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ENGINEERING AND ENVIRONMENTAL SERVICES

REPORT OF GEOTECHNICAL EVALUATION ASH POND DIKE NEW JOHNSONVILLE FOSSIL PLANT NEW JOHNSONVILLE, TENNESSEE

Prepared for
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by
Law Engineering, Inc.
Nashville, Tennessee

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January 17, 1994
Law Engineering Project Number 417.91199.01

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

January 18, 1994

Ms. Cheri Miller
Tennessee Valley Authority
Blue Ridge One South
1101 Market Street
Chattanooga, Tennessee 37402-2801

REPORT OF GEOTECHNICAL EVALUATION
Ash Pond Dike
New Johnsonville Fossil Plant
New Johnsonville, Tennessee
Law Engineering Project No. 417.91199.01

Dear Ms. Miller:

Law Engineering, Inc. has completed the requested geotechnical services for the referenced project. Our services were provided in general accordance with our Proposal No. 574-90223, dated December 31, 1990 and our Task Order Proposals dated June 30, 1993 and July 8, 1993.

The attached report contains a review of available background information, findings from our geotechnical exploration activities, and our evaluation of the distress which has occurred at the referenced site. The Appendices to the report include a site location plan, a boring/observation well location plan, a description of our field procedures, and our field data.

We will contact you in a few days to answer any questions you may have regarding the attached report. Please feel free to contact us if we may be of assistance in the meantime.

Sincerely,

LAW ENGINEERING, INC.

Melany L. Brite, P.E.
Senior Geotechnical Engineer
Registered Tennessee 21544

Richard D. Heckel, P.E.
Principal Geotechnical Engineer
Registered Tennessee 19378

MLB/RDH/ejh

Attachments: Report of Geotechnical Evaluation
Information from ASFE

Distribution: Addressee (2)
Jim Niehoff - Law Atlanta (1)

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1.0 INTRODUCTION

1.1 Project Description

The TVA New Johnsonville Fossil Plant currently sluices fly ash and bottom ash to a series of ponds located on a small island within the Tennessee River west of the generating station. The final pond within the series discharges clarified water to the river through three reinforced concrete spillway pipes located within the perimeter dike system.

During regular inspections of the dike in the first half of 1993, TVA personnel noted surface depressions over two of the spillway pipes. A camera inspection of the southernmost pipe indicated relatively severe deterioration, and some leakage within the joints. As a result, the southern and northern pipes were lined (slip-formed). The central pipe could not be slip-formed due to the build-up of excessive scale. Therefore, the central pipe was taken out of service. The northernmost pipe, which has been in and out of service over the years, was reactivated, and the southern pipe continues to be used.

TVA personnel have become concerned that the subsidence may affect the overall stability of the dike within the vicinity of the spillway pipes. Since the subsidence is an indication of internal erosion, stability of the dike could be compromised. Law Engineering was requested to conduct a preliminary geotechnical exploration to evaluate the severity of distress and the need for emergency repairs and actions.

1.2 Purpose and Scope of Exploration

Two phases of exploration (a preliminary phase and a supplemental phase) have been accomplished for this project. The purpose of the preliminary phase of exploration was to obtain limited subsurface data in the area of the discharge pipes to generally evaluate the severity of the embankment distress. The purpose of the supplemental phase of exploration was to obtain additional subsurface data within the area of the discharge pipes and at locations remote from the pipes for comparison purposes. Both phases of exploration included installation of ground-water observation wells to gauge the piezometric head at the borehole locations.

Our scope of services was outlined in Task Order Proposals dated June 30, 1993 (preliminary phase) and July 8, 1993 (supplemental phase). We note that the boring locations and proposed sampling outlined in our Task Order Proposal dated July 8, 1993 was modified following discussions between Ms. Cheri Miller of TVA and Mr. Rick Heckel of Law Engineering. Our sampling program was modified to include the collection of four to six Shelby tube samples from the two boreholes located at the discharge pipes. The locations of the remaining four borings, originally proposed along the dike cross-section at a distance of about 100 to 150 feet away from the discharge pipe area, were modified due to access considerations. The new locations agreed to by Ms. Miller and Mr. Heckel were along the dike crest at approximately 50-foot spacings extending north from the discharge pipe area.

Briefly, our authorized scopes of services included the following:

- Advancing fifteen soil test borings at requested locations (nine during the preliminary phase and six during the supplemental phase).
- Collecting undisturbed (Shelby tube) samples in selected borings.
- Installing a ground-water observation well in each borehole.
- Conducting laboratory testing on the selected Shelby tube samples collected.
- Providing a written report of our findings and conclusions.

The results of the laboratory testing was provided under separate cover. For your reference, we have included the laboratory data in Appendix C of this report.

As noted later in the text, and also on the appropriate boring logs, the number of boreholes was adjusted based on conditions encountered during the drilling. Offset borings, where accomplished, were advanced for the purpose of exploring subsurface conditions of the dike foundation materials, or attempting Shelby tube samples at selected depths.

2.0 PROJECT INFORMATION

2.1 Information Provided

Project information was provided by Ms. Cheri Miller, Mr. Jim Durdin, and Mr. Steve Baugh of the Tennessee Valley Authority (TVA) during several telephone conversations and meetings. We have been provided with a set of three related drawings, prepared by the TVA Division of Engineering Design. The drawings provided include the following:

- Drawing No. 10N527, "Ash Disposal Area West of Boat Harbor", revised dated June 6, 1983.
- Drawing No. 10N528, "Ash Disposal Spillway", revised dated June 6, 1983.
- Drawing No. 10N529, "Ash Disposal Area Sections", dated August 22, 1969.

We have also been provided with a copy of a document titled, "Johnsonville Steam Plant, Assessment of Leachate Containment, Ash Pond D" (Report No. WR28-2-30-101). The document, dated June, 1986, was prepared by TVA.

2.2 Background Information

2.2.1 <u>Preliminary Site Visit</u>. Prior to developing a proposed scope of services for this project, we visited the site on June 23, 1993. Mr. Rick Heckel, a principal geotechnical engineer from our Nashville office, met with Ms. Miller and Mr. Durdin at the site. During this visit, we observed the general condition of the dike and discharge area. We also obtained additional information regarding the general sequence of events leading to our initial contact on the project.

2.2.2 <u>General Description of Dike and Discharge Area</u>. The following project description is based on information provided by TVA personnel, our observations during our June 23, 1993 site visit, and our review of the project drawings provided. The ash pond under consideration is located on an island in Kentucky Lake (Tennessee River) west of the plant. This pond is the third in a series and is the final pond before water is discharged into Kentucky Lake. The dike retaining the ash pond is about 35 feet in height. The crest is about 30 feet wide near the discharge pipes, and about 14 feet wide in remaining areas. The dike crest serves as a roadway. The downstream slope is about 2 horizontal to 1 vertical. The pool level of the ash pond is typically about 5 feet below the dike crest elevation.

The dike was constructed in stages using compacted earth fill. According to Drawing No. 10N529, original grade in the discharge area was about Elevation 357 (feet, site datum). Prior to construction of the dike, soil fill was placed to about Elevation 365 in the dike foundation area. The first dike was constructed to about Elevation 378 in 1970. Ash fill was placed behind the dike to about Elevation 374, after which the dike was raised to about Elevation 390 in 1977. In 1992, compacted fill was placed on the downstream side of the dike, to widen the crest to about 30 feet in the area of the discharge pipes.

The discharge pipes are located near the extreme southwestern end of the pond. There are three pipes, each about 36 inches in diameter, that pass beneath the embankment. The pipes are spaced at about 75 feet center-to-center. Clarified water from the ash pond enters the pipes through drop inlet structures. The pipe discharge points are typically below the pool level of Kentucky Lake. The pipe invert elevations are about Elevation 351 at the bottom of the inlet structure and Elevation 349 at the bottom of the outlet structure.

During the past few years, the southern and middle pipes have been used for discharge of water to the river. The northernmost pipe has been in and out of service at various times since its installation. The pipe joints have been repaired on several occasions. The early repairs consisted of repacking the joints with grout. In recent months, however, it became apparent to TVA personnel that the pipes were becoming severely deteriorated.

In the Spring of 1993, TVA used a slipforming technique to repair the northern and southern pipes. The middle pipe reportedly could not be repaired, as the pipe had a somewhat oval shape due to calcite build-up. Therefore, TVA decided to take the central pipe out of operation. There are no current plans to grout or otherwise abandon the middle pipe. It is our understanding that, in conjunction with the slipforming repairs, there was no attempt to make any evaluations of or repairs to the soil materials around the exterior of the pipes.

2.2.3 General Description of Subsidence. According to Mr. Durdin, two sinkholes were discovered in the Fall of 1992. One sinkhole was located above the southern pipe, downstream of the toe of the embankment near the lake's edge (the distance from the toe of the embankment to the lake was about 50 feet). This sinkhole had been filled at the time of our preliminary site visit. The second sinkhole is located above the middle pipe, also downstream of the embankment toe. This sinkhole is about 15 to 20 feet in diameter and about 10 to 15 feet deep. Standing water was noted in the bottom of this feature about 5 feet below the surrounding ground surface.

A third sinkhole was reportedly discovered during the Spring of 1993. This sinkhole is located above the southern pipe at about the one-third point on the downstream slope, as measured from the toe. This sinkhole is about 8 feet in diameter and about 3 feet deep.

2.2.4 Pre-Slipforming Videotape. We were given two videotapes, reportedly showing the interior of the discharge pipes before being repaired with the slipforming technique. One of the videotapes provided was blank. We viewed the remaining videotape, and provided our comments to Ms. Miller during a telephone conversation on June 25, 1993. We understand that the pipe on the videotape viewed was the southern pipe.

In general, the videotape indicated seepage at several joints along the pipe. Some of the seepage was entering on the upstream side. Several of the pipe joints appeared to be severely deteriorated. Evidence of previous grout packing was noted in some of the joints. A detailed listing of our observations from the videotape is included in Appendix D.

3.0 GEOTECHNICAL FINDINGS

3.1 Surface Conditions

3.1.1 Introduction. We visited the site on several occasions during the course of our studies. The following listing is a summary of our site visits.

DATE	LAW REPRESENTATIVE ON SITE	ACTIVITY
06/23/93	Mr. Rick Heckel	Site Reconnaissance
07/01/93-07/02/93	Mr. Dave Mursch	Preliminary Drilling
07/07/93	Ms. Elizabeth Davis	Check water levels in observation wells installed in July 1993
07/20/93	Ms. Elizabeth Davis	Check water levels in observation wells installed in July 1993
09/09/93-09/15/93	Ms. Melany Brite	Supplemental Drilling

The following discussion is descriptive of the site conditions at the time of our site activities.

3.1.2 Surface Conditions. The study area encompasses the portion of the dike extending northward from the south discharge pipe about 350 linear feet. The approximate dimensions of the dike observed were similar to those indicated on the plans provided (i.e., about 35 feet in height with an approximately 30-foot crest width at the location of the discharge pipes). The crest serves as a one-lane road. The materials exposed on the crest consist of stiff, orange-brown, clayey soils with abundant chert gravel.

The downstream slope is about 2 horizontal to 1 vertical. Sporadic grasses and some erosional rills were noted on the downstream slope. The pool level of the ash pond was estimated to be about 4 to 5 feet below the dike crest elevation at the time of our June 23, 1993 site visit.

We observed the inlet structures for each of the three pipes, as well as the outlet points for the two operational pipes. The pipe discharge points were about 4 to 5 feet below the river level at the time of our June 23, 1993 site visit. As a result, we observed a geyser-like discharge under pressure from each of the two operational pipes.

We observed the three sinkholes reported by TVA personnel. Our observations of these sinkholes were described in **Section 2.2.3** (General Description of Subsidence) of this report.

3.2 Subsurface Conditions

3.2.1 <u>**Introduction**</u>. A total of 17 borings were advanced at the site. Ground water observation wells (piezometers) were installed in 14 of the boreholes. The drilling, field sampling, and well installation procedures are provided in Appendix B. The distribution of the borings/wells is summarized below.

Installed July 1993		
Boring/Well No.	Piezometer Installed	Remarks
B-1	NO	None
B-1A	YES	Drilled as offset to B-1 to extend to greater depth
B-2	YES	None
B-2A	NO	Drilled as offset to B-2 to extend to greater depth
B-3	YES	None
B-4	NO	Not drilled due to extra borings at B-1 and B-2
B-5	YES	None
B-6	YES	None
B-7	YES	None
B-8	YES	None
B-9	YES	None
Installed September 1993		
Boring No.	Piezometer Installed	Remarks
B-OW-1	YES	None
B-OW-1A	NO	Advanced to obtain UD sample at specific depth
B-OW-2	YES	None
B-OW-3	YES	None
B-OW-4	YES	None
B-OW-5	YES	None
B-0W-6	YES	None

The preliminary-phase borings (Borings B-1 through B-9) were advanced within several feet on either side of the discharge pipes. The pipe alignments were estimated based on the drop inlet and discharge locations. The supplemental-phase borings (Borings B-OW-1 through B-OW-6) were advanced both in the vicinity of and remote from the discharge pipes. The locations of the borings/observation wells have been indicated on the Boring/Observation Well Location Plan (Drawing No. 199-2) in Appendix A.

The borings were advanced to depths ranging from about 40 feet below ground level (bgl) to about 55 feet bgl. The borings were terminated at predetermined depths without encountering refusal. A general summary of the subsurface conditions has been presented in the following paragraphs. The actual subsurface conditions encountered at the individual boring locations, including stratification and consistencies, have been depicted on the boring logs and subsurface profiles in Appendix B.

3.2.2 Stratigraphy. Beneath surface materials, the borings typically encountered the types of materials expected based on a review of the dike cross section provided (Drawing No. 10N529). In general, the borings advanced on the upstream side of the crest encountered the following typical stratification:

DEPTH RANGE	MATERIAL DESCRIPTION
0 to 15 feet bgl	FILL - Stiff to very stiff, tan or brown and gray silty lean clay
15 to 25 feet bgl	FILL - Dense (granular) or soft to firm (fine-grained), black ash/cinders
25 to 35 feet bgl	FILL - Stiff to very stiff, brown and gray silty lean clay
35 feet to bottom of boring	ALLUVIUM - Stiff to very stiff, tan sandy silty lean clay

The borings advanced on the downstream side of the crest typically encountered a very thin ash fill zone, if any. The clay embankment fill in these borings was encountered to about the same depths as in the upstream borings.

The borings advanced on the berm (constructed on the downstream slope for our drilling purposes) encountered clay embankment fill soils over sandy silty lean clay alluvial foundation soils. The strata elevations in these borings were in the same general range as in the borings advanced on the crest.

3.2.3 Soil Consistency - Preliminary Borings. The soil consistencies indicated in the "typical stratification" provided in the preceding paragraph were representative of the general conditions encountered in the borings. However, variations in these consistencies were noted at several locations. In addition to occasional "firm" zones (N-value = 5 to 8 blows per foot), our preliminary-phase borings (B-1 through B-9) indicated zones of soft materials within about 5 to 10 feet of the estimated crown elevation of the discharge pipes (Elevation 350). Standard Penetration Resistance "N" values in the range of zero to 4 blows per foot (bpf) were encountered in each of the preliminary borings, except Borings B-2 and B-5 (central pipe).

3.2.4 <u>**Soil Consistency - Supplemental Borings**</u>. The "typical stratification" provided in **Section 3.2.1** is representative of the subsurface conditions encountered in the supplemental borings (Borings B-OW-1 through B-OW-6). In addition to occasional firm zones, N values indicative of a soft consistency were encountered at three sample locations. N values of 4 bpf were encountered at 20 feet bgl (within the ash fill) in Borings B-OW-4 and B-OW-6, and at 50 feet bgl (bottom of boring in alluvium) in Boring B-OW-2.

3.3 Ground-Water Observation Wells

Ground-water observation wells were installed in 14 of the 17 boreholes advanced at the site. The well installation procedures are described in Appendix B. The well locations are indicated on the Boring/Observation Well Location Plan in Appendix A.

Water levels were measured in the observation wells at the time of drilling and on several occasions after drilling (post-drilling measurements were limited for the wells installed during September, 1993). The data obtained from the observation wells has been summarized in **Table 199-1** in Appendix B. In general, water levels ranged from about Elevation 357 to 360 in the observation wells near the discharge pipes. Somewhat higher water levels have been measured in B-1A and B-2, on the upstream side at the south and central pipes, respectively. Ground water levels have been measured at about Elevation 366 at B-1A, and in the range of Elevation 366 to 367 in B-2.

Water level measurements were made in the uncased boreholes at the time of drilling (TOB). The TOB water levels are indicated on the appropriate boring logs.

4.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

4.1 General Discussion

The sinkholes present on the lower portion of the downstream slope, and in the area downstream of the embankment, indicate a significant amount of internal erosion has occurred. It is possible that the erosion has occurred into the joints or cracks within the underlying reinforced concrete pipes. Another possible mechanism is erosion or "piping" around the outside perimeter of the pipes.

Internal erosion can cause failure of earthen embankments if the erosion advances far enough toward the upstream end to provide a direct conduit to the reservoir. In such cases, the embankment would be washed out or breached. A breach of the ash pond would impair plant operations and cause environmental damage.

The preliminary geotechnical exploration was performed to assess the extent of embankment damage and the need for emergency repairs. Borings were made to check for extensive deposits of soft soils or voids. Observation wells were installed in the boreholes to check for water levels that may indicate subsurface anomalies.

4.2 Geotechnical Evaluation

The available boring data indicates that some soft soil zones are present around the discharge pipes. Data from the supplementary-phase borings suggests that the soft zones may be limited to the immediate areas of the discharge pipes. This is consistent with the information that the discharge pipes were installed in trenches excavated below the dike foundation level, and pipe backfill immediately above the pipe crown was loosely-compacted, as indicated on TVA drawings. Void zones within the embankment were not disclosed by our borings.

We have obtained three sets of water level data at the discharge pipe wells (B-1 through B-9) over a 2-month period. The water levels have been fairly consistent, with only minor variations between readings. Based on the dike cross section provided, we have estimated the expected piezometric surface through the dike at the three discharge pipes. The water level data obtained suggests a piezometric surface through the dike which is significantly lower (by about 15 feet) than expected. The level of the piezometric surface suggests the presence of some type of erosional conduit through the dike. As the water level is lower than expected, the erosion is most likely more prevalent on the downstream side of the dike. The erosion could be the result of broken pipe or open pipe joints, soft or loose soils, or voids around the pipe. The surface impacts of internal erosion have manifested in the form of sinkholes (dropouts) on the downstream face of the dike. However, from a subsurface standpoint, the impacts of the erosion are somewhat subtle, and the erosional mechanism is not immediately apparent in the areas in which drilling was accomplished.

4.3 Geotechnical Recommendations

Based on the available data, we have formulated recommendations for repair of the existing sinkholes, and for monitoring and exploration procedures for continued data gathering on this project. Since no voids or extensive deposits of soft soil were encountered, the available data does not indicate that the internal erosion presently requires emergency action. However, it is apparent that a significant amount of material has been internally eroded. In our professional opinion, there is a risk of additional internal erosion and failure of the dike. Therefore, we recommend that a program of further evaluation and correction be implemented as soon as practical. Recommendations for evaluation and repair are presented next.

•**Drilling and grouting program.** It is our opinion that a limited drilling and grouting program will be the most valuable tool for obtaining additional data and evaluating the extent of the damage to the dike. Documentation of the volume of grout taken by the dike would provide information regarding the extent of the internal erosion which has occurred. Additionally, the grouting would, in effect, be accomplishing a first-phase remediation of the internal erosion. If significant grout quantities are required during preliminary grouting, then a more detailed grouting program can be designed. If low quantities of grout are needed, then further exploration and subsurface repair may not be required.

A typical grouting program would involve treatment on a 10- to 20-foot grid pattern in the area of the pipes. Low pressures would be used to fill voids without damaging the pipes. For a typical grout location, grout takes (i.e., volume of grout pumped in) in excess of 60 cubic feet would be considered excessive, and would indicate the need for additional grout locations at closer spacing.

•**Repair existing sinkholes.** Sinkhole treatment should be monitored by an experienced engineer, who can determine suitable treatment procedures depending on the actual field conditions encountered. Sinkholes above the water level should first be excavated to remove soft and loose materials, and to search for a possible throat or conduit. The sinkhole may then be treated by lining the excavation with a suitable geotextile filter fabric, and filling the excavation with an open-graded stone such as Tennessee Department of Transportation (TDOT) Stone Gradation No. 67 to within about 2 feet of the surrounding ground surface. The fabric should be lapped over the top of the stone to encapsulate it, and then a clay cap placed over the stone to minimize surface water infiltration.

Sinkholes below the water level (such as between the toe of the embankment and the lake) may be filled with large rock (maximum particle size of about 6 inches) or concrete to a level above the existing water level. The remainder of the sinkhole may be filled with stone, using procedures similar to those described above.

•**Repair of Center Pipe.** As noted earlier, the center pipe was not slip-formed during recent repairs. Even though the pipe is no longer in operation, it may still be an avenue for subsurface erosion. Therefore, we recommend that the pipe be plugged with grout or concrete.

•**Daily monitoring of the pipe discharge area.** Daily monitoring should continue, and should include observations of the crest, the upstream and downstream slopes, the downstream toe, and the pipe discharge. Surface indications of ravelling or subsidence, the presence of a muddy pipe discharge, or other anomalous conditions should be recorded and immediately brought to the attention of TVA's designated representative.

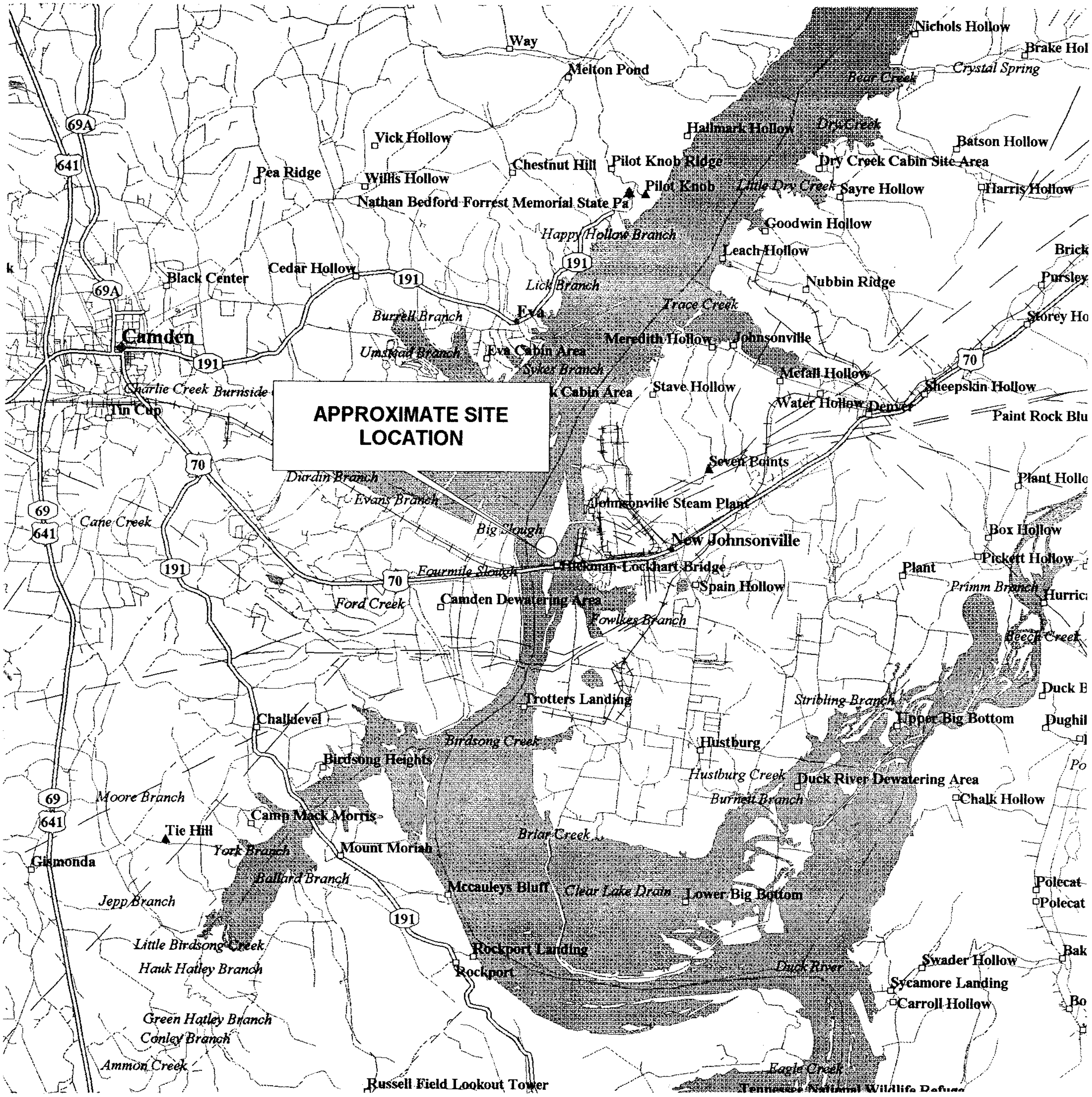
5.0 BASIS FOR RECOMMENDATIONS

The conclusions provided are based in part on the project information provided to us. They only apply to the specific project and site discussed in this report. If the project information section in this report contains incorrect information or if additional information is available, you should convey the correct or additional information to us and retain us to review our conclusions. We can then modify our conclusions if they are inappropriate.

Regardless of the thoroughness of a geotechnical exploration, there is always a possibility that conditions between borings will be different from those at specific boring locations. In addition, the passing of time may alter soil and ground water conditions.

We note that this geotechnical exploration was accomplished to provide only geotechnical data and conclusions. This study did not address environmental conditions and should not be interpreted as such.

APPENDIX A



SITE LOCATION PLAN

N

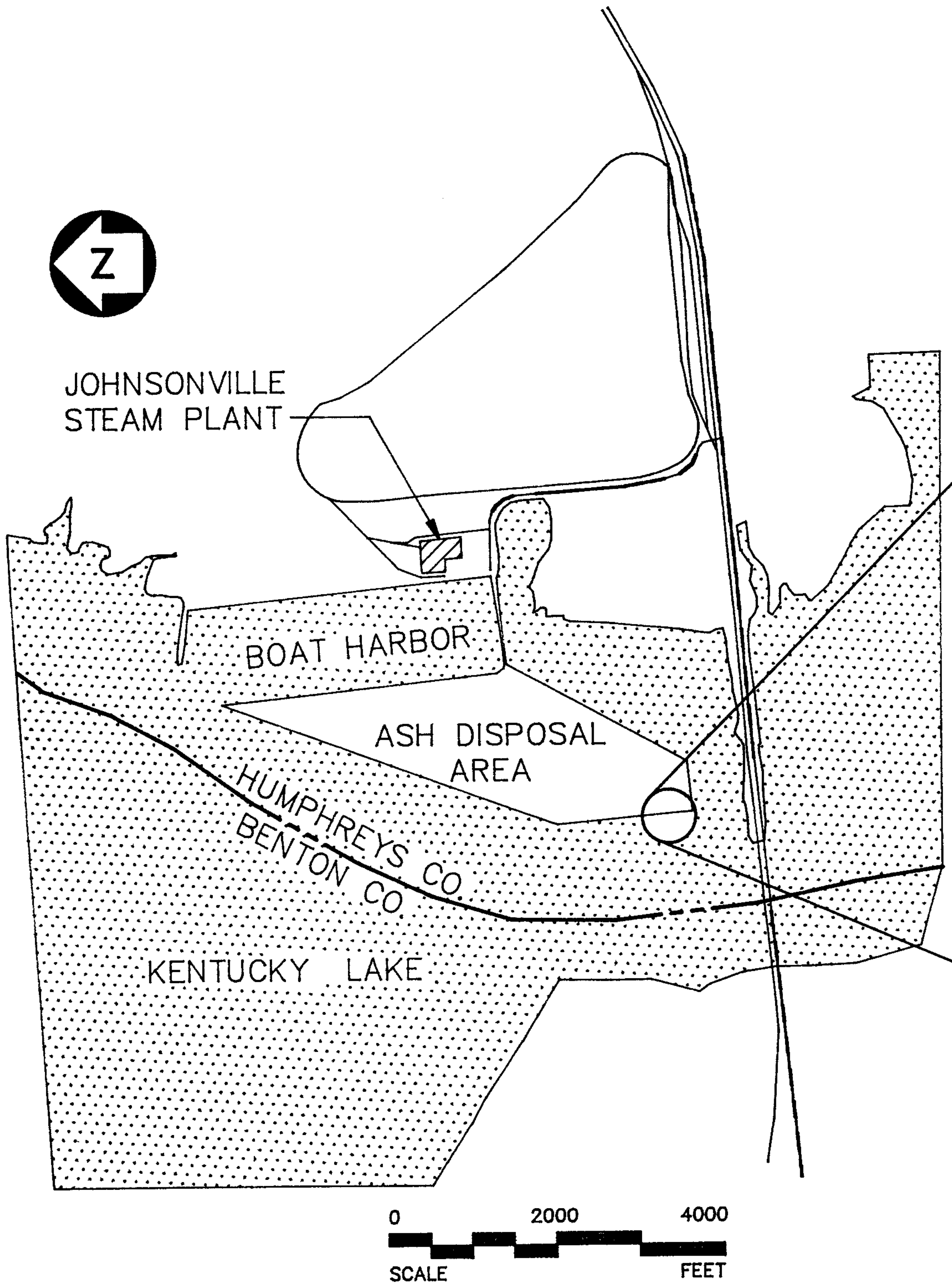
0 2000 4000

SCALE FEET

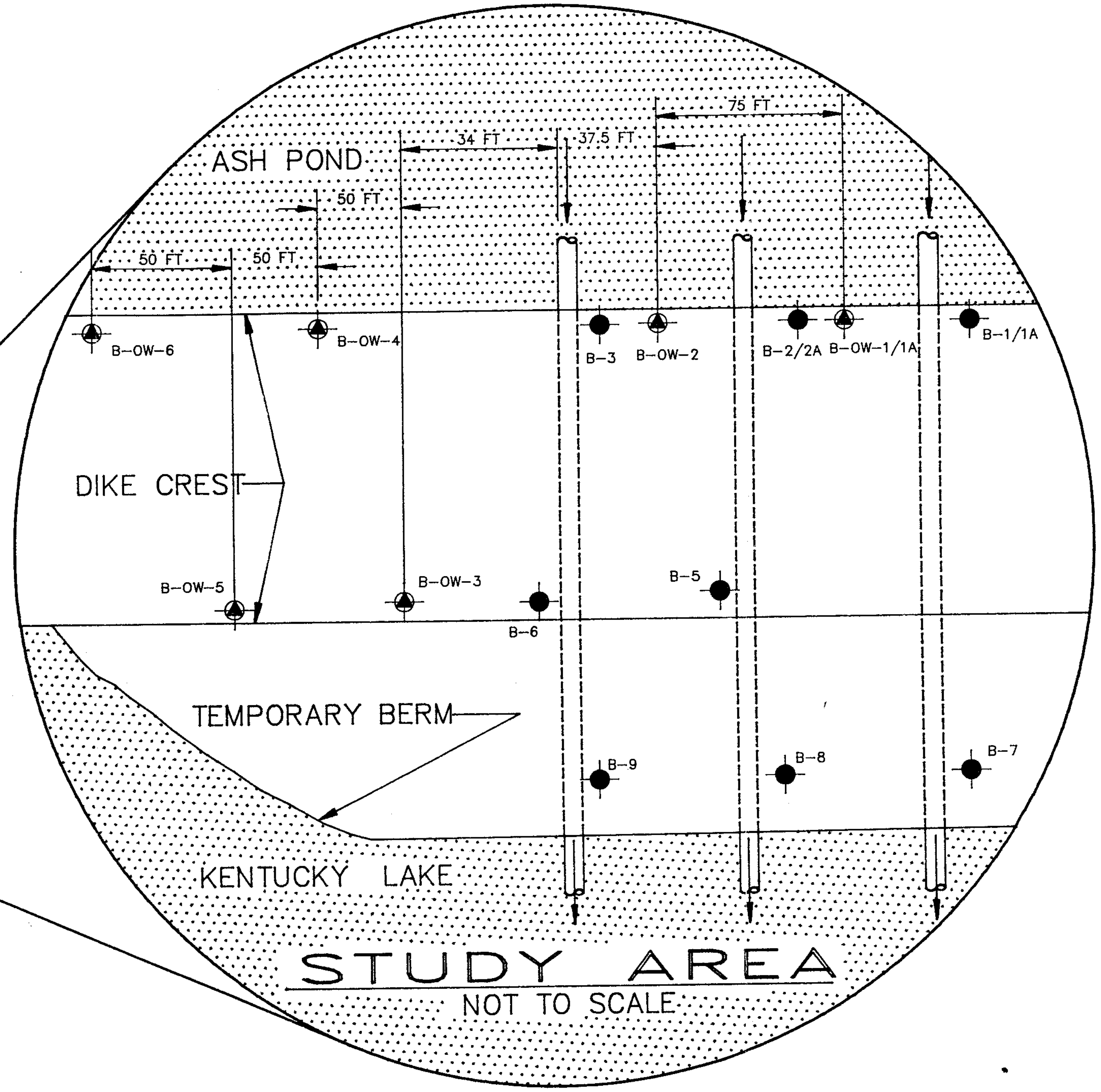
SOURCE: DeLORME MAPPING, MAP EXPERT–VERSION 1.0

LAW ENGINEERING, INC. 445 METROPLEX DRIVE NASHVILLE, TN 37211 OFFICE 615–832–0513 FAX 615–832–0983	PROJECT TITLE: SUPPLEMENTAL GEOTECHNICAL STUDY ASH POND DIKE TVA NEW JOHNSONVILLE FOSSIL PLANT NEW JOHNSONVILLE, TENNESSEE PREPARED FOR: TENNESSEE VALLEY AUTHORITY CHATTANOOGA, TENNESSEE	DRAWN BY: C.E.R. APPROVED BY: [signature] PROJECT NO. 417.91199.01 DRAWING NO. 199–01	DATE: 10/5/93 DATE: 10/11/93

FILE: 412\PORTRAIT



LOCALITY MAP



STUDY AREA

NOT TO SCALE

LEGEND

- OBSERVATION WELL INSTALLED 7/93 (LAW ENGINEERING)
- OBSERVATION WELL INSTALLED 9/93 (LAW ENGINEERING)

BORING/OBSERVATION WELL LOCATION PLAN

SOURCE: DRAWING NO. 10N527R12, PREPARED BY TVA, DIVISION OF ENGINEERING DESIGN, REVISED DATE 6/6/83 AND FIELD SKETCH BY LAW ENGINEERING

FILE: 412\199

LAW ENGINEERING, INC.
445 METROPLEX DRIVE
NASHVILLE, TN 37211
OFFICE 615-832-0513
FAX 615-832-0983

PROJECT TITLE:
SUPPLEMENTAL GEOTECHNICAL STUDY
ASH POND DIKE
TVA NEW JOHNSONVILLE FOSSIL PLANT
NEW JOHNSONVILLE, TENNESSEE

PREPARED FOR:
TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE

DRAWING TITLE:
BORING/OBSERVATION WELL LOCATION PLAN

ISSUED FOR:	DATE:

DRAWN BY: C.E.R.
DATE: 10/5/93
APPROVED BY: [signature]
DATE: 10/29/93
PROJECT NO. 417.91199.01
DRAWING NO. 199-02

APPENDIX B

FIELD TESTING PROCEDURES

Soil Test Borings

Soil sampling and penetration testing was performed in general accordance with ASTM Method D 1586, "Penetration Test and Split-Barrel Sampling of Soils". The borings were advanced with continuous flights of powered hollow stem augers (HSA) or rotary wash drilling techniques. At regular intervals, soil samples were obtained with a standard 1.4-inch I.D., 2-inch O.D., split-tube sampler inserted through the hollow stem. The sampler was first seated 6 inches to penetrate any loose cuttings, then driven an additional one foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot was recorded and is designated the "standard penetration resistance" (N-value). The standard penetration resistance, when properly evaluated, has been found to be an index to the soil strength, density, and ability to support foundations. Representative portions of each soil sample obtained were placed in glass jars and taken to our laboratory.

Undisturbed Soil Samples

Relatively undisturbed samples were obtained by forcing a section of 3-inch O.D., 16 gauge steel tubing into the soil at the desired sampling level. This sampling procedure is described by ASTM Method D 1587. The tube, together with the encased soil, was carefully removed from the ground and made airtight. The location and depths of undisturbed samples have been indicated on the appropriate Test Boring Records.

Observation Wells

Observation wells (piezometers) were installed in selected boreholes for the purpose of obtaining long-term ground-water level data. The observation wells typically consisted of 10-foot sections of 1-1/2 to 2-inch diameter PVC pipe. The lower 10-foot section of each well consisted of slotted pipe to form the screen. The remainder of each well was solid riser pipe. The annular space was backfilled with sand to a level 1 to 2 feet above the top of the screened section, then clay auger cuttings to within 2 to 3 feet of the ground surface. Bentonite clay was used to seal the upper 2 to 3 feet of the annular space.

Test Boring Records

Our interpretation of the conditions encountered at each boring location is indicated on the Test Boring Records. The boring records are based on the project engineer's field logs, visual-manual classification of the soil samples obtained, and laboratory testing conducted on selected samples. The depths designating strata changes on the boring records are approximate. In many geologic settings, the transition between strata is gradual. A Boring Record Legend outlining symbols and other pertinent information presented on the Test Boring Records is included with this report.

UNIFIED SOIL CLASSIFICATION

(Including Identification and Description)

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES	FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3 in. and basing fractions on estimated weights).		
COARSE-GRAINED SOILS More than half of material is larger than No. 200 sieve size.	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size. (For visual classification, the 1/4-in. size may be used as equivalent to the No. 4 sieve size)	Clean Gravels (Little or no fines).	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.		
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		
		Gravels with Fines (Appreciable amount of fines).	GM	Silty gravel, gravel-sand-silts mixture.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).		
			GC	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification procedures see CL below).		
	SANDS More than half of coarse fraction is smaller than No. 4 sieve size.	Clean Sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain size and substantial amounts of all intermediate particle sizes.		
			SP	Poorly graded sands or gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		
		Sands with Fines (Appreciable amount of fines	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).		
			SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).		
FINE-GRAINED SOILS More than half of material is smaller than No. 200 sieve size. The No. 200 sieve is about the smallest particle visible to the naked eye.					IDENTIFICATION PROCEDURES On Fraction Smaller than No. 40 Sieve Size		
					Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking).	Toughness (Consistency near PL)
	SILTS AND CLAYS	Liquid limit is less than 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None
			CL	Inorganic clays of low to medium plasticity gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium
			OL	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight
	SILTS AND CLAYS	Liquid limit is greater than 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to medium
			CH	Inorganic clays of high plasticity, fat clays.	High to very High	None	High
			OH	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to medium
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.		

CORRELATION OF PENETRATION RESISTANCE (ASTM D 1586) WITH RELATIVE DENSITY AND CONSISTENCY

	PENETRATION RESISTANCE, N Blows per foot	RELATIVE DENSITY
SANDS AND GRAVELS	0 - 4	Very Loose
	5 - 10	Loose
	11 - 20	Firm
	21 - 30	Very Firm
	31 - 50	Dense
	Over 50	Very Dense

	PENETRATION RESISTANCE, N Blows per foot	CONSISTENCY
SILTS AND CLAYS	0 - 2	Very Soft
	3 - 4	Soft
	5 - 8	Firm
	9 - 15	Stiff
	16 - 30	Very Stiff
	31+	Hard

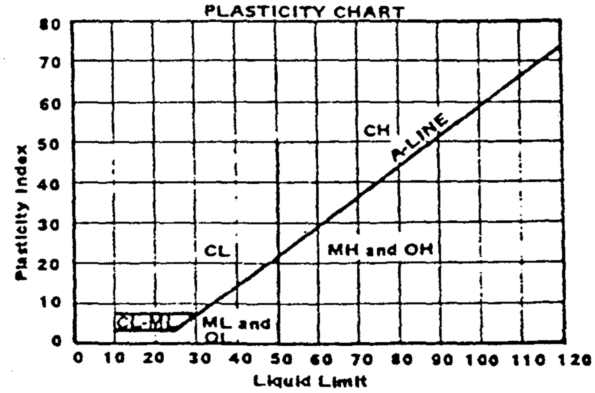
PARTICLE SIZE IDENTIFICATION

- BOULDERS - Greater than 12 inches
- COBBLES - 3 inches to 12 inches
- GRAVEL - Coarse - 3/4 inch to 3 inches; Fine - 4.76 mm to 3/4 inch
- SAND - Coarse - 2mm to 4.76 mm; Medium - 0.42 mm to 2 mm; Fine - 0.074mm to 0.42 mm
- SILT & CLAY - Less than 0.074mm

SOIL LABORATORY TEST DATA SYMBOLS FOR BORING LOGS

- γ_w = Wet Unit Weight
- γ_d = Dry Unit Weight
- e = Void Ratio
- q = Unconfined Compressive Strength
- C_c = Compression Index
- c = Cohesion, Total Stress
- c' = Cohesion, Effective Stress
- Φ = Friction Angle, Degrees, Total Stress
- Φ' = Friction Angle, Degrees, Effective Stress
- w = Moisture Content (%)
- LL = Liquid Limit (%)
- PL = Plastic Limit (%)
- PI = Plasticity Index (%) (LL-PL)
- TRIAXIAL = Triaxial Shear Test
- CONSOL. = Consolidation Test
- G.S. = Grain Size Distribution Test

PLASTICITY CHART



BORING RECORD LEGEND

CORRELATION OF PENETRATION RESISTANCE WITH RELATIVE DENSITY AND CONSISTENCY

	NO. OF BLOWS	N=RELATIVE DENSITY
SANDS & GRAVELS:	0-4	Very Loose
	5-10	Loose
	11-20	Firm
	21-30	Very Firm
	31-50	Dense
	Over 50	Very Dense

	NO. OF BLOWS	N=CONSISTENCY
SILTS & CLAYS:	0-2	Very Soft
	3-4	Soft
	5-8	Firm
	9-15	Stiff
	16-30	Very Stiff
	31-50	Hard
	Over 50	Very Hard

PARTICAL SIZE IDENTIFICATION

BOULDERS:		Greater than 300 mm
COBBLES:		75 mm to 300 mm
GRAVEL:	Coarse-	19 mm to 75 mm
	Fine-	4.75 mm to 19 mm
SANDS:	Coarse-	2 mm to 4.75 mm
	Medium-	0.425 mm to 2 mm
	Fine-	0.075 mm to 0.425 mm
SILTS & CLAYS:		less than 0.075 mm

KEY TO DRILLING SYMBOLS

UNDISTURBED SAMPLE

SPLIT SPOON SAMPLE

CORE SAMPLE

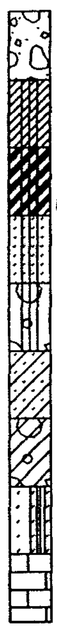
LOSS OF DRILLING WATER

WATER LEVEL AT TIME OF DRILLING

WATER LEVEL AT 24 HR.

KEY TO SOIL CLASSIFICATIONS

TOPSOIL-	Topsoil
FILL-	Fill materials
CL-	Low plasticity inorganic clays
CH-	High plasticity inorganic clays
ML-	Low plasticity inorganic silts
MH-	High plasticity inorganic silts
SP-	Poorly graded sands
SW-	Well graded sands
GP-	Poorly graded gravels



GW-	Well graded gravels
OL-	Low plasticity organic silts and clays
OH-	High plasticity organic silts and clays
SM-	Silty sands
GM-	Silty gravels
SC-	Clayey sands
GC-	Clayey gravels
SP-SM-	Typical dual classification
LIMESTONE	Limestone bedrock

QUALIFIERS

Percentage	Qualifer
Less than 10	Occasional or Trace
10 - 30	Some
31 - 49	Abundant

ROCK HARDNESS

Very Soft-	Rock disintegrates or easily compresses to touch; can be hard to very hard soil.
Soft-	Rock is coherent but breaks easily to thumb pressure at sharp edges and crumbles with firm hand pressure.
Moderately Hard-	Small pieces can be broken off along sharp edges by considerable hard thumb pressure; can be broken by light hammer blows.
Hard-	Rock cannot be broken by thumb pressure, but can be broken by moderate hammer blows.
Very Hard-	Rock can be broken by heavy hammer blows.

File: 412\bore_leg

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD
390.0	0.0	(FILL) - Silty LEAN CLAY (CL) with sand, stiff, brown, red, and gray						
385			5.5	16		11		
380			10.5	18		14		
	14.0	(ASH FILL) - Fine to medium SILTY SAND (SM) to medium SAND (SP), dense to very firm, black, wet, with a trace of gravel						
375			15.5	18		33		
370			20.5	14		22		
	23.0	(POSSIBLE TOPSOIL) - LEAN CLAY (CL), firm to very soft, wet, with matted roots and decayed wood	23.0	10		12		
365	26.0		25.5	13		1		
		REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 26.0 FEET						
360								
355								
350								
345								
340								
335								

REMARKS

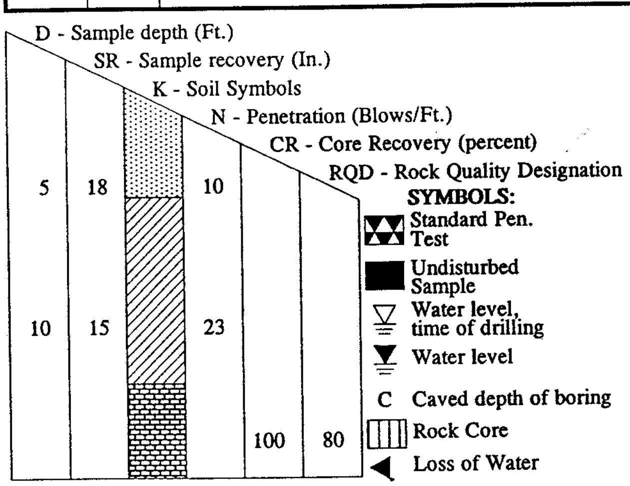
Drilled by: B. Grissom

Drilling Method: HSA

Borehole Logged by: R.D. Mursch

Water Level 8 feet TOB; caved at 19 feet

NOTE: Piezometer not installed in this borehole



TEST BORING RECORD

BORING NUMBER	B-1
DATE DRILLED	July 2, 1993
PROJECT NUMBER	417.91199.01
PROJECT	TVA New Johnsonville
PAGE 1 OF 1	

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD
390.0	0.0	NOTE: Borehole augered to 27 feet without sampling the materials encountered						
	27.0	Silty LEAN CLAY (CL), stiff to firm, brown and gray, wet, with a trace of sand	28.0	11		11		
			30.5	17				
			32.5	19		8		
			35.5	18		5		
		- VERY SOFT zone, 36 to 39 feet	38.0	18		2		
	41.0		40.5	18		6		
		REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 41.0 FEET						

Elevation scale: 390, 385, 380, 375, 370, 365, 360, 355, 350, 345, 340, 335

REMARKS

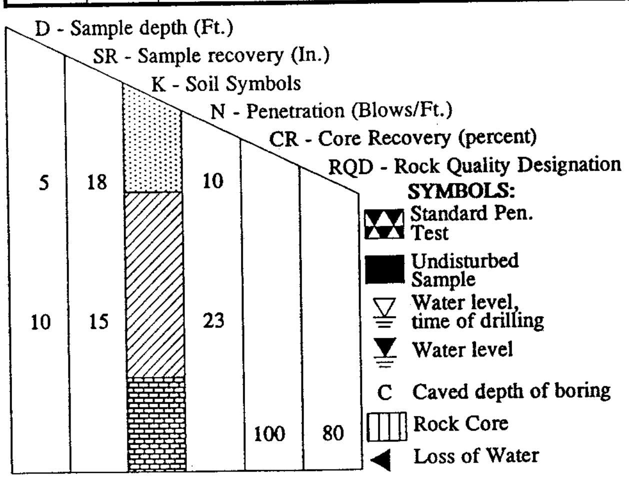
Drilled by: B. Grissom

Drilling Method: HSA

Borehole Logged by: R.D. Mursch

Set 41.7 linear feet of 1-inch PVC piezometer with hand-slotted screen section, lower 10 feet. Backfilled with sand to 30 feet, then soil auger cuttings to surface

Approximate Depths:
Bottom of Well: 40.5 feet
Top of Screen: 30.5 feet
Top of Sand: 30.0 feet
Stick-up: 1.2 feet



TEST BORING RECORD

BORING NUMBER	B-1A
DATE DRILLED	July 2, 1993
PROJECT NUMBER	417.91199.01
PROJECT	TVA New Johnsonville
PAGE 1 OF 1	

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD	REMARKS
390.0	0.0	(FILL) - Silty LEAN CLAY (CL), very stiff to firm, brown and gray							Drilled by: B. Grissom Drilling Method: HSA
385			5.5	18		20			Borehole Logged by: R.D. Mursch
		- Layer of 1 to 1-1/2 inch gravel from 6-1/2 to 7 feet - Plasticity of clay increased from 7 to 15 feet							Water Level 8.8 feet TOB
380			10.5	6		8			Set 30.0 linear feet of 1-inch diameter PVC piezometer with hand-slotted screen section, lower 10 feet; Backfilled with sand to 17 feet, then soil auger cuttings to surface
375	15.0	(ASH FILL) - Medium to coarse SAND with silt (SP or SM), dense to very firm, black, wet	15.5	18		42			
			18.0	12		38			
370			20.5	18		31			Approximate Depths: Bottom of Well: 27.5 feet
			23.0	18		22			Top of Screen: 17.5 feet Top of Sand: 17.0 feet
365	24.0	(UNCLASSIFIED)	25.5	14		4			Stick-up: 2.5 feet
	28.0	REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 28.0 FEET							
360									
355									
350									
345									
340									
335									

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER	B-2
DATE DRILLED	July 1, 1993
PROJECT NUMBER	417.91199.01
PROJECT	TVA New Johnsonville
PAGE 1 OF 1	

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD	REMARKS
390.0	0.0	NOTE: Borehole augered to 27 feet without sampling the materials encountered							Drilled by: B. Grissom Drilling Method: HSA Borehole Logged by: R.D. Mursch Water Level 8 feet TOB; caved at 18 feet NOTE: Piezometer not installed in this borehole Upon completion of boring, borehole was grouted to 7 feet then backfilled to surface with soil auger cuttings
	27.0	Silty LEAN CLAY (CL), stiff to firm, brown and gray, wet, with a trace of sand	28.0	14		10			
			30.5	18		6			
		- Driller noted soft zones from 32 to 32.5 feet and 36 to 37.5 feet	33.0	18		8			
			35.5	18		9			
			38.0	3		8			
	38.5	REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 38.5 FEET							

Elevation scale: 390, 385, 380, 375, 370, 365, 360, 355, 350, 345, 340, 335

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER	B-2A
DATE DRILLED	July 1, 1993
PROJECT NUMBER	417.91199.01
PROJECT	TVA New Johnsonville

PAGE 1 OF 1

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD
390.0	0.0	(FILL) - Silty LEAN CLAY (CL), stiff, brown and gray, with a trace of sand						
385			5.5	11		12		
380		- Sandy lens at 10 feet	10.5	16		11		
	14.0	(ASH FILL) - Medium to coarse SAND (SP), dense, black, wet, with a trace of gravel						
375			15.5	18		41		
370			20.5	18		46		
		- FIRM consistency, 21.5 to 24 feet	23.0	16		19		
	24.0	Silty LEAN CLAY (CL) with a trace of sand, interlayered with sandy silty LEAN CLAY (CL), firm to stiff, brown and gray, wet						
365			25.5			5		
		- Very soft consistency, 26.5 to 29 feet	28.0	9		0		
360			30.0	14				
			32.0	11		7		
355			35.5			5		
			38.5	20		10		
	39.0	REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 39.0 FEET.						
350								
345								
340								
335								

REMARKS

Drilled by: B. Grissom

Drilling Methods:
HSA 0 to 21.5 feet;
Rotary Wash/Water:
21.5 to 25.5 feet;
HSA (charged with water)
25.5 to 39 feet
Borehole Logged by:
R.D. Mursch

Set 40.5 linear feet of 1-inch diameter PVC piezometer with hand-slotted screen section, lower 10 feet; Backfilled with sand to about 30 feet, then soil auger cuttings to surface
Approximate Depths:
Bottom of Well: 38.0 feet
Top of Screen: 28.0 feet
Top of Sand: 30.0 feet
Stick-up: 2.5 feet

* Not recorded

Driller noted no loss of drilling fluids during the wash drilling/charged auger intervals

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER	B-3
DATE DRILLED	July 1, 1993
PROJECT NUMBER	417.91199.01
PROJECT	TVA New Johnsonville
PAGE 1 OF 1	

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD	REMARKS
390.0	0.0	(FILL) - Sandy LEAN CLAY (CL), soft to firm, brown and gray, with a trace of gravel							Drilled by: B. Grissom Drilling Method: HSA
385			5.5	7		3			Borehole Logged by: R.D. Mursch
380			10.5	15		8			Set 40 linear feet of 1-inch PVC piezometer with hand-slotted screen section, lower 10 feet; Backfilled with sand to 26.5 feet, then soil auger cuttings with 2-foot bentonite seal at surface
	12.0	(FILL) - Silty LEAN CLAY (CL), very stiff to stiff, gray, with a trace of sand							
375			15.5	16		15			Approximate Depths: Bottom of Well: 37.5 feet Top of Screen: 27.5 feet Top of Sand: 26.5 feet Stick-up: 2.5 feet
370			20.5	17		20			
365			25.5			11			* Not recorded
360			30.5	18					Water Level: 30 feet TOB
	32.0	Sandy LEAN CLAY (CL), firm to soft, brown, wet	32.5	11		6			
355		- Driller noted soft zone 35 to 37 feet							
	37.0	Sandy LEAN CLAY (CL), stiff, gray, wet	38.0	18		11			
350	41.0		40.5	18		14			
		REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 41.0 FEET							
345									
340									
335									

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER	B-5
DATE DRILLED	July 1, 1993
PROJECT NUMBER	417.91199.01
PROJECT	TVA New Johnsonville
PAGE 1 OF 1	

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD
390.0	0.0	(FILL) - Sandy LEAN CLAY (CL), very soft, brown						
385			5.0	16		2		
	7.5	(FILL) - Silty LEAN CLAY (CL), very stiff, brown and gray, with a trace of sand						
380			10.0	16		18		
375			15.0	16		18		
370			20.0	15		16		
			23.0	13				
365		- STIFF consistency, 24 to 28 feet	25.0	15		15		
	28.0	Silty LEAN CLAY (CL), soft, brown and gray, with a trace of sand						
360			30.0	16		4		
		- Wet below about 32 feet						
	33.0	Silty LEAN CLAY with sand (CL), soft to very soft, gray, wet	33.0			4		
355			35.0			3		
			38.0	7		0		
	39.0	Sandy LEAN CLAY (CL), firm, gray, wet	40.0	18		6		
350	40.5	REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 40.5 FEET						
345								
340								
335								

Note: the sample at 23.0 ft is shown by the Undisturbed Sample symbol.

REMARKS

Drilled by: B. Grissom

Drilling Method: HSA

Borehole Logged by: R.D. Mursch

Set 42.5 linear feet of 1-inch PVC piezometer with hand-slotted screen section, lower 10 feet; Backfilled with sand to 30 feet, then soil auger cuttings to surface

Approximate Depths:
Bottom of Well: 40 feet
Top of Screen: 30 feet
Top of Sand: 30 feet
Stick-up: 2.5 feet

* Not recorded

Water Level: 40 feet TOB

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER B-6
DATE DRILLED July 1, 1993
PROJECT NUMBER 417.91199.01
PROJECT TVA New Johnsonville
PAGE 1 OF 1

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION
390.0	0.0	(FILL) - Silty LEAN CLAY (CL), stiff to firm, brown and gray, with a trace of sand - VERY STIFF consistency, 7.5 to 12.5 feet.
	24.5	(FILL) - Silty LEAN CLAY (CL), very soft to soft, brown and gray, with a trace of sand
	29.0	REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 29.0 FEET

D	SR	N	CR	RQD
6.0	12	9		
11.0	14	16		
16.0		8		
18.5	21			
20.5		10		
23.5		7		
26.0		0		
28.5		4		

Elevation scale: 390, 385, 380, 375, 370, 365, 360, 355, 350, 345, 340, 335

REMARKS

Drilled by: B. Grissom

Drilling Method: HSA

Borehole Logged by:
R.D. Mursch

Set 33.0 linear feet of 1-inch PVC piezometer with hand-slotted screen section, lower 10 feet; Backfilled with sand to about 18 feet, then soil auger cuttings to surface

Approximate Depths:
Bottom of Well: 28.0 feet
Top of Screen: 18.0 feet
Top of Sand: 16.5 feet
Stick-up: 5.0 feet
* Not recorded

Water Level:
27.5 feet TOB

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER	B-7
DATE DRILLED	July 2, 1993
PROJECT NUMBER	417.91199.01
PROJECT	TVA New Johnsonville
PAGE 1 OF 1	

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD
390.0	0.0	(FILL) - Silty LEAN CLAY (CL), variable consistency, brown and gray, with a trace of sand						
			6.0	14		17		
		- Gravel in sample at 11 feet	11.0	0		10		
		0-14 feet, VERY STIFF to STIFF consistency	13.5	13		10		
		14-22 feet, FIRM consistency	16.0	14		5		
		22-27 feet, VERY SOFT consistency	18.5	22				
			20.5			6		
			23.5	0		0		
			26.0	10		0		
	27.0	Sandy LEAN CLAY (CL), firm, brown and gray	28.5	16		8		
	29.0	REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 29.0 FEET						

Elevation scale: 390, 385, 380, 375, 370, 365, 360, 355, 350, 345, 340, 335

REMARKS

Drilled by: B. Grissom

Drilling Method: HSA

Borehole Logged by: R.D. Mursch

Set 34.0 linear feet of 1-inch PVC piezometer with hand-slotted screen section, lower 10 feet; Backfilled with sand to 18 feet, then soil auger cuttings to surface

Approximate Depths:
Bottom of Well: 29.0 feet
Top of Screen: 19.0 feet
Top of Sand: 18.0 feet
Stick-up: 5.0 feet

Water Level: 20.5 feet TOB

* Not recorded

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER	B-8
DATE DRILLED	July 2, 1993
PROJECT NUMBER	417.91199.01
PROJECT	TVA New Johnsonville
PAGE 1 OF 1	

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD
390.0	0.0	(FILL) - Silty LEAN CLAY (CL), stiff to firm, brown and gray, with a trace of sand						
385			6.0	11		14		
380			11.0	17		11		
			13.5	16		11		
375			16.0	18		8		
		17-18.5 feet, SOFT CONSISTENCY	18.5			5		
370			21.0	14				
			23.0			8		
		24-26.5 feet, SOFT consistency						
365	26.5		26.0			4		
		REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 26.5 FEET						
360								
355								
350								
345								
340								
335								

REMARKS

Drilled by: B. Grissom

Drilling Method: HSA
Rotary wash/water

Borehole Logged by:
R.D. Mursch

Set 31.0 linear feet of 1-inch PVC piezometer with hand-slotted screen section, lower 10 feet; Backfilled with sand to 15 feet, then soil auger cuttings to surface

Approximate Depths:
Bottom of Well: 26.0 feet
Top of Screen: 16.0 feet
Top of Sand: 15.0 feet
Stick-up: 5.0 feet
* Not recorded

Borehole Dry Upon Completion

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER	B-9
DATE DRILLED	July 2, 1993
PROJECT NUMBER	417.91199.01
PROJECT	TVA New Johnsonville
PAGE 1 OF 1	

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD
390.0	0.0	(FILL) - Silty LEAN CLAY (CL), stiff to very stiff, tan and orange-brown, with a trace of fine sand and fine chert gravel						
385			5.0	16		14		
380			10.0	2		20		
			11.5	24				
	13.0	(FILL) - Cinders and Ash (SP/GP or SM/GM), firm to dense, black, wet, particle sizes coarse sand to fine gravel with fines layered throughout	13.5	13		20		
375			15.0	18		41		
370			20.0	16		21		
365			25.0	18		7		
			26.5	0				
	28.5	(ALLUVIUM) - Silty LEAN CLAY (CL), stiff to very stiff, brown, tan, and gray, with a trace of fine sand; Sand content, grain size increase with depth	28.5	18		16		
360			30.0	14		12		
355			35.0	18		16		
350			40.0	18		9		
345	45.5	(ALLUVIUM) - Fine Sandy Silty LEAN CLAY (CL), stiff, grayish-tan to gray, interlayered with orange sandy silty clay with oxide staining	45.0	18		13		
340			50.0	9		10		
335	55.5	REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 55.5 FEET	55.0	18		10		

REMARKS

Surface Cover: Gravel

Drilled by:
R. Tillery
M. Guymon

Drilling Method: HSA

Borehole Logged by: M. Brite

Water Level: 14 feet TOB

NOTE: Began hole 9-9-93; Completed hole/well 9-13-93

Set 57.6 linear feet of 2-inch diameter PVC piezometer with slotted screen section, lower 10 feet; Backfilled with sand to 43 feet, then soil auger cuttings with 2-foot bentonite seal at surface

Approximate Depths:
Bottom of Well: 55.0 feet
Top of Screen: 44.7 feet
Top of Sand: 43 feet
Stick-up: 2.6 feet

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

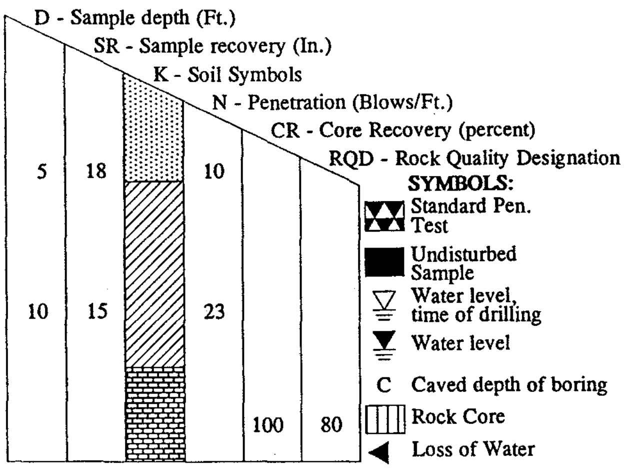
TEST BORING RECORD

BORING NUMBER	B-OW-1
DATE DRILLED	September 9, 1993
PROJECT NUMBER	417.91199.01
PROJECT	TVA New Johnsonville
PAGE 1 OF 1	

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD	REMARKS
390.0	0.0	NOTE: This boring advanced for purpose of attempting an undisturbed sample at about 40 feet; Augered to 37-foot depth before collecting any soil samples							Surface Cover: Weeds/Gravel Drilled by: R. Tillery, M. Guymon Drilling Method: HSA Borehole Logged by: M. Brite Borehole backfilled with soil auger cuttings upon completion * NOTE: Boring B-OW-1A offset 4 feet south of Boring B-OW-1
	37.0	Stiff, tan and brown alluvial silty LEAN CLAY (CL) with a trace of fine sand	38.0 39.0	12 0		10			
350	40.5	REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 40.5 FEET							

Elevation scale: 390, 385, 380, 375, 370, 365, 360, 355, 350, 345, 340, 335



TEST BORING RECORD

BORING NUMBER	B-OW-1A
DATE DRILLED	September 10, 1993
PROJECT NUMBER	417.91199.01
PROJECT	TVA New Johnsonville
PAGE 1 OF 1	

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION
390.0	0.0	(FILL) - Silty LEAN CLAY (CL), very stiff to stiff, brown, reddish-brown, and gray, with a trace of fine sand and fine chert gravel
	14.0	(FILL) - Cinders and Ash (SP/GP), dense to very dense, black, particle sizes range from sands to fine gravel with occasional fines (silt/clay sized) and fine chert gravel; Sample at 25 feet, loose consistency
	25.0	(ALLUVIUM) - Silty LEAN CLAY (CL), stiff to very stiff, tan, brown, and gray, with fine sand and occasional black mineral oxide nodules; Sand content increased with depth
		-FIRM consistency at 40 feet
	50.5	-SOFT consistency at 50 feet
		REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 50.5 FEET

Elevation scale: 390, 385, 380, 375, 370, 365, 360, 355, 350, 345, 340, 335

D	SR	K	N	CR	RQD
5.0	18		16		
10.0	18		12		
15.0	14		41		
20.0	18		58		
25.0	18		6		
30.0	16		14		
31.5	24				
33.5	18		17		
35.0	18		10		
36.5	24				
38.5	15		9		
40.0	18		6		
45.0	18		14		
50.0	18		4		

REMARKS

Surface Cover: Weeds/Gravel

Drilled by:
R. Tillery
M. Guymon

Drilling Method: HSA

Borehole Logged by: M. Brite

Water Level: 14 feet TOB

NOTE: Began hole 9-10-93; completed hole/well 9-13-93

Set 49.7 linear feet of 2-inch diameter PVC piezometer with slotted screen section, lower 10 feet; Backfilled with sand to 36.9 feet, then soil auger cuttings with 2-foot bentonite seal at surface

Approximate Depths
Bottom of Well: 49.2 feet
Top of Screen: 38.9 feet
Top of Sand: 36.9 feet
Stick-up: 0.5 feet

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER	B-OW-2
DATE DRILLED	September 10, 1993
PROJECT NUMBER	417.91199.01
PROJECT	TVA New Johnsonville
PAGE 1 OF 1	

LAW ENGINEERING

TEST BORING RECORD

BORING NUMBER	B-OW-3
DATE DRILLED	September 14, 1993
PROJECT NUMBER	417.91199.01
PROJECT	TVA New Johnsonville
PAGE 1 OF 1	

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION
390.0	0.0	(FILL) - Silty LEAN CLAY (CL), stiff, tan and gray, with fine sand, a trace of fine chert gravel, and thin lenses of gray silt
	14.0	(FILL) - Cinders and Ash (SP/GP) dense, black, sand to fine gravel sized, with some fines and occasional larger (1 - 1-1/2 inch) cinders
	18.0	(FILL) Silty LEAN CLAY (CL), stiff, tan and gray, with fine sand, occasional fine to coarse chert gravel, and a trace of black mineral oxide nodules; Sample at 25 feet, wet
	32.0	(POSSIBLE ALLUVIUM) - Silty LEAN CLAY (CL), stiff, tan, moist, with fine sand and occasional black mineral oxide nodules
	37.0	(ALLUVIUM) - Silty LEAN CLAY (CL), stiff, tan and grayish-tan, moist, with fine sand and black mineral oxide nodules
	47.0	(ALLUVIUM) - Fine Sandy Silty LEAN CLAY (CL), stiff, tan and gray, moist
340	50.5	REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 50.5 FEET

Elevation scale: 390, 385, 380, 375, 370, 365, 360, 355, 350, 345, 340, 335

D	SR	N	Sample
5.0	12	10	Standard Pen. Test
10.0	16	14	Standard Pen. Test
15.0	16	32	Standard Pen. Test
20.0	18	12	Standard Pen. Test
25.0	18	10	Standard Pen. Test
30.0	17	19	Standard Pen. Test
35.0	18	12	Standard Pen. Test
40.0	18	12	Standard Pen. Test
45.0	18	15	Standard Pen. Test
50.0	18	9	Standard Pen. Test

REMARKS

Surface Cover: Gravel

Drilled by:
R. Tillery
M. Guymon
M. Haire
Drilling Method: HSA
Borehole Logged by: M. Brite

Water Level: 24 feet TOB

Set 50.2 linear feet of 2-inch diameter PVC piezometer with slotted screen section, lower 10 feet; Backfilled with sand to 37.1 feet, then soil auger cuttings with 2-foot bentonite seal at surface

Approximate Depths:
Bottom of Well: 49.4 feet
Top of Screen: 39.1 feet
Top of Sand: 37.1 feet
Stick-up: 0.8 feet

Legend

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD	REMARKS
390.0	0.0	(FILL) - Silty LEAN CLAY (CL), firm to stiff, tan and reddish-brown, with dry zones, gray silty zones, with occasional fine chert gravel and trace fine sand; one-inch zone of ash/cinders at bottom of sample at 15 feet							Surface Cover: Weeds/Gravel Drilled by: R. Tillery, M. Guymon, M. Haire Drilling Method: HSA Borehole Logged by: M. Brite
385			5.0	8		8			
380			10.0	16		14			
375			15.0	14		10			
	17.0	(FILL) - Silty LEAN CLAY (CL), soft to stiff, brown and tan, with fine sand and a trace of fine chert gravel and black mineral oxide nodules							
370			20.0	12		4			
365			25.0	18		11			
	27.0	(POSSIBLE ALLUVIUM) - Silty LEAN CLAY (CL), stiff, brown with tan, with a little fine sand and black mineral oxide nodules							
360			30.0	12		15			Set 47.7 linear feet of 2-inch diameter PVC piezometer with hand-slotted screen section, lower 10 feet; Backfilled with sand to 32.2 feet, then soil auger cuttings with 2-foot bentonite seal at surface
	32.0	(ALLUVIUM) - Silty LEAN CLAY (CL), stiff, brown with tan, with a little fine sand and black mineral oxide nodules							
355			35.0	18		13			
350			40.0	18		10			Water Level: 40 feet TOB
345	45.5		45.0	18		12			Approximate Depths: Bottom of Well: 44.5 feet Top of Screen: 34.2 feet Top of Sand: 32.2 feet Stick-up: 3.2 feet
		REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 45.5 FEET							
340									
335									

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER B-OW-4
DATE DRILLED September 14, 1993
PROJECT NUMBER 417.91199.01
PROJECT TVA New Johnsonville
PAGE 1 OF 1

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD	REMARKS
390.0	0.0	(FILL) - Silty LEAN CLAY (CL), stiff to very stiff, tan and reddish-brown, with occasional fine to coarse chert gravel, gray silty zones, cinders, and a trace of fine sand							Surface Cover: Gravel Drilled by: R. Tillery M. Guymon M. Haire Drilling Method: HSA Borehole Logged by: M. Brite
385			5.0	18		14			
380			10.0	18		17			
	14.5	(FILL) - Cinders and Ash (SP/GP or SM/GM), dense, black; particle sizes range from fines (silt/clay) to fine gravel							
375			15.0	17		49			
	19.0	(FILL) - silty LEAN CLAY (CL), very stiff to stiff, tan and gray moist, jumbled, blocky, with black mineral oxide nodules; occasional fine chert gravel, cinders, and a little fine sand; Trace organics in gray material							
370			20.0	14		21			
365			25.0	14		13			
360			30.0	18		15			Set 45 linear feet of 2-inch diameter PVC piezometer with hand-slotted screen section, lower 10 feet; Backfilled with sand to 32.5 feet, then soil auger cutting with 2-foot bentonite soil at surface
	33.0	(ALLUVIUM) - Silty LEAN CLAY (CL), stiff to firm, tan, moist, with a little fine sand							
355			35.0	18		14			
350			40.0	18		8			Water Level: 40 feet TOB
345	45.5		45.0	18		13			Approximate Depths: Bottom of Well: 44.8 feet Top of Screen: 34.5 feet Top of Sand: 32.5 feet Stick-up: 0.5 feet
		REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 45.5 FEET							
340									
335									

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

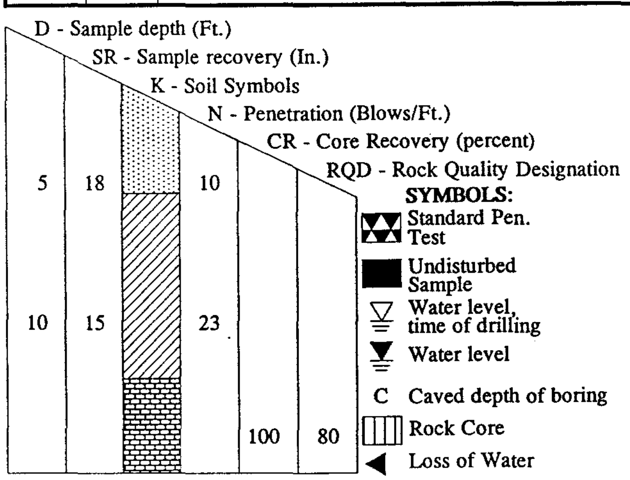
SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER B-OW-5
DATE DRILLED September 14, 1993
PROJECT NUMBER 417.91199.01
PROJECT TVA New Johnsonville
PAGE 1 OF 1

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD	REMARKS
390.0	0.0	(FILL) - Silty LEAN CLAY (CL), tan and gray, with occasional fine to coarse chert gravel, fine sand, and cinders; Some reddish-brown clay and, trace organics at about 10 feet							Surface Cover: Gravel, Sandy Clay Soil Drilled by: R. Tillery, M. Guymon, M. Haire Drilling Method: HSA Borehole Logged by: M. Brite
385			5.0	14		12			
380			10.0	18		13			
375	14.5	(FILL) - Cinders and Ash (SP/GP or SM/GM), dense, black; particle sizes range from fines (silt/clay) to fine gravel	15.0	18		48			
370			20.0	12		4			
365	22.0	(FILL) - Silty LEAN CLAY (CL), stiff to very stiff, tan and gray, moist, blocky, jumbled, with a trace of fine sand, fine chert gravel, and black mineral oxide nodules	25.0	18		13			
360			30.0	18		16			
355	32.0	(ALLUVIUM) - Silty LEAN CLAY (CL), stiff, tan, with a trace to a little fine sand and brown mineral oxide staining	35.0	18		12			Water Level: 34 feet TOB
350			40.0	18		13			Set 45.3 linear feet of 2-inch diameter PVC piezometer with hand-slotted screen section, lower 10 feet; Backfilled with sand to 33.9 feet, then soil auger cuttings with 2-foot bentonite seal at surface
345	45.5	REFUSAL NOT ENCOUNTERED; BORING TERMINATED AT 45.5 FEET	45.0	18		13			Approximate Depths: Bottom of Well: 44.2 feet Top of Screen: 33.9 feet Top of Sand: 31.9 feet Stick-Up: 1.1 feet
340									
335									



TEST BORING RECORD

BORING NUMBER B-OW-6
DATE DRILLED September 15, 1993
PROJECT NUMBER 417.91199.01
PROJECT TVA New Johnsonville
PAGE 1 OF 1

LAW ENGINEERING

APPENDIX C

LABORATORY TESTING PROCEDURES

Moisture Content

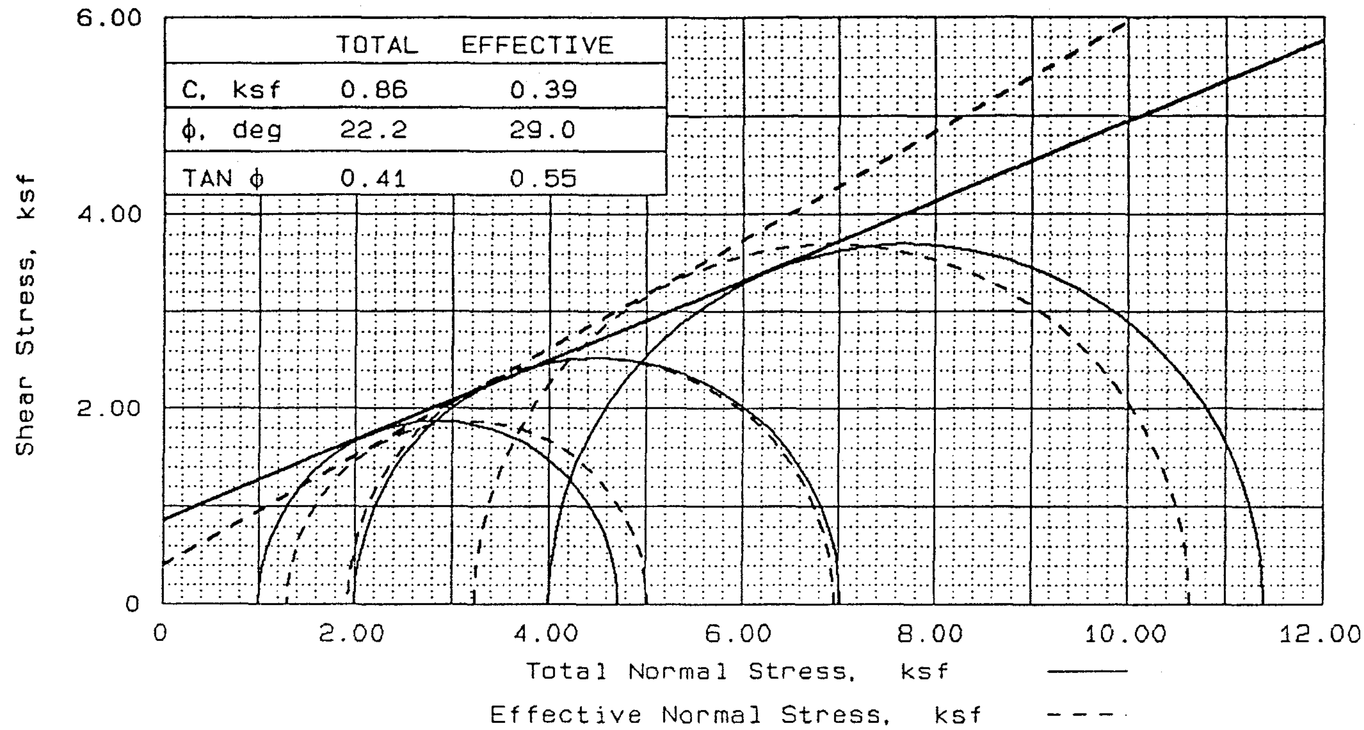
The moisture content is the ratio expressed as a percentage of the weight of water in a given mass of soil to the weight of the solid particles. This test is conducted in general accordance with ASTM Method D 2216.

Specific Gravity of Soil Samples

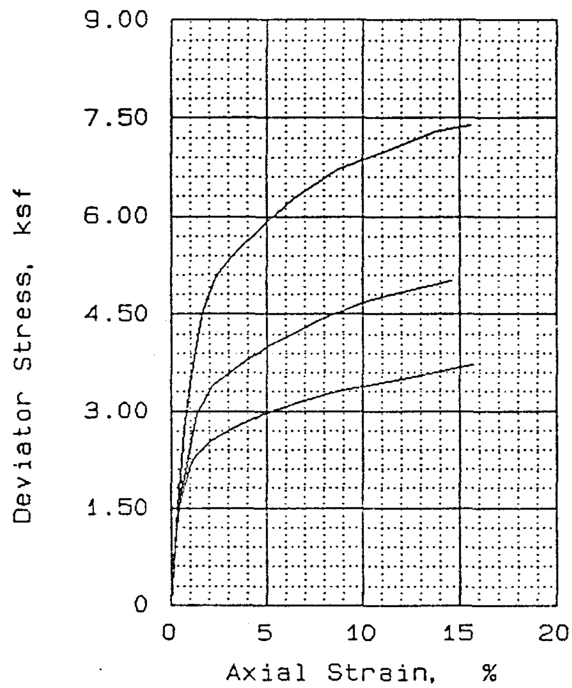
The specific gravity is the ratio of the weight of a given volume of soil solids to the weight of an equal volume of distilled water at 4 degrees Celsius. The specific gravity is used in soil weight-volume relationships. This test is conducted in general accordance with ASTM Method D 854-92.

Triaxial Shear Test

The strength parameters of selected soils were obtained by tiaxial shear testing of undisturbed samples. Several sections of each sample were extruded from the sampling tube. The samples were then trimmed into cylinders about 2.9 inches in diameter and encased in rubber membranes. Each sample was then placed in a compression chamber, saturated, and confined by all-round pressure until primary consolidation was complete. The axial load was then applied until the sample failed in shear. The test results have been presented in the form of stress-strain curves and Mohr diagrams on the accompanying Triaxial Compression Test sheets. This test is conducted in general accordance with ASTM Method D 4767.



	TOTAL	EFFECTIVE
C, ksf	0.86	0.39
ϕ, deg	22.2	29.0
TAN ϕ	0.41	0.55



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	24.0	23.4	24.5
	DRY DENSITY, pcf	99.7	101.1	100.1
	SATURATION, %	93.9	94.7	96.8
	VOID RATIO	0.690	0.668	0.685
	DIAMETER, in	2.86	2.86	2.87
	HEIGHT, in	5.99	5.99	5.99
AT TEST	WATER CONTENT, %	25.4	24.0	24.0
	DRY DENSITY, pcf	99.9	102.3	102.2
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.687	0.647	0.648
	DIAMETER, in	2.86	2.85	2.84
	HEIGHT, in	5.99	5.97	5.98
BACK PRESSURE, ksf		2.56	2.61	2.59
CELL PRESSURE, ksf		3.56	4.61	6.59
FAILURE STRESS, ksf		3.73	5.03	7.39
PORE PRESSURE, ksf		2.26	2.68	3.36
STRAIN RATE, %/min.		0.100	0.100	0.100
ULTIMATE STRESS, ksf				
PORE PRESSURE, ksf				
$\bar{\sigma}_1$ FAILURE, ksf		5.03	6.96	10.63
$\bar{\sigma}_3$ FAILURE, ksf		1.3	1.93	3.24

TYPE OF TEST:
CU with pore pressures

SAMPLE TYPE: Undisturbed

DESCRIPTION:

LL= PL= PI=

SPECIFIC GRAVITY= 2.70

REMARKS: Tested by:

Reviewed by:

FIG. NO. 1

CLIENT: TVA

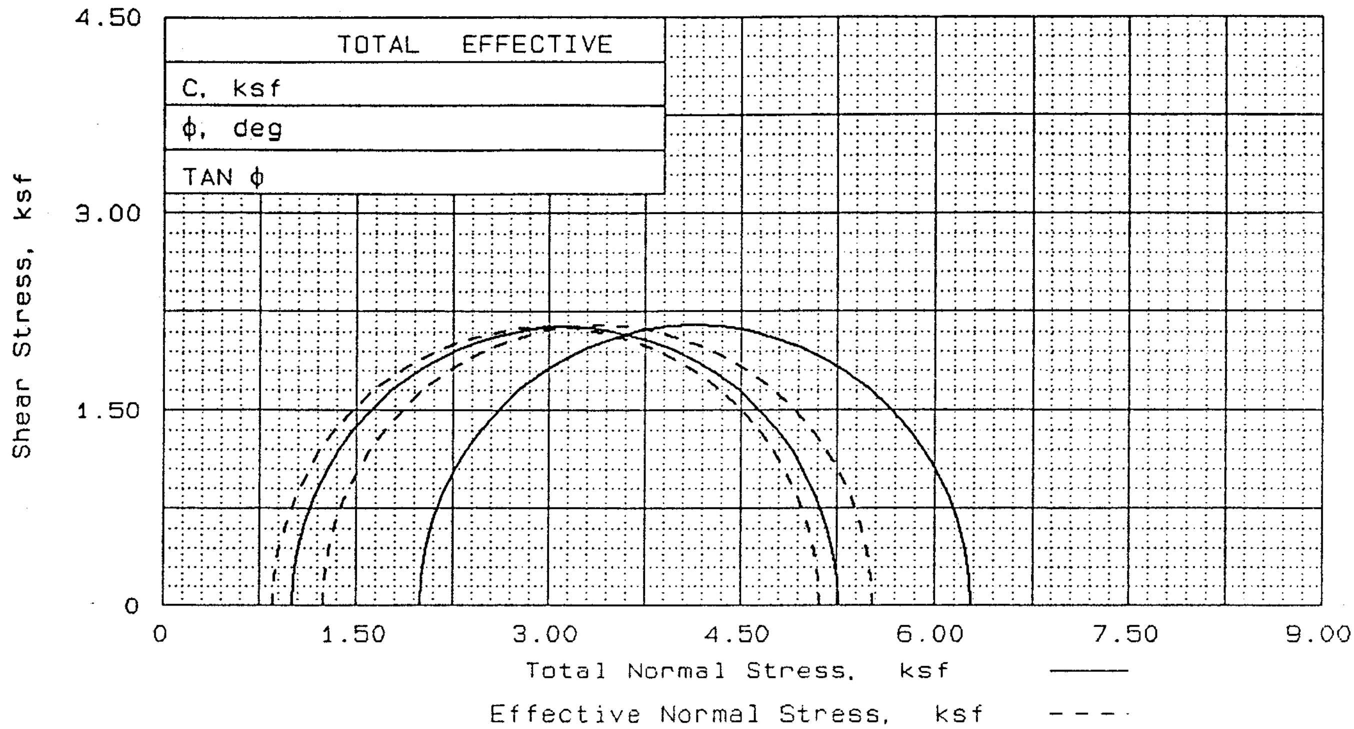
PROJECT: Johnsonville Ash Pond

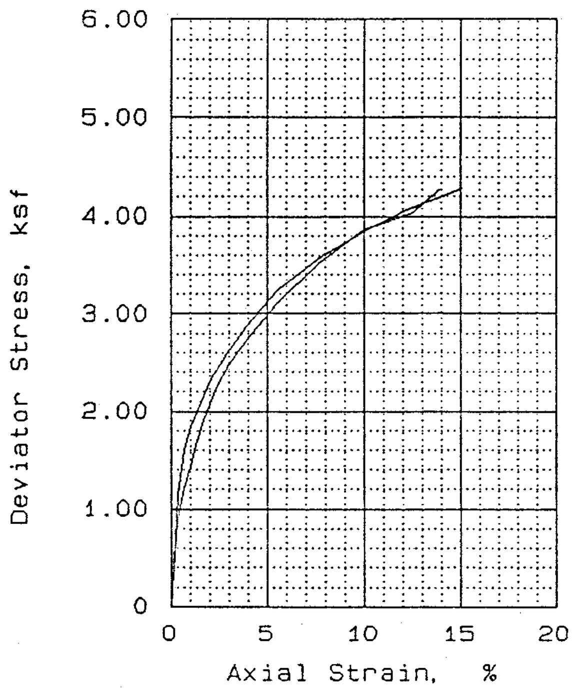
SAMPLE LOCATION: Bow 2 UD

PROJ. NO.: 5740143904 DATE: Nov. 2, 1993

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING, INC.





SAMPLE NO.		1	2
INITIAL	WATER CONTENT, %	22.5	23.0
	DRY DENSITY, pcf	102.5	102.1
	SATURATION, %	94.3	95.4
	VOID RATIO	0.645	0.651
	DIAMETER, in	2.87	2.87
	HEIGHT, in	6.00	6.00
AT TEST	WATER CONTENT, %	23.5	24.0
	DRY DENSITY, pcf	103.2	102.3
	SATURATION, %	100.0	100.0
	VOID RATIO	0.634	0.648
	DIAMETER, in	2.86	2.87
	HEIGHT, in	5.99	5.99
BACK PRESSURE, ksf		2.68	2.64
CELL PRESSURE, ksf		4.68	3.63
FAILURE STRESS, ksf		4.29	4.25
PORE PRESSURE, ksf		3.43	2.78
STRAIN RATE, %/min.		0.100	0.100
ULTIMATE STRESS, ksf			
PORE PRESSURE, ksf			
$\bar{\sigma}_1$ FAILURE, ksf		5.54	5.12
$\bar{\sigma}_3$ FAILURE, ksf		1.25	0.86

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: Undisturbed
DESCRIPTION:

LL= PL= PI=
SPECIFIC GRAVITY= 2.70
REMARKS: Tested by:

Reviewed by:

FIG. NO. 3

CLIENT: TVA

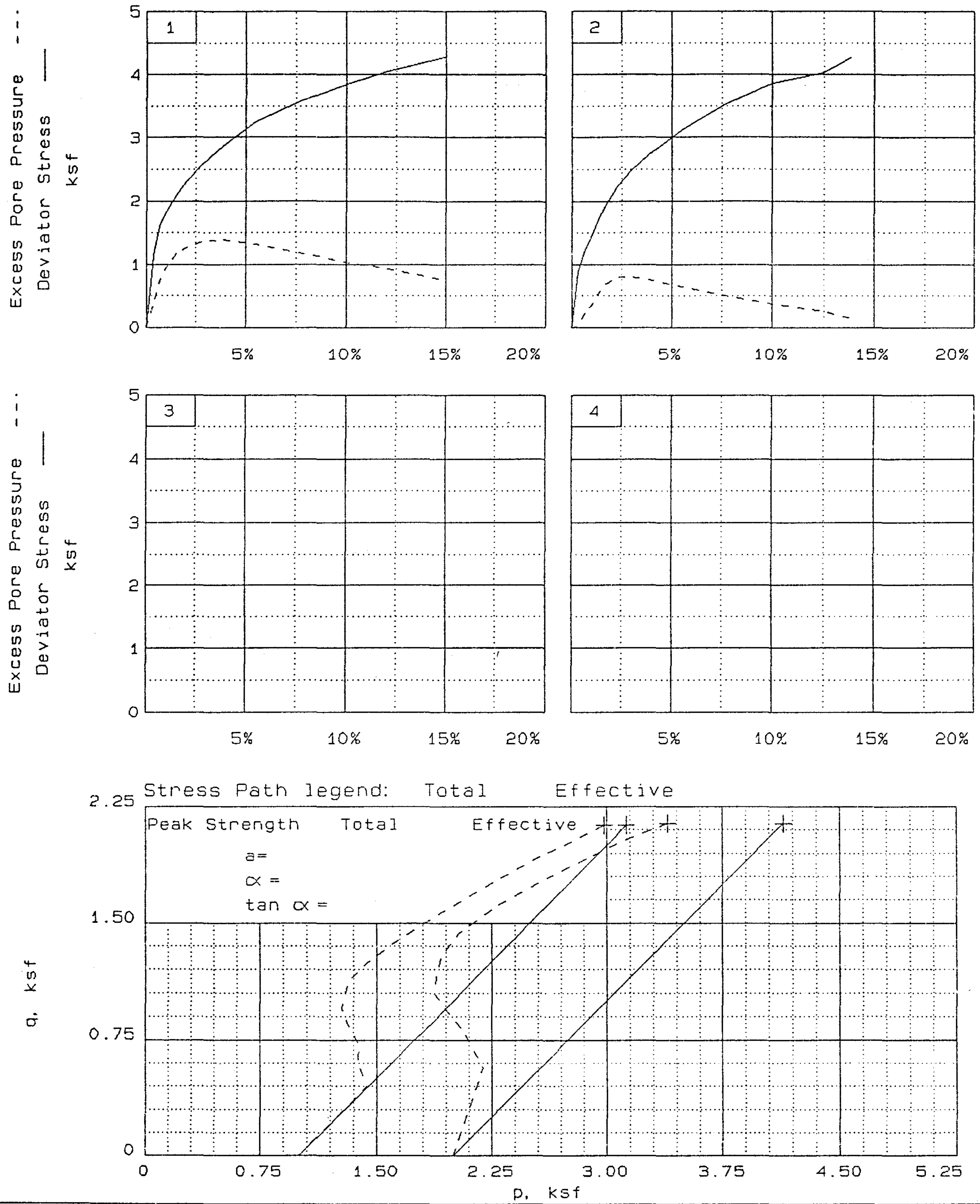
PROJECT: Johnsonville Ash Pond

SAMPLE LOCATION: B-2 UD @ 35.5-37.5 Ft.

PROJ. NO.: 5740143904 DATE: Nov. 2, 1993

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING, INC.

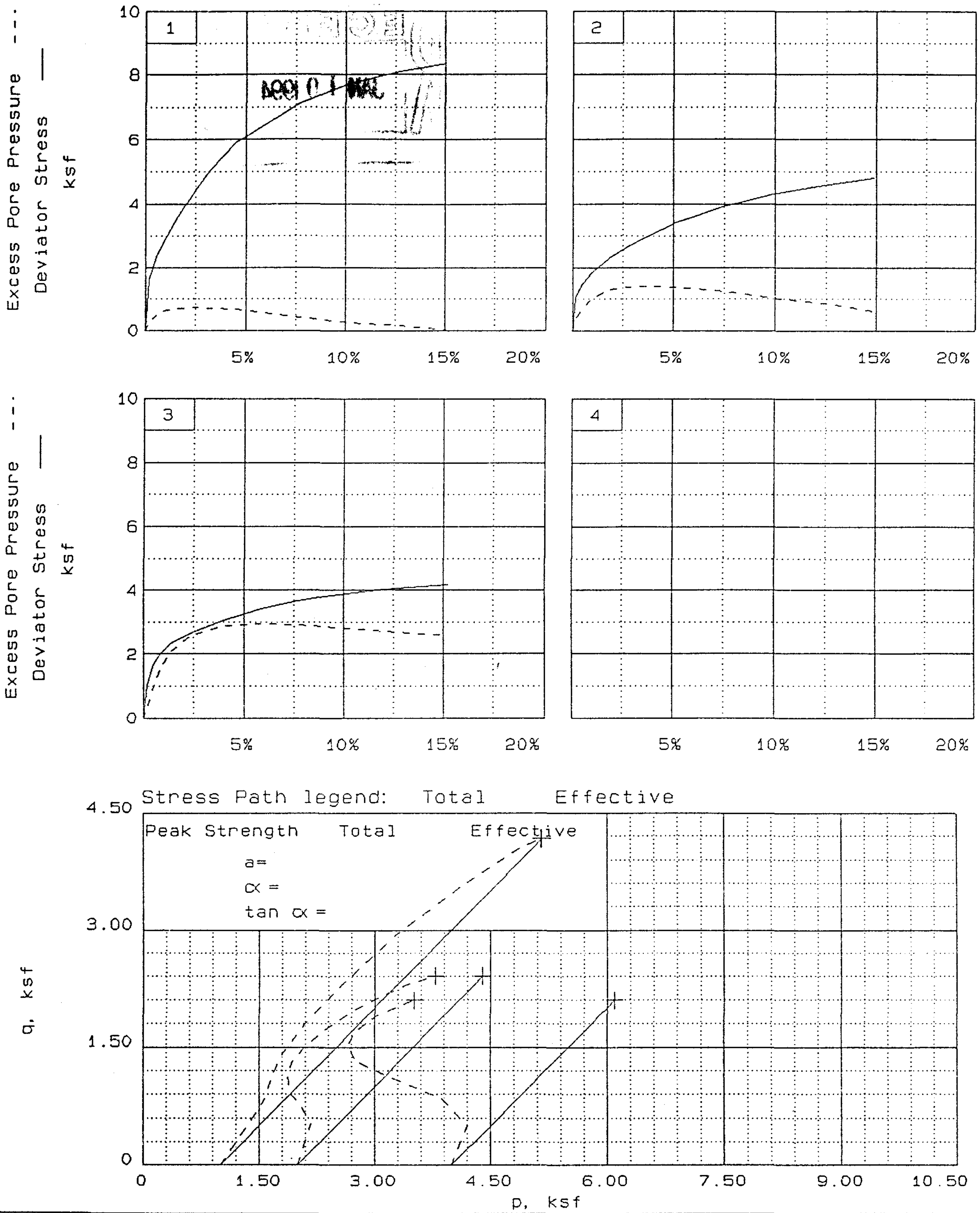


Client: TVA

Project: Johnsonville Ash Pond

Location: B-2 UD @ 35.5-37.5 Ft.

File: 143904B Project No.: 5740143904 Page 2/2 Fig. No. 3



Client: TVA

Project: Johnsonville Ash Pond

Location: B-1 UD @ 10.5-12.5 Ft.

File: 143904A Project No.: 5740143904 Page 2/2 Fig. No. 2

APPENDIX D

SUMMARY OF WATER LEVEL DATA
Observation Wells at Ash Pond Dike Discharge Area
New Johnsonville Fossil Plant
Law Engineering Project No. 417.91199.01

Observation Well No.	Ground Surface Elevation (feet site datum)	GROUNDWATER LEVELS									
		TOB (1)		07-07-93		07-20-93		09-14-93		09-15-93	
		FEET BGL (2)	ELEVATION	FEET BGL	ELEVATION	FEET BGL	ELEVATION	FEET BGL	ELEVATION	FEET BGL	ELEVATION
B-1A	390	NR (3)		23.3	366.7	23.1	366.9	24.2	365.8	N/A	
B-2	390	10.8	379.2	7.5	382.5	7.3	382.7	7.4	382.6	N/A	
B-3	390	NR		26.8	363.2	28.3	361.7	29.7	360.3	N/A	
B-5	390	30.0	360.0	30.1	359.9	30.2	359.8	31.8	358.2	N/A	
B-6	390	40.0	350.0	30.4	359.6	30.4	359.6	32.0	358.0	N/A	
B-7	380	27.5	352.5	19.2	360.8	19.1	360.9	20.8	359.2	N/A	
B-8	378	20.5	357.5	20.5	357.5	19.6	358.4	21.0	357.0	N/A	
B-9	378	Dry		19.2	358.8	19.3	358.7	20.4	357.6	N/A	
B-OW-1	390	14.0	376.0	N/A		N/A		7.5	382.5	28.6	361.4
B-OW-2	390	14.0	376.0	N/A		N/A		7.1	382.9	29.5	360.5
B-OW-3	390	24.0	366.0	N/A		N/A		7.2	382.8	32.2	357.8
B-OW-4	390	40.0	350.0	N/A		N/A		6.9	383.1	27.0	363.0
B-OW-5	390	40.0	350.0	N/A		N/A		N/A		32.6	357.4
B-OW-6	390	34.0	356.0	N/A		N/A		N/A		12.0	378.0

(1) TOB = Time of Boring, prior to well installation
(2) BGL = Below Ground Level
(3) NR = Not Reported

APPENDIX E

SUMMARY OF VIDEOTAPE VIEWING NOTES
Repair of Ash Pond Dike Discharge Pipes
New Johnsonville Fossil Plant
Law Engineering Project No. 417.91199.01

A videotape of one of the discharge pipes was viewed by our principal geotechnical engineer, Mr. Rick Heckel. The videotape, provided by TVA, was reportedly filmed prior to slipform repair of the subject pipe (unidentified). The following notes serve as record of our general observations of the videotape. Indicated distances are approximate.

The progress of the videotape was reportedly from the pipe outlet, extending upstream (east) toward the pipe inlet. Therefore, in the notes below, "right" would indicate south, and "left" would indicate north.

Joint 1	Seep, right side at midpoint
Joint 6	Seep, left side near bottom
Joint 10	Repacked to Joint 9
Joint 21	Seep, right side at 1/3 point from bottom
Joint 26	Spout near invert
Joint 33	Spout near invert
Joint 43	Seep, right side above midpoint
Joint 44	Seep, left side at 2/3 point from bottom
Joint 47	Drop inlet?

IMPORTANT INFORMATION
ABOUT YOUR
GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, thanks to the Association of Soil and Foundation Engineers (ASFE).

When ASFE was founded in 1969, subsurface problems were frequently being resolved through lawsuits. In fact, the situation had grown to such alarming proportions that consulting geotechnical engineers had the worst professional liability record of all design professionals. By 1980, *ASFE-member consulting soil and foundation engineers had the best professional liability record.* This dramatic turn-about can be attributed directly to client acceptance of problem-solving programs and materials developed by ASFE for its members' application. *This acceptance was gained because clients perceived the ASFE approach to be in their own best interests.* Disputes benefit only those who earn their living from others' disagreements.

The following suggestions and observations are offered to help you reduce the geotechnical-related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include: the general nature of the structure involved, its size and configuration; the location of the structure on the site and its orientation; physical concomitants such as access roads, parking lots, and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program. To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of his report may affect his recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should not be used:*

- When the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership, or
- for application to an adjacent site.

A geotechnical engineer cannot accept responsibility for problems which may develop if he is not consulted after factors considered in his report's development have changed.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by the geotechnical engineer who then renders an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those opined to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. For example, the actual interface between materials may be far more gradual or abrupt than the report indicates, and actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact.* For this reason, *most experienced owners retain their geotechnical consultant through the construction stage,* to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

SUBSURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly-changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy