DRAFT

Coal Combustion Waste Impoundment

Task 3- Dam Assessment Report

E. W. Brown Plant

Main Fly Ash Pond Dam
E.ON U.S. LLC
Harrodsburg, KY

Project # 0-381

Assessment of Dam Safety
Coal Combustion Surface Impoundments
For the REAC Program

Prepared for:

Lockheed Martin Services, Inc.
Edison, New Jersey
For
United States Environmental Protection Agency

Prepared by:

Dewberry
Fairfax, Virginia

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INTRODUCTION

The release of over five million cubic yards of coal ash from the Tennessee Valley Authority's Kingston, Tennessee, facility in December 2008, which flooded more than 300 acres of land, damaging homes and property, is a wake-up call for diligence on coal combustion waste disposal units. The government and utilities must marshal best efforts to prevent such catastrophic failure and damage. A first step toward this goal is to assess the stability and functionality of the ash impoundments and other units, then quickly take any needed corrective measures.

This assessment of the stability and functionality of the E. W. Brown Main Fly Ash Dam management unit is based on a review of available documents and on the site assessment conducted by Dewberry personnel on Tuesday, October 20, 2009. Dewberry found the supporting technical documentation adequate (Section 1.1.3). As detailed in Section 1.2.6, there are recommendations that may help to maintain a safe and trouble-free operation; Dewberry recommends an updated dam break analysis (currently in progress).

In summary, the **E. W. Brown Main Fly Ash Dam is SATISFACTORY for continued safe and reliable operation, with no recognized existing or potential management unit safety deficiencies.**

The assessment of E. W. Brown Auxiliary Ash Pond Dam is presented in a separate report.

PURPOSE AND SCOPE

The U.S. Environmental Protection Agency (EPA) is embarking on an initiative to investigate the potential for catastrophic failure of Coal Combustion Surface Impoundments (i.e., management unit) from occurring at electric utilities in an effort to protect lives and property from the consequences of a dam failure or the improper release of impounded slurry. The EPA initiative is intended to identify conditions that may adversely affect the structural stability and functionality of a management unit and its appurtenant structures (if present); to note the extent of deterioration (if present), status of maintenance and/or a need for immediate repair; to evaluate conformity with current design and construction practices; and to determine the hazard potential classification for units not currently classified by the management unit owner or by a state or federal agency. The initiative will address management units that are classified as having a Less-than-Low, Low, Significant or High Hazard Potential ranking. (For Classification, see pp. 3-8 of the 2004 Federal Guidelines for Dam Safety)

In February 2009, the EPA sent letters to coal-fired electric utilities seeking information on the safety of surface impoundments and similar facilities that receive liquid-borne material that store or dispose of coal combustion waste. This letter was issued under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 104(e), to assist the Agency in assessing the structural stability and functionality of such management units, including which facilities should be visited to perform a safety assessment of the berms, dikes, and dams used in the construction of these impoundments.

EPA requested that utility companies identify all management units including surface impoundments or similar diked or bermed management units or management units designated as landfills that receive liquid-borne material used for the storage or disposal of residuals or by-products from the combustion of coal, including, but not limited to, fly ash, bottom ash, boiler slag, or flue gas emission control residuals. Utility companies provided information on the size, design, age and the amount of material placed in the units so that EPA could gauge which management units had or potentially could rank as having High Hazard Potential. The USEPA and its contractors used the following definitions for this study:

"Surface Impoundment or impoundment means a facility or part of a facility which is a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials (although it may be lined with man-made materials), which is designed to hold an accumulation of liquid wastes or wastes containing free liquids, and which is not an injection well. Examples of surface impoundments are holding, storage, settling, and aeration pits, ponds, and lagoons."

For this study, the earthen materials could include coal combustion residuals. EPA did not provide an exclusion for small units or based on whether the placement was temporary or permanent. Furthermore, the study covers not only waste units designated as surface impoundments, but also other units designated as landfills which receive free liquids.

EPA is addressing any land-based units that receive fly ash, bottom ash, boiler slag, or flue gas emission control wastes along with free liquids. If the landfill is receiving coal combustion wastes with liquids limited to that for proper compaction, then there should not be free liquids present and EPA did not seek information on such units which are appropriately designated a landfill.

In some cases coal combustion wastes are separated from the water, and the water containing de minimus levels of fly ash, bottom ash, slag, or flue gas emission control wastes, are sent to an impoundment. EPA is including such impoundments in this study, because chemicals of concern may have leached from the solid coal combustion wastes into the waste waters, and suspended solids from the coal combustion wastes remain.

The purpose of this report is to evaluate the condition and potential of waste release from the selected High Hazard Potential management units. This evaluation included a site visit. Prior to conducting the site visit, a two-person team reviewed the information submitted to EPA, reviewed any relevant publicly available information from state or federal agencies regarding the unit hazard potential classification (if any) and accepted information provided via telephone communication with a management unit supervisor.

EPA sent two professional engineers, one licensed in the State of Kentucky, for a one-day site visit. The two-person team met with the owner of the management unit as well as several technical representatives and management unit supervisors to discuss the engineering characteristics of the unit as part of the site visit. During the site visit the team collected additional information about the management unit to be used in determining the hazard potential classification of the unit. Subsequent to the site visit the management unit owner provided additional engineering data.

Factors considered in determining the hazard potential classification of the management units(s) included the age and size of the impoundment, the quantity of coal combustion residuals or by-products that were stored or disposed of in these impoundments, its past operating history, and its geographic location relative to down gradient population centers and/or sensitive environmental systems.

This report presents the opinion of the assessment team as to the potential of catastrophic failure and reports on the condition of the management unit(s). The team considered criteria in evaluating dams under the National Inventory of Dams in making these determinations.

LIMITATIONS

The assessment of dam safety reported herein is based on field observations and review of readily available information provided by the owner/operator of the subject coal combustion waste management unit(s). Qualified Dewberry engineering personnel performed the field observations and review and made the assessment in conformance with the required scope of work and in accordance with reasonable and acceptable engineering practices. No other warranty, either written or implied, is made with regard to our assessment of dam safety.

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Doc 01: E.W. Brown Ash Pond Aerial Photo, September 2009
Doc 02: FMSM Engineers Design Report, Main Ash Pond Expansion, October 2007
Doc 03 – 87: Main Ash Pond Expansion Construction Drawings, October 2007, FMSM Engineers
Doc 88: Kentucky Division of Water Dam Inspection Report, July 30, 2008
Doc 89: ATC Associates Dam Inspection Report, January 2009
Doc 90: Embankment Cross Sections Station 228+00 – Station 231+00, Drawing 31/71, Revised November 19, 1991, FMSM Engineers.

APPENDIX B – PHOTOGRAPHS

Photographs 1 - 47

APPENDIX C – FIELD OBSERVATION CHECKLIST

Dam Inspection Checklist Form

1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

Conclusions are based on visual observations from a one-day site visit and review of technical documentation provided by E.ON U.S. LLC.

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

Based on a review of the engineering data provided by the owner's technical staff and Dewberry's observations during the site visit, the embankment appears to be structurally sound.

The Main Fly Ash Pond had been taken out of service prior to the site observations. Construction was underway as part of the planned phased expansion of the facility. The Main Fly Ash Pond had been drained and the emergency spillway abandoned.

The owner provided data included information pertaining to liquefaction potential, slope stability and hydrologic/hydraulic characteristic of the expanded and reconfigured Main Ash Pond. Dewberry assumes that the Kentucky Division of Water conducted an appropriate full review prior to issuing a construction permit.

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

The E. W. Brown Main Fly Ash Pond has been drained and taken out of service. The emergency spillway has been abandoned. The primary spillway remains but will be abandoned as part of the facility expansion. A new primary spillway is under construction at an alternate location within the footprint of the reconfigured Main Fly Ash Pond.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

Supporting technical documentation is adequate. Although documentation of the existing embankment is somewhat limited, the design documentation for the Main Fly Ash Pond incorporates prior data and presents stability analyses that incorporate a review of the existing dam.

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

The description of the management unit provided E.ON U.S. LLC was an accurate representation of what Dewberry engineers observed in the field.

1.1.5 Conclusions Regarding the Field Observations

Dewberry engineers were provided access to all areas in the vicinity of the management unit required to conduct a thorough field observation. The visible parts of the embankment dam were observed to have no signs of overstress, significant settlement, shear failure, or other signs of instability. The embankment dam visually appears structurally sound. There are no apparent indications of unsafe conditions or conditions needing remedial action.

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation

The current maintenance and methods of operation appear to be adequate for the fly ash management unit. There was no evidence of repaired embankments or prior releases observed during the site visit.

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

Surveillance and monitoring program appear to have been adequate. A new surveillance and monitoring program is planned for implementation when the reconfigured Main Fly Ash Pond is put back into service.

1.1.8 Classification Regarding Suitability for Continued Safe and Reliable Operation

The E. W. Brown Main Fly Ash facility is currently out of operation and important components, including the emergency spillway, have been abandoned. The embankment is considered stable at this time.

Analyses conducted in conjunction with the expansion and reconfiguration of the Main Fly Ash Pond indicate that the existing ash, on which the new embankments are supported, is subject to liquefaction if groundwater elevation is above 856 feet. Groundwater elevation at the start of the current phase of construction was 870 feet. The expansion plan anticipates that groundwater elevations will recede while the pond is out of service and continue to recede once the Phase 1 construction pond liner is installed. Groundwater elevations will be monitored during the Phase 1 construction and during the interim between Phase 1 and Phase 2, expected to be about one year. If groundwater does not recede to elevation 856 or lower, a drainage system will be installed in the fly ash to control groundwater to an elevation of 856 or lower.

Upon completion of the current expansion phase, the facility will have a substantially different configuration.

1.2 RECOMMENDATIONS

1.2.1 Recommendations Regarding the Structural Stability

No recommendations regarding structural stability appear warranted at this time.

1.2.2 Recommendations Regarding the Hydrologic/Hydraulic Safety

No recommendations appear warranted at this time.

1.2.3 Recommendations Regarding the Supporting Technical Documentation

No recommendations appear warranted at this time.

1.2.4 Recommendations Regarding the Description of the Management Unit(s)

No recommendations appear warranted at this time.

1.2.5 Recommendations Regarding the Field Observations

No recommendations appear warranted at this time.

1.2.6 Recommendations Regarding the Maintenance and Methods of Operation

The maintenance and operation of the dam appear to have been adequate. However, updating the 1991 Operations Plan should be completed prior to reopening the reconfigured Main Fly Ash Pond at the completion of the current phase of construction.

1.2.7 Recommendations Regarding the Surveillance and Monitoring Program

No recommendations pertaining to the surveillance and monitoring program appear warranted at this time.

1.2.8 Recommendations Regarding Continued Safe and Reliable Operation

No recommendations pertaining to the continued safe and reliable operation of the management unit appear warranted at this time.

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants

W. Michael Winkler – E.ON U.S. LLC
Jeffrey B. Heun, P.E. – E.ON U.S. LLC
David J. Millay, P.E. – E.ON U.S. LLC
Jeffrey Fraley – E.ON U.S. LLC
Tamara Lay – E.ON U.S. LLC
Hugh A. Ward, P.E. - Dewberry
Joseph P. Klein, III, P.E. – Dewberry

1.3.2 Acknowledgement and Signature

We acknowledge that the management unit referenced herein has been assessed on October 20, 2009.

Hugh A. Ward, PE (KY # 7164)

Joseph P. Klein, III, P.E. Geotechnical Engineer

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

2.1 LOCATION AND GENERAL DESCRIPTION

The E. W Brown Plant is located near the west bank of the Dix River, just upstream of Dix Dam at Herrington Lake in Mercer County, Kentucky approximately 5 miles northeast of Burgin, Kentucky. The plant is operated by Kentucky Utilities Company, an operating company of E.ON U.S. LLC (E.ON). The Main Fly Ash Dam is at the west side of the plant site, adjacent to the Auxiliary Fly Ash Pond. A project location aerial photograph is provided in Appendix A – Doc 01.

The E. W. Brown existing Main Fly Ash Dam is a compacted clay embankment with zones of graded stone filters and shot rock drains. The pond is not lined. The crest of the dam is at elevation 900 feet. The downstream toe of the dam is at elevation 774 feet, making the dam height 126 feet.

Construction has begun on the first phase of a multi-phased expansion of the Main Fly Ash Pond. Phase 1 construction consists of a new dike constructed upstream from the existing dam with a center line approximately 400 feet upstream from the existing dam. The new dike, referred to as the "starter dike" on construction drawings, has a design crest elevation of 902 feet, 2 feet higher than the existing dam. When the Main Fly Ash Pond is put back into service all storage is designed to be upstream of the new dike. Planned future phases of expansion will raise the crest of the starter dike by increasing width downstream toward the existing dam. The starter dike and planned subsequent expansions are supported on existing ash materials.

2.2 SIZE AND HAZARD CLASSIFICATION

The existing Main Fly Ash Pond Dam is on the west side of the E. W. Brown generating station. The existing dam has a maximum height of 126 feet and impounds approximately 126 acres (see Table 2.3-1 and Table 2.4-1). The dam crest length is 2,175 feet and the dam crest width is 20 feet. The dam crest elevation is at 900 feet and elevation at the lowest downstream toe of the dam is 774 feet.

The classification for size, based on the height of the dam, is "Large" with the USACE Recommended Guidelines for Safety Inspection of Dams ER 1110-2-106 criteria summarized in Table 2.2a.

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

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

The E. W. Brown Main Fly Ash Pond dam is classified by the Kentucky Department of Environmental Control Division of Water (KYDW) as Class C – High Hazard Structure. The KYDW rules define High Hazard structures as: ".....structures located such that failure may cause loss of life, or serious damage to houses, industrial or commercial buildings, important public utilities, main highways or major railroads. This classification must be

used if failure would cause probable loss of human life." This classification definition is similar to " Significant" classification per the Federal Guidelines for Dam Safety dated April 2004. As shown in Table 2.2b, dams assigned the "high hazard potential?" classification are those dams where failure or error of operation results in the probable loss of one or more human life is expected, probable economic loss, environmental damages and disruption of lifeline facilities.

Table 2.2b FEMA Federal Guidelines for Dam Safety Hazard Classification

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None Expected	Low and generally limited to owner
Significant	None Expected	Yes
High	Probable. One or more expected	Yes (but not necessary for this classification)

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

The data reviewed by Dewberry included Design Report dated October 19, 2007 (see Appendix A: Doc. 02) prepared by Fuller, Mossbarger, Scott & May Engineers, Inc. Data on the volume of residuals stored in the Main Fly Ash Pond at the time of inspection were not indicated. The surface area for the pond at normal pool elevation is approximately 126. The current volume of ash stored in the Main Fly Ash pond was not provided. The total ash storage capacity for each phase of expansion is provided in the Table 2.3-2.

Table 2.3-1: Amount of Residuals and Maximum Capacity of Unit

	E. W. Brown Main Fly Ash Pond Dam
Surface Area (acre)	126
Current Storage Capacity (acre-feet)	Data not provided
Total Storage Capacity (acre-feet)	See Table 2.3-2
Crest Elevation (feet)	900
Normal Pond Level (feet)	893

The existing Main Fly Ash Pond has been taken out of service. When the reconfigured pond is put back in service the area between the existing main pond and the starter dike will not be a part of the storage basin.

Subsequent phases of expansion will incrementally raise the crest elevation of the new dike to a final elevation of 962 feet. Raising the crest elevation will be accomplished by broadening the base in the downstream direction, filling in the unused space between the new dike and the existing dam. A schematic of the proposed expansion phases is provided on Figure 3 incorporated into the Design Report (Appendix A: Doc 02). The total storage capacity of the Main Fly Ash Pond for each phase of the expansion project is:

Table 2.3-2: Storage Capacity of Reconfigured Main Fly Ash Pond for Each Phase					
	Phase 1	**Phase 2**	**Phase 3**	**Phase 4**	**Phase 5**
Surface Area (acre)	73.45	80.14	88.50	97.87	106.42
Storage Capacity (acre-feet)	868	1655	3062	4740	6350
Dam Crest Elev. (feet)	902.0	912.0	928.0	946.0	962.0
Normal Pond Level (feet)	897.55	907.90	924.40	942.40	958.16

2.4 PRINCIPAL PROJECT STRUCTURES

2.4.1 Earth Embankment Dam

The existing Main Fly Ash Pond Dam is a soil and rock fill dam constructed in three stages. The initial dam was constructed prior to the 1970s. The initial crest elevation was approximately 830 feet. The dam was expanded in the 1970s to a crest elevation of 870 feet and in the early 1990s to the current crest elevation of 900 feet. The original dam is reportedly supported on rock, although the expansions generally consisted of widening the dam in the downstream direction, drawings for the current expansion program indicate that the upstream toe of the 1970s expansion is located partially over ash. (See Appendix A; Doc 57 and 58). Table 2.4.1-1 displays a summary of dimensions and size specifications for the E. W. Brown Main Fly Ash Dam. Photo Numbers 1 – 9, 11 – 17, 25 – 27, 30, 37 – 39, 44, and 45 show the embankment of the dam,

Table 2.4.1-1: Summary of Dam Dimensions and Size	
	E. W. Brown Main Fly Ash Pond Existing Main Dam
Dam Height	126'
Crest Width	20'
Length	2,175'
Side Slopes (upstream)	2:1
Side Slopes (downstream)	2:1
Hazard Classification	Class C – High Hazard

"As constructed" embankment cross-sections of the Main Fly Ash Pond Dam 1990 expansion indicate sections of a 6 foot deep cut-off trench were added to sections of the new dam..

2.4.2 Outlet Structures

The existing Main Fly Ash Pond had a principal spillway and an emergency spillway. Since the facility has been taken out of service and drained, the emergency spillway had been abandoned. As the principal spillway is located in an area that will not receive sluiced coal combustion waste, it is scheduled to be grouted and abandoned.

Construction drawings show that the area of the existing pond between the existing dam with a crest elevation of 900 feet and the new starter dike with a crest elevation of 902 feet will not be used for ash storage. The area is to be graded to provide positive drainage to a surface water storm drainage system (see Appendix A: Doc 24).

2.5 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

A dam break analysis, including the identification of critical infrastructure located within 5 miles downstream of the dam is currently underway.

Based on observations at the site and surrounding area, the critical infrastructure includes the railroad line serving the E. W. Brown generating station, the Dix River Dam and local roadways. Also at risk are residences along the bank of the Dix River/Lake Herrington in the vicinity of the plant.

3.0 SUMMARY OF RELEVANT REPORTS, PERMITS AND INCIDENTS

3.1 SUMMARY OF REPORTS ON THE SAFETY OF THE MANAGEMENT UNIT(S)

In response to a Freedom of Information request, E.ON U.S. LLC provided an extensive package of design information, performance monitoring data and past inspection documents for the E. W. Brown Main Fly Ash Pond Dam. The data were provided in the form of electronic files that are included in Appendix A. Reports directly relevant to the safety of the Main Fly Ash Pond Dam are summarized below.

The Kentucky Division of Water inspected the Main Fly Ash Pond Dam on July 30, 2008 (Appendix A: Doc 88). The report indicates no signs of slides, slumps or cracking on either the downstream or upstream slopes of the embankment. The report also indicates no signs of cracking or subsidence on the crest of the dam. The next Kentucky Division of Water inspection is scheduled for 2010.

E.ON U.S. LLC retained ATC Associates, Inc to conduct an inspection of the existing Main Fly Ash Pond Dam in 2009. The ATC Associates inspection was conducted on January 11, 2009 and reported the dam to be in generally good condition (Appendix A: Doc 89). The inspection reported issues at two general areas of the existing dam:

- Crest
  - Small washout area under sprinkler line
  - Small depression where drawdown pipe trench was backfilled
  - Two irregularities in width of crest on upstream slope of east embankment
- Seepage:
  - Minor amount of seepage at the north abutment
  - Wet area at toe of east slope

Recommendations for repairs were provided with priority ratings of "moderate" and "normal."

3.2 SUMMARY OF LOCAL, STATE AND FEDERAL ENVIRONMENTAL PERMITS

The facility is under regulation by the Kentucky Department for Environmental Protection, Division of Water (KYDW Permit 0737). Kentucky inspects the dam on a biannual basis. The dam was inspected by the Kentucky Division of Water in 2008 and is scheduled for another State inspection in 2010.

The E. W. Brown Main Fly Ash Pond spillway discharge is permitted under NPDES Permit No. 0002020 which expired January 31, 2007. A renewal application was submitted in mid 2006 and is currently in the public comment phase. A permit renewal is expected late in 2009 or early 2010.

3.3 SUMMARY OF SPILL/RELEASE INCIDENTS (IF ANY)

Data included in the review documentation did not indicate any spills, unpermitted release, or other performance related problems with the dam over the last 10 years.

4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

The reviewed documents did not include the original design and construction records. However, it is understood that initial construction of the Main Fly Ash Pond was prior to 1970. The dam was expanded in the 1970s and again in the early 1990s to the current crest elevation of 900 feet. Documentation provided for review indicates the existing dam is primarily a compacted clay embankment with additional zones of graded stone filters and shot rock drains (Appendix A: Doc 33). Available drawings indicate a shallow cut-off wall beneath a segment of the existing dam (Appendix A: Doc 90).

Drawings summarizing the results of stability analyses for the expansion and reconfiguration of the Main Fly Ash Pond dam include a schematic representation of the existing dam. The schematic drawing indicates the dam was constructed in three phases:

- .....Original Embankment with a crest elevation of approximately 830 feet.
- .....1970's Embankment with a crest elevation of approximately 870 feet.
- .....1990's Embankment with a crest elevation of 900 feet.

4.1.2 Significant Changes/Modifications in Design since Original Construction

According to the information included in the design report in Appendix A: Doc 02, the Main Fly Ash Pond was expanded multiple times through the early 1990s. Construction is currently underway to expand and reconfigure the facility. A new dike is being constructed about 400 feet upstream of the existing dam such that the area between the starter dike and existing dam will no longer be part of the storage basin. The area will be the base of planned future expansion of the starter dike from an initial crest elevation of 902 feet to a final crest elevation of 952 feet.

The starter dike as well as subsequent planed phases of expansion is supported on fly ash in the pond. Liquefaction analyses in the Design Report (See Appendix A: Doc 2) indicate a potential for liquefaction in the ash if groundwater is above elevation 856 feet. Groundwater elevation at the time of the design was 870 feet. The design analyses assumed with the pond out of service, and installation of a new pond liner should cause groundwater to recede. Current construction includes installation of monitoring wells beneath the starter dike to monitor groundwater elevation between the current construction and Phase 2 construction, expected to commence in 2011. If the groundwater elevation has not dropped below elevation 856 or lower, a drainage system will be installed to lower the groundwater elevation and stabilize the embankment against a potential liquefaction failure.

4.1.3 Significant Repairs/Rehabilitation since Original Construction

No information was provided regarding major repairs or rehabilitation of the existing dam. No evidence of prior releases, failures, or patchwork was observed on the earthen embankment during the visual site assessment and no documents or statements were provided to the dam assessor that indicates prior failures have occurred.

4.2 SUMMARY OF OPERATIONAL HISTORY

4.2.1 Original Operational Procedures

The reviewed documentation did not include the original operation procedures. The Main Fly Ash Pond has been operated under procedures developed in 1991 after the last expansion. The facility is currently out of service and undergoing reconfiguration and expansion. New operating procedures, including an Emergency Operations Plan, are being developed for the reconfigured impoundment.

4.2.2 Significant Changes in Operational Procedures since Original Startup

No documents have been provided to indicate any operational procedures have changed. However the current construction to expand and reconfigure the impoundment (see Section 4.1.2) implies a change in operating procedures.

4.2.3 Current Operational Procedures

The Main Fly Ash Pond is currently out of service. Coal combustion waste material is currently being sent to the Auxiliary Ash Pond during the ongoing expansion and reconfiguration of the Main Fly Ash Pond.

4.2.4 Other Notable Events since Original Startup

No notable events have been reported nor has the dam has experienced spills or unpermitted releases in the last 10 years.

5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry performed a site visit on Tuesday, October 20, 2009. The site visit began at 09:00 AM. The weather was clear and warm. Please refer to photographs in Appendix B taken by Dewberry during the October 20, 2009 dam inspection and the Dam Inspection Checklist, Appendix C. Selected photographs are included here for ease of visual reference. The overall assessment of the dam was that it was in satisfactory condition and no significant findings were noted.

5.2 EARTH EMBANKMENT DAM

5.2.1 Crest

The crest of the existing dam had no signs of any depressions, tension cracks or other indications of settlement or shear failure, and appeared to be in satisfactory condition. Figure 5.2.1-1 shows the crest of the existing Main Fly Ash Pond Dam.

Figure 5.2.1-1 Crest of Main Fly Ash Pond Dam Looking Westward.

5.2.2 Upstream Slope

The upstream slope mostly consists of unprotected compacted soil. Figure 5.2.2-1 shows the upstream slope of the existing embankment on the south side of the impoundment. Scarps, sloughs, bulging, cracks, scarps, depressions, or other indications of slope instability or signs of erosion were not observed. The less steep slope in the foreground of the photograph is an access ramp for construction equipment working in the out-of-service impoundment.

Figure 5.2.2-1. The Upstream Slope of the Main Dam (the Embankment on the Left Side of the Picture)

5.2.3 Downstream Slope and Toe

The downstream slope is protected with graded stone aggregate. Scarps, sloughs, depressions or other indications of slope instability or signs of erosion or uncontrolled seepage were not observed. Figure 5.2.3-1 shows the downstream slope at the southeastern side of the impoundment, the highest portion of the dam. Figure 5.2.3-2 shows the downstream slope along the northeastern side of the impoundment.

Figure 5.2.3-1. Downstream Slope at the Southeast Side of Impoundment

Figure 5.2.3-2. Downstream Slope at the Northeast Side of Impoundment

5.2.4 Abutments and Groin Areas

The abutments and groin areas appeared to be in good condition.

5.3 OUTLET STRUCTURES

5.3.1 Primary Spillway

The existing primary spillway consists of a vertical decant riser and a 24-inch diameter corrugated metal discharge pipe (Figure 5.3.1-1). As the pond is currently out of service no water was flowing through the primary spillway at the time of Dewberry's inspection. The primary riser is scheduled to be grouted and abandoned as part of the current expansion and reconfiguration construction.

Figure 5.3.1-1. Existing Primary Spillway Structure.

A new primary spillway was under construction at the time of Dewberry's site visit.

5.3.2 Emergency Spillway

The existing emergency spillway has been abandoned. The new emergency spillway for the reconfigured Main Fly Ash Pond is a piped spillway into the adjacent Auxiliary Fly Ash Pond. Figure 5.3.2-1 shows the new emergency spillway discharge end at the Auxiliary Fly Ash Pond.

Figure 5.3.2-1. New Emergency Spillway from Reconfigured Main Fly Ash Pond to Auxiliary Fly Ash Pond (Discharge End Shown)

6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Floods of Record

No documentation has been provided about the floods of record.

6.1.2 Inflow Design Flood

A calculation of the inflow design flood used for the existing pond was not included in the reviewed documents. The pond is now out of service. The reconfigured facility currently under construction includes a new upstream embankment with a crest elevation 2 ft. higher than the existing dam. When the pond is reopened in its new configuration, the area in which the existing spillways are located will not be within the water storage footprint.

Data reviewed for the new configuration indicates that the new upstream embankment will handle the PMP event without overtopping.

6.1.3 Spillway Rating

The spillway rating for the existing spillway was not found in the reviewed data. As the facility is out of service during construction of a reconfigured impoundment, the primary spillway is out of service and scheduled to be abandoned before the facility is reopened.

The existing emergency spillway has been abandoned.

Hydraulic and hydrologic data provided for the expanded and reconfigured Main Fly Ash Pond indicate that both the starter dike and final configuration can pass the PMP without overtopping. The data indicates the freeboard at the PMP the starter dike is 1.4 feet and at the final embankment configuration freeboard is 1.5 feet (see Appendix A: Doc. 43).

6.1.4 Downstream Flood Analysis

A downstream flood analysis was not performed as part of the E. W. Brown Main Fly Ash Pond dam design. A dam break analysis is currently being conducted, but results were not available at the time of Dewberry's evaluation.

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Supporting technical documentation is inadequate to assess the existing facility. Most of the provided information addressed the dam's expansion.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

The original hydrology/hydraulic assessment used for the design of the Main Fly Ash Pond was not included in the reviewed documents. However, the facility is out of service and no new coal combustion waste material is being added to the impoundment.

The reconfigured facility includes a new primary spillway and new emergency spillway. The new primary spillway, just beginning construction at the time of this assessment, will be a vertical decant riser with an invert elevation of 895 feet. The primary spillway will connect to the existing outfall system

The new secondary spillway consists of a 30-inch diameter HDPE pipe with an invert elevation of 892.5 feet. The secondary spillway discharges into the adjacent Auxiliary Ash Pond.

Technical data provided is adequate to assess the new design Main Fly Ash Pond configuration.

7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

The reviewed documents did not include the original stability analysis, design calculations or field measurements for the existing Main Fly Ash Pond. However, the design report for the expansion of the Main Fly Ash Pond currently underway includes analyses for the existing dam for both the Phase 1 expansion and the final expansion configurations (see Appendix A: Doc 57, 58 and 59). The analyses were conducted using UTEXAS4 software.

Stability analyses were conducted for long term stability of upstream and downstream embankments for shall and deep rotational failures. Analyses were conducted for normal pool and no pool conditions.

The stability analyses (Appendix A: Doc 02, 57, 58, and 59), for dynamic conditions were conducted using a pseudo-static loading condition based on a peak ground acceleration of 0.100g for a two percent probability of exceedance in 50 years.

7.1.2 Design Properties and Parameters of Materials

The design parameters used for the original dam design were not available from the reviewed documents.

However, design parameters for the stability analysis for the reconfiguration and expansion program currently underway (see Appendix A: Doc. 57, 58, and 59) are available. These parameters at least partially reflect the properties of the existing embankment. The density values listed in the parameter tables for the downstream slope range from 110 to 118 pounds per cubic foot (PCF). Angle of shearing resistance under effective stress analysis range is 28° to 38° for various zones and, where applicable, the effective cohesive strength is 100 pound per square foot.

7.1.3 Uplift and/or Phreatic Surface Assumptions

No uplift considerations are included in the stability analyses. The reconfigured Main Fly Ash Pond and new embankment upstream slope of the embankment are lined with a 4-ft. thick clay zone capped by a 60 mil Liner Low-Density Polyethylene (LLDP) flexible membrane liner (see Appendix A: Doc. 33).

In the stability analysis section of the design report for the proposed expansion and reconfiguration of the Main Fly Ash Pond (see Appendix A- Doc 02) a phreatic level was shown as a horizontal surface at elevation 870 feet.

7.1.4 Factors of Safety and Base Stresses

The reviewed documents did not include any information about the factors of safety and base stresses for the original design of the existing embankment.

In the stability analysis section of the design report for the proposed expansion and reconfiguration of the Main Fly Ash Pond (see Appendix A- Doc 02) the static and pseudo-static stability safety factors for the existing embankment are shown for the downstream slope. The report indicates that the pseudo-static analysis is without liquefaction. The computed Safety Factors are listed in Table 7.1.4.

Table 7.1.4: Factors of Safety E. W. Brown Main Fly Ash Dam (Note 1)

Location/Loading Condition	Required Safety Factor (Army Corps)	Computed Safety Factor
Final Dam Configuration (Crest Elev. 962)Upstream – Long Term Shallow Failure, No Pool , Static	1.5	2.1
Upstream – Long Term Shallow Failure, No Pool , Dynamic	1.2	1.8
Upstream – Long Term Deep Failure, No Pool , Static	1.5	2.3
Upstream – Long Term Deep Failure, No Pool , Dynamic	1.2	1.8
Downstream – Long Term Shallow Failure, Static (Note 2)	1.5	2.1
Downstream – Long Term Shallow Failure, Dynamic	1.2	1.3
Downstream – Long Term Deep Failure, Static	1.5	2.2
Downstream – Long Term Deep Failure, Dynamic	1.2	1.6
Starter Dike Long Term No pool, Static	1.5	2.0
Starter Dike Long Term No pool, Dynamic	1.2	1.4

Notes: 1 – Results are for Main Fly Ash Dam in final proposed configuration with crest elevation of 962 feet
2 – Shallow failure surface is contained within existing Main Fly Ash Pond embankment.

7.1.5 Liquefaction Potential

No liquefaction potential data were submitted for the existing embankment.

The design report for the expansion and reconfiguration of the Main Fly Ash Pond (see Appendix A- Doc 02) includes an evaluation of liquefaction potential for fly underlying the planned new embankments. The results of the evaluation indicated a potential for liquefaction in the fly ash materials in conditions resulting in a phreatic surface about elevation 856 feet. The report concludes that liquefaction could destabilize the existing dike and could cause progressive sliding of the planned larger dike. Based on the identified hazard, the design includes provisions for monitoring ground water levels beneath the starter dike for the period between Phase 1 and Phase 2 construction, expected to be about one year. If the water level does not recede as expected, a drainage system will be incorporated into the Phase 2 construction to control the groundwater lever at or below elevation 856 feet.

7.1.6 Critical Geological Conditions and Seismicity

Data in the Dam Construction Permit Application (see Appendix A: Doc 02) indicate the E. W. Brown Main Fly Ash Pond is underlain by rock of the Lexington and Tyrone Limestone formations. Members of the Lexington formation at the site include: Greer Limestone, Logana Limestone, and Curdsville Limestone. The Tyrone Limestone formation underlies the Curdsville Limestone.

Geologic maps of Kentucky identify the carbonate rock formations at the site as susceptible to formation of sinkholes. Drawings for the current expansion construction include provisions for treating discontinuities observed in the rock surface during construction (see Appendix A Doc 32). The same rock treatment requirements were included on the 2006 construction drawings for the adjacent Auxiliary Ash Pond Dam; however, the "as constructed" drawings do not indicate areas requiring treatment.

Drawings of the 1990 expansion of the existing Main Ash pond Dam indicate that isolated solution features were observed near the downstream toe of the expanded embankment. The drawings indicate that the areas were treated by backfilling surface cavities with course aggregate and a geotextile filter fabric.

The Design Report includes boring logs from several geotechnical explorations at the Main Fly Ash Pond. Borings at the southwest abutment and along the northern leg of the dam include rock coring data. The rock coring data indicate recoveries generally ranging from 60 to 100 percent and Rock Quality Designations (RQD) generally ranging from 24 to 85 percent. The values are consistent with the rock description of "thin bedded, irregular/nodular bedding with shale stringers and partings".

The rock core data and the filed notes on the 1990 "as constructed" drawings suggest that solution features are limited to localize cavities, and that design have included filed treatment procedures when irregularities in the rock are encountered.

The documents provided indicate that seismicity was considered in the design. The slope stability analyses included a dynamic load condition based on a peak ground acceleration of 0.100 g.

As part of this assessment the current Seismic Risk Map of the United States was also reviewed using the U. S. Geologic Survey web site. The 2%/50 year return period peak ground acceleration mapped for the sire is 0.100 g. The seismic design criteria are appropriate for this dam.

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Structural stability documentation is limited for the existing Main Fly Ash Pond. However, there is adequate information in the design report for the expansion and reconfiguration of the Main Fly Ash Pond to assess the structural stability of the existing embankment.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

Overall, the structural stability of the Main Fly Ash Pond embankment appears to be satisfactory based on the following observations during the October 20, 2009 field visit and dam evaluation by Dewberry, the 2006 Dam Construction Application Report, and the post-construction drawings.

- There were no indications of scarps, sloughs, depressions or bulging anywhere along the dam;
- Boils, sinks or uncontrolled seepage was not observed along the slopes, groins or toe;
- The crest appeared free of depressions and no significant vertical or horizontal alignment variations were observed; and
- The computed factors of safety comply with accepted criteria.

8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATIONAL PROCEDURES

The facility is currently out of service. The facility is to be restored to service upon completion of Phase 1 of a five- phase expansion and reconfiguration program. Phase 1 construction is currently underway.

Prior to being taken out of service, the Main Fly Ash Pond Dam was operated in accordance with the 1991 Operation Plan prepared in conjunction with the last expansion of the embankment. A new Operations Plan and Emergency Operation Plan are being prepared for the expanded and reconfigured Main Fly Ash Pond.

Discharge from the outflow structure is to an unnamed tributary to Herrington Lake. The facility NPDES permit (KY 0002020) has expired. A renewal application was submitted prior to the expiration date. The renewal process is currently in the public comment phase, is expected to be completed and a new permit issued by late 2009 or early 2010.

8.2 MAINTENANCE OF THE DAM AND PROJECT FACILITIES

Maintenance procedures for the Main Fly Ash Pond include:

- Weekly inspections by plant personnel;
- Annual engineering inspection;
- Removal of vegetation from joints, resealing and repair of joints/cracks in concrete sections as required;
- Repair of vehicle/traffic damages and replacement or repair of access gates as required.

8.3 ASSESSMENT OF MAINTENANCE AND METHODS OF OPERATION

8.3.1 Adequacy of Operational Procedures

Based on the assessments of this report operation procedures seem to have been adequate.

8.3.2 Adequacy of Maintenance

Various dam inspection reports including the Kentucky Division of Water inspection report of July 30, 2008 (see Appendix A: Doc 88), and the ATC Associates, Inc. report of January 22, 2009 (see Appendix A: Doc 89) reported no major maintenance issues. Although several maintenance recommendations were made, none of them are considered critical or imminent. This indicates that the maintenance plan is probably followed in practice and adequate maintenance is provided for the dam and the project facilities.

Although the maintenance program is adequate, several recommendations have been made to improve the maintenance and insure trouble-free operation.

The ATC Associates, Inc. January 22, 2009 recommended:

- Filling depression under a sprinkling line
- Repair of upstream crest narrowing
- Excavate and refill depressions at downstream slope at previous drawdown pipe location
- Install weir to allow monitoring of flow
- Monitor flow to evaluate seepage from cooling tower discharge to fly ash impoundment
- Remove blockage in Emergency Spillway prior to placing facility back in service
- Prepare Operations and Maintenance Plan for all aspects of the structure
- Prepare Emergency Operations Plan for structure distress scenarios
- Institute and document regular facility inspection plan
- Conduct visual inspection of the facility during the 2008 growing season
- Prepare current topographic mapping

The Dewberry engineering team site visit (October 20, 2009) or subsequent dam assessment did not result in any other major observations or additional maintenance recommendations to the items listed above.

9.0 ADEQUACY OF SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

9.1.1 Surveillance Inspections

Surveillance inspections of the Main Fly Ash Pond are conducted weekly. A written summary of observations is provided to facility management.

9.1.2 Annual Inspections

A third party inspection was conducted January 22, 2009 by ATC Associates. The inspection report identified did not identify any high priority issues. Some of the recommendations made in the ATC Associates report have been overtaken by commencement of construction of the new facility configuration; e.g., the emergency spillway has been abandoned and new primary and emergency spillways designed.

9.2 INSTRUMENTATION MONITORING

The Main Fly Ash Pond monitoring system consisted of a contained series of piezometers. Monitoring was suspended when the impoundment was taken out of service.

A network of piezometers is included in the design of the expanded and reconfigured Main Fly Ash Pond

9.3 ASSESSMENT OF SURVEILLANCE AND MONITORING PROGRAM

9.3.1 Adequacy of Inspection Program

Based on the data reviewed by Dewberry, including observations during the site visit, the inspection program is adequate.

9.3.2 Adequacy of Instrumentation Monitoring Program

An instrumentation monitoring program was implemented but there is little evidence that results were being tracked and analyzed for changes in conditions that might be detrimental to the embankment.