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October 17, 2016
File: 175534018
Revision 0

Indiana-Kentucky Electric Corporation
3932 U.S. Route 23
P.O. Box 468
Piketon, Ohio 45661

RE: Initial Structural Stability Assessment
West Boiler Slag Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Clifty Creek Station
Madison, Jefferson County, Indiana

1.0 PURPOSE

This letter documents Stantec's certification of the initial structural stability assessment for the Indiana-Kentucky Electric Corporation (IKEC) Clifty Creek Station's West Boiler Slag Pond. Based on this assessment, the West Boiler Slag Pond is in compliance with the structural stability requirements in the EPA Final CCR Rule at 40 CFR 257.73(d).

2.0 INITIAL STRUCTURAL STABILITY ASSESSMENT

As described in 40 CFR 257.73(d), documentation is required on how the West Boiler Slag Pond has been designed, constructed, operated, and maintained according to the structural stability requirements listed in the section. The combined capacity of all spillways must also be designed, constructed, operated, and maintained to adequately manage flow from the 1,000-year storm event based upon a hazard potential classification of "significant."

3.0 SUMMARY OF FINDINGS

The attached report presents the initial structural stability assessment of the West Boiler Slag Pond. The results show that the impoundment meets the structural stability requirements set forth in 40 CFR 257.73(d)(1)-(2).

4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Stan A. Harris, being a Professional Engineer in good standing in the State of Indiana, 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;

Re: **Initial Structural Stability Assessment**
West Boiler Slag Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Clifty Creek Station
Madison, Jefferson County, Indiana

2. that the information contained herein is accurate as of the date of my signature below; and

3. that the initial structural stability assessment for the IKEC Clifty Creek Station's West Boiler Slag Pond meets the requirements specified in 40 CFR 257.73(d)(1)-(2).

SIGNATURE ________________ DATE 10/17/16

ADDRESS: Stantec Consulting Services Inc.
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Cincinnati, Ohio 45241

TELEPHONE: (513) 842-8200

ATTACHMENTS: Clifty Creek West Boiler Slag Pond Initial Structural Stability Assessment Report

STAN A. HARRIS
REGISTERED
No. PE19700150
STATE OF INDIANA
PROFESSIONAL ENGINEER
10/17/16

Initial Structural Stability Assessment

Clifty Creek Station
West Boiler Slag Pond
Madison, Jefferson County, Indiana

Prepared for:
Indiana-Kentucky Electric Corporation
Piketon, Ohio

Prepared by:
Stantec Consulting Services Inc.
Cincinnati, Ohio

October 17, 2016

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1.0 PROJECT BACKGROUND

On April 17, 2015 the "Disposal of Coal Combustion Residuals (CCR) from Electric Utilities" (EPA Final CCR Rule) was published in the Federal Register. Stantec Consulting Services, Inc. (Stantec) was contracted by the Indiana-Kentucky Electric Corporation (IKEC) to analyze the structural stability of the Clifty Creek Station's West Boiler Slag Pond (WBSP) evaluate its compliance with §257.73 of the EPA Final CCR Rule.

As required by §257.73 of the EPA Final CCR Rule, an initial structural integrity evaluation is required by October 17, 2016 and must include an initial structural stability assessment for each existing CCR surface impoundment that meets the conditions of paragraph (b) as follows:

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.

2.0 UNIT DESCRIPTION

The Clifty Creek Station is located on the north shore of the Ohio River downstream of Madison, Indiana. The station consists of six coal-fired electric generating units, each nominally rated at 217 megawatts. The Clifty Creek Station is directly accessible from State Route 56. A plan view of the station is included in Appendix A.

The West Boiler Slag Pond is located southwest of the station. It is formed by natural grade to the north, east, and west and a dam on the south that runs along the bank of the Ohio River. The West Boiler Slag Pond serves as a settling basin for sluiced bottom ash produced at the station and receives stormwater runoff from approximately 510 acres (Stantec, 2010a). The pond contains two primary areas: the eastern portion near the sluice pipes that is actively dredged and a western portion with minimal deposition or dredging activities. A vegetation delta separates the two as a natural filtering zone. The pond discharges to the Ohio River through a principal spillway at the southern edge of the impoundment.

The subsections under §257.73(d) address conditions of appurtenances categorized as embankments, spillways, or hydraulic structures. Sections 2.1 to 2.3 below provide descriptions of the individual unit elements that fall within these appurtenance categories. Appendix A includes an overview of the Clifty Creek Station.

Note that all elevations included in this document and appendices are referenced to the North American Vertical Datum of 1988 (NAVD 88).

2.1 EMBANKMENTS

2.1.1 WBSP Dam

The WBSP Dam forms the southern boundary for the pond. It is an earthen dam with a crest length roughly 2,500 feet, a crest elevation of 475 feet mean sea level (MSL), and a structural height of about 42 feet. The minimum dam crest elevation is 469 mean sea level (MSL). The WBSP Dam is not currently registered with the Indiana Department of Natural Resources (IDNR), but has been identified as a significant hazard structure by American Electric Power Service Corporation (AEPSC) (Stantec, 2010a).

The WBSP Dam has a crest width of 20 feet. The upstream embankment has a slope of 1.5H:1V to 2H:1V. The downstream embankment has a slope of approximately 2.5H:1V with a break in the slope around elevation 446 feet. Below elevation 446 feet, the downstream embankment flattens until the river edge where it transitions to 4.5H:1V down to the river (GZA, 2009).

2.2 SPILLWAYS

2.2.1 Primary Spillway System

The WBSP primary spillway is a reinforced concrete box riser structure. One side of the structure has a 3-foot wide opening that acts as a weir with water level adjusted using stop logs. The riser structure outlets to the Ohio River at elevation 426.8 feet through a 36-inch diameter, 450-foot long reinforced concrete pipe (Stantec, 2010a).

2.3 HYDRAULIC STRUCTURES

Other than the primary spillway described above, no hydraulic structures are located at the WBSP.

3.0 FOUNDATIONS AND ABUTMENTS (§257.73(d)(1)(i))

Per §257.73(d)(1)(i), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with stable foundations and abutments. The West Boiler Slag Pond has the following features that fall within this requirement:

- WBSP Dam

Assessment of the foundations and abutments associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

- Review inspection reports of the facility, considering frequency of inspections, and if the inspections included review and/or assessment of features including cracking, settlement, deformation, or erosion of the foundations/abutments. Inspections should indicate that there are no significant signs of tension cracking, settlement, depressions, erosion, and/or deformations at the crest, slope, and toe of the structure.

- Confirm that an assessment of seepage conditions of the foundation, with considerations of heave and vertical exit gradient, has been performed. Verify that the seepage assessment follows appropriate methodologies (such as USACE EM 1110-2-1901) and that the foundations exhibit acceptable performance (e.g. FS for piping greater than or equal to 3.0).

3.1 WBSP DAM

3.1.1 Background

The WBSP Dam is an earthen dam tying into natural ground on both sides. Mapping of unconsolidated sediments indicate lowland areas adjacent to the Ohio River are predominantly underlain by clay, silt, sand, and gravel deposited as alluvium, lacustrine, and outwash deposits. Glacial deposits are Illinoian and Wisconsinan Quaternary age and belong to the Atherton Formation. Overlying alluvial deposits are Martinsville Formation. Bedrock underlying the site is of the Maquoketa Group, consisting of shale (about 80 percent) and limestone (about 20 percent) (Stantec, 2016). Based on Stantec (2016), the foundation of the WBSP Dam generally consists lean clay with sand and underlying foundation soils of lean clay with sand, sandy silt, or silt with sand. A layer of gravel with sand and silt was also observed underlying the dam.

3.1.2 Assessment

A qualified person performs inspections of the West Boiler Slag Pond weekly, monthly, quarterly, and annually. Regular site inspections have been conducted and documented for the West Boiler Slag Pond from 1976 to 2016. These inspections include observations related to foundation and abutment conditions with respect to observable cracking, settlement, depressions, erosion, and deformation.

AEPSC (2015) noted no significant change to the exterior slope was noted from the 2014 inspection. No settlement, misalignment, animal burrows, or seeps were observed. Signs of settlement, misalignment, and cracked were not observed on the crest.

GZA (2009) observed that the top of the dam was generally parallel to the Ohio River. Vertical alignment of the top of the dam appeared level, but noted that spot elevations of the crest ranged from 468.8 (left abutment) to 472.5 feet (right abutment).

Seepage analysis for the original dike construction is not available. A letter from the design engineer to the owner states that the dam is constructed of relatively impervious material on a foundation of impervious material with the limited exposure to the high river stages. Special measures against seepage through and beneath the dikes were not required (A Casagrande et al, 1952).

As part of the geotechnical exploration in 2009, a seepage analysis was conducted using SEEP/W (Stantec, 2010b). This module is part of the GeoStudio 2007, Version 7.23 software package developed by GEO-SLOPE International, Ltd. of Calgary, Alberta, Canada (GEO-SLOPE International, Ltd, 2007). This package also includes SLOPE/W module for slope stability analysis. The seepage analysis indicated that the factor of safety for piping/heave was 3.0 or greater for the WBSP Dam.

3.1.1 Conclusion

Based on the assessment of the foundation and abutments for the WBSP Dam, the EPA Final CCR Rule-related criteria listed above have been met.

4.0 SLOPE PROTECTION (§257.73(d)(1)(ii))

Per §257.73(d)(1)(ii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown. The West Boiler Slag Pond has the following features that fall within this requirement:

- WBSP Dam

Assessment of the slope protection associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. *Regular (weekly) inspections for erosion. Inspections should show there are no significant signs of deterioration in the slope protection configuration of the Item.*

2. *Appropriate slope protection shall be provided based on anticipated flow velocities. [Hydrologic/hydraulic calculations of flow velocities on the slope of the Item for the appropriate erosive forces. Some common slope protection measures include: riprap, gabions, paving (concrete or asphalt), or appropriate vegetative cover.]*

3. *If slope protection is riprap, filter layer(s) under the riprap shall be designed according to established filter criteria. However, existing riprap cover may be evaluated based on performance and observations during inspections.*

4.1 WBSP DAM

4.1.1 Background

Slope protection for the WBSP Dam consists of grass or riprap on the upstream toe of the dam. The downstream slope is also vegetated and mowed. Flow from the primary spillway's discharge pipe is adequately dissipated through a gradual pipe slope and discharge elevation into the receiving stream (GZA, 2009).

4.1.1 Assessment

As reported by the GZA (2009), regular drive-by inspections are performed with a checklist inspection quarterly, and an annual inspection by AEPSC. The spillway is regularly visited to take water quality samples, while the instrumentation in the dams are read monthly. Areas of erosion are prioritized for appropriate repairs. Regular site inspections performed by a registered professional engineer have been conducted and documented for the West Boiler Slag Pond from 1976 to 2015. Site inspection reports generally indicate appropriate maintenance of slope protection features of the dam.

Portions of the upstream slope of the WBSP dam are vegetated. This is an operational pond with bottom ash interior slopes due to regular dredging operations. Slopes are dressed and maintained. Riprap has been placed the length of the dam to protect against wave erosion. The last annual dam and dike inspection observed that the interior and exterior slopes of the dike were in fair and stable condition (AEPSC, 2015).

4.1.1 Conclusion

Based on the assessment of the slope protection for the WBSP Dam, the EPA Final CCR Rule-related criteria listed above have been met.

5.0 EMBANKMENT DIKE COMPACTION (§257.73(d)(1)(iii))

Per §257.73(d)(1)(iii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit. The West Boiler Slag Pond has the following features that fall within this requirement:

- WBSP Dam

Assessment of the dike compaction associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Documentation showing the dike was mechanically compacted. Acceptable documentation may include construction drawings, field notes, construction photographs, correspondences, or any evidence showing the dike was mechanically compacted during construction.

2. If no construction documentation is available specific data from geotechnical explorations of dike may be used. Geotechnical borings with continuous SPTs may be used to assess compaction of the dike. Appropriate methodology correlating blow counts and compaction (density) should be used.

5.1 WBSP DAM

5.1.1 Background

The dam was designed by Arthur and Leo Casagrande of Cambridge, Massachusetts from 1952 to 1954. The firm was also retained during the construction phase and reportedly made a number of site visits as the embankment and appurtenances were being built. Only limited design drawings exist for the WBSP Dam. Technical memoranda and letters between the firm and the plant during the design and construction of the plant and other structures do exist (GZA, 2009). Construction photos are available showing period-appropriate large construction equipment working on the site. Subsurface explorations of the dike were also available that provided SPT data used in the assessment.

5.1.1 Assessment

Historical construction photographs, technical memoranda, and letters provide documentation of compaction requirements related to the construction of the LRCP Dam. Construction criteria related to dike embankment materials and dike compaction as noted on this documentation include:

- A discussion of proposed dike materials and the need for proper moisture control and compaction in thin layers with heavy, rubber-tired equipment slightly on the dry side of optimum (A. Casagrande, 1952).

- A discussion of testing the foundation clay in situ with a vane borer with supervision by L. Casagrande (A. Casagrande, 1952).

- A discussion of selection of granular borrow with laboratory data and compaction requirements (A. Casagrande, 1953).

- A discussion of compaction of the foundation fill with a modern, heavy rubber-tired roller in 9-in. layers and compacted with four passes of a roller loaded to 50 or 60 tons (A. Casagrande, 1953).

Two previous geotechnical explorations were available to review as part of this assessment (Stantec, 2010; Stantec, 2016). Each was a geotechnical exploration and slope stability evaluation of the LRCP Dam. The programs included drilling and laboratory testing.

Stantec (2010) assigned drained shear strength parameters to the existing lean clay dam of 165 psf and 33.2 degrees. Correlating these results using NAVFAC DM-7.2 indicate that appropriate compaction exists within the embankment of the LRCP Dam (NAVFAC, 1986).

Stantec (2016) performed three moisture-density tests on the embankment lean clay to compare with in-situ natural moisture contents and unit weights of the soil. Natural moisture contents within the embankment varied from 15 to 25 percent with an average of 19 percent. Dry densities ranged from 106 to 115 pounds per cubic foot (pcf) with an average of 110 pcf. The results of the tests suggested the average natural moisture content of the embankment is 3 to 5 percent above optimum moisture and that the average percent compaction of the embankment soil is approximately 94 to 97 percent of standard Proctor maximum density.

5.1.2 Conclusion

Based on the assessment of the embankment dike compaction for the WBSP Dam, the EPA Final CCR Rule-related criteria listed above have been met.

6.0 VEGETATED SLOPES (§257.73(d)(1)(iv))

Per §257.73(d)(1)(iv), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with vegetated slopes of dikes and surrounding areas, except for slopes which have an alternate form or forms of slope protection. The West Boiler Slag Pond has the following features that fall within this requirement:

- WBSP Dam

Assessment of the vegetated slopes associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Regular inspection records showing vegetative cover sufficient to prevent surface erosion while allowing an unobstructed view to visually inspect the slope.

6.1 BACKGROUND

Slope protection for the LRCP Dam consists of short grass for both the interior and exterior slopes.

6.2 ASSESSMENT

A qualified person performs inspections of the West Boiler Slag Pond weekly, monthly, quarterly, and annually. Regular site inspections have been conducted and documented for the West Boiler Slag Pond from 1976 to 2016.

Portions of the upstream slope of the WBSP dam are vegetated. This is an operational pond with bottom ash interior slopes due to regular dredging operations. Slopes are dressed and maintained. Riprap has been placed the length of the dam to protect against wave erosion. The last annual dam and dike inspection observed that the interior and exterior slopes of the dike were in fair and stable condition (AEPSC, 2015).

6.3 CONCLUSION

Based on the assessment of the vegetated slopes for the WBSP Dam, the EPA Final CCR Rule-related criteria listed above have been met.

7.0 SPILLWAY CONDITION AND CAPACITY(§257.73(d)(1)(v))

Per §257.73(d)(1)(v), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with a single spillway or combination of spillways that meet the condition and capacity requirements as outlined in this section of the EPA Final CCR Rule. The combined capacity of all spillways are to be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in this section. The West Boiler Slag Pond has the following features that fall within this requirement:

- WBSP Dam Primary Spillway System

Assessment of the spillway condition and capacity associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Outlet channel must be of non-erodible material designed to carry sustained flow velocities based on the required flood events. [Estimate flow velocities and select appropriate material using hydraulic analysis for the following flood events: PMF (high hazard potential unit), 1000-year flood (Significant hazard unit), 100-year flood (low hazard potential unit).]

2. Must adequately manage flow during and following the peak discharge. [Estimate size of outlet structure based of hydraulic analysis for the following flood events: PMF (High hazard potential unit), 1000-year flood (Significant hazard potential unit), and 100-year flood (low hazard potential unit).]

3. Must be structurally stable. [Assess stability of structure using stability and stress analyses according to an appropriate methodology. Some acceptable methodologies may include: EM 1110-2-2400, EM 1110-2-2100, ACI 350, etc.]

4. Must maintain structural integrity. [Structural integrity may be warranted by periodic inspections of existing conduits. Inspections must show no significant presence of deformation, distortions, cracks, joint separation, etc.]

5. Must be free from significant amounts of obstruction and anomaly which may affect the operation of the hydraulic structure [Perform periodic pipe inspections to detect deterioration, deformation, distortion, bedding deficiencies, and sediment, and debris accumulations.]

7.1 PRIMARY SPILLWAY SYSTEM

7.1.1 Background

The West Boiler Slag Pond is classified as a significant hazard structure requiring the combined capacity of all spillways be adequate to manage the flow during and following the peak discharge from a 1000-year flood.

7.1.2 Assessment

7.1.2.1 Spillway Capacity

The Inflow Design Flood Control System Plan for the West Boiler Slag Pond demonstrates the West Boiler Slag Pond meets the capacity requirements outlined in §257.73(d)(1)(v) of the EPA Final CCR Rule. During the October 2015 annual dam and dike inspection, the primary spillway's outlet structure was in good condition and flowing steadily. Flood events of the Ohio River accumulate wood debris near the discharge pipe, but not appear to impede it (AEPSC, 2015).

7.1.2.2 Structural Stability

The West Boiler Slag Pond spillway is a 30-foot reinforced concrete decant-type overflow structure built 70 feet away of the right abutment. The intake shaft is rectangular with a 3.25-foot by 3.25-foot interior cross section (GZA, 2009). The top of the structure is approximately elevation 458 feet (AEPSC, 2016).

A 36-inch extra strength reinforced concrete pipe connects to the decant structure at elevation 433.0 feet and discharges 300 feet downstream to the Ohio River (GZA, 2009).

The West Boiler Slag Pond's spillway structure is inspected monthly during water quality sampling and annually as part of the dam and dike inspection. Physical condition, flow through the pipe, and maintenance concerns are noted and addressed. Video camera inspections of the structure were performed in 2007 and 2011. In October 2014, the first 10 joints of the discharge pipe at the outfall were sealed by an outside contractor.

7.1.3 Conclusion

Based on the assessment of the Primary Spillway System condition and capacity for the West Boiler Slag Pond, the EPA Final CCR Rule-related criteria listed above have been met.

8.0 SUDDEN DRAWDOWN ASSESSMENT (§257.73(d)(1)(vii))

Per §257.73(d)(1)(vii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with downstream slopes that can be inundated by an adjacent water body (such as a river, stream, or lake) to determine if structural stability is maintained during low pool or sudden drawdown of the adjacent water body. The West Boiler Slag Pond has the following feature that falls within this requirement:

- WBSP Dam

Assessment of the sudden drawdown associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Maintain slope stability during sudden drawdown of adjacent water body.

Guidance provided by the USEPA (2015) described the basis of the EPA Final CCR Rule's factor of safety criteria and methodology as EM 1110-2-1902 (USACE, 2003) or other appropriate methodologies. Table 3-1 of EM 1110-2-1902 (USACE, 2003) recommends a required minimum factor of safety of 1.1 for maximum surcharge pool under rapid drawdown conditions.

8.1 EMBANKMENTS

8.1.1 Background

The WBSP Dam has a potential sudden drawdown loading from the Ohio River. A sudden drawdown slope stability analysis of the downstream slope is required under the EPA Final CCR Rule §257.73(d)(1)(vii). The sudden drawdown slope stability analysis was performed in conjunction with the static safety factor assessment discussed in Stantec (2016).

8.1.2 Assessment

8.1.2.1 Material Properties

Stantec performed geotechnical explorations in 2010 and 2015 to characterize the embankments of the WBSP Dam. A laboratory testing program was performed for each exploration to determine the pertinent soil parameters for stability analyses. The strength parameters derived using the laboratory data and used in this sudden drawdown slope stability evaluation are presented in Table 1. The results of the laboratory testing and derivation of the strength parameters can be found in Stantec (2010b and 2016).

Table 1 Strength Parameters for Stability Analysis – WBSP Dam

Embankment	Soil Horizon	Unit Weight (pcf)	Effective Stress Strength Parameters		Total Stress Strength Parameters	
			c' (psf)	ϕ' (degrees)	c (psf)	ϕ (degrees)
West Boiler Slag Pond Dam	Embankment	130	165	33	600	13
	Lean Clay with Sand	119	160	27	1,200	5
	Gravel with Silt and Sand	130	0	35	0	35
	Sandy Silt	130	0	30	0	30
	Bottom Ash	115	0	28	0	28

8.1.2.2 Critical Cross Section Selection

Slope stability analyses were available from Stantec (2010a and 2016). Three cross sections from the WBSP Dam were analyzed under static, long-term, steady-state conditions using the maximum surcharge pool. The three sections that were analyzed are labeled Sections A-A', B-B', and C-C' and are shown in Figure 1.

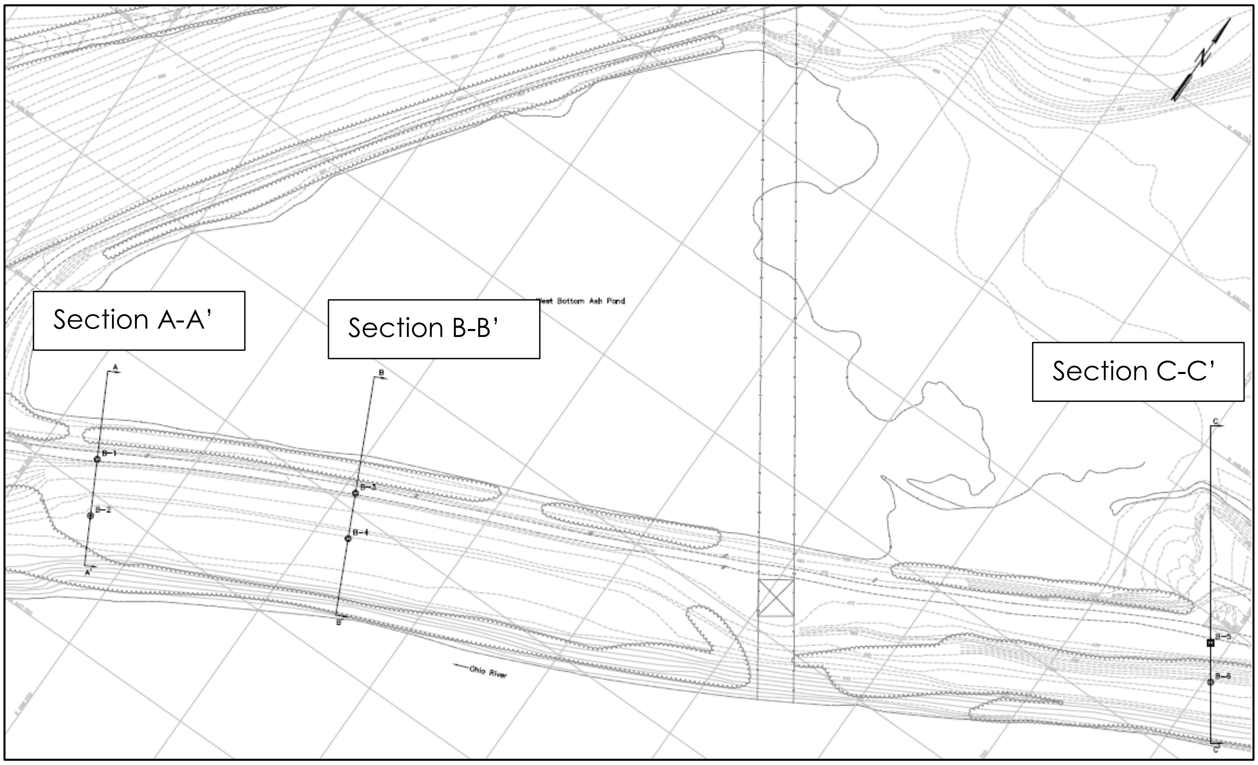

Figure 1 Clifty Creek Power Plant West Boiler Slag Pond – Plan View of Cross Sections

The summary of the static slope stability results from Stantec (2016) is listed in Table 2. The pond levels were set at the 50% PMP elevation (462.8 feet for the West Boiler Slag Pond). The tailwater was set near the elevation of the Ohio River.

Table 2 Static Slope Stability Results

Facility	Cross-Section	Drained Maximum Storage Pool Factor of Safety	Drained Maximum Surcharge Pool Factor of Safety	Undrained Maximum Storage Pool Factor of Safety
West Boiler Slag Pond	A-A'	2.30	2.30	1.35
	B-B'	2.44	2.44	1.30
	C-C'	2.30	2.18	1.53

A sudden drawdown stability analysis is required for the three WBSP Dam sections using the proposed water levels discussed in Section 8.1.2.3.

8.1.2.3 Water Levels

Clifty Creek Station's CCR surface impoundments are classified as a significant hazard. Under the EPA Final CCR Rule, the inflow design flood for a significant hazard potential CCR surface impoundment is the 1,000-year flood (§257.82(a)(3)(ii)). A rainfall amount for the 1,000-year storm event (7.16 inches) was obtained from the "Precipitation Frequency Atlas of the United States, NOAA Atlas 14" using a precipitation event duration of 6 hours (Bonnin et al, 2016).

Stantec (2010a) presents the reservoir routing analysis for the West Boiler Slag Pond assuming the 50-percent probable maximum precipitation (PMP) event. From NOAA (1980), a 6-hour rainfall depth (27.6 inches) for the PMP storm event as obtained. The reservoir routing model indicates that the West Boiler Slag Pond peak 50-percent PMP water surface elevation is 462.8 feet.

The sudden drawdown analysis has been performed assuming a maximum surcharge pool within the surface impoundment equal to the 50-percent PMP water surface elevation and a long-term maximum storage pool equal to the operating pool elevation reported in Stantec (2016).

Tailwater for the model is the Ohio River elevation. The 100-year flood level for the Ohio River was used for the tailwater flood pool elevation (FEMA, 2015). The normal pool for the Ohio River was determined from the elevations provided by NOAA (2016) for Madison, Indiana. Table 3 lists the headwater and tailwater elevations used for analysis.

Table 3 Clifty Creek Station Water Elevations for Stability Modeling

CCR Rule Criteria	Headwater West Boiler Slag Pond Elevation (feet)	Tailwater Ohio River Elevation (feet)
Long-term maximum storage pool loading condition	448.0	420.0
Maximum surcharge pool loading condition	462.8	463.0

8.1.2.4 Analysis Methodology

Stantec performed the sudden drawdown slope stability analyses using the GeoStudio 2007, Version 7.23 software package developed by GEO-SLOPE International, Ltd. of Calgary, Alberta, Canada (GEO-SLOPE International, Ltd., 2007). This package includes the SLOPE/W module for slope stability analysis. The analyses were performed in accordance with the recommendations and criteria outlined in the USACE Design Manual EM 1110-2-1902 "Slope Stability" (USACE, 2003).

8.1.2.5 Acceptance Criteria

A minimum factor of safety is not explicitly specified within the EPA Final CCR Rule §257.73(d)(1)(vii). In the EPA Final CCR Rule discussion, USACE (2003) is considered the basis for the slope stability analyses. Table 3-1, Minimum Required Factors of Safety: New Earth and Rock-Fill Dams, requires a factor of safety of 1.1 for a rapid drawdown condition from maximum surcharge pool.

8.1.2.6 Analysis Results

The slope stability assessments presented in this report are focused on the potential for slope failures of significant mass, which could directly impact potential release of water and CCR materials from the West Boiler Slag Pond. The search for a critical slip surface in the slope stability assessments is thus restricted to consider only potential surfaces where the depth (measured at the base of at least one slice) is more than ten feet vertically below the ground surface. Table 4 summarizes the sudden drawdown safety factor evaluation results at the West Boiler Slag Pond. The results of the analysis are included in Appendix B.

The results show that the sudden drawdown factor of safety assuming the 50-percent PMP event meets the criteria; therefore, the design is also acceptable for the 1000-year event and the requirements set forth in 40 CFR 257.73(d)(1)(vii).

Table 4 Factor of Safety Assessment Results

Facility	Cross Section	EPA Criteria	Recommended Factor of Safety Criteria	Calculated Factor of Safety
West Boiler Slag Pond	A-A'	Sudden Drawdown	1.1	1.7
	B-B'			1.8
	C-C'			1.9

8.1.3 Conclusion

Based on the assessment of the sudden drawdown for WBSP Dam, the EPA Final CCR Rule-related criteria listed above have been met.

9.0 REFERENCES

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Appendix A PLAN VIEW OF CLIFTY CREEK STATION

Appendix B SUDDEN DRAWDOWN ASSESSMENT

APPENDIX A
PLAN VIEW OF CLIFTY CREEK STATION

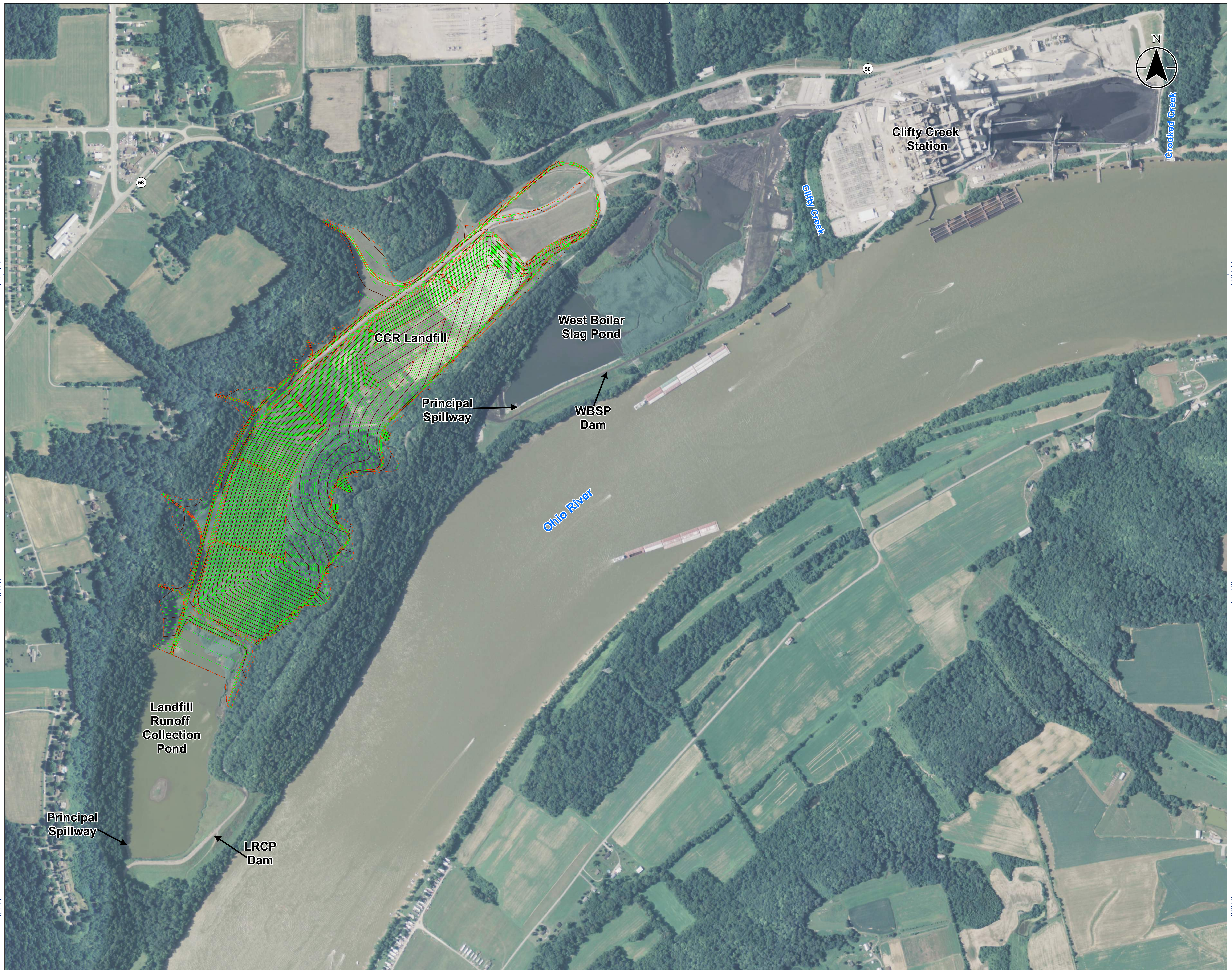

Figure No.
A-1

Title
Plan View of Clifty Creek Station

Client/Project
Clifty Creek Station - Structural Stability
Landfill Runoff Collection Pond and
West Boiler Slag Pond

Project Location 175534018

Madison
Jefferson County, IN

Prepared by AP on 2016-10-13
Technical Review by JH on 2016-10-13
Independent Review by SH on 2016-10-13

0 500 1,000 Feet
1:6,000 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1927 StatePlane Indiana East FIPS 1301
2. USDA - NAIP 2014 Ortho-Imagery
3. Fuller, Mossbarger, Scott, & May, Inc. (FMSM) (2006b). Permit Drawings. Indiana-Kentucky Electric Corporation. Clifty Creek Coal Ash Landfill Modification. Jefferson County, Madison Township, Indiana. November. Dwg. No. 16-30500-09-A. Coal Ash Landfill. Top of Cover

Stantec OVEC IKEC

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APPENDIX B
SUDDEN DRAWDOWN ASSESSMENT

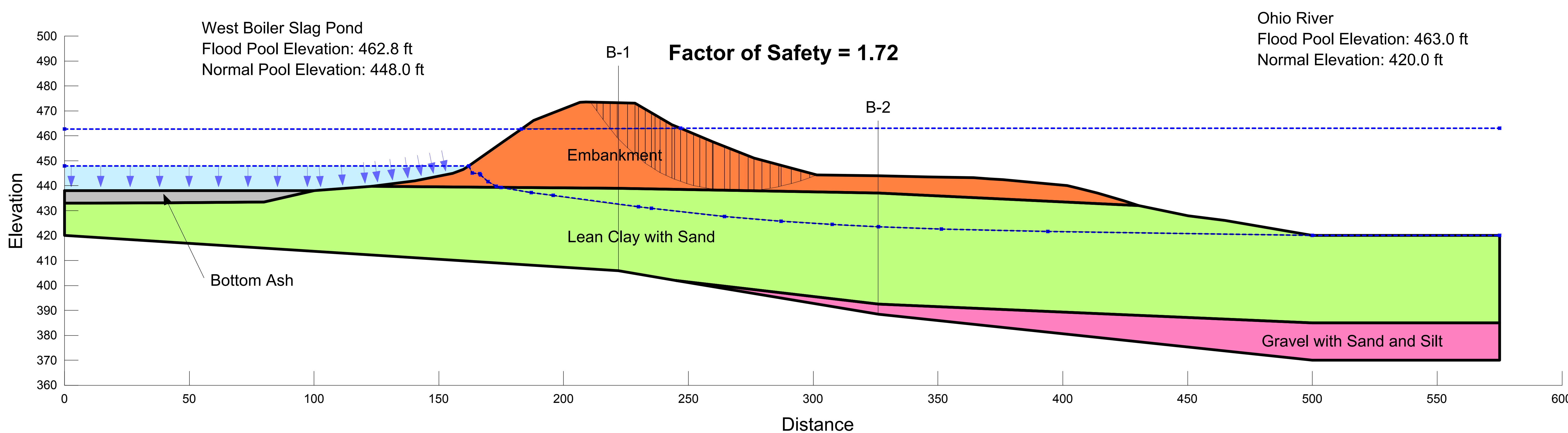
Sudden Drawdown

Indiana-Kentucky Electric Corporation
Clifty Creek Station
West Boiler Slag Pond Dam
Madison, Indiana
Section A-A'

Existing Geometry
Sudden Drawdown
Undrained, Sudden Drawdown Strengths

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material Type	Unit Weight	Effective - c'	Effective - phi'	Total - c	Total - phi
Embankment (SDD)	130 pcf	165 psf	33 °	600 psf	13 °
Lean Clay with Sand (SDD)	119 pcf	160 psf	27 °	1200 psf	5 °
Gravel With Silt and Sand (SDD)	130 pcf	0 psf	35 °	0 psf	35 °
Bottom Ash (SDD)	115 pcf	0 psf	28 °	0 psf	28 °



Indiana-Kentucky Electric Corporation
Clifty Creek Station
West Boiler Slag Pond Dam
Madison, Indiana
Section B-B'

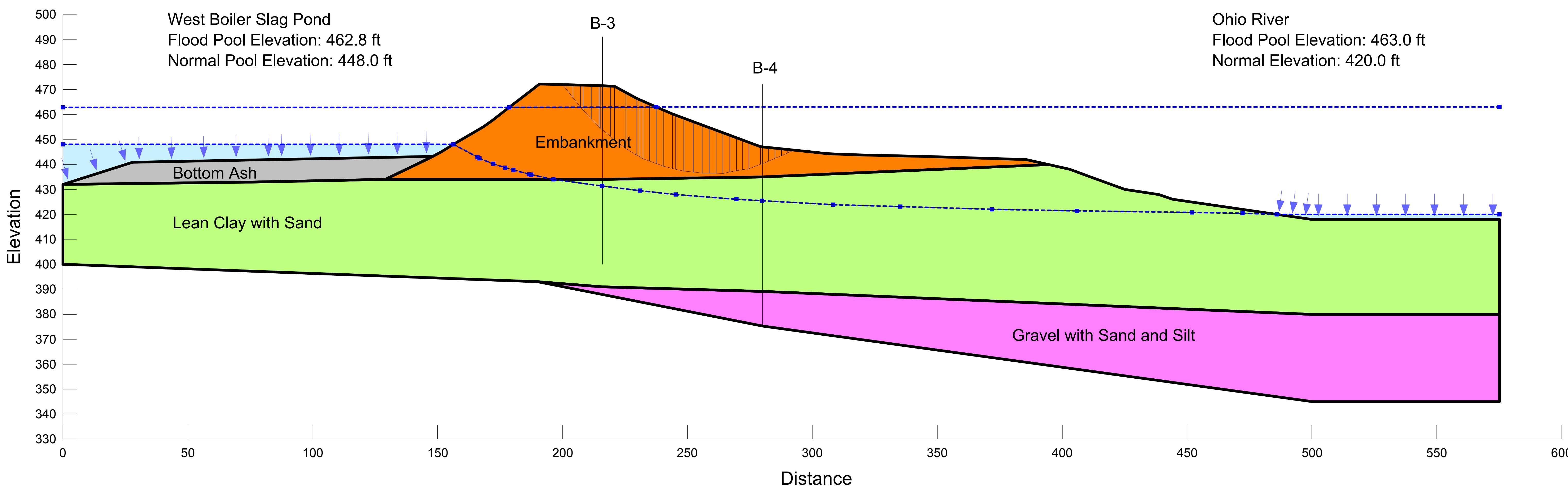
Sudden Drawdown

Existing Geometry
Sudden Drawdown
Undrained, Sudden Drawdown Strengths

Material	Unit Weight	Effective - c'	Effective - phi'	Total - c	Total - phi
Embankment (SDD)	130 pcf	165 psf	33 °	600 psf	13 °
Lean Clay With Sand (SDD)	119 pcf	160 psf	27 °	1200 psf	5 °
Gravel With Silt And Sand (SDD)	130 pcf	0 psf	35 °	0 psf	35 °
Bottom Ash (SDD)	115 pcf	0 psf	28 °	0 psf	28 °

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Factor of Safety = 1.83



Indiana-Kentucky Electric Corporation
Clifty Creek Station
West Boiler Slag Pond Dam
Madison, Indiana
Section C-C'

Sudden Drawdown

Existing Geometry
Sudden Drawdown
Undrained, Sudden Drawdown Strengths

Material Type	Unit Weight	Effective - c'	Effective - phi	Total - c	Total - phi
Embankment (SDD)	130 pcf	165 psf	33 °	600 psf	13 °
Lean Clay with Sand (SDD)	119 pcf	160 psf	27 °	1200 psf	5 °
Sandy Silt (SDD)	130 pcf	0 psf	30 °	0 psf	30 °
Bottom Ash (SDD)	115 pcf	0 psf	28 °	0 psf	28 °

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.