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11687 Lebanon Road, Cincinnati OH 45241

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
Landfill Runoff Collection 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 Landfill Runoff Collection Pond. Based on this assessment, the Landfill Runoff Collection 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 Landfill Runoff Collection 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 Landfill Runoff Collection 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**
Landfill Runoff Collection 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 Landfill Runoff Collection Pond meets the requirements specified in 40 CFR 257.73(d)(1)-(2).

SIGNATURE _____ DATE 10/17/16

ADDRESS: Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241

TELEPHONE: (513) 842-8200

ATTACHMENTS: Clifty Creek Landfill Runoff Collection Pond Initial Structural Stability Assessment Report

Initial Structural Stability Assessment

Clifty Creek Station
Landfill Runoff Collection 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 Landfill Runoff Collection Pond (LRCP) and 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 Landfill Runoff Collection Pond is located at the southern edge of the station. It is bordered by the station's coal combustion residuals (CCR) landfill to the north, natural grade to the east and west, and by a dam to the south that runs along the bank of the Ohio River. Approximately 508 acres of both landfill contact water and stormwater runoff drain to the Landfill Runoff Collection Pond. Upon the completion of the CCR landfill, the area draining to the Landfill Runoff Collection Pond will be reduced to approximately 443 acres (Stantec, 2016b).

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 provides an overview of the Clifty Creek Station and the Landfill Runoff Collection Pond.

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 LRCP Dam

The LRCP Dam forms the southern boundary for the pond, approximately 700 feet from the Ohio River. It is an earthen dam with a crest length roughly 1,600 feet and a maximum height of 70 feet. The minimum dam crest elevation is 502.9 feet mean sea level (MSL) with a maximum of 505.9 feet along the left abutment (GZA, 2009). The LRCP Dam is registered with the Indiana Department of Natural Resources (IDNR) as Dam No. 39-12.

The LRCP Dam consists of the main 70-foot high dam, a 25-foot high dike on top of an adjoining ridge, a natural rock ridge, and a 15-foot high saddle dike between the rock ridge and the east abutment (AEPSC, 1985). Figure 1 provides a sketch of the components of the LRCP Dam. The main dam has a constructed downstream slope of approximately 2.7H:1V above elevation 474 feet and 3.3H:1V below elevation 474 feet and an upstream slope of about 4.4H:1V. The saddle dike has a downstream slope of 2H:1V and a length of 250 feet (GZA, 2009).

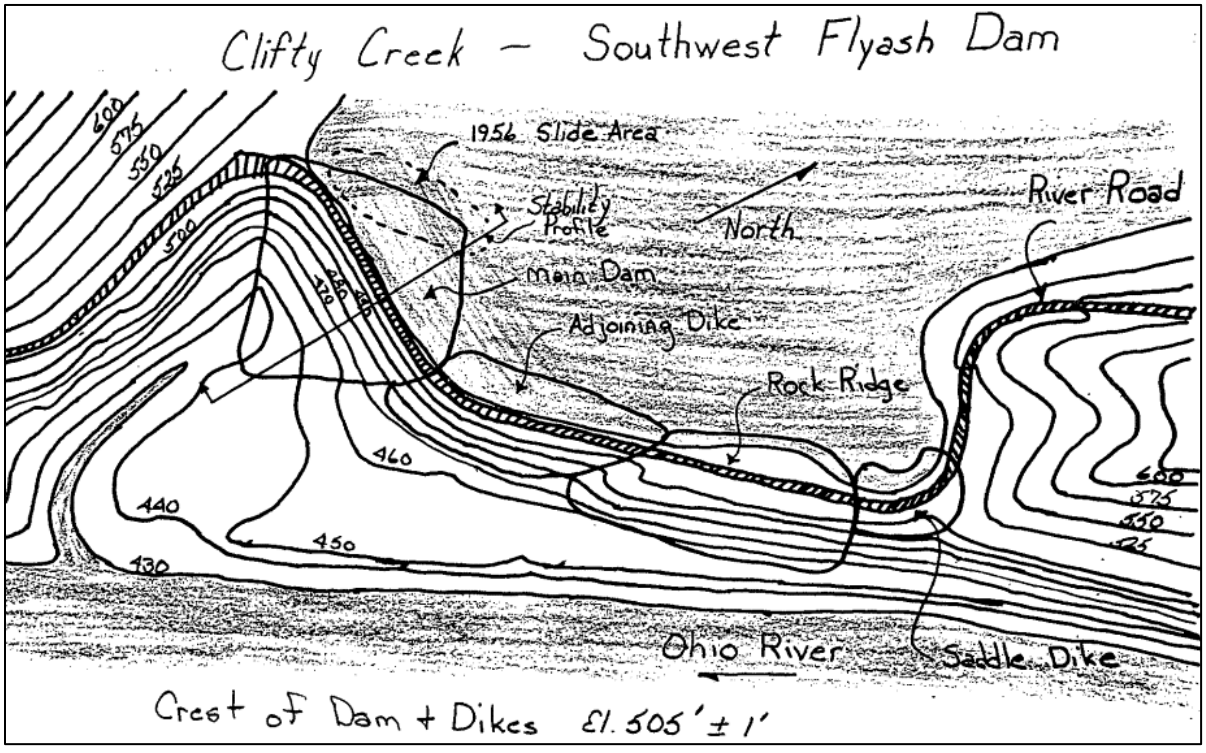

Figure 1 LRCP Dam Construction Detail *(AEPSC, 1985)*

2.2 SPILLWAYS

2.2.1 Primary Spillway System

The LRCP primary spillway is an inclined six-foot by three-foot reinforced concrete box culvert with a riser box structure containing grated inlets at 11-foot intervals in elevation. The inclined box is connected to a 400-foot long, 72-inch diameter concrete pipe that discharges to the Ohio River (Stantec, 2016b).

2.3 HYDRAULIC STRUCTURES

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

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 Landfill Runoff Collection Pond has the following features that fall within this requirement:

- LRCP 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 LRCP DAM

3.1.1 Background

The LRCP 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, 2016a). Based on previous geotechnical studies (AEPSC, 1985 and Stantec, 2016a), the foundation of the LRCP Dam generally consists lean clay, silty sands with interbedded layers of silty clay with a rock ridge of limestone with layers of calcareous shale on the southwest side.

3.1.2 Assessment

A qualified person performs inspections of the Landfill Runoff Collection Pond weekly, monthly, quarterly, and annually. Regular site inspections have been conducted and documented for the Landfill Runoff Collection 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 signs of new sloughing, depressions or areas of wetness and no seeps. A slip was being monitored near the left abutment, but appeared to have stabilized. The slip was thought to have no adverse effect on the integrity of the dam due to location and regrading of the area was discussed.

GZA (2009) observed no unusual movement and some shallow surficial erosion. The saddle dike exhibited shallows scarps on its 2H:1V slope, but the scarps were noted as healed and fully vegetated. Onsite discussions suggested that the scarps were a long-time condition and buttressing at the toe had been performed to attempt to mitigate further sloughing of the slope. This issue is noted in the previous inspections reports and continues to be monitored.

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, 2010). 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 LRCP Dam.

3.1.3 Conclusion

Based on the assessment of the foundation and abutments for the LRCP 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 Landfill Runoff Collection Pond has the following features that fall within this requirement:

- LRCP 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 LRCP DAM

4.1.1 Background

Slope protection for the LRCP Dam consists of grass with smaller areas of riprap on the upstream slope of the dam. The downstream slope is also covered with grass. 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).

4.1.2 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 Landfill Runoff Collection Pond from 1976 to 2016. Site inspection reports generally indicate appropriate maintenance of slope protection features of the dam.

The upstream slope of the LRCP dam is vegetated with short grass. Small riprap has been placed above the normal pool towards the dam crest. At the water line, an area of short wetland grasses was observed (GZA, 2009). Riprap has been placed the length of the dam to protect against wave erosion. The last annual dam and dike inspection observed no erosion due to wave action and that the slope was in stable condition (AEPSC, 2015).

4.1.3 Conclusion

Based on the assessment of the slope protection for the LRCP 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 Landfill Runoff Collection Pond has the following features that fall within this requirement:

- LRCP 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 LRCP 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 LRCP 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 construction equipment working on the site. Subsurface explorations and engineering analyses of the dike were also available that provided SPT data and shear strength testing results used in the assessment.

5.1.2 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-inch layers and compacted with four passes of a roller loaded to 50 or 60 tons (A. Casagrande, 1953).

Three previous geotechnical explorations were available to review as part of this assessment (AEPSC, 1985; Stantec, 2010; Stantec, 2016a). Each was a geotechnical exploration and slope stability evaluation of the LRCP Dam. The programs included drilling and laboratory testing.

AEPSC (1985) assigned undrained shear strength parameters to the existing lean clay dam of 2,500 pounds per square foot (psf) cohesion and an internal friction angle of 10 degrees based on estimates and interpretation from cone penetration testing. Stantec (2016a) assigned

drained shear strength parameters to the existing lean clay dam of 198 psf and 27.5 degrees with undrained shear strength parameters of 1,400 psf and 21 degrees. Correlating these results using NAVFAC DM-7.2 indicate that appropriate compaction exists within the embankment of the LRCP Dam (NAVFAC, 1986).

Stantec (2016a) performed a moisture-density test 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 17 to 24 percent with an average of 20 percent. Dry densities ranged from 99 to 114 pounds per cubic foot (pcf) with an average of 108 pcf. The results of the tests suggested the average natural moisture content of the embankment is about 3 percent above optimum moisture and that the average percent compaction of the embankment soil is approximately 98 percent of standard Proctor maximum density.

5.1.3 Conclusion

Based on the assessment of the embankment dike compaction for the LRCP 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 Landfill Runoff Collection Pond has the following features that fall within this requirement:

- LRCP 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 with smaller riprap areas on the upstream slope of the dam above the operating pool. Small wetland grasses are present at the base of the upstream slope. The downstream slope is covered with grass.

6.2 ASSESSMENT

Regular site inspections were conducted and documented regularly following construction of the LRCP Dam. Weekly, monthly, quarterly, and annual inspections are performed for the LRCP Dam.

In August 2015, Stantec personnel visited the site to observe existing conditions. The vegetation along the slopes of the LRCP Dam of the Landfill Runoff Collection Pond appeared mowed and maintained.

6.3 CONCLUSION

Based on the assessment of the vegetated slopes for the LRCP 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 Landfill Runoff Collection Pond has the following features that fall within this requirement:

- LRCP 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 Landfill Runoff Collection 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 Landfill Runoff Collection Pond demonstrates the Landfill Runoff Collection 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 freely discharging with no observed deficiencies or blockages (AEPSC, 2015).

7.1.2.2 Structural Stability

The Landfill Runoff Collection Pond spillway is a decant-type structure built along the natural slope near the right LRCP Dam abutment. The slope intake shaft is rectangular with a 3-foot by 6-foot cross section. It slopes at 2H:1V to 4H:1V to reflect natural ground. The top of the structure is approximately elevation 503 feet (AEPSC, 2016). There are four main intake elevations: 485.87, 490,79, 496.74, and 501.61 feet (FMSM, 2006).

A 72-inch extra strength reinforced concrete pipe connects to the decant structure at elevation 432.0 feet and discharges downstream to Panther Creek, flowing 700 feet to the Ohio River. The creek outlet is a reinforced concrete head wall with training walls with an invert at the pipe outlet of 430 feet (GZA, 2009).

The 390-foot-long discharge pipe is set on a 7.6-foot concrete cradle at the prepared foundation elevation. A series of 54 vertical steel struts are spaced at 4-foot centers within the pipe to add reinforcement due to the embankment fill weight. The joints of the reinforced concrete discharge pipe are cemented with rubber gaskets. Three 8-inch concrete water stops are placed on the upstream portion of the discharge pipe at 30-foot centers under the LRCP Dam (GZA, 2009).

The Landfill Runoff Collection 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. A recent 2009 video camera inspection of the structure was performed by Zemba Brothers of Zanesville, Ohio. A minor seep within the pipe was noted and addressed by an inflatable ring to seal the zone. Manned inspections of the structure were performed prior to 2009.

7.1.3 Conclusion

Based on the assessment of the primary spillway system condition and capacity for the Landfill Runoff Collection 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 Landfill Runoff Collection Pond has the following feature that falls within this requirement:

- LRCP 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 LRCP 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 (2016a).

8.1.2 Assessment

8.1.2.1 Material Properties

Stantec performed geotechnical explorations in 2010 and 2015 to characterize the embankment of the LRCP 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 (2010 and 2016a).

Table 1 Strength Parameters for Stability Analysis – LRCP Dam

Soil Horizon	Unit Weight (pcf)	Effective Stress Strength Parameters		Total Stress Strength Parameters	
		c' (psf)	ϕ' (degrees)	c (psf)	ϕ (degrees)
Embankment	129	198	28	1,400	21
Lean Clay with Sand	127	206	28	1,200	17
Silty Sand	94	0	30	0	30
Silty Clay with Sand	118	152	34	1,000	20
Sandy Silt	125	0	30	0	30
Clayey Gravel with Sand	130	0	35	0	35
Fly Ash	115	0	25	0	25

8.1.2.2 Critical Cross Section Selection

Slope stability analyses were available from Stantec (2010 and 2016a). Two cross sections through the LRCP Dam were analyzed under static, steady-state conditions using the maximum

surcharge pool. The two sections that were analyzed are labeled Sections D-D' and E-E' and are shown below in Figure 2.

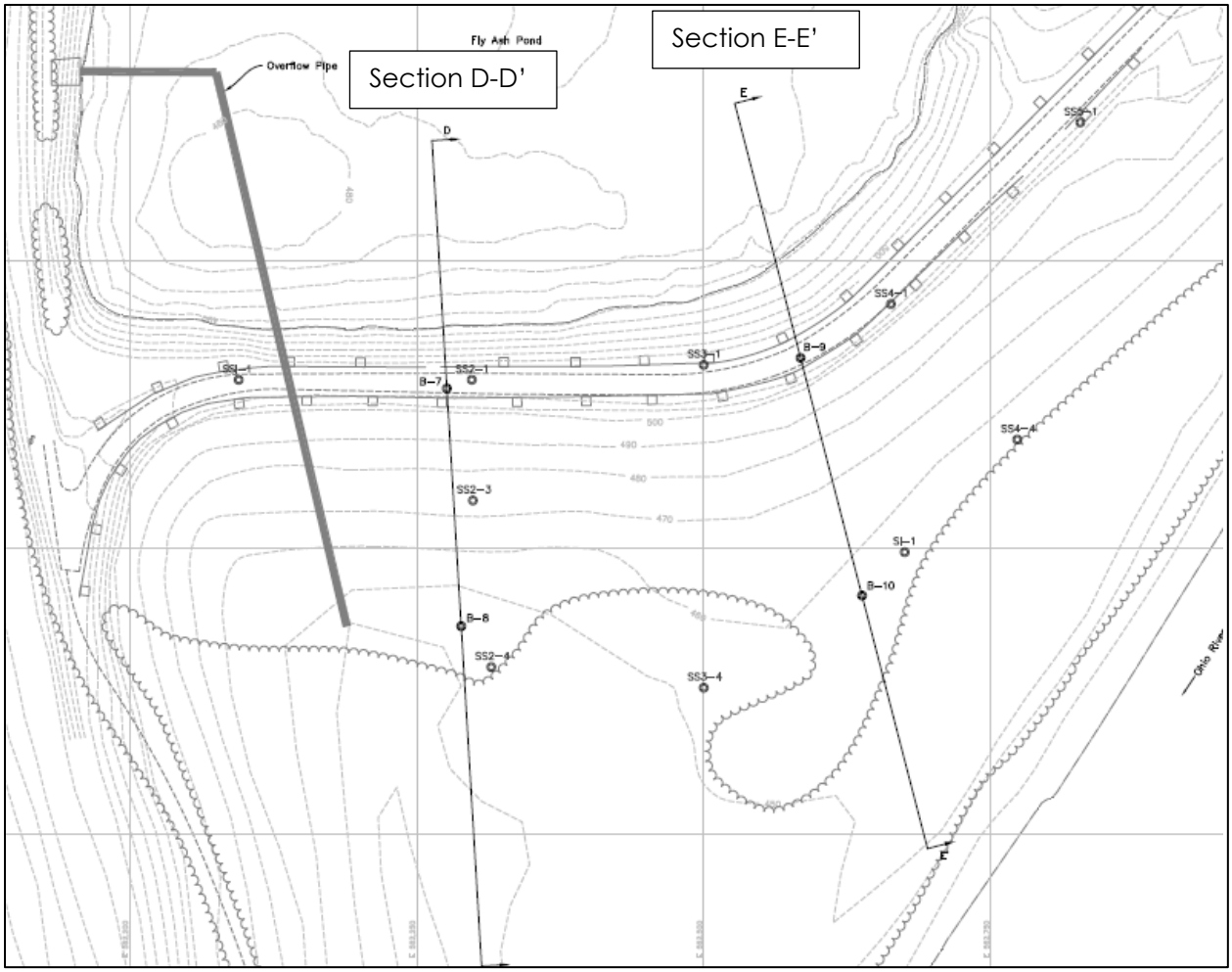

Figure 2 Clifty Creek LRCP Dam – Plan View of Cross Sections

The summary of the slope stability results from Stantec (2016a) is listed in Table 2. The pond levels were set at the 50% PMP elevation (501.4 feet for the Landfill Runoff Collection Pond). The tailwater was set near the elevation of the Ohio River.

Table 2 Slope Stability Results

Facility	Cross-Section	Maximum Surcharge Pool Factor of Safety
Landfill Runoff Collection Pond	D-D'	1.81
	E-E'	1.99

A sudden drawdown stability analysis is required for Section D-D' as the critical cross section for the LRCP Dam 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 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 (7.19 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 (2016b) presents the reservoir routing analysis for the Landfill Runoff Collection Pond assuming the probable maximum precipitation (PMP) event for existing and future landfill conditions. 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 Landfill Runoff Collection Pond existing and proposed conditions peak PMP water surface elevations are 500.4 and 501.4 feet, respectively.

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

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 Landfill Runoff Collection Pond Elevation (feet)	Tailwater Ohio River Elevation (feet)
Long-term maximum storage pool loading condition	485.0	420.0
Maximum surcharge pool loading condition	501.4	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 CCR Final 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 assessment presented in this report is focused on the potential for slope failures of significant mass, which could directly impact potential release of water and CCR materials from the Landfill Runoff Collection Pond. The search for a critical slip surface in the slope stability assessment 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 LRCP Dam Section D-D'. The results of the analysis are included in Appendix B.

The results show that the sudden drawdown factor of safety assuming the 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 Final CCR Rule Criteria	Recommended Factor of Safety Criteria	Calculated Factor of Safety
Landfill Runoff Collection Pond	D-D'	Sudden Drawdown	1.1	1.8

8.1.3 Conclusion

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

9.0 REFERENCES

American Electric Power Service Corporation (AEPSC) (2016). *History of Construction. CFR 257.73(c)(1). Landfill Runoff Collection Pond. Clifty Creek Plant*. Madison, Indiana. GERS-16-141.

American Electric Power Service Corporation (AEPSC) (2015). *2015 Dam and Dike Inspection Report. GERS-15-018*. Clifty Creek Plant. Madison, Indiana. October 5. Inspection Date: September 3, 2015. Revision 0.

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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

561022 564303 567584 570865

449474 446193 442912

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

Madison
Jefferson County, IN

175534018

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

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APPENDIX B
SUDDEN DRAWDOWN ASSESSMENT

Indiana-Kentucky Electric Corporation
Clifty Creek Station
Landfill Runoff Collection Pond Dam
Madison, Indiana
Section D-D'

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.

Sudden Drawdown

Material Type	Unit Weight	Effective - c'	Effective - phi	Total - c	Total - phi
Embankment (SDD)	129 pcf	198 psf	27.5 °	1400 psf	21 °
Lean Clay with Sand (SDD)	127 pcf	206 psf	28 °	1200 psf	17 °
Sandy Silt (SDD)	125 pcf	0 psf	30 °	0 psf	30 °
Silty Sand (SDD)	94 pcf	0 psf	30 °	0 psf	30 °
Clayey Gravel with Sand (SDD)	130 pcf	0 psf	35 °	0 psf	35 °
Fly Ash (SDD)	115 pcf	0 psf	25 °	0 psf	25 °