FAX COVER

Send To:

Name: Sam Shiya Date: 10-17-00

Company: Law Engr.

Address: Knville, TN.

Phone: 865-588-8544

Fax Number: 865-588-6677

Verification Number:

Number of pages including cover: 9

Subject: JOF- Stability Analysis Report

From: Tennessee Valley Authority

Name: RONALD O. POWELL

Organization: FOSSIL ENGR.

Address: LA2G-C

Phone: 615-751-8912

Fax Number: 615-751-7094

Verification Number:

Special Instructions:

Important! If you do not receive all pages, call us back immediately

TVA 15536 (F-RIM 3/94)

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

September 19, 1997

Mr. Kenneth W. Burnett
Tennessee Valley Authority
1101 Market Street, LP-2G
Chattanooga, TN 37402

Subject: **Report of Subsurface Exploration and Stability Analysis**
Tennessee Valley Authority
Johnsonville Fossil Plant, Ash Disposal Area
LAW Project 50385-5-0400/0035/0001

Dear Mr. Burnett:

We at Law Engineering and Environmental Services, Inc., (LAW) are pleased to submit this Report of Subsurface Exploration and Stability Analysis for the Johnsonville Fossil Plant, Ash Disposal Area. This work was conducted under TVA Contract No. TV-92657V, Task Assignment Order LA-035-1195170.

This report reviews the information provided to us, discusses the site and subsurface conditions, and presents the results of our stability analysis. The Appendices contain a Boring Location/Subsurface Section Plan, the Test Boring Logs, Subsurface Profile Sections, and the Laboratory Test Results.

We will be pleased to discuss our recommendations with you and would welcome the opportunity to provide the engineering and material testing services needed to successfully complete your project.

Sincerely,

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

Jeffery A. Abston, P.E.
Senior Engineer

for Carl Tockstein JEN

Carl D. Tockstein, P.E.
Chief Engineer

JAA/CDT:jen

cc: Jerry Glover

1725 LOUISVILLE DRIVE • KNOXVILLE, TN 37921-5904
(423) 588-8544 • FAX (423) 588-8026

TABLE OF CONTENTS

Page

1.0 EXECUTIVE SUMMARY

We were selected by the Tennessee Valley Authority (TVA) to perform a subsurface exploration and stability analysis for the proposed Johnsonville Fossil Plant Ash Disposal Area. The objectives of our exploration were to determine general subsurface conditions, obtain data to evaluate the existing ash and insitu soils at the site and perform a stability analysis for the proposed disposal area configuration.

The exploration consisted of drilling nine test borings in the disposal area to depths ranging from about 20 to 70 feet. The major findings and recommendations are as follows:

- The proposed configuration has a global stability safety factor of about 1.8 under static conditions and about 1.1 under seismic conditions with a maximum horizontal acceleration coefficient of 0.15 (taken from the USGS Map of Maximum Horizontal Accelerations contained in the Tennessee Division of Solid Waste Management guidance document).

- For the maximum slope of 2.2H:1V and considering a critical interface angle of 22.6 degrees (based on triaxial shear strength data from previous studies of the ash at this site), the calculated factor of safety for the cover under seismic loading is 0.65. Consequently, it is likely the cover will slip/slough during the design seismic event and will require subsequent repair. If it were reasonably possible to increase the critical interface angle (by compaction of the ash and/or other methods) to a value of 33 degrees, the factor of safety would increase to 1.0.

This summary is only an overview and should not be used as a separate document or in place of reading the entire report, including the appendices.

2.0 INTRODUCTION

This report presents the results of our subsurface exploration and subsequent stability analysis for the proposed final configuration of the ash disposal area at the TVA Johnsonville Fossil Plant near New Johnsonville, Tennessee. This work was performed for TVA's use in preparing a revised closure plan for the ash disposal area.

3.0 OBJECTIVES OF EXPLORATION

The objectives of our exploration were to determine general subsurface conditions and to obtain data to evaluate engineering properties, the existing ash and insitu soils at the site, and perform a stability analysis for the proposed disposal area configuration. An assessment of site environmental

conditions, or for the presence or absence of pollutants in the soil, bedrock, surface water, or ground water of the site were beyond the proposed objectives of our exploration.

4.0 SCOPE OF SERVICES

The scope of services for this exploration has included the following:

- Layout and drilling of nine test borings to depths ranging from about 20 to about 70 feet. The borings were advanced about 6 to 22-½ feet into the insitu soils.
- Standard Penetration Testing was performed at 5-foot intervals in the borings, and undisturbed samples of the insitu soils were obtained for laboratory testing.
- Consolidated undrained with pore pressure measurements and unconsolidated undrained triaxial tests, grain size analysis, permeability testing, and unified soil classifications were performed on representative undisturbed soil samples.
- The data obtained, along with data available from previous LAW testing to determine ash parameters, was used to perform stability analysis on two cross sections of the proposed ash stack configuration.

5.0 PROJECT INFORMATION AND SITE CONDITIONS

Project information was provided to us by Mr. Jerry Glover of TVA during telephone conversations. We have also received from Mr. Mike Hranek, an autocad drawing depicting the proposed final configuration of the disposal area. We understand that TVA is preparing a revised closure plan for the ash disposal area at their Johnsonville Fossil Plant in New Johnsonville, Tennessee. The original closure plan did not include any investigation of the insitu overburden. The current revision requires geotechnical input parameters for use in stability analysis and hydrogeologic modeling of the area.

The site is about 40 to 50 acres in size and is presently occupied by two existing ash stacks about 40 to 50 feet high. There are several towers supporting power lines located across the site. The plan provided to us indicates that an additional 20 to 50 feet of ash will be placed across the site.

6.0 SUBSURFACE CONDITIONS

Subsurface conditions were explored with nine widely spaced borings drilled in general accordance with the procedures presented in Appendix A. The boring locations and depths were selected by TVA personnel. Our geotechnical engineer established the actual boring locations in the field by

taping distances and estimating right angles relative to on-site landmarks. Boring elevations were obtained by survey using an existing observation well top as a temporary benchmark. The boring locations are shown on the Boring Location/Subsurface Section Plan in Appendix B, and the elevations are shown on the Test Boring Logs in Appendix C.

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

The test borings performed at this site typically encountered fill and alluvial soils. Fill is material that has been placed by man. Alluvial soils are soils that have been transported to their present location by running water.

After penetrating a layer of topsoil ranging in thickness from about ½-foot to 2½ feet or from the ground surface, the test borings except B-7 encountered fill to depths ranging from about 17½ to 62 feet. The fill was composed primarily of very loose to dense dark gray fine sand (flay ash). Standard penetration test (SPT) resistance values for the ash ranged from 0 blows per foot (bpf) to 50 bpf, and averaged about 8 bpf.

Beneath a 2-foot layer of topsoil in boring B-7 and after penetrating the ash in the remaining borings, alluvial soils were encountered to boring refusal or termination at depths ranging from 20-½ feet to 70-½ feet. The alluvial soils encountered were typically composed of very loose to very dense brown and tan silty sand and gravel and stiff to hard brown and tan silty sandy clay with gravel. SPT values for the alluvial soil ranged from 2 to 100 bpf and averaged about 32 bpf. All of the borings were terminated in or refused in the alluvial soils.

7.0 GROUND-WATER CONDITIONS

Ground water was observed in the test borings at depths ranging from about 10 to 55 feet at the time of drilling. For safety reasons, the borings were backfilled promptly after drilling; consequently, long-term measurements for the presence or absence of ground water were not obtained. Fluctuations in the ground-water level occur because of variations in rainfall, evaporation, construction activity, surface run-off, and other site-specific factors such as springs.

8.0 APPROACH TO STABILITY ANALYSIS

The stability analysis presented here evaluates the ability of the disposal area including its future cover system to maintain its integrity during long term static conditions and during a design earthquake event. Two potential failure mechanisms were considered:

1. Global stability of the landfill slopes under static conditions and under seismic loading.

2. Veneer stability of the landfill cover system under seismic loading.

8.1 Global Stability Under Static conditions and Seismic Loading

The global stability analysis of the slopes was performed using the computer program PCTABL5M. The input parameters for the analysis were based on :

- The proposed final configuration shown on the drawing provided to us,
- Laboratory testing of the insitu soils performed as part of this exploration,
- Laboratory testing of the ash from a previous study performed by LAW, dated November 7, 1995, titled **Fly Ash, Bottom Ash and Scrubber Gypsum Study,** and
- The estimated maximum horizontal acceleration (MHA) from the USGS Map of Maximum Horizontal Accelerations contained in the TDSWM guidance document.

We analyzed two cross sections of the proposed ash stack configuration, A-A' and B-B' shown on the Boring Location/Subsurface Section Plan in Appendix B. The following material parameters were used for the ash and underlying soil:

Material	Cohesion (PSF)	Friction Angle (Degrees)	Saturated Density (PCF)
Ash	0	22.6	103.0
Insitu Soil	400	27.0	130.0

Section A-A' was selected because it was the highest slope and B-B' was selected because it was the steepest slope. Section B-B' was the controlling section under static conditions with a

calculated safety factor of about 1.8. consequently, our seismic loading stability analysis was performed on section B-B'.

The seismic loading stability analysis material parameters were the same as those used in the static analysis. An estimated MHA of 0.15g was used to simulate the earthquake loading conditions. Our analysis indicated a safety factor of about 1.1 during the design seismic event.

8.2 Veneer Stability

When geosynthetic materials are used in a landfill cover system, the TDSWM requires that a veneer stability check be performed. The factor of safety against veneer failure is defined by the following equation:

$$\text{Factor of Safety} = \frac{\text{Resisting Forces}}{\text{Driving Forces}} = \frac{[\cos\alpha - a_{max}\sin\alpha]\tan\phi}{\sin\alpha + a_{max}\cos\alpha}$$

in which:

α = slope angle
ϕ = limiting interface friction coefficient
a_{max} = maximum horizontal acceleration (MHA)

For the maximum slope of 2.2 H:1V and considering a critical interface friction angle of 22.6 degrees (based on the lowest laboratory test value from the ash), the calculated factor of safety is 0.65. Therefore, we expect the cover will slip/slough during the design seismic event and will require subsequent repair.

If the value is unacceptable, a factor of safety equal to 1.0 can be obtained for the same slope configuration by increasing the critical interface friction angle to 33 degrees. This value may be attainable through compaction of the upper layers of the ash and use of a cap membrane designed with a higher strength.

9.0 LIMITATIONS

The analyses described in this report are based on LAW's understanding of the subsurface conditions at the site, proposed geometries, and the expectation that the additional ash to be added to the storage area will have properties similar to those previously tested from the site. If subsurface conditions, final configuration, or the nature of the additional ash change, the information contained in this report should be reviewed.