INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN
MARTIN LAKE STEAM ELECTRIC STATION
ASH POND AREA AND PERMANENT DISPOSAL POND NO. 5
RUSK COUNTY, TEXAS

October 2016

Prepared for:

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PBW Project No. 5196B

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.

10/5/16

Brian Thomas, P.E.
Principal Engineer
PASTOR, BEHLING & WHEELER, LLC

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1.0 INTRODUCTION

Luminant Generation Company, LLC (Luminant) owns and operates the Martin Lake Steam Electric Station (MLSES) located approximately five miles southwest of Tatum in Rusk County, Texas. The power plant and related support areas occupy approximately 700 acres on a peninsula on the southwest side of Martin Lake (Figure 1) The MLSES consists of three coal/lignite-fired units with a combined operating capacity of approximately 2,250 megawatts. Coal Combustion Residuals (CCR) including fly ash, bottom ash, and gypsum are generated as part of MLSES unit operation. The CCRs are transported off-site for beneficial use by third-parties, or are managed by Luminant on-site at Permanent Disposal Pond No. 5 (PDP-5) or are disposed at Luminant's A-1 Area Landfill.

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 MLSES.

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 MLSES 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 MLSES:

- West Ash Pond (WAP),
- East Ash Pond (EAP),
- New Scrubber Pond (SP), and
- Permanent Disposal Pond No. 5 (PDP-5).

1.3 Description of Bottom Ash Ponds

The WAP and EAP (collectively “Bottom Ash Ponds” or “BAPs”) are located approximately 2,000 feet east of the MLSES power plant (Figure 2). A simplified process flow diagram for the BAPs is shown on Figure 3. The WAP and EAP receive recovered sluice water from bottom ash dewatering bins and other MLSES process wastewater sources that typically include bottom ash fines. The ponds also act as surge basins for various water streams in the ash-water system. Process wastewater can be transferred from the MLSES impoundments to the SP and PDP-5 or used as makeup water to the bottom ash system. When sufficient ash has accumulated in either the WAP or EAP, the recovered sluice water is diverted to the other pond. Ash is then removed from the first pond and transported via rail car to the A-1 Area Landfill. The BAPs were originally constructed in the 1977 and upgraded in 1988 (WAP) and 2010 (EAP).

The WAP and EAP are constructed partially above and partially below grade and are surrounded by engineered earthen embankments that extend above grade. The WAP and EAP share an interior embankment and cover areas of approximately 14.6 acres and 9.6 acres, respectively. The crest elevation of the BAP embankments is 330 feet above mean sea level (MSL).

The BAPs impoundments were originally constructed in the 1977 with an in-situ compacted clay liner. The WAP was removed from service in March 1988 and re-lined with a double 60-mil high density polyethylene (HDPE) liner system overlain with a concrete revetment mat. The EAP was dredged and removed from service in 1989, and a new south embankment was constructed to allow for an increase in the size of the SP. The EAP remained inactive until the installation of a new double 60-mil HDPE liner system with concrete revetment mat was completed in February 2010.

1.4 Description of New Scrubber Pond

The New Scrubber Pond (SP) is located immediately south of the EAP and east of the WAP (Figure 2). The SP is an approximately 12.5 acre surface impoundment that is used to manage FGD wastes as well as discharge from the sludge thickener sumps, the plant yard sumps, and storm water management areas. Solids present in the FGD wastewater settle within the pond and are periodically removed and managed similar to the ash solids from the WAP and EAP. Process wastewater can be transferred from the SP to the BAPs and PDP-5, or used as makeup water to the scrubber systems. The SP was originally constructed in the 1977 and was expanded to its current size in 1989.

The SP is constructed partially above and partially below grade and is surrounded by engineered earthen embankments that extend above grade. The west embankment of the SP is an internal/shared embankment with the WAP and a portion of the northern embankment is an internal/shared embankment with the EAP. The crest elevation of the SP embankments is 330 feet MSL. Martin Lake (normal pool elevation 306 feet MSL) adjoins portions of the north and south embankments of the SP.

The SP was originally constructed in 1977 with an in-situ compacted clay liner and was expanded to its current size in 1989. The SP was relined in 1989 with a double 60-mil HDPE liner system, overlain with a concrete revetment mat.

1.5 Description of PDP-5

Permanent Disposal Pond No. 5 (PDP-5) is located approximately 3,000 feet west-northwest of the MLSES power plant (Figure 2). PDP-5 is an approximately 40-acre surface impoundment that was constructed in 2010 over three closed PDPs (PDPs 1-3; Figure 5). PDP-5 is primarily used to manage excess liquids, including storm water from large precipitation events and excess process wastewater from both the FGD and bottom ash loops. Recovered CCR wastewaters are received in PDP-5 during cleaning cycles for the BAPs and SP. Process wastewater can be transferred between the BAPs, SP, or used as makeup water for specific CCR related systems. Process wastewater can be transferred from PDP-5 to the BAPs and the SP.

PDP-5 is constructed above grade and is surrounded by engineered earthen embankments. The crest elevation of the PDP-5 embankments is 405.5 feet MSL, and the embankments are approximately 10 to 15 feet above surrounding grade. The liner system for the PDP-5 consists of the following:

- a six-inch thick soil layer over the closed PDPs (in-place permeability of $1x10^{-5}$ cm/sec);
- two-foot thick compacted clay liner (in-place permeability of $1x10^{-7}$ cm/sec); and
- three-foot thick compacted clay interior/exterior embankment liner (minimum in-place permeability of $1x10^{-7}$ cm/sec).

Based on available construction data the BAPs, SP and PDP-5 were constructed to provide the following estimated storage capacities:

- WAP: 232.6 acre-feet;
- EAP: 125.8 acre-feet;
- SP: 198.9 acre-feet; and
- PDP-5: 190.3 acre-feet.

Total design capacity of the CCR impoundments located within the ash pond area (WAP, EAP and SP is 557.2 acre-feet or approximately 181,564,000 gallons.

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 heights (14 to 21 feet above grade) and total operating capacities of the BAPs, SP and PDP-5 impoundments, these impoundments would be categorized as a small impoundment using 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, SP & PDP-5 are classified as a low hazard potential impoundment in accordance with the requirements of Section 257.73(a)(2) of the CCR Rule (PBW, 2016).

1.6 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 MLSES BAPs, SP and PDP-5 was performed in 2012 by Dewberry Consultants, LLC (Dewberry) on behalf of EPA. The results of the Dewberry assessment were presented in *Coal Combustion Residue Impoundment Round 12 - Dam Assessment Report, Martin Lake Steam Electric Plant Coal Combustion Residuals Impoundments, Luminant*, Tatum, Texas, Dewberry Consultants LLC, March 2014 (Dewberry, 2014).

As part of the assessment, Dewberry evaluated the "Hydrologic/Hydraulic Safety" of the BAPs and concluded the following:

- The BAPs, SP and PDP-5 only receive water pumped into the units at a controlled rate.
- The normal pool elevation of the BAPs and SP is managed to a relatively constant elevation of 328 feet, providing a 2-foot freeboard.
- The normal elevation of the PDP-5 is managed to a relatively constant elevation of 404 feet, providing a 2-foot freeboard.
- Dewberry examined the 100-year rainfall event and compared the data with the available freeboard. The freeboard should be adequate to contain the one-percent probability, 24- hour precipitation event (10.6 inches) without overtopping the impoundment embankments.
- Based on the information reviewed, the BAPs, SP and PDP-5 were given the highest rating of "Satisfactory" for hydrologic and hydraulic safety.

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, SP and PDP-5 must demonstrate that the impoundments are 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, SP and PDP-5. 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, SP and PDP-5 (the inflow design flood) must not be greater than the rate of outflows from the BAPs, SP and PDP-5 plus the maximum allowable storage in the impoundment.

2.1 Inflows to BAPs, SP and PDP-5

The BAPs, SP and PDP-5 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, SP and PDP-5. As shown on Figure 3, water coming into the BAPs consists of the following:

- bottom ash process water,
- miscellaneous plant sumps, and
- makeup water/process wastewater transfers from SP and/or PDP-5.

Water coming into the SP consists of:

- FGD scrubber wastewater,
- Boiler feed water treatment,
- Discharge from the sludge thickener sumps, and
- Makeup water/process wastewater transfers from BAPs and/or PDP-5.

Water coming into the PDP-5 consists of the following:

- excess process wastewater and transfers from BAPs and/or SP, and
- stormwater from large precipitation events.

Most of the sources of inflow to the BAPs, SP and PDP-5 are process units that generate water at controlled rates. With the exception of the miscellaneous plant process sumps, the rates at which these inflows are pumped into the BAPs, SP, and PDP-5 are not significantly affected by variations in precipitation intensity and associated flood conditions. In accordance with Luminant operating procedures, stormwater is allowed to accumulate to the extent practicable and the transfer of stormwater collected by the plant sumps is regularly monitored and regulated to ensure adequate freeboard is maintained in each of the CCR impoundments during a storm event.

Stormwater runoff generated from lignite storage areas is also pumped into the BAPs, SP and PDP-5. 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, SP and PDP-5 at a controlled rate. As a result, the rate at which this inflow is pumped into the BAPs, SP and PDP-5 is not significantly affected by variations in precipitation intensity and associated flood conditions.

In addition, the BAPs, SP and PDP-5 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, SP and PDP-5

The BAPs and PDP-5 act as surge basins for various water streams in the ash water system. Process wastewater can be transferred to and from the BAPs to the SP and PDP-5. The SP is used to manage FGD wastes as well as discharge from the sludge thickener sumps, plant yard sumps and stormwater management areas. Process wastewater from the SP can be transferred to the BAPs and PDP-5, or can be used as makeup water to the scrubber systems. The rate of outflow from the BAPs and SP is controlled to maintain the normal operating level of the impoundment at an approximate elevation 328 feet or less. Based on a crest elevation of approximately 330 feet for the earthen embankments around the BAPs and SP, a minimum 2-foot freeboard is maintained in the BAPs and SP under normal operating conditions.

The PDP-5 is primarily used to manage excess liquids, including stormwater from large precipitation events and excess process wastewater from both the FGD and BAPs. Process wastewater can be transferred from the PDP-5 to the BAPs and SP. The rate of outflow from the PDP-5 is controlled to maintain the normal operating level of the impoundment at an approximate elevation of 403.5 feet MSL. Based on a crest elevation of approximately 405.5 feet MSL for the earthen embankments around the PDP-5, a minimum 2-foot freeboard is maintained in the PDP-5 under normal operating conditions.

It should be noted that water is also removed from the BAPs, SP and PDP-5 through natural evaporation; however, evaporation from the BAPs, SP and PDP-5 was not considered as part of this evaluation.

2.3 Inflow Design Flood for BAPs, SP and PDP-5

As described in Section 1.5, the BAPs, SP and PDP-5 are classified as a low hazard potential CCR Impoundments. 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, SP and PDP-5 is the only inflow source that is affected by the inflow design flood.

The 100-year, 24-hour storm for the impoundments at the MLSES was estimated to be 10.6 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, SP and PDP-5 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, SP and PDP-5 are located above grade and all material that enters the ponds from the MLSES is pumped into the impoundments – there are no uncontrolled gravity discharges to the BAPs, SP and PDP-5.
- The design operating level in the BAPs and SP is an approximate elevation 328 feet MSL and the crest elevation of the earthen embankments around the BAPs and SP is approximately 330 feet MSL. As a result, a minimum 2-foot freeboard is maintained in the BAPs and SP under normal operating conditions.
- The design operating level in the PDP-5 is an approximate elevation of 403.5 feet MSL and the

crest elevation of the earthen embankments around the PDP-5 is approximately 405.5 feet MSL. As a result, a minimum 2-foot freeboard is maintained in the PDP-5 under normal operating conditions.

- Inflows to and outflows from the BAPs, SP and PDP-5 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 and SP (process outflow) is assumed to be equivalent to the inflow of process water to the impoundment (except for direct precipitation on the BAPs and SP) during the design flood event so that the design operating level of 328 feet MSL is maintained in the BAPs and SP.

- The rate of water decanted from the PDP-5 (process outflow) is assumed to be equivalent to the inflow of process water to the impoundment (except for direct precipitation on the PDP-5) during the design flood event so that the design operating level of 403.5 feet MSL is maintained in the PDP-5.

- Stormwater runoff from the lignite storage areas is not pumped to the PDP-5s during the design flood event. As a result, the lignite storage areas will accumulate stormwater.

- Evaporation from the BAPs, SP and PDP-5 is assumed to be negligible during the design flood event.

Based on these assumptions, the general water balance equation for the BAPs, SP and PDP-5 can be modified as follows:

Process Inflows + Direct Precipitation = Process Outflows + Change in BAP, SP and PDP-5 Storage

Since the rate of water decanted from the BAPs, SP and PDP-5 (process outflow) is assumed to be equivalent to the process water inflows to the impoundment, the BAP, SP and PDP-5 water balance equation becomes:

Direct Precipitation = Change in BAPs, SP and PDP-5 Storage

For the 100-year, 24-hour design flood event, direct precipitation on the BAPs and SP is estimated to be 10.6 inches. Based on the above equation, the water surface in the BAPs and SP would rise 10.6 inches (approximately 0.9 feet) to accommodate this precipitation. Since the design operating level for the BAPs and SP is an elevation of 328 feet MSL and the crest elevation of the earthen embankments around the BAPs and SP is approximately 330 feet MSL, the resulting water surface elevation of 328.9 feet MSL would still allow for approximately 1.1 feet of freeboard to remain in the BAPs and SP. As a result, the BAPs and SP are adequately designed to manage the inflow design flood in accordance with Section 257.82 of the CCR Rule.

For the 100-year, 24-hour design flood event, direct precipitation on PDP-5 is estimated to be 10.6 inches.

Based on the above equation, the water surface in the PDP-5 would rise 10.6 inches (approximately 0.9 feet) to accommodate this precipitation. Since the design operating level for the PDP-5 is an elevation of 403.5 feet MSL and the crest elevation of the earthen embankments around the PDP-5 is approximately 405.5 feet MSL, the resulting water surface elevation of 404.4 feet MSL would still allow for approximately 1.1 feet of freeboard to remain in the PDP-5. As a result, the PDP-5 is 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, SP and PDP-5 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, SP and PDP-5 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 and SP should be maintained at an approximate elevation of 328 feet MSL to provide approximately 2 feet of freeboard in the impoundment under normal operating conditions.
- The operating level in PDP-5 should be maintained at an approximate elevation of 403.5 feet MSL to provide approximately 2 feet of freeboard in the impoundment under normal operating conditions.
- The rate of water decanted from the BAPs and SP (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 328 feet MSL is maintained in the BAPs and SP.
- The rate of water decanted from the PDP-5 (process outflow) should be equivalent to the inflows of process water pumped into the impoundment during the design flood event so that the design operating level of 403.5 feet MSL is maintained in the PDP-5.
- Stormwater managed by MLSES sumps should be allowed to accumulate to the extent practicable and the transfer of stormwater collected by the plant sumps should be regularly monitored and regulated to ensure adequate freeboard is maintained in each of the CCR impoundments during a storm event.
- Stormwater runoff from the lignite storage areas should not be pumped to the BAPs, SP and PDP-5 during heavy precipitation events until Luminant personnel document through visual inspection that adequate freeboard is available in the BAPs, SP and PDP-5. As a result, the lignite storage areas will accumulate stormwater during periods of heavy precipitation until such time as the water can be pumped to the BAPs, SP and PDP-5 or otherwise managed.

In accordance with 257.82(c)(3) of the CCR Rule, this initial IDFCSP must be placed in the MLSES 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

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.

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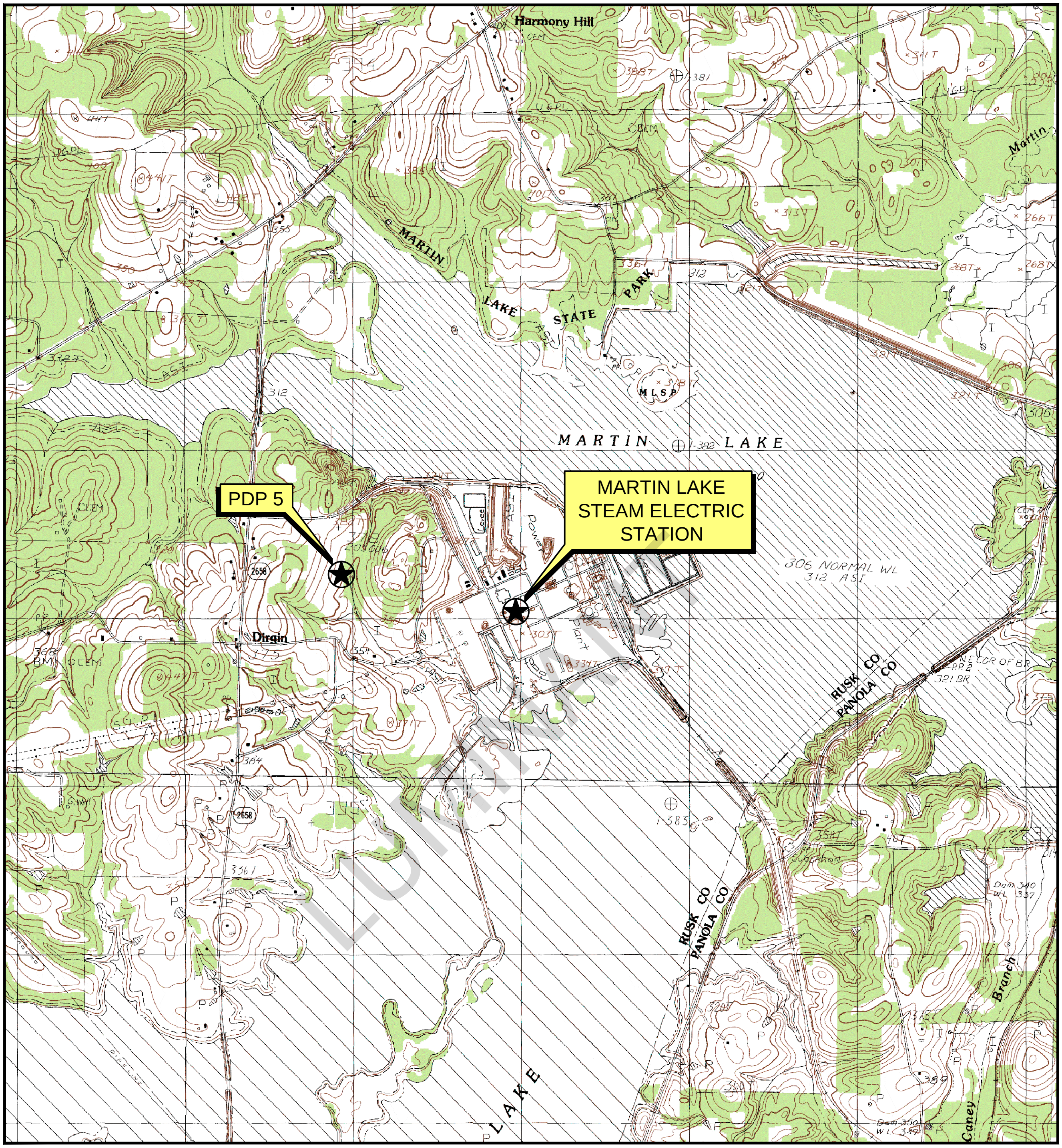
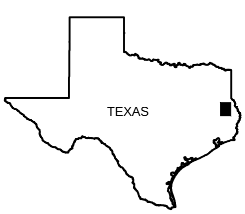
Figures





QUADRANGLE LOCATION

N

Scale in Feet

0 1500 3000

SOURCE:
Base map from www.tnris.gov, Tatum, TX 7.5 min. USGS quadrangle dated 1983.

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Figure 1

SITE LOCATION MAP

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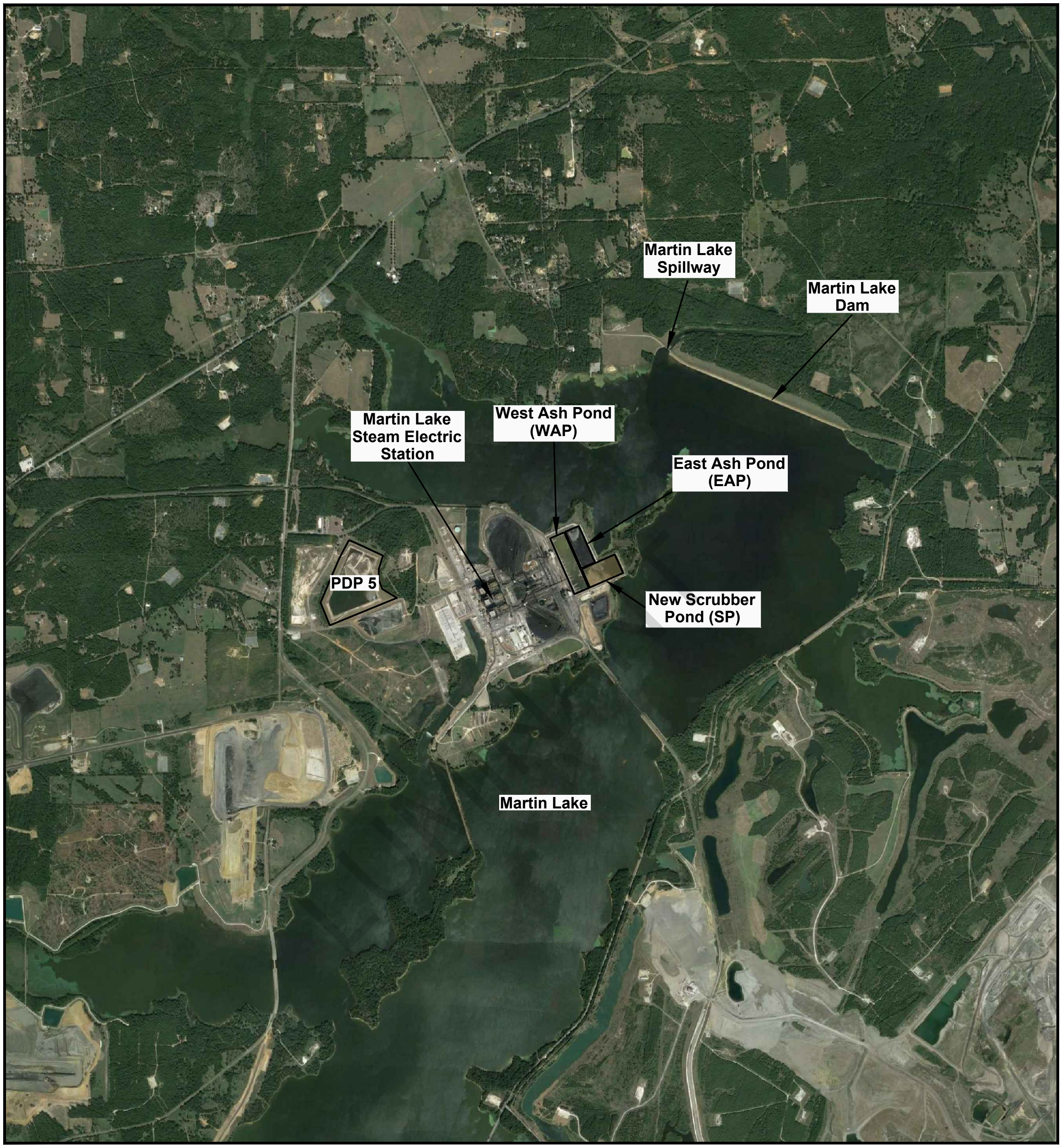
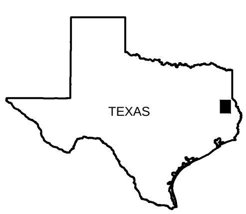
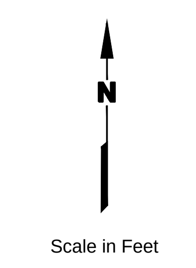




PHOTOGRAPH LOCATION



SOURCE:
Imagery from Google Earth, photography dated October 1, 2015.

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Figure 2

SITE VICINITY MAP

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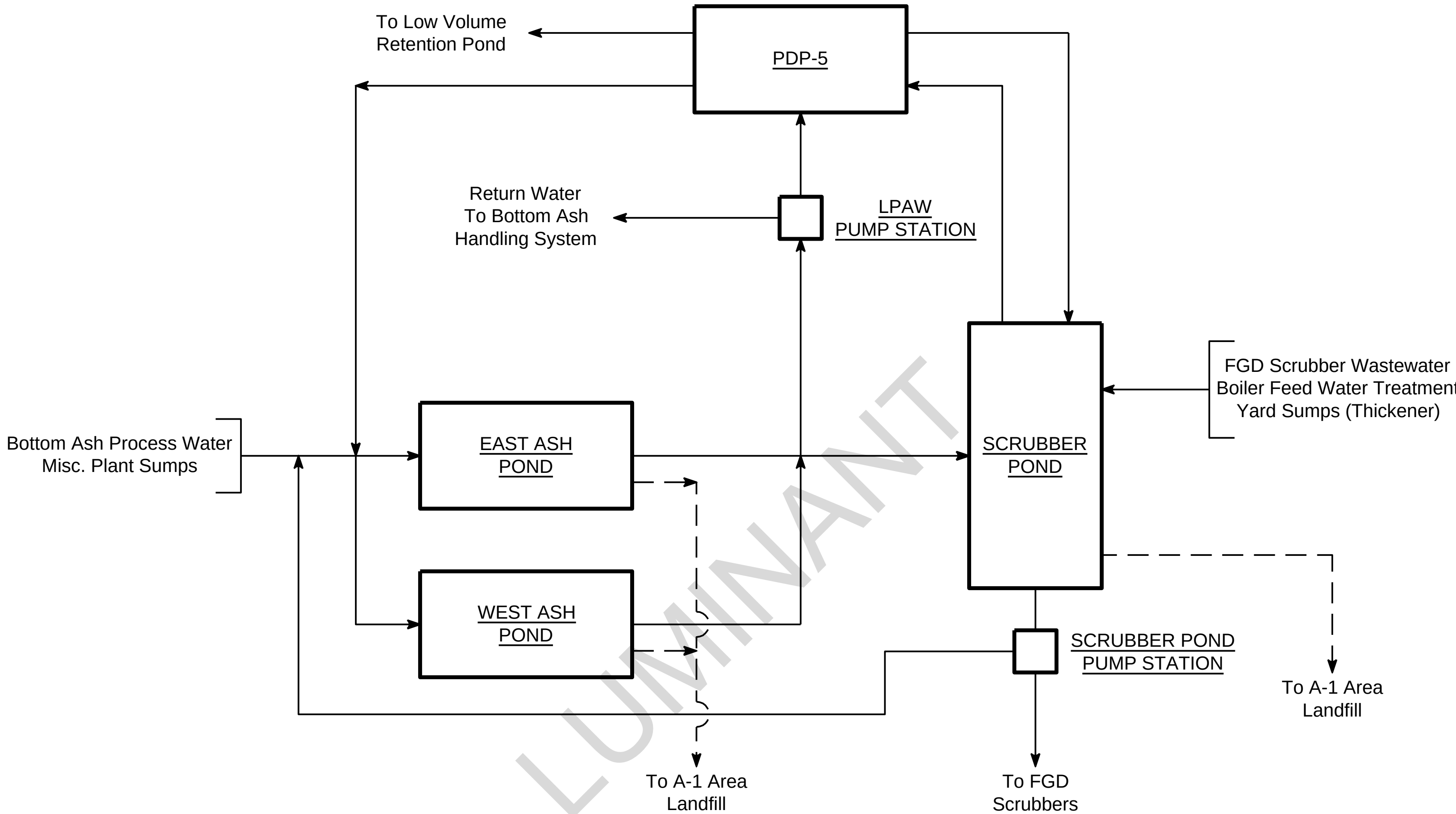

EXPLANATION

LUMINANT GENERATION COMPANY, LLC

MARTIN LAKE STEAM ELECTRIC STATION

Figure 3

SIMPLIFIED CCR SURFACE IMPOUNDMENT FLOW DIAGRAM

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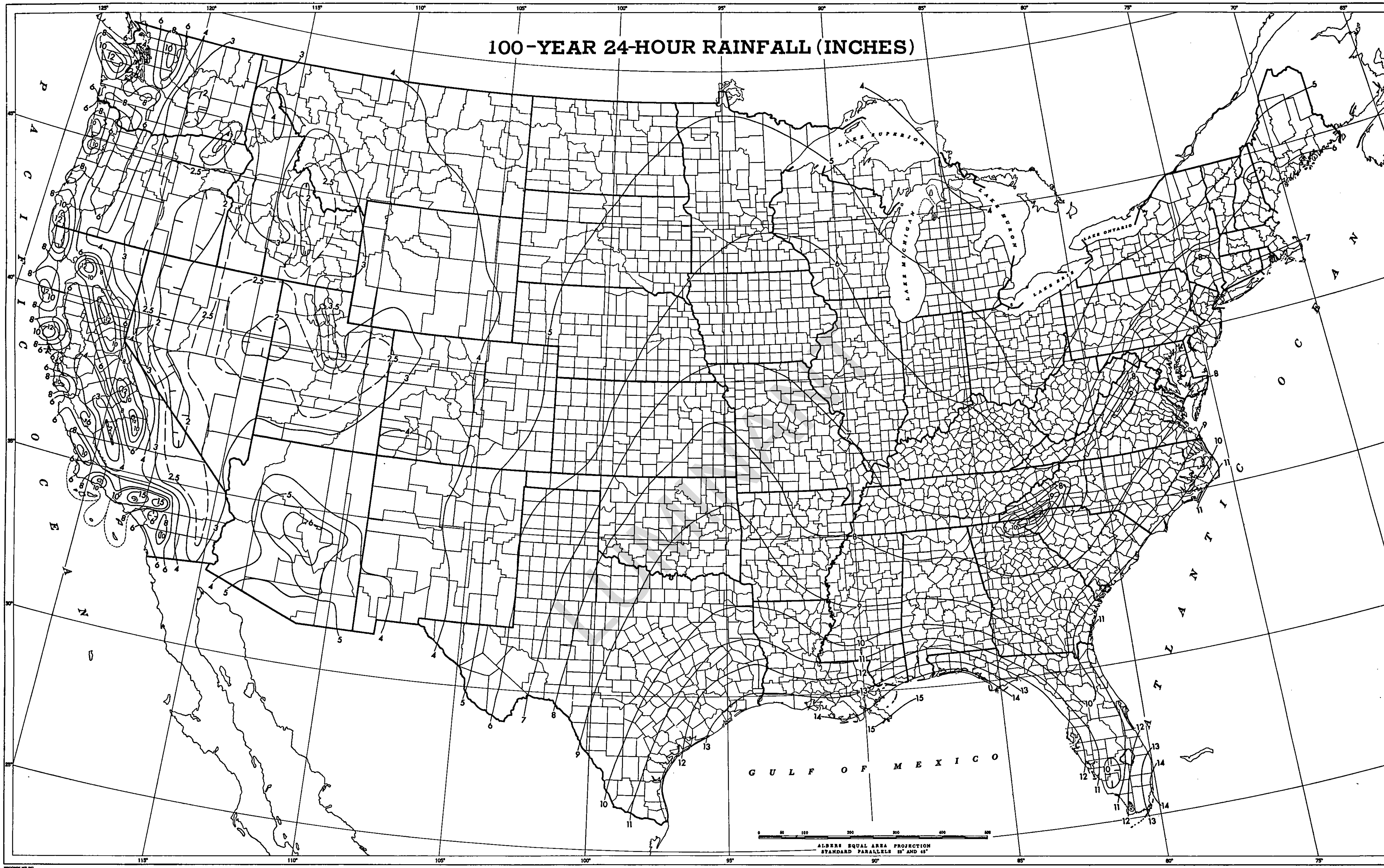
Appendix A

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°