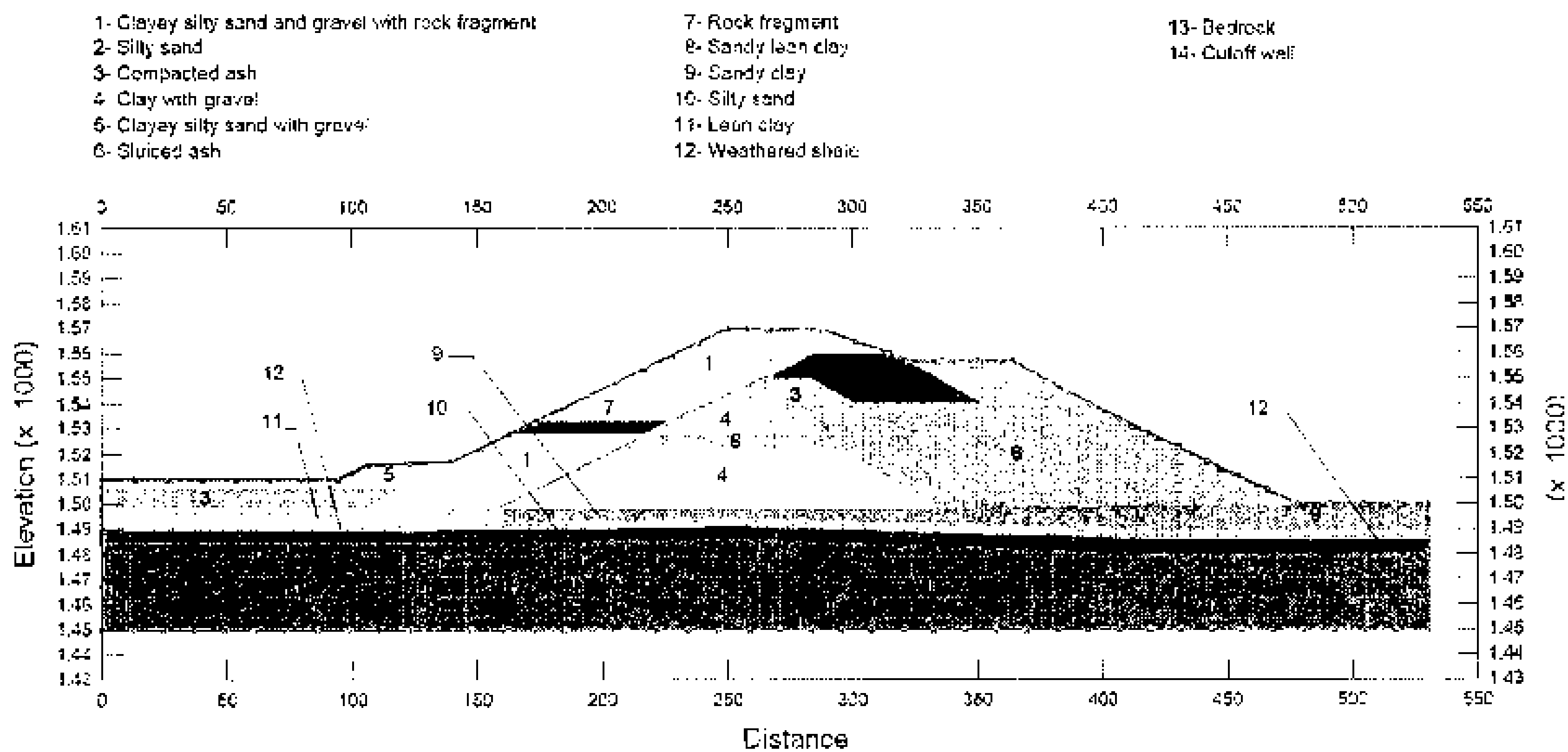

Figure 2. Idealized dike section B of Pond 1B.

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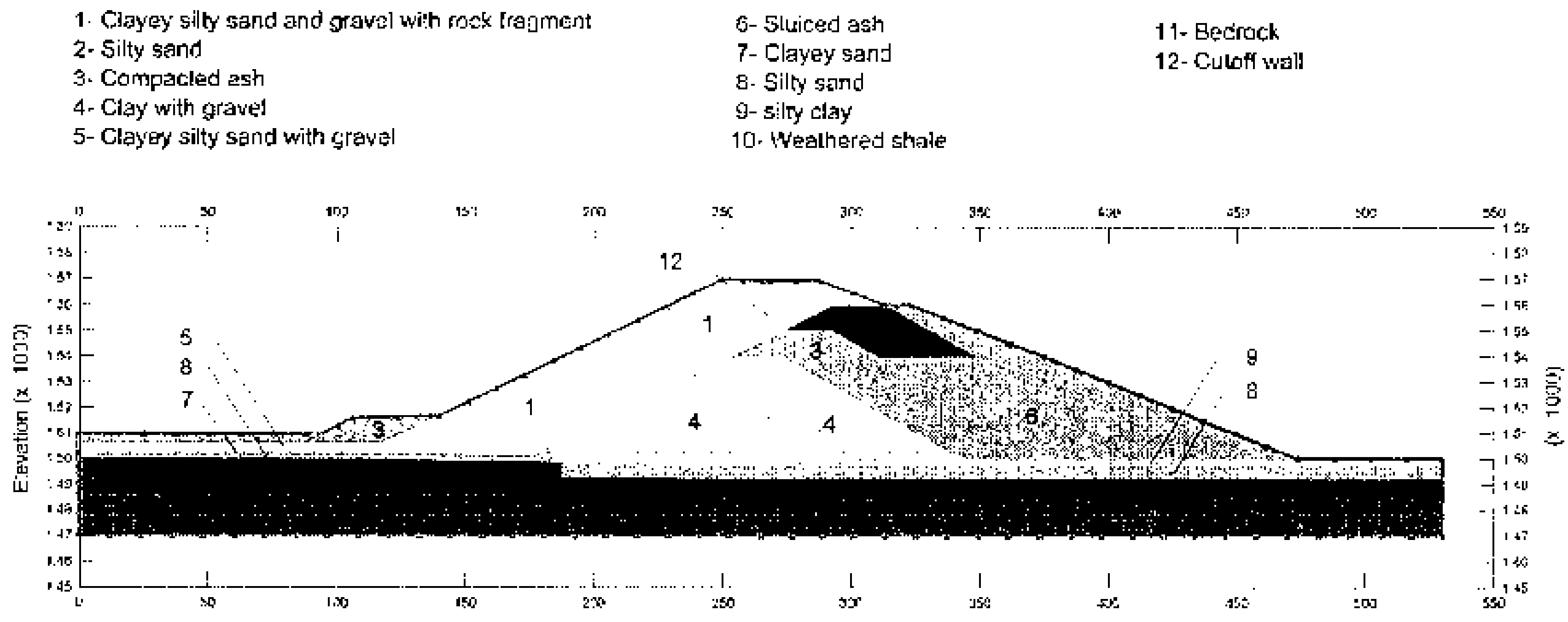

Figure 3. Idealized dike section C of Pond 1B.

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	Soil Type	Location	γ_{sat} (pcf)	φ (deg)	C (psf)	φ′ (psf)	C′ (psf)	Saturation k (ft/hr)
1	Clayey silty sand and gravel w/ shale fragment	Outer shell	136	36	0	36	0	0.05
2	Silty sand	Second raising	136	31	1006	36	0	5.0E-4
3	Compacted ash	First raising	100	30	0	30	0	0.069
4	Clay w/ gravel	Original dike	134	12	1810	25	700	3.5E-6
5	Clayey silty sand w/ gravel	Fill at toe	135	29	580	34	0	0.07
6	Sluiced ash	Impoundment	97	22	0	22	0	0.069
7	Sandy lean clay	Original Dike	140	21	1270	32	850	3.5E-6
8	Clayey silt	Foundation	98	20	400	39	0	1.58E-5
9	Silty sand	Foundation	91.5	15	1800	31	700	5.8E-3
10	Sandy silt	Foundation	100	20	400	28	0	2.13E-5
11	Lean clay w/ sand	Foundation	88	18	200	30	0	3.46E-6
12	Weathered shale	Foundation	140	35	1000	35	1000	2.1E-5
13	Bedrock	Bedrock	NA	NA	NA	NA	NA	1E-4
14	Cutoff wall	Middle of crest into original dike	150	NA	1200	NA	NA	6E-4

Table 1. Material parameters for Section A.

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	Soil Type	Location	γ_{sat} (pcf)	ϕ (deg)	C (psf)	ϕ' (psf)	C' (psf)	Saturation k (ft/hr)
1	Clayey silty sand and gravel w/ shale fragment	Outer shell	136	36	0	36	0	0.05
2	Silty sand	Second raising	136	31	1006	36	0	5E-4
3	Compacted ash	First raising	100	30	0	30	0	0.08
4	Clay w/ gravel	Original dike	134	12	1810	25	700	3.5E-6
5	Clayey silty sand w/ gravel	Fill at toe	135	29	580	34	0	5.0E-5
6	Sluiced ash	Impoundment	97	22	0	22	0	0.069
7	Rock fragments	Outer shell at elevation 1533 ft	136	35	0	35	0	0.8
8	Sandy lean clay	Original Dike	140	21	1270	32	850	1.2E-5
9	Sandy clay	Foundation	98	20	400	35	400	2.0E-6
10	Silty sand	Foundation	90	28	0	28	0	5.08E-3
11	Weathered shale	Foundation	140	35	1000	35	1000	2.1E-5
12	Lean clay	Foundation	92	12	1800	25	0	4.72E-4
13	Bedrock	Bedrock	NA	NA	NA	NA	NA	1.0E-4
14	Cutoff wall	Middle of crest into original dike	150	NA	1200	NA	NA	6.0E-4

Table 2. Material parameters for Section B.

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	Soil Type	Location	γ_{sat} (pcf)	φ (deg)	C (psf)	φ′ (psf)	C′ (psf)	Saturation k (ft/hr)
1	Clayey silty sand and gravel w/ shale fragment	Outer shell	136	36	0	36	0	0.05
2	Silty sand	Second raising	136	31	1006	36	0	5.0E-4
3	Compacted ash	First raising	100	30	0	30	0	0.08
4	Clay w/ gravel	Original dike	134	12	1810	25	700	3.5E-6
5	Clayey silty sand w/ gravel	Fill at toe	135	29	580	34	0	5.0E-5
6	Sluiced ash	Impoundment	97	22	0	22	0	0.069
7	Clayey sand	Foundation	97	22	900	36	100	6.08E-6
8	Silty sand	Foundation	90	6	400	18	400	5.0E-3
9	Silty clay	Foundation	110	22	900	36	100	3.26E-6
10	Weathered shale	Foundation	140	35	1000	35	1000	2.1E-5
11	Bedrock	Bedrock	NA	NA	NA	NA	NA	1.0E-4
12	Cutoff wall	Middle of crest into original dike	150	NA	1200	NA	NA	0.0006

Table 3. Material parameters for Section C.

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5. SEEPAGE ANALYSIS

Several seepage analyses were performed Using Geo-Studio Seep/W program to study the seepage behavior of the dikes and obtain the hydraulic gradient and pore pressure distributions across each dike sections. All the analyses were performed under two-dimensional transient conditions to establish the phreatic water surface and velocity field. The model inputs for a transient analysis include volumetric moisture content versus soil suction; and hydraulic conductivity versus soil suction curves. Seep/W has several built-in functions to estimate such functions based on soil type or grain size distribution, saturated hydraulic conductivity, and saturated volumetric moisture content (soil porosity). For more detail on the in-built functions and the estimation methods consult the user's manual of Seep/W [3]. The hydraulic conductivity of the cut-off wall was determined in laboratory as indicated in the Woodward-Clyde report. Operational pool levels used in the analyses were taken to be 1565 ft and 1558 ft for Pond 1A and Pond 1B, respectively.

Each analysis was performed in two stages. In stage one the pool levels were raised from the bottom of each pond to the operational pool levels without the cut-off wall, and in stage 2 the cut-off wall was activated by changing the material type of the elements that defined the wall. Figure 4 presents the computed total head distribution across Section A together with the seepage flow rates per unit length of the dike before the installation of the cut-off wall. The predicted phreatic surface can be seen to be in a reasonable agreement with the historical records of piezometer A-2 and A-3. To achieve such agreement the hydraulic conductivity of the outer shell was adjusted to 0.05 ft/hr. Depicted in Figure 5 are plots of historical readings of all the piezometers that are at or near Section A, including the piezometers installed in 2009. More information on the locations and screening depths of the piezometers has been included Appendix 3. The model predicts seepage at the toe that is confirmed by history of seepage and boils at this area of the dike. In general the model predictions are in reasonable agreement with the field observations and piezometric readings, indicating that the values of hydraulic conductivities and the boundary conditions used in the analysis were well selected.

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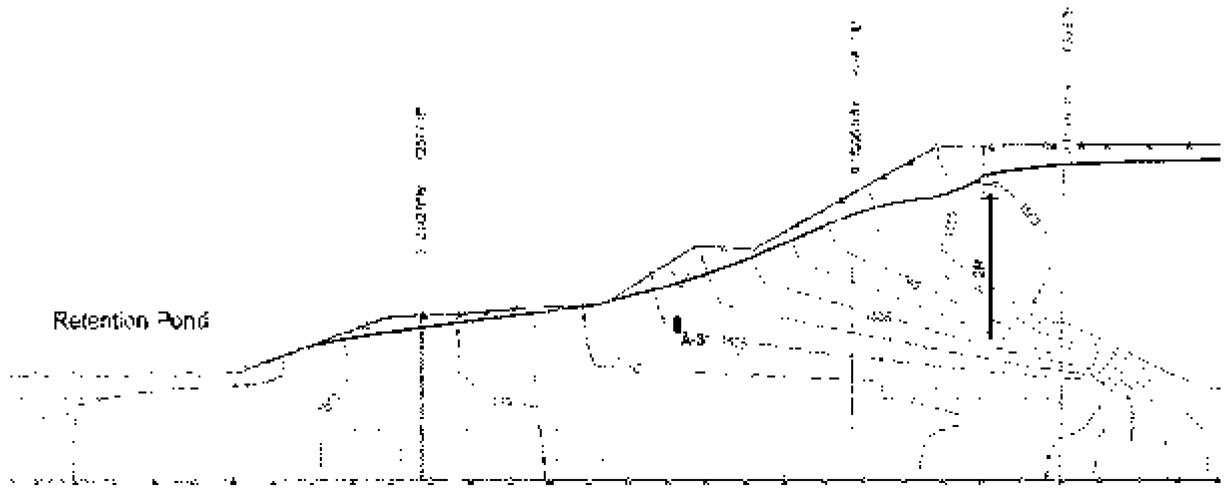

Figure 4. Computed total head distribution in Section A before construction of the cut-off wall.

Figure 6 shows similar results for the second stage of the analysis after the cut-off wall was activated. It can be seen that the computed phreatic surface is in reasonable agreement with the recorded piezometric water levels in piezometers P-0908S, P-0908D, and A-2R. Figure 7 shows the predicted hydraulic gradients (xy-gradient) at the toe and the retention pond. The maximum predicted gradient on the ground surface is about 0.3 that is within the acceptable range for this type of structure. The analysis showed that installation of the cut-off wall can lower the phreatic water levels and significantly decrease seepage flow rates through the embankment. These outcomes were expected and are consistent with field observations and monitoring data. The seepage analysis did not conclude any adverse condition that could be considered as a potential hazard to the safety and stability of the structure. The seepage areas that exist on the toe of the structure are, thereby, believed to be through permeable layers of the foundation soil, a normal phenomenon that occurs in majority of earthen structures and does not pose a threat on the stability. It has to be emphasized that this analysis is not a substitute for the regular inspections and monitoring program that is performed by the plant on quarterly basis. The inspection and monitoring program has to be continued and any unusual condition should be immediately reported to AEP Geotechnical Engineering.

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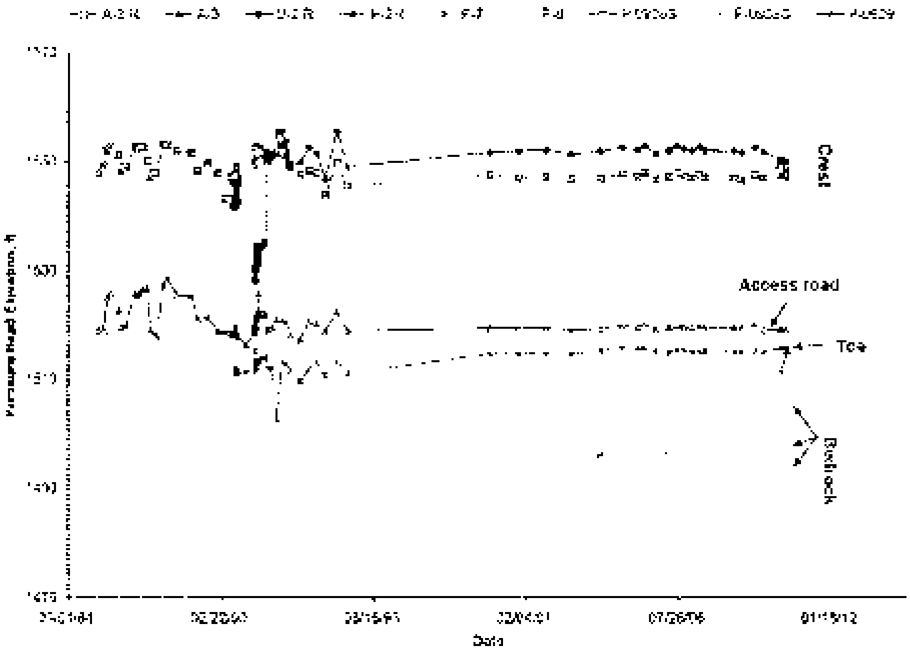

Figure 5. Historical piezometer records near Section A together with readings from newly installed piezometers P-0908S, P-0908D, and P-0909.

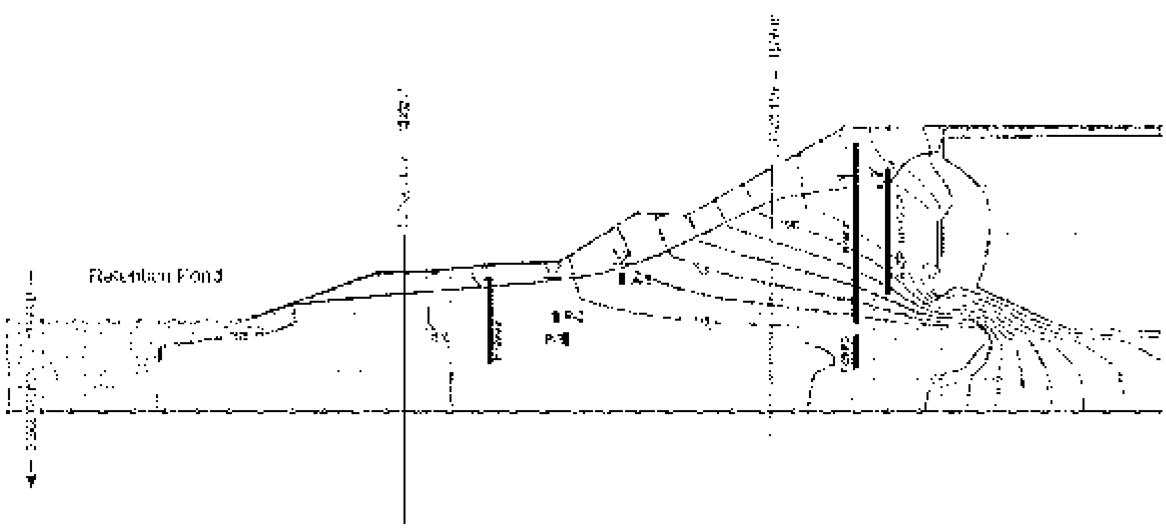

Figure 6. Computed total head distribution in Section A after construction of the cut-off wall.

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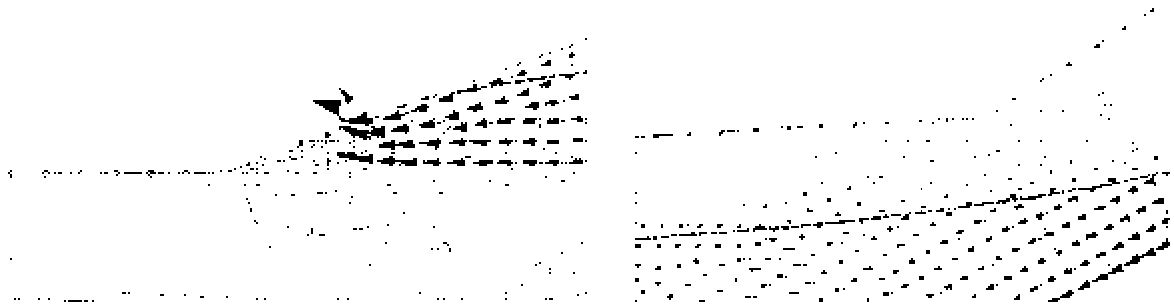

(a) (b)

Figure 7. Computed hydraulic gradients for Section A after construction of the cut-off wall (a) at retention pond, and (b) at the embankment toe.

For the portion of the dike that is represented by Section B, the reported seepage at elevation 1533 ft continued even after construction of the cut-off wall. Furthermore, the observed piezometric level on the downstream side of the wall from piezometer A-7R has been at about the same elevation (1533 ft) since the construction of the wall. Water elevations in the piezometer B-4R and P-0904 have been at (approximately) elevation 1542 ft and 1546 ft, respectively. These observations suggest that a relatively permeable horizontal layer exists at about elevation 1533 ft, which acts as a conduit to transfer water to the slope face. Such a structure could have been formed by segregation of fine and coarse portions of the shale rockfill during placement. A high permeable layer over a low permeable layer within the outer shell is incorporated into the analytical model of Section B, as depicted in Figure 2. Figure 8 shows the computed total head distribution across the cross-section of the dike along with the seepage flow rates per unit length of the dike. A saturated hydraulic conductivity of 0.05 ft/hr was used for the outer shell at this section. The computed water levels for piezometers A-6 and A-7R are in agreement with the recorded water levels that are marked on this figure and also presented in Figure 9. The readings from the piezometers varied with the pool level, however, the maximum water levels (Figure 9), most likely corresponding to the maximum experienced pool level, were used to back-calculate the hydraulic conductivity. The computed levels are within few feet of field observations.

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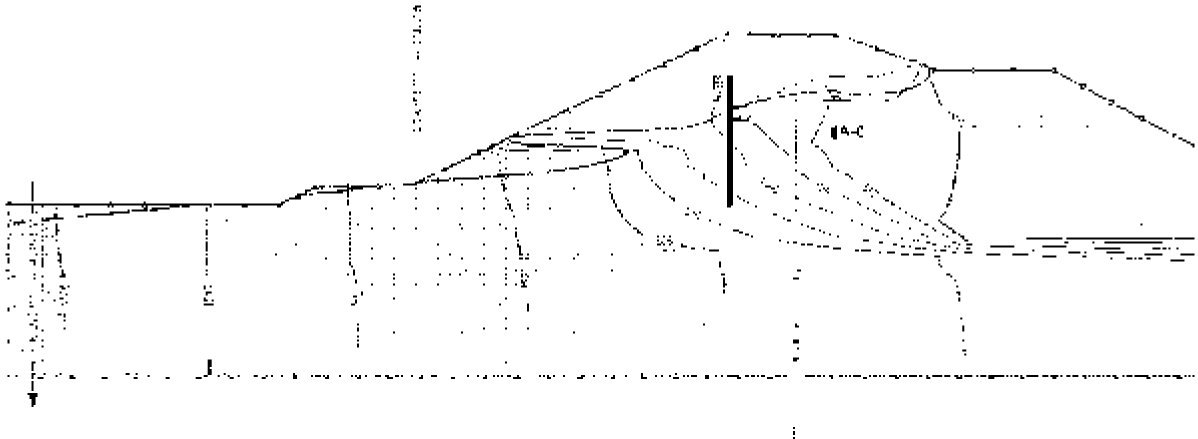

Figure 8. Computed total head distribution in Section B before installation of the cut-off wall.

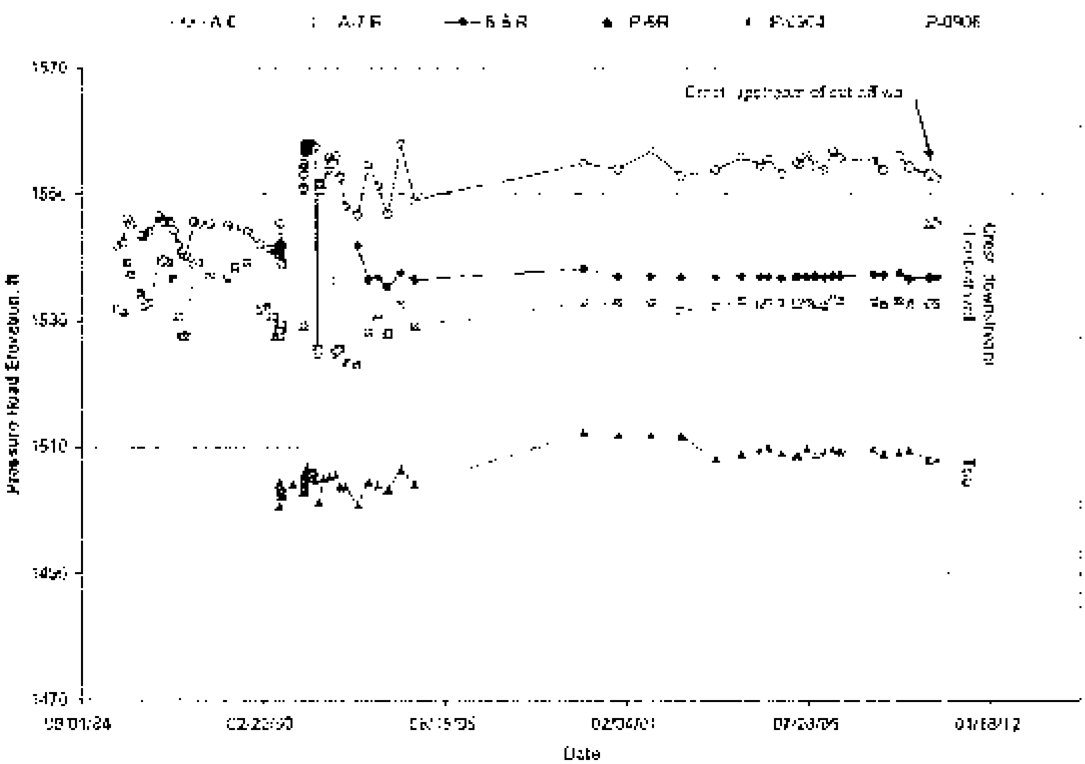

Figure 9. Historical piezometer records near Section B along with the readings from newly installed piezometers P-0904 and P-0905.

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Figure 10 illustrates computed total head distribution across the section after construction of the cut-off wall. The model predicted a 5 ft raise in the piezometric levels on the upstream side of the wall and a 5 ft drop on the downstream side, presenting consistency with the readings from piezometers A-6 and A-7R. Furthermore, the computed phreatic water level is in agreement with the readings from piezometers P-0906, P-5 and P-0904. Piezometer B-5R, located in the crest of Pond 1B between Section B and Section C, have a water level of about 1537 ft since 1992 (Figure 9), that is within the predicted levels on the downstream side of the cut-off wall.

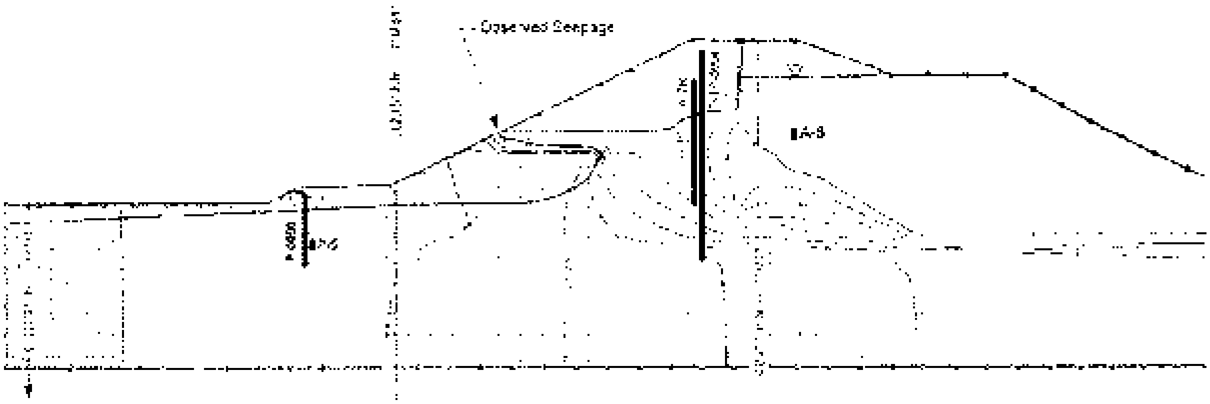

Figure 10. Computed total head distribution in Section B after installation of the cut-off wall.

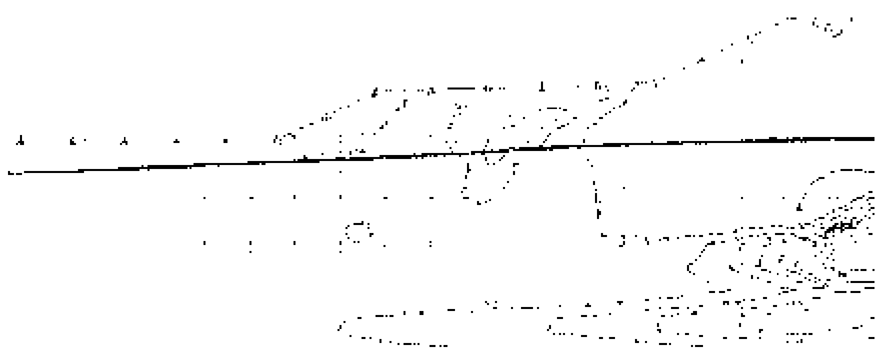

Figure 11. Computed hydraulic gradients at the toe of Section B at after installation of the cut-off wall.

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Figure 11 presents predicted hydraulic gradients at the toe of the section after construction of the cut-off wall. The maximum computed hydraulic gradient at the ground surface is less than 0.1 under the existing condition, an acceptable hydraulic gradient for this type of structure. Thus, no potential for piping failure due to internal erosion is believed to exits. The toe drain and inverted filter on the slope face was constructed to prevent future increases in the hydraulic gradients. Any unexplained raise in the piezometric levels at the toe area is an indication of pore pressure built up. Such condition can occur if the toe drain or inverted filter becomes clogged and it can be corrected by replacing the drain and filter layers.

A thin layer of ash on the slope of the original dike was not included in the seepage model for Section C, as analysis of Section A and B suggested a hydraulic conductivity of 0.05 ft/day for the outer shell that is very close to that of the compacted ash layer (0.08 ft/hr). Figure 12 shows the computed total head distribution across Section C before the construction of the cut-off wall. All the existing piezometers near this section were installed after the construction of the cut-off wall, thus no piezometric data are available to confirm the predicted phreatic surface. A hydraulic conductivity of 0.05 ft/hr back-calculated from analysis of Sections A and B was used for this section. The analysis predicts some seepage at the toe of the embankment before the construction of the cut-off wall, in agreement with the field observations made before 1991.

Figure 13 shows similar results for Section C after the construction of the cut-off wall. The predicted phreatic water levels are in agreement with the data from piezometers P-0901 and P-0902. Water level in Piezometer B-6 has not been shown on this figure because the screening depth of this piezometer is unknown. Figure 14 presents plots of recorded piezometric water levels for B-6, P-0901S, P-0901D, and P-0902. Figure 15 presents predicted hydraulic gradients at the toe of the section after construction of the cut-off wall. The maximum predicted gradient at the ground surface is about 0.2. No potential for piping failure due to internal erosion is believed to exits.

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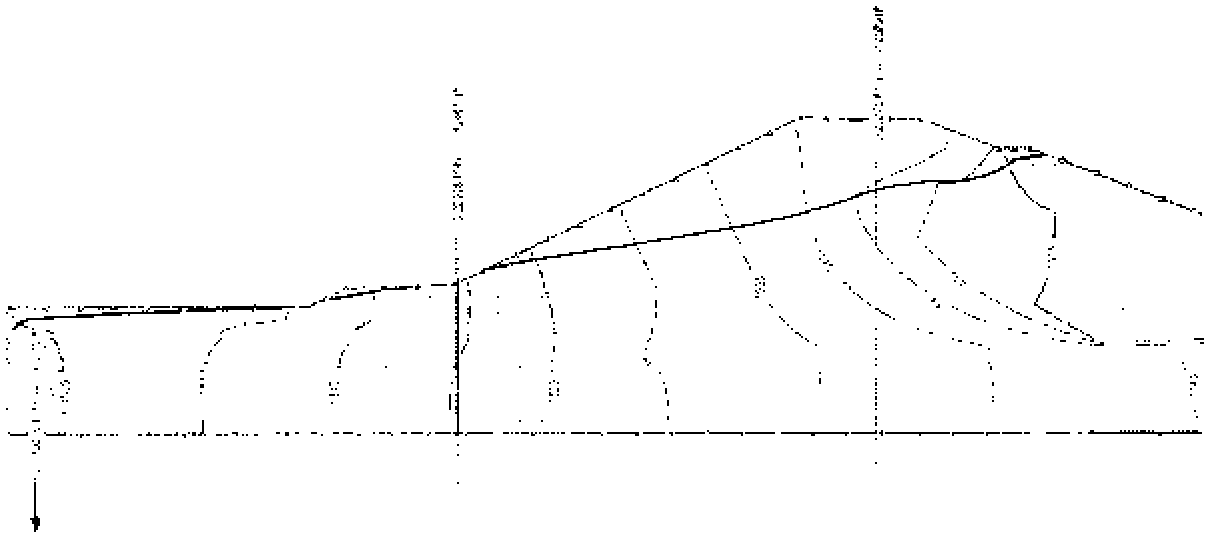

Figure 12. Computed total head distribution in Section C before installation of the cut-off wall.

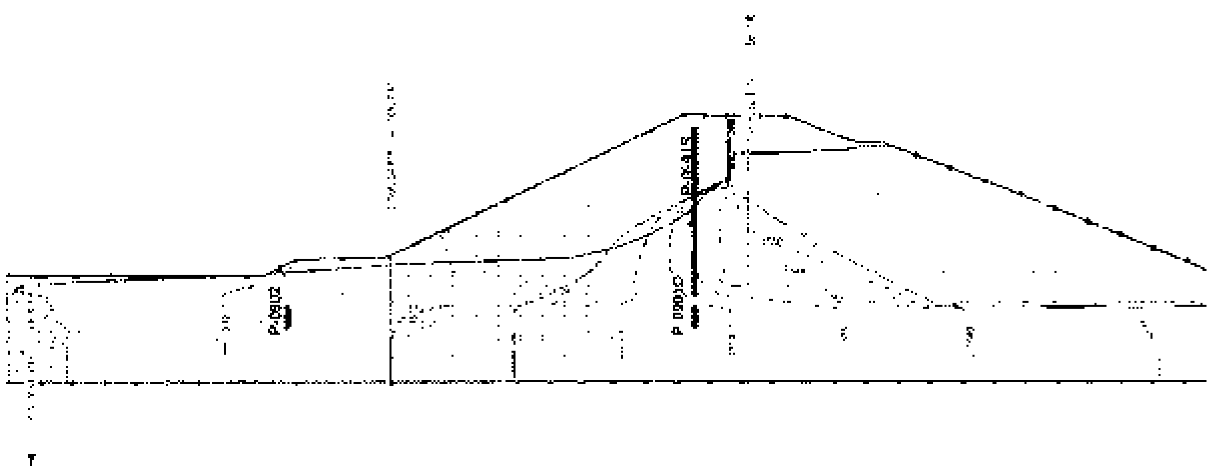

Figure 13. computed total head distribution in Section C after installation of the cut-off wall.

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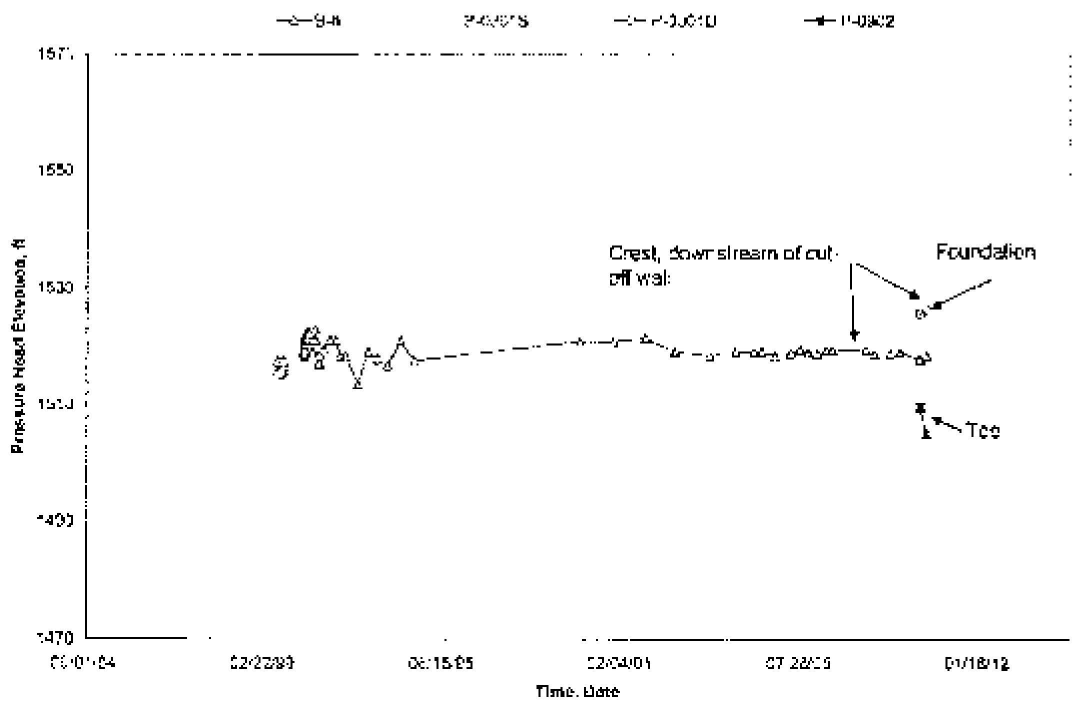

Figure 14. Piezometer water levels near Section C.

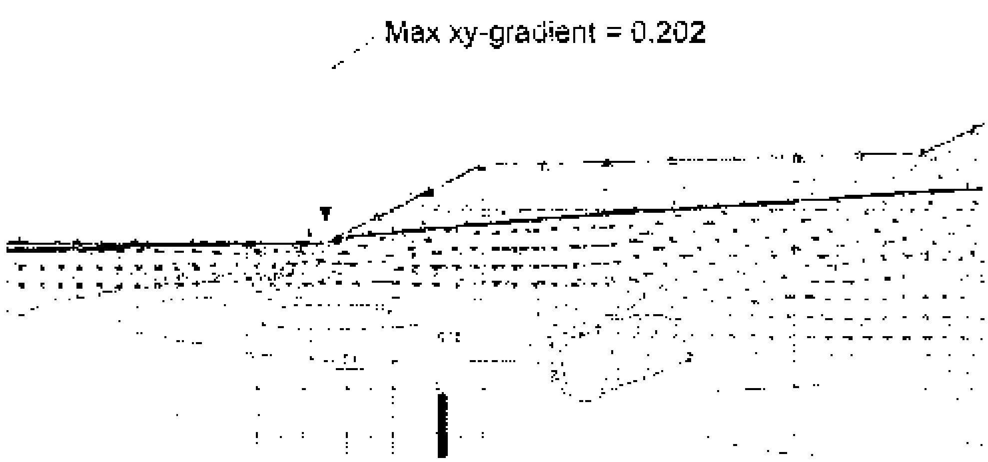

Figure 15. Computed hydraulic gradients at the toe of Section C at after installation of the cut-off wall.

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6. Stability Analysis

The current stability analyses were performed using the Geo-Slope software developed by Geo-Slope International. This program can utilize various limit equilibrium solution methods to compute safety factors against slope instability. In these methods the failure wedge is divided up into several slices and each slice is assumed to be under limit equilibrium condition. In order to make the whole assembly of slices a statistically determined structure different theories utilize a different simplifying assumption to estimate the induced forces on the sides of each slice. In this study the limit equilibrium theory of Morgenstern-Price was used that can satisfy the equilibrium equations of both forces and moments.

The facility has been in its current operational condition for several years. Therefore the analyses for static stability of the slopes were performed for steady state seepage condition using effective shear strength parameters. Pore water pressure distributions calculated in the seepage analyses were imported into the model and used to calculate effective stresses along the failure surface. In all the stability analyses the minimum depth for the failure surface was set to be 10 ft. Any failure surface less than 10 feet deep is considered to be a surface sloughing that can be prevented by the existing riprap revetment, or be easily repaired. The inverted filter system was not directly built into the model; instead, a vertical surcharge load was applied to the lower portion of the downstream slope to simulate its effect. Safety factors were calculated for the downstream slope of each section. A uniaxial compressive strength of 1200 lb/ft^2 was used for the cut-off wall. Upstream slopes of the sections are not susceptible to sliding because both the ponds are filled with sluiced ash all the way up to the maximum normal operating elevations. Ash excavation operation in Pond 1D is performed with care as not to excavate areas near the perimeter dikes. Thus, a berm is always maintained by the upstream slope of the dikes.

Three different failure modes were considered for each section under static loading. A deep failure starting at the crest and penetrating into the foundation soil, a shallow failure surface that enters and exits on the downstream face, and a block failure through the ash layer on the slope of the original dike (Sections A and B only). A summary of the computed safety factors for the three sections is presented in Table 4. It was determined that for Section A the critical failure mode was failure of the outer shell with a factor of safety of 1.5. For Section B and Section C

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the critical mode was determined to be deep failure with computed safety factors of 1.7 and 1.6, respectively. Block failure mode was not considered for Section C because the geometry of the embankment and the material shear strengths are similar to those of Section B. Thus, the factor of safety associated with block failure mode is expected to be the same as that of Section B, that is 2.0. All the calculated factor of safeties are equal or higher than the minimum acceptable factor of safety of 1.5 [4] under steady-state seepage condition. The graphical outputs that show the critical failure surface for each analysis are included in Appendix 5.

Section	Failure Mode		
	Deep Failure	Outer Shell Failure	Block Failure
A	1.8	1.5	1.9
B	1.7	1.7	2.0
C	1.6	1.8	

Note: for each failure mode a systematic search was performed to find the critical failure surface and the associated factor of safety

Table 4. Steady-state condition slope stability safety factors.

Stability analyses under seismic loadings were performed following the pseudostatic method. In this method the effect of the design earthquake is simulated by imposing a lateral acceleration to the failure wedge. USGS seismic hazard maps published in 2008 [5] for this geographic region recommends the peak acceleration, a_{max}, of $0.16g$ corresponding to 2-pecent probability of exceedacne in 50 years. There are different methods to determine a design lateral acceleration coefficient, a_h, for the slope stability analysis [6]. Application of Newmark sliding block analysis has shown that earth dams with a safety factor greater than 1.0 using $a_h > 0.5a_{max}$ are not expected to experience any large deformation during an earthquake [6]. Furthermore, the 1970 version of the Army Corps of Engineers Manual for the Engineering and design, Stability of earthen and rock fill dams [7] recommended $a_h = 0.1g$ for this geographical region. Therefore the current analyses was based on a lateral acceleration, a_h, of $0.1g$. This value is higher than $0.5a_{max} = 0.08g$ calculated following Newmak's method. Stability of the sections

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was assessed using drained and consolidated undrained shear strength parameters. Table 5 presents a summary of the stability analysis results for seismic condition with drained and undrained shear strengths.

Section	Analysis Type	
	Drained shear strength	Undrained shear strength
A	1.3	1.3
B	1.3	1.4
C	1.3	1.2

Table 5. Seismic condition slope stability safety factors.

7. Warning and Critical Piezometric Levels

The stability and safety of this facility highly depends on the proper performance of the cut-off wall and the toe drain in maintaining pore water pressures in the embankment within the design range. If the pore pressure begin to build-up in the embankment for example due to a crack in the cut-off wall the stability of the dike will need to be reviewed. The main purpose of the quarterly monitoring program is to detect any unexplained change in the groundwater regime so that any malfunctioning of the system can be corrected. The piezometric levels and seepage flow rates are reviewed by Geotechnical Engineering to assure that appropriate action will be taken if any unexplained behavior is recorded.

In this section, warning and critical piezometric levels have been established for the three critical sections studied. The warning and critical levels were determined by raising the phreatic surface in each stability model and calculating the corresponding safety factor. Warning level is defined as a water level sufficiently high that can lower safety factor of the dike section to values less than 1.5. The safety factors for Section A is already 1.5, thus any modest increase in the piezometric levels near this section above their maximum historical levels will raise a warning

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note. Warning levels for Sections B and C were determined to be 7 ft increase from the maximum historical water levels in the crest or toe piezometers. If water level in a number of piezometers triggers the warning level, it may become necessary to conduct a new seepage and stability assessment for dike sections near those piezometers to attain a more specific assessment of the condition.

A critical water level is a water level sufficiently high to reduce safety factors below 1.2 for any portion of the dike. Such condition indicates that failure of the dike may be imminent and therefore, the Geotechnical Engineering Section has to assess the condition immediately. The increase in the piezometric levels should be measured with reference to the historical maximum water level of a piezometer. Critical level for Section A was determined to be a 7 ft increase in a piezometric level beyond its historical maximum level. The critical levels for Section B were determined to be 12 ft increase in water level for a piezometer located on the crest (downstream of the cut-off wall) or 10 ft increase in water level for a piezometer located at the toe. The critical levels for Section C were calculated to be 28 ft increase in water levels on the crest (downstream of the cut-off wall) or 9 ft increase in water levels at the toe. Graphical outputs of the stability analyses of this section are presented in Appendix 5.

Besides improper functioning of the cut-off wall and toe drain system other factor can influence piezometric levels, including heavy precipitation, changes in the ground water regime, human error, and malfunctioning of a piezometer. Simultaneous increase of water levels in multiple piezometers that continues or persists for a period of time is usually an indication of a problem that needs to be closely monitored and immediately assessed. If a warning or critical condition is detected by plant personnel Geotechnical Engineering Section shall be informed immediately, and monitoring of the piezometers and flow rate measurements shall be continued daily until instructed otherwise by Geotechnial Engineering.

8. Liquefaction Potential

No liquefaction potential assessment has been performed for Pond 1. However, based on other studies performed on similar facilities [8 and 9] and a site specific liquefaction study performed for Pond 2 [10] at Clinch River Plant, this facility is believed to have no potential for liquefaction

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under the probable earthquakes that may affect this region because the magnitude of the expected earthquake is not sufficiently strong to impose cyclic stress ratios high enough to produce liquefaction.

9. CONCLUSIONS

In this study, a series of seepage and stability analyses were performed to assess the condition of the main dike that forms the bottom ash pond 1 at the Clinch River Plant. The subsurface stratigraphy and material parameters were selected based on the data from the 2009 and 1990 subsurface investigations as well as available design documents from AEP's archives. The hydraulic conductivity of the outer shell of the dike sections was calculated based on actual static water levels observed in the piezometers.

Three idealized dike section were developed, one for Pond 1A and two for Pond 1B. It was concluded that a relatively permeable horizontal layer exists in the downstream shell of the Pond 1B dike in the area modeled in Section B. This horizontal layer, most likely formed as a result of segregation of fine and coarse materials during construction, can direct water toward the slope face and cause the observed seepage on the face of the dike at elevation 1533 ft. Calculated phreatic surface from the seepage analyses for all the three section showed that the cut-off wall installed in 1991 has been effective in reducing static water levels and water pressures near the downstream slopes.

Steady-state factors of safety calculated for the dike sections were found to be 1.5 or higher. The calculated factors of safety under seismic condition were found to be 1.2 or higher. Under seismic loadings, the literature recommends a minimum factor of safety of 1.0 when a coefficient of lateral acceleration of $a_h = 0.5a_{max}$ is used [6]. In this study a coefficient of lateral acceleration of $0.62a_{max}$ was used, thus the calculated factor of safety of 1.2 is acceptable. The computed hydraulic gradients near the ground surface were found to be less than 0.5 for all the three sections. In conclusion, based on the outcomes of the seepage and stability analyses performed, slope failures, piping, or liquefaction at this facility is believed to be unlikely.

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10. References

[1] Clinch River Plant, Stability analysis of ash pond dikes, American Electric Power Service Corporation, 1990.

[2] Summary Report, Construction of cutoff wall, Ash pond 1A and 1B dikes, Clinch River Plant, Woodward – Clyde Consultant, December 1991.

[3] Geo Studio 2007 Help, Seep / W, 2007.

[4] US Army Corps of Engineers, Engineering and Design, Slope Stability. EM-1110-2-1902, October 2003.

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[6] Kramer, S. L., Geotechnical earthquake engineering, Prentice Hall, 1996.

[7] US Army Corps of Engineers, Engineering and Design, Stability of earth and rockfill dams, EM-1110-2-1902, 1970.

[8] Zand, B., Tu, W., Amaya, P.J., Wolfe, W.E., and Butalia, T. S., An experimental investigation on liquefaction potential and post-liquefaction shear strength of impounded fly ash, Fuel, Vol 88, No. 7, July 2009.

[9] Gandhi, S. R. and Dey, A. K., Liquefaction analysis of pond ash, Proceedings of the 15th international conference on solid waste technology management, Philadelphia, PA, Dec. 12-15, 1999.

[10] Clinch River Pond 2 Closure, Appalachian Power Company, Clinch River Plant, Final closure subsurface investigations and design calculations, January 2009.

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APPENDIX 1

FACILITY LAYOUT DRAWINGS

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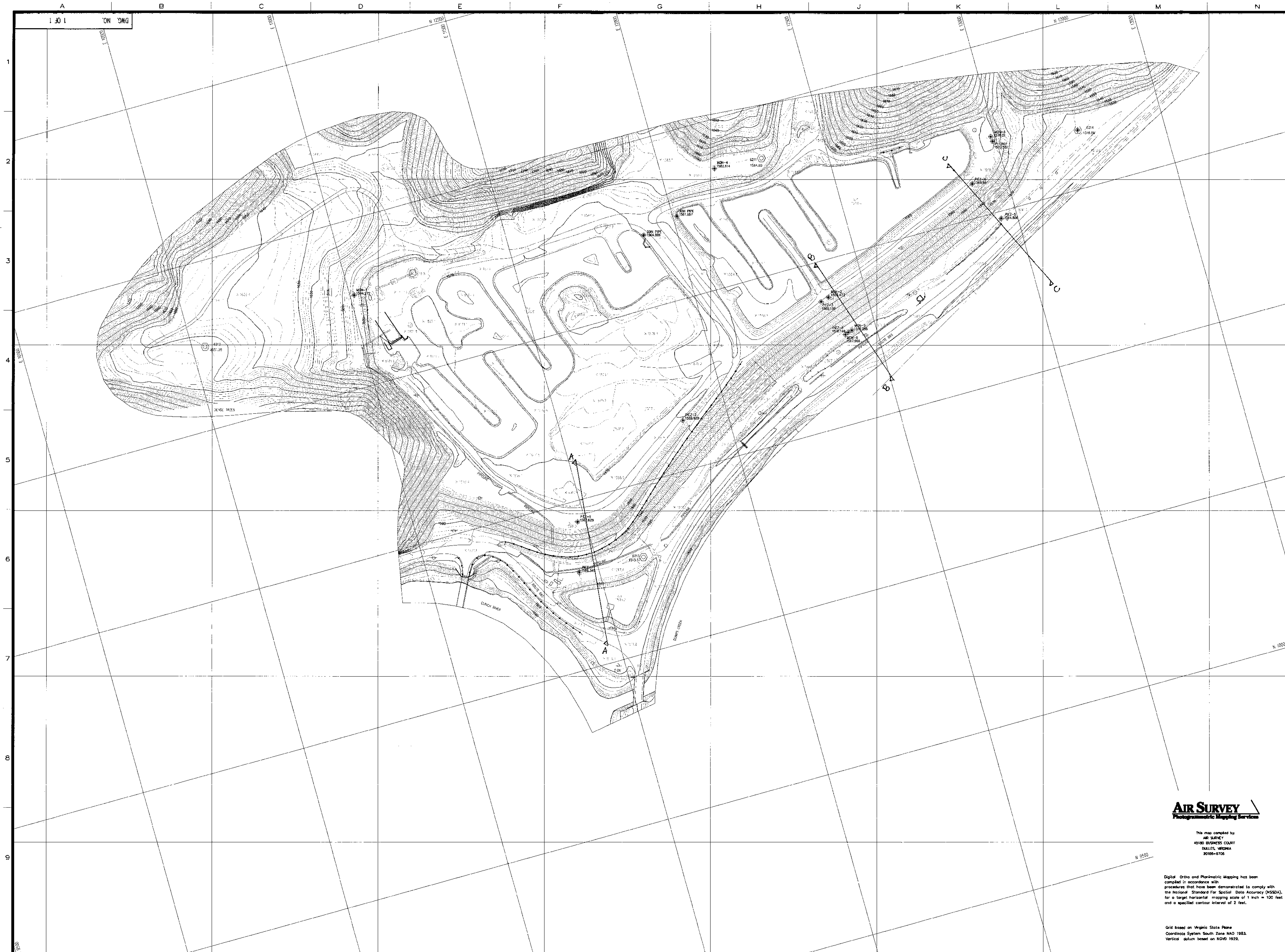

AIR SURVEY
Photogrammetric Mapping Services

This map compiled by:
AIR SURVEY
45180 BUSINESS COURT
DULLES, VIRGINIA
20166-6706

Digital Ortho and Planimetric Mapping has been compiled in accordance with procedures that have been demonstrated to comply with the National Standard For Spatial Data Accuracy (NSSDA), for a target horizontal mapping scale of 1 inch = 100 feet and a specified contour interval of 2 feet.

Grid based on Virginia State Plane Coordinate System South Zone NAD 1983. Vertical datum based on NGVD 1929.

DATE	NO.	DESCRIPTION	APPD.

REVISIONS

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CLINCH RIVER LANDFILL AND PONDS
RUSSELL COUNTY, VIRGINIA

DATE OF PHOTOGRAPHY: 3-04-06

SCALE: 1" = 100'

DWG. NO. 1 OF 1

SCALE:
DR:
CH:
ENGR.
PROJ. ENGR.
DATE:
APPROVED BY

CIVIL ENGINEERING DIVISION

AEP AMERICAN ELECTRIC POWER
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

APPENDIX 2

GEOTECHNICAL DATA REPORT

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GEOTECHNICAL DATA REPORT

AEP CLINCH RIVER DIKE DRILLING
CARBO, VIRGINIA

Prepared For:

AMERICAN ELECTRIC POWER

Columbus, Ohio

Prepared By:

MACTEC ENGINEERING AND CONSULTING, INC.

Abingdon, Virginia

MACTEC Project 3050090131

January 26, 2010

MACTEC

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MACTEC
engineering and constructing a better tomorrow

January 26, 2010

Mr. Gary F. Zych
American Electric Power
1 Riverside Plaza
Columbus, Ohio 43215

Phone: 614-716-2917

Subject: **Geotechnical Data Report**
AEP Clinch River Dike Drilling
Carbo, Virginia
MACTEC Project# 3050090131

Dear Mr. Zych:

MACTEC Engineering and Consulting, Inc., (MACTEC) is pleased to submit our results for soil and rock sampling, piezometer installation, and laboratory testing at the AEP Clinch River site in Carbo, Va. Our services, as authorized by Mr. Timothy A. Randolph of AEP, were provided in general accordance with our proposal number PROP09ABIN.030 dated July 30, 2009.

This report reviews the project information provided to us, discusses the site and subsurface conditions encountered, and presents our laboratory results. The Appendices contain the Field Exploratory Procedures, a Key Sheet, Test Boring Logs and Piezometer Construction Logs, and the Laboratory Test Procedures and Test Results.

MACTEC appreciates this opportunity to provide our services to you and we look forward to serving as your geotechnical consultant throughout this project. Please contact us if you have questions regarding the information presented.

For Brian Owens
with permission

Sincerely,
MACTEC ENGINEERING AND CONSULTING, INC.

Ryan D. Rasnake, P.E.
Engineering Services Manager

Brian D. Owens, P.E.
Principal Engineer
Office Manager

RDR/BDO:mss

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1.0 INTRODUCTION AND OBJECTIVES

This report presents the findings of our subsurface exploration and laboratory testing recently performed for the existing Ash Dike at the American Electric Power (AEP) Clinch River Plant in Carbo, Virginia. We were selected by Mr. Timothy A. Randolph on behalf of American Electric Power (AEP) to perform a subsurface exploration at the existing Ash Dike at the AEP Clinch River Plant.

The objectives of our subsurface exploration was to gather information including field test data and laboratory test data about the site and subsurface conditions that could be used by AEP in their analysis of the existing Ash Dike at the Clinch River Plant. An assessment of site environmental conditions or an assessment for the presence or absence of pollutants in the soil, bedrock, surface water, or ground water of the site was beyond the proposed objectives of our exploration. Therefore, any statements in this report or attachments regarding color, odor, or unusual items or conditions are for information purposes only.

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2.0 SUBSURFACE EXPLORATION SUMMARY

Subsurface conditions were explored with twelve widely spaced test borings drilled at predetermined locations at the site in general accordance with the procedures presented in Appendix A. The boring locations and depths were determined according to information provided by Mr. Gary Zych of AEP. Our geotechnical engineer established the actual boring locations in the field by taping distances and estimating angles relative to on-site landmarks. Therefore, the boring locations shown on the Boring Location Plan (Figure 2) should be considered approximate.

Subsurface conditions encountered at the boring locations are shown on the Test Boring Records in Appendix B. These Test Boring Records represent our interpretation of the subsurface conditions based on the field logs and visual examination of the field samples by one of our engineers. The lines designating the interfaces between various strata on the Test Boring Records represent the approximate interface locations.

The refusal materials in eight of the borings were explored using NQ rock coring procedures. The Recovery Ratio and Rock Quality Designation (RQD) of the recovered rock core samples were estimated in the laboratory during visual classification. The Recovery Ratio is defined as the percentage ratio between the length of core recovered and the length of core drilled on a given core run. RQD is defined as the percentage ratio between the sum of lengths of moderately hard or better core recovered that are at least 4 inches in length to the length of core drilled on a given core run. Recovery Ratios and RQD values are shown on the Test Boring Records in Appendix B. The recovery ratios ranged from 0 to 98 percent and the RQD values ranged from 0 to 92 percent.

A summary of the total depth, depth of fill/ash soils, depth of residual/alluvial soils and depth to bedrock encountered in the borings is shown below in Table 2-1.

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Table 2-1
Test Boring Summary

Boring Number	Date Completed	Top of Ground Elev. (feet)	Total Depth (feet)	Depth of Fill Soils (feet)	Thickness of Residual/Alluvial Soils (feet)	Depth to Top of Rock (feet)	Elevation of Top of Rock (feet)
B-0901	9/2/2009	1569.66	83.9	70.0	8.0	73.8	1490.86
B-0902	9/14/2009	1514.81	29.0	7.6	16.4	24.0	1490.81
B-0903	8/31/2009	1560.0	80.1	79.8	4.3	75.1	1484.90
B-0904	9/16/2009	1569.14	88.8	75.0	3.8	78.8	1490.34
B-0905	9/14/2009	1569.14	30.0	30.0	NE	NE	NE
B-0905A	9/22/2009	1569.14	80.0	80.0	NE	NE	NE
B-0906	9/3/2009	1518.15	35.0	21.4	6.5	30.0	1488.15
B-0907	9/15/2009	1567.0	85.5	70.0	10.5	80.5	1486.50
B-0908	9/11/2009	1567.63	89.5	71.5	12.9	84.6	1483.03
B-0908A	9/8/2009	1567.63	21.8	21.8	NE	NE	NE
B-0908B	9/8/2009	1567.63	19.5	19.5	NE	NE	NE
B-0909	9/11/2009	1519.35	38.8	20.5	13.3	33.8	1485.55

Note: Depths are in feet below ground surface.
Locations and elevations for borings 3,5, 5A, 7, 8A and 8B were estimated based on borings 0904 and 0908.

NE – Not Encountered

Prepared by RDR on 12/11/09
Checked by BDO on 12/11/09

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3.0 LABORATORY TESTING SUMMARY

Samples obtained during drilling were transported back to the MACTEC Abingdon, VA laboratory for testing. Laboratory testing was performed on soil samples selected by AEP. The laboratory testing program consisted of natural moisture tests, plasticity index tests, gradation tests with hydrometers, permeability tests, consolidation tests, triaxial compression tests and dry density tests. The results of the laboratory testing are presented in Appendix D and summarized in Table 3-1 below.

Table 3-1 – Summary of Laboratory Testing Program

Test Type	Test Standard	No. Tests	Test Results	
			Value Range	Type (Units)
Moisture Content	ASTM D 2216	25	31.5 – 31.9	(%)
Atterberg Limits - Liquid Limit	ASTM D 4318	12	31.0 – 46.0	(%)
Plastic Limit	ASTM D 4318	12	20.0 – 26.0	(%)
Plastic Index	ASTM D 4318	12	7.0 – 21.0	(%)
Gradation Analysis w/Hydrometer	ASTM D 422	11	See Appendix C	
Permeability of Soils	ASTM D 5084	3	$5.8*10^{-7}$ – $2.9*10^{-5}$	(cm/s)
Consolidation Tests	ASTM D 2435	3	0.08 – 0.19	C_c
	ASTM D 2435	3	.01	C_r
	ASTM D 2435	3	1.79 – 5.25	P_c(ksf)
Triaxial Compression Tests	ASTM D 4767	5	0.00-0.85	C(ksf)
	ASTM D 4767	5	17.70 – 36.50	Φ(deg)
Dry Density of Fly Ash	ASTM D 7263	2	59.77 – 69.02	(pcf)

Prepared By: *RDR 12/11/2009*
Checked By: *BDO 12/11/2009*

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4.0 PIEZOMETER INSTALLATION SUMMARY

Eight groundwater piezometers were installed under the supervision of a MACTEC professional during September 2009 at the AEP Clinch River Site in Carbo, Virginia. Piezometers were installed after the completion of drilling activities. All piezometers were constructed using a sand pack consisting of DSI GP#2 sand extending approximately one foot below the screened interval and approximately two feet above the screened interval. ENVIROPLUG medium bentonite pellet seals were placed approximately two feet above the sand pack and below the surface of bedrock. Annual space was grouted with Volclay grout to ground surface for each well. In borings containing two piezometers an ENVIROPLUG medium bentonite pellet seal of approximately five feet was placed two feet above the lower screen to approximately one foot of the bottom of the upper screen. A summary of the well installation and screen length is presented in Table 1. Piezometer installation logs are included in Appendix C.

Table 4-1
PIEZOMETER Installation Summary

Boring Number	Date Installed	Total Depth (feet)	Top of Screen (feet)	Bottom of Screen (feet)	Elevation of Top of Screen (feet)	Elevation of Bottom of Screen (feet)	Elevation of 24-HR Groundwater Level (feet)
B-0901	9/2/2009	66.5	7.0	66.0	1562.66	1503.66	1547.66
B-0901	9/2/2009	78.9	73.5	78.4	1496.16	1491.26	1547.66
B-0902	9/14/2009	23.0	7.0	22.0	1507.81	1492.81	1509.51
B-0904	9/16/2009	77.8	6.0	77.8	1563.14	1491.34	1561.14
B-0906	9/3/2009	29.0	6.0	29.0	1512.15	1489.15	1506.85
B-0908	9/11/2009	67.0	7.0	67.0	1560.63	1500.63	1518.23
B-0908	9/11/2009	83.4	76.0	83.4	1491.63	1484.23	1518.23
B-0909	9/11/2009	32.0	7.0	32.0	1512.35	1487.35	1491.75

Note: Depths in feet below ground surface

Prepared by RDR on 12/10/09
Checked by BDO on 12/11/09

Lockable, steel well casing protective caps were installed at each location. Well caps were extended approximately 3 foot above ground surface and set in concrete cement. One protective bollard was set approximately 3 foot from each well in general accordance with ASTM D5787.

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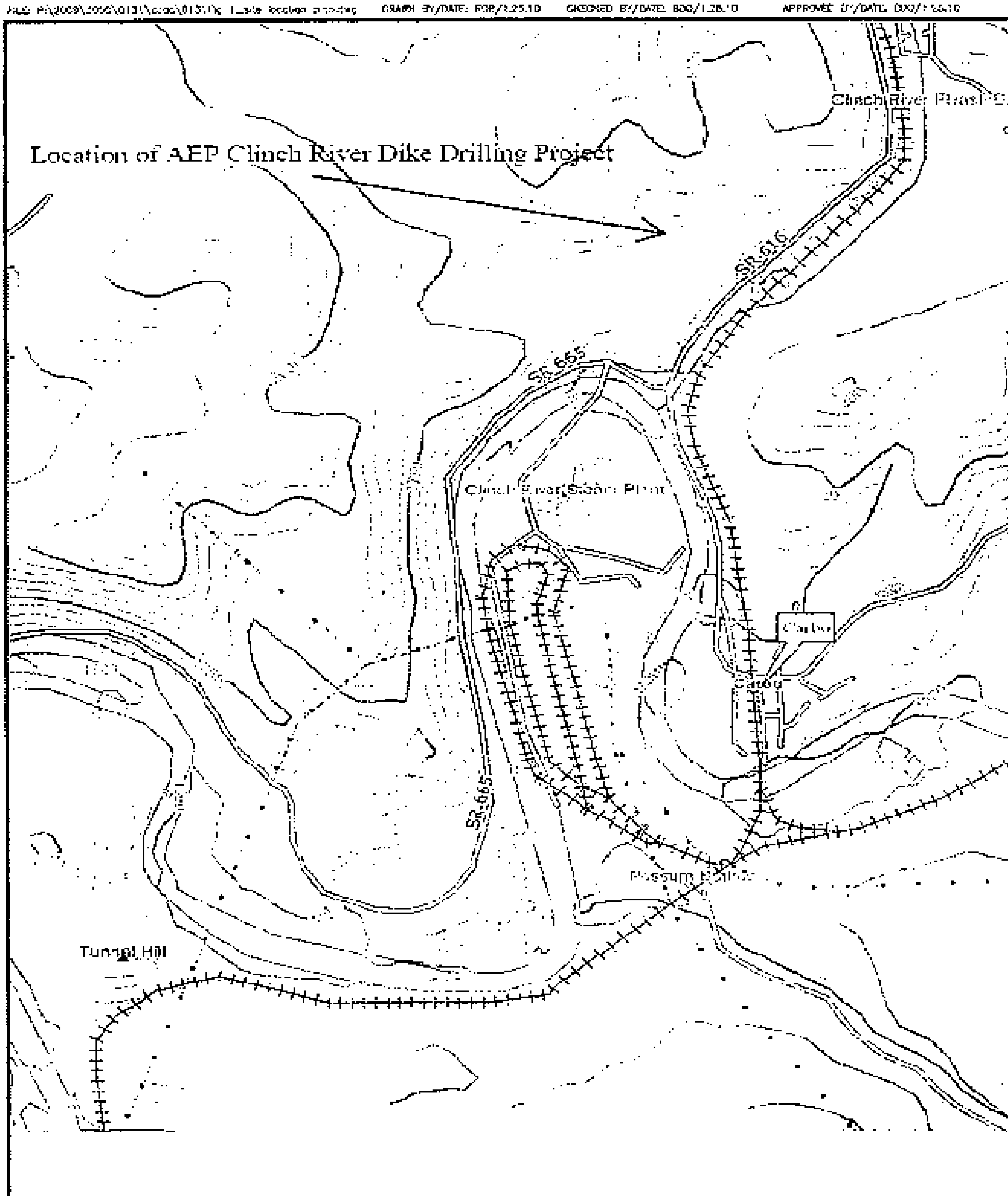
AEPCR000442

FIGURES

US EPA ARCHIVE DOCUMENT

DRAWN BY/DATE: CHECKED BY/DATE: APPROVED BY/DATE:



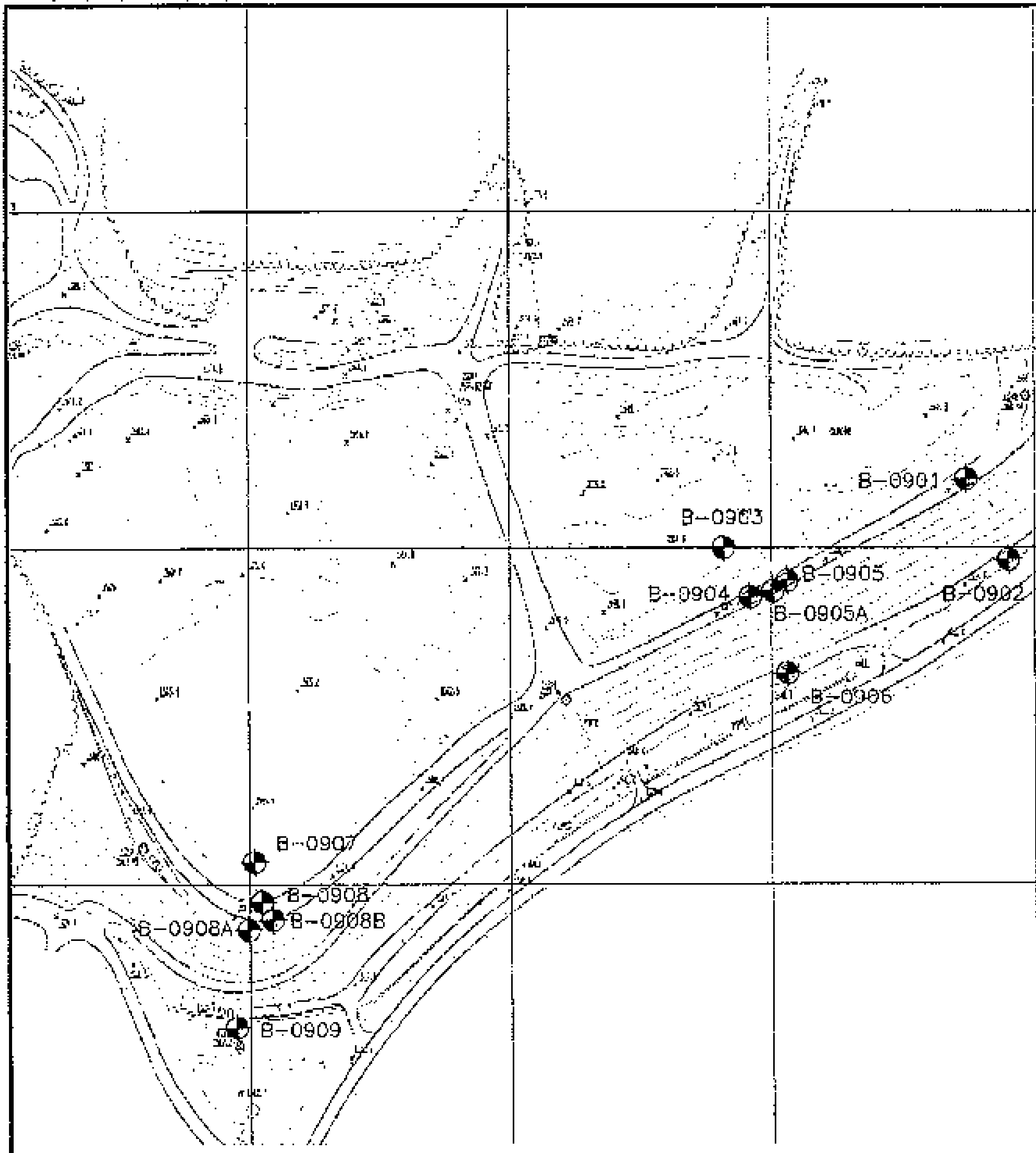
NOTE: DeLorme Topo USA 7.0

DRAWING NOT TO SCALE

AEP Dike Drilling Carbo, VA	MACTEC MACTEC Engineering and Consulting, Inc. 1070 West Main Street, Suite 5 Abingdon, Virginia 24210	SITE LOCATION PLAN PROJECT NO. 3050-09-0131 FIGURE 1

US EPA ARCHIVE DOCUMENT

FILE: P:\2009\3050\0131\acad\0131fig 2_boring location plan.dwg DRAWN BY/DATE: BDR/1.25.10 CHECKED BY/DATE: EDO/1.25.10 APPROVED BY/DATE: DDO/1.25.10



NOTE: Drawing provided by others.

DRAWING NOT TO SCALE

AEP Dike Drilling Carbo, VA	MACTEC MACTEC Engineering and Consulting, Inc. 1070 West Main Street, Suite 3 Abingdon, Virginia 24210	BORING LOCATION PLAN PROJECT NO. 3050-09-0131 FIGURE 2

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APPENDIX A

FIELD EXPLORATORY PROCEDURES

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FIELD EXPLORATORY PROCEDURES

Soil Test Boring

All boring and sampling operations were conducted in general accordance with ASTM D 1586. The borings were advanced by mechanically turning continuous steel hollow-stem auger flights into the ground. At regular intervals, soil samples were obtained with a standard 2.25-inch I.D., 2-inch O.D., split-tube sampler. The sampler was first seated 6 inches to penetrate any loose cuttings and then driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot of penetration was recorded and is designated the "standard penetration test (SPT) resistance." Proper evaluation of the penetration resistance provides an index to the soil's strength, density, and ability to support foundations.

Representative portions of the soil samples obtained from the split-tube sampler were sealed in glass jars and transported to our laboratory, where they were examined by our engineer to verify the driller's field classifications. Test Boring Records are attached, graphically showing the soil descriptions and penetration resistances.

Undisturbed Sampling

For quantitative testing, relatively undisturbed samples are obtained by pushing sections of thin-walled steel or brass tubing (Shelby tube) into the soil at the desired sampling levels. This procedure is described by ASTM Specification D 1587. Each tube is carefully removed from the ground, sealed, and transported to the laboratory for specialized testing. Locations and depths of undisturbed samples are shown on the Test Boring Records.

Rock Coring

Prior to coring, casing is set in the hole drilled through the overburden soils, if necessary, to keep the hole from caving. Refusal materials are then cored according to ASTM D 2113, using a diamond-studded bit fastened to the end of a hollow, double-tube core barrel. This device is rotated at high speeds, and the cuttings are brought to the surface by circulating water. Core samples of the material penetrated are protected and retained in the swivel-mounted inner tube. Upon completion of each core

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run, the core barrel is brought to the surface, the core recovery is measured, the samples are removed, and the core is placed in boxes for transportation and storage.

The core samples are returned to the laboratory where the refusal material is identified, and the percent core recovery and rock quality designation are determined by a soils engineer or geologist. The percent core recovery is the ratio of the sample length obtained to the depth drilled, expressed as a percent. The rock quality designation (RQD) is obtained by summing up the length of core recovered, including only the pieces of core that are 4 inches or longer, and divided by the total length drilled.

The percent core recovery and RQD are related to the soundness and continuity of the refusal material. Refusal material descriptions, recoveries, and the bit size used are shown on the "Test Boring Records."

The NQ and NX sizes designate bits that obtain rock cores 1-7/8 and 2-1/8 inches in diameter, respectively.

Water Level Measurements

Water level readings and caved depths are measured in completed borings as noted on the Test Boring Records. These water level readings indicate the approximate location of the ambient ground-water table at the time of our field investigation. In some instances, the caved depths may possibly indicate ground-water activity.

The time of boring water level reported on the Test Boring Records is determined by field crews as the drilling tools are advanced. Additional water table readings are generally obtained approximately one day after the borings are completed. The time lag is used to permit stabilization of the ground-water table that has been disrupted by the drilling operations. The readings are taken by dropping a weighted line down the boring or using an electrical probe to detect the water level surface.

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AEPCR000448

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APPENDIX B

KEY TO SYMBOLS AND DESCRIPTIONS

TEST BORING RECORDS

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MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of material is LARGER than No. 200 sieve size)	GRAVELS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	GW	Well graded gravels, gravel - sand mixtures, little or no fines.
			GP	Poorly graded gravels or gravel - sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel - sand - silt mixtures.
			GC	Clayey gravels, gravel - sand - clay mixtures.
	SANDS (More than 50% of coarse fraction is SMALLER than the No. 4 Sieve Size)	CLEAN SANDS (Little or no fines)	SW	Well graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand - silt mixtures
			SC	Clayey sands, sand - clay mixtures.
FINE GRAINED SOILS (More than 50% of material is SMALLER than No. 200 sieve size)	SILTS AND CLAYS (Liquid limit LESS than 50)		ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts and with slight plasticity
			CL	Inorganic lays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (Liquid limit GREATER than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils.

BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.

SILT OR CLAY	SAND			GRAVEL		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

No.200 No.40 No.10 No.4 3/4" 3" 12"

U.S. STANDARD SIEVE SIZE

Reference: The Unified Soil Classification System, Corps of Engineers, U.S. Army Technical Memorandum No. 3-357, Vol. 1, March, 1953 (Revised April, 1960)

Undisturbed Sample	Auger Cuttings
Standard Penetration Test	Bulk Sample
Rock Core	Crandall Sampler
Dilatometer	Pressure Meter
Packer	No Recovery
Water Table at time of drilling	Water Table after 24 hours
	Caved Level after 24 Hours

Correlation of Dynamic Cone Penetration Resistance with Relative Density and Consistency (Piedmont Residual Soils)

SAND & GRAVEL		SILT & CLAY	
No. of Blows	Relative Density	No. of Blows	Consistency
0 - 4	Very Loose	0 - 2	Very Soft
5-10	Loose	3 - 4	Soft
11-30	Firm	5-8	Firm
31-50	Dense	9-15	Stiff
Over 50	Very Dense	16-30	Very Stiff
		31-50	Hard
		Over 50	Very Hard

KEY TO SYMBOLS AND DESCRIPTIONS

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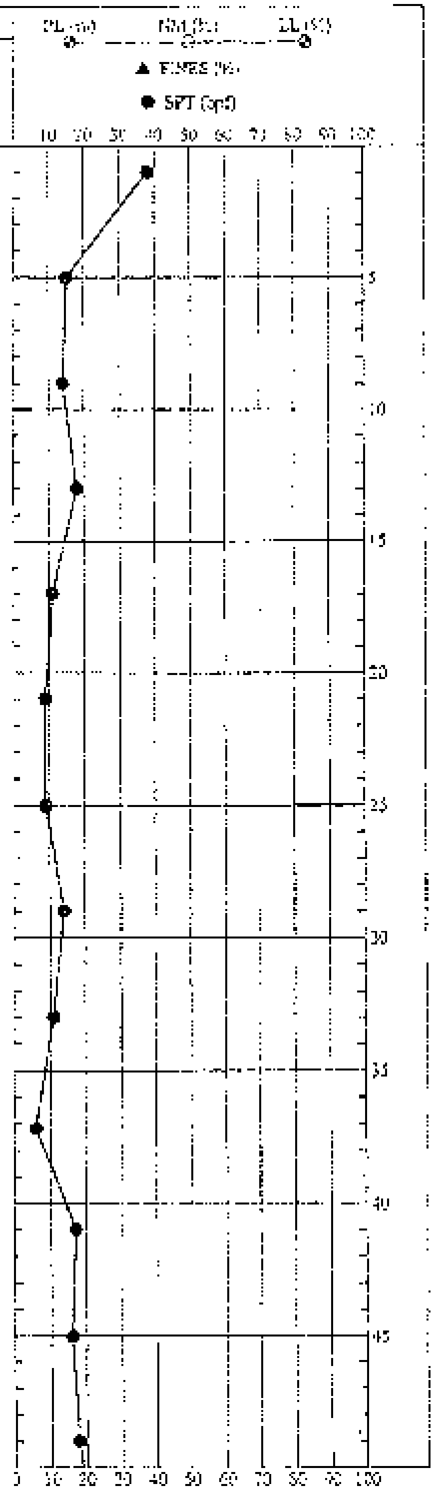
SOIL CLASSIFICATION AND REMARKS

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)
0	FILL: Hard, Red to Brown, CLAY (CL), with Silt and Rock Fragments, Moist	1569.56
3	Stiff to Very Stiff, Brown, Silty SAND (SM), with Sand and Rock Fragments, Moist	
5		1564.56
10		1559.56
15		1554.56
20		1549.66
25		1544.66
30		1539.66
33	SPOIL: Firm to Loose, Dark Brownish Gray, Silty SAND (SM), with Coal Fragments, Moist	
35		1534.66
37	FILL: Very Stiff to Hard, Brown to Gray, Silty CLAY (CH), with Rock Fragments, Coal and Sand, Wet to Moist.	
40		1529.66
45	NOTE: Rock Fragments More Evident at 44.5 to 45.0.	1524.66
50		1519.66

SAMPLES

IDENT	N-COUNT (1st 6" / 2nd 6" / 3rd 6")
SS-1	5-12-26 (N = 38)
UD-1	REC=2.0'
SS-2	11-9-6 (N = 15)
UD-2	REC=1.1'
SS-3	12-7-7 (N = 14)
UD-3	REC=1.2'
SS-4	7-10-8 (N = 18)
UD-4	REC=1.2'
SS-5	5-5-6 (N = 11)
UD-5	REC=1.3'
SS-6	3-4-5 (N = 9)
UD-6	REC=1.1'
SS-7	7-4-5 (N = 9)
UD-7	REC=2.0'
SS-8	6-7-7 (N = 14)
UD-8	REC=1.7'
SS-9	[illegible] (N = 11)
UD-9	REC=2.2
SS-10	[illegible] (N = 6)
UD-10	REC=1.7'
SS-11	5-5-6 (N = 17)
UD-11	REC=2.0'
SS-12	7-9-7 (N = 16)
UD-12	REC=1.6'
SS-13	5-6-12 (N = 18)



DRILLER: Tri-State Drilling
EQUIPMENT: CME 75 Track Rig
METHOD: 3.25" HSA
NORTHING: 3527406.982
EASTING: 10423765.283
LOGGED BY: Jon McDaniel
CHECKED BY: Ryan Retnsko RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.: B-0901
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 2, 2009
PROJECT NO.: 3050-09-0131

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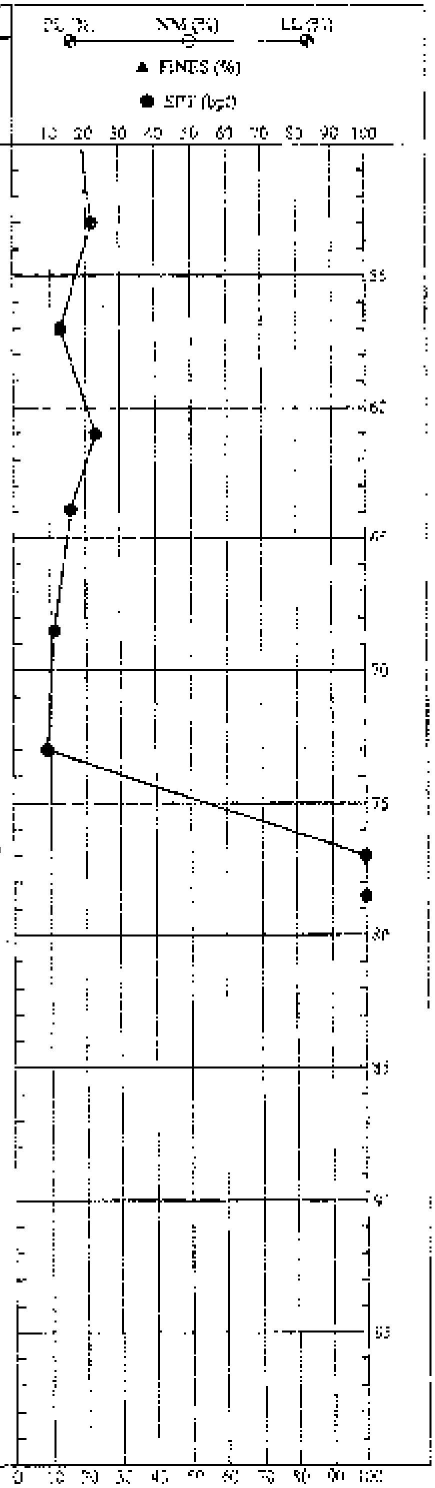
DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	ELEV (ft)	SAMPLES IDENT	TYPE	1st 6" / 2nd 6" / 3rd 6"
50	FILL: Very Stiff to Hard, Brown to Gray, Silty CLAY (CH), with Rock Fragments, Coal and Sand, Wet to Moist	1519.66	UD-13		REC=0.7'
			SS-14		10-11-11 (N = 22)
55		1514.66	UD-14		REC=1.5'
			SS-15		6-6-7 (N = 13)
	NOTE: 10 Gallons of Water Put in Hole at 58.0' Below Ground Surface to Clean Augers Because Steel Kept Getting Stuck in Hole and Augers would Cut.		UD-15		REC=0.5'
60		1509.66	SS-16		15-17-12 (N = 35)
	NOTE: Tube Refusal at 0.9'.		UD-16		REC=0.9
			SS-17		8-7-9 (N = 16)
65		1504.66			
			UD-17		REC=1.5'
	Stiff, Reddish Brown, Silty CLAY (CH), with Large Rock Fragments, Moist.		SS-18		7-4-7 (N = 11)
70	Firm, Light Gray to Brown, Silty CLAY (CH), with Sand, Moist	1499.66	UD-18		REC=2.0'
	Stiff, Brown, Sandy SILT (ML), with Clay, Moist.		SS-19		3-4-5 (N = 9)
75	Very Dense, Gray, Silty SAND (SM), with Rock Fragments, Wet.	1494.66	UD-19		REC=1.7'
			SS-20		11-55-50/4"
	Very Hard, Gray, Highly Weathered SHALE (HWR), Wet. NOTE: Material Too Hard for a UD Tube Auger Refusal at 78.9' Below Ground Surface (BGS) on 9/2/2009.		SS-21		50/6"
80	Moderately Hard, Gray, Close Joint Spacing, Moderately Weathered SHALE.	1489.66	RC-1		REC=73% RQD=43%
85	Coring Terminated at 83.9' Below Ground Surface (BGS) on 9/2/2009 Boring Terminated at 83.9' Below Ground Surface (BGS) on 9/2/2009	1484.66			
90		1479.66			
95		1474.66			
100		1469.66			



DRILLER:	Tri-State Drilling
EQUIPMENT:	CME 75 Track Rig
METHOD:	3.25" HSA
NORTHING:	3532486.992
EASTING:	10403737.283
LOGGED BY:	Jon McDaniel
CHECKED BY:	Ryan Ratecke RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.: B-0901
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 2, 2009
PROJECT NO.: 3050-09-0131

PAGE 2 OF 2

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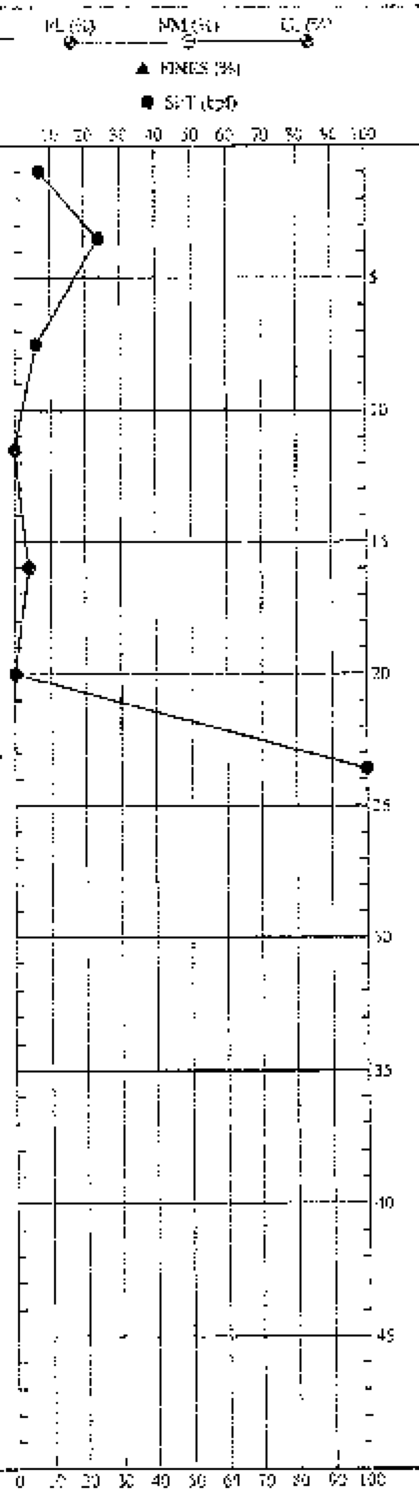
SOIL TEST BORING RECORD

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW)	ELEV (ft)
0	Crushed Stone	1514.81
	ASH: Very Stiff, Grayish Brown, Sandy SILT (ML), with Coal and Rock Fragments, Moist to Wet.	
5		1509.81
	Firm, Brownish Gray, Sandy SILT (ML), with Coal and Rock Fragments, Wet.	
	ALLUVIUM: Firm, Brownish Gray, Sandy SILT (ML), with Highly Weathered Rock Fragments, Trace of Clay, Wet.	
10		1504.81
	Very Stiff, Gray, SILT (ML), with Sand and Small Rock Fragments, Wet. NOTE: Last Spoon Blow Drove Spoon an Extra 0.5' in Soft Material.	
	Very Soft, Dark Brown to Black, Sandy SILT (ML), with Organics, Wet.	
15	NOTE: Materials in Augers. Water Introduced to Get Tools Back in Augers. Use Piston Sample.	1499.81
	Firm, Light Gray, Silty CLAY (CH), with Brown Water Staining Throughout and Root Fragments and Mica, Moist to Wet	
	Very Soft, Brown to Gray, Silty CLAY (CH), with Water Staining and Organics, Wet.	
20		1494.81
	Firm, Gray, Silty SAND (ML), Wet.	
	Very Hard, Gray, Highly Weathered SHALE (HWR), Moist	
	Soft, Gray, Moderately Close Joint Spacing, Moderately Weathered, SHALE, 0 to 30 Degree Joint Inclination.	
25		1489.81
	Auger Refusal at 24.0' Below Ground Surface (BGS) on 9/14/2009	
30	Coring Terminated at 29.0' Below Ground Surface (BGS) on 9/14/2009. Boring Terminated at 29.0' Below Ground Surface (BGS) on 9/14/2009.	1484.81
35		1479.81
40		1474.81
45		1469.81
50		1464.81

SAMPLES

Type/No.	Blows / REC
SS-1	4-3-4 (N = 7)
UD-1	REC=0.5'
SS-2	13-14-10 (N = 24)
UD-2	REC=2.0'
SS-3	3-3-3 (N = 6)
UD-3	REC=2.2'
SS-4	0-0-0 (N = 0)
UD-4	REC=1.7'
SS-5	0-1-3 (N = 4)
UD-5	REC=1.7'
SS-6	0-0-0 (N = 0)
UD-6	REC=1.6'
SS-7	11-22-50/5"
RC-1	REC=86% RQD=20%



DRILLER: Tri-State Drilling
EQUIPMENT: CME 75 Truck Rig
METHOD: 3.25" HSA
NORTHING: 3522363.518
EASTING: 10463874.606
LOGGED BY: Jim McDaniel
CHECKED BY: Ryan Rasnake RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

BORING NO.: B-0902
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 14, 2009
PROJECT NO.: 3050-09-0131

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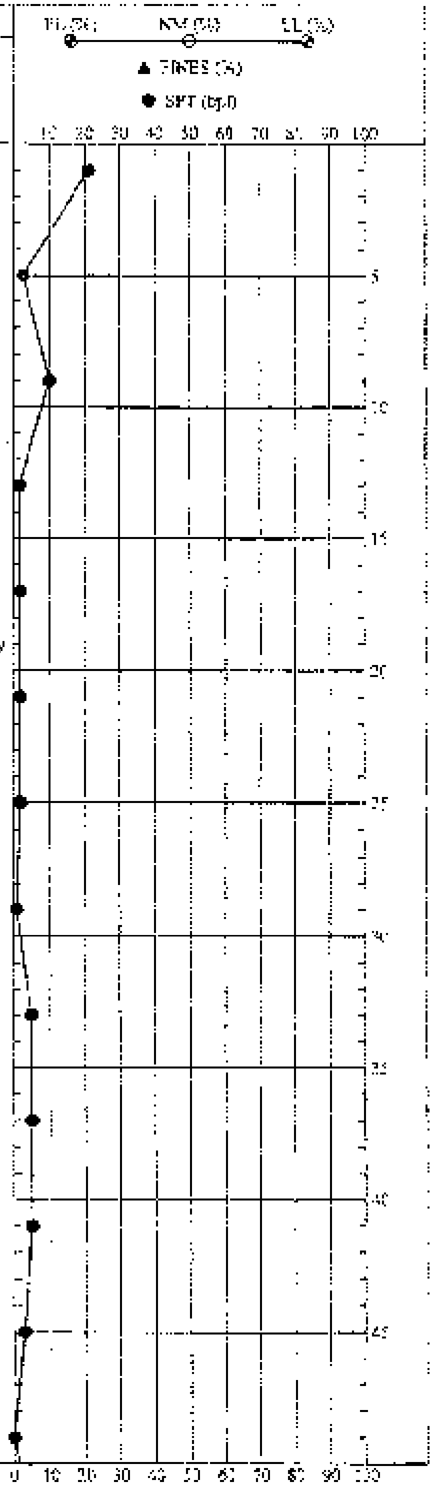
SOIL TEST BORING AEP CLINCH RIVER DIKE DRILLING REVISED 11-10-09.GPJ MAC_FRCHISP 11/27/09

US EPA ARCHIVE DOCUMENT

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW)	ELEV (ft)	SAMPLE IDENT	SAMPLE N-COUNT / REC
0	FILL: Stiff, Grayish to Reddish Brown, SILT (ML), with Rock Fragments, Moist to Wet	1560.00	SS-1	7-11-10 (N = 21)
	Soft, Brown, SILT (ML), with Rock Fragments, Wet		UD-1	REC=1.0'
5		1555.00	SS-2	4-2-1 (N = 3)
	Very Stiff, Brown, SILT (ML), with Rock Fragments, Wet		UD-2	REC=1.3'
	ASH: Soft, Dark Gray to White, Sandy SILT (ML), Wet		SS-3	1-5-9 (N = 10)
10		1550.00	UD-3	REC=1.2'
			SS-4	3-1-1 (N = 2)
15		1545.00	UD-4	REC=1.3'
			SS-5	0-2-1 (N = 2)
	NOTE: No Recovery-Began Using Piston Sampler		UD-5	No Recovery
20	Firm to Soft, Dark Gray, Sandy SILT (ML), Wet	1540.00	SS-6	0-2-1 (N = 2)
			UD-6	REC=2.0'
25		1535.00	SS-7	1-1-1 (N = 2)
			UD-7	REC=2.0'
	Very Loose, Gray, Silty SAND (SM), Wet		SS-8	0-0-1 (N = 1)
30	NOTE: White Streaks at 29.7' to 28.5'	1530.00	UD-8	REC=2.0'
	Firm, Gray to Light Gray, Sandy SILT (ML), Wet		SS-9	1-3-2 (N = 5)
35	NOTE: 33.6' to 32.9' Contains Stiff Sandier Material	1525.00	UD-9	REC=2.0'
			SS-10	2-3-2 (N = 5)
	Loose, Light Gray, Silty SAND (SM), Wet		UD-10	REC=2.0'
40		1520.00		
	Soft to Firm, Light to Gray, Sandy SILT (ML), with Rock Fragments, Wet		SS-11	2-4-1 (N = 5)
			UD-11	REC=1.9'
45		1515.00	SS-12	1-0-3 (N = 3)
			UD-12	REC=2.0'
	Very Stiff, Light Gray, SILT (ML), with Rock Fragments, Trace of Sand, Wet		SS-13	2-0-6 (N = 6)
50		1510.00		



DRILLER: Tri-State Drilling
EQUIPMENT: CME 75 Truck Rig
METHOD: 3.25" HSA
NORTHING: 3533219.29
EASTING: 10403292.98
LOGGED BY: Jon McDaniel
CHECKED BY: Ryan Rasmuse RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.: B-0903
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: August 31, 2009
PROJECT NO.: 3050-09-0131

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SOIL TEST BORING AEP CLINCH RIVER DIKE DRILLING BE.GPJ MACTEC.GDT

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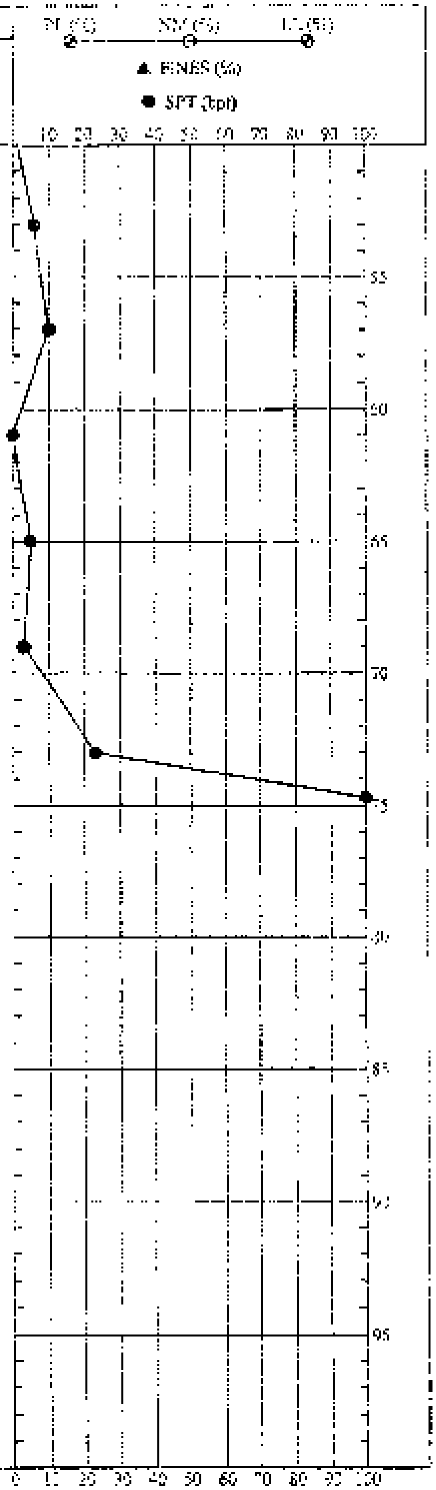
DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE ID	SAMPLE DATA
50	Loose, Light Gray, Silty SAND (SM), with Rock Fragments, Trace of Clay, Wet	1510.00	UD-13	REC=1.6'
	Stiff, Dark to Light Gray, Sandy SILT (ML), with Rock Fragments, Wet		SS-14	3-3-3 (N = 6)
55		1505.00	UD-14	REC=1.5
			SS-15	0-4-10 (N = 10)
			UD-15	REC=1.9'
60	Very Soft, Light to Dark Gray, Clayey SILT (MH), with Rock Fragments, Sand, and Organics, Wet	1500.00	SS-15	0-0-0 (N = 0)
			UD-16	REC=1.2'
	Loose, Brownish Gray, Clayey SAND (SC), with Silt and Rock Fragments, Wet			
65		1495.00	SS-17	0-1-4 (N = 5)
	Firm, Gray, Clayey SILT (MH), with Rock Fragments and Sand, Wet to Moist		UD-17	REC=1.7
			SS-18	0-0-3 (N = 3)
70	Loose, Gray, Silty SAND (SM), with Rock Fragments and Clay, Wet	1490.00	UD-18	REC=0.5'
	RESIDUAL: Hard, Gray, Sandy SILT (ML), with Rock Fragments, Moist		SS-19	5-10-13 (N = 23)
	Very Hard, Sandy CLAY (CL), with Rock Fragments, Moist. NOTE: Spoon Sample Taken Because Rig Lifting Off Ground On Augers-Materials Too Hard to Push Tube		SS-20	50/.5'
75	Moderately Hard, Gray, Close Joint Spacing, Moderately Weathered SHALE	1485.00	RC-1	REC=88% RQD=30%
80	Auger Refusal at 75.1' Below Ground Surface (BGS) on 9/1/2009. Rock Coring Terminated at 80.1' Below Ground Surface (BGS) on 9/1/2009. Boring Terminated at 80.1' Below Ground Surface (BGS) on 9/1/2009.	1480.00		
85		1475.00		
90		1470.00		
95		1465.00		
100		1460.00		

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.



SOIL TEST BORING AEP CLINCH RIVER DIKE DRILLING REVISED LOG.GPJ MACTEC.GDT 12/7/10

DRILLER:	Tri-State Drilling
EQUIPMENT:	CME 75 Truck Rig
METHOD:	3.25" HSA
NORTHING:	3523219.29
EASTING:	10403292.08
LOGGED BY:	Jon McDaniel
CHECKED BY:	Ryan Resnake RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

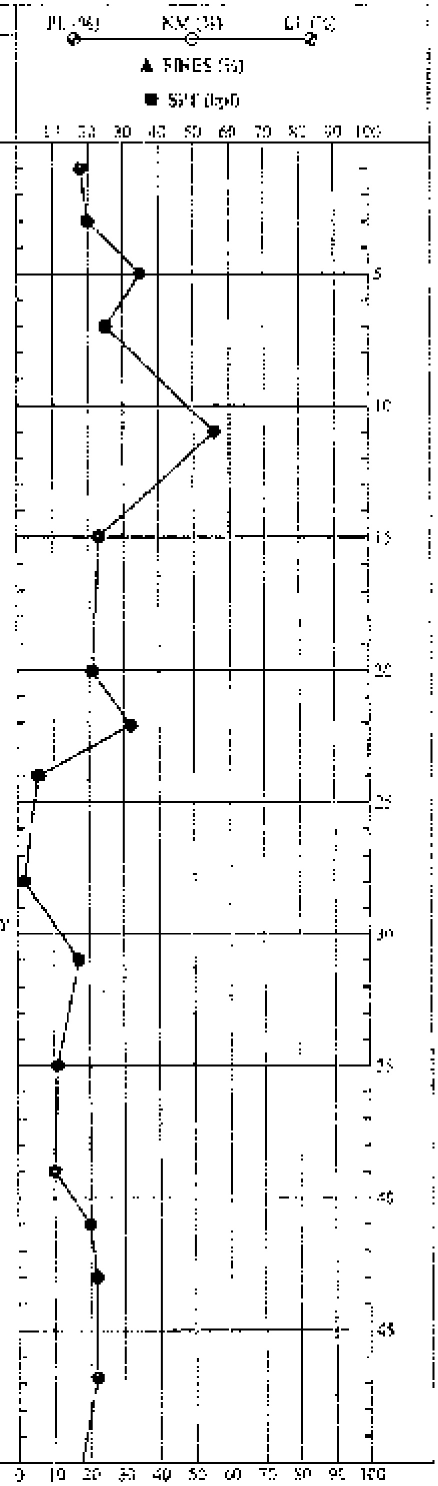
SOIL TEST BORING RECORD

BORING NO.: B-0903
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: August 31, 2009
PROJECT NO.: 3050-09-0131

MACTEC

US EPA ARCHIVE DOCUMENT

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.)	ELEV (ft)	SAMPLE NO.	BLOWS/6" (N) / RECOVERY
0	TOPSOIL	1569.14		
	FILL: Very Stiff to Hard, Reddish Brown to Brown, Silty CLAY (CL), with Sand, Mica and Weathered Shale Fragments, Moist		SS-1	5-10-8 (N = 18)
			SS-2	7-9-11 (N = 20)
5		1564.14	SS-3	9-16-19 (N = 35)
			SS-4	9-12-13 (N = 25)
			UD-1	REC=1.6'
10	Stiff, Tan to Brown, Silty CLAY (CL), with Weathered Shale, Moist	1559.14	SS-5	11-49-7 (N = 56)
	Stiff, Gray, Clayey SILT (MH), with Highly Weathered Shale Fragments, Moist		UD-2	REC=2.0'
15	FILL: Very Stiff, Reddish Brown, Clayey SILT (ML), with Weathered Rock Fragments and Mica, Moist	1554.14	SS-6	6-11-12 (N = 23)
			UD-3	REC=1.5'
20	Very Stiff, Grayish Brown, Silty CLAY (CL), with Weathered Shale Fragments, Moist	1549.14	SS-7	5-9-12 (N = 21)
	ASH: Firm, Grayish Brown, Silty SAND (SM), with Coal and Rock Fragments, Moist		UD-4	REC=0.0'
	FILL: Soft, Brown, Silty CLAY (CL), with Shale Fragments, Moist		SS-8	9-17-15 (N = 32)
	NOTE: UD-4 had No Recovery		SS-9	5-3-3 (N = 6)
25	ASH: Loose to Very Loose, Grayish Brown, Silty SAND (SM), with Coal and Rock Fragments, Moist to Wet	1544.14	UD-5	REC=2.0'
	NOTE: Wet from 28.5' and Below.		SS-10	3-1-1 (N = 2)
			UD-6	No Recovery
30	Very Stiff, Gray, Fine Sandy SILT (ML), with Fine Coal Fragments, Wet	1539.14	SS-11	11-9-8 (N = 17)
	FILL: Very Stiff to Stiff, Brown to Gray, Silty CLAY (CL), with Weathered Rock Fragments, Wet to Moist		UD-7	REC=1.9'
35		1534.14	SS-12	3-5-6 (N = 11)
			UD-8	REC=1.1'
	NOTE: SS Used Because of Difficult Augering.		SS-13	5-4-6 (N = 10)
40	Very Stiff, Brown to Gray Throughout, Clayey SILT (ML), with Weathered Shale Fragments and Organics, Moist	1529.14	SS-14	6-10-10 (N = 20)
	NOTE: Material Encountered Very Stiff-Used SS to Get Recovery		SS-15	6-8-14 (N = 22)
45		1524.14	UD-9	REC=1.2'
	Very Stiff, Reddish Brown to Brown Throughout, Silty CLAY (CL), with Highly Weathered Shale Fragments and Organics, Moist to Wet		SS-16	9-9-13 (N = 22)
			UD-10	REC=2.2'
50		1519.14		



SOIL TEST BORING SOIL GDT 10/2/09 MACTEC (side margin)

DRILLER:	Tri-State Drilling
EQUIPMENT:	CME 75 Truck Rig
METHOD:	3.25" HSA
NORTHING:	3573130.379
EASTING:	10403332.315
LOGGED BY:	Jon McDaniel
CHECKED BY:	Ryan Raschke RDR

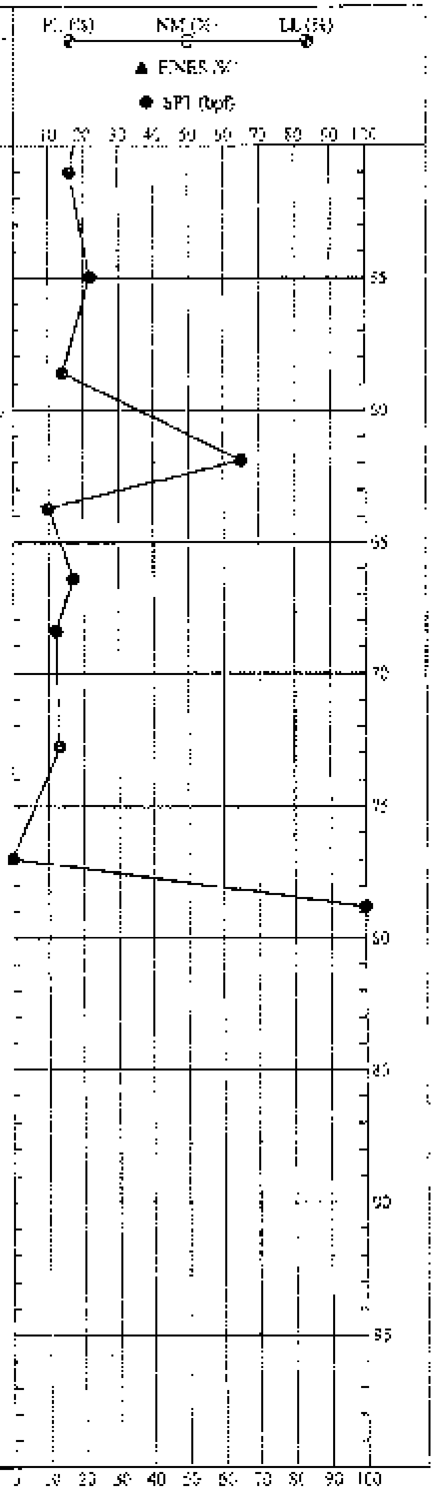
THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.: B-0904
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 16, 2009
PROJECT NO.: 3050-09-0131

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	ELEV (ft)	SAMPLES IDENT	TYPE	N-COUNT 6" 6" 6"
50	Very Stiff, Reddish Brown to Brown Throughout, Silty CLAY (CL), with Highly Weathered Shale Fragments and Organics, Moist to Wet.	1519.14	SS-17		6-9-10 (N = 19)
			UD-11		REC=1.3
55		1514.14	SS-18		4-9-13 (N = 22)
			UD-12		REC=0.9'
			SS-19		3-5-8 (N = 13)
60	NOTE: UD-13 had No Recovery-Tube was Bent During Pushing	1509.14	UD-13		No Recovery
	Hard, Brown, Silty CLAY (CL), with Highly Weathered Shale Fragments, Moist.		SS-20		5-19-46 (N = 65)
	Firm to Very Stiff, Brown to Gray, Silty CLAY (CL), with Highly Weathered Shale Fragments and Organics, Wet.		SS-21		2-4-6 (N = 10)
65		1504.14	UD-14		REC=0.7
			SS-22		10-7-10 (N = 17)
	Stiff, Tan, Clayey SILT (ML), with Weathered Rock Fragments and Organics, Wet.		SS-23		3-6-6 (N = 12)
70	Stiff, Grayish Brown, CLAY (CL), with Silt and Mica, Moist	1499.14			
	Stiff, Brown, Clayey SILT (ML), with Weathered Rock Fragments, Moist		UD-15		REC=2.5'
	Stiff, Brown, Silty CLAY (CL), with Weathered Rock Fragments, Moist		SS-24		4-5-8 (N = 13)
75	ALLUVIAL: Very Loose, Gray, Coarse SAND (SM), with Silt, Wet.	1494.14	UD-16		REC=2.2'
			SS-25		0-0-0 (N = 0)
	Very Hard, Dark Gray, Highly Weathered SHALE (HWR). NOTE: SS Used Because Rough Material in Hole Bottom.		SS-26		24-50/2"
80	NO RECOVERY: From Data from SPT-42/4 and SPT-36 in this Hole, the Material Not Recovered is Shale, with Joint Inclinations Between 75 and 95 Degrees from Horizontal.	1489.14	RC-1		REC=3% RQD=0%
85	Soft, Dark Gray, Moderately Close Jointing, Moderately Weathered SHALE. Joint Inclination of 75 to 90 Degrees.	1484.14	RC-2		REC=62% RQD=0%
90	Auger Refusal at 78.8' Below Ground Surface (BGS) on 9/17/2009. Coring Terminated at 88.8' Below Ground Surface (BGS) on 9/17/2009. Begin Coring at 78.8' Below Ground Surface (BGS) on 9/17/2009 Boring Terminated at 88.8' Below Ground Surface (BGS) on 9/17/2009.	1479.14			
95		1474.14			
100		1469.14			



DRILLER: Tri-State Drilling
EQUIPMENT: CME 75 Track Rig
METHOD: 3.25" HSA
NORTHING: 3532113.379
EASTING: 10403332.818
LOGGED BY: Joe McDaniel
CHECKED BY: Ryan Reineke RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.: B-0904
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 16, 2009
PROJECT NO.: 3050-09-0131 **PAGE 2 OF 2**

MACTEC

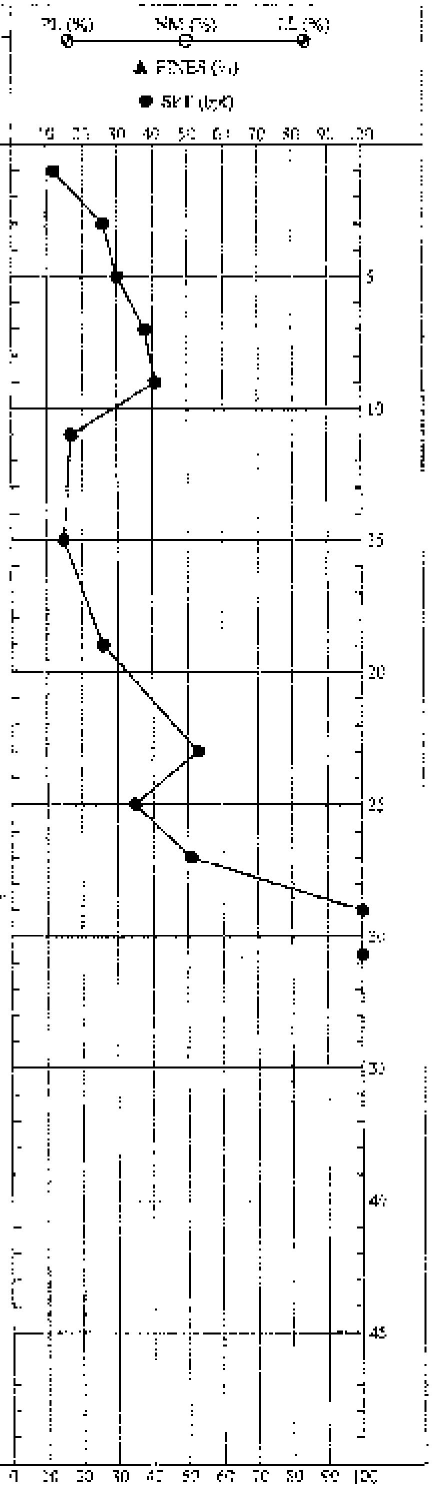
SOIL TEST BORING AEP CLINCH RIVER DIKE DRILLING REVISED 1-19-10.GPJ MACTEC.GDT 1/25/10

US EPA ARCHIVE DOCUMENT

SOIL CLASSIFICATION AND REMARKS

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	N COUNT
0	**ASH:** Firm, Brown, Sandy SILT (ML), with Rock Fragments and Organics, Moist.	1555.10		
	Very Stiff, Brown, Silty CLAY (CL), with Rock Fragments, Moist		SS-1	4-6-6 (N = 12)
	Very Stiff, Yellowish Brown, Sandy SILT (ML), with Sandstone Fragments, Moist.		SS-2	12-11-15 (N = 26)
5	Very Stiff to Hard, Yellowish Brown, Clayey SILT (ML), with Sand, Rock Fragments and Organics, Moist	1564.10	SS-3	5-16-14 (N = 30)
			SS-4	15-17-21 (N = 38)
	NOTE: Blow Counts Too High for UD Samples. Switched from 2.25 SSA to 3.25 HSA at 8.0'		SS-5	13-23-18 (N = 41)
10		1559.10	SS-6	8-9-8 (N = 17)
			UD-1	REC=1.7'
15	NOTE: UD-2 Only Pushed to 1.75 Due to SILT Material.	1554.10	SS-7	4-5-10 (N = 15)
			UD-2	REC=1.4'
	NOTE: UD-3 Only Pushed 1.9 Due to Stiff Material.		SS-8	5-13-13 (N = 26)
20		1549.10	UD-3	REC=1.7
			SS-9	17-32-21 (N = 53)
25	NOTE: No UD Because Too Hard at 24.0' to 25.0'.	1544.10	SS-10	6-13-22 (N = 35)
	Very Hard, Yellowish Brown, Clayey SILT (ML), with Rock and Coal Fragments, Moist. NOTE: No UD Because Too Hard at 28.0' to 30.0. NOTE: SS-12 had No Recovery-Only Gray Powder. NOTE: SPT Refusal on Limestone Fragments at 30.0' Below Ground Surface (BGS). Difficult Drilling Encountered at 29.5'.		SS-11	15-29-22 (N = 51)
			SS-12	10-15-50/2.5"
30	Auger Refusal at 30.0' Below Ground Surface (BGS) on 9/15/2009. Boring Terminated at 30.0 Below Ground Surface (BGS) on 9/15/2009.	1539.10	SS-13	50/1.5"
35		1534.10		
40		1529.10		
45		1524.10		
50		1519.10		



SOIL TEST BORING AEP CLINCH RIVER DIKE DRILLING REVISED 11.10 GPJ MACTEC.GDT 1/2/10

DRILLER: Tri-State Drilling
EQUIPMENT: CME 550X Truck Rig
METHOD: 2.25" SSA 0.0 to 8.0' 3.25" HSA 8.0 to 30.0
NORTHING: 3520133.779
EASTING: 10405330.818
LOGGED BY: Nick Smith
CHECKED BY: Ryan Rupnke

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.: B-0905
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 14, 2009
PROJECT NO.: 3050-09-0131

PAGE 1 OF 1

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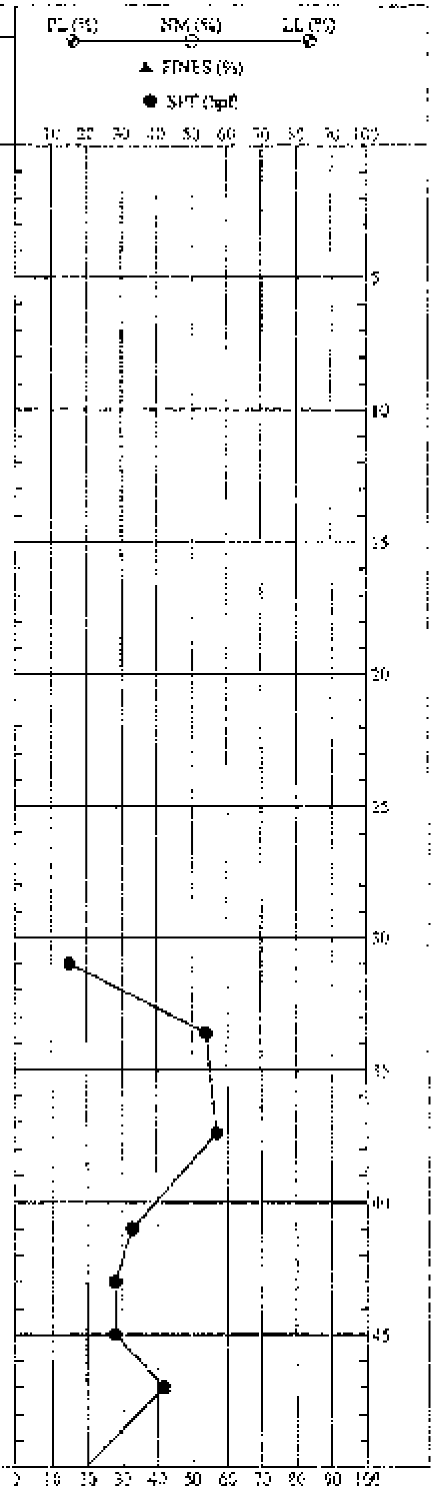
US EPA ARCHIVE DOCUMENT

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.)	ELEV (ft)	SAMPLE IDENT	BLOW COUNT
0	Auger Probed to 30.0' Below Ground Surface (BGS). No Sampling Completed.	1569.10		
5		1564.10		
10		1559.10		
15		1554.10		
20		1549.10		
25		1544.10		
30	ASH: Very Stiff, Yellowish to Reddish Brown, Clayey SILT (MH), with Rock Fragments and Organics, Moist	1539.10	SS-1	6-7-8 (N = 15)
	NOTE: Only Pushed 0.6' Due to Very Stiff Material		UD-1	REC=0.6
	Very Hard to Hard, Yellowish Brown to Brown, Clayey SILT (ML), with Rock Fragments, Moist		SS-2	16-20-34 (N = 54)
35	NOTE: Only Pushed 4.5' Due to Very Hard Material.	1534.10	UD-2	REC=1.4
	Hard, Yellowish Brown, Shale and Sandstone Fragments, Moist		SS-3	18-34-25 (N = 59)
40	NOTE: Difficult Augering Encountered from 36.0' to 44.0' Below Ground Surface (BGS).	1529.10	SS-4	21-17-16 (N = 33)
	Very Stiff to Hard, Brown to Tan, Clayey SILT (ML), with Rock Fragments and Coal, Moist		SS-5	28-15-13 (N = 28)
45	NOTE: Difficult Drilling with Augers Becoming Light	1524.10	SS-6	31-15-13 (N = 28)
	Dense, Dark Gray, Silty SAND (SM), with Coal Fragments, Moist		SS-7	16-17-25 (N = 42)
			UD-3	REC=1.?
50		1519.10		



DRILLER: Tri-State Drilling
EQUIPMENT: CME 550X Truck Rig
METHOD: 2.75" SSA 0.0' to 0.0' 3.25" HSA 0.0' to 50.0'
NORTHING: 3522130.379
EASTING: 10433330.518
LOGGED BY: Nick Smith
CHECKED BY: Ryan Rasnake RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.: B-0905A
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 22, 2009
PROJECT NO.: 3050-09-0131

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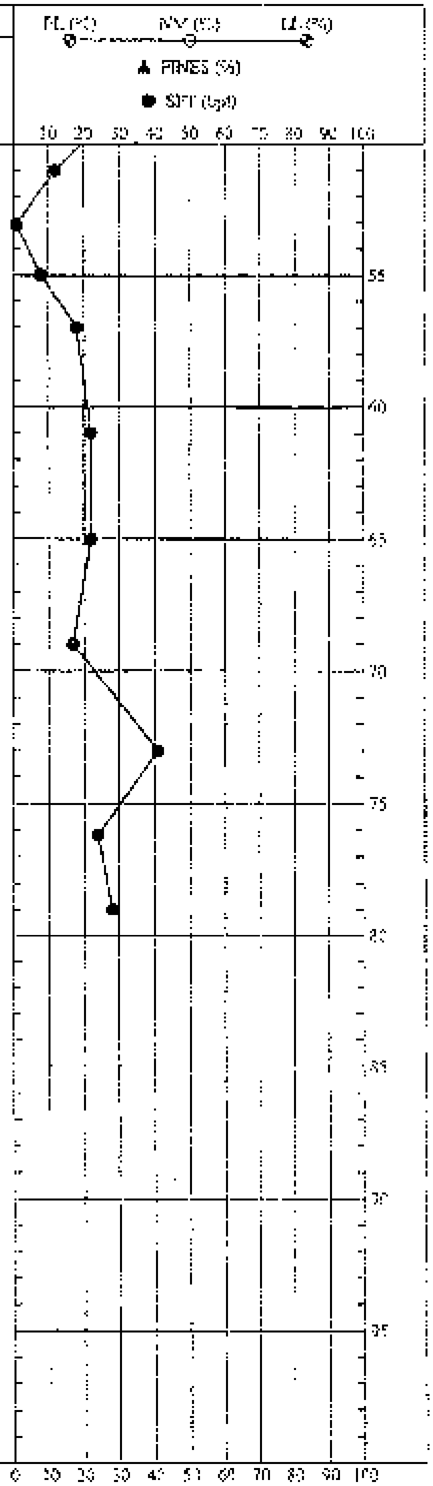
US EPA ARCHIVE DOCUMENT

SOIL CLASSIFICATION AND REMARKS

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	N-COUNT
50	Firm, Dark Gray, Silty SAND (SM), Wet.	1519.10	SS-8	3-6-6 (N = 12)
	NOTE: Too Wet and Loose, No Recovery.		UD-4	REC=0.[illegible]'
	NOTE: Ash Heaving Into Augers when Center Bit Removed		SS-9	0-1-0 (N = 1)
55	Very Loose, Dark Gray, Silty SAND (SM), Wet. NOTE: Started Flushing Center Bit Before Pulling Rods Because of Heaving. Did not try UD Because Too Loose, Wet and No Piston Sampler.	1514.10	SS-10	5-3-5 (N = 8)
	Very Stiff to Hard, Yellowish Red to Tan, Silty CLAY (CH), with Shale Fragments, Coal and Organics, Moist		SS-11	[illegible] (N = 13)
			UD-5	REC=0.9'
60		1509.10	SS-12	6-10-12 (N = 22)
			UD-6	REC=[illegible]'
65		1504.10	SS-13	6-9-13 (N = 22)
			UD-7	REC=[illegible]
			SS-14	[illegible] (N = 17)
70		1499.10	UD-8	REC=1.15'
			SS-15	14-18-23 (N = 41)
75	NOTE: Pushed 1.2' Due to Hard Material	1494.10	UD-9	REC=1.1'
			SS-16	15-14-10 (N = 24)
	NOTE: SPT Sample Taken Due to Difficult Augering.		SS-17	6-13-15 (N = 28)
80	Boring Terminated at 78.9' Below Ground Surface (BGS) on 9/22/2009.	1489.10		
85		1484.10		
90		1479.10		
95		1474.10		
100		1469.10		



DRILLER: Tri-State Drilling
EQUIPMENT: CME 550X Truck Rig
METHOD: 2.25" SSA 0.0' to 3.9' 3.25" HSA 6.0' to 80.0'
NORTHING: 3523[illegible]
EASTING: 10403[illegible]
LOGGED BY: Nick Smith
CHECKED BY: Ryan Rasnake RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.: B-0905A
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 22, 2009
PROJECT NO.: 3050-09-0131 **PAGE 2 OF 2**

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US EPA ARCHIVE DOCUMENT

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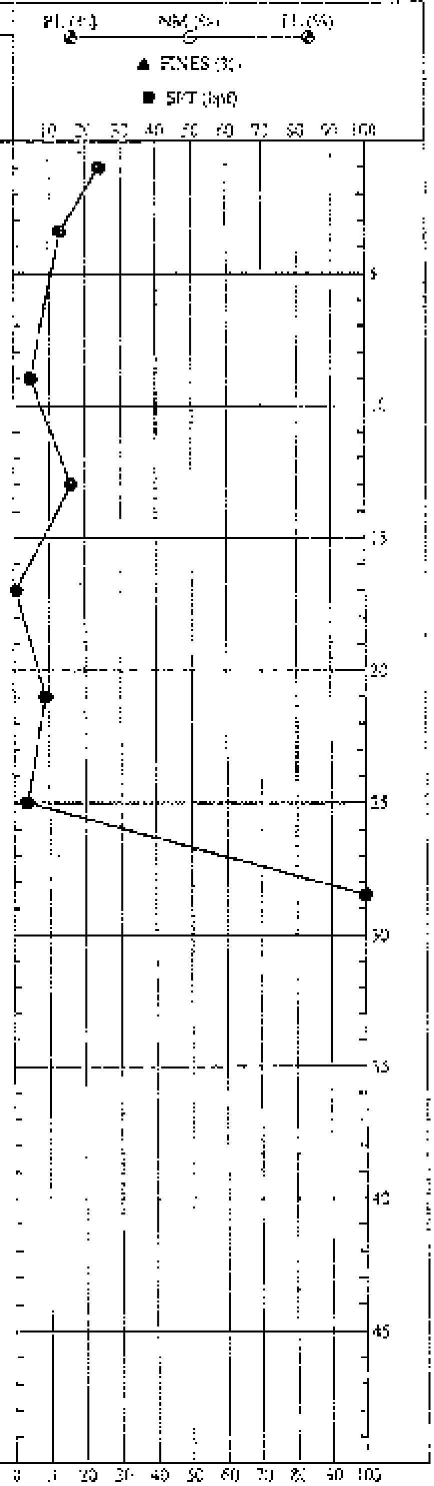
DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.)	ELEV. (ft)	SAMPLE IDENT.	TYPE	BLOW COUNT / REC
0	FILL: Crushed Stone from Road.	518.15			
	FILL: Firm, Grayish Brown, Silty SAND (SM), with Rock and Coal Fragments, Moist.		SS-1		8-15-9 (N = 24)
	Stiff, Reddish to Yellowish Brown, Silty CLAY (CH), with Rock and Coal Fragments, Moist.		UD-1		REC=0.5'
			SS-2		7-6-7 (N = 13)
5		513.15	UD-2		REC=1.5'
	NOTE: Because of the Difficulty of Augering, Elected to Use SS Sample.		SS-3		
	Soft, Brown, Silty CLAY (CH), Moist to Wet.		SS-4		3-3-2 (N = 5)
10		508.15	UD-3		REC=2.0'
	ASH: Firm, Gray, Sandy SILT (ML), with Rock and Coal Fragments, Wet.				
	NOTE: No Recovery		SS-5		12-10-5 (N = 15)
15	Soft, Gray, Sandy SILT (ML), with Rock Fragments, Wet.	503.15	UD-4		REC=2.0'
			SS-6		1-0-1 (N = 1)
			UD-5		REC=2.0'
20	Stiff, Gray, Sandy SILT (ML), with Rock Fragments, Wet.	498.15	SS-7		3-3-6 (N = 9)
	RESIDUAL: Stiff, Gray to Brown, Silty CLAY (CL), with Sand, Moist.		UD-6		REC=2.0'
	Soft, Brown, Silty SAND (SM), with Clay, Moist				
25		493.15	SS-8		2-2-2 (N = 4)
	Very Dense, Brown, Silty SAND (SM), with Clay, Moist		UD-7		REC=1.5'
			SS-9		15-50/5"
	Very Hard, Gray, Highly Weathered, SHALE (HWR), Moist		SS-10		
30	Moderately Hard, Gray, Moderately Close to Close Jointing, Slight to Moderately Weathered SHALE.	488.15	RC-1		REC=90% RQD=0%
35	Auger Refusal at 35.0' Below Ground Surface (BGS) on 9/3/2009. Coring Terminated at 35.0' Below Ground Surface (BGS) on 9/4/2009. Boring Terminated at 35.0' Below Ground Surface (BGS) on 9/4/2009.	483.15			
40		478.15			
45		473.15			
50		468.15			



DRILLER: Tri-State Drilling
EQUIPMENT: CME 75 Truck Rig
METHOD: 3.25" HSA
NORTHING: 3522035.927
EASTING: 10403414.543
LOGGED BY: Jon McDaniel
CHECKED BY: Ryan Rasnake RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.: B-0906
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 3, 2009
PROJECT NO.: 3050-09-0131

PAGE 1 OF 1

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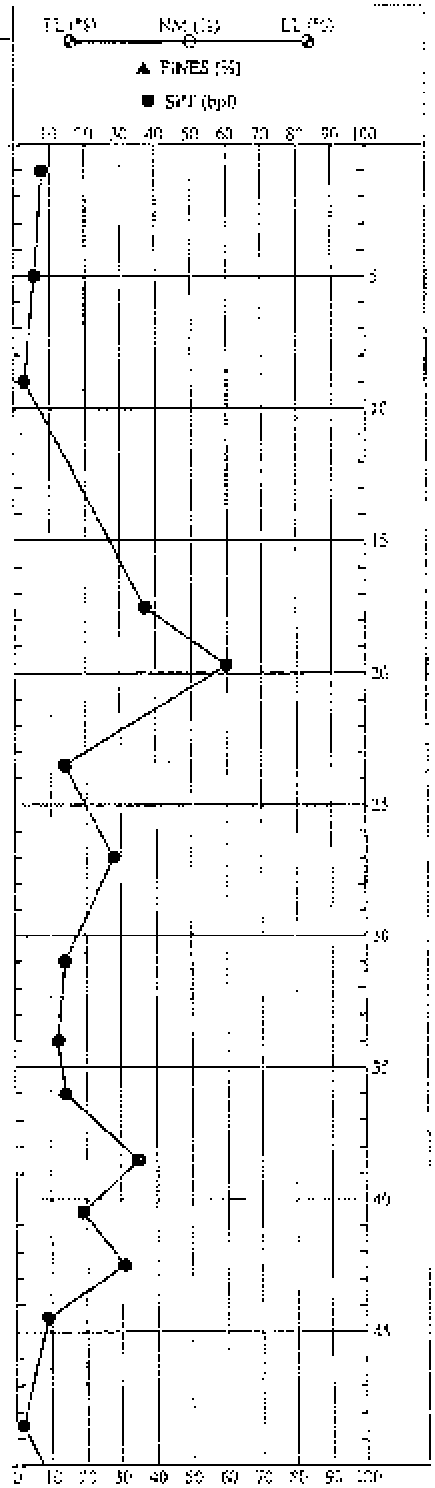
SOIL TEST BORING AEP CLINCH RIVER DIKE DRILLING REVISED 10-30-09.GPJ MACTEC.GDT 1/29/10

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW)	ELEV (ft)	SAMPLE IDENT	N COUNT / REC
0	ASH: Stiff, Dark Gray, Sandy SILT (ML), Moist	1667.00	SS-1	2-4-4 (N = 8)
	Stiff to Firm, Grayish Brown, Sandy SILT (ML), with Coal and Rock Fragments, Moist		UD-1	REC=2.0'
5	Soft to Very Soft, Grayish Brown, Sandy SILT (ML), with Coal and Rock Fragments, Moist	1662.00	SS-2	3-4-2 (N = 6)
			UD-2	REC=2.0'
			SS-3	2-2-1 (N = 3)
10	NOTE: UD-3=No Sample Lost from Tube on Exit	1657.00	UD-3	REC=2.0'
			SS-4	
15		1652.00	UD-4	REC=2.0'
	Hard, Gray, Fine, Sandy SILT (ML), with Coal Fragments, Wet		SS-5	5-16-21 (N = 37)
			UD-5	REC=0.2'
	Very Stiff to Stiff, Gray, SILT (ML), with Fine Sand, Wet		SS-6	11-48-12 (N = 60)
20	NOTE: Layering Apparent at 19.1' Below Ground Surface (BGS) to 19.5' Below Ground Surface (BGS).	1647.00	UD-6	REC=2.0
	Stiff, Gray, Silty SAND (SM), with Coal and Rock Fragments, Wet		SS-7	1-2-12 (N = 14)
25	Water Introduced to Hole to Allow Tools to Run Back in Augers	1642.00	UD-7	REC=2.0
	Very Stiff, Brownish Gray to Gray Throughout, Sandy SILT (ML), with Rock and Coal Fragments, Wet		SS-8	11-16-13 (N = 29)
			UD-8	REC=2.0'
30	Stiff, Gray, Sandy SILT (ML), with Black Streaking Throughout, Wet	1637.00	SS-9	2-7-7 (N = 14)
			UD-9	REC=1.0'
	Firm, Brownish Gray Silty SAND (SM), with Coal Fragments, Wet		SS-10	11-8-4 (N = 12)
35	Stiff, Gray, Sandy SILT (ML), with Fine Coal Fragments, Wet	1632.00	SS-11	9-8-6 (N = 14)
	Firm, Brownish Gray, Silty SAND (SM), with Coal Fragments, Wet		UD-10	REC=0.5'
	Stiff, Gray, Sandy SILT (ML), with Coal Fragments, Wet		SS-12	19-21-14 (N = 35)
40	Firm, Brownish Gray, Silty SAND (SM), with Coal Fragments, Wet. NOTE: Material Too Dense for UD Tube	1627.00	SS-13	2-7-12 (N = 19)
	Very Stiff, Gray, Sandy SILT (ML), with Coal Fragments, Wet			
	Firm, Brownish Gray, Silty SAND (SM), with Coal and Rock Fragments, Wet. NOTE: Material Too Dense for UD Tube		SS-14	5-16-15 (N = 31)
45		1622.00	SS-15	3-4-5 (N = 9)
			UD-11	REC=1.7'
	Very Loose, Brownish Gray, Silty SAND (SM), with Coal and Rock Fragments, Wet		SS-16	6-2-0 (N = 2)
50		1617.00		



DRILLER: Tri-State Drilling
EQUIPMENT: CME 75 Truck Rig
METHOD: 3.25" HSA
NORTHING: 353,561.16
EASTING: 10402579.31
LOGGED BY: Jon McDaniel
CHECKED BY: Ryan Rasnake RDR

SOIL TEST BORING RECORD

BORING NO.: B-0907
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 15, 2009
PROJECT NO.: 3050-09-0131 **PAGE 1 OF 2**

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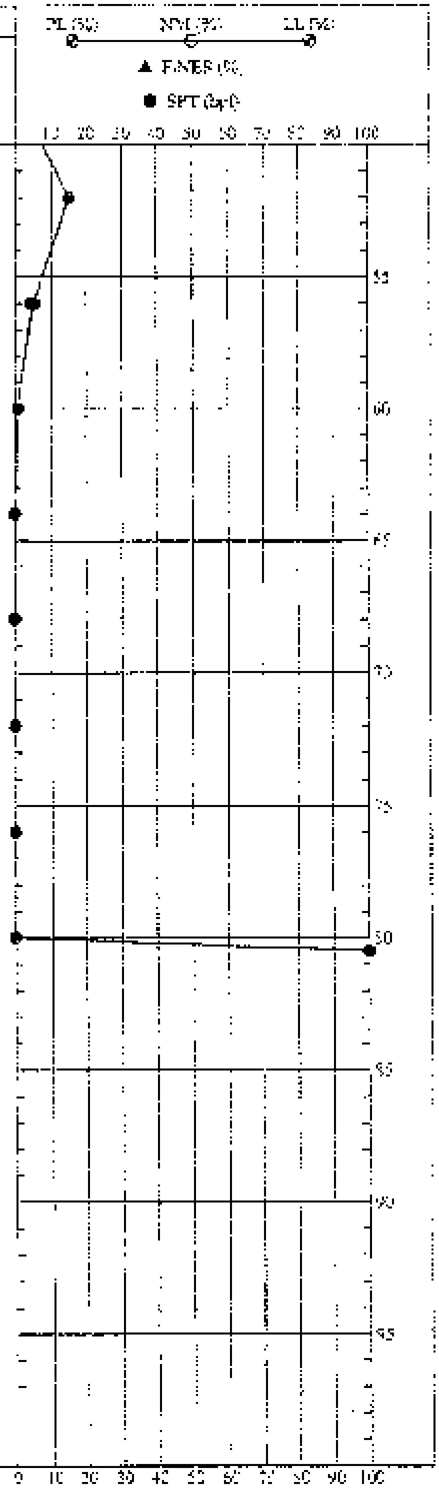
US EPA ARCHIVE DOCUMENT

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW)
50	Soft, Dark Gray, Sandy SILT (ML), with Clay Fragments, Wet.
	Firm, Brownish Gray, Silty SAND (SM), with Coal and Rock Fragments, Wet.
	Stiff, Gray, Sandy SILT (ML), with Fine Coal Fragments, Wet.
55	Loose, Brownish Gray, Silty SAND (SM), Coarse, with Coal and Rock Fragments, Wet.
	Stiff, Brownish Gray, Sandy SILT (ML), Coarse, with Coal and Rock Fragments, Wet.
60	Soft to Very Soft, Gray to Brown, SILT (MH), with Coal Fragments, Organics and Sand, Wet.
65	
70	ALLUVIUM: Very Soft, Grayish Brown, Clayey SILT (MH), with Rock Fragments and Sand, Wet.
	Very Soft, Brownish Gray, Silty CLAY (CH), with Fine Sand and Mica, Wet.
75	Very Soft, Brownish Tan to Gray, Sandy CLAY (CL), with Silt and Mica, Moist.
80	NOTE: SS-25 had No Recovery
	Hard, Gray, Moderately Close Joint Spacing, Slightly Weathered, SHALE.
	INCLUSIONS: High Angle Joints at 82.55 and 82.9 to 83.0 Below Ground Surface (BGS)
85	Auger Refusal at 80.5 Below Ground Surface (BGS) on 9.15.2009.
	Coring Terminated at 85.5 Below Ground Surface (BGS) on 9.16.2009.
	Boring Terminated at 85.5 Below Ground Surface (BGS) on 9.16.2009.
90	
95	
100	

ELEV. (ft)	SAMPLE No.	TYPE	BLOWS/6" / N / REC / RQD
1617.00	UD-12		REC=1.8
	SS-17		8-8-7 (N = 15)
	UD-13		REC=2.0
1612.00	SS-18		3-1-2 (N = 3)
	UD-14		REC=1.0
1607.00	SS-19		0-0-1 (N = 1)
	UD-15		REC=1.9
	SS-20		0-0-0 (N = 0)
1602.00	UD-16		REC=2.0
	SS-21		0-0-0 (N = 0)
1597.00	UD-17		REC=1.6
	SS-22		0-0-0 (N = 0)
	UD-18		REC=1.5
1592.00	SS-23		0-0-0 (N = 0)
	UD-19		REC=1.6
1587.00	SS-24		0-0-0 (N = 0)
	SS-25		50/0"
	RC-1		REC=90% RQD=92%
1582.00			
1577.00			
1572.00			
1567.00			



DRILLER: Tri-State Drilling
EQUIPMENT: CME 75 Truck Rig
METHOD: 3.25" HSA
NORTHING: 3521551.16
EASTING: 10402573.31
LOGGED BY: Jon McDaniel
CHECKED BY: Ryan Rasnake RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

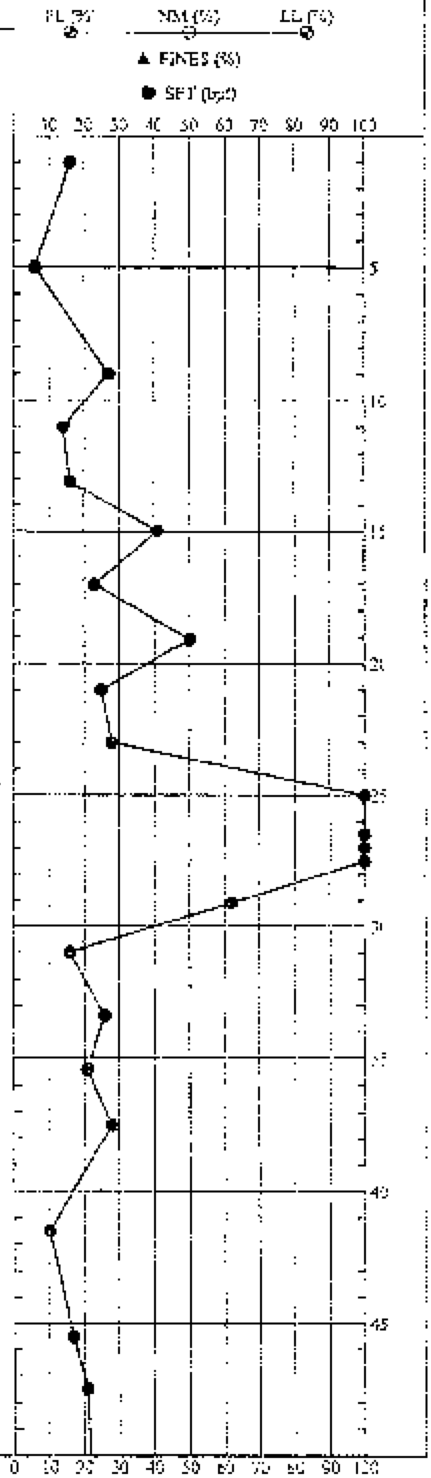
BORING NO.: B-0907
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 15, 2009
PROJECT NO.: 3050-09-0131

MACTEC

US EPA ARCHIVE DOCUMENT

SOIL TEST BORING RECORD (ELEVATION) - PRINTED 10/9/09 - AEP CLINCH RIVER DIKE

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.)	ELEV (ft)	SAMPLES IDENT	BLOW COUNT
0	TOPSOIL	1567.65		
	ASH: Stiff Brownish Gray, Sandy SILT (ML) with Coal, Clay and Rock Fragments, Moist		SS-1	5-9-7 (N = 16)
			UD-1	REC=2.1'
5		1562.65	SS-2	2-3-3 (N = 6)
	FILL: Stiff Gray, Clayey SILT (MH) with Sand and Coal Fragments, Moist		UD-2	REC=2.0'
	Very Stiff to Hard, Brown to Gray, Silty CLAY (CL), with Sand, Rock and Limestone Fragments, Moist to Wet		SS-3	19-15-12 (N = 27)
10		1557.65	SS-4	6-5-9 (N = 14)
	No Recovery		UD-3	REC=0.1'
			SS-5	12-11-15 (N = 26)
15		1552.65	SS-6	15-23-18 (N = 41)
			SS-7	9-11-12 (N = 23)
	No Recovery		UD-4	REC=0.1'
			SS-8	20-30-22 (N = 50)
20	NOTE: Wet at 19.8' to 20.0' Below Ground Surface (BGS) on 9/10/2009.	1547.65	SS-9	13-13-12 (N = 25)
			SS-10	15-14-14 (N = 28)
	Hard, Gray, Sandy SILT (ML), with Coal Fragments and Clay, Moist to Wet			
25		1542.65	SS-11	23-47-50/6"
			SS-12	40-50/3"
			SS-13	50/6"
			SS-14	50/6"
			UD-5	REC=0.1'
			SS-15	40-40-22 (N = 62)
30	Very Stiff to Hard, Gray, Sandy SILT (ML), with Coarse Sand, Wet	1537.65	SS-16	6-7-9 (N = 16)
			UD-6	REC=0.1'
			SS-17	9-9-11 (N = 20)
35		1532.65	SS-18	9-10-11 (N = 21)
	NOTE: Water Introduced to Hole. Used to Aid Auger Drilling.		SS-19	9-13-15 (N = 28)
			UD-7	REC=2.2'
40	Stiff to Very Stiff, Grayish Brown, Silty CLAY (CL), with Shale Rock Fragments, Moist	1527.65	SS-20	3-4-6 (N = 10)
			UD-8	REC=2.2'
45		1522.65	SS-21	6-6-11 (N = 17)
			SS-22	5-10-11 (N = 21)
			UD-9	REC=1.0'
50		1517.65		



SOIL TEST BORING AEP CLINCH RIVER DIKE DRILLING

DRILLER:	Tri-State Drilling
EQUIPMENT:	CME 75 Truck Rig
METHOD:	3.25" HSA
NORTHING:	3521467.007
EASTING:	10402509.492
LOGGED BY:	Jon McDonnel
CHECKED BY:	Ryan Risoski RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

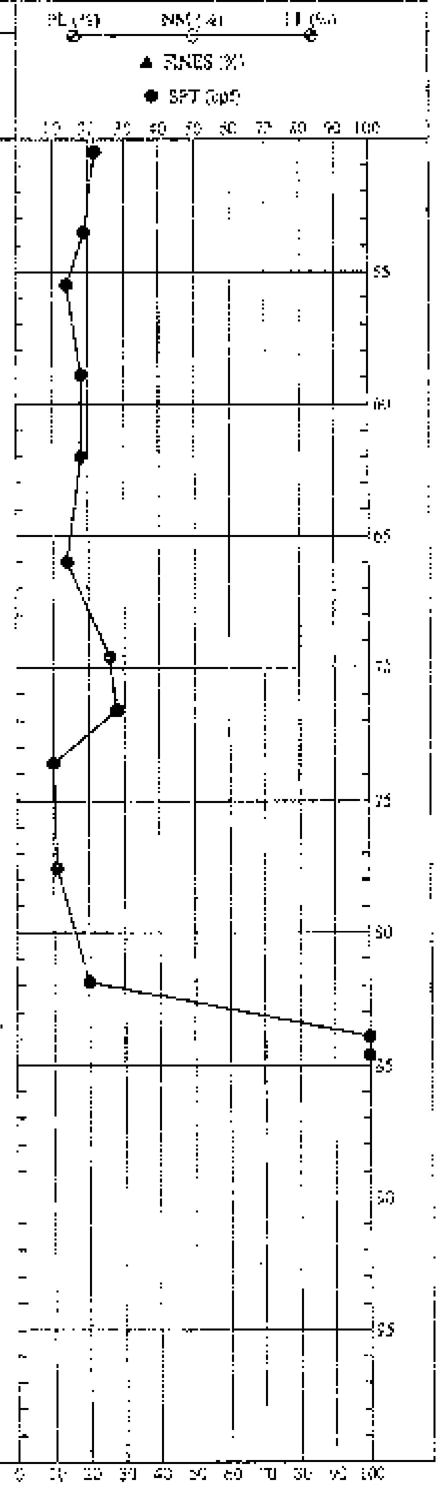
SOIL TEST BORING RECORD

BORING NO.: B-0908
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 11, 2009
PROJECT NO.: 3050-09-0121

MACTEC

US EPA ARCHIVE DOCUMENT

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.)	ELEVATION (ft)	SAMPLE NO.	N COUNT (1st 6", 2nd 6", 3rd 6")
50	Firm, Yellowish Brown, Silty SAND (ML), with Clay and Shale Fragments, Moist.	1517.63	SS-23	7-10-12 (N = 22)
	Yellowish Brown, Silty CLAY (CL), with Weathered Rock Fragments, Moist.		UD-10	REC=1.0'
	Very Stiff to Hard, Grayish Brown to Orange-Brown, Silty CLAY (CL), with Highly Weathered Shale Fragments and Organics, Moist.		SS-24	4-7-12 (N = 19)
55		1512.63	SS-25	4-4-8 (N = 14)
			UD-11	REC=1.4'
			SS-26	5-7-11 (N = 18)
60		1507.63	UD-12	REC=1.1'
			SS-27	7-8-10 (N = 18)
			UD-13	REC=2.0'
65		1502.63	SS-28	4-7-7 (N = 14)
			UD-14	REC=1.5'
70		1497.63	SS-29	7-12-14 (N = 26)
	RESIDUAL: Very Stiff, Dark Gray to Brown, Clayey SILT (ML), Trace of Fine Sand, Moist. NOTE: Used Split Spoon to Sample Due to Material in Bottom of Hole.		SS-30	5-15-13 (N = 28)
			SS-31	4-4-6 (N = 10)
75		1492.63	UD-15	REC=2.0'
	Stiff, Dark Gray, Sandy SILT (ML), Moist to Wet.		SS-32	3-4-7 (N = 11)
80		1487.63	UD-16	REC=2.3
	Firm, Dark Gray, Silty SAND (SM), with Shale Fragments, Wet.		SS-33	5-11-9 (N = 20)
	Very Dense, Whitish Gray, Coarse to Fine Grained, Silty SAND (SM), with Rock Fragments, Wet.		SS-34	15-11-50/6"
85	Coring Terminated at 84.8' Below Ground Surface (BGS) on 9/10/2009.	1482.63	SS-35	50/1"
	Moderately Hard, Light Grayish Gray, Moderately Close Joint Spacing, Moderately Weathered SHALE.		R-1	REC=93%, RQD=73%
90	Auger Refusal at 84.6' Below Ground Surface (BGS) on 9/10/2009. Coring Terminated at 89.5' Below Ground Surface (BGS) on 9/10/2009. Boring Terminated at 89.5' Below Ground Surface (BGS) on 9/10/2009.	1477.63		
95		1472.63		
100		1467.63		



DRILLER: Tri-State Drilling
EQUIPMENT: CME 75 Truck Rig
METHOD: 3.25" HSA
NORTHING: 3531467.007
EASTING: 10462559.492
LOGGED BY: Jon McDaniel
CHECKED BY: Ryan Reschke *RDR*

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.: B-09C8
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 11, 2009
PROJECT NO.: 3050-09-0131 **PAGE 2 OF 2**

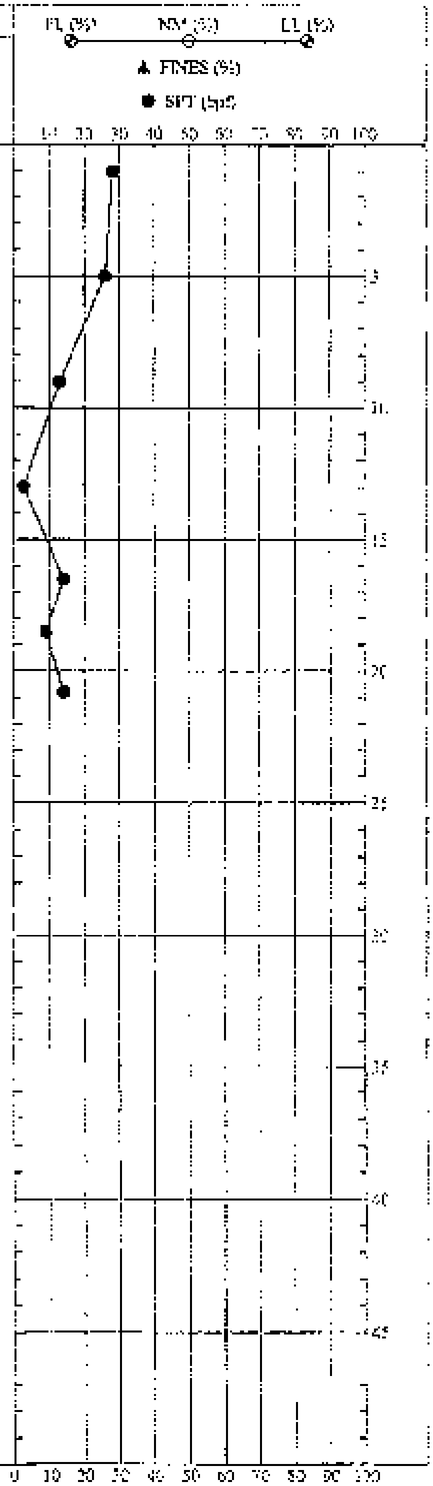
MACTEC

SOIL TEST BORING AEP CLINCH RIVER DIKE DRILLING REVISED 10-14-09 MACTEC

US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW)	ELEV (ft)	SAMPLE IDENT	N-COUNT (6"-6"-6")
0	**TOPSOIL**	1567.60		
	FILL: Very Stiff to Stiff, Reddish Brown to Gray, Clayey SAND (SC), with Sand, Rock, Coal and Organics, Moist.		SS-1	3-14-14 (N = 28)
			UD-1	REC=2.0'
5		1562.60	SS-2	12-13-13 (N = 26)
			UD-2	REC=2.0'
			SS-3	6-7-8 (N = 15)
10		1557.60		
	ASH: Soft, Gray, Sandy SILT (ML), with Coal and Rock Fragments, Moist.		UD-3	REC=2.0'
			SS-4	1-1-2 (N = 3)
15		1552.60	UD-4	REC=1.5'
	FILL: Very Stiff, Yellowish Brown, Silty **CLAY** (CH), with Rock Fragments, Moist.		SS-5	4-6-8 (N = 14)
	Firm to Stiff, Brown, Silty **CLAY** (CH), with Large Rock Fragments, Moist. NOTE: SS Sample Taken Due to Hard Material Encountered at 17.5'. NOTE: Auger Kicked Off in Hole at 1.5' Below Ground Surface (BGS) on 9/8/2009 Due to Rock.		SS-6	3-4-5 (N = 9)
			UD-5	REC=0.8'
20		1547.60	SS-7	5-9-5 (N = 14)
	Auger Refusal at 21.5' Below Ground Surface (BGS) on 9/8/2009. Will Offset 16.0' North of Original Location (Toward B-0907). Boring Terminated at 21.5' Below Ground Surface (BGS) on 9/8/2009.			
25		1542.60		
30		1537.60		
35		1532.60		
40		1527.60		
45		1522.60		
50		1517.60		



SOIL TEST BORING AEP CLINCH RIVER DIKE DRILLING REVISED 1-10-10.GPJ MACTEC.GDT 1/29/10

DRILLER: Tri-State Drilling
EQUIPMENT: CME 75 Truck Rig
METHOD: 3.25" HSA
NORTHING: 352,457.907
EASTING: 10,402,599.492
LOGGED BY: Jon McDaniel
CHECKED BY: Ryan Kosmke RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.: B-0908A
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 8, 2009
PROJECT NO.: 3050-09-0131

PAGE 1 OF 1

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW	LEGEND	ELEV (ft)	SAMPLES ID/INT	TYPE
0	Auger Probe to 19.5' Below Ground Surface (BGS) on 9/8/2009		1567.60		
5			1562.60		
10			1557.60	AU-1	
15			1552.60		
20	Auger Refusal at 19.5' Below Ground Surface (BGS) on 9/8/2009. Boring Terminated at 19.5' Below Ground Surface (BGS) on 9/8/2009.		1547.60		
25			1542.60		
30			1537.60		
35			1532.60		
40			1527.60		
45			1522.60		
50			1517.60		

SAMPLES: RECOVERY / ROD / REC

PL (%) — NM (%) — LL (%)

▲ FINES (%)

■ SPT (bpf)

0 10 20 30 40 50 60 70 80 90 100

SOIL TEST BORING AEP CLINCH RIVER DIKE DRILLING REVISED ... MACTEC.GDT

DRILLER: Tri-State Drilling
EQUIPMENT: CME 75 Track Rig
METHOD: 3.25" HSA
NORTHING: 3521457.297
EASTING: 10403599.492
LOGGED BY: Jon McDaniel
CHECKED BY: Ryan Raynolds RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.: B-090SB
PROJECT: AEP Clinch River Dike Drilling
LOCATION: Carbo, Virginia
DRILLED: September 8, 2009
PROJECT NO.: 3050-09-0131 **PAGE 1 OF 1**

MACTEC

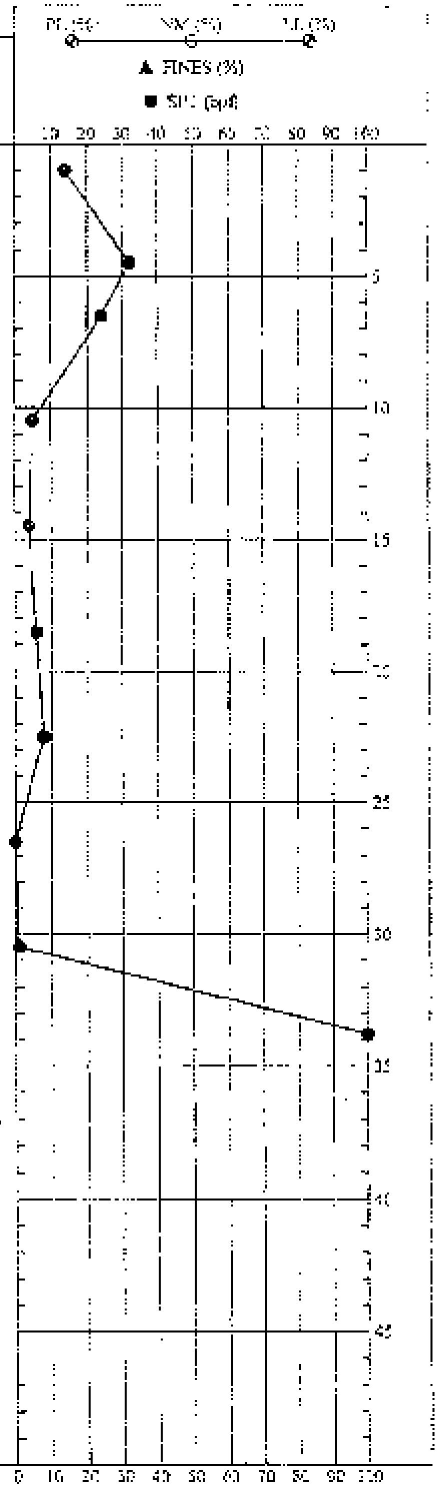
US EPA ARCHIVE DOCUMENT

SOIL TEST BORING RECORD

SOIL CLASSIFICATION AND REMARKS

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	IDENT	SAMPLES (BLOWS)
0	ASH: Firm, Grayish Brown, Silty SAND (SM), with Coal and Rock Fragments, Moist	1519.35	SS-1	4-7-7 (N = 14)
			UD-1	REC=1.5'
	Hard to Very Stiff, Gray, Sandy SILT (ML), with Small Coal Fragments, Wet			
5		1514.35	SS-2	10-16-16 (N = 32)
			SS-3	7-15-9 (N = 24)
	FILL: Very Stiff, Brown, Silty CLAY (CH), with Weathered Rock Fragments, Moist. NOTE: Material Too Hard for UD Tube		UD-2	REC=2.0'
10	Soft, Silty CLAY (CH), with Rock Fragments, Wet to Moist	1509.35	SS-4	1-3-2 (N = 5)
			UD-3	REC=2.0'
15		1504.35	SS-5	2-2-2 (N = 4)
			UD-4	REC=2.0'
	Stiff, Gray to Brown, Silty CLAY (CH), Moist		SS-6	2-2-4 (N = 6)
20		1499.35	UD-5	REC=2.0'
	ALLUVIUM: Stiff, Dark Gray, Clayey SILT (MH), Trace of Sand, Moist. NOTE: Streaks of Black Throughout		SS-7	2-3-5 (N = 8)
25		1494.35	UD-6	REC=2.0'
	Very Soft, Dark Gray to Brown, Sandy SILT (ML), with Clay, Wet		SS-8	0-0-0 (N = 0)
	Very Loose, Dark Gray to Brown, Silty SAND (SM), with Streaks of Dark Red to Brown Clay Throughout, and Rock Fragments, Wet		UD-7	REC=2.0'
30		1489.35	SS-9	0-0-1 (N = 1)
			UD-8	REC=2.0'
	Very Hard, Yellowish Brown, Highly Weathered SHALE (HWR), with Silt, Moist		SS-10	37-50/1"
35	Rock Coring Began at 33.8' Below Ground Surface (BGS) on 9/11/2009. Soft, Dark Gray to Brown, Close Joint Spacing, Highly Weathered SHALE, Wet	1484.35	RC-9	REC=70% RQD=15%
40	Auger Refusal at 33.8' Below Ground Surface (BGS) on 9/11/2009. Coring Terminated at 38.8' Below Ground Surface (BGS) on 9/11/2009. Boring Terminated at 38.8' Below Ground Surface (BGS) on 9/11/2009	1479.35		
45		1474.35		
50		1469.35		



DRILLER:	Tri-State Drilling
EQUIPMENT:	CME 75 Truck Rig
METHOD:	3.25" HSA
NORTHING:	3521314.623
EASTING:	10402694.551
LOGGED BY:	Jen McDaniel
CHECKED BY:	Ryan Rasmaker RDR

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

BORING NO.:	B-0909
PROJECT:	AEP Clinch River Dike Drilling
LOCATION:	Carbo, Virginia
DRILLED:	September 11, 2009
PROJECT NO.:	3050-09-0131

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US EPA ARCHIVE DOCUMENT

APPENDIX C

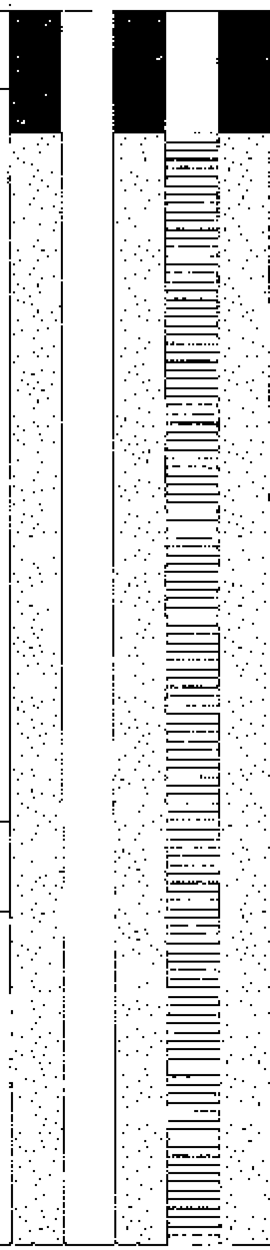
PIEZOMETER INSTALLATION LOGS

MACTEC Engineering and Consulting, Inc.	BORING NO. **B-0901** SHEET **1** OF **2**
	PROJECT **AEP Clinch River Dike Drilling**
	LOCATION **Carbo, Virginia**
	PROJECT NO **3050-09-0131**
	LOGGED BY **Jon McDaniel** CHECKED BY **Ryan Rasnake**

DEPTH FEET (bgs)	Water Level	STRATA	DESCRIPTION
0–3.0			FILL: Hard, Red to Brown, CLAY (CL), with Silt and Rock Fragments, Moist.
3.0–33.0	▼ (approx. 21.5)		Stiff to Very Stiff, Brown, Silty SAND (SM) with Sand and Rock Fragments, Moist.
33.0–36.5			SPOIL: Firm to Loose, Dark Brownish Gray, Silty SAND (SM), with Coal Fragments, Moist.
36.5–50			FILL: Very Stiff to Hard, Brown to Gray, Silty CLAY (CH), with Rock Fragments, Coal and Sand, Wet to Moist.
			NOTE: Rock Fragments More Evident at 44.5' to 45.0'

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

WELL CONSTRUCTION DETAIL



ELEVATION FEET: 1565.00, 1560.00, 1555.00, 1550.00, 1545.00, 1540.00, 1535.00, 1530.00, 1525.00, 1520.00

DRILLING CONTRACTOR	Tri-State Drilling
DRILLING METHOD	3.25" HSA
DRILLING EQUIPMENT	CME 75 Truck Rig
DATE DRILLED	9/2/2009

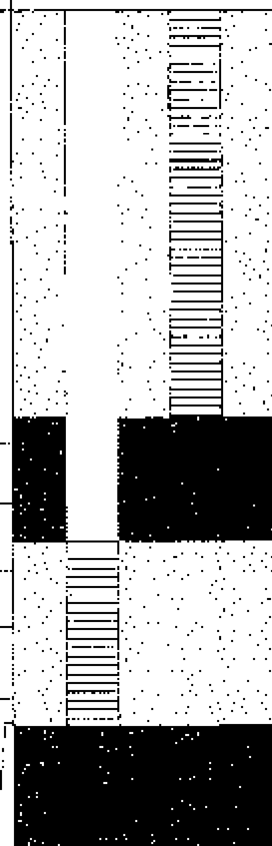
Northing: 3522466.902
Easting: 10403707.289

US EPA ARCHIVE DOCUMENT

MACTEC Engineering and Consulting, Inc.

BORING NO.	**B-0901**
SHEET	**2** OF **2**
PROJECT	**AEP Clinch River Dike Drilling**
LOCATION	**Carbo, Virginia**
PROJECT NO.	**3050-09-0131**
LOGGED BY	**Jon McDaniel**
CHECKED BY	**Ryan Rasnake** (RDR)

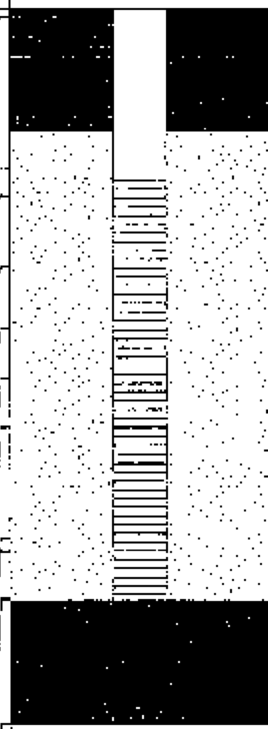
DEPTH FEET (bgs)	Water Level	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	Elevation
			FILL: Very Stiff to Hard, Brown to Gray, Silty **CLAY (CH)**, with Rock Fragments, Coal and Sand, Wet to Moist.		
55					1515.00
			NOTE: 15 Gallons fo Water Put in Hole at 56.0' below Ground Surface to Clean Augers Because Steel Kept Getting Stuck in Hole and Augers won't Cut.		
60			**NOTE:** Tube Refusal at 0.9'		1510.00
65					1505.00
			Stiff, Reddish Brown, Silty **CLAY (CH)**, with Large Rock Fragments, Moist.	Bentonite (66.9' - 71.5')	
70			Firm, Light Gray to Brown, Silty **CLAY (CH)**, with Sand, Moist.		1500.00
			Stiff, Brown, Sandy **SILT (ML)**, with Clay, Moist.		
75			Very Dense, Gray, Silty **SAND (SM)**, with Rock Fragments, Wet.	Sand (71.5' - 78.9')	1495.00
			Very Hard, Gray, Highly Weathered **SHALE (HWR)**, Wet. **NOTE:** Material Too Hard for a UD Tube. Auger Refusal at 78.9' Below Ground Surface (BGS) on 9/2/2009		
80			Moderately Hard, Gray, Close Joint Spacing, Moderately Weathered **SHALE**.	Bentonite (78.9' - 83.9')	1490.00
			Coring Terminated at 83.9' Below Ground Surface (BGS) on 9/2/2009. Boring Terminated at 83.9' Below Ground Surface (BGS) on 9/2/2008.		



US EPA ARCHIVE DOCUMENT

MACTEC Engineering and Consulting, Inc.	BORING NO.	**B-0902**	SHEET **1** OF **1**
	PROJECT	**AEP Clinch River Dike Drilling**	
	LOCATION	**Carbo, Virginia**	
	PROJECT NO.	**3050-09-0131**	RDE
	LOGGED BY	**Jon McDaniel**	CHECKED BY **Ryan Rasnake**

DEPTH FEET (bgs)	Water Level	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
			Crushed Stone	Bentonite (0' - 5')	
			ASH: Very Soft, Grayish Brown, Sandy **SILT (ML)**, with Coal and Rock Fragments, Moist to Wet.		
5	▼				1510.00
			Firm, Brownish Gray, Sandy SILT (ML), with Coal and Rock Fragments, Wet.	Sand (5' - 24')	
10	∇		**ALLUVIUM:** Firm, Brownish Gray, Sandy **SILT (ML)**, with Highly Weathered Rock Fragments, Trace of Clay, Wet.		1505.00
			Very Soft, Gray, **SILT (ML)**, with Sand and Small Rock Fragments, Wet. NOTE: Last Spoon Blow Drove Spoon an Extra 0.5' in Soft Material.		
15			Very Soft, Dark Brown to Black, Sandy **SILT (ML)**, with Organics, Wet. NOTE: Materials In Augers. Water Introduced to Get Tools Back in Augers. Use Piston Sampler		1500.00
20			Firm, Light Gray, Silty **CLAY (CH)**, with Brown Water Staining Throughout and Root Fragments and Mica, Moist to Wet.		1495.00
			Very Soft, Brown to Gray, Silty **CLAY (CH)**, with Water Staining and Organics, Wet.		
			Firm, Gray, Silty **SAND (ML)**, Wet.	Bentonite (24' - 29')	
			Very Hard, Gray, Highly Weathered **SHALE (HWR)**, Moist		
			Soft, Gray, Moderately Close Joint Spacing, Moderately Weathered, **SHALE**, 0 to 30 Degree Joint Inclination.		
			Auger Refusal at 24.0' Below Ground Surface (BGS) on 9/14/2009. Boring Terminated at 29.0' Below Ground Surface (BGS) on 9/14/2009. Boring Terminated at 29.0' Below Ground Surface (BGS) on 9/14/2009		



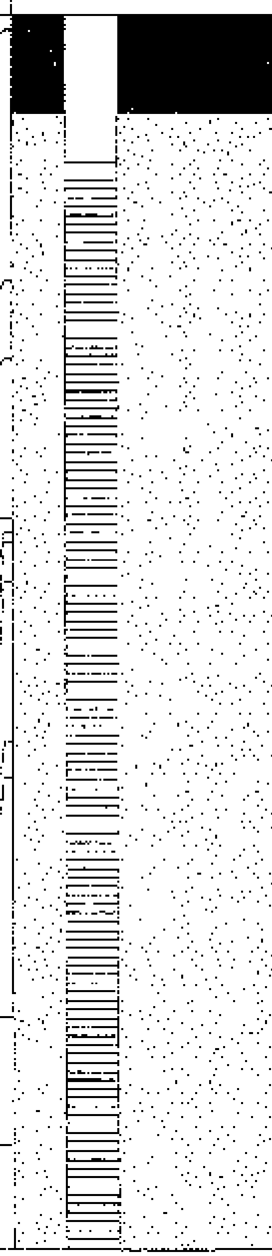
DRILLING CONTRACTOR	**Tri-State Drilling**	Northing:	3522303.510
DRILLING METHOD	**3.25" HSA**	Easting:	10463874.406
DRILLING EQUIPMENT	**CME 75 Truck Rig**		
DATE DRILLED	**9/14/2009**		

MACTEC Engineering and Consulting, Inc.

BORING NO.	B-0904
SHEET	1 OF 2
PROJECT	AEP Clinch River Dike Drilling
LOCATION	Carbo, Virginia
PROJECT NO.	3050-09-0131
LOGGED BY	Jon McDaniel
CHECKED BY	Ryan Rasnake

DEPTH FEET (bgs)	Water Level	DESCRIPTION	ELEVATION FEET
0		**TOPSOIL**	
		FILL: Very Stiff to Hard, Reddish Brown to Brown, Silty **CLAY (CL)**, with Sand, Mica and Weathered Shale Fragments, Moist.	
5			1565.00
	▼		
10		Stiff, Tan to Brown, Silty **CLAY (CL)**, with Weathered Shale, Moist.	1560.00
		Soft, Gray, Clayey **SILT (MH)**, with Highly Weathered Shale Fragments, Moist.	
15		**FILL:** Very Stiff, Reddish Brown, Clayey **SILT (ML)**, with Weathered Rock Fragments and Mica, Moist.	1555.00
20		Very Stiff, Grayish Brown, Silty **CLAY (CL)**, with Weathered Shale Fragments, Moist.	1550.00
		ASH: Firm, Grayish Brown, Silty **SAND (SM)**, with Coal and Rock Fragments, Moist.	
25		**FILL:** Soft, Brown, Silty **CLAY (CL)** with Shale Fragments, Moist. **NOTE:** UD 4 had No Recovery.	1545.00
		ASH: Loose to Very Loose, Grayish Brown, Silty **SAND (SM)**, with Coal and Rock Fragments, Moist to Wet. **NOTE:** Wet from 28.3' and Below.	
30			1540.00
		Very Stiff, Gray, Fine Sandy **SILT (ML)**, with Fine Coal Fragments, Wet.	
35		**FILL:** Very Stiff to Stiff, Brown to Gray, Silty **CLAY (CL)**, with Weathered Rock Fragments, Wet to Moist. **NOTE:** SS Used Because of Difficult Augering.	1535.00
40		Very Stiff, Brown to Gray Throughout, Clayey **SILT (ML)**, with Weathered Shale Fragments and Organics, Moist. **NOTE:** Material Encountered Very Stiff-Used SS to Get Recovery.	1530.00
4?		Very Stiff, Reddish Brown to Brown Throughout, Silty **CLAY (CL)**, with Highly Weathered Shale Fragments and Organics, Moist to Wet.	1525.00
			1520.00

WELL CONSTRUCTION DETAIL



DRILLING CONTRACTOR	Tri-State Drilling
DRILLING METHOD	3.25" HSA
DRILLING EQUIPMENT	CME 75 Truck Rig
DATE DRILLED	9/16/2009

Northing: 3522130.379
Easting: 10403332.818

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MACTEC Engineering and Consulting, Inc.	BORING NO.	**B-0904**	SHEET **2** OF **2**
	PROJECT	**AEP Clinch River Dike Drilling**	
	LOCATION	**Carbo, Virginia**	
	PROJECT NO.	**3050-09-0131**	
	LOGGED BY	**Jon McDaniel**	CHECKED BY **Ryan Rasnake**

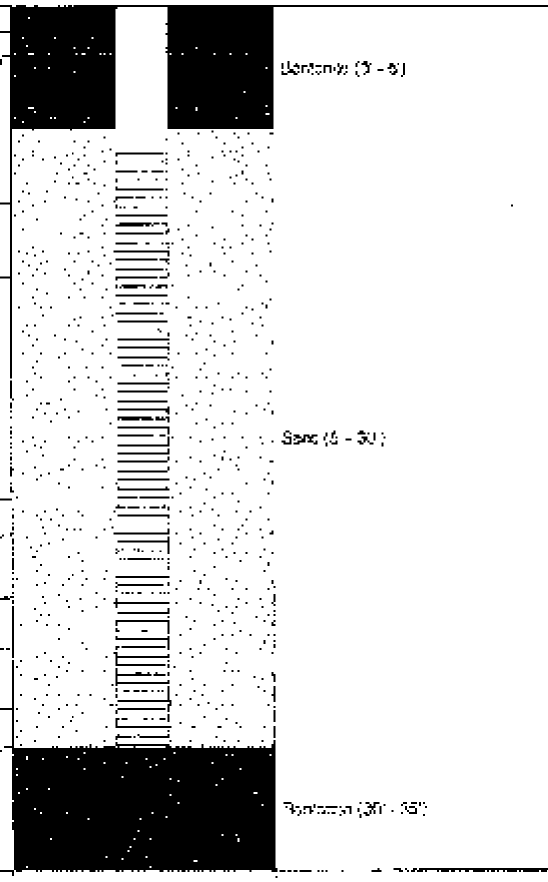
DEPTH FEET (bgs)	Water Level	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	Elevation
			Very Stiff, Reddish Brown to Brown Throughout, Silty **CLAY (CL)**, with Highly Weathered Shale Fragments and Organics, Moist to Wet.		1515.00
55					
60			**NOTE:** UD 13 had No Recovery-Tube was Bent During Pushing.		1510.00
			Hard, Brown, Silty **CLAY (CL)**, with Highly Weathered Shale Fragments, Moist.		
65			Stiff to Very Stiff, Brown to Gray, Silty **CLAY (CL)**, with Highly Weathered Shale Fragments and Organics, Wet.		1505.00
			Stiff, Tan, Clayey **SILT (ML)**, with Weathered Rock Fragments and Organics, Wet.		1500.00
70			Stiff, Grayish Brown, **CLAY (CL)**, with Silt and Mica, Moist.		
			Stiff, Brown, Clayey **SILT (ML)**, with Weathered Rock Fragments, Moist.		
75			Stiff, Brown, Silty **CLAY (CL)**, with Weathered Rock Fragments, Moist		1495.00
			ALLUVIAL: Very Loose, Gray, Coarse **SAND (SM)**, with Silt, Wet.		
80			Very Hard, Dark Gray, Highly Weathered **SHALE (HWR)**. **NOTE:** SS Used Because Rough Material in Hole Bottom.		1490.00
			NO RECOVERY: From Data From MW-0914 and SPT 36 in this Hole, the Material Not Recovered is Shale, with Joint Inclinations Between 75 and 95 Degrees from Horizontal.	Bentonite (78.8' - 88.8')	1485.00
85			Soft, Dark Gray, Moderately Close Jointing, Moderately Weathered **SHALE**, Joint Inclination of 75 to 90 Degrees.		
			Auger Refusal at 78.8' Below Ground Surface (BGS) on 9/17/2009. Coring Terminated at 88.8' Below Ground Surface (BGS) on 9/17/2009. Begin Coring at 78.8' Below Ground Surface (BGS) on 9/17/2009 Boring Terminated at 88.8' Below Ground Surface (BGS) on 9/17/2009.		

MACTEC Engineering and Consulting, Inc.

BORING NO.	B-0906
SHEET	1 OF 1
PROJECT	AEP Clinch River Dike Drilling
LOCATION	Carbo, Virginia
PROJECT NO.	3050-09-0131
LOGGED BY	Jon McDaniel
CHECKED BY	Ryan Rasnake (RDR)

DEPTH FEET (bgs)	DESCRIPTION
0	FILL: Crushed Stone from Road.
	FILL: Firm, Grayish Brown, Silty SAND (SM), with Rock and Coal Fragments, Moist
	Stiff, Reddish to Yellowish Brown, Silty CLAY (CH), with Rock and Coal Fragments, Moist. NOTE: Because of the Difficulty of Augering, Elected to Use SS Sample.
	Soft, Brown, Silty CLAY (CH), Moist to Wet.
11	ASH: Firm, Gray, Sandy SILT (ML), with Rock and Coal Fragments, Wet. NOTE: No Recovery
15	Soft, Gray, Sandy SILT (ML), with Rock Fragments, Wet.
20	Stiff, Gray, Sandy SILT (ML), with Rock Fragments, Wet.
	RESIDUAL: Soft, Gray to Brown, Silty CLAY (CL), with Sand, Moist.
	Soft, Brown, Silty SAND (SM), with Clay, Moist.
	Very Dense, Brown, Silty SAND (SM), with Clay, Moist.
	Very Hard, Gray, Highly Weathered SHALE (HWR), Moist
30	Moderately Hard, Gray, Moderately Close to Close Jointing, Slight to Moderately Weathered SHALE
35	Auger Refusal at 30.0' Below Ground Surface (BGS) on 9/3/2009. Coring Terminated at 35.0' Below Ground Surface (BGS) on 9/4/2009. Boring Terminated at 35.0' Below Ground Surface (BGS) on 9/4/2009.

WELL CONSTRUCTION DETAIL



ELEVATION FEET: 1515.00, 1510.00, 1505.00, 1500.00, 1495.00, 1490.00, 1485.00

DRILLING CONTRACTOR	Tri-State Drilling
DRILLING METHOD	3.25" HSA
DRILLING EQUIPMENT	CME 75 Truck Rig
DATE DRILLED	9/3/2009

Northing: 3522030.937
Easting: 10403414.543

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MACTEC Engineering and Consulting, Inc.

BORING NO. **B-0908** SHEET **1** OF **2**
PROJECT **AEP Clinch River Dike Drilling**
LOCATION **Carbo, Virginia**
PROJECT NO. **3050-09-0131**
LOGGED BY **Jon McDaniel** CHECKED BY **Ryan Rasnake** RDR

DEPTH FEET (bgs)	Water Level	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
0			**TOPSOIL**		
			ASH: Stiff, Brownish Gray, Sandy SILT (ML), with Coal, Clay and Rock Fragments, Moist.	Bentonite (0' - 5')	1565.00
5					1560.00
			FILL: Stiff, Gray, Clayey SILT (MH) with Sand and Coal Fragments, Moist.		
10			Very Stiff to Hard, Brown to Gray, Silty **CLAY (CL)**, with Sand, Rock and Limestone Fragments, Moist to Wet.		
			No Recovery		1555.00
15					1550.00
			No Recovery		
20	▽		**NOTE:** Wet at 19.8' to 20.0' Below Ground Surface (BGS) on 9/10/2009.		1545.00
25			Hard, Gray, Sandy SILT (ML), with Coal Fragments and Clay, Moist to Wet.		1540.00
30			Very Stiff to Hard, Gray, Sandy SILT (ML), with Coarse Sand, Wet.		1535.00
35			**NOTE:** Water Introduced to Hole. Used to Aid Auger Drilling.	Sand (5' - 69')	1530.00
40			Stiff to Very Stiff, Grayish Brown, Silty **CLAY (CL)**, with Shale Rock Fragments, Moist.		1525.00
45					1520.00
	▼				

DRILLING CONTRACTOR **Tri-State Drilling**
DRILLING METHOD **3.25" HSA**
DRILLING EQUIPMENT **CME 75 Truck Rig**
DATE DRILLED 9/11/2009

Northing: 3521467.007
Easting: 10402599.492

US EPA ARCHIVE DOCUMENT

MACTEC Engineering and Consulting, Inc.

BORING NO.	B-0908
PROJECT	AEP Clinch River Dike Drilling
LOCATION	Carbo, Virginia
PROJECT NO.	3050-09-0131
LOGGED BY	Jon McDaniel
CHECKED BY	Ryan Rasnake (RDR)

DEPTH FEET (bgs)	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION
	Firm, Yellowish Brown, Silty **SAND (ML)**, with Clay and Shale Fragments, Moist.		1515.00
	Yellowish Brown, Silty **CLAY (CL)**, with Weathered Rock Fragments, Moist.		
55	Very Stiff to Hard, Grayish Brown to Orange-Brown, Silty **CLAY (CL)**, with Highly Weathered Shale Fragments and Organics, Moist.		1510.00
60			1505.00
65			1500.00
70	RESIDUAL: Very Stiff, Dark Gray to Brown, Clayey **SILT (ML)**, Trace of Fine Sand, Moist. **NOTE:** Used Split Spoon to Sample Due to Material in Bottom of Hole.	Bentonite (69' - 74')	1495.00
75	Stiff, Dark Gray, Sandy **SILT (ML)**, Moist to Wet		1490.00
80	Firm, Dark Gray, Silty **SAND (SM)**, with Shale Fragments, Wet.	Sand (74' - 84.4')	1485.00
	Very Dense, Whitish Gray, Coarse to Fine Grained, Silty **SAND (SM)**, with Rock Fragments, Wet. Coring Terminated at 84.4' Below Ground Surface (BGS) on 9/10/2009.		
85	Moderately Hard, Light Gray to Gray, Moderately Close Joint Spacing, Moderately Weathered **SHALE**.	Bentonite (84.4' - 89.5')	1480.00
	Auger Refusal at 84.6' Below Ground Surface (BGS) on 9/10/2009. Coring Terminated at 89.5' Below Ground Surface (BGS) on 9/10/2009. Boring Terminated at 89.5' Below Ground Surface (BGS) on 9/10/2009.		

US EPA ARCHIVE DOCUMENT

MACTEC Engineering and Consulting, Inc.	BORING NO.	**B-0909** SHEET **1** OF **1**
	PROJECT	**AEP Clinch River Dike Drilling**
	LOCATION	**Carbo, Virginia**
	PROJECT NO.	**3050-09-0131**
	LOGGED BY	**Jon McDaniel** CHECKED BY **Ryan Rasnake** RDR

DEPTH FEET (bgs)	Water Level	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
0–3.5			**ASH:** Firm, Grayish Brown, Silty SAND (SM), with Coal and Rock Fragments, Moist.	Bentonite (0 - 5)	
3.5–7 (5)			Hard to Very Stiff, Gray, Sandy SILT (ML), with Small Coal Fragments, Wet.		1515.00
7–17.5 (10, 15)			**FILL:** Very Stiff, Brown, Silty CLAY (CH), with Weathered Rock Fragments, Moist. **NOTE:** Material Too Hard For UD Tube. Soft, Silty CLAY (CH), with Rock Fragments, Wet to Moist.		1510.00 1505.00
17.5–20.5 (20)			Stiff, Gray to Brown, Silty CLAY (CH), Moist.	Sand (5 - 33.8)	1500.00
20.5–25.5 (25)			**ALLUVIUM:** Stiff, Dark Gray, Clayey SILT (MH), Trace of Sand, Moist. **NOTE:** Streaks of Black Throughout.		1495.00
25.5–28.5	▼		Very Soft, Dark Gray to Brown, Sandy SILT (ML), with Clay, Wet.		
28.5–33.5 (30)			Very Loose, Dark Gray to Brown, Silty SAND (SM), with Streaks of Dark Red to Brown Clay Throughout and Rock Fragments, Wet.		1490.00
33.5–38.8 (35)			Very Hard, Yellowish Brown, Highly Weathered SHALE (HWR), with Silt, Moist. Rock Coring Begins at 33.8' Below Ground Surface (BGS) on 9/11/2009 Soft, Dark Gray to Brown, Close Joint Spacing, Highly Weathered SHALE, Wet. Auger Refusal at 33.8' Below Ground Surface (BGS) on 9/11/2009. Coring Terminated at 38.8' Below Ground Surface (BGS) on 9/11/2009. Boring Terminated at 38.8' Below Ground Surface (BGS) on 9/11/2009.	Bentonite (33.8 - 38.8)	1485.00

DRILLING CONTRACTOR	**Tri-State Drilling**
DRILLING METHOD	**3.25" HSA**
DRILLING EQUIPMENT	**CME 75 Truck Rig**
DATE DRILLED	**9/11/2009**

Northing: 3521314.823
Easting: 10492004.531

APPENDIX D

LABORATORY SOIL TEST RESULTS

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LABORATORY TEST PROCEDURES

Soil Classification

Soil classifications provide a general guide to the engineering properties of various soil types and enable the engineer to apply past experience to current situations. Samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests), color and texture. These classification descriptions are included on our Test Boring Records.

The classification system discussed above is primarily qualitative. A detailed soil classification requires two laboratory tests: grain size tests and plasticity tests. Using these test results the soil can be classified according to the AASHTO or Unified Classification Systems (ASTM D2487). Each of these classification systems and the in-place physical soil properties provide an index for estimating the soil's behavior. The soil classification and physical properties determined are presented in this report.

Moisture Content

The moisture content in a given mass of soil is the ratio, expressed as a percentage, of the weight of the water to the weight of the solid particles. This test was conducted in accordance with ASTM D 2216.

Grain Size Distribution

Grain Size Tests are performed to aid in determining the soil classification and the grain size distribution. The soil samples are prepared for testing according to ASTM D 421 (dry preparation) or ASTM D 2217 (wet preparation). If only the grain size distribution of soils coarser than a number 200 sieve (0.074-mm opening) is desired, the grain size distribution is determined by washing the sample over a number 200 sieve and, after drying, passing the samples through a standard set of nested sieves. If the grain size distribution of the soils finer than the number 200 sieve is also desired, the grain size distribution of the soils coarser than the number 10 sieve is determined by passing the sample through a set of nested sieves. Materials passing the number 10 sieve are dispersed with a dispersing agent and suspended in water, and the grain size distribution calculated

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from the measured settlement rate of the particles. These tests are conducted in accordance with ASTM D 422.

Atterberg Limits

Portions of the samples are taken for Atterberg limits testing to determine the plasticity characteristics of the soil. The plasticity index (PI) is the range of moisture content over which the soil deforms as a plastic material. It is bracketed by the liquid limit (LL) and the plastic limit (PL). The liquid limit is the moisture content at which the soil becomes sufficiently "wet" to flow as a heavy viscous fluid. The plastic limit is the lowest moisture content at which the soil is sufficiently plastic to be manually rolled into tiny threads. The liquid limit and plastic limit are determined in accordance with ASTM D4318.

Consolidation Tests

One-dimensional consolidation tests are conducted to determine the compression characteristics of soils under applied vertical stresses. Test results may provide information including the magnitude of settlement, the time-rate effects, and the past stress history of the soil.

Tests are conducted in general accordance with ASTM D 2435. A soil sample 2.5 inches in diameter and 1.0 inch thick is fitted into a stainless steel ring, with porous stones above and below the soil. The sample is then placed in a loading device and subjected to a series of increasing vertical stresses under conditions of no lateral strain. Time-deformation readings are recorded for each applied stress, and the resultant strain or void ratio is calculated.

Typically, test results include a plot of void ratio or percent strain versus the log of the applied stress. The virgin compression index (C_c), the rebound or swelling index (C_s), the coefficient of consolidation (C_v), the constrained modulus ($M=1/m_v$), and the preconsolidation stress (P'_c) are all important parameters obtained from this test.

Triaxial Shear Tests

Triaxial shear tests are used to measure the stress-strain characteristics and strength of soils under various loading conditions expected in the field. Tests may be undrained, semi-drained or fully-drained to simulate field behavior. Triaxial shear tests are performed in accordance with ASTM D 4767.

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Triaxial shear tests are conducted either on relatively undisturbed samples or on remolded/compacted specimens of soil. Diameters of specimens range between 1.4 and 6.0 inches and a minimum length/diameter ratio of 2 is standard. Either stress-controlled or strain-controlled tests are performed. Loads are measured using proving rings or electronic load cells, deformations are monitored using electronic LVDTs or dial indicators, and pore water pressure is measured with transducers. Normally, samples are saturated, consolidated and sheared to failure under compression loading, although extension loading is also possible.

Various consolidation conditions may be implemented in the triaxial apparatus. Stress and deformation occur in three dimensions under triaxial conditions. The three most common types of triaxial compression tests in routine use include:

CU = isotropically-consolidated undrained (i.e., CIU)

CD = isotropically-consolidated drained (i.e., CID)

UU = unconsolidated-undrained shear tests

The results of the tests are presented in terms of stress-strain curves and stress paths to failure. Alternatively, the strength may be represented by Mohr-Coulomb circles at failure. Short-term undrained strengths may be represented by total stress parameters (ϕ and C) or by undrained shear strengths (Su). The long-term drained strengths (condition of zero excess pore pressure response) are described by the effective stress parameters (ϕ' and C').

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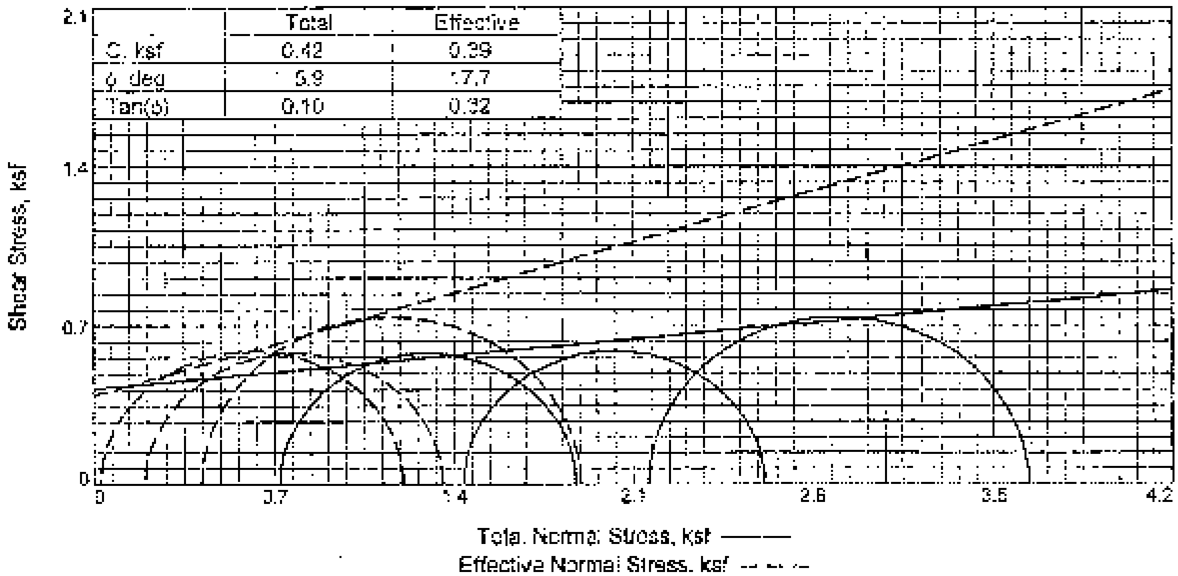
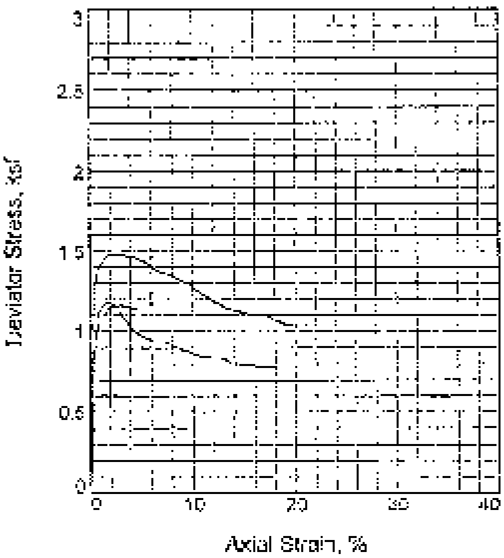


	Total	Effective
C, ksf	0.42	0.39
φ, deg	5.9	17.7
Tan(φ)	0.10	0.32



	Sample No.	1	2	3
Initial	Water Content, %	72.1	45.7	72.1
	Dry Density, pcf	50.3	59.1	52.5
	Saturation, %	92.5	76.0	99.0
	Void Ratio	1.6913	1.2903	1.5787
	Diameter, in.	2.85	2.74	2.83
	Height, in.	5.56	5.59	5.32
At Test	Water Content, %	75.8	55.2	68.4
	Dry Density, pcf	51.2	61.6	54.5
	Saturation, %	100.0	100.0	100.0
	Void Ratio	1.5450	1.1978	1.4850
	Diameter, in.	2.81	2.70	2.79
	Height, in.	5.53	5.52	5.25
	Strain rate, in./min.	0.01	0.01	0.01
	Back Pressure, psi	60.00	60.00	60.00
	Cell Pressure, psi	65.00	70.00	75.00
	Fail. Stress, ksf	1.16	1.18	1.48
	Total Pore Pr., ksf	9.16	10.05	10.38
	Ult. Stress, ksf			1.09
	Total Pore Pr., ksf			9.62
	$\bar{\sigma}_1$ Failure, ksf	1.36	1.20	1.89
	$\bar{\sigma}_3$ Failure, ksf	0.20	0.03	0.42

Type of Test:
CU with Pore Pressures

Sample Type: UD

Description: Gray Sandy SILT

Specific Gravity= 2.170

Remarks: Percent passing no. 200 sieve- pills 1 & 3: 86.7%; pill 2: 59.1%

Note: pills 1 & 3 were stage loaded

JAX, FL. _______

Client: American Electric Power

Project: Dike Drilling

Source of Sample: B-0902 **Depth:** 13.0'-15.0'

Sample Number: UD 4

Proj. No.: 6468-09-1-00 **Date Sampled:** 9-14-09

TRIAXIAL SHEAR TEST REPORT

MACTEC ENGINEERING AND CONSULTING, INC.

Tested By: FB Rajan Sukhram

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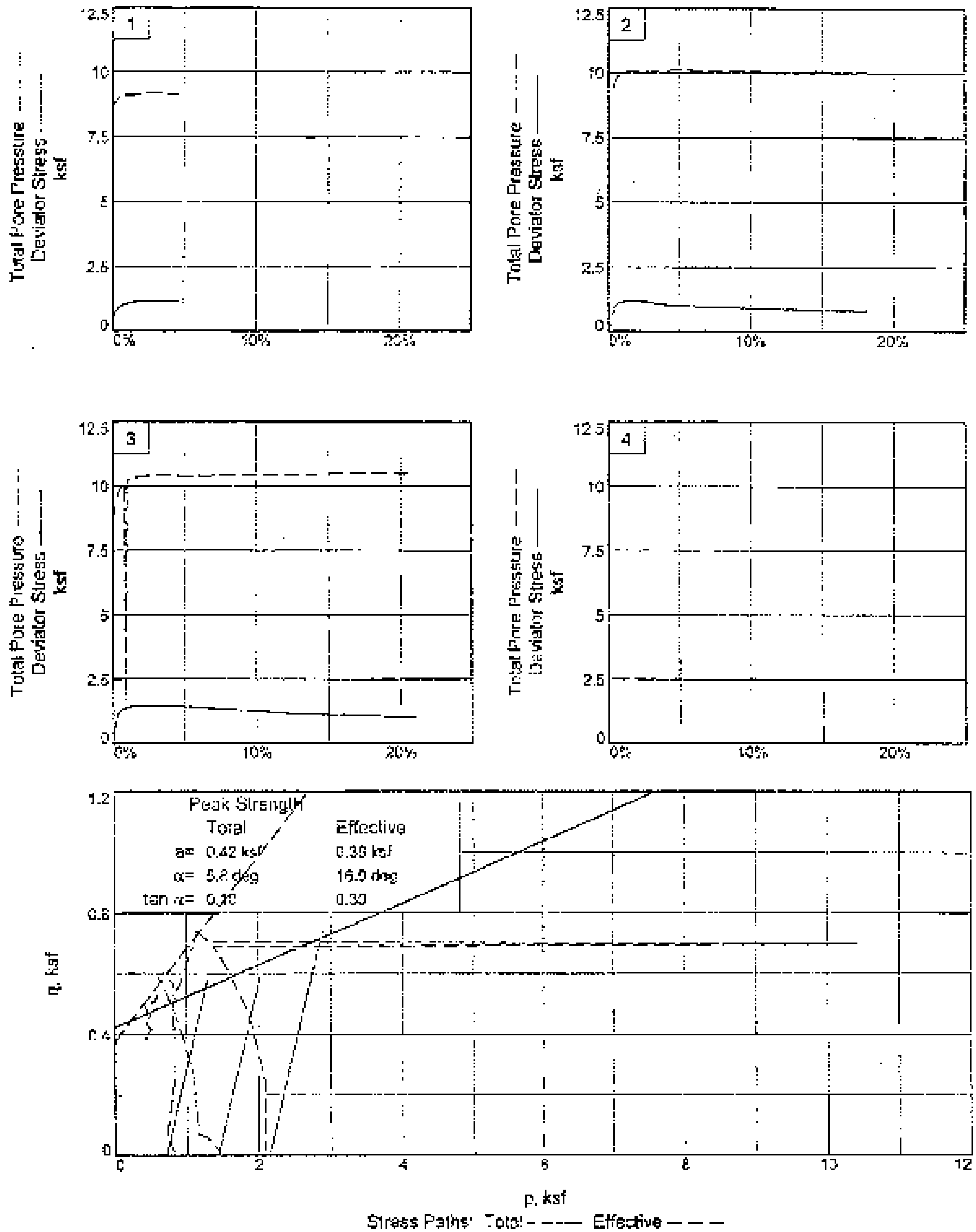
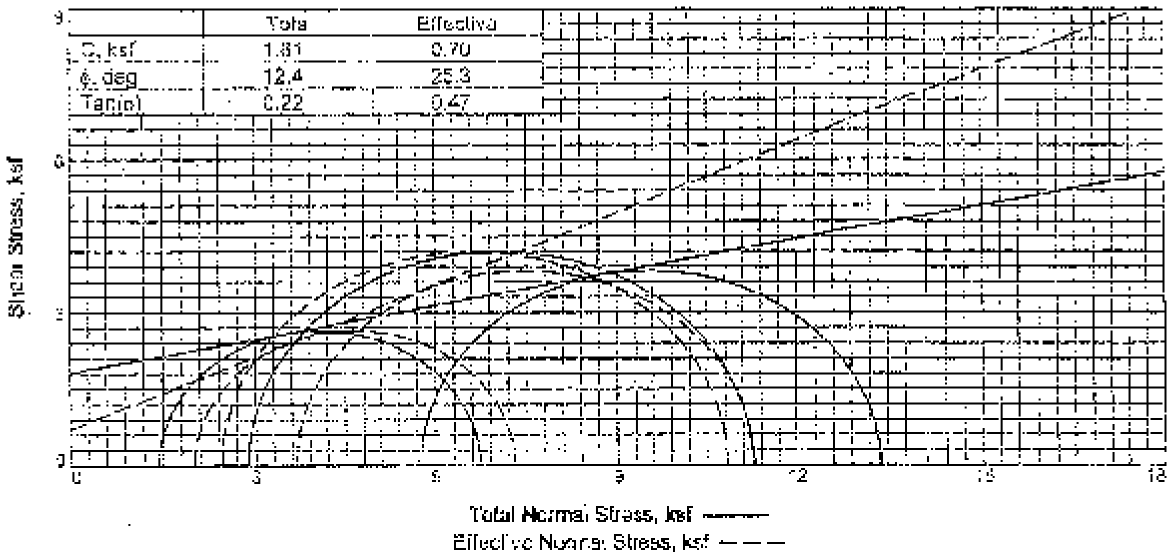
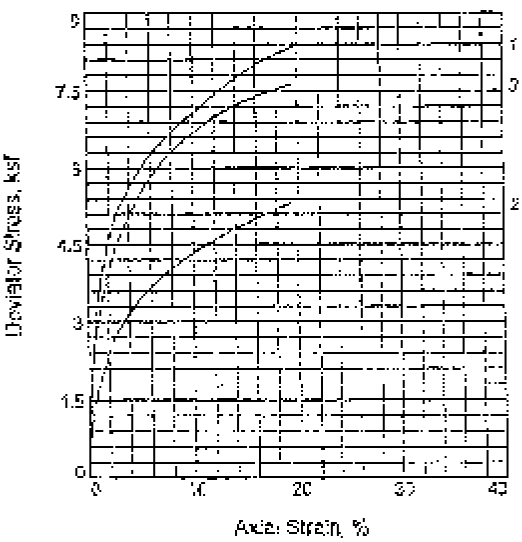


Client: American Electric Power
Project: Dike Drilling
Source of Sample: B-0902 **Depth:** 13.0'-15.0' **Sample Number:** UD-4
Project No.: 3050090131.02 **JAX, FL.** **MACTEC Engineering and Consulting, Inc.**

Tested By: FB





Sample No.		1	2	3
Initial	Water Content, %	11.9	6.6	14.5
	Dry Density, pcf	123.5	131.0	120.2
	Saturation, %	86.7	61.4	96.1
	Void Ratio	0.3725	0.2935	0.4103
	Diameter, in.	2.83	2.85	2.84
	Height, in.	5.61	5.57	5.61
At Test	Water Content, %	12.2	10.0	12.2
	Dry Density, pcf	127.2	133.2	127.3
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.3320	0.2723	0.3314
	Diameter, in.	2.80	2.83	2.79
	Height, in.	5.55	5.54	5.51
Strain rate, in./min.		0.01	0.01	0.01
Back Pressure, psi		50.00	50.00	50.00
Cell Pressure, psi		70.00	60.00	90.00
Fail. Stress, ksf		8.4	5.3	7.6
Total Pore Pr., ksf		7.6	6.6	9.3
Ult. Stress, ksf				
Total Pore Pr., ksf				
$\bar{\sigma}_1$ Failure, ksf		10.8	7.3	11.3
$\bar{\sigma}_3$ Failure, ksf		2.4	2.0	3.7

Type of Test:
CU with Pore Pressures

Sample Type:

Description: Brown sandy lean clay with gravel

LL= 42 PL= 22 PI= 20

Specific Gravity= 2.715

Remarks: All pills were found to contain rock fragments larger than 1/2" diameter

Jax FL. ________

Client: American Electric Power

Project: Dike Drilling

Source of Sample: B-0504 **Depth:** 52.0'-54.0'

Sample Number: UD-7

Proj. No.: 3063-09-[illegible] **Date Sampled:** 9-16-09

TRIAXIAL SHEAR TEST REPORT

MACTEC ENGINEERING AND CONSULTING, INC.

Tested By: FB

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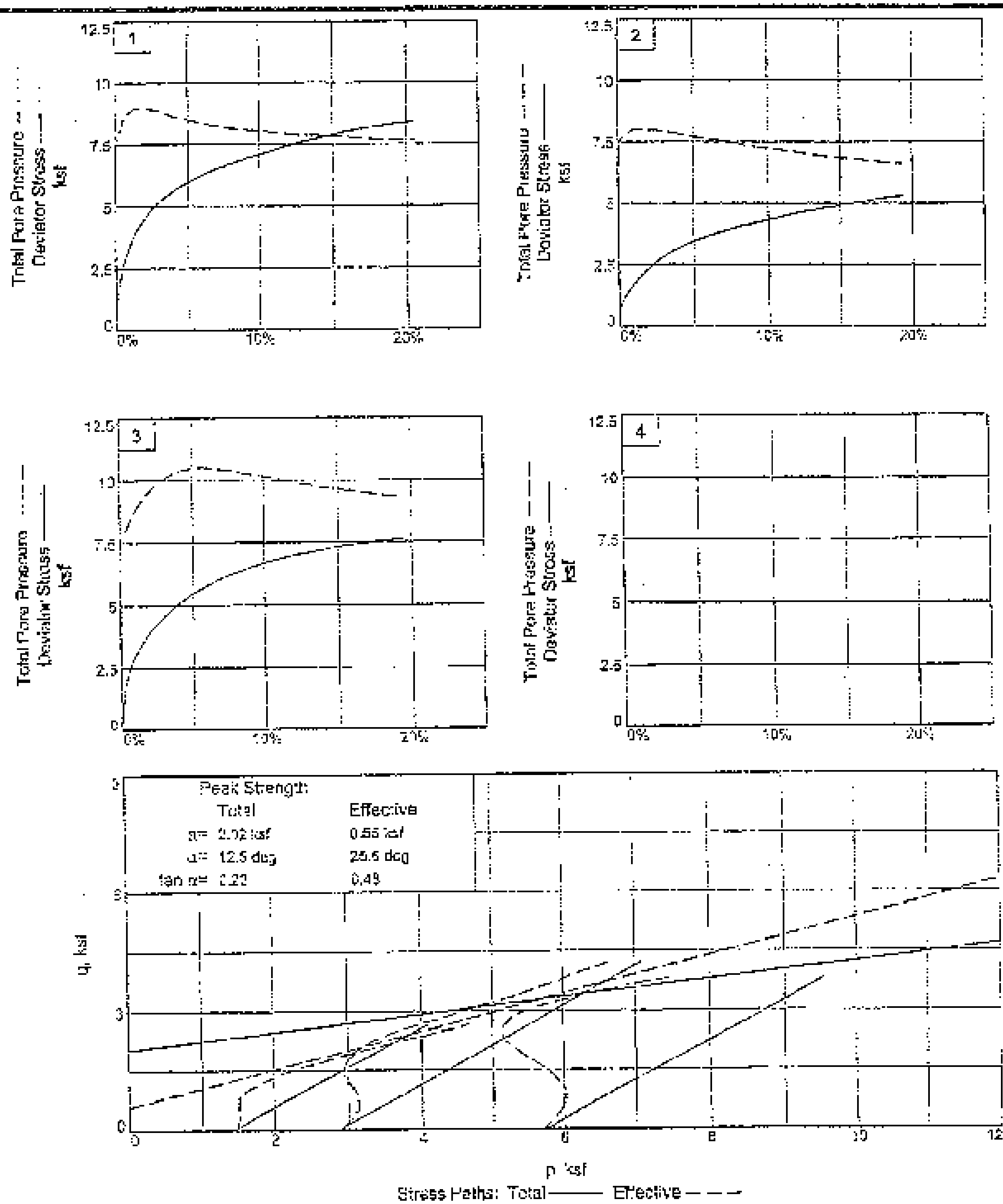

Client: American Electric Power
Project: Dike Drilling
Source of Sample: B-0904 **Depth:** 32.0'-34.0' **Sample Number:** UD-7
Project No.: 3050090131.02 Jax FL. ________ MACTEC Engineering and Consulting, Inc.

Tested By: FB Raini Subhusani

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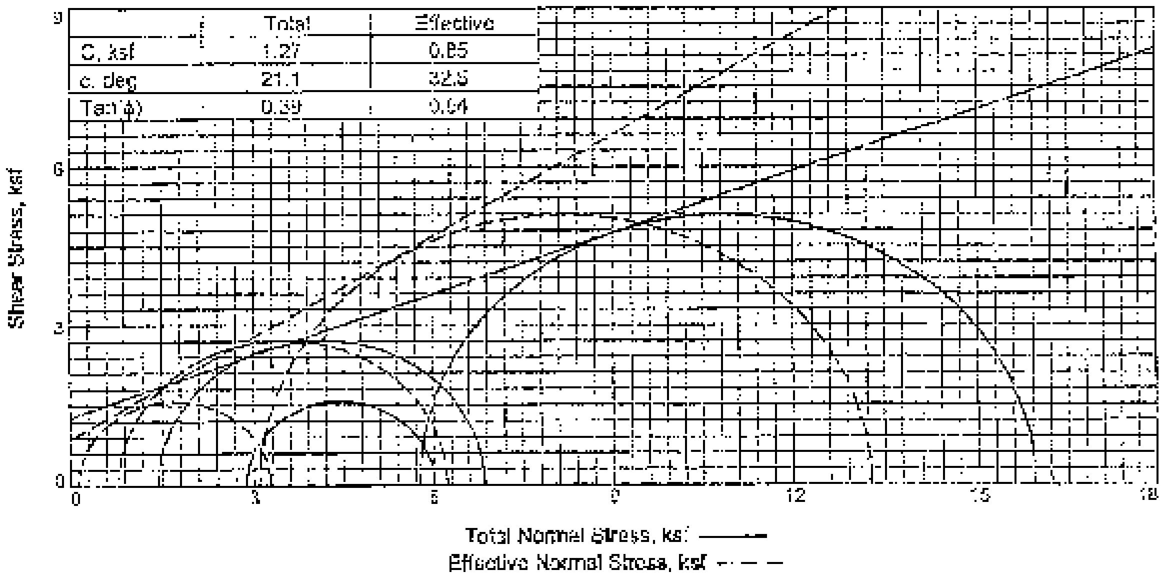
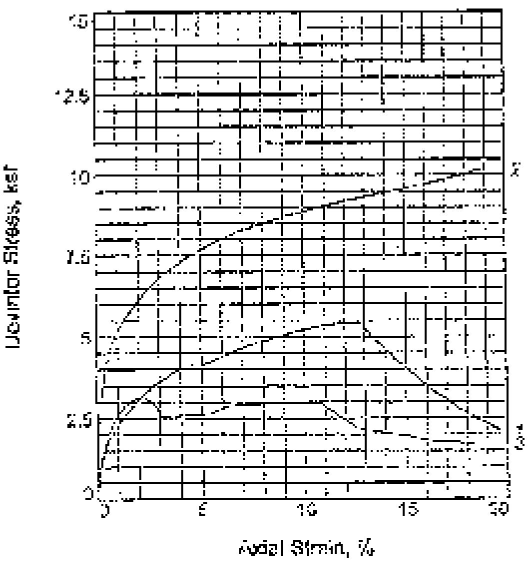


	Total	Effective
C, ksf	1.27	0.85
φ, deg	21.1	32.5
Tan(φ)	0.39	0.64



Sample No.		1	2	3
Initial	Water Content, %	16.8	15.4	16.1
	Dry Density, pcf	122.5	119.8	122.5
	Saturation, %	100.0	96.9	100.0
	Void Ratio	0.4911	0.4388	0.4604
	Diameter, in.	2.83	2.85	2.83
	Height, in.	5.56	5.59	5.64
At Test	Water Content, %	15.8	13.2	14.2
	Dry Density, pcf	124.9	126.3	127.0
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.4622	0.3647	0.4030
	Diameter, in.	2.80	2.80	2.80
	Height, in.	5.53	5.49	5.57
Strain rate, in./min.		0.01	0.01	0.01
Back Pressure, psi		50.00	50.00	50.00
Cell Pressure, psi		60.00	90.00	70.00
Fail. Stress, ksf		5.4	10.2	3.1
Total Pore Pr., ksf		7.8	9.9	9.9
Ult. Stress, ksf				
Total Pore Pr., ksf				
$\bar{\sigma}_1$ Failure, ksf		6.2	13.3	3.3
$\bar{\sigma}_3$ Failure, ksf		0.8	3.1	0.1

Type of Test:
CU with Pore Pressures

Sample Type:

Description: Gray-brown sandy lean clay

LL= 35 **PL=** 22 **PI=** 13

Specific Gravity= 2.928

Remarks: All pills were found to contain rock fragments larger than 1/2" diameter

Client: American Electric Power

Project: Dike Drilling

Source of Sample: B-0904 **Depth:** 47.5'-50.0'

Sample Number: UD-10

Proj. No.: [illegible] **Date Sampled:**

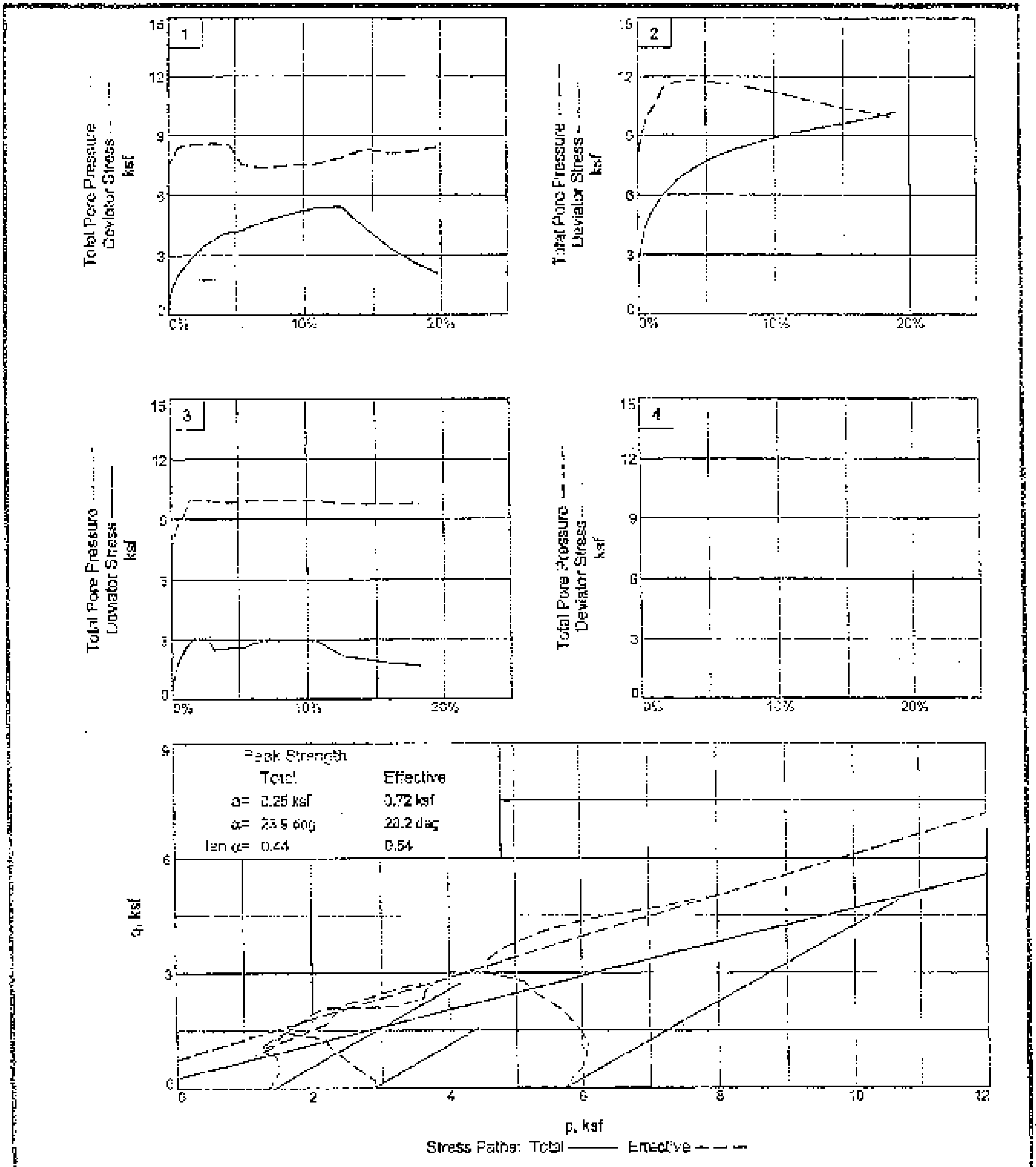
TRIAXIAL SHEAR TEST REPORT

MACTEC ENGINEERING AND CONSULTING, INC.

Jax FL. ________

US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

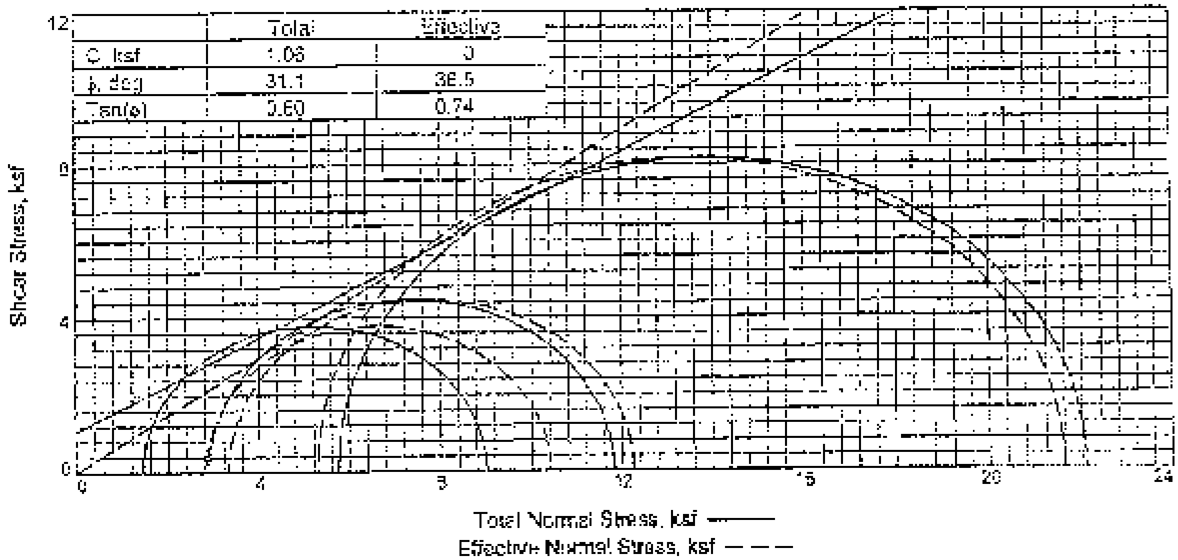


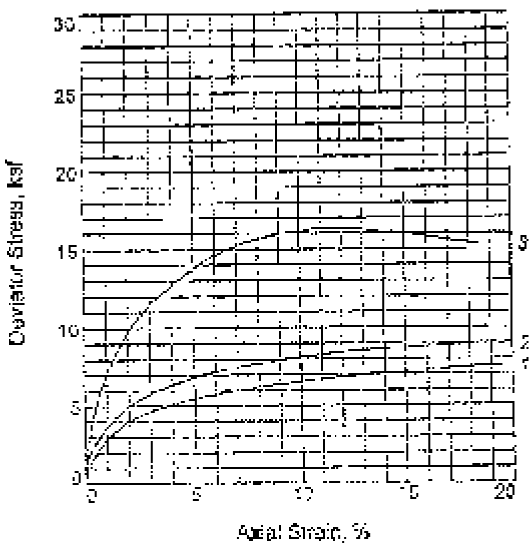
Client: American Electric Power

Project: Dike Drilling

Source of Sample: B-0904 Depth: 47.8-50.0' Sample Number: UD 10

Project No.: 3050090131.02 Jax FL. ______ MACTEC Engineering and Consulting, Inc.





Sample No.		1	2	3
Initial	Water Content, %	15.9	10.9	11.5
	Dry Density, pcf	114.2	119.5	120.2
	Saturation, %	90.9	71.5	77.7
	Void Ratio	0.4719	0.4098	0.3983
	Diameter, in.	2.87	2.88	2.87
	Height, in.	5.66	5.59	5.58
At Test	Water Content, %	16.7	13.5	11.0
	Dry Density, pcf	115.9	123.2	129.8
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.4502	0.3646	0.2955
	Diameter, in.	2.85	2.85	2.79
	Height, in.	5.62	5.52	5.44
Strain rate, in./min.		0.01	0.01	0.01
Back Pressure, psi		50.00	50.00	50.00
Cell Pressure, psi		50.00	70.00	90.00
Fail. Stress, ksf		7.6	8.9	15.3
Total Pore Pr., ksf		5.8	6.8	7.7
Ult. Stress, ksf				
Total Pore Pr., ksf				
$\bar{\sigma}_1$ Failure, ksf		10.4	12.3	21.0
$\bar{\sigma}_3$ Failure, ksf		2.8	3.3	5.3

Type of Test:
CU with Pore Pressures
Sample Type: UD
Description: Brown clayey sand with gravel

LL= 35 **PL=** 24 **PI=** 11
Specific Gravity= 2.693
Remarks: Pill A is sampled from B-0905 UD-5 (20.0'-22.0')

Client: American Electric Power

Project: Dike Drilling

Source of Sample: B-0905 **Depth:** 12.0'-14.0'
Sample Number: UD-1
Proj. No.: [illegible] **Date Sampled:**

TRIAXIAL SHEAR TEST REPORT
MACTEC ENGINEERING AND CONSULTING, INC.

Jax FL ________

Tested By: FB ____ Rajni Sureshwaran

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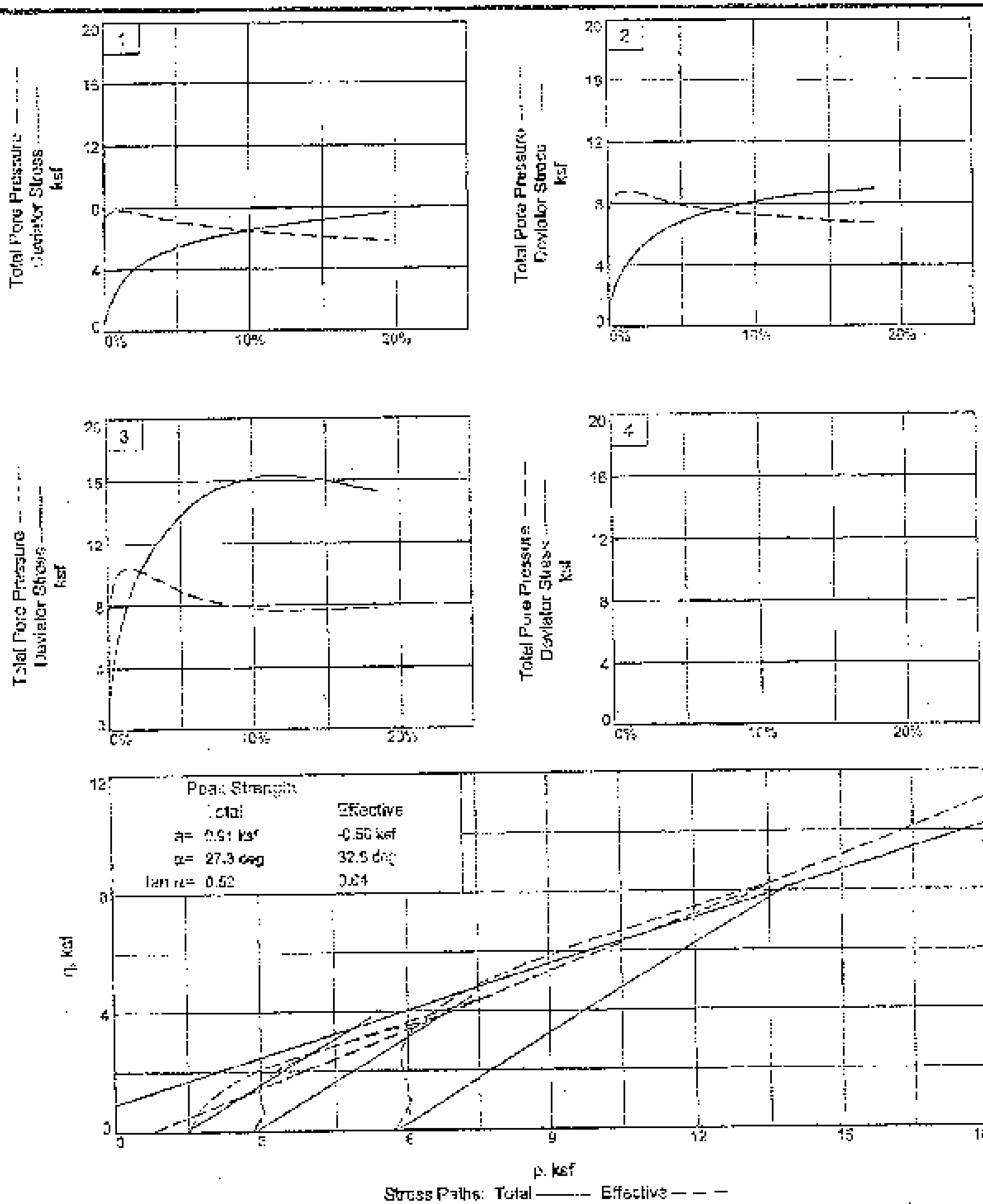
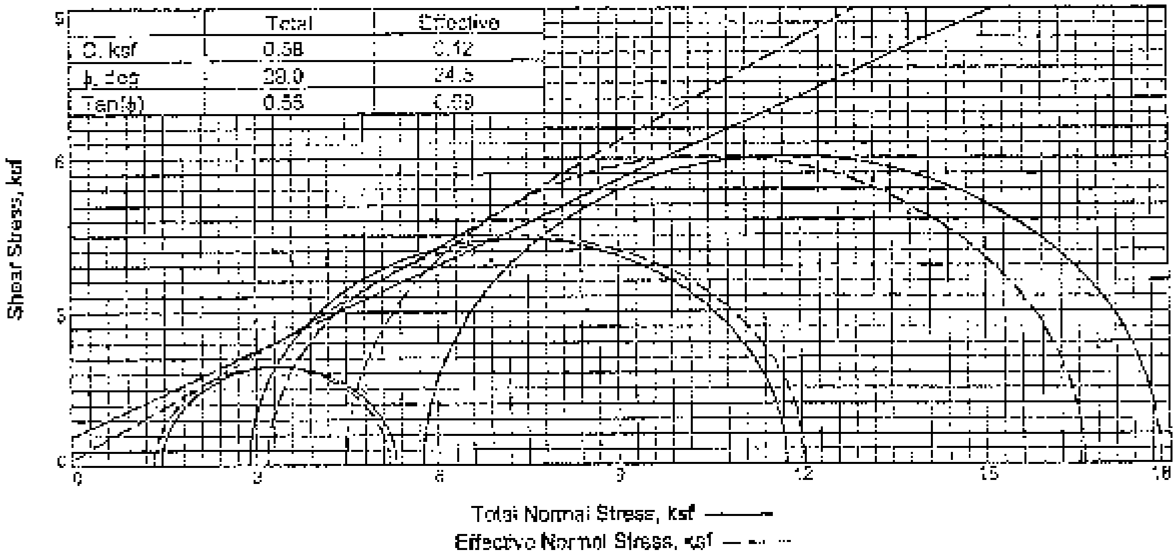
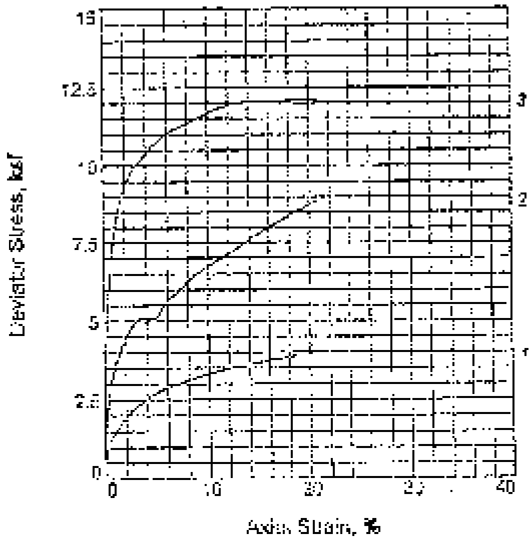


Client: American Electric Power
Project: Dike Drilling
Source of Sample: B-0305 **Depth:** 12.0'-14.0' **Sample Number:** UD-1
Project No.: 3050090131.03 Jax FL. ________ MACTEC Engineering and Consulting, Inc.

Tested By: EB ____________





	Sample No.	1	2	3
Initial	Water Content, %	17.3	17.3	17.3
	Dry Density, pcf	113.3	115.4	118.4
	Saturation, %	94.3	99.9	100.0
	Void Ratio	0.4999	0.4717	0.4395
	Diameter, in.	2.90	2.91	2.87
	Height, in.	5.50	5.03	4.95
At Test	Water Content, %	16.7	15.3	14.8
	Dry Density, pcf	116.7	120.0	124.3
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.4555	0.4160	0.4189
	Diameter, in.	2.37	2.88	2.82
	Height, in.	5.49	4.96	4.87
	Strain rate, in./min.	0.01	0.01	0.01
	Back Pressure, psi	50.00	50.00	50.00
	Cell Pressure, psi	60.00	70.00	90.00
	Fail. Stress, ksf	3.9	8.9	12.1
	Total Pore Pr., ksf	7.3	6.9	8.5
	Ult. Stress, ksf			
	Total Pore Pr., ksf			
	$\bar{\sigma}_1$ Failure, ksf	5.2	12.1	16.6
	$\bar{\sigma}_3$ Failure, ksf	1.3	3.2	4.5

Type of Test:
CU with Pore Pressures

Sample Type: UD

Description: Clayey silty gravel with sand

LL= 35 **PL=** 25 **PI=** 10

Specific Gravity= 2.721

Remarks:

Jax FL,

Client: American Electric Power

Project: Dike Drilling

Source of Sample: B-0509 **Depth:** 11.5-13.5'

Sample Number: UD-3

Date Sampled:

TRIAXIAL SHEAR TEST REPORT

MACTEC ENGINEERING AND CONSULTING, INC.

Tested By: FB

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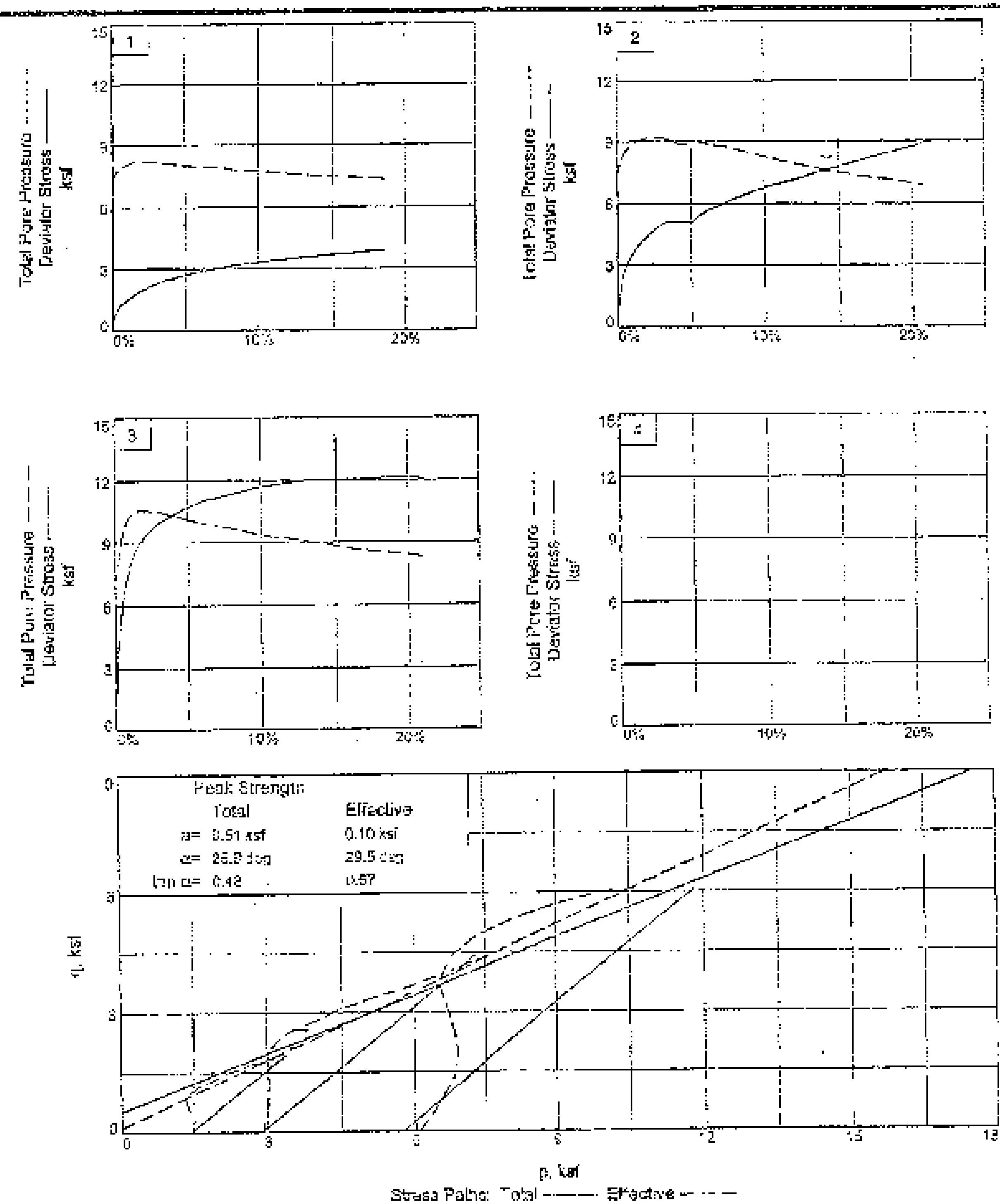

Client: American Electric Power
Project: Dike Drilling
Source of Sample: JI-0909 Depth: 11.5'-13.5' Sample Number: UD-3
Project No.: 3050090131.02 Jax FL.

MACTEC Engineering and Consulting, Inc.

Tested By: FB

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MACTEC ENGINEERING AND CONSULTING, INC
22010 Commerce Drive
Abingdon, Virginia 24211
(276) 676-0426

Project Name: AEP Dike Drilling
Project Number: 3050-09-0131
Report Date: 11/09/09

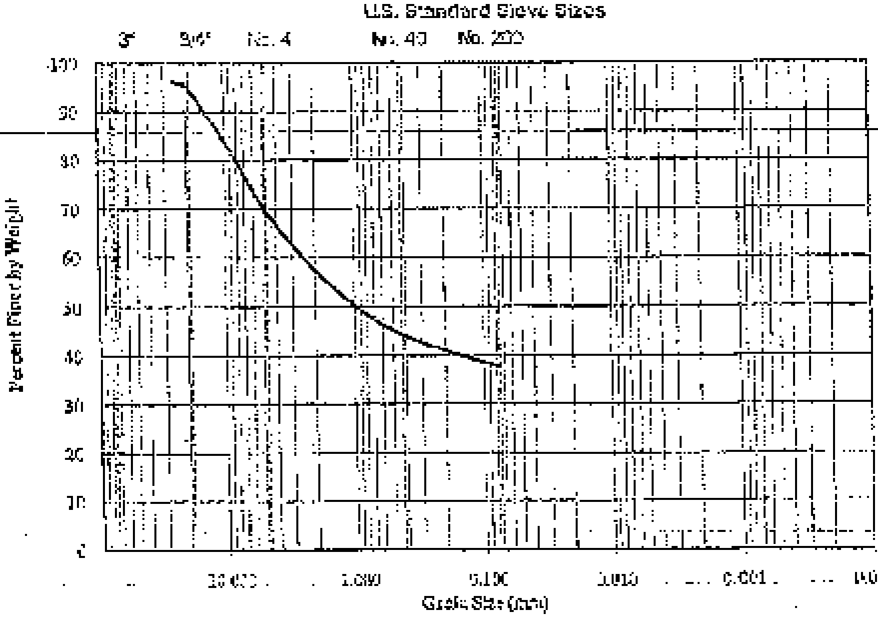
Washed Particle Size/Gradation Test Report
ASTM D422

Sample Number: UD-6 **Location:** B-0901

Percent Finer than No. 200: **37.7** % (from washing)

Sieve Size	Cumulative (g)	Wt. Retained Each Sieve (g)	Cumulative % Passing	Cumulative % Passing w/ Wash 200
1 in.	26.47	26.47	93.9	96.2
3/4 in.	36.82	10.35	91.5	94.7
3/8 in.	117.88	81.02	75.0	83.1
# 4	212.55	94.67	51.3	69.4
# 10	296.73	84.18	32.0	57.3
# 20	355.25	58.52	18.5	48.9
# 40	387.02	31.77	11.2	44.4
# 60	404.09	17.07	7.3	41.9
# 100	417.48	13.39	4.3	40.0
#200	433.17	15.69	2.7	37.7
PAN	456.05	22.88		
Wt. of Soil, g	695.72			

Particle Size Analysis
U.S. Standard Sieve Sizes



Performed By: MEH 11-11-09 Checked By: RDK 11-11-09

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MACTEC ENGINEERING AND CONSULTING, INC.
22010 Commerce Drive
Abingdon, VA 24211

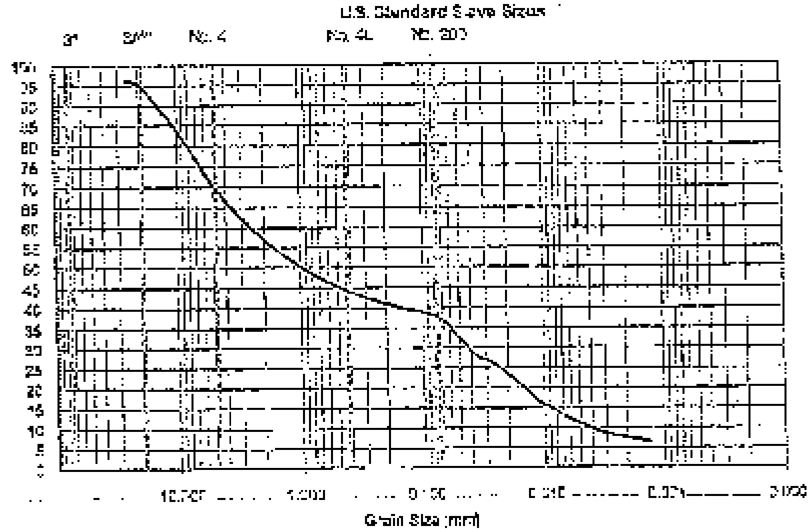
Sieve Analysis Test Report
Hydrometer/Sieve
ASTM D422

Project Name: AEP Dike Drilling
Project Number: 3050-09-0131
Report Date: 11/9/2009
Sample Number: B-0901 UD-6

Sieve and Hydrometer

Particle Size	Units	Cumulative Wt. Retained (g)	Wt. Retained Each Sieve (g)	Cumulative % Passing
25.0	mm	20.47	26.5	98.4
19.0	mm	36.86	10.4	94.7
9.5	mm	117.36	81.0	67.1
4.0	mm	212.55	94.7	65.4
2.0	mm	273.75	61.2	57.9
850	um	245.25	55.5	47.9
425	um	257.02	31.9	44.4
250	um	404.09	17.1	41.0
150	um	447.48	18.4	40.0
75	um	433.17	15.7	37.7
49	um	[illegible]	[illegible]	32.1
35	um	[illegible]	[illegible]	28.1
27	um	[illegible]	[illegible]	26.4
18	um	[illegible]	[illegible]	23.3
11	um	[illegible]	[illegible]	19.0
9.1	um	[illegible]	[illegible]	14.3
6.5	um	[illegible]	[illegible]	12.0
3.0	um	[illegible]	[illegible]	8.8
1.3	um	[illegible]	[illegible]	5.2
Wt. of Sample		390.72		

Particle Size Analysis
U.S. Standard Sieve Sizes



Performed by: MEH 11-11-09
Checked by: TDR 11-11-09

B-0901 UD-6, Hydrometer

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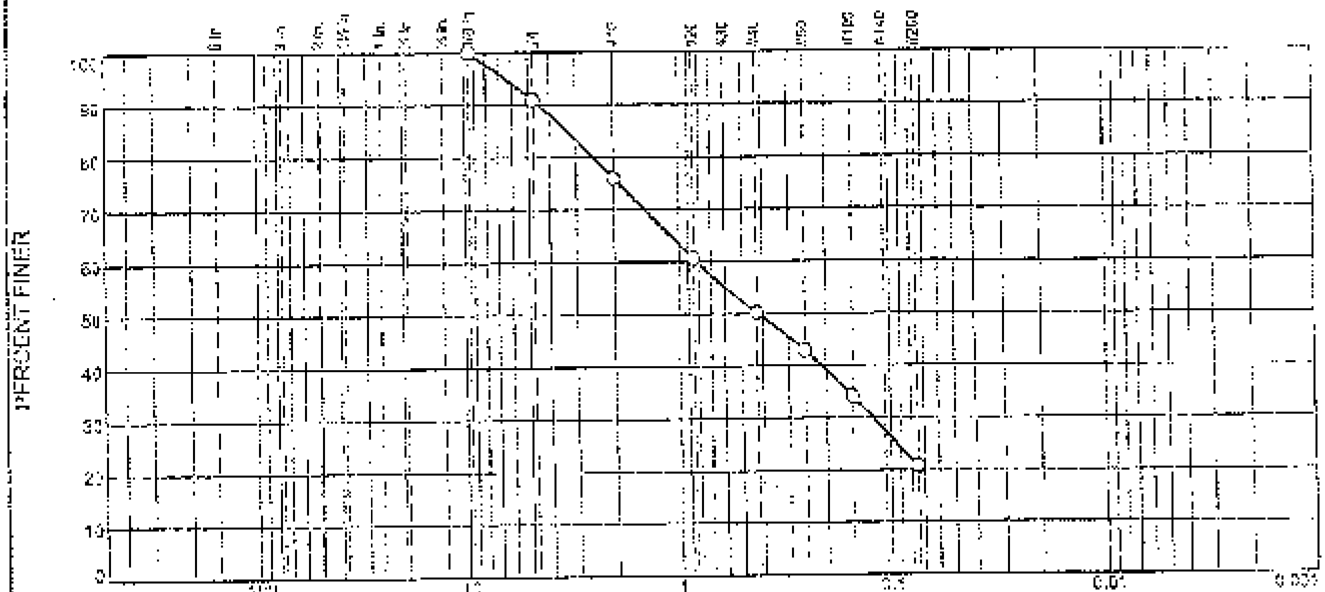
US EPA ARCHIVE DOCUMENT

Grain Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.1	14.9	25.8	29.5	20.7	

Test Results (ASTM D 422 w/o hyd & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/8"	100.0		
#4	90.9		
#10	76.0		
#20	60.6		
#40	50.2		
#60	42.9		
#100	34.0		
#200	20.7		

* (no specification provided)

Material Description

Brown medium to fine silty clayey SAND

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= SC-SM AASHTO (M 145)=

Coefficients

D_{90}= 4.4806 D_{85}= 3.2989 D_{60}= 0.8183
D_{50}= 0.4197 D_{30}= 0.1214 D_{15}=
D_{10}= C_u= C_c=

Remarks

Moisture content: 18.6 %

Date Received: Date Tested: 10-16-09

Tested By: FB

Checked By: Rami Sukhwani

Title:

Source of Sample: B-0904 Depth: 25.0-27.0 Date Sampled:
Sample Number: UD-5

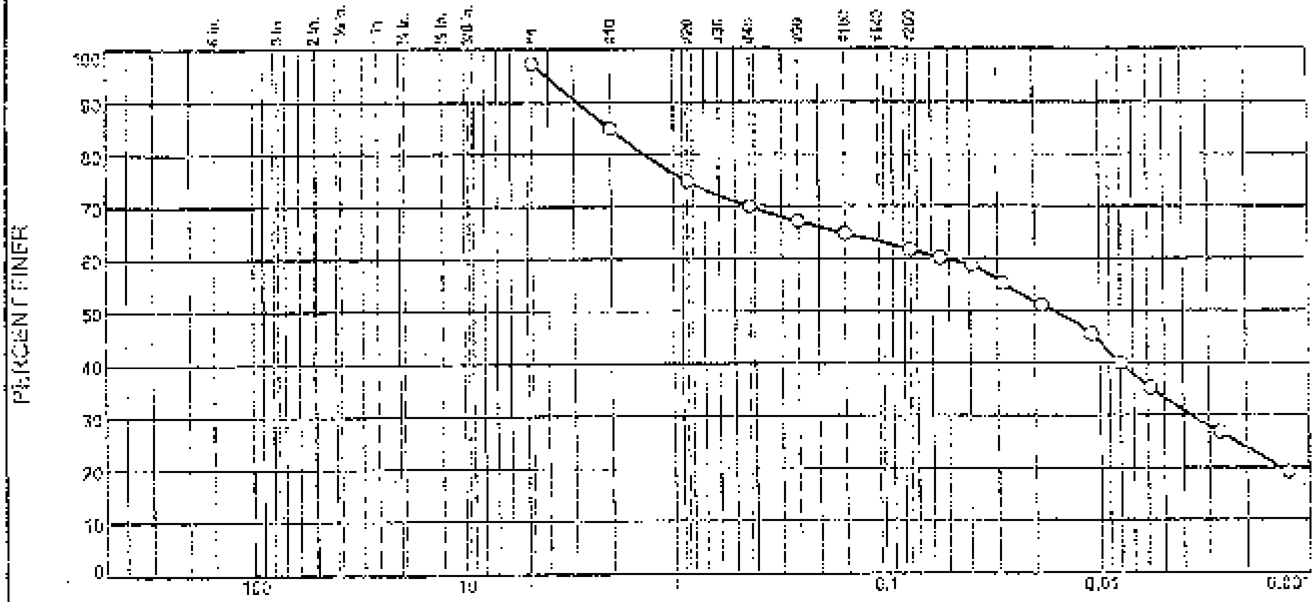
MACTEC ENGINEERING AND CONSULTING, INC.

Client: American Electric Power
Project: Pike Drilling
Project No: 3050-09-0131-02 Jax FL

Checked By: POR 11-13-09

US EPA ARCHIVE DOCUMENT

Grain Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
			12.4	14.9	8.4	28.1	33.5

TEST RESULTS (ASTM D 422)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	97.3		
#10	84.9		
#20	74.9		
#40	70.0		
#60	67.1		
#100	64.7		
#200	61.5		
0.0542 mm.	60.1		
0.0391 mm.	58.7		
0.0283 mm.	55.3		
0.0184 mm.	51.1		
0.0109 mm.	45.5		
0.0080 mm.	40.0		
0.0058 mm.	35.2		
0.0027 mm.	26.8		
0.0013 mm.	19.2		

* (no specification provided)

Material Description

Brown sandy lean clay with gravel

Atterberg Limits (ASTM D 4318)

PL= 21 LL= 42 PI= 20

Classification

USCS (D 2487)= CL AASHTO (M 145)= A-7-6(10)

Coefficients

D_{85}= 2.6725 D_{60}= 0.0118 D_{50}= 0.0535
D_{50}= 0.0162 D_{30}= 0.0037 D_{15}=
D_{10}= C_u= C_c=

Remarks

Moisture Content: 34.5%

Date Received: 10-15-09 Date Tested: 10-15-09
Tested By: FB
Checked By: Rajan Sukthwan
Title:

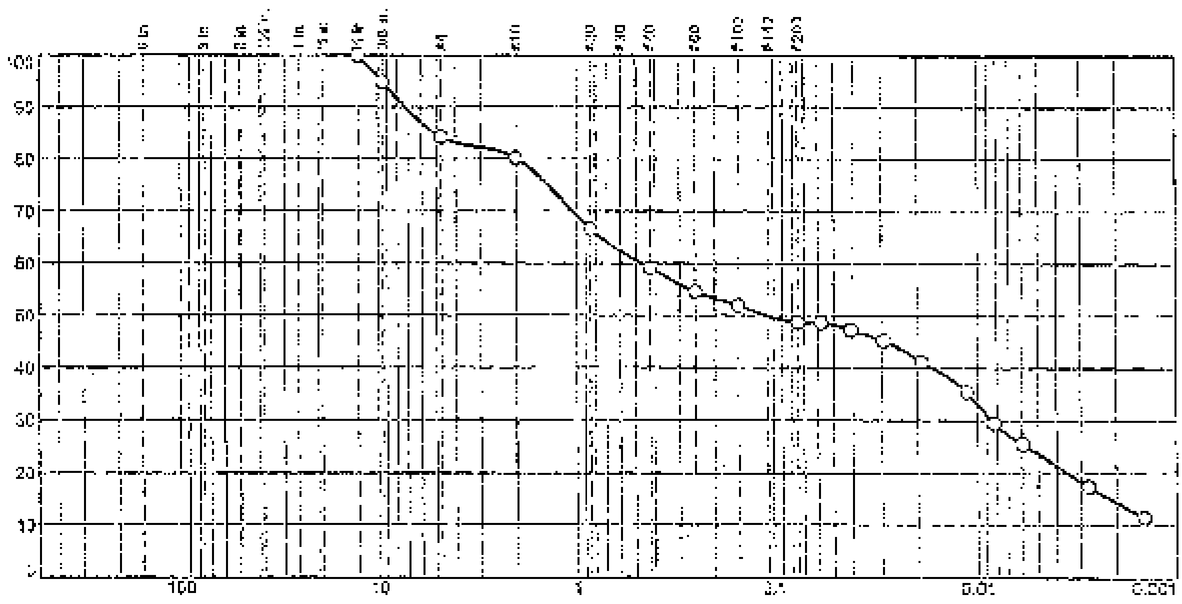
Source of Sample: B-0904 Depth: 32.0-34.0' Date Sampled: 9-16-09
Sample Number: UD-7

MACTEC ENGINEERING AND CONSULTING, INC.

Client: American Electric Power
Project: Dike Drilling
Project No: 3050090131.02 Jax, FL.

Checked By: RDR 11-13-09

Grain Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	15.8	4.0	21.1	10.5	24.8	23.8

TEST RESULTS (ASTM D 422)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1/2"	100.0		
3/8"	94.9		
#4	84.2		
#10	80.2		
#20	66.6		
#40	59.1		
#60	54.5		
#100	51.8		
#200	48.6		
0.0576 mm.	48.6		
0.0411 mm.	47.3		
0.0294 mm.	45.3		
0.0190 mm.	41.3		
0.0113 mm.	35.4		
0.0083 mm.	29.5		
0.0060 mm.	25.6		
0.0027 mm.	17.4		
0.0014 mm.	11.5		

* (no specification provided)

Material Description

Brown clayey fine sand with little fine gravel

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= SC-SM AASHTO (M 145)=

Coefficients

D_{90}= 7.2367 D_{85}= 5.1435 D_{60}= 0.4707
D_{50}= 0.1093 D_{30}= 0.0085 D_{15}= 0.0021
D_{10}= C_u= C_c=

Remarks

Moisture Content: 11.5%
F.M.=1.97

Date Received: 10-15-09 Date Tested: 10-15-09
Tested By: FB
Checked By: [signature]
Title:

Source of Sample: B-0904 Depth: 36.0'-38.0' Date Sampled:
Sample Number: UD-8

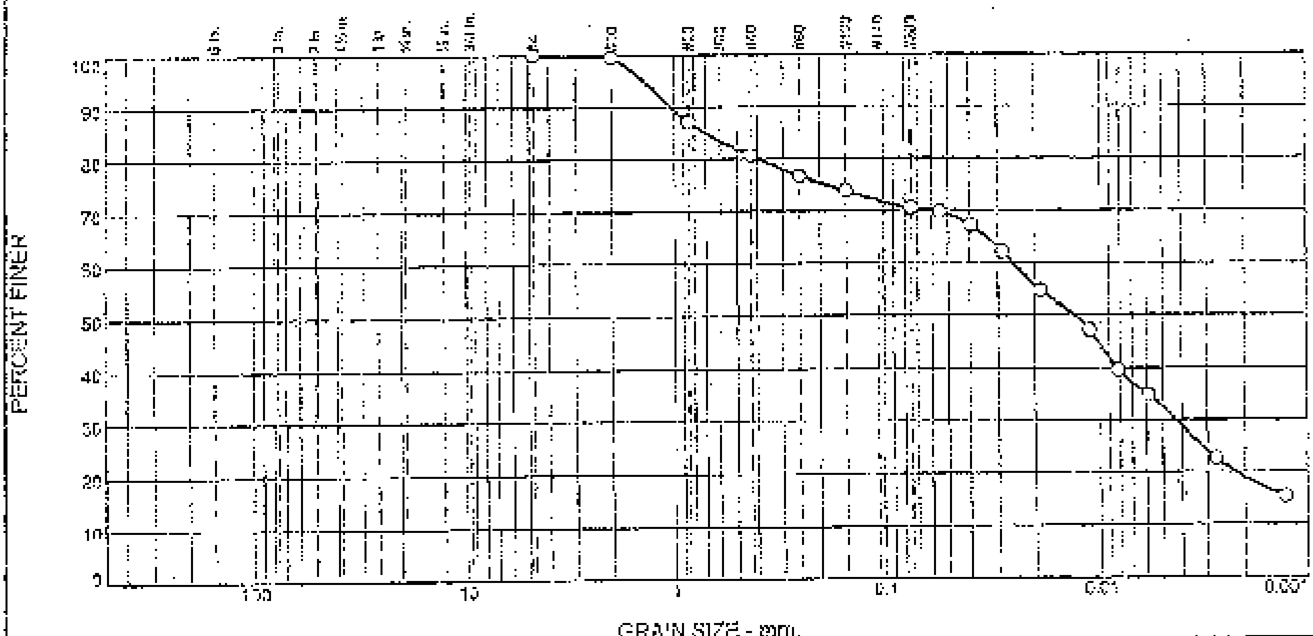
MACTEC ENGINEERING, AND CONSULTING, INC.

Client: American Electric Power
Project: Dike Drilling
Project No: 3050090131.07 Jax FL

Checked By: ZDR 11-18-09

US EPA ARCHIVE DOCUMENT

Grain Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.5	18.8	10.2	38.0	32.5

TEST RESULTS (ASTM D 422)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.5		
#20	87.2		
#40	80.7		
#60	76.7		
#100	73.8		
#200	70.5		
0.0549 mm.	69.7		
0.0393 mm.	67.2		
0.0286 mm.	62.2		
0.0187 mm.	54.7		
0.0112 mm.	47.2		
0.0082 mm.	39.5		
0.0059 mm.	34.8		
0.0027 mm.	22.7		
0.0013 mm.	15.3		

* (no specification provided)

Material Description

Gray-brown sandy lean clay

Atterberg Limits (ASTM D 4318)

PL= 22 LL= 35 PI= 13

Classification

USCS (D 2487)= CL AASHTO (M 145)= A-6(8)

Coefficients

D_{90}= 1.0280 D_{85}= 0.7050 D_{60}= 0.0254
D_{50}= 0.0131 D_{30}= 0.0043 D_{15}=
D_{10}= C_u= C_c=

Remarks

Moisture Content: 16.5%

Date Received: 10-15-09 Date Tested: 10-15-09
Tested By: FB
Checked By: Rajni Sukhavasi
Title:

Source of Sample: B-0904 Depth: 47.8'-50.0' Date Sampled:
Sample Number: UD-10

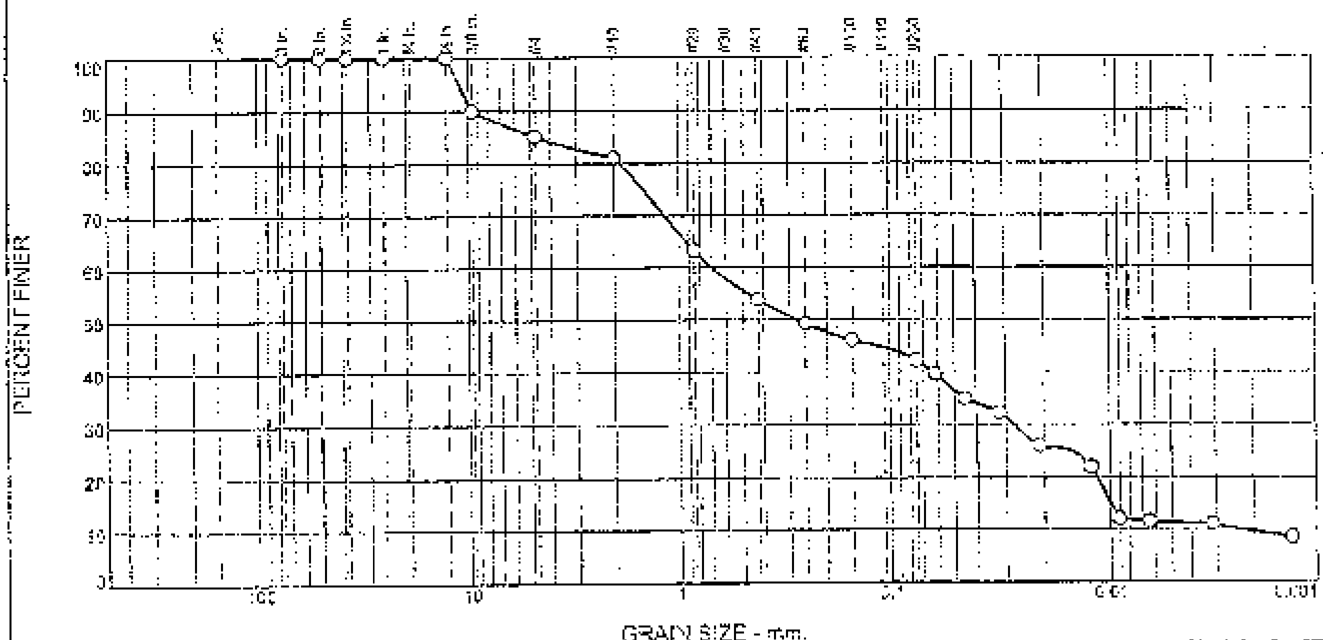
MACTEC ENGINEERING, AND CONSULTING, INC.

Client: American Electric Power
Project: Dike Drilling
Project No: 3050090031.02 Jax FL

Checked By: RSR 11-13-09

US EPA ARCHIVE DOCUMENT

Grain Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	14.9	4.0	27.2	11.7	30.9	11.3

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	100.0		
1/2"	100.0		
3/8"	90.9		
#4	85.1		
#10	81.1		
#20	63.3		
#40	53.5		
#60	49.2		
#100	46.1		
#200	41.2		
0.0614 mm.	35.5		
0.0446 mm.	34.9		
0.0325 mm.	32.2		
0.0209 mm.	26.1		
0.0123 mm.	23.1		
0.0091 mm.	12.9		
0.0064 mm.	11.5		
0.0031 mm.	11.7		
0.0013 mm.	9.4		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits (ASTM D 4318)

PL= 24 LL= 35 PI= 11

Classification

USCS (D 2487)= SC AASHTO (M 145)= A-6(1)

Coefficients

D_{90}= 9.5420 D_{85}= 4.6338 D_{60}= 0.7934
D_{50}= 0.2762 D_{30}= 0.0276 D_{15}= 0.0100
D_{10}= 0.0024 C_u= 295.45 C_c= 0.45

Remarks

Moisture content: 15.9%

Date Received: 10-14-09 Date Tested: 10-19-09

Tested By: PB

Checked By: Rajni Sukhwani

Title:

Source of Sample: B-0905 Depth: 12.0'-14.0' Date Sampled:

Sample Number: UD-1

MACTEC ENGINEERING AND CONSULTING, INC.

Client: American Electric Power
Project: Dike Drilling
Project No: 3050299131.02 Jax FL

Checked By: RDR 11-13-09

US EPA ARCHIVE DOCUMENT

MACTEC

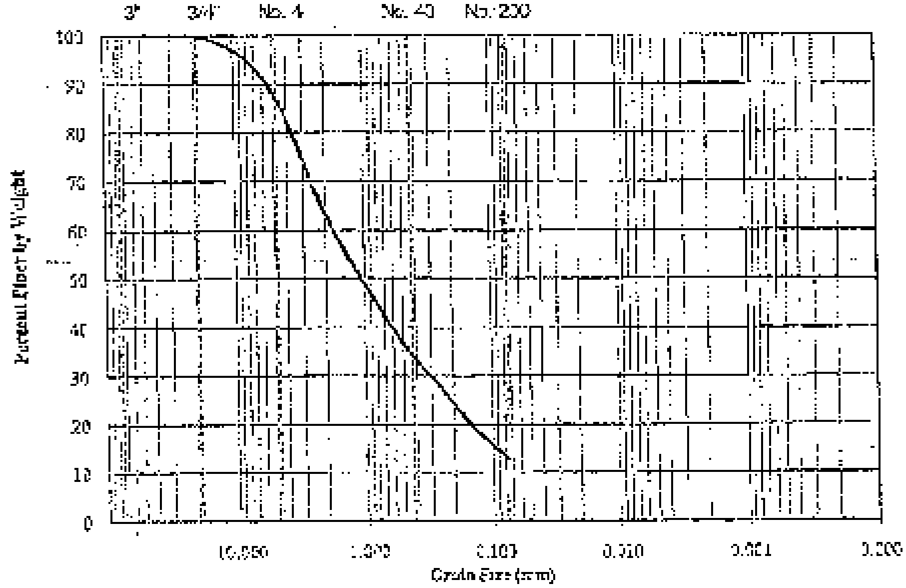
MACTEC ENGINEERING AND CONSULTING, INC
22010 Commerce Drive
Abingdon, Virginia 24211
(276) 676-0426

Project Name: AEP Dike Drilling
Project Number: 3050-09-0131
Report Date: 11/09/09

Washed Particle Size/Gradation Test Report
ASTM D422
Sample Number: UD-3 Location: B-0905A

Percent Finer than No. 200: 12.7 % (from washing)

Sieve Size	Cumulative (g)	Wt. Retained Each Sieve (g)	Cumulative % Passing	Cumulative % Passing w/ Wash 200
1 in.	0.00	0.00	100.0	100.0
3/4 in.	0.00	0.00	100.0	100.0
3/8 in.	34.46	34.46	96.1	96.5
# 4	129.31	94.85	85.5	87.2
# 10	370.55	241.24	56.3	63.3
# 20	546.13	175.58	38.6	45.9
# 40	663.38	117.25	25.4	34.3
# 60	732.04	68.66	17.7	27.5
# 100	805.38	73.34	9.4	20.3
#200	881.92	76.54	8.8	12.7
PAN	885.05	7.14		
Wt. of Soil, g	1010.13			



Performed By: NCH 11-11-09 Checked By: RDB 11-11-09 B-0905A UD-3, Sieve

US EPA ARCHIVE DOCUMENT

MACTEC

MACTEC ENGINEERING AND CONSULTING, INC.
22310 Commerce Drive
Abingdon, VA 24211

Sieve Analysis Test Report
Hydrometer/Sieve
ASTM D422

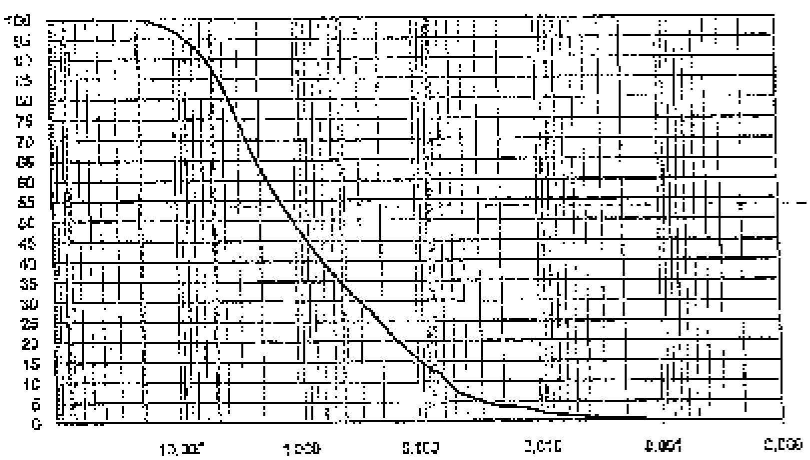
Project Name: AEP Dike Drilling
Project Number: 3050-09-0131
Report Date: 11/9/2009
Sample Number: 9-0505A UD-3

Sieve and Hydrometer

Particle Size	Units	Cumulative Wt. Retained (g)	Wt. Retained Each Sieve (g)	Cumulative % Passing
25.0	mm	0.00	0.0	100.0
19.0	mm	0.00	0.0	100.0
9.5	mm	34.45	34.5	96.6
4.8	mm	129.2	94.8	87.2
2.0	mm	373.55	241.2	63.3
850	um	544.[illegible]	170.9	46.3
425	um	663.[illegible]	117.3	34.5
250	um	732.0[illegible]	68.7	27.5
150	um	805.3[illegible]	73.3	20.3
75	um	881.9[illegible]	76.5	12.7
66	um	[illegible]	[illegible]	12.0
49	um	[illegible]	[illegible]	7.8
35	um	[illegible]	[illegible]	5.7
22	um	[illegible]	[illegible]	3.5
13	um	[illegible]	[illegible]	2.2
6.2	um	[illegible]	[illegible]	1.5
3.2	um	[illegible]	[illegible]	1.3
3.2	um	[illegible]	[illegible]	0.6
1.4	um	[illegible]	[illegible]	0.0
Wt. of Soil, g		1010.13		

Particle Size Analysis

U.S. Standard Sieve Sizes

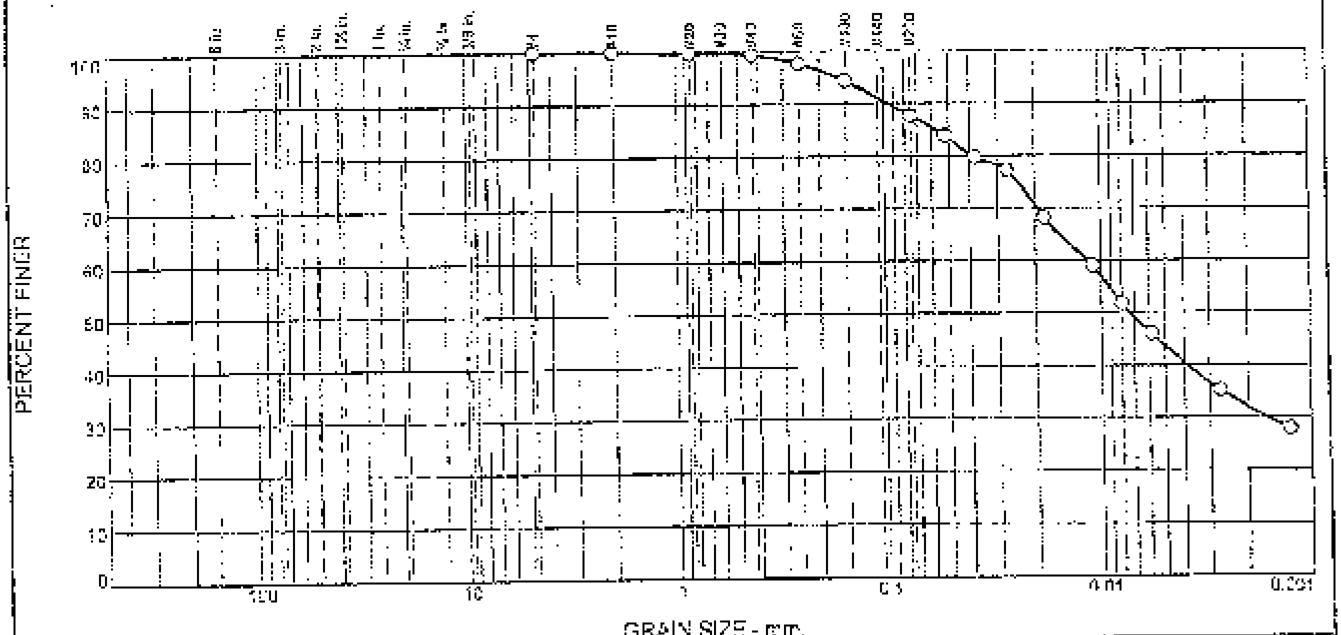


Performed by: NCH 11-11-09
Checked by: TDR 11-11-09

9-0505A UD-3, Hydrometer

US EPA ARCHIVE DOCUMENT

Grain Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.6	11.7	43.0	43.3

TEST RESULTS (ASTM D 422)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	100.0		
#20	99.7		
#40	99.4		
#60	97.7		
#100	94.5		
#200	87.7		
0.0515 mm.	83.8		
0.0377 mm.	79.7		
0.0270 mm.	77.2		
0.0180 mm.	68.2		
0.0109 mm.	59.0		
0.0080 mm.	51.7		
0.0058 mm.	46.0		
0.0027 mm.	35.1		
0.0013 mm.	27.8		

* (no specification provided)

Material Description

Gray and brown lean clay

Atterberg Limits (ASTM D 4318)

PL= 25 LL= 46 PI= 21

Classification

USCS (D 2487)= CL AASHTO (M 145)= A-7-6(27)

Coefficients

D_{90}= 0.0950 D_{85}= 0.0572 D_{60}= 0.0114
D_{50}= 0.0075 D_{30}= 0.0016 D_{15}=
D_{10}= C_u= C_c=

Remarks

Moisture Content: 31.9%

Date Received: 10-15-09 Date Tested: 10-15-09
Tested By: RS
Checked By: [signature]
Title:

Source of Sample: B-0906 Depth: 22.0'-24.0' Date Sampled:
Sample Number: UD-6

MACTEC ENGINEERING AND CONSULTING, INC.

Client: American Electric Power
Project: Dike Drilling
Project No: 3050090131.02 Jax, FL

Checked By: RDR 11-13-09

US EPA ARCHIVE DOCUMENT

MACTEC
MACTEC ENGINEERING AND CONSULTING, INC
22010 Commerce Drive
Abingdon, Virginia 24211
(276) 676-0426

Project Name: AEP Dike Drilling
Project Number: 5050-09-0331
Report Date: 11/09/09

Washed Particle Size/Gradation Test Report

ASTM D422

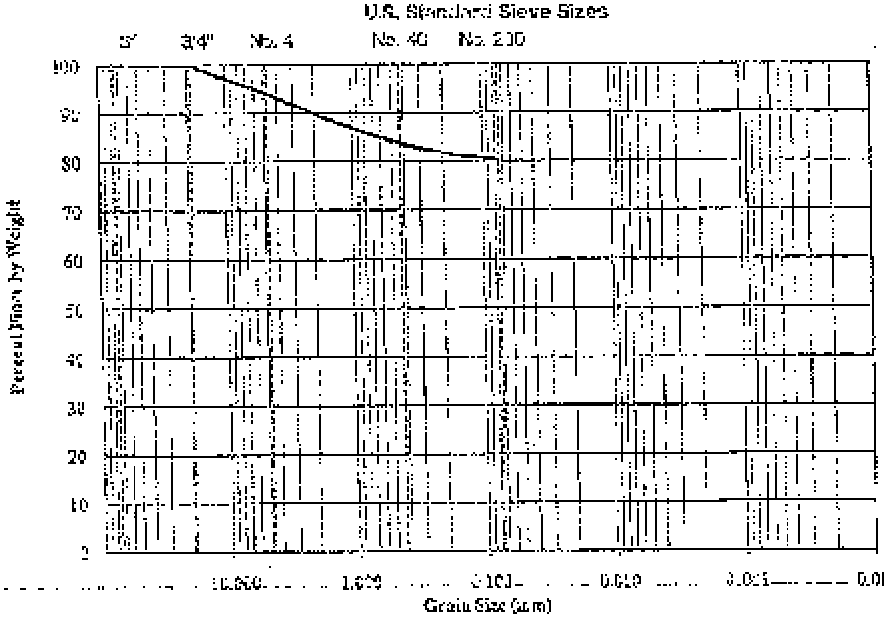
Sample Number: UD-13 **Location:** B-0903

Percent Finer than No. 200: 80.3 % (from washing)

Sieve Size	Cumulative (g)	Wt. Retained Each Sieve (g)	Cumulative % Passing	Cumulative % Passing w/ Wash 200
1 in.	0.00	0.00	100.0	100.0
3/4 in.	0.00	0.00	100.0	100.0
3/8 in.	13.17	13.17	85.4	97.0
# 4	26.65	13.48	69.5	94.0
# 10	44.64	17.98	49.0	89.9
# 20	60.72	16.08	30.6	86.3
# 40	72.45	11.73	17.2	83.7
# 60	78.74	6.29	10.1	82.3
# 100	83.09	4.35	5.1	81.3
#200	87.26	4.17	0.3	80.3
PAN	87.54	0.28		
Wt. of Soil, g	444.05			

Particle Size Analysis

U.S. Standard Sieve Sizes



Performed By: NCH 11-11-09 Checked By: RDR 11-11-09 D6913, C2413, Sieve

US EPA ARCHIVE DOCUMENT

MACTEC
MACTEC ENGINEERING AND CONSULTING, INC.
22010 Commerce Drive
Abingdon, VA 24211

Sieve Analysis Test Report
Hydrometer/Sieve
ASTM D422

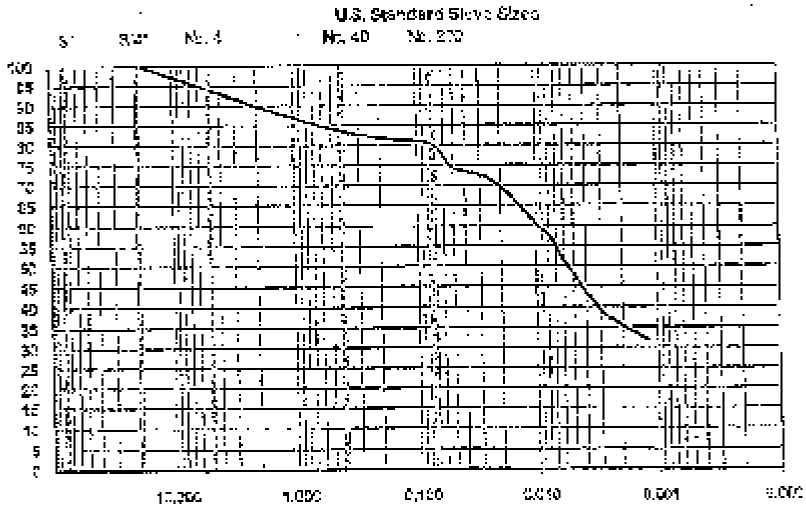
Project Name: ASP Dike Drilling
Project Number: 3050-08-0131
Report Date: 11/9/2009
Sample Number: 9-0208 UD-13

Sieve and Hydrometer

Particle Size	Units	Cumulative Wt. Retained (g)	Wt. Retained Each Sieve (g)	Cumulative % Passing
25.0	mm	0.00	0.0	100.0
19.0	mm	0.00	0.0	100.0
9.5	mm	13.17	13.2	97.0
4.8	mm	30.66	13.5	94.0
2.0	mm	44.64	18.0	89.9
850	um	60.72	16.1	86.3
425	um	72.45	11.7	83.7
250	um	78.74	6.3	82.3
150	um	83.09	4.4	81.3
75	um	87.28	4.2	80.3
52	um	[illegible]	[illegible]	74.7
37	um	[illegible]	[illegible]	73.3
28	um	[illegible]	[illegible]	71.9
17	um	[illegible]	[illegible]	67.9
10	um	[illegible]	[illegible]	60.0
7.6	um	[illegible]	[illegible]	56.7
5.5	um	[illegible]	[illegible]	43.8
3.9	um	[illegible]	[illegible]	39.7
1.3	um	[illegible]	[illegible]	33.5
Wt. of Soil, g		444.66		

Particle Size Analysis

U.S. Standard Sieve Sizes

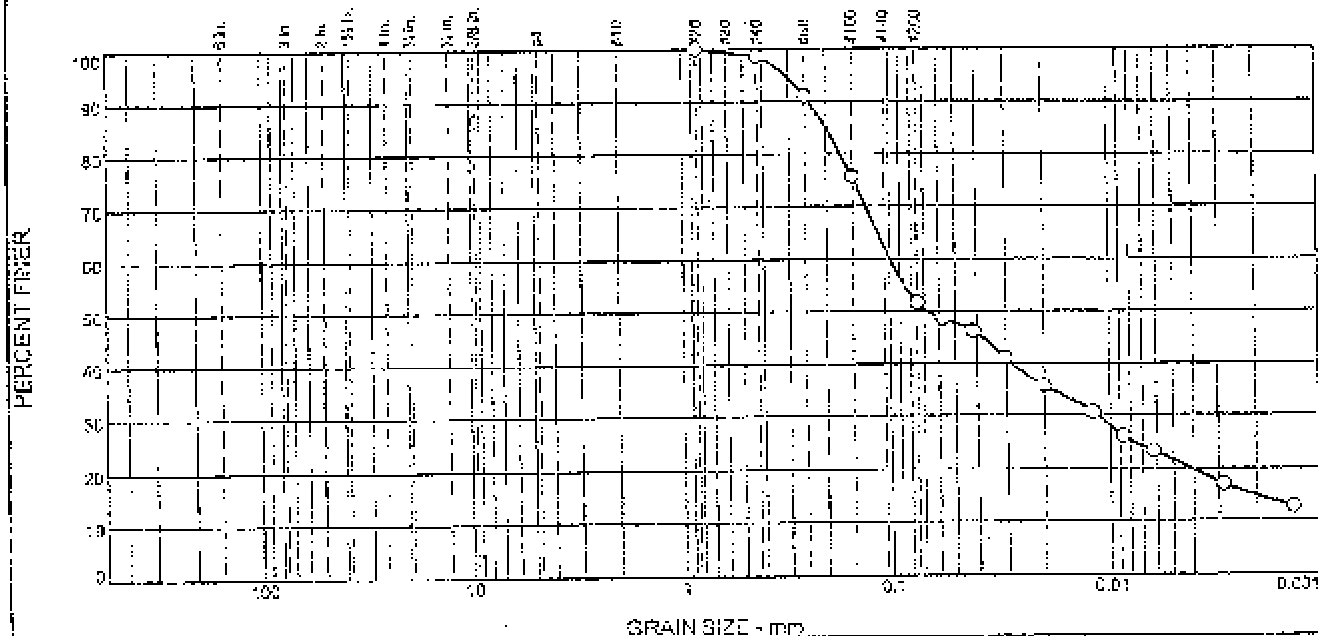


Performed by: NCH 11-11-09
Checked by: RDR 11-11-09

9-0208 UD-13 Hydrometer

US EPA ARCHIVE DOCUMENT

Grain Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.2	47.2	29.9	21.7

TEST RESULTS (ASTM D 422)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#20	100.0		
#40	98.5		
#60	91.1		
#100	75.6		
#200	51.6		
0.0573 mm.	48.4		
0.0413 mm.	46.2		
0.0304 mm.	41.1		
0.0200 mm.	35.5		
0.0119 mm.	30.5		
0.0087 mm.	26.1		
0.0062 mm.	23.4		
0.0029 mm.	17.1		
0.0013 mm.	12.6		

* (no specification provided)

Material Description

Gray brown lean CLAY with sand

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= CL AASHTO (M 145)=

Coefficients

D_{90}= 0.2337 D_{85}= 0.1981 D_{60}= 0.1002
D_{50}= 0.0579 D_{30}= 0.0115 D_{15}= 0.0021
D_{10}= C_u= C_c=

Remarks

Moisture Content: 23.8%

Date Received: 10-15-09 Date Tested: 10-15-09

Tested By: FB

Checked By: [signature]

Title:

Source of Sample: B-0905 Date Sampled:
Sample Number: TD-16

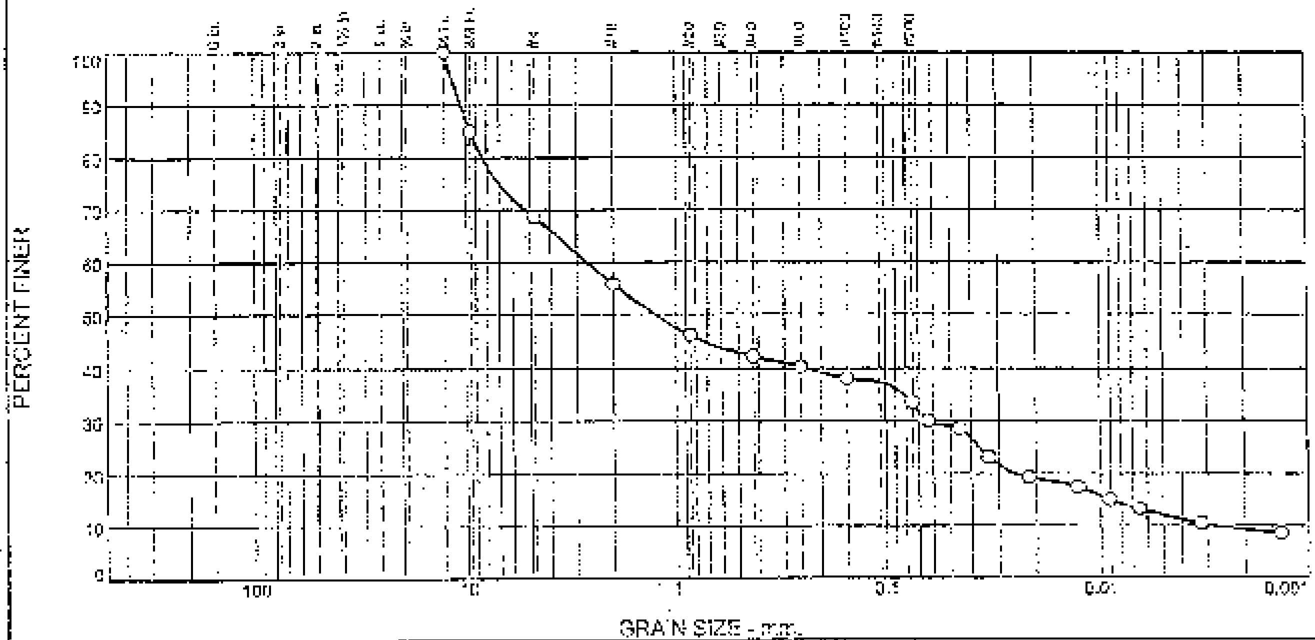
MACTEC ENGINEERING AND CONSULTING, INC.

Client: American Electric Power
Project: Dike Drilling
Project No: 3050090131.02 Jax FL

Checked By: *FDR 11-13-09*

US EPA ARCHIVE DOCUMENT

Grain Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	31.3	12.8	13.7	8.7	21.4	12.1

TEST RESULTS (ASTM D 422)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1/2"	100.0		
3/8"	85.0		
#4	68.7		
#10	55.9		
#20	46.1		
#40	42.2		
#60	40.3		
#100	35.1		
#200	33.5		
0.0631 mm.	30.0		
0.0452 mm.	28.5		
0.0333 mm.	23.2		
0.0216 mm.	19.3		
0.0126 mm.	17.4		
0.0091 mm.	15.0		
0.0065 mm.	13.2		
0.0032 mm.	10.4		
0.0013 mm.	8.5		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits (ASTM D 4318)

PL= 20 LL= 32 PI= 12

Classification

USCS (D 2487)= SC AASHTO (M 145)= A-2-6(0)

Coefficients

D_{85}= 10.5802 D_{60}= 9.5286 D_{60}= 2.6520
D_{50}= 1.2417 D_{30}= 0.0631 D_{15}= 0.0090
D_{10}= 0.0028 C_u= 950.65 C_c= 0.54

Remarks

Moisture content 14.1%

Date Received: 10-15-09 Date Tested: 10-15-09

Tested By: RS

Checked By: Rami Suleiman

Title:

Source of Sample: B-0908A Date Sampled:
Sample Number: UD-2

MACTEC ENGINEERING, AND CONSULTING, INC.

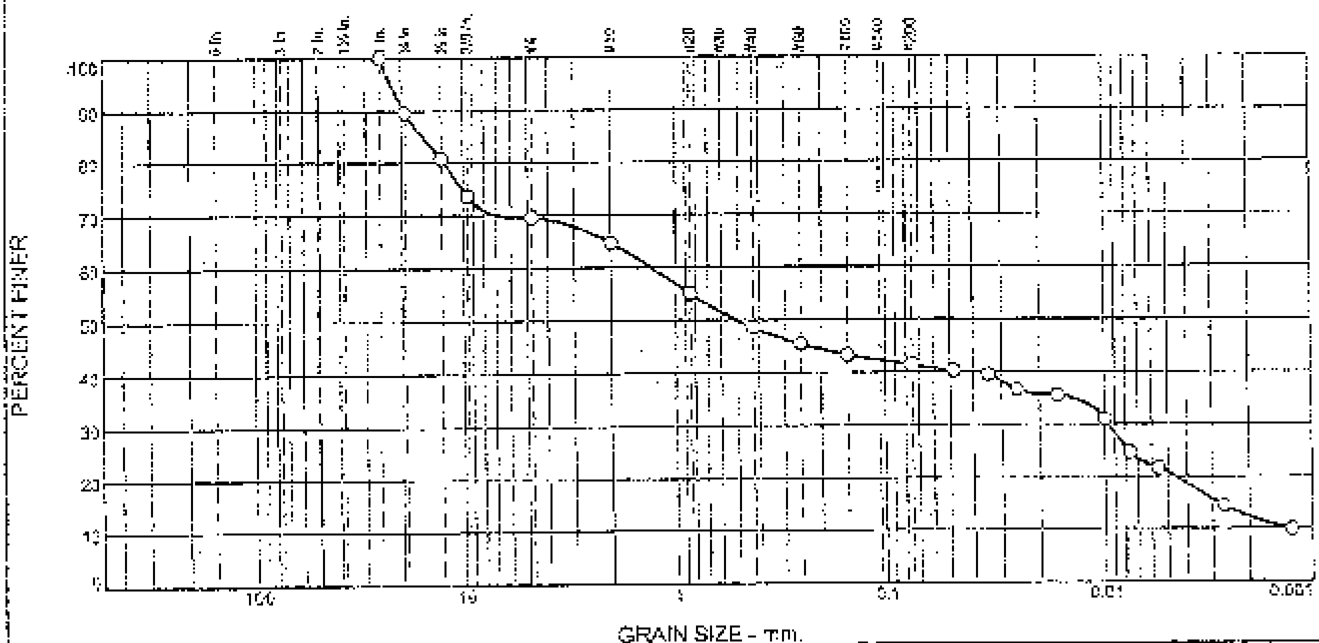
Client: American Electric Power
Project: Dike Drilling

Project No: 3050090131.02 Jax FL.

Checked By: RDR 11-13-09

US EPA ARCHIVE DOCUMENT

Grain Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.4	20.1	4.9	16.1	7.1	20.5	20.9

TEST RESULTS (ASTM D 422)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
3/4"	89.6		
1/2"	80.7		
3/8"	73.6		
#4	69.5		
#10	64.6		
#20	55.0		
#40	48.5		
#60	45.5		
#100	43.3		
#200	41.4		
0.0479 mm.	40.4		
0.0343 mm.	39.6		
0.0253 mm.	36.6		
0.0163 mm.	35.5		
0.0100 mm.	31.0		
0.0076 mm.	24.5		
0.0055 mm.	21.7		
0.0026 mm.	14.4		
0.0013 mm.	9.9		

* (no specification provided)

Material Description

Clayey silty gravel with sand

Atterberg Limits (ASTM D 4318)

PL= 25 LL= 35 PI= 10

Classification

USCS (D 2487)= GM AASHTO (M 145)= A-4(1)

Coefficients

D_{90}= 19.3229 D_{85}= 15.0615 D_{60}= 1.3038
D_{50}= 0.5131 D_{30}= 0.0093 D_{15}= 0.0020
D_{10}= 0.0013 C_u= 1020.02 C_c= 0.05

Remarks

Moisture Content: 17.3%

Date Received: 10-21-09 Date Tested: 10-21-09

Tested By: FD

Checked By:

Title:

Source of Sample: B-0909 Depth: 11.5-13.5' Date Sampled:

Sample Number: UD-3

MACTEC ENGINEERING AND CONSULTING, INC.

Client: American Electric Power
Project: Dike Drilling
Project No: 3050090131.02 Jax FL

Checked By: Rajni Sukumar

US EPA ARCHIVE DOCUMENT

MACTEC

22010 Commerce Drive
Abingdon, Va. 24211
(276) 676-0426
(276) 676-0761

Moisture Content, %

Project Name: Aep Dike Drilling
Project Number: 3050-09-0131
Date: 11/9/2009

Boring #	B-0911	B-0904	B-0906	B-0928	B-0908	B-0908		
Sample #	UD-6	UD-15	UD-1	UD-8	UD-13	UD-15		
Depth								
Tare + Wet	111.35	232.40	189.20	272.70	315.70	222.60		
Tare + Dry	96.70	185.22	163.05	239.14	261.45	176.53		
Water (w/w)	14.65	47.18	26.15	33.56	54.25	46.07		
Tare	8.13	7.97	8.20	8.44	8.38	8.38		
Dry Soil (w/s)	88.57	177.25	154.85	230.70	253.07	168.15		
Moisture, %	16.5	26.6	16.9	14.5	21.4	27.4		

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

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

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

Performed By: NCH 11-13-09 Checked By: RDR 11-9-09

US EPA ARCHIVE DOCUMENT

MACTEC

REPORT OF SOIL PERMEABILITY TESTING

Project: AEP Dike Drilling | Project Number: 3050-09-0131.02

Client: AEP | Date Completed: October 22, 2009

Sample Number: B-0904 UD-5

Sample Information:

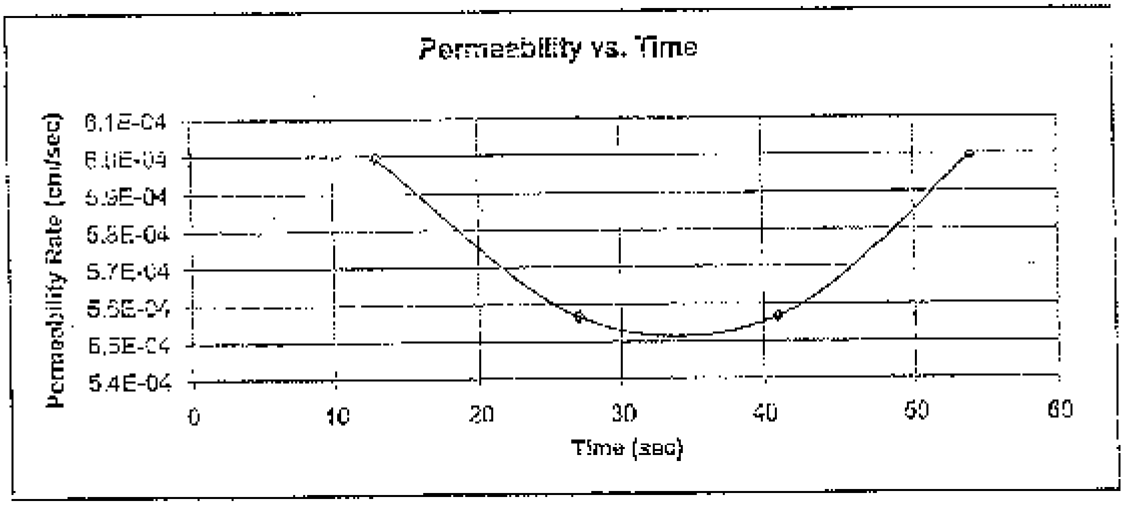
Dia. (in.)	4.00	Length (in)	2.84	Weight (gr)	604.3
Wet Density (pcf)	64.6	Moisture Content (%)	16.0	Dry Density (pcf)	54.7

Test Parameters

Test Method Used:	ASTM D-5084, method A	Permeant Fluid:	De-aired water
Maximum Hydraulic Gradient:	2.9	Minimum Hydraulic Gradient	1.3
Maximum Consolidation Stress (psi)	5	Minimum Consolidation Stress (psi)	5

Permeability Rate

5.8E-04



Reviewed By:

Rajni Sukhwani

MACTEC Engineering and Consulting, Inc.
3901 Carmichael Avenue
Jacksonville, Florida

US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

MACTEC

REPORT OF SOIL PERMEABILITY TESTING

Project: AEP Dike Drilling | **Project Number:** 3050-09-0151.02

Client AEP | **Date Completed:** October 22, 2009

Sample Number: B-3904 UD-3

Sample information:

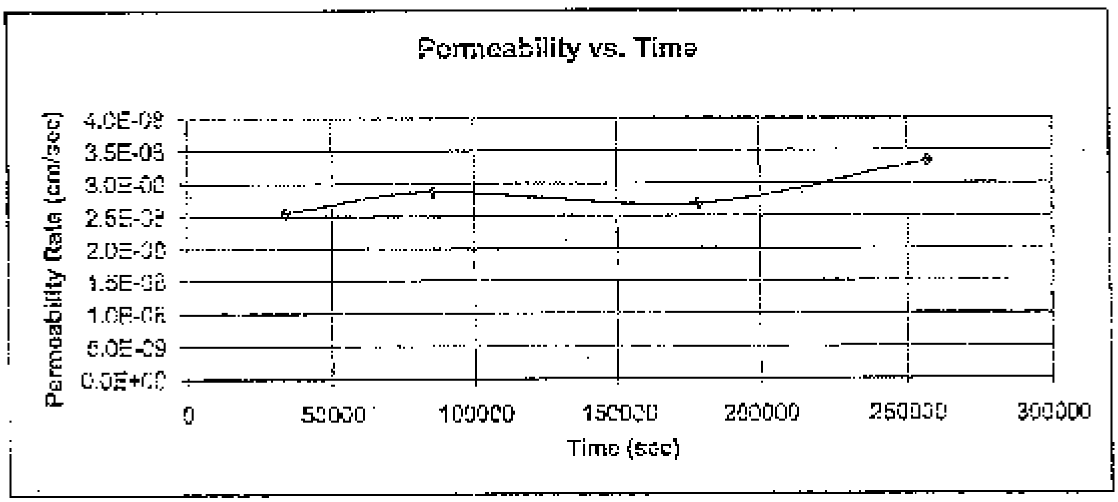
Dia. (in.)	2.84	Length (in)	3.86	Weight (gr)	838.6
Wet Density (pcf)	131.0	**Moisture Content (%)**	11.5	**Dry Density (pcf)**	117.4

Test Parameters

Test Method Used:	ASTM D-5084, method A	**Permeant Fluid:**	De-aired water
Maximum Hydraulic Gradient:	16.5	**Minimum Hydraulic Gradient**	8.3
Maximum Consolidation Stress (psi)	5	Minimum Consolidation Stress (psi)	5

Permeability Rate

2.9E-08



Reviewed By:

Rajani Sutkhusani

MACTEC Engineering and Consulting, Inc.
3901 Carmichael Avenue
Jacksonville, Florida

US EPA ARCHIVE DOCUMENT

MACTEC

REPORT OF SOIL PERMEABILITY TESTING

Project: AEP Dike Drilling

Project Number: 3050-09-0131.02

Client: AEP

Date Completed: October 22, 2009

Sample Number: B-0906 UD-16

Sample Information:

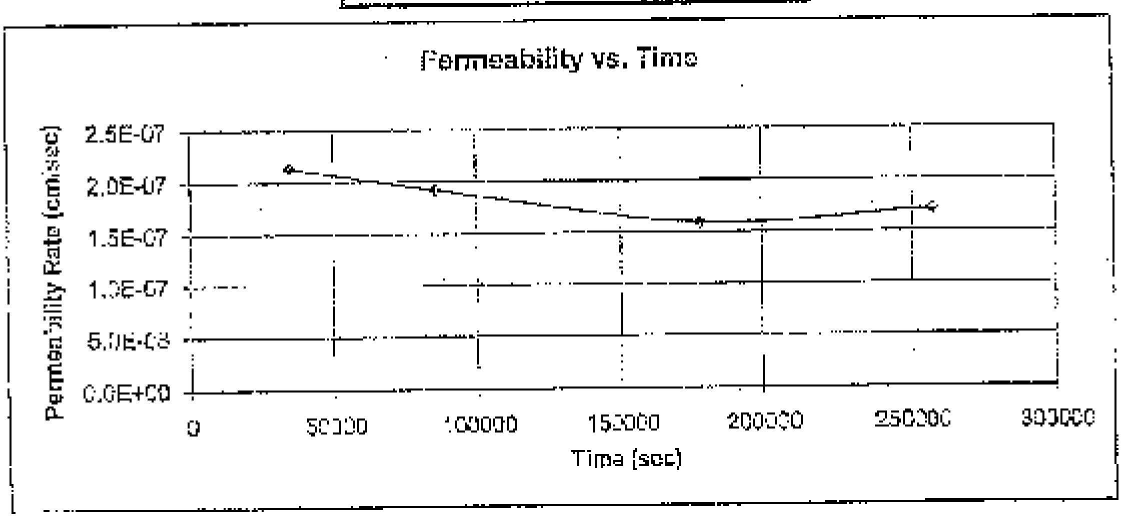
Dia. (in.)	2.85	Length (in)	4.56	Weight (gr)	939.1
Wet Density (pcf)	123.2	Moisture Content (%)	23.8	Dry Density (pcf)	99.5

Test Parameters

Test Method Used:	ASTM D-5084, method A	Permeant Fluid:	De-aired water
Maximum Hydraulic Gradient:	1.9	Minimum Hydraulic Gradient	0.9
Maximum Consolidation Stress (psi)	5	Minimum Consolidation Stress (psi)	5

Permeability Rate

1.8E-07



Reviewed By:

Rajni Sukhwani, E.I.

MACTEC Engineering and Consulting, Inc
3901 Carmichael Avenue
Jacksonville, Florida

MACTEC

22?10 Commerce Drive
Abingdon, Virginia 24211
Telephone: 276-679-0426 ~ Facsimile: 276-676-0761

Project Name: AEP Dike Drilling
Project Number: 3050-09-0131
Report Date: 11/09/09

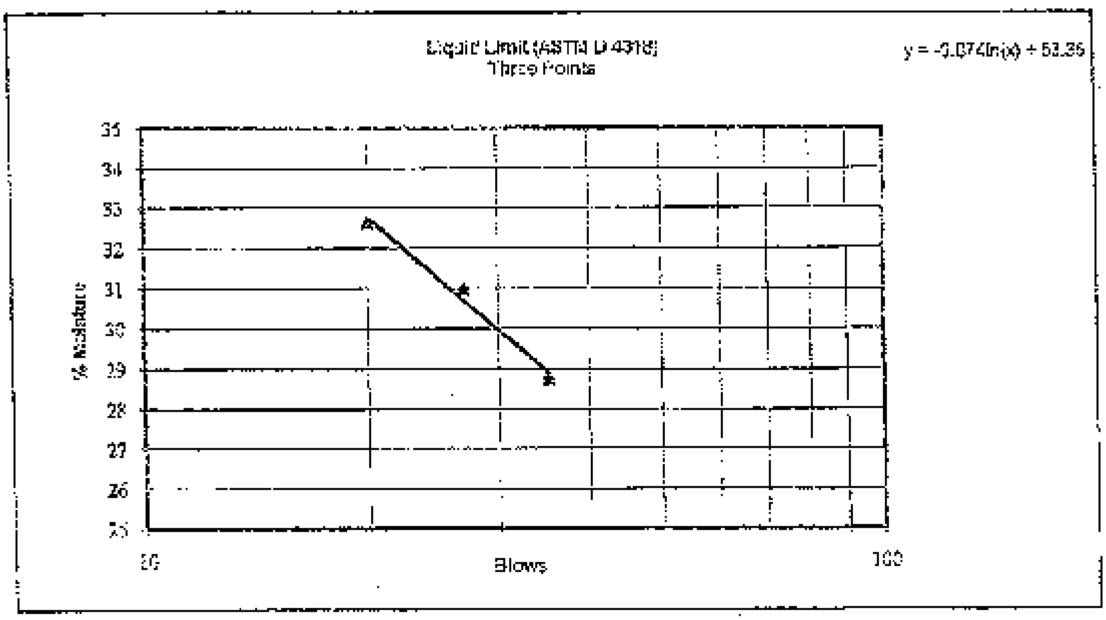
Soil Description: Yellowish Brown Silty SAND (SM)
10YR 5/4

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

Sample Number: B-0901
Depth (ft): UD-6 22.0' - 24.0'

Blows	% Moisture
35	28.8
27	31.0
20	32.6

Liquid Limit	Plastic Limit	Plasticity Index
31	24	7



Performed by: NCM 11-11-09 Checked by: RDR 11-11-09

US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

MACTEC

22010 Commerce Drive
Abingdon, Virginia 24211
Telephone: 276-676-0426 – Facsimile: 276-676-0781

Project Name: AEP Dike Drilling
Project Number: 3050-09-0131
Report Date: 11/09/09

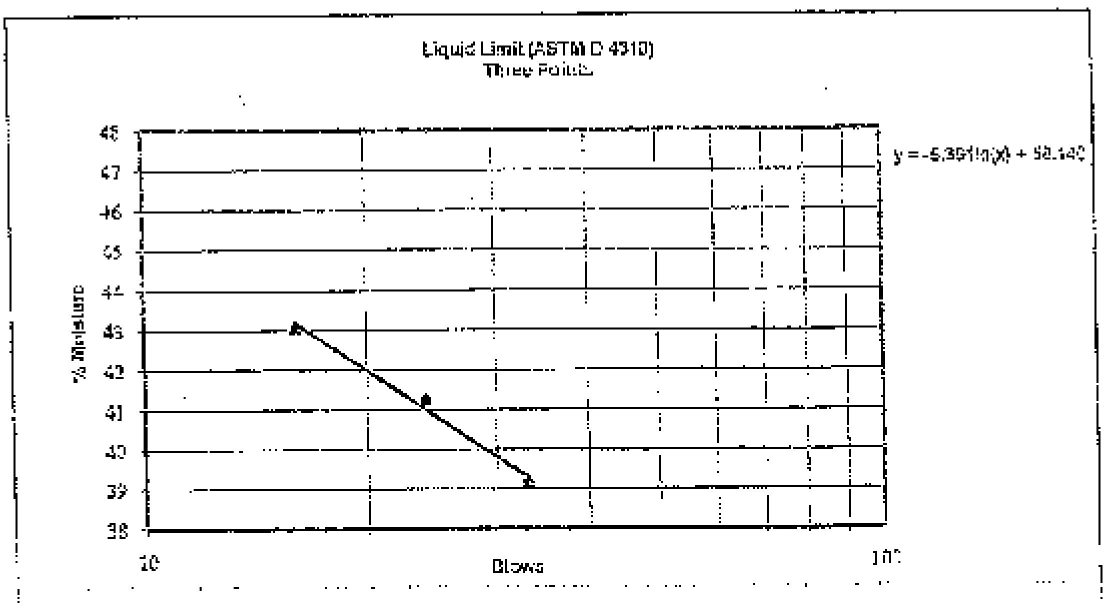
Soil Description: Light Olive Brown Clayey Sandy SILT (ML) 2.5y 5/3

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

Sample Number: B-0904
Depth (ft): UD-15 69.5' - 71.8

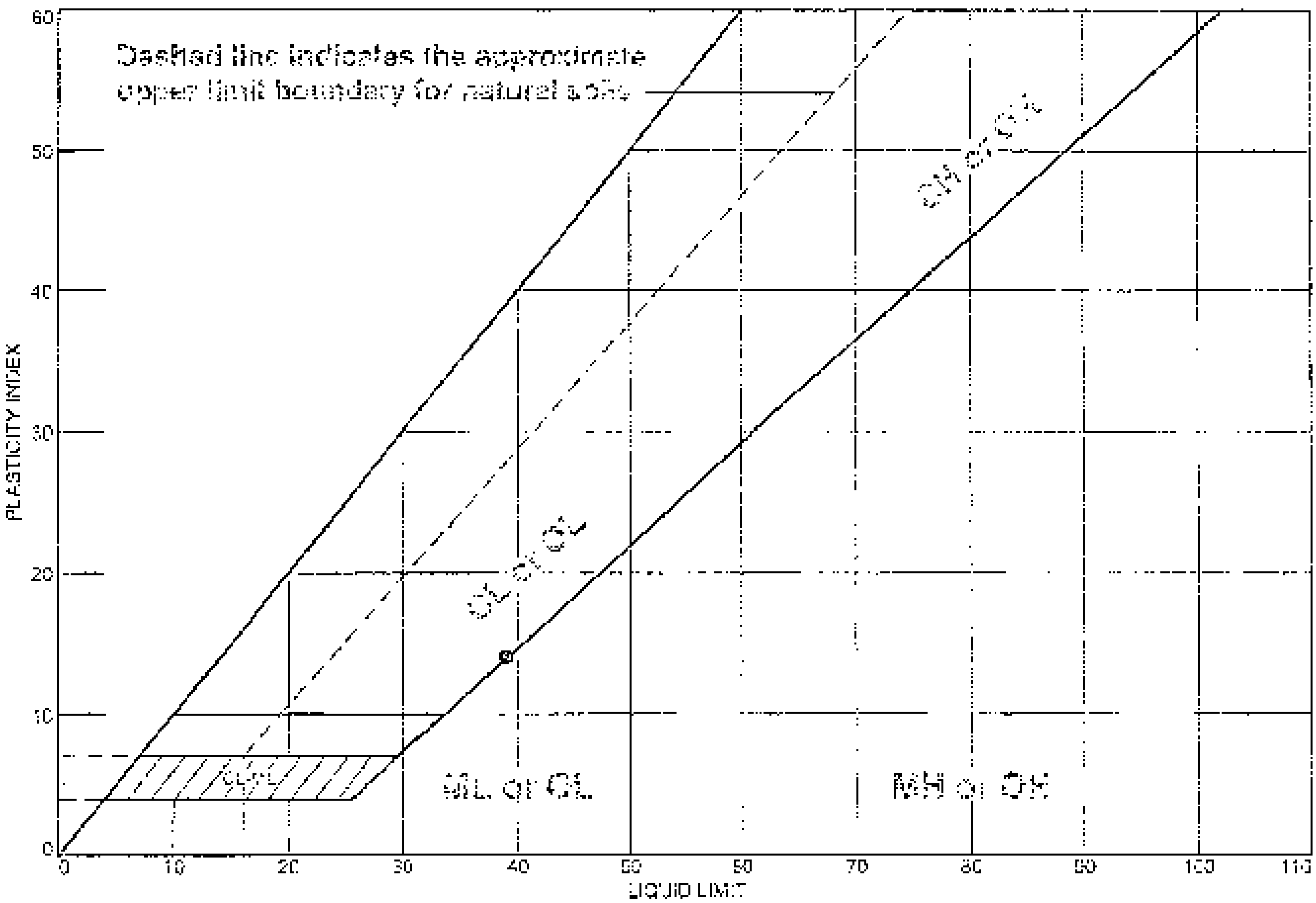
Blows	% Moisture
33	39.2
24	41.3
16	43.1

Liquid Limit	Plastic Limit	Plasticity Index
41	26	15



Performed by: MGH 11-11-09 Checked by: RDR 11-11-09

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray Clayey SAND	39	25	14	57.0	26.0	SC

Project No. 3050090131.02 **Client:** American Electric Power
Project: Dike Drilling

● **Source of Sample:** B-0905 **Depth:** 20.0'-22.0' **Sample Number:** UD-3

Remarks:
● Moisture Content: 15.2%

MACTEC ENGINEERING AND CONSULTING, INC.

Jax FL.

Tested By: FS **Checked By:** Rajni Sukhwani

US EPA ARCHIVE DOCUMENT

MACTEC
22010 Commerce Drive
Abingdon, Virginia 24211
Telephone: 276-676-0429 ~ Facsimile: 276-676-0751

Project Name: AEP Dike Drilling
Project Number: 3050-09-0131
Report Date: 11/09/09

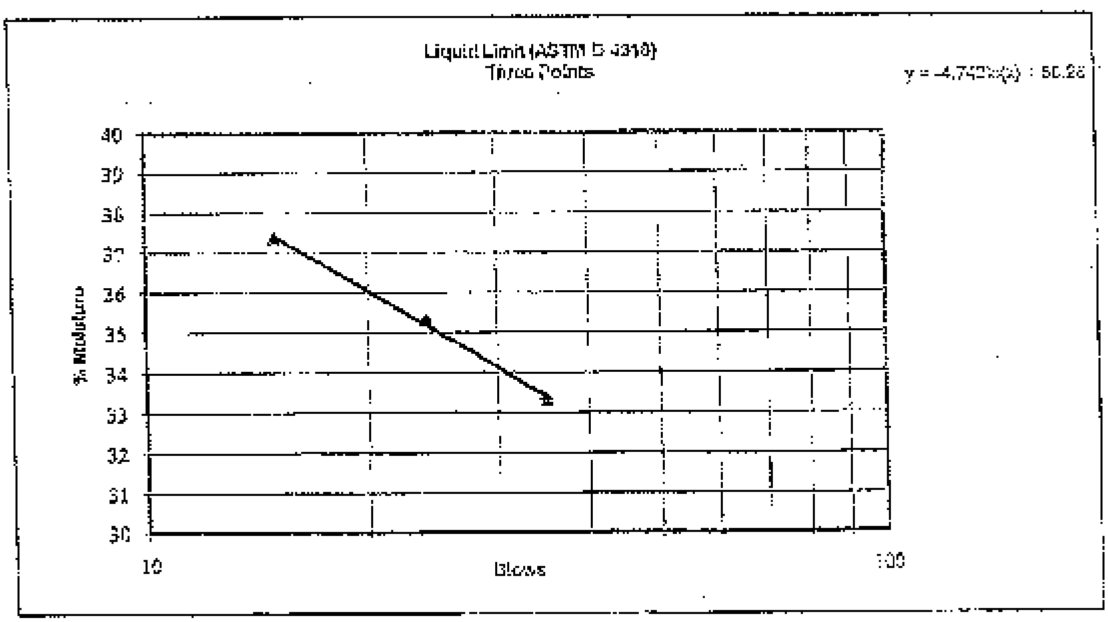
Soil Description: Very Dark Grayish Brown Lean CLAY with Sand (CL) 10YR 3/2

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

Sample Number: D-0908
Depth (ft): UD-8 42.5' - 44.5'

Blows	% Moisture
35	33.3
24	35.3
15	37.4

Liquid Limit	Plastic Limit	Plasticity Index
35	23	12



Performed by: *[handwritten initials] 11-11-09*   Checked by: *RDC 11-11-09*

US EPA ARCHIVE DOCUMENT

MACTEC

22010 Commerce Drive
Abingdon, Virginia 24211
Telephone: 276-676-0426 ~ Facsimile: 276-676-0761

Project Name: AEP Dike Drilling
Project Number: 3050-09-0131
Report Date: 11/09/09

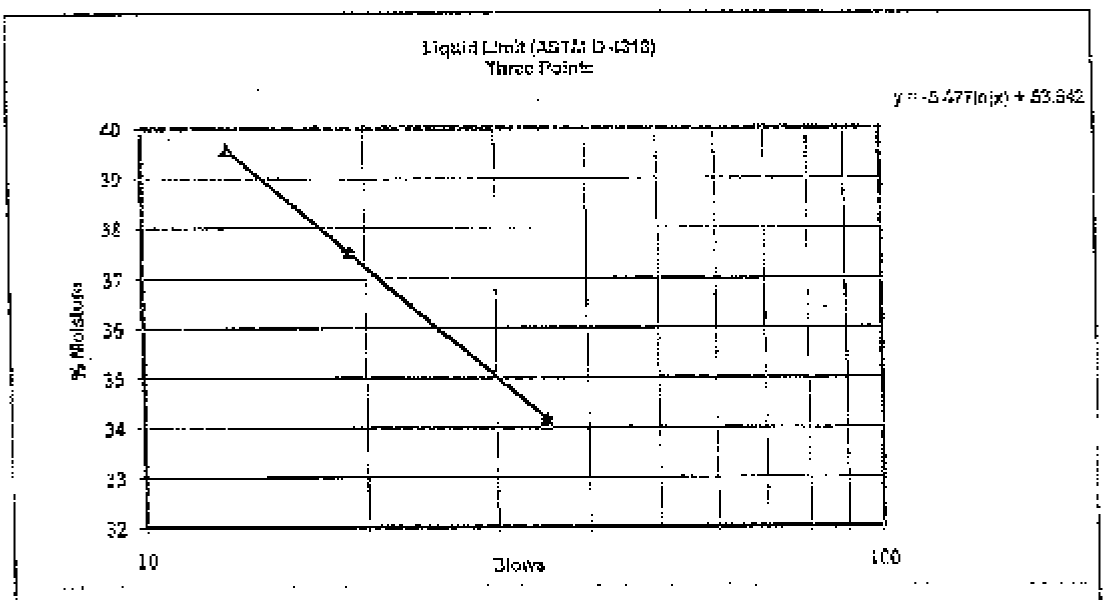
Soil Description: Grayish Brown Lean CLAY with Sand (CL) 2.5Y 5/2

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

Sample Number: B-0908
Depth (ft): UD-13 63.0' - 65.0'

Blows	% Moisture
35	34.2
19	37.5
13	39.6

Liquid Limit	Plastic Limit	Plasticity Index
36	24	12



Performed by: MEH 11-11-09

Checked by: RDR 11-11-09

US EPA ARCHIVE DOCUMENT

MACTEC

22010 Commerce Drive
Abingdon, Virginia 24211
Telephone: 276-676-0426 – Facsimile: 276-676-0761

Project Name: AEP Dike Drilling
Project Number: 3050-09-0131
Report Date: 11/09/09

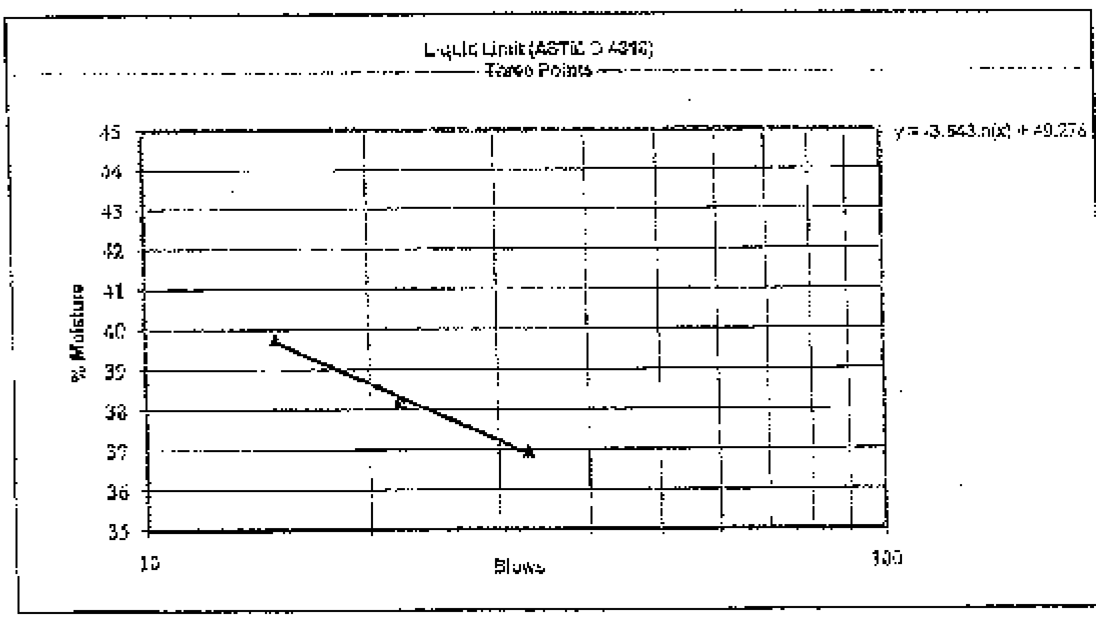
Soil Description: Dark Gray SILT with sand (ML)
2.5Y 4/1

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

Sample Number: B-0908
Depth (ft): UD-15 78.9 - 80.9'

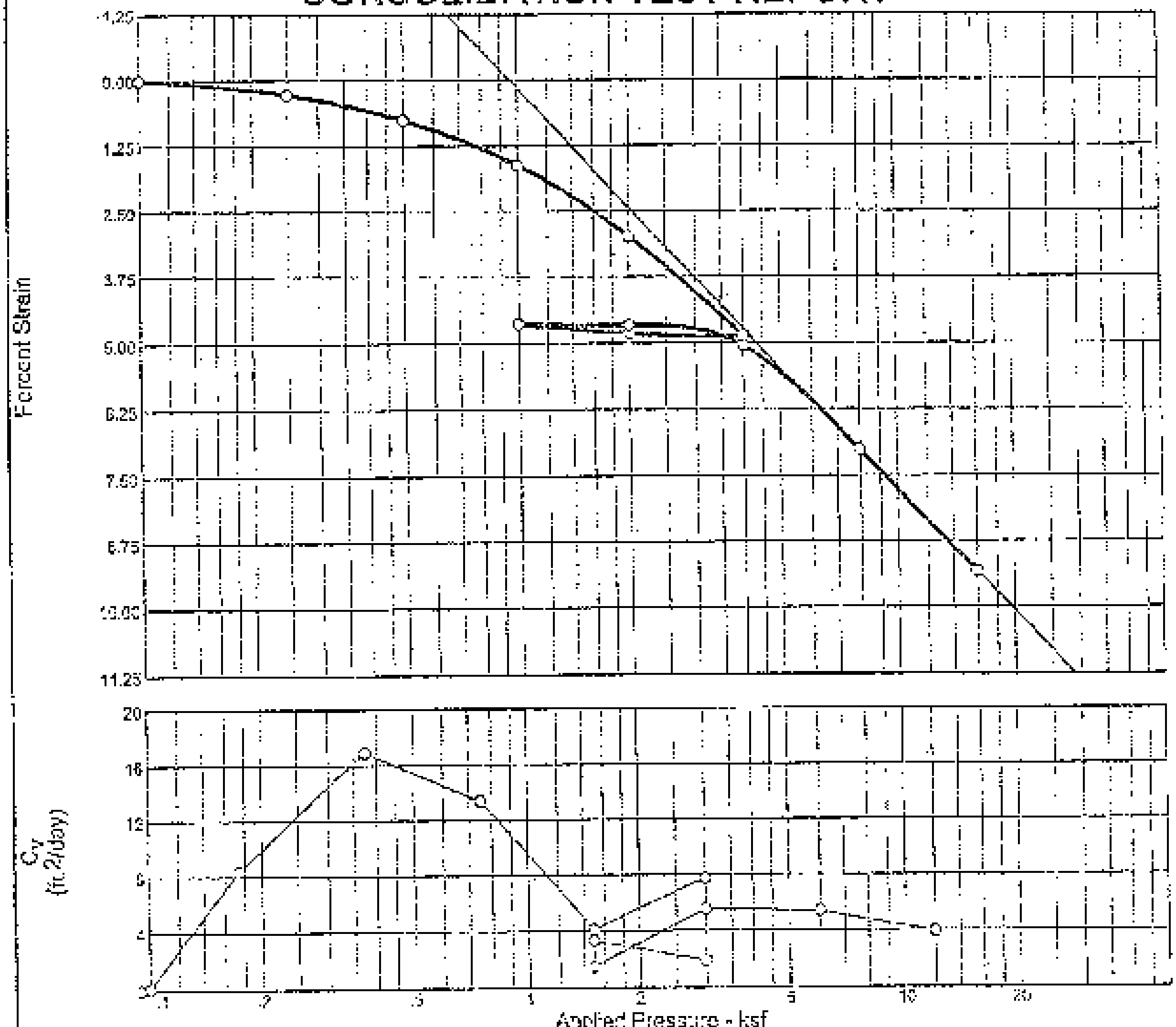
Blows	% Moisture
33	37.0
22	38.2
15	39.8

Liquid Limit	Plastic Limit	Plasticity Index
38	26	12



Performed by: NCK 11-11-09
Checked by: RDK 11-11-09

CONSOLIDATION TEST REPORT



MATERIAL DESCRIPTION	USCS	AASHTO
Brown clay with gravel		

LL	PI	Sp. Gr.	Overburden (ksf)	Dry Dens. (pcf) Init.	Dry Dens. (pcf) Final	Moisture Init.	Moisture Final	Saturation Init.	Saturation Final	Void Ratio Init.	Void Ratio Final	P_c (ksf)	C_c
		2.765		117.4		11.5 %	15.0 %	63.5 %	100.0 %	0.459	0.323	1.79	0.11

Preparation Process: Trimmed using cylindrical cutting ring	D2435 Method	C_r	Swell Press. (ksf)	Heave %
Condition of Test: Natural moisture, inundated at 0.05 ksf	B	0.01		

Project No. 3050090131.02 Client: American Electric Power

Project: Dike Drilling

Source: B-0904 Sample No.: UD-8 Elev./Depth: 36.0'-38.0'

CONSOLIDATION TEST REPORT

MACTEC ENGINEERING AND CONSULTING, INC.

Remarks:

Percent passing #200 sieve: 51.1%

Checked By:

Title: [signature]

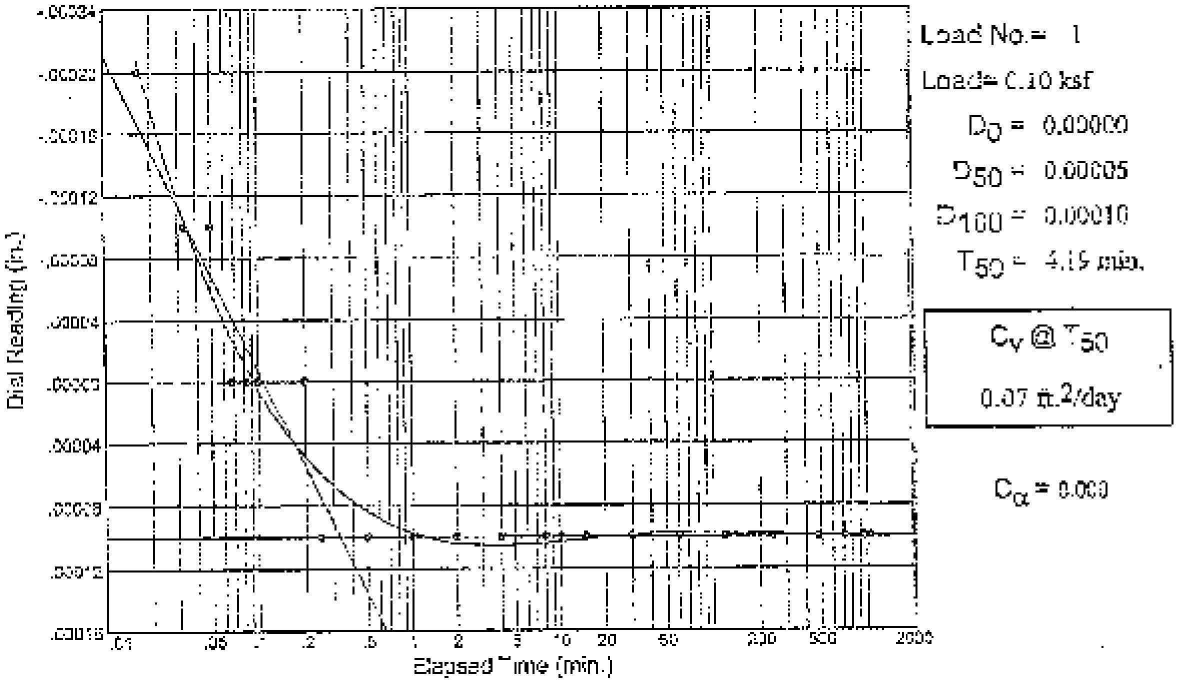
Jax FL

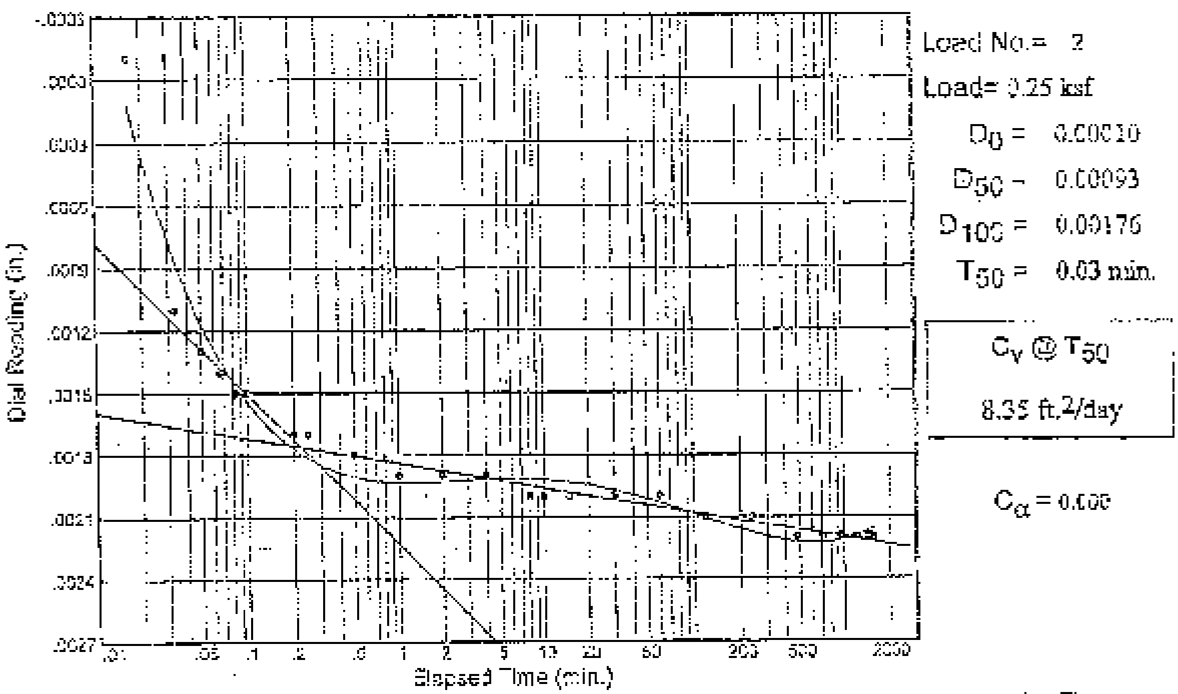
US EPA ARCHIVE DOCUMENT

Dial Reading vs. Time

Project No.: 3050-09-0131-02
Project: Dike Drilling

Source: B-0904 | Sample No.: UD-8 | Elev./Depth: 36.0'-38.0'





Jax FL.

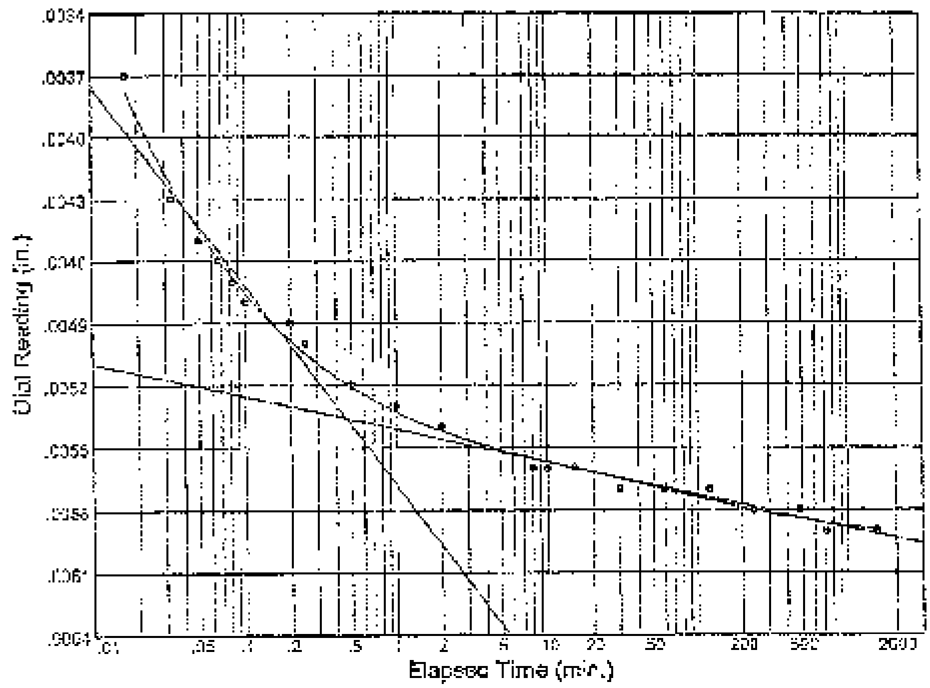
MACTEC Engineering and Consulting, Inc.

US EPA ARCHIVE DOCUMENT

Dial Reading vs. Time

Project No.: 3050-09-0131-02
Project: Dike Drilling

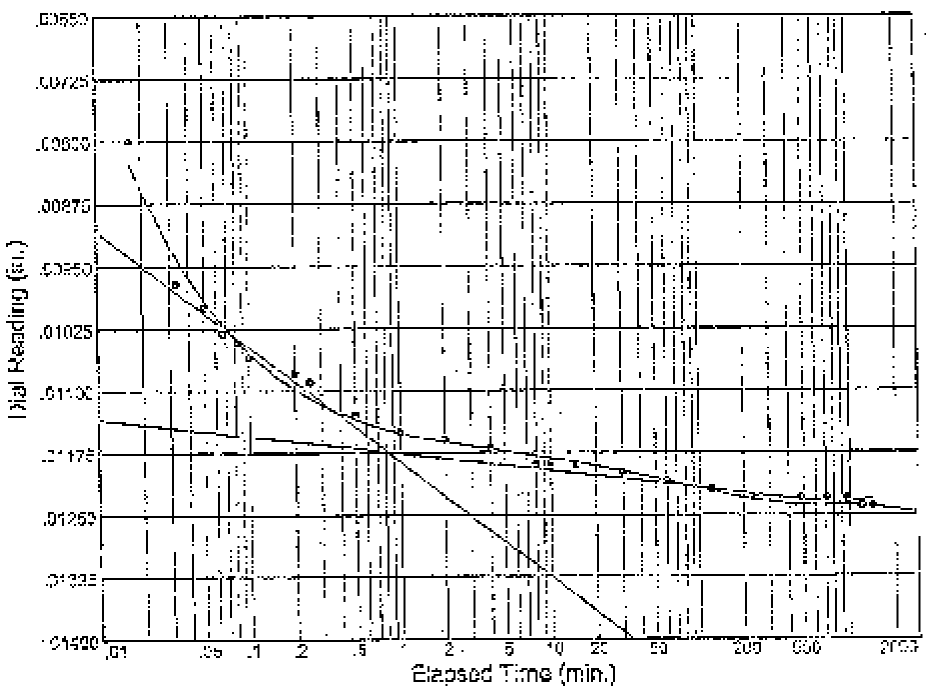
Source: B-0904 Sample No.: UD-3 Elev./Depth: 36.0-38.0'



Load No.= 3
Load= 0.50 ksf
D_0 = 0.00220
D_{50} = 0.00378
D_{100} = 0.00536
T_{50} = 0.02 min.

C_v @ T_{50}
16.91 ft.^{2}/day

C_α = 0.000



Load No.= 4
Load= 1.00 ksf
D_0 = 0.00560
D_{50} = 0.00867
D_{100} = 0.01175
T_{50} = 0.02 min.

C_v @ T_{50}
13.35 ft.^{2}/day

C_α = 0.000

Jax FL.

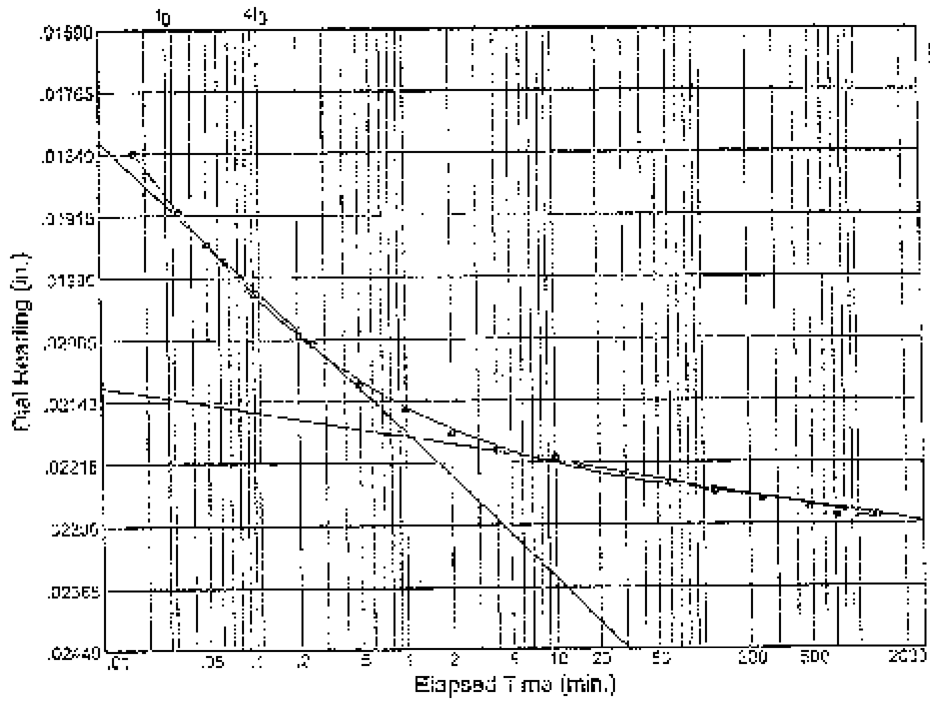
MACTEC Engineering and Consulting, Inc.

US EPA ARCHIVE DOCUMENT

Dial Reading vs. Time

Project No.: 3050-09-0131-02
Project: Dike Drilling

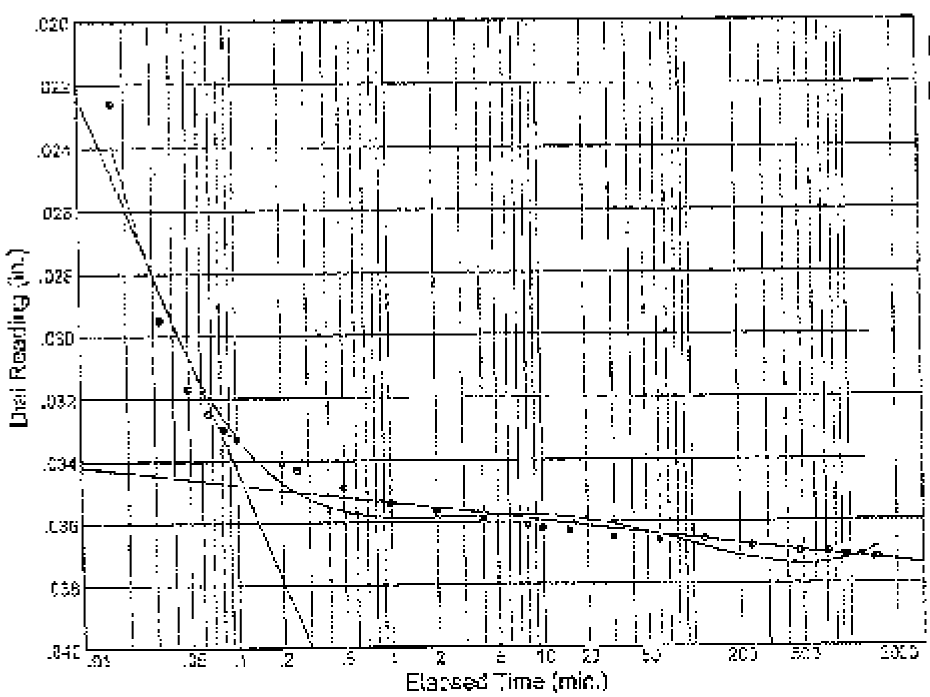
Source: B-0904 Sample No.: UD-8 Elev./Depth: 36.0-38.0'



Load No.= 5
Load= 2.00 ksf
D_0 = 0.01766
D_{50} = 0.01975
D_{100} = 0.02185
T_{50} = 0.07 min.

C_v @ T_{50}
4.10 ft.2/day

C_α = 0.000



Load No.= 6
Load= 4.00 ksf
D_0 = 0.02280
D_{50} = 0.02881
D_{100} = 0.03481
T_{50} = 0.03 min.

C_v @ T_{50}
7.75 ft.2/day

C_α = 0.001

Jax FL

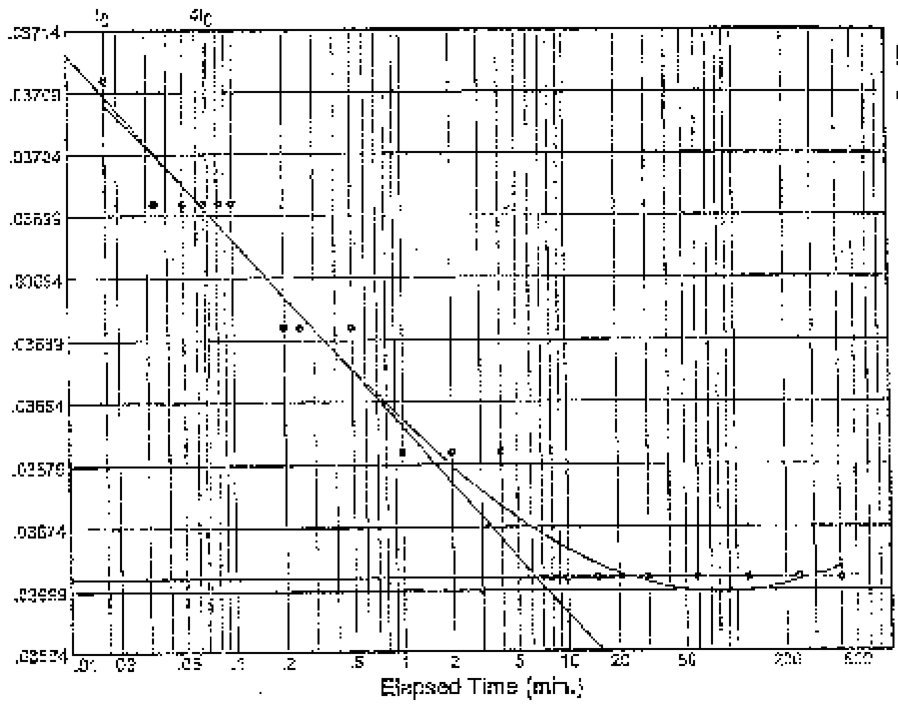
MACTEC Engineering and Consulting, Inc.

US EPA ARCHIVE DOCUMENT

Dial Reading vs. Time

Project No.: 3050-09-0131-02
Project: Dike Drilling

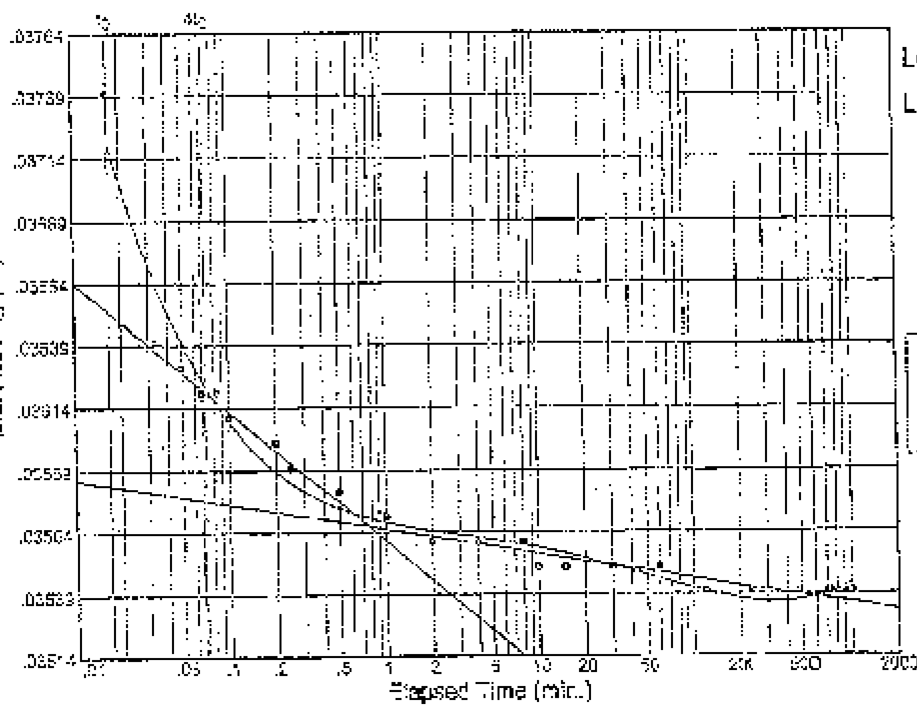
Source: D-0904 | Sample No.: UD-8 | Elev./Depth: 36.0'-38.0'



Load No.= 7
Load= 2.00 ksf
D_0 = 0.03720
D_{50} = 0.03695
D_{100} = 0.03670
T_{50} = 0.14 min.

C_v @ T_{50}
1.90 ft.^{2}/day

C_α = 0.000



Load No.= 8
Load= 1.00 ksf
D_0 = 0.03670
D_{50} = 0.03618
D_{100} = 0.03566
T_{50} = 0.08 min.

C_v @ T_{50}
3.32 ft.^{2}/day

Jax FL

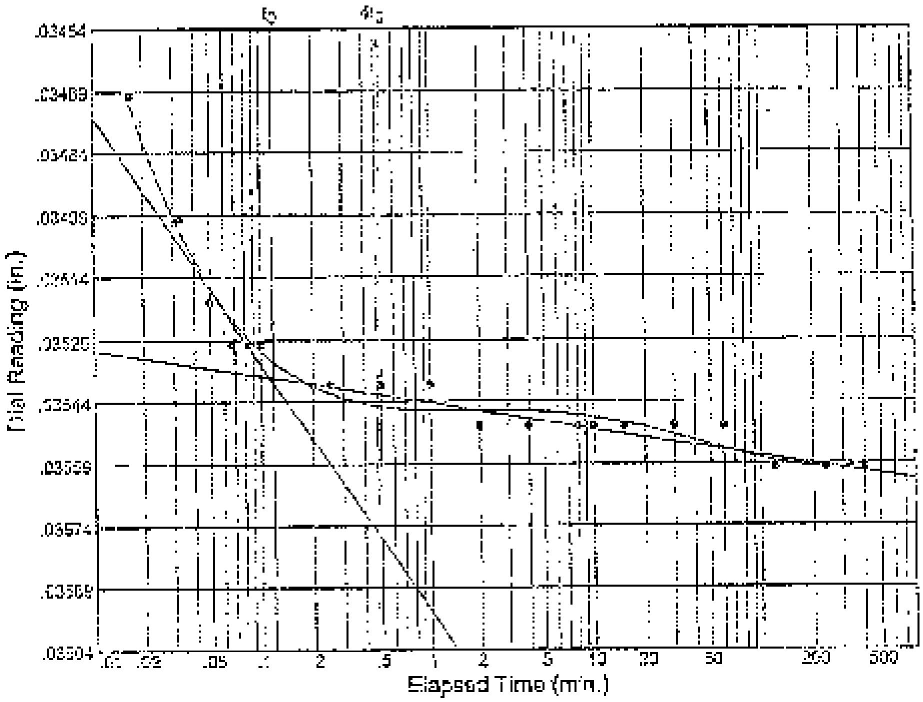
MACTEC Engineering and Consulting, Inc.

US EPA ARCHIVE DOCUMENT

Dial Reading vs. Time

Project No.: 3050-09-0131-02
Project: Dike Drilling

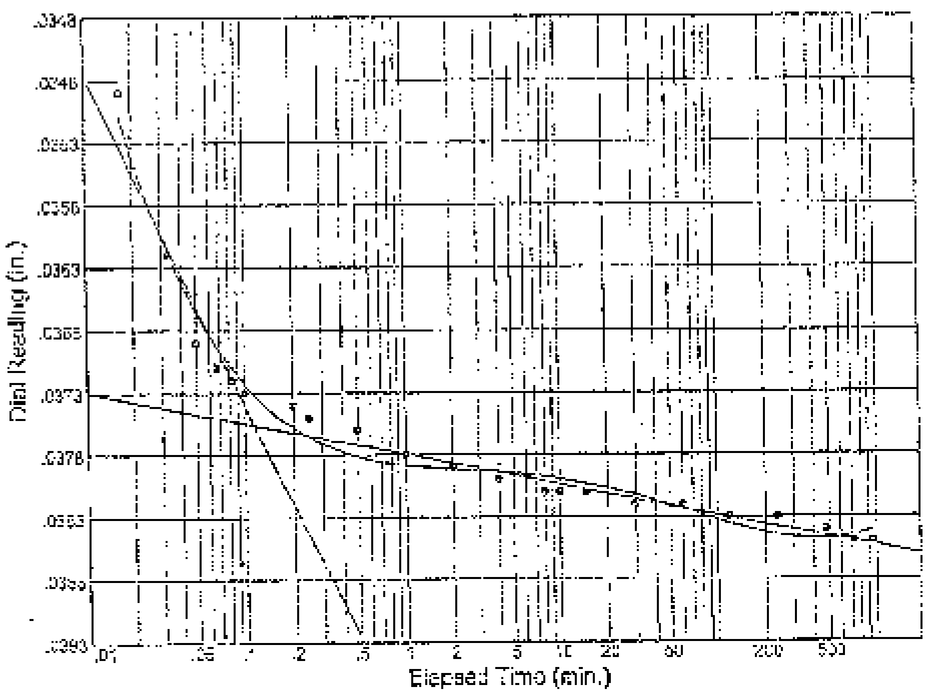
Source: B-0904 | Sample No.: UD-8 | Elev./Depth: 36.0-38.0'



Load No.= 9
Load= 2.00 ksf
D_0 = 0.03540
D_{50} = 0.03539
D_{100} = 0.03538
T_{50} = 0.18 min

C_v @ T_{50}
1.47 ft.2/day

C_α = 0.000



Load No.= 10
Load= 4.00 ksf
D_0 = 0.03560
D_{50} = 0.03655
D_{100} = 0.03756
T_{50} = 0.05 min.

C_v @ T_{50}
5.55 ft.2/day

C_α = 0.000

Jax FL

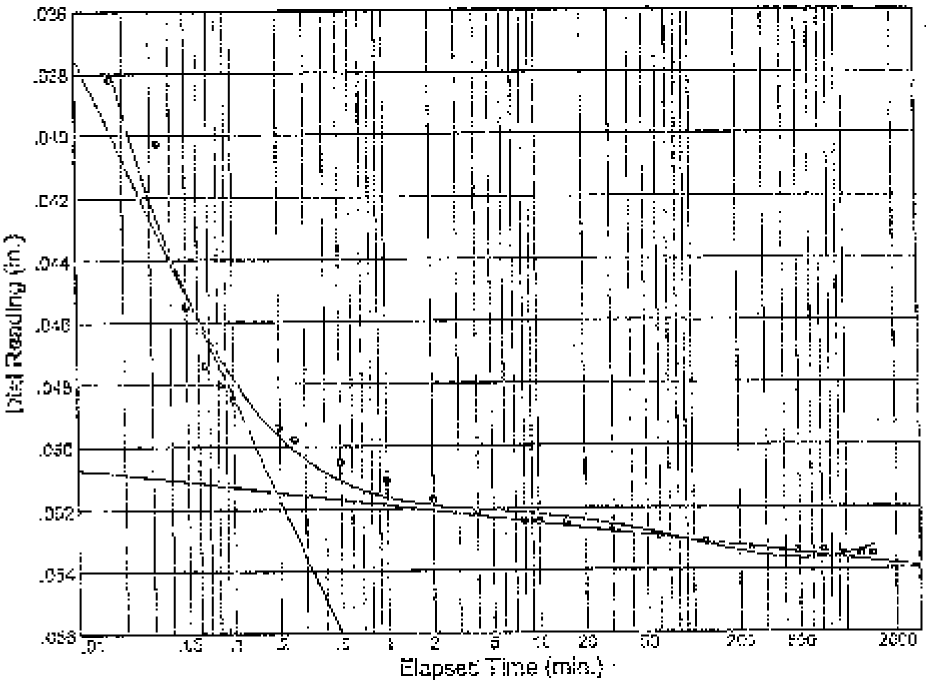
MACTEC Engineering and Consulting, Inc.

US EPA ARCHIVE DOCUMENT

Dial Reading vs. Time

Project No.: 3050-09-0131-02
Project: Dike Drilling

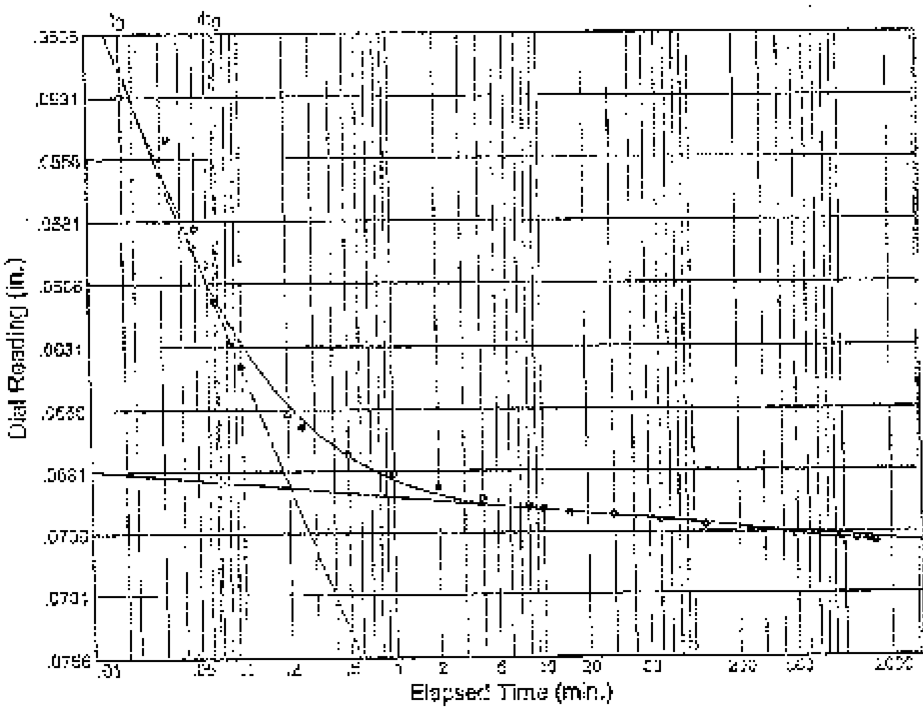
Source: B-0904 | Sample No.: UD-4 | Elev./Depth: 36.0-38.0'



Load No.= 11
Load= 8.00 ksf
D_0 = 0.03780
D_{50} = 0.04463
D_{100} = 0.05145
T_{50} = 0.05 min.

C_v @ T_{50}
5.40 ft.2/day

C_α = 0.001



Load No.= 12
Load= 16.00 ksf
D_0 = 0.05260
D_{50} = 0.06068
D_{100} = 0.06877
T_{50} = 0.06 min.

C_v @ T_{50}
3.93 ft.2/day

C_α = 0.001

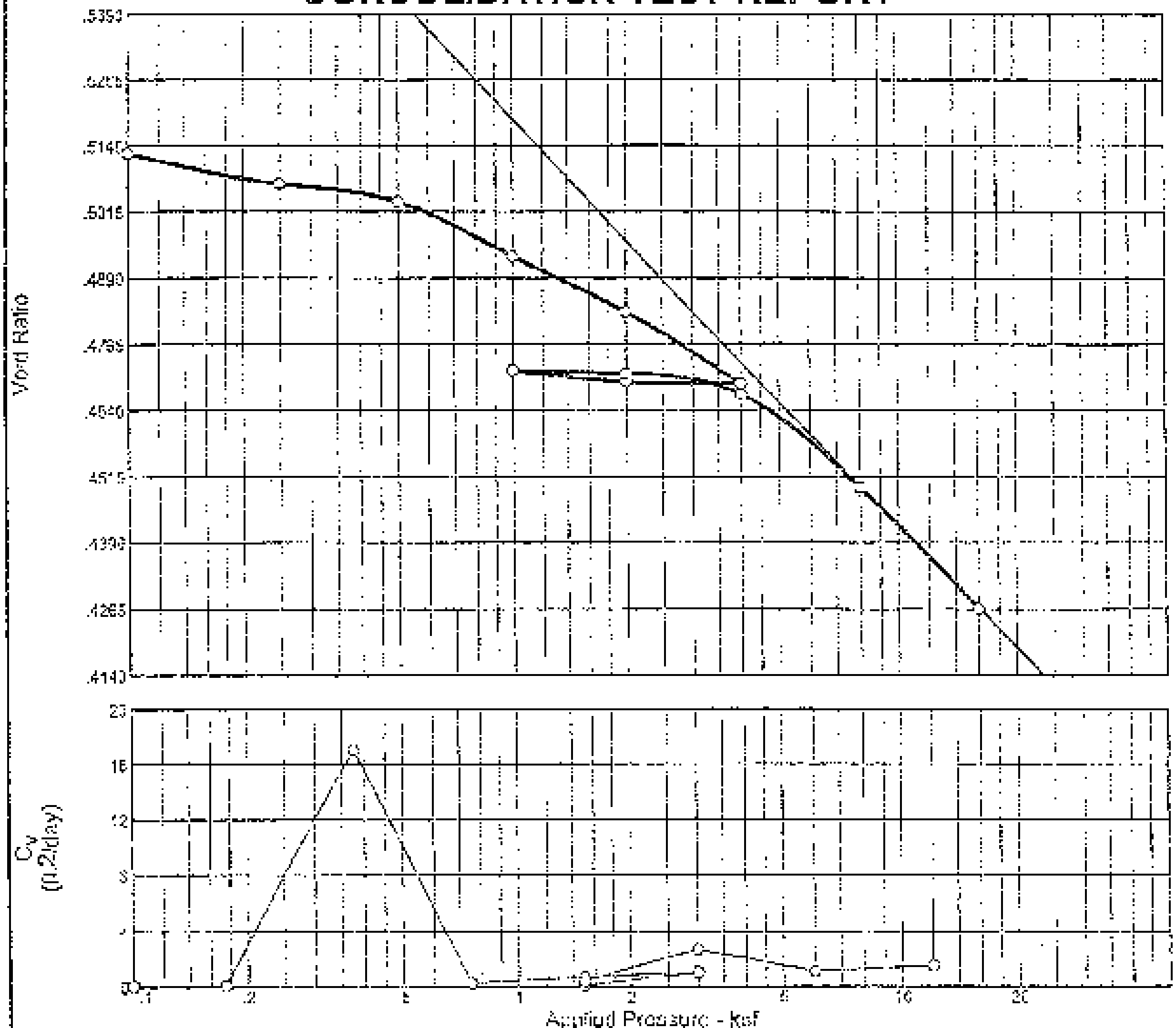
Jax FL

MACTEC Engineering and Consulting, Inc.

US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

CONSOLIDATION TEST REPORT



MATERIAL DESCRIPTION	USCS	AASHTO
Brown clay with gravel		

LL	PI	Sp. Gr.	Overburden (ksf)	Dry Dens. (pcf) Init.	Dry Dens. (pcf) Final	Moisture Init.	Moisture Final	Saturation Init.	Saturation Final	Void Ratio Init.	Void Ratio Final	P_c (ksf)	C_c
		2.656		110.7		19.2 %	16.9 %	100.0 %	100.0 %	0.515	0.427	1.95	0.08

Preparation Process: Trimmed using cylindrical cutting ring

Condition of Test: Natural moisture, inundated at 0.05 ksf

D2435 Method	C_r	Swell Press. (ksf)	Heave %
B	0.01		

Project No. 3050090131.02 Client: American Electric Power

Project: Dike Drilling

Source: B-0904 Sample No.: UD-11 Elev./Depth: 52.0'-54.0'

CONSOLIDATION TEST REPORT

MACTEC ENGINEERING AND CONSULTING, INC.

Remarks:

Percent passing #200 sieve: 75.5%

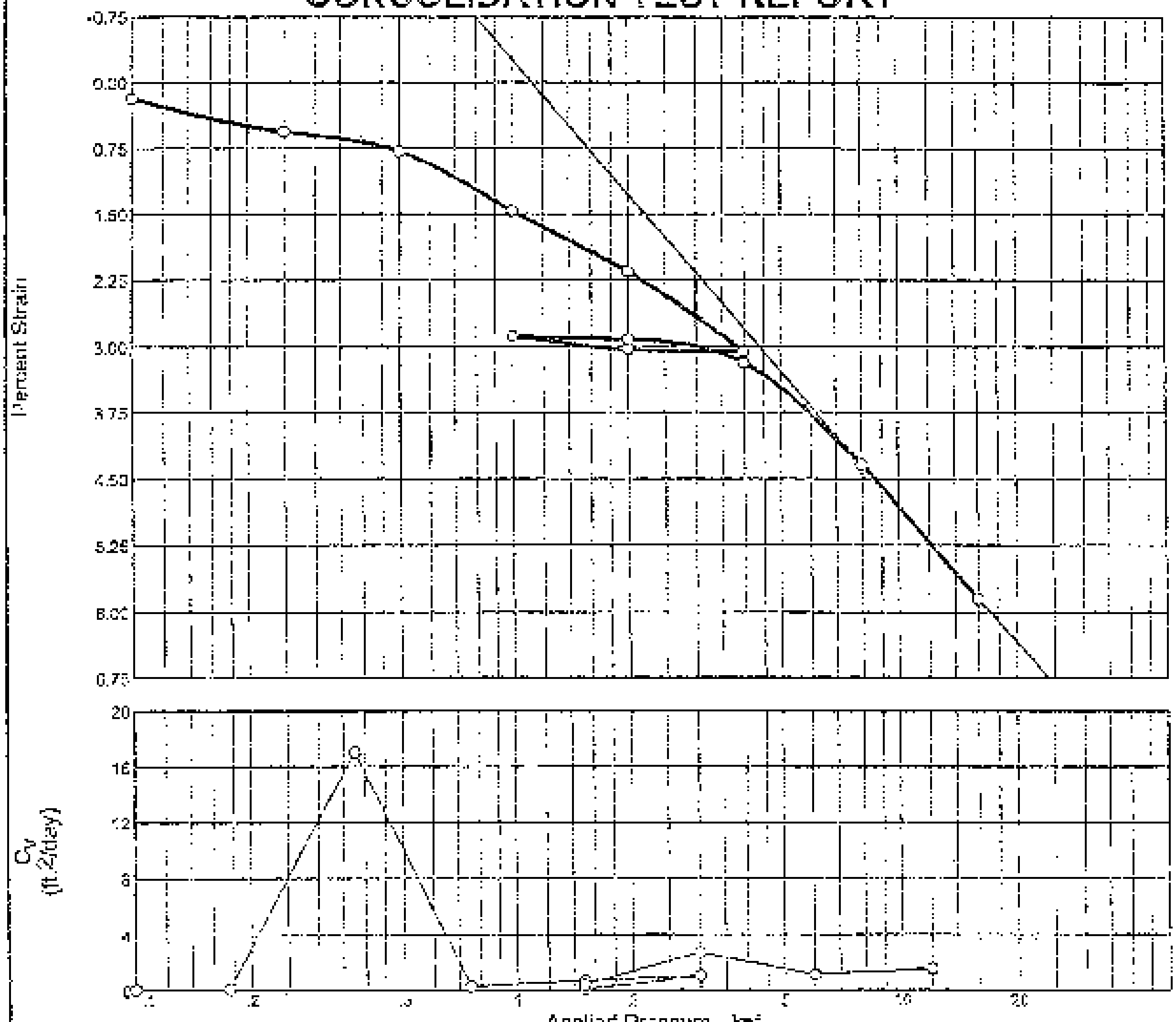
Checked By:

Title:

Jax FL.

US EPA ARCHIVE DOCUMENT

CONSOLIDATION TEST REPORT



MATERIAL DESCRIPTION	USCS	AASHTO
Brown clay with gravel		

LL	PI	Sp. Gr.	Overburden (ksf)	Dry Dens. (pcf) Init.	Dry Dens. (pcf) Final	Moisture Init.	Moisture Final	Saturation Init.	Saturation Final	Void Ratio Init.	Void Ratio Final	P_c (ksf)	C_c
		2.686		110.7		19.2 %	16.5 %	100.0 %	100.0 %	0.515	0.427	3.06	0.09

Preparation Process: Trimmed using cylindrical cutting ring	D2435 Method	C_r	Swell Press. (ksf)	Heave %
Condition of Test: Natural moisture, inundated at 0.05 ksf	B	0.01		

Project No. 3050080151.02 Client: American Electric Power

Project: Dike Drilling

Source: B-0904 Sample No.: UD-11 Elev./Depth: 52.0'-54.0'

Remarks:

Percent passing #200 sieve: 75.5%

CONSOLIDATION TEST REPORT

MACTEC ENGINEERING AND CONSULTING, INC.

Checked By:

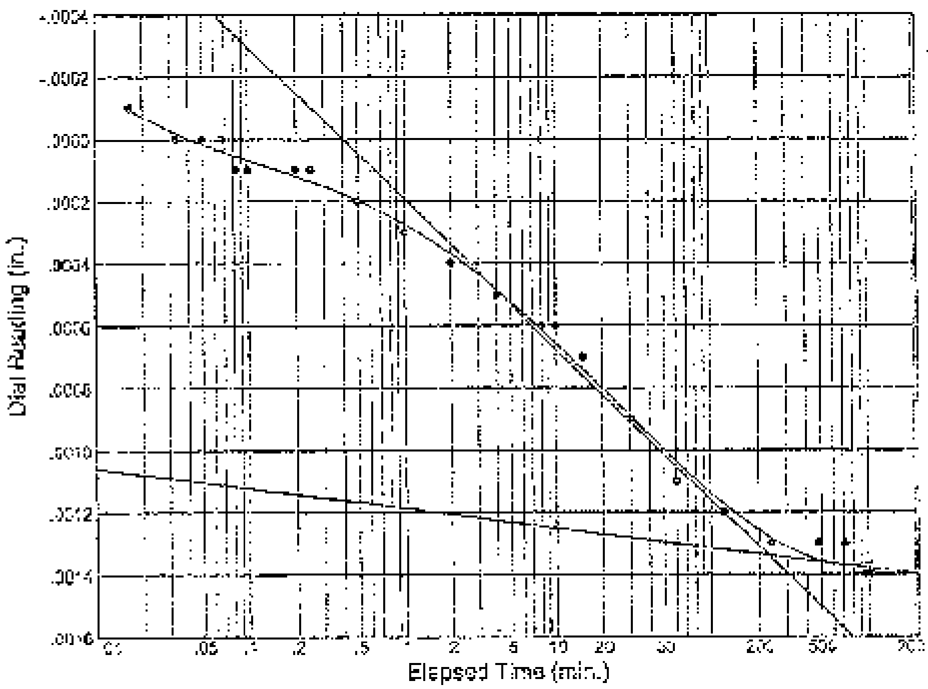
Title: [signature]

Jax FL.

Dial Reading vs. Time

Project No.: 3050390131.02
Project: Dike Drilling

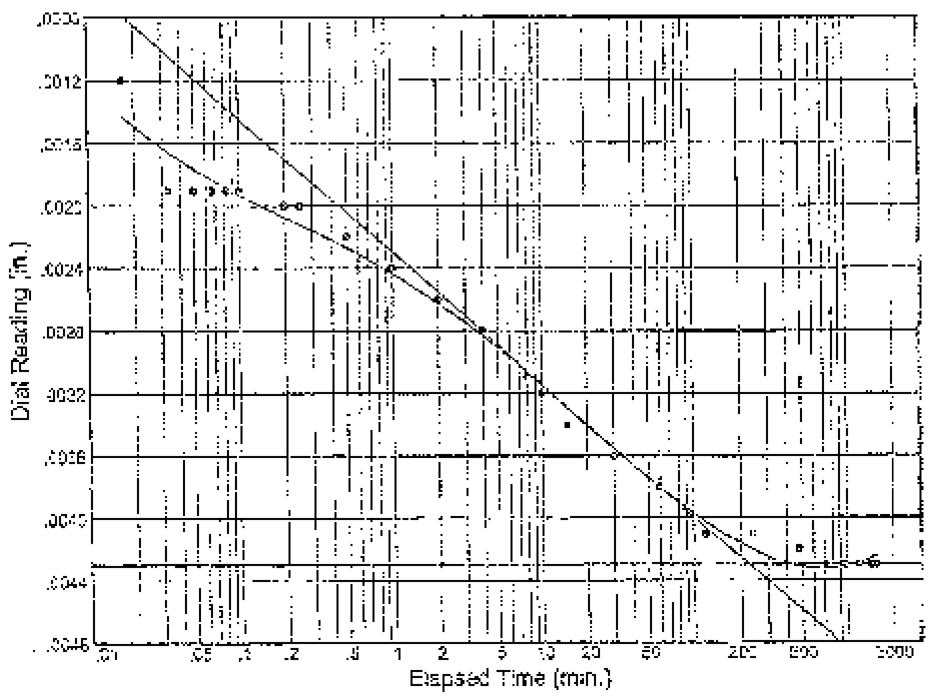
Source: B-0004 | Sample No.: UD-1 | Elev./Depth: 52.0-54.0'



Load No.= 1
Load= 0.10 ksf
D_0 = 0.00000
D_{50} = 0.00067
D_{100} = 0.00134
T_{50} = 10.63 min.

C_v @ T_{50}
0.03 ft.^{2}/day

C_α = 0.000



Load No.= 2
Load= 0.25 ksf
D_0 = 0.00140
D_{50} = 0.00285
D_{100} = 0.00430
T_{50} = 4.17 min.

C_v @ T_{50}
0.07 ft.^{2}/day

C_α = 0.000

Jax FL

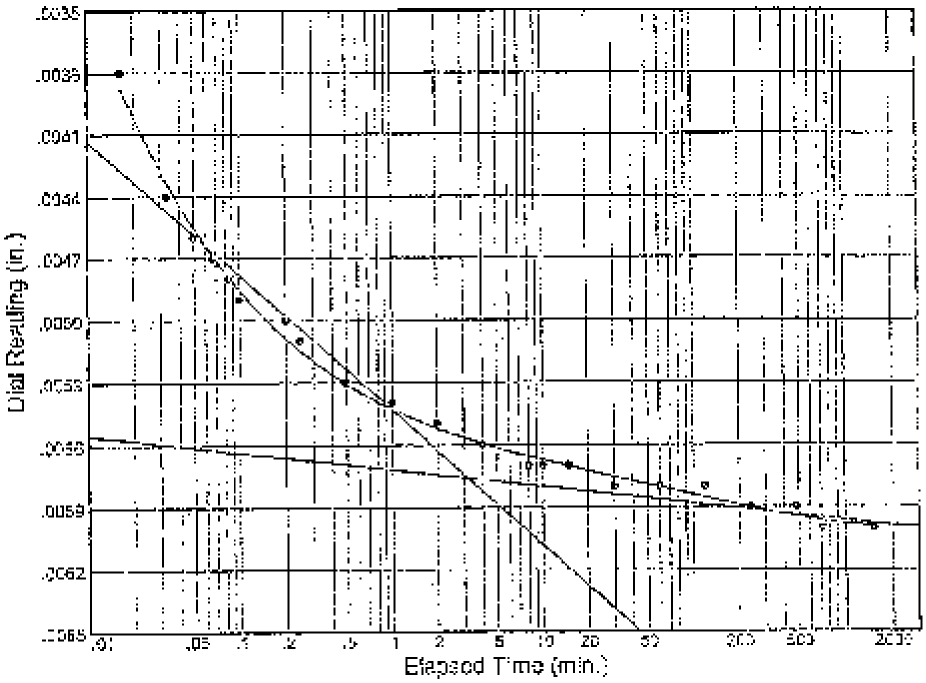
MACTEC Engineering and Consulting, Inc.

US EPA ARCHIVE DOCUMENT

Dial Reading vs. Time

Project No.: 3050090131.02
Project: Dike Drilling

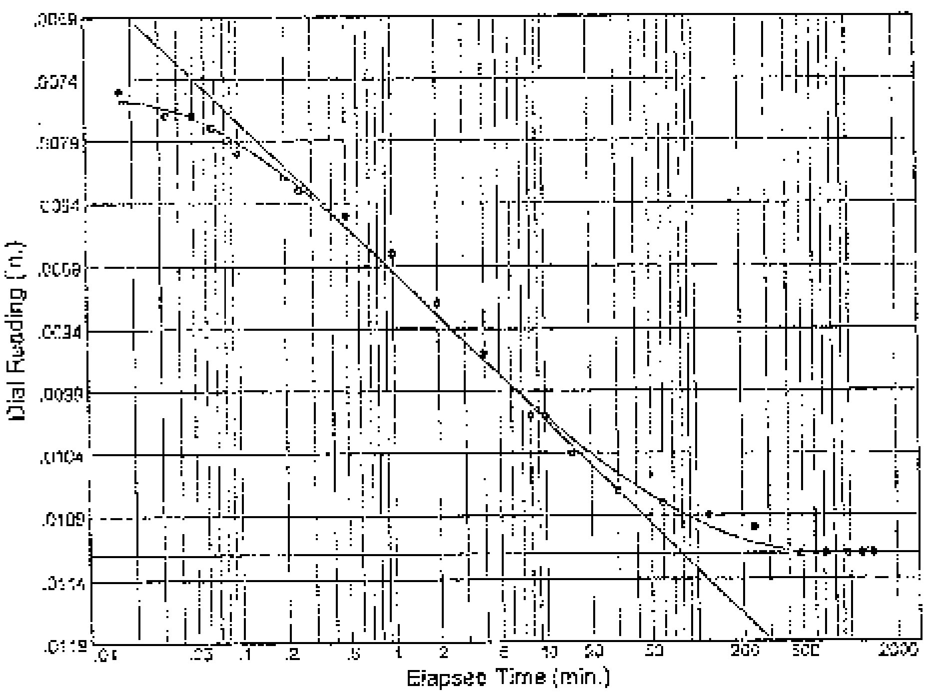
Source: B-0904 | Sample No.: UD-11 | Elev./Depth: 52.0-54.0'



Load No.= 3
Load= 0.50 ksf
D_0 = 0.00200
D_{50} = 0.00388
D_{100} = 0.00576
T_{50} = 0.02 min.

C_v @ T_{50}
17.03 ft.²/day

C_α = 0.000



Load No.= 4
Load= 1.00 ksf
D_0 = 0.00680
D_{50} = 0.00900
D_{100} = 0.01120
T_{50} = 1.13 min.

C_v @ T_{50}
0.25 ft.²/day

C_α = 0.000

Jax FL

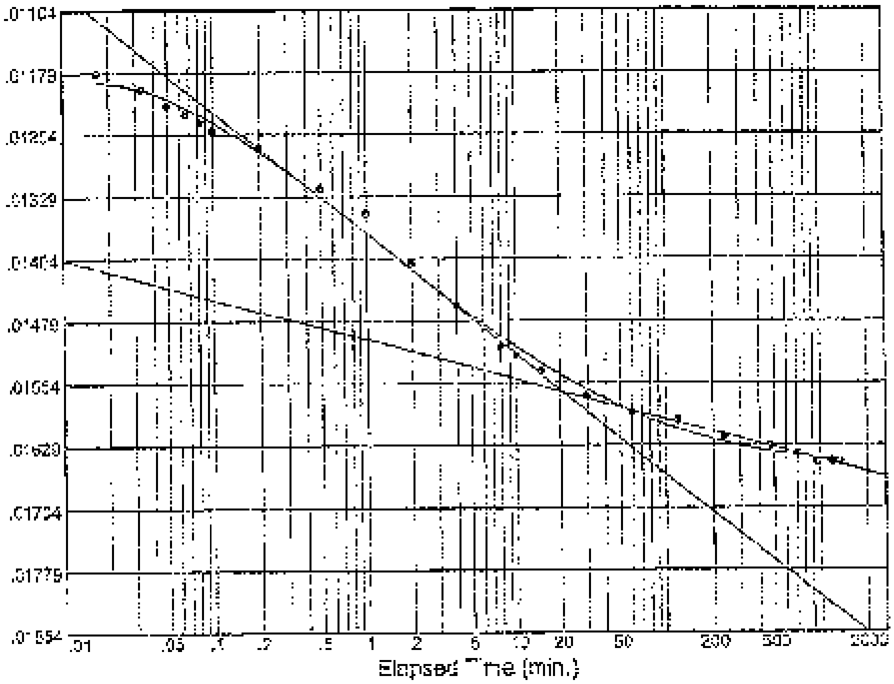
MACTEC Engineering and Consulting, Inc.

US EPA ARCHIVE DOCUMENT

Dial Reading vs. Time

Project No.: 3050090131.02
Project: Dike Drilling

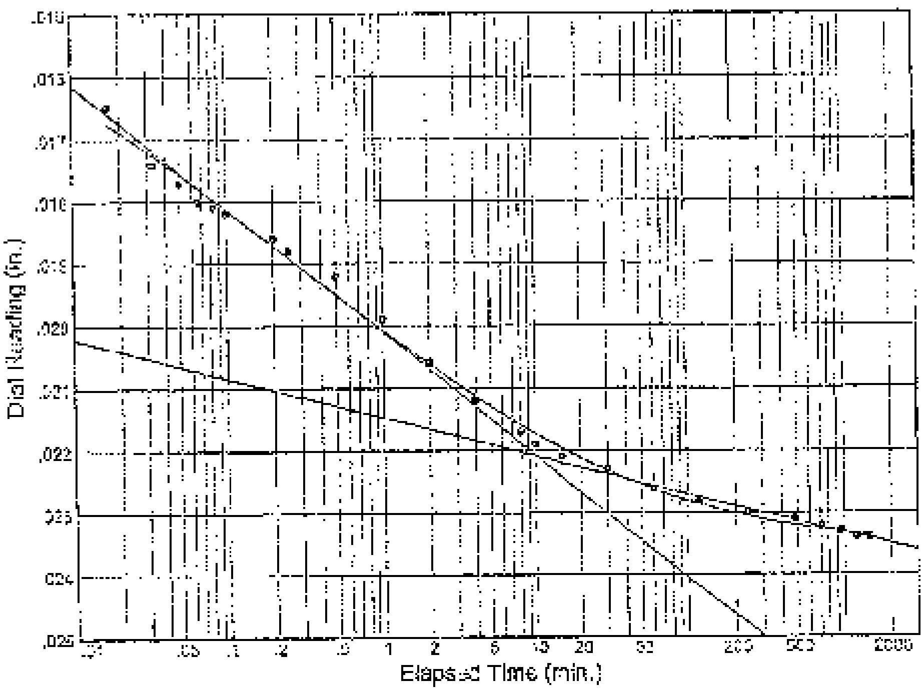
Source: B-0904 | Sample No.: UD-11 | Elev./Depth: 52.0'-54.0'



Load No.= 5
Load= 2.00 ksf
D_0 = 0.01070
D_{50} = 0.01318
D_{100} = 0.01565
T_{50} = 0.41 min.

C_v @ T_{50}
0.68 ft.²/day

C_α = 0.001



Load No.= 6
Load= 4.00 ksf
D_0 = 0.01580
D_{50} = 0.01894
D_{100} = 0.02209
T_{50} = 0.26 min.

C_v @ T_{50}
1.05 ft.²/day

C_α = 0.002

Jax FL

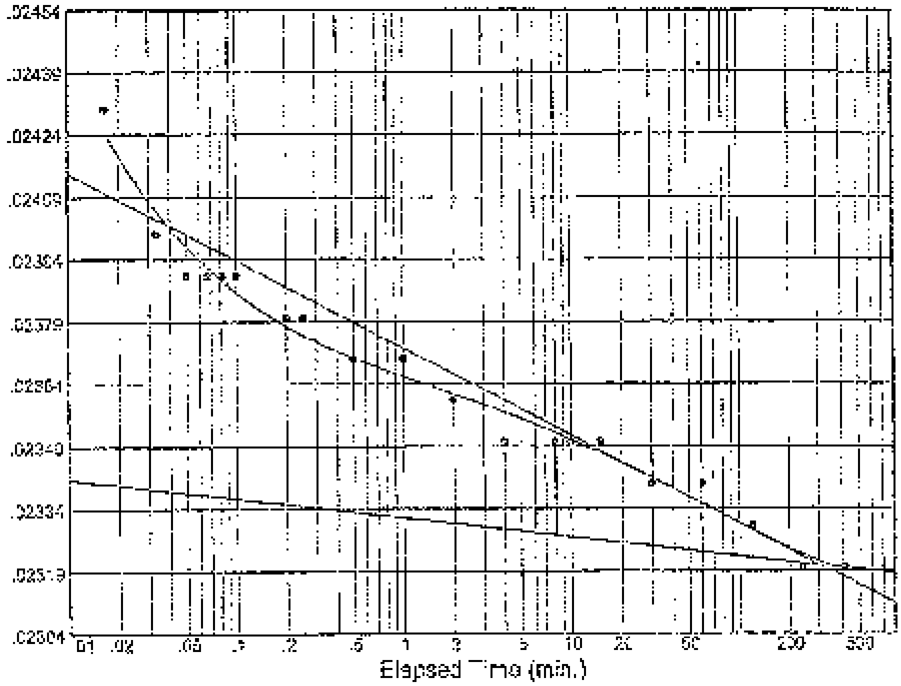
MACTEC Engineering and Consulting, Inc.

US EPA ARCHIVE DOCUMENT

Dial Reading vs. Time

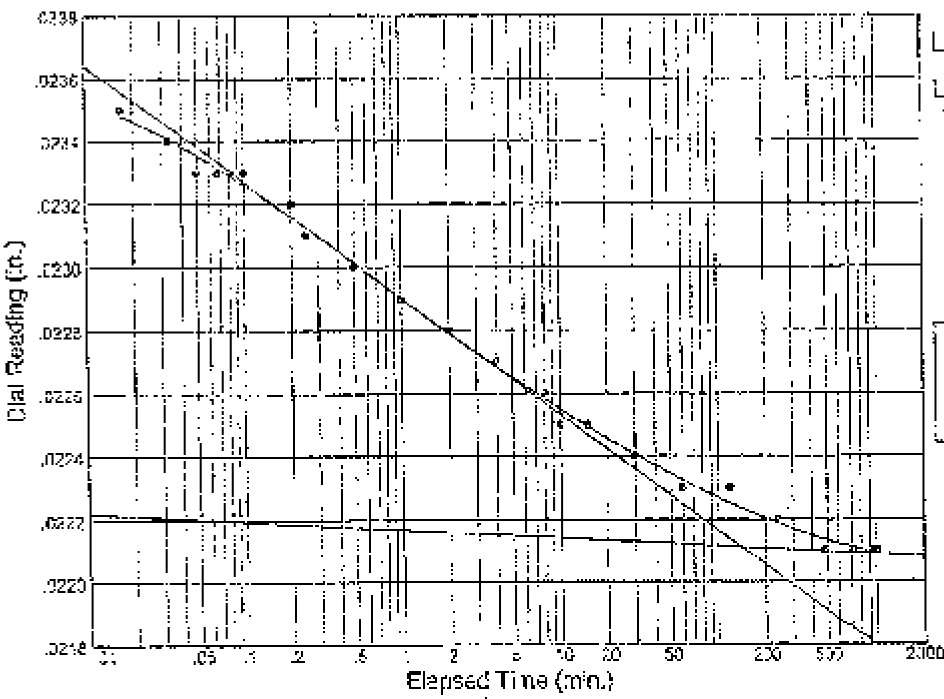
Project No.: 3850090131.02
Project: Dike Drilling

Source: B-0904 | Sample No.: UD-11 | Elev./Depth: 52.0-54.0



Load No.= 7
Load= 2.00 ksf
D_0 = 0.02430
D_{50} = 0.02375
D_{100} = 0.02321
T_{50} = 0.26 min.

C_v @ T_{50}
1.02 ft.^{2}/day



Load No.= 8
Load= 1.00 ksf
D_0 = 0.02320
D_{50} = 0.02266
D_{100} = 0.02211
T_{50} = 4.87 min.

C_v @ T_{50}
0.06 ft.^{2}/day

Jax FL.

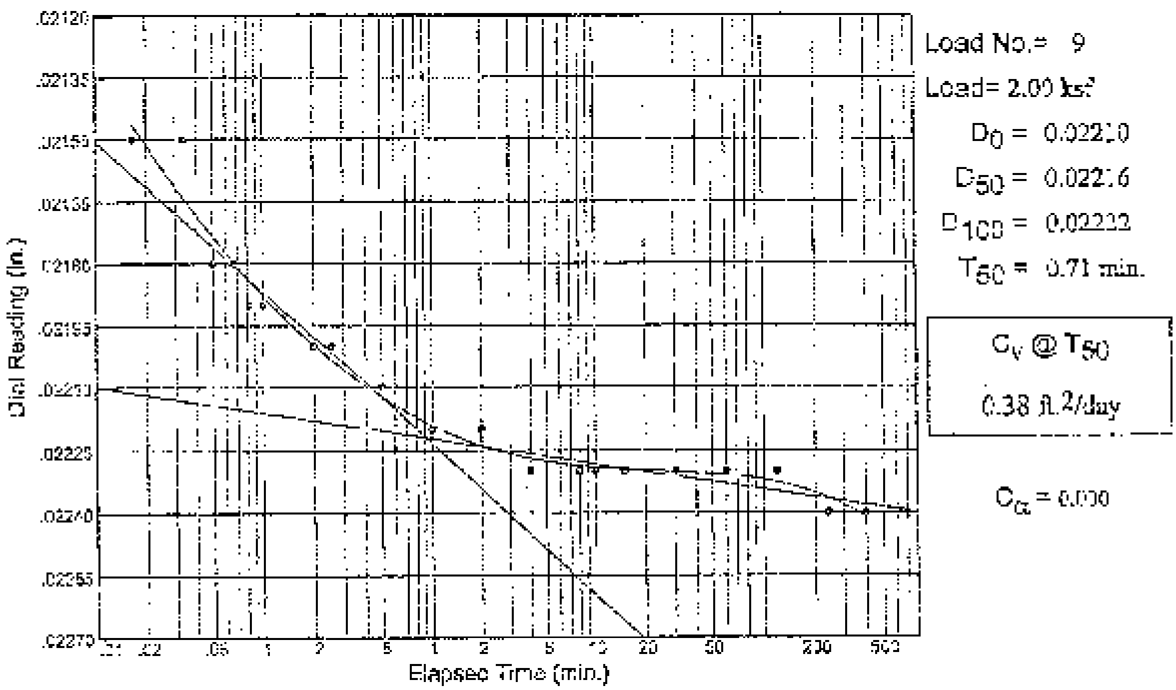
MACTEC Engineering and Consulting, Inc.

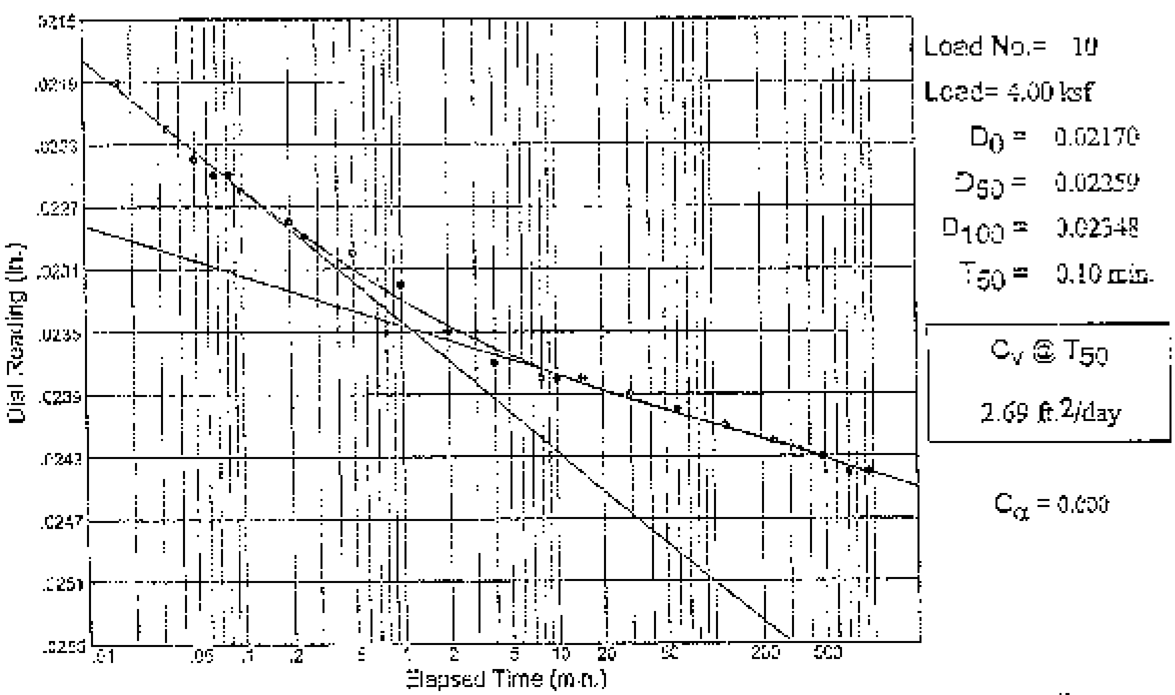
US EPA ARCHIVE DOCUMENT

Dial Reading vs. Time

Project No.: 3050090131.02
Project: Dike Drilling

Source: B-6904 | Sample No.: UD-11 | Elev./Depth: 52.0-54.0'





Jax FL.

MACTEC Engineering and Consulting, Inc.

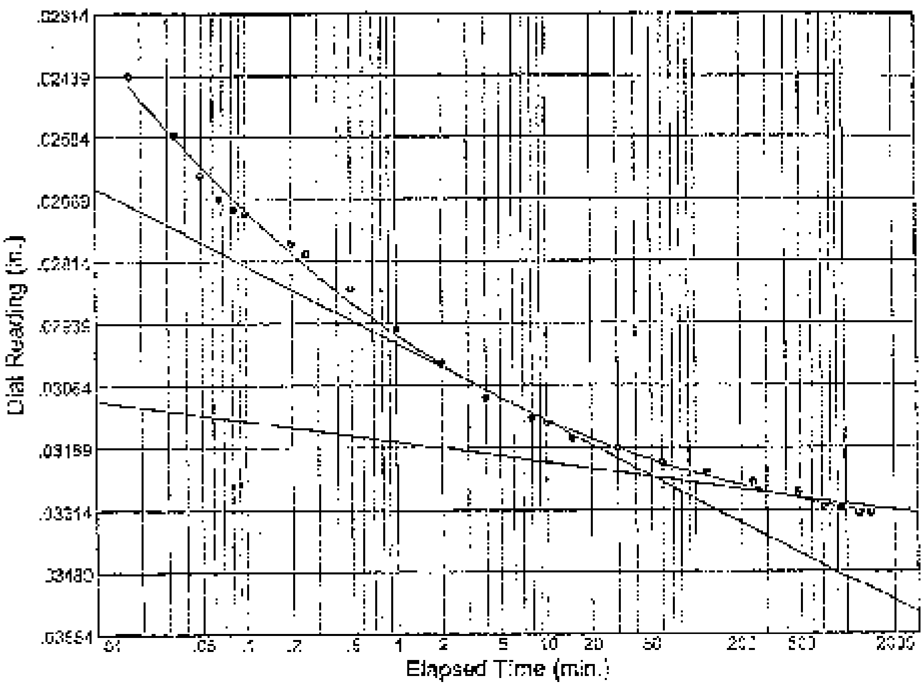
US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

Dial Reading vs. Time

Project No.: 3050090131.02
Project: Dike Drilling

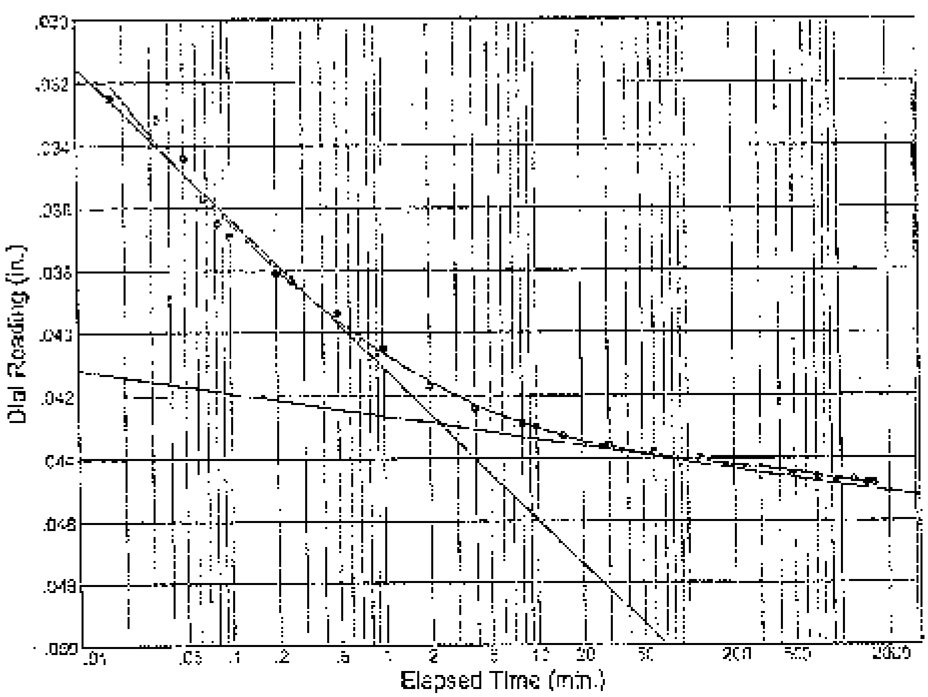
Source: B-0904 | Sample No.: UD-11 | Elev./Depth: 52.0-54.0



Load No.= 11
Load= 8.00 ksf
D_0 = 0.02390
D_{50} = 0.02819
D_{100} = 0.03248
T_{50} = 0.24 min.

C_v @ T_{50}
1.10 ft.^{2}/day

C_α = 0.001



Load No.= 12
Load= 16.00 ksf
D_0 = 0.03240
D_{50} = 0.03766
D_{100} = 0.04292
T_{50} = 0.17 min.

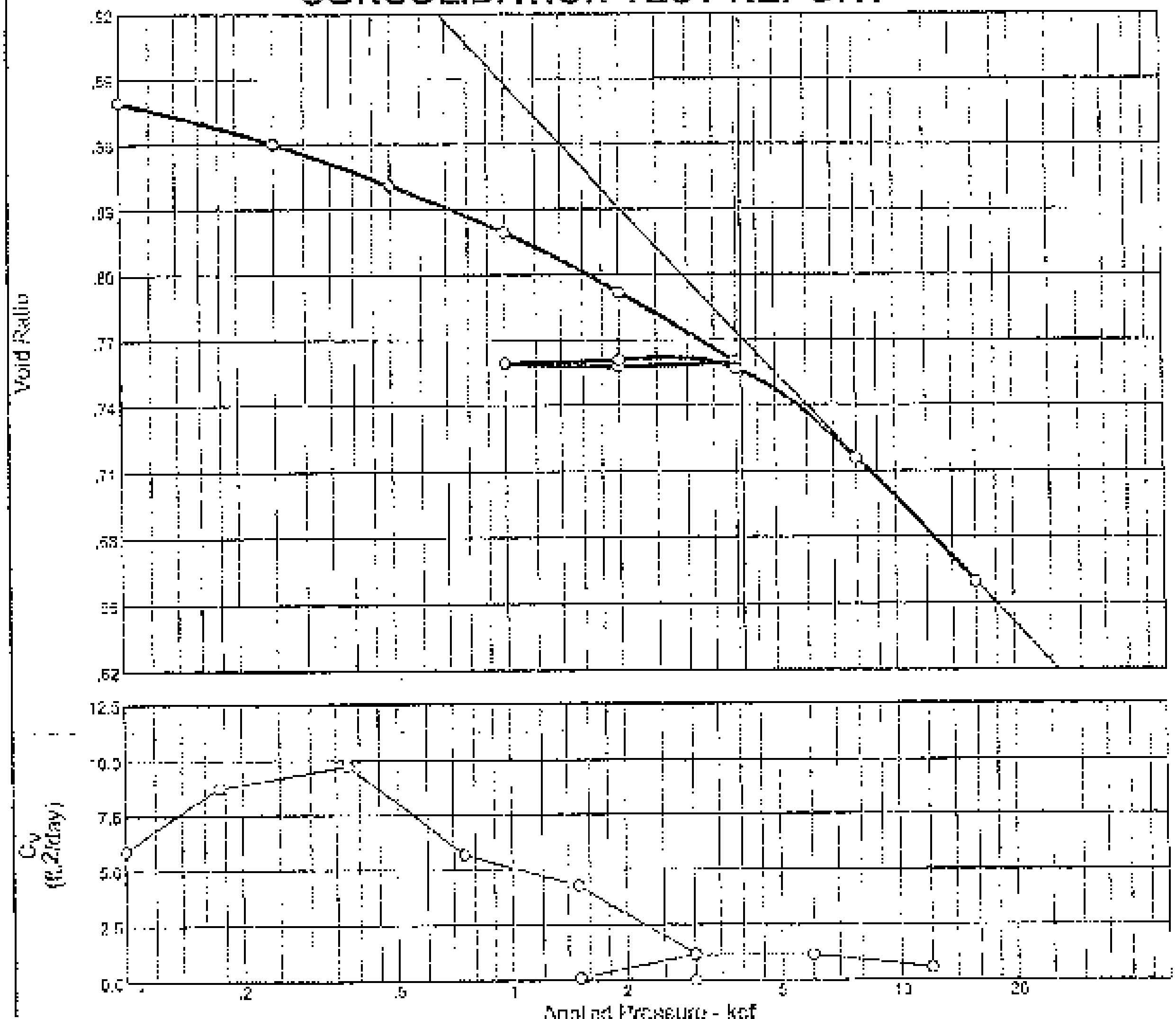
C_v @ T_{50}
1.50 ft.^{2}/day

C_α = 0.001

Jax FL.

MACTEC Engineering and Consulting, Inc.

CONSOLIDATION TEST REPORT



MATERIAL DESCRIPTION	USCS	AASHTO
Grey and brown lean clay	CL	A-7-6(20)

LL	PI	Sp. Gr.	Overburden (ksf)	Dry Dens. (pcf)		Moisture		Saturation		Void Ratio		P_c (ksf)	C_c
				Init.	Final	Init.	Final	Init.	Final	Init.	Final		
46	21	2.778		92.0		31.9 %	28.3 %	93.0 %	100.0 %	0.886	0.660	5.25	0.19

	D2435 Method	C_r	Swell Press. (ksf)	Heave %
Preparation Process: Trimmed using cylindrical cutting ring				
Condition of Test: Natural moisture, inundated at 0.05 ksf	B	0.01		

Project No. 2030090131.02 **Client:** American Electric Power

Project: Dike Drilling

Source: B-0906 **Sample No.:** UD-6 **Elev./Depth:** 22.0'-24.0'

CONSOLIDATION TEST REPORT

MACTEC ENGINEERING AND CONSULTING, INC.

Remarks:

Percent Passing #200 sieve, 93.2%

Checked By: Rajni Sivalingam

Title:

Jax FL

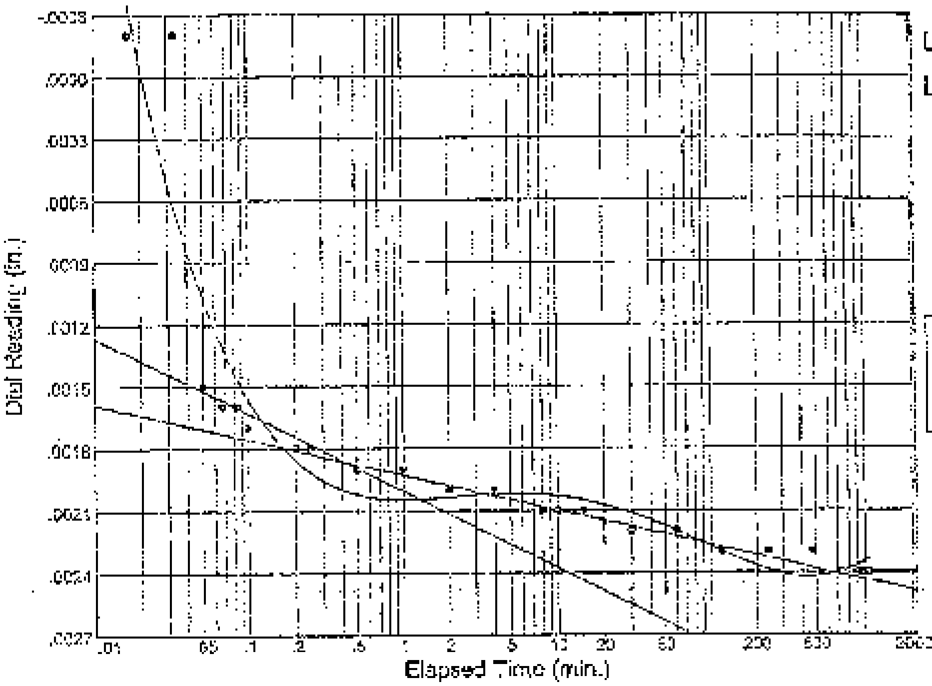
US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

Dial Reading vs. Time

Project No.: 3050090131.02
Project: Dike Drilling

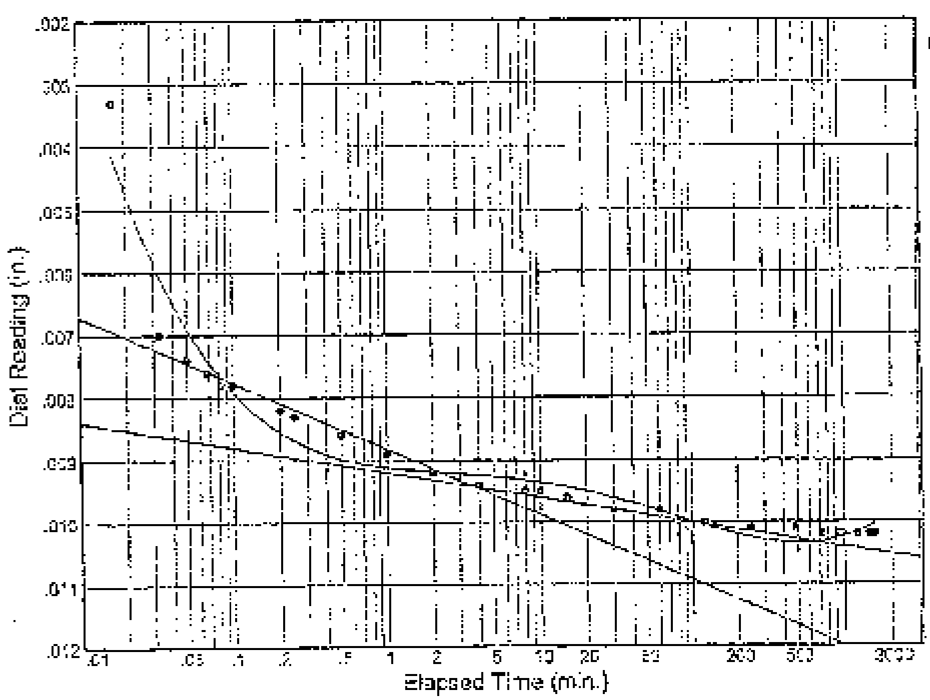
Source: B-0906 | Sample No.: UD-6 | Elev./Depth: 22.0'-24.0'



Load No.= 1
Load= 0.10 ksf
D_0 = 0.00060
D_{50} = 0.00093
D_{100} = 0.00166
T_{50} = 0.05 min.

C_v @ T_{50}
5.83 ft.²/day

C_α = 0.000



Load No.= 2
Load= 0.25 ksf
D_0 = 0.00240
D_{50} = 0.00592
D_{100} = 0.00943
T_{50} = 0.03 min.

C_v @ T_{50}
8.72 ft.²/day

C_α = 0.001

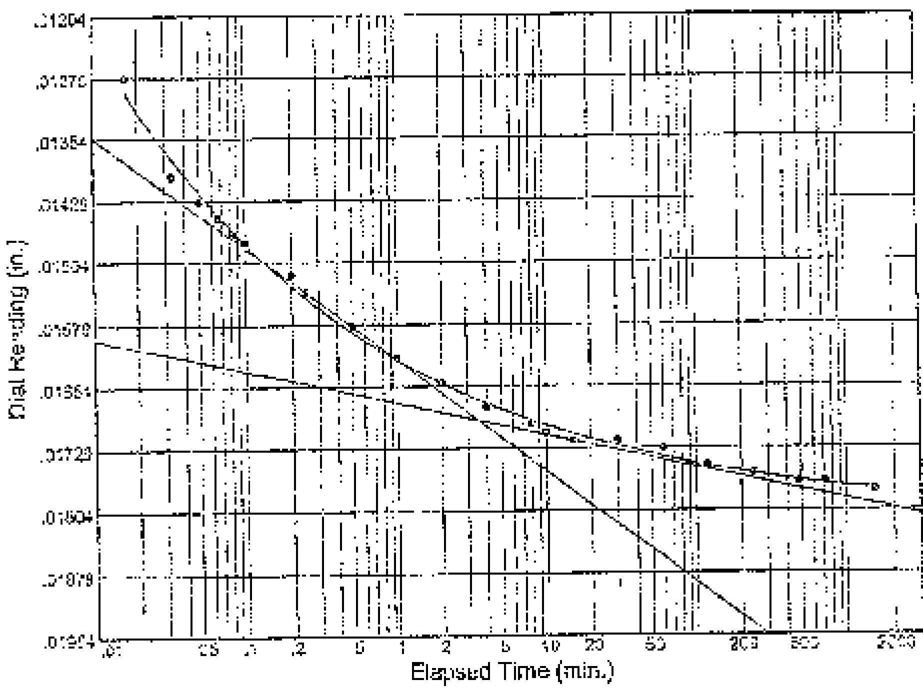
Jax FL

MACTEC Engineering and Consulting, Inc.

Dial Reading vs. Time

Project No.: 3050090131.02
Project: Dike Drilling

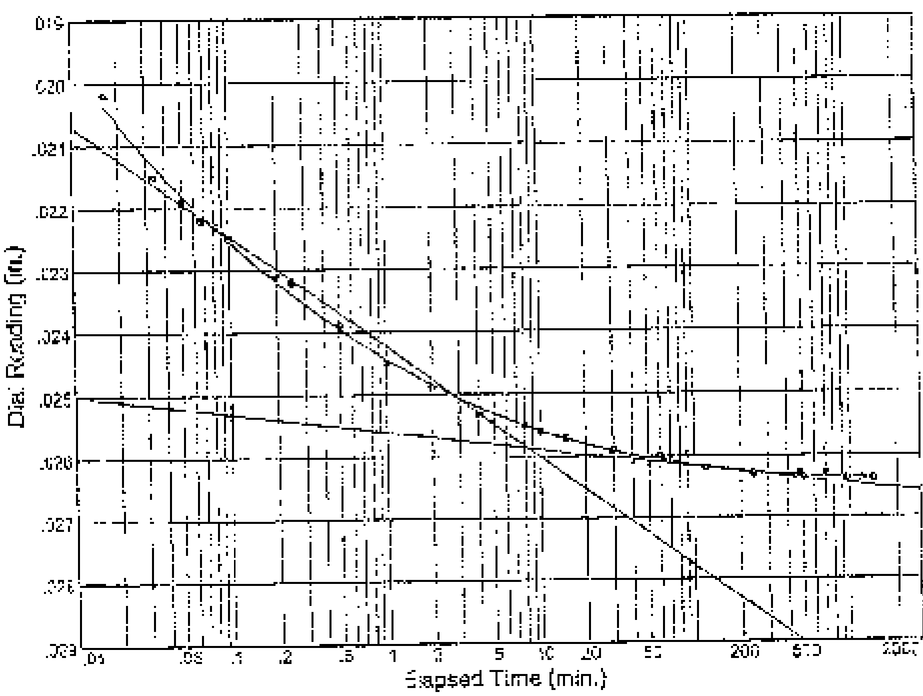
Source: B-0965 | Sample No.: UD-6 | Elev./Depth: 22.0-24.0



Load No.= 3
Load= 0.50 ksf
D_0 = 0.01020
D_{50} = 0.01357
D_{100} = 0.01695
T_{50} = 0.03 min.

C_v @ T_{50}
9.73 ft.²/day

C_α = 0.001



Load No.= 4
Load= 1.00 ksf
D_0 = 0.01750
D_{50} = 0.02168
D_{100} = 0.02586
T_{50} = 0.05 min.

C_v @ T_{50}
5.68 ft.²/day

C_α = 0.000

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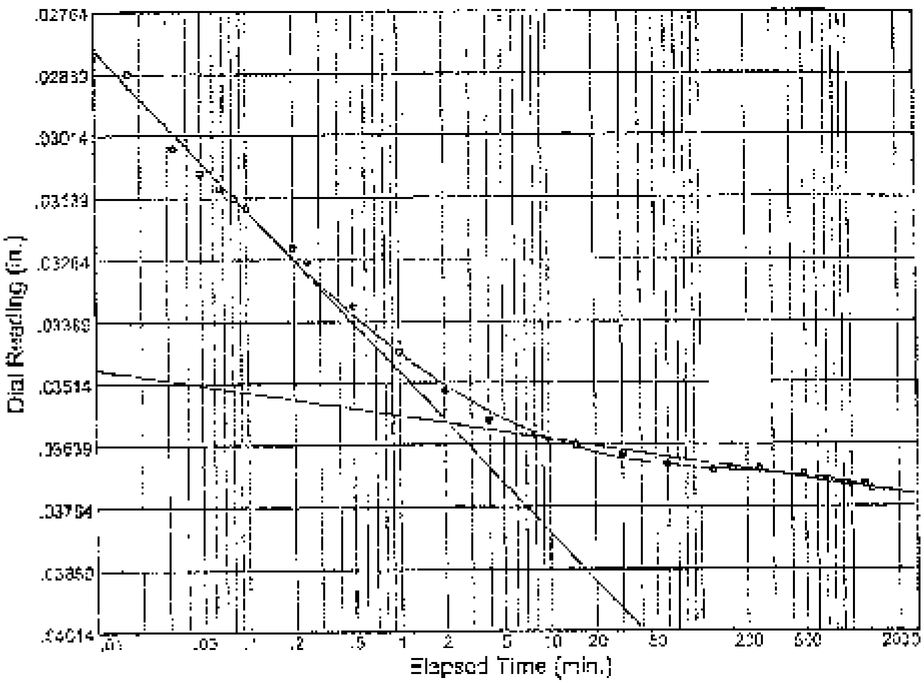
Dial Reading vs. Time

Project No.: 3050090131.02
Project: Dike Drilling

Source: B-0906 | Sample No.: UD-6 | Elev./Depth: 22.0'-24.0'



Load No.= 5

Load= 2.00 ksf

D_0 = 0.02590

D_{50} = 0.03093

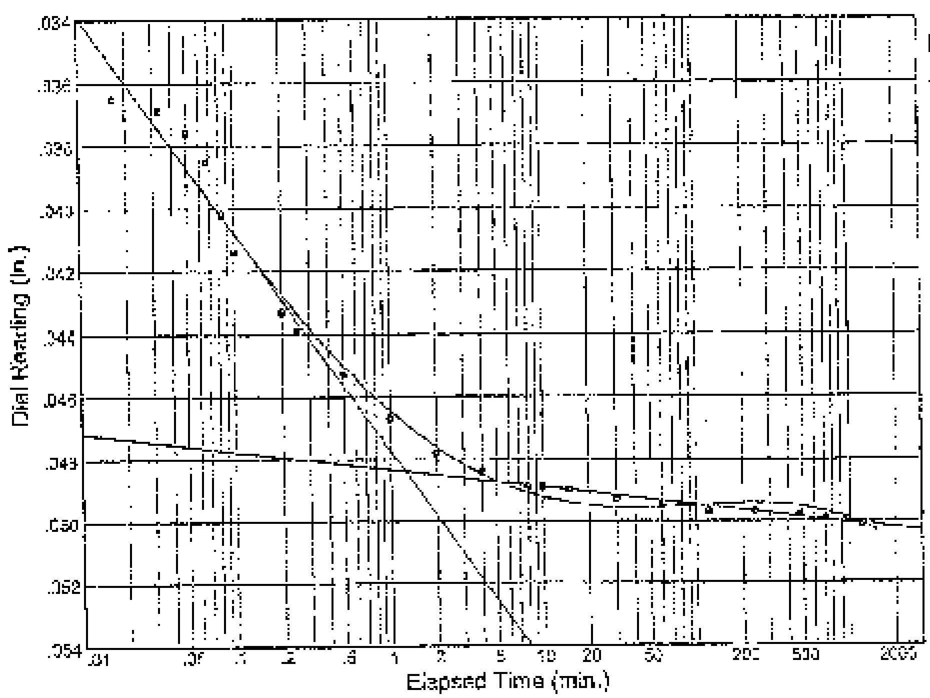
D_{100} = 0.03595

T_{50} = 0.05 min.

C_v @ T_{50}

4.26 ft^2/day

C_α = 0.001



Load No.= 6

Load= 4.00 ksf

D_0 = 0.03730

D_{50} = 0.04284

D_{100} = 0.04838

T_{50} = 0.21 min.

C_v @ T_{50}

1.18 ft^2/day

C_α = 0.001

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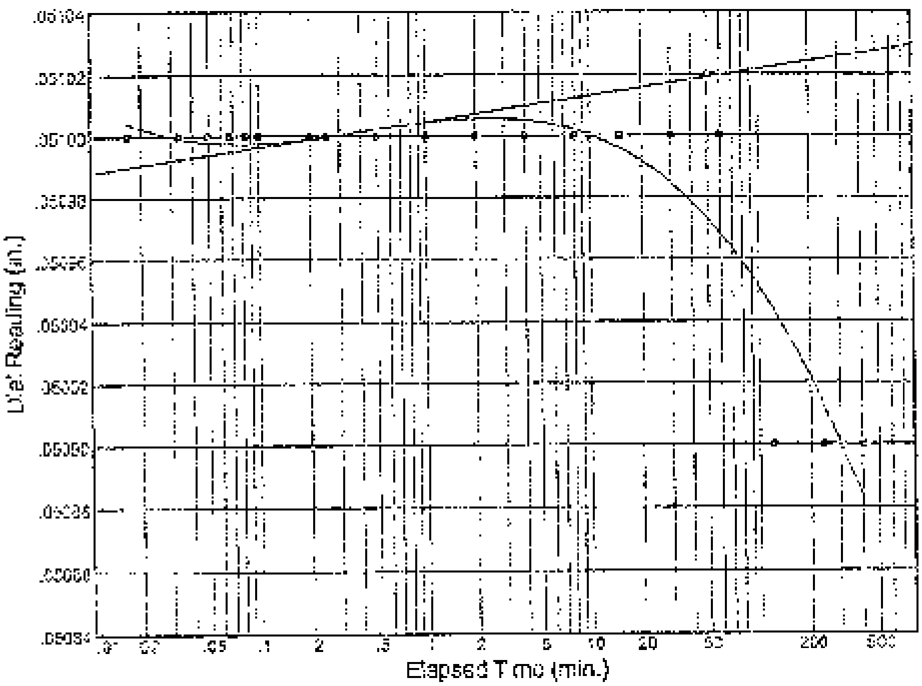
Dial Reading vs. Time

Project No.: 3050090131.02
Project: Dike Drilling

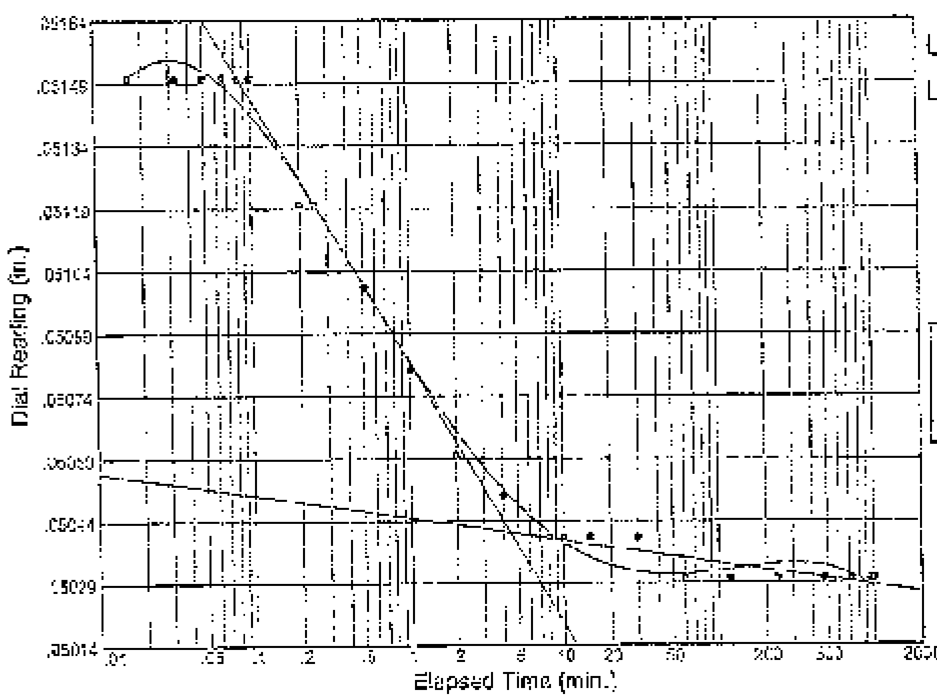
Source: B-0906 | Sample No.: UD-6 | Elev./Depth: 22.0-24.0



Load No.= 7
Load= 2.00 ksf
D_0 = 0.05100
D_{50} = 0.05095
D_{100} = 0.05090
T_{50} = 102.71 min.

C_v @ T_{50}
0.00 ft.^{2}/day

C_α = 0.000



Load No.= 8
Load= 1.00 ksf
D_0 = 0.05090
D_{50} = 0.05066
D_{100} = 0.05041
T_{50} = 2.01 min.

C_v @ T_{50}
0.12 ft.^{2}/day

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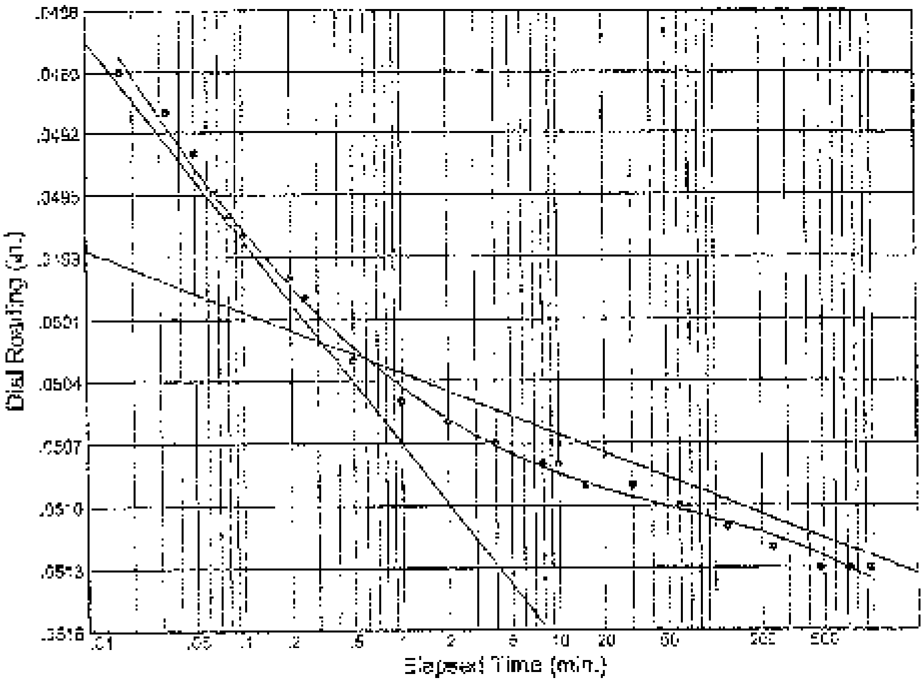
Dial Reading vs. Time

Project No.: 3050080131.02
Project: Dike Drilling

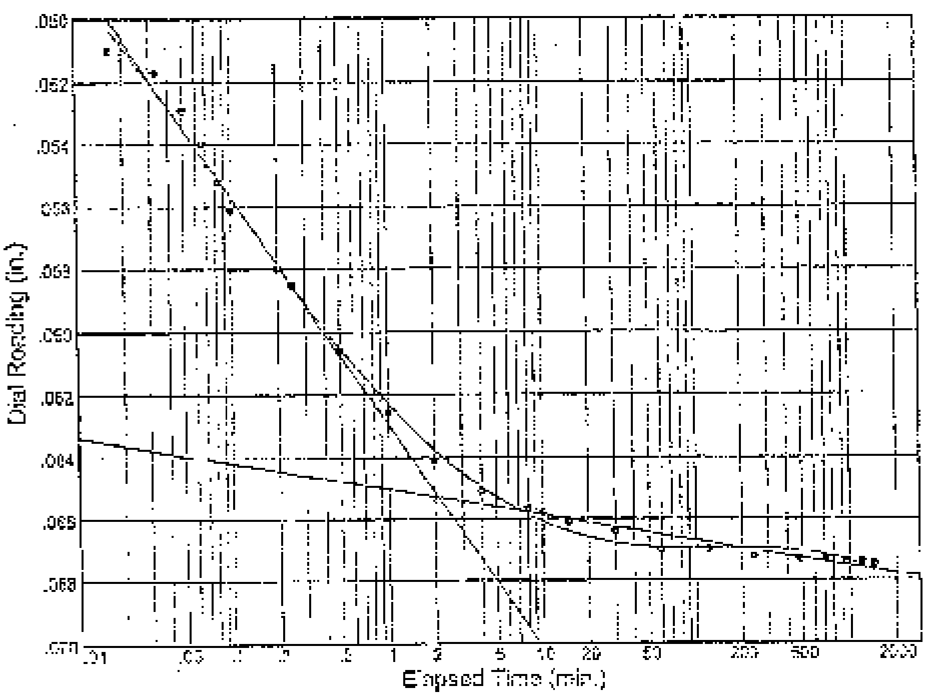
Source: B-0906 Sample No.: UD-6 Elev./Depth: 22.0'-24.0'



Load No.= 10
Load= 4.00 ksf
D_0 = 0.04970
D_{50} = 0.04995
D_{100} = 0.05021
T_{50} = 0.21 min.

C_v @ T_{50}
1.14 ft.^{2}/day

C_α = 0.000



Load No.= 11
Load= 8.00 ksf
D_0 = 0.05060
D_{50} = 0.05795
D_{100} = 0.06530
T_{50} = 0.21 min.

C_v @ T_{50}
1.13 ft.^{2}/day

C_α = 0.001

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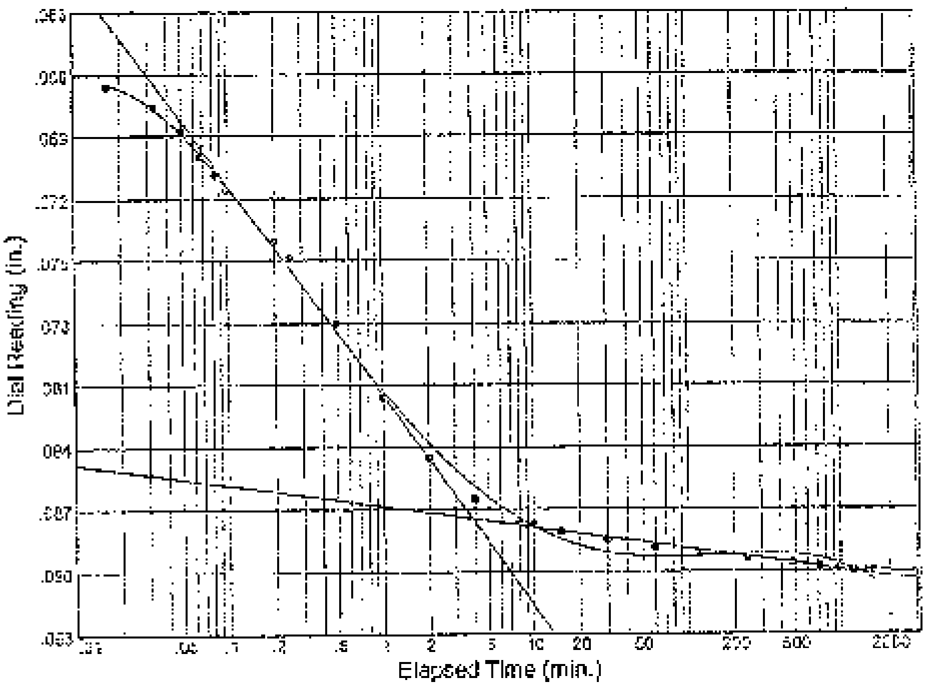
Dial Reading vs. Time

Project No.: 3050090131.02
Project: Dike Drilling

Source: B-0906 | Sample No.: UD-6 | Elev./Depth: 22.0-24.0



Load No.= 12
Load= 16.00 ksf
D_0 = 0.06750
D_{50} = 0.07749
D_{100} = 0.08747
T_{50} = 0.40 min.

C_v @ T_{50}
0.55 ft.^{2}/day

C_α = 0.001

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Abingdon, Va. 24211
(276) 676-0426
(276) 676-0761

Density of Soil Specimens
ASTM D 7263 Method B

Project Name: AEP Dike Drilling
Project Number: 3050-09-0131
Boring Number: B-0903
Sample Number: UD-9
Depth: 34'-36'

Moisture Content

Mass(g)	Tare + Wet Soil	1241.47				
	Tare + Dry Soil	1016.53				
	Water	224.94				
	Tare	477.47				
	Dry Soil	539.06				
	Water Content %	41.7282				

Weight - Volume Relations

Measurements(in)	Height	4.5920	4.6195	4.5760	4.5725	
	Average Height	4.59				
	Inside Diameter	2.8860	2.8760	2.8795	2.8870	
	Average Diameter	2.8821				

Mass(lb)	Tare + Sample	2.4085
	Tare	0.7152
	Sample	1.6932

Volume (PCF): 0.01731

Wet Density (PCF): 97.82

Dry Density (PCF): 69.02

Performed By: NCH 12/9/09

Reviewed By: RDR 12-9-09

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Density of Soil Specimens
ASTM D 7263 Method B

Project Name:	AEP Dike Drilling
Project Number:	3050-09-0131
Boring Number:	B-0907
Sample Number:	UD-14
Depth:	57' - 59'

Moisture Content

Mass(g)	Tare + Wet Soil	937.03				
	Tare + Dry Soil	641.62				
	Water	295.41				
	Tare	166.3				
	Dry Soil	475.32				
	Water Content %	62.1497				

Weight - Volume Relations

Measurements(in.)	Height	4.6385	4.7175	4.7510	4.6880	
	Average Height	4.69875				
	Inside Diameter	2.8750	2.8770	2.8675	2.8790	
	Average Diameter	2.8746				

Mass (lb)	Tare + Sample	2.4549
	Tare	0.7491
	Sample	1.7057

Volume (PCF): 0.0176

Wet Density (PCF): 96.92

Dry Density (PCF): 59.77

Performed By: 12/9/09 NCH

Reviewed By: RDR 12-9-09

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APPENDIX 3

PIEZOMETER DATA

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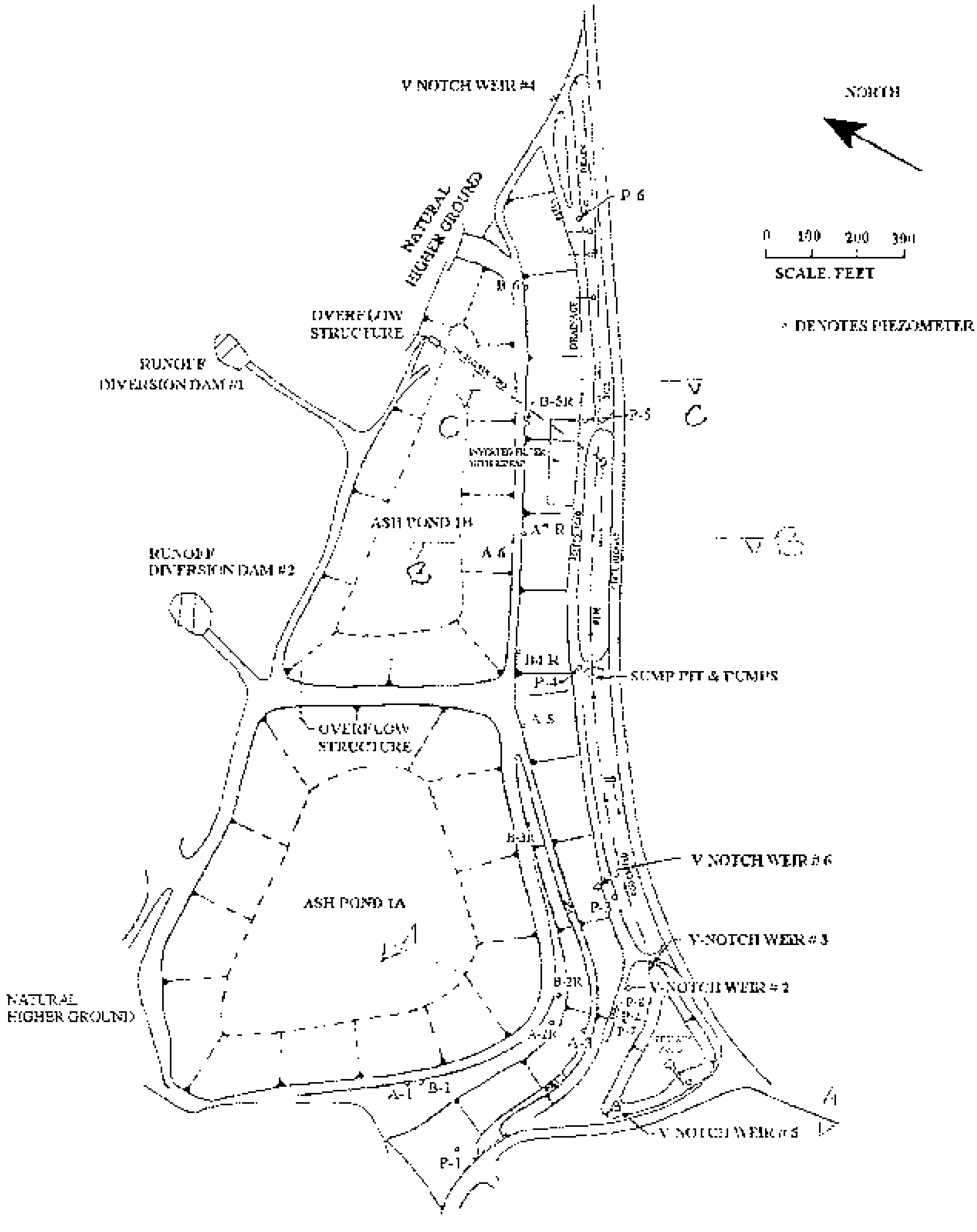

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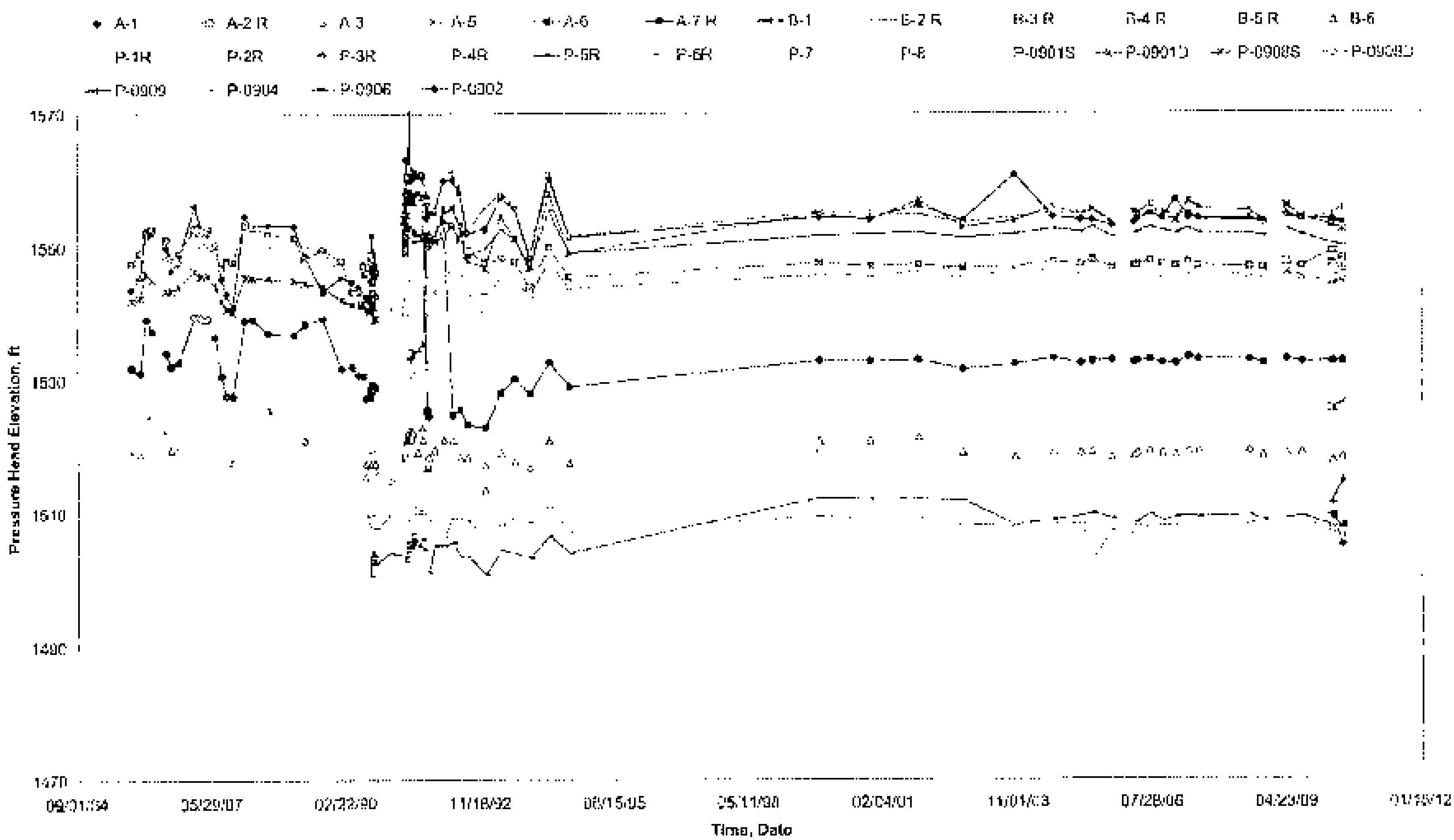
US EPA ARCHIVE DOCUMENT



AEPCR000544

Appendix 4

Seepage and Stability Model Inputs

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SEEP/W Analysis

[illegible]

File Information

- Created By: [illegible]
- Revision Number: [illegible]
- Last Edited By: [illegible]
- Date: [illegible]
- Time: [illegible]
- File Name: [illegible]
- Directory: [illegible]

Project Settings

- Length(L) Units: [illegible]
- Time(t) Units: [illegible]
- Force(F) Units: [illegible]
- Pressure(p) Units: [illegible]
- Mass(M) Units: [illegible]
- Mass Flux Units: [illegible]
- Unit Weight of Water: [illegible]
- View: [illegible]

Analysis Settings

SEEP/W Analysis

- Description: [illegible]
- Kind: SEEP/W
- Method: [illegible]
- Settings
  - Initial PWP: [illegible]
  - Include Air Flow: [illegible]
- Control
  - Apply Runoff: [illegible]
- Convergence
  - Maximum Number of Iterations: [illegible]
  - Tolerance: [illegible]
  - Minimum Change in K: [illegible]
  - Rate of Change in K: [illegible]
  - Minimum Change in K: [illegible]
  - Equation Solver: [illegible]
  - Potential Seepage Max # of Reviews: [illegible]
- Time
  - Starting Time: [illegible]
  - Duration: [illegible]
  - # of Steps: [illegible]
  - Step Generation Method: [illegible]
  - Save Steps Every: [illegible]
  - Use Adaptive Time Stepping: [illegible]

Section A

Materials

Outer shell-silty sand and shale fragment

- Model: [illegible]
- Hydraulic
  - K-Function: [illegible]
  - Vol. WC. Function: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

Toe clayey silt

- Model: [illegible]
- Hydraulic
  - K-Function: [illegible]
  - Vol. WC. Function: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

Original Dike clay with gravel

- Model: [illegible]
- Hydraulic
  - K-Function: [illegible]
  - Vol. WC. Function: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

Compacted ash

- Model: [illegible]
- Hydraulic
  - K-Function: [illegible]
  - Vol. WC. Function: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

Fly ash

- Model: [illegible]
- Hydraulic
  - K-Sat: [illegible]
  - Volumetric Water Content: [illegible]
  - Mv: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

Foundation - fly sand [illegible]

- Model: [illegible]
- Hydraulic
  - K-Sat: [illegible]
  - Volumetric Water Content: [illegible]
  - Mv: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

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Section A

Grd Rock
Model: [illegible]
Hydraulic
K-Sat: [illegible]
Volumetric Water Content: [illegible]
Mv: [illegible]
K-Ratio: 1
K-Direction: [illegible]

Original [illegible] clay
Model: [illegible]
Hydraulic
K-Function: [illegible]
Vol. WC. Function: [illegible]
K-Ratio: 1
K-Direction: [illegible]

Foundation [illegible] silt-08-UC15
Model: [illegible]
Hydraulic
K-Sat: [illegible]
Volumetric Water Content: [illegible]
Mv: [illegible]
K-Ratio: 1
K-Direction: [illegible]

Weathered shale
Model: [illegible]
Hydraulic
K-Sat: [illegible]
Volumetric Water Content: [illegible]
Mv: [illegible]
K-Ratio: [illegible]
K-Direction: [illegible]

Second [illegible]
Model: [illegible]
Hydraulic
K-Function: [illegible]
Vol. WC. Function: [illegible]
K-Ratio: [illegible]
K-Direction: [illegible]

Foundation [illegible] Clayey [illegible]
Model: [illegible]
Hydraulic
K-Sat: [illegible]
Volumetric Water Content: [illegible]
Mv: [illegible]
K-Ratio: [illegible]
K-Direction: [illegible]

Foundation Lean Clay-07-UC13

Section A

Model: [illegible]
Hydraulic
K-Sat: [illegible]
Volumetric Water Content: [illegible]
Mv: [illegible]
K-Ratio: [illegible]
K-Direction: [illegible]

Boundary Conditions

Potential Seepage Face
Review: [illegible]
Type: [illegible]

Rising Pool Level
Function: [illegible]
Type: [illegible]

Constant Head 1303
Type: [illegible]

Zero Flux
Type: [illegible]

Initial Water Tables

Initial Water Table 1
Max. negative head: [illegible]
Coordinates
Coordinate: [illegible]
Coordinate: [illegible]

Flux Sections

Flux Section 1
Coordinates
Coordinate: [illegible]
Coordinate: [illegible]

Flux Section 2
Coordinates
Coordinate: [illegible]
Coordinate: [illegible]

Flux Section 3
Coordinates
Coordinate: [illegible]
Coordinate: [illegible]

Flux Section [illegible]

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Coordinates
Coordinate: [illegible]
Coordinate: [illegible]

K Functions

Outer shell - clayey sand

Model: Data Point Function
Function: K-Function vs. Pore-Water Pressure
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K-Saturation: [illegible]
Data Points: Matric Suction (psf), K-Conductivity (ft/hr)
Data Point: [illegible]
Data Point: [illegible]
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Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K-Sat: [illegible]
Hyd. K-Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]
Residual Water Content: [illegible]

Compacted Ash

Model: Data Point Function
Function: K-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K-Saturation: [illegible]
Data Points: [illegible]
Data Point: [illegible]
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Data Point: [illegible]
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Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K-Sat: [illegible]
Hyd. K-Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]
Residual Water Content: [illegible]

Original Dike-clay with gravel

Model: Data Point Function
Function: K-Conductivity vs. Pore-Water Pressure
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K-Saturation: [illegible]
Data Points: Matric Suction (psf), K-Conductivity (ft/hr)
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Estimation Properties
Volume Water Content Function: Original Dike-clay with gravel

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Hydraulic K Sat: [illegible]
Hyd. K Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: 20
Residual Water Content: [illegible]

Top-clayey silt

Model: [illegible]
Function: K Conductivity vs. Pore-Water Pressure
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K Saturation: [illegible]
Data Points: Matric Suction (kPa), K Conductivity [illegible]
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Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K-Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: 20
Residual Water Content: [illegible]

Original Dike sandy lean clay

Model: [illegible]
Function: K Conductivity vs. Pore-Water Pressure
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K Saturation: [illegible]
Data Points: Matric Suction (kPa), K Conductivity [illegible]
Data Point: [illegible]
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Data Point: [illegible]
Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K-Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]
Residual Water Content: [illegible]

Outer shell - silt lower permeability

Model: [illegible]
Function: K Conductivity vs. Pore-Water Pressure
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K Saturation: [illegible]
Data Points: Matric Suction (kPa), K Conductivity [illegible]
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Estimation Properties
Volume Water Content Function: [illegible]

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Hydraulic K Sat: [illegible]
Hyd. K-Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]
Residual Water Content: [illegible]

Hydraulic Boundary Functions

Pool level 100 per year

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Y-Intercept: [illegible]
Data Points: [illegible]
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Data Point: [illegible]
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Data Point: [illegible]
Data Point: [illegible]

Vol. Water Content Functions

Outer shell clayey sand

Model: [illegible]
Function: Vol. Water Content [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Mv: [illegible]
Saturated Water Content: [illegible]
Porosity: [illegible]
Data Points: [illegible]
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Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Estimation Properties
Vol. WC Estimation Method: [illegible]
Sample Material: [illegible]
Saturated Water Content: [illegible]
Liquid Limit: [illegible]
Diameter at 10% passing: [illegible]
Diameter at 60% passing: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]

Compacted Ash

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Mv: [illegible]
Saturated Water Content: [illegible]
Porosity: [illegible]
Data Points: [illegible]
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Data Point: [illegible]
Estimation Properties
Vol. WC Estimation Method: [illegible]
Sample Material: [illegible]
Saturated Water Content: [illegible]
Liquid Limit: [illegible]
Diameter at 10% passing: [illegible]
Diameter at 60% passing: [illegible]
Maximum: [illegible]
Minimum: [illegible]

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Num. Points: [illegible]

Original Data: clay with gravel
Model: Data Points [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Mv: [illegible]
Saturated Water Content: [illegible]
Porosity: [illegible]
Data Points: [illegible]
Data Point: [illegible]
Data Point: [illegible]
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Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Estimation Properties
Vol. WC Estimation Method: [illegible]
Sample Material: Clay
Saturated Water Content: [illegible]
Liquid Limit: [illegible]
Diameter at 10% passing: [illegible]
Diameter at 60% passing: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]

Tuva clayey silt
Model: Data Points [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Mv: [illegible]
Saturated Water Content: [illegible]
Porosity: [illegible]
Data Points: [illegible]
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Data Point: [illegible]

Data Point: [illegible]
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Data Point: [illegible]
Estimation Properties
Vol. WC Estimation Method: [illegible]
Sample Material: [illegible]
Saturated Water Content: [illegible]
Liquid Limit: [illegible]
Diameter at 10% passing: [illegible]
Diameter at 60% passing: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]

Original Data: sandy lean clay
Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Mv: [illegible]
Saturated Water Content: [illegible]
Porosity: [illegible]
Data Points: [illegible]
Data Point: [illegible]
Data Point: [illegible]
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Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]

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Section A

Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]

Estimation Properties

Vol. WC Estimation Method: [illegible]
Sample Material: [illegible]
Saturated Water Content: [illegible]
Liquid Limit: [illegible]
Diameter at 10% passing: [illegible]
Diameter at 60% passing: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]

Regions

	Material	Points	Area (ft²)
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Fly [illegible]	[illegible]	[illegible]
[illegible]	Fly [illegible]	[illegible]	[illegible]
[illegible]	Fly [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Section A

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Lines

	Start Point	End Point	Hydraulic Boundary
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

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Section A

Section A

Points

X (ft)	Y (ft)	Hydraulic Boundary

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Section A

Section A

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SEEP/W Analysis

[illegible]

File Information

- Created By: [illegible]
- Revision Number: [illegible]
- Last Edited By: [illegible]
- Date: [illegible]
- Time: [illegible]
- File Name: [illegible]
- Directory: [illegible]

Project Settings

- Length(L) Units: [illegible]
- Time(t) Units: [illegible]
- Force(F) Units: [illegible]
- Pressure(p) Units: [illegible]
- Mass(M) Units: [illegible]
- Mass Flux Units: [illegible]
- Unit Weight of Water: [illegible]
- View: [illegible]

Analysis Settings

SEEP/W Analysis

- Description: [illegible]
- Kind: [illegible]
- Method: [illegible]
- Settings
  - Initial PWP: [illegible]
  - Include Air Flow: [illegible]
- Control
  - Apply Runoff: [illegible]
- Convergence
  - Maximum Number of Iterations: [illegible]
  - Tolerance: [illegible]
  - Maximum Change in K: [illegible]
  - Rate of Change in K: [illegible]
  - Minimum Change in K: [illegible]
  - Equation Solver: [illegible]
  - Potential Seepage Max # of Reviews: [illegible]
- Time
  - Starting Time: [illegible]
  - Duration: [illegible]
  - # of Steps: [illegible]
  - Step Generation Method: [illegible]
  - Save Steps Every: [illegible]
  - Use Adaptive Time Stepping: [illegible]

Materials

Outer shell - third raising

- Model: [illegible]
- Hydraulic
  - K-Function: [illegible]
  - Vol. WC. Function: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

Foundation layer [illegible]

- Model: [illegible]
- Hydraulic
  - K-Function: [illegible]
  - Vol. WC. Function: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

Original Dike-clay with gravel

- Model: [illegible]
- Hydraulic
  - K-Function: [illegible]
  - Vol. WC. Function: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

Compacted Ash - First raising

- Model: [illegible]
- Hydraulic
  - K-Function: [illegible]
  - Vol. WC. Function: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

[illegible]

- Model: [illegible]
- Hydraulic
  - K-Sat: [illegible]
  - Volumetric Water Content: [illegible]
  - Mv: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

Silty sand - [illegible]

- Model: [illegible]
- Hydraulic
  - K-Sat: [illegible]
  - Volumetric Water Content: [illegible]
  - Mv: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

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Section [illegible]

Bed Rock
Model: [illegible]
Hydraulic
K-Sat: [illegible]
Volumetric Water Content: [illegible]
Mv: [illegible]
K-Ratio: [illegible]
K-Direction: [illegible]

[illegible] shell rock fragment
Model: [illegible]
Hydraulic
K-Function: [illegible]
Vol. WC. Function: [illegible]
K-Ratio: [illegible]
K-Direction: [illegible]

[illegible] sandy lean clay
Model: [illegible]
Hydraulic
K-Function: [illegible]
Vol. WC. Function: [illegible]
K-Ratio: 1
K-Direction: [illegible]

clay foundation - [illegible]
Model: [illegible]
Hydraulic
K-Sat: [illegible]
Volumetric Water Content: [illegible]
Mv: [illegible]
K-Ratio: [illegible]
K-Direction: [illegible]

Weathered shale
Model: [illegible]
Hydraulic
K-Sat: [illegible]
Volumetric Water Content: [illegible]
Mv: [illegible]
K-Ratio: [illegible]
K-Direction: [illegible]

[illegible] - Second raising
Model: [illegible]
Hydraulic
K-Function: [illegible]
Vol. WC. Function: [illegible]
K-Ratio: [illegible]
K-Direction: [illegible]

silty clay - foundation at toe [illegible]
Model: [illegible]

Section [illegible]

Hydraulic
K-Sat: [illegible]
Volumetric Water Content: [illegible]
Mv: [illegible]
K-Ratio: [illegible]
K-Direction: [illegible]

Outer shell lower permeability
Model: [illegible]
Hydraulic
K-Function: [illegible]
Vol. WC. Function: [illegible]
K-Ratio: [illegible]
K-Direction: [illegible]

Boundary Conditions

Potential Seepage Face
Review: [illegible]
Type: [illegible]

Pending Pool Level
Function: [illegible]
Type: [illegible]

Constant Head [illegible]
Type: [illegible]

Zero Flux
Type: [illegible]

Initial Water Tables

Initial Water Table 1
Max. Negative Head: [illegible]
Coordinates
Coordinate: [illegible]
Coordinate: [illegible]

Flux Sections

Flux Section 1
Coordinates
Coordinate: [illegible]
Coordinate: [illegible]

Flux Section 2
Coordinates
Coordinate: [illegible]
Coordinate: [illegible]

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Flux Section 3
Coordinates
Coordinate: [illegible]
Coordinate: [illegible]

K Functions

Outer Shell - clayey sand

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K Saturation: [illegible]
Data Points: [illegible]
Data Point: [illegible]
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Data Point: [illegible]
Data Point: [illegible]
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Data Point: [illegible]
Data Point: [illegible]
Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K Function Estimation Method: [illegible]
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: [illegible]

Compacted Ash

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K Saturation: [illegible]
Data Points: [illegible]
Data Point: [illegible]
Data Point: [illegible]

Section B

Data Point: [illegible]
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Data Point: [illegible]
Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K Function Estimation Method: [illegible]
Maximum: 1000
Minimum: 0.01
Num. Points: 20
Residual Water Content: [illegible]

Original Dike-clay with gravel

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K Saturation: [illegible]
Data Points: [illegible]
Data Point: [illegible]
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Data Point: [illegible]

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Section [illegible]

Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]
Residual Water Content: [illegible]

[illegible] clayey silty sand
Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K Saturation: [illegible]
Data Points: [illegible]
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Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]
Residual Water Content: [illegible]

Rock fragment
Model: Data Point Function
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K Saturation: [illegible]
Data Points: [illegible]
Data Point: [illegible]
Data Point: [illegible]

Section [illegible]

Data Point: [illegible]
Data Point: [illegible]
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Data Point: [illegible]
Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]
Residual Water Content: [illegible]

Original [illegible] sandy lean clay
Model: Data Point Function
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K Saturation: [illegible]
Data Points: [illegible]
Data Point: [illegible]
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Data Point: [illegible]

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Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K-Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]
Residual Water Content: [illegible]

Outer shell - silt lower permeability

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K-Saturation: [illegible]
Data Points: [illegible]
Data Point: [illegible]
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Data Point: [illegible]
Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K-Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]
Residual Water Content: [illegible]

Layer

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K-Saturation: [illegible]
Data Points: [illegible]
Data Point: [illegible]
Data Point: [illegible]

Data Point: [illegible]
Data Point: [illegible]
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Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K-Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]
Residual Water Content: [illegible]

Hydraulic Boundary Functions

Pool Level 3ft ... year

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Y-Intercept: [illegible]
Data Points: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]

Vol. Water Content Functions

Outer shell clayey sand

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]

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Section 5

Mv: [illegible]
Saturated Water Content: [illegible]
Porosity: [illegible]
Data Points: [illegible] Water Content [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
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Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Estimation Properties
Vol. WC Estimation Method: [illegible]
Sample Material: [illegible]
Saturated Water Content: [illegible]
Liquid Limit: [illegible]
Diameter at 10% passing: [illegible]
Diameter at 60% passing: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]

Compacted Ash

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Mv: [illegible]
Saturated Water Content: [illegible]
Porosity: [illegible]
Data Points: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
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Data Point: [illegible]
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Data Point: [illegible]

Section 6

Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Estimation Properties
Vol. WC Estimation Method: [illegible]
Sample Material: [illegible]
Saturated Water Content: [illegible]
Liquid Limit: [illegible]
Diameter at 10% passing: [illegible]
Diameter at 60% passing: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]

Original Silt in clay with gravel

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Mv: [illegible]
Saturated Water Content: [illegible]
Porosity: [illegible]
Data Points: [illegible]
Data Point: [illegible]
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Data Point: [illegible]
Data Point: [illegible]
Estimation Properties
Vol. WC Estimation Method: [illegible]
Sample Material: [illegible]
Saturated Water Content: [illegible]

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Liquid Limit: [illegible]
Diameter at 10% passing: [illegible]
Diameter at 60% passing: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]

[illegible] clayey silt
Model: [illegible]
Function: Vol. Water Content [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Mv: [illegible]
Saturated Water Content: [illegible]
Porosity: [illegible]
Data Points: Matric Suction [illegible], Vol. Water Content [illegible]
Data Point: [illegible]
Data Point: [illegible]
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Estimation Properties
Vol. WC Estimation Method: [illegible]
Sample Material: [illegible]
Saturated Water Content: [illegible]
Liquid Limit: [illegible]
Diameter at 10% passing: [illegible]
Diameter at 60% passing: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]

Rock [illegible]
Model: [illegible]
Function: Vol. Water Content [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Mv: [illegible]
Saturated Water Content: [illegible]

Section B

Porosity: [illegible]
Data Points: Matric Suction [illegible], Vol. Water Content [illegible]
Data Point: [illegible]
Data Point: [illegible]
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Data Point: [illegible]
Estimation Properties
Vol. WC Estimation Method: [illegible]
Sample Material: [illegible]
Saturated Water Content: [illegible]
Liquid Limit: [illegible]
Diameter at 10% passing: [illegible]
Diameter at 60% passing: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]

Original [illegible] clay
Model: Data Point Function
Function: Vol. Water Content [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Mv: [illegible]
Saturated Water Content: [illegible]
Porosity: [illegible]
Data Points: Matric Suction [illegible], Vol. Water Content [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
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Section [illegible]

Data Point: [illegible]
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Data Point: [illegible]
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Data Point: [illegible]

Estimation Properties
Vol. WC Estimation Method: [illegible]
Sample Material: [illegible]
Saturated Water Content: [illegible]
Liquid Limit: [illegible]
Diameter at 10% passing: [illegible]
Diameter at 60% passing: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]

Low Permeability Berm
Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Max: [illegible]
Saturated Water Content: [illegible]
Secondary: [illegible]
Data Points: [illegible]
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Data Point: [illegible]

Estimation Properties
Vol. WC Estimation Method: [illegible]
Sample Material: [illegible]
Saturated Water Content: [illegible]
Liquid Limit: [illegible]
Diameter at 10% passing: [illegible]

Section [illegible]

Diameter at 60% passing: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]

Regions

	Material	Points	Area (ft²)
[illegible]	[illegible]	[illegible]	[illegible]

Lines

	Start Point	End Point	Hydraulic Boundary
[illegible]	[illegible]	[illegible]	[illegible]

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Section B

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Section B

[illegible]

Points

	X (ft)	Y (ft)	Hydraulic Boundary
[illegible]	[illegible]	[illegible]	[illegible]

Section B

[illegible]

AEPCR000564

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SEEP/W Analysis

File Information

- Created By: [illegible]
- Revision Number: [illegible]
- Last Edited By: [illegible]
- Date: [illegible]
- Time: [illegible]
- File Name: [illegible]
- Directory: [illegible]

Project Settings

- Length(L) Units: [illegible]
- Time(t) Units: [illegible]
- Force(F) Units: [illegible]
- Pressure(p) Units: [illegible]
- Mass(M) Units: [illegible]
- Mass Flux Units: [illegible]
- Unit Weight of Water: [illegible]
- View: [illegible]

Analysis Settings

SEEP/W Analysis

- Description: [illegible]
- Kind: [illegible]
- Method: [illegible]
- Settings
  - Initial PWP: [illegible]
  - Include Air Flow: [illegible]
- Control
  - Apply Runoff: [illegible]
- Convergence
  - Maximum Number of Iterations: [illegible]
  - Tolerance: [illegible]
  - Maximum Change in K: [illegible]
  - Rate of Change in K: [illegible]
  - Minimum Change in K: [illegible]
  - Equation Solver: [illegible]
  - Potential Seepage Max # of Reviews: [illegible]
- Time
  - Starting Time: [illegible]
  - Duration: [illegible]
  - # of Steps: [illegible]
  - Step Generation Method: [illegible]
  - Save Steps Every: [illegible]
  - Use Adaptive Time Stepping: [illegible]

Materials

Outer shell-silty sand and shale fragments

- Model: [illegible]
- Hydraulic
  - K-Function: [illegible]
  - Vol. WC. Function: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

Fine gray sandy silt

- Model: [illegible]
- Hydraulic
  - K-Function: [illegible]
  - Vol. WC. Function: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

Original Dike - clay with gravel

- Model: [illegible]
- Hydraulic
  - K-Function: [illegible]
  - Vol. WC. Function: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

First Raising Compacted Ash

- Model: [illegible]
- Hydraulic
  - K-Function: Compacted Ash
  - Vol. WC. Function: Compacted Ash
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

Fly ash

- Model: [illegible]
- Hydraulic
  - K-Sat: [illegible]
  - Volumetric Water Content: [illegible]
  - Mv: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

Foundation-Gray silt and sandy silt 02-UL4

- Model: [illegible]
- Hydraulic
  - K-Sat: [illegible]
  - Volumetric Water Content: [illegible]
  - Mv: [illegible]
  - K-Ratio: [illegible]
  - K-Direction: [illegible]

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Section C

Cold Rock
Model: [illegible]
Hydraulic
K-Sat: [illegible]
Volumetric Water Content: [illegible]
Mv: [illegible]
K-Ratio: 1
K-Direction

[illegible] clayey sand [illegible]
Model: [illegible]
Hydraulic
K-Sat: [illegible]
Volumetric Water Content: [illegible]
Mv: [illegible]
K-Ratio: [illegible]
K-Direction: [illegible]

Weathered Shale
Model: [illegible]
Hydraulic
K-Sat: [illegible]
Volumetric Water Content: [illegible]
Mv: [illegible]
K-Ratio: [illegible]
K-Direction: [illegible]

Second [illegible] shale rock [illegible]
Model: [illegible]
Hydraulic
K-Function: [illegible]
Vol. WC. Function: [illegible]
K-Ratio: 1
K-Direction: [illegible]

Foundation [illegible] clay - [illegible]
Model: [illegible]
Hydraulic
K-Sat: [illegible]
Volumetric Water Content: [illegible]
Mv: [illegible]
K-Ratio: 1
K-Direction: [illegible]

Boundary Conditions

Potential Seepage Face
Review: [illegible]
Type: [illegible]

Standing Pool Level
Function: [illegible]

Section C

Type: [illegible]

Constant Head 1523
Type: [illegible]

Zero Flux
Type: [illegible]

Initial Water Tables

Initial Water Table 1
Max. Negative Head: 5
Coordinates
Coordinate: [illegible]
Coordinate: [illegible]

Flux Sections

Flux Section 1
Coordinates
Coordinate: [illegible]
Coordinate: [illegible]

Flux Section 2
Coordinates
Coordinate: [illegible]
Coordinate: [illegible]

Flux Section 3
Coordinates
Coordinate: [illegible]
Coordinate: [illegible]

K Functions

[illegible] shell - clayey sand
Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K-Saturation: [illegible]
Data Points: [illegible]
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Data Point: [illegible]
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Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K-Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]
Residual Water Content: [illegible]

Compacted Ash

Model: [illegible]
Function: [illegible] Water [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K Saturation: [illegible]
Data Points: [illegible]
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Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K-Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]

Num. Points: [illegible]
Residual Water Content: [illegible]

Original Dike clay with grave

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K Saturation: [illegible]
Data Points: [illegible]
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Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K-Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]
Residual Water Content: [illegible]

Toe-sandy silt

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K Saturation: [illegible]
Data Points: [illegible]
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Data Point: [illegible]
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Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K-Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]
Residual Water Content: [illegible]

Outer shell - silt lower permeability

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
K Saturation: [illegible]
Data Points: [illegible]
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Estimation Properties
Volume Water Content Function: [illegible]
Hydraulic K Sat: [illegible]
Hyd. K-Function Estimation Method: [illegible]
Maximum: [illegible]
Minimum: [illegible]

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Num. Points: [illegible]
Residual Water Content: [illegible]

Hydraulic Boundary Functions

Pool Level [illegible] per year

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Y-Intercept: [illegible]
Data Points: [illegible]
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Data Point: [illegible]

Vol. Water Content Functions

Outer shell clayey sand

Model: [illegible]
Function: [illegible]
Curve Fit to Data: [illegible]
Segment Curvature: [illegible]
Mv: [illegible]
Saturated Water Content: [illegible]
Porosity: [illegible]
Data Points: [illegible]
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Data Point: [illegible]

Section C

Estimation Properties

Vol. WC Estimation Method: [illegible]

Sample Material: [illegible]

Saturated Water Content: [illegible]

Liquid Limit: [illegible]

Diameter at 10% passing: [illegible]

Diameter at 60% passing: [illegible]

Maximum: [illegible]

Minimum: [illegible]

Num. Points: [illegible]

Compacted Ash

Model: Data Point Function

Function: Vol. Water Content vs. Pore-Water Pressure

Curve Fit to Data: [illegible]

Segment Curvature: [illegible]

Mv: [illegible]

Saturated Water Content: [illegible]

Porosity: [illegible]

Data Points: Matric Suction, Vol. Water Content [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

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Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Estimation Properties

Vol. WC Estimation Method: Grain Size Function

Sample Material: [illegible]

Saturated Water Content: [illegible]

Liquid Limit: [illegible]

Diameter at 10% passing: [illegible]

Diameter at 60% passing: [illegible]

Maximum: [illegible]

Minimum: [illegible]

Num. Points: [illegible]

Original Dike Clay with gravel

Model: Data Point Function

Function: Vol. Water Content vs. Pore-Water Pressure

Section C

Curve Fit to Data: [illegible]

Segment Curvature: [illegible]

Mv: [illegible]

Saturated Water Content: [illegible]

Porosity: [illegible]

Data Points: Matric Suction, Vol. Water Content [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

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Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Estimation Properties

Vol. WC Estimation Method: Grain Size Function

Sample Material: [illegible]

Saturated Water Content: [illegible]

Liquid Limit: [illegible]

Diameter at 10% passing: [illegible]

Diameter at 60% passing: [illegible]

Maximum: [illegible]

Minimum: [illegible]

Num. Points: [illegible]

Tan sandy silt

Model: Data Point Function

Function: Vol. Water Content vs. Pore-Water Pressure

Curve Fit to Data: [illegible]

Segment Curvature: [illegible]

Mv: [illegible]

Saturated Water Content: [illegible]

Porosity: [illegible]

Data Points: Matric Suction, Vol. Water Content [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

Data Point: [illegible]

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Section C

Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
Data Point: [illegible]
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Data Point: [illegible]

Estimation Properties

Vol. WC Estimation Method: [illegible]
Sample Material: [illegible]
Saturated Water Content: 0.33 [illegible]
Liquid Limit: [illegible]
Diameter at 10% passing: [illegible]
Diameter at 50% passing: [illegible]
Maximum: [illegible]
Minimum: [illegible]
Num. Points: [illegible]

Regions

	Material	Points	Area (ft²)
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Region 4	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Air/ash	[illegible]	[illegible]
[illegible]	[illegible]	47,48,41,49,44	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Section C

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Lines

	Start Point	End Point	Hydraulic Boundary
[illegible]	[illegible]	[illegible]	[illegible]

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Section C

Section C

Points

	x (ft)	y (ft)	Hydraulic Boundary
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	

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Section C

APPENDIX 5

STABILITY ANALYSIS REPORT AND RESULTS

Figures 5-1 through 5-6: Stability results of Section A

Figures 5-7 through 5-13: Stability results of Section A

Figures 5-13 through 5-19: Stability results of Section A

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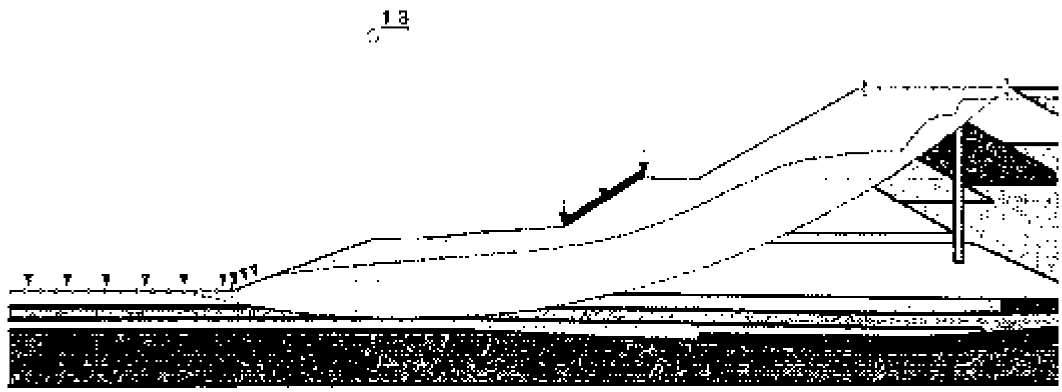

Figure 5.1. Stability of Section A under steady-state condition with a deep failure surface.

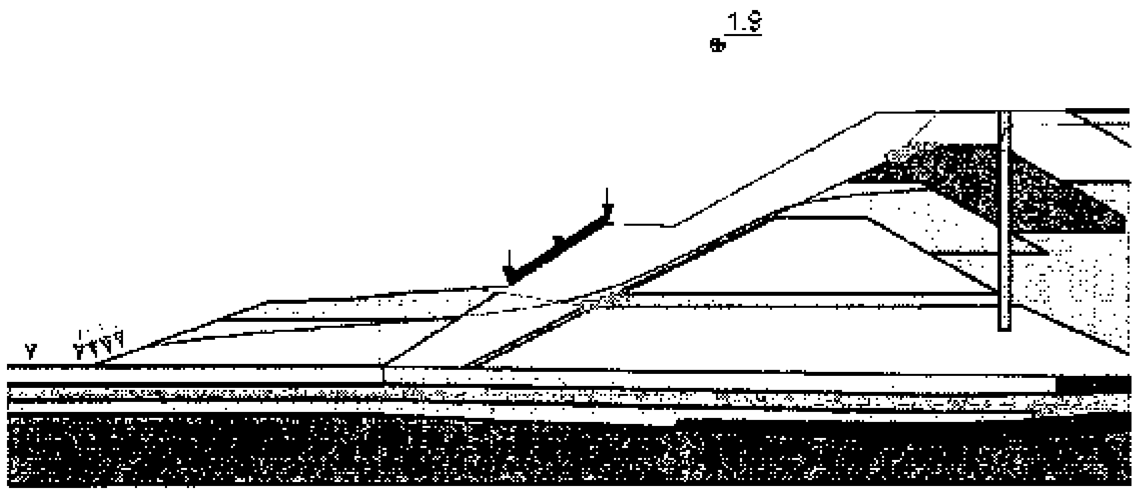

Figure 5.2. Stability of Section A under steady state seepage condition using block failure mode.

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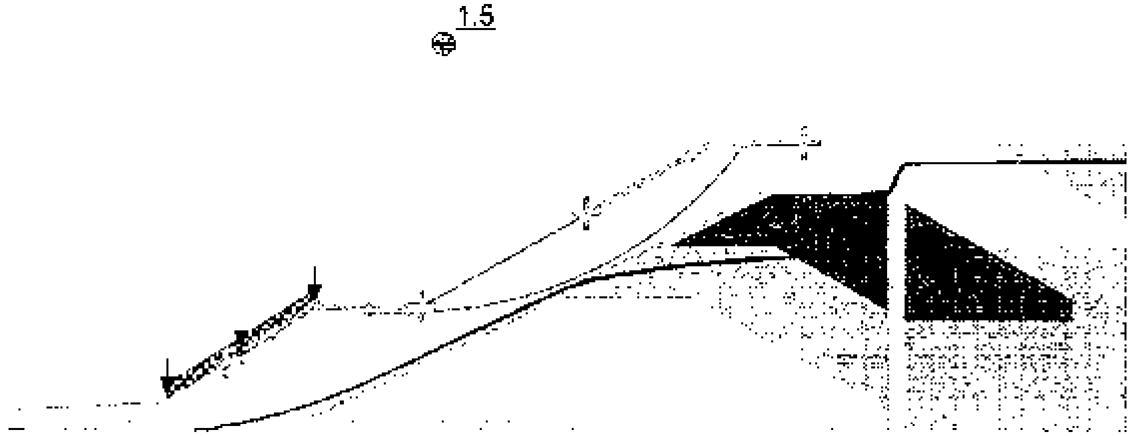

Figure 5.3. Stability of the outer shell of Section A under steady state seepage.

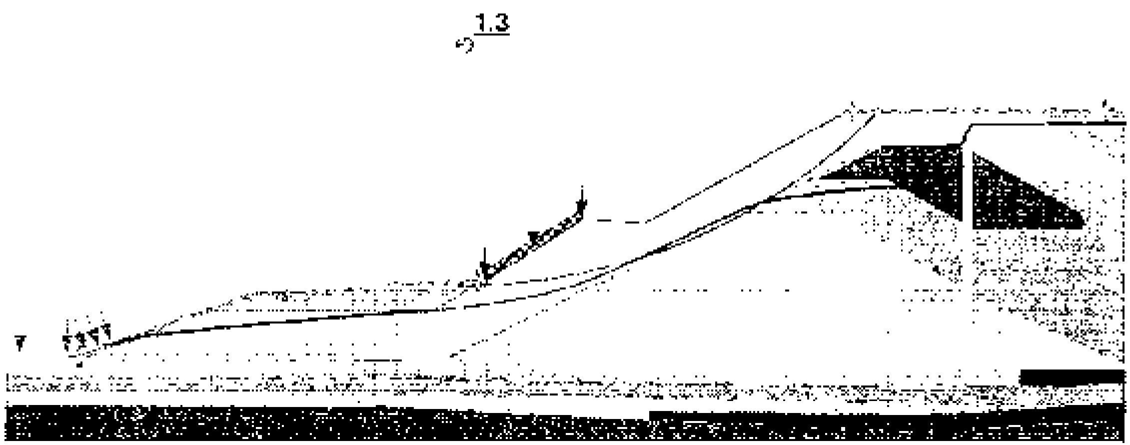

Figure 5.4. Critical failure surface and the corresponding factor of safety under seismic loading condition for Section A using drained material properties.

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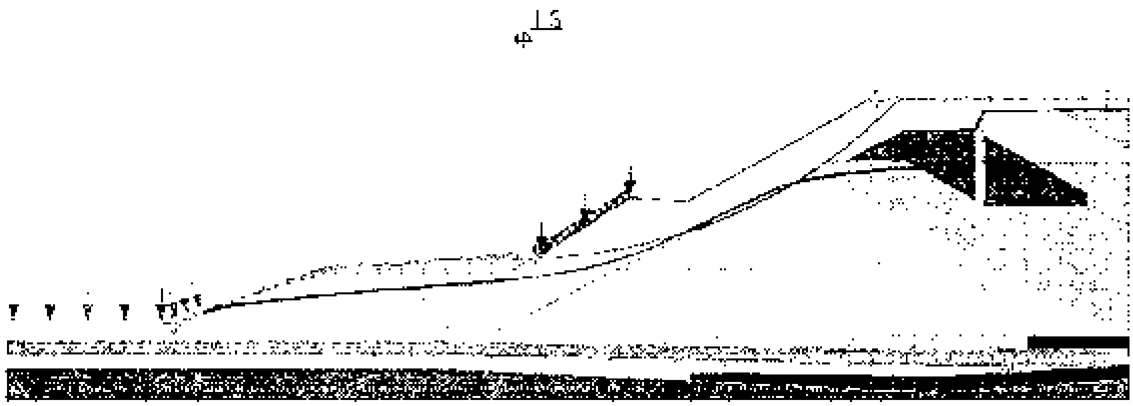

Figure 5.5. Critical failure surface and the corresponding factor of safety under seismic loading condition for Section A using consolidated undrained material properties.

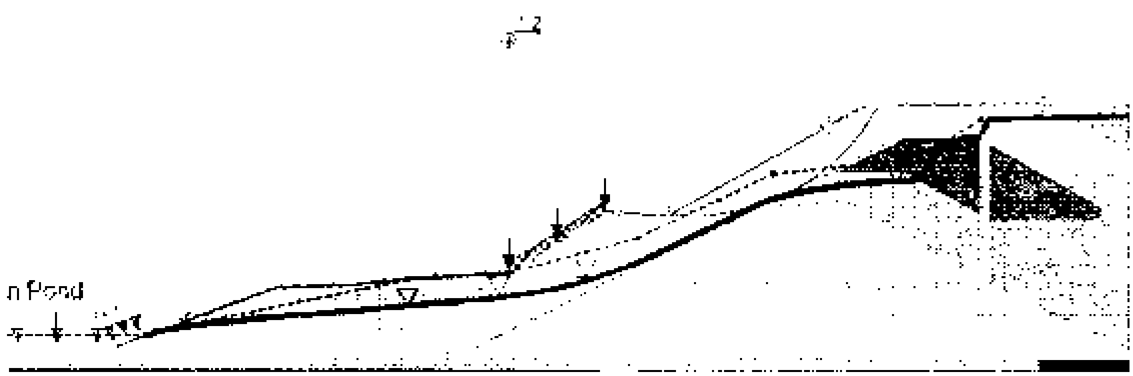

Figure 5.6. Stability of Section A after 7 ft raise in the piezometric water levels.

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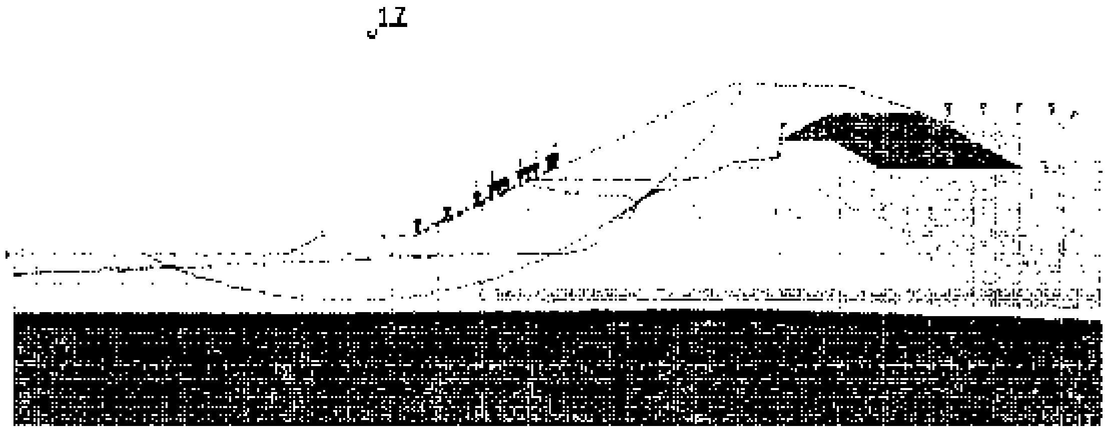

Figure 5.7. Stability of Section B under steady-state condition with a deep failure surface.

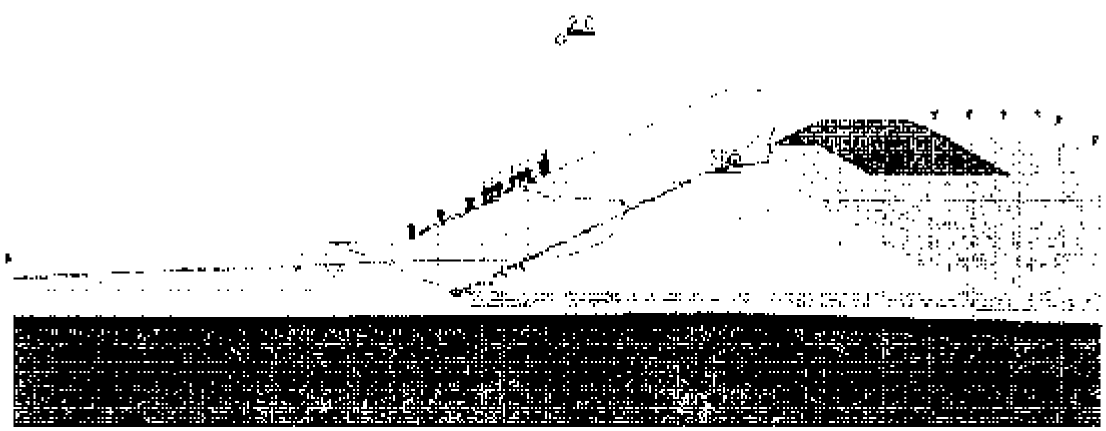

Figure 5.8. Stability of Section B under steady state seepage with a block failure mechanism.

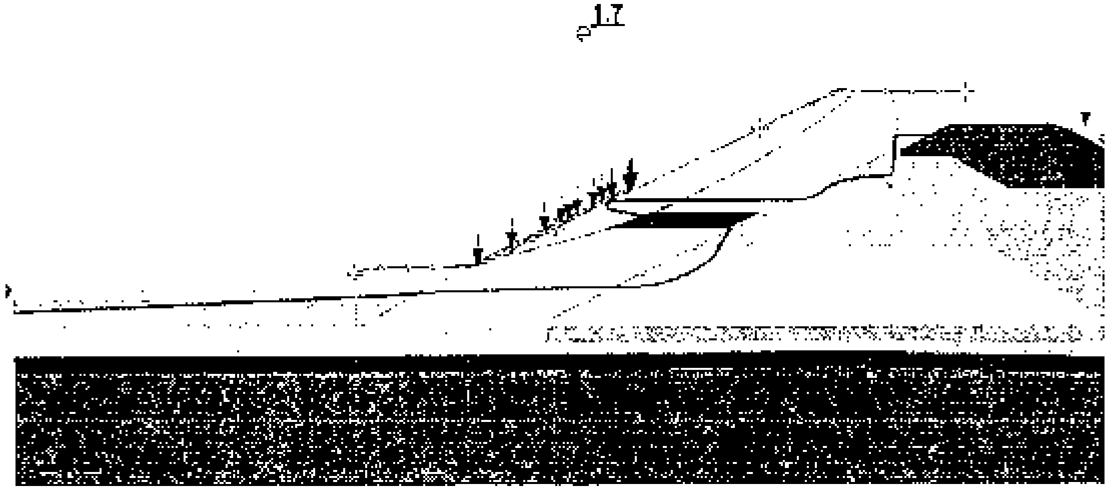

Figure 5.9. Stability of the outer shell of Section B under steady state seepage.

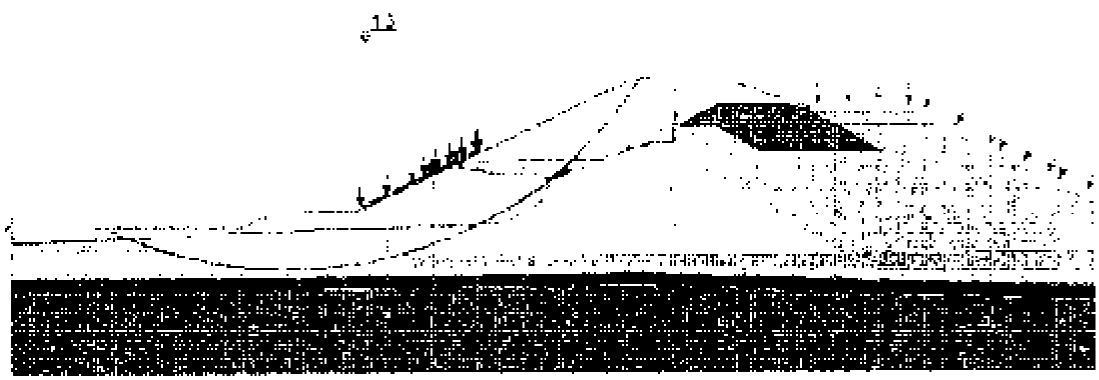

Figure 5.10. Stability analysis results of Section B under seismic loading using drained material properties.

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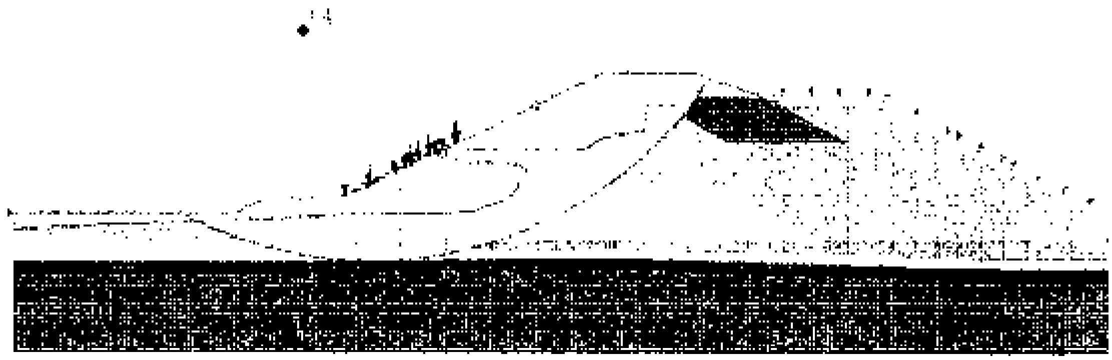

Figure 5.11. Stability analysis results of Section B under seismic loading using consolidated undrained material properties.

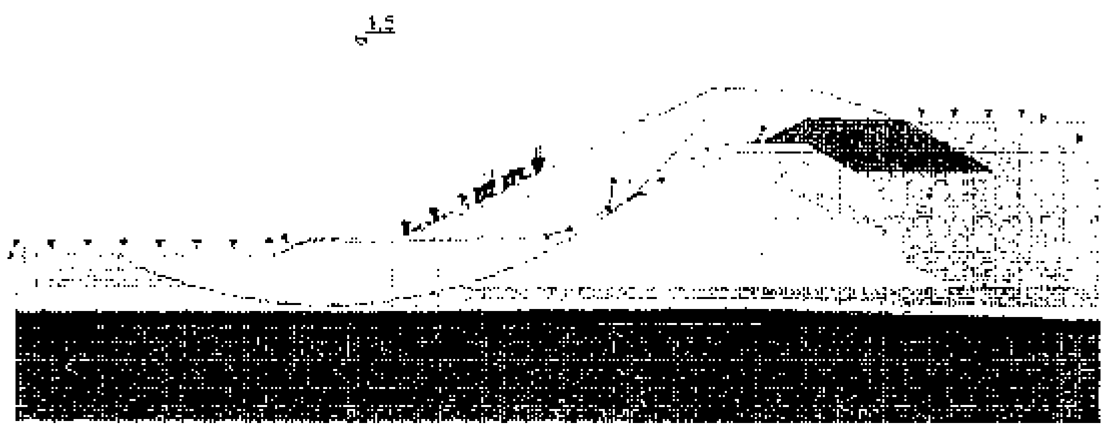

Figure 5.12. The warning water level for Section B was determined to be approximately 7 ft raise in the current piezometric levels.

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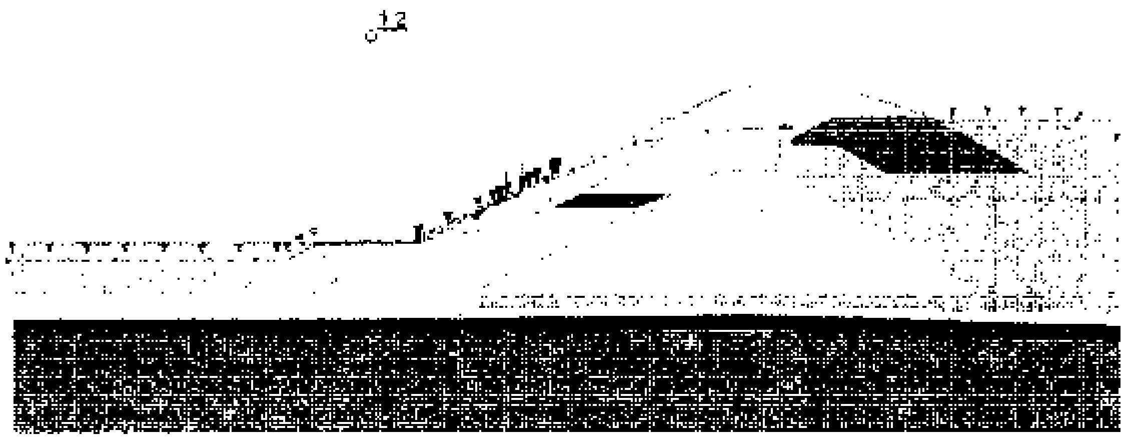

Figure 5.13. The critical water level for Section B is indicated by about 12 ft raise in the piezometric water levels at the crest or about 10 ft raise in the piezometric water levels at the toe.

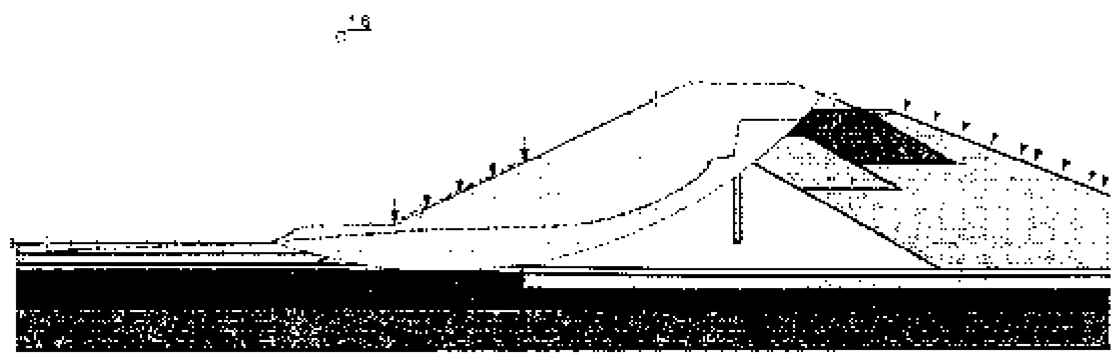

Figure 5.14. Stability of Section C under steady-state seepage condition with a deep failure surface.

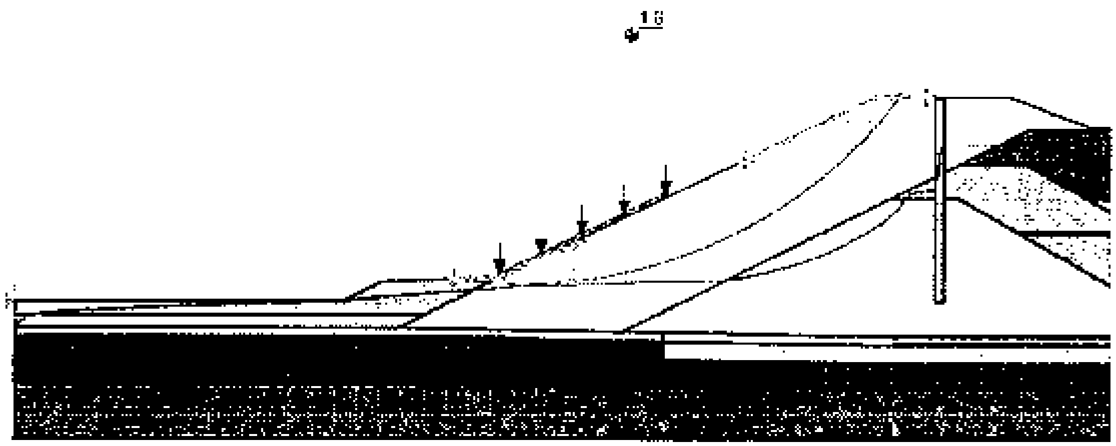

Figure 5.15. Stability of the outer shell of Section C under steady-state seepage condition.

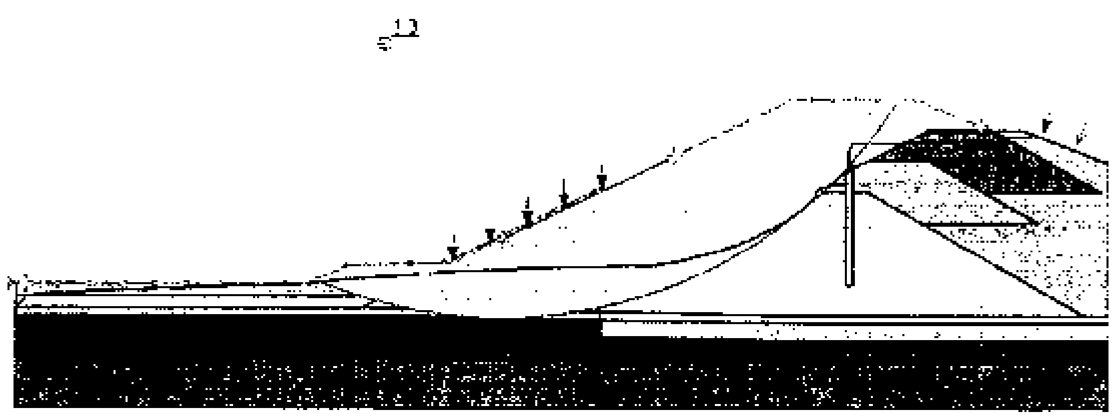

Figure 5.16. Stability of Section C under seismic loading condition using drained material shear strength.

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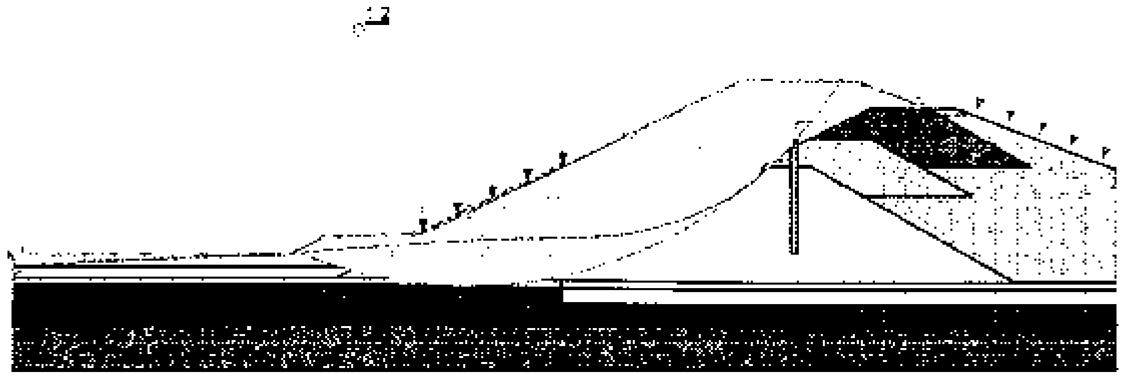

Figure 5.17. Stability of Section C under seismic loading condition using consolidated undrained shear strengths.

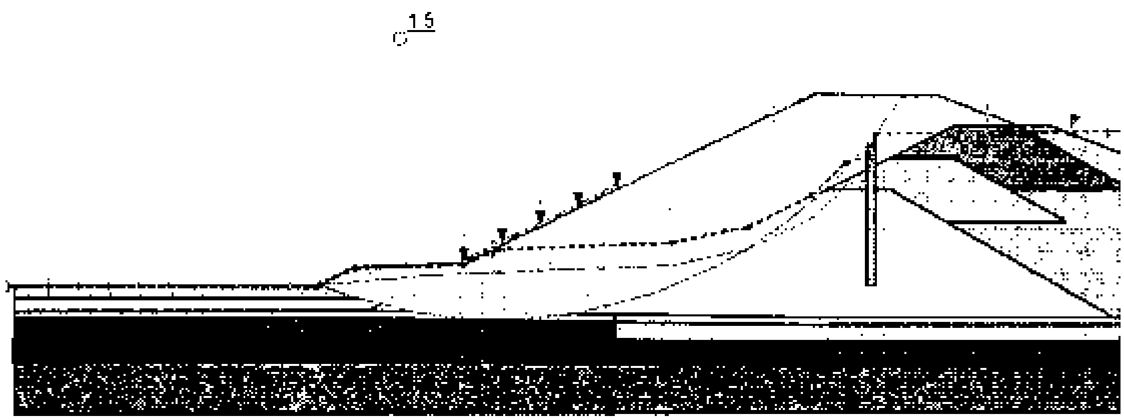

Figure 5.18. Stability analysis results for Section C after 7 ft increase of the phreatic water levels.

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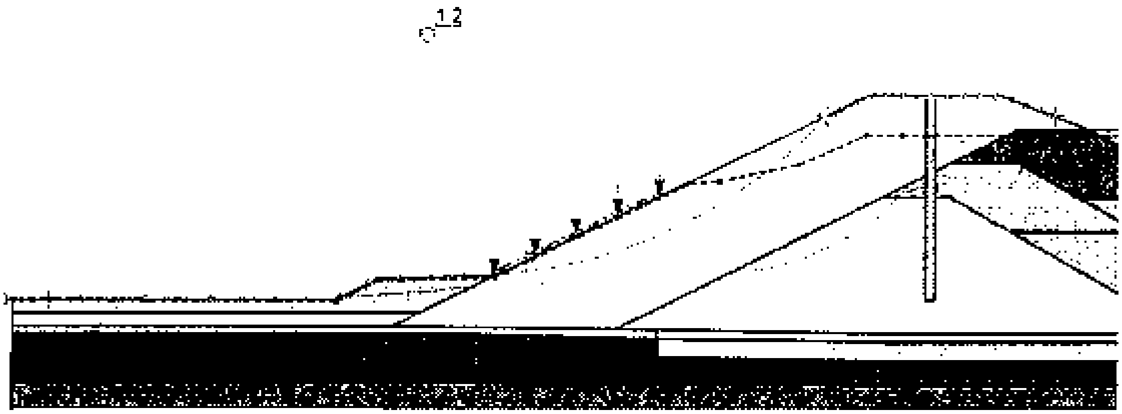

Figure 5.19. Stability analysis for Section C after 28 ft increase in the piezometric levels.

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APPENDIX A

Document 6

Ash Pond 2 Design Summary for Final Closure, by BBC&M Engineering

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January 15, 2009
001-11497-007

BBCM
SOLUTIONS TO BUILD ON

American Electric Power
Mr. Gary Zych, P.E
1 Riverside Plaza
Columbus, Ohio 43215

Re: Design Summary
Ash Pond 2 Final Closure
Clinch River Power Plant
Carbo, Virginia

Dear Mr Zych,

In accordance with our June 27, 2008 proposal, and written authorization on July 1, 2008, BBC&M Engineering, Inc. has completed engineering and design services associated with the final closure of Ash Pond No. 2 at the Clinch River Power Plant near Carbo, Virginia.

BBCM's scope of work consisted of engineering, design and permitting of the cap system for final closure under Virginia regulations, generally following the intent of the Virginia Department of Environmental Quality (VADEQ) regulations and guidelines, for Industrial Waste Disposal Facilities

Design Summary

It is proposed to close Clinch River Ash Pond No. 2 through re-grading and the application of a cap and vegetative cover The existing surface will be re-graded and filled to achieve a gently sloping (5%) surface to promote surface water runoff. The re-graded ash surface will be covered with a flexible geomembrane covered by a geocomposite drainage layer and 2-feet of soil fill. The surface of the soil fill will be seeded and mulched to promote the growth of a vegetative cover. Surface water run-on from the adjacent slope will be diverted and runoff from the capped areas will be directed into one of two sediment ponds, prior to being discharged into Dumps Creek

Drawings

Working in close association with AEP, drawings have been prepared for bidding and construction The drawings contain an Existing Site Plan, Phasing Plan, Final Grading Plan, Cross Sections, Details and an Erosion & Sediment Control Plan and Details. The drawings were developed in conjunction with geotechnical and surface water considerations.

Part 1: Geotechnical Analyses

In support of the final closure plan, BBCM performed a subsurface investigation to assess the overall stability of the site with respect to the proposed cap geometry. Soil and rock borings were performed to augment previous borings which were used to define the subsurface

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conditions at the site. Soil and rock samples were obtained and laboratory testing was performed on selected samples recovered in the field

Geotechnical analyses were performed by BBCM using the results of the boring program and laboratory testing The analyses covered slope stability, liquefaction and settlement based on the new geometry and loads imposed by the capping. Results of the analyses indicate that the proposed final grades are stable under ordinary conditions as well as under seismic conditions

Results of the Subsurface Investigation including geotechnical analyses are included in Part 1 of this submittal

Part 2: Cover System Stability

The stability of the proposed final cover system was evaluated by BBCM considering the impact of rainfall. These calculations, included as Part 2, demonstrate that the cover system exhibits adequate factors of safety against surficial failure modes

Part 3: Surface Water Controls

A series of runoff control structures including diversion berms, ditches, channels, sediment ponds and spillways were designed by BBCM for the final closure of Ash Pond 2 Storm water runoff was computed using National Resource Conservation Service (NRCS) methodology, including TR-55. This methodology was used to determine peak discharge from a given drainage area under a given rainfall amount.

Rainfall events were obtained from NOAA Atlas 14, given the coordinates for the site. The 25-year, 24-hour storm event was the basis for design of surface water control structures The 25-year storm for this area is 4 23 inches Surface water control structures, such as ditches and berms, were designed to pass the peak runoff from a 25-year, 24-hour storm event.

Sediment ponds were designed to contain 134 cubic yards of runoff per acre of drainage area below the level of the principal spillway Sediment pond principal spillways have been sized to pass the runoff from a 2-year, 24-hour storm event, without flows entering the emergency spillway. Sediment Pond emergency spillways have been designed to pass the 25-year storm without overtopping the banks of the pond and maintaining at least 1-foot of freeboard Runoff from the various storm events were routed through the ponds using the HEC-1 computer program using computed storage/discharge relationships and watershed characteristics for each pond

Calculations for runoff, discharge and pond sizing are contained in Part 3 of this submittal.

Part 4: Estimated Quantities

BBCM developed estimated quantities for the various construction components and waste volume This information is summarized as Part 4

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We appreciate the opportunity to be of service to you on this project. If you have any questions, please feel free to contact us at any time

Respectfully Submitted,

BBC&M ENGINEERING, INC.
Dublin Office

Michael G. Rowland, P.E
Senior Engineer

STATE OF OHIO
MICHAEL GILBERT ROWLAND
E-65559
REGISTERED
PROFESSIONAL ENGINEER
7/15/09

Stephen J. Loskota, P E
Senior Project Engineer

Submitted: 1 Copy

Attachments:
- Part 1: Geotechnical Analysis Report
- Part 2: Cover System Stability
- Part 3: Surface Water
- Part 4: Quantity Estimate

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PART 1

GEOTECHNICAL ANALYSIS REPORT

December, 2008

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GEOTECHNICAL ANALYSIS REPORT
CLINCH RIVER POWER PLANT
POND NO. 2 FINAL CLOSURE
CARBO, VIRGINIA

Report to

AMERICAN ELECTRIC POWER SERVICE CORP.
COLUMBUS, OHIO

Prepared by

BBC&M ENGINEERING, INC.
GEOTECHNICAL ENGINEERS
COLUMBUS, OHIO

December, 2008

December 12, 2008
C01-11497-007

BBCM
SOLUTIONS TO BUILD ON

American Electric Power
Mr Gary Zych, P E
1 Riverside Plaza
Columbus, Ohio 43215

Re: Geotechnical Analysis Report – Pond 2 Closure Plans
Clinch River Power Plant
Carbo, Virginia

Dear Mr. Zych,

In accordance with our June 27, 2008 proposal, and written authorization on July 1, 2008, BBC&M Engineering, Inc has completed the geotechnical analysis in support of the design for the closure of Ash Pond No 2 at the Clinch River Power Plant near Carbo, Virginia

BBC&M's scope of work consisted of engineering, design and permitting of the cap system for final closure under Virginia regulations, generally following the intent of the Virginia Department of Environmental Quality (VADEQ) regulations and guidelines, for Industrial Waste Disposal Facilities. The following report is a summary of our geotechnical analyses consisting of slope stability, liquefaction potential, and settlement analyses These analyses focus on deep seated modes of failure The stability of the final cover system was assessed separately.

We appreciate the opportunity to be of service to you on this project If you have any questions, please feel free to contact us at any time.

Respectfully Submitted,

BBC&M ENGINEERING, INC.
Dublin Office

Michael G. Rowland, P E
Senior Engineer

Stephen J Loskota, P E
Senior Project Engineer

Submitted: 1 Electronic Copy

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INTRODUCTION

Project Description

BBCM Engineering, Inc (BBCM) has been retained by AEP to provide design services for the final closure of the inactive Ash Pond No 2 (Pond 2) at the AEP Clinch River Power Plant near Carbo, Virginia in Russell County Services included a surface and subsurface site investigation, engineering and design The permit application itself will be prepared by AEP The design of the final cover generally follows the intent of the Virginia Department of Environmental Quality (VADEQ) regulations and guidelines, for Industrial Waste Disposal Facilities This report addresses the Geotechnical Analysis portion of the design

Pond 2 consists of a three tiered dike system constructed to impound coal combustion byproducts (both bottom and fly ash) To be consistent with previous reports performed by AEP, the dikes were termed Lower Level, Middle Level, and Upper Level dikes, although they are also known as Dikes 1, 2 and 3, respectively. Based on information provided by AEP, BBCM understands operations at Pond No 2, which began around 1954, were discontinued in 1997 and the pond has been inactive since that time During active operations, fly ash and bottom ash were sluiced into the pond areas Over the years, the capacity of Pond 2 was increased through vertical expansions consisting of first increasing the height of the lower dike, then subsequently constructing the middle and upper dikes At this time, the upper portion of the impoundment remains open to the environment A cover system will provide final closure of the facility

The proposed pond closure design will utilize dry coal ash placed as structural fill to achieve a 5% grade sloping away from the hillside to allow surface water to drain from the 20 acre site As much as 30 feet of fill will be required in some areas to achieve the final grade The completed pond will then be capped with a flexible membrane liner, geocomposite drainage layer, and cover soil

Purpose of This Work

The purpose of this work was to assess the impact of the proposed final cover system on the stability of the existing ash pond as well as to generally assess the long term stability of the overall system It is understood that this report will be included with the permit application prepared by AEP The geotechnical analyses summarized in this report consist of an evaluation of potential for the existing ash to liquefy under a seismic event, the stability of the overall pond under the weight of the new cover system (under both normal and seismic conditions) and to estimate the settlement of the existing ash and foundation soils under the weight of the proposed cover system Each of these analyses are dependent upon the existing subsurface conditions. To this end, BBCM performed a limited subsurface investigation at the facility to supplement the existing extensive data Please note that only analyses dealing with the existing subsurface conditions have been included in this report Other analyses, such as hydrologic and hydraulic and the surficial stability of the final cover itself have been documented in a separate design report

Available Geotechnical Data

An extensive analysis of the stability of Ash Pond No 2 was performed by AEP in 1990 In this report, entitled "Stability Analysis of Clinch River Ash Pond Dikes" dated January, 1990 the construction and operation of the facility was reviewed and the results of a subsurface investigation were summarized As part of this investigation, five soil borings and piezometers were installed and a large number of consolidated-undrained triaxial shear tests and direct shear tests were performed.

As part of our work, BBCM reviewed the AEP report In the report, AEP examined various combinations of circular and block failure surfaces for the existing dike configuration, as well as a progressive failure mode. AEP also performed a sensitivity analyses by reducing the drained friction angle of the dikes by 2 degrees, and found this had little effect on the failure surface and its factor of safety Overall, AEP determined the stability of the clay dike system at Pond 2 was satisfactory and operations could continue without modification Additionally, BBCM understands that no major problems have occurred at Pond 2 since the time of the report Some time after Ash Pond 2 was taken out of service, portions of the upper dike (Dike 3), which had not been filled to capacity, were removed to prevent surface water ponding: otherwise the existing geometry is largely the same as it was at the time of the 1990 report.

Limit equilibrium slope stability analyses in the 1990 report were generally performed along a single cross-section generated through the facility. Such analyses provide a factor of safety as an output which represents the resisting forces (soil strength) divided by the driving forces. A factor of safety of 1 0 implies that the slope is in a state of incipient failure AEP's lowest computed factor of safety was 1 3 for the middle dike

CURRENT SUBSURFACE INVESTIGATION

As part of the design of the final closure of Pond 2, BBCM performed a limited subsurface Investigation which was intended to supplement the available information The focus of this investigation was to confirm the condition of the lower and middle dikes, to confirm the top of bedrock elevation across the site, and to investigate the condition of the impounded ash which will become the foundation for the final cover system The details of this investigation are described in the following sections

FIELD WORK

During the period of July 22 through August 6, 2008, AEP personnel performed eight (8) soil borings, designated B-1 through B-8, that were extended to depths ranging from 23 6 to 81.8 feet below existing grades A project geologist, (Certified Professional in the state of Virginia) from BBCM was onsite between July 22 and 23 to meet with AEP plant personnel. perform a reconnaissance of the overall site, position the borings in the field, log Borings B-3 and B-4, and coordinate survey work The remaining borings were logged by AEP personnel

Borings B-3 and B-4 were located on the crest of the lower and middle dikes, respectively Borings B-1 and B-8 were located between the middle and upper dikes and Borings B-2, B-6, and B-7 were located between the upper dike (partially removed at this time) and the hillside The boring locations, as shown on the Plan of Borings and presented as Plate 1 in the Appendix A, were selected and field located by BBCM personnel. The ground surface elevations of the borings were initially estimated from recent topographic mapping provided by AEP for preliminary analyses, and later

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recorded during a site survey Logs of all borings are submitted in the appendix as Plates 4 through 19

All borings were performed with a truck mounted drill rig and were advanced between sampling attempts using 3¼-inch I D hollow-stem augers At regular intervals, disturbed, but representative, samples were obtained by lowering a 2-inch O D split-barrel sampler to the bottom of the hole and driving it into the soil by blows from a 140-pound hammer freely falling 30 inches (Standard Penetration Test, ASTM D1586) Split barrel samples were examined immediately after recovery and representative portions of each sample were placed in air tight jars and retained for subsequent laboratory testing

Upon encountering auger refusal in Borings B-3 and B-6, a changeover was made to rock coring techniques to verify the presence and condition of the bedrock At these locations, bedrock core were obtained by using a NQ rock coring techniques with water as the circulating fluid Recovered rock cores were catalogued in the field and preserved in compartmented boxes and delivered to our laboratory for inspection, classification and testing The rock coring was performed in accordance with ASTM D 2113.

During drilling procedures, personnel from BBCM or AEP performed the following specific duties:

- examined all samples recovered from the borings;
- cleaned soil samples of cuttings and preserved representative portions in airtight glass jars;
- preserved bedrock samples in core boxes;
- prepared a log of each boring;
- made hand-penetrometer measurements in soil samples exhibiting cohesion; and,
- provided liaison between the field personnel and the Project Manager so that the field investigation could be modified in the event that unexpected subsurface conditions were encountered

At the completion of drilling, all recovered samples were transported to the BBCM laboratory for further examination and testing

LABORATORY TESTING

In the laboratory, the samples were visually identified and on representative samples, moisture contents, liquid and plastic limit determinations, and grain-size analyses were performed. Results of these index tests permit an evaluation of strength and compressibility characteristics of the soil by comparison with similar soils for which these characteristics have been previously determined. Based upon the results of the laboratory visual identifications and testing program, soil descriptions contained on the field logs were modified, if necessary and laboratory-corrected logs are submitted as Plates 4 through 19 in Appendix A Results of the laboratory tests are shown graphically on the individual boring logs and a summary of test results is presented on Plates 20 and 21 in Appendix A The results of the grain size analyses are presented in curve form on Plates 24 through 45 in Appendix A

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Soils described in this report have been classified basically in accordance with the Unified Soil Classification System, but this system has been augmented by the use of special adjectives to designate the approximate percentages of minor soil components for the naturally occurring soils Definitions of these special adjectives and an explanation of the symbols and terms used on the boring logs are presented on Plates 2 and 3 in Appendix A

GENERAL SUBSURFACE CONDITIONS

Consistent with the purpose of the ash pond, coal ash fill was predominantly encountered in the borings Borings B-1, B-2, B-5, B-6 and B-8 encountered coal ash at the surface to depths of boring completion or near auger refusal upon bedrock The coal ash generally consisted of very-loose to loose fly ash, with zones of bottom ash. Borings B-5 and B-6 encountered between 2.5 and 5.0 feet of medium stiff silty clay and clayey silt just above the bedrock surface. Borings B-3 and B-4 were drilled on top of the lower and middle dike, respectively The dike material encountered in these borings was primarily composed of medium-dense to dense fine to coarse gravel consisting of shale fragments, with zones of hard silty clay and clayey silt, and zones of fine to coarse sand Natural soils were encountered in Boring B-3 beneath the lower dike consisting of organic clayey silt and fine to medium sand above the bedrock surface. Beneath the middle dike, Boring B-4 encountered coal ash consisting of approximately 12 feet of medium-dense to very -dense ash followed by 30 feet of loose to medium-dense ash

Bedrock was encountered in Borings B-2 through B-7 at elevations ranging from 1491 2 to 1522 4 feet above Mean Sea Level (MSL) Based on descriptions of the rock core and rock fragments obtained in the split spoon samples, bedrock at the site consists of very-soft to soft gray shale and hard gray limestone Generally, bedrock encountered beneath the dike system consisted of the very-soft to soft shale. Both rock types exhibited massive bedding with many diagonal fractures Rock Quality Designation of (RQD) of the limestone ranged between 26 to 64%.

Groundwater observations were made as each boring was being advanced and measurements were made at the completion of drilling During drilling, groundwater was encountered within the borings at depths of 11 5 to 24 4 feet below the existing grade, with groundwater elevations generally decreasing as the borings approached Dump's Creek

DESIGN CROSS SECTION FOR ANALYSES

Geometry

The three tiered dike system created from subsequent vertical expansions of Pond 2 is demonstrated on the design section developed by AEP in 1990 As previously noted, however, the upper dike was intentionally partially removed to prevent surface water ponding. Thus, the upper dike is no longer well defined Based on topographic data provided by AEP, BBCM developed a cross section of the surface topography through the pond Since only the surficial topography has changed since AEP's analysis, the subsurface stratigraphy and geometry of the dikes as shown on BBCM's design cross section were created based on AEP's design cross-section, as well as information from

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the new borings The ash pond site stratigraphy consists principally of the clay dike system and the impounded fly ash Beneath the fly ash, a layer of bottom ash placed directly over the bedrock serves as a drainage layer, although this layer was not well defined in the borings The design cross section is presented in Appendix B with the slope stability analysis.

Soil Layers

Cover System

The proposed cover system extends up from the crest of the middle dike at a 5% slope until it intersects the hillside The cover will consist of 24 inches of soil cover over a geocomposite drainage system and a 30-MIL PVC geosynthetic liner The soil cover will consist mainly of existing onsite soil/rock spoils processed to obtain a maximum 6 inch particle size. Dry fly ash will be placed as structural fill to bring the existing ground surface up to the planned elevation before the cover system can be constructed Additional material information can be found in the Cover System design package and details of the cover system are shown on the design plans

Coal Ash

The existing impounded coal ash consists mainly of loose fly ash with zones of bottom ash and pond ash Deposits of ash range from 30 feet beneath the middle dike to approximately 60 feet in the area between the middle dike and the hillside As part of the 1990 report, AEP performed two direct shear tests on the impounded ash and delineated the ash into two separate layers based the time of placement The upper fly ash layer begins at Elevation 1539, which is the bottom elevation of the middle dike The direct shear tests performed on the fly ash samples yielded drained friction angles of 30 and 27 degrees for the lower and upper fly ash layers, respectively. Based on information available in literature (DiGioia and Nuzzo 1972) and the fact that actual laboratory testing was performed on these samples, BBCM believes that these values are reasonable to represent the long-term strength of the in-place fly ash

Clay/Shale Dikes

The existing dikes were constructed of a mixture of compacted clay shale and rock fill. likely excavated from the nearby hillside which is used to contain the ash The dikes have historically performed well without any major stability or seepage problems The middle dike was constructed inside of the lower dike and founded on the ponded coal ash retained by the lower dike AEP assumed a drained friction angle of 32 degress with a cohesion value of 200 psf for their stability analyses.

Utilizing the correlations between index properties and fully softened shear strength included in Stark et al 2005, BBC&M estimated the shear strength of the dike material based on liquid limit and clay size fraction values obtained from during laboratory testing The liquid limit for samples obtained in this material ranged from 19 to 29, while the average clay size fraction (% finer than 0.05 mm) was 24 Adjusting for the impact of ball milling and using an effective normal stress between 50 and 100 kPa (approximately equal to the effective stress range in the clay dikes), the correlation suggests a fully softened friction angle between 30 and 33 degrees. Therefore, the assumed friction angle of 32 degrees appears reasonable

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Bottom Fill

Historical drawings detail a layer of bottom ash constructed beneath Pond 2 and directly over bedrock to serve as a drainage layer In AEP's stability report, this layer is modeled with a thickness of 10 to 12 feet and described as the same material as the clay dikes and exhibiting the same strength characteristics Based on the new borings, this layer was shown to be inconsistent in thickness and extent Based on a consolidated-undrained triaxial shear test, AEP assigned a friction angle of 28.5 degrees and a cohesion of 200 psf to model the strength of this layer For BBCM's analyses, the value of 28.5 degrees was maintained, but the cohesion value was reduced to 0 psf recognizing the inconsistencies associated with defining this layer in the borings

Bedrock

Rock core samples obtained in Borings B-3 and B-8 show that the bedrock surface at the site consists of very-soft to soft shale beneath the dike system (Borings B-2 through B-5) to hard limestone at the base of the hillside (Boring B-6) With the exception of Boring B-6, these borings also indicate that the top of bedrock is relatively flat, varying from El 1491.2 to 1496.7 across the site Based on the site topography, BBCM believes that Pond 2 was constructed in the old river valley of Dumps Creeks, and that Dumps Creek may have actually been re-routed as part of construction; thus the reason for the flat bedrock surface

The shear strength of these rocks is largely a function of the presence of joints and of particular importance, slickenside surfaces. However, the factors of safety computed for both circular and translational failure surfaces were shown to be independent of the strength of the bedrock as all slip surface passed well above the bedrock

Strength Parameters

Shear strength parameters for the fly ash, the clay/shale dikes, the bottom ash fill layer, and the riprap fill were developed in the 1990 report These parameters were developed based on laboratory testing performed as part of the analyses With exception of the shear strength of the clay dikes, BBCM used AEP's values to carry out the stability analyses A summary of the values used are shown in Table 1 below

Table 1: Summary of material shear strength parameters for stability analyses.

Material Description	γ_{wet} *(pcf)*	*Drained Strength*		*Reference*
		Φ'	c' (psf)	
Proposed Ash Fill and Cover	100	32	0	Assumed Value
Upper Ash Layer	101	27	0	AEP Direct Shear
Lower Ash Layer	92	30	0	AEP Direct Shear
Clay/Shale Dikes	134	32[1]	100[2]	AEP Assumed value
Bottom Fill	129	28.5	0[2]	AEP CU Triaxial Shear
Rip-Rap	125	35	0	AEP Section 1

[1]Value confirmed through Index correlations for fully softened shear strength
[2]Value reduced from 200 psf

Groundwater Level

During active operations, the fly ash was considered to be in 'full saturation' due to the nature of the placement of the material, implying the groundwater level was equivalent with the top of the fly ash in the active filling areas AEP's analysis incorporated this elevated groundwater level, as operations at Pond 2 were planned to continue for several years. However, since operations at the plant have become inactive, the groundwater level has fallen to lower levels BBCM estimated groundwater levels within the existing ash impoundment based on the groundwater levels encountered during drilling within the new borings Existing piezometer wells at the site were checked, but satisfactory data was not attainable as they have generally stopped functioning

As shown in the Design Cross Section, the groundwater levels encountered between Borings B-3 through B-6 fall in succession as the borings are distanced further from the hillside and the groundwater level approaches the normal pool elevation of Dumps Creek The groundwater level beneath the middle dike is located approximately 44 feet below the top of the dike and approximately 23 feet below the bottom of dike. The groundwater surface is shown on Design Cross Section in Appendix B

With the design of the final closure plans, groundwater recharge from rainfall events will be significantly reduced; with the only possible source of groundwater impact from the potential seepage emanating from the existing hillside. For these reasons, BBCM believes that the assumed phreatic surface incorporated in the following analyses is reasonable to represent long term conditions.

ANALYSES AND RESULTS

Liquefaction Potential

AEP evaluated the design seismic parameters using GeoSlope's Quake/W software as part of the final closure analysis. The following paragraphs were submitted by AEP to summarize their findings:

> A numerical model was developed to assess the potential of liquefaction of the saturated fly ash at the ash pond 2 for the long term conditions after the closure of the pond in Clinch River Plant. The analysis was conducted using Quake/W 2007 program, a component of GeoStudio 2007, built by Geo-Slope International, Ltd
>
> The model was prepared by BBCM using Slope/W program based on a review of available data, and the field exploration program performed for this study, one critical cross-section was developed showing the various material zones. Dynamic material properties of saturated fly ash were based on cyclic traiaxial tests results performed at Ohio State University (OSU) Equivalent linear analysis was conducted with strain dependent modulus and damping relationships for other materials were estimated using published relationships Table 1 summarizes the static and dynamic material properties used in this analysis
>
> No historical Earthquake record was available to be used in the analysis, however, USGS 2002 Interactive Deaggragations website provides the most

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AEPCR000299

likely synthetic seismograph record for the specified location The obtained acceleration-time history was used as the loading force in this analysis (AEP used a horizontal acceleration coefficient of 0 187 for this analysis)

The performed dynamic analyses using Quake/W program provides details on earthquake-induced porewater pressure, stresses, and other important parameters for various points within the model. In addition, the program highlights location where liquefaction occurs According to the results of the dynamic analysis there was no liquefaction within the fly ash under the applied earthquake loading. Maximum horizontal and vertical movement at the ground surface deformation on the existing dikes were less than 0.2 inch.

Table 2 Strength Parameters Used in the Liquefaction Analysis

Material	*Unit weight (pcf)*	*Friction angle (°)*	*Cohesion (psf)*	*Gmax (psf)*	*Damping ratio*
Proposed Ash fill	100	32	0	4×10^5	0.03
Upper Ash Layer	101	27	0	4×10^5	0.03
Lower Ash Layer	92	30	0	1×10^5	0.05
Clay/Shale Dikes	134	32	100	8×10^5	0.04
Bottom Fill	129	28.5	0	6×10^6	0.03
Rip-Rap	125	37	0	1×10^7	0.02
Shale	140	15	1100	8×10^7	0.01

Global Slope Stability Analysis

Following an examination of the previous slope stability analyses by AEP, BBCM performed a limited number of slope stability analyses to assess what impact the proposed cover system and associated fill would have on the computed factors of safety. Limit equilibrium slope stability analyses were performed using the aforementioned design cross-section, which was based on the original design cross-section developed by AEP Please note that this work focused on the potential for failure surfaces to develop through the existing dike system The veneer stability of the proposed cover system (which is independent of soil borings) was assessed separately

The slope stability analyses were performed using the 2-D limit equilibrium computer program Slide V 5 035 developed by Rocscience, Inc Both circular and translational (block type) deep-seated failure surfaces were examined under static (long-term) and pseudo-static loading conditions for the final slope configuration; with the analysis focused on the stability of the middle dike Stability of the lower dike, which is not being modified as part of the proposed cover system design, was only considered in a translational failure in combination with the middle dike The graphical computer output for these analyses has been included with this report in Appendix B Army Corps of Engineers (ACOE) specifications for earthen embankment dams require a minimum factor of safety of 1 5 with respect to shear failure for static conditions, and 1.0 for pseudo-static loading conditions Overall, factors of safety computed during this analysis were higher than those computed by AEP in 1990 mainly due to the lowered

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groundwater level in the impoundment. The following table shows the computed factors of safety for each stability analyses performed for this report

Table 3. Summary of slope stability safety factors for final ash pond configuration.

Load Case	Computed FS	$FS_{REQ'D}$
Static Loading with Final Slopes -Circular Failure Surface	1 67	1 5
Static Loading with Final Slopes -Translational Failure Surface -Middle Dike	2 67	1 5
Static Loading with Final Slopes -Translational Failure Surface -Lower and Middle Dikes	2 29	1 5
Pseudo-Static Loading with Final Slopes -Circular Failure Surface	1 13	1 0

Settlement

BBCM used the design cross section to estimate the maximum settlement due to the surcharge from the ash fill for the proposed cover. Settlements estimates were performed using the one-dimensional compression software FoSSA version 2 0 developed by ADAMA Engineering, Inc which is intended for the analyses of embankments and foundations Typical consolidation parameters of fly ash were used for the preliminary calculations. The lower fly ash layer was assigned a slightly lower compression index value in correlation with its higher shear strength derived from the direct shear test

Table 5: Consolidation parameter of impounded fly ash

Material Description	γ_{wet} *(pcf)*	*Poisons Ratio* v	Compression Index, c_c	*Recompression Index,* c_r	*Void Ratio* e_o
Upper Ash Layer	101	0 5	0 20	03	0 8
Lower Ash Layer	92	0 5	0.15	03	0 8

Results of the analysis indicate that settlement of the fly ash foundation in the range of 1.8 to 2.7 feet may be expected in areas of the foundation subjected to the thickest cover. Although modeled as a consolidation response, settlement should occur relatively quickly during construction due to the permeability characteristics of the fly ash and therefore settlement is not expected to adversely affect the cover system Output from the analysis is presented in Appendix C

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CONCLUSIONS

BBCM performed slope stability analyses, examined liquefaction potential, and estimated the maximum foundation settlement in support of our cover system design for Pond No. 2 at the Clinch River Power Plant BBCM believes the stability of the dike system has improved since operations at Pond 2 became inactive The additional driving forces on the middle dike created from the proposed fill and cover system had a smaller affect on the factor of safety in comparison to the drop in the groundwater level As discussed, it was concluded that the liquefaction would not be initiated under the design earthquake load Additionally, settlement is not expected to adversely affect the cover system as the majority of settlement should occur during placement of the fill layer, prior to constructing the final cover system.

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APPENDIX A: Subsurface Investigation

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EXPLANATION OF SYMBOLS AND TERMS USED ON BORING LOGS FOR SAMPLING AND DESCRIPTION OF SOIL

SAMPLING DATA

- Blocked-in "SAMPLES" column indicates sample was attempted and recovered within this depth interval

- Sample was attempted within this interval but not recovered

2/5/9 - The number of blows required for each 6-inch increment of penetration of a "Standard" 2-inch O D split-barrel sampler, driven a distance of 18 inches by a 140-pound hammer freely falling 30 inches. Addition of one of the following symbols indicates the use of a split-barrel other than the 2" O D. sampler:

2S - 2½"O D split-barrel sampler

3S - 3" O D split-barrel sampler

P - Shelby tube sampler, 3" O D , hydraulically pushed

R - Refusal of sampler in very-hard or dense soil, or on a resistant surface

50-2" - Number of blows (50) to drive a split-barrel sampler a certain number of inches (2), other than the normal 6-inch increment

S/D - Split-barrel sampler (S) advanced by weight of drill rods (D),

S/H - Split-barrel sampler (S) advanced by combined weight of rods and drive hammer (H)

SOIL DESCRIPTIONS

All soils have been classified basically in accordance with the Unified Soil Classification System, but this system has been augmented by the use of special adjectives to designate the approximate percentages of minor components as follows:

Adjective	Percent by Weight
trace	1 to 10
little	11 to 20
some	21 to 35
"and"	36 to 50

The following terms are used to describe density and consistency of soils:

Term (Granular Soils)	Blows per foot (N_{60})
Very-loose	Less than 5
Loose	5 to 10
Medium-dense	11 to 30
Dense	31 to 50
Very-dense	Over 50

Term (Cohesive Soils)	Qu (tsf)
Very-soft	Less than 0 25
Soft	0.25 to 0 5
Medium-stiff	0.5 to 1 0
Stiff	1 0 to 2 0
Very-stiff	2 0 to 4 0
Hard	Over 4 0

PLATE 2

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EXPLANATION OF SYMBOLS AND TERMS USED ON BORING LOGS FOR SAMPLING AND DESCRIPTION OF ROCK

SAMPLING DATA

When bedrock is encountered and rock core samples are attempted, the "SAMPLING EFFORT" column is used to record the type of core barrel used (NXM), the percentage of core recovered (REC) for each run of the sampler, and the Rock Quality Designation (ROD) value Rock-core barrels can be of either single- or double-tube construction, and a special series of double-tube barrels, designated by the suffix M, is commonly used to obtain maximum core recovery in very-soft or fractured rock Three basic groups of barrels are used most often in subsurface investigations for engineering purposes, and these groups and the diameters of the cores obtained are as follows:

AX, AW, AXM, AWM	-	1-1/8 inches
BX, BW, BXM, BWM	-	1-5/8 inches
NX, NW, NXM, NWM	-	2-1/8 inches

Rock Quality Designation (RQD) is expressed as a percentage and is obtained by summing the total length of all core pieces which are at least 4 inches long and then dividing this sum by the total length of core run. It has been found that there is a reasonably good relationship between the RQD value and the general quality of rock for engineering purposes This relationship is shown as follows:

RQD - %	General Quality
0 - 25	Very-poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

ROCK HARDNESS

THE FOLLOWING TERMS ARE USED TO DESCRIBE ROCK HARDNESS:

Term	Meaning	Mohs' Hardness
Very-soft	Rock such as shale can be easily picked apart by the fingers Sandstone is poorly cemented and very friable The rock resembles hard clay or dense sand, but has rock structure	Less than 1
Soft	Rock such as shale, siltstone or limestone can be scratched or powdered by fingernail pressure Sandstone is mostly poorly cemented, and individual sand grains can be separated from the main rock mass by a fingernail	1 to 1½
Medium-hard	Rock cannot be scratched by a fingernail, but can be powdered by a knife Sandstone is mostly well cemented, but individual grains can be removed by scratching with a knife.	2½ to 5½
Hard	Rock is well cemented and cannot be powdered by a knife. Rock can be powdered by a steel file	5½ to 6½
Very-hard	Rock cannot be scratched by a steel file and the core sample rings when struck with a hammer	Greater than 6½

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DATE: 7/28/08

LOG OF BORING NO. B-1
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

LOCATION: NAD 83 VA South Zone   COORDINATES: N 3521957.2; E 10404206.58   ELEVATION: 1558.4

DRILLING METHOD: 3-1/4" I.D. Hollow-stem Auger   COMPLETION DEPTH: 28.3'

SAMPLER(S): 2" O.D. Split-barrel Sampler

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLER EFFORT	N VALUE	SAMPLE REC-%	USCS	DESCRIPTION	TEST RESULTS
	0					ML-SM	FILL: Medium-dense to dense gray fly ash intermixed with bottom ash, dry	
		1	5/12/19	31	100			
	5							
		2	5/7/8	15	100			G
1548.4	10					ML-SM	FILL: Very-loose to loose gray fly ash, contains zones of bottom ash, moist	
		3	3/4/5	9	100			
	15							
		4	1/1/0	1	100			
	20							
1536.6		5	1/1/0	1	100	ML-SM	FILL: Very-loose gray fly ash, contains zones of bottom ash, contains few shale fragments, wet	MC=55 G
	25							
1530.1		6	1/1/0	1	67			
	30							
	35							

- Boring logged by AEP personnel
- Blind drilled 3-1/4" augers; no grounding procedures on this boring
- Static Water Level 0.0'; used 100 gallons of quick grout to grade

Chart: NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT; PLASTIC LIMIT — LIQUID LIMIT; 10 20 30 40

WATER LEVEL: 0.0
WATER NOTE: SWL
DATE: 7/28/08

SYMBOLS USED TO INDICATE TEST RESULTS: G = Gradations; S = Swell Consol; T = Triax Consol; C = Consol.; See Separate Curves; U = Unconfined (tsf); W = Unit Dry Wt (pcf); D = Relative Dens (%)

JOB: 011-11497-007

DATE: 8/6/08

LOG OF BORING NO. B-2
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

LOCATION: **NAD 83 VA South Zone** COORDINATES: N 3522090.54; E 10404660.72 ELEVATION: **1559.6**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **68.4'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N VALUE	SAMPLE REC-%	USCS	DESCRIPTION	TEST RESULTS
	0					ML-SM	FILL: Very-loose to loose gray fly ash intermixed with bottom ash, dry	
		1	3/1/1	2	60			
	5	2	3/2/4	6	100			
1547.2	10	3	3/2/4	6	100	ML-SM	FILL: Very-loose to loose gray fly ash intermixed with bottom ash, wet	
	15	4	2/4/2	6	100			
	20	5	1/2/5	7	100			
1532.2	25	6	1/1/2	3	100	ML-SM	FILL: Very-loose to loose gray fly ash, contains zones of bottom ash, wet	MC=66 G
	30	7	5/3/12	15	100			
	35							

NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT / PLASTIC LIMIT / LIQUID LIMIT: 10 20 30 40

WATER LEVEL: 35.4
WATER NOTE: Caved at 64.1'
DATE: 8/6/08

SYMBOLS USED TO INDICATE TEST RESULTS: G - Gradation; Sat

DATE: 8/6/08

LOG OF BORING NO. B-2
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

LOCATION: **NAD 83 VA South Zone** COORDINATES: N 3522090.54; E 10404660.72 ELEVATION: **1559.6**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **68.4'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV	DEPTH FEET	SAMPLE NUMBER	SAMPLE EFFORT	N VALUE	SAMPLE REC.%	USCS	DESCRIPTION	TEST RESULTS
	35					ML-SM	FILL: Very-loose to loose gray fly ash, contains zones of bottom ash, wet	
		8	1/0/2	2	100			
	40							
		9	SH/SH/SH		100			
	45							
		10	2/1/4	5	100			ML-SM G
	50							
		11	2/1/1	2	100			
	55							
		12	SH/SH/SH		100			
	60							
		13	5/3/6	9	100			
	65							
1492.3		14	5/17/50-1"R		73			
1491.2						SM	FILL: Medium-dense dark-gray bottom ash, wet	
	70							

NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT / PLASTIC LIMIT / LIQUID LIMIT: 10, 20, 30, 40

WATER LEVEL: 35.4
WATER NOTE: Caved at 64.1'
DATE: 8/6/08

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation; U - Uncon Comp; T - Triax Comp; C - Consol; See Separate Curves; P - Pocket Pen. (tsf); W - Unit Dry Wt (pcf); A - Atterberg Limits (%)

DATE: 8/6/08

LOG OF BORING NO. B-2
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

LOCATION: NAD 83 VA South Zone   COORDINATES: N 3522090.54; E 10404660.72   ELEVATION: 1559.6

DRILLING METHOD: 3-1/4" I.D. Hollow-stem Auger   COMPLETION DEPTH: 68.4'

SAMPLER(S): 2" O.D. Split-barrel Sampler

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N VALUE	SAMPLE REC-%	USCS	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT / PLASTIC LIMIT / LIQUID LIMIT (10 20 30 40)	TEST RESULTS
	70							- Boring logged by AEP personnel - Blind drilled 3-1/4" augers down; no grounding procedure used on this boring; moved boring 14' southwest - Drilling mud added to boring at 12.0' - Auger refusal encountered at 68.4'		
	75									
	80									
	85									
	90									
	95									
	100									
	105									

WATER LEVEL	▽ 35.4	▼	▼
WATER NOTE	Caved at 64.1'		
DATE	8/6/08		

SYMBOLS USED TO INDICATE TEST RESULTS: G - Gradation; O - Uncon. Comp.; T - Triax Comp.; C - Consol. — See Separate Figures; P - Pocket Penetrometer (tsf); N - Unit Dry Wt (pcf); S - Soluble Ions (%)

JOB: 011-11497-007

AEPCR000309

3018 N-VALUE WITH 1149700 GPJ BBCM.GDT 11/6/08

DATE: 7/22/08 - 7/23/08

LOG OF BORING NO. B-3
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

LOCATION: NAD 83 VA South Zone COORDINATES: N 3522639.7; E 10404557.48 ELEVATION: 1534.1

DRILLING METHOD: 3-1/4" I.D. Hollow-stem Auger COMPLETION DEPTH: 54.4'

SAMPLER(S): 2" O.D. Split-barrel Sampler, 3" O.D. Shelby Tube Sampler, NQ Rock Core Barrel

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N VALUE	SAMPLE REC. %	USCS	DESCRIPTION	TEST RESULTS
	0					GC-SC	FILL: Medium-dense to very-dense gray and brown fine to coarse gravel consisting of shale fragments, little to some (% varies) fine to coarse sand, some clayey silt, contains zones of medium-stiff to stiff clayey silt and zones of fine to coarse sand, dry	
		1	17/20/30	50	80			
	5	2	20/11/10	21	20			
		3	27/12/8	20	47			
	10	4	8/7/11	18	80			
		5	18/16/13	29	60			
	15	6	24/33/32	65	60			
		7	13/15/32	47	87			G
	20	8	21/35/37	72	93			
		9	21/25/50-5"R		27			
1510.1								
	25	10	15/11/16	27	53	GC-SC	FILL: Medium-dense to very-dense gray and brown fine to coarse gravel consisting of shale fragments, little to some (% varies) fine to coarse sand, some clayey silt, contains zones of medium-stiff to stiff clayey silt and zones of fine to coarse sand, wet	
		11	3/5/12	17	60			H=0.7-1.9
		12	P		80			H=4.5
	30							
1502.6								
		13	21/15/15	30	67	SM	FILL: Medium-dense gray bottom ash, wet	
1500.5								
	35		6			ML-CL	Medium-stiff to stiff gray organic clayey silt, some fine sand, wet.	

NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT / PLASTIC LIMIT / LIQUID LIMIT: 10 20 30 40

WATER LEVEL: 24.1

WATER NOTE: 18.5' encountered

DATE: 7/22/08

SYMBOLS USED TO INDICATE TEST RESULTS: G - Gradation; Q - Uncon Comp; T - Triax Comp; C - Consol. See Separate Curves. H - Penetrometer (tsf); U - Unit Dry Wt (pcf); R - Relative Dens (%)

2008 N VALUE WITH ... BBCM.GDT

DATE: 7/22/08 - 7/23/08

LOG OF BORING NO. B-3
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

LOCATION: NAD 83 VA South Zone   COORDINATES: N 3522639.7; E 10404557.48   ELEVATION: 1534.1
DRILLING METHOD: 3-1/4" I.D. Hollow-stem Auger   COMPLETION DEPTH: 54.4'
SAMPLER(S): 2" O.D. Split-barrel Sampler, 3" O.D. Shelby Tube Sampler, NQ Rock Core Barrel

ELEV.	DEPTH FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N VALUE	SAMPLE REC %	USCS	DESCRIPTION	TEST RESULTS
	35	14		5/6			TOP MUCK	Medium-stiff to stiff gray organic clayey silt, some fine sand, wet.	H=0.6 1.6
1498.0									
1497.2		15A		SH=18"		100	SM	Very-loose gray fine to medium sand, some silt, wet.	
		15B				42	CL-ML	Soft to medium-stiff gray silt "and" fine sand, few lenses of silt, slightly organic, trace fine to coarse sand, trace fine gravel, wet.	G; H=25.0 6
1494.8		16A		4/11/44	55	100		Very-dense brown and gray fine to coarse sand, little fine to coarse gravel, some silt, wet	
	40	16B				85			
1493.1									G
		17		50-2"R		13		Very-soft to soft dark-gray shale, diagonal bedding, numerous diagonal and irregular fractures, few smooth slickenside type features	
		18		NQ RQD 0%		38			
	45			RQD 0%					
		19				81			
	50			RQD 61%					
		20				98			
1479.7									
	55								
	60								
	65								
	70								

NATURAL CONSISTENCY INDEX; NATURAL MOISTURE CONTENT; PLASTIC LIMIT — LIQUID LIMIT: 10, 20, 30, 40

- Encountered water at 24.1'.
- Encountered cobbles at 5.5'
- Sample S-2 appeared to be cuttings, drove cobble
- Drilling mud added at 38.1'
- Encountered auger refusal at 42.0'
- Casing set at 42.0'
- Reamed out bore hole with 2-7/8" Tricone bit from 0.0' to 43.0'
- Backfilled boring with bentonite grout at completion.
- Water at 2.5' at completion (influenced by water for coring and drilling mud).
- Boring sounded at 53.9' at completion
- Caved at 18.5' after casing pulled

WATER LEVEL: 24.1
WATER NOTE: 18.5' encountered
DATE: 7/22/08

SYMBOLS USED TO INDICATE TEST RESULTS: G = Gradation; ... = Unconf. Comp; ... = Triax. Comp; ... = Consol. — See Separate Curves; H = Penetrometer (tsf); ... = Unit Dry Wt (pcf); ... = Relative Dens (%)

2008 NVALUE WITH 11497007.GPJ BBCM.GDT

AEPCR000311

DATE: 7/24/08

LOG OF BORING NO. B-4
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

LOCATION: NAD 83 VA South Zone   COORDINATES: N 3522561; E 10404636.87   ELEVATION: 1560.3

DRILLING METHOD: 3-1/4" I.D. Hollow-stem Auger   COMPLETION DEPTH: 66.9'

SAMPLER(S): 2" O.D. Split-barrel Sampler

NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT / PLASTIC LIMIT / LIQUID LIMIT (scale 10, 20, 30, 40)

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N VALUE	SAMPLE REC. %	USCS	DESCRIPTION	TEST RESULTS
	0					GC-SC	FILL: Medium-dense to dense gray and brown fine to coarse gravel consisting of shale fragments, little to some (% varies) fine to coarse sand, some clayey silt, contains zones of hard silty clay and zones of fine to coarse sand, dry	
		1	13/13/8	21	93			G
	5	2	8/11/11	22	80			H 4.5
		3	8/8/9	17	80			
	10	4	6/9/16	25	67			
		5	11/15/19	34	80			
	15	6	7/8/13	21	87			
		7	6/9/2	15	53			
	20	8	6/5/6	11	60			G
		9A	20/28/31	59	100			
		9B			100			
1536.6						SM-ML	FILL: Medium-dense to very-dense gray bottom ash, contains zones of fly ash, moist	
	25	10	5/7/8	15	100			
		11	15/16/19	35	100			
	30	12	6/12/14	26	100			G
		13	19/39/27	66	100			
	35	14	6/					

WATER LEVEL: 39.2
WATER NOTE: Caved at 54.9'
DATE: 7/24/08

SYMBOLS USED TO INDICATE TEST RESULTS: C - Consolidation; S - Direct Comp.; T - Triax. Comp.; Q - Unconf. — See Separate Curves; H - Penetrometer (tsf); W - Unit Dry Wt. (pcf); D - Relative Dens. [illegible]

AEPCR000312

DATE: 7/24/08

LOG OF BORING NO. B-4
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

LOCATION: **NAD 83 VA South Zone** COORDINATES: **N 3522561; E 10404636.87** ELEVATION: **1560.3**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **66.9'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH (FEET)	SAMPLE NUMBER	SAMPLE EFFORT	N VALUE	SAMPLE REC-%	USCS	DESCRIPTION	TEST RESULTS
	35	14	4/5		100			
1524.1						ML-SM	FILL: Loose to medium-dense gray fly ash and bottom ash, moist	
		15A 15B	1/3/15	18	100 100			
	40	16	6/11/7	18	100			
		17	SH-12"/1		100			G
1516.3						ML-SM	FILL: Loose to medium-dense gray fly ash and bottom ash, wet	
	45	18A 18B	3/12/15	27	100 100			
		19A 19B	4/[illegible]/2	8	100 100			
	50	20A 20B	6/13/14	27	100 100			
	55	21	7/9/12	21	100			G
1500.3	60	22A 22B	1/8/9	17	100 45	SM	FILL: Loose to medium-dense gray bottom ash, wet	H 96-16
	65	23A 23B	1/1/10	11	100 43			G
1494.1								
1493.4		24	50-2"R		13		Very-soft to soft gray shale.	
	70							

- Encountered seepage at 21.7'.
- Encountered water at 44.4'.
- Added drilling mud at 50.7'.

NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT / PLASTIC LIMIT / LIQUID LIMIT (scale: 10, 20, 30, 40)

WATER LEVEL: 39.2
WATER NOTE: Caved at 54.9'
DATE: 7/24/08

SYMBOLS USED TO INDICATE TEST RESULTS: G - Gradation; Q - Uncon. Comp.; T - Triax. Comp.; C - Consol.; See Separate Curves; H - Penetrometer (tsf); W - Unit Dry Wt. (pcf); D - Relative Dens. (%)

LOG OF BORING NO. B-5
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

DATE: 7/29/08

LOCATION: NAD 83 VA South Zone COORDINATES: N 3622491.17; E 10404707.72 ELEVATION: 1555.7

DRILLING METHOD: 3-1/4" I.D. Hollow-stem Auger COMPLETION DEPTH: 66.8'

SAMPLER(S): 2" O.D. Split-barrel Sampler

ELEV	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N VALUE	SAMPLE REC %	USCS	DESCRIPTION	TEST RESULTS
	0						ML-SM	FILL: Very-loose to medium-dense gray fly ash, contains zone of bottom ash, dry	
		1		6/6/6	12	100			
	5	2		2/1/1	2	100			
	10	3		1/1/14	15	100			G
	15								
1539.0		4		8/3/5	8	100	ML-SM	FILL: Loose gray fly ash intermixed with bottom ash, moist	
	20								
1534.0		5		4/2/2	4	100	ML-SM	FILL: Very-loose to loose gray fly ash, contains zones of bottom ash, wet.	MC=58, G
	25	6		5/17/48	65	100			
	30	7		1/0/0	0	100			
	35								

Plot header: NATURAL CONSISTENCY INDEX — NATURAL MOISTURE CONTENT — PLASTIC LIMIT — LIQUID LIMIT; scale 10, 20, 30, 40

WATER LEVEL: ∇ 47.5 ▼ ▼
WATER NOTE: Caved at 66.7'
DATE: 7/29/08

SYMBOLS USED TO INDICATE TEST RESULTS: G - Gradation; C - Consol.; See Separate Curves; P - Penetrometer (tsf); W - Unit Dry Wt. (pcf); D - Relative Dens. (%)

2008 N-VALUE WITH 11497007.GPJ BBLRI.GDT 11/6/08

DATE 7/29/08

LOG OF BORING NO. B-5
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

LOCATION: NAD 83 VA South Zone COORDINATES: N 3522491.17; E 10404707.72 ELEVATION: 1555.7

DRILLING METHOD: 3-1/4" I.D. Hollow-stem Auger COMPLETION DEPTH 66.8'

SAMPLER(S): 2" O.D. Split-barrel Sampler

ELEV.	DEPTH IN FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N VALUE	SAMPLE REC-%	USCS	DESCRIPTION	TEST RESULTS
							ML-SM	FILL: Very-loose to loose gray fly ash, contains zones of bottom ash, wet	
		8		2/1/4	5	100			
	40								
		9		6/4/3	7	100			
	45								
		10		5/4/5	9	100			MC=55, G
	50								
		11		2/1/1	2	100			
	55								
1499.0		12		2/1/2	3	100	CL	Medium-stiff gray silty clay, little fine to coarse sand, slightly organic, few seams of fine sand, wet	H 0.8
	60								
1494.0		13		39, 50-5"R		60		Very-soft gray shale with 60 degree silt filled fractures	
	65								
1489.9								Very-soft gray shale	
1488.9		14		50-1"R		?		- Blind drilled 3-1/4" augers; no grounding procedures in use on this boring - Borehole grouted upon completion	
	70								

NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT / PLASTIC LIMIT / LIQUID LIMIT: 10 20 30 40

WATER LEVEL: 47.5
WATER NOTE: Caved at 66.7'
DATE: 7/29/08

SYMBOLS USED TO INDICATE TEST RESULTS: G = Gradation; Q = Uncon Comp; T = Triax Comp; C = Consol; See Separate Survey; H = Penetrometer (tsf); U = Unit Dry Wt (pcf); D = Relative Dens (%)

2008 N VALUE WITH 11497-007.GPJ BBCM.GDT 11/6/08

DATE: 7/30/08 - 8/4/08

LOG OF BORING NO. B-6
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

LOCATION: NAD 83 VA South Zone COORDINATES: N 3522248.22; E 10405163.61 ELEVATION: 1566.7

DRILLING METHOD: 3-1/4" I.D. Hollow-stem Auger COMPLETION DEPTH: 54.6'

SAMPLER(S): 2" O.D. Split-barrel Sampler, NQ Rock Core Barrel

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N VALUE	SAMPLE REC-%	USCS	DESCRIPTION	TEST RESULTS
	0					ML-SM	FILL: Loose gray fly ash, contains zones of bottom ash	
		1	3/3/3	6	100			
	5							
		2	1/3/5	8	100			
	10							
1555.1								MC=56 G
		3	1/0/0	0	100	ML-SM	FILL: Very-loose gray fly ash, contains zones of bottom ash, wet	
	15							
		4	0/0/1	1	100			
	20							
		5	1/1/0	1	100			
	25							
		6	SH/SH/SH		100			MC=53 G
	30							
		7	SH/SH/SH		100			
	35							

NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT / PLASTIC LIMIT / LIQUID LIMIT: 10 20 30 40

WATER LEVEL: ▽ 34.7
WATER NOTE: Caved at 54.6'
DATE: 8/4/08

SYMBOLS FOR TEST RESULTS: G - Gradation, U - Unconf. Comp., T - Triax. Comp., C - Consol.; See Separate Report; N - Penetrometer (tsf), W - Unit Dry Wt. (pcf), D - Relative Dens. (%)

JOB: 011-11497-007 -CONTINUED- PLATE 14

AEPCR000316

DATE: 7/30/08 - 8/4/08

LOG OF BORING NO. B-6
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

LOCATION: NAD 83 VA South Zone COORDINATES: N 3522248.22; E 10405163.61 ELEVATION: 1566.7

DRILLING METHOD: 3-1/4" I.D. Hollow-stem Auger COMPLETION DEPTH: 54.6'

SAMPLER(S): 2" O.D. Split-barrel Sampler, NQ Rock Core Barrel

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	EFFORT	N VALUE	SAMPLE REC %	USCS	DESCRIPTION	TEST RESULTS
	35						ML-SM	FILL: Very-loose gray fly ash, contains zones of bottom ash, wet	
		8		SH / SH / SH		100			
	40								
1525.1		9		0 / 0 / 39	39	100	ML-CL	Medium-stiff brown and gray clayey silt, "and" fine to coarse sand, some fine gravel, contains limestone fragments	H-1.0
1522.4	45	10		NQ RQD 26% RQD 64%		100		Hard gray limestone, massive bedding, many diagonal (few near horizontal) fractures	
	50	11				100			
1512.1	55								
	60							- Blind drilled 3-1/4" augers; no grounding procedures in use on this boring - Encountered auger refusal at 44.3' - Drove 4" casing to 44.1' and started rock coring at 44.3' - Borehole grouted upon completion	
	65								
	70								

NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT / PLASTIC LIMIT / LIQUID LIMIT: 10 20 30 40

WATER LEVEL: ▽ 34.7
WATER NOTE: Caved at 54.6'
DATE: 8/4/08

SYMBOLS USED TO INDICATE TEST RESULTS
Q - Unconfined Comp / U - Uncon. Comp / T - Triax. Comp / C - Consol. — See Separate Curves
H - Penetrometer (tsf) / W - Unit Dry Wt. (pcf) / D - Relative Dens. (%)

JOB: 011-11497-007

AEPCR000317

DATE: 7/30/08 - 8/5/08

LOG OF BORING NO. B-7
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

LOCATION: NAD 83 VA South Zone   COORDINATES: N 3522654.09; E 10405203.14   ELEVATION: 1578.3

DRILLING METHOD: 3-1/4" I.D. Hollow-stem Auger   COMPLETION DEPTH: 81.8'

SAMPLER(S): 2" O.D. Split-barrel Sampler

ELEV.	DEPTH FEET	SAMPLE NUMBER	SAMPLE EFFORT	N VALUE	SAMPLE REC %	USCS	DESCRIPTION
	0					GM	FILL: Very-dense brown and gray fine to coarse gravel (limetone and chert fragments), little to some fine to coarse sand, little to some silt, dry
		1	10/37/27	64	53		
	5						
		2	10/27/44	71	53		
	10						
1566.7						ML-SM	FILL: Loose to dense gray fly ash, contains zones of bottom ash, moist
		3	26/27/21	48	100		
	15						
		4	8/16/16	32	100		
	20						
		5	2/4/6	10	100		
	25						
		6	11/12/19	31	100		
	30						
1546.7						ML-SM	FILL: Very-loose gray fly ash, contains zones of bottom ash, wet
		7	2/1/0	1	87		
	35						

NATURAL CONSISTENCY INDEX — NATURAL MOISTURE CONTENT ● — PLASTIC LIMIT — LIQUID LIMIT × (scale 10, 20, 30, 40)

TEST RESULTS

WATER LEVEL: ▽ 71.2

WATER NOTE: Caved at 81.3'

DATE: 8/5/08

SYMBOLS USED TO INDICATE TEST RESULTS: G - Gradations; U - Uncon Comp; T - Triax Comp; C - Consol; S - Soil Moisture-density; P - Penetrometer (tsf); W - Unit Dry Wt (pcf); R - Relative Dens (%)

JOB: 011-11497-007   -CONTINUED-

AEPCR000318

DATE: 7/30/08 - 8/5/08

LOG OF BORING NO. B-7
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

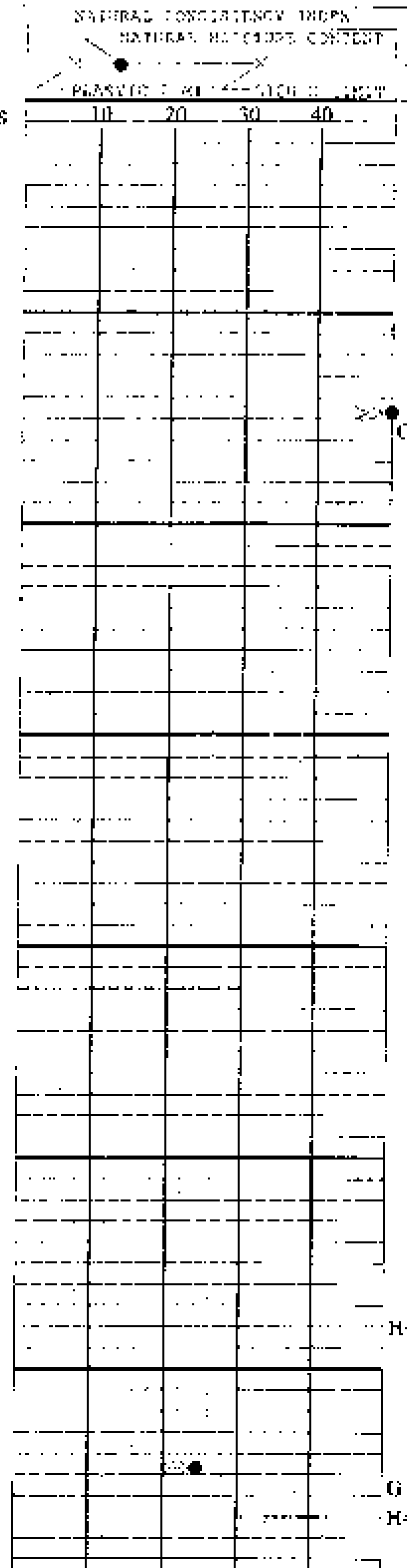
BBCM

LOCATION: NAD 83 VA South Zone COORDINATES: N 3522654.09; E 10405203.14 ELEVATION: 1578.3

DRILLING METHOD: 3-1/4" I.D. Hollow-stem Auger COMPLETION DEPTH: 81.8'

SAMPLER(S): 2" O.D. Split-barrel Sampler

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N VALUE	SAMPLE REC.-%	USCS	DESCRIPTION	TEST RESULTS
	35					ML-SM	FILL: Very-loose gray fly ash, contains zones of bottom ash, wet	
		8	4/3/1	4	100			
	40	9	1/1/3	4	100			G
	45	10	1/2/2	4	100			
	50							
1526.7		11	3/10/5	15	100	ML-SM	FILL: Loose to medium-dense gray fly ash, contains zones of bottom ash, wet	
	55	12	7/4/6	10	47			
	60							
1515.7		13	9/3/25	28	100	ML-CL	Very-stiff brown clayey silt, "and" fine to coarse sand, trace fine gravel, few roots, slightly organic	H=2.25
	65							
1511.7		14	11/15/29	44	73	ML	Very-stiff brown silt, little clay, some fine to coarse sand, little fine gravel, few roots	G H=2.5
	70							



WATER LEVEL: ▽ 71.2
WATER NOTE: Caved at 81.3'
DATE: 8/5/08

SYMBOLS USED TO INDICATE TEST RESULTS: Q - Unconfined Comp; U - Unconfined Comp; T - Triax Comp; C - Consol; Separate Curves; P - Penetrometer (tsf); W - Unit Dry Wt (pcf); Relative Dens.

AEPCR000319

DATE: 7/30/08 - 8/5/08

LOG OF BORING NO. B-7
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

LOCATION: NAD 83 VA South Zone COORDINATES: N 3522654.09; E 10405203.14 ELEVATION 1578.3

DRILLING METHOD: 3-1/4" I.D. Hollow-stem Auger COMPLETION DEPTH 81.8'

SAMPLER(S): 2" O.D. Split-barrel Sampler

ELEV	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N VALUE	SAMPLE REC. %	USCS	DESCRIPTION	TEST RESULTS
	70					ML	Very-stiff brown silt, little clay, some fine to coarse sand, little fine gravel, few roots	
1506.7		15	9/13/27	40	93	CL	Hard brown clayey silt, some fine to coarse sand, some fine gravel (limestone fragments)	H-4.5
	75							
1500.7		16	11/25/40	65	100	GM	Very-dense brown and gray fine to coarse gravel (limestone fragments), some fine to coarse sand, some silt, little clay	
	80							
1496.7 / 1496.5		17	50-2"R		13		Soft to medium-hard gray shale.	
	85							
	90							
	95							
	100							
	105							

- Boring logged by AEP personnel
- Blind drilled 3-1/4" augers; no grounding procedure used on this boring
- Fill and fly ash interface between 8.1'-11.6'
- Encountered auger refusal at 83.4'
- Borehole grouted upon completion

NATURAL CONSISTENCY INDEX — NATURAL MOISTURE CONTENT ●; PLASTIC LIMIT X — LIQUID LIMIT X; scale 10 20 30 40

WATER LEVEL: ∇ 71.2

WATER NOTE: Caved at 81.3'

DATE: 8/5/08

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. — See Separate Curves
H - Pocket Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

2008 N VALUE WITH ... BBCM.GDT 11/6/08

US EPA ARCHIVE DOCUMENT

AEPCR000320

LOG OF BORING NO. B-8
CLINCH RIVER POND #2 CLOSURE
CARBO, VIRGINIA

BBCM

DATE: 7/29/08

LOCATION: NAD 83 VA South Zone COORDINATES: N 3523040.68; E 10405041.75 ELEVATION: 1556.4

DRILLING METHOD: 3-1/4" I.D. Hollow-stem Auger COMPLETION DEPTH: 23.2'

SAMPLER(S): 2" O.D. Split-barrel Sampler

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N VALUE	SAMPLE REC.-%	USCS	DESCRIPTION	TEST RESULTS
	0						ML-SM	FILL: Very-loose to medium-dense gray fly ash, contains zones of bottom ash, dry	
		1		8/6/12	18	100			
	5								
		2		2/1/3	4	93			G
	10								
		3		4/4/4	8	100			
	15								
1539.7							ML-SM	FILL: Loose gray fly ash, contains zones of bottom ash, wet	
		4		2/3/3	6	100			G
	20								
		5		3/2/8	10	60			
1532.8									
	25							- Blind drilled 3-1/4" auger; no grounding procedures on this boring - Sounding 23.6'; SWL 0.0' - Borehole grouted upon completion.	
	30								
	35								

NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT / PLASTIC LIMIT / LIQUID LIMIT: 10 20 30 40

WATER LEVEL:
WATER NOTE:
DATE:

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
U - Uncon. Comp.
T - Triax. Comp.
C - Consol.
See Separate Curves
P - Penetrometer (tsf)
W - Unit Dry Wt. (pcf)
D - Relative Dens. (%)

2008 N VALUE WITH 13119-007.GPJ BBCM.GDT 11/6/08

JOB: 011-11497-007

US EPA ARCHIVE DOCUMENT

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BBCM

SUMMARY OF LABORATORY TEST RESULTS

BORING	APPRO. DEPTH	MC %	LL %	PL %	PI %	GRADATION: sieve	GRADATION: Hydrometer short	GRADATION: Hydrometer long	COMPACTION: standard	COMPACTION: modified	TRIAXIAL: unconsol undrain	TRIAXIAL: consolid undrain w/pores	TRIAXIAL: drained	DIRECT SHEAR: drained	DIRECT SHEAR: undrain	DIRECT SHEAR: residual	UNCONFIN COMPRESS	CONSOLID	SPECIFIC GRAVITY	UNIT DRY WEIGHT PCF	REMOLDED	PERMEABILITY: cohesive	PERMEABILITY: non-cohesive	PERMEABILITY: rigid wall	PERMEABILITY: flexible wall	RELATIVE DENSITY	L O I %	LOG OF SHELBY TUBE	ROCK CORE LOG
B-1	7.55	20	NP	NP	NP	*		*																					
B-1	22.55	55				*		*																					
B-2	27.65	66				*		*																					
B-2	47.65	83				*		*																					
B-3	2.35	7	19	15	4																								
B-3	9.85	5	19	12	7																								
B-3	17.35	6	26	18	8	*		*																					
B-3	27.35	22	25	17	8																								
B-3	28.80																											*	
B-3	34.85	24	34	21	13																								
B-3	37.50	26	24	18	6	*		*																					
B-3	39.95					*																							
B-4	2.45	7	27	17	10	*		*																					
B-4	7.45	7	20	14	6																								
B-4	12.45	7																											
B-4	19.95	11	29	17	12	*		*																					
B-4	29.25					*																							
B-4	42.45	64				*		*																					
B-4	54.95					*																							
B-4	64.60	24	NP	NP	NP	*		*																					

* SEE INDIVIDUAL TEST CURVES

TESTING SUMMARY - STANDARD

PROJECT: CLINCH RIVER POND #2 CLOSURE
LOCATION: CARBO, VIRGINIA
JOB NO.: 011-11497-007
DATE: 11/6/08

US EPA ARCHIVE DOCUMENT

BBCM

SUMMARY OF LABORATORY TEST RESULTS

BORING	APPRO. DEPTH	MC	LL	PL	PI	GRADATION: Sieve	GRADATION: Hydrometer Short	GRADATION: Hydrometer Long	COMPACTION: Standard	COMPACTION: Modified	TRIAXIAL: Unconsolidated Undrained	TRIAXIAL: Consolidated Undrained	TRIAXIAL: w/ Pore Pres.	DIRECT SHEAR: Drained	DIRECT SHEAR: Undrained	DIRECT SHEAR: Residual	UNCONFIN. COMPRESS.	CONSOLID.	SPECIFIC GRAVITY	UNIT DRY WEIGHT	REMOLDED	PERMEABILITY: Cohesive	PERMEABILITY: Noncohesive	PERMEABILITY: Rigid Wall	PERMEABILITY: Flexible Wall	RELATIVE DENSITY	LOI	SHELBY TUBE LOG	ROCK CORE LOG
		%	%	%	%	* SEE INDIVIDUAL TEST CURVES														PCF							%		
B-5	12.45	46	NP	NP	NP	*		*																					
B-5	22.45	58	NP	NP	NP	*		*																					
B-5	47.45	55				*		*																					
B-6	1.75																												
B-6	5.25																												
B-6	9.25																												
B-6	12.35	56				*		*																					
B-6	27.35	53	NP	NP	NP	*		*																					
B-7	1.75																												
B-7	5.25																												
B-7	9.25																												
B-7	42.35	59				*		*																					
B-7	67.35	25	23	21	2	*		*																					
B-7	77.35	13	19	16	3																								
B-8	7.45	22				*		*																					
B-8	17.45	66				*		*																					

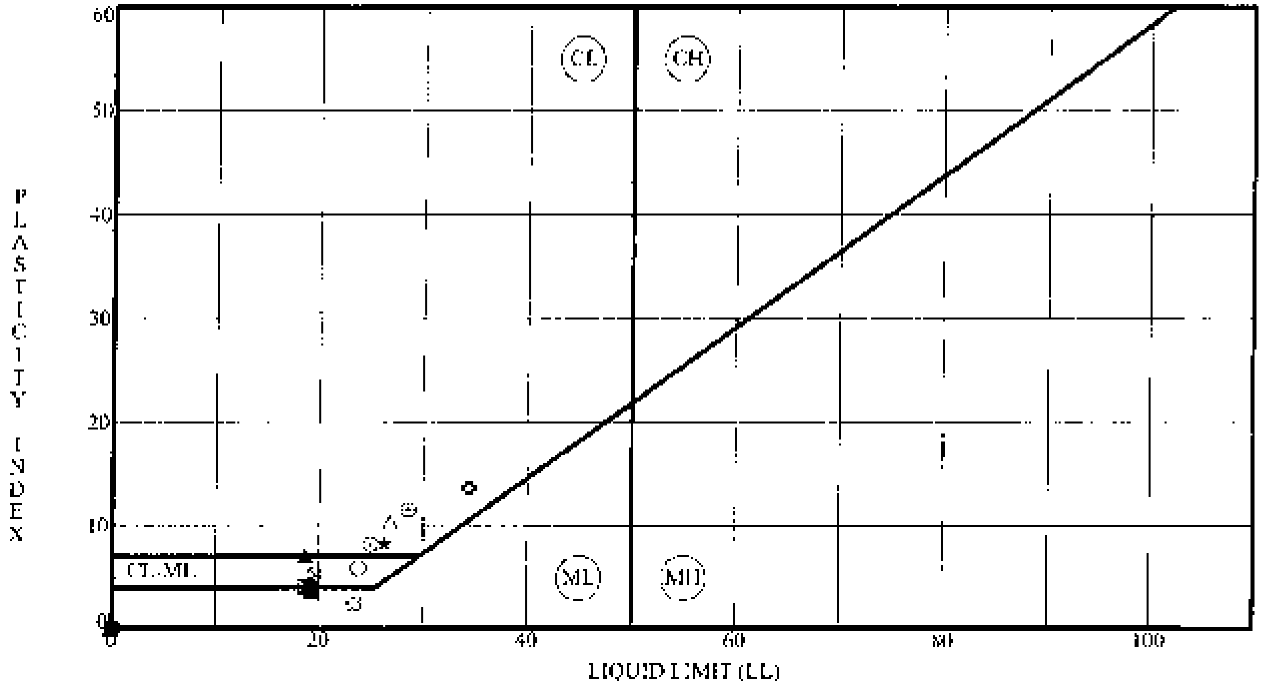
TESTING SUMMARY - STANDARD

PROJECT: CLINCH RIVER POND #2 CLOSURE
LOCATION: CARBO, VIRGINIA
JOB NO.: 011-11497-007
DATE: 11/6/08

PLATE 21

ATTERBERG LIMITS' RESULTS

BBCM



	Specimen Id.	Depth	MC	LL	PL	PI	Fines	ASTM Classification
●	B-1	7.55	20	NP	NP	NP	57.2	SANDY SILT ML
⊠	B-3	2.35	7	19	15	4		
▲	B-3	9.85	5	19	12	7		
★	B-3	17.35	6	26	18	8	31.0	CLAYEY SAND with GRAVEL SC
⊙	B-3	27.35	22	25	17	8		
✿	B-3	34.85	24	34	21	13		
○	B-3	37.50	26	24	18	6	57.4	SANDY SILTY CLAY CL-ML
△	B-4	2.45	7	27	17	10	29.2	CLAYEY SAND with GRAVEL SC
⊘	B-4	7.45	7	20	14	6		
⊕	B-4	19.95	11	29	17	12	38.5	CLAYEY SAND with GRAVEL SC
□	B-4	64.60	24	NP	NP	NP	26.2	SILTY SAND SM
⊖	B-5	12.45	46	NP	NP	NP	70.5	SILT with SAND ML
◑	B-5	22.45	58	NP	NP	NP	77.0	SILT with SAND ML
☆	B-6	27.35	53	NP	NP	NP	98.2	SILT ML
⊠	B-7	67.35	25	23	21	2	61.3	SANDY SILT ML
■	B-7	77.35	13	19	16	3		

PROJECT: CLINCH RIVER POND #2 CLOSURE
LOCATION: CARBO, VIRGINIA
JOB NO. 011-11497-007 DATE 11/6/08

ALP. REG. 11497007.GPJ BBCM.GDT 11/6/08

PLATE 22

US EPA ARCHIVE DOCUMENT

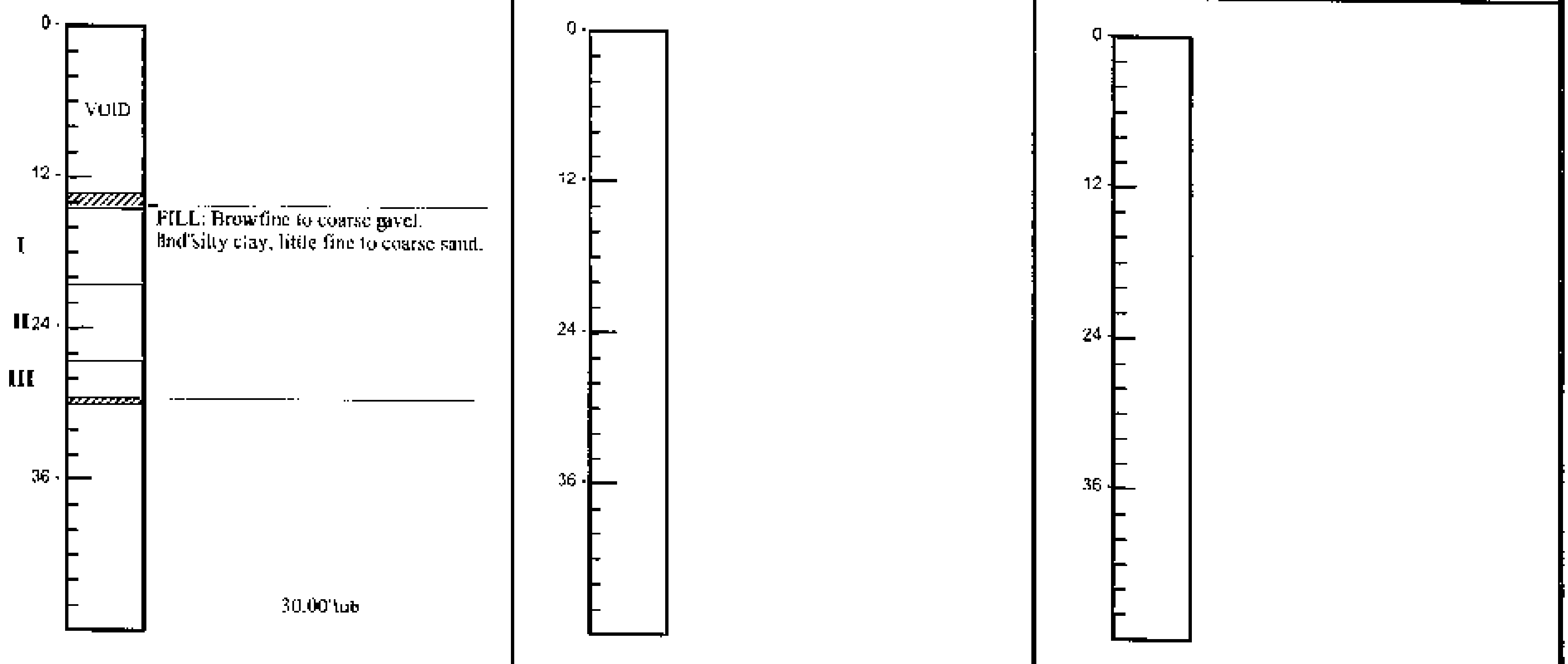
US EPA ARCHIVE DOCUMENT

JOB NUMBER : 011-11497-007
PROJECT : CLINCH RIVER POND #2 CLOSURE
LOCATION : CARBO, VIRGINIA

BBCM

LABORATORY LOG OF SHELBY TUBES

Boring B-3	Sample 12	Boring	Sample	Boring	Sample
Depth 28.1' to 29.3'	Recovery 15.00"	Depth	Recovery	Depth	Recovery



LEGEND

- Consolidation, Incremental
CRS - Consolidation, CRS
P P - Permeability, Vertical / Horizontal
Swelling Test
Wax
Unconfined Compression Test
- Triaxial Compression Test

H - Hand Penetrometer (tsf)
Ds - Direct Shear
LOI Loss on Ignition
AI - Atterberg Limits
MA - Sieve/Hydrometer
SG - Specific Gravity

SL - Shrinkage Limit
POR - Porosity
UDW - Unit Dry Weight
MC - Moisture Content
D_R - Relative Density
S - Sieve

AEPCR000325

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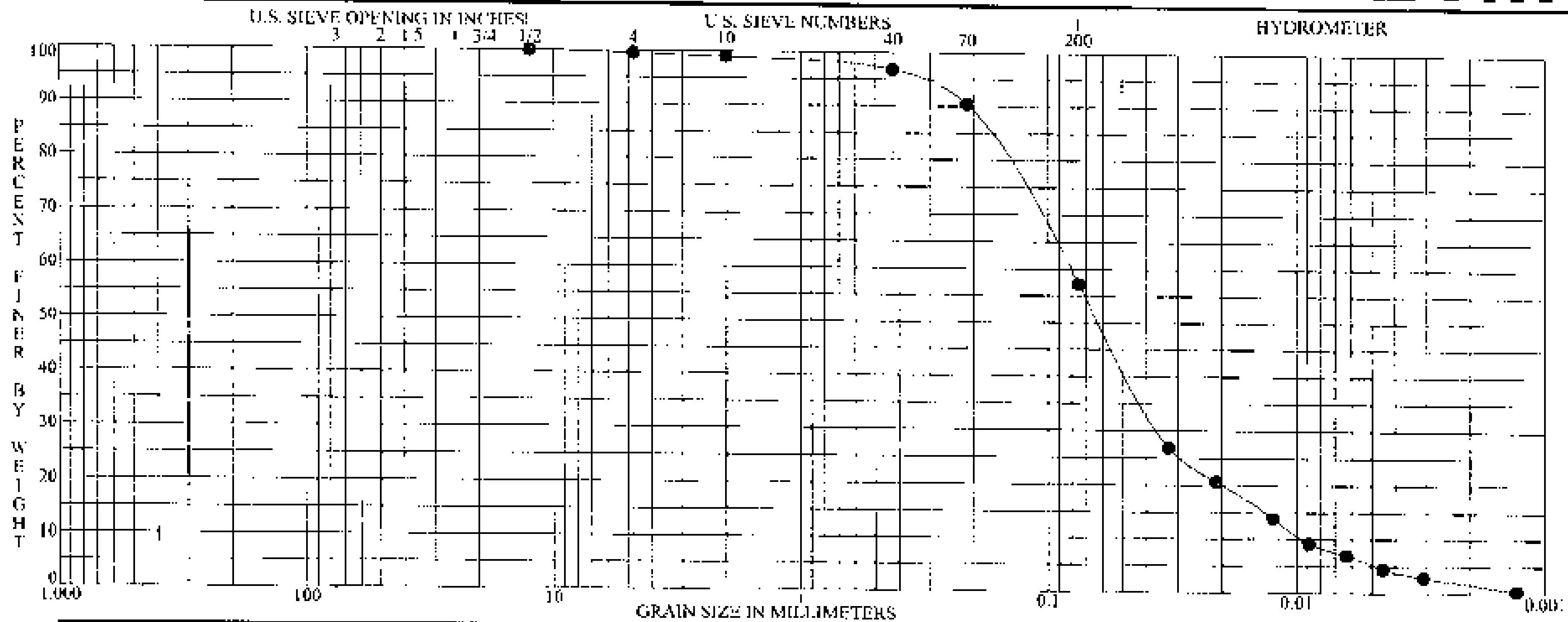

	Specimen Identification - Depth			Classification	MC%	LL	PL	PI	opt mc %	max pcf
●	B-1	S-2	6.8' to 8.3'	FLYASH Gray and brown silt, trace clay, "and" fine sand, trace medium to coarse sand, trace fine gravel.	20	NP	NP	NP		

	Specimen Identification - Depth			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	S-2	6.8' to 8.3'	12.5000	0.0819	0.0355	0.0094	0.4	42.4	51.9	5.3

ASTM D422

GRADATION CURVE

PROJECT CLINCH RIVER POND #2 CLOSURE
LOCATION CARBO, VIRGINIA
JOB NO. 011-11497-007
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PLATE 24

US EPA ARCHIVE DOCUMENT

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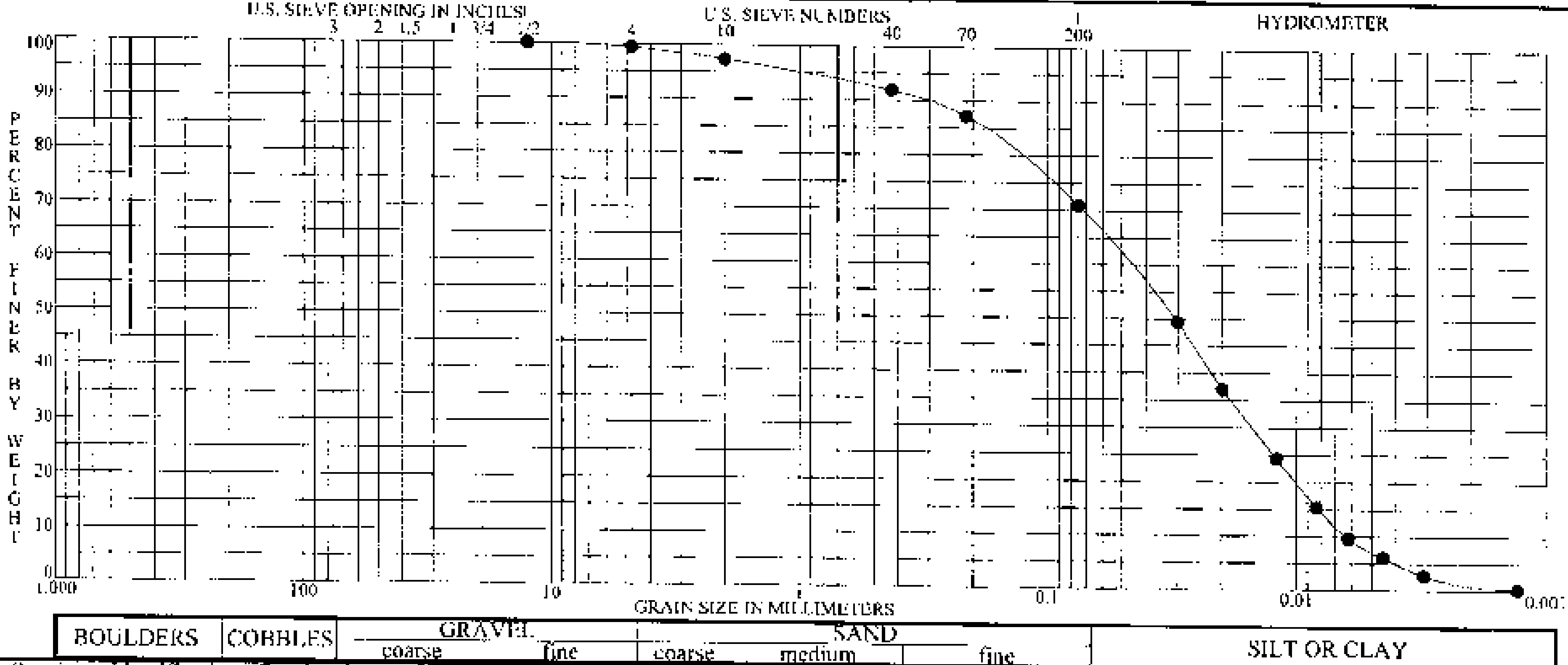

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-1 S-5 21.8' to 23.3'	FLYASH Gray silt, trace clay, some fine sand, trace medium to coarse sand, trace fine gravel.	55					

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-1 S-5 21.8' to 23.3'	12.5000	0.0470	0.0150	0.0063	0.6	28.5	63.6	7.3

ASTM D422 GRADATION CURVE

PROJECT CLINCH RIVER POND #2 CLOSURE
LOCATION CARBO, VIRGINIA
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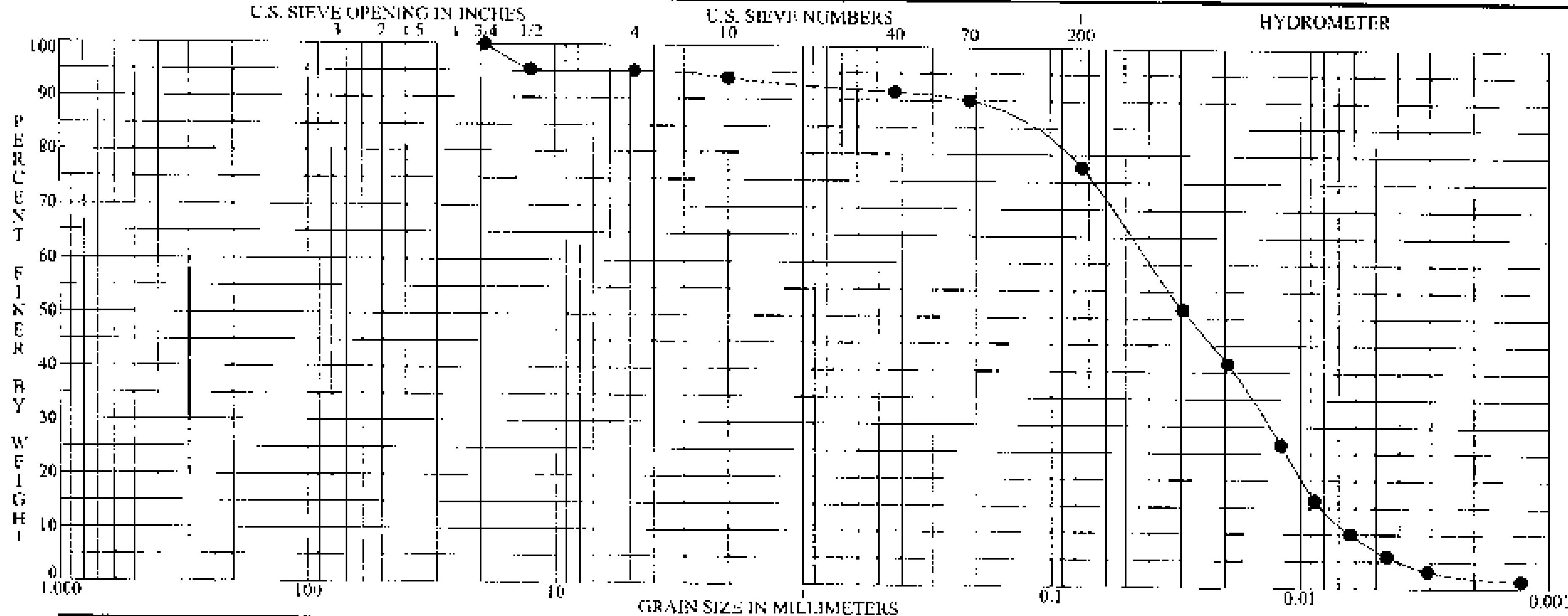

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
●	B-2 S-6 26.9' to 28.4'	FLYASH Gray, dark-gray and graybrown silt, trace clay, little fine to coarse sand, trace fine gravel.	66					

	Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-2 S-6 26.9' to 28.4'	19.0000	0.0397	0.0133	0.0062	4.9	17.4	70.4	7.3

ASTM D422 GRADATION CURVE

PROJECT CLINCH RIVER POND #2 CLOSURE
LOCATION CARBO, VIRGINIA
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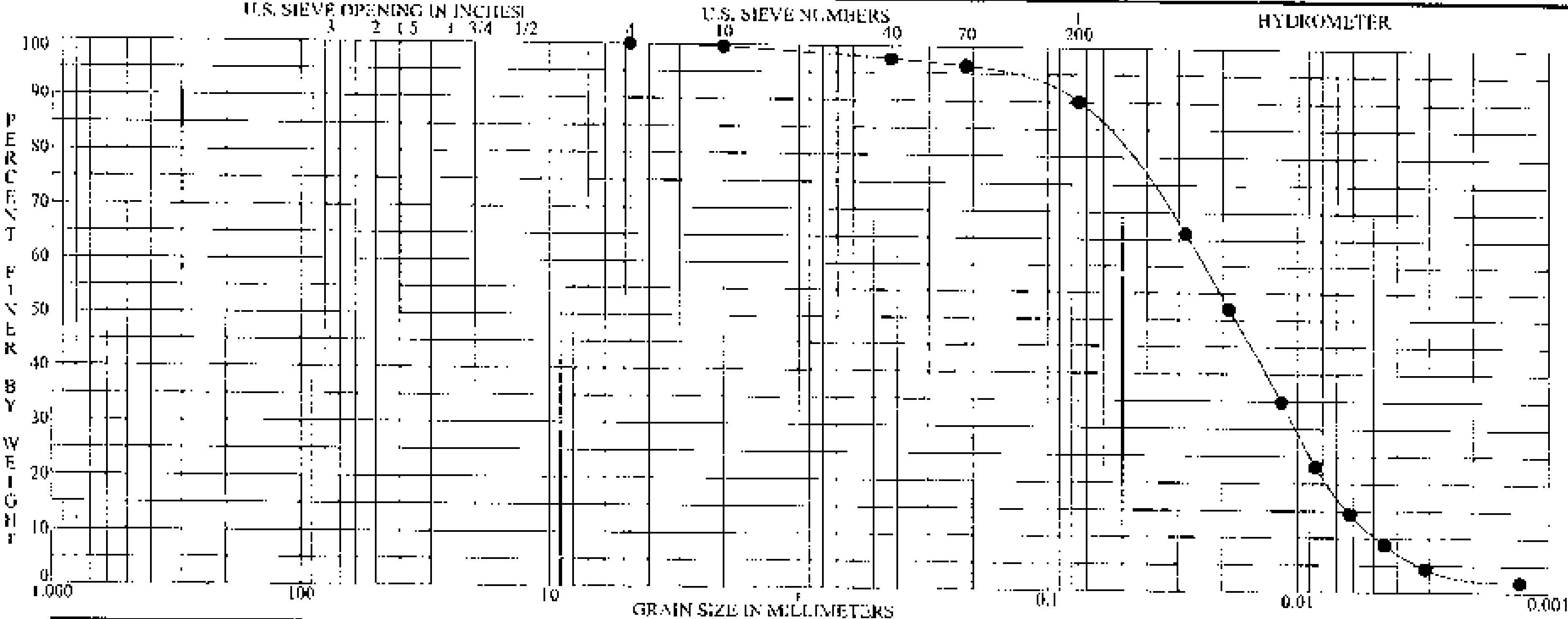

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-2 S-10 46.9' to 48.4'	FLYASH Gray silt, little clay, trace fine to coarse sand.	83					

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-2 S-10 46.9' to 48.4'	4.7500	0.0235	0.0102	0.0048	0.0	9.9	79.5	10.6

ASTM D422 **GRADATION CURVE**

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PLATE 27

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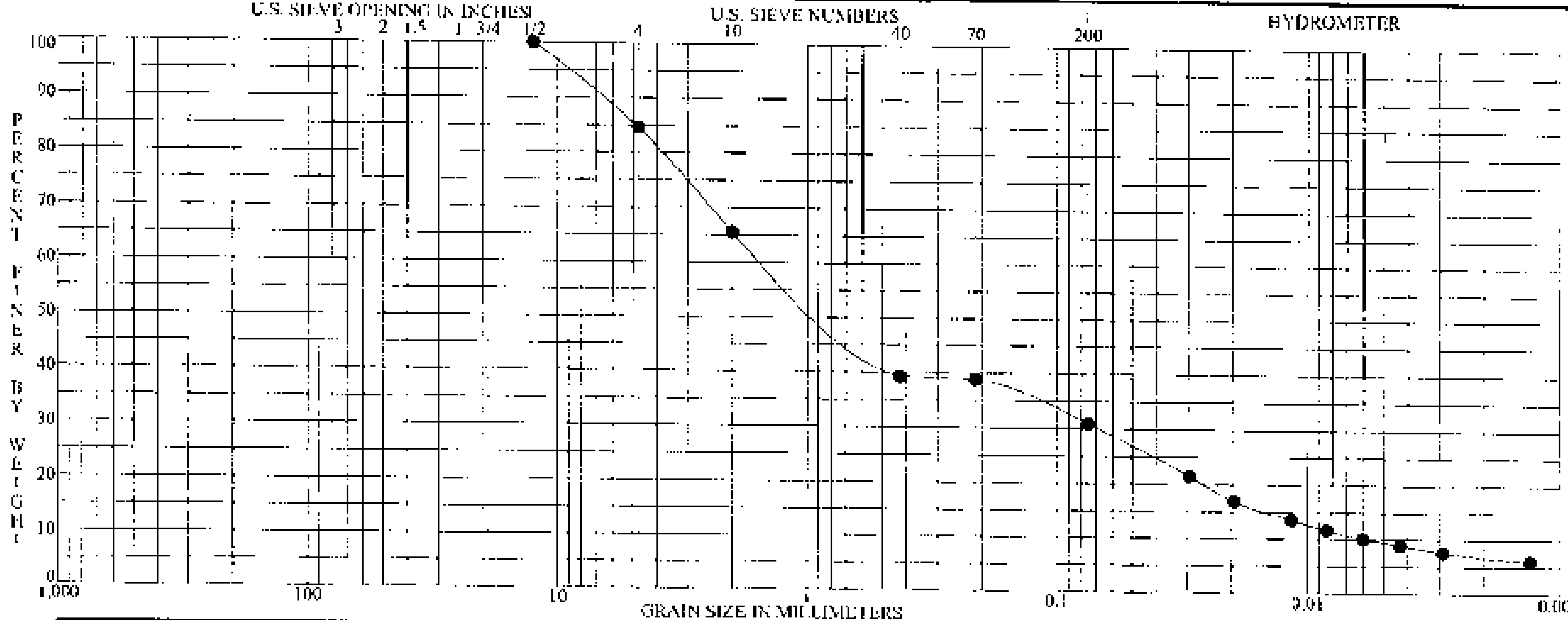

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-3 S-7 16.6' to 17.9'	FLYASH Gray fine to coarse sand, little fine gravel (shale fragments), little clayey silt.	6	26	18	8		

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-3 S-7 16.6' to 17.9'	12.5000	1.4413	0.0683	0.0058	15.5	53.6	21.5	9.5

ASTM D422

GRADATION CURVE

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LOCATION CARBO, VIRGINIA
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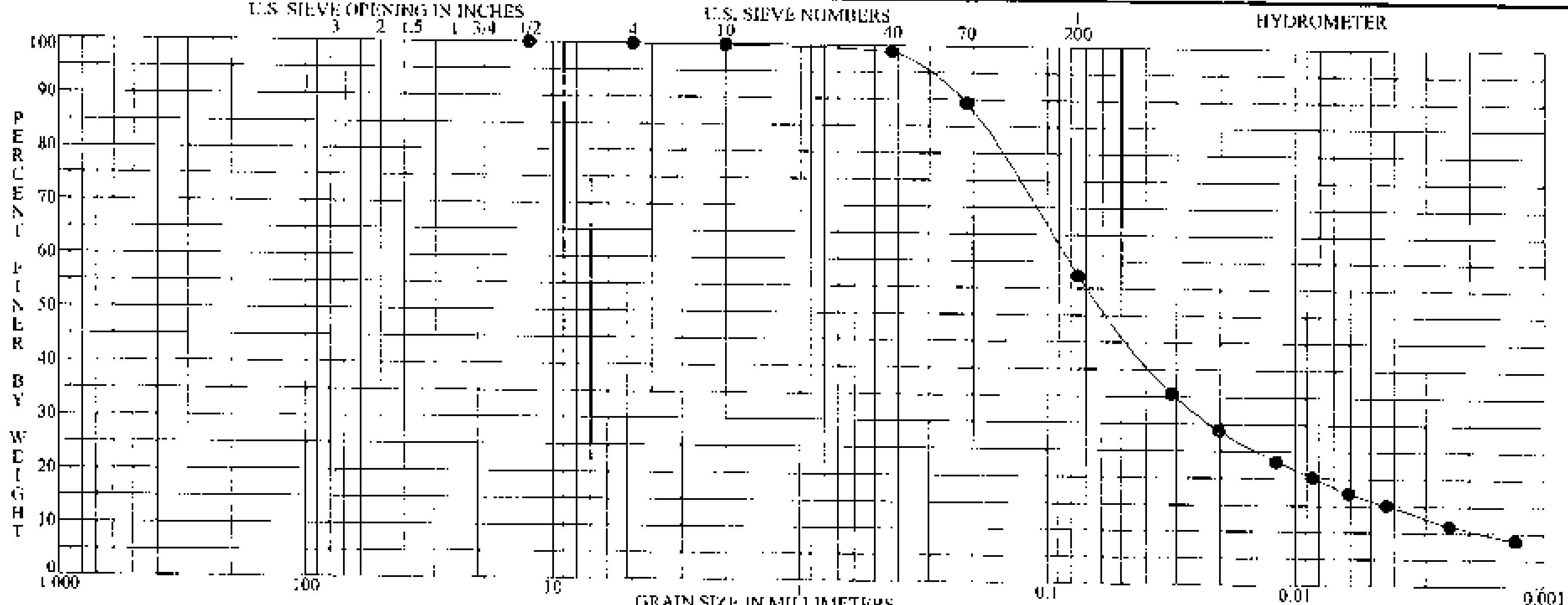

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-3 S-15b 36.9' to 37.4'	FLYASH Gray silty clay, "and" fine sand, trace medium to coarse sand, trace fine gravel.	26	24	18	6		

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-3 S-15b 36.9' to 37.4'	12.5000	0.0817	0.0219	0.0018	0.1	42.6	41.3	16.0

ASTM D422 GRADATION CURVE

PROJECT CLINCH RIVER POND #2 CLOSURE
LOCATION CARBO, VIRGINIA
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PLATE 29

US EPA ARCHIVE DOCUMENT

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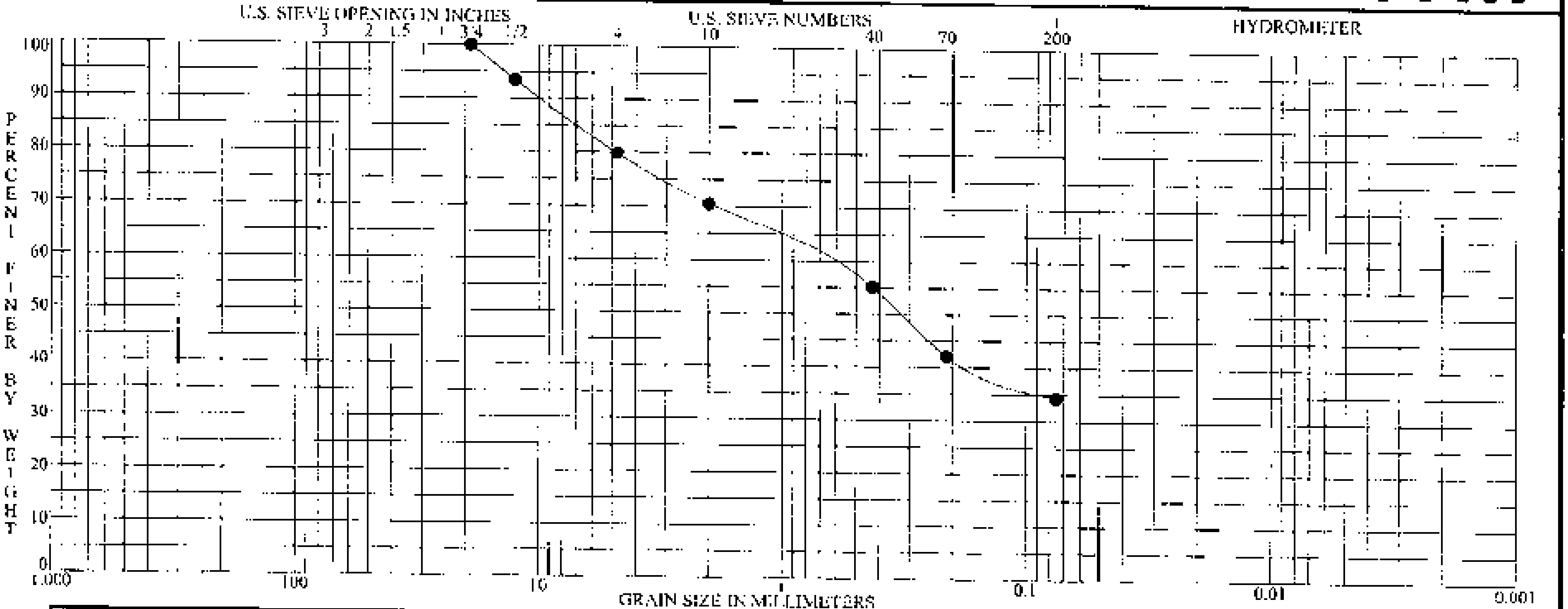

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-3 S-16b 36.9' to 37.4'	FLYASH Brown and gray fine to coarse sand, little fine gravel (shale fragments), some silt.						

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-3 S-16b 36.9' to 37.4'	19.0000	0.6968			20.2	45.4	34.4	

ASTM D422 | **GRADATION CURVE**

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GRADATION

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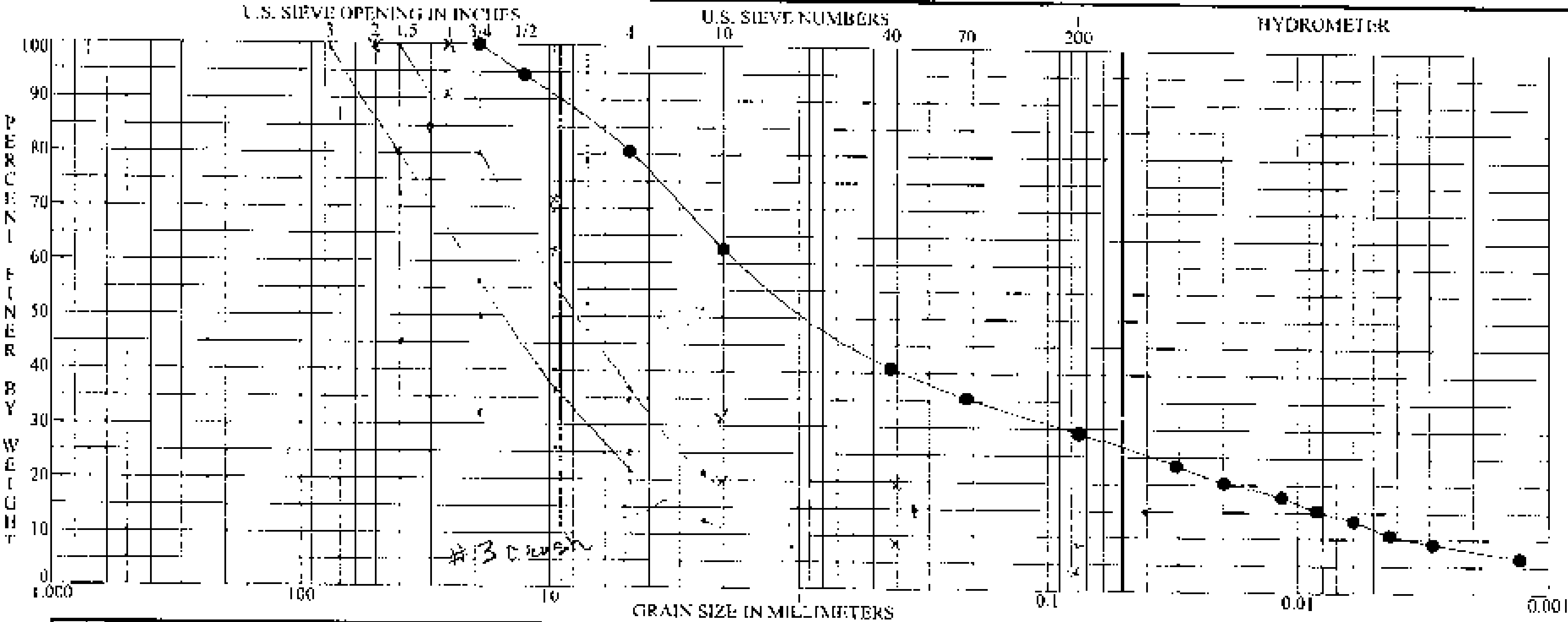

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-4 S-1 1.7' to 3.1'	FLYASH Brown and gray fine to coarse sand, little fine gravel (shale fragments), some clayey silt.	7	27	17	10		

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-4 S-1 1.7' to 3.1'	19.0000	1.6660	0.0859	0.0036	19.5	51.3	17.2	12.0

ASTM D422 | **GRADATION CURVE**

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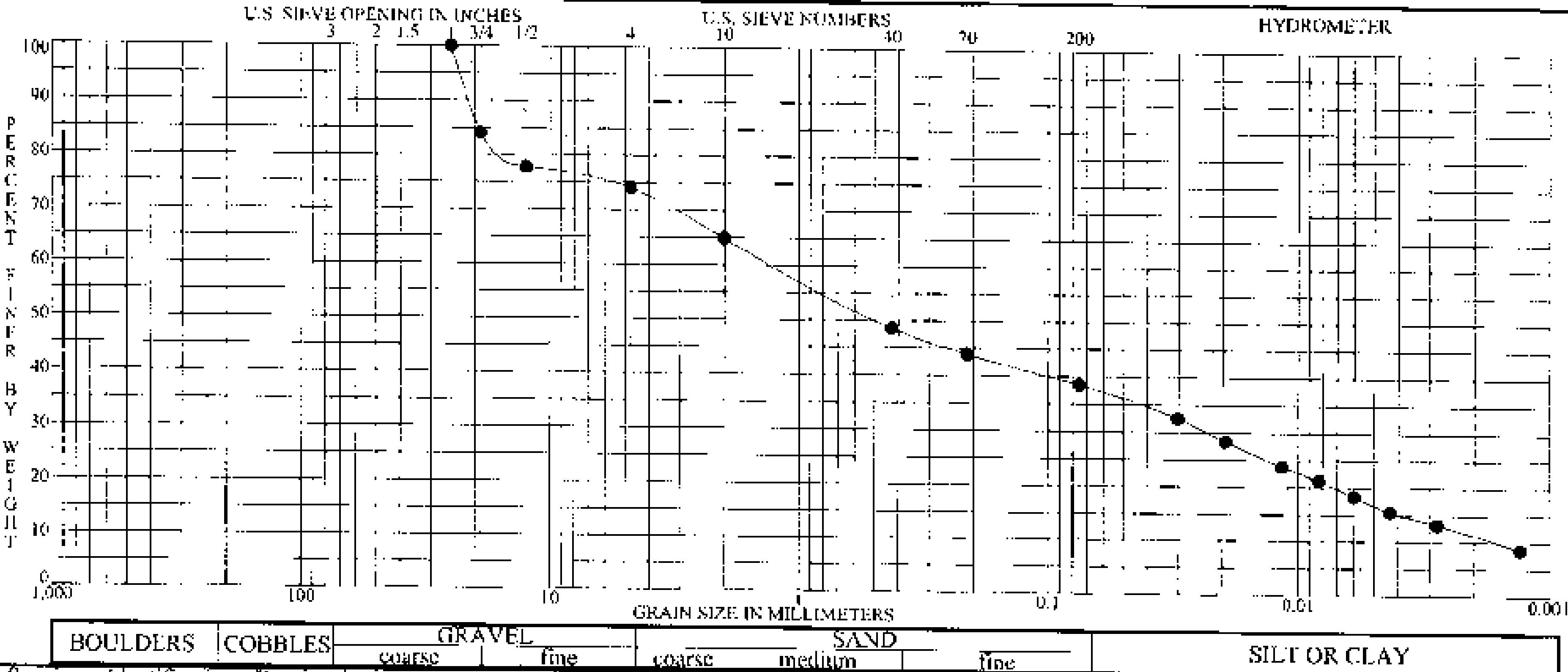

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-4 S-8 19.2' to 20.1'	FLYASH Brown and gray fine to coarse sand,some fine to coarse gravel (shale fragments), "and" silty clay.	11	29	17	12		

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-4 S-8 19.2' to 20.1'	25.0000	1.2594	0.0231	0.0016	26.0	35.5	21.7	16.8

ASTM D422 **GRADATION CURVE**

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LOCATION: CARBO, VIRGINIA
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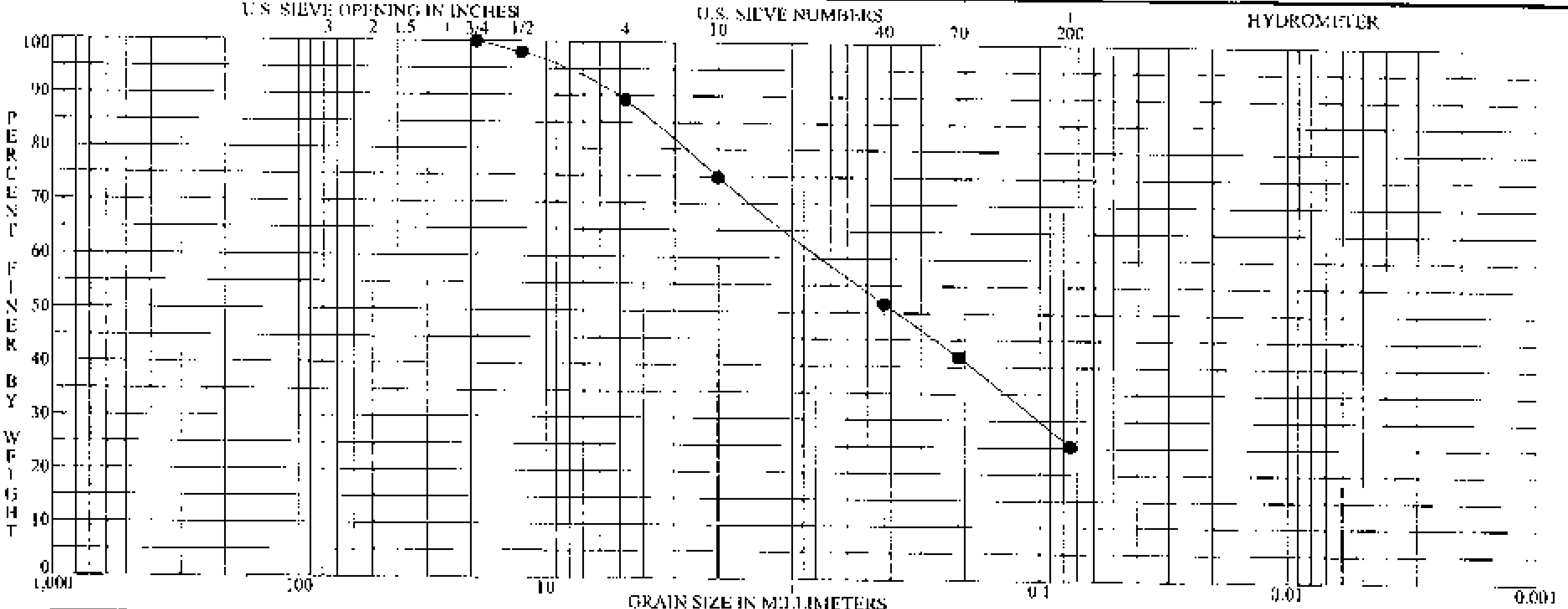

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-4 S-12 29.2' to 30.7'	FLYASH Gray fine to coarse sand, little fine gravel, some silt.						

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-4 S-12 29.2' to 30.7'	19.0000	0.7436	0.1013		10.8	64.0	25.2	

ASTM D422 **GRADATION CURVE**

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PLATE 33 GRNFLYASH

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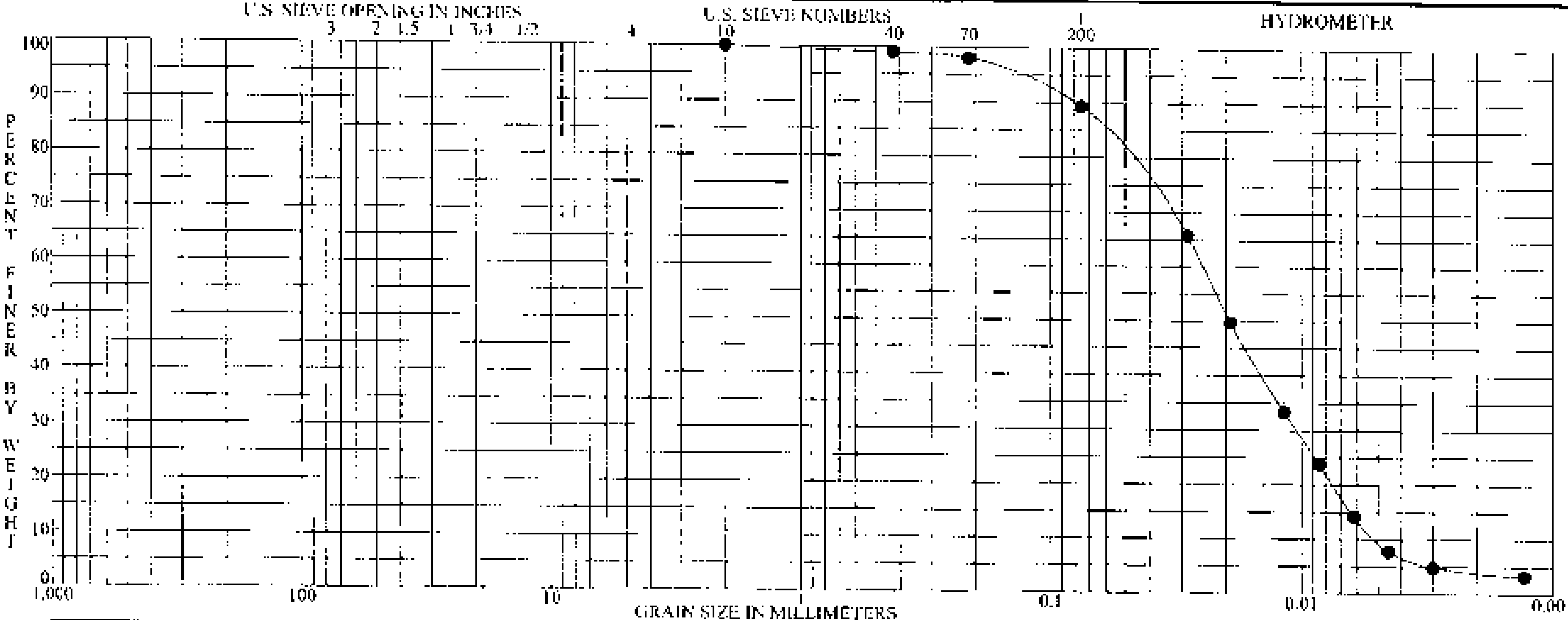

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-4 S-17 41.7' to 43.2'	FLYASH Gray silt, trace clay, little fine to medium sand.	64					

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-4 S-17 41.7' to 43.2'	2.0000	0.0246	0.0104	0.0050	0.0	10.6	79.5	9.9

ASTM D422 **GRADATION CURVE**

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LOCATION CARBO, VIRGINIA
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GRNFLASH

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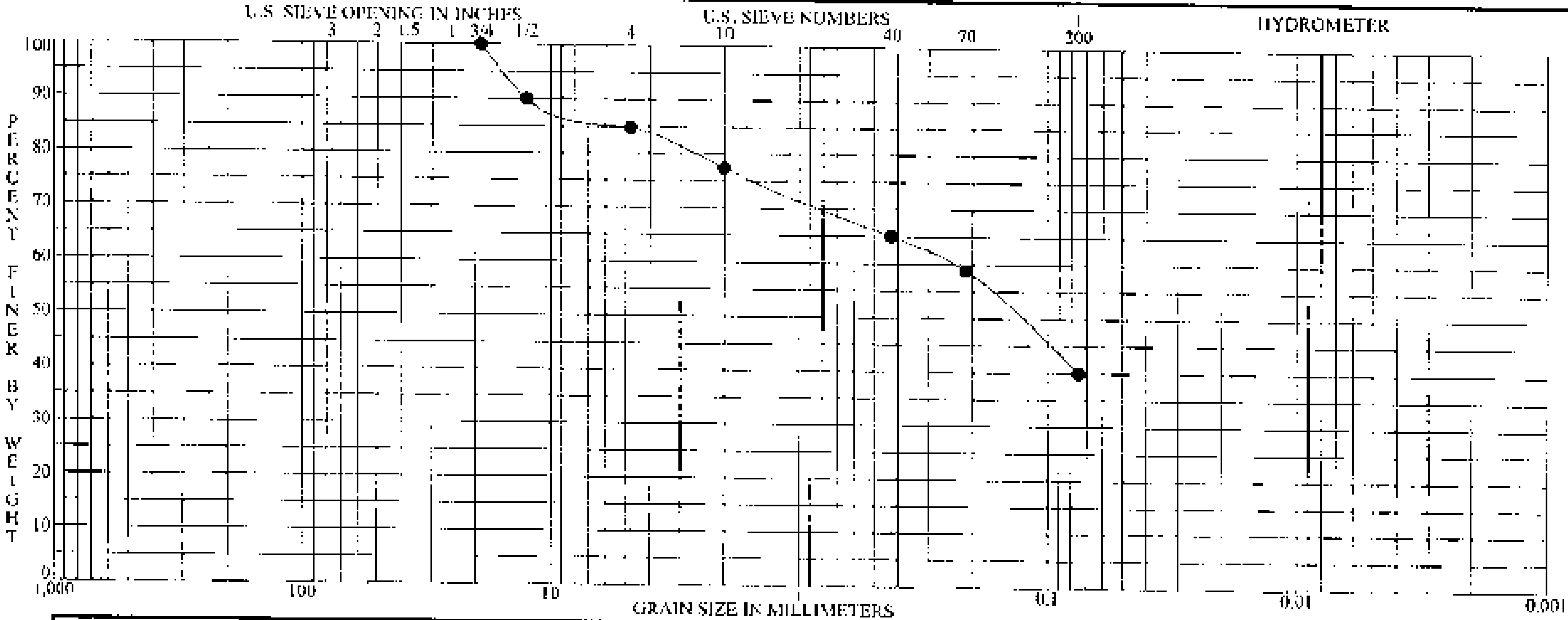

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-4 S-21 54.2' to 55.7'	FLYASH Gray fine to coarse sand, little fine gravel, "and" silt.						

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-4 S-21 54.2' to 55.7'	19.0000	0.2431			15.3	44.8	40.0	

ASTM D422 | GRADATION CURVE

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PLATE 35

US EPA ARCHIVE DOCUMENT

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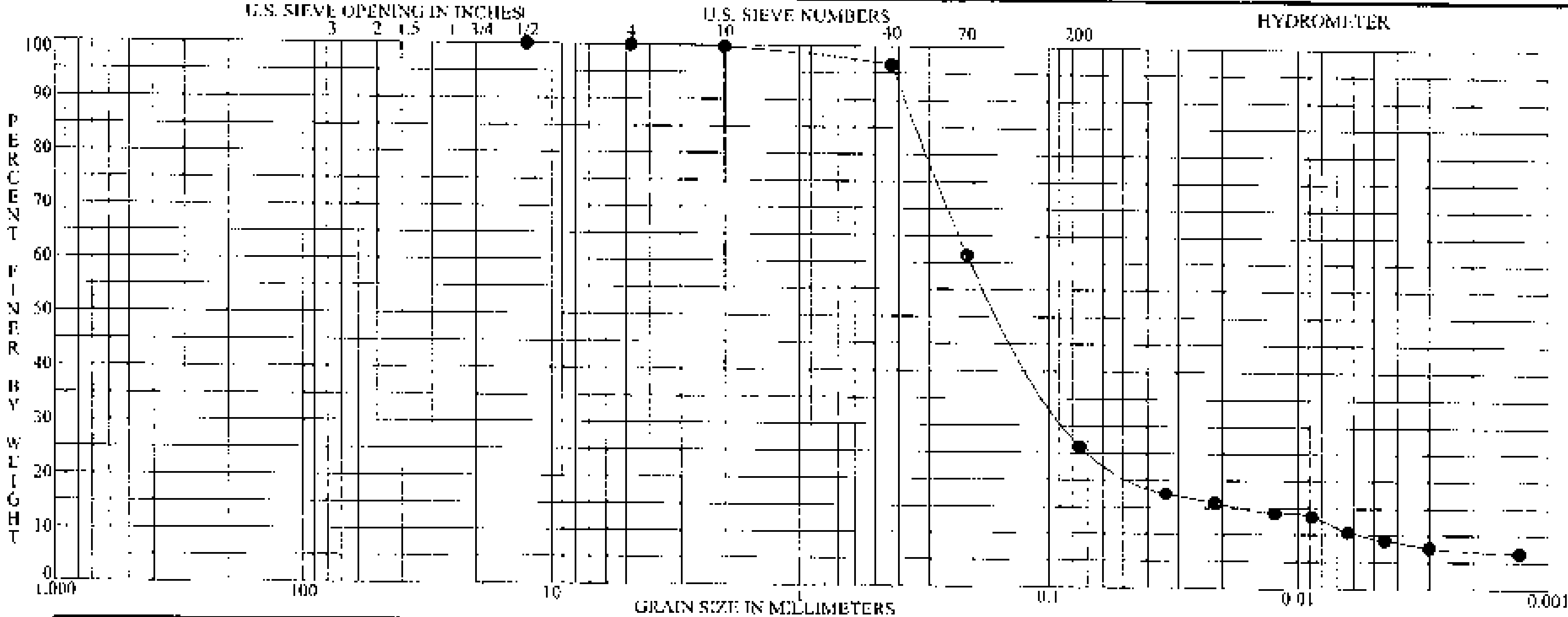

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-4 S-23a 64.2' to 65.0'	FLYASH Gray fine sand, trace medium to coarse sand, trace fine gravel, little silt, trace clay.	24	NP	NP	NP		

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-4 S-23a 64.2' to 65.0'	12.5000	0.2038	0.0840	0.0056	0.1	73.7	16.7	9.5

ASTM D422 GRADATION CURVE

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LOCATION CARBO, VIRGINIA
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GRAD CURVE

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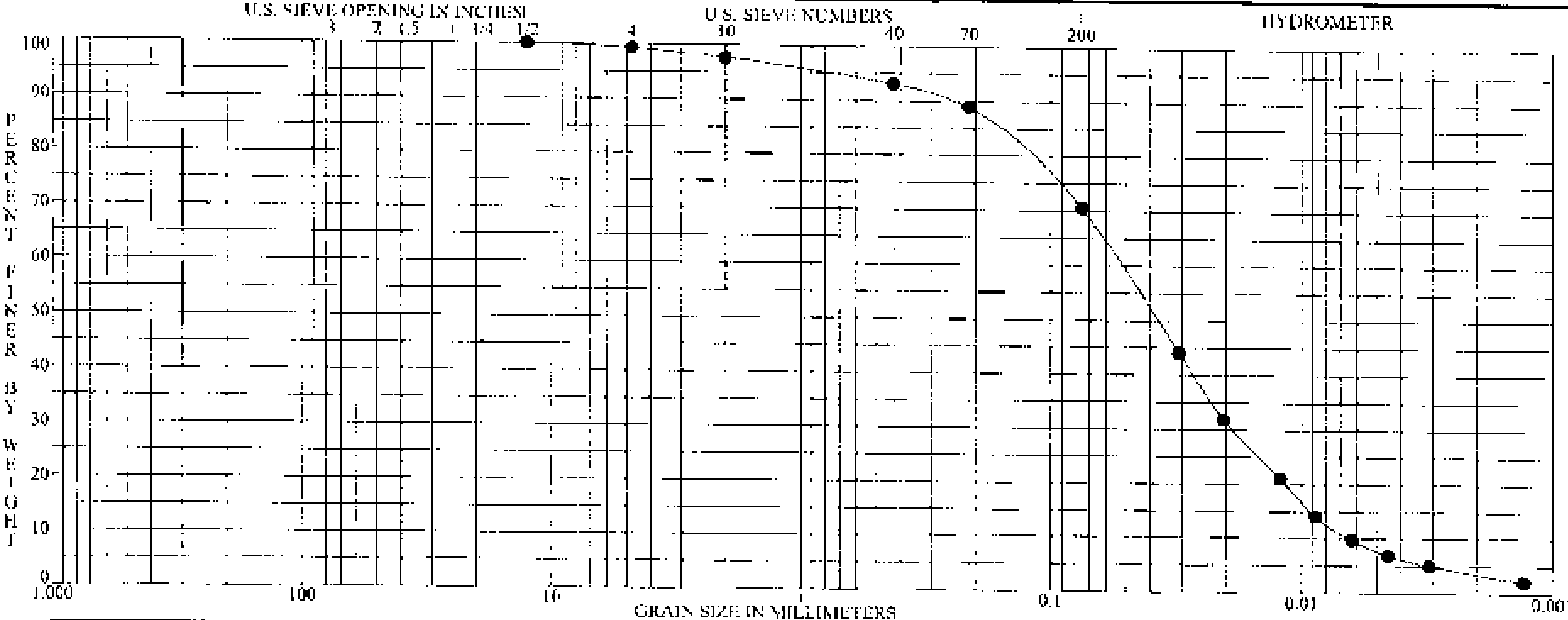

	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
●	B-5 S-3 11.7' to 13.2'	FLYASH Gray and dark-gray silt, trace clay, some fine sand, trace medium to coarse sand, trace fine gravel.	46	NP	NP	NP		

	Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-5 S-3 11.7' to 13.2'	12.5000	0.0525	0.0185	0.0064	0.7	28.8	62.8	7.8

ASTM D422 GRADATION CURVE

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PLATE 37 GRN-BLK89

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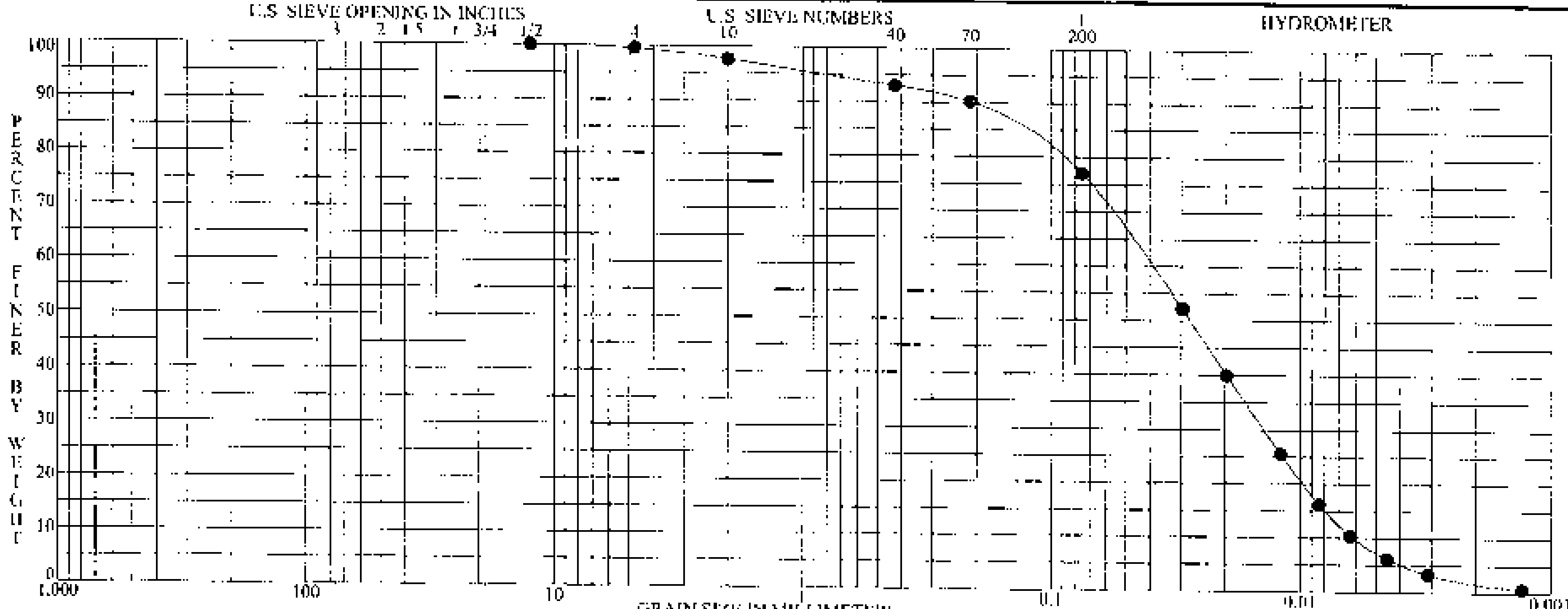

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
●	B-5 S-5 21.7' to 23.2'	FLYASH Gray, dark-gray and graybrown silt, trace clay, some fine to coarse sand, trace fine gravel.	58	NP	NP	NP		

	Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-5 S-5 21.7' to 23.2'	12.5000	0.0397	0.0140	0.0061	0.5	22.5	69.5	7.5

ASTM D422 GRADATION CURVE

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GRN-HYASH

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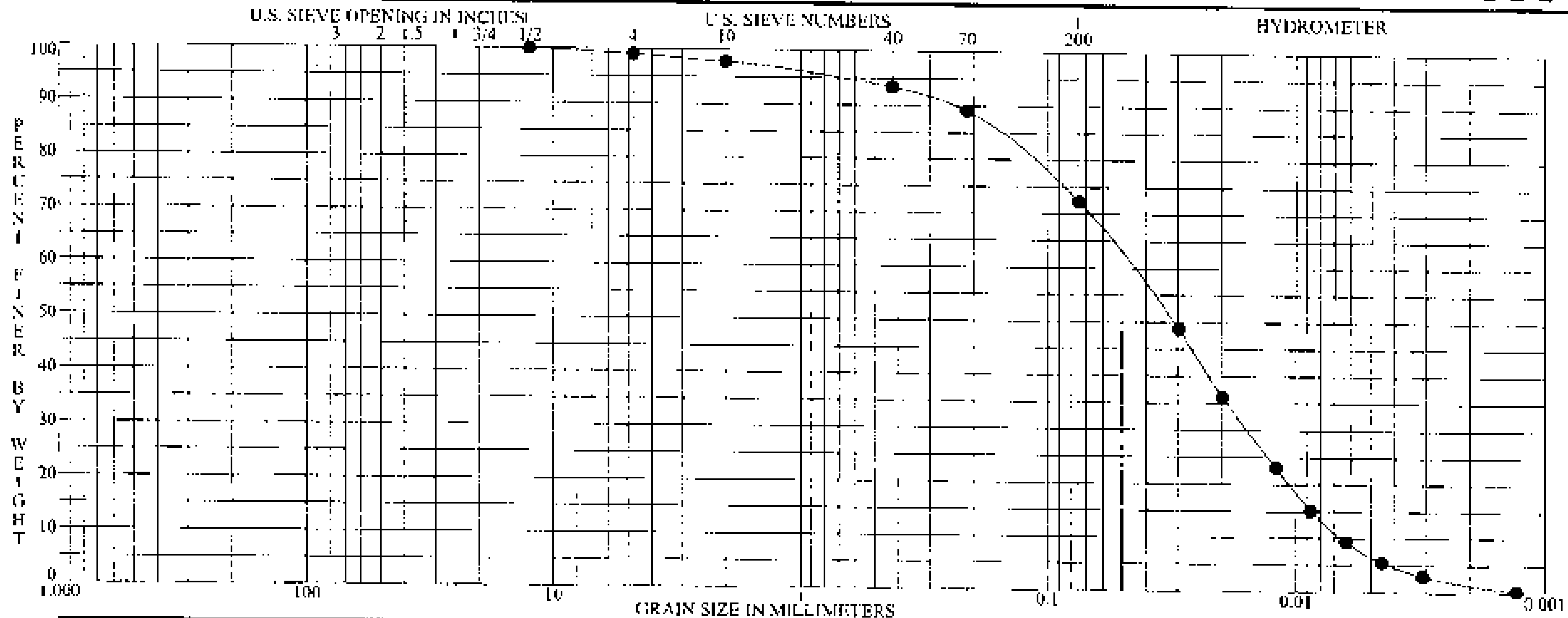

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-5 S-10 46.7' to 48.2'	FLYASH Gray silt, trace clay, some fine sand, trace medium to coarse sand, trace fine gravel.	55					

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-5 S-10 46.7' to 48.2'	12.5000	0.0460	0.0156	0.0066	1.0	26.7	65.7	6.7

ASTM D422 GRADATION CURVE

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PLATE 39

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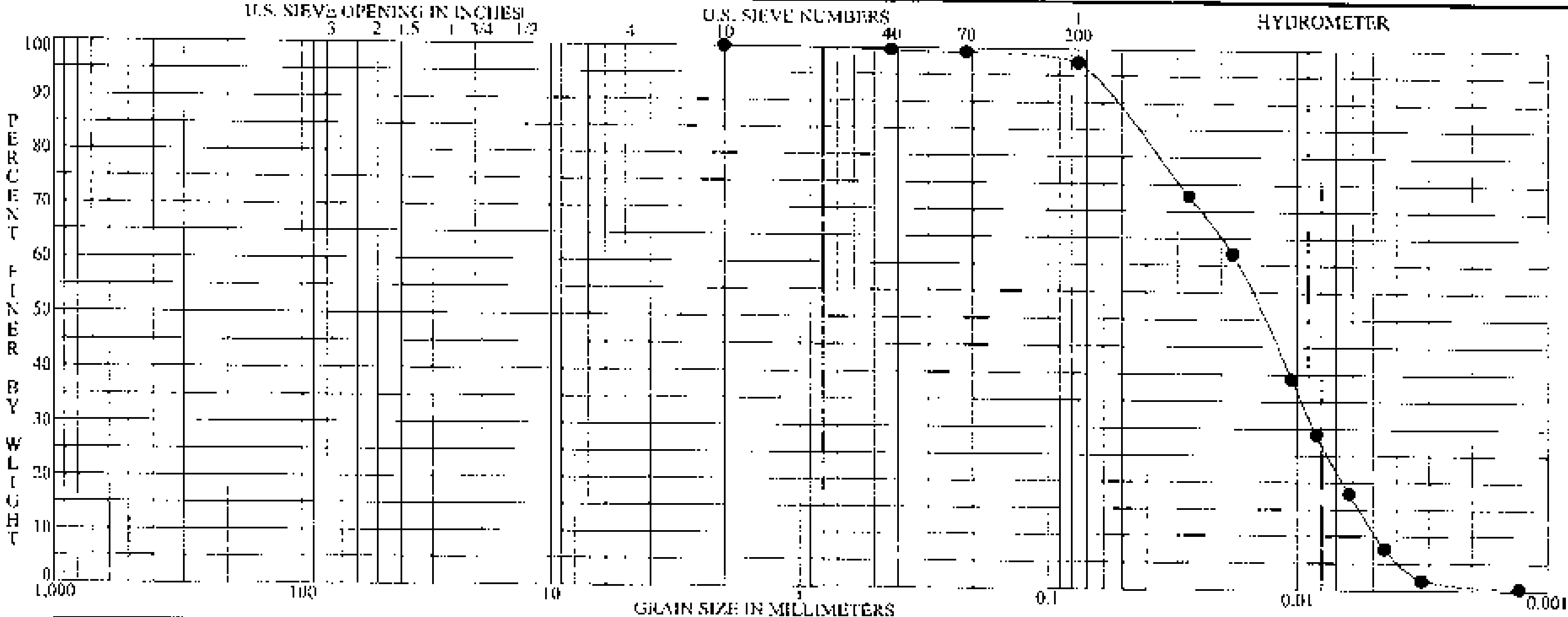

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-6 S-3 11.6' to 13.1'	FLYASH Gray and dark-gray silt, little clay, trace fine to medium sand.	56					

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-6 S-3 11.6' to 13.1'	2.0000	0.0172	0.0086	0.0048	0.0	2.6	86.4	11.1

ASTM D422 GRADATION CURVE

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LOCATION CARBO, VIRGINIA
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PLATE 40

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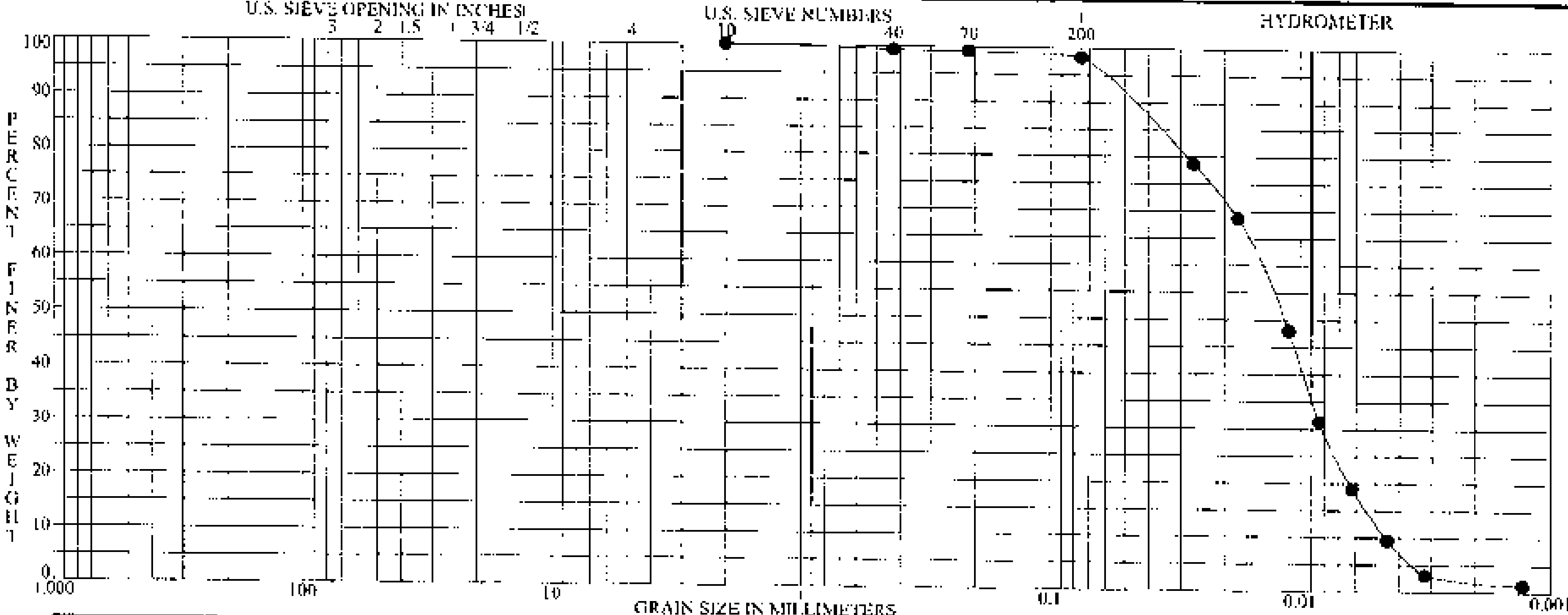

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
●	B-6 S-6 26.6' to 28.1'	FLYASH Gray and dark-gray silt, little clay, trace fine to medium sand.	53	NP	NP	NP		

	Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-6 S-6 26.6' to 28.1'	2.0000	0.0146	0.0081	0.0046	0.0	1.8	85.6	12.6

ASTM D422 **GRADATION CURVE**

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LOCATION: CARBO, VIRGINIA
JOB NO.: 011-11497-007
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AEPCR000343

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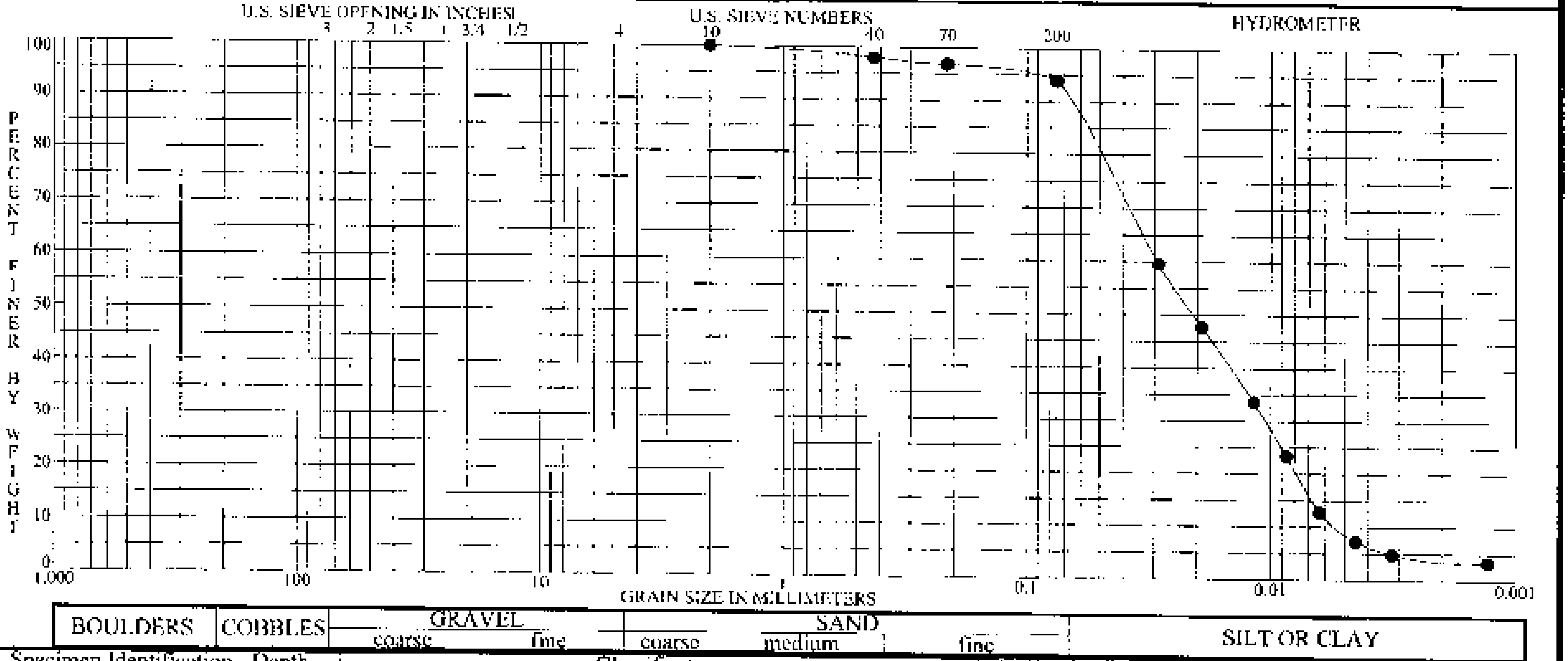

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-7 S-9 41.6' to 43.1'	FLYASH Gray, graybrown and dark-gray silt, trace clay, trace fine to medium sand.	59					

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-7 S-9 41.6' to 43.1'	2.0000	0.0290	0.0105	0.0053	0.0	6.1	84.9	9.0

ASTM D422 GRADATION CURVE

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PLATE 42

AEPCR000344

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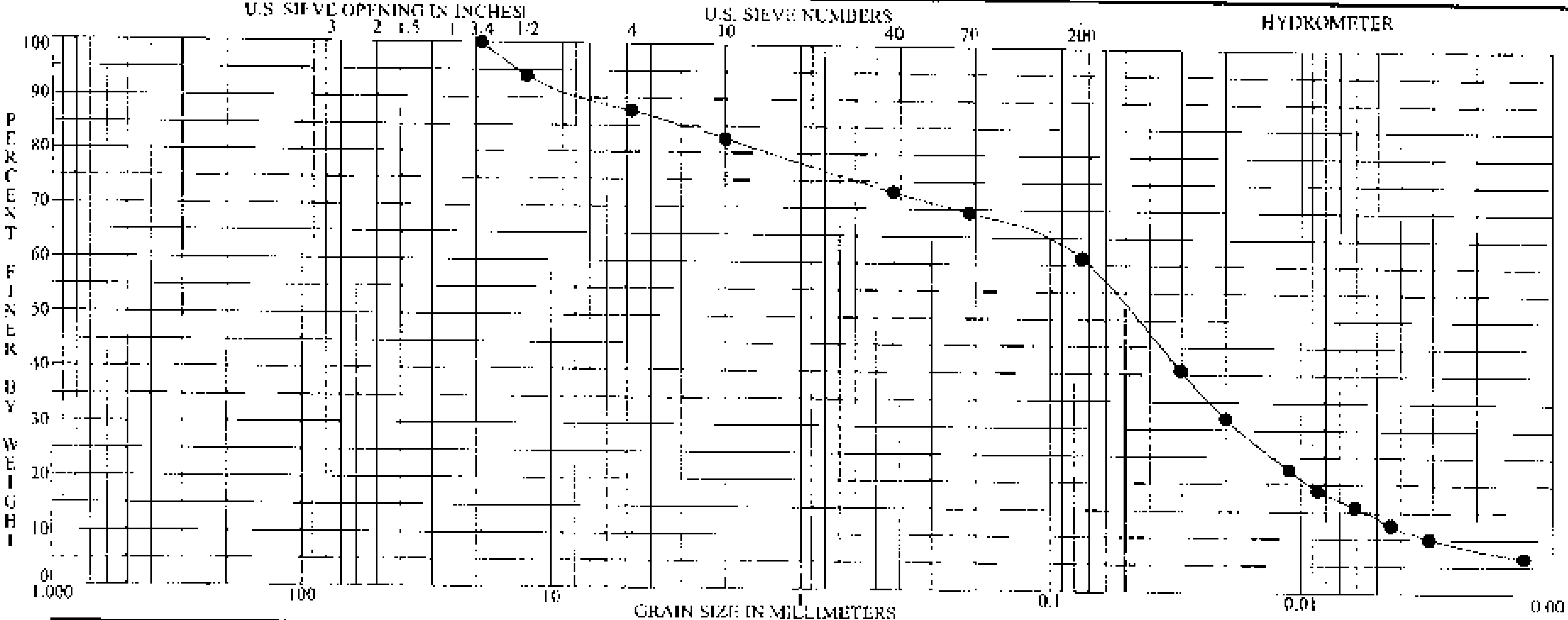

BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-7 S-14 66.6' to 67.7'	FLYASH Brown silt, little clay, some fine to coarse sand, little fine gravel.	25	23	21	2		

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-7 S-14 66.6' to 67.7'	19.0000	0.0709	0.0176	0.0030	12.3	26.4	47.4	13.9

ASTM D422 GRADATION CURVE

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LOCATION CARBO, VIRGINIA
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GRSVA.1-H89

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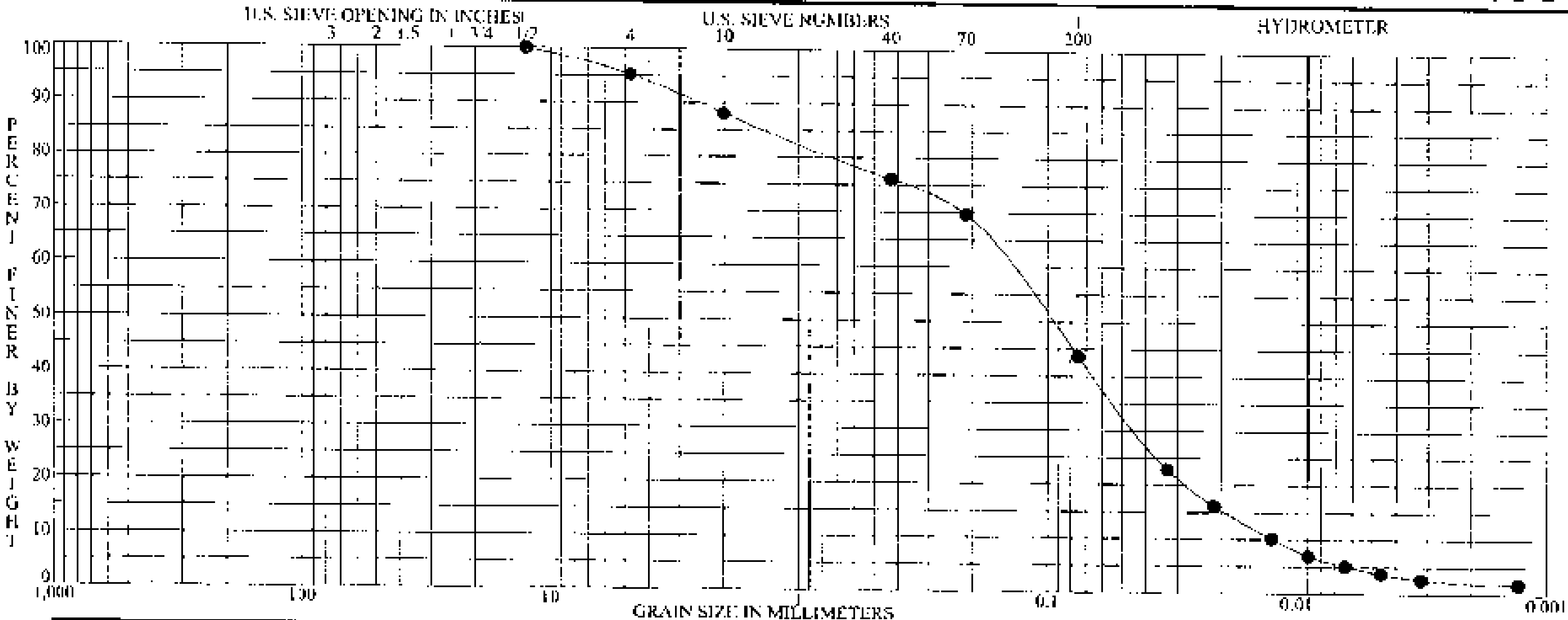

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
●	B-8 S-2 6.7' to 8.1'	FLYASH Fray fine to medium sand, trace coarse sand, trace fine gravel, "and" silt, trace clay.	22					

	Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-8 S-2 6.7' to 8.1'	12.5000	0.1439	0.0437	0.0123	4.8	51.5	39.5	4.1

ASTM D422 | **GRADATION CURVE**

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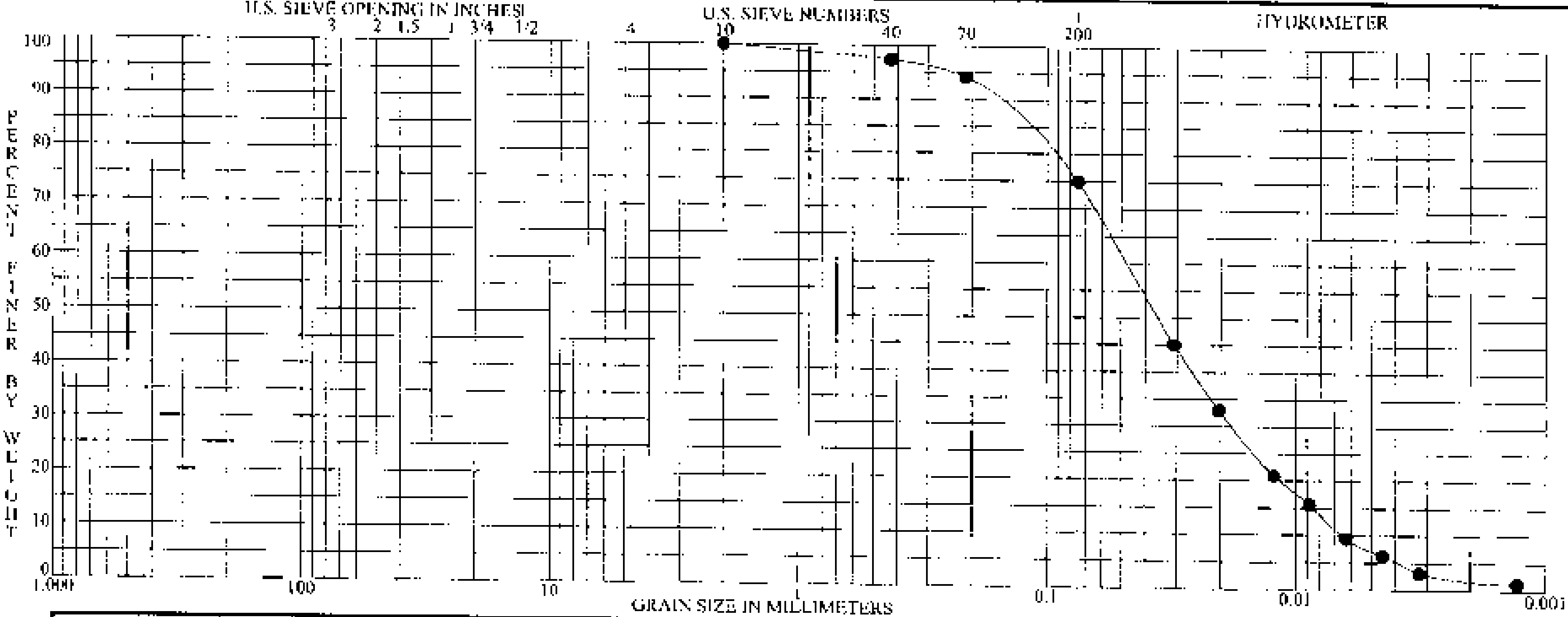
BBCM



BOULDERS	COBBLES	GRAVEL coarse	GRAVEL fine	SAND coarse	SAND medium	SAND fine	SILT OR CLAY

Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
● B-8 S-4 16.7' to 18.2'	FLYASH Graybrown and gray silt, trace clay, some fine to medium sand, few seams of fine sand.	66					

Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-8 S-4 16.7' to 18.2'	2.0000	0.0479	0.0179	0.0065	0.0	25.0	67.7	7.3

ASTM D422 GRADATION CURVE

PROJECT CLINCH RIVER POND #2 CLOSURE
LOCATION CARBO, VIRGINIA
JOB NO. 011-11497-007
DATE 11/6/08

PLATE 45

GRN-FLYASH

APPENDIX B: Slope Stability Analysis

US EPA ARCHIVE DOCUMENT

Global Stability Analysis

- Analyze static and pseudo-static conditions of final dike system and cover.
- Examine circular and translational failure surfaces.
- Progarn: Slide V. 5.035 developed by Rocscience, Inc.

Groundwater:
AEP stability analysis assumed groundwater was equivalent to height of newly placed ash fill above the middle dike since operations were active and ash was being sluiced in. Recently performed borings, however, indicate the groundwater level has lowered since operations have become inactive. The design cross section shown in this Appendix shows the groundwater levels as encountered during drilling. Generally, this lowered groundwater level improved the overall stability of the dike system in comparison with AEP's report.

Design parameters are shown on the graphical output for each stability run.

Summary of Results

Load Case	Computed FS	$FS_{REQ'D}$
Static Loading with Final Slopes -Circular Failure Surface	1.67	1.5
Static Loading with Final Slopes -Translational Failure Surface -Middle Dike	2.67	1.5
Static Loading with Final Slopes -Translational Failure Surface Lower and Middle Dikes	2.29	1.5
Pseudo-Static Loading with Final Slopes -Circular Failure Surface	1.13	1.0

US EPA ARCHIVE DOCUMENT

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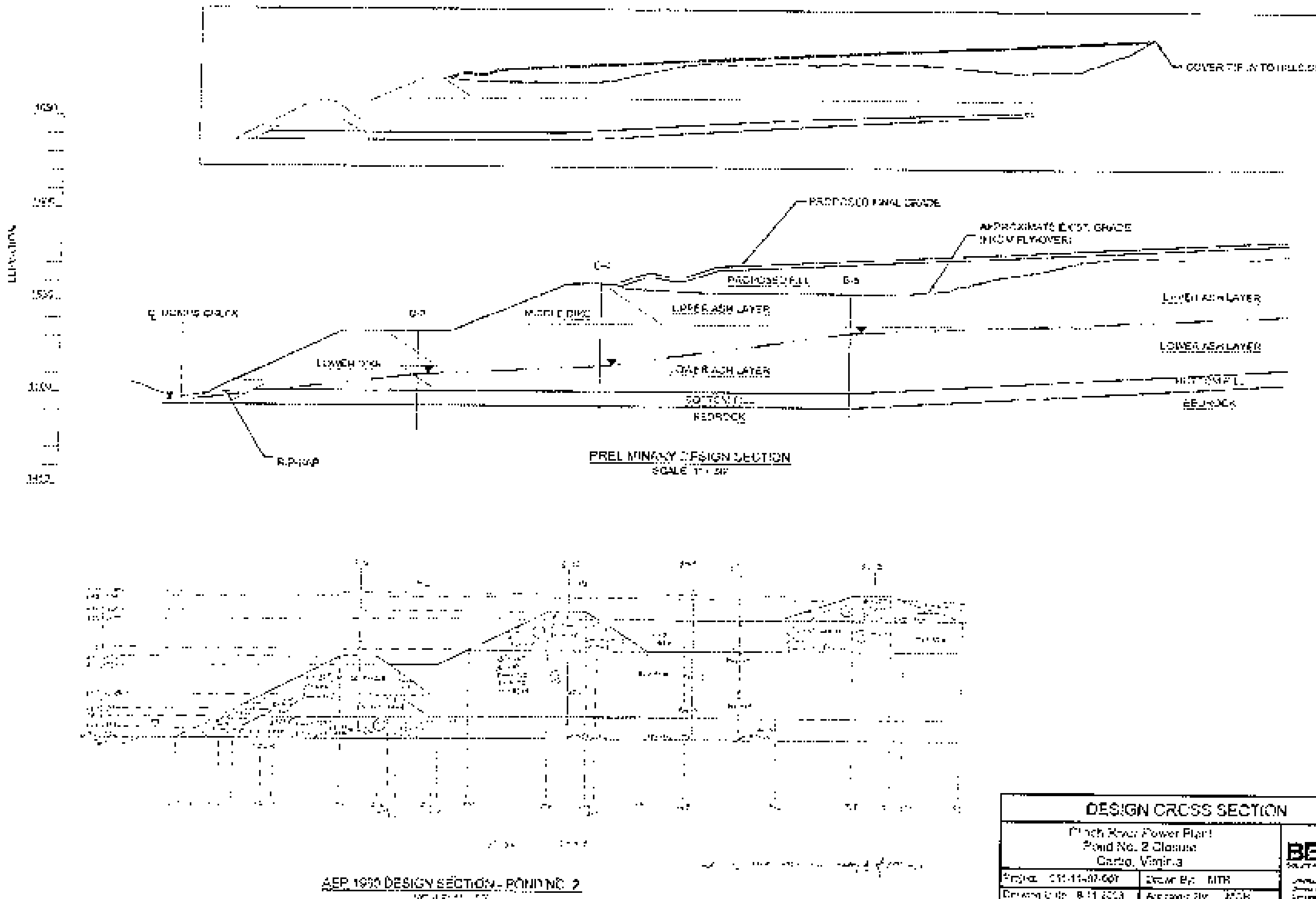
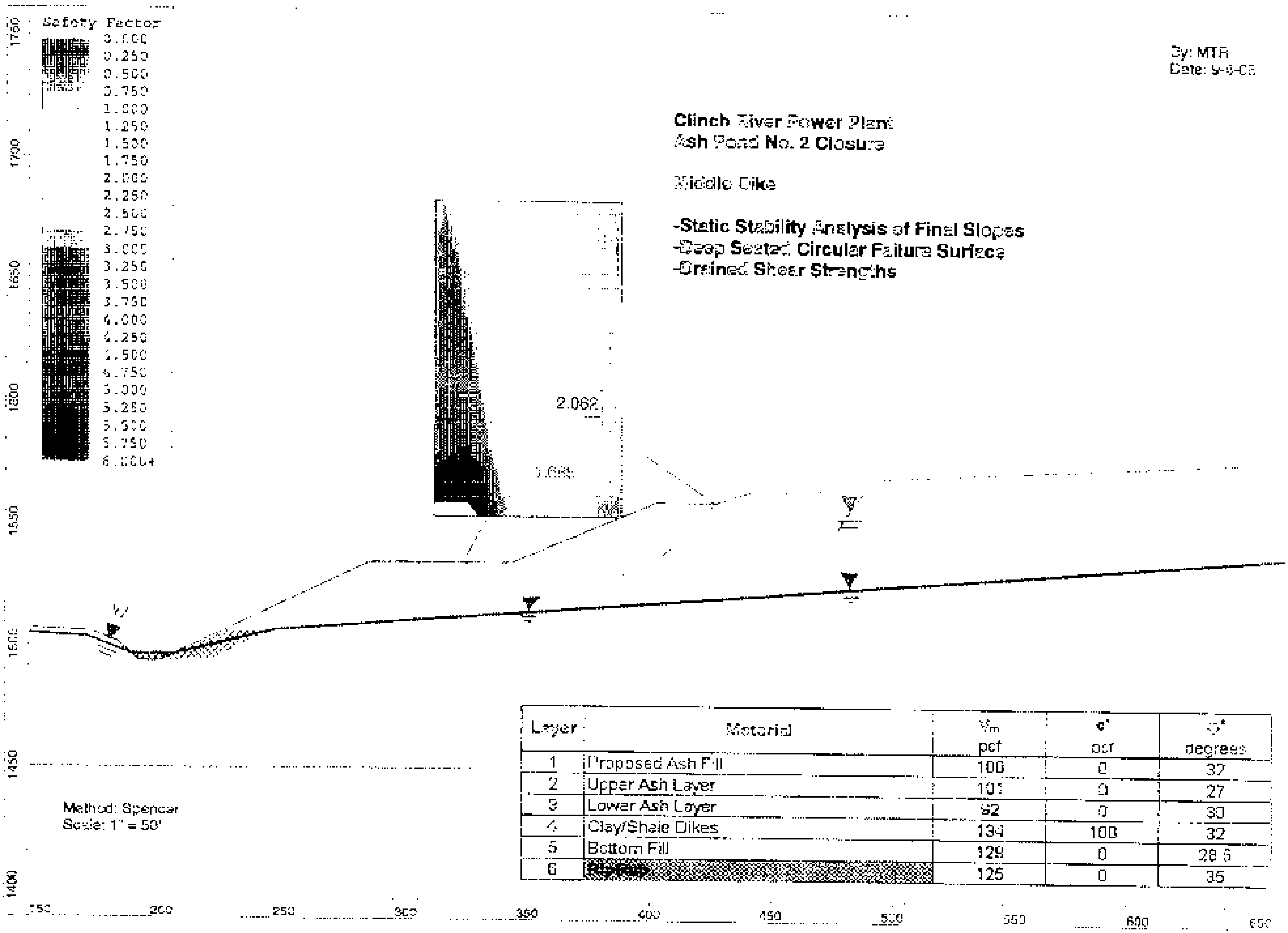


DESIGN CROSS SECTION	
Clinch River Power Plant Pond No. 2 Closure Carbo, Virginia	
Project: 011-11-07-001	Drawn By: MTR
Drawing Date: 8-11-2008	Approved By:
Last Update: 9-19-2008	Scale: 1" = 100'

PLATE

US EPA ARCHIVE DOCUMENT



Layer	Material	γ_m pcf	c' psf	ϕ' degrees
1	Proposed Ash Fill	100	0	37
2	Upper Ash Layer	101	0	27
3	Lower Ash Layer	92	0	30
4	Clay/Shale Dikes	134	100	32
5	Bottom Fill	129	0	28.5
6	Riprap	125	0	35

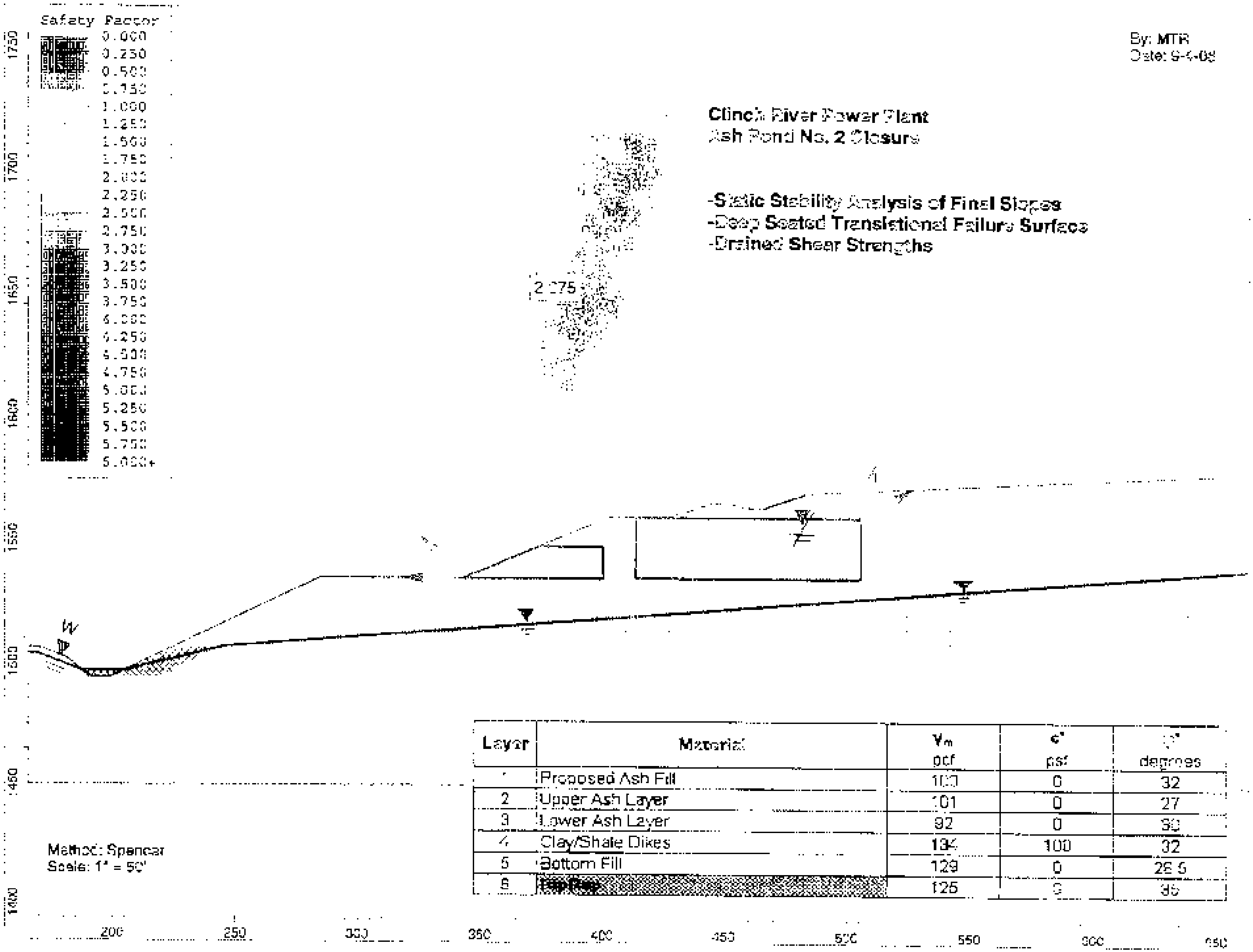
AEPCR000351

US EPA ARCHIVE DOCUMENT

By: MTR
Date: 9-4-08

Clinch River Power Plant
Ash Pond No. 2 Closure

-Static Stability Analysis of Final Slopes
-Deep Seated Translational Failure Surface
-Drained Shear Strengths



Layer	Material	γ_m pcf	c' psf	ϕ' degrees
1	Proposed Ash Fill	100	0	32
2	Upper Ash Layer	101	0	27
3	Lower Ash Layer	92	0	30
4	Clay/Shale Dikes	134	100	32
5	Bottom Fill	129	0	26.5
6	[illegible]	125	0	35

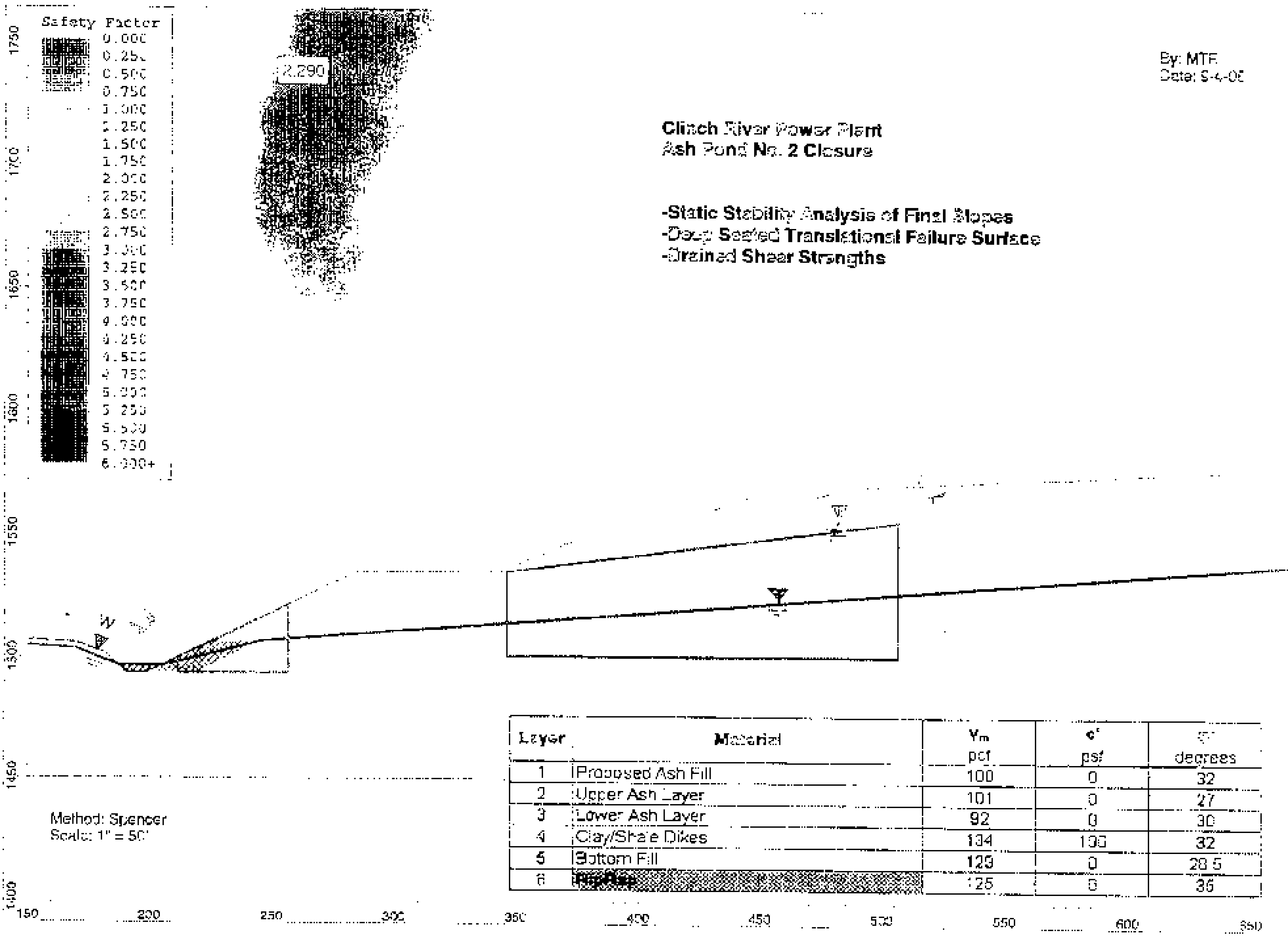
Method: Spencer
Scale: 1" = 50'

US EPA ARCHIVE DOCUMENT

By: MTF
Date: 9-4-08

Clinch River Power Plant
Ash Pond No. 2 Closure

-Static Stability Analysis of Final Slopes
-Deep Seated Translational Failure Surface
-Drained Shear Strengths



Layer	Material	γ_m pcf	c' psf	ϕ' degrees
1	Proposed Ash Fill	100	0	32
2	Upper Ash Layer	101	0	27
3	Lower Ash Layer	92	0	30
4	Clay/Shale Dikes	134	100	32
5	Bottom Fill	129	0	28.5
6	RipRap	125	0	36

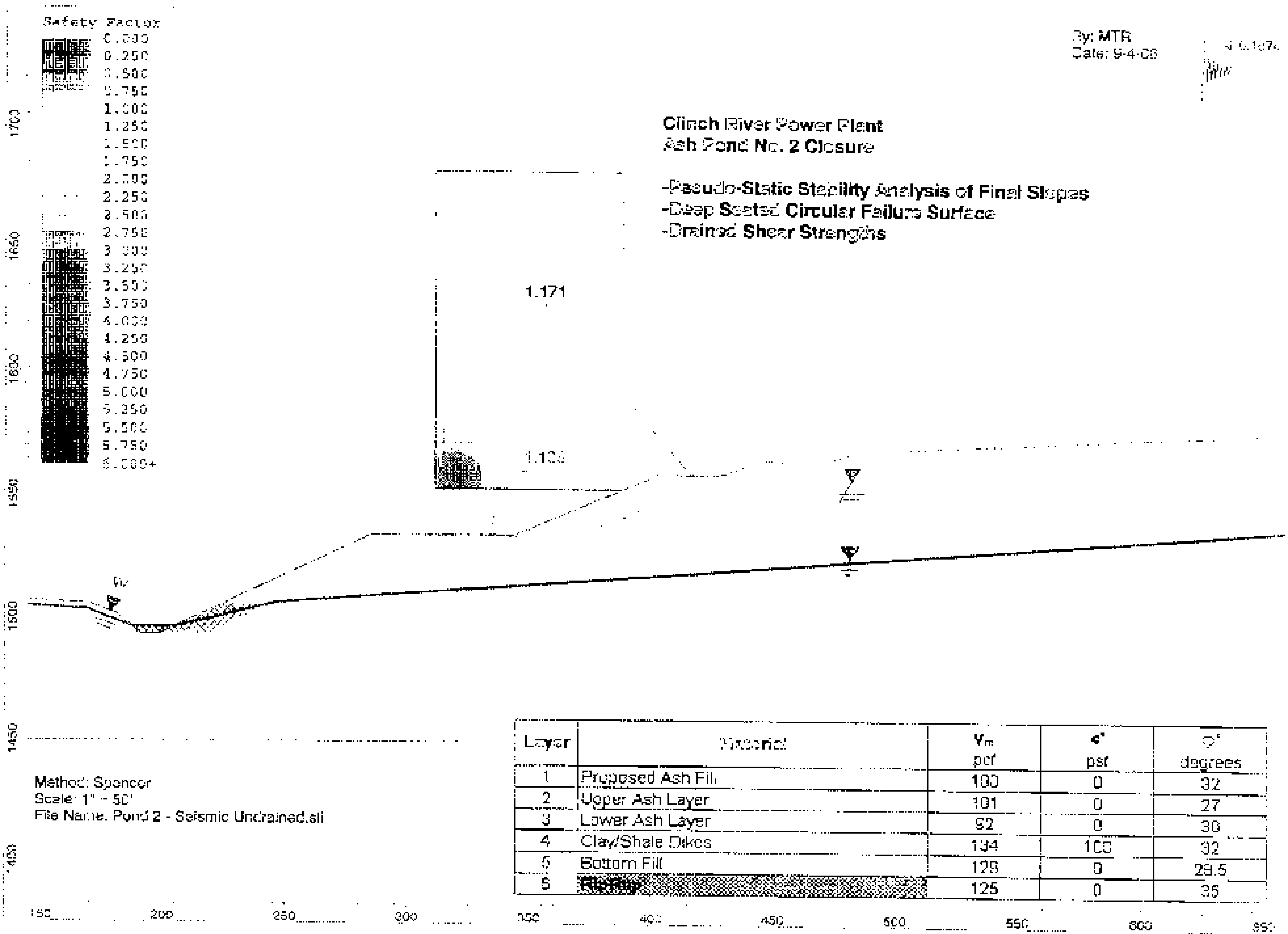
Method: Spencer
Scale: 1" = 50'

US EPA ARCHIVE DOCUMENT

By: MTR
Date: 9-4-08

Clinch River Power Plant
Ash Pond No. 2 Closure

-Pseudo-Static Stability Analysis of Final Slopes
-Deep Seated Circular Failure Surface
-Drained Shear Strengths

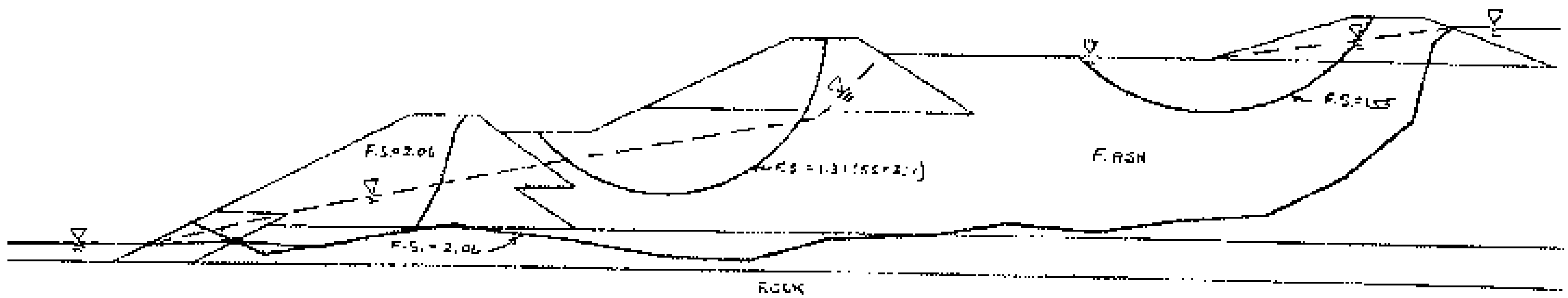


Method: Spencer
Scale: 1" = 50'
File Name: Pond 2 - Seismic Undrained.sli

Layer	Material	γ_m pcf	c' psf	φ' degrees
1	Proposed Ash Fill	100	0	32
2	Upper Ash Layer	101	0	27
3	Lower Ash Layer	92	0	30
4	Clay/Shale Dikes	134	100	32
5	Bottom Fill	129	0	29.5
6	Rip-Rap	125	0	35

US EPA ARCHIVE DOCUMENT

FROM AEP 1990 STABILITY ANALYSIS
SUMMARY OF RESULTS
POND 2



CASE	DESCRIPTION	F.S.
II A	LOWER DIKE	2.06
II B	MIDDLE DIKE	1.31
III D	UPPER DIKE	1.55
I 6	COMBINE DIKES	2.06

SUMMARY FIGURE 1

APPENDIX C: Settlement Analysis

US EPA ARCHIVE DOCUMENT

Foundation Settlement Calculations

- Compute settlement of foundation (ponded ash) under surcharge of proposed fill and cover.
- Progam: Foundation Stress and Settlement Analysis (FoSSA) Version 2.0
- Model fly ash as consolidation response
- Find maximum settlement of ash foundation under proposed fill – two areas on design cross section with deep fills.

Design Parameters

Material Description	*γ_{wet} (pcf)*	*Poisons Ratio* ν	Compression Index, c_c	*Recompression index, c_r*	*Void Ratio e_o*
Upper Ash Layer	101	0.5	0.20	.03	0.8
Lower Ash Layer	92	0.5	0.15	.03	0.8

*All other layers assumed incompressible

The above values are based on typical values for fly ash placed in very-loose to loose conditions.

Two areas on the design cross section to be analyzed for maximum foundation settlements. These sections correspond to x-values ranging from 100 to 240 and from 693 to 763 in the FoSSA program.

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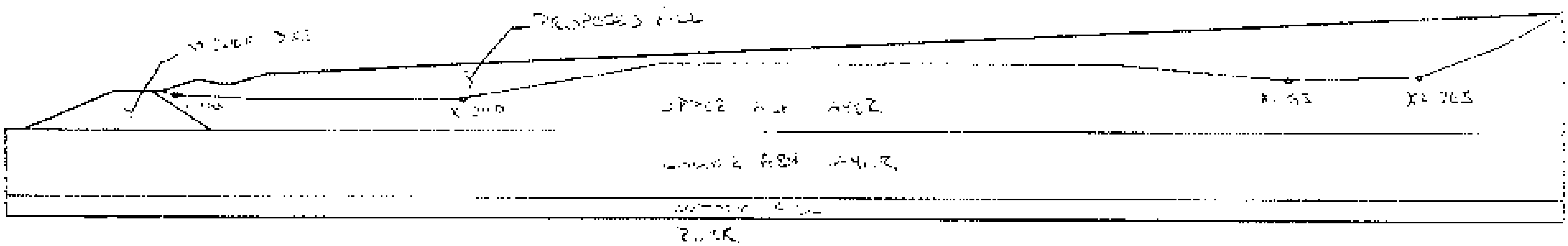
US EPA ARCHIVE DOCUMENT

4471.0007

CLIFTY CREEK POND 2 CLOSURE

SETTLEMENT ANALYSIS

SIGMA MODEL



Clinch River Power Plant -Pond 2 Closure

Report created by FoSSA(2.0): Copyright (c) 2003-2007, ADAMA Engineering, Inc.

PROJECT IDENTIFICATION

Title:	Clinch River Power Plant -Pond 2 Closure
Project Number:	011-11497 - 007
Client:	AEP
Designer:	MTR
Station Number:	

Description:

Company's Information:

Name:	BBCM
Street:	
Telephone #:	
Fax #:	
E-Mail:	

Original file path and name: G:\Columbu . . . alculations\Settlement\011-11497-007 Section 1.2ST
Original date and time of creating this file: Fri Sep 19 11:32:36 2008

GEOMETRY: Analysis of a 2D geometry

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INPUT DATA – FOUNDATION LAYERS – 5 layers

	Wet Unit Weight, γ [lb/ft³]	Poisson's Ratio μ	Description of Soil
1	101.00	0.50	Upper Ash Pond Layer
2	134.00	0.30	Exist. Clay Dike
3	92.00	0.50	Lower Ash Pond Layer
4	129.00	0.30	Bottom Fill
5	140.00	0.30	Rock

INPUT DATA – EMBANKMENT LAYERS – 1 layers

	Wet Unit Weight, γ [lb/ft³]	Description of Soil
1	100.00	New Ash Fill and Cover

INPUT DATA OF WATER

Point #	Coordinates (X, Z) : (X) [ft]	(Z) [ft]
1	0.00	1512.00
2	75.00	1515.00
3	212.00	1534.00
4	900.00	1534.00
5	1000.00	1534.00

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INPUT DATA FOR CONSOLIDATION -- α = 1/2

Layer # Undergoing Consolidation [Yes/No]		OCR Pc / Po	Cc	Cr	e0	Cv [ft²/day]	Drains at :
1	Yes	1.00	0.20	0.03	0.80	1.0000	Top & Bot.
2	No	N/A	N/A	N/A	N/A	N/A	N/A
3	Yes	1.00	0.15	0.03	0.80	1.0000	Top & Bot.
4	No	N/A	N/A	N/A	N/A	N/A	N/A
5	No	N/A	N/A	N/A	N/A	N/A	N/A

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ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z* [ft.]
1	100.00	0.00	1557.59	0.76	1556.83
2	115.56	0.00	1556.87	1.01	1555.86
3	131.11	0.00	1556.16	1.23	1554.93
4	146.67	0.00	1556.00	1.45	1554.55
5	162.22	0.00	1556.00	1.54	1554.46
6	177.78	0.00	1556.00	1.62	1554.38
7	193.33	0.00	1556.00	1.69	1554.31
8	208.89	0.00	1556.00	1.75	1554.25
9	224.44	0.00	1556.00	1.80	1554.20
10	240.00	0.00	1556.00	1.81	1554.19

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

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ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	693.00	0.00	1568.00	2.62	1565.38
2	703.00	0.00	1568.29	2.65	1565.64
3	713.00	0.00	1568.57	2.67	1565.91
4	723.00	0.00	1568.86	2.68	1566.18
5	733.00	0.00	1569.14	2.69	1566.45
6	743.00	0.00	1569.43	2.70	1566.73
7	753.00	0.00	1569.71	2.69	1567.02
8	763.00	0.00	1570.00	2.66	1567.34

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

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TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z): (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	9.70	1539.20	Upper Ash Pond Layer
	2	59.40	1560.10	
	3	79.40	1560.30	
	4	84.00	1560.00	
	5	91.00	1555.00	
	6	134.50	1556.00	
	7	245.00	1556.00	
	8	352.00	1575.00	
	9	557.00	1576.00	
	10	693.00	1568.00	
	11	763.00	1570.00	
	12	807.00	1587.00	
	13	840.70	1605.00	
2	1	9.70	1539.10	Exist. Clay Dike
	2	59.40	1560.00	
	3	79.40	1560.00	
	4	113.00	1539.10	
	5	840.00	1539.10	
3	1	0.00	1539.00	Lower Ash Pond Layer
	2	840.00	1539.00	
4	1	0.00	1503.00	Bottom Fill
	2	840.00	1503.00	
5	1	0.00	1494.00	Rock
	2	840.00	1494.00	

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AEPCR000364

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) (X) [ft]	(Z) [ft]	DESCRIPTION
1	X1 = 84.00 [ft]	1	102.10	1566.00	New Ash Fill and Cover
	X2 = 1605.00 [ft]	2	107.10	1566.00	
		3	117.00	1564.00	
		4	122.60	1564.00	
		5	140.60	1570.00	
		6	840.00	1605.00	

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AEPCR000365

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APPENDIX A

Document 7

Ash Pond 1 Construction of Cutoff Wall, by AEP

Summary Report

Construction of Cutoff Wall
Ash Pond 1A and 1B Dikes
Clinch River Plant
Carbo, Virginia

Prepared for:

American Electric Power Service Corporation

1 Riverside Plaza
Columbus, Ohio 43215

December 1991

90C4140

Prepared by:

Woodward – Clyde Consultants

201 Willowbrook Boulevard
Wayne, New Jersey 07470

US EPA ARCHIVE DOCUMENT

201 Willowbrook Boulevard
P.O. Box 290
Wayne, NJ 07470
201 785-0700
212 926-2878
Fax 201-785-0023

Woodward-Clyde Consultants

January 29, 1992

American Electric Power Service Corporation
1 Riverside Plaza
Columbus, OH 43215

Attn: Mr. Harald Jacobsen, Section Manager
Geotechnical Engineering Section
Civil Engineering Division

Re: Final Summary Report
Construction of Cutoff Walls
Ash Pond 1A and 1B Dikes
Clinch River Plant
Carbo, Virginia

Gentlemen:

Woodward-Clyde Consultants is pleased to submit herewith five copies of the above-referenced report.

We appreciate the opportunity to assist you on this interesting project. Please contact us if you have any questions.

Very truly yours,

Philippe Fayad, P.E.
Project Engineer

Majed A. Khoury, P.E.
Senior Associate

PF:MAK:am

cc: Michael Damian

mds\90C4140\d001ltr.w51

Summary Report

Construction of Cutoff Wall
Ash Pond 1A and 1B Dikes
Clinch River Plant
Carbo, Virginia

Prepared for:

American Electric Power Service Corporation

1 Riverside Plaza
Columbus, Ohio 43215

December 1991

90C4140

Prepared by:

Woodward – Clyde Consultants

201 Willowbrook Boulevard
Wayne, New Jersey 07470

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AEPCR000123

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During the period of November through December 1990 a cement-bentonite-fly ash (CBFA) cutoff wall was constructed within the Ash Ponds 1A and 1B dikes at the American Electric Power Service Corporation (AEP) Clinch River Plant located in Carbo, Virginia. The purpose of the cutoff wall was to block potential seepage paths in the dikes and to improve downstream stability. Inquip Corporation (Inquip) constructed the cutoff wall. Inquip was also responsible for implementing a quality control testing program during construction to verify that the cutoff wall was constructed in accordance with the design requirements and the Contract Documents. AEP provided full-time inspection of the Contractor's work. Woodward-Clyde Consultants (WCC) made periodic site visits during construction to observe the Contractor's work. In addition, WCC performed laboratory tests on CBFA slurry samples taken from the trench.

The dikes were previously constructed in four stages following the upstream construction method. The first stage corresponds to the original embankment which consisted of silty clay with shale and sandstone fragments. The second stage construction materials consisted of fly ash and bottom ash. The remaining stages were essentially constructed of the same material as the original material in the dikes. The cutoff wall was a minimum 30 in. wide and approximately 2,150 ft long. The cutoff wall was generally 65 ft deep and keyed into the original embankment except at both abutments where it keyed 1 ft to 2 ft into the shallow fractured bedrock.

Based on our review of the quality control field and laboratory test results, the daily inspection reports by AEP, and our visual observations of the dikes after construction of the cutoff wall, we conclude the following:

1. The cutoff wall was constructed in accordance with the intent of the design and generally to the locations and grades shown in the Contract Documents.

2. Laboratory tests on CBFA samples from the cutoff wall indicated a permeability of less than or equal to $5x10^{-6}$ cm/sec as required in the Contract Documents.

3. The piezometric levels upstream of the cutoff wall have increased after construction of the cutoff wall when compared to levels prior to construction. Also, a general piezometric drop is noticed across the cutoff wall.

4. There are no indications of significant underseepage beneath the cutoff wall.

5. The cutoff wall has been successful in intercepting most of the pervious seams in the embankment as evidenced by bare and dry calcified soil spots on the downstream face of the dikes.

6. The cutoff wall has also been successful in reducing seepage along the downstream face and toe of the dikes as evidenced by the reduced flow rates measured at the flow weirs. Post-construction seepage at the toe is clear and internal soil erosion was not observed. However, a boil area was noticed at the downstream toe of Dike 1A near Piezometer P-2 with clear water flowing without noticeable signs of internal soil erosion. The observed seepage does not appear to threaten the stability of the dikes.

Based on our conclusions related to the construction of the cutoff wall, we recommend the following:

1. AEP should continue to monitor the seepage at the downstream toe of the dikes, and two additional flow weirs should be installed.

2. Six observations wells should be installed in the downstream shells of the dikes. Monitoring the existing observation wells should continue on a monthly basis when the ponds are in service to confirm the effectiveness of the cutoff wall and to evaluate potential sources of post-construction seepage. A pair of piezometers should also be installed at the observed boil area location to understand the source of the observed seepage.

3. All downstream benches should be graded and drainage swales should be cleared of all vegetation and sediments. The objective is to enhance drainage patterns and to enhance seepage detection and evaluation.

4. The grass and vegetation cover observed on the downstream face of the dike should be mowed and the few small trees should be cut. The objective is to enhance inspection of the slopes, to allow a better evaluation of seepage patterns, and to prevent damage to the slope from tree roots.

1.1 GENERAL

This report describes the design and construction aspects of a cement-bentonite-fly ash (CBFA) cutoff wall within the Ash Pond 1A and 1B dikes at Appalachian Electric Power Service Company (AEP) Clinch River Plant located in Carbo, Virginia. A summary of piezometer measurements prior to and after construction of the cutoff wall is presented. Woodward-Clyde Consultants (WCC) also performed laboratory tests on materials used in the construction of the cutoff wall to verify the permeability of the CBFA backfill mix.

The evaluations presented herein are based on periodic site visits by WCC during construction to verify that the contractor's work was in accordance with the contract documents and the design concepts. Personnel from American Electric Power Service Corporation (AEP) provided full-time inspection during construction. Inquip Associates, Inc. of McLean, Virginia was the cutoff wall contractor. WCC's work was authorized by AEP's service order No. B-6955.

1.2 PROJECT DESCRIPTION

The Clinch River Plant is located off of Route 664, approximately 10 miles west of Lebanon, Virginia. Ash Ponds 1A and 1B are located at the intersection of Dumps Creek and Clinch River. A site location map is shown in Figure 1.

Ash Ponds 1A and 1B form a roughly triangular impoundment created by constructing a main dike as one side of the triangle with higher ground forming the remaining two sides of the triangle (See Figure 2). The crest of the 55-ft high main dike is currently at about el. 1,570 ft. This dike is about 2,000 ft long with an approximately 50-ft wide crest at Ash Pond 1A and an approximately 35-ft wide crest at Ash Pond 1B. A splitter dike separates Ash Pond 1A from Ash Pond 1B.

The dikes were originally constructed around 1955 to 1956 and have been raised following the upstream construction method. As seen on Figure 2, this method consists

AEPCR000129

of maintaining the downstream alignment of the dikes while raising the embankments in the upstream direction. Part of the addition of the dikes rested on the sedimented ash. The dikes were raised three times over a period of eight years with the latest construction to el. 1,570 ft completed in 1971. Although some of the dike extensions are shown in Figure 2 to have been constructed in the downstream direction, most of the extensions were in the upstream direction.

The typical cross-sections through Pond 1A and 1B dikes shown on Figure 2 have been inferred from AEP drawing No. 13-10585-3107-4 dated September 19, 1969 and revised in November 21, 1973 (4th revision). The elevation of the base of the dike has been corrected to reflect our best estimate of the original ground surface elevation (i.e. el. 1,500 ft). The original ground elevation shown at el. 1,515 ft in AEP drawing No. 13-10585-3107-4 contradicts other AEP documents and subsurface information described in Section 2.1. Also, downstream grading has been altered from the original drawings to reflect actual site conditions.

It appears that construction of the dikes necessitated the relocation of Dumps Creek. Documents provided by AEP indicate that the original bed of Dumps Creek passed beneath the Pond 1A dike.

Operating pool elevations at Pond 1A and 1B are el. 1,565 ft and el. 1,558 ft, respectively. Water level in Pond 1A is maintained by a 30-in. diameter spillway connected to Pond 1B. A 36-in. diameter pipe in Pond 1B carries the overflow to a catch basin at the toe of the dike, from which it flows by gravity to the recirculation pond through a 30-in. diameter reinforced concrete pipe (RCP).

1.3 BACKGROUND

Ponds 1A and 1B have had a history of obvious seepage at the downstream toe of the dikes since before WCC initial inspection in 1978. Toe drains, consisting of 10-in. diameter perforated pipe encased in a gravel backfill, have been installed along the toe of the dikes. Water flowing to the toe drains is collected in a sump and pumped into the 30-in. diameter RCP which carries the pond overflow to the recirculation pond.

AEPCR000130

Despite the toe drains, seepage was still occurring and a boil area was noted in 1975 near the downstream toe of Pond 1B. Small inverted filter blankets were constructed during the following years until 1984 when a larger inverted blanket (still noticeable) was placed over the general seepage area. Several seeps were also observed at the downstream toe of the Pond 1A dike and were reported in the various WCC inspection reports.

In response to the recommendations of the Virginia State Water Control Board and the recommendations in WCC inspection report dated May 1984, AEP performed a stability analysis of the dikes. A report summarizing the stability analyses was prepared by AEP in January 1990. The report concluded that the stability of the Pond 1A and 1B dikes was not adequate because of the high pore pressures measured in the embankment. The report recommended improving the stability of the dikes by lowering the phreatic surface in the downstream shells of the dikes by one of the following methods:

1- Impervious upstream core and upstream surface blanket,
2- Free draining downstream surcharge berm, or
3- Vertical seepage cutoff barrier.

AEP recommended implementing the third method by means of the slurry trench seepage cutoff method.

1.4 SCOPE OF WORK

AEP retained WCC to review AEP design concept, to finalize the design of a cutoff wall, to provide input to the contract documents developed for construction of the cutoff wall, and to provide periodic construction monitoring. These tasks were detailed in WCC's letter proposal dated May 17, 1990. Our activities with respect to these tasks are summarized below:

<u>Task 1: Review of AEP Design Concept</u>

WCC reviewed the available data provided by AEP and assessed the appropriateness and feasibility of a cutoff wall for controlling seepage and for

AEPCR000131

improving the stability of the dikes. A letter report dated July 12, 1990 summarizes our activities and conclusions relative to this task. A field investigation program consisting of borings and piezometers was recommended in a WCC letter dated July 13, 1990. These referenced letters are included in Appendix A.

Task 2: Design of Cutoff Wall

The additional information provided by the new borings and piezometers was reviewed and recommendations related to the design of the cutoff wall were presented by WCC in a letter dated September 24, 1990. This letter is also included in Appendix A.

Task 3: Cutoff Wall Input to Contract Documents

WCC's written input was not requested during this task. However, several telephone conversations took place between Messrs. Mike Damian of AEP and Majed Khoury and Philippe Fayad of WCC to discuss key issues associated with the contract documents. These contract documents are included in Appendix B.

Task 4: Construction Monitoring

Cutoff wall construction started on November 19, 1990 and was completed on December 19, 1990. A two-day site visit was conducted by Messrs. Philippe Fayad and Paul Dutko of WCC on November 15 and 16, 1990 before the start of construction. Two site visits were then conducted during construction by Messrs. Fayad and Dutko on November 27 and 28, 1990 and December 11, 1990, respectively. Personnel from AEP monitored the construction of the cutoff wall on a full-time basis and performed quality assurance testing. AEP daily inspection reports are included in Appendix C.

2.1 SUBSURFACE CONDITIONS

Subsurface conditions along the dikes of Pond 1A and 1B were summarized in the WCC letter dated September 24, 1990 (Appendix A) following the drilling of new borings mainly along the dike centerline. Grain-size analyses and Atterberg Limit tests were performed on selected representative soil samples. A soil profile along the axis of the dikes is presented in Figure 3 showing the approximate locations of the three material "zones" identified and described below:

Zone 1: Embankment Material

Zone 1 includes two material sub-zones:

Zone 1a. Fill material consisting of silty CLAY with gravel or sand-size shale and sandstone fragments and occasional boulders.

Zone 1b. Fill material consisting of fly ash or bottom ash with sand-size coal fragments.

Zone 2: Overburden

Zone 2 material includes soil encountered below the original ground surface and over the bedrock. The soil in Zone 2 consists of silty CLAY with gravel or sand-size shale and sandstone fragments and occasional sand seams or inclusions.

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Zone 3: Bedrock

Bedrock is encountered on average at about 10 ft below the original ground surface (estimated at el 1,500 ft). In general, the rock is highly fractured (RQD* = 0%) except for two borings where RQD ranged between 42% and 77%. The bedrock consists of shale, limestone, dolomite, and sandstone.

2.2 PIEZOMETRIC CONDITIONS PRIOR TO CUTOFF WALL

Piezometric information was obtained from observation wells screened through the embankment fill and the bedrock, and from piezometers installed along the downstream toe of the dike near the top of the bedrock. Old observation wells installed in the embankments provided additional information. The location of piezometers and observation wells is shown on Figure 2. A detailed discussion of the piezometric conditions is given in WCC letter dated September 24, 1990 (Appendix A). The following summarizes the major findings:

- The presence of relatively pervious seams was postulated in the later embankments extensions, but not in the original embankment material. These seams were suspected to provide potential flow channels between the pond water and the surface of the downstream slopes.

- The pore pressures in the upper fractured zones of the bedrock appear to respond to the regional groundwater regime as well as to the water levels in the ponds.

It was not possible, based on the available piezometric data, to estimate seepage quantities through either the pervious seams in the embankments or the fractured bedrock.

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* RQD corresponds to Rock Quality Designation which is equivalent to the percentage of total length of core pieces, 4-in. or longer, to the total length cored.

2.3 CUTOFF WALL DESIGN

2.3.1 Geometry

The solution proposed by AEP to mitigate the observed seepage, i.e. constructing a cutoff wall, was believed likely to reduce seepage in the embankments and hence to improve downstream stability. Based on the available subsurface and piezometric conditions, WCC recommended construction of a 65-ft deep cutoff wall terminating (keying) into the original low permeability embankment material. The wall would be 2.5 ft wide and would be constructed with a cement-bentonite-fly ash (CBFA) backfill mix having a permeability equal to or less than 5×10^{-6} cm/sec and a minimum strength of 8 psi at 7 days.

Two pipe crossings exist along the cutoff wall alignment and are shown on Figure 3. An 18-in. diameter transite pipe carries surface run-off from the steeply sloped areas north of Ponds 1A and 1B and discharges into Dumps Creek. This pipe is located at the splitter dike crossing and is buried about 5 ft below the surface. A 36-in. diameter outflow pipe connects the overflow structure in the northwest corner of Pond 1B to the downstream catch basin. The approximate alignment is shown on Figure 2 and the invert is estimated at about el. 1,498.5 ft, as inferred from AEP drawings No. 12-3434A-2 revised on July 17, 1958 (2nd revision) and No. 12-3032A-4 revised on June 21, 1963 (3rd revision).

2.3.2 Backfill Design Mix

A single backfill design mix was developed in WCC's Clifton, New Jersey laboratory using fly ash and Clinch River water provided by AEP. The mix consisted of the following ratios by weight:

Bentonite:Water ratio (B/W)	0.044
Cement:Water ratio (C/W)	0.225
Cement:Fly Ash ratio (C/FA)	1.5

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Before the contract was awarded, the Contractor proposed an alternate backfill mix that uses a proprietary admixture called Actisol. This admixture allows greater substitution of fly ash for cement and provides a mix that would meet the requirements of permeability and strength presented in the contract documents. Also, the Contractor requested that the acceptance of the cutoff wall be based on the 28-day permeability and strength rather than the 7-day measurements specified in the contract documents. AEP approved this request during the pre-award meeting held on September 9, 1990.

Five different backfill mixes using Actisol admixture were tested in WCC's laboratory using the same bentonite, cement, and water as in the original mix. The retarder was Marasperse C-21 manufactured by Daishowa and was similar to the retarder used during construction of the cutoff wall. The results of preconstruction laboratory testing are provided in Appendix D. The mix selected by the Contractor and approved by AEP corresponds to mix IQ-2 with the following quantity ratios expressed by weight:

Bentonite:Water ratio (B/W)	0.038
Cement:Water ratio (C/W)	0.1277
Cement:Fly Ash ratio (C/FA)	0.694
Actisol:Cement ratio (A/C)	0.0699
Retarder:Cement ratio (R/C)	0.00806

These ratios lead to the following design quantities per cubic yard of mix:

Bentonite	56 lbs
Cement	189 lbs
Fly Ash	272 lbs
Actisol	13.2 lbs
Water	1,480 lbs
Retarder	1.5 lbs

The above ratios yielded a laboratory CBFA mix with the following characteristics:

Characteristic	Average Slurry Parameter	Curing Time of Hardened Slurry, Days			
		3	7	14	28
Marsh Funnel viscosity, sec	34				
Mud Balance density, pcf	74				
Flexible-wall permeability, 10^{-6} cm/sec	N/A	9.4	7.0	3.4	2.7
Unconfined compression, psi	N/A	5.1	11.0	22.5	26.1

The results of the laboratory testing program suggested that the CBFA slurry characteristics (i.e. permeability, strength, etc.) were very sensitive to the amount of bentonite in the mix.

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3.1 GENERAL

The cutoff wall construction started at the right abutment on Monday, November 19, 1990 and was completed on Wednesday, December 19, 1990. The excavated material was originally stockpiled on the side of the trench, but was trucked to an on-site disposal area designated by AEP. A gravel cap was constructed on top of the completed cutoff wall in January and February 1991. WCC made site visits during construction to review the contractor's operations and AEP monitoring records. AEP's personnel maintained the daily inspection reports as presented in Appendix B.

3.2 SITE ORGANIZATION

The contractor had located the mixing plant on the north side of Pond 1A. The plant was composed of two high shear velocity mixing tanks, two 100-ton silos, and one 22 cubic yard averaging tank. A tank temporarily stored bulk cement before it was pumped to one of the silos. Fly ash was shuttled from AEP's power plant located near the site via pneumatic tanker trucks. Bentonite was shipped in bulk to the site by railroad cars where it was shuttled to the site via pneumatic tanker trucks. The proprietary admixture, Actisol was shipped in 50-lb bags. Retarder additive was shipped in 50-lb bags. Water was pumped directly from the Clinch River.

Two ponds were excavated to store bentonite-water (BW) slurry. Dry bentonite and water were mixed at the nozzle of a continuous Venturi tube high shear mixer and BW slurry was discharged into the first pond. The slurry was hydrated overnight and later pumped to the second pond. The slurry was typically mixed at a higher density than that required for the final mix. The density was adjusted by adding water to the slurry at the pump suction intake. Figure 4 presents the general setup of the contractor's operations.

3.3 MIXING OF SLURRY

3.3.1 Mixing Equipment

A schematic of Inquip's batch plant is shown in Figure 4. The entire batch plant is automated except for the Actisol admixture and the retarder which are added to the mixer by hand. A hopper is located over each of the two mixers and is suspended to a load cell. The purpose of the load cell is to measure the weight of cement and fly ash added to the hopper. A computerized driving system introduces the preset amounts of cement and fly ash into the hopper. A digital dial indicates at all times, the weight in the hopper. The hook-up, calibration, and programming of the scales were done by Moore Scale Service, Inc. of Stephens City, Virginia, on November 15 and 16, 1990. The load cells were described as to be fully compensated for temperature changes and were rated for 5,000 lbs with a 150 percent overload capacity.

BW slurry is pumped from the hydrated pond into a steel column of known volume. An overflow pipe controls the volume and helps indicating when the column is full. The dimensions of the column were measured by Inquip and indirectly checked by WCC using the known volume of the mixer. The total volume of each mixer was approximately 7.1 cubic yards. However, only about 4.3 cubic yards of material were mixed for each batch.

The CBFA slurry is pumped into an "averaging" tank from which it is pumped to the trench. The purpose of this tank is to average the excavation/backfilling operations. During excavation of the deeper portion of a panel, mixing operations produce slurry faster than the backhoe can excavate the soil, thus storing of the excess slurry in the tank is required. During the excavation of the upper (shallower) part of the panel, the backhoe can excavate soil faster than slurry is produced, thus drawing from the tank the balance of slurry required. The capacity of the "averaging" tank is about 4 to 5 CBFA batches, or approximately 20 cubic yards.

3.3.2 Mixing Sequence

The hydrated BW slurry is pumped from the ponds into the steel columns at the mixing plant. Water is added to the pump intake to adjust the viscosity of the slurry to the required value. Once the column is full, as indicated by the overflow pipe, the pump is shut-off and this volume of BW slurry is dropped into the mixing tank. In the meantime, the automated driving system pours into the hopper the predetermined weights of fly ash followed by cement. Retarder is added first to the BW slurry. Fly ash and cement are then introduced while slowly adding the Actisol additive. The CBFA slurry is mixed for about 2 minutes before being pumped to either the trench or to the "averaging" tank.

In general, the automated system performed adequately except for some problems related to the electronic driving system. The built-in programmable time lag closing circuitry, controlling the volume of solids (cement and fly ash) poured in the hopper, tended to overshoot the necessary volumes for each mix. During ideal conditions, the excess material is automatically compensated every few batches. Measurements and cross-check calculations indicated, however, that the correction was not done properly at the end of the day. Up to 6 percent excess fly ash and 2 percent excess cement were calculated at the end of a day.

3.3.3 Field Trial Mix

A field trial mix was attempted late in the afternoon of November 16, 1990. Initial density and viscosity testing of the BW slurry indicated that the slurry was richer in bentonite than the design mix. As a result, Inquip circulated the BW slurry in the pond while adding water at the pump intake. These efforts were however only partly successful, and water was added directly to the mixer to achieve the desired slurry characteristics.

It was originally intended to take samples of the CBFA trial mix for permeability and strength testing. However, because of the incorrect amount of material, samples were not taken. Samples were taken during the second day of operation and were shipped to WCC for testing.

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3.4 EXCAVATION

A hydraulic backhoe, Koehring 1266D with an extended dipper stick (reach of about 75 ft) excavated the trench. Excavation was done in continuous 20-ft to 30-ft long panels. The cutoff wall was constructed as close to the downstream edge of the crest as practically possible, i.e. about 15 ft from the downstream edge. The cutoff wall was a minimum 30 inches wide and approximately 2,150 ft long. The cutoff wall keyed by about 1 ft to 2 ft into the shallow fractured bedrock at both abutments. Excavation and backfill progressed at an average rate of about 5,700 ft^2/day. The cutoff wall was typically about 65 ft deep and keyed into the old embankment material.

Before excavation started in the morning, standing water on the top of the trench was removed with the bucket of the backhoe. The standing water appeared red-brown in color and was about 9 in. to 18 in. deep after an overnight setting. Every day, the first excavated panel was keyed a minimum of 2 ft into the previous day's hardened backfill to ensure continuity.

Precautions were taken when excavating around the 36-in. diameter pipe. The springline of the pipe was estimated at approximately 68 ft below the top of the dike. The trench above the pipe was, however, excavated to a depth of 60 ft, for a lateral distance of 10 ft on both sides of the estimated pipe centerline.

The 30-in. diameter pipe crossing the trench alignment at the east end of the splitter dike was removed over a distance of about 30 ft as quoted in AEP inspection reports. The pipe was then reinstalled through the hardened CBFA backfill, but no inspection by AEP was provided at the time of these operations. The details of the excavation at the pipe crossing are contained in item 5 of the pre-award minutes of the meeting between AEP and Inquip on 9 September, 1990. These details are included in Appendix B.

The excavated material was generally red-brown silty clay with shale and sandstone fragments. Layers of fly ash and bottom ash were encountered during excavation and were apparently harder to excavate. The original embankment material was generally similar to the majority of the embankment material in the later dike extensions. In some areas, zones of dry highly fractured shale were encountered as shown in the generalized cross section presented in Figure 3. The locations of these zones are very approximate and are based on AEP's inspection reports and as-built information. Also, some inconsistencies were observed between AEP's inspection reports and the as-built profile provided by AEP. Samples of the key material were taken and stored in ziplock bags. No rock samples were saved from the bedrock keying stratum in the areas close to both dike abutments.

3.5 CONSTRUCTION OF CUTOFF WALL CAP

The top of the cutoff wall was capped with clay and gravel as shown in Figure 2. The cap design consisted of excavating the hardened CBFA backfill to a depth of 2 ft below the ground surface, placing and compacting a 6-in. thick layer of clay, placing a Tensar BX1100 (SS1) geogrid, and backfilling the remaining portion with compacted Virginia DOT#21A gravel. The clay was imported from a borrow area located on AEP Power Plant property located about 5 miles from the site. The construction sequence was not observed by WCC and was not reported in AEP's inspection reports. It appeared, however, through verbal communication with AEP that construction of the cap went well.

4.1 GENERAL

Quality Control (QC) of the construction of the cutoff wall was the responsibility of the contractor. The QC program was defined in the contract documents and covered testing of water, bentonite, cement, bentonite-water slurry, cement-bentonite-fly ash slurry, and measuring the depth of the trench. AEP inspectors performed additional quality assurance (QA) tests and participated with the contractor in making his measurements. Results of QC testing performed by AEP were logged daily in the inspection reports and were submitted to WCC at the end of the cutoff wall construction. WCC performed additional testing on the BW and CBFA slurries during the site visits. Laboratory permeability and strength testing was also performed by WCC on samples taken from the trench, on a weekly basis. A summary of all QC testing results is presented in Tables 1 through 3. The following sections provide an overview of the QC tests based on AEP's records supplemented by measurements made by WCC during the two site visits.

4.2 ALIGNMENT

The alignment of the cutoff wall was field fit at the top of the dikes by the contractor. The location of the alignment was governed by the following conditions:

- The wall alignment should be located as close as practically possible to the downstream edge of the dikes to maximize the penetration of the wall into the original embankment. Based on the sequence of construction of the embankments, i.e. upstream extension, most of the original embankment material was located downstream of the present centerline of the dikes as shown in the typical cross-section in Figure 2.

- Disturbance to piezometers and observation wells installed at the crest of the dikes should be minimized.

- The radius of curvature of the wall should be maximized along the curved portions of the alignment to facilitate trench excavation.

Work progress along the alignment was controlled by wooden stakes located about 20 ft downstream of the trench centerline along the edge of the crest, and were placed in a non-linear (zig-zag) manner. This control procedure resulted in inaccurate stationing along the cutoff wall. The length of the wall as measured by the control stakes and presented in AEP inspection reports was about 100-ft longer than the length measured along the as-built alignment on Figure 2.

4.3 DEPTH

The depth of the trench was measured every 10 ft by AEP inspectors during construction. Results of depth measurements are summarized on Table 1.

Depth measurements were initially performed with a weighted tape. However, the tape broke a few times because of the high viscosity of the slurry at depth. A second attempt of depth measurements consisted of attaching the tape to the teeth of the bucket. The tape could not, however, be held straight along the boom, thus resulting in erroneous depth measurements.

Depth measurements were then made with a steel rope hooked to a heavy metal rod. Pipe clamps were attached at one-ft intervals to indicate the 65-ft, 66-ft, and 67-ft depth markings. This method provided repeatable depth measurements but was very difficult to operate because of the large combined weight of the rope and the metal rod. Measurements with the steel rope started on November 27, 1990 when the excavation reached about Station 2 + 80.

4.4 BENTONITE-WATER SLURRY TESTING

Bentonite-water (BW) slurry was tested for viscosity, density and temperature several times per day at the mixing plant (BW columns), and at the transfer pump between the storage (hydration) pond and the mixing plant. In the pond, BW was stored at a thicker consistency than needed for the mixing operation but was generally at about a Marsh

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Funnel viscosity of 40 sec. A hydrometer was available at the site and was used frequently to evaluate the density of the slurry. A density of 64 pcf measured with the mud balance was equivalent to a specific gravity of 1.024 measured with the hydrometer.

The BW slurry was also tested at the mixing plant. Slurry samples were taken from the transfer columns, shown on Figure 4, before the slurry was dumped into the mixers. The slurry was tested for viscosity, density, and temperature at least once a day, as reported by AEP.

The test results generally indicated that BW slurry had a uniform consistency with a Marsh Funnel viscosity around 32 sec, a Mud Balance density of about 64 pcf and a specific gravity of about 1.024. These results are summarized in Table 1.

4.5 CEMENT-BENTONITE-FLY ASH SLURRY TESTING

Cement-bentonite-fly ash (CBFA) slurry was tested in the mixing tanks for viscosity and density. Samples were taken at one occasion from the mixing tanks for laboratory permeability and strength testing. Samples were taken weekly from the trench and were sent to WCC laboratory for laboratory permeability and strength testing.

The CBFA slurry was tested in the mixing tanks just before it was pumped to the trench. The Mud Balance results indicated that the density was relatively uniform around 74 pcf. The viscosity as measured with the Marsh Funnel was, however, extremely variable and ranged from 31 sec to 95 sec with an average value of about 51 sec. The results are summarized in Table 2. These viscosity results are consistent with visual observations made at the mixing plant. The consistency of the CBFA slurry mix consisting of bentonite, cement, fly ash, Actisol additive and retarder was apparently very sensitive to the BW slurry properties and to the sequence of adding the materials. Mixing problems, including electronic driving system overshoots, pump clogging, poor mixing, and line bursting were reported in AEP's inspection reports and were observed by WCC during the site visits.

The laboratory permeability test results in Table 3 indicate that the hardened CBFA slurry from the trench had a permeability of 5×10^{-6} cm/sec or less at 7 days which meets the permeability requirements in the Contract Documents. The unconfined compressive strength test results indicate that the hardened CBFA slurry had an unconfined strength greater than 8 psi at 28 days, which meets the acceptance criteria set by AEP at the preaward meeting with Inquip (Appendix B). The Contract Documents required originally that the CBFA slurry has a minimum unconfined compressive strength of 8 psi after 7 days of curing. However, the key issue is that the slurry must be sufficiently hardened to become self-supporting before excavation begins at the adjacent section so that cracks do not form in the partially set slurry. Based on visual observations of the AEP inspectors, the slurry was sufficiently hardened before excavation began at an adjacent panel.

5.1 GENERAL

Ponds 1A and 1B were taken out of service on April 1990 for dewatering and excavation of ash. This was also necessary to allow for the start of construction of the cutoff wall. Refilling of the ponds began in May 1991. Ponds 1A and 1B reached their normal operating levels of el. 1,566 ft and el. 1,558 ft on or about May 10, 1991 and May 21, 1991, respectively. AEP performed daily monitoring of piezometers and observation wells, pool elevations, flow rates at the existing flow weirs, and flow rates at the seepage collection sump between May 6 and July 3, 1991, and then on about a monthly basis thereafter. A summary of water level measurements in observation wells, piezometers, and flow weirs is presented in Table 3.

The purpose of the post-construction observations was to evaluate the effectiveness of the cutoff wall and the performance of the dikes after the refilling of the ponds. The following sections present an evaluation of post-construction observations and monitoring through October 28, 1991.

5.2 GROUNDWATER LEVEL MEASUREMENTS

Groundwater levels in the embankments and in the foundations were monitored by two series of observation wells, A- and B-series, and one series of piezometers, P-series. A- and B-series wells consist of a 2-ft long slotted bottom section of PVC connected to a 1.5-in diameter solid PVC riser. The bottom of the wells were located at the bottom of the borehole. Relatively clean coarse sand was used to backfill the annulus space between the riser pipe and the borehole to about 2 to 3 ft from the ground surface. The water level data represents, therefore, the piezometric conditions of the most permeable layer encountered along the length of the observation wells. The P-series piezometers consist of Casagrande-type piezometers installed in the foundation soils immediately above the weathered bedrock and sealed with bentonite pellets. Each piezometer consists of a Geonor Model M-206 bronze-filtered sensor (14-in. long by 1/4-in. diameter) connected to a 1/4-in. I.D. polyethylene tubing.

Following construction of the cutoff wall, the observations wells were rehabilitated by the cutoff wall contractor. Independent depths checks performed in September 1991 by AEP revealed, however, obstructions in some of these wells. During a site visit on September 24, 1991, WCC recommended flushing all wells and bailing the water out. AEP personnel flushed the A- and the B-series wells on October 17, 1991 and found cement-bentonite slurry and soil sediments in some of the wells. The results of the flushing operations are presented in Table 5 which indicates that the flushing of the wells was generally effective in removing sediments but that few wells were still obstructed. The amount of sediments (or level of obstruction) in each well is represented by the difference between the measured bottom elevation and the bottom of the screen reported by AEP after the installation of the wells. A well is considered in good condition if this difference is less than 1 ft, i.e. within the level of accuracy of the depth measurements. Wells A-2, B-2, and B-4 and to a lesser extent A-1 are therefore questionable because the calculated difference is much larger than 1 ft.

The changes of water levels in observation wells with the pool elevation in Pond 1A are plotted in Figures 5 and 6. Figure 5 shows a hydrograph for all measurements available since the installation of the A-series observation wells. Figure 6 shows the most recent data. The water levels in wells installed upstream of the cutoff wall are about 15 ft higher than the water levels recorded prior to the construction of the cutoff wall, during normal pond operations. Also, the water levels followed the rise in pond elevation with little to no time-lag. The observation wells downstream of the cutoff walls recorded generally similar water levels to the levels measured prior to the construction of the cutoff wall. However, these observation wells recorded a slight increase in head, with the refilling of the pond, then stabilized. Although not very clear, a general drop in head across the wall can be inferred from the water level measurements. This trend is observed on cross-section B-B' in Figure 2 and in the data presented for cross-section B-B' in Figures 7 and 8. The piezometers located along the downstream toe and screened immediately above the bedrock horizon exhibit relatively low total heads which seems to indicate that underseepage is not significant.

The response of the observation wells and piezometers to the change in pool elevation in Pond 1B follows a similar trend to the one observed for Pond 1A. These measurements are plotted on Figures 9 and 10. The water level data relative to cross-section C-C' shown on Figure 2 are plotted on Figures 11 and 12. In general, the increase in head observed in the wells located downstream of the cutoff wall is much smaller than observed at Pond 1A following the filling of Pond 1B. Well A-7 is screened at the base of the original embankment fill, and is located downstream of the cutoff wall. Initial measurements have indicated that the well was dry. Flushing operations have, however, removed 14.5 ft of sediments and more time is needed to allow the head to reach hydrostatic conditions.

5.3 SEEPAGE OBSERVATIONS

Initial assessment by AEP personnel indicated that downstream conditions have markedly improved after construction of the cutoff wall. Inspection reports since July 1991, however, have indicated that some seepage areas have reactivated at the toe of Dike 1A. A site visit was conducted by WCC on September 24, 1991 to observe dike conditions during normal operations of the ash ponds and to evaluate visually the performance of the dikes after construction of the cutoff wall. Results of the site visit are summarized in a WCC memorandum dated September 30, 1991 and included in Appendix A.

Post-construction conditions of Pond 1A dike are best described by flow weir No.3 and by visual inspections by AEP and WCC. The flow rate measured at flow weir No. 3 decreased from 30 gpm on August 29, 1989 to about 3 to 6 gpm during the latest measurements, as shown in Table 4. Old calcified bare soil spots were often found in various locations along the downstream slopes. These calcified areas were apparently caused by old (before cutoff wall) seeps that became dry at the present. A few seeps were, however, observed along the toe of the Pond 1A dike and the general toe area around the recirculation pond was wet with 1 to 4 inches of standing water as observed by AEP personnel and as confirmed by WCC during the site visit. Water flowing from the seeps was clear with no sign of piping or erosion.

During the September 24, 1991 site visit, WCC observed a water boil in one area at the toe of the Pond 1A dike between piezometers P-2 and P-3 (Photo 4 in memorandum dated September 30, 1990 of Appendix A). Similar boils had been observed before 1984 at the toe of the Pond 1B dike and had been covered with an inverted filter blanket to prevent piping. The present boil was not reported by earlier inspections, prior to construction of the cutoff wall and is located about 10 ft above the bottom of the cutoff wall. Water flowing was clear with no sign of internal soil erosion. The volume of flowing water was difficult to quantify because the area around the boil was saturated with about 1 in. of standing water, but it was, however, estimated at about less than 1 gpm. At the present, this boil area does not appear to threaten the stability of the dike.

The general seepage pattern observed at Pond 1A dike indicates that the embankment face is dryer today than it was before the cutoff wall was constructed. Water seepage appears to have decreased as compared to conditions before the cutoff wall but some seeps are still observed at discrete locations along the toe. These seeps are clear with no sign of internal soil erosion and do not appear to threaten the stability of the dike.

Post-construction conditions of Pond 1B dike are best described by flow weirs No.1 and 2, and by visual inspections by AEP and WCC. The flow rate measured at flow weirs No. 1 and 2 installed at the toe of the inverted blanket became dry, following construction of the cutoff wall. This represents a major improvement compared to a combined flow of 29 gpm measured on August 29, 1989 before construction of the cutoff wall during normal operations, as shown in Table 4. Old calcified bare soil spots were also found in various locations along the downstream slopes which indicates that the embankment face is drier now than before construction of the cutoff wall. No seeps were reported along the toe which was generally densely vegetated.

Flow weir No. 4 installed at the right abutment is currently measuring about 53 gpm and appears to be intercepting the phreatic surface at the downstream toe of the dikes. Flow data are not available for flow weir No.4 prior to construction of the cutoff wall during normal pond operations. Chemical tests done on the water flowing into Weir No. 4 indicate that it is mostly natural spring water. A spring was observed by AEP personnel in March 1991 near flow weir No. 4 but it was attributed to a high water table in the abutment due to a very rainy time period.

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5.4 EVALUATION OF POST CONSTRUCTION DATA

In general, observation wells and piezometers appear to be operating properly, except for wells A-2, A-7, B-2, and B-4, and piezometer P-3. Also, wells B-3, and B-5 appear to be inoperable. The data from observation wells screened below the bottom of the cutoff wall are difficult to interpret because of their installation procedure which consisted of backfilling the annulus of the boreholes around the riser pipes with sand. The resulting piezometric heads are controlled by the most pervious layer along the riser pipe which could create a hydraulic source or sink, depending on their hydrostatic conditions. The wells screened below the bottom cutoff wall (B-series) may therefore be impacted by the fractured bedrock, which could introduce a pervious layer below the foundations.

The following trends can generally be inferred from the observation well and piezometer data as well as from seepage and visual observations:

- Piezometric data upstream of the cutoff wall is generally at or slightly below the pool elevation. This represents an increase over similar data collected prior to the construction of the cutoff wall.

- Piezometric data downstream of the cutoff wall have a decreasing trend towards the downstream toe at an approximate gradient of 60%. A projection of the slope to the piezometric surface intercepts the downstream toe corroborating seepage observations.

- A piezometric head drop of about 15 ft across the cutoff wall can be inferred from observation well data (only one representative cross-section through Pond 1A dike).

- Piezometric data at, or slightly above, the bedrock horizon indicate total heads close to the ground surface (i.e., about el. 1,515 ft) along the downstream toe, increasing toward the embankment at an average gradient of 17%. These piezometric heads are relatively small and seem to indicate that little underseepage is taking place.

Stability analyses were performed by AEP and were presented in an AEP report dated January 1990. Effective stress analyses were performed using the simplified (uncorrected) Janbu method with circular and wedge block failure surfaces. The stability analyses were performed with different phreatic surfaces representing conditions with and without cutoff wall. Soil parameters were derived from consolidated undrained triaxial tests conducted on one representative sample in each soil zone. Based on engineering correlations and judgement, the effective strength parameters selected for analyses by AEP appear to be conservative. Furthermore, the base of the embankments (i.e. original ground surface) was assumed at el. 1,515 ft but is now confirmed to be at about el. 1,500 ft. This assumption introduces an additional level of conservatism because the postulated foundation soils between el. 1,500 ft and 1,515 ft were assumed weaker than the actual embankment soils.

It should be mentioned that the method of slope stability most widely used by practitioners is the simplified Bishop analysis which is equivalent to the simplified (corrected) Janbu analysis*. The factors of safety presented by AEP correspond to the simplified (uncorrected) Janbu method. The corrected Janbu method consists of applying a correction factor to the resulting (uncorrected) factors of safety. The correction factor is related to cohesion, angle of internal friction, and the shape of the failure surface. If such a correction factor was applied, the resulting (corrected) factors of safety would have been about 10% higher than presented in AEP analyses.

AEP analyzed the case of no cutoff wall assuming a phreatic surface slightly higher than the phreatic surface measured by wells A-3 and A-5. As a result, the factor of safety calculated by AEP (i.e., 1.3) is expected to be lower than the factor of safety that would be calculated with the lower phreatic surface observed at the present. AEP has also evaluated the case of a cutoff wall in the embankment with no downstream phreatic surface. However, the downstream piezometric data collected after the construction of the cutoff wall indicate that a higher piezometric surface than assumed by AEP exist in the downstream shells. The estimated factor of safety of about 1.5 for this case is likely to be higher than actual. Based on the above considerations and the assumptions made

* Fredlund D.G., and Krahn J., 1977. Comparison of Slope Stability Methods of Analysis. Canadian Geotechnical Journal. Vol 14, No.2, pp. 429-439.

in the AEP analyses, it is possible that a more representative factor of safety for present condition (i.e. after construction of the cutoff wall) would be greater than 1.4.

In summary, the field observations of downstream slope conditions and seepage, and the water level measurements indicate that the cutoff wall has markedly improved conditions in the downstream shell of the dikes by intercepting pervious seams that may have existed in the dikes. However, due to the lack of reliable soil parameters and phreatic surface data, it is difficult to quantify by analyses the improvement resulting from the construction of the cutoff wall.

6.1 CONCLUSIONS

Based on our review of the results of the field and laboratory quality control tests, and on our review of the daily inspection reports prepared by AEP, it is our opinion that the CBFA cutoff wall was built in accordance with the contract documents (i.e., the cutoff wall was constructed generally to the locations and grades shown on the Drawings). Also, the laboratory tests performed on samples of CBFA slurry from the cutoff wall indicate that a permeability of less than or equal to 5×10^{-6} cm/sec was achieved.

Visual observations made during field inspections indicate that the cutoff wall was effective in intercepting pervious seams in the embankments. This conclusion is based on the following observations:

1- rain water is now being retained in the ponds;
2- present flow rates measured at the existing downstream V-notch flow weirs are significantly lower than before construction of the cutoff wall; and
3- several dry calcified bare soil spots are noticed on the downstream slopes of the dikes at the location of old seepage areas with seepage now observed only at the toe of the dikes.

Observation well and piezometer data generally corroborate the above visual observations. However, some of the wells do not appear to be functioning properly. The following general trends can be inferred from observation well and piezometric measurements:

- Piezometric levels, for wells located upstream of the cutoff wall, have increased after construction of the cutoff wall when compared to levels prior to construction.

- A general piezometric level drop is noticed across the cutoff wall.

- There are no indications of significant underseepage beneath the cutoff wall.

Some seepage has been recently reported by AEP personnel following construction of the cutoff wall along the toe of Pond 1A dike. Seepage appear however to have decreased markedly in comparison to conditions before construction of the cutoff wall. A new boil area was observed after construction of the cutoff wall at the toe of the Pond 1A dike between Piezometers P-2 and P-3. Volume of flowing water was difficult to quantify but it was estimated at less than 1 gpm. Water was clear with no sign of internal soil erosion. At the time of this report, and based on the available data, the observed seepage does not appear to threaten the stability of the dikes.

6.2 RECOMMENDATIONS

We recommend that the following measures be implemented to address the seepage spots and to continue monitoring the performance of the dikes:

- Install two flow weirs (Numbers 5 and 6) to collect seepage at the toe of the pond 1-A dike. The approximate locations of the weirs were identified at the site in the presence of Messrs. M. Damian and M. Stevenson of AEP and are shown in Figure 2. Smaller notch angles than the ones currently used could be utilized but the angles should be calculated to accommodate 5 times the flow presently measured.

- Treat the boil area, similarly to past occurrences of boil areas, by placing a graded filter blanket and riprap. We recommend covering a surface area of at least 20 ft by 20 ft. The boil area should be monitored on a monthly basis, changes in flow or evidence of soil erosion should be observed, and reports should be promptly forwarded to the Civil Engineering Division for review and analysis.

- Install six observation wells in the downstream shells of the dikes. Three piezometers could be installed at the Pond 1A dike and the remaining three at the Pond 1B dike. The bottom of the wells should be installed above the bottom of the cutoff wall and the annulus space between the riser pipe and the boring should be filled with clean, coarse sand. The objective of these wells is to improve our understanding of the piezometric levels downstream of the cutoff wall and to replace the defective wells.

A pair of piezometers should be installed at the boil area. One piezometer should be sealed in the underlying fractured bedrock and the other piezometer should be sealed in the foundation soils.

- Grade all downstream benches and clean drainage swales of all vegetation and sediments. The objective is to provide a free-draining downstream area to enhance seepage detection and evaluation of any observed seepage.

- Mow grass and vegetation cover, and cut the few small trees noticed in some areas. The objective is to enhance inspection of the downstream slopes, to allow a better evaluation of seepage patterns, and to prevent damage to the slopes from tree roots.

Some of these recommendations were presented verbally to Messrs M. Damian and M. Stevenson of AEP and in WCC memorandum dated September 30, 1991 (Appendix A). We further recommend that inspection of the dikes and collection of water level data and seepage rate data continue on a monthly basis when the ponds are in service. The data should be promptly forwarded to the Civil Engineering Division for review and analysis.

AEPCR000156

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APPENDIX A

Document 8

Clinch River Plant, Dike Inspection Checklist 2008

faxed to Sych 10/27/08
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CLINCH RIVER PLANT
DIKE INSPECTION CHECKLIST

1. GENERAL INFORMATION

Date of Inspection	10-25-08
Inspected by	D.L. Rosnoke
Weather	Raining
Temperature	55°
Rainfall During Past 7 Days	

Reservoir elevations at time of inspection:

Pond 1A	1572.66 - .71 = 1566.75
Pond 1B	1560.0 - 22.5 = 1558.13
Pond 2	Out of Service

2. EMBANKMENT CONDITION AT PONDS 1A & 1B

Please refer to the Ash Area 1 Dike Inspection Location Plan which is found on Page 8. Place a number and a descriptive sketch on the location plan at each problem area. Place the same number(s) next to the appropriate description(s) below.

DESCRIPTION	LOCATION NUMBERS
Cracks	No
Bulges	NO
Sliding	NO
Erosion	NO
Soft Soil	yes

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Leaking Pipe	NO
Seepage/Wetness	yes
Vegetative Cover	Good
Trees on Slope	NO
Hillside Runoff Drain #1	OK
Hillside Runoff Drain #2	OK Drain area need clean out
Rodent Burrows	yes
Other (Please Specify)	

3. PIEZOMETERS READINGS AT PONDS 1A & 1B

PIEZ. NO.	ELEV., TOP OF TUBE	DEPTH TO WATER FROM TOP OF TUBE	WATER ELEVATION	COMMENTS
A-1	1571.0	17.10	1553.9	
A-2R	1569.5	22.82	1546.68	
A-3	1535.0	15.44	1519.56	
A-5	1572.2	27.08	1545.12	
A-6	1571.3	17.43	1553.87	
A-7R	1572.0	39.50	1532.5	
B-1	1571.2	17.69	1553.51	
B-2R	1571.1	19.53	1551.57	
B-3R	1570.9	Can't Measure		
B-4R	1571.1	29.60	1541.5	
B-5R	1571.4	34.09	1537.31	
B-6	1571.8	53.10	1518.7	
P-1R	1529.85	14.30	1515.55	

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P-2R	1522.31	7.30	1515.01	
P-3R	1520.18	11.69	1508.49	
P-4R	1519.16	14.73	1504.43	
P-5R	1519.66	10.71	1508.95	
P-6R	1517.53	9.95	1561.58	
P-7	1523.14	27.28	1495.86	
P-8	1521.11	27.85	1493.26	

4. V-NOTCH WEIRS

Please determine the flow rate in gallons per minute for each of the V-notch weirs. This can be done by measuring the head H of water above the apex of the V-notch to the nearest 1/4 inch and comparing it to the chart below.

HEAD, H, INCHES	FLOW RATE, GPM 90° WEIR	FLOW RATE, GPM 22½° WEIR	HEAD, H, INCHES	FLOW RATE, GPM 90° WEIR	FLOW RATE, GPM 22½° WEIR
1	2	0.75	3	37	7.2
1 1/4	4	1	3 1/4	45	8.9
1 1/2	6	1.4	3 1/2	53	10.8
1 3/4	9	1.9	3 3/4	65	12.5
2	12	2.6	4	76	14.5
2 1/4	17	3.4	4 1/4	88	16.8
2 1/2	24	4.6	4 1/2	100	19
2 3/4	30	5.9	4 3/4	114	21.6

V-notch Weir #1: out of Service gallons per minute
V-notch Weir #2: 1 90 2 gallons per minute
V-notch Weir #3: ¼ 90° ½ gallons per minute
V-notch Weir #4: 2¾ 90 30 gallons per minute
V-notch Weir #5: 1¾ 90° 9 gallons per minute
V-notch Weir #6: 1¼ 22° 1 gallons per minute

5. SEEPAGE COLLECTION SUMP

Please determine the flow rate, in gallons per minute, of the two branches of the French drain at the 8 foot diameter seepage collection sump. This can be done by measuring how much the water

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level rises while recording the time during a period when both pumps are off. Flow rate is given by the following formula:

$$\text{FLOW RATE,} = \frac{(3.1416)(16)(7.48)(60)H}{t}$$

in which H = rise of water level in feet during the unpumped time interval t, in seconds.

FLOW RATE = 5" every min GALLONS PER MINUTE

6. DISCHARGE STRUCTURE AT POND 1B

Please note the conditions with regard to the following:

Condition of concrete OK

Are stoplogs available? OK

Obstructions NO

Foreign object in pond? Cenoshperes on Pond

Pedestrian access O.K.? OK

Erosion Problems NO

Other (Please specify) ______

7. MISCELLANEOUS AT PONDS 1A & 1B

Is seepage repair area O.K.? OK

What is condition of French drain? Is white precipitate building up impeding drainage? Good

wet place just above P-3 well

What is the overall condition of the discharge structure from Pond 1A to Pond 1B?

Good DRAIN Line about 3/4 under water

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Are seepage sump pumps O.K.? yes

Is entrance to 24"Φ seepage overflow pipe clear of obstructions? yes

8. PONDS 1A & 1B NOTES AND COMMENTS INCLUDING JOB ORDERS WRITTEN AND REPAIRS/MAINTENANCE SINCE LAST INSPECTION:

yard personel Removing Ash on Pond 1A

9. EMBANKMENT CONDITION AT POND 2 AREA

Please refer to the Ash Area 2 Dike Inspection Location Plan which is found on Page 9. Place a number and a descriptive sketch on the location plan at each problem area. Place the same number(s) next to the appropriate description(s) below.

DESCRIPTION	LOCATION NUMBERS
Cracks	Out of Service
Bulges	
Sliding	
Erosion	
Soft Soil	
Leaking Pipe	
Seepage/Wetness	

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DESCRIPTION	LOCATION NUMBERS
Vegetative Cover	
Trees on Slope	
Rodent Burrows	
Other (Please Specify)	

10. PIEZOMETER READINGS AT POND 2 AREA

PIEZ. NO.	ELEV., TOP OF TUBE	DEPTH TO WATER FROM TOP OF TUBE	WATER ELEVATION	COMMENTS
P-1	1557.0			
P-2	1555.8			
P-3	1556.7			
P-4	1557.4			
P-5	1557.7			
P-6	1557.4			
P-7	1557.9			
P-8	1557.4			
P-9	1558.2			
U-1	1560.0	46 00	1514.0	
U-2	1561.1	37.25	1523.85	DRY
U-3	1560.0	46.90	1513.1	DRY
U-4	1560.0	46.25	1513.75	
L-5	1532.0	No Cap full	of water	
L-6	1532.0	Gone		
L-7	1535.3	14.15	1521.15	
L-8	1534.7	20.62	1514.08	

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11. IS PERFORATED DRAIN PIPE BETWEEN LOWER LEVEL AND MIDDLE LEVEL DIKES WORKING PROPERLY AND IN GOOD CONDITION?

Out of Service

12. DISCHARGE STRUCTURE AT POND 2

Please note the conditions with regard to the following:

Condition of concrete	Out of Service
Gates/valves operational?	
Obstructions	
Is access clear?	
Erosion problems	
Other (Please specify)	

13. POND 2: NOTES AND COMMENTS INCLUDING JOB ORDERS WRITTEN AND REMEDIAL WORK DONE SINCE LAST INSPECTION

Out of Service

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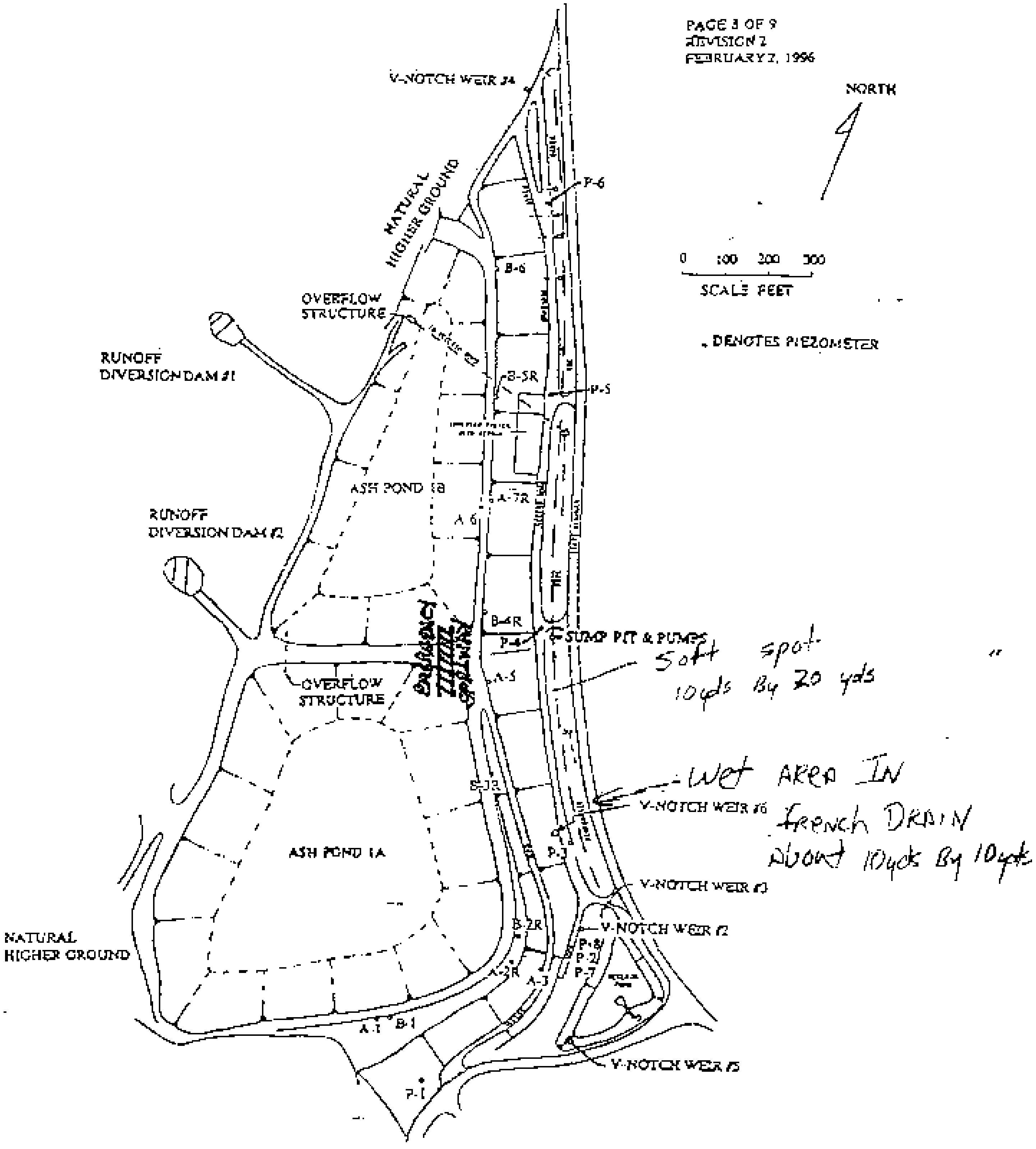
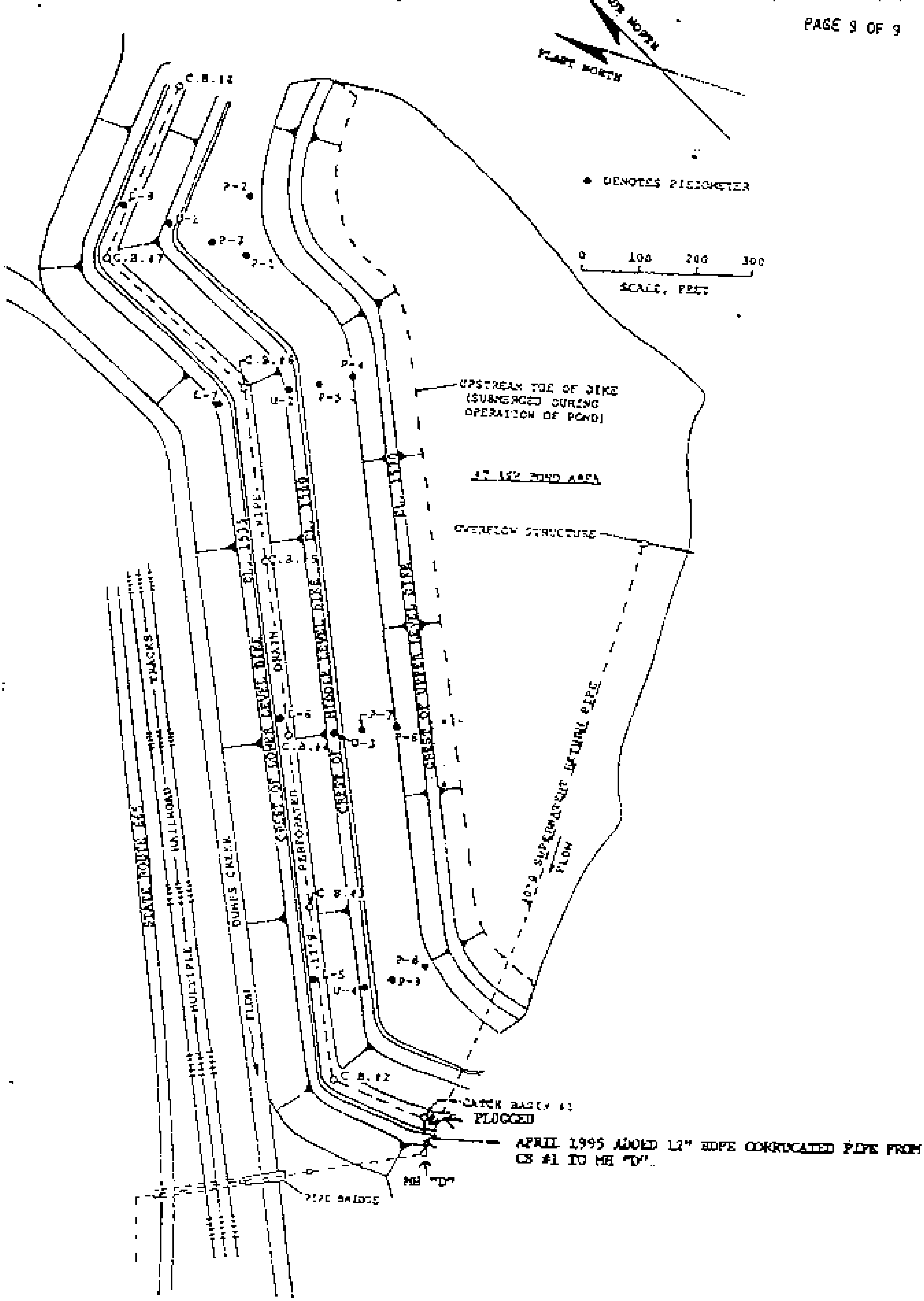


CLINCH RIVER PLANT: ASH AREA 1 DIKE INSPECTION LOCATION PLAN

US EPA ARCHIVE DOCUMENT



CLINCH RIVER PLANT: ASH AREA 2 DIKE INSPECTION LOCATION PLAN

US EPA ARCHIVE DOCUMENT

APPENDIX A

Document 9

Clinch River Plant, Dike Inspection Checklist 2009

US EPA ARCHIVE DOCUMENT

CLINCH RIVER PLANT
DIKE INSPECTION CHECKLIST

1. GENERAL INFORMATION

Date of Inspection 4-17-09 4-18-09

Inspected by D.L Rasnake

Weather Sunny

Temperature 65°

Rainfall During Past 7 Days ______

Reservoir elevations at time of inspection:

Pond 1A 1572.14 - 20.5" = ~~1553.16~~ 1555.93

Pond 1B 1560.3 - 16" = ~~1544.6~~ 1558.67

Pond 2 ______

2. EMBANKMENT CONDITION AT PONDS 1A & 1B

Please refer to the Ash Area 1 Dike Inspection Location Plan which is found on Page 8. Place a number and a descriptive sketch on the location plan at each problem area. Place the same number(s) next to the appropriate description(s) below.

DESCRIPTION	LOCATION NUMBERS
Cracks	NO
Bulges	NO
Sliding	NO
Erosion	NO
Soft Soil	yes

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Leaking Pipe	NO
Seepage/Wetness	yes
Vegetative Cover	Good
Trees on Slope	NO
Hillside Runoff Drain #1	OK
Hillside Runoff Drain #2	OK NEEds Cleaned out
Rodent Burrows	NO
Other (Please Specify)	

3. PIEZOMETERS READINGS AT PONDS 1A & 1B

PIEZ. NO.	ELEV., TOP OF TUBE	DEPTH TO WATER FROM TOP OF TUBE	WATER ELEVATION	COMMENTS
A-1	1571.0	16.23	1554.77	
A-2R	1569.5	21.94	1547.56	
A-3	1535.0	14.84	1520.16	
A-5	1572.2	26.11	1546.09	
A-6	1571.3	15.25	1556.05	
A-7R	1572.0	38.85	1533.15	
B-1	1571.2	16.65	1554.55	
B-2R	1571.1	18.50	1552.60	
B-3R	1570.9	CAN'T	MEASURE	
B-4R	1571.1	29.12	1541 98	
B-5R	1571.4	33.84	1537.56	
B-6	1571.8	52.91	1518.89	
P-1R	1529.85	11.00	1518.85	

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P-2R	1522.31	7.10	1515.21
P-3R	1520.18	12.54	1507.64
P-4R	1519.16	14.05	1505.11
P-5R	1519.66	10.50	1509.16
P-6R	1517.53	9.40	1508.13
P-7	1523.14	25.70	1497.44
P-8	1521.11	26.48	1494.63

4. V-NOTCH WEIRS

Please determine the flow rate in gallons per minute for each of the V-notch weirs. This can be done by measuring the head H of water above the apex of the V-notch to the nearest 1/4 inch and comparing it to the chart below.

HEAD, H, INCHES	FLOW RATE, GPM 90° WEIR	FLOW RATE, GPM 22½° WEIR	HEAD, H, INCHES	FLOW RATE, GPM 90° WEIR	FLOW RATE, GPM 22½° WEIR
1	2	0.75	3	37	7.2
1 1/4	4	1	3 1/4	45	8.9
1 1/2	6	1.4	3 1/2	53	10.8
1 3/4	9	1.9	3 3/4	65	12.5
2	12	2.6	4	76	14.5
2 1/4	17	3.4	4 1/4	88	16.8
2 1/2	24	4.6	4 1/2	100	19
2 3/4	30	5.9	4 3/4	114	21.6

V-notch Weir #1: Out of Service gallons per minute
V-notch Weir #2: 1 90° 2 gallons per minute
V-notch Weir #3: .25 90° 15 gallons per minute
V-notch Weir #4: 2.75 90° 30 gallons per minute
V-notch Weir #5: 1.5 90° 6 gallons per minute
V-notch Weir #6: 1.5 22° 1.4 gallons per minute

5. SEEPAGE COLLECTION SUMP

Please determine the flow rate, in gallons per minute, of the two branches of the French drain at the 8 foot diameter seepage collection sump. This can be done by measuring how much the water

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level rises while recording the time during a period when both pumps are off. Flow rate is given by the following formula:

$$\text{FLOW RATE,} = \frac{(3.1416)(16)(7.48)(60)H}{t}$$

in which H = rise of water level in feet during the unpumped time interval t, in seconds.

FLOW RATE = 5" every min GALLONS PER MINUTE

6. DISCHARGE STRUCTURE AT POND 1B

Please note the conditions with regard to the following:

Condition of concrete	OK
Are stoplogs available?	OK
Obstructions	NO
Foreign object in pond?	Cenoshperes on Pond
Pedestrian access O.K.?	OK
Erosion Problems	NO
Other (Please specify)	

7. MISCELLANEOUS AT PONDS 1A & 1B

Is seepage repair area O.K.? OK

What is condition of French drain? Is white precipitate building up impeding drainage? Good

2 places wet just Below P-3 well

What is the overall condition of the discharge structure from Pond 1A to Pond 1B?

Good Drain Line about 7/8 under water

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Are seepage sump pumps O.K.? yes

Is entrance to 24"ϕ seepage overflow pipe clear of obstructions? yes

8. PONDS 1A & 1B NOTES AND COMMENTS INCLUDING JOB ORDERS WRITTEN AND REPAIRS/MAINTENANCE SINCE LAST INSPECTION:

Pond 1A Looks Good Contrators
clening ash out of pond

Pond 1B Looks Good
cenosheres on Pond

9. EMBANKMENT CONDITION AT POND 2 AREA

Please refer to the Ash Area 2 Dike Inspection Location Plan which is found on Page 9. Place a number and a descriptive sketch on the location plan at each problem area. Place the same number(s) next to the appropriate description(s) below.

DESCRIPTION	LOCATION NUMBERS
Cracks	Out Service
Bulges	
Sliding	
Erosion	
Soft Soil	
Leaking Pipe	
Seepage/Wetness	

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DESCRIPTION	LOCATION NUMBERS
Vegetative Cover	
Trees on Slope	
Rodent Burrows	
Other (Please Specify)	

10. PIEZOMETER READINGS AT POND 2 AREA

PIEZ. NO.	ELEV., TOP OF TUBE	DEPTH TO WATER FROM TOP OF TUBE	WATER ELEVATION	COMMENTS
P-1	1557.0			
P-2	1555.8			
P-3	1556.7			
P-4	1557.4			
P-5	1557.7			
P-6	1557.4			
P-7	1557.9			
P-8	1557.4			
P-9	1558.2			
U-1	1560.0	45.82	1514 18	
U-2	1561.1	35.64	1525.46	
U-3	1560.0	45.89	1514.11	
U-4	1560.0	46.40	1513.60	
L-5	1532.0	NO CAP	Full of water	
L-6	1532.0	Gone		
L-7	1535.3	15.92	1519 38	
L-8	1534.7	19.75	1514.95	

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11. IS PERFORATED DRAIN PIPE BETWEEN LOWER LEVEL AND MIDDLE LEVEL DIKES WORKING PROPERLY AND IN GOOD CONDITION?

out of Service

12. DISCHARGE STRUCTURE AT POND 2

Please note the conditions with regard to the following:

Condition of concrete: Out of Service

Gates/valves operational? ______

Obstructions ______

Is access clear? ______

Erosion problems ______

Other (Please specify) ______

13. POND 2: NOTES AND COMMENTS INCLUDING JOB ORDERS WRITTEN AND REMEDIAL WORK DONE SINCE LAST INSPECTION

Out of Service

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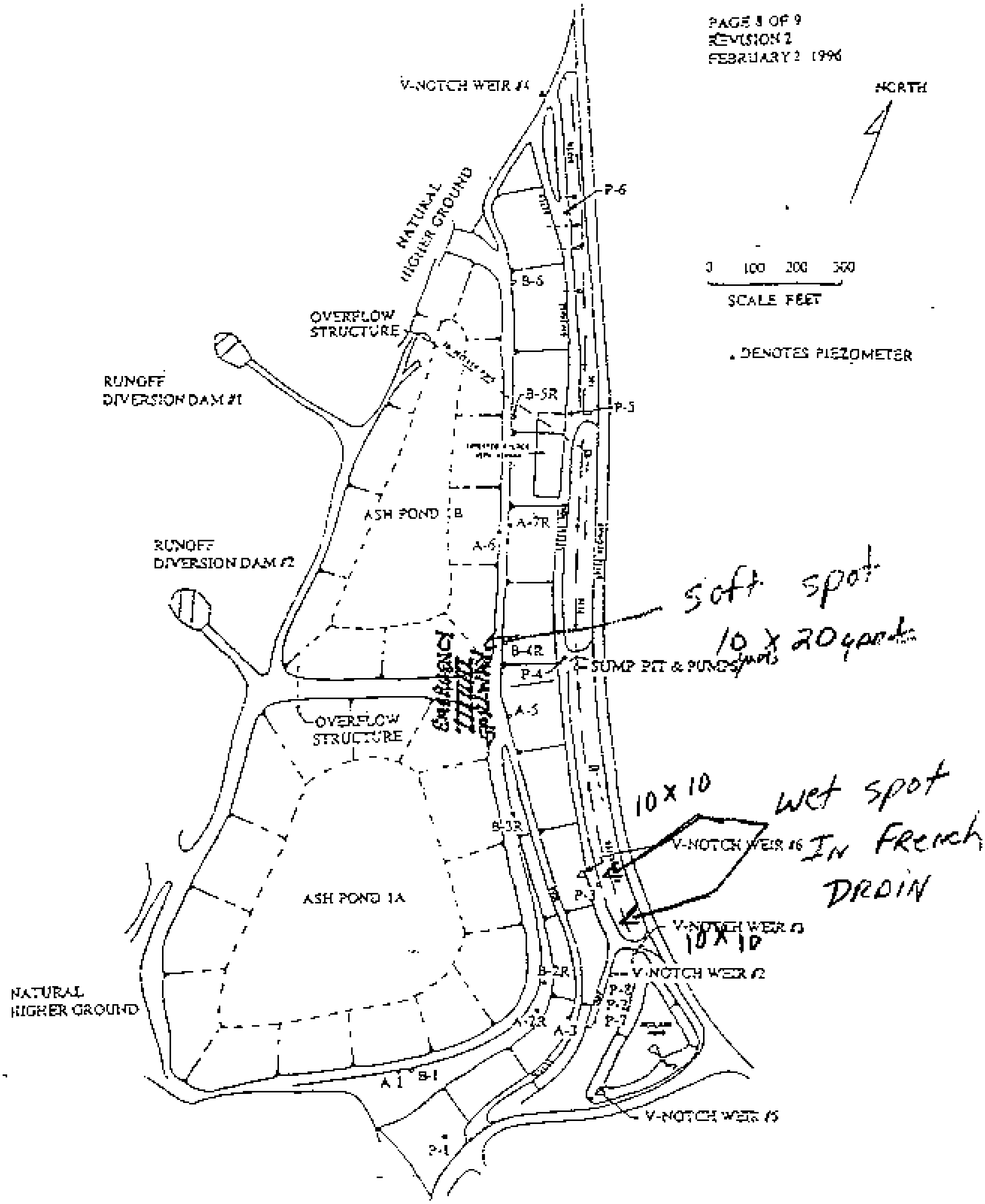

CLINCH RIVER PLANT- ASH AREA 1 DIKE INSPECTION LOCATION PLAN

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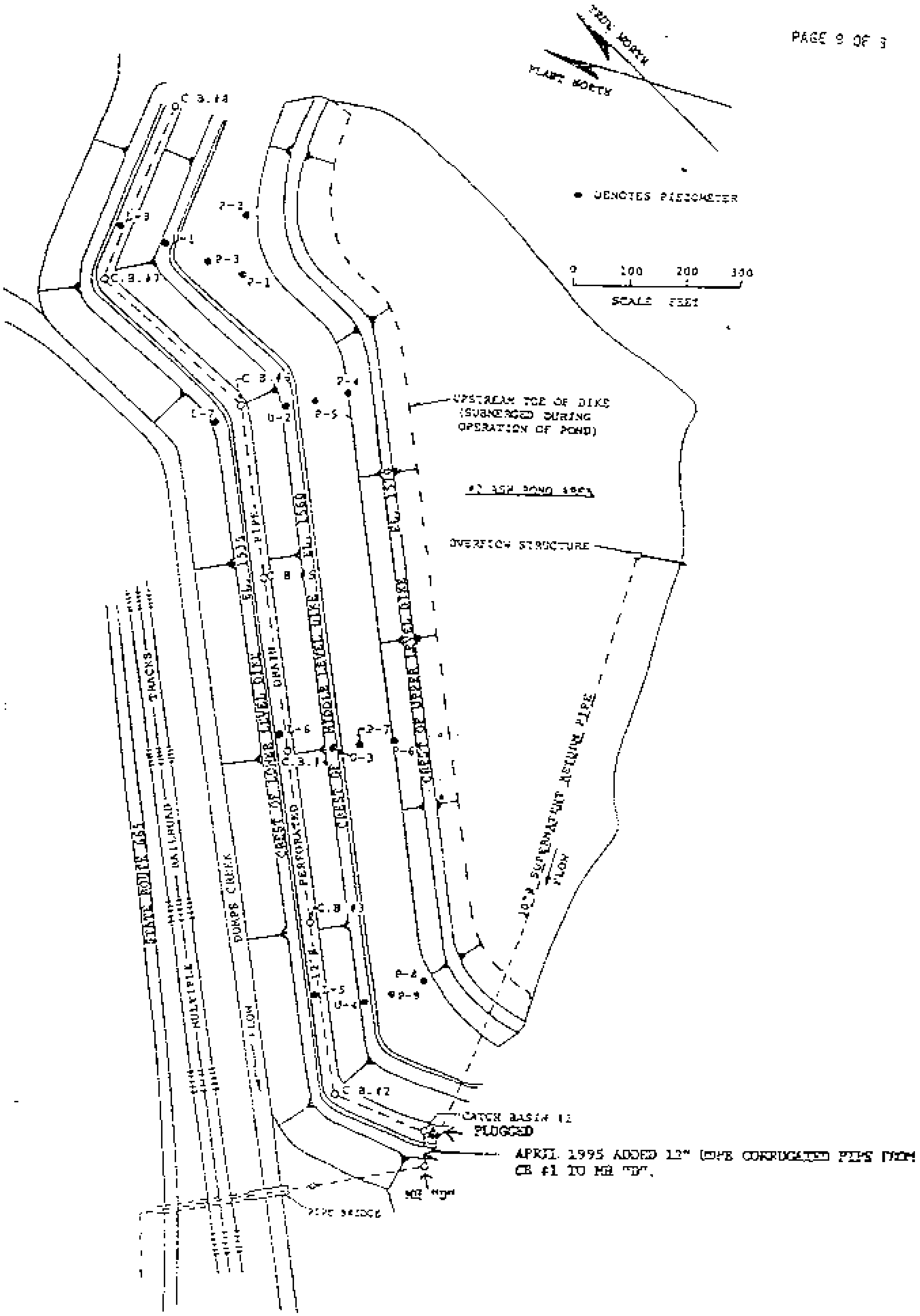

CLINCH RIVER PLANT: ASH AREA 2 DIKE INSPECTION LOCATION PLAN

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US EPA ARCHIVE DOCUMENT

APPENDIX A

Document 10

Clinch River Plant Ash Pond 1, Annual Dam & Dike Inspection Report, by AEP 2009

DAM & DIKE INSPECTION REPORT
RECLAIM POND
ASH POND 1A & 1B

CLINCH RIVER PLANT
CARBO, VA

INSPECTION DATE November 24, 2009

PREPARED BY ______________________ **DATE** ________
Behrad Zand, Engineer

REVIEWED BY Gary F. Zych **DATE** 1/6/2010
Gary F. Zych, P.E.

APPROVED BY ______________________ **DATE** ________
Pedro J. Amaya, P.E.
Section Manager - Geotechnical Engineering

QA/QC DOCUMENT NO.
GERS-09-048

COMMONWEALTH OF VIRGINIA
PEDRO JOSE AMAYA-PULGAR
NO. 036174
PROFESSIONAL ENGINEER

PROFESSIONAL ENGINEER SEAL & SIGNATURE

US EPA ARCHIVE DOCUMENT

2009 INSPECTION REPORT
RECLAIM POND
ASH POND 1A AND 1B

CLINCH RIVER PLANT
CARBO, VA

January 5, 2010

US EPA ARCHIVE DOCUMENT

1 INTRODUCTION

AEPSC Civil Engineering administers the company's Dam Inspection and Maintenance Program (DIMP). As part of DIMP, staff from the Geotechnical Engineering Section conducts dike and dam inspections annually. Mr. Behrad Zand conducted the 2009 inspection. This report has been prepared under the direction of Mr. Pedro J. Amaya, P.E. and presents a summary of the inspection and assessment of the condition of the facilities.

Mr. Jimmie Saunders at the Clinch River Plant was the project facility contact. The inspection was performed on November 24, 2009. Weather conditions were partially cloudy. Temperatures ranged from a low of 39°F to a high of 59°F, with a mean temperature of 49°F[1]. There was no rainfall on the day of inspection and 0.15 inches of rainfall on the day before inspection day. There was 0.15 inches of rainfall during the ten days prior to the inspection day.

At Clinch River Plant, the Ash Pond Complex consists of Ash Pond 1A, Ash Pond 1B and a Reclaim Pond as shown in Figures 1 through 5. The two ash ponds are formed by: earthen embankments approximately 60-ft. high on the west, south and east sides, a splitter embankment in the center and natural high ground along the north side. The embankments have interior slopes of approximately 3 Horizontal to 1 Vertical (3H to 1V) and exterior slopes of approximately 2H to 1V. The exterior dike on the south side has an underdrain and finger drain system installed downstream of the toe road to control and collect seepage. The Reclaim Pond is an excavated pond.

In addition to the Ash Pond Complex, there is Ash Pond 2 that is located across the road from the Complex. Ash Pond 2 has been out-of-service since 1998 and there is no free water in the pond. Therefore, no inspection was performed, although the site was visited.

2 SUMMARY OF VISUAL OBSERVATIONS

2.1 GENERAL

The summary of the visual observations uses terms to describe the general appearance or condition of an observed item, activity or structure. Their meaning of these terms is as follows:

[1] Weather data was obtained from www.weatherunderground.com website for Richland, VA.

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Good:	A condition or activity that is generally better or slightly better than what is minimally expected or anticipated from a design or maintenance point of view.
Fair or Satisfactory:	A condition or activity that generally meets what is minimally expected or anticipated from a design or maintenance point of view.
Poor:	A condition or activity that is generally below what is minimally expected or anticipated from a design or maintenance point of view.
Minor:	A reference to an observed item (e.g., erosion, seepage, vegetation, etc.) where the current maintenance condition is below what is normal or desired, but which is not currently causing concern from a structure safety or stability point of view.
Excessive:	A reference to an observed item (e.g., erosion, seepage, vegetation, etc.) where the current maintenance condition is above or worse than what is normal or desired, and which may have affected the ability of the observer to properly evaluate the structure or particular area being observed or which may be a concern from a structure safety or stability point of view.

Appendices A, B and C contain selected photographs taken during the inspection of the Reclaim Pond, Pond 1A and Pond 1B, respectively.

2.2 Reclaim Pond

1. The north slope of the Reclaim pond is protected by rip-rap and is in good condition. The remaining interior slopes of the pond have been vegetated with sufficient coverage in most places. There are a few areas on the slopes with insufficient vegetative coverage. There were no signs of major erosion on the slopes. Minor to moderate erosion gullies were present at several locations (e.g. Photo 1).

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2. The V-notch weir boxes referenced as Nos. 2, 3, and 5 were in fair condition. Clear water flow was discharging from all the weirs. Gray precipitate was observed on the downstream of weir box No. 3 (Photo 2), and at the bottom of all the weir boxes.
3. The surface of the Reclaim Pond was entirely covered with cenospheres (Photo 3).

2.3 POND 1A

1. Herbicide had been applied to the vegetation in the western groin ditch to eliminate heavy overgrown vegetation presented in this area. Dried vegetation was still present along the groin ditch (Photo 4), that limited the extent of the visual inspection.
2. The erosion protection for the groin ditch was in satisfactory condition. The area on the abutment within 25 ft from the center of the groin ditch was clear of any woody or overgrown vegetation except for one tree near the crest that was only 15 ft away from the center of the groin ditch.
3. The exterior slope of the west 1A dike was well vegetated and in good condition. Rip-rap protection has recently been installed along the toe area of the west dike near groin ditch (Photo 5) and to the west of the access road. There were no signs of erosion or excessive seepage on the slope or at the toe area.
4. The lower half of the southeast slope of 1A dike, downstream of the access road, is covered with an inverted filter for seepage and erosion control (Photo 6). The rip-rap of the filter was in good condition with no visual signs of rock deterioration or displacement.
5. The portions of the exterior slope of the south 1A dike above the haul road that was not covered by rip-rap (inverted filter) was well vegetated. There were no signs of sloughing, bulging, wet patches, or settlement on the upper section of the slope. The general condition of the slope was satisfactory (Photos 7). No animal burrows were observed on this portion of the slope.
6. There was no visual indication of piping or excessive seepage at the toe area of 1A dike. No signs of erosion were observed at the toe of the rip raped portions of the slope. A wet area was observed approximately at the middle of south 1A dike below the access road.
7. There was clear seepage flow from V-notch weir #6. Flow from the weir is directed into a stoned-lined ditch at the toe of the dike. The bottom of the weir box was covered with a layer of light gray precipitate.

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8. The top of dike road was in good condition with no visual evidence of dike settlement or misalignment. Several areas with minor rutting were observed on the road. There were no signs of instability or settlement on the access road along the toe of the south dike. Rutting was observed at a few areas of the road.
9. Reddish to light gray precipitate were present in most of the toe drain pipes (e.g. Photo 8).
10. The overflow tower from 1A to 1B ponds was in satisfactory conditions (Photo 9). There was no protective railing on the splitter dike around the overflow structure from 1A Pond to 1B Pond. The hand rail around the overflow structure was loose.
11. Two temporary spillway shafts have been installed to discharge the flow from 1A to 1B ponds to facilitate maintenance of the main spillway shaft. Photo 10 shows one of the new spillway shafts to the north of the overflow tower. The second shaft, located to the south of the overflow tower, has a higher invert elevation to pass discharge water from 1A to 1B ponds if the pool level increases to higher than normal levels during a storm event.
12. No staff gage is installed for 1A Pond and the pool level could not be determined. At the time of inspection the pool level appeared to be lower than its normal level, thus it is believed that the freeboard was sufficient. Plant personnel indicated that a staff gage will be installed in early 2010.
13. The rock slope on the northwest side of 1A pond appeared to be in stable condition. There was no visual indication of major cracks, rock deterioration, displacement, or instable rock blocks (Photo 11).

2.4 Pond 1B

1. Clear water was flowing in the east groin ditch below approximate elevation of 1520 ft. Clear seepage flow was present in V-notch weir #4.
2. Heavy vegetation, including woody vegetation, was present in or near the east groin ditch (Photo 12). The portion of the groin ditch that was not covered with vegetation and could be inspected was in fair condition with no signs of erosion, blockage, or instability. A portion of the slope and groin ditch near the crest has rip-rap protection (Photo 13).
3. An inverted filter has been installed on the lower half of the south slope of 1B dike (Photo 14). The rip-rap was in good condition with no signs of sloughing, displacement, or deterioration of the stones.

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4. There were no visual signs of piping or excessive seepage at the toe area of 1A dike. No signs of erosion were observed at the toe area or along the perimeters of the rip-rap (inverted filter). A seep was observed on the slope of the dike near the abutment at approximate elevation of 1540 ft.
5. Several small trees were present on the outboard slope 1B dike near the east abutment (e.g. Photo 12). A small tree was observed on the inboard slope of the south dike (Photo 15).
6. The portion of the outboard slopes not covered with rip-rap had vegetative cover. The slope appeared stable and was in satisfactory condition (Photo 13). Several areas on the slope were noticed to have insufficient vegetative coverage. A portion of the slope between piezometers B-5R and A7-R had no vegetative cover (Photo 16).
7. The area on the outboard slope at approximate elevation of 1533 near the interface with 1A pond that was reported in the previous inspection reports is now covered with the inverted filter.
8. Four animal burrows were observed on the south 1B slope above the inverted filter.
9. The inboard slope of the dike had sufficient vegetative coverage (Photo 15).
10. The top of dike road was in fair condition with no evidence of dike settlement or misalignment. Several areas with minor rutting were observed on the road.
14. There were no signs of instability or settlement on the access road along the toe of the south dike. Rutting was observed on a few areas of the road.
11. A layer of cenospheres covered the majority of the water surface in 1B pond (Photo 15).
12. Minor erosion developments were noticed on the slope of the drainage ditch at several locations (e.g. Photo 17).
13. The outlet structure from the pond was in fair condition. Flow under the slide gate was smooth and unobstructed. Portions of the outfall tower, particularly the interior, was rusty and the tower was in need of painting (Photo 18).
14. The exterior of the concrete manholes at the toe of the slope were in good condition. Surface water has appeared to collect in the bottom of the pipe pit structure.
15. No functional staff gage was installed in 1B pond. The plant personnel indicated that a staff gage will be installed in this pond.
16. Settlement cracks were present on the portion of splitter dike that has been constructed recently (Photo 19).
17. An old surface sloughing was noticed on the east hillside near the groin ditch (Photo 20).

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3 Assessment of Recent Instrumentation Data

3.1 Pond Water Levels

Pond water levels, as measured on the date of the previous inspections, are summarized in Table 1. Due to the lack of a staff gage the pool levels could not be determined during the current inspection. Plant personnel measure the pool levels during the routine inspections performed by the plant on quarterly basis.

Pond Name	7 Aug 2009	7 Jan 2009	31 Oct 2007	3 July 2007	6 Oct. 2006	1 Nov 2005	10 Sept 2003	14 Sept 2002	6 Nov. 2001
Reclaim Pond	Not measured	Not measured	Not measured	Not measured	Not measured	Not measured	Not measured	7.2 *	5.7 *
1A Pond	1566.8	1566.5	Not measured	1566.7	1566.7	1567 (approx.)	1566.8	1567.4	1566.9
1B Pond	1558.4	1559	1558.1	1558.4	1558	1559.0	1557.33	1556.35	1558.1
Pond 2	Dewatered								

* All depths and elevations reported in feet.

** Depth Measured Below Top of Sump Structure Grating Located on South Slope of Reclaim Pond.

Table 1. Pond elevations since 2001

3.2 Piezometer and Observation Wells

Twenty (20) piezometers located on or near the Ash Complex are being monitored by AEP. Locations of the piezometers are shown on Figure 6. Figure 7 presents the measurements recorded by the plant since 1985. Measurements recorded by the Plant since 2005 appear similar and within their normal historic range. Piezometers at the dewatered Ash Pond 2 are not included in the current AEP monitoring program. Several new piezometers have been installed on or near the dikes of 1A and 1B ponds. Plant personnel should monitor these wells along with the other instrumentations.

3.3 Flow Measurement Weirs

Flow through five V-Notched Weirs collecting seepage and surface runoff from the Ash Pond 1A and 1B Complex were measured during the inspection. Presented in Table 2 are the recorded measurements and previous measurements.

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AEPCR000373

Weir No.& Size	Flow Rate, GPM						
	24 Dec. 09	7 Jan. 09	31 Oct. 07	03 Nov. 05	15 Dec. 04	09 Sep. 03	14 Sep. 02
2-90°	9	8	3	6	7	2.5	1
3-90°	1	1.5	No flow	No flow	<2	No flow	0.5
4-90°	30	88	Unreadable	37	45	24(Oct 2003)	30
5-90°	12	37	10	7	12	6	6
6-22 1/2°	1	6.6	1.75	2.6	5.9	1	0.75

Table 2. Seepage flow rates at V-notch weirs since 2002

4 CONCLUSIONS

4.1 RECLAIM POND

The side slopes around the Reclaim Pond are in fair condition. The pond is performing as desired.

4.2 POND 1A

Overall, the embankments forming Pond 1A are in satisfactory condition. Measured seepage is clear and the flow rates are within their historical ranges. There are no signs of instability or piping. Few components are in poor condition and in need of improvement.

4.3 POND 1B

Overall, the earthen embankments forming Pond 1B are in satisfactory condition. Seepage areas are stable and there are no signs of increased flowrates or changes in the clarity of the seepage water. Few components are in poor condition and in need of improvement.

5 RECOMMENDATIONS

5.1 ITEMS THAT REQUIRE ATTENTION BEYOND THE REGULAR MAINTENANCE ACTIVITIES

Visual inspection of the Reclaim, 1A, and 1B ponds did not reveal any issue that would raise an immediate concern on the safety or stability of these facilities. Below is a summary of the components that were found to be in poor condition and in need of improvement:

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1- The west and east groin ditches should be cleared of any vegetation. In general, dried vegetation shall be removed after each application of herbicide. All the trees and woody vegetation that have grown on the slopes of the dikes should be removed.
2- The tree on the west abutment that is near the groin ditch should be removed.
3- All the broken or nonfunctional piezometers should be identified and abandoned properly.

Besides the above items, it is recommended that the plant begins monitoring water levels in the newly installed piezometers and wells. The quarterly inspection sheet should be updated to include the new wells and piezometers.

5.2 Regular Maintenance Items

The recommendations of this section are considered to be regular maintenance items that should be performed on regular basis to assure that the satisfactory condition of the facilities will be maintained. A facility-specific summary of recommendations is presented below.

5.2.1 Reclaim Pond

1- Cenospheres should be removed from the surface of the Reclaim Pond on regular basis.
2- The erosion rills on the slopes of the Reclaim Pond should be repaired by excavating the disturbed areas and placing rip-rap over fabric. The rip-rap protection will prevent re-occurrence of the erosion rills.
3- The areas with insufficient vegetative coverage should be seeded.
4- Monitoring of the instrumentation should be continued on quarterly basis.

5.2.2 Pond 1A

1. The seepage area on the lower section of the south dike, mentioned in the previous inspection reports, remains the primary concern at this facility. The plant shall continue monitoring the seepage flow from the pond for signs of piping or drastic changes in the flow rates or piezometric water levels. The wet area below the access road along the toe should be inspected frequently for signs of piping.
2. Erosion rills that form on the main dike or the splitter dike should be identified and repaired promptly

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AEPCR000375

3. Any large rutting that develops on the crest of the main dike, the splitter dike, or any of the access roads should be repaired on a timely manner.
4. It is recommended that the plant continues to mow the slopes of the dike at least twice a year. The area of the west hillside that is within 25 feet horizontal distance from the center of the groin ditch should be properly seeded and mowed regularly.
5. A staff gage should be installed in 1A pond to facilitate water level readings.
6. Protective railing should be installed around the overflow structure from 1A to 1B ponds, unless this structure is abandoned properly.
7. The section of the slope not covered by rip-rap should be thoroughly inspected by the plant personnel twice a year to identify animal burrows. All the animal holes shall be mud-packed. Generally, a good time to inspect and mud-pack animal burrows is early spring. The second inspection can be performed early autumn. It is a good practice to mow the slopes before the inspections.
8. Operation of the seepage collection system and pumps must be maintained to ensure the structural integrity of the dikes. This includes continuing the periodic program to replace the toe drain system as necessary to prevent build up of chemical precipitates within the stone and piping system. The drainage pipe should be flushed or replaced periodically to prevent blockage due to accumulation of precipitates.

5.2.3 Pond 1B

1. Seepage areas on the lower section of the dike, mentioned in previous inspection reports, still remain the main concern. Monitoring of the piezometers should be continued. The plant should continue monitoring the seepage flow from the pond for signs of piping or drastic changes in the flow rates.
2. The increasing number of animal burrows on the south slope of 1B pond is becoming a concern. It is recommended to install traps near the animal holes to control the population of the burrowing animals. Animal burrows on the slopes of the dike should be identified through regular inspections and mud-packed. Two inspections per year are recommended on early spring and early autumn, after each mow.
3. The erosion rills that form on the dike should be identified and repaired promptly.
4. Any large rutting that develops on the crest or any of the access roads should be repaired on a timely manner.

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AEPCR000376

5. Bare areas on the outboard slope should be seeded to establish a proper vegetative cover.
6. It is recommended that the plant continues to mow the vegetative cover of the slopes twice a year. The area of east hillside within 25 feet horizontal distance from the edge of the groin ditch should be maintained free of any woody vegetation.
7. Cenospheres should be removed from the surface of the pool on regular basis.
8. The overflow structure shall be painted.
9. A new staff gage shall be installed in 1B pond.

A good inspection and maintenance program needs to be emphasized especially in the area of instrumentation monitoring and maintaining routine vegetation and erosion control to preserve the intent of the design and operation of the facilities. Routine inspections, monitoring and maintenance by plant personnel should continue. If you have any questions with regard to this report, please do not hesitate to contact Behrad Zand at (614) 716-2873 (audinet 200-2873) or Pedro Amaya at (614) 716-2926 (audinet 200-2926)

AEPCR000377

FIGURES

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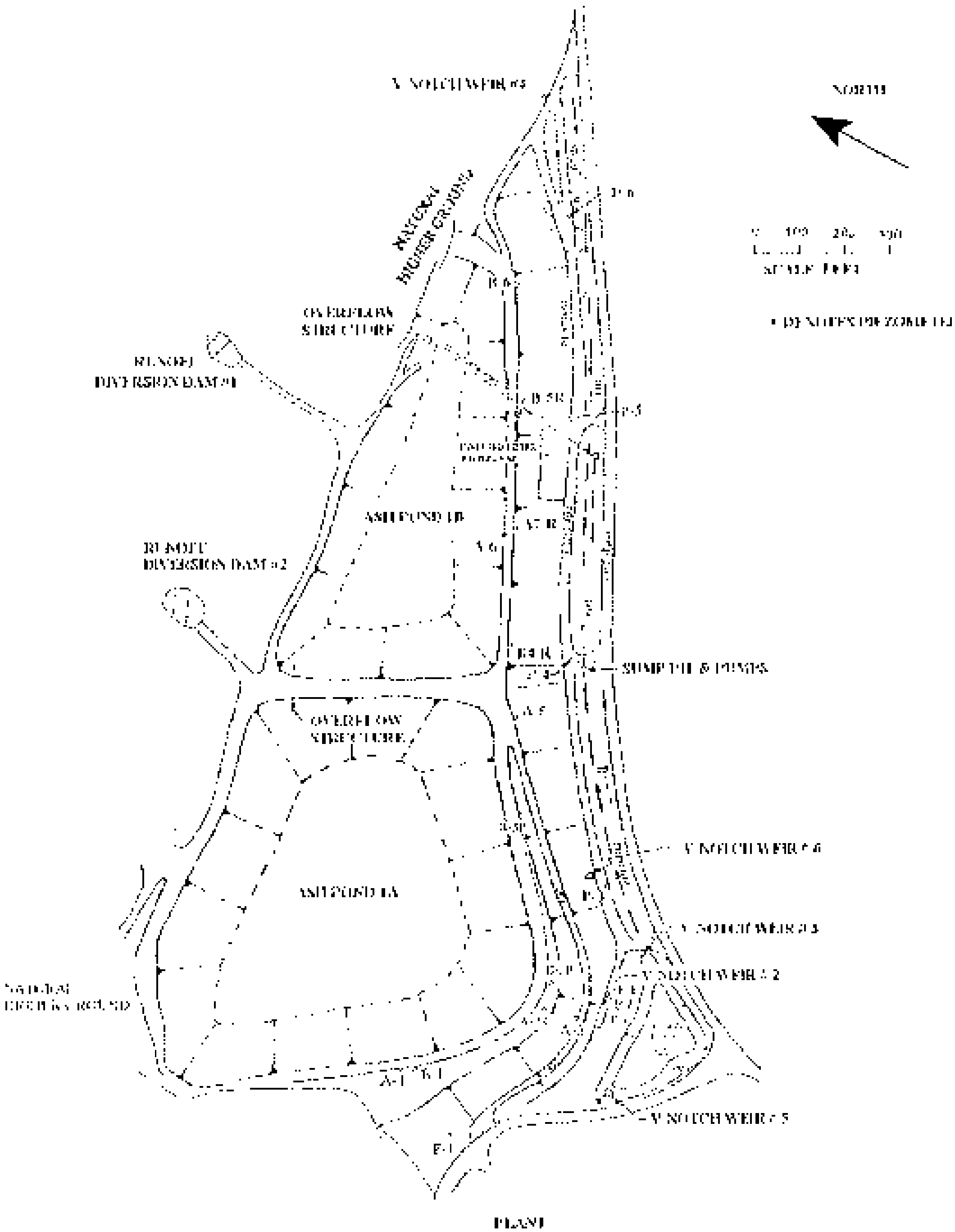

Figure 6. Piezometer location map

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	CLINCH RIVER POWER STATION	DWG NO: FIGURE 2
	SHEET 2 of 5	AEP SERVICE CORP. 1 RIVERSIDE PLAZA COLUMBUS OH 43215
	POND 1A & 2	

	CLINCH RIVER POWER STATION	DWG NO: FIGURE 3
	SHEET 3 of 5	AEP SERVICE CORP. 1 RIVERSIDE PLAZA COLUMBUS, OH 43215
	POND 1A & 1B	

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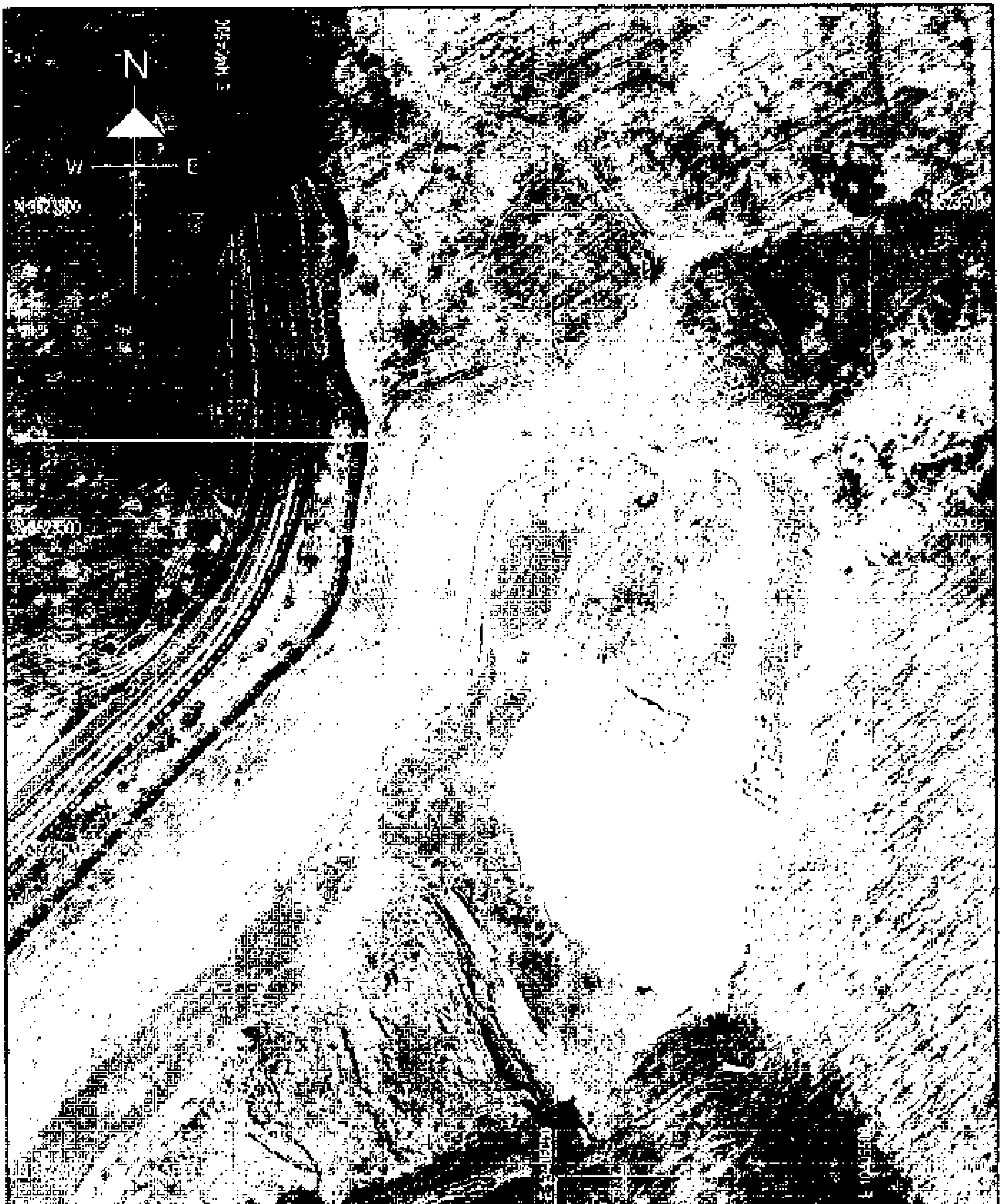

CLINCH RIVER POWER STATION SHEET 5 of 5 POND 2	DWG NO: FIGURE 5	
	AMERICAN ELECTRIC POWER	AEP SERVICE CORP. 1 RIVERSIDE PLAZA COLUMBUS, OH 43215

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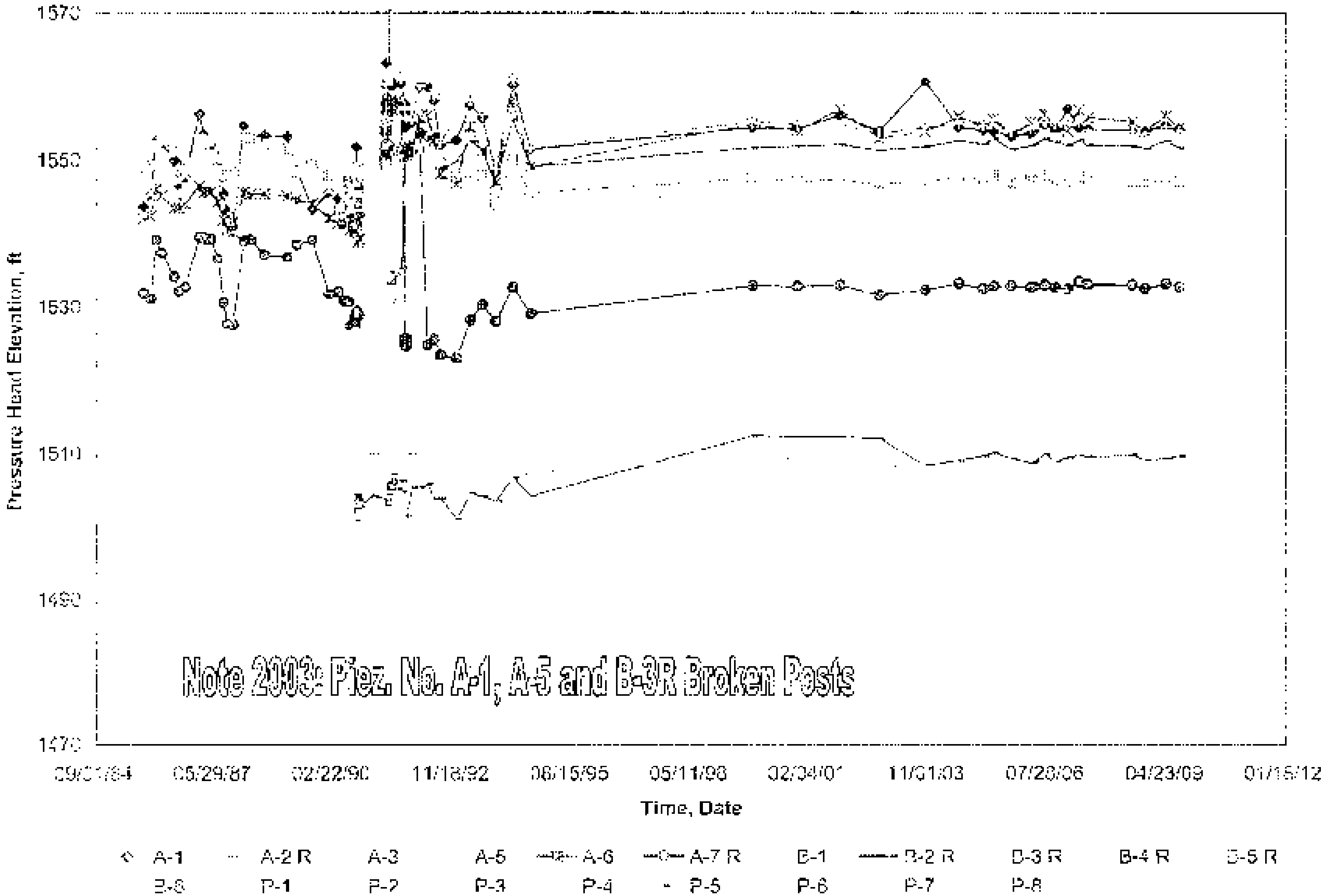

Figure 7. Piezometer readings since 1985

RECLAIM POND PHOTOGRAPHS

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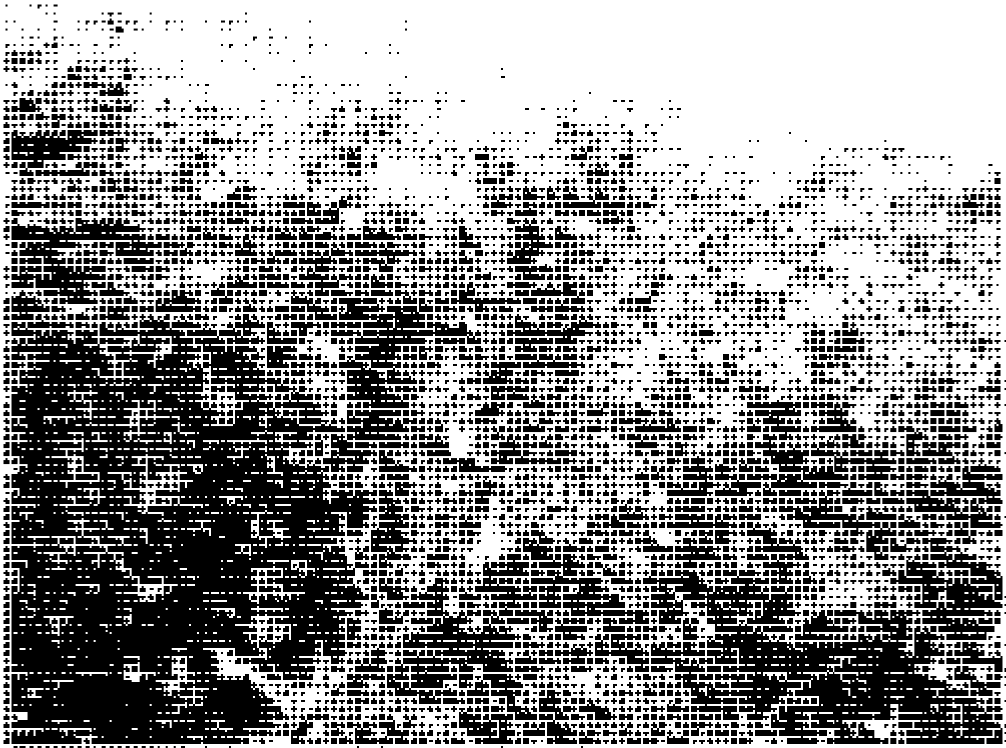

Photo 1. An erosion rill on the slope of the Reclaim Pond

Photo 2. Reclaim Pond viewed from the crest of West 1A dike

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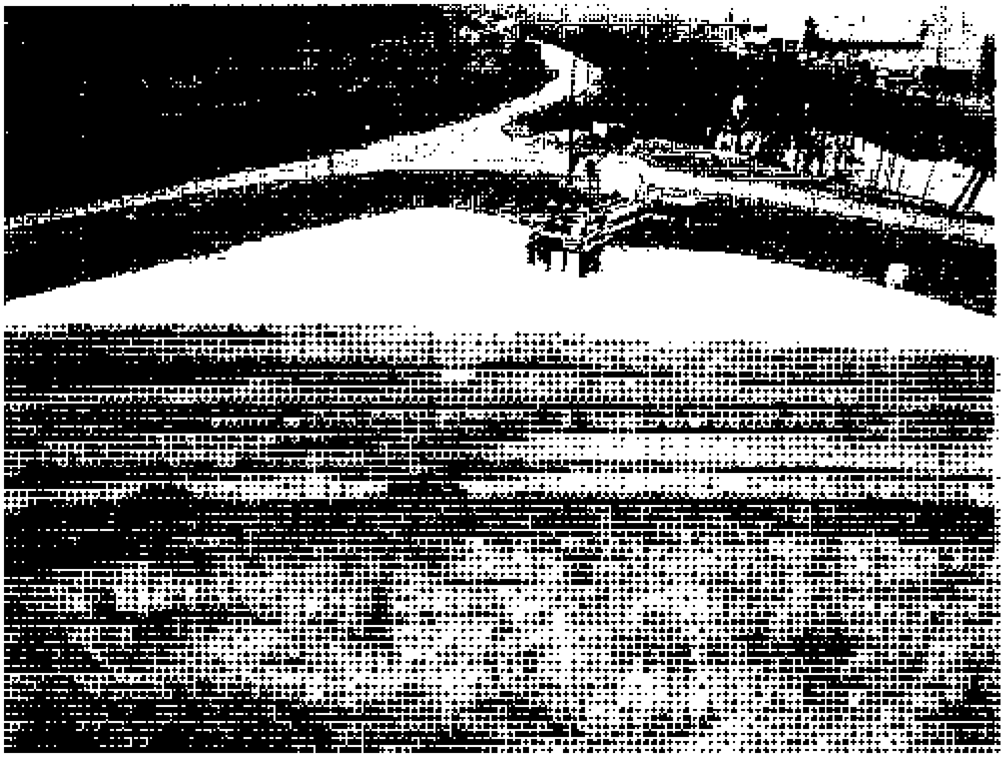

Photo 3. Reclaim Pond viewed from the crest of West 1A dike

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ASH POND 1A PHOTOGRAPHS

Photo 4. Groin ditch of the West 1A dike (western groin ditch)

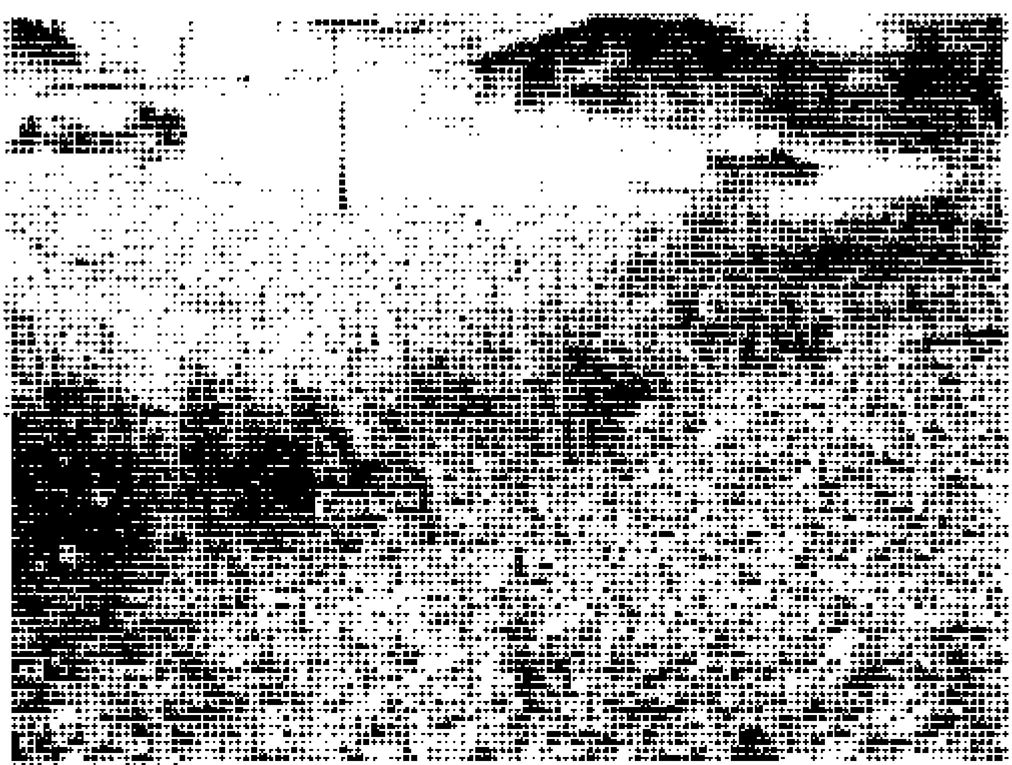

Photo 5. Rip-rap protection on the outboard slope of Pond 1A near the groin ditch

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Photo 6. Rip-rap protection of the outboard slope of the south 1A dike

Photo 7. South 1A dike above the access road

Photo 8. Build up of chemical precipitates in the toe drain pipes

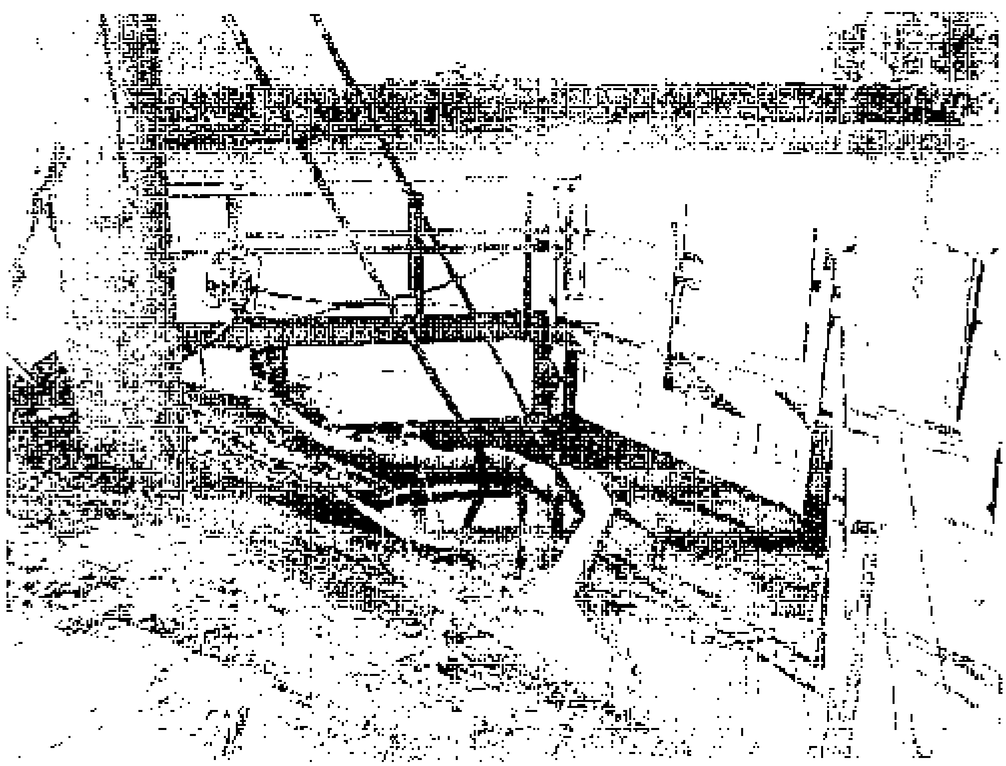

Photo 9. The overflow structure that discharges from 1A to 1B Ponds

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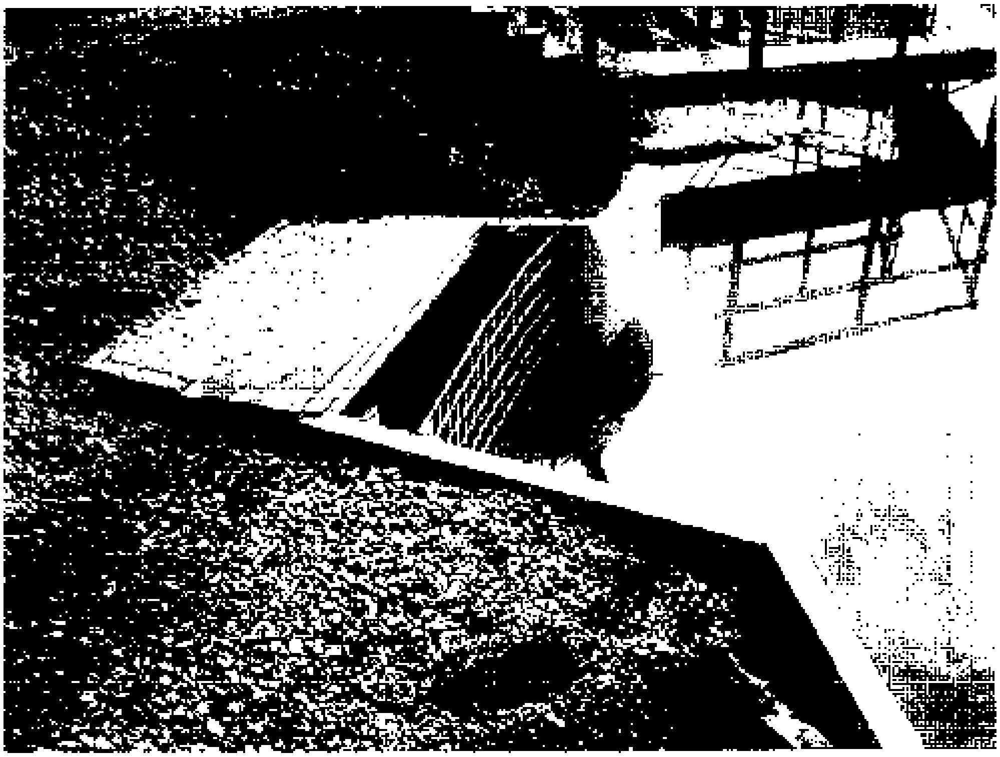

Photo 10. Inlet of the new spillway shaft from 1A to 1B ponds

Photo 11. Rock slope on the northeast of 1A pond

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ASH POND 1B PHOTOGRAPHS

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Photo 12. Groin ditch of 1B dike at the east side.

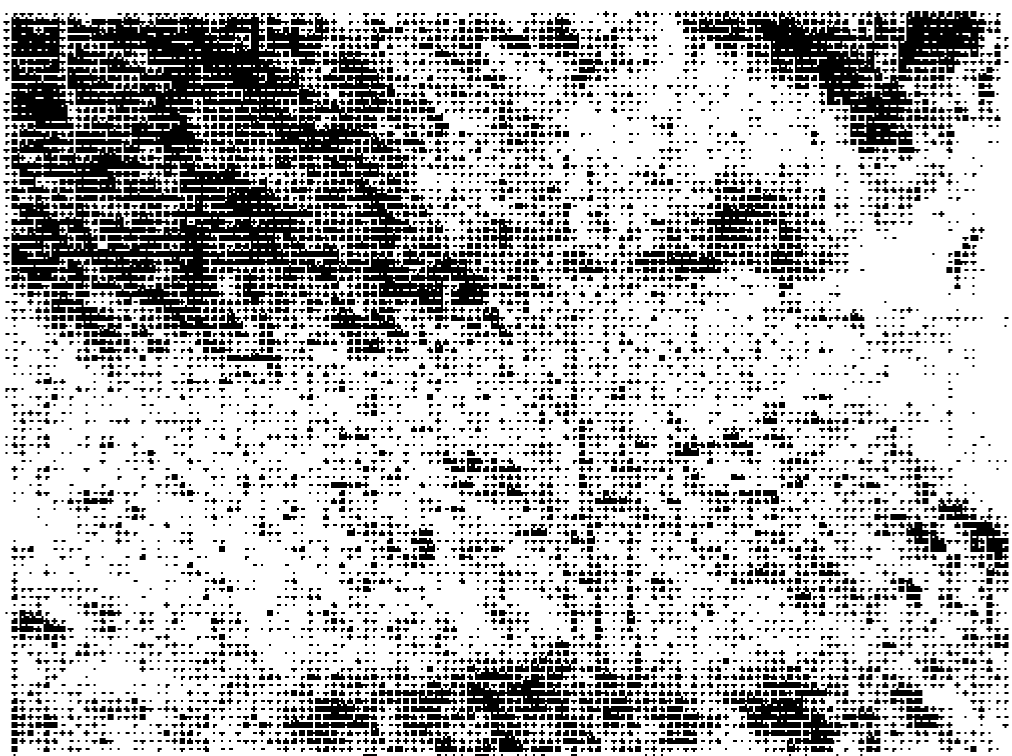

Photo 13. A portion of the east groin ditch and the slope next to it has rip-rap protection

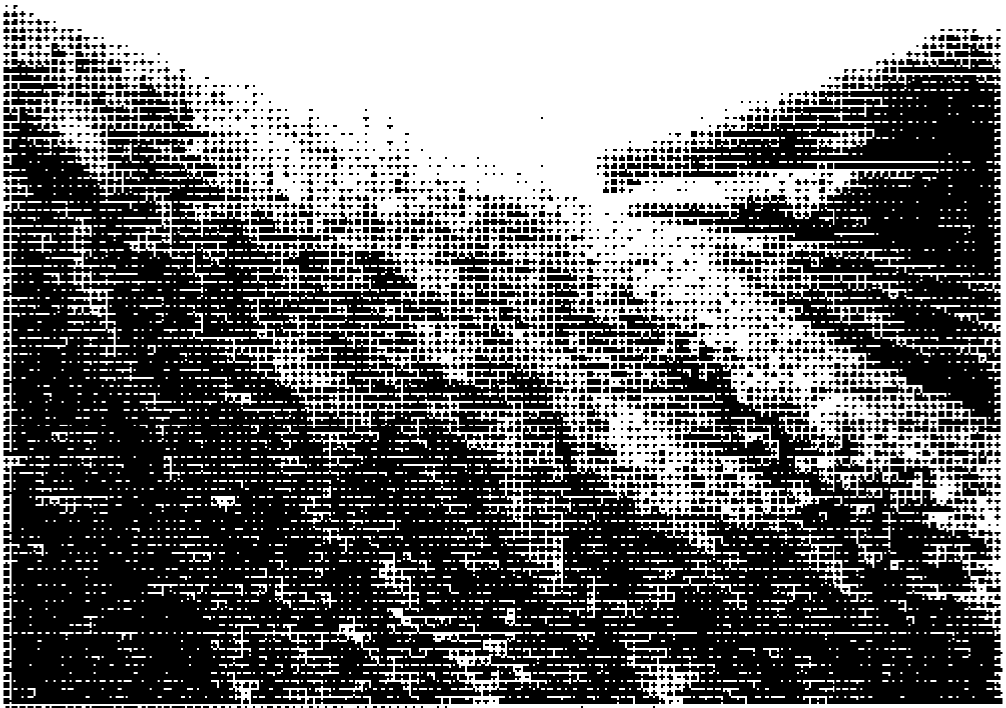

Photo 14. Outboard slope of south 1B dike. The lower half of the slope has rip-rap protection

Photo 15. Inboard slope of 1B dike

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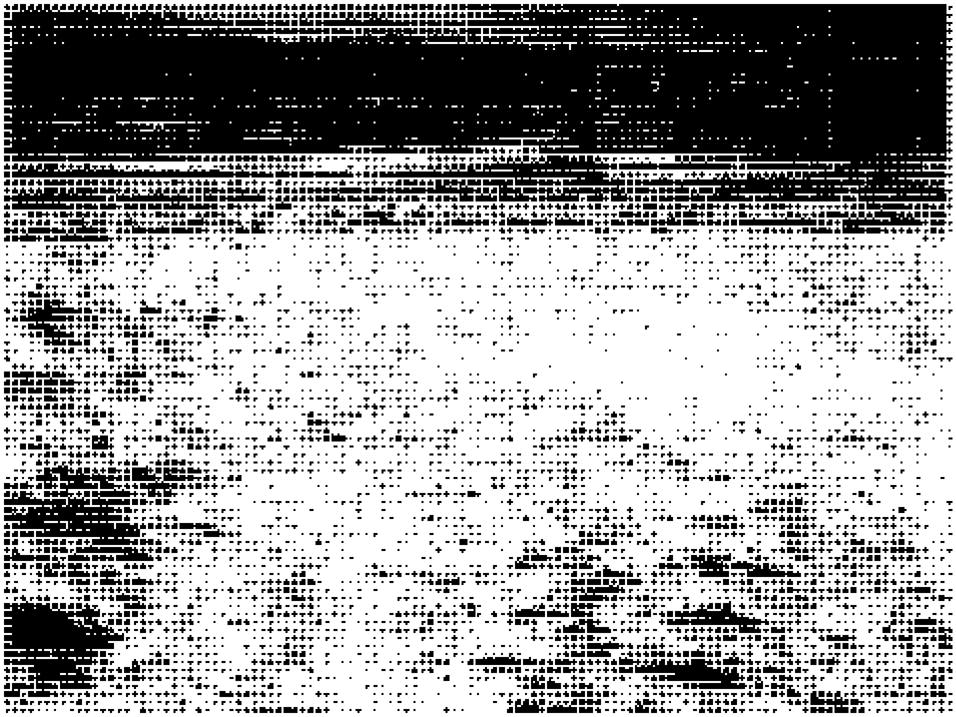

Photo 16. A bare area on the south 1B slope of the dike above the rip-rap. This portion of the slope is susceptible to erosion.

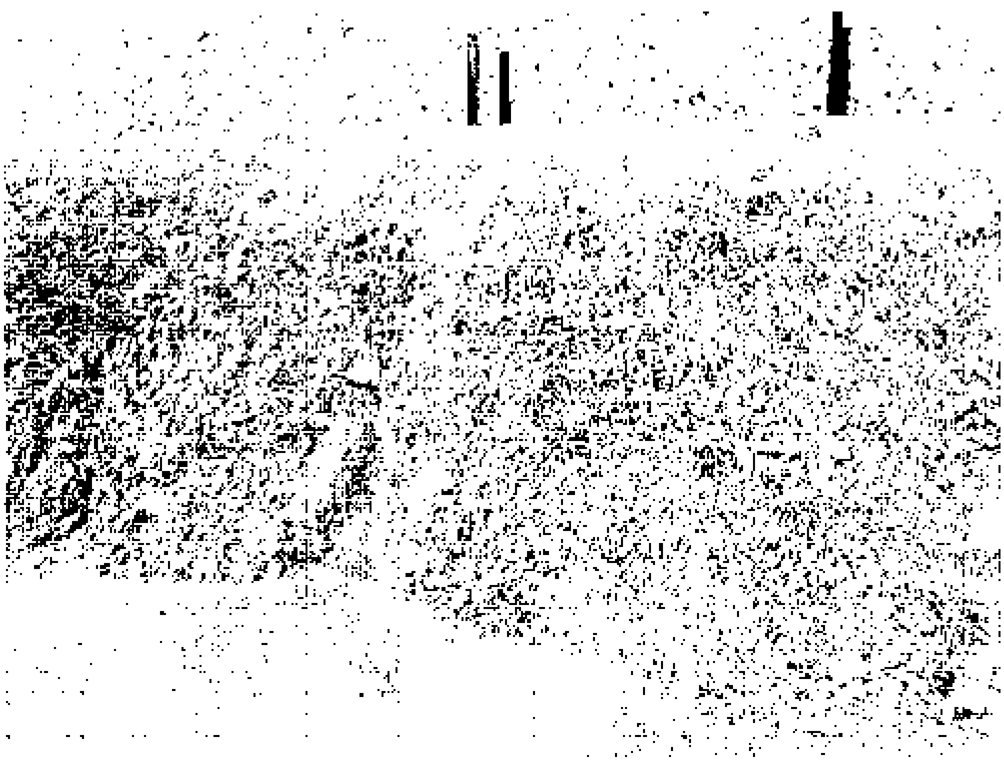

Photo 17. An erosion development at the toe of 1B dike

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Photo 18. Corrosion of the decant structure of 1B pond

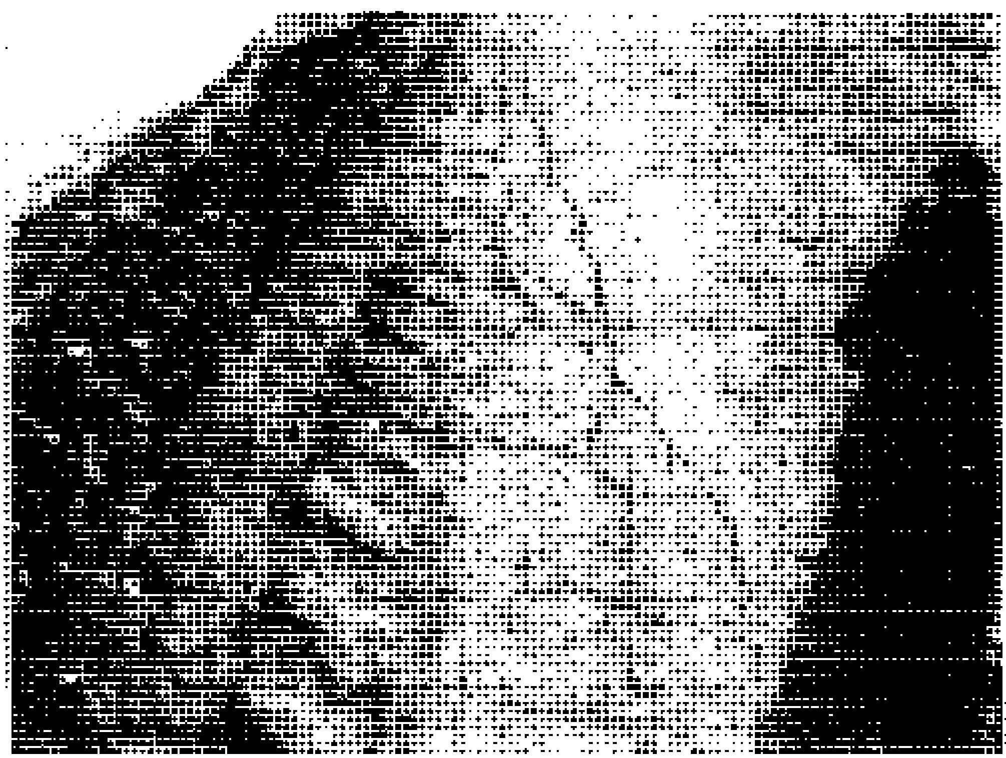

Photo 19. Settlement cracks on the newly constructed portion of the splitter dike

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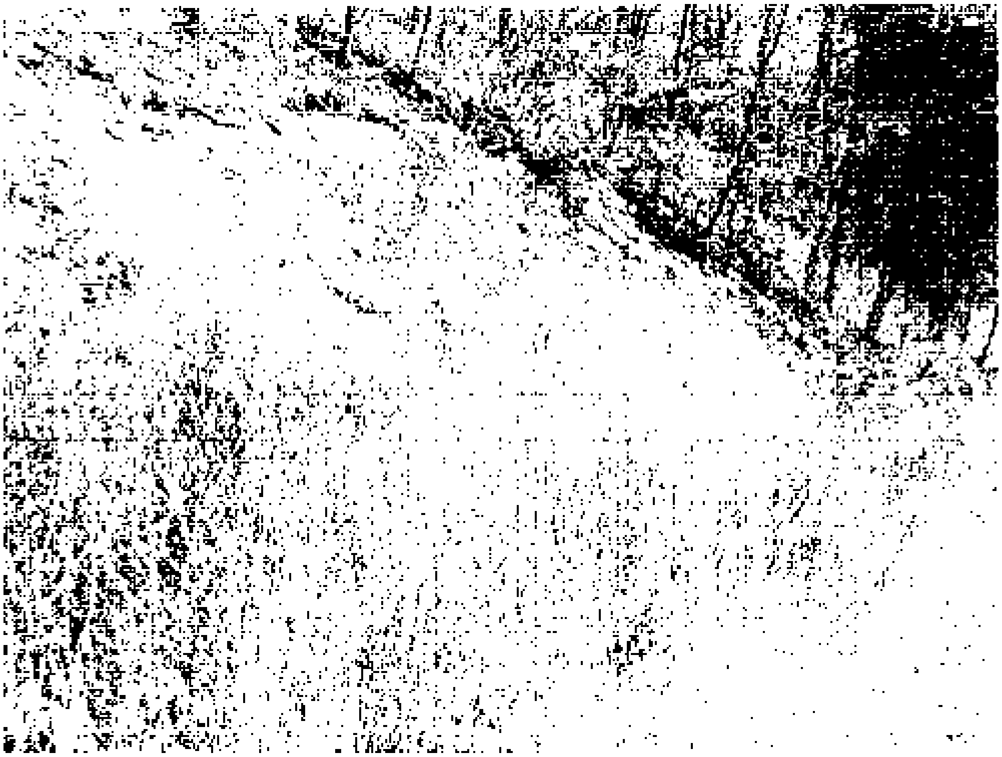

Photo 20. An old slide on the hillside near the east groin ditch above weir box No. 4

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APPENDIX A

Document 11

AEP Dam and Dike Inspection and Maintenance Program Summary

SUMMARY OF AEP'S DAM AND DIKE INSPECTION AND MAINTENANCE PROGRAM (DIMP)

Subject: Dam and Dike Inspection and Maintenance Program

Category: CIVIL (Maintenance)

CL # CIM CL 010G

Revision:
[illegible]

Purpose:
To describe the inspection, documentation and routine maintenance duties and responsibilities of Plant, Region Engineering, Environmental Services and Engineering Services under the AEP Dam Inspection and Maintenance Program. The program applies to all earthen dams and dikes used for ash or FGD sludge storage and disposal, waste water ponds and large cooling water storage facilities on the AEP System. Section IV of this letter briefly discusses Emergency Action Plans (EAP) but does not address actions to be taken under emergency conditions. For response to emergency conditions refer to the facility's Emergency Action Plan if applicable, or contact AEPSC Geotechnical Engineering Section.

Background:

From the 1940's through the 1970's, as the AEP System was expanding, AEP consulted extensively on its dams and dikes with one of the pioneers of geotechnical engineering, Professor Arthur Casagrande of Harvard University. If a dam or dike exhibited problems, AEP would monitor and repair it under his guidance. In the 1960's and 1970's large consulting companies engineered major dam construction projects with Casagrande Consultants acting as the owner's reviewer.

In the 1970s, AEP began to perform dam inspections with internal staff. In addition, the U.S. Army Corps of Engineers inspected several AEP dams in the late 1970's as part of a national program in response to the Buffalo Creek disaster in West Virginia. In 1979, AEP contracted with Woodward Clyde Consultants to begin inspecting existing ash disposal dams and dikes on the AEP System every two years. In 1983 AEP Civil Engineering initiated the Dam Inspection and Maintenance Program. Its purpose was to provide for systematic inspection, follow-up on significant inspection findings and to establish a contact point for plant concerns. Inspection checklists were created, and the plants were asked to perform periodic inspections.

Through the 1990's to the present, the program has been uniform and consistent. The purpose of this revision is to further strengthen the program throughout the entire AEP System and to reinforce the need to perform and document routine and formal inspections, collect instrumentation data where applicable and implement maintenance and remedial activities to assure the facilities are operated and maintained in a condition consistent with their design basis.

The Geotechnical Engineering Section (GES) of AEPSC Engineering Services coordinates the overall program, which is largely based on state regulations, Federal Emergency Management Agency guidelines, and sound engineering practice.

The inspection component of the program consists of four levels of inspection: (1) routine surveillance inspections by Plant personnel looking for changes in conditions (slips along dam face, erosion gullies, excessive settlement, malfunctioning drains, new seepage areas, etc.), (2) formal checklist type inspections by Plant or Region Engineering staff performed on a scheduled basis, (3) engineering inspections performed under the direction of a P.E. at a frequency determined by the dam's risk classification (1, 2, or 5 year intervals), and (4) non-routine plant inspections after unusual events such as heavy rains, seismic events, or other events that could cause a change in the condition of the facility.

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Inspection Schedule for Plant Formal (checklist) Inspections

VA	
Clinch River FAD 1A/1B	Inspect Quarterly
Clinch River FAD 2	Inspect Quarterly
Glen Lyn FAP	Inspect Quarterly
Glen Lyn SAP	Inspect Quarterly
Glen Lyn West Pond	Inspect Quarterly

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APPENDIX A

Document 12

EPA Impoundment Inventory, in Response to February 2009 Letter

* FOR INFORMATIONAL PURPOSES ONLY*

COMPANY	Appalachian Power Company	Appalachian Power Company
PLANT	Clinch River	Clinch River
ASH MANAGEMENT UNIT	Bottom Ash Pond 1A/1B	Bottom Ash Pond 2
QUESTION 1		
Dam Hazard Rating	Low	Low
Who Established Rating	VA DCR	VA DCR
Basis for Rating	Health Hazard	Health Hazard
No Rating Assigned	N/A	N/A
QUESTION 2		
Year Commissioned	1964	1964
Year(s) Expanded	Modified 1971	Placed out of service in 1998, closure plan submitted for regulatory approval in 2009
QUESTION 3 - Mark all that apply		
Fly Ash	X	X
Bottom Ash	X	X
Boiler Slag		
Flue Gas Emission Control Residuals		
Other (Specify)		
QUESTION 4		
Designed by P.E.	Not Available	Not Available
Constructed under P.E. Supervision	Not Available	Not Available
Inspection/monitoring under P.E. Supervision	Yes	Yes
QUESTION 5		
Date of Last Company Safety Assessment	1/7/2009	9/10/2003; Slope stability, liquefaction, and settlement analyses performed in 2008 as part of final closure design
Describe Evaluator's Credentials	VA P E	VA P E
Describe Past Followup Corrective Actions	Routine maintenance. Enhance seepage control	Routine maintenance
Describe Credentials of Corrective Action Implementers	Subcontractor under plant supervision	Under plant supervision
Describe Planned Followup Actions	1A -- reassess stability of dike. 1B -- Continue seepage control implementation on D/S slope. Routine maintenance(1A & 1B)	Routine maintenance
Date of Next Safety Assessment	2010	None (no free water in reservoir)
QUESTION 6		
Date of Last Regulatory Safety Inspection	3/19/2008	3/19/2008
Agency Name	Va DCR	Va DCR
Date of Planned Regulatory Safety Inspection	N/A	N/A
Agency Name	N/A	N/A
Copy of Most Recent Regulatory Inspection Included	Yes	Yes
QUESTION 7		
Safety Issues from Regulatory Inspections w/in Past Year	N/A	N/A
Corrective Actions	N/A	N/A
Documentation Included	N/A	N/A
QUESTION 8		
Surface Area (acres)	45 acres - This pond complex consists of a single pond (based on regulation under dam safety rules) which has been subdivided into two cells	No active impounding water area. No ash is currently sluiced to this inactive pond. A closure plan has been submitted to VDEQ for approval.
Total Storage Capacity	1,240 acre-ft	1,332 acre-ft
Volume Currently Stored	Variable - ash is routinely removed for use or disposal in dry landfill	1,332 acre-ft (estimated)
Date of Volume Measurement	N/A	N/A
Maximum Height (feet)	55	73
QUESTION 9		
Spills or Unpermitted Release History (10 Years)	No	No
QUESTION 10		
All legal owner(s) and operator(s)	Appalachian Power Company	Appalachian Power Company

CLINCH

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APPENDIX A

Document 13

AEP's Annual Inspection Form & Report to VA DCR

AMERICAN ELECTRIC POWER

American Electric Power
1 Riverside Plaza
Columbus OH 43215-2373
www.aep.com

Thomas J Roberts P E - Region 4 Dam Safety Engineer
Virginia Department of Conservation and Recreation
Dam Safety Program
8 Radford St
Christiansburg, Virginia 24073

April 17, 2009

Re: Clinch River Fly Ash Dike No 1 (16703)
Clinch River Fly Ash Dike No 2 (16702)
Glen Lyn Fly Ash Dam (07101)
Glen Lyn Bottom Ash Dam (07102)

Dear Mr. Roberts:

Enclosed please find the completed Annual Inspection Report forms the Clinch River facility, Ash Ponds 1A and 1B (Fly Ash Dike No 1), and the Glen Lyn facility, Fly Ash Dam and Bottom Ash Dam for 2009

If you have any questions, or if I can be of further assistance, please do not hesitate to contact me at (614) 716-2906

Sincerely,

William R Smith
AEP Service Corp , Civil Engineering
wrsmith@aep.com

Attachments: 1 2009 Annual Dam Inspection Report – Clinch River Plant
2. 2009 Annual Dam Inspection Report – Glen Lyn Plant

cc: J Saunders – Clinch River (w/ Clinch River attachments)
J Ryder – Glen Lyn (w/ Glen Lyn attachments)
P J Amaya – AEP Service Corp , Geotechnical Engineering (w/o attachments)
File

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Date Prepared: 2-13-2009
Prepared By: Behrad Zand

DCR
Virginia Department of Conservation & Recreation
State Parks • Soil & Water Conservation • Natural Heritage
Chesapeake Bay Local Assistance • Land Conservation
Outdoor Recreation Planning • Dam Safety & Floodplains

ANNUAL INSPECTION REPORT FOR VIRGINIA REGULATED IMPOUNDING STRUCTURES

Reference: Impounding Structures Regulations, 4VAC 50-20-10 et seq., including 4VAC 50-20-105, Virginia Soil and Water Conservation Board

Owner's Information

Name of Dam: Clinch River Ash Pond 1A and 1B
Inventory Number: 16703
Owner's Name: Appalachian Power Co.
Location-County/City: Russell County
Contact Person (if different from above): Pedro J. Amaya
Owner's Address: P.O. Box 2021-Clinch River
Hazard Classification: III
Name of reservoir: Roanoke, VA 24022
Purpose of reservoir:
Telephone No.: (Residential) (Business) 267-889-7324
Other means of communication:

Owner's Engineer

Name of Engineering Firm and Engineer: **American Electric Power Service Corporation ; Pedro J. Amaya, PE**
Professional Engineer Virginia License Number: 036174
Mailing Address: **1 Riverside Plaza, Columbus, OH 43215**

Telephone No.: (Business) 614-716-2926

Directions: Make note of all pertinent conditions and changes since the last inspection, or, if this is the first inspection, since the filing of a design report.

Date of This Inspection 1-7-2009
Date of Last Inspection 10-31-2007

1. EMBANKMENT

a. Any alteration made to the embankment? **No**

b. Erosion on embankment? **Minor erosion on the slope of the drainage ditch**

c. Settlement, misalignment or cracks in embankment? **No**

d. Seepage? If so, seepage flow rate and location (describe any turbidity and observed color within the flow): **Clear seepage at the toe area. The facility has a seepage collection system and seepage quantities are measured on regular basis.**

2. UPSTREAM SLOPE

a. Woody vegetation discovered? **No**
b. Rodent burrows discovered? **No**
c. Remedial work performed? **No**

3. INTAKE STRUCTURE NOTE: The intake structure consists of a steel decant tower and a concrete culvert

a. Deterioration of concrete? **No**
b. Exposure of rebar reinforcement? **No**
c. Is there a need to repair or replace the trash rack? **No**
d. Any problems with debris? **No**
e. Was the drawdown valve operated? **No**

US EPA ARCHIVE DOCUMENT

4. **ABUTMENT CONTACTS**

a. Any seepage? If so, estimate the flow rate and describe the location of the seep or damp areas (describe any turbidity and observed color within the flow): No

5. **EARTHEN EMERGENCY SPILLWAY**

a. Obstructions to flow? If so, describe plans to correct: NA

b. Rodent burrows discovered? NA

c. Any deterioration in the approach or discharge channel? NA

6. **CONCRETE EMERGENCY SPILLWAY**

a. Deterioration of concrete? NA

b. Exposed steel reinforcement? NA

c. Any leakage below concrete spillway? NA

d. Obstructions to flow? If so, lists plans to correct: NA

7. **DOWNSTREAM SLOPE**

a. Woody vegetation discovered? **No**

b. Rodent burrows discovered? **Yes**

c. Are seepage drains flowing? **No**

d. Any seepage or wet areas? **No – All the wet areas reported in the previous inspection reports are now covered and protected by riprap over fabric.**

8. **OUTLET PIPE**

a. Any water flowing outside of discharge pipe through the Impounding Structure? No

b. Describe any deflection or damage to the pipe: No

9. **STILLING BASIN**

a. Deterioration of concrete structures? NA

b. Exposure of rebar reinforcement? NA

c. Deterioration of the basin slopes? NA

d. Repairs made? NA

e. Any obstruction to flow? NA

10. **GATES**

a. Gate malfunctions or repairs? NA

b. Corrosion or damage? NA

c. Were any gates operated? If so, how often and to what extreme? NA

11. **RESERVOIR/WATERSHED**

a. New developments upstream of dam? No

b. Slides or erosion of lake banks around the rim? No

c. General comments to include silt, algae or other influence factors: No

US EPA ARCHIVE DOCUMENT

12. **INSTRUMENTS**

a List all instruments **20 piezometers and 5 V-notched weirs**

b Any readings of instruments? **Readings are taken on quarterly basis**

c Any installation of new instruments? **No**

13. **DOWNSTREAM/HAZARD ISSUES**

a New development in downstream inundation zone? **No**

b Note the maximum storm water discharge or peak elevation during the previous year **Not measured**

c Was general maintenance performed on dam? If so, when? Trees were removed from abutment area on Jan. 2009

d List actions that need to be accomplished before the next inspection:

1- Continue placing riprap on the downstream slope of 1B dike; 2- Reclassify the facility based on the new code; and 3-Reasses the safety of the facility according to the new regulations

14. **OVERALL EVALUATION OF IMPOUNDING STRUCTURE AND APPURTENANCES**

(Check one) [ ] **EXCELLENT** [X] **GOOD** [ ] **POOR**

General Comments: We understand that the Impounding Structure Regulations have recently been updated and that based on the new regulations the Hazard Classification of this facility should most likely be updated to "Significant". In response to correspondence we received from DCR on October 7, 2008 a new study was started and is in progress to reassess the hazard classification of the facility.

Recommendations: 1- Continue to place riprap on the downstream slope; 2- Continue to mow the slopes on regular basis; 3- Continue quarterly monitoring of the instrumentation; 4- Mud-pack the animal burrows; 5- Continue quarterly and annual inspections; and 6- continue the general maintenance

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CERTIFICATION BY OWNER'S ENGINEER (required only when an inspection by an engineer is required)

I hereby certify that the information provided in this report has been examined by me and found to be true and correct in my professional judgment

Signed: ______________________________ ______________________________ Virginia Number: ____________________
Professional Engineer's Signature Print Name

This ________ day of ______________, 20 ____.

Engineer's Virginia Seal:

CERTIFICATION BY OWNER

I hereby certify that the information provided in this report has been examined by me

Signed: ______________________________ ______________________________ Ricky L. Chatin
Owner's Signature Print Name

This 26 day of February, 20 09

Mail the executed form to the appropriate
Department of Conservation and Recreation
Division of Dam Safety and Floodplain Management
Regional Engineer

US EPA ARCHIVE DOCUMENT

DCR
Virginia Department of Conservation & Recreation

Date Prepared: 2-13-2009
Prepared By: Behrad Zand

ANNUAL INSPECTION REPORT FOR VIRGINIA REGULATED IMPOUNDING STRUCTURES

Reference: Impounding Structures Regulations, 4VAC 50-20-10 et seq., including 4VAC 50-20-105, Virginia Soil and Water Conservation Board

Owner's Information

Name of Dam: Clinch River Ash Pond 2
Owner's Name: Appalachian Power Co.
Contact Person (if different from above): Pedro J. Amaya
Owner's Address: P.O. Box 2021-Clinch River
Name of reservoir: Roanoke, VA 24022
Purpose of reservoir:
Telephone No.: (Residential) (Business) 567-889-7324
Other means of communication:

Inventory Number: 16702
Location-County/City: Russell County
Hazard Classification: III

Owner's Engineer

Name of Engineering Firm and Engineer: **American Electric Power Service Corporation, Pedro J. Amaya, PE VA**
Professional Engineer Virginia License Number: 036174
Mailing Address: **1 Riverside Plaza, Columbus, OH 43215**

Telephone No.: (Business) 614-716-2926

Directions: Make note of all pertinent conditions and changes since the last inspection, or, if this is the first inspection, since the filing of a design report.

Date of This Inspection NA
Date of Last Inspection NA

1. EMBANKMENT

a. Any alteration made to the embankment? **NA**

b. Erosion on embankment? **NA**

c. Settlement, misalignment or cracks in embankment? **NA**

d. Seepage? If so, seepage flow rate and location (describe any turbidity and observed color within the flow): **NA**

2. UPSTREAM SLOPE

a. Woody vegetation discovered? **NA**
b. Rodent burrows discovered? **NA**
c. Remedial work performed? **NA**

3. INTAKE STRUCTURE

a. Deterioration of concrete? **NA**
b. Exposure of rebar reinforcement? **NA**
c. Is there a need to repair or replace the trash rack? **NA**
d. Any problems with debris? **NA**
e. Was the drawdown valve operated? **NA**

US EPA ARCHIVE DOCUMENT

AEPCR000006

4. **ABUTMENT CONTACTS**
   a. Any seepage? If so, estimate the flow rate and describe the location of the seep or damp areas (describe any turbidity and observed color within the flow):
      NA

5. **EARTHEN EMERGENCY SPILLWAY**
   a. Obstructions to flow? If so, describe plans to correct: NA
   b. Rodent burrows discovered? NA
   c. Any deterioration in the approach or discharge channel? NA

6. **CONCRETE EMERGENCY SPILLWAY**
   a. Deterioration of concrete? NA
   b. Exposed steel reinforcement? NA
   c. Any leakage below concrete spillway? NA
   d. Obstructions to flow? If so, lists plans to correct: NA

7. **DOWNSTREAM SLOPE**
   a. Woody vegetation discovered? NA
   b. Rodent burrows discovered? NA
   c. Are seepage drains flowing? NA
   d. Any seepage or wet areas? NA

8. **OUTLET PIPE**
   a. Any water flowing outside of discharge pipe through the Impounding Structure? NA
   b. Describe any deflection or damage to the pipe: NA

9. **STILLING BASIN**
   a. Deterioration of concrete structures? NA
   b. Exposure of rebar reinforcement? NA
   c. Deterioration of the basin slopes? NA
   d. Repairs made? NA
   e. Any obstruction to flow? NA

10. **GATES**
   a. Gate malfunctions or repairs? NA
   b. Corrosion or damage? NA
   c. Were any gates operated? If so, how often and to what extreme? NA

11. **RESERVOIR/WATERSHED**
   a. New developments upstream of dam? NA
   b. Slides or erosion of lake banks around the rim? NA
   c. General comments to include silt, algae or other influence factors: NA

US EPA ARCHIVE DOCUMENT

12. INSTRUMENTS

a. List all instruments NA

b. Any readings of instruments? NA

c. Any installation of new instruments? NA

13. DOWNSTREAM/HAZARD ISSUES

a. New development in downstream inundation zone? **NA**

b. Note the maximum storm water discharge or peak elevation during the previous year NA

c. Was general maintenance performed on dam? If so, when? NA

d. List actions that need to be accomplished before the next inspection: NA

14. OVERALL EVALUATION OF IMPOUNDING STRUCTURE AND APPURTENANCES

NA

(Check one) ☐ **EXCELLENT** ☐ **GOOD** ☐ **POOR**

General Comments:

This facility was dewatered in 1998 and has been out of service since then. An application for the permanent closure of the facility has been filed with the regulator authorities.

Recommendations:

US EPA ARCHIVE DOCUMENT

AEPCR000008

CERTIFICATION BY OWNER'S ENGINEER (required only when an inspection by an engineer is required)

I hereby certify that the information provided in this report has been examined by me and found to be true and correct in my professional judgment

Signed: ______________________________ ______________ Virginia Number: ______________

Professional Engineer's Signature — Print Name

This ______ day of ______________, 20 ____.

Engineer's Virginia Seal:

CERTIFICATION BY OWNER

I hereby certify that the information provided in this report has been examined by me

Signed: [signature] ______________ Ricky L. Chatha ______________

Owner's Signature — Print Name

This 26 day of February, 20 09.

Mail the executed form to the appropriate
Department of Conservation and Recreation
Division of Dam Safety and Floodplain Management
Regional Engineer

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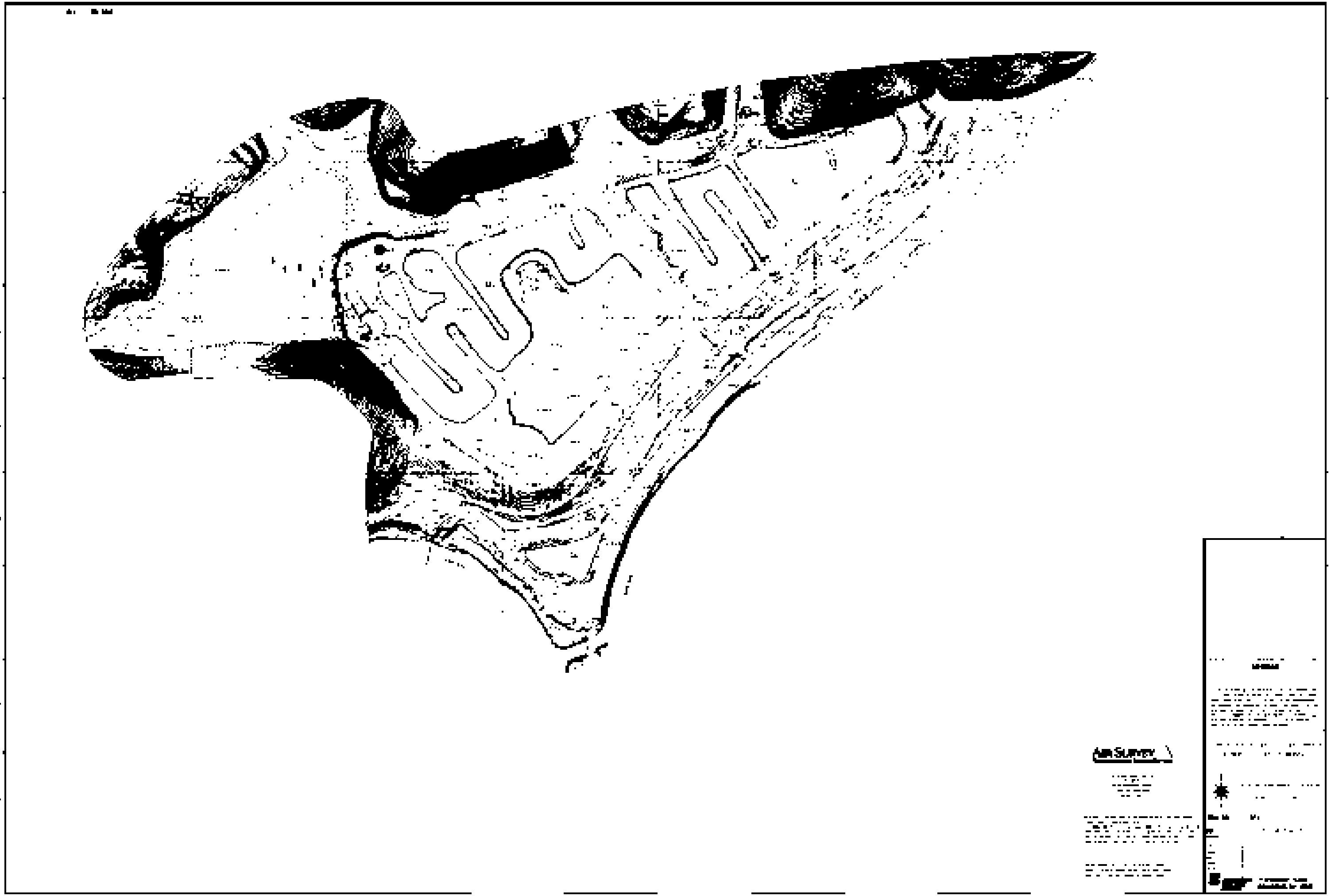
APPENDIX A

Document 14

Clinch River Plant Aerial Survey, Ash Pond 1



DOCUMENT 14: CLINCH RIVER PLANT AERIAL SURVEY, ASH POND 1 *FOR INFORMATIONAL PURPOSES ONLY* AEPCR000010

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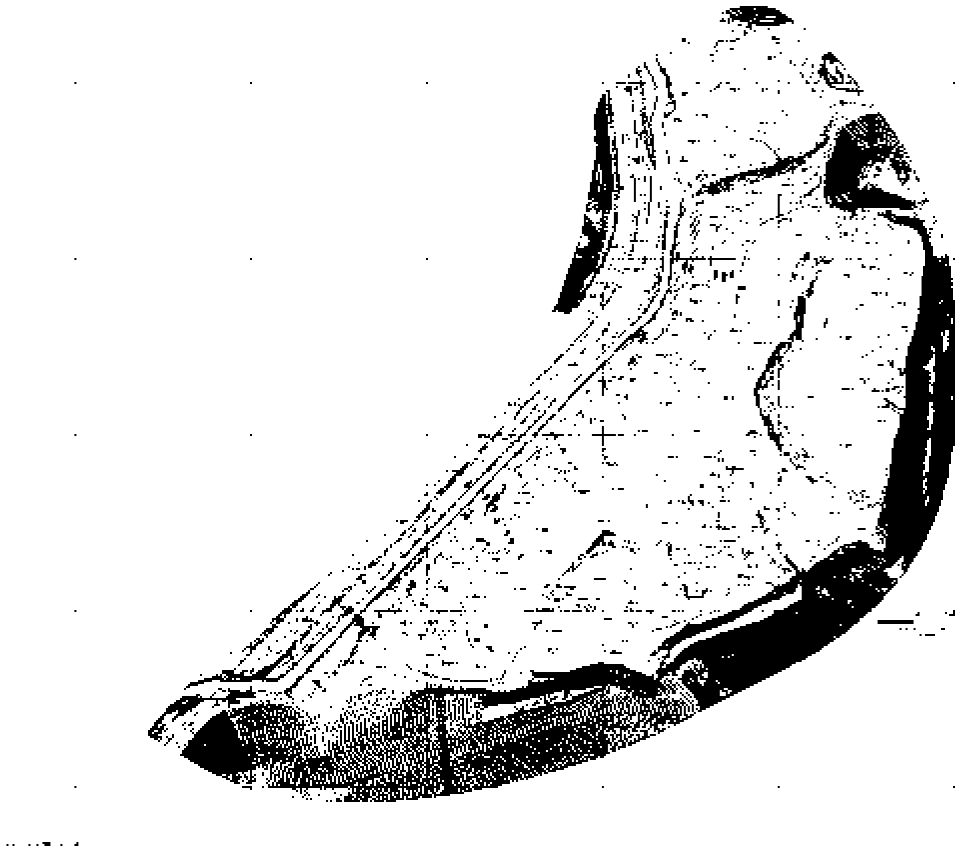
APPENDIX A

Document 15

Clinch River Plant Aerial Survey, Ash Pond 2



US EPA ARCHIVE DOCUMENT

APPENDIX A

Document 16

Draft Letter, Virginia Department of Conservation and Recreation, Dam Safety Region 4, dated December 29, 2011, #16703 (Flyash Dam No. 1)

Douglas W. Domenech
Secretary of Natural Resources

David A. Johnson
Director

COMMONWEALTH of VIRGINIA
DEPARTMENT OF CONSERVATION AND RECREATION
203 Governor Street
Richmond, Virginia 23219-2010
(804) 786-1712

December 29, 2011

Dewberry
Attn: Jerome Strauss P.E.
8401 Arlington Boulevard
Fairfax, Virginia 22031

Re: Comments for Coal Combustion Residue Impoundment Round 9 – Dam Assessment Report, Clinch River Power Plant, Clinch River Flyash Dam No.1, #16703

Dear Jerry,

Thank you for providing Virginia Department of Conservation and Recreation Dam Safety Region 4 the opportunity of including some comments on the Clinch River Power Plant Ash Pond Management Units for possible inclusion in the above referenced report. The following are my comments:

Summary

Under the provisions of 4VAC50-20-220 Unsafe Conditions, C. Nonimminent danger…" the of the Virginia Department of Conservation and Recreation Impounding Structure Regulations, Thomas I. Roberts, P.E., C.F.M. Regional Dam Safety Engineer intends to provide American Electric Power (AEP), a draft report in January 2012 indicating known deficiencies in the dam, and in February 2012 recommend that the current Regular Certificate to Operate the dam be replaced with a Conditional Certificate to Operate the dam. The Conditional Certificate to Operate the dam will contain a listing of requirements and completion dates that must be met by AEP. Once AEP has satisfactorily met the minimum safety requirements for their dam, AEP may apply for a new Regular Certificate to Operate and Maintain the dam.

Current Conditions

The Clinch River Flyash Dam No. 1, NID #VA16703, currently has a Regular Certificate to Operate and Maintain issued March 20, 2008 and expires March 31, 2014. Our records indicate that it is 55 feet high and has a potential storage capacity of 3150 acre-feet. Currently there is very little ponding volume above the settled ash. The dam functions by pumping flyash/water slurry into the impoundment where excavation equipment scoops it out and it is hauled away. About 110 acres of offsite drainage drains toward the impoundment and is supposed to be routed through and around the impoundment. The piping and ditching appears to be inadequate to channel even a fraction of the required flow around the impoundment. During a visit to the impoundment earlier this year, it was found that the channel to divert about 50 acres of the drainage had been blocked by a falling boulder, and all the offsite water was actively flowing into the impoundment from about 50 acres of offsite area. Based on information mentioned by AEP personnel onsite it appears that a large percentage of the embankment is made of coal combustion residue materials. Woody vegetation control on the dam does not comply with the minimum standards in the regulations. There is no Auxiliary Spillway (Emergency Spillway). The spillway appears to be much too small to handle the required storm flows. A toe drain has recently been installed using open graded stone.

Hazard Classification

The facility has been listed for many years as a Low Hazard Dam due to the proximity of the New River. Only this year did it come to the attention of VA DCR Dam Safety that this dam had failed once before in 1967. AEP, though asked, has not o provided any information on this failure, though it has been claimed by others that the failure caused a large discharge of ash into the Clinch River resulting in killing off all life in the river for 23 miles downstream in 1967. Currently this same stretch of Clinch River has the largest collection of species of endangered species of muscles than any other location in the United States. The Hazard Classifications for dams in Virginia is based on the Virginia Impounding Structure Regulations (Dam Safety) 4VAC50-20-40 "**Hazard potential classifications of impounding structures.**

A. Impounding structures shall be classified in one of three hazard classifications as defined in subsection B of this section and Table 1.

B. For the purpose of this chapter, hazards pertain to potential loss of human life or damage to the property of others downstream from the impounding structure in event of failure or faulty operation of the impounding structure or appurtenant facilities. Hazard potential classifications of impounding structures are as follows:

1. High Hazard Potential is defined where an impounding structure failure will cause probable loss of life or serious economic damage. "Probable loss of life" means that impacts will occur that are likely to cause a loss of human life, including but not limited to impacts to residences, businesses, other occupied structures, or major roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, major roadways, railroads, personal property, and agricultural interests. "Major roadways" include, but are not limited to, interstates, primary highways, high-volume urban streets, or other high-volume roadways.

2. Significant Hazard Potential is defined where an impounding structure failure may cause the loss of life or appreciable economic damage. "May cause loss of life" means that impacts will occur that could cause a loss of human life, including but not limited to impacts to facilities that are frequently utilized by humans other than residences, businesses, or other occupied structures, or to secondary roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, secondary roadways, railroads, personal property, and agricultural interests. "Secondary roadways" include, but

are not limited to, secondary highways, low-volume urban streets, service roads, or other low-volume roadways.

3. Low Hazard Potential is defined where an impounding structure failure would result in no expected loss of life and would cause no more than minimal economic damage. "No expected loss of life" means no loss of human life is anticipated

C. The hazard potential classification shall be proposed by the owner and shall be subject to approval by the board. To support the appropriate hazard classification, dam break analysis shall be conducted by the owner's engineer. Present and planned land-use for which a development plan has been officially approved by the locality in the dam break inundation zones downstream from the impounding structure shall be considered in determining the classification.

D. Impounding structures shall be subject to reclassification by the board as necessary."

With the knowledge of economic costs and environmental damage caused by failures of other Coal Combustion Residue Impoundments, the currently listed "Low Hazard" classification might not be the correct current hazard classification based on the Virginia regulatory definitions. One important issues that arises from the Hazard Classification is the minimum required safe spillway capacity.

Minimum Required Safe Spillway Capacity

Once the actual hazard classification has been determined, Table 1 of 4VAC50-20-50 "Performance Standards Required for Impounding Structures" is used to determine the minimum safe spillway capacity.

Hazard Potential Class of Dam	Spillway Design Flood (SDF)[B] For New Structures [F]	Spillway Design Flood (SDF)[B] for Existing Impounding Structures [F,G]	Minimum Threshold for Incremental Damage Analysis
High	PMF[C]	0.9 PMP[H]	100-YR[D]
Significant	.50 PMF	.50 PMF	100-YR[D]
Low	100-YR[D]	100-YR[D]	50-YR[E]

Since the main hazard in this dam is the material impounded and the material in the dam, an Incremental Damage Analysis under the provisions of 4VAC50-20-52 would not be applicable for this dam.

An analysis of the inflow and safe outflow needed for this structure is required. **Currently there is no operable outflow structure for this impoundment. Failure of this structure could result from this deficiency.**

Toe Drainage

A recently installed toe drain was apparently installed illegally without an Alteration Permit through VA DCR Dam Safety. The drain material appears to be constructed of open graded stone, with no filter diaphragm. **A drain incorrectly designed and installed could cause this dam to fail through soil piping in a manner that could be undetectable beforehand. Once properly reviewed, it may turn out that it would be safer for the facility for the entire toe drain to be removed than left in place.**

Blanket Drain

A blanket drain on about 2/3 the surface of the impoundment was apparently installed by AEP with a required Alteration Permit. This installation must be reviewed an analyzed for compliance with basic design requirements. A incorrectly designed and installed blanket drain could cause a failure by piping to progress without detection resulting in catastrophic sudden failure.

Structural Stability

The structural stability analysis report provided by AEP had not been signed by a P.E. licensed in Virginia and is not considered as a valid submittal.

Conclusion

With the better understanding of the inherent environmental and economic dangers posed by a the failure of a Coal Combustion Residue Impoundments, especially one that is at least partially constructed of Coal Combustion Residue materials, AEP as owner, should immediately take action to bring this dam at least in compliance with the minimum safety standards in the Virginia Impounding Structure Regulations.

Please contact me if there are questions on my comments above at: Thomas I. Roberts, P.E., C.F.M., Region 4 Dam Safety Engineer, VA DCR Dam Safety & Floodplain Management, 8 Radford Street, Christiansburg, Virginia, 24073. Phone 540-394-2550, and e-mail Thomas.Roberts@dcr.virginia.gov.

Sincerely

Thomas I. Roberts P.E., C.F.M.

cc Robert Bennett, P.E, R.A., C.F.M., Div. Director VA DCR Dam Safety & Floodplain Management

US EPA ARCHIVE DOCUMENT

APPENDIX A

Document 17

Draft Letter, Virginia Department of Conservation and Recreation, Dam Safety Region 4, dated December 29, 2011, #16702 (Flyash Dam No. 2)

Douglas W. Domenech
Secretary of Natural Resources

David A. Johnson
Director

COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND RECREATION

203 Governor Street
Richmond, Virginia 23219-2010
(804) 786-1712

December 29, 2011

Dewberry
Attn: Jerome Strauss P.E.
8401 Arlington Boulevard
Fairfax, Virginia 22031

Re: Comments for Coal Combustion Residue Impoundment Round 9 – Dam Assessment Report, Clinch River Power Plant, Clinch River Flyash Dam No.2, #16702

Dear Jerry,

Thank you for providing Virginia Department of Conservation and Recreation Dam Safety Region 4 the opportunity of including some comments on the Clinch River Power Plant Ash Pond Management Units for possible inclusion in the above referenced report. The following are my comments:

Summary

Under the provisions of 4VAC50-20-220 Unsafe Conditions, C. Nonimminent danger…" the of the Virginia Department of Conservation and Recreation Impounding Structure Regulations, Thomas I. Roberts, P.E., C.F.M. Regional Dam Safety Engineer intends to provide American Electric Power (AEP), a draft report in January 2012 indicating known deficiencies in the dam, and in February 2012 recommend that the current Regular Certificate to Operate the dam be replaced with a Conditional Certificate to Operate the dam. The Conditional Certificate to Operate the dam will contain a listing of requirements and completion dates that must be met by AEP. Once AEP has satisfactorily met the minimum safety requirements for their dam, AEP may apply for a new Regular Certificate to Operate and Maintain the dam.

Current Conditions

The Clinch River Flyash Dam No. 2, NID #VA16702, currently has a Regular Certificate to Operate and Maintain issued March 20, 2008 and expires March 31, 2014. Our records indicate that it is 65 feet high and has a potential storage capacity of 157 acre-feet. Currently there is not any permanent pool and capacity for very little ponding above the settled ash. The dam had functioned by pumping flyash/water slurry into the impoundment in the past but the piping is currently disconnected. About 40 acres of offsite drainage drains into the impoundment with no safe functioning outlet. Based on information mentioned by AEP personnel onsite and old plansheet showing crossections of the impoundment (in possession of AEP but copies not provided as promised) it appears that the bulk of the embankment is made of coal combustion residue materials. Woody vegetation control on the dam does not comply with the minimum standards in the regulations. There is no Auxiliary Spillway (Emergency Spillway) nor a functioning principal spillway Though AEP staff have indicated in recent years, and as recently as September 2011, that there is an intent to decommission the dam and make it no longer a regulated impounding structure, the required alteration permit and plans have not been provided to VA DCR Dam Safety & FM to date on this.

Hazard Classification

The facility has been listed for many years as a Low Hazard Dam due to the proximity of the New River. Only this year did it come to the attention of VA DCR Dam Safety that this dam had failed once before in 1967. AEP, though asked, has not o provided any information on this failure, though it has been claimed by others that the failure caused a large discharge of ash into the Clinch River resulting in killing off all life in the river for 23 miles downstream in 1967. Currently this same stretch of Clinch River has the largest collection of species of endangered species of muscles than any other location in the United States. The Hazard Classifications for dams in Virginia is based on the Virginia Impounding Structure Regulations (Dam Safety) 4VAC50-20-40 "**Hazard potential classifications of impounding structures.**

A. Impounding structures shall be classified in one of three hazard classifications as defined in subsection B of this section and Table 1.

B. For the purpose of this chapter, hazards pertain to potential loss of human life or damage to the property of others downstream from the impounding structure in event of failure or faulty operation of the impounding structure or appurtenant facilities. Hazard potential classifications of impounding structures are as follows:

1. High Hazard Potential is defined where an impounding structure failure will cause probable loss of life or serious economic damage. "Probable loss of life" means that impacts will occur that are likely to cause a loss of human life, including but not limited to impacts to residences, businesses, other occupied structures, or major roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, major roadways, railroads, personal property, and agricultural interests. "Major roadways" include, but are not limited to, interstates, primary highways, high-volume urban streets, or other high-volume roadways.

2. Significant Hazard Potential is defined where an impounding structure failure may cause the loss of life or appreciable economic damage. "May cause loss of life" means that impacts will occur that could cause a loss of human life, including but not limited to impacts to facilities that are frequently utilized by humans other than residences, businesses, or other occupied structures, or to secondary roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, secondary roadways, railroads,

personal property, and agricultural interests. "Secondary roadways" include, but are not limited to, secondary highways, low-volume urban streets, service roads, or other low-volume roadways.

3. Low Hazard Potential is defined where an impounding structure failure would result in no expected loss of life and would cause no more than minimal economic damage. "No expected loss of life" means no loss of human life is anticipated

C. The hazard potential classification shall be proposed by the owner and shall be subject to approval by the board. To support the appropriate hazard classification, dam break analysis shall be conducted by the owner's engineer. Present and planned land-use for which a development plan has been officially approved by the locality in the dam break inundation zones downstream from the impounding structure shall be considered in determining the classification.

D. Impounding structures shall be subject to reclassification by the board as necessary."

With the knowledge of economic costs and environmental damage caused by failures of other Coal Combustion Residue Impoundments, the currently listed "Low Hazard" classification might not be the correct current hazard classification based on the Virginia regulatory definitions. One important issues that arises from the Hazard Classification is the minimum required safe spillway capacity.

Minimum Required Safe Spillway Capacity

Once the actual hazard classification has been determined, Table 1 of 4VAC50-20-50 "Performance Standards Required for Impounding Structures" is used to determine the minimum safe spillway capacity.

Hazard Potential Class of Dam	Spillway Design Flood (SDF)[B] For New Structures [F]	Spillway Design Flood (SDF)[B] for Existing Impounding Structures [F,G]	Minimum Threshold for Incremental Damage Analysis
High	PMF[C]	0.9 PMP[H]	100-YR[D]
Significant	.50 PMF	.50 PMF	100-YR[D]
Low	100-YR[D]	100-YR[D]	50-YR[E]

Since the main hazard in this dam is the material impounded and the material in the dam, an Incremental Damage Analysis under the provisions of 4VAC50-20-52 would not be applicable for this dam.

An analysis of the inflow and safe outflow needed for this structure is required. **Currently there is no operable outflow structure for this impoundment. Failure of this structure could result from this deficiency.**

Structural Stability

The structural stability analysis report provided by AEP had not been signed by a P.E. licensed in Virginia and is not considered as a valid submittal. The report is falsely based on the assumption that only rainwater from the sky over the footprint of the impoundment flows to the impoundment and does not account for approximately 40 acres of offsite drainage area that drains to the impoundment. An "As-Built" drawing of the facility was provided by AEP, signed by a P.E. licensed in Virginia, that completely misrepresented the drainage conditions, showing a nonexistent drainage system to keep off-site drainage from entering the impoundment. Rainwater over the footprint of the impoundment and runoff onto the impoundment are trapped onsite with no outlet at all other than saturating the fill. The structural analysis does not address the hundreds of truckloads of shale illegally dumped on top of the North end of the impoundment without the lawfully required Alteration permit through Virginia DCR Dam Safety. With the history of this structure failing in 1967, extremely poor drainage conditions, lack of operable monitoring wells onsite, dumped surcharge material on top, and embankments constructed of Coal Combustion Residue material, AEP needs to have an adequate and correct structural analysis done of the dam as soon as possible.

Conclusion

With the better understanding of the inherent environmental and economic dangers posed by a the failure of a Coal Combustion Residue Impoundments, especially one that is at least partially constructed of Coal Combustion Residue materials, AEP as owner, should immediately take action to bring this dam at least in compliance with the minimum safety standards in the Virginia Impounding Structure Regulations.

Please contact me if there are questions on my comments above at: Thomas I. Roberts, P.E., C.F.M., Region 4 Dam Safety Engineer, VA DCR Dam Safety & Floodplain Management, 8 Radford Street, Christiansburg, Virginia, 24073. Phone 540-394-2550, and e-mail Thomas.Roberts@dcr.virginia.gov.

Sincerely

Thomas I. Roberts P.E., C.F.M.

cc Robert Bennett, P.E, R.A., C.F.M., Div. Director VA DCR Dam Safety & Floodplain Management

US EPA ARCHIVE DOCUMENT

APPENDIX B

Document 18

Ash Pond 1, Dam Inspection Check List Form

Coal Combustion Dam Inspection Checklist Form

US Environmental
Protection Agency

Site Name:	**Clinch River Plant**	**Date:**	**February 17, 2011**
Unit Name:	**ASH POND 1 (Ponds 1A /1B)**	**Operator's Name:**	**Appalachian Power**
Unit I.D.:	**VA16703**	**Hazard Potential Classification:**	**High** ☐ **Significant** ☒ **Low** ☐
	Inspector's Name:	Scott Clarke, P.E. and Lorainne Ramos Nieves, P.E., CFM	

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.

Note: Comments regarding each issue number have been listed below as needed.

Issue #	Yes	No	Issue #	Yes	No
1. Frequency of Company's Dam Inspections?	✔		18. Sloughing or bulging on slopes?		✔
2. Pool elevation (operator records)?	✔		19. Major erosion or slope deterioration?		✔
3. Decant inlet elevation (operator records)?		✔	20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?		N/A	Is water entering inlet, but not exiting outlet?		✔
5. Lowest dam crest elevation (operator records)?	✔		Is water exiting outlet, but not entering inlet?		✔
6. If instrumentation is present, are readings recorded (operator records)?	✔		Is water exiting outlet flowing clear?	✔	
7. Is the embankment currently under construction?		✔	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)?		✔	From underdrain?	✔	
9. Trees growing on embankment? (If so, indicate largest diameter below)		✔	At isolated points on embankment slopes?	✔	
10. Cracks or scarps on crest?		✔	At natural hillside in the embankment area?	✔	
11. Is there significant settlement along the crest?		✔	Over widespread areas?		✔
12. Are decant trashracks clear and in place?	✔		From downstream foundation area?		✔
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		✔	"Boils" beneath stream or ponded water?		✔
14. Clogged spillways, groin or diversion ditches?		✔	Around the outside of the decant pipe?		✔
15. Are spillway or ditch linings deteriorated?		✔	22. Surface movements in valley bottom or on hillside?		✔
16. Are outlets of decant or underdrains blocked?		✔	23. Water against downstream toe?		✔
17. Cracks or scarps on slopes?		✔	24. Were Photos taken during the dam inspection?	✔	

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.	Impoundments are inspected quarterly by the plant personnel, and annually through an outside consultant.
2.	Operating pool elevations for Pond 1A and Pond 1B are 1565 and 1558, respectively.
6.	Twenty piezometers and a staff gage in both Pond 1A and Pond 1B exist at Ash Pond 1. Readings are monitored in the plant's Dam Inspection Checklist.
5.	The lowest crest elevation for the Ash Pond 1 is 1570.0'.
16. & 20.	Pond 1A outfalls into Pond1B. Pond 1B outlets into a Reclaim Pond. Both pipes were completely submerged and not visible for inspection. The Reclaim Pond discharge is piped back to the plant to an onsite water treatment

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	facility for continued use onsite.
21.	The side hill embankment of Ash Pond 1 has an elaborate seepage control system, consisting of perforated pipe toe drains that run the length of the embankment, which collects seepage at several areas along the embankment either directly from cross drains or from v-notch weirs that collect seepage discharge. All seepage discharge originating from cross drains and v-notch weirs were notably clear and free of fines or sediment. A rate of discharge was not determined on the site visit; however, a completed quarterly inspection report, titled Dike Inspection Checklist, indicating flow rates for each v-notch weir has been requested. The north outside embankment groin was observed to be conveying some minor clear seepage flow. The south outside embankment groin was dry but was noted to have signs of erosion due to storm runoff.
*	An animal burrow was observed along the southern most part of the embankment of Pond 1A. The burrow was small in size and near the crest of the embankment.

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Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit N/A

INSPECTOR Scott Clarke, P.E. and Lorainne Ramos Nieves, P.E., CFM

Date February 17, 2011

Impoundment Name Ash Pond 1 (Ponds 1A /1B)

Impoundment Company AEP, Appalachian Power

EPA Region 3

State Agency (Field Office) Address Virginia Department of Conservation & Recreation, Division of Dam Safety and Floodplain Management; 8 Radford St., Suite 201 Christiansburg, VA 24073

Name of Impoundment Ash Pond 1 (Ponds 1A /1B)

(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: Settling pond for bottom ash disposal.

Nearest Downstream Town Name: St. Paul, VA

Distance from the impoundment: 6.0 mi.

Location:

Latitude	36	Degrees	56	Minutes	14.0	Seconds	**N**
Longitude	82	Degrees	11	Minutes	51.1	Seconds	**W**

State Virginia **County** Russell

	Yes	No
Does a state agency regulate this impoundment?	☒	☐

If So Which State Agency? Virginia DCR, Division of Dam Safety and Floodplain Management

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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:

Ash Pond 1 is adjacent to State Routes 616 and 665 as well as the Norfolk and Western Railway. In addition, the facility is located immediately upstream of Clinch River and Dump's Creek. The Clinch River Plant is located immediately south of the facility just across the Clinch River. A failure of this facility would impact State Route 616 and/or State Route 665 and potentially the existing railroad. While no probable loss of human life is expected, economic and environmental damage would be expected.

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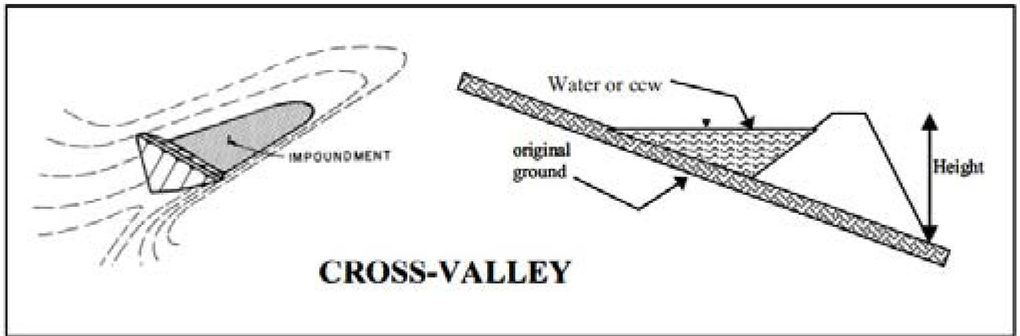
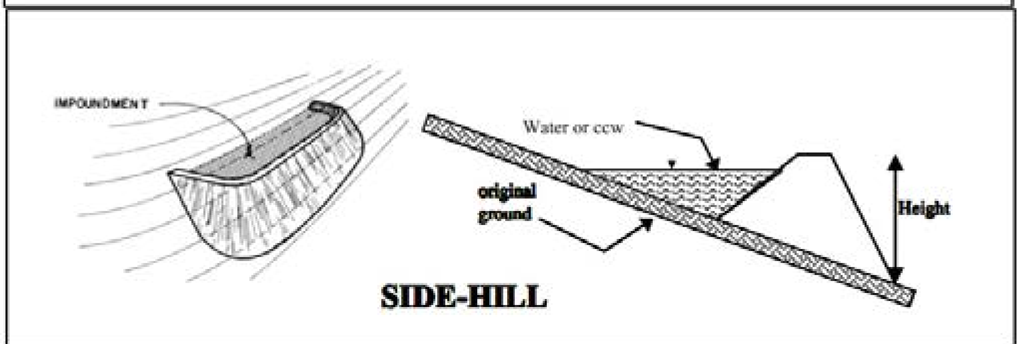
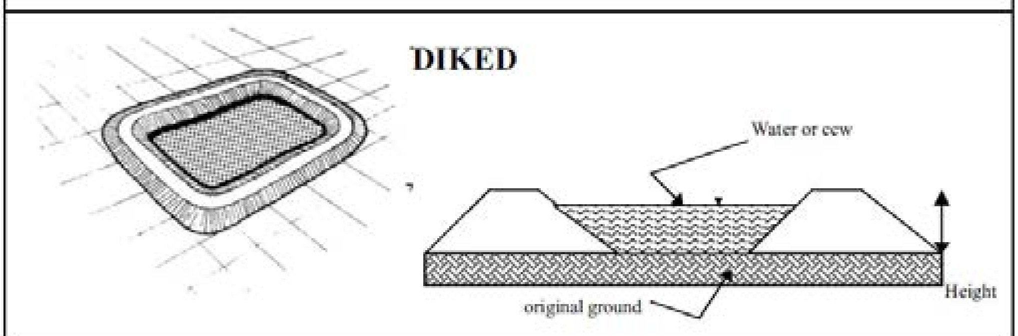
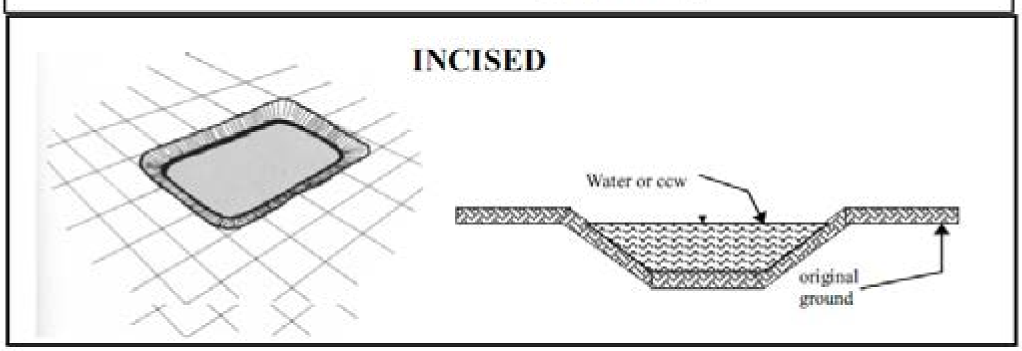
CONFIGURATION:









- [ ] Cross-Valley
- [x] Side-Hill
- [ ] Diked
- [ ] Incised (form completion optional)
- [ ] Combination Incised/Diked

Embankment Height (ft) 55 ft

Embankment Material Silty clay soil, mix. of shale and sandstone fragments, fly ash and bottom ash.

Pool Area (ac) 21 acre-ft

Liner None

Current Freeboard (ft) 5 ft/12 ft (Normal Freeboard)

Liner Permeability None

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TYPE OF OUTLET (Mark all that apply)

☐ **Open Channel Spillway**

☐ Trapezoidal

☐ Triangular

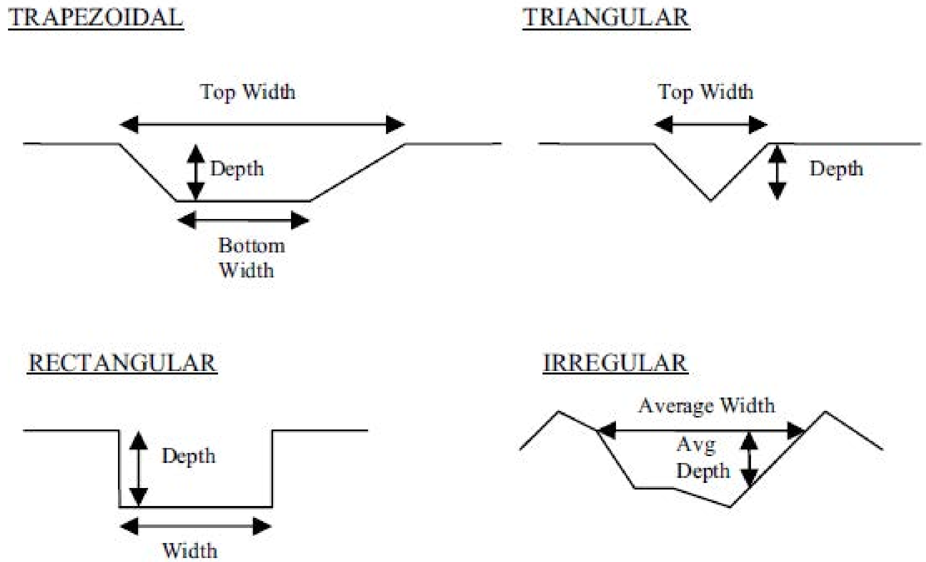
☐ Rectangular

☐ Irregular

depth (ft)

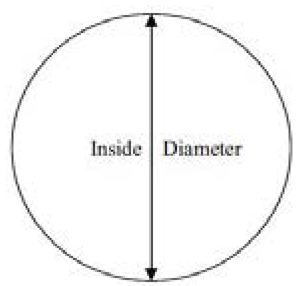
average bottom width (ft)

top width (ft)



☒ **Outlet**

30-inch inside diameter / Pond 1A
36-inch inside diameter / Pond 1B



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 **AEP Engineers**

	Yes	No
Has there ever been a failure at this site?	☐	☒
If So When?		

If So Please Describe :

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	Yes	No
Has there ever been significant seepages at this site?	☒	☐

If So When? On-going but mitigated

If So Please Describe :

The side hill embankment of Ash Pond 1 has an elaborate seepage control system, consisting of perforated pipe toe drains that run the length of the embankment, which collects seepage at several areas along the embankment either directly from cross drains or from v-notch weirs that collect seepage discharge. All seepage discharge originating from cross drains and v-notch weirs were notably clear and free of fines or sediment. A rate of discharge was not determined on the site visit; however, a completed quarterly inspection report, titled Dike Inspection Checklist, indicating flow rates for each v-notch weir has been requested. The north outside embankment groin was observed to be conveying some minor clear seepage flow.

	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 :

A soil-bentonite slurry wall was installed to depths of 60-65 feet along the center of the side hill embankment to help mitigate seepage occurring through the dike, particularly in high water conditions. Approximately 20 piezometers located both at the crest and near the toe of the embankment have been installed to monitor phreatic water table levels. The piezometers were placed on either side of the slurry wall; instrumentation placed on the inside of the slurry wall reaches elevations as high as water surface elevations and crest while those placed on the outside of the slurry wall go down to almost 5 feet from the toe of the embankment.

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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 plans or information were available at the time of the site visit regarding embankment foundation. Information has been requested from AEP and will be provided after clearing AEP legal.

Did the dam assessor meet with, or have documentation from, the design Engineer-of-Record concerning the foundation preparation?

The AEP Senior Civil Engineer and the AEP Geotechnical Engineer for the Clinch River Plant were both present during the site visit, however no plans or information were available at the time of the site visit regarding the design foundation preparation. Information has been requested from AEP and will be provided after clearing AEP legal.

From the site visit or from photographic documentation, was there evidence of prior releases, failures, or patchwork on the dikes?

No evidence of prior releases, failures, or patchwork on dikes could be noted at the time of the site visit.

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APPENDIX B

Document 19

Ash Pond 2, Dam Inspection Check List Form

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name:	**Clinch River Plant**	**Date:**	**February 17, 2011**
Unit Name:	**ASH POND 2 (Inactive)**	**Operator's Name:**	**Appalachian Power**
Unit I.D.:	**VA16702**	**Hazard Potential Classification:**	**High** ☐ **Significant** ☒ **Low** ☐
	Inspector's Name:	Scott Clarke, P.E. and Lorainne Ramos Nieves, P.E., CFM	

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.

Note: Comments regarding each issue number have been listed below as needed.

Issue #	Yes	No	Issue #	Yes	No
1. Frequency of Company's Dam Inspections?	✔		18. Sloughing or bulging on slopes?		✔
2. Pool elevation (operator records)?		✔	19. Major erosion or slope deterioration?		✔
3. Decant inlet elevation (operator records)?		✔	20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?		N/A	Is water entering inlet, but not exiting outlet?		N/A
5. Lowest dam crest elevation (operator records)?	✔		Is water exiting outlet, but not entering inlet?		N/A
6. If instrumentation is present, are readings recorded (operator records)?		✔	Is water exiting outlet flowing clear?		N/A
7. Is the embankment currently under construction?		✔	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)?		✔	From underdrain?	✔	
9. Trees growing on embankment? (If so, indicate largest diameter below)	✔		At isolated points on embankment slopes?	✔	
10. Cracks or scarps on crest?		✔	At natural hillside in the embankment area?		✔
11. Is there significant settlement along the crest?		✔	Over widespread areas?		✔
12. Are decant trashracks clear and in place?		N/A	From downstream foundation area?		✔
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?	✔		"Boils" beneath stream or ponded water?		✔
14. Clogged spillways, groin or diversion ditches?		N/A	Around the outside of the decant pipe?		✔
15. Are spillway or ditch linings deteriorated?		N/A	22. Surface movements in valley bottom or on hillside?		✔
16. Are outlets of decant or underdrains blocked?		✔	23. Water against downstream toe?	✔	
17. Cracks or scarps on slopes?		✔	24. Were Photos taken during the dam inspection?	✔	

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.	Impoundments are inspected quarterly by the plant personal, and annually through an outside consultant.
2.	Ash Pond 2 is currently inactive and on the day of the assessment had no pooling. According to quarterly inspections, titled Dike Inspection Checklist, a section of the upper level dike was removed in 1998 inhibiting the ability for the impoundment to pool water; no normal pool elevations were available for this impoundment.
5.	The lowest dam crest elevation would be equivalent to the upper level dike of the facility prior to it becoming inactive. The upper level crest elevation was 1570.0'.
9.	Along the remaining sections of the upper dike of Bottom Ash Pond 2 there is significant tree growth; largest tree size ranged from 12"- 18" diameter. Additionally, between the toe of the embankment and Dump's Creek there is

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	significant tree growth; largest tree size ranged from 18”- 24” diameter. Virginia DCR requires a 25 ft clear zone (i.e. no trees) beyond the toe of all impounding structures.
13.	Fissures/cracks were observed in an area near the outflow spillway structure on the surface of the impoundment where it was evident that local storm runoff had been draining to.
20.	Ash Pond 2 is currently inactive and on the day of the assessment had no significant pooling. In addition, the inlet of the overflow structure is located at an elevation significantly higher than the current finished grade inside the remaining sections of the upper dike. Discharge through the overflow structure and outfall pipes is not possible at this time.
21.	The entire side-hill embankment of the Ash Pond 2 has a seepage control system, consisting of perforated pipe toe drains that run the length of the embankment, which collects seepage along the crest of the lower level dike. Seepage discharge originating from the toe drain was not accessible/visible during the site visit and although a rate of discharge for ongoing seepage was not determined, the plant personal did indicate that minimal seepage, possibly due to high ground water elevations, outfalls into Dump’s Creek under a general NPDES permit.
23.	Ash Pond 2 has Dumps Creek running along the entire stretch of its embankment.
*	An animal burrow was observed along the middle level dike of Ash Pond 2. The burrow was small in size and near the crest of the embankment.

Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit	VA 0001015 / Outfall 015	**INSPECTOR**	Scott Clarke, P.E. and Lorainne Ramos Nieves, P.E., CFM

Date February 17, 2011
Impoundment Name Ash Pond 2 (Inactive)

Impoundment Company AEP, Appalachian Power
EPA Region 3

State Agency (Field Office) Address Virginia Department of Conservation & Recreation, Division of Dam Safety and Floodplain Management; 8 Radford St., Suite 201 Christiansburg, VA 24073
Name of Impoundment Ash Pond 2 (Inactive)

(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: Settling pond for bottom ash disposal.

Nearest Downstream Town Name: St. Paul, VA

Distance from the impoundment: 6.0 mi.

Location:

Latitude	36	Degrees	56	Minutes	18.6	Seconds	**N**
Longitude	82	Degrees	11	Minutes	27.0	Seconds	**W**

State Virginia **County** Russell

	Yes	No
Does a state agency regulate this impoundment?	☒	☐

If So Which State Agency? Virginia DCR, Division of Dam Safety and Floodplain Management / Virginia DEQ

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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:

Ash Pond 2 is adjacent to State Routes 616 as well as the Norfolk and Western Railway. In addition, the facility is located immediately upstream of Dumps Creek and Clinch River. The Clinch River Plant is located immediately south of the facility just across the Clinch River. A failure of this facility would impact State Route 616 and/or potentially the existing railroad. While no probable loss of human life is expected, economic and environmental damage would be expected.

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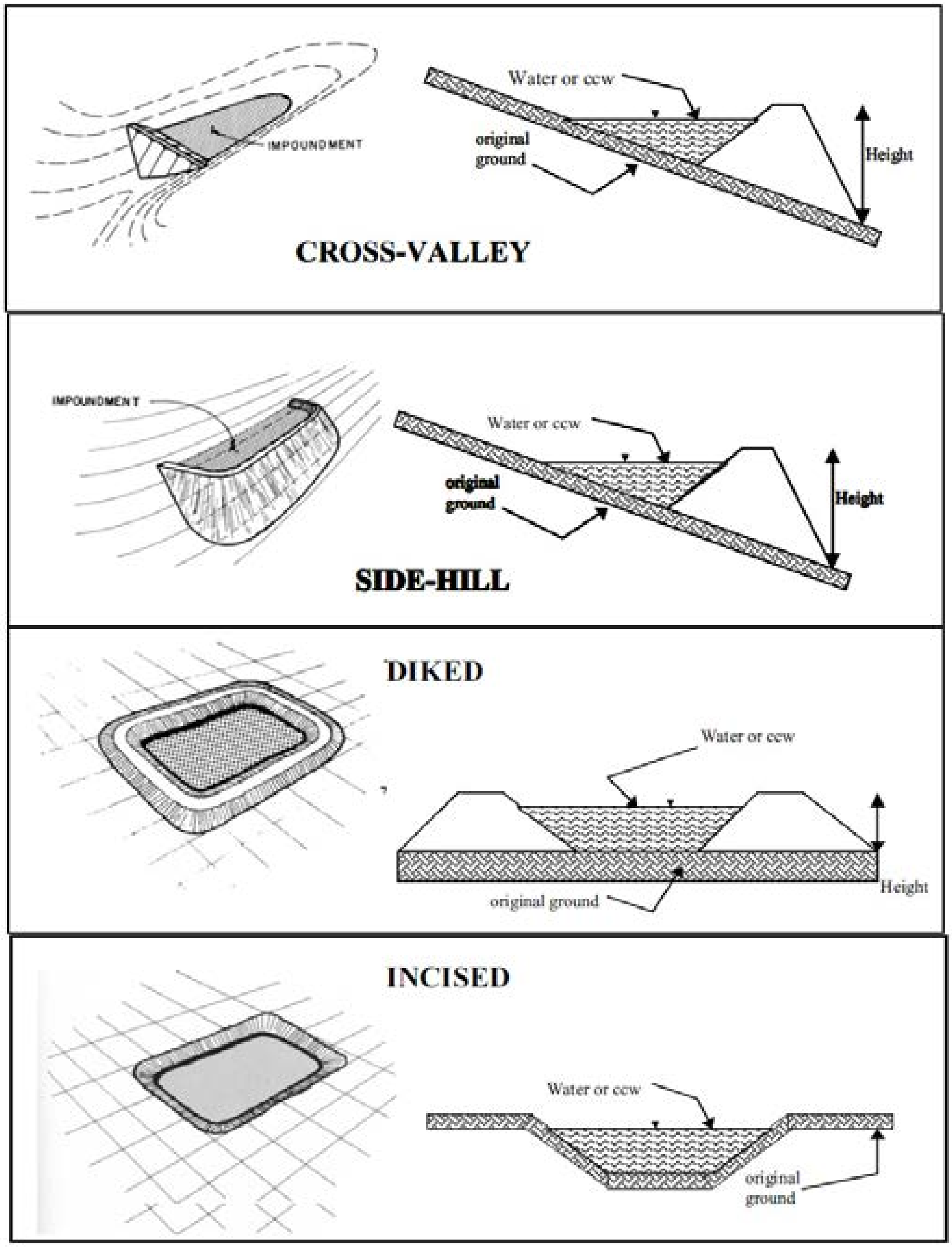
CONFIGURATION:



- ☐ Cross-Valley
- ☒ Side-Hill
- ☐ Diked
- ☐ Incised (form completion optional)
- ☐ Combination Incised/Diked

Embankment Height (ft)	56 ft	**Embankment Material**	Shale fragments, silty clay, clayey silt and sand.
Pool Area (ac)	12.5 acre-ft	**Liner**	None
Current Freeboard (ft)	N/A	**Liner Permeability**	None

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TYPE OF OUTLET (Mark all that apply)

[ ] **Open Channel Spillway**

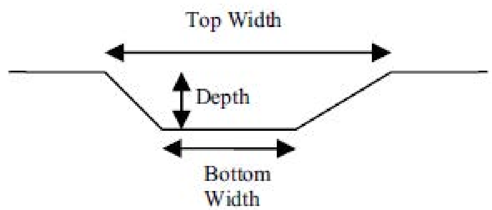
- [ ] Trapezoidal
- [ ] Triangular
- [ ] Rectangular
- [ ] Irregular

depth (ft)

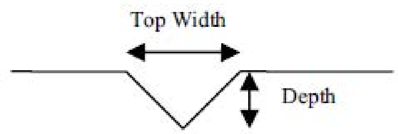
average bottom width (ft)

top width (ft)

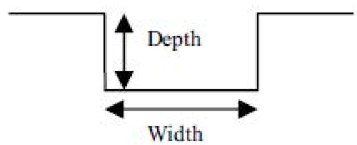
TRAPEZOIDAL



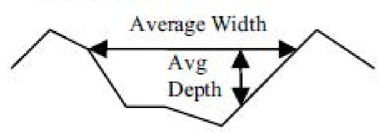
TRIANGULAR



RECTANGULAR

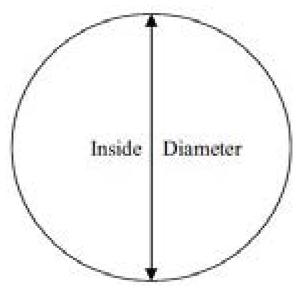


IRREGULAR



[x] **Outlet**

30” inside diameter



Material

- [ ] corrugated metal
- [ ] welded steel
- [x] concrete
- [ ] plastic (hdpe, pvc, etc.)
- [ ] other (specify):

	Yes	No
Is water flowing through the outlet?	[ ]	[x]

[ ] **No Outlet**

[ ] **Other Type of Outlet** (specify):

The Impoundment was Designed By **AEP Engineers**

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	Yes	No
Has there ever been a failure at this site?	☒	☐

If So When? 1967

If So Please Describe :

Minimal information regarding the failure of the Ash Pond 2 is said to have been recorded. According to AEP, plant records do not indicate the cause of failure or the extent of damages to the affected areas. No photographs were available of the failure and its aftermath; however, the failure is said to have occurred near the northern end of the embankment and may have been due to seepage. In addition to the location and possible cause of the failure, the impact on aquatic wildlife in Dump's Creek and Clinch River was recalled to have been extensive. Any additional information that can be compiled has been requested from AEP.

	Yes	No
Has there ever been significant seepages at this site?	☒	☐
If So When?	Minor, on-going	

If So Please Describe :

The side-hill embankment of Ash Pond 2 has a seepage control system, consisting of perforated pipe toe drains that run the length of the embankment, which collects seepage along the crest of the lower level dike. Seepage discharge originating from the toe drain was not accessible/visible during the site visit and although a rate of discharge for ongoing seepage was not determined, the plant personal did indicate that minimal seepage, possibly due to high ground water elevations, is collected from the system and outfalls into Dump's Creek under a general NPDES permit.

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	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 :

Approximately 14 piezometers are located both at the crest and near the toe of both the lower and middle level dikes of the Ash Pond 2 embankment. These piezometers were installed to monitor phreatic water table levels while the pond was active. A design summary for final closure indicates a 15-20 ft drop in the phreatic water levels for this impoundment in 2008. As previously noted, this impoundment is inactive and no record of instrumentation readings or monitoring is kept.

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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 plans or information were available at the time of the site visit regarding embankment foundation. Information has been requested from AEP and will be provided after clearing AEP legal.

Did the dam assessor meet with, or have documentation from, the design Engineer-of-Record concerning the foundation preparation?

The AEP Senior Civil Engineer and the AEP Geotechnical Engineer for the Clinch River Plant were both present during the site visit, however no plans or information were available at the time of the site visit regarding the design foundation preparation. Information has been requested from AEP and will be provided after clearing AEP legal.

From the site visit or from photographic documentation, was there evidence of prior releases, failures, or patchwork on the dikes?

No evidence of prior releases, failures, or patchwork on dikes could be noted at the time of the site visit.