MWG

Midwest Generation, LLC

Waukegan Generating Station

2023 Safety Factor Assessment for East Ash Pond & West Ash Pond

Revision 0

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1.0 PURPOSE & SCOPE

1.1 PURPOSE

The East and West Ash Ponds (the Ponds) at Midwest Generation, LLC's (MWG) Waukegan Generating Station ("Waukegan" or the "Station") are existing coal combustion residual (CCR) surface impoundments that are regulated by the Illinois Pollution Control Board's "Standards for the Disposal of Coal Combustion Residuals in CCR Surface Impoundments." These regulations are codified in Part 845 to Title 35 of the Illinois Administrative Code (35 Ill. Adm. Code 845, Ref. 1) and are also referred to herein as the "Illinois CCR Rule." Pursuant to 35 Ill. Adm. Code 845.460(a), MWG must conduct and complete an annual safety factor assessment that documents whether the critical cross section at each of the Ponds achieves the minimum safety factors specified in 35 Ill. Adm. Code 845.460(a).

This report documents the 2023 safety factor assessment conducted and completed in accordance with the Illinois CCR Rule by Sargent & Lundy (S&L) on behalf of MWG for the East and West Ash Ponds at Waukegan. This report:

- Lists the inputs and assumptions used in the 2023 safety factor assessment,
- Discusses the methodology used to conduct the 2023 safety factor assessment,
- Lists and compares the safety factor acceptance criteria for CCR surface impoundments promulgated by the Illinois CCR Rule and by the U.S. Environmental Protection Agency's (EPA) regulations for CCR surface impoundments,
- Summarizes the results from the initial federal safety factor assessment completed for the Ponds pursuant to the aforementioned U.S. EPA regulations,
- Evaluates potential changes to the inputs used in the initial federal safety factor assessment to determine whether new or updated liquefaction and/or structural stability analyses are warranted, and
- Provides the 2023 factors of safety for the East and West Ash Ponds in accordance with 35 Ill. Adm. Code 845.460(a).

1.2 SCOPE

In addition to being regulated under the Illinois CCR Rule, the Ponds at Waukegan are also regulated by the U.S. EPA's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," 40 CFR Part 257 Subpart D (Ref. 2), also referred to herein as the "Federal CCR Rule." Per the 2016 Water Infrastructure Improvements for the Nation (WIIN) Act, the East and West Ash Ponds will continue to be subject to both the Illinois and Federal CCR Rules until the U.S. EPA approves the Illinois EPA's CCR permit program; the Illinois EPA has yet to publish a timeline for submitting its proposed CCR permit program to the U.S. EPA for approval. However, the scope of this 2023 safety factor assessment is

strictly limited to demonstrating compliance with the Illinois CCR Rule. Pursuant to 40 CFR 257.73(f)(3), the next safety factor assessment for demonstrating compliance with the Federal CCR Rule is not required until 2026, five years after the last federal assessment was completed (2021).

2.0 INPUTS

Safety Factor Acceptance Criteria for CCR Surface Impoundments

The Illinois CCR Rule (Ref. 1, § 845.460) requires each existing CCR surface impoundment to achieve four minimum safety factors at the impoundment's critical cross section, which is defined by the Illinois CCR Rule as "the cross section anticipated to be the most susceptible of all cross-sections to structural failure based on appropriate engineering considerations, including loading conditions." The Federal CCR Rule (Ref. 2, § 257.73(e)) has the same safety factor acceptance criteria as the Illinois CCR Rule. Table 2-1 presents the safety factor acceptance criteria promulgated by both sets of regulations for existing CCR surface impoundments.

Table 2-1 – Safety Factor Acceptance Criteria for Existing CCR Surface Impoundments

Loading Condition	Minimum Allowable Factor of Safety	Illinois CCR Rule Reference	Federal CCR Rule Reference
Long-Term, Maximum Storage Pool	1.50	§ 845.460(a)(2)	§ 257.73(e)(1)(i)
Maximum Surcharge Pool	1.40	§ 845.460(a)(3)	§ 257.73(e)(1)(ii)
Seismic	1.00	§ 845.460(a)(4)	§ 257.73(e)(1)(iii)
Liquefaction	1.20	§ 845.460(a)(5)	§ 257.73(e)(1)(iv)

Initial Federal Safety Factor Assessment

Appendix A provides the initial federal safety factor assessment conducted by Geosyntec Consultants in 2016 for the Ponds (Ref. 3).

Site Topography & Aerial Images

Topographic data for the Ponds and the adjacent areas was obtained from an aerial survey flown at the site in December 2015 (Ref. 4). Historical and recent aerial images of the Ponds and adjacent areas were obtained from Google Earth Pro (Ref. 5).

Groundwater

Static water elevation data for groundwater at the site was obtained from annual groundwater monitoring reports prepared by KPRG and Associates, Inc. for the Ponds in accordance with 40 CFR 257.90(e) and 35 Ill. Adm. Code 845.610(e)(1) (Refs. 13 through 19).

Ash Pond Conditions

The operating and physical conditions for the Ponds were based on visual observations made by S&L during a site visit on September 19, 2023, discussions with MWG personnel, and the annual inspection reports prepared for the CCR surface impoundments in accordance with 40 CFR 257.83(b) and 35 Ill. Adm. Code 845.540(b) (Refs. 6 through 12).

Horizontal Seismic Coefficient

Pursuant to 35 Ill. Adm. Code 845.460(a)(4), the Ponds must have a minimum factor of safety of 1.00 when analyzed under a seismic loading condition. This loading condition is represented by a horizontal seismic coefficient that is based on a peak ground acceleration (PGA) with a 2 percent probability of exceedance in 50 years in accordance with the definition of "[m]aximum horizontal acceleration in lithified earth material" promulgated by 35 Ill. Adm. Code 845.120. The design horizontal seismic coefficient is also based on the mapped spectral response acceleration at a period of 1 second adjusted for site-specific soil conditions (S_{M1}). Table 2-2 presents the seismic response parameters obtained from ASCE 7-22 (Ref. 20) on which the Ponds' seismic loading condition was based.

Table 2-2 – Horizontal Seismic Coefficient Inputs

Parameter	Symbol	Value
Peak Ground Acceleration	PGA	0.066
Mapped Spectral Response, 1-Second Period, Adjusted for Site Effects	S_{M1}	0.13

3.0 ASSUMPTIONS

There are no assumptions in this document that require verification.

4.0 METHODOLOGY

As documented in last year's safety factor assessment, the 2022 factors of safety for the East and West Ash Ponds were based on the initial factors of safety calculated for the Ponds in 2016 pursuant to the Federal CCR Rule after it was determined that the bases for the initial federal safety factor assessment were still valid. Accordingly, the bases for the East and West Ash Ponds' initial factors of safety as documented within

the Ponds' initial federal safety factor assessment were re-evaluated to determine if any changes have occurred since the initial federal assessment was completed. Identified changes were then evaluated to determine if updates to the Ponds' previous structural stability and/or liquefaction analyses were warranted. Where no changes were noted for a given input, or where identified changes were determined to have no impact to the results and conclusions of the initial federal safety factor assessment, the previous evaluation of that input was considered to still be valid for this 2023 assessment.

5.0 ASSESSMENT

5.1 SUMMARY OF 2022 SAFETY FACTOR ASSESSMENT

The previous safety factor assessment for the East and West Ash Ponds was completed on October 14, 2022. The 2022 factors of safety for the East and West Ash Ponds were based on the factors of safety calculated in the initial federal safety factor assessment after it was determined that the bases for the initial federal safety factor assessment were still valid. The initial federal safety factor assessment for the East and West Ash Ponds concluded the Ponds' critical cross-sections are stable and meet the safety factor requirements presented in 40 CFR 257.73(e)(1)(i) through 257.73(e)(1)(iv). Because the Illinois and Federal CCR Rules have the same safety factor acceptance criteria, the 2022 safety factor assessment concluded that the factors of safety calculated for the Ponds in the initial federal safety factor assessment are in conformance with the safety factor criteria promulgated under 35 Ill. Adm. Code 845.460(a)(2) through 845.460(a)(5).

5.2 SUMMARY OF INITIAL FEDERAL SAFETY FACTOR ASSESSMENT

The initial federal safety factor assessment for the East and West Ash Ponds was completed in October 2016 and is included in its entirety in Appendix A. As previously stated, the results of this assessment indicated that the Ponds' critical cross-sections are stable and meet the factor of safety requirements presented in 40 CFR 257.73(e)(1)(i) through 257.73(e)(1)(iv). In addition to evaluating the pond's earthen dikes, the initial federal safety factor assessment also evaluated a metal bin retaining wall located along a portion of the East and West Ash Ponds' northern dikes. This wall section was analyzed to confirm it meets or exceeds the minimum factors of safety for bearing capacity, overturning, and sliding that are generally accepted industry standards.

5.3 CHANGES IN BASES FOR INITIAL FEDERAL SAFETY FACTORS

The following subsections summarize the evaluation conducted to determine if (1) changes to the design inputs used in East and West Ash Ponds' initial federal safety factor assessment have occurred since the

assessment was completed in 2016, and (2) whether the 2016 structural stability and liquefaction analyses can be accepted as-is for this 2023 assessment or if further analysis is required.

5.3.1 CHANGES IN GEOTECHNICAL DATA

Based on reviews of the annual inspection reports (Refs. 6 through 12) and Google Earth aerial images (Ref. 5), there have been no significant changes to the embankments or underlying soils that would require updating the geotechnical parameters used in the 2016 analysis (Ref. 3).

5.3.2 CHANGES IN TOPOGRAPHY ADJACENT TO ASH PONDS

Based on reviews of the annual inspection reports (Refs. 6 through 12) and Google Earth aerial images (Ref. 5), there have been no significant modifications to the ground surfaces adjacent to the Ponds (mass excavations, mass fill placement, *etc*.) since the initial federal safety factor assessment was completed. Therefore, the topographic data collected for the site in 2015 (Ref. 4) remains valid for use in this 2023 assessment.

5.3.3 CHANGES IN GROUNDWATER LEVEL

Based on reviews of the annual groundwater monitoring and corrective action reports for the Ponds (Refs. 13 through 18), no significant variations in seasonal groundwater elevations were noted. Because the East and West Ash Ponds are lined with a geomembrane liner, the embankments are not hydraulically connected to the water levels within the Ponds, and a typical phreatic surface normally associated with seepage through an earthen embankment is not applicable. The reported static groundwater elevation is valid for this analysis and there have been no significant changes in the surface water conditions near the site that would impact the site’s groundwater levels.

5.3.4 CHANGES IN EMBANKMENT GEOMETRY

Based on reviews of the annual inspection reports (Refs. 6 through 12), Google Earth aerial images (Ref. 5), and visual observations made by S&L in September 2023, there have been no significant modifications to the embankments for the Ponds since the initial federal safety factor assessment was completed. Therefore, there is no basis to re-evaluate the embankment geometry of the Ponds for this 2023 assessment.

5.3.5 CHANGES IN EARTHQUAKE DESIGN BASIS

The design horizontal seismic coefficient utilized in the initial technical analysis (Ref. 3) is based on published data in ASCE 7-10 (Ref. 21). Since the initial analysis was developed, an updated publication of the reference material has been produced (ASCE 7-22 (Ref. 20)), which provides updated values for the parameters used to determine the design horizontal seismic coefficient (see Table 2-2 and Table 5-1). Per

Table 5-1, S_{M1} has the same value under ASCE 7-22 and ASCE 7-10, but PGA has a lower value. Based on the reduction in PGA from ASCE 7-10 to ASCE 7-22, the horizontal seismic coefficient for the Ponds' seismic loading condition will be less than the value used in the initial federal safety factor assessment. Therefore, the horizontal seismic coefficient used for the 2016 analysis is conservative. Thus, it is not necessary to change the earthquake design basis used to conduct the initial safety factor assessment for the Ponds.

Table 5-1 – Seismic Loading Parameters Comparison

Parameter	Symbol	2016 Values per ASCE 7-10	2023 Values per ASCE 7-22
Peak Ground Acceleration	PGA	0.086	0.066
Mapped Spectral Response, 1-Second Period, Adjusted for Site Class Effects	S_{M1}	0.13	0.13

5.3.6 CHANGES IN ASH POND OPERATIONS

In June 2020, Waukegan took the West Ash Pond out of service for routine cleaning. During S&L's site visit in September 2023, it was noted that most of the CCR previously stored in the West Ash Pond had been removed and minimal surface water remained. In April 2021, MWG filed a notice of intent to close the West Ash Pond in accordance with the Federal CCR Rule's closure criteria (Ref. 2, § 257.102). Following the retirements of Units 7 and 8 in June 2022, Waukegan ceased placing all CCR wastestreams in the East Ash Pond. However, the pond will continue to manage stormwater run-off from the Station property until an alternate stormwater retention basin is constructed at the site, at which point MWG will file a notice of intent to close the East Ash Pond. Closure construction activities will commence at both ponds upon receipt of closure construction permits from the Illinois EPA in accordance with Subpart B of the Illinois CCR Rule.

The decrease in surface water elevation in the West Ash Pond decreases the driving forces in the embankment; therefore, the surface water elevation used for the 2016 analysis is conservative for the pond's current operation condition. Although the East Ash Pond no longer manages CCR wastestreams, the pond remains in service as a stormwater pond. Otherwise, the operating conditions at the East Ash Pond have not changed since the initial federal safety factor assessment was completed, and, thus, the 2016 structural stability analysis for the pond remains valid. Therefore, there is no basis to re-evaluate the surface water elevations used to conduct the initial federal safety factor assessment for the Ponds.

5.4 2023 SAFETY FACTOR ASSESSMENT

Other than the changes in the operational statuses of the East and West Ash Ponds, there have been no significant modifications to the Ponds. In addition, there have been no significant changes to the

embankments, underlying soils, adjacent topography, or groundwater levels. While the seismic design criteria for the Ponds has changed, the horizontal seismic coefficient calculated using the updated seismic design parameters will be less than the value used in the initial federal safety factor assessment, thereby making the 2016 analysis conservative under present design criteria. Therefore, the initial federal safety factor assessment completed in 2016 for the East and West Ash Ponds remains valid.

Based on the preceding observations, the initial factors of safety calculated for the East and West Ponds in 2016 pursuant to the Federal CCR Rule and the bases for these safety factors remain valid for this 2023 assessment. As previously discussed, because the Illinois and Federal CCR Rules have the same safety factor acceptance criteria, these factors of safety for the East and West Ash Ponds are in conformance with the safety factor criteria promulgated under 35 Ill. Adm. Code 845.460(a)(2) through 845.460(a)(5).

6.0 CONCLUSIONS

This assessment re-evaluated the factors and design inputs used as the bases for the initial federal safety factor assessment completed in 2016 in accordance with the Federal CCR Rule for Waukegan's East and West Ash Ponds (Ref. 3). It was determined that no significant changes have occurred within the last seven years that would invalidate the conclusions of the initial federal safety factor assessment. Therefore, the factors of safety reported in the initial federal safety factor assessment for the East and West Ash Ponds' earthen dikes and retaining wall remain valid for this 2023 assessment. Moreover, because the Illinois and Federal CCR Rules have the same safety factor acceptance criteria, these federal factors of safety for the East and West Ash Ponds are in conformance with the safety factor criteria promulgated under 35 Ill. Adm. Code 845.460(a)(2) through 845.460(a)(5).

Table 6-1 presents the 2023 factors of safety for the East and West Ash Ponds' earthen dikes at Waukegan in accordance with 35 Ill. Adm. Code 845.460(a).

Table 6-1 – 2023 Illinois CCR Rule Factors of Safety for the East and West Ash Ponds at the Waukegan Generating Station

Loading Condition	East Ash Pond	West Ash Pond	Min. Allowable Factor of Safety
Long-Term, Maximum Storage Pool	≥ 1.50	≥ 1.50	**1.50**
Maximum Surcharge Pool	≥ 1.40	≥ 1.40	**1.40**
Seismic	≥ 1.00	≥ 1.00	**1.00**
Liquefaction	Note 1	Note 1	**1.20**

Notes: 1) The embankment soils for the Ponds are not considered susceptible to liquefaction because saturation of the embankment soils is unlikely based on the installed geomembrane liner system. A limited portion of the bottom of the embankments may become saturated with groundwater based on the design phreatic surface. Liquefaction triggering analyses of these saturated soils show that liquefaction and associated post-liquefaction shear strength loss is unlikely for the design seismic event (Ref. 3). Thus, liquefaction safety factors are not reported.

7.0 CERTIFICATION

I certify that:

- This safety factor assessment was prepared by me or under my direct supervision.
- The work was conducted in accordance with the requirements of 35 Ill. Adm. Code 845.460.
- I am a registered professional engineer under the laws of the State of Illinois.

Certified By: Thomas J. Dehlin Date: October 13, 2023

Seal:

Thomas Dehlin
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8.0 REFERENCES

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APPENDIX A: 2016 FEDERAL SAFETY FACTOR ASSESSMENT FOR EAST & WEST ASH PONDS