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October 7, 2016

Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

Initial Static Safety Factor Assessment
Ash Pond A
EPA Final CCR Rule
TVA Gallatin Fossil Plant
Gallatin, Tennessee

1.0 PURPOSE

This letter documents AECOM's certification of the initial static safety factor assessment for the TVA Gallatin Fossil Plant's Ash Pond A. Based on this assessment, the Ash Pond A is in compliance with the static factors of safety specified in the Final CCR Rule at 40 CFR 257.73(e)(1)(i) and (ii).

2.0 INITIAL STATIC SAFETY FACTOR ASSESSMENT

The initial static safety factor assessment conducted pursuant to 40 CFR 257.73(e) addresses the following static factors of safety:

- Long-term, maximum storage pool loading condition; and
- Maximum surcharge pool loading condition.

AECOM compiled and reviewed available historical site, topographic and geotechnical data for the TVA Gallatin Fossil Plant's Ash Pond A as of October 7, 2016. A complete listing of documents reviewed is included in the attached references.

Based upon its review of these available documents, AECOM identified Section Q-Q' as the most critical cross section for the long-term maximum storage pool loading condition and Section I-I' as the most critical cross section for the maximum surcharge pool loading condition. These cross sections were analyzed for the loading conditions specified in 40 CFR 257.73(e)(1)(i) and (ii).

3.0 SUMMARY OF FINDINGS

The attached calculation package presents the static safety factor assessment for Section Q-Q' and I-I' for the loading conditions specified in 40 CFR 257.73(e)(1)(i) and (ii), respectively. The calculated static factors of safety are shown in the following table. The results show that the calculated static factors of safety for Section Q-Q' and I-I' exceed the minimum safety factors required under 40 CFR 257.73(e)(1)(i) and (ii).

Plant	Facility	Critical Cross Section	EPA Criteria	EPA Required Factor of Safety (FOS)	Calculated FOS
GAF	Ash Pond A	Q-Q'	Long-term maximum storage pool loading condition	1.50	1.88
GAF	Ash Pond A	I-I'	Maximum surcharge pool loading condition	1.40	2.08

4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Gabriel W. Lang, PE, being a Professional Engineer in good standing in the State of Tennessee, do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;
2. that the information contained herein is accurate as of the date of my signature below; and
3. that the initial static safety factor assessment for the TVA Gallatin Fossil Plant's Ash Pond A presented in the table above meets the requirements of the static factors of safety specified in 40 CFR 257.73(e)(1)(i) and (ii).

SIGNATURE ______________________ DATE 10/07/2016

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ATTACHMENTS: *Initial Static Safety Factor Assessment 40 CFR 257.73(e) – Existing Surface Impoundment Ash Pond A, TVA Gallatin Fossil Plant*

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STATE OF TENNESSEE
10/7/16

COAL COMBUSTION PRODUCT DISPOSAL PROGRAM
Gallatin Fossil Plant, Gallatin, Tennessee

Initial Safety Factor Assessment
40 CFR 257.73(e)
Existing CCR Surface Impoundment-
Ash Pond A
TVA Gallatin Fossil Plant

Prepared for

TVA

Tennessee Valley Authority
1101 Market St.
Chattanooga, TN 37402-2801

October 7, 2016 – Rev0

Prepared by

AECOM

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 OBJECTIVE

This assessment presents the results of AECOM's analysis of the existing surface impoundment, Ash Pond A, at Gallatin Fossil Plant (GAF) in Gallatin, Tennessee. AECOM was contracted by the Tennessee Valley Authority (TVA) to perform an initial static safety factor assessment of the GAF Ash Pond A based on the requirements of the recently published United States Environmental Protection Agency (EPA) Coal Combustion Residual (CCR) Rule 40 Code of Federal Regulations (CFR) §257.73(e). These regulations require that the initial safety factor assessment for an existing CCR surface impoundment be completed by October 17, 2016. The safety factor assessment for Gallatin Ash Pond A perimeter dike presented under this project scope is limited to the static safety factor assessment required by the CCR Rule. The CCR Rule also includes seismic stability assessments, which are being completed by other consultants.

URS Corporation and AECOM Technical Services, Inc. are wholly owned subsidiaries of AECOM. Any references to prior work products generated by URS are synonymous with AECOM.

1.2 OUTLINE OF RULE REQUIREMENTS

As required by 40 CFR §257.73(b), an initial safety factor assessment (§257.73(e)) is required for each existing CCR surface impoundment that:

1. Has a height of five feet or more and a storage volume of 20 acre-feet or more; or
2. Has a height of 20 feet or more.

The Gallatin Ash Pond A perimeter dike qualifies under the CCR Rule because this impoundment either (1) has a height of five feet or more and a storage volume of 20 acre-feet or more, (2) or has a height of 20 feet or more. The initial safety factor assessment requirements under the CCR Rule are explicitly outlined below, with specific sections of the CCR Rule cited as appropriate:

- §257.73(e)(1)(i): The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.
- §257.73(e)(1)(ii): The calculated static factor of safety under maximum surcharge pool loading condition must equal or exceed 1.40.
- §257.73(e)(2): The owner or operator of the CCR unit must obtain certification from a qualified professional engineer stating that the initial assessment and each subsequent periodic assessment specified in paragraph (e)(1) of this section meets the requirements of this section.
- §257.73(f)(3) [Part]: The owner or operator of the CCR unit must conduct and complete the assessments required by paragraphs (a)(2), (d), and (e) of this section every five years.
- The five year interval for the factor of safety assessment is based on the completion date of the initial assessment. If the initial factor of safety assessment was not completed within 24 months prior to Rule publication date (April 17, 2015), new analysis will be required to be completed within 18 months of Rule publication date.

This assessment is intended to address the above described slope stability requirements from the CCR Rule and to demonstrate compliance regarding completion of the assessment within 18 months of the Rule publication date.

1.3 DESCRIPTION OF THE STRUCTURE

The TVA Gallatin Fossil Plant (GAF) is a coal-fired electric generating plant located in Sumner County, Tennessee on the north bank of the Cumberland River. The GAF plant has been in operation since 1959, and currently consists of four coal-fired electric generating units.

Ash Pond A is located in the northeast corner of the GAF complex and was commissioned in 1970. Ash Pond A is located within the Ash Pond Complex, which is comprised of Ash Pond A, Ash Pond E, Bottom Ash Pond, and Middle Pond A. Ash Pond A is situated northeast of Ash Pond E, with Stilling Ponds B, C, and D located to the north of both Ash Ponds A and E. Divider dikes separate Pond A from Pond E. Middle Pond A and Bottom Ash Pond are located east and southeast of Ash Pond E, respectively. The Ash Pond Complex is shown in **Figure 1**.

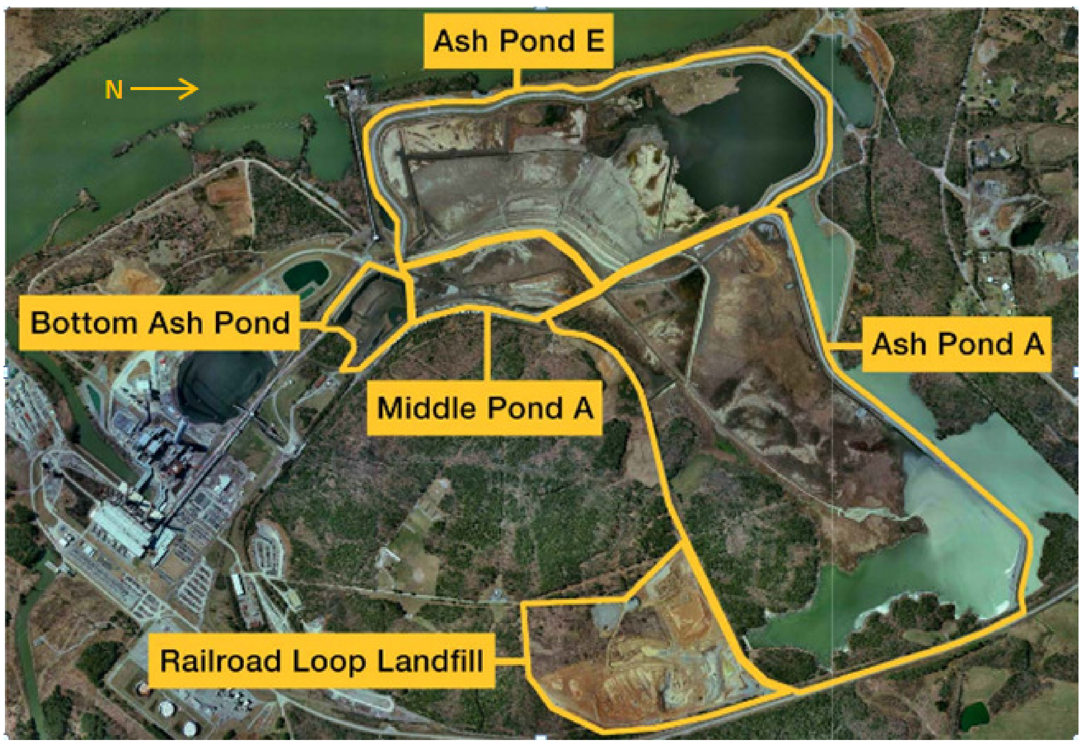


Figure 1: Aerial View of Ash Pond Complex

The perimeter dike which forms Ash Pond A is approximately 4,830 feet in length and varies in height from 19.5 to 28 feet. The dike was originally constructed of bottom ash to a crest elevation (El.) of approximately 461.5 feet MSL but was later raised to approximately El. 474 feet MSL. The raised portion was completed to the upstream of the original crest. Part of the raised bottom ash dike is founded on the original dike and partially on sluiced ash. The crest of the dike is approximately 35 feet in width.

The upstream dike slope is inclined approximately 1.5H:1V (horizontal:vertical). The downstream slope of the dike is inclined approximately 2.5H:1V. The toe of the downstream slope of the dike contains a rip rap stone bench. The bench has a slope inclined approximately 2H:1V. The rip rap bench was constructed to provide access along the downstream side of the Pond A perimeter dike. The crest elevation of the rip rap bench varies, ranging from approximately El. 460.0 to El. 462.5 feet MSL. It has a minimum crest width of 10 feet. The upper portion of the downstream slope consists of well maintained, grassy vegetation.

2.0 Project Reconnaissance

2.1 Review of Existing Data

As part of the CCR Rule assessment for Ash Pond A, AECOM reviewed available historical information and assessment reports. The existing data review included the following documents:

- AECOM (2016a). *Initial Safety Factor Assessment Geotechnical Exploration Report, Existing Surface Impoundment - Ash Pond A, TVA Gallatin Fossil Plant, Rev0.* October 7, 2016.
- AECOM (2016b). *Basis of Design Ash Pond Lowering and Flow Diversion, Gallatin Fossil Plant, Sumner County, Tennessee, Revision 0.* January 21, 2016.
- MACTEC Engineering and Consulting, Inc. (2004). *Report of Geotechnical Exploration, Ash Disposal Area and Potential On-site and Off-site Borrow Areas, Gallatin Fossil Plant, Gallatin, Tennessee.* October 14, 2004.
- Stantec Consulting Services Inc. (2010). *Report of Geotechnical Exploration and Slope Stability Evaluation, Ash Pond/ Stilling Pond Complex, Gallatin Fossil Plant – Gallatin, Tennessee.* May 27, 2010.
- Stantec Consulting Services Inc., and AECOM (2016). *Annual Instrumentation and Monitoring Program Final Report (Rev. 2) Fiscal Year 2015.* Prepared for Tennessee Valley Authority. February 19, 2016.
- Tuck Mapping Solutions, Inc. (2015a). LiDAR topographic survey flight. March 16, 2015. Big Stone Gap, Virginia. Prepared for Tennessee Valley Authority.
- Tuck Mapping Solutions, Inc. (2015b). Photography topographic survey flight. April 19, 2015. Big Stone Gap, Virginia. Prepared for Tennessee Valley Authority.
- URS (2014). *Ash Pond A and E Dikes Geotechnical Site Evaluation Report (Rev. 0).* February 21, 2014.

2.2 Data Gaps

During the existing data review, AECOM did not identify data gaps that would require additional geotechnical drilling/ sampling, in-situ tests, instrumentation, laboratory testing or field surveying.

3.0 Summary of Field Investigations and Laboratory Testing

In 2012, URS completed a geotechnical exploration and analysis on the divider and perimeter dikes of Ash Pond A (URS, 2014). The geotechnical exploration was performed along the crest and near the exterior toe of the Ash Pond A dikes. The exploration work on the dikes of Ash Pond A included six (6)

Hollow Stem Auger (HSA) Standard Penetration Test (SPT) soil borings, disturbed and undisturbed soil sampling, in-situ testing activities that included four (4) Marchetti dilatometer testing (DMT) and seven (7) cone penetration testing (CPT), laboratory testing, and the installation and monitoring of five (5) open stand-pipe piezometers and six (6) vibrating wire piezometers. Exploration activities were conducted between April 24 and May 3, and May 14, 15, and 17, 2012. Subsurface data gathered by URS in 2012 was used to supplement historical data previously gathered at Ash Pond A. Historic boring logs, in-situ test results, piezometer installation records, and laboratory testing results have been compiled by AECOM and are presented in the *Initial Safety Factor Assessment Geotechnical Exploration Report, Existing Surface Impoundment - Ash Pond A, TVA Gallatin Fossil Plant, Rev0* report (AECOM, 2016a). The geotechnical explorations, laboratory testing, and conclusions presented in this report were used as the basis for this analysis.

Recent LiDAR and photography flight topographic survey data gathered by TVA's survey subconsultant, Tuck Mapping Solutions, Inc. of Big Stone Gap, Virginia, was provided by TVA. The LiDAR and photography survey was completed July 8, 2015 and the data was used to update the Gallatin site topography basemap from which the stability cross sections were developed. Bathymetry topographic survey data for the Ash Pond and Stilling Ponds was provided to AECOM by TVA in December, 2014.

Seismic stability analyses are being performed by another consultant as part of the 40 CFR §257.73(e)(1)(iii) and (iv).

4.0 DETAILED TASK ANALYSIS CRITERIA

4.1 MATERIAL PROPERTIES

Based upon the results of historical subsurface explorations, the subsurface conditions encountered at Ash Pond A generally consist of initial and raised bottom ash dikes underlain by hydraulically sluiced fly ash and residual clay. Soil deposits at Ash Pond A are underlain by limestone bedrock. A summary of the subsurface conditions encountered at the Ash Pond A perimeter dike are summarized in **Table 1.** A detailed description of the subsurface profile is presented AECOM (2016a). Soil classifications provided are based on the Unified Soil Classification System (USCS).

Table 1: Generalized Subsurface Conditions

Materials	Approximate Elevation (feet MSL)	Apparent Density / Consistency
Bottom Ash Fill – Consists of moist, black and dark brown, silty sand (SM) and sand with silt (SP-SM, and SW-SM).	Elevation 474.7 to Elevation 443.8	Loose to Dense
Sluiced Fly Ash - Hydraulically placed fly ash deposits classified as wet, gray and black silty sand (SM), clayey sand (SC), and sandy silt (ML).	Elevation 462.1 to Elevation 444.2	Very Loose to Medium Dense
Residual Clay - Moist, light gray and brown lean clay (CL) and fat clay (CH).	Elevation. 450.7 to Elevation 421.8	Medium Stiff to Stiff
Limestone Bedrock	Elevation 451.2 to Elevation 421.5 (refusal elevation)	--

The strength properties used in the stability models were developed during the URS Geotechnical Site Evaluation (URS, 2014) by comparing SPT, CPT, DMT, and laboratory test results, and employing engineering judgment and local experience. Values for shear strength, unit weight, and angle of internal friction were estimated for each soil horizon using empirical correlations or laboratory test results and then each parameter was selected by comparing the results. A summary of the engineering parameters used in the initial static safety factor modeling is provided in **Table 2**.

Table 2: Material Properties for Slope Stability Analysis

Material	Unit Weight (pcf)	Drained (Effective Stress) Strength Parameters		Undrained (Total Stress) Strength Parameters	
		c' (psf)	Φ' (deg.)	c (psf)	Φ (deg.)
Pond A Raised Bottom Ash Dike-High	105	0	38	0	38
Pond A Raised Bottom Ash Dike-Low	105	0	30/ 33[1]	0	30/ 33[1]
Pond A Initial Bottom Ash Divider Dike	105	0	35	0	35
Bottom Ash Fill	110	0	36	0	36
Sluiced Ash	85	0	26	400	0
Residual Clay	125	200	27	1,000	0
Silted Material	85	0	24	0	24
Rip Rap Stone Bench	115	0	40	0	40
Gravel Road Surface	115	0	37	0	37
Limestone Bedrock	Impenetrable				

[1]Friction angle of Bottom Ash Fill material varies by location, based upon SPT N-Values measured in subsurface borings.

The results of the strength parameter correlations and derivation can be found in the *Initial Safety Factor Assessment Geotechnical Exploration Report, Existing Surface Impoundment - Ash Pond A, TVA Gallatin Fossil Plant, Rev0* report (AECOM, 2016a).

4.2 SELECTION OF CRITICAL CROSS SECTIONS

Historic steady state slope stability models were available from URS (URS, 2014). A total of six (6) stability cross sections were previously developed using the site geometry, material properties, and boundary conditions determined from the field explorations, laboratory testing, and review of historical data. The design cross sections were selected to be representative of the most critical dam geometries, such as the maximum embankment height, the steepest embankment slopes, the thickest interval of ash in the foundation, and the least resisting force at and beyond the downstream toe. At Ash Pond A, the cross sections which met these criteria were located along the northern leg of the perimeter dike, at cross sections H-H', I-I', J-J', K-K', L-L', and Q-Q'. The existing stability cross sections have been reviewed and revised based upon the latest topography and bathymetry data provided by TVA. The location of the cross sections is shown in **Figure 2**.

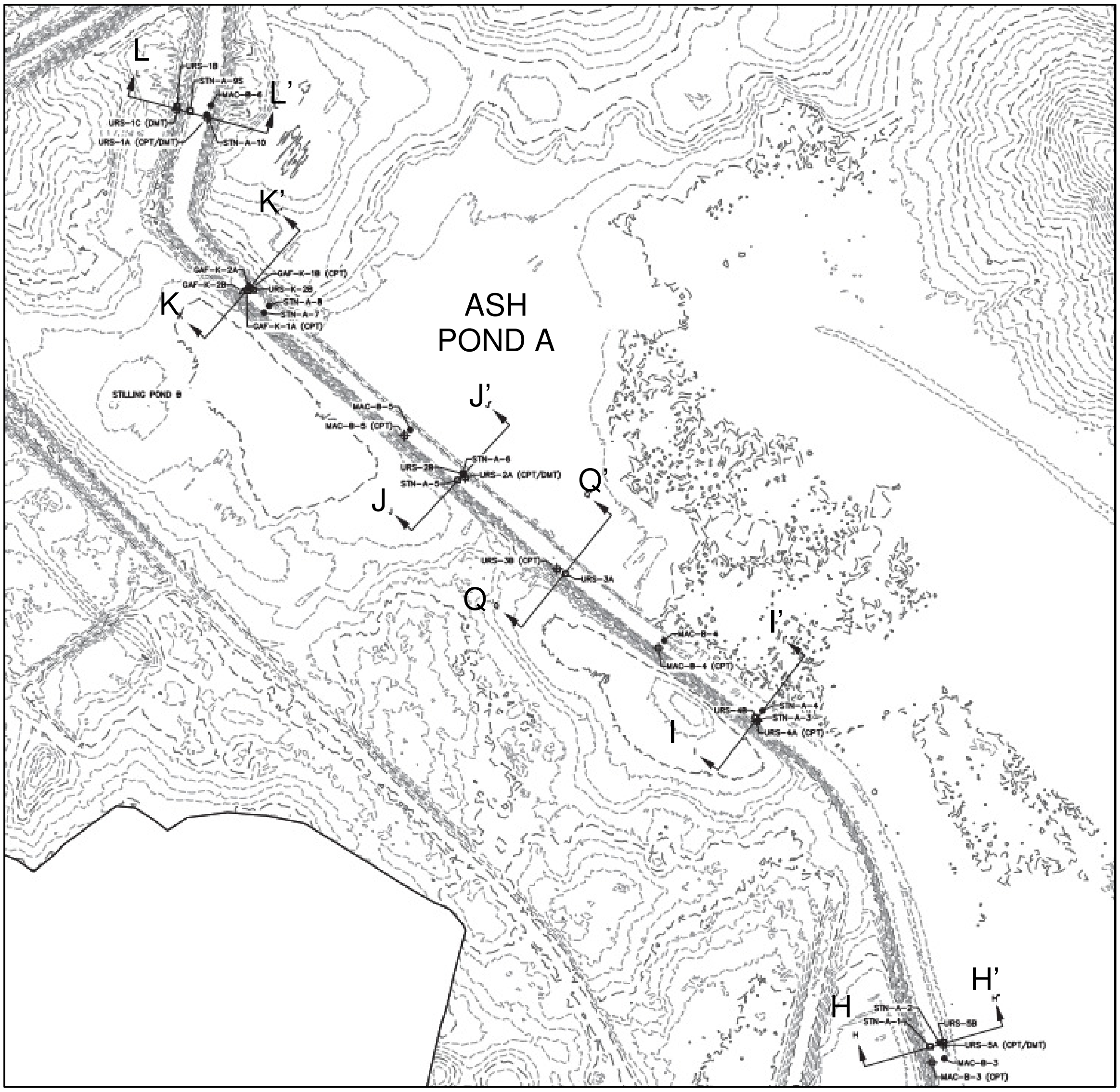


Figure 2: Location of Cross Sections

The summary of the initial safety factor slope stability analyses are provided below in **Table 3.**

Table 3: Initial Safety Factor Slope Stability Results

Cross Section	CCR Unit	CCR Rule Loading Condition	Factor of Safety (Global Failure, Exterior Slope)	Reference
H-H'	Ash Pond A	Long Term Maximum Storage Pool	1.95	AECOM (2016a)
	Ash Pond A	Maximum Surcharge Pool	Not applicable[2]	AECOM (2016a)
I-I'	Ash Pond A	Long Term Maximum Storage Pool	2.08	AECOM (2016a)
	Ash Pond A	Maximum Surcharge Pool	2.08	AECOM (2016a)
J-J'	Ash Pond A	Long Term Maximum Storage Pool	2.26	AECOM (2016a)
	Ash Pond A	Maximum Surcharge Pool	Not applicable[2]	AECOM (2016a)
K-K'	Ash Pond A	Long Term Maximum Storage Pool	2.19	AECOM (2016a)
	Ash Pond A	Maximum Surcharge Pool	2.19	AECOM (2016a)
L-L'	Ash Pond A	Long Term Maximum Storage Pool	2.25	AECOM (2016a)
	Ash Pond A	Maximum Surcharge Pool	2.27	AECOM (2016a)
Q-Q'	Ash Pond A	Long Term Maximum Storage Pool	1.88	AECOM (2016a)
	Ash Pond A	Maximum Surcharge Pool	Not applicable[2]	AECOM (2016a)

2-The maximum surcharge elevations at these cross sections did not reach the ground surface under the maximum surcharge storm event. Accordingly, no surcharge was induced for this condition.

As demonstrated in **Table 3**, Section Q-Q' resulted in the lowest factors of safety when analyzed for Long-term Maximum Storage Pool loading conditions and was determined to be the critical cross section under this loading condition. Section I-I' resulted in the lowest factor of safety with respect to the Maximum Surcharge Pool loading condition and was selected as the critical cross section.

4.3 WATER LEVELS

The long-term maximum storage pool loading condition specified in §257.73(e)(1)(i) is the pond operating water surface elevation obtained from automated pond level indicator instruments installed at each pond. The maximum surcharge pool loading condition specified in §257.73(e)(1)(ii) is the pool level determined based on hydraulic analyses conducted for the 1,000-year, 6-hour storm event. Further discussion of the upstream and downstream inflow water level selection is provided in AECOM (2016a).

Pond water levels utilized in the static slope stability models are summarized in **Table 4**.

Table 4: Summary of Headwater and Tailwater Pool Elevations

Body of Water	Long-Term Maximum Storage Pool Elevation (feet MSL)	Maximum Surcharge Pool Elevation (feet MSL)
Ash Pond A	463.0	467.7
Stilling Pond B	456.0	458.3
Stilling Pond C	456.0	458.3

4.4 Analysis Methodology

The stability analyses were performed using limit equilibrium methods through the computer software GeoStudio 2007 (Version 7.23) by GEO-SLOPE International, Ltd. (GEO-SLOPE, 2007). The GeoStudio software includes the SLOPE/W module which performs 2-dimensional limit equilibrium analysis based on the method of slices according to Spencer's Method.

The stability cross sections were analyzed for global stability, defined as a slip surface that would pass from the far half of the top of dike (crest nearest the Ash Pond) to the downstream toe of the dike. The resulting factor of safety slip surface encompasses the majority of the dike and represents a failure which would likely result in the release of impounded ash. Circular failure geometries were evaluated by defining entry/exit limits to develop the failure surface. The following stability analysis conditions were analyzed for the Gallatin Ash Pond A perimeter dike.

4.4.1 Steady State Maximum Storage Pool §257.73(e)(1)(i)

This analysis considers Ash Pond A and the downstream stilling ponds under normal operating conditions. The phreatic surface was modeled using a piezometric line developed based upon piezometer and pond level indicator data. The long-term maximum storage pool water elevations listed in **Table 4** were input for the ash pond and downstream stilling ponds. The phreatic surface passing through the dike was set equal to historical piezometer data representative of steady state operating conditions. Peak drained (effective stress) strength parameters were used for all materials.

4.4.2 Maximum Surcharge Pool §257.73(e)(1)(ii)

The maximum surcharge pool load condition is created by a rapid pool level rise during a flood. It is a temporary water level, higher than the normal pool, which does not last long enough to develop steady-state seepage within the impoundment embankment and foundation (USACE, 2003). The pool is assumed to rise faster than water can flow in or out of fine-grained soils, and the surcharge pressure may cause shear-induced, excess pore pressures in the saturated zones. This assumption is based on the significance of the surcharge pressure with respect to the size of the dike. During the maximum surcharge pool loading analysis, the tailwater elevation was conservatively maintained at the ordinary high water elevation, neglecting potential added resistance at the toe resulting from short term, surcharge loading conditions.

Performed as an undrained analysis, materials below the phreatic surface were considered saturated and modeled using undrained shear strength parameters. The partially saturated zones above the phreatic surface were modeled using drained material properties. The headwater and tailwater levels were assumed to be at the long term maximum storage pool elevations provided in **Table 4**.

The phreatic surface passing through the dike was modeled by drawing a piezometric line. A surcharge pressure reflecting the increased loading due to pool level rise from the maximum storage pool elevation to the 1,000-year, 6-hour storm event was applied to the ground surface on the inboard side of the dike. Surcharge pressures are discussed further in **Section 5.0**.

The slope stability in the downstream direction was evaluated. The required minimum factor of safety corresponds to the entry for "maximum surcharge pool" in **Table 5**.

At cross sections H-H', J-J', and Q-Q', as a result of pond in-fill and dewatering activities, the maximum surcharge pool elevations (based on the 1,000-year, 6-hour storm event) were below the ground surface. Therefore, the embankment is not likely to experience surcharge loading, and a change in stress state is not expected. Under these conditions, the factor of safety for maximum surcharge analysis at cross sections H-H', J-J', and Q-Q' is equal to the factor of safety obtained from the long term maximum storage pool loading condition.

4.5 Acceptance Criteria

The following summary is taken from the EPA's CCR Rule §257.73(e). The factor of safety assessment criteria are outlined in **Table 5** below.

Table 5: Required Factors of Safety

Loading Condition	CCR Rule Required Factor of Safety	CCR Rule Reference
Long-Term, Maximum Storage Pool Loading Condition	1.5	§257.73(e)(1)(i)
Maximum Surcharge Pool Loading Condition	1.4	§257.73(e)(1)(ii)

5.0 Analysis Assumptions

The following assumptions were made when performing the safety factor assessment.

- The analyses are intended to identify failures which would likely result in the loss of impounded ash. Therefore, circular slip surfaces in the downstream direction were considered. Upstream directional failures were not included.
- Global failure surfaces were defined using either an entry/exit circular slip surface or block failure geometry. The global (deep seated) failure surfaces were modeled by setting slip surface boundary conditions which limit the program to analyzing only global failure surfaces. The failure surface was defined with boundary limits behind the centerline of the dike crest and beyond the downstream toe of the dike. These criteria limit the program to analyzing only global (deep seated) failure surfaces, as specified in the CCR Rule.

- The long-term maximum storage pool elevation for Ash Pond A and the tailwater stilling ponds is the normal pool operating elevation determined from automated pond level indicators.
- The maximum surcharge pool elevations were applied to the model based on the flood pool level determined for the 1,000-year, 6-hour storm event. The surcharge pool was assumed to not last long enough for steady-state conditions to develop. Therefore, the phreatic surface determined for the long-term maximum storage pool was utilized within the embankment. A surcharge pressure was applied to the slow-draining soils along the ground surface, reflecting the difference in elevation between the flood pool and normal pool.
- Significant changes to the subsurface materials have not occurred. Therefore, material parameters developed by URS (2014) were used in the slope stability modeling.

6.0 Analysis Results

The existing dike configuration at Ash Pond A was analyzed at critical cross sections I-I' and Q-Q' in conjunction with the strength parameters presented in **Table 2**, and phreatic conditions modeled based upon piezometer water level readings. Result output plots from the SLOPE/W module can be found in **Appendix A**. **Table 6** below summarizes the factors of safety calculated for static loading conditions considered at stability cross section I-I' and Q-Q' for GAF Ash Pond A.

Table 6: Initial Static Safety Factor Assessment Results

Plant	Facility	Critical Cross Section	Loading Condition	CCR Rule Required Factor of Safety	Calculated Factor of Safety
GAF	Ash Pond A	Q-Q'	Long-Term, Maximum Storage Pool Loading Condition [§257.73(e)(1)(i)]	1.5	1.88
		I-I'	Maximum Surcharge Pool Loading Condition [§257.73(e)(1)(ii)]	1.4	2.08

7.0 Conclusions

Initial static safety factor assessments have been completed for the Gallatin Fossil Plant Ash Pond A in accordance with the EPA 40 CFR §257.73(e). Computed factors of safety for static slope stability at the critical cross sections meet or exceed the CCR Rule requirement under long-term, maximum storage pool loading condition [§257.73(e)(1)(i)] and maximum surcharge pool loading condition [§257.73(e)(1)(ii)]. These results demonstrate that the Gallatin Fossil Plant Ash Pond A meets the requirements of EPA 40 CFR §257.73(e) for static slope stability.

8.0 References

1. AECOM (2016a). *Initial Safety Factor Assessment Geotechnical Exploration Report, Existing Surface Impoundment Ash Pond A, TVA Gallatin Fossil Plant, Rev0.* October 7, 2016.

2. AECOM (2016b). *Basis of Design Ash Pond Lowering and Flow Diversion, Gallatin Fossil Plant, Sumner County, Tennessee, Revision 0.* January 21, 2016.
3. GEO-SLOPE International, Ltd. (2007). GeoStudio 2007, Version 7.23 Build 5099. Calgary, Alberta, Canada. www.geo-slope.com.
4. MACTEC Engineering and Consulting, Inc. (2004). *Report of Geotechnical Exploration, Ash Disposal Area and Potential On-site and Off-site Borrow Areas, Gallatin Fossil Plant, Gallatin, Tennessee.* October 14, 2004.
5. Stantec Consulting Services Inc. (2010). *Report of Geotechnical Exploration and Slope Stability Evaluation, Ash Pond/ Stilling Pond Complex, Gallatin Fossil Plant – Gallatin, Tennessee*. May 27, 2010.
6. Stantec Consulting Services Inc., and AECOM (2016). *Annual Instrumentation and Monitoring Program Final Report (Rev. 2) Fiscal Year 2015.* Prepared for Tennessee Valley Authority. February 19, 2016.
7. Tuck Mapping Solutions, Inc. (2015a). LiDAR topographic survey flight. March 16, 2015. Big Stone Gap, Virginia. Prepared for Tennessee Valley Authority.
8. Tuck Mapping Solutions, Inc. (2015a). Photography topographic survey flight. April 19, 2015. Big Stone Gap, Virginia. Prepared for Tennessee Valley Authority.
9. United States Army Corps of Engineers (USACE) (2003). Engineering and Design. *Slope Stability. Engineering Manual EM 1110-2-1902, Department of the Army.* October 31, 2003.
10. URS (2014). *Ash Pond A and E Dikes Geotechnical Site Evaluation Report (Rev. 0).* February 21, 2014.
11. URS (2015). *Pond A Dike Remediation Construction Record Documentation Report (Rev.0).* January 16, 2015.

APPENDIX A
STATIC SLOPE STABILITY ANALYSIS RESULTS

Tennessee Valley Authority
Gallatin Fossil Plant
Ash Pond A
Cross Section Q-Q'

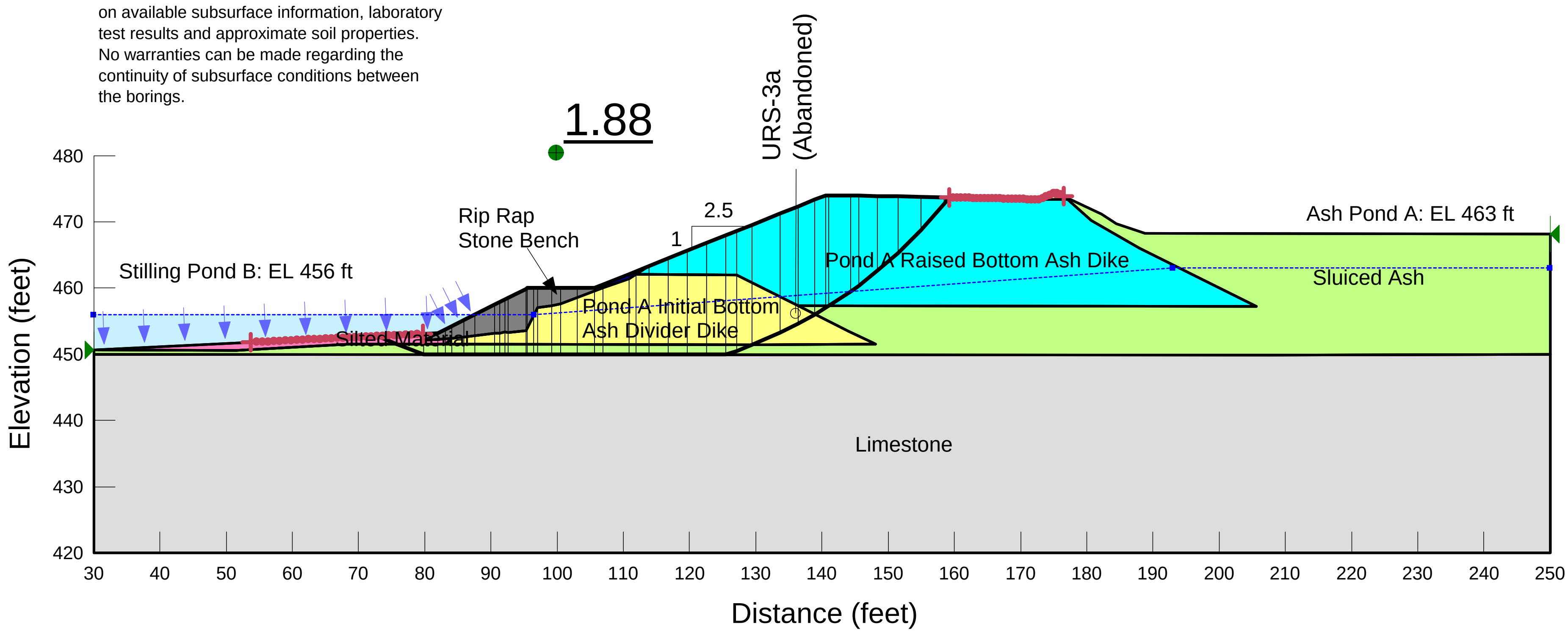
Factor of Safety: 1.88

Minimum Slip Surface Depth: 10 ft

Material	Unit Weight	Cohesion	Phi
Pond A Initial Bottom Ash Divider Dike	105 pcf	0 psf	35 °
Sluiced Ash	85 pcf	0 psf	26 °
Pond A Raised Bottom Ash Dike	105 pcf	0 psf	38 °
Silted Material	85 pcf	0 psf	24 °
Rip Rap Bench	115 pcf	0 psf	40 °
Bottom Ash Fill	110 pcf	0 psf	36 °

Slope Stability Long-term Maximum Storage Pool Block
Method: Spencer
Slip Surface: Entry and Exit
File Name: GAF_Section_Q.gsz

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.



Tennessee Valley Authority
Gallatin Fossil Plant
Ash Pond A
Cross Section I-I'

Factor of Safety: 2.08
Minimum Slip Surface Depth: 10 ft

Material Type	Unit Weight	Cohesion	Friction Angle
Pond A Raised Bottom Ash Dike - High	105 pcf	0 psf	38 °
Pond A Raised Bottom Ash Dike - Low	105 pcf	0 psf	30 °
Pond A Initial Bottom Ash Dike	105 pcf	0 psf	35 °
Sluiced Ash (Effective)	85 pcf	0 psf	26 °
Sluiced Ash (Total)	85 pcf	400 psf	0 °
Silted Material	85 pcf	0 psf	24 °
Residual Clay (Total)	125 pcf	1000 psf	0 °
Bottom Ash Fill	110 pcf	0 psf	36 °
Rip Rap Bench	115 pcf	0 psf	40 °

Slope Stability Maximum Surcharge Pool
Method: Spencer
Slip Surface: Entry and Exit
File Name: GAF_Section_I.gsz

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.