# REPORT ON RAILWAY-INDUCED GROUND VIBRATIONS FLY ASH DISPOSAL FACILITY AND BOTTOM ASH DISPOSAL FACILITY PHILIP SPORN POWER PLANT NEW HAVEN, WEST VIRGINIA NPDES NO. WV0001058

**Prepared For:**

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

**Prepared By:**

Geo/Environmental Associates, Inc.
3502 Overlook Circle
Knoxville, Tennessee 37909

GA File No. 09-387
May 27, 2010

GA

# REPORT ON RAILWAY-INDUCED GROUND VIBRATIONS
# FLY ASH DISPOSAL FACILITY AND BOTTOM ASH DISPOSAL FACILITY
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May 27, 2010

American Electric Power
1 Riverside Plaza
Columbus, Ohio 43215-2373

Attn.: Mr. Pedro J. Amaya, P.E.

RE: Report on Railway-Induced Ground Vibrations for
Fly Ash Disposal Facility and Bottom Ash Disposal Facility
Philip Sporn Power Plant
New Haven, Mason County, West Virginia
NPDES No. WV0001058
GA File No. 09-387

Dear Mr. Amaya:

At the request of American Electric Power (AEP), Geo/Environmental Associates, Inc. (GA) has prepared a report summarizing the impact of railway-induced ground vibrations on the dikes for the Fly Ash Disposal Facility and the Bottom Ash Disposal Facility at the Philip Sporn Power Plant. Specifically, this report is in response to the United States Environmental Protection Agency's (USEPA) request for information, Items 2a through 2s, issued in a letter dated November 13, 2009. Provided herein is the response addressing each of the USEPA's information requests for Items 2a through 2s. A copy of the November 13, 2009 letter in which the USEPA requests information is provided in Appendix I. Additionally, railway information and vibration data, laboratory and field testing data, slope stability analyses, liquefaction analyses, drawings, and references are provided in Appendices II through VII.

## BACKGROUND

### General

The Sporn Fly Ash and Bottom Ash Disposal Facilities are maintained and operated by American Electric Power to support disposal of ash generated at the Philip Sporn Power Plant. The site is located near the town of New Haven in Mason County, West Virginia. The Fly Ash Disposal Facility (i.e., Section H-H crest on the Western Dike) is located at approximate coordinates North 38° 58' 18", West 81° 55' 59". The Fly Ash Disposal Facility is bounded by the Mountaineer Power Plant on its north side; the Ohio River on its east side; the Bottom Ash

Disposal Facility and coal yard on its south side; and the CSX Rail Line and West Virginia State Route 62 on its west side. The Bottom Ash Disposal Facility (i.e., Section A-A crest on the Western Dike) is located at approximate coordinates N 38° 58' 05", W 81° 55' 45". The Bottom Ash Disposal Facility is bounded by the Clearwater Pond and Fly Ash Disposal Facility on its north side; the coal yard and the Ohio River on its east side; Philip Sporn Power Plant on its south side; and the CSX Rail Line and West Virginia State Route 62 on its west side.

## Fly Ash Disposal Facility

The Sporn Plant Fly Ash Disposal Facility generally consists of an above ground fly ash pond contained by four dikes (i.e., the Northern, Eastern, Southern, and Western dikes). Original construction of the dikes was conducted in 1959. Dike raisings and/or extensions were conducted at the Fly Ash Disposal Facility in 1965, 1968, and in 1972. The Southern, Western, and Northern Dikes are founded primarily on residual clay and silt materials. The original construction for the Eastern Dike is founded primarily on residual clay and silt materials. However, the upper portion of the Eastern Dike is constructed/founded primarily on fly ash that was hydraulically placed in the pond prior to 1972. Between 1996 and 2002, AEP implemented modifications to the Eastern Dike to address seepage observed on the exterior face of the dike and to improve the overall stability conditions of the slopes. In general, for the improvements, the company installed drainage collection provisions and regraded/buttressed the exterior slopes. A detailed historical review and design related to the 1996 through 2002 modifications to the Fly Ash Disposal Facility were provided in the AEP report *Philip Sporn Electric Generation Plant, Unit 5 Fly Ash Facility*, prepared in 1996. As indicated by the as-built topography shown on the Site Map drawing in Appendix VI: (1) the Northern Dike has an as-built crest ranging in elevation from about 612 feet, NGVD to about 620 feet, NGVD; (2) the Eastern Dike has an as-built crest of about 620 feet, NGVD; (3) the Southern Dike has an as-built crest ranging in elevation from about 612 feet, NGVD to about 620 feet, NGVD; and (4) the Western Dike has an as-built crest ranging in elevation from about 610 feet, NGVD to about 612 feet, NGVD.

Fly ash generated at the Philip Sporn Power Plant – Unit 5 is sluiced to and temporarily disposed in the Fly Ash Disposal Facility; where after, it is excavated and hauled for dry disposal into AEP's Little Broad Run Landfill. AEP maintains an operating pool level of approximately 605 feet, NGVD in the fly ash pond. A plan view drawing (i.e., Site Map) of the Fly Ash Disposal Facility is provided in Appendix VI.

## Bottom Ash Disposal Facility

The Bottom Ash Disposal Facility was built in 1948 to provide disposal capacity for bottom ash generated at the Philip Sporn Power Plant. In general, the Bottom Ash Disposal Facility consists of three dikes (i.e., the Northern, Eastern, and Western Dikes) which impound the bottom ash pond and the clearwater pond. The 1948 dikes were constructed on silty sand and/or silty clay original ground. Since the initial 1948 construction, the Bottom Ash Disposal Facility dikes have been raised/extended several times to achieve the as-built configuration shown on the plan view drawing provided in Appendix VI. Modifications to improve the overall stability of the Bottom Ash Disposal Facility dike slopes were implemented between 1996 and 2002. A detailed historical review and designs related to the 1996 through 2002 modifications are provided in the report *Philip Sporn Electric Generation Plant, Bottom Ash Facility*, prepared by AEP in 1996. As indicated by the as-built mapping shown on the plan view drawing in Appendix VI: (1) the Northern Dike (i.e., between the bottom ash pond and the clearwater pond) has an as-built crest ranging in elevation from about 593 feet, NGVD to about 598 feet, NGVD; (2) the Eastern Dike has an as-built crest ranging in elevation from about 594 feet, NGVD to about 598 feet, NGVD; (3) the Western Dike has an as-built crest elevation of about 594 feet, NGVD. The Bottom Ash Disposal Facility's bottom ash pond is generally maintained at or below an operating pool level of 583 feet, NGVD.

## CSX Transportation Railway Network Line

A railway line is located adjacent to the exterior (i.e. downstream) toes of the Fly Ash Disposal Facility and the Bottom Ash Disposal Facility Western Dikes. The adjacent railway is a CSX Transportation (CSX) rail network line that extends from Huntington, West Virginia to Parkersburg, West Virginia. Railway traffic for this line ranges from light high-rail vehicles to trains transporting tanker cars, industrial cargo cars, and coal cars. Based on discussions with personnel at CSX Huntington Division Headquarters, 2 to 4 trains generally travel the rail line between Huntington and Parkersburg each day. This information is consistent with the amount of rail traffic that was observed by GA while conducting onsite field studies and based on general observations made by AEP site personnel. However, as described in a November 9, 2009 letter issued by CSX (provided in Appendix II), train schedules and frequencies are not available to the general public. The main railway line superstructure consists of a typical railway roadbed composed of ballast and a single standard railway track running adjacent to the toe of the western dikes. Siding splits occur just south of the Bottom Ash Disposal Facility and near the northwest corner of the Fly Ash Disposal Facility. The siding at the northwest corner of the Fly Ash Disposal Facility extends adjacent to the exterior toe along a portion of the Fly Ash

Disposal Facility Northern Dike. A maximum speed limit (i.e., a slow order) of 25 miles per hour is in effect for the railway lines adjacent to the ash disposal facilities. The locations of the railway and the associated sidings are shown on the plan view drawing provided in Appendix VI.

In order to provide additional information for the USEPA pursuant to their November 13, 2009 letter, AEP has requested that GA evaluate the impact of railway vibrations on the Fly Ash Disposal and Bottom Ash Disposal Facilities. Correspondingly, we have conducted detailed field testing and engineering analyses on three critical sections. Specifically, we have evaluated the impact of railway vibrations on the Fly Ash Disposal Facility Eastern Dike Section K-K, the Fly Ash Disposal Facility Western Dike Section H-H, and the Bottom Ash Disposal Facility Western Dike Section A-A. Provided herein are itemized responses to each of the USEPA's requests regarding the railway vibration assessment.

## RESPONSES TO USEPA REQUEST FOR INFORMATION – ITEMS 2a TO 2s

Provided herein are USEPA Information Request Items 2a through 2s and corresponding responses prepared by GA. For completeness, the November 13, 2009 letter containing the information requests is provided in Appendix I. Background information, data, and analyses supporting the responses provided herein are included in Appendices II through VII.

### Information Request Item 2a

*Provide a description of the site including a site map depicting the location of the railway superstructure, embankments and other planimetric and topographic features.*

### Response to Item 2a

A site description is provided in the preceding Background & Site Description section of this document. A site map depicting the location of the railway superstructure, embankments, and other planimetric and topographic features is provided in Appendix VI.

### Information Request Item 2b

*Provide description, procedures and summary of field measurements of railway induced ground vibrations generated by loaded railway traffic under dynamic conditions at various speeds and stopping conditions.*

**Response to Item 2b**

Railway vibration monitoring was conducted at the site on November 11, 2009, January 6, 2010, and January 7, 2010. The vibration monitoring was performed by Michael E. Kalinski, Ph.D. (Dr. Kalinski), from the University of Kentucky in Lexington, Kentucky. In general, the vibration monitoring was conducted using seismographs installed at the following six locations:

- Downstream (exterior) toe of Bottom Ash Disposal Facility Western Dike Section A-A (Location A).
- Crest of Bottom Ash Disposal Facility Western Dike Section A-A (Location B).
- Downstream (exterior) toe of Fly Ash Disposal Facility Western Dike Section H-H (Location C).
- Crest of Fly Ash Disposal Facility Western Dike Section H-H (Location D).
- Crest of Fly Ash Disposal Facility Eastern Dike Section K-K (Location E).
- Downstream (exterior) bench of Fly Ash Disposal Facility Eastern Dike Section K-K (Location F).

Vibration monitoring Locations A through F are shown on the site map and section drawings provided in Appendix VI. A detailed discussion of the monitoring procedures, a summary of field measurements, and digital data is provided in Appendix II. As shown in the vibration monitoring data, peak particle velocities and accelerations related to railway traffic were measured at Locations A and B on the Western Dike of the Bottom Ash Disposal Facility and at Locations C and D on the Western Dike of the Fly Ash Disposal Facility. No vibrations due to railway traffic were detected at Location E or at Location F on the Eastern Dike of the Fly Ash Disposal Facility. Therefore, the critical sections assessed herein are the Bottom Ash Disposal Facility Western Dike Section A-A and the Fly Ash Disposal Facility Western Dike Section H-H. No additional analyses are provided herein for the Eastern Dike of the Fly Ash Disposal Facility because railway induced vibrations are non-detectable for this dike.

**Information Request Item 2c**

*Provide description, procedures and summary of field exploration and laboratory tests of in-situ subsurface conditions, including, but not limited to:*

i. *soil test & instrumentation location map;*
ii. *cross-sectional geometry of embankment sections depicting phreatic surface; and*
iii. *soil test boring logs and laboratory analyses of soil testing.*

**Response to Item 2c**

GA coordinated/conducted subsurface exploration, instrumentation installation, field testing, and laboratory testing for the Bottom Ash Disposal Facility and the Fly Ash Disposal Facility to use in the vibration assessment. Specifically, GA coordinated subsurface exploration and instrumentation installation performed by Horn and Associates, Inc. (Horn) from December 10, 2009 through December 18, 2009. GA coordinated field geophysical testing (i.e., on January 6 and 7, 2010) and laboratory testing conducted by Dr. Kalinski. GA conducted on-site laboratory testing concurrent with the drilling operations, as well as laboratory testing at our office in Knoxville, Tennessee. Additionally, in our vibration assessment, we applied subsurface exploration data and laboratory testing data that was previously developed by AEP. A summary of the subsurface exploration, instrumentation, field testing, and laboratory testing as related to the vibration analyses is provided herein. Field and laboratory data developed by Dr. Kalinski is provided in Appendix II. Field data from the subsurface exploration conducted by Horn and laboratory data developed by GA is provided in Appendix III.

Subsurface Exploration

As coordinated by GA, Horn drilled nine boreholes at the site. Boreholes GA-1A, GA-1B, GA-1C, and GA-1D were drilled at the crest of the Fly Ash Disposal Facility in the general vicinity of Eastern Dike Section K-K. Boreholes GA-2 and GA-3 were drilled in the Fly Ash Disposal Facility Eastern Dike. Boreholes GA-4A, GA-4B, and GA-4C were drilled at the crest of the Bottom Ash Disposal Facility in the Western Dike, near Section A-A. Borehole locations are shown on the site map and section drawings provided in Appendix VI.

In general the boreholes were sampled in accordance with ASTM D1586 (Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils) at varying sampling intervals. In addition, undisturbed soil samples were obtained in accordance with ASTM D6519 (Standard Practice for Sampling of Soil Using the Hydraulically Operated Stationary Piston Sampler). Upon retrieval, selected samples were immediately subjected to on-site laboratory testing. Thereafter, all samples were prepared and transported to GA's laboratory in Knoxville, Tennessee for further testing.

Detailed logs were developed for each of the boreholes and are provided in Appendix III. Additionally, graphical borehole logs are provided in Appendix III.

Instrumentation

At the completion of boreholes GA-1A, GA-1B, GA-1C, GA-4A, GA-4B, and GA-4C; Horn installed 70 mm Durham Geo Slope Indicator (DGSI) inclinometer casing in each hole in order to implement crosshole seismic testing. The DGSI inclinometer casing was installed and grouted full length (i.e., in accordance with ASTM D4428 - Standard Test Methods for Crosshole Seismic Testing) in order to accommodate the crosshole seismic testing. Thereafter, GA conducted a downhole inclinometer survey to evaluate the orientation and deviation in the boreholes. The results of the downhole inclinometer survey are provided in Appendix III. Additionally, Horn installed a 1-inch diameter standpipe piezometer in borehole GA-1D. In order to measure the potential piezometric level at any location in the fly ash deposit in which it was installed, standpipe piezometer GA-1D consisted of a pre-packed sand screen that extended through the length of the fly ash. Initial piezometric level readings for the standpipe piezometer are provided on the borehole logs provided in Appendix III.

Field Testing

In addition to the vibration monitoring, GA coordinated geophysical field testing conducted by Dr. Kalinski at the site on January 6 and 7, 2010. Specifically, Dr. Kalinski conducted crosshole seismic testing (i.e., in general accordance with ASTM D4428 - Standard Test Methods for Crosshole Seismic Testing) at boreholes GA-1A, GA-1B, and GA-1C through the Eastern Dike of the Fly Ash Disposal Facility and at boreholes GA-4A, GA-4B, and GA-4C through the Western Dike of the Bottom Ash Disposal Facility. The crosshole seismic testing was done to develop shear wave velocity and Poisson's ratio data for the embankment cross-sections. Results of the geophysical field testing conducted by Dr. Kalinski are provided in Appendix II.

Laboratory Testing

Laboratory testing was conducted on field samples obtained during the subsurface exploration phase of the program. Specifically, split-spoon and undisturbed piston samples obtained during the drilling operations were subjected to testing both at an on-site laboratory and at GA's Knoxville, Tennessee laboratory. In general, the laboratory testing consisted of:

1. in-place moisture and density determination of undisturbed fly ash piston samples;
2. specific gravity determination of undisturbed fly ash piston samples;
3. void ratio determination of undisturbed fly ash piston samples;
4. grain-size analyses on fly ash, bottom ash, and foundation soils;
5. Atterberg limit determination on fly ash and foundation soils;

6. Permeability testing on fly ash and foundation soils; and
7. Consolidated undrained triaxial strength testing with pore pressure measurements on fly ash and foundation soils.

Laboratory testing summary sheets and data developed by GA are provided in Appendix III. Additional laboratory testing data used in the vibration assessment included:

1. Damping ratio measurements conducted by Dr. Kalinski at the University of Kentucky. Specifically, Dr. Kalinski conducted free-free resonant column testing to measure the damping ratio for site fly ash and foundation soils. Measured damping ratios are presented in Dr. Kalinski's March 8, 2010 report provided in Appendix II.
2. Cyclic triaxial testing data developed by Ohio State University using reconstituted fly ash bulk samples obtained from the site. For the testing, the fly ash materials were reconstituted to an initial minimum density of 62 pounds per cubic feet, as measured for the in-place density during on-site laboratory testing of undisturbed fly ash piston tube samples. The Cyclic Stress Ratio (CSR) graph developed during the cyclic triaxial strength testing of the fly ash material is provided in Appendix III.
3. Pertinent laboratory data provided by AEP from historical sampling and laboratory testing performed on site materials. For reference, copies of the pertinent AEP laboratory data, as used in the vibration analyses, is provided in Appendix III.

## Information Request Item 2d

*Provide description, procedures and summary of slope stability analysis including but not limited to:*

- *i. soil strength parameters modeled and basis of values used;*
- *ii. loading conditions modeled from measured railway-induced ground vibrations generated by railway traffic;*
- *iii. factors of safety against shallow slope failures and global instability.*

## Response to Item 2d

### General

The computer programs *SLOPE/W* and *QUAKE/W* were used to analyze the slope stability along Section A-A of the Bottom Ash Disposal Facility Western Dike and along Section H-H of the Fly Ash Disposal Facility Western Dike. *SLOPE/W* and *QUAKE/W* are developed by GEO-SLOPE International, Ltd. of Calgary, Alberta, Canada. Specifically, the Morgenstern-Price limit equilibrium method (LEM) and the *QUAKE/W* finite element stress method (FESM) were used to evaluate the shallow-seated and deep-seated (global) stability of each critical slope in both an upstream and downstream direction. Phreatic levels used in these analyses were provided by AEP, and are based on *SEEP/W* finite element analyses and field measured piezometric levels developed for slope stability reports prepared by the company in 2009.

The LEM slope stability analyses were conducted using pseudo-static loading conditions for the maximum railway induced ground accelerations measured at the vibration monitoring locations. We conservatively applied the accelerations from the dike exterior toe vibration monitoring locations (i.e., Location A for Section A-A and Location C for Section H-H) to the downstream direction LEM slope stability analyses and we applied the accelerations from the dike crest monitoring locations (i.e., Location B for Section A-A and Location D for Section H-H) to the upstream direction LEM slope stability analyses. A summary of the accelerations used in the LEM pseudo-static analyses is provided in Table 1.

**TABLE 1**
**SUMMARY OF ACCELERATIONS USED IN**
**LIMIT EQUILIBRIUM METHOD PSEUDO-STATIC SLOPE STABILITY ANALYSES**

| Critical Section | Vibration Monitoring Location | Maximum Acceleration (g's) | |
|---|---|---|---|
| | | Horizontal | Vertical |
| Bottom Ash Disposal Facility Section A-A | Location A<br>(Exterior Toe - Adjacent to Track)<br>Downstream Direction Analyses | 0.033 | 0.008 |
| | Location B<br>(Crest)<br>Upstream Direction Analyses | 0.013 | 0.002 |
| Fly Ash Disposal Facility Section H-H | Location C<br>(Exterior Toe - Adjacent to Track)<br>Downstream Direction Analyses | 0.046 | 0.008 |
| | Location D<br>(Crest)<br>Upstream Direction Analyses | 0.010 | 0.003 |

The FESM slope stability analyses were conducted by applying the time-acceleration history data generated during the railway induced vibration events (i.e., as measured by Dr. Kalinski, provided in Appendix II) to the initial stress conditions generated using the *QUAKE/W* finite element computer program. GA conducted the FESM slope stability analyses using the maximum vibration data from each monitoring location. We conservatively applied the maximum vibration data from the dike exterior toe vibration monitoring locations (i.e., Location A for Section A-A and Location C for Section H-H) to the downstream direction FESM slope stability analyses and we applied the maximum vibration data from the dike crest vibration monitoring locations (i.e., Location B for Section A-A and Location D for Section H-H) to the upstream direction FESM slope stability analyses. A summary of the railway induced vibration data as applied in the FESM slope stability analyses is provided in Table 2.

**TABLE 2**
**SUMMARY OF RAILWAY INDUCED VIBRATION DATA USED IN FINITE ELEMENT STRESS METHOD SLOPE STABILITY ANALYSES**

| Critical Section | Vibration Monitoring Location | Maximum Railway Induced Vibration Data Used |
|---|---|---|
| Bottom Ash Disposal Facility<br>Section A-A | Location A<br>(Exterior Toe - Adjacent to Track)<br>Downstream Direction Analyses | November 11, 2009<br>12:12 pm Train<br>10 sec. to 20 sec. |
| | Location B<br>(Crest)<br>Upstream Direction Analyses | November 11, 2009<br>12:12 pm Train<br>16 sec. to 26 sec. |
| Fly Ash Disposal Facility<br>Section H-H | Location C<br>(Exterior Toe - Adjacent to Track)<br>Downstream Direction Analyses | November 11, 2009<br>12:12 pm Train<br>36 sec. to 46 sec. |
| | Location D<br>(Crest)<br>Upstream Direction Analyses | November 11, 2009<br>12:12 pm Train<br>0 sec. to 5.5 sec. |

Material Parameters

Material parameters used in the LEM and FESM slope stability analyses are based on site specific data or from using accepted reference materials in relation to the site specific soils/conditions. The strength properties used in the LEM slope stability analyses are based on the parameters AEP developed for Section A-A of the Bottom Ash Disposal Facility and Section H-H of the Fly Ash Disposal Facility, as provided in their 1998 and 2009 stability assessment

reports. A detailed summary of the material parameters used in the LEM analyses and the respective data sources are provided in Tables IV-2 and IV-3, in Appendix IV.
In general, the dynamic properties used in the FESM analyses were selected based on laboratory testing of site specific soil materials and/or field testing. A detailed summary of the material parameters used in the FESM analyses and the respective data sources are provided in Tables V-2 and V-3, in Appendix V.

Summary of Safety Factors and Stability Factors
*SLOPE/W* was used to calculate LEM slope stability analyses safety factors and FESM slope stability analyses stability factors. As described in *Stability Modeling with SLOPE/W©2007*, the LEM safety factor is defined as "the factor by which the shear strength of the soil must be reduced in order to bring the mass of the soil into a state of limiting equilibrium along a selected slip surface." Whereas, the FESM stability factor is defined as "the ratio of the summation of the available resisting shear force $S_r$ along a slip surface to the summation of the mobilized shear force $S_m$ along a slip surface." Slope stability safety factors and stability factors were generated for both the Bottom Ash Disposal Facility Section A-A and the Fly Ash Disposal Facility Section H-H. A summary of the stability analysis results for each of the evaluated conditions is provided in Table 3. *SLOPE/W* data and graphical plots generated for the LEM slope stability analyses are provided in Appendix IV. *SLOPE/W* data and graphical plots generated for the FESM slope stability analyses are provided in Appendix V.

As shown in Table 3, LEM safety factors and FESM stability factors were calculated for shallow-seated and deep-seated slip surface conditions. The LEM safety factors equal or exceed 1.70 for the Bottom Ash Disposal Facility Section A-A and 1.40 for the Fly Ash Disposal Facility Section H-H for the shallow-seated slip surface conditions. Moreover, the LEM safety factors equal or exceed 2.02 for the Bottom Ash Disposal Facility Section A-A and 1.65 for the Fly Ash Disposal Facility Section H-H for the deep-seated (global) slip surface conditions. The FESM stability factors equal or exceed 2.68 for the Bottom Ash Disposal Facility Section A-A and 1.78 for the Fly Ash Disposal Facility Section H-H for the shallow-seated slip surface conditions. The FESM safety factors equal or exceed 2.72 for the Bottom Ash Disposal Facility Section A-A and 2.12 for the Fly Ash Disposal Facility Section H-H for the deep-seated (global) slip surface conditions. Based on the results obtained in our stability assessment, we believe that the railway vibrations will not have a significant/consequential impact on the slope stability of the dikes for the Bottom Ash and Fly Ash Disposal Facilities.

| TABLE 3<br>SUMMARY OF LEM SAFETY FACTORS AND FESM STABILITY FACTORS | | | | |
|---|---|---|---|---|
| **Critical Section** | **Analysis Method** | **Pseudo-static or Rail Induced Vibration Loading Condition** | **Slope and Slip Surface Condition** | **Safety Factor or Stability Factor** |
| Bottom Ash Disposal Facility Section A-A | LEM | Location A (Exterior Toe) ($a_h = 0.033g$, $a_v = 0.008g$) | Downstream (Shallow) | 2.96 |
| | | | Downstream (Deep) | 3.08 |
| | | Location B (Crest) ($a_h = 0.013g$, $a_v = 0.002g$) | Upstream (Shallow) | 1.70 |
| | | | Upstream (Deep) | 2.02 |
| | FESM | Location A (Exterior Toe) (11-11-09 12:12 pm Train) | Downstream (Shallow) | 4.06 |
| | | | Downstream (Deep) | 4.25 |
| | | Location B (Crest) (11-11-09 12:12 pm Train) | Upstream (Shallow) | 2.68 |
| | | | Upstream (Deep) | 2.72 |
| Fly Ash Disposal Facility Section H-H | LEM | Location C (Exterior Toe) ($a_h = 0.046g$, $a_v = 0.008g$) | Downstream (Shallow) | 1.84 |
| | | | Downstream (Deep) | 2.15 |
| | | Location D (Crest) ($a_h = 0.010g$, $a_v = 0.003g$) | Upstream (Shallow) | 1.40 |
| | | | Upstream (Deep) | 1.65 |
| | FESM | Location C (Exterior Toe) (11-11-09 12:12 pm Train) | Downstream (Shallow) | 2.66 |
| | | | Downstream (Deep) | 2.75 |
| | | Location D (Crest) (11-11-09 12:12 pm Train) | Upstream (Shallow) | 1.78 |
| | | | Upstream (Deep) | 2.12 |

## Information Request Item 2e

*Evaluate the potential liquefaction of fly ash under the raised eastern dike of the Fly Ash Pond from instantaneous, as well as long term exposure, to railway induced ground vibrations from the west side of the Fly Ash Pond.*

## Response to Item 2e

Vibration monitoring conducted at the crest and at the downstream bench of the Fly Ash Disposal Facility Eastern Dike (i.e., along Section K-K) yielded non-detectable vibration levels due to rail traffic during three monitoring events (i.e., on November 11, 2009; January 6, 2010; and January 7, 2010). As such, we conclude that the Eastern Dike of the Fly Ash Disposal Facility is not subjected to instantaneous exposure, nor will it be subjected to long-term exposure to railway induced vibrations. Correspondingly, we believe that liquefaction of the fly ash material under the raised Eastern Dike of the Fly Ash Disposal Facility, due to railway induced ground vibration, is improbable.

**Information Request Item 2f**

*Evaluate the potential liquefaction of fly ash under the raised eastern dike of the Fly Ash Pond from train collision and derailment on the west side of the Fly Ash Pond.*

**Response to Item 2f**

We understand that the USEPA has released AEP from the responsibility of addressing Item 2f of the information request. As such, GA has removed this item from the scope of our assessment.

**Information Request Item 2g**

*Determine the root cause of apparent shallow sloughing of the dike slopes.*

**Response to Item 2g**

GA has evaluated the shallow sloughing conditions that were observed on the exterior face of the Fly Ash Disposal Area Western Dike. Using *SLOPE/W*, we have modeled the shallow sloughing conditions along Section H-H. We have modeled four conditions to evaluate the possible root cause of the shallow sloughing. The evaluated conditions are as follows:

1. Section H-H with a *moist* topsoil material on the exterior dike facing exhibiting an assumed effective friction angle, $\phi'$ of 27°.
2. Section H-H with a *saturated* topsoil material on the exterior dike facing exhibiting an assumed effective friction angle, $\phi'$ of 27°.
3. Section H-H with a *moist* topsoil material on the exterior dike facing exhibiting an effective friction angle, $\phi'$ of 27° and pseudo-static train loadings of $a_h = 0.046g$ and $a_v = 0.008g$.
4. Section H-H with a *saturated* topsoil material on the exterior dike facing exhibiting an effective friction angle, $\phi'$ of 27° and pseudo-static train loadings of $a_h = 0.046g$ and $a_v = 0.008g$.

The results of the shallow sloughing assessment are summarized in Table 4. *SLOPE/W* data and graphical plots generated during our assessment are provided in Appendix IV. As shown in the results, for moist topsoil conditions and no railway induced vibration loadings (i.e., Condition 1), a safety factor in excess of 1.2 is calculated. However, for saturated topsoil conditions with no train loadings (Condition 2), a safety factor less than 1.0 is obtained. For moist topsoil conditions and applied train loadings (Condition 3), a safety factor of about 1.1 is calculated.

For saturated topsoil conditions with train loadings (i.e., Condition 4), a safety factor less than 1.0 is calculated. It should be noted that the slip surface calculated for each of these conditions is relatively thin (i.e., less than about 1-foot in thickness) and would not have a significant impact on the stability/integrity of the existing dike. Based on our assessment (i.e., as shown in the results for Conditions 2 and 4), it appears that the primary cause of the shallow sloughing observed at the site is likely due to saturated conditions of the topsoil material. These saturated conditions are possibly caused by infiltration of surface runoff and/or shallow interflow within the topsoil that may occur during precipitation and/or snow melt events.

**TABLE 4**
**SUMMARY OF SHALLOW SLOUGHING STABILITY ANALYSES**

| Condition | Safety Factor |
|---|---|
| 1. Section H-H with *moist* topsoil material. | 1.23 |
| 2. Section H-H with *saturated* topsoil material. | 0.54 |
| 3. Section H-H with *moist* topsoil material and train loadings. | 1.08 |
| 4. Section H-H with *saturated* topsoil material and train loadings. | 0.47 |

**Information Request Item 2h**

*Evaluate the plans for the sloughing repairs in consideration of the determination of the root cause and description of potential changes, if any, that may need to be made to the plans to ensure long-term success of the repair.*

**Response to Item 2h**

GA has evaluated the plans for the sloughing repairs using proposed repair drawings provided by AEP (provided in Appendix IV). Based on our review of the drawing, we believe that the rock fill repair zone and filter fabric will provide adequate drainage capacity to reduce the potential for saturating the exterior face materials on the dike. The *SLOPE/W* slope stability safety factor for the repaired Section H-H, with maximum railway induced loadings from Location C, is about 1.6. Based on our assessment, it is our opinion that the proposed repairs will significantly reduce the potential for shallow sloughing along the Fly Ash Disposal Facility Western Dike.

**<u>Information Request Item 2i</u>**

*Provide conclusions regarding railway vibrations and their effect on slope stability and liquefaction potential at the Philip Sporn Fly Ash Pond dikes and on slope stability at the Bottom Ash Pond dike.*

**<u>Response to Item 2i</u>**

GA used *SLOPE/W* to calculate slope stability safety factors and stability factors for Section A-A of the Bottom Ash Disposal Facility Western Dike and Section H-H of the Fly Ash Disposal Facility Western Dike (See Table 3 and Appendices IV and V, herein, for results). The safety factors were calculated by applying LEM pseudo-static loading conditions. The stability factors were calculated by applying FESM dynamic loading conditions. Both the LEM pseudo-static analyses and the FESM dynamic analyses were evaluated by conservatively applying vibration/acceleration data from the dike exterior toe vibration monitoring locations (i.e., Location A for Section A-A and Location C for Section H-H) to the downstream direction slope stability analyses and by applying the vibration/acceleration data from the dike crest vibration monitoring locations (i.e., Location B for Section A-A and Location D for Section H-H) to the upstream direction slope stability analyses.

As presented previously in Table 3, LEM safety factors and FESM stability factors were calculated for shallow-seated and deep-seated slip surface conditions. The LEM safety factors equal or exceed 1.70 for the Bottom Ash Disposal Facility Section A-A and 1.40 for the Fly Ash Disposal Facility Section H-H for the shallow-seated slip surface conditions. Moreover, the LEM safety factors equal or exceed 2.02 for the Bottom Ash Disposal Facility Section A-A and 1.65 for the Fly Ash Disposal Facility Section H-H for the deep-seated (global) slip surface conditions. The FESM stability factors equal or exceed 2.68 for the Bottom Ash Disposal Facility Section A-A and 1.78 for the Fly Ash Disposal Facility Section H-H for the shallow-seated slip surface conditions. The FESM safety factors equal or exceed 2.72 for the Bottom Ash Disposal Facility Section A-A and 2.12 for the Fly Ash Disposal Facility Section H-H for the deep-seated (global) slip surface conditions. The slope stability analyses indicate that adequate safety factors/stability factors are available for each of the conservatively modeled dike/train loading conditions. Based on the results obtained in our stability assessment, <u>we believe that the railway vibrations will not have a significant/consequential impact on the slope stability of the dikes for the Bottom Ash and Fly Ash Disposal Facilities.</u>

GA used *QUAKE/W* to evaluate liquefaction potential at Section A-A of the Bottom Ash Disposal Facility Western Dike and Section H-H of the Fly Ash Disposal Facility Western Dike. Site specific material parameters and railway induced loadings were applied in the *QUAKE/W* finite element analyses, as described in Appendix V. Given the material parameters and railway induced loadings, *QUAKE/W* dynamic analyses were conducted to delineate potential liquefaction zones. As shown in the liquefaction analysis results provided in Appendix V, no liquefaction zones are predicted for Section A-A of the Bottom Ash Disposal Facility Western Dike or for Section H-H of the Fly Ash Disposal Facility Western Dike. Furthermore, vibration monitoring conducted at the crest and at the downstream bench of the Fly Ash Disposal Facility Eastern Dike (i.e., along Section K-K) yielded non-detectable vibration levels due to rail traffic during three monitoring events (i.e., on November 11, 2009; January 6, 2010; and January 7, 2010). As such, we conclude that the Eastern Dike of the Fly Ash Disposal Facility is not subjected to instantaneous exposure, nor will it be subjected to long-term exposure to railway induced vibrations. Correspondingly, we believe that liquefaction of the fly ash material under the raised Eastern Dike of the Fly Ash Disposal Facility, due to railway induced ground vibration, is improbable.

**Information Request Item 2j**
*Provide conclusions regarding train wreck and its effect on liquefaction potential at the raised eastern dike of the Philip Sporn Fly Ash Pond.*

**Response to Item 2j**
We understand that the USEPA has released AEP from the responsibility of addressing Item 2j of the information request. As such, GA has removed this item from the scope of our assessment.

**Information Request Item 2k**
*Provide recommendations for remedial action to enhance slope stability to acceptable safety margins and/or eliminate or minimize liquefaction potential, as may be required, depending on the results of the assessment.*

**Response to Item 2k**
GA calculated adequate slope stability safety factors (i.e., in excess of 1.5) for Section A-A of the Bottom Ash Disposal Facility Western Dike and Section H-H of the Fly Ash Disposal Facility Western Dike. Furthermore, given the measured railway induced loadings, no

liquefaction zones were predicted in the dynamic analyses. Therefore, no remedial actions (i.e., other than routine maintenance and the ongoing repairs to reduce shallow sloughing) are currently recommended.

**Information Request Item 2l**
*Provide a list of references.*

**Response to Item 2l**
A list of references is provided in Appendix VII.

**Information Request Item 2m**
*Provide tables as needed to facilitate presentation of data.*

**Response to Item 2m**
Pertinent tables have been provided in the body of this document and as needed in the appendices to facilitate presentation of the data.

**Information Request Item 2n**
*Provide figures as needed for illustration purposes.*

**Response to Item 2n**
Applicable figures are provided in the appendices to the document.

**Information Request Item 2o**
*Provide an appendix containing summary descriptions of field and laboratory test procedures that may be used to develop vibration data and additional soil and ash data as needed for the assessment.*

**Response to Item 2o**
Summary descriptions related to the field geophysical studies and the vibration monitoring are provided in Appendix II. Laboratory testing procedures were conducted in accordance with ASTM standards. Laboratory testing data is provided in Appendix III. Listings of applicable ASTM standards used in the sampling and testing of site soil and ash materials are listed in the references provided in Appendix VII.

**Information Request Item 2p**
*Provide an appendix containing the vibration monitoring data and all test boring logs and other field data considered in the study, including existing and additional data that may be obtained.*

**Response to Item 2p**
Field geophysical data and the vibration monitoring data are provided in Appendix II. Test borings and other field data related to the study are included in Appendix III.

**Information Request Item 2q**
*Provide an appendix containing all laboratory data considered in the assessment, including existing data and additional data developed for the assessment.*

**Response to Item 2q**
Laboratory data considered in the assessment is provided in Appendix III.

**Information Request Item 2r**
*Provide an appendix containing all calculations, including slope stability analyses and liquefaction analyses.*

**Response to Item 2r**
*SLOPE/W* slope stability analyses are provided in Appendix IV. *QUAKE/W* dynamic/liquefaction analyses are provided in Appendix V.

**Information Request for Item 2s**
*Provide certification of the assessment and report by a professional engineer registered in the state of West Virginia.*

**Response to Item 2s**
A certification of the assessment and report presented herein is provided at the front of this document.

Geo/Environmental Associates, Inc. appreciates this opportunity to be of continuing service to American Electric Power. If you have questions regarding this response letter, feel free to contact me at (865) 584-0344 or email me at rogerc@geoe.com.

Respectfully Submitted,
**Geo/Environmental Associates, Inc.**

Roger W Cecil, for:

Seth W. Frank, E.I.
Project Coordinator

Roger W Cecil

Roger W. Cecil, P.E.
Senior Geotechnical Engineer
West Virginia Registered P.E. No. 14,367

ROGER W. CECIL
14367

# APPENDIX I

# USEPA LETTER DATED NOVEMBER 13, 2009 REQUESTING ADDITIONAL INFORMATION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
ENFORCEMENT AND
COMPLIANCE ASSURANCE

**CERTIFIED MAIL-RETURN RECEIPT REQUESTED**

NOV 13 2000

Alan R. Wood, PE
Manager
Water & Ecological Resource Services Section
Environmental Services Division
American Electric Power
1 Riverside Plaza
Columbus, OH 43215-2373

**Re: Request for Information Pursuant to Section 308 of the Clean Water Act (33 U.S.C. § 1318)**

Dear Mr. Wood:

Enclosed is an Information Request issued pursuant to Section 308(a) of the Clean Water Act, 33 U.S.C. § 1318(a). Section 308 of the Clean Water Act authorizes the Administrator of the United States Environmental Protection Agency ("EPA") to require those subject to the Act to furnish information, conduct monitoring, provide entry to the Administrator or authorized representatives, and make reports as may be necessary to carry out the objectives of the Act This authority has been re-delegated to the undersigned Director of the Water Enforcement Division in the Office of Enforcement and Compliance Assurance. The enclosures, which are hereby made part of this letter, provide details of the information the American Electric Power ("AEP") Philip Sporn Generating Plant ("Facility") must provide to EPA and contain instructions on how this information is to be submitted to EPA.

Section 308(a) of the Clean Water Act, 33 U.S.C. § 1318(a) authorizes EPA to require any person to provide information required to carry out the objectives of the Clean Water Act. Accordingly, you are requested to respond to the enclosed Information Request (Enclosure 1). Please read the instructions in the enclosure carefully before preparing your response. Answer each request as clearly and completely as possible. To the extent that AEP has any of the requested data currently on file, that data may be submitted in the requested format as part of your response. Your response to this request must be accompanied by a certificate that is signed and dated by you or the person who is authorized by you to respond to the request The certification must state that the response is complete and contains all information and documentation available to you pursuant to the request A Statement of Certification is enclosed with this letter (Enclosure 2).

**Please submit your written responses in accordance with the deadlines set forth in the request to:**

Ginny Phillips
U.S. Environmental Protection Agency
Water Enforcement Division
1200 Pennsylvania Avenue, NW
Mail Code 2243A; Room 4118A
Washington, DC 20460
*(For deliveries by courier use the Zip Code 20004)*

You are entitled to assert a business confidentiality claim pursuant to the regulations set forth in 40 C.F.R. Part 2, Subpart B. If EPA determines the information you have designated meets the criteria in 40 C.F.R. § 2.208, the information will be disclosed only to the extent and by means of the procedures specified in Subpart B. Unless a confidentiality claim is asserted at the time the requested information is submitted, EPA may make the information available to the public without further notice to you.

Compliance with the provisions of this Information Request is mandatory. If you do not respond fully and truthfully to this Information Request or adequately justify your failure to do so, you may be subject to civil penalties or criminal fines under Section 309 of the Clean Water Act, 33 U.S.C. § 1319.

We appreciate your cooperation and prompt attention to this matter. Please contact Ginny Phillips of my staff at 202-564-6139 (phillips.ginny@epa.gov) within 72 hours of receipt this Information Request to inform us of your intention to comply with this request If you or your staff would like an opportunity to confer, have any questions, or would like to schedule a meeting relating to this Information Request, please contact Ginny Phillips. Thank you for your cooperation in this matter.

Sincerely,

Mark Pollins, Director
Water Enforcement Division

Enclosures

cc: Michael Zeto, West Virginia Department of Environmental Protection
Brian Long, West Virginia Department of Environmental Protection
Rick Rogers, EPA Region 3

Enclosure 1

## INFORMATION REQUEST

## I. STATUTORY AUTHORITY

1. This information is requested pursuant to Section 308 of the Clean Water Act, 33 U.S.C. § 1318.

## II. INSTRUCTIONS

1. Respond to Each Request Completely. Provide a separate report for each of the three reports requested. Within each report, indicate the subpart of the request being addressed.

2. Provide the Best Information Available. If any request or subpart of the request cannot be responded to in full, respond to the extent possible along with an explanation of why the request cannot be responded to in full.

3. Source(s) of Response. Include with each report, the name, position, and title of each person(s) who participated in developing the report.

4 Source(s) of Data. Any existing field and laboratory data relied upon by you to develop the reports required by this Information Request must be identified in the report and include an explanation of how the data are representative of the conditions at the site.

5. Indicate Objections to Requests. While you may indicate that you object to certain requests contained in this Information Request, you must provide responsive information notwithstanding those objections. To object without providing responsive information may subject you to the penalties discussed in the cover letter.

6. Claims of Privilege. If you claim that an entire document submitted in response to this Information Request is privileged communication, identify the document and provide the basis for the privilege. If you claim that any particular section of a document is privileged communication, identify that section and provide the basis for the privilege. Regardless of the assertion of a privilege, you must respond to the Information Request in full.

7. New Information. If you become aware of any information not previously known or not available to you as of the date of submission of your response to this Information Request, you must supplement your response to EPA within five (5) business days. Moreover, should you find, at any time after the submission of your response, that any portion of the submitted information is false or misrepresents the truth, you must notify EPA of this fact immediately and provide a corrected response within two (2) business days.

8. Submission of Response by U.S. Mail. Submit a paper copy and an electronic .pdf file on CD of your response to:

Ginny Phillips
U.S. Environmental Protection Agency
Water Enforcement Division
1200 Pennsylvania Avenue, NW
Mail Code 2243A; Rm. 4118A
Washington, DC 20460
202-564-6139
*(For deliveries by courier use the Zip Code 20004)*

9. Submission of Response by E-mail. Submit an electronic .pdf file of your response to phillips.ginny@epa.gov.

10. Retention of Records. All records and documents that were created and/or relied upon in responding to any part of this request must be maintained until EPA informs you that maintenance is no longer required.

11. Inclusion of Statement of Certification. The Statement of Certification found in Enclosure 2 must be submitted along with each submission made pursuant to this Information Request. This statement must be signed by you or a person authorized by you to respond to the Information Request.

## III. DEFINITIONS

Unless otherwise defined herein, terms used in this request shall have the meaning given to those terms in the Act, 33 U.S.C. § 1251 et seq., the regulations promulgated thereunder at 40 CFR § 122, and in AEP's NPDES Permit, No. WV0001058.

1. The terms "and" and "or" shall be construed either disjunctively or conjunctively as necessary to bring within the scope of this Information Request any information which might otherwise be construed to be outside its scope.

2. The term "any," as in "any documents," for example, shall mean "any and all."

3. The term "describe" means to detail, depict, or give an account of the requested information, or to report the content of any oral and/or written correspondence, communication, or conversation, or to report the contents of any document, including the title, the author, the position or title of the author, the addressee, the position or title of the addressee, indicated or blind copies, date, subject matter, number of pages, attachment or appendices, and all persons to whom the document was distributed, shown, or explained.

4. "State" shall mean the State of West Virginia.

5. "Person" means an individual, trust, firm, joint stock company, corporation (including a government corporation), partnership, association, State, municipality, commission, political subdivision of a State, or an interstate body.

6. "Facility" is defined as:

   AEP Philip Sporn, State Route 62, New Haven, WV 25265

7. "Permit" is defined as AEP Philip Sporn, National Pollutant Discharge Elimination System Permit Number WV0001058. Expiration Date: June 30, 2013.

## IV. SUPPLEMENTAL REPORTS TO BE SUBMITTED

AEP shall develop supplemental reports for the requests below to ensure that the coal combustion waste impoundments at the Facility are structurally sound and will continue in safe and reliable operation. AEP shall develop and submit a supplemental report for the following requests in accordance with this section:

1. Site-specific study of the potential for liquefaction of foundation ash under design earthquake loading conditions for the raised eastern dike at the Fly Ash Pond;
2. Site-specific assessment of the effect of railway-induced ground vibrations on the embankments at both the Fly Ash Pond and the Bottom Ash Pond; and
3. Analysis of slope stability under design earthquake loading conditions for the upper sections of the eastern dike of the Fly Ash Pond.

1. Report on Earthquake-Induced Liquefaction for Eastern Dike of Fly Ash Pond: Within ninety (90) days of receipt of this request, AEP shall perform a study and submit an engineering report to EPA addressing the potential for earthquake-induced liquefaction of sluiced ash deposits upon which the raised eastern dike of the Fly Ash Pond was constructed at the Facility. The study shall be based on the specific site characteristics, subsurface conditions, material properties and parameters existing at the raised Fly Ash Pond dike, as determined by field exploration and laboratory tests. Existing field and laboratory data may be used to the extent that the data are representative of the conditions at the ash pond dike. Additional test borings and laboratory tests shall be performed if needed to adequately and accurately characterize the subsurface profiles and evaluate the densities, strengths, moisture contents, classification and index properties of the soil and ash layers that comprise the subsurface profiles. The Experimental Investigation approach used in The Ohio State University Research Project # 60005876 reported in "*Draft Final Report of Evaluation of Liquefaction Potential of Impounded Fly Ash,*" dated October 17, 2005 and adapted from The Indian Institute of Technology (Madras, India) "*Liquefaction Analysis of Pond Ash*" contained in the Proceedings of the 15th International Conference on Solid Waste Technology & Management held on December 12-15, 1999 in Philadelphia, Pennsylvania, may be used in this study to evaluate the liquefaction potential of foundation ash supporting the raised dike of the Fly Ash

Pond at the Facility. However, the cyclic triaxial testing shall be on representative samples of Philip Sporn fly ash remolded to relative densities that bracket the in-situ relative densities of the fly ash. Alternatively, semi-empirical procedures may be used to evaluate liquefaction potential of the foundation ash, such as those presented in the paper "*Semi-Empirical Procedures for Evaluating Liquefaction Potential During Earthquakes*," by I. M. Idriss and R.W. Boulanger, Proceedings of The Joint11th International Conference on Soil Dynamics & Earthquake Engineering (ICSDEE) & 3rd International Conference on Earthquake Geotechnical Engineering (ICEGE) (pp. 32-56), January 7-9, 2004. The design earthquake ground acceleration shall be at least 0 06g. At a minimum, the report shall include the following:

(a) description of background information and approach of the study;
(b) description of the methodology and procedures used in the analysis;
(c) description of any additional field testing performed and the results obtained;
(d) description of any additional laboratory testing performed and the results obtained;
(e) description of the site(s) including site map(s) depicting planimetric and topographic features and the location of critical section(s) selected for analysis;
(f) description of the subsurface conditions at the critical sections and illustration of the analysis profiles;
(g) discussion of the design soil and ash properties and parameters and the basis of selection of these values or the source of the values;
(h) presentation of analysis results, including appropriate charts and graphs illustrating the results, and discussion of the results;
(i) conclusions regarding liquefaction potential under design earthquake loading conditions at the Philip Sporn Fly Ash Pond dike;
(j) recommendations for remedial action to eliminate or minimize liquefaction potential should the foundation ash be found susceptible to liquefaction under design earthquake loading;
(k) list of references;
(l) tables as needed to facilitate presentation of data;
(m) figures as needed for illustration purposes;
(n) an appendix containing summary descriptions of field and laboratory test procedures that may be used to develop additional soil and ash data as needed for the study;
(o) an appendix containing all test boring logs and other field data considered in the study, including existing data and additional data that may be obtained to fully characterize the analysis profiles;
(p) an appendix containing all laboratory test data considered in the study, including existing data and additional data developed for the study;
(q) an appendix containing calculations, including analysis calculations, *e.g.*, program SHAKE runs, and calculations for calculated values used in the analysis, *e.g.*, calculation of shear modulus values ($G_{max}$); and

(r) certification of the study and report by a professional engineer registered in the state of West Virginia.

2 Report on Railway-Induced Ground Vibration for Fly Ash Pond Dike and Bottom Ash Pond Dike: Within ninety (90) days of receipt of this request, AEP shall perform assessment and submit a report to EPA addressing the effect of railway-induced ground vibrations on the slope stability at the Fly Ash Pond dike and the Bottom Ash Pond dike located at the Facility. In addition, the study shall evaluate the potential for liquefaction of foundation ash under the raised eastern dike of the Fly Ash Pond due to railway-induced ground vibrations. The study shall be based on the specific site characteristics, railway loading conditions, subsurface conditions, material properties and parameters existing at the Fly Ash Pond dike and at the Bottom Ash Pond dike, as determined by field measurement, field exploration and laboratory tests. Existing field and laboratory data may be used to the extent that the data are representative of the conditions at the ash pond dikes. The study shall also examine the cause of apparently shallow sloughing of the dike slopes and determine whether the root cause of the sloughing is railway-induced ground vibration or some other cause, such as saturation of the thick topsoil layer on the relatively steep slopes and consequential loss of its nominal cohesive strength, leading to failure due to insufficient frictional shearing resistance, or a combination of causes. In light of the results of this examination, the study shall review plans for repairs of the sloughing and determine whether modifications to the plans ought to be made to ensure long-term success of the repair. At a minimum, the report shall include the following:

(a) a description of the site including a site map depicting the location of the railway superstructure, embankments and other planimetric and topographic features;

(b) description, procedures and summary of field measurements of railway-induced ground vibrations generated by loaded railway traffic under dynamic conditions at various speeds and stopping conditions;

(c) description, procedures and summary of field exploration and laboratory tests of in-situ subsurface conditions, including, but not limited to:
   (i) soil test & instrumentation location map;
   (ii) cross-sectional geometry of embankment sections depicting phreatic surface; and
   (iii) soil test boring logs and laboratory analyses of soil testing.

(d) description, procedures and summary of slope stability analysis including, but not limited to:
   (i) soil strength parameters modeled and basis of values used;
   (ii) loading conditions modeled from measured railway-induced ground vibrations generated by railway traffic;
   (iii) factors of safety against shallow slope failures and global slope instability.

(e) evaluation of the potential liquefaction of fly ash under the raised eastern dike of the Fly Ash Pond from instantaneous, as well as long term exposure, to railway induced ground vibrations from the west side of the Fly Ash Pond;

(f) evaluation of the potential liquefaction of fly ash under the raised eastern dike of the Fly Ash Pond from train collision and derailment on the west side of the Fly Ash Pond;

(g) determination of the root cause of apparently shallow sloughing of the dike slopes;

(h) evaluation of the plans for sloughing repairs in consideration of the determination of the root cause and description of potential changes, if any, that may need to be made to the plans to ensure long-term success of the repair;

(i) conclusions regarding railway vibrations and their effect on slope stability and liquefaction potential at the Philip Sporn Fly Ash Pond dikes and on slope stability at the Bottom Ash Pond dike;

(j) conclusions regarding train wreck and its effect on liquefaction potential at the raised eastern dike of the Philip Sporn Fly Ash Pond;

(k) recommendations for remedial action to enhance slope stability to acceptable safety margins and/or eliminate or minimize liquefaction potential, as may be required, depending on the results of the assessment;

(l) list of references;

(m) tables as needed to facilitate presentation of data;

(n) figures as needed for illustration purposes;

(o) an appendix containing summary descriptions of field and laboratory test procedures that may be used to develop vibration data and additional soil and ash data as needed for the assessment;

(p) an appendix containing the vibration monitoring data and all test boring logs and other field data considered in the study, including existing data and additional data that may be obtained;

(q) an appendix containing all laboratory test data considered in the assessment, including existing data and additional data developed for the assessment;

(r) an appendix containing all calculations, including slope stability analyses and liquefaction analyses; and

(s) certification of the assessment and report by a professional engineer registered in the state of West Virginia.

3. Report on Analysis of Seismic Slope Stability of Fly Ash Pond Eastern Dike Upper Section: Within ninety (90) days of receipt of this request, AEP shall submit a report to EPA of the "Seismic Slope Stability Analysis" to characterize the seismic stability of the Upper Section of the Fly Ash Pond eastern dike, which was constructed over sluiced fly ash deposits, at the Facility. The analysis shall be based on the specific site characteristics, subsurface conditions, material properties and parameters existing at the raised Fly Ash Pond dike, as determined by field exploration and laboratory tests. The analysis shall be based on a design earthquake ground acceleration of at least 0.06g. Pseudo-static design methodologies may be used Existing field and laboratory data may be used to the extent that the data are representative of the conditions at the ash pond dike. A report of the analysis shall be prepared and at a minimum the report shall include:

(a) a description of the geotechnical properties used for each soil and ash layer used in the analysis including total and effective shear strength parameters;
(b) a description of the data collection and modeling methodologies utilized by AEP in the evaluation of seismic slope stability;
(c) an analysis of embankment internal stresses, including static pore pressures under expected seepage conditions;
(d) an analysis of embankment internal stresses, including static pore pressures during normal and maximum waste placement conditions;
(e) analyses of embankment stability shall consider both slope and base sliding conditions;
(f) analyses of slope stability shall include evaluation of critical full height and partial height potential failure planes;
(g) computed minimum safety factors during the design earthquake event for both slope and base sliding conditions;
(h) conclusions regarding seismic slope stability under design earthquake loading conditions of upper section of the Fly Ash Pond eastern dike at the Facility;
(i) recommendations for remedial action to enhance seismic stability of the upper section of the Fly Ash Pond eastern dike to acceptable safety margins, as may be required, depending on the results of the assessment;
(j) list of references;
(k) tables as needed to facilitate presentation of data;
(l) figures as needed for illustration purposes;
(m) an appendix containing summary descriptions of field and laboratory test procedures that may be used to develop additional soil and ash data as needed for the analysis;
(n) an appendix containing all test boring logs and other field data considered in the analysis, including existing data and additional data that may be obtained;
(o) an appendix containing all laboratory test data considered in the analysis, including existing data and additional data developed for the analysis;
(p) an appendix containing all stability analysis calculations; and
(q) certification of the analysis by a professional engineer registered in the state of West Virginia.

Enclosure 2

## STATEMENT OF CERTIFICATION

I certify that the information contained in or accompanying this submission is true, accurate, and complete.

As to the identified portion(s) of this submission for which I cannot personally verify its truth and accuracy, I certify as the company official having supervisory responsibility for the person(s) who, acting under my direct instructions, made the verification, that this information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment.

By ______________________________
(Signature)

______________________________
(Title)

______________________________
(Date)

# APPENDIX II

# VIBRATION MONITORING, GEOPHYSICAL DATA AND LABORATORY TESTING CONDUCTED BY DR. MICHAEL KALINSKI

# DR. KALINSKI REPORT DATED NOVEMBER 30, 2009 RELATED TO NOVEMVER 11, 2009 VIBRATION MONITORING

November 30, 2009

Mr. Roger Cecil. P.E.
Geo/Environmental Associates
3502 Overlook Circle
Knoxville, TN 37909

**RE: Vibration monitoring at the AEP Sporn Power Plant, New Haven, West Virginia**

Dear Roger,

Vibration monitoring was performed on November 11, 2009 at six points at the AEP Sporn Power Plant in New Haven, West Virginia. Vibration monitoring was performed from approximately 8:05 A.M. until 4:25 P.M. by myself, along with the assistance of Mr. Seth Frank. This letter report describes the methods used and results obtained, and is accompanied by a CD containing the vibration data in ASCII format.

Vibration monitoring was performed at six locations on the perimeter levees that contain the fly ash and bottom ash at the power plant. The locations are described as follows:

- Location A: outside toe of the bottom ash levee adjacent to the train tracks;
- Location B: outside crest of the bottom ash levee adjacent to the train tracks;
- Location C: outside toe of the fly ash levee adjacent to the train tracks;
- Location D: outside crest of the fly ash levee adjacent to the train tracks;
- Location E: outside crest of the fly ash levee adjacent to the Ohio River; and
- Location F: outside toe of the fly ash levee adjacent to the Ohio River.

Mr. Frank used GPS while on site to obtain accurate coordinate information for each location.

Vibration monitoring was performed using six Blastmate III seismographs, which are manufactured by Instantel. The Blastmate III seismographs record four channels simultaneously during each event; one air wave channel with a microphone, and three ground wave channels using three geophones. The three geophones are oriented orthogonal to each other so that one geophone detects vertical particle motion, and the other two detect horizontal particle motion in two perpendicular directions. The two horizontal geophones are identified as longitudinal and transverse, with the longitudinal geophone oriented towards the vibration source, and the transverse oriented perpendicular to the longitudinal.

The geophones that accompany the Blastmate III have a damped resonant frequency of approximately 2.0 Hz and the data are sampled in the instrument at a rate of 1,024 samples per second. This allows vibrations to be recorded between the bandwidth of 2.0-250 Hz with minimal distortion. The vibrations imparted to the geophones are converted into voltage, and the voltage is converted to particle velocity using a calibration factor. To minimize wind and surface noise, the geophones are buried in sand a few inches below the ground surface and covered with a heavy weight such as a sand bag or water jug. The serial numbers of the seismographs used at each test location are as follows:

- Location A: Serial #BA11348;
- Location B: Serial #BA11347;
- Location C: Serial #BA10619;
- Location D: Serial #BA13539;
- Location E: Serial #BA13553; and
- Location F: Serial #BA11042.

Calibration certificates for each seismograph and its accompanying geophones are included in Appendix A of this report.

Vibration monitoring was performed on Nov. 11, 2009 from approximately 8:05 A.M. until 4:25 P.M. as indicated on the monitoring logs included in Appendix B of this report. During this period, three trains passed by the power plant at times of approximately 9:48 A.M., 12:12 P.M., and 1:36 P.M. The 9:48 and 1:36 trains were short trains. The 9:48 train consisted of an engine only, and the 1:36 train consisted of an engine and two empty lumber cars. The 12:12 train was a long train that consisted of two engines along with an estimated 95 cars (based on assumed train speed of 30 mph, vibration record length of 130 s, and average car length of 60 ft). The cars consisted of tank cars and coal cars.

The vibration monitoring logs included in Appendix B indicate when the seismographs were actively monitoring and when vibration events were recorded, including the three trains. The monitoring logs indicate that additional events were also recorded. These additional events correspond to occasional testing of the seismographs by stomping on the ground next to the geophones. Details regarding these additional test events are not included herein.

Vibrations from the 9:48 train were relatively small, and were only detected at Location C. For all logging, vibrations were only recorded when the vibration level exceeded 0.02 in./s. Below this level, vibrations were considered to be within the level of ambient noise. Summary reports for this and all other recorded vibration events are included in Appendix C of this report, and are also included in the attached CD (Appendix D). For each seismograph and vibration event, two reports are included: a time-domain Event Report and a frequency-domain FFT Report. Peak particle velocities (PPVs) can be found on the Event Reports. For the 9:48 event recorded at Location C, PPVs recorded by the transverse, vertical, and longitudinal geophones were 0.01, 0.02, and 0.02 in./s, respectively.

Vibrations from the 1:36 were also relatively small, and were only detected at Locations A and C. The Event Reports and FFT Reports for these two vibrations are also included in Appendix C. Peak Particle Velocities for this train at the two locations are summarized in the table below.

*Peak particle velocities recorded at Locations A and C from the 1:36 train*

| Location | Tran. PPV (in./s) | Vert. PPV (in./s) | Long. PPV (in./s) |
|---|---|---|---|
| A (#BA11348) | 0.02 | 0.02 | 0.02 |
| C (#BA10619) | 0.02 | 0.02 | 0.03 |

Vibrations from the 12:12 train were larger and longer in duration than the other two trains, and were detected at locations A, B, C, and D. The accompanying Event Reports and FFT Reports are also included in Appendix C. The overall duration of vibrations from the train was approximately 130 s. However, vibration levels at Locations B, C, and D fell below the 0.02-in./s threshold while the train passed, so the vibration records at these locations are either less than 130 s in duration, or separated into 2 or more recordings. Peak Particle Velocities for this train at the four locations are summarized in the table below.

*Peak particle velocities recorded at Locations A, B, C, and D from the 12:12 train*

| Location | Tran. PPV (in./s) | Vert. PPV (in./s) | Long. PPV (in./s) |
|---|---|---|---|
| A (#BA11348) | 0.03 | 0.06 | 0.05 |
| B (#BA11347) | 0.01 | 0.04 | 0.03 |
| C (#BA10619) | 0.05 | 0.06 | 0.07 |
| D (#BA13539) | 0.01 | 0.01 | 0.02 |

All of the vibration monitoring data are included in ASCII format on the attached CD. Given a sample rate of 1,024 samples/s, the vibration data should be plotted at a sample rate of 9.7656 x $10^{-4}$ s. Vibration data are presented in the ASCII files in units of particle velocity in mm/s. All Event Reports and FFT Reports are also included on the CD, along with photos taken during testing. Please note that the internal clocks on the six seismographs were only set to the nearest minute, so the time stamps on the monitoring logs and event records may be slightly out of synch between seismographs.

Thank you very much for providing me the opportunity to work with you on this project. Please do not hesitate to contact me if you have any questions or require any additional information.

Regards,

Michael E. Kalinski, Ph.D.

Attachments: Appendix A – calibration certificates for seismographs and geophones
Appendix B – vibration monitoring logs
Appendix C -- event reports
Appendix C – vibration data in ASCII format (on CD)

# APPENDIX A

## Calibration certificates for seismographs and geophones

# Calibration Certificate

A

Part Number: 714A0801
Description: BLASTMATE III
Serial Number: BA11348
Calibration Date: December 18, 2008
Calibration Equipment: 718A1501

*Instantel certifies that the above product was calibrated in accordance with the applicable Instantel procedures. These procedures are part of a quality system that is certified to the ISO9001:2000 quality standard, and are designed to assure that the product listed above meets or exceeds Instantel specifications.*

*Instantel further certifies that the measurement instruments used during the calibration of this product are traceable to the National Institute of Standards and Technology; or National Research Council of Canada. Evidence of traceability is on file at Instantel and is available upon request.*

*The environment in which this product was calibrated is maintained within the operating specifications of the instrument.*

*Please note that the sensor check function is intended to check that the sensors are connected to the unit, installed in the proper orientation and sufficiently level to operate properly. This function should not be confused with a formal calibration, which requires the sensors be checked against a reference that is traceable to a known standard. Instantel recommends that products be returned to Instantel or an authorized service and calibration facility for annual calibration.*

Calibrated By: Martin Hogue
Martin Hogue

Instantel

# Calibration Certificate

A

Part Number: 714A9701
Description: TRIAXIAL GEOPHONE (ISEE)
Serial Number: BG10482
Calibration Date: December 18, 2008
Calibration Equipment: 714J7401

*Instantel certifies that the above product was calibrated in accordance with the applicable Instantel procedures. These procedures are part of a quality system that is certified to the ISO9001:2000 quality standard, and are designed to assure that the product listed above meets or exceeds Instantel specifications.*

*Instantel further certifies that the measurement instruments used during the calibration of this product are traceable to the National Institute of Standards and Technology; or National Research Council of Canada. Evidence of traceability is on file at Instantel and is available upon request.*

*The environment in which this product was calibrated is maintained within the operating specifications of the instrument.*

*Please note that the sensor check function is intended to check that the sensors are connected to the unit, installed in the proper orientation and sufficiently level to operate properly. This function should not be confused with a formal calibration, which requires the sensors be checked against a reference that is traceable to a known standard. Instantel recommends that products be returned to Instantel or an authorized service and calibration facility for annual calibration.*

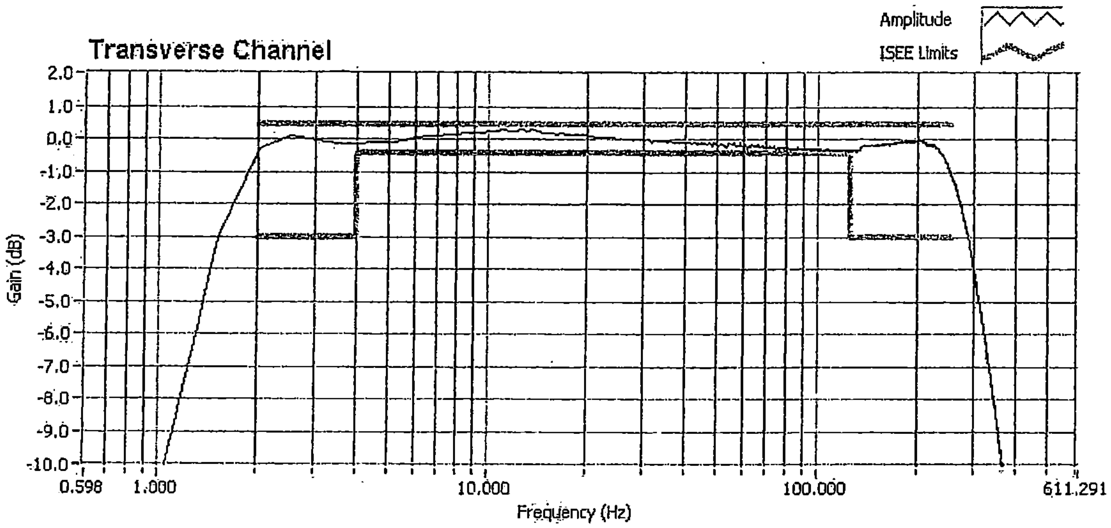
Calibrated By: Martin Hogue
Martin Hogue

**Instantel**

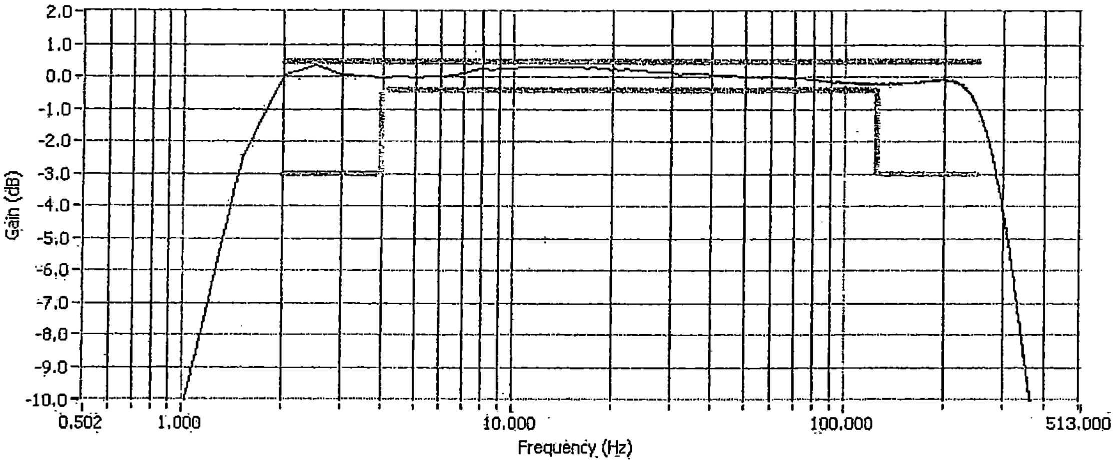
# Amplitude Frequency Response of BG10402

A

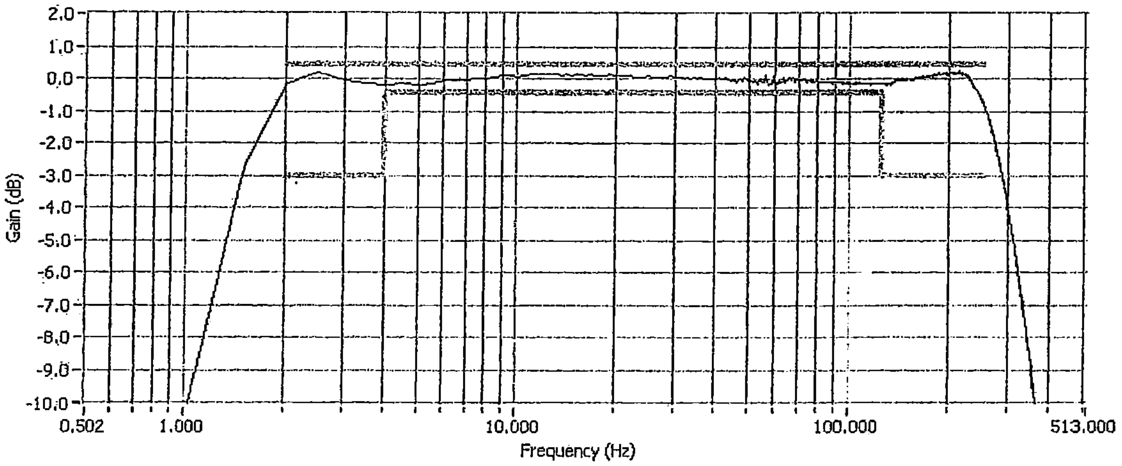
### Transverse Channel



### Vertical Channel



### Longitudinal Channel



# Calibration Certificate

B

Part Number: 714A0801
Description: BLASTMATE III
Serial Number: BA11347
Calibration Date: December 18, 2008
Calibration Equipment: 718A1501

*Instantel certifies that the above product was calibrated in accordance with the applicable Instantel procedures. These procedures are part of a quality system that is certified to the ISO9001:2000 quality standard, and are designed to assure that the product listed above meets or exceeds Instantel specifications.*

*Instantel further certifies that the measurement instruments used during the calibration of this product are traceable to the National Institute of Standards and Technology; or National Research Council of Canada. Evidence of traceability is on file at Instantel and is available upon request.*

*The environment in which this product was calibrated is maintained within the operating specifications of the instrument.*

*Please note that the sensor check function is intended to check that the sensors are connected to the unit, installed in the proper orientation and sufficiently level to operate properly. This function should not be confused with a formal calibration, which requires the sensors be checked against a reference that is traceable to a known standard. Instantel recommends that products be returned to Instantel or an authorized service and calibration facility for annual calibration.*

Calibrated By: Martin Hogue
Martin Hogue

Instantel

# Calibration Certificate

B

Part Number: 714A9701
Description: TRIAXIAL GEOPHONE (ISEE)
Serial Number: BG10479
Calibration Date: December 18, 2008
Calibration Equipment: 714J7401

*Instantel certifies that the above product was calibrated in accordance with the applicable Instantel procedures. These procedures are part of a quality system that is certified to the ISO9001:2000 quality standard, and are designed to assure that the product listed above meets or exceeds Instantel specifications.*

*Instantel further certifies that the measurement instruments used during the calibration of this product are traceable to the National Institute of Standards and Technology; or National Research Council of Canada. Evidence of traceability is on file at Instantel and is available upon request.*

*The environment in which this product was calibrated is maintained within the operating specifications of the instrument.*

*Please note that the sensor check function is intended to check that the sensors are connected to the unit, installed in the proper orientation and sufficiently level to operate properly. This function should not be confused with a formal calibration, which requires the sensors be checked against a reference that is traceable to a known standard. Instantel recommends that products be returned to Instantel or an authorized service and calibration facility for annual calibration.*

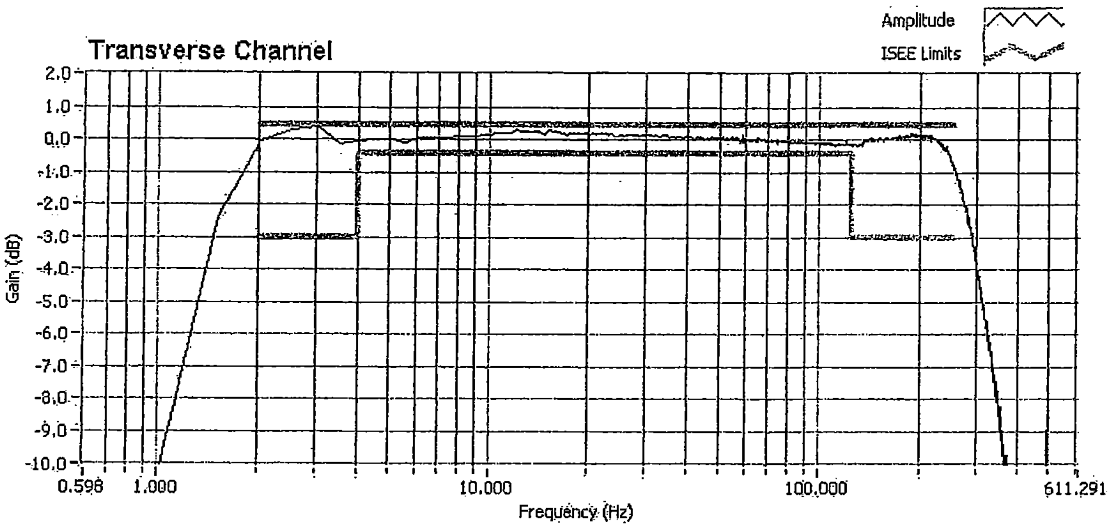
Calibrated By: ____________
Martin Hogue

Instantel

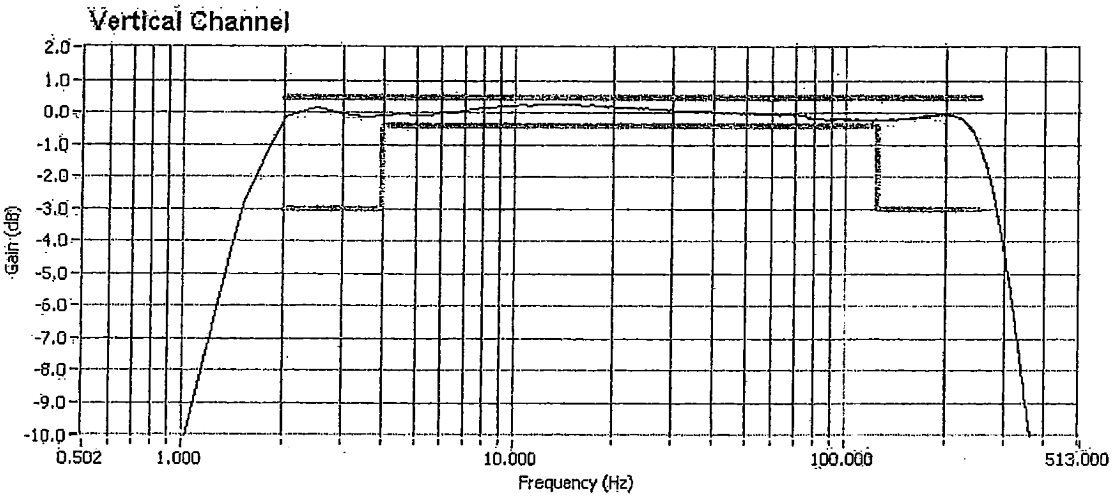
# Amplitude Frequency Response of BG10479

B

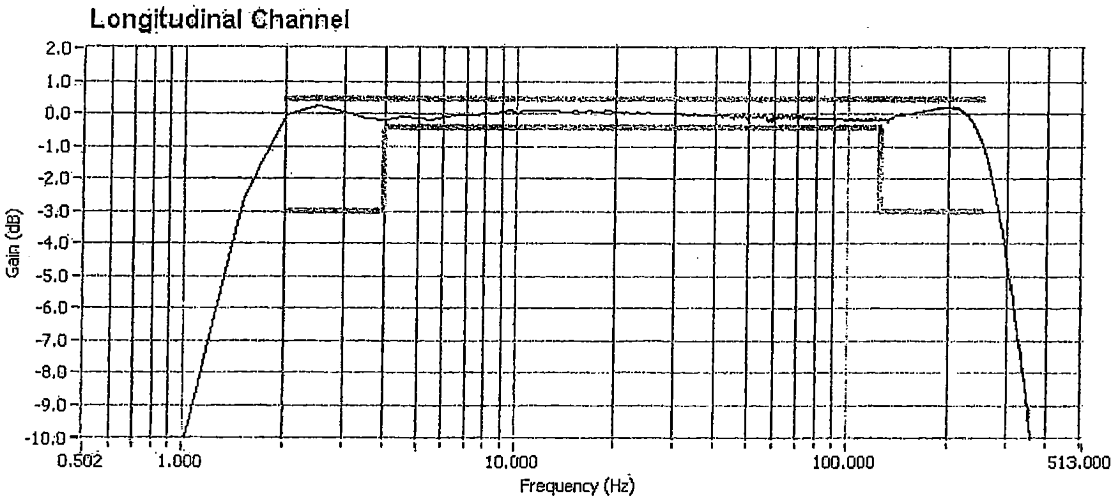
**Transverse Channel**



**Vertical Channel**



**Longitudinal Channel**



# Calibration Certificate

C

Part Number: 714A0801
Description: BLASTMATE III
Serial Number: BA10619
Calibration Date: May 27, 2009
Calibration Equipment: 718A1501

*Instantel certifies that the above product was calibrated in accordance with the applicable Instantel procedures. These procedures are part of a quality system that is certified to the ISO9001:2000 quality standard, and are designed to assure that the product listed above meets or exceeds Instantel specifications.*

*Instantel further certifies that the measurement instruments used during the calibration of this product are traceable to the National Institute of Standards and Technology; or National Research Council of Canada. Evidence of traceability is on file at Instantel and is available upon request.*

*The environment in which this product was calibrated is maintained within the operating specifications of the instrument.*

*Please note that the sensor check function is intended to check that the sensors are connected to the unit, installed in the proper orientation and sufficiently level to operate properly. This function should not be confused with a formal calibration, which requires the sensors be checked against a reference that is traceable to a known standard. Instantel recommends that products be returned to Instantel or an authorized service and calibration facility for annual calibration.*

Calibrated By: Dan Sawyer
Dan Sawyer

Instantel

714052

# Calibration Certificate

C

Part Number: 714A9701
Description: TRIAXIAL GEOPHONE (ISEE)
Serial Number: BG10510
Calibration Date: May 27, 2009
Calibration Equipment: 714J7402

*Instantel certifies that the above product was calibrated in accordance with the applicable Instantel procedures. These procedures are part of a quality system that is certified to the ISO9001:2000 quality standard, and are designed to assure that the product listed above meets or exceeds Instantel specifications.*

*Instantel further certifies that the measurement instruments used during the calibration of this product are traceable to the National Institute of Standards and Technology; or National Research Council of Canada. Evidence of traceability is on file at Instantel and is available upon request.*

*The environment in which this product was calibrated is maintained within the operating specifications of the instrument.*

*Please note that the sensor check function is intended to check that the sensors are connected to the unit, installed in the proper orientation and sufficiently level to operate properly. This function should not be confused with a formal calibration, which requires the sensors be checked against a reference that is traceable to a known standard. Instantel recommends that products be returned to Instantel or an authorized service and calibration facility for annual calibration.*

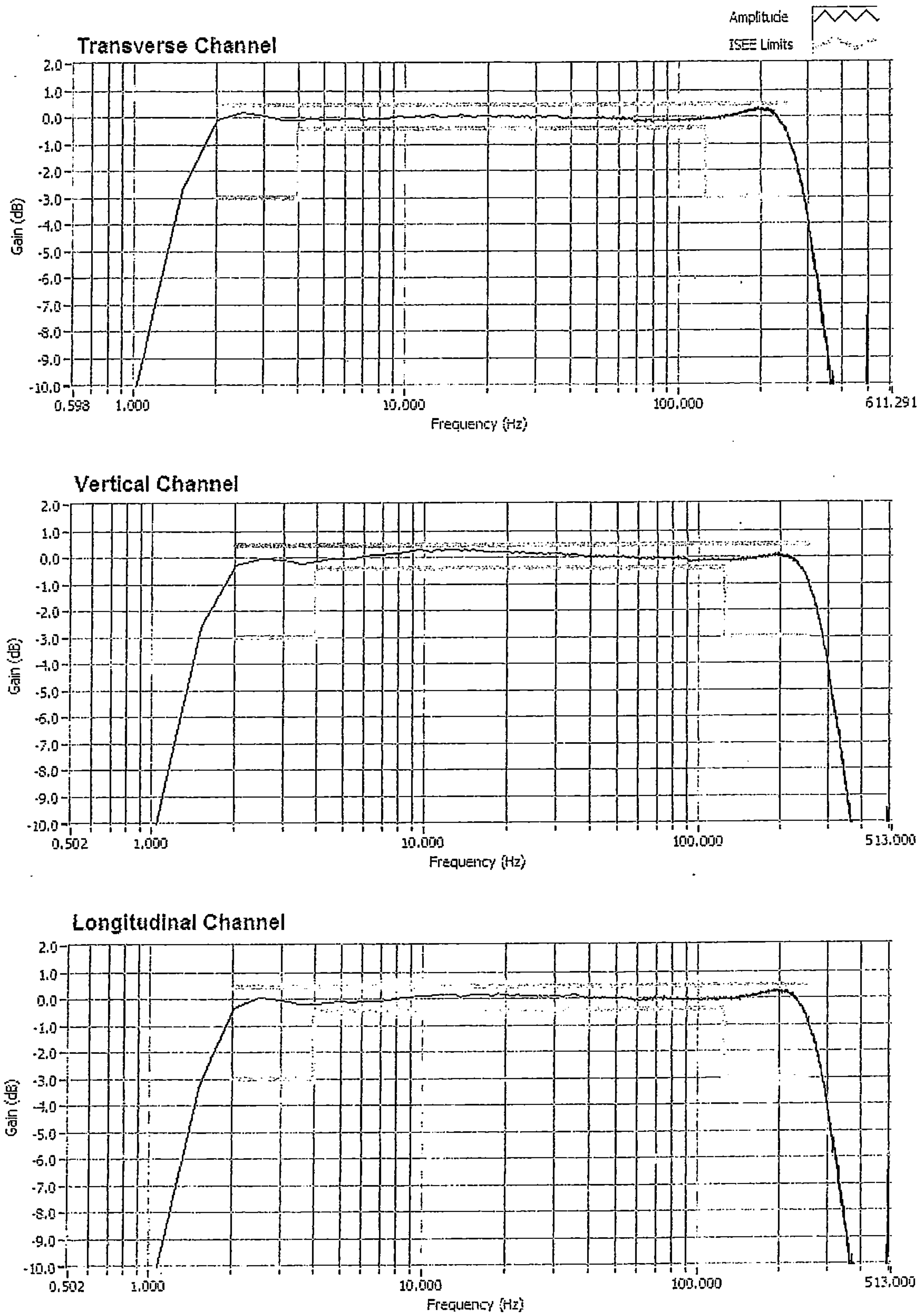
Calibrated By: Dan Sawyer
Dan Sawyer

Instantel®

71405201 Rev 00

# Amplitude Frequency Response of BG10510

C



# Calibration Certificate

D

Part Number: 714A0801
Description: BLASTMATE III
Serial Number: BA13539
Calibration Date: February 11, 2009
Calibration Equipment: 718A1501

*Instantel certifies that the above product was calibrated in accordance with the applicable Instantel procedures. These procedures are part of a quality system that is certified to the ISO9001:2000 quality standard, and are designed to assure that the product listed above meets or exceeds Instantel specifications.*

*Instantel further certifies that the measurement instruments used during the calibration of this product are traceable to the National Institute of Standards and Technology; or National Research Council of Canada. Evidence of traceability is on file at Instantel and is available upon request.*

*The environment in which this product was calibrated is maintained within the operating specifications of the instrument.*

*Please note that the sensor check function is intended to check that the sensors are connected to the unit, installed in the proper orientation and sufficiently level to operate properly. This function should not be confused with a formal calibration, which requires the sensors be checked against a reference that is traceable to a known standard. Instantel recommends that products be returned to Instantel or an authorized service and calibration facility for annual calibration.*

Calibrated By: Mark Benoit
Mark Benoit

**Instantel**

# Calibration Certificate

D

Part Number: 714A9701
Description: TRIAXIAL GEOPHONE (ISEE)
Serial Number: BG12432
Calibration Date: February 11, 2009
Calibration Equipment: 714J7401

*Instantel certifies that the above product was calibrated in accordance with the applicable Instantel procedures. These procedures are part of a quality system that is certified to the ISO9001:2000 quality standard, and are designed to assure that the product listed above meets or exceeds Instantel specifications.*

*Instantel further certifies that the measurement instruments used during the calibration of this product are traceable to the National Institute of Standards and Technology; or National Research Council of Canada. Evidence of traceability is on file at Instantel and is available upon request.*

*The environment in which this product was calibrated is maintained within the operating specifications of the instrument.*

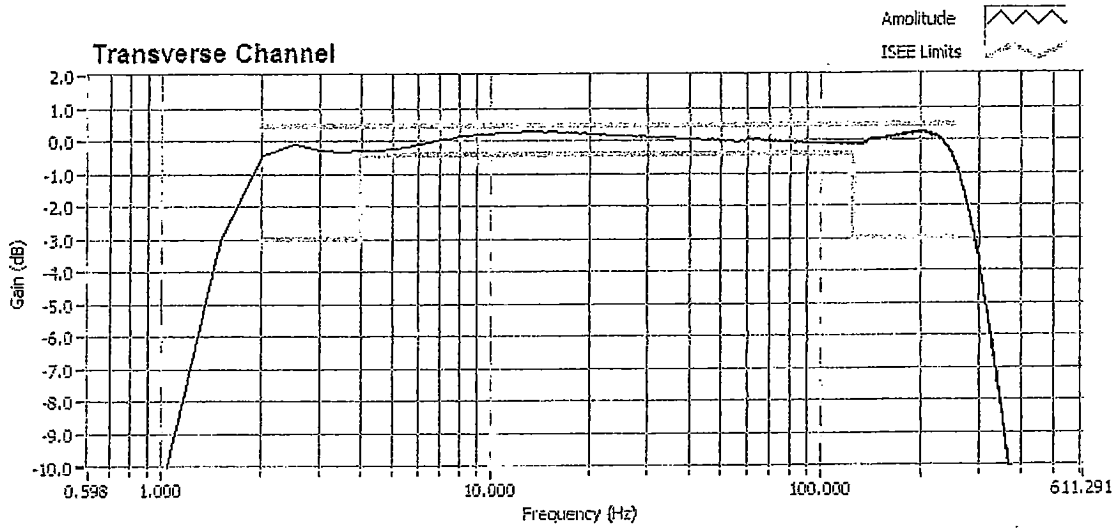
*Please note that the sensor check function is intended to check that the sensors are connected to the unit, installed in the proper orientation and sufficiently level to operate properly. This function should not be confused with a formal calibration, which requires the sensors be checked against a reference that is traceable to a known standard. Instantel recommends that products be returned to Instantel or an authorized service and calibration facility for annual calibration.*

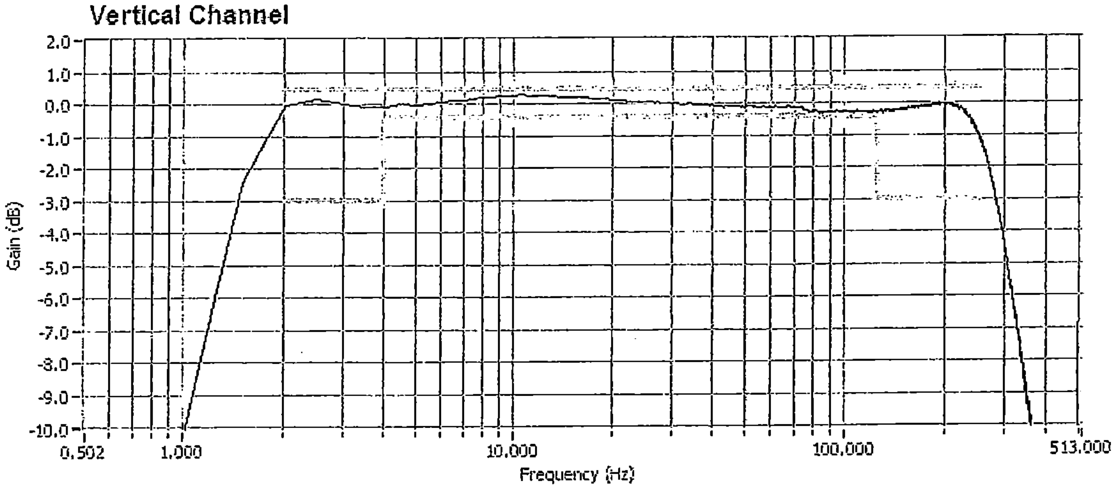
Calibrated By: Mark Benoit

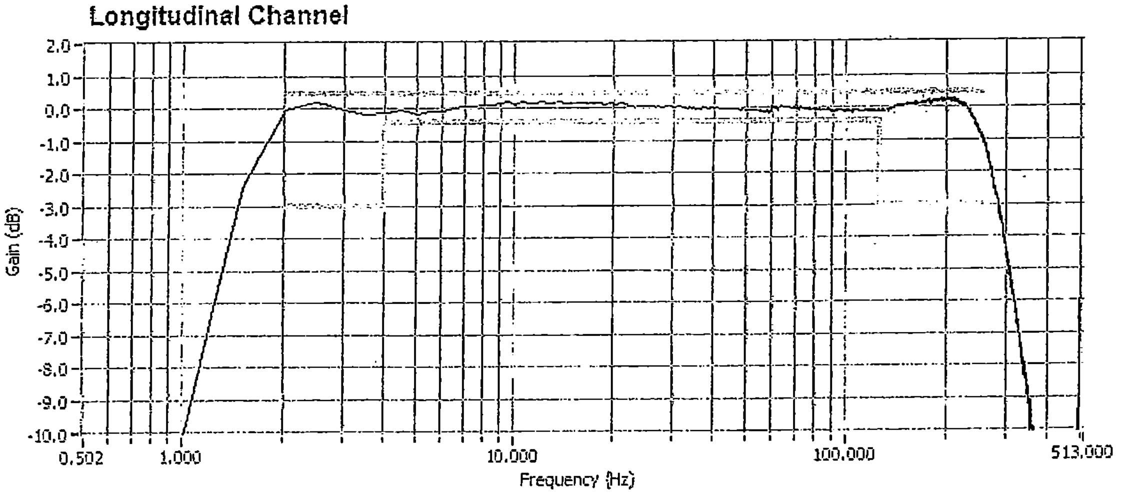
Instantel

D

# Amplitude Frequency Response of BG12432







# Calibration Certificate

E

Part Number: 714A0801
Description: BLASTMATE III
Serial Number: BA13553
Calibration Date: March 3, 2009
Calibration Equipment: 718A1501

*Instantel certifies that the above product was calibrated in accordance with the applicable Instantel procedures. These procedures are part of a quality system that is certified to the ISO9001:2000 quality standard, and are designed to assure that the product listed above meets or exceeds Instantel specifications.*

*Instantel further certifies that the measurement instruments used during the calibration of this product are traceable to the National Institute of Standards and Technology; or National Research Council of Canada. Evidence of traceability is on file at Instantel and is available upon request.*

*The environment in which this product was calibrated is maintained within the operating specifications of the instrument.*

*Please note that the sensor check function is intended to check that the sensors are connected to the unit, installed in the proper orientation and sufficiently level to operate properly. This function should not be confused with a formal calibration, which requires the sensors be checked against a reference that is traceable to a known standard. Instantel recommends that products be returned to Instantel or an authorized service and calibration facility for annual calibration.*

Calibrated By: Dan Sawyer
Dan Sawyer

Instantel

# Calibration Certificate

E

Part Number: 714A9701
Description: TRIAXIAL GEOPHONE (ISEE)
Serial Number: BG12494
Calibration Date: March 3, 2009
Calibration Equipment: 714J7401

*Instantel certifies that the above product was calibrated in accordance with the applicable Instantel procedures. These procedures are part of a quality system that is certified to the ISO9001:2000 quality standard, and are designed to assure that the product listed above meets or exceeds Instantel specifications.*

*Instantel further certifies that the measurement instruments used during the calibration of this product are traceable to the National Institute of Standards and Technology; or National Research Council of Canada. Evidence of traceability is on file at Instantel and is available upon request.*

*The environment in which this product was calibrated is maintained within the operating specifications of the instrument.*

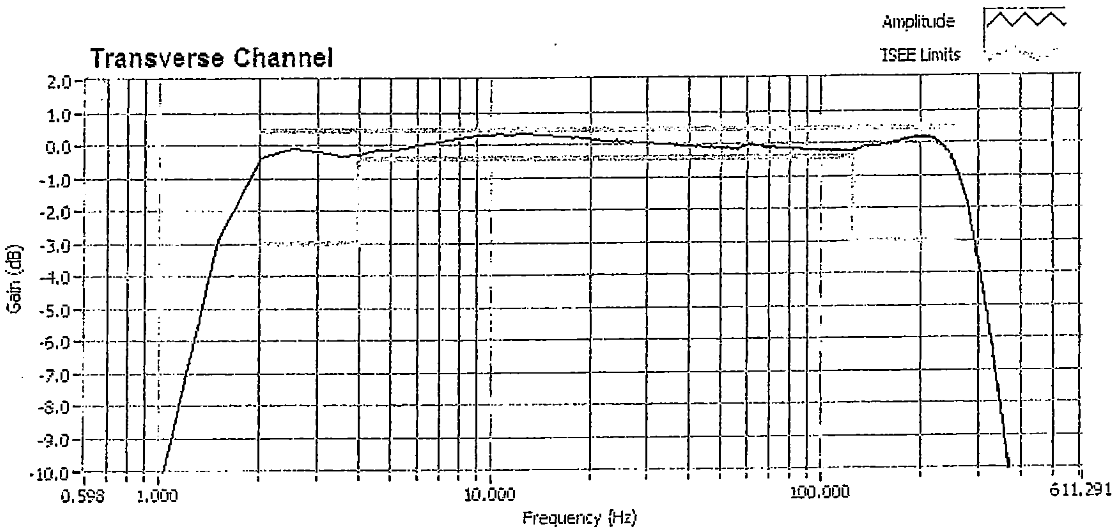
*Please note that the sensor check function is intended to check that the sensors are connected to the unit, installed in the proper orientation and sufficiently level to operate properly. This function should not be confused with a formal calibration, which requires the sensors be checked against a reference that is traceable to a known standard. Instantel recommends that products be returned to Instantel or an authorized service and calibration facility for annual calibration.*

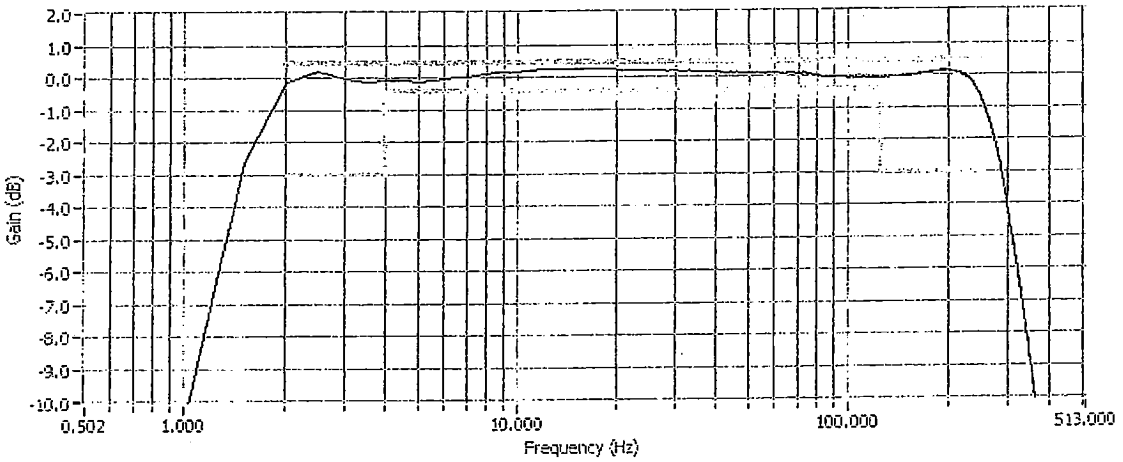
Calibrated By: Dan Sawyer
Dan Sawyer

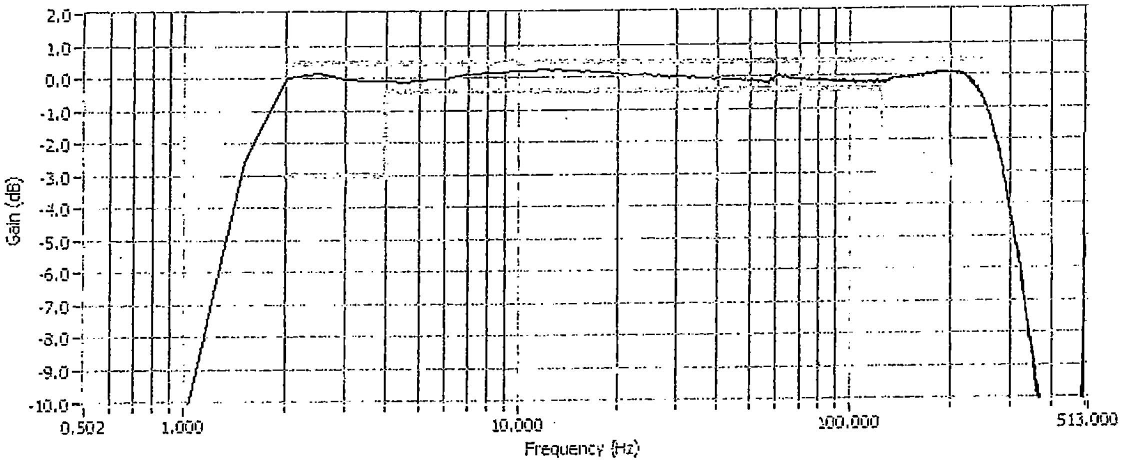
**Instantel**

E

# Amplitude Frequency Response of BG12494


Transverse Channel


Vertical Channel


Longitudinal Channel

# Calibration Certificate

F

Part Number: 714A0801
Description: BLASTMATE III
Serial Number: BA11042
Calibration Date: May 26, 2009
Calibration Equipment: 718A1501

*Instantel certifies that the above product was calibrated in accordance with the applicable Instantel procedures. These procedures are part of a quality system that is certified to the ISO9001:2000 quality standard, and are designed to assure that the product listed above meets or exceeds Instantel specifications.*

*Instantel further certifies that the measurement instruments used during the calibration of this product are traceable to the National Institute of Standards and Technology; or National Research Council of Canada. Evidence of traceability is on file at Instantel and is available upon request.*

*The environment in which this product was calibrated is maintained within the operating specifications of the instrument.*

*Please note that the sensor check function is intended to check that the sensors are connected to the unit, installed in the proper orientation and sufficiently level to operate properly. This function should not be confused with a formal calibration, which requires the sensors be checked against a reference that is traceable to a known standard. Instantel recommends that products be returned to Instantel or an authorized service and calibration facility for annual calibration.*

Calibrated By: Dan Sawyer
Dan Sawyer

**Instantel**

71405901 Rev 01

# Calibration Certificate

F

Part Number: 714A9701
Description: TRIAXIAL GEOPHONE (ISEE)
Serial Number: BG9432
Calibration Date: May 26, 2009
Calibration Equipment: 714J7402

*Instantel certifies that the above product was calibrated in accordance with the applicable Instantel procedures. These procedures are part of a quality system that is certified to the ISO9001:2000 quality standard, and are designed to assure that the product listed above meets or exceeds Instantel specifications.*

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*The environment in which this product was calibrated is maintained within the operating specifications of the instrument.*

*Please note that the sensor check function is intended to check that the sensors are connected to the unit, installed in the proper orientation and sufficiently level to operate properly. This function should not be confused with a formal calibration, which requires the sensors be checked against a reference that is traceable to a known standard. Instantel recommends that products be returned to Instantel or an authorized service and calibration facility for annual calibration.*

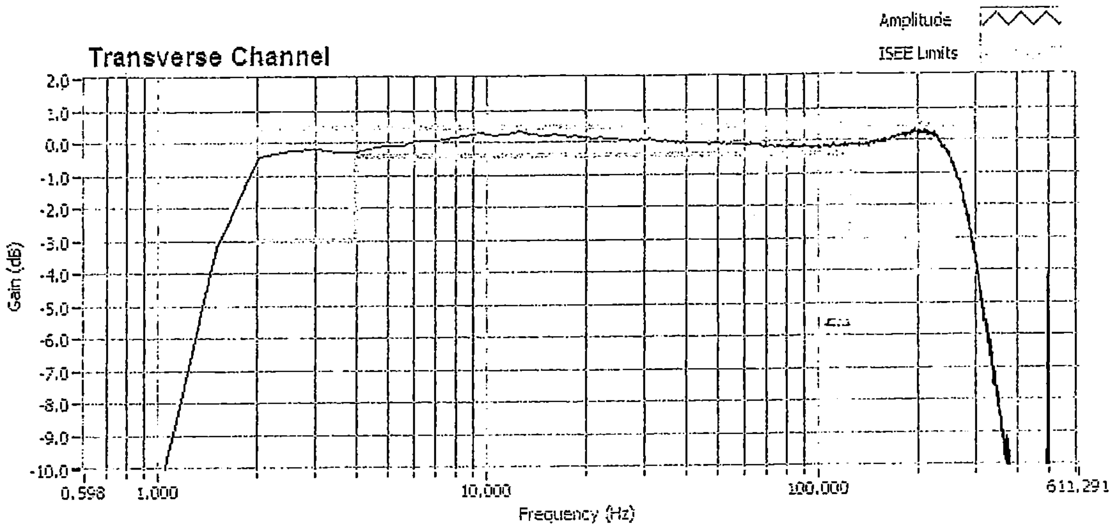
Calibrated By: Dan Sawyer
Dan Sawyer

Instantel

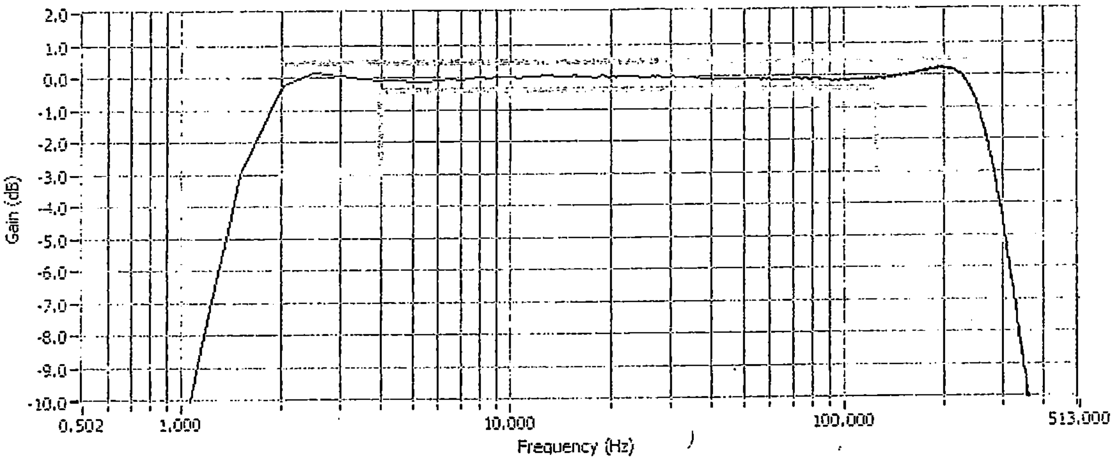
F

# Amplitude Frequency Response of BG9432

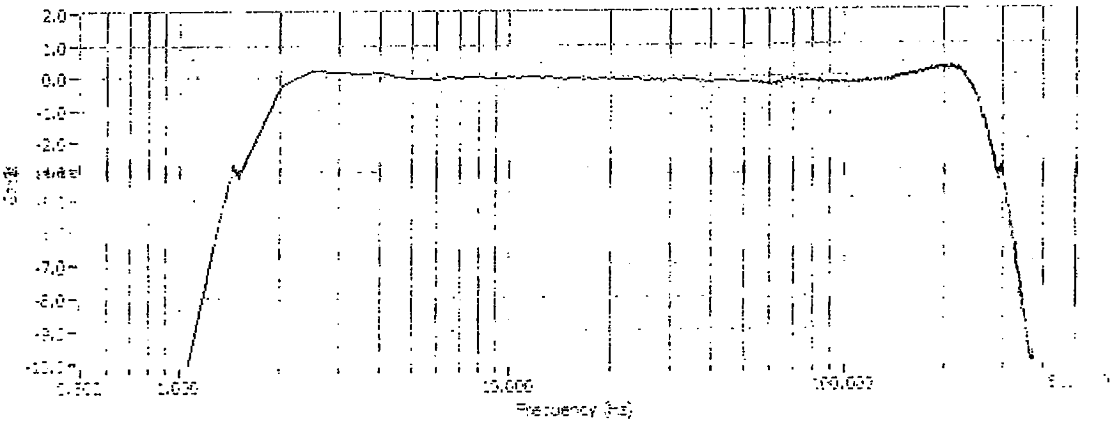
## Transverse Channel



## Vertical Channel



## Longitudinal Channel



# APPENDIX B

# Vibration monitoring logs

LOCATION A

```
                                                      ba11348__mlg
Printed: November 13, 2009 (V 8.01 - 8.01)  Event Report: Monitor Log

    Start Time            End Time                                          Status

------------------------  ------------------------                          SERIAL NUMBER: BA11348

Nov 11 /09 08:13:45                                    Start Monitoring Trigger Level: Geo: 0.0200 in/s
Nov 11 /09 08:13:50  Nov 11 /09 08:13:55                  Event recorded.  Trigger Vert: 0.0200 in/s
Nov 11 /09 08:13:55                                    Start Monitoring Trigger Level: Geo: 0.0200 in/s
Nov 11 /09 08:14:13  Nov 11 /09 08:14:18                  Event recorded.  Trigger Vert: 0.0200 in/s
Nov 11 /09 08:14:18                                    Start Monitoring Trigger Level: Geo: 0.0200 in/s
Nov 11 /09 08:14:32  Nov 11 /09 08:14:37                  Event recorded.  Trigger Vert: 0.0200 in/s
Nov 11 /09 08:14:37  Nov 11 /09 08:14:40  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
Nov 11 /09 08:15:43                                    Start Monitoring Trigger Level: Geo: 0.0200 in/s
Nov 11 /09 08:15:55  Nov 11 /09 08:16:01                  Event recorded.  Trigger Vert: 0.0200 in/s
Nov 11 /09 08:16:01  Nov 11 /09 08:17:39  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
Nov 11 /09 08:17:55  Nov 11 /09 09:24:23  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
Nov 11 /09 09:25:10  Nov 11 /09 09:48:10  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
Nov 11 /09 09:49:29                                    Start Monitoring Trigger Level: Geo: 0.0200 in/s
Nov 11 /09 10:02:09  Nov 11 /09 10:02:15                  Event recorded.  Trigger Vert: 0.0200 in/s
Nov 11 /09 10:02:15  Nov 11 /09 10:02:19  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
Nov 11 /09 10:02:52  Nov 11 /09 11:56:07  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
Nov 11 /09 11:56:30                                    Start Monitoring Trigger Level: Geo: 0.0200 in/s
Nov 11 /09 12:13:10  Nov 11 /09 12:15:27                  Event recorded.  Trigger Tran: 0.0200 in/s
Nov 11 /09 12:15:27                                    Start Monitoring Trigger Level: Geo: 0.0200 in/s
Nov 11 /09 13:36:33  Nov 11 /09 13:36:44                  Event recorded.  Trigger Vert: 0.0200 in/s
Nov 11 /09 13:36:44  Nov 11 /09 16:17:16  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
```

LOCATION B

```
                                                ba11347__mlg
Printed: November 13, 2009 (V 8.01 - 8.01)  Event Report: Monitor Log

     Start Time              End Time                                     Status

 ------------------------  ------------------------                       SERIAL NUMBER: BA11347

 Nov 10 /09 23:59:14                                     Start Monitoring Trigger Level: Geo: 0.0500 in/s
 Nov 10 /09 23:59:18  Nov 10 /09 23:59:24                  Event recorded.  Trigger Vert: 0.0500 in/s
 Nov 10 /09 23:59:24  Nov 10 /09 23:59:53           No events recorded.  (Keyboard Exit) Trigger Geo: 0.0500 in/s
 Nov 11 /09 08:06:28                                     Start Monitoring Trigger Level: Geo: 0.0200 in/s
 Nov 11 /09 08:06:34  Nov 11 /09 08:06:39                  Event recorded.  Trigger Vert: 0.0200 in/s
 Nov 11 /09 08:06:39  Nov 11 /09 08:06:58           No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
 Nov 11 /09 08:17:41  Nov 11 /09 09:23:29           No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
 Nov 11 /09 09:24:07  Nov 11 /09 09:48:09           No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
 Nov 11 /09 09:48:35  Nov 11 /09 10:01:54           No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
 Nov 11 /09 10:02:33                                     Start Monitoring Trigger Level: Geo: 0.0200 in/s
 Nov 11 /09 12:13:48  Nov 11 /09 12:13:54                  Event recorded.  Trigger Vert: 0.0200 in/s
 Nov 11 /09 12:13:54                                     Start Monitoring Trigger Level: Geo: 0.0200 in/s
 Nov 11 /09 12:13:58  Nov 11 /09 12:14:45                  Event recorded.  Trigger Vert: 0.0200 in/s
 Nov 11 /09 12:14:45                                     Start Monitoring Trigger Level: Geo: 0.0200 in/s
 Nov 11 /09 12:14:47  Nov 11 /09 12:15:22                  Event recorded.  Trigger Vert: 0.0200 in/s
 Nov 11 /09 12:15:22                                     Start Monitoring Trigger Level: Geo: 0.0200 in/s
 Nov 11 /09 12:15:28  Nov 11 /09 12:16:01                  Event recorded.  Trigger Vert: 0.0200 in/s
 Nov 11 /09 12:16:01  Nov 11 /09 16:17:32           No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
```

LOCATION C

```
                                                      ba10619__mlg
Printed: November 13, 2009 (V 8.01 - 8.01)  Event Report: Monitor Log

     Start Time             End Time                          Status

  ------------------------  ------------------------          SERIAL NUMBER: BA10619

  Nov 11 /09 08:43:26                                      Start Monitoring Trigger Level: Geo: 0.0200 in/s
  Nov 11 /09 08:43:31  Nov 11 /09 08:43:36                    Event recorded.  Trigger Vert: 0.0200 in/s
  Nov 11 /09 08:43:36  Nov 11 /09 08:43:42   No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 08:44:05  Nov 11 /09 09:18:19   No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 09:18:51                                      Start Monitoring Trigger Level: Geo: 0.0200 in/s
  Nov 11 /09 09:48:29  Nov 11 /09 09:48:35                    Event recorded.  Trigger Long: 0.0200 in/s
  Nov 11 /09 09:48:35  Nov 11 /09 09:54:19   No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 09:57:45  Nov 11 /09 10:13:59   No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 10:14:22  Nov 11 /09 11:50:33   No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 11:51:14                                      Start Monitoring Trigger Level: Geo: 0.0200 in/s
  Nov 11 /09 12:12:59  Nov 11 /09 12:14:16                    Event recorded.  Trigger Vert: 0.0200 in/s
  Nov 11 /09 12:14:16  Nov 11 /09 12:15:15                    Event recorded.  Trigger Tran: 0.0200 in/s
  Nov 11 /09 12:15:15  Nov 11 /09 12:21:05   No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 12:27:00                                      Start Monitoring Trigger Level: Geo: 0.0200 in/s
  Nov 11 /09 13:36:22  Nov 11 /09 13:36:30                    Event recorded.  Trigger Tran: 0.0200 in/s
  Nov 11 /09 13:36:30  Nov 11 /09 13:39:04   No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 13:40:31  Nov 11 /09 16:26:06   No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
```

LOCATION D

```
                                                ba13539__mlg
Printed: November 13, 2009 (V 8.01 - 8.01)  Event Report: Monitor Log

     Start Time            End Time                                  Status

  ----------------------- -----------------------                      SERIAL NUMBER: BA13539

  Nov 11 /09 08:33:28                                Start Monitoring Trigger Level: Geo: 0.0200 in/s
  Nov 11 /09 08:33:33  Nov 11 /09 08:33:38             Event recorded.  Trigger Vert: 0.0200 in/s
  Nov 11 /09 08:33:38  Nov 11 /09 08:33:43  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 08:34:23  Nov 11 /09 09:15:56  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 09:16:27  Nov 11 /09 09:52:23  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 09:52:45  Nov 11 /09 09:57:11  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 09:57:49                                Start Monitoring Trigger Level: Geo: 0.0200 in/s
  Nov 11 /09 12:12:25  Nov 11 /09 12:12:30             Event recorded.  Trigger Long: 0.0200 in/s
  Nov 11 /09 12:12:30  Nov 11 /09 12:18:57  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 12:19:24  Nov 11 /09 16:24:46  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
```

LOCATION E

```
                                              ba13553__mlg
Printed: November 13, 2009 (V 8.01 - 8.01)  Event Report: Monitor Log

     Start Time            End Time                                 Status

   -----------------------  -----------------------                SERIAL NUMBER: BA13553

   Nov 11 /09 08:59:54                              Start Monitoring Trigger Level: Geo: 0.0200 in/s
   Nov 11 /09 08:59:56  Nov 11 /09 09:00:01            Event recorded.  Trigger Tran: 0.0200 in/s
   Nov 11 /09 09:00:38  Nov 11 /09 09:00:40  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
   Nov 11 /09 09:01:33  Nov 11 /09 09:01:36  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
   Nov 11 /09 09:01:54  Nov 11 /09 10:06:08  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
   Nov 11 /09 10:06:34  Nov 11 /09 16:04:25  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
```

LOCATION F

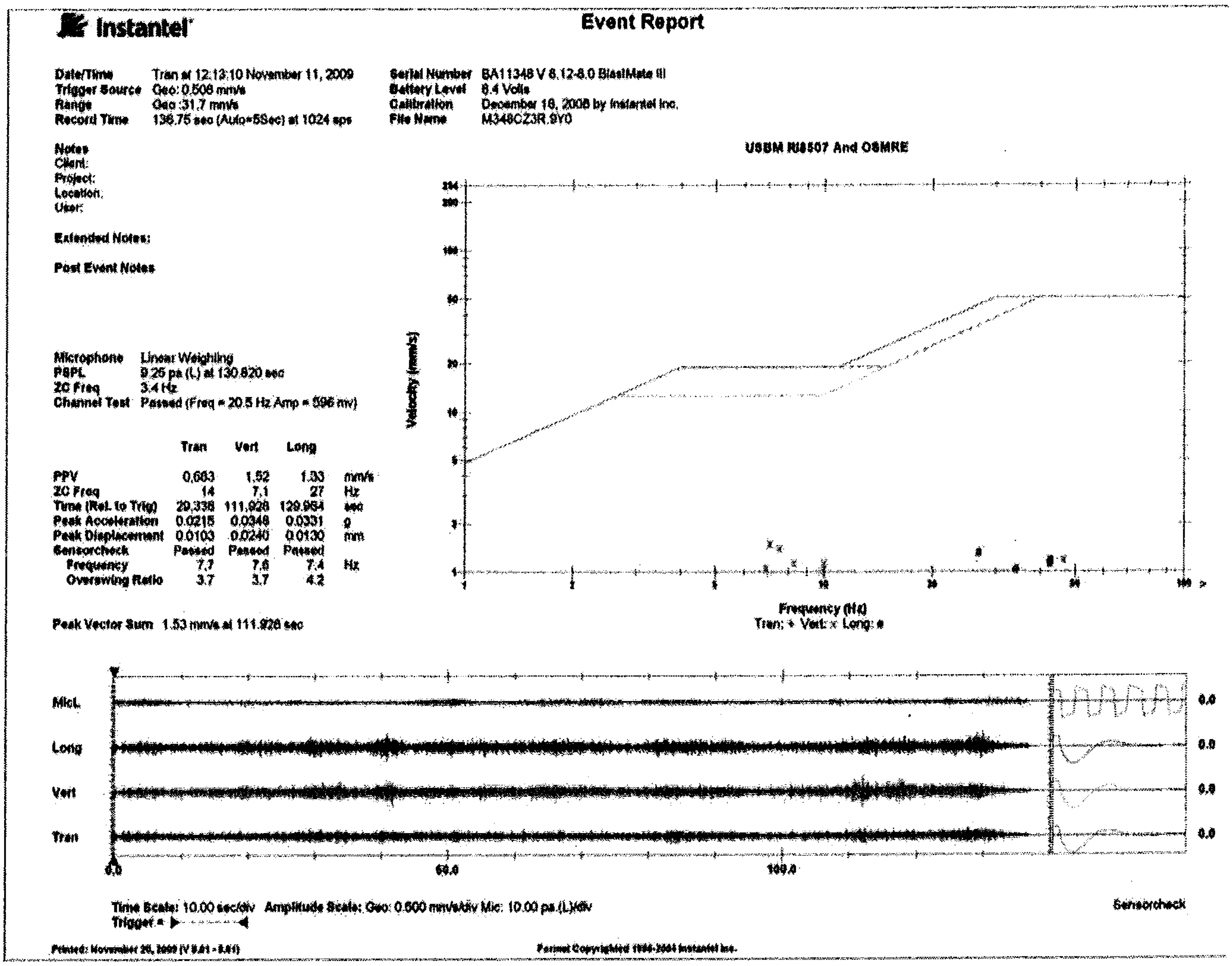
```
                                                          ba11042__mlg
Printed: November 13, 2009 (V 8.01 - 8.01)  Event Report: Monitor Log

      Start Time            End Time                                  Status

  ------------------------  ------------------------                    SERIAL NUMBER: BA11042

  Nov 11 /09 09:10:33                                   Start Monitoring Trigger Level: Geo: 0.0200 in/s
  Nov 11 /09 09:10:40  Nov 11 /09 09:10:45                 Event recorded.  Trigger Tran: 0.0200 in/s
  Nov 11 /09 09:10:45  Nov 11 /09 09:10:52  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 09:11:13  Nov 11 /09 10:08:06  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
  Nov 11 /09 10:08:29  Nov 11 /09 16:08:52  No events recorded.  (Keyboard Exit) Trigger Geo: 0.0200 in/s
```

# APPENDIX C

## Event reports

Friday, November 20, 2009
2:52 PM

A



**Instantel**

## Event Report

**Date/Time** Tran at 12:13:10 November 11, 2009
**Trigger Source** Geo: 0.508 mm/s
**Range** Geo :31.7 mm/s
**Record Time** 136.75 sec (Auto=5Sec) at 1024 sps

**Serial Number** BA11348 V 8.12-8.0 BlastMate III
**Battery Level** 6.4 Volts
**Calibration** December 16, 2008 by Instantel Inc.
**File Name** M348CZ3R.9Y0

**Notes**
**Client:**
**Project:**
**Location:**
**User:**

**Extended Notes:**

**Post Event Notes**

**Microphone** Linear Weighting
**PSPL** 9.25 pa (L) at 130.820 sec
**ZC Freq** 3.4 Hz
**Channel Test** Passed (Freq = 20.5 Hz Amp = 596 mv)

| | Tran | Vert | Long | |
|---|---|---|---|---|
| **PPV** | 0.663 | 1.52 | 1.33 | mm/s |
| **ZC Freq** | 14 | 7.1 | 27 | Hz |
| **Time (Rel. to Trig)** | 29.338 | 111.928 | 129.964 | sec |
| **Peak Acceleration** | 0.0215 | 0.0348 | 0.0331 | g |
| **Peak Displacement** | 0.0103 | 0.0240 | 0.0130 | mm |
| **Sensorcheck** | Passed | Passed | Passed | |
| **Frequency** | 7.7 | 7.6 | 7.4 | Hz |
| **Overswing Ratio** | 3.7 | 3.7 | 4.2 | |

**Peak Vector Sum** 1.53 mm/s at 111.928 sec

**Time Scale:** 10.00 sec/div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 10.00 pa.(L)/div
**Trigger** = ▶- - - - - - -◀

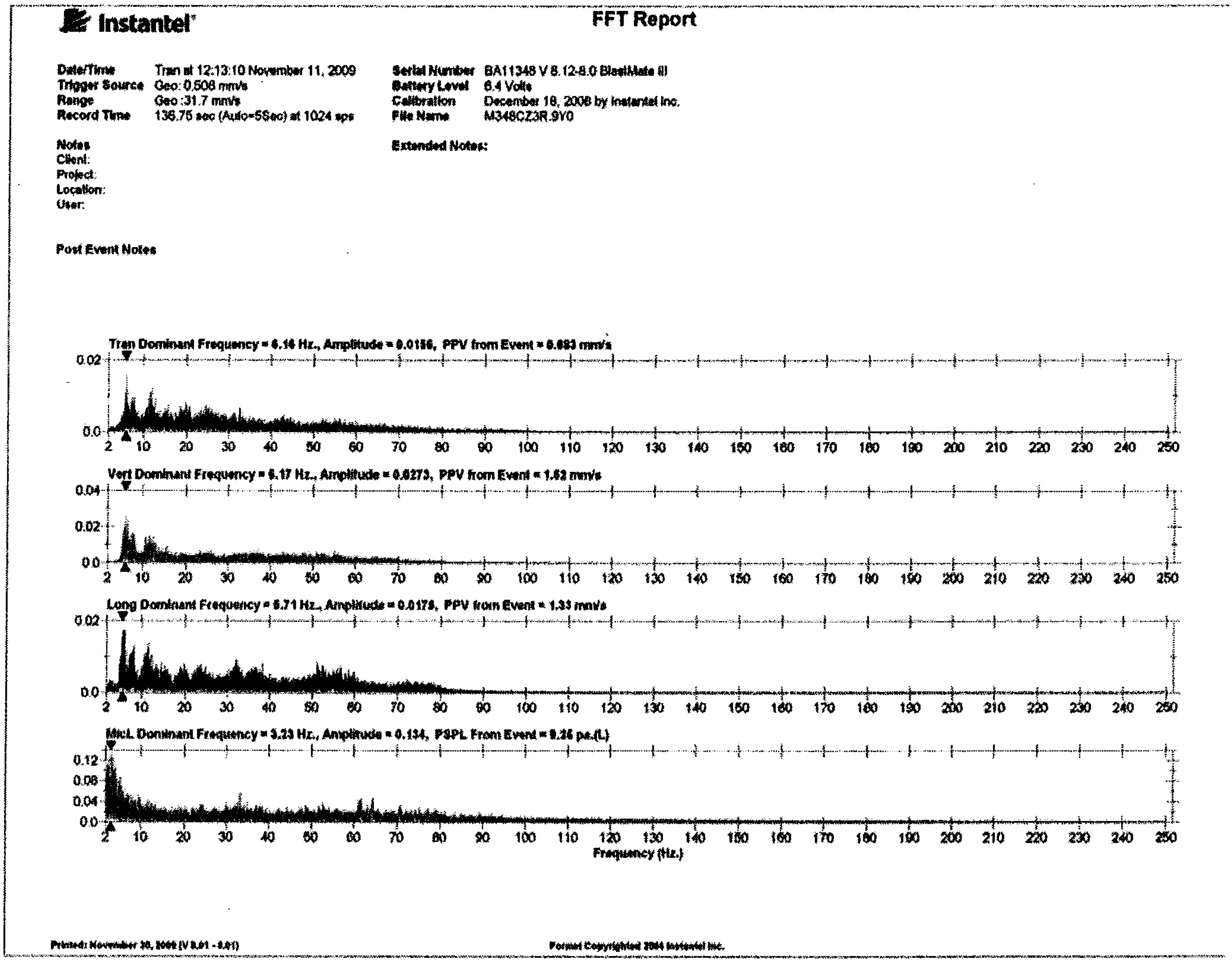
Sensorcheck

Printed: November 20, 2009 (V 9.61 - 9.61)

Format Copyrighted 1996-2004 Instantel Inc.

Monday, November 30, 2009
11:19 AM

A



**Instantel**

# FFT Report

**Date/Time** Tran at 12:13:10 November 11, 2009
**Trigger Source** Geo: 0.508 mm/s
**Range** Geo :31.7 mm/s
**Record Time** 136.75 sec (Auto=5Sec) at 1024 sps

**Serial Number** BA11348 V 8.12-8.0 BlastMate III
**Battery Level** 6.4 Volts
**Calibration** December 18, 2008 by Instantel Inc.
**File Name** M348CZ3R.9Y0

**Notes**
**Client:**
**Project:**
**Location:**
**User:**

**Extended Notes:**

**Post Event Notes**

**Tran Dominant Frequency = 6.16 Hz., Amplitude = 0.0156, PPV from Event = 0.883 mm/s**

**Vert Dominant Frequency = 6.17 Hz., Amplitude = 0.0273, PPV from Event = 1.62 mm/s**

**Long Dominant Frequency = 5.71 Hz., Amplitude = 0.0175, PPV from Event = 1.33 mm/s**

**MicL Dominant Frequency = 3.23 Hz., Amplitude = 0.134, PSPL From Event = 9.25 pa.(L)**

Printed: November 30, 2009 (V 8.01 - 8.01)

Friday, November 20, 2009
2:53 PM

A

**Instantel**

## Event Report

| | | | |
|---|---|---|---|
| **Date/Time** | Vert at 13:38:33 November 11, 2009 | **Serial Number** | BA11348 V 8.12-8.0 BlastMate III |
| **Trigger Source** | Geo: 0.508 mm/s | **Battery Level** | 6.5 Volts |
| **Range** | Geo :31.7 mm/s | **Calibration** | December 18, 2008 by Instantel Inc. |
| **Record Time** | 10.75 sec (Auto=5Sec) at 1024 sps | **File Name** | M348CZ3V.4X0 |

**Notes**
**Client:**
**Project:**
**Location:**
**User:**

**Extended Notes:**

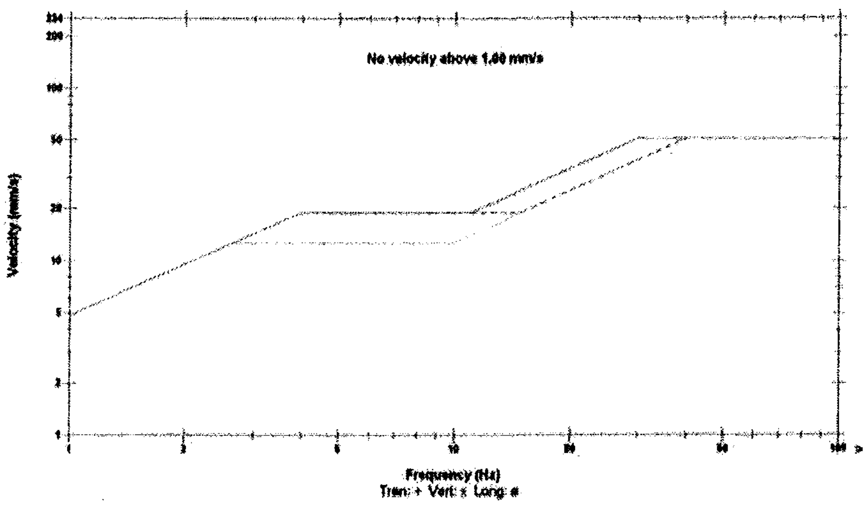
**Post Event Notes**

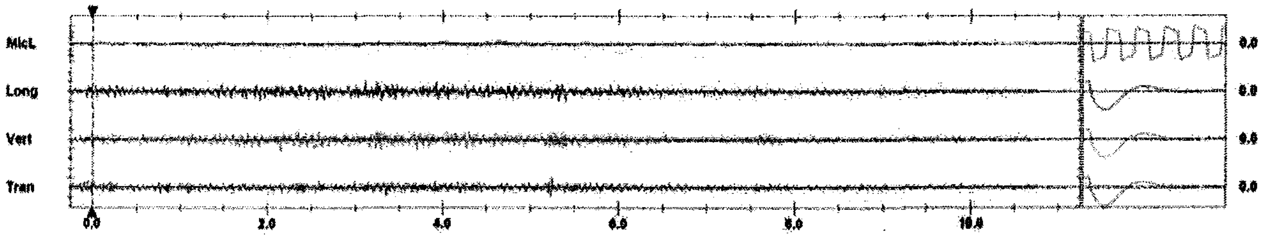
| | |
|---|---|
| **Microphone** | Linear Weighting |
| **PSPL** | 4.75 pa.(L) at 4.303 sec |
| **ZC Freq** | 11 Hz |
| **Channel Test** | Passed (Freq = 20.5 Hz Amp = 598 mv) |

| | Tran | Vert | Long | |
|---|---|---|---|---|
| **PPV** | 0.508 | 0.587 | 0.540 | mm/s |
| **ZC Freq** | 30 | 30 | 12 | Hz |
| **Time (Rel. to Trig)** | 5.245 | 2.150 | 5.401 | sec |
| **Peak Acceleration** | 0.0133 | 0.0149 | 0.0149 | g |
| **Peak Displacement** | 0.00267 | 0.00440 | 0.00415 | mm |
| **Sensorcheck** | Passed | Passed | Passed | |
| **Frequency** | 7.7 | 7.6 | 7.4 | Hz |
| **Overswing Ratio** | 3.7 | 3.7 | 4.2 | |

**Peak Vector Sum** 0.674 mm/s at 3.296 sec

**USBM RI8507 And OSMRE**





**Time Scale:** 0.50 sec/div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 10.00 pa.(L)/div

**Trigger =** ▶- - - - - - -◀

**Sensorcheck**

**Printed:** November 20, 2009 (V 9.61 - 3.61)

Friday, November 20, 2009
2:54 PM

A

**Instantel**

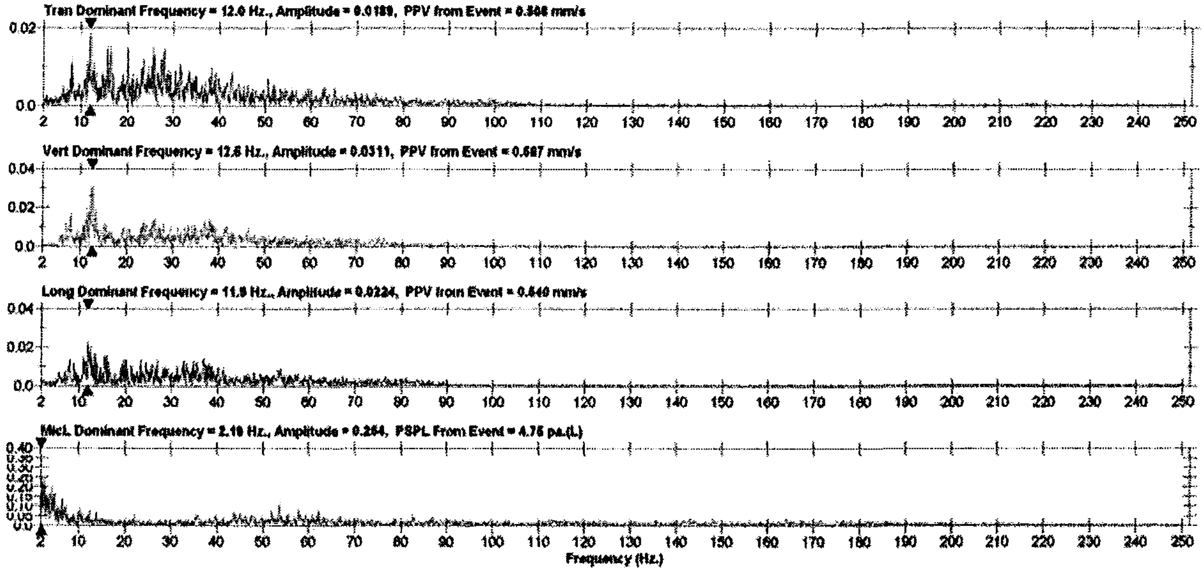
# FFT Report

| | | | |
|---|---|---|---|
| **Date/Time** | Vert at 13:36:33 November 11, 2009 | **Serial Number** | BA11348 V 8.12-8.0 BlastMate III |
| **Trigger Source** | Geo: 0.508 mm/s | **Battery Level** | 6.5 Volts |
| **Range** | Geo :31.7 mm/s | **Calibration** | December 18, 2008 by Instantel Inc. |
| **Record Time** | 10.75 sec (Auto=5Sec) at 1024 sps | **File Name** | M348CZ3V.4X0 |

**Notes**
**Client:**
**Project:**
**Location:**
**User:**

**Extended Notes:**

**Post Event Notes**



**Tran Dominant Frequency = 12.0 Hz., Amplitude = 0.0189, PPV from Event = 0.508 mm/s**

**Vert Dominant Frequency = 12.8 Hz., Amplitude = 0.0311, PPV from Event = 0.687 mm/s**

**Long Dominant Frequency = 11.9 Hz., Amplitude = 0.0224, PPV from Event = 0.640 mm/s**

**Micl. Dominant Frequency = 2.10 Hz., Amplitude = 0.254, PSPL From Event = 4.75 pa.(L)**

Printed: November 20, 2009 (V 9.01 - 3.01)

Friday, November 20, 2009
2:57 PM

B

**Instantel**

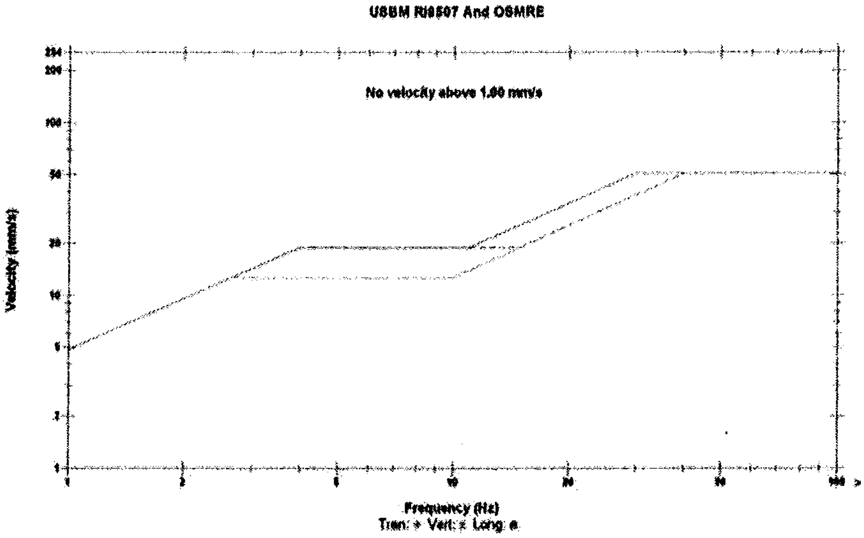
# Event Report

| | | | |
|---|---|---|---|
| **Date/Time** | Vert at 12:13:48 November 11, 2009 | **Serial Number** | BA11347 V 8.12-8.0 BlastMate III |
| **Trigger Source** | Geo: 0.508 mm/s | **Battery Level** | 6.5 Volts |
| **Range** | Geo :31.7 mm/s | **Calibration** | December 18, 2008 by Instantel Inc. |
| **Record Time** | 5.25 sec (Auto=5Sec) at 1024 sps | **File Name** | M347CZ3R.B00 |

**Notes**
**Client:**
**Project:**
**Location:**
**User:**

**Extended Notes:**

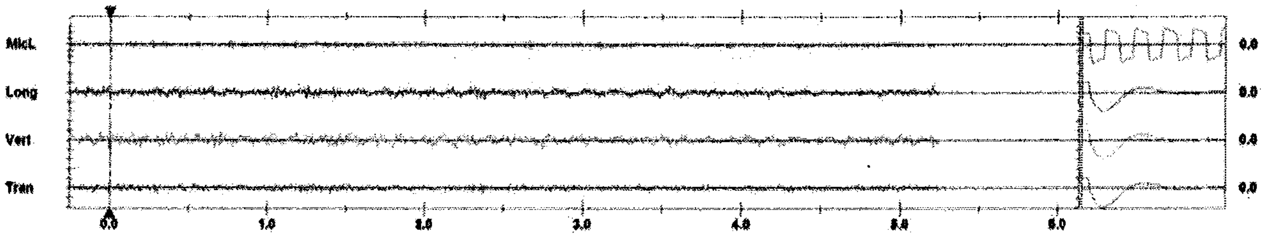
**Post Event Notes**



| | |
|---|---|
| **Microphone** | Linear Weighting |
| **PSPL** | 6.25 pa.(L) at 0.769 sec |
| **ZC Freq** | 51 Hz |
| **Channel Test** | Passed (Freq = 20.1 Hz Amp = 627 mv) |

| | Tran | Vert | Long | |
|---|---|---|---|---|
| **PPV** | 0.254 | 0.556 | 0.333 | mm/s |
| **ZC Freq** | 37 | 27 | 32 | Hz |
| **Time (Rel. to Trig)** | 1.403 | 0.001 | 2.381 | sec |
| **Peak Acceleration** | 0.00829 | 0.00994 | 0.0116 | g |
| **Peak Displacement** | 0.00133 | 0.00533 | 0.00602 | mm |
| **Sensorcheck** | Passed | Passed | Passed | |
| **Frequency** | 7.3 | 7.7 | 7.6 | Hz |
| **Overswing Ratio** | 4.3 | 3.6 | 4.1 | |

**Peak Vector Sum** 0.578 mm/s at 0.002 sec



**Time Scale:** 0.50 sec/div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 10.00 pa.(L)/div
**Trigger** = ▶- - - - - - -◀

Sensorcheck

**Printed: November 20, 2009 (V 8.01 - 8.01)**

B

**Instantel**

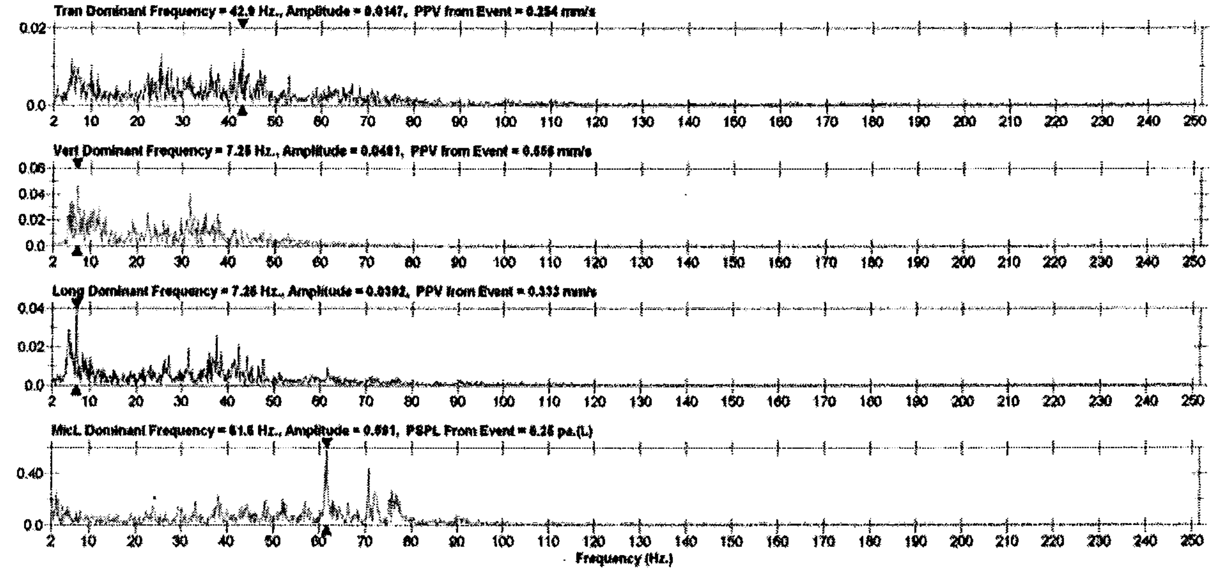
# FFT Report

| | | | |
|---|---|---|---|
| **Date/Time** | Vert at 12:13:48 November 11, 2009 | **Serial Number** | BA11347 V 8.12-8.0 BlastMate III |
| **Trigger Source** | Geo: 0.508 mm/s | **Battery Level** | 6.5 Volts |
| **Range** | Geo :31.7 mm/s | **Calibration** | December 18, 2008 by Instantel Inc. |
| **Record Time** | 5.25 sec (Auto=5Sec) at 1024 sps | **File Name** | M347CZ3R.B00 |

**Notes**
**Client:**
**Project:**
**Location:**
**User:**

**Extended Notes:**

**Post Event Notes**



Tran Dominant Frequency = 42.9 Hz., Amplitude = 0.0147, PPV from Event = 0.254 mm/s

Vert Dominant Frequency = 7.25 Hz., Amplitude = 0.0481, PPV from Event = 0.656 mm/s

Long Dominant Frequency = 7.25 Hz., Amplitude = 0.0392, PPV from Event = 0.333 mm/s

MicL Dominant Frequency = 61.6 Hz., Amplitude = 0.591, PSPL From Event = 0.25 pa.(L)

Printed: November 20, 2009 (V 8.01 - 8.01)

Friday, November 20, 2009
2:58 PM

B

Instantel

# Event Report

**Date/Time** Vert at 12:13:58 November 11, 2009
**Trigger Source** Geo: 0.508 mm/s
**Range** Geo :31.7 mm/s
**Record Time** 46.75 sec (Auto=5Sec) at 1024 sps

**Serial Number** BA11347 V 8.12-8.0 BlastMate III
**Battery Level** 6.4 Volts
**Calibration** December 18, 2008 by Instantel Inc.
**File Name** M347CZ3R.BA0

**Notes**
**Client:**
**Project:**
**Location:**
**User:**

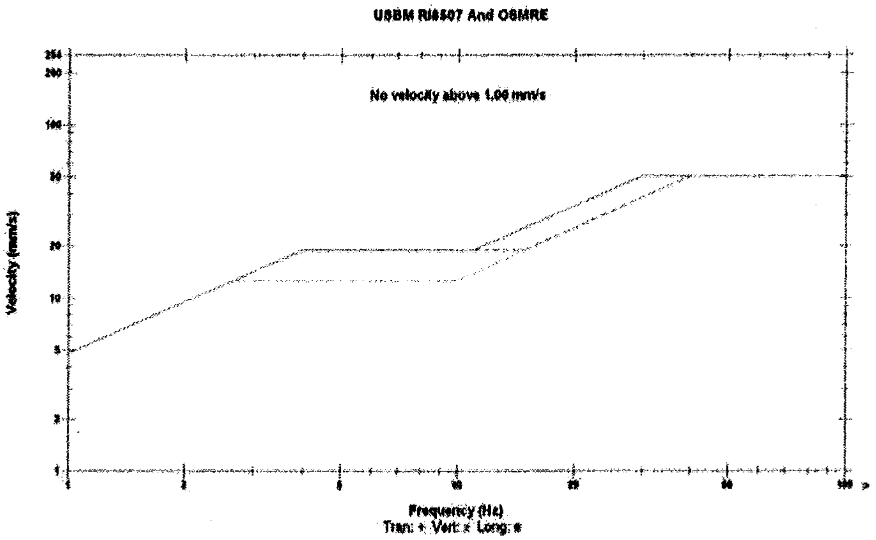
**Extended Notes:**

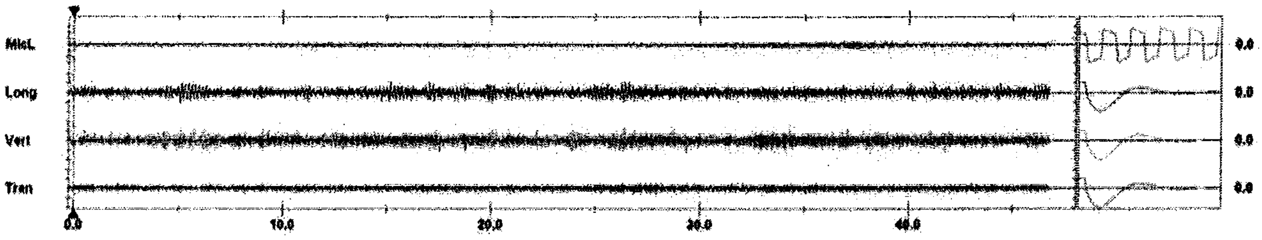
**Post Event Notes**

**Microphone** Linear Weighting
**PSPL** 7.00 pa.(L) at 38.173 sec
**ZC Freq** 32 Hz
**Channel Test** Passed (Freq = 20.1 Hz Amp = 627 mv)

| | Tran | Vert | Long | |
|---|---|---|---|---|
| **PPV** | 0.302 | 0.667 | 0.571 | mm/s |
| **ZC Freq** | 43 | 22 | 7.2 | Hz |
| **Time (Rel. to Trig)** | 27.941 | 40.984 | 17.056 | sec |
| **Peak Acceleration** | 0.0149 | 0.0149 | 0.0149 | g |
| **Peak Displacement** | 0.00395 | 0.0118 | 0.0116 | mm |
| **Sensorcheck** | Passed | Passed | Passed | |
| **Frequency** | 7.3 | 7.7 | 7.5 | Hz |
| **Overswing Ratio** | 4.3 | 3.6 | 4.1 | |

**Peak Vector Sum** 0.719 mm/s at 6.373 sec





**Time Scale:** 5.00 sec/div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 10.00 pa.(L)/div
Trigger = ▶--------◀

Sensorcheck

**Printed: November 20, 2009 (V 8.81 - 8.81)**

Friday, November 20, 2009
2:59 PM

B

**Instantel**

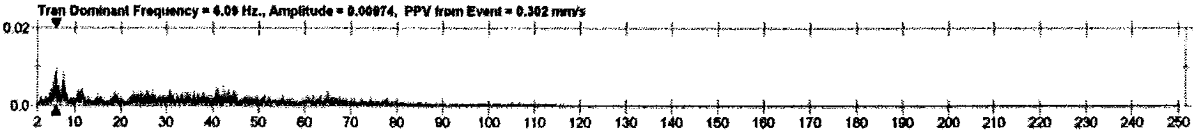
# FFT Report

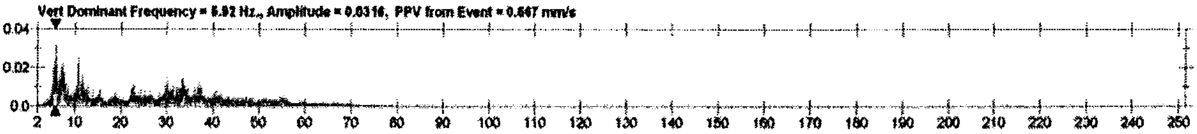
| | | | |
|---|---|---|---|
| **Date/Time** | Vert at 12:13:58 November 11, 2009 | **Serial Number** | BA11347 V 8.12-8.0 BlastMate III |
| **Trigger Source** | Geo: 0.508 mm/s | **Battery Level** | 6.4 Volts |
| **Range** | Geo :31.7 mm/s | **Calibration** | December 18, 2008 by Instantel Inc. |
| **Record Time** | 46.75 sec (Auto=5Sec) at 1024 sps | **File Name** | M347CZ3R.BA0 |

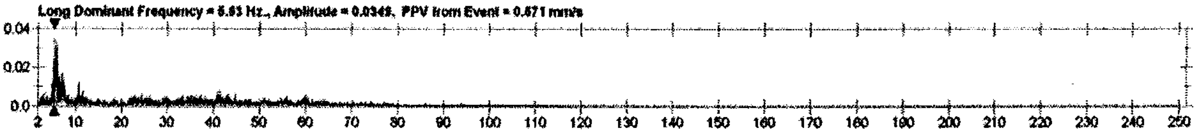
**Notes**
**Client:**
**Project:**
**Location:**
**User:**

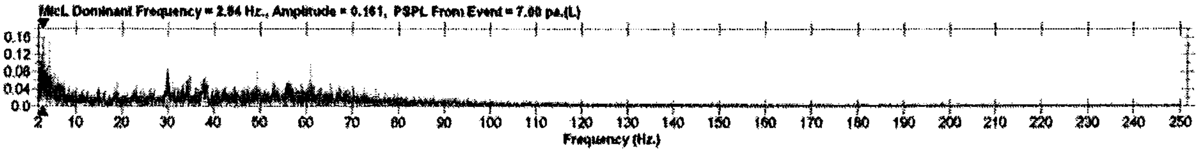
**Extended Notes:**

**Post Event Notes**


**Tran Dominant Frequency = 6.09 Hz., Amplitude = 0.00974, PPV from Event = 0.302 mm/s**

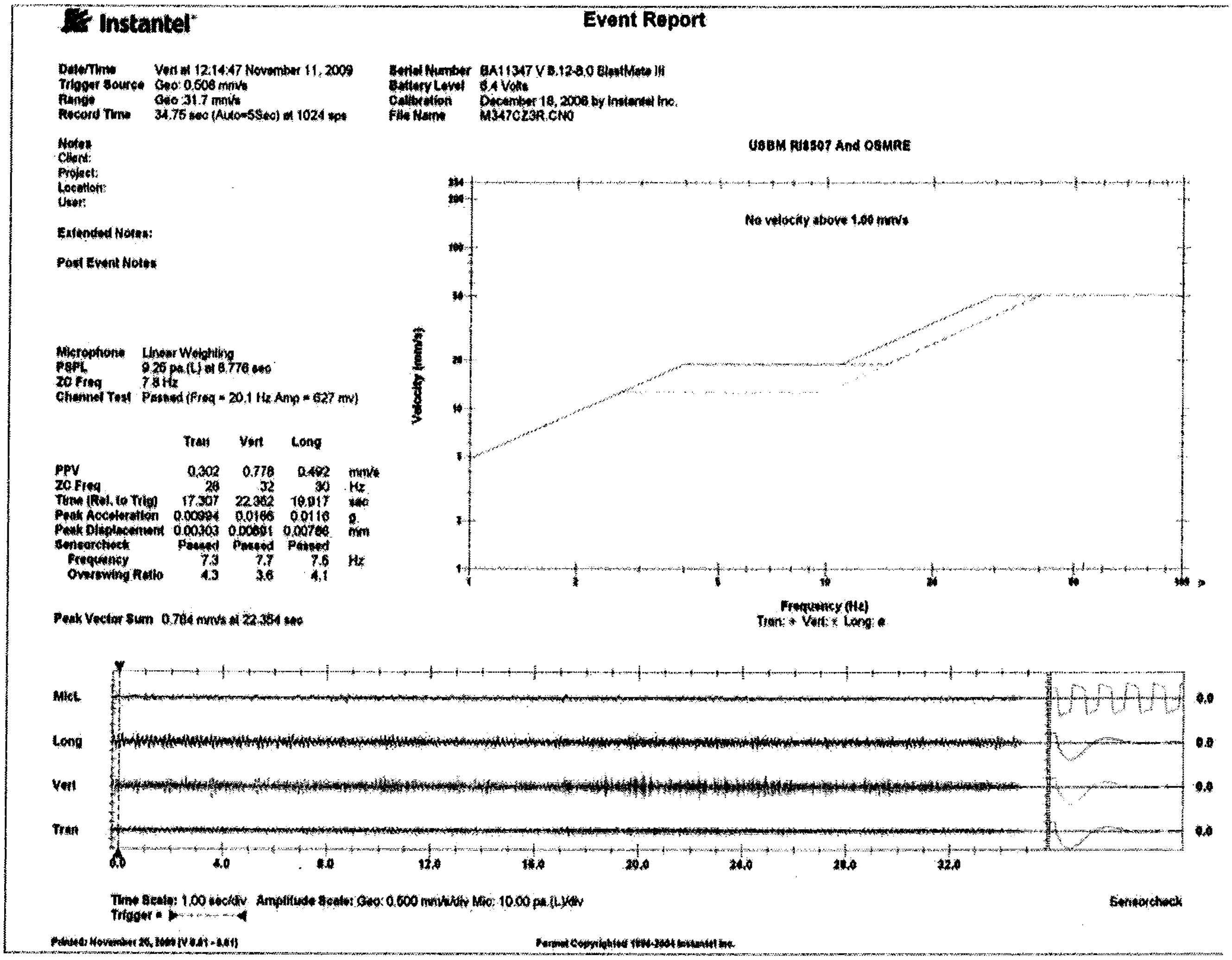

**Vert Dominant Frequency = 5.92 Hz., Amplitude = 0.0316, PPV from Event = 0.667 mm/s**


**Long Dominant Frequency = 5.83 Hz., Amplitude = 0.0348, PPV from Event = 0.671 mm/s**


**MicL Dominant Frequency = 2.84 Hz., Amplitude = 0.161, PSPL From Event = 7.00 pa.(L)**

Friday, November 20, 2009
2:59 PM

B



**Instantel**

## Event Report

| | | | |
|---|---|---|---|
| **Date/Time** | Vert at 12:14:47 November 11, 2009 | **Serial Number** | BA11347 V 8.12-8.0 BlastMate III |
| **Trigger Source** | Geo: 0.508 mm/s | **Battery Level** | 6.4 Volts |
| **Range** | Geo :31.7 mm/s | **Calibration** | December 18, 2008 by Instantel Inc. |
| **Record Time** | 34.75 sec (Auto=5Sec) at 1024 sps | **File Name** | M347CZ3R.CN0 |

**Notes**
**Client:**
**Project:**
**Location:**
**User:**

**Extended Notes:**

**Post Event Notes**

**Microphone** Linear Weighting
**PSPL** 9.25 pa.(L) at 6.776 sec
**ZC Freq** 7.8 Hz
**Channel Test** Passed (Freq = 20.1 Hz Amp = 627 mv)

| | Tran | Vert | Long | |
|---|---|---|---|---|
| **PPV** | 0.302 | 0.778 | 0.492 | mm/s |
| **ZC Freq** | 28 | 32 | 30 | Hz |
| **Time (Rel. to Trig)** | 17.307 | 22.352 | 19.017 | sec |
| **Peak Acceleration** | 0.00994 | 0.0166 | 0.0116 | g |
| **Peak Displacement** | 0.00303 | 0.00591 | 0.00788 | mm |
| **Sensorcheck** | Passed | Passed | Passed | |
| **Frequency** | 7.3 | 7.7 | 7.6 | Hz |
| **Overswing Ratio** | 4.3 | 3.6 | 4.1 | |

**Peak Vector Sum** 0.784 mm/s at 22.354 sec

**USBM RI8507 And OSMRE**

**Time Scale:** 1.00 sec/div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 10.00 pa.(L)/div
**Trigger =** ▶- - - - - -◀

Printed: November 20, 2009 (V 8.81 - 8.81)

Friday, November 20, 2009
3:00 PM

B

Instantel

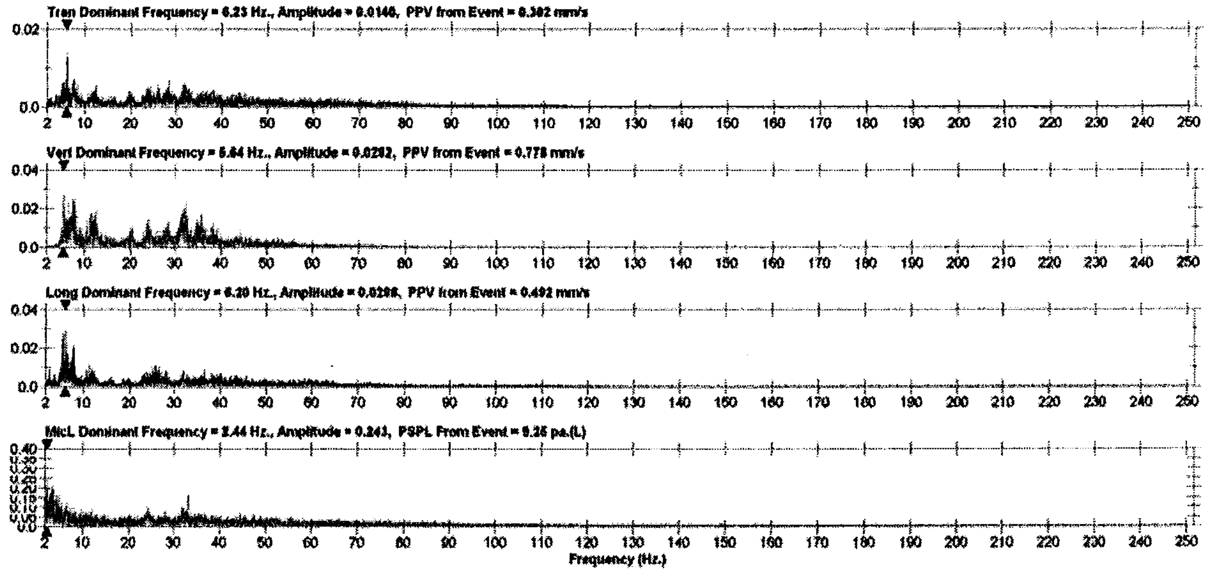
## FFT Report

| | | | |
|---|---|---|---|
| **Date/Time** | Vert at 12:14:47 November 11, 2009 | **Serial Number** | BA11347 V 8.12-8.0 BlastMate III |
| **Trigger Source** | Geo: 0.508 mm/s | **Battery Level** | 6.4 Volts |
| **Range** | Geo :31.7 mm/s | **Calibration** | December 18, 2008 by Instantel Inc. |
| **Record Time** | 34.75 sec (Auto=5Sec) at 1024 sps | **File Name** | M347CZ3R.CN0 |

**Notes**
Client:
Project:
Location:
User:

**Extended Notes:**

**Post Event Notes**



Printed: November 20, 2009 (V 8.01 - 8.01)

Friday, November 20, 2009
3:00 PM

B

**Instantel**

# Event Report

**Date/Time** Vert at 12:15:28 November 11, 2009
**Trigger Source** Geo: 0.508 mm/s
**Range** Geo :31.7 mm/s
**Record Time** 33.25 sec (Auto=5Sec) at 1024 sps

**Serial Number** BA11347 V 8.12-8.0 BlastMate III
**Battery Level** 6.4 Volts
**Calibration** December 18, 2008 by Instantel Inc.
**File Name** M347CZ3R.D50

**Notes**
**Client:**
**Project:**
**Location:**
**User:**

**Extended Notes:**

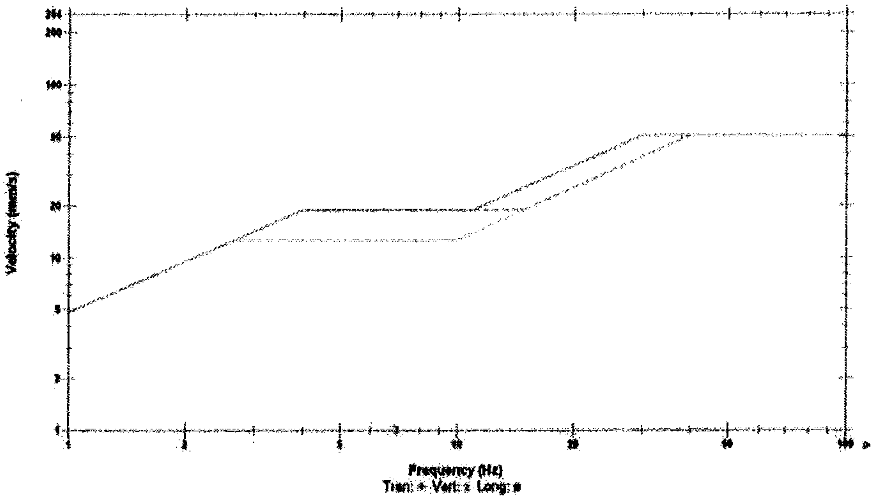
**Post Event Notes**

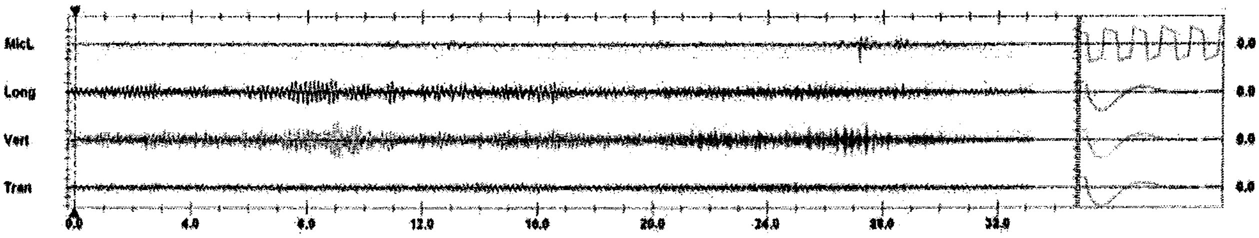
**Microphone** Linear Weighting
**PSPL** 52.0 pa (L) at 27.188 sec
**ZC Freq** 9.1 Hz
**Channel Test** Passed (Freq = 20.1 Hz Amp = 627 mv)

| | Tran | Vert | Long | |
|---|---|---|---|---|
| **PPV** | 0.286 | 1.03 | 0.746 | mm/s |
| **ZC Freq** | 30 | 7.0 | 7.5 | Hz |
| **Time (Rel. to Trig)** | 22.464 | 9.063 | 8.844 | sec |
| **Peak Acceleration** | 0.00994 | 0.0182 | 0.0116 | g |
| **Peak Displacement** | 0.00462 | 0.0211 | 0.0143 | mm |
| **Sensorcheck** | Passed | Passed | Passed | |
| **Frequency** | 7.3 | 7.7 | 7.5 | Hz |
| **Overswing Ratio** | 4.3 | 3.6 | 4.1 | |

**Peak Vector Sum** 1.06 mm/s at 8.927 sec

**USBM RI8507 And OSMRE**





**Time Scale:** 1.00 sec/div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 20.0 pa (L)/div
**Trigger =** ►-----◄

Sensorcheck

Printed: November 20, 2009 (V 9.61 - 9.61)

Friday, November 20, 2009
3:01 PM

B

**Instantel**

# FFT Report

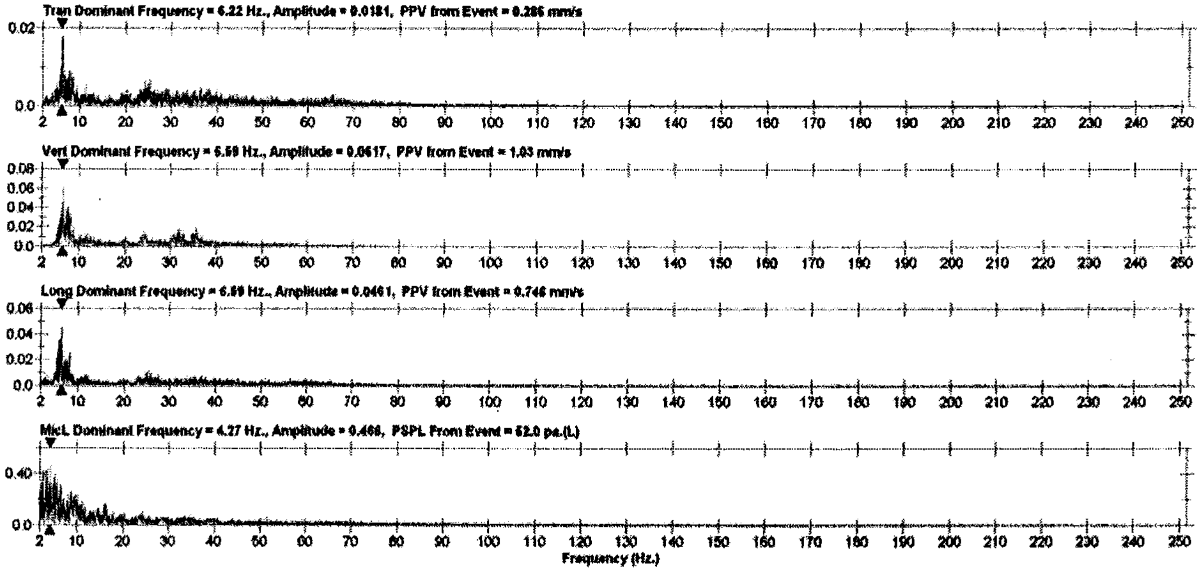
**Date/Time** Vert at 12:15:28 November 11, 2009
**Trigger Source** Geo: 0.508 mm/s
**Range** Geo :31.7 mm/s
**Record Time** 33.25 sec (Auto=5Sec) at 1024 sps

**Serial Number** BA11347 V 8.12-8.0 BlastMate III
**Battery Level** 6.4 Volts
**Calibration** December 18, 2008 by Instantel Inc.
**File Name** M347CZ3R.DS0

**Notes**
Client:
Project:
Location:
User:

**Extended Notes:**

**Post Event Notes**


Tran Dominant Frequency = 6.22 Hz., Amplitude = 0.0181, PPV from Event = 0.286 mm/s

Vert Dominant Frequency = 6.59 Hz., Amplitude = 0.0617, PPV from Event = 1.03 mm/s

Long Dominant Frequency = 6.59 Hz., Amplitude = 0.0461, PPV from Event = 0.746 mm/s

MicL Dominant Frequency = 4.27 Hz., Amplitude = 0.468, PSPL From Event = 52.0 pa.(L)

Printed: November 20, 2009 (V 8.01 - 8.01)

C

**Instantel**

# Event Report

**Date/Time** Long at 09:48:29 November 11, 2009
**Trigger Source** Geo: 0.508 mm/s
**Range** Geo :254 mm/s
**Record Time** 5.75 sec (Auto=5Sec) at 1024 sps

**Serial Number** BA10619 V 8.12-8.0 BlastMate III
**Battery Level** 6.3 Volts
**Calibration** May 27, 2009 by Instantel Inc.
**File Name** L619CZ3K.KT0

**Notes**
Client:
Project:
Location:
User:

**Extended Notes:**

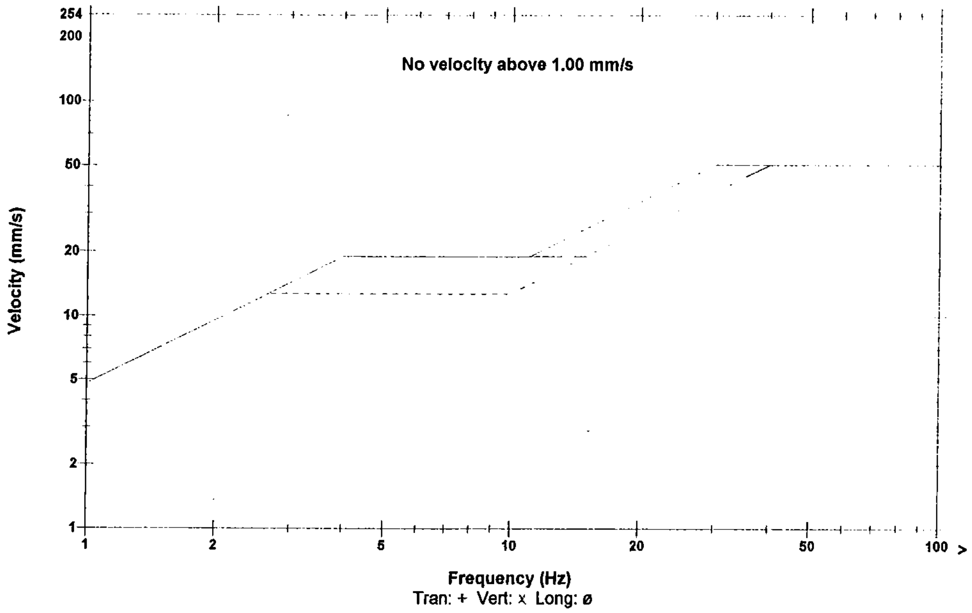
**Post Event Notes**

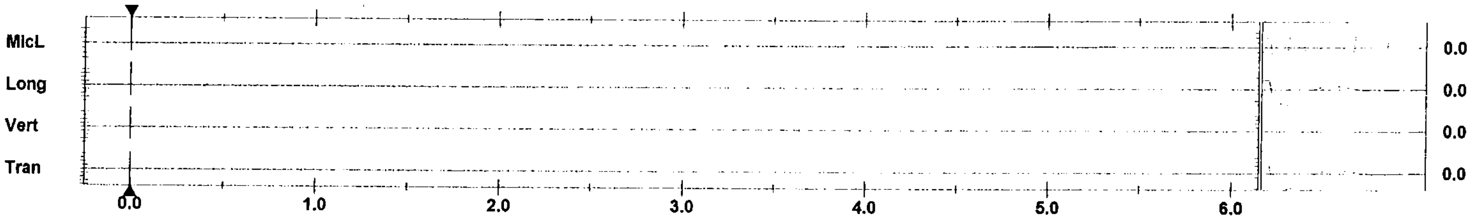
**Microphone** Linear Weighting
**PSPL** 1.50 pa.(L) at 0.165 sec
**ZC Freq** 51 Hz
**Channel Test** Passed (Freq = 20.1 Hz Amp = 614 mv)

| | Tran | Vert | Long | |
|---|---|---|---|---|
| **PPV** | 0.381 | 0.508 | 0.508 | mm/s |
| **ZC Freq** | 51 | 47 | 37 | Hz |
| **Time (Rel. to Trig)** | 0.682 | 0.006 | 0.000 | sec |
| **Peak Acceleration** | 0.0133 | 0.0265 | 0.0265 | g |
| **Peak Displacement** | 0.00130 | 0.00192 | 0.00291 | mm |
| **Sensorcheck** | Passed | Passed | Passed | |
| **Frequency** | 7.2 | 7.4 | 7.5 | Hz |
| **Overswing Ratio** | 4.2 | 3.5 | 4.0 | |

**Peak Vector Sum** 0.568 mm/s at 0.002 sec

**USBM RI8507 And OSMRE**





**Time Scale:** 0.50 sec/div **Amplitude Scale:** Geo: 2.00 mm/s/div Mic: 10.00 pa.(L)/div
**Trigger** = ▶—— ——◀

Sensorcheck

Printed: November 20, 2009 (V 8.01 - 8.01)

C

**Instantel**

# FFT Report

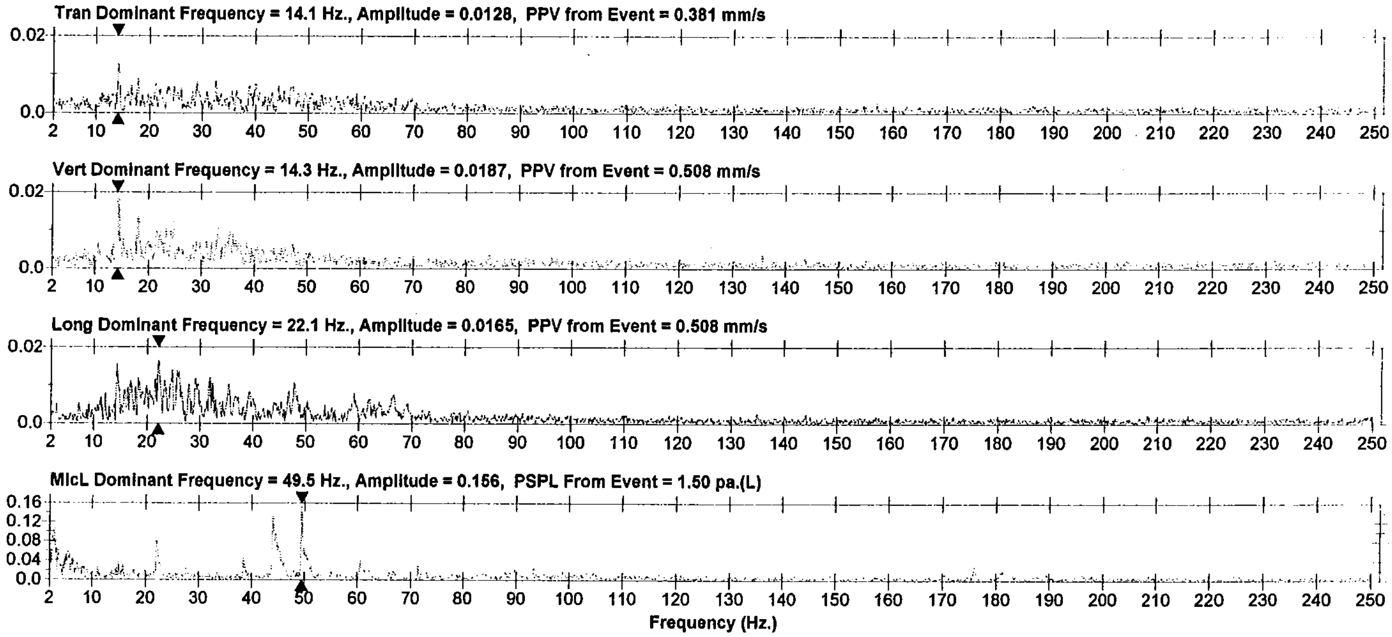
**Date/Time** Long at 09:48:29 November 11, 2009
**Trigger Source** Geo: 0.508 mm/s
**Range** Geo :254 mm/s
**Record Time** 5.75 sec (Auto=5Sec) at 1024 sps

**Serial Number** BA10619 V 8.12-8.0 BlastMate III
**Battery Level** 6.3 Volts
**Calibration** May 27, 2009 by Instantel Inc.
**File Name** L619CZ3K.KT0

**Notes**
Client:
Project:
Location:
User:

**Extended Notes:**

**Post Event Notes**



Printed: November 20, 2009 (V 8.01 - 8.01)

C

**Instantel**

# Event Report

| | |
|---|---|
| **Date/Time** | Vert at 12:12:59 November 11, 2009 |
| **Trigger Source** | Geo: 0.508 mm/s |
| **Range** | Geo :31.7 mm/s |
| **Record Time** | 77.25 sec (Auto=5Sec) at 1024 sps |

| | |
|---|---|
| **Serial Number** | BA10619 V 8.12-8.0 BlastMate III |
| **Battery Level** | 6.3 Volts |
| **Calibration** | May 27, 2009 by Instantel Inc. |
| **File Name** | L619CZ3R.9N0 |

**Notes**
Client:
Project:
Location:
User:

**Extended Notes:**

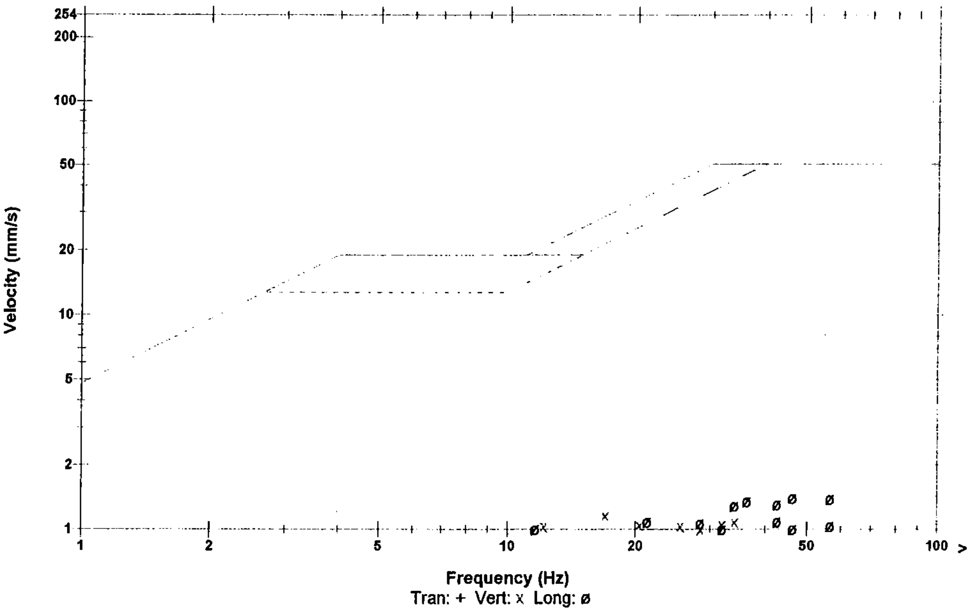
**Post Event Notes**

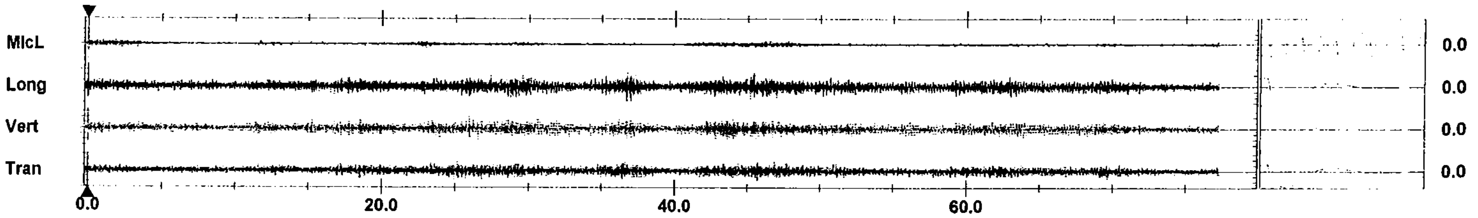
| | |
|---|---|
| **Microphone** | Linear Weighting |
| **PSPL** | 9.00 pa.(L) at 22.708 sec |
| **ZC Freq** | 39 Hz |
| **Channel Test** | Passed (Freq = 20.1 Hz Amp = 534 mv) |

| | Tran | Vert | Long | |
|---|---|---|---|---|
| **PPV** | 0.905 | 1.16 | 1.40 | mm/s |
| **ZC Freq** | 14 | 17 | 47 | Hz |
| **Time (Rel. to Trig)** | 45.714 | 25.931 | 36.707 | sec |
| **Peak Acceleration** | 0.0298 | 0.0298 | 0.0464 | g |
| **Peak Displacement** | 0.00846 | 0.0152 | 0.00843 | mm |
| **Sensorcheck** | Passed | Passed | Passed | |
| **Frequency** | 7.2 | 7.4 | 7.5 | Hz |
| **Overswing Ratio** | 4.1 | 3.5 | 4.0 | |

**Peak Vector Sum** 1.61 mm/s at 36.707 sec

**USBM RI8507 And OSMRE**





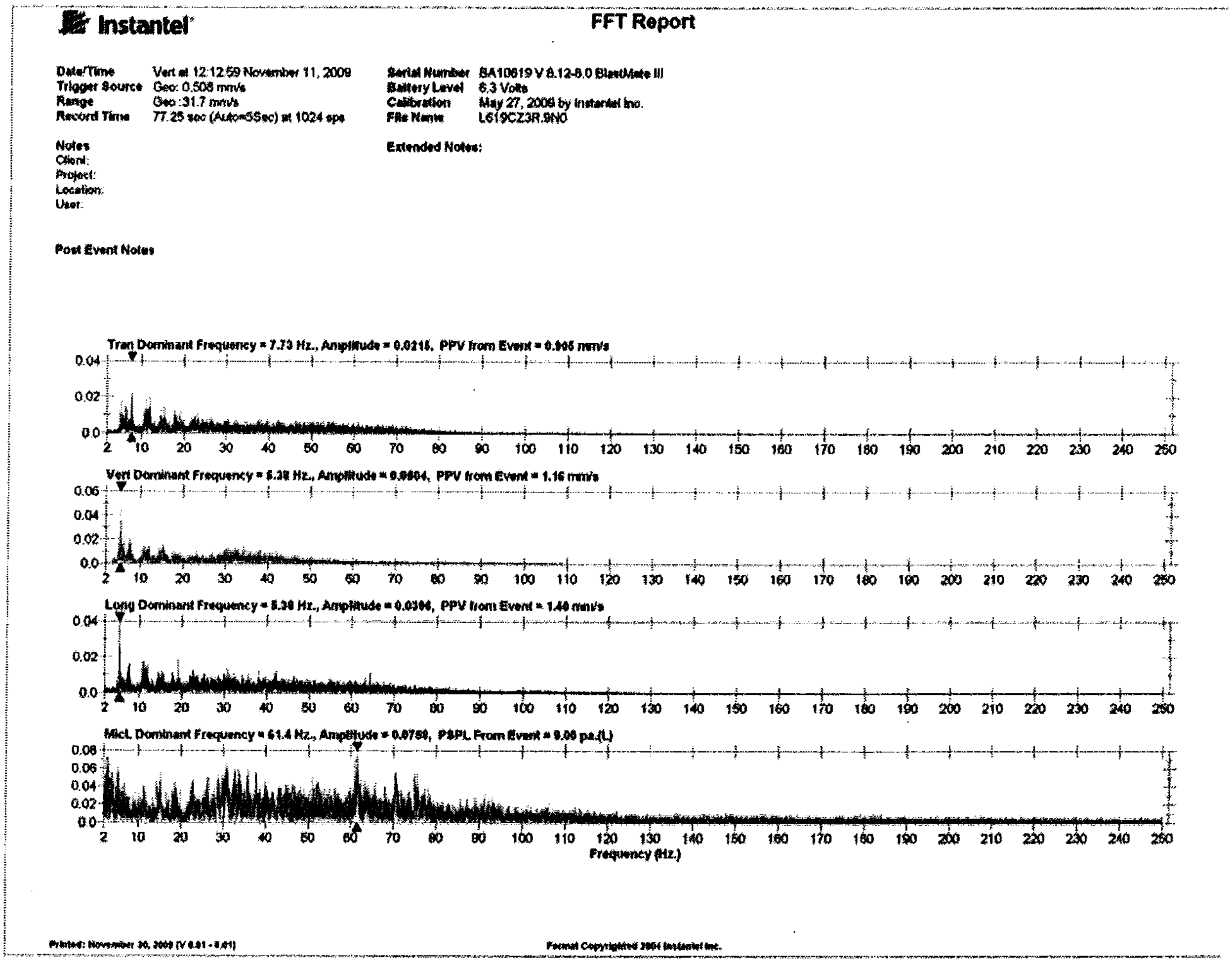
**Time Scale:** 5.00 sec/div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 10.00 pa.(L)/div
**Trigger =** ▶------◀

Sensorcheck

**Printed: November 20, 2009 (V 8.01 - 8.01)**

Monday, November 30, 2009
12:10 PM

C



Instantel

## FFT Report

| | | | |
|---|---|---|---|
| **Date/Time** | Vert at 12:12:59 November 11, 2009 | **Serial Number** | BA10619 V 8.12-8.0 BlastMate III |
| **Trigger Source** | Geo: 0.508 mm/s | **Battery Level** | 6.3 Volts |
| **Range** | Geo :31.7 mm/s | **Calibration** | May 27, 2009 by Instantel Inc. |
| **Record Time** | 77.25 sec (Auto=5Sec) at 1024 sps | **File Name** | L619CZ3R.9N0 |

**Notes**
Client:
Project:
Location:
User:

**Extended Notes:**

**Post Event Notes**

Tran Dominant Frequency = 7.73 Hz., Amplitude = 0.0215, PPV from Event = 0.965 mm/s

Vert Dominant Frequency = 5.38 Hz., Amplitude = 0.0504, PPV from Event = 1.16 mm/s

Long Dominant Frequency = 5.38 Hz., Amplitude = 0.0396, PPV from Event = 1.40 mm/s

Micl. Dominant Frequency = 61.4 Hz., Amplitude = 0.0759, PSPL From Event = 9.00 pa.(L)

Printed: November 30, 2009 (V 8.01 - 8.01)

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Friday, November 20, 2009
2:47 PM

C

**Instantel**

# Event Report

| | | | |
|---|---|---|---|
| **Date/Time** | Tran at 12:14:16 November 11, 2009 | **Serial Number** | BA10619 V 8.12-8.0 BlastMate III |
| **Trigger Source** | Geo: 0.508 mm/s | **Battery Level** | 6.3 Volts |
| **Range** | Geo :31.7 mm/s | **Calibration** | May 27, 2009 by Instantel Inc. |
| **Record Time** | 58.75 sec (Auto=5Sec) at 1024 sps | **File Name** | L619CZ3R.BS0 |

**Notes**
Client:
Project:
Location:
User:

**Extended Notes:**

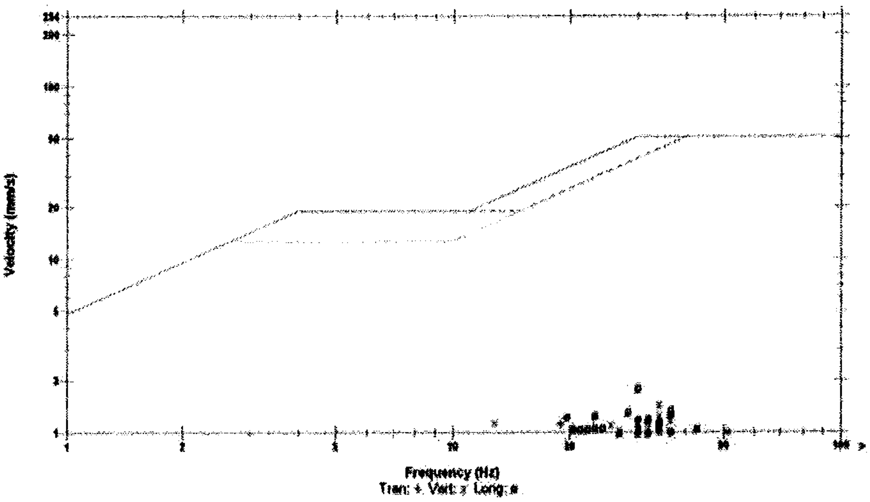
**Post Event Notes**

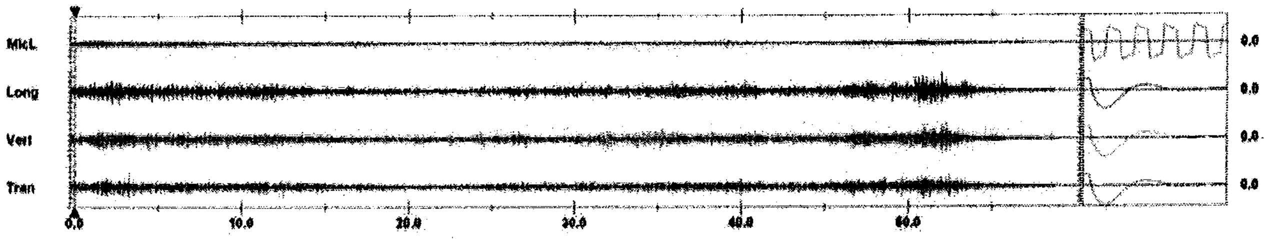
**Microphone** Linear Weighting
**PSPL** 7.00 pa (L) at 0.914 sec
**ZC Freq** 32 Hz
**Channel Test** Passed (Freq = 20.1 Hz Amp = 534 mv)

| | Tran | Vert | Long | |
|---|---|---|---|---|
| **PPV** | 1.16 | 1.48 | 1.81 | mm/s |
| **ZC Freq** | 34 | 34 | 30 | Hz |
| **Time (Rel. to Trig)** | 3.227 | 52.262 | 51.972 | sec |
| **Peak Acceleration** | 0.0298 | 0.0331 | 0.0398 | g |
| **Peak Displacement** | 0.00788 | 0.0184 | 0.00942 | mm |
| **Sensorcheck** | Passed | Passed | Passed | |
| **Frequency** | 7.2 | 7.4 | 7.5 | Hz |
| **Overswing Ratio** | 4.1 | 3.6 | 4.0 | |

**Peak Vector Sum** 1.98 mm/s at 51.972 sec

**USBM RI8507 And OSMRE**





Time Scale: 5.00 sec/div Amplitude Scale: Geo: 0.500 mm/s/div Mic: 10.00 pa.(L)/div
Trigger = ▶------◀

Sensorcheck

Printed: November 20, 2009 (V 8.01 - 8.01)

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Friday, November 20, 2009
2:48 PM

C

**Instantel**

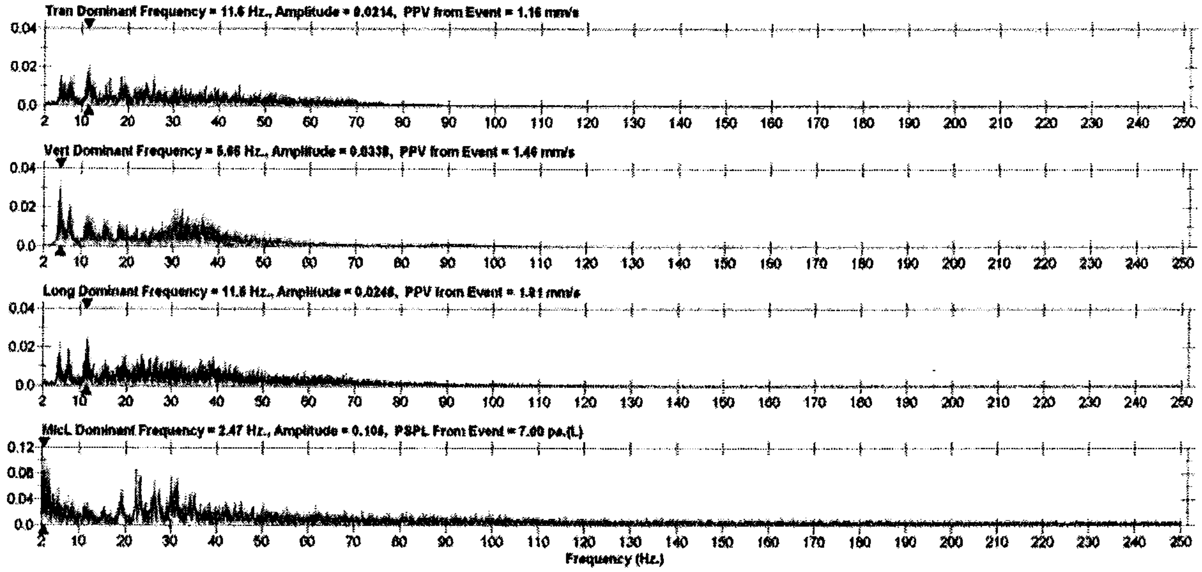
# FFT Report

| | | | |
|---|---|---|---|
| **Date/Time** | Tran at 12:14:16 November 11, 2009 | **Serial Number** | BA10619 V 8.12-8.0 BlastMate III |
| **Trigger Source** | Geo: 0.508 mm/s | **Battery Level** | 6.3 Volts |
| **Range** | Geo :31.7 mm/s | **Calibration** | May 27, 2009 by Instantel Inc. |
| **Record Time** | 58.75 sec (Auto=5Sec) at 1024 sps | **File Name** | L619CZ3R.BS0 |

**Notes**
**Client:**
**Project:**
**Location:**
**User:**

**Extended Notes:**

**Post Event Notes**


**Tran Dominant Frequency = 11.6 Hz., Amplitude = 0.0214, PPV from Event = 1.16 mm/s**

**Vert Dominant Frequency = 5.66 Hz., Amplitude = 0.0338, PPV from Event = 1.46 mm/s**

**Long Dominant Frequency = 11.6 Hz., Amplitude = 0.0248, PPV from Event = 1.81 mm/s**

**MicL Dominant Frequency = 2.47 Hz., Amplitude = 0.104, PSPL From Event = 7.00 pa.(L.)**

**Printed: November 20, 2009 (V 8.01 - 8.01)**

Friday, November 20, 2009
2:49 PM

C

**Instantel**

# Event Report

| | | | |
|---|---|---|---|
| **Date/Time** | Tran at 13:36:22 November 11, 2009 | **Serial Number** | BA10619 V 8.12-8.0 BlastMate III |
| **Trigger Source** | Geo: 0.508 mm/s | **Battery Level** | 6.4 Volts |
| **Range** | Geo :31.7 mm/s | **Calibration** | May 27, 2009 by Instantel Inc. |
| **Record Time** | 7.75 sec (Auto=5Sec) at 1024 sps | **File Name** | L619CZ3V.4M0 |

**Notes**
**Client:**
**Project:**
**Location:**
**User:**

**Extended Notes:**

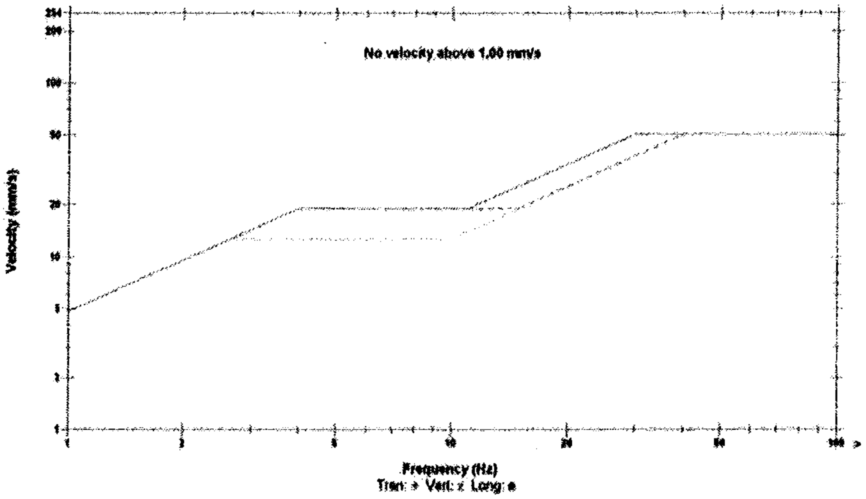
**Post Event Notes**

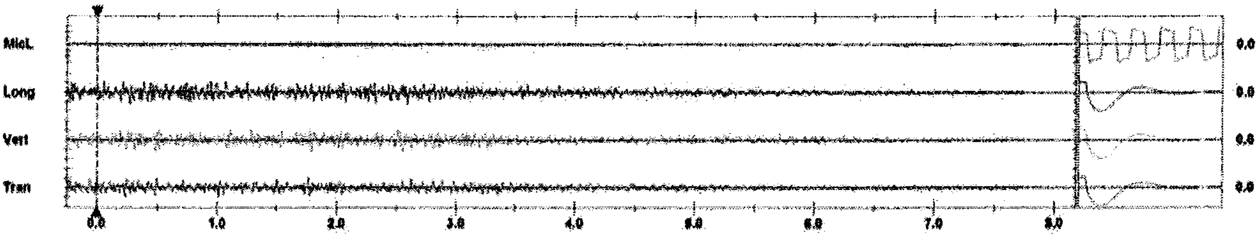
| | |
|---|---|
| **Microphone** | Linear Weighting |
| **PSPL** | 4.25 pa.(L) at 1.878 sec |
| **ZC Freq** | >100 Hz |
| **Channel Test** | Passed (Freq = 20.5 Hz Amp = 533 mv) |

| | Tran | Vert | Long | |
|---|---|---|---|---|
| **PPV** | 0.524 | 0.635 | 0.667 | mm/s |
| **ZC Freq** | 32 | 30 | 30 | Hz |
| **Time (Rel. to Trig)** | 0.000 | 1.792 | 0.270 | sec |
| **Peak Acceleration** | 0.0149 | 0.0149 | 0.0199 | g |
| **Peak Displacement** | 0.00315 | 0.00379 | 0.00378 | mm |
| **Sensorcheck** | Passed | Passed | Passed | |
| **Frequency** | 7.2 | 7.4 | 7.5 | Hz |
| **Overswing Ratio** | 4.1 | 3.6 | 4.0 | |

**Peak Vector Sum** 0.738 mm/s at 2.812 sec

**USBM RI8507 And OSMRE**





Time Scale: 0.50 sec/div Amplitude Scale: Geo: 0.500 mm/s/div Mic: 10.00 pa.(L)/div
Trigger = ▶------◀

Sensorcheck

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C

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# FFT Report

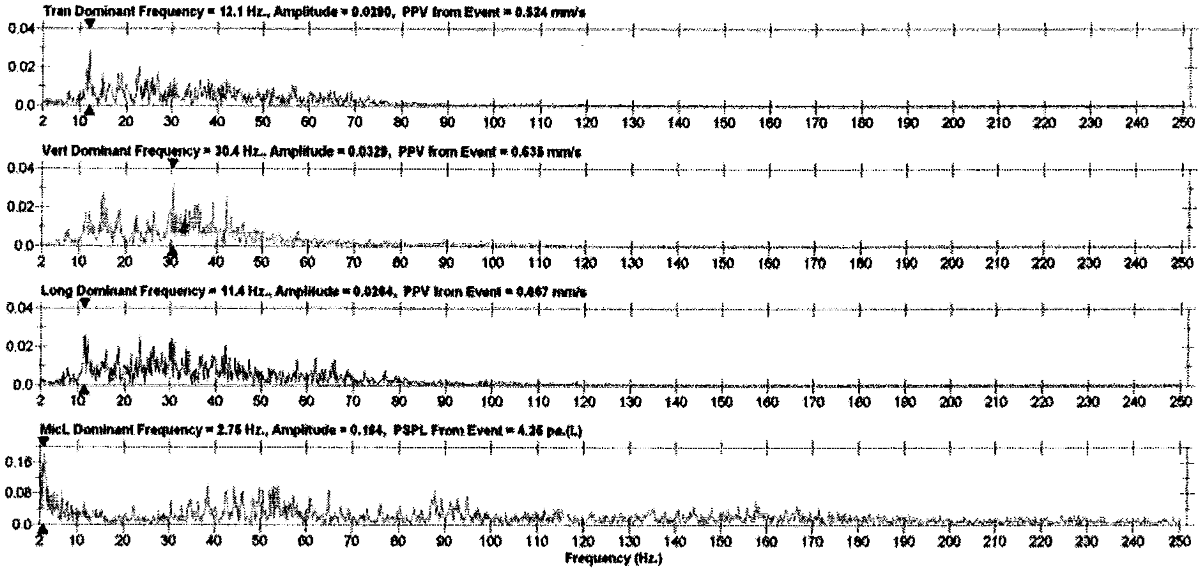
**Date/Time** Tran at 13:36:22 November 11, 2009
**Trigger Source** Geo: 0.508 mm/s
**Range** Geo :31.7 mm/s
**Record Time** 7.75 sec (Auto=5Sec) at 1024 sps

**Serial Number** BA10519 V 8.12-8.0 BlastMate III
**Battery Level** 6.4 Volts
**Calibration** May 27, 2009 by Instantel Inc.
**File Name** L619CZ3V.4M0

**Notes**
**Client:**
**Project:**
**Location:**
**User:**

**Extended Notes:**

**Post Event Notes**



**Tran Dominant Frequency = 12.1 Hz., Amplitude = 0.0290, PPV from Event = 0.524 mm/s**

**Vert Dominant Frequency = 30.4 Hz., Amplitude = 0.0329, PPV from Event = 0.635 mm/s**

**Long Dominant Frequency = 11.4 Hz., Amplitude = 0.0264, PPV from Event = 0.467 mm/s**

**MicL Dominant Frequency = 2.75 Hz., Amplitude = 0.184, PSPL From Event = 4.25 pa.(L)**

Printed: November 20, 2009 [V 8.01 - 8.01]

Friday, November 20, 2009
2:56 PM

D

**Instantel**

# FFT Report

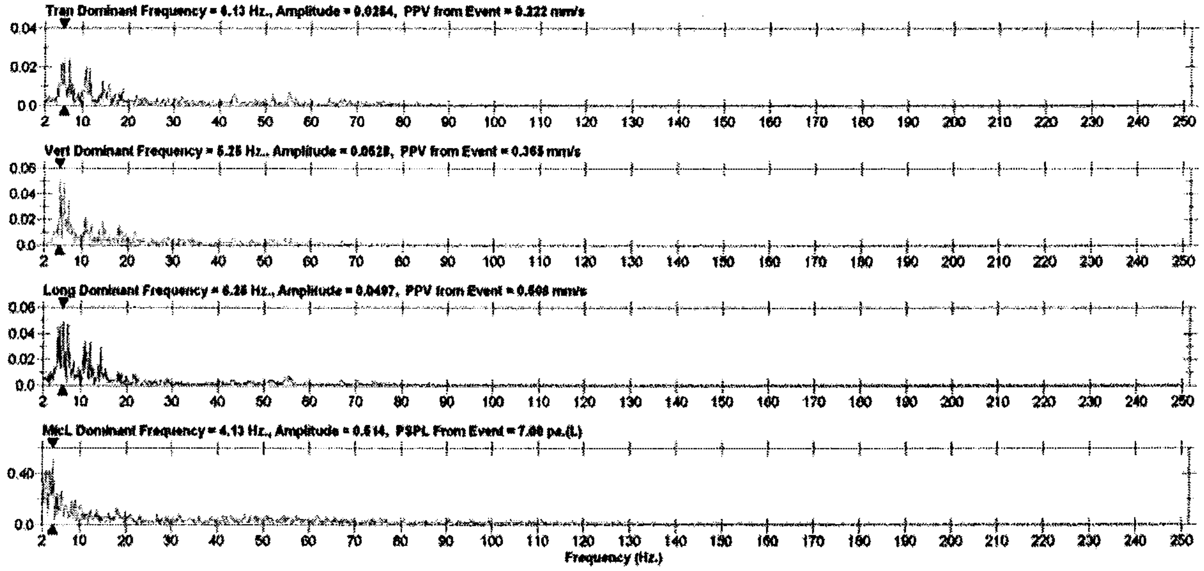
**Date/Time** Long at 12:12:25 November 11, 2009
**Trigger Source** Geo: 0.508 mm/s
**Range** Geo :31.7 mm/s
**Record Time** 5.25 sec (Auto=5Sec) at 1024 sps

**Serial Number** BA13539 V 8.12-8.0 BlastMate III
**Battery Level** 6.4 Volts
**Calibration** February 11, 2009 by Instantel Inc.
**File Name** O539CZ3R.8P0

**Notes**
Client:
Project:
Location:
User:

**Extended Notes:**

**Post Event Notes**


Tran Dominant Frequency = 6.13 Hz., Amplitude = 0.0284, PPV from Event = 0.222 mm/s

Vert Dominant Frequency = 5.25 Hz., Amplitude = 0.0528, PPV from Event = 0.365 mm/s

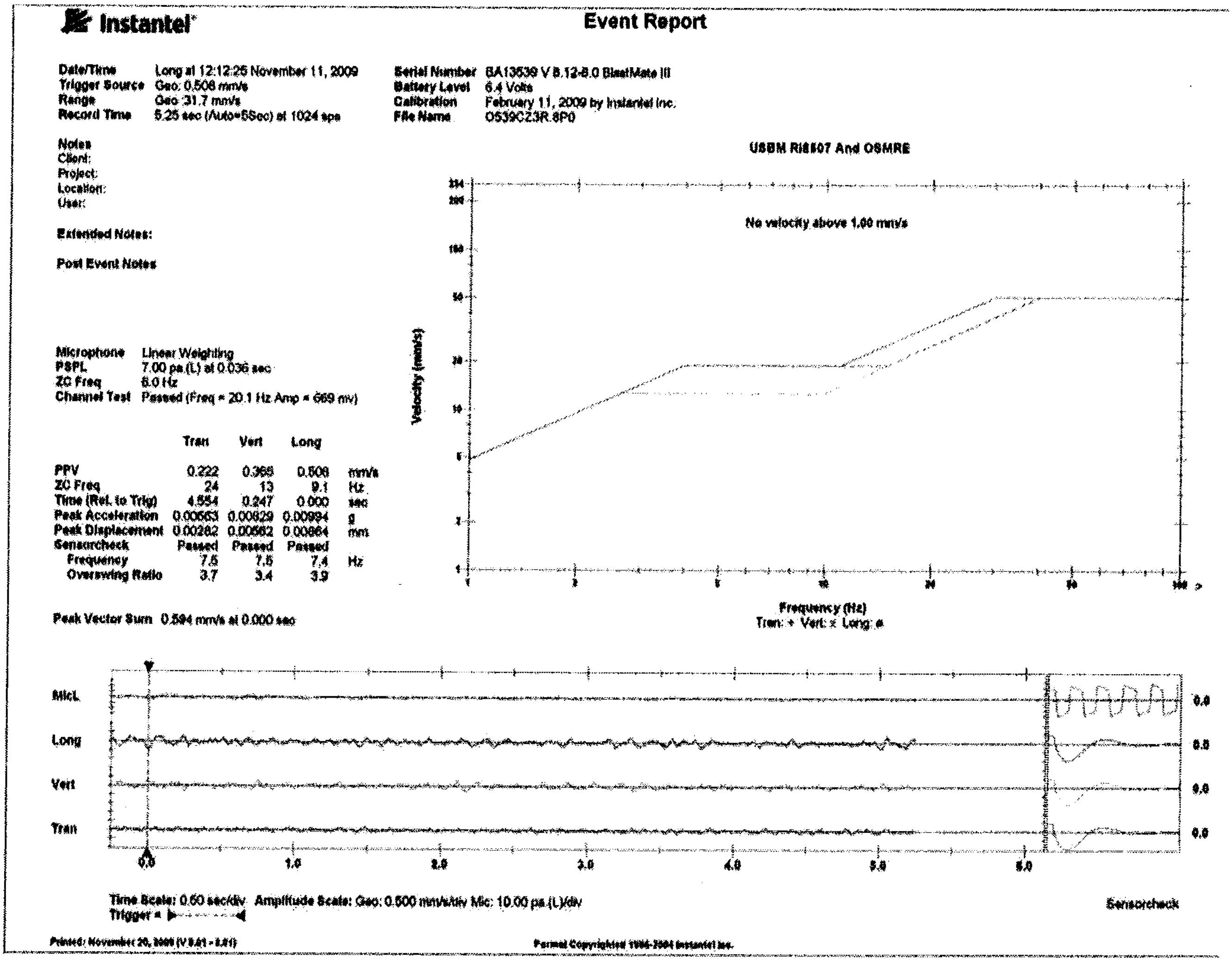
Long Dominant Frequency = 6.25 Hz., Amplitude = 0.0497, PPV from Event = 0.508 mm/s

MicL Dominant Frequency = 4.13 Hz., Amplitude = 0.514, PSPL From Event = 7.00 pa.(L)

Printed: November 20, 2009 (V 8.01 - 8.01)

Friday, November 20, 2009
2:55 PM

D



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## Event Report

**Date/Time** Long at 12:12:26 November 11, 2009
**Trigger Source** Geo: 0.508 mm/s
**Range** Geo: 31.7 mm/s
**Record Time** 5.25 sec (Auto=5Sec) at 1024 sps

**Serial Number** BA13539 V 8.12-8.0 BlastMate III
**Battery Level** 6.4 Volts
**Calibration** February 11, 2009 by Instantel Inc.
**File Name** O539CZ3R.8P0

**Notes**
**Client:**
**Project:**
**Location:**
**User:**

**Extended Notes:**

**Post Event Notes**

**Microphone** Linear Weighting
**PSPL** 7.00 pa.(L) at 0.036 sec
**ZC Freq** 6.0 Hz
**Channel Test** Passed (Freq = 20.1 Hz Amp = 669 mv)

| | Tran | Vert | Long | |
|---|---|---|---|---|
| **PPV** | 0.222 | 0.368 | 0.508 | mm/s |
| **ZC Freq** | 24 | 13 | 9.1 | Hz |
| **Time (Rel. to Trig)** | 4.554 | 0.247 | 0.000 | sec |
| **Peak Acceleration** | 0.00663 | 0.00829 | 0.00994 | g |
| **Peak Displacement** | 0.00262 | 0.00562 | 0.00864 | mm |
| **Sensorcheck** | Passed | Passed | Passed | |
| **Frequency** | 7.5 | 7.5 | 7.4 | Hz |
| **Overswing Ratio** | 3.7 | 3.4 | 3.9 | |

**Peak Vector Sum** 0.594 mm/s at 0.000 sec

**USBM RI8507 And OSMRE**

No velocity above 1.00 mm/s

**Time Scale:** 0.50 sec/div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 10.00 pa.(L)/div
**Trigger =** ▶- - - - - -◀

Sensorcheck

Printed: November 20, 2009 (V 8.01 - 8.01)

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# DR. KALINSKI REPORT DATED MARCH 8, 2010 RELATED TO JANUARY 6 AND 7, 2010 VIBRATION MONITORING, GEOPHYSICAL TESTING, AND LABORATORY DAMPING RATIO TESTING

March 8, 2010

Mr. Roger Cecil. P.E.
Geo/Environmental Associates
3502 Overlook Circle
Knoxville, TN 37909

**RE: Vibration monitoring crosshole seismic testing, and resonant column testing at the AEP Sporn Power Plant, New Haven, West Virginia (revised report)**

Dear Roger,

## OVERVIEW

Vibration monitoring and crosshole seismic testing were performed on January 6-7, 2010 at the AEP Sporn Power Plant in New Haven, West Virginia. Vibration monitoring was performed at the same six locations that were used in November 2009, and crosshole seismic testing was performed at two of these locations. Laboratory free-free resonant column testing was also performed on undisturbed fly ash specimens to estimate the material damping of the fly ash. This letter report describes the methods used and results, and is accompanied by a CD containing the data.

## VIBRATION MONITORING

Vibration monitoring was performed continuously for 30 hours from approximately 9:00 A.M. on January 6 until 3:00 P.M. on January 7 at six locations on the perimeter levees that contain the fly ash and bottom ash at the power plant. The locations are described as follows:

- Location A: outside toe of the bottom ash levee adjacent to the train tracks;
- Location B: outside crest of the bottom ash levee adjacent to the train tracks;
- Location C: outside toe of the fly ash levee adjacent to the train tracks;
- Location D: outside crest of the fly ash levee adjacent to the train tracks;
- Location E: outside crest of the fly ash levee adjacent to the Ohio River; and
- Location F: outside toe of the fly ash levee adjacent to the Ohio River.

These are the same locations that were used for vibration monitoring during the November 2009 survey.

Vibration monitoring was performed using six Blastmate III seismographs, which are manufactured by Instantel. The Blastmate III seismographs record four channels simultaneously during each event: one air wave channel with a microphone, and three ground wave channels using three geophones. The three geophones are oriented orthogonal to each other so that one geophone detects vertical particle motion, and the other two detect horizontal particle motion in two perpendicular directions. The two horizontal geophones are identified as longitudinal and transverse, with the longitudinal geophone oriented towards the vibration source, and the transverse oriented perpendicular to the longitudinal.

The geophones that accompany the Blastmate III have a damped resonant frequency of approximately 2.0 Hz and the data are sampled in the instrument at a rate of 1,024 samples per second. This allows vibrations to be recorded between the bandwidth of 2.0-250 Hz with minimal distortion. The vibrations imparted to the geophones are converted into voltage, and the voltage is converted to particle velocity using a calibration factor. To minimize wind and surface noise, the geophones are buried in sand a few inches below the ground surface and covered with a heavy weight such as a sand bag or water jug. The serial numbers of the seismographs used at each test location are as follows:

- Location A: Serial #BA11042;
- Location B: Serial #BA11291;
- Location C: Serial #BA10619;
- Location D: Serial #BA11821;
- Location E: Serial #BA11088; and
- Location F: Serial #BA11290.

Each instrument was calibrated according to ISO9001:2000 standards.

Vibration monitoring was performed on January 6-7, 2010 as indicated on the monitoring logs included in Appendix A of this report. During this period, four trains passed by the power plant:

- Train 1: January 6, 1:13 P.M.; approximately 95 seconds in duration;
- Train 2: January 7, 12:23 A.M.; approximately 132 seconds in duration;
- Train 3: January 7, 4:27 A.M.; approximately 120 seconds in duration; and
- Train 4: January 7, 12:05 P.M.; approximately 122 seconds in duration.

Trains 1 and 4 consisted of multiple (typically four) engines with mostly tank cars, and appeared to be traveling at a speed of around 25 mph. Trains 2 and 3 passed during the night and were not visually observed.

The vibration monitoring logs included in Appendix A indicate when the seismographs were actively monitoring and when vibration events were recorded, including the four trains. The monitoring logs indicate that additional events were also recorded. These additional events correspond to occasional testing of the seismographs by stomping on the ground next to the geophones. Details regarding these additional test events are not included herein.

For all logging, vibrations were only recorded when the vibration level exceeded 0.02 in./s. Below this level, vibrations were considered to be within the level of ambient noise. Peak particle velocities observed for each train and monitoring location are summarized in Table 1.

All of the vibration monitoring data are included in ASCII format in Appendix B on the attached CD. Given a sample rate of 1,024 samples/s, the vibration data should be plotted at a sample rate of 9.7656 x $10^{-4}$ s. Vibration data are presented in the ASCII files text in units of particle velocity in mm/s. Please note that the internal clocks on the six seismographs were set to the nearest minute, so the time stamps on the monitoring data may be slightly out of synch between seismographs.

Excel files containing particle acceleration are also included in Appendix B. Acceleration is defined a change in velocity per unit time, and was derived by calculating the difference in particle velocity between successive points and dividing the difference by the sample rate. For example, if the particle velocity for a given sample time is 0.349 mm/s, the particle velocity for the next sample time is 0.302 mm/s, and the sample rate is 1.019 x $10^{-4}$ s, then the particle acceleration is (0.302 mm/s – 0.349 mm/s)/9.77 x $10^{-4}$ s = -4.81 x $10^{-1}$ mm/$s^2$, or -4.90 x $10^{-3}$ g.

## CROSSHOLE SEISMIC TESTING

Crosshole seismic testing was performed at vibration monitoring Locations B (in bottom ash) and E (in fly ash). Crosshole seismic testing was performed using a three-hole array with one source hole and two receiver holes. The spacing at the ground surface was 10.0 ft, and an inclinometer survey was performed by Mr. Seth Frank to derive borehole spacing information for calculation of wave velocities. A mechanical wedge was used as a borehole seismic source, and BHG-2 borehole geophones were used as receivers. The BHG-2 geophones contain three geophones positioned in three orthogonal directions (one vertical and two horizontal). For crosshole seismic testing, the vertical geophone measures S-waves, while the horizontal geophones measure P-waves. All of the data were recorded using a Geometrics Geode multi-channel seismograph.

A set of typical crosshole data is shown in Fig. 1. For this record, the S-waves and P-waves are apparent on each trace. Although the vertical geophones are intended to record S-waves, there is some leakage of P-wave energy onto the records. Conversely, there is also leakage of S-wave energy onto the horizontally oriented geophones, which are primarily intended to record P-wave energy.

Spreadsheets including the details of crosshole seismic testing are included on the attached CD. Calculated wave velocities and values for Poisson's ratio are summarized in Tables 2 and 3, and the data are graphed in Figs. 2 and 3.

## FREE-FREE RESONANT COLUMN TESTING

Free-free resonant column testing was performed on 2 fly ash specimens and one clay foundation specimen recovered from the site to calculate material damping. Each specimen was approximately 6.0 in. long and 3.0 in. in diameter. Resonant column testing is performed by suspending the specimens horizontally. Accelerometers are glued to the outer perimeter of one end to detect torsional motion, while a torsional excitation device is fixed to the other end. The specimens are encased in a latex membrane with end caps during testing, and a vacuum pressure of approximately 9.0 psi is applied to provide confinement to the specimens.

When the specimen is excited in torsion, it resonates at a frequency $f_n$ that is calculated by performing spectral analysis of the free vibration record measured with the accelerometers. The auto power spectrum is calculated, which is a curve of accelerometer power versus frequency. The half-power bandwidth method is then used to estimate material damping. Given a resonant frequency $f_n$ and spectral power of $A$, frequencies $f_1$ and $f_2$ are identified as the frequencies corresponding to a power of $0.5A$. Material damping is then estimated as:

$D = (f_2 - f_1)/(2f_n)$.

Results are summarized in the table below.

| Specimen description | Material damping (%) |
|---|---|
| FLY ASH: recovered from GA-1A-ST-7, depth = 48.5-51.0 ft | 3.9 |
| FLY ASH: recovered from GA-1A-ST-4, depth = 36.5-39.0 ft | 5.1 |
| FOUNDATION SOIL: recovered from GA-ST-2, depth = 59.0-61.5 ft | 7.0 |

Please note that the material damping of 7.0% measured in the clay foundation soil specimen is higher than the typical range in material damping for clay specimens. Material damping of clay is typically around 2-4%. It was difficult to obtain a measurable signal in the clay specimen, which supports the observation that material damping in the clay is relatively high.

Thank you very much for providing me the opportunity to work with you on this project. Please do not hesitate to contact me if you have any questions or require any additional details or information.

Regards,

Michael E. Kalinski

Michael E. Kalinski, Ph.D.

Attachments: Tables 1-3
Figs. 1-3
Appendix A – vibration monitoring logs (on CD)
Appendix B -- vibration data (on CD)
Appendix C – crosshole seismic calculations (on CD)

*Table 1. Peak particle velocities (PPVs) recorded for each train and location*

| **Train** | **Location** | **Tran. PPV (in./s)** | **Vert. PPV (in./s)** | **Long. PPV (in./s)** |
|---|---|---|---|---|
| 1 | A | 0.007 | 0.035 | 0.016 |
| | B | 0.006 | 0.023 | 0.014 |
| | C | 0.044 | 0.042 | 0.047 |
| | D | ND* | ND | ND |
| | E | ND | ND | ND |
| | F | ND | ND | ND |
| 2 | A | 0.010 | 0.039 | 0.019 |
| | B | 0.007 | 0.024 | 0.010 |
| | C | 0.048 | 0.057 | 0.046 |
| | D | ND | ND | ND |
| | E | ND | ND | ND |
| | F | ND | ND | ND |
| 3 | A | 0.010 | 0.039 | 0.013 |
| | B | ND | ND | ND |
| | C | 0.055 | 0.054 | 0.053 |
| | D | ND | ND | ND |
| | E | ND | ND | ND |
| | F | ND | ND | ND |
| 4 | A | 0.009 | 0.039 | 0.016 |
| | B | 0.007 | 0.021 | 0.009 |
| | C | 0.043 | 0.049 | 0.047 |
| | D | 0.006 | 0.014 | 0.021 |
| | E | ND | ND | ND |
| | F | ND | ND | ND |

*ND = no vibrations detected above threshold level of 0.02 in./s

*Table 2. Summary of results from crosshole seismic testing at Location B (bottom ash site)*

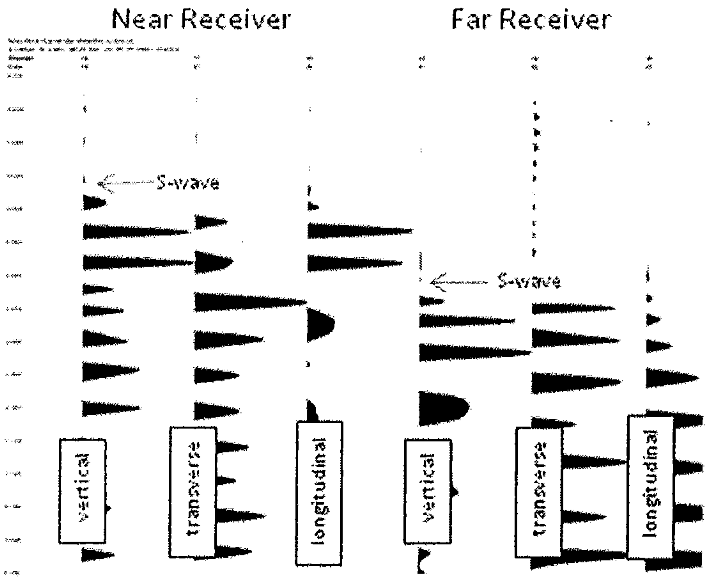
| **Depth (ft)** | **S-wave velocity (ft/s)** | **P-wave velocity (ft/s)** | **Poisson's ratio** | **Interpretation** |
|---:|---:|---:|---:|---|
| 10.0 | 814 | ?* | ? | unsaturated fill |
| 12.5 | 825 | ? | ? | unsaturated fill |
| 15.0 | 1061 | ? | ? | unsaturated fill |
| 17.5 | 1188 | ? | ? | unsaturated fill |
| 20.0 | 1501 | ? | ? | unsaturated fill |
| 22.5 | 1122 | ? | ? | unsaturated fill |
| 25.0 | 1741 | 3489 | 0.33 | unsaturated fill |
| 27.5 | 453 | 3917 | 0.49 | saturated fly ash |
| 30.0 | 500 | 5178 | 0.50 | saturated fly ash |
| 32.5 | 350 | 3854 | 0.50 | saturated fly ash |
| 35.0 | ? | 5750 | ? | foundation soil |
| 37.5 | 1468 | 5072 | 0.45 | foundation soil |
| 40.0 | 1505 | 6471 | 0.47 | foundation soil |
| 42.5 | 849 | 5638 | 0.49 | foundation soil |
| 45.0 | 1120 | 6414 | 0.48 | foundation soil |
| 47.5 | 1944 | 6400 | 0.45 | foundation soil |

*Could not be reliably identified on the data.

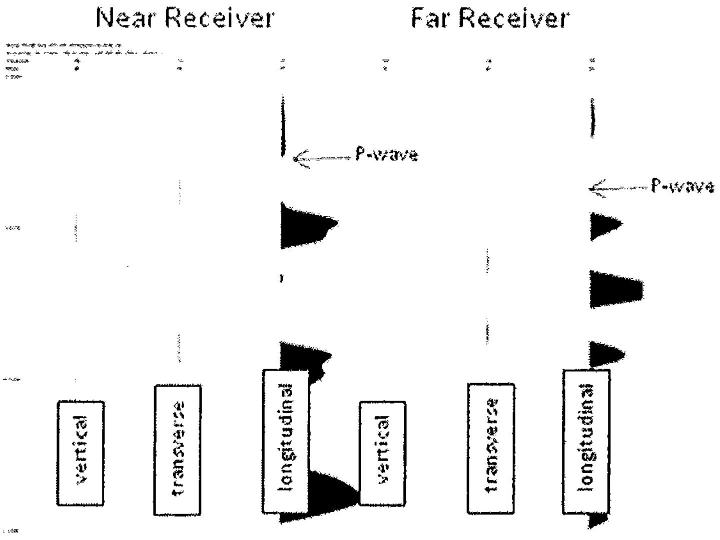
*Table 3. Summary of results from crosshole seismic testing at Location E (fly ash site)*

| Depth (ft) | S-wave velocity (ft/s) | P-wave velocity (ft/s) | Poisson's ratio | Interpretation |
|---|---|---|---|---|
| 10.0 | 1242 | ?* | ? | unsaturated fill |
| 15.0 | 1178 | 2195 | 0.30 | unsaturated fill |
| 17.5 | 690 | 2541 | 0.46 | unsaturated fill |
| 20.0 | 862 | 1930 | 0.38 | unsaturated fill |
| 22.5 | 963 | 1784 | 0.29 | unsaturated fill |
| 25.0 | 875 | 1718 | 0.33 | unsaturated fill |
| 27.5 | 1041 | ? | ? | unsaturated fill |
| 30.0 | 554 | 993 | 0.27 | unsaturated fly ash |
| 32.5 | 392 | 3963 | 0.50 | saturated fly ash |
| 35.0 | 364 | 5267 | 0.50 | saturated fly ash |
| 37.5 | 415 | 4740 | 0.50 | saturated fly ash |
| 40.0 | 321 | 4295 | 0.50 | saturated fly ash |
| 42.5 | 461 | 4282 | 0.49 | saturated fly ash |
| 45.0 | 470 | 4710 | 0.49 | saturated fly ash |
| 47.5 | 480 | 5894 | 0.50 | saturated fly ash |
| 50.0 | 516 | 5233 | 0.50 | saturated fly ash |
| 52.5 | 811 | 5233 | 0.49 | saturated fly ash |
| 55.0 | 403 | 3917 | 0.49 | saturated fly ash |
| 57.5 | 555 | 3942 | 0.49 | saturated fly ash |
| 60.0 | 527 | 5907 | 0.50 | saturated fly ash |
| 62.5 | 744 | 2069 | 0.43 | foundation soil |
| 65.0 | 771 | 2518 | 0.45 | foundation soil |
| 67.5 | 567 | 2389 | 0.47 | foundation soil |

*Could not be reliably identified on the data.



*a. S-wave arrivals*



*b. P-wave arrivals (rescaled view of Fig. 1a)*

*Fig. 1. Typical records from crosshole seismic testing (recorded at Location E at a depth of 40.0 ft below the ground surface in fly ash).*

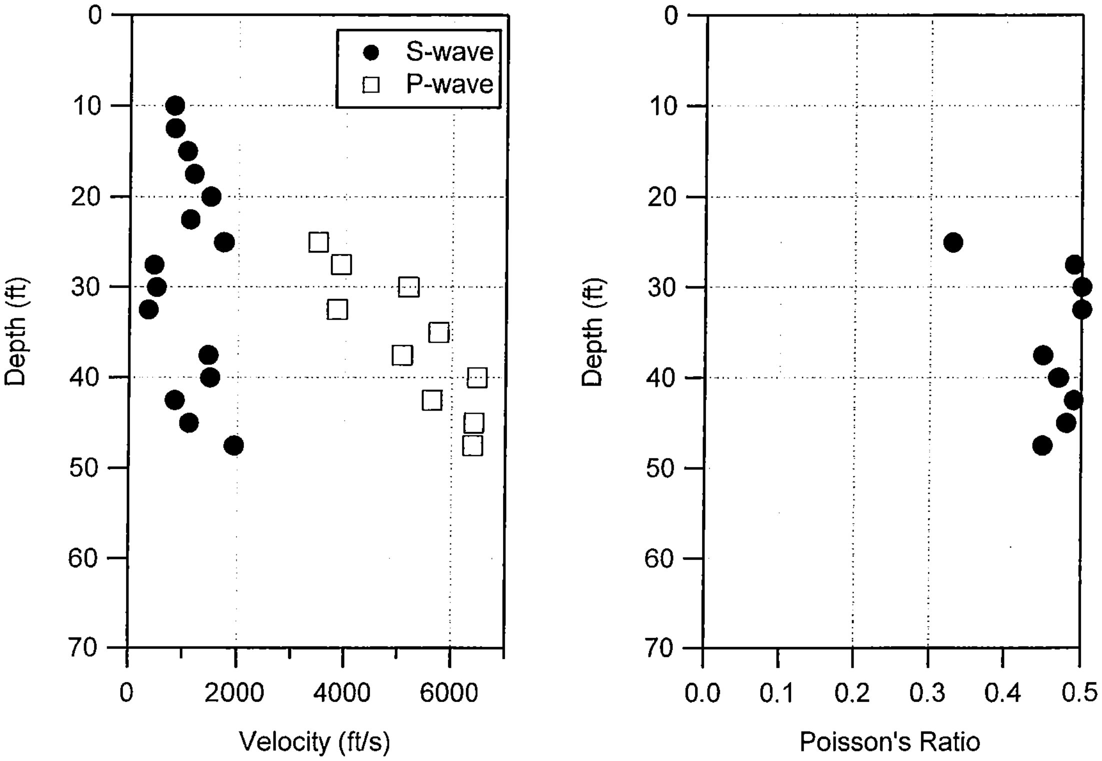


*Fig. 2. Graph of wave velocities and Poisson's ratio from crosshole seismic testing at Location B (bottom ash site)*

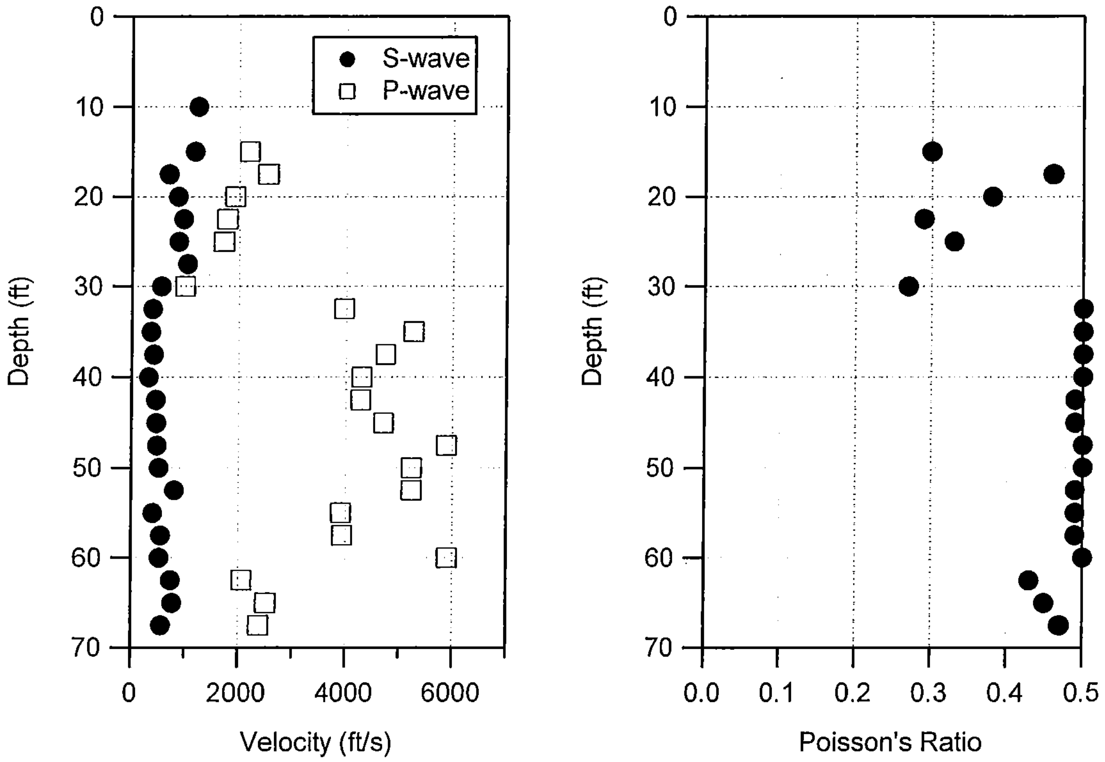


*Fig. 3. Graph of wave velocities and Poissons ratios from crosshole seismic testing at Location E (fly ash site)*

# CD WITH VIBRATION MONITORING DATA

# PHILIP SPORN
# BOTTOM ASH AND FLY ASH DISPOSAL FACILITIES

## VIBRATION MONITORING DATA PREPARED BY:
## DR. MICHAEL KALINSKI
## NOVEMBER 2009 & JANUARY 2010

# CSX TRANSPORTATION LETTER

# REGARDING RAILWAY FREQUENCIES AND SCHEDULES BETWEEN HUNTINGTON, WV AND PARKERSBURG, WV

CSX
How tomorrow moves™

1-877-TellCSX
TellCSX@csx.com
www.csx.com > Contact Us

November 10, 2009

Mr. Seth Frank
Geo-Environmental Associates, Inc.
3502 Overlook Circle
Knoxville, Tennessee 37909

Dear Mr. Frank:

You recently contacted CSX to request information concerning a train schedule for New Haven, West Virginia.

We hope you will understand, but because of security concerns, we cannot disclose train schedules or frequency information to the public.

We apologize for not being able to provide the information you requested, and thank you for contacting CSX.

Sincerely,

TellCSX Team

ej

Ref: 9309v7469016

*Did you know? CSX is the Railroad Industry's Charter Member of the EPA's SmartWay Program, an initiative to increase energy efficiency while reducing greenhouse gases and air pollution.*

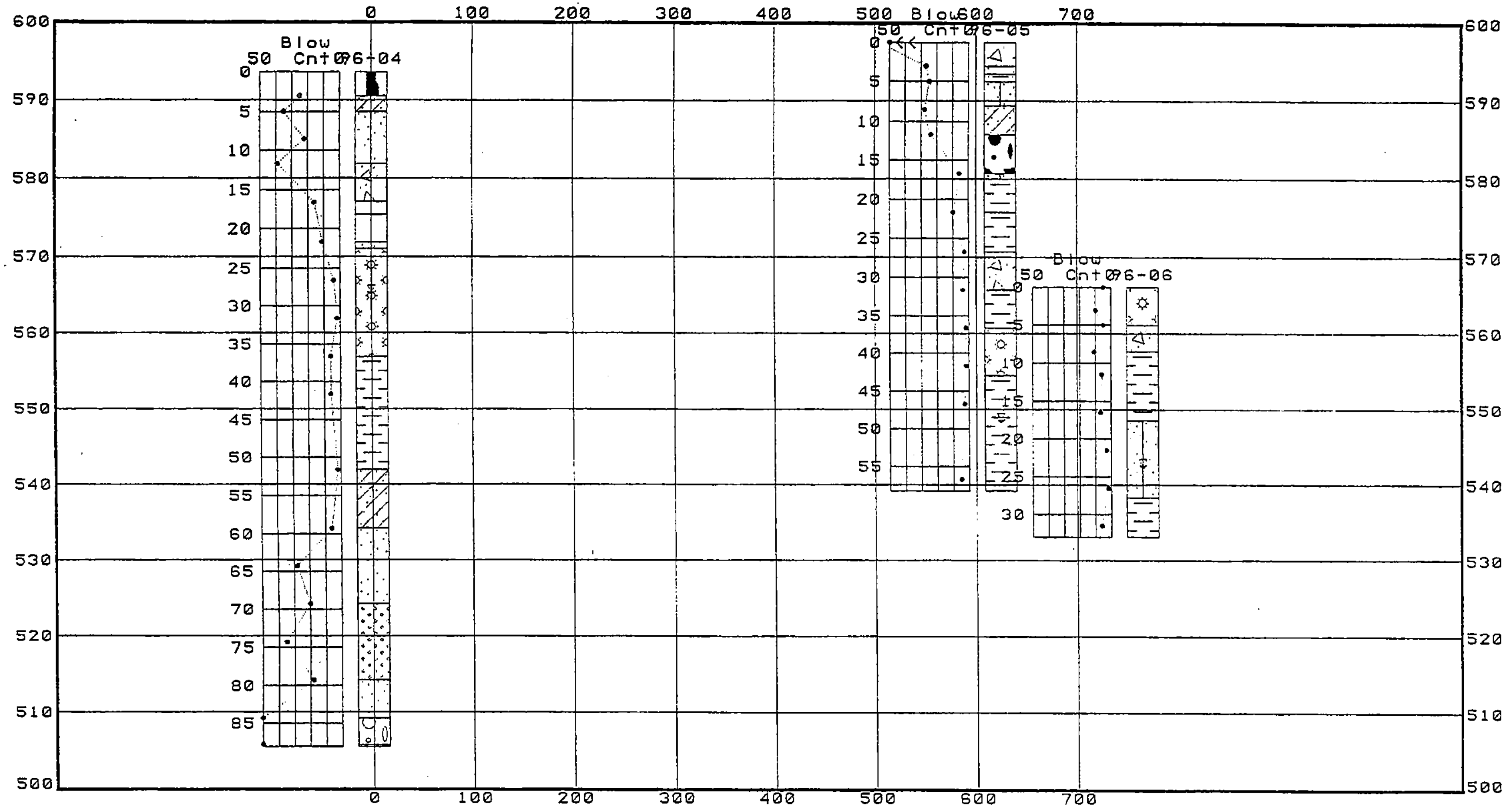
# APPENDIX III

# FIELD AND LABORATORY TEST DATA

# FIELD DATA FROM:
# *"PHILIP SPORN ELECTRIC GENERATING PLANT BOTTOM ASH FACILITY – ENGINEERING REPORT"*

## PREPARED/COMPILED BY:
## GEOTECH/HYDRO/SITE SECTION OF
## AMERICAN ELECTRIC POWER CORPORATION

## DATED: 1996



| Boring | North | East | Elev. | Depth |
|---|---|---|---|---|
| 96-04 7 | 17954.157 | 35752.5 | 593.5 | 88.0 |
| 96-05 7 | 18463.167 | 36113.5 | .597.4 | 58.2 |
| 96-06 7 | 18519.117 | 36243.1 | 566.1 | 33.0 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

DISTANCES:
Beginning 0.0
Ending 765.1
VIEWING ANGLES (degrees):
Horizontal 0.0
Vertical 0.0

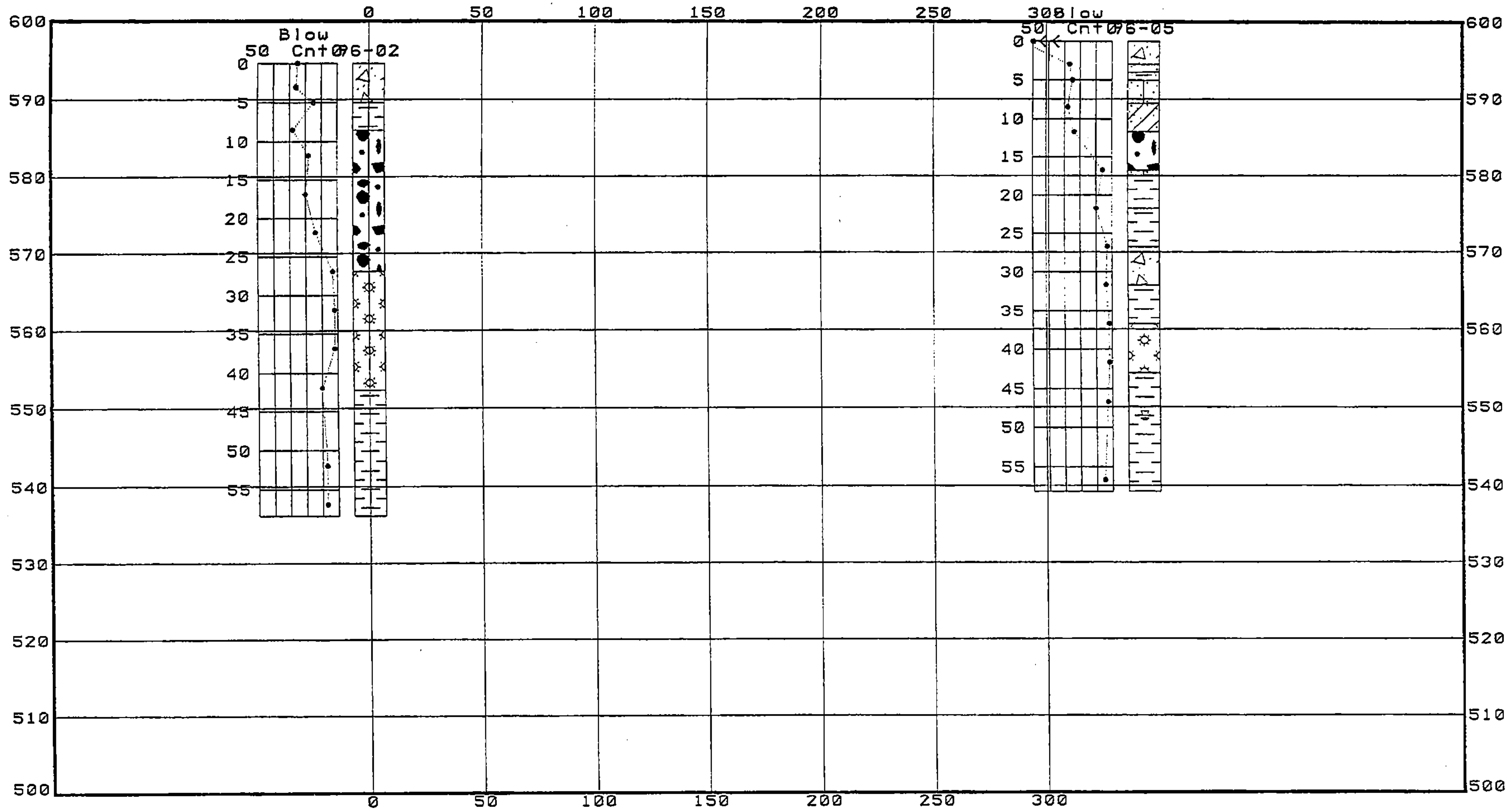
| Position | North | East |
|---|---|---|
| Left, Front | | |
| Right, Front | | |
| Left, Back | | |
| Right, Back | | |

SUBSURFACE FENCE DIAGRAM
SPORN ~~FLY~~ Bottom ASH DIKE

Sporn ~~fly~~ Bottom ash pond dikes

Sporn plant

| PROJECT # | DATE | PLATE |
|---|---|---|
| 3966 | JUL 96 | 1 |



| Boring | North | East | Elev. | Depth |
|---|---|---|---|---|
| 96-02 7 | 18158.157 | 36270.7 | 594.6 | 58.4 |
| 96-05 7 | 18463.167 | 36113.5 | 597.4 | 58.2 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

DISTANCES:
Beginning 0.0
Ending 343.3
VIEWING ANGLES (degrees):
Horizontal 0.0
Vertical 0.0

| Position | North | East |
|---|---|---|
| Left, Front | | |
| Right, Front | | |
| Left, Back | | |
| Right, Back | | |

SUBSURFACE FENCE DIAGRAM

SPORN ~~FLY~~ BOTTOM ASH DIKE

Sporn ~~Fly~~ Bottom ash pond dikes

Sporn plant

| PROJECT # | DATE | PLATE |
|---|---|---|
| 3966 | JUL 96 | 1 |

AMERICAN ELECTRIC POWER SERVICE CORPORATION

# AEP CIVIL ENGINEERING LABORATORY

## LOG OF BORING

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

COORDINATES N 717,700.5 E 1,735,921.2

GROUND ELEVATION 592.7 SYSTEM STATE PLANE

| WATER LEVEL | ∇ 27.9 | ▼ | ∇ |
|---|---|---|---|
| TIME | | | |
| DATE | 6-20-96 | | |

BORING NO. 96-01 DATE SHEET 1 OF 2

BORING START 06/14/96 BORING FINISH 06/20/96

PIEZOMETER TYPE WELL TYPE

HGT. RISER ABOVE GROUND DIA

DEPTH TO TOP OF WELL SCREEN BOTTOM

WELL DEVELOPMENT BACKFILL QUICK GROUT

FIELD PARTY MCR-WEB RIG BK-81

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | U S C S | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | 1.5 | | | | | | | ROAD BASE | | |
| 2 | SS | 3.0 | 4.5 | 11-10-7 | 1.5 | | | | SW | BLACK BOTTOM ASH Moist.<br>YELLOWISH ORANGE GRAVELLY SAND Dry to moist, 3/4" max size. | | |
| 3 | SS | 5.0 | 6.5 | 8-9-11 | 1.3 | | 5 | | | | | |
| 4 | SS | 8.5 | 10.0 | 10-25-30 | 1.2 | | | | | BLACK BOTTOM ASH Moist. | | |
| 5 | SS | 11.7 | 13.2 | 11-12-16 | 1.5 | | 10 | | | DARK BROWN SANDY SILT Moist, v-fine grain sand. | | |
| 6 | SS | 16.7 | 18.2 | 7-7-11 | 1.5 | | 15 | | | BLACK BOTTOM ASH Dry. | | |
| 7 | SS | 21.7 | 23.2 | 7-3-2 | 1.5 | | 20 | | | Moist this area | | |
| 8 | SS | 26.7 | 28.2 | 1-1-1 | 1.5 | | 25 | | | Saturated this area | ∇ | |
| 9 | SS | 31.7 | 33.2 | 1-2-2 | 1.5 | | 30 | | CL | GREENISH BROWN SANDY CLAY Saturated, low plasticity. | | |
| 10 | SS | 36.7 | 38.2 | 3-2-2 | 1.2 | | 35 | | CL | MULTI-COLORED BROWN SANDY CLAY Wet to saturated, low plasticity, v-fine sand. | | |
| 11 | ST | 41.7 | 43.7 | | 0 | | 40 | | | | | Belive material to soft to pickup in tube. |
| 12 | ST | 43.7 | 45.7 | | 0 | | 45 | | | | | |

*Continued Next Page*

| TYPE OF CASING USED | | |
|---|---|---|
| | NQ-2 ROCK CORE | |
| X | 6" x 3.25 HSA | |
| | 9" x 6.25 HSA | |
| | HW CASING ADVANCER | 4" |
| | NW CASING | 3" |
| | SW CASING | 6" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER WEB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

# AEP CIVIL ENGINEERING LABORATORY

## LOG OF BORING

JOB NUMBER 3966

COMPANY **APPALACHIAN POWER COMPANY** BORING NO. **96-01** DATE ______ SHEET **2** OF **2**

PROJECT **Sporn fly ash pond dikes** BORING START **06/14/96** BORING FINISH **06/20/96**

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET | | STANDARD PENETRATION RESISTANCE | TOTAL LENGTH RECOVERY | RQD | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FROM | TO | BLOWS / 6" | | % | | | | | | |
| 13 | SS | 51.7 | 53.2 | 1-1-2 | 1.0 | | | | CL | DARK GRAY SANDY CLAY Saturated, v-fine sand. | | Stopped boring at 53.2' grouted from 53.2 to grade with approximately 60 gallons of quick grout. |

AMERICAN ELECTRIC POWER SERVICE CORPORATION

# AEP CIVIL ENGINEERING LABORATORY

## LOG OF BORING

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

COORDINATES N 718,158.5 E 1,736,270.7

GROUND ELEVATION 594.6 SYSTEM STATE PLANE

BORING NO. 96-02 DATE ______ SHEET 1 OF 2

BORING START 06/13/96 BORING FINISH 06/13/96

PIEZOMETER TYPE ______ WELL TYPE ______

HGT. RISER ABOVE GROUND ______ DIA ______

DEPTH TO TOP OF WELL SCREEN ______ BOTTOM ______

WELL DEVELOPMENT ______ BACKFILL QUICK GROUT

FIELD PARTY MCR-WEB RIG BK-81

| WATER LEVEL | ▽ | ▼ | ▼ |
|---|---|---|---|
| TIME | | | |
| DATE | | | |

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SS | 0.0 | 1.5 | 10-12-13 | 1.2 | | | | | GRAY BOTTOM ASH Dry, with 2 to 3" of sandy clay. | | |
| 2 | SS | 3.0 | 4.5 | 10-13-13 | 1.5 | | | | | GRAY BOTTOM ASH Dry. | | |
| 3 | SS | 5.0 | 6.5 | 9-8-7 | 1.3 | | 5 | | CL | LIGHT BROWN CLAY Dry, medium to high plasticity. | | |
| 4 | SS | 8.5 | 10.0 | 16-16-12 | 1.1 | | 10 | | GP | DARK BROWN SAND AND GRAVEL Dry, 3/4" max size, rounded with some fines. | | |
| 5 | SS | 11.9 | 13.4 | 8-10-8 | 1.4 | | 15 | | | | | |
| 6 | SS | 16.9 | 18.4 | 6-11-9 | 1.3 | | 20 | | | DARK BROWN SAND AND GRAVEL Moist, quartz, 1/2" max size, rounded with some fines. | | |
| 7 | SS | 21.9 | 23.4 | 7-7-7 | 1.3 | | 25 | | | DARK BROWN SAND AND GRAVEL Saturated, rounded, 1" max size, quartz with some fines. | | |
| 8 | SS | 26.9 | 28.4 | 1-1-2 | 1.5 | | 30 | | | DARK GRAY FLY ASH Saturated. | | |
| 9 | SS | 31.9 | 33.4 | 1-1-1 | 1.5 | | 35 | | | | | |
| 10 | SS | 36.9 | 38.4 | 1-1-1 | 1.5 | | 40 | | | | | |
| 11 | SS | 41.9 | 43.4 | 4-4-6 | 1.3 | | | | CL | DARK GRAY CLAY Wet, medium to high plasticity, trace of organic material. | | |
| 12 | ST | 43.9 | 45.9 | | 1.0 | | 45 | | | | | |
| 13 | ST | 46.9 | 48.9 | | 2.0 | | | | | | | |

*Continued Next Page*

| TYPE OF CASING USED | | |
|---|---|---|
| | NQ-2 ROCK CORE | |
| X | 6" x 3.25 HSA | |
| | 9" x 6.25 HSA | |
| | HW CASING ADVANCER | 4" |
| | NW CASING | 3" |
| | SW CASING | 6" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER WEB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

# AEP CIVIL ENGINEERING LABORATORY

## LOG OF BORING

JOB NUMBER 3966

COMPANY **APPALACHIAN POWER COMPANY**

PROJECT **Sporn fly ash pond dikes**

BORING NO. 96-02 DATE ______ SHEET 2 OF 2

BORING START 06/13/96 BORING FINISH 06/13/96

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET | | STANDARD PENETRATION RESISTANCE | TOTAL LENGTH RECOVERY | RQD | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FROM | TO | BLOWS / 6" | | % | | | | | | |
| 14 | SS | 51.9 | 53.4 | 3-3-4 | 1.5 | | | | | | | |
| | | | | | | | 55 | | | | | |
| 15 | SS | 56.9 | 58.4 | 1-3-4 | 1.5 | | | | | | | |
| | | | | | | | | | | | | Grouted hole from 58.4' to grade with approximately 75 gallons of quick grout. |

AMERICAN ELECTRIC POWER SERVICE CORPORATION

# AEP CIVIL ENGINEERING LABORATORY

## LOG OF BORING

JOB NUMBER 3966

COMPANY **APPALACHIAN POWER COMPANY**

PROJECT **Sporn fly ash pond dikes**

COORDINATES N 718,215.9 E 1,736,382.8

GROUND ELEVATION 566.9 SYSTEM STATE PLANE

BORING NO. 96-03 DATE ______ SHEET 1 OF 2

BORING START 06/17/96 BORING FINISH 06/18/96

PIEZOMETER TYPE ______ WELL TYPE ______

HGT. RISER ABOVE GROUND ______ DIA ______

DEPTH TO TOP OF WELL SCREEN ______ BOTTOM ______

WELL DEVELOPMENT ______ BACKFILL QUICK GROUT

FIELD PARTY MCR-WEB RIG BK-81

| WATER LEVEL | ∇ 22.2 | ▼ | ∇ |
|---|---|---|---|
| TIME | | | |
| DATE | 6-18-96 | | |

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | SAMPLE DEPTH IN FEET TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SS | 0.0 | 1.5 | 1-2-4 | 1.3 | | | | | GRAY FLY ASH Moist. | | |
| 2 | SS | 3.0 | 4.5 | 6-5-4 | 1.5 | | 5 | | | GRAY BOTTOM ASH Moist. | | |
| 3 | SS | 5.0 | 6.5 | 3-2-2 | 1.5 | | | | | | | |
| 4 | SS | 8.5 | 10.0 | 4-6-6 | 1.5 | | 10 | | SC | BLACK COAL<br>LIGHT BROWN SANDY CLAY Dry to moist, v-fine grain sand. | | |
| 5 | SS | 11.7 | 13.2 | 4-3-3 | 1.5 | | | | CL | DARK GRAY CLAY Wet, medium to hight plasticity, trace of grganic material. | | |
| 6 | SS | 16.7 | 18.2 | 7-1-1 | 1.5 | | 15 | | | | | |
| 7 | ST | 21.7 | 23.7 | | 2.0 | | 20 | | | | ∇ | |
| 8 | SS | 26.7 | 28.2 | 1-1-1 | 1.5 | | 25 | | | | | |
| 9 | ST | 31.7 | 33.7 | | 2.0 | | 30 | | | | | |
| 10 | SS | 36.7 | 38.2 | 1-2-2 | 1.5 | | 35 | | SP | DARK GRAY AND BROWN SILTY SAND Wet to saturated, quartz, fine grain. | | |
| 11 | SS | 41.7 | 43.2 | 7-14-19 | .6 | | 40 | | GW | GRAY SAND AND GRAVEL Saturated, quartz, 1/2" max size, rounded. | | |
| 12 | SS | 46.7 | 47.6 | 37-50/.4 | .9 | | 45 | | | Brown | | |

*Continued Next Page*

| TYPE OF CASING USED | | |
|---|---|---|
| | NQ-2 ROCK CORE | |
| X | 6" x 3.25 HSA | |
| | 9" x 6.25 HSA | |
| | HW CASING ADVANCER | 4" |
| | NW CASING | 3" |
| | SW CASING | 6" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER WEB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

BORING NO. 96-03 DATE ____ SHEET 2 OF 2

PROJECT Sporn fly ash pond dikes

BORING START 06/17/96 BORING FINISH 06/18/96

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | U S C S | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | SS | 51.7 | 53.2 | 18-19-20 | 1.5 | | | | | Same with 3/4" max size. | | |
| 14 | SS | 56.7 | 57.0 | 50/.3 | .3 | | 55 | | | Brown | | |
| 15 | SS | 59.8 | 60.0 | 50/.2 | .2 | | 60 | | | LIGHT GRAY SANDSTONE Fine grain. | | |

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

AEP

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

COORDINATES N 717,954.5 E 1,735,752.5

GROUND ELEVATION 593.5 SYSTEM STATE PLANE

BORING NO. 96-04 DATE ____ SHEET 1 OF 2

BORING START 06/18/96 BORING FINISH 06/19/96

PIEZOMETER TYPE ____ WELL TYPE ____

HGT. RISER ABOVE GROUND ____ DIA ____

DEPTH TO TOP OF WELL SCREEN ____ BOTTOM ____

WELL DEVELOPMENT ____ BACKFILL QUICK GROUT

FIELD PARTY MCR-WEB RIG BK-81

| WATER LEVEL | ▽ | ▼ | ▼ |
|---|---|---|---|
| TIME | | | |
| DATE | | | |

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | | | | | | | | ROAD BASE | | |
| 2 | SS | 3.0 | 4.5 | 11-12-13 | 1.3 | | | | SC | DARK BROWN CLAYEY SAND Moist, trace of small gravel. | | |
| | | | | | | | 5 | | | | | |
| 3 | SS | 5.0 | 6.5 | 11-19-16 | 1.5 | | | | SP | DARK BROWN GRAVELLY SAND Moist, 1/2" max size, rounded with fines. | | |
| 4 | SS | 8.5 | 10.0 | 9-12-10 | 1.5 | | | | | | | |
| | | | | | | | 10 | | | | | |
| 5 | SS | 11.6 | 13.1 | 16-22-17 | 1.5 | | | | | BLACK BOTTOM ASH Moist with 1" layer of silty clay with slight plasticity. | | |
| | | | | | | | 15 | | | | | |
| 6 | SS | 16.6 | 18.1 | 9-9-7 | .4 | | | | | DARK BROWN, BLACK CLAYEY SAND Moist, some organic, may be older road base. | | |
| | | | | | | | 20 | | | | | |
| 7 | SS | 21.6 | 23.1 | 5-5-6 | 1.5 | | | | | BLACK BOTTOM ASH Saturated.<br>BLACK FLY ASH Saturated. | | |
| | | | | | | | 25 | | | | | |
| 8 | SS | 26.6 | 28.1 | 1-2-2 | 1.2 | | | | | | | |
| | | | | | | | 30 | | | | | |
| 9 | SS | 31.6 | 33.1 | 1-1-1 | 1.5 | | | | | | | |
| | | | | | | | 35 | | | | | |
| 10 | SS | 36.6 | 38.1 | .2-3-3 | 1.5 | | | | CL | ORANGE AND LIGHT BROWN MOTTLED SILTY CLAY Wet to saturated, medium to low plasticity. | | |
| | | | | | | | 40 | | | | | |
| 11 | SS | 41.6 | 43.1 | 3-3-3 | 1.5 | | | | | Same as sample with trace of organic material. | | |
| | | | | | | | 45 | | | | | |
| 12 | ST | 46.6 | 48.6 | | 2.0 | | | | | | | |

| TYPE OF CASING USED | | |
|---|---|---|
| | NQ-2 ROCK CORE | |
| X | 6" x 3.25 HSA | |
| | 9" x 6.25 HSA | |
| | HW CASING ADVANCER | 4" |
| | NW CASING | 3" |
| | SW CASING | 6" |

*Continued Next Page*

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER WEB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER 3966

COMPANY **APPALACHIAN POWER COMPANY**

BORING NO. 96-04 DATE ____ SHEET 2 OF 2

PROJECT **Sporn fly ash pond dikes**

BORING START 06/18/96 BORING FINISH 06/19/96

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | SS | 51.6 | 53.1 | 1-1-1 | 1.5 | | | | SC | GRAY AND BROWN CLAYEY SAND Wet to saturated, v-fine grain sand, slight to non plasticity. | | |
| | | | | | | | 55 | | | | | |
| 14 | SS | 59.3 | 60.8 | 3-3-3 | .8 | | 60 | | SP | DARK BROWN SAND Saturated, fine grain, with some fines, quartz. | | |
| 15 | SS | 64.3 | 65.8 | 15-16-2 | 1.5 | | 65 | | | DARK BROWN SAND Saturated, v-fine grain with some fines, quartz | | |
| 16 | SS | 69.3 | 70.8 | 8-9-11 | 1.5 | | 70 | | SW | DARK BROWN SAND Saturated, quartz. | | |
| 17 | SS | 74.3 | 75.8 | 14-14-19 | 1.5 | | 75 | | | | | |
| 18 | SS | 79.3 | 80.8 | 8-10-8 | 1.5 | | 80 | | SP | DARK BROWN AND GRAY SAND Saturated, quartz, fine grain. | | |
| 19 | SS | 84.3 | 85.1 | 8-50/.3 | .8 | | 85 | | GW | BROWN SAND AND GRAVEL Saturated, quartz, 1/2" max size, rounded. | | |
| 20 | SS | 87.7 | 87.9 | 50/.2 | .2 | | | | | GRAY CLAY SHALE Dry. | | |

# AMERICAN ELECTRIC POWER SERVICE CORPORATION
## AEP CIVIL ENGINEERING LABORATORY
### LOG OF BORING

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

COORDINATES N 718,463.6 E 1,736,113.5

GROUND ELEVATION 597.4 SYSTEM STATE PLANE

BORING NO. 96-05 DATE SHEET 1 OF 2

BORING START 06/12/96 BORING FINISH 06/12/96

PIEZOMETER TYPE WELL TYPE

HGT. RISER ABOVE GROUND DIA

DEPTH TO TOP OF WELL SCREEN BOTTOM

WELL DEVELOPMENT BACKFILL QUICK GROUT

FIELD PARTY MCR-WEB RIG BK-81

| | | | |
|---|---|---|---|
| WATER LEVEL | ▽ 48.8 | ▼ | ▽ |
| TIME | | | |
| DATE | 6-12-96 | | |

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SS | 0.0 | 1.5 | 14-22-35 | 1.0 | | | | | GRAY BOTTOM ASH | | |
| 2 | SS | 3.0 | 4.5 | 11-12-15 | 1.2 | | | | SP | DARK BROWN GRAVELLY SAND Moist, 1/2" max size, some fines. | | |
| 3 | SS | 5.0 | 6.5 | 10-10-15 | 1.3 | | 5 | | SM | BROWN CLAYEY SILT Moist, slight to non plasticity. | | |
| 5 | SS | 8.5 | 10.0 | 8-13-15 | 1.5 | | 10 | | SC | LIGHT BROWN SILTY SAND Dry, v-fine grain.<br>LIGHT AND DARK BROWN CLAYEY SAND Moist, trace of small gravel. | | |
| 6 | SS | 11.7 | 13.2 | 11-11-13 | 1.2 | | 15 | | GP | DARK BROWN CLAYEY SAND AND GRAVEL Moist, quartz, 3/4" max size, rounded. | | |
| 7 | SS | 16.7 | 18.2 | 3-2-4 | 1.5 | | 20 | | SM<br>CL | LIGHT BROWN SILTY SAND Moist, v-fine grain sand.<br>DARK GRAY SILTY CLAY Wet , medium to low plasticity,trace of organic material. | | |
| 8 | SS | 21.7 | 23.2 | 3-4-6 | 1.5 | | 25 | | CL | LIGHT BROWN CLAYEY SILTY Moist to wet, slight plasticity. | | |
| 9 | SS | 26.7 | 28.2 | 2-2-1 | 1.1 | | 30 | | | GRAY BOTTOM ASH Saturated. | | |
| 10 | SS | 31.7 | 33.2 | 1-2-2 | 1.3 | | 35 | | CL | DARK GRAY CLAY Wet to saturated, medium to low plasticity, trace of organic. | | |
| 11 | SS | 36.7 | 38.2 | 1-1-1 | 1.5 | | 40 | | | GRAY FLY ASH Saturated. | | |
| 12 | SS | 41.7 | 43.2 | 1-1-1 | 1.5 | | 45 | | CL | DARK GRAY SILTY CLAYMoist, low to medium plasticity, trace of organic material. | | |
| 13 | SS | 46.7 | 48.2 | 1-1-2 | 1.5 | | | | | BROWN CLAY Wet to saturated, medium to low plasticity. | ▽ | |

*Continued Next Page*

**TYPE OF CASING USED**

| | | |
|---|---|---|
| | NQ-2 ROCK CORE | |
| X | 6" x 3.25 HSA | |
| | 9" x 6.25 HSA | |
| | HW CASING ADVANCER | 4" |
| | NW CASING | 3" |
| | SW CASING | 6" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER WEB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

# AEP CIVIL ENGINEERING LABORATORY

## LOG OF BORING

JOB NUMBER 3966

COMPANY **APPALACHIAN POWER COMPANY** BORING NO. 96-05 DATE SHEET 2 OF 2

PROJECT **Sporn fly ash pond dikes** BORING START 06/12/96 BORING FINISH 06/12/96

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | U S C S | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | ST | 51.7 | 53.7 | | 2.0 | | | | | | | |
| 15 | SS | 56.7 | 58.2 | 2-2-3 | 1.5 | | 55 | | | **DARK GRAY SILTY CLAY** Wet to saturated, low to medium plasticity, trace of v-fine grain sand lens. | | Boring grouted from grade to 58 2' |

AMERICAN ELECTRIC POWER SERVICE CORPORATION

# AEP CIVIL ENGINEERING LABORATORY

## LOG OF BORING

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

COORDINATES N 718,519.1 E 1,736,243.1

GROUND ELEVATION 566.1 SYSTEM STATE PLANE

| WATER LEVEL | ∇ 23.6 | ▼ | ∇ |
|---|---|---|---|
| TIME | | | |
| DATE | 6-18-96 | | |

BORING NO. 96-06 DATE ______ SHEET 1 OF 1

BORING START 06/18/96 BORING FINISH 06/18/96

PIEZOMETER TYPE ______ WELL TYPE ______

HGT. RISER ABOVE GROUND ______ DIA ______

DEPTH TO TOP OF WELL SCREEN ______ BOTTOM ______

WELL DEVELOPMENT ______ BACKFILL QUICK GROUT

FIELD PARTY MCR-WEB RIG BK-81

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SS | 0.0 | 1.5 | 1-1-4 | 1.5 | | | | | **GRAY FLY ASH** Moist. | | |
| 2 | SS | 3.0 | 4.5 | 5-6-4 | 1.5 | | | | | | | |
| 3 | SS | 5.0 | 6.5 | 3-3-2 | 1.5 | | 5 | | | **GRAY BOTTOM ASH** Saturated. | | |
| 4 | SS | 8.5 | 10.0 | 5-5-6 | 1.5 | | 10 | | CL | **BROWN SILTY CLAY** Moist, low to medium plasticity (DIKE MATERIAL). | | |
| 5 | SS | 11.5 | 13.0 | 3-4-2 | 1.5 | | | | | **DARK BROWN SILTY CLAY** Saturated, medium to low plasticity, (DIKE MATERIAL). | | |
| 6 | SS | 16.5 | 18.0 | 4-4-3 | 1.5 | | 15 | | SM | **GRAY SILTY SAND** Saturated, v-fine grain, quartz. | | |
| 7 | SS | 21.5 | 23.0 | 1-1-2 | 1.3 | | 20 | | | | ∇ | |
| 8 | SS | 26.5 | 28.0 | 1-1-1 | 1.5 | | 25 | | | | | |
| 9 | SS | 31.5 | 33.0 | 2-3-3 | 1.5 | | 30 | | CL | **DARK GRAY CLAY** Saturated, medium to low plasticity with v-fine grain sand lens. | | |

| TYPE OF CASING USED | | |
|---|---|---|
| | NQ-2 ROCK CORE | |
| X | 6" x 3.25 HSA | |
| | 9" x 6.25 HSA | |
| | HW CASING ADVANCER | 4" |
| | NW CASING | 3" |
| | SW CASING | 6" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER WEB

# FIELD DATA FROM:
# *"PHILIP SPORN ELECTRIC GENERATING PLANT UNIT 5 ASH FACILITY – ENGINEERING REPORT"*

**PREPARED/COMPILED BY:**
**THE GEOTECHNICAL ENGINEERING SECTION OF AMERICAN ELECTRIC POWER SERVICE CORPORATION**

**DATED: JULY 1998**

AMERICAN ELECTRIC POWER SERVICE CORPORATION
AEP CIVIL ENGINEERING LABORATORY
LOG OF BORING

AEP

JOB NUMBER 3966
COMPANY APPALACHIAN POWER COMPANY
PROJECT Sporn fly ash pond dikes
COORDINATES N 720,983.0 E 1,734,516.1
GROUND ELEVATION 619.0 SYSTEM STATE PLANE

BORING NO. 96-101 DATE ______ SHEET 1 OF 2
BORING START 06/05/96 BORING FINISH 06/05/96
PIEZOMETER TYPE SS WELL TYPE ______
HGT. RISER ABOVE GROUND ______ DIA ______
DEPTH TO TOP OF WELL SCREEN 24.4 BOTTOM 33.4
WELL DEVELOPMENT NO BACKFILL QUICK GROUT
FIELD PARTY MCR-REB RIG BK-81

| WATER LEVEL | ∇ | ▼ | ∇ |
|---|---|---|---|
| TIME | | | |
| DATE | | | |

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 0.0 | | | 0 | | | | | No sample taken boring in road way | | |
| 2 | SS | 3.0 | 4.5 | 12-13-16 | 1.1 | | | | SM | BROWN SILTY GRAVELLY SAND Dry to moist, 1/2" max size, rounded, quartz. | | |
| 3 | SS | 5.0 | 6.5 | 7-9-9 | 1.2 | | 5 | | | | | |
| 3 | SS | 8.5 | 10.0 | 3-4-5 | 1.2 | | 10 | | SC | BROWN CLAYEY SAND Moist, fine grain with trace of gravel. | | |
| 4 | SS | 11.5 | 13.0 | 17-27-38 | 1.2 | | | | SM | BROWN SILTY GRAVELLY SAND Moist, fine grain, trace of gravel, quartz. | | |
| 5 | SS | 16.5 | 18.0 | 12-19-26 | 1.1 | | 15 | | | | | |
| 6 | SS | 21.5 | 23.0 | 16-21-27 | 1.1 | | 20 | | SW | BROWN GRAVELLY SAND Moist, trace of small gravel, quartz, rounded. | | 20.0 Top of seal.<br>22.0 Top of sand. |
| | | | | | | | 25 | | | | | 24.4 Top of screen.<br>594.6 |
| 7 | SS | 26.5 | 28.0 | 12-20-23 | 1.2 | | | | GP | BROWN SAND AND GRAVEL Moist to wet, quartz, rounded, 3/4" max size, some fines. | | |
| 8 | SS | 31.5 | 33.0 | 4-5-7 | 1.1 | | 30 | | SM | BROWN SILTY SAND Moist, 100% fine grain. | | |
| 9 | ST | 33.5 | 35.5 | | 1.6 | | | | | Push 2.0<br>Time 5 sec.<br>PSI 800<br>Top of sample, BROWN SILTY SAND | | 34.0 Bottom of pipe.<br>34.4 Bottom of screen. 584.6<br>35.0 Bottom of sand. |
| 10 | SS | 36.5 | 38.0 | 4-6-8 | 1.1 | | 35 | | CL | Bottom of sample, LIGHT GRAY CLAY Moist, low to medium plasticity. | | |
| 11 | SS | 41.5 | 43.0 | 4-5-6 | 1.1 | | 40 | | SM | DARK GRAY SILTY SAND Wet, non to slight plasticity, with reddish brown quartz sand lens. | | |
| 12 | ST | 43.5 | 45.5 | | 1.5 | | | | ML | PUSH 2.0<br>TIME 5 SEC | | |
| 13 | SS | 46.5 | 48.0 | 7-9-11 | 1.1 | | 45 | | SP | PSI 800<br>Bottom of sample, Drillers identification fly ash<br>I believe it is a light gray clay | | |

*Continued Next Page*

| TYPE OF CASING USED | | |
|---|---|---|
| | NQ-2 ROCK CORE | |
| X | 6" x 3.25 HSA | |
| | 9" x 6.25 HSA | |
| | HW CASING ADVANCER | 4" |
| | NW CASING | 3" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER REB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER 3966

COMPANY **APPALACHIAN POWER COMPANY**

BORING NO. 96-101 DATE______ SHEET 2 OF 2

PROJECT **Sporn fly ash pond dikes**

BORING START 06/05/96 BORING FINISH 06/05/96

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | ?????????????????????????????????????<br>Top of sample, BROWN SILTY<br>BROWN GRAVELLY SAND Moist, 1/2" max size, rounded, quartz. | | |

AMERICAN ELECTRIC POWER SERVICE CORPORATION

# AEP CIVIL ENGINEERING LABORATORY

## LOG OF BORING

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

COORDINATES N 720,707.5 E 1,734,001.7

GROUND ELEVATION 619.6 SYSTEM STATE PLANE

BORING NO. 96-102 DATE SHEET 1 OF 1

BORING START 06/05/96 BORING FINISH 06/05/96

PIEZOMETER TYPE WELL TYPE

HGT. RISER ABOVE GROUND DIA

DEPTH TO TOP OF WELL SCREEN BOTTOM

WELL DEVELOPMENT BACKFILL QUICK GROUT

FIELD PARTY MCR-REB RIG BK-81

| WATER LEVEL | ▽ | ▼ | ▼ |
|---|---|---|---|
| TIME | | | |
| DATE | | | |

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 0.0 | | | 0 | | | | | NO SAMPLE TAKEN BORING IN ROAD AUGER CUTTINGS INDICATE BROWN SAND AND GRAVEL | | Boring was grouted from grade to 48.2' with quick grout. |
| 2 | SS | 3.0 | 4.5 | 12-16-19 | 1.1 | | 5 | | SP | BROWN GRAVELLY SAND Moist, 1/2" max size, rounder, quartz with fines. | | |
| 3 | SS | 5.0 | 6.5 | 17-21-26 | 1.2 | | | | | | | |
| 4 | SS | 8.5 | 10.0 | 13-16-19 | 1.2 | | 10 | | | | | |
| 5 | SS | 11.7 | 13.2 | 15-28-32 | 1.2 | | 15 | | | | | |
| 6 | SS | 16.7 | 18.2 | 17-21-26 | 1.2 | | 20 | | | | | |
| 7 | SS | 21.7 | 23.2 | 19-21-24 | 1.1 | | 25 | | | Sample moist to wet. | | |
| 8 | SS | 26.7 | 28.2 | 9-9-11 | 1.1 | | 30 | | SM | DARK BROWN SANDY SILT Moist, non-plastic. | | |
| 9 | SS | 31.7 | 33.2 | 3-4-5 | 1.1 | | | | SC | BROWN SANDY CLAY Moist, low plasticity, with v-fine sand lens. | | |
| 10 | ST | 33.7 | 35.7 | | ? | | 35 | | | Time 5 sec.<br>Push 2.0<br>PSI 1000 | | |
| 11 | SS | 36.7 | 38.2 | 4-4-5 | 1.1 | | 40 | | SM | BROWN SILTY SAND Moist, with very fine sand lens. | | |
| 12 | SS | 41.7 | 43.2 | 3-5-8 | 1.1 | | 45 | | SP | BROWN GRAVELLY SAND Moist, 3/4" max size, rounded, quartz. | | |
| 13 | SS | 46.7 | 48.2 | 13-15-21 | 1.2 | | | | | | | |

### TYPE OF CASING USED

| | | |
|---|---|---|
| X | NQ-2 ROCK CORE | |
| | 6" x 3.25 HSA | |
| | 9" x 6.25 HSA | |
| | HW CASING ADVANCER | 4" |
| | NW CASING | 3" |
| | SW CASING | 6" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER REB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

# AEP CIVIL ENGINEERING LABORATORY

## LOG OF BORING

AEP

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

COORDINATES N 719,785.3 E 1,734,133.3

GROUND ELEVATION 618.0 SYSTEM STATE PLANE

BORING NO. 96-103 DATE ____ SHEET 1 OF 1

BORING START 06/04/96 BORING FINISH 06/04/96

PIEZOMETER TYPE ____ WELL TYPE ____

HGT. RISER ABOVE GROUND ____ DIA ____

DEPTH TO TOP OF WELL SCREEN ____ BOTTOM ____

WELL DEVELOPMENT ____ BACKFILL QUICK GROUT

FIELD PARTY MCR-REB RIG BK-81

| | | | |
|---|---|---|---|
| WATER LEVEL | ∇ | ▼ | ∇ |
| TIME | | | |
| DATE | | | |

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | SAMPLE DEPTH IN FEET TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 0.0 | | | 0 | | | | | NO SAMPLE TAKEN BORING LOCATED IN ROAD CUTTINGS INDICATE BROWN SAND AND GRAVEL | | Boring grouted from grade to 48.1 w\ 60 gallons of quick grout. |
| 2 | SS | 3.0 | 4.5 | 12-19-24 | 1.1 | | | | SP | DARK BROWN GRAVELLY SAND Moist, rounded, quartz, with fines, 3/4" max size. | | |
| 3 | SS | 5.0 | 6.5 | 14-17-19 | 1.2 | | 5 | | | | | |
| 4 | SS | 8.5 | 10.0 | 17-21-25 | 1.1 | | 10 | | | | | |
| 5 | SS | 11.6 | 13.1 | 19-25-28 | 1.1 | | 15 | | | | | |
| 6 | SS | 16.6 | 18.1 | 12-19-25 | 1.2 | | 20 | | | | | |
| 7 | SS | 21.6 | 23.1 | 5-14-21 | 1.1 | | 25 | | | | | |
| 8 | SS | 26.6 | 28.1 | 11-17-28 | 1.2 | | 30 | | | | | |
| 9 | SS | 31.6 | 33.1 | 8-9-10 | 1.1 | | 35 | | CL | BROWN SILTY CLAY Moist, with fine grin sand lens, low plasticity. | | |
| 10 | ST | 36.6 | 38.6 | | 1.6 | | 40 | | SP | time 5 sec.<br>Push 2.0<br>PSI 700<br>LIGHT BROWN SAND Fine grain. | | |
| 11 | SS | 41.6 | 43.1 | 4-5-6 | 1.1 | | 45 | | | BROWN SAND Moist, 100% fine grain, with fines. | | |
| 12 | SS | 46.6 | 48.1 | 6-6-5 | ? | | | | | | | |

| TYPE OF CASING USED | |
|---|---|
| X | NQ-2 ROCK CORE |
| | 6" x 3.25 HSA |
| | 9" x 6.25 HSA |
| | HW CASING ADVANCER 4" |
| | NW CASING 3" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER REB

# AMERICAN ELECTRIC POWER SERVICE CORPORATION
## AEP CIVIL ENGINEERING LABORATORY
## LOG OF BORING

AEP

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

COORDINATES N 719,229.2 E 1,734,600.2

GROUND ELEVATION 618.7 SYSTEM STATE PLANE

BORING NO. 96-104 DATE _____ SHEET 1 OF 2

BORING START 06/04/96 BORING FINISH 06/04/96

PIEZOMETER TYPE SS WELL TYPE _____

HGT. RISER ABOVE GROUND _____ DIA _____

DEPTH TO TOP OF WELL SCREEN 24.1 BOTTOM 33.1

WELL DEVELOPMENT NO BACKFILL QUICK GROUT

FIELD PARTY MCR-REB RIG BK-81

| WATER LEVEL | ▽ | ▼ | ▽ |
|---|---|---|---|
| TIME | | | |
| DATE | | | |

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | U S C S | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SS | 0.0 | | 2-4-8 | 1.1 | | | | CL | - | | |
| 2 | SS | 3.0 | 4.5 | 9-14-18 | 1.2 | | | | SP | **DARK BROWN CLAY** Moist, medium to high plasticity trace of sand. | | |
| 3 | SS | 5.0 | 6.5 | 73 | 1.1 | | 5 | | GW | **BROWN GRAVELLY SAND** Dry, quartz, 1/2" max, rounded. | | |
| 4 | SS | 8.5 | 10.0 | 9-18-25 | 1.2 | | 10 | | | **DARK BROWN SAND AND GRAVEL** Dry, quartz, 1/2" max, rounded.<br>**Same as above some fines, moist** | | |
| 5 | SS | 11.7 | 13.2 | 19-26-31 | 1.2 | | 15 | | SP | **DARK BROWN GRAVELLY SAND** Dry, 3/4" max, rounded, quartz. | | |
| 6 | SS | 16.7 | 18.2 | 18-21-26 | 1.2 | | 20 | | SC | **DARK BROWN CLAYEY SAND** Moist, trace of gravel. | | |
| 7 | SS | 21.7 | 23.2 | 17-21-25 | 1.2 | | 25 | | SP | **LIGHT BROWN GRAVELLY SAND** Dry, quartz, 3/4" max, rounded. | | 20.4 Top seal.<br>22.5 Top of sand.<br>24.1 Top of screen. |
| 8 | SS | 26.7 | 28.2 | 4-6-8 | 1.1 | | 30 | | CL | **LIGHT BROWN SILTY CLAY** Moist, low to medium plasticity. | | |
| 9 | ST | 31.7 | 33.7 | | 1.6 | | 35 | | | **PUSH 2.0**<br>**PSI 900**<br>**TIME 6 SEC.** | | 33.1 Bottom of screen. |
| 10 | SS | 36.7 | 38.2 | 3-3-5 | 1.2 | | 40 | | | **BROWN CLAYEY SAND** Fine grain?<br>**LIGHT BROWN SILTY CLAY** Moist, low to medium plasticity. | | 34.7 Bottom of sand. |
| 11 | SS | 41.7 | 43.2 | 4-4-7 | 1.1 | | 45 | | SM | **LIGHT BROWN SILTY SAND** Moist. v-fine grain 100%. | | |
| 12 | ST | 46.7 | 48.7 | | 1.5 | | | | | **PUSH 2.0**<br>**PSI 1200**<br>**TIME 6 SEC.** | | |

*Continued Next Page*

### TYPE OF CASING USED

| | |
|---|---|
| X | NQ-2 ROCK CORE |
| | 6" x 3.25 HSA |
| | 9" x 6.25 HSA |
| | HW CASING ADVANCER 4" |
| | NW CASING 3" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER REB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

## AEP CIVIL ENGINEERING LABORATORY

## LOG OF BORING

JOB NUMBER 3966

COMPANY **APPALACHIAN POWER COMPANY** BORING NO. 96-104 DATE______ SHEET 2 OF 2

PROJECT **Sporn fly ash pond dikes** BORING START 06/04/96 BORING FINISH 06/04/96

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET | | STANDARD PENETRATION RESISTANCE | TOTAL LENGTH RECOVERY | RQD | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FROM | TO | BLOWS / 6" | | % | | | | | | |
| | | | | | | | | | | DARK BROWN SANDY CLAY Fine grain. | | |

AMERICAN ELECTRIC POWER SERVICE CORPORATION

# AEP CIVIL ENGINEERING LABORATORY

## LOG OF BORING

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

COORDINATES N 718,782.8 E 1,735,084.7

GROUND ELEVATION 619.3 SYSTEM STATE PLANE

| WATER LEVEL | ∇ | ▼ | ∇ |
|---|---|---|---|
| TIME | | | |
| DATE | | | |

BORING NO. 96-105 DATE SHEET 1 OF 1

BORING START 06/03/96 BORING FINISH 06/03/96

PIEZOMETER TYPE WELL TYPE

HGT. RISER ABOVE GROUND DIA

DEPTH TO TOP OF WELL SCREEN BOTTOM

WELL DEVELOPMENT BACKFILL QUICK GROUT

FIELD PARTY MCR-REB RIG BK-81

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | SAMPLE DEPTH IN FEET TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | No sample taken. Boring located in road bed. Auger cuttings sand and gravel. | | Boring grouted from grade to 48.5' with 75 gallons of quick grout |
| 1 | SS | 3.0 | 4.5 | 7-10-11 | 1.1 | | | | SW | BROWN SAND Dry, quartz, rounded with trace of gravel. | | |
| 2 | SS | 5.0 | 6.5 | 12-16-21 | 1.2 | | 5 | | | BROWN GRAVELLY SAND Dry quartz, rounded, 1/2" max size. | | |
| 3 | SS | 8.5 | 10.0 | 9-15-17 | 1.2 | | | | | 3/4" max size trace of fines. | | |
| 4 | SS | 11.5 | 13.0 | 9-16-19 | 1.1 | | 10 | | | | | |
| 5 | SS | 16.5 | 18.0 | 9-14-17 | 1.2 | | 15 | | | Moist | | |
| 6 | SS | 21.5 | 23.0 | 7-9-14 | 1.1 | | 20 | | SM | DARK BROWN SILTY SAND Moist, with trace of small gravel. | | |
| 7 | SS | 26.5 | 28.0 | 5-6-7 | 1.2 | | 25 | | CL | BROWN SILTY CLAY Moist, low to medium plasticity. | | |
| 8 | ST | 31.5 | 33.5 | | 1.7 | | 30 | | | PUSH 2.0<br>PSI 700<br>TIME 8 SEC. | | |
| 9 | SS | 36.5 | 38.0 | 3-3-5 | 1.1 | | 35 | | | | | |
| 10 | SS | 41.5 | 43.0 | 4-4-5 | 1.2 | | 40 | | SP<br>SC | LIGHT BROWN CLAYEY SAND Moist, 100% v-fine grain. | | |
| 11 | ST | 46.5 | 48.0 | | 1.8 | | 45 | | | TIME 5 SEC<br>PSI 800<br>PUSH 2.0 | | |

TYPE OF CASING USED

| | |
|---|---|
| X | NQ-2 ROCK CORE |
| | 6" x 3.25 HSA |
| | 9" x 6.25 HSA |
| | HW CASING ADVANCER 4" |
| | NW CASING 3" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER REB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

## AEP CIVIL ENGINEERING LABORATORY

### LOG OF BORING

AEP

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

COORDINATES N 719,271.8 E 1,735,858.4

GROUND ELEVATION 618.9 SYSTEM STATE PLANE

BORING NO. 96-106 DATE ______ SHEET 1 OF 2

BORING START 05/28/96 BORING FINISH 05/28/96

PIEZOMETER TYPE ______ WELL TYPE ______

HGT. RISER ABOVE GROUND ______ DIA ______

DEPTH TO TOP OF WELL SCREEN ______ BOTTOM ______

WELL DEVELOPMENT ______ BACKFILL QUICK GROUT

FIELD PARTY MCR-REB RIG BK-81

| | | | |
|---|---|---|---|
| WATER LEVEL | ∇ 60.2 | ▼ | ∇ |
| TIME | | | |
| DATE | 5-28-96 | | |

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | SAMPLE DEPTH IN FEET TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | NO SAMPLE TAKEN BORING IN ROAD BED. | | |
| 1 | SS | 3.0 | 4.5 | 15-17-21 | 1.1 | | | | GP | DARK BROWN SAND AND GRAVEL Moist, 1/2" max, rounded, quartz, some fines. | | |
| 2 | SS | 5.0 | 6.5 | 17-24-30 | 1.1 | | 5 | | | 1" max size | | |
| 3 | SS | 8.5 | 10.0 | 13-17-20 | 1.2 | | 10 | | | 1/2" max size | | |
| 4 | SS | 11.5 | 13.0 | 11-11-14 | 1.2 | | | | | | | |
| 5 | SS | 16.5 | 18.0 | 13-15-17 | 1.1 | | 15 | | | 1/2" max size | | |
| 6 | SS | 21.5 | 23.0 | 6-8-10 | 1.2 | | 20 | | SC | BROWN SANDY CLAY Dry, slight to low plasticity. | | |
| 7 | SS | 26.5 | 28.0 | 4-6-6 | 1.2 | | 25 | | | GRAY FLY ASH Dry. | | |
| 8 | SS | 31.5 | 33.0 | 1-1-1 | 1.2 | | 30 | | | Saturated | | |
| 9 | SS | 36.5 | 38.0 | 1-1-1 | 1.2 | | 35 | | | | | |
| 10 | SS | 41.5 | 43.0 | 1-1-1 | 1.2 | | 40 | | | | | |
| 11 | SS | 46.5 | 48.0 | 3-2-2 | 1.1 | | 45 | | | | | |

*Continued Next Page*

**TYPE OF CASING USED**

| | | |
|---|---|---|
| X | NQ-2 ROCK CORE | |
| | 6" x 3.25 HSA | |
| | 9" x 6.25 HSA | |
| | HW CASING ADVANCER | 4" |
| | NW CASING | 3" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER REB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

BORING NO. 96-106 DATE ______ SHEET 2 OF 2

BORING START 05/28/96 BORING FINISH 05/28/96

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | SAMPLE DEPTH IN FEET TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | SS | 51.5 | 53.0 | 2-2-2 | 1.2 | | | | | | | |
| 13 | SS | 56.5 | 58.0 | 3-4-4 | 1.2 | | 55 | | CL | **DARK GRAY SILTY CLAY** Wet, low to medium plasticity, trace of organic material. | | |
| 14 | ST | 61.5 | 63.5 | | 1.6 | | 60 | | | Time 7 sec.<br>Push 2.0<br>PSI 600 | ▽ | |
| 15 | SS | 66.5 | 68.0 | 3-4-5 | 1.2 | | 65 | | | **BROWN SILTY CLAY** Trace of fine sand.<br>**BROWN CLAY** Wet, medium to high plasticity. | | |
| | | | | | | | | | | | | Boring grouted from 68.0' to grade with 125 gallons quick grout. |

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER 3966

COMPANY **APPALACHIAN POWER COMPANY**

PROJECT **Sporn fly ash pond dikes**

COORDINATES **N 719,691.4 E 1,736,040.0**

GROUND ELEVATION **618.8** SYSTEM **STATE PLANE**

BORING NO. **96-107** DATE ____ SHEET **1** OF **2**

BORING START **05/29/96** BORING FINISH **05/29/96**

PIEZOMETER TYPE ____ WELL TYPE ____

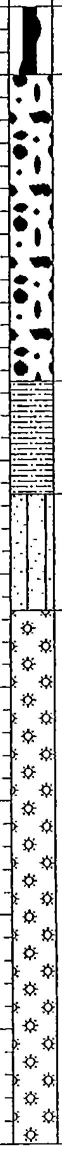
HGT. RISER ABOVE GROUND ____ DIA ____

DEPTH TO TOP OF WELL SCREEN ____ BOTTOM ____

WELL DEVELOPMENT ____ BACKFILL **QUICK GROUT**

FIELD PARTY **MCR-REB** RIG **BK-81**

| WATER LEVEL | ∇ 39.1 | ∇ | ∇ |
|---|---|---|---|
| TIME | | | |
| DATE | 5-29-96 | | |



| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | NO SAMPLE TAKEN BORING IN ROAD BED, AUGER CUTTINGS INDICATE BROWN SAND AND GRAVEL | | Boring was grouted from 73.1 to grade w/approximately 100 gallons of quick grout. |
| 1 | SS | 3.0 | 4.5 | 14-17-21 | 1.1 | | | GP | BROWN SAND AND GRAVEL Moist, quartz, rounded, some fine 3/4' max size. | | |
| 2 | SS | 5.0 | 6.5 | 17-21-28 | 1.2 | | 5 | | | | |
| 3 | SS | 8.5 | 10.0 | 14-18-24 | 1.1 | | 10 | | 1/2" max size | | |
| 4 | SS | 11.6 | 13.1 | 13-16-21 | 1.2 | | 15 | | | | |
| 5 | SS | 16.6 | 18.1 | 5-8-10 | 1.1 | | 20 | ML | BROWN SILT Moist, non to v-slight plasticity. | | |
| 6 | SS | 21.6 | 23.1 | 8-8-11 | 1.2 | | 25 | SM | Attempted shelby tube lifted rig<br>BROWN SILT SAND Moist, 100% v-fine grain. | | |
| 7 | SS | 26.6 | 28.1 | 4-5-9 | 1.2 | | 30 | | GRAY FLY ASH Moist. | | |
| 8 | SS | 31.6 | 33.1 | 5-8-11 | 1.2 | | 35 | | Saturated | | |
| 9 | SS | 36.6 | 38.1 | 1-1-1 | 1.1 | | 40 | | | ∇ | |
| 10 | SS | 41.6 | 43.1 | 1-1-1 | 1.2 | | 45 | | | | |
| 11 | SS | 46.6 | 48.1 | 1-1-1 | 1.2 | | | | | | |

*Continued Next Page*

**TYPE OF CASING USED**

| | |
|---|---|
| X | NQ-2 ROCK CORE |
| | 6" x 3.25 HSA |
| | 9" x 6.25 HSA |
| | HW CASING ADVANCER 4" |
| | NW CASING 3" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER REB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

AEP

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

BORING NO. 96-107 DATE ______ SHEET 2 OF 2

PROJECT Sporn fly ash pond dikes

BORING START 05/29/96 BORING FINISH 05/29/96

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | U S C S | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | SS | 51.6 | 53.1 | 2-1-1 | 1.2 | | | | | | | |
| 13 | SS | 56.6 | 58.1 | 0 | 1.3 | | 55 | | | | | Weight of 140# hammer. |
| 14 | SS | 61.6 | 63.1 | 4-7-10 | 1.2 | | 60 | | CL | DARK BROWN CLAY Moist. medium to high plasticity. | | |
| 15 | ST | 66.6 | 68.6 | | 1.5 | | 65 | | | Push 2.0<br>Time 5 sec.<br>PSI 600<br>BROWN CLAY | | |
| 16 | SS | 71.6 | 73.1 | 4-6-7 | 1.2 | | 70 | | | | | |

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

# LOG OF BORING

AEP

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

COORDINATES N 719,761.8 E 1,736,125.4

GROUND ELEVATION 603.4 SYSTEM STATE PLANE

BORING NO. 96-108 DATE ____ SHEET 1 OF 2

BORING START 06/11/96 BORING FINISH 06/11/96

PIEZOMETER TYPE SS WELL TYPE ____

HGT. RISER ABOVE GROUND ____ DIA ____

DEPTH TO TOP OF WELL SCREEN 63.3 BOTTOM 72.3

WELL DEVELOPMENT NO BACKFILL QUICK GROUT

FIELD PARTY MCR-WEB RIG BK-81

| | | | |
|---|---|---|---|
| WATER LEVEL | ▽ | ▼ | ▽ |
| TIME | | | |
| DATE | | | |

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | SAMPLE DEPTH IN FEET TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | No sample road base | | |
| 1 | SS | 3.0 | 4.5 | 11-15-16 | 1.2 | | | | | BLACK SAND AND BOTTOM ASH Moist. | | |
| 3 | SS | 5.0 | 6.5 | 12-17-21 | 1.5 | | 5 | | | | | |
| 4 | SS | 8.5 | 10.0 | 12-16-29 | .9 | | 10 | | SC | DARK BROWN CLAYEY SAND Moist, with fine sand lens. | | |
| 5 | SS | 11.6 | 13.1 | 9-18-22 | 1.2 | | 15 | | SP | DARK BROWN GRAVELLY SAND Moist, quartz, some fine, 1/2" max size. | | |
| 6 | SS | 16.6 | 18.1 | 18-24-21 | .8 | | 20 | | SC | DARK BROWN CLAYEY SAND Moist, trace of small gravel and ash. | | |
| 7 | SS | 21.6 | 23.1 | 6-6-8 | 1.5 | | 25 | | CL | LIGHT BROWN SILTY CLAY Moist, low plasticity. | | |
| 8 | SS | 26.6 | 28.1 | 4-4-4 | 1.0 | | 30 | | | BLACK BOTTOM ASH Saturated. | | |
| 9 | SS | 31.6 | 33.1 | 2-1-2 | 1.1 | | 35 | | | GRAY FLY ASH Saturated. | | |
| 10 | SS | 36.6 | 38.1 | 2-1-1 | 1.5 | | 40 | | | | | |
| 11 | SS | 41.6 | 43.1 | 3-5-7 | .8 | | 45 | | CL | LIGHT GRAY CLAY Moist to wet, medium to high plasticity. | | |
| 12 | ST | 46 6 | 48.6 | | 2.0 | | | | | PUSH 2.0<br>TIME 7 SEC.<br>PSI 1000 | | |

Continued Next Page

| TYPE OF CASING USED | | |
|---|---|---|
| X | NQ-2 ROCK CORE | |
| | 6" x 3.25 HSA | |
| | 9" x 6.25 HSA | |
| | HW CASING ADVANCER | 4" |
| | NW CASING | 3" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER REB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

AEP

JOB NUMBER 3966

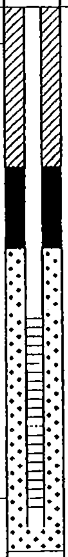
COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

BORING NO. 96-108 DATE ______ SHEET 2 OF 2

BORING START 06/11/96 BORING FINISH 06/11/96

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | SAMPLE DEPTH IN FEET TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | U S C S | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | SS | 51.6 | 53.1 | 2-2-3 | ? | | 55 | | CL | **DARK GRAY SILTY CLAY** Wet, low plasticity, trace of organic and sand. | | |
| 14 | SS | 56.6 | 58.1 | 2-2-3 | 1.5 | | 60 | | | | | 57.0 Top of seal. |
| 15 | SS | 61.6 | 63.1 | 3-4-5 | 1.5 | | 65 | | | | | 60.6 Top of sand.<br>63.3 Top screen. |
| 16 | SS | 66.6 | 68.1 | 4-4-5 | 1.5 | | 70 | | | | | |
| 17 | SS | 71.6 | 73.1 | 4-5-6 | 1.5 | | | | | | | 72.3 Bottom of screen.<br>74.0 Bottom of sand. |



AMERICAN ELECTRIC POWER SERVICE CORPORATION

# AEP CIVIL ENGINEERING LABORATORY

## LOG OF BORING

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

COORDINATES N 720,227.5 E 1,735,579.0

GROUND ELEVATION 619.6 SYSTEM STATE PLANE

| | | | |
|---|---|---|---|
| WATER LEVEL | ∇ 20.5 | ▼ | ∇ |
| TIME | | | |
| DATE | 5-30-96 | | |

BORING NO. 96-109 DATE ____ SHEET 1 OF 2

BORING START 05/29/96 BORING FINISH 05/30/96

PIEZOMETER TYPE ____ WELL TYPE ____

HGT. RISER ABOVE GROUND ____ DIA ____

DEPTH TO TOP OF WELL SCREEN ____ BOTTOM ____

WELL DEVELOPMENT ____ BACKFILL QUICK GROUT

FIELD PARTY MCR-REB RIG BK-81

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | NO SAMPLE TAKEN BORING LOCATED IN ROAD BASE. AUGER CUTTINGS INDICATE BROWN SAND AND GRAVEL | | Boring grouted from 73.2 to grade with 150 gallons quick grout. |
| 1 | SS | 3.0 | 4.5 | 13-19-24 | 1.2 | | | | GP | DARK BROWN SAND AND GRAVEL Moist, 1/2" max size, quartz, rounded, some fines. | | |
| 2 | SS | 5.0 | 6.5 | 15-18-21 | 1.1 | | 5 | | | | | |
| 3 | SS | 8.5 | 10.0 | 15-18-21 | 1.2 | | 10 | | | | | |
| 4 | SS | 11.7 | 13.2 | 12-13-14 | 1.0 | | | | SP | DARK BROWN SAND Moist, fine grain. | | |
| 5 | SS | 16.7 | 18.2 | 4-5-6 | 1.1 | | 15 | | ML | BROWN SANDY SILT Moist, non plasticity. | | |
| 6 | SS | 21.7 | 23.2 | 4-6-8 | 1.2 | | 20 | | | | ∇ | |
| 7 | ST | 26.7 | 28.7 | | 1.5 | | 25 | | | Time 10 sec<br>PSI 1200<br>Push 2.0<br>By watching rig psi possible .4 to .5 of fly ash in bottom of tube. | | |
| 8 | SS ~~ST~~ | 31.7 | 33.2 | 4-7-10 | 1.1 | | 30 | | | GRAY FLY ASH Moist. | | |
| 9 | SS | 36.7 | 38.2 | 1-1-1 | 1.2 | | 35 | | | Saturated | | |
| 10 | SS | 41.7 | 43.2 | 1-1-1 | 1.2 | | 40 | | | | | |
| 11 | SS | 46.7 | 48.2 | 1-1-3 | ? | | 45 | | | | | |

*Continued Next Page*

| TYPE OF CASING USED | | |
|---|---|---|
| X | NQ-2 ROCK CORE | |
| | 6" x 3.25 HSA | |
| | 9" x 6.25 HSA | |
| | HW CASING ADVANCER | 4" |
| | NW CASING | 3" |
| | SW CASING | 6" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER REB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

# AEP CIVIL ENGINEERING LABORATORY

## LOG OF BORING

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

PROJECT Sporn fly ash pond dikes

BORING NO. 96-109 DATE

SHEET 2 OF 2

BORING START 05/29/96 BORING FINISH 05/30/96

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | U S C S | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | SS | 51.7 | 66.7 | 1-1-2 | 1.2 | | | | | | | |
| 13 | SS | 56.7 | 58.2 | 1-1-4 | 1.2 | | 55 | | | | | |
| 14 | SS | 61.7 | 63.2 | 4-6-8 | ? | | 60 | | CL | **DARK BROWN CLAY** Moist, medium to high plasticity. | | |
| 15 | ST | 66.7 | 68.7 | | 1.7 | | 65 | | | Time 8 sec.<br>Push 2.0<br>PSI 1000<br>Material same as sample no. 14 | | |
| 16 | SS | 71.7 | 73.2 | 3-4-5 | 1.2 | | 70 | | | | | |

AMERICAN ELECTRIC POWER SERVICE CORPORATION
AEP CIVIL ENGINEERING LABORATORY
LOG OF BORING

AEP

JOB NUMBER 3966
COMPANY APPALACHIAN POWER COMPANY
PROJECT Sporn fly ash pond dikes
COORDINATES N 720,277.1 E 1,735,665.6
GROUND ELEVATION 602.3 SYSTEM STATE PLANE

BORING NO. 96-110 DATE ______ SHEET 1 OF 2
BORING START 06/06/96 BORING FINISH 06/10/96
PIEZOMETER TYPE SS WELL TYPE ______
HGT. RISER ABOVE GROUND ______ DIA ______
DEPTH TO TOP OF WELL SCREEN 43.7 BOTTOM 52.7
WELL DEVELOPMENT NO BACKFILL QUICK GROUT
FIELD PARTY MCR-REB RIG BK-81

| WATER LEVEL | ⊻ DRY | ⊻ | ⊻ |
|---|---|---|---|
| TIME | | | |
| DATE | 6-10-96 | | |

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | No sample taken, boring in road. | | Grouted grade to 73.1' with approximately 80 gallons. |
| 1 | SS | 3.0 | 4.5 | 13-18-24 | 1.1 | | | | | DARK GRAY BOTTOM ASH Dry | | |
| 2 | SS | 5.0 | 6.5 | 10-11-14 | 1.2 | | 5 | | | | | |
| 3 | SS | 8.5 | 10.0 | 5-7-9 | 1.1 | | 10 | | GP | DARK BROWN SAND AND GRAVEL Dry, quartz, rounded, 3/4" max. | | |
| 4 | SS | 11.6 | 13.1 | 6-7-10 | 1.1 | | 15 | | | | | |
| 5 | SS | 16.6 | 18.1 | 8-10-10 | 1.2 | | | | CL | BROWN CLAY Dry, low to medium plasticity with trace of v-fine sand. | | |
| 6 | SS | 18.6 | 20.1 | 9-11-12 | 1.2 | | 20 | | SC | Attempted to push tube lifted drill, destroyed end of tube.<br>BROWN SANDY CLAY Moist, low to medium plasticity with v-fine grain sand lens. | | |
| 7 | SS | 21.6<br>23.6 | 23.1 | 5-7-11 | 1.2 | | 25 | | | Grading to more sand<br>Attempted to push tube, top hole broken in tube, pushed approximately 1' lifted rig. | | |
| 9 | SS | 26.6 | 28.1 | 5-7-11 | 1.2 | | 30 | | | GRAYISH BROWN SILTY CLAY Moist, low to medium plasticity. | | |
| 10 | SS | 31.6 | 33.1 | 7-10-9 | 1.3 | | 35 | | CL | Could not move or knock tube off to the side of lead auger, pulled augers grouted hole moved approximately three feet down stream to start new hole. No spt taken on new hole untill this point. SWL dry augers to 26.6'. Auger set all weekend at this point. | | |
| 11 | SS | 36.6 | 38.1 | | 1.5 | | | | CL | REDDISH BROWN CLAY Dry to moist, medium to high plasticity. | | |
| 12 | ST | 38.6 | 40.6 | | 2.0 | | 40 | | | MEDIUM GRAY CLAY Moist to dry, medium to high plasticity, with odor of organic.<br>PUSH 2.0<br>PSI 1200<br>TIME 6 SEC. | | 39.1 Top of seal. |
| 13 | SS | 41.6 | 43.1 | 3-5-7 | 1.5 | | 45 | | | Top DARK BROWNISH GRAY SANDY CLAY<br>Bottom BROWN SANDY CLAY | | 41.7 Top of sand.<br>43.7 Top of screen. |
| 14 | SS | 46.6 | 48.1 | 3-4-4 | 1.5 | | | | | DARK GRAY CLAY Moist to wet, medium to high plasticity, strong odor of organic. | | |

*Continued Next Page*

| TYPE OF CASING USED | | |
|---|---|---|
| X | NQ-2 ROCK CORE | |
| | 6" x 3.25 HSA | |
| | 9" x 6.25 HSA | |
| | HW CASING ADVANCER | 4" |
| | NW CASING | 3" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER REB

AMERICAN ELECTRIC POWER SERVICE CORPORATION

## AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER 3966

COMPANY APPALACHIAN POWER COMPANY

BORING NO. 96-110 DATE________ SHEET 2 OF 2

PROJECT Sporn fly ash pond dikes

BORING START 06/06/96 BORING FINISH 06/10/96

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | USCS | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | SS | 51.6 | 53.1 | 3-3-5 | 1.5 | | | | | **GRAY BROWN CLAY** Moist to wet, medium to high plasticity, odor of organic with v-fine grain sand lens, water on out side of spoon. | | 52.7 Bottom of screen.<br>53.3 Bottom of sand. |
| 16 | SS | 56.6 | 58.1 | 3-4-4 | 1.5 | | 55 | | | | | |
| 17 | ST | 58.6 | 60.6 | | 2.0 | | | | | **PUSH 2.0**<br>**TIME 7 SEC.** | | |
| 18 | SS | 61.6 | 63.1 | 10 | ? | | 60 | | | **PSI 770**<br>**DARK GRAY SILTY CLAY**<br>**DARK GRAY CLAY** Moist to wet, medium to high plasticity, strong odor of organic material. | | |
| 19 | SS | 66.6 | 68.1 | 3-4-5 | 1.5 | | 65 | | | | | |
| 20 | SS | 71.6 | 73.1 | 4-7-11 | 1.4 | | 70 | | | | | |

Figure 8

# DUTCH CONE PENETROMETER
## Field Data Form

ct: Spohn Plant Ash Dike

Location:

Tested by: Roush-Brookes

Date: 7-26-96

Test No.: 96101 DCR

Remarks:

Test Procedure:
Rate of Feed: 2cm/sec or no more than 1 in/sec
Run test every 20 cm or approx. 8 inches

C = Cone F = Friction R = Resistance
CR = Cone Resistance LF = Local Friction
Weight of inner rod = 0.14 Kg/cm$^2$/rod length

| Depth<br>① | C<br>Kg/cm2<br>② | F + C<br>Kg/cm2<br>③ | F<br>③ — ②<br>Kg/cm2<br>④ | CR<br>② x 2<br>Kg/cm2<br>⑤ | LF<br>④ x 0.133<br>Kg/cm2<br>⑥ | Friction Ratio*<br>⑥ / ⑤<br>⑦ |
|---|---|---|---|---|---|---|
| 35.1 | 5.6 | 12.3 | | | | |
| 35.9 | 4.0 | | | | | |
| 36.7 | | | | | | |
| 37.5 | 4.0 | 6.3 | | | | |
| 38.3 | 6.6 | 10.6 | | | | |
| 1 | 5.0 | 8.3 | | | | |
| .9 | 4.3 | 9.3 | | | | |
| 40.7 | 3.3 | 7.3 | | | | |
| 41.5 | 4.6 | 7.6 | | | | |
| 42.3 | 4.3 | 8.3 | | | | |
| 43.1 | 4.3 | 7.3 | | | | |
| 43.9 | 7.6 | 8.9 | | | | |
| 44.7 | 8.0 | 14.0 | | | | |
| 45.3 | 8.3 | 12.0 | | | | |
| 46.3 | 15.3 | 28.0 | | | | |
| 47.1 | | 48.0 | | | | |
| | | | | | | |
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| | | | | | | |

Top Cone

Friction Resistance

Cone Resistance

Friction Ratio

DEPTH

Note: The friction ratio is computed by dividing the local friction by th

Figure 8 Page 1-3

# DUTCH CONE PENETROMETER

Field Data Form

Date: 7-30-96

ct: Sporn Plant

Test No.: B-96106 DCP

ocation: Fly Ash Dike

Tested by: Roush + Bowles

Remarks:

Test Procedure:

Rate of Feed: 2cm/sec or no more than 1 in/sec

Run test every 20 cm or approx. 8 inches

C = Cone F = Friction R = Resistance

CR = Cone Resistance LF = Local Friction

Weight of inner rod = 0.14 Kg/cm$^2$/rod length

| Depth ① | C Kg/cm2 ② | F + C Kg/cm2 ③ | F ③ – ② Kg/cm2 ④ | CR ② × 2 Kg/cm2 ⑤ | LF ④ × 0.133 Kg/cm2 ⑥ | Friction Ratio* ⑥ / ⑤ ⑦ |
|---|---|---|---|---|---|---|
| 24.40 | 16.0 | 24.0 | | | | |
| 25.15 | 16.0 | 30.0 | | | | |
| 25.70 | 16.0 | 50.0 | | | | |
| 26.35 | 10.0 | 12.0 | | | | |
| 27.00 | 6.4 | 14.4 | | | | |
| 5 | 4.0 | 10.0 | | | | |
| .30 | 4.2 | 6.6 | | | | |
| 28.95 | 4.8 | 7.2 | | | | |
| 29.60 | 4.0 | 6.2 | | | | |
| 30.25 | 3.2 | 5.6 | | | | |
| 30.90 | 2.8 | 4.7 | | | | |
| 31.55 | 3.6 | 5.8 | | | | |
| 32.20 | 2.8 | 4.8 | | | | |
| 32.85 | 2.0 | 4.4 | | | | |
| 33.50 | 3.2 | 6.3 | | | | |
| 34.15 | 3.2 | 6.4 | | | | |
| 34.80 | 2.8 | 5.6 | | | | |
| 35.45 | 2.7 | 4.9 | | | | |
| 36.10 | 2.9 | 4.7 | | | | |
| 36.75 | 2.8 | 5.2 | | | | |
| 37.40 | 2.9 | 4.3 | | | | |
| 38.05 | 3.2 | 4.8 | | | | |
| 3 0 | 2.8 | 4.7 | | | | |
| 5 | 2.4 | 5.8 | | | | |
| 10.00 | 4.0 | 6.4 | | | | |

Note: The friction ratio is computed by dividing the local friction by the

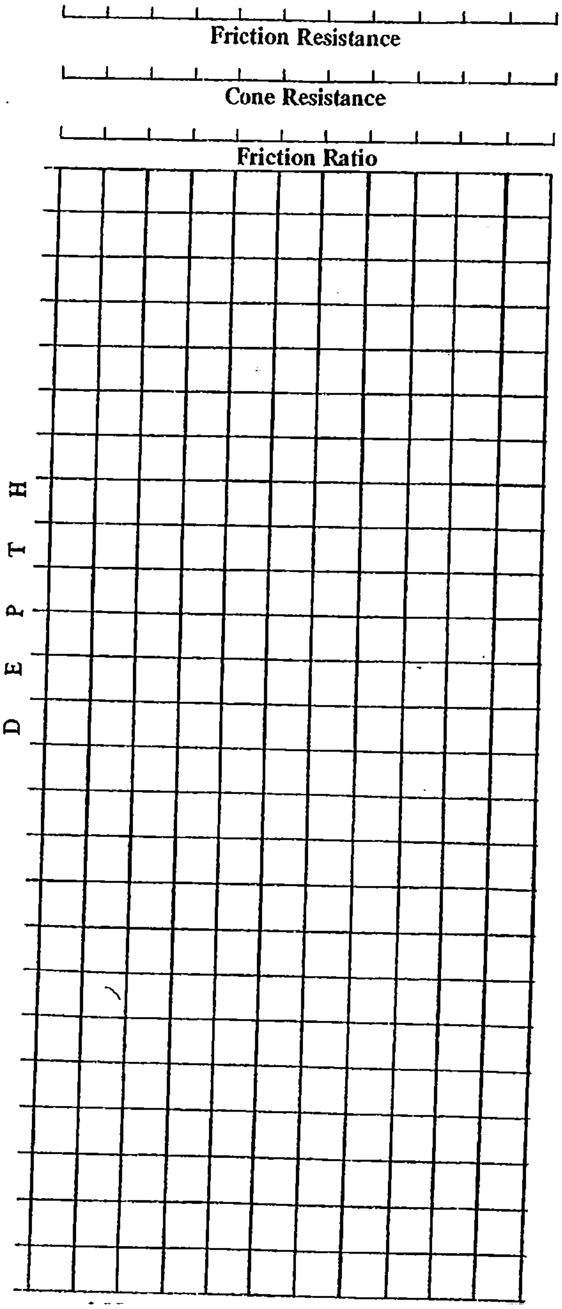

Figure 8 2-3

# DUTCH CONE PENETROMETER

## Field Data Form

Date: 7-30-96

ect:

Test No. B-96106 DCP

Location:

Tested by:

Remarks:

Test Procedure:
Rate of Feed: 2cm/sec or no more than 1 in/sec
Run test every 20 cm or approx. 8 inches

C = Cone F = Friction R = Resistance
CR = Cone Resistance LF = Local Friction
Weight of inner rod = 0.14 Kg/cm$^2$/rod length

| Depth<br>① | C<br>Kg/cm2<br>② | F + C<br>Kg/cm2<br>③ | F<br>③ — ②<br>Kg/cm2<br>④ | CR<br>② × 2<br>Kg/cm2<br>⑤ | LF<br>④ × 0.133<br>Kg/cm2<br>⑥ | Friction Ratio*<br>⑥ / ⑤<br>⑦ |
|---|---|---|---|---|---|---|
| 40.65 | 2.9 | 5.4 | | | | |
| 41.30 | 2.4 | 4.5 | | | | |
| 41.95 | 3.2 | 5.3 | | | | |
| 42.60 | 3.2 | 4.9 | | | | |
| 43.25 | 2.8 | 5.1 | | | | |
| [illegible].90 | 2.9 | 4.3 | | | | |
| 44.55 | 3.1 | 4.8 | | | | |
| 45.20 | 4.8 | 7.2 | | | | |
| 45.85 | 6.3 | 8.8 | | | | |
| 46.50 | 5.2 | 7.6 | | | | |
| 47.15 | 4.0 | 5.9 | | | | |
| 47.80 | 5.2 | 7.6 | | | | |
| 48.45 | 3.2 | 6.0 | | | | |
| 49.10 | 2.0 | 4.8 | | | | |
| 49.75 | 2.4 | 4.6 | | | | |
| 50.40 | 5.2 | 6.6 | | | | |
| 51.05 | 2.7 | 5.7 | | | | |
| 51.70 | 3.6 | 6.7 | | | | |
| 52.35 | 2.1 | 4.6 | | | | |
| 53.00 | 2.9 | 5.2 | | | | |
| 53.65 | 2.5 | 4.7 | | | | |
| 54.30 | 2.9 | 6.8 | | | | |
| [illegible]95 | 2.7 | 7.6 | | | | |
| | | | | | | |
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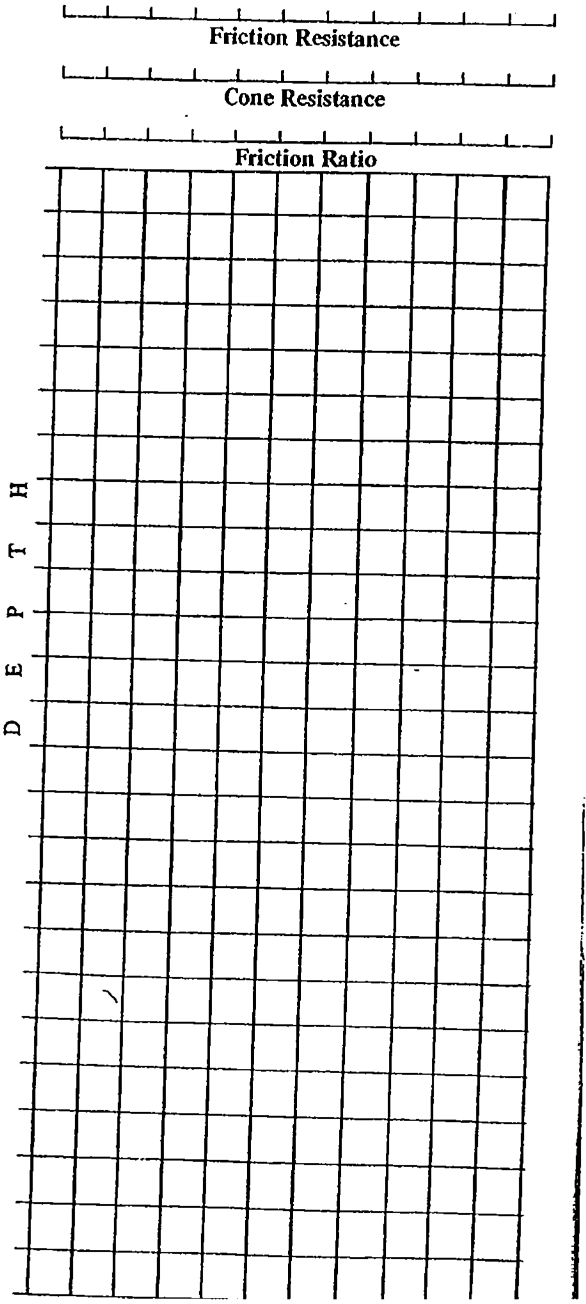

Note: The friction ratio is computed by dividing the local

Figure 8 3-3

# DUTCH CONE PENETROMETER

## Field Data Form

Date: 7-30-96

ect:

Test No.: B-96106 DCP

Location:

Tested by:

Remarks:

---

**Test Procedure:**

Rate of Feed: 2cm/sec or no more than 1 in/sec

Run test every 20 cm or approx. 8 inches

---

C = Cone F = Friction R = Resistance

CR = Cone Resistance LF = Local Friction

Weight of inner rod = 0.14 Kg/cm$^2$/rod length

| Depth ① | C Kg/cm2 ② | F + C Kg/cm2 ③ | F ③ — ② Kg/cm2 ④ | CR ② × 2 Kg/cm2 ⑤ | LF ④ × 0.133 Kg/cm2 ⑥ | Friction Ratio* ⑥ / ⑤ ⑦ |
|---|---|---|---|---|---|---|
| 55,60 | 3,2 | 4.8 | | | | |
| 56.25 | 2.2 | 5,4 | | | | |
| 56.90 | 2,1 | 4,0 | | | | |
| 57.55 | 2,4 | 4.4 | | | | |
| 58,20 | 3,2 | 5,5 | | | | |
| 85 | 2,3 | 5,2 | | | | |
| 9.50 | 2.4 | 4,3 | | | | |
| 60.15 | 2,1 | 4,2 | | | | |
| 60.80 | 1,9 | 3,4 | | | | |
| 61.45 | 1,8 | 3,1 | | | | |
| 62,10 | 1,2 | 2,8 | | | | |
| 62.75 | 1,2 | 2,6 | | | | |
| | | | | | | |
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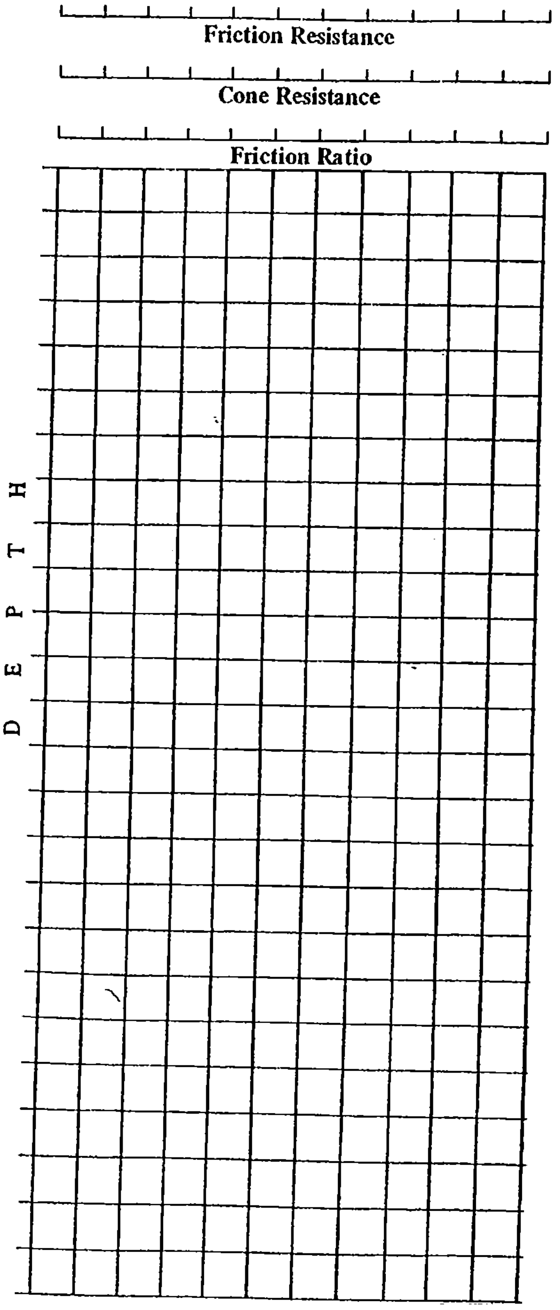


Note: The friction ratio is computed by dividing the local friction

Figure 8

## DUTCH CONE PENETROMETER

### Field Data Form

ect: Sporn Plant

Location: Fly Ash Dike

Tested by: Roush- Bawles

Date: 7-29-96

Test No.: B-96107 DCP

Remarks:

**Test Procedure:**

Rate of Feed: 2cm/sec or no more than 1 in/sec
Run test every 20 cm or approx. 8 inches

C = Cone F = Friction R = Resistance
CR = Cone Resistance LF = Local Friction
Weight of inner rod = 0.14 Kg/cm$^2$/rod length

| Depth<br>① | C<br>Kg/cm2<br>② | F + C<br>Kg/cm2<br>③ | F<br>③ — ②<br>Kg/cm2<br>④ | CR<br>② × 2<br>Kg/cm2<br>⑤ | LF<br>④ × 0.133<br>Kg/cm2<br>⑥ | Friction Ratio*<br>⑥ / ⑤<br>⑦ |
|---|---|---|---|---|---|---|
| 30.70 | 2.4 | 6.0 | | | | |
| 31.35 | 2.8 | 6.0 | | | | |
| 32.00 | 4.0 | 6.4 | | | | |
| 32.65 | 2.4 | 4.5 | | | | |
| 33.30 | 2.4 | 5.6 | | | | |
| 95 | 3.8 | 6.0 | | | | |
| 34.60 | 3.7 | 6.4 | | | | |
| 35.25 | 2.4 | 5.6 | | | | |
| 35.90 | 2.5 | 4.7 | | | | |
| 36.55 | 3.8 | 6.2 | | | | |
| 37.20 | 3.8 | 6.0 | | | | |
| 37.85 | 2.4 | 4.8 | | | | |
| 38.50 | 3.9 | 5.6 | | | | |
| 39.15 | 2.4 | 4.5 | | | | |
| 39.80 | 1.6 | 2.8 | | | | |
| 40.45 | 2.0 | 4.0 | | | | |
| 41.10 | 2.3 | 4.5 | | | | |
| 41.75 | 2.5 | 4.8 | | | | |
| 42.40 | 2.4 | 4.4 | | | | |
| 43.05 | 3.4 | 5.6 | | | | |
| 43.70 | 3.8 | 5.6 | | | | |
| 44.35 | 4.0 | 6.0 | | | | |
| 00 | 3.8 | 6.0 | | | | |
| 65 | 3.2 | 5.2 | | | | |
| 46.30 | 2.4 | 3.2 | | | | |

Note: The friction ratio is

Friction Resistance

Cone Resistance

Friction Ratio

DEPTH

Figure 8 2-2

# DUTCH CONE PENETROMETER

## Field Data Form

Date: 7-29-96

ct:

Test No.: B-96107 DCP

Location:

Tested by:

Remarks:

Test Procedure:

Rate of Feed: 2cm/sec or no more than 1 in/sec

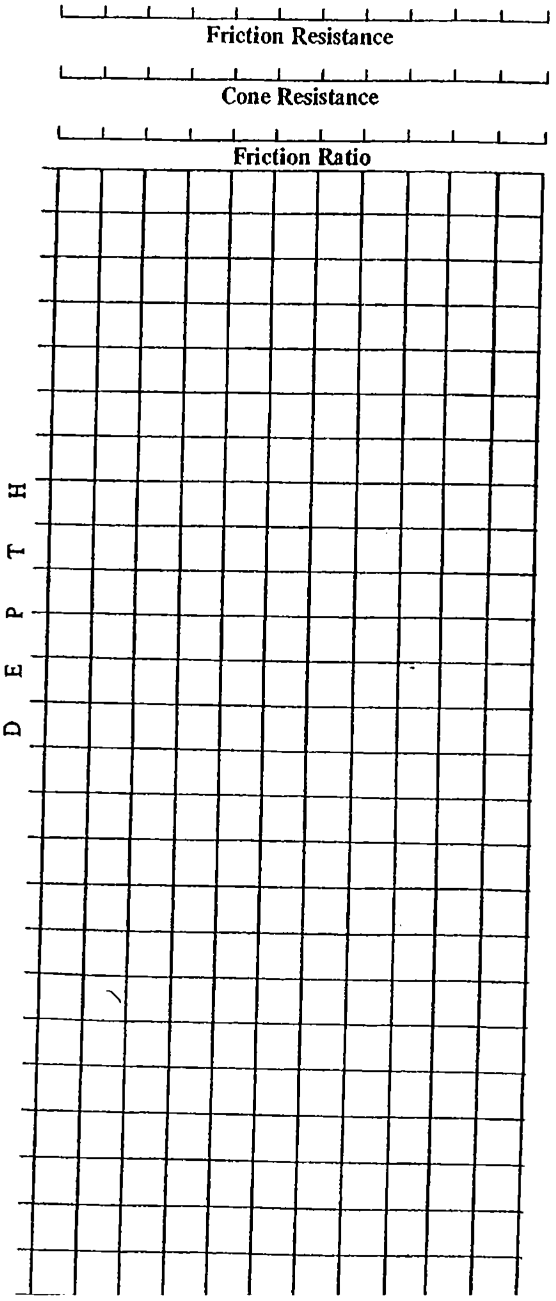
Run test every 20 cm or approx. 8 inches

C = Cone F = Friction R = Resistance

CR = Cone Resistance LF = Local Friction

Weight of inner rod = 0.14 Kg/cm$^2$/rod length

| Depth ① | C Kg/cm2 ② | F + C Kg/cm2 ③ | F ③ — ② Kg/cm2 ④ | CR ② × 2 Kg/cm2 ⑤ | LF ④ × 0.133 Kg/cm2 ⑥ | Friction Ratio* ⑥ / ⑤ ⑦ |
|---|---|---|---|---|---|---|
| 46.95 | 2.4 | 3.2 | | | | |
| 47.60 | 2.2 | 4.5 | | | | |
| 48.25 | 2.4 | 5.7 | | | | |
| 48.90 | 3.8 | 5.6 | | | | |
| 49.55 | 2.4 | 6.4 | | | | |
| 20 | 2.0 | 6.0 | | | | |
| 50.85 | 3.6 | 5.6 | | | | |
| 51.50 | 2.4 | 5.8 | | | | |
| 52.15 | 2.8 | 5.2 | | | | |
| 52.80 | 4.0 | 5.9 | Pulled Rod | Ran | | |
| 53.45 | 2.0 | 3.6 | augers | To | 49.0' | |
| 54.10 | 0.0 | 5.2 | | | | |
| 54.75 | 0.0 | 4.4 | | | | |
| 55.40 | 2.0 | 4.2 | | | | |
| 56.05 | 2.4 | 5.2 | | | | |
| 56.70 | 0.0 | 5.2 | | | | |
| 57.35 | 1.8 | 4.4 | | | | |
| 58.65 | 0.0 | 6.4 | | | | |
| 59.30 | 3.6 | 6.4 | | | | |
| 59.95 | 2.4 | 5.6 | | | | |
| 60.60 | 2.4 | 4.4 | | | | |
| 61.25 | 2.0 | 4.0 | | | | |
| 90 | 1.6 | 3.2 | | | | |
| 2.55 | 1.6 | 2.4 | | | | |
| | | | Stopped | Boring | | |



Note: The friction ratio is computed

Figure 8

Page 1-3

# DUTCH CONE PENETROMETER

## Field Data Form

Date: 7-30-96

ct: Sporn Plant

Test No.: 96109 DCP

Location: Fly Ash Dike

Tested by: Roush + Banks

Remarks:

---

Test Procedure:

Rate of Feed: 2cm/sec or no more than 1 in/sec

Run test every 20 cm or approx. 8 inches

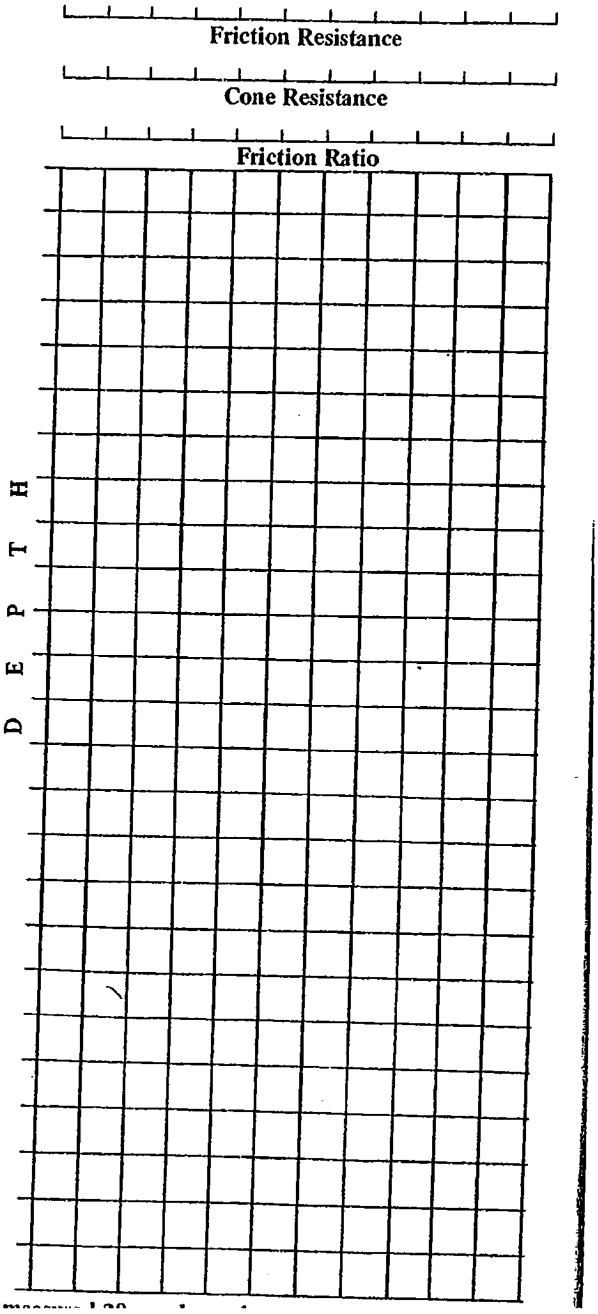
---

C = Cone F = Friction R = Resistance

CR = Cone Resistance LF = Local Friction

Weight of inner rod = 0.14 Kg/cm² /rod length

| Depth ① | C Kg/cm2 ② | F + C Kg/cm2 ③ | F ③ − ② Kg/cm2 ④ | CR ② × 2 Kg/cm2 ⑤ | LF ④ × 0.133 Kg/cm2 ⑥ | Friction Ratio* ⑥ / ⑤ ⑦ |
|---|---|---|---|---|---|---|
| 29.20 | 3.8 | 6.0 | | | | |
| 29.85 | 4.0 | 7.6 | | | | |
| 30.50 | 2.4 | 5.2 | | | | |
| 31.15 | 9.6 | 10.4 | | | | |
| 31.80 | 4.5 | 10.4 | | | | |
| 45 | 5.6 | 6.4 | | | | |
| 10 | 2.4 | 5.7 | | | | |
| 33.75 | 3.2 | 5.2 | | | | |
| 34.40 | 3.2 | 4.8 | | | | |
| 35.05 | 3.9 | 5.9 | | | | |
| 35.70 | 3.6 | 6.4 | | | | |
| 36.35 | 3.2 | 5.6 | | | | |
| 37.00 | 4.0 | 6.2 | | | | |
| 37.65 | 3.2 | 5.7 | | | | |
| 38.30 | 3.2 | 5.6 | | | | |
| 38.95 | 4.0 | 6.4 | | | | |
| 39.60 | 3.6 | 5.6 | | | | |
| 40.25 | 2.4 | 5.2 | | | | |
| 40.90 | 2.2 | 4.3 | | | | |
| 41.55 | 2.5 | 4.4 | | | | |
| 42.20 | 2.4 | 4.5 | | | | |
| 42.85 | 2.2 | 5.6 | | | | |
| 4 50 | 3.2 | 5.2 | | | | |
| 5 | 2.4 | 5.6 | | | | |
| 44.80 | 4.0 | 8.0 | | | | |



Note: The friction ratio is computed by dividing the local friction by the cone resistance

Figure 8 Page 2-3

# DUTCH CONE PENETROMETER

## Field Data Form

ct: Sporn Plant

Date:

Test No.:

cation:

Tested by:

Remarks:

**Test Procedure:**

Rate of Feed: 2cm/sec or no more than 1 in/sec
Run test every 20 cm or approx. 8 inches

C = Cone F = Friction R = Resistance
CR = Cone Resistance LF = Local Friction
Weight of inner rod = 0.14 Kg/cm$^2$/rod length

| Depth<br>① | C<br>Kg/cm2<br>② | F + C<br>Kg/cm2<br>③ | F<br>③ — ②<br>Kg/cm2<br>④ | CR<br>② × 2<br>Kg/cm2<br>⑤ | LF<br>④ × 0.133<br>Kg/cm2<br>⑥ | Friction Ratio*<br>⑥ / ⑤<br>⑦ |
|---|---|---|---|---|---|---|
| 45,45 | 2.8 | 4,4 | | | | |
| 46,10 | 2.2 | 4.8 | | | | |
| 46,75 | 2.8 | 4.9 | | | | |
| 47.4 | 3,2 | 5.6 | | | | |
| 48,05 | 2,4 | 5,6 | | | | |
| 70 | 2.0 | 4,9 | | | | |
| ,35 | 2.0 | 4,4 | | | | |
| 50,06 | 2,4 | 5,3 | | | | |
| 50,65 | 2,0 | 4,8 | | | | |
| 51,30 | 2.0 | 4.5 | | | | |
| 51,95 | 2.4 | 5,2 | | | | |
| 52,60 | 2.2 | 4.3 | | | | |
| 53,25 | 1.9 | 4.0 | | | | |
| 53,90 | 2.0 | 4.3 | | | | |
| 54.55 | 1.9 | 4.8 | | | | |
| 55.20 | 1.8 | 4.4 | | | | |
| 55.85 | 1,6 | 4,0 | | | | |
| 56,30 | 2,6 | 4.7 | | | | |
| 57,15 | 1,9 | 4.8 | | | | |
| 57.80 | 1,6 | 4,7 | | | | |
| 58.45 | 2.8 | 5,2 | | | | |
| 59,10 | 3,2 | 5.8 | | | | |
| 5 75 | 3,3 | 6.4 | | | | |
| 10 | 3,6 | 6,0 | | | | |
| 61,05 | 2,0 | 3,6 | | | | |

Friction Resistance

Cone Resistance

Friction Ratio

DEPTH

Note: The friction ratio is computed by dividing the local friction by the cone resistance

Figure 8 Page 3 - 3

# DUTCH CONE PENETROMETER

## Field Data Form

ct: Sporn Plant

Date:

Test No.:

cation:

Tested by:

Remarks:

**Test Procedure:**

Rate of Feed: 2cm/sec or no more than 1 in/sec

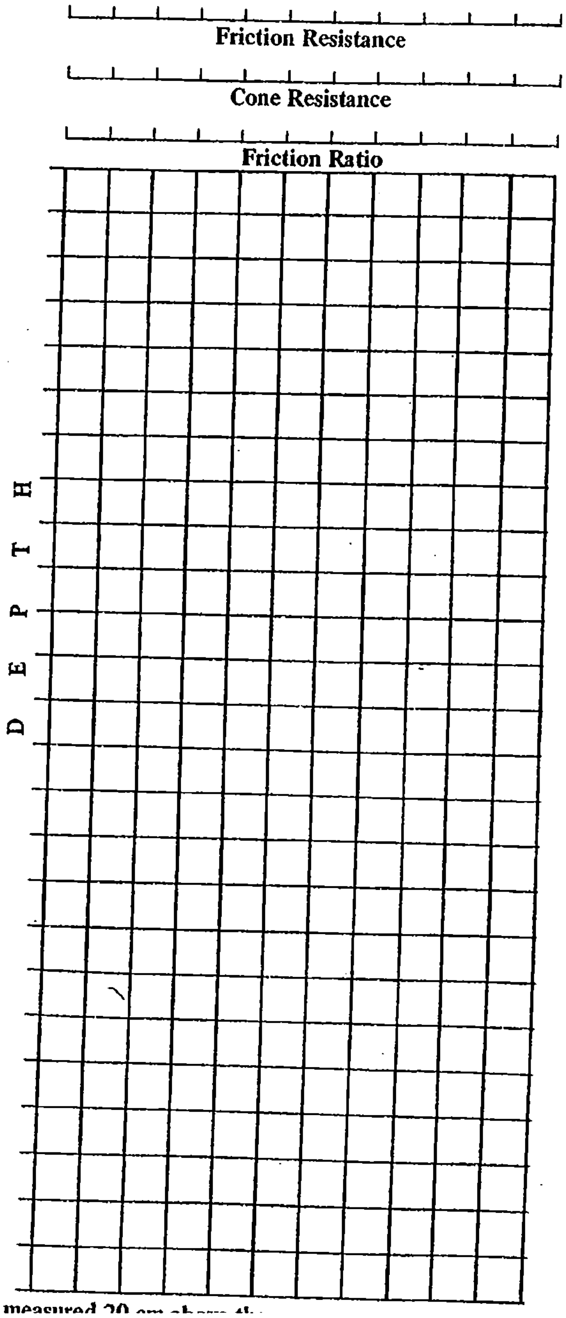
Run test every 20 cm or approx. 8 inches

C = Cone F = Friction R = Resistance

CR = Cone Resistance LF = Local Friction

Weight of inner rod = 0.14 Kg/cm$^2$/rod length

| Depth ① | C Kg/cm2 ② | F + C Kg/cm2 ③ | F ③ — ② Kg/cm2 ④ | CR ② × 2 Kg/cm2 ⑤ | LF ④ × 0.133 Kg/cm2 ⑥ | Friction Ratio* ⑥ / ⑤ ⑦ |
|---|---|---|---|---|---|---|
| 61.76 | 1.9 | 3.2 | | | | |
| 62.35 | 1.2 | 2.3 | | | | |
| 63.00 | .9 | 1.4 | | | | |



Note: The friction ratio is computed by dividing the local friction by the cone resistance measured 20 cm above the

# AEP CIVIL ENGINEERING LABORATORY
## LOG OF BORING

JOB NUMBER 3015
COMPANY APPALACHIAN POWER COMPANY
PROJECT SPORN PLANT ASH HAUL ROAD
COORDINATES
GROUND ELEVATION SYSTEM

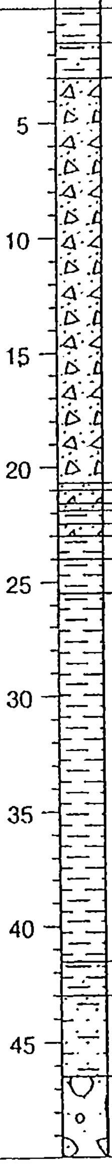
| WATER LEVEL | ∇ DRY | ▼ | ▼ |
|---|---|---|---|
| TIME | | | |
| DATE | 9-9-93 | | |

BORING NO. 9301 DATE SHEET 1 OF 2
BORING START 09/13/93 BORING FINISH 09/14/93
PIEZOMETER TYPE SS WELL TYPE
HGT. RISER ABOVE GROUND 2.5 DIA 1"
DEPTH TO TOP OF WELL SCREEN 3.5 BOTTOM 12.5
WELL DEVELOPMENT BACKFILL BENTONITE
FIELD PARTY MCR-TLS RIG BK-81

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % |
|---|---|---|---|---|---|---|
| 1 | SS | 0.0 | 1.5 | 3-3-4 | 1.2 | |
| 2 | SS | 1.5 | 3.0 | 5-15-15 | .9 | |
| 3 | SS | 3.0 | 4.5 | 10-12-13 | 1.1 | |
| 4 | SS | 4.5 | 6.0 | 7-20-22 | 1.2 | |
| 5 | SS | 6.0 | 7.5 | 10-18-20 | 1.4 | |
| 6 | SS | 7.5 | 9.0 | 18-20-16 | 1.4 | |
| 7 | SS | 9.0 | 10.5 | 25-16-13 | 1.5 | |
| 8 | SS | 10.5 | 12.0 | 1-11-10 | 1.4 | |
| 9 | SS | 12.0 | 13.5 | 13-12-13 | 1.3 | |
| 10 | SS | 13.5 | 15.0 | 14-11-5 | 1.4 | |
| 11 | SS | 15.0 | 16.5 | 5-4-2 | 1.3 | |
| 12 | SS | 16.5 | 18.0 | 1-1-1 | 1.5 | |
| 13 | SS | 18.0 | 19.5 | 0 | 1.5 | |
| 14 | SS | 19.5 | 21.0 | 1-1-4 | 1.5 | |
| 15 | SS | 21.0 | 22.5 | 8-7-8 | 1.5 | |
| 16 | SS | 22.5 | 24.0 | 6-5-6 | .8 | |
| 17 | SS | 24.0 | 25.5 | 7-10-10 | 1.2 | |
| 18 | ST | 25.5 | 27.5 | | 1.3 | |
| 19 | SS | 27.5 | 29.0 | 5-5-9 | 1.5 | |
| 20 | ST | 29.0 | 31.0 | | 1.7 | |
| 21 | SS | 31.0 | 32.5 | 5-7-9 | 1.2 | |
| 22 | ST | 32.5 | 34.5 | | 1.4 | |
| 23 | SS | 34.5 | 36.0 | 6-7-9 | 1.5 | |
| 24 | ST | 36.0 | 38.0 | | 2.0 | |
| 25 | SS | 38.0 | 39.5 | 5-7-8 | ? | |
| 26 | ST | 39.5 | 41.5 | | 2.0 | |
| 27 | SS | 41.5 | 43.0 | 4-5-5 | ? | |
| 28 | ST | 43.0 | 45.0 | | 2.0 | |
| 29 | SS | 45.0 | 46.5 | 3-3-4 | ? | |
| 30 | ST | 46.5 | 48.5 | | 1.6 | |

DEPTH IN FEET

GRAPH LOG



U S C S

SOIL / ROCK IDENTIFICATION

BROWN SILTY CLAY Dry.
BROWN SANDY CLAY Moist, with some gravel.
GRAY BOTTOM ASH Moist.
GRAY FLY ASH Moist.
BROWN SAND AND GRAVEL
GRAY FLY ASH
BLACK BOTTOM ASH
BROWN SILTY CLAY Wet.
BLACK BOTTOM ASH Wet.
BROWN SILTY CLAY Moist.
BROWN SANDY CLAY Moist.
BROWN AND GRAY SILTY CLAY Mottled,moist
BROWN SILTY CLAY Moist.
BROWN AND GRAY SILTY CLAY Moist.
BROWN/GRAY CLAY
BROWN SILTY CLAY Moist.
BROWN SANDY CLAY Moist.
BROWN CLAYEY SAND Moist.
BROWN SAND AND GRAVEL Wet.

WELL

DRILLER'S NOTES

Inside of augers dry untill hitting sand and gravel.
3.0 Top of gravel.
3.5 Top of screen.
12.5 Bottom of screen.
13.0 Bottom of gravel and bottom of hole.

Continued Next Page

| TYPE OF CASING USED | | |
|---|---|---|
| | NQ-2 ROCK CORE | |
| X | 6" x 3.25 HSA | |
| | 9" x 6.25 HSA | |
| | HW CASING ADVANCER | 4" |
| | NW CASING | 3" |
| | SW CASING | 6" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER

AMERICAN ELECTRIC POWER SERVICE CORPORATION
AEP CIVIL ENGINEERING LABORATORY
LOG OF BORING

AEP

JOB NUMBER 3015

COMPANY APPALACHIAN POWER COMPANY

PROJECT SPORN PLANT ASH HAUL ROAD

COORDINATES

GROUND ELEVATION 600.3 SYSTEM

BORING NO. SI-3 DATE SHEET 1 OF 2

BORING START 06/16/88 BORING FINISH 06/23/99

PIEZOMETER TYPE WELL TYPE

HGT. RISER ABOVE GROUND DIA 6"

DEPTH TO TOP OF WELL SCREEN BOTTOM

WELL DEVELOPMENT BACKFILL

FIELD PARTY MCR/TJH RIG B-61

| WATER LEVEL | ▽ 28.0 | ▼ 49.0 | ▽ |
|---|---|---|---|
| TIME | | 0710 | |
| DATE | 06/19/88 | 06/23/88 | |

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | U S C S | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SS | 3.0 | 4.5 | 16-16-14 | .83 | | 5 | | | BROWN SILTY SAND, moist, quartz, trace of small gravel | | |
| 2 | SS | 8.0 | 9.5 | 5-4-3 | .17 | | 10 | | | LIMESTONE AND SAND | | |
| 3 | SS | 13.0 | 14.5 | 4-4-5 | .5 | | 15 | | | SILTY SAND AND GRAVEL, wet to saturated, quartz, 1/2 " max size, rounded | | |
| 4 | SS | 18.0 | 19.5 | 11-12-11 | 1.0 | | 20 | | | BROWN SANDY SILT, moist | | |
| 5 | SS | 23.0 | 24.5 | 5-6-8 | 1.0 | | 25 | | | BROWN SANDY SILT. moist | | |
| 6 | SS | 28.0 | 29.5 | 7-8-9 | 1.0 | | 30 | | | BROWN SANDY SILT,moist | ▽ | |
| 7 | SS | 33.0 | 34.5 | 8-9-11 | .83 | | 35 | | | BROWN CLAY, moist to wet, medium to low plasticity | | |
| 8 | SS | 38.0 | 39.5 | 7-8-10 | 1.0 | | 40 | | | GRAY ORGANIC SILT, moist | | |
| 9 | SS | 43.0 | 44.5 | 4-4-5 | 1.3 | | 45 | | | GRAY BROWN SILTY SAND,moist to wet w/ organic material | | |
| 10 | ST | 45.0 | 47.0 | | 2.0 | | | | | | | SHELBY TUBE<br>PUSH 2.0'<br>REC 2.0'<br>TIME 4 SEC |
| 11 | ST | 47.0 | 49.0 | | 1.2 | | | | | | ▼ | |

Continued Next Page

**TYPE OF CASING USED**

| | |
|---|---|
| | NQ-2 ROCK CORE |
| | 6" x 3.25 HSA |
| | 9" x 6.25 HSA |
| | HW CASING ADVANCER 4" |
| | NW CASING 3" |

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

AEP

JOB NUMBER 3015

COMPANY APPALACHIAN POWER COMPANY

OJECT SPORN PLANT ASH HAUL ROAD

BORING NO. SI-3 DATE ______ SHEET 2 OF 2

BORING START 06/16/88 BORING FINISH 06/23/99

| SAMPLE NUMBER | SAMPLE | SAMPLE DEPTH IN FEET FROM | TO | STANDARD PENETRATION RESISTANCE BLOWS / 6" | TOTAL LENGTH RECOVERY | RQD % | DEPTH IN FEET | GRAPH LOG | U S C S | SOIL / ROCK IDENTIFICATION | WELL | DRILLER'S NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | SS | 53.0 | 54.5 | 34-50/.2 | .5 | | 55 | | | BROWN SILTY SAND AND GRAVEL, saturated, 3/4" max. size , rounded, quartz | | PSI 550<br>SHELBY TUBE<br>PUSH 1.2'<br>REC 1.2'<br>TIME 7 SEC<br>PSI 750 |
| 13 | SS | 58.0 | 59.5 | 22-26-29 | .67 | | 60 | | | BROWN SILTY SAND AND GRAVEL, saturated, 3/4" max. size, rounded, quartz | | |
| 14 | SS | 63.0 | 64.5 | 24-24-29 | .83 | | 65 | | | BROWN SAND AND GRAVELsaturated, 1/2" max size, rounded, quartz | | |
| 15 | SS | 68.0 | 69.5 | 19-14-10 | .25 | | 70 | | | DARK BROWN SAND AND GRAVEL, saturated, 3/4"max. size, rounded, quartz, some fines | | |
| 16 | SS | 73.0 | 74.5 | 22-19-10 | .67 | | 75 | | | BROWN SILTY SAND, saturated, w/ some 1" max. size quartz | | |
| 17 | SS | 78.0 | 79.5 | 8-8-9 | .5 | | 80 | | | BROWN SAND, saturated, quartz, trace of fines | | |
| 18 | SS | 83.0 | 84.5 | 12-12-15 | .25 | | 85 | | | BROWN SAND, saturated, quartz, trace of fines | | |
| 19 | SS | 88.0 | 89.5 | 14-17-17 | .75 | | 90 | | | BROWN SANDsaturated, quartz, trace of fines | | |
| 20 | SS | 93.0 | 94.5 | 12-19-16 | 1.2 | | 95 | | | BROWN SILTY SAND AND GRAVEL, saturated, 1" max. size, quartz | | |
| | | | | | | | 100 | | | GRAY SANDSTONE<br>Auger Refusal 95.2'<br>Set HW casing at 95'<br>Used 3 7/8"roller bit to cut gray sandstone to 101.7'<br>Cut rock to 99'<br>Casing not on rock, Set casing at 96'<br>Cut rock to 101.7'<br>Void in sandstone at 99.2' and 100.1', both voids approx .3 to .4'<br>Lost water 99,2<br>Tip of slope indicator at 101.7'<br>Indicator casing installed in 10' lengths | | |

FIELD DATA FROM:
"*PHILIP SPORN POWER PLANT – STABILITY ANALYSIS*"

PREPARED/COMPILED BY:
THE GEOTECHNICAL ENGINEERING SECTION OF AMERICAN
ELECTRIC POWER SERVICE CORPORATION

DATED: MARCH 2009

# GEOTECHNICAL DATA COLLECTION REPORT

## AEP SPORN FLY ASH AND BOTTOM ASH POND COMPLEX
## NEW HAVEN, WEST VIRGINIA

HCN/TERRACON PROJECT NO. N2095019
March 3, 2009

---

*Prepared For:*

**AMERICAN ELECTRIC POWER**

*Prepared by:*

**H.C. NUTTING**
**A Terracon Company**
**Charleston, West Virginia**

H. C. NUTTING
A Terracon COMPANY

912 Morris Street
Charleston, West Virginia 25301
304-344-0821 Fax:304-342-4711

March 3, 2009

HCN/Terracon Project No. N2095019

Mr. Tim Howdyshell
**American Electric Power**
1 Riverside Plaza – 22nd Floor
Columbus, OH 43215

**Re: Geotechnical Data Collection Report**
**AEP Sporn Fly Ash and Bottom Ash Pond Complex**
**New Haven, West Virginia**

Dear Mr. Howdyshell:

H. C. Nutting Company (HCN), a Terracon company is pleased to present our geotechnical data collection report for the geotechnical services associated with the maintenance of the American Electric Power (AEP) Sporn Fly Ash and Bottom Ash Pond Complex in New Haven, West Virginia. This work was performed in general accordance with our proposal dated February 9, 2009 and AEP Letter of Authorization dated February 10, 2009.

## SCOPE OF WORK

HCN's scope of work for this project included performing a total of five (5) test borings, installation of observation wells at all 5 boring locations, inspection of drilling activities, preparation of boring logs based on visual classification, and preparation of this report.

## FIELD EXPLORATION

### Test Borings

A total of five (5) Standard Penetration Test (SPT) borings were drilled for this project. The test borings were selected and staked in the field by AEP and HCN personnel and later surveyed in the field by AEP surveyor (to be provided).

The test borings were performed utilizing a drill rig mounted on an All-Terrain Vehicle. The field operations were performed between February 16, 2009 through February 23, 2009. Boreholes were advanced and stabilized using hollow-stem augers. The drilling activities were performed under the supervision of HCN personnel.

Sampling was accomplished using the Standard Penetration Test (ASTM D 1586) and Shelby tube (ASTM D 1587) methods. Split-spoon samples were obtained at 2.5 ft. intervals. Shelby tube samples were collected at within cohesive soils. The borings were completed at depths of 50 feet below the existing ground surface.

After completion of drilling activities, all of the five test borings were converted into observation wells. All wells were constructed from 1.92-inch OD (1.5-inch ID) threaded PVC with #10 slot screen and 5-foot solid PVC section at the top. The PVC casing was constructed to just below the existing ground surface and protected with a "Global HRB 141412-F H20" locking steel protective cover. The well pad was then constructed around the observation well with approximate dimensions of 3 feet by 3 feet and a minimum of 8 inch thickness.

Each well was developed using a surge block and evacuated until the discharge water stabilized. All development data and estimated purge volumes were recorded and are shown on the attached well development logs.

On the following table we have indicated the beginning and ending depths of the screening sections.

**Observation Well Screen Depths**

| Boring | Screening Section | |
|---|---|---|
| | Beginning Depth (feet) | Ending Depth (feet) |
| PZ-09-01 | 6 | 50.3 |
| PZ-09-02 | 5.5 | 35 |
| PZ-09-03 | 6 | 50.4 |
| PZ-09-04 | 5.5 | 49.8 |
| PZ-09-05 | 5.2 | 50.2 |

The observation well logs are included with this report.

## CLOSING

We appreciate the opportunity of working with you on this project. Please contact us concerning any questions that may arise during review of the report, or if you require additional information as you proceed into the final design and construction stage of this project.

Thank you for your consideration.

Respectfully submitted,
**H. C. NUTTING COMPANY**

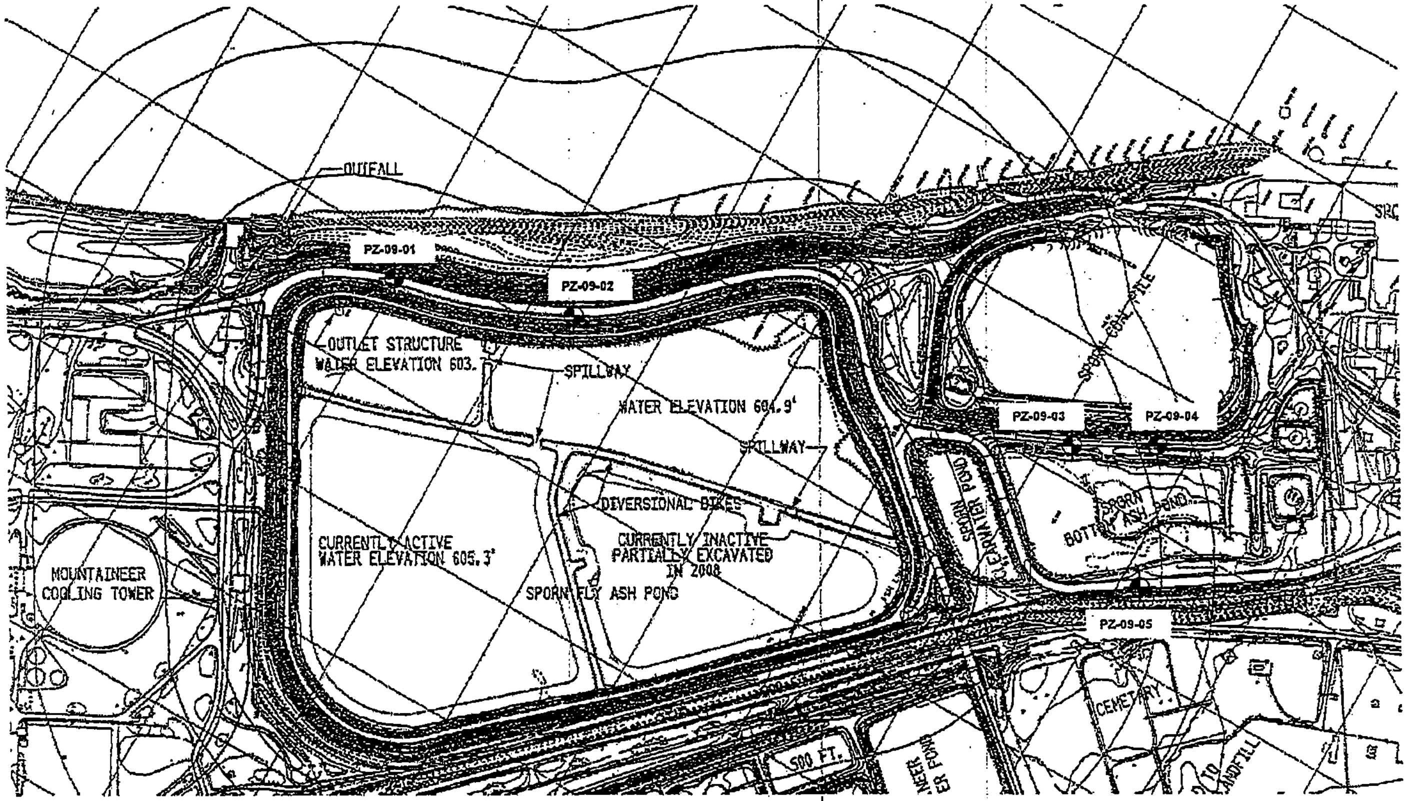
Lewis E. Eplin
Staff Geologist

Yogesh S. Rege, P.E.
Department Manager
Geotechnical Services

YOGESH S. REGE
REGISTERED
16606
STATE OF
WEST VIRGINIA
PROFESSIONAL ENGINEER

# APPENDIX

FIGURE 1: BORING LOCATION DIAGRAM
LOG OF TEST BORINGS
WELL DEVELOPMENT LOGS
OBSERVATION WELL LOGS
GENERAL NOTES
UNIFIED SOIL CLASSIFICATION SYSTEM



⌖ Approximate Boring Location

| | | | |
|---|---|---|---|
| Project Mngr: | YSR | Project No. | N2095019 |
| Drawn By: | YSR | Scale: | NTS |
| Checked By: | YSR | File No. | N2095019 |
| Approved By: | | Date: | 2/23/2009 |

**Terracon**
Consulting Engineers and Scientists
Charleston, West Virginia

## Boring Location Diagram

Sporn Fly Ash and Bottom Ash Pond Complex
New Haven, West Virginia
American Electric Power

FIG. No.
1

# LOG OF BORING NO. PZ-09-01

Page 1 of 2

CLIENT
**American Electric Power**

SITE
**Philip Sporn Power Plant**
**New Haven, West Virginia**

PROJECT
**Sporn Fly Ash and Bottom Ash Pond Complex**

Boring Location: 721043.509, 1735345.011

DESCRIPTION

Approx. Surface Elev.: 600.817 ft

| | | |
|---|---|---|
| 0.5 | **ASPHALT** | 600.5 |
| 1 | **FILL**, stabilized and compacted bottom ash | 600 |
| | **FILL**, silty sand with bottom ash, trace gravel, gray, medium dense, dry to moist<br>- Geogrid observed at 4' | |
| 8.5 | | 592.5 |
| | **FILL**, silty sand with bottom ash, gray to dark gray, medium dense, moist | |
| 12 | | 589 |
| | **FILL**, silty sand with gravel, light brown, medium dense, moist | |
| 14 | | 587 |
| | **FILL**, lean clay with sand, light brown, stiff, moist | |
| 18.5 | ▼ | 582.5 |
| | **FILL**, silty sand with gravel, dark brown, loose, moist | |
| 21 | ▽ | 580 |
| | **FILL**, bottom ash with coal fragments, black, medium dense, wet | |
| 23.5 | | 577.5 |
| | **LEAN CLAY with SAND** light brown, stiff, moist | |
| 28.5 | | 572.5 |
| | **SANDY LEAN CLAY**, brown to gray, stiff, moist | |

**Continued Next Page**

| USCS SYMBOL | SAMPLES NUMBER | TYPE | RECOVERY, in. | SPT - N** BLOWS / ft. | TESTS WATER CONTENT, % | DRY UNIT WT pcf | UNCONFINED STRENGTH, psf | |
|---|---|---|---|---|---|---|---|---|
| SM | 1 | SS | 18 | 24 | | | | |
| SM | 2 | SS | 18 | 17 | | | | |
| SM | 3 | SS | 18 | 16 | | | | |
| SM | 4 | SS | 18 | 14 | | | | |
| SM | 5 | SS | 18 | 12 | | | | |
| CL | 6 | SS | 12 | 16 | | | 9000* | |
| CL | 7 | SS | 12 | 10 | | | 4000* | |
| SM | 8 | SS | 18 | 14 | | | | |
| | 9 | SS | 18 | 18 | | | | |
| CL | 10 | SS | 18 | 19 | | | 7000* | |
| CL | 11 | ST | 24 | | | | | 800 psi/24 sec |
| CL | 12 | SS | 18 | 20 | | | 7000* | |
| CL | 13 | SS | 18 | 16 | | | 6500* | |

DEPTH, ft.: 5, 10, 15, 20, 25, 30

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

| WATER LEVEL OBSERVATIONS, ft | | | | |
|---|---|---|---|---|
| WL | ▽ 21 | WD | ▼ 18.1 | 4 hr |
| WL | ▼ 18 | 48 hr | ▽ | |
| WL | | | | |

Terracon

| | | | |
|---|---|---|---|
| BORING STARTED | | | 2-20-09 |
| BORING COMPLETED | | | 2-21-09 |
| RIG | Track | FOREMAN | |
| LOGGED | LE | JOB # | N2095019 |

REVISED BORING LOGS SPORN BOTTOM ASH POND COMPLEX.GPJ TERRACON.GDT 3/3/09

# LOG OF BORING NO. PZ-09-01

Page 2 of 2

| | |
|---|---|
| CLIENT | American Electric Power |
| SITE | Philip Sporn Power Plant<br>New Haven, West Virginia |
| PROJECT | Sporn Fly Ash and Bottom Ash Pond Complex |

| GRAPHIC LOG | DESCRIPTION | | DEPTH, ft. | USCS SYMBOL | SAMPLES | | | | TESTS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | NUMBER | TYPE | RECOVERY, in. | SPT - N** BLOWS / ft. | WATER CONTENT, % | DRY UNIT WT pcf | UNCONFINED STRENGTH, psf |
| ▨ | **SANDY LEAN CLAY**, brown to gray, stiff, moist | | | CL | 14 | SS | 18 | 18 | | | 6500* |
| ▨ | | | 35 | | | | | | | | |
| ▨ | | | | CL | 15 | SS | 18 | 10 | | | 4500* |
| ▨ | | | | CL | 16 | SS | 18 | 18 | | | 4000* |
| ▨ | | | 40 | | | | | | | | |
| ▨ | | | | CL | 17 | SS | 18 | 14 | | | 3500* |
| ▨ | | | | CL | 18 | SS | 18 | 18 | | | 5000* |
| ▨ | | | 45 | | | | | | | | |
| ▨ 47 | | 554 | | CL | 19 | SS | 18 | 13 | | | 3000* |
| ▨ | **CLAYEY SAND**, brown, dense, very moist, fine grained sand<br>- with gravel at 49' | | | SC | 20 | SS | 18 | 47 | | | |
| ▨ 50 | | 551 | 50 | | | | | | | | |
| | **BORING COMPLETED** | | | | | | | | | | |

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

| WATER LEVEL OBSERVATIONS, ft | | | | |
|---|---|---|---|---|
| WL | ∇ 21 | WD | ▼ 18.1 | 4 hr |
| WL | ▼ 18 | 48 hr | ∇ | |
| WL | | | | |

Terracon

| | | | |
|---|---|---|---|
| BORING STARTED | | | 2-20-09 |
| BORING COMPLETED | | | 2-21-09 |
| RIG | Track | FOREMAN | |
| LOGGED | LE | JOB # | N2095019 |

REVISED BORING LOGS SPORN BOTTOM ASH POND COMPLEX.GPJ TERRACON.GDT 3/3/09

# LOG OF BORING NO. PZ-09-02

Page 1 of 2

| | |
|---|---|
| CLIENT | American Electric Power |
| SITE | Philip Sporn Power Plant<br>New Haven, West Virginia |
| PROJECT | Sporn Fly Ash and Bottom Ash Pond Complex |

Boring Location: 720306.293, 1735648.836

Approx. Surface Elev.: 601.345 ft

| | DESCRIPTION | |
|---|---|---|
| 0.5 | **ASPHALT** | 601 |
| 2 | **FILL**, stabilized and compacted bottom ash | 599.5 |
| 7 | **FILL**, silty sand with bottom ash and gravel, dark gray to brown, very dense, moist | 594.5 |
| 16 ▼ | **FILL**, silty sand with gravel, light brown, dense, moist | 585.5 |
| 23.5 | **FILL**, silty sand, light brown, very dense, dry to moist, fine grained ▼ | 578 |
| 26 ▽ | **FILL**, silty sand, light brown, dense, moist, fine grained | 575.5 |
| 28.5 | **FILL**, bottom ash with coal fragments, black, medium dense, wet | 573 |
| | **LEAN CLAY**, trace to with sand, gray to light brown, very stiff to stiff, moist<br>- Trace organics (roots) at 28.5 - 29' | |

Continued Next Page

| USCS SYMBOL | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES RECOVERY, in. | SAMPLES SPT - N** BLOWS / ft. | TESTS WATER CONTENT, % | TESTS DRY UNIT WT pcf | TESTS UNCONFINED STRENGTH, psf | TESTS |
|---|---|---|---|---|---|---|---|---|
| | 1 | SS | 12 | 52 | | | | |
| SM | 2 | SS | 18 | 65 | | | | |
| SM | 3 | SS | 18 | 51 | | | | |
| SM | 4 | SS | 18 | 36 | | | | |
| SM | 5 | SS | 18 | 47 | | | | |
| SM | 6 | SS | 18 | 45 | | | | |
| SM | 7 | SS | 18 | 37 | | | 9000* | |
| SM | 8 | ST | 12 | | | | | 1000 psi/24 sec |
| SM | 9 | SS | 18 | 33 | | | 9000* | |
| SM | 10 | SS | 18 | 38 | | | | |
| | 11 | SS | 18 | 21 | | | | |
| CL | 12 | SS | 18 | 16 | | | 8000* | |
| CL | 13 | ST | 24 | | | | | 1200 psi/30 sec |

DEPTH, ft.: 5, 10, 15, 20, 25, 30

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

| WATER LEVEL OBSERVATIONS, ft | | | | |
|---|---|---|---|---|
| WL | ▽ 26 | WD | ▼ 16 | 24 hr |
| WL | ▼ 21.1 | 72 hr | ▼ | |
| WL | | | | |

Terracon

| | | | |
|---|---|---|---|
| BORING STARTED | | | 2-19-09 |
| BORING COMPLETED | | | 2-20-09 |
| RIG | Track | FOREMAN | |
| LOGGED | LE | JOB # | N2095019 |

# LOG OF BORING NO. PZ-09-02

Page 2 of 2

CLIENT: American Electric Power

SITE: Philip Sporn Power Plant
New Haven, West Virginia

PROJECT: Sporn Fly Ash and Bottom Ash Pond Complex

| GRAPHIC LOG | DESCRIPTION |
|---|---|
| ▨ | **LEAN CLAY**, trace to with sand, gray to light brown, very stiff to stiff, moist |
| | 50 551.5 |
| | **BORING COMPLETED** |

Depth, ft. scale: 35, 40, 45, 50

| | | SAMPLES | | | | TESTS | | |
|---|---|---|---|---|---|---|---|---|
| DEPTH, ft. | USCS SYMBOL | NUMBER | TYPE | RECOVERY, in. | SPT - N** BLOWS / ft. | WATER CONTENT, % | DRY UNIT WT pcf | UNCONFINED STRENGTH, psf |
| | CL | 14 | SS | 18 | 34 | | | 8000* |
| 35 | | | | | | | | |
| | CL | 15 | SS | 12 | 19 | | | 3000* |
| | CL | 16 | SS | 18 | 17 | | | 8000* |
| 40 | | | | | | | | |
| | CL | 17 | SS | 18 | 24 | | | 7000* |
| | CL | 18 | SS | 18 | 23 | | | 4000* |
| 45 | | | | | | | | |
| | CL | 19 | SS | 18 | 12 | | | 2500* |
| | CL | 20 | SS | 18 | 13 | | | 3000* |
| 50 | | | | | | | | |

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

| WATER LEVEL OBSERVATIONS, ft | | | |
|---|---|---|---|
| WL | ∇ 26 | WD | ▼ 16 24 hr |
| WL | ▼ 21.1 | 72 hr | ∇ |
| WL | | | |

Terracon

| | | | |
|---|---|---|---|
| BORING STARTED | | | 2-19-09 |
| BORING COMPLETED | | | 2-20-09 |
| RIG | Track | FOREMAN | |
| LOGGED | LE | JOB # | N2095019 |

REVISED BORING LOGS SPORN BOTTOM ASH POND COMPLEX.GPJ TERRACON.GDT 3/3/09

# LOG OF BORING NO. PZ-09-03

Page 1 of 2

| | |
|---|---|
| CLIENT<br>American Electric Power | |
| SITE<br>Philip Sporn Power Plant<br>New Haven, West Virginia | PROJECT<br>Sporn Fly Ash and Bottom Ash Pond Complex |

Boring Location: 718396.378, 1736131.654

Approx. Surface Elev.: 596.521 ft

| DESCRIPTION | Depth, ft. | Elev., ft |
|---|---|---|
| **FILL**, silty sand with gravel, yellowish brown to dark brown, medium dense to dense, moist, fine to coarse grained sand, rounded gravel | 11 | 585.5 |
| **FILL**, silty sand with gravel, yellowish brown to dark brown, medium dense, moist, fine to coarse grained sand, rounded gravel | 13.5 | 583 |
| **FILL**, sandy lean clay, light brown to gray, medium stiff, very moist, fine grained sand ▼ | 18 | 578.5 |
| **FILL**, lean clay with sand, brown and gray mottled, very stiff, moist, fine grained sand ∇ | 23.5 | 573 |
| **FILL**, coal and bottom ash, black, medium dense, wet, sand to gravel size particles | 28.5 | 568 |
| **FILL**, coal and bottom ash, black to dark gray, loose, wet, fine sand to silt size particles with gravel size coal fragments | 31 | 565.5 |

| USCS SYMBOL | SAMPLES NUMBER | TYPE | RECOVERY, in. | SPT - N** BLOWS / ft. | TESTS WATER CONTENT, % | DRY UNIT WT pcf | UNCONFINED STRENGTH, psf | |
|---|---|---|---|---|---|---|---|---|
| SM | 1 | SS | 14 | 30 | | | | |
| SM | 2 | SS | 18 | 29 | | | | |
| SM | 3 | SS | 18 | 45 | | | | |
| SM | 4 | SS | 14 | 70 | | | | |
| SM | 5 | SS | 18 | 22 | | | | |
| CL | 6 | SS | 18 | 8 | | | | |
| CL | 7 | ST | 21.5 | | | | | 800 psi/30 sec |
| CL | 8 | SS | 18 | 20 | | | 9000* | |
| CL | 9 | SS | 18 | 24 | | | 9000* | |
| SM | 10 | SS | 10 | 15 | | | | |
| SM | 11 | SS | 14 | 12 | | | | |
| SM | 12 | SS | 18 | 4 | | | | |
| SM | 13 | SS | 18 | 6 | | | | |

DEPTH, ft.: 5, 10, 15, 20, 25, 30

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

| WATER LEVEL OBSERVATIONS, ft | | | |
|---|---|---|---|
| WL | ∇ 23 | WD | ▼ 16.8 24 hr |
| WL | ∇ | | ∇ |
| WL | | | |

Terracon

| | | | |
|---|---|---|---|
| BORING STARTED | | | 2-17-09 |
| BORING COMPLETED | | | 2-18-09 |
| RIG | Track | FOREMAN | |
| LOGGED | LE | JOB # | N2095019 |

# LOG OF BORING NO. PZ-09-03

Page 2 of 2

CLIENT: American Electric Power

SITE: Philip Sporn Power Plant
New Haven, West Virginia

PROJECT: Sporn Fly Ash and Bottom Ash Pond Complex

| GRAPHIC LOG | DESCRIPTION | | DEPTH, ft. | USCS SYMBOL | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES RECOVERY, in. | SAMPLES SPT - N** BLOWS / ft. | TESTS WATER CONTENT, % | TESTS DRY UNIT WT pcf | TESTS UNCONFINED STRENGTH, psf | TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ▩ | **FILL**, coal and bottom ash, black to dark gray, loose to very loose, wet, fine sand to silt size particles | | | SM | 14 | SS | 12 | 5 | | | | |
| | | | 35 | | | | | | | | | |
| | | | | SM | 15 | SS | 18 | 4 | | | | |
| | | | | SM | 16 | SS | 18 | 3 | | | | |
| | | | 40 | | | | | | | | | |
| | | | | SM | 17 | SS | 6 | 4 | | | | |
| | 43.5 | 553 | | | | | | | | | | |
| ▨ | **SANDY LEAN CLAY**, dark gray, stiff to very soft, moist to wet, fine grained sand | | | CL | 18 | SS | 18 | 9 | | | 500* | |
| | | | 45 | | | | | | | | | |
| | | | | CL | 19 | ST | 22 | | | | | 800 psi/15 sec |
| | | | | CL | 20 | SS | 18 | W.H. | | | 500* | |
| | 50 | 546.5 | 50 | | | | | | | | | |
| | BORING COMPLETED | | | | | | | | | | | |

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

| WATER LEVEL OBSERVATIONS, ft | | | | |
|---|---|---|---|---|
| WL | ∇ 23 | WD | ▼ 16.8 | 24 hr |
| WL | ∇ | | ∇ | |
| WL | | | | |

Terracon

| | |
|---|---|
| BORING STARTED | 2-17-09 |
| BORING COMPLETED | 2-18-09 |
| RIG Track | FOREMAN |
| LOGGED LE | JOB # N2095019 |

REVISED BORING LOGS SPORN BOTTOM ASH POND COMPLEX.GPJ TERRACON.GDT 3/3/09

# LOG OF BORING NO. PZ-09-04

CLIENT
American Electric Power

SITE
Philip Sporn Power Plant
New Haven, West Virginia

PROJECT
Sporn Fly Ash and Bottom Ash Pond Complex

Boring Location: 718148.27, 1736259.447

DESCRIPTION

Approx. Surface Elev.: 593.692 ft

**FILL**, silty sand with gravel, gray, medium dense, moist, medium to coarse grained sand

3.5 590

**FILL**, silty sand, trace gravel and clay, light brown, dense to medium dense, moist

8 585.5

**FILL**, lean clay, light brown

11 582.5

**FILL**, well graded sand with gravel, light brown, medium dense, moist, coarse to fine grained sand, rounded gravel ▼

18.5 575

**FILL**, silty sand with gravel, trace clay, dark brown to gray, dense, very moist, coarse to fine grained sand, rounded gravel

21 572.5

**FILL**, well graded gravel with sand, brown, dense to medium dense, wet, rounded gravel ▽

27 566.5

**FILL**, bottom ash, gray to black, medium dense to very loose, wet, fine sand to silt size particles

Continued Next Page

| DEPTH, ft. | USCS SYMBOL | SAMPLES NUMBER | TYPE | RECOVERY, in. | SPT - N** BLOWS / ft. | TESTS WATER CONTENT, % | DRY UNIT WT pcf | UNCONFINED STRENGTH, psf | |
|---|---|---|---|---|---|---|---|---|---|
| | SM | 1 | SS | 17 | 27 | | | | |
| | SM | 2 | SS | 18 | 43 | | | | |
| 5 | | | | | | | | | |
| | SM | 3 | SS | 18 | 28 | | | | |
| | CL | 4 | ST | 20 | | | | | 800 psi/34 sec |
| 10 | | | | | | | | | |
| | SW | 5 | SS | 18 | 21 | | | | |
| | SW | 6 | SS | 12 | 23 | | | | |
| 15 | | | | | | | | | |
| | SW | 7 | SS | 14 | 26 | | | | |
| | SM | 8 | SS | 18 | 30 | | | | |
| 20 | | | | | | | | | |
| | GW | 9 | SS | 18 | 35 | | | | |
| | GW | 10 | SS | 18 | 16 | | | | |
| 25 | | | | | | | | | |
| | GW | 11 | SS | 18 | 10 | | | | |
| | SP | 12 | SS | 18 | 9 | | | | |
| 30 | | | | | | | | | |
| | SP | 13 | SS | 18 | 6 | | | | |

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

| WATER LEVEL OBSERVATIONS, ft | | | |
|---|---|---|---|
| WL | ▽ 23 | WD | ▼ 14.5 24 hr |
| WL | ▽ - | | ▽ |
| WL | | | |

| | | | |
|---|---|---|---|
| BORING STARTED | | | 2-18-09 |
| BORING COMPLETED | | | 2-19-09 |
| RIG | Track | FOREMAN | |
| LOGGED | LE | JOB # | N2095019 |

REVISED BORING LOGS SPORN BOTTOM ASH POND COMPLEX.GPJ TERRACON.GDT 3/3/09

# LOG OF BORING NO. PZ-09-04

Page 2 of 2

CLIENT
**American Electric Power**

SITE **Philip Sporn Power Plant**
**New Haven, West Virginia**

PROJECT
**Sporn Fly Ash and Bottom Ash Pond Complex**

| DESCRIPTION | DEPTH, ft. | USCS SYMBOL | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES RECOVERY, in. | SAMPLES SPT - N** BLOWS / ft. | TESTS WATER CONTENT, % | TESTS DRY UNIT WT pcf | TESTS UNCONFINED STRENGTH, psf | |
|---|---|---|---|---|---|---|---|---|---|---|
| **FILL**, bottom ash, gray to black, medium dense to very loose, wet, fine sand to silt size particles | | SP | 14 | SS | 18 | 9 | | | | |
| | 35 | | | | | | | | | |
| | | SP | 15 | SS | 18 | 11 | | | | |
| | | SP | 16 | SS | 18 | WOT | | | | |
| | 40 | | | | | | | | | |
| 41 — 552.5 | | | | | | | | | | |
| **LEAN CLAY**, dark gray, stiff, very moist to wet, high silt content | | CL | 17 | SS | 18 | 9 | | | | |
| | | CL | 18 | ST | | | | | | 800 psi/15 sec |
| | 45 | | | | | | | | | |
| | | CL | 19 | SS | 18 | 9 | | | | |
| | | CL | 20 | SS | 18 | 10 | | | | |
| 50 — 543.5 | 50 | | | | | | | | | |
| **BORING COMPLETED** | | | | | | | | | | |

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

| WATER LEVEL OBSERVATIONS, ft | | | |
|---|---|---|---|
| WL | ▽ 23 | WD ▼ 14.5 | 24 hr |
| WL | ▽ | ▼ | |
| WL | | | |

Terracon

| | | | |
|---|---|---|---|
| BORING STARTED | 2-18-09 | | |
| BORING COMPLETED | 2-19-09 | | |
| RIG | Track | FOREMAN | |
| LOGGED | LE | JOB # | N2095019 |

# LOG OF BORING NO. PZ-09-05

Page 1 of 2

| | |
|---|---|
| CLIENT<br>American Electric Power | |
| SITE Philip Sporn Power Plant<br>New Haven, West Virginia | PROJECT<br>Sporn Fly Ash and Bottom Ash Pond Complex |

| GRAPHIC LOG | Boring Location: 717959.368, 1735750.984<br>DESCRIPTION<br>Approx. Surface Elev.: 593.453 ft | DEPTH, ft. | USCS SYMBOL | SAMPLES NUMBER | TYPE | RECOVERY, in. | SPT - N** BLOWS / ft. | TESTS WATER CONTENT, % | DRY UNIT WT pcf | UNCONFINED STRENGTH, psf |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0.5 **ASPHALT** 593 | | | | | | | | | |
| | 1.4 **FILL**, stabilized and compacted bottom ash 592 | | | | | | | | | |
| | 2.5 591 | | SM | 1 | SS | 15 | 47 | | | |
| | **FILL**, silty sand with gravel, yellowish brown and gray, dense, dry to moist | | SM | 2 | SS | 18 | 25 | | | |
| | **FILL**, silty sand with bottom ash, trace gravel, dark brown to black, medium dense, moist | 5 | | | | | | | | |
| | 6.5 587 | | SM | 3 | SS | 18 | 46 | | | |
| | **FILL**, silty sand with gravel, trace bottom ash and coal, yellowish brown, dense, moist, fine to coarse grained sand<br>Trace clay at 8.5' | | CL | 4 | SS | 17 | 43 | | | |
| | 9.5 584 | 10 | | | | | | | | |
| | **FILL**, silty sand with gravel, brown, dense, moist, fine to coarse grained sand | | | | | | | | | |
| | 11 582.5 | | | | | | | | | |
| | **FILL**, silty sand with bottom ash and gravel, reddish brown to black, dense to medium dense, moist to wet, fine to coarse grained sand, cobbles present | | SM | 5 | SS | 17 | 50/5 | | | |
| | | | SM | 6 | SS | 2 | 50/2 | | | |
| | ▽ | 15 | | | | | | | | |
| | | | SM | 7 | SS | 18 | 32 | | | |
| | Clay seam at 17' | | | | | | | | | |
| | | | SM | 8 | SS | 18 | 15 | | | |
| | ▼ | 20 | | | | | | | | |
| | | | SM | 9 | SS | 18 | 22 | | | |
| | | | SM | 10 | SS | 18 | 12 | | | |
| | | 25 | | | | | | | | |
| | 26 567.5 | | | | | | | | | |
| | **FILL**, silty sand with bottom ash, trace gravel, dark gray to black, loose to very loose, wet, fine grained sand, silt size particles | | SM | 11 | SS | 18 | 6 | | | |
| | | | SM | 12 | SS | 18 | 8 | | | |
| | ▼ | 30 | | | | | | | | |
| | | | SM | 13 | SS | 18 | 3 | | | |

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

| WATER LEVEL OBSERVATIONS, ft | | | |
|---|---|---|---|
| WL | ▽ 15 | WD ▼ 20 | AB |
| WL | ▼ 29.8 | 20 hr ▼ | |
| WL | | | |

Terracon

| | | | |
|---|---|---|---|
| BORING STARTED | | | 2-16-09 |
| BORING COMPLETED | | | 2-16-09 |
| RIG | Track | FOREMAN | |
| LOGGED | LE | JOB # | N2095019 |

REVISED BORING LOGS SPORN BOTTOM ASH POND COMPLEX.GPJ TERRACON.GDT 3/3/09

# LOG OF BORING NO. PZ-09-05

Page 2 of 2

CLIENT
American Electric Power

SITE
Philip Sporn Power Plant
New Haven, West Virginia

PROJECT
Sporn Fly Ash and Bottom Ash Pond Complex

| DESCRIPTION | DEPTH, ft. | USCS SYMBOL | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES RECOVERY, in. | SAMPLES SPT - N** BLOWS / ft. | TESTS WATER CONTENT, % | TESTS DRY UNIT WT pcf | TESTS UNCONFINED STRENGTH, psf | TESTS |
|---|---|---|---|---|---|---|---|---|---|---|
| |  | SM | 14 | SS | 18 | 2 |  |  |  |  |
| 34.5 559 |  |  |  |  |  |  |  |  |  |  |
| **LEAN CLAY with SAND**, light brown and gray mottled to brown and gray mottled, soft to stiff, wet to very moist | 35 |  |  |  |  |  |  |  |  |  |
|  |  | CL | 15 | SS | 18 | 14 |  |  | 2000* |  |
| Sand content increase with depth |  | CL | 16 | ST | 17.5 |  |  |  |  | 800 psi/10 sec |
|  | 40 |  |  |  |  |  |  |  |  |  |
|  |  | CL | 17 | SS | 6 | 6 |  |  | 500* |  |
|  |  | CL | 18 | SS | 18 | 14 |  |  |  |  |
| 45 548.5 | 45 |  |  |  |  |  |  |  |  |  |
| **CLAYEY SAND**, reddish brown and gray mottled, medium dense to loose, very moist to wet, fine grained sand |  | SC | 19 | SS | 18 | 8 |  |  |  |  |
|  |  | SC | 20 | SS | 18 | 8 |  |  |  |  |
| 50 543.5 | 50 |  |  |  |  |  |  |  |  |  |
| **BORING COMPLETED** |  |  |  |  |  |  |  |  |  |  |

REVISED BORING LOGS SPORN BOTTOM ASH POND COMPLEX.GPJ TERRACON.GDT 3/3/09

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

| WATER LEVEL OBSERVATIONS, ft | | | | |
|---|---|---|---|---|
| WL | ∇ 15 | WD | ▼ 20 | AB |
| WL | ∇ 29.8 | 20 hr | ∇ |  |
| WL |  |  |  |  |

Terracon

| | | | |
|---|---|---|---|
| BORING STARTED | | | 2-16-09 |
| BORING COMPLETED | | | 2-16-09 |
| RIG | Track | FOREMAN | |
| LOGGED | LE | JOB # | N2095019 |

# Well Development Log

**H. C. NUTTING**
A Terracon COMPANY
790 Morrison Road • Columbus, OH 43230 • (614) 863-3113

JOB N2095019
SHEET NO. 1 OF 1
CALCULATED BY JCE DATE 2/21/09
CHECKED BY — DATE —
SCALE NTS

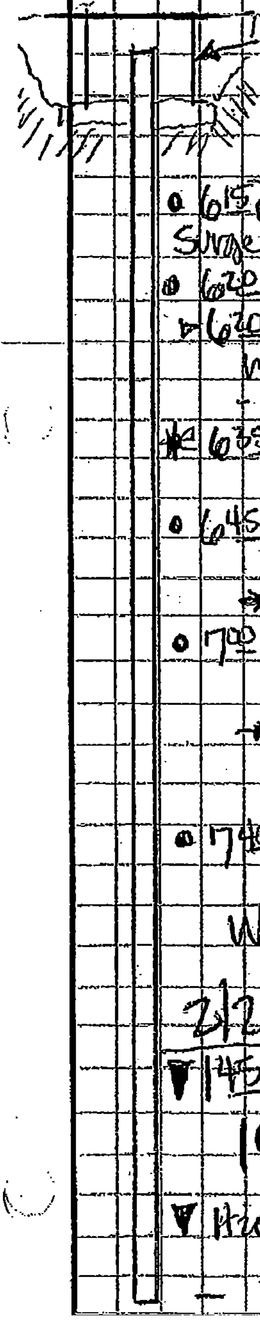
American Electric Power

Sporn Plant

Date Well Installed: Feb. 21, 2009

## PZ-09-01

▼ Initial GW Elev. Prior to Well Development 18.1' B.G.S.



Gnd. Surface/Top of Vault 0.0' B.G.S.
– Top of Well Riser 1.06' B.G.S. (12 3/4")

2/21/09

- $6^{15}$ pm Initial H2O Rdg - Water @ 18.1' BGS
Surge Well w/ 3' long by 1" Ø PVC Surge Block
- $6^{20}$ Initiate Pumping - No Sediment Noted
- ▸ $6^{20}$ - $6^{35}$ pm Pump 15± gals Dark brown heavily silted H2O w/ fine sand
  - Well Depleted -
- ✱ $6^{35}$ - $6^{45}$ pm Pump 10± gals Brown heavily silted H2O w/ fine sand while adding 20± gals potable H2O to top of well
- $6^{45}$ - $6^{50}$ pm Pump 5± gals Brown moderately to slightly silty H2O w/ some fine sand
  - → $6^{50}$ - $7^{00}$ pm Allow well to recharge.
- $7^{00}$ - $7^{10}$ pm Pump 10± gals. Brown moderately silty H2O w/ some fine sand
  - → $7^{10}$ - $7^{35}$ pm Allow well to recharge
  - ▼ $7^{35}$ pm H2O Rdg - Water @ 22.5' BGS
- $7^{40}$ - $7^{55}$ pm Pump 10± gals Brown moderately to slightly silty H2O w/ some to trace fine sand. Well nearly depleted.

Well Development Complete $8^{00}$ pm

✱ Well Volume ✱
- 1 1/2" ID Screen & Riser 0.09 gals/L.F.
- 32.2' x 0.09 = 2.9 gals.

Min. development volume
3 x 2.9 gals = 8.7 gals.

2/23/09
▼ $1^{45}$ pm H2O @ 18.0' BGS.

- 20± gals potable H2O added to well during development.
- 50± gals H2O pumped from well during development.

▼ H2O Rdg 2/25/09 $11^{30}$ Am 18.0' BGS

– Bottom of Well 50.3' B.G.S.

# Well Development Log

H. C. NUTTING
A Terracon COMPANY
790 Morrison Road • Columbus, OH 43230 • (614) 863-3113

JOB N2095019
SHEET NO. 1 OF 1
CALCULATED BY JCE DATE 2/21/09
CHECKED BY — DATE —
SCALE NTS

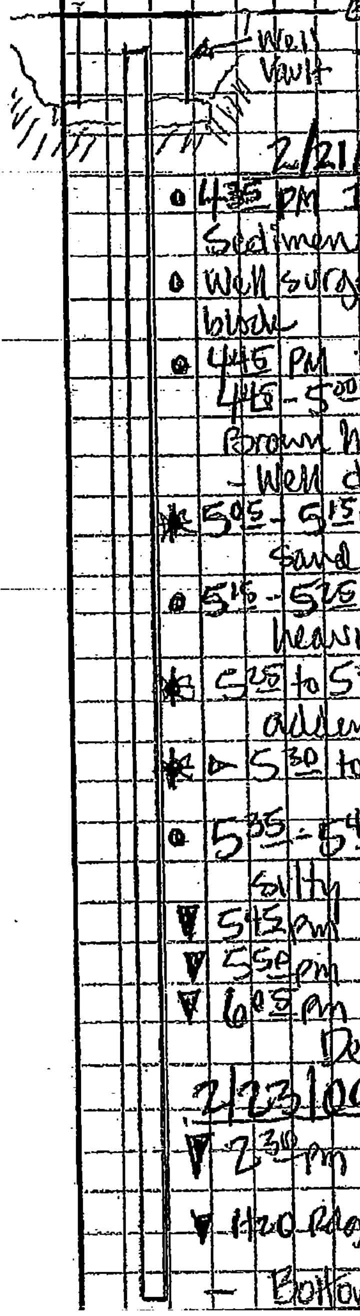
American Electric Power

Sporn Plant

Date Well Installed: Feb. 20, 2009

PZ-09-02

▼ Initial GW Elev. Prior to Well Development 16.0' B.G.S.



Grd. Surface/Top of Vault 0.0' B.G.S.
Top of Well Riser 0.44' B.G.S. (5¼")

2/21/09

- $4^{35}$ pm Initial H2O Rdg 16.0' BGS
  Sediment noted in Bottom of Well
- Well surged w/ 3' long by 1" ϕ PVC surge block
- $4^{45}$ PM Initiate pumping
  $4^{45}$ - $5^{00}$ pm Pumped 15± gals of Dark Brown heavily silted H2O w/ fine sand
  - Well depleted - Recharge for 5 mins.

* $5^{05}$ - $5^{15}$ pm Pumped 10± gals Brown heavily silted H2O w/ fine sand while adding 15± gals potable H2O to top of well

- $5^{15}$ - $5^{25}$ pm Pump 10± Brown moderately silty then back to heavily silted H2O w/ fine sand - Well depleted.

* $5^{25}$ to $5^{30}$ pm Pump 5± gals Br. heavily silted H2O while adding 5± gals potable H2O to top of well.

* ▷ $5^{30}$ to $5^{35}$ pm Add 10± gals potable H2O to top of well.

- $5^{35}$ - $5^{45}$ pm Pump 10± gals Brown moderately to slightly silty H2O w/ some fine sand - Suspend Pumping

▼ $5^{45}$ pm H2O @ 18.8' BGS
▼ $5^{50}$ pm H2O @ 18.0' BGS
▼ $6^{05}$ pm H2O @ 17.2' BGS
Development Complete

2/23/09
▼ $2^{30}$ pm H2O @ 21.2' BGS

▼ H2O Rdg 2/25/09 $12^{50}$ pm 22.3' BGS

— Bottom of Well 34.7' B.G.S.

* Well Volume *
- 1½" ID Screen & Riser 0.09 gals/L.F.
- 18.7' x 0.09 = 1.7 gals.
  Min. development volume
  3 x 1.7 gals = 5.1 gals.

- 30± gals H2O Added to well during development
- 50± Total gals H2O Pumped from well during development.

# Well Development Log

**H. C. NUTTING**
A Terracon COMPANY

790 Morrison Road • Columbus, OH 43230 • (614) 863-3113

JOB N2095019
SHEET NO. 1 OF 1
CALCULATED BY JCE DATE 2/19/09
CHECKED BY – DATE 2/20/09
SCALE NTS

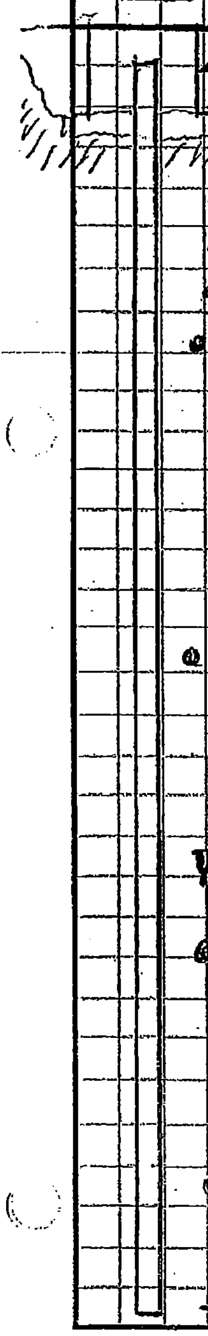
American Electric Power

Sporn Plant

Date Well Installed: Feb. 18, 2009

PZ-09-03

▼ Initial GW Elev. Prior to Well Development 16.8' B.G.S.



Grd. Surface/Top of Vault 0.0' B.G.S.
Well Vault – Top of Well Riser 1.14' B.G.S. (13 5/8")

2/19/09

- 9$^{00}$ Am Initial H2O Rdg - water @ 16.8' BGS
Surge well w/ 3' long PVC 1" ø Surge Blade
Sediment in well to 47.6' ± B.G.S.
- 11$^{00}$ Am initiate pumping set up
11$^{10}$ - 11$^{30}$ Am Pump 15 ± gals Gray heavily silted H2O w/ fine sand + Agitate well
11$^{45}$ - 12$^{00}$ pm Pump 15 ± gals Gray heavily silted H2O w/ fine sand
12$^{00}$ pm - 12$^{45}$ pm Pump 45 ± gals Gray heavily to moderately silty H2O w/ fine sand - Sand content diminishing

▼ H2O reading 2$^{00}$ pm after allowing well to settle 17.0' ± BGS
- 2$^{00}$ - 2$^{20}$ pm Pump 20 ± gals Gray heavy to moderately silty H2O w/ fine sand

▼ H2O Rdg 2$^{25}$ pm 16.9' ± BGS Suspend development

* Well Volume *
- 1 1/2" ID Screen & Riser 0.09 gals/L.F.
- 34.2' x 0.09 = 3.1 gals.
Min. development volume 3 x 3.1 = 9.3 gals.

2/20/09

▼ H2O Rdg 5$^{30}$ pm 16.9' ± BGS Sediment in well to 48.0' ±
* Jetted well to suspend sediment w/ 5 to 10 gals potable H2O
- Resume pumping - All sediment in suspension
5$^{40}$ - 6$^{00}$ pm Pump 20 ± gals Heavily silted H2O w/ fine sand
6$^{00}$ - 6$^{30}$ pm Pump 30 gals Gray heavily then moderately silty H2O w/ fine sand - Sand content diminishing
6$^{30}$ - 6$^{45}$ pm Pump 15 ± gals Gray moderately to slightly silty H2O w/ some fine sand

▼ H2O level @ completion 6$^{50}$ pm 17.0' ± B.G.S.

5 to 10 gals H2O added to well during jetting / 160 ± total gals H2O pumped during development

– Bottom of Well 50.4' B.G.S.

# Well Development Log

**H. C. NUTTING**
A Terracon COMPANY
790 Morrison Road • Columbus, OH 43230 • (614) 863-3113

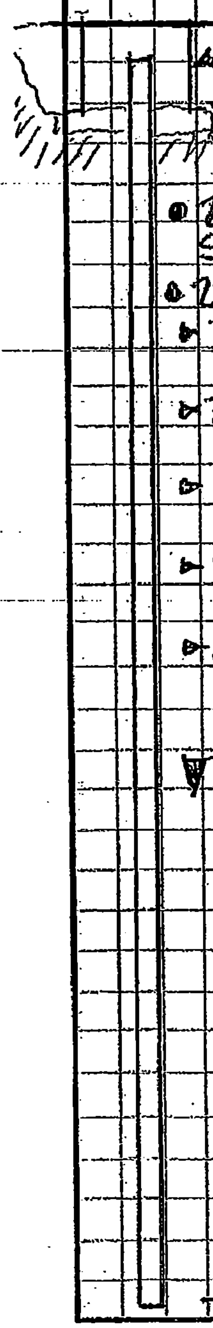
JOB N2095019
SHEET NO. 1 OF 1
CALCULATED BY JCE DATE 2/21/09
CHECKED BY — DATE —
SCALE NTS

American Electric Power
Sporn Plant

Date Well Installed: Feb. 19, 2009

PZ-09-04

▼ Initial GW Elev. Prior to Well Development 14.1' B.G.S.



Grd. Surface/Top of Vault 0.0' B.G.S.
Top of Well Riser 0.59' B.G.S. (7 1/8")

*** Well Volume ***
- 1½" ID Screen & Riser 0.09 gals/L.F.
- 35.7' x 0.09 = 3.2 gals.

Min. development volume
3 x 3.21 gals = 9.6 gals.

2/21/09
- $2^{50}$ pm Initial H2O Rdg. Water @ 14.1 BGS
  Surge well w/ 3' long by 1" ∅ PVC Surge block
- $2^{55}$ pm Initiate Pumping
- $2^{55}$-$3^{05}$ pm Pumped 10 gals. Dark Gray very heavily silted H2O w/ fine sand
- $3^{05}$-$3^{25}$ pm Pumped 25± gals Gray heavily silted H2O w/ fine sand
- $3^{25}$ pm - $3^{40}$ pm Pumped 20± gals Gray to Lt. gray moderately silty H2O w/ some fine sand
- $3^{40}$-$4^{05}$ pm Pumped 25± gals Lt. gray moderately to slightly silty H2O w/ some fine sand
- $4^{05}$ - $4^{15}$ pm Pumped 10± gals Lt. gray slightly silty H2O w/ some fine sand

▼ H2O Rdg $4^{25}$ pm Water @ 14.5' BGS

90± Total gals. H2O pumped from well during development

Development complete $4^{25}$ pm

← Bottom of Well 49.8' B.G.S.

# Well Development Log

H. C. NUTTING
A Terracon COMPANY
790 Morrison Road • Columbus, OH 43230 • (614) 863-3113

JOB N2095019
SHEET NO. 1 OF 1
CALCULATED BY JCE DATE 2/20/09
CHECKED BY ______ DATE ______
SCALE NTS

American Electric Power
Sporn Plant

Date Well Installed: Feb. 17, 2009

PZ-09-05

▼ Initial GW Elev. Prior to Well Development 15.7' B.G.S.

Grd. Surface/Top of Vault 0.0' B.G.S.
Well Vault – Top of well Riser 0.2' B.G.S. (2½")

2/20/09
- $2^{30}$ pm Initial $H_2O$ Rdg - water @ 15.7' BGS
Surge well w/ 3' long PVC 1" ø surge block
- $2^{35}$ pm Initiate Pumping
  $2^{35}$ - $3^{00}$ pm Pump 20 gals Brown/Gray heavily silted $H_2O$ w/ fine sand
- ▸ Sediment in well to 46.5'± BGS

* Jetted well w/ 5 to 10 gallons potable $H_2O$ to suspend sediment
- Resume Pumping
  $3^{25}$ pm - $3^{40}$ pm Pumped 15± gallons Brown/gray heavily silted $H_2O$ w/ fine sand
  $3^{40}$ pm - $4^{00}$ pm Pumped 20± gallons Brown to light brown moderately silty $H_2O$ w/ some fine sand
  $4^{00}$ pm - $4^{20}$ pm Pumped 20± gallons light brown moderately to slightly silty $H_2O$ w/ trace fine sand
  $4^{20}$ pm - $4^{35}$ pm Pumped 15± gallons light brown slightly silty $H_2O$ w/ trace fine sand

* Well Volume *
- 1½" ID Screen & Riser
  0.09 gals/L.F.
- 34.5' x 0.09 = 3.1 gals.
  Min. development volume
  3 x 3.1 = 9.3 gals.

▼ $H_2O$ level immediately after pumping 15.9' B.G.S.

▸ 5 to 10 gallons $H_2O$ added to well during jetting.

90± gals. Total $H_2O$ Pumped from Well during development

2/20/09 $4^{40}$ pm Development Complete

– Bottom of Well 50.2' B.G.S.

TERRACON PROJECT NO. N2095019

PROJECT SPORN FLY ASH AND BOTTOM ASH POND COMPLEX

SUMMARY ELEVATIONS
(FT. NGVD)

COORDINATES 721044.45 N/1735346.82 E (NAD 27)(NGVD29 WV N)

DATE INSTALLED 02/21/09

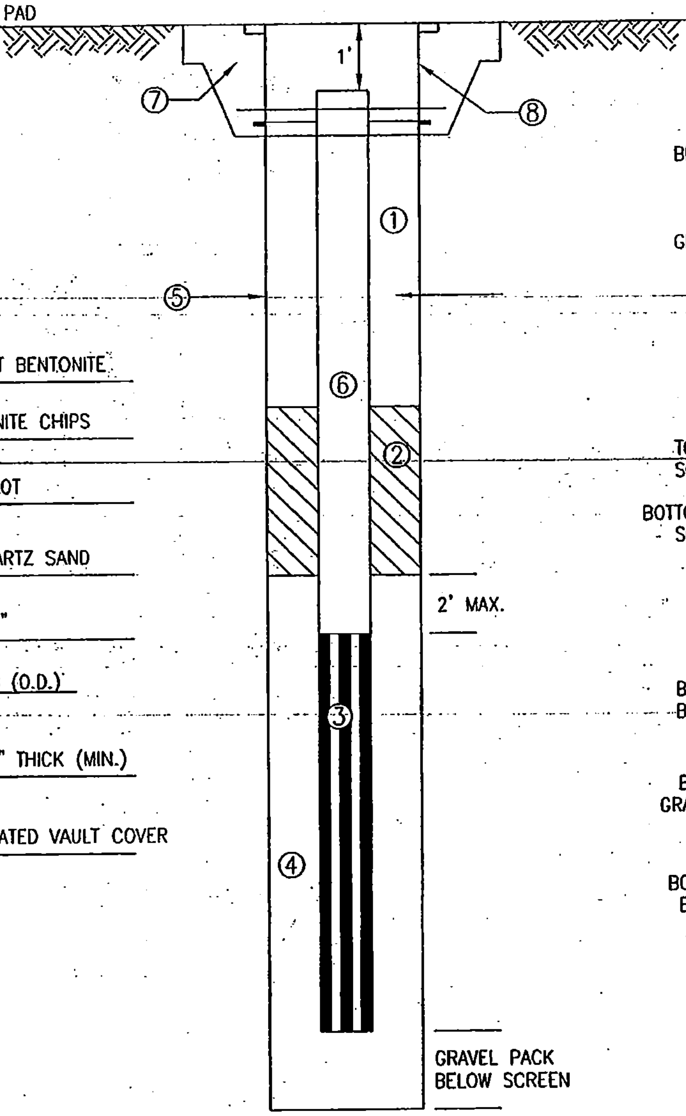
PIEZOMETER NO. PZ-09-01

REF. DATUM PT.

REF. DATUM PT.:
TOP OF PROTECTIVE
VAULT/GROUND SURFACE

GROUND SURFACE/TOP OF PAD

GRADE 0' (600.82')



DEPTH (ELEV.)

TOP OF BENTONITE SEAL 4.0' (596.82')

TOP OF GRAVEL PACK 5.0' (595.82')

TOP OF SCREEN 6.0' (594.82')

BOTTOM OF SCREEN 50.3' (550.52')

BOTTOM OF BLANK SEC. N/A

BOTTOM OF GRAVEL PACK 51.0' (549.82')

BOTTOM OF BOREHOLE 51.0' (549.82')

1 GROUT SEAL MATERIAL: CEMENT BENTONITE
2 BENTONITE SEAL MATERIAL: BENTONITE CHIPS
3 SCREEN SIZE: 0.010" SLOT
4 GRAVEL PACK MATERIAL: #5 QUARTZ SAND
5 BOREHOLE DIAMETER 6" MIN. 7"
6 1.92" DIA. PVC CASING (O.D.)
7 CONCRETE PAD DIMENSIONS: 3'x3'x8" THICK (MIN.)
8 PROTECTIVE STEEL H2 RATED VAULT COVER

NOTE: DEPTHS OF MATERIALS ARE TAKEN FROM TOP OF VAULT/GROUND SURFACE

SCALE: NTS

| | | | | |
|---|---|---|---|---|
| GEOTECHNICAL ENGINEERING SECTION<br>CIVIL DESIGN STANDARD | | REVISION<br>0 | | OBSERVATION WELL |
| APP'D. | DR. | C.K. | DATE | |
| AMERICAN ELECTRIC POWER SERVICE CORP. | | | | CDS-04A SH. |

AMERICAN ELECTRIC POWER
SPORN FLY ASH AND BOTTOM ASH POND COMPLEX

GEOLOGIST/ENGINEER:
LEWIS EPLIN H.C. NUTTING CO.

TERRACON PROJECT NO. N2095019

PROJECT SPORN FLY ASH AND BOTTOM ASH POND COMPLEX

SUMMARY ELEVATIONS
(FT. NGVD)

COORDINATES 720305.06 N/1735649.89 E (NAD 27)(NGVD29 WV N)

DATE INSTALLED 02/20/09

PIEZOMETER NO. PZ-09-02

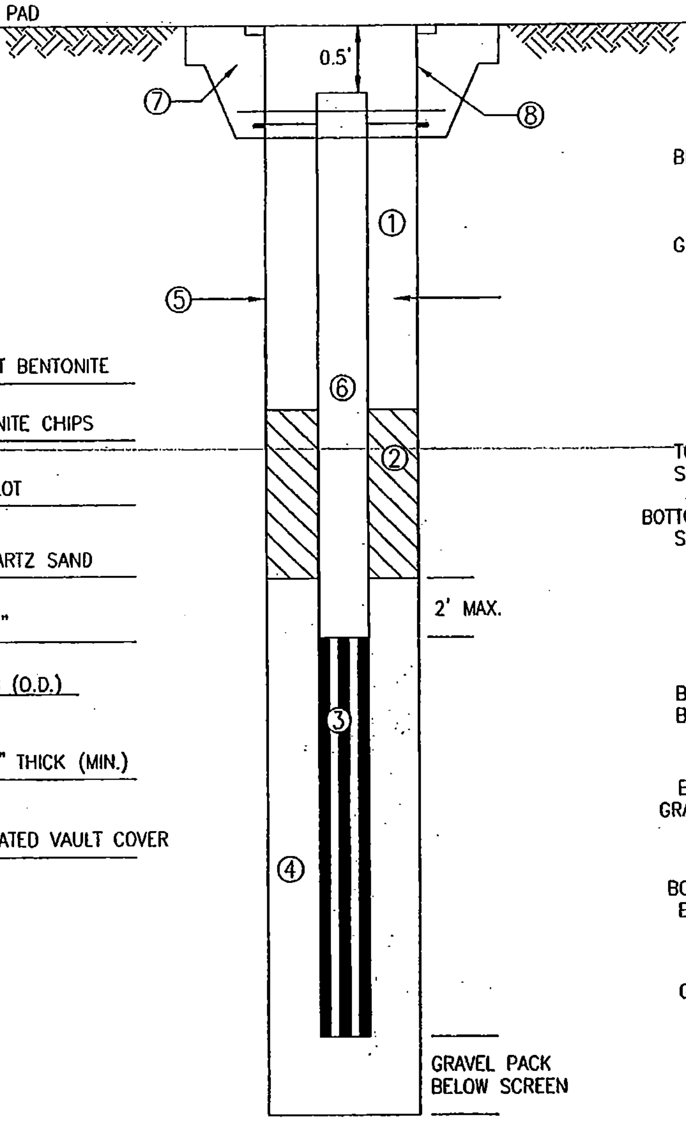
REF. DATUM PT. ______

REF. DATUM PT.:
TOP OF PROTECTIVE
VAULT/GROUND SURFACE

GROUND SURFACE/TOP OF PAD

GRADE 0' (601.35')

DEPTH (ELEV.)



1 GROUT SEAL MATERIAL: CEMENT BENTONITE
2 BENTONITE SEAL MATERIAL: BENTONITE CHIPS
3 SCREEN SIZE: 0.010" SLOT
4 GRAVEL PACK MATERIAL: #5 QUARTZ SAND
5 BOREHOLE DIAMETER 6" MIN. 7"
6 1.92" DIA. PVC CASING (O.D.)
7 CONCRETE PAD DIMENSIONS: 3'x3'x8" THICK (MIN.)
8 PROTECTIVE STEEL H2 RATED VAULT COVER

TOP OF BENTONITE SEAL 2.0' (599.35')
TOP OF GRAVEL PACK 3.5' (597.85')
TOP OF SCREEN 5.5' (595.85')
BOTTOM OF SCREEN 35.0' (566.35')
BOTTOM OF BLANK SEC. N/A
BOTTOM OF GRAVEL PACK 36.0' (565.35')
BOTTOM OF BOREHOLE 50.0' (551.35')

GROUTED 36.0' TO 50.0'

NOTE: DEPTHS OF MATERIALS ARE TAKEN FROM TOP OF VAULT/GROUND SURFACE

SCALE: NTS

GEOTECHNICAL ENGINEERING SECTION
CIVIL DESIGN STANDARD

REVISION 0

OBSERVATION
WELL

APP'D.
DR.
C.K.
DATE

AMERICAN ELECTRIC POWER SERVICE CORP.

CDS-04A
SH.

AMERICAN ELECTRIC POWER
SPORN FLY ASH AND BOTTOM ASH POND COMPLEX

GEOLOGIST/ENGINEER:
LEWIS EPLIN H.C. NUTTING CO.

TERRACON PROJECT NO. N2095019

PROJECT SPORN FLY ASH AND BOTTOM ASH POND COMPLEX

SUMMARY ELEVATIONS
(FT. NGVD)

COORDINATES 718399.12 N/1736131.92 E (NAD 27)(NGVD29 WV N)

DATE INSTALLED 02/18/09

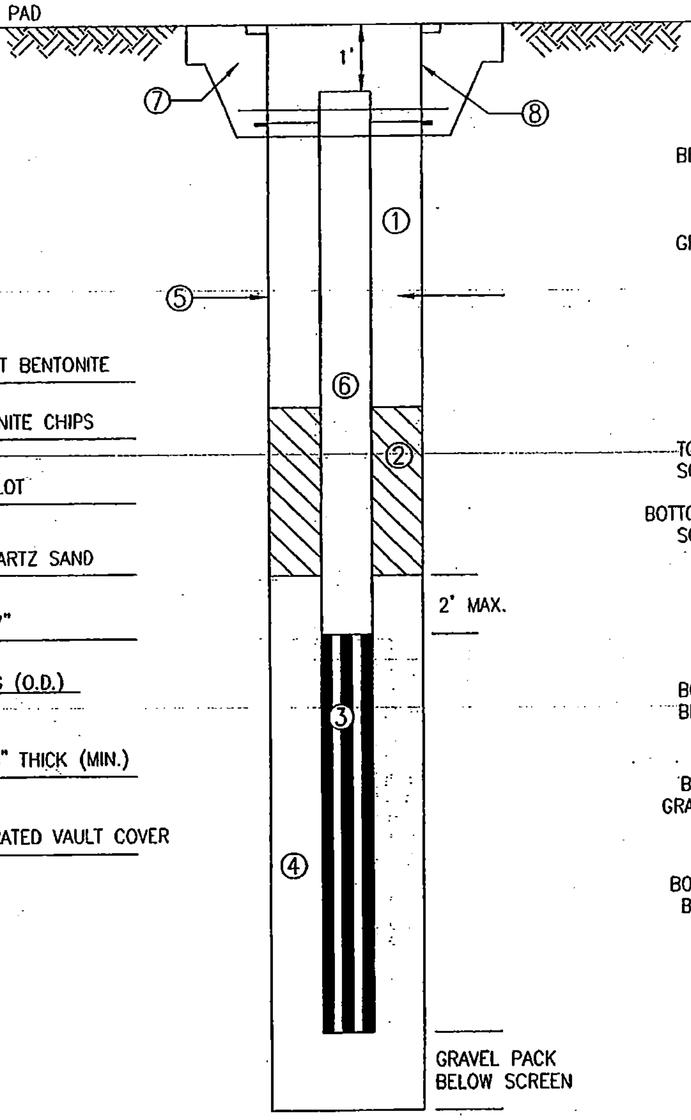
PIEZOMETER NO. PZ-09-03

REF. DATUM PT.:
TOP OF PROTECTIVE
VAULT/GROUND SURFACE

REF. DATUM PT.

GROUND SURFACE/TOP OF PAD

GRADE 0' (596.52')



DEPTH (ELEV.)

TOP OF BENTONITE SEAL 4.0' (592.52')

TOP OF GRAVEL PACK 5.0' (591.52')

| | | |
|---|---|---|
| 1 | GROUT SEAL MATERIAL: | CEMENT BENTONITE |
| 2 | BENTONITE SEAL MATERIAL: | BENTONITE CHIPS |
| 3. | SCREEN SIZE: | 0.010" SLOT |
| 4 | GRAVEL PACK MATERIAL: | #5 QUARTZ SAND |
| 5 | BOREHOLE DIAMETER 6" MIN. | 7" |
| 6 | 1.92" DIA. PVC CASING (O.D.) | |
| 7 | CONCRETE PAD DIMENSIONS: | 3'x3'x8" THICK (MIN.) |
| 8 | PROTECTIVE STEEL H2 RATED VAULT COVER | |

TOP OF SCREEN 6.0' (590.52')

BOTTOM OF SCREEN 50.4' (546.12')

BOTTOM OF BLANK SEC. N/A

BOTTOM OF GRAVEL PACK 51.0' (545.52')

BOTTOM OF BOREHOLE 51.0' (545.52')

NOTE: DEPTHS OF MATERIALS ARE TAKEN FROM TOP OF VAULT/GROUND SURFACE

SCALE: NTS

| | | | | |
|---|---|---|---|---|
| GEOTECHNICAL ENGINEERING SECTION<br>CIVIL DESIGN STANDARD | | REVISION 0 | | OBSERVATION WELL |
| APP'D. | DR. | C.K. | DATE | |
| AMERICAN ELECTRIC POWER SERVICE CORP. | | | | CDS-04A \| SH. |

AMERICAN ELECTRIC POWER
SPORN FLY ASH AND BOTTOM ASH POND COMPLEX

GEOLOGIST/ENGINEER:
LEWIS EPLIN H.C. NUTTING CO.

TERRACON PROJECT NO. N2095019

PROJECT SPORN FLY ASH AND BOTTOM ASH POND COMPLEX

SUMMARY ELEVATIONS
(FT. NGVD)

COORDINATES 718150.72 N/1736258.64 E (NAD 27)(NGVD29 WV N)

DATE INSTALLED 02/19/09

PIEZOMETER NO. PZ-09-04

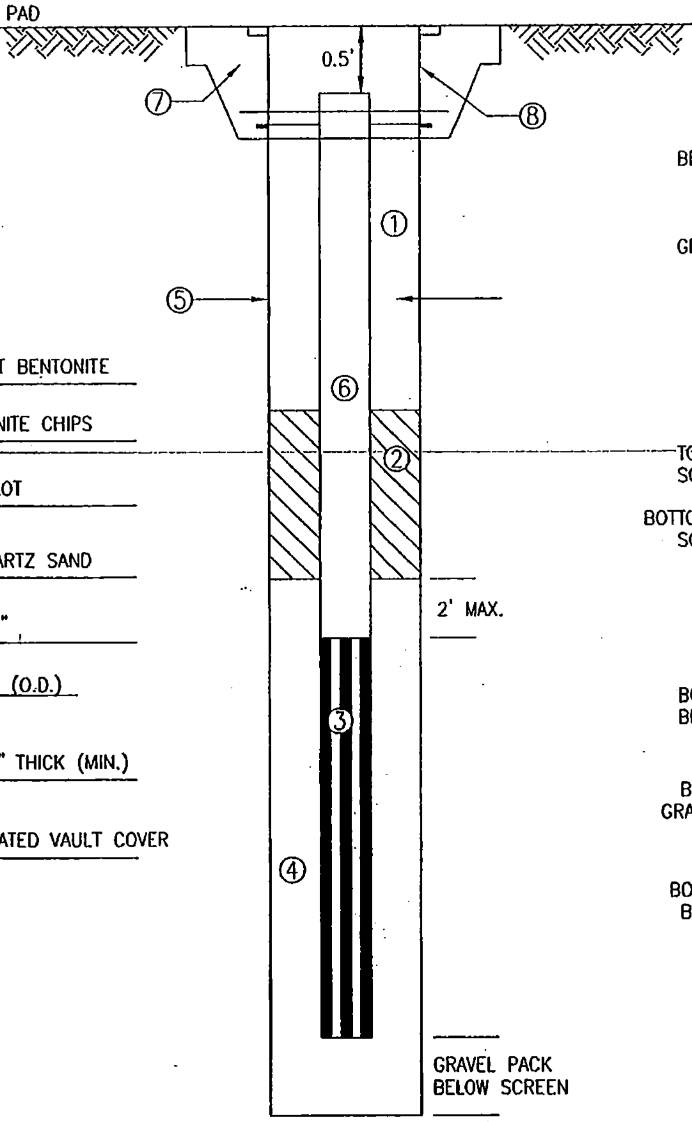
REF. DATUM PT.:
TOP OF PROTECTIVE
VAULT/GROUND SURFACE

REF. DATUM PT. ______

GROUND SURFACE/TOP OF PAD

GRADE 0' (593.69')

DEPTH (ELEV.)



TOP OF BENTONITE SEAL 3.5' (590.19')

TOP OF GRAVEL PACK 4.5' (589.19')

TOP OF SCREEN 5.5' (588.19')

BOTTOM OF SCREEN 49.8' (543.89')

BOTTOM OF BLANK SEC. N/A

BOTTOM OF GRAVEL PACK 51.0' (542.69')

BOTTOM OF BOREHOLE 51.0' (542.69')

1 GROUT SEAL MATERIAL: CEMENT BENTONITE

2 BENTONITE SEAL MATERIAL: BENTONITE CHIPS

3 SCREEN SIZE: 0.010" SLOT

4 GRAVEL PACK MATERIAL: #5 QUARTZ SAND

5 BOREHOLE DIAMETER 6" MIN. 7"

6 1.92" DIA. PVC CASING (O.D.)

7 CONCRETE PAD DIMENSIONS: 3'x3'x8" THICK (MIN.)

8 PROTECTIVE STEEL H2 RATED VAULT COVER

NOTE: DEPTHS OF MATERIALS ARE TAKEN FROM TOP OF VAULT/GROUND SURFACE

SCALE: NTS

| | | | | |
|---|---|---|---|---|
| GEOTECHNICAL ENGINEERING SECTION<br>CIVIL DESIGN STANDARD | | REVISION 0 | | OBSERVATION WELL |
| APP'D. | DR. | C.K. | DATE | |
| AMERICAN ELECTRIC POWER SERVICE CORP. | | | | CDS-04A SH. |

AMERICAN ELECTRIC POWER
SPORN FLY ASH AND BOTTOM ASH POND COMPLEX

GEOLOGIST/ENGINEER:

LEWIS EPLIN H.C. NUTTING CO.

TERRACON PROJECT NO. N2095019

PROJECT SPORN FLY ASH AND BOTTOM ASH POND COMPLEX

SUMMARY ELEVATIONS
(FT. NGVD)

COORDINATES 717961.56 N/1735749.39 E (NAD 27)(NGVD29 WV N)

DATE INSTALLED 02/17/09

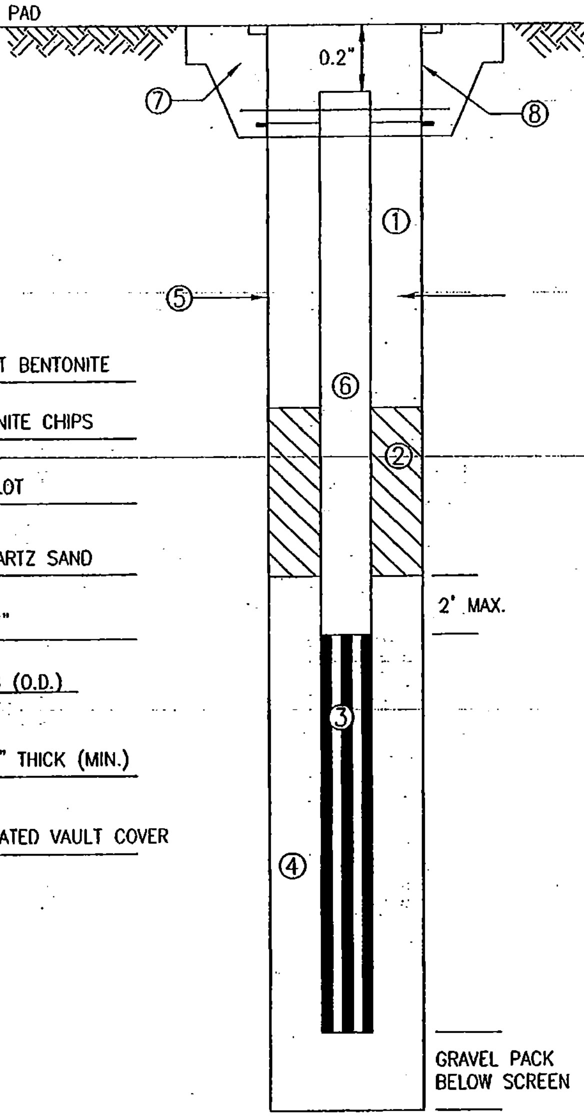
PIEZOMETER NO. PZ-09-05

REF. DATUM PT.:
TOP OF PROTECTIVE
VAULT/GROUND SURFACE

REF. DATUM PT. ________

GROUND SURFACE/TOP OF PAD

GRADE 0' (593.45')



DEPTH (ELEV.)

TOP OF BENTONITE SEAL 3.2' (590.25')

TOP OF GRAVEL PACK 4.2' (589.25')

1 GROUT SEAL MATERIAL: CEMENT BENTONITE

2 BENTONITE SEAL MATERIAL: BENTONITE CHIPS

3 SCREEN SIZE: 0.010" SLOT

4 GRAVEL PACK MATERIAL: #5 QUARTZ SAND

5 BOREHOLE DIAMETER 6" MIN. 7"

6 1.92" DIA. PVC CASING (O.D.)

7 CONCRETE PAD DIMENSIONS: 3'x3'x8" THICK (MIN.)

8 PROTECTIVE STEEL H2 RATED VAULT COVER

TOP OF SCREEN 5.2' (588.25')

BOTTOM OF SCREEN 50.2' (543.25')

BOTTOM OF BLANK SEC. N/A

BOTTOM OF GRAVEL PACK 51.0' (542.45')

BOTTOM OF BOREHOLE 51.0' (542.45')

NOTE: DEPTHS OF MATERIALS ARE TAKEN FROM TOP OF VAULT/GROUND SURFACE

SCALE: NTS

GEOTECHNICAL ENGINEERING SECTION
CIVIL DESIGN STANDARD

REVISION 0

OBSERVATION WELL

APP'D.

DR.

C.K.

DATE

AMERICAN ELECTRIC POWER SERVICE CORP.

CDS-04A

SH.

AMERICAN ELECTRIC POWER
SPORN FLY ASH AND BOTTOM ASH POND COMPLEX

GEOLOGIST/ENGINEER:

LEWIS EPLIN H.C. NUTTING CO.

# GENERAL NOTES

**DRILLING & SAMPLING SYMBOLS:**

SS: Split Spoon - 1-$^3$/8" I.D., 2" O.D., unless otherwise noted
ST: Thin-Walled Tube - 2" O.D., unless otherwise noted
RS: Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted
DB: Diamond Bit Coring - 4", N, B
BS: Bulk Sample or Auger Sample

HS: Hollow Stem Auger
PA: Power Auger
HA: Hand Auger
RB: Rock Bit
WB: Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value".

**WATER LEVEL MEASUREMENT SYMBOLS:**

WL: Water Level
WCI: Wet Cave in
DCI: Dry Cave in
AB: After Boring

WS: While Sampling
WD: While Drilling
BCR: Before Casing Removal
ACR: After Casing Removal

N/E: Not Encountered

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

**DESCRIPTIVE SOIL CLASSIFICATION:** Soil classification is based on the Unified Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

**CONSISTENCY OF FINE-GRAINED SOILS**

| Unconfined Compressive Strength, Qu, psf | Standard Penetration or N-value (SS) Blows/Ft. | Consistency |
|---|---|---|
| < 500 | 0 - 1 | Very Soft |
| 500 – 1,000 | 2 - 4 | Soft |
| 1,000 – 2,000 | 4 - 8 | Medium Stiff |
| 2,000 – 4,000 | 8 - 15 | Stiff |
| 4,000 – 8,000 | 15 - 30 | Very Stiff |
| 8,000+ | > 30 | Hard |

**RELATIVE DENSITY OF COARSE-GRAINED SOILS**

| Standard Penetration or N-value (SS) Blows/Ft. | Relative Density |
|---|---|
| 0 – 3 | Very Loose |
| 4 – 9 | Loose |
| 10 – 29 | Medium Dense |
| 30 – 49 | Dense |
| > 50 | Very Dense |

**RELATIVE PROPORTIONS OF SAND AND GRAVEL**

| Descriptive Term(s) of other constituents | Percent of Dry Weight |
|---|---|
| Trace | < 15 |
| With | 15 – 29 |
| Modifier | > 30 |

**GRAIN SIZE TERMINOLOGY**

| Major Component of Sample | Particle Size |
|---|---|
| Boulders | Over 12 in. (300mm) |
| Cobbles | 12 in. to 3 in. (300mm to 75 mm) |
| Gravel | 3 in. to #4 sieve (75mm to 4.75 mm) |
| Sand | #4 to #200 sieve (4.75mm to 0.075mm) |
| Silt or Clay | Passing #200 Sieve (0.075mm) |

**RELATIVE PROPORTIONS OF FINES**

| Descriptive Term(s) of other constituents | Percent of Dry Weight |
|---|---|
| Trace | < 5 |
| With | 5 – 12 |
| Modifiers | > 12 |

**PLASTICITY DESCRIPTION**

| Term | Plasticity Index |
|---|---|
| Non-plastic | 0 |
| Low | 1-10 |
| Medium | 11-30 |
| High | > 30 |

Terracon

# UNIFIED SOIL CLASSIFICATION SYSTEM

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A] | | | | | Soil Classification | |
|---|---|---|---|---|---|---|
| | | | | | Group Symbol | Group Name[B] |
| Coarse Grained Soils More than 50% retained on No. 200 sieve | Gravels More than 50% of coarse fraction retained on No. 4 sieve | Clean Gravels Less than 5% fines[C] | $Cu \geq 4$ and $1 \leq Cc \leq 3$[E] | | GW | Well-graded gravel[F] |
| | | | $Cu < 4$ and/or $1 > Cc > 3$[E] | | GP | Poorly graded gravel[F] |
| | | Gravels with Fines More than 12% fines[C] | Fines classify as ML or MH | | GM | Silty gravel[F,G,H] |
| | | | Fines classify as CL or CH | | GC | Clayey gravel[F,G,H] |
| | Sands 50% or more of coarse fraction passes No. 4 sieve | Clean Sands Less than 5% fines[D] | $Cu \geq 6$ and $1 \leq Cc \leq 3$[E] | | SW | Well-graded sand[I] |
| | | | $Cu < 6$ and/or $1 > Cc > 3$[E] | | SP | Poorly graded sand[I] |
| | | Sands with Fines More than 12% fines[D] | Fines classify as ML or MH | | SM | Silty sand[G,H,I] |
| | | | Fines Classify as CL or CH | | SC | Clayey sand[G,H,I] |
| Fine-Grained Soils 50% or more passes the No. 200 sieve | Silts and Clays Liquid limit less than 50 | inorganic | $PI > 7$ and plots on or above "A" line[J] | | CL | Lean clay[K,L,M] |
| | | | $PI < 4$ or plots below "A" line[J] | | ML | Silt[K,L,M] |
| | | organic | Liquid limit - oven dried | $< 0.75$ | OL | Organic clay[K,L,M,N] |
| | | | Liquid limit - not dried | | | Organic silt[K,L,M,O] |
| | Silts and Clays Liquid limit 50 or more | inorganic | PI plots on or above "A" line | | CH | Fat clay[K,L,M] |
| | | | PI plots below "A" line | | MH | Elastic Silt[K,L,M] |
| | | organic | Liquid limit - oven dried | $< 0.75$ | OH | Organic clay[K,L,M,P] |
| | | | Liquid limit - not dried | | | Organic silt[K,L,M,Q] |
| Highly organic soils | Primarily organic matter, dark in color, and organic odor | | | | PT | Peat |

---

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$  $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

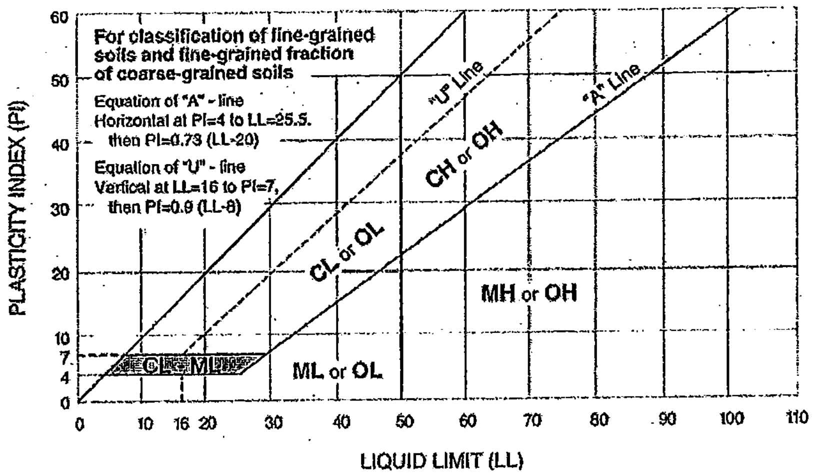
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] $PI \geq 4$ and plots on or above "A" line.

[O] $PI < 4$ or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon

Form 111—6/98

# FIELD DATA COLLECTED BY:
# GEO/ENVIRONMENTAL ASSOCIATES, INC.

## DATED: DECEMBER 2009 & JANUARY 2010

**Geo/Environmental Associates, Inc.**

Boring No. GA-1A

Page 1 Of 2

**PROJECT: AEP Philip Sporn**

**PROJECT NO: 09-387**

Start Date: 12-10-09

Finish Date: 12-10-09

Logged By: Seth Frank

Location: FAP – East Dike section K-K

Ground Elevation: 619.13' NGVD29

Drilling Contractor: Horn and Associates

Driller: Tom Leininger

Helper: Robert, George

Drill Type: Diedrich D120 Truck Mounted

AEP Contacts: Mark King and Ginger MacKnight

Notes: woven fabric approx 0.5' bgs

NAD27 Coordinates Provided by AEP

N 719696.84 E 1736037.33

Thickness of Soil:

Depth Drilled In Rock:

Total Depth of Boring: 69.0'

| DEPTH (FEET) | | SAMPLE NOS., & SPLIT SPOON RECOVERY | SOIL/BEDROCK DESCRIPTION | BLOW COUNTS AND COMMENTS |
|---|---|---|---|---|
| FROM | TO | | | |
| 2.0 | 2.5 | S-1 / 0.4' | Sand, gravel, brown, very dense, damp | 50 / 0.5' |
| 4.0 | 4.6 | S-2 / 0.5' | Sand, gravel, brown, very dense, damp | 35-50 / 0.1' |
| 6.5 | 7.0 | S-3 / 0.4' | Sand, gravel, brown, very dense, damp | 50 / 0.5' |
| 9.0 | 10.5 | S-4 / 0.4' | Sand, gravel, brown, very dense, damp | 33-37-31 |
| 11.5 | 13.0 | S-5 / 1.4' | Sand, gravel, brown, very dense, damp | 35-36-29 |
| 14.0 | 14.5 | S-6 / 0.4' | Sand, gravel, brown, very dense, damp | 50 / 0.5' |
| 16.5 | 18.0 | S-7 / 1.5' | Sand, clay, brown, medium dense, damp | 17-17-13 |
| 19.0 | 20.5 | S-8 / 1.5' | Sand, clay, brown, medium dense, damp | 20-12-11 |
| 20.5 | 22.0 | S-9 / 1.3' | Sand, clay, brown, medium dense, damp | 11-14-15 |
| 22.0 | 23.5 | S-10 / 1.5' | 0 -1.1' Sand, clay, brown / 1.1-1.5' Bottom Ash, sand, black, dense, damp | 23-26-20 |
| 23.5 | 25.0 | S-11 / 1.5' | Sand, bottom ash streaks, clay, brown streaked black, dense, damp | 17-20-17 |
| 25.0 | 26.5 | S-12 / 1.5' | Bottom Ash, fly ash, grey-black, dense, moist (approximate start of fly ash) | 17-16-16 |

**Geo/Environmental Associates, Inc.**

**Project Name/ Job Number:** 09-387

**Boring Log No.:** GA-1A

**Page** 2 **of** 2

| DEPTH (FEET) | | SAMPLE NO., SAMPLE INTERVAL & SPLIT SPOON RECOVERY | SOIL/BEDROCK DESCRIPTION | BLOW COUNTS AND COMMENTS |
|---|---|---|---|---|
| FROM | TO | | | |
| 26.5 | 27.2 | ST-1 / 0.7' | Fly Ash, bottom ash, grayish black, wet | W/L ≈ 27' bgs |
| 28.5 | 31.0 | ST-2 / 2.66' | Fly Ash, gray, wet | |
| 31.0 | 32.5 | S-13 / 1.5' | Fly Ash, gray, loose, wet | 3-2-3 |
| 32.5 | 35.0 | ST-3 / 2.50' | Fly Ash, gray, wet | |
| 35.0 | 36.5 | S-14 / 1.5' | Fly Ash, gray, loose wet | 3-3-3 |
| 36.5 | 39.0 | ST-4 / 2.60' | Fly Ash, gray, wet | |
| 39.0 | 40.5 | S-15 / 1.5' | Fly Ash, gray, loose, wet | 2-3-2 |
| 40.5 | 43.0 | ST-5 / 2.55' | Fly Ash, gray, wet | |
| 43.0 | 44.5 | S-16 / 1.5' | Fly Ash, gray, loose, wet | 1-3-3 |
| 44.5 | 47.0 | ST-6 / 2.55' | Fly Ash, gray, wet | |
| 47.0 | 48.5 | S-17 / 1.5' | Fly Ash, gray, loose, wet | 5-4-4 |
| 48.5 | 51.0 | ST-7 / 2.41' | Fly Ash, gray, wet | |
| 51.0 | 52.5 | S-18 / 1.5' | Fly Ash, gray, loose, wet | 7-2-4 |
| 52.5 | 55.0 | ST-8 / 2.55' | Fly Ash, gray, wet | |
| 55.0 | 56.5 | S-19 / 1.5' | Fly Ash, gray, loose, wet | 1-3-4 |
| 56.5 | 59.0 | ST-9 / 2.37' | Fly Ash, gray, wet | |
| 59.0 | 60.5 | S-20 / 1.5' | 0-1.0' Fly Ash, clay, gray 1.0-1.5' Clay, silt, brown, stiff, wet (approximate end of fly ash) | 3-4-8 |
| 60.5 | 63.0 | ST-10 / 2.49' | Clay, silt, brown | |
| 69.0 | 70.5 | S-21 / 1.5' | Silt, clay, brown, very stiff, moist-wet | 6-8-8 |
| | | | | |
| | | | Set Inclinometer at ≈ 69' bgs. Back fill with grout mix: approx 1 unit pcc, 1 unit bentonite, 6.25 units water by weight. | |

**Geo/Environmental Associates, Inc.**

**Boring No.** GA-1B

**Page** 1 **Of** 1

**PROJECT: AEP Philip Sporn**

**PROJECT NO: 09-387**

Start Date: 12-11-09

Finish Date: 12-14-09

Logged By: Seth Frank

Location: FAP – East Dike section K-K

Ground Elevation: 619.04' NGVD29

Drilling Contractor: Horn and Associates

Driller: Tom Leininger

Helper: Robert, George, Jared

Drill Type: Diedrich D120 Truck Mounted

AEP Contacts: Mark King and Ginger MacKnight

Notes: woven fabric approx 0.5' bgs

NAD27 Coordinates Provided by AEP

N 719704.38 E 1736031.96

Thickness of Soil:

Depth Drilled In Rock:

Total Depth of Boring: 69.0'

| DEPTH (FEET) | | SAMPLE NOS., & SPLIT SPOON RECOVERY | SOIL/BEDROCK DESCRIPTION | BLOW COUNTS AND COMMENTS |
|---|---|---|---|---|
| FROM | TO | | | |
| 9.0 | 10.5 | S-1 / 1.2' | Sand, gravel, brown, very dense, damp | 32-37-35 |
| 19.0 | 20.5 | S-2 / 1.5' | Sand, clay, brown – mottled black, medium dense, damp | 12-7-9 |
| 29.0 | 30.5 | S-3 / 1.5' | Fly Ash, gray, loose, wet | 5-4-5 |
| 39.0 | 40.5 | S-4 / 1.5' | Fly Ash, gray, very loose, wet | 0-1-0 |
| 49.0 | 50.5 | S-5 / 1.5' | Fly Ash, gray, loose, wet | 2-3-5 |
| 59.0 | 60.5 | S-6 / 1.5' | 0-1.0 Fly Ash, gray, very loose, wet<br>1.0-1.5 Clay, silty, brown, soft, damp-moist | 0-0-3 |
| 69.0 | 70.5 | S-7 / 1.5' | Clay, silty, brown, very stiff, damp-moist | 9-10-10 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | Set Inclinometer at ≈ 69' bgs. Back fill with grout mix: approx 1 unit pcc, 1 unit bentonite, 6.25 units water by weight. | |

# Geo/Environmental Associates, Inc.

**Boring No.** GA-1C

**Page** 1 **Of** 1

**PROJECT: AEP Philip Sporn**

**PROJECT NO: 09-387**

Start Date: 12-16-09

Finish Date: 12-16-09

Logged By: Seth Frank

Location: FAP – East Dike section K-K

Ground Elevation: 619.03' NGVD29

Drilling Contractor: Horn and Associates

Driller: Tom Leininger

Helper: Robert, George, Jared

Drill Type: Diedrich D120 Truck Mounted

AEP Contacts: Mark King and Ginger MacKnight

Notes: woven fabric approx 0.5' bgs

NAD27 Coordinates Provided by AEP

N 719712.67 E 1736026.24

Thickness of Soil:

Depth Drilled In Rock:

Total Depth of Boring: 79.0'

| **DEPTH (FEET)** | | **SAMPLE NOS., & SPLIT SPOON RECOVERY** | **SOIL/BEDROCK DESCRIPTION** | **BLOW COUNTS AND COMMENTS** |
|---|---|---|---|---|
| **FROM** | **TO** | | | |
| 9.0 | 10.5 | S-1 / 1.4' | Sand, gravel, brown, very dense, damp | 29-30-31 |
| 19.0 | 20.5 | S-2 / 1.5' | Sand, clay, brown streaked black, medium dense, damp-moist | 9-11-7 |
| 29.0 | 30.5 | S-3 / 1.5' | Fly Ash, grayish black, medium dense, wet | 9-8-7 |
| 35.0 | | Vain Shear 1 | 30 lb-ft / 60° 10 lb-ft / 360° | |
| 39.0 | 41.5 | ST-1 / 0.98' | Fly Ash, grey, wet | |
| 42.5 | | Vane Shear 2 | 100 lb-ft / 90° 60 lb-ft / 360° | |
| 50.0' | | Vane Shear 3 | 40 lb-ft / 60° 20 lb-ft / 360° | |
| 59.0 | 60.5 | S-4 / 1.5' | Fly Ash, clay, organic material, silty, brownish black, soft, moist-wet | 1-1-3 |
| 69.0 | 71.5 | ST-2 / 2.58' | Clay, silty, sandy, brown, moist-wet | |
| 79.0 | 80.5 | S-5 / 1.5' | Clay, silty, brown, stiff, wet | 5-8-7 1.75 tsf |
| | | | | |
| | | | | |
| | | | Set Inclinometer at ≈ 79' bgs. Back fill with grout mix: approx 1 | |

**Geo/Environmental Associates, Inc.**

**Boring No.** GA-1D

**Page** 1 **Of** 2

**PROJECT: AEP Philip Sporn**

**PROJECT NO: 09-387**

Start Date: 12-16-09

Finish Date: 12-17-09

Logged By: Seth Frank

Location: FAP – East Dike section K-K

Ground Elevation: 619.21' NGVD29

Drilling Contractor: Horn and Associates

Driller: Tom Leininger

Helper: Robert, George, Jared

Drill Type: Diedrich D120 Truck Mounted

AEP Contacts: Mark King and Ginger MacKnight

Notes: woven fabric approx 0.5' bgs

NAD27 Coordinates Provided by AEP

N 719729.38 E 1736015.38

Thickness of Soil:

Depth Drilled In Rock:

Total Depth of Boring: 59.0'

| DEPTH (FEET) | | SAMPLE NOS., & SPLIT SPOON RECOVERY | SOIL/BEDROCK DESCRIPTION | BLOW COUNTS AND COMMENTS |
|---|---|---|---|---|
| FROM | TO | | | |
| 9.0 | 9.4 | S-1 / 0.3' | Sand, gravel, brown, very dense, damp | 50 / 0.4' |
| 19.0 | 20.5 | S-2 / 1.4' | Sand, clay, brown streaked black, medium dense, damp-moist | 21-14-12 |
| 29.0 | 30.5 | ST-1 / 1.17' | Fly Ash, gray, wet | |
| 32.5 | | Vane Shear 1 | 10 lb-ft / 60° 10 lb-ft / 360° | |
| 39.0 | 41.5 | ST-2 / 2.48' | Fly Ash, gray, wet | |
| 42.5 | | Vane Shear 2 | 30 lb-ft / 60° 20 lb-ft / 360° | |
| 50.5' | | Vane Shear 3 | 30 lb-ft / 60° 20 lb-ft / 360° | |
| 59.0 | 61.5 | ST-3 / 2.36' | Fly Ash, clay, grayish black | |
| | | | | |
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**Geo/Environmental Associates, Inc.**

**Project Name/ Job Number:** 09-387

**Boring Log No.:** GA-1D

**Page** 2 **of** 2

| DEPTH (FEET) | | SAMPLE NO., SAMPLE INTERVAL & SPLIT SPOON RECOVERY | SOIL/BEDROCK DESCRIPTION | BLOW COUNTS AND COMMENTS |
|---|---|---|---|---|
| FROM | TO | | | |
| | | | Set Piezometer at approximately 60' bgs | |
| 0 | 0.5 | | Flush Mount Piezometer Cover | |
| 0.5 | 23.0 | | Grout | |
| 23.0 | 25.0 | | Bentonite | |
| 25.0 | 60.0 | | Prepak Screen Backfilled With Sand | |
| 60.0 | 61.5 | | Bentonite mix | |
| | | | | |
| | | | Water Elevation December 17, 2009: 25.2' bgs | |
| | | | Water Elevation January 8, 2010: 25.6' bgs | |
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**Geo/Environmental Associates, Inc.**

**Boring No.** GA-2

**Page** 1 **Of** 2

**PROJECT: AEP Philip Sporn**

**PROJECT NO: 09-387**

Start Date: 12-17-09

Finish Date: 12-18-09

Logged By: Seth Frank

Location: FAP – East Dike section M-M

Ground Elevation: 619.76' NGVD29

Drilling Contractor: Horn and Associates

Driller: Tom Leininger

Helper: Robert, George, Jared

Drill Type: Diedrich D120 Truck Mounted

AEP Contacts: Mark King and Ginger MacKnight

Notes: woven fabric approx 0.5' bgs

NAD27 Coordinates Provided by AEP

N 721075.13 E 1735262.04

Thickness of Soil:

Depth Drilled In Rock:

Total Depth of Boring: 69.0'

| DEPTH (FEET) | | SAMPLE NOS., & SPLIT SPOON RECOVERY | SOIL/BEDROCK DESCRIPTION | BLOW COUNTS AND COMMENTS |
|---|---|---|---|---|
| FROM | TO | | | |
| 4.0 | 4.5 | S-1 / 0.3' | Sand, gravel, brown, very dense, damp | 50 / 0.5' |
| 9.0 | 9.8 | S-2 / 0.5' | Sand, gravel, brown, very dense, damp-moist | 35-50 / 0.3' |
| 14.0 | 14.8 | S-3 / 0.6' | Sand, gravel, clay, brown, very dense, damp-moist | 29-50 / 0.3' |
| 19.0 | 20.5 | S-4 / 1.4' | Sand, brown, dense, damp | 27-22-18 |
| 24.0 | 25.5 | S-5 / 1.5' | Sand, bottom ash, black, dense, damp | 22-18-14 |
| 29.0 | 30.5 | S-6 / 1.5' | Fly Ash, gray, loose, moist-wet | 2-4-5 |
| 34.0 | 35.5 | S-7 / 1.5' | Fly Ash, gray, very loose, wet | 2-1-2 |
| 39.0 | 41.5 | ST-1 / 1.10' | Fly Ash, gray, wet | |
| 44.0 | 45.5 | S-8 / 1.5' | Fly Ash, gray, very loose, wet | 1-0-2 |
| 49.0 | 50.5 | S-9 / 1.5' | Fly Ash, gray, very loose, wet | 1-0-0 |
| 54.0 | 55.5 | S-10 / 1.5' | Fly Ash, gray, very loose, wet | 0-0-0 |
| 59.0 | 61.5 | ST-2 / 2.50' | Fly Ash at top of sample – Transition to Silt, clay, sand, brown, moist | |

**Geo/Environmental Associates, Inc.**

**Project Name/ Job Number:** 09-387

**Boring Log No.:** GA-2

**Page** 2 **of** 2

| DEPTH (FEET) | | SAMPLE NO., SAMPLE INTERVAL & SPLIT SPOON RECOVERY | SOIL/BEDROCK DESCRIPTION | BLOW COUNTS AND COMMENTS |
|---|---|---|---|---|
| FROM | TO | | | |
| 64.0 | 65.5 | S-11 / 1.5’ | Sand, clay, brown, medium dense, moist | 6-9-8 |
| 69.0 | 71.5 | ST-3 / 1.70’ | Sand, clay, brown, some gravel at bottom of tube | |
| | | | | |
| | | | | |
| | | | Backfill hole with grout mix | |
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**Geo/Environmental Associates, Inc.**

Boring No. GA-3

Page 1 Of 2

**PROJECT: AEP Philip Sporn**

**PROJECT NO: 09-387**

Start Date: 12-17-09

Finish Date: 12-17-09

Logged By: Seth Frank

Location: FAP – East Dike section L-L

Ground Elevation: 619.83' NGVD29

Drilling Contractor: Horn and Associates

Driller: Tom Leininger

Helper: Robert, George, Jared

Drill Type: Diedrich D120 Truck Mounted

AEP Contacts: Mark King and Ginger MacKnight

Notes: woven fabric approx 0.5' bgs

NAD27 Coordinates Provided by AEP

N 720258.79 E 1735560.40

Thickness of Soil:

Depth Drilled In Rock:

Total Depth of Boring: 79.0'

| DEPTH (FEET) | | SAMPLE NOS., & SPLIT SPOON RECOVERY | SOIL/BEDROCK DESCRIPTION | BLOW COUNTS AND COMMENTS |
|---|---|---|---|---|
| FROM | TO | | | |
| 4.0 | 4.5 | S-1 / 0.4' | Sand, gravel, dark brown, very dense, damp | 50 / 0.5' |
| 9.0 | 10.5 | S-2 / 1.1' | Sand, gravel, brown, dense, moist | 37-31-17 |
| 14.0 | 15.5 | S-3 / 1.4' | Sand, clay, brown, dense, damp | 23-24-12 |
| 19.0 | 20.5 | S-4 / 1.5' | Clay, sand, silt, brown, very stiff, moist-wet | 14-13-12 2.5 tsf |
| 24.0 | 25.5 | S-5 / 1.5' | Clay, sand, silt, brown, hard, wet | 22-18-14 2.25 tsf |
| 29.0 | 31.5 | ST-1 / 1.51' | Fly Ash, gray | |
| 34.0 | 35.5 | S-6 / 1.5' | Fly Ash, gray, medium dense, wet | 6-7-8 |
| 39.0 | 41.5 | S-7 / 1.5' | Fly Ash, gray, very loose, wet | 3-0-1 |
| 44.0 | 45.5 | S-8 / 1.5' | Fly Ash, gray, loose, wet | 0-2-3 |
| 49.0 | 51.5 | ST-2 / 2.34' | Fly Ash, gray | |
| 54.0 | 55.5 | S-9 / 1.5' | Fly Ash, gray, loose, wet | 5-5-5 |
| 59.0 | 60.5 | S-10 / 1.5' | 0.0-0.1' Ash, clay, gray<br>0.1-1.5' Clay, silty, sandy, brown, very stiff, moist-wet | 7-10-14 |

**Geo/Environmental Associates, Inc.**

**Project Name/ Job Number:** 09-387

**Boring Log No.:** GA-3

**Page** 2 **of** 2

| DEPTH (FEET) | | SAMPLE NO., SAMPLE INTERVAL & SPLIT SPOON RECOVERY | SOIL/BEDROCK DESCRIPTION | BLOW COUNTS AND COMMENTS |
|---|---|---|---|---|
| FROM | TO | | | |
| 64.0 | 65.5 | S-11 / 1.5’ | Clay, silt, sand, brown, very stiff, moist | 8-9-13 |
| 69.0 | 70.5 | S-12 / 1.5’ | Clay, silt, reddish brown, very stiff, moist | 8-9-9 |
| 74.0 | 75.5 | S-13 / 1.5’ | Clay, sand, silt, brown, soft, moist-wet | 0-2-2 |
| 79.0 | 81.5 | ST-3 / 2.27’ | Clay, sand, silt, brown | |
| | | | | |
| | | | | |
| | | | Backfill hole with grout mix | |
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**Geo/Environmental Associates, Inc.**

**Boring No.** GA-4A

**Page** 1 **Of** 2

**PROJECT: AEP Philip Sporn**

**PROJECT NO: 09-387**

Start Date: 12-14-09

Finish Date: 12-15-09

Logged By: Seth Frank

Location: BAP – West Dike section A-A

Ground Elevation: 593.40' NGVD29

Drilling Contractor: Horn and Associates

Driller: Tom Leininger

Helper: Robert, George, Jared

Drill Type: Diedrich D120 Truck Mounted

AEP Contacts: Mark King and Ginger MacKnight

Notes: asphalt surface approx 0.5' thick

NAD27 Coordinates Provided by AEP

N 717984.64 E 1735736.82

Thickness of Soil:

Depth Drilled In Rock:

Total Depth of Boring: 49.0'

| DEPTH (FEET) | | SAMPLE NOS., & SPLIT SPOON RECOVERY | SOIL/BEDROCK DESCRIPTION | BLOW COUNTS AND COMMENTS |
|---|---|---|---|---|
| FROM | TO | | | |
| 2.0 | 2.3 | S-1 / 0.3' | Sand, gravel, brown, very dense, damp | 50 / 0.3' |
| 4.0 | 5.5 | S-2 / 0.9' | Sand, gravel, clay, brown, medium dense, damp | 13-12-13 |
| 6.5 | 8.0 | S-3 / 1.5' | 0-1.0' Sand, gravel, brown / 1.0-1.5 Bottom Ash, grey-black, dense, damp | 33-22-17 |
| 9.0 | 10.5 | S-4 / 1.4' | 0-1.1' Sand, gravel, bottom ash, brown-black / 1.1-1.4' Sand, clay, dense, damp | 25-30-20 |
| 11.5 | 11.9 | S-5 / 0.4' | Bottom Ash, clay, black, very dense, damp | 50 / 0.4' |
| 14.0 | 15.5 | S-6 / 1.5' | 0.5 Sand, gravel, brown, medium dense, damp<br>0.5 Bottom Ash, clayey, grayish black, medium dense, moist<br>0.5 Sand, clay, brown, medium dense, wet | 19-14-14<br>W/L ≈ 15' bgs |
| 16.5 | 18.0 | S-7 / 1.4' | Sand, clay, gravel, dark brown, medium dense, wet | 15-14-8 |
| 19.0 | 20.5 | S-8 / 1.5' | Sand, clay, dark brown, medium dense, wet | 18-15-14 |
| 20.5 | 22.0 | S-9 / 1.3' | Sand, bottom ash, gravel, brown-black, medium dense, moist | 13-11-10 |
| 22.0 | 23.5 | S-10 / 1.5' | Sand, brown, medium dense, wet | 5-11-12 |
| 23.5 | 25.0 | S-11 / 1.5' | Sand, clay, brown-black, loose, wet | 3-2-3 |

**Geo/Environmental Associates, Inc.**

**Project Name/ Job Number:** 09-387

**Boring Log No.:** GA-4A

**Page** 2 **of** 2

| DEPTH (FEET) | | SAMPLE NO., SAMPLE INTERVAL & SPLIT SPOON RECOVERY | SOIL/BEDROCK DESCRIPTION | BLOW COUNTS AND COMMENTS |
|---|---|---|---|---|
| FROM | TO | | | |
| 26.5 | 28.0 | S-13 / 1.5' | Fly Ash, bottom ash mix at top, black transition to grey, very loose, wet (approximate start of fly ash) | 4-2-2 |
| 28.0 | 30.5 | ST-1 / 2.55' | Fly Ash, gray, wet | |
| 30.5 | 32.0 | S-14 / 1.5' | Fly Ash, gray, very loose, wet | 1-1-2 |
| 32.0 | 34.5 | ST-2 / 2.24' | Fly Ash, gray, wet | |
| 34.5 | 36.0 | S-15 / 1.5' | 0.5' Fly Ash, gray, medium dense, wet (approximate end of fly ash)<br>0.5' Fly Ash, clay, gray, medium dense, wet<br>0.5' Clay, sand, brown, very stiff, moist-wet | 9-11-9 |
| 36.0 | 38.0 | ST-3 / 1.52' | Clay, red-brown, moist | |
| 44.0 | 45.5 | S-16 / 1.5' | Clay, sand, red-brown, very stiff, moist | 20-12-10 1.75 tsf |
| 49.0 | 50.5 | S-17 / 1.5' | Clay, sand, brown-gray, stiff, wet | 0-3-7 0.75 tsf |
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| | | | Set Inclinometer at ≈ 49' bgs. Back fill with grout mix: approx 1 unit pcc, 1 unit bentonite, 6.25 units water by weight. | |
| | | | | |

**Geo/Environmental Associates, Inc.**

**Boring No.** GA-4B

**Page** 1 **Of** 1

**PROJECT: AEP Philip Sporn**

**PROJECT NO: 09-387**

Start Date: 12-15-09

Finish Date: 12-15-09

Logged By: Seth Frank

Location: BAP West Dike section A-A

Ground Elevation: 593.37' NGVD29

Drilling Contractor: Horn and Associates

Driller: Tom Leininger

Helper: Robert, George, Jared

Drill Type: Diedrich D120 Truck Mounted

AEP Contacts: Mark King and Ginger MacKnight

Notes: asphalt surface approx 0.5' thick

NAD27 Coordinates Provided by AEP

N 717992.94 E 1735731.64

Thickness of Soil:

Depth Drilled In Rock:

Total Depth of Boring: 49.0'

| DEPTH (FEET) | | SAMPLE NOS., & SPLIT SPOON RECOVERY | SOIL/BEDROCK DESCRIPTION | BLOW COUNTS AND COMMENTS |
|---|---|---|---|---|
| FROM | TO | | | |
| 9.0 | 10.5 | S-1 / 0.4' | Sand, gravel, brown, dense, damp | 30-25-18 |
| 19.0 | 20.5 | S-2 / 0.5' | Sand, clay, brown – mottled black, medium dense, damp | 12-12-14 |
| 29.0 | 31.5 | ST-1 / 2.38' | Fly Ash, gray, wet | |
| 32.5 | | Vain Shear | 30 lb-ft / 60° 10 lb-ft / 360° | |
| 39.0 | 40.5 | S-3 / 1.5' | Clay, silty, sandy, grayish brown streaked red, very stiff, moist-wet | 4-8-9 1.25 tsf |
| 49.0 | 50.5 | S-4 / 1.5' | Sand, clay, silt, grayish brown, soft, wet | 1-1-1 |
| | | | | |
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| | | | | |
| | | | Set Inclinometer at ≈ 49' bgs. Back fill with grout mix: approx 1 unit pcc, 1 unit bentonite, 6.25 units water by weight. | |

**Geo/Environmental Associates, Inc.**

**Boring No.** GA-4C

**Page** 1 **Of** 1

**PROJECT: AEP Philip Sporn**

**PROJECT NO: 09-387**

Start Date: 12-15-09

Finish Date: 12-15-09

Logged By: Seth Frank

Location: BAP West Dike section A-A

Ground Elevation: 593.34' NGVD29

Drilling Contractor: Horn and Associates

Driller: Tom Leininger

Helper: Robert, George, Jared

Drill Type: Diedrich D120 Truck Mounted

AEP Contacts: Mark King and Ginger MacKnight

Notes: asphalt surface approx 0.5' thick

NAD27 Coordinates Provided by AEP

N 718001.45 E 1735726.53

Thickness of Soil:

Depth Drilled In Rock:

Total Depth of Boring: 49.0'

| DEPTH (FEET) | | SAMPLE NOS., & SPLIT SPOON RECOVERY | SOIL/BEDROCK DESCRIPTION | BLOW COUNTS AND COMMENTS |
|---|---|---|---|---|
| FROM | TO | | | |
| 9.0 | 10.5 | S-1 / 1.4' | Sand, bottom ash, clay, brownish black, dense, damp | 28-19-19 |
| 19.0 | 20.5 | S-2 / 1.5' | Bottom Ash, black, medium dense, moist-wet | 5-5-10 |
| 30.0 | | Vain Shear | 40 lb-ft / 60° 20 lb-ft / 360° | |
| 32.5 | | Vain Shear | 30 lb-ft / 60° 10 lb-ft / 360° | |
| 49.0 | 50.5 | S-3 / 1.5' | Clay, sand, reddish gray, stiff, wet | 6-6-4 0.5 tsf |
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| | | | | |
| | | | Set Inclinometer at ≈ 49' bgs. Back fill with grout mix: approx 1 unit pcc, 1 unit bentonite, 6.25 units water by weight. | |

# Geo/Environmental Associates, Inc.

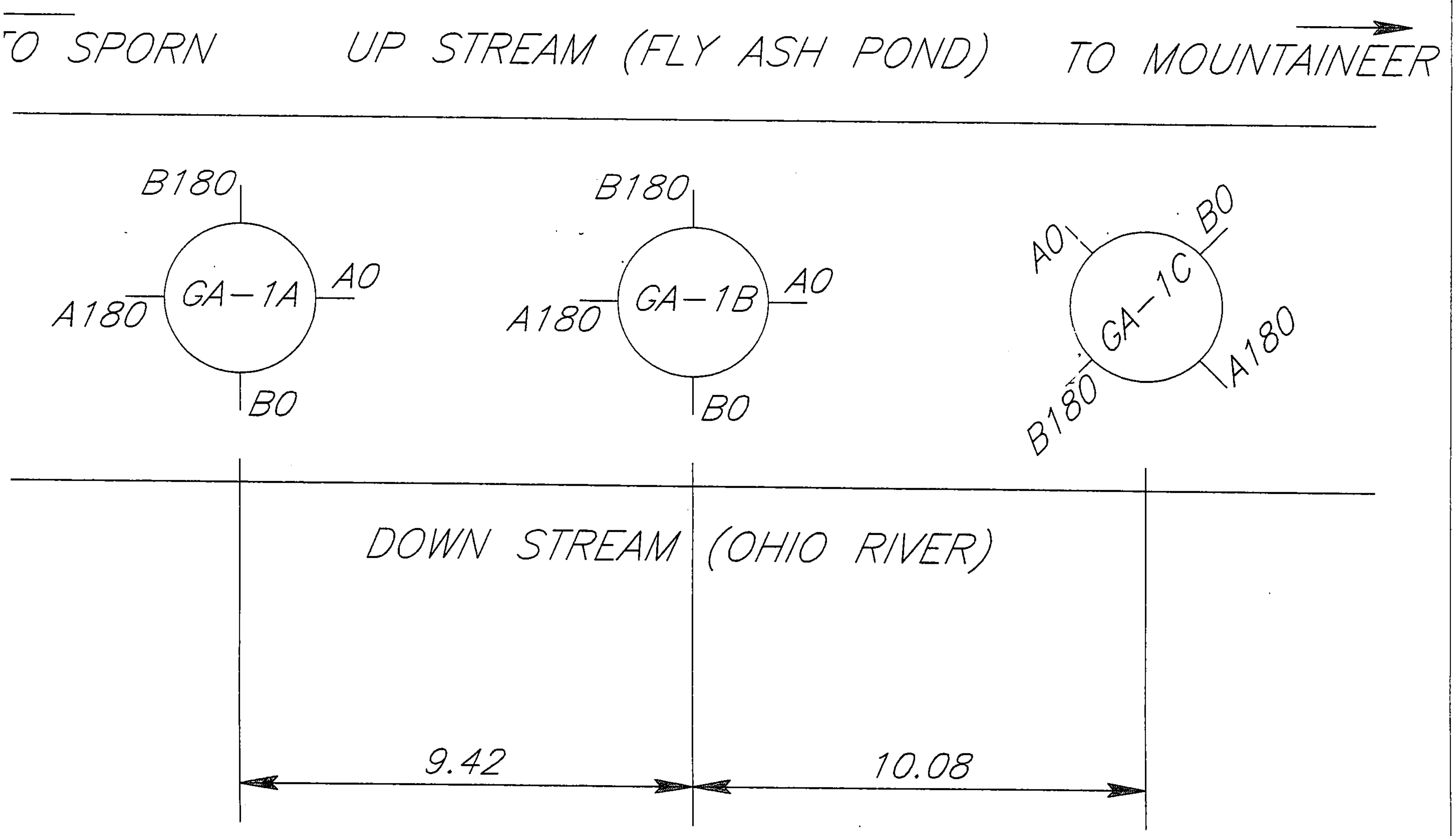
## GA-1A, 1B, & 1C Inclinometer Survey

**Project:** Fly Ash Pond East Dike Cross Borehole Seismic
**GA Job No.:** 09-387
**Title:** Down Hole Inclinometer Survey
**Performed By:** SWF
**Location:** N 38.97292 W 081.92823
**Date:** January 6-7, 2010

| | GA-1A | ←Distance (ft)→ | GA-1B | ←Distance (ft)→ | *GA-1C | | |
|---|---|---|---|---|---|---|---|
| **Depth (feet)** | A-Axis Cumulative Deviation (inches) | Based on Top of Pipe Distance = 9.42' | A-Axis Cumulative Deviation (inches) | Based on Top of Pipe Distance = 10.08' | A-Axis Cumulative Deviation (inches) | B-Axis Cumulative Deviation (inches) | Combined A&B Axis Deviation (inches) |
| **2.5** | -0.91 | 9.51 | 0.22 | 10.02 | 0.27 | -0.48 | -0.53 |
| **4.5** | -1.81 | 9.60 | 0.38 | 9.96 | 0.57 | -0.98 | -1.10 |
| **6.5** | -2.59 | 9.67 | 0.42 | 9.91 | 0.88 | -1.44 | -1.64 |
| **8.5** | -3.19 | 9.71 | 0.29 | 9.87 | 1.22 | -1.88 | -2.19 |
| **10.5** | -3.57 | 9.71 | -0.14 | 9.87 | 1.50 | -2.27 | -2.66 |
| **12.5** | -3.95 | 9.69 | -0.71 | 9.88 | 1.80 | -2.64 | -3.14 |
| **14.5** | -4.40 | 9.68 | -1.27 | 9.88 | 2.12 | -2.99 | -3.62 |
| **16.5** | -4.92 | 9.68 | -1.83 | 9.89 | 2.45 | -3.34 | -4.09 |
| **18.5** | -5.49 | 9.68 | -2.40 | 9.90 | 2.82 | -3.67 | -4.59 |
| **20.5** | -6.03 | 9.67 | -3.08 | 9.91 | 3.20 | -3.98 | -5.08 |
| **22.5** | -6.58 | 9.65 | -3.79 | 9.93 | 3.62 | -4.30 | -5.60 |
| **24.5** | -7.17 | 9.64 | -4.57 | 9.96 | 3.96 | -4.61 | -6.06 |
| **26.5** | -7.75 | 9.62 | -5.34 | 9.99 | 4.25 | -4.91 | -6.47 |
| **28.5** | -8.14 | 9.59 | -6.04 | 10.01 | 4.59 | -5.14 | -6.89 |
| **30.5** | -8.41 | 9.55 | -6.87 | 10.05 | 4.89 | -5.40 | -7.27 |
| **32.5** | -8.74 | 9.51 | -7.70 | 10.07 | 5.22 | -5.76 | -7.77 |
| **34.5** | -9.22 | 9.48 | -8.45 | 10.09 | 5.56 | -6.20 | -8.31 |
| **36.5** | -9.82 | 9.48 | -9.11 | 10.10 | 5.83 | -6.65 | -8.83 |
| **38.5** | -10.46 | 9.48 | -9.78 | 10.12 | 6.09 | -7.10 | -9.33 |
| **40.5** | -10.91 | 9.45 | -10.55 | 10.14 | 6.33 | -7.50 | -9.78 |
| **42.5** | -11.35 | 9.42 | -11.29 | 10.17 | 6.67 | -7.85 | -10.27 |
| **44.5** | -11.93 | 9.42 | -11.99 | 10.18 | 7.15 | -8.16 | -10.82 |
| **46.5** | -12.64 | 9.43 | -12.57 | 10.18 | 7.71 | -8.45 | -11.43 |
| **48.5** | -13.35 | 9.43 | -13.18 | 10.17 | 8.31 | -8.77 | -12.07 |
| **50.5** | -13.91 | 9.42 | -13.95 | 10.19 | 8.81 | -9.12 | -12.67 |
| **52.5** | -14.41 | 9.42 | -14.37 | 10.17 | 9.28 | -9.52 | -13.30 |
| **54.5** | -14.94 | 9.44 | -14.67 | 10.14 | 9.72 | -9.97 | -13.93 |
| **56.5** | -15.55 | 9.45 | -15.17 | 10.14 | 10.09 | -10.42 | -14.50 |
| **58.5** | -16.20 | 9.48 | -15.50 | 10.12 | 10.39 | -10.80 | -14.98 |
| **60.5** | -16.82 | 9.51 | -15.72 | 10.12 | 10.46 | -11.08 | -15.23 |
| **62.5** | -17.42 | 9.54 | -15.96 | 10.11 | 10.63 | -11.37 | -15.56 |
| **64.5** | -17.98 | 9.57 | -16.23 | 10.09 | 11.05 | -11.76 | -16.12 |
| **66.5** | -18.46 | 9.58 | -16.53 | 10.05 | 11.62 | -12.25 | -16.87 |
| **68.5** | | | | | 12.19 | -12.78 | -17.66 |
| **70.5** | | | | | 12.57 | -13.31 | -18.30 |
| **72.5** | | | | | 12.98 | -13.82 | -18.95 |
| **74.5** | | | | | 13.46 | -14.34 | -19.66 |
| **76.5** | | | | | 14.01 | -14.89 | -20.43 |

# PHILIP SPORN FLY ASH POND EAST DIKE
# BOREHOLES: GA–1A, 1B, AND 1C
# APPROXIMATE TOP OF PIPE ORIENTATION

(NOT TO SCALE)



# Geo/Environmental Associates, Inc.

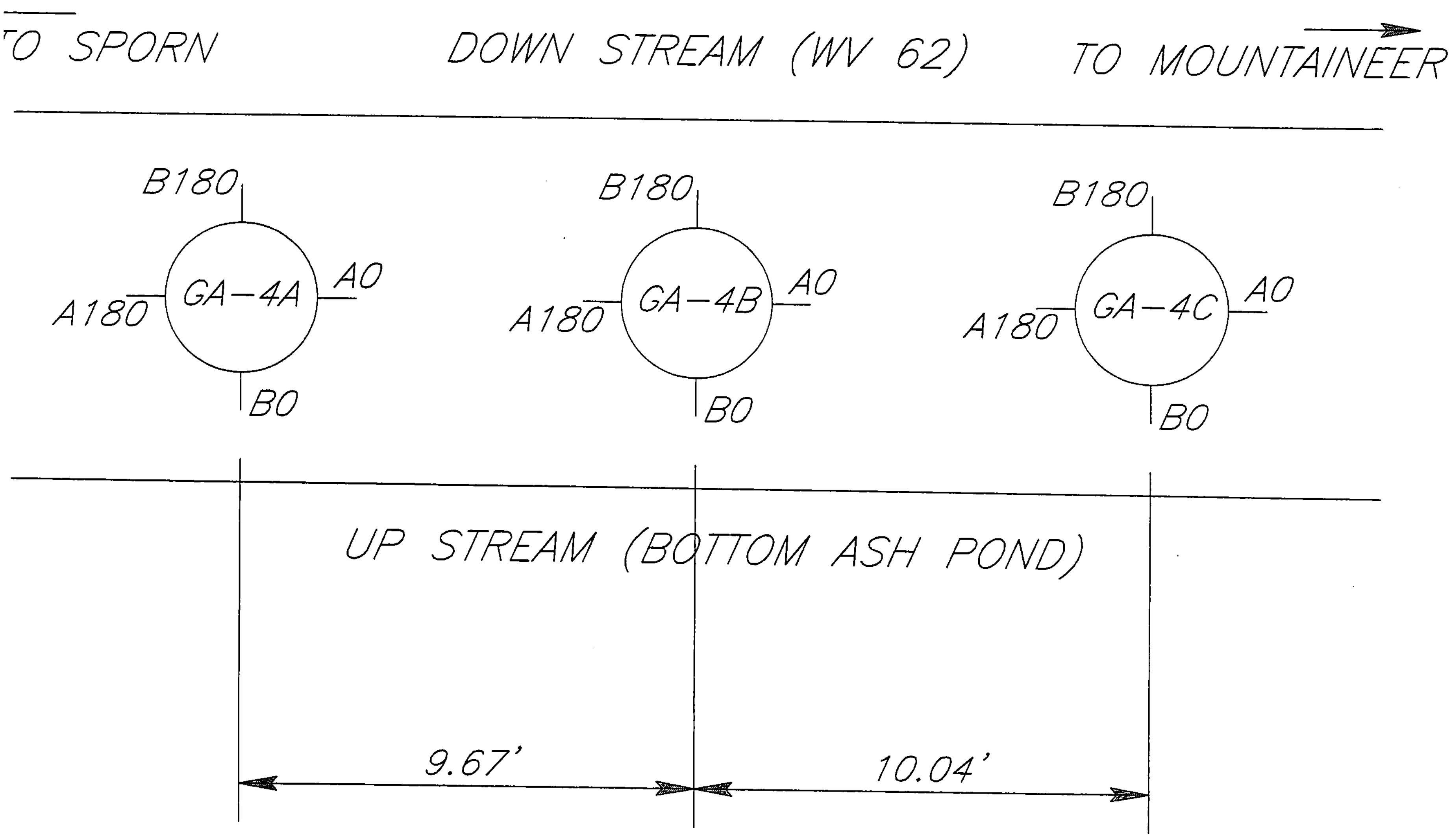
## GA-4A, 4B, & 4C Inclinometer Survey

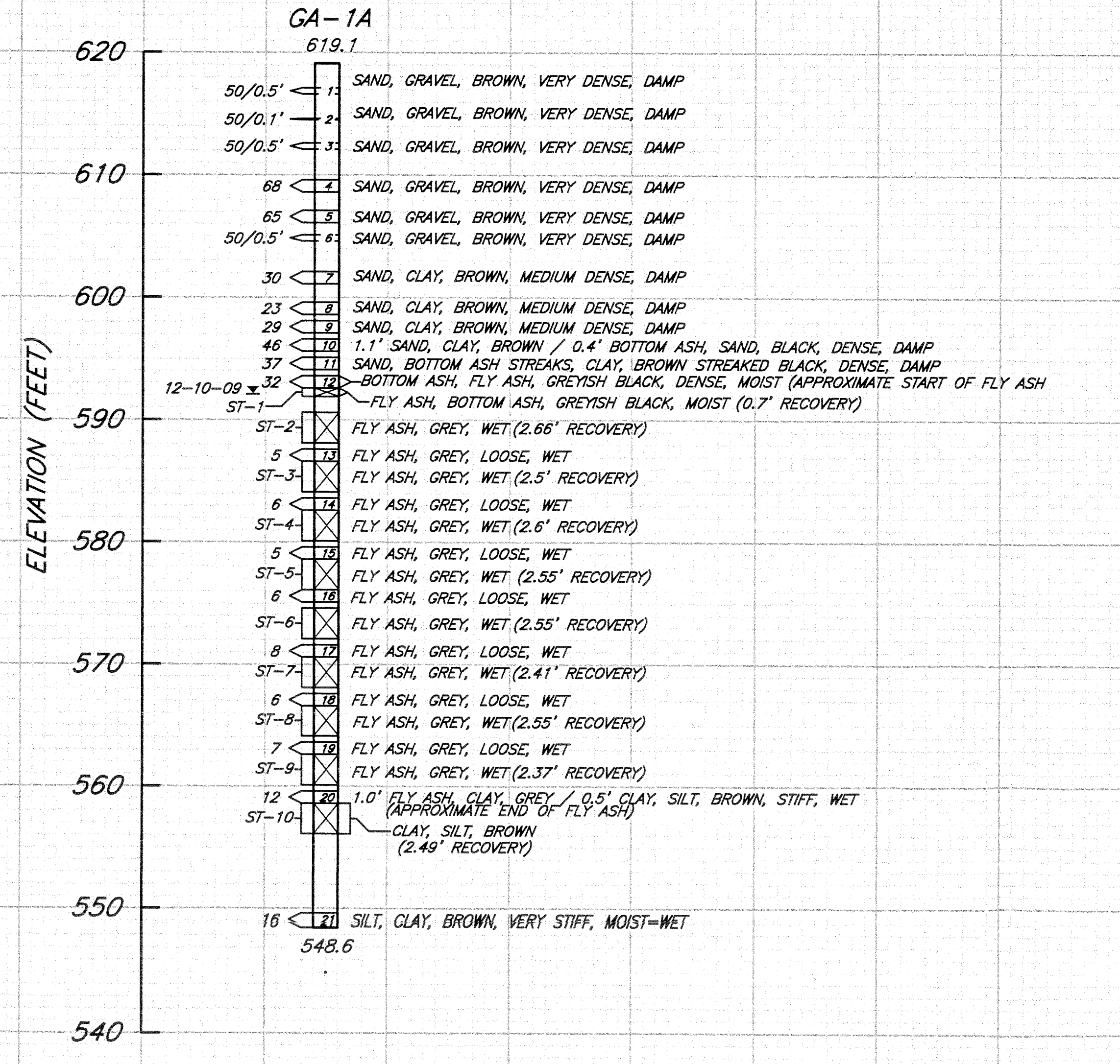
| | |
|---|---|
| **Project:** | Bottom Ash Pond West Dike Cross Borehole Seismic |
| **GA Job No.:** | 09-387 |
| **Title:** | Down Hole Inclinometer Survey |
| **Performed By:** | SWF |
| **Location:** | N 38.96816 W 081.92926 |
| **Date:** | January 6-7, 2010 |

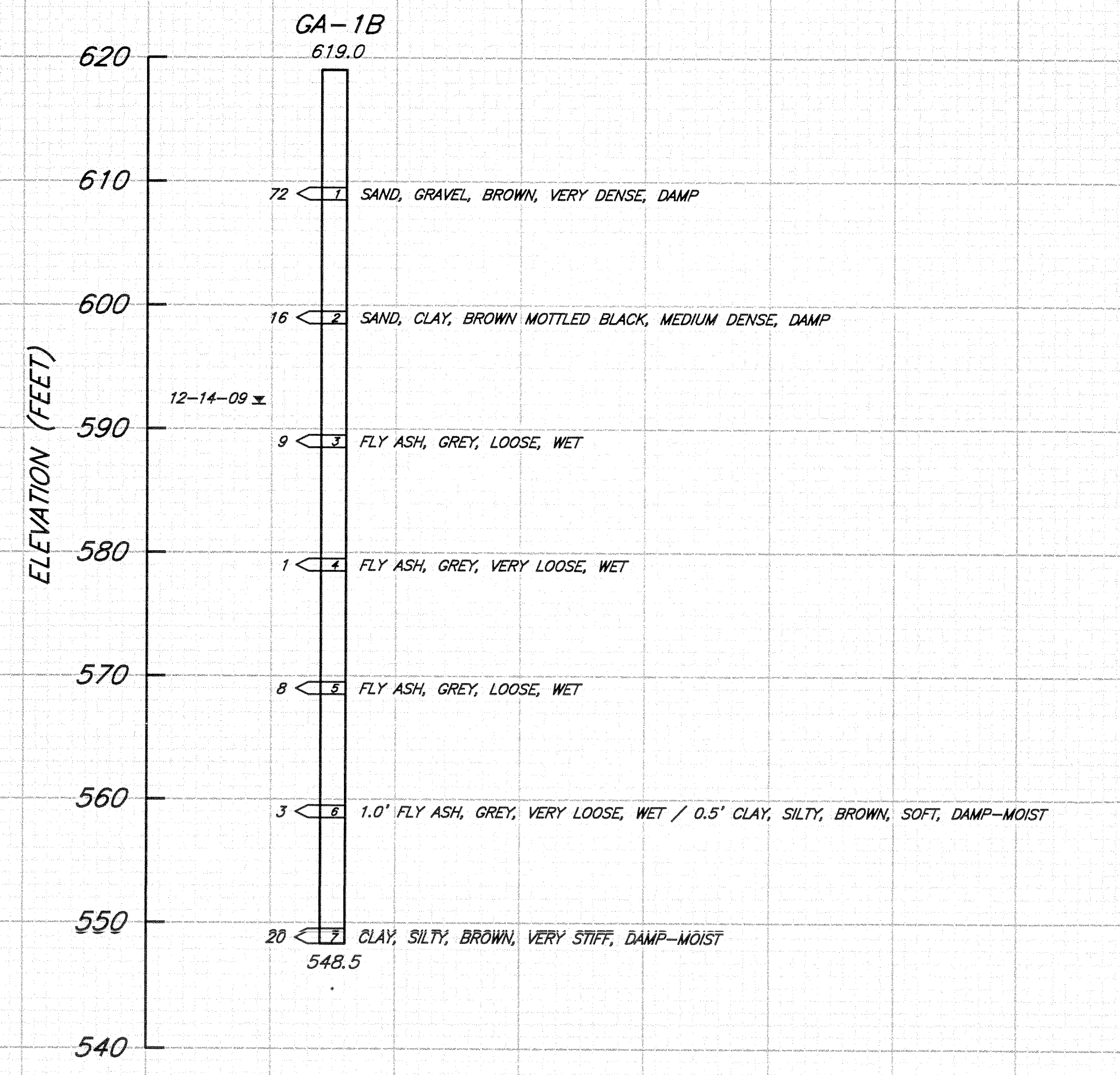
| **GA-4A** | | ←Distance (ft)→ | **GA-4B** | | ←Distance (ft)→ | **GA-4C** | |
|---|---|---|---|---|---|---|---|
| **Depth (feet)** | A-Axis Cumulative Deviation (inches) | Based on Top of Pipe Distance = 9.67' | **Depth (feet)** | A-Axis Cumulative Deviation (inches) | Based on Top of Pipe Distance = 10.04' | **Depth (feet)** | A-Axis Cumulative Deviation (inches) |
| **2.5** | -0.11 | 9.67 | **4** | -0.13 | 10.03 | **4** | -0.24 |
| **4.5** | -0.17 | 9.66 | **6** | -0.26 | 10.02 | **6** | -0.45 |
| **6.5** | -0.21 | 9.66 | **8** | -0.35 | 10.02 | **8** | -0.64 |
| **8.5** | -0.21 | 9.65 | **10** | -0.46 | 10.01 | **10** | -0.76 |
| **10.5** | -0.15 | 9.62 | **12** | -0.73 | 10.03 | **12** | -0.85 |
| **12.5** | -0.12 | 9.59 | **14** | -1.06 | 10.05 | **14** | -0.90 |
| **14.5** | -0.16 | 9.57 | **16** | -1.34 | 10.07 | **16** | -0.97 |
| **16.5** | -0.18 | 9.54 | **18** | -1.70 | 10.10 | **18** | -0.98 |
| **18.5** | -0.16 | 9.51 | **20** | -2.11 | 10.17 | **20** | -0.58 |
| **20.5** | -0.14 | 9.47 | **22** | -2.50 | 10.25 | **22** | -0.03 |
| **22.5** | -0.05 | 9.45 | **24** | -2.73 | 10.29 | **24** | 0.22 |
| **24.5** | 0.06 | 9.42 | **26** | -2.89 | 10.32 | **26** | 0.43 |
| **26.5** | 0.06 | 9.41 | **28** | -3.09 | 10.35 | **28** | 0.57 |
| **28.5** | 0.12 | 9.38 | **30** | -3.34 | 10.37 | **30** | 0.63 |
| **30.5** | 0.41 | 9.32 | **32** | -3.78 | 10.42 | **32** | 0.75 |
| **32.5** | 0.84 | 9.25 | **34** | -4.19 | 10.47 | **34** | 0.97 |
| **34.5** | 1.18 | 9.20 | **36** | -4.50 | 10.52 | **36** | 1.27 |
| **36.5** | 1.55 | 9.15 | **38** | -4.70 | 10.56 | **38** | 1.57 |
| **38.5** | 1.98 | 9.11 | **40** | -4.79 | 10.59 | **40** | 1.78 |
| **40.5** | 2.42 | 9.06 | **42** | -4.89 | 10.60 | **42** | 1.82 |
| **42.5** | 2.85 | 9.02 | **44** | -4.99 | 10.61 | **44** | 1.86 |
| **44.5** | 3.29 | 8.98 | **46** | -4.96 | 10.62 | **46** | 1.99 |
| **46.5** | 3.82 | 8.96 | **48** | -4.65 | 10.62 | **48** | 2.27 |

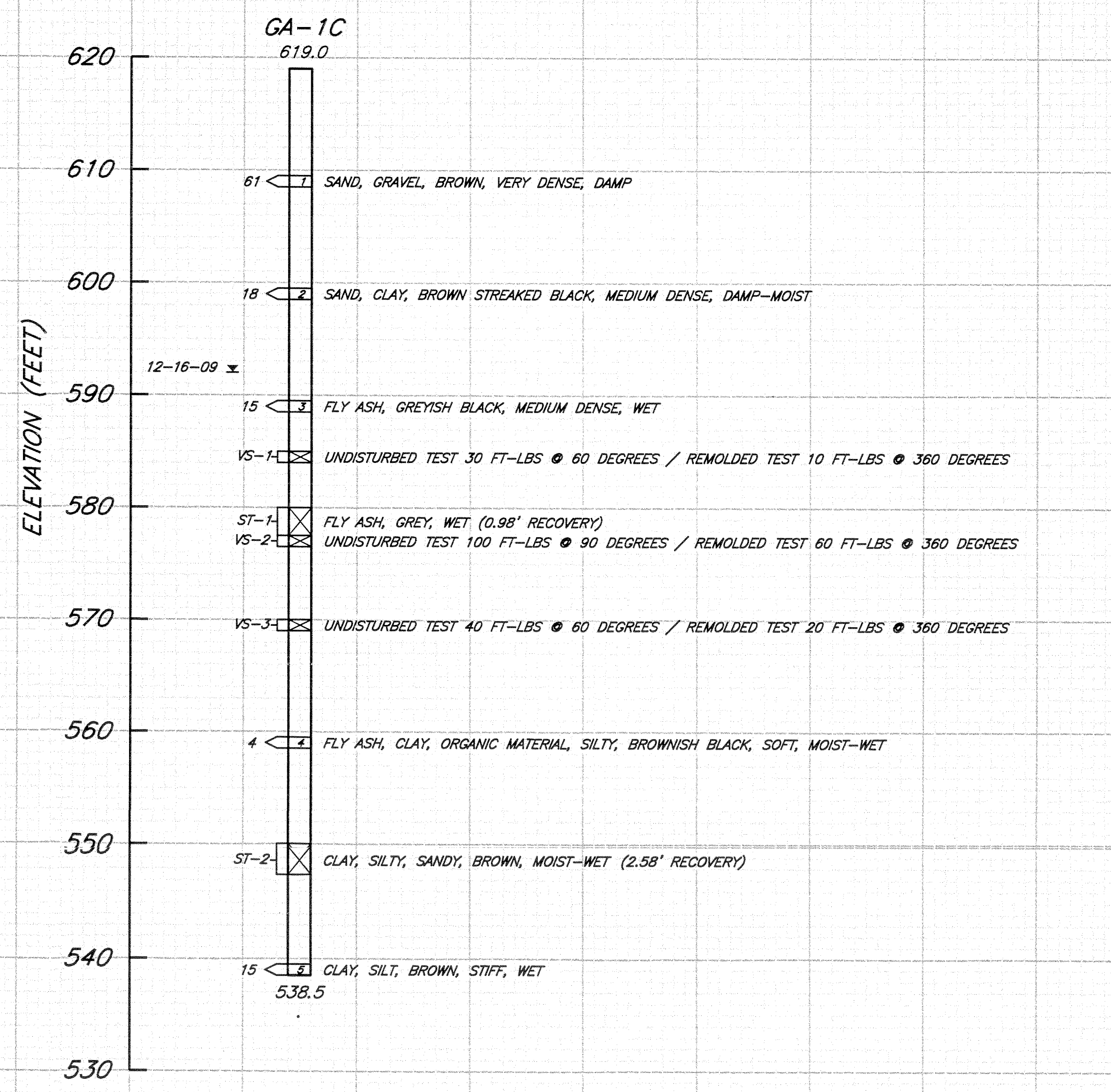
## PHILIP SPORN BOTTOM ASH POND WEST DIKE
## BOREHOLES: GA-4A, 4B, AND 4C
## APPROXIMATE TOP OF PIPE ORIENTATION

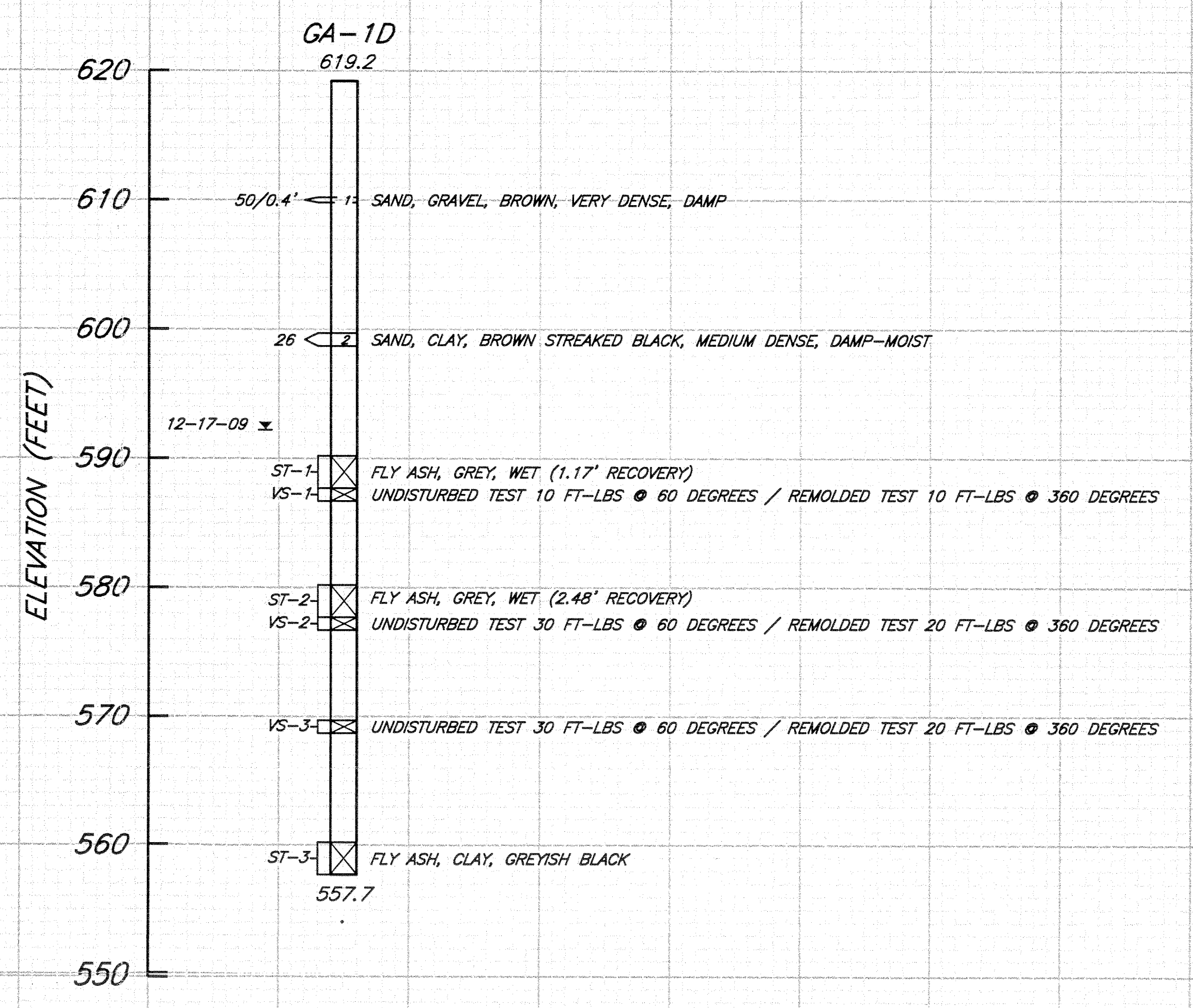
(NOT TO SCALE)

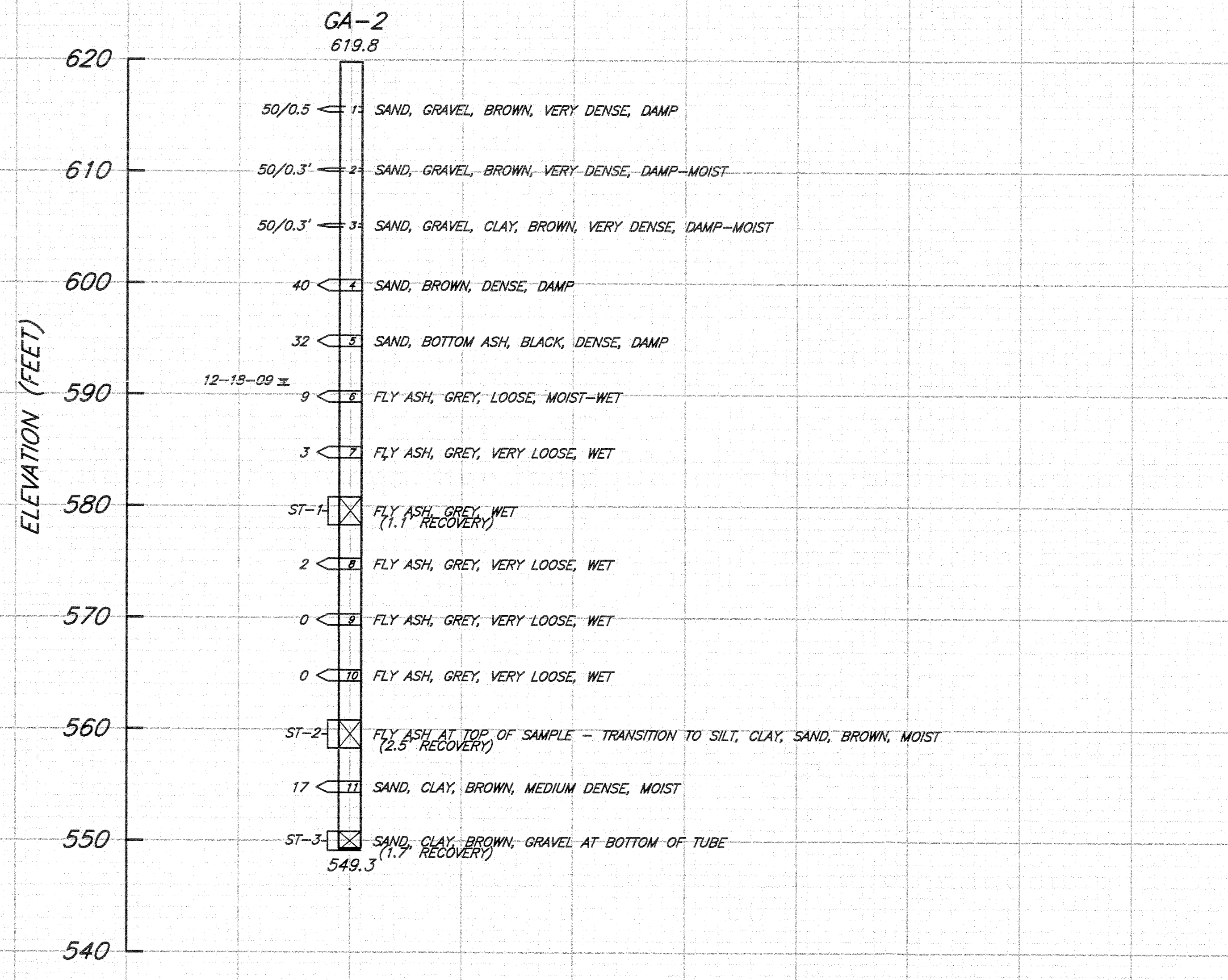


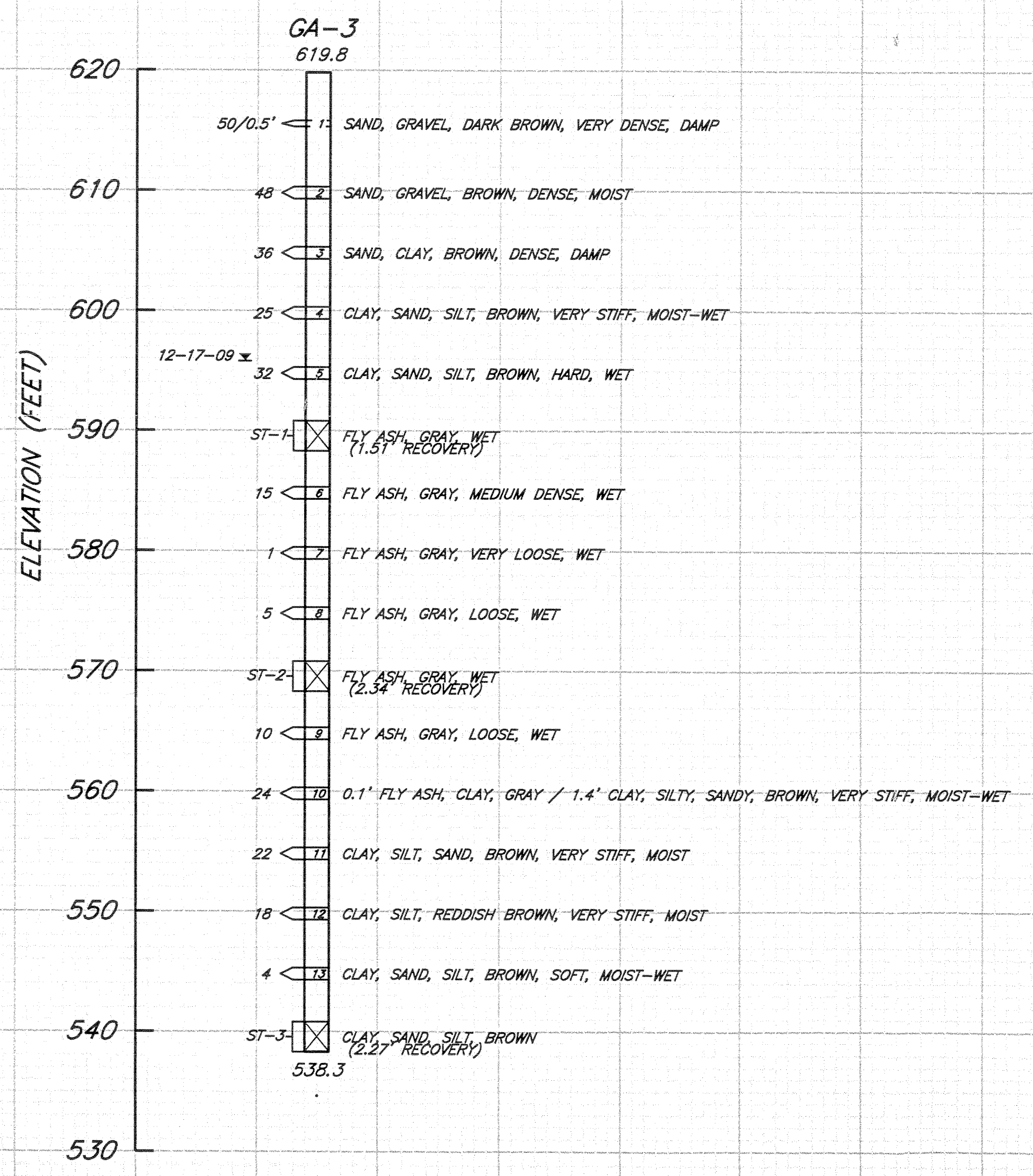












## LEGEND

**SAMPLED HOLE**

1 —— HOLE NUMBER

100.0 —— SURFACE ELEVATION

5 1 DRIVE-SAMPLE #1 WITH "N" VALUE (AS PER A.S.T.M. D1586) UNLESS OTHERWISE NOTED

1-1-93 WATER FIRST ENCOUNTERED DURING DRILLING

1-1-93 WATER LEVEL AT COMPLETION OF DRILLING

1-1-93 WATER LEVEL ON DATE SHOWN

APPROX CHANGE IN TYPE OF MATERIAL

ST-1 UNDISTURBED SAMPLE#1

75.0 —— BOTTOM ELEVATION OF HOLE

REF REFUSAL OF AUGERS OR SAMPLE TUBE

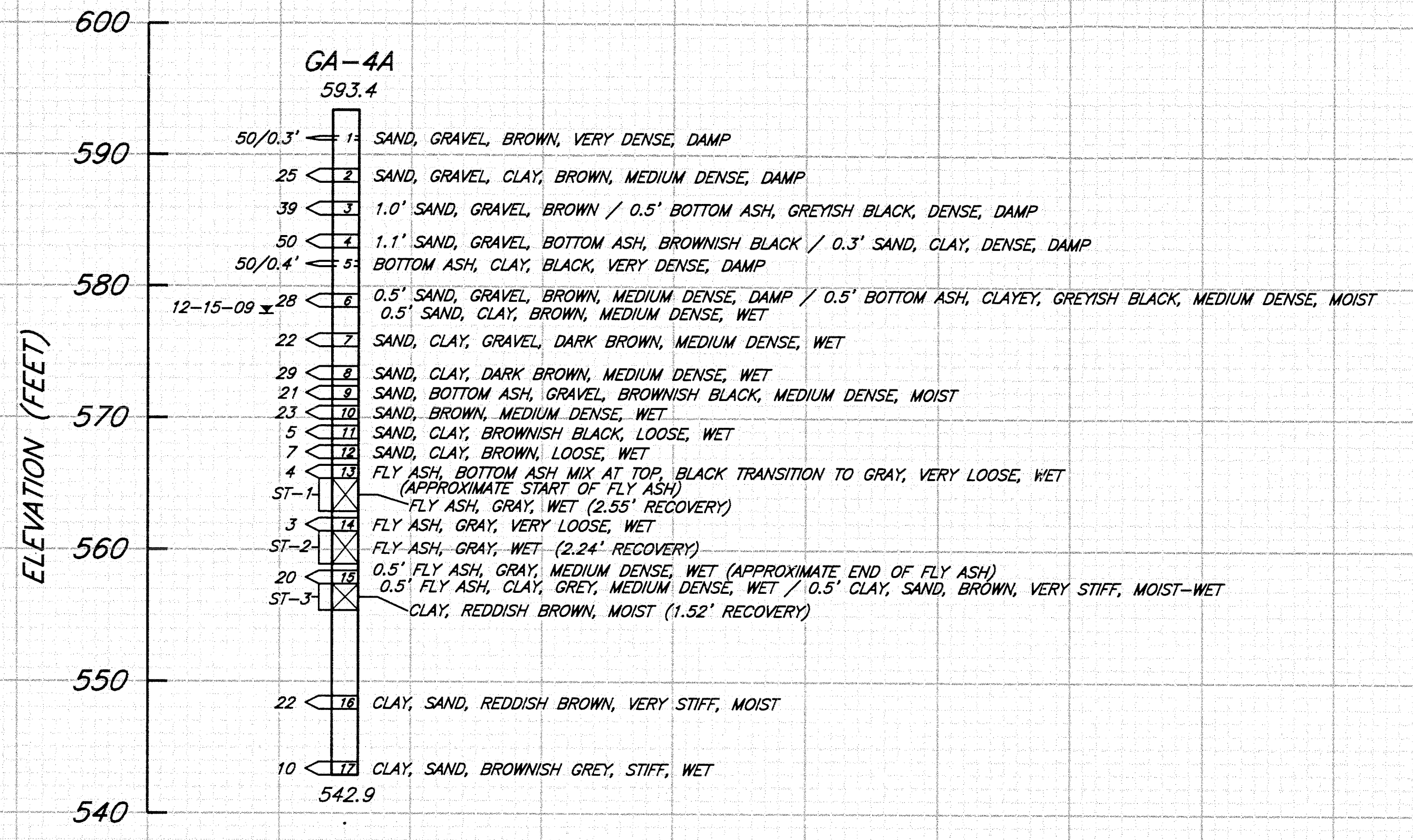
NO REF– NO REFUSAL OF AUGERS OR SAMPLE TUBE

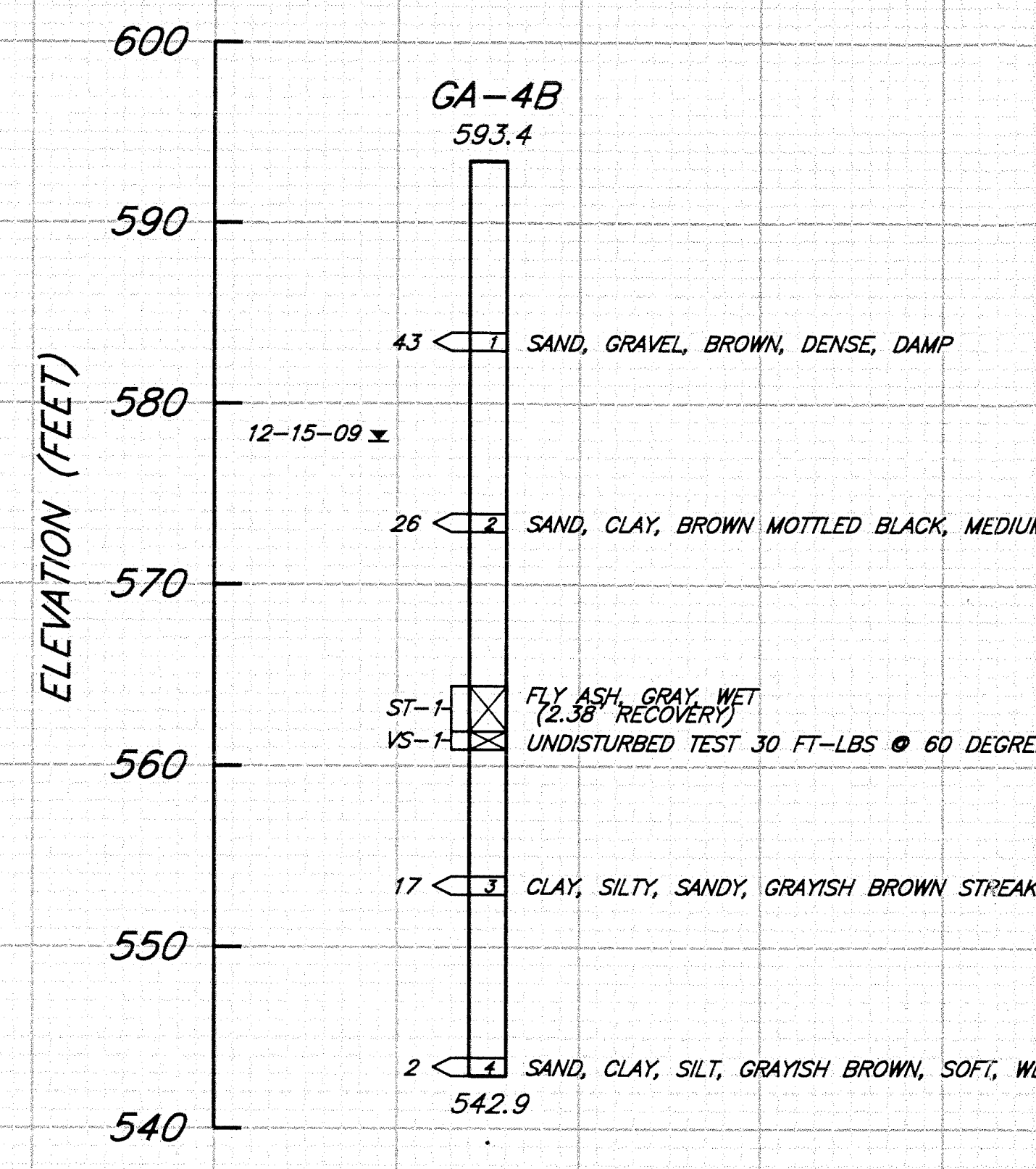
DRY – DRY UPON COMPLETION

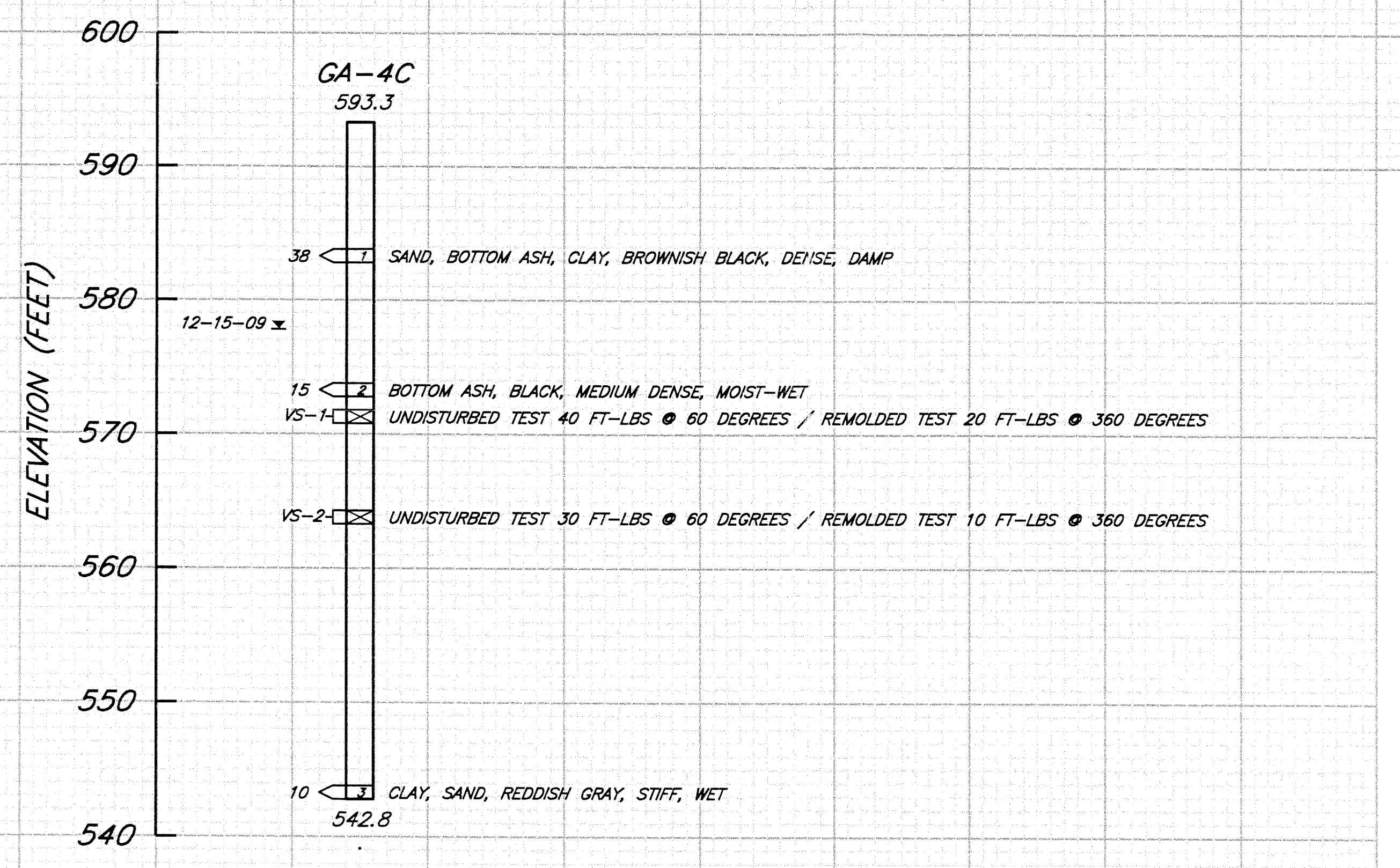
NOTE: THE SYMBOL i INDICATES INITIAL WATER LEVEL MEASUREMENT.

## ABBREVIATIONS

| | |
|---|---|
| ABUND | –ABUNDANT |
| APPROX | –APPROXIMATE |
| ARG | –ARGILLACEOUS |
| ASPH | –ASPHALT |
| AX | –CORE DRILL SIZE |
| BD/S | –BAND/S |
| BL | –BLUE |
| BLDR/S | –BOULDER/S |
| BLK | –BLACK |
| BLSH | –BLUISH |
| BP/S | –BEDDING PLANE/S |
| BR | –BROWN |
| BRECC | –BRECCIATED |
| BRK/S | –BRICK/S |
| BRNSH | –BROWNISH |
| BX/BQ | –CORE DRILL SIZE |
| C | –COARSE |
| CALC | –CALCAREOUS |
| CAV/Y | –CAVITY/CAVITIES |
| CBLS | –COBBLES |
| CEM | –CEMENT/CEMENTED |
| CHT/Y | –CHERT/CHERTY |
| CL/Y | –CLAY/CLAYEY |
| CNDS | –CINDERS |
| CONC | –CONCRETE |
| CS | –CRUSHED STONE |
| CSG | –CASING |
| D | –DENSE/DENSELY |
| DEB | –DEBRIS |
| DEC | –DECOMPOSED |
| DF/S | –DIAGONAL FRACTURE/S |
| DISPL | –DISPLACEMENT |
| DK | –DARK |
| DLLG | –DRILLING |
| DO | –DITTO |
| DOL | –DOLOMITE |
| DWR | –DRILL WATER RETAINED |
| ELEV | –ELEVATION |
| EST | –ESTIMATED |
| F | –FINE/FINELY |
| FE | –FERROUS |
| FM | –FORMATION |
| FOSS | –FOSSILIFEROUS |
| FRAC/S | –FRACTURE/S |
| FRAG/S | –FRAGMENT/S |
| GD | –GROUND |
| GPM | –GALLONS PER MINUTE |
| GR | –GRAY |
| GRN | –GREEN |
| GRND | –GRAINED |
| GRNSH | –GREENISH |
| GRSH | –GRAYISH |
| GVL/Y | –GRAVEL/LY |
| GYP | –GYPSUM |
| HD | –HARD |
| HYCB | –HONEYCOMBED |
| i | –INITIAL WATER LEVEL DURING DRILLING |
| JTD | –JOINTED |
| KSF | –KIPS PER SQUARE FOOT |
| LAM | –LAMINATED |
| LDW | –LOST DRILL WATER |
| LEA | –LEACHED |
| LG | –LARGE |
| LGT | –LIGHT |
| LL | –LIQUID LIMIT |
| LS | –LIMESTONE |
| LSE | –LOOSE |
| LTL | –LITTLE |
| LYS | –LAYERS |
| LZ | –LENSES |
| M | –MEDIUM |
| MATL | –MATERIAL |
| MAX | –MAXIMUM |
| MIC | –MICACEOUS |
| MIN | –MINIMUM |
| MINL | –MINERAL |
| MOD | –MODERATELY |
| MOTT | –MOTTLED |
| NX | –CORE DRILL SIZE |
| NODS | –NODULES |
| NUM | –NUMEROUS |
| OCC | –OCCASIONAL/OCCASIONALLY |
| ORG | –ORGANIC |
| OSBP/S | –OPEN,STAINED BEDDING PLANE/S |
| OSDF/S | –OPEN,STAINED DIAGONAL FRACTURE/S |
| OSLBP/S | –OPEN,STAINED,LEACHED BEDDING PLANE/S |
| OSLVF/S | –OPEN,STAINED,LEACHED VERTICAL FRACTURE/S |
| OSVF/S | –OPEN,STAINED VERTICAL FRACTURE/S |
| OVB | –OVERBURDEN |
| PF | –PARTLY FILLED |
| PHOS | –PHOSPHATIC |
| PI | –PLASTICITY INDEX |
| POSS | –POSSIBLE/POSSIBLY |
| PL | –PLASTIC LIMIT |
| PP | –POCKET PENETROMETER (TSF) |
| PROB | –PROBABLE/PROBABLY |
| PROJ | –PROJECTED |
| PTG | –PARTING |
| PTLY | –PARTLY |
| PTTD | –PITTED |
| PZ | –PIEZOMETER |
| RDSH | –REDDISH |
| RECY | –RECOVERY |
| REF | –REFUSAL |
| RK | –ROCK |
| RTN | –ROTTEN |
| RTS | –ROOTS |
| SAT | –SATURATED |
| SCATT | –SCATTERED |
| SD/Y | –SAND/Y |
| SVRLY | –SEVERELY |
| SEV | –SEVERAL |
| SH/Y | –SHALE/Y |
| SL | –SLIGHTLY |
| SLSD | –SLICKENSIDED |
| SLST | –SILTSTONE |
| SM | –SOME |
| SML | –SMALL |
| SOFN | –SOFTENED |
| SOLN | –SOLUTION |
| SPLE | –SAMPLE |
| SS | –SANDSTONE |
| ST | –STAINED |
| STA | –STATION |
| STKS | –STREAKS |
| STRAT | –STRATIFIED |
| SURF | –SURFACE |
| T | –TAN |
| TOR | –TOP OF ROCK |
| TR/S | –TRACE/TRACES |
| TSF | –TONS PER SQUARE FOOT |
| USC | –UNIFIED SOIL CLASSIFICATION |
| V | –VERY |
| VAR | –VARIABLE/VARIABLY |
| VEG | –VEGETATION |
| VF/S | –VERTICAL FRACTURE/S |
| W | –% NATURAL MOISTURE CONTENT |
| w/ | –WITH |
| WB | –WASHBOARD |
| WD | –WOOD |
| WEA | –WEATHERED |
| WHT | –WHITE |
| WT | –WEIGHT |
| WTR | –WATER |
| XCPT | –EXCEPT |
| XLN | –CRYSTALLINE |
| YEL | –YELLOW |
| YELSH | –YELLOWISH |
| ZN/S | –ZONE/S |
| $\gamma\delta$ | –DRY UNIT WEIGHT IN PCF |
| qu | –UNCONFINED COMPRESSIVE STRENGTH IN KSF |







ROGER W. CECIL
14367

Roger W Cecil 5/27/10

THESE DRAWINGS ARE PART OF A SET OF DESIGN DOCUMENTS WHICH ALSO CONTAINS A WRITTEN TEXT. THAT TEXT EXPLAINS SOME OF THE DETAILS SHOWN HEREIN AND THEREFORE THESE DRAWINGS SHOULD ONLY BE USED IN CONJUNCTION WITH THE TEXT.

| DATE | REVISIONS | BY |
|---|---|---|
| | | |
| | | |
| | | |

# BOREHOLE LOGS

FLY ASH & BOTTOM ASH
DISPOSAL FACILITIES
PHILIP SPORN PLANT
NEW HAVEN, WEST VIRGINIA

SCALE: AS SHOWN | DR JAG | CHK SWF | REV RWC

PREPARED FOR:

AEP SERVICE CORPORATION

PREPARED BY:
GA Geo/Environmental Associates, Inc.
3502 OVERLOOK CIRCLE • KNOXVILLE, TENNESSEE 37909 • (865) 584-0344

PROJ: 09-387 | DATE: 5-27-10 | SHEET 1 OF 1

# LABORATORY DATA FROM:
# *"PHILIP SPORN ELECTRIC GENERATING PLANT BOTTOM ASH FACILITY – ENGINEERING REPORT"*

PREPARED/COMPILED BY:
GEOTECH/HYDRO/SITE SECTION OF
AMERICAN ELECTRIC POWER CORPORATION

DATED: 1996

# SUMMARY OF MATERIAL PROPERTIES

PROJECT: SPORN PLANT - FLY ASH POND DIKES
NUMBER:

| Borehole or Excav No. | Depth ft. | ASTM Description | ASTM Classif-ication | Soil Type | Maximum Dry Density pcf | Optimum Moisture % | Liquid Limit % | Plastic Limit % | Gravel % | Sand % | <#200 Sieve % | <.002 mm % | Specific Gravity | Prmblty cm/sec | Natural Moisture % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 96-01 | 0 0 | SILT | ML | | | | NP | NP | 0.0 | 10.6 | 89.4 | 18.4 | | | 13.1 |
| 96-01 | 5.0 | | | | | | | | | | | | | | 5.1 |
| 96-01 | 8.5 | SILTY SAND | SM | | | | NP | NP | 13.5 | 54.1 | 32.4 | 2.9 | | | |
| 96-01 | 16.7 | SILTY SAND | SM | | | | NP | NP | 11.0 | 57.3 | 31.7 | 1 6 | | | |
| 96-01 | 21.7 | | | | | | | | | | | | | | 46.4 |
| 96-01 | 26.7 | SILT with SAND | ML | | | | NP | NP | 0.1 | 15.7 | 84.2 | 0.8 | | | |
| 96-01 | 36.7 | | | | | | 26.1 | 18.1 | | | | | | | 24.7 |
| 96-01 | 51.7 | | | | | | 24.8 | 18.2 | | | | | | | 25.2 |
| 96-02 | 0.0 | | | | | | 41.2 | 24.5 | | | | | | | 30.5 |
| 96-02 | 5 0 | | | | | | 31.1 | 19.1 | | | | | | | 15.5 |
| 96-02 | 16.9 | | | | | | | | | | | | | | 6 6 |
| 96-02 | 31.9 | | | | | | | | | | | | | | 49.7 |
| 96-02 | 51.9 | | | | | | 39.5 | 22.4 | | | | | | | 28.8 |
| 96-03 | 26.7 | | | | | | 34.4 | 20.6 | | | | | | | 29.3 |
| 96-04 | 5.0 | SILTY SAND with | SM | | | | NP | NP | 31.9 | 49.6 | 18.5 | 5.1 | | | |
| 96-04 | 5.0 | GRAVEL | | | | | | | | | | | | | |
| 96-04 | 11.6 | SILTY SAND | SM | | | | NP | NP | 4.1 | 58.1 | 37.8 | 4.8 | | | 12.0 |
| 96-04 | 16.6 | SILTY SAND with | SM | | | | NP | NP | 24.9 | 45.7 | 29.4 | 5.9 | | | |
| 96-04 | 16.6 | GRAVEL | | | | | | | | | | | | | |
| 96-04 | 26.6 | | | | | | | | | | | | | | 63.4 |
| 96-04 | 31.6 | SILTY SAND | SM | | | | NP | NP | 6.9 | 47.3 | 45.8 | 1.8 | | | |
| 96-04 | 41.6 | | | | | | 28.1 | 18 4 | | | | | | | 22.1 |
| 96-04 | 51.6 | | | | | | 25.7 | 17.2 | | | | | | | 24.5 |
| 96-05 | 0.0 | | | | | | 28.5 | 20.1 | | | | | | | 18.5 |
| 96-05 | 5.0 | | | | | | NP | NP | | | | | | | 11.6 |
| 96-05 | 21.7 | | | | | | 27.2 | 17.1 | | | | | | | 15.3 |
| 96-05 | 26.7 | | | | | | NP | NP | | | | | | | 70.6 |
| 96-05 | 31.7 | | | | | | | | | | | | | | 38.4 |
| 96-05 | 36.7 | | | | | | NP | NP | | | | | | | 52.5 |
| 96-05 | 41.7 | | | | | | | | | | | | | | 40.9 |
| 96-05 | 56.7 | | | | | | 33.8 | 20.5 | | | | | | | 28.0 |
| 96-06 | 11.5 | | | | | | 34.9 | 19.7 | | | | | | | 25.0 |

AEP Civil Engineering Laboratory, Groveport, Ohio.

August 29, 1996 page 1 of 2

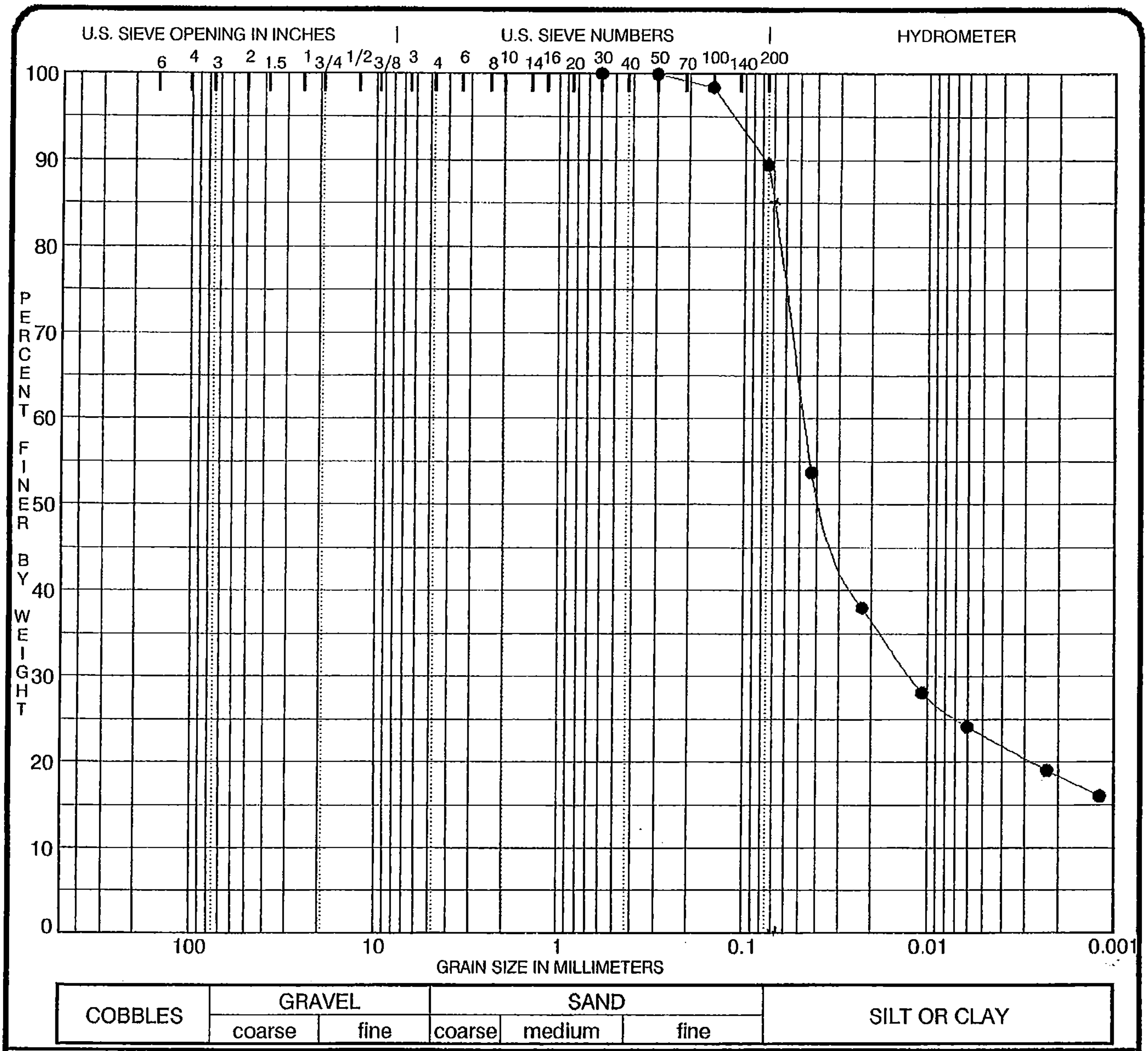
SUMMARY OF MATERIAL PROPERTIES

PROJECT: SPORN PLANT - FLY ASH POND DIKES
NUMBER:

| Borehole or Excav No. | Depth ft. | ASTM Description | ASTM Classif-ication | Soil Type | Maximum Dry Density pcf | Optimum Moisture % | Liquid Limit % | Plastic Limit % | Gravel % | Sand % | <#200 Sieve % | <.002 mm % | Specific Gravity | Prmblty cm/sec | Natural Moisture % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 96-06 | 31.5 | | | | | | 33.0 | 21.8 | | | | | | | 29.9 |

AEP Civil Engineering Laboratory, Groveport, Ohio

August 29, 1996 page 2 of 2



| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-01 | 0.0 | | 13.1 | NP | NP | NP | | |
| | | | SILT | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-01 | 0.0 | 0.600 | 0.047 | 0.012 | | 0.0 | 10.6 | 89.4 | 18.4 |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.

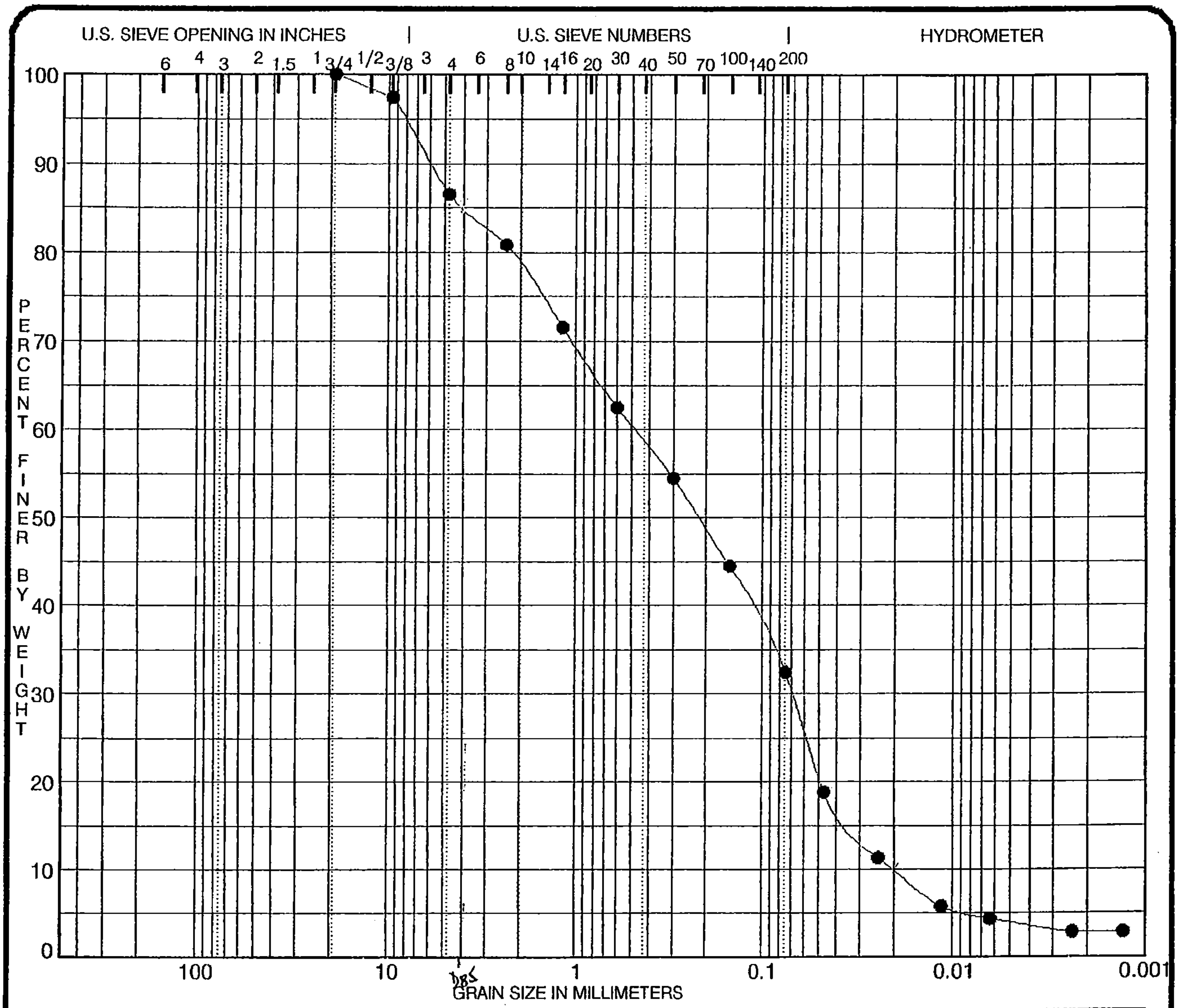
DATE **08/29/96**

# GRADATION CURVES

**American Electric Power Service Corp.**

Civil Engineering Laboratory

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-01 | 8.5 | | | NP | NP | NP | | |
| | | | SILTY SAND | | | | | | |

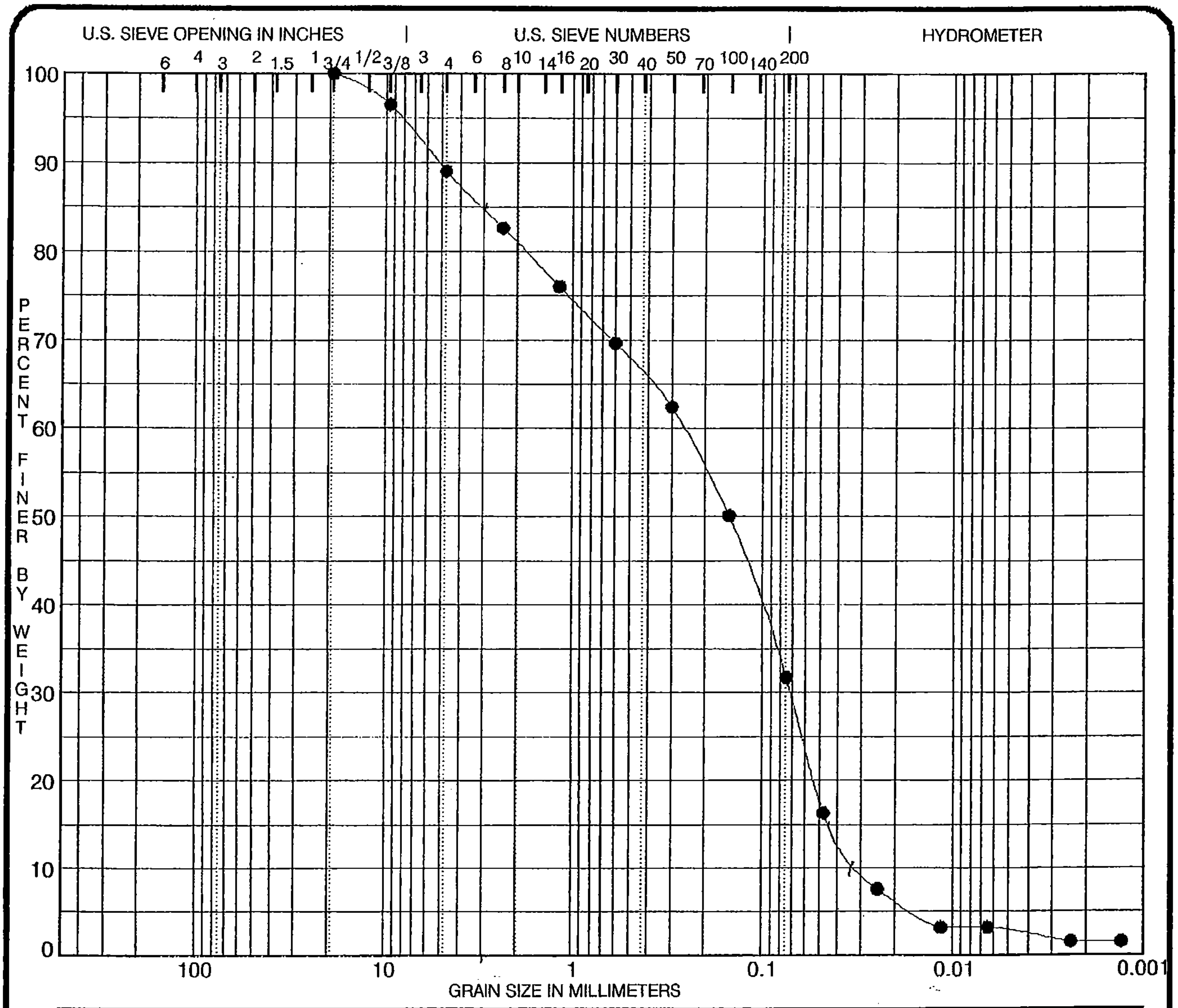
| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-01 | 8.5 | 19.000 | 0.483 | 0.069 | 0.020 | 13.5 | 54.1 | 32.4 | 2.9 |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.
DATE **08/29/96**

# GRADATION CURVES

**American Electric Power Service Corp.**
Civil Engineering Laboratory



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-01 | 16.7 | | | NP | NP | NP | | |
| | | | SILTY SAND | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-01 | 16.7 | 19.000 | 0.262 | 0.071 | 0.030 | 11.0 | 57.3 | 31.7 | 1.6 |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.

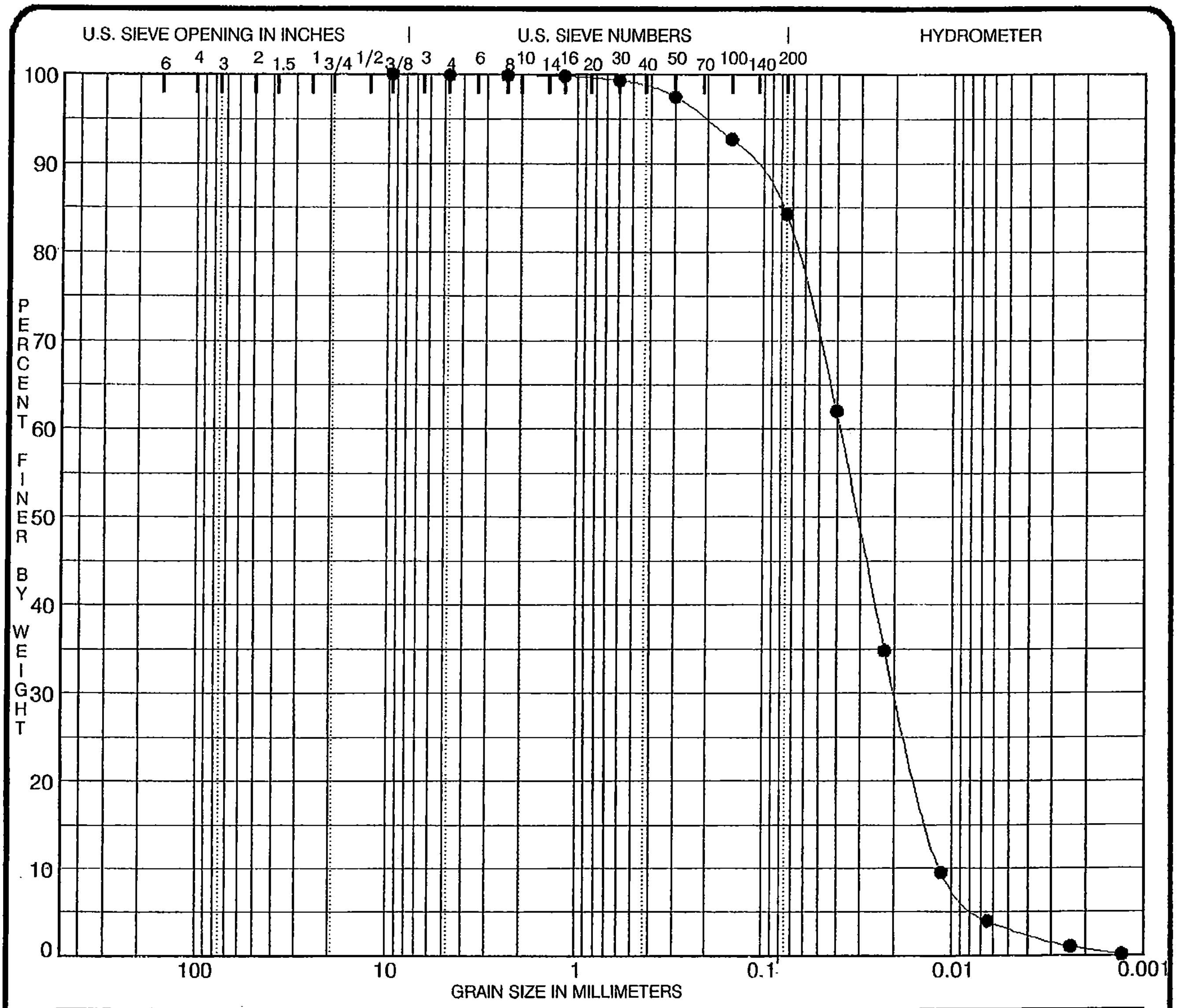
DATE **08/29/96**

# GRADATION CURVES

**American Electric Power Service Corp.**

Civil Engineering Laboratory

AEP



<table>
<tr><td rowspan="2">COBBLES</td><td colspan="2">GRAVEL</td><td colspan="3">SAND</td><td rowspan="2">SILT OR CLAY</td></tr>
<tr><td>coarse</td><td>fine</td><td>coarse</td><td>medium</td><td>fine</td></tr>
</table>

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | **96-01** | **26.7** | | | **NP** | **NP** | **NP** | | |
| | | | **SILT with SAND** | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | **96-01** | **26.7** | **9.500** | **0.039** | **0.020** | **0.012** | **0.1** | **15.7** | **84.2** | **0.8** |

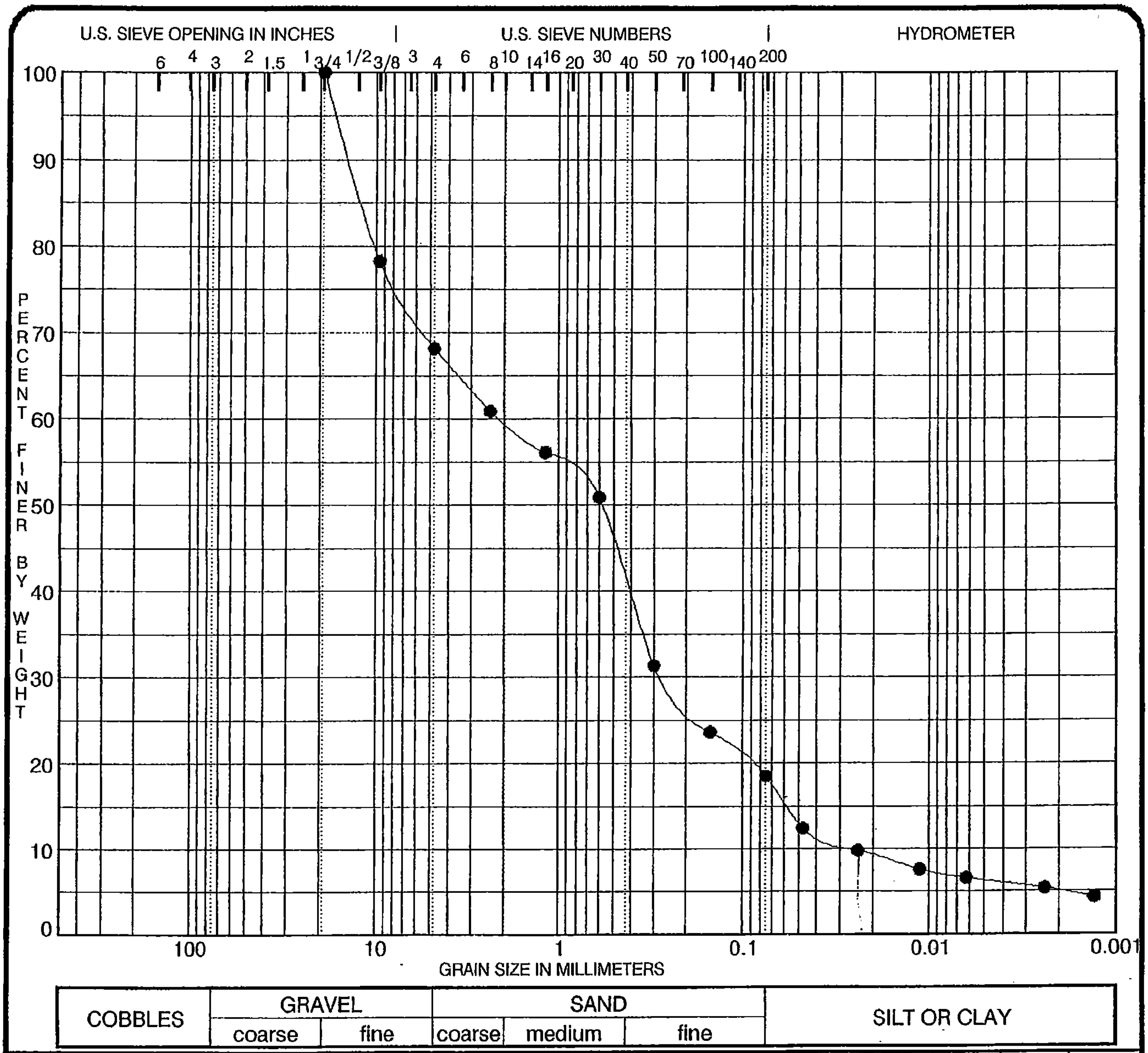
PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.
DATE **08/29/96**

## GRADATION CURVES

**American Electric Power Service Corp.**
Civil Engineering Laboratory

AEP



| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | **96-04** | **5.0** | | | **NP** | **NP** | **NP** | | |
| | | | **SILTY SAND with GRAVEL** | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | **96-04** | **5.0** | **19.000** | **2.072** | **0.267** | **0.025** | **31.9** | **49.6** | **18.5** | **5.1** |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

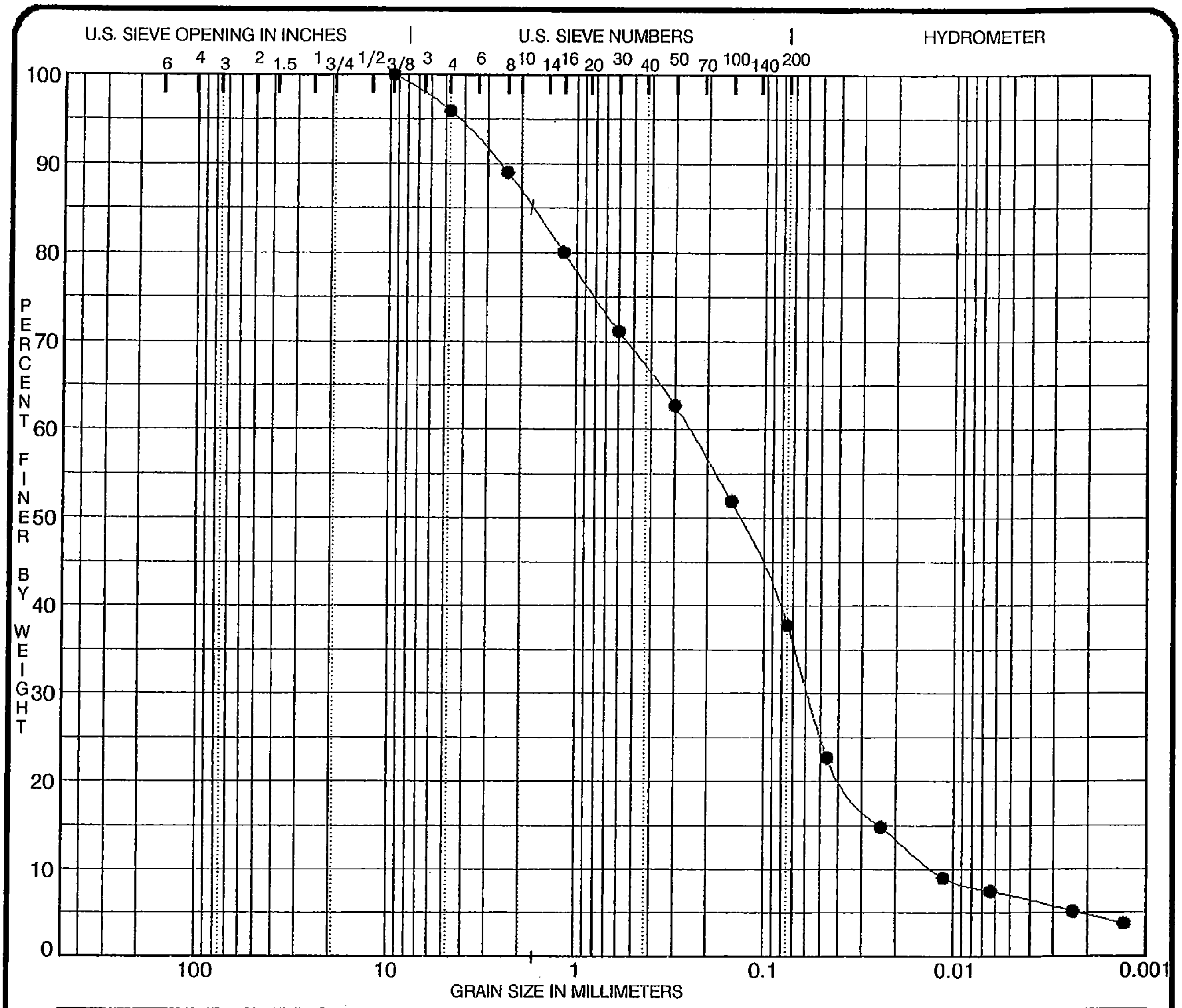
JOB NO.

DATE **08/29/96**

# GRADATION CURVES

**American Electric Power Service Corp.**

Civil Engineering Laboratory



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-04 | 11.6 | | 12.0 | NP | NP | NP | |
| | | | SILTY SAND | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-04 | 11.6 | 9.500 | 0.252 | 0.059 | 0.013 | 4.1 | 58.1 | 37.8 | 4.8 |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

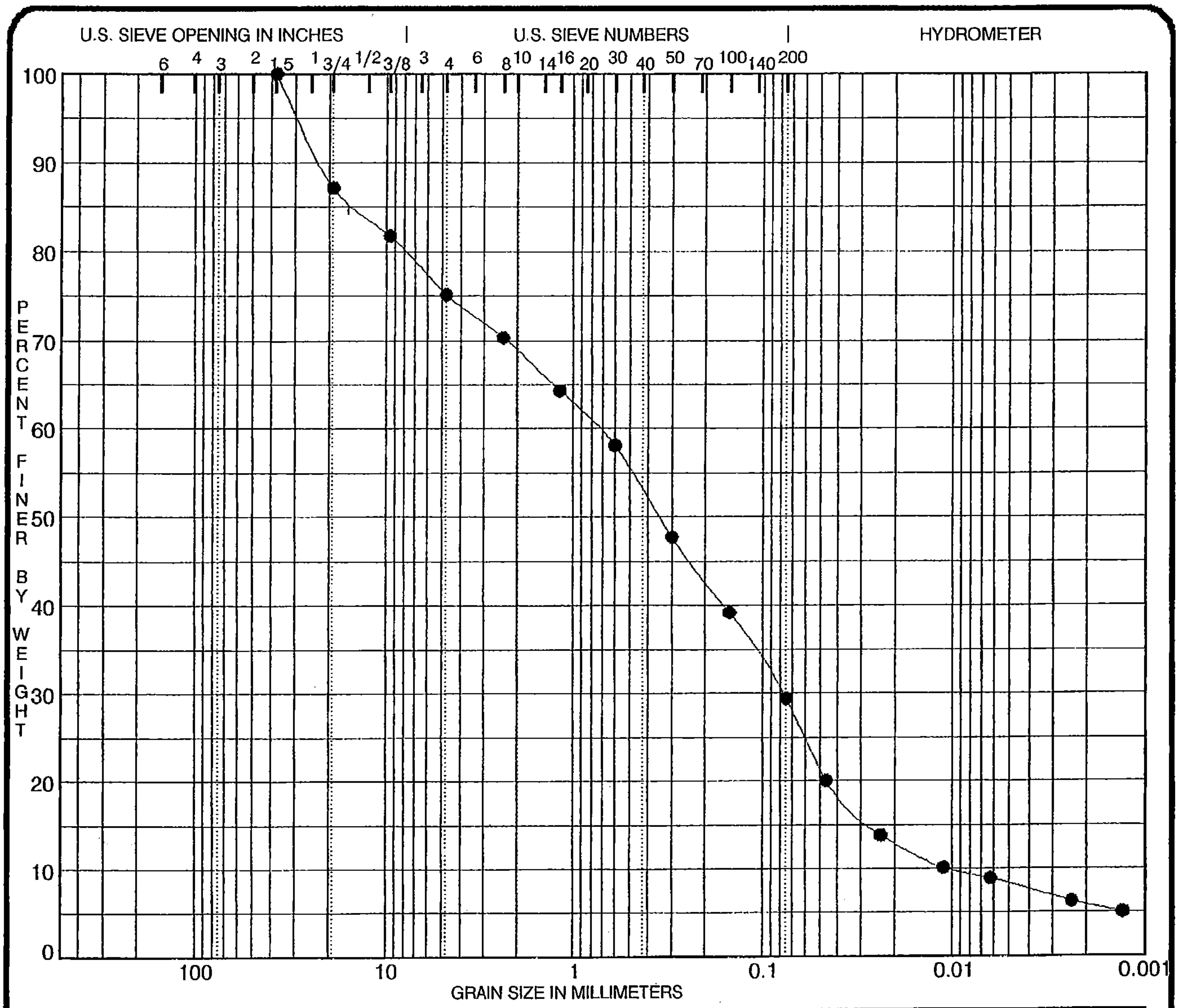
JOB NO.

DATE **08/29/96**

# GRADATION CURVES

**American Electric Power Service Corp.**

Civil Engineering Laboratory



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|
| ● 96-04 16.6 | | | NP | NP | NP | | |
| | SILTY SAND with GRAVEL | | | | | | |

| Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|
| ● 96-04 16.6 | 37.500 | 0.738 | 0.078 | 0.011 | 24.9 | 45.7 | 29.4 | 5.9 |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

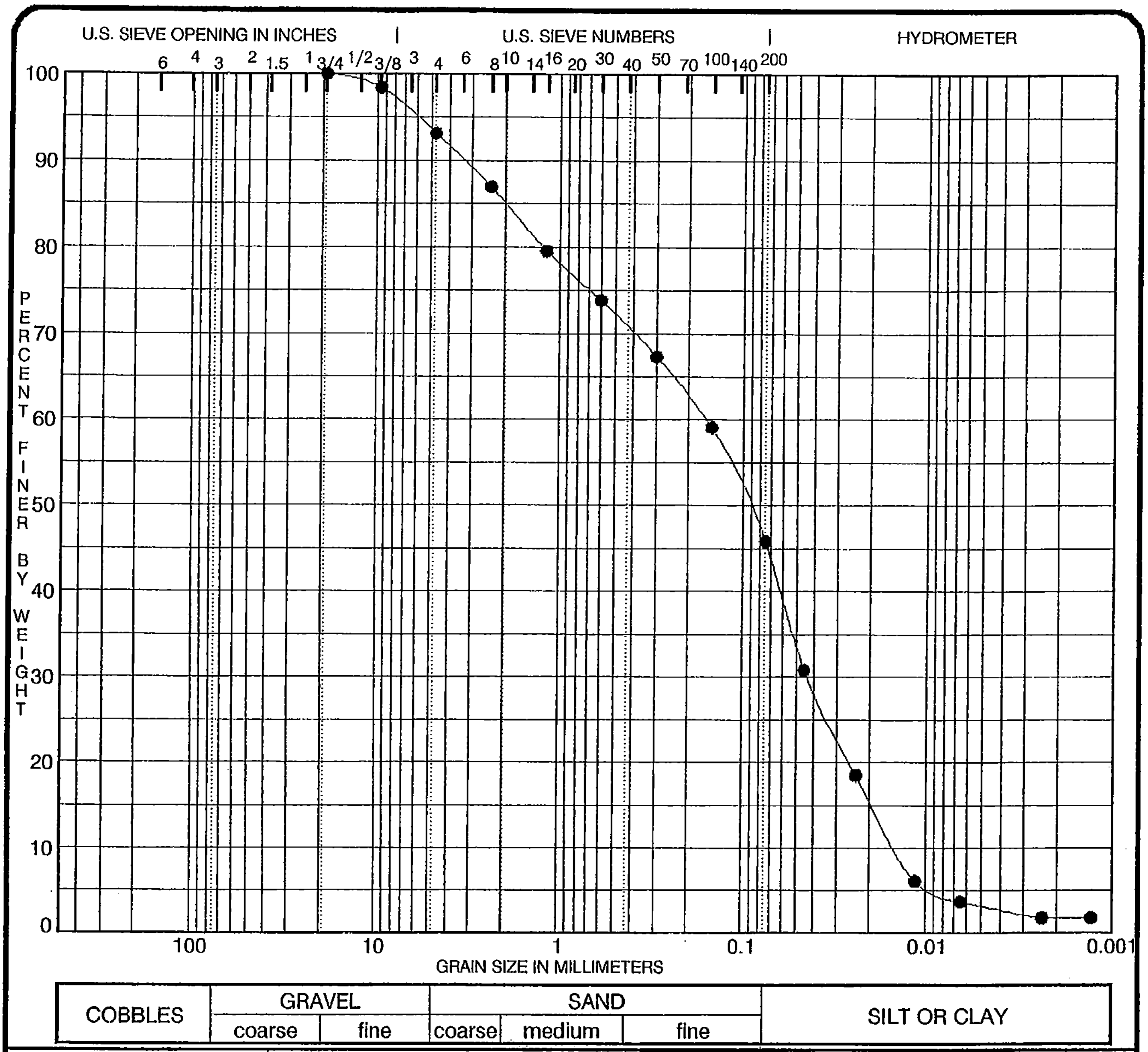
JOB NO.

DATE **08/29/96**

# GRADATION CURVES

**American Electric Power Service Corp.**

Civil Engineering Laboratory



| Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|
| ● 96-04 31.6 | | | NP | NP | NP | | |
| | SILTY SAND | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|
| ● 96-04 31.6 | 19.000 | 0.162 | 0.044 | 0.014 | 6.9 | 47.3 | 45.8 | 1.8 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.
DATE **08/29/96**

# GRADATION CURVES

**American Electric Power Service Corp.**
Civil Engineering Laboratory

**H. C. NUTTING COMPANY**
EMPLOYEE OWNED
GEOTECHNICAL, ENVIRONMENTAL AND TESTING ENGINEERS
SINCE 1921

CORPORATE CENTER
4120 AIRPORT ROAD
CINCINNATI, OHIO 45226
(513) 321-5816
FAX (513) 321-0294

Order No. 90979.027

August 29, 1996

Mr. P.J. Amaya
American Electric Power Corporation
1 Riverside Plaza
Columbus, Ohio 45315

Re: **Laboratory Tests**
Project: **Sporn Plant-Bottom Ash Pond Complex Testing-Contract No. C-9117, LOA-001-96**

Dear Mr. Amaya:

Submitted herewith is our report covering the results of nine (9) **Consolidated Undrained Triaxial** tests with pore pressure measurements, four (4) **Moisture Contents** and **Atterberg Limits**. Tests were performed per your request by letter dated August 14, 1996. All samples were obtained and shipped to our laboratory from the referenced project by your representative. Cost for these tests were as outlined per Contract No. C-9117.

Should any discussion be required concerning this report, please feel free contact the undersigned. The H.C. Nutting Company **thanks** American Electric Power for allowing them this opportunity to be of service. Attached are the tabulated and plotted results.

**H.C. NUTTING COMPANY**

Robert L. House

Robert L. House,
Vice President/Lab. Director

H.C. Nutting Company
4120 Airport Road
Cincinnati, Ohio 45226

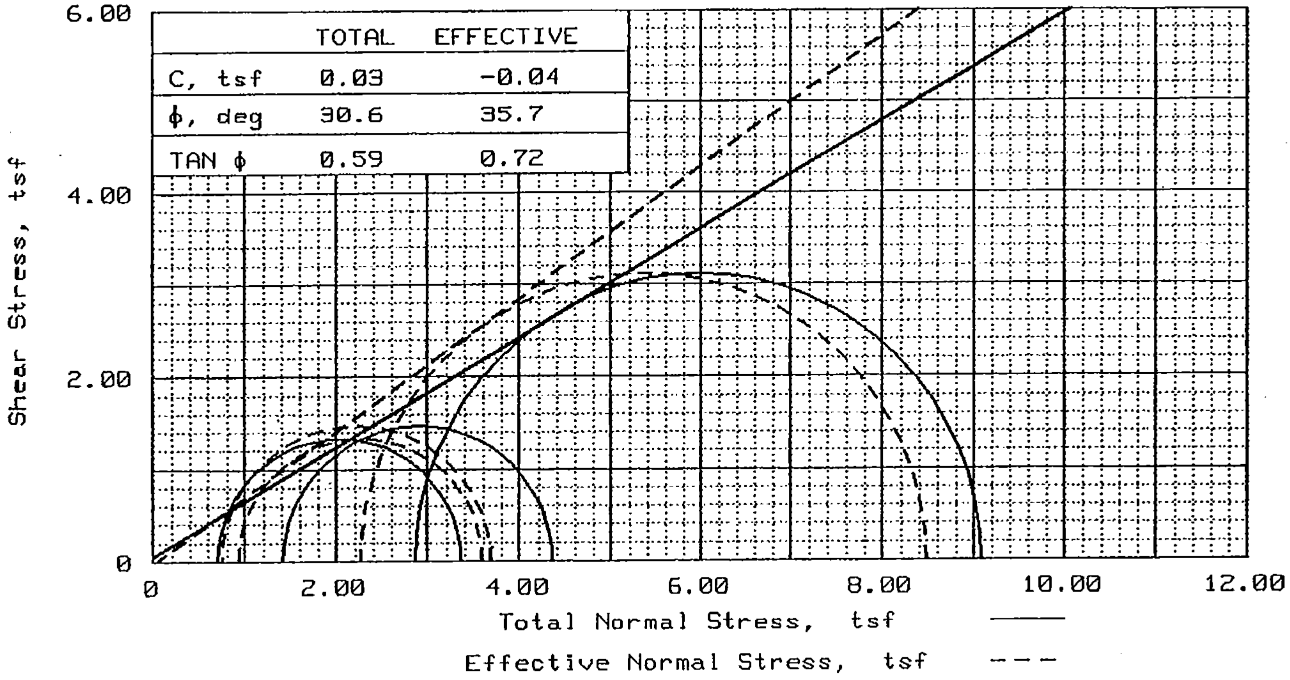
8/27/96smo

American Electric Power
Sporn Plant-Bottom Ash Pond Complex
New Haven, WV
HCN W.O. # 90979.027

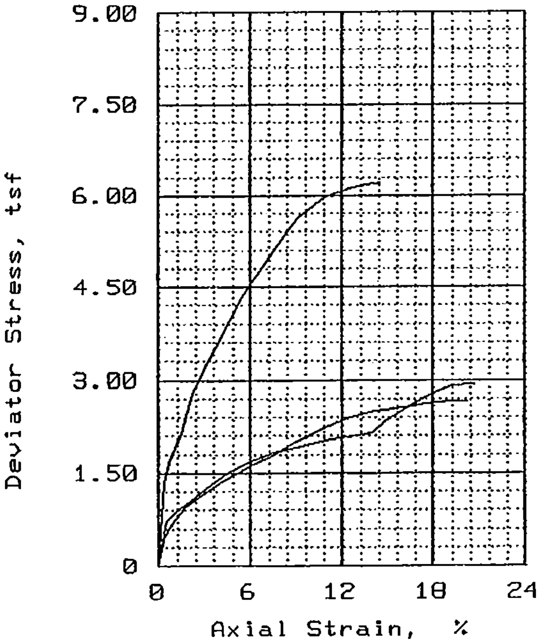
## TABLE II

## TABULATION OF UNDISTURBED TEST DATA

| Boring No. | Sample No. | Depth (Ft.) | Triaxial Compressive Strength (TSF) | Confining Pressure P.S.I. | Failure Strain (%) | Dry Density (Lbs./Cu. Ft.) | Water Content (%) | Lab No. |
|---|---|---|---|---|---|---|---|---|
| 9602-12 | ST-12 | 43.9-45.9 | 1.82 | 10 | 20.2 | 96.4 | 26.9 | 5623 |
| | | | | | | | | |
| 9602-13 | ST-13 | 45.9-48.9 | 1.96 | 20 | 6.9 | 91.0 | 30.0 | 5624 |
| | | | 2.65 | 40 | 5.8 | 91.2 | 31.3 | 5624 |
| | | | | | | | | |
| 9603-7 | ST-7 | 21.7-23.7 | 0.96 | 5 | 9.0 | 95.7 | 29.2 | 5625 |
| | | | 1.54 | 10 | 8.0 | 96.3 | 27.8 | 5625 |
| | | | 1.20 | 20 | 7.6 | 96.6 | 28.4 | 5625 |
| | | | | | | | | |
| 9604-12 | ST-12 | 46.6-48.6 | 2.65 | 10 | 19.1 | 103.8 | 21.8 | 5626 |
| | | | 2.93 | 20 | 20.7 | 100.6 | 24.2 | 5626 |
| | | | 6.22 | 40 | 14.6 | 99.6 | 24.8 | 5626 |
| | | | | | | | | |



| | TOTAL | EFFECTIVE |
|---|---|---|
| C, tsf | 0.03 | -0.04 |
| ϕ, deg | 30.6 | 35.7 |
| TAN ϕ | 0.59 | 0.72 |



| | SAMPLE NO. | 1 | 2 | 3 |
|---|---|---|---|---|
| INITIAL | WATER CONTENT, % | 21.8 | 24.2 | 24.8 |
| | DRY DENSITY, pcf | 103.8 | 100.6 | 99.6 |
| | SATURATION, % | 93.3 | 95.6 | 95.5 |
| | VOID RATIO | 0.637 | 0.688 | 0.705 |
| | DIAMETER, in | 2.84 | 2.85 | 2.85 |
| | HEIGHT, in | 5.60 | 5.60 | 5.60 |
| AT TEST | WATER CONTENT, % | 21.0 | 22.9 | 20.0 |
| | DIAMETER, in | 2.81 | 2.75 | 2.79 |
| | HEIGHT, in | 5.55 | 5.41 | 5.49 |
| | Strain rate, %/min | 0.001 | 0.001 | 0.001 |
| | BACK PRESSURE, tsf | 5.04 | 5.04 | 5.04 |
| | CELL PRESSURE, tsf | 5.76 | 6.48 | 7.92 |
| | FAILURE STRESS, tsf | 2.65 | 2.93 | 6.22 |
| | PORE PRESSURE, tsf | 4.81 | 5.72 | 5.64 |
| | ULTIMATE STRESS, tsf | | | |
| | PORE PRESSURE, tsf | | | |
| | $\bar{\sigma}_1$ FAILURE, tsf | 3.60 | 3.69 | 8.50 |
| | $\bar{\sigma}_3$ FAILURE, tsf | 0.95 | 0.76 | 2.28 |

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE:
DESCRIPTION: Br & GR LEAN CLAY
w/sand layers
LL= 25 PL= 18 PI= 7.0
SPECIFIC GRAVITY= 2.72
REMARKS: Lab No. 5626

FIG. NO.

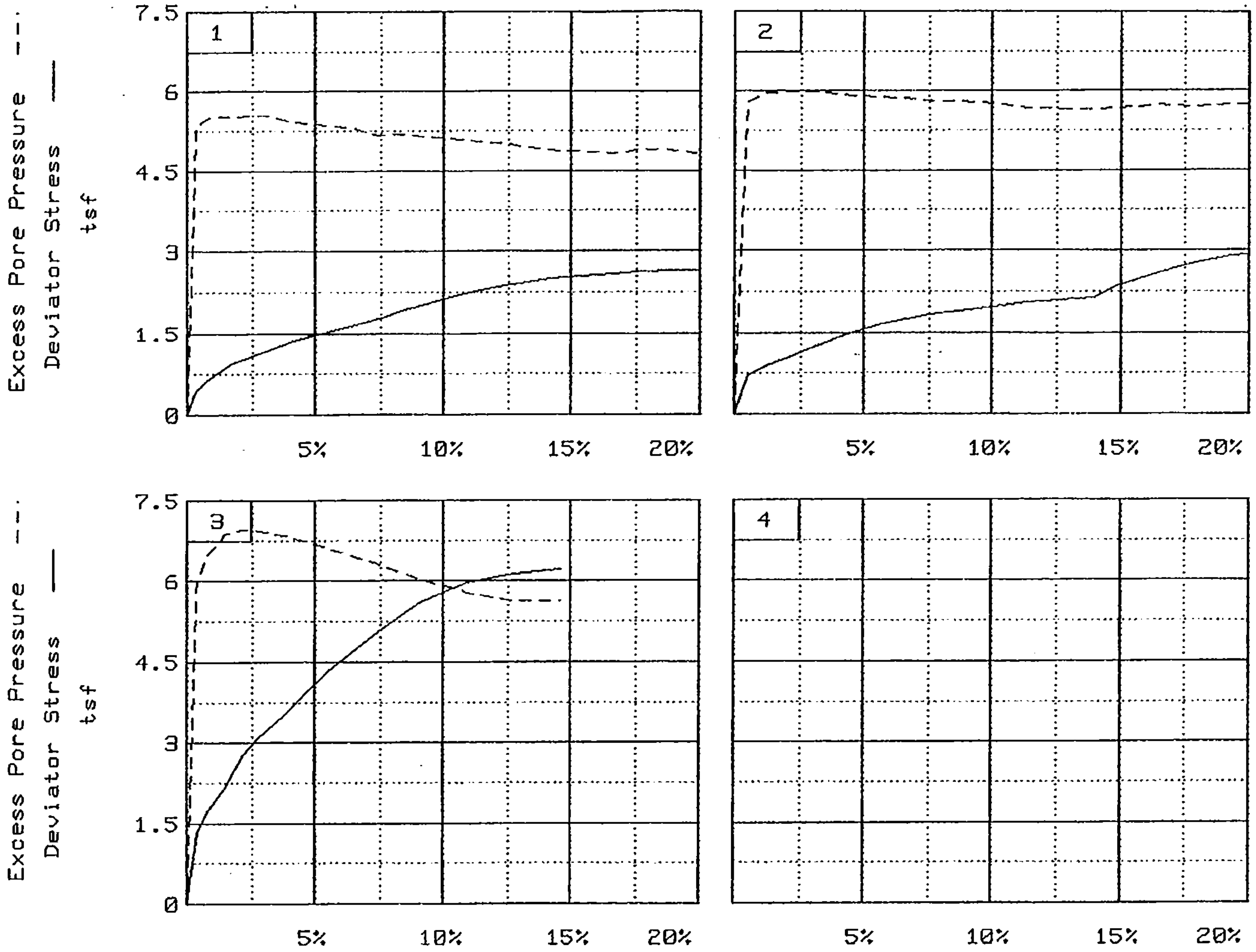
CLIENT: American Electric Power

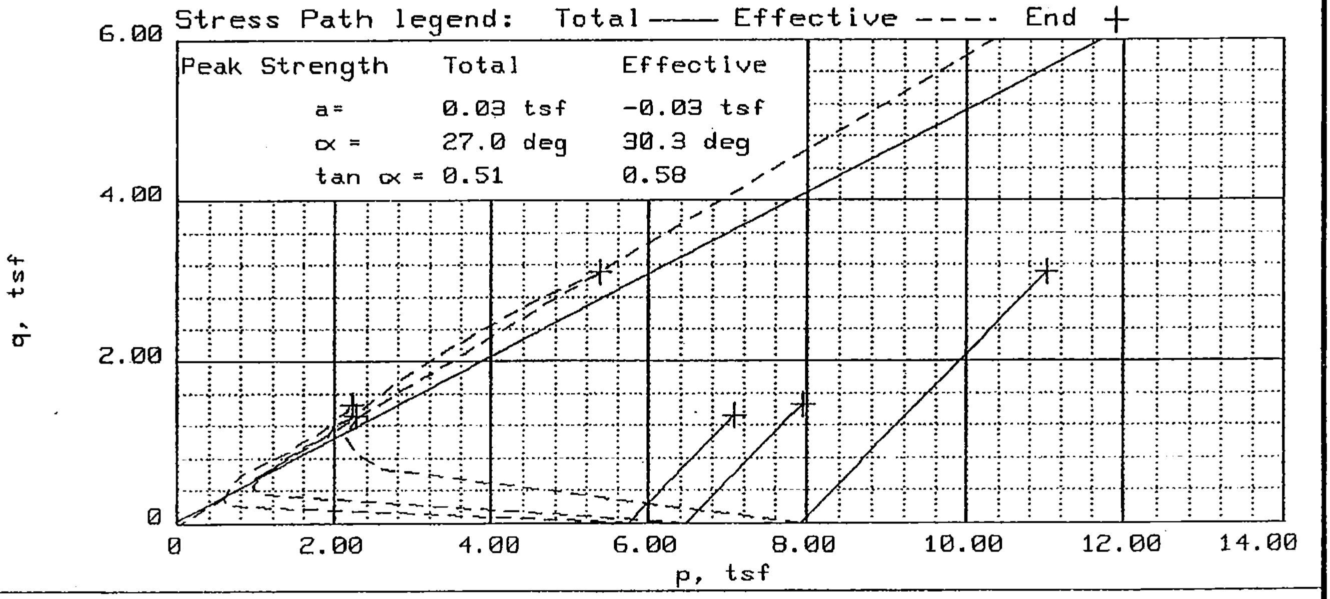
PROJECT: Sporn Plt-Bott. Ash Pond Complex
New Haven, WV
SAMPLE LOCATION: Boring:9604-1~~5~~ 13
Depth:46.6-48.6' Sample:ST-1~~2~~ 13

PROJ. NO.: 90979.027 DATE: 8/27/96

TRIAXIAL SHEAR TEST REPORT

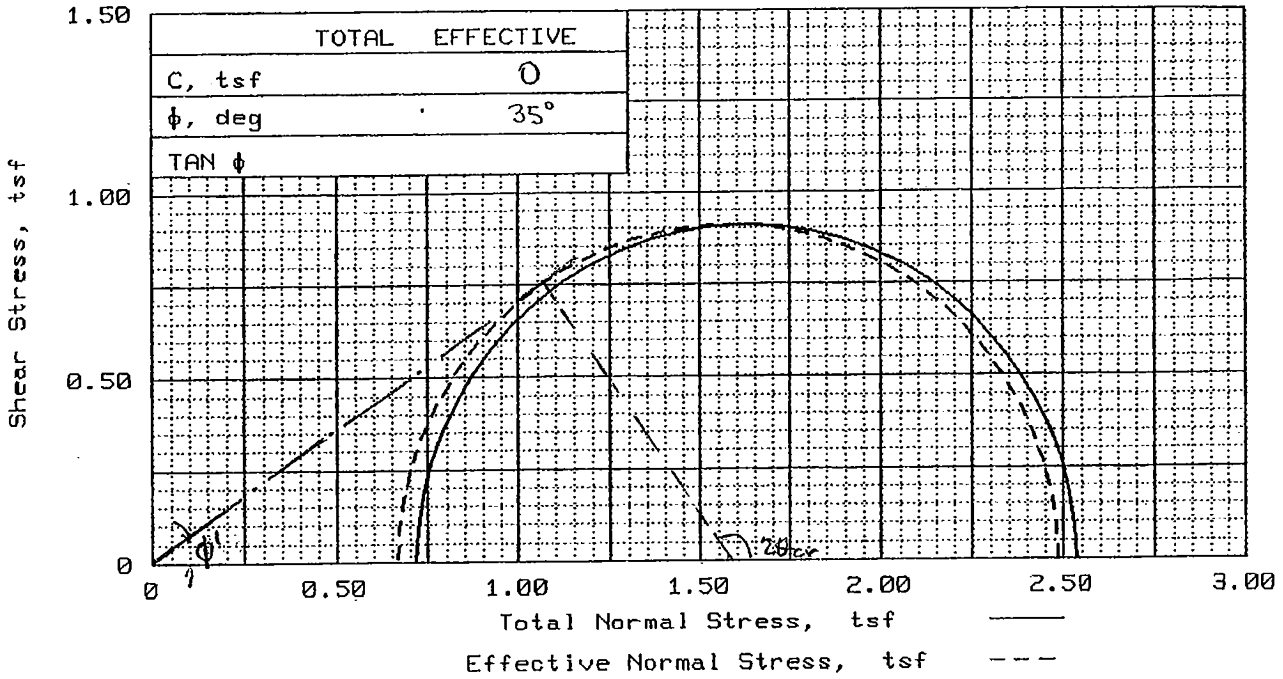
**H. C. NUTTING COMPANY**



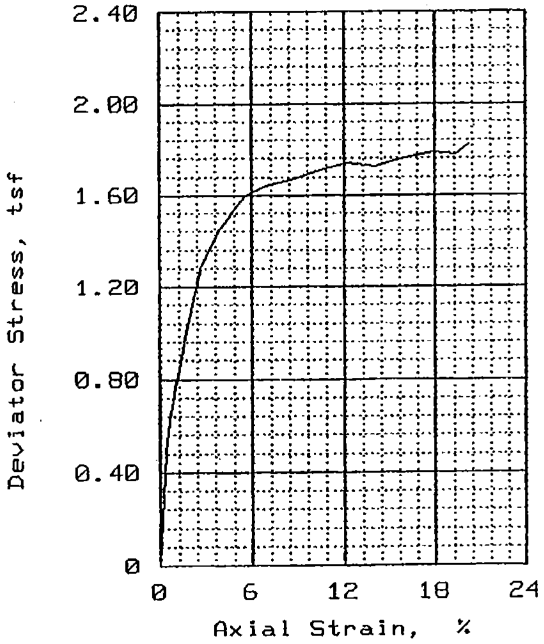


| Peak Strength | Total | Effective |
|---|---|---|
| a= | 0.03 tsf | -0.03 tsf |
| α = | 27.0 deg | 30.3 deg |
| tan α = | 0.51 | 0.58 |

Client: American Electric Power
Project: Sporn Plt-Bott. Ash Pond Complex New Haven, WV
Location: Boring:9604-12 Depth:46.6-48.6' Sample:ST-12
File: 5626 Project No.: 90979.027 Page 2/2 Fig. No. ____



| | TOTAL | EFFECTIVE |
|---|---|---|
| C, tsf | | 0 |
| φ, deg | | 35° |
| TAN φ | | |



| | | |
|---|---|---|
| SAMPLE NO. | | 1 |
| INITIAL | WATER CONTENT, % | 26.9 |
| | DRY DENSITY, pcf | 96.4 |
| | SATURATION, % | 96.3 |
| | VOID RATIO | 0.761 |
| | DIAMETER, in | 2.84 |
| | HEIGHT, in | 5.60 |
| AT TEST | WATER CONTENT, % | 27.4 |
| | DIAMETER, in | 2.81 |
| | HEIGHT, in | 5.54 |
| Strain rate, %/min | | 0.001 |
| BACK PRESSURE, tsf | | 5.04 |
| CELL PRESSURE, tsf | | 5.76 |
| FAILURE STRESS, tsf | | 1.82 |
| PORE PRESSURE, tsf | | 5.09 |
| ULTIMATE STRESS, tsf | | |
| PORE PRESSURE, tsf | | |
| $\bar{\sigma}_1$ FAILURE, tsf | | 2.49 |
| $\bar{\sigma}_3$ FAILURE, tsf | | 0.67 |

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE:
DESCRIPTION: Br LEAN CLAY

LL= 33 PL= 23 PI= 10.0
SPECIFIC GRAVITY= 2.72 (Assumed)
REMARKS: Lab No. 5623

$\frac{\sigma_1'}{\sigma_3'} = \tan^2 \theta_{cr} \therefore \frac{2.49}{0.67} = 3.76 \Rightarrow \theta_{cr} \approx 62.6°$

$2\theta_{cr} \approx 125°$

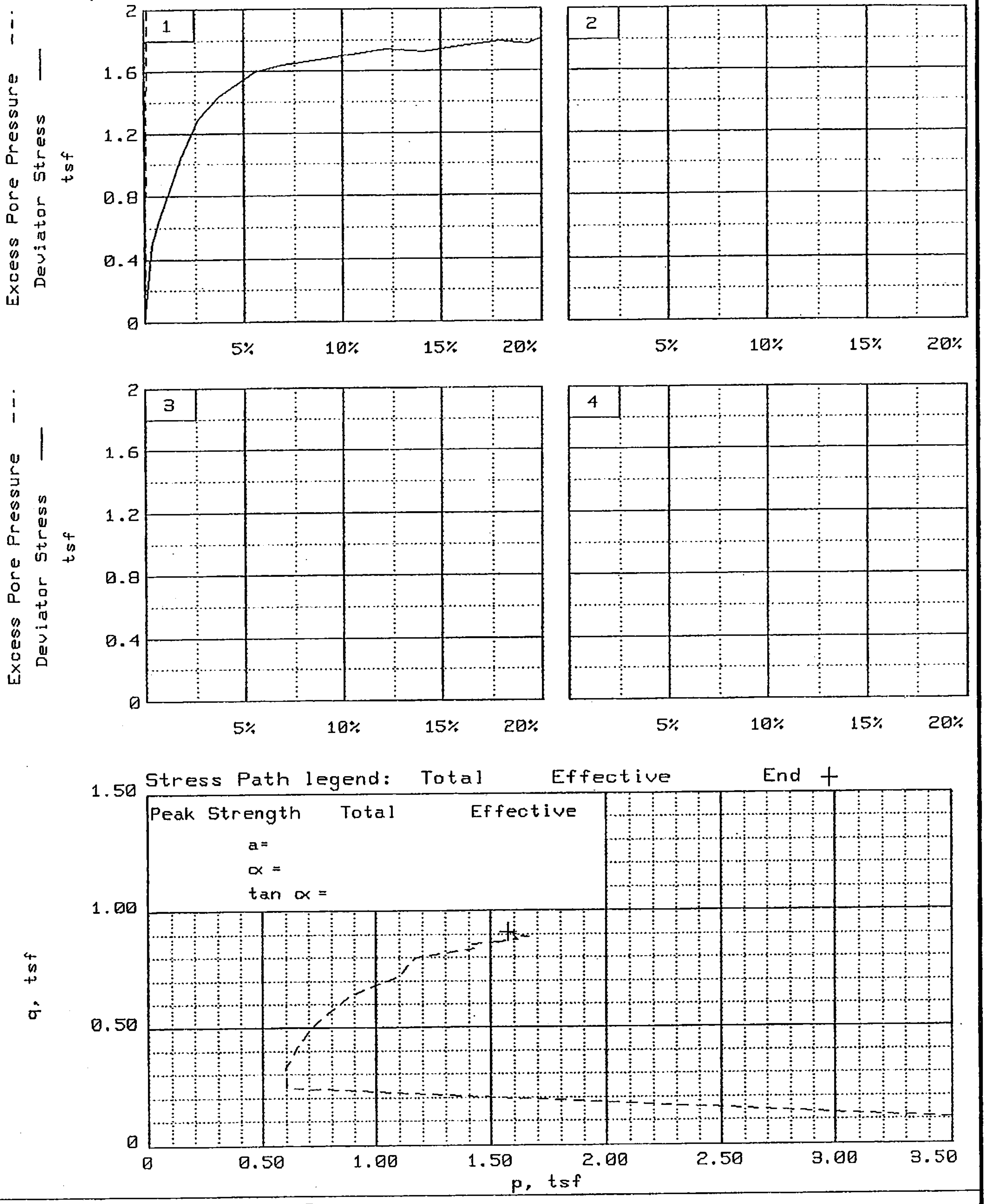
FIG. NO. [illegible]

CLIENT: American Electric Power

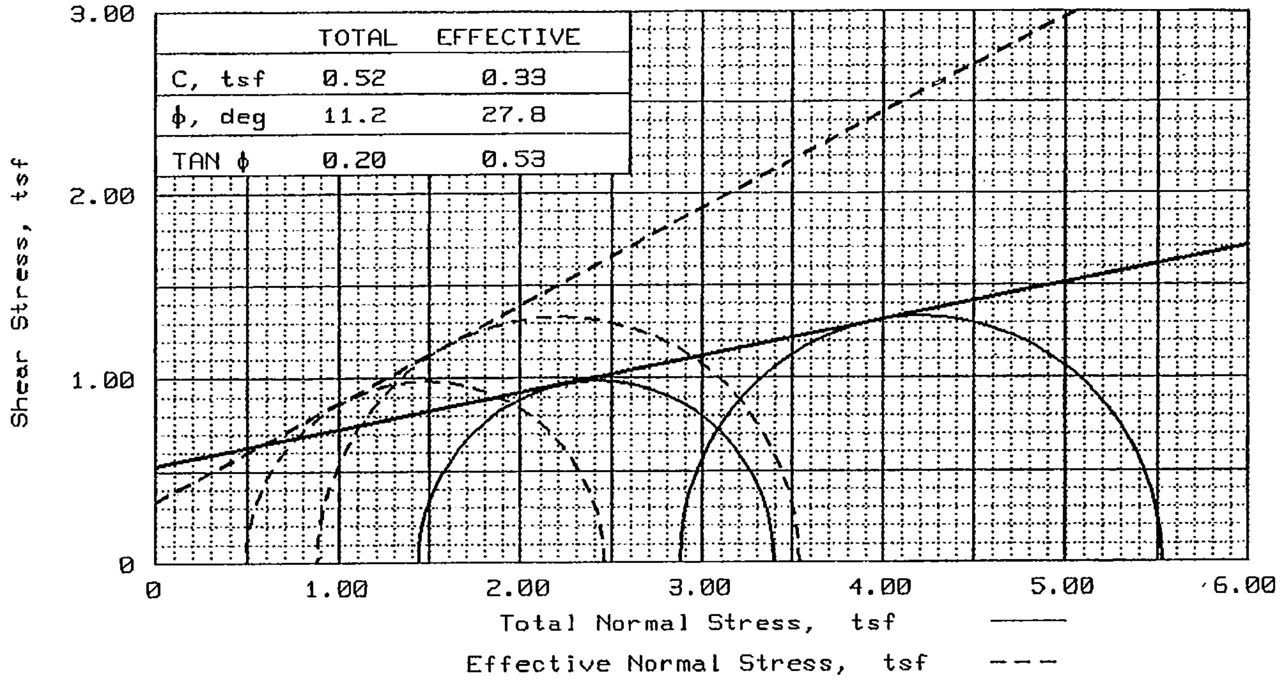
PROJECT: Sporn Plt-Bott. Ash Pond Complex
New Have, WV
SAMPLE LOCATION: Boring:9602-12
Depth:43.9-45.9' Sample:ST-12
PROJ. NO.: 90979.027 DATE: 8/27/96

TRIAXIAL SHEAR TEST REPORT

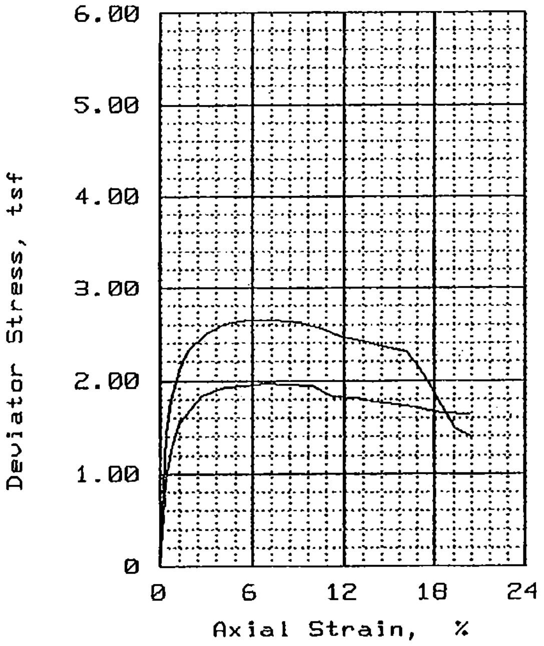
**H. C. NUTTING COMPANY**



Client: American Electric Power
Project: Sporn Plt-Bott. Ash Pond Complex New Have, WV
Location: Boring:9602-12 Depth:43.9-45.9' Sample:ST-12
File: 5623 Project No.: 90979.027 Page 2/2 Fig. No. ____



| | TOTAL | EFFECTIVE |
|---|---|---|
| C, tsf | 0.52 | 0.33 |
| ϕ, deg | 11.2 | 27.8 |
| TAN ϕ | 0.20 | 0.53 |



| SAMPLE NO. | | 1 | 2 |
|---|---|---|---|
| INITIAL | WATER CONTENT, % | 30.0 | 31.3 |
| | DRY DENSITY, pcf | 91.0 | 91.2 |
| | SATURATION, % | 100.0 | 98.8 |
| | VOID RATIO | 0.865 | 0.861 |
| | DIAMETER, in | 2.84 | 2.84 |
| | HEIGHT, in | 5.60 | 5.56 |
| AT TEST | WATER CONTENT, % | 32.6 | 30.2 |
| | DIAMETER, in | 2.79 | 2.79 |
| | HEIGHT, in | 5.51 | 5.47 |
| Strain rate, %/min | | 0.001 | 0.001 |
| BACK PRESSURE, tsf | | 5.04 | 5.04 |
| CELL PRESSURE, tsf | | 6.48 | 7.92 |
| FAILURE STRESS, tsf | | 1.96 | 2.65 |
| PORE PRESSURE, tsf | | 5.98 | 7.03 |
| ULTIMATE STRESS, tsf | | | |
| PORE PRESSURE, tsf | | | |
| $\bar{\sigma}_1$ FAILURE, tsf | | 2.46 | 3.55 |
| $\bar{\sigma}_3$ FAILURE, tsf | | 0.5 | 0.89 |

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE:
DESCRIPTION: Br LEAN CLAY

LL= 31 PL= 24 PI= 7.0
SPECIFIC GRAVITY= 2.72 (Assumed)
REMARKS: Lab No. 5624

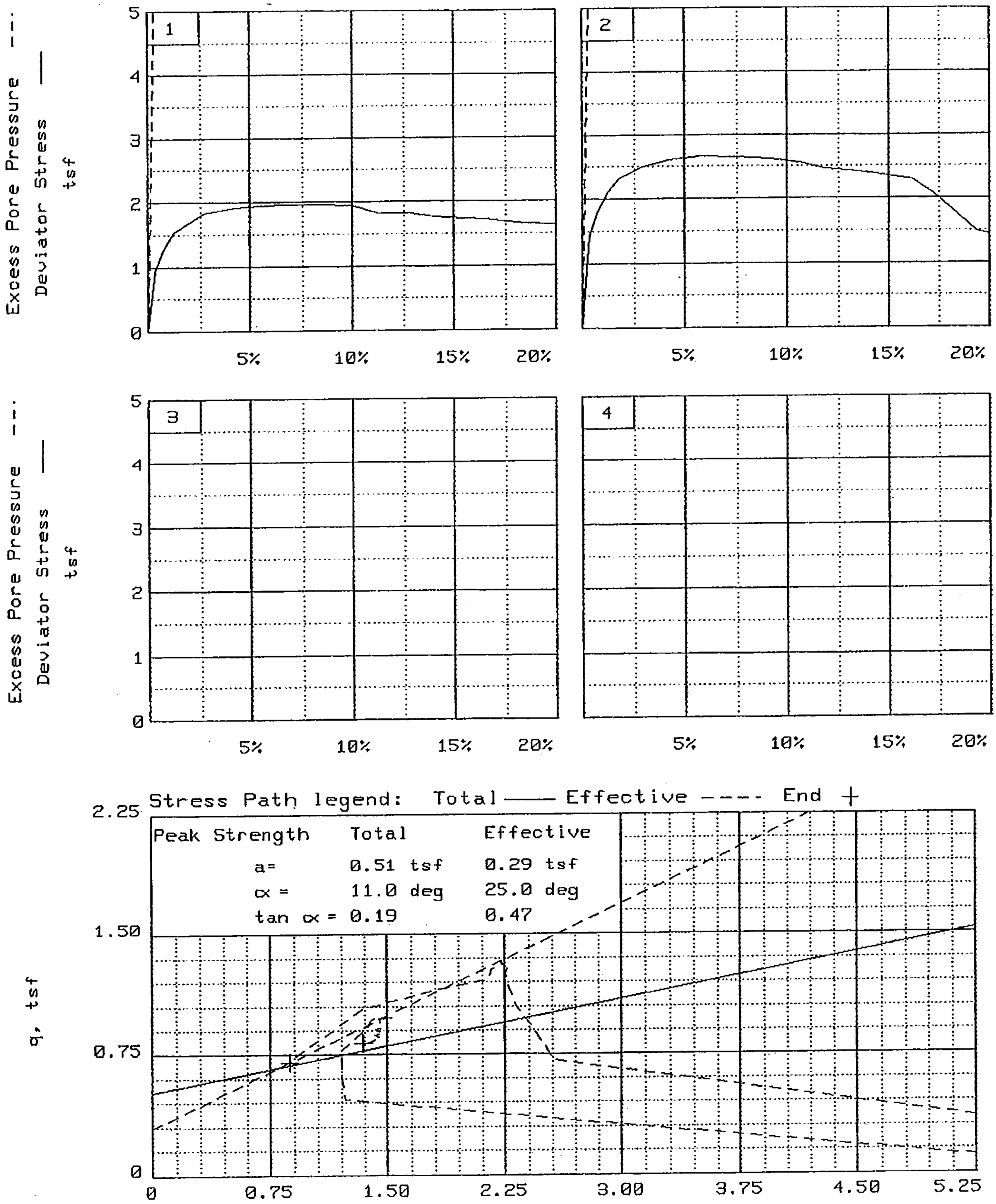
FIG. NO.

CLIENT: American Electric Power

PROJECT: Sporn Plt-Bott. Ash Pond Complex
New Haven, WV
SAMPLE LOCATION: Boring:9602-13
Depth:46.9-48.9' Sample:ST-13
PROJ. NO.: 90979.027 DATE: 8/27/96

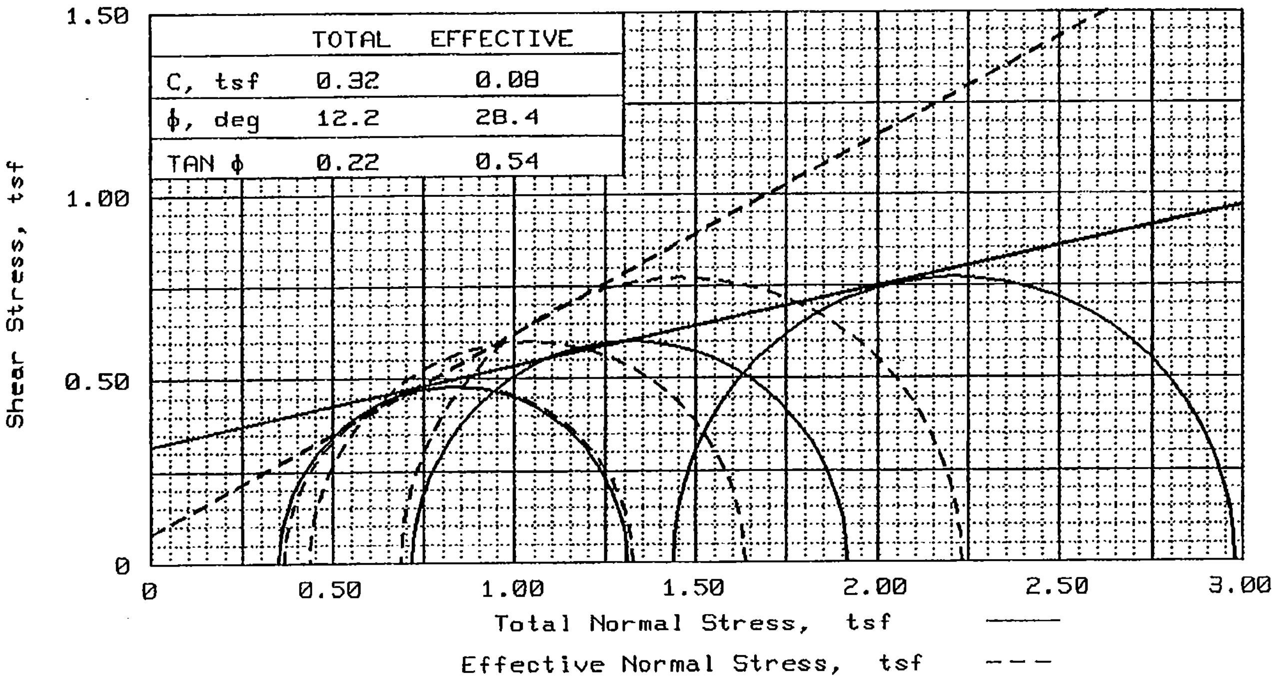
TRIAXIAL SHEAR TEST REPORT

**H. C. NUTTING COMPANY**

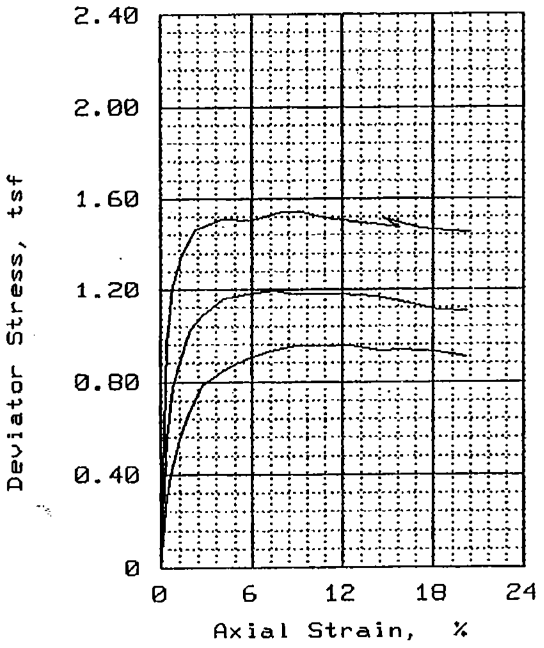


| Peak Strength | Total | Effective |
|---|---|---|
| a= | 0.51 tsf | 0.29 tsf |
| α = | 11.0 deg | 25.0 deg |
| tan α = | 0.19 | 0.47 |

Client: American Electric Power
Project: Sporn Plt-Bott. Ash Pond Complex New Haven, WV
Location: Boring:9602-13 Depth:46.9-48.9' Sample:ST-13
File: 5624 Project No.: 90979.027 Page 2/2 - Fig. No. ____



| | TOTAL | EFFECTIVE |
|---|---|---|
| C, tsf | 0.32 | 0.08 |
| ϕ, deg | 12.2 | 28.4 |
| TAN ϕ | 0.22 | 0.54 |



| | SAMPLE NO. | 1 | 2 | 3 |
|---|---|---|---|---|
| INITIAL | WATER CONTENT, % | 29.2 | 27.8 | 28.4 |
| | DRY DENSITY, pcf | 95.7 | 96.3 | 96.6 |
| | SATURATION, % | 100.0 | 98.9 | 100.0 |
| | VOID RATIO | 0.775 | 0.763 | 0.759 |
| | DIAMETER, in | 2.84 | 2.84 | 2.84 |
| | HEIGHT, in | 5.60 | 5.60 | 5.60 |
| AT TEST | WATER CONTENT, % | 28.9 | 27.5 | 25.6 |
| | DIAMETER, in | 2.82 | 2.78 | 2.81 |
| | HEIGHT, in | 5.55 | 5.49 | 5.55 |
| | Strain rate, %/min | 0.001 | 0.001 | 0.001 |
| | BACK PRESSURE, tsf | 5.04 | 5.04 | 5.04 |
| | CELL PRESSURE, tsf | 5.40 | 6.48 | 5.76 |
| | FAILURE STRESS, tsf | 0.96 | 1.54 | 1.20 |
| | PORE PRESSURE, tsf | 5.03 | 5.79 | 5.32 |
| | ULTIMATE STRESS, tsf | | | |
| | PORE PRESSURE, tsf | | | |
| | $\bar{\sigma}_1$ FAILURE, tsf | 1.33 | 2.23 | 1.64 |
| | $\bar{\sigma}_3$ FAILURE, tsf | 0.37 | 0.69 | 0.44 |

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE:
DESCRIPTION: Gr LEAN CLAY

LL= 33 PL= 22 PI= 11.0
SPECIFIC GRAVITY= 2.72 (Assumed)
REMARKS: Lab No. 5625

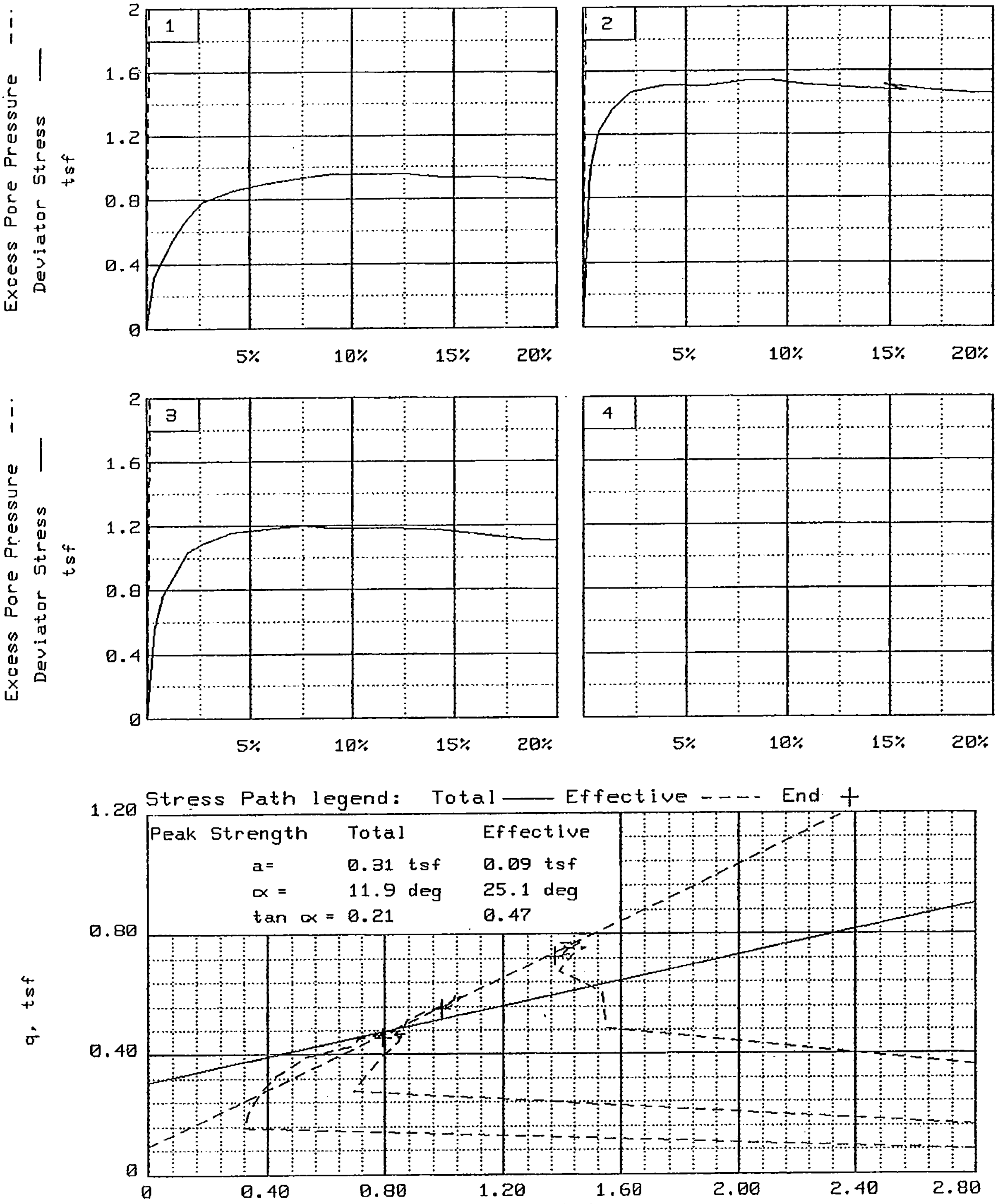
FIG. NO.

CLIENT: American Electric Power

PROJECT: Sporn Plt-Bott. Ash Pond Complex
New Haven, WV
SAMPLE LOCATION: Boring:9603-7
Depth:21.7-23.7′ Sample:ST-7
PROJ. NO.: 90979.027 DATE: 8/27/96

TRIAXIAL SHEAR TEST REPORT

**H. C. NUTTING COMPANY**



| Peak Strength | Total | Effective |
|---|---|---|
| a= | 0.31 tsf | 0.09 tsf |
| α = | 11.9 deg | 25.1 deg |
| tan α = | 0.21 | 0.47 |

Client: American Electric Power
Project: Sporn Plt-Bott. Ash Pond Complex New Haven, WV
Location: Boring:9603-7 Depth:21.7-23.7' Sample:ST-7
File: 5625 Project No.: 90979.027 Page 2/2 Fig. No. ____

BBC&M
ENGINEERING, INC

October 30, 1995
T-533D

American Electric Power Service Corporation

1 Riverside Plaza
Columbus, Ohio 43215

Attention : Mr. M. T. Damian

RE: Laboratory Testing
BBC&M JOB NO. T-533D
Bottom Ash Testing - Sporn Fly Ash Pond Dike Remediation
New Haven, West Virginia

Gentlemen :

Enclosed are the results of the laboratory testing on the BOTTOM ASH sample for the Sporn Fly Ash Pond Dike Remediation project. Included are the appropriate curves, summary sheets with listed numerical values, as well as the laboratory test data sheets and notes.

We are pleased to have been of service to you. If you have any questons regarding this work please contact this office.

Very Truly Yours ,

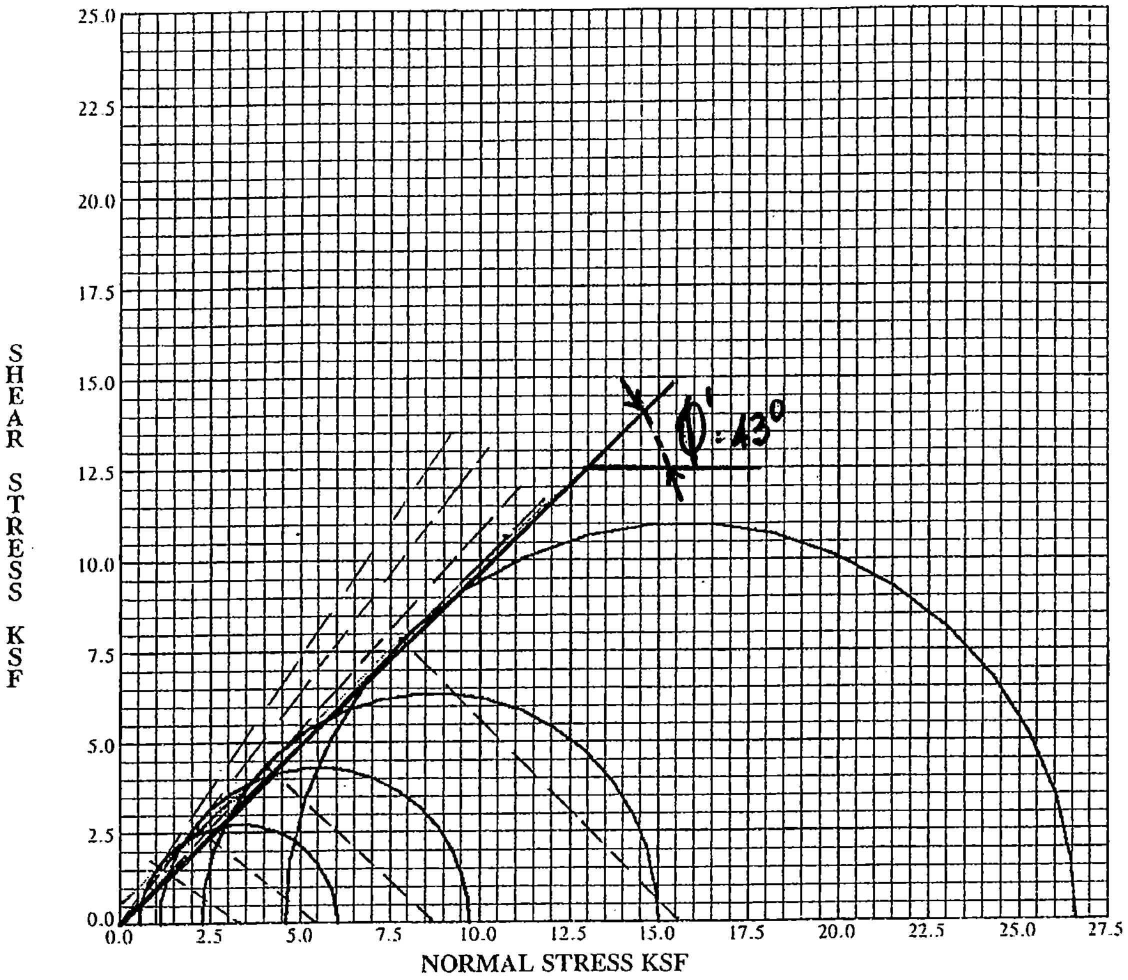
BBC&M ENGINEERING, INC.
John D. Jenkins, Jr.
John D. Jenkins, Jr.
Laboratory Supervisor

*GEOTECHNICAL CONSULTANTS* 6190 ENTERPRISE COURT, DUBLIN, OHIO 43016-7297 (614) 793-BBCM(2226) FAX (614) 793-2410

# SUMMARY OF TRIAXIAL COMPRESSION TESTS

SATURATED, CONSOLIDATED, DRAINED
( PEAK STRESSES PLOTTED )

SHEAR STRESS VS NORMAL STRESS



EFFECTIVE STRESS ———

| Specimen Identification | Classification | DD | MC% |
|---|---|---|---|
| SPORN PLANT BUCKET<br>( Bottom Ash ) | Dark-gray and gray fine to coarse sand, little fine to coarse gravel, trace silt. | 60 | 42 |
| SPORN PLANT BUCKET<br>( Bottom Ash ) | Dark-gray and gray fine to coarse sand, little fine to coarse gravel, trace silt. | 60 | 36 |
| SPORN PLANT BUCKET<br>( Bottom Ash ) | Dark-gray and gray fine to coarse sand, little fine to coarse gravel, trace silt. | 60 | 40 |
| SPORN PLANT BUCKET<br>( Bottom Ash ) | Dark-gray and gray fine to coarse sand, little fine to coarse gravel, trace silt. | 60 | 37 |

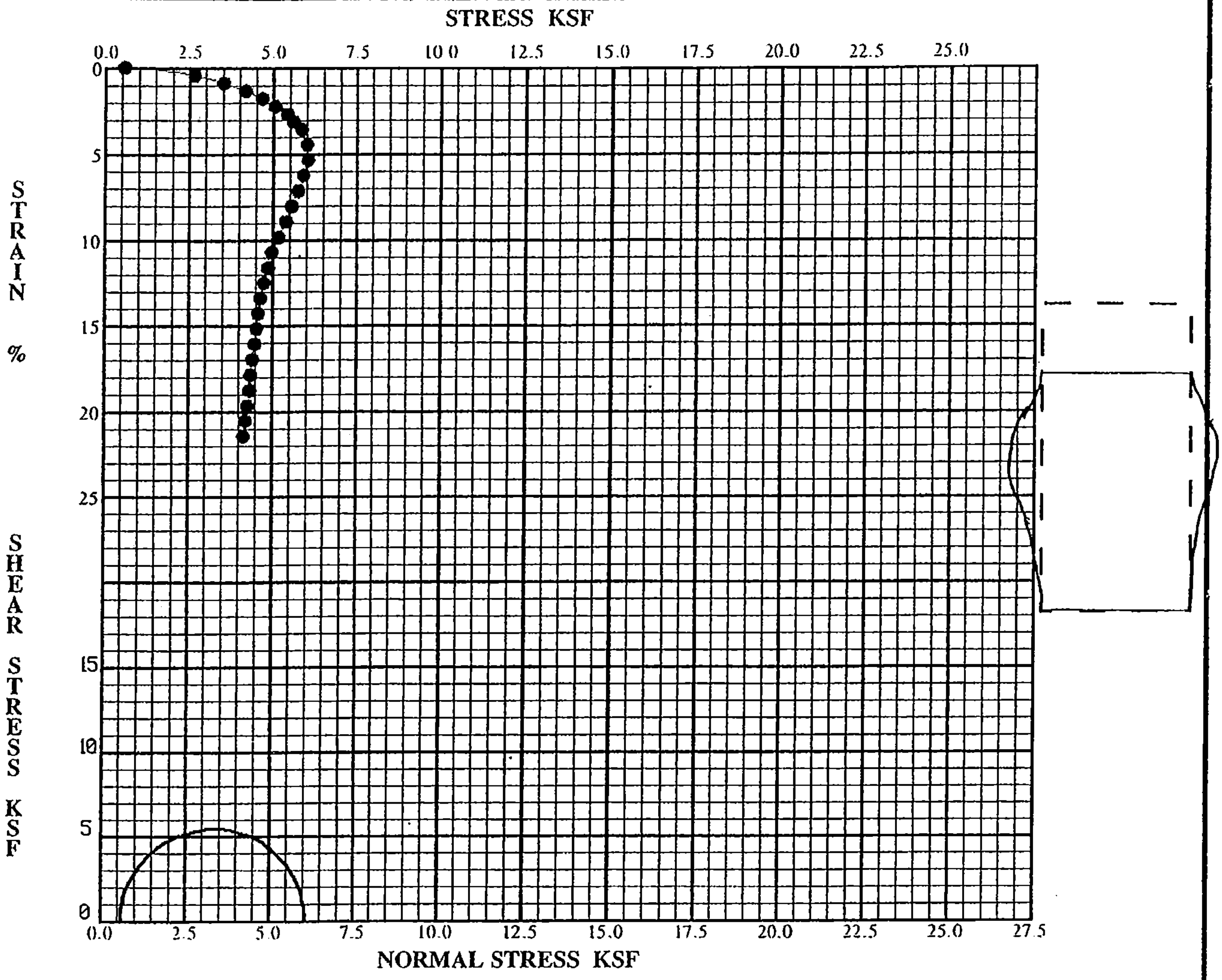
BBC&M ENGINEERING, INC.

PROJECT Bottom Ash Testing - Sporn Plant
LOCATION New Haven, West Virginia
JOB NO. T533D DATE 10/29/95

PLATE

# TRIAXIAL COMPRESSION TESTS

## SATURATED, CONSOLIDATED, DRAINED



EFFECTIVE STRESS ——— ● EFFECTIVE AXIAL STRESS

| | Specimen Identification | Classification | DD | MC% |
|---|---|---|---|---|
| ● | SPORN PLANT BUCKET<br>( Bottom Ash ) | Dark-gray and gray fine to coarse sand, little fine to coarse gravel, trace silt. | 60 | 42 |

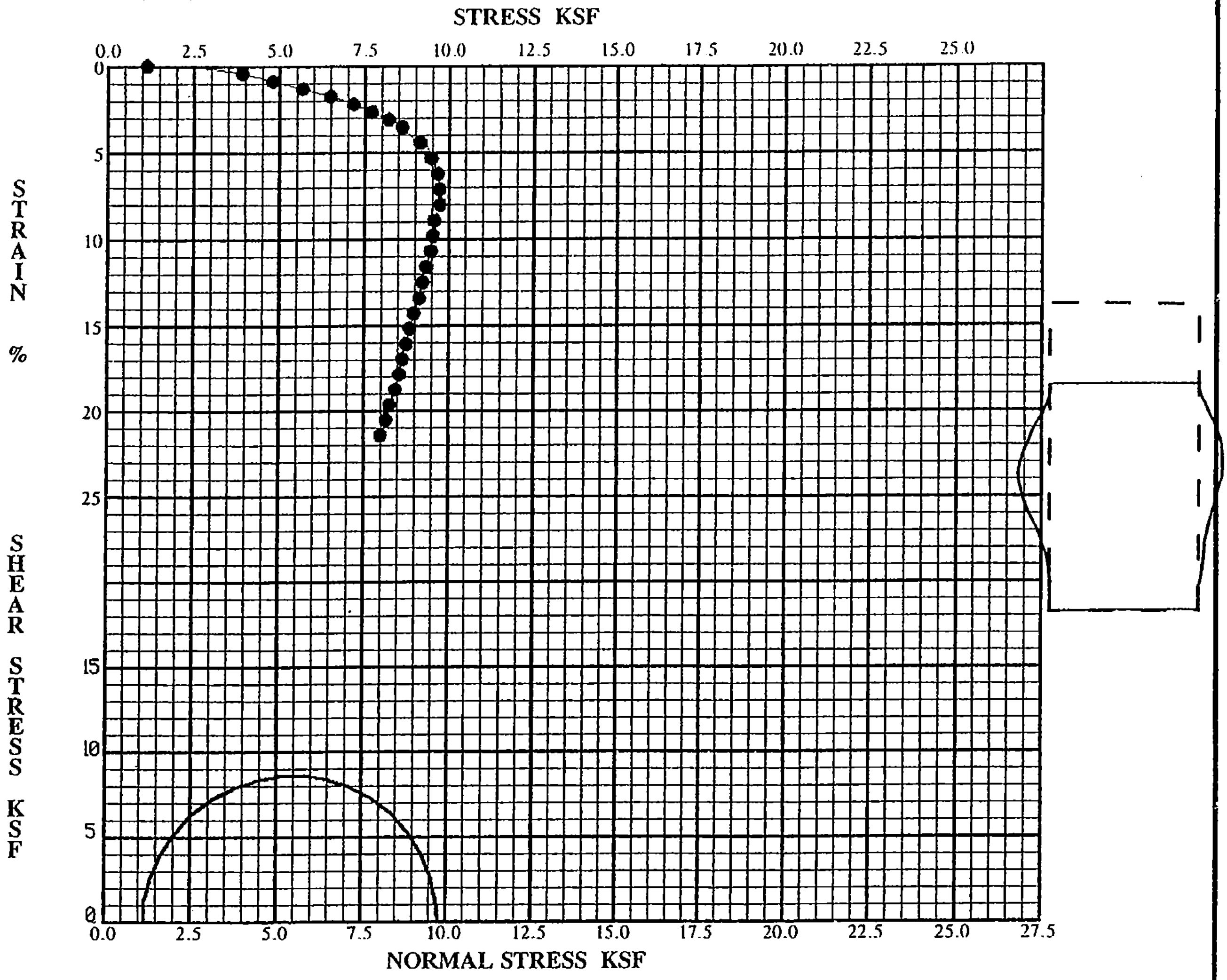
BBC&M ENGINEERING, INC.

PROJECT Bottom Ash Testing - Sporn Plant
LOCATION New Haven, West Virginia
JOB NO. T533D DATE 10/29/95

PLATE

# TRIAXIAL COMPRESSION TESTS

SATURATED, CONSOLIDATED, DRAINED



**EFFECTIVE STRESS** ——— ● **EFFECTIVE AXIAL STRESS**

| | Specimen Identification | Classification | DD | MC% |
|---|---|---|---|---|
| ● | **SPORN PLANT BUCKET**<br>**( Bottom Ash )** | **Dark-gray and gray fine to coarse sand, little fine to coarse gravel, trace silt.** | **60** | **36** |

BBC&M ENGINEERING, INC.

PROJECT Bottom Ash Testing - Sporn Plant

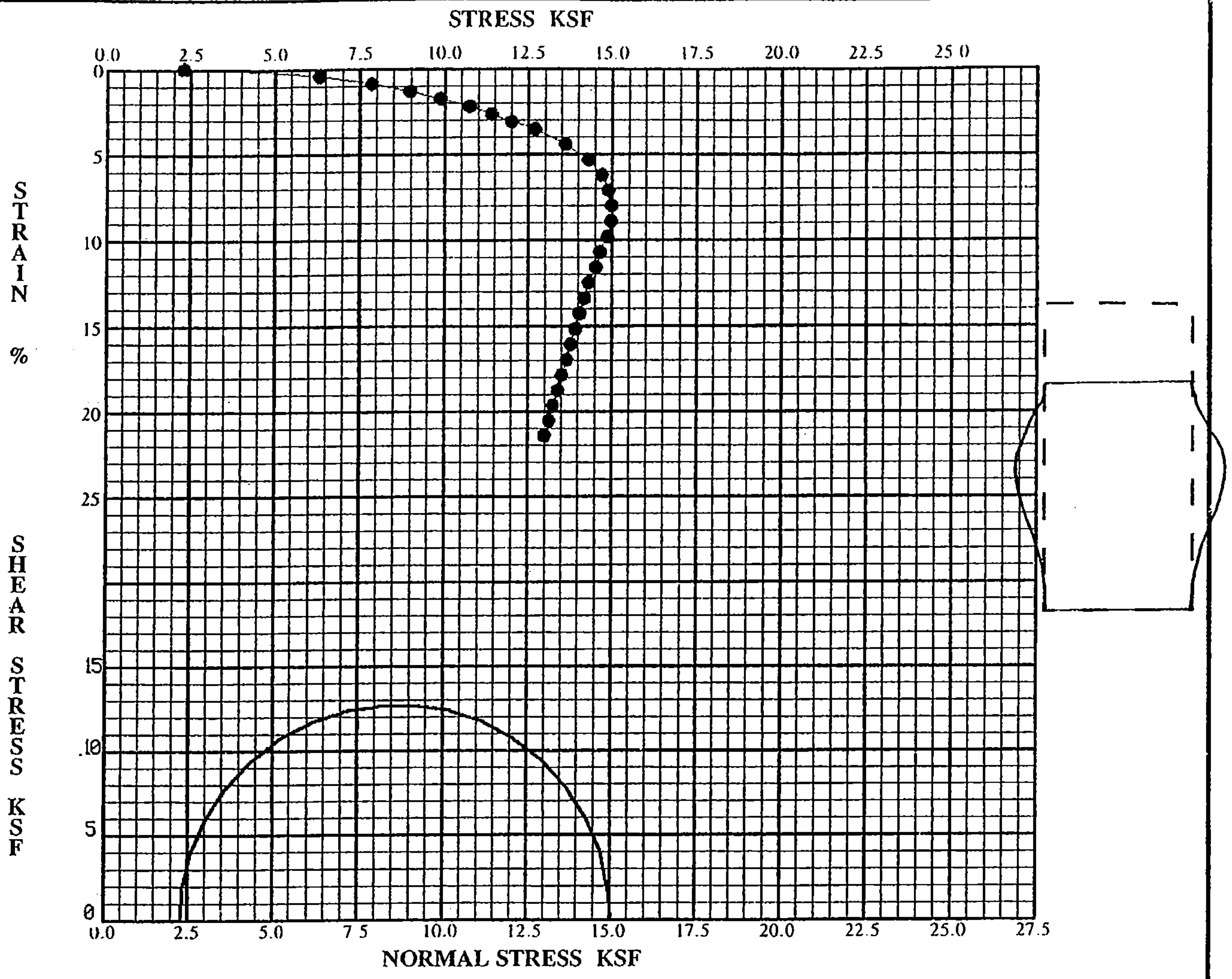
LOCATION New Haven, West Virginia

JOB NO. T533D DATE 10/29/95

PLATE

# TRIAXIAL COMPRESSION TESTS

SATURATED, CONSOLIDATED, DRAINED



**EFFECTIVE STRESS** ——— ● **EFFECTIVE AXIAL STRESS**

| Specimen Identification | | Classification | DD | MC% |
|---|---|---|---|---|
| ● | **SPORN PLANT** **BUCKET**<br><br>**( Bottom Ash )** | **Dark-gray and gray fine to coarse sand, little fine to coarse gravel, trace silt.** | **60** | **40** |

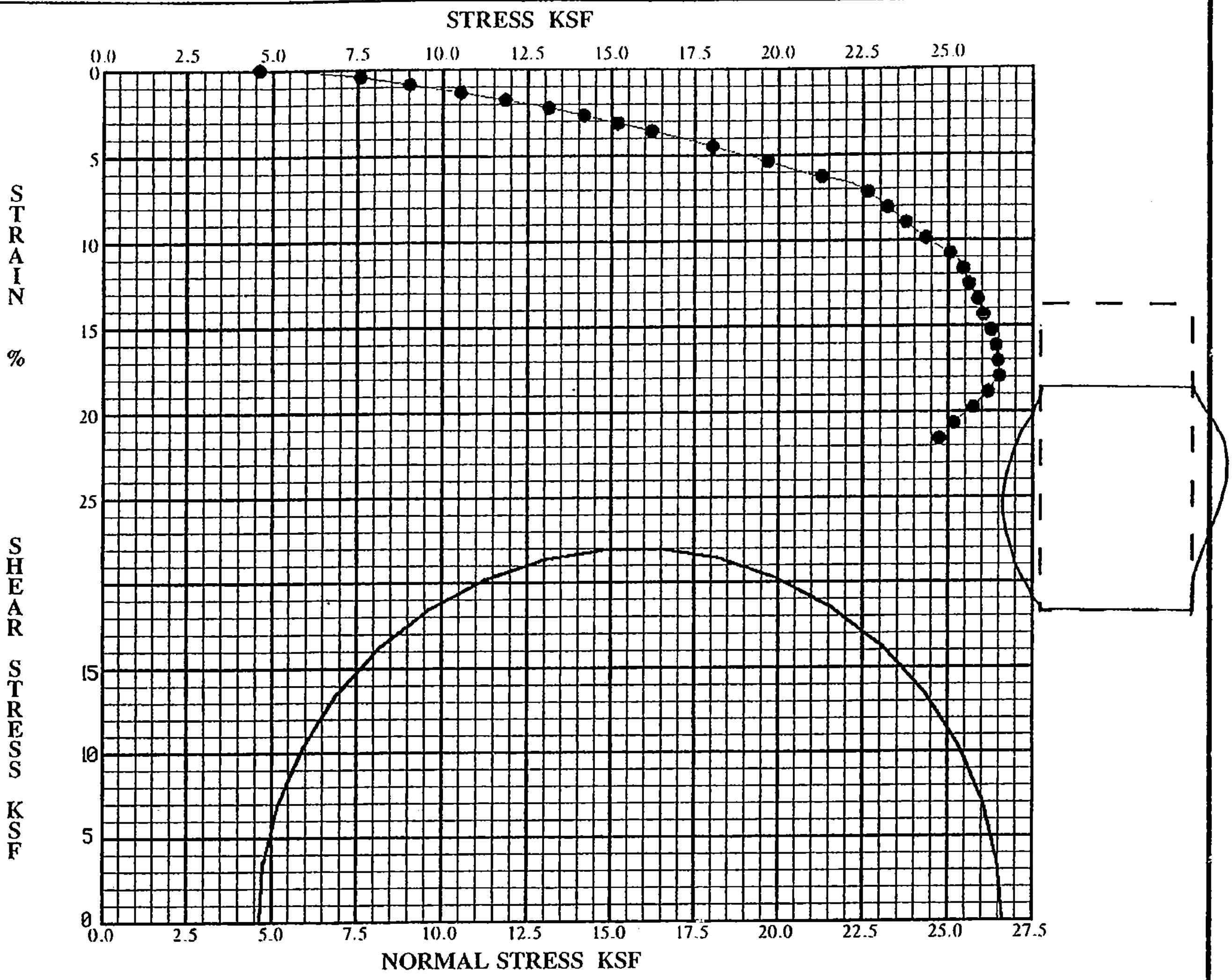
BBC&M ENGINEERING, INC.

PROJECT Bottom Ash Testing - Sporn Plant
LOCATION New Haven, West Virginia
JOB NO. T533D DATE 10/29/95

PLATE

# TRIAXIAL COMPRESSION TESTS

SATURATED, CONSOLIDATED, DRAINED



**EFFECTIVE STRESS** ——— ● **EFFECTIVE AXIAL STRESS**

| Specimen Identification | | Classification | DD | MC% |
|---|---|---|---|---|
| ● | **SPORN PLANT BUCKET**<br>**( Bottom Ash )** | **Dark-gray and gray fine to coarse sand, little fine to coarse gravel, trace silt.** | **60** | **37** |

BBC&M ENGINEERING, INC.

PROJECT Bottom Ash Testing - Sporn Plant
LOCATION New Haven, West Virginia
JOB NO. T533D DATE 10/29/95

PLATE

# TRIAXIAL COMPRESSION TEST DATA AND COMPUTATION SHEET

PROJECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533D DATE : 10/8-12/95

ORING : SAMPLE : 75% Dr (4psi) DEPTH :

MATERIAL :

---

Circ. : 8.97"

Height : 5.60" Diam. : 2.855" Area : 6.402in²

Volumn : 35.850 in³ = 587.48 cm³

DRY Wt. of Sple. : 565.55 gms.

UDW : 60.1 Pcf

Vol. Change - cc :

Type of Test : CD

Load Cell : 5K

| Moisture Content | Before Test | After Test |
|---|---|---|
| Pan No. : | | OM-36 |
| Wet Wt. Sple. + Pan : | | 927.72 |
| Dry Wt. Sple. + Pan : | N A | 691.66 |
| Wt. of Pan : | | 129.74 |
| Wt. of Dry Soil : | | 561.92 |
| Wt. of Water : | | 236.06 |
| % Moisture | | 42.0 |

Hc = 5.596" Ac = 6.397in² LOADING RATE = .004"/MIN

| Dial Defl. Inchx$10^{-3}$ | Strain | 1 - Strain | Average Area | Load lbs. | Incremental Deviator Stress | | Total Vert. Stress ksf | |
|---|---|---|---|---|---|---|---|---|
| | | | | | psi | ksf | | |
| 0 | .0000 | 1.0000 | 6.40 | 0 | 0.00 | 0.00 | 0.58 | |
| 25 | .0045 | .9955 | 6.43 | 93 | 14.46 | 2.08 | 2.66 | |
| 50 | .0089 | .9911 | 6.46 | 132 | 20.43 | 2.94 | 3.52 | |
| 75 | .0134 | .9866 | 6.49 | 162 | 24.96 | 3.59 | 4.17 | |
| 100 | .0179 | .9821 | 6.52 | 185 | 28.37 | 4.09 | 4.67 | |
| 25 | .0223 | .9777 | 6.55 | 204 | 31.15 | 4.48 | 5.06 | |
| 50 | .0268 | .9732 | 6.58 | 221 | 33.59 | 4.84 | 5.42 | |
| 75 | .0313 | .9687 | 6.61 | 230 | 34.80 | 5.01 | 5.59 | |
| 200 | .0357 | .9643 | 6.64 | 242 | 36.45 | 5.25 | 5.83 | |
| 50 | .0447 | .9553 | 6.70 | 252 | 37.61 | 5.42 | 6.00 | |
| 300 | .0536 | .9464 | 6.76 | 256 | 37.87 | 5.45 | 6.03 | |
| 50 | .0625 | .9375 | 6.83 | 252 | 36.90 | 5.31 | 5.89 | |
| 400 | .0715 | .9285 | 6.89 | 247 | 35.85 | 5.16 | 5.74 | |
| 50 | .0804 | .9196 | 6.96 | 240 | 34.48 | 4.97 | 5.55 | |
| 500 | .0893 | .9107 | 7.03 | 235 | 33.43 | 4.81 | 5.39 | |
| 50 | .0983 | .9017 | 7.10 | 227 | 31.97 | 4.60 | 5.18 | |
| 600 | .1072 | .8928 | 7.17 | 219 | 30.54 | 4.40 | 4.98 | |
| 50 | .1162 | .8838 | 7.24 | 215 | 29.70 | 4.28 | 4.86 | |
| 700 | .1251 | .8749 | 7.32 | 212 | 28.96 | 4.17 | 4.75 | |
| 50 | .1340 | .8640 | 7.41 | 209 | 28.21 | 4.06 | 4.64 | |
| 800 | .1430 | .8570 | 7.47 | 207 | 27.71 | 3.99 | 4.57 | |
| 50 | .1519 | .8481 | 7.55 | 207 | 27.42 | 3.95 | 4.53 | |
| 900 | .1608 | .8392 | 7.63 | 206 | 27.00 | 3.89 | 4.47 | |
| 50 | .1698 | .8302 | 7.71 | 205 | 26.59 | 3.83 | 4.41 | |
| 1000 | .1787 | .8213 | 7.79 | 204 | 26.19 | 3.77 | 4.35 | |
| 50 | .1876 | .8124 | 7.88 | 205 | 26.02 | 3.75 | 4.33 | |
| 1100 | .1966 | .8034 | 7.97 | 204 | 25.60 | 3.69 | 4.27 | |
| 50 | .2055 | .7945 | 8.06 | 203 | 25.19 | 3.63 | 4.21 | |
| 1200 | .2144 | .7856 | 8.15 | 202 | 24.79 | 3.57 | 4.15 | |

2.725
0.58
3.305

# TRIAXIAL SHEAR TEST

( back pressure and pore pressure data )

saturation

PROJECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533D DATE : 10/8/95

BORING : SAMPLE : 75% Dr (4 psi) DEPTH :

| Increment Number | Time | Elapsed Time Minutes | Chamber Pressure psi | Applied Back Pressure psi | Measured Pore Pressure psi | Pipette Reading cc | Volume Inflow cc | Dial Indicator Reading Inches |
|---|---|---|---|---|---|---|---|---|
| 1 | 3:12 PM | 0 | 4 | 0 | 0 | 0.0 | 0 | 0.100 |
| | | 4 | ✓ | ✓ | 0.6-0.3 | 39.0 | +39.0 | |
| 2 | 3:20 PM | 0 | 4 | 0 | 0.3 | 0 | +39.0 | |
| | | 5 | ✓ | ✓ | ✓ | 41.5 | +80.5 | |
| 3 | 3:27 PM | 0 | 10.0 | 6.0 | 0.3 | 0 | +80.5 | |
| | | 2 | ✓ | ✓ | 6.0 | 50.0 | +130.5 | |
| 4 | 3:32 PM | 0 | 20.0 | 16.0 | 6.0 | 0 | +130.5 | |
| | | 2 | ✓ | ✓ | 16.0 | 41.1 | +171.6 | |
| 5 | 3:40 PM | 0 | 20.0 | 19.0 | 16.0 | 0 | +171.6 | |
| | | 1 | ✓ | ✓ | 19.0 | 3.3 | +174.9 | |
| 6 | 3:41 PM | 0 | 30.0 | 29.0 | 19.0 | 3.3 | +174.9 | |
| | | 2 | ✓ | ✓ | 29.0 | 17.2 | +188.8 | |
| | | | | | | | | |
| 7 | 3:44 PM | 0 | 40.0 | 39.0 | 29.0 | 17.2 | +188.8 | |
| | | 1 | ✓ | ✓ | 39.0 | 24.3 | +195.9 | |
| 8 | 3:46 PM | 0 | 41.0 | 40.0 | 39.0 | 24.3 | +195.9 | |
| | | 1 | ✓ | ✓ | 40.0 | 22.5 | +194.1 | |
| | | 5 | ✓ | ✓ | ✓ | 20.0 | +191.6 | |
| | | | | | | | | |
| 9 | 3:57 PM | 0 | 40.5 | 40.0 | 40.0 | 20.0 | +191.6 | |
| | | 1 | ✓ | ✓ | ✓ | 22.5 | +194.1 | |
| | | | | | | | | |
| 10 | 4:00 | 0 | 41.0 | 40.0 | 40.0 | 22.5 | +194.1 | |
| | | 1 | ✓ | ✓ | ✓ | 21.5 | +193.1 | |
| | | 12 | ✓ | ✓ | ✓ | 15.0 | +186.6 | |
| | | 20 | ✓ | ✓ | ✓ | 10.0 | +181.6 | |
| | RESET | PIPETTE | | ✓ | ✓ | 42.5 | +181.6 | |
| | | | | | | 16.3 | +120.4 | 26.2+35.0 = 61.2 |

Dial indicator reading before saturation 0.100 in.

Dial indicator reading after saturation 0.100 in.

Change in height during saturation (ΔHs) 0.000 in.

EMARKS : B = 7.0/10.0 = 70% @ 4:00 PM RESET to 41 psi & 40 psi. (CONNECTED TOP & BOTTOM TO BACK-PRESSURE BURETTES)

10/12/95 B = 9.8/10.0 = 98%

# TRIAXIAL SHEAR TEST

Preliminary Consolidation

PROJECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533D DATE : 10/8-12/95

BORING : SAMPLE : 75% Dr (4psi) DEPTH :

| Increment Number | Time | Elapsed Time Minutes | Chamber Pressure psi . | Applied Back Pressure psi | Measured Pore Pressure psi | Pipette Reading cc | Volume Change (ΔV) cc | Dial Indicator Reading Inches |
|---|---|---|---|---|---|---|---|---|
| 1 | 9:17 PM | 0 | 44.0 | 40.0 | 40.0 | 50.0 | 0 | 0.100 |
|  |  | 1 | ✓ | ✓ | ✓ | 49.0 | -1.0 |  |
| 10/9/95 | 7:25 AM |  |  |  |  |  |  |  |
| 10/10/95 | 12:15 PM |  | ✓ | ✓ | 40.1 | 49.0 | -1.0 |  |
| 10/11/95 | 10:25 AM |  | ✓ | ✓ | 40.1 | 49.1 | -0.9 |  |
| 10/12/95 | 10:50 Am |  | ✓ | ✓ | 40.0 | 49.1 | -0.9 | 0.104 |

Dial indicator reading before consolidation 0.100 in.

Dial indicator reading after consolidation 0.104 in.

Change in height during consolidation ($\Delta H_o$) 0.004 in.

EMARKS :

## TRIAXIAL SHEAR TEST

CONSOLIDATION/SATURATION CALCULATIONS

PROJECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533 D DATE : 10/12/95

BORING : ______ SAMPLE : 75% Dr (4psi) DEPTH : ______

### ASTM D-4767

Hc - Ho - ΔHo
where :
Ho - initial height of specimen -. in.
ΔHo - change of height in specimen after consolidation - in.

Ac - ( Vo - ΔVsat - ΔVc ) / Hc
where :
Vo - initial volume of specimen - in.$^3$
ΔVc - change in volume during consolidation ( burette ) - in.$^3$
ΔVsat - change in volume during saturation - in.$^3$ as follows :
ΔVsat - 3Vo ΔHs / Ho
where :
ΔHs - change in height during saturation - in.

Ho - 5.600"
ΔHo - 0.004"
Vo - 35.850 in$^3$
ΔVc - 0.0549 in$^3$
ΔVsat - 0.00 in$^3$
ΔHs - 0.00"

therefore :
Hc - 5.596"
Ac - 6.397 in$^2$

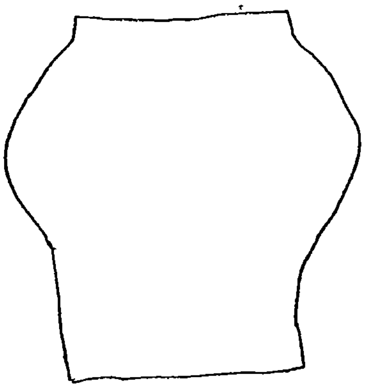
---

Piston Load (saturation) 44 psi X .1963 in$^2$ = 8.64# = 3918 gms.

Piston Load (shear) 4 psi X .1963 in$^2$ = 0.79# = 356 gms.

ΔVc = 0.9cc = 0.0549 in$^3$

Ac = (35.850 in$^3$ - 0.00 in$^3$ - 0.0549 in$^3$)/5.596" = 35.7952 in$^3$/5.596" = 6.397 in$^2$



## TRIAXIAL COMPRESSION TEST DATA AND COMPUTATION SHEET

PROJECT : Bottom Ash Testing - Spurn Plant JOB NO : T-533D DATE : 10/12-22/95

BORING : SAMPLE : 75% Dr (8 psi) DEPTH :

MATERIAL :

Circ. : 8.97"
Height : 5.60" Diam. : 2.855" Area : 6.402 $in^2$
Volumn : 35.8501 $in^3$ = 587.48 $Cm^3$
DRY Wt. of Sple. : 565.55 gms.
UDW : 60.1 pcf
Vol. Change - cc :
Type of Test : CD
Load Cell : 5K

| Moisture Content | Before Test | After Test |
|---|---|---|
| Pan No. : | N.A. | A-12 |
| Wet Wt. Sple. + Pan : | | 928.74 |
| Dry Wt. Sple. + Pan : | | 728.92 |
| Wt. of Pan : | | 166.16 |
| Wt. of Dry Soil : | | 562.76 |
| Wt. of Water : | | 199.82 |
| % Moisture | | 35.5 |

Hc = 5.594" Ac = 6.33 $in^3$ Loading Rate = .005"/min.

| Dial Defl. Inchx$10^{-3}$ | Strain | 1 - Strain | Average Area | Load lbs. | Incremental Deviator Stress | | Total Vert. Stress | |
|---|---|---|---|---|---|---|---|---|
| | | | | | psi | ksf | ksf | |
| 0 | .0000 | 1.0000 | 6.33 | 0 | 0.00 | 0.00 | 1.15 | |
| 25 | .0045 | .9955 | 6.36 | 122 | 19.18 | 2.76 | 3.91 | |
| 50 | .0089 | .9911 | 6.39 | 162 | 25.35 | 3.65 | 4.80 | |
| 75 | .0134 | .9866 | 6.42 | 201 | 31.31 | 4.51 | 5.66 | |
| 100 | .0179 | .9821 | 6.45 | 239 | 37.05 | 5.34 | 6.49 | |
| 25 | .0223 | .9777 | 6.47 | 270 | 41.73 | 6.01 | 7.16 | |
| 50 | .0268 | .9732 | 6.50 | 295 | 45.38 | 6.54 | 7.69 | |
| 75 | .0313 | .9687 | 6.53 | 320 | 49.00 | 7.06 | 8.21 | |
| 200 | .0358 | .9642 | 6.57 | 340 | 51.75 | 7.45 | 8.60 | |
| 50 | .0447 | .9553 | 6.63 | 368 | 55.51 | 7.99 | 9.14 | |
| 300 | .0536 | .9464 | 6.69 | 386 | 57.70 | 8.31 | 9.46 | |
| 50 | .0626 | .9374 | 6.75 | 399 | 59.11 | 8.51 | 9.66 | 4.29 |
| 400 | .0715 | .9285 | 6.82 | 406 | 59.53 | 8.57 | 9.72 | 1.15 |
| 50 | .0804 | .9196 | 6.88 | 410 | 59.59 | 8.58 | 9.73 | 5.44 |
| 500 | .0894 | .9106 | 6.95 | 406 | 58.42 | 8.41 | 9.56 | |
| 50 | .0983 | .9017 | 7.02 | 408 | 58.12 | 8.37 | 9.52 | |
| 600 | .1073 | .8927 | 7.09 | 409 | 57.69 | 8.31 | 9.46 | |
| 50 | .1162 | .8838 | 7.16 | 407 | 56.84 | 8.19 | 9.34 | |
| 700 | .1251 | .8749 | 7.24 | 406 | 56.08 | 8.08 | 9.23 | |
| 50 | .1341 | .8659 | 7.31 | 405 | 55.40 | 7.98 | 9.13 | |
| 800 | .1430 | .8570 | 7.39 | 401 | 54.26 | 7.81 | 8.96 | |
| 50 | .1519 | .8481 | 7.46 | 399 | 53.49 | 7.70 | 8.85 | |
| 900 | .1609 | .8391 | 7.54 | 398 | 52.79 | 7.60 | 8.75 | |
| 50 | .1698 | .8302 | 7.62 | 396 | 51.97 | 7.48 | 8.63 | |
| 1000 | .1788 | .8212 | 7.71 | 396 | 51.31 | 7.40 | 8.55 | |
| 50 | .1877 | .8123 | 7.79 | 394 | 50.58 | 7.28 | 8.43 | |
| 1100 | .1966 | .8034 | 7.88 | 389 | 49.37 | 7.11 | 8.26 | |
| 50 | .2056 | .7944 | 7.97 | 388 | 48.68 | 7.01 | 8.16 | |
| 1200 | .2145 | .7855 | 8.06 | 383 | 47.52 | 6.84 | 7.99 | |

BBC&M ENGINEERING, INC.

# TRIAXIAL SHEAR TEST

( back pressure and pore pressure data )

saturation

.ROJECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533D DATE : 10/12-19/95

BORING : SAMPLE : 75% Dr (8psi) DEPTH :

| Increment Number | Time | Elapsed Time Minutes | Chamber Pressure psi | Applied Back Pressure psi | Measured Pore Pressure psi | Pipette Reading cc | | Volume Inflow cc (TOTAL) | Dial Indicator Reading Inches |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | TOP | B.T. | | |
| 1 | 9:35 PM | 0 | 8.0 | 0 | 0 | 3.5 | 20.5 | 0 | 0.100 |
| | | 2 | ✓ | 0 | 0.6 | 10.0 | 25.8 | + 11.8 | |
| 2 | 9:37 PM | 0 | 8.0 | 4 | 0.6 | 10.0 | 25.8 | +11.8 | |
| | | 2 | ✓ | ✓ | 3.7 | 37.0 | 50.0 | +63.0 | |
| | | 4 | ✓ | ✓ | 4.0 | 40.5 | 50.0 | +66.5 | |
| 3 | 9:44 PM | 0 | 8.0 | 6.0 | 4.0 | 0.0 | 0.0 | +66.5 | |
| | | 3 | ✓ | ✓ | 6.0 | 29.5 | 0.0 | + 96.0 | |
| 4 | 9:48 PM | 0 | 15.0 | 13.0 | 6.0 | 29.0 | 0.0 | +96.0 | |
| | | 3 | ✓ | ✓ | 13.0 | 37.0 | 50.0 | +154.0 | |
| 5 | 9:55 PM | 0 | 25.0 | 23.0 | 13.0 | 0.0 | 0.0 | +154.0 | |
| | | 2 | ✓ | ✓ | 23.0 | 0.0 | 47.0 | +201.0 | |
| 6 | 9:57 PM | 0 | 35.0 | 33.0 | 23.0 | 0.0 | 47.0 | +201.0 | |
| | | 2 | ✓ | ✓ | 33.0 | 26.6 | 47.0 | + 227.60 | |
| 7 | 10:00 PM | 0 | 41.0 | 40.0 | 33.0 | 26.6 | 47.0 | +227.6 | |
| | | 1 | ✓ | ✓ | 40.0 | 39.5 | 47.0 | + 240.5 | |
| | | | RESET | TO SATURATE | | | | | |
| | | | | T B | | | | | |
| | 10:05 PM | 0 | 41.0 | 40.0 / 40.0 | 40.0 | 41.5 | 20.4 | +240.5 | |
| 10/13/95 | 7:05 AM | | ✓ | ✓ ✓ | ✓ | 44.2 | 23.7 | +246.5 | |
| 10/15/95 | 10:30 AM | | ✓ | ✓ | ✓ | 45.0 | 43.7 | +267.3 | |
| 10/16/95 | 8:05 PM | | ✓ | ✓ | ✓ | ✓ | 49.5 | +273.1 | |
| 10/17/95 | 1:30 PM | | ✓ | ✓ | ✓ | 48.0 | 49.5 | +276.1 | |
| 10/17/95 | 1:32 PM | | ✓ | ✓ | ✓ | 20.8 | 20.0 | +276.1 | RESET |
| 10/19/95 | 8:05 AM | | ✓ | ✓ | ✓ | 20.7 | 22.5 | +278.5 | +2.4 |
| 10/19/95 | 10:20 AM | | ✓ | ✓ | ✓ | ✓ | 23.4 | +279.4 | +0.9 |

Dial indicator reading before saturation 0.100 in.

Dial indicator reading after saturation 0.100 in.

Change in height during saturation (ΔHs) 0.000 in.

HARKS : - USED TOP & BOTTOM PIPETTES - B = 2.5/5.0 = 50% 10/19/95

BBC&M ENGINEERING, INC.

# TRIAXIAL SHEAR TEST

Preliminary Consolidation

PROJECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533D DATE : 10/19-22/95

BORING : SAMPLE : 75% Dr (8 psi) DEPTH :

| Increment Number | Time | Elapsed Time Minutes | Chamber Pressure psi | Applied Back Pressure psi | Measured Pore Pressure psi | Pipette Reading cc T | B | Volume Change (ΔV) cc | Dial Indicator Reading Inches |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 10:20 AM | 0 | 48.0 | 40.0 | 40.0 | 19.9 | 24.1 | 0 | 0.100 |
| | | 1 | ✓ | ✓ | ✓ | 18.6 | 22.5 | (-1.3)+(-1.6) | (-2.9) |
| | 11:05 | 25 | — | ✓ | — | 21.0 | 19.7 | (+2.4)+(-2.8) | (-0.4)+(-2.9) |
| | 10:35 PM | | ✓ | ✓ | ✓ | 14.0 | 26.7 | -3.3 total | (-7.0)+(+7.0) |
| | | | | | | | | | |
| 10/22/95 | 10:50 AM | | ✓ | ✓ | ✓ | 33.5 | 11.1 | | (-19.5)+(+15.6) |
| | | | | | | | | -7.2 total | -3.9 |

Dial indicator reading before consolidation 0.100 in.

Dial indicator reading after consolidation 0.106 in.

Change in height during consolidation ($\Delta H_o$) 0.006 in.

REMARKS :

BBC&M ENGINEERING, INC.

# TRIAXIAL SHEAR TEST

## CONSOLIDATION/SATURATION CALCULATIONS

OJECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533D DATE : 10/22/95

BORING : ______ SAMPLE : 75% Dr (8psi) DEPTH : ______

### ASTM D-4767

Hc - Ho - ΔHo

where :

Ho - initial height of specimen - in.

ΔHo - change of height in specimen after consolidation - in.

Ac - ( Vo - ΔVsat - ΔVc ) / Hc

where :

Vo - initial volume of specimen - in.$^3$

ΔVc - change in volume during consolidation ( burette ) - in.$^3$

ΔVsat - change in volume during saturation - in.$^3$ as follows :

ΔVsat - 3Vo ΔHs / Ho

where :

ΔHs - change in height during saturation - in.

Ho - 5.600"
ΔHo - 0.006"
Vo - 35.8501 in$^3$
ΔVc - 0.4394 in$^3$
ΔVsat - 0.00 in$^3$
ΔHs - 0.00"

therefore :
Hc - 5.594"
Ac - 6.33 in$^2$

---

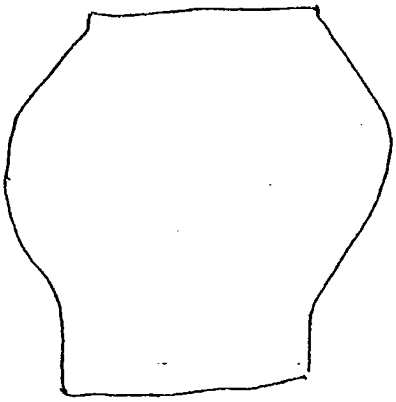
Piston Load = (saturation) 48psi X .1963 in$^2$ = 9.42# = 4274 gms.

Piston Load = (shear) 8psi X .1963 in$^2$ = 1.57# = 712 gms.

ΔVc = 7.2cc = 0.4394 in$^3$

ΔVsat = 3 X 35.8501 in$^3$ X 0.00"/5.60" = 0.00 in$^3$

Ac = (35.8501 in$^3$ - 0.00 in$^3$ - 0.4394 in$^3$)/5.594" = 35.4107 in$^3$/5.594 in = 6.53 in$^2$



# TRIAXIAL COMPRESSION TEST DATA AND COMPUTATION SHEET

PROJECT : Bottom Ash Testing - Spoan Plant JOB NO. : T-533D DATE : 10/22-25/95

BORING : SAMPLE : 75% Dr (16 psi) DEPTH :

MATERIAL :

Circ. : 8.97"

Height : 5.60" Diam. : 2.855" Area : 6.402 in²

Volumn : 35.8501 in³ = 587.48 cm³

Dry Wt. of Sple. : 565.55 gms.

UDW : 60.1 pcf

Vol. Change - cc :

Type of Test : CD

Load Cell : 5K

| Moisture Content | Before Test | After Test |
|---|---|---|
| Pan No. : | | JJ-6 |
| Wet Wt. Sple. + Pan : | | 912.58 |
| Dry Wt. Sple. + Pan : | | 685.48 |
| Wt. of Pan : | NA | 122.18 |
| Wt. of Dry Soil : | | 563.30 |
| Wt. of Water : | | 227.10 |
| % Moisture | | 40.3 |

Hc = 5.594" Ac = 6.37 in² Loading Rate = 0.005"/min.

| Dial Defl. Inchx10$^{-3}$ | Strain | 1 - Strain | Average Area | Load lbs. | Incremental Deviator Stress psi | Incremental Deviator Stress ksf | Total Vert. Stress ksf | |
|---|---|---|---|---|---|---|---|---|
| 0 | .0000 | 1.0000 | 6.37 | 0 | 0.00 | 0.00 | 2.30 | |
| 25 | .0045 | .9955 | 6.40 | 178 | 27.81 | 4.01 | 6.31 | |
| 50 | .0089 | .9911 | 6.43 | 248 | 38.57 | 5.55 | 7.85 | |
| 75 | .0134 | .9866 | 6.46 | 299 | 46.28 | 6.67 | 8.97 | |
| 100 | .0179 | .9821 | 6.49 | 341 | 52.54 | 7.57 | 9.87 | |
| 25 | .0223 | .9777 | 6.52 | 382 | 58.59 | 8.44 | 10.74 | |
| 50 | .0268 | .9732 | 6.55 | 414 | 63.21 | 9.10 | 11.40 | |
| 75 | .0313 | .9687 | 6.58 | 443 | 67.33 | 9.69 | 11.99 | |
| 200 | .0358 | .9642 | 6.61 | 477 | 72.16 | 10.39 | 12.69 | |
| 50 | .0447 | .9553 | 6.67 | 524 | 78.56 | 11.31 | 13.61 | |
| 300 | .0536 | .9464 | 6.73 | 561 | 83.36 | 12.00 | 14.30 | |
| 50 | .0626 | .9374 | 6.80 | 585 | 86.03 | 12.39 | 14.69 | 6.34 |
| 400 | .0715 | .9285 | 6.86 | 600 | 87.46 | 12.59 | 14.89 | 2.30 |
| 50 | .0804 | .9196 | 6.93 | 610 | **88.02** | **12.68** | **14.98** | **8.64** |
| 500 | .0894 | .9106 | 7.00 | 616 | 88.00 | 12.67 | 14.97 | |
| 50 | .0983 | .9017 | 7.06 | 616 | 87.25 | 12.56 | 14.86 | |
| 600 | .1073 | .8927 | 7.14 | 612 | 85.71 | 12.34 | 14.64 | |
| 50 | .1162 | .8838 | 7.21 | 612 | 84.88 | 12.22 | 14.52 | |
| 700 | .1251 | .8749 | 7.28 | 607 | 83.38 | 12.01 | 14.31 | |
| 50 | .1341 | .8659 | 7.36 | 607 | 82.47 | 11.88 | 14.18 | |
| 800 | .1430 | .8570 | 7.43 | 606 | 81.56 | 11.74 | 14.04 | |
| 50 | .1519 | .8481 | 7.51 | 606 | 80.69 | 11.62 | 13.92 | |
| 900 | .1609 | .8391 | 7.59 | 605 | 79.71 | 11.48 | 13.78 | |
| 50 | .1698 | .8302 | 7.67 | 605 | 78.88 | 11.36 | 13.66 | |
| 1000 | .1788 | .8212 | 7.76 | 604 | 77.84 | 11.21 | 13.51 | |
| 50 | .1877 | .8123 | 7.84 | 604 | 77.04 | 11.09 | 13.39 | |
| 1100 | .1966 | .8034 | 7.93 | 603 | 76.04 | 10.95 | 13.25 | |
| 50 | .2056 | .7944 | 8.02 | 603 | 75.19 | 10.83 | 13.13 | |
| 1200 | .2145 | .7855 | 8.11 | 602 | 74.23 | 10.69 | 12.99 | |

BBC&M ENGINEERING, INC.

# TRIAXIAL SHEAR TEST

( back pressure and pore pressure data )

saturation

PROJECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533D DATE : 10/22-24/95

BORING : SAMPLE : 75% Dr (16 psi) DEPTH :

| Increment Number | Time | Elapsed Time Minutes | Chamber Pressure psi | Applied Back Pressure psi | Measured Pore Pressure psi | Pipette Reading cc | Volume Inflow cc | Dial Indicator Reading Inches |
|---|---|---|---|---|---|---|---|---|
| 1 | 2:19PM | 0 | 4.0 | 0.00 | 0.00 | 60.0T / 60.0B | 0 | 0.100 |
| | | 1 | | | | 6.7 10.5 | | |
| | OPEN TRANSDUCER - CLOSE TOP | | | | | 6.7 50.0 | + 53.3 | |
| | OPEN TRANSDUCER - OPEN TOP | | | | | 39.0 0.0 | +32.3 | |
| | | | | | | 39.0 50.0 | + 50.0 | |
| | | | | | | 0.0 0.0 | 135.6 TOTAL | |
| | | | | | | 40.5 50.0 | + 90.5 | |
| | | | | | | 0.0 0.0 | 225.5 TOTAL | |
| | 2:50 PM | ~~31~~ | 4.0 | 0.0 | 0.00 | 9.3 22.0 | +31.3 = 256.8 TOTAL | |
| | 9:50 PM | | ✓ | ✓ | ✓ | 15.3 16.0 | 256.8 TOTAL | |
| 2 | 9:50 PM | 0 | 10.0 | 8.0 | 0.0 | 15.3 16.0 | | |
| | | 5 | ✓ | ✓ | 8.0 | 20.0 34.5 | +38.2 = 295.0 TOTAL | |
| 3 | 9:55 PM | 0 | 20.0 | 18.0 | 8.0 | 20.0 34.5 | 295.0 | |
| | | 2 | ✓ | ✓ | 18.0 | 36.8 35.0 | +17.3 = 312.3 TOTAL | |
| 4 | 9:57 PM | 0 | 30.0 | 28.0 | 18.0 | 36.8 35.0 | 312.3 | |
| | | 2 | ✓ | ✓ | 28.0 | 40.9 36.5 | +5.6 = 317.9 TOTAL | |
| 5 | 9:59 PM | 0 | 40.0 | 38.0 | 28.0 | 40.9 36.5 | 317.9 | |
| | | 3 | | | 38.0 | 41.2 41.1 | +4.9 = 322.8 TOTAL | |
| 6 | 10:02 PM | 0 | 42.0 | 40.0 | 38.0 | 41.2 41.1 | 322.8 | |
| | | 1 | ✓ | ✓ | 40.0 | 40.6 44.6 | +2.9 = 325.7 TOTAL | |
| 10/23/95 | 9:00AM | | ✓ | ✓ | ✓ | 43.5 47.2 | +5.5 = 331.2 TOTAL | |
| | 8:10 PM | | ✓ | | ✓ | 51.3 41.2 | +1.8 = 333.0 TOTAL | |
| | | RESET | ✓ | ✓ | ✓ | 20.0 41.2 | 333.0 | |
| | 1:00 PM | | ✓ | ✓ | ✓ | 29.9 29.7 | +1.8 = 334.8 | 0.100 |

Dial indicator reading before saturation 0.100 in.

Dial indicator reading after saturation 0.100 in.

Change in height during saturation (ΔHs) 0.000 in.

REMARKS : 10/23/95 B = 3.8/5.0 = 76% @ 8:15PM B = 4.2/5.0 = 84% @ 1:00PM B = 4.4/5.0 = 88%

BBC&M ENGINEERING, INC.

## TRIAXIAL SHEAR TEST

### Preliminary Consolidation

PROJECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533D DATE : 10/24-25/95

BORING : ______ SAMPLE : 75% Dr (16 psi) DEPTH : ______

| Increment Number | Time | Elapsed Time Minutes | Chamber Pressure psi | Applied Back Pressure psi | Measured Pore Pressure psi | Pipette Reading cc | Volume Change (ΔV) cc | Dial Indicator Reading Inches |
|---|---|---|---|---|---|---|---|---|
| 1 | 1:05PM | 0 | 56.0 | 40.0 | 40.0 | 29.7 | 0 | 0.100 |
| | | 1 | ✓ | ✓ | 40.1 | 29.6 | | |
| 10/25/95 | 7:00 AM | | ✓ | ✓ | ✓ | 26.1 | -3.6 | 0.106 |

Dial indicator reading before consolidation 0.100 in.

Dial indicator reading after consolidation 0.106 in.

Change in height during consolidation ($\Delta H_0$) 0.006 in.

REMARKS : ______

# TRIAXIAL SHEAR TEST

## CONSOLIDATION/SATURATION CALCULATIONS

JECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533D DATE : 10/25/95

BORING : ________ SAMPLE : 75% Dr (16 psi) DEPTH : ________

## ASTM D-4767

Hc - Ho - ΔHo

where :

Ho - initial height of specimen - in.

ΔHo - change of height in specimen after consolidation - in.

Ac - ( Vo - ΔVsat - ΔVc ) / Hc

where :

Vo - initial volume of specimen - in.$^3$

ΔVc - change in volume during consolidation ( burette ) - in.$^3$

ΔVsat - change in volume during saturation - in.$^3$ as follows :

ΔVsat - 3Vo ΔHs / Ho

where :

ΔHs - change in height during saturation - in.

Ho - 5.600"

ΔHo - 0.006"

Vo - 35.8501 in$^3$

ΔVc - 0.2197 in$^3$

ΔVsat - 0.00 in$^3$

ΔHs - 0.00 in$^3$

therefore :

Hc - 5.594"

Ac - 6.369 in$^2$

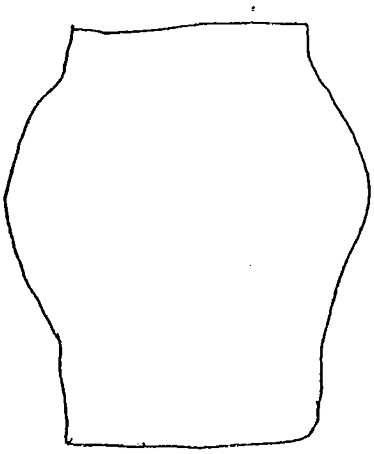
---

Piston Load (Saturation) = 56 psi x .1963 in$^2$ = 10.99# = 4986 gms.

Piston Load (Shear) = 16 psi x .1963 in$^2$ = 3.14# = 1425 gms.

ΔVc = 3.6 cc = 0.2197 in$^3$

Ac = (35.8501 in$^3$ - 0.00 in$^3$ - 0.2197 in$^3$)/5.594" = 35.6304 in$^3$/5.594" = 6.37 in$^2$



# TRIAXIAL COMPRESSION TEST DATA AND COMPUTATION SHEET

PROJECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533D DATE : 10/25-28/95

BORING : SAMPLE : 75%Dr (32 psi) DEPTH :

MATERIAL :

Circ. : 8.97"

Height : 5.60" Diam. : 2.855" Area : 6.402 in²

Volumn : 35.8501 in³ = 587.48 cm³

Dry Wt. of Sple. : 585.55 gms.

UDW : 60.1 pcf

Vol. Change - cc :

Type of Test : CD

Load Cell : 5k

| Moisture Content | Before Test | After Test |
|---|---|---|
| Pan No. : | | TOG-10 |
| Wet Wt. Sple. + Pan : | | 893.24 |
| Dry Wt. Sple. + Pan : | | 686.38 |
| Wt. of Pan : | NA | 124.56 |
| Wt. of Dry Soil : | | 561.82 |
| Wt. of Water : | | 206.86 |
| % Moisture | | 36.8 |

Hc = 5.558" Ac = 6.227 in² LOADING RATE = 0.005"/MIN.

| Dial Defl. Inchx10$^{-3}$ | Strain | 1 - Strain | Average Area | Load lbs. | Incremental Deviator Stress | | Total Vert. Stress ksf | |
|---|---|---|---|---|---|---|---|---|
| | | | | | psi | ksf | | |
| 0 | .0000 | 1.0000 | 6.23 | 0 | 0.00 | 0.00 | 4.61 | |
| 25 | .0045 | .9955 | 6.26 | 129 | 20.61 | 2.97 | 7.58 | |
| 50 | .0090 | .9910 | 6.29 | 193 | 30.68 | 4.42 | 9.03 | |
| 75 | .0135 | .9865 | 6.32 | 260 | 41.14 | 5.92 | 10.53 | |
| 100 | .0180 | .9820 | 6.34 | 318 | 50.16 | 7.22 | 11.83 | |
| 25 | .0225 | .9775 | 6.37 | 376 | 59.03 | 8.50 | 13.11 | |
| 50 | .0270 | .9730 | 6.40 | 424 | 66.25 | 9.54 | 14.15 | |
| 75 | .0315 | .9685 | 6.43 | 472 | 73.41 | 10.57 | 15.18 | |
| 200 | .0360 | .9640 | 6.46 | 520 | 80.50 | 11.59 | 16.20 | |
| 50 | .0450 | .9550 | 6.52 | 607 | 93.10 | 13.41 | 18.02 | |
| 300 | .0540 | .9460 | 6.59 | 689 | 104.55 | 15.06 | 19.67 | |
| 50 | .0630 | .9370 | 6.65 | 770 | 115.79 | 16.67 | 21.28 | |
| 400 | .0720 | .9280 | 6.71 | 840 | 125.19 | 18.03 | 22.64 | |
| 50 | .0810 | .9190 | 6.78 | 875 | 129.06 | 18.58 | 23.19 | |
| 500 | .0900 | .9100 | 6.85 | 910 | 132.85 | 19.13 | 23.74 | |
| 50 | .0990 | .9010 | 6.91 | 946 | 136.90 | 19.71 | 24.32 | |
| 600 | .1080 | .8920 | 6.98 | 991 | 141.98 | 20.44 | 25.05 | |
| 50 | .1169 | .8831 | 7.05 | 1020 | 144.68 | 20.83 | 25.44 | |
| 700 | .1259 | .8741 | 7.13 | 1040 | 145.86 | 21.00 | 25.61 | |
| 50 | .1349 | .8651 | 7.20 | 1063 | 147.64 | 21.26 | 25.87 | |
| 800 | .1439 | .8561 | 7.28 | 1083 | 148.76 | 21.42 | 26.03 | |
| 50 | .1529 | .8471 | 7.35 | 1105 | 150.34 | 21.65 | 26.26 | |
| 900 | .1619 | .8381 | 7.43 | 1125 | 151.41 | 21.80 | 26.41 | 10.95 |
| 50 | .1709 | .8291 | 7.51 | 1140 | 151.80 | 21.86 | 26.47 | 4.61 |
| 1000 | .1799 | .8201 | 7.60 | 1156 | 152.11 | 21.90 | 26.51 | 15.56 |
| 50 | .1889 | .8111 | 7.68 | 1150 | 149.74 | 21.56 | 26.17 | |
| 1100 | .1979 | .8021 | 7.77 | 1140 | 146.72 | 21.13 | 25.74 | |
| 50 | .2069 | .7931 | 7.86 | 1122 | 142.75 | 20.56 | 25.17 | |
| 1200 | .2159 | .7841 | 7.95 | 1111 | 139.75 | 20.12 | 24.73 | |
| | | | | | | | | |

BBC&M ENGINEERING, INC.

# TRIAXIAL SHEAR TEST

( back pressure and pore pressure data )

saturation

ROJECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533D DATE : 10/25-27/95

BORING : SAMPLE : 75% Dr (32 psi) DEPTH :

| Increment Number | Time | Elapsed Time Minutes | Chamber Pressure psi | Applied Back Pressure psi | Measured Pore Pressure psi | Pipette Reading cc | | Volume Inflow cc | Dial Indicator Reading Inches |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | TOP | BOT. | | |
| 1 | 8:51 PM | 0 | 4.0 | 0.00 | 0.00 | 5.0 | 6.3 | 0.00 | 0.100 |
| | | | ✓ | ✓ | ✓ | 42.8 | 50.0 | (+37.8)+(+43.7) | = (81.5) |
| | | | | | | — | 0 | 81.5 | |
| | | | | | | — | 50.0 | (0)+(+50.0) | = 131.5 |
| | | | | | | — | — | 131.5 | |
| | | | | | | 0 | 0 | | |
| | | | | | | 43.3 | 46.8 | (+43.3)+(+46.8) | = 90.1 |
| | | | | | | | | 221.6 TOTAL | |
| 2 | 9:20 PM | | 10.0 | 8.0 | 0.00 | 0 | 0 | 221.6 TOTAL | |
| | | | ✓ | ✓ | 8.0 | 19.5 | 19.5 | +39.0 | |
| 3 | | | 20.0 | 18.0 | 8.0 | 19.5 | 19.5 | 260.6 TOTAL | |
| | | | ✓ | ✓ | 18.0 | 27.2 | 25.2 | +13.4 | |
| 4 | | | 30.0 | 28.0 | 18.0 | 27.2 | 25.2 | 274.0 TOTAL | |
| | | | ✓ | ✓ | 28.0 | 30.5 | 30.5 | +8.6 | |
| 5 | | | 40.0 | 40.0 | 28.0 | 30.5 | 30.5 | 282.6 TOTAL | |
| | | | ✓ | ✓ | 40.0 | 33.5 | 33.2 | +5.7 | |
| | 9:34PM | | ✓ | ✓ | ✓ | | | 288.3 TOTAL | |
| 10/26/95 | 7:10 AM | | ✓ | ✓ | ✓ | 37.0 | 37.8 | +8.1 = 296.4 TOTAL | |
| 10/27/95 | 7:25 Am | | ✓ | ✓ | ✓ | 38.0 | 21.0 | +1.0 -16.5 = | -15.5 |
| | | | | | | | | 280.9 TOTAL | 0.100 |

Dial indicator reading before saturation 0.100 in.

Dial indicator reading after saturation 0.100 in.

Change in height during saturation (ΔHs) 0.00 in.

MARKS : 10/26/95 @ 7:10 Am B = 3.7/5.0 = 74% 10/27/95 @ 7:30 Am B = 4.3/5.0 = 86%

BBC&M ENGINEERING, INC.

# TRIAXIAL SHEAR TEST

## Preliminary Consolidation

PROJECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533D DATE : 10/27-28/95

BORING : ______ SAMPLE : 75% Dr (32 psi) DEPTH : ______

| Increment Number | Time | Elapsed Time Minutes | Chamber Pressure psi | Applied Back Pressure psi | Measured Pore Pressure psi | Pipette Reading cc | Volume Change (ΔV) cc | Dial Indicator Reading Inches |
|---|---|---|---|---|---|---|---|---|
| 1 | 7:30 AM | 0 | 56.0 | 40.0 | 40.0 | 36.0 | 0 | 0.100 |
|  |  | 1 | ✓ | ✓ | 40.2 | 29.3 | -6.7 |  |
|  |  |  |  |  |  |  |  |  |
| 2 | 7:32 AM | 0 | 72.0 | 40.0 | 40.2 | 29.3 | -6.7 |  |
|  |  | 1 | ✓ | ✓ | 40.4 | 20.0 | -16.0 |  |
| 10/28/95 | 9:10 AM |  | ✓ | ✓ | 40.0 | 15.7 | -20.3 | 0.142 |

Dial indicator reading before consolidation 0.100 in.
Dial indicator reading after consolidation 0.142 in.
Change in height during consolidation ($\Delta H_o$) 0.042 in.

REMARKS : ______

# TRIAXIAL SHEAR TEST

## CONSOLIDATION/SATURATION CALCULATIONS

PROJECT : Bottom Ash Testing - Sporn Plant JOB NO. : T-533D DATE : 10/28/95

BORING : ______ SAMPLE : 75% Dr (32 psi) DEPTH : ______

**ASTM D-4767**

Hc - Ho - ΔHo
where :
Ho - initial height of specimen - in.
ΔHo - change of height in specimen after consolidation - in.

Ac - ( Vo - ΔVsat - ΔVc ) / Hc
where :
Vo - initial volume of specimen - in.$^3$
ΔVc - change in volume during consolidation ( burette ) - in.$^3$
ΔVsat - change in volume during saturation - in.$^3$ as follows :
ΔVsat - 3Vo ΔHs / Ho
where :
ΔHs - change in height during saturation - in.

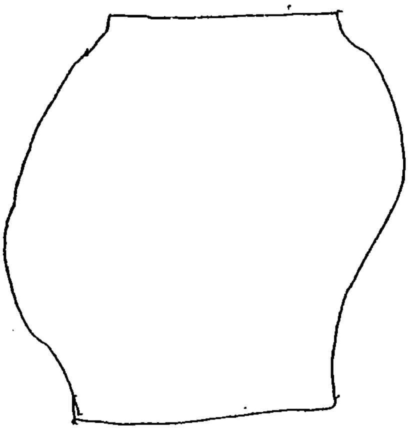
Ho - 5.600"
ΔHo - 0.042"
Vo - 35.8501 in$^3$
ΔVc - 1.2388 in$^3$
ΔVsat - 0.0000 in$^3$
ΔHs - 0.00"

therefore :
Hc - 5.558"
Ac - 6.227 in$^2$

Piston Load (Saturation) = 72 psi X .1963 in$^2$ = 14.13 # = 6411 gms.
Piston Load ( Shear ) = 32 psi X .1963 in$^2$ = 6.28 # = 2849 gms.

$\Delta V_c$ = 20.3 cc = 1.2388 in$^3$

$A_c$ = (35.8501 in$^3$ - 0.00 in$^3$ - 1.2388 in$^3$) / 5.558" = 34.6113 in$^3$ / 5.558" = 6.227 in$^2$



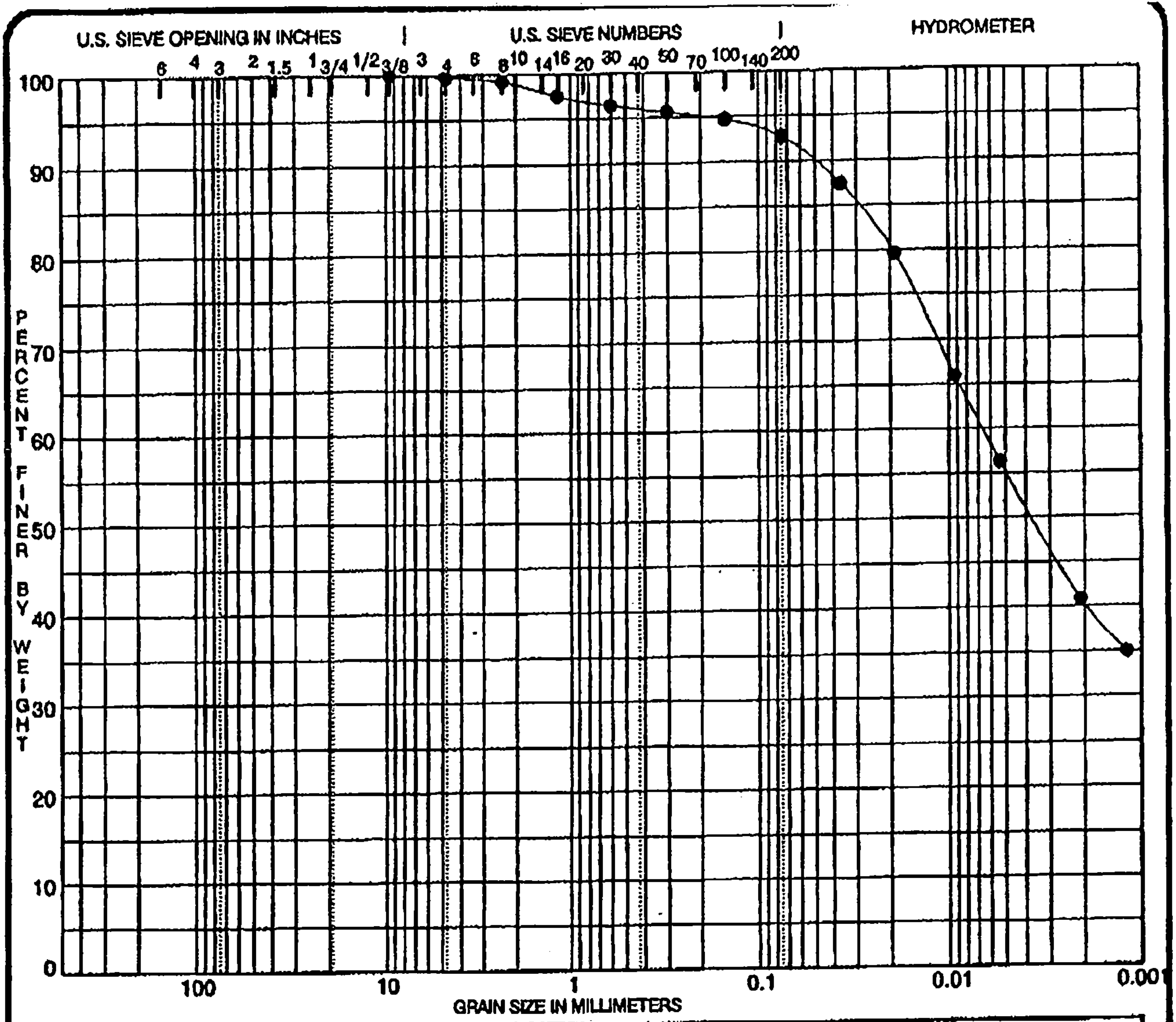
## SUMMARY OF MATERIAL PROPERTIES

PROJECT: SPORN PLANT ASH HAUL ROAD - ASH HAUL ROAD SLIP
NUMBER: 3015

| Borehole or Excav No. | Depth ft. | ASTM Description | ASTM Classification | Soil Type | Maximum Dry Density pcf | Optimum Moisture % | Liquid Limit % | Plastic Limit % | Gravel % | Sand % | <#200 Sieve % | <.002 mm % | Specific Gravity | Prmblty cm/sec | Natural Moisture % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-5619 | 0.0 | FAT CLAY | CH | | 105.2 | 20.6 | 51.6 | 22.3 | 0.3 | 7.0 | 92.7 | 40.3 | 2.75 | 5.44E-09 | 20.2 |

AEP Civil Engineering Laboratory, Groveport, Ohio

August 18, 1994 page 1 of 1



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | S-5619 | 0.0 | | 20.2 | 51.6 | 22.3 | 29.3 | 2.75 |
| | | | FAT CLAY CH | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | S-5619 | 0.0 | 9.500 | 0.007 | | | 0.3 | 7.0 | 92.7 | 40.3 |

PROJECT SPORN PLANT ASH HAUL ROAD - ASH HAUL ROAD SLIP

JOB NO. 3015

DATE 08/18/94

## GRADATION CURVES

American Electric Power Service Corp.
GROVEPORT, OHIO

JOB NO. 3015

DATE: AUG 18 94

PROJECT SPORN PLANT ASH HAUL ROAD

LOCATION: ASH HAUL ROAD SLIP

SOURCE OF MATERIAL S-5619 DEPTH 0.0 ft.

DESCRIPTION OF MATERIAL

ASTM DESCRIPTION FAT CLAY CH

| | | | |
|---|---|---|---|
| MAX. DRY DENSITY, pcf | 105.2 | OPTIMUM MOISTURE, % | 20.6 |
| SPECIFIC GRAVITY | 2.75 | | |
| SAMPLE HGT., mm | 49.670 | SAMPLE DIA., mm | 70.130 |
| CHAMBER PRESSURE, psi | 80.0 | BACK PRESSURE, psi | 70.0 |
| B-PARAMETER | 0.98 | EFFECTIVE PRESSURE, psi | 10.0 |
| INITIAL HEAD, mm | 1778.8 | | |

| | BEFORE | AFTER |
|---|---|---|
| WATER CONTENT, % | 22.0 | 24.2 |
| WET DENSITY, pcf | 125.5 | |
| DRY DENSITY, pcf | 102.8 | |
| SATURATION, % | 90.60 | |
| VOID RATIO | 0.6693 | |

PERMEABILITY COEFFICIENT K, cm/sec 5.44E-09

## FLEXIBLE-MEMBRANE PERMEABILITY TEST

American Electric Power Service Corp.
Groveport, Ohio

AEP

JOB NO. 3015

DATE: 08/18/94

PROJECT SPORN PLANT ASH HAUL ROAD

LOCATION: ASH HAUL ROAD SLIP

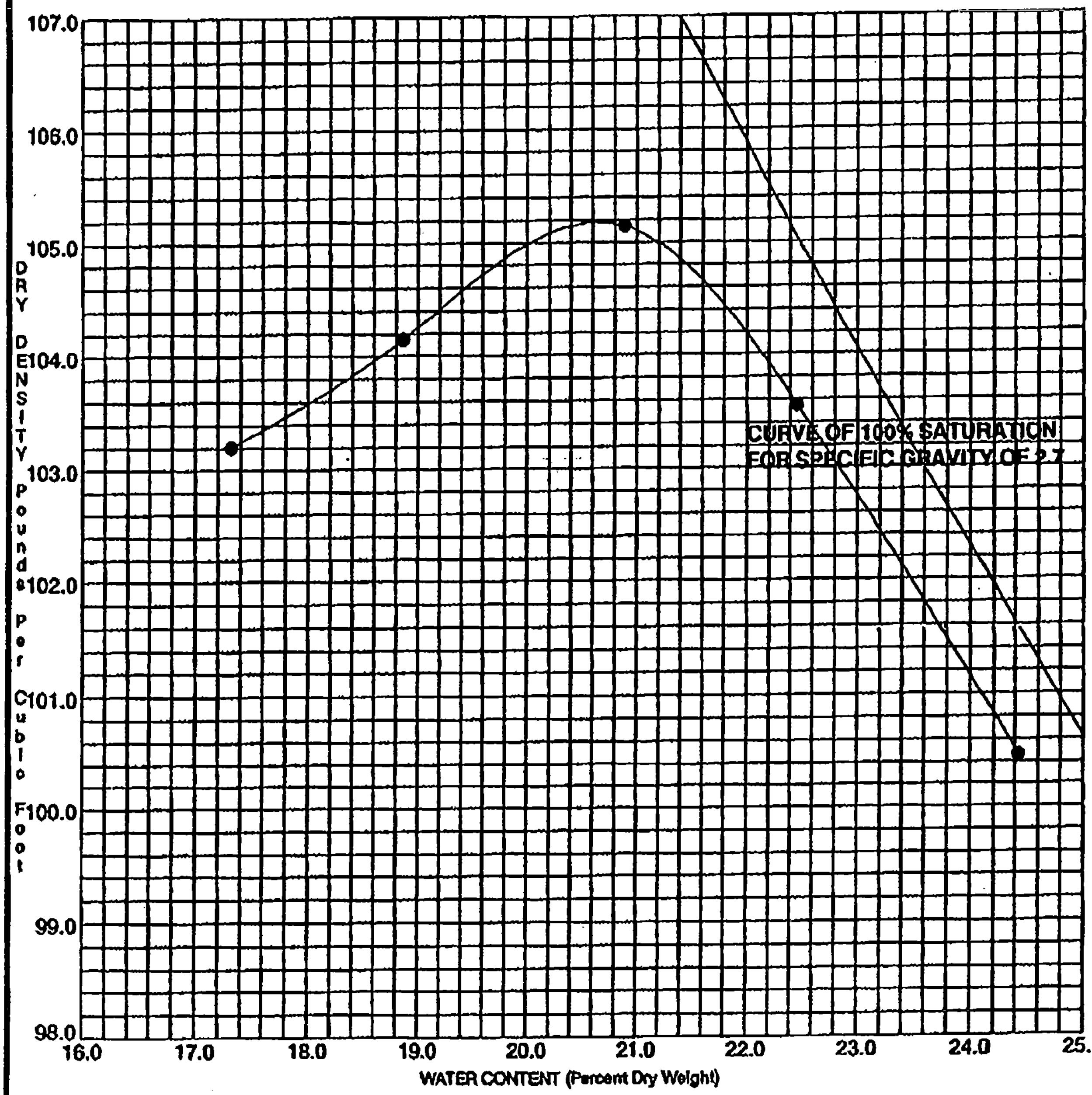
SOURCE OF MATERIAL S-5619

DEPTH 0.0 FT.

DESCRIPTION OF MATERIAL

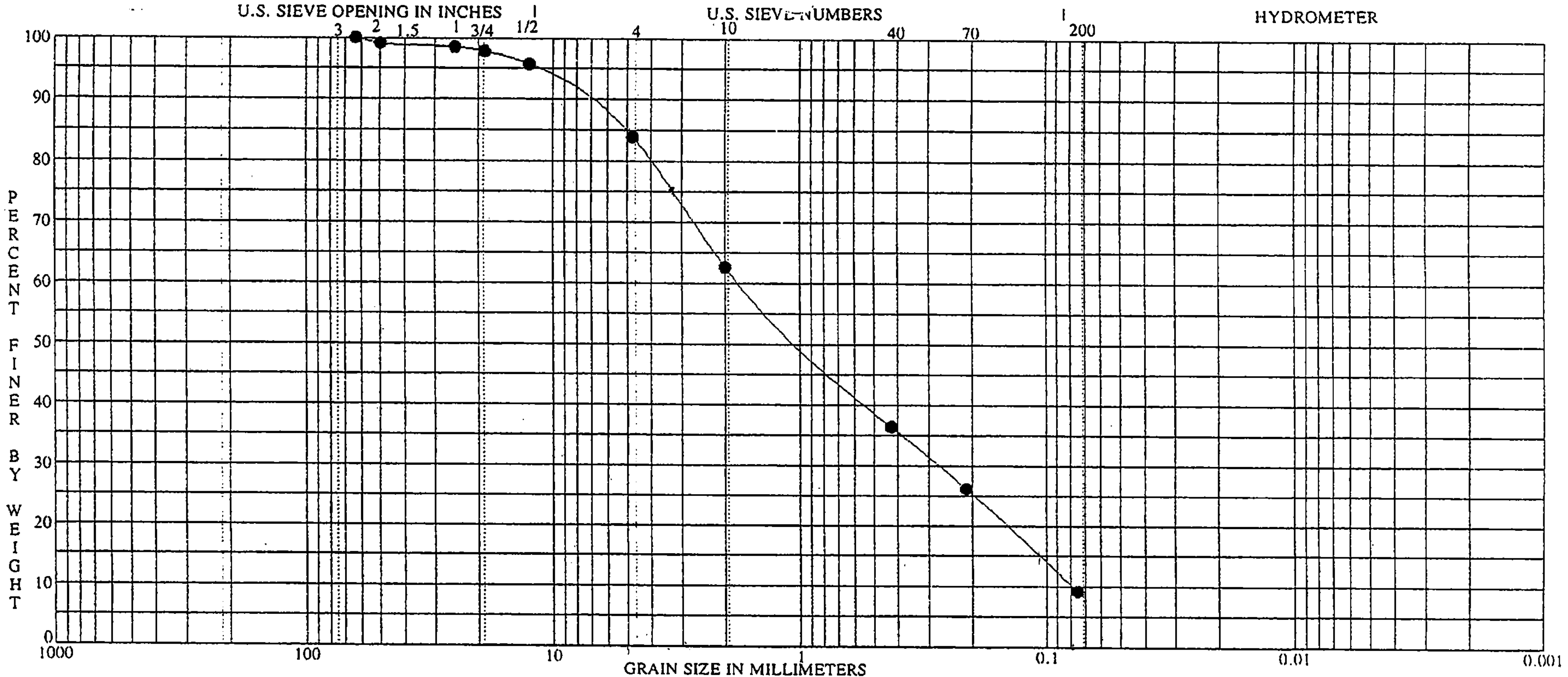
ASTM DESCRIPTION FAT CLAY CH

METHOD ASTM D698-91 MTHD A MAX. DRY DENSITY 105.2 PCF OPTIMUM MOISTURE 20.6 %



# MOISTURE-DENSITY RELATIONSHIP

American Electric Power Service Corp.
Groveport, Ohio



| BOULDERS | COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|---|
| | | coarse | fine | coarse | medium | fine | |

| | Specimen Identification - Depth | | Classification | MAX. Density | MIN. Density | Specific Gravity |
|---|---|---|---|---|---|---|
| ● | SPORN PLANT | BUCKET | **BOTTOM ASH** : Dark-gray and gray fine to coarse sand, little fine to coarse gravel, trace silt. | 65.2 | 48.6 | 2.54 |

| | Specimen Identification - Depth | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | SPORN PLANT | BUCKET | 63.0000 | 1.7150 | 0.2735 | 0.0787 | 16.1 | 74.7 | 9.2 | |

BBC&M ENGINEERING, INC

## GRADATION CURVE

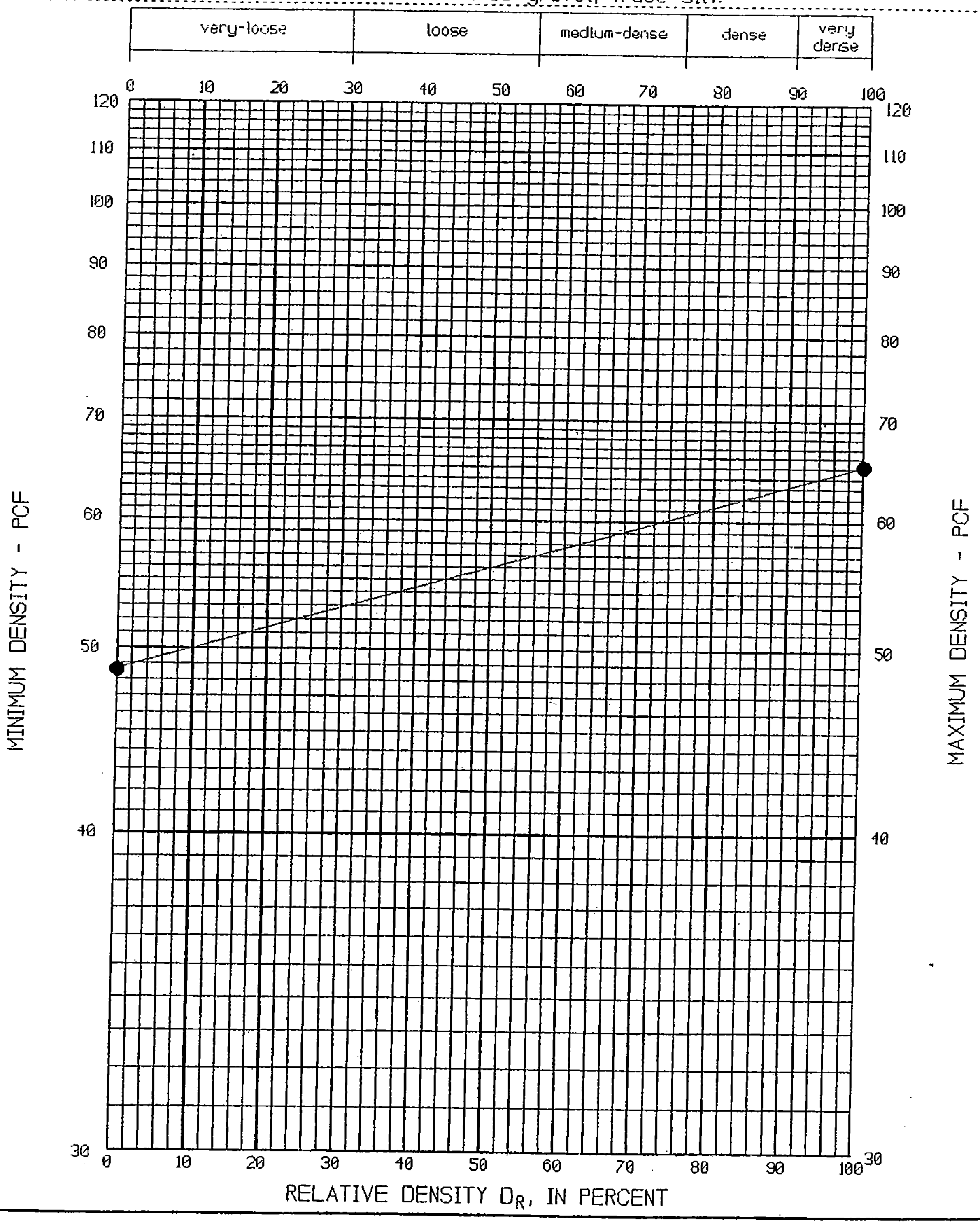
PROJECT Bottom Ash Testing - Sporn Plant
LOCATION New Haven, West Virginia
JOB NO. T533D DATE 10/27/95

PLATE

# RELATIVE DENSITY - MAX/MIN METHOD

Project : Sporn Fly Ash Pond Dike Remediation
Location : New Haven, West Virginia
Sample : Bucket
Material : Bottom Ash : Dark-gray and gray fine to coarse sand,
little fine to coarse gravel, trace silt.

JOB NO.: T-J33D



## RELATIVE DENSITY TEST DATA AND COMPUTATION SHEET

PROJECT : ______ JOB NO. : I-533D DATE : 10/7/95

;ORING : ______ SAMPLE : ______ DEPTH : ______

MATERIAL : ______

| **MINIMUM DENSITY DETERMINATION ( 0% RELATIVE DENSITY )** | | |
|---|---|---|
| Test No. | 1 | 2 |
| Wt. Soil + Mold , gms. | 9227 | 9214 |
| Wt. Mold , gms. | 6688 | 6688 |
| Wt. Soil ( Ws ) , gms | 2539 | 2526 |
| Volumn of Mold ( Vc ), $ft^3$ | .1145 | .1145 |
| Minimum Density ( PCF ) = $\frac{Ws_{(min)}}{Vc_{(min)} X 453.6}$ | 48.9 | 48.64 |

| **MAXIMUM DENSITY DETERMINATION ( 100% RELATIVE DENSITY )** | | | |
|---|---|---|---|
| Test No. | - | 1 | 2 |
| Method INT. HT. | - | 7.00" | |
| Avg. Void Reading , inches | Rf | 2.53 | |
| Final Ht. of Soil , inches | Hf | 4.47 | |
| Area of Sample Surface, $ft^2$ | A | .1963 | |
| Calib. Vol. of Mold , $ft^3$ | Vc | .1145 | |
| Soil Volumn = $\frac{Hf}{12}$ X A | Vs | .0731 | |
| Wt. Wet Soil + Mold , gms. | - | 9667 | |
| Wt. Mold , gms. | - | 6688 | |
| Wt. Wet Soil , gms | Ww | 2979 | |
| Wt. Dry Soil , gms. | Ws | 2162 | |
| Maximum Density ( PCF ) = $\frac{Ws_{(max)}}{Vs_{(max)} X 453.6}$ | - | 65.2 | |

| **RELATIVE DENSITY COMPUTATION** | | |
|---|---|---|
| Test No. | 1 | |
| In-place density , pcf | ( ) | |
| maximum lab. density , pcf | 65.20 | |
| minimum lab. density , pcf | 48.64 | |
| Relative Density - % | DESIRED 75% | |

| Moisture Content | After Test |
|---|---|
| Pan No. : | DW-1 |
| Wet Wt. Sple. + Pan : | 3257 |
| Dry Wt. Sple. + Pan : | 2453 |
| Wt. of Pan : | 324 |
| Wt. of Dry Soil : | 2129 |
| Wt. of Water : | 804 |
| % Moisture ( mc ) | 37.76 |

@ 75% $D_R$ : DRY SOIL FOR TX = 565.55 gms.
(VOL. OF SPECIMEN = 35.85 $in^3$)

$$Ws = \frac{Ww}{1 + mc}$$

Bottom Insert Thickness : 0.25" inches

$H_f$ = Ht. of Mold - Bottom Insert Thickness - Average Top Void Reading ( Rf ) .

$H_f$ = 6.75 inches

Tested By : D.W. Computed By : JJ Checked By : ______

JAR + sample (wet): 477.06
JAR = 282.91

# SPECIFIC GRAVITY DETERMINATION

Dry 469.07

Steps:

1. Weigh flask partly filled with distilled water.
2. Add dry soil and weigh again; difference in weights = weight of soil added ($W_s$)
3. After soaking period, evacuate for 15 minutes, then add distilled water to calibration line.
4. Weigh flask, soil and $H_2O$ ($W_{bws}$) (Record temperature)
5. Determine from calibration chart, weight of flask and $H_2O$ for temperature recorded ($W_{bw}$)
6. Specific gravity = $\frac{W_s}{W_s + W_{bw} - W_{bws}}$

Job. No T-533 D
Date

Boring:
Sample:
Depth:

| | | | |
|---|---|---|---|
| Material: | | | |
| Flask No. | 3 | | |
| A: Flask + $H_2O$ + Soil | 536.03 | | |
| B: Flask + $H_2O$ | 469.98 | | |
| C: $W_s$ = A - B | 66.05 | | |
| Temp. °C | 28.6 | | |
| D: $W_{bw}$ (from chart) | 649.57 | | |
| E: (C+D) = $W_{bw}+W_s$ | 715.62 | | |
| F: $W_{bws}$ | 689.58 | | |
| G = (E - F) = $W_s + W_{bw} - W_{bws}$ | 26.04 | | |
| Specific Gravity = $\frac{C}{G}$ | 2.54 | | |

F : L-15

Tested By: JB
Computed By: JB
Checked By:

# Appendix VI

### TABLE 3.7
### COMMON PROPERTIES OF CLAY SOILS‡

| Consistency | N | Hand test | $\gamma_{sat}$,* g/cm³ | Strength† $U_c$, kg/cm² |
|---|---|---|---|---|
| Hard | >30 | Difficult to indent | >2.0 | >4.0 |
| Very stiff | 15-30 | Indented by thumbnail | 2.08-2.24 | 2.0-4.0 |
| Stiff | 8-15 | Indented by thumb | 1.92-2.08 | 1.0-2.0 |
| Medium (firm) | 4-8 | Molded by strong pressure | 1.76-1.92 | 0.5-1.0 |
| Soft | 2-4 | Molded by slight pressure | 1.60-1.76 | 0.25-0.5 |
| Very soft | <2 | Extrudes between fingers | 1.44-1.60 | 0-0.25 |

*$\gamma_{sat} = \gamma_{dry} + \gamma_w \left(\frac{e}{1+e}\right)$

†Unconfined compressive strength $U_c$ is usually taken as equal to twice the cohesion $c$ or the undrained shear strength $s_u$. For the drained strength condition, most clays also have the additional strength parameter $\phi$, although for most normally consolidated clays $c = 0$ (Lambe and Whitman (1969)[3]). Typical values for $s_u$ and drained strength parameters are given in Table 3.30, Hunt (1984).[1]

‡From Hunt (1984).[1] Reprinted with permission of McGraw-Hill Book Company.

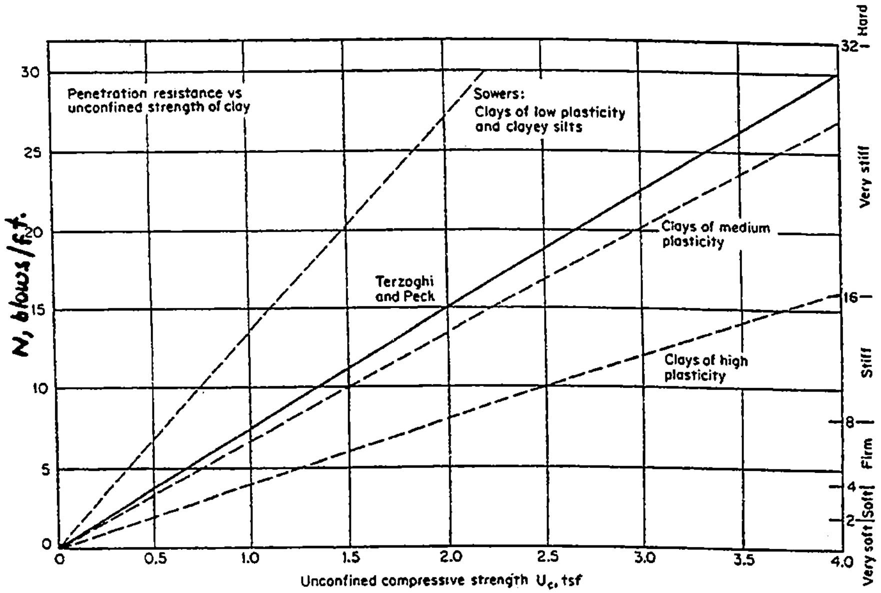


FIG. 3.35 Correlations of SPT $N$ values with $U_c$ for cohesive soils of varying plasticities. [From NAVFAC 1971[44]]

### TABLE 3.5
### COMMON PROPERTIES OF COHESIONLESS SOILS**

| Material | Compactness | $D_R$, % | $N$* | $\gamma$ dry,† g/cm³ | Void ratio $e$ | Strength‡ $\phi$ |
|---|---|---|---|---|---|---|
| GW: well-graded gravels, gravel-sand mixtures | Dense | 75 | 90 | 2.21 | 0.22 | 40 |
| | Medium dense | 50 | 55 | 2.08 | 0.28 | 36 |
| | Loose | 25 | <28 | 1.97 | 0.36 | 32 |
| GP: poorly graded gravels, gravel-sand mixtures | Dense | 75 | 70 | 2.04 | 0.33 | 38 |
| | Medium dense | 50 | 50 | 1.92 | 0.39 | 35 |
| | Loose | 25 | <20 | 1.83 | 0.47 | 32 |
| SW: well-graded sands, gravelly sands | Dense | 75 | 65 | 1.89 | 0.43 | 37 |
| | Medium dense | 50 | 35 | 1.79 | 0.49 | 34 |
| | Loose | 25 | <15 | 1.70 | 0.57 | 30 |
| SP: poorly graded sands, gravelly sands | Dense | 75 | 50 | 1.76 | 0.52 | 36 |
| | Medium dense | 50 | 30 | 1.67 | 0.60 | 33 |
| | Loose | 25 | <10 | 1.59 | 0.65 | 29 |
| SM: silty sands | Dense | 75 | 45 | 1.65 | 0.62 | 35 |
| | Medium dense | 50 | 25 | 1.55 | 0.74 | 32 |
| | Loose | 25 | <8 | 1.49 | 0.80 | 29 |
| ML: inorganic silts, very fine sands | Dense | 75 | 35 | 1.49 | 0.80 | 33 |
| | Medium dense | 50 | 20 | 1.41 | 0.90 | 31 |
| | Loose | 25 | <4 | 1.35 | 1.0 | 27 |

*$N$ is blows per foot of penetration in the SPT. Adjustments for gradation are after Burmister (1962).[24] See Table 6.4 for general relationships of $D_R$ vs. $N$.

†Density given is for $G_s = 2.68$ (quartz grains).

‡Friction angle $\phi$ depends on mineral type, normal stress, and grain angularity as well as $D_R$ and gradation (see Fig. 3.29).

**From Hunt (1984).[1] Reprinted with permission of McGraw-Hill Book Company.

"GEOTECHNICAL ENGINEERING TECHNIQUES AND PRACTICES", ROY. E. HUNT, McGraw-Hill, INC., 1986, USA

Figure 8-6 gives the approximate range of $k$ values one may expect to obtain. The coefficient of permeability is plotted on a log scale, since the range of permeabilities is so large. No other engineering property of any material exhibits such a large range of values as does the permeability of soil.

An empirical equation relating the coefficient of permeability to the effective grain size ($D_{10}$) from a sieve analysis was reported by A. Hazen (ca. 1892) based on work with rapid sand filters in water treatment plants. He found that for sands with $D_{10}$ sizes between 0.1 and 3.0 mm, the coefficient of permeability could be expressed approximately† as

$$k = C(D_{10}^2) \qquad \text{cm/s} \tag{8-9}$$

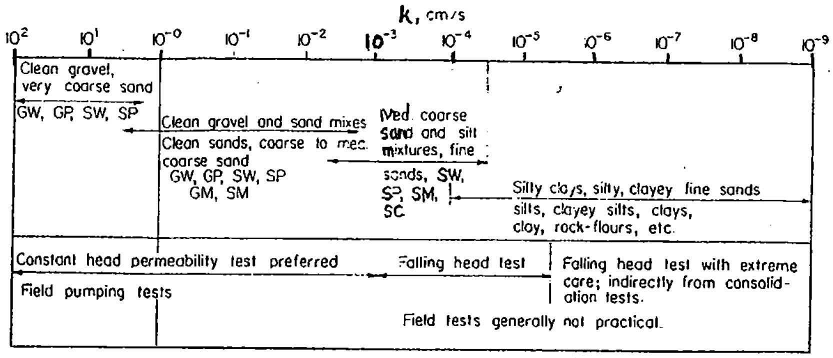


**Figure 8-6** Typical ranges of permeability coefficients and suggested test methods.

Is this equation $D_{10}$ is the effective grain size in centimeters, with $C$ such that $k$ is in centimeters per second. The coefficient $C$ varies, according to Hazen, from about 40 to 150 and the values may be taken as follows:

| $C$ | Sand (any or all of the following applies) |
|---|---|
| 40–80 | Very fine, well graded or with appreciable fines [(−) No. 200] |
| 80–120 | Medium coarse, poorly graded: clean, coarse but well graded |
| 120–150 | Very coarse, very poorly graded, gravelly, clean |

One would expect that poorly graded sand would have a larger coefficient than well-graded materials, since the void spaces would be more ordered and larger with poorly graded soil.

An estimate of the permeability $k_2$ at a void ratio of $e_2$ when a test was performed with results of $k_1$ at void ratio $e_1$ may be made as

$$k_2 = k_1\left(\frac{e_2}{e_1}\right)^2$$

Other equations more complicated than this have been suggested, but in the range of void ratios (0.5 to 1.1) likely to be used, this equation is considerably simpler and the results are sufficiently precise considering the precision with which $k_1$ can be determined.

"PHYSICAL AND GEOTECHNICAL PROPERTIES OF SOILS",
JOSEPH E. BOWLES, McGRAW-Hill, Inc, 1984 Second Edition pg 251&252

# LABORATORY DATA FROM:
# *"PHILIP SPORN ELECTRIC GENERATING PLANT UNIT 5 ASH FACILITY – ENGINEERING REPORT"*

## PREPARED/COMPILED BY:
## THE GEOTECHNICAL ENGINEERING SECTION OF AMERICAN ELECTRIC POWER SERVICE CORPORATION

## DATED: JULY 1998

**H. C. NUTTING COMPANY**
EMPLOYEE OWNED
GEOTECHNICAL, ENVIRONMENTAL AND TESTING ENGINEERS
SINCE 1921

CORPORATE CENTER
4120 AIRPORT ROAD
CINCINNATI, OHIO 45226
(513) 321-5816
FAX (513) 321-0294

Order No. 90979.030

December 19, 1996

Mr. J.P. Amaya
American Electric Power Corporation
1 Riverside Plaza
Columbus, OH 45315

Re: **Laboratory Tests**
Project: **Sporn Plt-Bott. Ash Pond**
**Certification-C-9117**
**LOA-002-96**

Dear Mr. Amaya:

Submitted herewith is our report covering the results of seventeen (17) consolidated undrained triaxial tests with pore pressure measurements, seven (7) mechanical sieve and hydrometer and (7) Atterberg Limits. Tests were performed per your request by letter dated November 22, 1996. All samples were obtained and shipped to our laboratory from the referenced project by your representative. Cost for these tests were as outlined per Contract No. C-9117.

Should any discussion be required concerning this report, please feel free contact the undersigned. The H.C. Nutting Company thanks American Electric Power for allowing them this opportunity to be of service.

Respectfully submitted,

**H.C. NUTTING COMPANY**

Robert L. House

Robert L. House,
Vice President/Lab. Director

H.C. Nutting Company
4120 Airport Road
Cincinnati, Ohio 45226

12/19/69smo

American Electric Power
Sporn Plt-Bott. Ash Pond Certification LOA-002-96
New Haven, WV
HCN W.O. #90979.030

## TABLE I

## CLASSIFICATION TEST DATA

| | | | | Mechanical Analysis | | | | Atterberg Limits | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lab No. | Boring No. | Sample No. | Depth (Ft.) | % Gravel | % Sand | % Silt | % Clay | Liquid Limit (%) | Plastic Limit (%) | Plasticity Index | U.S.C.S Classifi-cation |
| 8563 | 96-101 | ST-10 | --- | 0 | 18 | 58 | 24 | 27 | 20 | 7 | CL-ML |
| 8564 | 96-104 | ST-9 | 31.7-33.7 | 16 | 46 | 26 | 12 | NP | NP | NP | SM |
| 8565 | 96-106 | ST-15 | 61.5-63.5 | 0 | 7 | 58 | 35 | 38 | 24 | 14 | CL |
| 8566 | 96-107 | ST-16 | 66.6-68.6 | 0 | 16 | 52 | 32 | 43 | 26 | 17 | CL |
| 8567 | 96-108 | ST-10 | 41.6-43.6 | 0 | 7 | 52 | 42 | 44 | 30 | 14 | ML |
| 8568 | 96-109 | ST-8 | 26.7-28.7 | 0 | 54 | 43 | 3 | NP | NP | NP | SM |
| 8569 | 96-110 | ST-18 | 58.6-60.6 | 0 | 19 | 50 | 31 | 39 | 27 | 12 | ML |

**H.C. NUTTING COMPANY**

Robert L. House

**Robert L. House,**
**Vice President/Lab. Director**

H.C. Nutting Company
4120 Airport Road
Cincinnati, Ohio 45226

12/19/96smo

American Electric Power
Sporn Plt-Bott. Ash Pond Certification LOA-002-96
New Haven, WV
HCN W.O. # 90979.030

## TABLE II
## TABULATION OF UNDISTURBED TEST DATA

PAGE 1 OF 2

| Boring No. | Sample No. | Depth (Ft.) | Triaxial Compressive Strength (TSF) | Confining Pressure P.S.I. | Failure Strain (%) | Dry Density (Lbs./Cu. Ft.) | Water Content (%) | Lab No. |
|---|---|---|---|---|---|---|---|---|
| 96-101 | ST-10 | --- | 4.31 | 14 | 13.4 | 106.5 | 18.5 | 8563 |
| | | | 5.69 | 28 | 15.9 | 113.5 | 16.8 | " |
| | | | 9.15 | 56 | 21.8 | 114.3 | 15.4 | " |
| | | | | | | | | |
| 96-104 | ST-9 | 31.7-33.7 | 3.67 | 14 | 23.4 | 119.4 | 8.2 | 8564 |
| | | | 3.22 | 28 | 24.6 | 113.3 | 9.2 | " |
| | | | --- | 56 | --- | --- | 9.9 | " |
| | | | | | | | | |
| 96-106 | ST-15 | 61.5-63.5 | 2.17 | 21 | 17.5 | 97.1 | 26.5 | 8565 |
| | | | 3.69 | 42 | 15.8 | 98.1 | 26.5 | " |
| | | | 3.64 | 84 | 20.4 | 99.1 | 26.5 | " |
| | | | | | | | | |
| 96-107 | ST-16 | 66.6-68.6 | 2.18 | 21 | 15.7 | 98.3 | 26.0 | 8566 |
| | | | 3.40 | 42 | 11.7 | 97.2 | 27.4 | " |
| | | | 5.83 | 84 | 12.1 | 96.5 | 28.4 | " |
| | | | | | | | | |

**H.C. NUTTING COMPAN**

Robert L. House

Robert L. House,
Vice President/Lab. Director

H.C. Nutting Company
4120 Airport Road
Cincinnati, Ohio 45226

12/19/96smo

American Electric Power
Sporn Plt-Bott. Ash Pond Certification LOA-002-96
New Haven, WV
HCN W.O. # 90979.030

## TABLE II
## TABULATION OF UNDISTURBED TEST DATA

PAGE 2 OF 2

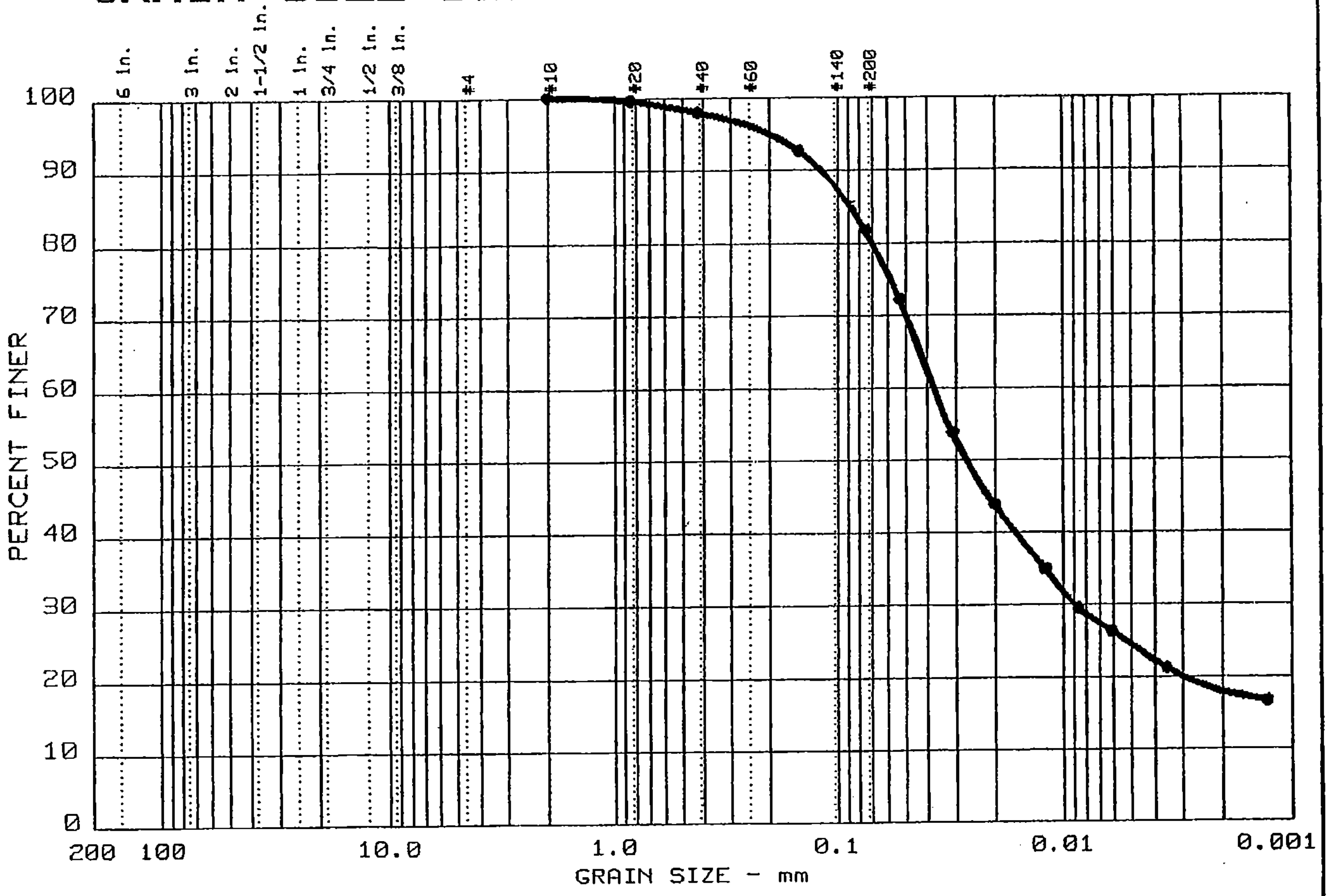
| Boring No. | Sample No. | Depth (Ft.) | Triaxial Compressive Strength (TSF) | Confining Pressure P.S.I. | Failure Strain (%) | Dry Density (Lbs./Cu. Ft.) | Water Content (%) | Lab No. |
|---|---|---|---|---|---|---|---|---|
| 96-108 | ST-10 | 41.6-43.6 | 1.77 | 14 | 7.4 | 88.1 | 34.6 | 8567 |
| | | | 2.25 | 28 | 12.8 | 85.1 | 38.4 | " |
| | | | 3.82 | 56 | 15.8 | 84.7 | 36.9 | " |
| | | | | | | | | |
| 96-109 | ST-8 | 26.7-28.7 | UNIT WT. | --- | --- | 74.3 | 4.1 | 8568 |
| | | | | | | | | |
| 96-110 | ST-18 | 58.6-60.6 | 2.55 | 21 | 6.3 | 94.3 | 28.9 | 8569 |
| | | | 2.70 | 42 | 9.3 | 93.9 | 28.8 | " |
| | | | 5.22 | 84 | 5.7 | 94.5 | 27.5 | " |
| | | | | | | | | |

H.C. NUTTING COMPAN

Robert L. House

Robert L. House,
Vice President/Lab. Director

# GRAIN SIZE DISTRIBUTION TEST REPORT



| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 18.3 | 57.3 | 24.4 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 27 | 7 | 0.09 | 0.04 | 0.03 | 0.009 | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| ● SILTY CLAY WITH SAND | CL-ML | |

Project No.: 90979.030
Project: Sporn Plt-Bott.Ash Pond Certification LOI-002-96*
● Location: Boring:96-101 Sample:ST-10

*New Haven, WV

Date: 12/13/95

Remarks:

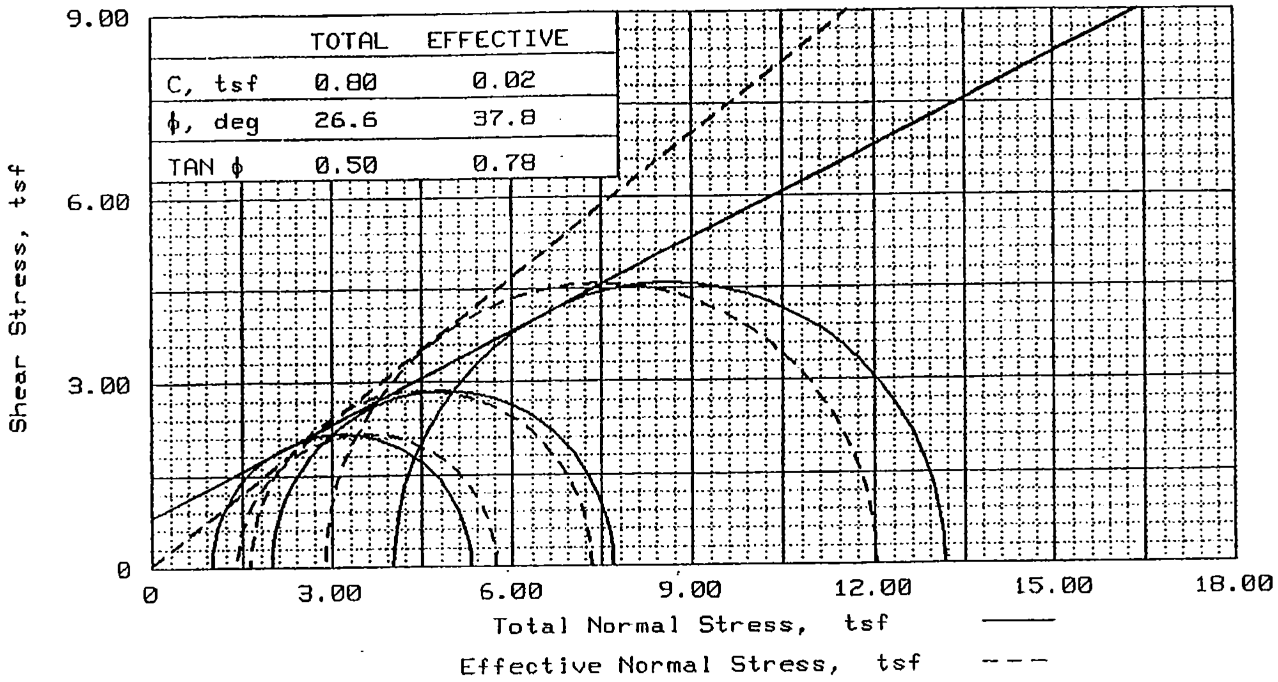
Client: American Electric Power

Lab No. 8563

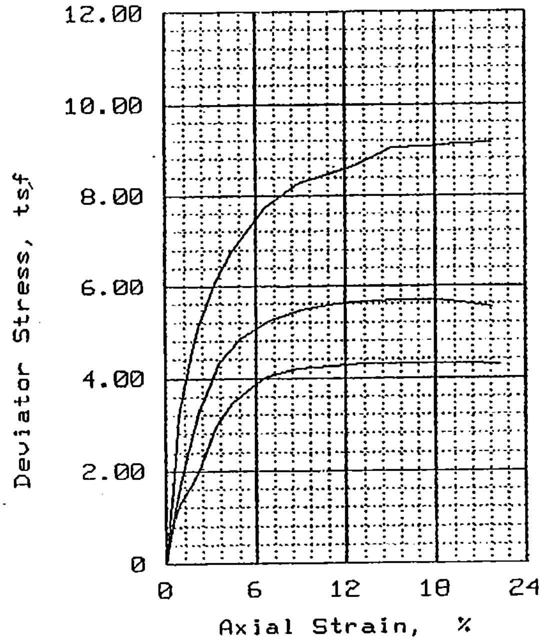
GRAIN SIZE DISTRIBUTION TEST REPORT

**H. C. NUTTING COMPANY**

Figure No. ______



| | TOTAL | EFFECTIVE |
|---|---|---|
| C, tsf | 0.80 | 0.02 |
| ϕ, deg | 26.6 | 37.8 |
| TAN ϕ | 0.50 | 0.78 |



| | SAMPLE NO. | 1 | 2 | 3 |
|---|---|---|---|---|
| INITIAL | WATER CONTENT, % | 18.5 | 16.8 | 15.4 |
| | DRY DENSITY, pcf | 106.5 | 113.5 | 114.3 |
| | SATURATION, % | 100.0 | 100.0 | 100.0 |
| | VOID RATIO | 0.594 | 0.496 | 0.485 |
| | DIAMETER, in | 2.84 | 2.85 | 2.85 |
| | HEIGHT, in | 4.54 | 4.52 | 4.62 |
| AT TEST | WATER CONTENT, % | 22.5 | 18.2 | 16.3 |
| | DIAMETER, in | 2.81 | 2.82 | 2.78 |
| | HEIGHT, in | 4.49 | 4.47 | 4.50 |
| | Strain rate, %/min | 0.001 | 0.001 | 0.001 |
| | BACK PRESSURE, tsf | 2.88 | 2.88 | 2.88 |
| | CELL PRESSURE, tsf | 3.89 | 4.90 | 6.91 |
| | FAILURE STRESS, tsf | 4.31 | 5.69 | 9.15 |
| | PORE PRESSURE, tsf | 2.46 | 3.25 | 4.02 |
| | ULTIMATE STRESS, tsf | | | |
| | PORE PRESSURE, tsf | | | |
| | $\bar{\sigma}_1$ FAILURE, tsf | 5.74 | 7.34 | 12.04 |
| | $\bar{\sigma}_3$ FAILURE, tsf | 1.43 | 1.65 | 2.89 |

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE:
DESCRIPTION: BR & GR SILTY CLAY WITH SAND
LL= 27 PL= 20 PI= 7.0
SPECIFIC GRAVITY=
REMARKS: Lab No. 8563

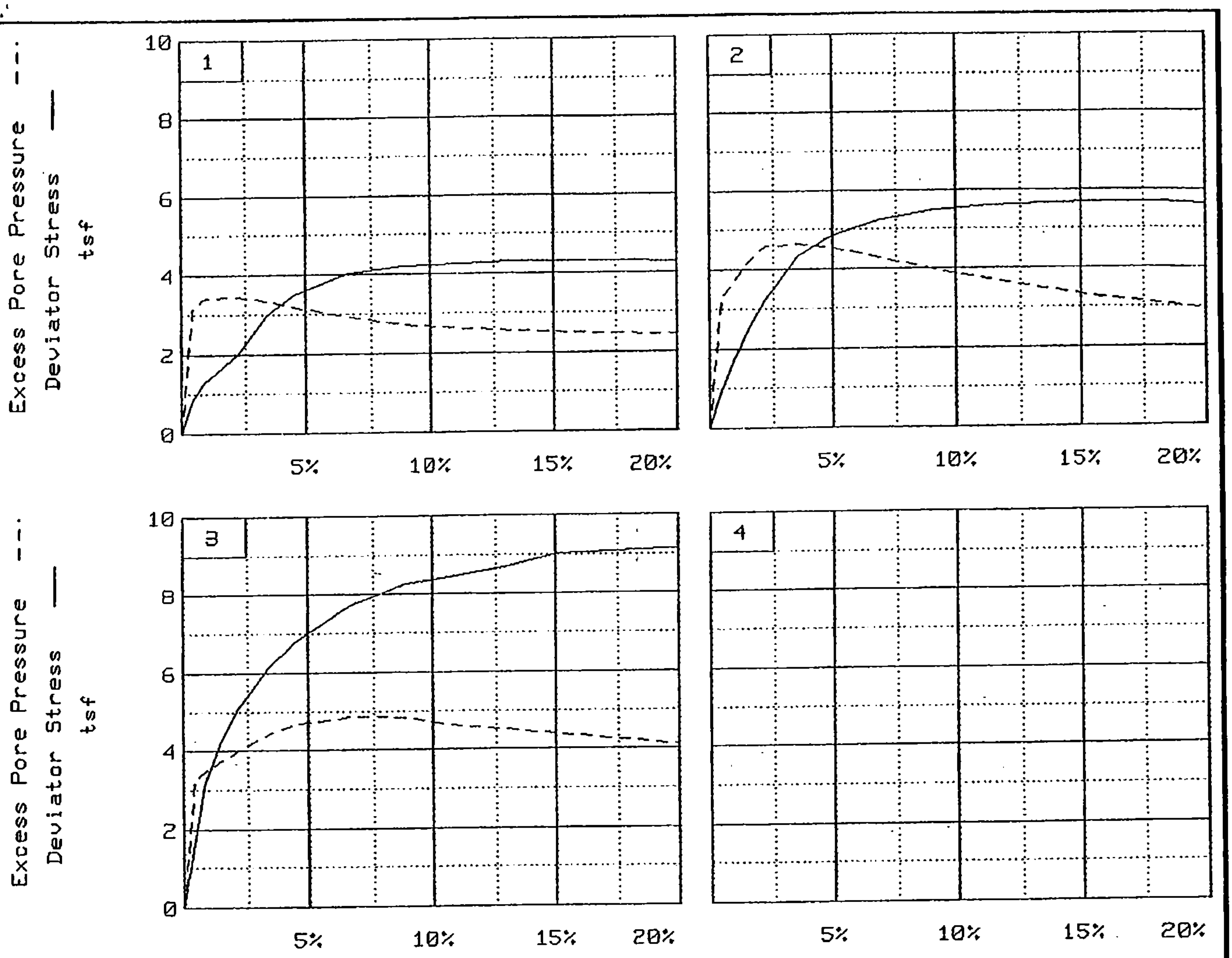
CLIENT: American Electric Power

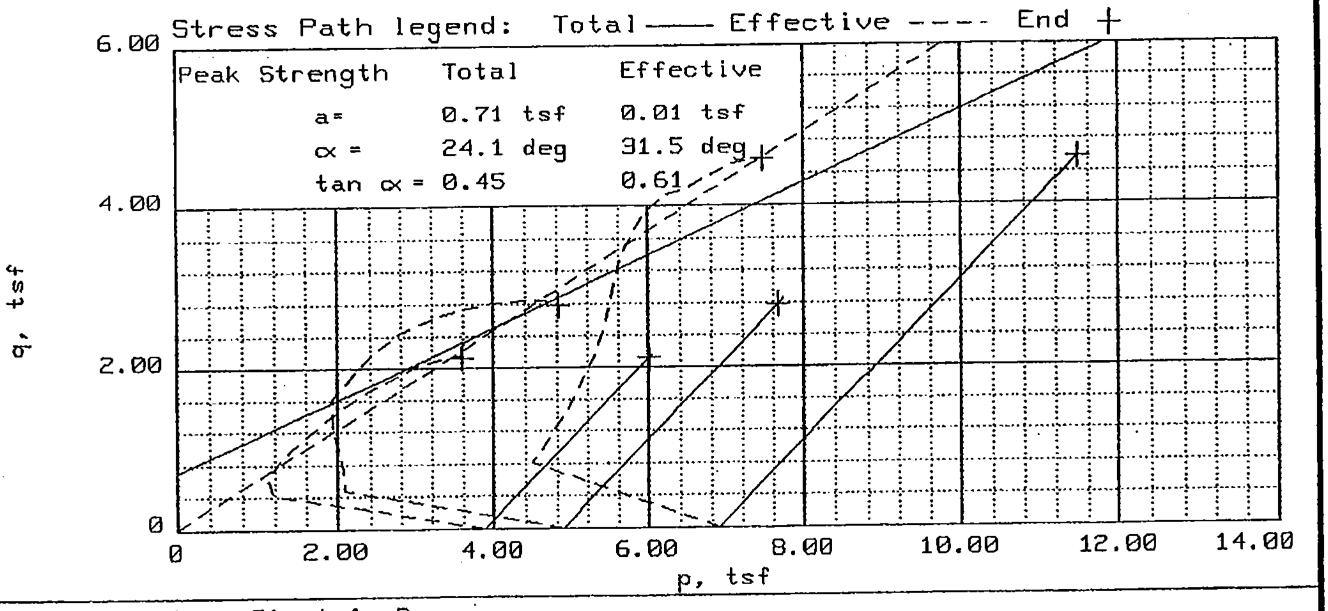
PROJECT: Sporn Plt-Bott.Ash Pond
Certification LOA-002-96, New Haven, WV
SAMPLE LOCATION: Boring:96-101
Sample:ST-10
PROJ. NO.: 90979.030 DATE: 12/13/96

TRIAXIAL SHEAR TEST REPORT

**H. C. NUTTING COMPANY**

FIG. NO.





| Peak Strength | Total | Effective |
|---|---|---|
| a= | 0.71 tsf | 0.01 tsf |
| α = | 24.1 deg | 31.5 deg |
| tan α = | 0.45 | 0.61 |

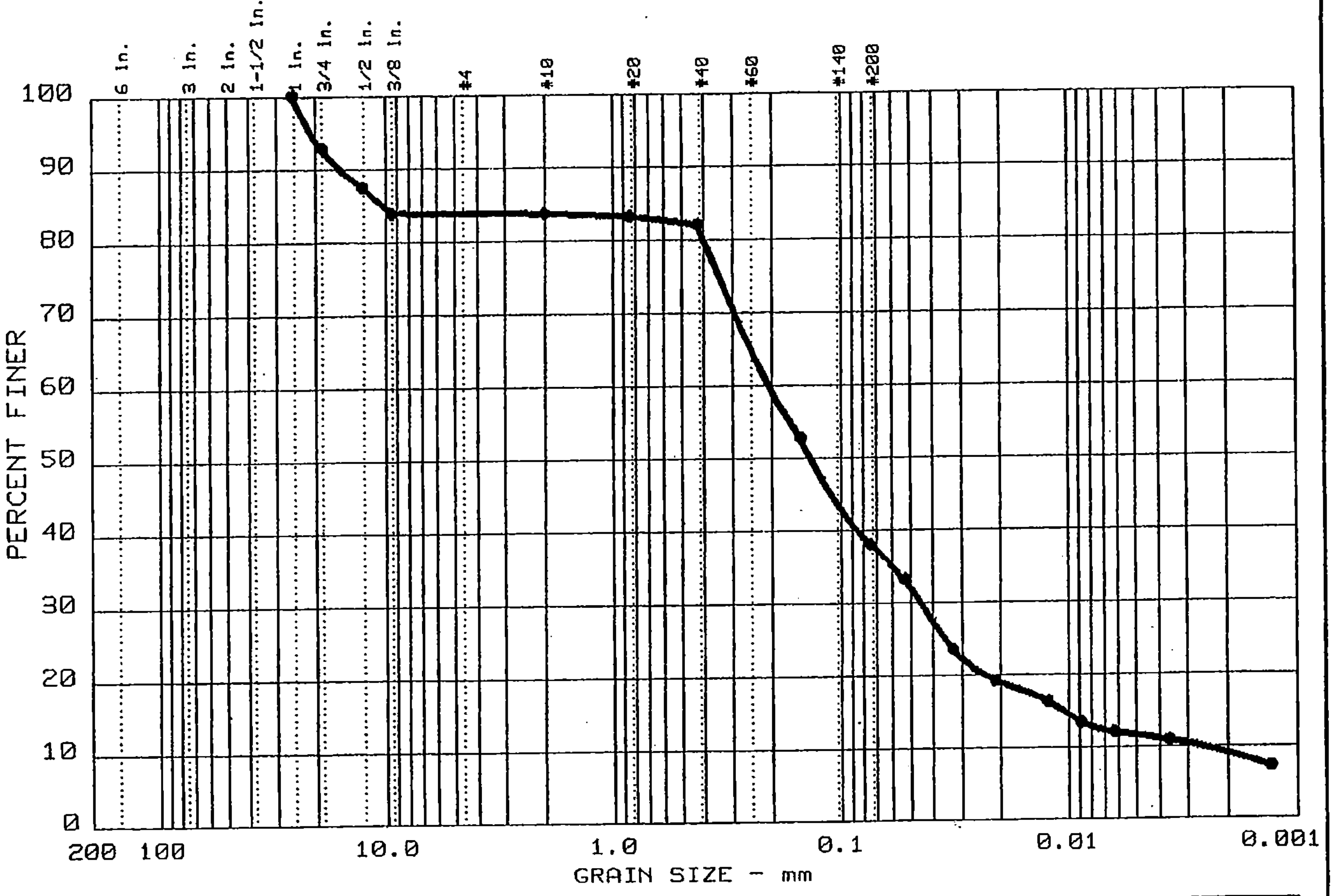
Client: American Electric Power

Project: Sporn Plt-Bott.Ash Pond Certification LOA-002-96, New Haven, WV

Location: Boring:96-101 Sample:ST-10

File: 8563 Project No.: 90979.030 Page 2/2 Fig. No. ——

# GRAIN SIZE DISTRIBUTION TEST REPORT



| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 16.2 | 45.7 | 26.4 | 11.7 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | NP | NP | 10.35 | 0.20 | 0.14 | 0.045 | 0.0106 | 0.0025 | 3.92 | 80.6 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| ● SILTY SAND WITH GRAVEL | SM | |

Project No.: 90979.030
Project: Sporn Plt-Bott. Ash Pond Certification LOA-002-96
● Location: Boring:96-104 Depth:31.7-33.7' *
*New Haven, WV

Date: 12/13/95

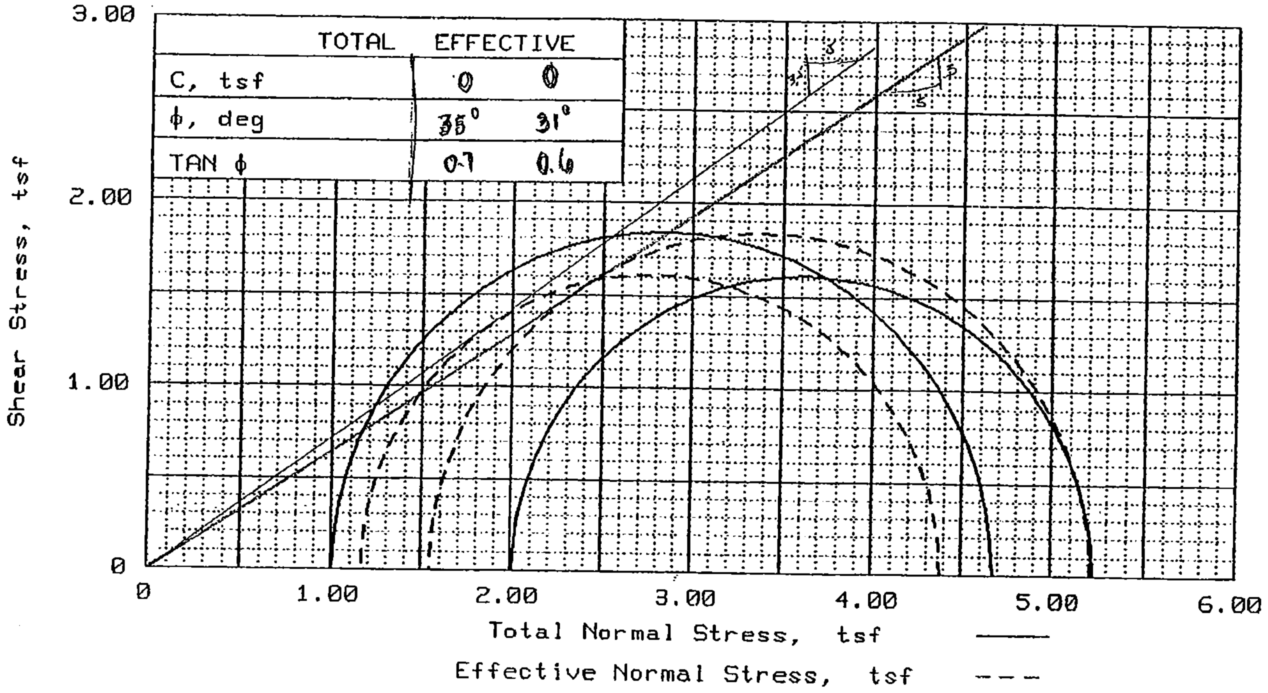
Remarks:
Client: American Electric Power

* Sample:ST-9
Lab No. 8564

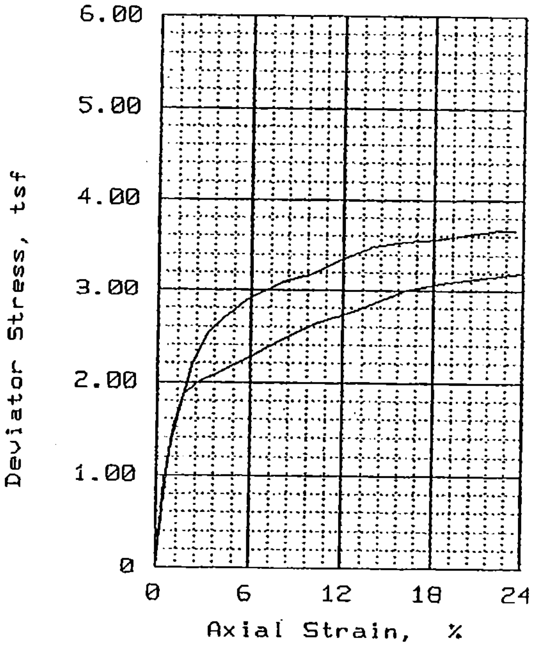
GRAIN SIZE DISTRIBUTION TEST REPORT

**H. C. NUTTING COMPANY**

Figure No. ______



|  | TOTAL | EFFECTIVE |
|---|---|---|
| C, tsf | 0 | 0 |
| ϕ, deg | 35° | 31° |
| TAN ϕ | 0.7 | 0.6 |



| SAMPLE NO. |  | 1 | 2 |
|---|---|---|---|
| INITIAL | WATER CONTENT, % | 8.2 | 9.2 |
|  | DRY DENSITY, pcf | 119.4 | 113.3 |
|  | SATURATION, % | 100.0 | 100.0 |
|  | VOID RATIO | 0.401 | 0.477 |
|  | DIAMETER, in | 2.85 | 2.81 |
|  | HEIGHT, in | 4.91 | 4.40 |
| AT TEST | WATER CONTENT, % | 13.5 | 14.2 |
|  | DIAMETER, in | 2.77 | 2.75 |
|  | HEIGHT, in | 4.78 | 4.31 |
|  | Strain rate, %/min | 0.001 | 0.001 |
|  | BACK PRESSURE, tsf | 2.88 | 2.88 |
|  | CELL PRESSURE, tsf | 3.89 | 4.90 |
|  | FAILURE STRESS, tsf | 3.67 | 3.22 |
|  | PORE PRESSURE, tsf | 2.34 | 3.72 |
|  | ULTIMATE STRESS, tsf |  |  |
|  | PORE PRESSURE, tsf |  |  |
|  | $\bar{\sigma}_1$ FAILURE, tsf | 5.22 | 4.39 |
|  | $\bar{\sigma}_3$ FAILURE, tsf | 1.55 | 1.17 |

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE:
DESCRIPTION: BR SILTY SAND WITH GRAVEL
LL= NP PL= NP PI= NP
SPECIFIC GRAVITY=
REMARKS: Lab No. 8564

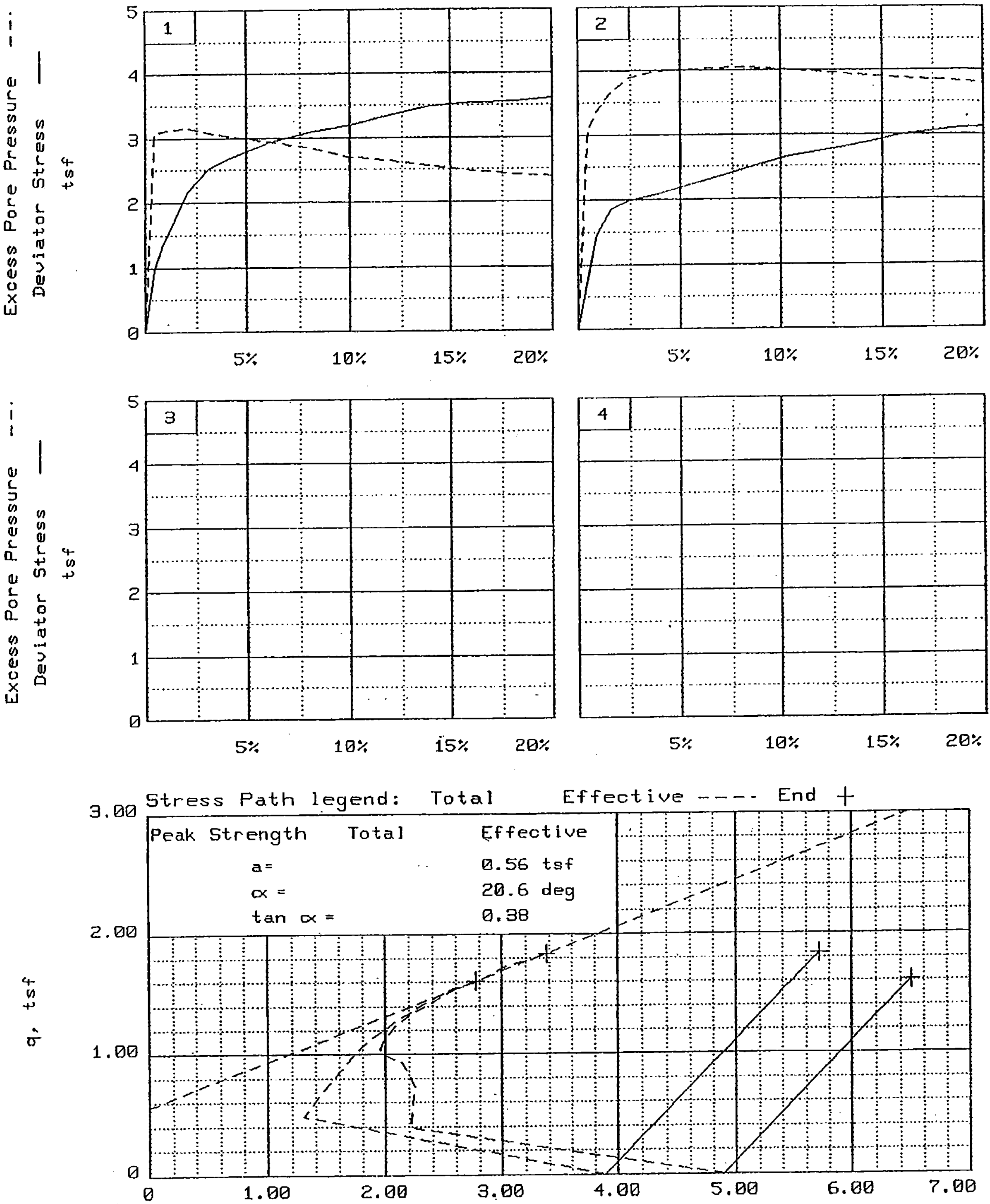
CLIENT: American Electric Power

PROJECT: Sporn Plt-Bott.Ash Pond
Certification LOA-002-96, New Haven, WV
SAMPLE LOCATION: Boring:96-104
Depth:31.7-33.7' Sample:ST-9
PROJ. NO.: 90979.030 DATE: 12/13/96

FIG. NO.

TRIAXIAL SHEAR TEST REPORT

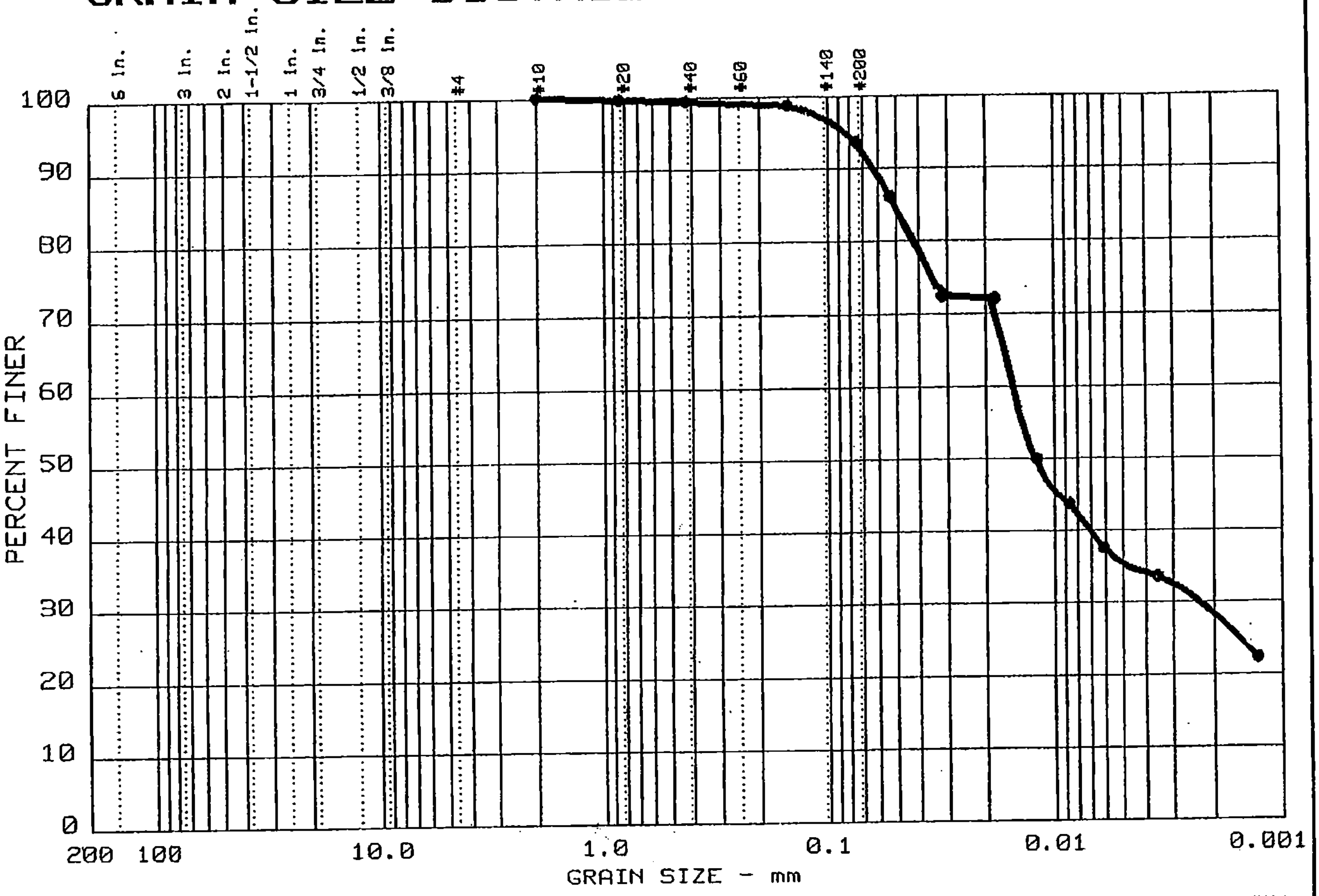
**H. C. NUTTING COMPANY**



| Peak Strength | Total | Effective |
|---|---|---|
| a= | | 0.56 tsf |
| ∝ = | | 20.6 deg |
| tan ∝ = | | 0.38 |

Client: American Electric Power
Project: Sporn Plt-Bott.Ash Pond Certification LOA-002-96, New Haven, WV
Location: Boring:96-104 Depth:31.7-33.7' Sample:ST-9
File: 8564 Project No.: 90979.030 Page 2/2 Fig. No. ____

# GRAIN SIZE DISTRIBUTION TEST REPORT



| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 6.5 | 58.2 | 35.3 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 38 | 14 | 0.05 | 0.02 | 0.01 | 0.002 | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| ● LEAN CLAY | CL | |

Project No.: 90979.030

Project: Sporn Plt-Bott.Ash Pond Certification LOA-002-96*

● Location: Boring:96-106 Depth:61.5-63.5' *
*New Haven, WV

Date: 12/13/95

Remarks:

Client: American Electric Power

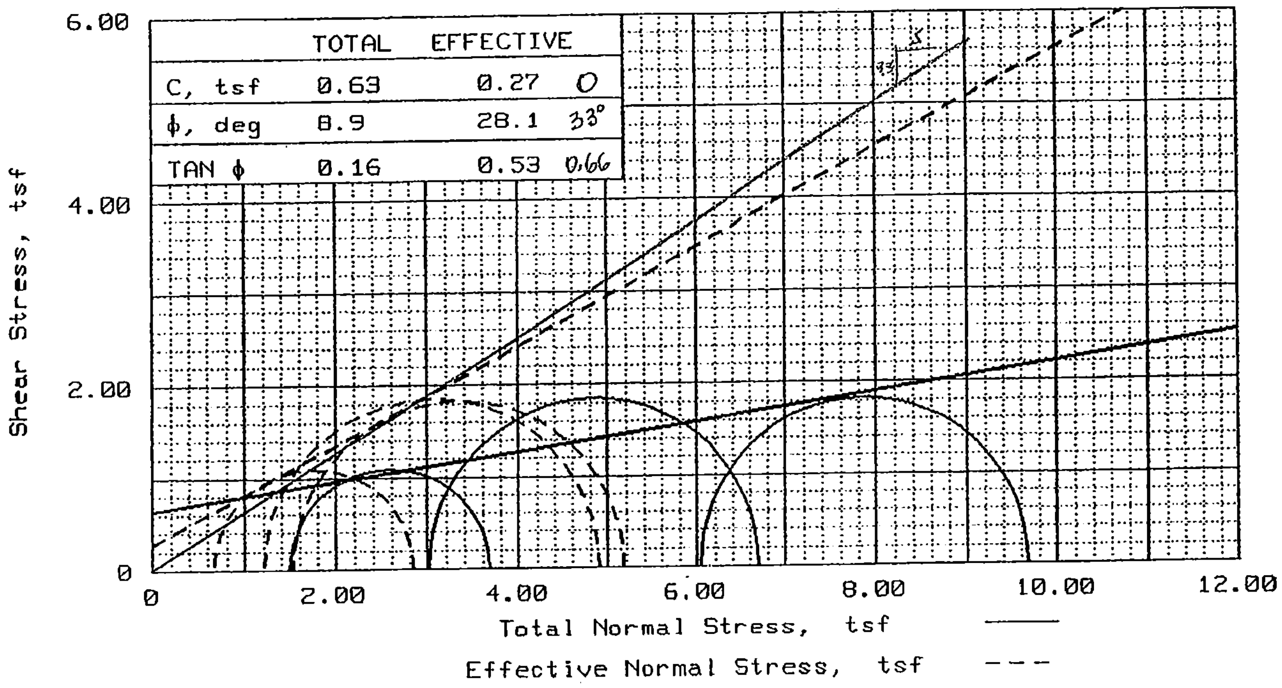
* Sample:ST-15

Lab No. 8565

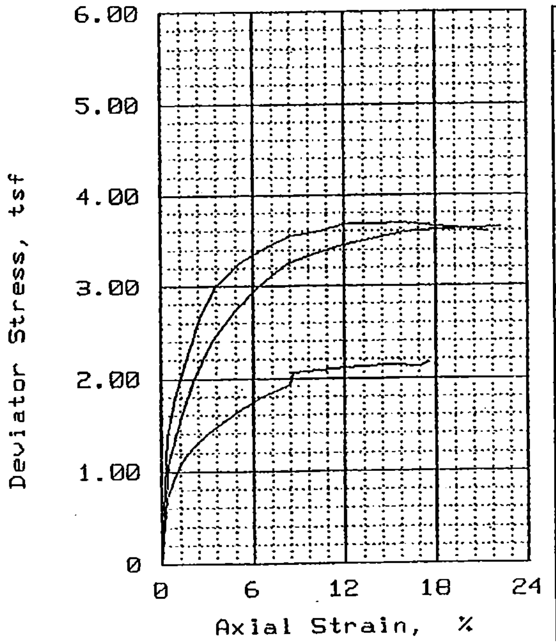
GRAIN SIZE DISTRIBUTION TEST REPORT

**H. C. NUTTING COMPANY**

Figure No. ______



| | TOTAL | EFFECTIVE | |
|---|---|---|---|
| C, tsf | 0.63 | 0.27 | 0 |
| ϕ, deg | 8.9 | 28.1 | 33° |
| TAN ϕ | 0.16 | 0.53 | 0.66 |



| | SAMPLE NO. | 1 | 2 | 3 |
|---|---|---|---|---|
| INITIAL | WATER CONTENT, % | 26.5 | 26.5 | 26.5 |
| | DRY DENSITY, pcf | 97.1 | 98.1 | 99.1 |
| | SATURATION, % | 96.4 | 98.7 | 100.0 |
| | VOID RATIO | 0.749 | 0.730 | 0.713 |
| | DIAMETER, in | 2.78 | 2.83 | 2.84 |
| | HEIGHT, in | 5.25 | 5.37 | 5.16 |
| AT TEST | WATER CONTENT, % | 26.7 | 24.7 | 25.0 |
| | DIAMETER, in | 2.73 | 2.77 | 2.77 |
| | HEIGHT, in | 5.16 | 5.26 | 5.04 |
| | Strain rate, %/min | 0.001 | 0.001 | 0.001 |
| | BACK PRESSURE, tsf | 2.88 | 2.88 | 2.88 |
| | CELL PRESSURE, tsf | 4.39 | 5.90 | 8.93 |
| | FAILURE STRESS, tsf | 2.17 | 3.69 | 3.64 |
| | PORE PRESSURE, tsf | 3.72 | 4.67 | 7.38 |
| | ULTIMATE STRESS, tsf | | | |
| | PORE PRESSURE, tsf | | | |
| | $\bar{\sigma}_1$ FAILURE, tsf | 2.85 | 4.92 | 5.19 |
| | $\bar{\sigma}_3$ FAILURE, tsf | 0.68 | 1.23 | 1.55 |

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE:
DESCRIPTION: Br LEAN CLAY

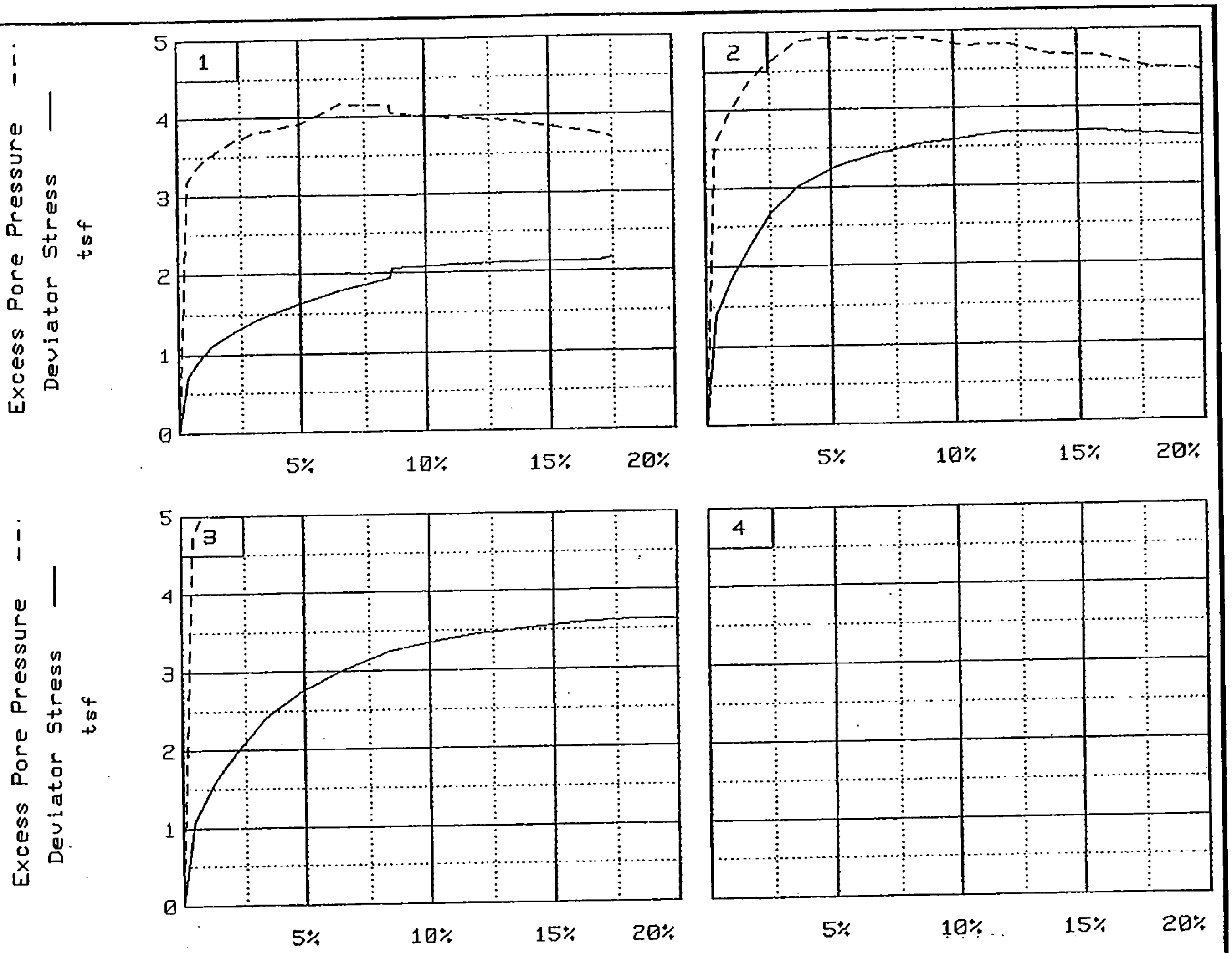
LL= 38 PL= 24 PI= 14.0
SPECIFIC GRAVITY=
REMARKS: Lab No. 8565

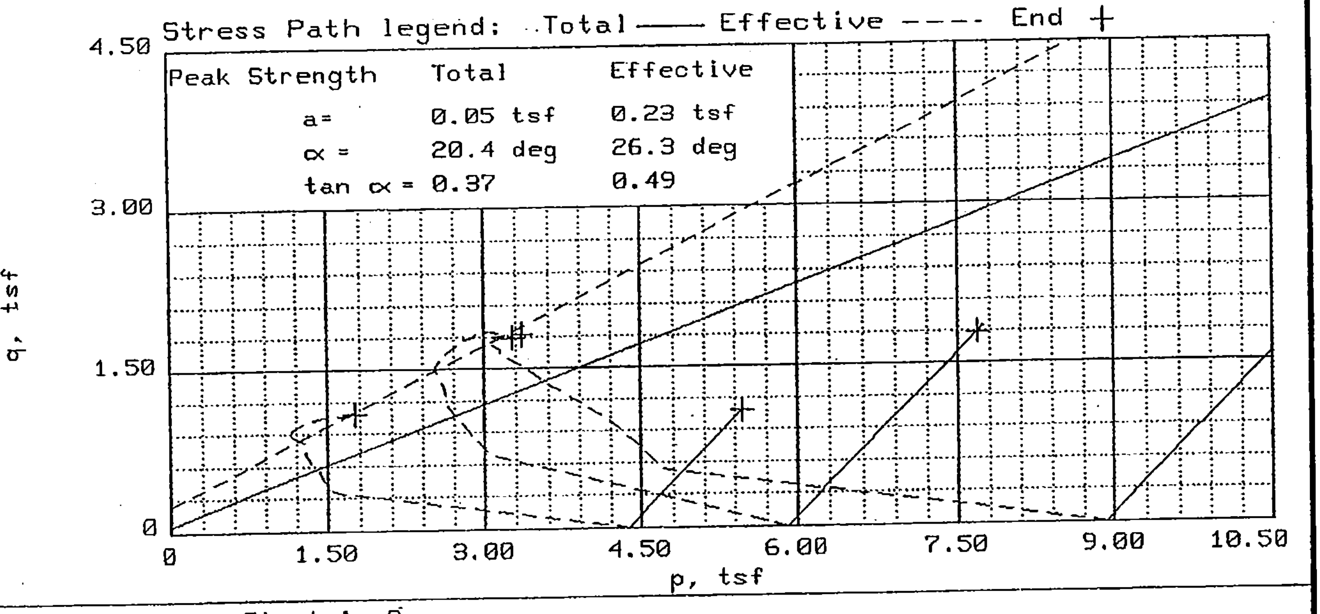
FIG. NO.

CLIENT: American Electric Power

PROJECT: Sporn Plt-Bott.Ash Pond
Certification LOA-002-96, New Haven, WV
SAMPLE LOCATION: Boring:96-106
Depth:61.5-63.5' Sample:ST-15
PROJ. NO.: 90979.030 DATE: 12/19/96

TRIAXIAL SHEAR TEST REPORT
## H. C. NUTTING COMPANY





| Peak Strength | Total | Effective |
|---|---|---|
| a= | 0.05 tsf | 0.23 tsf |
| ∝ = | 20.4 deg | 26.3 deg |
| tan ∝ = | 0.37 | 0.49 |

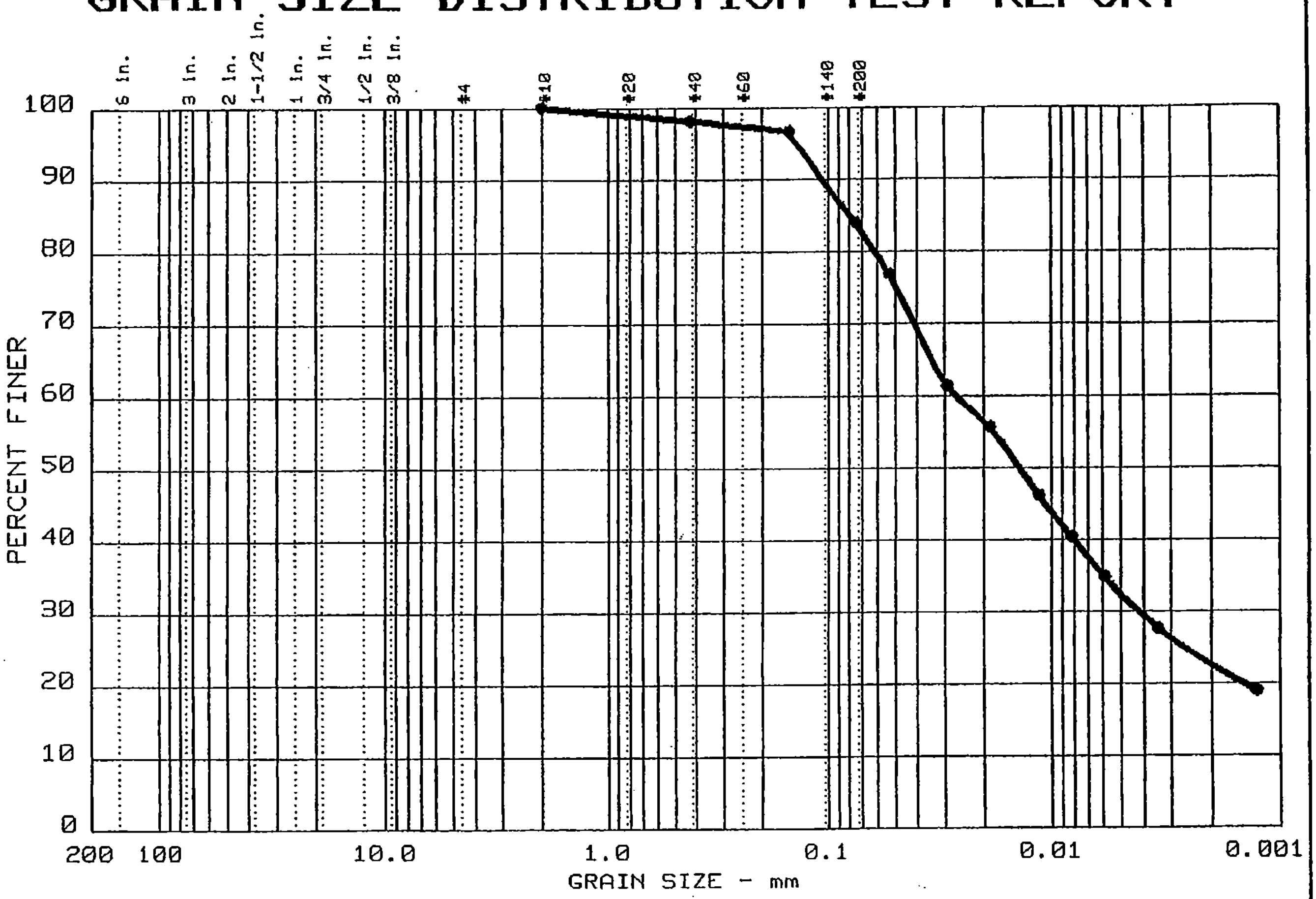
Client: American Electric Power

Project: Sporn Plt-Bott.Ash Pond Certification LOA-002-96, New Haven, WV

Location: Boring:96-106 Depth:61.5-63.5' Sample:ST-15

File: 8565 Project No.: 90979.030 Page 2/2 Fig. No. ——

# GRAIN SIZE DISTRIBUTION TEST REPORT



| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 16.1 | 51.5 | 32.4 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 43 | 17 | 0.08 | 0.03 | 0.01 | 0.004 | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| ● CLAY WITH SAND | CL | |

Project No.: 90979.030

Project: Sporn Plt-~~Bott~~Fly.Ash Pond Certification LOA-002-96*

● Location: Boring:96-107 Depth:66.6-68.6' *

*New Haven, WV

Date: 12/13/95

Remarks:

Client: American Electric Power

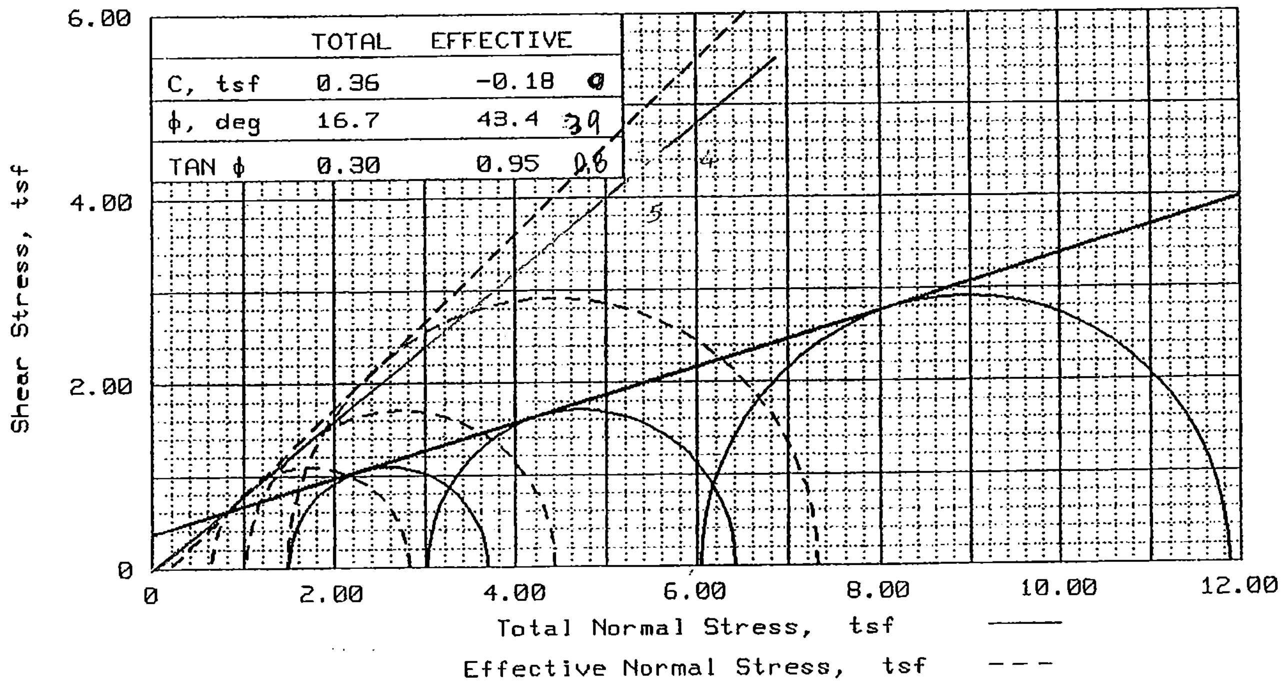
* Sample:ST-16

Lab No. 8566

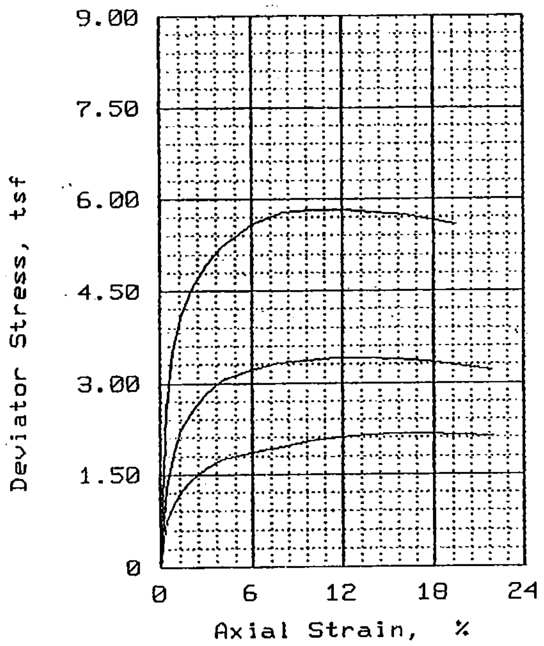
Figure No. ______

GRAIN SIZE DISTRIBUTION TEST REPORT

**H. C. NUTTING COMPANY**



| | TOTAL | EFFECTIVE |
|---|---|---|
| C, tsf | 0.36 | -0.18 0 |
| ϕ, deg | 16.7 | 43.4 39 |
| TAN ϕ | 0.30 | 0.95 0.8 |



| | SAMPLE NO. | 1 | 2 | 3 |
|---|---|---|---|---|
| INITIAL | WATER CONTENT, % | 26.0 | 27.4 | 28.4 |
| | DRY DENSITY, pcf | 98.3 | 97.2 | 96.5 |
| | SATURATION, % | 95.8 | 98.4 | 100.0 |
| | VOID RATIO | 0.747 | 0.767 | 0.778 |
| | DIAMETER, in | 2.83 | 2.85 | 2.84 |
| | HEIGHT, in | 5.20 | 5.21 | 5.16 |
| AT TEST | WATER CONTENT, % | 26.6 | 25.6 | 23.6 |
| | DIAMETER, in | 2.78 | 2.81 | 2.73 |
| | HEIGHT, in | 5.11 | 5.13 | 4.96 |
| | Strain rate, %/min | 0.001 | 0.001 | 0.001 |
| | BACK PRESSURE, tsf | 2.88 | 2.88 | 2.88 |
| | CELL PRESSURE, tsf | 4.39 | 5.90 | 8.93 |
| | FAILURE STRESS, tsf | 2.18 | 3.40 | 5.83 |
| | PORE PRESSURE, tsf | 3.74 | 4.87 | 7.43 |
| | ULTIMATE STRESS, tsf | | | - |
| | PORE PRESSURE, tsf | | | |
| | $\bar{\sigma}_1$ FAILURE, tsf | 2.82 | 4.43 | 7.33 |
| | $\bar{\sigma}_3$ FAILURE, tsf | 0.65 | 1.04 | 1.5 |

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE:
DESCRIPTION: Br CLAY WITH SAND

LL= 43 PL= 17 PI= 26.0
SPECIFIC GRAVITY=
REMARKS: Lab No. 0566

FIG. NO.

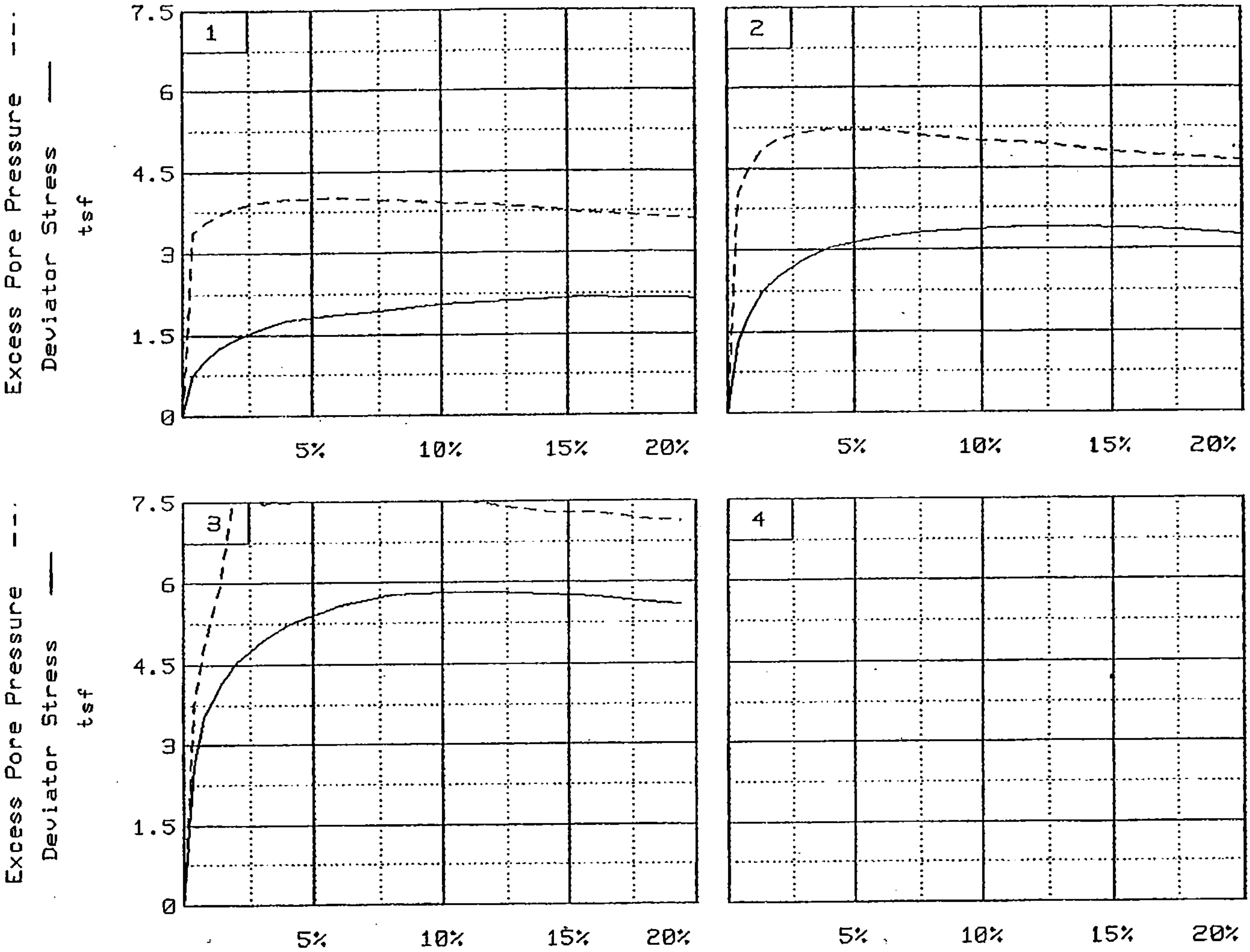
CLIENT: American Electric Power

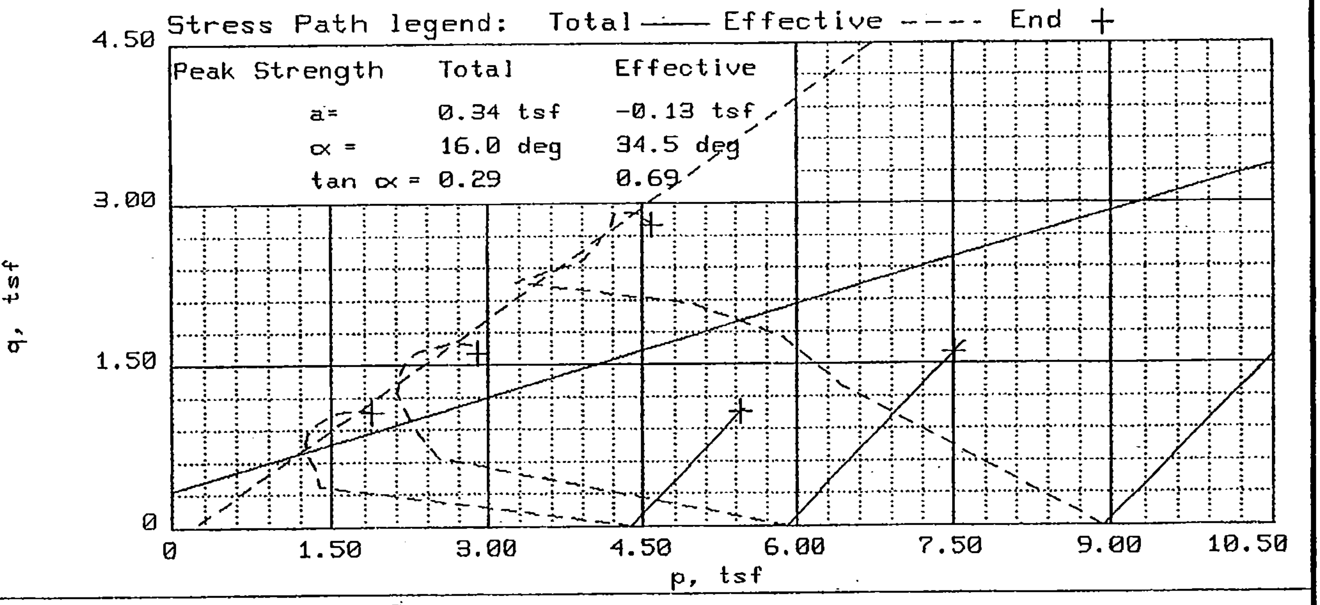
PROJECT: Sporn Plt-~~Bott~~ Fly.Ash Pond
Certification LOA-002-96, New Haven, WV
SAMPLE LOCATION: Boring:96-107
Depth:66.6-68.6′ Sample:ST-16

PROJ. NO.: 90979.030 DATE: 12/13/96

TRIAXIAL SHEAR TEST REPORT

**H. C. NUTTING COMPANY**





| Peak Strength | Total | Effective |
|---|---|---|
| a= | 0.34 tsf | -0.13 tsf |
| α = | 16.0 deg | 34.5 deg |
| tan α = | 0.29 | 0.69 |

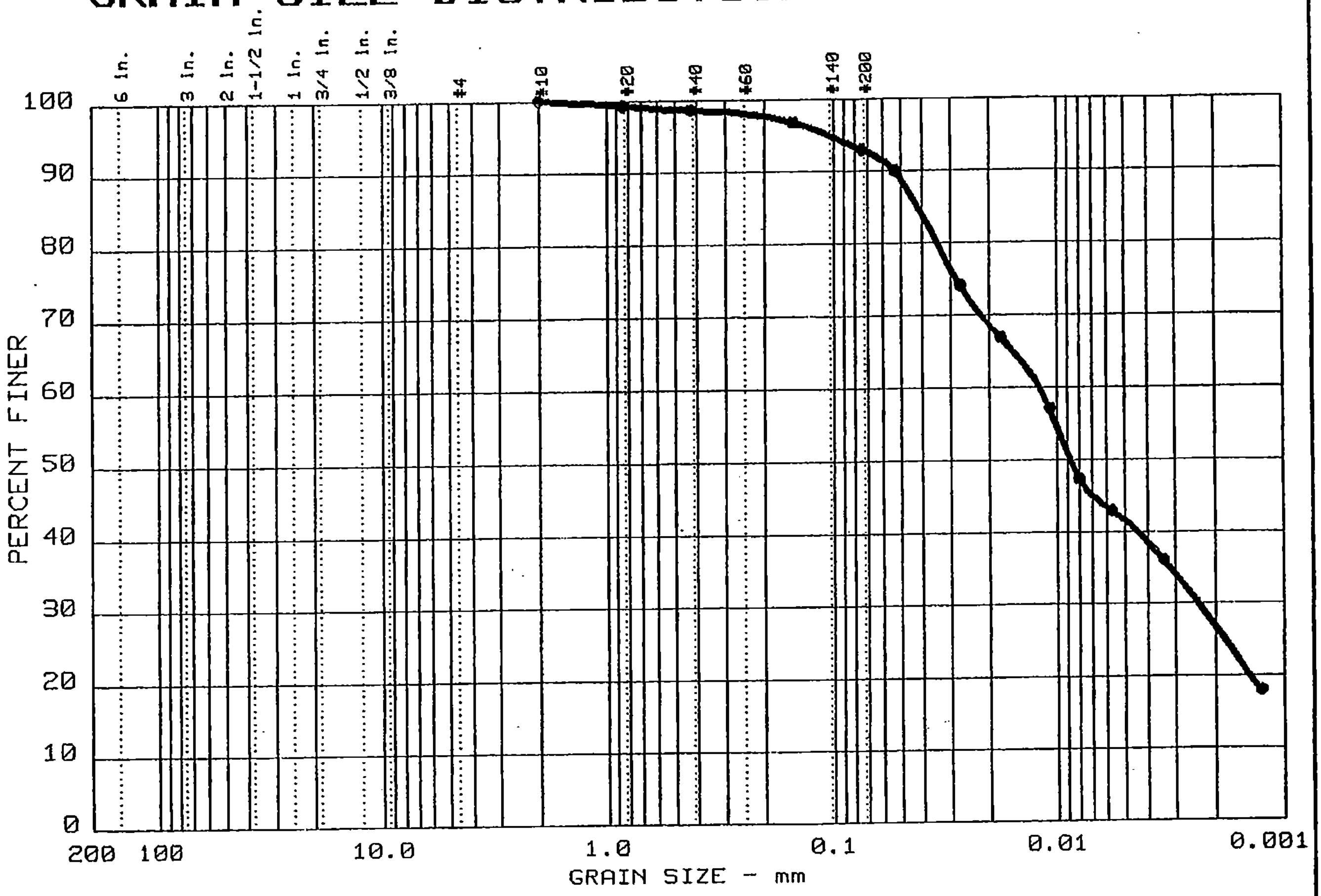
Client: American Electric Power

Project: Sporn Plt-Bott.Ash Pont Certification LOA-002-96, New Haven, WV

Location: Boring:96-107 Depth:66.6-68.6' Sample:ST-16

File: 8566 Project No.: 90979.030 Page 2/2 Fig. No. ____

# GRAIN SIZE DISTRIBUTION TEST REPORT



| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 7.2 | 51.3 | 41.5 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 44 | 14 | 0.04 | 0.01 | 0.01 | 0.002 | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| ● SILT | ML | |

Project No.: 90979.030
Project: Sporn Plt-~~Bott~~fly.Ash Pond Certification LOA-002-96*
● Location: Boring:96-108 Depth:41.6-43.6' *
* New Haven, WV

Date: 12/16/95

GRAIN SIZE DISTRIBUTION TEST REPORT

**H. C. NUTTING COMPANY**

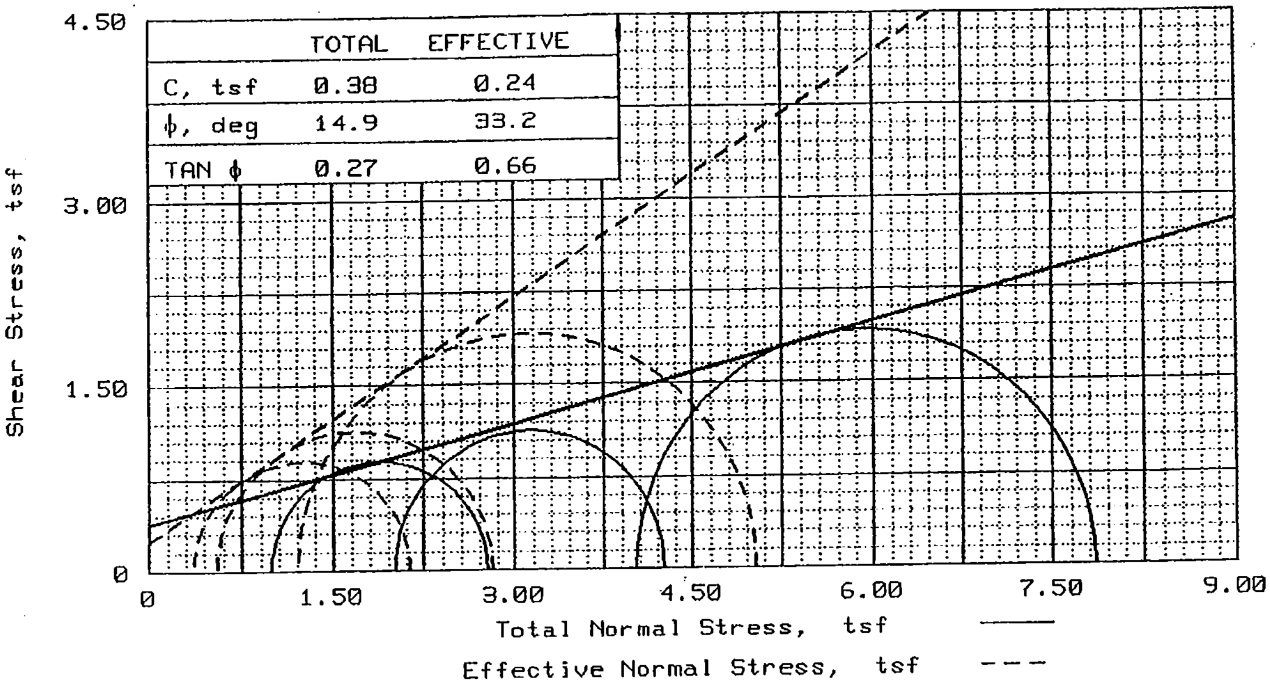
Remarks:

Client: American Electric Power

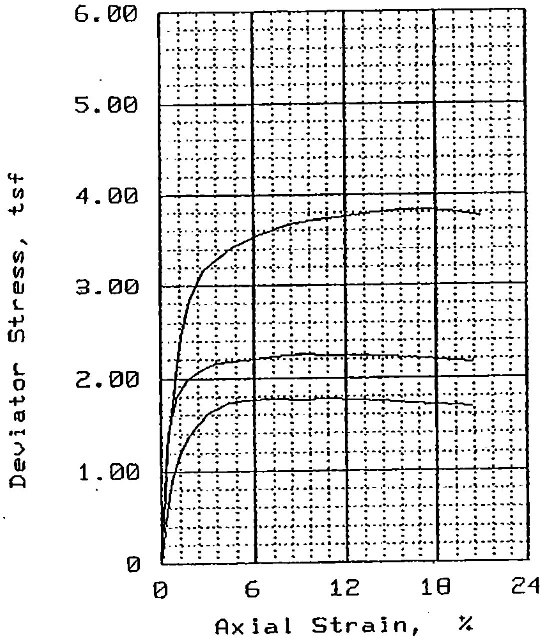
* Sample:ST-10

Lab No. 8567

Figure No. ______



| | TOTAL | EFFECTIVE |
|---|---|---|
| C, tsf | 0.38 | 0.24 |
| ϕ, deg | 14.9 | 33.2 |
| TAN ϕ | 0.27 | 0.66 |



| | SAMPLE NO. | 1 | 2 | 3 |
|---|---|---|---|---|
| INITIAL | WATER CONTENT, % | 34.6 | 38.4 | 36.9 |
| | DRY DENSITY, pcf | 88.1 | 85.1 | 84.7 |
| | SATURATION, % | 100.0 | 100.0 | 100.0 |
| | VOID RATIO | 0.913 | 0.980 | 0.990 |
| | DIAMETER, in | 2.83 | 2.84 | 2.84 |
| | HEIGHT, in | 5.56 | 5.56 | 5.56 |
| AT TEST | WATER CONTENT, % | 34.5 | 33.9 | 32.9 |
| | DIAMETER, in | 2.81 | 2.80 | 2.75 |
| | HEIGHT, in | 5.52 | 5.49 | 5.38 |
| | Strain rate, %/min | 0.001 | 0.001 | 0.001 |
| | BACK PRESSURE, tsf | 2.88 | 2.88 | 2.88 |
| | CELL PRESSURE, tsf | 3.89 | 4.90 | 6.91 |
| | FAILURE STRESS, tsf | 1.77 | 2.25 | 3.82 |
| | PORE PRESSURE, tsf | 3.51 | 4.33 | 5.70 |
| | ULTIMATE STRESS, tsf | | | |
| | PORE PRESSURE, tsf | | | |
| | $\bar{\sigma}_1$ FAILURE, tsf | 2.14 | 2.81 | 5.04 |
| | $\bar{\sigma}_3$ FAILURE, tsf | 0.37 | 0.56 | 1.22 |

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE:
DESCRIPTION: ~~SILT~~ ClAy

LL= 44 PL= 14 PI= 30.0
SPECIFIC GRAVITY= 0
REMARKS: Lab No. 8567

FIG. NO.

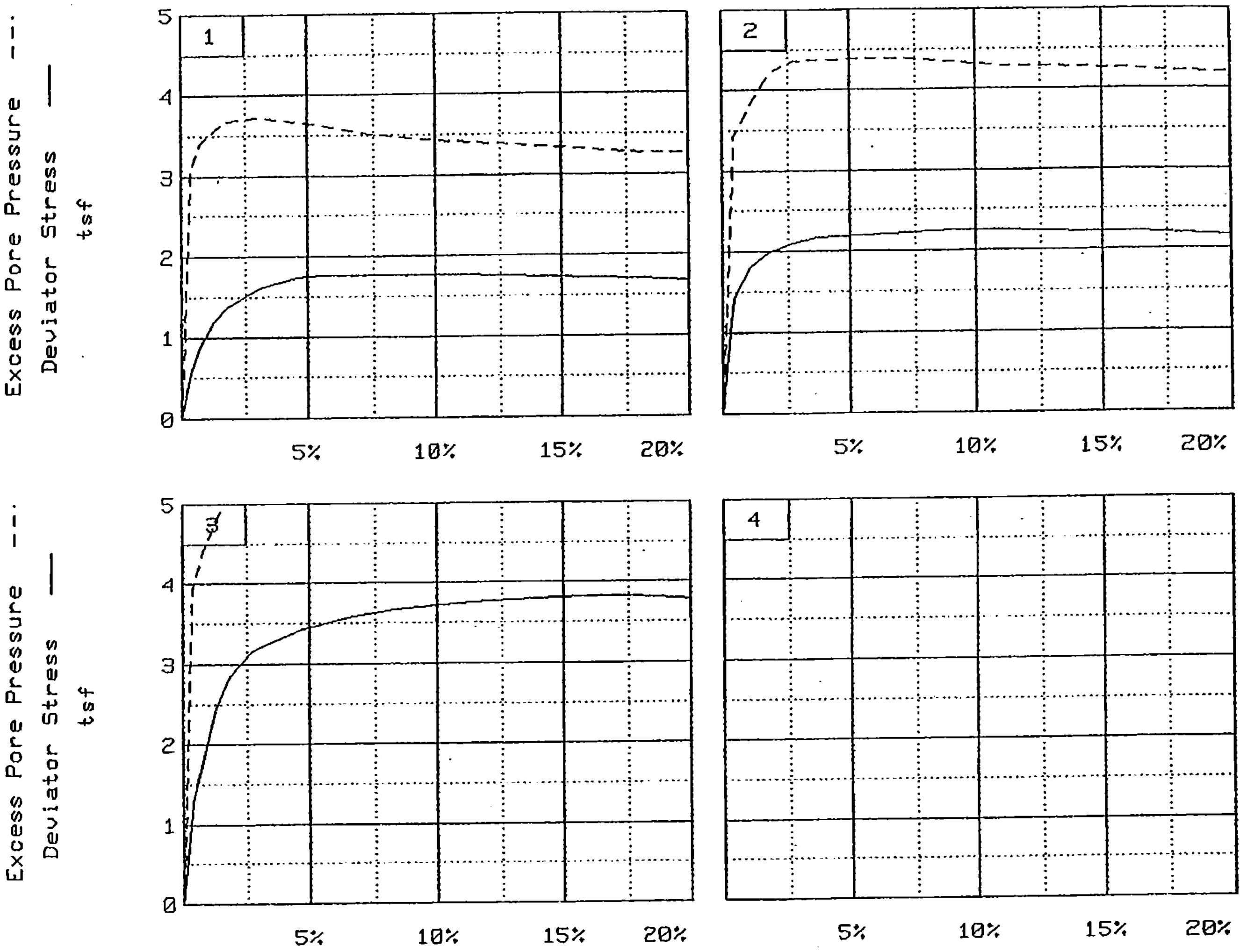
CLIENT: American Electric Power

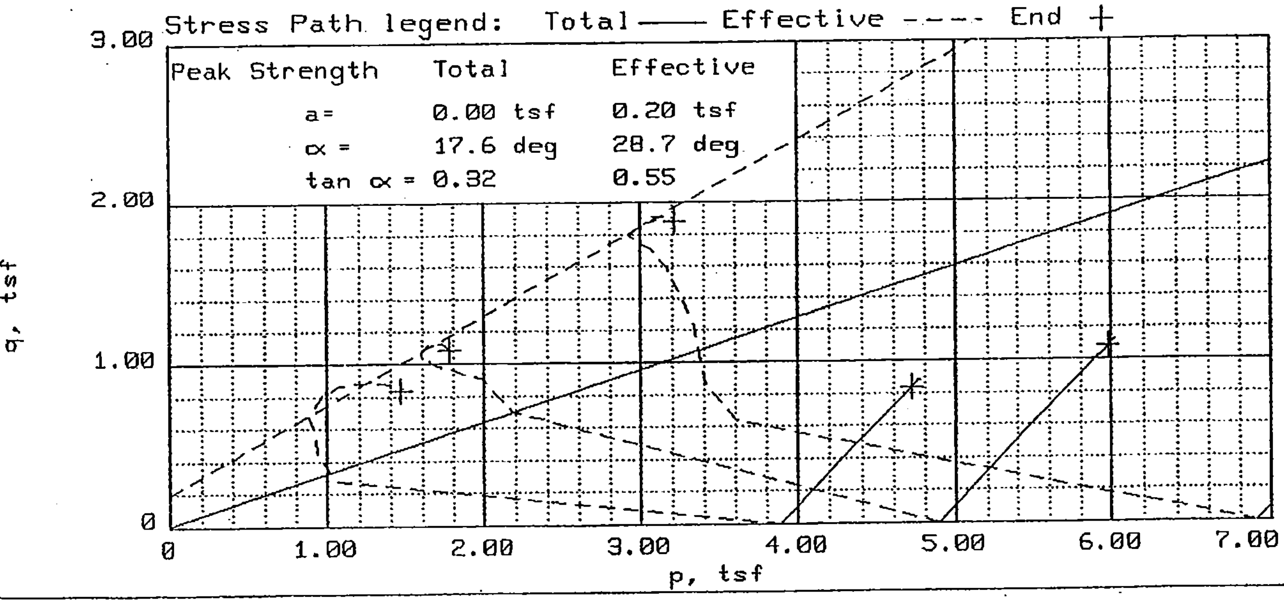
PROJECT: Sporn Plt-~~Bott~~ fly. Ash Pond
Certification LOA-002-96
SAMPLE LOCATION: Boring:96-108
Depth:41.6-43.6' Sample:ST-10

PROJ. NO.: 90979.030 DATE: 12/16/96

TRIAXIAL SHEAR TEST REPORT

**H. C. NUTTING COMPANY**

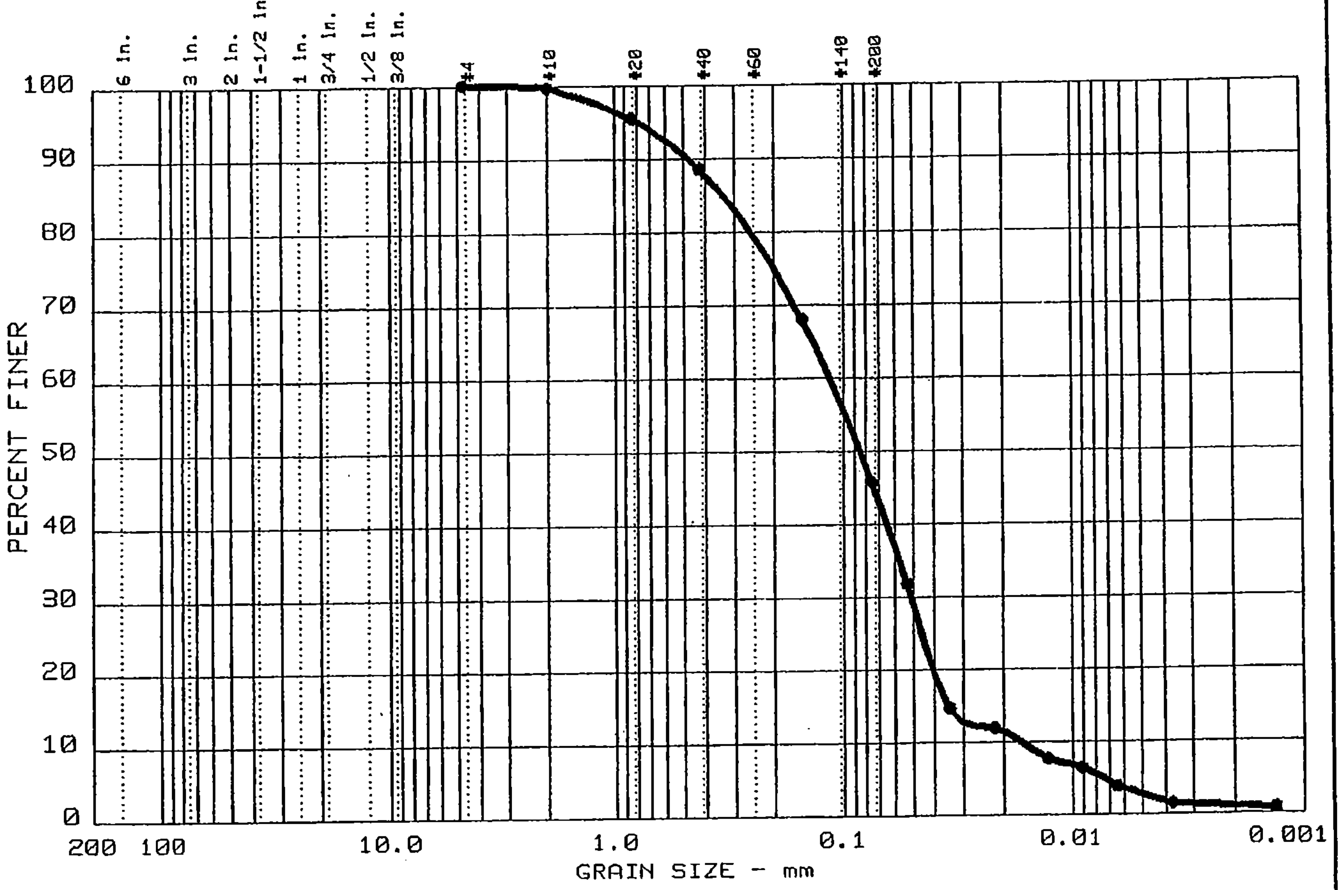




| Peak Strength | Total | Effective |
|---|---|---|
| a = | 0.00 tsf | 0.20 tsf |
| α = | 17.6 deg | 28.7 deg |
| tan α = | 0.32 | 0.55 |

Client: American Electric Power
Project: Sporn Plt-Bott. Ash Pond Certification LOA-002-96
Location: Boring:96-108 Depth:41.6-43.6' Sample:ST-10
File: 8567 Project No.: 90979.030 Page 2/2 Fig. No. ____

# GRAIN SIZE DISTRIBUTION TEST REPORT



| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 54.3 | 43.0 | 2.7 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | NP | NP | 0.33 | 0.11 | 0.08 | 0.051 | 0.0347 | 0.0168 | 1.34 | 6.8 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| ● SILTY SAND (Fly Ash) | SM | |

Project No.: 90979.030

Project: Sporn Plt-~~Bott~~Fly Ash Pond Certification LOA-002-96*

● Location: Boring:96-109 Depth:26.7-28.7' *

* New Haven, WV

Date: 12/16/95

Remarks:

Client: American Electric Power

* Sample:ST-8

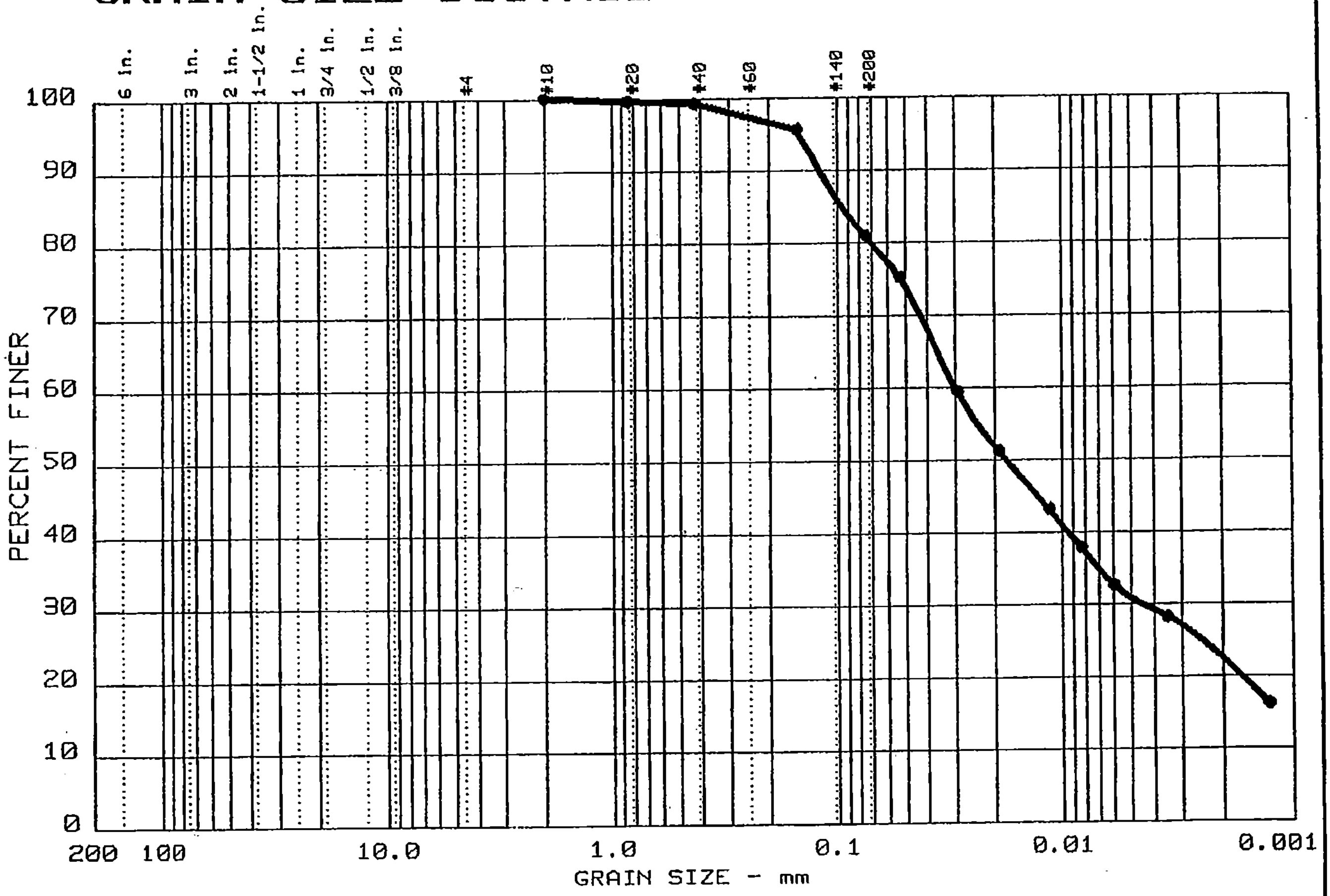
Lab No. 8568

GRAIN SIZE DISTRIBUTION TEST REPORT

## H. C. NUTTING COMPANY

Figure No. ______

# GRAIN SIZE DISTRIBUTION TEST REPORT



| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 19.0 | 50.3 | 30.7 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 39 | 12 | 0.10 | 0.03 | 0.02 | 0.005 | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| ● SILT WITH SAND | ML | |

Project No.: 90979.030

Project: Sporn Plt-~~Bott.~~ Fly Ash Pond Certification LOA-002-96*

● Location: Boring:96-110 Depth:58.6-60.6' *

* New Haven, WV

Date: 12/16/95

GRAIN SIZE DISTRIBUTION TEST REPORT

**H. C. NUTTING COMPANY**

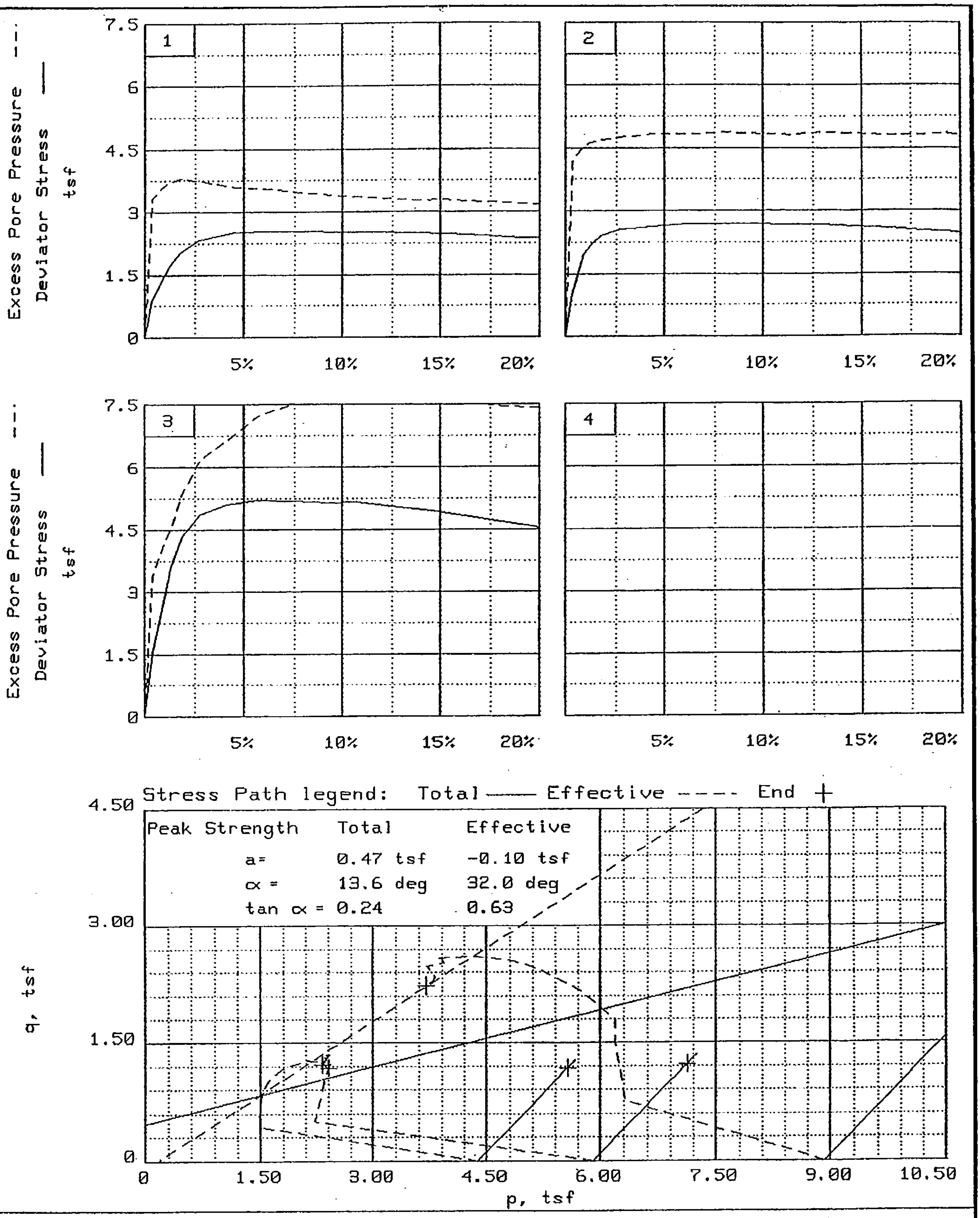
Remarks:

Client: American Electric Power

* Sample:ST-18

Lab No. 8569

Figure No. ______



Client: American Electric Power

Project: Sporn Plt-Bott. Ash Pond Certification LOA-002-96, New Haven, WV

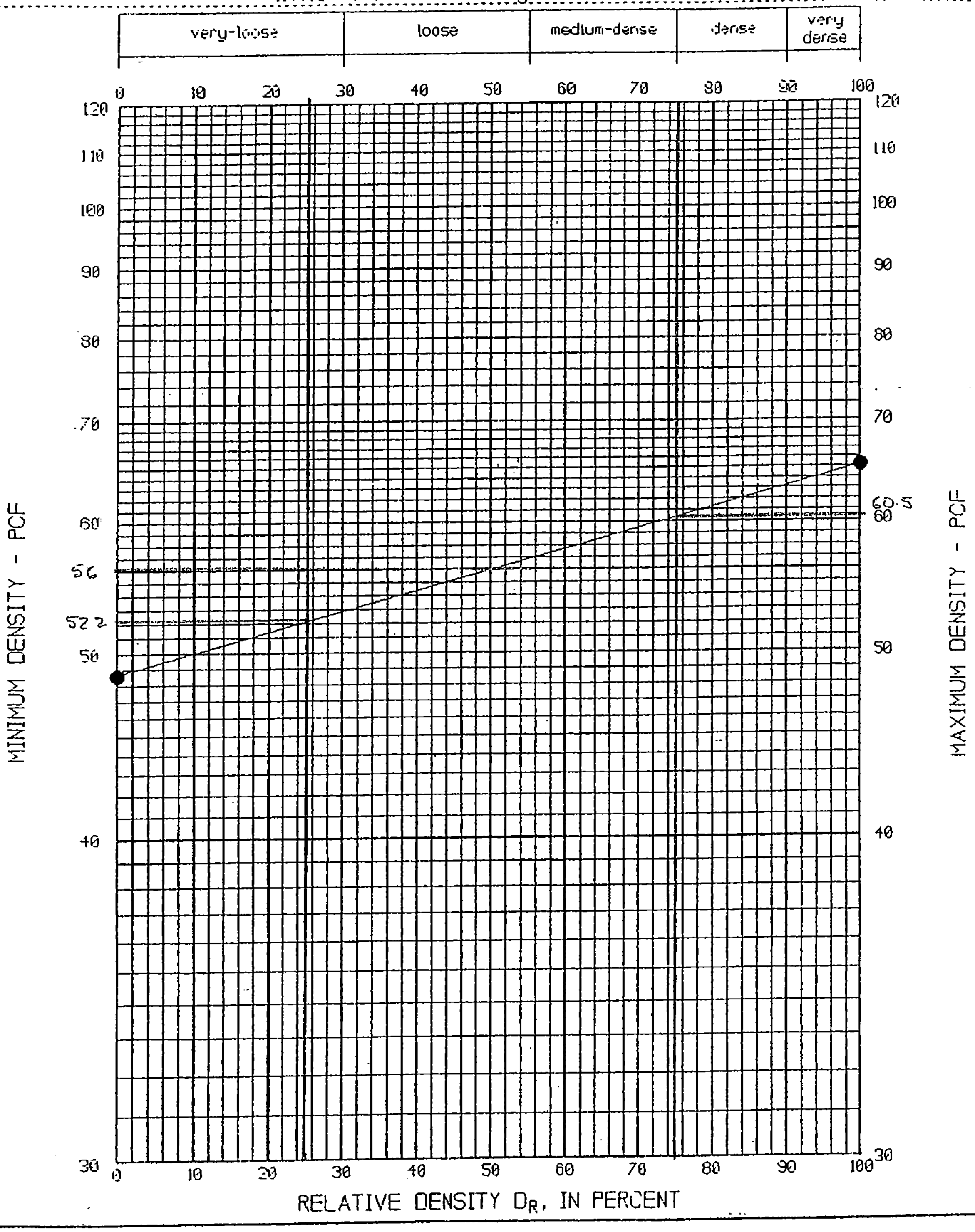
Location: Boring:96-110 Depth:58.6-60.6' Sample:St-18

File: 8569 Project No.: 09079.030 Page 2/2 Fig. No. ____

# RELATIVE DENSITY - MAX/MIN METHOD

Project : Sporn Fly Ash Pond Dike Remediation
Location : New Haven, West Virginia
Sample : Bucket
Material : Bottom Ash : Dark-gray and gray fine to coarse sand, little fine to coarse gravel, trace silt.

JOB NO.



SUMMARY OF MATERIAL PROPERTIES

JECT: SPORN PLANT - FLY ASH POND DIKES
BER:

| ehole Excav | Depth ft. | ASTM Description | ASTM Classif-ication | Soil Type | Maximum Dry Density pcf | Optimum Moisture % | Liquid Limit % | Plastic Limit % | Gravel % | Sand % | <#200 Sieve % | <.002 mm % | Specific Gravity | Prmblty cm/sec | Natural Moisture % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -101 | 5.0 | SILTY SAND with GRAVEL | SM | | | | NP | NP | 29.9 | 51.2 | 18.9 | | | | 6.5 |
| -101 | 8.5 | SILTY SAND with GRAVEL | SM | | | | NP | NP | 17.6 | 44.1 | 38.3 | | | | 10.0 |
| -101 | 16.5 | SILTY SAND with GRAVEL | SM | | | | NP | NP | 24.7 | 57.3 | 18.0 | | | | 4.2 |
| -101 | 21.5 | POORLY GRADED SAND with SILT and GRAVEL | SP-SM | | | | NP | NP | 43.2 | 49.1 | 7.7 | | | | 2.6 |
| -101 | 26.5 | POORLY GRADED SAND with SILT and GRAVEL | SP-SM | | | | NP | NP | 35.5 | 52.3 | 12.2 | | | | 6.8 |
| -101 | 31.5 | [redacted] Silty Clay w/sand | (CL-ML) | SEE TRIAXIAL TESTING BY [illegible] | | | NP | NP | 0.4 | 48.7 | 50.9 | | | | 10.8 |
| -101 | 36.5 | LEAN CLAY | CL | | | | 26.6 | 16.3 | 0.0 | 10.7 | 89.3 | | | | 17.0 |
| -102 | 8.5 | SILTY SAND with GRAVEL | SM | | | | NP | NP | 31.3 | 49.7 | 19.0 | | | | 6.5 |
| -102 | 16.7 | POORLY GRADED GRAVEL with SILT and SAND | GP-GM | | | | NP | NP | 50.2 | 42.9 | 6.9 | | | | 2.8 |
| -102 | 26.7 | SANDY SILT | ML | | | | NP | NP | 1.7 | 37.1 | 61.2 | | | | 11.8 |
| -102 | 31.7 | LEAN CLAY with SAND | CL | | | | 27.7 | 18.4 | 0.0 | 24.2 | 75.8 | | | | 18.4 |
| -102 | 36.7 | SANDY LEAN CLAY | CL | | | | 23.8 | 16.2 | 0.0 | 47.3 | 52.7 | | | | 15.6 |
| -102 | 41.7 | POORLY GRADED SAND with SILT and GRAVEL | SP-SM | | | | NP | NP | 38.3 | 52.5 | 9.2 | | | | 5.3 |
| -103 | 21.6 | POORLY GRADED SAND with SILT and GRAVEL | SP-SM | | | | NP | NP | 40.0 | 51.0 | 9.0 | | | | 4.7 |
| -103 | 31.6 | LEAN CLAY with SAND | CL | | | | 28.6 | 18.8 | 0.0 | 26.6 | 73.4 | | | | 14.5 |
| -103 | 41.6 | SILTY SAND | SM | | | | NP | NP | 0.0 | 53.7 | 46.3 | | | | 11.4 |
| -104 | 3.0 | POORLY GRADED SAND with SILT and GRAVEL | SP-SM | | | | NP | NP | 41.5 | 53.6 | 4.9 | | | | 1.1 |
| -104 | 8.5 | POORLY GRADED SAND with SILT and GRAVEL | SP-SM | | | | NP | NP | 30.8 | 57.5 | 11.7 | | | | 1.0 |
| -104 | 11.7 | POORLY GRADED SAND with SILT and GRAVEL | SP-SM | | | | NP | NP | 41.7 | 48.5 | 9.8 | | | | 1.2 |
| -104 | 16.7 | SILTY SAND with GRAVEL | SM | | | | NP | NP | 19.4 | 64.7 | 15.9 | | | | 4.0 |
| -104 | 21.7 | SILTY SAND with GRAVEL | SM | | | | NP | NP | 34.4 | 47.5 | 18.1 | | | | 2.9 |
| -104 | 36.7 | LEAN CLAY with SAND | CL | | | | 27.2 | 19.0 | 0.0 | 22.8 | 77.2 | | | | 18.9 |
| -104 | 41.7 | SANDY SILT | ML | | | | NP | NP | 0.0 | 35.3 | 64.7 | | | | 8.1 |
| -105 | 3.0 | POORLY GRADED SAND with SILT and GRAVEL | SP-SM | | | | NP | NP | 40.2 | 53.9 | 5.9 | | | | 1.6 |
| -105 | 16.5 | POORLY GRADED SAND with SILT and GRAVEL | SP-SM | | | | NP | NP | 42.7 | 48.8 | 8.5 | | | | 3.1 |
| -105 | 21.5 | SILTY SAND with GRAVEL | SM | | | | NP | NP | 19.0 | 61.9 | 19.1 | | | | 6.7 |
| -105 | 26.5 | LEAN CLAY with SAND | CL | | | | 27.4 | 17.7 | 0.0 | 26.6 | 73.4 | | | | 13.3 |
| -105 | 36.5 | LEAN CLAY | CL | | | | 28.8 | 18.7 | 0.0 | 4.4 | 95.6 | | | | 22.1 |
| -105 | 41.5 | SILTY SAND | SM | | | | NP | NP | 0.0 | 51.2 | 48.8 | | | | 11.9 |
| -106 | 11.5 | SILTY SAND with GRAVEL | SM | | | | NP | NP | 19.1 | 59.8 | 21.1 | | | | 5.5 |
| -106 | 21.5 | SANDY LEAN CLAY | CL | | | | 26.1 | 17.5 | 0.0 | 33.4 | 66.6 | | | | 11.1 |
| -106 | 31.5 | SILT | ML | | | | NP | NP | 0.0 | 11.1 | 88.9 | | 2.29 | | 42.6 |

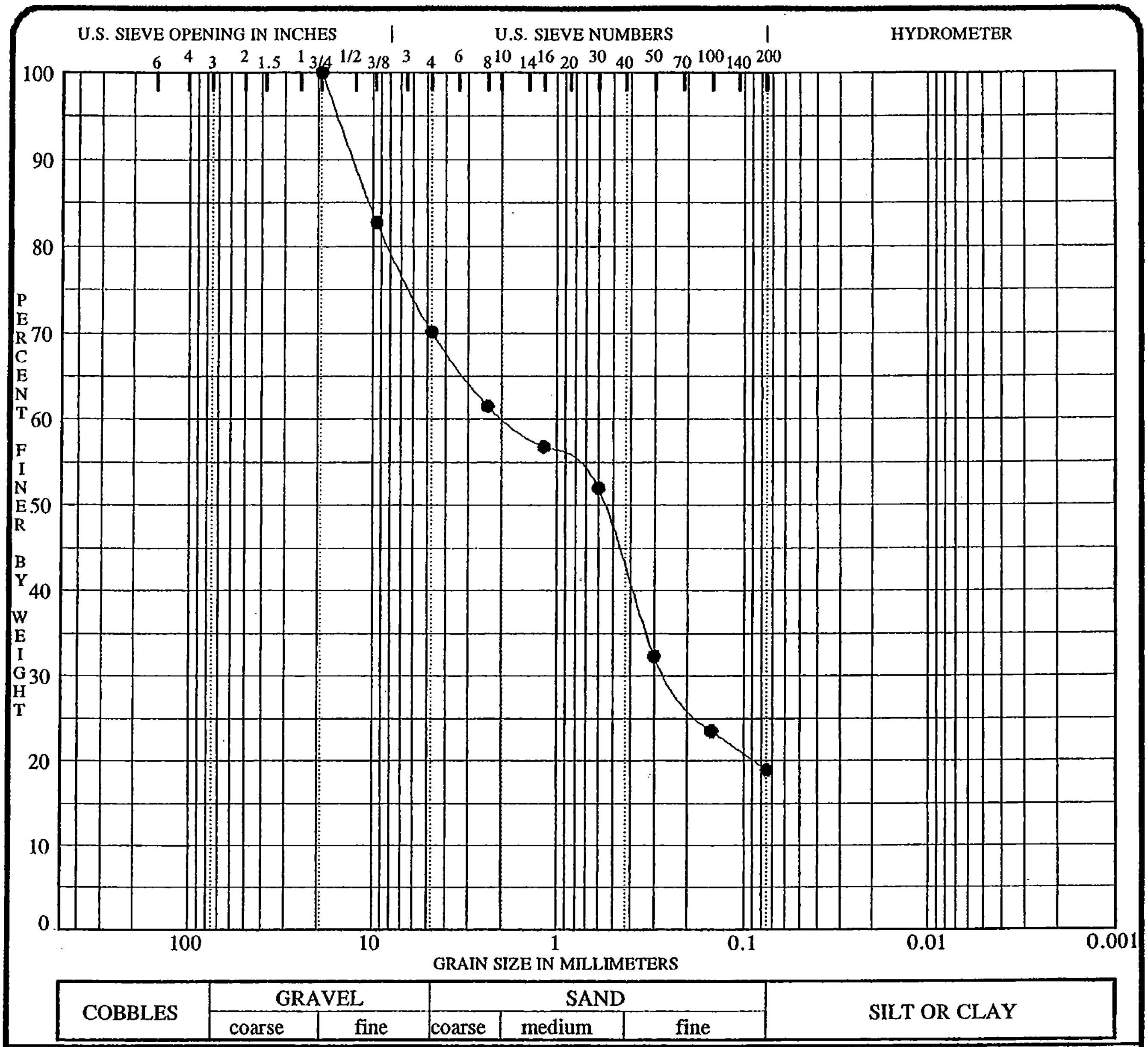
P Civil Engineering Laboratory, Groveport, Ohio

## SUMMARY OF MATERIAL PROPERTIES

OJECT: SPORN PLANT - FLY ASH POND DIKES
MBER:

| rehole Excav . | Depth ft. | ASTM Description | ASTM Classif-ication | Soil Type | Maximum Dry Density pcf | Optimum Moisture % | Liquid Limit % | Plastic Limit % | Gravel % | Sand % | <#200 Sieve % | <.002 mm % | Specific Gravity | Prmblty cm/sec | Natural Moisture % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -106 | 51.5 | SILT with SAND | ML | | | | NP | NP | 0.0 | 15.2 | 84.8 | | 2.42 | | 35.7 |
| -106 | 56.5 | LEAN CLAY | CL | | | | 43.6 | 25.6 | 0.0 | 2.6 | 97.4 | | | | 31.9 |
| -107 | 11.6 | POORLY GRADED SAND with SILT and GRAVEL | SP-SM | | | | NP | NP | 34.7 | 54.9 | 10.4 | | | | 3.9 |
| -107 | 16.6 | SANDY LEAN CLAY | CL | | | | 25.2 | 18.1 | 0.0 | 31.9 | 68.1 | | | | 14.0 |
| -107 | 21.6 | SANDY SILT | ML | | | | NP | NP | 0.0 | 35.4 | 64.6 | | | | 11.4 |
| -107 | 36.6 | SILT with SAND | ML | | | | NP | NP | 0.0 | 21.9 | 78.1 | | 2.38 | | 37.6 |
| -107 | 56.6 | SILT | ML | | | | NP | NP | 0.0 | 11.3 | 88.7 | | 2.31 | | 36.2 |
| -107 | 71.6 | LEAN CLAY | CL | | | | 41.3 | 21.1 | 0.0 | 11.4 | 88.6 | | | | 25.2 |
| -108 | 3.0 | SILTY SAND with GRAVEL | SM | | | | NP | NP | 14.8 | 50.6 | 34.6 | | | | 9.1 |
| -108 | 8.5 | SILTY SAND | SM | | | | NP | NP | 13.7 | 49.9 | 36.4 | | | | 6.2 |
| -108 | 11.6 | SILTY SAND with GRAVEL | SM | | | | NP | NP | 34.4 | 50.4 | 15.2 | | | | 3.0 |
| -108 | 16.6 | SILTY SAND with GRAVEL | SM | | | | NP | NP | 16.9 | 55.3 | 27.8 | | | | 1.9 |
| -108 | 21.6 | SANDY SILTY CLAY | CL-ML | | | | 23.3 | 16.5 | 0.0 | 40.5 | 59.5 | | | | 12.2 |
| -108 | 26.6 | SILTY SAND | SM | | | | NP | NP | 10.4 | 72.7 | 16.9 | | | | 20.6 |
| -108 | 41.6 | LEAN CLAY | CL | | | | 38.7 | 20.3 | 0.0 | 9.5 | 90.5 | | | | 23.2 |
| -108 | 56.6 | LEAN CLAY with SAND | CL | | | | 34.9 | 20.1 | 0.0 | 25.3 | 74.7 | | | | 25.1 |
| -109 | 8.5 | POORLY GRADED SAND with SILT and GRAVEL | SP-SM | | | | NP | NP | 34.7 | 55.9 | 9.4 | | | | 0.4 |
| -109 | 11.7 | SILTY SAND | SM | | | | NP | NP | 4.9 | 72.1 | 23.0 | | | | 4.3 |
| -109 | 16.7 | SANDY SILTY CLAY | CL-ML | | | | 22.9 | 17.1 | 0.0 | 40.9 | 59.1 | | | | 9.0 |
| -109 | 36.7 | SILT | ML | | | | NP | NP | 0.0 | 8.9 | 91.1 | | 2.34 | | 38.1 |
| -109 | 56.7 | SILT | ML | | | | NP | NP | 0.0 | 0.9 | 99.1 | | 2.29 | | 34.3 |
| -109 | 71.7 | LEAN CLAY | CL | | | | 40.3 | 21.8 | 0.0 | 6.8 | 93.2 | | | | 23.7 |
| -110 | 5.0 | SILTY SAND | SM | | | | NP | NP | 8.8 | 59.5 | 31.7 | | | | 6.8 |
| -110 | 8.5 | POORLY GRADED GRAVEL with SILT and SAND | GP-GM | | | | NP | NP | 53.3 | 38.0 | 8.7 | | | | 0.1 |
| -110 | 16.6 | LEAN CLAY with SAND | CL | | | | 25.5 | 17.6 | 0.0 | 29.1 | 70.9 | | | | 11.5 |
| -110 | 21.6 | SANDY SILTY CLAY | CL-ML | | | | 24.0 | 17.0 | 0.0 | 41.1 | 58.9 | | | | 12.5 |
| -110 | 31.6 | LEAN CLAY with SAND | CL | | | | 30.7 | 18.4 | 0.0 | 18.0 | 82.0 | | | | 14.7 |
| -110 | 46.6 | LEAN CLAY | CL | | | | 36.2 | 21.3 | 0.0 | 12.3 | 87.7 | | | | 25.1 |
| -110 | 56.6 | LEAN CLAY | CL | | | | 37.5 | 20.3 | 0.0 | 13.1 | 86.9 | | | | 24.4 |
| -110 | 66.6 | LEAN CLAY with SAND | CL | | | | 38.7 | 21.7 | 0.0 | 16.2 | 83.8 | | | | 25.6 |

P Civil Engineering Laboratory, Groveport, Ohio



| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|
| ● 96-101 | 5.0 | | 6.5 | NP | NP | NP | | |
| | | SILTY SAND with GRAVEL SM | | | | | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | % < .002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-101 | 5.0 | 19.000 | 1.892 | 0.250 | | 29.9 | 51.2 | 18.9 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.

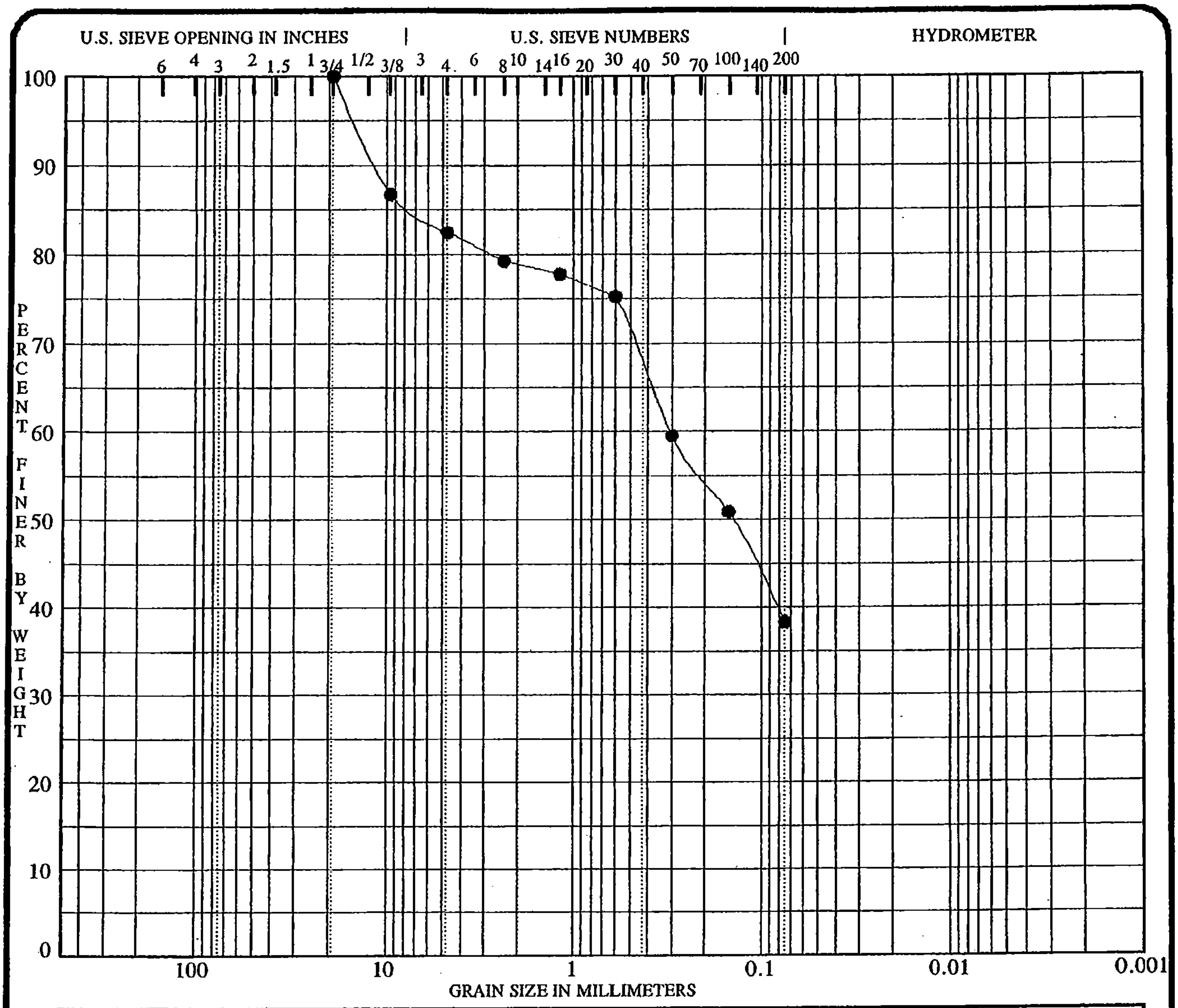
DATE 05/21/97

## GRADATION CURVES

**American Electric Power Service Corp.**

Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | **96-101** | **8.5** | | **10.0** | **NP** | **NP** | **NP** | | |
| | | | **SILTY SAND with GRAVEL SM** | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | **96-101** | **8.5** | **19.000** | **0.307** | | | **17.6** | **44.1** | **38.3** | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

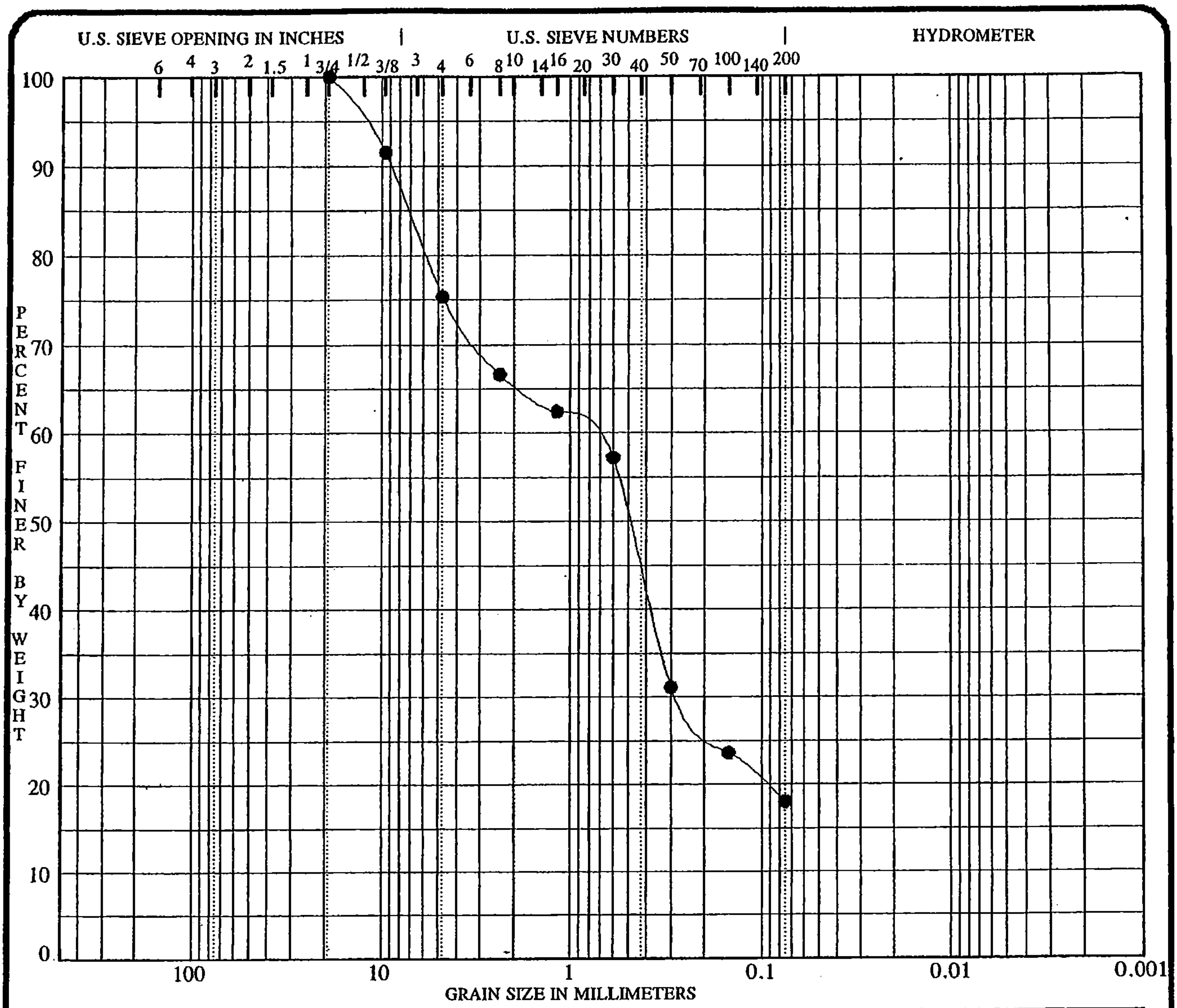
JOB NO.

DATE **05/21/97**

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|
| ● 96-101 16.5 | | 4.2 | NP | NP | NP | | |
| | SILTY SAND with GRAVEL SM | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|
| ● 96-101 16.5 | 19.000 | 0.864 | 0.271 | | 24.7 | 57.3 | 18.0 | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.

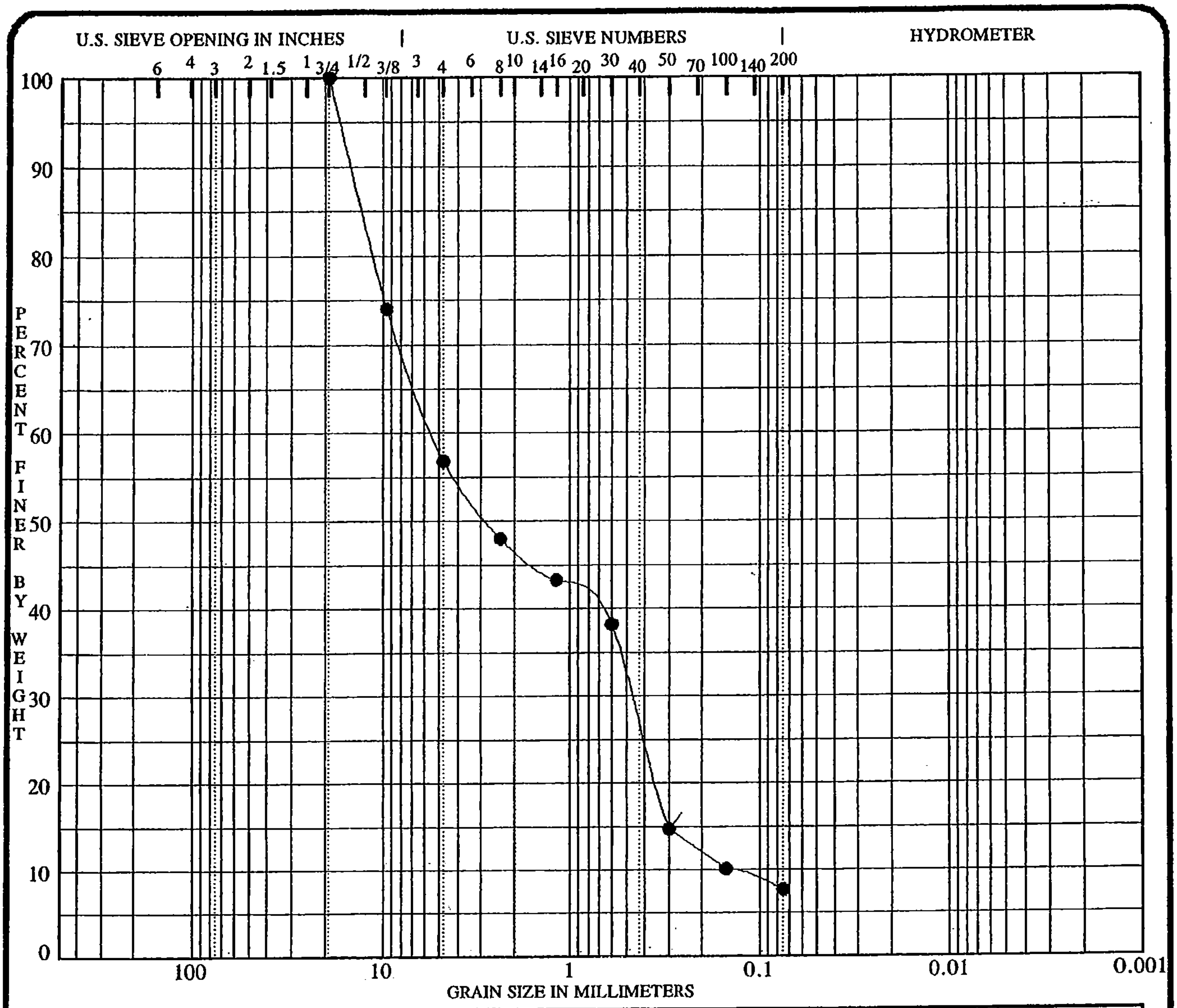
DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**

Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|
| ● 96-101 | 21.5 | | 2.6 | NP | NP | NP | |
| | | POORLY GRADED SAND with SILT and GRAVEL SP-SM | | | | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-101 | 21.5 | 19.000 | 5.404 | 0.471 | 0.146 | 43.2 | 49.1 | 7.7 | |

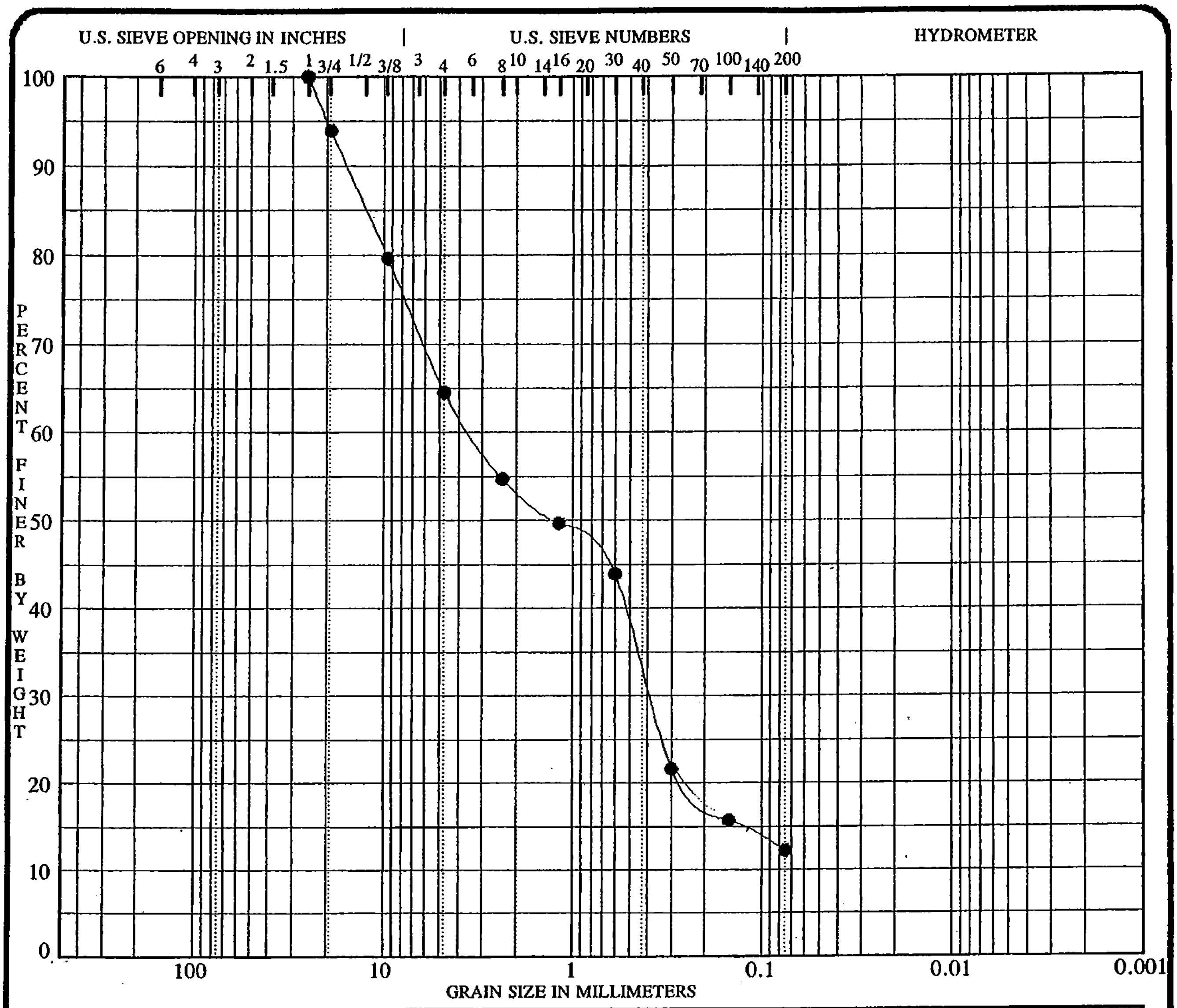
PROJECT SPORN PLANT - FLY ASH POND DIKES

JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-101 | 26.5 | | 6.8 | NP | NP | NP | |
| | POORLY GRADED SAND with SILT and GRAVEL SP-SM | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-101 | 26.5 | 25.000 | 3.445 | 0.390 | | 35.5 | 52.3 | 12.2 | |

PROJECT SPORN PLANT - FLY ASH POND DIKES

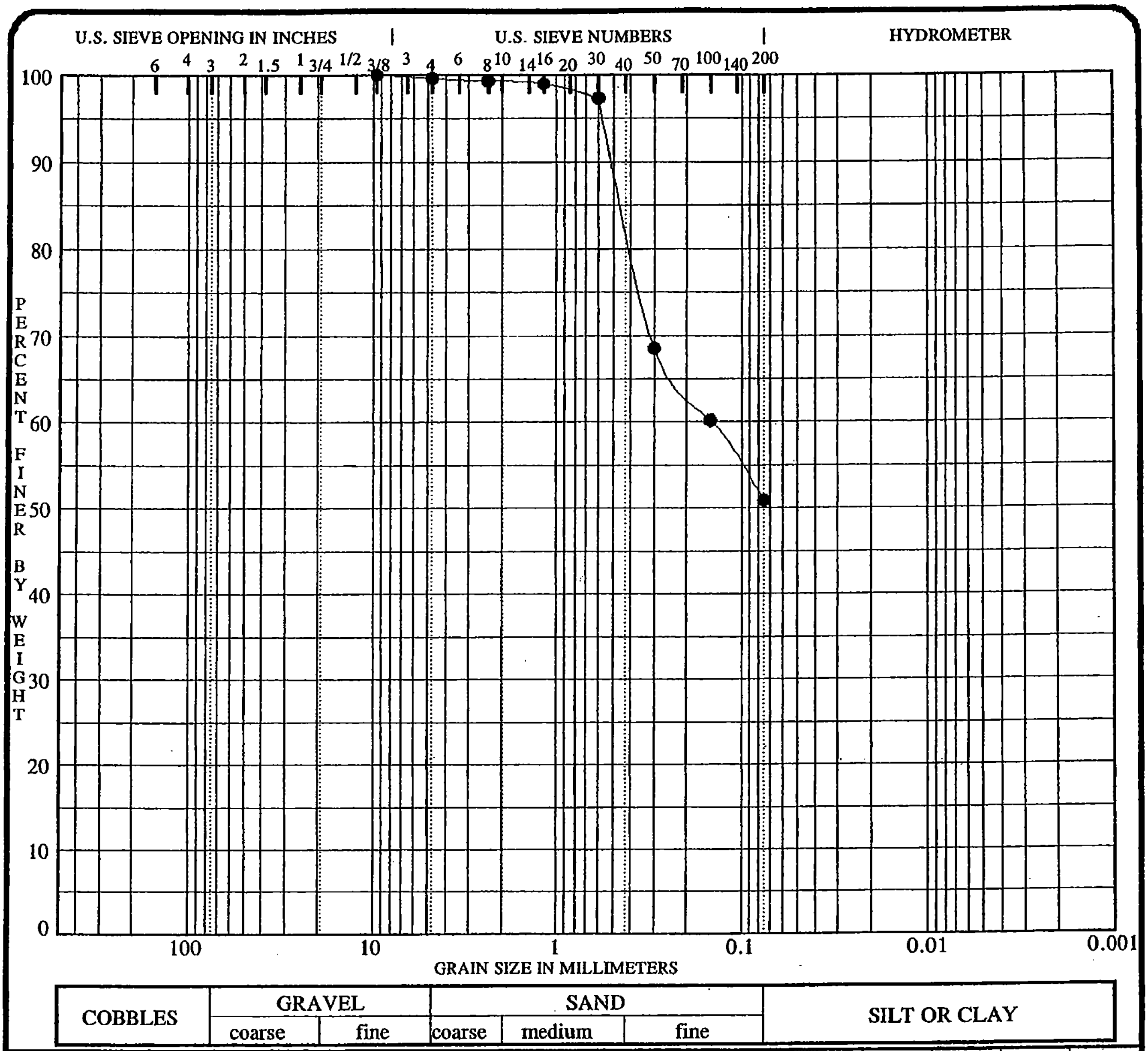
JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-101 | 31.5 | | 10.8 | NP | NP | NP | |
| | | | SANDY SILT ML | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-101 | 31.5 | 9.500 | 0.148 | | | 0.4 | 48.7 | 50.9 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

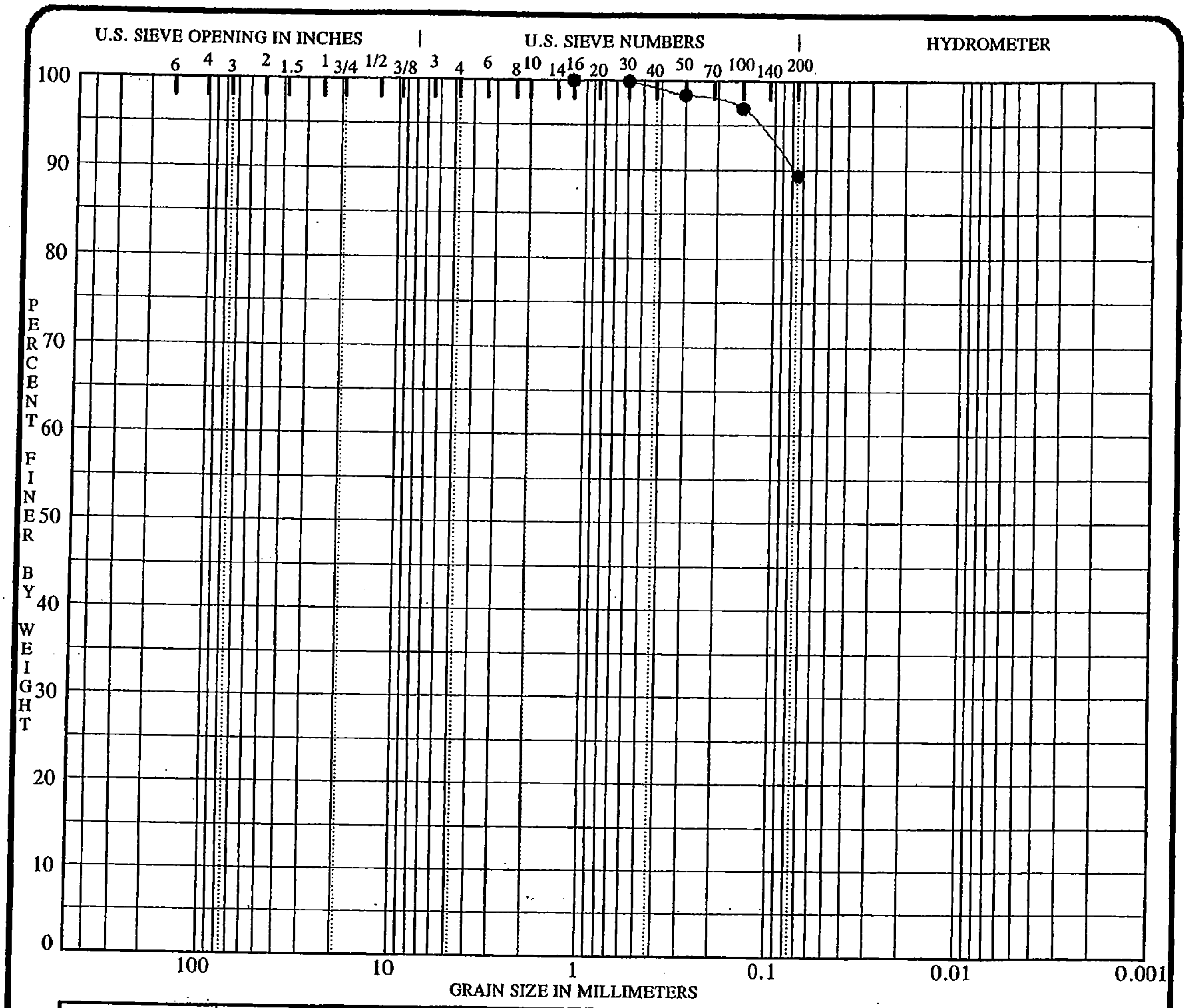
JOB NO.

DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**

Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-101 | 36.5 | | 17.0 | 26.6 | 16.3 | 10.3 | |
| | | | LEAN CLAY CL | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-101 | 36.5 | 1.180 | | | | 0.0 | 10.7 | 89.3 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

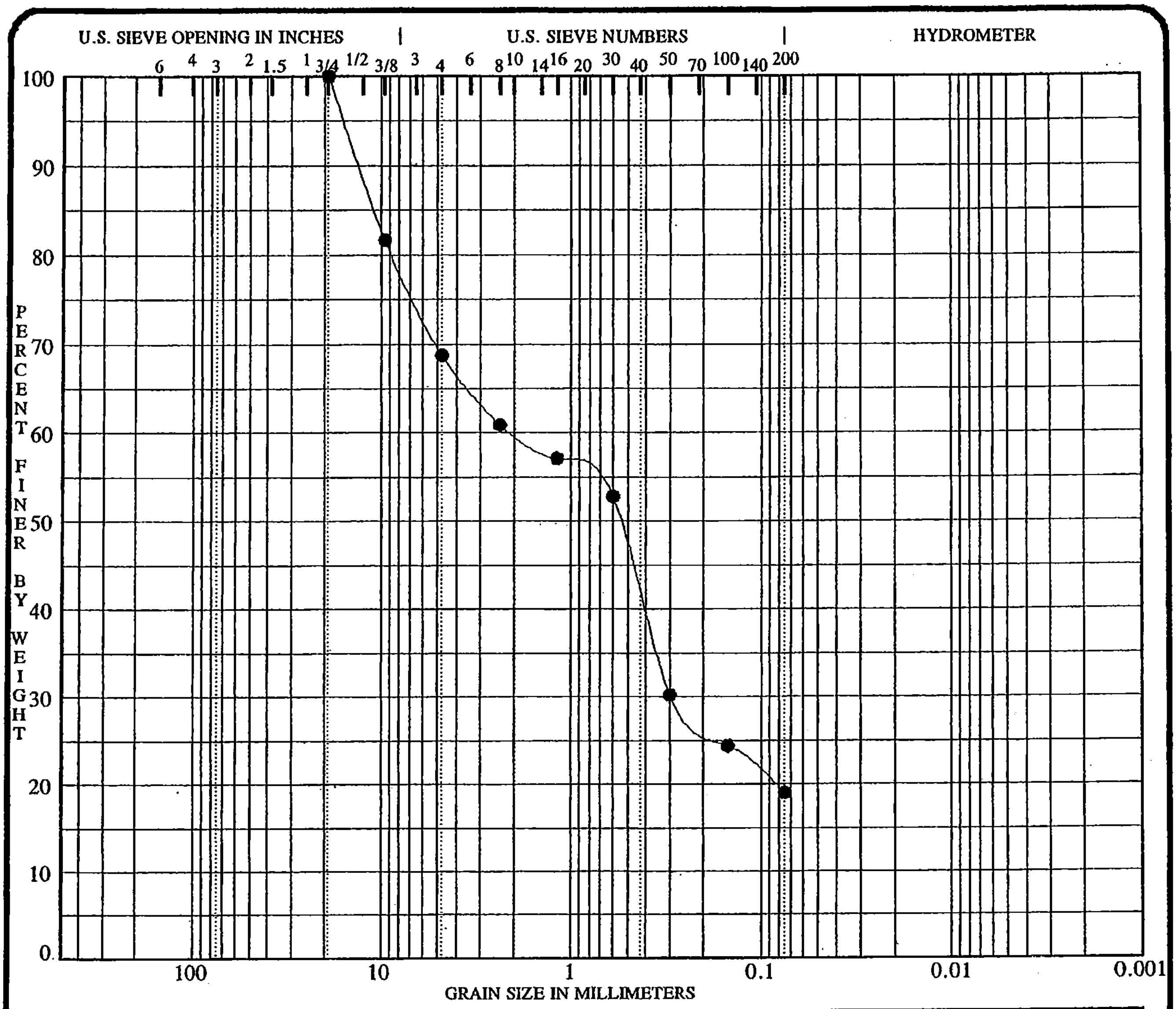
JOB NO.

DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-102 | 8.5 | | 6.5 | NP | NP | NP | |
| | | | SILTY SAND with GRAVEL SM | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-102 | 8.5 | 19.000 | 2.003 | 0.293 | | 31.3 | 49.7 | 19.0 | |

PROJECT SPORN PLANT - FLY ASH POND DIKES

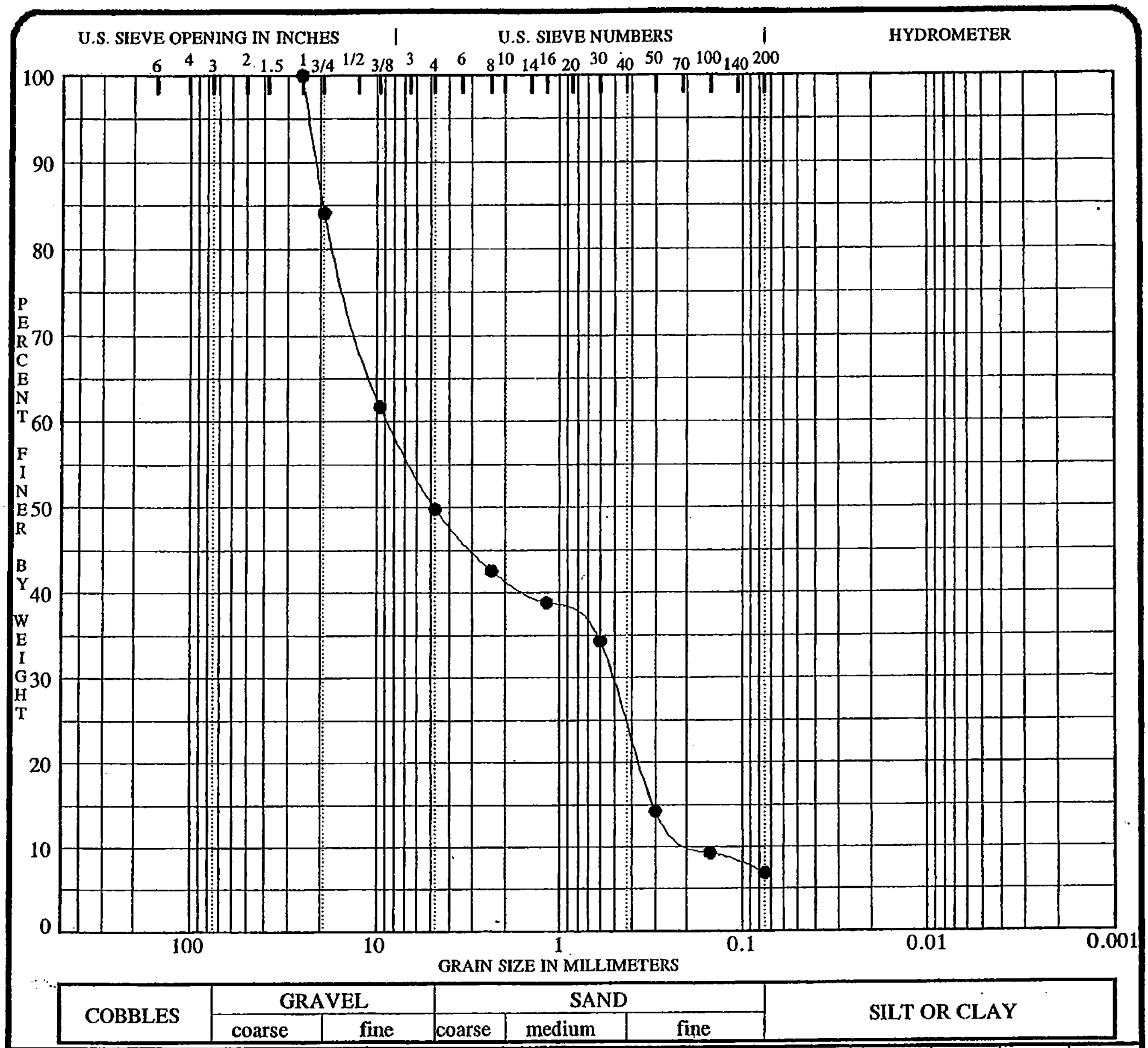
JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|
| ● 96-102 | 16.7 | | 2.8 | NP | NP | NP | | |
| | | POORLY GRADED GRAVEL with SILT and SAND GP-GM | | | | | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-102 | 16.7 | 25.000 | 8.604 | 0.517 | 0.166 | 50.2 | 42.9 | 6.9 | |

PROJECT SPORN PLANT - FLY ASH POND DIKES

JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

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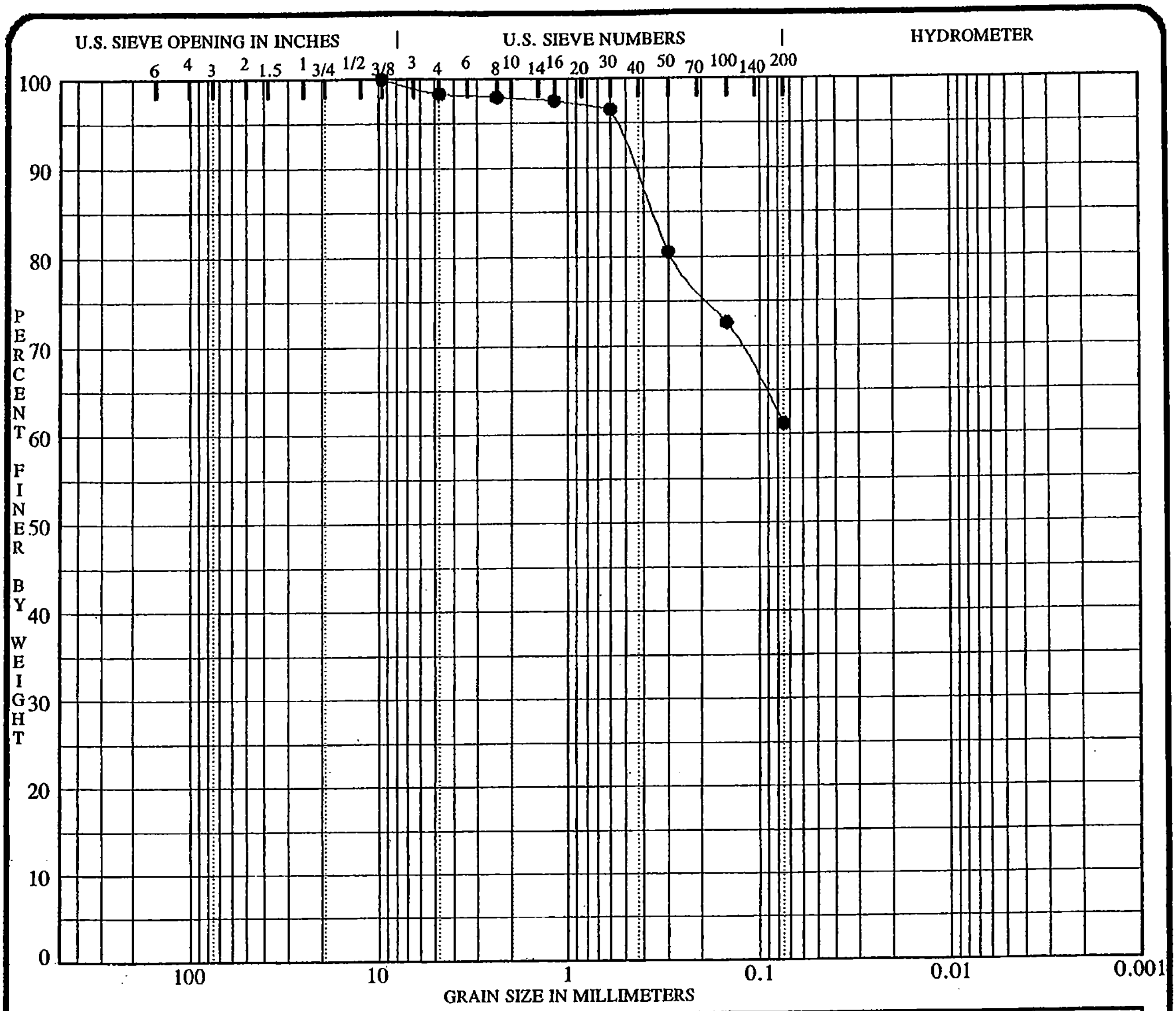


| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-102 | 26.7 | | 11.8 | NP | NP | NP | |
| | | | SANDY SILT ML | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-102 | 26.7 | 9.500 | | | | 1.7 | 37.1 | 61.2 | |

PROJECT SPORN PLANT - FLY ASH POND DIKES

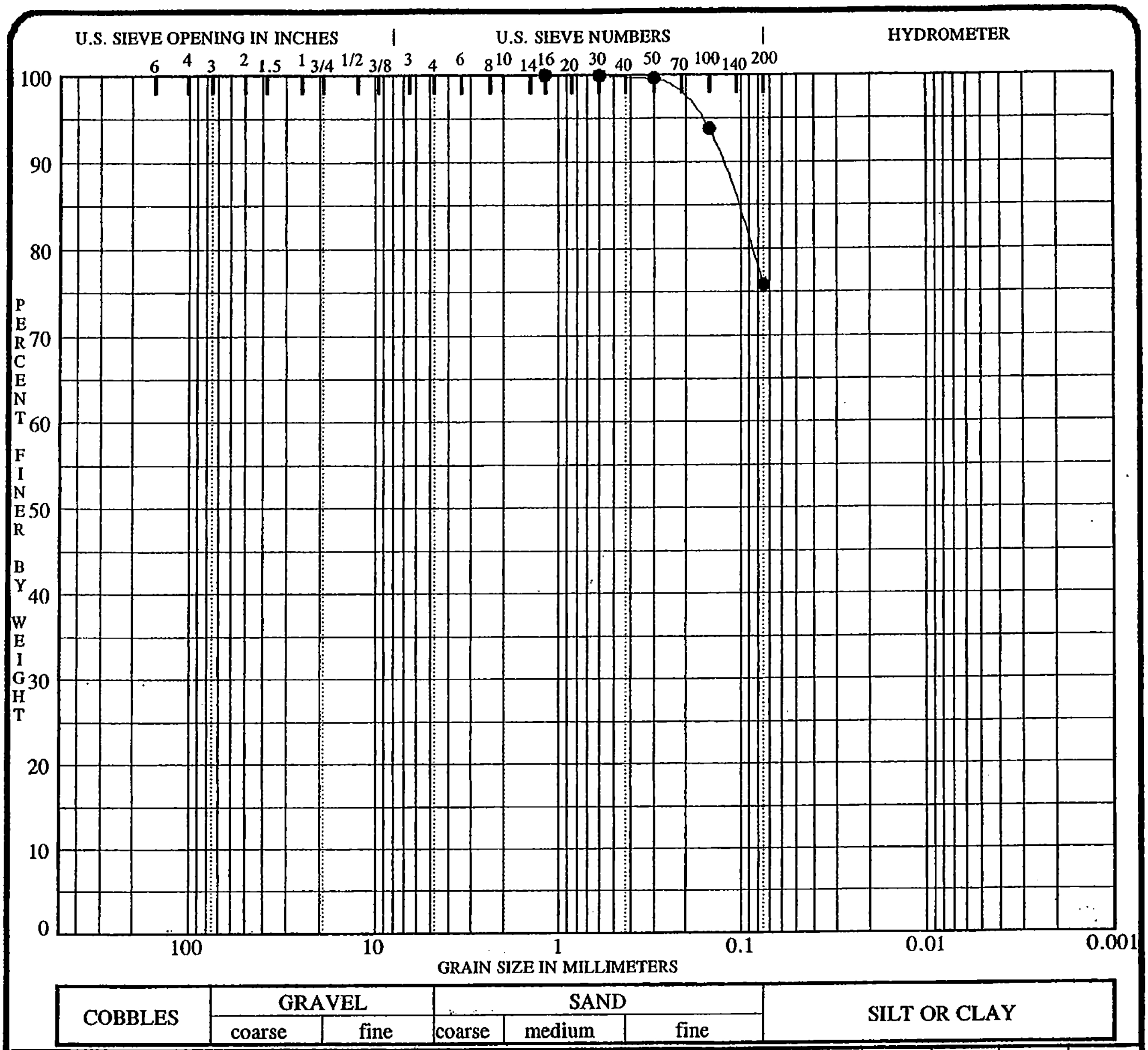
JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|
| ● 96-102 31.7 | | 18.4 | 27.7 | 18.4 | 9.3 | | |
| | **LEAN CLAY with SAND CL** | | | | | | |

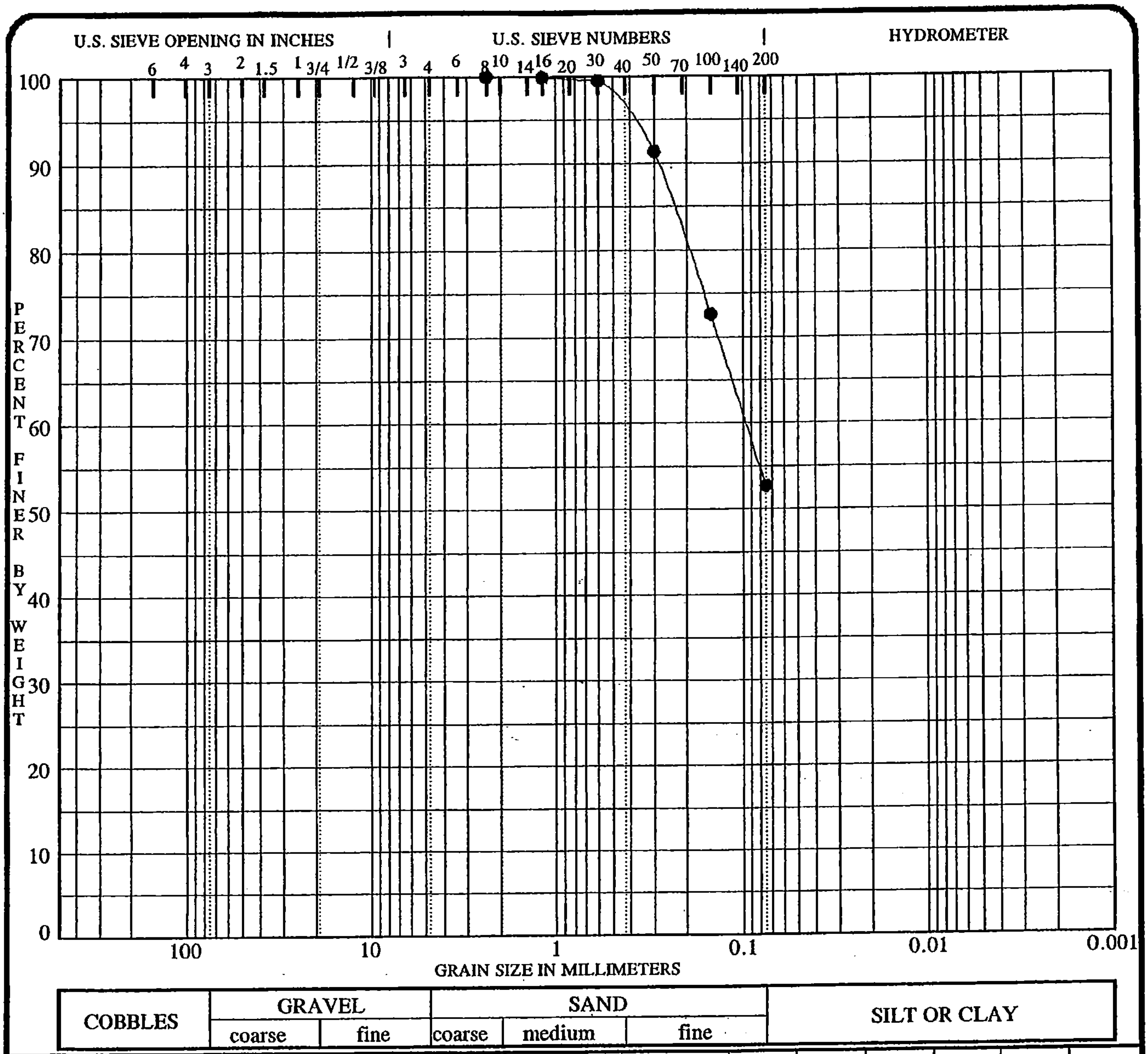
| Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|
| ● 96-102 31.7 | 1.180 | | | | 0.0 | 24.2 | 75.8 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.
DATE 05/21/97

## GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio



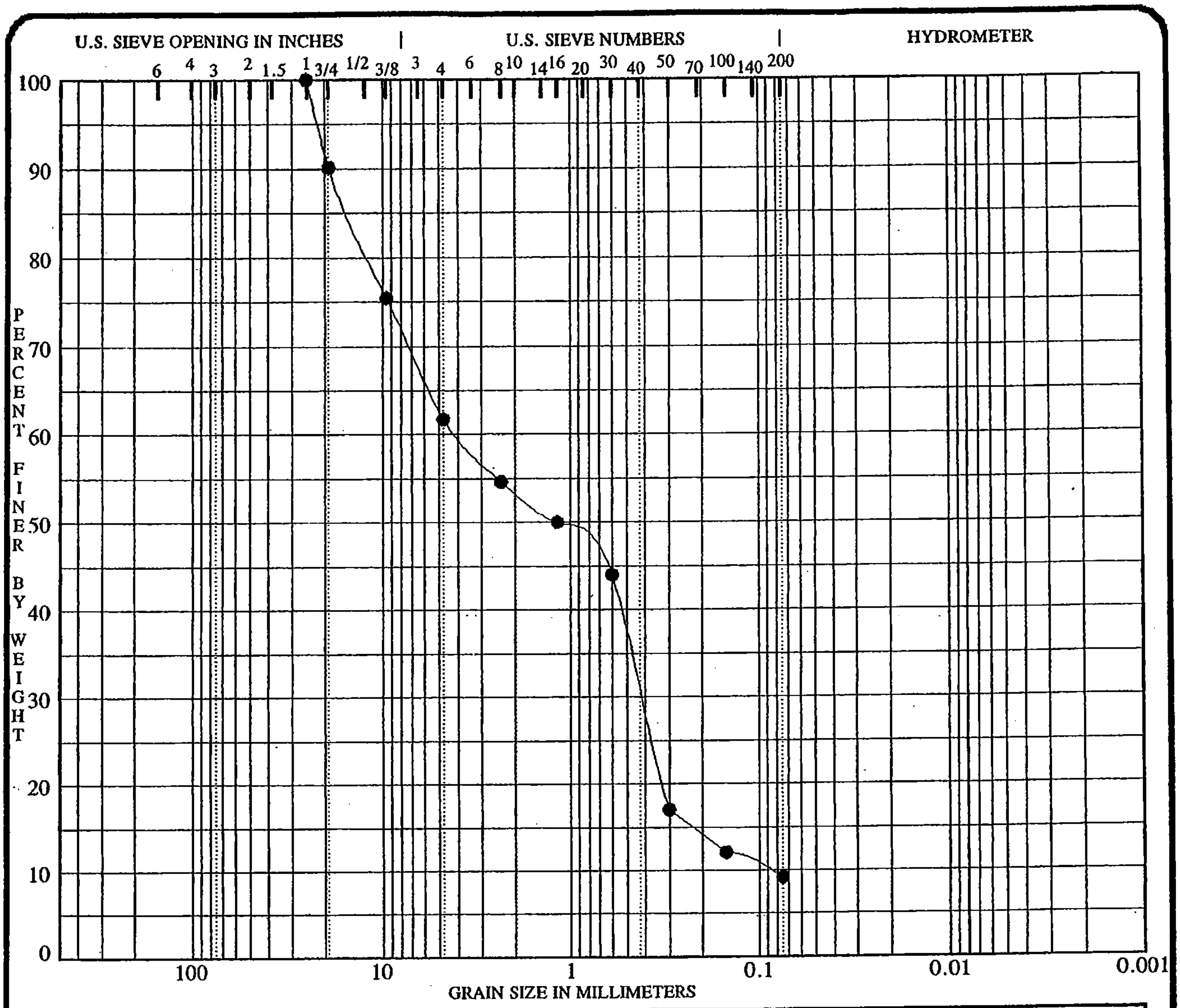
| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-102 | 36.7 | SANDY LEAN CLAY CL | 15.6 | 23.8 | 16.2 | 7.6 | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-102 | 36.7 | 2.360 | 0.097 | | | 0.0 | 47.3 | 52.7 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**
JOB NO.
DATE 05/21/97

# GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-102 | 41.7 | | 5.3 | NP | NP | NP | |
| | POORLY GRADED SAND with SILT and GRAVEL SP-SM | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-102 | 41.7 | 25.000 | 4.018 | 0.419 | 0.091 | 38.3 | 52.5 | 9.2 | |

PROJECT SPORN PLANT - FLY ASH POND DIKES

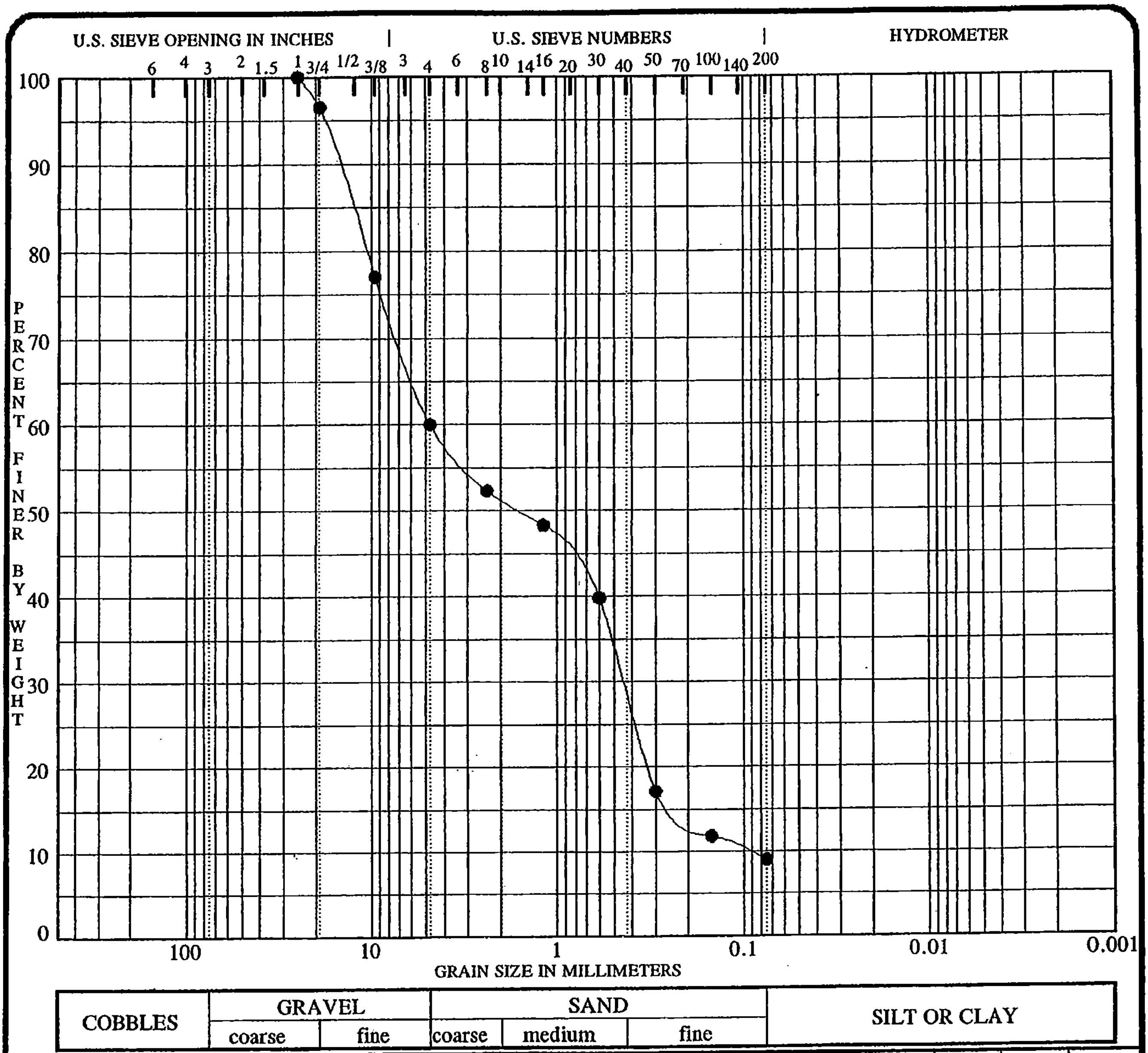
JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|
| ● 96-103 | 21.6 | | 4.7 | NP | NP | NP | |
| | | POORLY GRADED SAND with SILT and GRAVEL SP-SM | | | | | |

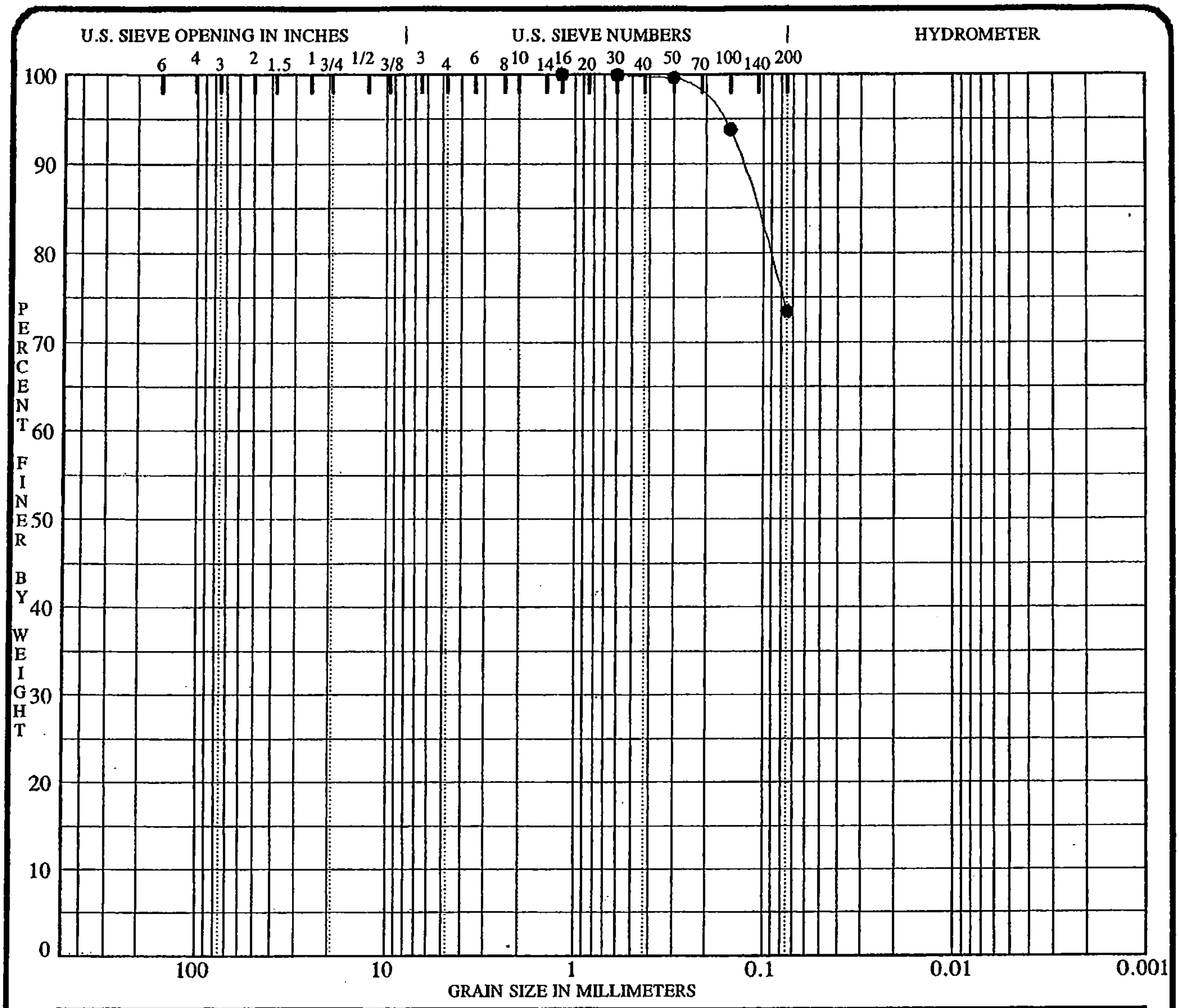
| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | % < .002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-103 | 21.6 | 25.000 | 4.750 | 0.445 | 0.096 | 40.0 | 51.0 | 9.0 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO. ______
DATE 05/21/97

# GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-103 | 31.6 | | 14.5 | 28.6 | 18.8 | 9.8 | | |
| | | | LEAN CLAY with SAND CL | | | | | | |

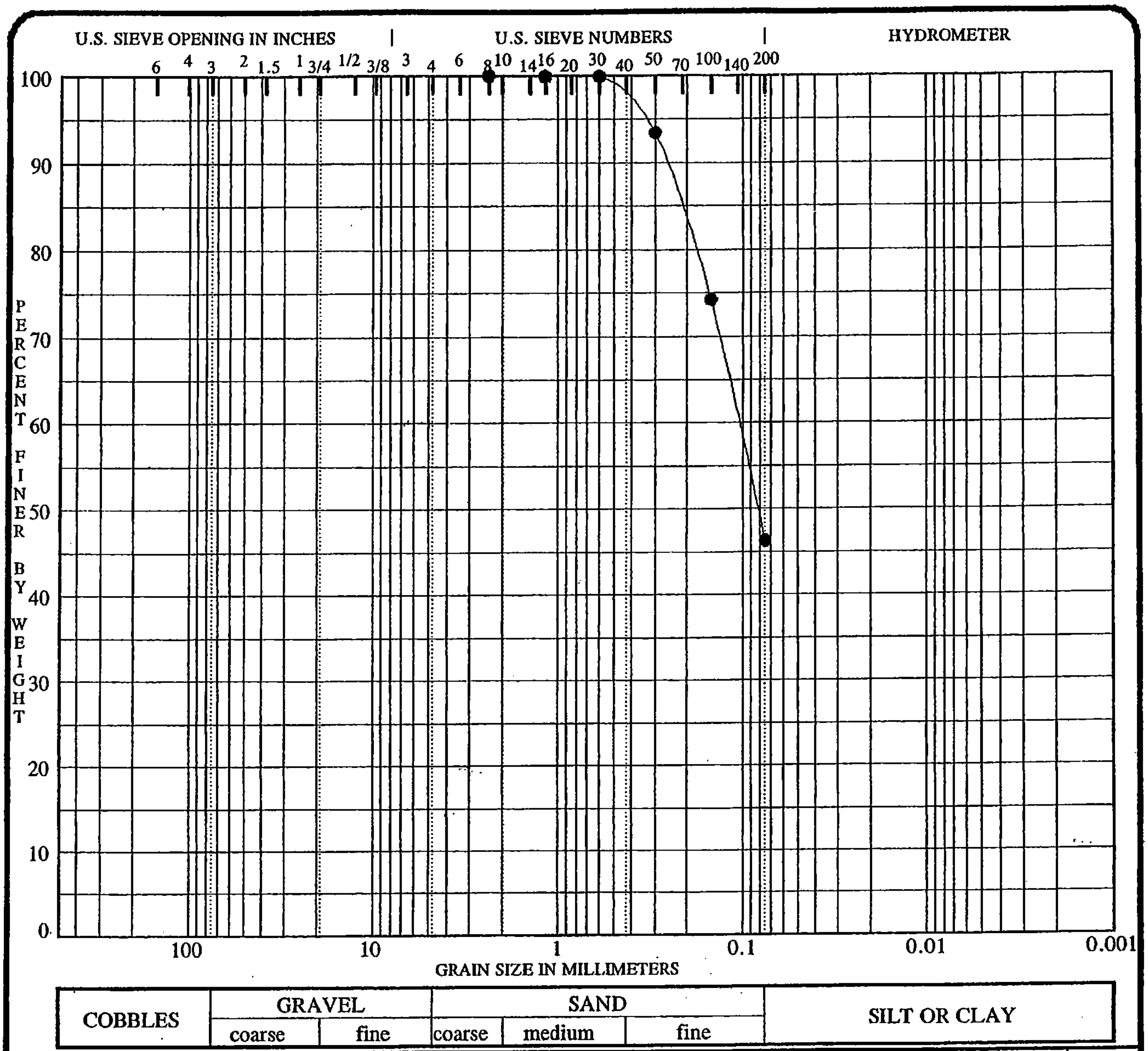
| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-103 | 31.6 | 1.180 | | | | 0.0 | 26.6 | 73.4 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.
DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio



| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|
| ● 96-103 | 41.6 | | 11.4 | NP | NP | NP | | |
| | | SILTY SAND SM | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-103 | 41.6 | 2.360 | 0.105 | | | 0.0 | 53.7 | 46.3 | |
| | | | | | | | | | |
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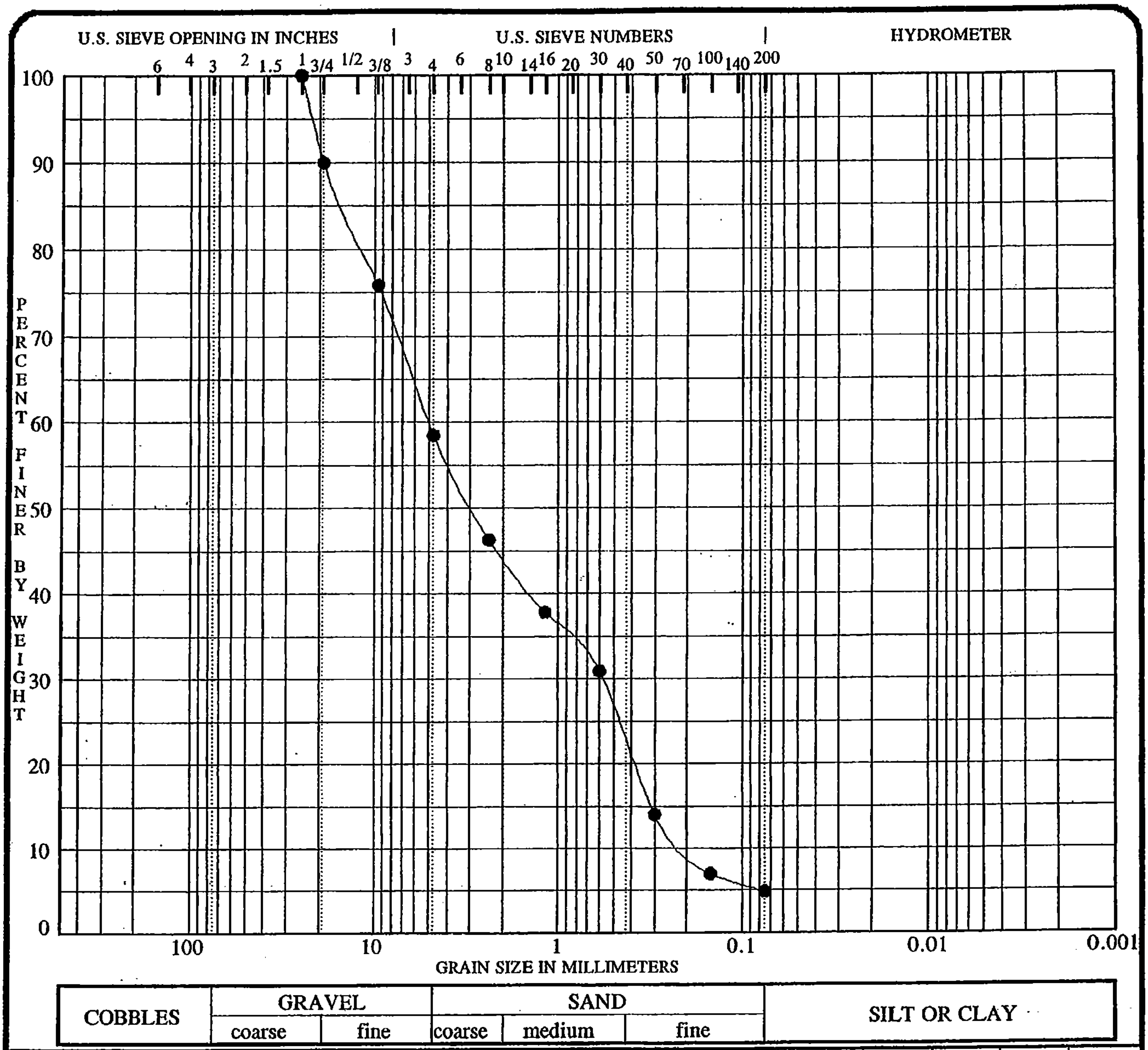
PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.
DATE 05/22/97

## GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio

AEP



| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|
| ● 96-104 | 3.0 | | 1.1 | NP | NP | NP | |
| | | POORLY GRADED SAND with SILT and GRAVEL SP-SM | | | | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-104 | 3.0 | 25.000 | 5.044 | 0.578 | 0.202 | 41.5 | 53.6 | 4.9 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

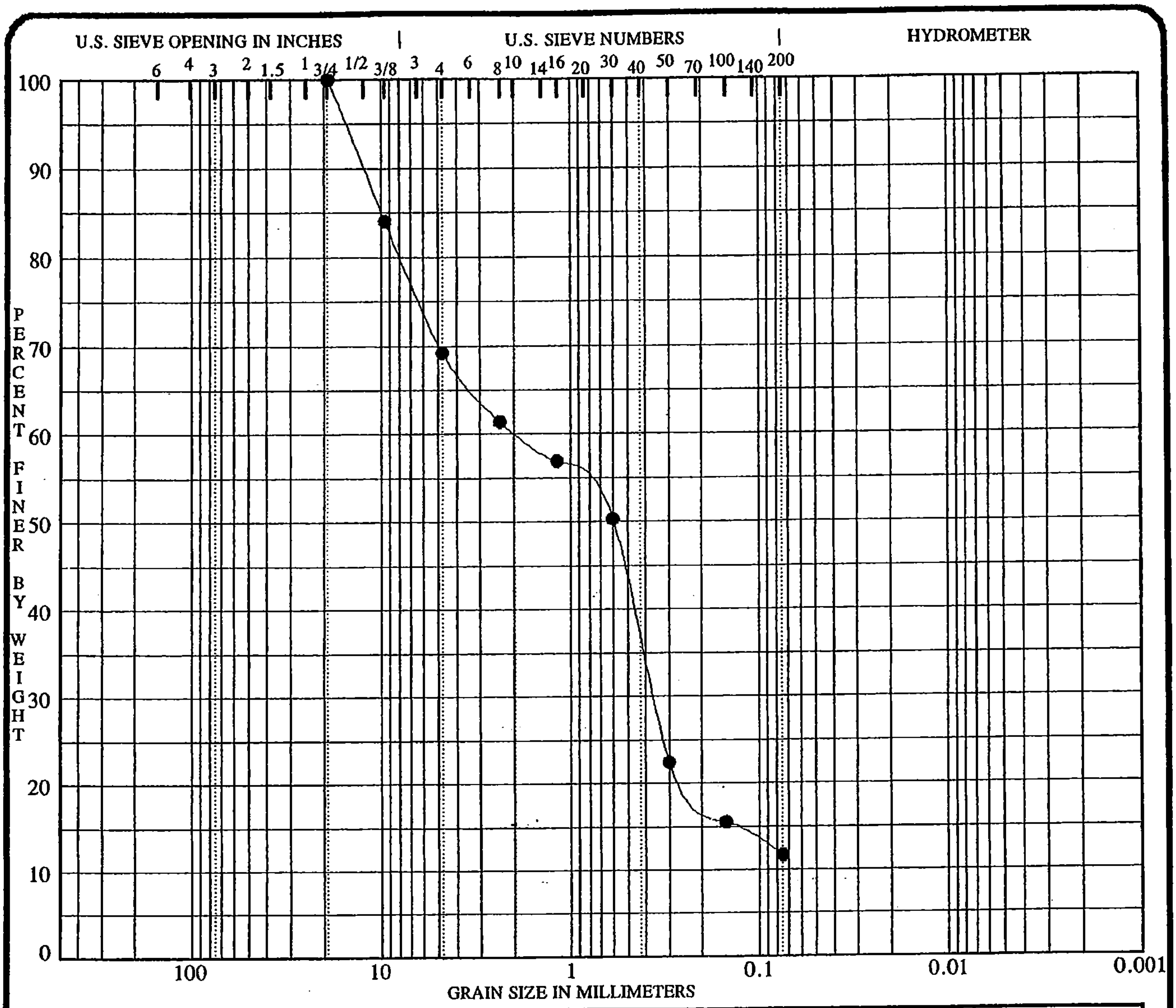
JOB NO.

DATE **05/21/97**

## GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-104 | 8.5 | | 1.0 | NP | NP | NP | |
| | | POORLY GRADED SAND with SILT and GRAVEL SP-SM | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-104 | 8.5 | 19.000 | 1.902 | 0.362 | | 30.8 | 57.5 | 11.7 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

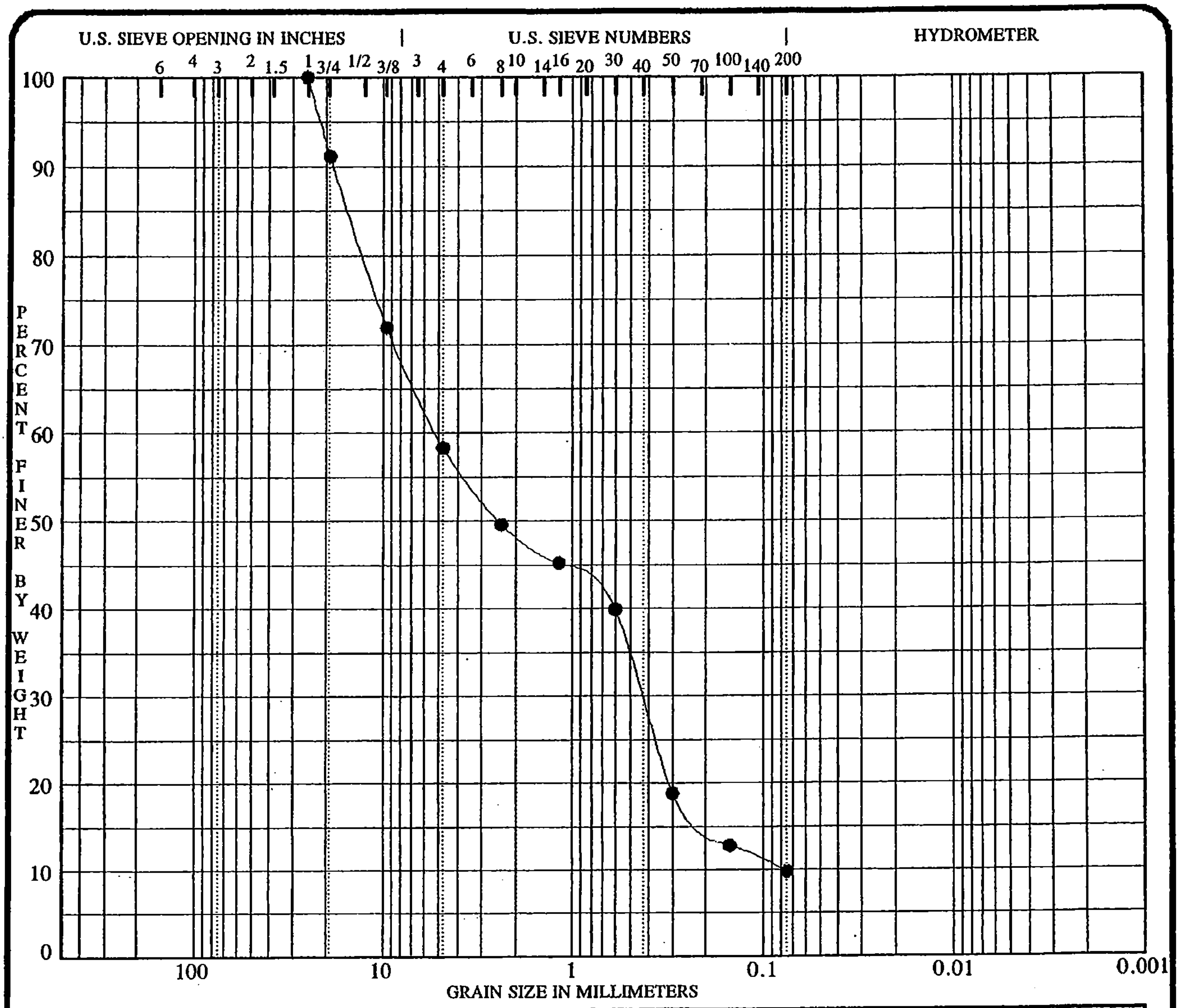
JOB NO.

DATE 05/21/97

## GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-104 | 11.7 | | 1.2 | NP | NP | NP | | |
| | | | POORLY GRADED SAND with SILT and GRAVEL SP-SM | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | % < .002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-104 | 11.7 | 25.000 | 5.180 | 0.433 | 0.079 | 41.7 | 48.5 | 9.8 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

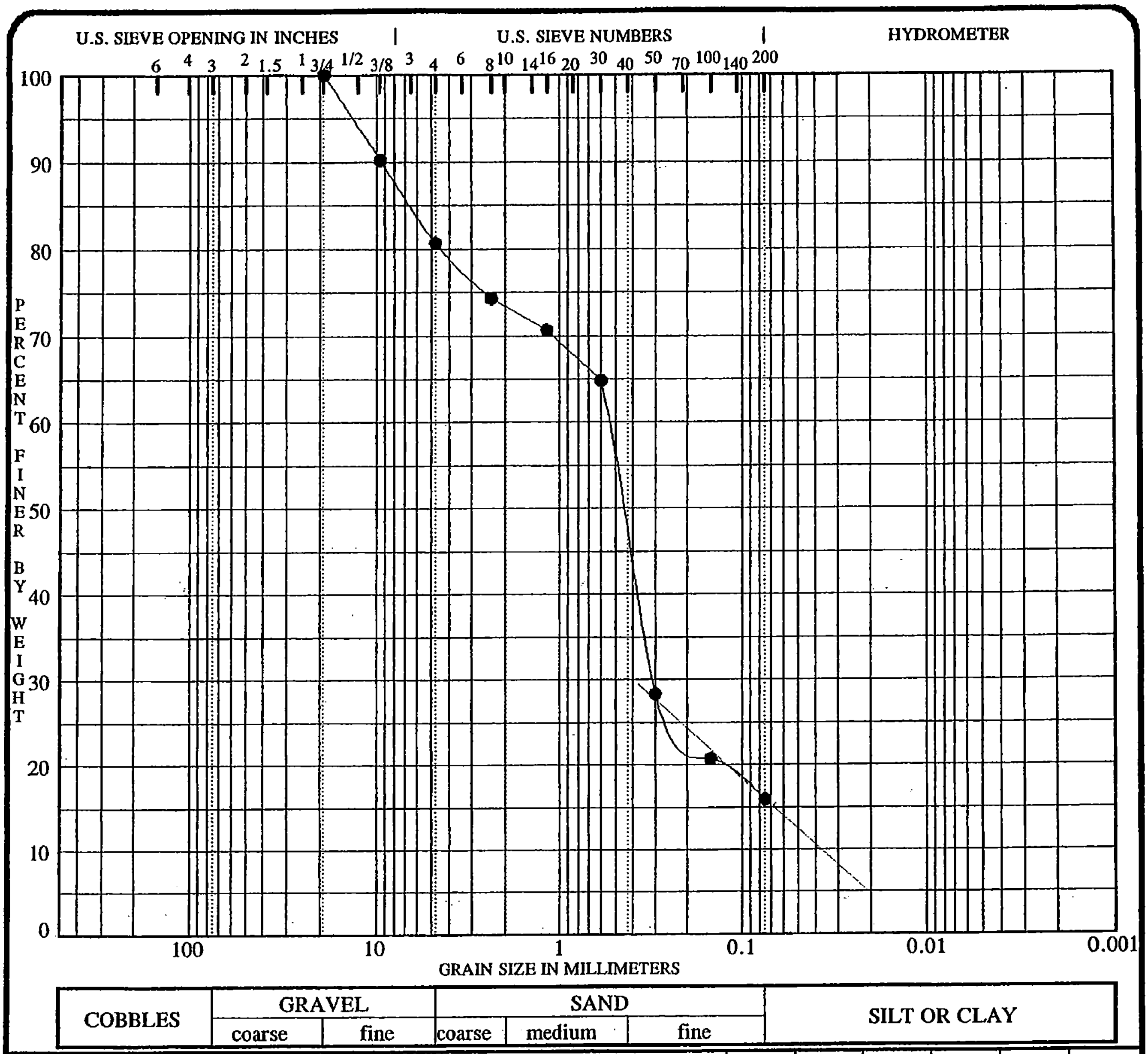
JOB NO.

DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**

Groveport, Ohio



| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | **96-104** | **16.7** | | **4.0** | **NP** | **NP** | **NP** | | |
| | | | **SILTY SAND with GRAVEL SM** | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | **96-104** | **16.7** | **19.000** | **0.548** | **0.310** | | **19.4** | **64.7** | **15.9** | |
| | | | | | | | | | | |
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PROJECT **SPORN PLANT - FLY ASH POND DIKES**

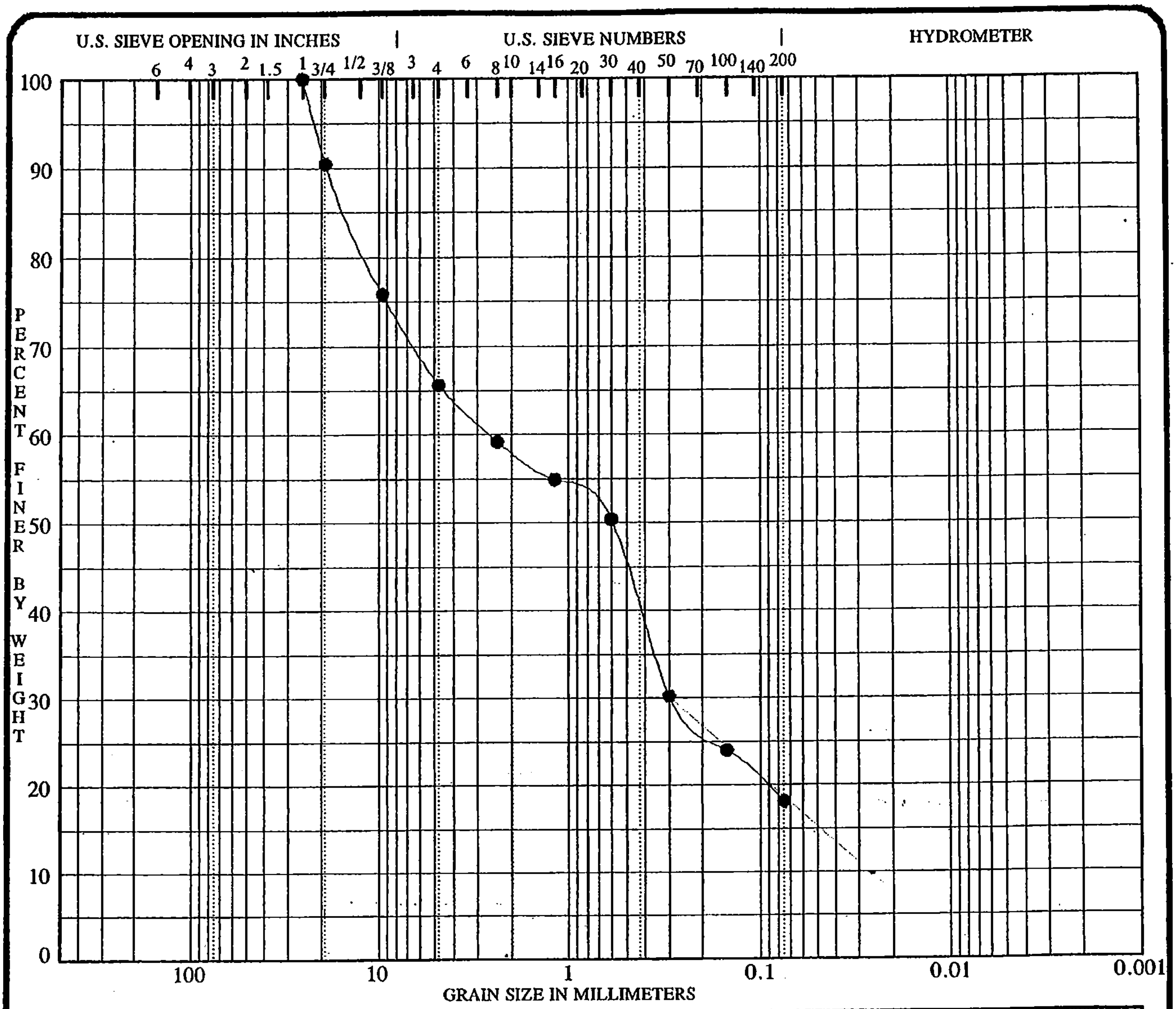
JOB NO.

DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**

Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-104 | 21.7 | | 2.9 | NP | NP | NP | | |
| | | | SILTY SAND with GRAVEL SM | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-104 | 21.7 | 25.000 | 2.576 | 0.293 | | 34.4 | 47.5 | 18.1 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

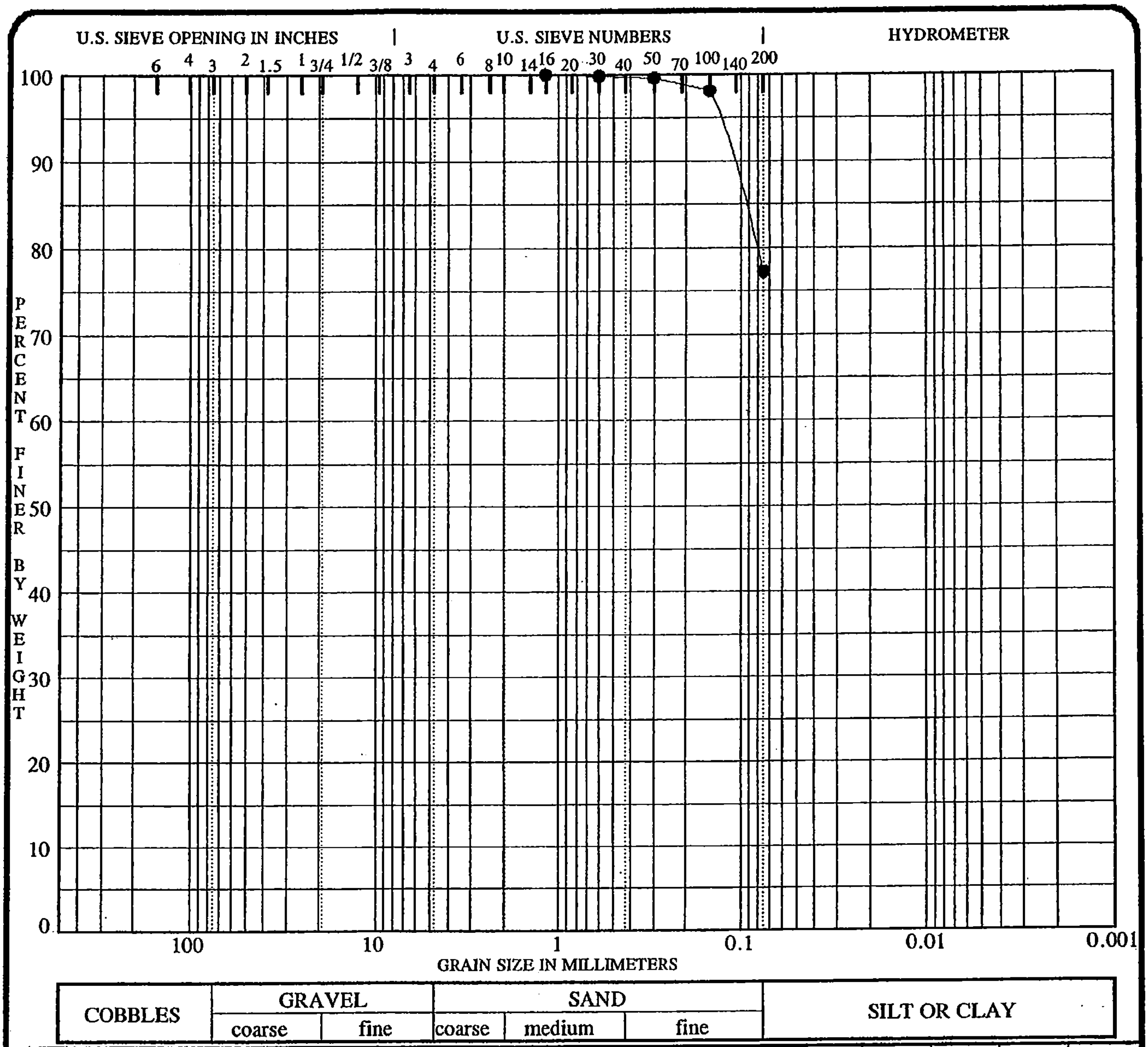
JOB NO.

DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**

Groveport, Ohio



| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-104 | 36.7 | | 18.9 | 27.2 | 19.0 | 8.2 | |
| | | | LEAN CLAY with SAND CL | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-104 | 36.7 | 1.180 | | | | 0.0 | 22.8 | 77.2 | |

PROJECT SPORN PLANT - FLY ASH POND DIKES

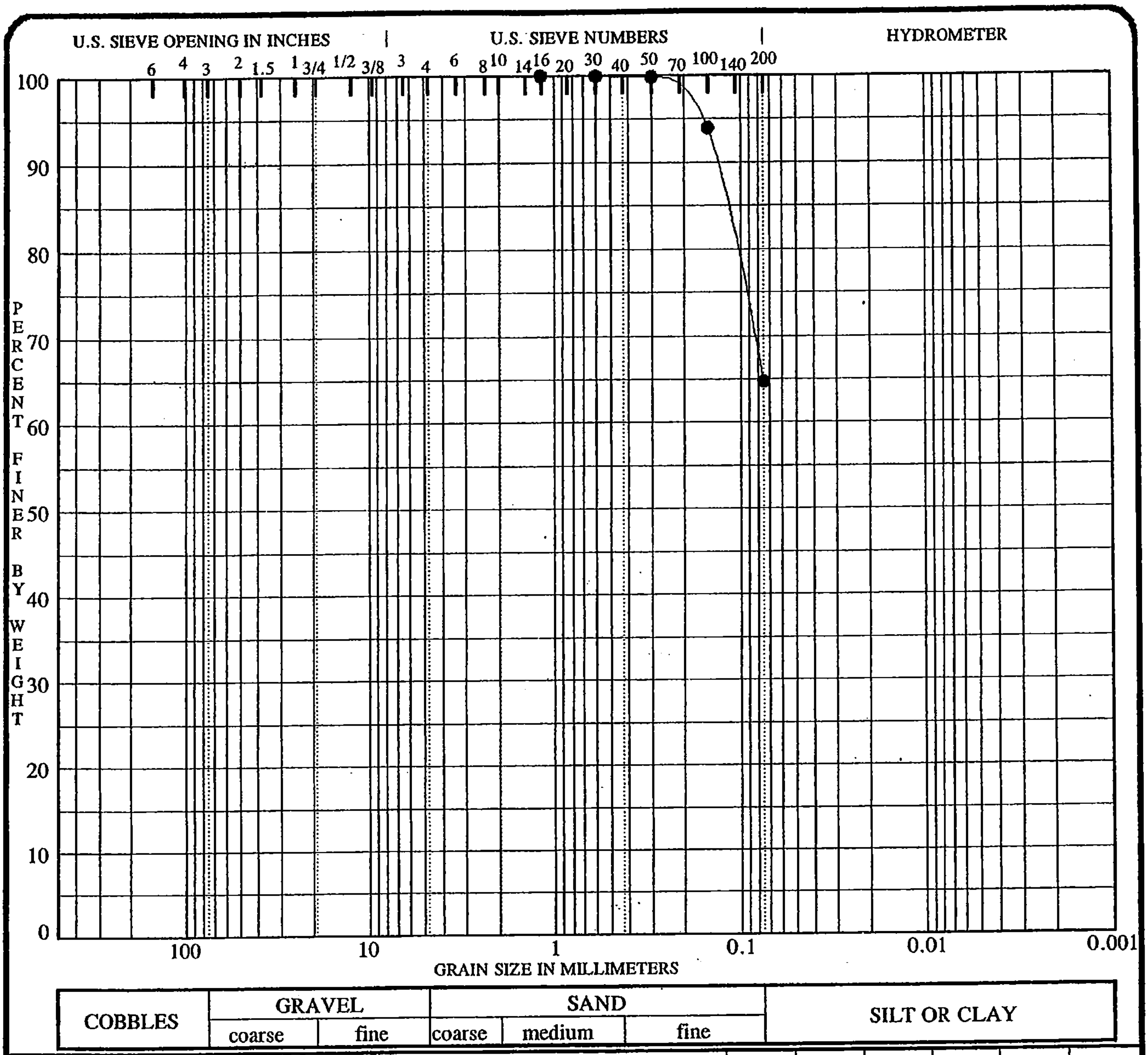
JOB NO. ____________

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-104 | 41.7 | | 8.1 | NP | NP | NP | | |
| | | | SANDY SILT ML | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

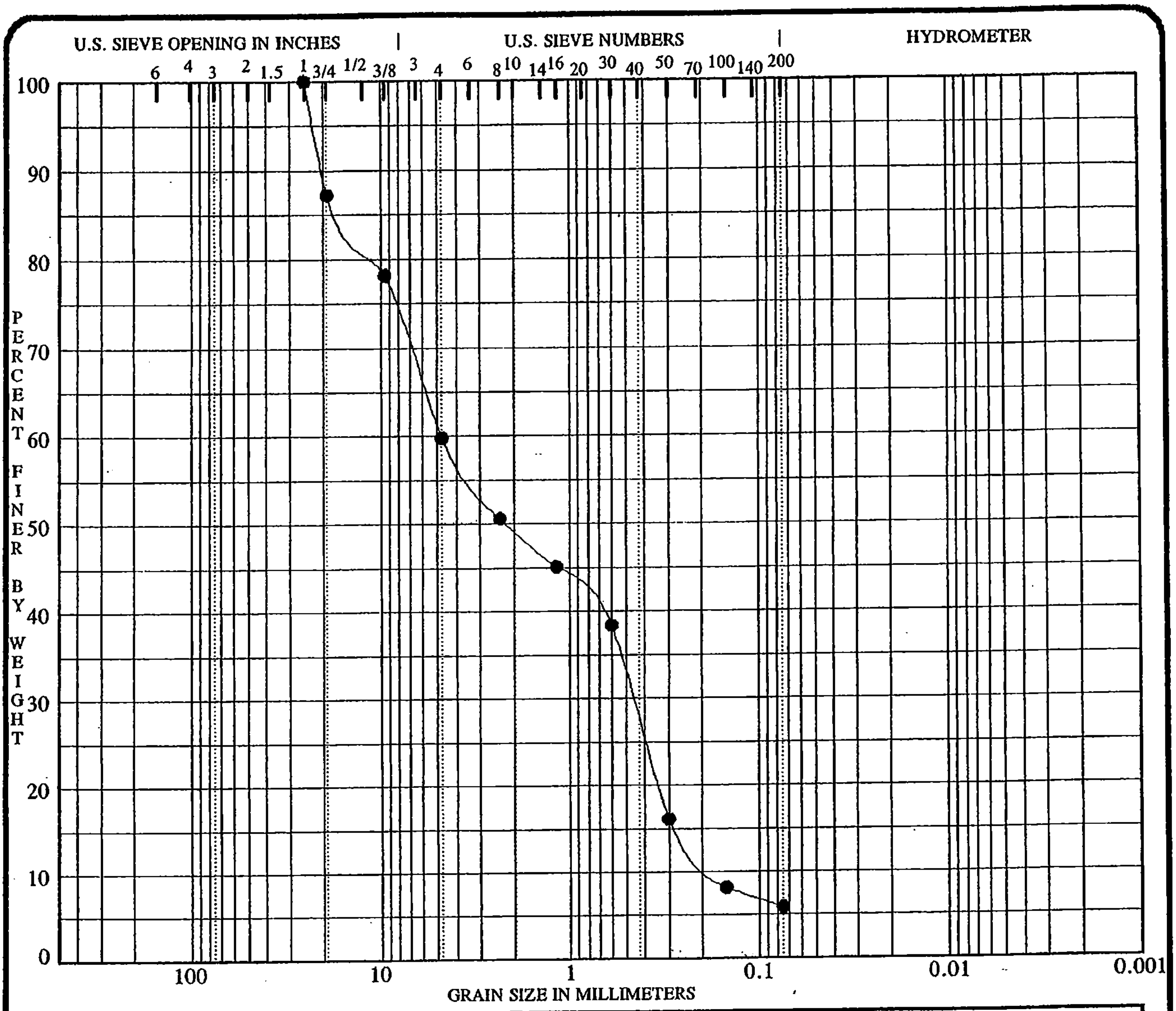
| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-104 | 41.7 | 1.180 | | | | 0.0 | 35.3 | 64.7 | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

PROJECT SPORN PLANT - FLY ASH POND DIKES

JOB NO.
DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|
| ● 96-105 | 3.0 | | 1.6 | NP | NP | NP | |
| | POORLY GRADED SAND with SILT and GRAVEL SP-SM | | | | | | |

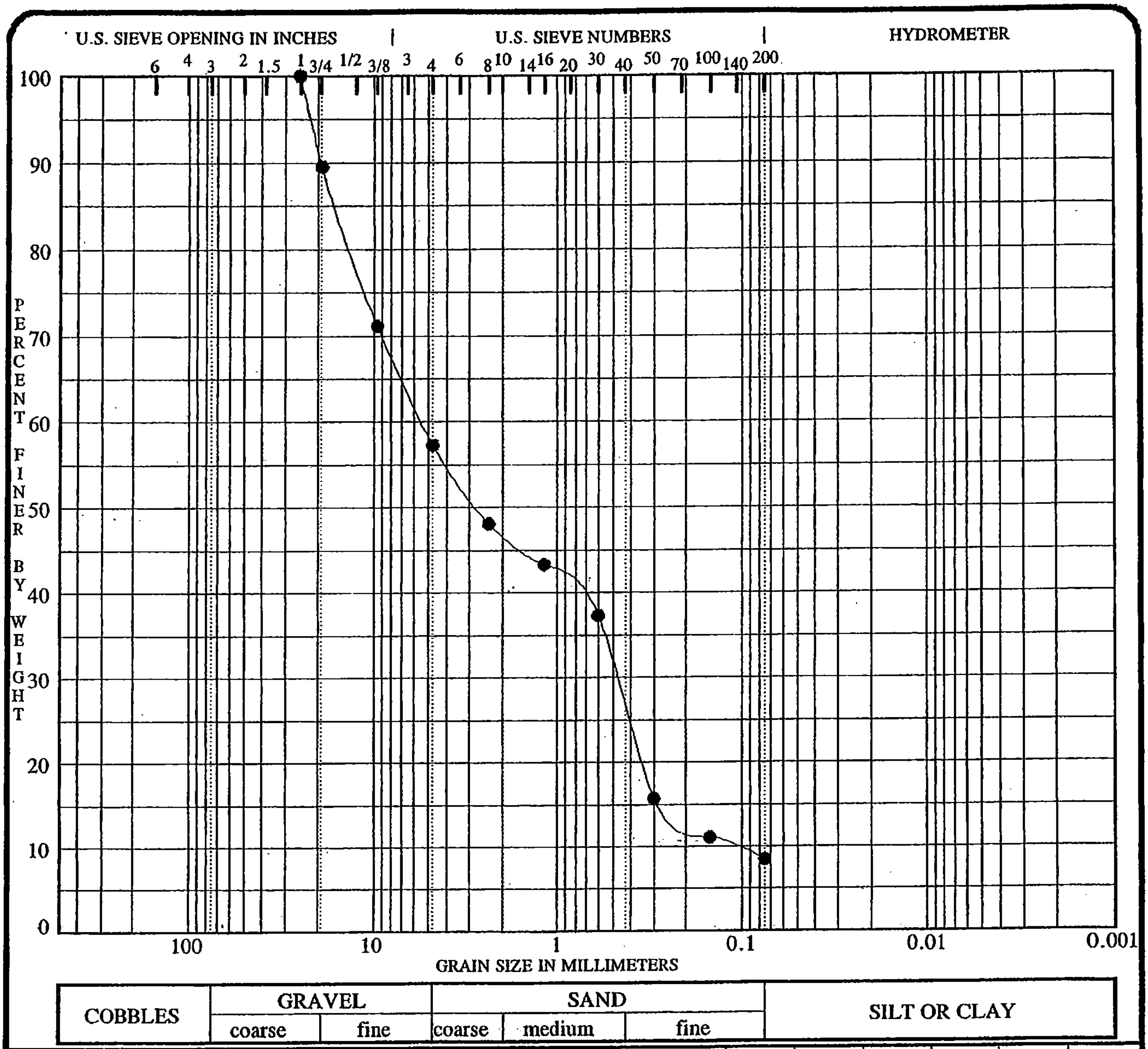
| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | % < .002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-105 | 3.0 | 25.000 | 4.786 | 0.462 | 0.176 | 40.2 | 53.9 | 5.9 | |

PROJECT SPORN PLANT - FLY ASH POND DIKES

JOB NO.
DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio



| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-105 | 16.5 | | 3.1 | NP | NP | NP | |
| | POORLY GRADED SAND with SILT and GRAVEL SP-SM | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | % < .002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-105 | 16.5 | 25.000 | 5.440 | 0.475 | 0.112 | 42.7 | 48.8 | 8.5 | |

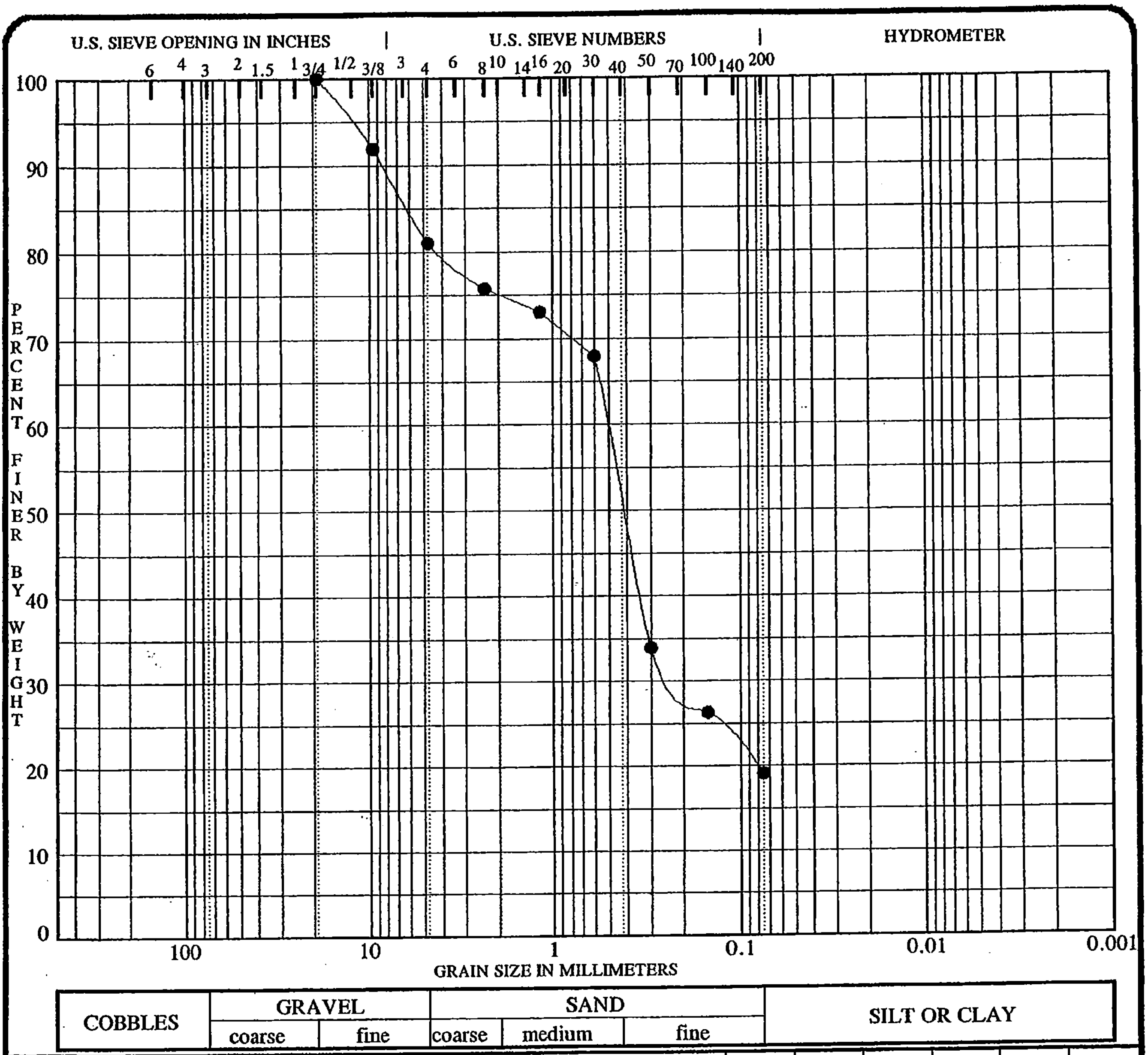
PROJECT SPORN PLANT - FLY ASH POND DIKES

JOB NO.
DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|
| ● 96-105 21.5 | SILTY SAND with GRAVEL SM | 6.7 | NP | NP | NP | | |

| Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|
| ● 96-105 21.5 | 19.000 | 0.511 | 0.210 | | 19.0 | 61.9 | 19.1 | |

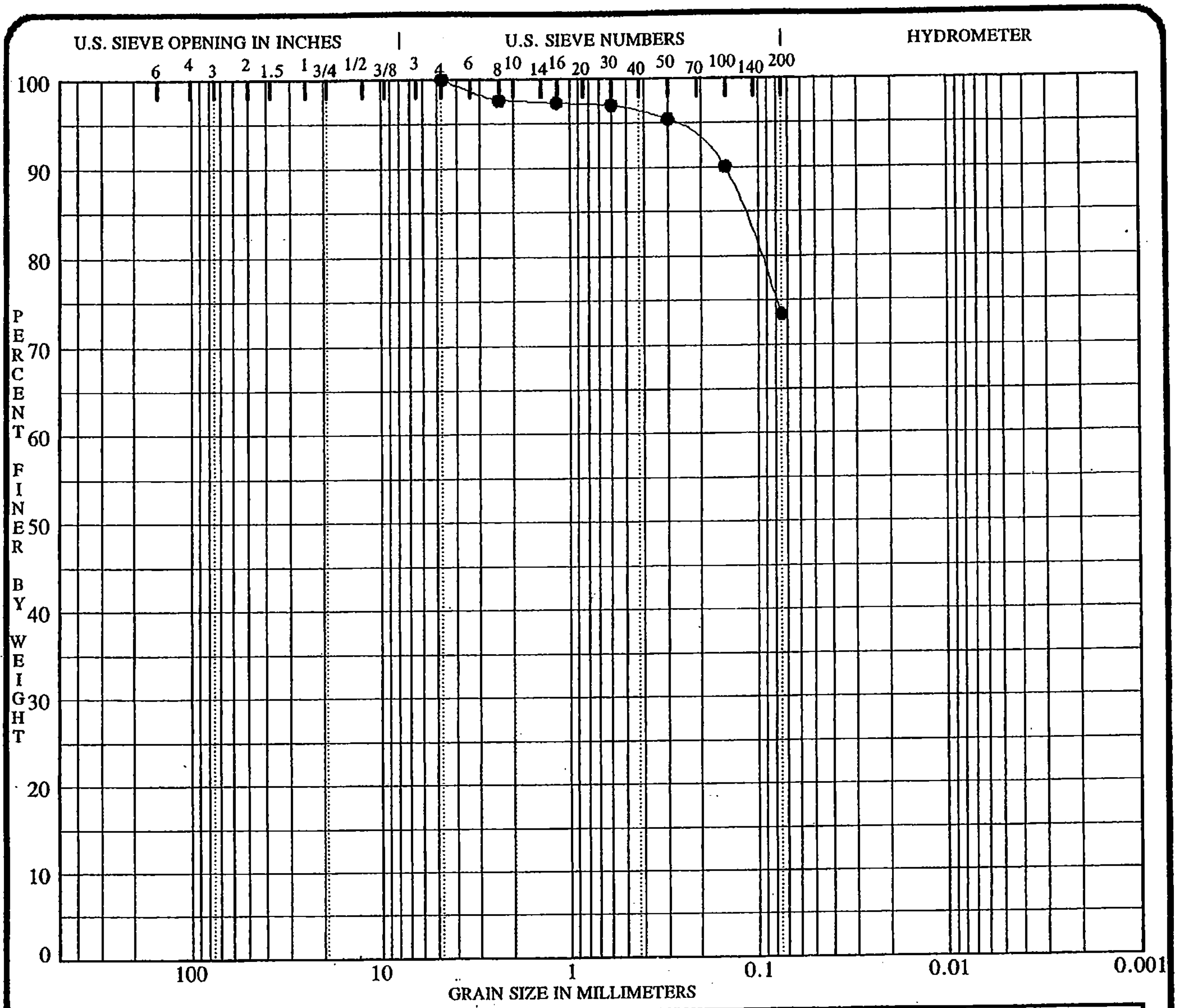
PROJECT SPORN PLANT - FLY ASH POND DIKES

JOB NO.
DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-105 | 26.5 | | 13.3 | 27.4 | 17.7 | 9.8 | | |
| | | | LEAN CLAY with SAND CL | | | | | | |
| | | | | | | | | | |
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| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-105 | 26.5 | 4.750 | | | | 0.0 | 26.6 | 73.4 | |
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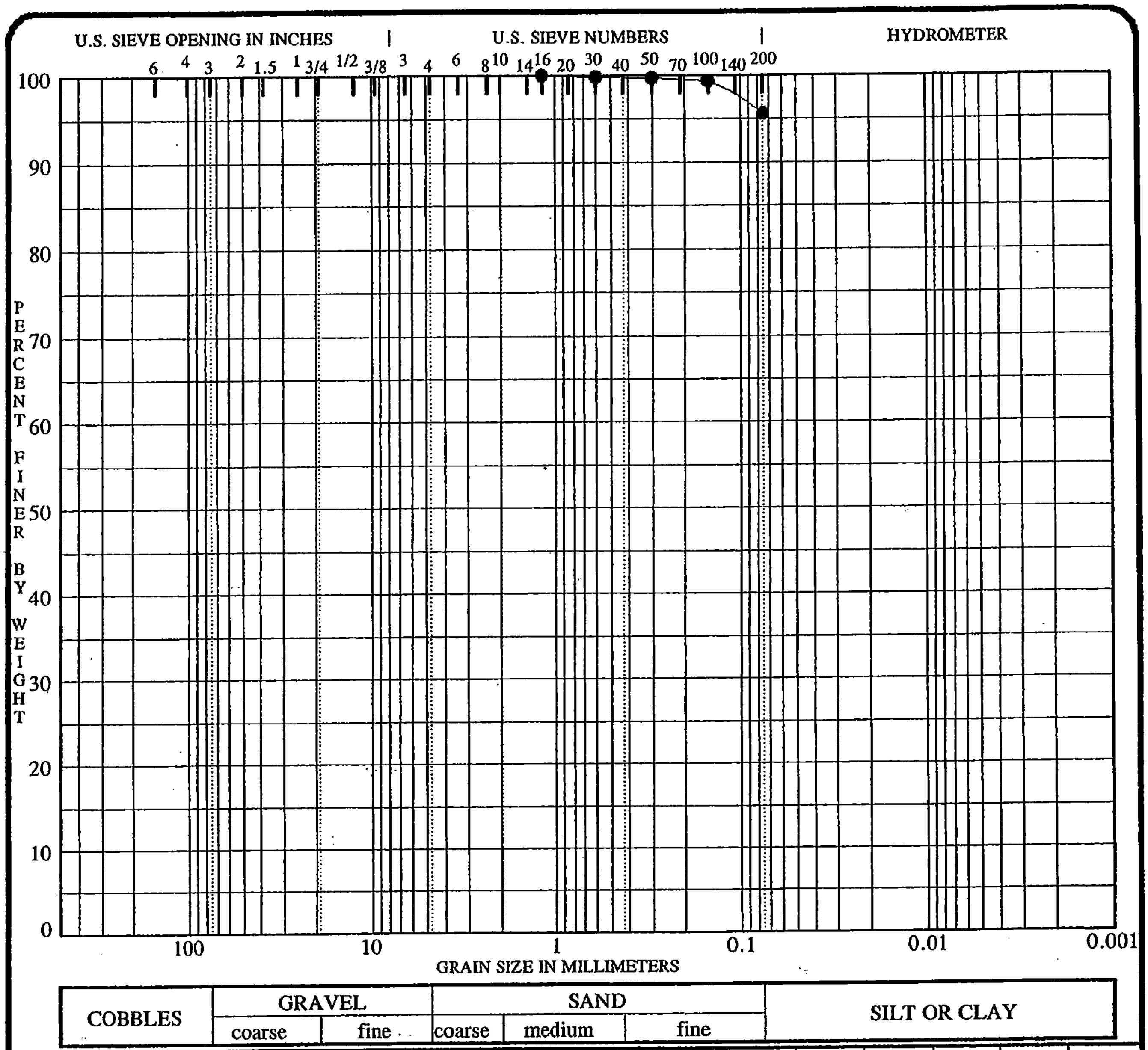
PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.

DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio



| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-105 | 36.5 | LEAN CLAY CL | 22.1 | 28.8 | 18.7 | 10.1 | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | % < .002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-105 | 36.5 | 1.180 | | | | 0.0 | 4.4 | 95.6 | |

PROJECT SPORN PLANT - FLY ASH POND DIKES

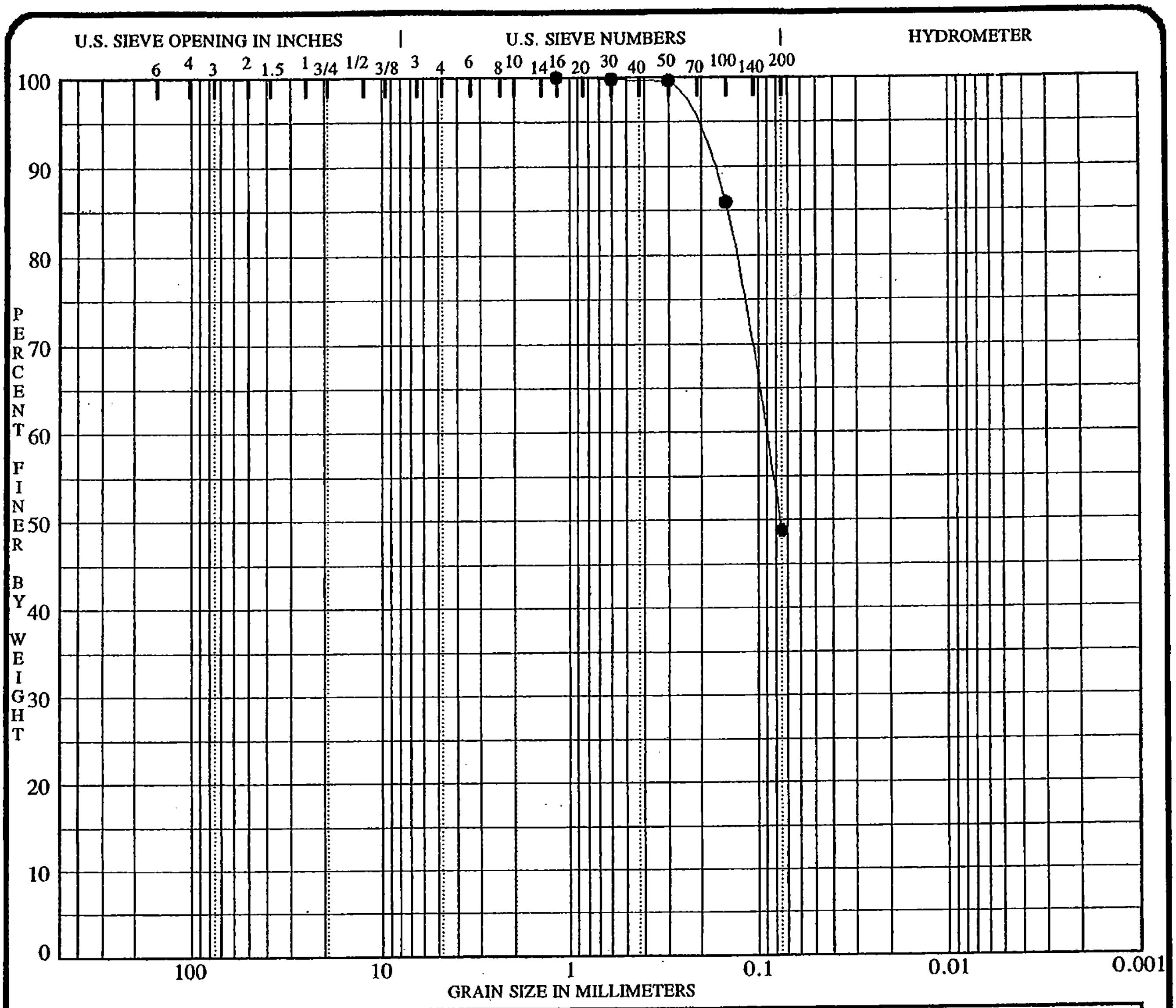
JOB NO.

DATE 05/21/97

## GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-105 | 41.5 | SILTY SAND SM | 11.9 | NP | NP | NP | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-105 | 41.5 | 1.180 | 0.093 | | | 0.0 | 51.2 | 48.8 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

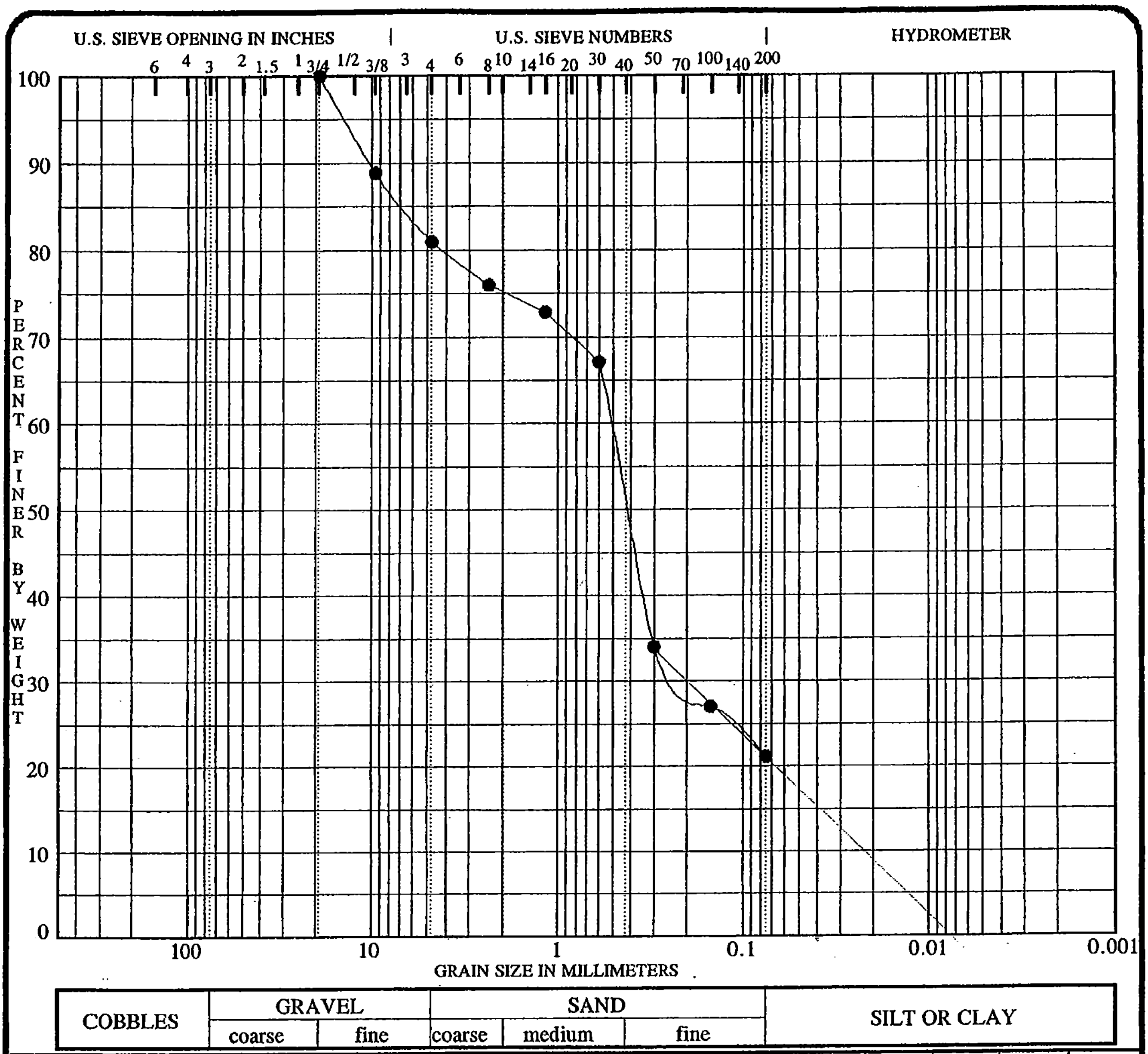
JOB NO.

DATE **05/21/97**

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| Specimen Identification | | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-106 | 11.5 | | 5.5 | NP | NP | NP | |
| | | | SILTY SAND with GRAVEL SM | | | | | |

| Specimen Identification | | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-106 | 11.5 | 19.000 | 0.517 | 0.202 | | 19.1 | 59.8 | 21.1 | |

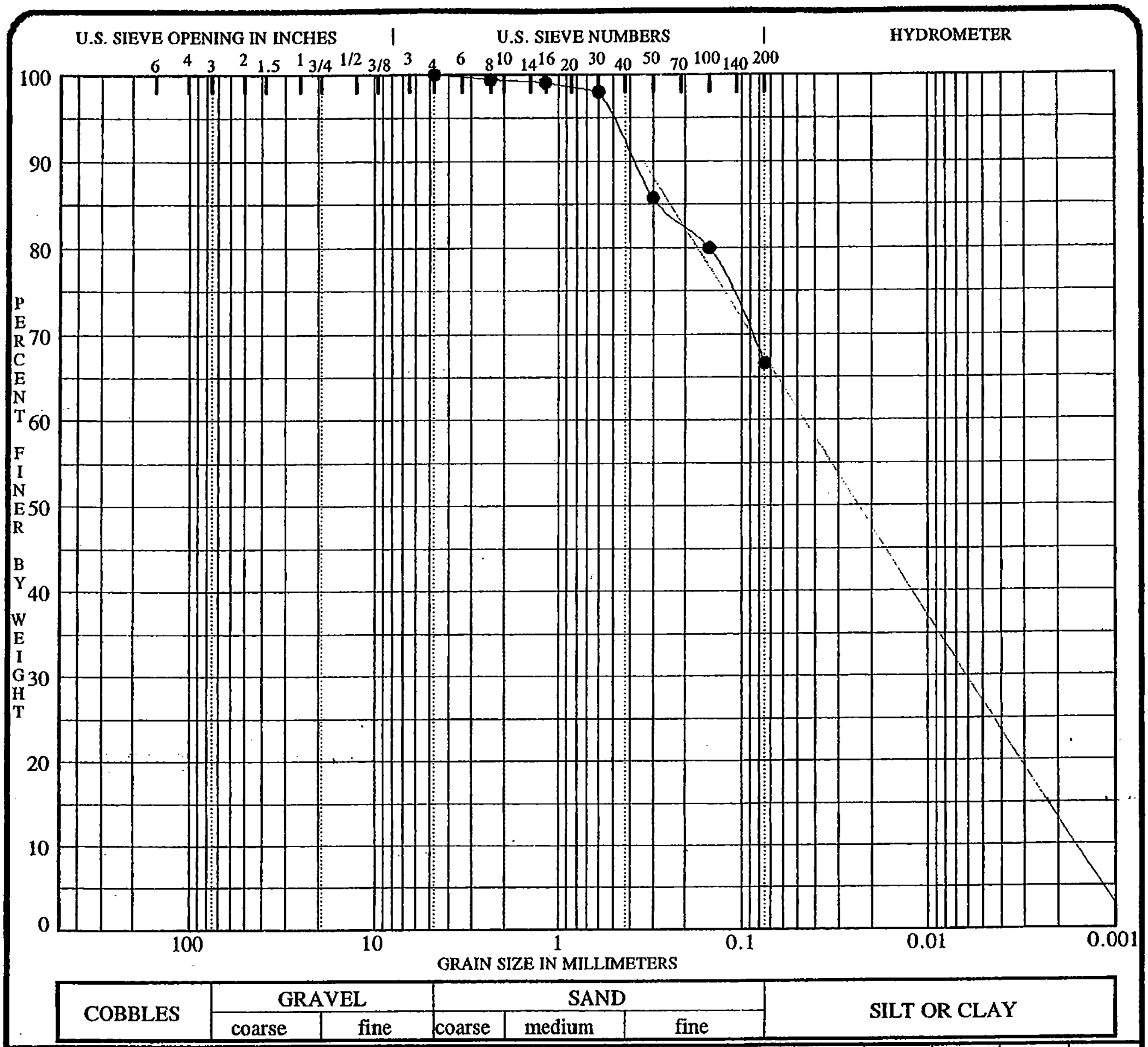
PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.
DATE 05/21/97

## GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio

AEP



| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|
| ● 96-106 | 21.5 | | 11.1 | 26.1 | 17.5 | 8.6 | | |
| | | SANDY LEAN CLAY CL | | | | | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-106 | 21.5 | 4.750 | | | | 0.0 | 33.4 | 66.6 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

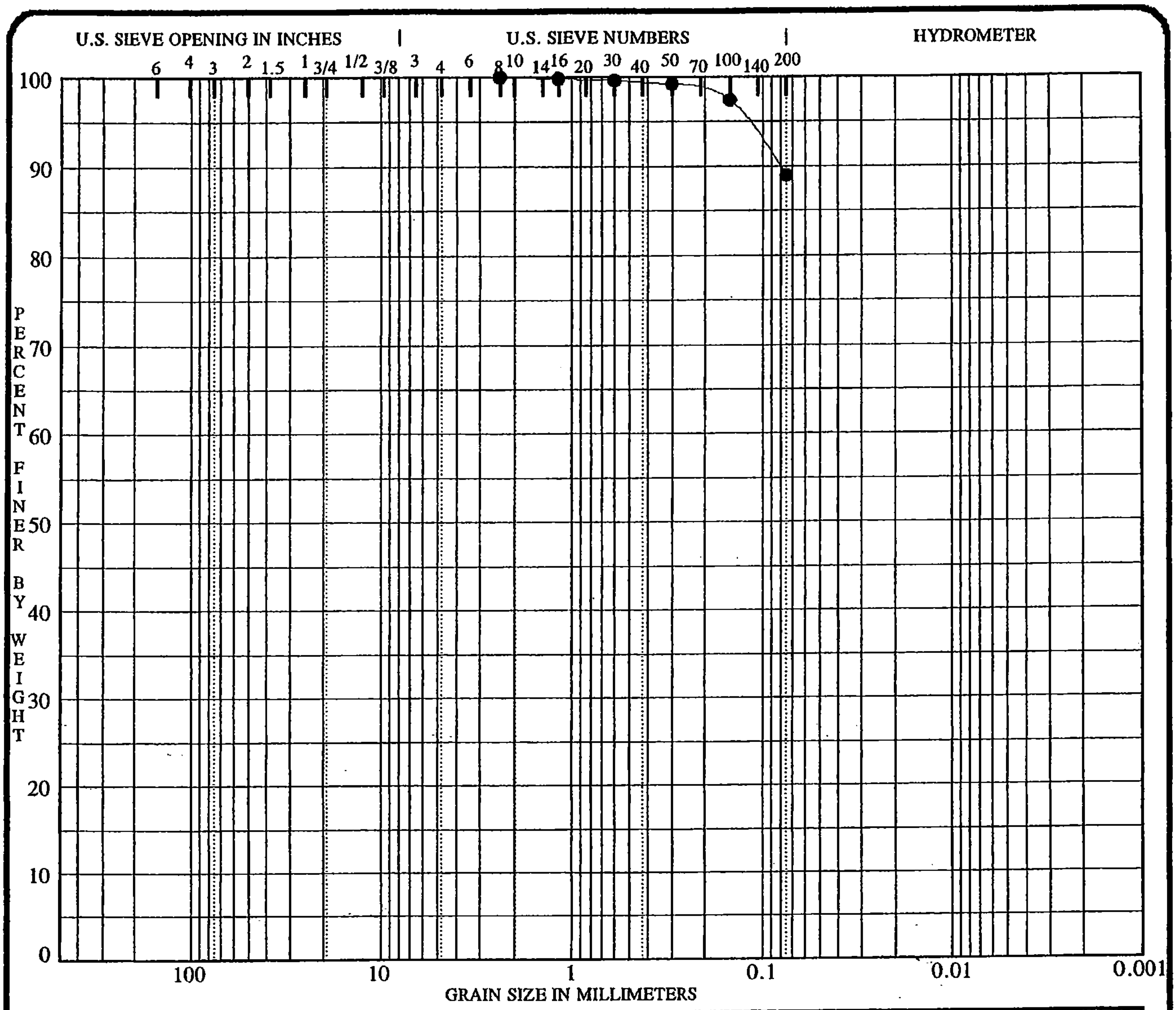
JOB NO.

DATE 05/21/97

## GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|
| ● | 96-106 31.5 | | 42.6 | NP | NP | NP | 2.29 | |
| | | SILT ML | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

| | Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-106 31.5 | 2.360 | | | | 0.0 | 11.1 | 88.9 | |
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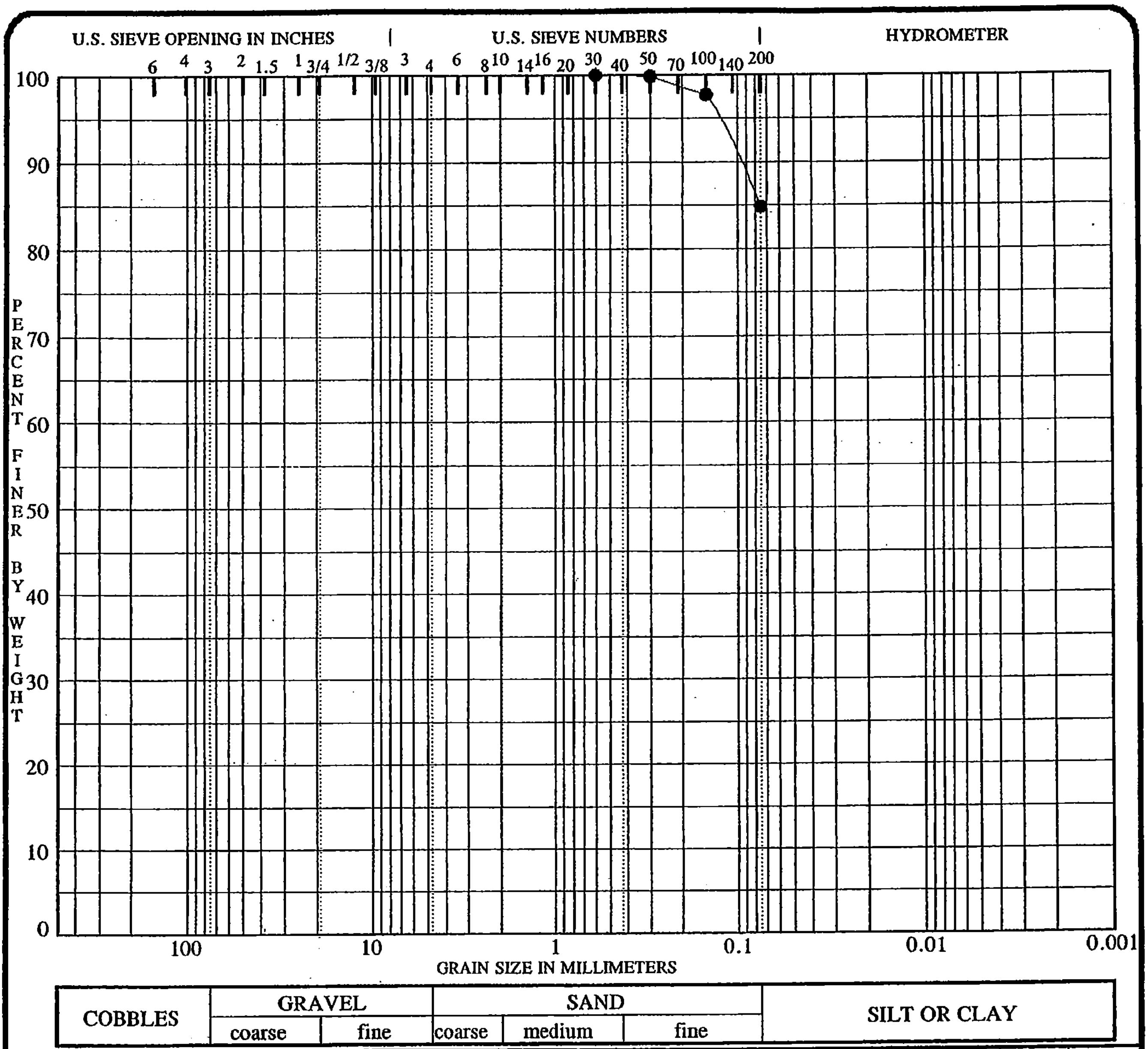
PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio



| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|
| ● 96-106 | 51.5 | | 35.7 | NP | NP | NP | 2.42 | |
| | | SILT with SAND ML | | | | | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-106 | 51.5 | 0.600 | | | | 0.0 | 15.2 | 84.8 | |

PROJECT SPORN PLANT - FLY ASH POND DIKES

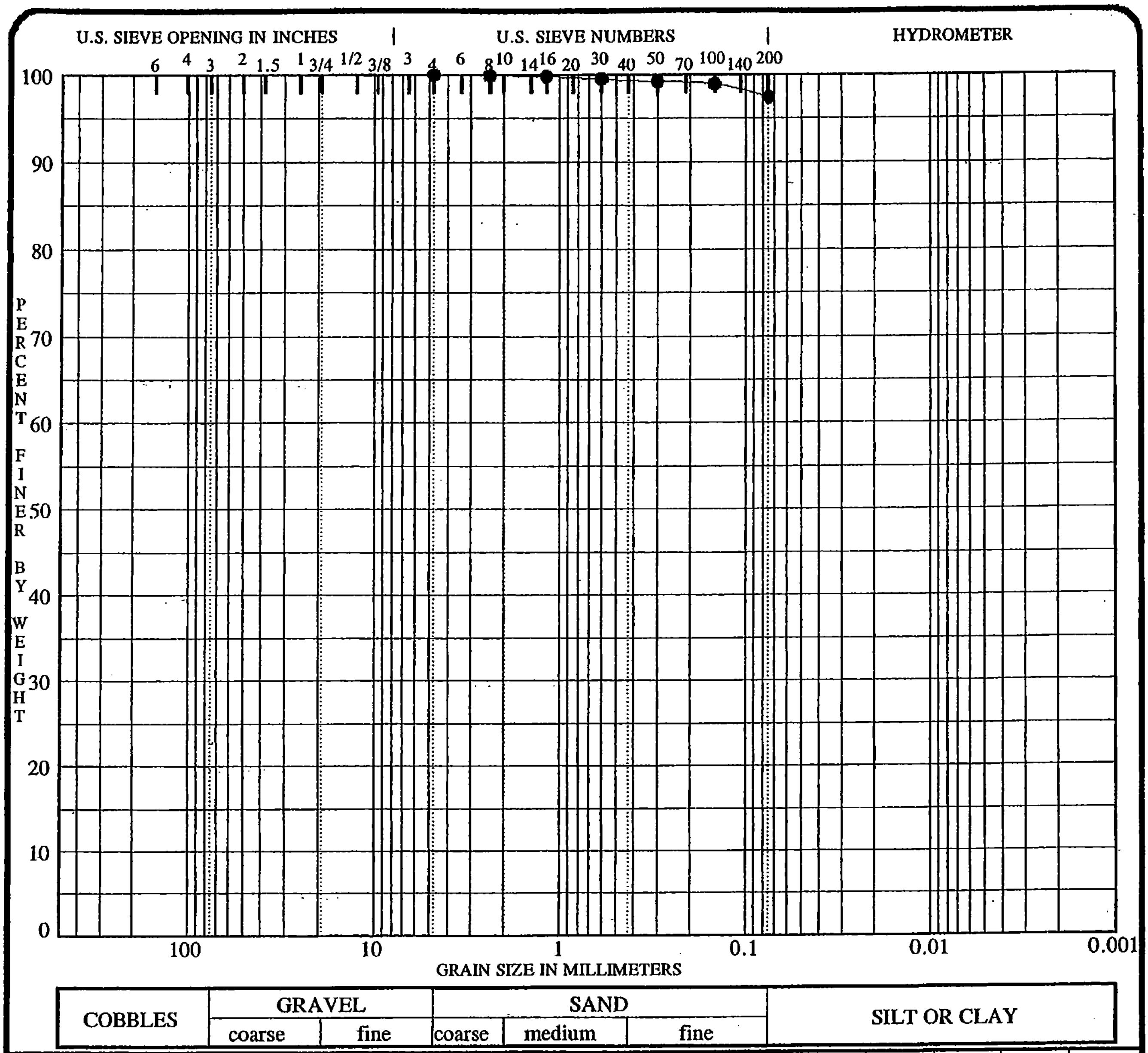
JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|
| ● 96-106 | 56.5 | | 31.9 | 43.6 | 25.6 | 18.0 | |
| | | LEAN CLAY CL | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-106 | 56.5 | 4.750 | | | | 0.0 | 2.6 | 97.4 | |
| | | | | | | | | | |
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PROJECT **SPORN PLANT - FLY ASH POND DIKES**

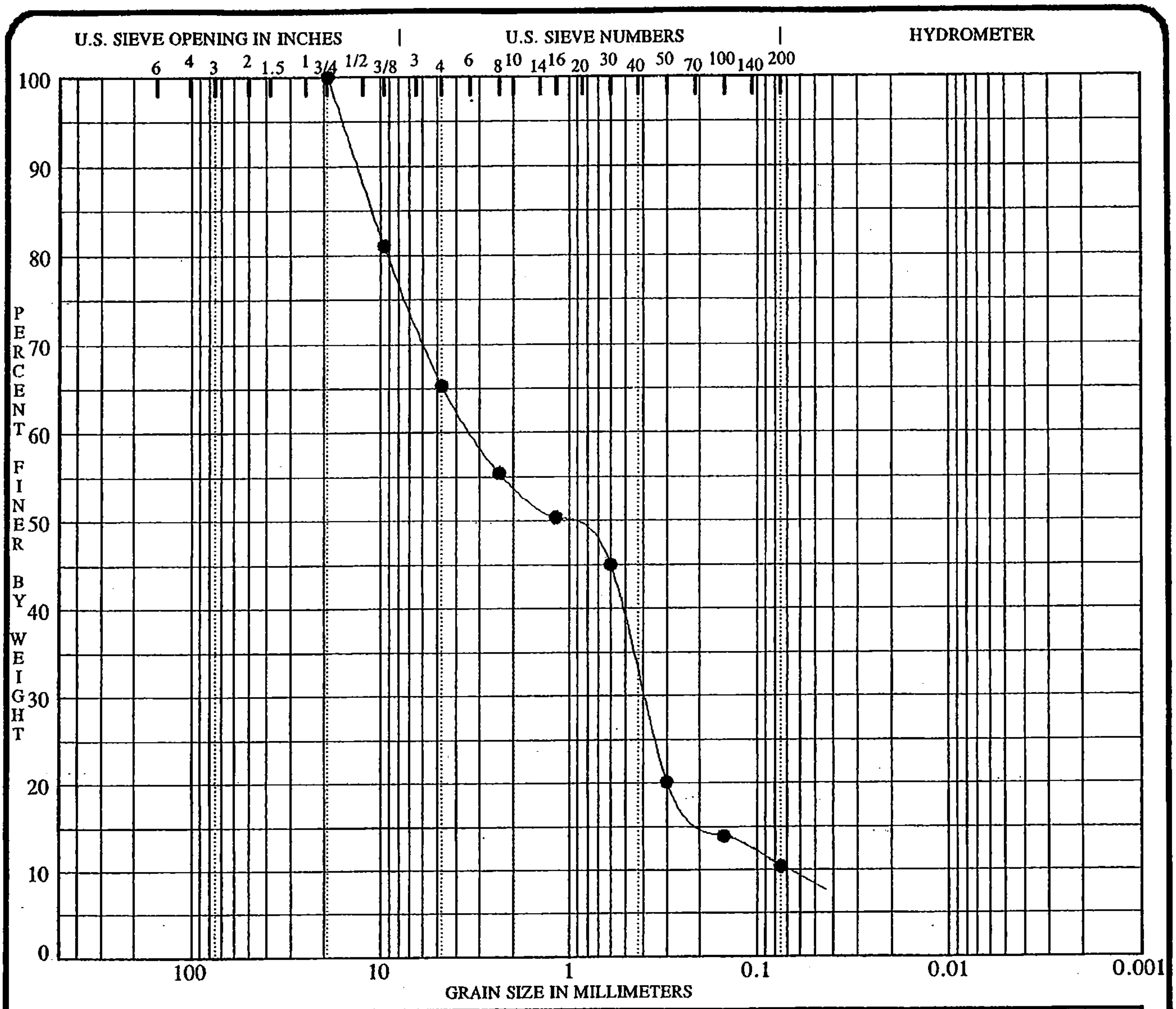
JOB NO.

DATE 05/21/97

# GRADATION CURVES

**American Electric Power Service Corp.**

Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-107 | 11.6 | | 3.9 | NP | NP | NP | |
| | POORLY GRADED SAND with SILT and GRAVEL SP-SM | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-107 | 11.6 | 19.000 | 3.266 | 0.395 | | 34.7 | 54.9 | 10.4 | |

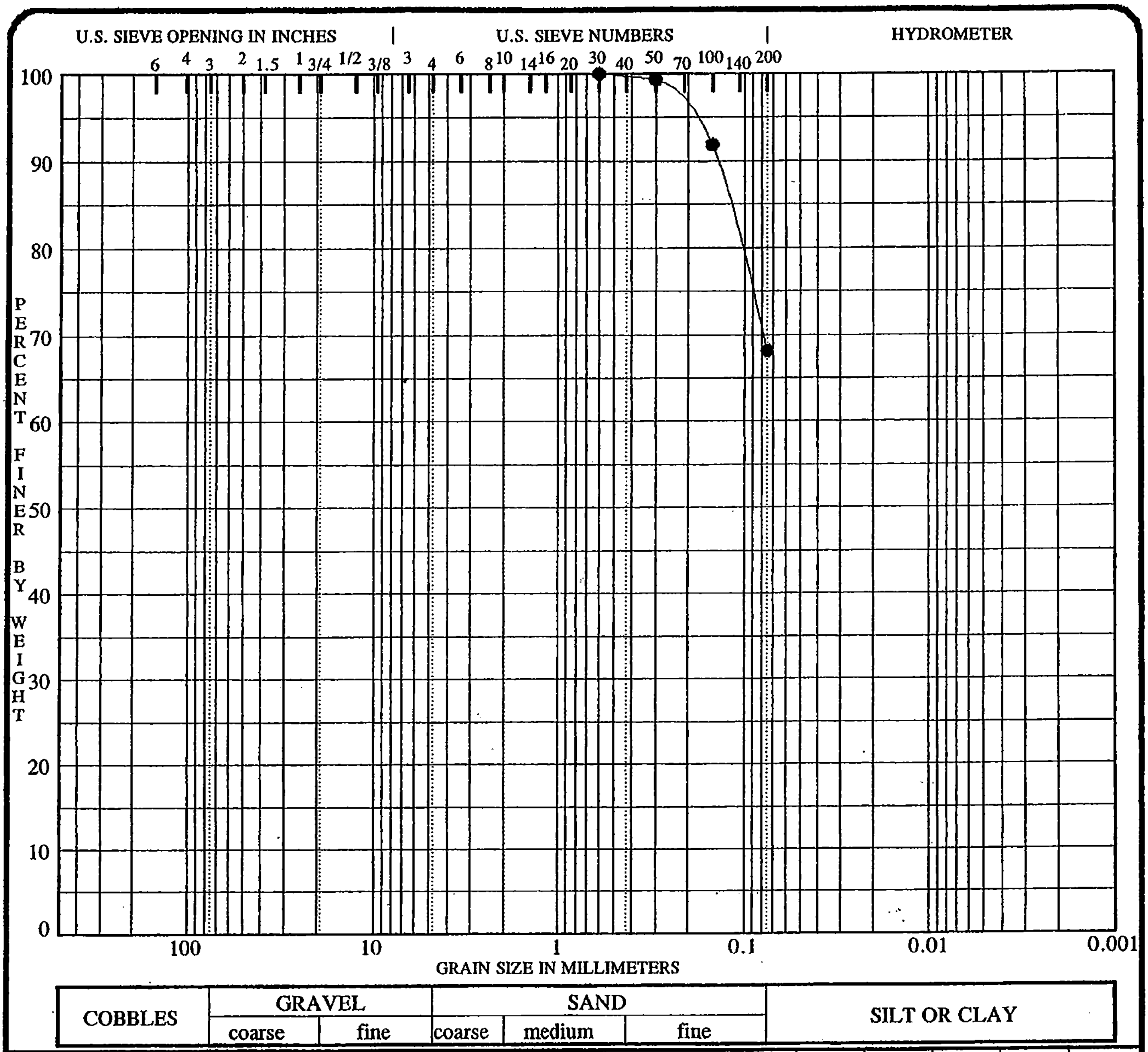
PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.

DATE **05/21/97**

## GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio



| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-107 | 16.6 | | 14.0 | 25.2 | 18.1 | 7.1 | |
| | | | SANDY LEAN CLAY CL | | | | | |

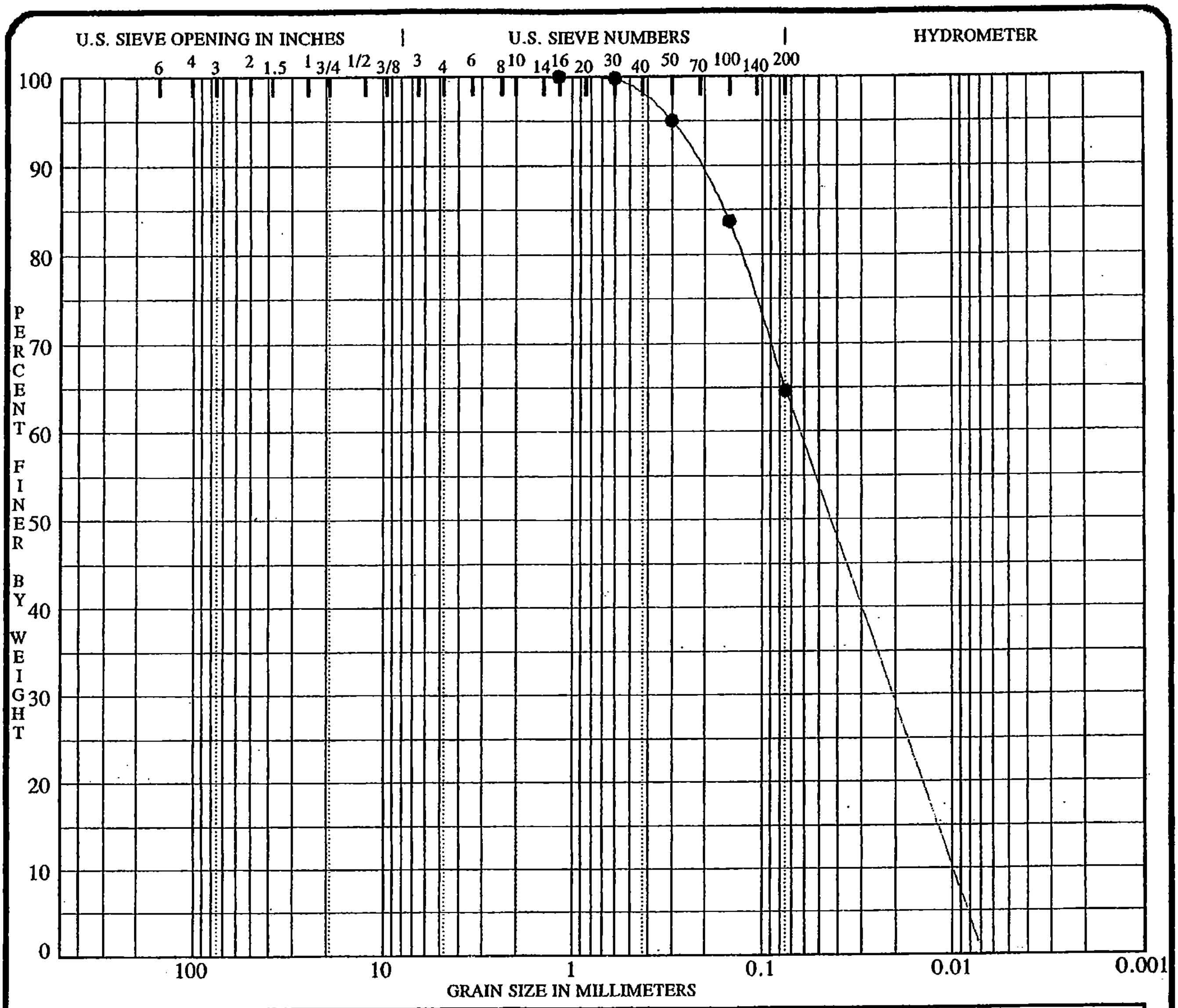
| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-107 | 16.6 | 0.600 | | | | 0.0 | 31.9 | 68.1 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.
DATE 05/21/97

## GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-107 | 21.6 | | 11.4 | NP | NP | NP | | |
| | | | SANDY SILT ML | | | | | | |
| | | | | | | | | | |
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| | | | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-107 | 21.6 | 1.180 | | | | 0.0 | 35.4 | 64.6 | |
| | | | | | | | | | | |
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PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO. __________

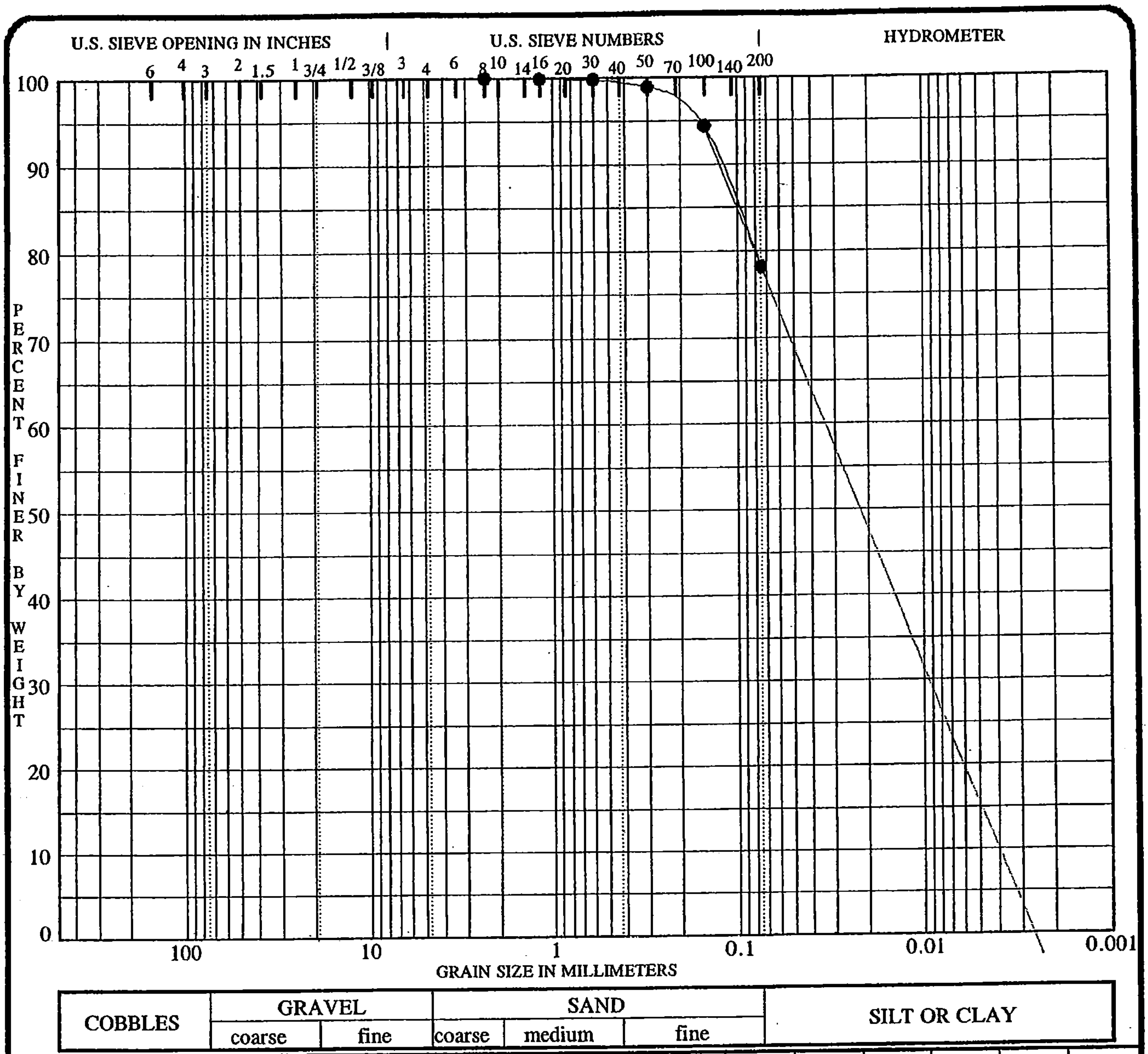
DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**

Groveport, Ohio

AEP



| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|
| ● 96-107 | 36.6 | SILT with SAND ML | 37.6 | NP | NP | NP | 2.38 | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-107 | 36.6 | 2.360 | | | | 0.0 | 21.9 | 78.1 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

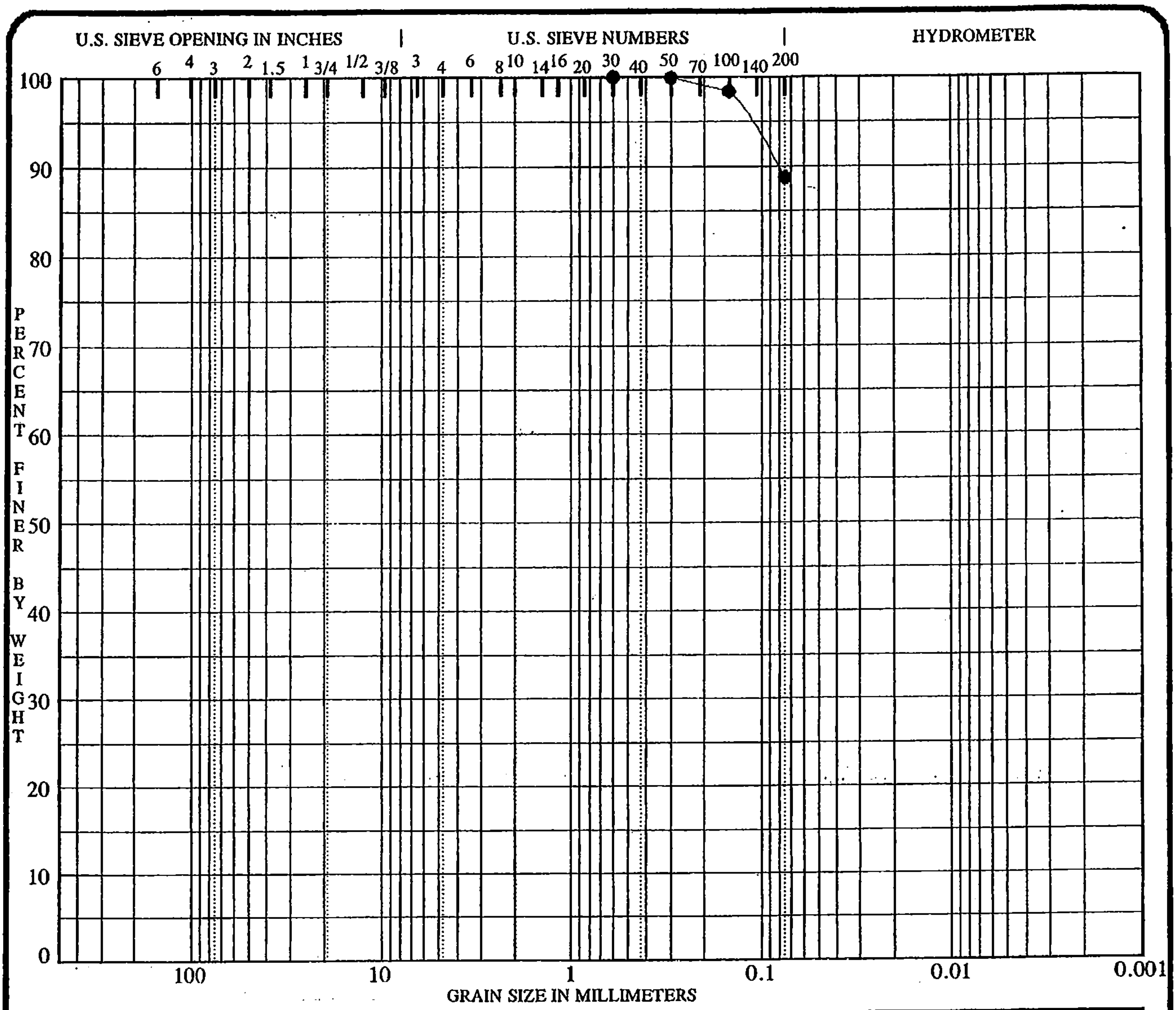
JOB NO.

DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|
| ● | 96-107 56.6 | | 36.2 | NP | NP | NP | 2.31 | |
| | | SILT ML | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

| | Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-107 56.6 | 0.600 | | | | 0.0 | 11.3 | 88.7 | |
| | | | | | | | | | |
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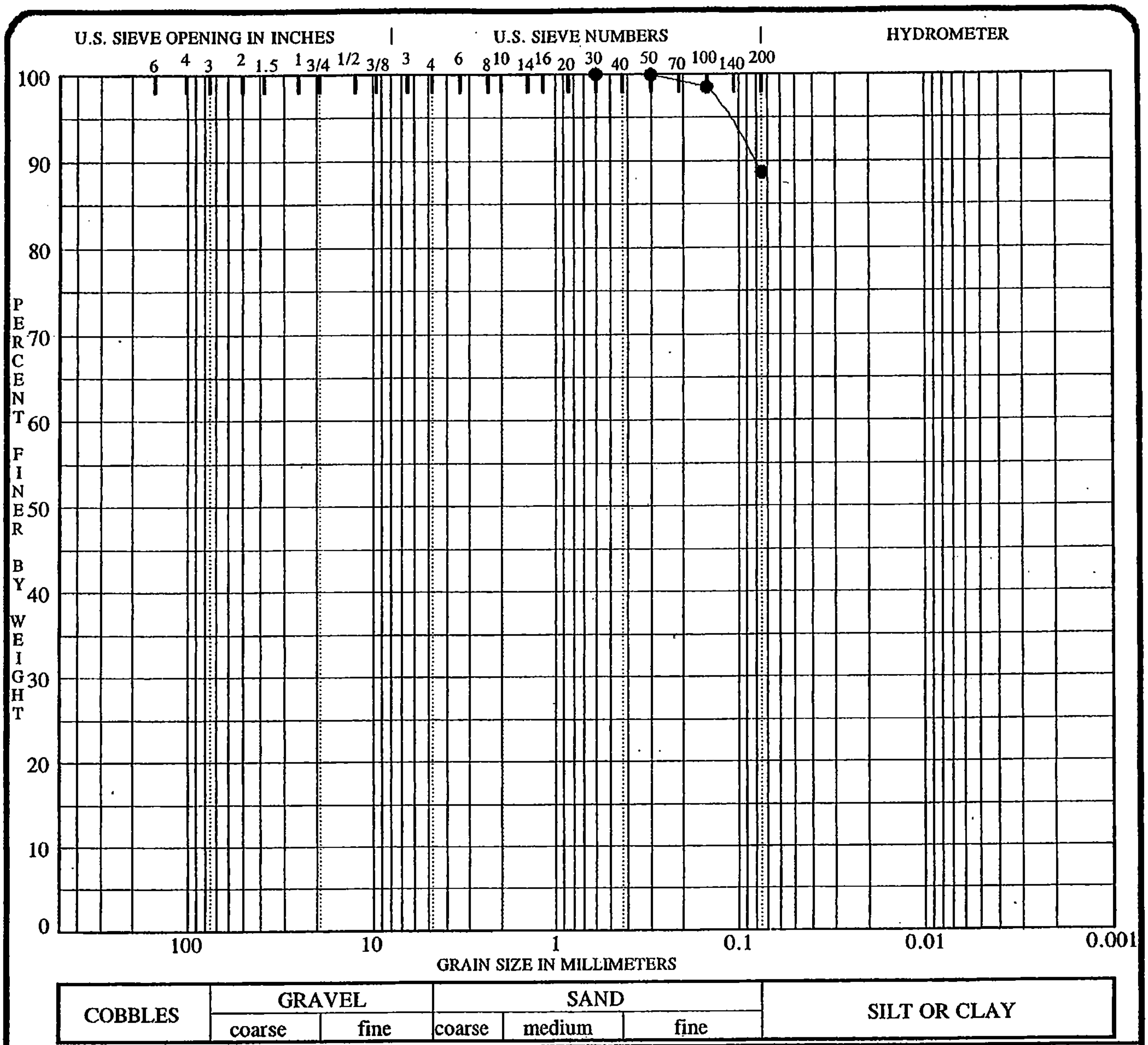
PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.
DATE 05/21/97

# GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio

AEP



| Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|
| ● 96-107 71.6 | | 25.2 | 41.3 | 21.1 | 20.2 | | |
| | LEAN CLAY CL | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|
| ● 96-107 71.6 | 0.600 | | | | 0.0 | 11.4 | 88.6 | |
| | | | | | | | | |
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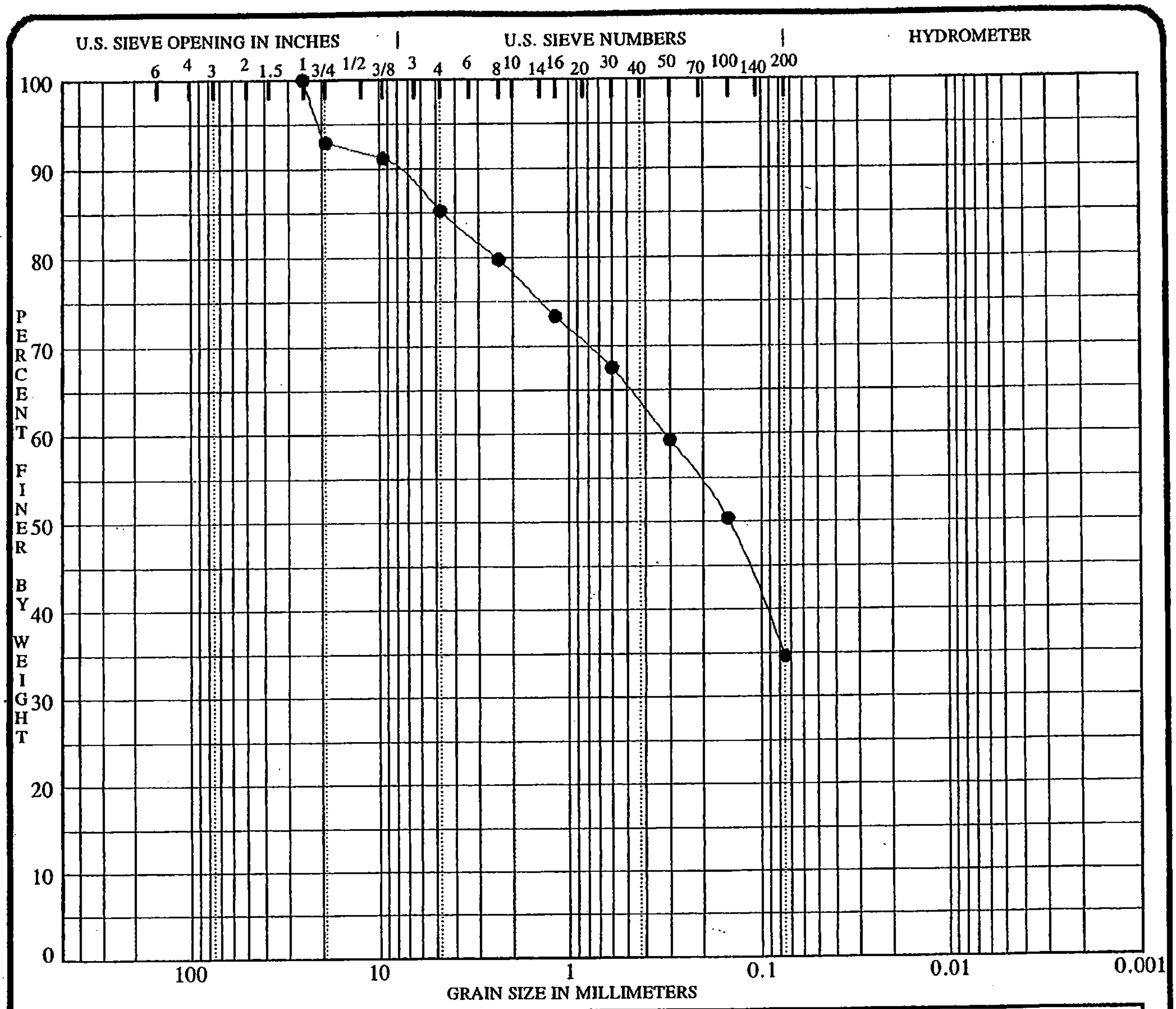
PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.

DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|
| ● 96-108 | 3.0 | SILTY SAND with GRAVEL SM | 9.1 | NP | NP | NP | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | % < .002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-108 | 3.0 | 25.000 | 0.318 | | | 14.8 | 50.6 | 34.6 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

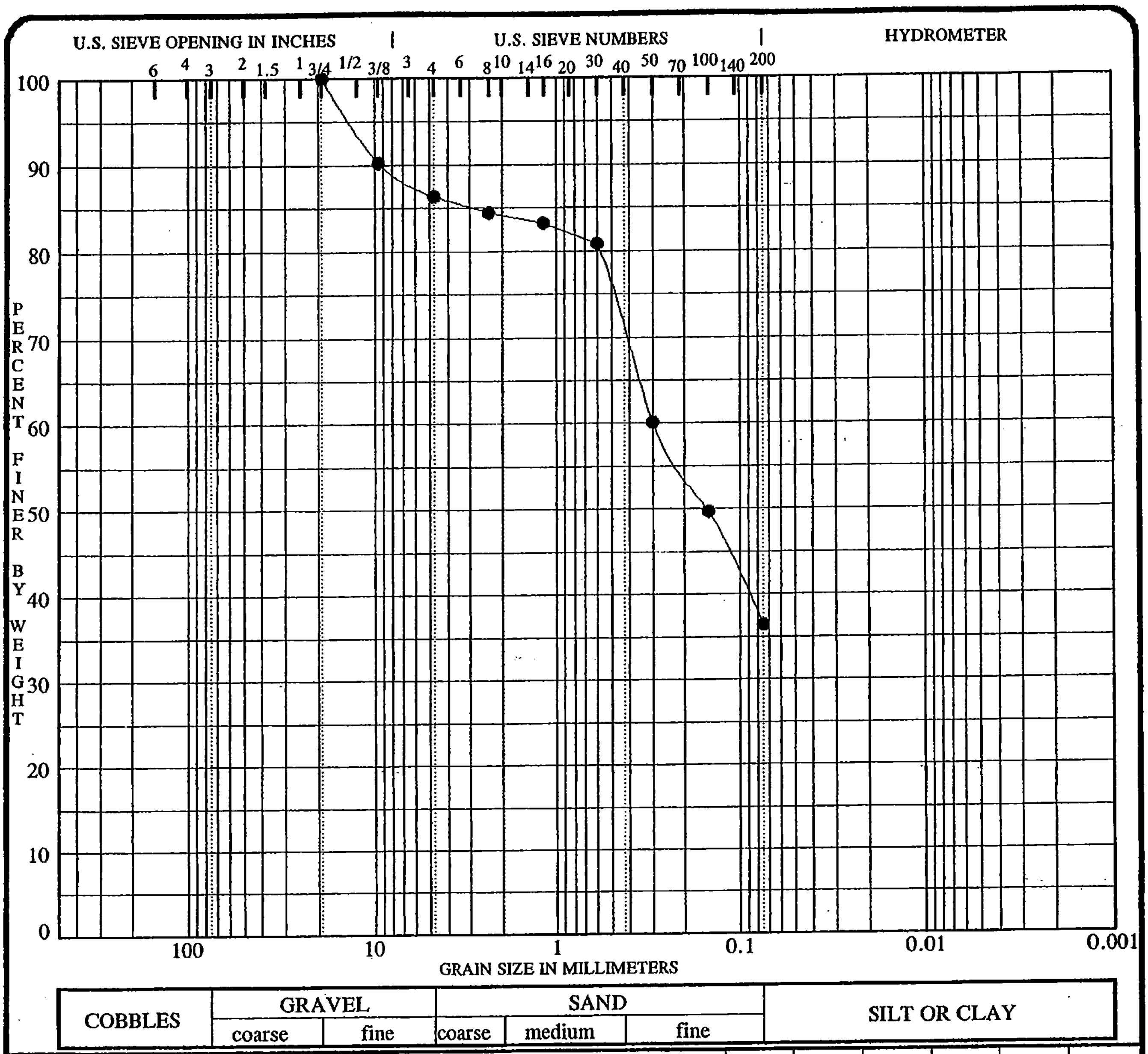
JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-108 | 8.5 | | 6.2 | NP | NP | NP | | |
| | | | SILTY SAND SM | | | | | | |
| | | | | | | | | | |
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| | | | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | % < .002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-108 | 8.5 | 19.000 | 0.298 | | | 13.7 | 49.9 | 36.4 | |
| | | | | | | | | | | |
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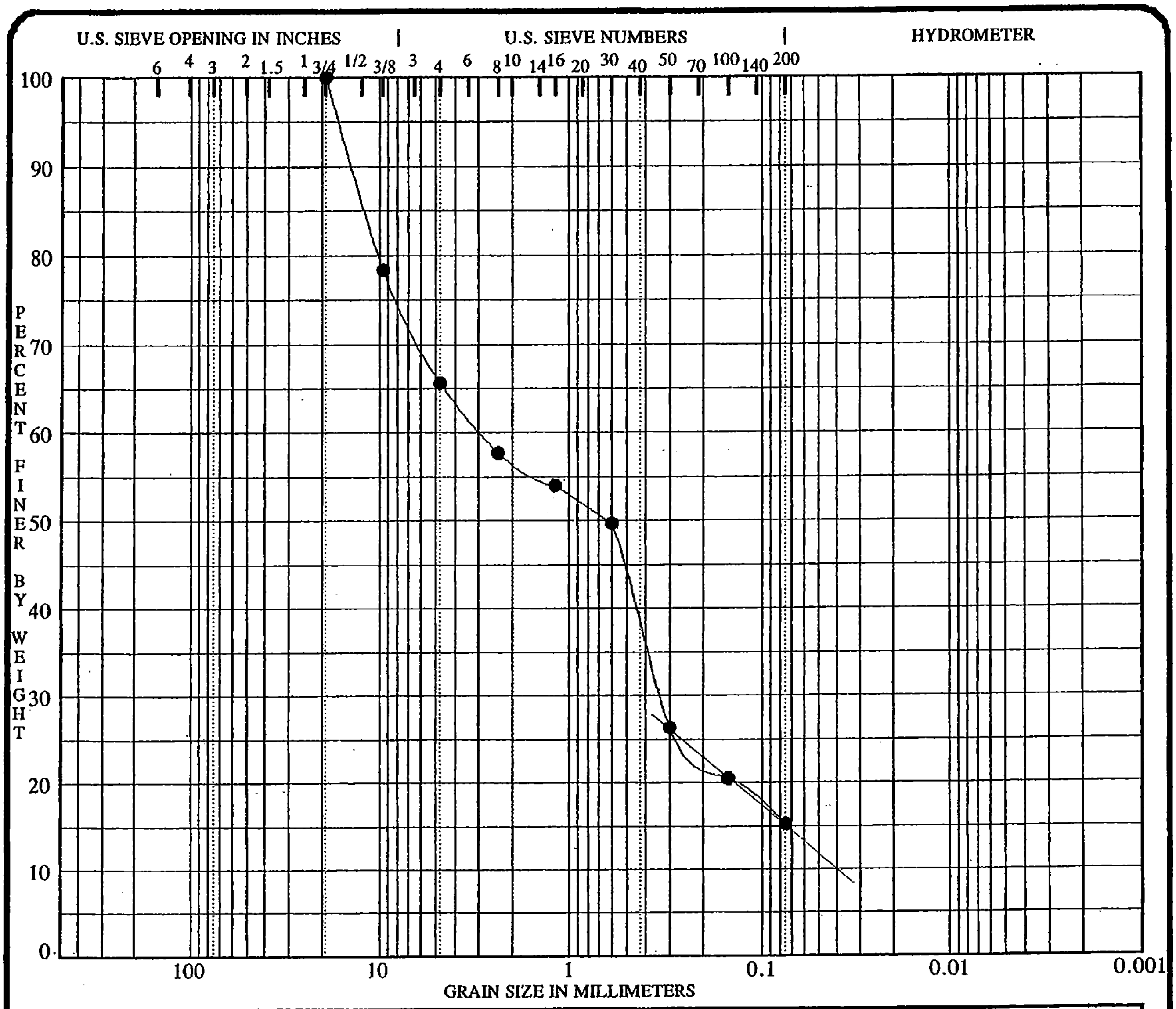
PROJECT SPORN PLANT - FLY ASH POND DIKES

JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio



<table>
<tr><td rowspan="2">COBBLES</td><td colspan="2">GRAVEL</td><td colspan="3">SAND</td><td rowspan="2">SILT OR CLAY</td></tr>
<tr><td>coarse</td><td>fine</td><td>coarse</td><td>medium</td><td>fine</td></tr>
</table>

| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|
| ● 96-108 | 11.6 | | 3.0 | NP | NP | NP | |
| | | SILTY SAND with GRAVEL SM | | | | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-108 | 11.6 | 19.000 | 2.893 | 0.335 | | 34.4 | 50.4 | 15.2 | |

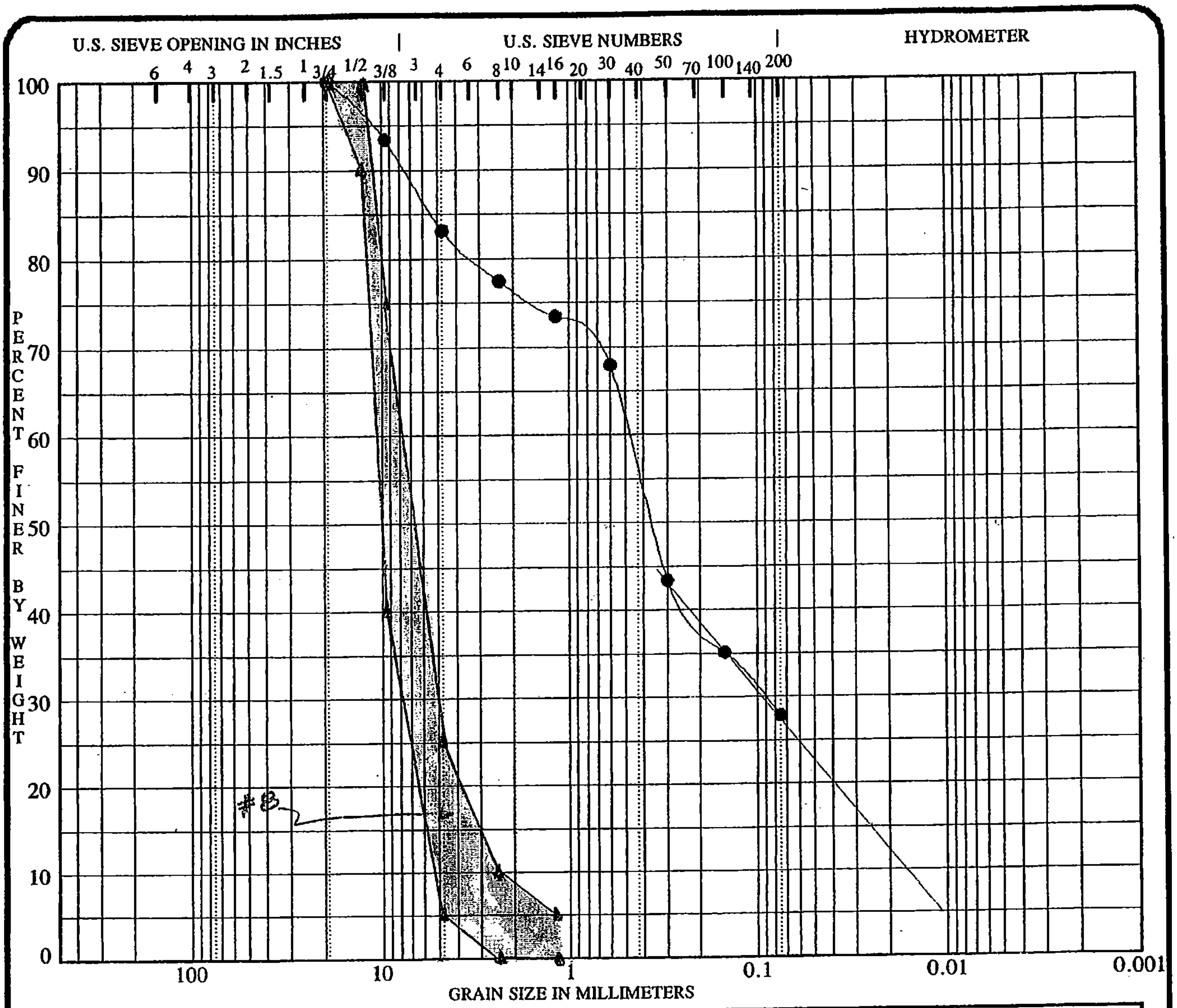
PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.
DATE 05/21/97

# GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|
| ● 96-108 | 16.6 | | 1.9 | NP | NP | NP | |
| | | SILTY SAND with GRAVEL SM | | | | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● 96-108 | 16.6 | 19.000 | 0.480 | 0.092 | | 16.9 | 55.3 | 27.8 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

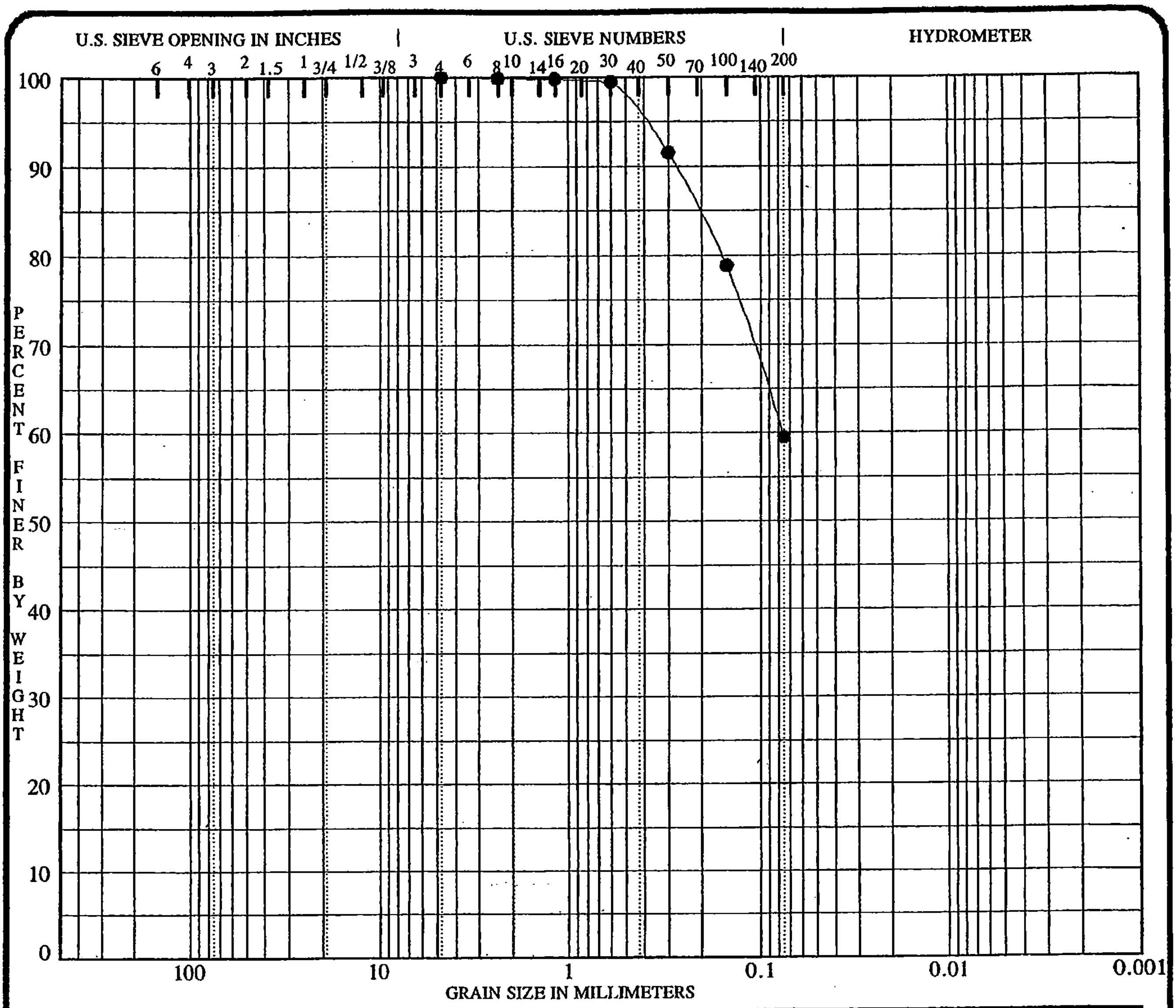
JOB NO.

DATE 05/21/97

# GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|
| ● 96-108 21.6 | | 12.2 | 23.3 | 16.5 | 6.7 | | |
| | SANDY SILTY CLAY CL-ML | | | | | | |

| Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|
| ● 96-108 21.6 | 4.750 | 0.076 | | | 0.0 | 40.5 | 59.5 | |

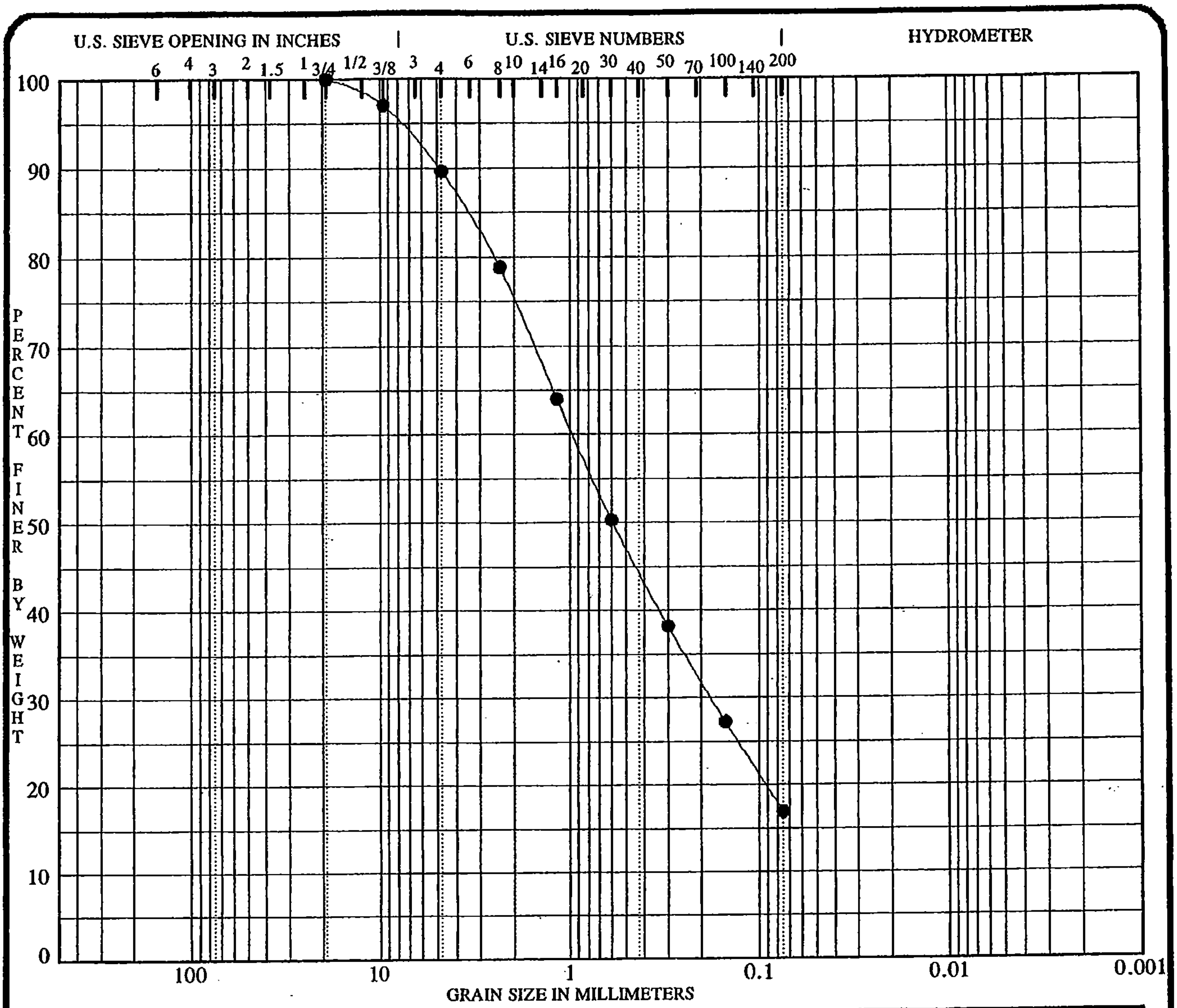
PROJECT SPORN PLANT - FLY ASH POND DIKES

JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|
| ● 96-108 26.6 | | 20.6 | NP | NP | NP | | |
| | SILTY SAND SM | | | | | | |
| | | | | | | | |
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| | | | | | | | |

| Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | % <.002 |
|---|---|---|---|---|---|---|---|---|
| ● 96-108 26.6 | 19.000 | 0.969 | 0.179 | | 10.4 | 72.7 | 16.9 | |
| | | | | | | | | |
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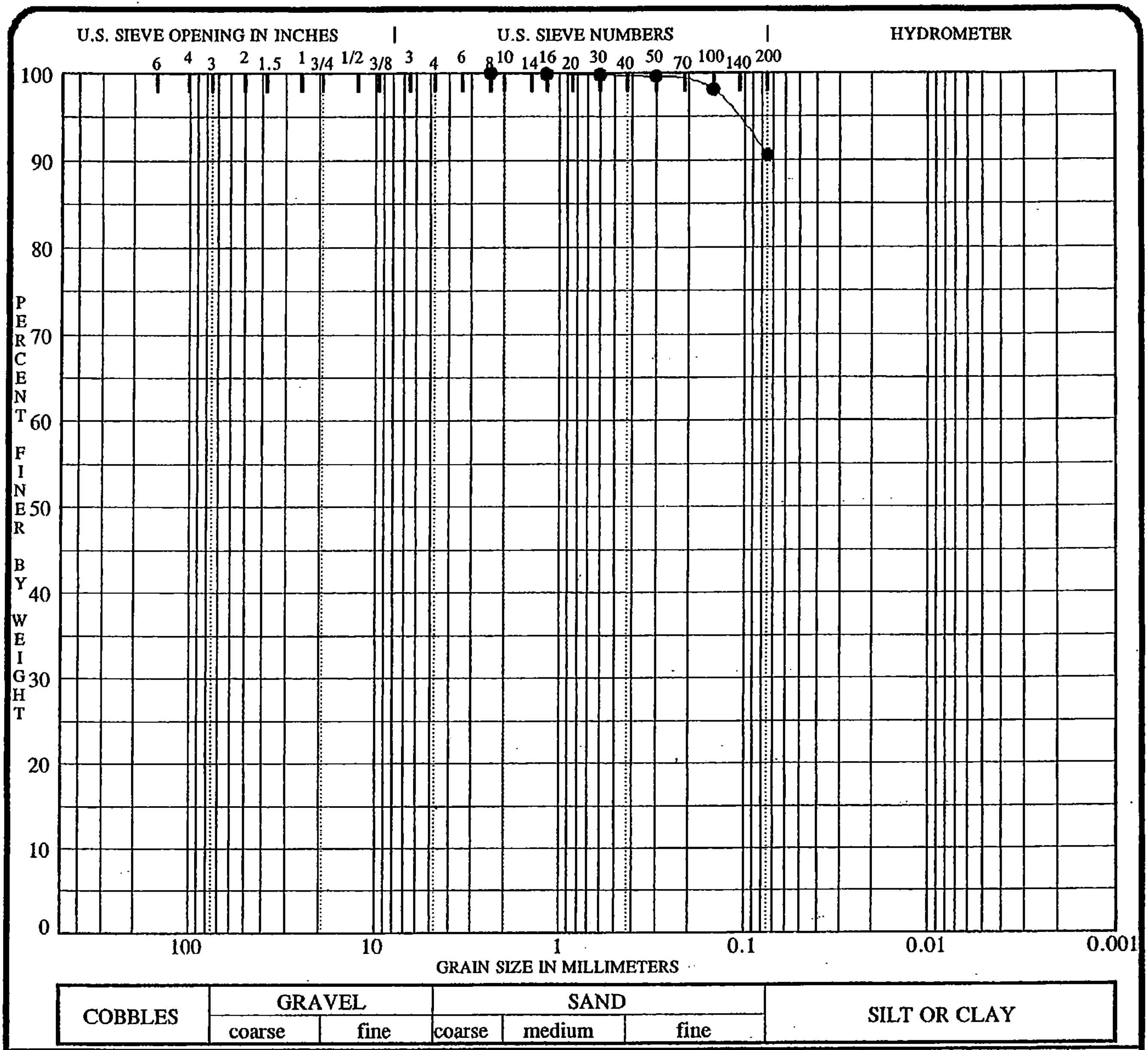
PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.

DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio



| | Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|
| ● | 96-108 41.6 | | 23.2 | 38.7 | 20.3 | 18.4 | | |
| | | LEAN CLAY CL | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

| | Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-108 41.6 | 2.360 | | | | 0.0 | 9.5 | 90.5 | |
| | | | | | | | | | |
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PROJECT SPORN PLANT - FLY ASH POND DIKES

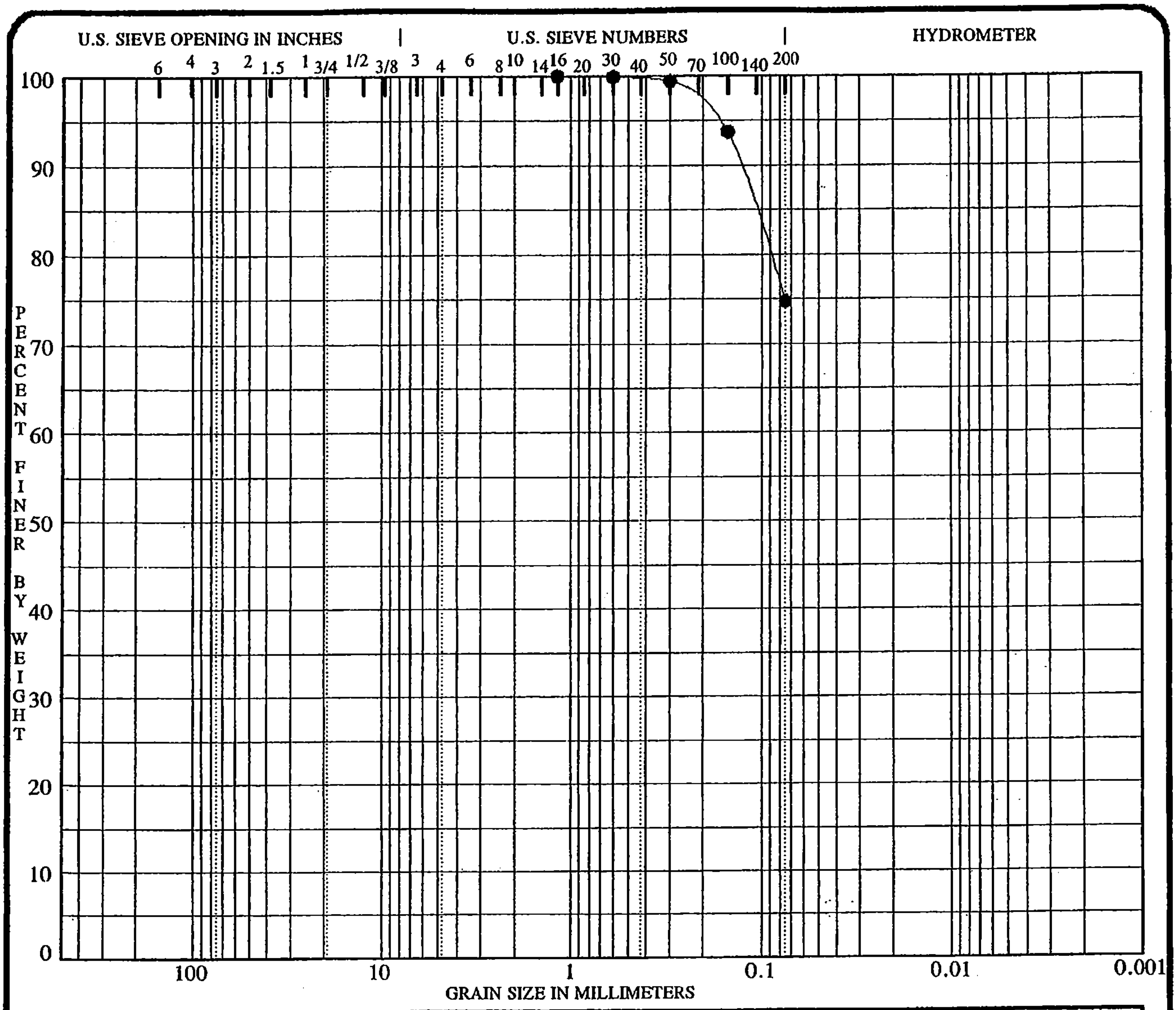
JOB NO.

DATE 05/21/97

## GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-108 | 56.6 | | 25.1 | 34.9 | 20.1 | 14.9 | | |
| | | | LEAN CLAY with SAND CL | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-108 | 56.6 | 1.180 | | | | 0.0 | 25.3 | 74.7 | |
| | | | | | | | | | | |
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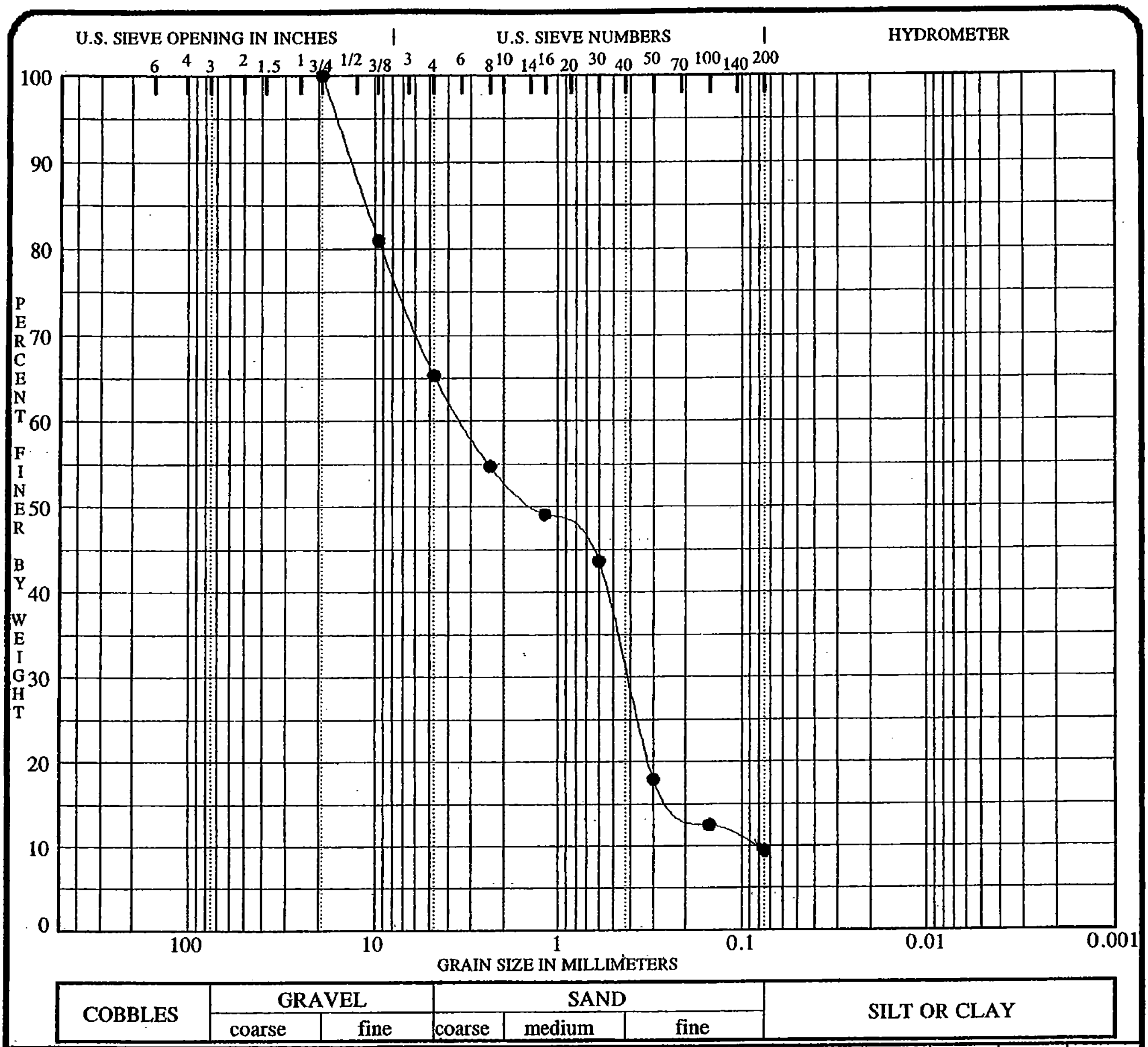
PROJECT SPORN PLANT - FLY ASH POND DIKES

JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio



| Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|
| ● 96-109 8.5 | | 0.4 | NP | NP | NP | |
| | POORLY GRADED SAND with SILT and GRAVEL SP-SM | | | | | |

| Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|
| ● 96-109 8.5 | 19.000 | 3.348 | 0.416 | 0.086 | 34.7 | 55.9 | 9.4 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.
DATE **05/21/97**

# GRADATION CURVES

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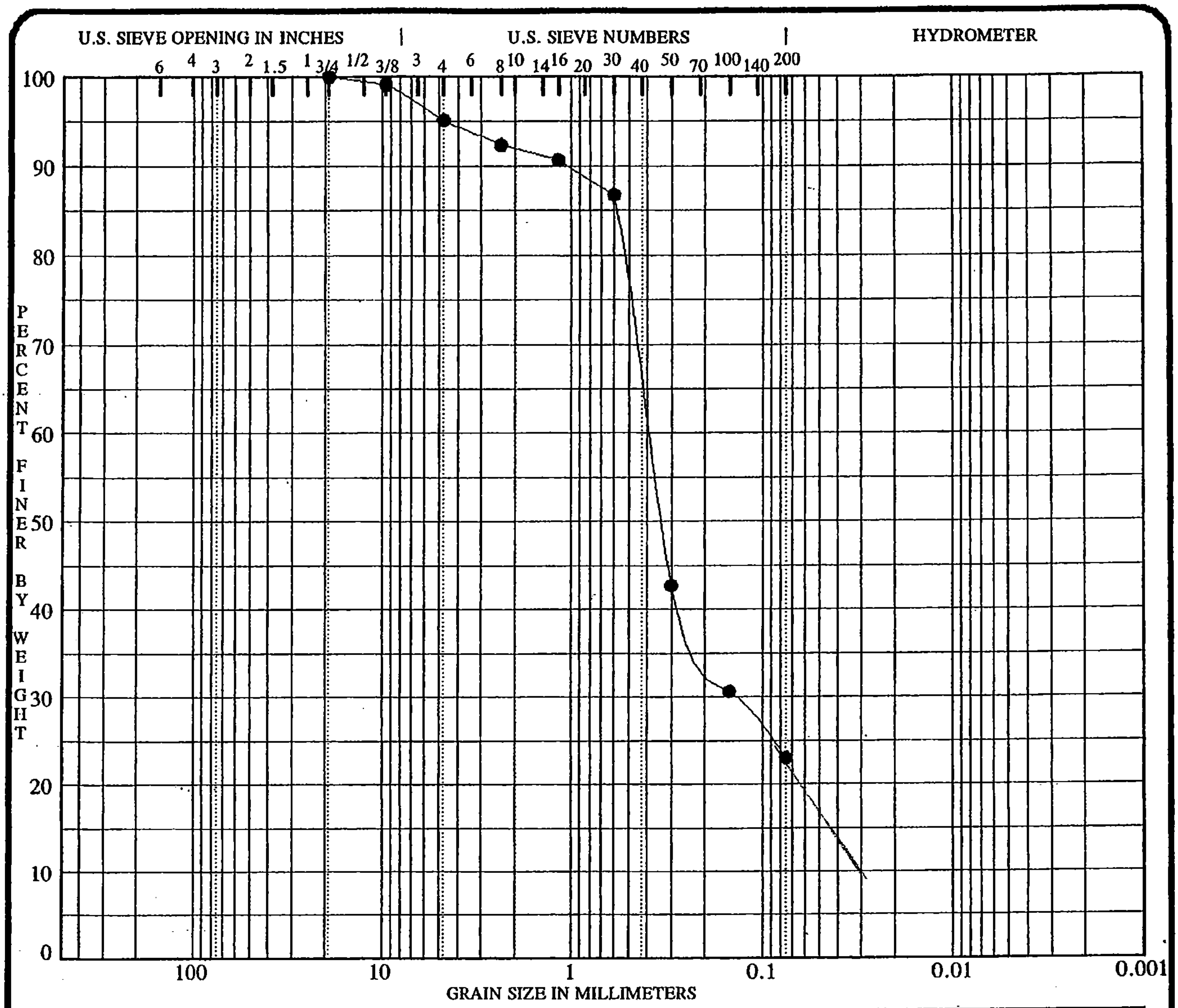
Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-109 | 11.7 | | 4.3 | NP | NP | NP | | |
| | | | SILTY SAND SM | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | % < .002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-109 | 11.7 | 19.000 | 0.394 | 0.142 | | 4.9 | 72.1 | 23.0 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.

DATE 05/21/97

## GRADATION CURVES

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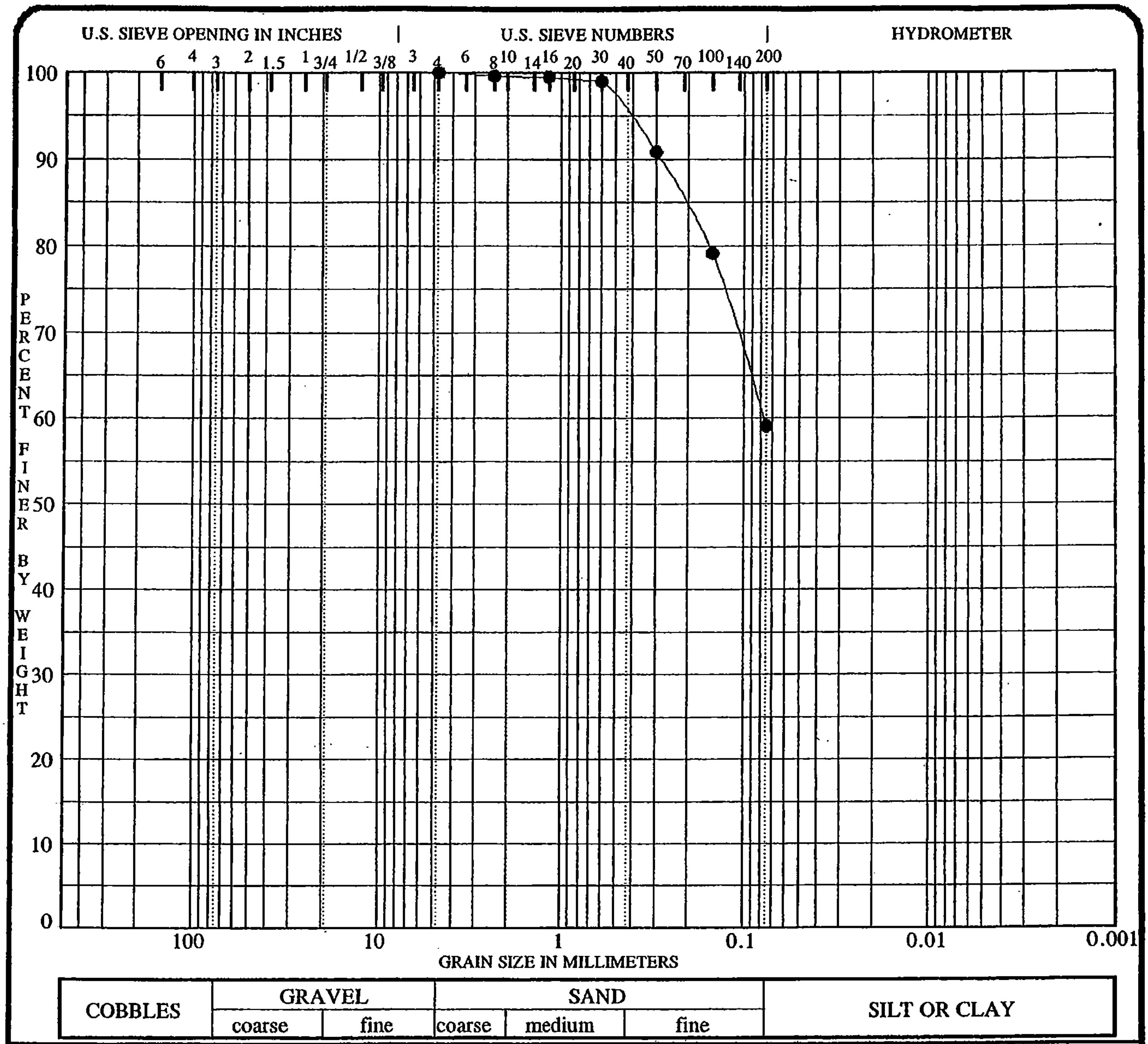

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-109 | 16.7 | | 9.0 | 22.9 | 17.1 | 5.7 | | |
| | | | SANDY SILTY CLAY CL-ML | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-109 | 16.7 | 4.750 | 0.077 | | | 0.0 | 40.9 | 59.1 | |
| | | | | | | | | | | |
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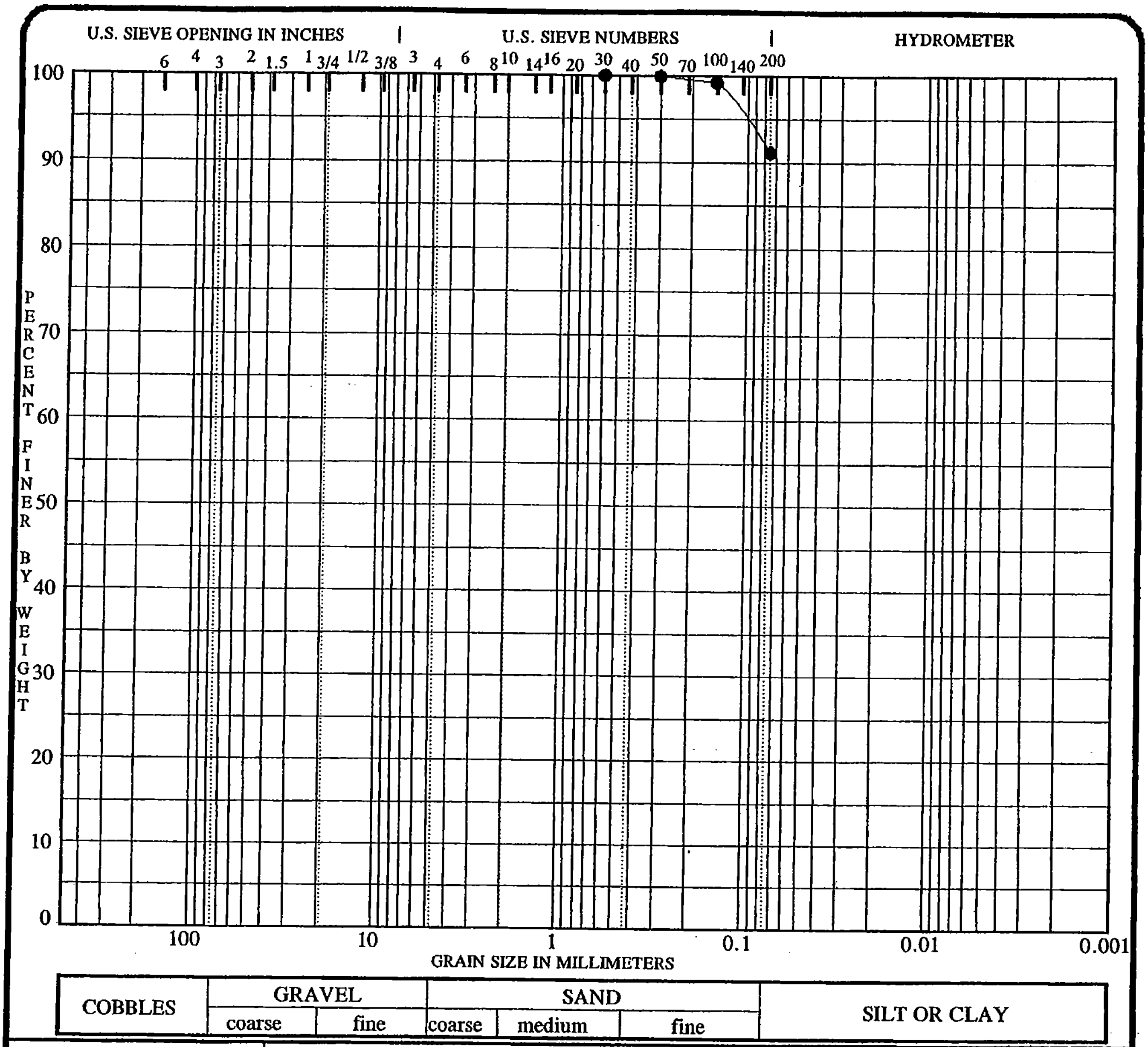
PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.

DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio



| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-109 | 36.7 | | 38.1 | NP | NP | NP | 2.34 | |
| | | | SILT ML | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-109 | 36.7 | 0.600 | | | | 0.0 | 8.9 | 91.1 | |

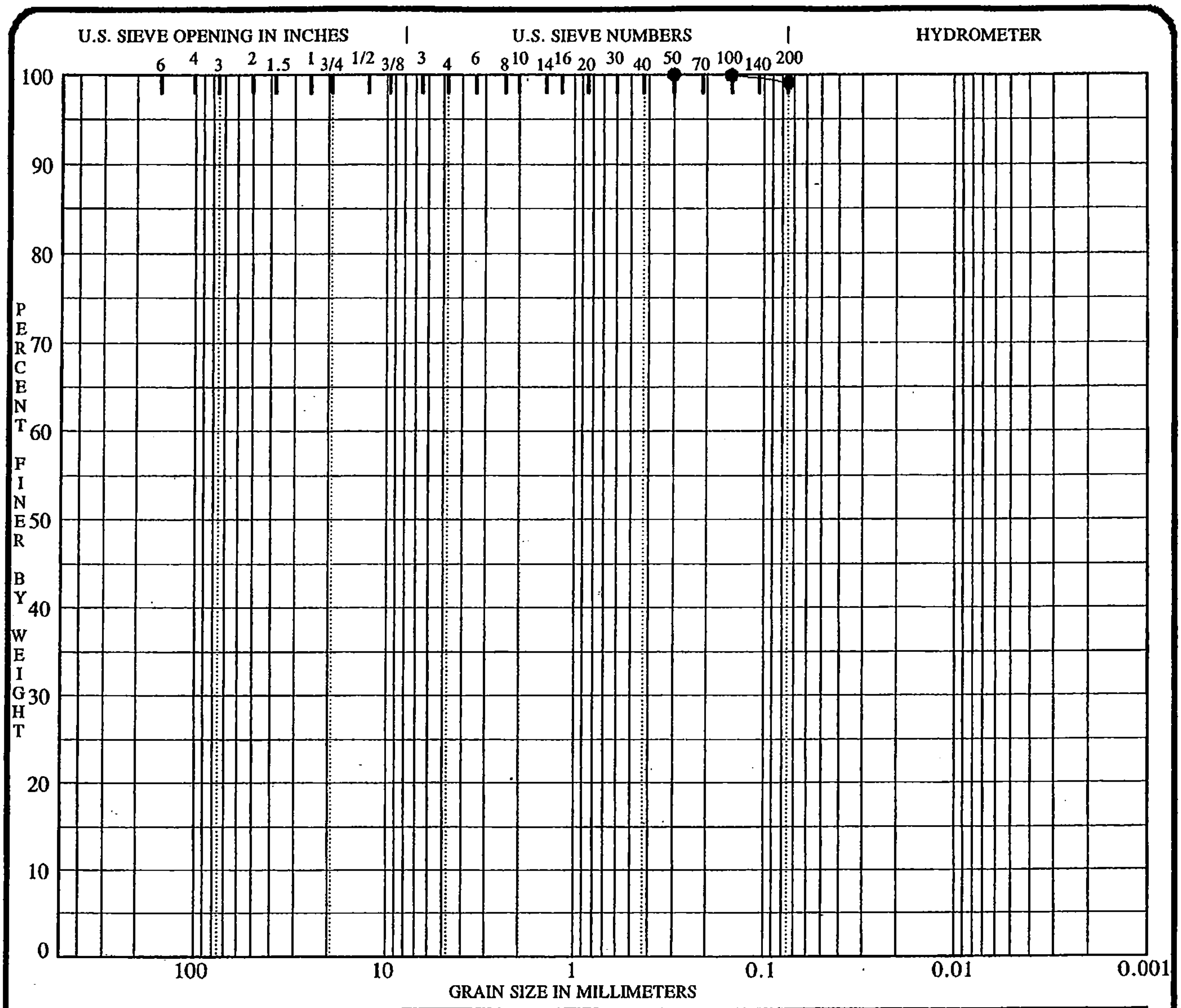
PROJECT SPORN PLANT - FLY ASH POND DIKES

JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|
| ● 96-109 56.7 | | 34.3 | NP | NP | NP | 2.29 | |
| | SILT ML | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

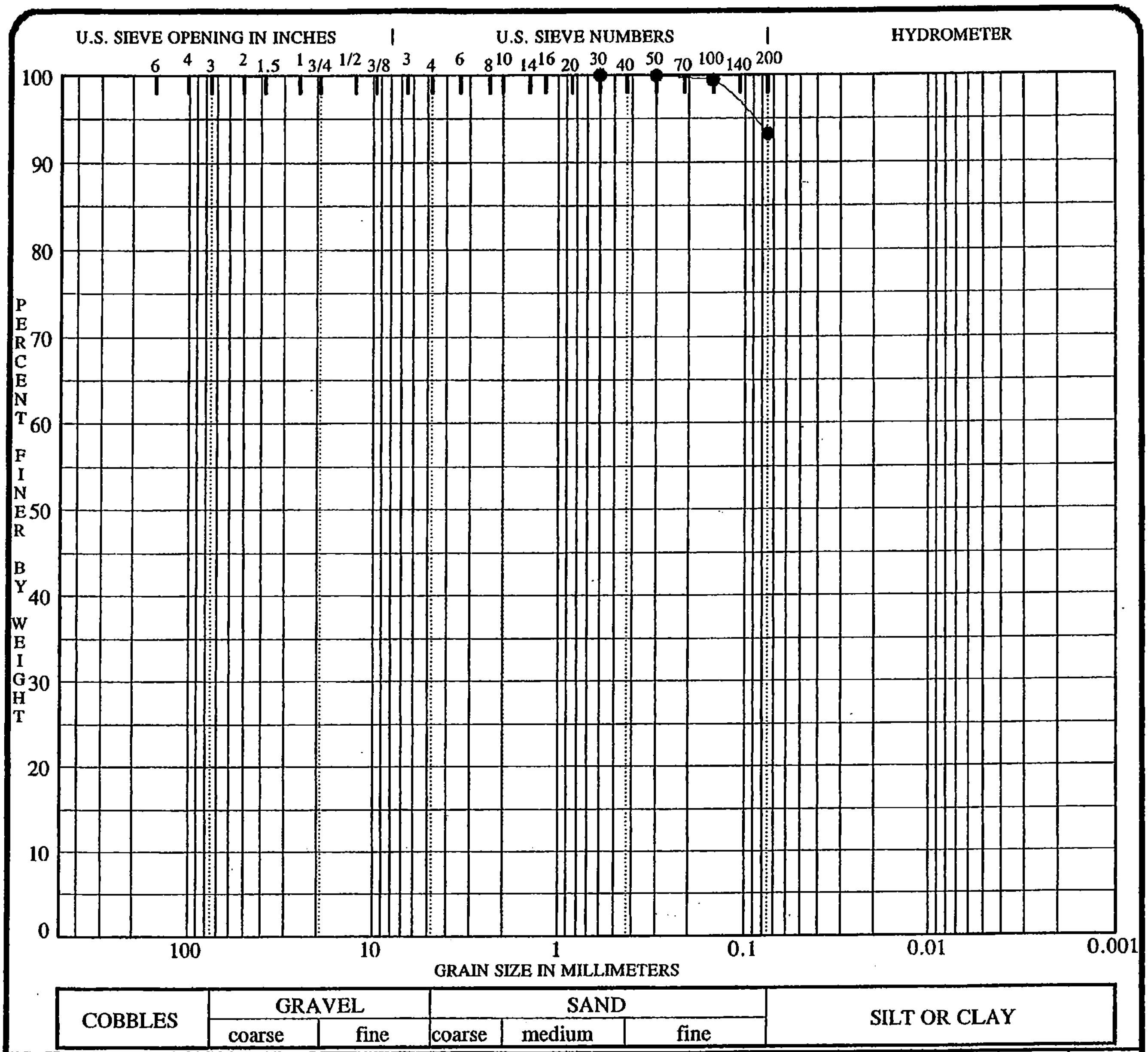
| Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|
| ● 96-109 56.7 | 0.300 | | | | 0.0 | 0.9 | 99.1 | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.
DATE 05/21/97

# GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio



| | Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|
| ● | 96-109 71.7 | | 23.7 | 40.3 | 21.8 | 18.5 | |
| | | LEAN CLAY CL | | | | | |

| | Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | % < .002 |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-109 71.7 | 0.600 | | | | 0.0 | 6.8 | 93.2 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO. ____________

DATE **05/21/97**

# GRADATION CURVES

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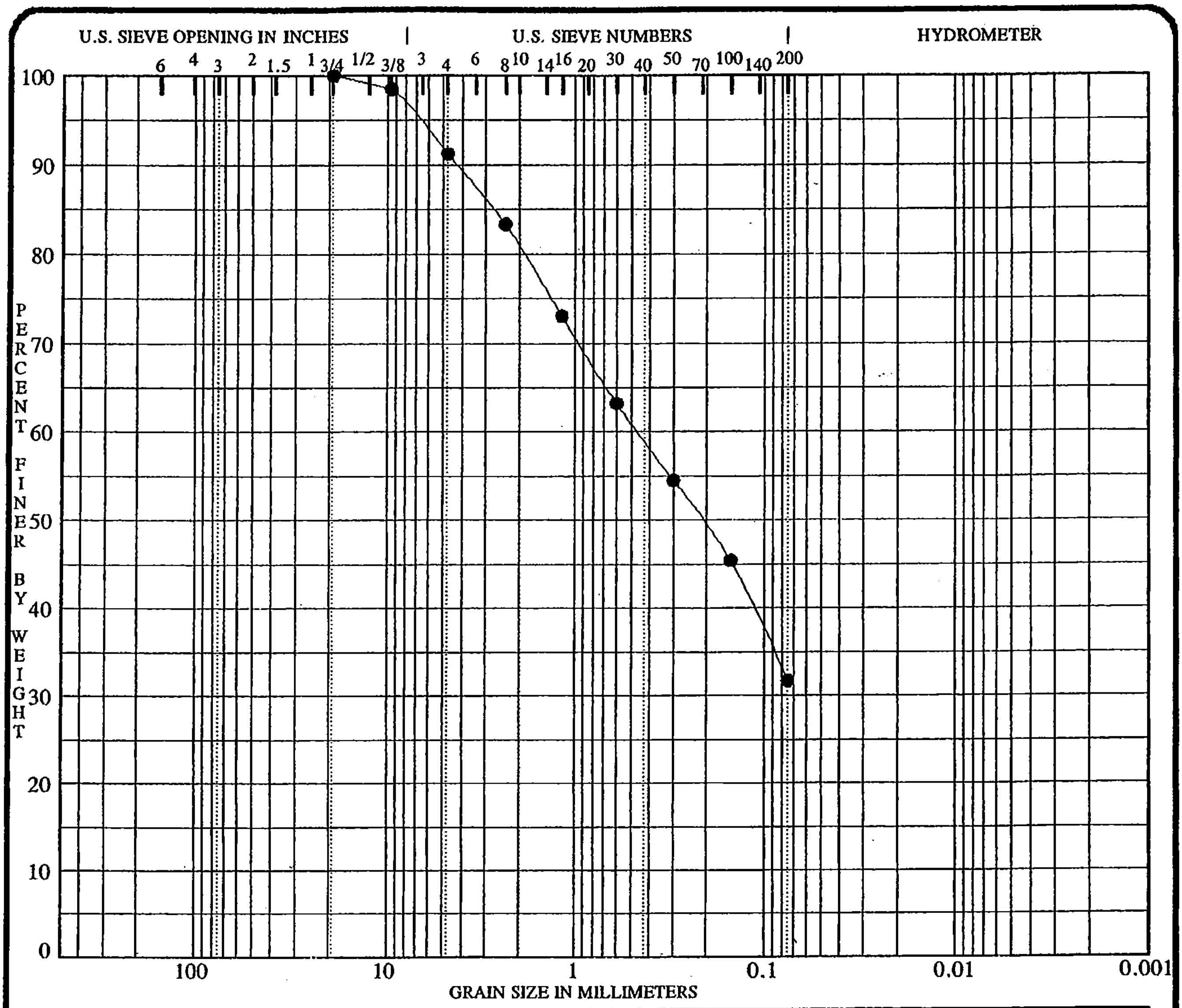
AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-110 | 5.0 | | 6.8 | NP | NP | NP | | |
| | | | SILTY SAND SM | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-110 | 5.0 | 19.000 | 0.465 | | | 8.8 | 59.5 | 31.7 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.

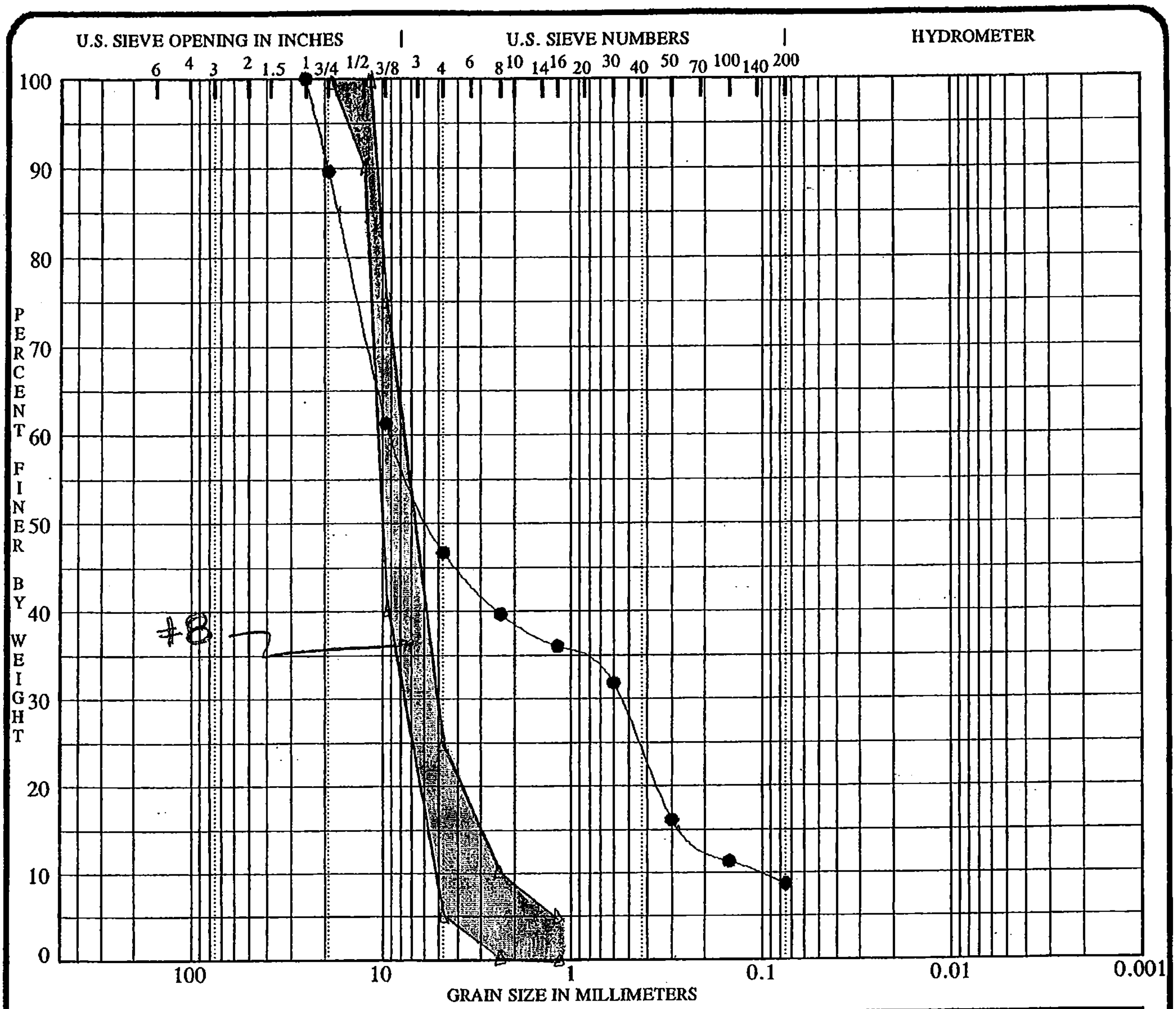
DATE **05/21/97**

# GRADATION CURVES

**American Electric Power Service Corp.**

Groveport, Ohio

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | 96-110 | 8.5 | | 0.1 | NP | NP | NP | |
| | POORLY GRADED GRAVEL with SILT and SAND GP-GM | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-110 | 8.5 | 25.000 | 8.931 | 0.554 | 0.106 | 53.3 | 38.0 | 8.7 | |

PROJECT SPORN PLANT - FLY ASH POND DIKES

JOB NO.

DATE 05/21/97

# GRADATION CURVES

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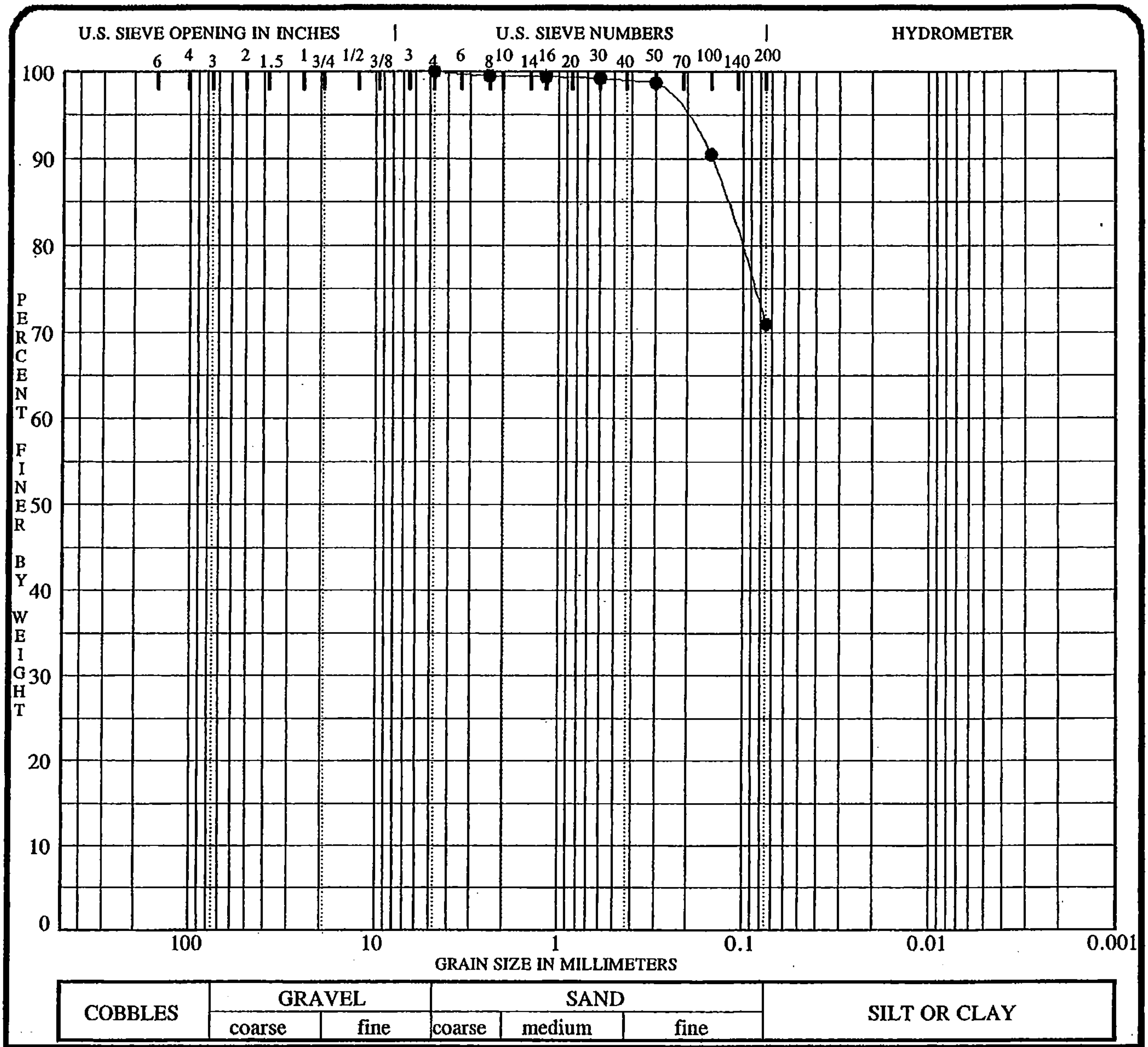
Groveport, Ohio



| Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|
| ● 96-110 16.6 | | 11.5 | 25.5 | 17.6 | 8.0 | | |
| | LEAN CLAY with SAND CL | | | | | | |

| Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|
| ● 96-110 16.6 | 4.750 | | | | 0.0 | 29.1 | 70.9 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO.

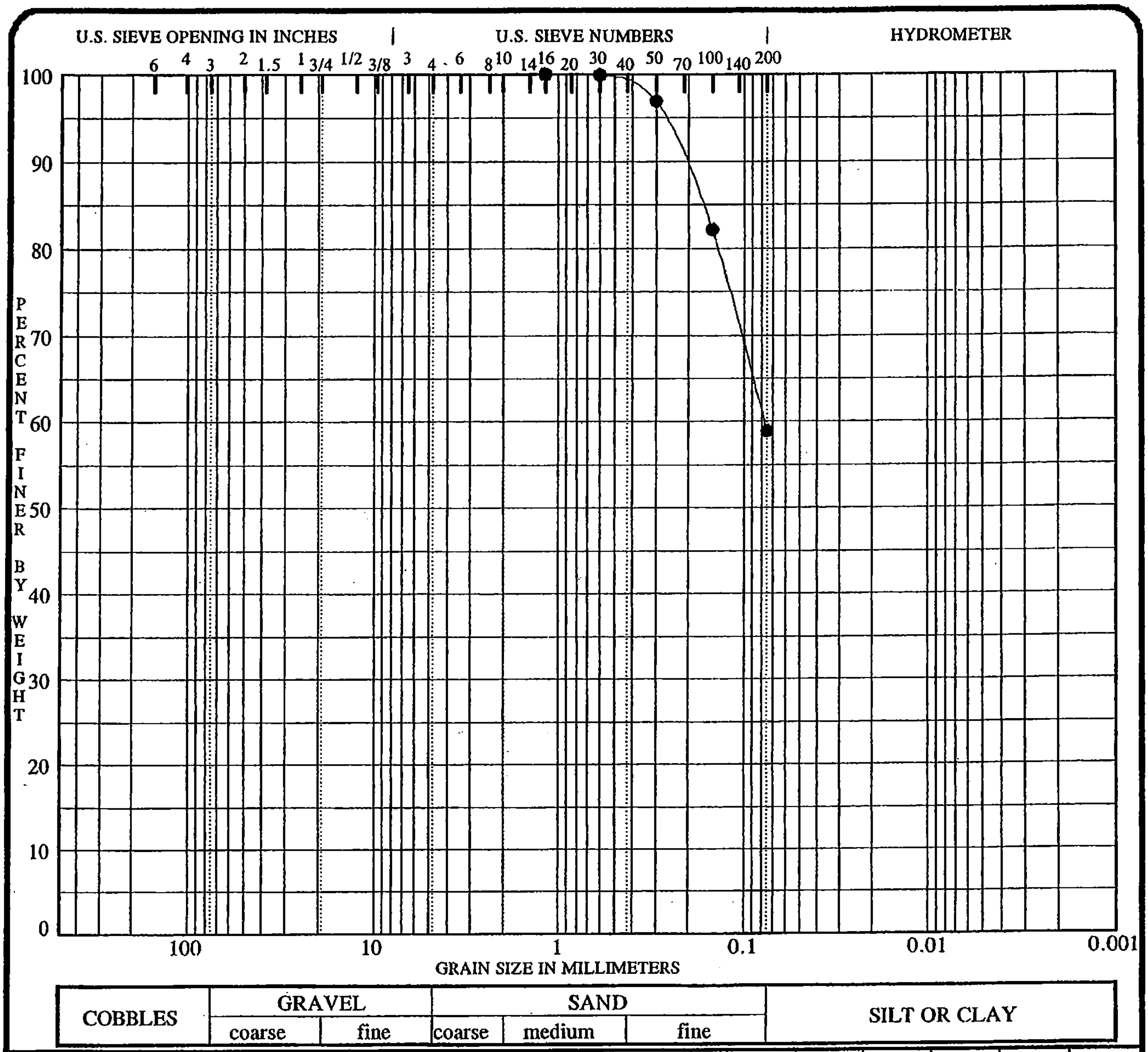
DATE **05/21/97**

## GRADATION CURVES

**American Electric Power Service Corp.**

Groveport, Ohio

AEP



| | Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|
| ● | 96-110 21.6 | | 12.5 | 24.0 | 17.0 | 7.0 | | |
| | | SANDY SILTY CLAY CL-ML | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

| | Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-110 21.6 | 1.180 | 0.078 | | | 0.0 | 41.1 | 58.9 | |
| | | | | | | | | | |
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PROJECT SPORN PLANT - FLY ASH POND DIKES

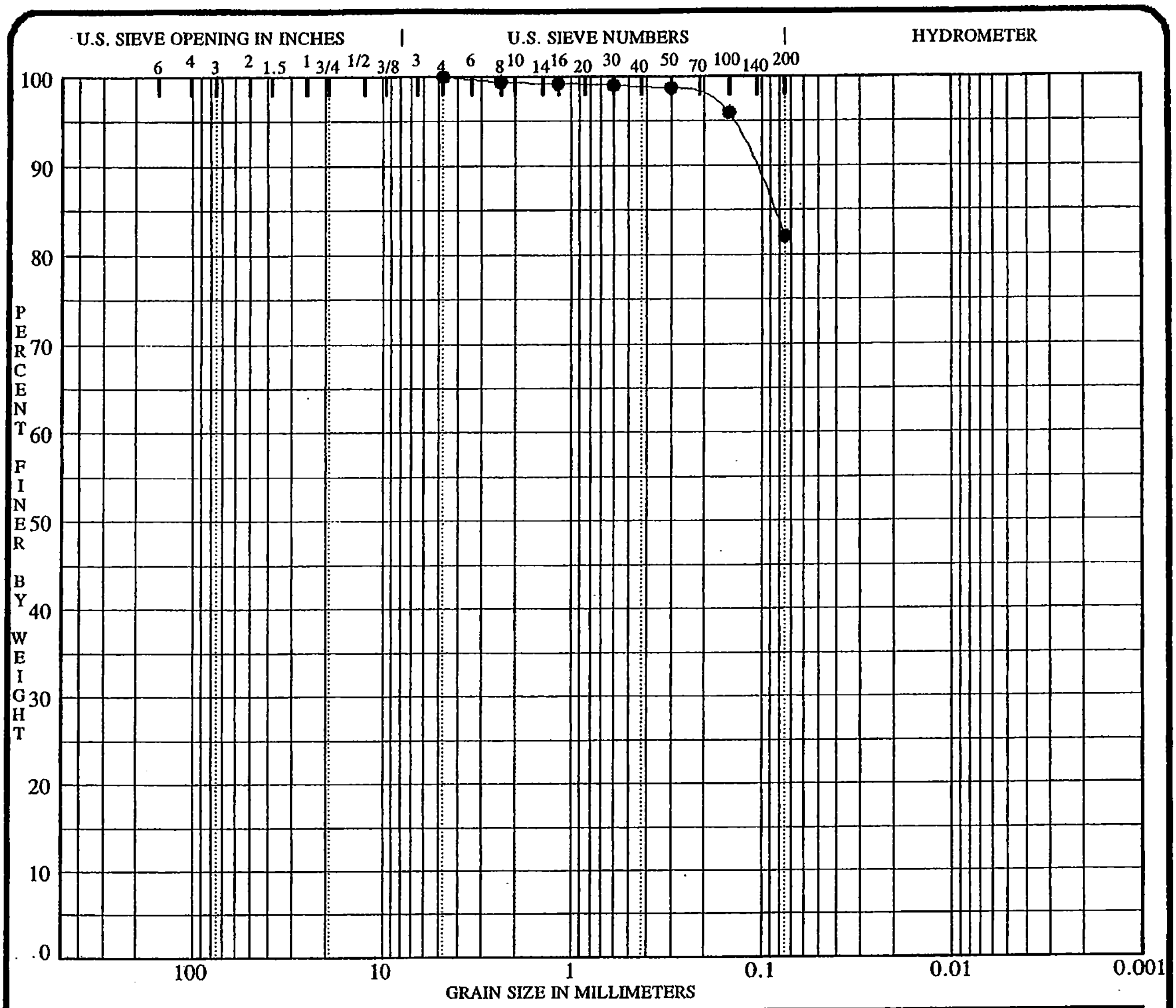
JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



<table>
<tr><td rowspan="2">COBBLES</td><td colspan="2">GRAVEL</td><td colspan="3">SAND</td><td rowspan="2">SILT OR CLAY</td></tr>
<tr><td>coarse</td><td>fine</td><td>coarse</td><td>medium</td><td>fine</td></tr>
</table>

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-110 | 31.6 | | 14.7 | 30.7 | 18.4 | 12.3 | | |
| | | | LEAN CLAY with SAND CL | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-110 | 31.6 | 4.750 | | | | 0.0 | 18.0 | 82.0 | |
| | | | | | | | | | | |
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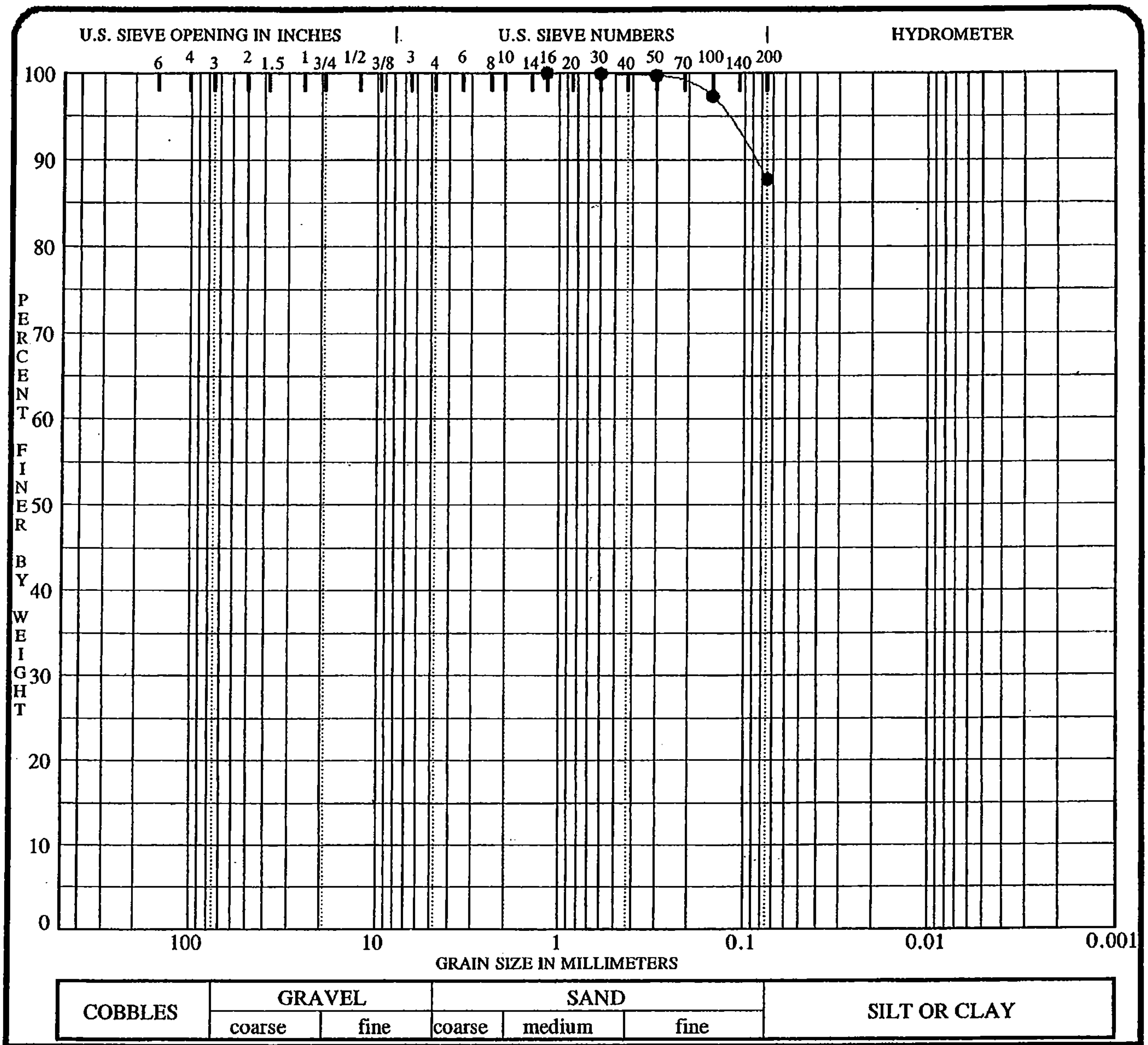
PROJECT SPORN PLANT - FLY ASH POND DIKES
JOB NO.
DATE 05/21/97

## GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

AEP



| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-110 | 46.6 | | 25.1 | 36.2 | 21.3 | 14.9 | | |
| | | | LEAN CLAY CL | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-110 | 46.6 | 1.180 | | | | 0.0 | 12.3 | 87.7 | |
| | | | | | | | | | | |
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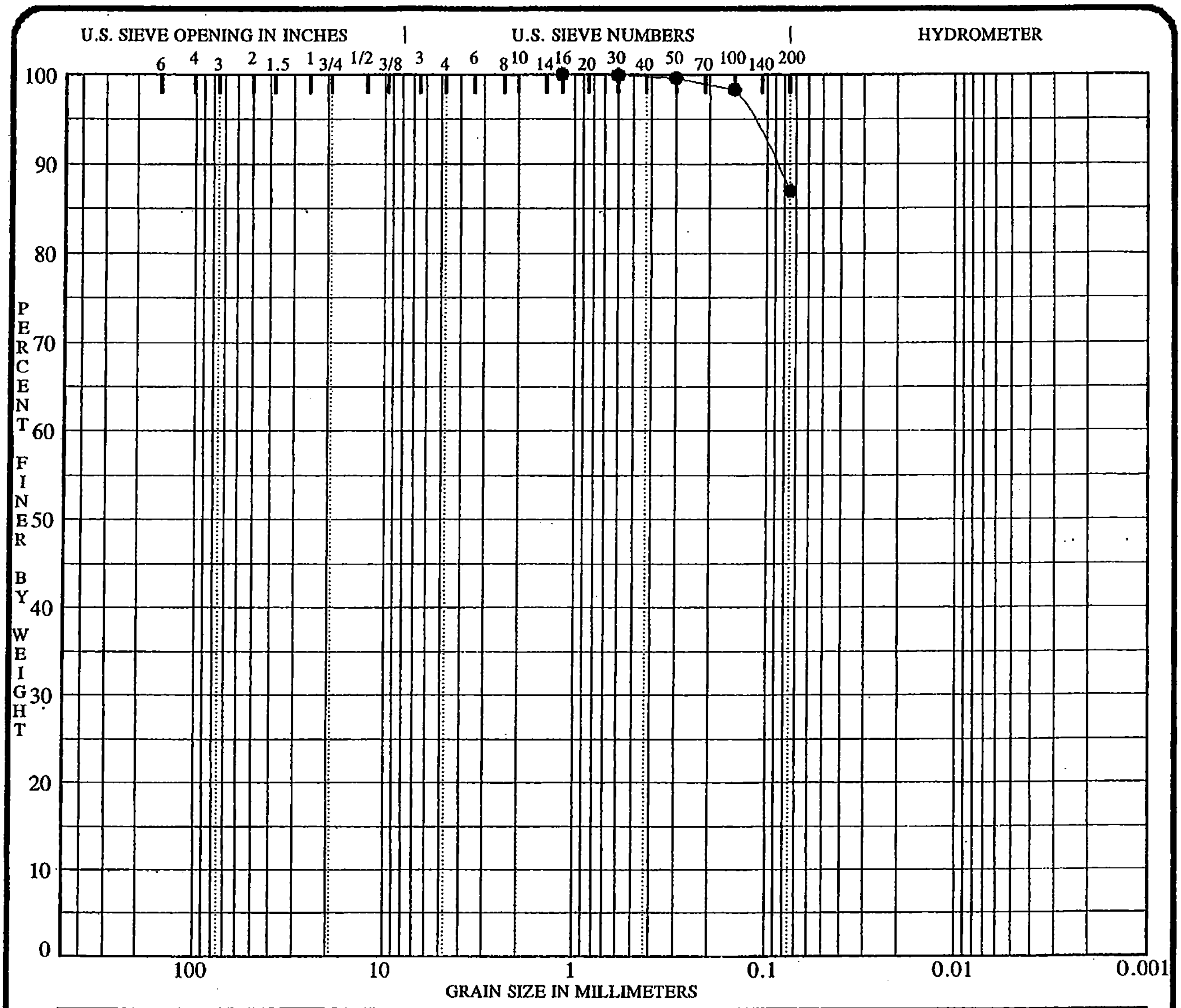
PROJECT **SPORN PLANT - FLY ASH POND DIKES**
JOB NO. ______
DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-110 | 56.6 | LEAN CLAY CL | 24.4 | 37.5 | 20.3 | 17.1 | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-110 | 56.6 | 1.180 | | | | 0.0 | 13.1 | 86.9 | |

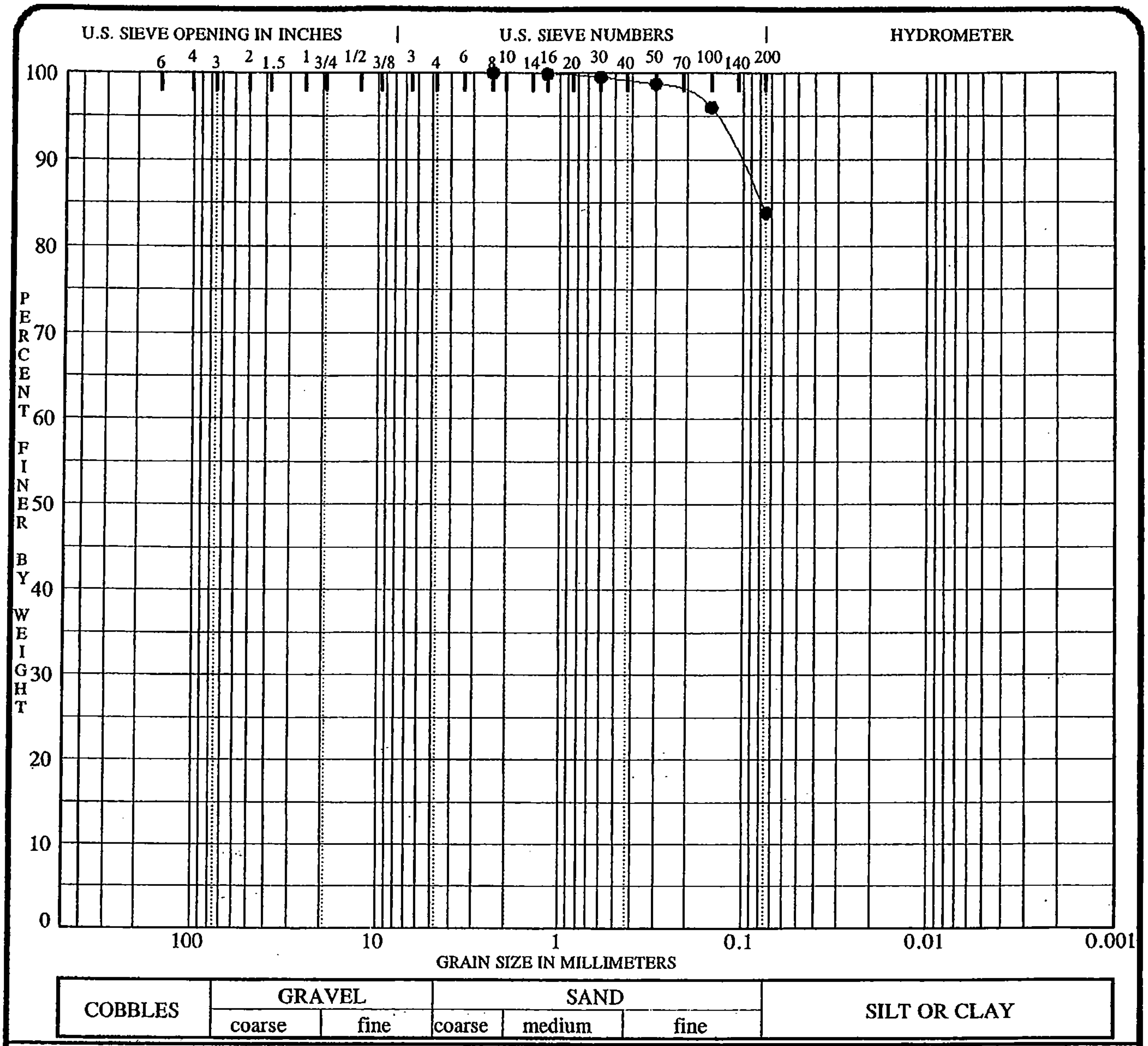
PROJECT **SPORN PLANT - FLY ASH POND DIKES**

JOB NO. ____________

DATE **05/21/97**

## GRADATION CURVES

**American Electric Power Service Corp.**
Groveport, Ohio



| Specimen Identification | | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | 96-110 | 66.6 | | 25.6 | 38.7 | 21.7 | 17.0 | | |
| | | | LEAN CLAY with SAND CL | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

| Specimen Identification | | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 96-110 | 66.6 | 2.360 | | | | 0.0 | 16.2 | 83.8 | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

PROJECT SPORN PLANT - FLY ASH POND DIKES

JOB NO.

DATE 05/21/97

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, Ohio

# APPENDIX 5

### TABLE 3.7
### COMMON PROPERTIES OF CLAY SOILS‡

| Consistency | N | Hand test | $\gamma_{sat}$,* g/cm³ | Strength† $U_c$, kg/cm² |
|---|---|---|---|---|
| Hard | >30 | Difficult to indent | >2.0 | >4.0 |
| Very stiff | 15-30 | Indented by thumbnail | 2.08-2.24 | 2.0-4.0 |
| Stiff | 8-15 | Indented by thumb | 1.92-2.08 | 1.0-2.0 |
| Medium (firm) | 4-8 | Molded by strong pressure | 1.76-1.92 | 0.5-1.0 |
| Soft | 2-4 | Molded by slight pressure | 1.60-1.76 | 0.25-0.5 |
| Very soft | <2 | Extrudes between fingers | 1.44-1.60 | 0-0.25 |

*$\gamma_{sat} = \gamma_{dry} + \gamma_w\left(\frac{e}{1+e}\right)$

†Unconfined compressive strength $U_c$ is usually taken as equal to twice the cohesion c or the undrained shear strength $s_u$. For the drained strength condition, most clays also have the additional strength parameter $\phi$, although for most normally consolidated clays $c = 0$ (Lambe and Whitman (1969)³). Typical values for $s_u$ and drained strength parameters are given in Table 3.30, Hunt (1984).¹

‡From Hunt (1984).¹ Reprinted with permission of McGraw-Hill Book Company.

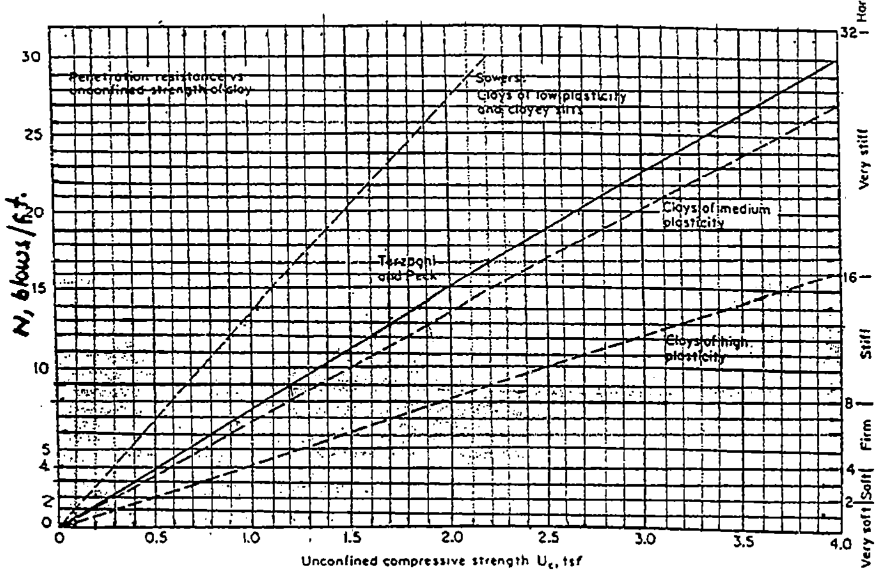


FIG. 3.35 Correlations of SPT N values with $U_c$ for cohesive soils of varying plasticities. (From NAVFAC 1971)⁴¹

### TABLE 3.5
### COMMON PROPERTIES OF COHESIONLESS SOILS**

| Material | Compactness | $D_R$, % | N* | $\gamma$ dry,† g/cm³ | Void ratio e | Strength‡ $\phi$ |
|---|---|---|---|---|---|---|
| GW: well-graded gravels, gravel-sand mixtures | Dense | 75 | 90 | 2.21 | 0.22 | 40 |
| | Medium dense | 50 | 55 | 2.08 | 0.28 | 36 |
| | Loose | 25 | <28 | 1.97 | 0.36 | 32 |
| GP: poorly graded gravels, gravel-sand mixtures | Dense | 75 | 70 | 2.04 | 0.33 | 38 |
| | Medium dense | 50 | 50 | 1.92 | 0.39 | 35 |
| | Loose | 25 | <20 | 1.83 | 0.47 | 32 |
| SW: well-graded sands, gravelly sands | Dense | 75 | 65 | 1.89 | 0.43 | 37 |
| | Medium dense | 50 | 35 | 1.79 | 0.49 | 34 |
| | Loose | 25 | <15 | 1.70 | 0.57 | 30 |
| SP: poorly graded sands, gravelly sands | Dense | 75 | 50 | 1.76 | 0.52 | 36 |
| | Medium dense | 50 | 30 | 1.67 | 0.60 | 33 |
| | Loose | 25 | <10 | 1.59 | 0.65 | 29 |
| SM: silty sands | Dense | 75 | 45 | 1.65 | 0.62 | 35 |
| | Medium dense | 50 | 25 | 1.55 | 0.74 | 32 |
| | Loose | 25 | <8 | 1.49 | 0.80 | 29 |
| ML: inorganic silts, very fine sands | Dense | 75 | 35 | 1.49 | 0.80 | 33 |
| | Medium dense | 50 | 20 | 1.41 | 0.90 | 31 |
| | Loose | 25 | <4 | 1.35 | 1.0 | 27 |

*N is blows per foot of penetration in the SPT. Adjustments for gradation are after Burmister (1962).¹⁴ See Table 6.4 for general relationships of $D_R$ vs. N.

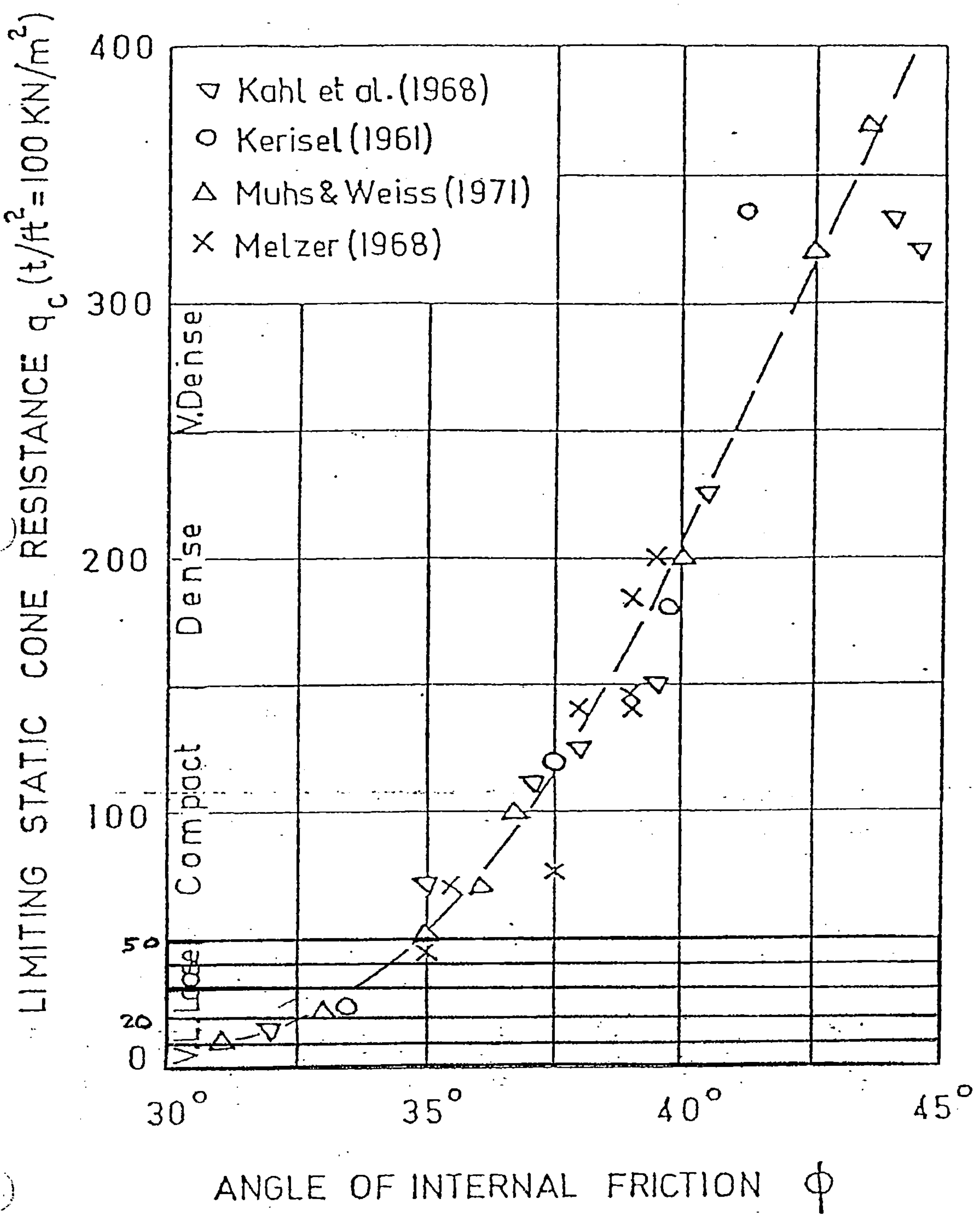
†Density given is for $G_s$ = 2.68 (quartz grains).

‡Friction angle $\phi$ depends on mineral type, normal stress, and grain angularity as well as $D_R$ and gradation (see Fig. 3.29).

**From Hunt (1984).¹ Reprinted with permission of McGraw-Hill Book Company.

"GEOTECHNICAL ENGINEERING TECHNIQUES AND PRACTICES", ROY. E. HUNT, McGRAW-HILL, INC., 1986, USA

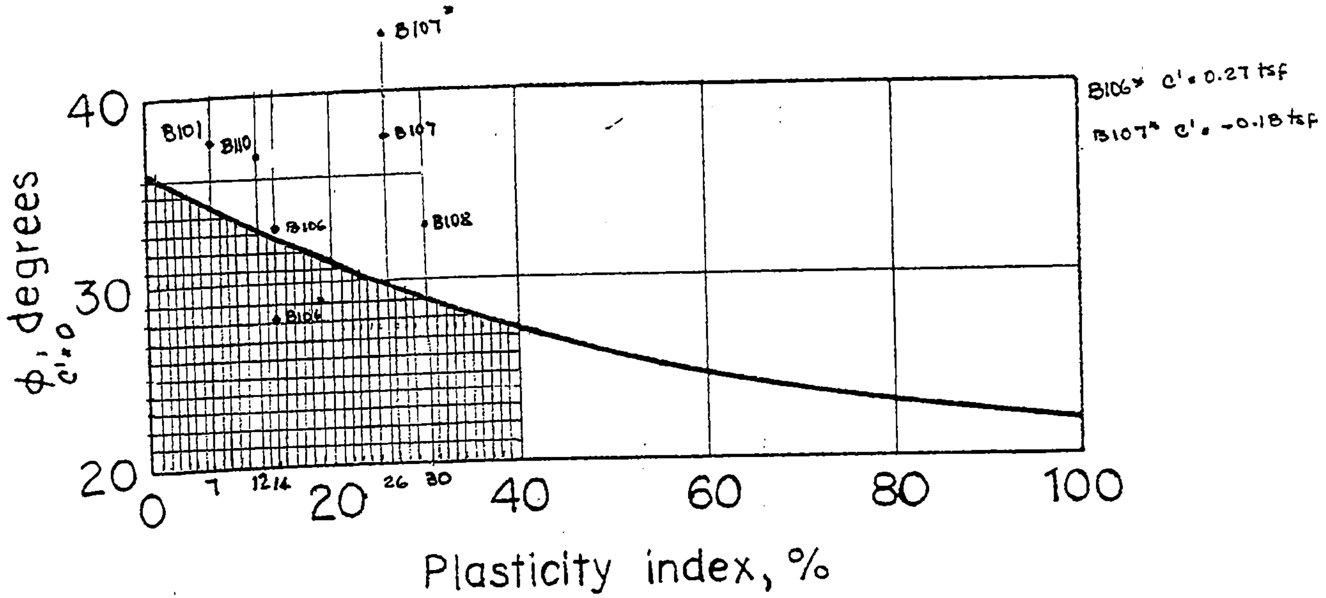
FIG. 11 APPROXIMATE RELATION BETWEEN STATIC CONE RESISTANCE AND ANGLE OF INTERNAL FRICTION OF SAND.



Meyerhof (1974)

# SPORN FLY ASH FACILITY

ACTUAL
$\phi'$ Vs. PI
(BASED ON TRIAXIAL $\overline{CU}$ TESTS)



F3.30 Approximate relationship between $\phi$ and PI clays of moderate to low sensitivity under drained Conditions. [From Terzaghi and Peck (1967).[21] Reprinted with permission of John Wiley & Sons, Inc.]

Roy E. Hunt, "Geotechnical Engineering Techniques and Practices", McGraw-Hill, Inc., 1986, USA.

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FORM GE-8 (C)

ENGINEERING DEPT.
AMERICAN ELECTRIC POWER SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

SHEET 1 OF
DATE 5/5/97 BY PJ Amaya CK.
COMPANY CENTRAL OPERATING G.O.
PLANT SPORN

SUBJECT Unit 5 Fly Ash Facility

STRENGTH PARAMETERS

NORTHERN DIKE:

BORING B-101 - ELEV. : 619.0

| DEPTH | SN | DESCRIPTION | N | γd (PCF) | STRENGTH PARAMETER | SOURCE |
|---|---|---|---|---|---|---|
| 3.0 to 4.5 | | Si. Gravelly Sand (SM)<br>Mc = 6.5% | 29 | 1.65 g/cm³ | φ = 35° | TABLE 3.5 (1) |
| 5.0 to 6.5 | | " " | 18 | 1.55 g/cm³ | φ = 32° | TABLE 3.5 (1) |
| 8.5 to 10.0 | ④ | Si, Gravelly Sand (SM)<br>Mc 10% | 9 | 1.49 g/cm³ | φ = 29° | TABLE 3.5 (1) |
| 11.5 to 13.0 | ② | Si. Gravelly Sand (SM)<br>Mc = 4.2% | 65 | 1.65 g/cm³ | φ = 35° | TABLE 3.5 (1) |
| 16.5 to 18.0 | | " " " | 45 | 1.65 g/cm³ | φ = 35° | TABLE 3.5 (1) |
| 21.5 to 23.0 | | Si. Gravelly Sand (SP-SM)<br>Mc = [illegible] | 48 | 1.65 g/cm³ | φ = 35° | TABLE 3.5 (1) |
| 26.5 to 28.0 | | Si. Gravelly Sand (SP-SM)<br>Mc = 6.8% | 43 | 1.65 g/cm³ | φ = 35° | TABLE 3.5 (1) |
| 31.5 to 33.0 | ③ | Br/Gr SiCL w SA (CL-ML) | 12 | 2.08 g/cm³ * | Uc = 0.9 tsf, φ = 34° | Fig 3.35 & 3.30 (1) |
| 33.5 to 35.5 | ① | PI = 7.0, Mc = 17% | ST | 111 | C = 1600 psf φ = 26<br>c' = 0 + φ' = 38° | TRIAXIAL TESTING PERFORMED BY H.C. NUTTING. |
| 36.5 to 38.0 | | PI = 10, Mc = 17% | 14 | 2.08 g/cm³ | Uc = 1.0 tsf ; φ = 34° | Fig. 3.35 & 3.30 (1) |
| 41.5 to 43.0 | ⑤ | Gr. Silty Sand (SM) | 11 | 1.55 g/cm³ | φ = 32° | TABLE 3.5 (1) |
| [illegible]5 to 45.5 | ⑥ | Gray Clay (CL) | ST | 86.0 | C = 750 psf φ = 15°<br>C' = 0 psf φ' = 33° | TRIAXIAL TESTING B-108 |
| 46.5 to 48.0 | | Gr. Gravelly Sand (SP) | 20 | 1.67 g/cm³ | φ = 33° | TABLE 3.5 (1) |
| | ⑦ | | | | | |

* Sam

7222(R3-84)IAP50
FORM GE-8 (C)

**ENGINEERING DEPT.**
**AMERICAN ELECTRIC POWER SERVICE CORP.**
**1 RIVERSIDE PLAZA**
**COLUMBUS, OHIO**

SHEET 2 OF
DATE 5/15/97 BY P.J. Amaya CK.
COMPANY CENTRAL OPERATING G.O.
PLANT SPORN

SUBJECT Unit 5 Fly Ash Facility

STRENGTH PARAMETERS

NORTHERN DIKE (CONTINUED)

BORING B-102 - Elev. = 619.6

| DEPTH | SN | DESCRIPTION | N | $\gamma_d$ (PCF) | STRENGTH PARAMETERS | SOURCE |
|---|---|---|---|---|---|---|
| 3.0 to 4.5 | ⑤ | Si Gravelly Sand (SM)<br>Mc = 6.5% | 35 | 1.67 g/cm³ | $\phi = 33^\circ$ | TABLE 3.5 (1) |
| 5.0 to 6.5 | | " " | 47 | 1.76 g/cm³ | $\phi = 35^\circ$ | TABLE 3.5 (1) |
| 8.5 to 10.0 | ⑦ | Si Gravelly Sand (SM)<br>Mc = 6.5% | 35 | 1.67 g/cm³ | $\phi = 33^\circ$ | TABLE 3.5 (1) |
| 11.7 to 13.2 | | " " | 60 | 1.76 g/cm³ | $\phi = 35$ | TABLE 3.5 (1) |
| 16.7 to 18.2 | ③ | Si Sandy Gravel (GP)<br>Mc = 2.8% | 47 | 1.76 g/cm³ | $\phi = 35^\circ$ | TABLE 3.5 (1) |
| 21.7 to 23.2 | | " " | 45 | 1.76 g/cm³ | $\phi = 35^\circ$ | TABLE 3.5 (1) |
| 26.7 to 28.2 | ② | SANDY SILT (ML)<br>Mc = 11.8% | 20 | 1.55 g/cm³ | $\phi = 31^\circ$ | TABLE 3.5 (1) |
| 31.7 to 33.2 | ④ | SANDY CLAY (CL)<br>PI = 9, Mc = 18.% | 9 | 1.92 g/cm³ * | $U_c$ = 0.7 ksf; $\phi = 34^\circ$ | Fig. 3.35 & 3.30 (1) |
| 33.7 to 35.7 | ① | " " " | ST | " " | C = 1600 PSF $\phi = 26^\circ$<br>C' = 0 $\phi' = 38$ | TRIAXIAL TESTING<br>— B-101 — |
| 36.7 to 38.2 | | Sandy Clay (CL)<br>PI = 8 Mc = 16% | 9 | 1.92 g/cm³ * | $U_c$ = 0.7 ksf; $\phi = 34^\circ$ | Fig. 3.35 & 3.30 (1) |
| 41.7 to 43.2 | ⑥ | GRAVELLY SAND (SP)<br>Mc = 5% | 13 | 1.59 g/cm³ | $\phi = 29^\circ$ | TABLE 3.5 (1) |
| [illegible]6.7 to 48.2 | | " " " | 36 | 1.67 g/cm³ | $\phi = 33^\circ$ | TABLE 3.5 (1) |

* SATURATED

7222(R3-84)IAP50
FORM GE-8 (C)

**ENGINEERING DEPT.**
**AMERICAN ELECTRIC POWER SERVICE CORP.**
**1 RIVERSIDE PLAZA**
**COLUMBUS, OHIO**

SHEET 1 OF
DATE 5/15/97 BY PJ Amaya CK.
COMPANY CENTRAL OPERATING G.O.
PLANT SPORN.

SUBJECT UNIT 5 FLY ASH FACILITY

STRENGTH PARAMETERS

WESTERN DIKE

BORING B-103 - Elev. - 618.

| DEPTH | SN | DESCRIPTION | N | $\gamma_d$ (pcf) | STRENGTH PARAMETER | SOURCE |
|---|---|---|---|---|---|---|
| 3.0 to 4.5 | ② | s.GRAVELLY SAND (SP)<br>Mc = 4.7% | 43 | 1.76 g/cm³ | Φ = 35° | TABLE 3.5 (1) |
| 5.0 to 6.5 | ③ | " " " | 36 | 1.67 g/cm³ | Φ = 33° | TABLE 3.5 (1) |
| 8.5 to 10.0 | | " " " | 46 | 1.76 g/cm³ | Φ = 36° | TABLE 3.5 (1) |
| 11.6 to 13.1 | | " " " | 53 | 1.76 g/cm³ | Φ = 36° | TABLE 3.5 (1) |
| 16.6 to 18.1 | | | 44 | 1.76 g/cm³ | Φ = 35° | TABLE 3.5 (1) |
| 21.6 to 23.1 | | " " " | 45 | 1.76 g/cm³ | Φ = 36° | TABLE 3.5 (1) |
| 26.6 to 28.1 | | " " " | 45 | 1.76 g/cm³ | Φ = 36° | TABLE 3.5 (1) |
| 31.6 to 33.1 | ① | Br SILTY CLAY (CL)<br>PI = 10 Mc 14.5% | 19 | 2.08 g/cm³* | Uc = 1.4 tsf, Φ = 34° | FIGURES 3.35 & 3.3 |
| 36.6 to 38.6 | ④ | Silty SAND (SM) | 5T | 1.59 g/cm³ | Φ = 29° | TABLE 3.5 (1) |
| 41.6 to 43.1 | | " Mc = 11% " | 11 | 1.59 g/cm³ | Φ = 29° | TABLE 3.5 (1) |
| 46.6 to 48.1 | | Silty SAND (SM) | 11 | 1.59 g/cm³ | Φ = 29° | TABLE 3.5 (1) |

*SATURATED

7222(R3-84)IAP50
FORM GE-8 (C)

ENGINEERING DEPT.
AMERICAN ELECTRIC POWER SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

SHEET 2 OF
DATE 5/15/97 BY PJAMoyA CK.
COMPANY CENTRAL OPERATING G.O.
PLANT SPORN.

SUBJECT Unit 5 Fly Ash Facility

STRENGTH PARAMETERS (continue)

WESTERN DIKE (continue)

BORING B-104 - ELEV. 618.7

| DEPTH | SN | DESCRIPTION | N | γd (pcf) | STRENGTH PARAMETER | SOURCE |
|---|---|---|---|---|---|---|
| 0.0 to 1.5 | ④ | Br. silty Clay (CL) | 12 | 1.92 g/cm³* | Uc 0.8 tsf ; Φ = 32° | FIGURE 3.35 (1) |
| 3.0 to 4.5 | ③ | Gravelly SAND (SP)<br>Mc = 1% | 32 | 1.67 g/cm³ | Φ = 33° | TABLE 3.5 (1) |
| 5.0 to 6.5 |  | " " " | 73 | 2.08 g/cm³ | Φ = 36° | TABLE 3.5 (1) |
| 8.5 to 10.0 |  | " Mc = 1% " | 43 | 1.97 g/cm³ | Φ = 35° | TABLE 3.5 (1) |
| 11.7 to 13.2 |  | Gravelly SAND (SP)<br>Mc = 1% | 57 | 1.76 g/cm³ | Φ = 36° | TABLE 3.5 (1) |
| 16.7 to 18.2 | ② | Gr. silty Sand (SM)<br>Mc = 4% | 47 | 1.65 g/cm³ | Φ = 35° | TABLE 3.5 (1) |
| 21.7 to 23.2 |  | " Mc = 3% " " | 46 | 1.65 g/cm³ | Φ = 35° | TABLE 3.5 (1) |
| 26.7 to 28.2 | ① | Br silty Clay (CL)<br>PI = 8 , Mc = 19% | 14 | 2.08 g/cm³* | Uc 1.0 tsf ; Φ = 34° | FIGURE 3.35 (1) |
| 31.7 to 33.7 | ⑤ | Br. silty SAND (SM)<br>Mc = 9% NP | ST | 116 | Φ = 31° | TRIAXIAL TEST<br>H.C. NUTTING COMP. |
| 36.7 to 38.2 |  | " " " | 8 | 116 | Φ = 29° | TABLE 3.5 (1) |
| 41.7 to 43.2 | ⑥ | Br. Sandy Silt (ML)<br>Mc = 8% | 11 | 116 | Φ = 27° | TABLE 3.5 (1) |
| 7 to 48.1 |  | Br. " " | ST | 116 | Φ = 27° | TABLE 3.5 (1) |

* SATURATED

7222(R3-84)IAP50
FORM GE-8 (C)

**ENGINEERING DEPT.**
**AMERICAN ELECTRIC POWER SERVICE CORP.**
**1 RIVERSIDE PLAZA**
**COLUMBUS, OHIO**

SHEET 3 OF
DATE 5/15/97 BY P.J. Amaya CK.
COMPANY Central Operating G.O.
PLANT Sporn

SUBJECT Unit 5 Fly Ash Facility

## STRENGTH PARAMETERS (CONTINUED)

WESTERN DIKE (CONTINUED)

### BORING B-105 - ELEV. = 619.3

| DEPTH | SN | DESCRIPTION | N | $\gamma_d$ (PCF) | STRENGTH PARAMETER | SOURCE |
|---|---|---|---|---|---|---|
| 3.0 to 4.5 | ④ | Si, Gravelly Sand (SM)<br>Mc 2% | 21 | 1.59 g/cm³ | Φ = 31° | TABLE 3.5 (1) |
| 5.0 to 6.5 | ③ | " " " | 37 | 1.55 g/cm³ | Φ = 35° | TABLE 3.5 (1) |
| 8.5 to 10.0 | | " " " | 32 | 1.55 g/cm³ | Φ = 34° | TABLE 3.5 (1) |
| 11.5 to 13.0 | | " " " | 35 | 1.55 g/cm³ | Φ = 34° | TABLE 3.5 (1) |
| 16.5 to 18.0 | | " Mc 3% " | 31 | 1.55 g/cm³ | Φ = 33° | TABLE 3.5 (1) |
| 21.5 to 23.0 | ② | Br, SILTY SAND (SM)<br>Mc 7. | 23 | 1.49 g/cm³ | Φ = 32° | TABLE 3.5 (1) |
| 26.5 to 28.0 | ① | Br. silty clay (CL)<br>PI = 10, Mc [illegible] | 13 | 2.08 g/cm³* | Uc = 0.95 tsf, Φ = 34° | FIGURE 3.35 (1) |
| 31.5 to 33.5 | | " " " | ST | 2.08 g/cm³* | Uc = 0.95 tsf, Φ = 34° | Figure 3.35 (1) |
| 36.5 to 38.0 | ⑤ | " " "<br>PI = 10", Mc = 22% | 8 | 1.92 g/cm³* | Uc = 0.6 tsf; Φ = 34° | Figure 3.35 (1) |
| 41.5 to 43.0 | ⑥ | Br. Silty Sand (SM)<br>Mc 12% | 9 | 1.49 g/cm³ | Φ = 29° | TABLE 3.5 (1) |
| 46.5 to 48.0 | | " " | ST | 1.49 g/cm³ | Φ = 29° | TABLE 3.5 (1) |

* SATURATED

7222(R3-84)IAP50
FORM GE-8 (C)

**ENGINEERING DEPT.**
**AMERICAN ELECTRIC POWER SERVICE CORP.**
**1 RIVERSIDE PLAZA**
**COLUMBUS, OHIO**

SHEET 1 OF
DATE 5/16/97 BY PJ Amaya CK.
COMPANY CENTRAL OPERATING G.O.
PLANT SPORN PLANT

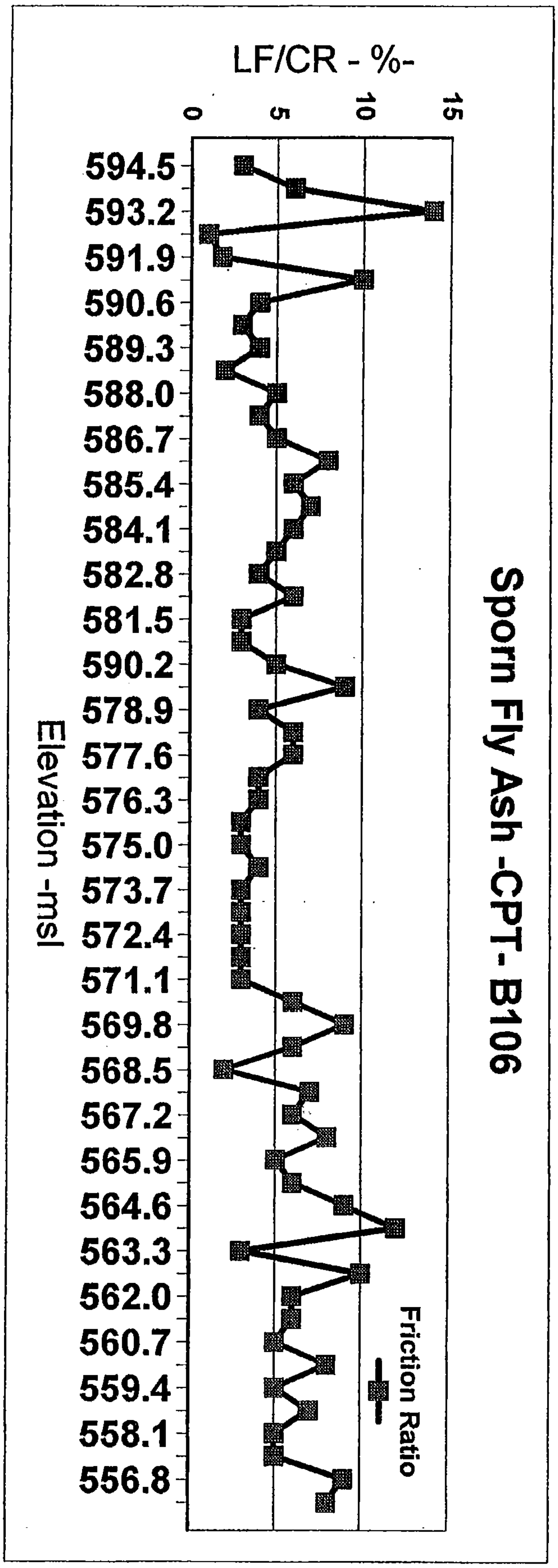
SUBJECT UNIT 5 FLY ASH FACILITY

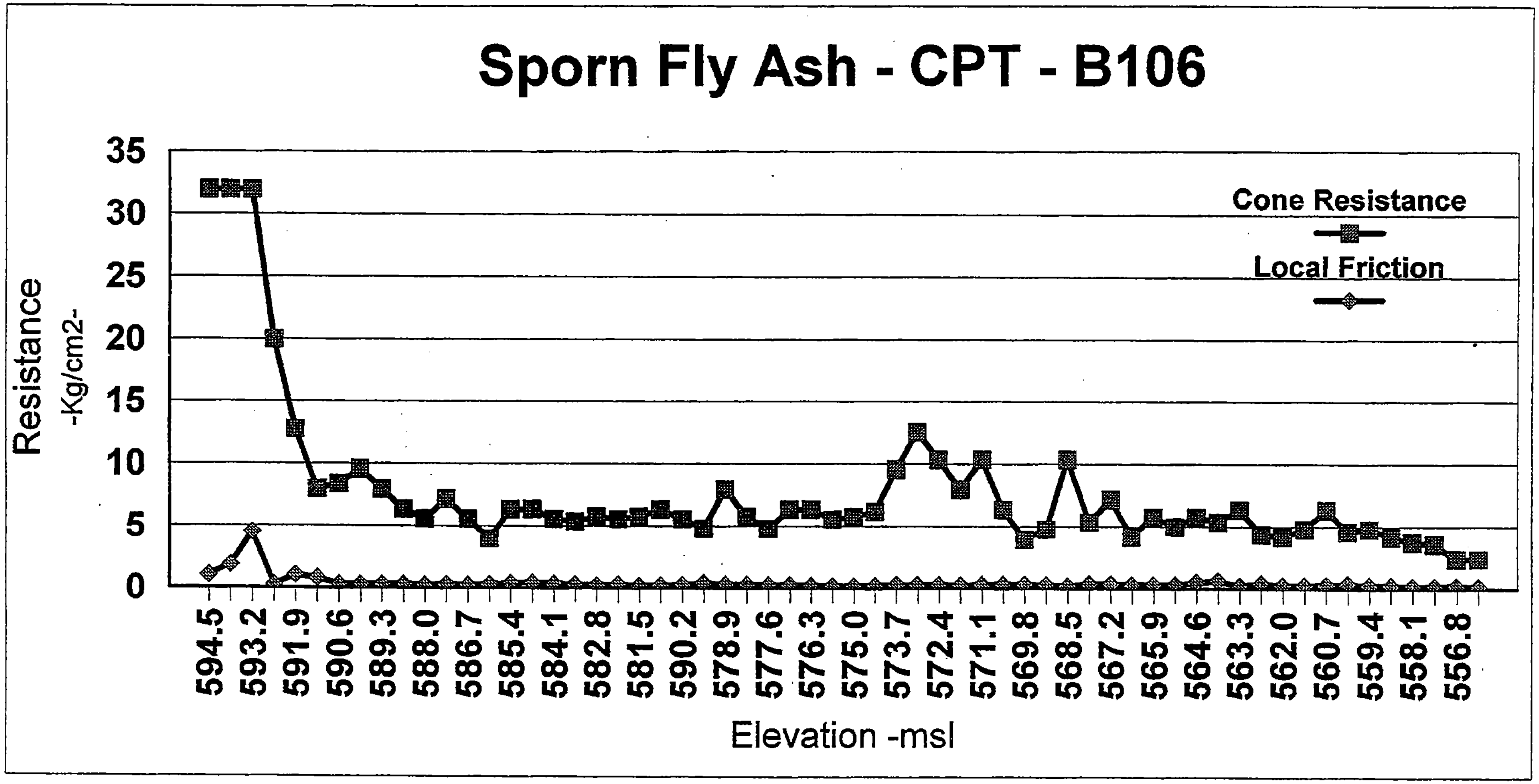
STRENGTH PARAMETERS

SOUTHERN DIKE:

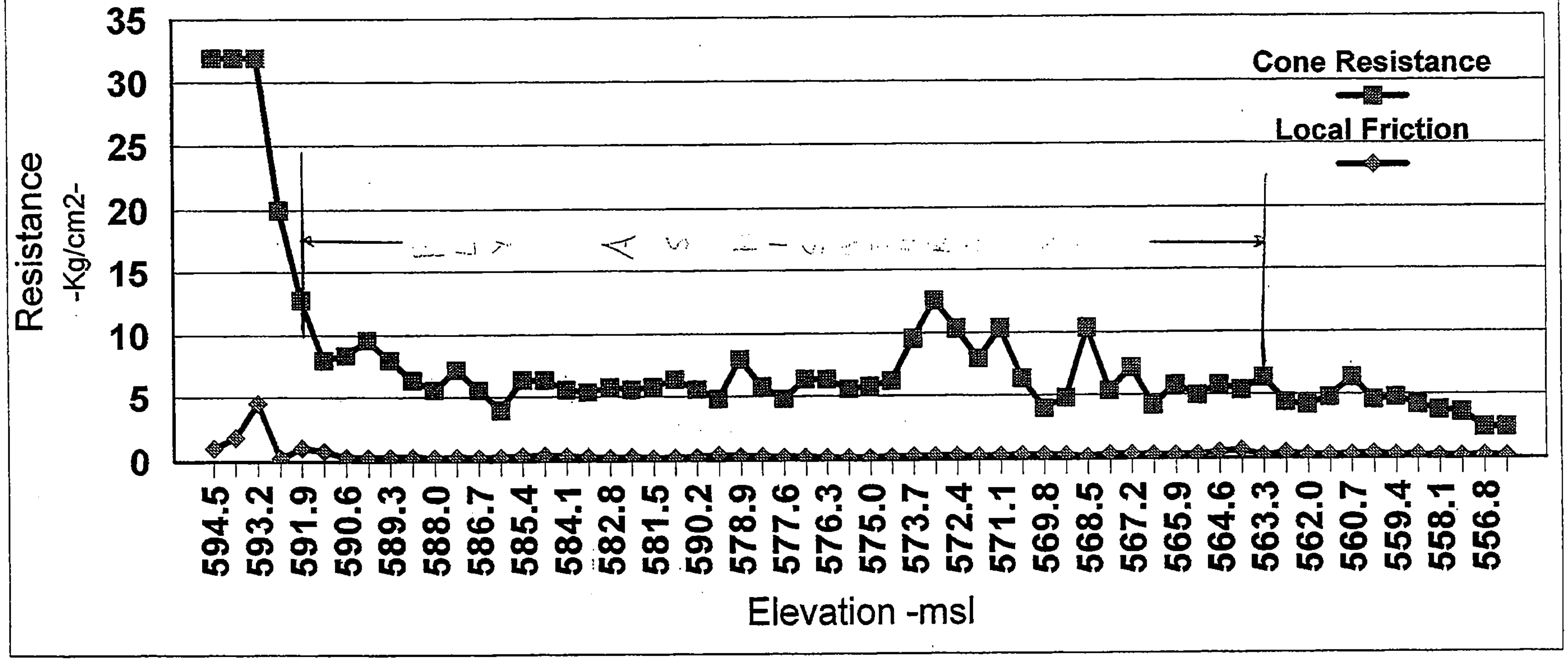
BORING B-106 - ELEV.=618.9.

| DEPTH | SN | DESCRIPTION | N | $\gamma_d$ (PCF) | STRENGTH PARAMETERS | SOURCE |
|---|---|---|---|---|---|---|
| 3.0 to 4.5 | ⑤ | Gravelly silty sand (SM) | 38 | 1.55 g/cm³ | $\phi = 33°$ | TABLE 3.5 (1) |
| | | " " " | | | | |
| 5.0 to 6.5 | | " " " | 54 | 1.65 g/cm³ | $\phi = 35°$ | TABLE 3.5 (1) |
| 8.5 to 10. | ④ | " " " | 37 | 1.55 g/cm³ | $\phi = 33°$ | TABLE 3.5 (1) |
| 11.5 to 13. | ⑥ | " Mc = 6% " " | 25 | 1.55 g/cm³ | $\phi = 32°$ | TABLE 3.5 (1) |
| 16.5 to 18. | | " " " | 32 | 1.55 g/cm³ | $\phi = 33°$ | TABLE 3.5 (1) |
| 21.5 to 23. | ③ | SANDY CLAY (CL) | 18 | 2.08 g/cm³* | $U_c$ = 1.3 tsf, $\phi = 34°$ | FIGURE 3.35 (1) |
| | | PI = 9, Mc = 11% | | | | |
| 26.5 to 28. | | FLY ASH (ML) | 12 | 74 | $\phi = 29°$ | TABLE 3.5 (1) |
| | | Mc = 4% | | | | |
| 31.5 to 33 | | " " " | 2 | 74 | $\phi = 27°$ | TABLE 3.5 (1) |
| | ② | SG = 2.29 Mc = 43% | | | | |
| 36.5 to 38 | | " " " | 2 | 74 | $\phi = 27°$ | TABLE 3.5 (1) |
| 41.5 to 43 | | " " " | 2 | 74 | $\phi = 27°$ | TABLE 3.5 (1) |
| 46.5 to 48. | | " " " | 4 | 74 | $\phi = 27°$ | TABLE 3.5 (1) |
| [illegible].5 to 53.0 | | SG = 2.42 Mc = 36% | 4 | 74 | $\phi = 27°$ | TABLE 3.5 (1) |
| 56.5 to 58 | | GRAY SILTY CLAY (CL) | 8 | 1.92 g/cm³* | $U_c$ = 1.0 tsf, $\phi = 32°$ | FIGURE 3.35 (1) |
| | ⑦ | PI = 18 Mc = 32% | | | C = 1200 psf $\phi = 9°$ | TRIAXIAL TEST |
| 61.5 to 63.5 | ① | PI = 74 Mc = 26% | ST | 98 | $c' = 0$ ; $\phi' = 32°$ | [illegible] |


Sporn Fly Ash -CPT- B106
LF/CR - %-
0
5
10
15
Friction Ratio
Elevation -msl
594.5
593.2
591.9
590.6
589.3
588.0
586.7
585.4
584.1
582.8
581.5
590.2
578.9
577.6
576.3
575.0
573.7
572.4
571.1
569.8
568.5
567.2
565.9
564.6
563.3
562.0
560.7
559.4
558.1
556.8


Sporn Fly Ash - CPT - B106
Cone Resistance
Local Friction
Resistance
-Kg/cm2-
35
30
25
20
15
10
5
0
594.5
593.2
591.9
590.6
589.3
588.0
586.7
585.4
584.1
582.8
581.5
590.2
578.9
577.6
576.3
575.0
573.7
572.4
571.1
569.8
568.5
567.2
565.9
564.6
563.3
562.0
560.7
559.4
558.1
556.8
Elevation -msl

# Sporn Fly Ash - CPT - B106



7222(R3-84)IAP50
FORM GE-8 (C)

**ENGINEERING DEPT.**
**AMERICAN ELECTRIC POWER SERVICE CORP.**
**1 RIVERSIDE PLAZA**
**COLUMBUS, OHIO**

SHEET 1 OF
DATE 5/5/97 BY PJAmalgu CK.
COMPANY Central Operating G.O.
PLANT Sporn

SUBJECT Unit 5 Fly Ash Facility

# STRENGTH PARAMETERS.

## EASTERN DIKE:

BORING B-107 - Elev. = 618.8.

| DEptH(ft) | | DESCRIPTION | N | $\gamma_d$ (pcf) | STRENGTH PARAMETER | SOURCE. |
|---|---|---|---|---|---|---|
| 3.0 to 4.5 | ② | Gr. silty Sand (SP) | 38 | 1.67 g/cm³ | φ = 33° | TABLE 3.5 (1) |
| 5.0 to 6.5 | ③ | Sand and Gravel | 49 | 1.76 g/cm³ | φ = 36° | TABLE 3.5 (1) |
| 8.5 to 10. | | " " | 42 | 1.74 g/cm³ | φ = 35° | TABLE 3.5 (1) |
| 11.6 to 13.1 | | Mc = 8% " | 37 | 1.83 g/cm³ | φ = 33° | TABLE 3.5 (1) |
| 16.6 to 18.1 | ① | Silty clay (CL)<br>PI = 7, Mc = 14% | 18 | 2.08 g/cm³ * | Uc = 1.3 tsf ; φ' = 34° | Fig. 3.[illegible] (1) |
| 21.6 to 23.1 | ⑨ | Sandy Silt (ML)<br>Mc = 11% | 19 | 1.41 g/cm³ | φ = 31° | TABLE 3.5 (1) |
| 26.6 to 28.1 | ⑧ | Gray Fly Ash (ML) | 14 | 74.3 | φ = 30° | TABLE 3.5 (1) |
| 31.6 to 33.1 | | " " | 19 | 74.3 | φ = 31° | TABLE 3.5 (1) |
| 36.6 to 38.1 | | " "<br>SG = 2.28 Mc = 38% | 2 | 74.3 | φ = 27° | TABLE 3.5 (1) |
| 41.6 to 43.1 | | " " | 2 | 74.3 | φ = 27° | TABLE 3.5 (1) |
| 46.6 to 48.1 | | " " | 2 | 74.3 | φ = 27° | TABLE 3.5 (1) |
| 51.6 to 53.1 | | " " | 2 | 74.3 | φ = 27° | TABLE 3.5 (1) |
| 56.6 to 58.1 | | SG = 2.31 Mc = 32% | 0 | 74.3 | φ = 27° | TABLE 3.5 (1) |
| 61.6 to 73.1 | ⑪ | PI = 20 Mc = 25% | 17 - 13 | 97.3 | Uc = 1.7 tsf; φ' = 30° | Fig. 3.35 & 3.30 (1)<br>PEAK STRENGTH |

**ENGINEERING DEPT.**
**AMERICAN ELECTRIC POWER SERVICE CORP.**
**1 RIVERSIDE PLAZA**
**COLUMBUS, OHIO**

SHEET 2 OF

DATE 5/5/97 BY PJ Amaya CK.

COMPANY Central Operating G.O.

PLANT Sporn.

SUBJECT Unit 5 Fly Ash Facility

STRENGTH PARAMETERS (CONTINUED)

BORING B-108 – EL. 603.4

| DEPTH | SN | DESCRIPTION | N | $\gamma_d$ (pcf) | STRENGTH PARAMETERS | SOURCE |
|---|---|---|---|---|---|---|
| 3.0 TO 4.5 | ④ | BOTTOM ASH (SM)<br>Mc = 9% | 31 | 56.0 | $\phi = 32°$ | TABLE 3.5 (1) |
| 5.0 to 6.5 | | " " | 38 | 60.5 | $\phi = 34°$ | TABLE 3.5 (1) |
| 8.5 to 10.0 | ⑤ | silty sand (sm)<br>Mc = 6.1% | 45 | 1.65 g/cm³ | $\phi = 35°$ | TABLE 3.5 (1) |
| 11.6 to 13.1 | | Gr. silty Sand (SM)<br>Mc = 3% | 40 | 1.55 g/cm³ | $\phi = 34°$ | TABLE 3.5 (1) |
| 16.6 to 18.1 | | Gr. silty Sand (SM)<br>Mc = 2% | 45 | 1.65 g/cm³ | $\phi = 3$[illegible] | TABLE 3.5 (1) |
| 21.6 to 23.1 | ⑥ | Sa, Silty Clay (CL)<br>PI = 7 Mc [illegible] | 14 | 2.06 g/cm³ | Uc 1.0 tsf $\phi$ 34° | Fig. 3.3 & 3.20 (1) |
| 26.6 to 28.1 | ⑦<br>⑧ | Bottom Ash (SM) | 8 | 52.2 | $\phi = 29°$ | TABLE 3.5 (1) |
| 31.6 to 33.1 | | Gray Fly Ash (ML)<br>Mc = 4% | 3 | 74.3 | $\phi = 27°$ | TABLE 3.5 (1) |
| 36.6 to 38.1 | | " " | 2 | 74.3 | $\phi = 27°$ | TABLE 3.5 (1) |
| 41.6 to 53.1 | ⑩ | PI = 15 Mc = 23<br>Gray Clay (CL)<br>PI = 30, Mc = 37% | 5-12<br>ST | 86.0 | Uc 0.7 [illegible] $\phi$ = 32°<br>C = 750 psf $\phi$ = 15°<br>C' = 0 psf $\phi'$ = 33° | Fig. 3.3 & 3.5 (1)<br>PEAK STRENGTH<br>H.C. NUTTING Co.<br>TRIAXIAL TESTING |
| 56.6 to 73.1 | ⑫ | Gray Silty Clay (CL)<br>PI 15, Mc 25 | ST *<br>5-11 | 94.2 | C = 100 psf $\phi$ = 17°<br>C' = 0 psf $\phi'$ = 37°<br>Uc [illegible] $\phi$ [illegible] | * TRIAXIAL TESTING<br>– B-110 –<br>Fig. 3.3 & 3.5 |

* - Unsaturated.

7222(R3-84)IAP50
FORM GE-8 (C)

**ENGINEERING DEPT.**
**AMERICAN ELECTRIC POWER SERVICE CORP.**
**1 RIVERSIDE PLAZA**
**COLUMBUS, OHIO**

SHEET 3 OF
DATE 5/5/97 BY P. J. Amaya CK.
COMPANY Central Operating G.O.
PLANT Sporn

SUBJECT Unit 5 Fly Ash Facility

## STRENGTH PARAMETERS (CONTINUED)

### BORING B-109 - ELEV. = 619.6

| DEPTH | SN | DESCRIPTION | N | γd (pcf) | STRENGTH PARAMETER | SOURCE |
|---|---|---|---|---|---|---|
| 3.0 to 4.5 | ② | Gr[illegible] Silty Sand (SP) | 43 | 1.76 g/cm³ | φ = 35° | TABLE 3.5 (1) |
| 5.0 to 6.5 | ③ | " " | 39 | 1.76 g/cm³ | φ = 34° | TABLE 3.5 (1) |
| 8.5 to 10.0 | | " Mc = 1[illegible]% " | 39 | 1.76 g/cm³ | φ = 34° | TABLE 3.5 (1) |
| | ④ | | | | | |
| 11.7 to 13.2 | | SC SAND (SM)<br>Mc = 4% | 27 | 1.55 g/cm³ | φ = 32° | Table 3.5 (1) |
| 16.7 to 18.2 | ① | Sandy Silty Clay (CL)<br>Mc = 9% | 11 | 1.92 g/cm³* | Uc = 0.8 tsf ; φ' = 36° | Fig. 3.35 & 3.30 ( |
| 21.7 to 23.2 | | " PI = 6 " | 14 | 2.08 g/cm³ | Uc = 1.0 tsf ; φ' = [illegible] | Fig. 3.3[illegible] & 3.[illegible] |
| 26.7 to 28.7 | ⑪ | Gray Fly Ash (ML)<br>Mc = 4% | ST | 74.3 | φ = 3[illegible] | 1+ C. MUTTING Comp. TESTING. & TABLE 3.5 |
| 31.7 to 33.2 | | " " | 17 | 74.3 | φ = 30° | TABLE 3.5 (1) |
| 36.7 to 38.2 | | SG = 2.39"<br>Mc = 38% | 2 | 74.3 | φ = 27° | TABLE 3.5 (1) |
| 41.7 to 43.2 | | " " | 2 | 74.3 | φ = 27° | TABLE 3.5 (1) |
| 46.7 to 48.2 | | " " | 4 | 74.3 | φ = 27° | TABLE 3.5 (1) |
| 51.7 to 66.7 | | " " | 3 | 74.3 | φ = 27° | TABLE 3.5 (1) |
| 56.7 to 58.2 | | SG = [illegible] "<br>[illegible] | 5 | 74.3 | φ = 27° | TABLE 3.5 (1) |
| 61.7 to 73.2 | 12 | Brown Clay (CL)<br>[illegible] = 13%, Mc = [illegible]% | ST<br>9-14 | 97.3 | c = 700 psf φ = 17°<br>c' = 0 φ' = 39° | TRIAXIAL TESTING<br>= B-107 — |

7222(R3-84)IAP50
FORM GE-8 (C)

**ENGINEERING DEPT.**
**AMERICAN ELECTRIC POWER SERVICE CORP.**
**1 RIVERSIDE PLAZA**
**COLUMBUS, OHIO**

SHEET 4 OF
DATE 5/5/97 BY P.J. Amaya CK.
COMPANY Central Operating G.O.
PLANT Sporn

SUBJECT Unit 5 Fly Ash Facility

## STRENGTH PARAMETERS (CONTINUED)

### BORING B-110 - ELEV: 602.3

| DEPTH | SN | DESCRIPTION | N | $\gamma_d$ (PCF) | STRENGTH PARAMETERS | SOURCE |
|---|---|---|---|---|---|---|
| 3.0 to 4.5 | ⑤ | BOTTOM ASH (SM) | 42 | 60.5 | $\phi = 35°$ | TABLE 3.5 (1) |
| 5.0 to 6.5 | | " Mc ? " | 25 | 56.0 | $\phi = 32°$ | TABLE 3.5 (1) |
| 8.5 to 10.0 | ⑥ | SAND & GRAVEL (GP)<br>Mc 11% | 16 | 1.83 g/cm³ | $\phi = 32°$ | TABLE 3.5 (1) |
| 11.6 to 13.1 | | " " | 17 | 1.83 g/cm³ | $\phi = 32°$ | TABLE 3.5 (1) |
| 16.6 to 18.1 | ⑨ | Sandy silty clay (CL)<br>PI = 8, Mc 12% | 20 | 2.08 g/cm³* | Uc = 1.5 tsf; $\phi = 31°$ | Fig. 3.35 & 3.30 |
| 18.6 to 20.1 | | Sandy silty Clay (CL)<br>PI = 7, Mc = 12% | 23 | 2.08 g/cm³* | Uc = 1.7 tsf; $\phi = 31°$ | Fig. 3.35 & 3.30(1 |
| 21.6 to 23.1 | | " " | 18 | 2.08 g/cm³* | Uc = 1.3 tsf; $\phi = 31$ | Fig. 3.35 & 3.30( |
| 26.6 to 28.1 | | " " | 18 | 2.08 g/cm³* | Uc = 1.3 tsf; $\phi = 31$ | Fig. 3.35 & 3.30( |
| 31.6 to 33.1 | ⑩ | REDISH Br. Clay (CL)<br>PI = 12, Mc = 15% | 19 | 2.08 g/cm³* | Uc = 1.4 tsf; $\phi = 33°$ | Fig. 3.35 & 3.30(1) |
| 36.6 to 50.0 | ⑦ | GRAY CLAY (CL)<br>PI = 15, Mc = 25% | ST<br>8 & 12 | 86.0 | Uc = 1.2 tsf; $\phi$ =<br>C = 750 psf $\phi = 15°$<br>C' = 0 $\phi' = 33°$ | Fig. 3.35 & 3.30(<br>TRIAXIAL TESTING<br>— B108 — |
| 51.6 to 73.1 | ⑧ | Gray Silty Clay (CL)<br>PI = 12, Mc 28%<br>PI = 17, Mc = 24%<br>PI = 17, Mc = 26% | ST.<br>9 to 14 | 94.2 | C = 100 psf $\phi = 17°$<br>C' = 0 $\phi' = 37°$<br>Uc = 1.2 tsf; $\phi = 31°$ | PEAK STRENGTH H.C. NUTTING CO.<br>TRIAXIAL TESTING<br>Fig. 3.35 & 3.30(1 |
| | 13 | | | | | |

*SATURATED

7222(R3-84)IAP50
FORM GE-8 (C)

**ENGINEERING DEPT.**
**AMERICAN ELECTRIC POWER SERVICE CORP.**
**1 RIVERSIDE PLAZA**
**COLUMBUS, OHIO**

SHEET 1 OF
DATE 5/6/97 BY P J Amaya CK.
COMPANY CENTRAL OPERATING G.O.
PLANT SPORN

SUBJECT Unit 5 Fly Ash Facility

## STRENGTH PARAMETERS

## BORING SI-3 (1988)

• 10 FEET REPLACED WITH REINFORCED BOTTOM ASH – 1995

• UNDERDRAIN PLACED ON THE SANDY SILT soil – 1995

| DEPTH | SN | DESCRIPTION | N | $\gamma_d$ (PCF) | STRENGTH PARAMETERS | SOURCE |
|---|---|---|---|---|---|---|
| 3.0 to 4.5 | ⑤ | Silty Sand (SM) | 30 | 1.55 g/cm² | ϕ.32° | TABLE 3.5 (1) |
| 8.0 to 9.5 | | Gravelly Sand (SP) | 7 | 1.59 g/cm³ | ϕ = 29° | TABLE 3.5 (1) |
| 13.0 to 14.5 | | Silty Sand Gravel (GP | 9 | 1.97 g/cm³ | ϕ = 32° | TABLE 3.5 (1) |
| 18.0 to 19.5 | ⑥ | Sandy silt (ML) | 23 | 1.41 g/cm³ | ϕ. 31 | TABLE 3.5 (1) |
| 23.0 to 24.5 | | " " " | 14 | 1.41 g/cm³ | ϕ = 31° | TABLE 3.5 (1) |
| 28.0 to 29.5 | | " " " | 17 | 1.41 g/cm³ | ϕ = 31° | TABLE 3.5 (1) |
| 33.0 to 34.5 | ⑦ | Brown Si Clay | 20 | 2.08 g/cm³ * | Uc 1.4 tsf; ϕ.33° | B-110 (31.6 - 33) |
| 38.0 to 39.5 | ⑧ | Organic Silty Clay | 17 | 2.08 g/cm³ * | Uc 1.2 tsf; ϕ = 32° | B-110 (36.6 - 50) |
| 43.0 to 49.0 | ⑨ | Gray Clay | 9 | 1.92 g/cm³ * | c' = 0 ϕ' = 33° | B-110 (36.6 - 50) |
| 53.0 to 54.5 | ⑫ | Silty Sand & Gravel (GW) | >50 | 2.08 g/cm³ | ϕ = 36° | TABLE 3.5 (1) |
| 58.0 to 59.5 | | " " " | 55 | 2.08 g/cm³ | ϕ = 36° | TABLE 3.5 (1) |
| 63 to 64.5 | | Sand & Gravel (GP) | 53 | 1.92 g/cm³ | ϕ = 35° | TABLE 3.5 (1) |
| 8 to 69.5 | | " " " | 24 | 1.83 g/cm³ | ϕ = 32° | TABLE 3.5 (1) |
| 73.0 to 74.5 | | Silty Sand (SM) | 29 | 1.55 g/cm³ | ϕ = 32° | TABLE 3.5 (1) |
| 78 to 89.5 | | Sand (SP) | 27 | 1.67 g/cm³ | ϕ = 33° | TABLE 3.5 (1) |

7222(R3-84)IAP50
FORM GE-8 (C)

**ENGINEERING DEPT.**
**AMERICAN ELECTRIC POWER SERVICE CORP.**
**1 RIVERSIDE PLAZA**
**COLUMBUS, OHIO**

SHEET 2 OF
DATE 5/6/97 BY PJ Amage CK
COMPANY CENTRAL OPERATING G.O.
PLANT SPORN

**SUBJECT** Unit 5 Fly Ash Facility

STRENGTH PARAMETERS (CONTINUED)

Boring 9301 (1993)

| DEPTH | SN | DESCRIPTION | N | $\gamma_d$ (pcf) | STRENGTH PARAMETERS | SOURCES |
|---|---|---|---|---|---|---|
| 0.0 to 1.5 | ① | Silty Clay (cl) | 7 | 1.92 g/cm³ * | $U_c$ = 1.1 tsf ; $\phi$ = 30° | TABLE 3.35 (1) |
| 1.5 to 3.0 | | SANDY Clay (?L) | 30 | 2.24 g/cm³ * | $U_c$ = 4.0 tsf ; $\phi$ = 30° | TABLE 3.35 (1) |
| 3.0 to 4.5 | ④ | BOTTOM ASH (SM) | 25 | 52.2 | $\phi$ = 32° | TABLE 3.5 (1) |
| 4.5 to 6.0 | ⑪ | GRAY Fly ASH (ML) | 42 | 74.3 | $\phi$ = 33° | TABLE 3.5 (1) |
| 6.0 to 7.5 | | " " " | 38 | 74.3 | $\phi$ = 33° | TABLE 3.5 (1) |
| 7.5 to 9.0 | | " " " | 36 | 74.3 | $\phi$ = 33° | TABLE 3.5 (1) |
| 9.0 to 10.5 | | " " " | 29 | 74.3 | $\phi$ = 33° | TABLE 3.5 (1) |
| 10.5 to 12.0 | | " " " | 21 | 74.3 | $\phi$ = 31° | TABLE 3.5 (1) |
| 12.0 to 13.5 | | " " " | 25 | 74.3 | $\phi$ = 31° | TABLE 3.5 (1) |
| 13.5 to 15.0 | | " " " | 16 | 74.3 | $\phi$ = 31° | TABLE 3.5 (1) |
| 15.0 to 16.5 | | " " " | 6 | 74.3 | $\phi$ = 27° | TABLE 3.5 (1) |
| 16.5 to 18.0 | | " " " | 2 | 74.3 | $\phi$ = 27° | TABLE 3.5 (1) |
| [illegible].0 to 19.5 | | " " " | 0 | 74.3 | $\phi$ = 27° | TABLE 3.5 (1) |
| 19.5 to 21.0 | | " " " | 5 | 74.3 | $\phi$ = 27° | TABLE 3.5 (1) |
| 21.0 to 22.5 | | [illegible] | 15 | 1.83 [illegible] | $\phi$ = 3[illegible] | TABLE 3.5 (1) |

7222(R3-84)IAP50
FORM GE-8 (C)

ENGINEERING DEPT.
AMERICAN ELECTRIC POWER SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

SHEET 3 OF
DATE 5/7/97 BY PJ Amaya CK.
COMPANY Central Operating G.O.
PLANT Sporn.

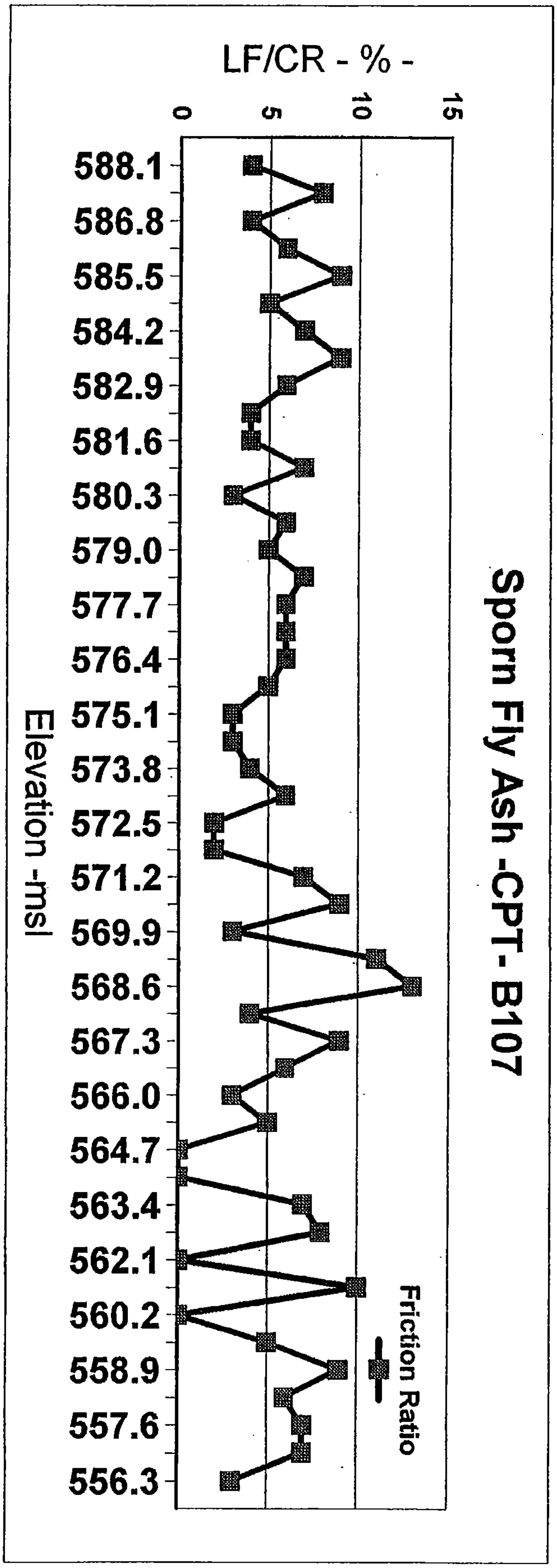
SUBJECT Unit 5 Fly Ash Facility

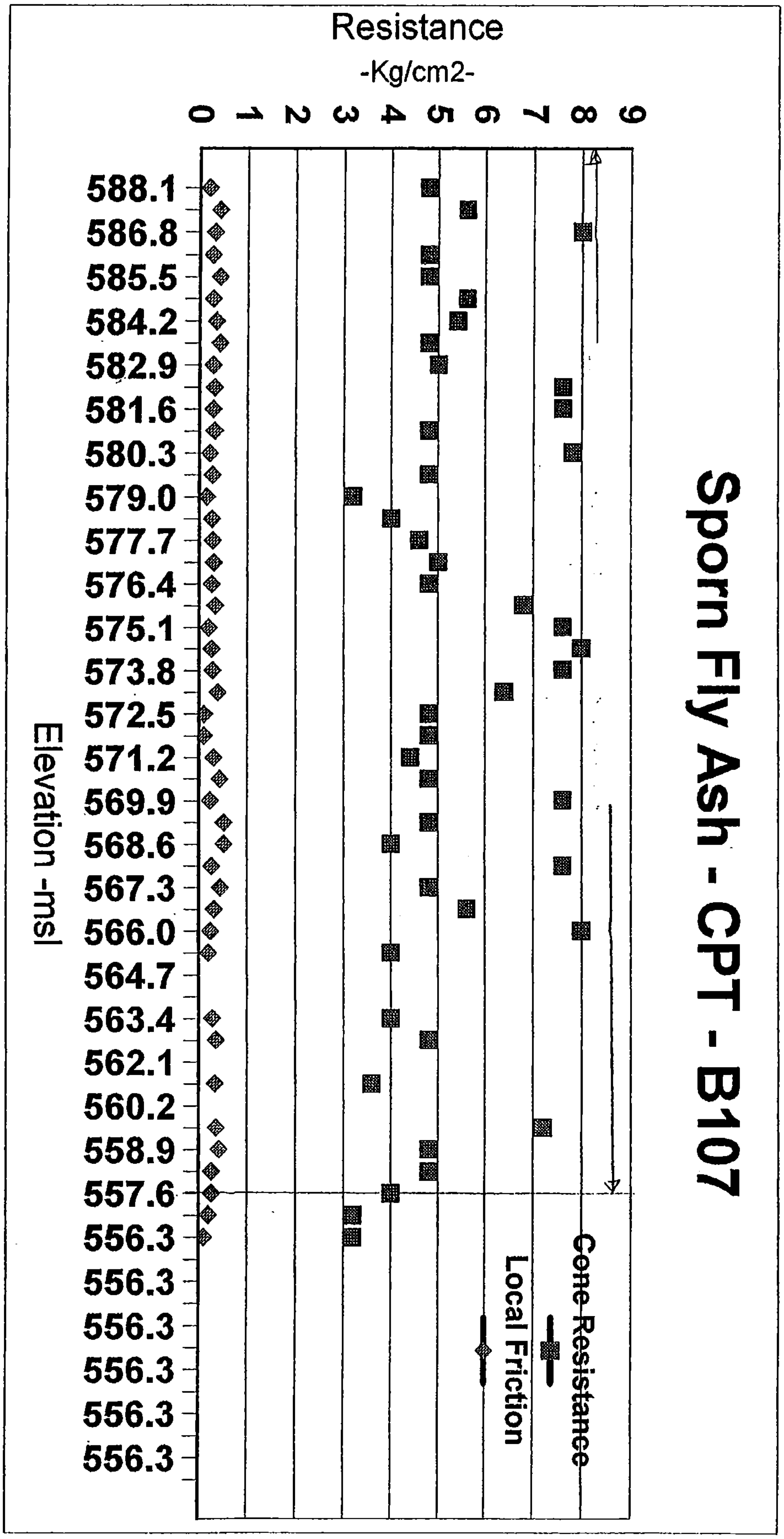
STRENGTH PARAMETERS (CONTINUED)

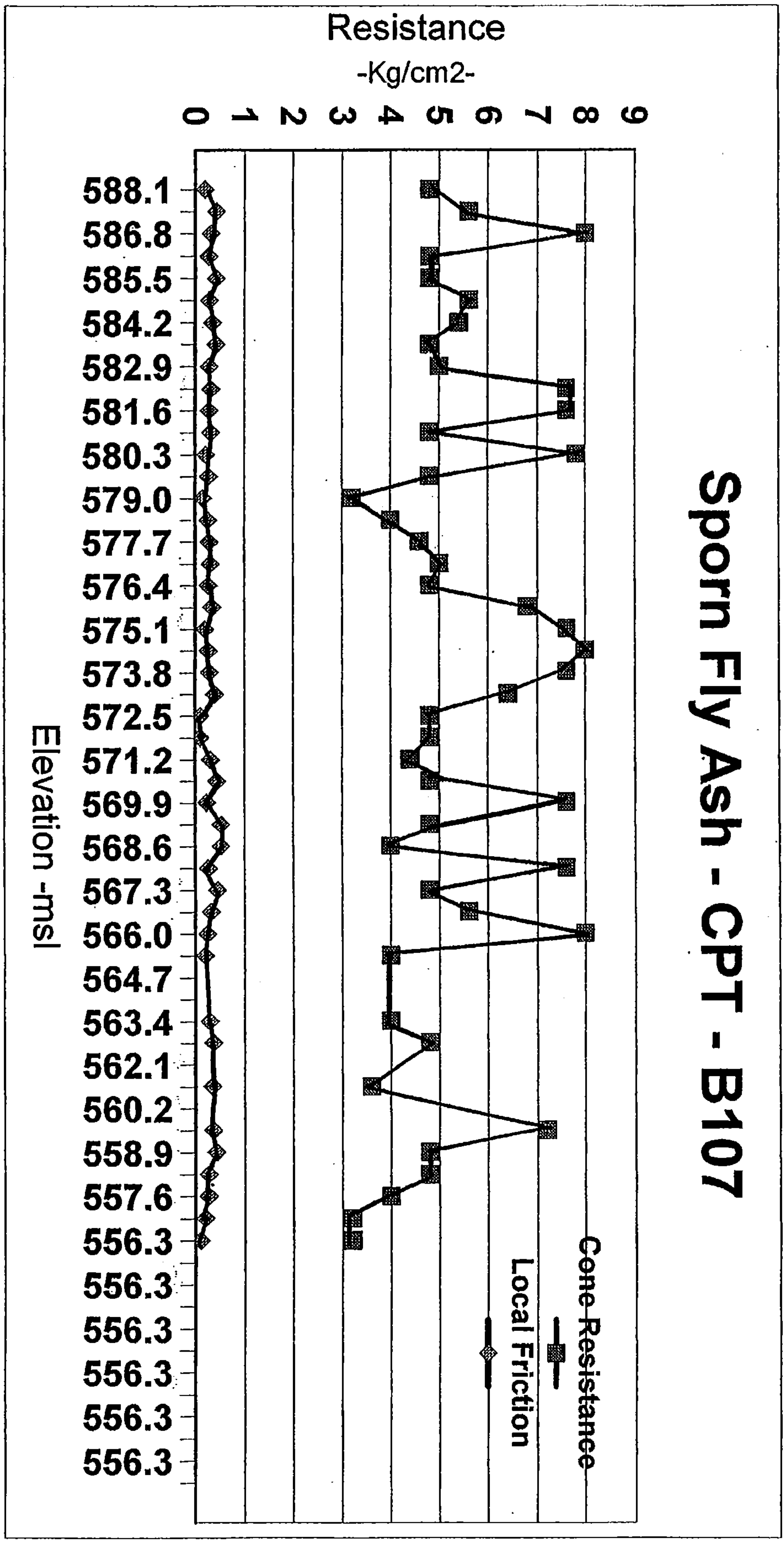
BORING 9301 (Continued)

| DEPTH | SU | DESCRIPTION | N | $\gamma_d$ (pcf) | STRENGTH PARAMETERS | SOURCE |
|---|---|---|---|---|---|---|
| 22.5 to 24.0 | ⑩ | Sandy silty clay (CL) | 11 | 1.92 g/cm$^3$ * | $U_c$ = 0.6; $\phi'$ = 34° | B-110 (21.6-23.6 |
| 24.0 to 27.5 | | Brown silty clay (CL) | 20 | 2.08 g/cm$^3$ * | $U_c$ 1.4 tsf ; $\phi'$ 33° | B-110 |
| 27.5 to 31.0 | | " " " | 14 | 2.08 g/cm$^3$ * | $U_c$ 1.0 tsf ; $\phi'$ 32° | B-110 |
| 31.0 to 34.5 | | " " " | 16 | 2.08 g/cm$^3$ * | $U_c$ 1.7 tsf ; $\phi'$ 32° | B-110 |
| 34.5 to 38.0 | | " " " | 16 | 2.08 g/cm$^3$ * | $U_c$ 1.2 tsf ; $\phi$ 32° | B-110 |
| 38.0 to 41.5 | | " " " | 15 | 2.08 g/cm$^3$ * | $U_c$ 1.1 tsf ; $\phi$ 32° | B-110 |
| 41.5 to 45 | ⑨ | gray clay (CL) | 10 | 1.92 g/cm$^3$ * | $U_c$ = 0.75 tsf ; $\phi$ = 33° | TABLE 3.3 |
| 45.0 to 46.5 | ⑫ | Sand & Gravel (GP) | 7 | 1.83 g/cm$^3$ | $\phi$ = 32° | TABLE 3.5 |

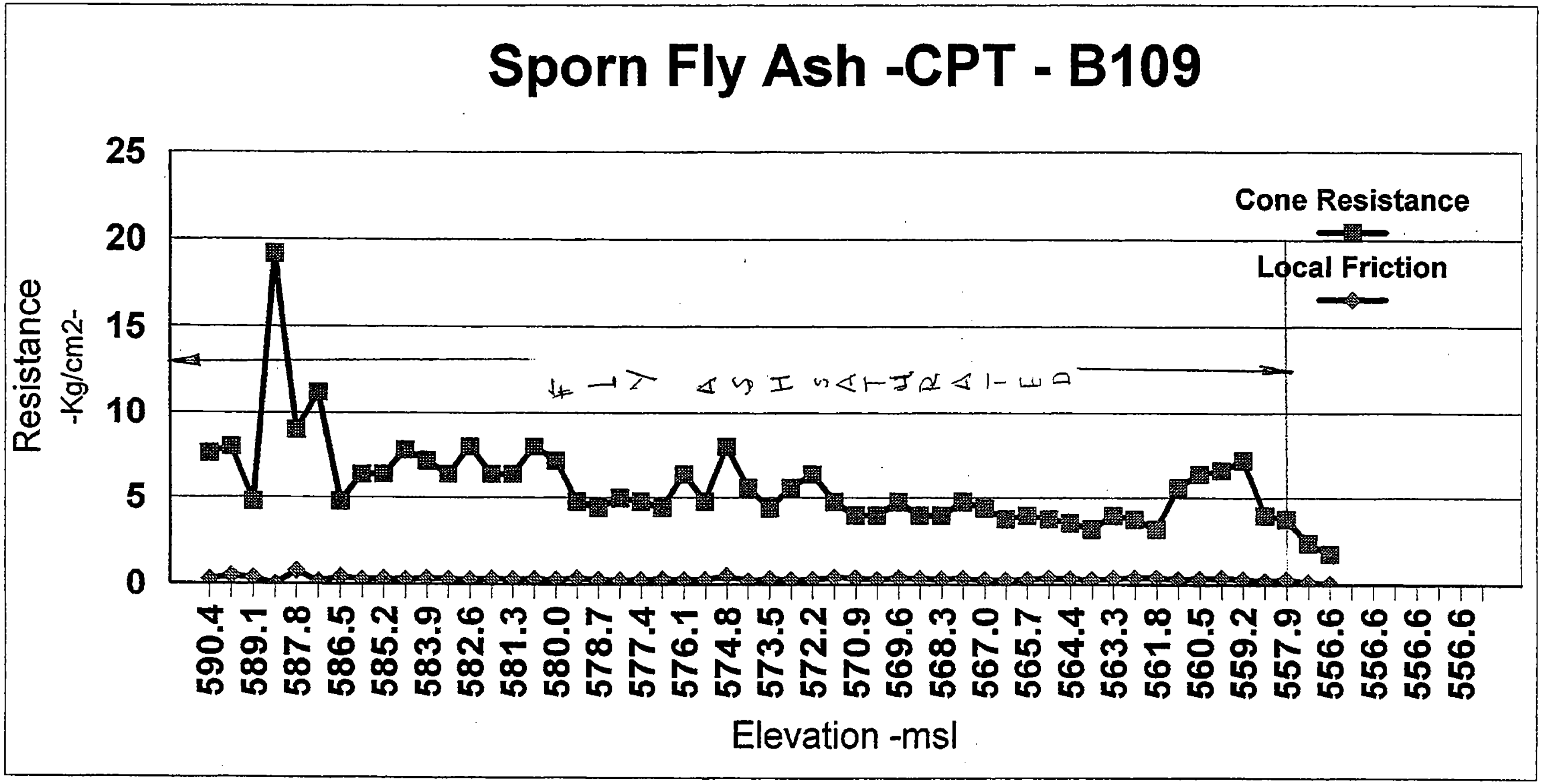
* Saturated


Sporn Fly Ash -CPT- B107
LF/CR - % -
0
5
10
15
Elevation -msl
588.1
586.8
585.5
584.2
582.9
581.6
580.3
579.0
577.7
576.4
575.1
573.8
572.5
571.2
569.9
568.6
567.3
566.0
564.7
563.4
562.1
560.2
558.9
557.6
556.3
Friction Ratio

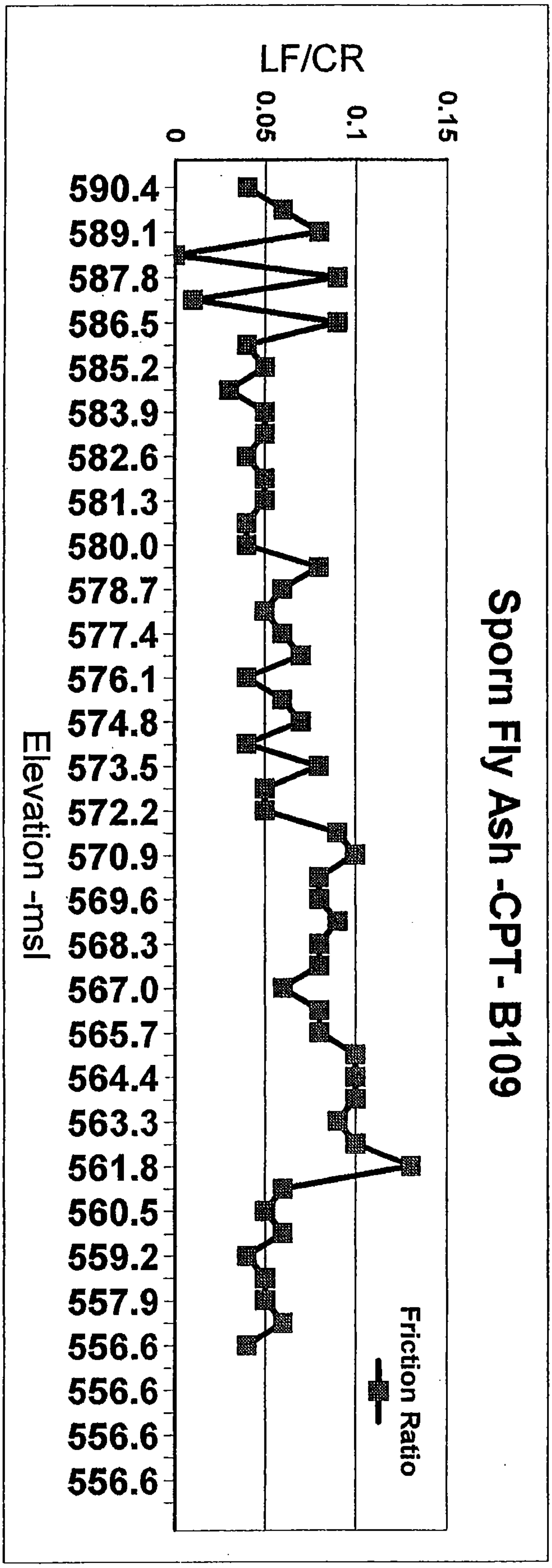

Sporn Fly Ash - CPT - B107
Resistance
-Kg/cm2-
0
1
2
3
4
5
6
7
8
9
Elevation -msl
588.1
586.8
585.5
584.2
582.9
581.6
580.3
579.0
577.7
576.4
575.1
573.8
572.5
571.2
569.9
568.6
567.3
566.0
564.7
563.4
562.1
560.2
558.9
557.6
556.3
556.3
556.3
556.3
556.3
556.3
Cone Resistance
Local Friction



Sporn Fly Ash - CPT - B107



Sporn Fly Ash -CPT - B109


Sporn Fly Ash -CPT- B109
LF/CR
0
0.05
0.1
0.15
Elevation -msl
590.4
589.1
587.8
586.5
585.2
583.9
582.6
581.3
580.0
578.7
577.4
576.1
574.8
573.5
572.2
570.9
569.6
568.3
567.0
565.7
564.4
563.3
561.8
560.5
559.2
557.9
556.6
556.6
556.6
556.6
Friction Ratio

## BORING B-106 - CPT - STRENGTH PARAMETERS. - FLY-ASH

AVERAGE $\gamma' = 119.7 \text{ lbs}/ft^3$

@ 27' ELEVATION - 591.9 ; $\sigma_v' = 27' \times 119.7 \frac{lbs}{ft^3} = 3,231.9 \text{ lbs}/ft^2$

$= 1.62 \text{ tsf} = 1.6 \text{ Kg}/cm^2$

USING FIG. 3.28 (or 5)②(1) STATIC CONE RESISTANCE $q_c$ VS. $D_r$, THE FLY ASH AT THIS LOCATION HAS A RELATIVE DENSITY $D_r = 0\%$.

FROM FIG. 3.29 (or 11)②(1) FRICTION ANGLE AND RELATIVE DENSITY RELATIONSHIPS FOR GRANULAR SOILS, THE FLY ASH AT THIS LOCATION HAS A $\phi'_{MAX.} = 28°$(1) or $\phi = 30°$(2)

$\boxed{\phi \text{ BASED ON SPT} = 27° \text{ to } 29°}$

## BORING B-107 - CPT - STRENGTH PARAMETERS

AVERAGE $\gamma' = 1.69 \text{ Kg}/cm^3 = 105.7 \text{ lbs}/ft^3$

@ 26.6', ELEVATION 592.2 ; $\sigma_v' = 26.6 \times 105.7$ 2,811.6 lbs/ft²

$= 1.4 \text{ tsf} = 1.4 \text{ Kg}/cm^2$

USING FIG. 3.28(1) or FIG (5)(2) STATIC CONE RESISTANCE $q_c$ V.S. $D_r$, THE FLY ASH AT THIS LOCATION HAS A RELATIVE DENSITY, $D_r = 0\%$

FROM FIG. 3,29(1) or FIG. 11(2) THE FLY ASH AT THIS LOCATION HAS A $\phi'_{max} = 28°$(1) or $\phi = 30°$(2)

$\boxed{\phi \text{ BASED ON SPT} = 27° \text{ to } 31°}$

---

(1) "GEOTECHNICAL ENGINEERING, TECHNIQUES AND PRACTICE" Roy E. Hunt.

(2) "INTERPRETATION OF THE CONE PENETRATION TEST" - THE DUTCH CONE PENETROMETER CONVERSION KIT - Hogentogler & Co. INC.

# BORING B-109 – CPT – STRENGTH PARAMETERS.

AVERAGE $\gamma = 1.71$ Kg/cm³ = 106.6 lbs/ft³

@ 26.7' ELEVATION, 592.9; $\sigma_v' = 20.5' \times (106.6) + 6.2(106.6 - 62.4) =$

$\sigma_v' = 2459.3$ lbs/ft² = 1.23 tsf = 1.2 Kg/cm

USING FIG. 3.28.(1) OR FIG 5.(2) STATIC CONE RESISTANCE $q_c$ VS. $D_r$, THE FLY ASH AT THIS LOCATION HAS A RELATIVE DENSITY,

$D_r = 0\%$

FROM FIG. 3.29 (1) OR FIG. 11 (2) THE FLY ASH AT THIS LOCATION HAS A $\phi'_{MAX} = 28°$ (1) or $\phi = 30°$ (2)

$\boxed{\phi \text{ BASED ON SPT} = 27° \text{ to } 30°}$

# LABORATORY DATA FROM:
# *"PHILIP SPORN POWER PLANT – STABILITY ANALYSIS"*

## PREPARED/COMPILED BY:
## THE GEOTECHNICAL ENGINEERING SECTION OF AMERICAN ELECTRIC POWER SERVICE CORPORATION

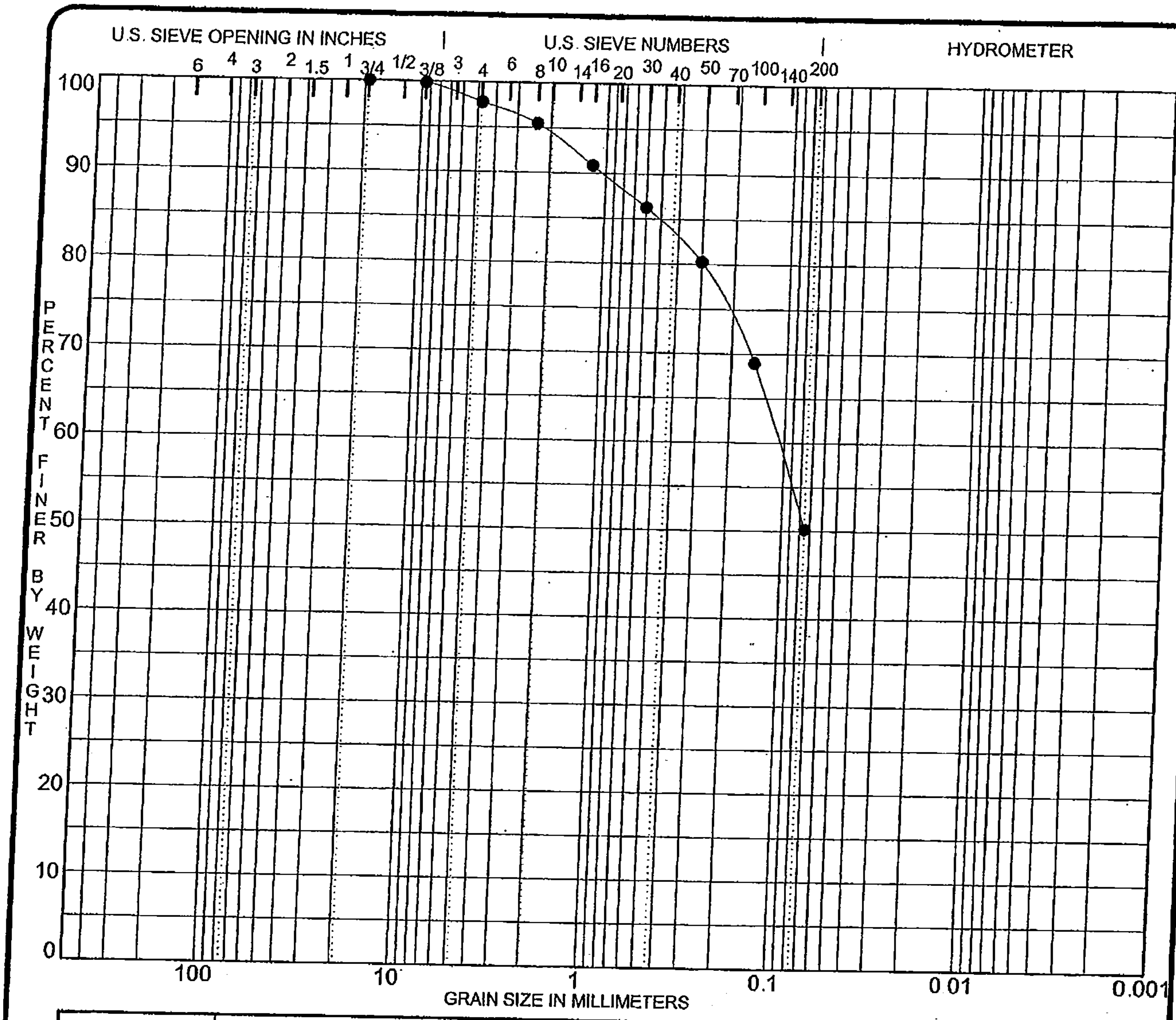
## DATED: MARCH 2009

PROJECT. NUMBER: SPORN PLANT - FLY ASH POND DIKES - FLY ASH POND DIKES

# SUMMARY OF MATERIAL PROPERTIES

| Sample Number | Depth ft. | ASTM Description | ASTM Class. | Max. Dry Density pcf | Optimum Moisture % | Liquid Limit % | Plastic Limit % | Gravel % | Sand % | <#200 Sieve % | <.002 mm % | Sp.G | Prmblty cm/sec | Nat. Moist. % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PZ-0901 | 3.5 | SANDY SILT | ML | | | NP | NP | 2.2 | 47.6 | 50.2 | | | | |
| PZ-0901 | 26.0 | | | | | 34.9 | 19.3 | | | | | | 3.61E-07 | |
| PZ-0902 | 8.5 | SILTY SAND with GRAVEL | SM | | | NP | NP | 33.0 | 52.9 | 14.0 | | | | |
| PZ-0902 | 18.5 | | | | | 25.6 | 18.2 | | | | | | | 13.3 |
| PZ-0902 | 31.0 | LEAN CLAY with SAND | CL | | | 29.5 | 17.4 | 0.0 | 20.6 | 79.4 | 21.3 | | | |
| PZ-0902 | 31.0 | | | | | 27.5 | 17.1 | | | | | | | |
| PZ-0903 | 16.0 | | | | | 33.3 | 19.5 | | | | | | | 18.1 |
| PZ-0903 | 23.5 | SILTY SAND | SM | | | NP | NP | 8.9 | 57.5 | 33.5 | | | | |
| PZ-0903 | 46.0 | LEAN CLAY | CL | | | 45.6 | 24.7 | 0.0 | 0.9 | 99.1 | 32.6 | | 1.08E-07 | |
| PZ-0904 | 8.0 | | | | | 29.2 | 19.8 | | | | | | | 16.5 |
| PZ-0904 | 43.5 | | | | | 36.9 | 22.3 | | | | | | | 28.4 |
| PZ-0905 | 11.0 | SILTY SAND with GRAVEL | SM | | | NP | NP | 19.6 | 61.2 | 19.2 | | | | |
| PZ-0905 | 38.0 | LEAN CLAY | CL | | | 31.2 | 19.1 | 0.0 | 6.5 | 93.5 | 22.6 | | | 25.3 |

AEP Civil Engineering Laboratory, Groveport, Ohio



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | PZ-0901 | 3.5 | SANDY SILT ML<br>Ash Mixture - Samples 2,3,4 Combined | | NP | NP | NP | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | PZ-0901 | 3.5 | 19.000 | 0.108 | | | 2.2 | 47.6 | 50.2 | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES - FLY ASH POND DIKES**

JOB NO.

DATE 8/14/09

## GRADATION CURVES

American Electric Power Service Corp.
Groveport, OH 43125

AEP

JOB NO. ____________________

DATE: Jul 17, 09

PROJECT SPORN PLANT - FLY ASH POND DIKES

LOCATION: FLY ASH POND DIKES

SOURCE OF MATERIAL PZ-0901

DEPTH 27.0 ft.

DESCRIPTION OF MATERIAL

ASTM DESCRIPTION

| | | | |
|---|---|---|---|
| MAX. DRY DENSITY, pcf | | OPTIMUM MOISTURE, % | |
| SPECIFIC GRAVITY | 2 70 | | |
| SAMPLE HGT., mm | 146.130 | SAMPLE DIA., mm | 72.310 |
| CHAMBER PRESSURE, psi | 70 0 | BACK PRESSURE, psi | 60.0 |
| B-PARAMETER | 1.00 | EFFECTIVE PRESSURE, psi | 10.0 |
| INITIAL HEAD, mm | 2373.2 | | |

| | BEFORE | AFTER |
|---|---|---|
| WATER CONTENT, % | 26.7 | 27.0 |
| WET DENSITY, pcf | 122.4 | |
| DRY DENSITY, pcf | 96.6 | |
| SATURATION, % | 96.79 | |
| VOID RATIO | 0.7441 | |

**PERMEABILITY COEFFICIENT K, cm/sec 3.61E-07**

**FLEXIBLE-MEMBRANE PERMEABILITY TEST**

American Electric Power Service Corp.
Groveport, Ohio

AEP

CIVIL LABORATORY
AMERICAN ELECTRIC POWER SERVICE CORPORATION
4001 BIXBY ROAD
GROVEPORT, OHIO 43125
(614) 836-4200

AEP AMERICAN ELECTRIC POWER

## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

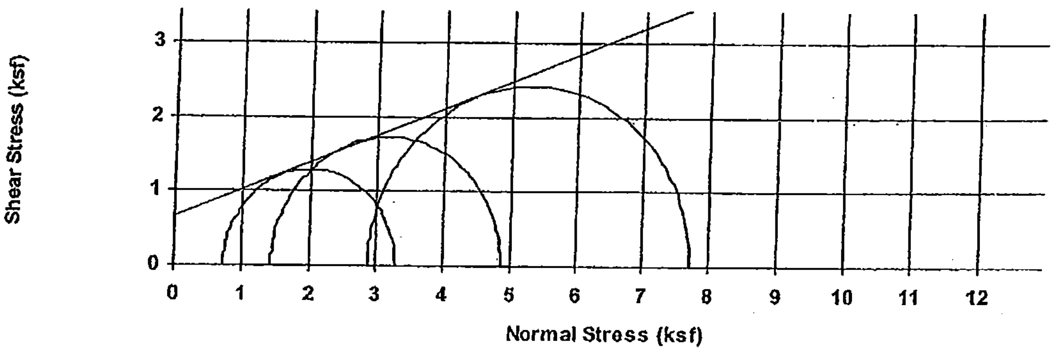
Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10906

**Material Description:** Boring PZ-0901, Shelby Tube - 26' - 28'; Lab # S-10906

| Point Designation | Initial Conditions | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|
| | Water Content, % | Dry Density, pcf | Degree of Saturation | Water Content, % | Confining Stress, (ksf) | Deviator Stress | Induced Pore Pressure (ksf) |
| A | 23.9% | 102.1 | 99.2% | 24.39% | 0.72 | 2.57 | 0.13 |
| B | 26.7% | 96.6 | 96.8% | 27.0% | 1.44 | 3.44 | 0.42 |
| C | 22.8% | 104.5 | 100.4% | 22.6% | 2.88 | 4.84 | 1.35 |

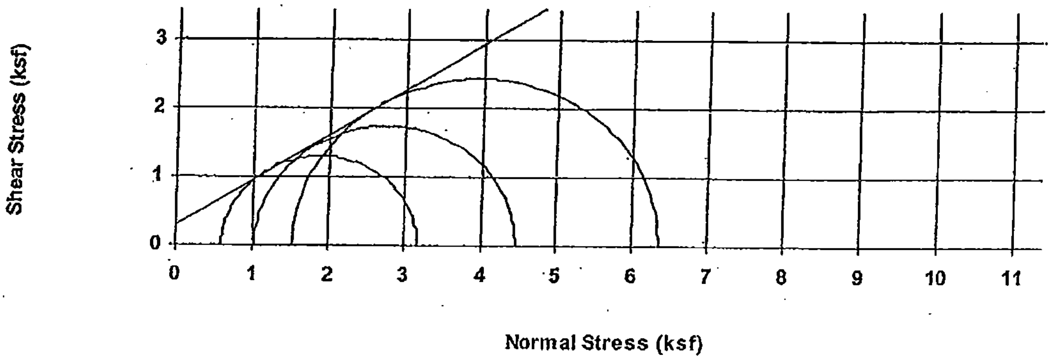
| Point Designation | Axial Strain, % | q, (ksf) | Effective Stresses, (ksf) | | | Total Stresses, (ksf) | | |
|---|---|---|---|---|---|---|---|---|
| | | | Major, (ksf) | Minor, (ksf) | p', (ksf) | Major, (ksf) | Minor, (ksf) | p, (ksf) |
| A | 15.0% | 1.29 | 3.16 | 0.59 | 1.88 | 3.29 | 0.72 | 2.01 |
| B | 15.0% | 1.72 | 4.46 | 1.02 | 2.74 | 4.88 | 1.44 | 3.16 |
| C | 11.0% | 2.42 | 6.36 | 1.53 | 3.94 | 7.72 | 2.88 | 5.30 |

### Total Stress Envelope



ϕ: 19.9 °
c : 0.66 ksf

### Effective Stress Envelope



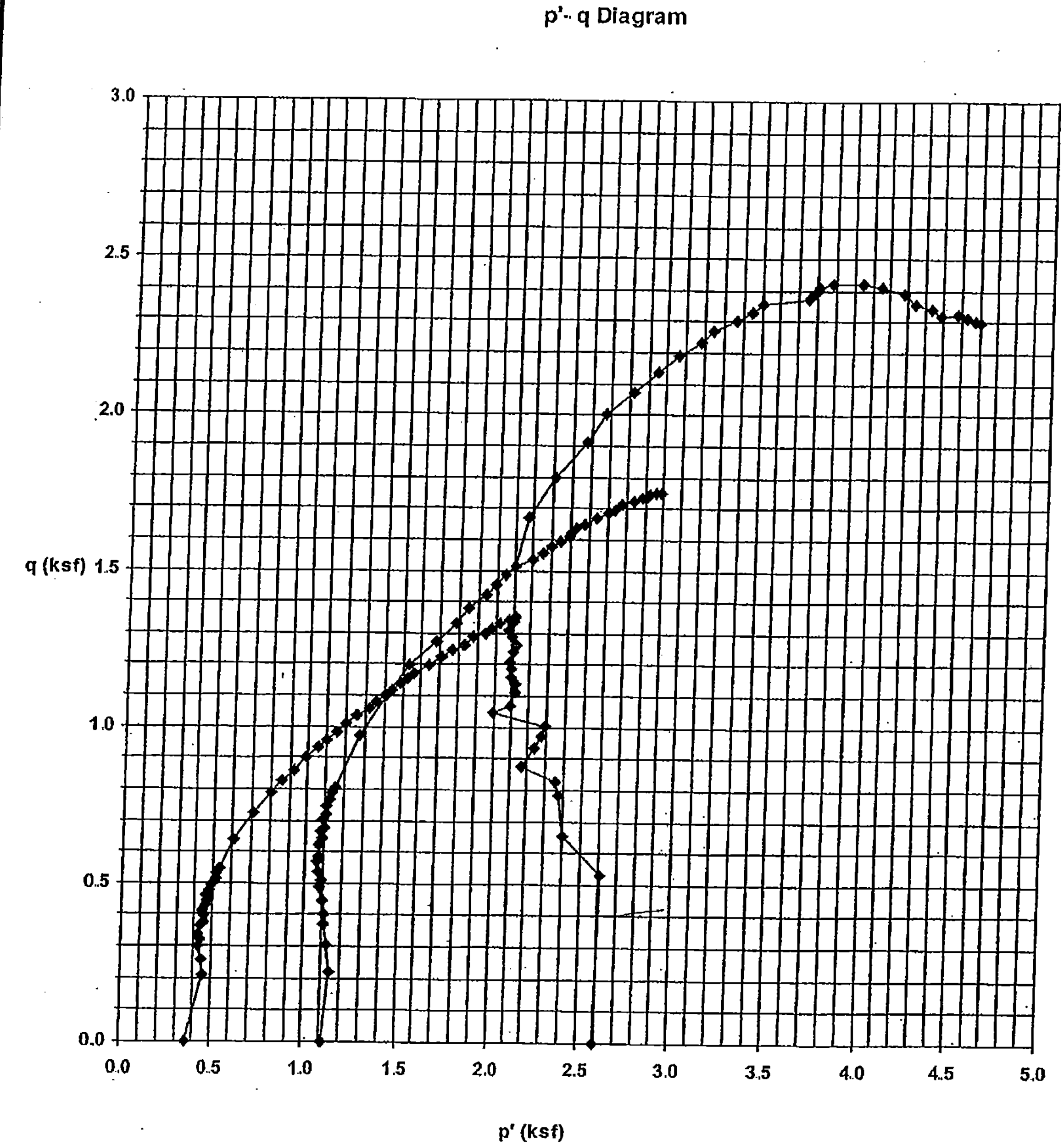
ϕ ': 33.3 °
c' : 0.29 ksf

Report Date: Friday August 14, 2009

FOSSIL AND HYDRO GENERATION
CIVIL AND MINING ENGINEERING DIVISION
CIVIL LABORATORY SECTION
AMERICAN ELECTRIC POWER SERVICE CORPORATION
4001 BIXBY ROAD
GROVEPORT, OHIO 43125
(614) 836-4200

# Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10906



Report Date: Friday, August 14 2009

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**CIVIL LABORATORY SECTION**
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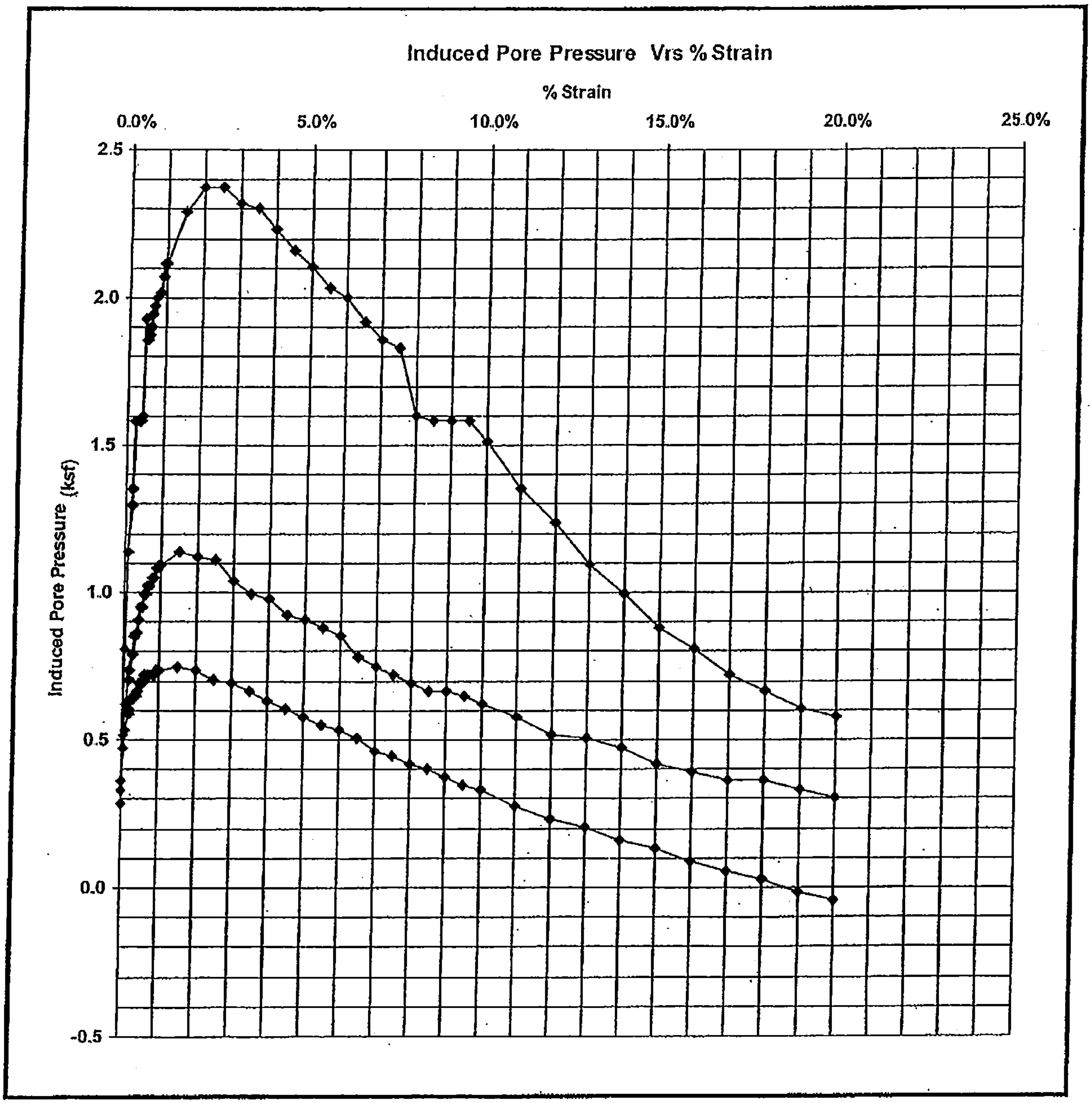
**Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767**

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10906



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**Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767**

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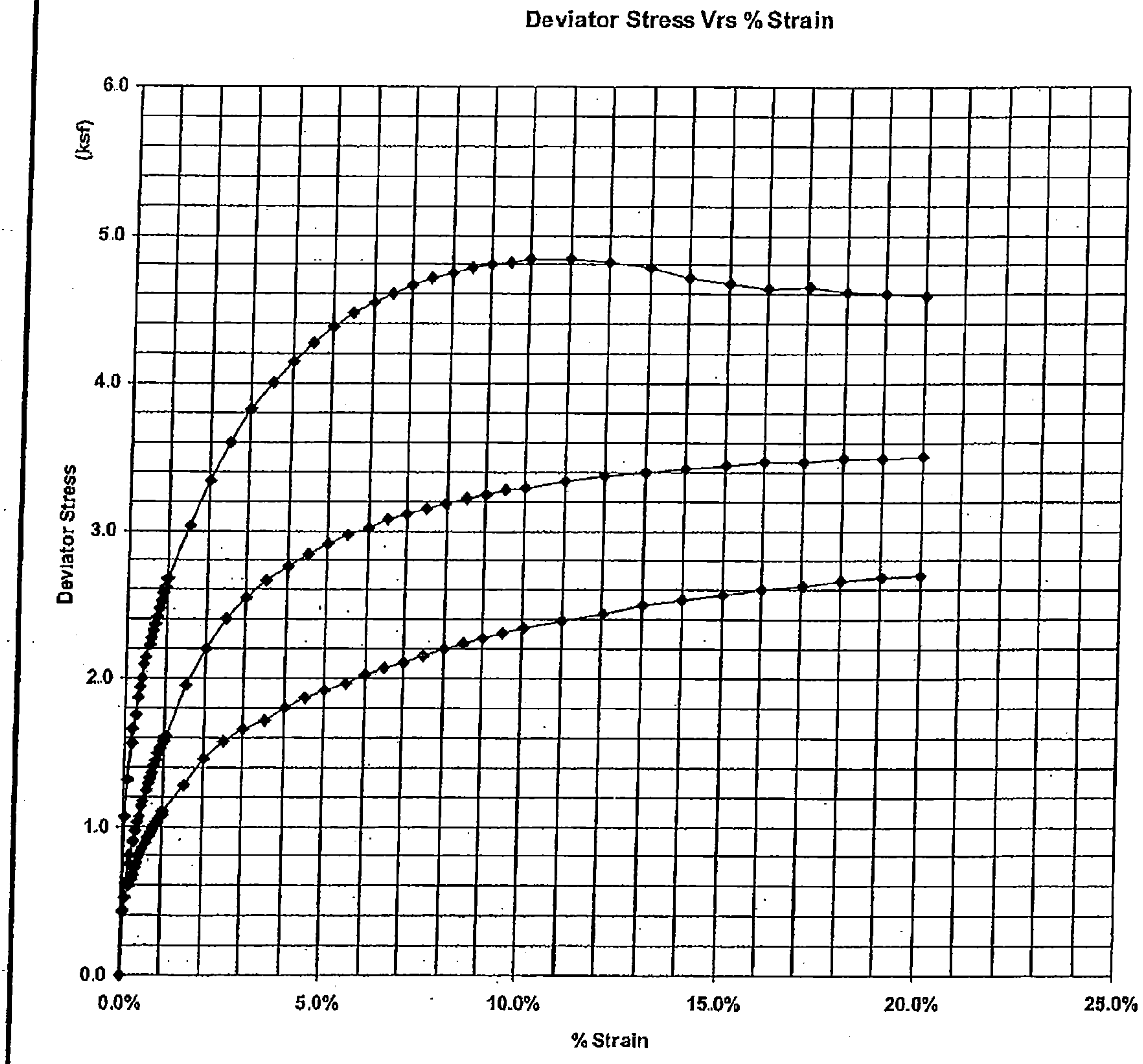

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Report Date: Friday August 14, 2009

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# Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10906
Point: A

**Material Description:** Boring PZ-0901, Shelby Tube - 26' - 28'; Lab # S-10906

## Moisture Determination ASTM D2216

| | Before Testing | After Testing |
|---|---|---|
| Tare No. | T-100 | T-100 |
| Mass of Container and Wet Specimen (Mcws), grams | 1425.44 | 1429.80 |
| Mass of Container and Over Dry Specimen (Mcs), grams | 1190.68 | 1190 68 |
| Mass of Container (Mc), grams | 210.10 | 210 10 |
| Mass of Water (Mw), grams: | 234.76 | 239.12 |
| Mass of Solid Particles (Ms), grams: | 980.58 | 980 58 |
| Moisture Content (w), % | 23.94% | 24.39% |

## Initial Condition of Speciman ASTM D2435

| | (1) | (2) | (3) | Average |
|---|---|---|---|---|
| Diameter Measurents, Inches: | 2.835 | 2 838 | 2.825 | 2.833 |
| Height Measurements, Inches: | 5.815 | 5.808 | 5.801 | 5.808 |

Initial Volume of Specimen (Vo), In.3: 36.60
Dry Mass of Specimen After Testing, (Md), grams: 980.58
Dry Unit Weight, (γ d) pcf: 102.06
Specific Gravity of the Solids, (G): 2 70
Volume of Solids, (Vs), Cu. In.: 22.1626
Height of Solids,( Hs),In.: 3 5167
Void Ratio Before Consolidation (Eo): 0.6515
Intitall Degree of Saturation: (So) 99 21%

## Saturation - ASTM D4767 Section 8.2

Dial Indicator Reading Prior to Saturation (Rb:) In. 0
Cell Pressure AfterSaturation, psi: 63 00
Back Presssure After Saturation After, psi: 60.00
Pore Pressure Paramenter B: 1
Dial Indicator Reading After Saturation, (Ra) In.: 0.016
Change in Height during Satureation, (Delta Hs) In. 0.016
Change In Volume of Specimen during Saturation (Delta Vsat), In.3: 0.302

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# Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10906
Point: A

**Consolidation- ASTM D2435, Section 11.5:**

| Sample No: | T: | Burette 2: | Burette3: | Rc: |
|---|---|---|---|---|
| 10906 | 0 | 23.6 | 23.7 | 0.016 |
| 10906 | 0.25 | 23.5 | 23.5 | |
| 10906 | 0.5 | 23.5 | 23.5 | |
| 10906 | 1 | 23.4 | 23.4 | |
| 10906 | 2 | 23.4 | 23.3 | |
| 10906 | 4 | 23.3 | 23.2 | |
| 10906 | 8 | 23.2 | 23 | |
| 10906 | 15 | 23.1 | 22.8 | 0.019 |
| 10906 | 30 | 23 | 22.6 | 0.02 |
| 10906 | 60 | 22.9 | 22.5 | 0.021 |
| 10906 | 120 | 22.7 | 22.2 | 0.022 |
| 10906 | 240 | 22.5 | 22.3 | 0.022 |
| 10906 | 450 | 22.3 | 22.2 | 0.022 |
| 10906 | 1440 | 22.2 | 22.2 | 0.023 |

**Specimen Height After Consolidation, (Hc), In.:** 5.79

**Volume Change During Consolidation (Delta Vc), In.3:** 0.18

**Cross-Sectional Area of Specimen After Consolidation (Ac), In.2:** 6.24

**Triaxial Compression Testing ASTM D 4767**

**Sample Depth:** 0 ft.

**Cell Pressure:** 65 psi

**Back Pressure:** 60 psi

**Confining Pressure:** 5 psi

**Strain Rate:** 0.006 in./min.

**Specimen Height After Consolidation, (Hc), In.:** 5.79

**Correction for Vert Displacement, In.:** 0

**Load due to Friction and Uplift:** 16.3 lbs.

**Correction for Filter Paper:** 0

**Thickness of Membrane (tm), In.:** 0.012

σ1−σ3= **Deviator Stress at Failure, ksf:** 2.57

σ3 f= **Effective Consolidation Stress at Failure, ksf:** 0.72

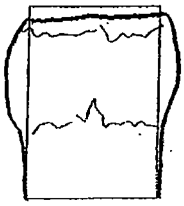
σ1= **Total Major Principal Stress at Failure:** 3.29

σ '3f= σ3−Δυ= **Effective Minor Principal Stress at Failure,ksf:** 0.59

σ '1f= **Effective Major Principal Stress at Failure, ksf:** 3.16

**Axial Strain at Failure:** 15.01%

**Failure Sketch**



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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10906
Point: A

| Pa: Applied Force | Vertical Displacement Reading In. : | Pore Pressure psi: | Axial Strain (E1): | (P) - Force Adj for U and F lbs: | Corrected Vertical Displac In : | Correction for Membrane ksf: | (A) Area In.2: | (σ1-σ3) Deviator Stress ksf: | [Δυ] Induced Pore Water Pressure ksf: | σ3 Effective Consolidation Stress ksf | σ1 Total Major Principal Stress ksf | σ3 Effective Minor Principal Stress ksf | σ1 ' Effective Major Principal Stress ksf | p' | q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16.3 | 0 000 | 62.5 | 0 00% | 0 0 | 0.000 | 0.00002 | 6 244 | 0 00 | 0.3600 | 0.72 | 0 72 | 0 36 | 0 36 | 0 36 | 0 00 |
| 34.6 | 0.003 | 63.3 | 0.05% | 18 3 | 0 003 | 0.00024 | 6.247 | 0 42 | 0.4752 | 0 72 | 1.14 | 0.24 | 0 67 | 0 46 | 0.21 |
| 38.7 | 0.006 | 63 7 | 0.10% | 22 4 | 0 006 | 0 00047 | 6.250 | 0.52 | 0 5328 | 0 72 | 1.24 | 0.19 | 0 70 | 0 45 | 0 26 |
| 42 3 | 0 009 | 64 1 | 0.16% | 26.0 | 0 009 | 0 00080 | 6 254 | 0.60 | 0.5904 | 0.72 | 1 32 | 0 13 | 0.73 | 0 43 | 0 30 |
| 44 1 | 0 012 | 64 2 | 0.20% | 27.8 | 0.012 | 0.00100 | 6 257 | 0 64 | 0.6048 | 0 72 | 1 36 | 0.12 | 0 75 | 0.43 | 0.32 |
| 45.8 | 0 014 | 64.4 | 0.25% | 29.5 | 0 014 | 0.00120 | 6.260 | 0.68 | 0 6336 | 0 72 | 1 40 | 0.09 | 0.76 | 0 43 | 0.34 |
| 48.0 | 0 018 | 64.5 | 0 31% | 31.7 | 0 018 | 0.00151 | 6.263 | 0.73 | 0 6480 | 0.72 | 1.45 | 0 07 | 0.80 | 0.44 | 0.36 |
| 49.2 | 0.020 | 64.5 | 0 35% | 32 9 | 0 020 | 0.00169 | 6 266 | 0 75 | 0.6480 | 0.72 | 1 47 | 0.07 | 0 83 | 0.45 | 0 38 |
| 50.9 | 0 023 | 64.6 | 0.40% | 34 6 | 0 023 | 0 00197 | 6 269 | 0 79 | 0.6624 | 0 72 | 1 51 | 0.06 | 0.85 | 0 45 | 0 40 |
| 52 5 | 0 026 | 64.8 | 0.46% | 36 2 | 0.026 | 0 00224 | 6 273 | 0.83 | 0.6912 | 0 72 | 1.55 | 0 03 | 0.86 | 0.44 | 0.41 |
| 53 7 | 0.029 | 64 8 | 0.50% | 37.4 | 0.029 | 0 00246 | 6 276 | 0.86 | 0 6912 | 0 72 | 1 58 | 0 03 | 0 88 | 0.46 | 0 43 |
| 55 1 | 0.032 | 64.8 | 0.56% | 38.8 | 0 032 | 0.00275 | 6.279 | 0 89 | 0 6912 | 0.72 | 1 61 | 0 03 | 0.92 | 0 47 | 0.44 |
| 56 9 | 0.035 | 65.0 | 0.61% | 40.6 | 0 035 | 0 00300 | 6 283 | 0 93 | 0.7200 | 0 72 | 1.65 | 0 00 | 0.93 | 0.46 | 0.46 |
| 57 3 | 0.038 | 65 0 | 0 65% | 41 0 | 0 038 | 0 00319 | 6 285 | 0 94 | 0.7200 | 0.72 | 1 66 | 0.00 | 0 94 | 0 47 | 0 47 |
| 58 4 | 0.041 | 65.0 | 0 70% | 42 1 | 0.041 | 0 00344 | 6.288 | 0.96 | 0 7200 | 0.72 | 1 68 | 0 00 | 0 96 | 0 48 | 0.48 |
| 59 4 | 0 043 | 65.0 | 0 75% | 43 1 | 0.043 | 0.00366 | 6.291 | 0.98 | 0.7200 | 0 72 | 1.70 | 0.00 | 0.98 | 0.49 | 0.49 |
| 60.5 | 0 046 | 65.0 | 0 80% | 44 2 | 0.046 | 0.00392 | 6.294 | 1 01 | 0.7200 | 0 72 | 1 73 | 0.00 | 1 01 | 0 50 | 0 50 |
| 61.6 | 0 049 | 65 0 | 0.85% | 45 3 | 0.049 | 0.00417 | 6 298 | 1 03 | 0.7200 | 0.72 | 1 75 | 0.00 | 1 03 | 0.52 | 0.52 |
| 62.8 | 0 053 | 65 1 | 0.91% | 46 5 | 0 053 | 0 00446 | 6 302 | 1 06 | 0.7344 | 0.72 | 1.78 | -0 01 | 1.04 | 0.51 | 0.53 |
| 63 8 | 0.056 | 65 1 | 0.96% | 47 5 | 0 056 | 0.00473 | 6 305 | 1 08 | 0 7344 | 0 72 | 1.80 | -0.01 | 1.07 | 0 53 | 0 54 |
| 64 5 | 0.058 | 65 1 | 1.00% | 48 2 | 0 058 | 0 00492 | 6.307 | 1.10 | 0.7344 | 0 72 | 1 82 | -0 01 | 1 08 | 0 53 | 0.55 |
| 73 0 | 0.087 | 65 2 | 1 50% | 56.7 | 0 087 | 0 00736 | 6.339 | 1 28 | 0.7488 | 0.72 | 2.00 | -0 03 | 1.25 | 0.61 | 0.64 |
| 80.9 | 0.116 | 65.1 | 2 00% | 64.6 | 0.116 | 0.00981 | 6.372 | 1 45 | 0.7344 | 0.72 | 2.17 | -0.01 | 1.44 | 0.71 | 0 73 |
| 86.9 | 0 145 | 64.9 | 2 50% | 70.6 | 0 145 | 0.01227 | 6.405 | 1 58 | 0.7056 | 0 72 | 2 30 | 0.01 | 1 59 | 0 80 | 0 79 |
| 91 0 | 0 174 | 64 8 | 3.00% | 74.7 | 0 174 | 0.01473 | 6 438 | 1.66 | 0 6912 | 0 72 | 2 38 | 0 03 | 1.69 | 0.86 | 0 83 |
| 94 4 | 0 203 | 64 6 | 3.50% | 78.1 | 0 203 | 0 01717 | 6.471 | 1 72 | 0.6624 | 0.72 | 2.44 | 0.06 | 1 78 | 0 92 | 0 86 |
| 98 4 | 0.231 | 64 4 | 4 00% | 82 1 | 0.231 | 0 01961 | 6.504 | 1 80 | 0.6336 | 0 72 | 2 52 | 0.09 | 1 88 | 0.99 | 0 90 |
| 102 2 | 0.261 | 64.2 | 4 50% | 85.9 | 0.261 | 0 02209 | 6 539 | 1.87 | 0.6048 | 0 72 | 2 59 | 0 12 | 1.98 | 1.05 | 0.93 |
| 104.7 | 0.290 | 64.0 | 5 01% | 88 4 | 0.290 | 0.02454 | 6.573 | 1.91 | 0.5760 | 0 72 | 2.63 | 0.14 | 2 06 | 1 10 | 0 96 |
| 107.9 | 0 318 | 63.8 | 5.50% | 91 6 | 0 318 | 0.02698 | 6 608 | 1 97 | 0 5472 | 0.72 | 2.69 | 0.17 | 2 14 | 1.16 | 0 98 |
| 110 9 | 0.347 | 63 7 | 6.00% | 94.6 | 0 347 | 0.02942 | 6 643 | 2.02 | 0.5328 | 0 72 | 2.74 | 0 19 | 2.21 | 1.20 | 1.01 |
| 113 7 | 0.376 | 63 5 | 6.51% | 97.4 | 0.376 | 0.03190 | 6 679 | 2.07 | 0.5040 | 0 72 | 2 79 | 0 22 | 2 28 | 1 25 | 1 03 |
| 116.4 | 0.406 | 63 2 | 7.01% | 100.1 | 0.406 | 0 03437 | 6.715 | 2.11 | 0.4608 | 0 72 | 2.83 | 0.26 | 2 37 | 1 32 | 1 06 |
| 119.1 | 0.434 | 63 1 | 7.51% | 102.8 | 0.434 | 0 03680 | 6.751 | 2.16 | 0 4464 | 0.72 | 2.88 | 0 27 | 2.43 | 1.35 | 1.08 |
| 122.0 | 0.463 | 62.9 | 8.01% | 105.7 | 0.463 | 0.03926 | 6 788 | 2 20 | 0 4176 | 0.72 | 2 92 | 0 30 | 2 51 | 1.40 | 1.10 |
| 124 3 | 0.492 | 62.8 | 8 50% | 108 0 | 0 492 | 0 04170 | 6 825 | 2.24 | 0.4032 | 0.72 | 2.96 | 0.32 | 2 55 | 1 44 | 1 12 |
| 126 6 | 0 521 | 62.6 | 9.01% | 110 3 | 0 521 | 0.04415 | 6 862 | 2.27 | 0.3744 | 0 72 | 2.99 | 0.35 | 2.62 | 1.48 | 1.14 |
| 128.9 | 0 550 | 62.4 | 9.51% | 112.6 | 0.550 | 0.04661 | 6.900 | 2 30 | 0.3456 | 0.72 | 3.02 | 0 37 | 2.68 | 1.53 | 1.15 |

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Report Date: Friday, August 14, 2009

## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10906
Point: A

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 131.3 | 0.579 | 62.3 | 10 01% | 115.0 | 0.579 | 0 04907 | 6 939 | 2 34 | 0 3312 | 0.72 | 3 06 | 0 39 | 2 73 | 1.56 | 1 17 |
| 135.5 | 0.637 | 61.9 | 11 01% | 119 2 | 0.637 | 0.05399 | 7 017 | 2 39 | 0 2736 | 0 72 | 3 11 | 0 45 | 2 84 | 1.64 | 1.20 |
| 139 6 | 0.695 | 61.6 | 12 01% | 123 3 | 0.695 | 0.05890 | 7.097 | 2.44 | 0 2304 | 0.72 | 3.16 | 0.49 | 2.93 | 1.71 | 1 22 |
| 143 7 | 0 753 | 61.4 | 13 01% | 127 4 | 0 753 | 0 06380 | 7 178 | 2 49 | 0 2016 | 0.72 | 3 21 | 0 52 | 3 01 | 1 76 | 1 25 |
| 147 2 | 0.810 | 61.1 | 14.01% | 130.9 | 0.810 | 0 06868 | 7 261 | 2.53 | 0 1584 | 0 72 | 3 25 | 0.56 | 3.09 | 1 83 | 1 26 |
| 151 3 | 0 868 | 60 9 | 15.01% | 135.0 | 0.868 | 0 07360 | 7 347 | 2.57 | 0.1296 | 0 72 | 3 29 | 0 59 | 3 16 | 1.88 | 1 29 |
| 154 6 | 0.926 | 60 6 | 16.01% | 138 3 | 0.926 | 0.07851 | 7.435 | 2.60 | 0 0864 | 0.72 | 3 32 | 0 63 | 3 23 | 1.93 | 1.30 |
| 158 0 | 0 984 | 60 4 | 17.02% | 141 7 | 0 984 | 0 08343 | 7.525 | 2 63 | 0 0576 | 0 72 | 3 35 | 0.66 | 3.29 | 1 98 | 1.31 |
| 161 5 | 1 042 | 60 2 | 18.02% | 145 2 | 1 042 | 0 08833 | 7 616 | 2 66 | 0 0288 | 0 72 | 3 38 | 0 69 | 3 35 | 2.02 | 1 33 |
| 165 0 | 1 100 | 59 9 | 19 01% | 148.7 | 1 100 | 0 09322 | 7 710 | 2.68 | -0 0144 | 0 72 | 3.40 | 0 73 | 3 42 | 2.08 | 1.34 |
| 168.1 | 1.158 | 59.7 | 20 02% | 151.8 | 1 158 | 0.09814 | 7 807 | 2.70 | -0 0432 | 0.72 | 3 42 | 0.76 | 3.47 | 2.11 | 1.35 |

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# Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10906
Point: B

**Material Description:** Boring PZ-0901, Shelby Tube - 26' - 28'; Lab # S-10906

## Moisture Determination ASTM D2216

| | Before Testing | After Testing |
|---|---|---|
| Tare No. | 4 | 4 |
| Mass of Container and Wet Specimen (Mcws), grams | 1389.93 | 1393.24 |
| Mass of Container and Over Dry Specimen (Mcs), grams | 1142.12 | 1142.12 |
| Mass of Container (Mc), grams | 213.10 | 213 10 |
| Mass of Water (Mw), grams: | 247.81 | 251.12 |
| Mass of Solid Particles (Ms), grams: | 929.02 | 929.02 |
| Moisture Content (w), % | 26.67% | 27.03% |

## Initial Condition of Speciman ASTM D2435

| | (1) | (2) | (3) | Average |
|---|---|---|---|---|
| Diameter Measurents, Inches: | 2.854 | 2 852 | 2.835 | 2.847 |
| Height Measurements, Inches: | 5.75 | 5.75 | 5.76 | 5.753 |

Initial Volume of Specimen (Vo), In.3: 36 63
Dry Mass of Specimen After Testing, (Md), grams: 929.02
Dry Unit Weight, (γ d) pcf: 96.63
Specific Gravity of the Solids, (G): 2.70
Volume of Solids, (Vs), Cu. In.: 20.9972
Height of Solids,( Hs),In.: 3 2983
Void Ratio Before Consolidation (Eo): 0.7443
Intitail Degree of Saturation: (So) 96.76%

## Saturation - ASTM D4767 Section 8.2

Dial Indicator Reading Prior to Saturation (Rb:) In. 0
Cell Pressure AfterSaturation, psi: 65.00
Back Presssure After Saturation After, psi: 60 00
Pore Pressure Paramenter B: 1
Dial Indicator Reading After Saturation, (Ra) In.: 0.024
Change in Height during Satureation, (Delta Hs) In. 0.024
Change In Volume of Specimen during Saturation (Delta Vsat), In.3: 0.458

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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10906
Point: B

**Consolidation- ASTM D2435, Section 11.5:**

| Sample No: | T: | Burette 2: | Burette3: | Rc: |
|---|---|---|---|---|
| 10906 | 0 | 23.8 | 23.8 | 0.024 |
| 10906 | 0.25 | 23.7 | 23.7 | |
| 10906 | 0.5 | 23.6 | 23.6 | |
| 10906 | 1 | 23.6 | 23.6 | |
| 10906 | 2 | 23.5 | 23.5 | |
| 10906 | 4 | 23.4 | 23.3 | |
| 10906 | 8 | 23.2 | 23.2 | |
| 10906 | 15 | 23 | 23 | 0.028 |
| 10906 | 30 | 22.8 | 22.8 | 0.03 |
| 10906 | 60 | 22.6 | 22.5 | 0.031 |
| 10906 | 120 | 22.4 | 22.3 | 0.031 |
| 10906 | 240 | 22.3 | 22.2 | 0.032 |
| 10906 | 450 | 22.1 | 22.1 | 0.032 |
| 10906 | 1440 | 22 | 22 | 0.032 |

Specimen Height After Consolidation, (Hc), In.: 5.72

Volume Change During Consolidation (Delta Vc), In.3: 0.22

Cross-Sectional Area of Specimen After Consolidation (Ac), In.2: 6.28

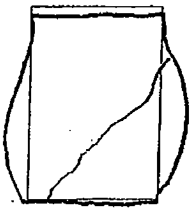
**Triaxial Compression Testing ASTM D 4767**

Sample Depth: 0 ft.
Cell Pressure: 70 psi
Back Pressure: 60 psi
Confining Pressure: 10 psi
Strain Rate: 0.006 In/min.

Specimen Height After Consolidation, (Hc), In.: 5.72
Correction for Vert Displacement, In.: 0
Load due to Friction and Uplift: 19.1 lbs.
Correction for Filter Paper: 0
Thickness of Membrane (tm), In.: 0.012

| | | | |
|---|---|---|---|
| | σ1–σ3= | Deviator Stress at Failure, ksf: | 3.44 |
| | σ3 f= | Effective Consolidation Stress at Failure, ksf: | 1.44 |
| | σ1= | Total Major Principal Stress at Failure: | 4.88 |
| σ '3f= | σ3–Δ υ= | Effective Minor Principal Stress at Failure,ksf: | 1.02 |
| | σ '1f= | Effective Major Principal Stress at Failure, ksf: | 4.46 |
| | | Axial Strain at Failure: | 15.00% |

Failure Sketch



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Report Date: Friday, August 14, 2009

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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10906
Point: B

| Pn: Applied Force | Vertical Displacement Reading In.: | Pore Pressure psi: | Axial Strain (E1): | (P) - Force Adj for U and F lbs: | Corrected Vertical Displac In.: | Correction for Membrane ksf: | (A) Area In. 2: | (σ1−σ3) Deviator Stress ksf: | [Δu] Induced Pore Water Pressure ksf: | σ3 Effective Consolidation Stress ksf | σ1 Total Major Principal Stress ksf | σ3 Effective Minor Principal Stress ksf | σ1 ' Effective Major Principal Stress ksf | p' | q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.1 | 0.000 | 62.3 | 0.00% | 0.0 | 0.000 | 0.00002 | 6.283 | 0.00 | 0.3312 | 1.44 | 1.44 | 1.11 | 1.11 | 1.11 | 0.00 |
| 38.3 | 0.003 | 63.6 | 0.05% | 19.2 | 0.003 | 0.00026 | 6.286 | 0.44 | 0.5184 | 1.44 | 1.88 | 0.92 | 1.36 | 1.14 | 0.22 |
| 45.8 | 0.006 | 64.3 | 0.10% | 26.7 | 0.006 | 0.00048 | 6.289 | 0.61 | 0.6192 | 1.44 | 2.05 | 0.82 | 1.43 | 1.13 | 0.31 |
| 51.7 | 0.009 | 64.9 | 0.16% | 32.6 | 0.009 | 0.00079 | 6.293 | 0.75 | 0.7056 | 1.44 | 2.19 | 0.73 | 1.48 | 1.11 | 0.37 |
| 54.5 | 0.011 | 65.1 | 0.20% | 35.4 | 0.011 | 0.00096 | 6.295 | 0.81 | 0.7344 | 1.44 | 2.25 | 0.71 | 1.51 | 1.11 | 0.40 |
| 58.3 | 0.014 | 65.5 | 0.25% | 39.2 | 0.014 | 0.00123 | 6.299 | 0.89 | 0.7920 | 1.44 | 2.33 | 0.65 | 1.54 | 1.10 | 0.45 |
| 61.7 | 0.018 | 65.9 | 0.31% | 42.6 | 0.018 | 0.00152 | 6.303 | 0.97 | 0.8496 | 1.44 | 2.41 | 0.59 | 1.56 | 1.08 | 0.49 |
| 64.0 | 0.020 | 66.0 | 0.35% | 44.9 | 0.020 | 0.00171 | 6.305 | 1.02 | 0.8640 | 1.44 | 2.46 | 0.58 | 1.60 | 1.09 | 0.51 |
| 66.0 | 0.023 | 66.3 | 0.40% | 46.9 | 0.023 | 0.00193 | 6.308 | 1.07 | 0.9072 | 1.44 | 2.51 | 0.53 | 1.60 | 1.07 | 0.53 |
| 69.1 | 0.026 | 66.6 | 0.46% | 50.0 | 0.026 | 0.00224 | 6.312 | 1.14 | 0.9504 | 1.44 | 2.58 | 0.49 | 1.63 | 1.06 | 0.57 |
| 70.5 | 0.029 | 66.6 | 0.50% | 51.4 | 0.029 | 0.00244 | 6.315 | 1.17 | 0.9504 | 1.44 | 2.61 | 0.49 | 1.66 | 1.07 | 0.58 |
| 73.7 | 0.032 | 66.9 | 0.56% | 54.6 | 0.032 | 0.00273 | 6.318 | 1.24 | 0.9936 | 1.44 | 2.68 | 0.45 | 1.69 | 1.07 | 0.62 |
| 75.7 | 0.035 | 66.9 | 0.61% | 56.6 | 0.035 | 0.00299 | 6.322 | 1.29 | 0.9936 | 1.44 | 2.73 | 0.45 | 1.73 | 1.09 | 0.64 |
| 77.6 | 0.037 | 67.1 | 0.65% | 58.5 | 0.037 | 0.00316 | 6.324 | 1.33 | 1.0224 | 1.44 | 2.77 | 0.42 | 1.75 | 1.08 | 0.66 |
| 78.9 | 0.040 | 67.1 | 0.70% | 59.8 | 0.040 | 0.00342 | 6.327 | 1.36 | 1.0224 | 1.44 | 2.80 | 0.42 | 1.78 | 1.10 | 0.68 |
| 81.0 | 0.043 | 67.3 | 0.75% | 61.9 | 0.043 | 0.00367 | 6.331 | 1.40 | 1.0512 | 1.44 | 2.84 | 0.39 | 1.79 | 1.09 | 0.70 |
| 82.7 | 0.046 | 67.3 | 0.80% | 63.6 | 0.046 | 0.00390 | 6.334 | 1.44 | 1.0512 | 1.44 | 2.88 | 0.39 | 1.83 | 1.11 | 0.72 |
| 85.1 | 0.048 | 67.5 | 0.85% | 66.0 | 0.048 | 0.00413 | 6.337 | 1.50 | 1.0800 | 1.44 | 2.94 | 0.36 | 1.86 | 1.11 | 0.75 |
| 86.7 | 0.052 | 67.5 | 0.91% | 67.6 | 0.052 | 0.00444 | 6.341 | 1.53 | 1.0800 | 1.44 | 2.97 | 0.36 | 1.89 | 1.13 | 0.77 |
| 88.9 | 0.055 | 67.6 | 0.96% | 69.8 | 0.055 | 0.00470 | 6.344 | 1.58 | 1.0944 | 1.44 | 3.02 | 0.35 | 1.93 | 1.14 | 0.79 |
| 90.2 | 0.057 | 67.6 | 1.00% | 71.1 | 0.057 | 0.00490 | 6.347 | 1.61 | 1.0944 | 1.44 | 3.05 | 0.35 | 1.95 | 1.15 | 0.80 |
| 105.7 | 0.086 | 67.9 | 1.50% | 86.6 | 0.086 | 0.00733 | 6.379 | 1.95 | 1.1376 | 1.44 | 3.39 | 0.30 | 2.25 | 1.28 | 0.97 |
| 117.4 | 0.114 | 67.8 | 2.00% | 98.3 | 0.114 | 0.00976 | 6.411 | 2.20 | 1.1232 | 1.44 | 3.64 | 0.32 | 2.51 | 1.42 | 1.10 |
| 126.9 | 0.143 | 67.7 | 2.50% | 107.8 | 0.143 | 0.01220 | 6.444 | 2.40 | 1.1088 | 1.44 | 3.84 | 0.33 | 2.73 | 1.53 | 1.20 |
| 134.3 | 0.172 | 67.2 | 3.00% | 115.2 | 0.172 | 0.01468 | 6.478 | 2.55 | 1.0368 | 1.44 | 3.99 | 0.40 | 2.95 | 1.68 | 1.27 |
| 140.4 | 0.200 | 66.9 | 3.50% | 121.3 | 0.200 | 0.01709 | 6.511 | 2.67 | 0.9936 | 1.44 | 4.11 | 0.45 | 3.11 | 1.78 | 1.33 |
| 145.5 | 0.229 | 66.8 | 4.00% | 126.4 | 0.229 | 0.01953 | 6.545 | 2.76 | 0.9792 | 1.44 | 4.20 | 0.46 | 3.22 | 1.84 | 1.38 |
| 150.1 | 0.257 | 66.4 | 4.50% | 131.0 | 0.257 | 0.02199 | 6.579 | 2.85 | 0.9216 | 1.44 | 4.29 | 0.52 | 3.36 | 1.94 | 1.42 |
| 154.0 | 0.286 | 66.3 | 5.00% | 134.9 | 0.286 | 0.02445 | 6.614 | 2.91 | 0.9072 | 1.44 | 4.35 | 0.53 | 3.45 | 1.99 | 1.46 |
| 157.5 | 0.315 | 66.1 | 5.50% | 138.4 | 0.315 | 0.02688 | 6.649 | 2.97 | 0.8784 | 1.44 | 4.41 | 0.56 | 3.53 | 2.05 | 1.49 |
| 160.8 | 0.343 | 65.9 | 6.00% | 141.7 | 0.343 | 0.02930 | 6.684 | 3.02 | 0.8496 | 1.44 | 4.46 | 0.59 | 3.61 | 2.10 | 1.51 |
| 163.9 | 0.372 | 65.4 | 6.50% | 144.8 | 0.372 | 0.03178 | 6.720 | 3.07 | 0.7776 | 1.44 | 4.51 | 0.66 | 3.73 | 2.20 | 1.54 |
| 166.8 | 0.400 | 65.2 | 6.99% | 147.7 | 0.400 | 0.03419 | 6.756 | 3.11 | 0.7488 | 1.44 | 4.55 | 0.69 | 3.81 | 2.25 | 1.56 |
| 169.5 | 0.429 | 65.0 | 7.49% | 150.4 | 0.429 | 0.03663 | 6.792 | 3.15 | 0.7200 | 1.44 | 4.59 | 0.72 | 3.87 | 2.30 | 1.58 |
| 172.1 | 0.458 | 64.8 | 8.00% | 153.0 | 0.458 | 0.03909 | 6.829 | 3.19 | 0.6912 | 1.44 | 4.63 | 0.75 | 3.94 | 2.34 | 1.59 |
| 174.4 | 0.486 | 64.6 | 8.49% | 155.3 | 0.486 | 0.04152 | 6.866 | 3.22 | 0.6624 | 1.44 | 4.66 | 0.78 | 3.99 | 2.39 | 1.61 |
| 176.8 | 0.515 | 64.6 | 8.99% | 157.7 | 0.515 | 0.04396 | 6.904 | 3.25 | 0.6624 | 1.44 | 4.69 | 0.78 | 4.02 | 2.40 | 1.62 |
| 179.2 | 0.543 | 64.5 | 9.49% | 160.1 | 0.543 | 0.04640 | 6.942 | 3.27 | 0.6480 | 1.44 | 4.71 | 0.79 | 4.07 | 2.43 | 1.64 |

Report Date: Friday, August 14, 2009

**Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767**

Company: AEP

Project: SPORN ASH DISP. FACILITY

Sample No: 10906

Point: B

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 181 2 | 0 572 | 64.3 | 10 00% | 162 1 | 0.572 | 0 04886 | 6 981 | 3 29 | 0.6192 | 1 44 | 4.73 | 0.82 | 4.12 | 2.47 | 1.65 |
| 185 4 | 0 629 | 64 0 | 11 00% | 166 3 | 0 629 | 0 05375 | 7 059 | 3.34 | 0.5760 | 1 44 | 4.78 | 0 86 | 4 20 | 2 53 | 1 67 |
| 189 0 | 0 686 | 63.6 | 11.99% | 169 9 | 0 686 | 0.05862 | 7.139 | 3 37 | 0 5184 | 1.44 | 4 81 | 0 92 | 4.29 | 2.61 | 1.68 |
| 192.6 | 0.744 | 63.5 | 13.00% | 173.5 | 0.744 | 0.06352 | 7.222 | 3 40 | 0.5040 | 1 44 | 4 84 | 0.94 | 4 33 | 2.63 | 1 70 |
| 196 1 | 0.801 | 63.3 | 13.99% | 177.0 | 0.801 | 0.06839 | 7.305 | 3 42 | 0.4752 | 1 44 | 4.86 | 0 96 | 4 39 | 2 68 | 1 71 |
| 199.5 | 0.858 | 62 9 | 15 00% | 180.4 | 0.858 | 0 07331 | 7.392 | 3.44 | 0.4176 | 1 44 | 4.88 | 1.02 | 4.46 | 2 74 | 1.72 |
| 203 0 | 0 915 | 62.7 | 16 00% | 183 9 | 0.915 | 0 07818 | 7.480 | 3.46 | 0.3888 | 1.44 | 4 90 | 1.05 | 4 51 | 2 78 | 1 73 |
| 206.0 | 0 972 | 62.5 | 16 99% | 186 9 | 0 972 | 0 08305 | 7 569 | 3.47 | 0 3600 | 1.44 | 4.91 | 1 08 | 4 55 | 2.82 | 1 74 |
| 209 4 | 1 029 | 62.5 | 17 99% | 190 3 | 1 029 | 0 08794 | 7 662 | 3.49 | 0 3600 | 1 44 | 4.93 | 1 08 | 4.57 | 2 82 | 1.74 |
| 212.4 | 1 087 | 62.3 | 19 00% | 193 3 | 1 087 | 0 09284 | 7 756 | 3 50 | 0 3312 | 1 44 | 4.94 | 1 11 | 4.60 | 2 86 | 1 75 |
| 215.5 | 1 144 | 62 1 | 20 00% | 196.4 | 1 144 | 0 09773 | 7 853 | 3 50 | 0 3024 | 1 44 | 4 94 | 1.14 | 4 64 | 2.89 | 1 75 |

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AEP
AMERICAN ELECTRIC POWER

# Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10906
Point: C

**Material Description:** Boring PZ-0901, Shelby Tube - 26' - 28'; Lab # S-10906

**Moisture Determination ASTM D2216**

| | Before Testing | After Testing |
|---|---|---|
| Tare No. | T-29 | T-29 |
| Mass of Container and Wet Specimen (Mcws), grams | 1460.95 | 1459.15 |
| Mass of Container and Over Dry Specimen (Mcs), grams | 1228.10 | 1228.10 |
| Mass of Container (Mc), grams | 207.93 | 207.93 |
| Mass of Water (Mw), grams: | 232.85 | 231.05 |
| Mass of Solid Particles (Ms), grams: | 1020.17 | 1020.17 |
| Moisture Content (w), % | 22.82% | 22.65% |

**Initial Condition of Speciman ASTM D2435**

| | (1) | (2) | (3) | Average |
|---|---|---|---|---|
| Diameter Measurents, Inches: | 2.853 | 2.842 | 2.843 | 2.846 |
| Height Measurements, Inches: | 5.85 | 5.842 | 5.853 | 5.848 |
| Initial Volume of Specimen (Vo), In.3: | 37.20 | | | |
| Dry Mass of Specimen After Testing, (Md), grams: | 1020.17 | | | |
| Dry Unit Weight, (γ d) pcf: | 104.46 | | | |
| Specific Gravity of the Solids, (G): | 2.70 | | | |
| Volume of Solids, (Vs), Cu. In.: | 23.0574 | | | |
| Height of Solids,( Hs),In.: | 3.6245 | | | |
| Void Ratio Before Consolidation (Eo): | 0.6136 | | | |
| Intitail Degree of Saturation: (So) | 100.44% | | | |

**Saturation - ASTM D4767 Section 8.2**

| | |
|---|---|
| Dial Indicator Reading Prior to Saturation (Rb:) In. | 0 |
| Cell Pressure AfterSaturation, psi: | 80.00 |
| Back Presssure After Saturation After, psi: | 60.00 |
| Pore Pressure Paramenter B: | 1 |
| Dial Indicator Reading After Saturation, (Ra) In.: | -0.008 |
| Change in Height during Satureation, (Delta Hs) In. | -0.008 |
| Change In Volume of Specimen during Saturation (Delta Vsat), In.3: | -0.153 |

Report Date: Friday, August 14, 2009

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AEP AMERICAN ELECTRIC POWER

## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10906
Point: C

**Consolidation- ASTM D2435, Section 11.5:**

| Sample No: | T: | Burette 2: | Burette3: | Rc: |
|---|---|---|---|---|
| 10906 | 0 | 23.7 | 23.6 | -0.008 |
| 10906 | 0.25 | 23.2 | 23.4 | |
| 10906 | 0.5 | 23.1 | 23.3 | |
| 10906 | 1 | 22.9 | 23.3 | |
| 10906 | 2 | 22.7 | 23.2 | |
| 10906 | 4 | 22.3 | 23.1 | |
| 10906 | 8 | 21.9 | 22.9 | |
| 10906 | 15 | 21.3 | 22.7 | 0.004 |
| 10906 | 30 | 20.4 | 22.4 | 0.006 |
| 10906 | 60 | 19.3 | 22 | 0.012 |
| 10906 | 120 | 18 | 21.5 | 0.018 |
| 10906 | 240 | 17 | 21 | 0.022 |
| 10906 | 450 | 16.3 | 20.7 | 0.026 |
| 10906 | 1440 | 15.8 | 20.5 | 0.029 |

**Specimen Height After Consolidation, (Hc), In.:** 5.82

**Volume Change During Consolidation (Delta Vc), In.3:** 0.67

**Cross-Sectional Area of Specimen After Consolidation (Ac), In.2:** 6.30

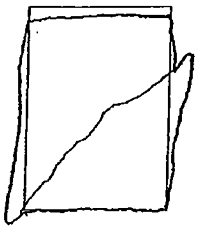
**Triaxial Compression Testing**
**ASTM D 4767**

**Sample Depth:** 26 ft.
**Cell Pressure:** 80 psi
**Back Pressure:** 60 psi
**Confining Pressure:** 20 psi
**Strain Rate:** 0.006 In/min.

**Specimen Height After Consolidation, (Hc), In.:** 5.82
**Correction for Vert Displacement, In.:** 0
**Load due to Friction and Uplift:** 17.9 lbs.
**Correction for Filter Paper:** 0
**Thickness of Membrane (tm), In.:** 0.012

$\sigma 1-\sigma 3=$ **Deviator Stress at Failure, ksf:** 4.84
$\sigma 3$ f= **Effective Consolidation Stress at Failure, ksf:** 2.88
$\sigma 1=$ **Total Major Principal Stress at Failure:** 7.72
$\sigma$ '3f= $\sigma 3-\Delta u=$ **Effective Minor Principal Stress at Failure,ksf:** 1.53
$\sigma$ '1f= **Effective Major Principal Stress at Failure, ksf:** 6.36
**Axial Strain at Failure:** 11.00%

**Failure Sketch**



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AEP
AMERICAN ELECTRIC POWER

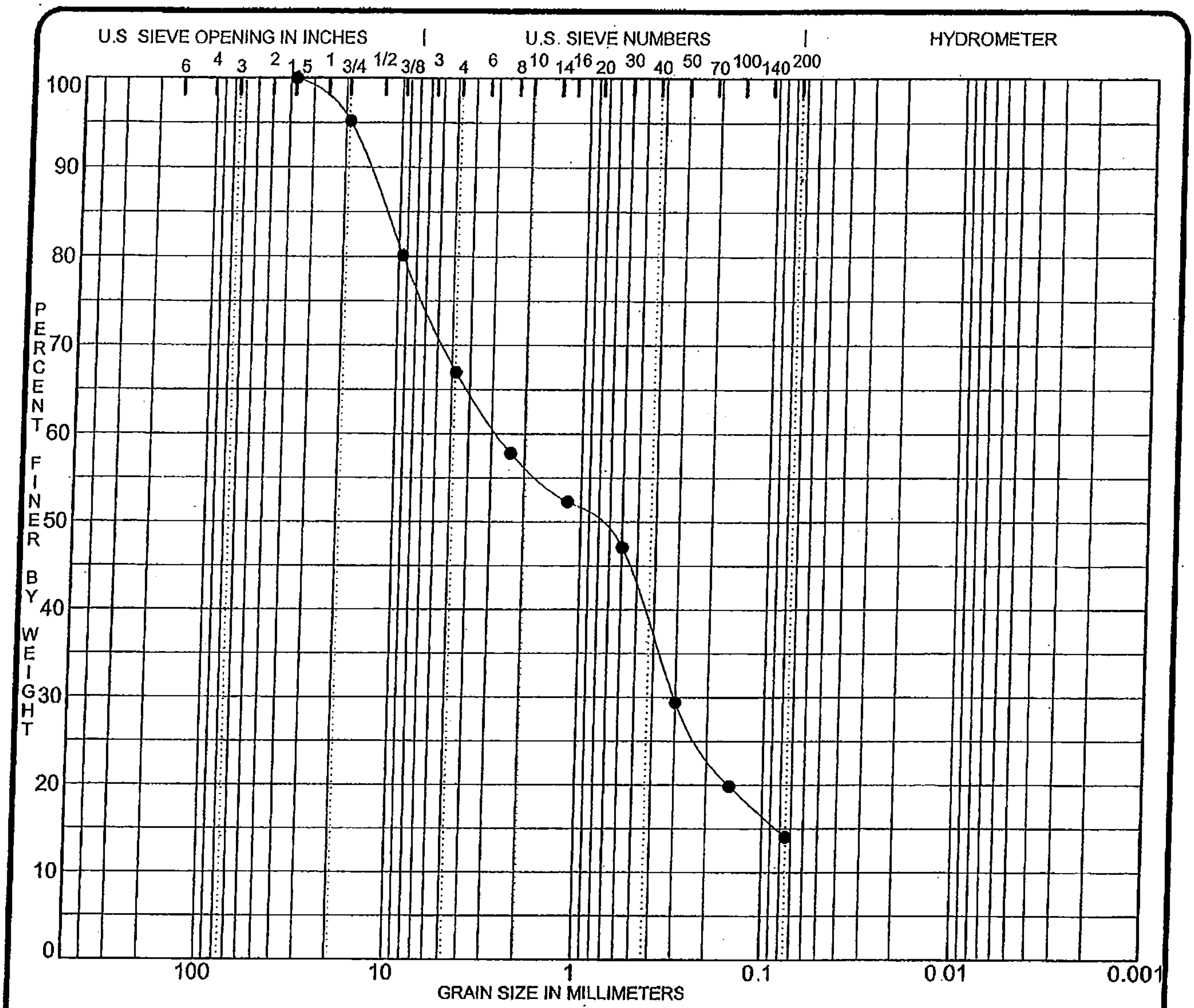
## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10906
Point: C

| Pa: Applied Force | Vertical Displacement Reading In.: | Pore Pressure psi: | Axial Strain (E1): | (P) - Force Adj for U and F lbs: | Corrected Vertical Displac In.: | Correction for Membrane ksf: | (A) Area In 2: | (σ1−σ3) Deviator Stress ksf: | [Δu] Induced Pore Water Pressure ksf: | σ3 Effective Consolidation Stress ksf | σ1 Total Major Principal Stress ksf | σ3 Effective Minor Principal Stress ksf | σ1 ' Effective Major Principal Stress ksf | p' | q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 9 | 0.000 | 62.0 | 0.00% | 0.0 | 0.000 | 0 00000 | 6 304 | 0.00 | 0.2880 | 2.88 | 2 88 | 2.59 | 2 59 | 2.59 | 0.00 |
| 64 6 | 0.003 | 65 6 | 0 05% | 46.7 | 0 003 | 0.00025 | 6 307 | 1.07 | 0.8064 | 2.88 | 3.95 | 2.07 | 3.14 | 2.61 | 0 53 |
| 75.4 | 0.006 | 67.9 | 0 10% | 57.5 | 0 006 | 0 00047 | 6.310 | 1 31 | 1.1376 | 2 88 | 4 19 | 1 74 | 3 05 | 2 40 | 0 66 |
| 86.6 | 0.009 | 69 0 | 0.16% | 68.7 | 0.009 | 0 00079 | 6 314 | 1 57 | 1.2960 | 2.88 | 4 45 | 1.58 | 3.15 | 2 37 | 0 78 |
| 90.4 | 0 011 | 69 4 | 0.20% | 72 5 | 0.011 | 0.00096 | 6.316 | 1.65 | 1 3536 | 2.88 | 4.53 | 1 53 | 3.18 | 2 35 | 0.83 |
| 94.7 | 0.014 | 71 0 | 0 25% | 76.8 | 0.014 | 0.00121 | 6.320 | 1.75 | 1.5840 | 2 88 | 4 63 | 1 30 | 3.04 | 2.17 | 0 87 |
| 100.0 | 0.018 | 71 0 | 0 31% | 82.1 | 0 018 | 0 00151 | 6.324 | 1 87 | 1.5840 | 2.88 | 4.75 | 1.30 | 3.16 | 2 23 | 0.93 |
| 103.4 | 0.020 | 71.0 | 0 35% | 85.5 | 0.020 | 0 00169 | 6 326 | 1 94 | 1 5840 | 2.88 | 4 82 | 1 30 | 3 24 | 2.27 | 0.97 |
| 106 1 | 0 023 | 71 1 | 0.40% | 88 2 | 0.023 | 0 00195 | 6.329 | 2.00 | 1.5984 | 2 88 | 4 88 | 1.28 | 3 29 | 2 28 | 1.00 |
| 109.9 | 0 027 | 73 4 | 0.46% | 92 0 | 0 027 | 0.00223 | 6.333 | 2.09 | 1 9296 | 2.88 | 4.97 | 0 95 | 3 04 | 2 00 | 1.04 |
| 112.2 | 0.029 | 72.9 | 0 50% | 94.3 | 0 029 | 0.00243 | 6 336 | 2 14 | 1 8576 | 2 88 | 5 02 | 1 02 | 3 16 | 2.09 | 1 07 |
| 115.9 | 0.033 | 73.0 | 0.56% | 98.0 | 0.033 | 0 00275 | 6 340 | 2 22 | 1.8720 | 2.88 | 5 10 | 1.01 | 3 23 | 2 12 | 1.11 |
| 118.3 | 0.036 | 73 2 | 0.61% | 100.4 | 0.036 | 0 00298 | 6.343 | 2 28 | 1.9008 | 2.88 | 5.16 | 0 98 | 3 26 | 2.12 | 1 14 |
| 120 1 | 0 038 | 73 5 | 0.65% | 102 2 | 0 038 | 0.00317 | 6.345 | 2 32 | 1 9440 | 2 88 | 5 20 | 0.94 | 3.25 | 2.09 | 1.16 |
| 122.4 | 0 041 | 73 7 | 0 70% | 104 5 | 0 041 | 0 00340 | 6 348 | 2 37 | 1 9728 | 2 88 | 5 25 | 0 91 | 3 27 | 2.09 | 1 18 |
| 124.8 | 0.044 | 73 9 | 0 75% | 106 9 | 0 044 | 0 00366 | 6 352 | 2 42 | 2.0016 | 2.88 | 5.30 | 0 88 | 3.30 | 2.09 | 1 21 |
| 127.3 | 0 047 | 74.0 | 0.80% | 109.4 | 0.047 | 0.00391 | 6.355 | 2.48 | 2 0160 | 2 88 | 5 36 | 0.86 | 3 34 | 2 10 | 1 24 |
| 129.4 | 0 049 | 74.0 | 0.85% | 111.5 | 0 049 | 0 00414 | 6.358 | 2 52 | 2 0160 | 2 88 | 5 40 | 0 86 | 3.39 | 2.12 | 1 26 |
| 131 9 | 0 053 | 74.4 | 0.91% | 114.0 | 0 053 | 0 00443 | 6 362 | 2 58 | 2.0736 | 2 88 | 5.46 | 0 81 | 3.38 | 2 09 | 1 29 |
| 133.9 | 0.056 | 74 7 | 0.96% | 116 0 | 0.056 | 0 00466 | 6 365 | 2.62 | 2.1168 | 2.88 | 5 50 | 0 76 | 3 38 | 2 07 | 1.31 |
| 136.3 | 0.058 | 74 7 | 1 00% | 118 4 | 0.058 | 0.00488 | 6.368 | 2 67 | 2 1168 | 2 88 | 5.55 | 0 76 | 3.44 | 2.10 | 1 34 |
| 152.8 | 0.087 | 75.9 | 1 50% | 134.9 | 0 087 | 0.00733 | 6.400 | 3 03 | 2 2896 | 2.88 | 5 91 | 0.59 | 3 62 | 2 10 | 1.51 |
| 167 3 | 0 116 | 76.5 | 2 00% | 149.4 | 0 116 | 0.00974 | 6 433 | 3.33 | 2.3760 | 2.88 | 6 21 | 0 50 | 3 84 | 2 17 | 1 67 |
| 180 1 | 0 146 | 76.5 | 2 50% | 162 2 | 0.146 | 0 01221 | 6 466 | 3.60 | 2 3760 | 2 88 | 6.48 | 0 50 | 4.10 | 2.30 | 1.80 |
| 191.1 | 0.174 | 76.1 | 3.00% | 173 2 | 0.174 | 0.01462 | 6.499 | 3 82 | 2 3184 | 2.88 | 6 70 | 0 56 | 4 38 | 2.47 | 1.91 |
| 200 1 | 0.204 | 76 0 | 3.50% | 182 2 | 0 204 | 0.01707 | 6.533 | 4 00 | 2 3040 | 2 88 | 6.88 | 0 58 | 4.58 | 2.58 | 2 00 |
| 207 7 | 0 233 | 75.5 | 4.00% | 189.8 | 0 233 | 0.01952 | 6 567 | 4.14 | 2.2320 | 2 88 | 7.02 | 0.65 | 4 79 | 2 72 | 2 07 |
| 214.5 | 0 262 | 75.0 | 4 50% | 196 6 | 0 262 | 0 02195 | 6.601 | 4 27 | 2 1600 | 2.88 | 7 15 | 0.72 | 4 99 | 2 85 | 2.13 |
| 220.7 | 0.291 | 74 6 | 5 00% | 202 8 | 0 291 | 0.02440 | 6.636 | 4 38 | 2.1024 | 2.88 | 7 26 | 0 78 | 5 15 | 2.97 | 2 19 |
| 226.2 | 0.320 | 74 1 | 5.50% | 208.3 | 0 320 | 0.02683 | 6.671 | 4 47 | 2.0304 | 2 88 | 7 35 | 0.85 | 5.32 | 3 08 | 2 23 |
| 230 7 | 0.349 | 73 9 | 6.00% | 212.8 | 0.349 | 0.02926 | 6 706 | 4.54 | 2.0016 | 2.88 | 7 42 | 0.88 | 5.42 | 3.15 | 2.27 |
| 234.8 | 0 378 | 73 3 | 6.50% | 216 9 | 0 378 | 0 03173 | 6 743 | 4.60 | 1 9152 | 2 88 | 7 48 | 0 96 | 5.57 | 3 27 | 2.30 |
| 238.9 | 0.407 | 72 9 | 7 00% | 221 0 | 0 407 | 0 03416 | 6.779 | 4.66 | 1.8576 | 2 88 | 7.54 | 1 02 | 5 68 | 3 35 | 2 33 |
| 242.5 | 0.437 | 72 7 | 7 50% | 224.6 | 0.437 | 0.03661 | 6.815 | 4.71 | 1 8288 | 2.88 | 7 59 | 1.05 | 5.76 | 3.41 | 2.35 |
| 245 5 | 0.466 | 71.1 | 8.00% | 227.6 | 0.466 | 0.03904 | 6.852 | 4.74 | 1.5984 | 2.88 | 7.62 | 1.28 | 6.03 | 3.65 | 2.37 |
| 248.5 | 0 495 | 71.0 | 8.50% | 230.6 | 0.495 | 0.04149 | 6 890 | 4.78 | 1 5840 | 2.88 | 7.66 | 1.30 | 6 07 | 3.69 | 2.39 |
| 250.9 | 0.524 | 71 0 | 9 00% | 233 0 | 0 524 | 0 04392 | 6.928 | 4.80 | 1.5840 | 2.88 | 7.68 | 1.30 | 6.10 | 3.70 | 2.40 |
| 253 3 | 0.553 | 71 0 | 9 50% | 235 4 | 0.553 | 0.04637 | 6.966 | 4 82 | 1 5840 | 2.88 | 7 70 | 1.30 | 6.12 | 3 71 | 2 41 |

Report Date: Friday August 14, 2009

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 255.5 | 0 582 | 70.5 | 10.00% | 237.6 | 0 582 | 0 04878 | 7.004 | 4 84 | 1 5120 | 2.88 | 7 72 | 1.37 | 6 20 | 3.79 | 2 42 |
| 258 4 | 0 640 | 69.4 | 11 00% | 240 5 | 0.640 | 0.05366 | 7.083 | 4 84 | 1 3536 | 2.88 | 7 72 | 1 53 | 6 36 | 3 94 | 2.42 |
| 260.4 | 0.699 | 68.6 | 12 00% | 242 5 | 0.699 | 0 05858 | 7 164 | 4 82 | 1.2384 | 2 88 | 7 70 | 1.64 | 6.46 | 4.05 | 2 41 |
| 261.6 | 0.756 | 67.6 | 13.00% | 243.7 | 0.756 | 0 06342 | 7 246 | 4.78 | 1 0944 | 2.88 | 7.66 | 1 79 | 6 57 | 4.18 | 2.39 |
| 261.4 | 0.815 | 66 9 | 14.00% | 243.5 | 0 815 | 0 06830 | 7.330 | 4 72 | 0 9936 | 2 88 | 7 60 | 1.89 | 6.60 | 4 24 | 2 36 |
| 262 5 | 0 873 | 66 1 | 15.00% | 244 6 | 0 873 | 0.07320 | 7.417 | 4 68 | 0.8784 | 2 88 | 7 56 | 2 00 | 6 68 | 4.34 | 2.34 |
| 263 7 | 0 931 | 65 6 | 16.00% | 245 8 | 0.931 | 0 07806 | 7 505 | 4 64 | 0.8064 | 2.88 | 7.52 | 2 07 | 6.71 | 4.39 | 2 32 |
| 267 4 | 0 990 | 65 0 | 17.01% | 249 5 | 0.990 | 0.08298 | 7 596 | 4 65 | 0 7200 | 2.88 | 7 53 | 2 16 | 6 81 | 4 48 | 2 32 |
| 269 3 | 1 047 | 64.6 | 18 00% | 251 4 | 1.047 | 0 08782 | 7.688 | 4.62 | 0 6624 | 2 88 | 7 50 | 2 22 | 6 84 | 4.53 | 2 31 |
| 271 6 | 1 106 | 64 2 | 19 00% | 253.7 | 1.106 | 0 09270 | 7.783 | 4.60 | 0.6048 | 2.88 | 7.48 | 2.28 | 6.88 | 4 58 | 2 30 |
| 274 8 | 1 164 | 64.0 | 20 00% | 256 9 | 1 164 | 0 09760 | 7.880 | 4 60 | 0.5760 | 2.88 | 7 48 | 2 30 | 6 90 | 4 60 | 2.30 |



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | PZ-0902 | 8.5 | | | NP | NP | NP | |
| | | | SILTY SAND with GRAVEL SM | | | | | |
| | | | Sand & Gravel Mixture - Samples 4,5,6 Combined | | | | | |
| | | | | | | | | |
| | | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | PZ-0902 | 8.5 | 37.500 | 2.790 | 0.307 | | 33.0 | 52.9 | 14.0 | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

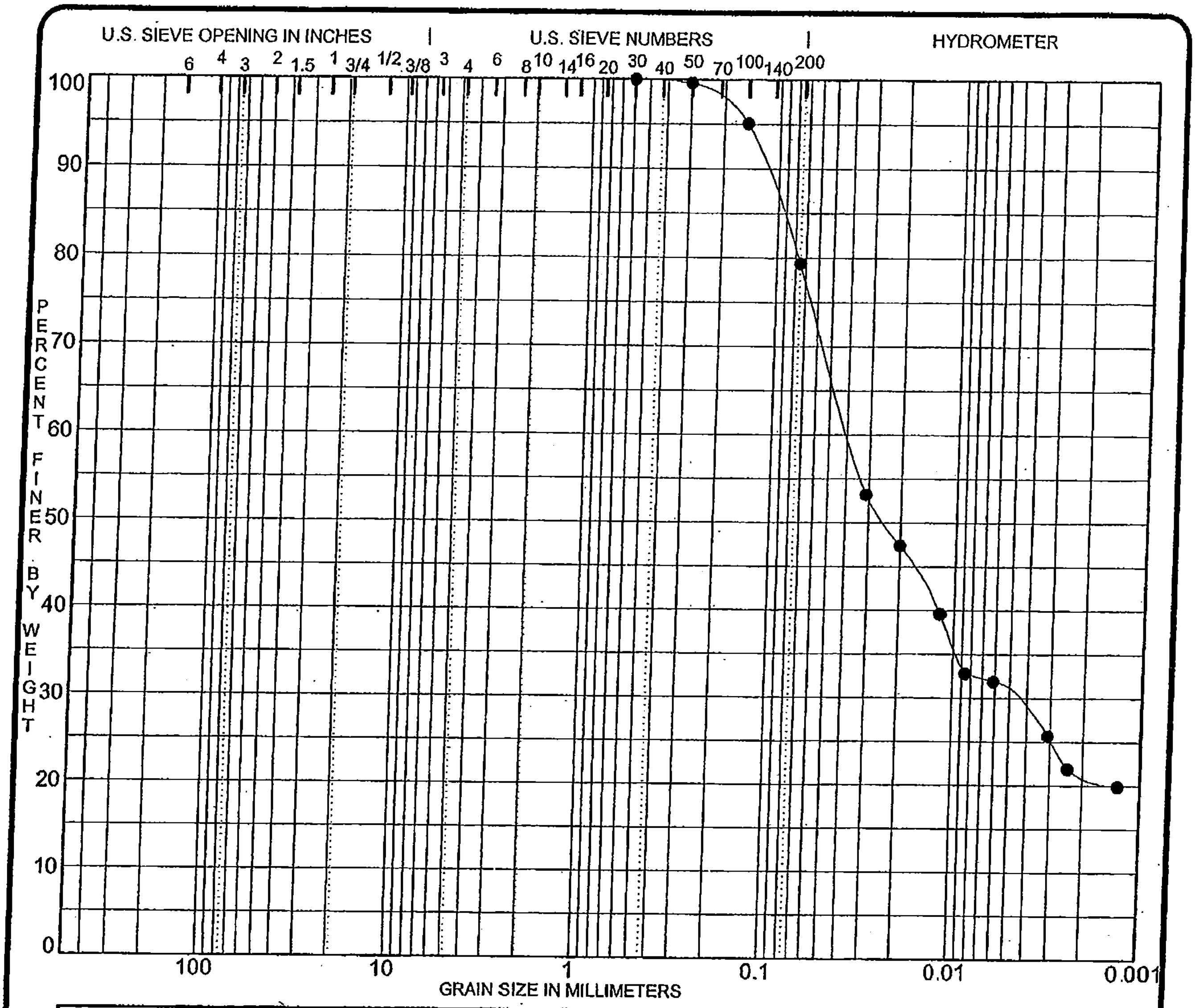
PROJECT SPORN PLANT - FLY ASH POND DIKES - FLY ASH POND DIKES

JOB NO.

DATE 8/14/09

# GRADATION CURVES

American Electric Power Service Corp.
Groveport, OH 43125



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|---|---|
| ● | PZ-0902 | 31.0 | | | 29.5 | 17.4 | 12.2 | | |
| | | | **LEAN CLAY with SAND CL** | | | | | | |
| | | | **Shelby Tube Sample - 31' - 33'** | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | PZ-0902 | 31.0 | 0.600 | 0.039 | 0.005 | | 0.0 | 20.6 | 79.4 | 21.3 |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

PROJECT **SPORN PLANT - FLY ASH POND DIKES - FLY ASH POND DIKES**

JOB NO.

DATE 8/14/09

## GRADATION CURVES

American Electric Power Service Corp.
Groveport, OH 43125

AEP

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AMERICAN ELECTRIC POWER SERVICE CORPORATION
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GROVEPORT, OHIO 43125
(614) 836-4200

AEP
AMERICAN ELECTRIC POWER

# Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

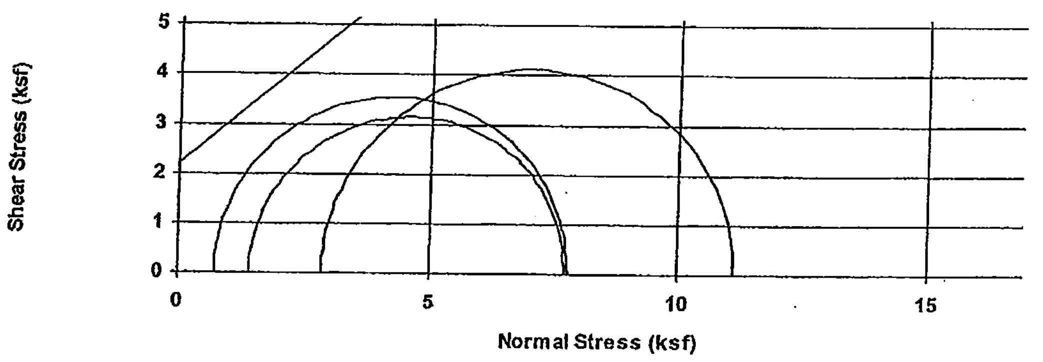
Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918

**Material Description:** Boring PZ-0902, Shelby Tube - 31' - 33'; Lab # S-10918

| Point Designation | Initial Conditions | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|
| | Water Content, % | Dry Density, pcf | Degree of Saturation | Water Content, % | Confining Stress, (ksf) | Deviator Stress | Induced Pore Pressure (ksf) |
| A | 16.2% | 117.4 | 100.5% | 16.62% | 0.72 | 7.09 | -1.15 |
| B | 17.2% | 114.3 | 98.1% | 17.6% | 1.44 | 6.30 | -0.42 |
| C | 17.3% | 114.5 | 98.8% | 17.4% | 2.88 | 8.24 | 0.60 |

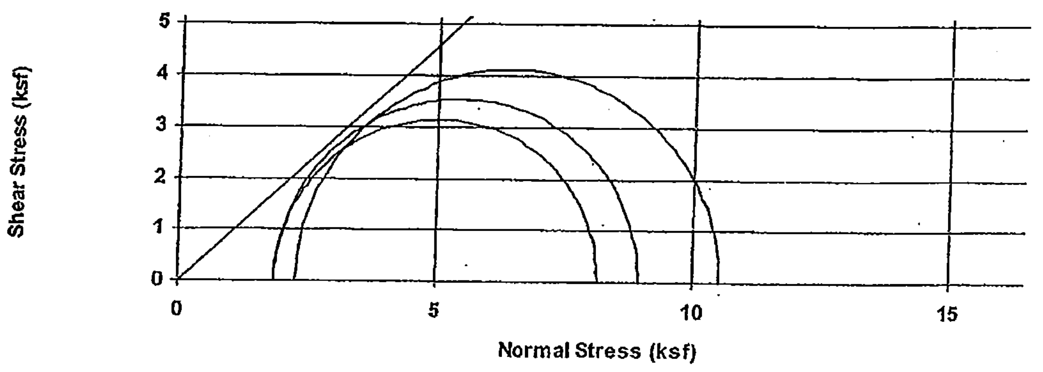
| Point Designation | Axial Strain, % | q, (ksf) | Effective Stresses, (ksf) | | | Total Stresses, (ksf) | | |
|---|---|---|---|---|---|---|---|---|
| | | | Major, (ksf) | Minor, (ksf) | p', (ksf) | Major, (ksf) | Minor, (ksf) | p, (ksf) |
| A | 15.0% | 3.54 | 8.96 | 1.87 | 5.42 | 7.81 | 0.72 | 4.26 |
| B | 15.0% | 3.15 | 8.16 | 1.86 | 5.01 | 7.74 | 1.44 | 4.59 |
| C | 15.0% | 4.12 | 10.52 | 2.28 | 6.40 | 11.12 | 2.88 | 7.00 |

## Total Stress Envelope



φ: 40.0 °
c : 2.20 ksf

## Effective Stress Envelope



φ ': 42.7 °
c' : 0.00 ksf

Report Date: Friday, August 14, 2009

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AMERICAN ELECTRIC POWER SERVICE CORPORATION
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# Test Report for Consolidated-Undrained Triaxial Compression Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918

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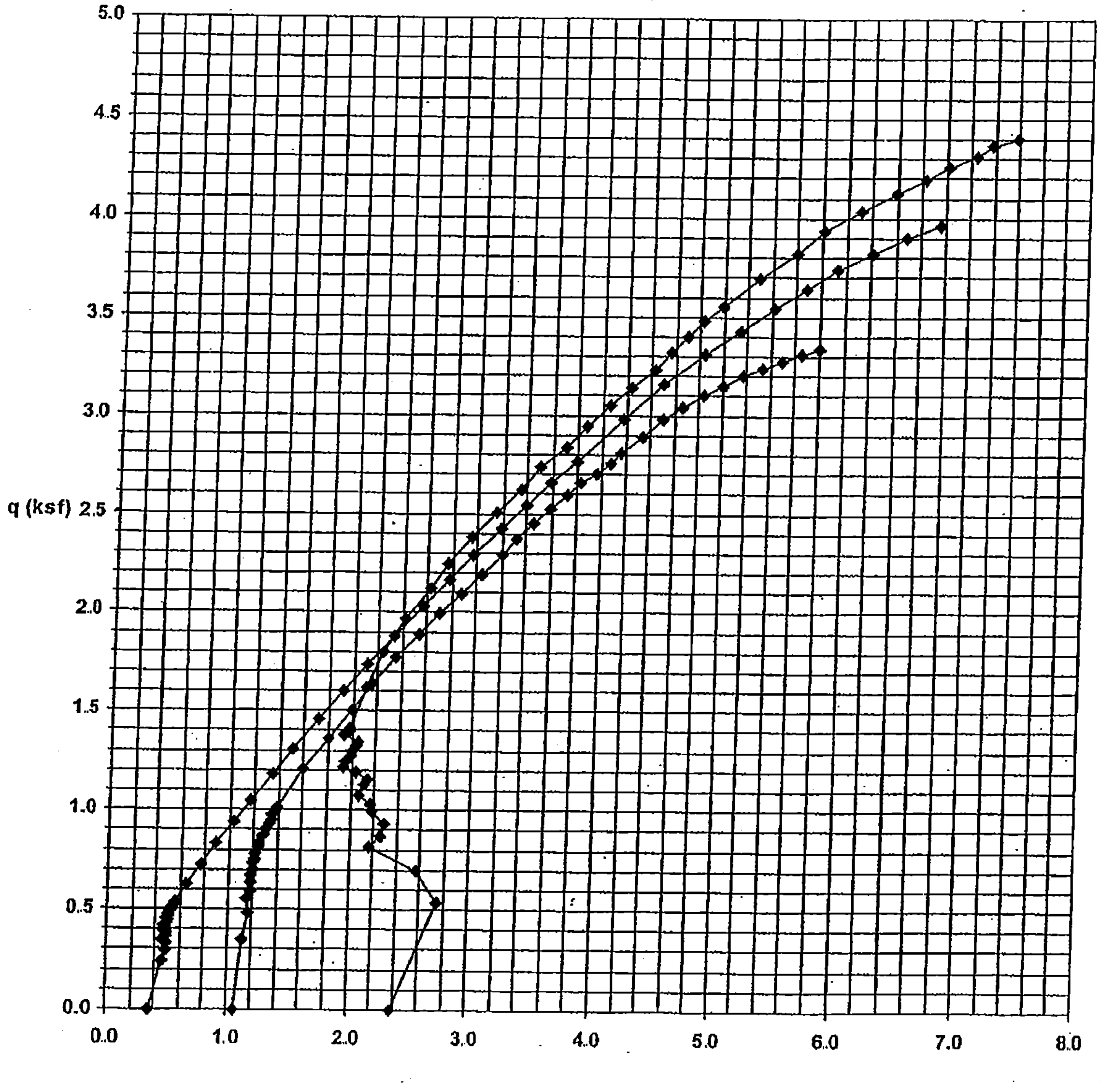
p'- q Diagram



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Report Date: Friday, August 14, 2009

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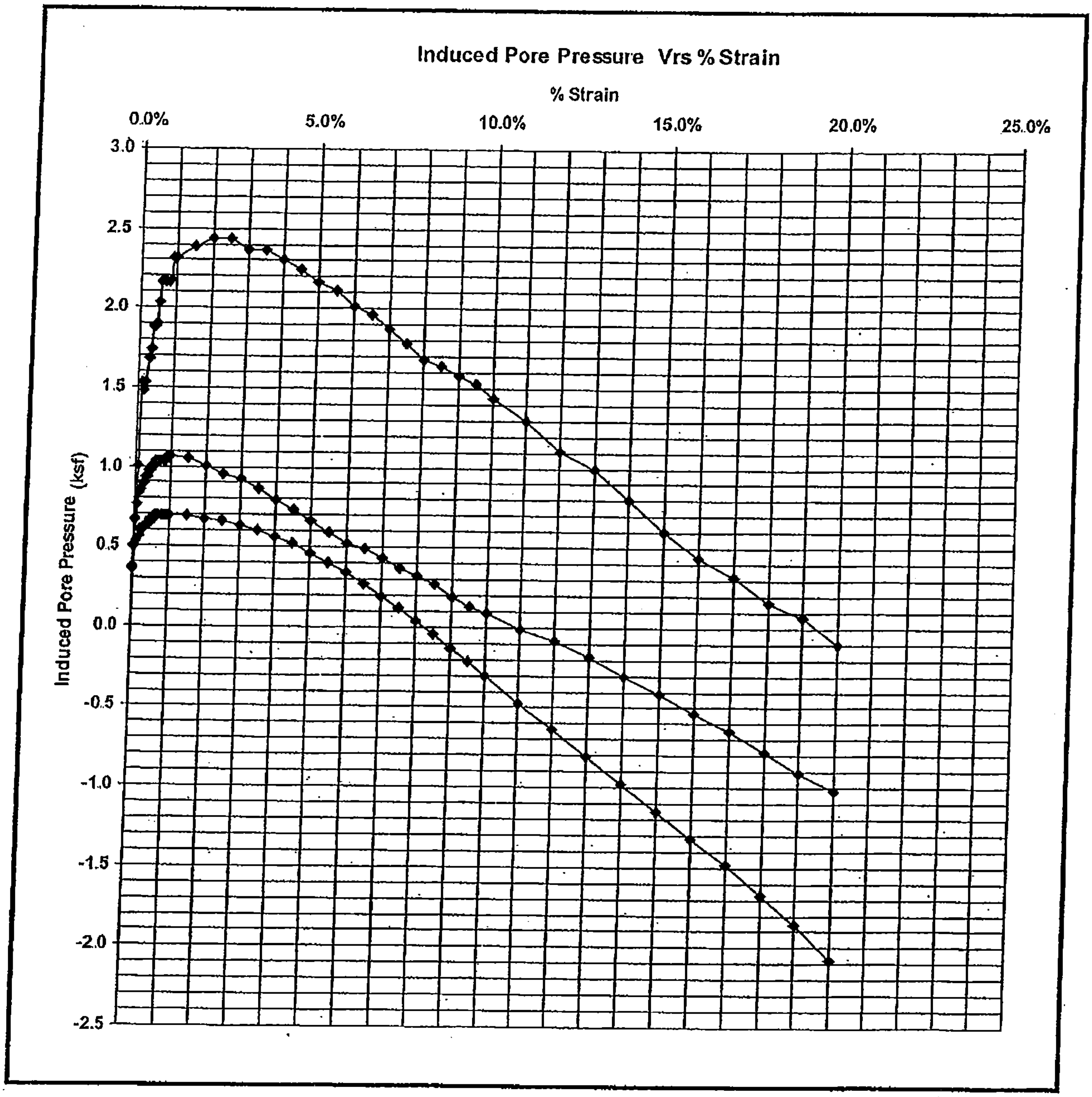
# Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918



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Report Date: Friday, August 14 2009

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**Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767**

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918

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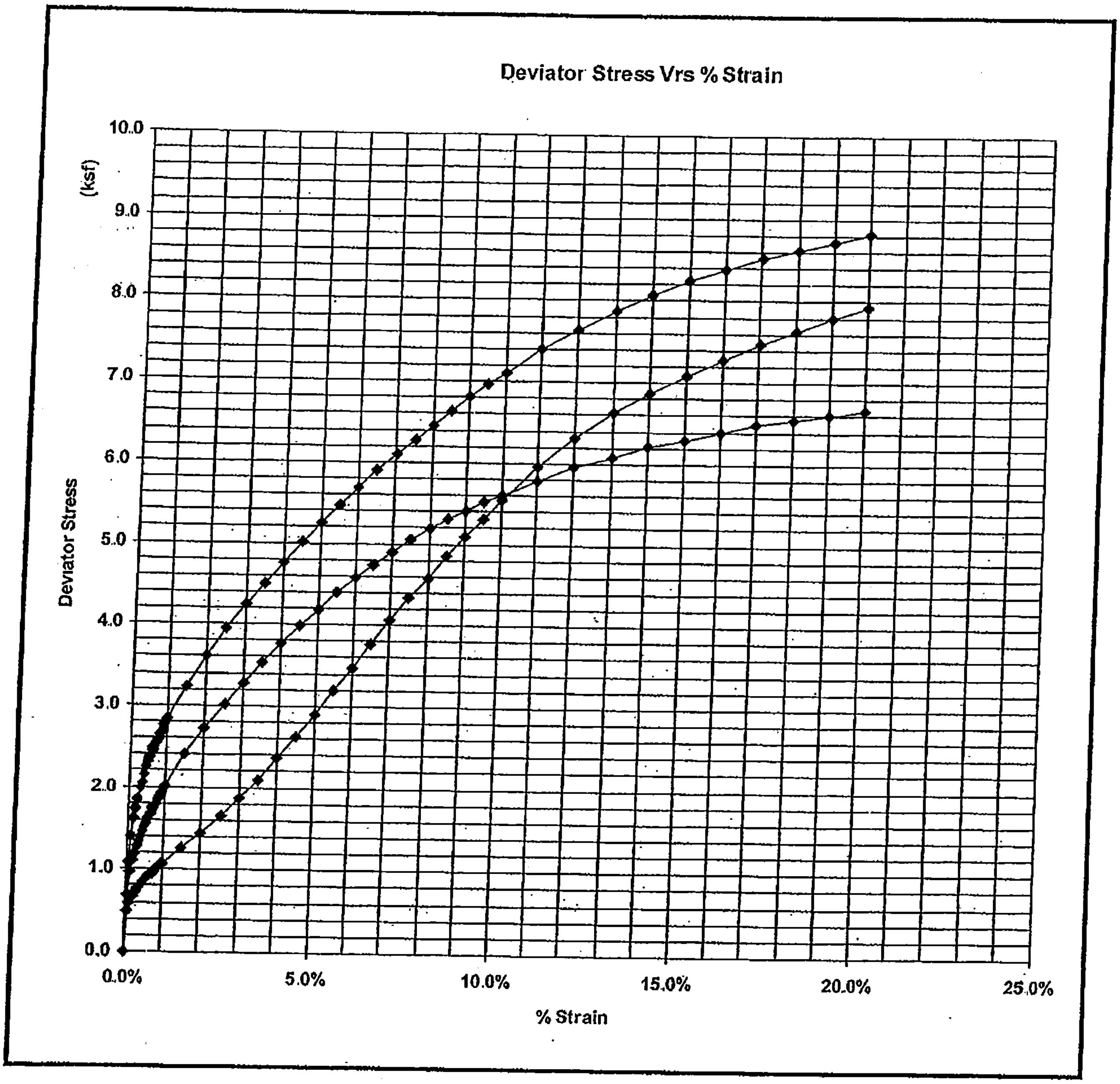

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Report Date: Friday, August 14, 2009

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## Test Report for Consolidated-Undrained Triaxial Compression Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918
Point: A

**Material Description:** Boring PZ-0902, Shelby Tube - 31' - 33'; Lab # S-10918

### Moisture Determination ASTM D2216

| | Before Testing | After Testing |
|---|---|---|
| Tare No. | #28 | #28 |
| Mass of Container and Wet Specimen (Mcws), grams | 1493.00 | 1497.17 |
| Mass of Container and Over Dry Specimen (Mcs), grams | 1313 92 | 1313.92 |
| Mass of Container (Mc), grams | 211.24 | 211.24 |
| Mass of Water (Mw), grams: | 179.08 | 183.25 |
| Mass of Solid Particles (Ms), grams: | 1102.68 | 1102.68 |
| Moisture Content (w), % | 16.24% | 16.62% |

### Initial Condition of Speciman ASTM D2435

| | (1) | (2) | (3) | Average |
|---|---|---|---|---|
| Diameter Measurents, Inches: | 2.813 | 2.803 | 2.824 | 2.813 |
| Height Measurements, Inches: | 5.763 | 5.753 | 5.757 | 5.758 |

Initial Volume of Specimen (Vo), In.3: 35 79
Dry Mass of Specimen After Testing, (Md), grams: 1102.68
Dry Unit Weight, (γ d) pcf: 117.37
Specific Gravity of the Solids, (G): 2.70
Volume of Solids, (Vs), Cu. In.: 24.9222
Height of Solids,( Hs),In.: 4.0092
Void Ratio Before Consolidation (Eo): 0.4361
Intitall Degree of Saturation: (So) 100 54%

### Saturation - ASTM D4767 Section 8.2

Dial Indicator Reading Prior to Saturation (Rb:) In. 0
Cell Pressure AfterSaturation, psi: 73.00
Back Presssure After Saturation After, psi: 70.00
Pore Pressure Paramenter B: 1
Dial Indicator Reading After Saturation, (Ra) In.: 0.003
Change in Height during Satureation, (Delta Hs) In. 0.003
Change In Volume of Specimen during Saturation (Delta Vsat), In.3: 0.056

Report Date: Friday, August 14, 2009

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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918
Point: A

**Consolidation- ASTM D2435, Section 11.5:**

| Sample No: | T: | Burette 2: | Burette3: | Rc: |
|---|---|---|---|---|
| 10918 | 0 | 23.7 | 24.1 | 0.003 |
| 10918 | 0.25 | 23.6 | 24 | |
| 10918 | 0.5 | 23.6 | 24 | |
| 10918 | 1 | 23.5 | 24 | |
| 10918 | 2 | 23.5 | 23.9 | |
| 10918 | 4 | 23.4 | 23.8 | |
| 10918 | 8 | 23.3 | 23.8 | |
| 10918 | 15 | 23.2 | 23.7 | 0.005 |
| 10918 | 30 | 23 | 23.6 | 0.005 |
| 10918 | 60 | 23 | 23.5 | 0.006 |
| 10918 | 180 | 22.9 | 23.4 | 0.007 |
| 10918 | 240 | 22.8 | 23.3 | 0.008 |
| 10918 | 454 | 22.8 | 23.3 | 0.009 |
| 10918 | 1440 | 22.9 | 23.1 | 0.01 |

Specimen Height After Consolidation, (Hc), In.: 5.75

Volume Change During Consolidation (Delta Vc), In.3: 0 11

Cross-Sectional Area of Specimen After Consolidation (Ac), In.2: 6.20

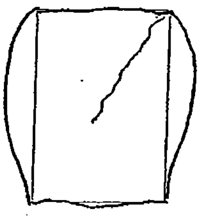
**Triaxial Compression Testing ASTM D 4767**

Sample Depth: 31 ft.
Cell Pressure: 75 psi
Back Pressure: 70 psi
Confining Pressure: 5 psi
Strain Rate: 0.006 in./min.

Specimen Height After Consolidation, (Hc), In.: 5.75
Correction for Vert Displacement, In.: 0
Load due to Friction and Uplift: 15 3 lbs.
Correction for Filter Paper: 0
Thickness of Membrane (tm), In.: 0.012

σ1−σ3= Deviator Stress at Failure, ksf: 7.09
σ3 f= Effective Consolidation Stress at Failure, ksf: 0.72
σ1= Total Major Principal Stress at Failure: 7.81
σ '3f= σ3− Δ υ= Effective Minor Principal Stress at Failure,ksf: 1.87
σ '1f= Effective Major Principal Stress at Failure, ksf: 8.96
Axial Strain at Failure: 15 00%

Failure Sketch



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**AMERICAN ELECTRIC POWER**

# Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918
Point: A

| Pa: Applied Force | Vertical Displacement Reading In.: | Pore Pressure psi: | Axial Strain (E1): | (P) - Force Adj for U and F lbs: | Corrected Vertical Displac In.: | Correction for Membrane ksf: | (A) Area In 2: | (σ1−σ3) Deviator Stress ksf: | [Δu] Induced Pore Water Pressure ksf: | σ3 Effective Consolidation Stress ksf | σ1 Total Major Principal Stress ksf | σ3 Effective Minor Principal Stress ksf | σ1 ' Effective Major Principal Stress ksf | p' | q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.3 | 0.001 | 72.5 | 0.01% | 0.0 | 0.001 | 0.00005 | 6.199 | 0.00 | 0.3600 | 0.72 | 0.72 | 0.36 | 0.36 | 0.36 | 0.00 |
| 36.2 | 0.003 | 73.5 | 0.05% | 20.9 | 0.003 | 0.00024 | 6.201 | 0.49 | 0.5040 | 0.72 | 1.21 | 0.22 | 0.70 | 0.46 | 0.24 |
| 41.0 | 0.006 | 73.7 | 0.10% | 25.7 | 0.006 | 0.00048 | 6.204 | 0.60 | 0.5328 | 0.72 | 1.32 | 0.19 | 0.78 | 0.49 | 0.30 |
| 44.2 | 0.009 | 73.9 | 0.16% | 28.9 | 0.009 | 0.00079 | 6.208 | 0.67 | 0.5616 | 0.72 | 1.39 | 0.16 | 0.83 | 0.49 | 0.33 |
| 45.4 | 0.012 | 74.2 | 0.20% | 30.1 | 0.012 | 0.00099 | 6.211 | 0.70 | 0.6048 | 0.72 | 1.42 | 0.12 | 0.81 | 0.46 | 0.35 |
| 47.1 | 0.014 | 74.2 | 0.25% | 31.8 | 0.014 | 0.00123 | 6.214 | 0.74 | 0.6048 | 0.72 | 1.46 | 0.12 | 0.85 | 0.48 | 0.37 |
| 48.5 | 0.018 | 74.3 | 0.31% | 33.2 | 0.018 | 0.00152 | 6.218 | 0.77 | 0.6192 | 0.72 | 1.49 | 0.10 | 0.87 | 0.48 | 0.38 |
| 49.3 | 0.020 | 74.4 | 0.35% | 34.0 | 0.020 | 0.00171 | 6.220 | 0.79 | 0.6336 | 0.72 | 1.51 | 0.09 | 0.87 | 0.48 | 0.39 |
| 50.5 | 0.023 | 74.4 | 0.40% | 35.2 | 0.023 | 0.00195 | 6.223 | 0.81 | 0.6336 | 0.72 | 1.53 | 0.09 | 0.90 | 0.49 | 0.41 |
| 51.8 | 0.026 | 74.6 | 0.46% | 36.5 | 0.026 | 0.00224 | 6.227 | 0.84 | 0.6624 | 0.72 | 1.56 | 0.06 | 0.90 | 0.48 | 0.42 |
| 52.9 | 0.029 | 74.6 | 0.50% | 37.6 | 0.029 | 0.00245 | 6.229 | 0.87 | 0.6624 | 0.72 | 1.59 | 0.06 | 0.92 | 0.49 | 0.43 |
| 54.1 | 0.032 | 74.6 | 0.56% | 38.8 | 0.032 | 0.00274 | 6.233 | 0.89 | 0.6624 | 0.72 | 1.61 | 0.06 | 0.95 | 0.50 | 0.45 |
| 55.1 | 0.035 | 74.8 | 0.61% | 39.8 | 0.035 | 0.00298 | 6.236 | 0.92 | 0.6912 | 0.72 | 1.64 | 0.03 | 0.94 | 0.49 | 0.46 |
| 55.9 | 0.037 | 74.8 | 0.65% | 40.6 | 0.037 | 0.00320 | 6.239 | 0.93 | 0.6912 | 0.72 | 1.65 | 0.03 | 0.96 | 0.50 | 0.47 |
| 56.9 | 0.040 | 74.8 | 0.70% | 41.6 | 0.040 | 0.00344 | 6.242 | 0.96 | 0.6912 | 0.72 | 1.68 | 0.03 | 0.99 | 0.51 | 0.48 |
| 57.8 | 0.043 | 74.8 | 0.75% | 42.5 | 0.043 | 0.00370 | 6.245 | 0.98 | 0.6912 | 0.72 | 1.70 | 0.03 | 1.01 | 0.52 | 0.49 |
| 58.8 | 0.046 | 74.8 | 0.80% | 43.5 | 0.046 | 0.00396 | 6.248 | 1.00 | 0.6912 | 0.72 | 1.72 | 0.03 | 1.03 | 0.53 | 0.50 |
| 59.6 | 0.049 | 74.8 | 0.85% | 44.3 | 0.049 | 0.00418 | 6.251 | 1.02 | 0.6912 | 0.72 | 1.74 | 0.03 | 1.05 | 0.54 | 0.51 |
| 60.7 | 0.053 | 74.8 | 0.92% | 45.4 | 0.053 | 0.00450 | 6.256 | 1.04 | 0.6912 | 0.72 | 1.76 | 0.03 | 1.07 | 0.55 | 0.52 |
| 61.5 | 0.055 | 74.8 | 0.96% | 46.2 | 0.055 | 0.00473 | 6.258 | 1.06 | 0.6912 | 0.72 | 1.78 | 0.03 | 1.09 | 0.56 | 0.53 |
| 62.2 | 0.057 | 74.8 | 1.00% | 46.9 | 0.057 | 0.00491 | 6.261 | 1.07 | 0.6912 | 0.72 | 1.79 | 0.03 | 1.10 | 0.57 | 0.54 |
| 70.4 | 0.086 | 74.8 | 1.50% | 55.1 | 0.086 | 0.00740 | 6.293 | 1.25 | 0.6912 | 0.72 | 1.97 | 0.03 | 1.28 | 0.66 | 0.63 |
| 79.3 | 0.115 | 74.7 | 2.00% | 64.0 | 0.115 | 0.00985 | 6.325 | 1.45 | 0.6768 | 0.72 | 2.17 | 0.04 | 1.49 | 0.77 | 0.72 |
| 89.3 | 0.144 | 74.6 | 2.50% | 74.0 | 0.144 | 0.01231 | 6.357 | 1.66 | 0.6624 | 0.72 | 2.38 | 0.06 | 1.72 | 0.89 | 0.83 |
| 99.4 | 0.173 | 74.4 | 3.00% | 84.1 | 0.173 | 0.01478 | 6.390 | 1.88 | 0.6336 | 0.72 | 2.60 | 0.09 | 1.97 | 1.03 | 0.94 |
| 109.4 | 0.201 | 74.2 | 3.50% | 94.1 | 0.201 | 0.01721 | 6.423 | 2.09 | 0.6048 | 0.72 | 2.81 | 0.12 | 2.21 | 1.16 | 1.05 |
| 121.9 | 0.230 | 73.9 | 4.00% | 106.6 | 0.230 | 0.01969 | 6.457 | 2.36 | 0.5616 | 0.72 | 3.08 | 0.16 | 2.52 | 1.34 | 1.18 |
| 134.4 | 0.259 | 73.6 | 4.50% | 119.1 | 0.259 | 0.02214 | 6.490 | 2.62 | 0.5184 | 0.72 | 3.34 | 0.20 | 2.82 | 1.51 | 1.31 |
| 148.2 | 0.288 | 73.2 | 5.01% | 132.9 | 0.288 | 0.02464 | 6.525 | 2.91 | 0.4608 | 0.72 | 3.63 | 0.26 | 3.17 | 1.71 | 1.45 |
| 162.0 | 0.316 | 72.8 | 5.50% | 146.7 | 0.316 | 0.02705 | 6.559 | 3.19 | 0.4032 | 0.72 | 3.91 | 0.32 | 3.51 | 1.91 | 1.60 |
| 175.8 | 0.345 | 72.4 | 6.00% | 160.5 | 0.345 | 0.02952 | 6.594 | 3.48 | 0.3456 | 0.72 | 4.20 | 0.37 | 3.85 | 2.11 | 1.74 |
| 190.0 | 0.374 | 71.9 | 6.50% | 174.7 | 0.374 | 0.03199 | 6.629 | 3.76 | 0.2736 | 0.72 | 4.48 | 0.45 | 4.21 | 2.33 | 1.88 |
| 204.9 | 0.402 | 71.3 | 7.00% | 189.6 | 0.402 | 0.03445 | 6.665 | 4.06 | 0.1872 | 0.72 | 4.78 | 0.53 | 4.59 | 2.56 | 2.03 |
| 218.5 | 0.431 | 70.8 | 7.50% | 203.2 | 0.431 | 0.03690 | 6.701 | 4.33 | 0.1152 | 0.72 | 5.05 | 0.60 | 4.93 | 2.77 | 2.16 |
| 231.6 | 0.460 | 70.3 | 8.00% | 216.3 | 0.460 | 0.03937 | 6.737 | 4.58 | 0.0432 | 0.72 | 5.30 | 0.68 | 5.26 | 2.97 | 2.29 |
| 245.2 | 0.489 | 69.7 | 8.50% | 229.9 | 0.489 | 0.04183 | 6.774 | 4.85 | -0.0432 | 0.72 | 5.57 | 0.76 | 5.61 | 3.19 | 2.42 |
| 257.8 | 0.517 | 69.1 | 9.00% | 242.5 | 0.517 | 0.04430 | 6.811 | 5.08 | -0.1296 | 0.72 | 5.80 | 0.85 | 5.93 | 3.39 | 2.54 |
| 270.3 | 0.546 | 68.5 | 9.50% | 255.0 | 0.546 | 0.04675 | 6.849 | 5.31 | -0.2160 | 0.72 | 6.03 | 0.94 | 6.25 | 3.59 | 2.66 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 282.4 | 0 575 | 67.9 | 10.00% | 267.1 | 0 575 | 0.04921 | 6.887 | 5 54 | -0 3024 | 0 72 | 6 26 | 1 02 | 6 56 | 3 79 | 2 77 |
| 306 0 | 0.632 | 66.7 | 11 00% | 290.7 | 0 632 | 0.05414 | 6.965 | 5 96 | -0 4752 | 0 72 | 6.68 | 1 20 | 7 15 | 4.17 | 2.98 |
| 326 7 | 0.690 | 65.6 | 12 00% | 311.4 | 0.690 | 0.05906 | 7 044 | 6 31 | -0 6336 | 0.72 | 7.03 | 1 35 | 7.66 | 4 51 | 3.15 |
| 346 2 | 0 747 | 64.4 | 13 00% | 330 9 | 0.747 | 0.06399 | 7 125 | 6 62 | -0 8064 | 0.72 | 7.34 | 1.53 | 8.15 | 4.84 | 3.31 |
| 362 1 | 0 805 | 63.2 | 14.00% | 346 8 | 0.805 | 0.06890 | 7 207 | 6.86 | -0 9792 | 0 72 | 7 58 | 1 70 | 8 56 | 5.13 | 3.43 |
| 378.0 | 0.862 | 62.0 | 15.00% | 362 7 | 0.862 | 0 07383 | 7.292 | 7 09 | -1.1520 | 0 72 | 7 81 | 1.87 | 8 96 | 5.42 | 3.54 |
| 392.6 | 0 920 | 60.8 | 16.00% | 377.3 | 0.920 | 0 07875 | 7.379 | 7 28 | -1.3248 | 0.72 | 8 00 | 2.04 | 9 33 | 5.69 | 3 64 |
| 407.1 | 0 977 | 59 7 | 17 01% | 391 8 | 0 977 | 0 08368 | 7 468 | 7.47 | -1 4832 | 0.72 | 8 19 | 2 20 | 9 67 | 5 94 | 3 74 |
| 421 0 | 1.035 | 58 4 | 18 00% | 405.7 | 1 035 | 0 08859 | 7 559 | 7.64 | -1.6704 | 0.72 | 8 36 | 2 39 | 10 03 | 6.21 | 3 82 |
| 434.8 | 1.092 | 57 1 | 19 01% | 419 5 | 1 092 | 0 09353 | 7 653 | 7.80 | -1.8576 | 0.72 | 8 52 | 2.58 | 10 38 | 6.48 | 3 90 |
| 447 2 | 1 150 | 55 6 | 20 01% | 431 9 | 1.150 | 0 09846 | 7 749 | 7.93 | -2.0736 | 0 72 | 8 65 | 2 79 | 10 72 | 6 76 | 3 96 |

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# Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918
Point: B

**Material Description:** Boring PZ-0902, Shelby Tube - 31' - 33'; Lab # S-10918

## Moisture Determination ASTM D2216

| | Before Testing | After Testing |
|---|---|---|
| Tare No. | #900 | #900 |
| Mass of Container and Wet Specimen (Mcws), grams | 1499 01 | 1502 94 |
| Mass of Container and Over Dry Specimen (Mcs), grams | 1310.23 | 1310.23 |
| Mass of Container (Mc), grams | 215.43 | 215.43 |
| Mass of Water (Mw), grams: | 188.78 | 192.71 |
| Mass of Solid Particles (Ms), grams: | 1094.8 | 1094.8 |
| Moisture Content (w), % | 17.24% | 17.60% |

## Initial Condition of Speciman ASTM D2435

| | (1) | (2) | (3) | Average |
|---|---|---|---|---|
| Diameter Measurents, Inches: | 2.849 | 2.839 | 2.834 | 2.841 |
| Height Measurements, Inches: | 5.756 | 5.766 | 5.751 | 5.758 |

| | |
|---|---|
| Initial Volume of Specimen (Vo), In.3: | 36.49 |
| Dry Mass of Specimen After Testing, (Md), grams: | 1094.8 |
| Dry Unit Weight, (γ d) pcf: | 114.30 |
| Specific Gravity of the Solids, (G): | 2 70 |
| Volume of Solids, (Vs), Cu. In.: | 24.7441 |
| Height of Solids,( Hs),In.: | 3.9043 |
| Void Ratio Before Consolidation (Eo): | 0.4747 |
| Intitail Degree of Saturation: (So) | 98 07% |

## Saturation - ASTM D4767 Section 8.2

| | |
|---|---|
| Dial Indicator Reading Prior to Saturation (Rb:) In. | 0 |
| Cell Pressure AfterSaturation, psi: | 75.00 |
| Back Presssure After Saturation After, psi: | 70.00 |
| Pore Pressure Paramenter B: | 0.99 |
| Dial Indicator Reading After Saturation, (Ra) In.: | 0.003 |
| Change In Height during Satureation, (Delta Hs) In. | 0.003 |
| Change In Volume of Specimen during Saturation (Delta Vsat), In.3: | 0.057 |

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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918
Point: B

**Consolidation- ASTM D2435, Section 11.5:**

| Sample No: | T: | Burette 2: | Burette3: | Rc: |
|---|---|---|---|---|
| 10918 | 0 | 24.1 | 23.9 | 0.003 |
| 10918 | 0.25 | 24 | 23.8 | |
| 10918 | 0.5 | 24 | 23.8 | |
| 10918 | 1 | 24 | 23.8 | |
| 10918 | 2 | 23.9 | 23.7 | |
| 10918 | 4 | 23.9 | 23.7 | |
| 10918 | 8 | 23.8 | 23.5 | |
| 10918 | 15 | 23.7 | 23.4 | 0.005 |
| 10918 | 30 | 23.6 | 23.2 | 0.006 |
| 10918 | 60 | 23.5 | 23.1 | 0.006 |
| 10918 | 180 | 23.4 | 23 | 0.007 |
| 10918 | 240 | 23.4 | 22.9 | 0.007 |
| 10918 | 452 | 23.3 | 22.9 | 0.008 |
| 10918 | 1440 | 23.3 | 22.9 | 0.008 |

Specimen Height After Consolidation, (Hc), In.: 5.75

Volume Change During Consolidation (Delta Vc), In.3: 0.11

Cross-Sectional Area of Specimen After Consolidation (Ac), In.2: 6.32

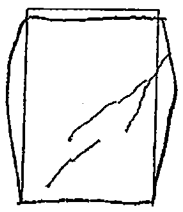
**Triaxial Compression Testing ASTM D 4767**

Sample Depth: 31 ft.
Cell Pressure: 80 psi
Back Pressure: 70 psi
Confining Pressure: 10 psi
Strain Rate: 0.006 In/min.

Specimen Height After Consolidation, (Hc), In.: 5.75
Correction for Vert Displacement, In.: 0
Load due to Friction and Uplift: 18.6 lbs.
Correction for Filter Paper: 0
Thickness of Membrane (tm), In.: 0.012

$\sigma1-\sigma3=$ Deviator Stress at Failure, ksf: 6.30
$\sigma3$ f= Effective Consolidation Stress at Failure, ksf: 1.44
$\sigma1=$ Total Major Principal Stress at Failure: 7.74
$\sigma'3f=$ $\sigma3-\Delta u=$ Effective Minor Principal Stress at Failure,ksf: 1.86
$\sigma'1f=$ Effective Major Principal Stress at Failure, ksf: 8.16
Axial Strain at Failure: 15.00%

**Failure Sketch**



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# Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918
Point: B

| Pa: Applied Force | Vertical Displacement Reading In.: | Pore Pressure psi: | Axial Strain (E1): | (P) - Force Adj for U and F lbs: | Corrected Vertical Displac In.: | Correction for Membrane ksf: | (A) Area In 2: | (σ1-σ3) Deviator Stress ksf: | [Δu] Induced Pore Water Pressure ksf: | σ3 Effective Consolidation Stress ksf | σ1 Total Major Principal Stress ksf | σ3 Effective Minor Principal Stress ksf | σ1 ' Effective Major Principal Stress ksf | p' | q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.6 | 0.000 | 72.6 | 0.00% | 0.0 | 0.000 | 0.00000 | 6.317 | 0.00 | 0.3744 | 1.44 | 1.44 | 1.07 | 1.07 | 1.07 | 0.00 |
| 49.0 | 0.003 | 74.6 | 0.05% | 30.4 | 0.003 | 0.00022 | 6.320 | 0.69 | 0.6624 | 1.44 | 2.13 | 0.78 | 1.47 | 1.12 | 0.35 |
| 61.0 | 0.006 | 75.3 | 0.10% | 42.4 | 0.006 | 0.00047 | 6.324 | 0.97 | 0.7632 | 1.44 | 2.41 | 0.68 | 1.64 | 1.16 | 0.48 |
| 67.3 | 0.009 | 75.8 | 0.16% | 48.7 | 0.009 | 0.00076 | 6.327 | 1.11 | 0.8352 | 1.44 | 2.55 | 0.60 | 1.71 | 1.16 | 0.55 |
| 70.9 | 0.011 | 75.9 | 0.20% | 52.3 | 0.011 | 0.00097 | 6.330 | 1.19 | 0.8496 | 1.44 | 2.63 | 0.59 | 1.78 | 1.18 | 0.59 |
| 74.7 | 0.015 | 76.2 | 0.25% | 56.1 | 0.015 | 0.00124 | 6.334 | 1.27 | 0.8928 | 1.44 | 2.71 | 0.55 | 1.82 | 1.18 | 0.64 |
| 77.9 | 0.018 | 76.5 | 0.31% | 59.3 | 0.018 | 0.00149 | 6.337 | 1.35 | 0.9360 | 1.44 | 2.79 | 0.50 | 1.85 | 1.18 | 0.67 |
| 80.1 | 0.020 | 76.5 | 0.35% | 61.5 | 0.020 | 0.00171 | 6.340 | 1.40 | 0.9360 | 1.44 | 2.84 | 0.50 | 1.90 | 1.20 | 0.70 |
| 83.0 | 0.023 | 76.8 | 0.40% | 64.4 | 0.023 | 0.00193 | 6.343 | 1.46 | 0.9792 | 1.44 | 2.90 | 0.46 | 1.92 | 1.19 | 0.73 |
| 85.3 | 0.026 | 76.8 | 0.46% | 66.7 | 0.026 | 0.00222 | 6.346 | 1.51 | 0.9792 | 1.44 | 2.95 | 0.46 | 1.97 | 1.22 | 0.76 |
| 87.4 | 0.029 | 77.0 | 0.50% | 68.8 | 0.029 | 0.00244 | 6.349 | 1.56 | 1.0080 | 1.44 | 3.00 | 0.43 | 1.99 | 1.21 | 0.78 |
| 90.3 | 0.032 | 77.0 | 0.56% | 71.7 | 0.032 | 0.00271 | 6.353 | 1.62 | 1.0080 | 1.44 | 3.06 | 0.43 | 2.05 | 1.24 | 0.81 |
| 92.4 | 0.035 | 77.2 | 0.61% | 73.8 | 0.035 | 0.00297 | 6.356 | 1.67 | 1.0368 | 1.44 | 3.11 | 0.40 | 2.07 | 1.24 | 0.83 |
| 95.1 | 0.038 | 77.2 | 0.65% | 76.5 | 0.038 | 0.00319 | 6.359 | 1.73 | 1.0368 | 1.44 | 3.17 | 0.40 | 2.13 | 1.27 | 0.86 |
| 96.2 | 0.040 | 77.2 | 0.70% | 77.6 | 0.040 | 0.00339 | 6.362 | 1.75 | 1.0368 | 1.44 | 3.19 | 0.40 | 2.16 | 1.28 | 0.88 |
| 98.3 | 0.043 | 77.2 | 0.75% | 79.7 | 0.043 | 0.00365 | 6.365 | 1.80 | 1.0368 | 1.44 | 3.24 | 0.40 | 2.20 | 1.30 | 0.90 |
| 100.9 | 0.046 | 77.2 | 0.80% | 82.3 | 0.046 | 0.00390 | 6.368 | 1.86 | 1.0368 | 1.44 | 3.30 | 0.40 | 2.26 | 1.33 | 0.93 |
| 102.6 | 0.049 | 77.2 | 0.85% | 84.0 | 0.049 | 0.00414 | 6.372 | 1.89 | 1.0368 | 1.44 | 3.33 | 0.40 | 2.30 | 1.35 | 0.95 |
| 104.8 | 0.052 | 77.4 | 0.91% | 86.2 | 0.052 | 0.00443 | 6.375 | 1.94 | 1.0656 | 1.44 | 3.38 | 0.37 | 2.32 | 1.35 | 0.97 |
| 106.7 | 0.055 | 77.4 | 0.96% | 88.1 | 0.055 | 0.00468 | 6.379 | 1.98 | 1.0656 | 1.44 | 3.42 | 0.37 | 2.36 | 1.37 | 0.99 |
| 108.3 | 0.058 | 77.4 | 1.00% | 89.7 | 0.058 | 0.00488 | 6.381 | 2.02 | 1.0656 | 1.44 | 3.46 | 0.37 | 2.39 | 1.38 | 1.01 |
| 126.1 | 0.086 | 77.3 | 1.50% | 107.5 | 0.086 | 0.00729 | 6.413 | 2.41 | 1.0512 | 1.44 | 3.85 | 0.39 | 2.80 | 1.59 | 1.20 |
| 141.1 | 0.115 | 77.0 | 2.00% | 122.5 | 0.115 | 0.00975 | 6.446 | 2.73 | 1.0080 | 1.44 | 4.17 | 0.43 | 3.16 | 1.80 | 1.36 |
| 154.6 | 0.144 | 76.6 | 2.50% | 136.0 | 0.144 | 0.01221 | 6.480 | 3.01 | 0.9504 | 1.44 | 4.45 | 0.49 | 3.50 | 1.99 | 1.51 |
| 167.2 | 0.172 | 76.4 | 3.00% | 148.6 | 0.172 | 0.01462 | 6.513 | 3.27 | 0.9216 | 1.44 | 4.71 | 0.52 | 3.79 | 2.15 | 1.64 |
| 180.0 | 0.201 | 76.0 | 3.50% | 161.4 | 0.201 | 0.01706 | 6.547 | 3.53 | 0.8640 | 1.44 | 4.97 | 0.58 | 4.11 | 2.34 | 1.77 |
| 191.8 | 0.230 | 75.5 | 4.00% | 173.2 | 0.230 | 0.01950 | 6.581 | 3.77 | 0.7920 | 1.44 | 5.21 | 0.65 | 4.42 | 2.53 | 1.89 |
| 202.7 | 0.259 | 75.1 | 4.50% | 184.1 | 0.259 | 0.02194 | 6.615 | 3.99 | 0.7344 | 1.44 | 5.43 | 0.71 | 4.69 | 2.70 | 1.99 |
| 213.2 | 0.287 | 74.6 | 5.00% | 194.6 | 0.287 | 0.02436 | 6.650 | 4.19 | 0.6624 | 1.44 | 5.63 | 0.78 | 4.97 | 2.87 | 2.09 |
| 223.6 | 0.316 | 74.1 | 5.50% | 205.0 | 0.316 | 0.02681 | 6.685 | 4.39 | 0.5904 | 1.44 | 5.83 | 0.85 | 5.24 | 3.04 | 2.19 |
| 233.4 | 0.345 | 73.6 | 6.00% | 214.8 | 0.345 | 0.02923 | 6.720 | 4.57 | 0.5184 | 1.44 | 6.01 | 0.92 | 5.49 | 3.21 | 2.29 |
| 242.5 | 0.374 | 73.4 | 6.50% | 223.9 | 0.374 | 0.03167 | 6.756 | 4.74 | 0.4896 | 1.44 | 6.18 | 0.95 | 5.69 | 3.32 | 2.37 |
| 251.2 | 0.402 | 73.0 | 7.00% | 232.6 | 0.402 | 0.03411 | 6.793 | 4.90 | 0.4320 | 1.44 | 6.34 | 1.01 | 5.90 | 3.46 | 2.45 |
| 259.6 | 0.431 | 72.6 | 7.50% | 241.0 | 0.431 | 0.03655 | 6.830 | 5.04 | 0.3744 | 1.44 | 6.48 | 1.07 | 6.11 | 3.59 | 2.52 |
| 267.5 | 0.460 | 72.2 | 8.00% | 248.9 | 0.460 | 0.03900 | 6.867 | 5.18 | 0.3168 | 1.44 | 6.62 | 1.12 | 6.30 | 3.71 | 2.59 |
| 275.0 | 0.489 | 71.9 | 8.50% | 256.4 | 0.489 | 0.04145 | 6.905 | 5.31 | 0.2736 | 1.44 | 6.75 | 1.17 | 6.47 | 3.82 | 2.65 |
| 281.4 | 0.518 | 71.3 | 9.01% | 262.8 | 0.518 | 0.04390 | 6.943 | 5.41 | 0.1872 | 1.44 | 6.85 | 1.25 | 6.66 | 3.96 | 2.70 |
| 288.3 | 0.546 | 70.9 | 9.50% | 269.7 | 0.546 | 0.04632 | 6.981 | 5.52 | 0.1296 | 1.44 | 6.96 | 1.31 | 6.83 | 4.07 | 2.76 |

Report Date: Friday, August 14, 2009

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 294.5 | 0.575 | 70.6 | 10 00% | 275 9 | 0.575 | 0 04873 | 7 019 | 5.61 | 0 0864 | 1.44 | 7 05 | 1.35 | 6.97 | 4 16 | 2.81 |
| 306.4 | 0.633 | 69 9 | 11.01% | 287 8 | 0.633 | 0.05365 | 7.099 | 5 78 | -0 0144 | 1 44 | 7.22 | 1 45 | 7 24 | 4 35 | 2.89 |
| 318.1 | 0.690 | 69 4 | 12 00% | 299.5 | 0 690 | 0.05848 | 7 179 | 5 95 | -0.0864 | 1.44 | 7 39 | 1.53 | 7.48 | 4 50 | 2 97 |
| 328.6 | 0.748 | 68.7 | 13 00% | 310 0 | 0.748 | 0 06338 | 7 262 | 6.08 | -0 1872 | 1.44 | 7.52 | 1 63 | 7 71 | 4.67 | 3.04 |
| 338 6 | 0 805 | 67.9 | 14 00% | 320 0 | 0.805 | 0 06824 | 7 346 | 6.20 | -0 3024 | 1.44 | 7 64 | 1.74 | 7.95 | 4 84 | 3 10 |
| 347 6 | 0 863 | 67.1 | 15.00% | 329.0 | 0.863 | 0.07313 | 7.433 | 6 30 | -0.4176 | 1.44 | 7 74 | 1 86 | 8 16 | 5.01 | 3.15 |
| 356 8 | 0 920 | 66.3 | 16.00% | 338.2 | 0 920 | 0.07799 | 7 521 | 6 40 | -0.5328 | 1 44 | 7.84 | 1.97 | 8.37 | 5 17 | 3 20 |
| 365 6 | 0.978 | 65 5 | 17.00% | 347 0 | 0.978 | 0.08288 | 7.612 | 6.48 | -0 6480 | 1.44 | 7 92 | 2.09 | 8 57 | 5 33 | 3.24 |
| 373 3 | 1.035 | 64 6 | 18.00% | 354 7 | 1.035 | 0 08776 | 7.705 | 6 54 | -0.7776 | 1.44 | 7 98 | 2 22 | 8 76 | 5.49 | 3.27 |
| 381.9 | 1 092 | 63 7 | 19 00% | 363 3 | 1 092 | 0.09261 | 7 799 | 6 62 | -0.9072 | 1 44 | 8 06 | 2.35 | 8.96 | 5 65 | 3 31 |
| 389.9 | 1 150 | 62 9 | 20 00% | 371.3 | 1 150 | 0.09747 | 7 897 | 6.67 | -1 0224 | 1.44 | 8 11 | 2.46 | 9 14 | 5 80 | 3.34 |

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# Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918
Point: C

**Material Description:** Boring PZ-0902, Shelby Tube - 31' - 33'; Lab # S-10918

## Moisture Determination ASTM D2216

| | Before Testing | After Testing |
|---|---|---|
| Tare No. | R-3 | R-3 |
| Mass of Container and Wet Specimen (Mcws), grams | 1515.47 | 1516.93 |
| Mass of Container and Over Dry Specimen (Mcs), grams | 1324.08 | 1324.08 |
| Mass of Container (Mc), grams | 216.28 | 216.28 |
| Mass of Water (Mw), grams: | 191.39 | 192.85 |
| Mass of Solid Particles (Ms), grams: | 1107.8 | 1107.8 |
| Moisture Content (w), % | 17.28% | 17.41% |

## Initial Condition of Speciman ASTM D2435

| | (1) | (2) | (3) | Average |
|---|---|---|---|---|
| Diameter Measurents, Inches: | 2.843 | 2.848 | 2.837 | 2.843 |
| Height Measurements, Inches: | 5.801 | 5.809 | 5.811 | 5.807 |

Initial Volume of Specimen (Vo), In.3: 36.85
Dry Mass of Specimen After Testing, (Md), grams: 1107.8
Dry Unit Weight, (γ d) pcf: 114.51
Specific Gravity of the Solids, (G): 2.70
Volume of Solids, (Vs), Cu. In.: 25.0379
Height of Solids,( Hs),In.: 3.9451
Void Ratio Before Consolidation (Eo): 0.4720
Intitail Degree of Saturation: (So) 98.84%

## Saturation - ASTM D4767 Section 8.2

Dial Indicator Reading Prior to Saturation (Rb:) In. 0
Cell Pressure AfterSaturation, psi: 90.00
Back Presssure After Saturation After, psi: 70.00
Pore Pressure Paramenter B: 1
Dial Indicator Reading After Saturation, (Ra) In.: -0.004
Change in Height during Satureation, (Delta Hs) In. -0.004
Change In Volume of Specimen during Saturation (Delta Vsat), In.3: -0.076

Report Date: Friday, August 14, 2009

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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918
Point: C

**Consolidation- ASTM D2435, Section 11.5:**

| Sample No: | T: | Burette 2: | Burette3: | Rc: |
|---|---|---|---|---|
| 10918 | 0 | 23.8 | 23.7 | -0.004 |
| 10918 | 0.25 | 23.5 | 23.5 | |
| 10918 | 0.5 | 23.5 | 23.5 | |
| 10918 | 1 | 23.5 | 23.4 | |
| 10918 | 2 | 23.4 | 23.3 | |
| 10918 | 4 | 23.2 | 23.1 | |
| 10918 | 8 | 23.1 | 22.8 | |
| 10918 | 15 | 22.9 | 22.4 | 0.005 |
| 10918 | 30 | 22.5 | 22 | 0.008 |
| 10918 | 60 | 22 | 21.4 | 0.011 |
| 10918 | 180 | 21.2 | 20.6 | 0.015 |
| 10918 | 240 | 21.1 | 20.4 | 0.016 |
| 10918 | 450 | 20.8 | 20.1 | 0.018 |
| 10918 | 1440 | 20.7 | 20.4 | 0.02 |

Specimen Height After Consolidation, (Hc), In.: 5.79

Volume Change During Consolidation (Delta Vc), In.3: 0.39

Cross-Sectional Area of Specimen After Consolidation (Ac), In.2: 6.31

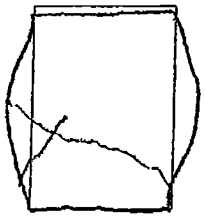
**Triaxial Compression Testing ASTM D 4767**

Sample Depth: 31 ft.
Cell Pressure: 90 psi
Back Pressure: 70 psi
Confining Pressure: 20 psi
Strain Rate: 0.006 in/min.

Specimen Height After Consolidation, (Hc), In.: 5.79
Correction for Vert Displacement, In.: 0
Load due to Friction and Uplift: 20 lbs.
Correction for Filter Paper: 0
Thickness of Membrane (tm), In.: 0.012

$\sigma1-\sigma3=$ Deviator Stress at Failure, ksf: 8.24
$\sigma3$ f= Effective Consolidation Stress at Failure, ksf: 2.88
$\sigma1=$ Total Major Principal Stress at Failure: 11.12
$\sigma$ '3f= $\sigma3-\Delta\upsilon=$ Effective Minor Principal Stress at Failure,ksf: 2.28
$\sigma$ '1f= Effective Major Principal Stress at Failure, ksf: 10.52
Axial Strain at Failure: 15.01%

**Failure Sketch**



Report Date: Friday, August 14, 2009

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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

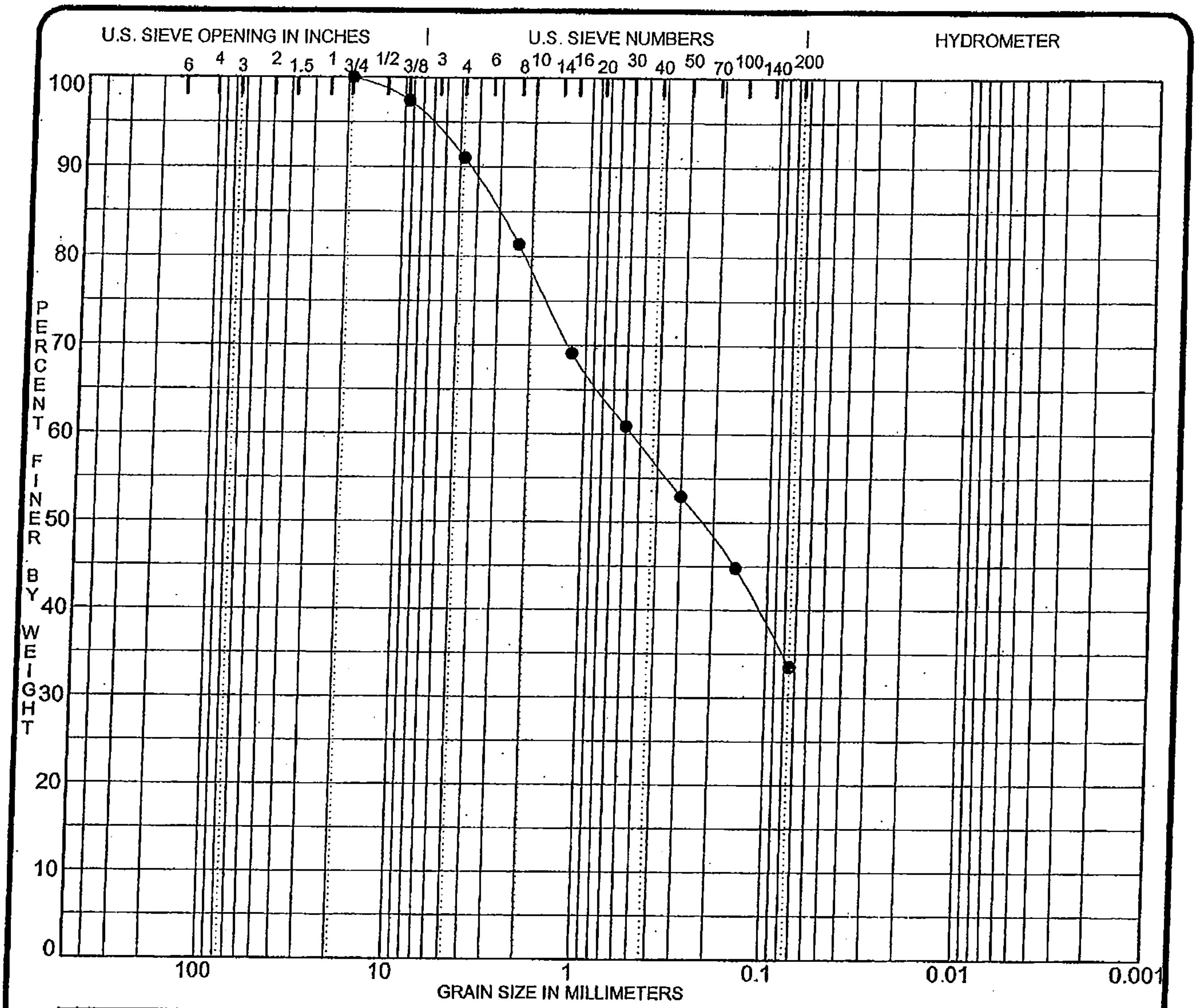
Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918
Point: C

| Pa: Applied Force | Vertical Displacement Reading In.: | Pore Pressure psi: | Axial Strain (El): | (P) - Force Adj for U and F lbs: | Corrected Vertical Displac In.: | Correction for Membrane ksf: | (A) Area In 2: | (σ1−σ3) Deviator Stress ksf: | [Δu] Induced Pore Water Pressure ksf: | σ3 Effective Consolidation Stress ksf | σ1 Total Major Principal Stress ksf | σ3 Effective Minor Principal Stress ksf | σ1 ' Effective Major Principal Stress ksf | p' | q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.0 | 0.000 | 73.5 | 0.00% | 0.0 | 0.000 | 0.00000 | 6.314 | 0.00 | 0.5040 | 2.88 | 2.88 | 2.38 | 2.38 | 2.38 | 0.00 |
| 67.4 | 0.003 | 74.7 | 0.05% | 47.4 | 0.003 | 0.00025 | 6.317 | 1.08 | 0.6768 | 2.88 | 3.96 | 2.20 | 3.28 | 2.74 | 0.54 |
| 81.2 | 0.006 | 77.0 | 0.10% | 61.2 | 0.006 | 0.00049 | 6.321 | 1.39 | 1.0080 | 2.88 | 4.27 | 1.87 | 3.27 | 2.57 | 0.70 |
| 91.2 | 0.009 | 80.6 | 0.16% | 71.2 | 0.009 | 0.00076 | 6.324 | 1.62 | 1.5264 | 2.88 | 4.50 | 1.35 | 2.97 | 2.16 | 0.81 |
| 96.0 | 0.011 | 80.3 | 0.20% | 76.0 | 0.011 | 0.00096 | 6.327 | 1.73 | 1.4832 | 2.88 | 4.61 | 1.40 | 3.13 | 2.26 | 0.86 |
| 101.8 | 0.014 | 80.6 | 0.25% | 81.8 | 0.014 | 0.00120 | 6.330 | 1.86 | 1.5264 | 2.88 | 4.74 | 1.35 | 3.21 | 2.28 | 0.93 |
| 107.7 | 0.018 | 81.7 | 0.31% | 87.7 | 0.018 | 0.00150 | 6.334 | 1.99 | 1.6848 | 2.88 | 4.87 | 1.20 | 3.19 | 2.19 | 1.00 |
| 110.5 | 0.020 | 82.1 | 0.35% | 90.5 | 0.020 | 0.00170 | 6.336 | 2.06 | 1.7424 | 2.88 | 4.94 | 1.14 | 3.19 | 2.17 | 1.03 |
| 114.8 | 0.023 | 83.1 | 0.40% | 94.8 | 0.023 | 0.00194 | 6.339 | 2.15 | 1.8864 | 2.88 | 5.03 | 0.99 | 3.15 | 2.07 | 1.08 |
| 119.0 | 0.027 | 83.1 | 0.46% | 99.0 | 0.027 | 0.00224 | 6.343 | 2.25 | 1.8864 | 2.88 | 5.13 | 0.99 | 3.24 | 2.12 | 1.12 |
| 122.2 | 0.029 | 83.2 | 0.50% | 102.2 | 0.029 | 0.00244 | 6.346 | 2.32 | 1.9008 | 2.88 | 5.20 | 0.98 | 3.30 | 2.14 | 1.16 |
| 124.7 | 0.032 | 84.1 | 0.56% | 104.7 | 0.032 | 0.00271 | 6.350 | 2.37 | 2.0304 | 2.88 | 5.25 | 0.85 | 3.22 | 2.04 | 1.19 |
| 127.8 | 0.035 | 85.0 | 0.61% | 107.8 | 0.035 | 0.00297 | 6.353 | 2.44 | 2.1600 | 2.88 | 5.32 | 0.72 | 3.16 | 1.94 | 1.22 |
| 129.6 | 0.038 | 85.1 | 0.65% | 109.6 | 0.038 | 0.00317 | 6.356 | 2.48 | 2.1744 | 2.88 | 5.36 | 0.71 | 3.19 | 1.95 | 1.24 |
| 132.2 | 0.041 | 85.0 | 0.70% | 112.2 | 0.041 | 0.00342 | 6.359 | 2.54 | 2.1600 | 2.88 | 5.42 | 0.72 | 3.26 | 1.99 | 1.27 |
| 134.4 | 0.043 | 85.0 | 0.75% | 114.4 | 0.043 | 0.00366 | 6.362 | 2.59 | 2.1600 | 2.88 | 5.47 | 0.72 | 3.31 | 2.01 | 1.29 |
| 137.1 | 0.046 | 85.0 | 0.80% | 117.1 | 0.046 | 0.00391 | 6.365 | 2.65 | 2.1600 | 2.88 | 5.53 | 0.72 | 3.37 | 2.04 | 1.32 |
| 139.0 | 0.049 | 85.1 | 0.85% | 119.0 | 0.049 | 0.00413 | 6.368 | 2.69 | 2.1744 | 2.88 | 5.57 | 0.71 | 3.39 | 2.05 | 1.34 |
| 142.1 | 0.053 | 86.1 | 0.91% | 122.1 | 0.053 | 0.00445 | 6.372 | 2.75 | 2.3184 | 2.88 | 5.63 | 0.56 | 3.32 | 1.94 | 1.38 |
| 143.8 | 0.055 | 86.0 | 0.96% | 123.8 | 0.055 | 0.00467 | 6.375 | 2.79 | 2.3040 | 2.88 | 5.67 | 0.58 | 3.37 | 1.97 | 1.40 |
| 145.6 | 0.058 | 86.1 | 1.00% | 125.6 | 0.058 | 0.00487 | 6.378 | 2.83 | 2.3184 | 2.88 | 5.71 | 0.56 | 3.39 | 1.98 | 1.42 |
| 164.2 | 0.087 | 86.6 | 1.50% | 144.2 | 0.087 | 0.00730 | 6.410 | 3.23 | 2.3904 | 2.88 | 6.11 | 0.49 | 3.72 | 2.11 | 1.62 |
| 181.7 | 0.116 | 86.9 | 2.00% | 161.7 | 0.116 | 0.00976 | 6.443 | 3.60 | 2.4336 | 2.88 | 6.48 | 0.45 | 4.05 | 2.25 | 1.80 |
| 197.6 | 0.145 | 86.9 | 2.50% | 177.6 | 0.145 | 0.01218 | 6.476 | 3.94 | 2.4336 | 2.88 | 6.82 | 0.45 | 4.38 | 2.41 | 1.97 |
| 212.0 | 0.174 | 86.4 | 3.00% | 192.0 | 0.174 | 0.01464 | 6.510 | 4.23 | 2.3616 | 2.88 | 7.11 | 0.52 | 4.75 | 2.63 | 2.12 |
| 224.9 | 0.203 | 86.4 | 3.50% | 204.9 | 0.203 | 0.01707 | 6.543 | 4.49 | 2.3616 | 2.88 | 7.37 | 0.52 | 5.01 | 2.76 | 2.25 |
| 238.2 | 0.231 | 86.0 | 4.00% | 218.2 | 0.231 | 0.01950 | 6.577 | 4.76 | 2.3040 | 2.88 | 7.64 | 0.58 | 5.33 | 2.95 | 2.38 |
| 251.3 | 0.260 | 85.6 | 4.50% | 231.3 | 0.260 | 0.02194 | 6.612 | 5.02 | 2.2464 | 2.88 | 7.90 | 0.63 | 5.65 | 3.14 | 2.51 |
| 263.4 | 0.290 | 85.0 | 5.01% | 243.4 | 0.290 | 0.02442 | 6.647 | 5.25 | 2.1600 | 2.88 | 8.13 | 0.72 | 5.97 | 3.34 | 2.62 |
| 275.0 | 0.318 | 84.7 | 5.50% | 255.0 | 0.318 | 0.02682 | 6.682 | 5.47 | 2.1168 | 2.88 | 8.35 | 0.76 | 6.23 | 3.50 | 2.73 |
| 286.3 | 0.347 | 84.0 | 6.00% | 266.3 | 0.347 | 0.02927 | 6.717 | 5.68 | 2.0160 | 2.88 | 8.56 | 0.86 | 6.54 | 3.70 | 2.84 |
| 297.9 | 0.376 | 83.6 | 6.50% | 277.9 | 0.376 | 0.03169 | 6.753 | 5.89 | 1.9584 | 2.88 | 8.77 | 0.92 | 6.82 | 3.87 | 2.95 |
| 309.3 | 0.406 | 83.0 | 7.01% | 289.3 | 0.406 | 0.03417 | 6.790 | 6.10 | 1.8720 | 2.88 | 8.98 | 1.01 | 7.11 | 4.06 | 3.05 |
| 319.5 | 0.434 | 82.4 | 7.51% | 299.5 | 0.434 | 0.03660 | 6.827 | 6.28 | 1.7856 | 2.88 | 9.16 | 1.09 | 7.38 | 4.23 | 3.14 |
| 329.7 | 0.463 | 81.7 | 8.01% | 309.7 | 0.463 | 0.03904 | 6.864 | 6.46 | 1.6848 | 2.88 | 9.34 | 1.20 | 7.65 | 4.42 | 3.23 |
| 340.0 | 0.492 | 81.4 | 8.51% | 320.0 | 0.492 | 0.04147 | 6.901 | 6.64 | 1.6416 | 2.88 | 9.52 | 1.24 | 7.87 | 4.56 | 3.32 |
| 350.1 | 0.521 | 81.0 | 9.00% | 330.1 | 0.521 | 0.04389 | 6.939 | 6.81 | 1.5840 | 2.88 | 9.69 | 1.30 | 8.10 | 4.70 | 3.40 |
| 359.3 | 0.550 | 80.6 | 9.50% | 339.3 | 0.550 | 0.04632 | 6.977 | 6.96 | 1.5264 | 2.88 | 9.84 | 1.35 | 8.31 | 4.83 | 3.48 |

**Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767**

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10918
Point: C

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 368.6 | 0 579 | 80 0 | 10 01% | 348.6 | 0 579 | 0.04878 | 7.016 | 7 11 | 1 4400 | 2 88 | 9 99 | 1 44 | 8 55 | 4.99 | 3 55 |
| 386 9 | 0.637 | 79.0 | 11 00% | 366.9 | 0.637 | 0.05365 | 7.095 | 7 39 | 1 2960 | 2 88 | 10.27 | 1.58 | 8 98 | 5 28 | 3 70 |
| 403 5 | 0 695 | 77.7 | 12 00% | 383.5 | 0 695 | 0 05852 | 7.175 | 7.64 | 1.1088 | 2 88 | 10.52 | 1.77 | 9 41 | 5 59 | 3.82 |
| 419.6 | 0.753 | 76 9 | 13 01% | 399 6 | 0 753 | 0.06342 | 7 258 | 7.86 | 0.9936 | 2.88 | 10 74 | 1 89 | 9.75 | 5.82 | 3.93 |
| 434.5 | 0.810 | 75 6 | 14 00% | 414 5 | 0 810 | 0.06828 | 7.342 | 8.06 | 0 8064 | 2 88 | 10 94 | 2 07 | 10 13 | 6 10 | 4.03 |
| 448.9 | 0 869 | 74 2 | 15.01% | 428 9 | 0.869 | 0 07318 | 7.429 | 8.24 | 0 6048 | 2 88 | 11 12 | 2 28 | 10.52 | 6.40 | 4 12 |
| 461 8 | 0.926 | 73.1 | 16.01% | 441.8 | 0 926 | 0.07805 | 7 518 | 8.38 | 0 4464 | 2 88 | 11 26 | 2.43 | 10 82 | 6 63 | 4 19 |
| 474 4 | 0 984 | 72 2 | 17 01% | 454.4 | 0.984 | 0 08293 | 7 608 | 8.52 | 0 3168 | 2 88 | 11 40 | 2.56 | 11.08 | 6.82 | 4 26 |
| 486 1 | 1 042 | 71.1 | 18.01% | 466.1 | 1.042 | 0 08779 | 7 701 | 8 63 | 0 1584 | 2 88 | 11.51 | 2.72 | 11.35 | 7 04 | 4 31 |
| 497 3 | 1 100 | 70.5 | 19.01% | 477 3 | 1.100 | 0 09269 | 7 796 | 8.72 | 0 0720 | 2.88 | 11.60 | 2.81 | 11 53 | 7 17 | 4.36 |
| 508.3 | 1 158 | 69 3 | 20.01% | 488.3 | 1.158 | 0 09756 | 7 894 | 8 81 | -0 1008 | 2 88 | 11.69 | 2.98 | 11 79 | 7 39 | 4.41 |



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|
| ● PZ-0903 23.5 | | | NP | NP | NP | | |
| | **SILTY SAND SM** | | | | | | |
| | **Ash Mixture - Samples10,11,12,13 Combined** | | | | | | |
| | | | | | | | |
| | | | | | | | |

| Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %< 002 |
|---|---|---|---|---|---|---|---|---|
| ● PZ-0903 23.5 | 19.000 | 0.556 | | | 8.9 | 57.5 | 33.5 | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

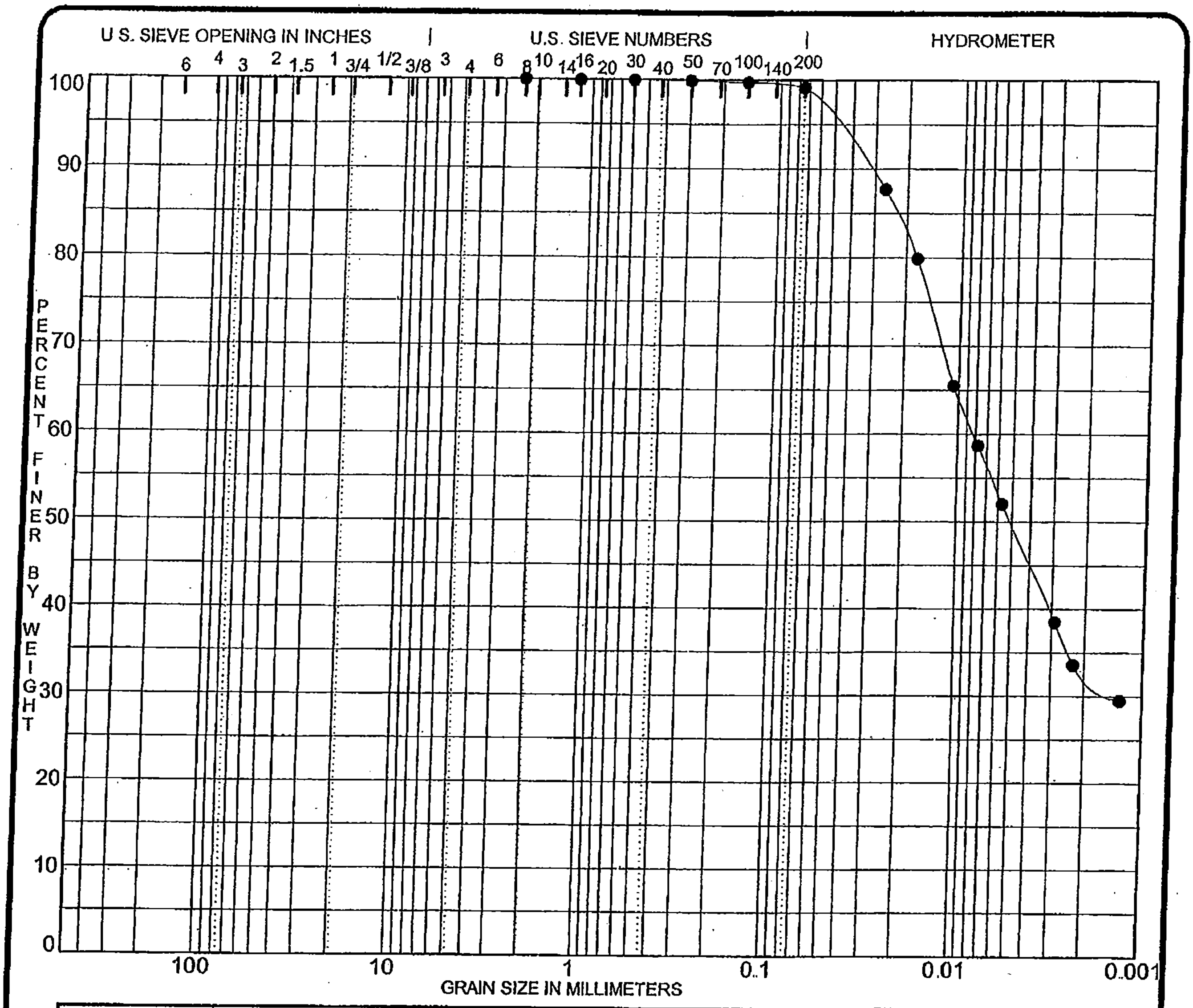
PROJECT SPORN PLANT - FLY ASH POND DIKES - FLY ASH POND DIKES

JOB NO.

DATE 8/14/09

## GRADATION CURVES

American Electric Power Service Corp.
Groveport, OH 43125



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | Classification | MC% | LL | PL | PI | Sp.Gr. | |
|---|---|---|---|---|---|---|---|
| ● PZ-0903 46.0 | | | 45.6 | 24.7 | 20.9 | | |
| | **LEAN CLAY CL** | | | | | | |
| | **Shelby Tube Sample - 46' - 48'** | | | | | | |
| | | | | | | | |
| | | | | | | | |

| Specimen Identification | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|
| ● PZ-0903 46.0 | 2.360 | 0.008 | 0.001 | | 0.0 | 0.9 | 99.1 | 32.6 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

PROJECT SPORN PLANT - FLY ASH POND DIKES - FLY ASH POND DIKES

JOB NO.

DATE 8/14/09

## GRADATION CURVES

American Electric Power Service Corp.
Groveport, OH 43125

JOB NO. __________ DATE: Jul 31, 09

PROJECT SPORN PLANT - FLY ASH POND DIKES

LOCATION: FLY ASH POND DIKES

SOURCE OF MATERIAL PZ-0903 DEPTH 46.0 ft.

DESCRIPTION OF MATERIAL

ASTM DESCRIPTION

| | | | |
|---|---|---|---|
| MAX DRY DENSITY, pcf | | OPTIMUM MOISTURE, % | |
| SPECIFIC GRAVITY | 2.70 | | |
| SAMPLE HGT., mm | 146 740 | SAMPLE DIA., mm | 71.480 |
| CHAMBER PRESSURE, psi | 70.0 | BACK PRESSURE, psi | 60.0 |
| B-PARAMETER | 1.00 | EFFECTIVE PRESSURE, psi | 10 0 |
| INITIAL HEAD, mm | 2369.2 | | |

| | BEFORE | AFTER |
|---|---|---|
| WATER CONTENT, % | 35.4 | 34.3 |
| WET DENSITY, pcf | 117.0 | |
| DRY DENSITY, pcf | 86.5 | |
| SATURATION, % | 100.51 | |
| VOID RATIO | 0.9497 | |

**PERMEABILITY COEFFICIENT K, cm/sec 1.08E-07**

**FLEXIBLE-MEMBRANE PERMEABILITY TEST**

**American Electric Power Service Corp.**

Groveport, Ohio

AEP

CIVIL LABORATORY
AMERICAN ELECTRIC POWER SERVICE CORPORATION
4001 BIXBY ROAD
GROVEPORT, OHIO 43125
(614) 836-4200

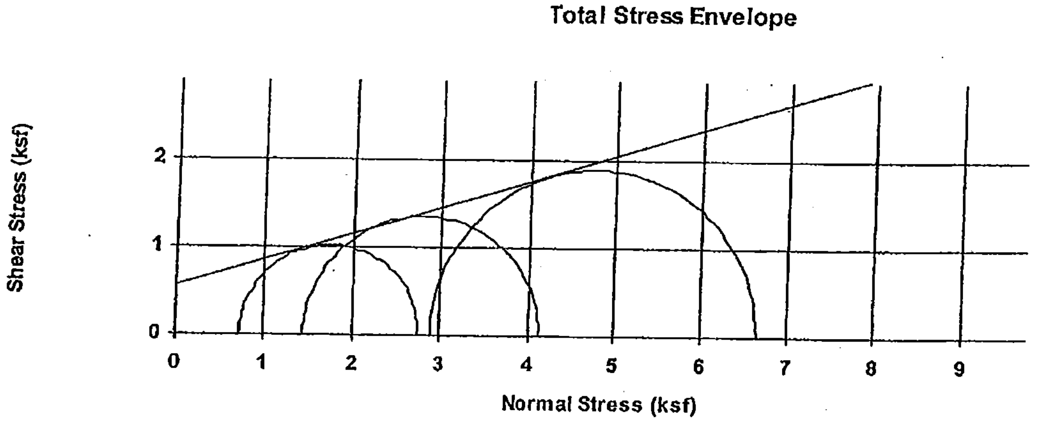
## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922

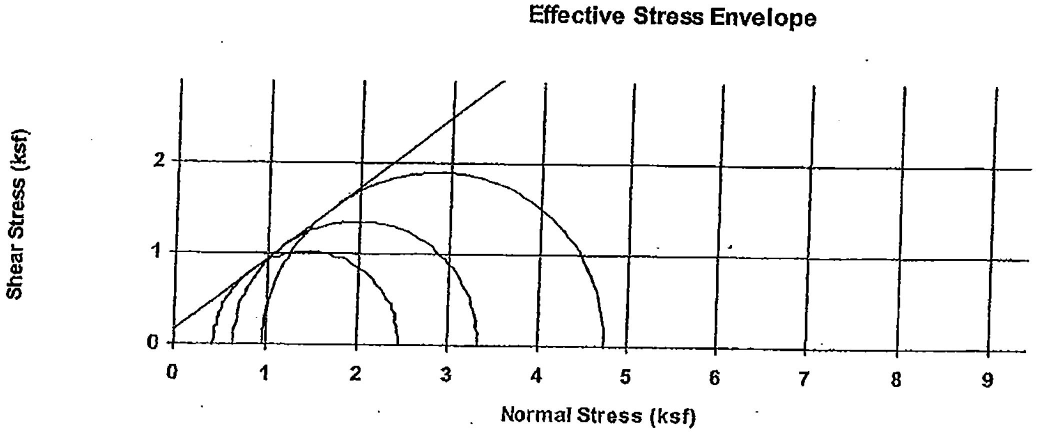
**Material Description:** Boring PZ-0903, Shelby Tube - 46' - 48'; Lab # S-10922

| Point Designation | Initial Conditions | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|
| | Water Content, % | Dry Density, pcf | Degree of Saturation | Water Content, % | Confining Stress, (ksf) | Deviator Stress | Induced Pore Pressure (ksf) |
| A | 29 5% | 93.1 | 98.3% | 28 43% | 0.72 | 2.03 | 0 30 |
| B | 35 4% | 86 4 | 100 5% | 34 3% | 1 44 | 2.69 | 0.81 |
| C | 30 3% | 92.3 | 99.0% | 27 3% | 2 88 | 3 77 | 1 92 |

| Point Designation | Axial Strain, % | q, (ksf) | Effective Stresses, (ksf) | | | Total Stresses, (ksf) | | |
|---|---|---|---|---|---|---|---|---|
| | | | Major, (ksf) | Minor, (ksf) | p', (ksf) | Major, (ksf) | Minor, (ksf) | p, (ksf) |
| A | 15 0% | 1 01 | 2 45 | 0.42 | 1.43 | 2 75 | 0.72 | 1.73 |
| B | 13 0% | 1 35 | 3 33 | 0.63 | 1.98 | 4 13 | 1.44 | 2 79 |
| C | 15.0% | 1 89 | 4.74 | 0 96 | 2.85 | 6.65 | 2.88 | 4.77 |


Total Stress Envelope

ϕ: 16.6 °
c : 0.55 ksf


Effective Stress Envelope

ϕ ': 37.9 °
c': 0.17 ksf

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Report Date: Friday, August 14, 2009

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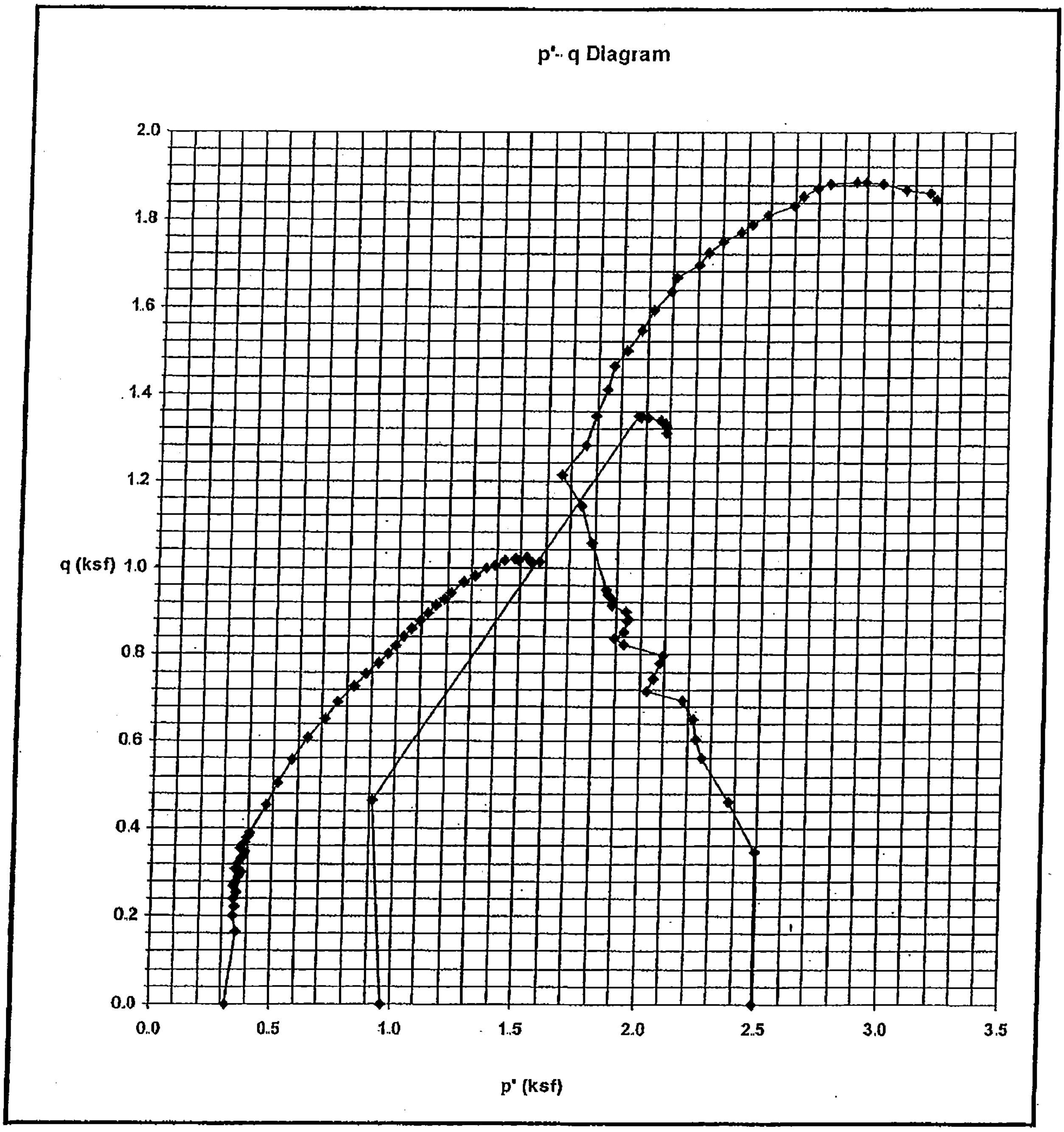
## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922



Report Date: Friday, August 14, 2009

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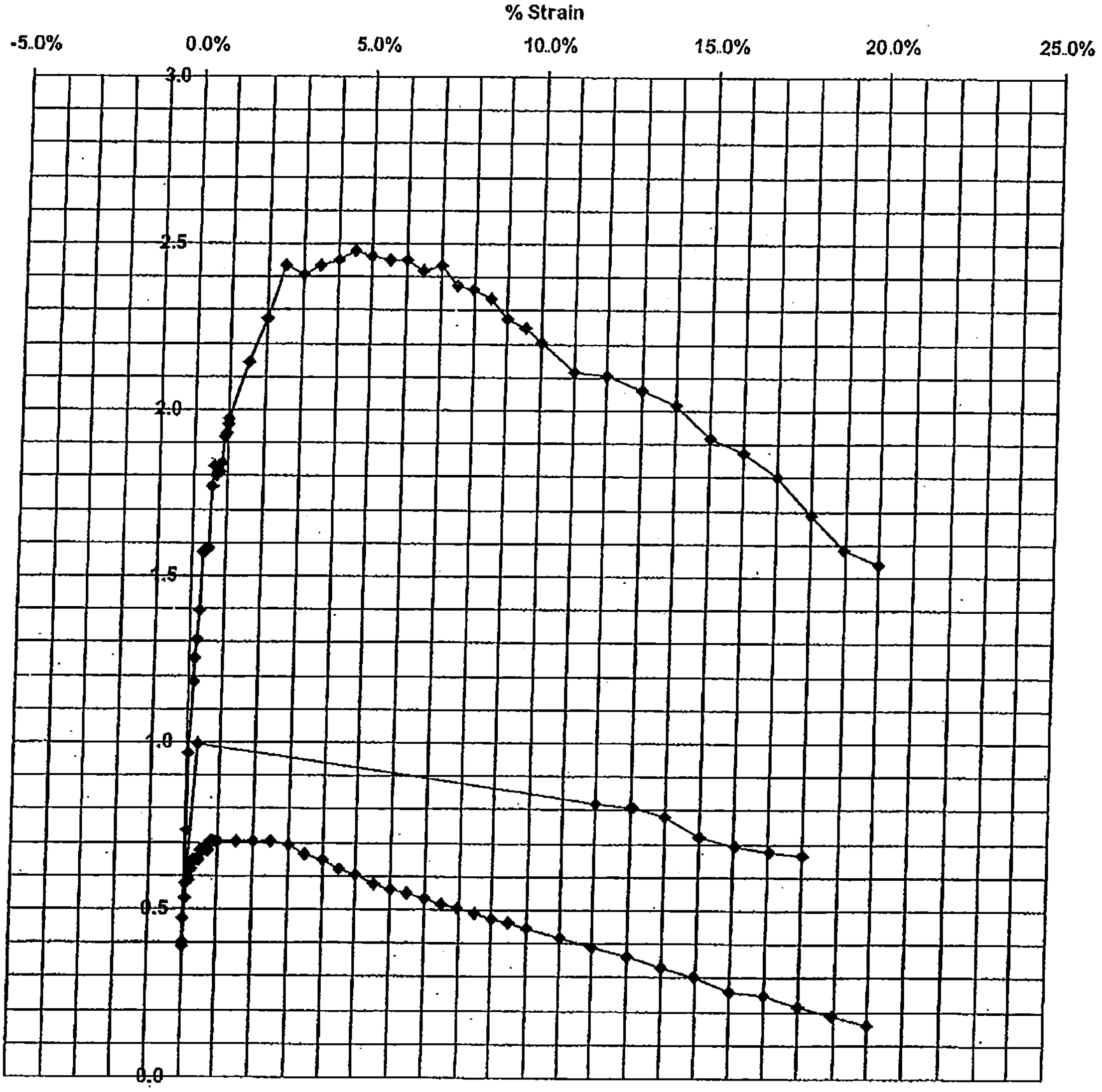
## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922

Induced Pore Pressure Vrs % Strain



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**Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767**

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922

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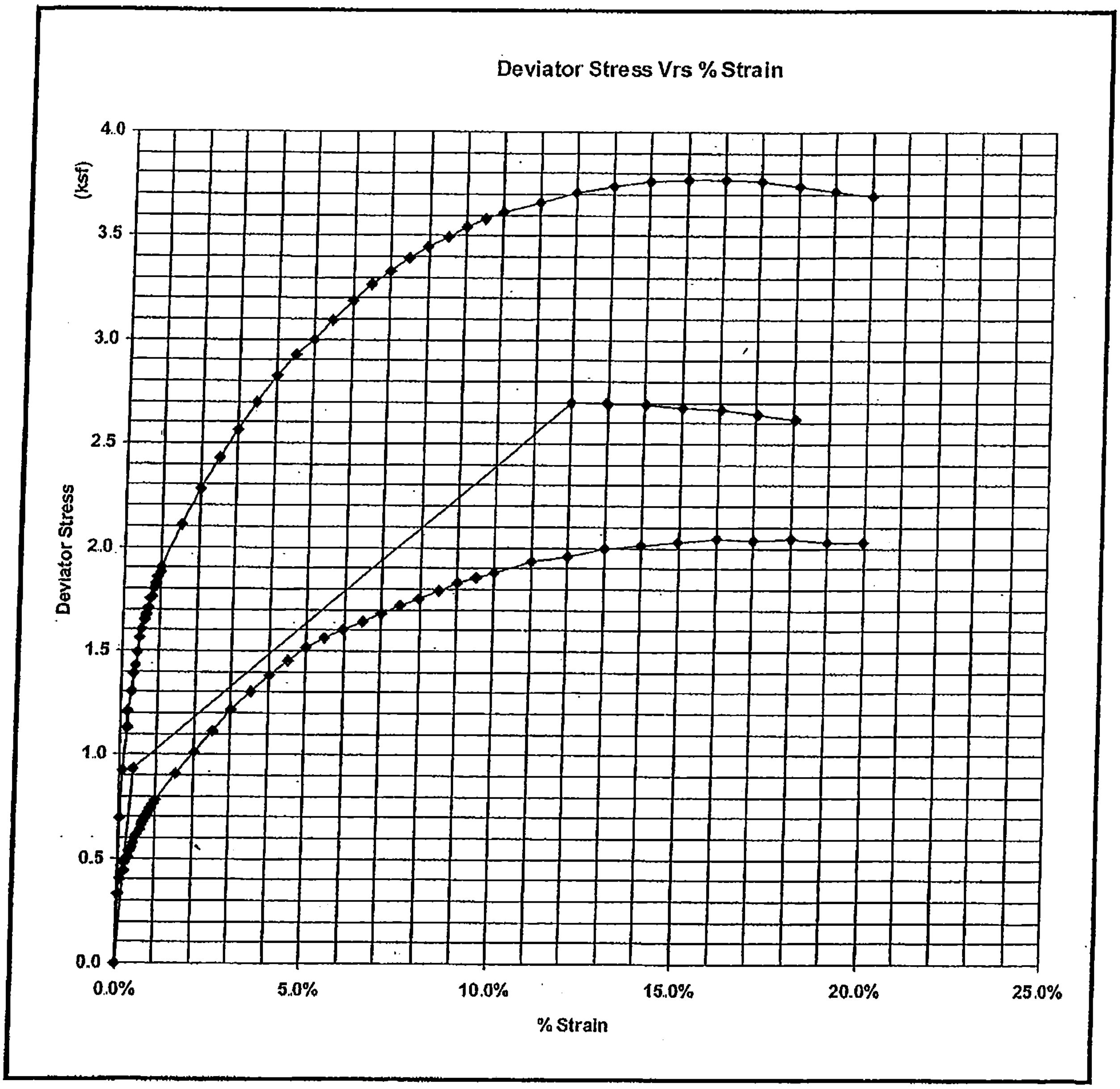

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Report Date: Friday, August 14 2009

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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922
Point: A

**Material Description:** Boring PZ-0903, Shelby Tube - 46' - 48'; Lab # S-10922

### Moisture Determination ASTM D2216

| | Before Testing | After Testing |
|---|---|---|
| Tare No. | TV | TV |
| Mass of Container and Wet Specimen (Mcws), grams | 1333.67 | 1324.63 |
| Mass of Container and Over Dry Specimen (Mcs), grams | 1077.83 | 1077.83 |
| Mass of Container (Mc), grams | 209.64 | 209 64 |
| Mass of Water (Mw), grams: | 255.84 | 246.8 |
| Mass of Solid Particles (Ms), grams: | 868.19 | 868.19 |
| Moisture Content (w), % | 29.47% | 28 43% |

### Initial Condition of Speciman ASTM D2435

| | (1) | (2) | (3) | Average |
|---|---|---|---|---|
| Diameter Measurents, Inches: | 2 829 | 2.84 | 2.817 | 2.829 |
| Height Measurements, Inches: | 5.66 | 5.637 | 5.655 | 5.651 |

Initial Volume of Specimen (Vo), In.3: 35.51
Dry Mass of Specimen After Testing, (Md), grams: 868.19
Dry Unit Weight, (γ d) pcf: 93 14
Specific Gravity of the Solids, (G): 2 70
Volume of Solids, (Vs), Cu. In.: 19.6224
Height of Solids,( Hs),In.: 3 1225
Void Ratio Before Consolidation (Eo): 0.8097
Intitail Degree of Saturation: (So) 98.27%

### Saturation - ASTM D4767 Section 8.2

Dial Indicator Reading Prior to Saturation (Rb:) In.. 0
Cell Pressure AfterSaturation, psi: 63.00
Back Presssure After Saturation After, psi: 60.00
Pore Pressure Paramenter B: 1
Dial Indicator Reading After Saturation, (Ra) In.: 0.021
Change in Height during Satureation, (Delta Hs) In.. 0.021
Change In Volume of Specimen during Saturation (Delta Vsat), In.3: 0.396

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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922
Point: A

**Consolidation- ASTM D2435, Section 11.5:**

| Sample No: | T: | Burette 2: | Burette3: | Rc: |
|---|---|---|---|---|
| 10922 | 0 | 24.1 | 24 | 0.021 |
| 10922 | 0.25 | 23.9 | 23.8 | |
| 10922 | 0.5 | 23.9 | 23.7 | |
| 10922 | 1 | 23.8 | 23.7 | |
| 10922 | 2 | 23.8 | 23.6 | |
| 10922 | 4 | 23.6 | 23.4 | |
| 10922 | 8 | 23.4 | 23.2 | |
| 10922 | 15 | 23.2 | 22.9 | 0.027 |
| 10922 | 30 | 23 | 22.5 | 0.028 |
| 10922 | 60 | 22.6 | 22.1 | 0.03 |
| 10922 | 120 | 22.3 | 21.6 | 0.032 |
| 10922 | 240 | 22.1 | 21.3 | 0.034 |
| 10922 | 360 | 22 | 21.2 | 0.036 |
| 10922 | 1440 | 21.8 | 21 | 0.037 |

Specimen Height After Consolidation, (Hc), In.: 5.61

Volume Change During Consolidation (Delta Vc), In.3: 0.32

Cross-Sectional Area of Specimen After Consolidation (Ac), In.2: 6.20

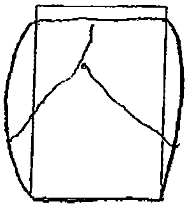
**Triaxial Compression Testing ASTM D 4767**

Sample Depth: 0 ft.
Cell Pressure: 65 psi
Back Pressure: 60 psi
Confining Pressure: 5 psi
Strain Rate: 0.006 in./min.

Specimen Height After Consolidation, (Hc), In.: 5.61
Correction for Vert Displacement, In.: 0
Load due to Friction and Uplift: 17.4 lbs.
Correction for Filter Paper: 0
Thickness of Membrane (tm), In.: 0.012

$\sigma1-\sigma3=$ Deviator Stress at Failure, ksf: 2.03
$\sigma3$ f= Effective Consolidation Stress at Failure, ksf: 0.72
$\sigma1=$ Total Major Principal Stress at Failure: 2.75
$\sigma'3f=$ $\sigma3-\Delta u=$ Effective Minor Principal Stress at Failure,ksf: 0.42
$\sigma'1f=$ Effective Major Principal Stress at Failure, ksf: 2.45
Axial Strain at Failure: 14.99%

**Failure Sketch**



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Report Date: Friday August 14, 2009

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# Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922
Point: A

| Pa: Applied Force | Vertical Displacement Reading In.: | Pore Pressure psi: | Axial Strain (El): | (P) - Force Adj for U and F lbs: | Corrected Vertical Displac In.: | Correction for Membrane ksf: | (A) Area In 2: | (σ1−σ3) Deviator Stress ksf: | [Δυ] Induced Pore Water Pressure ksf: | σ3 Effective Consolidation Stress ksf | σ1 Total Major Principal Stress ksf | σ3 Effective Minor Principal Stress ksf | σ1 ' Effective Major Principal Stress ksf | p' | q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17.4 | 0.000 | 62.8 | 0.00% | 0.0 | 0.000 | -0.00002 | 6.197 | 0.00 | 0.4032 | 0.72 | 0.72 | 0.32 | 0.32 | 0.32 | 0.00 |
| 31.6 | 0.003 | 63.7 | 0.05% | 14.2 | 0.003 | 0.00025 | 6.201 | 0.33 | 0.5328 | 0.72 | 1.05 | 0.19 | 0.52 | 0.35 | 0.16 |
| 34.7 | 0.005 | 64.0 | 0.10% | 17.3 | 0.005 | 0.00047 | 6.203 | 0.40 | 0.5760 | 0.72 | 1.12 | 0.14 | 0.55 | 0.34 | 0.20 |
| 36.6 | 0.009 | 64.1 | 0.16% | 19.2 | 0.009 | 0.00077 | 6.207 | 0.44 | 0.5904 | 0.72 | 1.16 | 0.13 | 0.57 | 0.35 | 0.22 |
| 38.1 | 0.011 | 64.3 | 0.20% | 20.7 | 0.011 | 0.00098 | 6.210 | 0.48 | 0.6192 | 0.72 | 1.20 | 0.10 | 0.58 | 0.34 | 0.24 |
| 39.3 | 0.014 | 64.3 | 0.25% | 21.9 | 0.014 | 0.00124 | 6.213 | 0.51 | 0.6192 | 0.72 | 1.23 | 0.10 | 0.61 | 0.35 | 0.25 |
| 40.6 | 0.017 | 64.5 | 0.31% | 23.2 | 0.017 | 0.00153 | 6.217 | 0.54 | 0.6480 | 0.72 | 1.26 | 0.07 | 0.61 | 0.34 | 0.27 |
| 41.3 | 0.019 | 64.5 | 0.35% | 23.9 | 0.019 | 0.00170 | 6.219 | 0.55 | 0.6480 | 0.72 | 1.27 | 0.07 | 0.62 | 0.35 | 0.28 |
| 42.4 | 0.022 | 64.5 | 0.40% | 25.0 | 0.022 | 0.00196 | 6.222 | 0.58 | 0.6480 | 0.72 | 1.30 | 0.07 | 0.65 | 0.36 | 0.29 |
| 43.5 | 0.026 | 64.5 | 0.46% | 26.1 | 0.026 | 0.00224 | 6.226 | 0.60 | 0.6480 | 0.72 | 1.32 | 0.07 | 0.67 | 0.37 | 0.30 |
| 44.2 | 0.028 | 64.7 | 0.50% | 26.8 | 0.028 | 0.00244 | 6.228 | 0.62 | 0.6768 | 0.72 | 1.34 | 0.04 | 0.66 | 0.35 | 0.31 |
| 45.3 | 0.031 | 64.7 | 0.56% | 27.9 | 0.031 | 0.00275 | 6.232 | 0.64 | 0.6768 | 0.72 | 1.36 | 0.04 | 0.69 | 0.36 | 0.32 |
| 46.2 | 0.034 | 64.7 | 0.61% | 28.8 | 0.034 | 0.00302 | 6.236 | 0.66 | 0.6768 | 0.72 | 1.38 | 0.04 | 0.71 | 0.37 | 0.33 |
| 46.8 | 0.036 | 64.7 | 0.65% | 29.4 | 0.036 | 0.00319 | 6.238 | 0.68 | 0.6768 | 0.72 | 1.40 | 0.04 | 0.72 | 0.38 | 0.34 |
| 47.5 | 0.039 | 64.7 | 0.69% | 30.1 | 0.039 | 0.00342 | 6.241 | 0.69 | 0.6768 | 0.72 | 1.41 | 0.04 | 0.73 | 0.39 | 0.35 |
| 48.2 | 0.042 | 64.9 | 0.74% | 30.8 | 0.042 | 0.00366 | 6.244 | 0.71 | 0.7056 | 0.72 | 1.43 | 0.01 | 0.72 | 0.37 | 0.35 |
| 49.0 | 0.045 | 64.9 | 0.80% | 31.6 | 0.045 | 0.00393 | 6.247 | 0.72 | 0.7056 | 0.72 | 1.44 | 0.01 | 0.74 | 0.38 | 0.36 |
| 49.7 | 0.048 | 64.9 | 0.85% | 32.3 | 0.048 | 0.00419 | 6.251 | 0.74 | 0.7056 | 0.72 | 1.46 | 0.01 | 0.75 | 0.38 | 0.37 |
| 50.5 | 0.051 | 64.9 | 0.91% | 33.1 | 0.051 | 0.00447 | 6.254 | 0.76 | 0.7056 | 0.72 | 1.48 | 0.01 | 0.77 | 0.39 | 0.38 |
| 50.9 | 0.054 | 64.9 | 0.95% | 33.5 | 0.054 | 0.00470 | 6.257 | 0.77 | 0.7056 | 0.72 | 1.49 | 0.01 | 0.78 | 0.40 | 0.38 |
| 51.6 | 0.056 | 64.9 | 1.00% | 34.2 | 0.056 | 0.00491 | 6.260 | 0.78 | 0.7056 | 0.72 | 1.50 | 0.01 | 0.80 | 0.41 | 0.39 |
| 57.4 | 0.084 | 64.9 | 1.50% | 40.0 | 0.084 | 0.00738 | 6.292 | 0.91 | 0.7056 | 0.72 | 1.63 | 0.01 | 0.92 | 0.47 | 0.45 |
| 62.1 | 0.112 | 64.9 | 2.00% | 44.7 | 0.112 | 0.00982 | 6.324 | 1.01 | 0.7056 | 0.72 | 1.73 | 0.01 | 1.02 | 0.52 | 0.50 |
| 67.2 | 0.140 | 64.9 | 2.49% | 49.8 | 0.140 | 0.01227 | 6.356 | 1.12 | 0.7056 | 0.72 | 1.84 | 0.01 | 1.13 | 0.57 | 0.56 |
| 72.0 | 0.168 | 64.8 | 3.00% | 54.6 | 0.168 | 0.01475 | 6.389 | 1.22 | 0.6912 | 0.72 | 1.94 | 0.03 | 1.24 | 0.64 | 0.61 |
| 76.2 | 0.196 | 64.6 | 3.50% | 58.8 | 0.196 | 0.01722 | 6.422 | 1.30 | 0.6624 | 0.72 | 2.02 | 0.06 | 1.36 | 0.71 | 0.65 |
| 80.1 | 0.224 | 64.5 | 4.00% | 62.7 | 0.224 | 0.01967 | 6.456 | 1.38 | 0.6480 | 0.72 | 2.10 | 0.07 | 1.45 | 0.76 | 0.69 |
| 83.7 | 0.253 | 64.3 | 4.50% | 66.3 | 0.253 | 0.02214 | 6.490 | 1.45 | 0.6192 | 0.72 | 2.17 | 0.10 | 1.55 | 0.83 | 0.72 |
| 87.0 | 0.280 | 64.2 | 4.99% | 69.6 | 0.280 | 0.02458 | 6.523 | 1.51 | 0.6048 | 0.72 | 2.23 | 0.12 | 1.63 | 0.87 | 0.76 |
| 89.8 | 0.308 | 64.0 | 5.49% | 72.4 | 0.308 | 0.02704 | 6.558 | 1.56 | 0.5760 | 0.72 | 2.28 | 0.14 | 1.71 | 0.93 | 0.78 |
| 92.1 | 0.336 | 63.9 | 5.99% | 74.7 | 0.336 | 0.02949 | 6.593 | 1.60 | 0.5616 | 0.72 | 2.32 | 0.16 | 1.76 | 0.96 | 0.80 |
| 94.4 | 0.365 | 63.8 | 6.49% | 77.0 | 0.365 | 0.03196 | 6.628 | 1.64 | 0.5472 | 0.72 | 2.36 | 0.17 | 1.81 | 0.99 | 0.82 |
| 96.9 | 0.393 | 63.7 | 7.00% | 79.5 | 0.393 | 0.03443 | 6.664 | 1.68 | 0.5328 | 0.72 | 2.40 | 0.19 | 1.87 | 1.03 | 0.84 |
| 99.1 | 0.421 | 63.6 | 7.49% | 81.7 | 0.421 | 0.03687 | 6.699 | 1.72 | 0.5184 | 0.72 | 2.44 | 0.20 | 1.92 | 1.06 | 0.86 |
| 101.3 | 0.449 | 63.5 | 7.99% | 83.9 | 0.449 | 0.03933 | 6.736 | 1.75 | 0.5040 | 0.72 | 2.47 | 0.22 | 1.97 | 1.09 | 0.88 |
| 103.5 | 0.477 | 63.4 | 8.49% | 86.1 | 0.477 | 0.04178 | 6.773 | 1.79 | 0.4896 | 0.72 | 2.51 | 0.23 | 2.02 | 1.12 | 0.89 |
| 105.9 | 0.505 | 63.3 | 8.99% | 88.5 | 0.505 | 0.04425 | 6.810 | 1.83 | 0.4752 | 0.72 | 2.55 | 0.24 | 2.07 | 1.16 | 0.91 |
| 107.8 | 0.533 | 63.2 | 9.49% | 90.4 | 0.533 | 0.04671 | 6.847 | 1.85 | 0.4608 | 0.72 | 2.57 | 0.26 | 2.11 | 1.19 | 0.93 |

Report Date: Friday, August 14, 2009

**AMERICAN ELECTRIC POWER**

## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922
Point: A

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 109 6 | 0.561 | 63 1 | 9 99% | 92 2 | 0 561 | 0 04918 | 6.886 | 1.88 | 0.4464 | 0 72 | 2 60 | 0 27 | 2.15 | 1.21 | 0 94 |
| 113 3 | 0.617 | 62 9 | 10.99% | 95 9 | 0 617 | 0 05411 | 6 963 | 1 93 | 0 4176 | 0.72 | 2.65 | 0.30 | 2 23 | 1 27 | 0.96 |
| 116.1 | 0.673 | 62 7 | 11 99% | 98 7 | 0.673 | 0 05900 | 7 042 | 1 96 | 0 3888 | 0.72 | 2.68 | 0.33 | 2 29 | 1 31 | 0 98 |
| 119.2 | 0.729 | 62 5 | 12 99% | 101 8 | 0.729 | 0.06394 | 7 123 | 1 99 | 0 3600 | 0 72 | 2 71 | 0 36 | 2.35 | 1 36 | 1.00 |
| 121.6 | 0 785 | 62 3 | 13 99% | 104 2 | 0 785 | 0.06885 | 7.206 | 2 01 | 0.3312 | 0 72 | 2.73 | 0 39 | 2 40 | 1.40 | 1.01 |
| 123 9 | 0 841 | 62 1 | 14 99% | 106 5 | 0 841 | 0.07376 | 7 290 | 2.03 | 0 3024 | 0.72 | 2.75 | 0.42 | 2 45 | 1.43 | 1 01 |
| 126.0 | 0.897 | 61 8 | 15 99% | 108 6 | 0 897 | 0.07867 | 7 377 | 2.04 | 0 2592 | 0.72 | 2 76 | 0 46 | 2.50 | 1 48 | 1 02 |
| 127 2 | 0.954 | 61 7 | 16 99% | 109.8 | 0.954 | 0 08361 | 7 466 | 2 03 | 0 2448 | 0.72 | 2 75 | 0 48 | 2 51 | 1.49 | 1.02 |
| 129 3 | 1.010 | 61.5 | 17 98% | 111.9 | 1.010 | 0 08851 | 7 557 | 2 04 | 0 2160 | 0 72 | 2.76 | 0.50 | 2 55 | 1.53 | 1.02 |
| 130 0 | 1.066 | 61 3 | 18 99% | 112 6 | 1.066 | 0 09343 | 7.650 | 2.03 | 0.1872 | 0 72 | 2.75 | 0.53 | 2 56 | 1.55 | 1 01 |
| 131 6 | 1.122 | 61.1 | 19 98% | 114 2 | 1.122 | 0 09834 | 7.745 | 2.02 | 0 1584 | 0 72 | 2.74 | 0 56 | 2 59 | 1.57 | 1 01 |

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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922
Point: B

**Material Description:** Boring PZ-0903, Shelby Tube - 46' - 48'; Lab # S-10922

### Moisture Determination ASTM D2216

| | Before Testing | After Testing |
|---|---|---|
| Tare No. | Q | Q |
| Mass of Container and Wet Specimen (Mcws), grams | 1309 98 | 1301.68 |
| Mass of Containei and Over Dry Specimen (Mcs), grams | 1021 69 | 1021.69 |
| Mass of Container (Mc), grams | 206.24 | 206 24 |
| Mass of Water (Mw), grams: | 288.29 | 279 99 |
| Mass of Solid Particles (Ms), grams: | 815.45 | 815.45 |
| Moisture Content (w), % | 35.35% | 34 34% |

### Initial Condition of Speciman ASTM D2435

| | (1) | (2) | (3) | Average |
|---|---|---|---|---|
| Diameter Measurents, Inches: | 2.826 | 2 812 | 2.805 | 2.814 |
| Height Measurements, Inches: | 5.775 | 5 776 | 5.779 | 5.777 |

Initial Volume of Specimen (Vo), In.3: 35.94
Dry Mass of Specimen After Testing, (Md), grams: 815.45
Dry Unit Weight, ($\gamma$d) pcf: 86 45
Specific Gravity of the Solids, (G): 2.70
Volume of Solids, (Vs), Cu. In.: 18.4304
Height of Solids,( Hs),In.: 2.9627
Void Ratio Before Consolidation (Eo): 0 9498
Intitall Degree of Saturation: (So) 100.50%

### Saturation - ASTM D4767 Section 8.2

Dial Indicator Reading Prior to Saturation (Rb:) In. 0
Cell Pressure AfterSaturation, psi: 65.00
Back Presssure After Saturation After, psi: 60.00
Pore Pressure Paramenter B: 1
Dial Indicator Reading After Saturation, (Ra) In.: 0.03
Change in Height during Satureation, (Delta Hs) In. 0.03
Change In Volume of Specimen during Saturation (Delta Vsat), In.3: 0 560

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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922
Point: B

**Consolidation- ASTM D2435, Section 11.5:**

| Sample No: | T: | Burette 2: | Burette3: | Rc: |
|---|---|---|---|---|
| 10922 | 0 | 23.9 | 23.7 | 0.03 |
| 10922 | 0.25 | 23.8 | 23.5 | |
| 10922 | 0.5 | 23.7 | 23.5 | |
| 10922 | 1 | 23.7 | 23.5 | |
| 10922 | 2 | 23.7 | 23.4 | |
| 10922 | 4 | 23.6 | 23.3 | |
| 10922 | 8 | 23.5 | 23.2 | |
| 10922 | 15 | 23.4 | 23.1 | 0.036 |
| 10922 | 30 | 23.1 | 22.9 | 0.036 |
| 10922 | 60 | 22.8 | 22.5 | 0.039 |
| 10922 | 120 | 22.5 | 22.2 | 0.042 |
| 10922 | 240 | 22.1 | 21.8 | 0.042 |
| 10922 | 360 | 21.9 | 21.6 | 0.046 |
| 10922 | 1440 | 21.6 | 21.3 | 0.048 |

**Specimen Height After Consolidation, (Hc), In.:** 5.73

**Volume Change During Consolidation (Delta Vc), In 3:** 0.29

**Cross-Sectional Area of Specimen After Consolidation (Ac), In.2:** 6.13

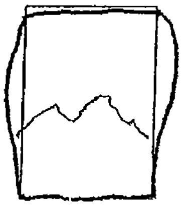
**Triaxial Compression Testing ASTM D 4767**

**Sample Depth:** 46 ft.
**Cell Pressure:** 70 psi
**Back Pressure:** 60 psi
**Confining Pressure:** 10 psi
**Strain Rate:** 0.006 In/min.

**Specimen Height After Consolidation, (Hc), In.:** 5.73
**Correction for Vert Displacement, In.:** 0
**Load due to Friction and Uplift:** 17.9 lbs.
**Correction for Filter Paper:** 0
**Thickness of Membrane (tm), In.:** 0.012

$\sigma 1-\sigma 3=$ **Deviator Stress at Failure, ksf:** 2.69
$\sigma 3$ f= **Effective Consolidation Stress at Failure, ksf:** 1.44
$\sigma 1=$ **Total Major Principal Stress at Failure:** 4.13
$\sigma '3f=$ $\sigma 3-\Delta \upsilon=$ **Effective Minor Principal Stress at Failure,ksf:** 0.63
$\sigma '1f=$ **Effective Major Principal Stress at Failure, ksf:** 3.33
**Axial Strain at Failure:** 13.02%

**Failure Sketch**



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Report Date: Friday August 14, 2009

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# Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922
Point: B

| Pa: Applied Force | Vertical Displacement Reading In.: | Pore Pressure psi: | Axial Strain (E1): | (P) - Force Adj for U and F lbs: | Corrected Vertical Displac In.: | Correction for Membrane ksf: | (A) Area In 2: | $(\sigma_1-\sigma_3)$ Deviator Stress ksf: | $[\Delta u]$ Induced Pore Water Pressure ksf: | $\sigma_3$ Effective Consolidation Stress ksf | $\sigma_1$ Total Major Principal Stress ksf | $\sigma_3$ Effective Minor Principal Stress ksf | $\sigma_1'$ Effective Major Principal Stress ksf | p' | q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 9 | 0.000 | 63 3 | 0.00% | 0.0 | 0 000 | 0.00000 | 6.125 | 0 00 | 0 4752 | 1.44 | 1 44 | 0 96 | 0.96 | 0.96 | 0 00 |
| 57 6 | 0.020 | 66.9 | 0.35% | 39.7 | 0 020 | 0.00173 | 6.147 | 0.93 | 0 9936 | 1 44 | 2 37 | 0 45 | 1.37 | 0 91 | 0.46 |
| 151.0 | 0 686 | 65 7 | 11 97% | 133.1 | 0 686 | 0 05928 | 6.958 | 2.70 | 0 8208 | 1 44 | 4.14 | 0.62 | 3 31 | 1.97 | 1.35 |
| 152.8 | 0 744 | 65 6 | 12 99% | 134.9 | 0 744 | 0 06429 | 7 039 | 2 70 | 0.8064 | 1 44 | 4.14 | 0 63 | 3 33 | 1 98 | 1.35 |
| 152 8 | 0 746 | 65 6 | 13 02% | 134.9 | 0 746 | 0 06446 | 7 042 | 2 69 | 0.8064 | 1.44 | 4.13 | 0 63 | 3.33 | 1.98 | 1 35 |
| 154.4 | 0.803 | 65 4 | 14 02% | 136 5 | 0.803 | 0 06942 | 7 124 | 2 69 | 0 7776 | 1.44 | 4 13 | 0 66 | 3.35 | 2 01 | 1 34 |
| 155 5 | 0.861 | 65 0 | 15 03% | 137 6 | 0.861 | 0.07438 | 7.208 | 2.67 | 0 7200 | 1 44 | 4.11 | 0 72 | 3.39 | 2.06 | 1.34 |
| 156 8 | 0.918 | 64 8 | 16.03% | 138 9 | 0.918 | 0.07934 | 7.294 | 2.66 | 0 6912 | 1 44 | 4.10 | 0 75 | 3 41 | 2.08 | 1.33 |
| 157 8 | 0.976 | 64 7 | 17.03% | 139 9 | 0.976 | 0.08432 | 7.383 | 2.64 | 0.6768 | 1 44 | 4.08 | 0 76 | 3.41 | 2.09 | 1 32 |
| 158 6 | 1.033 | 64 6 | 18.03% | 140 7 | 1.033 | 0.08926 | 7.472 | 2.62 | 0.6624 | 1.44 | 4 06 | 0 78 | 3.40 | 2.09 | 1 31 |

Report Date: Friday, August 14, 2009

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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922
Point: C

**Material Description:** Boring PZ-0903, Shelby Tube - 46' - 48'; Lab # S-10922

### Moisture Determination ASTM D2216

| | Before Testing | After Testing |
|---|---|---|
| Tare No. | Y | Y |
| Mass of Container and Wet Specimen (Mcws), grams | 1361 13 | 1334.81 |
| Mass of Container and Over Dry Specimen (Mcs), grams | 1093 60 | 1093.60 |
| Mass of Container (Mc), grams | 210.21 | 210.21 |
| Mass of Water (Mw), grams: | 267.53 | 241.21 |
| Mass of Solid Particles (Ms), grams: | 883 39 | 883.39 |
| Moisture Content (w), % | 30.28% | 27.31% |

### Initial Condition of Speciman ASTM D2435

| | (1) | (2) | (3) | Average |
|---|---|---|---|---|
| Diameter Measurents, Inches: | 2.807 | 2 825 | 2.827 | 2.820 |
| Height Measurements, Inches: | 5.841 | 5 841 | 5.835 | 5 839 |

Initial Volume of Specimen (Vo), In.3: 36.46

Dry Mass of Specimen After Testing, (Md), grams: 883.39

Dry Unit Weight, (γd) pcf: 92.30

Specific Gravity of the Solids, (G): 2.70

Volume of Solids, (Vs), Cu. In.: 19 9659

Height of Solids,( Hs),In.: 3.1974

Void Ratio Before Consolidation (Eo): 0.8261

Intitail Degree of Saturation: (So) 98.98%

### Saturation - ASTM D4767 Section 8.2

Dial Indicator Reading Prior to Saturation (Rb:) In. 0

Cell Pressure AfterSaturation, psi: 65.00

Back Presssure After Saturation After, psi: 60.00

Pore Pressure Paramenter B: 1

Dial Indicator Reading After Saturation, (Ra) In.: 0.031

Change in Height during Satureation, (Delta Hs) In. 0.031

Change In Volume of Specimen during Saturation (Delta Vsat), In.3: 0.581

Report Date: Friday, August 14 2009

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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922
Point: C

**Consolidation- ASTM D2435, Section 11.5:**

| Sample No: | T: | Burette 2: | Burette3: | Rc: |
|---|---|---|---|---|
| 10922 | 0 | 23.4 | 23.8 | 0.031 |
| 10922 | 0.25 | 23.1 | 23.5 | |
| 10922 | 0.5 | 23 | 23.5 | |
| 10922 | 1 | 22.9 | 23.4 | |
| 10922 | 2 | 22.8 | 23.3 | |
| 10922 | 4 | 22.5 | 23.1 | |
| 10922 | 8 | 22.2 | 22.7 | |
| 10922 | 15 | 21.8 | 22.3 | 0.046 |
| 10922 | 30 | 21.1 | 21.6 | 0.051 |
| 10922 | 60 | 19.9 | 20.5 | 0.058 |
| 10922 | 120 | 18.2 | 19.1 | 0.068 |
| 10922 | 240 | 16.2 | 17.4 | 0.08 |
| 10922 | 360 | 15 | 16.4 | 0.086 |
| 10922 | 1440 | 13.1 | 14.7 | 0.098 |

**Specimen Height After Consolidation, (Hc), In.:** 5.74

**Volume Change During Consolidation (Delta Vc), In.3:** 1.18

**Cross-Sectional Area of Specimen After Consolidation (Ac), In.2:** 6.04

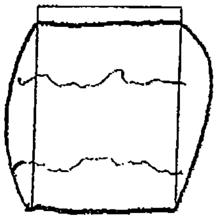
**Triaxial Compression Testing**
**ASTM D 4767**

**Sample Depth:** 46 ft.
**Cell Pressure:** 80 psi
**Back Pressure:** 60 psi
**Confining Pressure:** 20 psi
**Strain Rate:** 0.006 In/min.

**Specimen Height After Consolidation, (Hc), In.:** 5.74
**Correction for Vert Displacement, In.:** 0
**Load due to Friction and Uplift:** 22.5 lbs.
**Correction for Filter Paper:** 0
**Thickness of Membrane (tm), In.:** 0.012

$\sigma1-\sigma3=$ **Deviator Stress at Failure, ksf:** 3.77
$\sigma3$ f= **Effective Consolidation Stress at Failure, ksf:** 2.88
$\sigma1=$ **Total Major Principal Stress at Failure:** 6.65
$\sigma$ '3f= $\sigma3-\Delta\upsilon=$ **Effective Minor Principal Stress at Failure,ksf:** 0.96
$\sigma$ '1f= **Effective Major Principal Stress at Failure, ksf:** 4.74
**Axial Strain at Failure:** 15.00%

**Failure Sketch**



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## Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922
Point: C

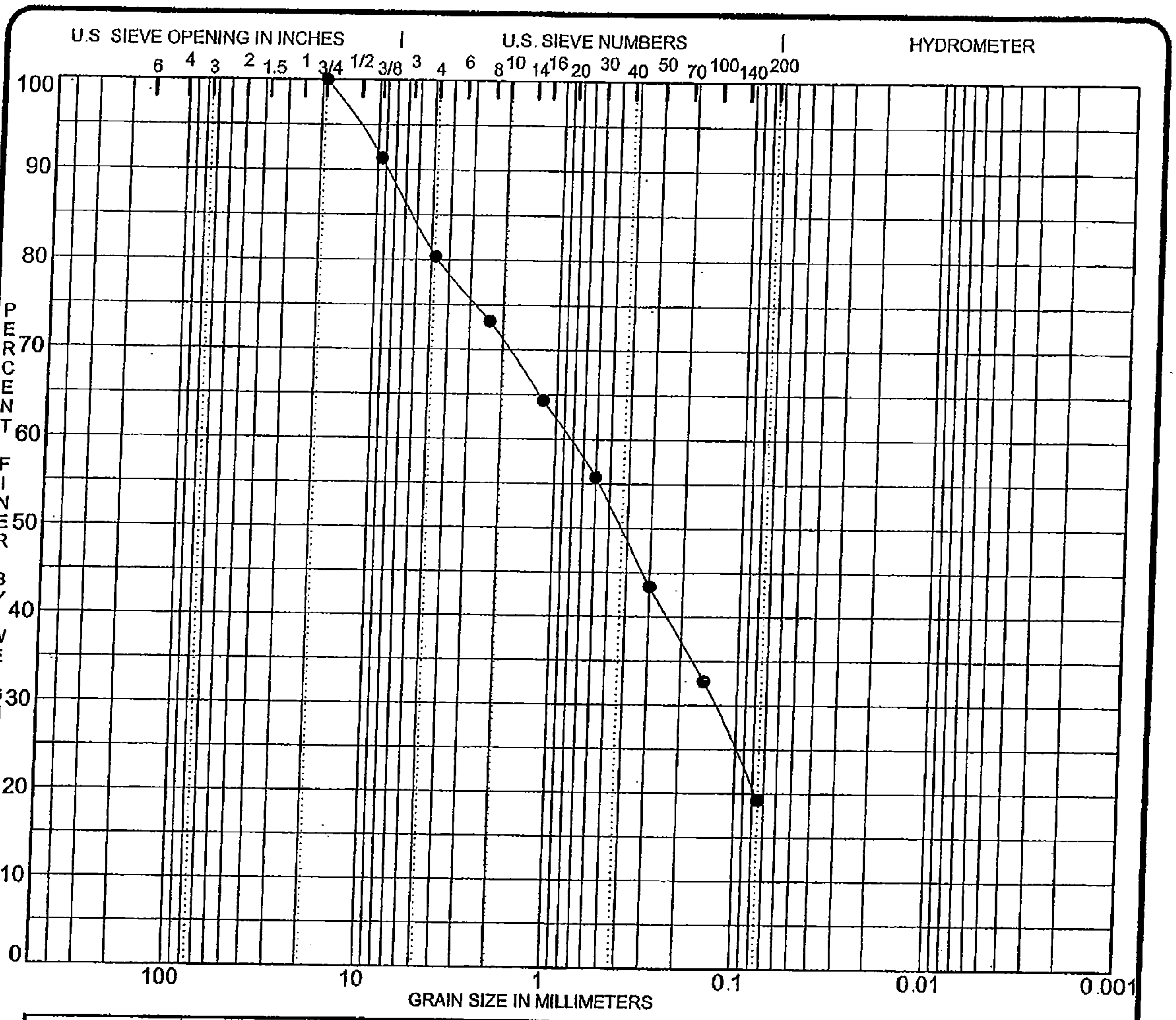
| Pa: Applied Force | Vertical Displacement Reading In.: | Pore Pressure psi: | Axial Strain (El): | (P) - Force Adj for U and F lbs: | Corrected Vertical Displac In.: | Correction for Membrane ksf: | (A) Area In.2: | (σ1–σ3) Deviator Stress ksf: | [Δu] Induced Pore Water Pressure ksf: | σ3 Effective Consolidation Stress ksf | σ1 Total Major Principal Stress ksf | σ3 Effective Minor Principal Stress ksf | σ1 ' Effective Major Principal Stress ksf | p' | q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22.5 | 0 000 | 62.7 | 0 00% | 0.0 | 0.000 | 0.00002 | 6 044 | 0.00 | 0 3888 | 2.88 | 2.88 | 2 49 | 2.49 | 2.49 | 0 00 |
| 51.7 | 0.003 | 65 1 | 0 05% | 29.2 | .0 003 | 0.00024 | 6 046 | 0.70 | 0.7344 | 2.88 | 3 58 | 2 15 | 2 84 | 2.49 | 0 35 |
| 61 2 | 0.006 | 66 7 | 0 10% | 38.7 | 0 006 | 0 00049 | 6 049 | 0.92 | 0.9648 | 2 88 | 3.80 | 1.92 | 2 84 | 2 38 | 0.46 |
| 69.8 | 0.009 | 68 2 | 0.16% | 47.3 | 0 009 | 0 00080 | 6 053 | 1 12 | 1.1808 | 2 88 | 4 00 | 1 70 | 2..82 | 2.26 | 0 56 |
| 73.4 | 0 011 | 68.7 | 0 20% | 50.9 | 0 011 | 0 00099 | 6.056 | 1 21 | 1.2528 | 2.88 | 4 09 | 1 63 | 2.84 | 2.23 | 0 60 |
| 77.2 | 0.014 | 69.1 | 0 25% | 54.7 | 0 014 | 0 00123 | 6.059 | 1 30 | 1 3104 | 2.88 | 4.18 | 1 57 | 2.87 | 2.22 | 0 65 |
| 81.0 | 0.018 | 69.7 | 0 31% | 58.5 | 0 018 | 0 00155 | 6.062 | 1 39 | 1 3968 | 2.88 | 4.27 | 1 48 | 2 87 | 2 18 | 0.69 |
| 82 8 | 0 020 | 70 9 | 0 35% | 60 3 | 0 020 | 0 00174 | 6.065 | 1.43 | 1 5696 | 2 88 | 4 31 | 1 31 | 2 74 | 2 03 | 0.72 |
| 85 3 | 0 023 | 70.9 | 0 40% | 62.8 | 0 023 | 0 00198 | 6.068 | 1.49 | 1.5696 | 2 88 | 4 37 | 1 31 | 2.80 | 2 05 | 0 74 |
| 88 5 | 0 026 | 71 0 | 0 46% | 66 0 | 0 026 | 0 00229 | 6.071 | 1.56 | 1.5840 | 2 88 | 4.44 | 1 30 | 2.86 | 2.08 | 0.78 |
| 90 0 | 0 029 | 71.0 | 0 50% | 67 5 | 0.029 | 0.00250 | 6.074 | 1.60 | 1 5840 | 2.88 | 4.48 | 1 30 | 2 89 | 2.09 | 0.80 |
| 92 1 | 0 032 | 72 3 | 0 56% | 69.6 | 0 032 | 0.00280 | 6 078 | 1 65 | 1 7712 | 2.88 | 4 53 | 1 11 | 2 76 | 1.93 | 0 82 |
| 93 4 | 0 035 | 72 7 | 0 61% | 70 9 | 0.035 | 0.00302 | 6 080 | 1 68 | 1 8288 | 2 88 | 4 56 | 1 05 | 2.73 | 1 89 | 0 84 |
| 94 7 | 0 037 | 72 5 | 0.65% | 72 2 | 0.037 | 0.00325 | 6 083 | 1 71 | 1 8000 | 2 88 | 4 59 | 1.08 | 2 79 | 1 93 | 0.85 |
| 96 7 | 0 040 | 72 6 | 0.70% | 74 2 | 0.040 | 0.00349 | 6 086 | 1 75 | 1 8144 | 2 88 | 4.63 | 1.07 | 2 82 | 1..94 | 0.88 |
| 97 2 | 0 043 | 72 6 | 0 75% | 74 7 | 0.043 | 0.00372 | 6 089 | 1 76 | 1 8144 | 2 88 | 4.64 | 1.07 | 2 83 | 1.95 | 0 88 |
| 98 8 | 0 046 | 72.8 | 0 80% | 76 3 | 0 046 | 0.00399 | 6.092 | 1 80 | 1 8432 | 2.88 | 4 68 | 1 04 | 2.84 | 1.94 | 0 90 |
| 99.9 | 0 049 | 73 3 | 0 85% | 77 4 | 0.049 | 0.00422 | 6 095 | 1.82 | 1 9152 | 2.88 | 4 70 | 0 96 | 2 79 | 1 88 | 0.91 |
| 101 1 | 0 052 | 73.4 | 0 91% | 78 6 | 0.052 | 0 00451 | 6.099 | 1 85 | 1 9296 | 2 88 | 4.73 | 0 95 | 2 80 | 1 88 | 0.93 |
| 102 3 | 0.055 | 73.6 | 0 96% | 79 8 | 0.055 | 0 00481 | 6.102 | 1.88 | 1 9584 | 2 88 | 4.76 | 0.92 | 2 80 | 1 86 | 0.94 |
| 103 2 | 0.057 | 73.7 | 1 00% | 80 7 | 0.057 | 0.00498 | 6.105 | 1.90 | 1 9728 | 2 88 | 4.78 | 0.91 | 2 81 | 1 86 | 0 95 |
| 112 7 | 0.086 | 74.9 | 1 50% | 90 2 | 0 086 | 0.00748 | 6.136 | 2.11 | 2.1456 | 2 88 | 4.99 | 0.73 | 2.84 | 1.79 | 1 05 |
| 120 7 | 0 115 | 75 8 | 2 00% | 98.2 | 0.115 | 0 00997 | 6.167 | 2.28 | 2.2752 | 2.88 | 5 16 | 0 60 | 2.89 | 1.75 | 1 14 |
| 127 6 | 0 143 | .76.9 | 2 50% | 105.1 | 0.143 | 0 01245 | 6.198 | 2.43 | 2.4336 | 2.88 | 5 31 | 0 45 | 2 88 | 1 66 | 1 21 |
| 134.1 | 0 172 | 76.7 | 3 00% | 111.6 | 0.172 | 0 01493 | 6.230 | 2.56 | 2.4048 | 2.88 | 5 44 | 0 48 | 3 04 | 1 76 | 1 28 |
| 140 6 | 0 201 | 76 9 | 3 50% | 118 1 | 0 201 | 0 01743 | 6.263 | 2 70 | 2.4336 | 2.88 | 5.58 | 0.45 | 3.14 | 1.80 | 1.35 |
| 146.7 | 0 229 | 77 0 | 4 00% | 124 2 | 0 229 | 0 01991 | 6 295 | 2 82 | 2.4480 | 2.88 | 5.70 | 0.43 | 3 25 | 1.84 | 1.41 |
| 152.0 | 0 258 | 77 2 | 4.50% | 129 5 | 0 258 | 0.02241 | 6.328 | 2 92 | 2.4768 | 2.88 | 5.80 | 0.40 | 3 33 | 1 87 | 1.46 |
| 156 2 | 0 287 | 77 1 | 5 00% | 133 7 | 0 287 | 0.02490 | 6.361 | 3.00 | 2.4624 | 2.88 | 5.88 | 0 42 | 3.42 | 1 92 | 1 50 |
| 161.1 | 0 316 | 77 0 | 5 50% | 138 6 | 0 316 | 0.02741 | 6.395 | 3 09 | 2.4480 | 2 88 | 5 97 | 0.43 | 3 53 | 1.98 | 1 55 |
| 166.0 | 0 344 | 77 0 | 6 00% | 143 5 | 0 344 | 0.02990 | 6.429 | 3.18 | 2.4480 | 2 88 | 6 06 | 0 43 | 3 62 | 2.02 | 1 59 |
| 170 7 | 0.373 | 76 8 | 6 50% | 148 2 | 0 373 | 0.03240 | 6.464 | 3 27 | 2.4192 | 2 88 | 6.15 | 0.46 | 3.73 | 2.10 | 1.63 |
| 174.4 | 0.402 | 76 9 | 7.00% | 151 9 | 0 402 | 0.03486 | 6.498 | 3 33 | 2.4336 | 2.88 | 6.21 | 0.45 | 3.78 | 2 11 | 1 67 |
| 178.1 | 0.430 | 76.5 | 7 50% | 155.6 | 0.430 | 0.03736 | 6.533 | 3 39 | 2 3760 | 2.88 | 6.27 | 0.50 | 3.90 | 2 20 | 1.70 |
| 181.6 | 0.459 | 76 4 | 8.00% | 159 1 | 0.459 | 0.03984 | 6.569 | 3.45 | 2 3616 | 2.88 | 6.33 | 0.52 | 3.97 | 2 24 | 1.72 |
| 184 9 | 0.488 | 76.2 | 8.50% | 162 4 | 0 488 | 0.04236 | 6.605 | 3 50 | 2 3328 | 2.88 | 6.38 | 0.55 | 4 05 | 2 30 | 1.75 |
| 188 0 | 0.517 | 75.8 | 9.00% | 165 5 | 0 517 | 0.04484 | 6.641 | 3.54 | 2.2752 | 2.88 | 6 42 | 0 60 | 4 15 | 2.38 | 1.77 |
| 190 7 | 0.545 | 75 6 | 9.50% | 168 2 | 0 545 | 0.04733 | 6.678 | 3 58 | 2 2464 | 2.88 | 6 46 | 0 63 | 4 21 | 2.42 | 1.79 |

Report Date: Friday, August 14, 2009

**Test Report for Consolidated-Undrained Triaxial Compresion Test - ASTM D 4767**

Company: AEP
Project: SPORN ASH DISP. FACILITY
Sample No: 10922
Point: C

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 193.5 | 0.574 | 75 3 | 10 00% | 171 0 | 0 574 | 0 04983 | 6.715 | 3 62 | 2.2032 | 2 88 | 6.50 | 0 68 | 4.29 | 2.49 | 1.81 |
| 197.7 | 0 632 | 74.7 | 11 00% | 175 2 | 0 632 | 0 05483 | 6.791 | 3 66 | 2.1168 | 2.88 | 6 54 | 0 76 | 4 42 | 2 59 | 1 83 |
| 202.2 | 0 689 | 74.6 | 11.99% | 179 7 | 0 689 | 0.05977 | 6.867 | 3.71 | 2 1024 | 2.88 | 6.59 | 0.78 | 4 49 | 2.63 | 1 85 |
| 206.2 | 0.746 | 74 3 | 13 00% | 183 7 | 0.746 | 0.06477 | 6.946 | 3 74 | 2 0592 | 2.88 | 6.62 | 0.82 | 4.56 | 2.69 | 1 87 |
| 209.6 | 0 803 | 74.0 | 13.99% | 187.1 | 0 803 | 0 06974 | 7 027 | 3.76 | 2.0160 | 2 88 | 6.64 | 0 86 | 4.63 | 2.75 | 1.88 |
| 212.5 | 0 861 | 73 3 | 15.00% | 190 0 | 0.861 | 0.07476 | 7 110 | 3.77 | 1.9152 | 2 88 | 6.65 | 0 96 | 4 74 | 2.85 | 1.89 |
| 215.0 | 0 919 | 73 0 | 16 00% | 192 5 | 0.919 | 0.07974 | 7 195 | 3.77 | 1.8720 | 2 88 | 6.65 | 1 01 | 4 78 | 2.89 | 1.89 |
| 217.0 | 0 976 | 72 5 | 16 99% | 194 5 | 0.976 | 0.08469 | 7 281 | 3.76 | 1.8000 | 2 88 | 6 64 | 1 08 | 4.84 | 2.96 | 1 88 |
| 218.3 | 1 033 | 71 7 | 18 00% | 195 8 | 1.033 | 0 08969 | 7 370 | 3 74 | 1.6848 | 2 88 | 6 62 | 1 20 | 4.93 | 3 06 | 1 87 |
| 220 1 | 1.090 | 71 0 | 18 99% | 197.6 | 1.090 | 0.09465 | 7 461 | 3 72 | 1 5840 | 2.88 | 6 60 | 1.30 | 5.02 | 3 16 | 1 86 |
| 221 5 | 1.148 | 70 7 | 20.00% | 199.0 | 1.148 | 0 09965 | 7 554 | 3 69 | 1 5408 | 2.88 | 6.57 | 1 34 | 5.03 | 3 19 | 1.85 |



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | PZ-0905 | 11.0 | | | NP | NP | NP | |
| | | | SILTY SAND with GRAVEL SM | | | | | |
| | | | Ash Mixture - Samples 5,6,7,8 Combined | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | PZ-0905 | 11.0 | 19.000 | 0.836 | 0.130 | | 19.6 | 61.2 | 19.2 | |

PROJECT SPORN PLANT - FLY ASH POND DIKES - FLY ASH POND DIKES

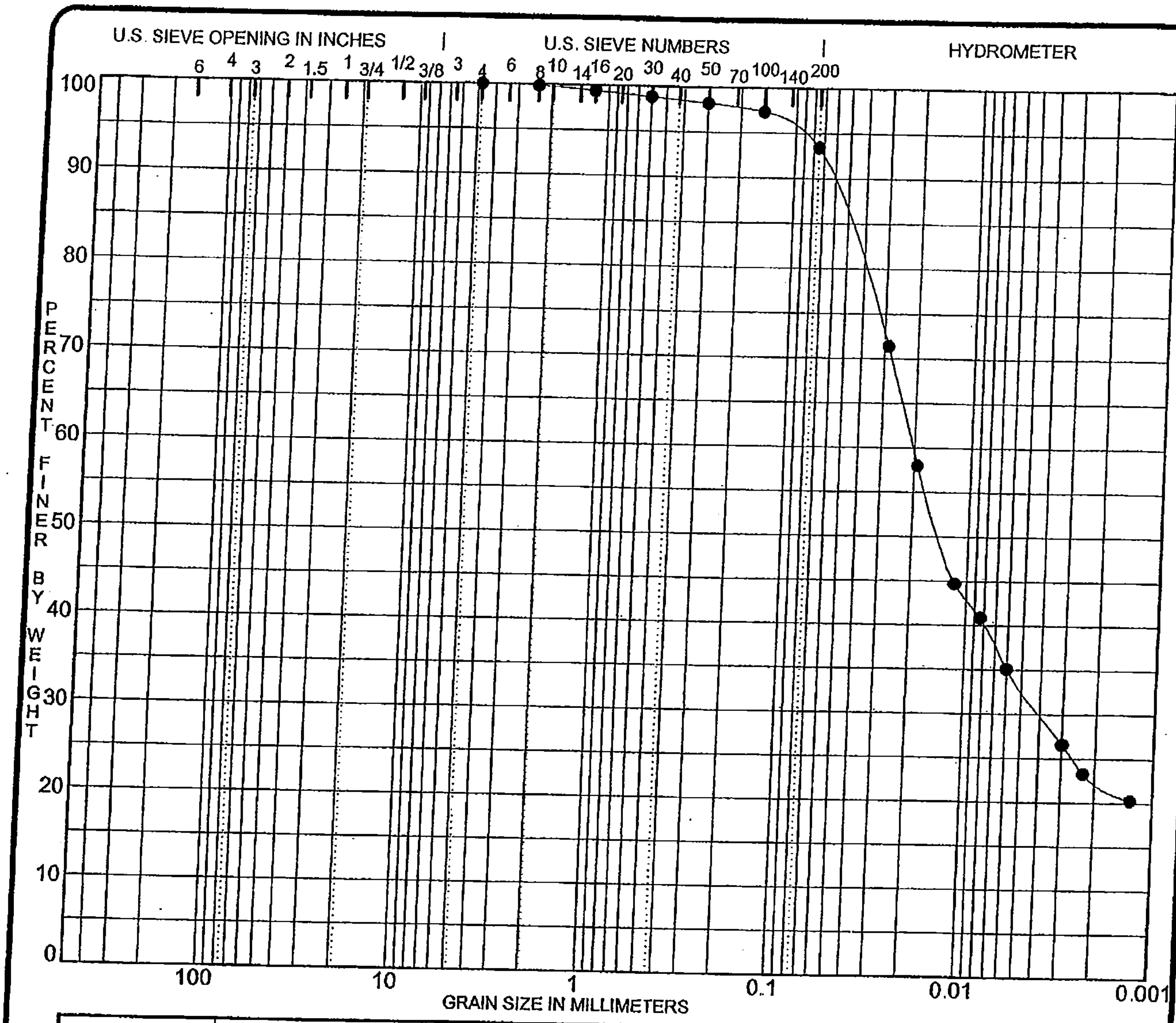
JOB NO.

DATE 8/14/09

## GRADATION CURVES

American Electric Power Service Corp.
Groveport, OH 43125

AEP



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | MC% | LL | PL | PI | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| ● | PZ-0905 | 38.0 | | 25.3 | 31.2 | 19.1 | 12.0 | |
| | | | **LEAN CLAY CL** | | | | | |
| | | | **Shelby Tube Sample - 38' - 40'** | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Fines | %<.002 |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | PZ-0905 | 38.0 | 4.750 | 0.020 | 0.004 | | 0.0 | 6.5 | 93.5 | 22.6 |

PROJECT **SPORN PLANT - FLY ASH POND DIKES - FLY ASH POND DIKES**

JOB NO.
DATE 8/14/09

## GRADATION CURVES

American Electric Power Service Corp.
Groveport, OH 43125

AEP

# LABORATORY DATA DEVELOPED BY: GEO/ENVIRONMENTAL ASSOCIATES, INC.

## DATED: DECEMBER 2009 & JANUARY 2010

# SUMMARY OF LABORATORY TEST RESULTS

Page 1 of 2

| | | | | | | ATTERBERG LIMITS | | | | Project: Philip Sporn Plant<br>Project Number: 09-387<br>Date: January 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Boring | Sample No. | Sample Type* | Depth (ft) | Natural Moisture (%) | Dry Density (pcf) | Liquid Limit (%) | Plasticity Index (%) | USCS | Other Test ** | Soil Description |
| GA-1A | ST-1 | ST | 26.5-27.2 | 26.8 | 80.6 | -- | -- | SM | S | Ash mix, clay, sandy, dark brown & light brown |
| GA-1A | ST-2 | ST | 28.5-31.0 | 53.3 | 61.3 | 46 | np | ML | S | Fly Ash, gray |
| GA-1A | ST-3 | ST | 32.5-35.0 | 58.5 | 61.0 | -- | -- | ML | S | Fly Ash, dark gray, dark brown |
| GA-1A | ST-4 | ST | 36.5-39.0 | 33.0 | -- | -- | -- | ML | S | Fly Ash, dark gray |
| GA-1A | ST-5 | ST | 40.5-43.0 | 46.6 | 69.3 | 37 | np | ML | S | Fly Ash, dark gray, dark brown |
| GA-1A | ST-6 | ST | 44.5-47.0 | 44.6 | 71.9 | 44 | np | ML | S,T | Fly Ash, dark gray |
| GA-1A | ST-7 | ST | 48.5-51.0 | 37.2 | -- | -- | -- | ML | S | Fly Ash, dark gray |
| GA-1A | ST-8 | ST | 52.5-55.0 | 53.3 | 65.7 | 44 | np | ML | S | Fly Ash, gray |
| GA-1A | ST-9 | ST | 56.5-59.0 | 51.5 | 66.5 | 45 | np | ML | S | Fly Ash, dark gray |

*ST-SHELBY TUBE SAMPLE, SS-SPLIT SPOON SAMPLE, B-BAG SAMPLE, J-JAR SAMPLE

**TEST RESULTS REPORTED ON OTHER SHEETS:

T-TRIAXIAL
S-SIEVE OR GRAIN SIZE ANALYSIS
U-UNCONFINED COMPRESSION

P-PROCTOR TEST
K-PERMEABILITY
C-CONSOLIDATION

**Geo/Environmental Associates**

DATA CHECKED BY __________

# SUMMARY OF LABORATORY TEST RESULTS

| | | | | | | ATTERBERG LIMITS | | | | Project: Philip Sporn Plant<br>Project Number: 09-387<br>Date: January 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Boring | Sample No. | Sample Type* | Depth (ft) | Natural Moisture (%) | Dry Density (pcf) | Liquid Limit (%) | Plasticity Index (%) | USCS | Other Test ** | Soil Description |
| GA-1A | ST-10 | ST | 60.5-63.0 | 53.7 | 63.5 | 44 | np | ML | S | Fly Ash, dark gray, dark brown |
| GA-1C | ST-2 | ST | 69.0-71.5 | 28.2 | 95.1 | 35 | 16 | CL | S,T | Clay, silty, brown |
| GA-2 | ST-2 | ST | 59.0-61.5 | 20.3 | -- | 20 | 4 | CL/ML | S | Clay, silty, brown |
| GA-2 | ST-3 | ST | 69.0-71.5 | 20.8 | -- | 23 | 6 | CL/ML | S | Clay, silty, light brown |
| GA-3 | ST-3 | ST | 79.0-81.5 | 24.4 | -- | 32 | 12 | CL | S | Clay, silty, light brown |
| GA-4A | ST-1 | ST | 28.0-30.5 | 73.4 | 51.7 | -- | -- | ML | S | Fly Ash, dark gray |
| GA-4A | ST-2 | ST | 32.0-34.5 | 57.2 | 59.2 | -- | -- | ML | S | Fly Ash, dark gray |
| GA-4A | ST-3 | ST | 36.0-38.0 | 33.8 | -- | 32 | 10 | CL | S | Clay, silty, light brown w/fly ash |
| GA-4B | ST-1 | ST | 29.0-31.5 | 56.3 | 61.7 | -- | -- | ML | S | Fly Ash, dark gray |

*ST-SHELBY TUBE SAMPLE, SS-SPLIT SPOON SAMPLE, B-BAG SAMPLE, J-JAR SAMPLE

**TEST RESULTS REPORTED ON OTHER SHEETS:

| | |
|---|---|
| T-TRIAXIAL | P-PROCTOR TEST |
| S-SIEVE OR GRAIN SIZE ANALYSIS | K-PERMEABILITY |
| U-UNCONFINED COMPRESSION | C-CONSOLIDATION |

**Geo/Environmental Associates**

DATA CHECKED BY ________

# Void Ratio Work Sheet

Project : Philip Sporn Plant

Project No. : 09-387

Samples : Boring Ga-1A

| **Boring** | GA-1A | GA-1A | GA-1A | GA-1A | GA-1A | GA-1A | GA-1A | GA-1A | GA-1A | GA-1A |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample No.** | ST-1 | ST-2 | ST-3 | ST-4 | ST-5 | ST-6 | ST-7 | ST-8 | ST-9 | ST-10 |
| **Depth** | 26.5-27.2 | 28.5-31.0 | 32.5-35.0 | 36.5-39.0 | 40.5-43.0 | 44.5-47.0 | 48.5-51.0 | 52.8-55.0 | 56.5-59.0 | 60.5-63.0 |
| **Moist(+1)** | 1.268 | 1.533 | 1.585 | 1.33 | 1.466 | 1.446 | 1.372 | 1.533 | 1.515 | 1.537 |
| **Wet Density** | 102.2 | 94.0 | 96.6 | 113.0 | 101.7 | 104.0 | 106.2 | 100.7 | 100.7 | 97.6 |
| **Dry Density** | 80.6 | 61.3 | 61.0 | 85.0 | 69.3 | 71.9 | 77.4 | 65.7 | 66.5 | 63.5 |
| **Wet wt** | 1.413 | 2.090 | 2.601 | 1.433 | 2.963 | 2.101 | 1.482 | 3.118 | 2.206 | 3.107 |
| **Dry wt** | 1.114 | 1.363 | 1.641 | 1.077 | 2.021 | 1.453 | 1.080 | 2.034 | 1.456 | 2.021 |
| **Water wt** | 0.299 | 0.727 | 0.960 | 0.356 | 0.942 | 0.648 | 0.402 | 1.084 | 0.750 | 1.086 |
| **Volume** | 0.0138 | 0.0222 | 0.0269 | 0.0127 | 0.0291 | 0.0202 | 0.0140 | 0.0310 | 0.0219 | 0.0318 |
| **Spec. Grav.** | 2.36 | 2.21 | 2.32 | 2.49 | 2.36 | 2.43 | 2.43 | 2.44 | 2.40 | 2.30 |
| **Vol. Solids** | 0.0076 | 0.0099 | 0.0113 | 0.0069 | 0.0137 | 0.0096 | 0.0071 | 0.0134 | 0.0097 | 0.0141 |
| **Vol. Water** | 0.0048 | 0.0116 | 0.0154 | 0.0057 | 0.0151 | 0.0104 | 0.0064 | 0.0174 | 0.0120 | 0.0174 |
| **Vol. Air** | 0.0014 | 0.0007 | 0.0002 | 0.0001 | 0.0003 | 0.0002 | 0.0004 | 0.0003 | 0.0002 | 0.0003 |
| **Porosity** | 0.4517 | 0.5547 | 0.5786 | 0.4540 | 0.5284 | 0.5256 | 0.4912 | 0.5691 | 0.5560 | 0.5571 |
| **Void Ratio** | 0.8237 | 1.2456 | 1.3731 | 0.8314 | 1.1203 | 1.1081 | 0.9653 | 1.3206 | 1.2524 | 1.2577 |

# Void Ratio Work Sheet

Project : Philip Sporn Plant

Project No. : 09-387

Samples : Borings GA-1C, GA-4A & GA-4B

| **Boring** | GA-1C | GA-4A | GA-4A | GA-4B |
|---|---|---|---|---|
| **Sample No.** | ST-2 | ST-1 | ST-2 | ST-1 |
| **Depth** | 69.0-71.5 | 28.0-30.5 | 32.0-34.5 | 29.0-31.5 |
| **Moist(+1)** | 1.282 | 1.734 | 1.572 | 1.563 |
| **Wet Density** | 121.9 | 89.6 | 93.0 | 96.5 |
| **Dry Density** | 95.1 | 51.7 | 59.2 | 61.7 |
| **Wet wt** | 2.684 | 1.995 | 1.722 | 1.382 |
| **Dry wt** | 2.094 | 1.151 | 1.095 | 0.884 |
| **Water wt** | 0.590 | 0.844 | 0.627 | 0.498 |
| **Volume** | 0.0220 | 0.0223 | 0.0185 | 0.0143 |
| **Spec. Grav.** | 2.71 | 2.25 | 2.29 | 2.31 |
| **Vol. Solids** | 0.0124 | 0.0082 | 0.0077 | 0.0061 |
| **Vol. Water** | 0.0095 | 0.0135 | 0.0100 | 0.0080 |
| **Vol. Air** | 0.0002 | 0.0006 | 0.0008 | 0.0002 |
| **Porosity** | 0.4372 | 0.6325 | 0.5856 | 0.5710 |
| **Void Ratio** | 0.7770 | 1.7213 | 1.4133 | 1.3312 |

# DENSITY CALCULATIONS

Project : Philip Sporn Plant

Date : January 07, 2010

Project No. : 09-387

| Boring | Sample No. | Ht | Dia | Wt(gm) | Wt(lbs) | Moisture Data (w/tare) wet wt | dry wt | tare wt | Moist | Area | Volume | Wet Density | Dry Density |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GA-1A | ST-1 | 3.77 | 2.84 | 640.9 | 1.413 | 878.4 | 718.8 | 123.2 | 26.8 | 0.0440 | 0.0138 | 102.2 | 80.6 |
| GA-1A | ST-2 | 5.98 | 2.86 | 947.8 | 2.090 | 833.5 | 584.7 | 117.9 | 53.3 | 0.0446 | 0.0222 | 94.0 | 61.3 |
| GA-1A | ST-3 | 7.19 | 2.87 | 1180 | 2.601 | 606.9 | 426.1 | 117.1 | 58.5 | 0.0449 | 0.0269 | 96.6 | 61.0 |
| GA-1A | ST-4 | 3.46 | 2.84 | 650 | 1.433 | 1035.2 | 844.6 | 266.6 | 33.0 | 0.0440 | 0.0127 | 113.0 | 85.0 |
| GA-1A | ST-5 | 7.78 | 2.87 | 1343.8 | 2.963 | 748.1 | 548.7 | 123.1 | 46.9 | 0.0449 | 0.0291 | 101.7 | 69.3 |
| GA-1A | ST-6 | 5.55 | 2.83 | 952.9 | 2.101 | 952.9 | 659.0 | 0.0 | 44.6 | 0.0437 | 0.0202 | 104.0 | 71.9 |
| GA-1A | ST-7 | 3.78 | 2.85 | 672.3 | 1.482 | 954.8 | 768.6 | 267.7 | 37.2 | 0.0443 | 0.0140 | 106.2 | 77.4 |
| GA-1A | ST-8 | 8.33 | 2.86 | 1414.2 | 3.118 | 889.8 | 621.5 | 118.2 | 53.3 | 0.0446 | 0.0310 | 100.7 | 65.7 |
| GA-1A | ST-9 | 6.02 | 2.83 | 1000.6 | 2.206 | 895.3 | 632.6 | 122.1 | 51.5 | 0.0437 | 0.0219 | 100.7 | 66.5 |
| GA-1A | ST-10 | 8.56 | 2.86 | 1409.3 | 3.107 | 663.1 | 474.3 | 122.4 | 53.7 | 0.0446 | 0.0318 | 97.6 | 63.5 |
| GA-1C | ST-2 | 5.88 | 2.87 | 1217.6 | 2.684 | 1217.6 | 950.1 | 0.0 | 28.2 | 0.0449 | 0.0220 | 121.9 | 95.1 |
| GA-4A | ST-1 | 5.99 | 2.86 | 904.9 | 1.995 | 811.4 | 579.5 | 263.7 | 73.4 | 0.0446 | 0.0223 | 89.6 | 51.7 |
| GA-4A | ST-2 | 4.98 | 2.86 | 780.9 | 1.722 | 762.3 | 579.4 | 259.5 | 57.2 | 0.0446 | 0.0185 | 93.0 | 59.2 |
| GA-4B | ST-1 | 3.88 | 2.85 | 626.7 | 1.382 | 587.8 | 418.2 | 117.0 | 56.3 | 0.0443 | 0.0143 | 96.5 | 61.7 |

| GA-1A | Fly Ash Pond East Dike - Section K-K | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sample | ST-2 | ST-3 | ST-4 | ST-5 | ST-6 | ST-7 | ST-8 | ST-9 | ST-10 |
| | Sample Depth (ft) | **28.5-31.0** | **32.5-35.0** | **36.5-39.0** | **40.5-43.0** | **44.5-47.0** | **48.5-51.0** | **52.5-55.0** | **56.5-59.0** | **60.5-63.0** |
| DENSITY | Tube Weight (g) | 2672 | 2658 | 2676 | 2673 | 2675 | 2657 | 2683 | 2671 | 2508 |
| | Tube & Sample Weight (g) | 7826 | 8022 | 8234 | 8080 | 8065 | 7930 | 7975 | 7820 | 8186 |
| | Sample Weight (g) | 5154 | 5364 | 5558 | 5407 | 5390 | 5273 | 5292 | 5149 | 5678 |
| | Sample Weight (lbs) | 11.36 | 11.83 | 12.25 | 11.92 | 11.88 | 11.62 | 11.67 | 11.35 | 12.52 |
| | Recovery Length (ft) | 2.66 | 2.5 | 2.6 | 2.55 | 2.55 | 2.41 | 2.55 | 2.37 | 2.49 |
| | Sample Volume ($ft^3$) | 0.120 | 0.113 | 0.117 | 0.115 | 0.115 | 0.109 | 0.115 | 0.107 | 0.112 |
| | Density ($lbs/ft^3$) | **94.8** | **104.9** | **104.5** | **103.7** | **103.4** | **107.0** | **101.5** | **106.2** | **111.5** |
| MOISTURE | Moist Sample Weight (g) | 103.54 | 79.83 | 100.6 | 84.72 | 85.84 | 84.61 | 90.97 | 91.42 | 90.5 |
| | Dry Sample Weight (g) | 75.49 | 53.78 | 66.03 | 58.14 | 52.71 | 51.65 | 59.67 | 54.03 | 72.94 |
| | Moisture Content (%) | **37.2** | **48.4** | **52.4** | **45.7** | **62.9** | **63.8** | **52.5** | **69.2** | **24.1** |
| SPECIFIC GRAVITY | Sample Weight (g) | 74.36 | 47.6 | 48.95 | 56.49 | 40.09 | 44.73 | 47.85 | 38.43 | 69.41 |
| | Flask & Water (g) | 673.32 | 680.56 | 673.32 | 680.56 | 673.23 | 680.48 | 673.06 | 680.52 | 673.02 |
| | Flask, Water, and Sample (g) | 719.23 | 708.49 | 702.72 | 710.64 | 695.29 | 705.24 | 701.01 | 702.66 | 716.77 |
| | Specific Gravity of Solids | **2.61** | **2.42** | **2.50** | **2.14** | **2.22** | **2.24** | **2.40** | **2.36** | **2.70** |
| VOID RATIO | Volume of Sample ($cm^3$) | 3395.7 | 3191.4 | 3319.1 | 3255.3 | 3255.3 | 3076.6 | 3255.3 | 3025.5 | 3178.7 |
| | Weight of Solids (g) | 3757.7 | 3613.6 | 3648.1 | 3710.6 | 3309.7 | 3218.9 | 3471.2 | 3043.1 | 4576.3 |
| | Volume of Solids ($cm^3$) | 1437.7 | 1493.3 | 1457.0 | 1734.8 | 1488.5 | 1437.1 | 1443.6 | 1289.9 | 1691.8 |
| | Void Ratio | **1.36** | **1.14** | **1.28** | **0.88** | **1.19** | **1.14** | **1.25** | **1.35** | **0.88** |

| GA-1C | Fly Ash Pond East Dike - Section K-K | | |
|---|---|---|---|
| | Sample | ST-1 | ST-2 |
| | Sample Depth (ft) | **39.0-41.5** | **69.0-71.5** |
| DENSITY | Tube Weight (g) | 2667 | 2667 |
| | Tube & Sample Weight (g) | 5095 | 8663 |
| | Sample Weight (g) | 2428 | 5996 |
| | Sample Weight (lbs) | 5.35 | 13.22 |
| | Recovery Length (ft) | 0.98 | 2.58 |
| | Sample Volume ($ft^3$) | 0.044 | 0.116 |
| | Density ($lbs/ft^3$) | **121.2** | **113.7** |
| MOISTURE | Moist Sample Weight (g) | 75.15 | 84.75 |
| | Dry Sample Weight (g) | 46.08 | 65.06 |
| | Moisture Content (%) | **63.1** | **30.3** |
| SPECIFIC GRAVITY | Sample Weight (g) | 43.65 | 57.43 |
| | Flask & Water (g) | 673.41 | 680.85 |
| | Flask, Water, and Sample (g) | 696.56 | 717.27 |
| | Specific Gravity of Solids | **2.13** | **2.73** |
| VOID RATIO | Volume of Sample ($cm^3$) | 1251.0 | 3293.6 |
| | Weight of Solids (g) | 1488.8 | 4602.9 |
| | Volume of Solids ($cm^3$) | 699.2 | 1683.9 |
| | Void Ratio | **0.79** | **0.96** |

| GA-1D | Fly Ash Pond East Dike - Section K-K | | | |
|---|---|---|---|---|
| | Sample | ST-1 | ST-2 | ST-3 |
| | Sample Depth (ft) | **29.0-31.5** | **39.0-41.5** | **59.0-61.5** |
| DENSITY | Tube Weight (g) | 2668 | 2665 | 2673 |
| | Tube & Sample Weight (g) | 5014 | 7952 | 7533 |
| | Sample Weight (g) | 2346 | 5287 | 4860 |
| | Sample Weight (lbs) | 5.17 | 11.66 | 10.71 |
| | Recovery Length (ft) | 1.17 | 2.48 | 2.36 |
| | Sample Volume ($ft^3$) | 0.053 | 0.112 | 0.106 |
| | Density ($lbs/ft^3$) | **98.1** | **104.3** | **100.7** |
| MOISTURE | Moist Sample Weight (g) | 80.9 | 84.89 | 84.19 |
| | Dry Sample Weight (g) | 52.33 | 57.14 | 59.66 |
| | Moisture Content (%) | **54.6** | **48.6** | **41.1** |
| SPECIFIC GRAVITY | Sample Weight (g) | 47.49 | 44.37 | 46.25 |
| | Flask & Water (g) | 673.36 | 680.53 | 673.19 |
| | Flask, Water, and Sample (g) | 698.44 | 705.66 | 700.87 |
| | Specific Gravity of Solids | **2.12** | **2.31** | **2.49** |
| VOID RATIO | Volume of Sample ($cm^3$) | 1493.6 | 3165.9 | 3012.7 |
| | Weight of Solids (g) | 1517.5 | 3558.7 | 3444.0 |
| | Volume of Solids ($cm^3$) | 716.1 | 1543.2 | 1382.8 |
| | Void Ratio | **1.09** | **1.05** | **1.18** |

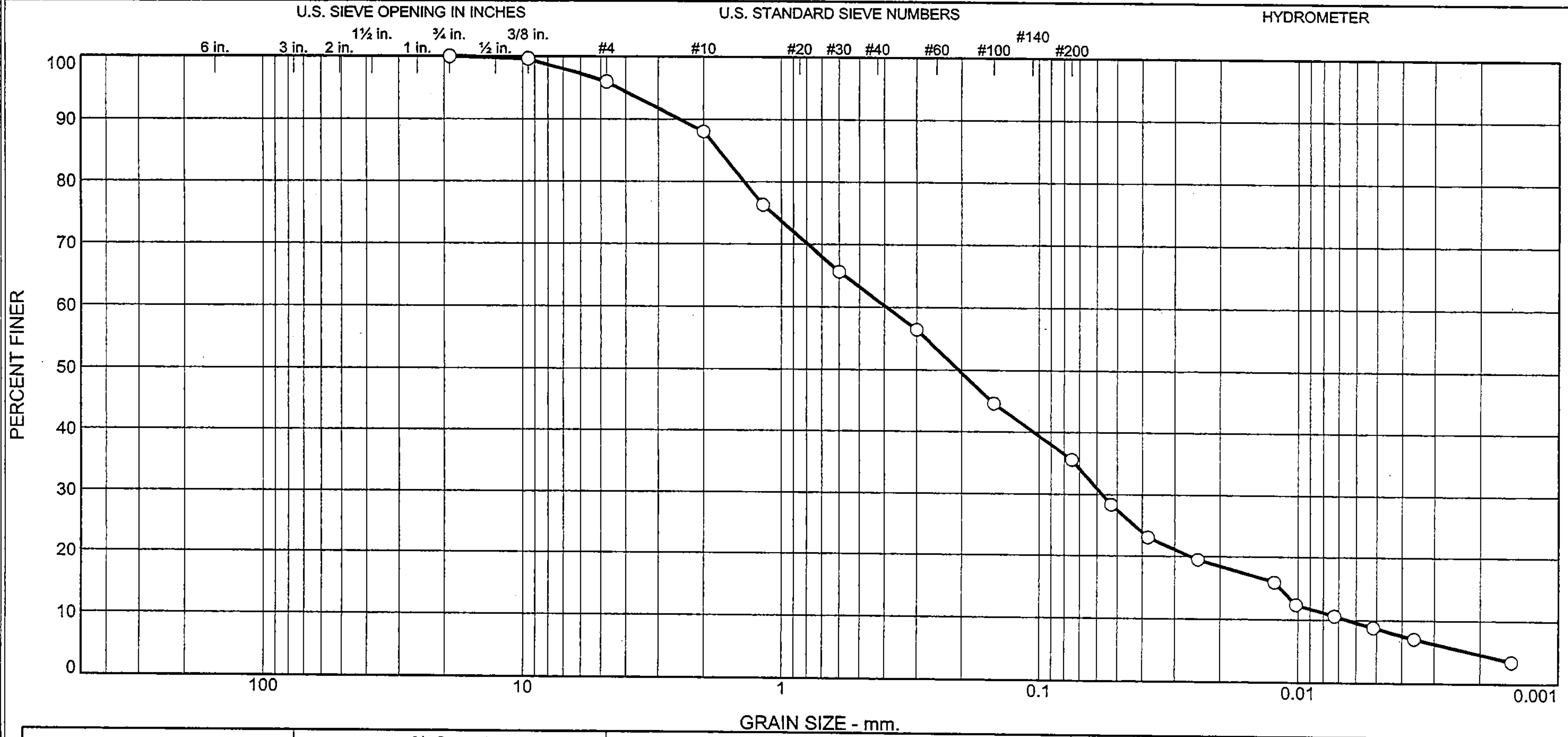
| GA-2 | Fly Ash Pond East Dike - Section M-M | | | |
|---|---|---|---|---|
| | **Sample** | **ST-1** | **ST-2** | **ST-3** |
| | **Sample Depth (ft)** | **39.0-41.5** | **59.0-61.5** | **69.0-70.5** |
| DENSITY | Tube Weight (g) | 2669 | 2657 | 2659 |
| | Tube & Sample Weight (g) | 4859 | 8808 | 6679 |
| | Sample Weight (g) | 2190 | 6151 | 4020 |
| | Sample Weight (lbs) | 4.83 | 13.56 | 8.86 |
| | Recovery Length (ft) | 1.10 | 2.50 | 1.70 |
| | Sample Volume ($ft^3$) | 0.050 | 0.113 | 0.077 |
| | Density ($lbs/ft^3$) | **97.4** | **120.3** | **115.6** |
| MOISTURE | Moist Sample Weight (g) | 62.21 | 73.94 | 96.65 |
| | Dry Sample Weight (g) | 34.09 | 59.79 | 79.79 |
| | Moisture Content (%) | **82.5** | **23.7** | **21.1** |
| SPECIFIC GRAVITY | Sample Weight (g) | 32.52 | 51.63 | 55.71 |
| | Flask & Water (g) | 686.86 | 673.69 | 681.01 |
| | Flask, Water, and Sample (g) | 704.09 | 706.28 | 714.17 |
| | Specific Gravity of Solids | **2.13** | **2.71** | **2.47** |
| VOID RATIO | Volume of Sample ($cm^3$) | 1404.2 | 3191.4 | 2170.2 |
| | Weight of Solids (g) | 1200.1 | 4973.9 | 3318.7 |
| | Volume of Solids ($cm^3$) | 564.2 | 1834.3 | 1343.3 |
| | Void Ratio | **1.49** | **0.74** | **0.62** |

| GA-3 | Fly Ash Pond East Dike - Section L-L | | | |
|---|---|---|---|---|
| | Sample | ST-1 | ST-2 | ST-3 |
| | Sample Depth (ft) | **29.0-31.5** | **49.0-51.5** | **79.0-81.5** |
| DENSITY | Tube Weight (g) | 2655 | 2653 | 2659 |
| | Tube & Sample Weight (g) | 5565 | 7463 | 8276 |
| | Sample Weight (g) | 2910 | 4810 | 5617 |
| | Sample Weight (lbs) | 6.42 | 10.60 | 12.38 |
| | Recovery Length (ft) | 1.51 | 2.34 | 2.27 |
| | Sample Volume ($ft^3$) | 0.068 | 0.105 | 0.102 |
| | Density ($lbs/ft^3$) | **94.2** | **100.5** | **121.0** |
| MOISTURE | Moist Sample Weight (g) | 54.9 | 84.35 | 93.18 |
| | Dry Sample Weight (g) | 40.85 | 53.78 | 66.03 |
| | Moisture Content (%) | **34.4** | **56.8** | **41.1** |
| SPECIFIC GRAVITY | Sample Weight (g) | 37.96 | 43.22 | 65.77 |
| | Flask & Water (g) | 680.82 | 673.27 | 680.82 |
| | Flask, Water, and Sample (g) | 700.62 | 697.43 | 721.95 |
| | Specific Gravity of Solids | **2.09** | **2.27** | **2.67** |
| VOID RATIO | Volume of Sample ($cm^3$) | 1927.6 | 2987.2 | 2897.8 |
| | Weight of Solids (g) | 2165.3 | 3066.8 | 3980.4 |
| | Volume of Solids ($cm^3$) | 1035.9 | 1352.4 | 1491.2 |
| | Void Ratio | **0.86** | **1.21** | **0.94** |

| GA-4A | Bottom Ash Pond West Dike - Section A-A | | | |
|---|---|---|---|---|
| | Sample | **ST-1** | **ST-2** | **ST-3** |
| | Sample Depth (ft) | **28.0-30.5** | **32.0-34.5** | **36.0-38.0** |
| DENSITY | Tube Weight (g) | 2666 | 2667 | 2678 |
| | Tube & Sample Weight (g) | 7502 | 7165 | 6105 |
| | Sample Weight (g) | 4836 | 4498 | 3427 |
| | Sample Weight (lbs) | 10.66 | 9.92 | 7.56 |
| | Recovery Length (ft) | 2.55 | 2.24 | 1.52 |
| | Sample Volume ($ft^3$) | 0.115 | 0.101 | 0.069 |
| | Density ($lbs/ft^3$) | **92.7** | **98.2** | **110.3** |
| MOISTURE | Moist Sample Weight (g) | 77.78 | 72.51 | 72.92 |
| | Dry Sample Weight (g) | 41.3 | 51.55 | 52.06 |
| | Moisture Content (%) | **88.3** | **40.7** | **40.1** |
| SPECIFIC GRAVITY | Sample Weight (g) | 30.22 | 35.05 | 51.82 |
| | Flask & Water (g) | 680.47 | 673.21 | 673.21 |
| | Flask, Water, and Sample (g) | 696.81 | 692.85 | 705.99 |
| | Specific Gravity of Solids | **2.18** | **2.27** | **2.72** |
| VOID RATIO | Volume of Sample ($cm^3$) | 3255.3 | 2859.5 | 1940.4 |
| | Weight of Solids (g) | 2567.8 | 3197.8 | 2446.6 |
| | Volume of Solids ($cm^3$) | 1179.4 | 1405.9 | 899.0 |
| | Void Ratio | **1.76** | **1.03** | **1.16** |

| GA-4B | Bottom Ash Pond West Dike - Section A-A | |
|---|---|---|
| | Sample | **ST-1** |
| | Sample Depth (ft) | **29.0-31.5** |
| DENSITY | Tube Weight (g) | 2684 |
| | Tube & Sample Weight (g) | 7601 |
| | Sample Weight (g) | 4917 |
| | Sample Weight (lbs) | 10.84 |
| | Recovery Length (ft) | 2.38 |
| | Sample Volume ($ft^3$) | 0.107 |
| | Density ($lbs/ft^3$) | **101.0** |
| MOISTURE | Moist Sample Weight (g) | 80.67 |
| | Dry Sample Weight (g) | 48.5 |
| | Moisture Content (%) | **66.3** |
| SPECIFIC GRAVITY | Sample Weight (g) | 47.83 |
| | Flask & Water (g) | 680.66 |
| | Flask, Water, and Sample (g) | 707.42 |
| | Specific Gravity of Solids | **2.27** |
| VOID RATIO | Volume of Sample ($cm^3$) | 3038.3 |
| | Weight of Solids (g) | 2956.2 |
| | Volume of Solids ($cm^3$) | 1302.2 |
| | Void Ratio | **1.33** |

# Particle Size Distribution Report



|  | % +3" | % Gravel |  | % Sand |  |  | % Fines |  |
|---|---|---|---|---|---|---|---|---|
|  |  | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 4.0 | 8.0 | 27.0 | 25.5 | 26.9 | 8.6 |

|  | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ |  | GA-1A ST1 | 26.5'-27.2' |  | SM | Ash mix, clay, sandy, dark brown & light brown | 26.8 | nv | np |

Client American Electric Power

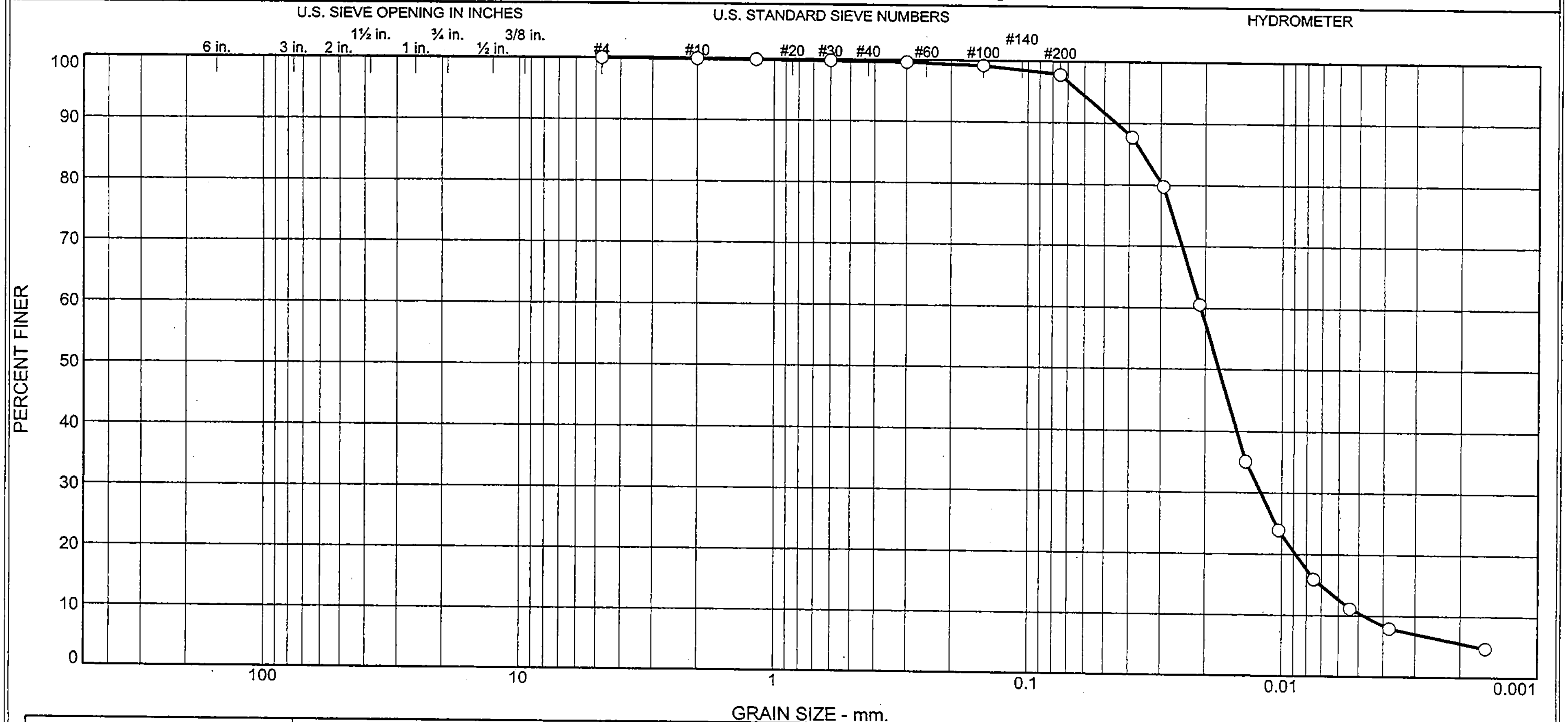
Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental**
**Associates, Inc.**
**Knoxville, Tennessee**

# Particle Size Distribution Report



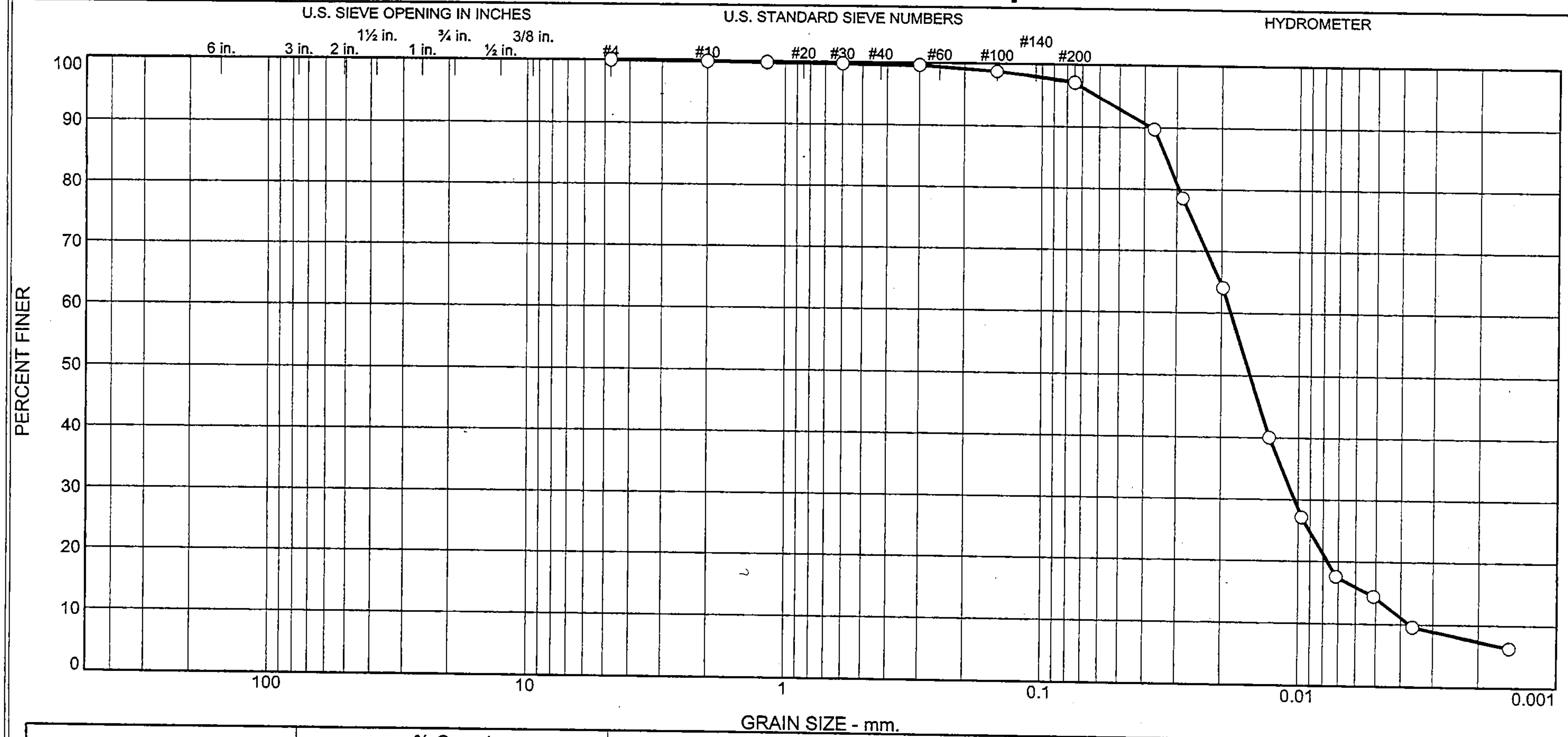
| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 1.9 | 87.4 | 10.4 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-1A ST2 | 28.5'-31.0' | | ML | Fly Ash, gray | 53.3 | 46 | np |

Client American Electric Power
Project Philip Sporn Plant
Project No. 09-387
Figure

**Geo/Environmental Associates, Inc.**
**Knoxville, Tennessee**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 2.6 | 83.1 | 14.0 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-1A ST3 | 32.5'-35.0' | | ML | Fly Ash, dark gray, dark brown | 58.5 | nv | np |

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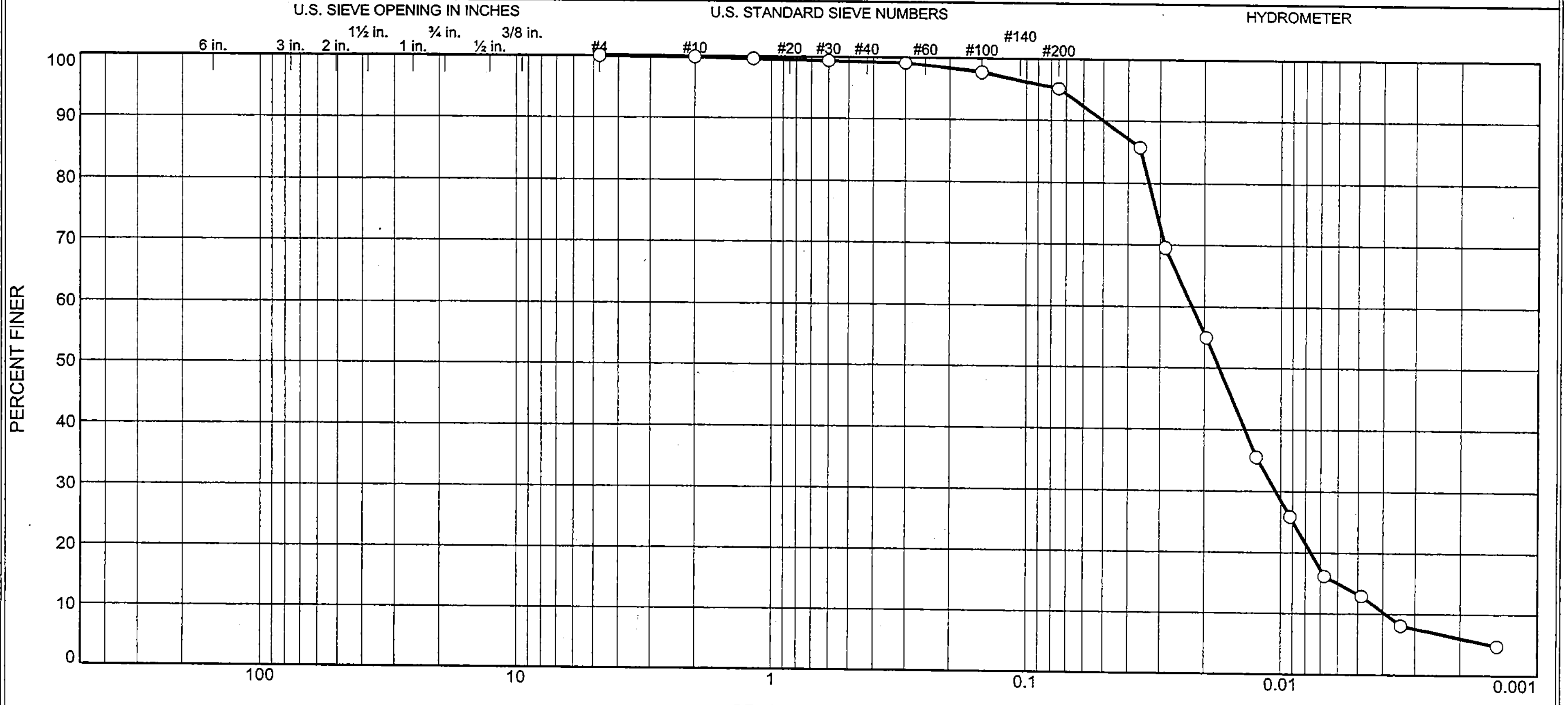
Project Philip Sporn Plant
Project No. 09-387
Figure

**Geo/Environmental Associates, Inc.**
**Knoxville, Tennessee**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 0.7 | 4.0 | 82.0 | 13.2 |
| | | | | | | | | |
| | | | | | | | | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-1A ST4 | 36.5'-39.0' | | ML | Fly Ash, dark gray | 33.0 | nv | np |
| | | | | | | | | | |
| | | | | | | | | | |

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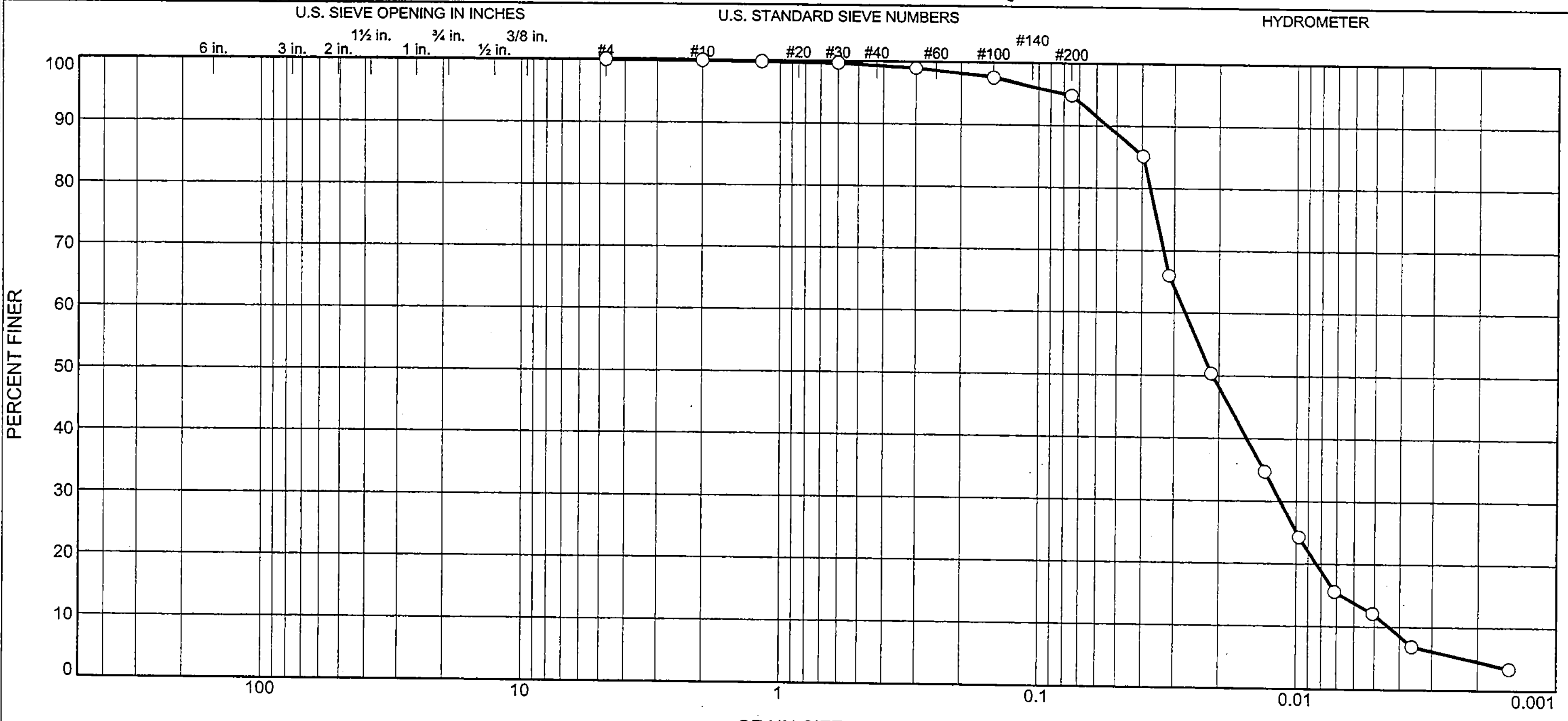
Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental Associates, Inc.
Knoxville, Tennessee**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 0.6 | 4.5 | 83.0 | 11.8 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-1A ST5 | 40.5'-43.0' | | ML | Fly Ash, dark gray, dark brown | 46.6 | 37 | np |

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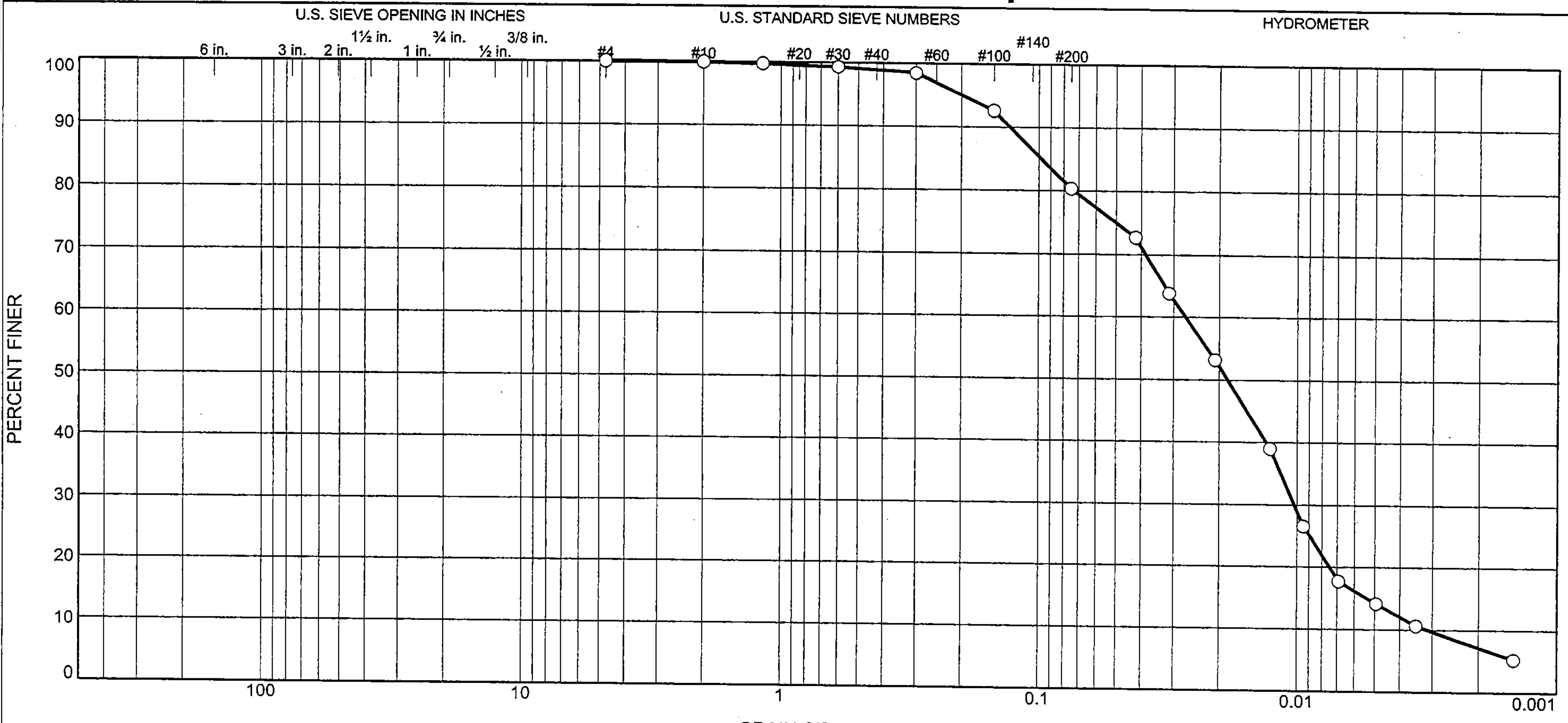
Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental Associates, Inc. Knoxville, Tennessee**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 1.1 | 18.5 | 66.1 | 14.2 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-1A ST6 | 44.5'-47.0' | 12/18/09 | ML | Fly Ash, dark gray | 44.6 | 44 | np |

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Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental Associates, Inc.**
**Knoxville, Tennessee**

# CONSTANT HEAD PERMEABILITY TESTING
# ASTM D5084-90/EPA 9100 Method 2.8

**PROJECT NAME** : Philip Sporn Plant

**PROJECT NUMBER** : 09-387

**CLIENT** : AEP

**DATE** : December 18, 2009

---

## SAMPLE LOCATION AND CONDITIONS

**Sample Id.:** GA-1A ST-6 - 20 psi

**Depth of Tested Sample** : 44.5' - 47.0'

**Remolded:** No

**Sample Type** : Shelby Tube

**Sample Description :** Fly Ash, dark gray - 20 psi triaxial specimen

## INITIAL SPECIMEN PROPERTIES

**Length (in.):** 5.55

**Volume (ft$^3$):** 0.0202

**Wet Density (PCF):** 104.0

**Diameter (in.):** 2.83

**Weight (lbs):** 2.10

**Dry Density (PCF):** 71.9

**Area (ft$^2$):** 0.0437

**Moisture (%):** 44.6

**Chamber Pressure (psi):** 10

**Change in Pore Pressure (psi):** 2.0

**Influent Pressure (psi):** 8

**Change in Chamber Pressure (psi):** 2.0

**Back Pressure (psi):** 5

**"B" Factor:** 1.0

## PERMEABILITY CALCULATIONS

k = Hydraulic Conductivity, (cm/sec)

L = Length of Sample, along path of flow, (cm)

Q = Quantity of flow, taken as the average of inflow and outflow, (cm$^3$)

A = Cross-sectional area of specimen, (cm$^2$)

t = Interval of time, over which the flow Q occurs, (sec)

h = Difference in hydraulic head across specimen, (cm)

$$k = \frac{QL}{Ath} \text{ cm/sec}$$

$$k = \frac{(600.0)(14.10)}{(40.58)(14{,}506)(211.01)}$$

$$k = \frac{8{,}460.00}{124{,}211{,}770.81}$$

$$k = 6.81 \times 10^{-5} \text{ cm/sec}$$

# CONSTANT HEAD PERMEABILITY TESTING
# ASTM D5084-90/EPA 9100 Method 2.8

**PROJECT NAME** : Philip Sporn Plant

**PROJECT NUMBER** : 09-387

**CLIENT** : AEP

**DATE** : December 18, 2009

---

## SAMPLE LOCATION AND CONDITIONS

**Sample Id.:** GA-1A ST-6 - 40 psi

**Depth of Tested Sample** : 44.5' - 47.0'

**Remolded:** No

**Sample Type** : Shelby Tube

**Sample Description :** Fly Ash, dark gray - 40 psi triaxial specimen

## INITIAL SPECIMEN PROPERTIES

| | | | | | |
|---|---|---|---|---|---|
| **Length (in.):** | 5.58 | **Volume ($ft^3$):** | 0.0206 | **Wet Density (PCF):** | 103.8 |
| **Diameter (in.):** | 2.85 | **Weight (lbs):** | 2.14 | **Dry Density (PCF):** | 71.5 |
| **Area ($ft^2$):** | 0.0443 | **Moisture (%):** | 45.2 | | |

| | | | |
|---|---|---|---|
| **Chamber Pressure (psi):** | 10 | **Change in Pore Pressure (psi):** | 2.0 |
| **Influent Pressure (psi):** | 8 | **Change in Chamber Pressure (psi):** | 2.0 |
| **Back Pressure (psi):** | 5 | **"B" Factor:** | 1.0 |

## PERMEABILITY CALCULATIONS

k = Hydraulic Conductivity, (cm/sec)

$$k = \frac{QL}{Ath} \text{ cm/sec}$$

L = Length of Sample, along path of flow, (cm)

Q = Quantity of flow, taken as the average of inflow and outflow, ($cm^3$)

$$k = \frac{(600.0)(14.17)}{(41.16)(8,599)(211.01)}$$

A = Cross-sectional area of specimen, ($cm^2$)

$$k = \frac{8,502.00}{74,683,790.59}$$

t = Interval of time, over which the flow Q occurs, (sec)

h = Difference in hydraulic head across specimen, (cm)

$$k = 1.14 \times 10^{-4} \text{ cm/sec}$$

# CONSTANT HEAD PERMEABILITY TESTING
# ASTM D5084-90/EPA 9100 Method 2.8

**PROJECT NAME** : Philip Sporn Plant

**PROJECT NUMBER** : 09-387

**CLIENT** : AEP

**DATE** : December 18, 2009

---

## SAMPLE LOCATION AND CONDITIONS

**Sample Id.:** GA-1A ST-6 - 60 psi

**Depth of Tested Sample** : 44.5' - 47.0'

**Remolded:** No

**Sample Type** : Shelby Tube

**Sample Description :** Fly Ash, dark gray - 60 psi triaxial specimen

## INITIAL SPECIMEN PROPERTIES

**Length (in.):** 5.44

**Diameter (in.):** 2.86

**Area (ft$^2$):** 0.0446

**Volume (ft$^3$):** 0.0202

**Weight (lbs):** 2.10

**Moisture (%):** 41.6

**Wet Density (PCF):** 104.0

**Dry Density (PCF):** 73.5

**Chamber Pressure (psi):** 10

**Influent Pressure (psi):** 8

**Back Pressure (psi):** 5

**Change in Pore Pressure (psi):** 2.0

**Change in Chamber Pressure (psi):** 2.0

**"B" Factor:** 1.0

## PERMEABILITY CALCULATIONS

k = Hydraulic Conductivity, (cm/sec)

L = Length of Sample, along path of flow, (cm)

Q = Quantity of flow, taken as the average of inflow and outflow, (cm$^3$)

A = Cross-sectional area of specimen, (cm$^2$)

t = Interval of time, over which the flow Q occurs, (sec)

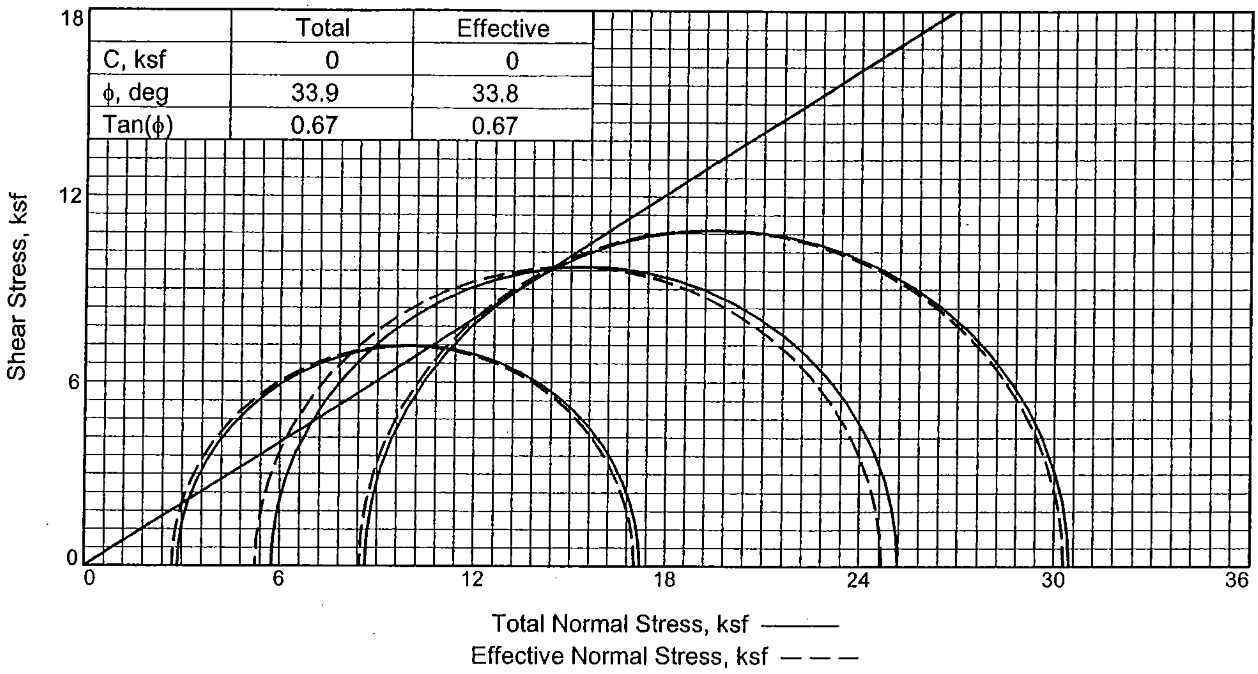
h = Difference in hydraulic head across specimen, (cm)

$$k = \frac{QL}{Ath} \text{ cm/sec}$$

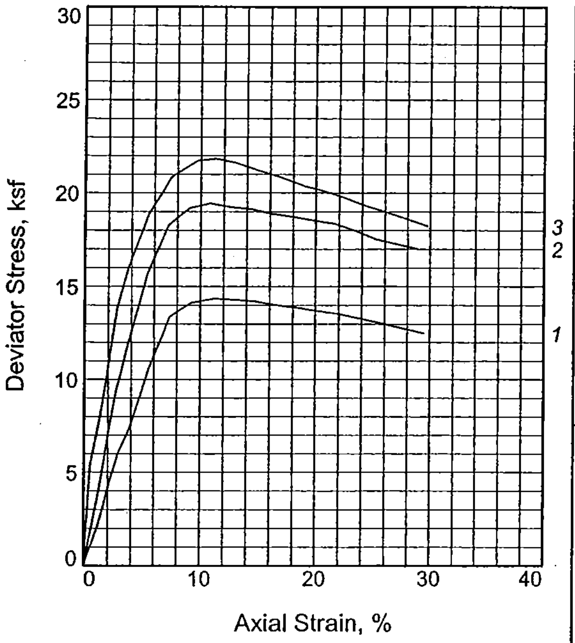
$$k = \frac{(600.0)(13.82)}{(41.45)(9{,}531)(211.01)}$$

$$k = \frac{8{,}292.00}{83{,}361{,}600.05}$$

$$k = 9.95 \times 10^{-5} \text{ cm/sec}$$



| | Total | Effective |
|---|---|---|
| C, ksf | 0 | 0 |
| ϕ, deg | 33.9 | 33.8 |
| Tan(ϕ) | 0.67 | 0.67 |



| | Sample No. | 1 | 2 | 3 |
|---|---|---|---|---|
| Initial | Water Content, % | 44.6 | 45.2 | 41.6 |
| | Dry Density, pcf | 71.9 | 71.5 | 73.5 |
| | Saturation, % | 97.7 | 98.0 | 94.8 |
| | Void Ratio | 1.1095 | 1.1210 | 1.0651 |
| | Diameter, in. | 2.83 | 2.85 | 2.86 |
| | Height, in. | 5.55 | 5.58 | 5.44 |
| At Test | Water Content, % | 40.1 | 44.4 | 40.7 |
| | Dry Density, pcf | 76.8 | 73.0 | 76.3 |
| | Saturation, % | 100.0 | 100.0 | 100.0 |
| | Void Ratio | 0.9746 | 1.0779 | 0.9883 |
| | Diameter, in. | 2.77 | 2.83 | 2.82 |
| | Height, in. | 5.43 | 5.54 | 5.37 |
| | Strain rate, in./min. | 0.00 | 0.00 | 0.00 |
| | Back Pressure, psi | 30.00 | 30.00 | 30.00 |
| | Cell Pressure, psi | 50.00 | 70.00 | 90.00 |
| | Fail. Stress, ksf | 14.3 | 19.4 | 21.8 |
| | Total Pore Pr., ksf | 4.5 | 4.8 | 4.5 |
| | Ult. Stress, ksf | | | |
| | Total Pore Pr., ksf | | | |
| | $\bar{\sigma}_1$ Failure, ksf | 17.0 | 24.7 | 30.3 |
| | $\bar{\sigma}_3$ Failure, ksf | 2.7 | 5.3 | 8.5 |

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

**Sample Type:** Shelby Tube

**Description:** Fly Ash, dark gray

**LL=** 44

**Specific Gravity=** 2.43

**Remarks:**

**Figure** 1

**Client:** American Electric Power

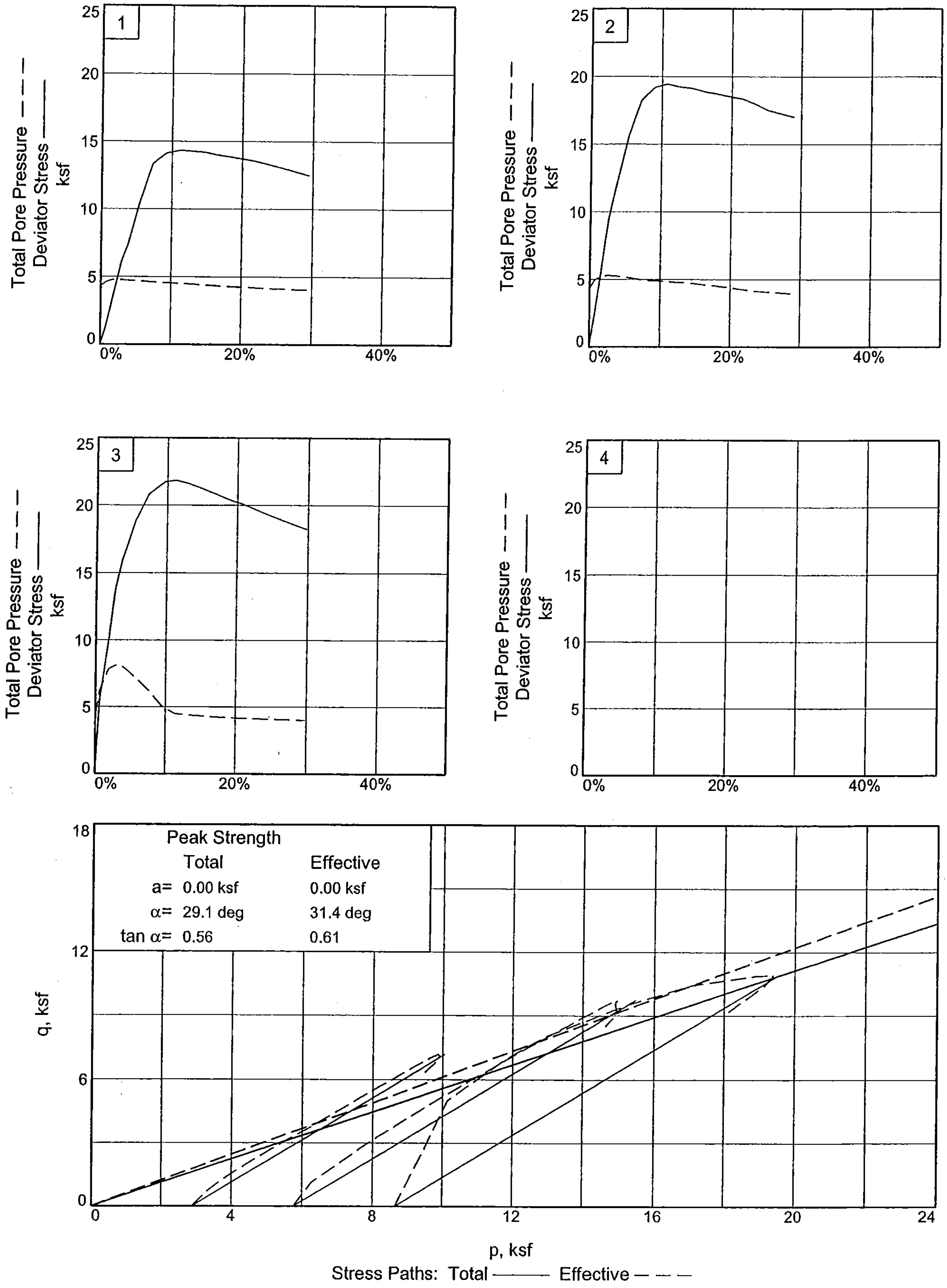
**Project:** Philip Sporn Plant

**Sample Number:** GA-1A ST6 **Depth:** 44.5'-47.0'

**Proj. No.:** 09-387 **Date Sampled:** 12/18/09

TRIAXIAL SHEAR TEST REPORT

Geo/Environmental Associates, Inc.



**Client:** American Electric Power

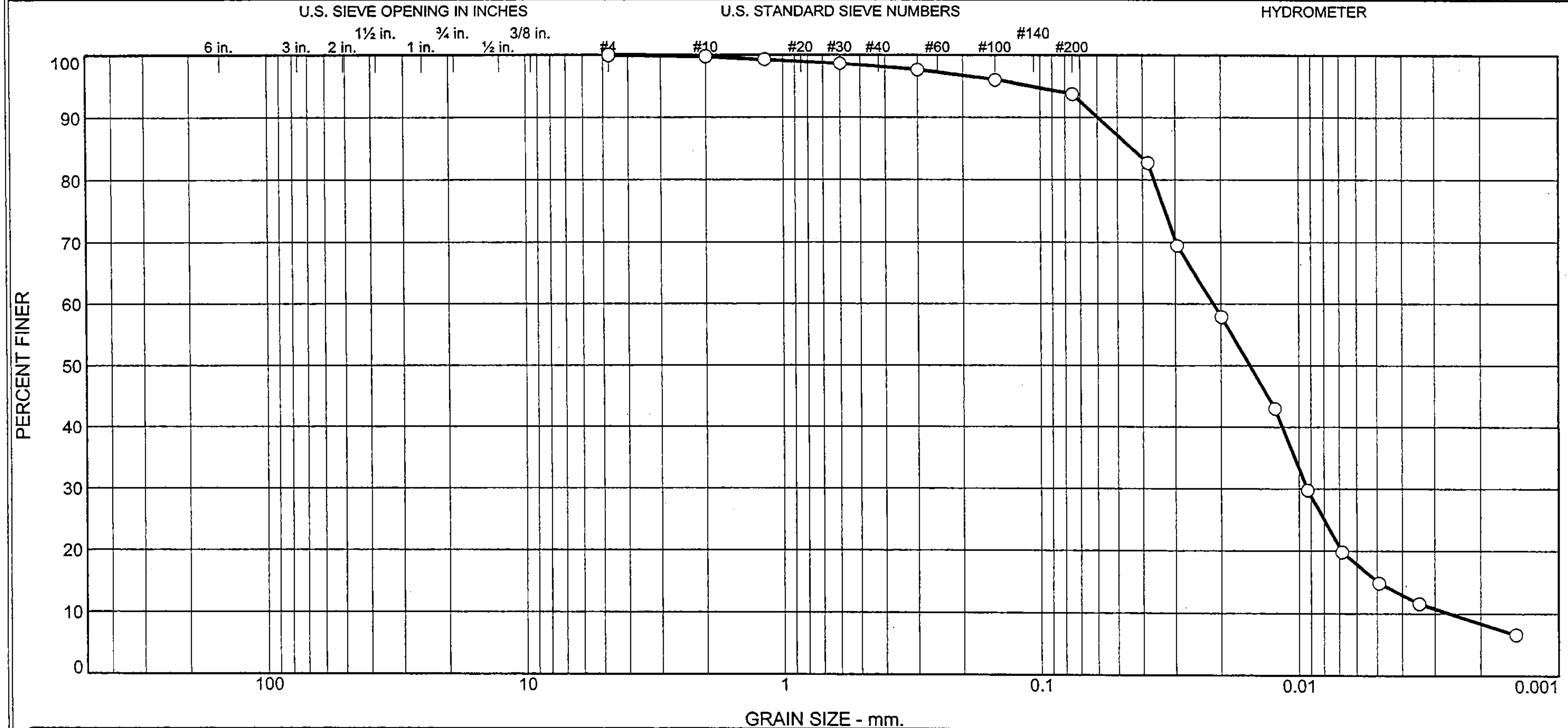
**Project:** Philip Sporn Plant

**Depth:** 44.5'-47.0' **Sample Number:** GA-1A ST6

**Project No.:** 09-387 **Figure** 2

**Geo/Environmental Associates, Inc.**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.2 | 1.7 | 4.4 | 78.6 | 15.1 |
| | | | | | | | | |
| | | | | | | | | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-1A ST7 | 48.5'-51.0' | | ML | Fly Ash, dark gray | 37.2 | nv | np |
| | | | | | | | | | |
| | | | | | | | | | |

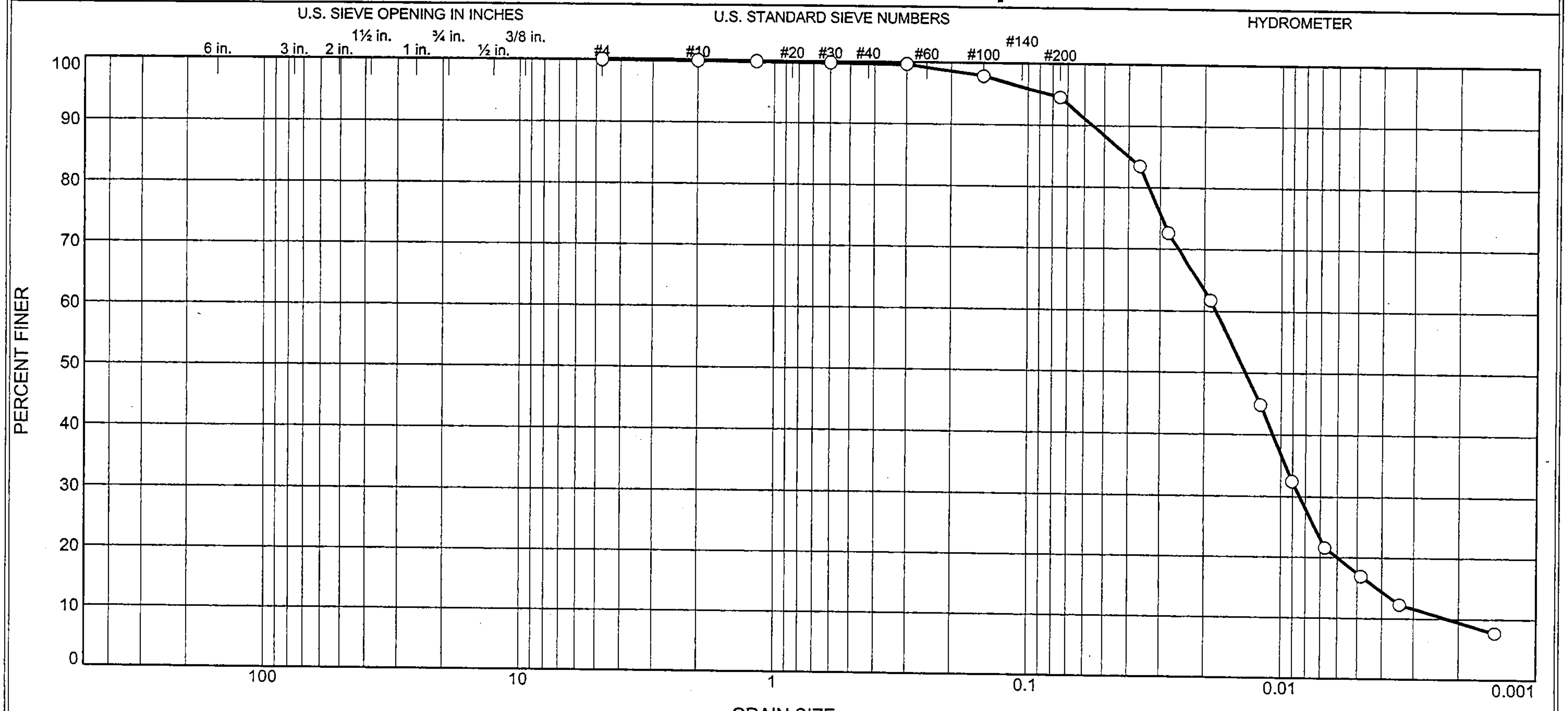
Client American Electric Power

Project Philip Sporn Plant

Project No. 09-387 Figure

**Geo/Environmental Associates, Inc.**
**Knoxville, Tennessee**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 5.2 | 77.1 | 17.4 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-1A ST8 | 52.5'-55.0' | | ML | Fly Ash, gray | 53.3 | 44 | np |

Client American Electric Power

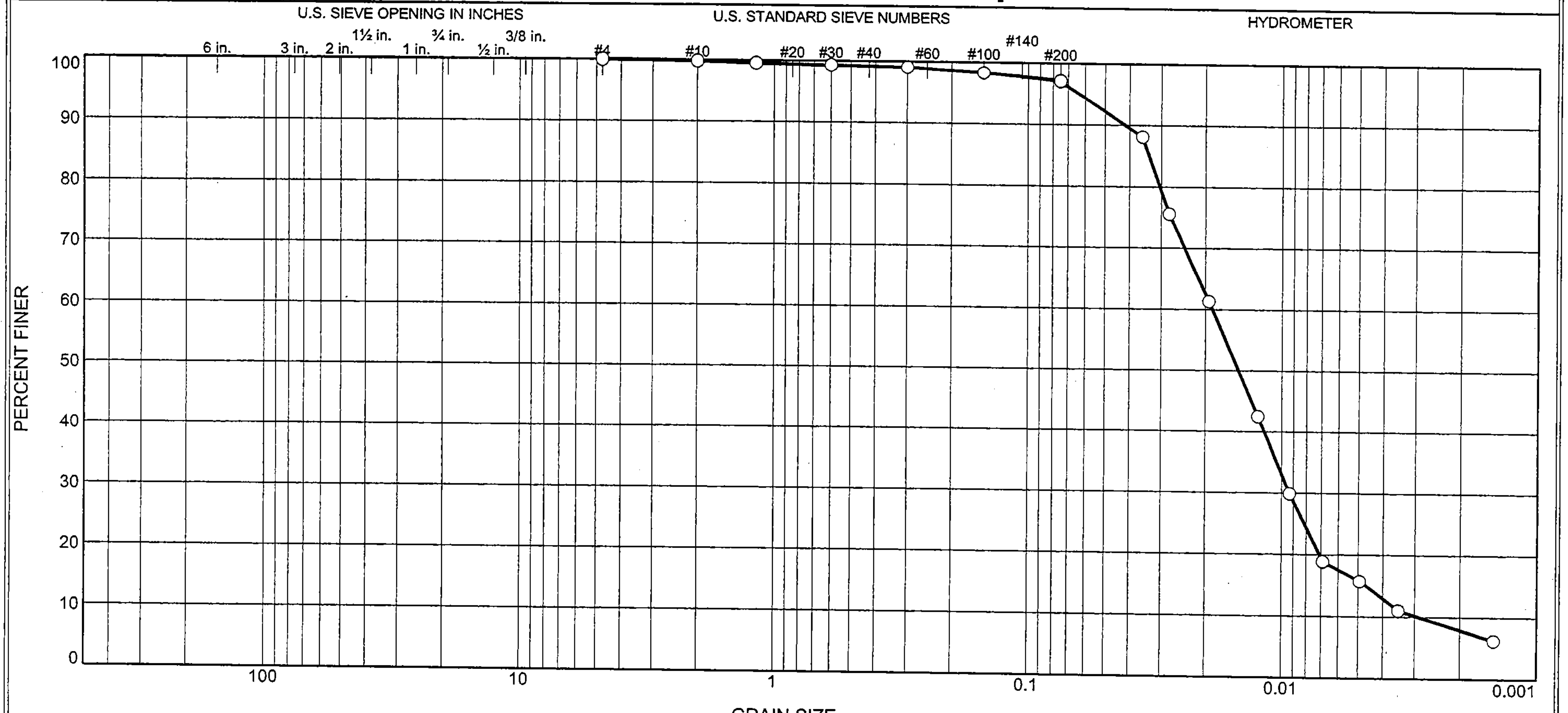
Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental Associates, Inc.
Knoxville, Tennessee**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.2 | 0.6 | 2.1 | 81.3 | 15.8 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-1A ST9 | 56.5'-59.0' | | ML | Fly Ash, dark gray | 51.5 | 45 | np |

Client American Electric Power

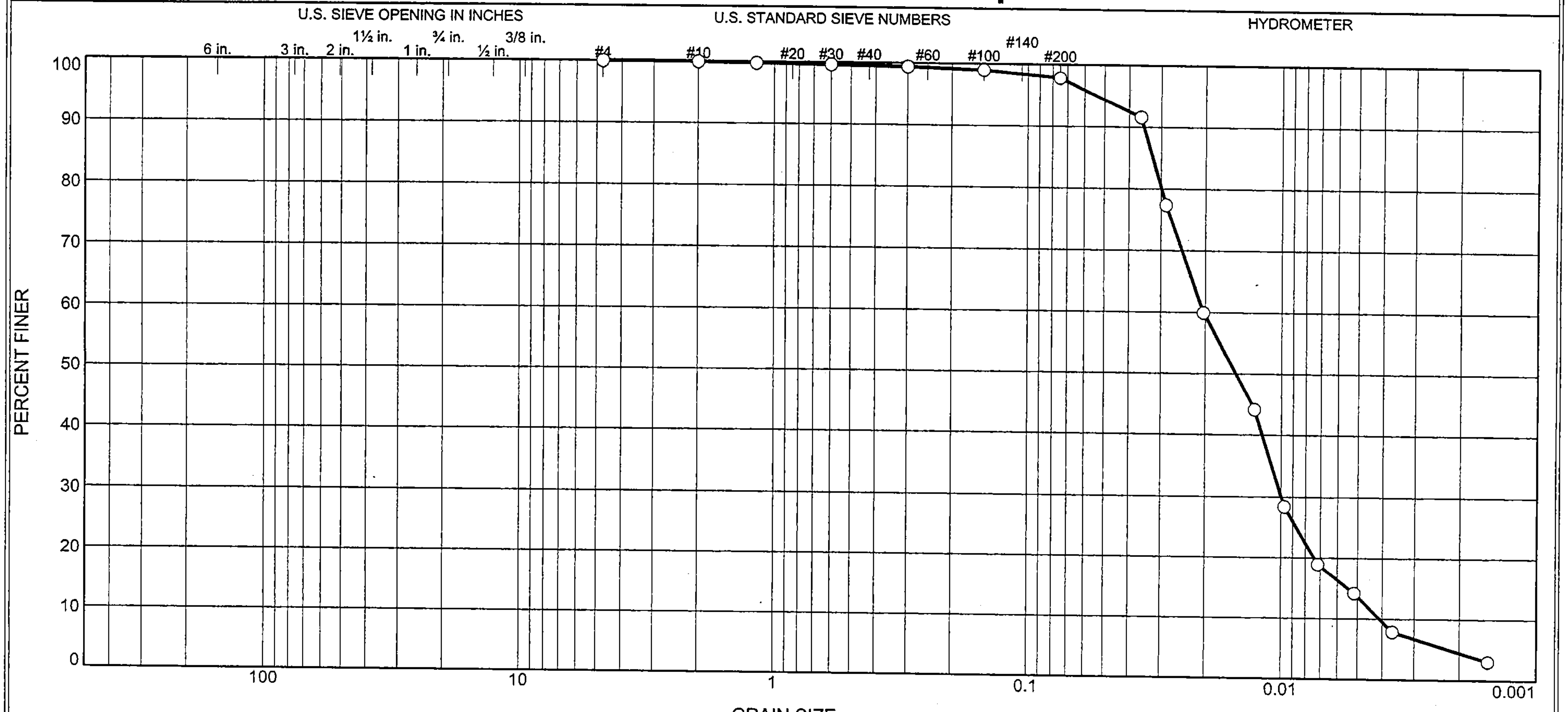
Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental Associates, Inc.**
**Knoxville, Tennessee**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 0.4 | 1.7 | 84.2 | 13.6 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA1A ST10 | 60.5'-63.0' | | ML | Fly Ash, dark gray, dark brown | 53.7 | 44 | np |

Client American Electric Power

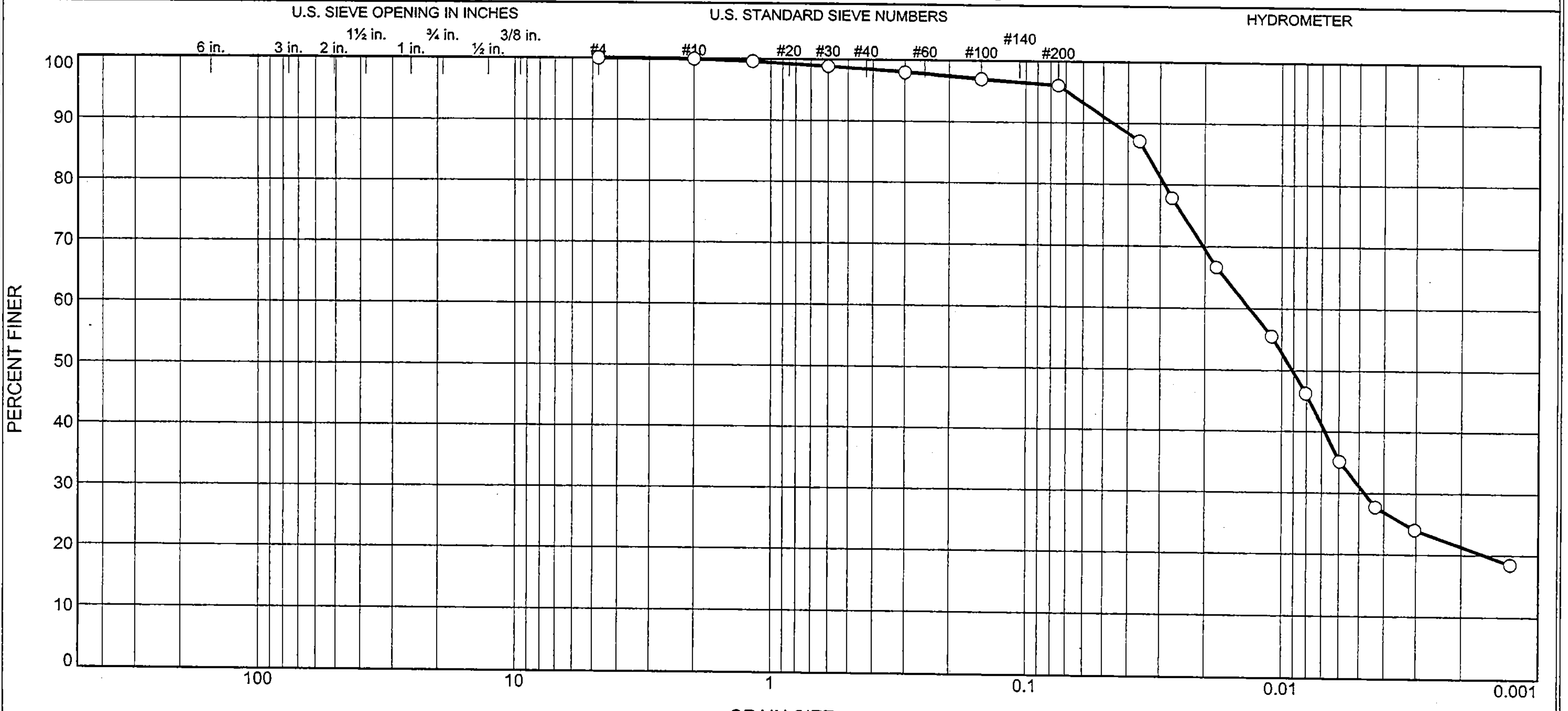
Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental Associates, Inc.**
**Knoxville, Tennessee**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 1.5 | 2.3 | 65.0 | 31.1 |
| | | | | | | | | |
| | | | | | | | | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-1C ST2 | 69.0'-71.5' | | CL | Clay, silty, brown | 27.2 | 35 | 19 |
| | | | | | | | | | |
| | | | | | | | | | |

Client American Electric Power

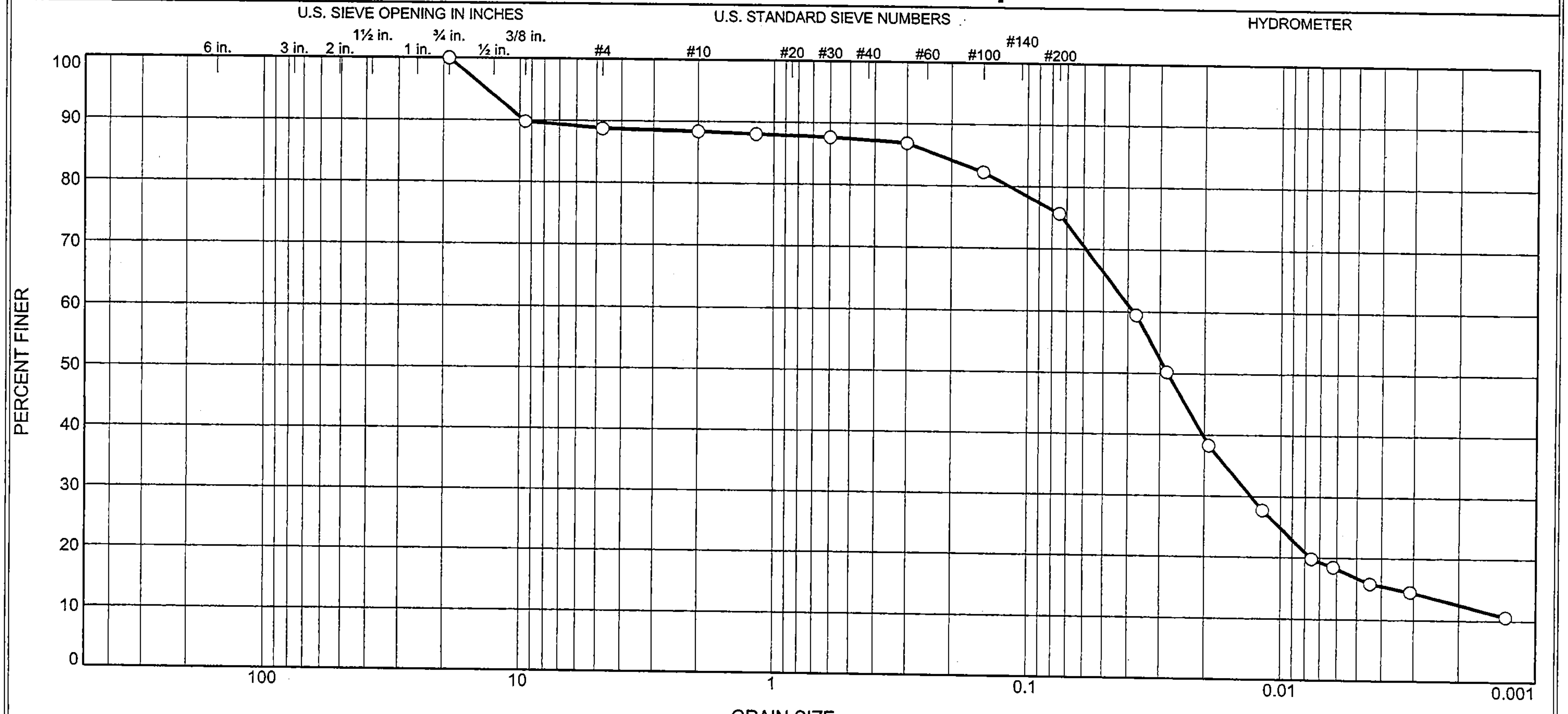
Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental Associates, Inc.**
**Knoxville, Tennessee**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 11.3 | 0.4 | 1.1 | 11.5 | 58.9 | 16.8 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-2 ST2 | 59.0'-61.5' | | CL-ML | Clay, silty, brown | 20.3 | 20 | 16 |

Client American Electric Power

Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental Associates, Inc.**
**Knoxville, Tennessee**

# CONSTANT HEAD PERMEABILITY TESTING
# ASTM D5084-90/EPA 9100 Method 2.8

**PROJECT NAME** : Philip Sporn Plant

**PROJECT NUMBER** : 09-387

**CLIENT** : AEP

**DATE** : December 29, 2009

---

## SAMPLE LOCATION AND CONDITIONS

**Sample Id.:** GA-1C ST-2 - 20 psi

**Depth of Tested Sample** : 69.0' - 71.5'

**Remolded:** No

**Sample Type** : Shelby Tube

**Sample Description :** Clay, silty brown - 20 psi triaxial specimen

## INITIAL SPECIMEN PROPERTIES

| | | | | | |
|---|---|---|---|---|---|
| **Length (in.):** | 5.15 | **Volume ($ft^3$):** | 0.0190 | **Wet Density (PCF):** | 122.7 |
| **Diameter (in.):** | 2.85 | **Weight (lbs):** | 2.33 | **Dry Density (PCF):** | 96.3 |
| **Area ($ft^2$):** | 0.0443 | **Moisture (%):** | 27.4 | | |

| | | | |
|---|---|---|---|
| **Chamber Pressure (psi):** | 10 | **Change in Pore Pressure (psi):** | 2.0 |
| **Influent Pressure (psi):** | 8 | **Change in Chamber Pressure (psi):** | 2.0 |
| **Back Pressure (psi):** | 5 | **"B" Factor:** | 1.0 |

## PERMEABILITY CALCULATIONS

k = Hydraulic Conductivity, (cm/sec)

$$k = \frac{QL}{Ath} \text{ cm/sec}$$

L = Length of Sample, along path of flow, (cm)

Q = Quantity of flow, taken as the average of inflow and outflow, ($cm^3$)

$$k = \frac{(16.8)(13.08)}{(41.16)(63{,}300)(211.01)}$$

A = Cross-sectional area of specimen, ($cm^2$)

$$k = \frac{219.74}{549{,}771{,}362.28}$$

t = Interval of time, over which the flow Q occurs, (sec)

h = Difference in hydraulic head across specimen, (cm)

$$k = 4.00 \times 10^{-7} \text{ cm/sec}$$

# CONSTANT HEAD PERMEABILITY TESTING
# ASTM D5084-90/EPA 9100 Method 2.8

**PROJECT NAME** : Philip Sporn Plant

**PROJECT NUMBER** : 09-387

**CLIENT** : AEP

**DATE** : December 29, 2009

---

## SAMPLE LOCATION AND CONDITIONS

**Sample Id.:** GA-1C ST-2 - 40 psi

**Depth of Tested Sample** : 69.0' - 71.5'

**Remolded:** No

**Sample Type** : Shelby Tube

**Sample Description :** Clay, silty brown - 40 psi triaxial specimen

## INITIAL SPECIMEN PROPERTIES

| | | | | | |
|---|---|---|---|---|---|
| **Length (in.):** | 5.97 | **Volume ($ft^3$):** | 0.0224 | **Wet Density (PCF):** | 121.7 |
| **Diameter (in.):** | 2.87 | **Weight (lbs):** | 2.72 | **Dry Density (PCF):** | 94.9 |
| **Area ($ft^2$):** | 0.0449 | **Moisture (%):** | 28.2 | | |

| | | | |
|---|---|---|---|
| **Chamber Pressure (psi):** | 10 | **Change in Pore Pressure (psi):** | 2.0 |
| **Influent Pressure (psi):** | 8 | **Change in Chamber Pressure (psi):** | 2.0 |
| **Back Pressure (psi):** | 5 | **"B" Factor:** | 1.0 |

## PERMEABILITY CALCULATIONS

k = Hydraulic Conductivity, (cm/sec)

$$k = \frac{QL}{Ath} \text{ cm/sec}$$

L = Length of Sample, along path of flow, (cm)

Q = Quantity of flow, taken as the average of inflow and outflow, ($cm^3$)

$$k = \frac{(16.8)(15.16)}{(41.74)(63,300)(211.01)}$$

A = Cross-sectional area of specimen, ($cm^2$)

$$k = \frac{254.69}{557,518,383.42}$$

t = Interval of time, over which the flow Q occurs, (sec)

h = Difference in hydraulic head across specimen, (cm)

$$k = 4.57 \times 10^{-7} \text{ cm/sec}$$

# CONSTANT HEAD PERMEABILITY TESTING
# ASTM D5084-90/EPA 9100 Method 2.8

**PROJECT NAME** : Philip Sporn Plant

**PROJECT NUMBER** : 09-387

**CLIENT** : AEP

**DATE** : December 29, 2009

---

## SAMPLE LOCATION AND CONDITIONS

**Sample Id.:** GA-1C ST-2 - 60 psi

**Depth of Tested Sample** : 69.0' - 71.5'

**Remolded:** No

**Sample Type** : Shelby Tube

**Sample Description :** Clay, silty brown - 60 psi triaxial specimen

## INITIAL SPECIMEN PROPERTIES

**Length (in.):** 5.88

**Volume ($ft^3$):** 0.0220

**Wet Density (PCF):** 121.9

**Diameter (in.):** 2.87

**Weight (lbs):** 2.68

**Dry Density (PCF):** 95.1

**Area ($ft^2$):** 0.0449

**Moisture (%):** 28.2

**Chamber Pressure (psi):** 10

**Change in Pore Pressure (psi):** 2.0

**Influent Pressure (psi):** 8

**Change in Chamber Pressure (psi):** 2.0

**Back Pressure (psi):** 5

**"B" Factor:** 1.0

## PERMEABILITY CALCULATIONS

k = Hydraulic Conductivity, (cm/sec)

$$k = \frac{QL}{Ath} \text{ cm/sec}$$

L = Length of Sample, along path of flow, (cm)

$$k = \frac{(23.0)(14.94)}{(41.74)(69,600)(211.01)}$$

Q = Quantity of flow, taken as the average of inflow and outflow, ($cm^3$)

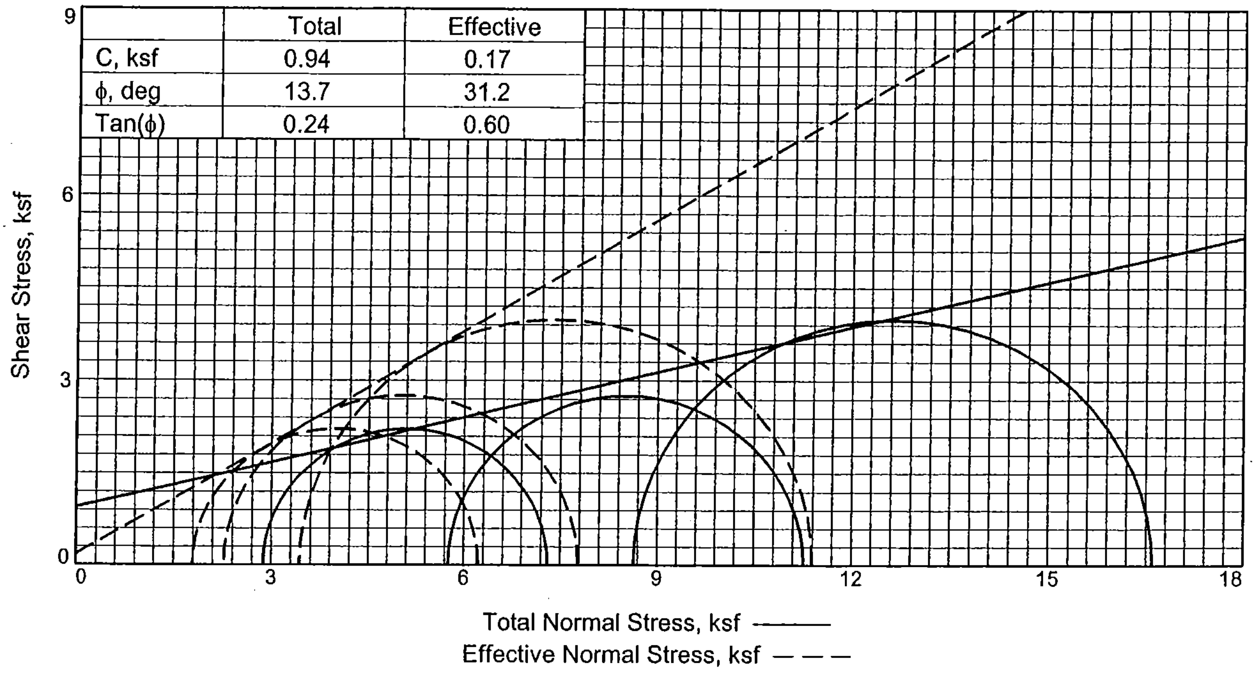
A = Cross-sectional area of specimen, ($cm^2$)

$$k = \frac{343.62}{613,005,995.04}$$

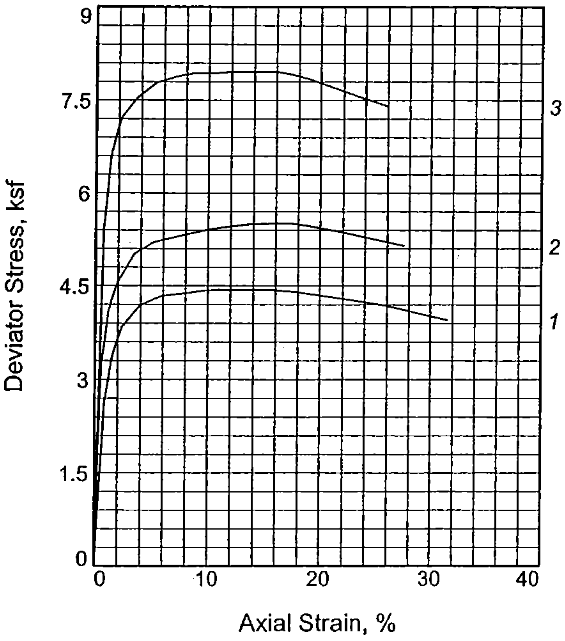
t = Interval of time, over which the flow Q occurs, (sec)

h = Difference in hydraulic head across specimen, (cm)

$$k = 5.61 \times 10^{-7} \text{ cm/sec}$$



| | Total | Effective |
|---|---|---|
| C, ksf | 0.94 | 0.17 |
| ϕ, deg | 13.7 | 31.2 |
| Tan(ϕ) | 0.24 | 0.60 |



| | Sample No. | 1 | 2 | 3 |
|---|---|---|---|---|
| Initial | Water Content, % | 27.4 | 28.2 | 28.2 |
| | Dry Density, pcf | 96.3 | 94.9 | 95.1 |
| | Saturation, % | 98.1 | 97.8 | 98.1 |
| | Void Ratio | 0.7572 | 0.7825 | 0.7782 |
| | Diameter, in. | 2.85 | 2.87 | 2.87 |
| | Height, in. | 5.15 | 5.97 | 5.88 |
| At Test | Water Content, % | 25.1 | 24.1 | 25.2 |
| | Dry Density, pcf | 100.6 | 102.3 | 100.6 |
| | Saturation, % | 100.0 | 100.0 | 100.0 |
| | Void Ratio | 0.6812 | 0.6539 | 0.6823 |
| | Diameter, in. | 2.81 | 2.80 | 2.82 |
| | Height, in. | 5.08 | 5.82 | 5.77 |
| | Strain rate, in./min. | 0.00 | 0.00 | 0.00 |
| | Back Pressure, psi | 30.00 | 30.00 | 30.00 |
| | Cell Pressure, psi | 50.00 | 70.00 | 90.00 |
| | Fail. Stress, ksf | 4.4 | 5.5 | 8.0 |
| | Total Pore Pr., ksf | 5.4 | 7.8 | 9.5 |
| | Ult. Stress, ksf | | | |
| | Total Pore Pr., ksf | | | |
| | $\bar{\sigma}_1$ Failure, ksf | 6.2 | 7.8 | 11.4 |
| | $\bar{\sigma}_3$ Failure, ksf | 1.8 | 2.3 | 3.4 |

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

**Sample Type:** Shelby Tube

**Description:** Clay, silty, brown

**LL=** 35 **PL=** 19 **PI=** 16

**Specific Gravity=** 2.71

**Remarks:**

**Figure** 1

**Client:** American Electric Power

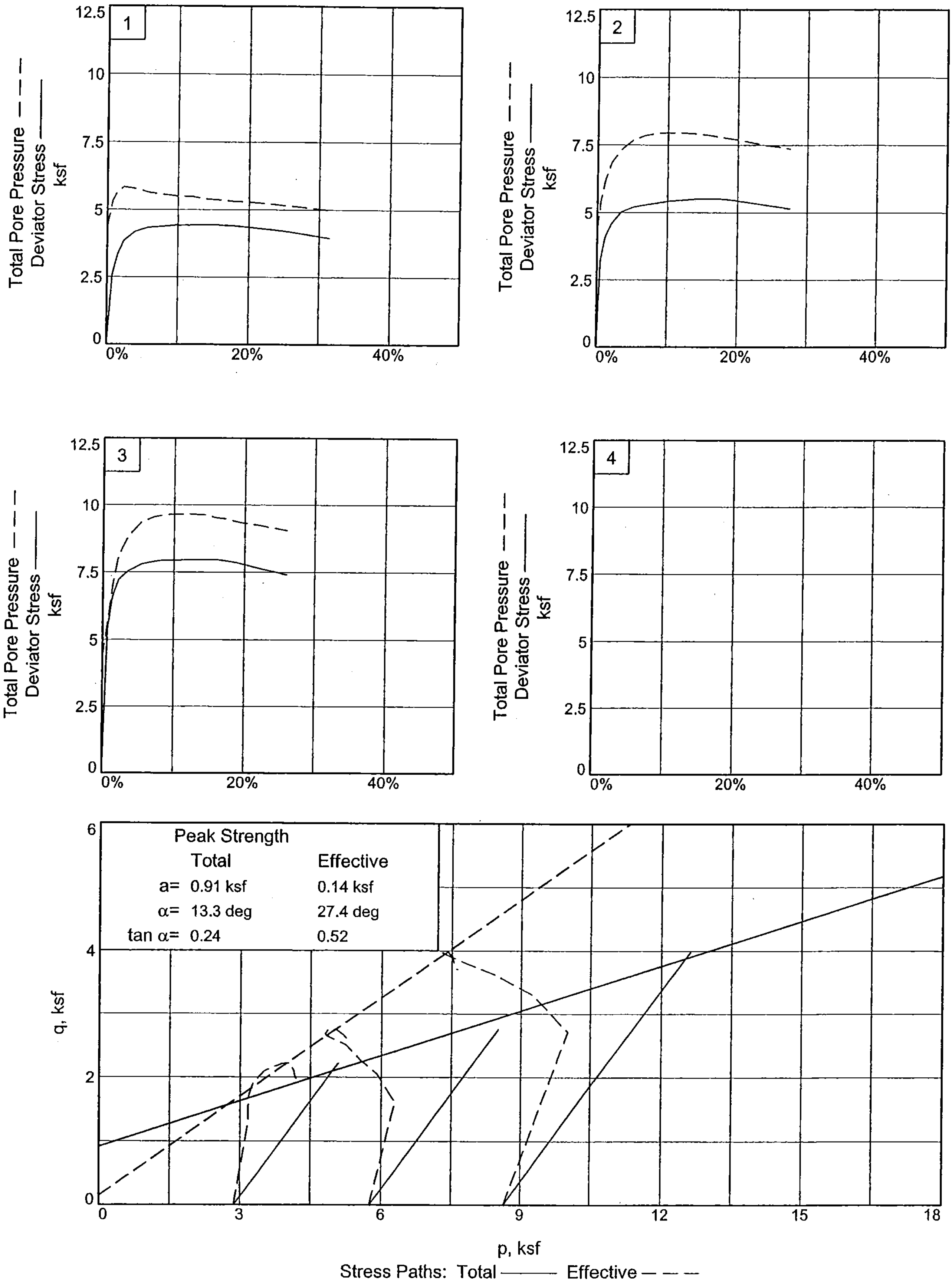
**Project:** Philip Sporn Plant

**Sample Number:** GA-1C ST2 **Depth:** 69.0'-71.5'

**Proj. No.:** 09-387 **Date Sampled:**

TRIAXIAL SHEAR TEST REPORT

Geo/Environmental Associates, Inc.



Peak Strength

| | Total | Effective |
|---|---|---|
| a= | 0.91 ksf | 0.14 ksf |
| α= | 13.3 deg | 27.4 deg |
| tan α= | 0.24 | 0.52 |

**Client:** American Electric Power

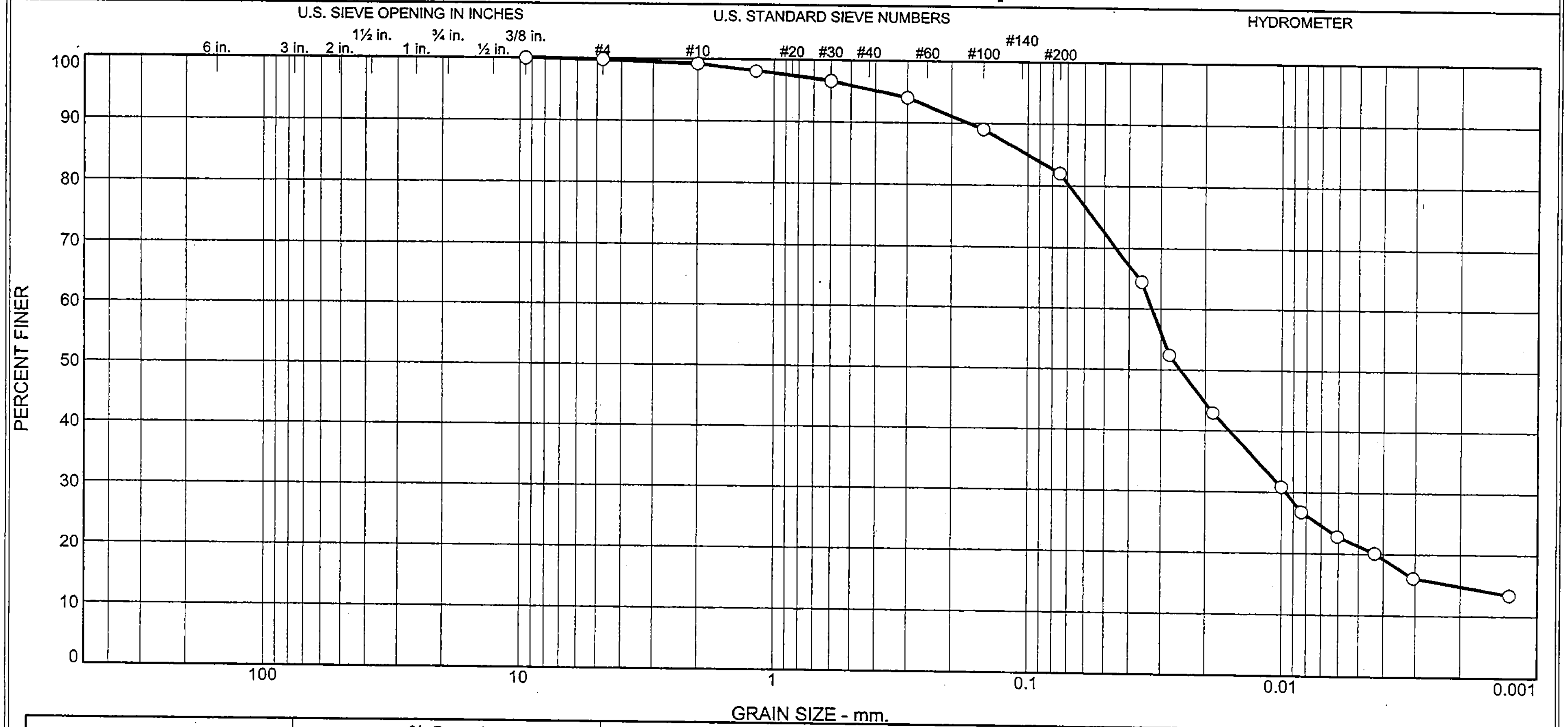
**Project:** Philip Sporn Plant

**Depth:** 69.0'-71.5' **Sample Number:** GA-1C ST2

**Project No.:** 09-387 **Figure** 2

**Geo/Environmental Associates, Inc.**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.2 | 0.6 | 3.9 | 13.3 | 60.7 | 21.3 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-2 ST3 | 69.0'-71.5' | | CL-ML | Clay, silty, light brown | 20.8 | 23 | 17 |

Client American Electric Power

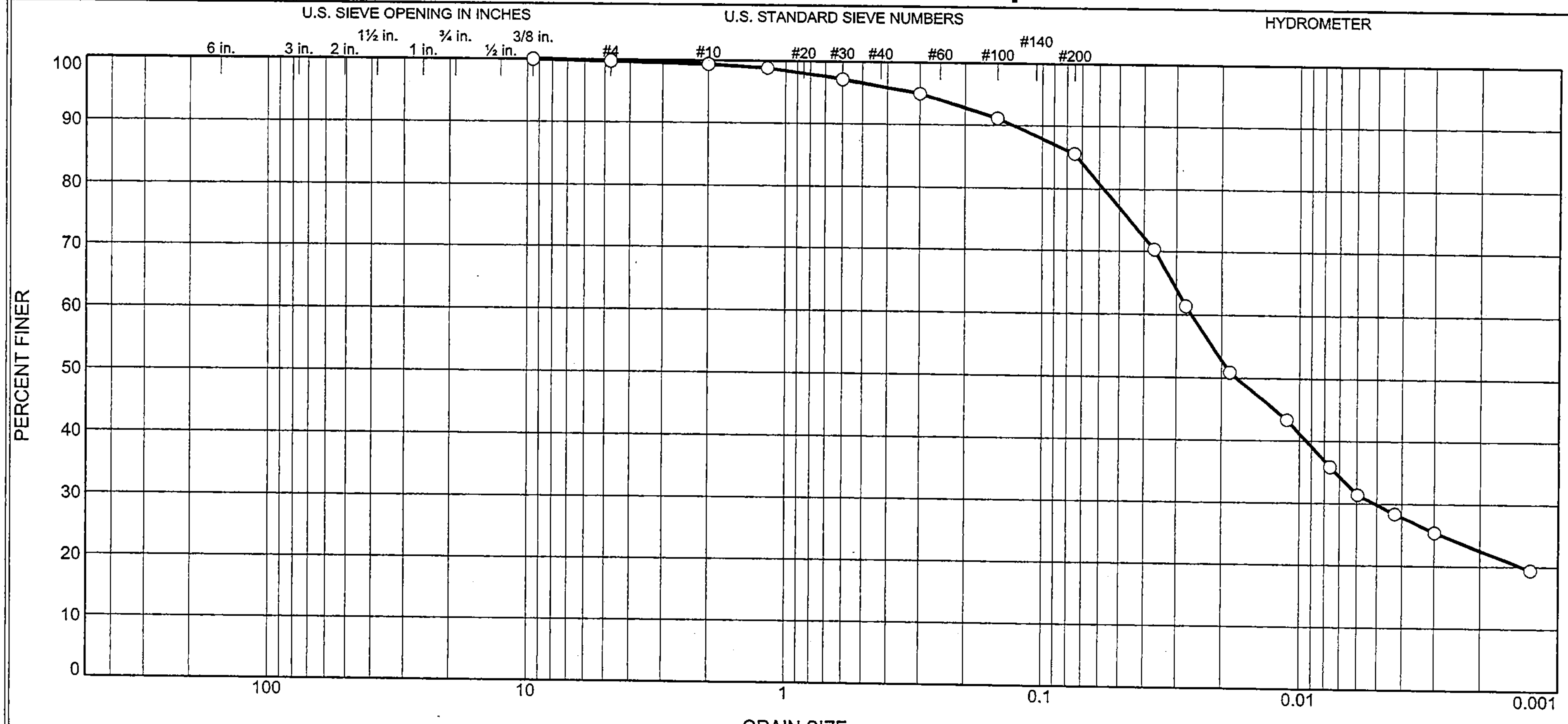
Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental Associates, Inc. Knoxville, Tennessee**

# Particle Size Distribution Report



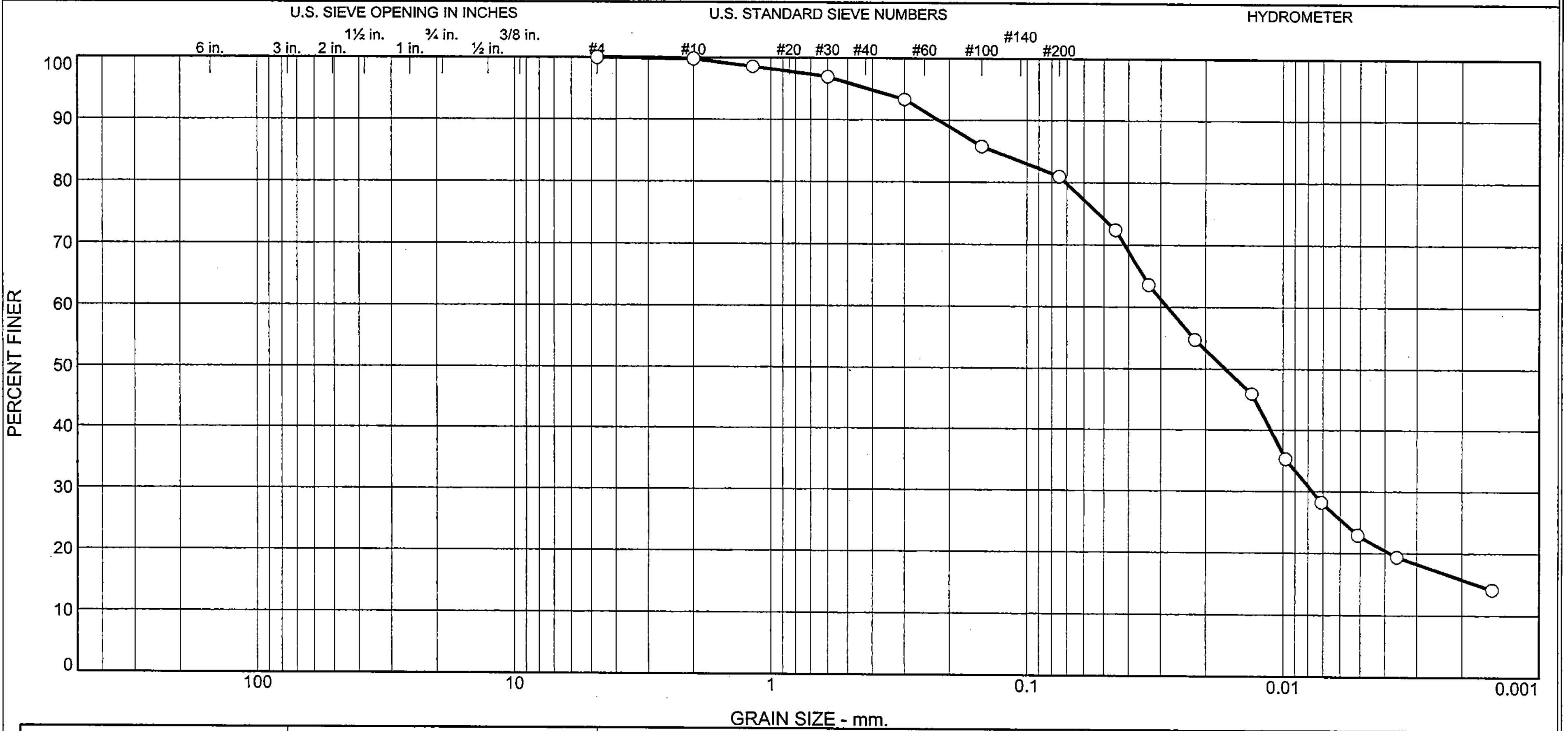
| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.2 | 0.4 | 3.4 | 10.5 | 55.7 | 29.8 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-3 ST3 | 79.0'-81.5' | | CL | Clay, silty, light brown | 24.4 | 32 | 20 |

Client American Electric Power
Project Philip Sporn Plant
Project No. 09-387
Figure

**Geo/Environmental Associates, Inc.**
**Knoxville, Tennessee**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.2 | 4.7 | 14.2 | 58.3 | 22.6 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-4A ST1 | 28.0'-30.5' | | ML | Fly Ash, dark gray | 73.4 | nv | np |

Client American Electric Power

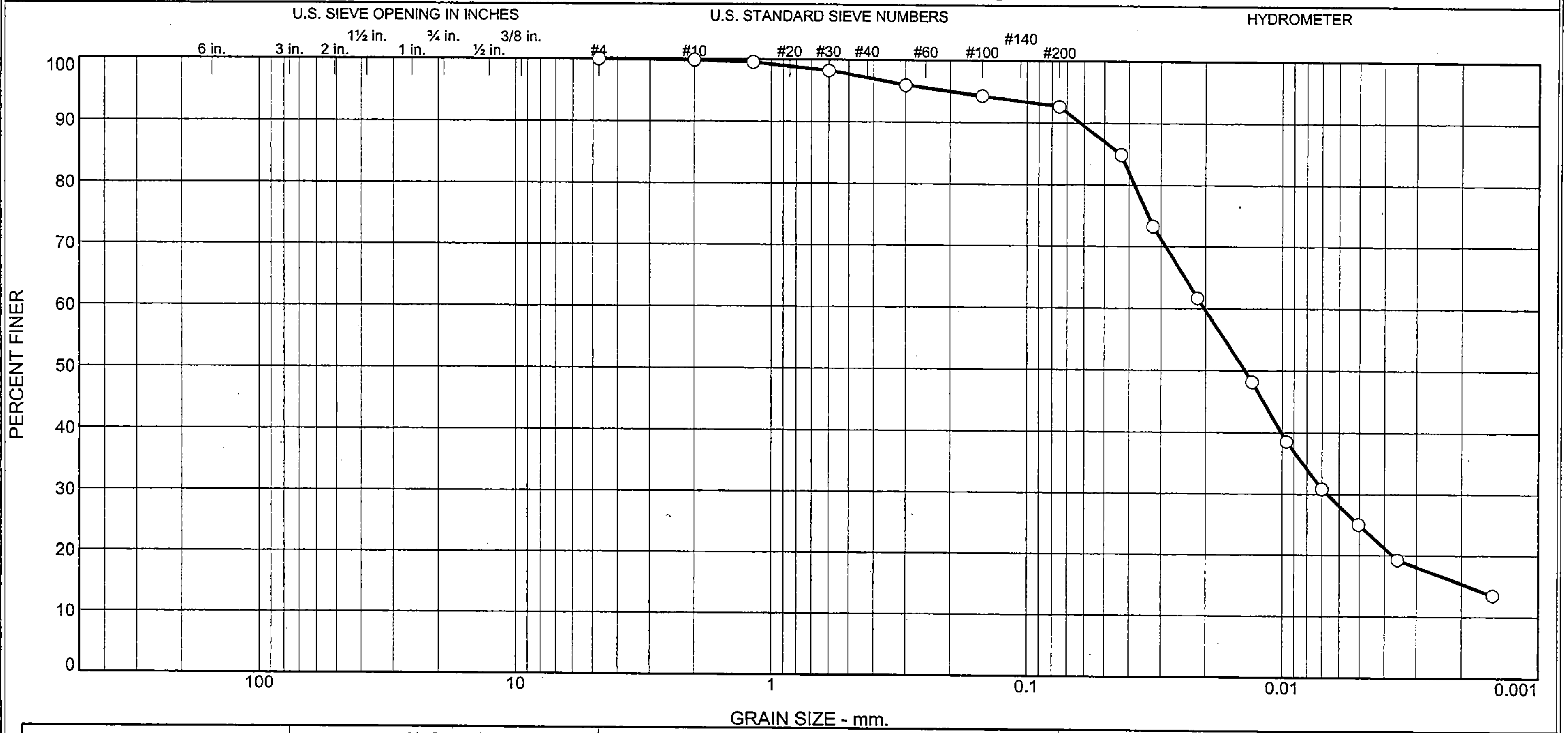
Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental Associates, Inc. Knoxville, Tennessee**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 2.8 | 4.5 | 67.8 | 24.8 |
| | | | | | | | | |
| | | | | | | | | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-4A ST2 | 32.0'-34.5' | | ML | Fly Ash, dark gray | 57.2 | nv | np |
| | | | | | | | | | |
| | | | | | | | | | |

Client American Electric Power

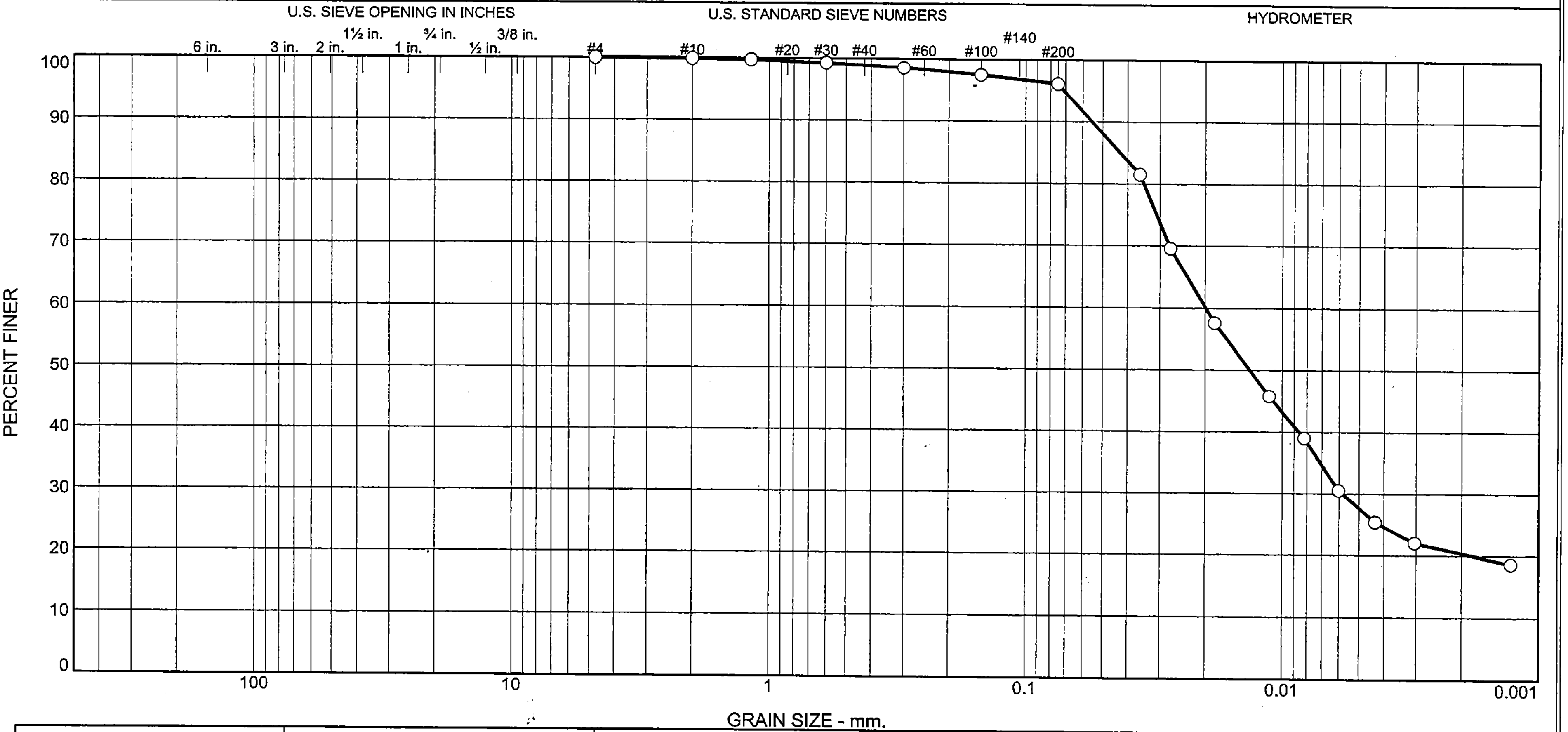
Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental Associates, Inc. Knoxville, Tennessee**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 1.0 | 2.8 | 68.5 | 27.6 |
| | | | | | | | | |
| | | | | | | | | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-4A ST3 | 36.0'-38.0' | | CL | Clay, silty, light brown w/ fly ash | 33.8 | 32 | 22 |
| | | | | | | | | | |
| | | | | | | | | | |

Client American Electric Power

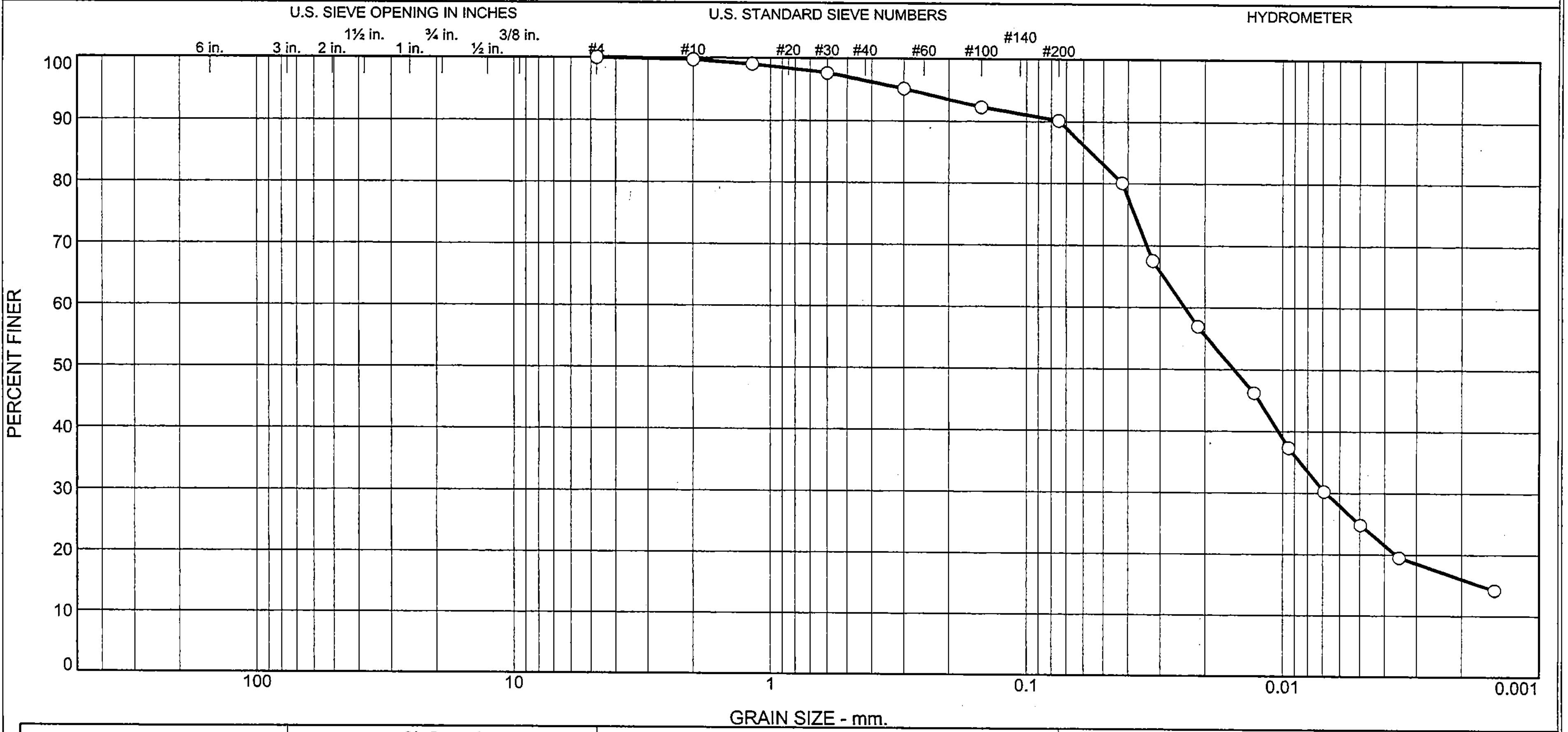
Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental Associates, Inc. Knoxville, Tennessee**

# Particle Size Distribution Report



| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.3 | 3.3 | 6.3 | 65.2 | 24.9 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | | GA-4B ST1 | 29.0'-31.5' | | ML | Fly Ash, dark gray | 56.3 | nv | np |

Client American Electric Power

Project Philip Sporn Plant

Project No. 09-387

Figure

**Geo/Environmental Associates, Inc.**
**Knoxville, Tennessee**

Geo/Environmental
Associates, Inc.

Job Name: AEP Philip Sporn
Job Number: 09-387
Title: Gmax Calcs for Section H-H
Computed By: SWF Checked by:
Date: 4/26/10 Sheet: 1 Of: 2

Small Strain Shear Modulus $\left[G_{max}\ (lbs/ft^2)\right] = \frac{\gamma \cdot V_v^2}{g}$

Where: $\gamma$ = unit weight (lbs/ft³)

$V_v$ = shear wave velocity (ft/s)

$g$ = gravitational acceleration (32.2 ft/s²)

---

Silty Sand (1) $\frac{130\,(694)^2}{32.2} = 194493$ lbs/ft²

Silty Sand (2) $\frac{107\,(978.7)^2}{32.2} = 3182930$ lbs/ft²

Gravelly Sand (3) $\frac{105\,(978.7)^2}{32.2} = 3123436$ lbs/ft²

Silty Clay (4) $\frac{115\,(978.7)^2}{32.2} = 3420906$ lbs/ft²

Silty Sand (5) $\frac{131\,(694)^2}{32.2} = 1959450$ lbs/ft²

Sandy Silt (6) $\frac{130\,(694)^2}{32.2} = 1933302$ lbs/ft²

Fly Ash (7) $\frac{110\,(476.25)^2}{32.2} = 774831$ lbs/ft²

Silty Sand (8) $\frac{112\,(978.7)^2}{32.2} = 3331665$ lbs/ft²

**GA**

Geo/Environmental
Associates, Inc.

Job Name: AEP Philip Sporn
Job Number: 09-387
Title: $G_{max}$ Calcs for Section A-A
Computed By: SWF Checked by:
Date: 4/26/10 Sheet: 2 Of: 2

Clayey Sand (9) $\frac{115(1377.2)^2}{32.2} = 6816193$ lbs/ft$^2$

Sand (10) $\frac{123(1377.2)}{32.2} = 7245081$ lbs/ft$^2$

Sand and Gravel (11) $\frac{123(1377.2)^2}{32.2} = 7245081$ lbs/ft$^2$

Riprap (12) $\frac{115(1178.9)^2}{32.2} = 4963590$ lbs/ft$^2$

GA

Geo/Environmental
Associates, Inc.

Job Name: AEP Philip Sporn
Job Number: 09-387
Title: $G_{max}$ Calcs for Section A-A
Computed By: SWF Checked by:
Date: 4/26/10 Sheet: 1 Of: 1

Small Strain Shear Modulus $\left[G_{max}\left(\text{lbs}/\text{ft}^2\right)\right] = \frac{\gamma \cdot V_v}{g}$

Where: $\gamma$ = unit weight ($\text{lbs}/\text{ft}^3$)

$V_v$ = shear wave velocity ($\text{ft}/\text{s}$)

$g$ = gravitational acceleration ($32.2\ \text{ft}/\text{s}^2$)

---

Silty Clay (1) $\frac{123\,(1377.2)^2}{32.2} = 7245081\ \text{lbs}/\text{ft}^2$

Fly Ash (2) $\frac{97\,(434.33)^2}{32.2} = 568271\ \text{lbs}/\text{ft}^2$

Bottom Ash (3) $\frac{80\,(1377.2)^2}{32.2} = 4712248\ \text{lbs}/\text{ft}^2$

Clayey Sand (4) $\frac{104\,(1178.9)^2}{32.2} = 4488812\ \text{lbs}/\text{ft}^2$

Bottom Ash (5) $\frac{62\,(1178.9)^2}{32.2} = 2676022\ \text{lbs}/\text{ft}^2$

Gravelly Sand (6) $\frac{111\,(1178.9)^2}{32.2} = 4790943\ \text{lbs}/\text{ft}^2$

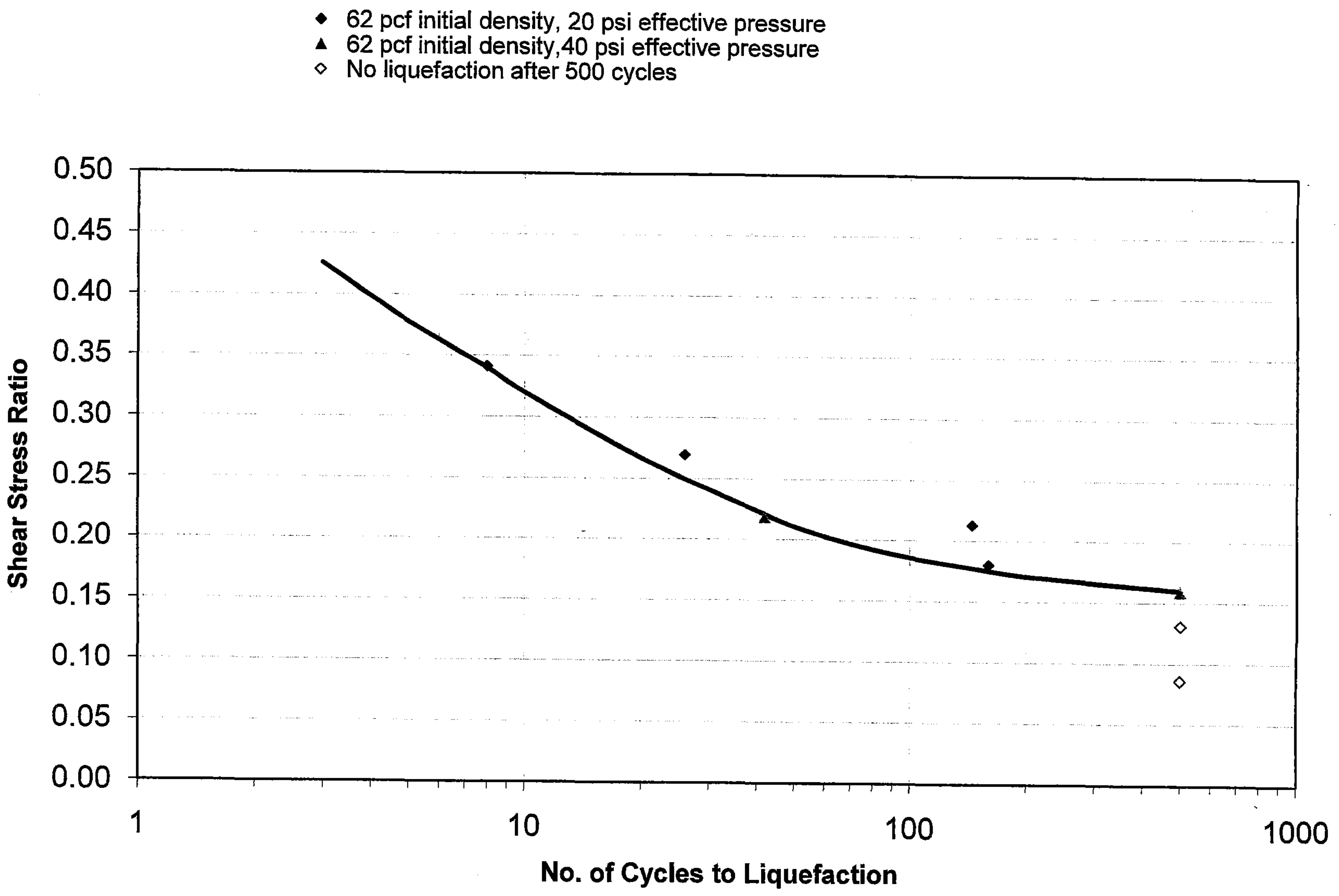
Clayey Sand (7) $\frac{110\,(1178.9)^2}{32.2} = 4747781\ \text{lbs}/\text{ft}^2$

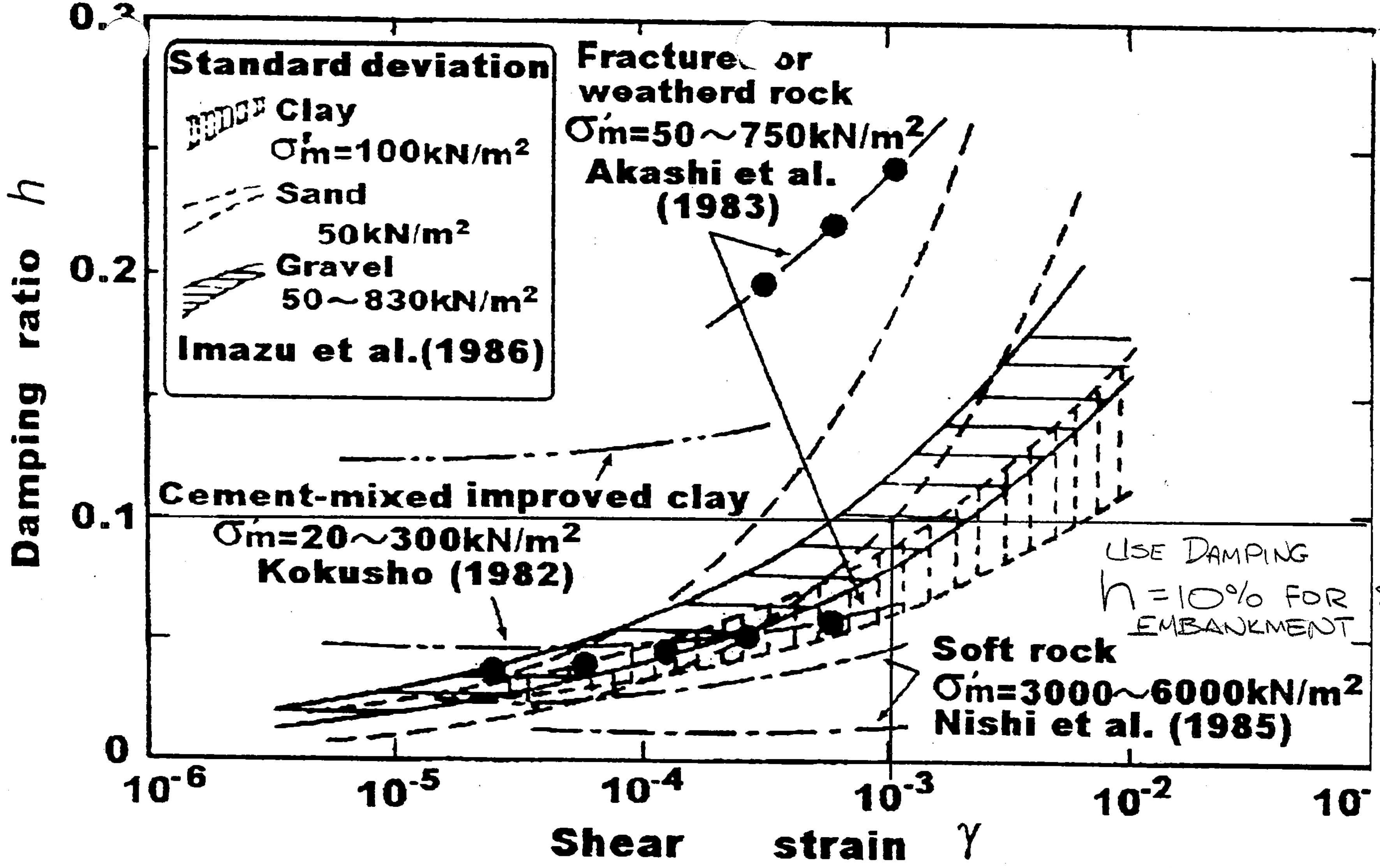
Road Material (8) $\frac{145\,(1178.9)^2}{32.2} = 6258440\ \text{lbs}/\text{ft}^2$

# MISCELLANEOUS REFERENCES

## CSR GRAPH DEVELOPED BY OSU FOR SPORN FLY ASH
## DAMPING RATIO OF DIFFERENT TYPES OF SOILS (KOKUSHO)
## SEED-IDRISS DAMPING VALUES FROM SHAKE91

Sporn Fly Ash Triaxial Cyclic Strength

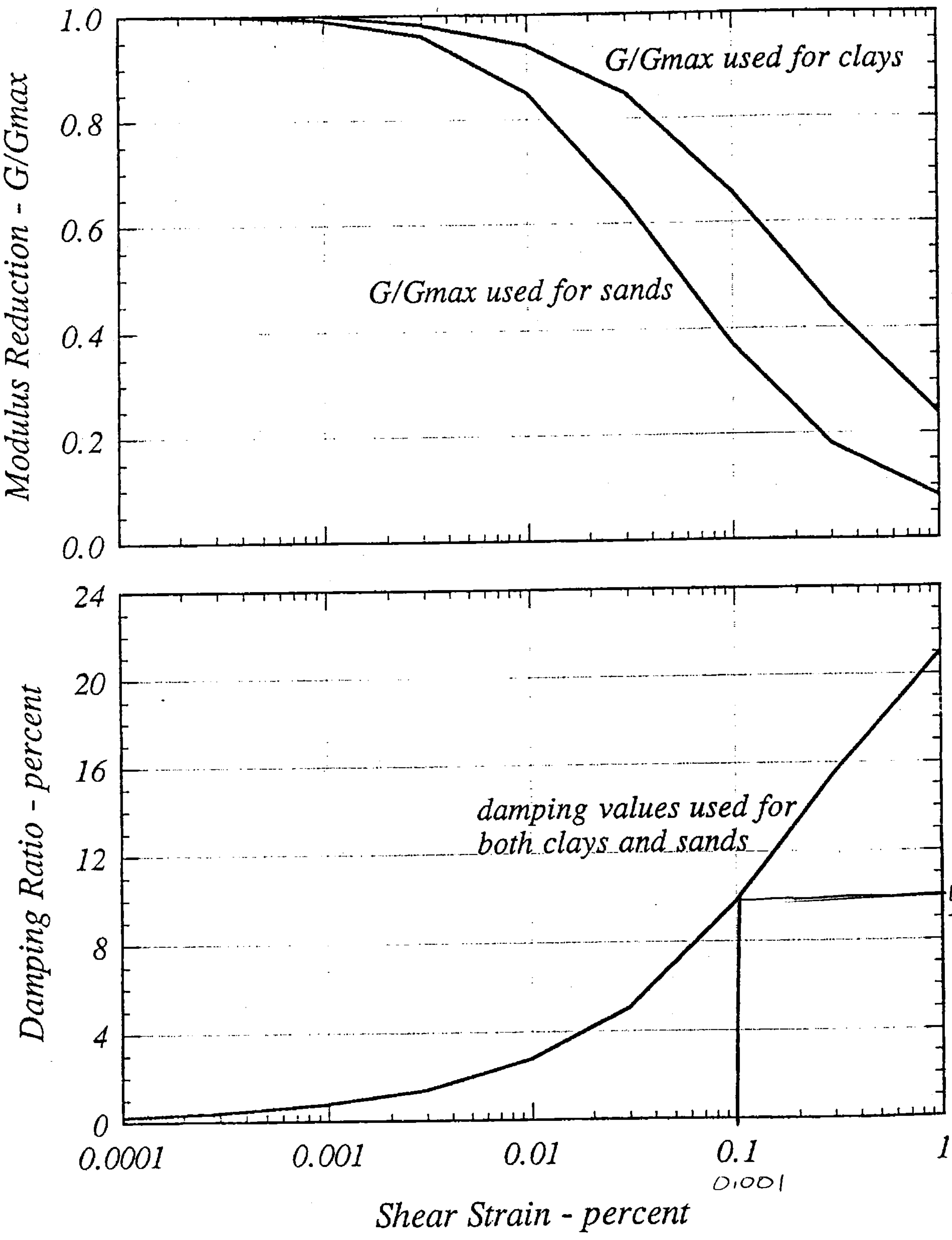




USE DAMPING
h = 10% FOR SANDY
EMBANKMENT MATERIALS

Fig. 10.20 Damping ratio of different types of soils (Kokusho, 1987)

FROM GEOTECHNICAL EARTHQUAKE ENGINEERING BY IKUO TOWHATA 2008



USE DAMPING =10% FOR SANDY DIKE MATERIAL

Fig. B-2 Moduius Reduction and Damping Values Used for Sample Problem

FROM SHAKE91 USERS MANUAL (SEED IDRISS)

# APPENDIX IV

# LEM SLOPE STABILITY ANALYSES

# LIMIT EQUILIBRIUM METHOD SLOPE STABILITY ANALYSIS SUMMARY
# RAILWAY-INDUCED VIBRATION ASSESSMENT
# BOTTOM ASH AND FLY ASH DIPOSAL FACILITIES
# PHILIP SPORN PLANT
# NEW HAVEN, MASON COUNTY, WEST VIRGINIA
# GA FILE NO. 09-387

## GENERAL

Geo/Environmental Associates, Inc. (GA) has prepared pseudo-static slope stability analyses for the western dikes of the Bottom Ash Disposal and Fly Ash Disposal Facilities at the Philip Sporn Plant. Specifically, GA has evaluated Section A-A for the Bottom Ash Disposal Facility Western Dike and Section H-H for the Fly Ash Disposal Facility Western Dike. The slope stability analyses were conducted using the computer program *SLOPE/W*. *SLOPE/W* is developed by GEO-SLOPE International, Ltd. of Calgary, Alberta, Canada.

The slope stability analyses provided herein are based on the Morgenstern-Price Limit Equilibrium Method (LEM) provided in the *SLOPE/W* program. The Morgenstern-Price LEM is a robust method that satisfies both moment and force equilibrium conditions. Furthermore, the Morgenstern-Price LEM is capable of utilizing user defined functions to develop both shear and normal interslice forces. More specifically, the half-sine function was applied to the slope stability analyses provided herein to determine interslice forces.

The slope stability analyses were performed in both the upstream and downstream directions for both of the critical sections. At the request of the USEPA, both shallow-seated and deep-seated (global) slip surfaces were modeled in the slope stability analyses. The phreatic levels used in the analyses were adapted from previous seepage and stability analyses prepared for the critical sections by AEP. We understand that the phreatic levels developed by AEP were based on *SEEP/W* seepage analyses and from site specific piezometer readings and subsurface exploration data.

Ground acceleration loadings developed from railway vibration monitoring were applied in the LEM pseudo-static analyses. GA conservatively applied the accelerations from the dike exterior toe vibration monitoring locations (i.e., Location A for Section A-A and Location C for Section H-H) to the downstream direction LEM slope stability analyses and we applied the accelerations from the dike crest monitoring locations (i.e., Location B for Section A-A and Location D for Section H-H) to the upstream direction LEM slope stability analyses. The acceleration values used in the analyses are provided in Table IV-1.

**TABLE IV-1**
**SUMMARY OF ACCELERATIONS USED IN**
**LIMIT EQUILIBRIUM METHOD PSEUDO-STATIC SLOPE STABILITY ANALYSES**

| Critical Section | Vibration Monitoring Location | Maximum Acceleration (g's) | |
|---|---|---|---|
| | | Horizontal | Vertical |
| Bottom Ash Disposal Facility Section A-A | Location A<br>(Exterior Toe - Adjacent to Track)<br>Downstream Direction Analyses | 0.033 | 0.008 |
| | Location B<br>(Crest)<br>Upstream Direction Analyses | 0.013 | 0.002 |
| Fly Ash Disposal Facility Section H-H | Location C<br>(Exterior Toe - Adjacent to Track)<br>Downstream Direction Analyses | 0.046 | 0.008 |
| | Location D<br>(Crest)<br>Upstream Direction Analyses | 0.010 | 0.003 |

## MATERIAL PARAMETERS

Strength parameters for the various embankment and foundation materials used in the slope stability analyses for critical Sections A-A and H-H are provided in Tables IV-2 and IV-3, respectively. In general, the strength parameters were selected based on previous parameters developed by AEP and based on laboratory testing conducted by GA in December 2009 and January 2010. Effective stress conditions were assumed; therefore, material parameters used in the slope stability analyses and presented herein are effective strength parameters. Additionally, the Mohr-Coulomb material model was used in the analyses.

TABLE IV.2. LEM MATERIAL PARAMETERS FOR SECTION A-A ANALYSES

| | **Silty Clay (1)** | **Fly Ash (2)** | **Bottom Ash (3)** | **Clayey Sand (4)** | **Bottom Ash (5)** | **Gravelly Sand (6)** | **Clayey Sand (7)** | **Road Material (8)** | **Clayey Sand (9)** | **Sand (10)** | **Sand & Gravel (11)** | **Riprap (12)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Moist Unit Weight γ (pcf)** | 123 | 139 | 80 | 105 | 62 | 111 | 104 | 145 | 115 | 123 | 123 | 115 |
| **Saturated Unit Weight γ (pcf)** | 123 | 134 | 80 | 105 | 80 | 115 | 110 | 145 | 115 | 123 | 123 | 115 |
| Source | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) |
| **Cohesion** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Source | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) |
| **Phi Angle φ (degrees)** | 36 | 33 | 36 | 31 | 38 | 34 | 34 | 36 | 29 | 29 | 32 | 38 |
| Source | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) | AEP(1,2) |

Note:

(1) AEP Philip Sporn Electric Generating Plant Bottom Ash Facility - Engineering Report, 1996

(2) AEP Philip Sporn Power Plant Bottom Ash Disposal Facility - Stability Analysis, 2009

TABLE IV.2. LEM MATERIAL PARAMETERS FOR SECTION H-H ANALYSES

| | Silty Sand (1) | Silty Sand (2) | Gravelly Sand (3) | Silty Clay (4) | Silty Sand (5) | Sandy Silt (6) | Fly Ash (7) | Rock Fill (9) |
|---|---|---|---|---|---|---|---|---|
| **Moist Unit Weight $\gamma$ (pcf)** | 125 | 107 | 105 | 115 | 126 | 125 | 90 | 115 |
| **Saturated Unit Weight $\gamma$ (pcf)** | 130 | 112 | 110 | 120 | 131 | 130 | 102 | 115 |
| Source | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ |
| **Cohesion (psf)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Source | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ |
| **Phi Angle $\varphi$ (degrees)** | 34 | 35 | 33 | 32 | 31 | 27 | 27 | 38 |
| Source | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ |

Note:

(1) AEP Philip Sporn Electric Generating Plant Bottom Ash Facility - Engineering Report, 1996

(2) AEP Philip Sporn Power Plant Bottom Ash Disposal Facility - Stability Analysis, 2009

## SLOPE STABILITY ANALYSIS RESULTS

Graphical output from the LEM slope stability analyses are provided in this appendix. Specifically, the results show the critical slip surface and corresponding safety factor for each of the modeled conditions. The slope stability analysis results are tabulated in Table IV-4.

**TABLE IV-4**
**SUMMARY OF LEM SAFETY FACTORS AND FESM STABILITY FACTORS**

| Critical Section | Analysis Method | Pseudo-Static Loading Condition | Slope and Slip Surface Condition | Safety Factor |
|---|---|---|---|---|
| Bottom Ash Disposal Facility Section A-A | LEM | Location A (Exterior Toe)<br>($a_h = 0.033g$, $a_v = 0.008g$) | Downstream (Shallow) | 2.96 |
| | | | Downstream (Deep) | 3.08 |
| | | Location B (Crest)<br>($a_h = 0.013g$, $a_v = 0.002g$) | Upstream (Shallow) | 1.70 |
| | | | Upstream (Deep) | 2.02 |
| Fly Ash Disposal Facility Section H-H | LEM | Location C (Exterior Toe)<br>($a_h = 0.046g$, $a_v = 0.008g$) | Downstream (Shallow) | 1.84 |
| | | | Downstream (Deep) | 2.15 |
| | | Location D (Crest)<br>($a_h = 0.010g$, $a_v = 0.003g$) | Upstream (Shallow) | 1.40 |
| | | | Upstream (Deep) | 1.65 |

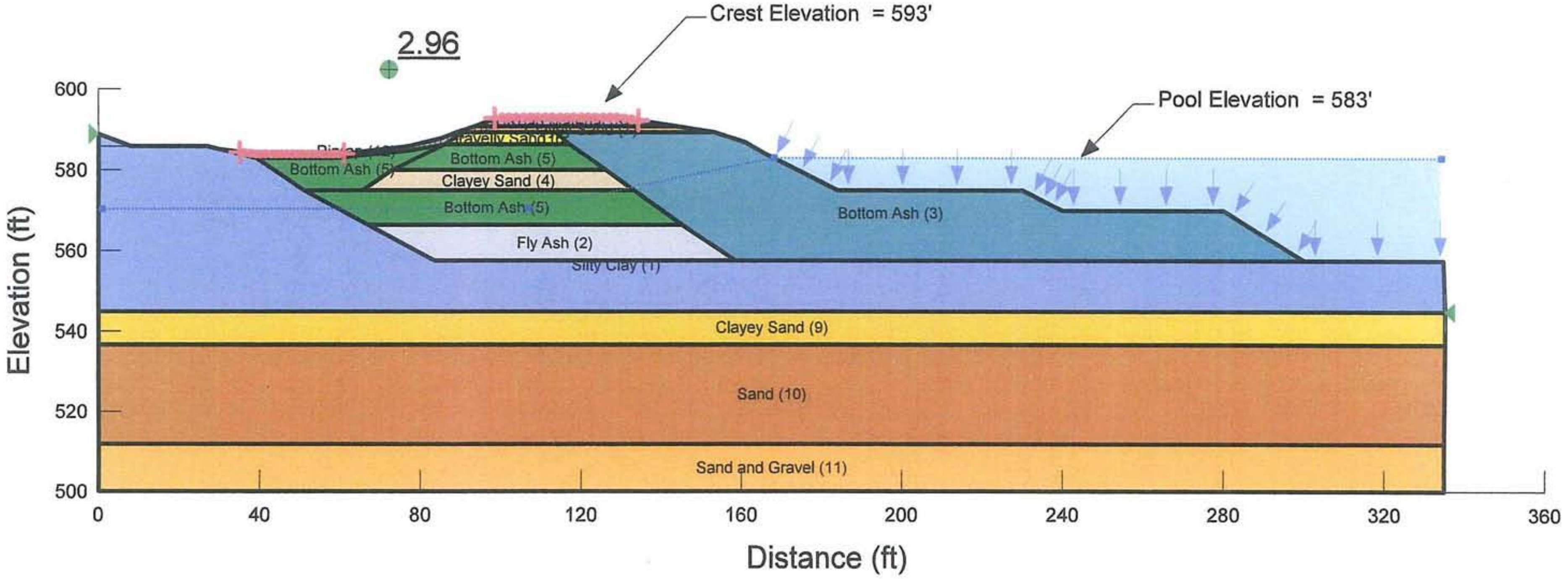
## SUMMARY OF RESULTS

GA used *SLOPE/W* to calculate slope stability safety factors for Section A-A of the Bottom Ash Disposal Facility Western Dike and Section H-H of the Fly Ash Disposal Facility Western Dike (See Table IV-4 and graphical output provided in this appendix). The safety factors were calculated by applying LEM pseudo-static train loading conditions developed from railway-induced vibrations. Specifically, the LEM pseudo-static analyses were evaluated by conservatively applying accelerations from the dike exterior toe vibration monitoring locations (i.e., Location A for Section A-A and Location C for Section H-H) to the downstream direction LEM slope stability analyses and by applying the accelerations from the dike crest monitoring locations (i.e., Location B for Section A-A and Location D for Section H-H) to the upstream direction LEM slope stability analyses.

As shown in Table IV-4, the LEM safety factors equal or exceed 1.70 for the Bottom Ash Disposal Facility Section A-A and 1.40 for the Fly Ash Disposal Facility Section H-H for the shallow-seated slip surface conditions. Moreover, the LEM safety factors equal or exceed 2.02 for the Bottom Ash Disposal Facility Section A-A and 1.65 for the Fly Ash Disposal Facility Section H-H for the deep-seated (global) slip surface conditions. The LEM slope stability analyses indicate that adequate safety factors/stability factors are available for each of the conservatively modeled dike/train loading conditions.

# BOTTOM ASH DISPOSAL FACILITY
# SECTION A-A
# LEM SLOPE STABILITY ANALYSIS RESULTS

Title: Sporn Bottom Ash Disposal Facility
Comments: LEM - Location A (Exterior Toe)
Railway Induced Pseudo Static Analysis
Down Stream Shallow Failure Surface
File Name: BAP_A-A_Slope-DS_Shallow.gsz
Date: 5/3/2010
Horz Seismic Load: 0.033
Vert Seismic Load: 0.008



# SLOPE/W Analysis

## File Information

Title: Sporn Bottom Ash Disposal Facility
Comments: LEM - Location A (Exterior Toe) Railway Induced Pseudo Static Analysis Down Stream Shallow Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 170
Last Edited By: Seth Frank
Date: 5/3/2010
Time: 4:15:55 PM
File Name: BAP_A-A_Slope-DS_Shallow.gsz
Directory: E:\Final Analysis Files\LEM BAP_A-A GA\Shallow\
Last Solved Date: 5/3/2010
Last Solved Time: 4:16:10 PM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

Description: Bottom Ash Pond Section A-A Downstream Seismic Stability with Existing Piezo Levels
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Apply Phreatic Correction: Yes
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line with B-bar

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack

Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Advanced
Number of Slices: 30
Optimization Tolerance: 0.05
Minimum Slip Surface Depth: 1 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

# Materials

## Fly Ash (2)

Model: Mohr-Coulomb
Unit Weight: 139 pcf
Unit Wt. Above Water Table: 134 pcf
Cohesion: 0.1 psf
Phi: 33 °
Phi-B: 18 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Bottom Ash (3)

Model: Mohr-Coulomb
Unit Weight: 80 pcf
Unit Wt. Above Water Table: 80 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Clayey Sand (4)

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Unit Wt. Above Water Table: 105 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 20 °
Pore Water Pressure

Piezometric Line: 1
B-bar: 0
Add Weight: Yes

## Bottom Ash (5)

Model: Mohr-Coulomb
Unit Weight: 80 pcf
Unit Wt. Above Water Table: 62 pcf
Cohesion: 0.1 psf
Phi: 38 °
Phi-B: 20 °
Pore Water Pressure
- Piezometric Line: 1
- Add Weight: Yes

## Gravelly Sand (6)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Unit Wt. Above Water Table: 111 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °
Pore Water Pressure
- Piezometric Line: 1
- Add Weight: Yes

## Clayey Sand (7)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 104 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °
Pore Water Pressure
- Piezometric Line: 1
- Add Weight: Yes

## Road Material (8)

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °
Pore Water Pressure
- Piezometric Line: 1
- Add Weight: Yes

## Silty Clay (1)

Model: Mohr-Coulomb

Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °
Pore Water Pressure
    Piezometric Line: 1
    B-bar: 0
    Add Weight: Yes

### Clayey Sand (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °
Pore Water Pressure
    Piezometric Line: 1
    Add Weight: Yes

### Sand (10)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °
Pore Water Pressure
    Piezometric Line: 1
    Add Weight: Yes

### Sand and Gravel (11)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 18 °
Pore Water Pressure
    Piezometric Line: 1
    Add Weight: Yes

### Riprap (12)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Add Weight: No

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (35, 584.55556) ft
Left-Zone Right Coordinate: (61, 584.11765) ft
Left-Zone Increment: 20
Right Projection: Range
Right-Zone Left Coordinate: (98.5, 592.81818) ft
Right-Zone Right Coordinate: (134.204, 592.328) ft
Right-Zone Increment: 20
Radius Increments: 20

## Slip Surface Limits

Left Coordinate: (0, 589) ft
Right Coordinate: (335, 545) ft

## Piezometric Lines

### Piezometric Line 1

Coordinates

| | X (ft) | Y (ft) |
|---|---|---|
| | 1 | 570.5 |
| | 107 | 570.5 |
| | 168 | 583 |
| | 334 | 583 |

Maximum Suction: 120 psf

## Seismic Loads

Horz Seismic Load: 0.033
Vert Seismic Load: 0.008
Ignore seismic load in strength: No

## Regions

| | Material | Points | Area (ft²) |
|---|---|---|---|
| Region 1 | Sand (10) | 3,4,5,6 | 8375 |
| Region 2 | Sand and Gravel (11) | 6,5,2,1 | 4020 |
| Region 3 | Clayey Sand (9) | 7,8,4,3 | 2680 |
| Region 4 | Silty Clay (1) | 9,36,10,45,11,12,13,14,15,16,17,8,7 | 5834.125 |
| Region 5 | Fly Ash (2) | 13,18,15,14 | 688.5 |
| Region 6 | Bottom Ash (5) | 12,19,20,18,13 | 680 |
| Region 7 | Clayey Sand (4) | 19,21,22,20 | 301.25 |
| | | | |

| | | | |
|---|---|---|---|
| Region 8 | Bottom Ash (5) | 21,23,24,22 | 273 |
| Region 9 | Bottom Ash (5) | 11,12,19,21,23,39,38,37 | 243.875 |
| Region 10 | Gravelly Sand (6) | 23,25,26,24 | 81 |
| Region 11 | Bottom Ash (3) | 26,27,28,29,34,30,35,31,16,15,18,20,22,24 | 2927.75 |
| Region 12 | Riprap (12) | 25,40,41,42,43,44,45,11,37,38,39,23 | 59.875 |
| Region 13 | Road Material (8) | 32,46,47,33 | 80.5 |
| Region 14 | Clayey Sand (7) | 46,40,25,26,27,47 | 85.5 |

# Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 500 |
| Point 2 | 335 | 500 |
| Point 3 | 0 | 537 |
| Point 4 | 335 | 537 |
| Point 5 | 335 | 512 |
| Point 6 | 0 | 512 |
| Point 7 | 0 | 545 |
| Point 8 | 335 | 545 |
| Point 9 | 0 | 589 |
| Point 10 | 27 | 586 |
| Point 11 | 39 | 583 |
| Point 12 | 51 | 575 |
| Point 13 | 67 | 566.5 |
| Point 14 | 83.5 | 557.5 |
| Point 15 | 158.5 | 557.5 |
| Point 16 | 300 | 557.5 |
| Point 17 | 334.5 | 557.5 |
| Point 18 | 145 | 566.5 |
| Point 19 | 65.5 | 575 |
| Point 20 | 133 | 575 |
| Point 21 | 73 | 580 |
| Point 22 | 126 | 580 |
| Point 23 | 86 | 586.5 |
| Point 24 | 117 | 586.5 |
| Point 25 | 90.5 | 589.5 |
| Point 26 | 113.5 | 589.5 |
| Point 27 | 153 | 589.5 |
| Point 28 | 161 | 587 |
| Point 29 | 166 | 584 |
| Point 30 | 230 | 575 |
| Point 31 | 280 | 570 |
| Point 32 | 99 | 593 |
| Point 33 | 129.5 | 593 |
| Point 34 | 184 | 575 |
| Point 35 | 240 | 570 |
| Point 36 | 8 | 586 |
| Point 37 | 52 | 583 |

| | | |
|---|---|---|
| Point 38 | 59 | 583 |
| Point 39 | 77.5 | 585 |
| Point 40 | 89 | 589.5 |
| Point 41 | 85 | 588 |
| Point 42 | 77 | 586 |
| Point 43 | 60 | 584 |
| Point 44 | 39 | 584 |
| Point 45 | 30 | 585.25 |
| Point 46 | 93.5 | 591 |
| Point 47 | 143.5 | 591 |

## Critical Slip Surfaces

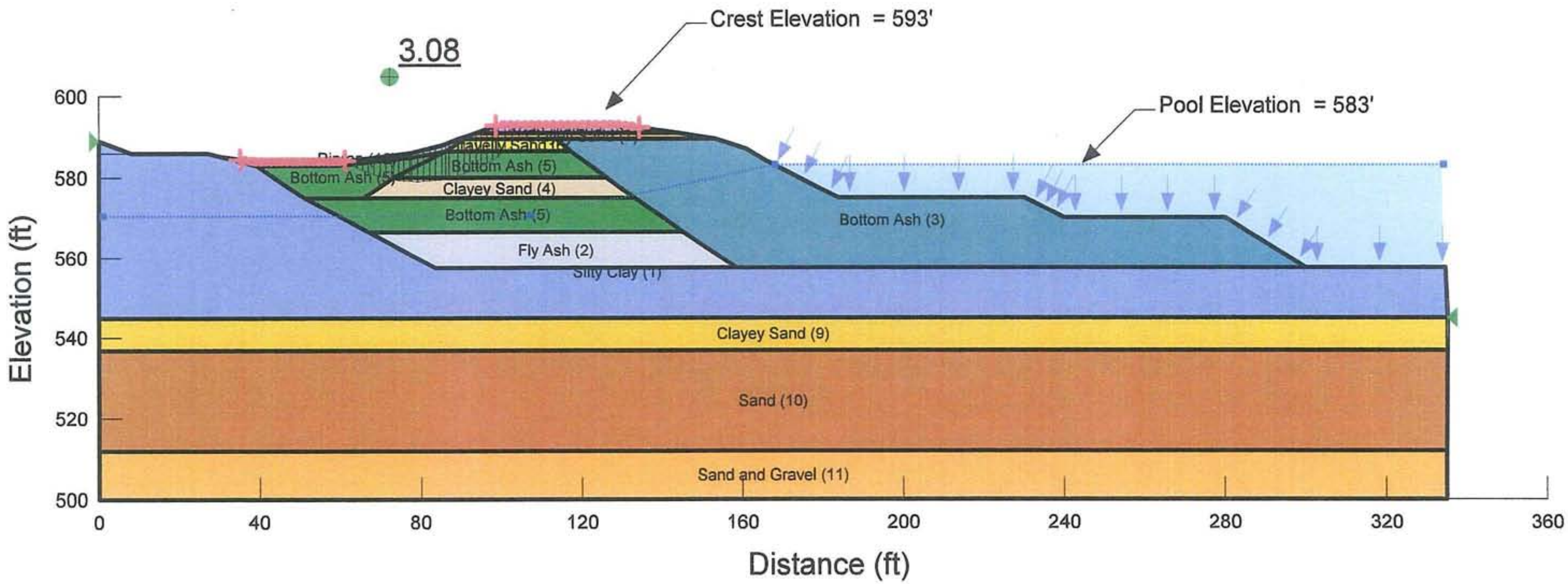
| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 8886 | 2.96 | (63.183, 681.319) | 97.226 | (103.836, 593) | (61, 584.118) |

### Slices of Slip Surface: 8886

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 8886 | 61.727275 | 584.10675 | -120.00338 | 11.266171 | 8.8020973 | 0 |
| 2 | 8886 | 63.18182 | 584.09585 | -120.00316 | 32.540073 | 25.423091 | 0 |
| 3 | 8886 | 64.636365 | 584.1067 | -119.99659 | 51.281082 | 40.065172 | 0 |
| 4 | 8886 | 66.09091 | 584.13935 | -119.99758 | 67.443836 | 52.692899 | 0 |
| 5 | 8886 | 67.545455 | 584.19375 | -119.99901 | 80.988344 | 63.275029 | 0 |
| 6 | 8886 | 69 | 584.27 | -120.00088 | 91.884465 | 71.788012 | 0 |
| 7 | 8886 | 70.454545 | 584.36815 | -120.00293 | 100.12128 | 78.223315 | 0 |
| 8 | 8886 | 71.90909 | 584.48825 | -119.99808 | 105.68048 | 82.56664 | 0 |
| 9 | 8886 | 73.363635 | 584.6304 | -119.99978 | 108.56797 | 84.822598 | 0 |
| 10 | 8886 | 74.81818 | 584.79465 | -120.00068 | 108.81354 | 85.014456 | 0 |
| 11 | 8886 | 76.272725 | 584.9811 | -120.00054 | 106.44386 | 83.163054 | 0 |
| 12 | 8886 | 77.666665 | 585.18035 | -120.00335 | 111.73416 | 87.296296 | 0 |
| 13 | 8886 | 79 | 585.3907 | -119.99976 | 124.78022 | 97.48899 | 0 |
| 14 | 8886 | 80.333335 | 585.6201 | -120.00074 | 135.51114 | 105.8729 | 0 |
| 15 | 8886 | 81.666665 | 585.8687 | -119.99826 | 143.95815 | 112.47244 | 0 |
| 16 | 8886 | 83 | 586.1366 | -119.99927 | 150.15511 | 117.31403 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 17 | 8886 | 84.333335 | 586.424 | -120.00302 | 154.13064 | 120.42005 | 0 |
| 18 | 8886 | 85.866135 | 586.7804 | -119.99856 | 167.60056 | 130.94391 | 0 |
| 19 | 8886 | 87.299205 | 587.13335 | -119.9974 | 184.59693 | 124.5122 | 0.1 |
| 20 | 8886 | 88.43307 | 587.43095 | -120.0015 | 195.54538 | 131.89702 | 0.1 |
| 21 | 8886 | 89.75 | 587.79645 | -119.99887 | 200.18623 | 135.02732 | 0.1 |
| 22 | 8886 | 91.25 | 588.23565 | -119.99706 | 199.91 | 134.841 | 0.1 |
| 23 | 8886 | 92.75 | 588.70125 | -120.00025 | 198.89113 | 134.15376 | 0.1 |
| 24 | 8886 | 94.326995 | 589.22035 | -120.00027 | 208.75191 | 140.80494 | 0.1 |
| 25 | 8886 | 95.79499 | 589.72825 | -119.99888 | 228.61514 | 154.20286 | 0.1 |
| 26 | 8886 | 97.076995 | 590.1949 | -120.00161 | 245.39868 | 165.5235 | 0.1 |
| 27 | 8886 | 98.359 | 590.6821 | -120.00006 | 260.32494 | 175.59139 | 0.1 |
| 28 | 8886 | 99.087 | 590.96545 | -120.00239 | 264.01274 | 178.07884 | 0.1 |
| 29 | 8886 | 99.9509 | 591.3174 | -119.99943 | 216.71032 | 157.44926 | 0.1 |
| 30 | 8886 | 101.50475 | 591.968 | -120.00149 | 130.39937 | 94.740689 | 0.1 |
| 31 | 8886 | 103.0586 | 592.6506 | -120.00042 | 40.059422 | 29.104874 | 0.1 |

Title: Sporn Bottom Ash Disposal Facility
Comments: LEM - Location A (Exterior Toe)
Railway Induced Pseudo Static Analysis
Down Stream Deep Failure Surface
File Name: BAP_A-A_Slope-DS_Deep.gsz
Date: 5/3/2010
Horz Seismic Load: 0.033
Vert Seismic Load: 0.008



# SLOPE/W Analysis

## File Information

Title: Sporn Bottom Ash Disposal Facility
Comments: LEM - Location A (Exterior Toe) Railway Induced Pseudo Static Analysis Down Stream Deep Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 169
Last Edited By: Seth Frank
Date: 5/3/2010
Time: 4:12:57 PM
File Name: BAP_A-A_Slope-DS_Deep.gsz
Directory: E:\Final Analysis Files\LEM BAP_A-A GA\Deep\
Last Solved Date: 5/3/2010
Last Solved Time: 4:13:12 PM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

Description: Bottom Ash Pond Section A-A Downstream Seismic Stability with Existing Piezo Levels
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Apply Phreatic Correction: Yes
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line with B-bar

SlipSurface

    - Direction of movement: Right to Left
    - Use Passive Mode: No
    - Slip Surface Option: Entry and Exit
    - Critical slip surfaces saved: 1
    - Optimize Critical Slip Surface Location: No
    - Tension Crack
        - Tension Crack Option: (none)
- FOS Distribution
    - FOS Calculation Option: Constant
- Advanced
    - Number of Slices: 30
    - Optimization Tolerance: 0.05
    - Minimum Slip Surface Depth: 5 ft
    - Optimization Maximum Iterations: 2000
    - Optimization Convergence Tolerance: 1e-007
    - Starting Optimization Points: 8
    - Ending Optimization Points: 16
    - Complete Passes per Insertion: 1
    - Driving Side Maximum Convex Angle: 5 °
    - Resisting Side Maximum Convex Angle: 1 °

## Materials

### Fly Ash (2)

- Model: Mohr-Coulomb
- Unit Weight: 139 pcf
- Unit Wt. Above Water Table: 134 pcf
- Cohesion: 0.1 psf
- Phi: 33 °
- Phi-B: 18 °
- Pore Water Pressure
    - Piezometric Line: 1
    - Add Weight: Yes

### Bottom Ash (3)

- Model: Mohr-Coulomb
- Unit Weight: 80 pcf
- Unit Wt. Above Water Table: 80 pcf
- Cohesion: 0.1 psf
- Phi: 36 °
- Phi-B: 20 °
- Pore Water Pressure
    - Piezometric Line: 1

Add Weight: Yes

### Clayey Sand (4)

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Unit Wt. Above Water Table: 105 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 20 °
Pore Water Pressure
Piezometric Line: 1
B-bar: 0
Add Weight: Yes

### Bottom Ash (5)

Model: Mohr-Coulomb
Unit Weight: 80 pcf
Unit Wt. Above Water Table: 62 pcf
Cohesion: 0.1 psf
Phi: 38 °
Phi-B: 20 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

### Gravelly Sand (6)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Unit Wt. Above Water Table: 111 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

### Clayey Sand (7)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 104 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °
Pore Water Pressure

Piezometric Line: 1
Add Weight: Yes

## Road Material (8)

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Silty Clay (1)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °
Pore Water Pressure
Piezometric Line: 1
B-bar: 0
Add Weight: Yes

## Clayey Sand (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Sand (10)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Sand and Gravel (11)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 18 °
Pore Water Pressure
  Piezometric Line: 1
  Add Weight: Yes

## Riprap (12)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1
  Add Weight: No

# lip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (35, 584.55556) ft
Left-Zone Right Coordinate: (61, 584.11765) ft
Left-Zone Increment: 20
Right Projection: Range
Right-Zone Left Coordinate: (98.5, 592.81818) ft
Right-Zone Right Coordinate: (134.204, 592.328) ft
Right-Zone Increment: 20
Radius Increments: 20

# Slip Surface Limits

Left Coordinate: (0, 589) ft
Right Coordinate: (335, 545) ft

# Piezometric Lines

## iezometric Line 1

### Coordinates

| X (ft) | Y (ft) |
|---|---|
| 1 | 570.5 |
| 107 | 570.5 |
| 168 | 583 |
| 334 | 583 |

Maximum Suction: 120 psf

## Seismic Loads

Horz Seismic Load: 0.033
Vert Seismic Load: 0.008
Ignore seismic load in strength: No

## Regions

| | Material | Points | Area (ft$^2$) |
|---|---|---|---|
| Region 1 | Sand (10) | 3,4,5,6 | 8375 |
| Region 2 | Sand and Gravel (11) | 6,5,2,1 | 4020 |
| Region 3 | Clayey Sand (9) | 7,8,4,3 | 2680 |
| Region 4 | Silty Clay (1) | 9,36,10,45,11,12,13,14,15,16,17,8,7 | 5834.125 |
| Region 5 | Fly Ash (2) | 13,18,15,14 | 688.5 |
| Region 6 | Bottom Ash (5) | 12,19,20,18,13 | 680 |
| Region 7 | Clayey Sand (4) | 19,21,22,20 | 301.25 |
| Region 8 | Bottom Ash (5) | 21,23,24,22 | 273 |
| Region 9 | Bottom Ash (5) | 11,12,19,21,23,39,38,37 | 243.875 |
| Region 10 | Gravelly Sand (6) | 23,25,26,24 | 81 |
| Region 11 | Bottom Ash (3) | 26,27,28,29,34,30,35,31,16,15,18,20,22,24 | 2927.75 |
| Region 12 | Riprap (12) | 25,40,41,42,43,44,45,11,37,38,39,23 | 59.875 |
| Region 13 | Road Material (8) | 32,46,47,33 | 80.5 |
| Region 14 | Clayey Sand (7) | 46,40,25,26,27,47 | 85.5 |

## oints

| X (ft) | Y (ft) |
|---|---|

| | | |
|---|---|---|
| Point 1 | 0 | 500 |
| Point 2 | 335 | 500 |
| Point 3 | 0 | 537 |
| Point 4 | 335 | 537 |
| Point 5 | 335 | 512 |
| Point 6 | 0 | 512 |
| Point 7 | 0 | 545 |
| Point 8 | 335 | 545 |
| Point 9 | 0 | 589 |
| Point 10 | 27 | 586 |
| Point 11 | 39 | 583 |
| Point 12 | 51 | 575 |
| Point 13 | 67 | 566.5 |
| Point 14 | 83.5 | 557.5 |
| Point 15 | 158.5 | 557.5 |
| Point 16 | 300 | 557.5 |
| Point 17 | 334.5 | 557.5 |
| Point 18 | 145 | 566.5 |
| Point 19 | 65.5 | 575 |
| Point 20 | 133 | 575 |
| Point 21 | 73 | 580 |
| Point 22 | 126 | 580 |
| Point 23 | 86 | 586.5 |
| Point 24 | 117 | 586.5 |
| Point 25 | 90.5 | 589.5 |
| Point 26 | 113.5 | 589.5 |
| Point 27 | 153 | 589.5 |
| Point 28 | 161 | 587 |
| Point 29 | 166 | 584 |
| Point 30 | 230 | 575 |
| Point 31 | 280 | 570 |
| Point 32 | 99 | 593 |

| | | |
|---|---|---|
| Point 33 | 129.5 | 593 |
| Point 34 | 184 | 575 |
| Point 35 | 240 | 570 |
| Point 36 | 8 | 586 |
| Point 37 | 52 | 583 |
| Point 38 | 59 | 583 |
| Point 39 | 77.5 | 585 |
| Point 40 | 89 | 589.5 |
| Point 41 | 85 | 588 |
| Point 42 | 77 | 586 |
| Point 43 | 60 | 584 |
| Point 44 | 39 | 584 |
| Point 45 | 30 | 585.25 |
| Point 46 | 93.5 | 591 |
| Point 47 | 143.5 | 591 |

## Critical Slip Surfaces

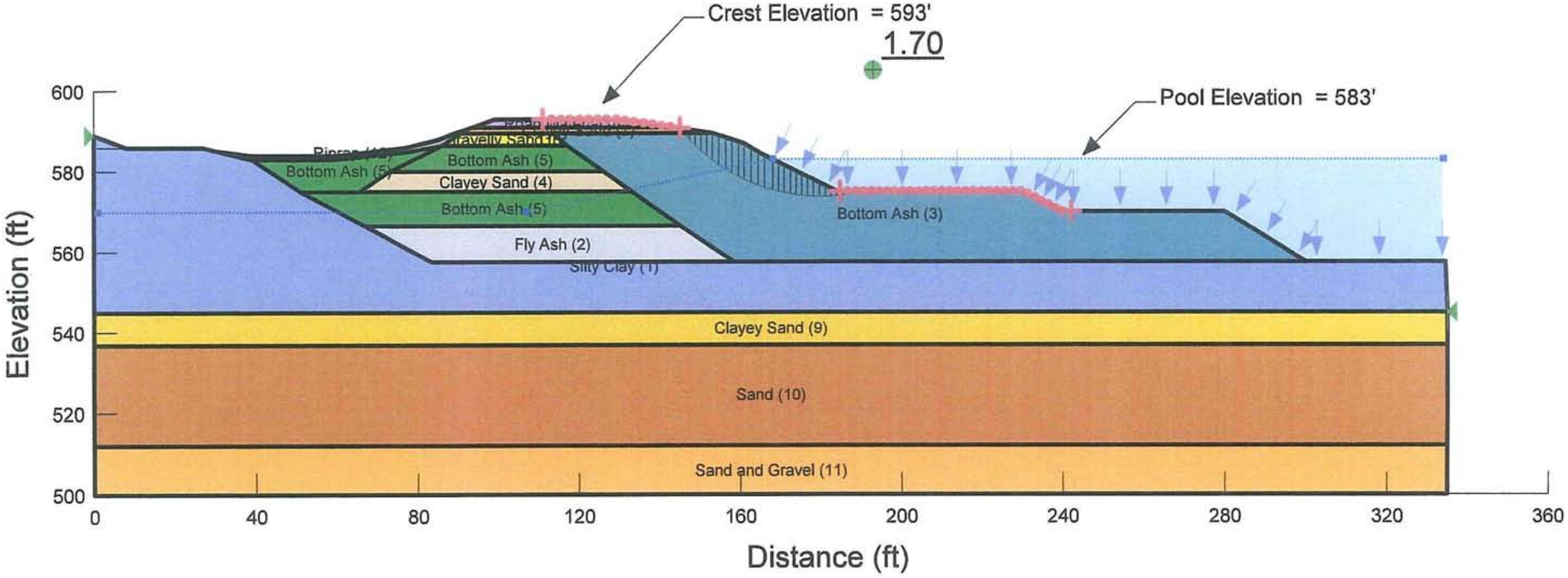
| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 8935 | 3.08 | (79.139, 615.039) | 35.849 | (107.414, 593) | (61, 584.118) |

### Slices of Slip Surface: 8935

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 8935 | 61.676715 | 583.74005 | -120.00057 | 63.268393 | 49.430686 | 0 |
| 2 | 8935 | 63.09019 | 582.99355 | -120.00073 | 173.03503 | 135.18978 | 0.1 |
| 3 | 8935 | 64.56371 | 582.2966 | -119.99908 | 244.0901 | 190.70409 | 0.1 |
| 4 | 8935 | 66.03723 | 581.67925 | -119.99912 | 309.54554 | 241.84348 | 0.1 |
| 5 | 8935 | 67.51075 | 581.1372 | -120.00295 | 368.52089 | 287.92007 | 0.1 |
| 6 | 8935 | 68.984275 | 580.6668 | -120.00109 | 420.24464 | 328.33109 | 0.1 |
| 7 | 8935 | 70.4578 | 580.26515 | -120.00008 | 464.13199 | 362.61965 | 0.1 |
| | 8935 | 71.93132 | 579.92995 | -119.99952 | 499.8019 | 390.48804 | 0.1 |
| 9 | 8935 | 72.83404 | 579.74905 | -119.99954 | 511.66111 | 307.43701 | 0.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10 | 8935 | 73.666665 | 579.6164 | -120.0013 | 536.26278 | 322.21918 | 0.1 |
| 11 | 8935 | 75 | 579.4359 | -120.00164 | 561.07546 | 337.12815 | 0.1 |
| 12 | 8935 | 76.333335 | 579.30605 | -119.99809 | 577.22302 | 346.83058 | 0.1 |
| 13 | 8935 | 77.25 | 579.2405 | -120.00098 | 588.32117 | 353.49903 | 0.1 |
| 14 | 8935 | 78.25 | 579.2087 | -120.00304 | 603.41415 | 362.5678 | 0.1 |
| 15 | 8935 | 79.75 | 579.20285 | -120.00256 | 617.63024 | 371.10969 | 0.1 |
| 16 | 8935 | 81.25 | 579.25985 | -119.99803 | 622.66406 | 374.13431 | 0.1 |
| 17 | 8935 | 82.75 | 579.38005 | -119.99973 | 619.4061 | 372.17673 | 0.1 |
| 18 | 8935 | 84.25 | 579.56405 | -120.00111 | 608.75521 | 365.77703 | 0.1 |
| 19 | 8935 | 85.5 | 579.76225 | -120.00492 | 602.2389 | 361.86164 | 0.1 |
| 20 | 8935 | 86.35891 | 579.9262 | -120.00023 | 604.44967 | 363.19 | 0.1 |
| 21 | 8935 | 87.85891 | 580.2863 | -119.99973 | 619.10255 | 483.69592 | 0.1 |
| 22 | 8935 | 89.75 | 580.80505 | -120.0015 | 627.88581 | 490.55816 | 0.1 |
| 23 | 8935 | 91.25 | 581.3068 | -120.00053 | 625.42706 | 488.63717 | 0.1 |
| 24 | 8935 | 92.75 | 581.88395 | -120.00207 | 621.96572 | 485.93288 | 0.1 |
| 25 | 8935 | 94.1875 | 582.50985 | -120.00008 | 627.10272 | 489.94634 | 0.1 |
| 6 | 8935 | 95.5625 | 583.18235 | -120.00279 | 640.59021 | 500.48393 | 0.1 |
| 27 | 8935 | 96.9375 | 583.9301 | -120.00278 | 651.65106 | 509.12561 | 0.1 |
| 28 | 8935 | 98.3125 | 584.75875 | -120.00302 | 660.35458 | 515.92554 | 0.1 |
| 29 | 8935 | 99.9174 | 585.84705 | -119.99922 | 627.9034 | 490.5719 | 0.1 |
| 30 | 8935 | 101.70045 | 587.20155 | -120.00011 | 540.22934 | 364.38929 | 0.1 |
| 31 | 8935 | 103.43175 | 588.70155 | -119.99827 | 407.58142 | 274.91714 | 0.1 |
| 32 | 8935 | 105.0159 | 590.25 | -120.00127 | 276.84491 | 186.73425 | 0.1 |
| 33 | 8935 | 106.3672 | 591.7395 | -120.00238 | 128.48372 | 93.348884 | 0.1 |
| 34 | 8935 | 107.20695 | 592.7395 | -120.00041 | 15.557807 | 11.303409 | 0.1 |

Title: Sporn Bottom Ash Disposal Facility
Comments: LEM - Location B (Crest)
Railway Induced Pseudo Static Analysis
Up Stream Shallow Failure Surface
File Name: BAP_A-A_Slope-US_Shallow.gsz
Date: 5/3/2010
Horz Seismic Load: 0.013
Vert Seismic Load: 0.002



# SLOPE/W Analysis

## File Information

Title: Sporn Bottom Ash Disposal Facility
Comments: LEM - Location B (Crest) Railway Induced Pseudo Static Analysis Up Stream Shallow Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 171
Last Edited By: Seth Frank
Date: 5/3/2010
Time: 4:20:21 PM
File Name: BAP_A-A_Slope-US_Shallow.gsz
Directory: E:\Final Analysis Files\LEM BAP_A-A GA\Shallow\
Last Solved Date: 5/3/2010
Last Solved Time: 4:20:44 PM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

- Description: Bottom Ash Pond Section A-A Downstream Seismic Stability with Existing Piezo Levels
- Kind: SLOPE/W
- Method: Morgenstern-Price
- Settings
  - Apply Phreatic Correction: Yes
  - Side Function
    - Interslice force function option: Half-Sine
  - PWP Conditions Source: Piezometric Line with B-bar
- SlipSurface
  - Direction of movement: Left to Right
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Optimize Critical Slip Surface Location: No
  - Tension Crack

Tension Crack Option: (none)

FOS Distribution

FOS Calculation Option: Constant

Advanced

Number of Slices: 30

Optimization Tolerance: 0.05

Minimum Slip Surface Depth: 5 ft

Optimization Maximum Iterations: 2000

Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8

Ending Optimization Points: 16

Complete Passes per Insertion: 1

Driving Side Maximum Convex Angle: 5 °

Resisting Side Maximum Convex Angle: 1 °

# Materials

## Fly Ash (2)

Model: Mohr-Coulomb

Unit Weight: 139 pcf

Unit Wt. Above Water Table: 134 pcf

Cohesion: 0.1 psf

Phi: 33 °

Phi-B: 18 °

Pore Water Pressure

Piezometric Line: 1

Add Weight: Yes

## Bottom Ash (3)

Model: Mohr-Coulomb

Unit Weight: 80 pcf

Unit Wt. Above Water Table: 80 pcf

Cohesion: 0.1 psf

Phi: 36 °

Phi-B: 20 °

Pore Water Pressure

Piezometric Line: 1

Add Weight: Yes

## Clayey Sand (4)

Model: Mohr-Coulomb

Unit Weight: 105 pcf

Unit Wt. Above Water Table: 105 pcf

Cohesion: 0.1 psf

Phi: 31 °

Phi-B: 20 °

Pore Water Pressure

Piezometric Line: 1
B-bar: 0
Add Weight: Yes

## Bottom Ash (5)

Model: Mohr-Coulomb
Unit Weight: 80 pcf
Unit Wt. Above Water Table: 62 pcf
Cohesion: 0.1 psf
Phi: 38 °
Phi-B: 20 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Gravelly Sand (6)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Unit Wt. Above Water Table: 111 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Clayey Sand (7)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 104 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Road Material (8)

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Silty Clay (1)

Model: Mohr-Coulomb

Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °
Pore Water Pressure
Piezometric Line: 1
B-bar: 0
Add Weight: Yes

## Clayey Sand (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Sand (10)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Sand and Gravel (11)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 18 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Riprap (12)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: No

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (111, 593) ft
Left-Zone Right Coordinate: (145, 590.76316) ft
Left-Zone Increment: 15
Right Projection: Range
Right-Zone Left Coordinate: (184.69356, 575) ft
Right-Zone Right Coordinate: (242, 570) ft
Right-Zone Increment: 30
Radius Increments: 30

## Slip Surface Limits

Left Coordinate: (0, 589) ft
Right Coordinate: (335, 545) ft

## Piezometric Lines

### Piezometric Line 1

Coordinates

| | X (ft) | Y (ft) |
|---|---|---|
| | 1 | 570 |
| | 107 | 570 |
| | 168 | 583 |
| | 334 | 583 |

Maximum Suction: 120 psf

## Seismic Loads

Horz Seismic Load: 0.013
Vert Seismic Load: 0.002
Ignore seismic load in strength: No

## Regions

| | Material | Points | Area (ft$^2$) |
|---|---|---|---|
| Region 1 | Sand (10) | 3,4,5,6 | 8375 |
| Region 2 | Sand and Gravel (11) | 6,5,2,1 | 4020 |
| Region 3 | Clayey Sand (9) | 7,8,4,3 | 2680 |
| Region 4 | Silty Clay (1) | 9,36,10,45,11,12,13,14,15,16,17,8,7 | 5834.125 |
| Region 5 | Fly Ash (2) | 13,18,15,14 | 688.5 |
| Region 6 | Bottom Ash (5) | 12,19,20,18,13 | 680 |
| Region 7 | Clayey Sand (4) | 19,21,22,20 | 301.25 |
| | | | |

| | | | |
|---|---|---|---|
| Region 8 | Bottom Ash (5) | 21,23,24,22 | 273 |
| Region 9 | Bottom Ash (5) | 11,12,19,21,23,39,38,37 | 243.875 |
| Region 10 | Gravelly Sand (6) | 23,25,26,24 | 81 |
| Region 11 | Bottom Ash (3) | 26,27,28,29,34,30,35,31,16,15,18,20,22,24 | 2927.75 |
| Region 12 | Riprap (12) | 25,40,41,42,43,44,45,11,37,38,39,23 | 59.875 |
| Region 13 | Road Material (8) | 32,46,47,33 | 80.5 |
| Region 14 | Clayey Sand (7) | 46,40,25,26,27,47 | 85.5 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 500 |
| Point 2 | 335 | 500 |
| Point 3 | 0 | 537 |
| Point 4 | 335 | 537 |
| Point 5 | 335 | 512 |
| Point 6 | 0 | 512 |
| Point 7 | 0 | 545 |
| Point 8 | 335 | 545 |
| Point 9 | 0 | 589 |
| Point 10 | 27 | 586 |
| Point 11 | 39 | 583 |
| Point 12 | 51 | 575 |
| Point 13 | 67 | 566.5 |
| Point 14 | 83.5 | 557.5 |
| Point 15 | 158.5 | 557.5 |
| Point 16 | 300 | 557.5 |
| Point 17 | 334.5 | 557.5 |
| Point 18 | 145 | 566.5 |
| Point 19 | 65.5 | 575 |
| Point 20 | 133 | 575 |
| Point 21 | 73 | 580 |
| Point 22 | 126 | 580 |
| Point 23 | 86 | 586.5 |
| Point 24 | 117 | 586.5 |
| Point 25 | 90.5 | 589.5 |
| Point 26 | 113.5 | 589.5 |
| Point 27 | 153 | 589.5 |
| Point 28 | 161 | 587 |
| Point 29 | 166 | 584 |
| Point 30 | 230 | 575 |
| Point 31 | 280 | 570 |
| Point 32 | 99 | 593 |
| Point 33 | 129.5 | 593 |
| Point 34 | 184 | 575 |
| Point 35 | 240 | 570 |
| Point 36 | 8 | 586 |
| Point 37 | 52 | 583 |

| | | |
|---|---|---|
| Point 38 | 59 | 583 |
| Point 39 | 77.5 | 585 |
| Point 40 | 89 | 589.5 |
| Point 41 | 85 | 588 |
| Point 42 | 77 | 586 |
| Point 43 | 60 | 584 |
| Point 44 | 39 | 584 |
| Point 45 | 30 | 585.25 |
| Point 46 | 93.5 | 591 |
| Point 47 | 143.5 | 591 |

## Critical Slip Surfaces

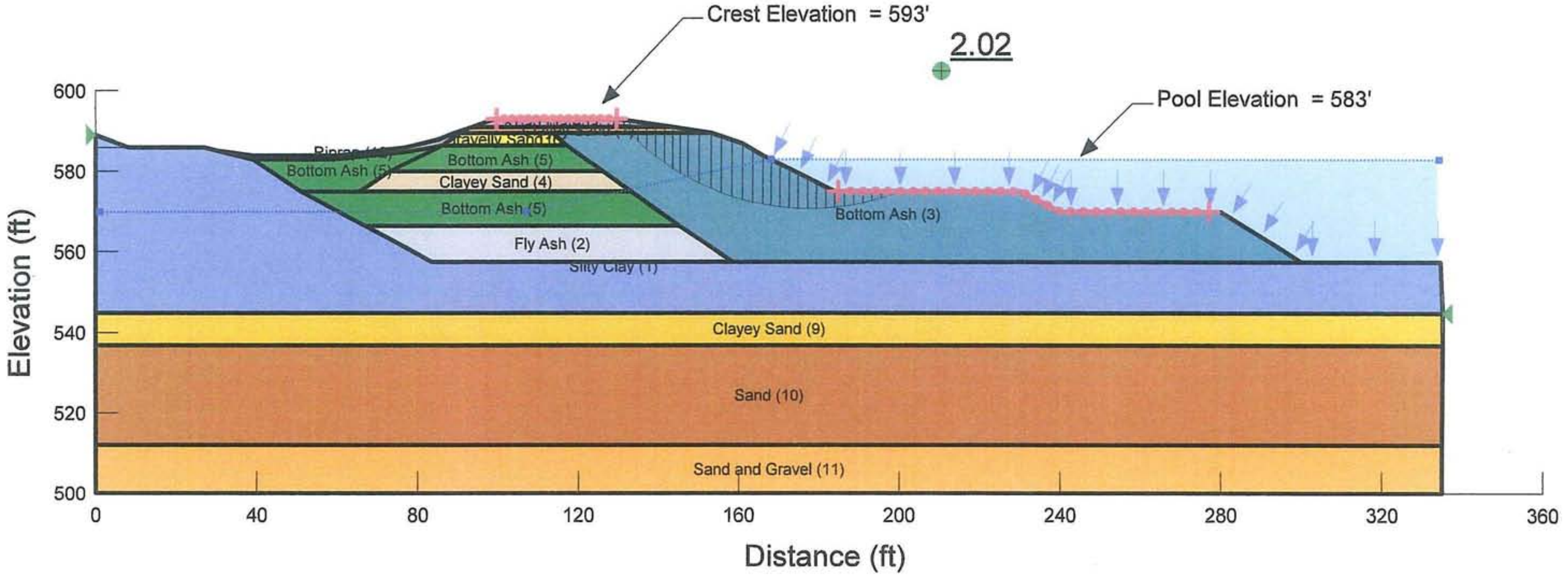
| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 14521 | 1.70 | (180.119, 618.555) | 44.785 | (145, 590.763) | (190.542, 575) |

### Slices of Slip Surface: **14521**

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 14521 | 145.51885 | 590.1316 | -120.00117 | 18.684997 | 12.60319 | 0.1 |
| 2 | 14521 | 146.7339 | 588.7209 | -119.99814 | 91.506002 | 66.483002 | 0.1 |
| 3 | 14521 | 148.12635 | 587.23075 | -119.99966 | 160.54552 | 116.64314 | 0.1 |
| 4 | 14521 | 149.51885 | 585.86795 | -120.00143 | 224.63109 | 163.20404 | 0.1 |
| 5 | 14521 | 150.9113 | 584.617 | -119.99767 | 284.48892 | 206.6933 | 0.1 |
| 6 | 14521 | 152.30375 | 583.4659 | -120.00261 | 340.73808 | 247.56071 | 0.1 |
| 7 | 14521 | 153.86155 | 582.2902 | -120.00041 | 394.2038 | 286.40583 | 0.1 |
| 8 | 14521 | 155.58465 | 581.10205 | -44.645913 | 450.71182 | 327.4613 | 0.1 |
| 9 | 14521 | 157.20515 | 580.08565 | 36.637589 | 501.83044 | 337.98239 | 0.1 |
| 10 | 14521 | 158.7231 | 579.22075 | 107.57206 | 545.99128 | 318.53021 | 0.1 |
| 11 | 14521 | 160.24105 | 578.4319 | 173.96704 | 584.09716 | 297.97697 | 0.1 |
| 12 | 14521 | 161.83335 | 577.6831 | 238.91299 | 602.01999 | 263.81268 | 0.1 |
| 13 | 14521 | 163.5 | 576.9772 | 302.25081 | 598.37303 | 215.14539 | 0.1 |
| 14 | 14521 | 165.16665 | 576.3489 | 360.95191 | 587.16472 | 164.35323 | 0.1 |
| 15 | 14521 | 167 | 575.74725 | 420.18735 | 573.18918 | 111.16234 | 0.1 |
| 16 | 14521 | 168.72725 | 575.2495 | 483.62893 | 582.27091 | 71.667592 | 0.1 |
| 17 | 14521 | 170.1818 | 574.8927 | 505.89347 | 611.80356 | 76.948185 | 0.1 |
| 18 | 14521 | 171.63635 | 574.5869 | 524.97528 | 637.85765 | 82.013846 | 0.1 |
| 19 | 14521 | 173.0909 | 574.331 | 540.94389 | 659.79946 | 86.353622 | 0.1 |
| 20 | 14521 | 174.54545 | 574.1242 | 553.84827 | 676.93628 | 89.428671 | 0.1 |
| 21 | 14521 | 176 | 573.9658 | 563.73598 | 688.55653 | 90.68744 | 0.1 |
| 22 | 14521 | 177.45455 | 573.8553 | 570.63013 | 693.96881 | 89.610798 | 0.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 23 | 14521 | 178.9091 | 573.79235 | 574.56105 | 692.47242 | 85.667623 | 0.1 |
| 24 | 14521 | 180.36365 | 573.77665 | 575.53897 | 683.59862 | 78.509931 | 0.1 |
| 25 | 14521 | 181.8182 | 573.80825 | 573.56653 | 666.88926 | 67.802929 | 0.1 |
| 26 | 14521 | 183.27275 | 573.88725 | 568.63857 | 642.11438 | 53.3833 | 0.1 |
| 27 | 14521 | 184.8178 | 574.0249 | 560.04928 | 593.52163 | 24.319086 | 0.1 |
| 28 | 14521 | 186.45335 | 574.22805 | 547.36871 | 575.00498 | 20.078921 | 0.1 |
| 29 | 14521 | 188.0889 | 574.49285 | 530.84588 | 549.48493 | 13.542062 | 0.1 |
| 30 | 14521 | 189.72445 | 574.8204 | 510.407 | 517.1551 | 4.90278 | 0.1 |

Title: Sporn Bottom Ash Disposal Facility
Comments: LEM - Location B (Crest)
Railway Induced Pseudo Static Analysis
Up Stream Deep Failure Surface
File Name: BAP_A-A_Slope-US_Deep.gsz
Date: 5/3/2010
Horz Seismic Load: 0.013
Vert Seismic Load: 0.002



# SLOPE/W Analysis

## File Information

Title: Sporn Bottom Ash Disposal Facility
Comments: LEM - Location B (Crest) Railway Induced Pseudo Static Analysis Up Stream Deep Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 170
Last Edited By: Seth Frank
Date: 5/3/2010
Time: 4:24:31 PM
File Name: BAP_A-A_Slope-US_Deep.gsz
Directory: E:\Final Analysis Files\LEM BAP_A-A GA\Deep\
Last Solved Date: 5/3/2010
Last Solved Time: 4:24:58 PM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

Description: Bottom Ash Pond Section A-A Downstream Seismic Stability with Existing Piezo Levels
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Apply Phreatic Correction: Yes
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line with B-bar

SlipSurface

Direction of movement: Left to Right
Use Passive Mode: No
Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Advanced
Number of Slices: 30
Optimization Tolerance: 0.05
Minimum Slip Surface Depth: 10 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

## Materials

### Fly Ash (2)

Model: Mohr-Coulomb
Unit Weight: 139 pcf
Unit Wt. Above Water Table: 134 pcf
Cohesion: 0.1 psf
Phi: 33 °
Phi-B: 18 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

### Bottom Ash (3)

Model: Mohr-Coulomb
Unit Weight: 80 pcf
Unit Wt. Above Water Table: 80 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °
Pore Water Pressure
Piezometric Line: 1

- Add Weight: Yes

## Clayey Sand (4)

- Model: Mohr-Coulomb
- Unit Weight: 105 pcf
- Unit Wt. Above Water Table: 105 pcf
- Cohesion: 0.1 psf
- Phi: 31 °
- Phi-B: 20 °
- Pore Water Pressure
  - Piezometric Line: 1
  - B-bar: 0
  - Add Weight: Yes

## Bottom Ash (5)

- Model: Mohr-Coulomb
- Unit Weight: 80 pcf
- Unit Wt. Above Water Table: 62 pcf
- Cohesion: 0.1 psf
- Phi: 38 °
- Phi-B: 20 °
- Pore Water Pressure
  - Piezometric Line: 1
  - Add Weight: Yes

## Gravelly Sand (6)

- Model: Mohr-Coulomb
- Unit Weight: 115 pcf
- Unit Wt. Above Water Table: 111 pcf
- Cohesion: 0.1 psf
- Phi: 34 °
- Phi-B: 19 °
- Pore Water Pressure
  - Piezometric Line: 1
  - Add Weight: Yes

## Clayey Sand (7)

- Model: Mohr-Coulomb
- Unit Weight: 110 pcf
- Unit Wt. Above Water Table: 104 pcf
- Cohesion: 0.1 psf
- Phi: 34 °
- Phi-B: 19 °
- Pore Water Pressure

Piezometric Line: 1
Add Weight: Yes

## Road Material (8)

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Silty Clay (1)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °
Pore Water Pressure
Piezometric Line: 1
B-bar: 0
Add Weight: Yes

## Clayey Sand (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Sand (10)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

### Sand and Gravel (11)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 18 °
Pore Water Pressure
    Piezometric Line: 1
    Add Weight: Yes

### Riprap (12)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Add Weight: No

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (99.45937, 593) ft
Left-Zone Right Coordinate: (129.5, 593) ft
Left-Zone Increment: 15
Right Projection: Range
Right-Zone Left Coordinate: (184.69356, 575) ft
Right-Zone Right Coordinate: (277, 570) ft
Right-Zone Increment: 30
Radius Increments: 30

## Slip Surface Limits

Left Coordinate: (0, 589) ft
Right Coordinate: (335, 545) ft

## Piezometric Lines

### Piezometric Line 1

### Coordinates

| X (ft) | Y (ft) |
|---|---|
| 1 | 570 |
| 107 | 570 |
| 168 | 583 |
| 334 | 583 |

Maximum Suction: 120 psf

## Seismic Loads

Horz Seismic Load: 0.013
Vert Seismic Load: 0.002
Ignore seismic load in strength: No

## Regions

| | Material | Points | Area (ft$^2$) |
|---|---|---|---|
| Region 1 | Sand (10) | 3,4,5,6 | 8375 |
| Region 2 | Sand and Gravel (11) | 6,5,2,1 | 4020 |
| Region 3 | Clayey Sand (9) | 7,8,4,3 | 2680 |
| Region 4 | Silty Clay (1) | 9,36,10,45,11,12,13,14,15,16,17,8,7 | 5834.125 |
| Region 5 | Fly Ash (2) | 13,18,15,14 | 688.5 |
| Region 6 | Bottom Ash (5) | 12,19,20,18,13 | 680 |
| Region 7 | Clayey Sand (4) | 19,21,22,20 | 301.25 |
| Region 8 | Bottom Ash (5) | 21,23,24,22 | 273 |
| Region 9 | Bottom Ash (5) | 11,12,19,21,23,39,38,37 | 243.875 |
| Region 10 | Gravelly Sand (6) | 23,25,26,24 | 81 |
| Region 11 | Bottom Ash (3) | 26,27,28,29,34,30,35,31,16,15,18,20,22,24 | 2927.75 |
| Region 12 | Riprap (12) | 25,40,41,42,43,44,45,11,37,38,39,23 | 59.875 |
| Region 13 | Road Material (8) | 32,46,47,33 | 80.5 |
| Region 14 | Clayey Sand (7) | 46,40,25,26,27,47 | 85.5 |

## Points

| X (ft) | Y (ft) |
|---|---|

| | | |
|---|---|---|
| Point 1 | 0 | 500 |
| Point 2 | 335 | 500 |
| Point 3 | 0 | 537 |
| Point 4 | 335 | 537 |
| Point 5 | 335 | 512 |
| Point 6 | 0 | 512 |
| Point 7 | 0 | 545 |
| Point 8 | 335 | 545 |
| Point 9 | 0 | 589 |
| Point 10 | 27 | 586 |
| Point 11 | 39 | 583 |
| Point 12 | 51 | 575 |
| Point 13 | 67 | 566.5 |
| Point 14 | 83.5 | 557.5 |
| Point 15 | 158.5 | 557.5 |
| Point 16 | 300 | 557.5 |
| Point 17 | 334.5 | 557.5 |
| Point 18 | 145 | 566.5 |
| Point 19 | 65.5 | 575 |
| Point 20 | 133 | 575 |
| Point 21 | 73 | 580 |
| Point 22 | 126 | 580 |
| Point 23 | 86 | 586.5 |
| Point 24 | 117 | 586.5 |
| Point 25 | 90.5 | 589.5 |
| Point 26 | 113.5 | 589.5 |
| Point 27 | 153 | 589.5 |
| Point 28 | 161 | 587 |
| Point 29 | 166 | 584 |
| Point 30 | 230 | 575 |
| Point 31 | 280 | 570 |
| oint 32 | 99 | 593 |

| | | |
|---|---|---|
| Point 33 | 129.5 | 593 |
| Point 34 | 184 | 575 |
| Point 35 | 240 | 570 |
| Point 36 | 8 | 586 |
| Point 37 | 52 | 583 |
| Point 38 | 59 | 583 |
| Point 39 | 77.5 | 585 |
| Point 40 | 89 | 589.5 |
| Point 41 | 85 | 588 |
| Point 42 | 77 | 586 |
| Point 43 | 60 | 584 |
| Point 44 | 39 | 584 |
| Point 45 | 30 | 585.25 |
| Point 46 | 93.5 | 591 |
| Point 47 | 143.5 | 591 |

## Critical Slip Surfaces

| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 14583 | 2.02 | (177.569, 633.864) | 63.092 | (129.5, 593) | (200.275, 575) |

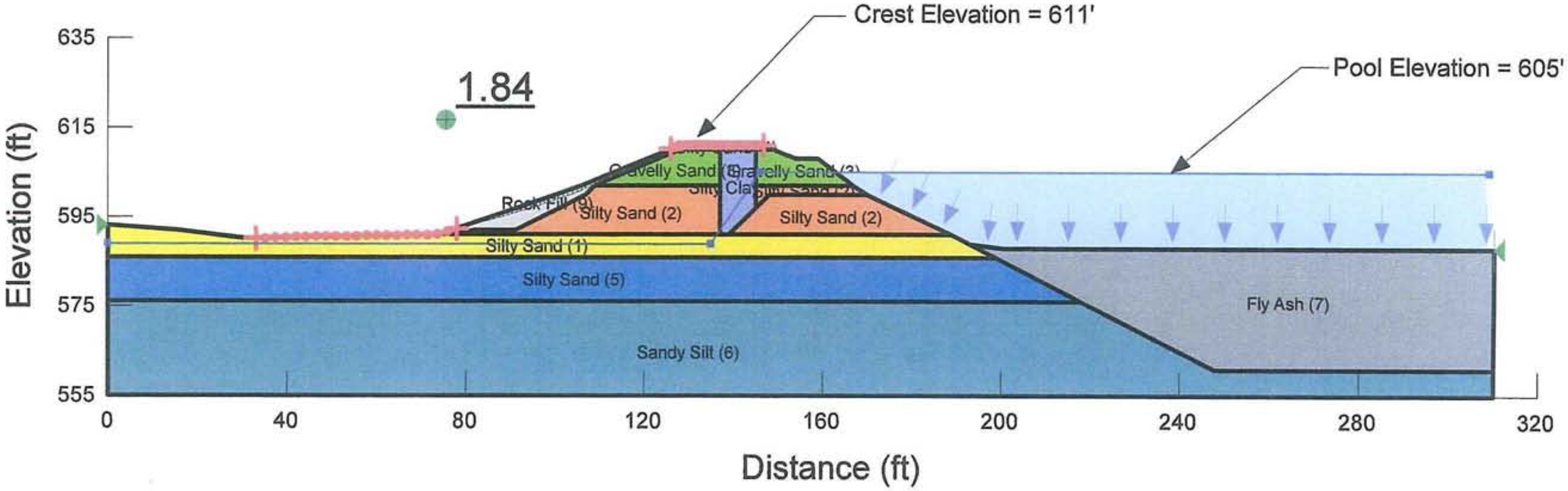
### Slices of Slip Surface: 14583

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 14583 | 130.3873 | 592 | -120.00172 | 72.537349 | 52.701469 | 0.1 |
| 2 | 14583 | 131.9923 | 590.25 | -120.00096 | 216.3283 | 145.91528 | 0.1 |
| 3 | 14583 | 133.789 | 588.4596 | -119.99908 | 305.76698 | 222.15272 | 0.1 |
| 4 | 14583 | 135.947 | 586.4716 | -119.99968 | 396.64481 | 288.17933 | 0.1 |
| 5 | 14583 | 138.105 | 584.6586 | -120.00062 | 479.73498 | 348.54787 | 0.1 |
| 6 | 14583 | 140.263 | 583.0018 | -120 | 555.9645 | 403.93186 | 0.1 |
| 7 | 14583 | 142.421 | 581.4863 | -119.99918 | 626.08437 | 454.87692 | 0.1 |
| | 14583 | 144.42355 | 580.19185 | -120.00133 | 689.59767 | 501.02204 | 0.1 |
| 9 | 14583 | 146.2707 | 579.09375 | -43.250596 | 752.63389 | 546.82053 | 0.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10 | 14583 | 148.6457 | 577.817 | 63.172602 | 830.15827 | 557.24771 | 0.1 |
| 11 | 14583 | 151.54855 | 576.41065 | 184.04323 | 916.46617 | 532.13642 | 0.1 |
| 12 | 14583 | 154.33335 | 575.22495 | 290.23947 | 976.9592 | 498.93109 | 0.1 |
| 13 | 14583 | 157 | 574.23665 | 383.14394 | 1012.8074 | 457.47728 | 0.1 |
| 14 | 14583 | 159.66665 | 573.38205 | 468.09944 | 1037.672 | 413.81867 | 0.1 |
| 15 | 14583 | 162.25 | 572.67445 | 543.19547 | 1024.6562 | 349.80173 | 0.1 |
| 16 | 14583 | 164.75 | 572.10205 | 609.13733 | 972.63014 | 264.09298 | 0.1 |
| 17 | 14583 | 167 | 571.67265 | 663.38834 | 923.50873 | 188.98853 | 0.1 |
| 18 | 14583 | 169.14285 | 571.34865 | 727.02551 | 914.41841 | 136.14892 | 0.1 |
| 19 | 14583 | 171.42855 | 571.0828 | 743.61388 | 933.15313 | 137.70832 | 0.1 |
| 20 | 14583 | 173.71425 | 570.90105 | 754.98014 | 944.10728 | 137.40891 | 0.1 |
| 21 | 14583 | 176 | 570.80265 | 761.10184 | 946.41322 | 134.63659 | 0.1 |
| 22 | 14583 | 178.28575 | 570.7872 | 762.07575 | 939.20805 | 128.69415 | 0.1 |
| 23 | 14583 | 180.57145 | 570.85465 | 757.85286 | 921.59837 | 118.96808 | 0.1 |
| 24 | 14583 | 182.85715 | 571.00525 | 748.45627 | 892.88984 | 104.93713 | 0.1 |
| 25 | 14583 | 185.1625 | 571.24235 | 733.69385 | 835.01816 | 73.616416 | 0.1 |
| 26 | 14583 | 187.48745 | 571.56835 | 713.35184 | 809.56131 | 69.900275 | 0.1 |
| 27 | 14583 | 189.8124 | 571.9834 | 687.41949 | 774.50725 | 63.272963 | 0.1 |
| 28 | 14583 | 192.13735 | 572.48935 | 655.85488 | 729.75992 | 53.695152 | 0.1 |
| 29 | 14583 | 194.4623 | 573.0884 | 618.4998 | 675.31475 | 41.278482 | 0.1 |
| 30 | 14583 | 196.78725 | 573.78335 | 575.13338 | 611.34806 | 26.311506 | 0.1 |
| 31 | 14583 | 199.1122 | 574.5776 | 525.57154 | 538.14386 | 9.134326 | 0.1 |

# FLY ASH DISPOSAL FACILITY
# SECTION H-H
# LEM SLOPE STABILITY ANALYSIS RESULTS

Title: Sporn Fly Ash Disposal Facility
Comments: LEM - Location C (Exterior Toe)
Railway Induced Pseudo Static Analysis
Down Stream Shallow Failure Surface
File Name: FAP_H-H_Slope-DS_Shallow.gsz
Date: 5/3/2010
Horz Seismic Load: 0.046
Vert Seismic Load: 0.008



# SLOPE/W Analysis

## File Information

Title: Sporn Fly Ash Disposal Facility
Comments: LEM - Location C (Exterior Toe) Railway Induced Pseudo Static Analysis Down Stream Shallow Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 172
Last Edited By: Seth Frank
Date: 5/3/2010
Time: 3:17:51 PM
File Name: FAP_H-H_Slope-DS_Shallow.gsz
Directory: E:\Final Analysis Files\LEM FAP_H-H GA\Shallow\
Last Solved Date: 5/3/2010
Last Solved Time: 3:18:12 PM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

Description: Fly Ash Pond Section H-H Downstream Seismic Stability
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Apply Phreatic Correction: Yes
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line with B-bar

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack

Tension Crack Option: (none)

FOS Distribution

FOS Calculation Option: Constant

Advanced

Number of Slices: 50

Optimization Tolerance: 0.05

Minimum Slip Surface Depth: 1 ft

Optimization Maximum Iterations: 2000

Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8

Ending Optimization Points: 16

Complete Passes per Insertion: 1

Driving Side Maximum Convex Angle: 5 °

Resisting Side Maximum Convex Angle: 1 °

## Materials

### Silty Sand (1)

Model: Mohr-Coulomb

Unit Weight: 130 pcf

Unit Wt. Above Water Table: 125 pcf

Cohesion: 0.1 psf

Phi: 34 °

Phi-B: 18 °

Pore Water Pressure

Piezometric Line: 1

Add Weight: Yes

### Silty Sand (2)

Model: Mohr-Coulomb

Unit Weight: 112 pcf

Unit Wt. Above Water Table: 107 pcf

Cohesion: 0.1 psf

Phi: 35 °

Phi-B: 18 °

Pore Water Pressure

Piezometric Line: 1

Add Weight: Yes

### Gravelly Sand (3)

Model: Mohr-Coulomb

Unit Weight: 110 pcf

Unit Wt. Above Water Table: 105 pcf

Cohesion: 0.1 psf

Phi: 33 °

Phi-B: 17 °

Pore Water Pressure

Piezometric Line: 1
Add Weight: Yes

## Silty Clay (4)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Unit Wt. Above Water Table: 115 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 17 °
Pore Water Pressure
Piezometric Line: 1
B-bar: 0
Add Weight: Yes

## Silty Sand (5)

Model: Mohr-Coulomb
Unit Weight: 131 pcf
Unit Wt. Above Water Table: 126 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 16 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Sandy Silt (6)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 14 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Fly Ash (7)

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Unit Wt. Above Water Table: 102 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 15 °
Pore Water Pressure
Piezometric Line: 1
B-bar: 0
Add Weight: Yes

### Rock Fill (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Add Weight: No

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (33, 590.06452) ft
Left-Zone Right Coordinate: (78, 592.34198) ft
Left-Zone Increment: 20
Right Projection: Range
Right-Zone Left Coordinate: (126, 610.18182) ft
Right-Zone Right Coordinate: (146.73585, 611) ft
Right-Zone Increment: 20
Radius Increments: 30

## Slip Surface Limits

Left Coordinate: (0, 593) ft
Right Coordinate: (310, 588) ft

## Piezometric Lines

### Piezometric Line 1

Coordinates

| | X (ft) | Y (ft) |
|---|---|---|
| | 0 | 589 |
| | 135 | 589 |
| | 146 | 605 |
| | 309 | 605 |

## Seismic Loads

Horz Seismic Load: 0.046
Vert Seismic Load: 0.008
Ignore seismic load in strength: No

## Regions

| | Material | Points | Area (ft²) |
|---|---|---|---|
| Region 1 | Sandy Silt (6) | 1,3,4,5,6,2 | 5355 |
| Region 2 | Silty Sand (5) | 7,8,4,3 | 2085 |
| Region 3 | Silty Sand (1) | 7,9,36,35,34,33,32,42,10,12,13,14,29,8 | 973.49995 |
| Region 4 | Silty Sand (2) | 11,37,38,39,16,12,10 | 420 |
| Region 5 | Silty Clay (4) | 16,17,18,19,20,13,12 | 134 |
| Region 6 | Gravelly Sand (3) | 41,17,16,39 | 148 |
| Region 7 | Silty Sand (2) | 19,20,23,24,22 | 51.5 |
| Region 8 | Silty Sand (1) | 40,26,21,18,17,41 | 19 |
| Region 9 | Silty Sand (2) | 13,20,23,24,14 | 324 |
| Region 10 | Gravelly Sand (3) | 21,27,28,22,19,18 | 121 |
| Region 11 | Fly Ash (7) | 30,31,6,5,4,8,29 | 2399 |
| Region 12 | Rock Fill (9) | 11,10,42,15,25,40,41,39,38,37 | 120.4339 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 555 |
| Point 2 | 310 | 555 |
| Point 3 | 0 | 576 |
| Point 4 | 218 | 576 |
| Point 5 | 248 | 561 |
| Point 6 | 310 | 561 |
| Point 7 | 0 | 586 |
| Point 8 | 199 | 586 |
| Point 9 | 0 | 590 |
| Point 10 | 76 | 591 |
| Point 11 | 82 | 592 |
| Point 12 | 137 | 591 |
| Point 13 | 139 | 591 |
| Point 14 | 189 | 591 |
| Point 15 | 106 | 602 |
| Point 16 | 137 | 602 |
| Point 17 | 137 | 610 |
| Point 18 | 145 | 610 |
| Point 19 | 145 | 602 |
| Point 20 | 145 | 597 |
| Point 21 | 149 | 610 |
| Point 22 | 167 | 602 |
| Point 23 | 148 | 600 |
| Point 24 | 170 | 600 |
| Point 25 | 128 | 611 |
| Point 26 | 147 | 611 |
| Point 27 | 154 | 608 |
| Point 28 | 159 | 608 |
| Point 29 | 193 | 589 |

| | | |
|---|---|---|
| Point 30 | 201 | 588 |
| Point 31 | 310 | 588 |
| Point 32 | 49.5 | 590.5 |
| Point 33 | 46.5 | 590.5 |
| Point 34 | 31 | 590 |
| Point 35 | 15.5 | 592 |
| Point 36 | 0 | 593 |
| Point 37 | 91 | 592 |
| Point 38 | 107 | 600 |
| Point 39 | 109 | 602 |
| Point 40 | 130 | 611 |
| Point 41 | 128 | 610 |
| Point 42 | 74 | 590.96226 |

## Critical Slip Surfaces

| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 13115 | 1.84 | (20.316, 828.893) | 243.483 | (128.974, 611) | (78, 592.342) |

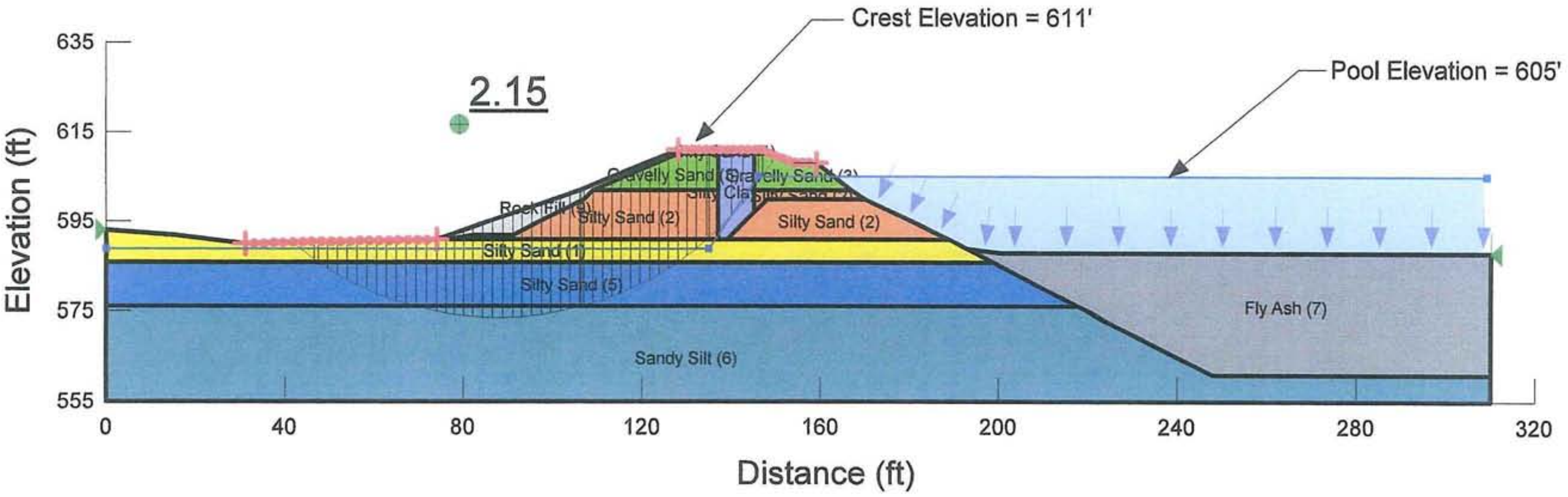
### Slices of Slip Surface: 13115

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 13115 | 78.51852 | 592.46965 | -216.50769 | 5.3842747 | 4.2066564 | 0 |
| 2 | 13115 | 79.555555 | 592.72735 | -232.58337 | 15.904935 | 12.426297 | 0 |
| 3 | 13115 | 80.59259 | 592.9899 | -248.9737 | 25.926002 | 20.255613 | 0 |
| 4 | 13115 | 81.62963 | 593.2573 | -265.65718 | 35.439622 | 27.688467 | 0 |
| 5 | 13115 | 82.66667 | 593.52955 | -282.6505 | 44.435682 | 34.71696 | 0 |
| 6 | 13115 | 83.703705 | 593.80675 | -299.94209 | 52.906969 | 41.335455 | 0 |
| 7 | 13115 | 84.74074 | 594.08885 | -317.53899 | 60.844514 | 47.536944 | 0 |
| 8 | 13115 | 85.77778 | 594.37585 | -335.45715 | 68.243118 | 53.317367 | 0 |
| 9 | 13115 | 86.814815 | 594.6678 | -353.66625 | 75.094015 | 58.669874 | 0 |
| 10 | 13115 | 87.85185 | 594.9647 | -372.20097 | 81.392268 | 63.590609 | 0 |
| 11 | 13115 | 88.88889 | 595.2666 | -391.03985 | 87.132038 | 68.075009 | 0 |
| 12 | 13115 | 89.925925 | 595.5735 | -410.18955 | 92.310436 | 72.120817 | 0 |
| 13 | 13115 | 90.96296 | 595.8854 | -429.64781 | 96.921991 | 75.723758 | 0 |
| 14 | 13115 | 92 | 596.20235 | -449.42961 | 100.97398 | 78.889522 | 0 |
| 15 | 13115 | 93.03704 | 596.52435 | -469.52288 | 104.4509 | 81.605984 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 16 | 13115 | 94.074075 | 596.85145 | -489.93399 | 107.36404 | 83.881977 | 0 |
| 17 | 13115 | 95.11111 | 597.18365 | -510.66001 | 109.70638 | 85.712015 | 0 |
| 18 | 13115 | 96.14815 | 597.52095 | -531.70667 | 111.48925 | 87.104947 | 0 |
| 19 | 13115 | 97.185185 | 597.86345 | -553.08056 | 112.71505 | 88.06265 | 0 |
| 20 | 13115 | 98.22222 | 598.2111 | -574.7684 | 113.37682 | 88.57968 | 0 |
| 21 | 13115 | 99.25926 | 598.5639 | -596.78524 | 113.49528 | 88.672234 | 0 |
| 22 | 13115 | 100.29629 | 598.92195 | -619.12777 | 113.05471 | 88.328019 | 0 |
| 23 | 13115 | 101.33335 | 599.28525 | -641.80173 | 112.07592 | 87.563304 | 0 |
| 24 | 13115 | 102.3704 | 599.6538 | -664.79402 | 110.56144 | 86.380065 | 0 |
| 25 | 13115 | 103.4074 | 600.02765 | -688.12836 | 108.51398 | 84.780412 | 0 |
| 26 | 13115 | 104.44445 | 600.4068 | -711.78238 | 105.94526 | 82.773508 | 0 |
| 27 | 13115 | 105.4815 | 600.7913 | -735.77955 | 102.84906 | 80.354491 | 0 |
| 28 | 13115 | 106.5 | 601.17415 | -759.66379 | 102.51369 | 80.092476 | 0 |
| 29 | 13115 | 107.5 | 601.55515 | -783.44447 | 104.93794 | 81.986502 | 0 |
| 30 | 13115 | 108.5 | 601.9412 | -807.53256 | 106.84764 | 83.478529 | 0 |
| 31 | 13115 | 109.5 | 602.3323 | -831.93448 | 108.26398 | 84.585091 | 0 |
| 32 | 13115 | 110.5 | 602.7285 | -856.65507 | 109.17069 | 85.293492 | 0 |
| 33 | 13115 | 111.5 | 603.1298 | -881.70061 | 109.59829 | 85.627567 | 0 |
| 34 | 13115 | 112.5 | 603.53625 | -907.06478 | 109.53046 | 85.574578 | 0 |
| 35 | 13115 | 113.5 | 603.94795 | -932.73602 | 108.9701 | 85.136774 | 0 |
| 36 | 13115 | 114.5 | 604.3648 | -958.7649 | 107.93828 | 84.330628 | 0 |
| 37 | 13115 | 115.5 | 604.7869 | -985.12691 | 106.40991 | 83.13653 | 0 |
| 38 | 13115 | 116.5 | 605.2143 | -1011.7268 | 104.41557 | 81.578382 | 0 |
| 39 | 13115 | 117.5 | 605.64695 | -1038.7441 | 101.9306 | 79.636915 | 0 |
| 40 | 13115 | 118.5 | 606.08495 | -1066.0805 | 98.967046 | 77.32153 | 0 |
| 41 | 13115 | 119.5 | 606.5283 | -1093.7316 | 95.509728 | 74.620377 | 0 |
| 42 | 13115 | 120.5 | 606.977 | -1121.7839 | 91.580149 | 71.550254 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 43 | 13115 | 121.5 | 607.43115 | -1150.1404 | 87.156902 | 68.094435 | 0 |
| 44 | 13115 | 122.5 | 607.8908 | -1178.7953 | 82.240646 | 64.253435 | 0 |
| 45 | 13115 | 123.5 | 608.35595 | -1207.8356 | 76.825951 | 60.023011 | 0 |
| 46 | 13115 | 124.5 | 608.8266 | -1237.1622 | 70.907255 | 55.398819 | 0 |
| 47 | 13115 | 125.5 | 609.3028 | -1266.8628 | 64.478599 | 50.376203 | 0 |
| 48 | 13115 | 126.5 | 609.7846 | -1296.9296 | 57.533026 | 44.949726 | 0 |
| 49 | 13115 | 127.5 | 610.27205 | -1327.3558 | 50.061147 | 39.112054 | 0 |
| 50 | 13115 | 128.4868 | 610.7586 | -1357.7005 | 23.09149 | 18.041049 | 0 |

Title: Sporn Fly Ash Disposal Facility
Comments: LEM - Location C (Exterior Toe)
Railway Induced Pseudo Static Analysis
Down Stream Deep Failure Surface
File Name: FAP_H-H_Slope-DS_Deep.gsz
Date: 5/4/2010
Horz Seismic Load: 0.046
Vert Seismic Load: 0.008



# SLOPE/W Analysis

Report generated using GeoStudio 2007, version 7.16.

## File Information

Title: Sporn Fly Ash Disposal Facility
Comments: LEM - Location C (Exterior Toe) Railway Induced Pseudo Static Analysis Down Stream Deep Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 174
Last Edited By: Roger Cecil
Date: 5/4/2010
Time: 8:59:09 PM
File Name: FAP_H-H_Slope-DS_Deep.gsz
Directory: P:\Frank\Philip Sporn\Final Analysis Files\LEM FAP_H-H GA\Deep\
Last Solved Date: 5/4/2010
Last Solved Time: 8:59:49 PM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

Description: Fly Ash Pond Section H-H Downstream Seismic Stability
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Apply Phreatic Correction: Yes
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line with B-bar

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1

Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Advanced
Number of Slices: 50
Optimization Tolerance: 0.05
Minimum Slip Surface Depth: 5 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

## Materials

### Silty Sand (1)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 18 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

### Silty Sand (2)

Model: Mohr-Coulomb
Unit Weight: 112 pcf
Unit Wt. Above Water Table: 107 pcf
Cohesion: 0.1 psf
Phi: 35 °
Phi-B: 18 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

### Gravelly Sand (3)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 105 pcf
Cohesion: 0.1 psf

Phi: 33 °
Phi-B: 17 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

### Silty Clay (4)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Unit Wt. Above Water Table: 115 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 17 °
Pore Water Pressure
Piezometric Line: 1
B-bar: 0
Add Weight: Yes

### Silty Sand (5)

Model: Mohr-Coulomb
Unit Weight: 131 pcf
Unit Wt. Above Water Table: 126 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 16 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

### Sandy Silt (6)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 14 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

### Fly Ash (7)

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Unit Wt. Above Water Table: 102 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 15 °
Pore Water Pressure

Piezometric Line: 1
B-bar: 0
Add Weight: Yes

### Rock Fill (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1
  Add Weight: No

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (31, 590) ft
Left-Zone Right Coordinate: (74, 590.96226) ft
Left-Zone Increment: 20
Right Projection: Range
Right-Zone Left Coordinate: (128, 611) ft
Right-Zone Right Coordinate: (159, 608) ft
Right-Zone Increment: 20
Radius Increments: 30

## Slip Surface Limits

Left Coordinate: (0, 593) ft
Right Coordinate: (310, 588) ft

## Piezometric Lines

### Piezometric Line 1

#### Coordinates

| | X (ft) | Y (ft) |
|---|---|---|
| | 0 | 589 |
| | 135 | 589 |
| | 146 | 605 |
| | 309 | 605 |

## Seismic Loads

Horz Seismic Load: 0.046
Vert Seismic Load: 0.008
Ignore seismic load in strength: No

## Regions

| | Material | Points | Area (ft²) |
|---|---|---|---|
| Region 1 | Sandy Silt (6) | 1,3,4,5,6,2 | 5355 |
| Region 2 | Silty Sand (5) | 7,8,4,3 | 2085 |
| Region 3 | Silty Sand (1) | 7,9,36,35,34,33,32,42,10,12,13,14,29,8 | 973.49995 |
| Region 4 | Silty Sand (2) | 11,37,38,39,16,12,10 | 420 |
| Region 5 | Silty Clay (4) | 16,17,18,19,20,13,12 | 134 |
| Region 6 | Gravelly Sand (3) | 41,17,16,39 | 148 |
| Region 7 | Silty Sand (2) | 19,20,23,24,22 | 51.5 |
| Region 8 | Silty Sand (1) | 40,26,21,18,17,41 | 19 |
| Region 9 | Silty Sand (2) | 13,20,23,24,14 | 324 |
| Region 10 | Gravelly Sand (3) | 21,27,28,22,19,18 | 121 |
| Region 11 | Fly Ash (7) | 30,31,6,5,4,8,29 | 2399 |
| Region 12 | Rock Fill (9) | 11,10,42,15,25,40,41,39,38,37 | 120.4339 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 555 |
| Point 2 | 310 | 555 |
| Point 3 | 0 | 576 |
| Point 4 | 218 | 576 |
| Point 5 | 248 | 561 |
| Point 6 | 310 | 561 |
| Point 7 | 0 | 586 |
| Point 8 | 199 | 586 |
| Point 9 | 0 | 590 |
| Point 10 | 76 | 591 |
| Point 11 | 82 | 592 |
| Point 12 | 137 | 591 |
| Point 13 | 139 | 591 |

| | | |
|---|---|---|
| Point 14 | 189 | 591 |
| Point 15 | 106 | 602 |
| Point 16 | 137 | 602 |
| Point 17 | 137 | 610 |
| Point 18 | 145 | 610 |
| Point 19 | 145 | 602 |
| Point 20 | 145 | 597 |
| Point 21 | 149 | 610 |
| Point 22 | 167 | 602 |
| Point 23 | 148 | 600 |
| Point 24 | 170 | 600 |
| Point 25 | 128 | 611 |
| Point 26 | 147 | 611 |
| Point 27 | 154 | 608 |
| Point 28 | 159 | 608 |
| Point 29 | 193 | 589 |
| Point 30 | 201 | 588 |
| Point 31 | 310 | 588 |
| Point 32 | 49.5 | 590.5 |
| Point 33 | 46.5 | 590.5 |
| Point 34 | 31 | 590 |
| Point 35 | 15.5 | 592 |
| Point 36 | 0 | 593 |
| Point 37 | 91 | 592 |
| Point 38 | 107 | 600 |
| Point 39 | 109 | 602 |
| Point 40 | 130 | 611 |
| Point 41 | 128 | 610 |
| Point 42 | 74 | 590.96226 |

## Critical Slip Surfaces

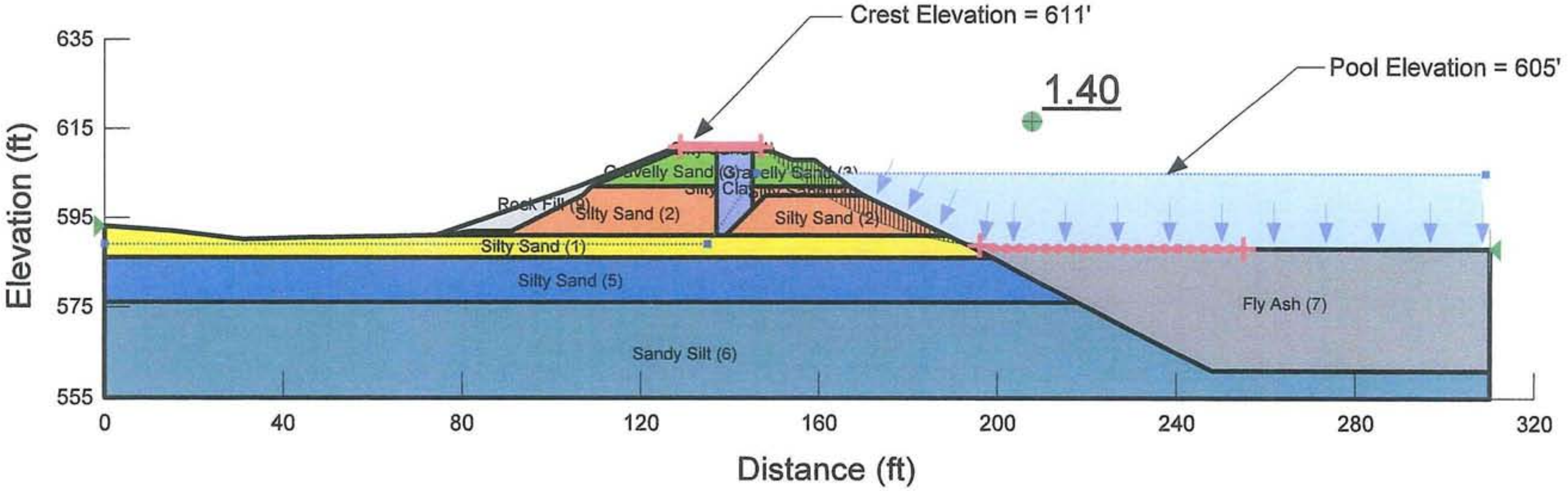
| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 3707 | 2.15 | (87.752, 644.982) | 71.424 | (149.834, 609.666) | (41.7475, 590.347) |

## Slices of Slip Surface: 3707

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 3707 | 42.57181 | 589.67335 | -42.016937 | 128.22302 | 86.487516 | 0.1 |
| 2 | 3707 | 44.94805 | 587.8375 | 72.540509 | 438.92526 | 247.12963 | 0.1 |
| 3 | 3707 | 46.98552 | 586.3375 | 166.14085 | 692.50159 | 355.0348 | 0.1 |
| 4 | 3707 | 48.48552 | 585.3322 | 228.87329 | 841.29336 | 367.9791 | 0.1 |
| 5 | 3707 | 50.59632 | 583.99645 | 312.22469 | 1067.9864 | 454.10746 | 0.1 |
| 6 | 3707 | 52.788965 | 582.7129 | 392.31539 | 1291.0025 | 539.98568 | 0.1 |
| 7 | 3707 | 54.98161 | 581.5311 | 466.03999 | 1496.9524 | 619.43465 | 0.1 |
| 8 | 3707 | 57.174255 | 580.44545 | 533.8145 | 1685.0684 | 691.74313 | 0.1 |
| 9 | 3707 | 59.3669 | 579.4511 | 595.85538 | 1854.7767 | 756.43623 | 0.1 |
| 10 | 3707 | 61.55954 | 578.544 | 652.46999 | 2005.6515 | 813.07349 | 0.1 |
| 11 | 3707 | 63.752185 | 577.7206 | 703.85237 | 2137.5016 | 861.42338 | 0.1 |
| 12 | 3707 | 65.94483 | 576.97785 | 750.18761 | 2250.3891 | 901.41201 | 0.1 |
| 13 | 3707 | 68.13747 | 576.31315 | 791.68019 | 2344.4311 | 932.98687 | 0.1 |
| 14 | 3707 | 70.425345 | 575.702 | 829.79748 | 2385.9527 | 792.90069 | 0.1 |
| 15 | 3707 | 72.80845 | 575.149 | 864.32154 | 2447.215 | 806.5245 | 0.1 |
| 16 | 3707 | 75 | 574.71255 | 891.5385 | 2530.2731 | 834.97696 | 0.1 |
| 17 | 3707 | 77 | 574.3788 | 912.38071 | 2636.0081 | 878.23204 | 0.1 |
| 18 | 3707 | 79 | 574.103 | 929.58977 | 2725.7976 | 915.21359 | 0.1 |
| 19 | 3707 | 81 | 573.88455 | 943.20604 | 2801.9924 | 947.09897 | 0.1 |
| 20 | 3707 | 83.125 | 573.71655 | 953.68065 | 2870.1339 | 976.48171 | 0.1 |
| 21 | 3707 | 85.375 | 573.60605 | 960.57874 | 2929.0877 | 1003.0054 | 0.1 |
| 22 | 3707 | 87.625 | 573.5666 | 963.06495 | 2973.4614 | 1024.3481 | 0.1 |
| 23 | 3707 | 89.875 | 573.59805 | 961.0861 | 3004.4047 | 1041.1228 | 0.1 |
| 24 | 3707 | 92.07143 | 573.6964 | 954.962 | 3018.3246 | 1051.3358 | 0.1 |
| 25 | 3707 | 94.214285 | 573.85865 | 944.84134 | 3016.9858 | 1055.8103 | 0.1 |
| 26 | 3707 | 96.35714 | 574.08605 | 930.61007 | 3006.4616 | 1057.6992 | 0.1 |
| 27 | 3707 | 98.5 | 574.3792 | 912.32289 | 2987.4365 | 1057.3232 | 0.1 |
| 28 | 3707 | 100.64287 | 574.73895 | 889.91216 | 2960.6975 | 1055.1179 | 0.1 |
| 29 | 3707 | 102.7857 | 575.1663 | 863.23977 | 2926.8126 | 1051.4429 | 0.1 |
| 30 | 3707 | 104.92855 | 575.6625 | 832.23791 | 2886.3114 | 1046.6027 | 0.1 |
| 31 | 3707 | 106.1352 | 575.964 | 813.43608 | 2862.6603 | 1044.1319 | 0.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 32 | 3707 | 106.6352 | 576.1 | 804.96132 | 2852.9756 | 1230.5711 | 0.1 |
| 33 | 3707 | 108 | 576.49565 | 780.26331 | 2823.0064 | 1227.4039 | 0.1 |
| 34 | 3707 | 110.05555 | 577.1383 | 740.19075 | 2775.9066 | 1223.1815 | 0.1 |
| 35 | 3707 | 112.16665 | 577.8693 | 694.5582 | 2725.2162 | 1220.1424 | 0.1 |
| 36 | 3707 | 114.27775 | 578.6756 | 644.25928 | 2668.559 | 1216.322 | 0.1 |
| 37 | 3707 | 116.38885 | 579.55995 | 589.06462 | 2605.857 | 1211.8111 | 0.1 |
| 38 | 3707 | 118.5 | 580.5255 | 528.81257 | 2536.9664 | 1206.6206 | 0.1 |
| 39 | 3707 | 120.61115 | 581.57605 | 463.25152 | 2461.5625 | 1200.7064 | 0.1 |
| 40 | 3707 | 122.72225 | 582.7159 | 392.12844 | 2379.203 | 1193.9549 | 0.1 |
| 41 | 3707 | 124.83335 | 583.95005 | 315.11755 | 2289.1474 | 1186.1168 | 0.1 |
| 42 | 3707 | 126.94445 | 585.2844 | 231.85487 | 2190.6886 | 1176.986 | 0.1 |
| 43 | 3707 | 129 | 586.68495 | 144.46122 | 2027.551 | 1270.1601 | 0.1 |
| 44 | 3707 | 131.05405 | 588.19625 | 50.156728 | 1846.0709 | 1211.3594 | 0.1 |
| 45 | 3707 | 133.31485 | 590 | -62.400122 | 1639.1079 | 1105.5922 | 0.1 |
| 46 | 3707 | 134.7608 | 591.20915 | -137.84979 | 1500.7346 | 1050.8256 | 0.1 |
| 47 | 3707 | 136 | 592.3347 | -37.654405 | 1411.3675 | 988.25014 | 0.1 |
| 48 | 3707 | 138.51345 | 594.7815 | -13.438985 | 1339.6938 | 837.1336 | 0.1 |
| 49 | 3707 | 141.2702 | 597.71975 | 8.0222125 | 1087.6773 | 674.64338 | 0.1 |
| 50 | 3707 | 143.75675 | 600.7 | 20.770424 | 841.01883 | 512.54809 | 0.1 |
| 51 | 3707 | 145.5 | 602.9595 | 26.301049 | 601.80565 | 373.73706 | 0.1 |
| 52 | 3707 | 146.4686 | 604.3233 | 42.226639 | 503.96304 | 299.85512 | 0.1 |
| 53 | 3707 | 146.9686 | 605.0466 | -2.9065669 | 436.09629 | 283.20424 | 0.1 |
| 54 | 3707 | 148 | 606.66555 | -103.92901 | 260.873 | 169.4129 | 0.1 |
| 55 | 3707 | 149.41725 | 608.95205 | -246.60938 | 21.756806 | 14.129035 | 0.1 |

Title: Sporn Fly Ash Disposal Facility
Comments: LEM - Location D (Crest)
Railway Induced Pseudo Static Analysis
Up Stream Shallow Failure Surface
File Name: FAP_H-H_Slope-US_Shallow.gsz
Date: 5/3/2010
Horz Seismic Load: 0.01
Vert Seismic Load: 0.003



# SLOPE/W Analysis

## File Information

Title: Sporn Fly Ash Disposal Facility
Comments: LEM - Location D (Crest) Railway Induced Pseudo Static Analysis Up Stream Shallow Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 177
Last Edited By: Seth Frank
Date: 5/3/2010
Time: 3:19:19 PM
File Name: FAP_H-H_Slope-US_Shallow.gsz
Directory: E:\Final Analysis Files\LEM FAP_H-H GA\Shallow\
Last Solved Date: 5/3/2010
Last Solved Time: 3:19:42 PM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

Description: Fly Ash Pond Section H-H Downstream Seismic Stability
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Apply Phreatic Correction: No
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: Piezometric Line with B-bar
SlipSurface
    Direction of movement: Left to Right
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: No
    Tension Crack

Tension Crack Option: (none)

FOS Distribution

FOS Calculation Option: Constant

Advanced

Number of Slices: 50

Optimization Tolerance: 0.05

Minimum Slip Surface Depth: 2 ft

Optimization Maximum Iterations: 2000

Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8

Ending Optimization Points: 16

Complete Passes per Insertion: 1

Driving Side Maximum Convex Angle: 5 °

Resisting Side Maximum Convex Angle: 1 °

## Materials

### Silty Sand (1)

Model: Mohr-Coulomb

Unit Weight: 130 pcf

Unit Wt. Above Water Table: 125 pcf

Cohesion: 0.1 psf

Phi: 34 °

Phi-B: 18 °

Pore Water Pressure

Piezometric Line: 1

Add Weight: Yes

### Silty Sand (2)

Model: Mohr-Coulomb

Unit Weight: 112 pcf

Unit Wt. Above Water Table: 107 pcf

Cohesion: 0.1 psf

Phi: 35 °

Phi-B: 18 °

Pore Water Pressure

Piezometric Line: 1

Add Weight: Yes

### Gravelly Sand (3)

Model: Mohr-Coulomb

Unit Weight: 110 pcf

Unit Wt. Above Water Table: 105 pcf

Cohesion: 0.1 psf

Phi: 33 °

Phi-B: 17 °

Pore Water Pressure

Piezometric Line: 1
Add Weight: Yes

## Silty Clay (4)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Unit Wt. Above Water Table: 115 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 17 °
Pore Water Pressure
  Piezometric Line: 1
  B-bar: 0
  Add Weight: Yes

## Silty Sand (5)

Model: Mohr-Coulomb
Unit Weight: 131 pcf
Unit Wt. Above Water Table: 126 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 16 °
Pore Water Pressure
  Piezometric Line: 1
  Add Weight: Yes

## Sandy Silt (6)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 14 °
Pore Water Pressure
  Piezometric Line: 1
  Add Weight: Yes

## Fly Ash (7)

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Unit Wt. Above Water Table: 102 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 15 °
Pore Water Pressure
  Piezometric Line: 1
  B-bar: 0
  Add Weight: Yes

### Rock Fill (9)

Model: Mohr-Coulomb

Unit Weight: 115 pcf

Cohesion: 0 psf

Phi: 38 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Add Weight: No

## Slip Surface Entry and Exit

Left Projection: Range

Left-Zone Left Coordinate: (128.79943, 611) ft

Left-Zone Right Coordinate: (147, 611) ft

Left-Zone Increment: 20

Right Projection: Range

Right-Zone Left Coordinate: (196.12179, 588.60978) ft

Right-Zone Right Coordinate: (255, 588) ft

Right-Zone Increment: 20

Radius Increments: 30

## Slip Surface Limits

Left Coordinate: (0, 593) ft

Right Coordinate: (310, 588) ft

## Piezometric Lines

### Piezometric Line 1

Coordinates

| | X (ft) | Y (ft) |
|---|---|---|
| | 0 | 589 |
| | 135 | 589 |
| | 146 | 605 |
| | 309 | 605 |

## Seismic Loads

Horz Seismic Load: 0.01

Vert Seismic Load: 0.003

Ignore seismic load in strength: No

## Regions

| | Material | Points | Area (ft²) |
|---|---|---|---|
| Region 1 | Sandy Silt (6) | 1,3,4,5,6,2 | 5355 |
| Region 2 | Silty Sand (5) | 7,8,4,3 | 2085 |
| Region 3 | Silty Sand (1) | 7,9,36,35,34,33,32,42,10,12,13,14,29,8 | 973.49995 |
| Region 4 | Silty Sand (2) | 11,37,38,39,16,12,10 | 420 |
| Region 5 | Silty Clay (4) | 16,17,18,19,20,13,12 | 134 |
| Region 6 | Gravelly Sand (3) | 41,17,16,39 | 148 |
| Region 7 | Silty Sand (2) | 19,20,23,24,22 | 51.5 |
| Region 8 | Silty Sand (1) | 40,26,21,18,17,41 | 19 |
| Region 9 | Silty Sand (2) | 13,20,23,24,14 | 324 |
| Region 10 | Gravelly Sand (3) | 21,27,28,22,19,18 | 121 |
| Region 11 | Fly Ash (7) | 30,31,6,5,4,8,29 | 2399 |
| Region 12 | Rock Fill (9) | 11,10,42,15,25,40,41,39,38,37 | 120.4339 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 555 |
| Point 2 | 310 | 555 |
| Point 3 | 0 | 576 |
| Point 4 | 218 | 576 |
| Point 5 | 248 | 561 |
| Point 6 | 310 | 561 |
| Point 7 | 0 | 586 |
| Point 8 | 199 | 586 |
| Point 9 | 0 | 590 |
| Point 10 | 76 | 591 |
| Point 11 | 82 | 592 |
| Point 12 | 137 | 591 |
| Point 13 | 139 | 591 |
| Point 14 | 189 | 591 |
| Point 15 | 106 | 602 |
| Point 16 | 137 | 602 |
| Point 17 | 137 | 610 |
| Point 18 | 145 | 610 |
| Point 19 | 145 | 602 |
| Point 20 | 145 | 597 |
| Point 21 | 149 | 610 |
| Point 22 | 167 | 602 |
| Point 23 | 148 | 600 |
| Point 24 | 170 | 600 |
| Point 25 | 128 | 611 |
| Point 26 | 147 | 611 |
| Point 27 | 154 | 608 |
| Point 28 | 159 | 608 |
| Point 29 | 193 | 589 |

| | | |
|---|---|---|
| Point 30 | 201 | 588 |
| Point 31 | 310 | 588 |
| Point 32 | 49.5 | 590.5 |
| Point 33 | 46.5 | 590.5 |
| Point 34 | 31 | 590 |
| Point 35 | 15.5 | 592 |
| Point 36 | 0 | 593 |
| Point 37 | 91 | 592 |
| Point 38 | 107 | 600 |
| Point 39 | 109 | 602 |
| Point 40 | 130 | 611 |
| Point 41 | 128 | 610 |
| Point 42 | 74 | 590.96226 |

## Critical Slip Surfaces

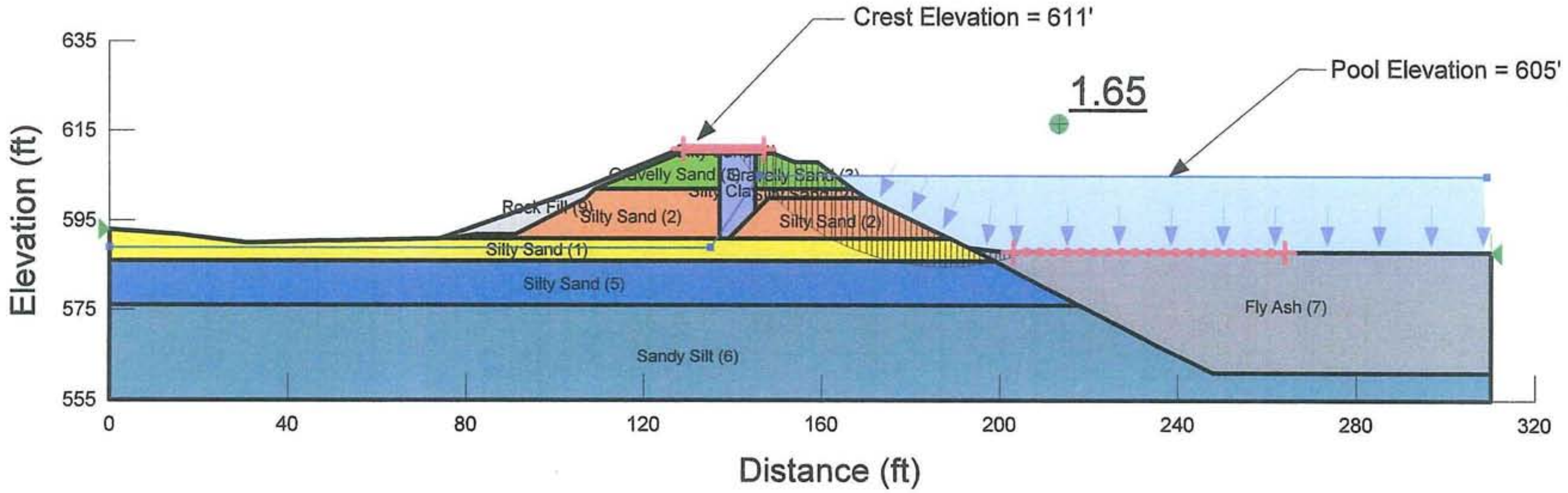
| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 13028 | 1.40 | (204.098, 671.188) | 82.963 | (147, 611) | (196.122, 588.61) |

### Slices of Slip Surface: 13028

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 13028 | 147.5365 | 610.5 | -343.19715 | -30.175059 | -20.353334 | 0.1 |
| 2 | 13028 | 148.5365 | 609.58195 | -285.91432 | 14.03658 | 9.1154618 | 0.1 |
| 3 | 13028 | 149.5 | 608.72685 | -232.55814 | 51.277534 | 33.30002 | 0.1 |
| 4 | 13028 | 150.5 | 607.8666 | -178.87401 | 94.005221 | 61.047704 | 0.1 |
| 5 | 13028 | 151.5 | 607.03345 | -126.88622 | 133.96983 | 87.001023 | 0.1 |
| 6 | 13028 | 152.5 | 606.22635 | -76.524084 | 171.36208 | 111.28384 | 0.1 |
| 7 | 13028 | 153.5 | 605.4444 | -27.730185 | 206.35975 | 134.01159 | 0.1 |
| 8 | 13028 | 154.03935 | 605.0298 | -1.8588825 | 225.75979 | 146.61012 | 0.1 |
| 9 | 13028 | 154.60865 | 604.6061 | 24.578507 | 265.20888 | 156.26719 | 0.1 |
| 10 | 13028 | 155.6685 | 603.8312 | 72.931996 | 337.71708 | 171.95344 | 0.1 |
| 11 | 13028 | 156.72835 | 603.08165 | 119.70686 | 407.60287 | 186.96185 | 0.1 |
| 12 | 13028 | 157.7882 | 602.35655 | 164.9538 | 475.17277 | 201.45856 | 0.1 |
| 13 | 13028 | 158.65905 | 601.7768 | 201.12602 | 525.40369 | 227.06167 | 0.1 |
| 14 | 13028 | 159.41575 | 601.28785 | 231.64015 | 547.73509 | 221.33205 | 0.1 |
| 15 | 13028 | 160.2473 | 600.7632 | 264.38225 | 548.97753 | 199.27576 | 0.1 |
| 16 | 13028 | 161.07885 | 600.25215 | 296.26437 | 548.61144 | 176.69532 | 0.1 |
| 17 | 13028 | 161.87095 | 599.77745 | 325.89129 | 546.85741 | 154.72214 | 0.1 |
| 18 | 13028 | 162.62365 | 599.33765 | 353.32741 | 543.91963 | 133.45411 | 0.1 |
| 19 | 13028 | 163.5 | 598.83985 | 384.39468 | 558.50512 | 121.91344 | 0.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 20 | 13028 | 164.5 | 598.2877 | 418.84849 | 591.13305 | 120.63495 | 0.1 |
| 21 | 13028 | 165.5 | 597.7533 | 452.19169 | 623.0836 | 119.6598 | 0.1 |
| 22 | 13028 | 166.5 | 597.2363 | 484.45297 | 654.31058 | 118.93558 | 0.1 |
| 23 | 13028 | 167.5 | 596.7363 | 515.65617 | 682.01337 | 116.48457 | 0.1 |
| 24 | 13028 | 168.5 | 596.253 | 545.8124 | 712.06628 | 116.41222 | 0.1 |
| 25 | 13028 | 169.5 | 595.78605 | 574.95324 | 741.11608 | 116.34847 | 0.1 |
| 26 | 13028 | 170.49315 | 595.3381 | 602.90384 | 758.95063 | 109.26514 | 0.1 |
| 27 | 13028 | 171.47945 | 594.90875 | 629.69665 | 790.25307 | 112.42282 | 0.1 |
| 28 | 13028 | 172.46575 | 594.4945 | 655.5461 | 820.50816 | 115.50768 | 0.1 |
| 29 | 13028 | 173.45205 | 594.09505 | 680.46939 | 849.63515 | 118.45114 | 0.1 |
| 30 | 13028 | 174.4384 | 593.7102 | 704.47954 | 877.53867 | 121.17731 | 0.1 |
| 31 | 13028 | 175.42475 | 593.33975 | 727.59845 | 904.1203 | 123.60193 | 0.1 |
| 32 | 13028 | 176.41105 | 592.9835 | 749.82319 | 929.25547 | 125.63984 | 0.1 |
| 33 | 13028 | 177.39735 | 592.6413 | 771.17943 | 952.81749 | 127.18434 | 0.1 |
| 34 | 13028 | 178.38365 | 592.3129 | 791.67807 | 974.6444 | 128.1144 | 0.1 |
| 35 | 13028 | 179.36995 | 591.9981 | 811.31851 | 994.69554 | 128.40198 | 0.1 |
| 36 | 13028 | 180.35625 | 591.6968 | 830.11371 | 1012.7603 | 127.89051 | 0.1 |
| 37 | 13028 | 181.34255 | 591.40885 | 848.08741 | 1028.7145 | 126.47645 | 0.1 |
| 38 | 13028 | 182.3289 | 591.1341 | 865.23325 | 1042.432 | 124.07591 | 0.1 |
| 39 | 13028 | 183.3369 | 590.86695 | 881.90188 | 1056.4205 | 117.71428 | 0.1 |
| 40 | 13028 | 184.36655 | 590.6078 | 898.07627 | 1069.9223 | 115.9116 | 0.1 |
| 41 | 13028 | 185.3962 | 590.3626 | 913.37461 | 1080.3691 | 112.63923 | 0.1 |
| 42 | 13028 | 186.42585 | 590.13125 | 927.81285 | 1087.7322 | 107.86693 | 0.1 |
| 43 | 13028 | 187.4555 | 589.91355 | 941.39799 | 1091.9848 | 101.57205 | 0.1 |
| 44 | 13028 | 188.48515 | 589.70945 | 954.12967 | 1092.9139 | 93.611146 | 0.1 |
| 45 | 13028 | 189.5 | 589.52145 | 965.86015 | 1087.9548 | 82.3539 | 0.1 |
| 46 | 13028 | 190.5 | 589.349 | 976.62053 | 1072.2988 | 64.535795 | 0.1 |
| 47 | 13028 | 191.5 | 589.1891 | 986.60417 | 1053.44 | 45.081327 | 0.1 |
| 48 | 13028 | 192.5 | 589.0417 | 995.82342 | 1031.5689 | 24.110628 | 0.1 |
| 49 | 13028 | 193.0395 | 588.9658 | 1000.5375 | 1001.8541 | 0.88805506 | 0.1 |
| 50 | 13028 | 193.58615 | 588.8957 | 1004.8988 | 1006.0724 | 0.59798134 | 0.1 |
| 51 | 13028 | 194.6004 | 588.77245 | 1012.5734 | 1013.9447 | 0.69868901 | 0.1 |
| 52 | 13028 | 195.61465 | 588.6619 | 1019.5225 | 1020.1109 | 0.29983991 | 0.1 |

Title: Sporn Fly Ash Disposal Facility
Comments: LEM - Location D (Crest)
Railway Induced Pseudo Static Analysis
Up Stream Deep Failure Surface
File Name: FAP_H-H_Slope-US_Deep.gsz
Date: 5/4/2010
Horz Seismic Load: 0.01
Vert Seismic Load: 0.003



# SLOPE/W Analysis

## File Information

Title: Sporn Fly Ash Disposal Facility
Comments: LEM - Location D (Crest) Railway Induced Pseudo Static Analysis Up Stream Deep Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 179
Last Edited By: Jeff Gateley
Date: 5/4/2010
Time: 2:51:09 PM
File Name: FAP_H-H_Slope-US_Deep.gsz
Directory: P:\Frank\Philip Sporn\Final Analysis Files\LEM FAP_H-H GA\Deep\
Last Solved Date: 5/4/2010
Last Solved Time: 2:54:56 PM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

Description: Fly Ash Pond Section H-H Downstream Seismic Stability
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Apply Phreatic Correction: No
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line with B-bar

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1

Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Advanced
Number of Slices: 50
Optimization Tolerance: 0.05
Minimum Slip Surface Depth: 15 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

# Materials

## Silty Sand (1)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 18 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Silty Sand (2)

Model: Mohr-Coulomb
Unit Weight: 112 pcf
Unit Wt. Above Water Table: 107 pcf
Cohesion: 0.1 psf
Phi: 35 °
Phi-B: 18 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: Yes

## Gravelly Sand (3)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 105 pcf
Cohesion: 0.1 psf

Phi: 33 °
Phi-B: 17 °
Pore Water Pressure
  Piezometric Line: 1
  Add Weight: Yes

## Silty Clay (4)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Unit Wt. Above Water Table: 115 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 17 °
Pore Water Pressure
  Piezometric Line: 1
  B-bar: 0
  Add Weight: Yes

## Silty Sand (5)

Model: Mohr-Coulomb
Unit Weight: 131 pcf
Unit Wt. Above Water Table: 126 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 16 °
Pore Water Pressure
  Piezometric Line: 1
  Add Weight: Yes

## Sandy Silt (6)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 14 °
Pore Water Pressure
  Piezometric Line: 1
  Add Weight: Yes

## Fly Ash (7)

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Unit Wt. Above Water Table: 102 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 15 °
Pore Water Pressure

Piezometric Line: 1
B-bar: 0
Add Weight: Yes

### Rock Fill (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Add Weight: No

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (128.79943, 611) ft
Left-Zone Right Coordinate: (147, 611) ft
Left-Zone Increment: 20
Right Projection: Range
Right-Zone Left Coordinate: (203, 588) ft
Right-Zone Right Coordinate: (264, 588) ft
Right-Zone Increment: 20
Radius Increments: 30

## Slip Surface Limits

Left Coordinate: (0, 593) ft
Right Coordinate: (310, 588) ft

## Piezometric Lines

### Piezometric Line 1

**Coordinates**

| | X (ft) | Y (ft) |
|---|---|---|
| | 0 | 589 |
| | 135 | 589 |
| | 146 | 605 |
| | 309 | 605 |

## Seismic Loads

Horz Seismic Load: 0.01
Vert Seismic Load: 0.003
Ignore seismic load in strength: No

## Regions

| | Material | Points | Area (ft²) |
|---|---|---|---|
| Region 1 | Sandy Silt (6) | 1,3,4,5,6,2 | 5355 |
| Region 2 | Silty Sand (5) | 7,8,4,3 | 2085 |
| Region 3 | Silty Sand (1) | 7,9,36,35,34,33,32,42,10,12,13,14,29,8 | 973.49995 |
| Region 4 | Silty Sand (2) | 11,37,38,39,16,12,10 | 420 |
| Region 5 | Silty Clay (4) | 16,17,18,19,20,13,12 | 134 |
| Region 6 | Gravelly Sand (3) | 41,17,16,39 | 148 |
| Region 7 | Silty Sand (2) | 19,20,23,24,22 | 51.5 |
| Region 8 | Silty Sand (1) | 40,26,21,18,17,41 | 19 |
| Region 9 | Silty Sand (2) | 13,20,23,24,14 | 324 |
| Region 10 | Gravelly Sand (3) | 21,27,28,22,19,18 | 121 |
| Region 11 | Fly Ash (7) | 30,31,6,5,4,8,29 | 2399 |
| Region 12 | Rock Fill (9) | 11,10,42,15,25,40,41,39,38,37 | 120.4339 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 555 |
| Point 2 | 310 | 555 |
| Point 3 | 0 | 576 |
| Point 4 | 218 | 576 |
| Point 5 | 248 | 561 |
| Point 6 | 310 | 561 |
| Point 7 | 0 | 586 |
| Point 8 | 199 | 586 |
| Point 9 | 0 | 590 |
| Point 10 | 76 | 591 |
| Point 11 | 82 | 592 |
| Point 12 | 137 | 591 |
| Point 13 | 139 | 591 |

| | | |
|---|---|---|
| Point 14 | 189 | 591 |
| Point 15 | 106 | 602 |
| Point 16 | 137 | 602 |
| Point 17 | 137 | 610 |
| Point 18 | 145 | 610 |
| Point 19 | 145 | 602 |
| Point 20 | 145 | 597 |
| Point 21 | 149 | 610 |
| Point 22 | 167 | 602 |
| Point 23 | 148 | 600 |
| Point 24 | 170 | 600 |
| Point 25 | 128 | 611 |
| Point 26 | 147 | 611 |
| Point 27 | 154 | 608 |
| Point 28 | 159 | 608 |
| Point 29 | 193 | 589 |
| Point 30 | 201 | 588 |
| Point 31 | 310 | 588 |
| Point 32 | 49.5 | 590.5 |
| Point 33 | 46.5 | 590.5 |
| Point 34 | 31 | 590 |
| Point 35 | 15.5 | 592 |
| Point 36 | 0 | 593 |
| Point 37 | 91 | 592 |
| Point 38 | 107 | 600 |
| Point 39 | 109 | 602 |
| Point 40 | 130 | 611 |
| Point 41 | 128 | 610 |
| Point 42 | 74 | 590.96226 |

## Critical Slip Surfaces

| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 8510 | 1.65 | (187.536, 639.88) | 55.084 | (140.63, 611) | (206.05, 588) |

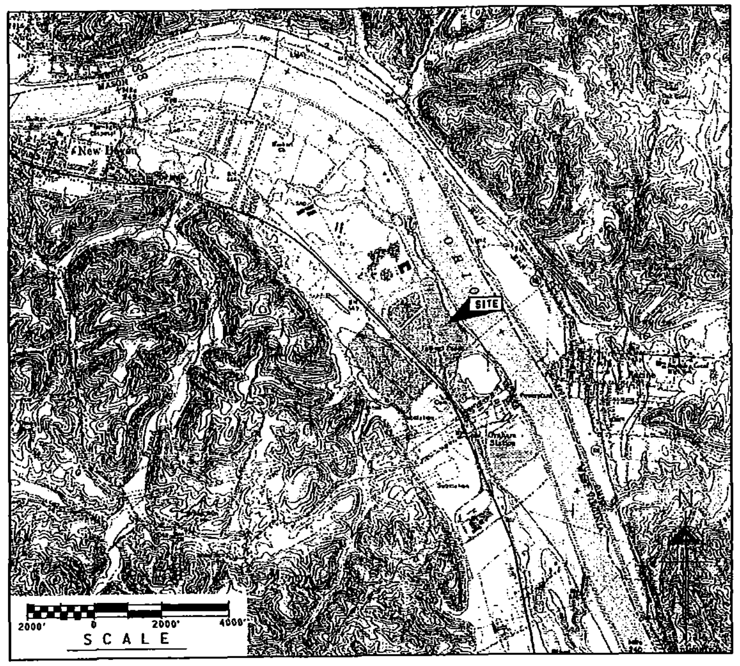
## Slices of Slip Surface: 8510

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 8510 | 140.9451 | 610.5 | -802.00234 | -113.56639 | -76.601495 | 0.1 |
| 2 | 8510 | 141.88365 | 609.07625 | -627.95384 | 39.013006 | 24.378032 | 0.1 |
| 3 | 8510 | 143.1302 | 607.30295 | -404.17672 | 219.3324 | 137.05409 | 0.1 |
| 4 | 8510 | 144.37675 | 605.6671 | -188.96038 | 387.13008 | 241.90572 | 0.1 |
| 5 | 8510 | 145.25175 | 604.5793 | -41.663951 | 457.33477 | 296.99667 | 0.1 |
| 6 | 8510 | 145.75175 | 603.98875 | 40.570403 | 522.49304 | 312.96422 | 0.1 |
| 7 | 8510 | 146.5 | 603.1412 | 115.98706 | 613.18593 | 322.88472 | 0.1 |
| 8 | 8510 | 147.272 | 602.29135 | 169.01833 | 684.56624 | 334.80073 | 0.1 |
| 9 | 8510 | 148.272 | 601.25985 | 233.38425 | 732.56457 | 349.52982 | 0.1 |
| 10 | 8510 | 149.269 | 600.25985 | 295.78462 | 792.31508 | 347.67437 | 0.1 |
| 11 | 8510 | 150.2817 | 599.317 | 354.62166 | 856.026 | 351.0871 | 0.1 |
| 12 | 8510 | 151.76905 | 597.9989 | 436.87104 | 942.98866 | 354.38737 | 0.1 |
| 13 | 8510 | 153.25635 | 596.7724 | 513.4041 | 1021.009 | 355.42881 | 0.1 |
| 14 | 8510 | 154.625 | 595.71525 | 579.3671 | 1105.5175 | 368.41445 | 0.1 |
| 15 | 8510 | 155.875 | 594.81045 | 635.82691 | 1199.188 | 394.46969 | 0.1 |
| 16 | 8510 | 157.125 | 593.9575 | 689.07879 | 1289.1796 | 420.19514 | 0.1 |
| 17 | 8510 | 158.375 | 593.15355 | 739.21397 | 1375.88 | 445.79834 | 0.1 |
| 18 | 8510 | 159.7847 | 592.30575 | 792.13196 | 1420.906 | 440.2723 | 0.1 |
| 19 | 8510 | 161.35405 | 591.424 | 847.11604 | 1421.3902 | 402.11109 | 0.1 |
| 20 | 8510 | 162.56935 | 590.781 | 887.26565 | 1423.0777 | 361.40978 | 0.1 |
| 21 | 8510 | 163.66665 | 590.24145 | 920.92981 | 1448.6141 | 355.92758 | 0.1 |
| 22 | 8510 | 165 | 589.62195 | 959.59071 | 1497.1449 | 362.58489 | 0.1 |
| 23 | 8510 | 166.33335 | 589.04495 | 995.59413 | 1542.1568 | 368.66119 | 0.1 |
| 24 | 8510 | 167.75 | 588.4782 | 1030.9868 | 1585.1477 | 373.78623 | 0.1 |
| 25 | 8510 | 169.25 | 587.9255 | 1065.4635 | 1629.0404 | 380.13742 | 0.1 |
| 26 | 8510 | 170.60805 | 587.46515 | 1094.2077 | 1661.7746 | 382.82872 | 0.1 |
| 27 | 8510 | 171.8241 | 587.0878 | 1117.6896 | 1698.4847 | 391.75122 | 0.1 |
| 28 | 8510 | 173.04015 | 586.74095 | 1139.3909 | 1731.9345 | 399.67569 | 0.1 |
| 29 | 8510 | 174.2562 | 586.42405 | 1159.114 | 1761.9746 | 406.63461 | 0.1 |
| 30 | 8510 | 175.47225 | 586.1365 | 1177.0624 | 1788.5412 | 412.44761 | 0.1 |
| 31 | 8510 | 176.7263 | 585.8707 | 1193.6909 | 1813.7605 | 372.57541 | 0.1 |

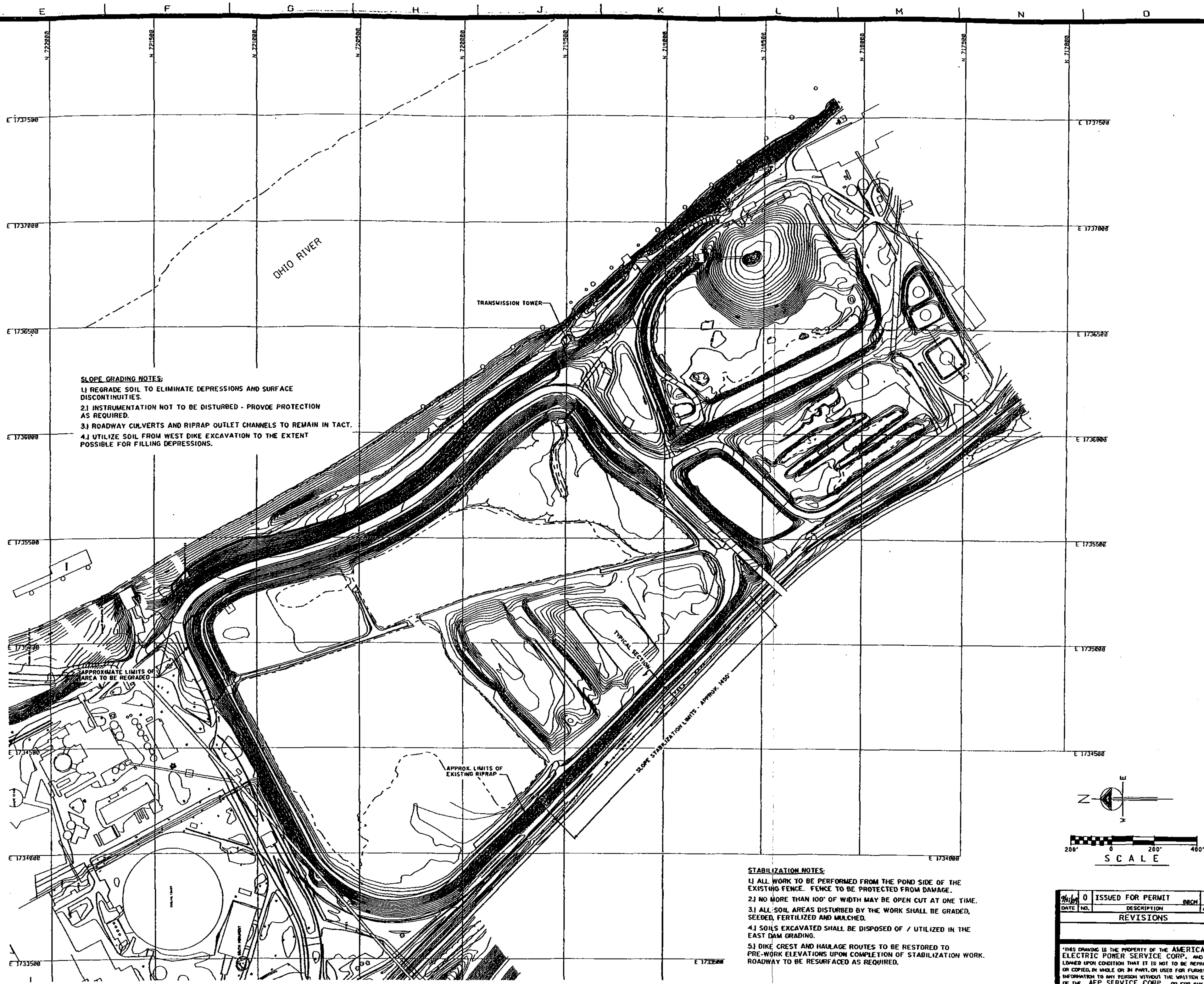
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 32 | 8510 | 178.01825 | 585.62805 | 1208.8111 | 1833.3432 | 375.25674 | 0.1 |
| 33 | 8510 | 179.3102 | 585.41715 | 1222.0051 | 1848.1995 | 376.25555 | 0.1 |
| 34 | 8510 | 180.6022 | 585.23765 | 1233.1734 | 1858.2066 | 375.55778 | 0.1 |
| 35 | 8510 | 181.8942 | 585.08915 | 1242.4536 | 1863.103 | 372.92375 | 0.1 |
| 36 | 8510 | 183.18615 | 584.97145 | 1249.7512 | 1862.5513 | 368.20747 | 0.1 |
| 37 | 8510 | 184.4781 | 584.88435 | 1255.2117 | 1856.3872 | 361.22266 | 0.1 |
| 38 | 8510 | 185.7701 | 584.8277 | 1258.7476 | 1844.3736 | 351.87956 | 0.1 |
| 39 | 8510 | 187.06205 | 584.8014 | 1260.3549 | 1826.2144 | 340.00265 | 0.1 |
| 40 | 8510 | 188.354 | 584.8054 | 1260.1075 | 1801.7788 | 325.46896 | 0.1 |
| 41 | 8510 | 189.66665 | 584.8408 | 1257.9328 | 1765.3028 | 304.85864 | 0.1 |
| 42 | 8510 | 191 | 584.9086 | 1253.6883 | 1711.4803 | 275.06917 | 0.1 |
| 43 | 8510 | 192.33335 | 585.0089 | 1247.4419 | 1650.0812 | 241.93006 | 0.1 |
| 44 | 8510 | 193.59925 | 585.13355 | 1239.6965 | 1561.2314 | 193.19764 | 0.1 |
| 45 | 8510 | 194.7977 | 585.2796 | 1230.517 | 1510.9958 | 168.52867 | 0.1 |
| 46 | 8510 | 195.99615 | 585.45245 | 1219.7787 | 1455.4233 | 141.58961 | 0.1 |
| 47 | 8510 | 197.1946 | 585.65235 | 1207.3312 | 1394.5468 | 112.49049 | 0.1 |
| 48 | 8510 | 198.39305 | 585.87955 | 1193.1114 | 1328.3335 | 81.249589 | 0.1 |
| 49 | 8510 | 199.49555 | 586.11195 | 1178.6463 | 1277.5618 | 50.399973 | 0.1 |
| 50 | 8510 | 200.4994 | 586.3451 | 1164.0753 | 1247.5633 | 42.539267 | 0.1 |
| 51 | 8510 | 201.63125 | 586.6334 | 1146.1081 | 1209.2788 | 32.187085 | 0.1 |
| 52 | 8510 | 202.89375 | 586.9838 | 1124.1912 | 1171.5808 | 24.146215 | 0.1 |
| 53 | 8510 | 204.15625 | 587.36685 | 1100.3434 | 1130.0212 | 15.121585 | 0.1 |
| 54 | 8510 | 205.41875 | 587.7833 | 1074.3126 | 1084.5763 | 5.229594 | 0.1 |

# FLY ASH DISPOSAL FACILITY
# SECTION H-H
# LEM SLOPE STABILITY ANALYSES
# FOR SHALLOW SLOUGHING ASSESSMENT

DWG. NO. 5-30075



LOCATION MAP



SLOPE GRADING NOTES;

1.) REGRADE SOIL TO ELIMINATE DEPRESSIONS AND SURFACE DISCONTINUITIES.

2.) INSTRUMENTATION NOT TO BE DISTURBED - PROVDE PROTECTION AS REQUIRED.

3.) ROADWAY CULVERTS AND RIPRAP OUTLET CHANNELS TO REMAIN IN TACT.

4.) UTILIZE SOIL FROM WEST DIKE EXCAVATION TO THE EXTENT POSSIBLE FOR FILLING DEPRESSIONS.

STABILIZATION NOTES:

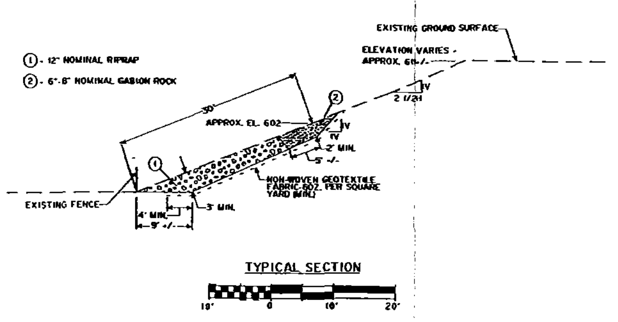
1.) ALL WORK TO BE PERFORMED FROM THE POND SIDE OF THE EXISTING FENCE. FENCE TO BE PROTECTED FROM DAMAGE.

2.) NO MORE THAN 100' OF WIDTH MAY BE OPEN CUT AT ONE TIME.

3.) ALL SOIL AREAS DISTURBED BY THE WORK SHALL BE GRADED, SEEDED, FERTILIZED AND MULCHED.

4.) SOILS EXCAVATED SHALL BE DISPOSED OF / UTILIZED IN THE EAST DAM GRADING.

5.) DIKE CREST AND HAULAGE ROUTES TO BE RESTORED TO PRE-WORK ELEVATIONS UPON COMPLETION OF STABILIZATION WORK. ROADWAY TO BE RESURFACED AS REQUIRED.



TYPICAL SECTION

| DATE | NO. | DESCRIPTION | | APPD. |
|---|---|---|---|---|
| 9/21/09 | 0 | ISSUED FOR PERMIT | BBCH | RJA |

REVISIONS

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APPALACHIAN POWER COMPANY

PHILIP SPORN PLANT

GRAHAM STATION W. VA.

UNIT 5 FLY ASH POND MODIFICATIONS

DWG. NO. 5-30075-0

| ARCH | — | ELEC | — | MECH | — | STR | GS |
|---|---|---|---|---|---|---|---|

SCALE: 1"=200'
DR:
CK: T.H.
SGD SUPV:
DATE: 9/21/09

APPROVED BY: CIVIL ENGINEERING DIVISION Thomas R. Zelina

AEP AMERICAN ELECTRIC POWER
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

9/21/09

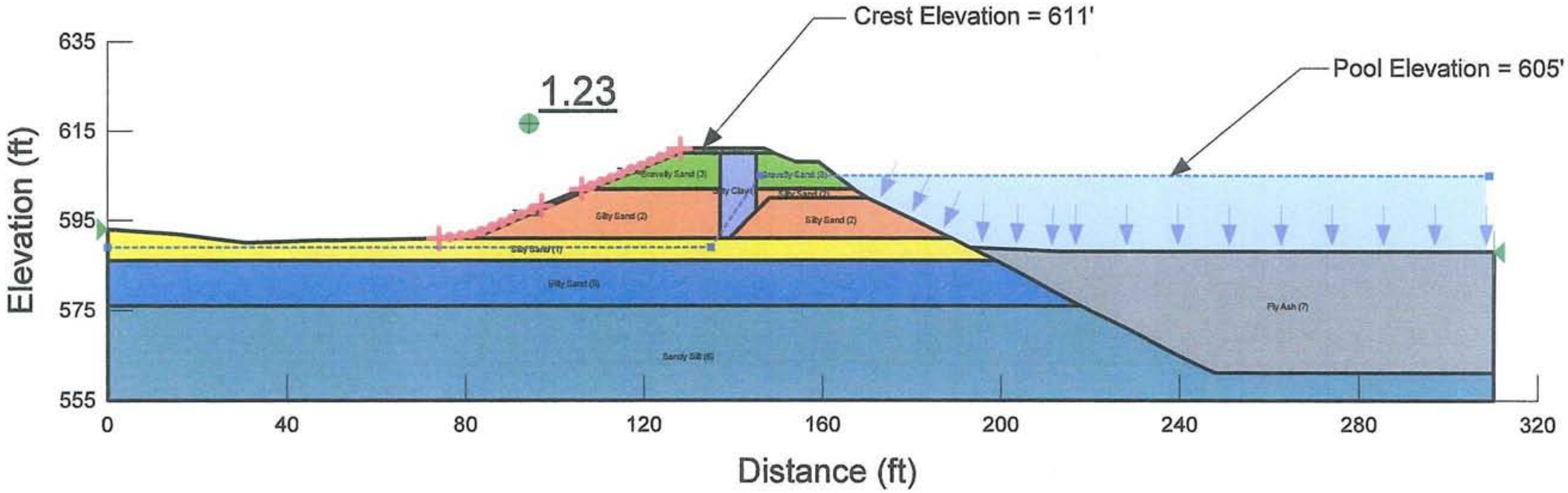
NOTE: THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS

HENDERSON AERIAL SURVEYS INC.
3889 GROVE CITY RD. GROVE CITY, OHIO 43123
JOB NO.: 42140 NAME: SPORN PLANT
NAD27/NAVD29 WV South
SCALE: 1"=100' AERIAL PHOTOGRAPHY EXPOSED: 05.22.07
CONTOUR INTERVAL two(2)foot SHEET: 1 OF 1

NOTE: CONTOURS INSIDE TREE LINES SHOULD BE CONSIDERED AS GROUND OBSCURED

DRAWING IS IN US SURVEY FEET

Title: Sporn Fly Ash Disposal Facility Western Dike Section H-H
Comments: Shallow Sloughing Assessment
Moist Topsoil Material (Condition 1)
File Name: Sporn FADF-Shallow Sloughing Assessment for Section H-H Condition 1.gsz
Date: 5/4/2010
Horz Seismic Load: 0
Vert Seismic Load: 0



# SLOPE/W Analysis

Report generated using GeoStudio 2007, version 7.16. Copyright © 1991-2010 GEO-SLOPE International Ltd.

## File Information

Title: Sporn Fly Ash Disposal Facility Western Dike Section H-H
Comments: Shallow Sloughing Assessment Moist Topsoil Material (Condition 1)
Created By: Roger W. Cecil, P.E.
Revision Number: 183
Last Edited By: Roger Cecil
Date: 5/4/2010
Time: 9:02:42 AM
File Name: Sporn FADF-Shallow Sloughing Assessment for Section H-H Condition 1.gsz
Directory: C:\Working Folder\Sporn\VIBRATION ASSESSMENT\
Last Solved Date: 5/4/2010
Last Solved Time: 9:02:50 AM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

Description: Shallow Sloughing Assessment
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
  Apply Phreatic Correction: No
  Side Function
    Interslice force function option: Half-Sine
  PWP Conditions Source: Piezometric Line
  Use Staged Rapid Drawdown: No
Slip Surface
  Direction of movement: Right to Left
  Use Passive Mode: No
  Slip Surface Option: Entry and Exit
  Critical slip surfaces saved: 1

Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Advanced
Number of Slices: 50
Optimization Tolerance: 0.05
Minimum Slip Surface Depth: 0.5 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

# Materials

## Silty Sand (1)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Silty Sand (2)

Model: Mohr-Coulomb
Unit Weight: 112 pcf
Unit Wt. Above Water Table: 107 pcf
Cohesion: 0.1 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Gravelly Sand (3)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 105 pcf
Cohesion: 0.1 psf
Phi: 33 °
Phi-B: 0 °

Pore Water Pressure
Piezometric Line: 1

## Silty Clay (4)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Unit Wt. Above Water Table: 115 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Silty Sand (5)

Model: Mohr-Coulomb
Unit Weight: 131 pcf
Unit Wt. Above Water Table: 126 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Sandy Silt (6)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Fly Ash (7)

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Unit Wt. Above Water Table: 102 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Topsoil

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0 psf

Phi: 27 °
Phi-B: 0 °

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (74, 591) ft
Left-Zone Right Coordinate: (96.98653, 598.24439) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (105.97741, 601.99059) ft
Right-Zone Right Coordinate: (128, 611) ft
Right-Zone Increment: 10
Radius Increments: 10

## Slip Surface Limits

Left Coordinate: (0, 593) ft
Right Coordinate: (310, 588) ft

## Piezometric Lines

### Piezometric Line 1

Coordinates

| | X (ft) | Y (ft) |
|---|---|---|
| | 0 | 589 |
| | 135 | 589 |
| | 146 | 605 |
| | 309 | 605 |

## Seismic Loads

Horz Seismic Load: 0
Vert Seismic Load: 0

## Regions

| | Material | Points | Area (ft$^2$) |
|---|---|---|---|
| Region 1 | Sandy Silt (6) | 1,3,4,5,6,2 | 5355 |
| Region 2 | Silty Sand (5) | 7,8,4,3 | 2085 |

| | | | |
|---|---|---|---|
| Region 3 | Silty Sand (1) | 7,9,36,35,34,33,32,10,41,12,13,14,42,8 | 974 |
| Region 4 | Silty Sand (2) | 40,39,16,12,41 | 467 |
| Region 5 | Silty Clay (4) | 16,17,18,19,20,13,12 | 134 |
| Region 6 | Gravelly Sand (3) | 38,17,16,39 | 152 |
| Region 7 | Silty Sand (2) | 19,20,24,25,23 | 51.5 |
| Region 8 | Silty Sand (1) | 37,27,22,18,17,38 | 19 |
| Region 9 | Silty Sand (2) | 13,20,24,25,14 | 324 |
| Region 10 | Gravelly Sand (3) | 22,28,29,23,19,18 | 121 |
| Region 11 | Fly Ash (7) | 30,31,6,5,4,8,42 | 2405.5 |
| Region 12 | Topsoil | 38,21,26,37 | 2 |
| Region 13 | Topsoil | 21,38,39,15 | 16 |
| Region 14 | Topsoil | 39,40,41,10,11,15 | 22 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 555 |
| Point 2 | 310 | 555 |
| Point 3 | 0 | 576 |
| Point 4 | 218 | 576 |
| Point 5 | 248 | 561 |
| Point 6 | 310 | 561 |
| Point 7 | 0 | 586 |
| Point 8 | 199 | 586 |
| Point 9 | 0 | 590 |
| Point 10 | 74 | 591 |
| Point 11 | 82 | 592 |
| Point 12 | 137 | 591 |
| Point 13 | 139 | 591 |
| Point 14 | 189 | 591 |
| Point 15 | 106 | 602 |
| Point 16 | 137 | 602 |
| Point 17 | 137 | 610 |
| Point 18 | 145 | 610 |
| Point 19 | 145 | 602 |
| Point 20 | 145 | 597 |

| | | |
|---|---|---|
| Point 21 | 126 | 610 |
| Point 22 | 149 | 610 |
| Point 23 | 167 | 602 |
| Point 24 | 148 | 600 |
| Point 25 | 170 | 600 |
| Point 26 | 128 | 611 |
| Point 27 | 147 | 611 |
| Point 28 | 154 | 608 |
| Point 29 | 159 | 608 |
| Point 30 | 214 | 588 |
| Point 31 | 310 | 588 |
| Point 32 | 49.5 | 590.5 |
| Point 33 | 46.5 | 590.5 |
| Point 34 | 31 | 590 |
| Point 35 | 15.5 | 592 |
| Point 36 | 0 | 593 |
| Point 37 | 130 | 611 |
| Point 38 | 128 | 610 |
| Point 39 | 108 | 602 |
| Point 40 | 84 | 592 |
| Point 41 | 76 | 591 |
| Point 42 | 193 | 589 |

## Critical Slip Surfaces

| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 496 | 1.23 | (19.266, 782.232) | 200.189 | (108.187, 602.875) | (83.5294, 592.637) |

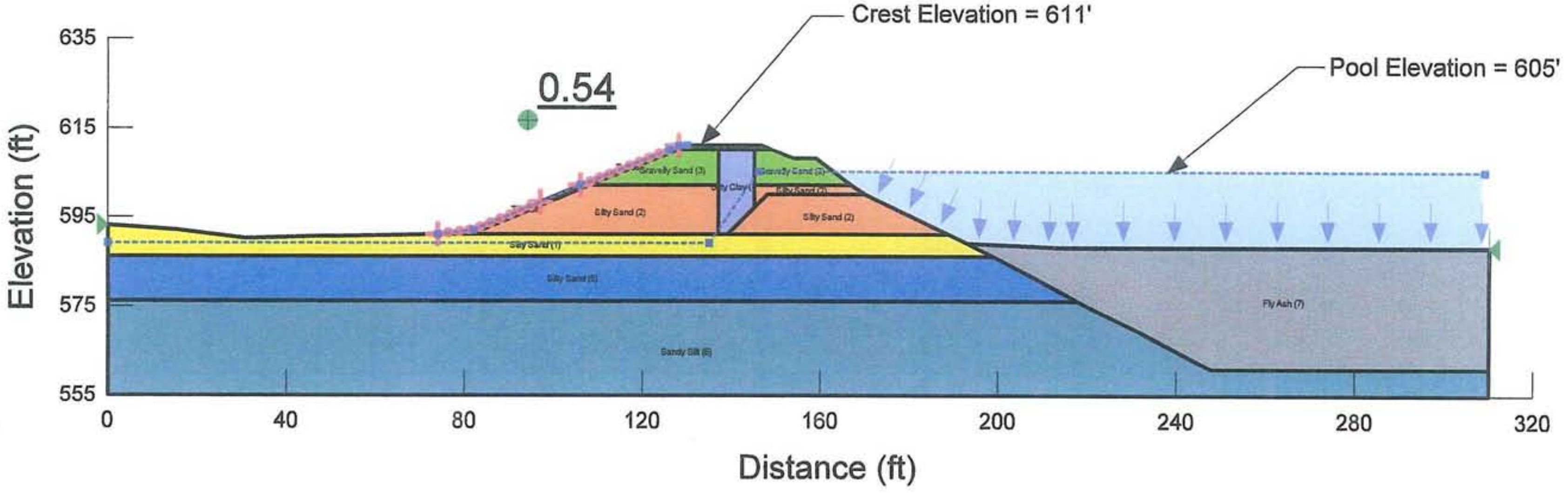
### Slices of Slip Surface: 496

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 496 | 83.773605 | 592.72035 | 0 | 2.1243523 | 1.0824116 | 0 |
| 2 | 496 | 84.2621 | 592.88735 | 0 | 6.2940586 | 3.206983 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | 496 | 84.750595 | 593.05575 | 0 | 10.305439 | 5.2508836 | 0 |
| 4 | 496 | 85.239085 | 593.22555 | 0 | 14.156294 | 7.2129921 | 0 |
| 5 | 496 | 85.727575 | 593.39675 | 0 | 17.844633 | 9.0922945 | 0 |
| 6 | 496 | 86.216065 | 593.5694 | 0 | 21.368284 | 10.887685 | 0 |
| 7 | 496 | 86.70456 | 593.7435 | 0 | 24.725481 | 12.598262 | 0 |
| 8 | 496 | 87.193055 | 593.919 | 0 | 27.914473 | 14.223135 | 0 |
| 9 | 496 | 87.681545 | 594.0959 | 0 | 30.931794 | 15.760536 | 0 |
| 10 | 496 | 88.170035 | 594.27425 | 0 | 33.779751 | 17.211643 | 0 |
| 11 | 496 | 88.65853 | 594.45405 | 0 | 36.452999 | 18.573731 | 0 |
| 12 | 496 | 89.147025 | 594.6353 | 0 | 38.951941 | 19.847005 | 0 |
| 13 | 496 | 89.635515 | 594.818 | 0 | 41.277023 | 21.031694 | 0 |
| 14 | 496 | 90.124005 | 595.00215 | 0 | 43.426758 | 22.127039 | 0 |
| 15 | 496 | 90.612495 | 595.18775 | 0 | 45.397773 | 23.131321 | 0 |
| 16 | 496 | 91.10099 | 595.3748 | 0 | 47.194363 | 24.046729 | 0 |
| 17 | 496 | 91.589485 | 595.5633 | 0 | 48.813171 | 24.871553 | 0 |
| 18 | 496 | 92.077975 | 595.7533 | 0 | 50.254696 | 25.606047 | 0 |
| 19 | 496 | 92.566465 | 595.9448 | 0 | 51.521323 | 26.251425 | 0 |
| 20 | 496 | 93.054955 | 596.13775 | 0 | 52.613551 | 26.807943 | 0 |
| 21 | 496 | 93.54345 | 596.3322 | 0 | 53.529977 | 27.274885 | 0 |
| 22 | 496 | 94.031945 | 596.5281 | 0 | 54.273033 | 27.653491 | 0 |
| 23 | 496 | 94.520435 | 596.7255 | 0 | 54.841337 | 27.943057 | 0 |
| 24 | 496 | 95.008925 | 596.92445 | 0 | 55.239217 | 28.145787 | 0 |
| 25 | 496 | 95.49742 | 597.12485 | 0 | 55.467189 | 28.261945 | 0 |
| 26 | 496 | 95.985915 | 597.32675 | 0 | 55.525796 | 28.291806 | 0 |
| 27 | 496 | 96.474405 | 597.5302 | 0 | 55.4156 | 28.235658 | 0 |
| 28 | 496 | 96.962895 | 597.73515 | 0 | 55.139027 | 28.094737 | 0 |
| 29 | 496 | 97.451385 | 597.94165 | 0 | 54.698533 | 27.870295 | 0 |
| 30 | 496 | 97.93988 | 598.1497 | 0 | 54.092781 | 27.561648 | 0 |
| 31 | 496 | 98.428375 | 598.35925 | 0 | 53.322348 | 27.169093 | 0 |
| 32 | 496 | 98.916865 | 598.5703 | 0 | 52.391567 | 26.694837 | 0 |
| 33 | 496 | 99.405355 | 598.7829 | 0 | 51.29728 | 26.13727 | 0 |
| 34 | 496 | 99.89385 | 598.9971 | 0 | 50.043817 | 25.498599 | 0 |
| 35 | 496 | 100.38235 | 599.21285 | 0 | 48.629916 | 24.77818 | 0 |
| 36 | 496 | 100.87085 | 599.4301 | 0 | 47.056163 | 23.976312 | 0 |
| 37 | 496 | 101.35935 | 599.64895 | 0 | 45.32133 | 23.092371 | 0 |
| 38 | 496 | 101.84785 | 599.8694 | 0 | 43.427903 | 22.127622 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 39 | 496 | 102.33635 | 600.0914 | 0 | 41.374658 | 21.081441 | 0 |
| 40 | 496 | 102.8248 | 600.31495 | 0 | 39.158529 | 19.952267 | 0 |
| 41 | 496 | 103.31325 | 600.5401 | 0 | 36.782035 | 18.741383 | 0 |
| 42 | 496 | 103.80175 | 600.7669 | 0 | 34.244002 | 17.44819 | 0 |
| 43 | 496 | 104.29025 | 600.99525 | 0 | 31.541409 | 16.071151 | 0 |
| 44 | 496 | 104.77875 | 601.2252 | 0 | 28.673131 | 14.60969 | 0 |
| 45 | 496 | 105.26725 | 601.4568 | 0 | 25.638039 | 13.063234 | 0 |
| 46 | 496 | 105.75575 | 601.69 | 0 | 22.435036 | 11.431222 | 0 |
| 47 | 496 | 106.20015 | 601.9035 | 0 | 19.020712 | 9.691537 | 0 |
| 48 | 496 | 106.62365 | 602.10835 | 0 | 15.204579 | 7.7471198 | 0 |
| 49 | 496 | 107.07035 | 602.3257 | 0 | 11.040893 | 5.6256161 | 0 |
| 50 | 496 | 107.51705 | 602.5444 | 0 | 6.7294443 | 3.4288231 | 0 |
| 51 | 496 | 107.9638 | 602.7645 | 0 | 2.2680943 | 1.1556518 | 0 |

Title: Sporn Fly Ash Disposal Facility Western Dike Section H-H
Comments: Shallow Sloughing Assessment
Saturated Topsoil Material (Condition 2)
File Name: Sporn FADF-Shallow Sloughing Assessment for Section H-H Condition 2.gsz
Date: 5/4/2010
Horz Seismic Load: 0
Vert Seismic Load: 0



# SLOPE/W Analysis

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## File Information

Title: Sporn Fly Ash Disposal Facility Western Dike Section H-H
Comments: Shallow Sloughing Assessment Saturated Topsoil Material (Condition 2)
Created By: Roger W. Cecil, P.E.
Revision Number: 184
Last Edited By: Roger Cecil
Date: 5/4/2010
Time: 9:05:43 AM
File Name: Sporn FADF-Shallow Sloughing Assessment for Section H-H Condition 2.gsz
Directory: C:\Working Folder\Sporn\VIBRATION ASSESSMENT\
Last Solved Date: 5/4/2010
Last Solved Time: 9:05:48 AM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

Description: Shallow Sloughing Assessment
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Apply Phreatic Correction: No
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1

Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Advanced
Number of Slices: 50
Optimization Tolerance: 0.05
Minimum Slip Surface Depth: 0.5 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

# Materials

## Silty Sand (1)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Silty Sand (2)

Model: Mohr-Coulomb
Unit Weight: 112 pcf
Unit Wt. Above Water Table: 107 pcf
Cohesion: 0.1 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Gravelly Sand (3)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 105 pcf
Cohesion: 0.1 psf
Phi: 33 °
Phi-B: 0 °

Pore Water Pressure
Piezometric Line: 1

### Silty Clay (4)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Unit Wt. Above Water Table: 115 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Silty Sand (5)

Model: Mohr-Coulomb
Unit Weight: 131 pcf
Unit Wt. Above Water Table: 126 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Sandy Silt (6)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Fly Ash (7)

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Unit Wt. Above Water Table: 102 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Topsoil

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0 psf

Phi: 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 2

## Slip Surface Entry and Exit

**Left Projection:** Range
**Left-Zone Left Coordinate:** (74, 591) ft
**Left-Zone Right Coordinate:** (96.98653, 598.24439) ft
**Left-Zone Increment:** 10
**Right Projection:** Range
**Right-Zone Left Coordinate:** (105.97741, 601.99059) ft
**Right-Zone Right Coordinate:** (128, 611) ft
**Right-Zone Increment:** 10
**Radius Increments:** 10

## Slip Surface Limits

**Left Coordinate:** (0, 593) ft
**Right Coordinate:** (310, 588) ft

## Piezometric Lines

### Piezometric Line 1

Coordinates

| | X (ft) | Y (ft) |
|---|---|---|
| | 0 | 589 |
| | 135 | 589 |
| | 146 | 605 |
| | 309 | 605 |

### Piezometric Line 2

Coordinates

| | X (ft) | Y (ft) |
|---|---|---|
| | 74 | 591 |
| | 82 | 592 |
| | 106 | 602 |
| | 126 | 610 |

| | | |
|---|---|---|
| | 128 | 611 |
| | 130 | 611 |

## Seismic Loads

Horz Seismic Load: 0
Vert Seismic Load: 0

## Regions

| | Material | Points | Area (ft$^2$) |
|---|---|---|---|
| Region 1 | Sandy Silt (6) | 1,3,4,5,6,2 | 5355 |
| Region 2 | Silty Sand (5) | 7,8,4,3 | 2085 |
| Region 3 | Silty Sand (1) | 7,9,36,35,34,33,32,10,41,12,13,14,42,8 | 974 |
| Region 4 | Silty Sand (2) | 40,39,16,12,41 | 467 |
| Region 5 | Silty Clay (4) | 16,17,18,19,20,13,12 | 134 |
| Region 6 | Gravelly Sand (3) | 38,17,16,39 | 152 |
| Region 7 | Silty Sand (2) | 19,20,24,25,23 | 51.5 |
| Region 8 | Silty Sand (1) | 37,27,22,18,17,38 | 19 |
| Region 9 | Silty Sand (2) | 13,20,24,25,14 | 324 |
| Region 10 | Gravelly Sand (3) | 22,28,29,23,19,18 | 121 |
| Region 11 | Fly Ash (7) | 30,31,6,5,4,8,42 | 2405.5 |
| Region 12 | Topsoil | 38,21,26,37 | 2 |
| Region 13 | Topsoil | 21,38,39,15 | 16 |
| Region 14 | Topsoil | 39,40,41,10,11,15 | 22 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 555 |
| Point 2 | 310 | 555 |
| Point 3 | 0 | 576 |
| Point 4 | 218 | 576 |
| Point 5 | 248 | 561 |
| Point 6 | 310 | 561 |
| Point 7 | 0 | 586 |
| Point 8 | 199 | 586 |

| | | |
|---|---|---|
| Point 9 | 0 | 590 |
| Point 10 | 74 | 591 |
| Point 11 | 82 | 592 |
| Point 12 | 137 | 591 |
| Point 13 | 139 | 591 |
| Point 14 | 189 | 591 |
| Point 15 | 106 | 602 |
| Point 16 | 137 | 602 |
| Point 17 | 137 | 610 |
| Point 18 | 145 | 610 |
| Point 19 | 145 | 602 |
| Point 20 | 145 | 597 |
| Point 21 | 126 | 610 |
| Point 22 | 149 | 610 |
| Point 23 | 167 | 602 |
| Point 24 | 148 | 600 |
| Point 25 | 170 | 600 |
| Point 26 | 128 | 611 |
| Point 27 | 147 | 611 |
| Point 28 | 154 | 608 |
| Point 29 | 159 | 608 |
| Point 30 | 214 | 588 |
| Point 31 | 310 | 588 |
| Point 32 | 49.5 | 590.5 |
| Point 33 | 46.5 | 590.5 |
| Point 34 | 31 | 590 |
| Point 35 | 15.5 | 592 |
| Point 36 | 0 | 593 |
| Point 37 | 130 | 611 |
| Point 38 | 128 | 610 |
| Point 39 | 108 | 602 |
| Point 40 | 84 | 592 |
| Point 41 | 76 | 591 |
| Point 42 | 193 | 589 |

## Critical Slip Surfaces

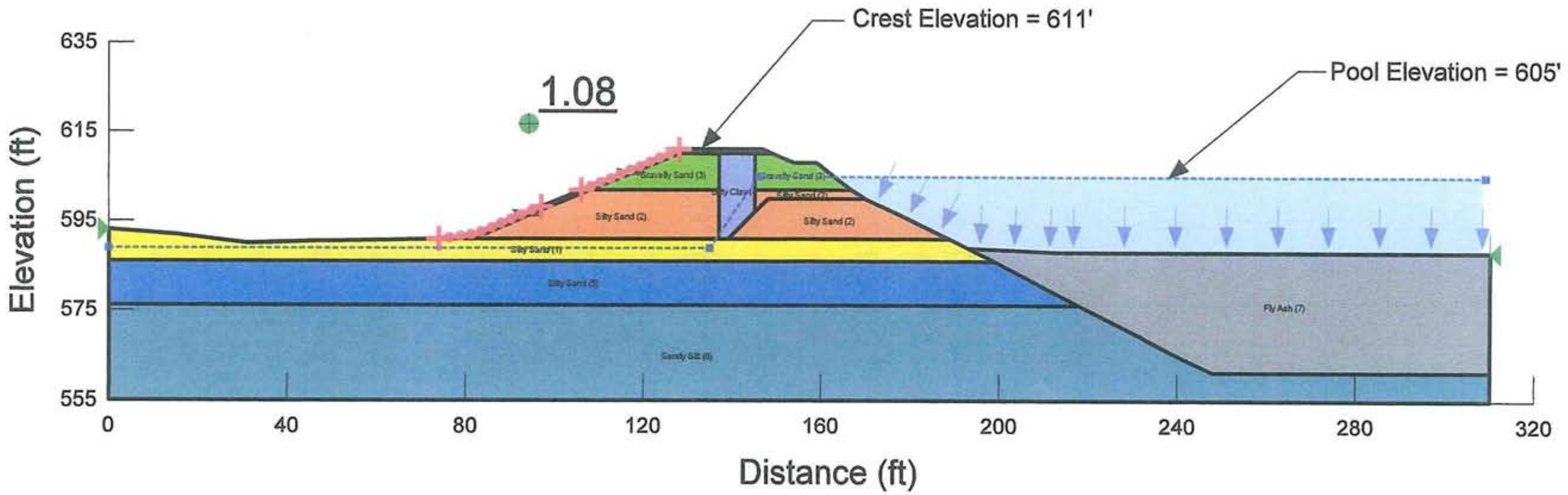
| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 496 | 0.54 | (19.266, 782.232) | 200.189 | (108.187, 602.875) | (83.5294, 592.637) |

### Slices of Slip Surface: 496

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 496 | 83.773605 | 592.72035 | 1.1625606 | 2.117182 | 0.48640389 | 0 |
| 2 | 496 | 84.2621 | 592.88735 | 3.4437545 | 6.273922 | 1.4420424 | 0 |
| 3 | 496 | 84.750595 | 593.05575 | 5.6371171 | 10.2741 | 2.362661 | 0 |
| 4 | 496 | 85.239085 | 593.22555 | 7.7422427 | 14.115899 | 3.2475403 | 0 |
| 5 | 496 | 85.727575 | 593.39675 | 9.7589253 | 17.79713 | 4.0956698 | 0 |
| 6 | 496 | 86.216065 | 593.5694 | 11.687155 | 21.316194 | 4.9062407 | 0 |
| 7 | 496 | 86.70456 | 593.7435 | 13.526542 | 24.669585 | 5.6776639 | 0 |
| 8 | 496 | 87.193055 | 593.919 | 15.276704 | 27.858629 | 6.410811 | 0 |
| 9 | 496 | 87.681545 | 594.0959 | 16.937456 | 30.877926 | 7.1030241 | 0 |
| 10 | 496 | 88.170035 | 594.27425 | 18.508613 | 33.727856 | 7.7545919 | 0 |
| 11 | 496 | 88.65853 | 594.45405 | 19.989239 | 36.404994 | 8.3642448 | 0 |
| 12 | 496 | 89.147025 | 594.6353 | 21.381843 | 38.909737 | 8.9309079 | 0 |
| 13 | 496 | 89.635515 | 594.818 | 22.681473 | 41.238694 | 9.4553762 | 0 |
| 14 | 496 | 90.124005 | 595.00215 | 23.892184 | 43.392296 | 9.9358032 | 0 |
| 15 | 496 | 90.612495 | 595.18775 | 25.012289 | 45.370996 | 10.373279 | 0 |
| 16 | 496 | 91.10099 | 595.3748 | 26.040114 | 47.173344 | 10.767919 | 0 |
| 17 | 496 | 91.589485 | 595.5633 | 26.975901 | 48.7979 | 11.118864 | 0 |
| 18 | 496 | 92.077975 | 595.7533 | 27.821811 | 50.245162 | 11.425268 | 0 |
| 19 | 496 | 92.566465 | 595.9448 | 28.574275 | 51.517513 | 11.690164 | 0 |
| 20 | 496 | 93.054955 | 596.13775 | 29.233556 | 52.611648 | 11.911733 | 0 |
| 21 | 496 | 93.54345 | 596.3322 | 29.80182 | 53.531878 | 12.091068 | 0 |
| 22 | 496 | 94.031945 | 596.5281 | 30.27744 | 54.276831 | 12.2283 | 0 |
| 23 | 496 | 94.520435 | 596.7255 | 30.658792 | 54.848925 | 12.325488 | 0 |
| 24 | 496 | 95.008925 | 596.92445 | 30.94806 | 55.250587 | 12.382756 | 0 |
| 25 | 496 | 95.49742 | 597.12485 | 31.141733 | 55.48044 | 12.40119 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 26 | 496 | 95.985915 | 597.32675 | 31.242005 | 55.540923 | 12.380917 | 0 |
| 27 | 496 | 96.474405 | 597.5302 | 31.249185 | 55.434487 | 12.323027 | 0 |
| 28 | 496 | 96.962895 | 597.73515 | 31.159795 | 55.161666 | 12.229564 | 0 |
| 29 | 496 | 97.451385 | 597.94165 | 30.976048 | 54.723032 | 12.099693 | 0 |
| 30 | 496 | 97.93988 | 598.1497 | 30.698255 | 54.121017 | 11.934493 | 0 |
| 31 | 496 | 98.428375 | 598.35925 | 30.322984 | 53.358073 | 11.736964 | 0 |
| 32 | 496 | 98.916865 | 598.5703 | 29.852451 | 52.432886 | 11.505306 | 0 |
| 33 | 496 | 99.405355 | 598.7829 | 29.285128 | 51.346054 | 11.240603 | 0 |
| 34 | 496 | 99.89385 | 598.9971 | 28.621361 | 50.10003 | 10.943928 | 0 |
| 35 | 496 | 100.38235 | 599.21285 | 27.861513 | 48.693548 | 10.614452 | 0 |
| 36 | 496 | 100.87085 | 599.4301 | 27.004065 | 47.127196 | 10.253248 | 0 |
| 37 | 496 | 101.35935 | 599.64895 | 26.047535 | 45.401614 | 9.8613956 | 0 |
| 38 | 496 | 101.84785 | 599.8694 | 24.994168 | 43.515549 | 9.4371152 | 0 |
| 39 | 496 | 102.33635 | 600.0914 | 23.842486 | 41.469648 | 8.9814873 | 0 |
| 40 | 496 | 102.8248 | 600.31495 | 22.59103 | 39.260843 | 8.4936943 | 0 |
| 41 | 496 | 103.31325 | 600.5401 | 21.242057 | 36.889797 | 7.9729216 | 0 |
| 42 | 496 | 103.80175 | 600.7669 | 19.792268 | 34.353484 | 7.4193101 | 0 |
| 43 | 496 | 104.29025 | 600.99525 | 18.242829 | 31.650754 | 6.8316791 | 0 |
| 44 | 496 | 104.77875 | 601.2252 | 16.593249 | 28.782337 | 6.2106507 | 0 |
| 45 | 496 | 105.26725 | 601.4568 | 14.843037 | 25.743409 | 5.5540171 | 0 |
| 46 | 496 | 105.75575 | 601.69 | 12.991902 | 22.532885 | 4.8613735 | 0 |
| 47 | 496 | 106.20015 | 601.9035 | 11.0159 | 19.108705 | 4.1234899 | 0 |
| 48 | 496 | 106.62365 | 602.10835 | 8.8062445 | 15.278095 | 3.2975725 | 0 |
| 49 | 496 | 107.07035 | 602.3257 | 6.3944361 | 11.096618 | 2.3958813 | 0 |
| 50 | 496 | 107.51705 | 602.5444 | 3.8969775 | 6.7646065 | 1.4611299 | 0 |
| 51 | 496 | 107.9638 | 602.7645 | 1.3133153 | 2.2805365 | 0.49282382 | 0 |

Title: Sporn Fly Ash Disposal Facility Western Dike Section H-H
Comments: Shallow Sloughing Assessment
Moist Topsoil Material with Maximum Pseudo-Static Train Loads
(Condition 3)
File Name: Sporn FADF-Shallow Sloughing Assessment for Section H-H Condition 3.gsz
Date: 5/4/2010
Horz Seismic Load: 0.046
Vert Seismic Load: 0.008



# SLOPE/W Analysis

## File Information

Title: Sporn Fly Ash Disposal Facility Western Dike Section H-H
Comments: Shallow Sloughing Assessment Moist Topsoil Material with Maximum Pseudo-Static Train Loads (Condition 3)
Created By: Roger W. Cecil, P.E.
Revision Number: 187
Last Edited By: Roger Cecil
Date: 5/4/2010
Time: 9:09:43 AM
File Name: Sporn FADF-Shallow Sloughing Assessment for Section H-H Condition 3.gsz
Directory: C:\Working Folder\Sporn\VIBRATION ASSESSMENT\
Last Solved Date: 5/4/2010
Last Solved Time: 9:09:54 AM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

Description: Shallow Sloughing Assessment
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Apply Phreatic Correction: No
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: Piezometric Line
    Use Staged Rapid Drawdown: No
Slip Surface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit

Critical slip surfaces saved: 1
Optimize Critical Slip Surface Location: No
Tension Crack
    Tension Crack Option: (none)

FOS Distribution
    FOS Calculation Option: Constant

Advanced
    Number of Slices: 50
    Optimization Tolerance: 0.05
    Minimum Slip Surface Depth: 0.5 ft
    Optimization Maximum Iterations: 2000
    Optimization Convergence Tolerance: 1e-007
    Starting Optimization Points: 8
    Ending Optimization Points: 16
    Complete Passes per Insertion: 1
    Driving Side Maximum Convex Angle: 5 °
    Resisting Side Maximum Convex Angle: 1 °

# Materials

## Silty Sand (1)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

## Silty Sand (2)

Model: Mohr-Coulomb
Unit Weight: 112 pcf
Unit Wt. Above Water Table: 107 pcf
Cohesion: 0.1 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

## Gravelly Sand (3)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 105 pcf
Cohesion: 0.1 psf
Phi: 33 °

Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Silty Clay (4)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Unit Wt. Above Water Table: 115 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Silty Sand (5)

Model: Mohr-Coulomb
Unit Weight: 131 pcf
Unit Wt. Above Water Table: 126 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Sandy Silt (6)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Fly Ash (7)

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Unit Wt. Above Water Table: 102 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Topsoil

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf

Cohesion: 0 psf
Phi: 27 °
Phi-B: 0 °

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (74, 591) ft
Left-Zone Right Coordinate: (96.98653, 598.24439) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (105.97741, 601.99059) ft
Right-Zone Right Coordinate: (128, 611) ft
Right-Zone Increment: 10
Radius Increments: 10

## Slip Surface Limits

Left Coordinate: (0, 593) ft
Right Coordinate: (310, 588) ft

## Piezometric Lines

### Piezometric Line 1

Coordinates

| | X (ft) | Y (ft) |
|---|---|---|
| | 0 | 589 |
| | 135 | 589 |
| | 146 | 605 |
| | 309 | 605 |

## Seismic Loads

Horz Seismic Load: 0.046
Vert Seismic Load: 0.008
Ignore seismic load in strength: No

## Regions

| | Material | Points | Area (ft²) |
|---|---|---|---|
| Region 1 | Sandy Silt (6) | 1,3,4,5,6,2 | 5355 |

| | | | |
|---|---|---|---|
| Region 2 | Silty Sand (5) | 7,8,4,3 | 2085 |
| Region 3 | Silty Sand (1) | 7,9,36,35,34,33,32,10,41,12,13,14,42,8 | 974 |
| Region 4 | Silty Sand (2) | 40,39,16,12,41 | 467 |
| Region 5 | Silty Clay (4) | 16,17,18,19,20,13,12 | 134 |
| Region 6 | Gravelly Sand (3) | 38,17,16,39 | 152 |
| Region 7 | Silty Sand (2) | 19,20,24,25,23 | 51.5 |
| Region 8 | Silty Sand (1) | 37,27,22,18,17,38 | 19 |
| Region 9 | Silty Sand (2) | 13,20,24,25,14 | 324 |
| Region 10 | Gravelly Sand (3) | 22,28,29,23,19,18 | 121 |
| Region 11 | Fly Ash (7) | 30,31,6,5,4,8,42 | 2405.5 |
| Region 12 | Topsoil | 38,21,26,37 | 2 |
| Region 13 | Topsoil | 21,38,39,15 | 16 |
| Region 14 | Topsoil | 39,40,41,10,11,15 | 22 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 555 |
| Point 2 | 310 | 555 |
| Point 3 | 0 | 576 |
| Point 4 | 218 | 576 |
| Point 5 | 248 | 561 |
| Point 6 | 310 | 561 |
| Point 7 | 0 | 586 |
| Point 8 | 199 | 586 |
| Point 9 | 0 | 590 |
| Point 10 | 74 | 591 |
| Point 11 | 82 | 592 |
| Point 12 | 137 | 591 |
| Point 13 | 139 | 591 |
| Point 14 | 189 | 591 |
| Point 15 | 106 | 602 |
| Point 16 | 137 | 602 |
| Point 17 | 137 | 610 |
| Point 18 | 145 | 610 |
| Point 19 | 145 | 602 |

| | | |
|---|---|---|
| Point 20 | 145 | 597 |
| Point 21 | 126 | 610 |
| Point 22 | 149 | 610 |
| Point 23 | 167 | 602 |
| Point 24 | 148 | 600 |
| Point 25 | 170 | 600 |
| Point 26 | 128 | 611 |
| Point 27 | 147 | 611 |
| Point 28 | 154 | 608 |
| Point 29 | 159 | 608 |
| Point 30 | 214 | 588 |
| Point 31 | 310 | 588 |
| Point 32 | 49.5 | 590.5 |
| Point 33 | 46.5 | 590.5 |
| Point 34 | 31 | 590 |
| Point 35 | 15.5 | 592 |
| Point 36 | 0 | 593 |
| Point 37 | 130 | 611 |
| Point 38 | 128 | 610 |
| Point 39 | 108 | 602 |
| Point 40 | 84 | 592 |
| Point 41 | 76 | 591 |
| Point 42 | 193 | 589 |

## Critical Slip Surfaces

| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 496 | 1.08 | (19.266, 782.232) | 200.189 | (108.187, 602.875) | (83.5294, 592.637) |

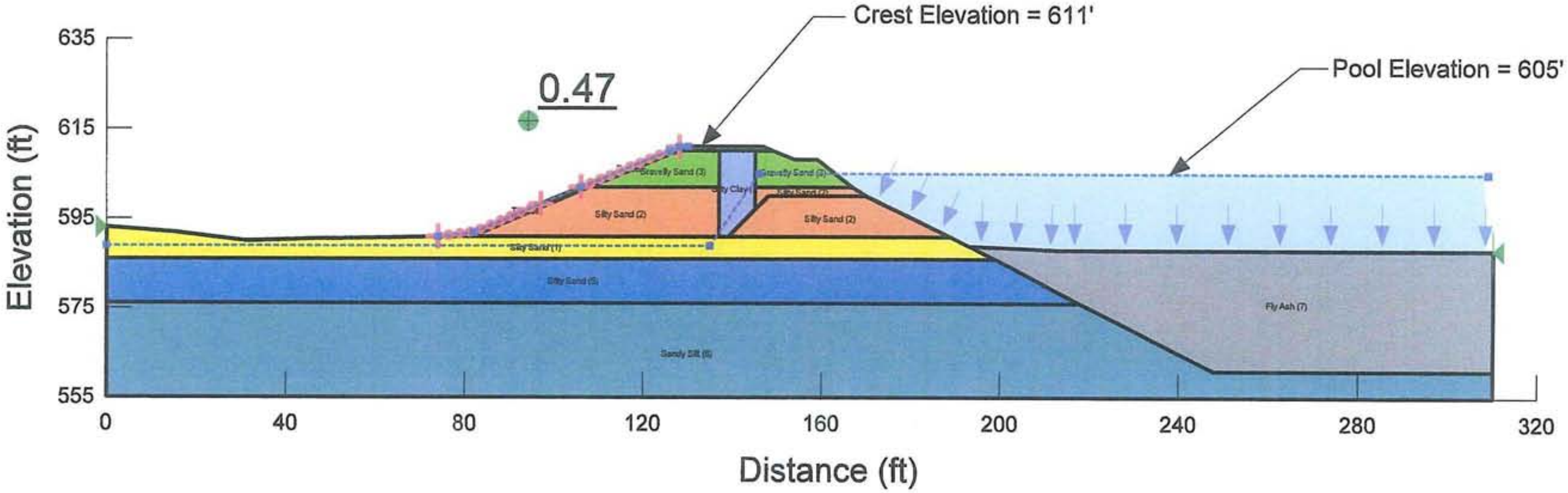
### Slices of Slip Surface: 496

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 496 | 83.773605 | 592.72035 | 0 | 2.1071048 | 1.0736235 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2 | 496 | 84.2621 | 592.88735 | 0 | 6.2425552 | 3.1807408 | 0 |
| 3 | 496 | 84.750595 | 593.05575 | 0 | 10.220128 | 5.2074153 | 0 |
| 4 | 496 | 85.239085 | 593.22555 | 0 | 14.037623 | 7.152526 | 0 |
| 5 | 496 | 85.727575 | 593.39675 | 0 | 17.693049 | 9.0150585 | 0 |
| 6 | 496 | 86.216065 | 593.5694 | 0 | 21.185006 | 10.7943 | 0 |
| 7 | 496 | 86.70456 | 593.7435 | 0 | 24.509606 | 12.488268 | 0 |
| 8 | 496 | 87.193055 | 593.919 | 0 | 27.667988 | 14.097544 | 0 |
| 9 | 496 | 87.681545 | 594.0959 | 0 | 30.656682 | 15.62036 | 0 |
| 10 | 496 | 88.170035 | 594.27425 | 0 | 33.474148 | 17.05593 | 0 |
| 11 | 496 | 88.65853 | 594.45405 | 0 | 36.120805 | 18.404469 | 0 |
| 12 | 496 | 89.147025 | 594.6353 | 0 | 38.593211 | 19.664223 | 0 |
| 13 | 496 | 89.635515 | 594.818 | 0 | 40.891812 | 20.835419 | 0 |
| 14 | 496 | 90.124005 | 595.00215 | 0 | 43.015121 | 21.917299 | 0 |
| 15 | 496 | 90.612495 | 595.18775 | 0 | 44.963592 | 22.910094 | 0 |
| 16 | 496 | 91.10099 | 595.3748 | 0 | 46.735776 | 23.813067 | 0 |
| 17 | 496 | 91.589485 | 595.5633 | 0 | 48.334049 | 24.627428 | 0 |
| 18 | 496 | 92.077975 | 595.7533 | 0 | 49.755086 | 25.351483 | 0 |
| 19 | 496 | 92.566465 | 595.9448 | 0 | 51.003176 | 25.987416 | 0 |
| 20 | 496 | 93.054955 | 596.13775 | 0 | 52.076911 | 26.534511 | 0 |
| 21 | 496 | 93.54345 | 596.3322 | 0 | 52.976789 | 26.993022 | 0 |
| 22 | 496 | 94.031945 | 596.5281 | 0 | 53.703337 | 27.363217 | 0 |
| 23 | 496 | 94.520435 | 596.7255 | 0 | 54.258968 | 27.646325 | 0 |
| 24 | 496 | 95.008925 | 596.92445 | 0 | 54.646103 | 27.84358 | 0 |
| 25 | 496 | 95.49742 | 597.12485 | 0 | 54.863359 | 27.954278 | 0 |
| 26 | 496 | 95.985915 | 597.32675 | 0 | 54.913171 | 27.979658 | 0 |
| 27 | 496 | 96.474405 | 597.5302 | 0 | 54.797982 | 27.920967 | 0 |
| 28 | 496 | 96.962895 | 597.73515 | 0 | 54.516435 | 27.777511 | 0 |
| 29 | 496 | 97.451385 | 597.94165 | 0 | 54.072869 | 27.551503 | 0 |
| 30 | 496 | 97.93988 | 598.1497 | 0 | 53.46594 | 27.242257 | 0 |
| 31 | 496 | 98.428375 | 598.35925 | 0 | 52.698101 | 26.851023 | 0 |
| 32 | 496 | 98.916865 | 598.5703 | 0 | 51.769915 | 26.378089 | 0 |
| 33 | 496 | 99.405355 | 598.7829 | 0 | 50.683851 | 25.824712 | 0 |
| 34 | 496 | 99.89385 | 598.9971 | 0 | 49.4386 | 25.190225 | 0 |
| 35 | 496 | 100.38235 | 599.21285 | 0 | 48.03664 | 24.475891 | 0 |
| 36 | 496 | 100.87085 | 599.4301 | 0 | 46.474807 | 23.680097 | 0 |
| 37 | 496 | 101.35935 | 599.64895 | 0 | 44.757474 | 22.805072 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 38 | 496 | 101.84785 | 599.8694 | 0 | 42.881511 | 21.849221 | 0 |
| 39 | 496 | 102.33635 | 600.0914 | 0 | 40.849419 | 20.813819 | 0 |
| 40 | 496 | 102.8248 | 600.31495 | 0 | 38.658118 | 19.697295 | 0 |
| 41 | 496 | 103.31325 | 600.5401 | 0 | 36.308256 | 18.49998 | 0 |
| 42 | 496 | 103.80175 | 600.7669 | 0 | 33.798648 | 17.221271 | 0 |
| 43 | 496 | 104.29025 | 600.99525 | 0 | 31.126269 | 15.859626 | 0 |
| 44 | 496 | 104.77875 | 601.2252 | 0 | 28.293685 | 14.416353 | 0 |
| 45 | 496 | 105.26725 | 601.4568 | 0 | 25.296051 | 12.888982 | 0 |
| 46 | 496 | 105.75575 | 601.69 | 0 | 22.134105 | 11.27789 | 0 |
| 47 | 496 | 106.20015 | 601.9035 | 0 | 18.763037 | 9.5602449 | 0 |
| 48 | 496 | 106.62365 | 602.10835 | 0 | 14.997122 | 7.6414152 | 0 |
| 49 | 496 | 107.07035 | 602.3257 | 0 | 10.889009 | 5.5482271 | 0 |
| 50 | 496 | 107.51705 | 602.5444 | 0 | 6.6360133 | 3.3812176 | 0 |
| 51 | 496 | 107.9638 | 602.7645 | 0 | 2.2363867 | 1.1394959 | 0 |

Title: Sporn Fly Ash Disposal Facility Western Dike Section H-H
Comments: Shallow Sloughing Assessment
Saturated Topsoil Material with Maximum Pseudo-Static Train Loads
(Condition 4)
File Name: Sporn FADF-Shallow Sloughing Assessment for Section H-H Condition 4.gsz
Date: 5/4/2010
Horz Seismic Load: 0.046
Vert Seismic Load: 0.008



# SLOPE/W Analysis

## File Information

Title: Sporn Fly Ash Disposal Facility Western Dike Section H-H
Comments: Shallow Sloughing Assessment Saturated Topsoil Material with Maximum Pseudo-Static Train Loads (Condition 4)
Created By: Roger W. Cecil, P.E.
Revision Number: 186
Last Edited By: Roger Cecil
Date: 5/4/2010
Time: 9:12:48 AM
File Name: Sporn FADF-Shallow Sloughing Assessment for Section H-H Condition 4.gsz
Directory: C:\Working Folder\Sporn\VIBRATION ASSESSMENT\
Last Solved Date: 5/4/2010
Last Solved Time: 9:12:54 AM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

Description: Shallow Sloughing Assessment
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Apply Phreatic Correction: No
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit

Critical slip surfaces saved: 1
Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Advanced
Number of Slices: 50
Optimization Tolerance: 0.05
Minimum Slip Surface Depth: 0.5 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

# Materials

## Silty Sand (1)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Silty Sand (2)

Model: Mohr-Coulomb
Unit Weight: 112 pcf
Unit Wt. Above Water Table: 107 pcf
Cohesion: 0.1 psf
Phi: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Gravelly Sand (3)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 105 pcf
Cohesion: 0.1 psf
Phi: 33 °

Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Silty Clay (4)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Unit Wt. Above Water Table: 115 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Silty Sand (5)

Model: Mohr-Coulomb
Unit Weight: 131 pcf
Unit Wt. Above Water Table: 126 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Sandy Silt (6)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Fly Ash (7)

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Unit Wt. Above Water Table: 102 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

### Topsoil

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf

Cohesion: 0 psf
Phi: 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 2

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (74, 591) ft
Left-Zone Right Coordinate: (96.98653, 598.24439) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (105.97741, 601.99059) ft
Right-Zone Right Coordinate: (128, 611) ft
Right-Zone Increment: 10
Radius Increments: 10

## Slip Surface Limits

Left Coordinate: (0, 593) ft
Right Coordinate: (310, 588) ft

## Piezometric Lines

### Piezometric Line 1

Coordinates

| | X (ft) | Y (ft) |
|---|---|---|
| | 0 | 589 |
| | 135 | 589 |
| | 146 | 605 |
| | 309 | 605 |

### Piezometric Line 2

Coordinates

| | X (ft) | Y (ft) |
|---|---|---|
| | 74 | 591 |
| | 82 | 592 |
| | 106 | 602 |

| | | |
|---|---|---|
| | 126 | 610 |
| | 128 | 611 |
| | 130 | 611 |

## Seismic Loads

Horz Seismic Load: 0.046
Vert Seismic Load: 0.008
Ignore seismic load in strength: No

## Regions

| | Material | Points | Area (ft$^2$) |
|---|---|---|---|
| Region 1 | Sandy Silt (6) | 1,3,4,5,6,2 | 5355 |
| Region 2 | Silty Sand (5) | 7,8,4,3 | 2085 |
| Region 3 | Silty Sand (1) | 7,9,36,35,34,33,32,10,41,12,13,14,42,8 | 974 |
| Region 4 | Silty Sand (2) | 40,39,16,12,41 | 467 |
| Region 5 | Silty Clay (4) | 16,17,18,19,20,13,12 | 134 |
| Region 6 | Gravelly Sand (3) | 38,17,16,39 | 152 |
| Region 7 | Silty Sand (2) | 19,20,24,25,23 | 51.5 |
| Region 8 | Silty Sand (1) | 37,27,22,18,17,38 | 19 |
| Region 9 | Silty Sand (2) | 13,20,24,25,14 | 324 |
| Region 10 | Gravelly Sand (3) | 22,28,29,23,19,18 | 121 |
| Region 11 | Fly Ash (7) | 30,31,6,5,4,8,42 | 2405.5 |
| Region 12 | Topsoil | 38,21,26,37 | 2 |
| Region 13 | Topsoil | 21,38,39,15 | 16 |
| Region 14 | Topsoil | 39,40,41,10,11,15 | 22 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 555 |
| Point 2 | 310 | 555 |
| Point 3 | 0 | 576 |
| Point 4 | 218 | 576 |
| Point 5 | 248 | 561 |
| Point 6 | 310 | 561 |
| Point 7 | 0 | 586 |

| | | |
|---|---|---|
| Point 8 | 199 | 586 |
| Point 9 | 0 | 590 |
| Point 10 | 74 | 591 |
| Point 11 | 82 | 592 |
| Point 12 | 137 | 591 |
| Point 13 | 139 | 591 |
| Point 14 | 189 | 591 |
| Point 15 | 106 | 602 |
| Point 16 | 137 | 602 |
| Point 17 | 137 | 610 |
| Point 18 | 145 | 610 |
| Point 19 | 145 | 602 |
| Point 20 | 145 | 597 |
| Point 21 | 126 | 610 |
| Point 22 | 149 | 610 |
| Point 23 | 167 | 602 |
| Point 24 | 148 | 600 |
| Point 25 | 170 | 600 |
| Point 26 | 128 | 611 |
| Point 27 | 147 | 611 |
| Point 28 | 154 | 608 |
| Point 29 | 159 | 608 |
| Point 30 | 214 | 588 |
| Point 31 | 310 | 588 |
| Point 32 | 49.5 | 590.5 |
| Point 33 | 46.5 | 590.5 |
| Point 34 | 31 | 590 |
| Point 35 | 15.5 | 592 |
| Point 36 | 0 | 593 |
| Point 37 | 130 | 611 |
| Point 38 | 128 | 610 |
| Point 39 | 108 | 602 |
| Point 40 | 84 | 592 |
| Point 41 | 76 | 591 |
| Point 42 | 193 | 589 |

## Critical Slip Surfaces

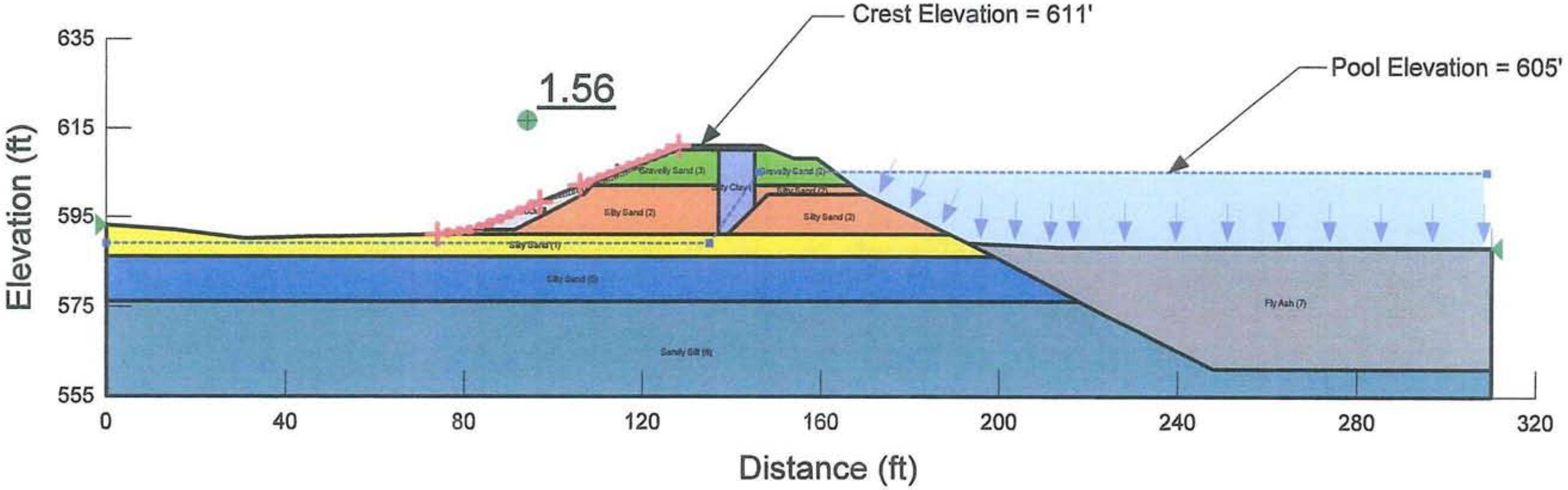
| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 496 | 0.47 | (19.266, 782.232) | 200.189 | (108.187, 602.875) | (83.5294, 592.637) |

## Slices of Slip Surface: 496

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 496 | 83.773605 | 592.72035 | 1.1625606 | 2.0985779 | 0.47692464 | 0 |
| 2 | 496 | 84.2621 | 592.88735 | 3.4437545 | 6.2181589 | 1.4136297 | 0 |
| 3 | 496 | 84.750595 | 593.05575 | 5.6371171 | 10.182405 | 2.3159401 | 0 |
| 4 | 496 | 85.239085 | 593.22555 | 7.7422427 | 13.98911 | 3.1829381 | 0 |
| 5 | 496 | 85.727575 | 593.39675 | 9.7589253 | 17.63647 | 4.0138095 | 0 |
| 6 | 496 | 86.216065 | 593.5694 | 11.687155 | 21.12327 | 4.8079409 | 0 |
| 7 | 496 | 86.70456 | 593.7435 | 13.526542 | 24.444072 | 5.5627592 | 0 |
| 8 | 496 | 87.193055 | 593.919 | 15.276704 | 27.602515 | 6.2803146 | 0 |
| 9 | 496 | 87.681545 | 594.0959 | 16.937456 | 30.591271 | 6.9569661 | 0 |
| 10 | 496 | 88.170035 | 594.27425 | 18.508613 | 33.412643 | 7.5939826 | 0 |
| 11 | 496 | 88.65853 | 594.45405 | 19.989239 | 36.063199 | 8.1900916 | 0 |
| 12 | 496 | 89.147025 | 594.6353 | 21.381843 | 38.541415 | 8.7432386 | 0 |
| 13 | 496 | 89.635515 | 594.818 | 22.681473 | 40.847733 | 9.2561717 | 0 |
| 14 | 496 | 90.124005 | 595.00215 | 23.892184 | 42.976829 | 9.7241125 | 0 |
| 15 | 496 | 90.612495 | 595.18775 | 25.012289 | 44.932989 | 10.150103 | 0 |
| 16 | 496 | 91.10099 | 595.3748 | 26.040114 | 46.712846 | 10.533283 | 0 |
| 17 | 496 | 91.589485 | 595.5633 | 26.975901 | 48.316869 | 10.873767 | 0 |
| 18 | 496 | 92.077975 | 595.7533 | 27.821811 | 49.745552 | 11.170703 | 0 |
| 19 | 496 | 92.566465 | 595.9448 | 28.574275 | 50.997461 | 11.425184 | 0 |
| 20 | 496 | 93.054955 | 596.13775 | 29.233556 | 52.076911 | 11.63927 | 0 |
| 21 | 496 | 93.54345 | 596.3322 | 29.80182 | 52.980591 | 11.810174 | 0 |
| 22 | 496 | 94.031945 | 596.5281 | 30.27744 | 53.712832 | 11.940929 | 0 |
| 23 | 496 | 94.520435 | 596.7255 | 30.658792 | 54.272246 | 12.031656 | 0 |
| 24 | 496 | 95.008925 | 596.92445 | 30.94806 | 54.661263 | 12.08248 | 0 |
| 25 | 496 | 95.49742 | 597.12485 | 31.141733 | 54.882288 | 12.096417 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 26 | 496 | 95.985915 | 597.32675 | 31.242005 | 54.93397 | 12.071659 | 0 |
| 27 | 496 | 96.474405 | 597.5302 | 31.249185 | 54.822536 | 12.011222 | 0 |
| 28 | 496 | 96.962895 | 597.73515 | 31.159795 | 54.544734 | 11.915222 | 0 |
| 29 | 496 | 97.451385 | 597.94165 | 30.976048 | 54.10679 | 11.785702 | 0 |
| 30 | 496 | 97.93988 | 598.1497 | 30.698255 | 53.50547 | 11.620856 | 0 |
| 31 | 496 | 98.428375 | 598.35925 | 30.322984 | 52.745107 | 11.424642 | 0 |
| 32 | 496 | 98.916865 | 598.5703 | 29.852451 | 51.82438 | 11.195257 | 0 |
| 33 | 496 | 99.405355 | 598.7829 | 29.285128 | 50.745757 | 10.934736 | 0 |
| 34 | 496 | 99.89385 | 598.9971 | 28.621361 | 49.509802 | 10.643192 | 0 |
| 35 | 496 | 100.38235 | 599.21285 | 27.861513 | 48.117116 | 10.320745 | 0 |
| 36 | 496 | 100.87085 | 599.4301 | 27.004065 | 46.566403 | 9.9675092 | 0 |
| 37 | 496 | 101.35935 | 599.64895 | 26.047535 | 44.858296 | 9.5845611 | 0 |
| 38 | 496 | 101.84785 | 599.8694 | 24.994168 | 42.991535 | 9.1701166 | 0 |
| 39 | 496 | 102.33635 | 600.0914 | 23.842486 | 40.96676 | 8.725253 | 0 |
| 40 | 496 | 102.8248 | 600.31495 | 22.59103 | 38.782756 | 8.2500965 | 0 |
| 41 | 496 | 103.31325 | 600.5401 | 21.242057 | 36.438313 | 7.7428789 | 0 |
| 42 | 496 | 103.80175 | 600.7669 | 19.792268 | 33.932254 | 7.2046825 | 0 |
| 43 | 496 | 104.29025 | 600.99525 | 18.242829 | 31.26156 | 6.6333748 | 0 |
| 44 | 496 | 104.77875 | 601.2252 | 16.593249 | 28.426954 | 6.0295739 | 0 |
| 45 | 496 | 105.26725 | 601.4568 | 14.843037 | 25.425452 | 5.39201 | 0 |
| 46 | 496 | 105.75575 | 601.69 | 12.991902 | 22.254108 | 4.7193299 | 0 |
| 47 | 496 | 106.20015 | 601.9035 | 11.0159 | 18.870158 | 4.0019443 | 0 |
| 48 | 496 | 106.62365 | 602.10835 | 8.8062445 | 15.086751 | 3.200078 | 0 |
| 49 | 496 | 107.07035 | 602.3257 | 6.3944361 | 10.957005 | 2.3247449 | 0 |
| 50 | 496 | 107.51705 | 602.5444 | 3.8969775 | 6.6792125 | 1.4176195 | 0 |
| 51 | 496 | 107.9638 | 602.7645 | 1.3133153 | 2.2514378 | 0.47799728 | 0 |

Title: Sporn Fly Ash Disposal Facility Western Dike Section H-H
Comments: Shallow Sloughing Assessment
with Ongoing Repairs
File Name: Sporn FADF-Shallow Sloughing Assessment for Section H-H_REPAIR.gsz
Date: 5/4/2010
Horz Seismic Load: 0.046
Vert Seismic Load: 0.008



# SLOPE/W Analysis

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## File Information

Title: Sporn Fly Ash Disposal Facility Western Dike Section H-H
Comments: Shallow Sloughing Assessment with Ongoing Repairs
Created By: Roger W. Cecil, P.E.
Revision Number: 191
Last Edited By: Roger Cecil
Date: 5/4/2010
Time: 8:58:30 AM
File Name: Sporn FADF-Shallow Sloughing Assessment for Section H-H_REPAIR.gsz
Directory: C:\Working Folder\Sporn\VIBRATION ASSESSMENT\
Last Solved Date: 5/4/2010
Last Solved Time: 8:58:41 AM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

Description: Shallow Sloughing Assessment
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Apply Phreatic Correction: No
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: Piezometric Line
    Use Staged Rapid Drawdown: No
Slip Surface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1

Optimize Critical Slip Surface Location: No

Tension Crack

Tension Crack Option: (none)

FOS Distribution

FOS Calculation Option: Constant

Advanced

Number of Slices: 50

Optimization Tolerance: 0.05

Minimum Slip Surface Depth: 0.5 ft

Optimization Maximum Iterations: 2000

Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8

Ending Optimization Points: 16

Complete Passes per Insertion: 1

Driving Side Maximum Convex Angle: 5 °

Resisting Side Maximum Convex Angle: 1 °

# Materials

## Silty Sand (1)

Model: Mohr-Coulomb

Unit Weight: 130 pcf

Unit Wt. Above Water Table: 125 pcf

Cohesion: 0.1 psf

Phi: 34 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

## Silty Sand (2)

Model: Mohr-Coulomb

Unit Weight: 112 pcf

Unit Wt. Above Water Table: 107 pcf

Cohesion: 0.1 psf

Phi: 35 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

## Gravelly Sand (3)

Model: Mohr-Coulomb

Unit Weight: 110 pcf

Unit Wt. Above Water Table: 105 pcf

Cohesion: 0.1 psf

Phi: 33 °

Phi-B: 0 °

Pore Water Pressure
Piezometric Line: 1

## Silty Clay (4)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Unit Wt. Above Water Table: 115 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Silty Sand (5)

Model: Mohr-Coulomb
Unit Weight: 131 pcf
Unit Wt. Above Water Table: 126 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Sandy Silt (6)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Fly Ash (7)

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Unit Wt. Above Water Table: 102 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

## Rockfill

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0 psf

Phi: 38 °
Phi-B: 0 °

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (74, 591) ft
Left-Zone Right Coordinate: (96.98653, 598.24439) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (105.97741, 601.99059) ft
Right-Zone Right Coordinate: (128, 611) ft
Right-Zone Increment: 10
Radius Increments: 10

## Slip Surface Limits

Left Coordinate: (0, 593) ft
Right Coordinate: (310, 588) ft

## Piezometric Lines

### Piezometric Line 1

#### Coordinates

| | X (ft) | Y (ft) |
|---|---|---|
| | 0 | 589 |
| | 135 | 589 |
| | 146 | 605 |
| | 309 | 605 |

## Seismic Loads

Horz Seismic Load: 0.046
Vert Seismic Load: 0.008
Ignore seismic load in strength: No

## Regions

| | Material | Points | Area (ft²) |
|---|---|---|---|
| Region 1 | Sandy Silt (6) | 1,3,4,5,6,2 | 5355 |

| | | | |
|---|---|---|---|
| Region 2 | Silty Sand (5) | 7,8,4,3 | 2085 |
| Region 3 | Silty Sand (1) | 7,9,36,35,34,33,32,10,41,12,13,14,45,8 | 974 |
| Region 4 | Silty Sand (2) | 40,42,43,39,16,12,41 | 420.34 |
| Region 5 | Silty Clay (4) | 16,17,18,19,20,13,12 | 134 |
| Region 6 | Gravelly Sand (3) | 38,17,16,39,44 | 151.832 |
| Region 7 | Silty Sand (2) | 19,20,24,25,23 | 51.5 |
| Region 8 | Silty Sand (1) | 37,27,22,18,17,38 | 19 |
| Region 9 | Silty Sand (2) | 13,20,24,25,14 | 324 |
| Region 10 | Gravelly Sand (3) | 22,28,29,23,19,18 | 121 |
| Region 11 | Fly Ash (7) | 30,31,6,5,4,8,45 | 2405.5 |
| Region 12 | Rockfill | 38,21,26,37 | 2 |
| Region 13 | Rockfill | 21,38,44,39,15 | 16.168 |
| Region 14 | Rockfill | 39,43,42,40,41,10,11,15 | 68.66 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 555 |
| Point 2 | 310 | 555 |
| Point 3 | 0 | 576 |
| Point 4 | 218 | 576 |
| Point 5 | 248 | 561 |
| Point 6 | 310 | 561 |
| Point 7 | 0 | 586 |
| Point 8 | 199 | 586 |
| Point 9 | 0 | 590 |
| Point 10 | 74 | 591 |
| Point 11 | 82 | 592 |
| Point 12 | 137 | 591 |
| Point 13 | 139 | 591 |
| Point 14 | 189 | 591 |
| Point 15 | 106 | 602 |
| Point 16 | 137 | 602 |
| Point 17 | 137 | 610 |
| Point 18 | 145 | 610 |
| Point 19 | 145 | 602 |

| | | |
|---|---|---|
| Point 20 | 145 | 597 |
| Point 21 | 126 | 610 |
| Point 22 | 149 | 610 |
| Point 23 | 167 | 602 |
| Point 24 | 148 | 600 |
| Point 25 | 170 | 600 |
| Point 26 | 128 | 611 |
| Point 27 | 147 | 611 |
| Point 28 | 154 | 608 |
| Point 29 | 159 | 608 |
| Point 30 | 214 | 588 |
| Point 31 | 310 | 588 |
| Point 32 | 49.5 | 590.5 |
| Point 33 | 46.5 | 590.5 |
| Point 34 | 31 | 590 |
| Point 35 | 15.5 | 592 |
| Point 36 | 0 | 593 |
| Point 37 | 130 | 611 |
| Point 38 | 128 | 610 |
| Point 39 | 108.7 | 602 |
| Point 40 | 84 | 592 |
| Point 41 | 76 | 591 |
| Point 42 | 91.3 | 592 |
| Point 43 | 106.9 | 600.2 |
| Point 44 | 109.2 | 602.48 |
| Point 45 | 193 | 589 |

## Critical Slip Surfaces

| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 1322 | 1.56 | (78.795, 686.555) | 90.165 | (128, 611) | (96.9865, 598.244) |

### Slices of Slip Surface: 1322

| | Slip Surfac | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength | Cohesive |
|---|---|---|---|---|---|---|---|

|  | e |  |  |  |  | (psf) | Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 1322 | 97.28698 | 598.30735 | 0 | 6.5487514 | 5.1164453 | 0 |
| 2 | 1322 | 97.88788 | 598.4354 | 0 | 19.442419 | 15.190082 | 0 |
| 3 | 1322 | 98.488775 | 598.56775 | 0 | 31.914716 | 24.934509 | 0 |
| 4 | 1322 | 99.08967 | 598.7044 | 0 | 43.951596 | 34.338751 | 0 |
| 5 | 1322 | 99.69057 | 598.8454 | 0 | 55.535302 | 43.388933 | 0 |
| 6 | 1322 | 100.29146 | 598.99075 | 0 | 66.649912 | 52.072618 | 0 |
| 7 | 1322 | 100.89235 | 599.14045 | 0 | 77.276528 | 60.375041 | 0 |
| 8 | 1322 | 101.49325 | 599.29455 | 0 | 87.399683 | 68.284116 | 0 |
| 9 | 1322 | 102.09415 | 599.45305 | 0 | 97.005794 | 75.789233 | 0 |
| 10 | 1322 | 102.69505 | 599.616 | 0 | 106.0767 | 82.876198 | 0 |
| 11 | 1322 | 103.29595 | 599.78345 | 0 | 114.60088 | 89.536022 | 0 |
| 12 | 1322 | 103.89685 | 599.9554 | 0 | 122.56712 | 95.759931 | 0 |
| 13 | 1322 | 104.49775 | 600.13185 | 0 | 129.96443 | 101.53934 | 0 |
| 14 | 1322 | 105.09865 | 600.31285 | 0 | 136.78685 | 106.8696 | 0 |
| 15 | 1322 | 105.69955 | 600.4984 | 0 | 143.02544 | 111.74372 | 0 |
| 16 | 1322 | 106.32095 | 600.6952 | 0 | 148.30533 | 115.86882 | 0 |
| 17 | 1322 | 106.96285 | 600.90365 | 0 | 152.58197 | 119.2101 | 0 |
| 18 | 1322 | 107.6047 | 601.1174 | 0 | 156.20179 | 122.03821 | 0 |
| 19 | 1322 | 108.3128 | 601.35975 | -771.24951 | 170.01534 | 119.04602 | 0.1 |
| 20 | 1322 | 108.95 | 601.58265 | -785.16367 | 165.72369 | 116.04097 | 0.1 |
| 21 | 1322 | 109.65115 | 601.8357 | -800.94418 | 164.21907 | 114.98743 | 0.1 |
| 22 | 1322 | 110.41375 | 602.11665 | -818.47775 | 165.45459 | 107.44746 | 0.1 |
| 23 | 1322 | 111.03665 | 602.35255 | -833.1929 | 165.5921 | 107.53677 | 0.1 |
| 24 | 1322 | 111.65955 | 602.5937 | -848.23779 | 165.23744 | 107.30645 | 0.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 25 | 1322 | 112.28245 | 602.8402 | -863.61941 | 164.4095 | 106.76878 | 0.1 |
| 26 | 1322 | 112.9053 | 603.09205 | -879.34454 | 163.11238 | 105.92642 | 0.1 |
| 27 | 1322 | 113.52815 | 603.3493 | -895.4044 | 161.36509 | 104.79172 | 0.1 |
| 28 | 1322 | 114.15105 | 603.6121 | -911.79 | 159.15712 | 103.35785 | 0.1 |
| 29 | 1322 | 114.77395 | 603.8804 | -928.53663 | 156.52256 | 101.64694 | 0.1 |
| 30 | 1322 | 115.39685 | 604.15425 | -945.63421 | 153.45117 | 99.652355 | 0.1 |
| 31 | 1322 | 116.01975 | 604.4338 | -963.07264 | 149.94777 | 97.377221 | 0.1 |
| 32 | 1322 | 116.64265 | 604.71905 | -980.87058 | 146.03192 | 94.834239 | 0.1 |
| 33 | 1322 | 117.26555 | 605.01 | -999.03142 | 141.70574 | 92.024783 | 0.1 |
| 34 | 1322 | 117.88845 | 605.30675 | -1017.5435 | 136.96288 | 88.944733 | 0.1 |
| 35 | 1322 | 118.51135 | 605.60945 | -1036.4239 | 131.80604 | 85.595844 | 0.1 |
| 36 | 1322 | 119.13425 | 605.9181 | -1055.6889 | 126.23528 | 81.978148 | 0.1 |
| 37 | 1322 | 119.75715 | 606.23275 | -1075.3248 | 120.24662 | 78.08907 | 0.1 |
| 38 | 1322 | 120.38005 | 606.55345 | -1095.3323 | 113.83365 | 73.924437 | 0.1 |

|  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
| 39 | 1322 | 121.00295 | 606.8803 | -1115.7254 | 106.99036 | 69.480355 | 0.1 |
| 40 | 1322 | 121.62585 | 607.21345 | -1136.5176 | 99.706992 | 64.750478 | 0.1 |
| 41 | 1322 | 122.24875 | 607.5529 | -1157.7066 | 91.972843 | 59.727863 | 0.1 |
| 42 | 1322 | 122.87165 | 607.8987 | -1179.2764 | 83.773662 | 54.403252 | 0.1 |
| 43 | 1322 | 123.4648 | 608.2339 | 0 | 66.674695 | 52.091981 | 0 |
| 44 | 1322 | 124.0282 | 608.55795 | 0 | 57.764842 | 45.13084 | 0 |
| 45 | 1322 | 124.59155 | 608.8874 | 0 | 48.437083 | 37.843196 | 0 |
| 46 | 1322 | 125.1549 | 609.22235 | 0 | 38.679681 | 30.219879 | 0 |
| 47 | 1322 | 125.7183 | 609.5629 | 0 | 28.481487 | 22.252176 | 0 |
| 48 | 1322 | 126.21465 | 609.8673 | 0 | 21.036726 | 16.435692 | 0 |
| 49 | 1322 | 126.69105 | 610.16415 | 0 | 15.878217 | 12.405423 | 0 |
| 50 | 1322 | 127.2146 | 610.49495 | 0 | 9.8267589 | 7.6775055 | 0 |
| 51 | 1322 | 127.7382 | 610.8308 | 0 | 3.3458689 | 2.6140793 | 0 |

# APPENDIX V

# FESM SLOPE STABILITY AND LIQUEFACTION ANALYSES

# FINITE ELEMENT STRESS METHOD STABILITY ANALYSIS SUMMARY
# RAILWAY-INDUCED VIBRATION ASSESSMENT
# BOTTOM ASH AND FLY ASH DISPOSAL FACILITIES
# PHILIP SPORN PLANT
# NEW HAVEN, MASON COUNTY, WEST VIRGINIA
# GA FILE NO. 09-387

## GENERAL

Geo/Environmental Associates, Inc. (GA) has prepared finite element stress method (FESM) slope stability analyses for the western dikes of the Bottom Ash Disposal and Fly Ash Disposal Facilities at the Philip Sporn Plant. Specifically, GA has evaluated Section A-A for the Bottom Ash Disposal Facility Western Dike and Section H-H for the Fly Ash Disposal Facility Western Dike. The FESM analyses were conducted using the finite element computer program *QUAKE/W* and the slope stability analyses were conducted using *SLOPE/W*. Both *QUAKE/W* and *SLOPE/W* are developed by GEO-SLOPE International, Ltd. of Calgary, Alberta Canada.

The *QUAKE/W* program was used to conduct finite element analyses in order to model initial stresses in the western dikes under static conditions. Thereafter, the *QUAKE/W* program was used to approximate the stress conditions at specified time steps generated during the field measured railway-induced vibration events. The results of the railway-induced vibration events that are modeled in the *QUAKE/W* finite element analyses are then evaluated for liquefaction. The stresses developed in the railway-induced vibration analyses are then applied in *SLOPE/W* to conduct slope stability analyses based on the Newmark Deformation Analysis Method. Specifically, *SLOPE/W* uses the stress conditions generated by *QUAKE/W* to perform a static analysis for each time step with the stress conditions approximated at that time step. The result is a dynamic analysis for the specific train vibration event. The *SLOPE/W* slope stability analyses were performed in both the upstream and downstream directions for both Section A-A and H-H. At the request of the USEPA, both shallow-seated and deep-seated (global) slip surfaces were modeled in the FESM slope stability analyses. GA conservatively applied the vibration events from the dike exterior toe monitoring locations (i.e., Location A for Section A-A and Location C for Section H-H) to the downstream direction FESM slope stability analyses. We applied the accelerations from the dike crest monitoring locations (i.e., Location B for Section A-A and Location D for Section H-H) to the upstream direction FESM slope stability analyses. Table V-1 summarizes the vibration event applied in each analysis.

**TABLE V-1**
**SUMMARY OF VIBRATION EVENTS USED IN**
**FINITE ELEMENT STRESS METHOD SLOPE STABILITY ANALYSES**

| Critical Section | Vibration Monitoring Location | Maximum Railway Induced Vibration Data Used |
|---|---|---|
| Bottom Ash Disposal Facility Section A-A | Location A<br>(Exterior Toe - Adjacent to Track)<br>Downstream Direction Analyses | November 11, 2009<br>12:12 pm Train<br>10 sec. to 20 sec. |
| | Location B<br>(Crest)<br>Upstream Direction Analyses | November 11, 2009<br>12:12 pm Train<br>16 sec. to 26 sec. |
| Fly Ash Disposal Facility Section H-H | Location C<br>(Exterior Toe - Adjacent to Track)<br>Downstream Direction Analyses | November 11, 2009<br>12:12 pm Train<br>36 sec. to 46 sec. |
| | Location D<br>(Crest)<br>Upstream Direction Analyses | November 11, 2009<br>12:12 pm Train<br>0 sec. to 5.5 sec. |

## MATERIAL PARAMETERS

Strength parameters for the various embankment and foundation materials used in the finite element stability analyses for critical Sections A-A and H-H are provided in Tables V-2 and V-3, respectively. In general, the parameters are based on site specific data and by applying accepted reference data to the site specific soils/conditions. Material parameters required for the finite element stress analysis include the unit weight, damping ratio, small strain shear modulus, Poisson's ratio, and effective friction angle, ϕ'. The damping ratio for the fly ash and foundation materials was measured by free-free resonant column testing performed by Dr. Kalinski at the University of Kentucky. The damping ratio for all other materials was developed by relating published data to site specific soils. Small strain shear modulus and Poisson's ration values were calculated from shear wave velocity data that was obtained by Dr. Kalinski using crosshole seismic testing performed at site. Unit weight and ϕ' were determined from in-situ and laboratory testing performed by AEP and GA.

TABLE V.2. FESM AND QUAKE/W MATERIAL PARAMETERS FOR SECTION A-A ANALYSIS

| | **Silty Clay (1)** | **Fly Ash (2)** | **Bottom Ash (3)** | **Clayey Sand (4)** | **Bottom Ash (5)** | **Gravelly Sand (6)** | **Clayey Sand (7)** | **Road Material (8)** | **Clayey Sand (9)** | **Sand (10)** | **Sand & Gravel (11)** | **Riprap (12)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Unit Weight $\gamma$ (pcf)** | 123 | 97 | 80 | 105 | 62 | 111 | 110 | 145 | 115 | 123 | 123 | 145 |
| Source | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ |
| **Damping Ratio $\lambda$ (%)** | 7 | 4.5 | 10 | 10 | 10 | 10 | 10 | 10 | 7 | 7 | 7 | 10 |
| Source$^{(6)}$ | Kalinski Report | Kalinski Report | Seed-Idriss, Kokusho | Seed-Idriss, Kokusho | Seed-Idriss, Kokusho | Seed-Idriss, Kokusho | Seed-Idriss, Kokusho | Seed-Idriss, Kokusho | Kalinski Report | Kalinski Report | Kalinski Report | Seed-Idriss, Kokusho |
| **Small Strain Shear Modulus $G_{max}$ (psf)** | 1,839,790 | 568,271 | 4,712,248 | 4,488,812 | 2,676,022 | 4,790,943 | 4,747,781 | 6,258,440 | 6,816,193 | 7,245,081 | 7,245,081 | 6,258,440 |
| Source$^{(3)}$ | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report |
| **Poisson's Ratio $\nu$** | .468 | 0.495 | 0.468 | 0.352 | 0.352 | 0.352 | 0.468 | 0.352 | 0.468 | 0.468 | 0.468 | 0.352 |
| Source | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report |
| **Cyclic Number Function$^{(4,5)}$** | QUAKE | OSU | QUAKE | QUAKE | QUAKE | QUAKE | QUAKE | QUAKE | QUAKE | QUAKE | QUAKE | QUAKE |
| **Phi Angle $\varphi$ (degrees)** | 36 | 33 | 36 | 31 | 38 | 34 | 34 | 36 | 29 | 29 | 32 | 38 |
| Source | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ |

Notes:

(1) AEP Philip Sporn Electric Generating Plant Bottom Ash Facility - Engineering Report, 1996
(2) AEP Philip Sporn Power Plant Bottom Ash Disposal Facility - Stability Analysis, 2009
(3) $G_{max}$ derived from shear wave velocities from cross hole measurements
(4) Cyclic Number Function for fly ash based on data prepared by Ohio State University (OSU)
(5) Cyclic Number Function for other materials based on functions built into QUAKE/W computer program (QUAKE)
(6) Damping Ratios From:
- Kalinski Report
- Seed Idriss (SHAKE91 Users Manual)
- Kokusho (Geotchnical Earthquake Engineering by Kuo Towhata)

TABLE V.3. FESM AND QUAKE/W MATERIAL PARAMETERS FOR SECTION H-H ANALYSIS

| | **Silty Sand (1)** | **Silty Sand (2)** | **Gravelly Sand (3)** | **Silty Clay (4)** | **Silty Sand (5)** | **Sandy Silt (6)** | **Fly Ash (7)** | **Silty Sand (8)** |
|---|---|---|---|---|---|---|---|---|
| **Unit Weight γ (pcf)** | 130 | 107 | 105 | 115 | 131 | 130 | 90 | 112 |
| Source | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | GA | AEP$^{(1,2)}$ |
| **Damping Ratio λ (%)** | 10 | 10 | 10 | 10 | 7 | 7 | 4.5 | 10 |
| Source$^{(6)}$ | Seed-Idriss, Kokusho | Seed-Idriss, Kokusho | Seed-Idriss, Kokusho | Seed-Idriss, Kokusho | Kalinski Report | Kalinski Report | Kalinski Report | Seed-Idriss, Kokusho |
| **Small Strain Shear Modulus $G_{max}$ (psf)** | 1,944,493 | 3,182,930 | 3,123,436 | 3,420,906 | 1,959,450 | 1,933,302 | 774,831 | 3,331,665 |
| Source$^{(3)}$ | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report |
| **Poisson's Ratio ν** | 0.352 | 0.352 | 0.352 | 0.352 | 0.45 | 0.45 | 0.495 | 0.45 |
| Source | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report | Kalinski Report |
| **Cyclic Number Function$^{(4,5)}$** | QUAKE | QUAKE | QUAKE | QUAKE | QUAKE | QUAKE | OSU | QUAKE |
| **Phi Angle φ (degrees)** | 34 | 35 | 33 | 32 | 31 | 27 | 27 | 38 |
| Source | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ | AEP$^{(1,2)}$ |

Notes:

(1) AEP Philip Sporn Electric Generating Plant Fly Ash Facility - Engineering Report, 1998
(2) AEP Philip Sporn Power Plant Fly Ash Disposal Facility - Stability Analysis, 2009
(3) $G_{max}$ derived from shear wave velocities from cross hole measurements
(4) Cyclic Number Function for fly ash based on data prepared by Ohio State University (OSU)
(5) Cyclic Number Function for other materials based on functions built into QUAKE/W computer program (QUAKE)
(6) Damping Ratios From:
- Kalinski Report
- Seed Idriss (SHAKE91 Users Manual)
- Kokusho (Geotchnical Earthquake Engineering by Kuo Towhata)

## SLOPE STABILITY ANALYSIS RESULTS

Graphical output from the FESM slope stability analyses are provided in this appendix. Specifically, the results show the critical slip surface and corresponding safety factor for each of the modeled conditions. The slope stability analysis results are tabulated in Table V-4.

**TABLE V-4**
**SUMMARY OF FESM STABILITY FACTORS**

| Critical Section | Analysis Method | Rail Induced Vibration Loading Condition | Slope and Slip Surface Condition | Stability Factor |
|---|---|---|---|---|
| Bottom Ash Disposal Facility Section A-A | FESM | Location A (Exterior Toe) (11-11-09 12:12 pm Train) | Downstream (Shallow) | 4.06 |
| | | | Downstream (Deep) | 4.25 |
| | | Location B (Crest) (11-11-09 12:12 pm Train) | Upstream (Shallow) | 2.68 |
| | | | Upstream (Deep) | 2.72 |
| Fly Ash Disposal Facility Section H-H | FESM | Location C (Exterior Toe) (11-11-09 12:12 pm Train) | Downstream (Shallow) | 2.66 |
| | | | Downstream (Deep) | 2.75 |
| | | Location D (Crest) (11-11-09 12:12 pm Train) | Upstream (Shallow) | 1.78 |
| | | | Upstream (Deep) | 2.12 |

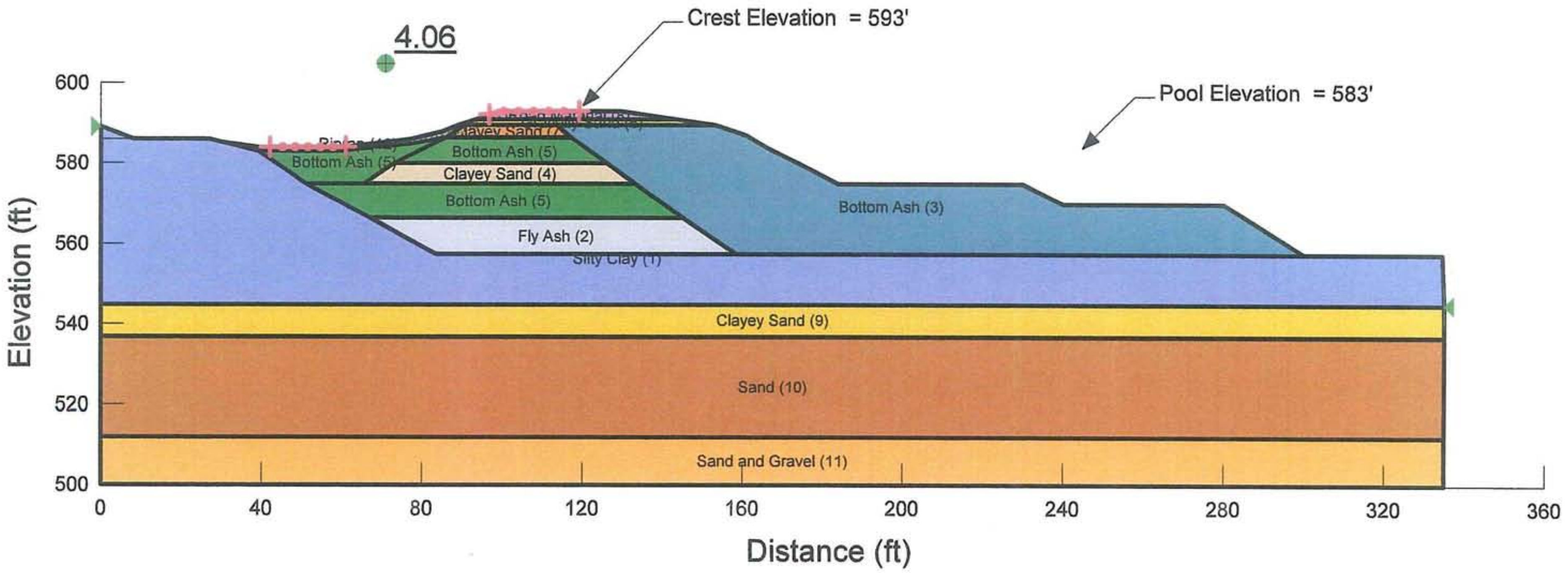
## SUMMARY OF RESULTS

GA used *QUAKE/W* to perform finite element stress analyses for Sections A-A of the Bottom Ash Disposal Facility Western Dike and Section H-H of the Fly Ash Disposal Facility Western Dike. Given the material parameters and railway induced loadings, *QUAKE/W* analyses were performed to delineate potential liquefaction zones. As shown in the liquefaction analysis results provided in this appendix; for the measured railway-induced vibrations, no liquefaction zones are predicted for Section A-A of the Bottom Ash Disposal Facility Western Dike or for Section H-H of the Fly Ash Disposal Facility Western Dike. It should be noted that vibration monitoring conducted at the crest and at the downstream bench of the Fly Ash Disposal Facility Eastern Dike (i.e., along Section K-K) yielded non-detectable vibration levels due to rail traffic during three monitoring events (i.e., on November 11, 2009; January 6, 2010; and January 7, 2010). Correspondingly, we believe that liquefaction of the fly ash material under the raised Eastern Dike of the Fly Ash Disposal Facility, due to railway induced ground vibration, is improbable.

GA used *SLOPE/W* to perform FESM stability analyses for Sections A-A of the Bottom Ash Disposal Facility Western Dike and Section H-H of the Fly Ash Disposal Facility Western Dike. The *SLOPE/W* program uses the Newmark Deformation Analysis Method to analyze the stability at specified time steps during a vibration event. The stresses within the western dikes for each time step were calculated by the associated *QUAKE/W* analysis. As shown in Table V-4, the FESM stability factors equal or exceed 2.68 for the Bottom Ash Disposal Facility Section A-A and 1.78 for the Fly Ash Disposal Facility Section H-H for the shallow-seated slip surface conditions. Moreover, the FESM stability factors exceed 2.72 for the Bottom Ash Disposal Facility Section A-A and 2.12 for the Fly Ash Disposal Facility Section H-H for the deep-seated (global) slip surface conditions. Based on the results obtained in our FESM stability assessment, we believe that railway induced vibrations will not have a significant/consequential impact on the slope stability of the dikes for the Bottom Ash and Fly Ash Disposal Facilities.

# BOTTOM ASH DISPOSAL FACILITY
# SECTION A-A
# FESM SLOPE STABILITY ANALYSIS RESULTS

Title: Sporn Bottom Ash Disposal Facility
Comments: FESM - Location A (Exterior Toe)
Railway Induced Vibration Loadings
Down Stream Shallow Failure Surface
File Name: BAP_A-A_Slope-DS_Shallow.gsz
Date: 5/3/2010



# Newmark Deformation

## File Information

Title: Sporn Bottom Ash Disposal Facility
Comments: FESM - Location A (Exterior Toe) Railway Induced Vibration Loadings Down Stream Shallow Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 165
Last Edited By: Seth Frank
Date: 5/3/2010
Time: 7:31:40 PM
File Name: BAP_A-A_Slope-DS_Shallow.gsz
Directory: E:\Final Analysis Files\BAP_A-A GA\Shallow\
Last Solved Date: 5/3/2010
Last Solved Time: 8:03:36 PM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### Newmark Deformation

Kind: SLOPE/W
Parent: Bottom Ash Pond A-A
Method: QUAKE/W Newmark Deformation
Settings
- Initial Stress: Parent Analysis
- PWP Conditions Source: Parent Analysis

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution

FOS Calculation Option: Constant

Time

Starting Time: 0 sec

Duration: 10 sec

# of Steps: 10240

Advanced

Number of Slices: 30

Optimization Tolerance: 0.01

Minimum Slip Surface Depth: 1 ft

Optimization Maximum Iterations: 2000

Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8

Ending Optimization Points: 16

Complete Passes per Insertion: 1

Driving Side Maximum Convex Angle: 5 °

Resisting Side Maximum Convex Angle: 1 °

## Materials

### Fly Ash (2)

Model: Mohr-Coulomb

Unit Weight: 139 pcf

Unit Wt. Above Water Table: 134 pcf

Cohesion: 0.1 psf

Phi: 33 °

Phi-B: 18 °

### Bottom Ash (3)

Model: Mohr-Coulomb

Unit Weight: 80 pcf

Unit Wt. Above Water Table: 80 pcf

Cohesion: 0.1 psf

Phi: 36 °

Phi-B: 20 °

### Clayey Sand (4)

Model: Mohr-Coulomb

Unit Weight: 105 pcf

Unit Wt. Above Water Table: 105 pcf

Cohesion: 0.1 psf

Phi: 31 °

Phi-B: 20 °

### Bottom Ash (5)

Model: Mohr-Coulomb

Unit Weight: 80 pcf

Unit Wt. Above Water Table: 62 pcf

Cohesion: 0.1 psf
Phi: 38 °
Phi-B: 20 °

## Gravelly Sand (6)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Unit Wt. Above Water Table: 111 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °

## Clayey Sand (7)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 104 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °

## Road Material (8)

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °

## Silty Clay (1)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °

## Clayey Sand (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °

## Sand (10)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °

## Sand and Gravel (11)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 18 °

### Riprap (12)

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (42, 584) ft
Left-Zone Right Coordinate: (61, 584.11765) ft
Left-Zone Increment: 6
Right Projection: Range
Right-Zone Left Coordinate: (96.63839, 592.14123) ft
Right-Zone Right Coordinate: (119, 593) ft
Right-Zone Increment: 6
Radius Increments: 10

## Slip Surface Limits

Left Coordinate: (0, 589) ft
Right Coordinate: (335, 545) ft

## Regions

| | Material | Points | Area (ft$^2$) |
|---|---|---|---|
| Region 1 | Sand (10) | 3,4,5,6 | 8375 |
| Region 2 | Sand and Gravel (11) | 6,5,2,1 | 4020 |
| Region 3 | Clayey Sand (9) | 7,8,4,3 | 2680 |
| Region 4 | Silty Clay (1) | 9,36,10,45,11,12,13,14,15,16,17,8,7 | 5834.125 |
| Region 5 | Fly Ash (2) | 13,18,15,14 | 688.5 |
| Region 6 | Bottom Ash (5) | 12,19,20,18,13 | 680 |
| Region 7 | Clayey Sand (4) | 19,21,22,20 | 301.25 |
| Region 8 | Bottom Ash (5) | 21,23,24,22 | 273 |
| Region 9 | Bottom Ash (5) | 11,12,19,21,23,39,38,37 | 243.875 |
| Region 10 | Clayey Sand (7) | 23,25,26,24 | 81 |
| Region 11 | Bottom Ash (3) | 26,27,28,29,34,30,35,31,16,15,18,20,22,24 | 2927.75 |
| Region 12 | Riprap (12) | 25,40,41,42,43,44,45,11,37,38,39,23 | 59.875 |
| Region 13 | Road Material (8) | 32,46,47,33 | 80.5 |
| Region 14 | Gravelly Sand (6) | 46,40,25,26,27,47 | 85.5 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 500 |
| Point 2 | 335 | 500 |
| Point 3 | 0 | 537 |
| Point 4 | 335 | 537 |
| Point 5 | 335 | 512 |
| Point 6 | 0 | 512 |
| Point 7 | 0 | 545 |
| Point 8 | 335 | 545 |
| Point 9 | 0 | 589 |
| Point 10 | 27 | 586 |
| Point 11 | 39 | 583 |
| Point 12 | 51 | 575 |
| Point 13 | 67 | 566.5 |
| Point 14 | 83.5 | 557.5 |
| Point 15 | 158.5 | 557.5 |
| Point 16 | 300 | 557.5 |
| Point 17 | 334.5 | 557.5 |
| Point 18 | 145 | 566.5 |
| Point 19 | 65.5 | 575 |
| Point 20 | 133 | 575 |
| Point 21 | 73 | 580 |
| Point 22 | 126 | 580 |
| Point 23 | 86 | 586.5 |
| Point 24 | 117 | 586.5 |
| Point 25 | 90.5 | 589.5 |
| Point 26 | 113.5 | 589.5 |
| Point 27 | 153 | 589.5 |
| Point 28 | 161 | 587 |
| Point 29 | 166 | 584 |
| Point 30 | 230 | 575 |
| Point 31 | 280 | 570 |
| Point 32 | 99 | 593 |
| Point 33 | 129.5 | 593 |
| Point 34 | 184 | 575 |
| Point 35 | 240 | 570 |
| Point 36 | 8 | 586 |
| Point 37 | 52 | 583 |
| Point 38 | 59 | 583 |
| Point 39 | 77.5 | 585 |
| Point 40 | 89 | 589.5 |
| Point 41 | 85 | 588 |
| Point 42 | 77 | 586 |
| Point 43 | 60 | 584 |
| Point 44 | 39 | 584 |
| Point 45 | 30 | 585.25 |

| | | |
|---|---|---|
| Point 46 | 93.5 | 591 |
| Point 47 | 143.5 | 591 |

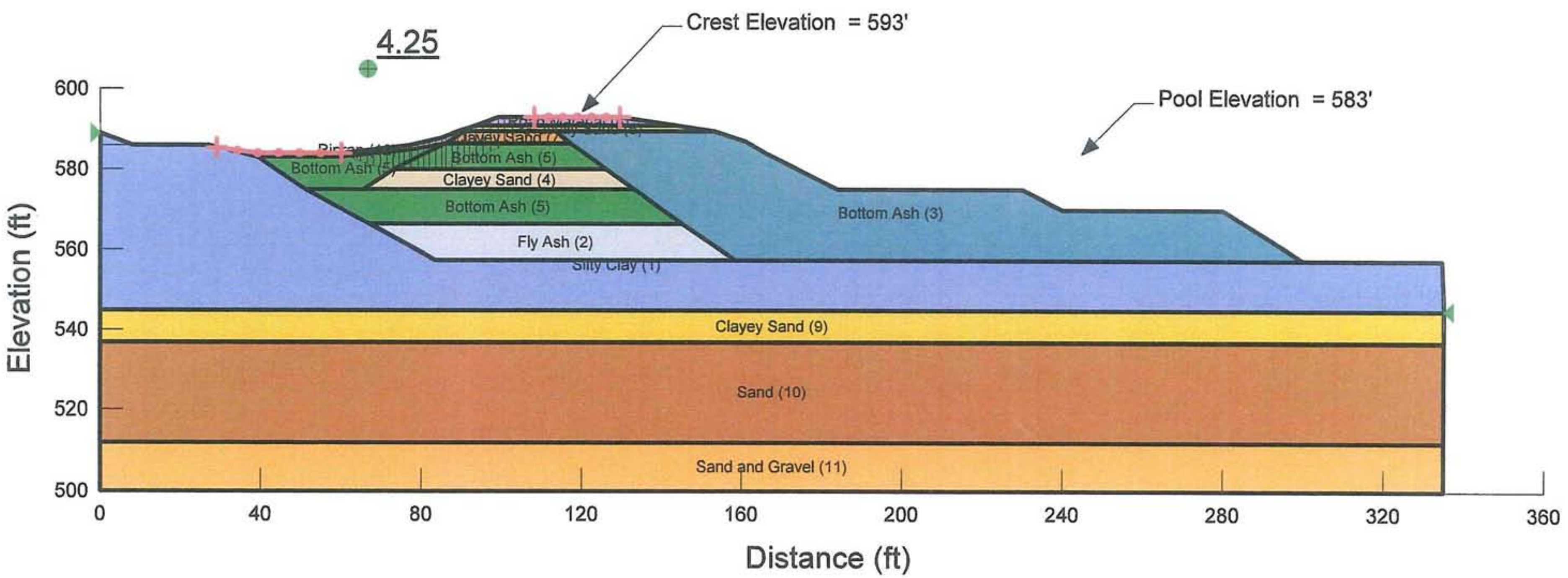
## Critical Slip Surfaces

| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 486 | 4.06 | (63.275, 681.586) | 97.495 | (103.991, 593) | (61, 584.118) |

### Slices of Slip Surface: 486

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 486 | 61.727275 | 584.10605 | 0 | 132.712 | 96.420914 | 0.1 |
| 2 | 486 | 63.18182 | 584.0938 | 0 | 126.4312 | 91.857646 | 0.1 |
| 3 | 486 | 64.636365 | 584.1033 | 0 | 122.17749 | 88.767139 | 0.1 |
| 4 | 486 | 66.09091 | 584.1345 | 0 | 118.46185 | 86.067573 | 0.1 |
| 5 | 486 | 67.545455 | 584.18735 | 0 | 114.04979 | 82.862026 | 0.1 |
| 6 | 486 | 69 | 584.262 | 0 | 120.11868 | 87.271328 | 0.1 |
| 7 | 486 | 70.454545 | 584.3585 | 0 | 133.8631 | 97.257235 | 0.1 |
| 8 | 486 | 71.90909 | 584.47685 | 0 | 141.86291 | 103.06944 | 0.1 |
| 9 | 486 | 73.363635 | 584.61715 | 0 | 145.45992 | 105.68282 | 0.1 |
| 10 | 486 | 74.81818 | 584.77955 | 0 | 145.91275 | 106.01182 | 0.1 |
| 11 | 486 | 76.272725 | 584.9641 | 0 | 144.40131 | 104.91369 | 0.1 |
| 12 | 486 | 77.666665 | 585.1614 | 0 | 146.39111 | 106.35937 | 0.1 |
| 13 | 486 | 79 | 585.36985 | 0 | 167.88772 | 121.97757 | 0.1 |
| 14 | 486 | 80.333335 | 585.5973 | 0 | 188.06356 | 136.63618 | 0.1 |
| 15 | 486 | 81.666665 | 585.84385 | 0 | 206.55368 | 150.07003 | 0.1 |
| 16 | 486 | 83 | 586.1096 | 0 | 223.10133 | 162.0926 | 0.1 |
| 17 | 486 | 84.333335 | 586.3948 | 0 | 237.52021 | 172.56853 | 0.1 |
| 18 | 486 | 85.82648 | 586.7388 | 0 | 250.8599 | 182.26039 | 0.1 |
| 19 | 486 | 87.23972 | 587.0841 | 0 | 255.17381 | 172.11691 | 0.1 |
| 20 | 486 | 88.41324 | 587.3895 | 0 | 257.80716 | 173.89313 | 0.1 |
| 21 | 486 | 89.75 | 587.7577 | 0 | 258.46195 | 174.33478 | 0.1 |
| 22 | 486 | 91.25 | 588.19395 | 0 | 256.60872 | 173.08477 | 0.1 |
| 23 | 486 | 92.75 | 588.6565 | 0 | 251.96996 | 169.95588 | 0.1 |
| 24 | 486 | 94.398915 | 589.1972 | 0 | 243.63425 | 164.33338 | 0.1 |
| 25 | 486 | 95.91486 | 589.7192 | 0 | 238.41867 | 160.81542 | 0.1 |
| 26 | 486 | 97.148915 | 590.16705 | 0 | 234.80978 | 158.3812 | 0.1 |
| 27 | 486 | 98.38297 | 590.63385 | 0 | 225.41613 | 152.0451 | 0.1 |
| 28 | 486 | 99.161615 | 590.936 | 0 | 216.47537 | 146.01448 | 0.1 |
| 29 | 486 | 100.10127 | 591.3174 | 0 | 231.2146 | 167.98724 | 0.1 |
| 30 | 486 | 101.6573 | 591.968 | 0 | 258.67814 | 187.94067 | 0.1 |
| 31 | 486 | 103.21335 | 592.6506 | 0 | 218.16197 | 158.50395 | 0.1 |

Title: Sporn Bottom Ash Disposal Facility
Comments: FESM - Location A (Exterior Toe)
Railway Induced Vibration Loadings
Down Stream Deep Failure Surface
File Name: BAP_A-A_Slope-DS_Deep.gsz
Date: 5/3/2010



# Newmark Deformation

## File Information

Title: Sporn Bottom Ash Disposal Facility
Comments: FESM - Location A (Exterior Toe) Railway Induced Vibration Loadings Down Stream Deep Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 167
Last Edited By: Seth Frank
Date: 5/3/2010
Time: 8:17:20 PM
File Name: BAP_A-A_Slope-DS_Deep.gsz
Directory: E:\Final Analysis Files\BAP_A-A GA\Deep\
Last Solved Date: 5/3/2010
Last Solved Time: 8:32:36 PM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### Newmark Deformation

Kind: SLOPE/W
Parent: Bottom Ash Pond A-A
Method: QUAKE/W Newmark Deformation
Settings
- Initial Stress: Parent Analysis
- PWP Conditions Source: Parent Analysis

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution

FOS Calculation Option: Constant

Time

Starting Time: 0 sec

Duration: 10 sec

# of Steps: 10240

Advanced

Number of Slices: 30

Optimization Tolerance: 0.01

Minimum Slip Surface Depth: 1 ft

Optimization Maximum Iterations: 2000

Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8

Ending Optimization Points: 16

Complete Passes per Insertion: 1

Driving Side Maximum Convex Angle: 5 °

Resisting Side Maximum Convex Angle: 1 °

## Materials

### Fly Ash (2)

Model: Mohr-Coulomb

Unit Weight: 139 pcf

Unit Wt. Above Water Table: 134 pcf

Cohesion: 0.1 psf

Phi: 33 °

Phi-B: 18 °

### Bottom Ash (3)

Model: Mohr-Coulomb

Unit Weight: 80 pcf

Unit Wt. Above Water Table: 80 pcf

Cohesion: 0.1 psf

Phi: 36 °

Phi-B: 20 °

### Clayey Sand (4)

Model: Mohr-Coulomb

Unit Weight: 105 pcf

Unit Wt. Above Water Table: 105 pcf

Cohesion: 0.1 psf

Phi: 31 °

Phi-B: 20 °

### Bottom Ash (5)

Model: Mohr-Coulomb

Unit Weight: 80 pcf

Unit Wt. Above Water Table: 62 pcf

Cohesion: 0.1 psf
Phi: 38 °
Phi-B: 20 °

## Gravelly Sand (6)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Unit Wt. Above Water Table: 111 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °

## Clayey Sand (7)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 104 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °

## Road Material (8)

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °

## Silty Clay (1)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °

## Clayey Sand (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °

## Sand (10)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °

## Sand and Gravel (11)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 18 °

### Riprap (12)

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (29, 585.5) ft
Left-Zone Right Coordinate: (60, 584) ft
Left-Zone Increment: 6
Right Projection: Range
Right-Zone Left Coordinate: (108, 593) ft
Right-Zone Right Coordinate: (129.5, 593) ft
Right-Zone Increment: 6
Radius Increments: 10

## Slip Surface Limits

Left Coordinate: (0, 589) ft
Right Coordinate: (335, 545) ft

## Regions

| | Material | Points | Area (ft$^2$) |
|---|---|---|---|
| Region 1 | Sand (10) | 3,4,5,6 | 8375 |
| Region 2 | Sand and Gravel (11) | 6,5,2,1 | 4020 |
| Region 3 | Clayey Sand (9) | 7,8,4,3 | 2680 |
| Region 4 | Silty Clay (1) | 9,36,10,45,11,12,13,14,15,16,17,8,7 | 5834.125 |
| Region 5 | Fly Ash (2) | 13,18,15,14 | 688.5 |
| Region 6 | Bottom Ash (5) | 12,19,20,18,13 | 680 |
| Region 7 | Clayey Sand (4) | 19,21,22,20 | 301.25 |
| Region 8 | Bottom Ash (5) | 21,23,24,22 | 273 |
| Region 9 | Bottom Ash (5) | 11,12,19,21,23,39,38,37 | 243.875 |
| Region 10 | Clayey Sand (7) | 23,25,26,24 | 81 |
| Region 11 | Bottom Ash (3) | 26,27,28,29,34,30,35,31,16,15,18,20,22,24 | 2927.75 |
| Region 12 | Riprap (12) | 25,40,41,42,43,44,45,11,37,38,39,23 | 59.875 |
| Region 13 | Road Material (8) | 32,46,47,33 | 80.5 |
| Region 14 | Gravelly Sand (6) | 46,40,25,26,27,47 | 85.5 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 500 |
| Point 2 | 335 | 500 |
| Point 3 | 0 | 537 |
| Point 4 | 335 | 537 |
| Point 5 | 335 | 512 |
| Point 6 | 0 | 512 |
| Point 7 | 0 | 545 |
| Point 8 | 335 | 545 |
| Point 9 | 0 | 589 |
| Point 10 | 27 | 586 |
| Point 11 | 39 | 583 |
| Point 12 | 51 | 575 |
| Point 13 | 67 | 566.5 |
| Point 14 | 83.5 | 557.5 |
| Point 15 | 158.5 | 557.5 |
| Point 16 | 300 | 557.5 |
| Point 17 | 334.5 | 557.5 |
| Point 18 | 145 | 566.5 |
| Point 19 | 65.5 | 575 |
| Point 20 | 133 | 575 |
| Point 21 | 73 | 580 |
| Point 22 | 126 | 580 |
| Point 23 | 86 | 586.5 |
| Point 24 | 117 | 586.5 |
| Point 25 | 90.5 | 589.5 |
| Point 26 | 113.5 | 589.5 |
| Point 27 | 153 | 589.5 |
| Point 28 | 161 | 587 |
| Point 29 | 166 | 584 |
| Point 30 | 230 | 575 |
| Point 31 | 280 | 570 |
| Point 32 | 99 | 593 |
| Point 33 | 129.5 | 593 |
| Point 34 | 184 | 575 |
| Point 35 | 240 | 570 |
| Point 36 | 8 | 586 |
| Point 37 | 52 | 583 |
| Point 38 | 59 | 583 |
| Point 39 | 77.5 | 585 |
| Point 40 | 89 | 589.5 |
| Point 41 | 85 | 588 |
| Point 42 | 77 | 586 |
| Point 43 | 60 | 584 |
| Point 44 | 39 | 584 |
| Point 45 | 30 | 585.25 |

| | | |
|---|---|---|
| Point 46 | 93.5 | 591 |
| Point 47 | 143.5 | 591 |

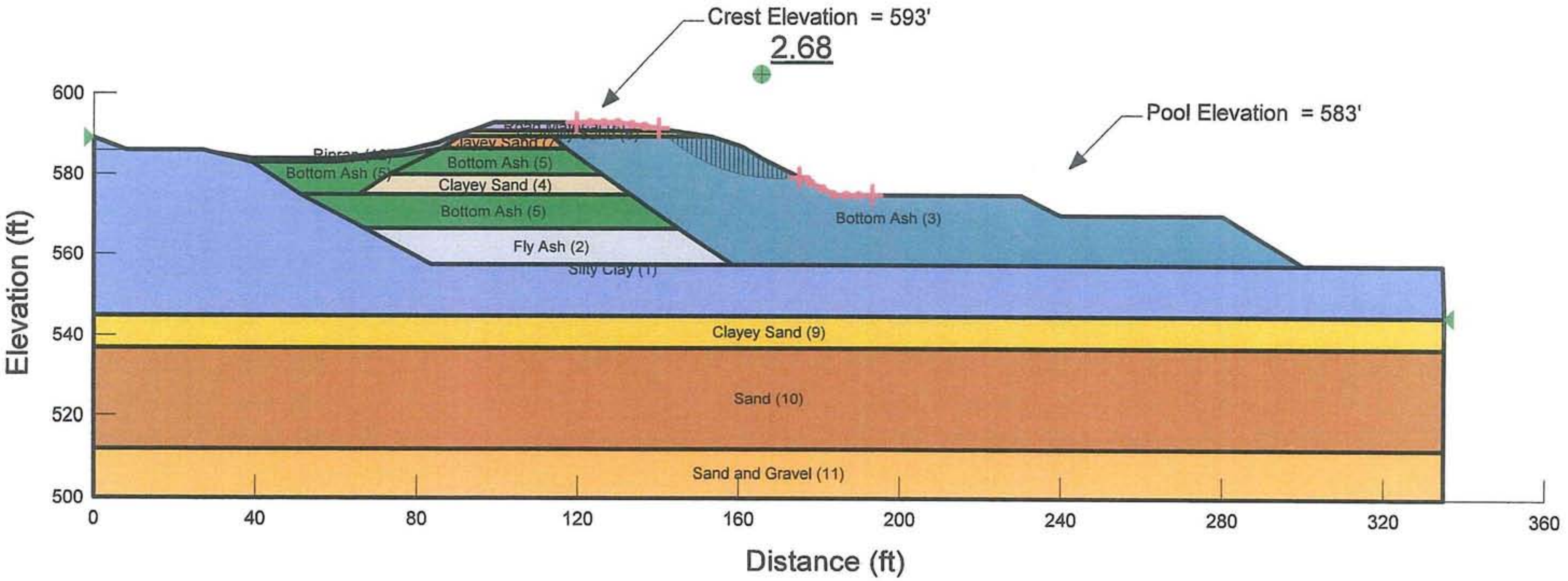
## Critical Slip Surfaces

| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 467 | 4.25 | (78.153, 619.683) | 40.035 | (108, 593) | (60, 584) |

### Slices of Slip Surface: 467

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 467 | 60.754865 | 583.63565 | 0 | 94.071581 | 68.347005 | 0.1 |
| 2 | 467 | 62.328745 | 582.9188 | 0 | 199.09944 | 155.55353 | 0.1 |
| 3 | 467 | 63.96678 | 582.25585 | 0 | 259.4939 | 202.73886 | 0.1 |
| 4 | 467 | 65.604815 | 581.675 | 0 | 313.9366 | 245.27415 | 0.1 |
| 5 | 467 | 67.24285 | 581.17255 | 0 | 362.96559 | 283.5798 | 0.1 |
| 6 | 467 | 68.880885 | 580.74545 | 0 | 407.1413 | 318.09365 | 0.1 |
| 7 | 467 | 70.518915 | 580.3913 | 0 | 447.00977 | 349.24231 | 0.1 |
| 8 | 467 | 72.15695 | 580.1081 | 0 | 483.13273 | 377.46466 | 0.1 |
| 9 | 467 | 73.65465 | 579.90725 | 0 | 523.89385 | 314.78718 | 0.1 |
| 10 | 467 | 75 | 579.7778 | 0 | 566.62148 | 340.46053 | 0.1 |
| 11 | 467 | 76.333335 | 579.69475 | 0 | 603.12592 | 362.39461 | 0.1 |
| 12 | 467 | 77.25 | 579.65875 | 0 | 625.34079 | 375.74265 | 0.1 |
| 13 | 467 | 78.243985 | 579.6548 | 0 | 645.34275 | 387.76104 | 0.1 |
| 14 | 467 | 79.73195 | 579.68585 | 0 | 670.26655 | 402.73677 | 0.1 |
| 15 | 467 | 81.219915 | 579.7724 | 0 | 688.24291 | 413.53806 | 0.1 |
| 16 | 467 | 82.70788 | 579.9148 | 0 | 699.27595 | 420.16738 | 0.1 |
| 17 | 467 | 84.22593 | 580.1188 | 0 | 701.28394 | 547.90306 | 0.1 |
| 18 | 467 | 85.5 | 580.33095 | 0 | 696.26985 | 543.98563 | 0.1 |
| 19 | 467 | 86.75 | 580.58925 | 0 | 688.93895 | 538.2581 | 0.1 |
| 20 | 467 | 88.25 | 580.9497 | 0 | 678.46098 | 530.07181 | 0.1 |
| 21 | 467 | 89.75 | 581.3722 | 0 | 666.27702 | 520.55266 | 0.1 |
| 22 | 467 | 91.25 | 581.8589 | 0 | 652.83881 | 510.05358 | 0.1 |
| 23 | 467 | 92.75 | 582.41235 | 0 | 638.51038 | 498.85898 | 0.1 |
| 24 | 467 | 94.416665 | 583.11375 | 0 | 621.79068 | 485.79612 | 0.1 |
| 25 | 467 | 96.25 | 583.98615 | 0 | 596.79897 | 466.27046 | 0.1 |
| 26 | 467 | 98.083335 | 584.9773 | 0 | 561.74514 | 438.8834 | 0.1 |
| 27 | 467 | 99.77595 | 586.00185 | 0 | 526.1106 | 411.04265 | 0.1 |
| 28 | 467 | 101.52775 | 587.20225 | 0 | 468.82362 | 316.22553 | 0.1 |
| 29 | 467 | 103.47945 | 588.70225 | 0 | 388.23216 | 261.8659 | 0.1 |
| 30 | 467 | 105.2694 | 590.25 | 0 | 272.29712 | 183.66673 | 0.1 |
| 31 | 467 | 107.04175 | 592 | 0 | 183.5753 | 133.37526 | 0.1 |

Title: Sporn Bottom Ash Disposal Facility
Comments: FESM - Location B (Crest)
Railway Induced Vibration Loadings
Up Stream Shallow Failure Surface
File Name: BAP_A-A_Slope-US_Shallow.gsz
Date: 5/3/2010



# Newmark Deformation

## File Information

- Title: Sporn Bottom Ash Disposal Facility
- Comments: FESM - Location B (Crest) Railway Induced Vibration Loadings Up Stream Shallow Failure Surface
- Created By: Seth W. Frank, E.I.
- Revision Number: 166
- Last Edited By: Seth Frank
- Date: 5/3/2010
- Time: 7:20:16 PM
- File Name: BAP_A-A_Slope-US_Shallow.gsz
- Directory: E:\Final Analysis Files\BAP_A-A GA\Shallow\
- Last Solved Date: 5/3/2010
- Last Solved Time: 7:37:36 PM

## Project Settings

- Length(L) Units: feet
- Time(t) Units: Seconds
- Force(F) Units: lbf
- Pressure(p) Units: psf
- Strength Units: psf
- Unit Weight of Water: 62.4 pcf
- View: 2D

## Analysis Settings

### Newmark Deformation

- Kind: SLOPE/W
- Parent: Bottom Ash Pond A-A
- Method: QUAKE/W Newmark Deformation
- Settings
  - Initial Stress: Parent Analysis
  - PWP Conditions Source: Parent Analysis
- SlipSurface
  - Direction of movement: Left to Right
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Optimize Critical Slip Surface Location: No
  - Tension Crack
    - Tension Crack Option: (none)
- FOS Distribution

FOS Calculation Option: Constant

Time

Starting Time: 0 sec

Duration: 10 sec

# of Steps: 10240

Advanced

Number of Slices: 30

Optimization Tolerance: 0.01

Minimum Slip Surface Depth: 1 ft

Optimization Maximum Iterations: 2000

Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8

Ending Optimization Points: 16

Complete Passes per Insertion: 1

Driving Side Maximum Convex Angle: 5 °

Resisting Side Maximum Convex Angle: 1 °

## Materials

### Fly Ash (2)

Model: Mohr-Coulomb

Unit Weight: 139 pcf

Unit Wt. Above Water Table: 134 pcf

Cohesion: 0.1 psf

Phi: 33 °

Phi-B: 18 °

### Bottom Ash (3)

Model: Mohr-Coulomb

Unit Weight: 80 pcf

Unit Wt. Above Water Table: 80 pcf

Cohesion: 0.1 psf

Phi: 36 °

Phi-B: 20 °

### Clayey Sand (4)

Model: Mohr-Coulomb

Unit Weight: 105 pcf

Unit Wt. Above Water Table: 105 pcf

Cohesion: 0.1 psf

Phi: 31 °

Phi-B: 20 °

### Bottom Ash (5)

Model: Mohr-Coulomb

Unit Weight: 80 pcf

Unit Wt. Above Water Table: 62 pcf

Cohesion: 0.1 psf
Phi: 38 °
Phi-B: 20 °

## Gravelly Sand (6)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Unit Wt. Above Water Table: 111 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °

## Clayey Sand (7)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 104 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °

## Road Material (8)

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °

## Silty Clay (1)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °

## Clayey Sand (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °

## Sand (10)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °

## Sand and Gravel (11)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 18 °

## Riprap (12)

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °

# Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (119.5, 593) ft
Left-Zone Right Coordinate: (140, 591.5) ft
Left-Zone Increment: 6
Right Projection: Range
Right-Zone Left Coordinate: (175, 579.5) ft
Right-Zone Right Coordinate: (193, 575) ft
Right-Zone Increment: 6
Radius Increments: 10

# Slip Surface Limits

Left Coordinate: (0, 589) ft
Right Coordinate: (335, 545) ft

# Regions

| | Material | Points | Area (ft$^2$) |
|---|---|---|---|
| Region 1 | Sand (10) | 3,4,5,6 | 8375 |
| Region 2 | Sand and Gravel (11) | 6,5,2,1 | 4020 |
| Region 3 | Clayey Sand (9) | 7,8,4,3 | 2680 |
| Region 4 | Silty Clay (1) | 9,36,10,45,11,12,13,14,15,16,17,8,7 | 5834.125 |
| Region 5 | Fly Ash (2) | 13,18,15,14 | 688.5 |
| Region 6 | Bottom Ash (5) | 12,19,20,18,13 | 680 |
| Region 7 | Clayey Sand (4) | 19,21,22,20 | 301.25 |
| Region 8 | Bottom Ash (5) | 21,23,24,22 | 273 |
| Region 9 | Bottom Ash (5) | 11,12,19,21,23,39,38,37 | 243.875 |
| Region 10 | Clayey Sand (7) | 23,25,26,24 | 81 |
| Region 11 | Bottom Ash (3) | 26,27,28,29,34,30,35,31,16,15,18,20,22,24 | 2927.75 |
| Region 12 | Riprap (12) | 25,40,41,42,43,44,45,11,37,38,39,23 | 59.875 |
| Region 13 | Road Material (8) | 32,46,47,33 | 80.5 |
| Region 14 | Gravelly Sand (6) | 46,40,25,26,27,47 | 85.5 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 500 |
| Point 2 | 335 | 500 |
| Point 3 | 0 | 537 |
| Point 4 | 335 | 537 |
| Point 5 | 335 | 512 |
| Point 6 | 0 | 512 |
| Point 7 | 0 | 545 |
| Point 8 | 335 | 545 |
| Point 9 | 0 | 589 |
| Point 10 | 27 | 586 |
| Point 11 | 39 | 583 |
| Point 12 | 51 | 575 |
| Point 13 | 67 | 566.5 |
| Point 14 | 83.5 | 557.5 |
| Point 15 | 158.5 | 557.5 |
| Point 16 | 300 | 557.5 |
| Point 17 | 334.5 | 557.5 |
| Point 18 | 145 | 566.5 |
| Point 19 | 65.5 | 575 |
| Point 20 | 133 | 575 |
| Point 21 | 73 | 580 |
| Point 22 | 126 | 580 |
| Point 23 | 86 | 586.5 |
| Point 24 | 117 | 586.5 |
| Point 25 | 90.5 | 589.5 |
| Point 26 | 113.5 | 589.5 |
| Point 27 | 153 | 589.5 |
| Point 28 | 161 | 587 |
| Point 29 | 166 | 584 |
| Point 30 | 230 | 575 |
| Point 31 | 280 | 570 |
| Point 32 | 99 | 593 |
| Point 33 | 129.5 | 593 |
| Point 34 | 184 | 575 |
| Point 35 | 240 | 570 |
| Point 36 | 8 | 586 |
| Point 37 | 52 | 583 |
| Point 38 | 59 | 583 |
| Point 39 | 77.5 | 585 |
| Point 40 | 89 | 589.5 |
| Point 41 | 85 | 588 |
| Point 42 | 77 | 586 |
| Point 43 | 60 | 584 |
| Point 44 | 39 | 584 |
| Point 45 | 30 | 585.25 |

| | | |
|---|---|---|
| Point 46 | 93.5 | 591 |
| Point 47 | 143.5 | 591 |

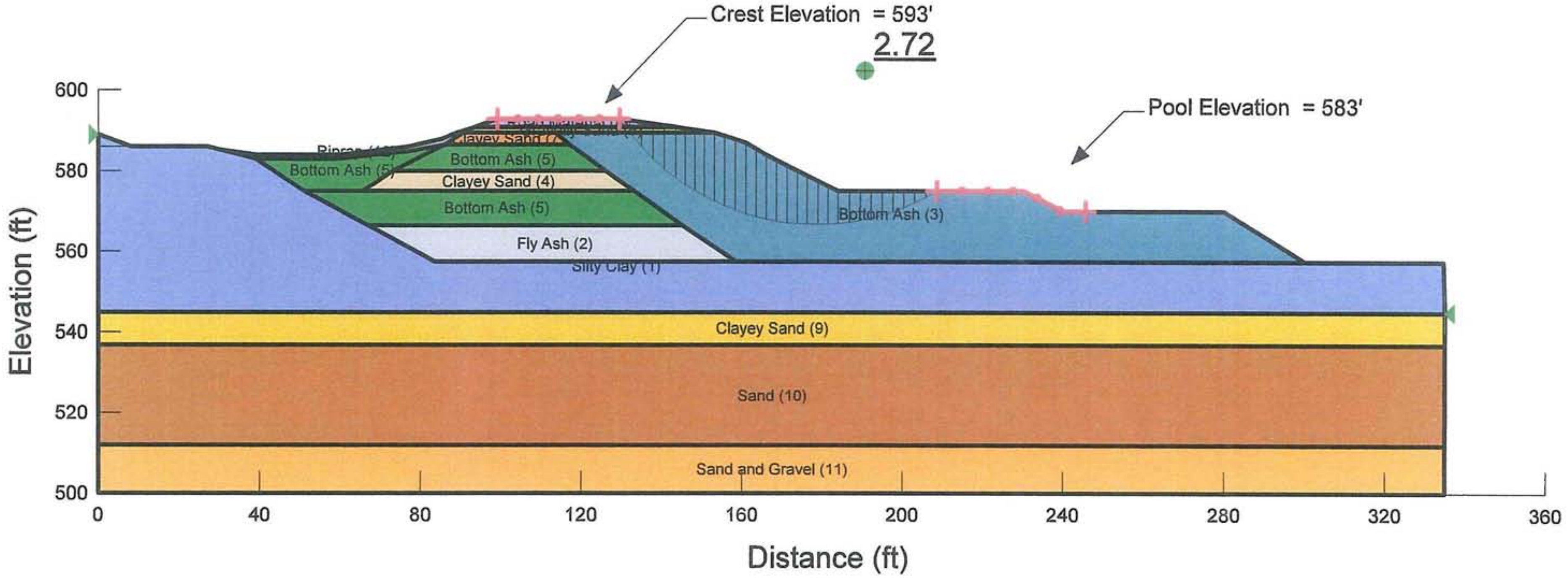
## Critical Slip Surfaces

| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 466 | 2.68 | (169.939, 621.781) | 42.583 | (140, 591.5) | (175, 579.5) |

### Slices of Slip Surface: 466

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 466 | 140.25715 | 591.25 | 0 | -26.485719 | -19.243002 | 0.1 |
| 2 | 466 | 141.34125 | 590.25 | 0 | 120.38016 | 81.197441 | 0.1 |
| 3 | 466 | 142.8341 | 588.9502 | 0 | 273.97966 | 199.05788 | 0.1 |
| 4 | 466 | 144.09375 | 587.94685 | 0 | 321.02098 | 233.2354 | 0.1 |
| 5 | 466 | 145.28125 | 587.0715 | 0 | 365.44787 | 265.51342 | 0.1 |
| 6 | 466 | 146.46875 | 586.2574 | 0 | 407.784 | 296.27242 | 0.1 |
| 7 | 466 | 147.65625 | 585.50045 | 0 | 448.16593 | 325.6116 | 0.1 |
| 8 | 466 | 148.84375 | 584.7971 | 0 | 485.77458 | 352.93589 | 0.1 |
| 9 | 466 | 150.03125 | 584.14435 | 0 | 513.93785 | 373.39771 | 0.1 |
| 10 | 466 | 151.21875 | 583.53965 | 0 | 533.44769 | 387.57243 | 0.1 |
| 11 | 466 | 152.40625 | 582.9807 | 0 | 543.66052 | 394.99249 | 0.1 |
| 12 | 466 | 153.57145 | 582.47445 | 0 | 544.06196 | 395.28415 | 0.1 |
| 13 | 466 | 154.7143 | 582.0177 | 0 | 534.55437 | 388.37648 | 0.1 |
| 14 | 466 | 155.85715 | 581.59865 | 0 | 514.68736 | 373.94226 | 0.1 |
| 15 | 466 | 157 | 581.2161 | 0 | 483.9991 | 351.64593 | 0.1 |
| 16 | 466 | 158.14285 | 580.86905 | 0 | 487.29797 | 354.0427 | 0.1 |
| 17 | 466 | 159.2857 | 580.55665 | 0 | 526.35413 | 382.41866 | 0.1 |
| 18 | 466 | 160.42855 | 580.27805 | 0 | 560.99891 | 407.58957 | 0.1 |
| 19 | 466 | 161.625 | 580.02265 | 0 | 592.53721 | 430.50348 | 0.1 |
| 20 | 466 | 162.875 | 579.79305 | 0 | 620.45587 | 450.78757 | 0.1 |
| 21 | 466 | 164.125 | 579.60175 | 0 | 642.84129 | 467.05154 | 0.1 |
| 22 | 466 | 165.375 | 579.4482 | 0 | 658.08176 | 478.12438 | 0.1 |
| 23 | 466 | 166.5625 | 579.33605 | 0 | 669.96292 | 486.75655 | 0.1 |
| 24 | 466 | 167.6875 | 579.2615 | 0 | 678.86232 | 493.22235 | 0.1 |
| 25 | 466 | 168.8125 | 579.21685 | 0 | 685.591 | 498.11102 | 0.1 |
| 26 | 466 | 169.9375 | 579.20195 | 0 | 690.20444 | 501.46288 | 0.1 |
| 27 | 466 | 171.0625 | 579.21675 | 0 | 692.75417 | 503.31537 | 0.1 |
| 28 | 466 | 172.1875 | 579.26135 | 0 | 693.29851 | 503.71085 | 0.1 |
| 29 | 466 | 173.3125 | 579.3358 | 0 | 691.87194 | 502.67439 | 0.1 |
| 30 | 466 | 174.4375 | 579.44025 | 0 | 688.51645 | 500.23648 | 0.1 |

Title: Sporn Bottom Ash Disposal Facility
Comments: FESM - Location B (Crest)
Railway Induced Vibration Loadings
Up Stream Deep Failure Surface
File Name: BAP_A-A_Slope-US_Deep.gsz
Date: 5/3/2010



# Newmark Deformation

leport generated using GeoStudio 2007, version 7.15. Copyright © 1991-2009 GEO-SLOPE International Ltd.

## File Information

Title: Sporn Bottom Ash Disposal Facility
Comments: FESM - Location B (Crest) Railway Induced Vibration Loadings Up Stream Deep Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 167
Last Edited By: Seth Frank
Date: 5/3/2010
Time: 8:03:02 PM
File Name: BAP_A-A_Slope-US_Deep.gsz
Directory: E:\Final Analysis Files\BAP_A-A GA\Deep\
Last Solved Date: 5/3/2010
Last Solved Time: 8:20:38 PM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### Newmark Deformation

Kind: SLOPE/W
Parent: Bottom Ash Pond A-A
Method: QUAKE/W Newmark Deformation
Settings
    Initial Stress: Parent Analysis
    PWP Conditions Source: Parent Analysis
SlipSurface
    Direction of movement: Left to Right
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: No
    Tension Crack
        Tension Crack Option: (none)
FOS Distribution

FOS Calculation Option: Constant

Time

Starting Time: 0 sec
Duration: 10 sec
# of Steps: 10240

Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 5 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

## Materials

### Fly Ash (2)

Model: Mohr-Coulomb
Unit Weight: 139 pcf
Unit Wt. Above Water Table: 134 pcf
Cohesion: 0.1 psf
Phi: 33 °
Phi-B: 18 °

### Bottom Ash (3)

Model: Mohr-Coulomb
Unit Weight: 80 pcf
Unit Wt. Above Water Table: 80 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °

### Clayey Sand (4)

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Unit Wt. Above Water Table: 105 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 20 °

### Bottom Ash (5)

Model: Mohr-Coulomb
Unit Weight: 80 pcf
Unit Wt. Above Water Table: 62 pcf

Cohesion: 0.1 psf
Phi: 38 °
Phi-B: 20 °

## Gravelly Sand (6)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Unit Wt. Above Water Table: 111 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °

## Clayey Sand (7)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 104 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 19 °

## Road Material (8)

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °

## Silty Clay (1)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °

## Clayey Sand (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °

## Sand (10)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 29 °
Phi-B: 15 °

## Sand and Gravel (11)

Model: Mohr-Coulomb
Unit Weight: 123 pcf
Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 18 °

### Riprap (12)

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0.1 psf
Phi: 36 °
Phi-B: 20 °

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (99, 593) ft
Left-Zone Right Coordinate: (129.5, 593) ft
Left-Zone Increment: 6
Right Projection: Range
Right-Zone Left Coordinate: (208.5, 575) ft
Right-Zone Right Coordinate: (245.5, 570) ft
Right-Zone Increment: 6
Radius Increments: 10

## Slip Surface Limits

Left Coordinate: (0, 589) ft
Right Coordinate: (335, 545) ft

## Regions

| | Material | Points | Area (ft$^2$) |
|---|---|---|---|
| Region 1 | Sand (10) | 3,4,5,6 | 8375 |
| Region 2 | Sand and Gravel (11) | 6,5,2,1 | 4020 |
| Region 3 | Clayey Sand (9) | 7,8,4,3 | 2680 |
| Region 4 | Silty Clay (1) | 9,36,10,45,11,12,13,14,15,16,17,8,7 | 5834.125 |
| Region 5 | Fly Ash (2) | 13,18,15,14 | 688.5 |
| Region 6 | Bottom Ash (5) | 12,19,20,18,13 | 680 |
| Region 7 | Clayey Sand (4) | 19,21,22,20 | 301.25 |
| Region 8 | Bottom Ash (5) | 21,23,24,22 | 273 |
| Region 9 | Bottom Ash (5) | 11,12,19,21,23,39,38,37 | 243.875 |
| Region 10 | Clayey Sand (7) | 23,25,26,24 | 81 |
| Region 11 | Bottom Ash (3) | 26,27,28,29,34,30,35,31,16,15,18,20,22,24 | 2927.75 |
| Region 12 | Riprap (12) | 25,40,41,42,43,44,45,11,37,38,39,23 | 59.875 |
| Region 13 | Road Material (8) | 32,46,47,33 | 80.5 |
| Region 14 | Gravelly Sand (6) | 46,40,25,26,27,47 | 85.5 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 500 |
| Point 2 | 335 | 500 |
| Point 3 | 0 | 537 |
| Point 4 | 335 | 537 |
| Point 5 | 335 | 512 |
| Point 6 | 0 | 512 |
| Point 7 | 0 | 545 |
| Point 8 | 335 | 545 |
| Point 9 | 0 | 589 |
| Point 10 | 27 | 586 |
| Point 11 | 39 | 583 |
| Point 12 | 51 | 575 |
| Point 13 | 67 | 566.5 |
| Point 14 | 83.5 | 557.5 |
| Point 15 | 158.5 | 557.5 |
| Point 16 | 300 | 557.5 |
| Point 17 | 334.5 | 557.5 |
| Point 18 | 145 | 566.5 |
| Point 19 | 65.5 | 575 |
| Point 20 | 133 | 575 |
| Point 21 | 73 | 580 |
| Point 22 | 126 | 580 |
| Point 23 | 86 | 586.5 |
| Point 24 | 117 | 586.5 |
| Point 25 | 90.5 | 589.5 |
| Point 26 | 113.5 | 589.5 |
| Point 27 | 153 | 589.5 |
| Point 28 | 161 | 587 |
| Point 29 | 166 | 584 |
| Point 30 | 230 | 575 |
| Point 31 | 280 | 570 |
| Point 32 | 99 | 593 |
| Point 33 | 129.5 | 593 |
| Point 34 | 184 | 575 |
| Point 35 | 240 | 570 |
| Point 36 | 8 | 586 |
| Point 37 | 52 | 583 |
| Point 38 | 59 | 583 |
| Point 39 | 77.5 | 585 |
| Point 40 | 89 | 589.5 |
| Point 41 | 85 | 588 |
| Point 42 | 77 | 586 |
| Point 43 | 60 | 584 |
| Point 44 | 39 | 584 |
| Point 45 | 30 | 585.25 |

| | | |
|---|---|---|
| Point 46 | 93.5 | 591 |
| Point 47 | 143.5 | 591 |

## Critical Slip Surfaces

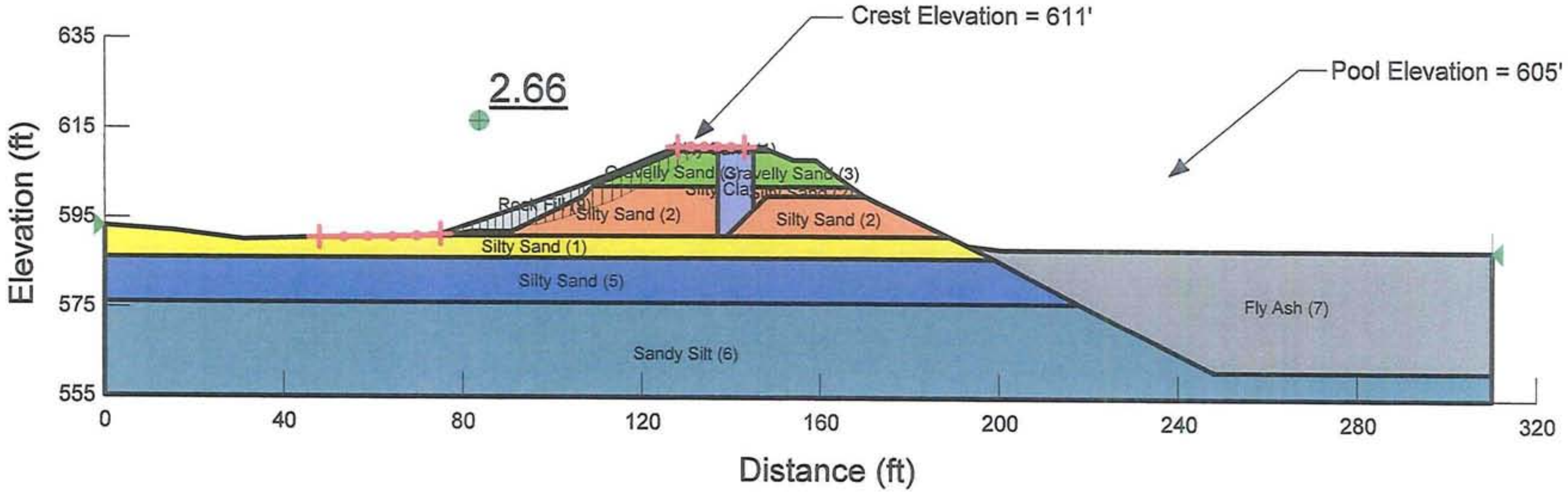
| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 468 | 2.72 | (178.486, 625.634) | 58.861 | (129.5, 593) | (208.5, 575) |

### Slices of Slip Surface: 468

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 468 | 130.1965 | 592 | 0 | -59.253752 | -43.050371 | 0.1 |
| 2 | 468 | 131.4573 | 590.25 | 0 | 127.20839 | 85.803145 | 0.1 |
| 3 | 468 | 133.4564 | 587.79265 | 0 | 336.0944 | 244.18687 | 0.1 |
| 4 | 468 | 136.326 | 584.61075 | 0 | 478.14785 | 347.39475 | 0.1 |
| 5 | 468 | 139.1956 | 581.8487 | 0 | 598.95429 | 435.16576 | 0.1 |
| 6 | 468 | 142.0652 | 579.4302 | 0 | 697.38458 | 506.67955 | 0.1 |
| 7 | 468 | 144.6875 | 577.46595 | 0 | 857.8771 | 623.28419 | 0.1 |
| 8 | 468 | 147.0625 | 575.88265 | 0 | 981.42837 | 713.04945 | 0.1 |
| 9 | 468 | 149.4375 | 574.45855 | 0 | 1083.5821 | 787.26851 | 0.1 |
| 10 | 468 | 151.8125 | 573.1806 | 0 | 1171.2392 | 850.95507 | 0.1 |
| 11 | 468 | 154.33335 | 571.97655 | 0 | 1252.7138 | 910.14987 | 0.1 |
| 12 | 468 | 157 | 570.85345 | 0 | 1321.999 | 960.48849 | 0.1 |
| 13 | 468 | 159.66665 | 569.8804 | 0 | 1353.1058 | 983.0889 | 0.1 |
| 14 | 468 | 162.25 | 569.0715 | 0 | 1363.1516 | 990.38759 | 0.1 |
| 15 | 468 | 164.75 | 568.41265 | 0 | 1365.7593 | 992.28223 | 0.1 |
| 16 | 468 | 167.2857 | 567.8633 | 0 | 1361.6935 | 989.3282 | 0.1 |
| 17 | 468 | 169.85715 | 567.4234 | 0 | 1379.7884 | 1002.475 | 0.1 |
| 18 | 468 | 172.4286 | 567.09975 | 0 | 1367.5352 | 993.57247 | 0.1 |
| 19 | 468 | 175 | 566.8904 | 0 | 1340.3971 | 973.85552 | 0.1 |
| 20 | 468 | 177.5714 | 566.7941 | 0 | 1299.0432 | 943.81011 | 0.1 |
| 21 | 468 | 180.14285 | 566.81035 | 0 | 1242.4741 | 902.71027 | 0.1 |
| 22 | 468 | 182.7143 | 566.9392 | 0 | 1209.3056 | 878.61198 | 0.1 |
| 23 | 468 | 185.3611 | 567.1919 | 0 | 1197.4862 | 870.02463 | 0.1 |
| 24 | 468 | 188.0833 | 567.577 | 0 | 1182.2059 | 858.92287 | 0.1 |
| 25 | 468 | 190.80555 | 568.0934 | 0 | 1164.2246 | 845.85868 | 0.1 |
| 26 | 468 | 193.5278 | 568.7447 | 0 | 1141.1109 | 829.06556 | 0.1 |
| 27 | 468 | 196.25 | 569.5356 | 0 | 1112.2987 | 808.13232 | 0.1 |
| 28 | 468 | 198.9722 | 570.47205 | 0 | 1078.1415 | 783.31565 | 0.1 |
| 29 | 468 | 201.69445 | 571.5617 | 0 | 1038.2906 | 754.36231 | 0.1 |
| 30 | 468 | 204.4167 | 572.8141 | 0 | 996.51714 | 724.01208 | 0.1 |
| 31 | 468 | 207.1389 | 574.24115 | 0 | 949.04593 | 689.52223 | 0.1 |

# FLY ASH DISPOSAL FACILITY
# SECTION H-H
# FESM SLOPE STABILITY ANALYSIS RESULTS

Title: Sporn Fly Ash Disposal Facility
Comments: FESM - Location C (Exterior Toe)
Railway Induced Vibration Loadings
Down Stream Shallow Failure Surface
File Name: FAP_H-H_Slope-DS_Toe Accel.gsz
Date: 5/3/2010



# Newmark Deformation

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## File Information

Title: Sporn Fly Ash Disposal Facility
Comments: FESM - Location C (Exterior Toe) Railway Induced Vibration Loadings Down Stream Shallow Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 169
Last Edited By: Seth Frank
Date: 5/3/2010
Time: 8:41:34 PM
File Name: FAP_H-H_Slope-DS_Toe Accel.gsz
Directory: E:\Final Analysis Files\FAP_H-H GA\Shallow\
Last Solved Date: 5/3/2010
Last Solved Time: 9:04:20 PM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### Newmark Deformation

Kind: SLOPE/W
Parent: Dynamic QUAKE/W
Method: QUAKE/W Newmark Deformation
Settings
    Initial Stress: Parent Analysis
    PWP Conditions Source: Parent Analysis
SlipSurface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: Yes
    Tension Crack
        Tension Crack Option: (none)
FOS Distribution

FOS Calculation Option: Constant

Time

Starting Time: 0 sec

Duration: 10 sec

# of Steps: 10240

Advanced

Number of Slices: 30

Optimization Tolerance: 0.01

Minimum Slip Surface Depth: 5 ft

Optimization Maximum Iterations: 2000

Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8

Ending Optimization Points: 16

Complete Passes per Insertion: 1

Driving Side Maximum Convex Angle: 5 °

Resisting Side Maximum Convex Angle: 1 °

## Materials

### Silty Sand (1)

Model: Mohr-Coulomb

Unit Weight: 130 pcf

Unit Wt. Above Water Table: 125 pcf

Cohesion: 0.1 psf

Phi: 34 °

Phi-B: 18 °

### Silty Sand (2)

Model: Mohr-Coulomb

Unit Weight: 112 pcf

Unit Wt. Above Water Table: 107 pcf

Cohesion: 0.1 psf

Phi: 35 °

Phi-B: 18 °

### Gravelly Sand (3)

Model: Mohr-Coulomb

Unit Weight: 110 pcf

Unit Wt. Above Water Table: 105 pcf

Cohesion: 0.1 psf

Phi: 33 °

Phi-B: 17 °

### Silty Clay (4)

Model: Mohr-Coulomb

Unit Weight: 120 pcf

Unit Wt. Above Water Table: 115 pcf

Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 17 °

## Silty Sand (5)

Model: Mohr-Coulomb
Unit Weight: 131 pcf
Unit Wt. Above Water Table: 126 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 16 °

## Sandy Silt (6)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 14 °

## Fly Ash (7)

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Unit Wt. Above Water Table: 102 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 15 °

## Rock Fill (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °

# Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (47.90981, 590.5) ft
Left-Zone Right Coordinate: (75, 591.30719) ft
Left-Zone Increment: 5
Right Projection: Range
Right-Zone Left Coordinate: (128.0816, 611) ft
Right-Zone Right Coordinate: (143, 611) ft
Right-Zone Increment: 5
Radius Increments: 10

## Slip Surface Limits

Left Coordinate: (0, 593) ft
Right Coordinate: (310, 588) ft

## Regions

| | Material | Points | Area (ft$^2$) |
|---|---|---|---|
| Region 1 | Sandy Silt (6) | 1,3,4,5,6,2 | 5355 |
| Region 2 | Silty Sand (5) | 7,8,4,3 | 2085 |
| Region 3 | Silty Sand (1) | 7,9,36,35,34,33,32,42,10,12,13,14,29,8 | 973.49995 |
| Region 4 | Silty Sand (2) | 11,37,38,39,16,12,10 | 420 |
| Region 5 | Silty Clay (4) | 16,17,18,19,20,13,12 | 134 |
| Region 6 | Gravelly Sand (3) | 41,17,16,39 | 148 |
| Region 7 | Silty Sand (2) | 19,20,23,24,22 | 51.5 |
| Region 8 | Silty Sand (1) | 40,26,21,18,17,41 | 19 |
| Region 9 | Silty Sand (2) | 13,20,23,24,14 | 324 |
| Region 10 | Gravelly Sand (3) | 21,27,28,22,19,18 | 121 |
| Region 11 | Fly Ash (7) | 30,31,6,5,4,8,29 | 2399 |
| Region 12 | Rock Fill (9) | 11,10,42,15,25,40,41,39,38,37 | 120.4339 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 555 |
| Point 2 | 310 | 555 |
| Point 3 | 0 | 576 |
| Point 4 | 218 | 576 |
| Point 5 | 248 | 561 |
| Point 6 | 310 | 561 |
| Point 7 | 0 | 586 |
| Point 8 | 199 | 586 |
| Point 9 | 0 | 590 |
| Point 10 | 76 | 591 |
| Point 11 | 82 | 592 |
| Point 12 | 137 | 591 |
| Point 13 | 139 | 591 |
| Point 14 | 189 | 591 |
| Point 15 | 106 | 602 |
| Point 16 | 137 | 602 |
| Point 17 | 137 | 610 |
| Point 18 | 145 | 610 |
| Point 19 | 145 | 602 |
| Point 20 | 145 | 597 |
| Point 21 | 149 | 610 |
| Point 22 | 167 | 602 |
| Point 23 | 148 | 600 |
| Point 24 | 170 | 600 |

| | | |
|---|---|---|
| Point 25 | 128 | 611 |
| Point 26 | 147 | 611 |
| Point 27 | 154 | 608 |
| Point 28 | 159 | 608 |
| Point 29 | 193 | 589 |
| Point 30 | 201 | 588 |
| Point 31 | 310 | 588 |
| Point 32 | 49.5 | 590.5 |
| Point 33 | 46.5 | 590.5 |
| Point 34 | 31 | 590 |
| Point 35 | 15.5 | 592 |
| Point 36 | 0 | 593 |
| Point 37 | 91 | 592 |
| Point 38 | 107 | 600 |
| Point 39 | 109 | 602 |
| Point 40 | 130 | 611 |
| Point 41 | 128 | 610 |
| Point 42 | 74 | 590.96226 |

## Critical Slip Surfaces

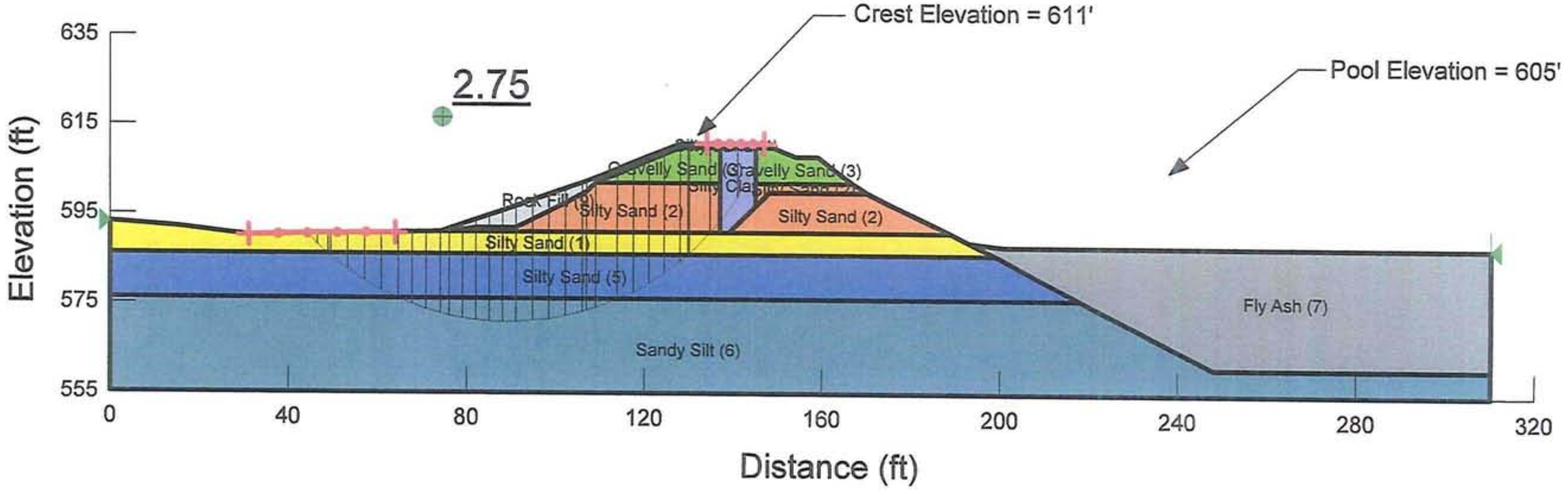
| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 355 | 2.66 | (75.638, 687.771) | 96.466 | (134.049, 611) | (75, 591.307) |

### Slices of Slip Surface: 355

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 355 | 75.751195 | 591.3081 | 0 | 284.64646 | 222.39019 | 0 |
| 2 | 355 | 77.253585 | 591.32155 | 0 | 322.85372 | 252.24097 | 0 |
| 3 | 355 | 79.003585 | 591.369 | 0 | 347.63371 | 243.41575 | 0.1 |
| 4 | 355 | 81.001195 | 591.4595 | 0 | 388.79775 | 272.23912 | 0.1 |
| 5 | 355 | 82.86595 | 591.5802 | 0 | 418.97026 | 293.36613 | 0.1 |
| 6 | 355 | 84.59785 | 591.72605 | 0 | 416.63337 | 291.72983 | 0.1 |
| 7 | 355 | 86.32975 | 591.9034 | 0 | 391.51011 | 274.13833 | 0.1 |
| 8 | 355 | 88.10062 | 592.1179 | 0 | 381.81666 | 298.30787 | 0 |
| 9 | 355 | 89.910465 | 592.3712 | 0 | 390.71273 | 305.25824 | 0 |
| 10 | 355 | 91.72031 | 592.6596 | 0 | 419.10351 | 327.43955 | 0 |
| 11 | 355 | 93.58057 | 592.99345 | 0 | 474.21604 | 332.04965 | 0.1 |
| 12 | 355 | 95.491255 | 593.37525 | 0 | 549.60758 | 384.83937 | 0.1 |
| 13 | 355 | 97.40194 | 593.79745 | 0 | 618.73647 | 433.24394 | 0.1 |
| 14 | 355 | 99.31264 | 594.2606 | 0 | 657.84934 | 460.63107 | 0.1 |
| 15 | 355 | 101.2233 | 594.7653 | 0 | 683.61809 | 478.67454 | 0.1 |
| 16 | 355 | 103.13395 | 595.3122 | 0 | 704.68144 | 493.42326 | 0.1 |
| 17 | 355 | 105.04465 | 595.9021 | 0 | 721.3706 | 505.10913 | 0.1 |
| 18 | 355 | 106.5 | 596.37675 | 0 | 731.61234 | 512.28048 | 0.1 |
| 19 | 355 | 108 | 596.90175 | 0 | 706.38873 | 494.61871 | 0.1 |
| 20 | 355 | 110.0785 | 597.67015 | 0 | 655.8395 | 459.22377 | 0.1 |
| 21 | 355 | 112.23555 | 598.5247 | 0 | 613.37536 | 429.49005 | 0.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 22 | 355 | 114.3926 | 599.4402 | 0 | 588.48952 | 412.06479 | 0.1 |
| 23 | 355 | 116.54965 | 600.4185 | 0 | 572.14853 | 400.62271 | 0.1 |
| 24 | 355 | 118.7067 | 601.4618 | 0 | 553.6596 | 387.67663 | 0.1 |
| 25 | 355 | 120.81205 | 602.5443 | 0 | 506.71926 | 329.06733 | 0.1 |
| 26 | 355 | 122.86575 | 603.6652 | 0 | 461.2928 | 299.56705 | 0.1 |
| 27 | 355 | 124.91945 | 604.8521 | 0 | 426.48823 | 276.96469 | 0.1 |
| 28 | 355 | 126.97315 | 606.1079 | 0 | 399.09242 | 259.17364 | 0.1 |
| 29 | 355 | 129 | 607.4175 | 0 | 353.58683 | 229.62197 | 0.1 |
| 30 | 355 | 131.3554 | 609.0408 | 0 | 273.07778 | 177.33878 | 0.1 |
| 31 | 355 | 133.3799 | 610.5 | 0 | 185.32641 | 125.00424 | 0.1 |

Title: Sporn Fly Ash Disposal Facility
Comments: FESM - Location C (Exterior Toe)
Railway Induced Vibration Loadings
Down Stream Deep Failure Surface
File Name: FAP_H-H_Slope-DS_Toe Accel.gsz
Date: 5/3/2010



# Newmark Deformation

## File Information

Title: Sporn Fly Ash Disposal Facility
Comments: FESM - Location C (Exterior Toe) Railway Induced Vibration Loadings Down Stream Deep Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 167
Last Edited By: Seth Frank
Date: 5/3/2010
Time: 11:30:08 AM
File Name: FAP_H-H_Slope-DS_Toe Accel.gsz
Directory: E:\Final Analysis Files\FAP_H-H GA\Deep\
Last Solved Date: 5/3/2010
Last Solved Time: 11:45:02 AM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### Newmark Deformation

Kind: SLOPE/W
Parent: Dynamic QUAKE/W
Method: QUAKE/W Newmark Deformation
Settings
  Initial Stress: Parent Analysis
  PWP Conditions Source: Parent Analysis
SlipSurface
  Direction of movement: Right to Left
  Use Passive Mode: No
  Slip Surface Option: Entry and Exit
  Critical slip surfaces saved: 1
  Optimize Critical Slip Surface Location: Yes
  Tension Crack
    Tension Crack Option: (none)
FOS Distribution

FOS Calculation Option: Constant

Time

Starting Time: 0 sec

Duration: 10 sec

# of Steps: 10240

Advanced

Number of Slices: 30

Optimization Tolerance: 0.01

Minimum Slip Surface Depth: 10 ft

Optimization Maximum Iterations: 2000

Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8

Ending Optimization Points: 16

Complete Passes per Insertion: 1

Driving Side Maximum Convex Angle: 5 °

Resisting Side Maximum Convex Angle: 1 °

# Materials

## Silty Sand (1)

Model: Mohr-Coulomb

Unit Weight: 130 pcf

Unit Wt. Above Water Table: 125 pcf

Cohesion: 0.1 psf

Phi: 34 °

Phi-B: 18 °

## Silty Sand (2)

Model: Mohr-Coulomb

Unit Weight: 112 pcf

Unit Wt. Above Water Table: 107 pcf

Cohesion: 0.1 psf

Phi: 35 °

Phi-B: 18 °

## Gravelly Sand (3)

Model: Mohr-Coulomb

Unit Weight: 110 pcf

Unit Wt. Above Water Table: 105 pcf

Cohesion: 0.1 psf

Phi: 33 °

Phi-B: 17 °

## Silty Clay (4)

Model: Mohr-Coulomb

Unit Weight: 120 pcf

Unit Wt. Above Water Table: 115 pcf

Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 17 °

## Silty Sand (5)

Model: Mohr-Coulomb
Unit Weight: 131 pcf
Unit Wt. Above Water Table: 126 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 16 °

## Sandy Silt (6)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 14 °

## Fly Ash (7)

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Unit Wt. Above Water Table: 102 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 15 °

## Rock Fill (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °

# Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (31, 590) ft
Left-Zone Right Coordinate: (64, 590.77358) ft
Left-Zone Increment: 5
Right Projection: Range
Right-Zone Left Coordinate: (134, 611) ft
Right-Zone Right Coordinate: (147, 611) ft
Right-Zone Increment: 5
Radius Increments: 10

## Slip Surface Limits

Left Coordinate: (0, 593) ft
Right Coordinate: (310, 588) ft

## Regions

| | Material | Points | Area (ft²) |
|---|---|---|---|
| Region 1 | Sandy Silt (6) | 1,3,4,5,6,2 | 5355 |
| Region 2 | Silty Sand (5) | 7,8,4,3 | 2085 |
| Region 3 | Silty Sand (1) | 7,9,36,35,34,33,32,42,10,12,13,14,29,8 | 973.49995 |
| Region 4 | Silty Sand (2) | 11,37,38,39,16,12,10 | 420 |
| Region 5 | Silty Clay (4) | 16,17,18,19,20,13,12 | 134 |
| Region 6 | Gravelly Sand (3) | 41,17,16,39 | 148 |
| Region 7 | Silty Sand (2) | 19,20,23,24,22 | 51.5 |
| Region 8 | Silty Sand (1) | 40,26,21,18,17,41 | 19 |
| Region 9 | Silty Sand (2) | 13,20,23,24,14 | 324 |
| Region 10 | Gravelly Sand (3) | 21,27,28,22,19,18 | 121 |
| Region 11 | Fly Ash (7) | 30,31,6,5,4,8,29 | 2399 |
| Region 12 | Rock Fill (9) | 11,10,42,15,25,40,41,39,38,37 | 120.4339 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 555 |
| Point 2 | 310 | 555 |
| Point 3 | 0 | 576 |
| Point 4 | 218 | 576 |
| Point 5 | 248 | 561 |
| Point 6 | 310 | 561 |
| Point 7 | 0 | 586 |
| Point 8 | 199 | 586 |
| Point 9 | 0 | 590 |
| Point 10 | 76 | 591 |
| Point 11 | 82 | 592 |
| Point 12 | 137 | 591 |
| Point 13 | 139 | 591 |
| Point 14 | 189 | 591 |
| Point 15 | 106 | 602 |
| Point 16 | 137 | 602 |
| Point 17 | 137 | 610 |
| Point 18 | 145 | 610 |
| Point 19 | 145 | 602 |
| Point 20 | 145 | 597 |
| Point 21 | 149 | 610 |
| Point 22 | 167 | 602 |
| Point 23 | 148 | 600 |
| Point 24 | 170 | 600 |

| | | |
|---|---|---|
| Point 25 | 128 | 611 |
| Point 26 | 147 | 611 |
| Point 27 | 154 | 608 |
| Point 28 | 159 | 608 |
| Point 29 | 193 | 589 |
| Point 30 | 201 | 588 |
| Point 31 | 310 | 588 |
| Point 32 | 49.5 | 590.5 |
| Point 33 | 46.5 | 590.5 |
| Point 34 | 31 | 590 |
| Point 35 | 15.5 | 592 |
| Point 36 | 0 | 593 |
| Point 37 | 91 | 592 |
| Point 38 | 107 | 600 |
| Point 39 | 109 | 602 |
| Point 40 | 130 | 611 |
| Point 41 | 128 | 610 |
| Point 42 | 74 | 590.96226 |

## Critical Slip Surfaces

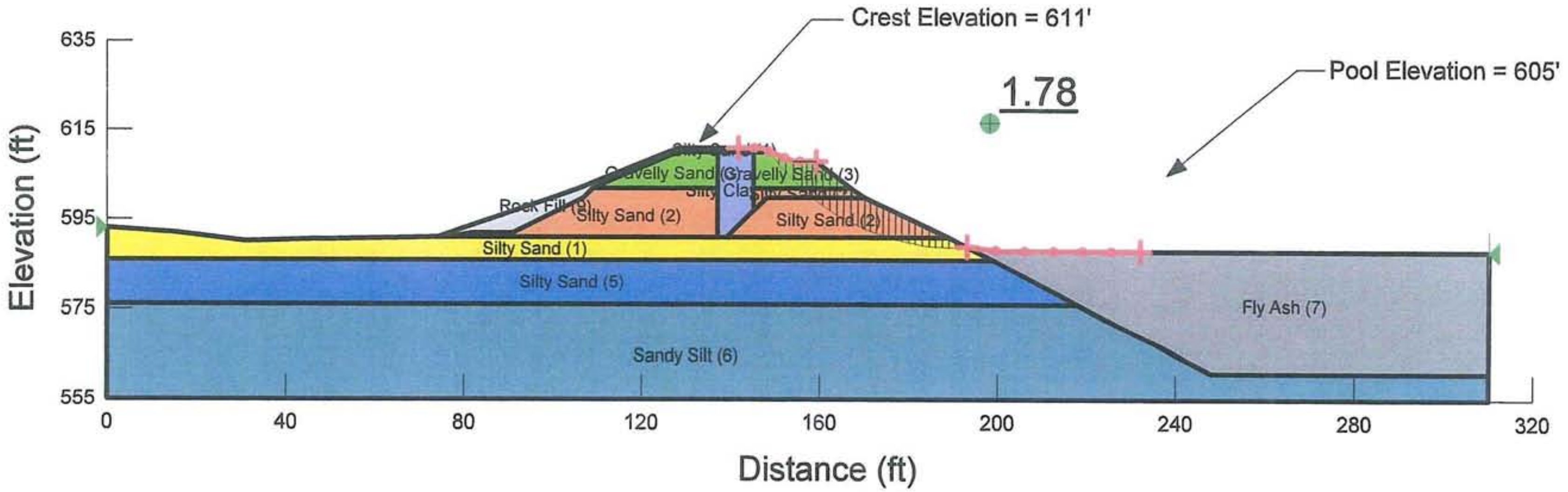
| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 195 | 2.75 | (89.238, 632.496) | 61.632 | (147, 611) | (44.1974, 590.426) |

### Slices of Slip Surface: 195

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 195 | 45.348695 | 589.2571 | 0 | 474.46624 | 320.03152 | 0.1 |
| 2 | 195 | 47.641025 | 587.04425 | 0 | 669.70015 | 451.71845 | 0.1 |
| 3 | 195 | 49.141025 | 585.69245 | 0 | 793.82407 | 476.97762 | 0.1 |
| 4 | 195 | 51.3882 | 583.91385 | 0 | 1032.4603 | 620.36472 | 0.1 |
| 5 | 195 | 55.1646 | 581.18885 | 0 | 1411.7303 | 848.25317 | 0.1 |
| 6 | 195 | 58.941005 | 578.86815 | 0 | 1721.5239 | 1034.3959 | 0.1 |
| 7 | 195 | 62.71741 | 576.9007 | 0 | 1991.1263 | 1196.3894 | 0.1 |
| 8 | 195 | 66.17134 | 575.3678 | 0 | 2222.2999 | 1132.3183 | 0.1 |
| 9 | 195 | 69.302805 | 574.2002 | 0 | 2413.5994 | 1229.7903 | 0.1 |
| 10 | 195 | 72.43427 | 573.22095 | 0 | 2609.3296 | 1329.5198 | 0.1 |
| 11 | 195 | 75 | 572.5396 | 0 | 2753.4299 | 1402.9426 | 0.1 |
| 12 | 195 | 77.5 | 572.011 | 0 | 2874.0821 | 1464.418 | 0.1 |
| 13 | 195 | 80.5 | 571.50505 | 0 | 3008.9453 | 1533.1342 | 0.1 |
| 14 | 195 | 83.5 | 571.1499 | 0 | 3138.5347 | 1599.1633 | 0.1 |
| 15 | 195 | 86.5 | 570.94285 | 0 | 3244.7254 | 1653.2702 | 0.1 |
| 16 | 195 | 89.5 | 570.8825 | 0 | 3327.9367 | 1695.6685 | 0.1 |
| 17 | 195 | 92.875 | 570.9998 | 0 | 3411.3721 | 1738.1809 | 0.1 |
| 18 | 195 | 96.625 | 571.33715 | 0 | 3470.244 | 1768.1776 | 0.1 |
| 19 | 195 | 100.375 | 571.9083 | 0 | 3491.1086 | 1778.8087 | 0.1 |
| 20 | 195 | 104.125 | 572.71995 | 0 | 3472.5924 | 1769.3742 | 0.1 |
| 21 | 195 | 106.5 | 573.3328 | 0 | 3443.903 | 1754.7562 | 0.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 22 | 195 | 108 | 573.7983 | 0 | 3413.7009 | 1739.3675 | 0.1 |
| 23 | 195 | 111.435 | 575.05895 | 0 | 3300.7106 | 1681.796 | 0.1 |
| 24 | 195 | 115.63625 | 576.8377 | 0 | 3123.2615 | 1876.6449 | 0.1 |
| 25 | 195 | 119.16875 | 578.65735 | 0 | 2935.4014 | 1763.7671 | 0.1 |
| 26 | 195 | 122.70125 | 580.7822 | 0 | 2680.1674 | 1610.407 | 0.1 |
| 27 | 195 | 126.23375 | 583.25205 | 0 | 2385.5102 | 1433.3591 | 0.1 |
| 28 | 195 | 128.84675 | 585.2895 | 0 | 2143.6187 | 1288.0161 | 0.1 |
| 29 | 195 | 129.84675 | 586.1342 | 0 | 2030.7327 | 1369.7465 | 0.1 |
| 30 | 195 | 132.4039 | 588.6342 | 0 | 1588.5956 | 1071.5212 | 0.1 |
| 31 | 195 | 135.9039 | 592.2716 | 0 | 1133.122 | 793.42059 | 0.1 |
| 32 | 195 | 139 | 596.2922 | 0 | 869.89263 | 543.56924 | 0.1 |
| 33 | 195 | 143 | 602.643 | 0 | 500.92104 | 313.0102 | 0.1 |
| 34 | 195 | 145.80895 | 608.1224 | 0 | 260.43552 | 169.1288 | 0.1 |
| 35 | 195 | 146.80895 | 610.5 | 0 | 164.66091 | 111.06519 | 0.1 |

Title: Sporn Fly Ash Disposal Facility
Comments: FESM - Location D (Crest)
Railway Induced Vibration Loadings
Up Stream Shallow Failure Surface
File Name: FAP_H-H_Slope-US_Crest Accel.gsz
Date: 5/3/2010



# Newmark Deformation

## File Information

- Title: Sporn Fly Ash Disposal Facility
- Comments: FESM - Location D (Crest) Railway Induced Vibration Loadings Up Stream Shallow Failure Surface
- Created By: Seth W. Frank, E.I.
- Revision Number: 169
- Last Edited By: Seth Frank
- Date: 5/3/2010
- Time: 10:39:44 AM
- File Name: FAP_H-H_Slope-US_Crest Accel.gsz
- Directory: E:\Final Analysis Files\FAP_H-H GA\Shallow\
- Last Solved Date: 5/3/2010
- Last Solved Time: 10:59:48 AM

## Project Settings

- Length(L) Units: feet
- Time(t) Units: Seconds
- Force(F) Units: lbf
- Pressure(p) Units: psf
- Strength Units: psf
- Unit Weight of Water: 62.4 pcf
- View: 2D

## Analysis Settings

### Newmark Deformation

- Kind: SLOPE/W
- Parent: Dynamic QUAKE/W
- Method: QUAKE/W Newmark Deformation
- Settings
  - Initial Stress: Parent Analysis
  - PWP Conditions Source: Parent Analysis
- SlipSurface
  - Direction of movement: Left to Right
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Optimize Critical Slip Surface Location: Yes
  - Tension Crack
    - Tension Crack Option: (none)
- FOS Distribution

FOS Calculation Option: Constant

Time

Starting Time: 0 sec
Duration: 5.499 sec
# of Steps: 5631

Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 5 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

## Materials

### Silty Sand (1)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 34 °
Phi-B: 18 °

### Silty Sand (2)

Model: Mohr-Coulomb
Unit Weight: 112 pcf
Unit Wt. Above Water Table: 107 pcf
Cohesion: 0.1 psf
Phi: 35 °
Phi-B: 18 °

### Gravelly Sand (3)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Unit Wt. Above Water Table: 105 pcf
Cohesion: 0.1 psf
Phi: 33 °
Phi-B: 17 °

### Silty Clay (4)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Unit Wt. Above Water Table: 115 pcf

Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 17 °

## Silty Sand (5)

Model: Mohr-Coulomb
Unit Weight: 131 pcf
Unit Wt. Above Water Table: 126 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 16 °

## Sandy Silt (6)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 14 °

## Fly Ash (7)

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Unit Wt. Above Water Table: 102 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 15 °

## Rock Fill (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °

# Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (141.5, 611) ft
Left-Zone Right Coordinate: (159, 608) ft
Left-Zone Increment: 5
Right Projection: Range
Right-Zone Left Coordinate: (193.1477, 588.98154) ft
Right-Zone Right Coordinate: (232, 588) ft
Right-Zone Increment: 6
Radius Increments: 10

## Slip Surface Limits

Left Coordinate: (0, 593) ft
Right Coordinate: (310, 588) ft

## Regions

| | Material | Points | Area (ft$^2$) |
|---|---|---|---|
| Region 1 | Sandy Silt (6) | 1,3,4,5,6,2 | 5355 |
| Region 2 | Silty Sand (5) | 7,8,4,3 | 2085 |
| Region 3 | Silty Sand (1) | 7,9,36,35,34,33,32,42,10,12,13,14,29,8 | 973.49995 |
| Region 4 | Silty Sand (2) | 11,37,38,39,16,12,10 | 420 |
| Region 5 | Silty Clay (4) | 16,17,18,19,20,13,12 | 134 |
| Region 6 | Gravelly Sand (3) | 41,17,16,39 | 148 |
| Region 7 | Silty Sand (2) | 19,20,23,24,22 | 51.5 |
| Region 8 | Silty Sand (1) | 40,26,21,18,17,41 | 19 |
| Region 9 | Silty Sand (2) | 13,20,23,24,14 | 324 |
| Region 10 | Gravelly Sand (3) | 21,27,28,22,19,18 | 121 |
| Region 11 | Fly Ash (7) | 30,31,6,5,4,8,29 | 2399 |
| Region 12 | Rock Fill (9) | 11,10,42,15,25,40,41,39,38,37 | 120.4339 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 555 |
| Point 2 | 310 | 555 |
| Point 3 | 0 | 576 |
| Point 4 | 218 | 576 |
| Point 5 | 248 | 561 |
| Point 6 | 310 | 561 |
| Point 7 | 0 | 586 |
| Point 8 | 199 | 586 |
| Point 9 | 0 | 590 |
| Point 10 | 76 | 591 |
| Point 11 | 82 | 592 |
| Point 12 | 137 | 591 |
| Point 13 | 139 | 591 |
| Point 14 | 189 | 591 |
| Point 15 | 106 | 602 |
| Point 16 | 137 | 602 |
| Point 17 | 137 | 610 |
| Point 18 | 145 | 610 |
| Point 19 | 145 | 602 |
| Point 20 | 145 | 597 |
| Point 21 | 149 | 610 |
| Point 22 | 167 | 602 |
| Point 23 | 148 | 600 |
| Point 24 | 170 | 600 |

| | | |
|---|---|---|
| Point 25 | 128 | 611 |
| Point 26 | 147 | 611 |
| Point 27 | 154 | 608 |
| Point 28 | 159 | 608 |
| Point 29 | 193 | 589 |
| Point 30 | 201 | 588 |
| Point 31 | 310 | 588 |
| Point 32 | 49.5 | 590.5 |
| Point 33 | 46.5 | 590.5 |
| Point 34 | 31 | 590 |
| Point 35 | 15.5 | 592 |
| Point 36 | 0 | 593 |
| Point 37 | 91 | 592 |
| Point 38 | 107 | 600 |
| Point 39 | 109 | 602 |
| Point 40 | 130 | 611 |
| Point 41 | 128 | 610 |
| Point 42 | 74 | 590.96226 |

## Critical Slip Surfaces

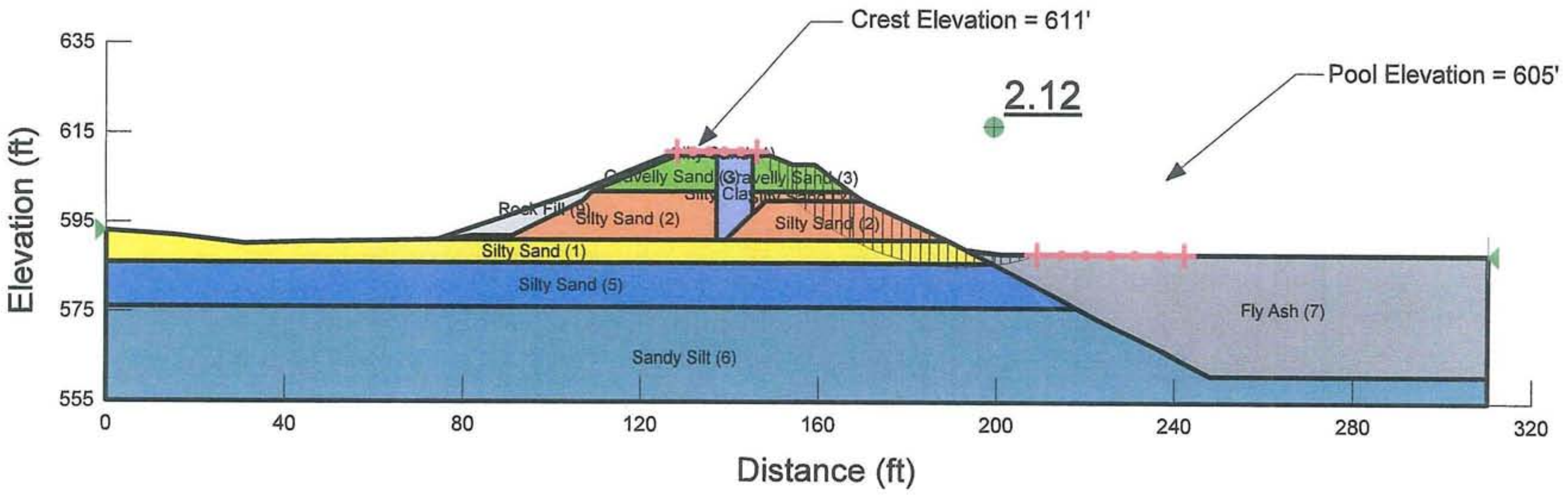
| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 159 | 1.78 | (189.993, 639.776) | 50.892 | (148.564, 610.218) | (193.148, 588.981) |

### Slices of Slip Surface: 159

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 159 | 148.6421 | 610.10905 | 0 | 162.50377 | 109.61018 | 0.1 |
| 2 | 159 | 148.86015 | 609.80805 | 0 | 173.56961 | 112.71742 | 0.1 |
| 3 | 159 | 149.83335 | 608.54455 | 0 | 202.07218 | 131.22721 | 0.1 |
| 4 | 159 | 151.5 | 606.50875 | 0 | 246.07613 | 159.80371 | 0.1 |
| 5 | 159 | 153.16665 | 604.67035 | 0 | 281.88175 | 183.05615 | 0.1 |
| 6 | 159 | 154.94495 | 602.8981 | 0 | 310.09631 | 201.3789 | 0.1 |
| 7 | 159 | 156.47875 | 601.4846 | 0 | 443.07922 | 310.24741 | 0.1 |
| 8 | 159 | 157.65645 | 600.4846 | 0 | 675.69428 | 473.12623 | 0.1 |
| 9 | 159 | 158.62265 | 599.7046 | 0 | 805.26342 | 563.85151 | 0.1 |
| 10 | 159 | 159.8 | 598.81945 | 0 | 869.51491 | 608.84089 | 0.1 |
| 11 | 159 | 161.4 | 597.68625 | 0 | 952.55328 | 666.98499 | 0.1 |
| 12 | 159 | 163 | 596.64215 | 0 | 1020.6785 | 714.68676 | 0.1 |
| 13 | 159 | 164.6 | 595.6808 | 0 | 1074.7243 | 752.53005 | 0.1 |
| 14 | 159 | 166.2 | 594.7969 | 0 | 1115.6518 | 781.18778 | 0.1 |
| 15 | 159 | 167.75 | 594.0092 | 0 | 1143.5643 | 800.73237 | 0.1 |
| 16 | 159 | 169.25 | 593.3099 | 0 | 1160.3026 | 812.4526 | 0.1 |
| 17 | 159 | 170.68365 | 592.69475 | 0 | 1177.4832 | 824.48262 | 0.1 |
| 18 | 159 | 172.05095 | 592.1568 | 0 | 1190.1136 | 833.32653 | 0.1 |
| 19 | 159 | 173.41825 | 591.6637 | 0 | 1199.3232 | 839.77512 | 0.1 |
| 20 | 159 | 174.78555 | 591.2141 | 0 | 1205.2935 | 843.95563 | 0.1 |
| 21 | 159 | 176.2209 | 590.78865 | 0 | 1228.9742 | 828.95354 | 0.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 22 | 159 | 177.7243 | 590.3906 | 0 | 1266.0058 | 853.93171 | 0.1 |
| 23 | 159 | 179.2277 | 590.04115 | 0 | 1296.4809 | 874.48738 | 0.1 |
| 24 | 159 | 180.73115 | 589.7393 | 0 | 1338.8804 | 903.08626 | 0.1 |
| 25 | 159 | 182.2346 | 589.4842 | 0 | 1369.3704 | 923.65202 | 0.1 |
| 26 | 159 | 183.738 | 589.2751 | 0 | 1389.4518 | 937.19708 | 0.1 |
| 27 | 159 | 185.2414 | 589.1115 | 0 | 1400.4422 | 944.61022 | 0.1 |
| 28 | 159 | 186.74485 | 588.99295 | 0 | 1403.8518 | 946.91003 | 0.1 |
| 29 | 159 | 188.2483 | 588.9191 | 0 | 1401.0401 | 945.01346 | 0.1 |
| 30 | 159 | 189.66665 | 588.88905 | 0 | 1392.8711 | 939.50342 | 0.1 |
| 31 | 159 | 191 | 588.898 | 0 | 1380.1791 | 930.94258 | 0.1 |
| 32 | 159 | 192.33335 | 588.9419 | 0 | 1364.0048 | 920.03288 | 0.1 |
| 33 | 159 | 193.0245 | 588.97405 | 0 | 1355.4562 | 914.26676 | 0.1 |
| 34 | 159 | 193.09835 | 588.9785 | 0 | 1355.3505 | 690.58557 | 0.1 |

Title: Sporn Fly Ash Disposal Facility
Comments: FESM - Location D (Crest)
Railway Induced Vibration Loadings
Up Stream Deep Failure Surface
File Name: FAP_H-H_Slope-US_Crest Accel.gsz
Date: 5/3/2010



# Newmark Deformation

## File Information

Title: Sporn Fly Ash Disposal Facility
Comments: FESM - Location D (Crest) Railway Induced Vibration Loadings Up Stream Deep Failure Surface
Created By: Seth W. Frank, E.I.
Revision Number: 173
Last Edited By: Seth Frank
Date: 5/3/2010
Time: 4:48:26 PM
File Name: FAP_H-H_Slope-US_Crest Accel.gsz
Directory: E:\Final Analysis Files\FAP_H-H GA\Deep\
Last Solved Date: 5/3/2010
Last Solved Time: 4:59:50 PM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### Newmark Deformation

Kind: SLOPE/W
Parent: Dynamic QUAKE/W
Method: QUAKE/W Newmark Deformation
Settings
  Initial Stress: Parent Analysis
  PWP Conditions Source: Parent Analysis
SlipSurface
  Direction of movement: Left to Right
  Use Passive Mode: No
  Slip Surface Option: Entry and Exit
  Critical slip surfaces saved: 1
  Optimize Critical Slip Surface Location: Yes
  Tension Crack
    Tension Crack Option: (none)
FOS Distribution

FOS Calculation Option: Constant

Time

Starting Time: 0 sec

Duration: 5.499 sec

# of Steps: 5631

Advanced

Number of Slices: 30

Optimization Tolerance: 0.01

Minimum Slip Surface Depth: 10 ft

Optimization Maximum Iterations: 2000

Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8

Ending Optimization Points: 16

Complete Passes per Insertion: 1

Driving Side Maximum Convex Angle: 5 °

Resisting Side Maximum Convex Angle: 1 °

## Materials

### Silty Sand (1)

Model: Mohr-Coulomb

Unit Weight: 130 pcf

Unit Wt. Above Water Table: 125 pcf

Cohesion: 0.1 psf

Phi: 34 °

Phi-B: 18 °

### Silty Sand (2)

Model: Mohr-Coulomb

Unit Weight: 112 pcf

Unit Wt. Above Water Table: 107 pcf

Cohesion: 0.1 psf

Phi: 35 °

Phi-B: 18 °

### Gravelly Sand (3)

Model: Mohr-Coulomb

Unit Weight: 110 pcf

Unit Wt. Above Water Table: 105 pcf

Cohesion: 0.1 psf

Phi: 33 °

Phi-B: 17 °

### Silty Clay (4)

Model: Mohr-Coulomb

Unit Weight: 120 pcf

Unit Wt. Above Water Table: 115 pcf

Cohesion: 0.1 psf
Phi: 32 °
Phi-B: 17 °

### Silty Sand (5)

Model: Mohr-Coulomb
Unit Weight: 131 pcf
Unit Wt. Above Water Table: 126 pcf
Cohesion: 0.1 psf
Phi: 31 °
Phi-B: 16 °

### Sandy Silt (6)

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Unit Wt. Above Water Table: 125 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 14 °

### Fly Ash (7)

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Unit Wt. Above Water Table: 102 pcf
Cohesion: 0.1 psf
Phi: 27 °
Phi-B: 15 °

### Rock Fill (9)

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (128, 611) ft
Left-Zone Right Coordinate: (146, 611) ft
Left-Zone Increment: 5
Right Projection: Range
Right-Zone Left Coordinate: (209, 588) ft
Right-Zone Right Coordinate: (242, 588) ft
Right-Zone Increment: 6
Radius Increments: 10

## Slip Surface Limits

Left Coordinate: (0, 593) ft
Right Coordinate: (310, 588) ft

## Regions

| | Material | Points | Area (ft$^2$) |
|---|---|---|---|
| Region 1 | Sandy Silt (6) | 1,3,4,5,6,2 | 5355 |
| Region 2 | Silty Sand (5) | 7,8,4,3 | 2085 |
| Region 3 | Silty Sand (1) | 7,9,36,35,34,33,32,42,10,12,13,14,29,8 | 973.49995 |
| Region 4 | Silty Sand (2) | 11,37,38,39,16,12,10 | 420 |
| Region 5 | Silty Clay (4) | 16,17,18,19,20,13,12 | 134 |
| Region 6 | Gravelly Sand (3) | 41,17,16,39 | 148 |
| Region 7 | Silty Sand (2) | 19,20,23,24,22 | 51.5 |
| Region 8 | Silty Sand (1) | 40,26,21,18,17,41 | 19 |
| Region 9 | Silty Sand (2) | 13,20,23,24,14 | 324 |
| Region 10 | Gravelly Sand (3) | 21,27,28,22,19,18 | 121 |
| Region 11 | Fly Ash (7) | 30,31,6,5,4,8,29 | 2399 |
| Region 12 | Rock Fill (9) | 11,10,42,15,25,40,41,39,38,37 | 120.4339 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 0 | 555 |
| Point 2 | 310 | 555 |
| Point 3 | 0 | 576 |
| Point 4 | 218 | 576 |
| Point 5 | 248 | 561 |
| Point 6 | 310 | 561 |
| Point 7 | 0 | 586 |
| Point 8 | 199 | 586 |
| Point 9 | 0 | 590 |
| Point 10 | 76 | 591 |
| Point 11 | 82 | 592 |
| Point 12 | 137 | 591 |
| Point 13 | 139 | 591 |
| Point 14 | 189 | 591 |
| Point 15 | 106 | 602 |
| Point 16 | 137 | 602 |
| Point 17 | 137 | 610 |
| Point 18 | 145 | 610 |
| Point 19 | 145 | 602 |
| Point 20 | 145 | 597 |
| Point 21 | 149 | 610 |
| Point 22 | 167 | 602 |
| Point 23 | 148 | 600 |
| Point 24 | 170 | 600 |

| | | |
|---|---|---|
| Point 25 | 128 | 611 |
| Point 26 | 147 | 611 |
| Point 27 | 154 | 608 |
| Point 28 | 159 | 608 |
| Point 29 | 193 | 589 |
| Point 30 | 201 | 588 |
| Point 31 | 310 | 588 |
| Point 32 | 49.5 | 590.5 |
| Point 33 | 46.5 | 590.5 |
| Point 34 | 31 | 590 |
| Point 35 | 15.5 | 592 |
| Point 36 | 0 | 593 |
| Point 37 | 91 | 592 |
| Point 38 | 107 | 600 |
| Point 39 | 109 | 602 |
| Point 40 | 130 | 611 |
| Point 41 | 128 | 610 |
| Point 42 | 74 | 590.96226 |

## Critical Slip Surfaces

| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 391 | 2.12 | (191.93, 639.025) | 53.805 | (146, 611) | (209, 588) |

### Slices of Slip Surface: 391

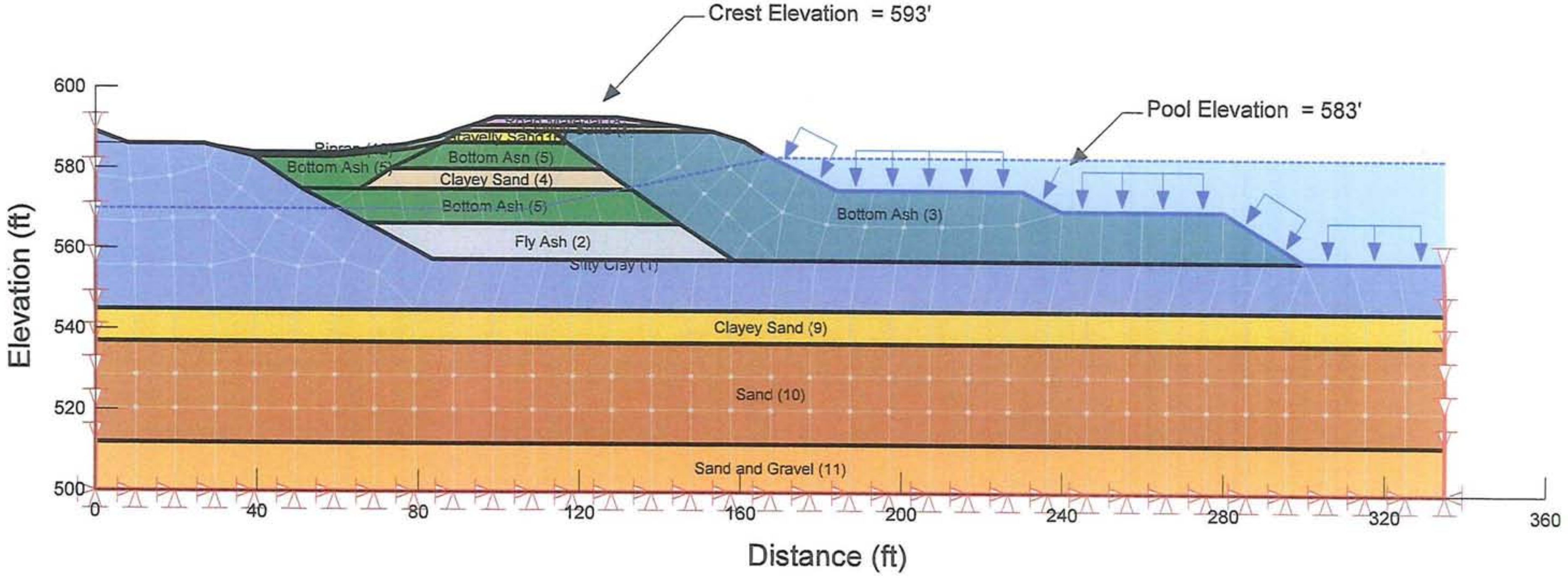
| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 391 | 146.31265 | 610.5 | 0 | 160.59657 | 108.32375 | 0.1 |
| 2 | 391 | 146.81265 | 609.71165 | 0 | 173.88004 | 112.91902 | 0.1 |
| 3 | 391 | 148 | 608.00705 | 0 | 256.31804 | 166.45488 | 0.1 |
| 4 | 391 | 149.97255 | 605.37805 | 0 | 316.66484 | 205.64455 | 0.1 |
| 5 | 391 | 151.91765 | 603.08265 | 0 | 365.45026 | 237.32618 | 0.1 |
| 6 | 391 | 153.4451 | 601.4319 | 0 | 509.48986 | 356.74864 | 0.1 |
| 7 | 391 | 154.4447 | 600.4319 | 0 | 722.0131 | 505.55902 | 0.1 |
| 8 | 391 | 155.91705 | 599.07365 | 0 | 869.3267 | 608.70911 | 0.1 |
| 9 | 391 | 157.97235 | 597.31075 | 0 | 982.33502 | 687.83839 | 0.1 |
| 10 | 391 | 160 | 595.7366 | 0 | 1091.2183 | 764.07926 | 0.1 |
| 11 | 391 | 162 | 594.32935 | 0 | 1181.7215 | 827.45027 | 0.1 |
| 12 | 391 | 164 | 593.0522 | 0 | 1249.0588 | 874.60041 | 0.1 |
| 13 | 391 | 166 | 591.8945 | 0 | 1294.8235 | 906.64515 | 0.1 |
| 14 | 391 | 167.33495 | 591.17215 | 0 | 1314.9288 | 920.72307 | 0.1 |
| 15 | 391 | 168.83495 | 590.44615 | 0 | 1388.9718 | 936.8733 | 0.1 |
| 16 | 391 | 171.06695 | 589.44335 | 0 | 1525.0999 | 1028.6929 | 0.1 |
| 17 | 391 | 173.20085 | 588.5981 | 0 | 1627.8763 | 1098.0164 | 0.1 |
| 18 | 391 | 175.33475 | 587.8558 | 0 | 1705.2759 | 1150.2231 | 0.1 |
| 19 | 391 | 177.4687 | 587.212 | 0 | 1759.5379 | 1186.8233 | 0.1 |
| 20 | 391 | 179.60265 | 586.663 | 0 | 1794.8675 | 1210.6534 | 0.1 |
| 21 | 391 | 181.73655 | 586.2059 | 0 | 1812.738 | 1222.7072 | 0.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 22 | 391 | 183.83625 | 585.84285 | 0 | 1805.8775 | 1085.0807 | 0.1 |
| 23 | 391 | 185.90175 | 585.5692 | 0 | 1785.4823 | 1072.826 | 0.1 |
| 24 | 391 | 187.96725 | 585.37645 | 0 | 1756.5748 | 1055.4566 | 0.1 |
| 25 | 391 | 190 | 585.2643 | 0 | 1748.374 | 1050.5291 | 0.1 |
| 26 | 391 | 192 | 585.2297 | 0 | 1759.7982 | 1057.3935 | 0.1 |
| 27 | 391 | 194 | 585.2695 | 0 | 1762.4931 | 1059.0127 | 0.1 |
| 28 | 391 | 196 | 585.3839 | 0 | 1757.2488 | 1055.8616 | 0.1 |
| 29 | 391 | 198 | 585.57335 | 0 | 1744.8351 | 1048.4027 | 0.1 |
| 30 | 391 | 199.236 | 585.71925 | 0 | 1726.017 | 1037.0956 | 0.1 |
| 31 | 391 | 200.236 | 585.871 | 0 | 1694.0834 | 863.17863 | 0.1 |
| 32 | 391 | 202 | 586.18095 | 0 | 1657.0309 | 844.29941 | 0.1 |
| 33 | 391 | 204 | 586.60175 | 0 | 1630.3437 | 830.7016 | 0.1 |
| 34 | 391 | 206 | 587.10295 | 0 | 1613.9898 | 822.3689 | 0.1 |
| 35 | 391 | 208 | 587.68695 | 0 | 1604.0017 | 817.2797 | 0.1 |

# BOTTOM ASH DISPOSAL FACILITY
# SECTION A-A
# LIQUEFACTION ANALYSIS RESULTS

Title: Sporn Bottom Ash Disposal Facility
Comments: QUAKE/W Finite Element Analysis
Accelerations at Toe
File Name: BAP_A-A_Quake_Toe Accel_Mesh.gsz
Date: 5/3/2010

# QUAKE/W MESH

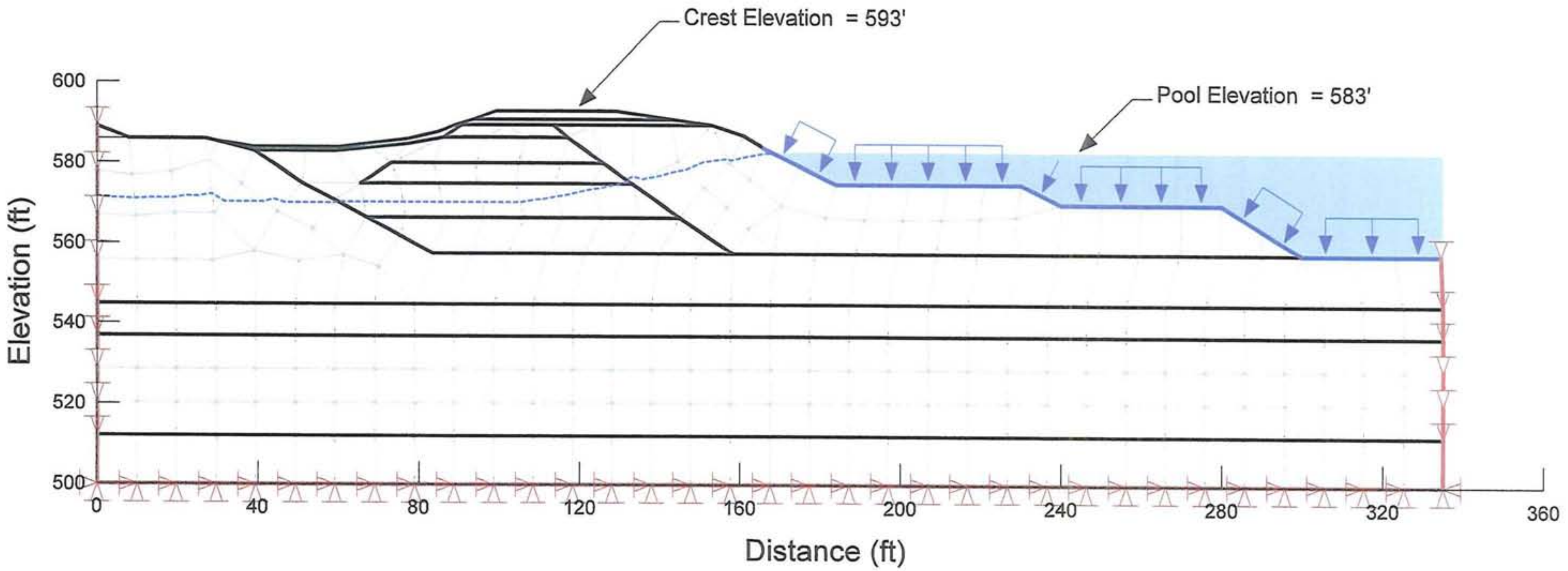


Title: Sporn Bottom Ash Disposal Facility
Comments: QUAKE/W Finite Element Analysis
Accelerations at Toe
File Name: BAP_A-A_Quake_Toe Accel.gsz
Date: 5/3/2010

# QUAKE/W MESH WITH LIQUEFIED ZONES
# NOTE: NO LIQUEFACTION PREDICTED

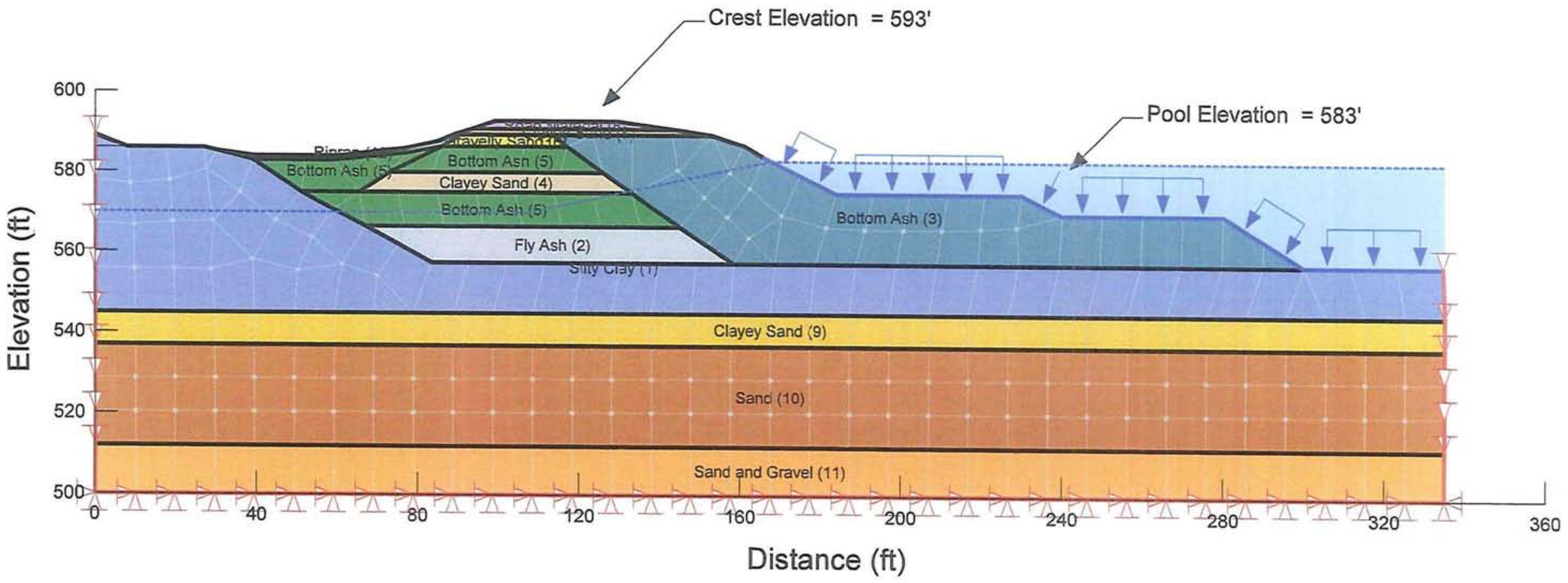
ELEMENT THAT DOES NOT LIQUEFY UNDER THE MODELED CONDITIONS → ◺

ELEMENT THAT LIQUEFIES UNDER THE MODELED CONDITIONS → ◺



Title: Sporn Bottom Ash Disposal Facility
Comments: QUAKE/W Finite Element Analysis
Accelerations at Crest
File Name: BAP_A-A_Quake_Crest Accel_Mesh.gsz
Date: 5/3/2010

# QUAKE/W MESH

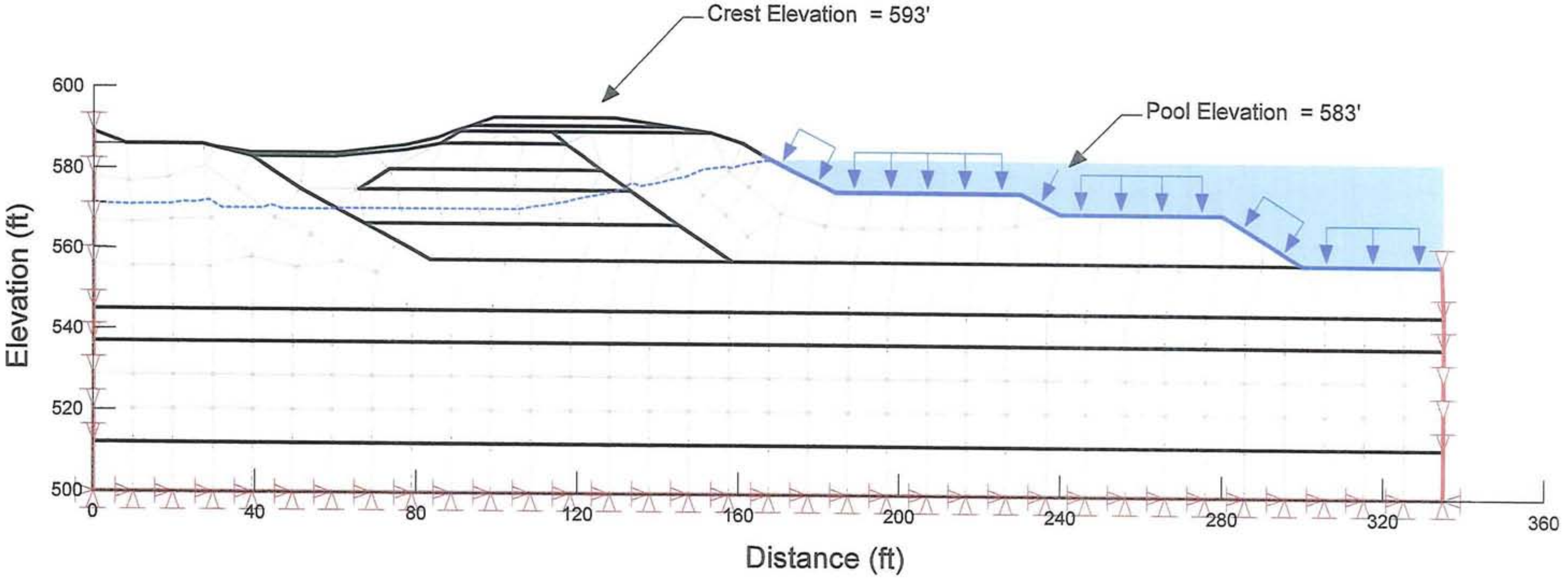


Title: Sporn Bottom Ash Disposal Facility
Comments: QUAKE/W Finite Element Analysis
Accelerations at Crest
File Name: BAP_A-A_Quake_Crest Accel.gsz
Date: 5/3/2010

## QUAKE/W MESH WITH LIQUEFIED ZONES
## NOTE: NO LIQUEFACTION PREDICTED

ELEMENT THAT DOES NOT LIQUEFY UNDER THE MODELED CONDITIONS ⟶ ◺

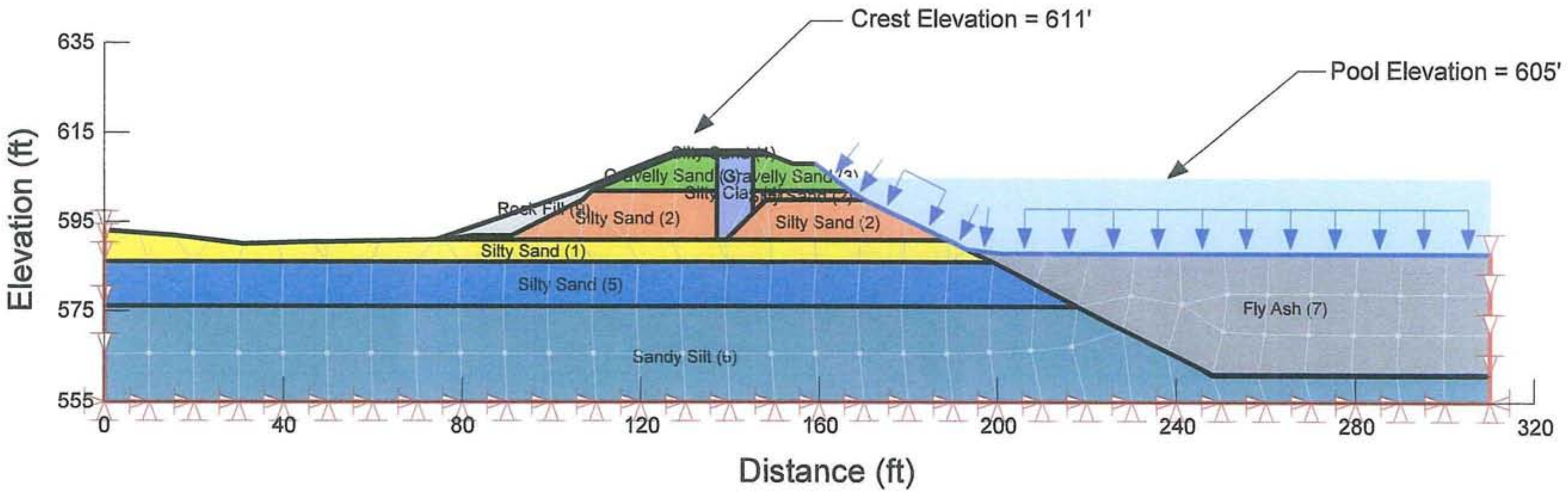
ELEMENT THAT LIQUEFIES UNDER THE MODELED CONDITIONS ⟶ ◺



# FLY ASH DISPOSAL FACILITY
# SECTION H-H
# LIQUEFACTION ANALYSIS RESULTS

Title: Sporn Fly Ash Disposal Facility
Comments: QUAKE/W Finite Element Analysis
Accelerations at Toe Location C
File Name: FAP_H-H_Quake_Toe Accel_Mesh.gsz
Date: 5/3/2010

## QUAKE/W MESH

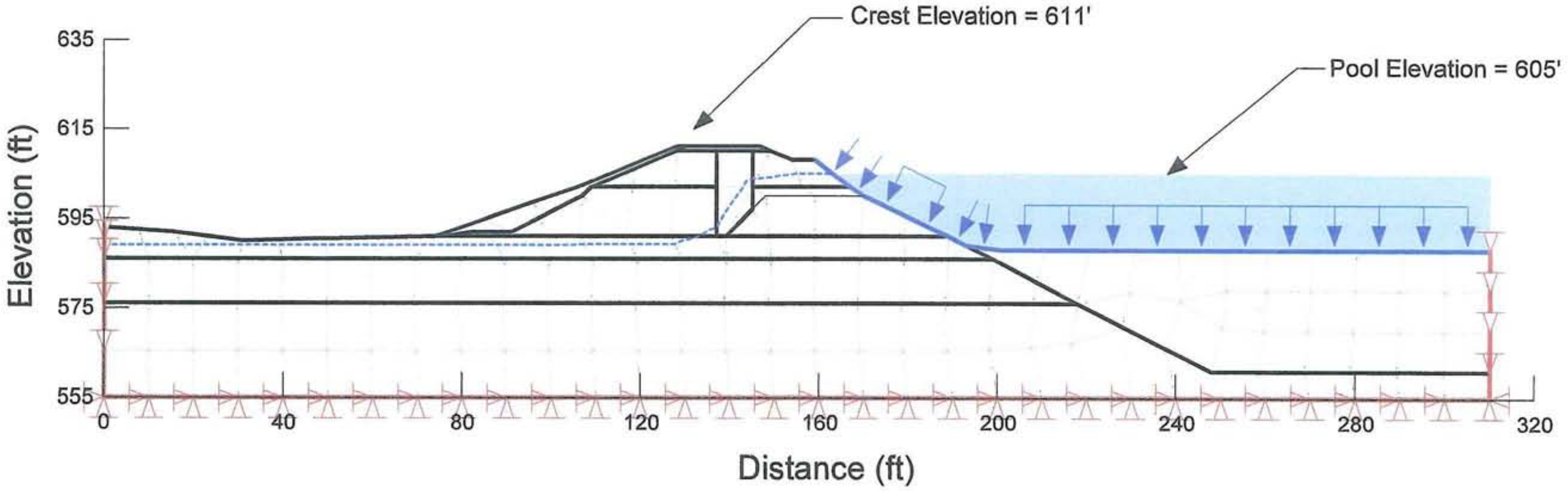


Title: Sporn Fly Ash Disposal Facility
Comments: QUAKE/W Finite Element Analysis
Accelerations at Toe Location C
File Name: FAP_H-H_Quake_Toe Accel.gsz
Date: 5/3/2010

## QUAKE/W MESH WITH LIQUEFIED ZONES
## NOTE: NO LIQUEFACTION PREDICTED

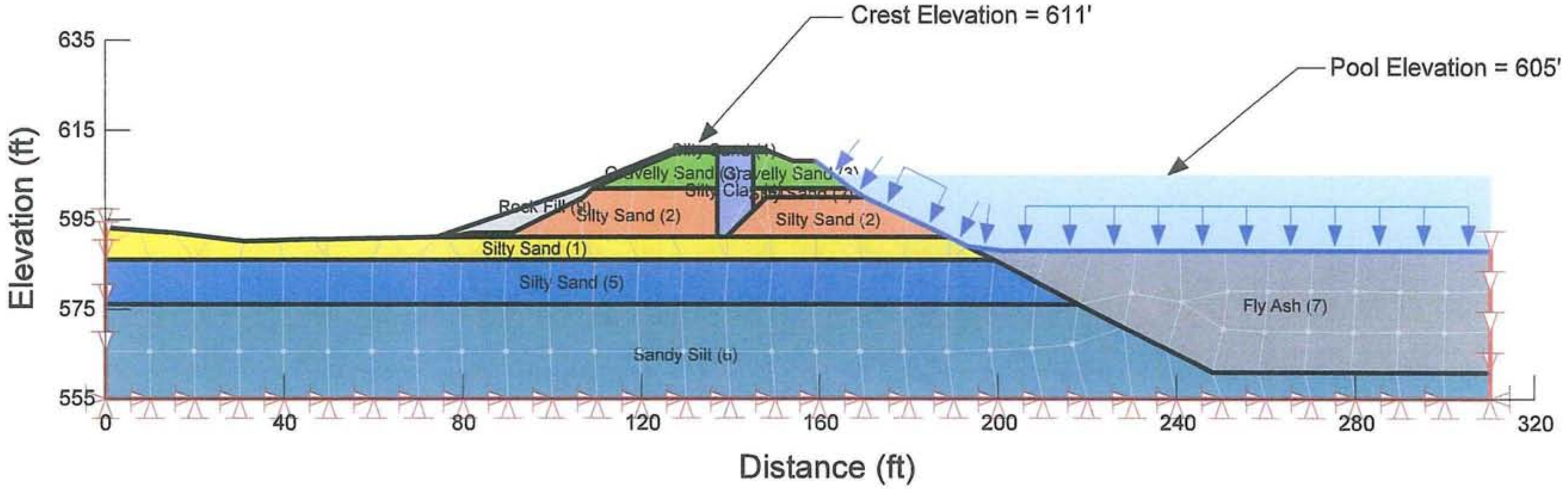
ELEMENT THAT DOES NOT LIQUEFY UNDER THE MODELED CONDITIONS → ◺

ELEMENT THAT LIQUEFIES UNDER THE MODELED CONDITIONS → ◺



Title: Sporn Fly Ash Disposal Facility
Comments: QUAKE/W Finite Element Analysis
Accelerations at Crest Location D
File Name: FAP_H-H_Quake_Crest Accel_Mesh.gsz
Date: 5/3/2010

# QUAKE/W MESH

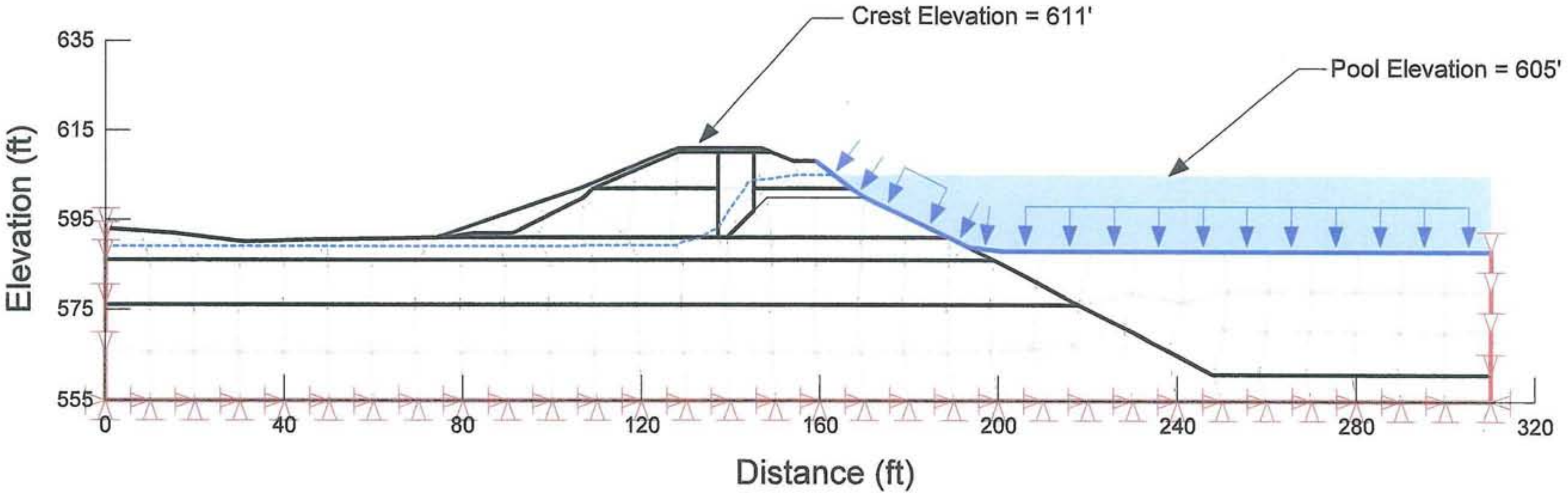


Title: Sporn Fly Ash Disposal Facility
Comments: QUAKE/W Finite Element Analysis
Accelerations at Crest Location D
File Name: FAP_H-H_Quake_Crest Accel.gsz
Date: 5/3/2010

## QUAKE/W MESH WITH LIQUEFIED ZONES
## NOTE: NO LIQUEFACTION PREDICTED

ELEMENT THAT DOES NOT LIQUEFY UNDER THE MODELED CONDITIONS → ◺

ELEMENT THAT LIQUEFIES UNDER THE MODELED CONDITIONS → ◺



# APPENDIX VI

# DRAWINGS

GRAPHIC SCALE
100' 0 100' 200'

NOTES

1. AS-BUILT TOPOGRAPHIC MAPPING PREPARED BY HENDERSON AERIAL SURVEYS, INC. DATED 5-22-07 AND PROVIDED BY AEP.

LEGEND

| | |
|---|---|
| ◉ GA-3 | SAMPLED BOREHOLE |
| ◉ B-108 | SAMPLED BOREHOLE WITH PIEZOMETER |
| ● D | VIBRATION MONITORING LOCATION |
| K K 0+00 | SECTION LINE |

ROGER W. CECIL 14367
Roger W. Cecil 5/27/10

THESE DRAWINGS ARE PART OF A SET OF DESIGN DOCUMENTS WHICH ALSO CONTAINS A WRITTEN TEXT. THAT TEXT EXPLAINS SOME OF THE DETAILS SHOWN HEREIN AND THEREFORE THESE DRAWINGS SHOULD ONLY BE USED IN CONJUNCTION WITH THE TEXT.

| DATE | REVISIONS | BY |
|---|---|---|
| | | |
| | | |
| | | |

**SITE MAP**

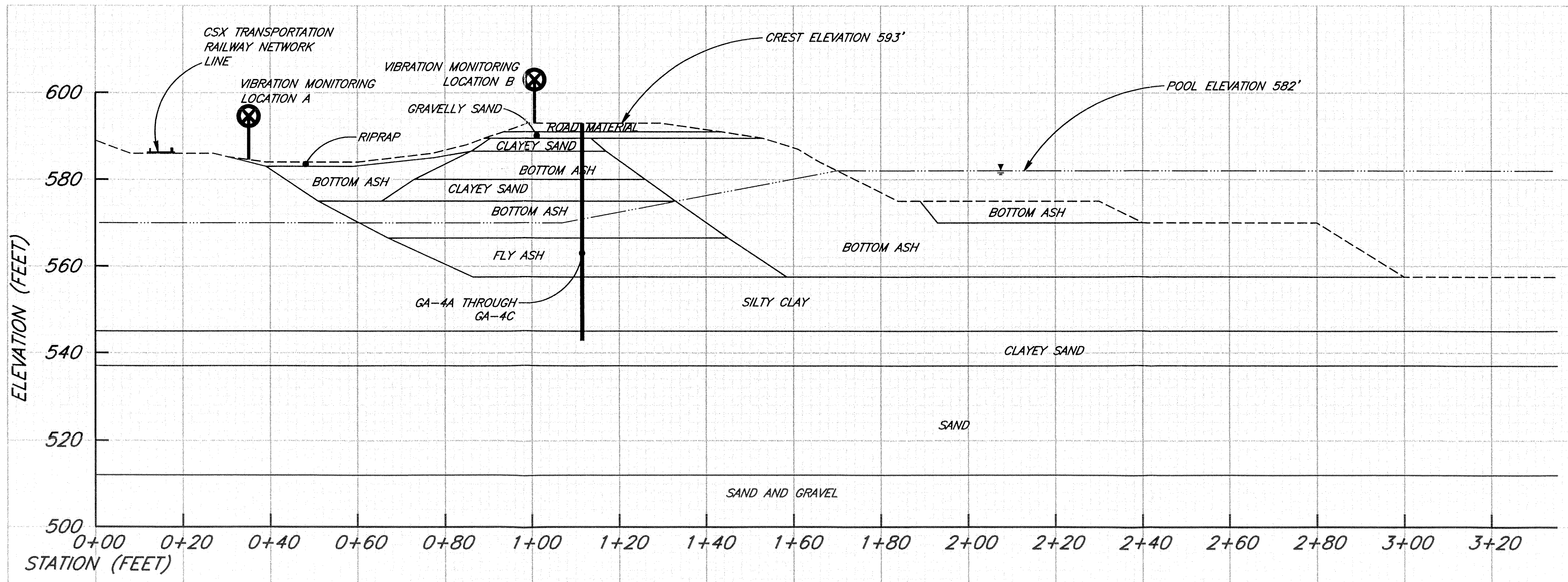
FLY ASH & BOTTOM ASH
DISPOSAL FACILITIES
PHILIP SPORN PLANT
NEW HAVEN, WEST VIRGINIA

SCALE: AS SHOWN
DR JAG
CHK SWF
REV RWC

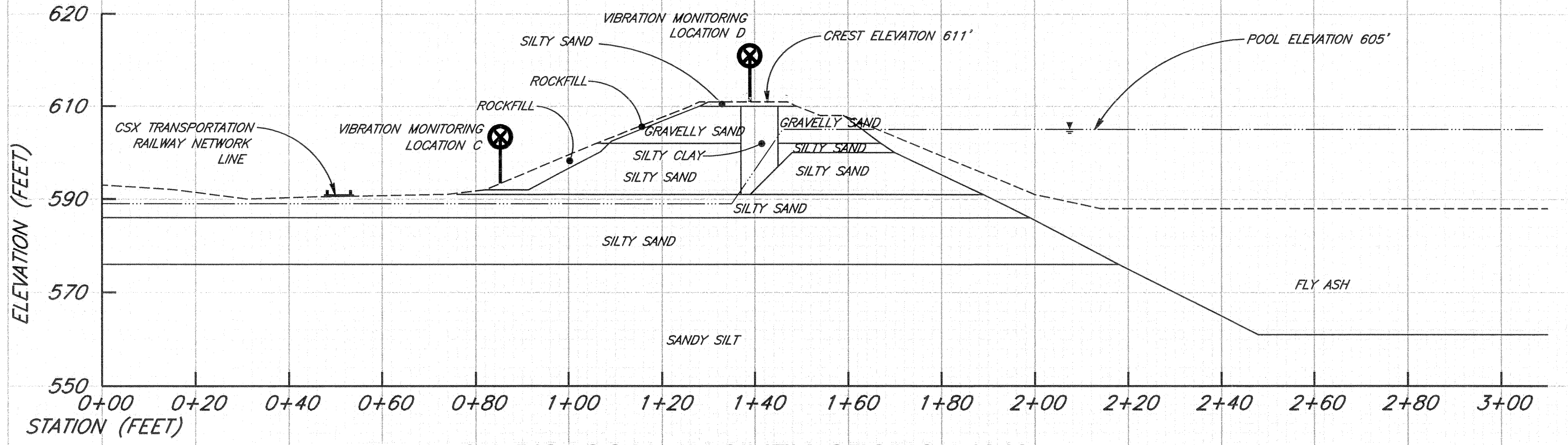
PREPARED FOR:
AEP SERVICE CORPORATION

PREPARED BY:
GA Geo/Environmental Associates, Inc.
3502 OVERLOOK CIRCLE • KNOXVILLE, TENNESSEE 37909 • (865) 584-0344

PROJ: 09-387
DATE: 5-27-10
SHEET 1 OF 2



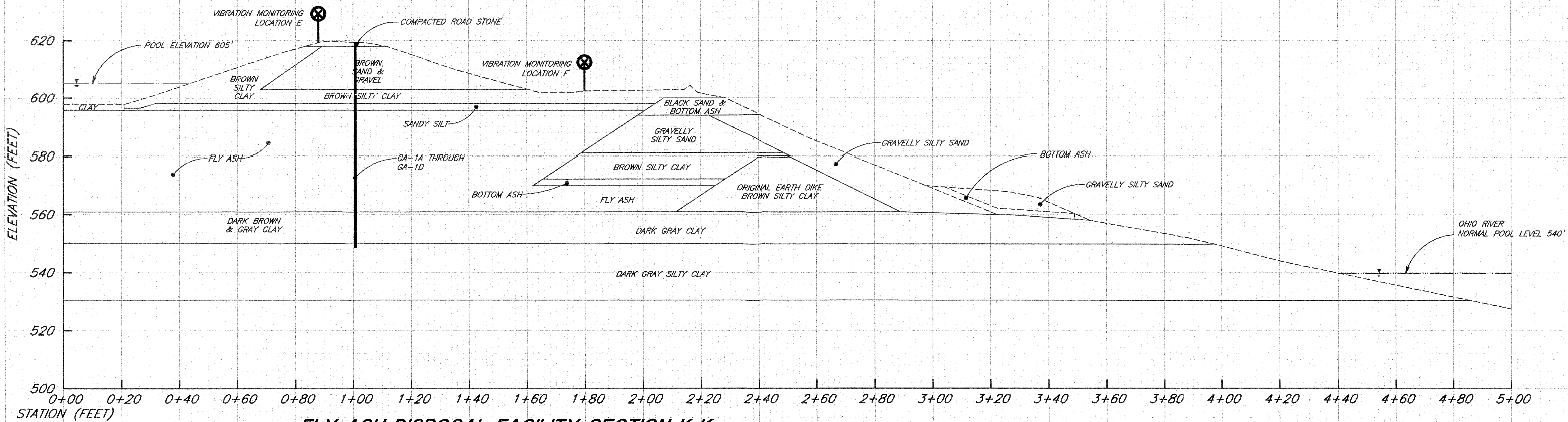
## BOTTOM ASH DISPOSAL FACILITY SECTION A-A



## FLY ASH DISPOSAL FACILITY SECTION H-H

## NOTES

1. AS-BUILT SECTIONS ADAPTED FROM PREVIOUS SECTIONS PREPARED BY AEP AND FROM TOPOGRAPHIC MAPPING PREPARED BY HENDERSON AERIAL SURVEYS, INC., DATED 5-22-07.



## FLY ASH DISPOSAL FACILITY SECTION K-K

ROGER W. CECIL
14367
Roger W. Cecil 5/27/10

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| DATE | REVISIONS | BY |
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**SECTIONS**
FLY ASH & BOTTOM ASH
DISPOSAL FACILITIES
PHILIP SPORN PLANT
NEW HAVEN, WEST VIRGINIA

SCALE: AS SHOWN
DR JAG
CHK SWF
REV RWC

PREPARED FOR:
AEP SERVICE CORPORATION

PREPARED BY:
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3502 OVERLOOK CIRCLE • KNOXVILLE, TENNESSEE 37909 • (865) 584-0344

PROJ: 09-387
DATE: 5-27-10
SHEET 2 OF 2

# APPENDIX VII

# REFERENCES

# REFERENCES

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