INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN
MONTICELLO STEAM ELECTRIC STATION
BOTTOM ASH PONDS
TITUS COUNTY, TEXAS

October 2016

Prepared for:

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PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Pastor, Behling & Wheeler, LLC under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that the inflow design flood control plan has been prepared in accordance with the requirements of Section 257.82 of the CCR Rule.

STATE OF TEXAS
BRIAN D. THOMAS
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LICENSED
PROFESSIONAL ENGINEER
10/5/16

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Brian Thomas, P.E.
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1.0 INTRODUCTION

Luminant Generation Company, LLC (Luminant) owns and operates the Monticello Steam Electric Station (MOSES) located approximately nine miles southwest of Mount Pleasant in Titus County, Texas. The power plant and related support areas occupy approximately 1,000 acres on peninsula located between Lake Monticello and Lake Bob Sandlin (Figure 1). The MOSES consists of three coal/lignite-fired units with a combined operating capacity of approximately 1,880 megawatts. Coal Combustion Residuals (CCR) including fly ash, bottom ash, and gypsum are generated as part of MOSES unit operation. The CCRs are transported off-site for beneficial use by third-parties or are placed in mine pits in the Winfield South Mine/G-Ash Area.

The CCR Rule (40 CFR 257 Subpart D - *Standards for the Receipt of Coal Combustion Residuals in Landfills and Surface Impoundments*) has been promulgated by EPA to regulate the management and disposal of CCRs as solid waste under Resource Conservation and Recovery Act (RCRA) Subtitle D. The final CCR Rule was published in the Federal Register on April 17, 2015. The effective date of the CCR Rule was October 19, 2015.

The CCR Rule establishes national operating criteria for existing CCR surface impoundments and landfills, including development of initial and periodic inflow design flood control system plans (IDFCSPs) for all CCR impoundments. Pastor, Behling & Wheeler, LLC (PBW) was retained by Luminant to develop the initial IDFCSP for the CCR impoundments at the MOSES.

1.1 Inflow Design Flood Control System Plan Requirements

Section 257.82 of the CCR Rule specifies that an inflow design flood control system be designed, constructed, operated, and maintained for each existing CCR surface impoundment. The flood control system must adequately:

- Manage flow into the CCR impoundment during and following the peak discharge of the specified inflow design flood.
- Manage flow from the CCR impoundment to collect and control the peak discharge resulting from the specified inflow design flood.

The inflow design flood (IDF) for each CCR impoundment varies based on the hazard potential classification of the impoundment:

- High hazard potential impoundment: Probable Maximum Flood
- Significant hazard potential impoundment: 1,000-year flood
- Low hazard potential impoundment: 100-year flood

The inflow design flood control system plan must be certified by a qualified professional engineer and must document how the inflow design flood control system has been designed and constructed to comply with the requirements of section 257.82 of the CCR Rule.

In accordance with 257.82(c)(3) of the CCR Rule, the initial IDFCSP for an existing CCR surface impoundment must be completed and placed in the facility operating record no later than October 17, 2016. Periodic IDFCSPs must be completed every five years from the completion date of the initial plan. In addition, the IDFCSP must be amended whenever there is a change in conditions that would substantially affect the plan.

1.2 MOSES Impoundments Subject to Inflow Design Flood Control System Plan Requirements

The CCR Rule defines coal combustion residuals such as fly ash, bottom ash, boiler slag, gypsum, and related solids generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers. The IDFCSP requirements of the CCR Rule apply to surface impoundments that dispose or otherwise engage in solid waste management of CCRs.

This IDFCSP address the following CCR surface impoundments at the MOSES:

- Northeast Ash Water Pond (NE Pond),
- West Ash Settling Pond (West Pond), and
- Southwest Ash Settling Pond (SW Pond)

The NE Pond, West Pond and SW Pond (collectively “Bottom Ash Ponds” or “BAPs”) are located approximately 800 feet southeast of the MOSES power plant (Figure 2).

1.3 Description of Bottom Ash Ponds

The BAPs are located approximately 1,100 feet from Lake Monticello (normal pool elevation 340 feet above mean sea level (MSL)). The NE Pond and West Ponds share an interior embankment and are each approximately 500 feet wide, covering an area of approximately 5.5 acres and 6.6 acres, respectively. The crest elevation of the BAP embankments are approximately 386.5 feet MSL. The approximately 8-

acre SW Pond shares an embankment with the West Pond (North end of the SW Pond). Due to their proximity to each other, the NE Pond, West Pond and SW Pond will be considered one CCR surface impoundment (identified as the "BAPs") for the purposes of this hazard potential classification assessment.

A simplified process flow diagram for the BAPs is shown on Figure 3. The BAPs receive recovered overflow from bottom ash dewatering bins and other MOSES process wastewater sources. The ponds also act as a surge basin for various water streams in the ash-water system. Recovered sluice water, process waters and stormwater runoff from the MOSES ash-water system are pumped to each pond through a series of above grade pipes. The BAPs are located partially above and partially below grade and all material that enters the ponds is pumped into the impoundments – there are no gravity discharges to the BAPs.

The Bottom Ash Ponds serve as settling basins to remove residual bottom ash and fines from a sump that receives the recovered sluice water associated with the dewatering bins, which is the primary bottom ash removal process at MOSES. Water is pumped from the SW Pond, as needed, and returned for reuse in the bottom ash system. When sufficient ash has accumulated in either the NE or West Ponds, the recovered sluice water is diverted to the other pond. Ash is then removed from the first pond. Based on the design of the BAPs, minimal accumulation of solids occurs within the SW Pond.

The BAPs are surrounded by engineered earthen dikes that extend approximately 10 to 20 feet above grade depending on the surrounding topography. The exterior slopes of the embankments are vegetated with grasses and similar vegetation. The south embankment of the Northeast Pond and east embankment of the SW Pond also act as embankments for the MOSES Stormwater Collection Pond.

Based on the *CCR Study for Monticello Steam Electric Station* (Burns and McDonnell, 2015), the BAPs were originally constructed in the 1974 as a two-basin system and were subsequently segregated and relined with a 3-foot thick clay liner in 1990. As-built engineering drawings indicate that the existing 3-foot compacted clay liner was constructed to a maximum permeability of $1 \text{ X } 10^{-7}$ cm/sec.

Based on available construction data, each of the BAPs were constructed to provide the following estimated storage capacities:

- NE Pond: 100 acre-feet
- West Pond: 130 acre-feet
- SW Pond: 145 acre-feet

The total design operating capacity of the BAPs is approximately 122,200,000 gallons or approximately 375 acre-ft.

The US Army Corps of Engineers (USACE) classifies the relative size of dams based on the height of the dam and the storage capacity of the impounded area behind the dam (USACE, 1979). As shown in the table below, based on the embankment height (10 to 20 feet above grade) and total operating capacity (375 acre-ft) of the BAPs, the BAPs would be categorized as small impoundments based on the USACE dam size classification criteria:

USACE Dam Size Classification		
Size Category	**Impoundment Capacity (acre-ft)**	**Impoundment Height (ft)**
Small	50 and < 1,000	25 and < 40
Intermediate	1,000 and < 50,000	40 and < 100
Large	> 50,000	> 100

The BAPs are classified as a low hazard potential impoundment in accordance with the requirements of Section 257.73(a)(2) of the CCR Rule (PBW, 2016A).

1.4 2014 EPA Evaluation of BAP Hydraulic Capacity

In 2009, the EPA initiated a program to assess the stability and functionality of coal ash impoundments at coal-fired electric generating plants across the United States. The assessment of the stability and functionality of the MOSES BAPs was performed in 2014 by O'Brien & Gere (OBG) on behalf of EPA. The results of the OBG assessment were presented in *Dam Safety Assessment of CCW Impoundments, Luminant Generation Co., LLC, Monticello Steam Electric Station*, O'Brien & Gere, June 2014 (OBG, 2014).

OBG did not conduct a hydrologic or hydraulic analysis to evaluate stormwater inflow into the BAPs; however, OBG concluded the following with regards to stormwater inflows into the BAPs:

- The impounding structures of the BAPs are all above-grade on all sides except for the west side of the Scrubber Pond, therefore, storm runoff is limited to direct precipitation on the impoundments.

- Available volume provided by the normal operating freeboard is sufficient to contain a 24-hour, 100-year storm without overtopping the embankments.

- The 24-hour, 100-year rainfall at the Site is approximately 10-inches and the generally available freeboard is approximately two and one-half feet. Thus, the ponds have the capacity to handle approximately four times the 100-year rainfall before the impoundments would be overtopped.

The "Scrubber Pond" referenced in the OBG report does not contain CCRs and has not received any CCRs since October 19, 2015; hence, the pond (currently referred to as the Rubber-Lined Pond) is not subjecct to the CCR rule. The CCR surface impoundment structures at MOSES (i.e. BAPs) are above-grade on all sides.

2.0 HYDRAULIC CAPACITY EVALUATION OF BAPS

The CCR Rule defines the inflow design flood (IDF) as "the flood hydrograph that is used in the design or modification of the CCR surface impoundment and its appurtenant works." From an engineering design standpoint, the IDF is the rate of water coming into a surface impoundment over time that the impoundment must be able to safely pass or contain using a combination of outlet works and surcharge storage (freeboard).

The IDFCSP for the BAPS must demonstrate that the impoundment is designed to manage flow into and out of the units during and following the peak discharge of the specified inflow design flood. This demonstration will be accomplished through calculation of a water balance for the BAPs. The basic equation for the water balance is as follows:

Inflows = Outflows + Change in Impoundment Storage

For the water balance to demonstrate compliance with CCR requirements, the rate of inflows into the BAPs (the inflow design flood) must not be greater than the rate of outflows from the BAPs plus the maximum allowable storage in the impoundment.

2.1 Inflows to BAPs

The BAPs are located partially above and partially below grade and inflows that enter the impoundment are pumped into the units under controlled conditions – there are no gravity or uncontrolled discharges to the BAPs. As shown on Figure 3, water coming into the BAPs consists of the following:

- bottom ash process water;
- FGD scrubber sump water;
- boiler feed water treatment water; and
- make-up water from north operating pond (to maintain the operating level in the BAP during periods of low inflows).

Most of the sources of inflow to the BAPs are process units that generate water at controlled rates. The rates at which these inflows are pumped into the BAPs are not significantly affected by variations in precipitation intensity and associated flood conditions.

Stormwater runoff generated from lignite storage areas is also pumped into the BAPs. The quantity of stormwater runoff generated from the lignite storage areas does vary depending on precipitation;

however, runoff from the lignite storage areas is allowed to accumulate in these areas and is pumped into the BAPs at a controlled rate. As a result, the rate at which this inflow is pumped into the BAPs is not significantly affected by variations in precipitation intensity and associated flood conditions.

In addition, the BAPs receive water from direct precipitation on the impoundment itself. This inflow is affected by variations in precipitation intensity and associated flood conditions.

2.2 Outflows from BAPs

Decant water is pumped out of the BAPs and returned to the MOSES bottom ash handling system and/or transferred to the North Operating Pond for use as a source of process water at the MOSES. The rate of outflow from the BAPs is controlled to maintain the design operating level in the impoundment of approximately elevation 384 feet. Based on a crest elevation of approximately 386.5 feet for the earthen embankments around the BAPs, a minimum 2.5-foot freeboard is maintained in the BAPs under normal operating conditions.

It should be noted that water is also removed from the BAPs through natural evaporation; however, evaporation from the BAPs was not considered as part of this evaluation.

2.3 Inflow Design Flood for BAPs

As described in Section 1.2, the BAPs are classified as a low hazard potential CCR Impoundment. In accordance with Section 257.82(a)(3) of the CCR Rule, the inflow design flood for a low hazard potential CCR impoundment is the 100-year flood event. Direct precipitation on the BAPs is the only inflow source that is affected by the inflow design flood.

The 100-year, 24-hour storm for the BAPs was estimated to be 9.9 inches based on the 100-Year, 24-Hour Rainfall Graph from US Department of Commerce Technical Paper No. 40 (Hershfield, 1961). A copy of the 100 -Year, 24-Hour Rainfall Graph from Technical Paper No. 40 is reproduced in Appendix A.

2.4 Hydraulic Capacity Evaluation

A hydraulic capacity evaluation was performed on the BAPs for the inflow design flood as part of the development of the IDFCSP. The evaluation was based on the water balance equation described above and the following assumptions:

- The BAPs are located above grade and all material that enters the ponds from the MOSES is pumped into the impoundment – there are no uncontrolled gravity discharges to the BAPs.
- The design operating level in the BAPs is approximately elevation 384 feet and the crest elevation of the earthen embankments around the BAPs is approximately 386.5 feet. As a result, a minimum 2.5-foot freeboard is maintained in the BAPs under normal operating conditions.
- Inflows to and outflows from the BAPs considered as part of the evaluation are as described in Sections 2.1 and 2.2 of this report.
- The rate of water decanted from the BAPs (process outflow) is assumed to be equivalent to the inflow of process water to the impoundment (except for direct precipitation on the BAPs) during the design flood event so that the design operating level of 384 feet is maintained in the BAPs.
- Stormwater runoff from the lignite storage area is not pumped into the BAPs during the design flood event. As a result, the lignite storage areas will accumulate stormwater.
- Evaporation from the BAPs is assumed to be negligible during the design flood event.

Based on these assumptions, the general water balance equation for the BAPs can be modified as follows:

Process Inflows + Direct Precipitation = Process Outflows + Change in BAP Storage

Since the rate of water decanted from the BAPs (process outflow) is assumed to be equivalent to the process water inflows to the impoundment, the BAP water balance equation becomes:

Direct Precipitation = Change in BAP Storage

For the 100-year, 24-hour design flood event, direct precipitation on the BAPs is estimated to be 9.9 inches. Based on the above equation, the water surface in the BAPs would rise 9.9 inches (approximately 0.8 feet) to accommodate this precipitation. Since the design operating level for the BAPs is Elevation 384 and the crest elevation of the earthen embankments around the BAPs is approximately 386.5 feet, the resulting water surface elevation of 384.9 feet would still allow for approximately 1.7 feet of freeboard to remain in the BAPs. As a result, the BAPs are adequately designed to manage the inflow design flood in accordance with Section 257.82 of the CCR Rule.

3.0 INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN FOR BAPs

As currently configured, the BAPs are adequately designed to manage the 100-year, 24-hour inflow design flood in accordance with Section 257.82 of the CCR Rule. The BAPs should be operated in accordance with the following Inflow Design Flood Control System Plan to maintain adequate freeboard in the impoundment to manage the design flood conditions:

- The operating level in the BAPs should be maintained at approximately elevation 384 feet to provide approximately 2.5 feet of freeboard in the impoundment under normal operating conditions.
- The rate of water decanted from the BAPs (process outflow) should be equivalent to the inflows of process water pumped to the impoundment during the design flood event so that the design operating level of 384 feet is maintained in the BAPs.
- Stormwater runoff from the lignite storage areas should not be pumped to the BAPs during heavy precipitation events until Luminant personnel document through visual inspection that adequate freeboard is available in the BAPs. As a result, these areas will accumulate stormwater during periods of heavy precipitation until such time as the water can be pumped to the BAPs or otherwise managed.

In accordance with 257.82(c)(3) of the CCR Rule, this initial IDFCSP must be placed in the MOSES facility operating record no later than October 17, 2016. Subsequent periodic IDFCSPs must be completed every five years from the completion date of this initial plan. In addition, the IDFCSP must be amended whenever there is a change in conditions that would substantially affect the plan.

4.0 REFERENCES

Burns & McDonnell, 2015. CCR Study for Monticello Steam Electric Station, July 31.

Hershfield, OM. 1961. Rainfall Frequency Atlas of the United States for Durations from 30 minutes to 24 hours and Return Periods from 1 to 100 Years, U.S. Dept. Commerce, Weather Bureau. Technical Paper No. 40. Washington, DC.

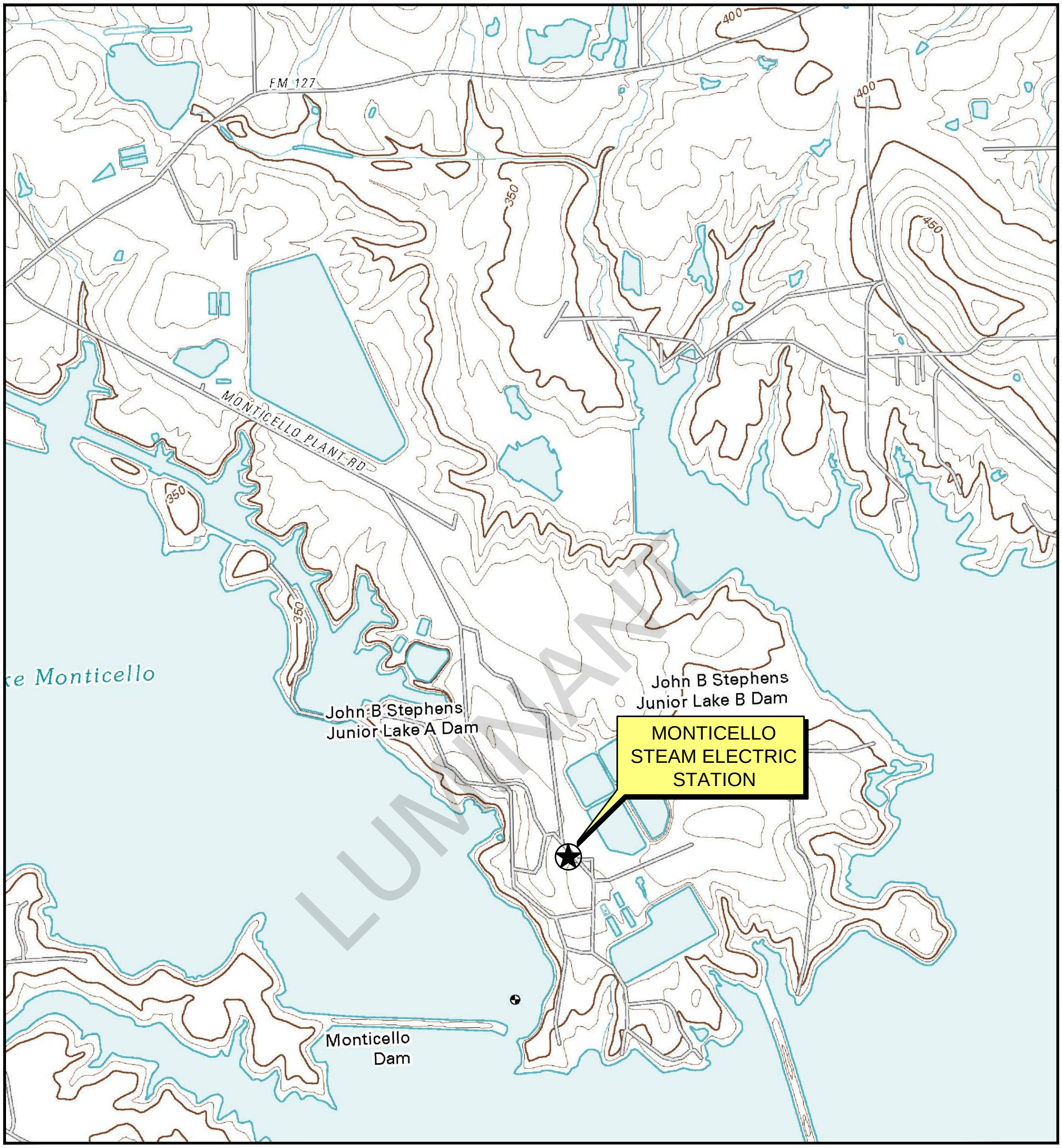
O'Brien & Gere (OBG), 2014. *Dam Safety Assessment of CCW Impoundments, Luminant Generation Co., LLC/Monticello Steam Electric Station*, June3.

Pastor, Behling & Wheeler, LLC (PBW), 2016. Annual Surface Impoundment Inspection Report – Luminant Monticello Steam Electric Station Bottom Ash Ponds, Titus County, Texas. January 15.

Pastor, Behling & Wheeler, LLC (PBW), 2016A. Hazard Classification Assessment – Monticello Electric Station North and South Bottom Ash Ponds, Titus County, Texas. October.

United States Army Corps of Engineers (USACE), 1979. *Recommended Guidelines for Safety Inspections of Dams*, ER 1110-2-106, September 26.

Figures



QUADRANGLE LOCATIONS

Scale in Feet
0 1000 2000

SOURCE:
Base map from www.tnris.gov, Monticello, TX 7.5 min. USGS quadrangle dated 2010.

LUMINANT GENERATION COMPANY, LLC
MONTICELLO STEAM ELECTRIC STATION

Figure 1

SITE LOCATION MAP

PROJECT: 5196A	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

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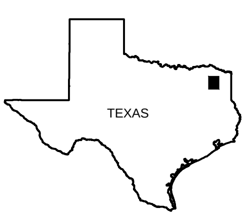

PHOTOGRAPH LOCATION

N

Scale in Feet

0 1000 2000

SOURCE:
Imagery from Google Earth, aerial photography dated 12-5-15.

LUMINANT GENERATION COMPANY, LLC

MONTICELLO STEAM ELECTRIC STATION

Figure 2

SITE VICINITY MAP

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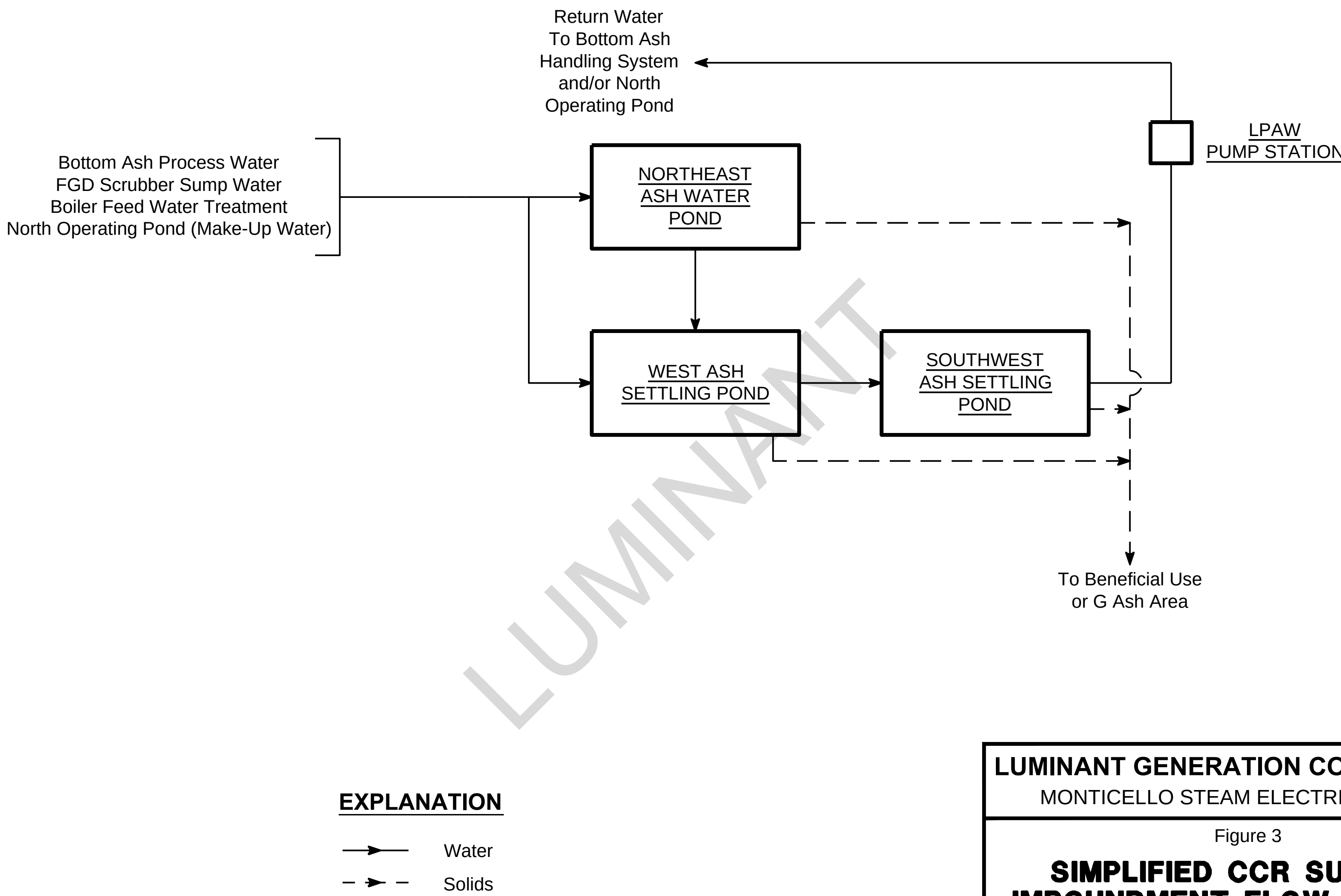

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MONTICELLO STEAM ELECTRIC STATION

Figure 3

SIMPLIFIED CCR SURFACE IMPOUNDMENT FLOW DIAGRAM

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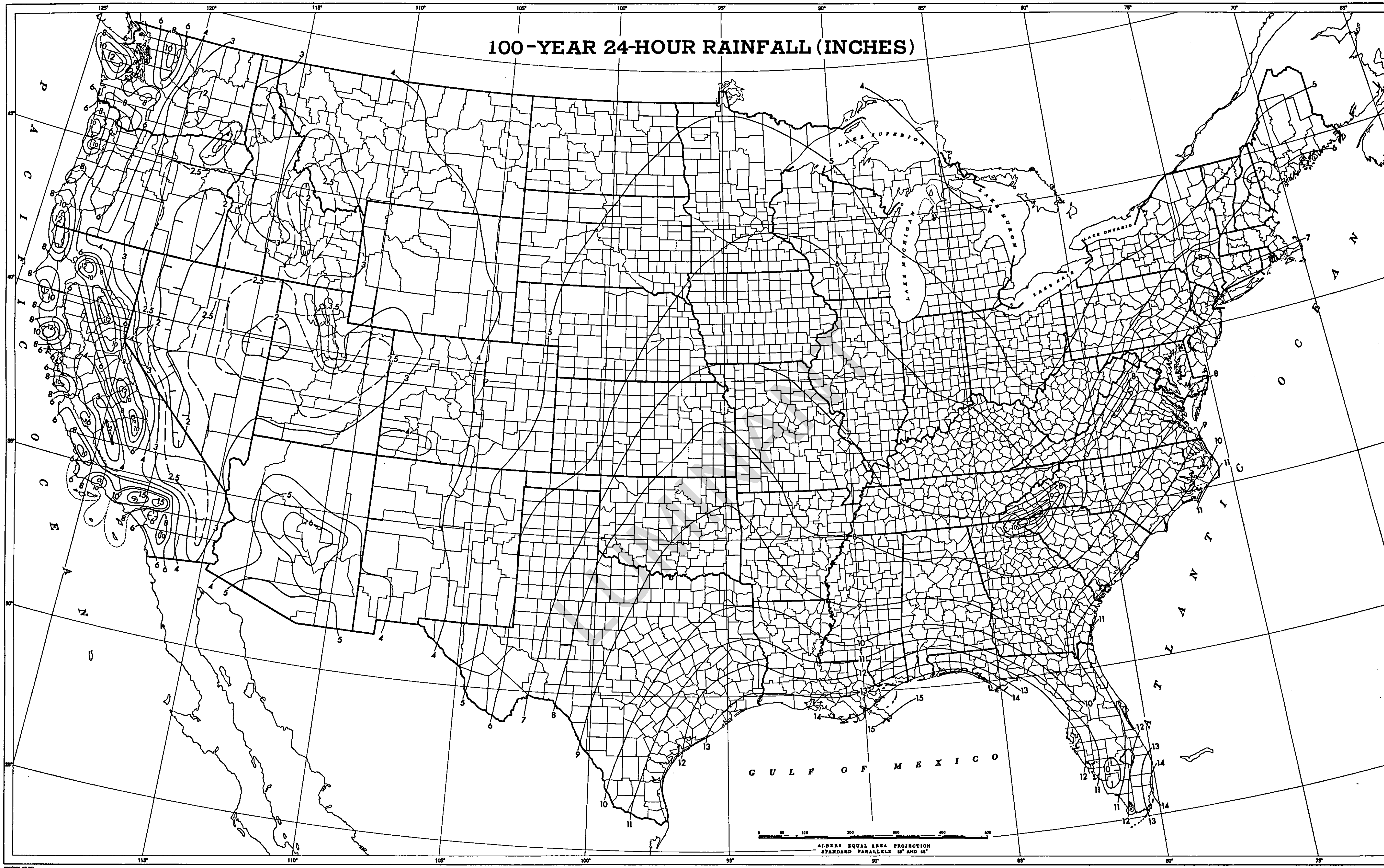
Appendix A

US Department of Commerce Technical Paper No. 40
100-Year, 24-Hour Rainfall Graph


100-YEAR 24-HOUR RAINFALL (INCHES)
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ONTARIO
LAKE ERIE
ALBERS EQUAL AREA PROJECTION
STANDARD PARALLELS 29° AND 45°