Bottom Ash Pond
Periodic Structural Stability Assessment
General James Gavin Power Plant
Cheshire, Ohio
S&ME Project No. 20-5506

PREPARED FOR:

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1.0 Introduction

1.1 Background

S&ME, Inc. (S&ME) has completed a Periodic Structural Stability Assessment of the Bottom Ash Pond Complex at the Gavin Power Plant in Cheshire, Ohio. This assessment was carried out to fulfill the requirements of CFR §257.73 (d). The Initial Structural Stability Assessment for the Bottom Ash Pond Complex was prepared by American Electric Power dated October, 2016. Concurrent with the preparation of this assessment, S&ME, Inc. prepared the Periodic Safety Factor Assessment as well as the periodic update to the Inflow Design Flood Control System Plan the for this CCR unit. The results of these assessments are referenced in this report.

1.2 Location and Description of CCR Unit

The Gavin Power Plant, as shown in Figure 1-1, is located along the Ohio River, approximately 10 miles north of Gallipolis, Ohio. The Bottom Ash Pond Complex, which was put into service in 1974, is located immediately south of the generating plant and consists of a four-sided upground earthen embankment structure. Within the overall complex is a smaller, non-structural, embankment separating the main pond from the recirculation pond. The bottom ash pond is used to manage bottom ash which is sluiced to the pond from the two units. The total length of the exterior embankment is 6550 feet and the embankment varies in height, as measured above the exterior grade, from 28 to 39 feet. The pond is completely isolated from exterior surface water inflow. The main pond covers a footprint of approximately 58 acres and the smaller reclamation pond covers a footprint of approximately 1.3 acres. The original construction drawings indicated that the inboard and outboard slopes were designed with 2H:1V slope angles. Survey data taken at the boring locations reveal a range of outboard slope angles from 1.8H:1V to 2.2H:1V. The embankment was constructed as a homogenous dam.

The Bottom Ash Pond Complex is classified by the Ohio Department of Natural Resources (ODNR) Division of Soil and Water Resources as a Class I Dam. The Bottom Ash Pond Complex is composed of two ponds that are connected by a single hydraulic structure on a shared interior dike. The Main Pond discharges through the shared structure into the Reclamation Pond for final treatment. The Reclamation Pond discharges through an outlet structure to a pipe network that discharges into the Ohio River. A portion of the discharge is directed to a pump station from which is conveyed back to the plant for use as process water.

Figure 1-1 – Gavin Plant

2.0 Scope

A Structural Stability Assessment for CCR Surface Impoundments, as defined by CFR §257.73 (d), is intended to assess whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein. To this end, the assessment requires that seven separate areas of the pond design and operation be evaluated, as follows:

1. The pond must be supported on a stable foundation;

2. The pond must maintain adequate slope protection to protect against erosion owing to wave action or other causes;

3. The dikes (referred to as the dam embankments within this report) must be constructed in a manner that the applied loading conditions are sufficiently resisted;

4. The vegetation on the slopes should be maintained in a manner to prevent the growth of woody vegetation while minimizing erosion;

5. The pond should have a spillway or combination of spillways adequately to safely pass the design flood, in the case of the Bottom Ash Pond Complex, the design flood is the PMF;

6. Any hydraulic structures underlying the base of the CCR or passing through the dike must maintain adequate structural integrity and should be free of defects which could negatively affect the performance of the structure; and,

7. For CCR units where the downstream (outboard) slopes can be inundated by an adjacent water body, the outboard slopes must maintain stability during an inundation and drawdown event.

3.0 Information Review and Site Visit

Although the initial version of the structural stability assessment was prepared by others, S&ME is very familiar with the Bottom Ash Pond Complex, having previously completed subsurface investigations and stability analyses of the embankments. Additionally, S&ME completed the Initial Safety Factor Assessment and the Initial Inflow Design Flood Control System Plan. S&ME conducted a cursory review of documents relating to the bottom ash pond and conducted a site visit at the facility. In addition to the recent inspection and groundwater reports which are available on the facility CCR website, S&ME has the following documents in our files:

- Grading and Fence Plan, 1974 (Dr. No. 12-014-9)
- Excavation Plan, Not dated (Dr. No. MHD-SK-012887)
- Sections, 1971 (Dr. No. 12-3015-3)
- Principal Spillway conduit and Impact Basin, 1973 (DWG No. 670 C 205 R1)
- Principal Spillway Plan and Sections, 1973 (DWG No. 670 C 201 R2)
- Principal Spillway Floating Platform and Skimmer, 1973 (DWG No. 670 C206)
- Reclaim Pond Outlet Structure – Plan and Profile, 1994 (DWG No. 12-30408-2)
- Modification of Bottom Ash Complex Pond & Outfall Pipe, 1994 (DWG 12-30401-2)
- Bottom Ash Pond Complex Pond Outfall – Plan and Profile, 1994 (DWG 12-30407-1)
- Bottom Ash Pond Investigation, BBC&M Engineering, Inc., July, 2009
- Assessment of Dam Safety Final Report, Clough Harbour, & Assoc., September, 2009
- Addendum to Bottom Ash Pond Investigation, BBC&M Engineering, Inc. April, 2010

On June 24, 2021, the undersigned S&ME Senior Engineer met with Mr. Taylor Huffman of Lightstone Generation at Gavin Plant and conducted a site visit at the bottom ash pond. The participants discussed and observed the operations of the bottom ash and recirculation ponds, including the hydraulic structures within the ponds and the pump station which returns a portion of the discharge back to the plant. The crest and inboard and outboard slopes were observed, and no significant geometry changes appeared to have been made since the initial safety factor assessment. Likewise, there did not appear to be any significant changes to the components of the inflow flood control system, including the principal spillway discharge pipeline and outfall. While the site visit was not a formal inspection, visual observations of the bottom ash pond did not reveal any dam safety concerns. S&ME also walked along the path of the discharge line and observed the river outfall while discussing with Mr. Huffman recent repairs made to this line.

4.0 Assessments

The remainder of this report addresses each the seven items identified in CFR §257.73 (d), *Periodic Structural Stability Assessments*. In many cases, the results of the concurrently performed the Periodic Safety Factor Assessment as well as the periodic update to the Inflow Design Flood Control System Plan are referenced.

4.1 Stable Foundations and Abutments

The bottom ash pond, which was put into service in 1974, consists of a four-sided upground earthen embankment structure. Within the pond is a smaller, non-structural, baffle. The total length of the exterior embankments is 6550 feet and the embankments vary in height above the exterior grade from 28 to 39 feet. The embankments create a continuous structure; there are no abutments in the conventional sense of the term.

The embankments are supported on natural soils consisting of a layer of alluvium silt, clay and fine sand over glacial outwash deposits of variable thickness overlying the bedrock surface. The alluvium clays and silts were deposited in the backwater of the Ohio River, while the outwash materials typically consist of sand, gravel and silt deposits deposited during the last ice age. Based on available geologic literature, the glacial outwash extends to the bedrock surface, estimated to be roughly 60 feet below the natural ground surface.

More specifically, and as detailed in the Periodic Safety Factor Assessment, the borings performed through the foundation encountered soils that are described as follows:

- 3 to 24 feet of alluvium soil consisting of medium-stiff to hard brown mottled with gray silty clay. Hand penetrometer measurements within this stratum ranged from 1.0 to 4.5+ tons per square foot (tsf), while SPT N-values (corrected for 60% energy) ranged from 7 to 24 with an average of 13. The material predominantly classified as lean clay (CL) under the Unified Soil Classification System. Within the context of the slope stability analyses, this layer is referred to as is hereafter referred to as the 'Upper Alluvium' layer.

- 3 to 20 feet of alluvium soil consisting of very-soft to medium-stiff brown mottled with gray silty clay. Recovered samples within this stratum often contained lenses of silt or were interbedded with fine to medium sand. Many layers of loose sand or loose silt interbedded with silty clay were also encountered. Typically, this stratum was underlain by loose to medium dense sand in the saturated condition. Hand penetrometer measurements within this layer ranged from 0.0 to 1.0 tons per square foot (tsf), while SPT N-values (corrected for 60% energy) ranged from 0 to 10 with an average of approximately 3.5. The material predominantly classified as lean clay with sand (CL) or sandy lean clay (CL) under the Unified Soil Classification System. Within the context of the slope stability analyses, this layer is referred to as the 'Lower Alluvium' layer.

- All borings were terminated after penetrating 3.9 to 7.3 feet into loose to medium-dense brown fine to medium sand. SPT N_{60}-values within this stratum ranged from 3 to 46 bpf with an average of 15. The percent passing the 200 sieve ranged between 4.4 and 44.

The stability of the foundation soils to support the pond embankments was evaluated as part of the Periodic Safety Factor Assessment. This evaluation demonstrates that the foundation soils are stable under all load cases evaluated.

4.2 Adequate Slope Protection Against Erosion, Wave Action, and Drawdown

The bottom ash pond contains a combination of rip-rap and bottom ash on the inboard slopes that provide protection against wave erosion. This granular material is also freely-draining and provides resistance to sudden drawdown on the interior of the pond, as it provides confining pressures to the more drawdown-susceptible clay embankments. The exterior slopes are well vegetated and have proven to be resistant to flood waters along the exterior ditches of the pond. Sudden drawdown is not anticipated on the exterior slopes of the bottom ash pond, as flood waters would be expected to rise and fall more slowly. Additionally, full-saturation of the clay embankments would not be anticipated, as discussed in the Transient Seepage Analysis performed in Section 4.7.

Based on our review of the CCR inspection reports, we understand that problems with erosion and sudden drawdown have not been reported for the pond.

For these reasons we believe the embankments do have adequate protection against erosion, wave action and sudden drawdown.

4.3 Dikes Compacted Sufficient to Withstand the Range of Loading Conditions

The bottom ash pond embankments were constructed in the early 1970's of compacted cohesive soils. It is understood that the project specifications required the fill to be compacted to 95% of the maximum dry density as determined by Standard Proctor. Such a specification is consistent with typical practice for dam construction. Note, no testing records are available for the fill.

As part of past subsurface investigations, four borings were performed through the crest of the embankments. These borings encountered 1.0 to 2.5 feet of roadway base consisting of bottom ash/boiler slag at the ground surface overlying 29.5 to 39.0 feet of embankment fill consisting of stiff to hard brown mottled with gray silty clay. A few zones of fine to coarse gravel were encountered within the fill. Hand penetrometer measurements within this layer ranged from 1.5 to 4.5+ tons per square foot (tsf), while SPT N-values (corrected for 60% energy) ranged from 10 to 42 with an average of 17. Index testing results, including liquid limit and plasticity index of samples tested within this stratum are summarized in Table 1. The material predominantly classified as a lean clay (CL) under the Unified Soil Classification System, with some samples identified as a fat clay (CH).

Table 1. Summary of index values embankment fill soil encountered in borings.

Table 4-1: Summary of Index Values – Embankment Fill

Statistic	MC	LL	PL	PI	CF
Sample Size	27	22	22	22	11
Minimum	16	30	16	12	22
Maximum	23	53	25	28	37
Mean	20	41	21	20	30
Median	20	41	22	20	31
Mode	20	41	22	20	32
Standard Deviation	1.9	6.1	2.4	4.1	4.1
Sample Size	27	22	22	22	11

The information above suggests that the embankments were well compacted and are comprised of soils suitable for use as a dam. The ability of the embankments to resist the various load combinations was evaluated as part of the Periodic Safety Factor Assessment. This evaluation demonstrates that the embankments are stable under all load cases evaluated. Furthermore, these analyses also suggest that the embankment soils will not liquefy under a credible earthquake scenario.

4.4 Presence of Vegetated Slopes or Other Forms of Protection

The outboard slopes are well maintained and mowed on a regular basis to prevent the growth of woody vegetation while maintaining adequate grass cover to minimize erosion. The crest of the bottom ash pond embankment consists of a gravel roadway, while the inboard slopes are protected with bottom ash.

4.5 Spillway Capacity to Manage Flow During and Following Design Flood

The Bottom Ash Pond Complex is composed of two ponds that are connected by a single hydraulic structure on a shared interior dike. The complex is completely separated from surface water flows. The Main Pond discharges through the shared structure into the Reclamation Pond for final treatment. The Reclamation Pond discharges through an outlet structure to a pipe network that discharges into the Ohio River. A portion of the discharge is directed to a pump station from which is conveyed back to the plant for use as process water.

Concurrent with the preparation of this Structural Stability Assessment, S&ME updated the Inflow Design Flood Control System Plan. As part of this work, a detailed hydrologic routing was performed to assess the ability of the spillway system to safely pass the design flood. As the Bottom Ash Pond is a high hazard potential impoundment, the design flood is the Probable Maximum Flood (PMF). Two hydraulic scenarios were considered, 1) The water in the pond starting at the normal pool elevation with functioning spillways and 2) The water in the pond starting at the normal pool with a hypothetical inoperable spillway. With both scenarios, the water surface did not reach the embankment crest, indicating that the flood water can be safely passed with the current spillway configuration.

4.6 Structural Integrity of Hydraulic Structures Passing Through CCR Unit

The bottom ash pond spillway was originally located on the west side of the reclaim pond. The spillway structure, which is still in place, discharged into a 42-inch steel pipe which run under the embankment and discharged into Kyger Creek. This spillway was abandoned in 1993 by grouting the pipe in place, and replaced with a new discharge pipe consisting of a 30-inch Spirolight HDPE pipe on the north side of the reclaim pond. It should be noted that the section of the new pipe which runs beneath the embankment is encased in the original 42-inch reinforced concrete emergency overflow pipe. The annulus between the new plastic pipe and the original concrete pipe was grouted. Once the new discharge pipe passes beneath the embankment, it turns to the east and runs along the toe of the embankment, discharging directly into the river.

As documented in the January 8, 2020 inspection report, settlement holes have been observed above the discharge pipe near the toe of the north embankment. Lightstone indicated that these locations were excavated, and it was determined that the holes were related to infiltration of soil into the joints in the pipe. All identified locations have been repaired, as subsequently documented in the January 8, 2021 inspection report. Based on these repairs, it is believed that the discharge pipe is presently functioning as designed. Additionally, as the original spillway was grouted in place, it is believed that the risk of collapse is low.

4.7 Integrity of Outboard Slopes During External Flood Event

The bottom ash pond embankments are located within the 100-year floodplain of the Ohio River. The mapped base flood elevation at the pond ranges from El. 572.6 on the north side to El. 572.2 on the south side. The outboard embankment toe ranges in elevation from roughly El. 570 for the north embankment to El. 560 for the south embankment. Comparing these elevations suggests that as much as 12 feet of the outboard embankment could be inundated during a 100-year flood on the Ohio River. For comparison, the crest of the embankment ranges from El. 595 to El. 600 which is well above the flood level indicating there is no risk of overtopping during such a flood.

A flood event in and of itself does not necessarily cause instability along the outboard embankments. During the initial flood event, the water acts as a stabilizing force on the outboard embankments and potentially reduces the difference in piezometric head between the pond pool elevation and the Ohio River. However, the duration of the flood event and associated degree of saturation of the embankment slopes are the critical factors for instability of the embankments. As the flood occurs, the water begins to penetrate the outboard embankment slopes producing a progressively deeper wetting front. After the flood recedes, the wetting front reverses and the water seeps back out of the embankment soils. This reversal in flow causes a reduction in effective stress and shear strength. Therefore, a longer duration flood is more critical than a short duration event. Additionally, a rapidly declining water level along the outboard slope causes greater instability than a slowly declining water level. Lastly, the degree that the seepage penetrates into the embankment is a function of the permeability of the embankment soils.

While the target flood elevation was based on the FEMA flood maps, S&ME reviewed historical flood data to estimate the potential duration of such a flood. Specifically, S&ME reviewed a significant event which occurred in 2011. The flood duration was obtained from data provided in the 2011 flood from gauging stations along the Ohio River. This flood was particularly long as it peaked twice over a 44-day period. A flood of this magnitude could last on the order of 2 to 3 weeks although for much of that duration, the water level would be below the peak elevation, and therefore not inundating the embankments for much of this time.

As previously discussed in Section 4.3 of this report, the Bottom Ash Pond embankments were constructed in the early 1970's of compacted cohesive soils on roughly 2:1 (H:V) outboard slopes. The project specifications required the fill to be compacted to 95% of the maximum dry density as determined by Standard Proctor. The borings performed through the embankments encountered fill consisting of stiff to hard brown mottled with gray silty clay. The material predominantly classified as a lean clay (CL) under the Unified Soil Classification System, with some samples identified as a fat clay (CH). Such soils, when compacted in accordance with the project specifications, may be expected to exhibit relatively low permeability. From our prior experience with transient seepage analyses with similar clay soils, the depth of penetration during a 3-week flood will only be predicted to be on the order of six inches. That said, it is common for the outer two to three feet of embankments comprised of cohesive soils to exhibit a higher permeability owing to weathering. Considering this, it is believed that a large flood on the Ohio River at the Gavin Plant may result in sloughing of near-surface soils along the lower portion of the outboard slopes. However, these shallow failures (anticipated to be less than 3 feet deep), should they occur, would not directly impact the integrity of the embankment in terms of deep-seated failures and would not result in the failure of the unit. Moreover, the 100-year flood elevation (FEMA BFE) only inundates the lowermost 5 to 10 feet of embankments so any sloughing would be at a point where the overall embankment is well over 120 feet wide.

5.0 Certification

Based on our previous investigations and current assessment of the Bottom Ash Pond facility, S&ME certifies that this assessment meets the requirements of CFR §257.73 (d).

We appreciate having been given the opportunity to be of service on this project. If you have any questions, please do not hesitate to contact this office.

Sincerely,

S&ME, Inc.

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Registration No.

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