



**US Army Corps  
of Engineers ®**

Fort Worth District

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**SAM RAYBURN DAM AND RESERVOIR  
ANGELINA RIVER  
NECHES RIVER BASIN, TEXAS**

**WATER CONTROL MANUAL  
APPENDIX B  
MASTER RESERVOIR REGULATION MANUAL**

**DEPARTMENT OF THE ARMY  
CORPS OF ENGINEERS  
FORT WORTH DISTRICT**

**FEBRUARY 2018**

**ORIGINAL MAY 1971**



**SAM RAYBURN DAM AND RESERVOIR**



**SAM RAYBURN DAM AND RESERVOIR**

## NOTICE TO USERS OF THIS MANUAL

Regulations specify that this Water Control Manual be used in loose-leaf form, and only those sections or parts thereof requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that inserts can be made to keep the manual current. All elevations referred to in this Water Control Manual, unless noted otherwise, are in feet, National Geodetic Vertical Datum of 1929 (NGVD29). The datum conversion from NGVD29 to NAVD88 is:  $NGVD29 + 0.0 \text{ feet} = NAVD88$  for Sam Rayburn Dam and Reservoir.

## EMERGENCY REGULATION ASSISTANCE PROCEDURES

Assistance with the flood control regulations of Sam Rayburn Dam will be provided during duty hours by the Fort Worth District Water Management Branch 817-886-1551. During non-duty hours, assistance can be obtained by contacting the Primary Regulator (817) 791-0973 cell number and in the order listed, one of the following persons:

## EMERGENCY PERSONNEL ROSTER

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Title and Name	Residence/Cell Telephone
Primary Regulator	817-791-0973
Chief, Water Resources Branch Redacted PII	817-886-1542
Chief, Water Management Section Redacted PII	817-886-1682
Chief, E&C Division Redacted PII	Redacted PII
Chief, Operations Division Redacted PII	Redacted PII
Manager, Piney Woods Regional Office Redacted PII	Redacted PII
Manager, Sam Rayburn Reservoir Redacted PII	Redacted PII
Water Management, Southwestern Division–Dallas CESWD-RBT-W (Water Management and Infrastructure Safety) Redacted PII	Redacted PII
Hydraulic Engineer, Redacted PII	Redacted PII

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**SAM RAYBURN DAM AND RESERVOIR  
ANGELINA RIVER BASIN, TEXAS**

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**Pertinent Data – Sam Rayburn Dam and Reservoir**

(See Exhibit A for Supplementary Pertinent Data)

**LOCATION:** In Jasper County, R.M. 25.2 on Angelina River, Neches River Basin, 10 miles northwest of Jasper, Texas.

**DRAINAGE AREA:**  
3,449 square miles  
One inch of runoff 183,947 acre-feet

**DAM:**  
Type: Rolled earth fill  
Length (including spillway and dike): 19,430 feet  
Maximum Height 120 feet  
Top Width: 42 feet  
Dikes: 10 feet

**ORIGINAL SPILLWAY:**  
Crest Elev.: 176.0 feet NGVD29  
Length: 2,200 feet  
Type: Broadcrested Weir, 16 cycles  
Control: None

**NEW SPILLWAY:**  
Crest Elev.: 176.0 feet NGVD29  
Length: 640 feet Net Opening  
Type: Labyrinth Weir, 16 cycles  
Control: None

**INFLOW:**  
Spillway Design Flood peak, cfs (1947 Study) 395,600  
Spillway Design Flood volume, ac-ft (1947 Study) 3,784,700  
Spillway Design Flood runoff, inches (1947 Study) 20.55

Probable Maximum Flood peak, cfs (1992 Study) 980,100  
Probable Maximum Flood volume, ac-ft (1992 Study) 4,217,000  
Probable Maximum Flood runoff, inches (1992 Study) 22.93

**OUTFLOW:**  
Total routed peak outflow, cfs (1961 DM2) 147,400  
Probable Maximum Flood total, cfs (1992 Study) 237,715

**OUTLET WORKS:**  
Type: Two 10 feet by 20 feet gate controlled conduits  
Invert Elev.: 105.0 feet NGVD29  
Control: 2 tractor type gates, 10 feet by 20 feet plus one emergency type gate

**POWER FEATURES:**  
Units: 2 - 26,000 kW  
Installed Capacity: 52,000 kW  
Dependable Capacity: 49,000 kW

Feature	Elev Feet* (NGVD29)	Reservoir Area (acres)	Reservoir Capacity			Spillway Capacity (cfs)	Outlet Works Capacity (cfs)
			Accumu- lative (ac-ft)	Runoff (inches)	Incre- mental (ac-ft)		
Top of Dam	193.6***						
PMF Design Water Surface (1992 Study)	186.91	198,000	6,338,100	34.46		228,399**	21,301
Max. Design Water Surface (1961 DM2)	183.0	172,800	5,611,000	30.47		125,300	22,100
Spillway Crest	176.0	153,800	4,442,400	24.15			
Top of Flood Control Pool	173.0	142,700	3,997,600	21.73	1,121,567		
Top of Power Pool (2004 Survey)	164.4	112,590	2,876,033	15.64	1,415,043		
Top of Power Head and Sediment Reserve (2004 Survey)	149.0	72,013	1,460,990	7.94	1,460,990		
Total Storage					3,997,600		
Maximum Tailwater	121.5						
Streambed (1947 Study)	70.0						

\* The elevations listed on the pertinent data sheet is based on the datum of NGVD29. The datum conversion from NGVD29 to NAVD88 is: NGVD29 + 0.0 feet = NAVD88.

\*\* Labyrinth spillway capacity under high flow condition based on the study dated Oct 2014. \*\*\*Includes parapet wall from original top of dam elevation of 190.0 feet.

**AUTHORIZATION:** River and Harbor Act of 2 Mar 45 (PL 79-14) (SD 98/76/1), modified by River and Harbor Act of 30 Jun 48 (PL 80-858). PL 88-123 approved 11 Sep 63 changed name of project from McGee Bend to Sam Rayburn Reservoir.

**FINAL PROJECT COST (OCT 81):**

Federal:	\$65,315,000
Non-Federal	<u>3,000,000*</u>
Total:	\$68,315,000

**ANNUAL O&M COST (FY 14):**

Federal:	\$5,632,700
Non-Federal:	<u>0</u>
Total:	\$5,632,700

**COST ALLOCATION METHOD:** Separable costs – remaining benefits

**LOCAL AGENCY:** Lower Neches Valley Authority and City of Lufkin, Texas

**LAND ACQUISITION:**

	: Guide Contour (NGVD29)	: Area (Acres)
Fee Simple	171.0	115,767
Easement	179.0	51,314
Forest Service		<u>33,000</u>
Total		200,081

**FLOOD DATA:**

Date	Peak Discharge (cfs) **
August 1915	82,000
June 1929	33,300
February 1932	48,800
May 1935	29,100
December 1940	13,800
November 1941	36,200
May 1944	49,900
April 1945	22,400
February 1946	24,200
June 1950	25,700
May 1953	46,000
May 1957	38,700
June 1961	20,300
July 1973	18,100
June 1969	18,600

\*\* Gaging Station: Angelina River near Horger gage (March 1928 - April 1951), February 1958-September 1973 (Discontinued).

**STATUS OF PROJECT:** Construction of project initiated 7 Sep 56. Deliberate impoundment began 29 Mar 65. Power generation began 23 Sep 65. Commercial power operation began 1 Jul 66 (1 unit) and 1 May 68 (2 units). Project is complete and operational.

**\*NON-FEDERAL PARTICIPATION AND LOCAL COOPERATION:**

As a unit of the four reservoir plan for the Neches-Angelina Rivers Basin, this project was constructed subject to contribution by local interests of \$15,000,000 toward the first cost of the system upon completion of the entire system. The Lower Neches Valley Authority (LNVA) furnished assurances that it was willing to contribute \$2,000,000 toward the completion of Town Bluff Dam and B.A. Steinhagen Lake, exclusive of power facilities, and \$3,000,000 toward construction of Sam Rayburn Reservoir. Public Law 80-858 provides that the sponsoring agency will be permitted to withdraw from B.A. Steinhagen Lake not to exceed 2,000 cfs for its own use. By resolution of 8 Sep 55, LNVA also agreed to contribute an additional \$200,000 annually for 50 years, which is (1) an additional \$10,000,000 of non-federal funding toward the first cost of construction, and (2) paid in full in 2015. A water supply contract with LNVA was approved by the secretary of the Army on 22 Jan 57 and a Memorandum Understanding between the U.S. and LNVA approved on 30 July 2015 embodying the above provisions. LNVA pays no O&M cost except on features and appurtenances which may be provided and owned by the LNVA.

A contract with the city of Lufkin was approved on 22 May 69 for 2.98 percent (43,000 ac-ft) of the conservation storage between elevations 164.4 and 149.0 feet NGVD29. The City of Lufkin agreed to pay annual installments totaling \$525,600 over an approximately 50-yr period, in addition to a share of the project's annual O&M cost for the life of the project.

**REMARKS:** Marketing agency for the hydropower generated is the Southwestern Power Administration. Construction of related projects in Neches-Angelina Rivers Basin included in the authorizing Act included in the Rivers and Harbors Act of 2 Mar 45, i.e., construction of Dam “A” and Rockland Reservoir is to be deferred until justified by future considerations. Dam “A” and Rockland Reservoir were de-authorized in November 1988.

Dependable yield\*\*\*: 1,263 cfs or 816.3 MGD  
 \*\*\*Based on a critical dry period from 1953-1957 and 50 years of sedimentation

Annual Visitation (10-year average, 2004-2014): 1,558,040

Shoreline at top of conservation pool: 750 miles

**SAM RAYBURN DAM AND RESERVOIR  
ANGELINA RIVER, TEXAS  
WATER CONTROL MANUAL**

**CHAPTER I – INTRODUCTION**

**1-01. Authorization.** This manual is submitted as required by Engineering Regulation (ER) 1110-2-240, Water Control Management, dated 30 May 2016, and is prepared in accordance with ER 1110-2-8156, Engineering and Design, Preparation of Water Control Manuals, dated 31 August 1995.

**1-02. Purpose and Scope.** The purpose of this manual is to document the Sam Rayburn Dam and Reservoir Regulation plan. This manual also provides a concise reference source for higher authority personnel who will be concerned with or responsible for reservoir regulations during the life of the project. This manual also includes the regulation plan for Sam Rayburn Dam and Reservoir and the background material necessary to understand the purpose and application of the plan. Sam Rayburn Dam and Reservoir was originally identified as “McGee Bend Dam and Reservoir.”

**1-03. Related Manuals and Reports.** This manual is Appendix B to the Neches River Basin Water Control Master Reservoir Regulation Manual. A full report on the public hearing and the report on the preliminary examination of the Neches River and tributaries was submitted to the Chief of Engineers by the District Engineer, Galveston District, on 10 April 1937. A subsequent report titled Senate Document Number 98, 76th Congress, 1st Session was published on 14 April 1939, in this report, the District Engineer recommended the construction of four dams (Rockland Dam, McGee Bend Dam, Dam A, and Dam B) for the purpose of regulating the flow of the river for the benefit of navigation, the control of floods, the conservation of water, and the development of hydroelectric power. In 1945, Sam Rayburn Reservoir was authorized by the River and Harbor Act of 1945 (Public Law 14, 79th Congress, 1st Session) in accordance with the plan outlined in Senate Document 98 (76th Congress, 1st Session). The authorizing act was modified by the River and Harbor Act approved 30 June 1948 (Public Law 858, 80th Congress, 2nd Session). The Definite Project Report for Sam Rayburn Reservoir was prepared by the Knappen Engineering Company of New York, New York under the direction of the Galveston District Engineer and was submitted to the Chief of Engineers on 1 October 1947. Reinvestigation of Sam Rayburn Reservoir was authorized by the Chief of Engineers on 16 May 1950. The report was submitted in October 1953. Authority to initiate advance planning on the Sam Rayburn project is contained in the advice of allotment for preconstruction planning C-395, dated 7 September 1955.

The hydrology on Sam Rayburn Reservoir, as originally submitted in 1945 in connection with the Definite Project Report studies, was previously brought up to date and resubmitted in 1955 as Appendix I, Hydrology to Design Memorandum No. 2, General. However, subsequent to submission of Design Memorandum No. 2, major changes were adopted in the reservoir regulation plan, spillway dimensions, freeboard requirements, etc. All approved and

recommended changes in Hydrology have been incorporated in Design Memorandum No. 15 Sam Rayburn Dam and Reservoir, Hydrology (revised), dated November 1959. In May 1971, the Fort Worth District (SWF) of the United States Army Corps of Engineers (USACE) published a reservoir regulation manual for Sam Rayburn Dam and Reservoir. The manual contains plans and procedures for regulation of the reservoir during both normal and flood conditions.

The reports and design memorandums important to the regulation of Sam Rayburn Dam and Reservoir are listed in Table 1-1.

**1-04. Project Owner.** The U.S. Government owns and Water Management Office in Fort Worth District operates Sam Rayburn Dam and Reservoir.

**TABLE 1-1**

**Related Manuals and Reports for Sam Rayburn Dam and Reservoir**

Title	Date
1. Report on Survey of Neches River and Tributaries, Texas - For Flood Control and Allied Purposes	December 1939
2. Definite Project Report on McGee Bend, Dam "B," Rockland, and Dam "A" Reservoirs - Volume I of 5 Volumes - General - Volume II of 5 Volumes - McGee Bend Reservoir - Volume III of 5 Volumes - Dam "B" Reservoir - Volume IV of 5 Volumes - Rockland Reservoir - Volume V of 5 Volumes - Dam "A" Reservoir	September - October 1947
3. Analysis of Design for Construction of Spillway	February 1948
4. Definite Project Report (Revised) on McGee Bend Reservoir - Real Estate Section	July 1951
5. McGee Bend Reservoir - Brief Report on Angelina River Project - Reinvestigation of McGee Bend Reservoir, Angelina River, TX - 1st revision - 2nd revision	January 1952  November 1952 July 1953
6. Dam B Reservoir - Reservoir Regulation Manual	March 1956
7. McGee Bend Reservoir - Survey Data - Dam Site Work Areas and Reservoir Area	July 1961
8. McGee Bend Reservoir - Design Memorandum No. 1 - Construction for Fiscal Year 1956	May 1958
9. McGee Bend Reservoir - Design Memorandum No. 2 - General Design - General Design (Revised)	December 1955 April 1961
10. McGee Bend Reservoir - Design Memorandum No. 3 Real Estate - Construction Area Part I - First Increment - Construction Area Part I - Second Increment Relocations (Real Estate) - Part I - Gulf Coast & S.F. Railroad - Part II - First Increment (Hwy 147) - Part II - Second Increment (Hwy 147) - Part III - Highway 96 Reservoir Area - Part I - Part II - Part III - Part IV - Part V	  January 1957 February 1957  August 1957 March 1957 July 1957 August 1959  December 1957 August 1958 February 1959 April 1960 September 1960

**TABLE 1-1 (CONTINUED)**

**Related Manuals and Reports for Sam Rayburn Dam and Reservoir**

Title	Date
11. McGee Bend Reservoir - Design Memorandum No. 4 Relocations:	
- Part I - Pipelines (Section A, B, C, D, E)	
- Part II - Highways (Section A, B, C, D, E, F)	
- Part III - County Roads and Forest Service Roads	September 1958
- Supplement No. 1	May 1959
- Part IV - Railroads:	
- GC and SF Railway	Oct 1957
- A and NR Railroad	February 1960
- Part V - Power & Telephone Lines:	
- (Section A) - Texas Power & Light Co.	
- (Section B) - Deep East Texas Electric Coop. Inc.	November 1961
- (Section C) - Jasper-Newton Coop.	
- Part VI - Cemeteries:	
- (Section A) - Cemeteries No. 1 through 16	September 1958
- (Section B) - Cemeteries	January 1960
12. McGee Bend Reservoir - Design Memorandum No. 5 - Spillway	August 1956
13. McGee Bend Reservoir - Design Memorandum No. 6 - Availability of Materials	September 1956
14. McGee Bend Reservoir - Design Memorandum No. 7 - Earthen Dam	November 1956
15. McGee Bend Reservoir - Design Memorandum No. 8 - Hydro Power Studies	July 1959
16. McGee Bend Reservoir - Design Memorandum No. 10 - Clearing (Part I)	November 1960
- Clearing (Part II)	January 1962
17. McGee Bend Reservoir - Design Memorandum No. 11 - Power Plant Preliminary Design Report No. 11-1	January 1960
- Flood Control Outlet and Power Intake Works Design Report No. 11-2 - (Inlet Channel, Outlet Channel, Retaining Walls, Stilling Basin, and Earthen Dam)	January 1960
- Flood Control Outlet Works, Power Intake, and Power Plant Design Memorandum Report No. 11-3	
- Volume No. 1	February 1962
- Volume No. 2	April 1962
- Volume No. 3	June 1961
- Volume No. 4	June 1961
- Volume No. 5	June 1961
- Volume No. 6	August 1961

**TABLE 1-1 (CONTINUED)****Related Manuals and Reports for Sam Rayburn Dam and Reservoir**

Title	Date
18. Design Memorandum Report No. 11-4 - Flood Control Outlet & Power Intake (Quantity & Cost Estimate)	March 1962
19. McGee Bend Reservoir - Design Memorandum No. 12 Operational Buildings & Utilities - Revised Addition	August 1961 November 1962
20. McGee Bend Reservoir - Design Memorandum No. 13 Recreation Facilities: - Preliminary Recreation Plan (Section A) - Construction Design Memo (part of Master Plan) (Sect. B) - Joint Master Plan (Design Memorandum No. 13B) - Revised No. 13B - Part One (Updated Joint Master Plan - No. 13C) - Appendix A (Cost Estimates for Joint Master Plan - No. 13C) - Appendix B (Updated Joint Master Plan - No. 13C) - Appendix A-A (Updated Joint Master Plan - No. 13C)	December 1956 May 1962 July 1962 January 1966 September 1970 September 1970 September 1970 October 1972
21. McGee Bend Reservoir - Design Memo. No. 14 - Brookeland	March 1959
22. McGee Bend Reservoir - Design Memo. No. 15 - Hydrology (Revised)	November 1959
23. McGee Bend Reservoir - Design Memo. No. 16 - Cost Allocation - First Revised Addition - Second Revised Addition	November 1965 September 1989 August 1996
24. McGee Bend Reservoir - Design Memo. No. 17 - West Access Road	December 1960
25. McGee Bend Reservoir - Design Memo. No. 18, - Cathodic Protection of Flood Control & Power Intake Gates	March 1962
26. McGee Bend Reservoir - Design Memo. No. 19, - Shelter for Fallout Protection	Indefinite
27. McGee Bend Reservoir - Design Memo. No. 20, - Exhibition and Guided Tour	March 1971
28. McGee Bend Reservoir - Design Memo. No. 21 - Shoreline Erosion	September 1975
29. McGee Bend Reservoir - Analysis of Design	November 1962
30. Analysis of Design - Appendix A, - General, Foundation Treatment, and Hydraulics - Computations	November 1962
31. Analysis of Design - Appendix B, - Structural, Part I - Computations	November 1962
32. Analysis of Design - Appendix C, - Structural, Part 2 - Computations	November 1962
33. Analysis of Design - Appendix D, - Gates and Guides - Computations	November 1962
34. Analysis of Design - Appendix E, - Mechanical & Electrical Computations	November 1962
35. Analysis of Design - Appendix F, - Two Transfer Arrangement Computations	November 1962

**TABLE 1-1 (CONTINUED)**

**Related Manuals and Reports for Sam Rayburn Dam and Reservoir**

Title	Date
36. Neches River Saltwater Barrier - Miscellaneous Paper H-74-9	March 1956
37. Neches River Master Manual	
38. Sam Rayburn Reservoir - Reservoir Regulation Manual, Appendix 2	May 1971
39. Sam Rayburn Reservoir	
- Instructions for Regulating Storage in Sam Rayburn Reservoir	March 1965
40. Sam Rayburn Reservoir - Pool Raise (approved April 1972)	
- Raising the Top of Conservation Pool Level at Sam Rayburn Reservoir	April 1972
41. Sam Rayburn Reservoir - Approval of Interim Operating Rule Curves	February 1981
42. Sam Rayburn Dam and Reservoir - Reconnaissance Report, - Dam Safety Assurance Program	May 1984
43. Submission of Design Analysis Report (DAR) for Addition of Hydropower to Town Bluff Dam	1984
44. Sam Rayburn Dam and Reservoir - Storage Reallocation Study	June 1986
45. Sam Rayburn Dam and Reservoir - Spillway Erodibility, - Reconnaissance Report for Major Rehab. Program	September 1986
- Reconnaissance Report (Revised)	April 1988
- Reconnaissance Report (Revised)	March 1990
- Reconnaissance Re-Evaluation Report	April 1991
- Reconnaissance Re-Evaluation Report	July 1991
46. Sam Rayburn Dam and Reservoir - Flood Emergency Plan	
47. Sam Rayburn Dam and Reservoir - Storage Reallocation Study	
48. Sam Rayburn Dam and Reservoir - Dam Safety Assurance Program - Spillway Modification and Freeboard Restoration	October 1992
49. Periodic Inspection Report No. 12	April 2016

**1-05. Operating Agency.** USACE is the operating agency for Sam Rayburn Dam and Reservoir. The Lake Manager at Sam Rayburn Dam has the responsibility for its operations and management of the lake. The District Engineer through the Water Resources Branch of the Engineering and Construction Division directs water control activities.

USACE operates the hydropower facilities at the dam in coordination with Southwestern Power Administration (SWPA), which markets the hydroelectric capacity and energy from the project.

The project is staffed during normal working hours throughout the year. The Lake Manager at Sam Rayburn Dam has the responsibility for its operations. Lake Rangers are also available on holidays and weekends to provide assistance with the lake operations.

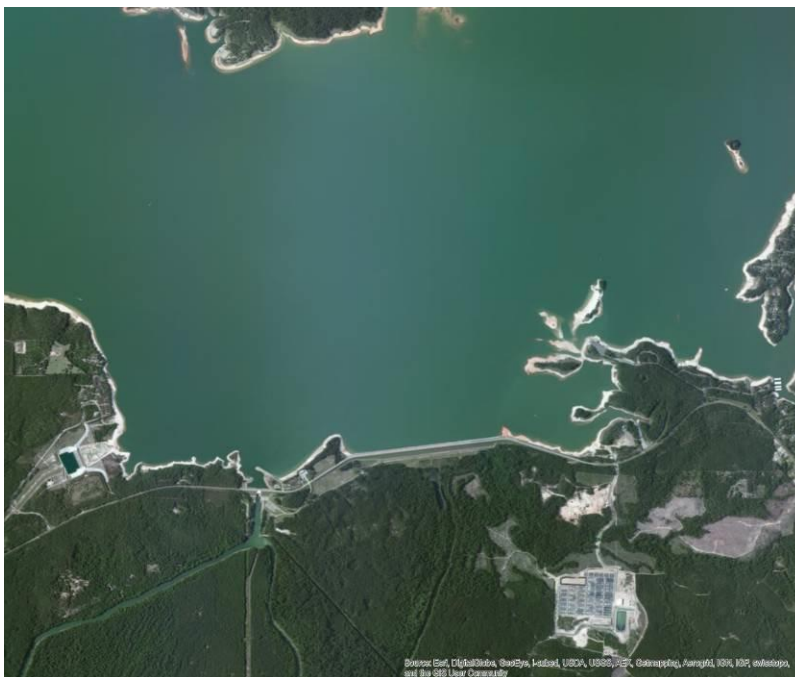
The Lake Manager will have a current list of the Water Resources Branch personnel including home telephone numbers to contact when necessary. The Lake Manager will furnish the Water Resources Branch a list of project personnel, giving their office and home telephone numbers. The Lake Manager resides as close to the project as is considered prudent to carry out his official duties.

**1-06. Regulating Agencies.** USACE-SWF is the regulatory agency for Sam Rayburn Dam and Reservoir. The regulation of the dam and hydropower is the responsibility of the Water Resources Branch of the Engineering and Construction Division, Fort Worth District.

## **CHAPTER II – DESCRIPTION OF PROJECT**

**2-01. Location.** Sam Rayburn Dam and Reservoir are located on the Angelina River at river mile 25.2 about 10 miles northwest of Jasper, Texas. The lake is located in the north central part of Jasper County. The total drainage area above Sam Rayburn Dam is 3,449 square miles, which is 97% of the drainage area of the Angelina River Basin. The location of the dam and reservoir is shown on Plates 2-1a and 2-1b, respectively.

**2-02. Purpose.** Sam Rayburn Dam and Reservoir is a multi-purpose project used for flood control, water supply, hydropower, navigation, fish and wildlife, and recreation. The project is a unit of the Neches-Angelina River Basin System, which consists of two constructed USACE lakes and two deauthorized projects (Dam A and Rockland Reservoir), and various channel improvements and levees operated to provide flood protection along the Neches-Angelina River. Sam Rayburn Dam and Reservoir operates in conjunction with Town Bluff Dam and B.A. Steinhagen Lake to provide flood control to the Angelina and Neches River Basin system in Southeast Texas, supply water to the Lower Neches Valley Authority (LNVA) and the Beaumont and Lufkin areas, produce a clean source of electric generation and provide recreation. An aerial view of the Sam Rayburn Dam is shown in Figure 2-1.



**Figure 2-1. Aerial View of Sam Rayburn Dam**

**2-03. Physical Components.** Sam Rayburn Dam consists of a rolled earthfill main embankment, two rolled saddle dikes, an uncontrolled labyrinth weir spillway, outlet works, and hydropower facility. The total length of the dam is 19,430 feet, including spillway and dikes.

The general plan of the embankment and spillway is shown on Plate 2-2. Additional information on Sam Rayburn Dam and Reservoir is provided in Exhibit A, Supplementary Pertinent Data.

a. **Embankment.** The main embankment consists of a 12,400 feet long rolled earthfill structure with a crown width of 42 feet. The maximum height of embankment is about 120 feet and the top of embankment is at elevation 190.0 feet. The upstream slope protection consists of 24-inch of rock riprap on 9-inch of gravel bedding, extending from the top of the dam to the top of the power head and sediment storage at elevation 149.0. The downstream slope protection consists of 18-inch of riprap on 7-inch of bedding extending from the ground surface up to elevation 123.5. All other areas of the embankment are protected by native grasses. A roadway on the top of dam is 24 feet wide with two 8-foot shoulders and an additional one foot on each side for metal guard rails and posts. Two saddle dikes were constructed about 4.2 miles east of the left abutment, and are named Dike A and Dike C. The dikes consist of rolled earthfill and are a total of 3,790 feet long. Maximum height of Dike A is 22 feet and Dike C is 18 feet. The top of dike width is 10 feet. Both dikes have 1 vertical on 2.5 horizontal (1V on 2.5H) side slopes. Slope protection of Dike A is 12-inch of rock riprap on 6-inch of gravel bedding, and no slope protection other than grassing is on Dike C. The embankment plan, profiles and a typical section are shown on Plate 2-3. The dike plans, profiles, and a typical section are shown on Plate 2-4. The upstream view of the embankment is shown in Figure 2-2.



**Figure 2-2. Upstream View of Embankment and Intake Structures**

In 1996, a concrete parapet wall was erected on top of the embankment to increase the freeboard. The parapet wall is an inverted tee, about 3.6 feet high, raising the top of the dam to elevation 193.6 feet.

b. **Spillway.** The spillway is an uncontrolled labyrinth weir with a net opening of 640 feet and crest at elevation 176.0 feet. The spillway is located in a saddle about 7,000 feet west of the right abutment of the main embankment and about 5,000 feet west of the outlet works and powerhouse. The discharge capacity of the spillway is 228,399 cubic feet per second (cfs) when the water surface elevation is at 186.91 feet. It is the first labyrinth weir emergency spillway constructed by USACE. The spillway plan, profile and section are shown on Plate 2-5. The aerial view of the spillway is shown in Figure 2-3.



**Figure 2-3. Aerial View of Spillway**

c. Outlet Works. The outlet works consist of two 10-foot by 20-foot conduits through the powerhouse structure with the intake adjacent to the power intake structure on the left side of the powerhouse. The conduit discharges are controlled by two 10-foot by 20-foot tractor-type gates with intake inverts at elevation of 105.0 feet and outlet inverts at elevation 85.0 feet. The powerhouse and outlet works are located in a saddle earth-fill dam about 2,000 feet west of the main embankment. The conduits are 180 feet long. The outlet works are shown on Plate 2-6. The tractor-type gate is shown in Figure 2-4.



**Figure 2-4. Tractor-Type Gates**



**Figure 2-5. Outlet Works Stilling Basin and Discharge Channel**

d. Stilling Basin. The spillway stilling basin is 109 feet long and 640 feet wide, with 33 feet tall training walls on either side. The floor of the spillway stilling basin is at elevation 102.0 feet. The outlet works stilling basin is 145 feet long and 44 feet wide. The floor of the stilling basin is at elevation 61.0 feet. Both basins have baffle blocks and an end sill to assist in the dissipation of kinetic energy and reduce erosion velocities in the existing downstream channel. The outlet works stilling basin and discharge channel are shown in Figure 2-5.

e. Hydropower Facilities. The hydropower facility at Sam Rayburn Dam is named the Sam Rayburn Hydroelectric Powerplant. SWPA markets the hydropower output from the project. Power generation began in in September 1965 with limited output during the equipment testing period. The commercial power production began on 1 July 1966. The powerhouse is located approximately 2000 feet west of the main embankment. The power intake consists of four 10-foot by 28-foot penstocks with inverts at elevation 105.0 feet. Flows through the penstocks are controlled by four 18 feet wide and 28 feet high caterpillar gates. The powerhouse contains two 26,000 kilowatt (kW) vertical type generators connected to Kaplan type turbines each having a guaranteed capacity of 29,700 horsepower at a net head of 53 feet. A section of power intakes is shown on Plate 2-7. The powerhouse is shown in Figure 2-6. The draft tube gates are shown in Figure 2-7. The downstream channel is shown in Figure 2-8, and the generators are shown in Figure 2-9.

f. Water Supply Facilities. There are no water supply intake facilities within the lake.



Figure 2-6. Powerhouse



Figure 2-7. Draft Tube Gates



Figure 2-8. Downstream Channel



Figure 2-9. Powerhouse Generators

**2-04. Related Control Facilities.** Sam Rayburn Reservoir is part of the USACE plan for flood control on the Neches River and its tributaries. The plan presently consists of two USACE projects, Sam Rayburn Dam and Town Bluff Dam (also known as Dam B). The two dams are operated to control floods, conserve water, regulate stream flow for water supply and navigation on the Neches River downstream of Town Bluff Dam, and generate hydroelectric power.

USACE built a Permanent Salt Water Barrier across the Neches River downstream of Town Bluff Dam in Jefferson and Orange Counties near Beaumont, Texas. The saltwater barrier was completed in October 2003 and is operated by LNVA. Daily coordination between USACE and LNVA is necessary to ensure that the project purpose of stream flow regulation for water supply in the vicinity of Beaumont is met.

**2-05. Real Estate Acquisition.** A total of 115,767 acres for fee simple, 51,314 acres for flood flowage easement, and 33,000 acres for forest service land were acquired for the operation of the Sam Rayburn Dam and Reservoir. The real estate fee take line is based on a guide contour elevation of 171.0 feet, while the flood flowage easement was based on a guide contour elevation of 179.0 feet for main part of the lake and a guide contour elevation 189.0 feet for the upper reaches.

**2-06. Public Facilities.** Ten recreation areas around the reservoir are operated by USACE for public use and an additional six parks are leased and operated by county governments and private individuals. The areas are listed in Table 2-1 and shown on Plate 2-8. Facilities provided at these parks consist of roads, parking areas, boat ramps, camping and picnicking facilities, walkways, sanitation facilities, potable water, and swimming areas.

**TABLE 2-1**

**Recreation Areas at Sam Rayburn Dam and Reservoir**

1. Ebenezer Park
2. Twin Dikes Park
3. Mill Creek Park
4. San Augustine Park
5. Rayburn Park
6. Hanks Creek Park
7. Monterey Park
8. Marion Ferry Park
9. Etoile Park
10. Ralph McAlister Park
11. Umphrey Family Pavilion\*
12. Cassells-Boykin Park\*
13. Sam Rayburn Marina Resort\*
14. Powell Park Marina\*
15. Jackson Hill Marina\*
16. Shirley Creek Marina\*

Note: \* Indicates parks leased and operated by county government or private individuals.

### **CHAPTER III – HISTORY OF PROJECT**

**3-01. Authorization.** Congressional authority for the construction of the Sam Rayburn Dam and Reservoir (McGee Bend Dam and Reservoir) on the Angelina River was contained in the River and Harbor Act approved 2 March 1945 (Public Law 14, 79th Congress, 1st Session) in accordance with the plan outlined in Senate Document 98 (76th Congress, 1st Session). The authorization was modified by the River and Harbor Act approved 30 June 1948 (Public Law 858, 80th Congress, 2nd Session). Authority to initiate advance planning is contained in the advice of allotment for preconstruction planning C-395, dated 7 September 1955.

On 11 September 1963, McGee Bend Dam and Reservoir was officially renamed Sam Rayburn Dam and Reservoir (Public Law 88-123, 88th Congress, H.R. 7594). Mr. Sam Rayburn was a Texas Congressman who served as Speaker of the U.S. House of Representatives for 17 years, the longest tenure in U.S. history, and he was a champion of soil and water conservation.

**3-02. Planning and Design.** A public hearing was held in Jacksonville, Texas on 9 September 1936, for the purpose of affording all interested parties an opportunity to present their views concerning improvement of the Neches River and its tributaries in connection with the preliminary examination and review of reports on the Neches River, Texas. At this public hearing and in further correspondence and conferences, local interest, represented by both the Sabine-Neches Conservation District, a state-authorized agency, and the Lower Neches Valley Authority (LNVA) requested improvements in the Neches River watershed for flood control, water conservation, and allied purposes.

A full report of the aforementioned public hearing along with the report on preliminary examination of the Neches River and tributaries was submitted to the Chief of Engineers by the District Engineer, Galveston District, on 10 April 1937. Subsequently printed as Senate Document 98, Seventy-sixth Congress, First Session, the District Engineer recommended the construction of four dams for the benefit of navigation, the control of floods, the conservation of water, and the development of hydropower on the lower watershed. The dams recommended for construction were as follows:

- a. Rockland Dam at river mile 164.5 on the Neches River
- b. McGee Bend (now Sam Rayburn) Dam at river mile 25.2 on the Angelina River
- c. Dam A at river mile 142.0 on the Neches River
- d. Dam B (now Town Bluff) at river mile 113.7 on the Neches River

The Chief of Engineers' recommendation was made subject to the provision that, before construction was started upon any element of the project, the State of Texas or other responsible local agency give assurances satisfactory to the Secretary of War (the Army), that upon completion of the entire project the agency would contribute the sum of \$5,000,000 towards the first cost of the work.

In a later report on survey of the Neches River and tributaries dated 15 December 1939, the

District Engineer considered the feasibility of other improvements requested by local interests, concluded that none were economically justifiable at that time, and recommended that no improvements be undertaken by the Federal Government other than those requested in Senate Document 98.

Subsequent to the preparation of the survey report but prior to authorization for construction of the project, LNVA submitted an application to the Federal Government for a permit to construct an earthen dam across the Neches River near Rockland, Tyler County, Texas. At the time the application for the permit was under consideration by the Office, Chief of Engineers, the 1945 River and Harbor Bill was being formulated. Since the bill contained the authorization of the Neches and Angelina Rivers project, LNVA was willing for USACE to construct the project in accordance with the plan contained in Senate Document 98, in lieu of being granted a permit to construct Rockland Dam. The granting of the permit was therefore held in abeyance in compliance with the desires of LNVA. The River and Harbor Act authorizing construction of the Neches-Angelina project was approved 2 March 1945 (Public Law 14, 79th Congress, Chapter 19, 1st Session, S. 35).

A public hearing was held in Jasper, Texas, on 13 November 1946 to give information to all interested parties concerning the project plan for improvement of the Neches and Angelina Rivers, Texas and to obtain their views thereon. Approximately 400 persons attended the hearing, including representatives of Federal, State, County, and municipal agencies, local civic groups, private businesses, and landowners. The preponderance of the opinions expressed at the hearing was favorable to the proposal of USACE. The principal opposition to Sam Rayburn Reservoir was from individuals within the reservoir area whose lands would be inundated. Mr. W.R. Cousins, landowner in the reservoir area, stated that he represented himself and approximately 100 other land owners within the reservoir area who objected to the proposed construction. The residents of the town of Brookeland objected to the proposed level of the water surface in Sam Rayburn Reservoir. They presented a petition requesting that the water surface level of the proposed reservoir be lowered and the Santa Fe Railroad, U.S. Highway 96, and the town of Brookeland be left intact, or if that is not possible, that the town, railroad and highway be relocated together at a site approved by a committee representing Brookeland.

The Definite Project Report for the Neches and Angelina Rivers, Texas project was being formulated in 1946 and it became evident that Dam B and one of the two large reservoirs could be constructed with benefits exceeding costs. The combination of McGee Bend Dam with hydropower facilities and Dam B without hydropower facilities had a positive B/C ratio. With a recommendation forthcoming that construction of the Rockland and Dam A reservoirs be deferred, a 15 November 1946 letter from the District Engineer to LNVA noted that “the storage capacities of McGee Bend and Dam B Reservoirs are now designed to fully meet the existing multiple water demands of the lower Neches River valley under conditions of severe drought, plus a reasonable allowance for future increased water uses.” The letter went on to suggest that LNVA furnish assurances that it would contribute \$5,000,000 toward the first cost of the construction McGee Bend (Sam Rayburn Dam) and Dam B (Town Bluff Dam) at the time of their completion instead of at the time that all four reservoirs have been constructed. In reply to

this suggestion, the LNVA furnished assurances that it was willing to contribute \$2,000,000 toward completions of Town Bluff Dam and B.A. Steinhagen Lake, exclusive of hydropower facilities, and \$3,000,000 upon completion of the Sam Rayburn Dam and Reservoir. The assurances were forwarded to the Office, Chief of Engineers, on 10 February 1947 and accepted by the Under Secretary of War (the Army) on 27 March 1947.

Results of the definite project studies were presented in a report prepared in five volumes by the Knappen Engineering Company of New York, New York, under the direction of the Galveston District Engineer and were submitted to the Division Engineer, Southwestern Division, Corps of Engineers, during September and October 1947. Volume II, Sam Rayburn Reservoir contains only the data pertinent to the Sam Rayburn Dam and Reservoir, and was submitted 1 October 1947.

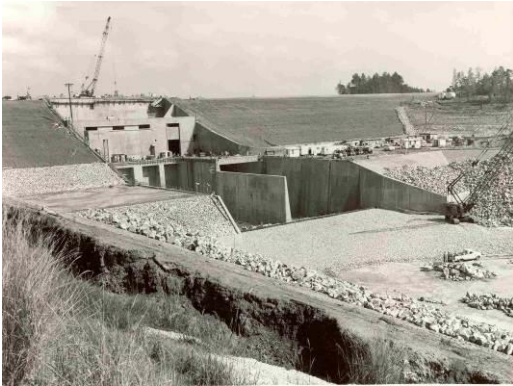
Reinvestigation of Sam Rayburn Reservoir was authorized by the Chief of Engineers on 16 May 1950. The national economy changed considerably from the time the project document was prepared in 1939 and 1953. In view of the changes in the economy, reinvestigations were made of the storage capacities allocated to the various purposes of the project and comparative studies were made of costs and benefits that would accrue to the project as planned and with reduced storage capacities. The policies governing land acquisition, relocations and reservoir clearing were reviewed with a view to reducing project costs and cost estimates and benefits were revised to the July 1953 price level. This report was then submitted in October 1953.

The hydrology on Sam Rayburn Reservoir was also brought up to date and resubmitted in 1955 as Appendix I, Hydrology to Design Memorandum No. 2 General. However, subsequent to submission of Design Memorandum No. 2, major changes were adopted in the reservoir regulation plan, spillway dimensions, freeboard requirements, etc. The updated hydrology report was submitted as Design Memorandum No. 15 Sam Rayburn Dam and Reservoir, Hydrology (Revised), dated November 1959.

A public hearing was held at Jasper, Texas, on 13 December 1960 with a total attendance of 225 persons, which included representatives of various federal, state, and local governmental agencies and interested individuals. The purpose of the hearing was to inform the public of the location and extent of the areas selected for development for public use, the proposed plan of recreational development, and to secure information relative to the extent that state and local governmental agencies would desire to participate in the development and operation of recreational facilities and activities in the interest of the general public.

**3-03. Construction.** The construction of Sam Rayburn Dam began in September 1956 and was completed in March 1965 with an initial conservation pool elevation of 164.0 feet and deliberate impoundment began on 29 March 1965. The construction cost of the dam was \$68,315,000. The ultimate project conservation pool elevation was raised to 164.4 feet on 7 April 1972. The conservation pool at Sam Rayburn Reservoir remains at elevation 164.4 feet to this day. Due to the potential for erosion in the discharge channel below the original uncontrolled broadcrested weir, in 1994, construction began on a 640-foot labyrinth weir spillway at the same location with

the same crest elevation. The new spillway was completed in 1996. Also in 1996, a parapet wall was constructed on top of the existing dam embankment to increase the freeboard height to comply with Dam Safety requirement ER 1110-8-2 (FR). Table 3-1 outlines the important dates in the construction of Sam Rayburn Dam. Figures 3-1 through 3-4 show some of the construction phases.



**Figure 3-1. Dam Construction**



**Figure 3-2. Dam Construction**



**Figure 3-3. Dam Construction**



**Figure 3-4. Dam Construction**

**TABLE 3-1****Resume of Construction Activities**

Activity	Date
First construction contract award	6 August 1956
Construction began on earthen dam	11 July 1957
Closure of earthen embankment	15 January 1965
Flow diverted through outlet works	11 February 1965
Deliberate impoundment began	29 March 1965
Dedication of dam	May 1965
Power generation began	23 September 1965
Conservation pool filled to elevation 164.0	11 May 1968
Conservation pool filled/raised to elevation 164.4	7 April 1972
Construction began on labyrinth weir	10 January 1994
Labyrinth weir and parapet wall completed	5 December 1996

**3-04. Related Projects.** Sam Rayburn Dam is one of four dams authorized in the Neches-Angelina River Basin by the River and Harbor Act of 1945 (Public Law 14, 79th Congress, 1st Session). The four dams are known as Rockland Dam, McGee Bend Dam (Sam Rayburn Dam and Reservoir), Dam A, and Dam B (Town Bluff Dam and B.A. Steinhagen Lake). In 1945, Congress approved the funding for Dam B, and construction began in 1947. Congress changed the name of Dam B to Town Bluff Dam, B.A. Steinhagen Lake in 1967. Rockland Dam and Dam A, which were to be located on the Neches River upstream from the confluence of the Neches and Angelina Rivers, were deferred on the basis of economic studies until justified by future conditions. Rockland Dam and Dam A were deauthorized in November 1988. The dam and lake projects of the Neches River Basin are listed in Table 3-2.

**TABLE 3-2****Neches-Angelina River Basin Projects**

Project	Stream	Year of Completion
Sam Rayburn Dam (McGee Bend Dam)	Angelina River	1965
Rockland Dam	Neches River	Deauthorized (Nov 1988)
Dam A	Neches River	Deauthorized (Nov 1988)
Town Bluff Dam (Dam B)	Neches River	1951

**3-05. Modification to Regulations.** The top of the conservation pool at Sam Rayburn Reservoir was raised from 164.0 feet to 164.4 feet due to a reallocation of flood control storage to water supply storage for the city of Lufkin, Texas, on 7 April 1972. Contract No. DACW63-69-C0007, dated 7 January 1969, provides the city of Lufkin with 2.98 percent of the storage space between elevations 149.0 and 164.4 feet. The reallocation of flood control storage to water supply storage was the result of the Secretary of the Army approving a water supply contract with the city of Lufkin, Texas on 27 May 1969. The official raising of the conservation pool was directed in a letter from Southwestern Division dated 7 April 1972.

In July 1980, a policy was adopted by Southwestern Division to limit the drawdown at Corps of Engineer's projects that have hydro-electric power facilities. When Sam Rayburn Reservoir is in the conservation pool, the maximum drawdown is limited to 2 feet in a month. During periods of extended high power demands, a deviation from this policy may be approved by Southwestern Division.

On 13 February 1981, reservoir power pool operating rule curves were initially adopted for a one-year trial period. The rule curves divide the power pool storage space (149.0 to 164.4) into four zones with bounding elevation limits that fluctuate with time of year and serve to restrict the allowable hydropower generation discharge volume as the lake level falls. The basis for development of these rule curves included the need for salinity control releases to protect freshwater supply intakes on the lower Neches River in the vicinity of Beaumont. The need for salinity control releases from Town Bluff Dam and Sam Rayburn Dam were greatly reduced in October 2003 upon completion of the permanent saltwater barrier on the lower Neches River. Although re-evaluation of the 1981 operating rule curves has been discussed, they remain in effect today.

On 10 July 2014, the latest amendment to the Certificate of Adjudication No. 06-4411 was issued as No. 064411K by the Texas Commission on Environmental Quality (TCEQ). The original

certificate from August 1986 authorized LNVA to maintain two impoundments (Lake Sam Rayburn on the Angelina River and B.A. Steinhagen on the Neches River); to divert and use not to exceed 381,876 acre-feet of water per year from several points on Pine Island Bayou, tributary of the Neches River, and the Neches River, and 792,000 acre-feet of water per year from the perimeter of Lake Sam Rayburn and a point on B.A. Steinhagen Lake, Neches River Basin for agricultural, industrial, mining, and municipal purposes.

The July 2014 amendment authorizes LNVA to use up to 1,173,876 acre-feet of water, for agricultural, industrial, municipal, and mining purposes of which a) 1,153,876 acre-feet is for agricultural, industrial, and municipal purposes; and b) 20,000 acre-feet is for agricultural, industrial, municipal, and mining purposes within the LNVA service area. The complete certificate is on file in the Records Division of the TCEQ. A copy of this certificate is in Exhibit B.

Due to the erosion potential of the spillway discharge channel, the original spillway was replaced with a 640-foot labyrinth weir spillway (with stilling basin) at the same location and with the same crest elevation (176.0 feet) as the original spillway between 1994 and 1996. In 1996, a concrete parapet wall was erected on top of the existing dam embankment to increase the freeboard height as per a Dam Safety requirement - ER 1110-8-2 (FR). The parapet wall is an inverted tee, about 3.6 feet high, raising the top of the dam from 190.0 feet to elevation 193.6 feet.

**3-06. Principal Regulation Problems.** Releases over 14,000 cfs from Sam Rayburn Reservoir will inundate some access roads along the Angelina River between Sam Rayburn Dam and B.A. Steinhagen Lake, restricting local residents from passage to their homes.

## **CHAPTER IV – WATERSHED CHARACTERISTICS**

**4-01. General Characteristics.** The Angelina River originates in Rusk County, approximately 10 miles south of Henderson, Texas, and flows in a southerly direction for approximately 205 miles where it joins the Neches River at river mile 126.1, just above B.A. Steinhagen Lake, 12 miles west of Jasper, Texas. The watershed lies in the eastern part of Texas, between north latitudes 30°53' and 32°25' and west longitudes 93°50' and 95°22'. The watershed of the Angelina River has a total drainage area of 3,449 square miles.

Sam Rayburn Dam is located on the Angelina River at river mile 25.2. The lake is formed by flows from the mainstem Angelina River and tributaries of Striker Creek, Mud Creek, Attoyac Bayou and Ayish Bayou. The slope of the Angelina River in the vicinity of Sam Rayburn Dam varies from 1.1 feet per mile above the reservoir to less than 0.5 feet per mile in the pine flats below the reservoir.

The Angelina River has four principal tributaries that flow into its river system. Striker Creek enters the Angelina River at river mile 178.0 and has a drainage area of 196 square miles. Mud Creek enters at river mile 168.2 and has a drainage area of 585 square miles. Attoyac Bayou enters at river mile 53.8 and has a drainage area of 676 square miles. Ayish Bayou enters just above the dam at river mile 25.7 and has a drainage area of 417 square miles.<sup>1</sup> The watershed and location of the dam are shown on Plate 4-1.

The basin is crossed by a network of highways and railroads. The watershed is within the South Central Plains or “Piney Woods” ecoregion.<sup>2</sup> Over half of the watershed area is forested, and almost a quarter is pastureland. Numerous oil and gas fields are located within the basin and oil refineries are found near the fields. Commercial timber is produced in large quantities with lumber mills and wood product and other manufacturing plants located throughout the basin. The population of the basin was approximately 275,000 in 2010.

**4-02. Topography.** The Angelina River is the principal tributary to the Neches River and is formed by the junction of Shawnee and Barnhart Creeks in southwestern Rusk County near Henderson, Texas, at an elevation of about 475 feet. From there it flows in a general southeasterly direction to its confluence with the Neches River on the left bank of the Neches River at river mile 126.1, near Jasper, Texas, at approximately elevation 60 feet. The average slope of the streambed varies from 10.3 feet per mile on Shawnee Creek at the headwaters to 3.3 feet per mile between the Shawnee and Barnhart Junction and Mud Creek, to 1.1 feet per mile from there to the head of Sam Rayburn Reservoir, to less than 0.5 feet per mile in the pine flats below the reservoir.

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<sup>1</sup> Definite Project Report on Mc Gee Bend, Dam “B”, Rockland, and Dam “A” Reservoirs, Volume II, Mc Gee Bend Reservoir, Appendix I, Hydrology, 1947.

<sup>2</sup> <https://www.epa.gov/eco-research/ecoregion-download-files-state-region-6>

The region varies from hilly to rolling with a maximum relief of about 200 feet, sharper topographic features being in evidence in the immediate area of Angelina River and its principal tributaries. The upland areas are moderately to sharply dissected whereas the lowland areas are relatively flat and featureless. The slope of the land is gentle in a southerly or Gulfward direction. Plate 4-2 and Plate 4-3 present the natural profiles of the Angelina River and Neches River, respectively.

**4-03. Geology and Soils.** The geologic formations outcropping in the Angelina drainage area consist of sedimentary deposits of marine and non-marine origin and of Tertiary age. The formations dip gently southward with the older formations outcropping upstream from the younger. The reservoir is underlain by east-west bands of three Eocene formations: the Yegua, Cadell, and Manning Formations. The strata are principally marine and beach deposited sands and clays with some sandstone, shale and tuffaceous beds. The Sam Rayburn dam site is underlain by the Oligocene Catahoula Formation, which consists of non-marine lacustrine and deltaic deposits of clay, silt, and sand, some moderately hard sandstone and siltstone, and beds of tuff and volcanic ash some of which have altered to fuller's earth.<sup>3</sup>

In the upper half of the watershed, the more weather resistant strata tend to form ridges of hills following the east-west strike of the strata with steep northern faces and gently sloping southern faces. All of the above-mentioned formations are considered young on the geological time scale and contain but few strata that could be considered hard rock, many of the sand and silt horizons are indurate, however, and generally the clays are compact and shale-like in structure. In the area of Sam Rayburn Dam the Angelina River has cut a valley into the primary deposits approximately 30 feet deep in the valley and consists of layers of sand with various amounts of silt. Oxbow lakes and sloughs are found in the valley. The sides of the valley are covered with residual soils which grade into the primary deposits. The depth of such soils decreases with height above the valley bottom and varies in general from 10 to 15 feet to a foot or two. No folds or faults or similar structural features occur in the area of the dam. Major limitations of the geologic characteristics of the watershed include low permeability, high water table, frequent flooding, and high erodibility.

The Angelina drainage area lies on the South Central Plains or "Piney Woods" ecoregion. The reservoir and the south half of the basin sits in the Southern Tertiary Uplands subregion, which is characterized by hilly dissected terrain and well-drained soils and permeable sediments. The north half of the basin is in the Tertiary Uplands subregion, which is characterized by gently rolling well-drained Ultisols and Alfisols, typically with sandy and loamy surface textures.<sup>4</sup>

**4-04. Sediment.** A system of 14 sedimentation ranges and 9 degradation ranges were established, surveyed, and monuments placed on the reservoir area and below the dam during the design of the dam. A schedule prepared in the Office of the Division Engineer, SWD indicates

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<sup>3</sup> [mrdata.usgs.gov/sgmc/tx.html](http://mrdata.usgs.gov/sgmc/tx.html)

<sup>4</sup> <https://www.epa.gov/eco-research/ecoregion-download-files-state-region-6>

that surveys were planned for about 5-year intervals. However, currently sediment surveys are done periodically depending on need and available funding.

In 1991, the Texas Legislature authorized the Texas Water Development Board (TWDB) to develop a non-profit, self-supporting, reservoir volumetric survey program, which is named the Hydrographic Survey Program. The program includes a standard volumetric survey and a sedimentation survey. Since 1992, TWDB's Hydrographic Survey Program has completed 147 hydrographic surveys on 104 unique reservoirs. This includes 81 of the 109 water supply reservoirs monitored for inclusion in TWDB's monthly Water Conditions Report. The TWDB web site is: (<https://www.twdb.texas.gov/surfacewater/conditions/report/index.asp>).

The TWDB performed a standard volumetric survey for Sam Rayburn Reservoir in 2004.<sup>5</sup> Results from the survey indicate Sam Rayburn Reservoir encompasses 112,590 surface acres and contains a total volume of 2,876,033 acre-feet at top of power pool elevation 164.4 feet.

Original area capacity information dated February 1965 was based on USGS quadrangle sheets and detailed sedimentation ranges. Records indicate that Sam Rayburn Reservoir had a total surface area of 114,500 acres and a volume of 2,898,500 acre-feet of water at the top of power pool elevation 164.4 feet. The 2004 TWDB survey results indicate that the total volume at top of power pool elevation is 2,876,033 acre-feet. Comparisons show that Sam Rayburn Reservoir lost 22,467 acre-feet of water or 0.8% in power pool storage compared to the 1965 data. The volume between the top of the power pool 164.4 feet and the top of power head or sediment reserve 149.0 feet decreased from 1,446,500 acre-feet to 1,415,042 acre-feet. However, the volume below top of power head or sediment reserve elevation 149.0 increased from 1,452,020 acre-feet to 1,460,990 acre-feet. Comparisons between the historical USACE 1971 survey and the 2004 TWDB volumetric survey are presented in Table 4-1. It is noted that the accuracy of the different procedures for determining storage may account for the increase storage below elevation 149 feet.

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<sup>5</sup> [www.twdb.texas.gov/hydro\\_survey/samrayburn/2004-04/SamRayburn2004\\_FinalReport.pdf](http://www.twdb.texas.gov/hydro_survey/samrayburn/2004-04/SamRayburn2004_FinalReport.pdf)

**TABLE 4-1**

**Area and Capacity Comparisons of Sam Rayburn Reservoir**

Feature	USACE	TWDB
	Original Design	Latest Survey
Year	1965	2004
Surface Area at Power Pool Elevation 164.4 feet (acres)	114,500	112,590
Volume at Power Pool Elevation 164.4 feet (acre-feet)	2,898,500	2,876,033
Volume between Power Pool Elevation 164.4 feet to Power Head Elevation 149.0 feet (acre-feet)	1,446,500	1,415,043
Volume below Power Head and Sediment Reserve (Elev. 149.0 feet (acre-feet))	1,452,020	1,460,990

NOTE: Data is obtained from “Volumetric Survey of Sam Rayburn Reservoir, TWDB November 2006.”

**4-05. Climate.** The Angelina River watershed is in the eastern part of the state of Texas. The climate over the basin is considered to be generally mild with the annual normal temperature being about 66 degrees Fahrenheit throughout the watershed. However, sharp extremes are occasionally recorded and short duration freezes and snowfall occur occasionally throughout the winter. The summers are hot and fairly humid. Southerly winds prevail during the spring, summer and fall months. Snowfall in the basin is rare and has little effect on the runoff characteristics of the watershed.

a. **Temperature.** The mean annual temperature over the basin is about 66 degrees Fahrenheit. January, the coldest month, has an average minimum daily temperature of about 37 degrees, August, the warmest month, has an average maximum daily temperature of about 94 degrees. Temperatures in the watershed have ranged from a maximum of 112 degrees recorded at Nacogdoches to a minimum of -8 degrees recorded at Tyler.<sup>6</sup> The average length of the growing season between killing frosts varies from 255 days at Town Bluff at the lower part of the watershed to 239 days at Henderson near the upper watershed boundary.<sup>7</sup> Table 4-2 gives

<sup>6</sup> www.ncdc.noaa.gov/cdo-web/datasets

<sup>7</sup> texasalmanac.com/sites/default/files/images/almanac-feature/countyweatherA.pdf

temperature data for several National Weather Service (NWS) stations in or near the Angelina River Basin.

**TABLE 4-2**  
**Temperatures in/near the Angelina River Basin**

Station	Period of Record	Temperatures (°F)				
		Mean Annual	Average January Minimum	Average August Maximum	Minimum Recorded	Maximum Recorded
Center	1940-2014	65.1	35.1	94.4	2	112
Dialville 2 W	1898-1978**	65.9	37.1	94.3	-5	111
Henderson	1941-2015	65.1	35.6	93.3	-1	111
Jacksonville	1953-2015	66.3	35.8	94.6	5	110
Jasper	1954-1972, 1981-2010**	66.2	37.1	93.0	6	105
Lufkin	1906-2015	67.1	38.5	95.0	-2	112
Nacogdoches	1900-2015	65.7	36.8	94.3	-4	112
Rusk	1942-2015	64.9	36.1	93.7	0	110
Sam Rayburn Dam	1968-2015	65.9	36.9	93.6	6	109
Tyler	1901-2015	66.3	37.1	95.4	-8*	110

NOTES: 1. \* From “Reservoir Regulation Manual for Sam Rayburn Reservoir, Angelina River, Texas, Corps of Engineers, U.S. Army, May 1971.”  
2. \*\*Period of available NOAA data ends in year indicated.

b. Precipitation. The normal annual precipitation over the Neches River watershed varies from 41.13 inches at Tyler, near the northernmost edge, to 58.22 inches at Sam Rayburn.<sup>8</sup> The monthly distribution of the average annual precipitation at nine NWS stations in the watershed area is shown in Table 4-3.

<sup>8</sup> [www.ncdc.noaa.gov/cdo-web/datasets](http://www.ncdc.noaa.gov/cdo-web/datasets)

**TABLE 4-3**

**Average Monthly and Annual Rainfall in/near the Neches River Basin**

Month	Precipitation (Inches)				
	Sam Rayburn Dam 1968-2015	Tyler 1901-2015	Dialville 1931-2015	Henderson 1942-2015	Jacksonville 1954-2015
January	5.36	2.95	3.93	3.89	3.68
February	4.22	3.33	3.52	3.85	3.56
March	5.03	3.50	4.07	4.14	3.64
April	4.19	3.80	4.04	4.27	3.97
May	5.08	4.85	4.92	5.11	4.61
June	5.56	4.05	3.89	4.37	3.74
July	4.63	2.87	2.81	3.03	2.76
August	3.62	1.87	2.86	3.02	2.50
September	4.11	2.77	3.34	3.63	3.73
October	4.98	3.73	3.89	3.96	4.07
November	5.71	3.55	4.13	4.20	3.91
December	5.73	3.86	4.29	4.24	3.49
<b>Total</b>	<b>58.22</b>	<b>41.13</b>	<b>45.69</b>	<b>47.71</b>	<b>43.66</b>
Precipitation Minimum Yearly	30.41 (2010)	24.92 (2005)	29.40 (1996)	23.18 (1963)	27.24 (2011)
Precipitation Maximum Yearly	86.69 (1973)	68.05 (2015)	69.64 (1991)	69.64 (2015)	72.37 (1990)

NOTES: 1. The total annual precipitation is computed by summation of monthly averages.  
 2. Data reflect "Climatological Data" from the NWS. Data as of 2015.

**TABLE 4-3 (CONTINUED)**

**Average Monthly and Annual Rainfall in/near the Neches River Basin**

Month	Precipitation (Inches)			
	Rusk 1941-2015	Nacogdoches 1900-2015	Lufkin 1906-2015	Jasper 1952-2015
January	4.15	4.06	4.15	4.30
February	3.78	4.03	3.56	4.51
March	4.07	4.17	3.65	4.10
April	4.15	4.14	3.82	4.15
May	4.81	4.82	5.00	5.02
June	4.09	4.05	3.81	4.98
July	3.05	3.50	3.22	3.93
August	2.71	2.74	2.95	3.69
September	3.89	3.43	3.36	4.35
October	4.44	3.79	3.24	3.86
November	4.15	4.46	4.49	5.10
December	4.29	4.53	4.50	5.21
<b>Total</b>	<b>47.58</b>	<b>47.72</b>	<b>45.75</b>	<b>53.20</b>
Precipitation Minimum Yearly	27.00 (1953)	22.27 (2010)	26.49 (1963)	32.08 (1962)
Precipitation Maximum Yearly	79.56 (1991)	72.20 (2015)	79.04 (2004)	79.06 (1991)

NOTES: 1. The total annual precipitation is computed by summation of monthly averages.  
 2. Data reflect "Climatological Data" from the NWS. Data as of 2015.

c. Snowfall. Minor accumulations of snowfall occur periodically during the winter months; however, snowfall does not contribute significantly to area precipitation or runoff.

d. Evaporation. A NWS “Class A” evaporation pan has been established at Sam Rayburn Reservoir and records are available from 1968 to present. The evaporation pan at Sam Rayburn Reservoir is 10-inch deep with 47.5-inch diameter. From measurements collected between January 1968 and December 2015, the estimated average annual evaporation from the lake is about 47 inches. The average monthly and annual evaporation from Sam Rayburn reservoir are given in Table 4-4A. The highest recorded observed annual pan evaporation was 72.18 inches in 1974, while the lowest was 53.73 inches in 1994. The highest evaporation during a single month was 10.01 inches in July 1998. The evaporation pan heats up much faster than the lake, thus the pan evaporation is much higher than actual evaporation, and a coefficient must be used to estimate actual lake evaporation.

A longer period of record, however, is desirable for estimating average evaporation rates. The State of Texas maintained a Bureau of Plant Industry, sunken-type evaporation station at the Agricultural Experiment Station at Nacogdoches, Texas, about 50 miles north of Sam Rayburn Dam. Table 4-4B lists the Nacogdoches Experiment Station average monthly and average annual evaporation derived from 1915 through 1947.

The TWDB has collected lake evaporation data from 1954 through 2014 from the National Oceanic and Atmospheric Administration (NOAA) and the National Climatic Data Center (NCDC).<sup>9</sup> The average monthly and annual evaporation from TWDB data are given in Table 4-4C. The evaporation rates for the Angelina River Watershed are computed using the pan coefficients in the ThEvap program for quadrangle 613.

Figures 4-1 through 4-3 show the instruments and equipment of weather station at Sam Rayburn Reservoir.

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<sup>9</sup> [www.twdb.texas.gov/surfacewater/conditions/evaporation](http://www.twdb.texas.gov/surfacewater/conditions/evaporation)



**Figure 4-1. Overview of Weather Station at Sam Rayburn Reservoir**



**Figure 4-2. Thermometer**



**Figure 4-3. Evaporation Pan**

**TABLE 4-4A**

**Sam Rayburn Reservoir Average Monthly and Annual Evaporation (Jan 1968 - Dec 2015)**

Month	Reservoir Evaporation (Inches)		
	Measured Pan Evaporation	Monthly Pan Coefficient	Calculated Reservoir Evaporation
January	2.67	0.76	2.03
February	3.09	0.74	2.29
March	4.79	0.74	3.54
April	5.96	0.73	4.35
May	7.07	0.68	4.81
June	7.62	0.73	5.56
July	7.93	0.74	5.87
August	7.75	0.74	5.74
September	6.04	0.76	4.59
October	4.78	0.79	3.78
November	3.19	0.8	2.55
<u>December</u>	<u>2.70</u>	<u>0.79</u>	<u>2.13</u>
Annual	63.59	0.75	47.24

NOTES: The Pan coefficients were developed by the USACE. The calculation was based on Sam Rayburn Reservoir measured pan evaporation data.

**TABLE 4-4B****The State of Texas – Bureau of Plant Industry, Nacogdoches, Texas****Average Monthly Evaporation Data, 1915-1947**

Pan coefficient = 0.94			
Month	Observed pan evaporation (inches)	Evaporation from reservoir surface (inches)	Observed precipitation (inches)
January	1.56	1.47	4.67
February	2.06	1.94	3.88
March	3.10	2.91	4.30
April	3.89	3.66	4.80
May	4.68	4.40	5.51
June	5.48	5.15	3.70
July	5.83	5.48	3.98
August	5.82	5.47	2.86
September	4.62	4.34	2.71
October	3.67	3.45	3.05
November	2.27	2.13	4.73
<u>December</u>	<u>1.68</u>	<u>1.58</u>	<u>5.13</u>
Annual	44.66	41.98	49.32

NOTE: Corresponding to period for which evaporation records are available.

**TABLE 4-4C**

**TWDB Average Monthly and Annual Evaporation, Sam Rayburn Reservoir, 1954-2014**

Month	Quadrangular Lake Evaporation rate (inches)	Monthly Pan Coefficients for quadrangle 613 of ThEvap Program
January	1.89	0.76
February	2.24	0.74
March	3.49	0.74
April	4.18	0.73
May	4.69	0.68
June	5.66	0.73
July	5.99	0.74
August	5.88	0.74
September	4.70	0.76
October	3.75	0.79
November	2.60	0.80
<u>December</u>	<u>1.95</u>	<u>0.79</u>
Annual	47.02	0.75

e. Wind. The prevailing winds over the watershed are from the south during the spring, summer and fall months, while northerly winds prevail during the winter months. Severe winds have been experienced near Sam Rayburn Reservoir. The fastest recorded velocity in the vicinity of the watershed was 100 miles per hour, recorded in Smith County, Texas in May 1978.<sup>10</sup> (Data provided by the NOAA NCDC for the period 1950-2015)

From the "Sam Rayburn Dam and Reservoir, Angelina River, Texas, Dam Safety Assurance Study, Spillway Modification and Freeboard Restoration, September 1992" report, the design wind speed is 35 mph, the fetch for wind setup is 15.39 miles and the computed required freeboard is 7.2 feet. This freeboard was computed for a Probable Maximum Flood (PMF) elevation of 186.91 feet. At this elevation, the dam with back-curved parapet wall will provide adequate freeboard for a wind velocity of 35 miles per hour over land. The average annual wind movement over Sam Rayburn Reservoir is about 87,600 miles, which is an average wind speed of approximately 10 miles per hour for an entire year.<sup>11</sup> Tornadoes occur on occasion in the

<sup>10</sup> [www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=10127638](http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=10127638)

<sup>11</sup> [www.ncdc.noaa.gov/sites/default/files/attachments/wind1996.pdf](http://www.ncdc.noaa.gov/sites/default/files/attachments/wind1996.pdf)

watershed. In 1990, a tornado reaching the F3 level left 2 people injured and over 20 homes damaged in and round Apple Springs, Texas, 48 miles south of Sam Rayburn Reservoir.<sup>12</sup>

**4-06. Storms and Floods.** The Angelina River Watershed is subject to three general types of flood-producing rainfall: thunderstorms, frontal rainfall, and tropical cyclones. Generally, the highest 24-hour and monthly precipitation periods have occurred during tropical cyclones. However, there are some instances of heavy precipitation resulting from local thunder storms. The maximum 24-hour rainfall reported in or adjacent to the basin was 17.76 inches, which occurred at Port Arthur (just outside the basin) on 28 July 1943. The maximum monthly rainfall reported was 26.79 inches, which occurred at San Augustine in August 1915.<sup>13</sup>

Because of the slow rate of runoff and the small conveyance capacity of the natural channel, it is not unusual for floods to prevail above bankfull stage for several months. The period of most frequent flooding is from November to June, inclusive. However, floods may occur at any time during the year. Based on the historical data, the maximum known flood in the vicinity of the Neches River near Rockland gage and the Neches River at Evadale was May 1884 with estimated peak discharges of 62,000 cfs and 125,000 cfs, respectively. Upstream from Sam Rayburn Reservoir, the largest recorded flows in any of its four major tributaries took place in 1909, when on the Attoyac Bayou, near Chireno, Texas, flows reached 50,000 cfs.

The major storms experienced over the watershed for which rainfall data are available, together with the average rainfall depths produced on the watershed above the dam, are listed in Table 4-5.

Table 4-6 lists the pertinent data for major lakes and dams and gages in the Neches River Basin. Table 4-7 gives stages and discharges for the top 16 major floods recorded at gages on the Neches River Watershed.

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<sup>12</sup> <http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=10138334>

<sup>13</sup> [www.ncdc.noaa.gov/cdo-web/datasets](http://www.ncdc.noaa.gov/cdo-web/datasets)

**TABLE 4-5****Major Recorded Storms on the Angelina River Watershed, 1908-2015**

Storm Date	Precipitation in Inches					
	Sam Rayburn Dam Gage	Jasper Gage	Dialville Gage	Lufkin Gage	Henderson Gage	Nacogdoches Gage
1908, May 12-18	—	—	—	5.60	—	1.98
1914, April 24-28	—	—	—	4.80	—	3.66
1929, May 24-31	—	—	—	—	—	5.62
1932, Feb 16-21	—	—	—	6.95	—	8.82
1935, May 16-20	—	—	—	7.40	—	5.80
1940, Nov 21-26	—	—	—	16.55	—	15.80
1944, April 29-May 4	—	—	7.60	10.60	7.93	9.30
1953, Apr 28-May 5	—	11.30	2.78	—	3.79	8.68
1953, May 11-19	—	9.70	8.85	6.70	6.52	9.00
1973, June 10-17	11.25	9.40	4.14	8.70	5.70	3.70
1974, Jan 22-29	5.35	—	4.94	8.60	3.80	5.58
1979, Sep 13-20	7.60	7.30	7.78	5.20	4.50	3.82
1981, May 31-Jun 6	10.83	12.00	5.29	2.60	2.70	4.15
1989, Jun 24-July 2	12.61	15.50	3.49	9.30	2.01	6.45
1991, Aug 9-16	6.03	7.02	12.36	7.41	2.87	6.54
1993, Jun 18-22	2.39	5.47	9.66	3.47	15.07	5.49
1994, Oct 15-22	10.29	8.90	4.48	14.30	4.81	8.60
1996, Sep 25-27	5.90	8.90	1.56	2.50	1.30	3.66
1998, Sep 11-17	8.13	12.60	8.67	5.00	12.13	7.60
2001, Jun 1-7	11.12	8.00	9.98	10.20	8.36	10.82
2001, Aug 28-Sep 5	5.91	7.10	2.96	4.50	3.11	5.30
2004, Nov 18-24	10.66	7.90	6.24	11.80	6.22	7.91
2005, Sep 24	14.00	7.60	1.07	5.30	5.40	4.50
2006, Oct 6-19	20.16	14.90	4.12	6.00	2.19	4.79
2013, Oct 13-14	1.30	10.20	0.68	8.00	0.11	0.67
2015, May 11-27	8.82	10.09	11.21	14.92	8.79	12.62

NOTE: The rainfall data were tabulated from published precipitation records from the NWS.

**TABLE 4-6****Pertinent Data for Major Lakes and Dams and Gages in the Neches River Basin**

Station	Stream	Period of Record	Miles Above Mouth	Datum (ft)	Drainage Area (Sq. Mi.)	Maximum Floods of Record		
						Date	Gage Height (ft)	Peak Discharge (cfs)
near Rockland	Neches River	1903-2015	158.5	88.41	3,636	May 1884	34.90	62,000
						6 May 1944	31.84	49,800
						2 Apr 1922	—	45,200
near Town Bluff	Neches River	1951-2015	113.7	0.00	7,573	May 1884	86.80	120,000
						6 May 1944	84.98	99,700
						21 May 1953	82.85	90,900
at Evadale	Neches River	1904-2015	55.6	8.25	7,951	May 1884	26.20	125,000
						Aug 1915	24.50	102,000
						11 May 1944	23.58	92,100
near Jacksonville**	Mud Creek	1939-2015	—	271.64	376	25 Apr 1966	15.20	27,500
						3 May 1944	14.09	23,400
						7 Jul 2007	12.63	18,600
near Alto	Angelina River	1940-2015	149.3	214.30	1,276	31 Mar 1989	23.20	42,500
						May 1908	22.00	(Approx.)
						28 April 1966	21.51	30,600
						9 Jul 2007	21.55	30,000

NOTE: USGS Annual Water-Data Reports. \*\*Historic stage of 20 feet in May 1908, Dec 1913. Flood of May 1884 even higher.

**TABLE 4-6 (CONTINUED)****Pertinent Data for Major Lakes and Dams and Gages in the Neches River Basin**

Station	Stream	Period of Record	Miles Above Mouth	Datum (ft)	Drainage Area (Sq. Mi.)	Maximum Floods of Record		
						Date	Gage Height (ft)	Peak Discharge (cfs)
near Chireno	Attoyac Bayou	1924-2015	41.0	169.58	503	1902	29.90	50,000
						24 Nov 1940	25.97	31,900
						30 Jan 1999	26.01	31,700
near San Augustine	Ayish Bayou	1959-2015	44.1	190.22	89	30 Mar 2008	21.14	42,100
						14 Sep 1978	18.02	18,200
						21 Sep 1958	17.50	15,900
near Horger	Angelina River	1928-1973		68.54	3486	Aug 1915	39.5	82,000
						6 May 1944	36.9	49,900
						24 Feb 1932	36.35	48,800
Reservoir	Stream	Period of Record	Miles Above Mouth	Datum (ft)	Drainage Area (Sq. Mi.)	Maximum Lake Elevation		
						Date	Elev. (feet)	Volume (ac-ft)
Sam Rayburn Reservoir	Angelina River	1965-2015	25.2	0.0	3,449	9 Mar 1992	174.95	4,283,000
B.A. Steinhagen Lake	Neches River	1951-2015	113.7	0.0	7,573	22 May 1953	85.21	128,400

NOTE: The information is derived from the United States Geological Survey (USGS) Annual Water-Data Reports.

**TABLE 4-7****Top 16 Recorded Major Floods in the Neches River Watershed, 1884-2015**

Date	Angelina River near Alto		Attoyac Bayou near Chireno		Neches River near Rockland		Neches River near Town Bluff*		Neches River at Evadale	
	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)
1884, May	—	—	—	—	34.90	62,000	86.80	120,000	26.20	125,000
1902	—	—	29.90	50,000	—	—	—	—	—	—
1915, Aug	—	—	—	—	21.40**	13,300**	—	—	24.50	102,000
1922, Apr	—	—	—	—	28.90**	45,200	—	—	21.80	71,500
1932, Jan-Mar	21.50	—	—	—	26.70	33,600	—	—	21.45	73,400
1935, May-Jun	—	—	—	—	28.90	39,700	—	—	20.60	64,100
1944, May-Jun	—	—	22.53	17,400	31.84	49,800	—	—	23.58	92,100
1940, Nov	—	—	25.97	31,900	25.50	25,900	—	—	20.78	59,600
1945, Apr	—	—	20.12	9,310	28.37	37,500	—	—	19.89	53,000
1953, Mar-May	—	—	22.63	18,700	27.70	34,400	82.85	90,900	22.53	80,300
1957, May	—	—	21.34	14,300	25.34	29,700	80.04	62,000	20.55	55,300
1966, Feb-May	21.51	30,600	19.62	8,700	25.60	26,800	74.11	27,200	18.12	27,300
1989, Mar-Jul	23.20	42,500	19.30	7,930	33.20	42,000	78.49	49,200	20.79	47,900
1992, Mar	—	—	19.49	8,200	29.00	27,300	75.73	34,000	19.33	37,500
1994, Oct	—	—	23.41	21,500	33.29	42,300	76.17	35,400	19.33	41,400
2007, Jul	21.55	30,000	—	—	—	—	—	—	—	—
2015, Mar-Jun	29.63	14,700	—	—	—	—	73.50	28,000	18.58	31,200

NOTES: 1. Data retrieved from USGS Peak Streamflow for Texas database.

2. \*Deliberate impoundment for B.A. Steinhagen Lake began on 16 April 1951. Therefore, peak flood flows at this gage after this impoundment date may be impacted by Town Bluff Dam. \*\*No USGS data available. Data retrieved from “Reservoir Regulation Manual, Dam B Reservoir, Neches River, Texas, March 1956.”

Historical descriptions of the major floods that have been experienced in the Neches River Watershed are as follows:

a. Storm of May 1884. The flood of May 1884 produced the highest known stages in the Neches River near Diboll, which is near Rockland, Neches River at Evadale, and Angelina River near Lufkin. The stages for the flood of May 1884 have been established from identified flood marks - estimated 34.9 feet at Neches River near Rockland Gage, 86.8 feet at Neches River near Town Bluff Gage, and 26.2 feet at Neches River at Evadale Gage. A comparison of the May 1884 stages with the stages of the other major floods indicates that the flood of May 1884 was probably the greatest flood that has occurred in the Neches River from city of Reese to the mouth of the river. The peak discharge for this flood is estimated to be 62,000 cfs at Neches River near Rockland Gage, 120,000 cfs at Neches River near Town Bluff Gage, and 125,000 cfs at Neches River at Evadale Gage.

b. Storm of 1902. The 1902 flood reached a stage of 29.90 feet on the Attoyac Bayou near Chireno Gage. The estimated peak discharge for this flood was 50,000 cfs.

c. Storm of August 1915. The August 1915 flood was one of the largest recorded in the basin. The storm was centered at San Augustine, where the total depth of rainfall was 19.8 inches for a 4-day period. The flood of August 1915 produced the highest known stages at Angelina River near Horger Gage and Village Creek near Kountze Gage, and produced near-maximum stages in the Neches River below the mouth of the Angelina River. The maximum average daily stages were 21.40 feet at Neches River near Rockland Gage and 24.50 feet at Neches River at Evadale Gage. The peak discharges for this flood at Rockland and Evadale gages were 13,300 and 102,000 cfs, respectively. Flood marks indicate that the August 1915 flood stage at Neches River at Evadale Gage was about 1.70 feet lower than the May 1884 flood.

d. Storm of March-April 1922. The 25 March to 4 April 1922 storm produced an average depth of rainfall over the Neches River Basin at about 8.60 inches. The storm had a center of 11.35 inches at Rockland. The flood produced by this storm reached stages of 28.90 feet at Neches River near Rockland Gage and 21.80 feet at Neches River at Evadale Gage. The peak discharges for this flood at Neches River near Rockland Gage and Neches River at Evadale Gage were 45,200 and 71,500 cfs, respectively. No information is available concerning the peak stages and discharges of this flood on the Angelina River.

e. Storm of January-March 1932. Heavy rains occurred over the Neches River Basin during January and February 1932. The principal storm period was 13–23 February 1932. The rainfall for this period exceeded 5 inches over the major portion of the basin and had a center of 9.26 inches at Nacogdoches. The flood resulting from this storm reached stages of 21.5 feet at Angelina River at Alto Gage, 26.70 feet at Neches River near Rockland Gage, and 21.45 feet at Neches River at Evadale Gage. The peak discharges for this flood at Rockland and Evadale gages were 33,600 and 73,400 cfs, respectively.

f. Storm of May-June 1935. Rainfall was frequent and general over the entire Neches River Basin during May 1935. The principal storm periods were 2-6 May and 15-20 May 1935. The average depth of rainfall over the greater part of the watershed was about 5 inches for the first storm period and more than 4 inches for the second storm period. These storms produced a flood that reached stages of 28.90 feet at Neches River near Rockland Gage and 20.60 feet at Neches River at Evadale Gage. The peak discharges for this flood at Rockland and Evadale gages were 39,700 and 64,100 cfs, respectively.

g. Storm of November-December 1940. Heavy rains occurred over the Neches River Basin during the period 21-26 November 1940. The storm had centers at Lufkin and Appleby, where 16.60 and 17.50 inches, respectively, were recorded. The flood produced by this storm reached stages of 25.50 feet near Rockland, 20.78 feet at Evadale, 8.80 feet at Beaumont on the Neches River and 34.50 feet at Horger on the Angelina River. The peak discharges at Horger, Rockland, and Evadale were 36,200, 25,900, and 59,600 cfs, respectively.

h. Storm of May-June 1944. From 29 April to 5 May 1944, heavy rains occurred over the Neches River Basin, with 16.00, 15.91, and 12.00 inches at Pollok, Jackson Hill, and Flint, respectively. This flood reached stages of 22.53 feet at Attoyac Bayou near Chireno Gage, 31.84 feet at Neches River near Rockland Gage, and 23.58 feet at Neches River at Evadale Gage. The peak discharges of this flood at Chireno, Rockland, and Evadale gages were 17,400, 49,800, and 92,100 cfs, respectively.

i. Storm of April 1945. An average of 5 inches of precipitation fell at stations in the Neches River Basin during the first week of April 1945. The flood event occurred during the period of 2–15 April 1945. The maximum stages produced by these storms were 20.12 feet at Attoyac Bayou near Chireno Gage, 28.37 feet at Neches River near Rockland Gage, and 19.89 feet at Neches River at Evadale Gage. The peak discharges for this flood at Chireno, Rockland and Evadale gages were 9,310, 37,500 and 53,000 cfs, respectively.

j. Storm of May 1953. General rains occurred over the Neches River Basin during May 1953. The flood event occurred during the period of 17-24 May 1953. The maximum stages produced by these storms were 27.70 feet at Neches River near Rockland Gage, 82.85 feet at Neches River near Town Bluff Gage, and 22.53 feet at Neches River at Evadale Gage. The peak discharges for this flood at Chireno, Rockland, Town Bluff and Evadale gages were 18,700, 34,400, 90,900, and 80,300 cfs, respectively.

k. Storm of May 1957. Intense rains fell over the Neches Basin in late April 1957. The Henderson, Nacogdoches, and Alto gages all recorded more than 10 inches of precipitation. The flood event occurred during the period of 1–10 May 1957. The maximum stages produced by these storms were 21.34 feet at Attoyac Bayou near Chireno Gage, 25.34 feet at Neches River near Rockland Gage, 80.04 feet at Neches River near Town Bluff Gage, and 20.55 feet at Neches River at Evadale. The peak discharges for this flood at Chireno, Rockland, Town Bluff, and Evadale gages were 14,300, 29,700, 62,000, and 55,300 cfs, respectively.

l. Storm of Feb-Apr 1966. Heavy rains over the basin, including over 10 inches recorded at the Henderson and Rusk gages, fell in late April 1966. The maximum stages produced by these storms were 21.51 feet at Angelina River near Alto Gage, 19.62 feet at Attoyac Bayou near Chireno Gage, 25.60 feet at Neches River near Rockland Gage, 74.11 feet at Neches River near Town Bluff Gage, and 18.12 feet at Neches River at Evadale Gage. The peak discharges for this flood at Alto, Chireno, Rockland, Town Bluff, and Evadale gages were 30,600, 8,700, 26,800, 27,200, and 27,300 cfs, respectively.

m. Storm of Mar-July 1989. An average of 7 inches of precipitation was recorded at stations in the basin, with a peak of 12.3 inches recorded at Henderson over a short period in late March 1989. The main flood event occurred over the Neches River Basin during the period of 02–06 July 1989. The maximum stages produced by these storms were 23.20 feet at Angelina River near Alto Gage, 19.30 feet at Attoyac Bayou near Chireno Gage, 33.20 feet at Neches River near Rockland Gage, 78.49 feet at Neches River near Town Bluff Gage, and 20.79 feet at Neches River at Evadale Gage. The peak discharges for this flood at Alto, Chireno, Rockland, Town Bluff, and Evadale gages were 42,500, 7,930, 42,000, 49,200, and 47,900 cfs, respectively.

n. Storm of Mar-Apr 1992. The fall of 1991 and winter of early 1992 had above normal rainfall in the Neches River basin, with antecedent conditions causing Sam Rayburn reservoir to rise. An average of 4 inches of precipitation was recorded at stations in the basin in mid-March 1992. The flood event occurred during the period of 6–12 March 1992. The maximum stages produced by these storms were 19.49 feet at Attoyac Bayou near Chireno Gage, 29.00 feet at Neches River near Rockland Gage, 75.73 feet at Neches River near Town Bluff Gage, and 19.33 feet at Neches River at Evadale Gage. The peak discharges for this flood at Chireno, Rockland, Town Bluff, and Evadale gages were 8,200, 27,300, 34,000, and 37,500 cfs, respectively. Historical maximum elevation for Sam Rayburn Lake was and still is 174.95 feet.

o. Storm of October 1994. An average of 7.5 inches of precipitation was recorded at stations in the basin in mid-October, including a peak of 14.3 inches at the Lufkin gage. The flood event occurred during the period of 18–25 October 1994. The maximum stages produced by these storms were 23.41 feet at Attoyac Bayou near Chireno Gage, 33.29 feet at Neches River near Rockland Gage, 76.17 feet at Neches River near Town Bluff Gage, and 19.33 feet at Neches River at Evadale Gage. The peak discharges for this flood at Chireno, Rockland, Town Bluff, and Evadale gages were 21,500, 42,300, 35,400, and 41,400 cfs, respectively.

p. Storm of July 2007. During the first week of July 2007, 12 inches of precipitation was recorded at the Dialville gage and 10.5 inches were recorded at the Jacksonville gage. The flood event occurred over the Angelina River Basin during 09 July 2007. This storm produced a flood that reached stages of 21.55 feet at Angelina River near Alto Gage with a peak discharge of 30,000 cfs.

q. Storm of March-June 2015. Record precipitation was recorded in the State of Texas during May 2015. In the Neches Basin over a two week period in May, 14.9 inches were recorded at the Lufkin gage, 12.6 inches were recorded at the Nacogdoches gage, and 11.2 inches

were recorded at the Dialville gage. The maximum stages produced by these storms were 29.63 feet at Angelina River near Alto Gage, 73.50 feet at Neches River near Town Bluff Gage, and 18.58 feet at Neches River at Evadale Gage. The peak discharges for this flood at Alto, Town Bluff, and Evadale gages were 14,700, 28,000 and 31,200 cfs, respectively. Figures 4-4 through 4-9 show the inundation of Corps property at Sam Rayburn Reservoir during the 2015 flood.

The USGS historical information of all the major floods is listed in Table 4-8 (pg. T4.8-1). The data shown in the table covers the period 1884 to 2015.

Figures 4-4 through 4-9 are the scenes of 2015 flood at Sam Rayburn Reservoir.



**Figure 4-4. Public Ramp**



**Figure 4-5. Marina Resort**



**Figure 4-6. Picnic Area**



**Figure 4-7. Access Road**



**Figure 4-8. Park**



**Figure 4-9. Boat Ramp and Courtesy Dock**

**4-07. Runoff Characteristics.** Floods may occur at almost any time of year in the Angelina River watershed. The watershed's numerous wide, shallow, gently sloping valleys, along with the predominantly forested land use, provide ample initial abstraction and depression storage that tend to regulate the storm runoff. With minor exceptions, rapid variations in the runoff of the Angelina and Neches Rivers are unusual. The period of most frequent flooding is from November to June, inclusive. However, floods may occur at any time during the year. Because of the slow rate of runoff and the small conveyance capacity of the natural channel, it is not unusual for floods to prevail above bankfull stage for several months.

Runoff was been observed by the USGS on the Angelina River near Horger gage, 12.6 miles downstream from the Sam Rayburn Reservoir, from 7 March 1928 to 16 April 1951 and from February 1958 to September 1973 (Records after April 1951 are affected by backwater from B.A. Steinhagen Lake). At Horger (drainage area 3,486 square miles) the average annual runoff for the 23-year period was 2,309,000 acre-feet. During this same period a minimum flow of 13.0 cfs was recorded on 22 September 1937.

The computed monthly and annual inflow volumes, based on change in lake storage, are shown in Table 4-9 (pg. T4.9-1). The monthly inflow volume exceedence frequency curves, based on data from 1908 to 2015 are shown on Plates 4-4 through 4-15. Table 4-10 shows the monthly inflow volume frequency for the 5-, 10-, 25-, and 50-year events.

**TABLE 4-10**

**Sam Rayburn Reservoir Monthly Inflow Volume Frequency**

MONTH	Inflow Volume in Acre-Feet Frequency of Occurrence in Years			
	5	10	25	50
January	447,702	620,358	848,597	1,021,253
February	444,864	591,477	785,288	931,900
March	454,668	589,486	767,707	902,525
April	424,866	601,322	834,584	1,011,040
May	478,639	701,841	996,899	1,220,101
June	251,671	374,056	535,840	658,224
July	87,563	152,488	309,546	461,886
August	43,166	72,202	161,072	315,052
September	63,669	100,154	148,384	184,868
October	68,474	133,965	307,786	521,976
November	192,010	324,058	498,616	630,664
December	341,365	498,368	705,915	862,919

NOTE: Based on computed inflows for period January 1908 to December 2015.

**4-08. Water Quality.** Texas Commission on Environmental Quality (TCEQ) publishes the assessment reports for the quality of surface waters for the Neches River Basin in the biennial Integrated Report (formerly called the “Texas Water Quality Inventory and 303(d) List”) that evaluates the quality of all surface waters in Texas. The Integrated Report is prepared according to Clean Water Act Sections 305(b) and 303(d). In the report, the TCEQ classifies water bodies based on the body’s ability to support its designated uses, in other words its “Level of Support”.<sup>14</sup>

According to the 2012 TCEQ report, Sam Rayburn Reservoir has a number of water quality concerns. In 2012, the TCEQ sampled water quality at 10 locations in Sam Rayburn Reservoir, and reported measurements and classifications of various water quality parameters in the basin. On Sam Rayburn Reservoir, the Fish Consumption Use is not supported throughout the reservoir because of a restricted fish consumption advisory issued by the Texas Department of Health in November 1995 due to elevated levels of mercury in fish tissue. In the 2012 Texas 303(d) list, the parameter “mercury in edible tissue” is classified as Category 5 “The water body does not

<sup>14</sup> [www.tceq.texas.gov/waterquality/assessment/12twqi/twqi12](http://www.tceq.texas.gov/waterquality/assessment/12twqi/twqi12)

meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants”. It has been assigned to group C – “Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.”

In the report, Mercury is classified as “Not Supporting” the Fish Consumptive designated use due to mercury in fish tissue. Arsenic, Manganese, Iron, and Ammonia are classified as “Screening Level Concern” and the remaining pollutants are classified as “Fully Supporting” or “No Concern”. Arsenic, Manganese, and Iron are sediment-related pollutants. A list of pollutants and their average values from the 10 sites on Sam Rayburn Reservoir, along with their classifications are shown in Tables 4-11A and 4-11B, respectively.

In surface water segments adjacent to the reservoir (Angelina River above Sam Rayburn Reservoir (ID 611), East Fork Angelina River (ID 611A), and Ayish Bayou (ID 610A) segments), bacteria is also listed as a parameter that is not supporting the designated water quality standards.

The USGS has periodically sampled 20 sites on Sam Rayburn Reservoir for various biological and chemical parameters, most recently in 1999.<sup>15</sup> The mean concentrations of the various parameters for the 3 sampling stations with the most comprehensive records are shown in Table 4-11C. The sampling results indicate that the levels of the various biological and chemical constituents monitored were generally within the criteria set by the TCEQ. Samples taken during the summer months, when the lake becomes thermally stratified, were found to have levels of some parameters that were outside the standards.

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<sup>15</sup>[nwis.waterdata.usgs.gov/usa/nwis/qwdata/?huc\\_cd=12020005&format=station\\_list&sort\\_key=site\\_no&index\\_pmcode\\_00065=3&index\\_pmcode\\_00060=4&index\\_pmcode\\_00062=5&index\\_pmcode\\_72020=6&sort\\_key=site\\_no&group\\_key=county\\_cd&sitefile\\_output\\_format=station\\_list](https://nwis.waterdata.usgs.gov/usa/nwis/qwdata/?huc_cd=12020005&format=station_list&sort_key=site_no&index_pmcode_00065=3&index_pmcode_00060=4&index_pmcode_00062=5&index_pmcode_72020=6&sort_key=site_no&group_key=county_cd&sitefile_output_format=station_list)

**TABLE 4-11A****TCEQ Integrated Assessment Report, General Use, Aquatic Life Use, and Recreation Use,****2012**

Major Constituents	Mean Concentration	LOS
Dissolved Oxygen Screening Level (mg/l)	—	NC
Aluminum (µg/l)	—	FS
Zinc (µg/l)	1.2	FS
Nickel (µg/l)	1.7	FS
Copper (µg/l)	0.7	FS
Manganese (µg/l)	1411.7	CS
Iron (µg/l)	58103.0	CS
Silver (µg/l)	—	NC
Mercury (µg/l)	—	NS
E. coli (colonies/100 ml)	4.8	FS
Total Dissolved Solids (mg/l)	92.6	FS
pH (Standard Units)	—	FS
Temperature (F)	—	FS
Ammonia Nitrogen (mg/l as N)	0.3	CS
Sulfate (SO <sub>4</sub> ) (mg/l)	20.6	FS
Orthophosphorus (µg/l)	0.1	NC
Phosphorus (µg/l)	0.3	NC

LOS: Level of Support

NC: No Concern

FS: Fully Supporting

CS: Screening Level Concern

NS: Not Supporting

—: None Available

**TABLE 4-11B**

**TCEQ Integrated Assessment Report Fish Consumption Use and Public Water Supply Use,**

**2012**

Major Constituents	Mean Concentration	LOS
Lead (µg/l)	0.2	FS
Selenium (µg/l)	0.4	FS
Arsenic (µg/l)	1.3	CS
Cadmium (µg/l)	0.1	FS
Nitrate (NO <sub>3</sub> ) (µg/l)	0.4	FS
Chloride (Cl <sup>-</sup> ) (mg/l)	13.9	FS
Fluoride (F) (µg/l)	0.1	FS
Chromium (µg/l)	1.7	FS

LOS: Level of Support

NC: No Concern

FS: Fully Supporting

CS: Screening Level Concern

NS: Not Supporting

**TABLE 4-11C****USGS Water Quality Sampling, 1999**

Major Constituents	Mean Concentrations (1)		
	Station CC	Station IC	Station KC
Dissolved Oxygen @ 1.0 ft depth (mg/l)	8.6	8.2	8.3
Dissolved Oxygen @ 10.0 ft depth (mg/l)	8.2	7.7	8.1
Specific Conductance (mho/cm)	130.0	145.0	175.0
Total Dissolved Solids (mg/l)	73.3	83.7	100.0
pH (Standard Units)	7.2	7.3	7.4
Temperature, F	71.6	70.1	73.7
Alkalinity (mg/l as CaCO <sub>3</sub> )	16.7	22.0	25.7
Hardness, non-carbonate (mg/l as CaCO <sub>3</sub> )	9.3	6.7	11.0
Transparency (Secchi disc, m)	1.7	1.1	0.6
Ammonia Nitrogen (mg/l as N)	0.3	0.3	0.4
Nitrate + Nitrite Nitrogen (NO <sub>2</sub> + NO <sub>3</sub> ) (mg/l as N)	0.1	0.1	0.1
Sodium (dissolved) mg/l as Na	12.4	14.5	18.7
Potassium (dissolved) K (mg/l)	2.6	2.9	3.3
Chloride (CL) (mg/l)	14.4	14.9	22.1
Sulfate (SO <sub>4</sub> ) (mg/l)	17.2	18.9	16.5
Calcium (Ca) (mg/l)	5.8	6.4	6.9
Magnesium (Mg) (mg/l)	2.8	3.1	3.6
Silica (SiO <sub>2</sub> ) (mg/l)	7.7	9.4	12.6
Fluoride (F) (mg/l)	0.1	0.1	0.1
Manganese (Mn) (µg/L)	37.1	26.5	26.1
Fecal Coliform (2)	(colony count/100 ml)		
Winter	1	1	1
Spring	2	1	2
Summer	1	1	3

(1) Measurements are in mg/L unless otherwise stated. Mean are taken at a 1.0-foot depth unless otherwise stated.

NOTE: The water quality sampling for all parameters was conducted on the following dates:  
Winter: 24 Feb 1999; Spring: 20-21 Apr 1999; and Summer: 25-26 Aug 1999.

**4-09. Channel and Floodway Characteristics.** The channel capacity of the Angelina River below Sam Rayburn Dam to Town Bluff Dam is about 15,000 cfs. The channel capacity of Neches River from Town Bluff Dam to Evadale is 20,000 cfs. At the Neches River near Town Bluff gage, some residential flooding begins to occur at a stage of 71.0 feet which is approximately 21,300 cfs (Feb 2018). At the Neches River at Evadale gage, the channel capacity is 20,000 cfs, however, according to the USGS, only minor flooding occurs which does not include structures. The stage of the Neches River Saltwater Barrier at Beaumont gage, channel capacity is 40,000 cfs which causes only minor flooding.

The estimated travel time for flood flows from the Angelina River near Alto gage (river mile 149.3) to Sam Rayburn Reservoir (river mile 25.2) is about 36 hours. Travel time from Sam Rayburn Reservoir (river mile 25.2) to Town Bluff Dam (river mile 113.7) is about 8 hours. Travel time from Town Bluff Dam (river mile 113.7) to Neches River at Evadale gage (river mile 54.6) is about 72 hours, and from Neches River at Evadale gage to the Neches River Salt Water Barrier at Beaumont gage is about 48 hours. The existing channel capacities along the Neches River are given in Table 4-12.

The locations of the USGS stream gages in the Neches River Basin are shown on Plates 5-1a and 5-1b, respectively. Discharge rating curves for the key control points are shown on Plates 4-16 through 4-18. These curves are only valid for rough use. The rating curves used by the Water Resources Branch are adjusted by the USGS for changing conditions and reflect the current stage-flow relationships at the gages.

**TABLE 4-12**

**Channel Capacities on Angelina and Neches Rivers**

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Reach	Channel Capacity (cfs)
Angelina River from Sam Rayburn Dam to mouth	15,000
Neches River from Town Bluff Dam to Beaumont	20,000
Neches River near Beaumont to Gulf	40,000

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Table 4-13 and Plate 4-19 show flood peak travel times between upstream gages and Sam Rayburn Reservoir and between Sam Rayburn Reservoir and the downstream gages on the Angelina River and Neches River.

**TABLE 4-13**

**Flood Peak Travel Times between Sam Rayburn Reservoir and the Gage at Salt Water  
Barrier on the Neches River**

Reach	Average Travel Time (hours)	Cumulative Travel Time (hours)
Alto Gage (river mile 149.3) to Sam Rayburn Reservoir (river mile 25.2)	36	36
Sam Rayburn Reservoir (river mile 25.2) to B.A. Steinhagen Lake (river mile 113.7)	8	44
B.A. Steinhagen Lake (river mile 113.7) to Evadale Gage (river mile 54.6)	72	116
Evadale Gage (river mile 54.6) to Salt Water Barrier (river mile 27.7)	48	164

**4-10. Upstream Structures.** Lake Tyler, Lake Striker, Lake Nacogdoches and Lake Kurth are located in the headwaters of the Angelina River above Sam Rayburn Reservoir. Lake Naconiche and Pinkston Reservoir are located on Attoyac Bayou, a tributary of the Angelina River. None of these lakes have appreciable effects on the operation of Sam Rayburn Dam.

Lake Tyler, located about 8 miles southeast of Tyler, Texas on Prairie Creek (on the west) and Mud Creek (on the east), the tributaries of the Angelina River, is owned and operated by the City of Tyler. Lake Tyler has a storage capacity of 77,284 acre-feet and is used for municipal, domestic and industrial purposes.<sup>16</sup>

Lake Striker and Striker Dam, located about 15 miles northeast of Rusk, Texas on Striker Creek, a tributary of the Angelina River, are owned and operated by the Angelina-Nacogdoches Counties Water Control and Improvement District No. 1. Lake Striker has a capacity of 22,865 acre-feet and is used for industrial power plant cooling.<sup>17</sup>

Lake Nacogdoches, located about 10 miles west of Nacogdoches, Texas on the Loco Bayou, a tributary of the Angelina River, is controlled by the City of Nacogdoches. Lake Nacogdoches has a capacity of 39,523 acre-feet and is used for municipal water supply and recreation.<sup>18</sup>

<sup>16</sup> <http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/tyler/index.asp>

<sup>17</sup> <http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/striker/index.asp>

<sup>18</sup> <http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/nacogdoches/index.asp>

Lake Kurth is located 6 miles north of Lufkin, Texas on the south bank of Angelina River flood plain. The facility is an off-channel reservoir. Lake Kurth is owned and operated by City of Lufkin and has a capacity of 14,769 acre-feet.<sup>19</sup>

Lake Naconiche, located about 13 miles north of Nacogdoches, Texas on Naconiche Creek, a tributary of Attoyac Bayou, is controlled by the Nacogdoches County Commissioner Precinct 1 and has a capacity of 15,031 acre-feet.

Pinkston Lake and Dam, located 10 miles west of Center off State Highway 7 on Sandy Creek, a tributary of the Attoyac Bayou, is owned and operated by the City of Center. Pinkston Dam and Lake has a conservation capacity of 7,380 acre-feet and is used for municipal water supply and recreation.<sup>20</sup>

**4-11. Downstream Structures.** Town Bluff Dam and B.A. Steinhagen Lake are located approximately 20 miles downstream from Sam Rayburn Reservoir, where the Angelina and Neches Rivers combine just before entering the Lake. B.A. Steinhagen Lake has a conservation capacity of 66,972 acre-feet and serves to regulate releases from Sam Rayburn Reservoir. It also has power facilities of its own, with an installed capacity of 7,680 kW.

The Salt Water Barrier (RM 27.7) near Beaumont is downstream of Sam Rayburn Reservoir on the Neches River. The structure is to prevent salt water intrusion from the Gulf of Mexico and protect the fresh water supplies of LNVA and the city of Beaumont.

**4-12. Economic Data.** The Angelina River Watershed is rural, with an economy based on agriculture, mineral production, manufacturing, and wholesale and retail trade. The Sam Rayburn drainage area comprises parts of 10 counties in southeast Texas.

Based on the information published by U.S. Census Bureau Texas State Data Center, the population within the Angelina River Basin has continually increased over the last 50 years, with a gradual levelling off in the past decade. Population projections indicate that growth is anticipated to continue. County Business Patterns (CBP), a database published by the U.S. Census Bureau, provides valuable information on the number of industrial and business establishments within a particular county.<sup>21</sup> Sectors that are typically heavy consumers of water include: agriculture, forestry, fishing and hunting, mining, manufacturing, professional, scientific and technical services, health care and social assistance, and accommodation and food services. For some of the major counties in the basin, CBP data was reviewed for a 13-year period from 2000 to 2012. The number of industries in many of the heavy water-consumer sectors has shown an overall increase in the number of establishments across the counties. The number of industries involved in mining sector which is known to be a fairly heavy user of water has shown

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<sup>19</sup> <http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/kurth/index.asp>

<sup>20</sup> <http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/pinkston/index.asp>

<sup>21</sup> <http://www.census.gov/programs-surveys/cbp.html>

a marked increase, and has compensated for the slight downturn in the manufacturing sector in this region. The healthcare sector is also showing an increase in total number of establishments.

The following sections provide information on population, agricultural production, and industries in the counties in the Neches River Basin and surrounding area.

a. Population. Sam Rayburn Reservoir lies within Angelina, Jasper, Nacogdoches, San Augustine, and Sabine Counties. Based on the 2014 U.S. Census Bureau data, Angelina County has a population of 87,750, of which 41 percent, or 36,141 people, is in Lufkin, the county seat. Jasper County has a population of 35,552 of which 21 percent, or 7,637 people, is in Jasper. Nacogdoches County has a population of 65,301, of which 51 percent, or 33,687 people, is in Nacogdoches, 10 miles north of the reservoir. San Augustine County has a population of 8,610, of which 24 percent, or 2,050 people reside in San Augustine. Sabine County has a population of 10,350, of which 12 percent, or 1,199 people reside in Hemphill, the county seat.

The population growth of the 10 counties within the Neches River Basin since the construction of Sam Rayburn Reservoir is shown in Table 4-14. Although varying proportions of the total population of the counties listed lie within the watershed boundaries, the entire population of each county is provided.

**TABLE 4-14****Population Growth of Counties within the Neches River Basin**

County	1960	1970	1980	1990	2000	2010
Angelina	39,814	49,349	64,172	69,884	80,130	86,771
Cherokee	33,120	32,008	38,127	41,049	46,659	50,845
Jasper	22,100	24,692	30,781	31,102	35,604	35,710
Nacogdoches	28,046	36,362	46,786	54,753	59,203	64,524
Newton	10,372	11,657	13,254	13,569	15,072	14,445
Rusk	36,421	34,102	41,382	43,735	47,372	53,330
Sabine	7,302	7,187	8,702	9,586	10,469	10,834
San Augustine	7,722	7,858	8,785	7,999	8,946	8,865
Shelby	20,479	19,672	23,084	22,034	25,224	25,448
Smith	86,350	97,096	128,366	151,309	174,706	209,714
Hardin	24,629	29,996	40,721	41,320	48,073	54,635
Jefferson	245,659	244,773	250,938	239,397	252,051	252,273
Tyler	10,666	12,417	16,223	16,646	20,871	21,766
Orange	60,357	71,170	83,838	80,509	84,906	82,010

NOTE: Source: Census.gov

b. Agriculture. Over one-half of the Angelina River Basin is classified as timberland and one-third is agricultural land. The majority of the farmland is used for livestock. Also, a large percentage of the cropland grown in the area is classified as “forage,” which is land used for hays, grasses, and greenchop. According to the East Texas Regional Water Planning Area, 2016 East Texas Region Water Plan, irrigation and livestock comprises about 18 percent of the region’s water use, while manufacturing and municipal use comprise 55 and 17 percent, respectively.<sup>22</sup> By 2060, manufacturing use is projected to rise to 59 percent, with agriculture and municipal use shrinking to 14 and 15 percent, respectively. Table 4-15 lists the acreage of cropland planted in each major crop, the total agricultural acreage, the quantity of livestock, and the agricultural income for each county during the year 2012.

<sup>22</sup> [www.twdb.texas.gov/waterplanning/rwp/plans/2016/I/Region\\_I\\_2016\\_RWPV1.pdf](http://www.twdb.texas.gov/waterplanning/rwp/plans/2016/I/Region_I_2016_RWPV1.pdf)

**TABLE 4-15****Agricultural Production for Major Counties in Angelina River Basin, 2012**

Product	Angelina County	Cherokee County	Jasper County	Nacogdoches County	Newton County	Rusk County	Sabine County
Corn (acres)	—	D	D	D	—	D	3
Cotton (acres)	—	—	—	—	—	—	—
Oats (acres)	—	—	—	—	—	—	—
Sorghum (acres)	—	—	—	—	D	—	—
Wheat (acres)	—	1,501	—	—	—	—	—
Cropland Planted (acres)	21,687	67,789	16,337	43,706	8,902	47,469	4,603
Land in Farms and Ranches (acres)	116,977	301,338	88,130	264,818	58,782	274,327	29,035
Cattle (1000 head)	16	47	13	41	5	37	5
Crop Market Value*	4,292	89,696	5,618	5,718	1,043	19,263	566
Livestock Market Value*	42,156	44,287	4,451	316,656	1,906	56,040	14,162
All Agriculture Market Value*	46,448	133,984	10,069	322,374	2,948	75,303	14,728

- NOTES: 1. (D) Withheld to avoid disclosing data for individual farms.  
2. Data from 2012 Census of Agriculture, prepared by National Agricultural Statistics Service, U.S. Department of Agriculture.  
3. \* Quantity given in \$1,000s.

**TABLE 4-15 (CONTINUED)****Agricultural Production for Major Counties in Angelina River Basin, 2012**

Product	San Augustine County	Shelby County	Smith County	Tyler County	Hardin County	Jefferson County	Orange County
Corn (acres)	60	D	14	D	—	—	—
Cotton (acres)	—	—	—	—	—	D	—
Oats (acres)	—	—	—	—	—	—	—
Sorghum (acres)	—	890	—	—	—	—	—
Wheat (acres)	—	—	D	—	—	—	—
Cropland Planted (acres)	8,922	36,385	77,116	16,390	22,708	112,735	6,718
Land in Farms and Ranches (acres)	72,890	197,189	302,339	90,670	68,508	353,971	52,799
Cattle (1000 head)	10,555	38,099	42,885	11	8	41	8
Crop Market Value*	1,243	9,715	59,512	14,293	3,219	21,590	1,918
Livestock Market Value*	61,971	463,571	17,278	4,851	D	16,440	2,417
All Agriculture Market Value*	63,215	473,287	76,790	19,144	D	38,030	4,335

- NOTES: 1. (D) Withheld to avoid disclosing data for individual farms.  
2. Data from 2012 Census of Agriculture, prepared by National Agricultural Statistics Service, U.S. Department of Agriculture.  
3. \* Quantity given in \$1,000s.

c. **Industry.** Due to the size of the Neches River watershed, a large variety of industries are represented in the area. According to the 2016 East Texas Region Water Plan, much of the region supports various types of timber industry, livestock (predominantly beef cattle, as well as poultry), as well as scattered oil and gas production and manufacturing. The report also states that manufacturing comprises about 45 percent of the region's total water use, and is projected to

increase to above 60 percent by 2030.<sup>23</sup> Table 4-16 gives the estimated number of people employed in various industries in each county, as compiled by the 2012 United States Census.

**TABLE 4-16****Employment in Counties within the Angelina River Basin, 2012**

Industry	Number Employed						
	Angelina County	Cherokee County	Jasper County	Nacogdoches County	Newton County	Rusk County	Sabine County
Agriculture, Forestry, Fishing & Hunting	186	149	78	50	109	69	10
Construction, Mining, Oil & Gas	1,292	530	800	1,157	58	2,213	134
Manufacturing	4,733	2,793	1,500	3,653	86	1,340	286
Trade, Transportation & Utilities	6,750	2,341	2,190	3,607	243	2,515	314
Finance, Insurance, & Real Estate	1,198	415	357	740	60	435	62
Professional, Scientific & Business Services	1,459	318	275	624	57	1,035	60
Education & Healthcare	7,989	2,691	2,254	3,291	343	1,653	329
Arts, Leisure & Hospitality	3,277	816	798	2,617	60	1,067	75
Communication & Information	400	118	42	139	10	175	10
Public Administration	1,403	641	29	531	60	717	60
Other Services	1,421	376	377	861	52	679	81
<b>Total</b>	<b>30,108</b>	<b>11,188</b>	<b>8,700</b>	<b>17,270</b>	<b>1,138</b>	<b>11,898</b>	<b>1,421</b>

NOTE: Data from the United States Census, 2012.

<sup>23</sup> [www.twdb.texas.gov/waterplanning/rwp/regions/g/](http://www.twdb.texas.gov/waterplanning/rwp/regions/g/)

**Table 4-16 (CONTINUED)****Employment in Counties within the Angelina River Basin, 2012**

Industry	Number Employed						
	San Augustine County	Shelby County	Smith County	Tyler County	Hardin County	Jefferson County	Orange County
Agriculture, Forestry, Fishing & Hunting	28	227	75	148	80	60	10
Construction, Mining, Oil & Gas	130	862	4,921	60	1,837	15,092	1,945
Manufacturing	60	2,289	7,438	70	674	14,102	5,272
Trade, Transportation & Utilities	355	1,484	17,735	618	2,491	21,483	4,371
Finance, Insurance, & Real Estate	57	474	4,677	105	313	4,356	886
Professional, Scientific & Business Services	11	145	7,002	56	423	14,538	545
Education & Healthcare	401	804	22,240	544	998	17,140	1,518
Arts, Leisure & Hospitality	80	439	10,849	232	1,227	11,162	2,104
Communication & Information	10	60	2,233	25	70	1,228	231
Public Administration	10	148	3,600	4	131		1,024
Other Services	20	260	5,388	175	650	4,705	1,145
<b>Total</b>	<b>1,162</b>	<b>7,192</b>	<b>86,158</b>	<b>2,037</b>	<b>8,894</b>	<b>103,886</b>	<b>19,051</b>

NOTE: Data from the United States Census, 2012.

d. Flood Damages. The damages prevented in the Neches River Basin by Sam Rayburn Dam and Town Bluff Dam as a system during fiscal year 2015 were estimated to be \$273,721,300 with \$232,663,105 by Sam Rayburn Dam and \$41,058,195 by Town Bluff Dam. The cumulative damages prevented since the completion of the projects in 1965 through 2015 are \$1,405,844,177, and the average is \$27.6 million per year. Table 4-17 and Table 4-18 show discharge versus damages incurred for agricultural and non-agricultural on Neches River at both Evadale and Beaumont. The damages shown in the tables are estimated to occur at the various discharge levels, as the exact amount of damage will vary.

**TABLE 4-17**

**Discharge versus Damages on Neches River at Evadale, 2013**

Discharge (cfs)	Damages (X\$1,000)						
	Crops (1)	Crops (2)	Crops (3)	Crops (4)	Crops (C)	Other ag.	Non-ag.
24,000	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
30,000	\$214.6	\$250.2	\$186.0	\$241.4	\$206.4	\$119.6	\$104.5
40,000	\$457.8	\$352.7	\$594.5	\$527.0	\$402.5	\$202.6	\$2,924.5
60,000	\$690.7	\$786.3	\$499.7	\$648.5	\$565.0	\$318.1	\$8,042.5
80,000	\$803.4	\$920.2	\$609.9	\$791.6	\$686.0	\$430.1	\$12,184.3
100,000	\$868.7	\$996.7	\$668.7	\$867.9	\$751.0	\$533.7	\$15,924.1
120,000	\$917.9	\$1,052.9	\$705.4	\$915.5	\$792.4	\$631.9	\$19,866.5
140,000	\$959.3	\$1,099.9	\$734.8	\$953.7	\$825.5	\$729.0	\$23,711.4
200,000	\$1,033.8	\$1,184.5	\$787.7	\$1,022.5	\$885.1	\$903.8	\$30,632.2

Crops(1) = Jan, Feb, Dec

Crops(2) = Mar, Nov

Crops(3) = Apr, May, Oct

Crops(4) = Jun, Jul, Aug, Sep

NOTES: 1. This table is estimated on roughly available data.

2. Price levels are for September 2013. To convert the prices to a different year, average annual cost indexes must be applied.

**TABLE 4-18**

**Discharge versus Damages on Neches River at Beaumont, 2013**

Discharge (cfs)	Damages (X\$1,000)						
	Crops (1)	Crops (2)	Crops (3)	Crops (4)	Crops (C)	Other ag.	Non-ag.
20,000	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
25,000	\$253.0	\$291.4	\$170.9	\$213.9	\$179.6	\$116.7	\$0.0
30,000	\$406.5	\$479.5	\$325.1	\$418.2	\$378.8	\$196.9	\$1.0
40,000	\$662.8	\$793.1	\$580.1	\$745.9	\$666.6	\$357.0	\$7.0
60,000	\$991.1	\$1,142.2	\$895.6	\$1,151.6	\$1,018.4	\$626.4	\$52.0
80,000	\$1,110.2	\$1,359.8	\$1,111.1	\$1,428.7	\$1,229.7	\$978.8	\$163.0
100,000	\$1,227.1	\$1,509.4	\$1,257.2	\$1,616.4	\$1,426.0	\$1,112.4	\$377.0
120,000	\$1,322.1	\$1,630.3	\$1,372.7	\$1,764.8	\$1,544.9	\$1,335.3	\$1,062.0
158,000	\$1,466.4	\$1,812.6	\$1,541.7	\$1,982.2	\$1,733.5	\$1,775.3	\$3,047.0

Crops (1) = Jan, Feb, Dec

Crops (2) = Nov, Mar

Crops (3) = Apr, May, Oct

Crops (4) = Jun, Jul, Aug, Sep

NOTES: 1. This table is estimated on roughly available data.

2. Price levels are for September 2013. To convert the prices to a different year, average annual cost indexes must be applied.

## **CHAPTER V - DATA COLLECTION AND COMMUNICATION NETWORKS**

### **5-01. Hydrometeorological Stations.**

a. Facilities. The Water Resources Branch of the USACE, Fort Worth District, the NWS, and the USGS cooperate to collect hydrometeorological data and maintain a reliable communication network. Plate 5-1 shows the locations of USGS stream gages in the Neches River Basin. Commercial television weather services provide current radar and forecasted weather conditions to assist the Water Resource Branch in monitoring storm events.

1. Precipitation Gages. The NWS and USGS maintain a network of rain gages and observers throughout the Neches River basin. The NWS precipitation gages used to forecast runoff in the Neches River Watershed are listed in Table 5-1 and are shown on Plate 5-3, respectively.

**TABLE 5-1**  
**Upstream NWS Precipitation Gages**

Name of Station	Description
Frankston 4.4 NNE	Non-Recording
Port Arthur Airport	Recording
Palestine 2 NE	Recording
Alto 5 SW	Discontinued
Beaumont RSCH CTR	Non-Recording
Beaumont City	Non-Recording
Center	Recording
Chireno	Discontinued
Cleveland	Non-Recording
Dialville 2 W	Non-Recording
Evadale	Discontinued
Henderson	Non-Recording
Jacksonville	Non-Recording
Jasper	Non-Recording
Kountze	Non-Recording
Livingston 2 NNE	Non-Recording
Longview 11 SE	Recording
Lovelady	Discontinued
Lufkin Angelia County Airport	Recording
Lufkin #2	Non-Recording
Moscow	Discontinued
Nacogdoches	Recording
New Summerfield 2 W	Recording
Rockland 2W	Discontinued
Rusk	Non-Recording
Sam Rayburn Dam	Non-Recording
San Augustine	Recording
Town Bluff Dam	Non-Recording
Tyler Pounds Field	Recording
Warren 2 S	Discontinued
Woodville	Non-Recording

**TABLE 5-1**  
**Upstream NWS Precipitation Gages**

Name of Station	Description
Frankston 4.4 NNE	Non-Recording
Port Arthur Airport	Recording
Palestine 2 NE	Recording
Alto 5 SW	Discontinued
Beaumont RSCH CTR	Non-Recording
Beaumont City	Non-Recording
Center	Recording
Chireno	Discontinued
Cleveland	Non-Recording
Dialville 2 W	Non-Recording
Evadale	Discontinued
Henderson	Non-Recording
Jacksonville	Non-Recording
Jasper	Non-Recording
Kountze	Non-Recording
Livingston 2 NNE	Non-Recording
Longview 11 SE	Recording
Lovelady	Discontinued
Lufkin Angelia County Airport	Recording
Lufkin #2	Non-Recording
Moscow	Discontinued
Nacogdoches	Recording
New Summerfield 2 W	Recording
Rockland 2W	Discontinued
Rusk	Non-Recording
Sam Rayburn Dam	Non-Recording
San Augustine	Discontinued
Town Bluff Dam	Non-Recording
Tyler Pounds Field	Recording
Warren 2 S	Discontinued
Woodville	Non-Recording

2. Weather Radar Sites. The NWS maintains 12 Doppler radar sites across Texas for surveillance of immediate weather conditions. The NWS also cooperates with the Department of Defense to obtain radar information from four military sites in Texas.

3. Stream Gages. The USGS maintains 14 stream gages in the Neches River Basin. The gages are listed in Table 5-2A. The stream gages designated as stations for forecasting and regulating Sam Rayburn Dam are listed in Table 5-2B. A hydrologic gage network was established for use in connection with the operation of the Sam Rayburn Dam. The hydrologic gage network for the Neches River Basin is shown on Plate 5-1. The travel times for flows from the Alto gage to Sam Rayburn Dam are shown on Plate 5-2.

**TABLE 5-2A****USGS Stream Gages in Neches River Basin**

Station Number	Name of Station	Description
08031290	Lake Athens near Athens	Recording
08031400	Lake Palestine near Frankston	Recording
08032000	Neches River near Neches	Recording
08032200	Lake Jacksonville near Jacksonville	Recording
08032500	Neches River near Alto	Recording
08033000	Neches River near Diboll	Recording
08033500	Neches River near Rockland	Recording
08033810	Lake Striker near Reklaw	Recording
08033900	East Fork Angelina River near Cushing	Recording
08034000	Lake Tyler near Whitehouse	Recording
08034500	Mud Creek near Jacksonville	Recording
08036500	Angelina River near Alto	Recording
08036700	Lake Nacogdoches near Nacogdoches	Recording
08037050	Bayou Lanana at Nacogdoches	Recording
08038000	Attoyac Bayou near Chireno	Recording
08039100	Ayish Bayou near San Augustine	Recording
08039300	Sam Rayburn Reservoir near Jasper	Recording
08040000	B.A. Steinhagen Lake at Town Bluff	Recording
08040600	Neches River near Town Bluff	Recording
08041000	Neches River near Evadale	Recording
08041500	Village Creek near Kountze	Recording
08041700	Pine Island Bayou near Sour Lake	Recording
08041749	Pine Island Bayou above BI Pump Plant	Recording
08041780	Neches River Saltwater Barrier at Beaumont	Recording

**TABLE 5-2B**

**Regulating Stations for Sam Rayburn Dam**

Station Number	USGS Gage Station	Method of Reporting
08040600	Neches River near Town Bluff	Satellite Telemeter
08041000	Neches River near Evadale	Satellite Telemeter

b. Reporting. Data Collection Platforms (DCPs) have been installed at all USACE, Fort Worth District, lakes, and at numerous stream gages and precipitation stations. The DCPs transmit hydrometeorological data using the Geostationary Operational Environmental Satellite (GOES) to the NOAA Center in Wallops Island, Virginia. The data are then decoded and re-transmitted using Domestic Satellites (DOMSATs), making the data available for nationwide reception. The Water Management Office captures, processes, and stores the data in the Fort Worth District’s Water Control Data System (WCDS).

The Water Management Office collects and stores the majority of hydrometeorological data in the WCDS. Thus, hourly lake elevations and stream gage stages are stored in the WCDS network. Some meteorological and hydropower data are collected by telephone. Project personnel collect precipitation, evaporation, and, maximum and minimum air temperature data from weather stations. The information is reported to the Water Management Office by e-mail or sometimes by facsimile and telephone.

The Water Management Office personnel use the data in the WCDS to operate the 27 lakes that the Fort Worth District manages. All the data entered into the WCDS is stored in a database and used for water management decisions, to generate reports, and to conduct hydrologic studies. The Water Management Office also serves as a source of hydrologic data for state and local government agencies and the general public.

c. Maintenance. Maintenance costs are shared among the USGS, NWS, USACE, TWDB, and various river authorities. Maintenance and repair of the weather station instrumentation are the responsibilities of the NWS. Maintenance and repair of stream gaging stations are the responsibility of the USGS. Assistance in gage repair can be obtained by contacting the USGS in Fort Worth, Texas, at (817) 263-9545.

**5-02. Water Quality Stations.** The USGS has collected data and monitors the water quality in Sam Rayburn Reservoir at twenty-nine stations near the dam, however only 11 of those locations have been sampled since 1999. In addition, TCEQ, LNVA, and Angelina-Neches River Authority monitor water quality using 133 active monitoring stations through Neches River Basin.

a. Facilities. The 20 designated sites where USGS water quality samples were taken for Sam Rayburn Reservoir were stations AC, BC, CC, DC, EC, FC, GC, HC, IC, JC, KC, LC, MC, NC, CL, IL, BR, IR, CR and PS. The chemical, biological, and field parameters were measured at these 20 sites. Table 4-11C shows the most recent data for constituents sampled of 3 most comprehensive records on Sam Rayburn Reservoir.

The Neches River Basin is divided into 14 classified segments and 28 unclassified water bodies by TCEQ to report water quality information. The Segment 610, "Sam Rayburn Reservoir", is designated to provide the water quality data for the reservoir.

b. Reporting. The USGS summarizes and publishes its collected water quality data annually in the "Water Resources Data: Texas" book for its current sampling locations. However, Sam Rayburn Reservoir is not sampled yearly and only years for which it was sampled are published in the yearly data book.

The "Texas Integrated Report of Surface Water Quality," formerly called the "Texas Water Quality Inventory and 303(d) List," evaluates the quality of surface waters in Texas, and provides resource managers with a tool for making informed decisions when directing agency programs. The TCEQ publishes the report every 2 years (in even-numbered years). The water quality assessment results for Sam Rayburn Reservoir are included in the report.

c. Maintenance. Maintenance and calibration of the equipment related to water quality are conducted or monitored by USGS and TCEQ.

### **5-03. Sedimentation and Degradation Ranges.**

a. Facilities. The sedimentation ranges, which are needed to determine the rate of sedimentation and the location of sediment deposits, were established as directed in Engineer Regulation (ER) 1100-2-240 and Engineer Manual (EM) 1100-2-4000.

1. Sedimentation Ranges. There are 14 sedimentation ranges in the Sam Rayburn Reservoir area. The ranges cross the lake normal to the original stream flow as practical. The elevations and locations of the monuments are referenced to appropriate datum systems established by other Federal agencies. Monuments are used at multiple locations for future survey at common reference points. Sedimentation ranges have not been utilized at Sam Rayburn Reservoir since the 1965 survey. The TWDB uses bathymetric survey independent of the USACE established sedimentation ranges.

2. Degradation Ranges. There are 9 degradation ranges downstream of Sam Rayburn Reservoir and Dam. Each range consists of two or more permanent monuments placed at selected locations along the discharge channel downstream of the dam.

b. Reporting. The frequency of sedimentation surveys will depend on hydrologic conditions and the need for determining sediment deposition and storage depletion. Normally, a period of no more than 20 years would elapse between sedimentation surveys. However, sedimentation surveys are currently done periodically depending on need and funding availability. Complete or partial surveys will be made of degradation ranges, as found necessary on the basis of reconnaissance.

For Sam Rayburn Reservoir, two surveys have been performed since 1965, including the historical 1965 USACE original design, and the 2004 TWDB volumetric survey. The 2004 TWDB survey results indicated that the surface area had decreased from 114,500 acres in the original design to 112,590 acres and the volume decreased from 2,898,500 acre-feet of water in the original design to 2,876,033 acre-feet of water at top of power pool elevation 164.4 feet.

c. Maintenance. Project personnel will inspect the survey monuments to determine their respective conditions. A report will be forwarded to the Water Management Office following the inspection that describes the condition of the monuments not found, destroyed, or otherwise disturbed. Monuments and witness points that have been damaged or are missing will be replaced and reset. Completion of monument surveys is dependent on funds and personnel availability.

**5-04. Recording Hydrologic Data**. Hydrologic information is recorded as the Water Management Office receives it. The recording procedures for each type of data are as follows:

a. Stages and Lake Elevations. Stream stage and lake stage data are recorded every 15 minutes and transmitted every hour by the DCPs through a GOES Satellite to Wallops Island, VA, then retransmitted to a DOMSAT. The District's WCDS accesses the data by a downlink. The recorded data and monthly data summaries are kept in the reservoir logbooks and in other Water Management Office files. Additional data sets from non-Corps reservoirs are received from the Internet, by facsimile, and/or by telephone.

b. Precipitation. Hourly precipitation data from numerous DCPs across the state are transmitted to the Water Management Office in the manner described in paragraph 5-04.a. The Water Management Office also receives precipitation data from the NWS and other precipitation observers through the Automated Field Observations and Services (AFOS) system and stores the data in the WCDS. The NWS daily state precipitation summary is filed and retained for approximately 1 year. The Water Management Office receives daily rainfall and weather reports from 22 of the 25 District lakes, including Sam Rayburn Reservoir.

c. Temperature Data. The lake personnel record the daily maximum and minimum air temperatures at the lake.

d. Radar Reports. The Water Management Office receives radar images and weather information from commercial weather services by cable TV. This information is used primarily

for short-term decision making. The weather reports are updated throughout the day by the NWS.

e. Hydropower. The Water Management Office requires hydropower release data and megawatts produced. The Sam Rayburn Powerhouse provides hydropower release data by email every day of the week to the Fort Worth District Water Management Office for the preceding 24 hour period.

**5-05. Communication Network**. Sam Rayburn Reservoir is served by telephone, facsimile, email, and cell phone. The telephone number for the Sam Rayburn Reservoir project office is (409) 384-5716.

The National Telecommunications and Information Administration (NTIA) and the Department of Commerce, assign radio frequencies exclusively to the USACE. The assigned VHF FM frequencies are 163.5125 and 163.4375 MHz. Both of the VHF FM frequencies are maintained at most project offices and in some vehicles assigned to the Fort Worth District. The radio equipment using the VHF FM frequencies will only transmit about 20 miles. Therefore, radio communications cannot be made between the Sam Rayburn Dam project office and the Fort Worth District Office, or between other district lakes.

If necessary, the Fort Worth District Emergency Operation Center (EOC) can contact other districts in the SWD by HF side-band radio during an emergency. This radio frequency is good for communications between the EOCs in Fort Worth, Texas, Galveston, Texas, Little Rock, Arkansas, and Tulsa, Oklahoma.

**5-06. Communication with the Project**.

a. Water Resources Branch with Project Office. The primary mode of communication between the Sam Rayburn Reservoir project office and the Water Resources Branch is by telephone. In addition, communication is made by fax, email, and cell phones as backups to the Lake office telephone. Should communication between the project and the District be disrupted, the Lake Manager would direct regulation of the lake on his or her own initiative in accordance with the Emergency Rules and Regulations listed in Section 7-05 and Exhibit C of this manual.

b. Between Project Office and Others. The Lake Manager will maintain a current list of the residents and/or property endangered or inconvenienced by large and/or prolonged releases in order to give adequate warning before such releases. Warning of possible flood conditions can be conveyed by telephone, radio, television, citizens-band radio, use of law enforcement personnel, and civil defense agencies and their communications systems. National Guard, Reserve Military Units, and citizen volunteers may also be needed to convey warning messages. Plate 5-4 shows a schematic of the lines of communication for use in routine communications and in case of an emergency.

**5-07. Project Reporting Instructions.** Both daily lake operation information and emergency lake operation information will be submitted to the Water Management Office of the Fort Worth District.

a. Daily Operations. Daily reservoir data will be submitted to the Water Management Office on regular working days by facsimile or electronic mailing between 0800 and 0845 hours each morning for transmission of hydrologic data. For electronic mailing, the Internet Web site is: (<http://www.swf-wc.usace.army.mil>). Project personnel will confirm gate changes and promptly report all scheduled or unscheduled equipment outages affecting water control by telephone at (817) 886-1551 or by facsimile at (817) 886-6472 or by email at CESWF-OD-L@usace.army.mil. The Water Resources Branch may request additional information as needed.

Daily data reported to the District Office include the following: (1) As of 0800 hours – Reservoir elevation: number of gates open and increments of opening, precipitation and evaporation for the preceding 24 hours, weather conditions and maximum and minimum temperatures, if required. (2) Each gate operation – All changes in gate operation, including time of gate operation, increments of opening, and reservoir elevation at time of each gate operation for the preceding 24 hours. (3) Stage report – During flood periods, besides the regular 0800-hour reading from the reservoir and reporting gages (Alto and Sam Rayburn Reservoir), include the 0000-hour (midnight) reading, which may be read from the recorder charts. The Sam Rayburn Powerhouse provides hydropower release data by email every day of the week to the Fort Worth District Water Management Office for the preceding 24 hour period.

b. Emergency Operations. In the event of an emergency or flood situation, the Lake Manager will notify key personnel in the Fort Worth District Water Management Office. A list of these names will be posted on the project bulletin board. These names are shown on page iii, Notice to Users of This Manual. If unusual conditions arise during non-working hours, one of the persons listed on page iii should be contacted.

**5-08. Warnings.** Before any major increase in discharge due to operation of the gates, warning of such operation shall be given to parties in the immediate area downstream of the dam. A warning horn will be sounded for 10 seconds to alert people downstream at least 2 minutes before any appreciable increase or decrease in the release rate from the dam. After the horn sounds, the operator will observe the downstream area to ensure that no one remains there. Signs in the discharge area shall state the meaning of the warning signal. A warning horn will be sounded from the dam only during the initial releases. The law enforcement agencies shown in Table 5-3 may also be contacted to assist in warning the public and evacuating downstream areas.

**TABLE 5-3**

**Law Enforcement and Key Sam Rayburn Project Telephone Numbers**

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Agency	Telephone Number
Texas Department of Public Safety, Jasper, Texas	(409) 384-5712
City of Jasper Police Dispatch	(409) 384-3471
Sam Rayburn Dam Manager	(409) 698 5458
Angelina National Forest Rangers	(936) 897-1068
LNVA Office Dispatch	(409) 892-1805
Sheriff, Jasper County	(409) 384-5417

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## **CHAPTER VI – HYDROLOGIC FORECASTS**

**6-01. General.** Hydrologic forecasts of stream flow amounts are made daily to maintain the current status of the Neches River Basin for flood control and water supply.

a. Role of Corps of Engineers. Hydrologic forecasts are made by the Water Management Office for use in the regulation of lakes to maximize flood control, hydropower, water supply, and other authorized purposes. The forecasts are furnished to project personnel and other USACE personnel with a need for this information. Planned changes in the release rates are furnished to the National Weather Service River Forecast Center (NWS-RFC) in Fort Worth, Texas. The Public Affairs Office, which is kept informed of the lake conditions, makes news releases.

b. Role of Other Agencies. The NWS-RFC provides information about river flow and flood forecasts to USACE and the general public. The NWS Weather Wire circuit disseminates this information to subscribing government agencies and news media. The National Weather Service Weather Service Forecast Offices (NWS-WSFO) issues routine reports containing the following information:

1. Weather forecasts (daily forecasts, severe weather forecasts, and 5-day extended forecasts).
2. Quantitative precipitation forecasts: Four successive 6-hour precipitation forecasts are updated every 12 hours. Three successive 24-hour precipitation forecasts are updated every 12 hours.
3. Three-day river stage forecasts, when conditions warrant, from the NWS-RFC.
4. Urgent priority messages such as severe weather warnings, severe weather watches and statements, and instructions from civil defense centers during emergency situations.
5. Other information reports, on a periodic basis:
  - (a). Winter weather and road conditions
  - (b). River and flood warning bulletins
  - (c). Damage reports
  - (d). Thirty-day weather forecasts

## **6-02. Flood Control Forecasts.**

a. Requirements. Flood forecasts are required whenever substantial rainfall has fallen above or below Sam Rayburn Dam or during the evacuation of the flood pool from Sam Rayburn Reservoir.

b. Methods. Water Managers continually monitor and adjust water releases at USACE projects based on ever-changing hydrometeorological conditions. The Corps Water Management System (CWMS) is the automated decision support tool developed for USACE Water Managers. CWMS tracks the hydrologic cycle and performs scenario-based forecasts that can include stage and flow forecasts, project release scheduling and release review, emergency activation alerts, inundation mapping and economic damage reporting. The CWMS Automated Information System was developed by the USACE Hydrologic Engineering Center (HEC) under funding from the Water Management Community of Practice and has been implemented to varying degrees at various USACE Water Management Offices. A CWMS forecasting model has been developed for the Neches River Basin by the Fort Worth District, HEC, and the USACE MMC (Modeling, Mapping, and Consequences) Production Center. The USACE makes the following forecasts with assistance from the NWS.

1. Predicting Inflow into Sam Rayburn Reservoir. A rainfall-runoff HEC-HMS model was developed within CWMS by the Fort Worth District for the Angelina River Basin above the Alto gage. This model is used to predict the inflow into Sam Rayburn Reservoir. The inflow forecasting model consists of HEC-METVUE and HEC-HMS models that are linked to real-time data with CWMS. Both models use a 1-hour time interval.

Precipitation estimates are available from two main sources: precipitation gages and radar. The NWS uses the data from these sources to produce a suite of hydrologic forecasts. Weather Surveillance Radar–1988 Doppler (WSR-88D), also known as Next Generation Weather Radar (NEXRAD), observes the presence of severe weather and calculates the speed and direction of the weather. The WSR-88D also provides estimated quantitative area precipitation amounts.

The NWS adds to the accuracy of the WSR-88D quantitative precipitation estimates (QPE) through a procedure for improving the radar estimates of rainfall that is referred to as “ground truthing.” The precipitation data set produced from the ground truthing is known as the Multi-sensor Precipitation Estimate (MPE). The NWS and other agencies may poll some automated gages on a 4-hour basis, and the poll results may also be used for ground truthing.

Hourly NWS gridded rainfall data is downloaded from the NWS West Gulf Forecasting Center in real-time and processed into HEC-DSS format using HEC-METVUE. The HEC-HMS model is then used to compute runoff from the gridded precipitation. Initial and uniform losses are adjusted to real-time basin conditions within CWMS. These losses are subtracted from the precipitation hyetograph at each subbasin grid cell to obtain the rainfall runoff hyetograph. Each grid cell hyetograph is then routed and combined by the HEC-HMS model to obtain the total

inflow hydrograph for Sam Rayburn Reservoir. A map of the Neches River Model subbasins is shown on Plate 4-1.

There is a DCP at Sam Rayburn Reservoir which records the lake elevation. An inflow hydrograph can be computed using observed lake elevations, an elevation-capacity table, and hourly lake releases.

The HEC-HMS model is executed with forecast time and an initial estimate of loss rates as determined by the user. The computed hydrographs at Sam Rayburn Reservoir are compared with observed runoff volume, shape, and time of peak. If the comparison is not favorable, then subbasin loss rates are adjusted accordingly and the HEC-HMS model is re-executed. This calibration process is repeated until the comparisons are favorable. This process ultimately results in a forecasted inflow into Sam Rayburn Reservoir.

2. Predicting Lake Levels. The forecasted inflows as computed by the HEC-HMS model are routed into Sam Rayburn Reservoir. The model will add the routed inflows to the storage in the lake and subtract the releases to forecast the lake elevations.

3. Predicting Flow at Downstream Control Points. The flood forecasting system is used to predict flows in the Neches River near Town Bluff gage. The predicted flows for the control points located downstream of the project are computed by combining the estimated local flow in the river channel and the potential routed releases from Sam Rayburn Reservoir and B.A. Steinhagen Lake. If the predicted flows exceed downstream controls, no releases will be made above that required for firm power.

(a). Estimating Local Flow. Local flow forecasts can be obtained from two sources: the NWS-RFC's river forecast model or the Neches River HEC-HMS model. If the latter method is used, the subbasin hydrographs for the uncontrolled areas below Sam Rayburn Reservoir are computed using the same procedure discussed in paragraph 6-02.b.(1).

(b). Routing Reservoir Releases to Downstream Control Points. The HEC-HMS model is used to route releases from Sam Rayburn Reservoir Lake to downstream points by using the Modified Puls and Muskingum flow routing methods. The releases are determined based on the predicted available channel capacity at the downstream control points. The determined releases are then incorporated into the HEC-HMS model. The observed flows at the downstream control points on the Neches River are provided by stream gages. The downstream control points are located on the Neches River near Town Bluff gage and the Neches River at Evadale gage. Plate 4-19 shows flood crest travel times in the Neches River Basin from Sam Rayburn Reservoir to the Neches River Saltwater Barrier at Beaumont gage.

(c). Regulated Flow. The releases from Sam Rayburn Reservoir combine with uncontrolled flows from the Angelina River and are reregulated by B.A. Steinhagen Lake from which releases are then measured at the gage near Town Bluff on the Neches River.

**6-03. Conservation Purpose Forecast.** The conservation storage is used for water supply, hydropower, irrigation, fish and wildlife, and general recreation. Conservation storage forecasts are made when needed based on forecasted inflow, historical average evaporation, and estimated demand.

**6-04. Long-Range Forecast.** Long-range weather forecasts are made by the NWS Climate Prediction Center, and available at the “Outlooks Index” in the website [http://www.cpc.ncep.noaa.gov/products/OUTLOOKS\\_index.shtml](http://www.cpc.ncep.noaa.gov/products/OUTLOOKS_index.shtml). The outlooks website contains both temperature and precipitation forecast for “Monthly to Seasonal” and “Extended Range” categories. Special products, such as current UV index forecast and soil moisture outlooks are also available on this website.

**6-05. Drought Forecast.** The latest February 2017 LNVA Drought Contingency Plan is located in Exhibit J. In general, the three factors used to determine the severity of a drought are the lake content, lake inflow, and the Palmer Drought Severity Index (PDSI). The PDSI reflects the cumulative excess or deficiency in moisture relative to seasonal norms and typically ranges from +4 to -4 but may exceed these values. A PDSI of -4 indicates that abnormally dry conditions have prevailed. The NWS publishes the PDSI about once a week. Drought conditions can be accessed at this website:  
[http://www.cpc.ncep.noaa.gov/products/monitoring\\_and\\_data/drought.shtml](http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml)

**CHAPTER VII – WATER CONTROL PLAN**

**7-01. General Objectives.** The primary operational objectives of Sam Rayburn Dam and Reservoir are provision of flood control, water supply, and hydro-electric power generation. Support of the authorized navigation purpose occurs as a by-product of the primary operational objectives. Incidental operational objectives are to protect and enhance the fish, wildlife and aquatic habitat, and provide general recreation.

All elevations referred to in this Water Control Manual, unless noted otherwise, are in feet, National Geodetic Vertical Datum of 1929 (NGVD29). The datum conversion from NGVD29 to NAVD88 is: NGVD29 + 0.0 feet = NAVD88 for Sam Rayburn Dam and Reservoir.

**7-02. Project Constraints.**

a. Outlet Works.

1. Low-Flow Outlets. There are no Low-Flow Outlets at Sam Rayburn Dam.

2. Gated Conduits. Two 10.0' x 20.0' rectangular conduits with upstream invert at elevation 105.0 are controlled by two 10' x 20' tractor type service gates. Gated release capacity for several pertinent pool elevations are shown in Table 7-1.

**TABLE 7-1**  
**Service Gate Release Capacity**

Pool Elevation [ft]	Discharge [cfs] for Two Gates at 10.0 Feet (Half Open)	Discharge [cfs] for Two Gates at 20.0 Feet (Full Open)
149.0 (Bottom of Conservation/Power Pool)	8,000	16,200
164.4 (Top of Conservation/Power Pool)	9,300	20,000
173.0 (Top of Flood Pool)	10,000	22,000
176.0 (Spillway Crest)	10,200	22,600

Gate rating curves for selected partial and full open gate settings are shown on Plate 7-3. Gate rating curves for two 10-foot x 20-foot conduits fully open gate settings are shown on Plate 7-7.

Gate opening and closing operations should be accomplished as symmetrically as practicable with allowable difference in gate opening height between the two gates not to exceed one foot. For continuous operation the gates will normally be set at any desired increment of opening height up to 10 feet (half open), after which the next opening step is directly to full open in one continuous operation – first one gate, followed immediately by the other. Closure from full open to half open should be accomplished analogously in reverse order. Standard practice is to use gate opening heights at 0.5-foot increments between closed and half open. This practice provides sufficient control of release rates since one-half foot of opening height equates to a discharge of approximately 250 cfs.

Results of hydraulic analyses indicate a stable flow regime should persist for incremental gate opening heights up to a maximum of 16 feet. However, the gates have never been continuously operated at any opening height between 10 feet (half open) and full open, and there is concern setting the gates at an opening height between 10 feet (half open) and full open may result in excessive vibration or other abnormal behavior that could damage a gate. *Therefore, no instructions should be given to set the gates anywhere between half open and full open without management approval.* Because both gates set at 10 feet in unison with typical rates of generation from both turbine generators will produce a combined discharge of between 18,000 and 19,000 cfs, the probability of a need to set the gates at an opening height exceeding 10 feet (half open) is low.

3. Uncontrolled Spillway. Labyrinth weir consisting of 16 cycles at 40 feet per cycle spanning a 640 foot wide outlet channel. The weir has an effective length (measured along the crest) of approximately 3,200 feet at crest elevation 176.0. Discharge capacity at maximum design pool elevation 183.0 is 155,661 cfs. A discharge rating for the uncontrolled spillway is shown on Plate 7-4.

4. Hydropower Facilities. The powerhouse contains two vertical hydro-electric turbine generators which may be operated singly or in tandem. Each unit consists of a Kaplan type (adjustable blade) turbine connected to a generator designed for a normal continuous output not to exceed 26 MW with maximum output of 30 MW allowed for short duration emergencies if sufficient head is available and operating temperatures permit. Generation typically occurs at about the 25 MW per unit output level, and is typically scheduled (by others) to provide peaking power during times of the day when power demand is highest. The rate of discharge associated with a given level of generation output can vary significantly with the hydraulic head (headwater minus tailwater) available to power a turbine. Tailwater elevation varies with the generation output level, and is also affected by B.A. Steinhagen Lake levels greater than 81.0, and gated releases from Sam Rayburn when they are in progress.

Table 7-2 below shows approximate typical rates of single unit turbine discharge for selected Sam Rayburn pool elevations coincident with B.A. Steinhagen Lake at about elevation 82.5 feet, and the assumption of no gated releases from Sam Rayburn. Both units generating in tandem may be expected to produce approximately twice the rate of discharge shown.

**TABLE 7-2**

**Generation Discharge for 25 MW Output at Selected Pool Elevations**

Pool Elevation [ft]	Number of Units Generating	Generation Discharge [cfs]
149	1	5,600
150	1	5,500
155	1	5,100
160	1	4,700
165	1	4,400
170	1	4,100
173	1	4,000
176	1	3,900

Hydropower generation accomplished with water from the conservation storage space is governed by a set of operating rule curves approved and implemented in 1981. These rule curves and associated documentation specify the number of unit-hours available for generation based on time of year and reservoir pool elevation. A copy of the original final documentation of these rule curves is presented in Exhibit E – Hydropower Operating Rule Curves. A plot of the rule curves, including selected information pertinent to their application, is shown on Plate 7-11.

As per the aforementioned operating rule curves, “In any zone of the conservation pool power may be generated on a volume basis over a seven-day period, if regulation capability of Town Bluff Dam is such that the LNVA [Lower Neches Valley Authority] needs can be met.” For a given weekly allotment of generation volume, this provision allows for some day-to-day variation in the quantity and timing of generation to better coincide with times of peak power demand. Guidance for the distribution of a given weekly allotment of generation volume over a seven-day period was finalized in October 2015 and is presented in Exhibit F – Guidelines for Flexible Scheduling of Hydropower Generation.

Contract No. DE-GM75-80SW00058 (see Exhibit G) defines the 1986 operating arrangement between the USACE Southwestern Division (SWD) and the DOE Southwestern Power Administration (SWPA). This arrangement states a minimum Sam Rayburn hydropower release of 1,150 dsf (about 6 unit-hours of generation at 25MW output) will normally be allowed during flood conditions (i.e., even when such release contributes to flows on the Neches River at Evadale in excess of 20,000 cfs), but recognizes the need may occur to reduce the rate of reservoir release to less than this value in the interest of reducing downstream flood damages.

5. Rate of Change in Release. With the exception of the 10 feet to full open range in gate opening height (see 7-02.a.2), the rate of change in gate opening height should not be more than 0.5 gate-feet every half hour. The normal rates of change in release may be exceeded at the discretion of the Chief, Water Management Office. Additionally, the Fort Worth District

Water Management Office, or the Lake Manager, at their discretion, may exceed the normal rates of change in release in the event of drowning, accidents, failure of operational facilities, severe weather, or other emergencies deemed to require a more rapid rate of increase or decrease in the rate of release.

b. Downstream Conditions. Flood control is one of the authorized purposes for Sam Rayburn Dam, and is therefore a primary objective of its water control plan of regulation. For so long as the flood storage capacity of Sam Rayburn Reservoir is forecast not to be exceeded, the total combined controlled rate of release (gated discharge plus turbine discharge) will not normally exceed 20,000 cfs, and will not normally contribute to rates of flow on the Neches River at Evadale in excess of 20,000 cfs.

Fort Worth District field surveys of the reach of the Angelina River extending from Sam Rayburn Dam to the confluence of the Angelina River with the Neches River in the upper end of B.A. Steinhagen Lake have revealed information regarding the impacts of high rates of release from Sam Rayburn Reservoir. Results of field surveys conducted in 1989, and again in 1991, indicate rates of release in excess of about 15,000 cfs will inundate, to the point of being impassable, up to about 10 county and private roads along the Angelina River downstream of the dam, and keep about 20 people from accessing their homes. The 1989 report also indicated a rate of release of about 18,500 cfs resulted in flooding of two homes located along the bank of the Angelina River in the Trout Creek area. A field survey conducted in March 1992 concluded releases up to 16,500 cfs could be made without significant damages or hardship. In March and April 1992, following the event which produced the pool of record for Sam Rayburn, rates of release ranging from 16,500 cfs to 17,000 cfs were made for 27 consecutive days.

**7-03. Overall Plan for Water Control.** There are two Corps of Engineers projects within the Neches River Basin: Sam Rayburn Dam and Reservoir on the Angelina River (a major tributary to the Neches River); and B.A. Steinhagen Lake and Town Bluff Dam on the main stem of the Neches River just below the confluence of the Angelina River with the Neches River.

The conservation storage space in Sam Rayburn Reservoir (below 164.4) is regulated to provide water supply and hydropower benefits via rules of operation which also serve to reduce the probability of depleting the conservation storage space during time of drought. The flood control storage space in Sam Rayburn (164.4 to 173.0) is regulated to provide flood damage reduction benefits downstream of the dam along the Angelina and Neches Rivers. Regulation of the surcharge storage space in Sam Rayburn residing between top of flood pool elevation 173.0 and uncontrolled spillway crest elevation 176.0 is designed to reduce the probability of damaging uncontrolled spills. The design outflow capacity of the uncontrolled spillway effectively provides some indirect control of the rate of release when the pool rises above the spillway crest.

The primary function of B.A. Steinhagen Lake is to re-regulate the power releases from Sam Rayburn Reservoir. The re-regulation of the daily fluctuation in discharge from Sam Rayburn Reservoir contributes to more consistent flows and stages on the lower Neches River, particularly during periods of relatively low runoff in the Neches Basin. More consistent flows and stages

benefits downstream water supply withdrawal activities along the lower Neches as well as navigation interests in the vicinity of Beaumont. While there is no dedicated flood control storage provided in B.A. Steinhagen Lake, it is part of the flood control system for the Neches River Basin, operating in conjunction with Sam Rayburn Reservoir. The lake's normal operating level ranges from 81.0 to 83.0. The storage in the operating range is frequently used with smaller floods to attenuate peak flow and reduce downstream damages.

**7-04. Standing Instructions to Project Personnel.** The Fort Worth District Water Management Office will give instructions for making releases from Sam Rayburn Dam to project personnel as applicable. The lake will normally be regulated in accordance with the plan of regulation presented in paragraph 7-05 of this chapter. Should an emergency situation occur, such as a power outage, inoperable gates, unexpected powerhouse shutdown, or a drowning accident, the Fort Worth District Water Management Office will be notified immediately. In the event communications with the Fort Worth District Water Management Office are disrupted, the lake regulation will become the responsibility of the Lake Manager, in accordance with Exhibit D - Standing Instructions to Lake Manager, of this water control manual. The Lake Manager will immediately make every effort to re-establish communications with the Fort Worth District Water Management Office.

**7-05. Plan of Regulation.**

a. General. The maximum allowable rate of controlled release from Sam Rayburn Reservoir is 20,000 cfs. Controlled releases normally should not contribute to flows on the Neches River at Evadale in excess of 20,000 cfs. An exception to this rule may be warranted when the pool is forecast to rise into surcharge (above 173.0) and pre-emptive releases resulting in the exceedance of this 20,000 cfs control at Evadale may be expected to ultimately minimize peak river stages on the lower Neches River. A minimum hydropower release of 1,150 dsf (about 6 unit-hours of generation at 25MW output) per day will normally be maintained during flood conditions, but may be reduced in the interest of reducing downstream flood damages. Refer to Contract No. DE-GM75-80SW00058 in Exhibit G for the protocol for reducing the minimum hydropower release to less than 1,150 dsf during time of flood.

Releases from the conservation storage space below 164.4 will normally be made via hydropower generation and in accordance with applicable guidance and agreements pertaining to releases made for purposes of water supply and hydropower generation. See Exhibits E, F, and G for details.

The flood control storage space between 164.4 and 173.0 will normally be evacuated expediently to maximize flood storage space available to control runoff from subsequent events. In the interest of maximizing hydropower benefits, releases from the flood storage space will normally be made via hydropower generation insofar as its capacity for discharge can meet the allowable rate of release. Hydropower generation discharge capacity will normally be augmented with releases through the flood gates when the allowable rate of release exceeds the hydropower generation discharge capacity. Downstream gaging stations are shown in Table 7-3.

**TABLE 7-3**

**Downstream USGS Gaging Stations from Sam Rayburn Dam**

USGS Gage ID	USGS Gage Name	Distance below Dam [River Miles]	Estimated Flood Flow Travel Time (1)
08040000	B.A. Steinhagen Lake at Town Bluff, TX	32	6 / 12 hours
08040600	Neches River near Town Bluff, TX	34	6 / 18 hours (2)
*08041000	<i>Neches River at Evadale, TX</i>	91	2 / 3.5 days

(1) First effect / Full effect.  
 (2) Assumes Rayburn release are passed through Town Bluff Dam.  
*\*Control Point for Sam Rayburn releases. Releases from the storage space below 173.0 should not normally contribute to flows on the Neches River at Evadale in excess of 20,000 cfs.*

b. Normal Regulation of Conservation Storage. See Plates 7-10 and 7-11 for guidance typically sufficient for normal operations. See Exhibits E and F for background and additional detail.

c. Normal Regulation of Flood Storage. Refer to the Normal Schedule for Lake Regulation shown on Plate 7-1. Release requirements will normally be met via hydropower generation insofar as its capacity for discharge can meet the required rate of release. The general rules for making flood releases are summarized below:

1. Lake elevation 164.4 and 165.0. Subject to downstream controls, release not less than 4,200 dsf per day.
2. Lake elevation 165.0 and 165.5. Subject to downstream controls, release not less than 8,400 dsf per day.
3. Lake elevation 165.5 and 173.0 and not forecast to exceed 173.0. Subject to downstream controls, make releases at rates not to exceed 20,000 cfs.
4. Lake elevation forecasted to exceed 173.0. Operate in accordance with the guidance shown on Plate 7-9, Inflow vs. Outflow.

d. Emergency Reservoir Regulation. If communications between the Fort Worth District Water Management Office and the Sam Rayburn Dam Project Office are disrupted, the Lake Manager, on his own initiative, will direct regulation of the reservoir as described on Plate 7-2, Emergency Schedule for Lake Regulation, until communication is restored.

**7-06. Recreation.**

a. Upstream Recreation. All recreation area access roads for both USACE-managed and out-granted areas are constructed above the top of conservation pool elevation 164.4. Access roads may be inundated as the lake level rises into the flood pool. This may cause some or all parks and recreation facilities to be temporarily closed.

b. Downstream Recreation. Requests for special releases will be considered as planned deviations in accordance with Section 7-15.d. The project office receives periodic inquiries from recreation users concerning projected downstream flows, but to date no requests have been made to adjust flows to accommodate recreation activities.

**7-07. Water Quality.** Although water quality is not an authorized purpose for Sam Rayburn Dam, compliance with Public Law 92-500 requires that all federal facilities be managed, operated, and maintained to protect and enhance the quality of water and land resources through conformance with applicable federal, state, interstate, and local substantive standards.

**7-08. Fish and Wildlife.** Fish and wildlife resources are managed by the State of Texas Parks and Wildlife Department. USACE support activities with regard to fish and wildlife include active management of invasive aquatic vegetation in cooperation with Texas Parks and Wildlife. USACE also is responsible as the primary manager for all fee lands (including leases, licenses and easements), and provides timber management/oversight for timber stand improvement and salvage harvests, as well as the fire management program, both of which enhance wildlife value of federal land.

**7-09. Water Supply.** The LNVA, a conservation and reclamation district, and an agency of the State of Texas, is engaged in the sale and distribution of Neches River waters to municipal, industrial, and agricultural consumers. The LNVA contributed \$15,000,000 toward the first cost of construction of the Neches and Angelina Rivers, Texas, project. As per the River and Harbor Act of 1948 (Public Law 858, Eightieth Congress, 2<sup>nd</sup> Session, 30 June 1948), Section 104, the LNVA is permitted to withdraw from the pool of Dam B (now B.A. Steinhagen Lake and Town Bluff Dam) not to exceed 2,000 cfs for its own use. Releases from Sam Rayburn Reservoir support LNVA's authorized withdrawals from B.A. Steinhagen Lake when runoff from downstream of Sam Rayburn Dam is insufficient to meet LNVA's needs. Such releases are typically made via Sam Rayburn hydropower generation and regulated by Town Bluff Dam to meet LNVA's daily requirements.

A water supply storage space contract (Exhibit C2) with the city of Lufkin, Texas, was approved on 22 May 1969 for 2.98 percent of the conservation storage space between 164.4 and 149.0. To date the city has not made any water supply withdrawals from Sam Rayburn Reservoir.

**7-10. Hydroelectric Power.** The power generated at Sam Rayburn Dam is marketed by the Southwestern Power Administration (SWPA), an agency of the U.S. Department of Energy. The Sam Rayburn Dam Electric Cooperative, in accordance with the terms of their contract with SWPA, receives all of the power generated at Sam Rayburn Dam.

**7-11. Navigation.** Although neither Sam Rayburn Dam nor Town Bluff Dam (located on the Neches River 33 river miles downstream of Sam Rayburn Dam) are navigable structures, both were authorized as parts of the Neches River-Angelina River Project, for which navigation is an authorized purpose. Town Bluff Dam's re-regulation of the daily fluctuation in hydropower discharge from Sam Rayburn Dam serves downstream navigation interests in the vicinity of Beaumont, Texas, by contributing to more consistent flows and stages in the lower Neches River.

**7-12. Drought Contingency Plans.** When the drainage basin is in a drought condition and the lake levels are lower than normal, refer to the February 2017 LNVA Drought Contingency Plan for the Neches River Basin, Texas, located in Exhibit J. The plan presents a broad outline of actions necessary to manage the water resources of the Neches River Basin during a drought.

In 2011-2012 a severe drought occurred on the Sam Rayburn watershed and the lake elevation dropped to 150.83 feet. In the fall of 2011 the drought was forecast to continue for several months. Meetings and studies were convened which ultimately resulted in the purchase of riprap to cover the upstream face of the dam from 147 to 142 feet. Placement of that riprap would protect the dam from erosion if it were necessary to pull the lake below 149 feet in a severe drought. The turbines at Rayburn had been modified so that hydropower generation could continue for a few feet below elevation 149 feet. The riprap is stockpiled at the lake and will be placed in the event of a severe drought which could pull the lake below 149 feet.

**7-13. Emergency Action Plans.** The Emergency Action Plan (EAP) contains detailed instructions and procedures to be followed by USACE personnel at the Sam Rayburn Dam Project Office to properly handle any event at the project that could develop into an emergency condition. The most current edition of the EAP is located in the Geotechnical Office – Fort Worth District and is dated September 2016. Copies of this EAP are also available in the Fort Worth District Water Management Office and at the Sam Rayburn Dam Project Office.

**7-14. Other.** Under the USACE system for Dam Safety Action Classification (DSAC) ratings, Sam Rayburn Dam was rated as DSAC Class III effective 25 May 2017. DSAC Class III is a class of dams that have issues where the dam is significantly inadequate or the combination of life, economic, or environmental consequences with probability of failure is moderate to high. Based upon the most recent risk assessment of Sam Rayburn Dam in 2016, USACE considers this dam to be a moderate to high risk dam among its more than 700 dams because of the risk associated with the potential for backward erosion piping of the main embankment at the foundation and along the left abutment and for the potential for concentrated leak erosion of the embankment at the powerhouse during an extreme event. Due to its DSAC Class III rating, USACE will develop and implement interim risk reduction measures and/or long term risk reduction measures to reduce the risk.

**7-15. Deviation from Normal Regulation.** There are occasions when it is necessary or desirable to deviate from the water control plan for short periods of time. Prior approval for a deviation is obtained from the Southwestern Division Water Management Office

(CESWD-RBT-W). The requirement for prior approval of action from CESWD may be suspended in emergencies. All deviations will be recorded and will be stored in electronic format. Analysis of the expected impacts of a proposed deviation will include consideration of its effect on dam safety. Deviation requests usually fall into the following categories:

a. Emergencies. Emergencies that can occur include drowning(s), failure of the operation facilities, and flushing of pollutants. Under emergency conditions necessary action is taken immediately by the Lake Manager (in cooperation with the Sam Rayburn Powerhouse Superintendent if involving the Sam Rayburn Powerhouse), unless such an action creates an equal or worse condition. For emergencies, the Fort Worth District Water Management Office will be informed as soon as practicable as to the nature of the emergency and the subsequent response by telephone, email, or fax. A follow-up written documentation explaining the deviation will be furnished to the Southwestern Division Water Management Office as soon as practical.

b. Unplanned Minor Deviations. There are unplanned instances that create a temporary need for minor deviations from the normal regulation of the lake. These unplanned instances are not considered emergencies and require prior approval for deviations. Construction accounts for the majority of unplanned deviations. Possible reasons for unplanned deviations include stream crossings of pipelines, bridge work, embankment repair, utility placement, and other major construction contracts. Requests for changing release rates can vary from a few hours to a few days.

Each request is analyzed on its own merit. Consideration is given to upstream and downstream watershed conditions, potential flood threats, conditions of the lake, and possible alternative measures. In the interest of maintaining good public relations, the requests for deviation are usually approved, provided that there are no adverse effects on the overall operation of the project, or other projects. Approval of these minor deviations will be obtained from the Southwestern Division Water Management Office.

c. Unplanned Major Deviations. There are unplanned instances that may be considered for major deviations from the normal regulation plan, but are not emergencies. Requests for changes in release rates generally involve short time periods ranging from a few hours to a few days in an effort to minimize damages or optimize benefits. Flood control releases account for the major portion of these incidents and typical examples include project pre-releases or flows exceeding downstream channel capacity.

Each request is analyzed on its own merit. In evaluating the proposed deviation, consideration must be given to the upstream and downstream watershed conditions, potential flood threats, condition of the lakes, and possible alternative measures that can be taken. Approval of these major deviations will be obtained from the Southwestern Division Water Management Office.

d. Planned Deviations. Each planned deviation is analyzed on its own merit. Sufficient data on flood potential, lake and watershed conditions, possible alternate measures, benefits to be

expected and possible effects on other authorized and useful purposes will be presented with each deviation. Each recommended deviation is submitted in writing to the Southwestern Division Water Management Office for review and approval. An example of a planned deviation is a need to maintain or inspect an aspect of the project. Approval of such deviations will only be granted when the evaluations have been fully reviewed and verified to be necessary. Any concerns with “Dam Safety” will be taken into consideration as well with deviation approvals.

**7-16. Rates of Change in Release.** The service gates will normally be opened and closed at a rate not to exceed 0.5 gate-feet per half hour. See 7-02.a.5 for additional information regarding rate of change in release.

**7-17. Operation Curves and Tables.**

Plate 7-3: Outlet Works Conduit Rating Curves

Plate 7-4: Spillway Rating Curve

Plate 7-5: Lake Evaporation Curves

Plate 7-6: Tailwater Rating Curves

Plate 7-8: Reservoir Area and Capacity Curves

Plate 7-9: Surcharge Operations Guide Curves – Outflow vs. Inflow

Plate 7-10: Guidelines for Flexible Scheduling of Hydropower Generation

Plate 7-11: 1981 Rule Curves for Hydropower Generation

Page T7.4-1 of this water control manual: Tabulated Area and Capacity Values

## **CHAPTER VIII – EFFECT OF WATER CONTROL PLAN**

**8-01. General.** Sam Rayburn Dam is a multiple-purpose project that is designed and operated in conjunction with Town Bluff Dam for hydropower generation and as a water supply system for users in the Lower Neches River Basin. The lake is used for flood control, conservation storage, hydropower generation, recreation and wildlife management.

### **8-02. Flood Control.**

a. Spillway Design Flood. A Spillway Design Flood study was performed for Sam Rayburn Dam at the time it was initially designed. A Definite Project Report on “McGee Bend, Dam “B”, Rockland, and Dam “A” Reservoir, Neches and Angelina Rivers, Texas, In 5 Volumes, Volume II, McGee Bend Reservoir” was prepared by USACE, Galveston Project Office in 1947. The spillway design flood hydrographs for Sam Rayburn Dam and Reservoir were discussed in Appendix I, Hydrology of the Report. This flood was routed through the “Ultimate original spillway which was modified in “Design Memorandum No. 5, Spillway” in August 1956. The final Spillway Design Flood maximum elevation and outflow were determined in the 1961 DM2.

1. Spillway Design Storm. The selection of the Spillway Design Storm was based on the major storms that have occurred on June 27 to July 1, 1899, May 22 to 26, 1908, December 1 to 5, 1913, April 20 to 26, 1915, August 16 to 21, 1915, September 14 to 15, 1919, September 6 to 11, 1921, June 30 to July 2, 1932, July 22 to 27, 1933, June 10 to 18, 1935, September 14 to 19, 1936, September 25 to 28, 1936, July 19 to 25, 1938, and August 6 to 10, 1940, in the region within 500 miles of the Angelina River watershed. The maximum average depths of rainfall over a storm area of 3,449 square miles were determined from the actual distribution of these storms, and were used for the study of Spillway Design Storm for Sam Rayburn Dam. Rainfall depth-duration curves for these storms were submitted to the Hydrometeorological Section of the River and Flood Division, National Weather Service for analysis. From their analysis, the Hydrometeorological Section submitted as their preliminary estimate of the maximum possible precipitation over the watershed above Sam Rayburn Dam site a total average depth of 23.7 inches in 72 hours. The depth-duration relation as recommended by the Hydrometeorological Section has been adopted as a basis for the Spillway Design Storm. The 6-hour values of rainfall scaled from the adopted depth-duration relation and the critical arrangement of the 6-hour values were used as the Spillway Design Storm distribution for the Angelina River Basin above the Sam Rayburn Dam site.

2. Minimum Infiltration Rates. The computed infiltration rates for the Neches River Basin above the principal gaging stations vary from a minimum of 0.02 to a maximum of 0.16 inch per hour. In estimating the runoff from the Spillway Design Storm, a uniform infiltration rate of 0.05 inch per hour has been assumed. The assumption gave an estimated runoff of 20.55 inches or 83.5 percent of the rainfall for the Spillway Design Storm. The rainfall-excess for the Spillway Design Flood is shown on Plate 8-1.

3. Unit Hydrographs. A study was made of the storms and hydrographs of run-off at the principal gaging stations in the Neches River Basin in order to determine unit hydrographs. Synthetic unit hydrographs were computed for selected gaging stations in the Angelina River watershed by use of a method described in an article by Franklin F. Snyder on page 447 of "Transactions of the American Geophysical Union, Nineteenth Meeting, 1938." Values of coefficients (Ct and Cp) in Snyder's equation were derived by a trial and error procedure at selected gaging stations in the Angelina River watershed. In these studies synthetic unit hydrographs were developed at the following selected gaging stations: Angelina River at Horger and Lufkin, and Striker Creek near Summerfield.

The values of Ct and Cp were varied within reasonable limits until the synthetic unit hydrographs would reproduce the hydrographs for some of the larger floods at the above gaging stations. A synthetic unit hydrograph for natural flow at the Sam Rayburn Dam site was developed for 6-hour rainfall-excess by using a lag of 117 hours, a base length of 23 days, Ct of 6.00, and Cp of 320. Another synthetic unit hydrograph for full reservoir conditions was developed with an assumption of the head of the reservoir assumed to be at about river mile 106.0 and 80.8 river miles upstream from Sam Rayburn Dam site. The area tributary to the head of the reservoir has a drainage area of 1,758 square miles. The synthetic unit hydrograph at the head of the reservoir was developed using a lag of 99 hours, a base length of 20 days, Ct of 6.5, and Cp of 400. The basic coefficients used in developing the synthetic unit hydrograph at the head of the reservoir were derived from the larger floods at the Lufkin gaging station on the Angelina River. The drainage area of 1,695 square miles between the head of reservoir and the Sam Rayburn Dam site was considered in three parts each of which has different runoff characteristics, watershed constants and areas as follows:

- (a). The reservoir area of 231 square miles. The run-off rates were taken as the rainfall rates and added directly to the computed spillway flood hydrograph.
- (b). One hydrograph was constructed for the 101 square miles of the area adjacent to the reservoir which consists of numerous small areas with no well-defined drainage lines, and
- (c). One hydrograph was constructed for 21 areas each drained by a stream flowing directly into the reservoir.

The final unit hydrograph for flow into full reservoir for the entire area above the dam site (exclusive of the reservoir area) for a 6-hour period of rainfall was obtained by plotting the hydrographs discussed above, inclusive, for one inch of run-off and adding the ordinates graphically.

4. Spillway Design Flood Hydrographs. In order to determine the critical conditions of the Spillway Design Flood at the Sam Rayburn Dam site, the Spillway Design Storm was distributed uniformly over the watershed above Sam Rayburn Dam and two flood hydrographs were computed. The first hydrograph was determined for natural flow at the dam site based on the synthetic unit hydrograph discussed in Section 8-02, a.3. The computed hydrograph has a peak discharge of 188,200 cfs and volume of 3,748,500 acre-feet. The second

hydrograph representing flow into full reservoir was computed using the unit hydrograph derived for flow into full reservoir plus the run off from the 231 square miles reservoir surface at a rate equal to the rate of rainfall. The computed hydrograph with a peak inflow of 395,600 cfs and volume of 3,784,700 acre-feet was recommended and adapted for the Spillway Design Flood.

The routing computations showed that the lake would reach a maximum elevation of 183.0 feet and the peak outflow was 147,400 cfs. Plate 8-1 shows the lake elevation and Spillway Design Flood hydrographs in the 1961 study.

b. Standard Project Flood. In September 1992, a Spillway Modification and Freeboard Restoration study for Sam Rayburn Reservoir was prepared under the Dam Safety Assurance Program outlined in Draft ER 1130-2-417. The purpose of the study was to review the adequacy of Sam Rayburn Dam with respect to the hydrologic criteria provided in Hydrometeorological Report No. 51 (HMR-51), June 1978, subject: "Probable Maximum Precipitation Estimates, United States East of the 105th Meridian". The study consisted of hydrologic analysis for Sam Rayburn Dam Probable Maximum Flood (PMF). The study assumed that the reservoir level at the beginning of the flood would be at elevation 176.0 feet and that the outlet works would be open during the passage of the flood. No antecedent flood such as the Standard Project Flood was assumed to precede the Spillway Design Flood, assuming starting elevation of 176.0 feet. Three feet above the top of flood control is equivalent to presuming a relatively large antecedent event. The details of the Probable Maximum Storm are discussed in Section 8-02, c.1.

The threshold flood is the inflow flood event which would threaten a potential dam failure. For the original spillway design, the threshold flood is the largest flood which could be safely passed through the spillway without a dam breach. Several sizes of floods were analyzed including the 0.25 PMF, the 0.32 PMF, the 0.46 PMF and the 0.5 PMF in developing the threshold flood. The 0.32 PMF flood with a spillway flow of 14,000 cfs was the estimated capacity of producing a dam breach. Thus a failure would have occurred with the original spillway for a SPF equal to 0.5 PMF. A modified spillway was required to make the project capable of handling the SPF and PMF safely. For the SPF study, it was assumed that a Standard Project Storm would occur 5 days prior to the Probable Maximum Storm (discussed in Section 8-02, c.1).

c. Probable Maximum Flood. The following paragraphs describe the details of PMF analysis in the 1992 study.

1. Probable Maximum Storm. The Probable Maximum Storm rainfall above the Sam Rayburn Dam Site was determined in accordance with the method described in HMR-51 and HMR-52. A hypothetical elliptical transposition of the PMF was used in the study. The resulting average over the area for a 96 hour rainfall total 27.67 inches is based on critical centering of the hypothetical elliptical Probable Maximum Precipitation (PMP) at a location approximately 6 miles east of the city of Nacogdoches, Texas. The storm pattern is shown on Plate 8-2.

2. Minimum Infiltration Rates. The adopted infiltration rates were taken from

“Design Memorandum No. 15 on McGee Bend Reservoir, Angelina River, Texas, Hydrology,” dated November 1958. The adopted rates include an initial loss of 0.6 inch and a uniform loss rate of 0.05 inch per hour. Application of these assumed losses to the Probable Maximum Storm rainfall produced an estimated runoff of 22.93 inches, or 82.9 percent of the total rainfall for the Probable Maximum Storm. The 1992 PMF study rainfall, losses and rainfall excess are shown on Plate 8-3.

3. Unit Hydrographs. Unit hydrograph determinations were made for a total of 18 storms at seven gages in and around the Neches River basin. These unit hydrograph determinations were used as the basis for the adoption of a  $C_p640$  value of 400. This value of  $C_p640$  and computed standard time to peak “ $t_p$ ” value were used in Snyder’s equations to determine the standard unit hydrograph peak rate of discharge value “ $q_p$ ”. The standard value of “ $q_p$ ” was increased by 25% in accordance with ER 1110-8-2 (FR) dated 1 March, 1991, and “ $t_p$ ” was adjusted correspondingly. The peak value of “ $q_p$ ” and the corresponding value of “ $t_p$ ” were read into the Watershed Runoff Computer Model which used these values and Snyder’s relationship as the basis for the derivation of the synthetic unit hydrograph for each subarea.

4. Unit Hydrograph for Flow into Full Lake. The total drainage area of 3,449 square miles above the Sam Rayburn Dam site was divided into 37 sub-basins. The sub-basins layout is shown on Plate 8-2. The method used for developing the unit hydrographs for the sub-areas is as follow:

(a). The reservoir area at the emergency spillway crest (elevation 176.0 feet) is 153,800 acres or about 240.3 square miles. The run-off rates were taken as the rainfall rates and added directly to the computed spillway flood hydrograph.

(b). Unit Hydrograph for the remaining sub-areas were determined using the method mentioned in Section 8-02, c.3.

5. Routing Reach Parameters. Eighteen routing reaches were used in the development of Sam Rayburn Reservoir hydrologic model. Reach routings were performed using a modified puls method based upon storage-discharge relationships for each reach. The storage-discharge relationships were developed using a typical valley cross section for each reach and applying Manning’s equation. Routing through the remaining reaches (except through the reservoirs) was assumed to be instantaneous, i.e., the hydrographs were translated to the next control point with no attenuation of the flood.

6. Probable Maximum Flood Hydrographs. The PMF hydrographs representing flow into full pool was computed using the unit hydrograph developed for each sub-area, the routing reach parameters discussed above, the rainfall from HMR-51 distributed according to the SWD distribution, the infiltration rates discussed above, and the runoff equal to the rate of rainfall from the lake surfaces. The reservoir elevation at beginning of the PMF routing was 176.0 feet (three feet above the top of flood pool, which is the spillway crest elevation). The routing computations for flow into a full reservoir indicated that the lake would rise to a maximum level of 186.91 feet

and the peak inflow would be 980,100 cfs with a volume 4,217,000 acre-feet. Peak outflow was computed as 237,715 cfs. Plate 8-3 shows the PMF inflow-outflow hydrographs and the reservoir surface elevations.

d. Other Floods. Based on historical data, the maximum known flood in the vicinity of the dam downstream was approximately 82,000 cfs in 1915. The highest record lake elevation is 175.15 feet on 10 March 1992. Additional information on historical floods can be found in Section 4-06 of this manual.

**8-03. Recreation**. Facilities such as public boat ramps, docks, restrooms, picnic shelters, fishing piers, and campsites have been provided. Public use of USACE lakes is governed by Title 36 of the Code of Federal Regulations. The 10-year average annual visitation to Sam Rayburn Reservoir is 1,558,040.

A rise or fall in the lake elevation at Sam Rayburn Reservoir has some effect on the lands surrounding the lake, recreational facilities, and project visitation. A rise above elevation 173.0 temporarily restricts the use of many recreational facilities due to inundation or loss of access. Other effects associated with high water levels include the accumulation of driftwood, the degradation of surrounding vegetation, and increased shoreline erosion.

A substantial lowering of the lake elevation, due to water supply requirements or drought, exposes aesthetically unpleasing banks and mud flats, and creates a boating hazard due to increased shallow areas. Boat ramps and beaches may also become unusable during drawdown periods. Although fluctuation of the pool level is unavoidable, the effects on recreational opportunities can be reduced by placing roads, utilities, and recreational facilities in locations less prone to flooding.

**8-04. Water Quality**. Water Quality is not an authorized purpose at Sam Rayburn Reservoir. However, available data indicates that generally good water quality conditions exist. Additional water quality data can be found in Section 4-08.

**8-05. Fish and Wildlife**. The management of fish and wildlife resources is conducted in cooperation with the Texas Parks and Wildlife Department and U.S. Fish and Wildlife. The species of fish that the Texas Parks and Wildlife Department has stocked the lake with are: largemouth bass, smallmouth bass, catfish, crappie, white bass, hybrid striped bass, and sunfish. There are a number of small wildlife management areas surrounding the lake, within which hunting dove, waterfowl, quail, rabbit, and squirrel are permitted. Other species of wildlife found in the area include white-tailed deer, gray and red foxes, coyotes, fox squirrels, armadillos, wild turkeys, owls, and more than a hundred bird species.

**8-06. Water Supply**. As a unit of the four reservoir plan for the Neches-Angelina Rivers Basin, Sam Rayburn Dam project was constructed subject to contribution by local interests of \$5,000,000 toward the first cost of the system upon completion of the entire system. The LNVA furnished assurances that it was willing to contribute \$2,000,000 toward the completion of Town

Bluff Dam and B.A. Steinhagen Lake, exclusive of power facilities, and \$3,000,000 toward construction of Sam Rayburn Dam and Reservoir. Public Law 80-858 provides that the sponsoring agency will be permitted to withdraw from B.A. Steinhagen Lake not to exceed 2,000 cfs for its own use. By resolution of 8 September 1955, LNVA also agreed to contribute an additional \$200,000 annually for 50 years, which is an additional \$10,000,000 of non-federal funding toward the first cost of construction, and paid in full in 2015. A water supply contract with LNVA was approved by the secretary of the Army on 22 January 1957 and a Memorandum Understanding between the U.S. and LNVA approved on 30 July 2015 embodying the above provisions.

A contract with the city of Lufkin was approved on 22 May 1969 for 2.98 percent (43,000 ac-ft) of the conservation storage between elevations 149.0 and 164.4 feet. The Texas Commission on Environmental Quality (TCEQ) granted water rights to the city of Lufkin on 25 August 2010 by Certificate of adjudication No. 06-4411g. City of Lufkin will pay an estimated \$525,600 annual payment, in addition to their share of the annual O&M cost, for this water supply storage space.

**8-07. Hydroelectric Power.** Hydropower is authorized as a project purpose. The power facility at Sam Rayburn Dam consists of two Kaplan units, each having an installed capacity of 26,000 kilowatts to produce an estimated annual average energy of 10.4 million kilowatt-hours for users in Southeast Texas and Southwest Louisiana. The maximum peaking capability is equal to the total installed capacity at the facility times 1.15 (59,400 kilowatts).

The power is marketed by the SWPA, an agency of the Department of Energy, to public bodies and cooperatives in the SWPA region. Currently the Sam Rayburn Dam Electric Cooperative, Inc. purchases and receives all of the power and energy generated at Sam Rayburn Dam.

Except during flood control operations, releases are normally limited to an average daily release of 8800 day-second-feet (dsf) in order to fully utilize all discharges through the generating facilities. During flood operations, produce as much energy as possible by releasing part of the flood waters through turbines. In accordance with the congressional authorization of Sam Rayburn Dam, water above elevation 149.0 feet, less contracted water supply storage, is available for hydropower generation, which is subject to the Hydropower Operating Rule Curves included as Exhibit E.

**8-08. Navigation.** Sam Rayburn Dam operates with Town Bluff Dam to regulate the flow of the river for the benefit of navigation.

**8-09. Drought Contingency Plans.** The purpose of the Drought Contingency Plan is to provide a basic reference for water management decisions and responses to a water shortage in the Angelina and Neches River Basins due to a drought. The Drought Contingency Plan provides a plan for implementing actions necessary for conservation of water supply depending on the severity of the drought and the reservoir level. This plan enables the Water Resources Branch to effectively coordinate with the public and other district elements during drought

conditions. The latest LNVA Drought Contingency Plan for Sam Rayburn Reservoir is dated February 2017 and is located in Exhibit J.

**8-10. Flood Emergency Action Plan.** The FEP contains detailed instructions and procedures to be followed by USACE personnel at the Sam Rayburn Dam Project Office to properly handle any event at the project that could develop into an emergency condition. The most current edition of the FEP is located at the Geotechnical Office - Fort Worth District and is dated September 1984 and updated in September 2008. Copies of this FEP are also available in the Fort Worth District Water Management Office and at the Sam Rayburn Reservoir Project Office.

**8-11. Frequencies.** Sam Rayburn Reservoir levels for the period of record, since deliberate impoundment began on 29 March 1965, are displayed on Plate 8-4.

a. Annual Peak Elevation Frequency. The annual peak lake levels for the period 1965 through 2015 were tabulated. The annual peak elevations were arranged in descending order and assigned median plotting positions. The elevation probability was derived from studies based on methods discussed in "Statistical Methods in Hydrology," by Leo R. Beard, dated January 1962. The annual peak elevation frequency curve is shown on Plate 8-5. Data from this analysis indicated the 50-year and the 100-year flood frequency pool level to be 175.5 feet and 175.9 feet, respectively.

b. Lake Elevation Duration. The lake-elevation-duration curve shown on Plate 8-6 is based on the midnight lake elevations for the period 16 March 1973 to 30 June 2014. The conservation pool was raised on 7 April 1972 from elevation 164.0 feet to 164.4 feet. Sam Rayburn Reservoir reached the top of the conservation pool for the first time on 12 May 1968. The lake-elevation-duration curve shows the percent of time that the lake level equals or exceeds a given elevation.

c. Key Control Points. Key control points are located on Neches River near Rockland, Neches River near Town Bluff, and Neches River at Evadale. Rating curves for the key control points are shown on Plate 4-16 through Plate 4-18.

**8-12. Other Studies.** The vision for the CWMS National Implementation Effort is to have all USACE watersheds fully modeled within CWMS. These models will be operated daily to provide decision support to local Water Managers and to have results automatically consolidated into standardized briefing tools within a CorpsMap for executive and public use. CorpsMap viewer supports visualization and analysis of USACE infrastructure, and real-time display of atmospheric, coastal, critical infrastructure, and watershed data.

The CWMS Automated Information System was developed by the HEC under funding from the Water Management Community of Practice and has been implemented to varying degrees at USACE Water Management Offices. USACE offices apply CWMS data flow elements (data acquisition, verification, validation, transformation, storage, visualization, dissemination elements). For this effort, USACE Leadership, the Critical Infrastructure Protection and

Resilience (CIPR) Program, and the Dam Safety Program have recognized the value of these watershed models to the Nation and have committed funding for watershed model development to support the needs of multiple programs.

## **CHAPTER IX - WATER CONTROL MANAGEMENT**

### **9-01. Responsibilities and Organizations.**

a. Corps of Engineers. Sam Rayburn Reservoir is owned by the USACE. As the owner of the project, the Corps of Engineers is responsible for the overall operation and maintenance of the lake. The Lake Manager, operating through the Sam Rayburn Reservoir Office, Jasper, Texas, and the Engineering and Construction Division, is directly responsible for the Lake's maintenance and operation. Project reporting instructions are presented in Chapter V, and project operating instructions are presented in Chapter VII of this manual.

1. Responsibilities and Duties during Normal Operations. The Water Resources Branch, Engineering and Construction Division, Fort Worth District is charged with the following responsibilities and duties under the general supervision of the SWD Office in Dallas, Texas.

- (a). Regulation of lakes and dissemination of data.
- (b). Investigations and refinement of regulation procedures, including the following:
  - (1). Analysis of past floods.
  - (2). Reconnaissance to determine channel capacities.
  - (3). Improvement of forecasting techniques.
  - (4). Plan and coordinate the hydrometeorologic reporting network with the NWS and the USGS.
- (c). Train personnel in flood control duties, including the following:
  - (1). Periodic visits to projects by the branch personnel to familiarize themselves with regulation facilities and become acquainted with the operating personnel.
  - (2). Instruct personnel of other branches in flood control procedures to supplement the Water Resources Branch during flood emergencies, when necessary.
- (d). Prepare reports on lake regulation.
  - (1). Recurring reports.

(2). Water Control Manuals.

(3). Post Flood reports.

2. Responsibilities and Duties during Flood Emergencies. During flood emergency, the Water Resources Branch is responsible for the following:

(a). Evaluation of current meteorologic, hydrologic, and hydraulic data.

(b). Provide analysis of the storm and effects of the flooding to the District Engineer and other District personnel.

(c). When necessary, furnish personnel to assist lake personnel in flood regulations.

(d). Regulation of lakes in accordance with flood control schedules.

(e). Furnish information to higher authority, which will include:

(1). Initial reports to the SWD and Office of the Chief of Engineers by telephone or E-mail.

(2). Provide information for situation reports.

3. Assignment of Personnel. During non-flood periods, personnel of the Water Resources Branch issue instructions for the routine regulation of the lake. However, during flood periods, assistance from other personnel may be required to maintain effective regulation of the lakes. The area and magnitude of the flood will determine the number of people engaged in each particular activity. Plate 9-1 shows the organization during flood control regulation.

4. Provision for 24-Hour Alert. The NWS and Lake Manager have been provided with a list of names and telephone numbers of key personnel of the Engineering and Construction Division with instruction to provide warning if unusual conditions occur. Responsible personnel are on duty at the Fort Worth District Office 24 hours a day during flood emergencies and/or whenever project conditions warrant. Responsible personnel will be on duty or on call at the lake at all times.

5. Role of the Lake Manager. The Lake Manager will regulate the lake according to instructions issued by personnel of the Water Resources Branch. The instructions will follow the "Normal Regulations for Flood Control" and "Emergency Regulations for Flood Control" contained in Chapter VII and Exhibit C of this manual. If the Lake Manager loses communication with the District Office, he will immediately make every effort to reestablish communication while initiating emergency regulations for flood control. The Lake Manager will

make daily observations at the lake project's weather station and report those observations as directed in paragraph 5-07.

b. Other Federal Agencies. The NWS is officially responsible for issuing flood warnings to the public. The NWS provides weather and river forecast information, which is used to make real time operation decisions for Sam Rayburn Reservoir. The USGS develops and maintains stage versus discharge curves for each stream gage. The USGS also collects and maintains reservoir elevation and water quality data for the USACE lakes in the Fort Worth District. The SWPA, U.S. Department of Energy, markets the power and energy generated by the Sam Rayburn hydropower plant.

**9-02. Interagency Coordination.** The USACE, NWS, and the USGS cooperate to accumulate rainfall and streamflow data used in forecasting river stages, stream flows and lake levels. The Fort Worth District's Supplement A to ER 500-1-1 gives a list of Federal Agencies with which the District will coordinate in emergencies. The SWPA coordinates with USACE regarding releases from the project through the hydropower turbines

a. Local Press and Corps Bulletins. The USACE, through their Public Affairs Office, makes press releases to the news media of flood situations in the area of concern. The Water Resources Branch may supplement this information with observed conditions and technical advice to enable local interests to obtain optimum flood protection and to perform rescue and relief functions. USACE further assists in flood fighting, through the office of the Emergency Operations, who furnishes sandbags and other necessary equipment based on equipment on hand and need.

b. National Weather Service. The NWS and USACE exchange hydrometeorologic data and reports in obtaining and disseminating data. This exchange of data is discussed in great detail in Chapter VI of this manual.

c. United States Geological Survey. The USGS and USACE cooperate in a program for the operation and maintenance of stream gages throughout the Fort Worth District. During floods, the USGS and USACE coordinate field activities to maximize the number of stream discharge measurements.

d. Other Federal, State, or Local Agencies. The Fort Worth District exchanges information with State government officials, Texas Department of Public Safety (TxDPS) Highway Patrol Division, and others during flood emergencies. The Fort Worth District also coordinates with State agencies concerning fish and wildlife throughout normal operation.

Since one of the functions of B.A. Steinhagen Lake is to reregulate the releases of Sam Rayburn reservoir, all releases from the two reservoirs are coordinated.

**9-03. Interagency Agreements.** As a unit of the four reservoir plan for the Neches-Angelina Rivers Basin, Sam Rayburn Dam and Reservoir project was constructed subject to contribution

by local interests of \$5,000,000 toward the first cost of the system upon completion of the entire system. The LNVA furnished assurances that it was willing to contribute \$2,000,000 toward the completion of Town Bluff Dam and B.A. Steinhagen Lake, exclusive of power facilities, and \$3,000,000 toward construction of Sam Rayburn Reservoir. Public Law 80-858 provides that the sponsoring agency will be permitted to withdraw from B.A. Steinhagen Lake not to exceed 2,000 cfs for its own use. By resolution of 8 September 1955, LNVA also agreed to contribute an additional \$200,000 annually for 50 years, which is an additional \$10,000,000 of non-federal funding toward the first cost of construction and paid in full in 2015. A water supply contract with LNVA was approved by the secretary of the Army on 22 January 1957 and a Memorandum Understanding between the United States and LNVA approved on 30 July 2015 conditions of the earlier contract permanent following the completion of the originally required payments..

The Robert D. Willis Hydropower Project at Town Bluff Dam was construction started in March, 1987 and the hydropower facilities became available for commercial operation on 17 November 1989. The hydropower project is a first-of-its-kind partnership between private enterprise and the U. S. Government in that the Sam Rayburn Municipal Power Agency (SRMPA) paid for the entire project in advance, rather than reimbursing the Federal Government over the life of the project. SRMPA is owned by the cities of Liberty, Livingston, and Jasper. Tenaska Communications markets the power for SRMPA.

A contract with the city of Lufkin was approved on 22 May 1969 for 2.98 percent (43,000 ac-ft) of the conservation storage between elevations 164.4 and 149.0 feet. The TCEQ granted water rights to the city of Lufkin on 25 August 2010 by Certificate of adjudication No. 06-4411g. City of Lufkin will pay an estimated \$525,600 onetime payment, in addition to their share of the annual O&M cost, for this water supply storage space.

A contract entitled “Memorandum of Understanding (MOU) between the SWPA and the USACE” was approved on 23 July 1980. An “Operating Arrangement between the SWPA and the USACE”, in compliance with the MOU, was approved on 23 October 1986. Both contracts state the principles and procedures relating to reservoir regulation and power scheduling of the USACE and the SWPA.

**9-04. Commissions, River Authority, Compacts, and Committees.** The TCEQ issues and regulates permits for water use in the State of Texas. The LNVA is informed of the lake regulations at Sam Rayburn Reservoir.

**9-05. Non-Federal Hydropower.** There are no non-federal hydropower facilities at Sam Rayburn Reservoir.

**9-06. Reports.** Table 9-1 lists reports prepared by the Water Resources Branch. The tabulation also describes when each report is required and the regulation requiring the report.

**TABLE 9-1**

**Tabulation of Reports**

Name of Report	When Required	Regulation Requiring Report
Daily Report	Daily	—
Monthly Reservoir Report	Monthly	ER 1110-2-240
Flood Situation Reports	During Floods	ER 500-1-1
Post Flood Reports	Following a Flood Causing Major Damage	ER 500-1-1
Annual Reports	Annually	ER 1110-2-240

a. Daily Report. The daily report is prepared by the Water Resources Branch. It contains water control information on most of the major lakes in the Fort Worth District. An example of a daily report is shown on Plate 9-2. Copies of the report are sent to all subscribing offices and agencies. The daily report is also posted on the Internet at the following URL address: <http://www.swf-wc.usace.army.mil/>.

b. Monthly Reports. The Water Resources Branch prepares monthly reservoir reports in accordance with ER 1110-2-240. The monthly report, shown on Plate 9-3, is a tabular record of lake operations. It is prepared for all lakes under the supervision or of direct interest to the Fort Worth District.

c. Flood Situation Reports. The Water Resources Branch supplies the Emergency Operations Center (EOC) in the Fort Worth District with information in accordance with ER 500-1-1. This report contains hydrometeorological conditions for the area, the name of the lake, pertinent lake data, lake elevation, predicted maximum elevation and anticipated data, inflow and outflow rates in cfs, percent of flood control storage utilized to date, and any other data relevant to the flood situation. The EOC then provides the information to the appropriate government officials and community organizations concerned or effected by the flooding.

d. Post Flood Reports. The post flood reports are prepared in accordance with ER 500-1-1, when a flood has resulted in major damage. The report describes flood emergency operations performed by the USACE. Included are available hydrologic information, damage estimates, and other engineering data considered essential for flood control and flood plain studies performed to review possible damage claims against the United States. The report is prepared using information compiled by the Water Resources Branch and when completed, includes a paragraph on the final damage costs from the flood event, including damages to USACE Property, Parks, and other structures.

e. Annual Report. The Water Resources Branch prepares an annual report for the SWD Reservoir Control Center. The report summarizes general river basin conditions and the activities and accomplishments of the Water Resources Branch during the preceding year.

**EXHIBIT A**

**SUPPLEMENTARY PERTINENT DATA**

**SAM RAYBURN DAM AND RESERVOIR**

**EXHIBIT A**

**SUPPLEMENTARY PERTINENT DATA**

**SAM RAYBURN DAM AND RESERVOIR**

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**1. GENERAL INFORMATION**

<b>Item</b>	<b>Description</b>
Other Name for Project	Originally McGee Bend Reservoir, PL 88-123 changed the name to Sam Rayburn Reservoir on 11 September 1963
Location	Neches River Basin, Texas Angelina River, at river mile 25.2
Type of Project	Dam and Reservoir
Objective of Regulations	Multipurpose project for Flood Control, Water Supply, Hydropower, Navigation, Fish and Wildlife and Recreation
Project Owner	USACE
Operating Agency	USACE The working hours of operation for weekdays are 0800 to 1645; working hours for weekends and holiday vary. During flood emergency conditions 24-hour per day duty is the general procedure.
Regulating Agency	USACE
Water Supply Contracts	The LNVA furnished assurances that it was willing to contribute \$2,000,000 toward the completion of Town Bluff Dam and B.A. Steinhagen Lake, exclusive of power facilities, and \$3,000,000 toward construction of Sam Rayburn Reservoir. Public Law 80-858 provides that the sponsoring agency will be permitted to withdraw from B.A. Steinhagen Lake not to exceed 2,000 cfs for its own use. By resolution of 8 September 1955, LNVA also agreed to contribute an additional \$200,000 annually for 50 years after completion of Sam Rayburn Reservoir. A water supply contract with LNVA was approved by the secretary of the Army on 22 January 1957 embodying the above provisions.

**1. GENERAL INFORMATION (CONTINUED)**

Water Supply Contracts

LNVA pays no O&M cost except on features and appurtenances which may be provided and owned by the LNVA. A contract with the city of Lufkin was approved on 22 May 69 for 2.98 percent (43,000 ac-ft) of the conservation storage between elevations 149.0 and 164.40 feet NGVD29. (Contract No. DA-41-443-CIVENG-57-20 dated 24 August 1956).

City of Lufkin will pay an estimated \$525,600 annual payment, in addition to their share of the annual O&M cost, for this water supply storage space (Contract No. DACW63-69-C-0007).

Project Cost

\$68,315,000

Deliberate Impoundment Date

29 March 1965

Federal Power Marketing Administration

SWPA

**2. LAKE INFORMATION**

Feature	Elevation (Feet NGVD29)	Lake Area (Acres)	Storage (Acre-Feet)	Runoff (Inches)
Top of Dam with Parapet Wall	193.6	—	—	—
Top of Dam	190.0	—	—	—
Maximum Design Water Surface Elevation (1961 DM2)	183.0	172,800	5,611,000	30.47
PMF Design Water Surface Elevation (1992 Study)	186.91	198,000	6,338,100	34.46
Top of Spillway Crest	176.0	153,800	4,442,400	24.15
Top of Flood Control Pool	173.0	142,700	3,997,600	21.73
Top of Power Pool (2004 Survey)	164.4	112,590	2,876,033	15.64
Top of Power Head and Sediment Reserve (2004 Survey)	149.0	72,013	1,460,990	7.94
Maximum Tailwater	121.5	0	0	0
Streambed (1947 Study)	70.0	0	0	0

Item	Description
Real Estate (Fee Title)	Upper guide contour of elevation 171.0 feet. Fee simple title includes 115,767 acres.
Real Estate (Flowage Easement)	Upper guide contour of elevation 179.0 feet. Flowage easement includes 51,314 acres.
Forest Service Land Permit	33,000 acres - Used for Sam Rayburn Reservoir Acquisition (see pg. 2-4)
Range of Clearing Lake length at top of conservation pool	Below elevation 173.0 feet 60 miles from the dam to the most upstream shoreline

**2. LAKE INFORMATION (Continued)**

<b>Item</b>	<b>Description</b>
Shoreline length at top of conservation pool	750 miles
Safety aspects	When the hydropower units are providing Responsive Reserve Service (RRS) and generation is required, the horn sounds simultaneously as releases are made. For all other releases, a warning horn will sound for 10 seconds to alert those downstream at least 5 minutes before significant changes in discharge.
Datum	The elevations listed in the Appendix A is based on the datum conversion from NGVD29 to NAVD88: $NGVD29 + 0.0 \text{ feet} = NAVD88$ for Sam Rayburn Dam and Reservoir.

**3. HYDROLOGY**

<b>Item</b>	<b>Description</b>
Drainage Area	3,449 square miles
Volume from One-Inch Runoff	183,947 ac-ft
<b>Probable Maximum Flood (1992 Study)</b>	
Maximum Water Design Surface elev.	186.91 feet
Duration of Storm	96 hours
Average Infiltration Rate	0.05 inches/hour
Total Volume of Rainfall	27.67 inches
Total Volume of Runoff	22.93 inches
Volume into full pool	4,217,000 ac-ft
Peak Inflow to full pool	980,100 cfs
Peak Outflow (reservoir level 186.91 feet)	
Total	237,715 cfs
Storm Type	Probable Maximum Storm determined from HMR 51 and HMR 52 guidelines
<b>Spillway Design Flood (1961 DM2)</b>	
Design water surface elev.	183.0 feet
Duration of Storm	72 hours
Average Infiltration Rate	0.05 inches/hour
Total Volume of Rainfall	23.7 inches
Total Volume of Runoff	20.55 inches
Peak Inflow	395,600 cfs
Peak Outflow	147,400 cfs
Storm Type	Spillway Design Storm
Climate	Moderate, with hot summers, and cool winters

**3. HYDROLOGY (CONTINUED)**

<b>Item</b>	<b>Description</b>
Average Precipitation (Gages listed in Table 4-3)	48 inches per year (1900-2015)
Average Evaporation from lake	47 inches per year (1968-2015)
Storm Type	Primarily local thunderstorms, frontal storms, and occasional Gulf Coast and Pacific Ocean hurricanes
Flood Seasons	Primarily November through June, but floods can occur at any time of year
Low Flood Seasons	July through October
Minimum Monthly Inflow and Date of Occurrence	0 ac-ft (in CY 1980, CY 1982, CY 1993, CY 1999, CY 2005, CY 2008, CY 2010, CY 2011, CY 2012, CY 2013, CY 2016)
Minimum Annual Inflow and Date of Occurrence	371,534 ac-ft (in CY 2011)
Mean Annual Inflow	2,104,248 ac-ft (Jan 1908-Dec 2016 records)
Maximum Annual Inflow and Date of Occurrence	4,605,148 ac-ft (CY 1991)
Maximum Monthly Inflow and Date of Occurrence	1,547,000 ac-ft (May 1944)
Maximum Average Daily Inflow and Date of Occurrence	102,766 cfs (29 January 1999)
Maximum 8-Hour Inflow and Date of Occurrence	136,600 cfs (29 January 1999)
Maximum Flood Volume and Date of Occurrence	2,825,000 ac-ft (January-March 1932)

**3. HYDROLOGY (CONTINUED)**

Item	Description
Names and Locations of Key Stream Flow Stations	<p>Upstream</p> <p>Lake Tyler near Whitehouse  Mud Creek near Jacksonville  Angelina River near Alto  Attoyac Bayou near Chireno  Ayish Bayou near San Augustine</p> <p>Downstream</p> <p>Sam Rayburn Reservoir near Jasper  Neches River near Neches  Neches River near Diboll  Neches River near Rockland  Neches River near Town Bluff  Neches River near Evadale  Village Creek near Kountze  Pine Island Bayou near Sour Lake  Pine Island Bayou above BI Pump Plant, Beaumont  Neches River Saltwater Barrier at Beaumont</p>
Type of Hydrometeorologic Data Recorded at Damsite	<p>Automatic water stage recorders to furnish continuous records of lake levels and river stage below the dam.</p> <p>Tile staff gages provide lake level and tailwater elevations.</p> <p>NWS station at the dam consists of: a rain gage, recording rain gage, Type A evaporation pan, anemometer and maximum-minimum thermometer.</p>
Precipitation Stations Used in Hydrologic Forecasting (NWS)	<p>San Augustine - Recording gage  Nacogdoches – Recording gage  Lufkin - Recording gage  Woodville – Recording gage  Town Bluff Dam – Recording gage  Jasper – Recording gage  Center - Standard gage  Rush - Standard gage  Henderson - Standard gage</p>

**3. HYDROLOGY (CONTINUED)**

<b>Item</b>	<b>Description</b>
Number of Sediment Ranges	14 (Periodic Surveys)
Number of Degradation Ranges	9 (Periodic Surveys)

**4. EMBANKMENTS**

<b>Item</b>	<b>Description</b>
Location	Angelina River of the Neches River Basin at river mile 25.2
Purpose	Impoundment
Type	Non-overflow embankment
Type of Fill	Rolled earthfill with impervious clay core
Slope Protection	Rock riprap and turf upstream, turf downstream
Height	120 feet above streambed
Length	12,400 feet
Top Elevation	190.0 feet 193.6 feet with parapet wall
Freeboard	6.64 feet
Used for Roadway	Yes, recreation Road 255
Elevation of Streambed	70.0 feet
Closure date	15 January 1965

**5. DIKE**

<b>Item</b>	<b>Description</b>
<b>A. <u>DIKE A</u></b>	
Location	Left bank of Angelina River from embankment Station 17+37 to Station 32+55
Purpose	Impoundment
Type	Non-overflow saddle dike
Slope protection	12-inch riprap upstream, turf downstream
Maximum Height	Approximately 24.5 feet
Length	1,500 feet
Top elevation	192.5 feet
Design flood	PMF with lake level starting at spillway crest
Freeboard	5.54 feet
Elevation of toe	Minimum elevation 168.0 feet

**5. DIKE (CONTINUED)**

<b>Item</b>	<b>Description</b>
<b>B. <u>DIKE C</u></b>	
Location	Left bank of the river from Station 8+15 to Station 31+15
Purpose	Impoundment
Type	Non-overflow saddle dike
Type of Fill	Entirely select impervious fill
Slope Protection	Turf protection
Maximum Height	Approximately 18.0 feet
Length	2,290 feet
Top Elevation	190.0 feet
Design Flood	PMF with lake level starting at spillway crest
Freeboard	3.04 feet
Elevation of Toe	Minimum elevation 172.0 feet

**6. SPILLWAY**

<b>Item</b>	<b>Description</b>
Location	Right abutment, 7,000 feet west of the main embankment
Crest Elevation	176.0 feet
Length	640 feet actual Net Opening
Type	16 cycle labyrinth weir
Total Maximum outflow (1992 Study, Lake elev. 186.91 feet)	237,715 cfs
Type of Energy Dissipator	Stilling basin with baffle blocks

**7. OUTLET FACILITIES**

<b>Item</b>	<b>Description</b>
<b>A. <u>Control Gates</u></b>	
Location	Adjacent to the powerhouse penstock intakes
Purpose	Regulation of outflow
Type	Two 10 by 20-foot rectangular conduits located under the dam and controlled by tractor type broom gates
Number and Size of Outlet	2 water passages, each passage is controlled by a service gate or an emergency gate, each 10 by 20 foot
Type of Gate	Two 10 x 20 foot tractor cable on drum operated by electric motor
Entrance Invert Elevation	105.0 feet
Maximum Discharge at Pertinent Elevations	Top of conservation pool Elev. 164.4 feet - 20,200 cfs Top of flood control pool Elev. 173.0 feet - 22,000 cfs
Minimum time required to open and close Flood Gates:	
Normal Conditions	The gates are raised 1 foot per hour for 5 hours until it is halfway open, and then raised to fully open in one-half hour. Total opening time is 5-1/2 hours.
Emergency Conditions	One service gate may be opened or closed in 30 minutes, both gates in 1 hour. Emergency gates are identical to the service gates. An emergency bulkhead is operated by the double girder bridge crane on the service desk.
Type energy dissipater	Stilling basin

**8. HYDROELECTRIC POWER FACILITIES**

<b>Item</b>	<b>Description</b>
Location	In an earthfill dam about 2000 feet west of main embankment
Purpose	Generation of hydroelectric power and discharge for water supply and flood control
Type of Facility	Hydropower peaking power plant
Maximum Output Capacity	Two 26,000 kilowatts generators
Type of Unit	Two Vertical Kaplan Turbines
Power Online Date	23 September 1965
Normal Plan for Generation	Multi-purpose for hydropower, water supply and flood releases
Speed	120 RPM
Rated Head	53 feet
Rated Flow	8,800 cfs with both units
Maximum Flow through Turbine Pertinent Elevations:	
Top of conservation pool	4,720 cfs - Elev. 164.4 feet
Top of flood control pool	4,050 cfs - Elev. 173.0 feet

**9. CONTROL POINTS**

<b>Item</b>	<b>Description</b>
<b>A. <u>Neches River near Rockland Gage, No. 08033500</u></b>	
Location	River mile 32.4 of Angelina River
Purpose of control	To indicate the total flow at the gage, including releases from upstream reservoirs and local flow
Channel description	The stream bed is of sand and silt and is clean. The banks are of silty loam, are covered with a heavy growth of trees and brush, and are fairly stable. The channel is straight for about 800 feet below and 1,200 feet above the gage.
Drainage area	3,636 square miles
Treatment of uncontrolled runoff.	Contributes to target flow at gage
Target Flow Rate	Uncontrolled
Time of Water Travel from Rockland Gage	72 hours to Neches River near Town Bluff Gage
Monitoring provisions	Recording river gage with DCP
Dikes or levees downstream	None

**9. CONTROL POINTS (CONTINUED)**

<b>Item</b>	<b>Description</b>
<b>B. <u>Neches River near Town Bluff Gage, No. 08040600</u></b>	
Location	River mile 114.9, 1.8 miles downstream of Town Bluff Dam
Purpose of control	To indicate the total flow at the gage, including releases from upstream reservoirs and local flow
Channel description	The stream bed is of sand and silt and is clean. The banks are of silty loam, are covered with a heavy growth of trees and brush, and are fairly stable. The channel is straight for about 800 feet below and 1,200 feet above the gage.
Drainage area	7,574 square miles
Treatment of uncontrolled runoff.	Contributes to target flow at gage
Target Flow Rate	20,000 cfs
Time of Water Travel from Sam Rayburn Dam	8 hours to B.A. Steinhagen Lake
Monitoring provisions	Recording river gage with DCP
Dikes or levees downstream	None

**9. CONTROL POINTS (CONTINUED)**

Item	Description
C. <u>Neches River at Evadale Gage, Gage No. 08041000</u>	
Location	River mile 132.1 of the Neches River downstream of B.A. Steinhagen Lake
Purpose of control	To indicate the total flow at the gage, including releases from upstream reservoirs and local flow
Channel description	The bed and banks are composed of uniform loose sand with scattered sunken logs. The banks are steep. The overflow plan is heavily wooded. The channel is straight for 500 feet upstream and 200 feet downstream.
Drainage area	7,951 square miles
Treatment of uncontrolled runoff	Contributes to target flow at gage
Target Flow Rate	20,000 cfs
Time of Water Travel from Sam Rayburn Dam	80 hours to Evadale gage
Monitoring provisions	Recording river gage with DCP
Dikes or levees downstream	None

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**10. CONTROL STRUCTURES DOWNSTREAM**

<b>Item</b>	<b>Description</b>
<b>A. <u>Neches River Salt Water Barrier at Beaumont, Texas</u></b>	
Location	Salt Water Barrier, river mile 27.7 on Neches River crossing Jefferson and Orange Counties, Texas
Purpose of control	Prevent salt water from intruding in the Neches River upstream of the city Beaumont, Texas
Type	Rolled earth fill dam 760 foot long, and 24.5 foot high
Navigation passages	Controlled by 2 sector gates 56 x 30 foot
Gate flow passages	Gate bays controlled by five 45 x 24.5 foot tainter gates Net length is 122.5 feet
Flood flow passage	650 foot overflow earthen with concrete broad crested weir 20 feet wide crest elevation 4.5 feet
Project owner	LNVA
Regulating agency	LNVA
Operation	The permanent salt water barrier went into operation in late October 2003. The salt water barrier control room is staffed 12 hours a day, 7 days a week and may be contacted at: (409) 898-0646.

**EXHIBIT B**

**CONTRACT BETWEEN THE UNITED STATES OF AMERICA AND**

**THE LOWER NECHES VALLEY AUTHORITY**

**MEMORANDUM OF UNDERSTANDING**

**FOR**

**SAM RAYBURN RESERVOIR, TEXAS**

MEMORANDUM OF UNDERSTANDING  
BETWEEN THE  
UNITED STATES OF AMERICA AND  
THE LOWER NECHES VALLEY AUTHORITY

SUBJECT: Operations of McGee Bend Dam and Dam B Reservoirs

THIS Agreement entered into this 30 day of July, 2015, by and between the UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the U.S. Army Corps of Engineers District Commander executing this agreement, and the Lower Neches Valley Authority (hereinafter called the "Authority");

WITNESSETH THAT:

WHEREAS, the River and Harbor Act of 1945 (Public Law 79-14) authorized the construction of McGee Bend Reservoir (Sam Rayburn Reservoir) on the Angelina River, and Dam B (Town Bluff Dam), on the Neches River, Texas (hereinafter called the "Project") in accordance with Senate Document 76-98; and

WHEREAS, the River and Harbor Act of 1948 (Public Law 80-858) modified the Project "so as to provide that the local agency which gives assurances that upon the completion of the entire project it will contribute toward the first cost of the work the sum of \$5,000,000 shall be permitted to withdraw from the pool of Dam B not to exceed 2,000 cubic feet of water per second for its own use"; and

WHEREAS, the Authority is the local agency that gave the required assurances and contributed the required moneys for the Project; and

WHEREAS, on August 24, 1956, the Government and the Authority entered Contract No. DA-41-443-CIVENG-57-20 (hereinafter called the "Contract"), wherein the Government acknowledged receipt of \$2,000,000 from the Authority and the Authority agreed to pay the Government \$3,000,000 on demand and \$200,000 annually for 50 years, all of which the Authority has paid; and

WHEREAS, the period of the Contract was 50 years and expires on December 31, 2015, and as of that date, the Authority has satisfied all of its requirements under the Contract; and

WHEREAS, the Authority has requested the Government enter into this Agreement to memorialize the Authority's contribution to the construction of the Project and recognize its entitlement pursuant to the River and Harbor Act of 1948 to withdraw from the pool of Dam B not to exceed 2,000 cubic feet of water per second for its own use;

SUBJECT: Operations of McGee Bend Dam and Dam B Reservoirs

NOW, THEREFORE, the Government and the Authority share the following understanding:

ARTICLE 1. Authority's Right to Water Releases. Having completed the payments required pursuant to the River and Harbor Act of 1948 (Act) under the Contract, the Authority has the right to releases under the provisions of the Act, to withdraw from the pool of Dam B not to exceed 2,000 cubic feet per second for its own use at any time so long as releases when combined with local runoff below Dam B will not cause flooding.

ARTICLE 2. Operation and Maintenance. The Government will operate and maintain Sam Rayburn Reservoir and Town Bluff Dam in accordance with the Water Control Manual. No annual payments for Operation and Maintenance for the Project are required from the Authority.

ARTICLE 3. Water Control Manual. The parties recognize that the Water Control Manual of the Project will be periodically updated in accordance with Corps policy, so that the multiple purposes of the Project are optimized.

ARTICLE 4. Federal and State Laws.

a. Compliance. In acting under its rights and obligations hereunder, the Authority agrees to comply with all applicable Federal and State laws and regulations, including but not limited to: 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)), and the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655).

b. Civil Rights Act. The Authority furnishes, as part of this agreement, an assurance (Exhibit D) that it will comply with Title VI of the Civil Rights Act of 1964 (78 Stat. 241, 42 U.S.C. 2000d, et seq.) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 195 of Title 32, Code of Federal Regulations.

c. Regulatory Program. Any discharges of water or pollutants into a navigable stream or tributary thereof resulting from the Authority's facilities and operations undertaken under this agreement shall be performed only in accordance with applicable Federal, State, and local laws and regulations.

SUBJECT: Operations of McGee Bend Dam and Dam B Reservoirs

d. Lobbying Activities. The Authority furnishes, as part of this agreement, a certification (Exhibit E and if applicable, Standard Form-LLL "Disclosure of Lobbying Activities") that it will comply with Title 31 U.S.C. Section 1352 of the limitation on use of appropriated funds to influence certain Federal contracting and financial transactions (Public Law 101-121, October 23, 1989) and Federal Acquisition Regulation 52.203-12 issued pursuant thereto.

ARTICLE 5. Duration of Agreement. This Memorandum shall become effective when signed by the District Commander or his duly authorized representative. The right of the Authority to request water releases from the pool of Dam B shall be continued so long as the Government continues to operate the Project.

IN WITNESS WHEREOF,

UNITED STATES OF AMERICA

  
\_\_\_\_\_  
CLAY A. MORGAN  
Lieutenant Colonel (EN)  
Acting Commander

LOWER NECHES VALLEY AUTHORITY

  
\_\_\_\_\_  
Jordan Reese, President  
Board of Directors

DATE: 30 JULY 2015

DATE: 7-21-15

**EXHIBIT C1**  
**CONTRACT BETWEEN THE LOWER NECHES VALLEY AUTHORITY OF TEXAS**  
**AND THE UNITED STATES OF AMERICA**

**FOR**  
**WATER STORAGE SPACE IN SAM RAYBURN RESERVOIR, TEXAS**

OFFICIAL RECORD COPY

CONTRACT  
CONSERVATION STORAGE  
McGEE BEND DAM AND DAM B RESERVOIRS

CMB

Contract No. DA-41-443-CIVENG-57-20

This contract entered into this 24th day of August, 1956, by and between the UNITED STATES OF AMERICA (hereinafter called the Government) represented by the Contracting Officer executing this contract, and the LOWER NECHES VALLEY AUTHORITY, an agency of the State of Texas in the City of Beaumont, Texas (hereinafter called the Authority), WITNESSETH THAT:

WHEREAS, in Senate Document Numbered 98, 76th Congress, 1st Session, the Chief of Engineers recommended construction of Rockland Reservoir on the Neches River, McGee Bend Reservoir on the Angelina River, and two power re-regulating dams, A and B on the Neches River below Rockland Dam, for the benefit of navigation, the control of floods, the conservation of water, the generation of hydroelectric power, and for other beneficial purposes incidental thereto, subject to the provision that, before construction was started on any element of the project, the State of Texas or other responsible local agency give assurances satisfactory to the Secretary of War that upon completion of the entire project it would contribute toward the first cost of the work the sum of \$5,000,000; and,

WHEREAS, construction of the improvements, in accordance with the plan presented in Senate Document 98, is authorized by the River and Harbor Act approved March 2, 1945 (Public Law 114, 79th Congress, 1st Session); and,

WHEREAS, the River and Harbor Act of 1948, approved June 30, 1948 (Public Law 858, 80th Congress, 2d Session) modified the existing project for the Neches and Angelina Rivers, Texas, adopted in the River and Harbor Act approved March 2, 1945, "so as to provide that the local agency which gives assurances that upon completion of the entire project it will contribute toward the first cost of the work the sum of \$5,000,000 shall be permitted to withdraw from the pool of Dam B not to exceed 2,000 cubic feet of water per second for its own use"; and,

WHEREAS, the Authority is a duly authorized and created State governmental agency, body politic and corporate, created as essential for the accomplishment of the purposes of Section 59 of Article 16 of the Constitution of the State of Texas, to the extent authorized in the creating act; and,

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WHEREAS, the Authority, on January 29, 1947, in compliance with provisions contained in Public Law 114 and Senate Document 98, enacted a resolution assuring the Secretary of War that upon completion of Dam B Reservoir on the Neches River, it would contribute \$2,000,000 toward the first cost of the work and upon completion of McGee Bend Dam and its reservoir on the Angelina River, it would contribute \$3,000,000 toward the first cost of the work; and,

WHEREAS, the aforesaid assurances were accepted by the Under Secretary of War on March 27, 1947; and,

WHEREAS, the Authority, by resolution enacted September 26, 1947, amended the resolution of January 29, 1947, to provide for assurance to the Secretary of War that, at any time after the Congress appropriated sufficient funds for the construction of Dam B and its reservoir which would by the addition of \$2,000,000 be sufficient to complete Dam B and its reservoir that, upon demand by the Secretary of War the Authority would contribute the said \$2,000,000 toward the cost of construction of Dam B and its reservoir and upon completion of McGee Bend Dam and its reservoir on the Angelina River it would contribute \$3,000,000 toward the first cost of the work; and,

WHEREAS, the amended assurance was accepted by the Secretary of the Army on November 13, 1947, and the Authority paid to the Government the sum of \$1,500,000 on October 3, 1949, and \$500,000 on July 17, 1950 for the completion of Dam B; and,

WHEREAS, the Authority, by resolution enacted September 8, 1955, amended and supplemented assurances theretofore made, and assured the Secretary of War (Army) that upon completion of McGee Bend Dam and its reservoir, in addition to the \$3,000,000 in cash which the Authority had theretofore assured that it would pay to the Government, that each year thereafter the Authority would pay to the Government the sum of \$200,000 per year for a period of fifty (50) years.

NOW, THEREFORE, the parties hereto do mutually agree as follows:

ARTICLE I. WATER RELEASES.- The Government agrees, to the extent that water is available in the McGee Bend Reservoir above elevation 1149, to make releases of water from McGee Bend Reservoir as required for the generation of power, with such releases at least sufficient to generate power equivalent to 42,200 kilowatts for a minimum period of 75 hours per month for each of the six monthly periods from mid-April through mid-October of each year. The Government reserves the right to utilize the releases made from McGee Bend Reservoir as may be necessary for the operation of a pumped storage installation to meet scheduled power demands if such an installation is provided.

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The Authority shall have the right to order releases from Dam B, subject to the provisions of Section 104, Public Law 858, 80th Congress, 2nd Session, to be made by the Government at any time so long as such releases when combined with local runoff below Dam B will not cause flooding, ~~and to the extent that such releases from Dam B are compatible with successful operation of a pumped storage installation at McGee Bend Reservoir if such an installation is provided.~~

*W.F.W.*  
*[Signature]*

The Government reserves the right to take such measures as may be necessary in the operation of McGee Bend Reservoir and Dam B Reservoir to preserve life or property.

(See Insert "A" attached hereto)

*W.F.W.*  
*[Signature]*

INSERT "A"

The obligation of the Government under Article 1 is subject to such limitations as are imposed by Federal statute including the Rivers and Harbors Act of March 2, 1945 (P.L. 14, 79th Congress) and, without affecting any of the obligations of the Authority, the Government will be relieved of its obligation to make releases of water in accordance with Article 1 in the event the Authority does not have or fails to obtain the right to use such water.

*W.F.W.*  
*[Signature]*

~~provided by the generation of hydroelectric power at these two reservoirs,~~ and in consideration of the previous payment by the Authority to the Government of \$2,000,000 toward the cost of construction of Dam B, receipt of which is hereby acknowledged, it is agreed the Authority shall pay to the Government:

(1) \$3,000,000 upon demand by the Secretary of the Army at any time after the Congress has appropriated sufficient funds for the construction of McGee Bend Reservoir which would, by the addition of \$3,000,000, be sufficient to complete the McGee Bend Reservoir.

(2) \$200,000 on the first day of January following completion of McGee Bend Reservoir and \$200,000/each year thereafter for a total period of fifty (50) years. on the first day of January of

(3) In the event of delay or default in the payments contained in paragraph (2) of this Article, the Authority shall pay interest on such overdue payments at the rate of two and one-half percent (2½%) per annum thereon, compounded annually, and such interest shall be charged from the date such payments are due until paid.

*W.F.W.*  
*[Signature]*

ARTICLE 5. PERIOD OF CONTRACT. The period of this contract shall be fifty (50) years from the date the first payment of \$200,000 is due.

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The Authority shall have the right to order releases from Dam B, subject to the provisions of Section 104, Public Law 858, 80th Congress, 2nd Session, to be made by the Government at any time so long as such releases when combined with local runoff below Dam B will not cause flooding, ~~and to the extent that such releases from Dam B are compatible with successful operation of a pumped storage installation at McGee Bend Reservoir if such installation is provided.~~

*W.F.W.*  
*[Signature]*

The Government reserves the right to take such measures as may be necessary in the operation of McGee Bend Reservoir and Dam B Reservoir to preserve life or property.

*W.F.W.*  
*[Signature]*

(See Insert "A" attached hereto)

ARTICLE 2. FEDERAL AND STATE LAWS.- This contract should not be construed to relieve the Authority from complying with any applicable Federal or State laws.

ARTICLE 3. REGULATION OF THE USE OF WATER.- The regulation of the use of water released from Dam B Reservoir shall be the responsibility of the Authority and shall not be considered a part of this contract.

ARTICLE 4. CONSIDERATION AND PAYMENT.- In consideration of the benefits anticipated to accrue to the Authority from the regulated flow provided by the generation of hydroelectric power at McGee Bend Reservoir, and in consideration of the previous payment by the Authority to the Government of \$2,000,000 toward the cost of construction of Dam B, receipt of which is hereby acknowledged, it is agreed the Authority shall pay to the Governments

(1) \$3,000,000 upon demand by the Secretary of the Army at any time after the Congress has appropriated sufficient funds for the construction of McGee Bend Reservoir which would, by the addition of \$3,000,000, be sufficient to complete the McGee Bend Reservoir.

(2) \$200,000 on the first day of January following completion of McGee Bend Reservoir and \$200,000/each year thereafter for a total period of fifty (50) years. on the first day of January of

(3) In the event of delay or default in the payments contained in paragraph (2) of this Article, the Authority shall pay interest on such overdue payments at the rate of two and one-half percent (2½%) per annum thereon, compounded annually, and such interest shall be charged from the date such payments are due until paid.

*W.F.W.*  
*[Signature]*

ARTICLE 5. PERIOD OF CONTRACT. The period of this contract shall be fifty (50) years from the date the first payment of \$200,000 is due.

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ARTICLE 6. RENEWALS.- It is the understanding and expectation of the parties hereto that upon expiration of this contract the Authority shall have the right, subject to any required approval of appropriate State authorities, to negotiate for releases and other flows, then available, from the McGee Bend and Dam B Reservoirs. The terms of the new contract shall be subject to mutual agreement at the time.

ARTICLE 7. DEFAULT.- In the event that the Authority refuses or fails to comply with any of the terms of this contract, including the foregoing provisions with respect to payments, the Government reserves the right to terminate this contract, subject to the provision that delays in payment under Article 4(3) not in excess of three (3) years will not constitute default.

ARTICLE 8. OPERATION AND MAINTENANCE.- The Government shall operate and maintain the McGee Bend and Dam B Reservoirs owned by the Government. The Authority shall be responsible for operation and maintenance of all features and appurtenances which may be provided and owned by the Authority.

ARTICLE 9. RELEASE OF CLAIMS.- The Authority shall hold and save the Government, including its officers, agents, and employees, harmless from liability of any nature or kind for or on account of any claim for damages which may be filed or asserted as a result of the releases made for or by the Authority as provided in Article 1, or as a result of the construction, operation or maintenance of any features or appurtenances owned and operated by the Authority.

ARTICLE 10. TRANSFER OR ASSIGNMENT.- The Authority shall not transfer or assign this contract nor any rights acquired thereunder nor grant any interest, privilege, or license whatsoever in connection with this contract without permission in writing from the Secretary of the Army; provided that this restriction shall not be construed to apply to any water which may be obtained from the releases from Dam B Reservoir by the Authority and furnished to any third party or parties nor any method of allocation thereof.

ARTICLE 11. OFFICIALS NOT TO BENEFIT.- No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

ARTICLE 12. COVENANT AGAINST CONTINGENT FEES.- The Authority warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or

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bona fide established commercial or selling agencies maintained by the Authority for the purpose of securing business. For breach or violation of this warranty the Government shall have the right to annul this contract without liability or in its discretion to add to the contract price or consideration the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 13. DISPUTES.- Except as otherwise provided in this contract, any dispute concerning a question of fact arising under this contract which is not disposed of by agreement shall be decided by the Contracting Officer, who shall reduce his decision to writing and mail or otherwise furnish a copy thereof to the Authority. Within 30 days from the date of receipt of such copy, the Authority may appeal by mailing or otherwise furnishing to the Contracting Officer a written appeal addressed to the Secretary, and the decision of the Secretary or his duly authorized representative for the hearing of such appeals shall, unless determined by a court of competent jurisdiction to have been fraudulent or capricious or arbitrary or so grossly erroneous as necessarily to imply bad faith, or not supported by substantial evidence, be final and conclusive; provided that, if no such appeal is taken, the decision of the Contracting Officer shall be final and conclusive. In connection with any appeal proceeding under this clause, the Authority shall be afforded an opportunity to be heard and to offer evidence in support of its appeal. Pending final decision of a dispute hereunder, the Authority shall proceed diligently with the performance of the contract and in accordance with the Contracting Officer's decision.

ARTICLE 14. APPROVAL OF CONTRACT.- This contract shall be subject to the written approval of the Secretary of the Army or his duly authorized representative and shall not be binding until so approved.

ARTICLE 15. DEFINITIONS.- (a) The term "Secretary" means the Secretary of the Army; the terms "Secretary of the Army" or "Head of the Department" as used herein shall have one and the same meaning, and the term "his duly authorized representative" means the Chief of Engineers, Department of the Army, or an individual or board designated by him.

(b) The term "Contracting Officer" as used herein shall include his duly appointed successor or his authorized representative.

ARTICLE 16. ALTERATIONS.- The following alterations have been made in the provisions of this contract:

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IN WITNESS WHEREOF, the parties hereto have executed this agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

By

Harry O. Fischer

HARRY O. FISCHER  
Colonel, CE  
Contracting Officer

(SEAL)

ATTEST:

G. R. Bauer

Nome Texas  
(Address)

LOWER NECHES VALLEY AUTHORITY

By

W. F. Wood

President, Board of Directors

Approved:

22 Jan 1957

~~RECORDED~~

Wilbur M. Soucken  
Secretary of the Army

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**EXHIBIT C2**

**CONTRACT BETWEEN THE UNITED STATES OF AMERICA AND**

**THE CITY OF LUFKIN**

**FOR**

**WATER STORAGE SPACE IN SAM RAYBURN RESERVOIR, TEXAS**

CONTRACT NO. DACW63-69-C-0007  
69 JAN 07

CONTRACT BETWEEN THE UNITED STATES OF AMERICA  
AND  
THE CITY OF LUFKIN, TEXAS  
FOR  
WATER STORAGE SPACE IN SAM RAYBURN RESERVOIR

THIS CONTRACT, entered into on the date set forth above, by the United States of America (hereinafter called the "Government") represented by the Contracting Officer of the Corps of Engineers executing this contract, and the City of Lufkin, Texas, with its offices and seat of government in the City of Lufkin, Texas (hereinafter called "Lufkin"), WITNESSETH THAT:

WHEREAS, the Act of Congress approved March 2, 1945 (Public Law 14, 79th Congress, 1st Session), authorized the construction, operation and maintenance of the Sam Rayburn Dam and Reservoir on the Angelina River, Texas (hereinafter called the "Project"); and

WHEREAS, Lufkin desires to contract with the Government for inclusion in the Project of storage for municipal and industrial water supply, and for payment for the cost thereof in accordance with the provisions of the Water Supply Act of 1958, as amended, (43 USC 390b-f); and

WHEREAS, Lufkin is empowered so to contract with the Government, and is vested with all necessary powers for accomplishment of the purposes of this contract.

NOW, THEREFORE, the parties do mutually agree as follows:

ARTICLE 1. WATER STORAGE SPACE. Lufkin shall have the right to utilize an undivided one and twenty-five hundredths percent (1.25%) of the storage space in the Project between elevations 164.4 feet above mean sea level and 149.0 feet above mean sea level for a present water supply and an undivided one and seventy-three hundredths percent (1.73%) of the storage space in the Project between elevations 164.4 feet above mean sea level and 149.0 feet above mean sea level for a future water supply as deemed necessary by Lufkin to impound water for municipal and industrial use, and to make such withdrawals as granted to Lufkin by the Texas Water Commission or its successors, to the extent such storage space will provide.

The Government shall not be responsible for diversion by others nor will it become a party to any controversies between users of the aforesaid storage space except as such controversies may affect storage space reserved by the Government.

1.25  
1.73  
2.98

Reviewed for legal sufficiency  
(APP 1-403.51)  
*AMZ*

Reviewed for Compliance  
with Procurement Principles,  
and Regulations  
(APP 1-403.52)  
*[Signature]*

Lufkin shall have the right to construct within the reservoir area, such installations or facilities required for the purpose of diversion or withdrawal of water from the Project, subject to the approval of the Contracting Officer as to design and location; the cost of such installations or facilities or any modifications thereof shall be borne by Lufkin.

The Government reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property.

Lufkin recognizes that this contract provides storage space only, as stated above, and that any water that may be impounded therein will be raw water. The Government makes no representation with respect to quality or availability of water and assumes no responsibility therefor, or for treatment of the water.

ARTICLE 2. METERING. For the purpose of maintaining an accurate record of water resources at the Project, Lufkin, prior to use of the water storage space, agrees to install suitable meters or metering devices satisfactory to the Contracting Officer, without cost to the Government. Lufkin shall furnish the Government monthly statements of the quantity of water withdrawn.

ARTICLE 3. FEDERAL AND STATE LAWS. Lufkin shall utilize such storage space and make withdrawals from such space in a manner consistent with Federal and State Laws.

ARTICLE 4. REGULATION OF THE USE OF WATER. The regulation of the use of water stored in the aforesaid storage space shall be the responsibility of Lufkin and shall not be considered a part of this contract.

ARTICLE 5. CONSIDERATION AND PAYMENT. In consideration of the payments provided in this contract to be paid by Lufkin to the Government, it is agreed that the Government will provide storage space in the Project as provided in Article 1. In consideration of the Government's providing the aforesaid storage space to Lufkin, it is agreed that Lufkin shall pay the following sums to the Government:

a. \$220,000 which is the estimated cost, including interest during construction, of providing 18,000 acre-feet of present water supply storage space, as determined in the manner set out in Exhibit A attached hereto and made a part hereof. The sum of \$220,000 shall be paid in fifty (50) consecutive annual installments in the amount of \$7,698.98 each, commencing on the first day of January 1970, and annually thereafter on the aforesaid date of each year until fifty (50) equal consecutive yearly payments have been made. Except for the first payment, which shall be applied solely to retirement of principal, all installments shall include accrued interest at the rate of two and five hundred ninety-one thousandths percent (2.591%) per annum on the unpaid balance. The last annual

installment shall be adjusted upward or downward when due to assure repayment of all capital costs within the contract period. A schedule of annual payments is shown in Exhibit A.

b. \$305,600 which is the estimated cost, including interest during construction, of providing 25,000 acre-feet of future water supply storage space as determined in the manner set out in Exhibit A. The sum of \$305,600 shall be paid in forty (40) consecutive annual installments in the amount of \$12,049.07 each, commencing on the first day of January 1976, and annually thereafter on the aforesaid date of each year until forty (40) equal consecutive yearly payments have been made. Except for the first payment, which shall be applied solely to retirement of principal, all installments shall include accrued interest at the rate of two and five hundred ninety-one thousandths percent (2.591%) per annum of the unpaid balance. The last annual installment shall be adjusted upward or downward when due to assure repayment of all capital costs within the contract period. A schedule of annual payments is shown in Exhibit A.

c. Lufkin shall have the right, at any time it so elects, to prepay the indebtedness under Article 5a and b, in whole or in part, with accrued interest thereon to the date of such prepayment.

d. In the event water is first used from the present water supply storage space prior to the first day of January 1970 or from the future water supply storage space prior to the first day of January 1976, the initial payment shall be due and payable on the date of first use of water from each respective water supply storage space with annual payments thereafter on the anniversary date of the first use of said storage space.

e. .692 percent of the annual experienced joint use costs of ordinary operation and maintenance of the Project, which shall be applicable to the present water supply storage space. Items of operation and maintenance which form the basis of computation and which will be used in future computation of operation and maintenance charges for the present water supply storage space are shown in Exhibit A. Each payment shall be equal to .692 percent of the actual experienced cost of operation and maintenance for the preceding Government fiscal year. The first payment shall be due and payable on the first day of January 1970. Annual payments shall be due and payable in advance on the first day of January thereafter. In the event water is first used from the present water supply storage space prior to the first day of January 1970, annual payment for operation and maintenance shall be due and payable on the date of first use. Annual payments thereafter will be due and payable in advance on the anniversary date of the first use.

f. .964 percent of the annual experienced joint use costs of ordinary operation and maintenance of the Project, which shall be applicable to the future water supply storage space. Items of operation and maintenance which form the basis of computation and which will be used in future computation of operation and maintenance charges for the future water supply storage space are shown in Exhibit A. Each payment shall be equal to .964 percent of the actual experienced cost of operation and maintenance for the preceding Government fiscal year. The first payment shall be due and payable on the first day of January 1976. Annual payments shall be due and payable in advance on the first day of January thereafter. In the event water is first used from the future water supply storage space prior to the first day of January 1976, annual payment for operation and maintenance shall be due and payable on the date of first use. Annual payments thereafter will be due and payable in advance on the anniversary date of the first use.

g. 1.689 percent of the joint use cost of sedimentation resurveys when incurred. Payment shall be made with the first annual payment becoming due after the date said cost is incurred.

h. 1.689 percent of the joint use cost of major capital replacements when incurred. Payment shall be made with the first annual payment becoming due after the date said cost is incurred.

i. The extent of the Government's operation and maintenance of the Project shall be determined by the Contracting Officer and all records and accounting thereof shall be kept and maintained by the Contracting Officer. In the event Lufkin should desire additional operation and maintenance over and above that provided by the Government, Lufkin shall bear the entire cost of such additional operation and maintenance.

j. In the event of default in the payment of costs contained in Article 5a, b, e, f, g, and h, the amount of such payments shall be increased by an amount equal to interest on such overdue payments at the rate of two and five hundred ninety-one thousandths percent (2.591%) per annum thereon, compounded annually, and such amount equal to interest shall be charged from the date such payments are due until paid.

ARTICLE 6. PERIOD OF CONTRACT. This contract shall become effective as of the date of approval by the Secretary of the Army, and shall continue in full force and effect under the conditions set forth herein, not to exceed the life of the Project.

ARTICLE 7. PERMANENT RIGHTS TO STORAGE. Upon completion of payments by Lufkin, as provided in Article 5 herein, Lufkin shall have a permanent right, under the provisions of Public Law 38-140, to the use of the water supply storage space in the Project as provided in Article 1, subject to the following:

a. Lufkin shall continue payment of annual operation and maintenance costs allocated to water supply.

b. Lufkin shall bear the costs allocated to water supply of any necessary reconstruction, rehabilitation or replacement of Project features which may be required to continue satisfactory operation of the Project. Such costs will be established by the Contracting Officer. Repayment arrangements including schedules will be in writing and will be made a part of this contract.

c. Upon completion of payments by Lufkin as provided in Article 5a herein, the Contracting Officer shall redetermine the storage space for municipal and industrial water supply, taking into account such equitable reallocation of reservoir storage capacities among the purposes served by the Project as may be necessary due to sedimentation. Such findings, and the storage space allocated to municipal and industrial water supply, shall be defined and described in an exhibit which will be made a part of this contract. Following the same principle, such reallocation of reservoir storage capacity may be further adjusted from time to time as the result of sedimentation resurveys to reflect actual rates of sedimentation and the exhibit revised to show the revised storage space allocated to municipal and industrial water supply.

d. The permanent rights of Lufkin under this contract shall be continued so long as the United States continues to operate the Project. In the event the United States no longer operates the Project, such rights may be continued subject to the execution of a separate contract, or additional supplemental agreement providing for:

(1) Continued operation by Lufkin of such part of the facility as is necessary for utilization of the water supply storage space allocated to it;

(2) terms which will protect the public interest; and

(3) effective absolvment of the United States by Lufkin from all liability in connection with such continued operation.

ARTICLE 8. OPERATION AND MAINTENANCE. The Government shall operate and maintain the Project owned by the Government. Lufkin shall have the right to make withdrawals of water for its purposes as needed in accordance with Article 1. Lufkin shall be responsible for operation and maintenance of all features and appurtenances which may be provided and owned by Lufkin.

ARTICLE 9. RIGHTS-OF-WAY. The grant of an easement for right-of-way over, across, in, and upon Government-owned lands, under control of the Secretary of the Army, required for construction of intake facilities at

point of withdrawal and for transmission of water from point of withdrawal, shall be by separate instrument without additional cost to Lufkin, under the authority and in accordance with the provisions of Public Law 1028 (10 U.S.C. 2669), approved 10 August 1956.

ARTICLE 10. RELEASE OF CLAIMS. Lufkin shall hold and save the Government, including its officers, agents, and employees, harmless from liability of any nature or kind for or on account of any claim for damages which may be filed or asserted as a result of storage and withdrawal or release of water from the Project made or ordered by Lufkin, or as a result of the construction, operation, or maintenance of the features or appurtenances owned and operated by Lufkin.

ARTICLE 11. TRANSFER OR ASSIGNMENT. Lufkin shall not transfer or assign this contract, nor any rights acquired thereunder, nor suballot said water or storage space or any part thereof, nor grant any interest, privilege, or license whatsoever in connection with this contract, without the approval of the Secretary of the Army or his authorized representative; provided that, this restriction shall not be construed to apply to any water which may be obtained from the water supply storage by Lufkin and furnished to any third party or parties.

ARTICLE 12. OFFICIALS NOT TO BENEFIT. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this contract or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

ARTICLE 13. COVENANT AGAINST CONTINGENT FEES. Lufkin warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by Lufkin for the purpose of securing business. For breach or violation of this warranty the Government shall have the right to annul this contract without liability or in its discretion to add to the contract price or consideration the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 14. APPROVAL OF CONTRACT. This contract shall be subject to the written approval of the Secretary of the Army, and shall not be binding until so approved.

IN WITNESS WHEREOF, the parties hereto have executed this agreement as of the day and year first above written.

APPROVED:

THE UNITED STATES OF AMERICA

\_\_\_\_\_  
Date January 7, 1969

By R. S. Kristoferson  
R. S. KRISTOFERSON  
Colonel, CE  
Contracting Officer

ATTEST:

LUFKIN, TEXAS

Lynn L. Latham  
City Clerk of Lufkin  
*Lucy*

By Earl Pickett  
Mayor  
(Title)

APPROVED:

Stanley R. Reed  
Secretary of the Army  
27 MAY 1969

DATE: \_\_\_\_\_

I, Lynn L. Latham, certify that I am the City Clerk of Lufkin herein; that Earl Pickett who signed this contract on behalf of Lufkin was then Mayor of said Lufkin; that said contract was duly signed for and on behalf of Lufkin by authority of its governing body and is within the scope of its legal powers.

In witness whereof, I have hereunto affixed my hand and seal of said Lufkin, this 7 day of January 1968.

CORPORATE SEAL

Lynn L. Latham  
City Clerk of Lufkin  
*Lucy*

EXHIBIT A

35 AC-FT.

1. Amount of water desired.

The City of Lufkin desires to contract for storage space of 18,000 acre-feet for initial use and 25,000 acre-feet for future use, making a total storage space of 43,000 acre-feet in the Project. In terms of yield, this storage space is equivalent to the following:

Initial use - 10,700,000 gallons per day, or 16.6 cfs or 12,000 acre-feet per annum.

Future use - 25,000,000 gallons per day, or 38.7 cfs or 28,000 acre-feet per annum.

*E. H. RSK*

2. Critical periods of operation for flood control and power generation.

Studies were conducted on the effects of flood control storage and power generation of allocating 43,000 acre-feet of storage to water supply. Flood routing studies made in connection with the design of Sam Rayburn Reservoir indicated that maximum storage utilization in the reservoir for the period since 1908 would have occurred during passage of the flood of March-July 1922. The critical power period study was based on the 43.5-month critical period of low flow from mid-July 1953 through February 1957.

3. Reservoir storages.

$$\begin{aligned} \text{PRESENT USE} &= 18,000 \div 1,443,600 = 1.25\% \\ \text{FUTURE USE} &= 25,000 \div 1,443,600 = 1.73\% \end{aligned}$$

Flood control storage, elevation 173.0-164.0 - 1,145,000 acre-feet. Conservation storage, elevation 164.0-149.0 - 1,400,600 acre-feet. In order to provide Lufkin with a present water supply of 12,000 acre-feet per annum, a storage space of 18,000 acre-feet added to conservation pool elevation would result in storage of 1,418,600 acre-feet at elevation 164.17. Provision of the future water supply of 16,000 acre-feet per annum, or a total of 28,000 acre-feet per annum, would result in the addition of 43,000 acre-feet of storage on top of the conservation pool. This would present a conservation storage of 1,443,600 acre-feet at elevation 164.4. The present water supply is 1.25 percent of the storage between the bottom of the conservation pool and the modified top of the conservation pool elevation. The total storage is 2.98 percent of the storage between the bottom of the conservation pool and the modified top of the conservation pool elevation.

4. Effect of storage on flood control and power operations.

Flood routing studies based on a recurrence of the 1922 flood indicated that a reduction of flood control storage by 43,000 acre-feet would have not increased the maximum reservoir elevation of 176.0. This flood would increase the modified discharge at Evadale by 700 cfs. Critical

period power studies based on the increased head available from the allocation of 43,000 acre-feet of water supply storage showed that the average annual firm energy would be increased from about 50,340,000 kwh to 50,700,000 kwh, or 360,000 kwh. Contractual agreements provide for the Government to make releases of water as required for the generation of power, with such releases at least sufficient to generate power equivalent to 42,000 kilowatts for a minimum period of 75 hours (3,150,000 kwh) per month for each of the six monthly periods from mid-April through mid-October of each year. The allocation of 43,000 acre-feet of water supply will not adversely affect these requirements.

5. Cost of water supply storage.

Inasmuch as power and flood control operations would not be adversely affected by the allocation of water supply, it was determined that the amount to be paid the Government would be based on the conversion of flood control storage to water supply use. The current approved project estimate (1 July 1968) indicates a Federal first cost allocated to flood control of \$14,959,500. Interest during construction for flood control was computed by using one-half of the construction period (8 years) and the interest rate specified in the Water Supply Act of 1958 - 2.591 percent. This resulted in an interest figure of \$1,550,400, which added to the first cost for flood control totaled \$16,509,900. The specific construction expenditures for flood control facilities of \$2,293,500 and interest during construction of specific flood control facilities of \$237,700 were deducted, resulting in a figure of \$13,978,700 for allocation purposes. The total flood control storage is 1,145,000 acre-feet. The cost of water supply storage equals 43,000/1,145,000 x \$13,978,700 equals \$525,600. The unit cost of water supply storage is \$525,600/43,000 equals \$12.22 per acre-foot. The cost of the present storage of 18,000 acre-feet is \$220,000. The cost of the future storage of 25,000 acre-feet is \$305,600.

6. Annual payment.

*EMRSK*

Costs of the annual payment for the present water supply storage were based on 50 yearly payments, with the first payment interest free. The interest rate, as established by the Water Supply Act of 1958, is 2.591 percent. Annual payments for the future water supply storage were based on 40 yearly payments with the first payment interest free. The interest rate for the future storage is also 2.591 percent. Computation of the annual payment was based on the following:

$$\text{Amortization rate} = \frac{i}{(1 + i)^{h-1}}$$

Wherein  $i$  = interest rate = .02591

$h$  = 49 years for present storage

39 years for future storage

Present storage

$$\text{Amortization rate} = \frac{.02591}{(1 + .02591)^{49-1}}$$

$$\text{Log } 1.02591 = .0111092$$

$$49 \times .0111092 = .5443508$$

$$\text{Antilog} = 3.502280$$

$$\text{Amortization rate} = \frac{.02591}{3.502280-1} = .01035446$$

$$\text{Annual payment} = X = \frac{\text{Sum}-X}{\frac{1}{\text{Int rate} + \text{amortization coefficient}}}$$

Wherein Sum = \$220,000

$$\text{Int rate} = .02591$$

$$\text{Amort coeff} = .01035446$$

$$X = \frac{220,000-X}{\frac{1}{.02591+.01035446}} =$$

$$\frac{220,000-X}{27.5752072} =$$

\$7,698.98 - annual payment for present storage

*EM RSR*

Future storage

$$\text{Amortization rate} = \frac{.02591}{(1+.02591)^{39-1}}$$

$$\text{Log } 1.02591 = .0111092$$

$$39 \times .0111092 = .4332588$$

$$\text{Antilog} = 2.711806$$

$$\text{Amortization rate} = \frac{.02591}{2.711806-1} = .01513592$$

$$\text{Annual payment} = X = \frac{\text{Sum} - X}{\frac{1}{\text{Int rate} + \text{amortization coefficient}}}$$

Wherein Sum = 305,600

Interest rate = .02591

Amort coeff = .01513592

$$X = \frac{305,600 - X}{.02591 + .01513592}$$

$$\frac{305,600 - X}{24.362995739} =$$

\$12,049.07 - annual payment for future storage

7. Costs of operation and maintenance.

Determination of the operation and maintenance costs chargeable to the water supply was based on the proportion of the water supply storage to the flood control storage in the Project. Flood control storage in the Project is 1,145,000 acre-feet. Water supply storage is 43,000 acre-feet.

From cost allocation studies (RCS-ENGCW-P-7) dated 30 September 1968, the annual experienced joint use costs for operation and maintenance of the Project are \$183,600. The joint use costs for operation and maintenance allocated to flood control is \$80,900. The cost of operation and maintenance chargeable to water supply is 43,000/1,145,000 acre-feet x \$80,900 = \$3,040. The cost for the present water supply is 18,000 acre-feet/43,000 acre-feet x \$3,040 = \$1,270. The percent of the annual experienced joint use cost of ordinary operation and maintenance of the project for the present water supply is \$1,270/\$183,600 = 0.692 percent. The cost for the future water supply is 25,000 acre-feet/43,000 acre-feet x \$3,040 = \$1,770. The percent of the annual experienced joint use cost of ordinary operation and maintenance of the Project for the future water supply is \$1,770/\$183,600 = 0.964 percent. EM BK

8. Cost of major replacements and sedimentation surveys.

The cost of the major replacements and sedimentation surveys was determined on the proportion of the water supply storage, 43,000 acre-feet, to the total usable storage, 2,545,600 acre-feet. This proportion resulted in a determination of 43,000 acre-feet/2,545,600 acre-feet = 1.689 percent of the joint use costs for replacements and sedimentation surveys.

9. Cost allocation

Multiple-purpose project

Federal first cost - flood control	\$14,959,500
Interest during construction	+ 1,550,400*
Construction expenditures in specific flood control facilities	- 2,293,500
Interest during construction	- <u>237,700*</u>
Total	\$13,978,700
Total annual experienced joint use O&M costs	\$ 183,600
Allocated joint use O&M costs to flood control	\$ 80,900
Total flood control storage	1,145,000 acre-feet

$$\frac{43,000 \text{ acre-feet}}{1,145,000 \text{ acre-feet}} \times \$13,978,700 = .0376 \times \$13,978,700 = \$525,600$$

$$\$525,600 \div 43,000 \text{ acre-feet} = \$12.22 \text{ unit cost per acre-foot}$$

$$\text{Present storage} - 18,000 \text{ acre-feet} \times \$12.22 = \$220,000$$

$$\text{Future storage} - 25,000 \text{ acre-feet} \times \$12.22 = \$305,600$$

\*Based on 2.591 percent and one-half of construction period (8 years)

$$\text{O\&M**} \frac{43,000 \text{ acre-feet}}{1,145,000 \text{ acre-feet}} = .0376 \times \$80,900 = \$3,040$$

$$\text{Present O\&M} \frac{18,000 \text{ acre-feet}}{43,000 \text{ acre-feet}} \times \$3,040 = \$1,270 / \$183,600 = 0.692\%$$

$$\text{Future O\&M} \frac{25,000 \text{ acre-feet}}{43,000 \text{ acre-feet}} \times \$3,040 = \$1,770 / \$183,600 = 0.964\%$$

\*\*O&M computations based on cost allocation studies (RCS-ENG CW-P-7) dated 30 September 1968.

ANNUAL PAYMENTS FOR PRESENT WATER SUPPLY STORAGE SPACE

NO.	PAYMENT TO INTEREST	PAYMENT TO PRINCIPAL	TOTAL PAYMENT	BALANCE DUE
				220000.00
1	0.00	7698.98	7698.98	212301.02
2	5500.72	2198.26		210102.76
3	5443.70	2255.22		207847.54
4	5385.33	2313.65		205533.89
5	5325.38	2373.60		203160.29
6	5263.88	2435.10		200725.19
7	5200.79	2498.19		198227.00
8	5136.06	2562.92		195664.08
9	5069.66	2629.32		193034.76
10	5001.53	2697.45		190337.31
11	4931.64	2767.34		187569.97
12	4859.94	2839.04		184730.93
13	4785.38	2912.60		181818.33
14	4710.91	2988.07		178830.26
15	4633.49	3065.49		175764.77
16	4554.07	3144.91		172619.86
17	4472.58	3226.40		169393.46
18	4388.98	3310.00		166083.46
19	4303.22	3395.76		162587.70
20	4215.24	3483.74		159203.96
21	4124.97	3574.01		155829.95
22	4032.37	3666.61		151963.34
23	3937.37	3761.61		148201.73
24	3839.91	3859.07		144342.06
25	3739.92	3959.06		140383.00

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NO.	PAYMENT TO INTEREST	PAYMENT TO PRINCIPAL	TOTAL PAYMENT	BALANCE DUE
26	3637.34	4061.64		136621.96
27	3532.10	4166.98		132155.08
28	3424.14	4274.84		127880.24
29	3313.58	4385.60		123494.84
30	3199.75	4499.23		118995.41
31	3083.17	4615.81		114379.20
32	2963.58	4735.40		109644.20
33	2840.88	4858.10		104786.10
34	2715.01	4983.97		99802.13
35	2585.87	5113.11		94689.02
36	2453.39	5245.59		89443.43
37	2317.48	5381.50		84061.93
38	2178.04	5520.94		78540.99
39	2035.00	5663.98		72877.01
40	1888.24	5810.74		67066.27
41	1737.59	5961.29		61104.98
42	1583.23	6115.75		54989.23
43	1424.77	6274.21		48715.02
44	1262.21	6436.77		42276.25
45	1095.43	6603.55		35674.70
46	924.33	6774.65		28900.05
47	748.80	6950.18		21949.87
48	568.72	7130.26		14819.61
49	383.98	7315.00		7504.61
50	194.44	7504.54		0.07

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*RSK*

ANNUAL PAYMENTS FOR FUTURE WATER SUPPLY STORAGE SPACE

NO.	PAYMENT TO INTEREST	PAYMENT TO PRINCIPAL	TOTAL PAYMENT	BALANCE DUE
				305000.00
1	0.00	12049.07	12049.07	293550.93
2	7605.90	4443.17		289107.76
3	7490.78	4558.29		284549.47
4	7372.68	4676.39		279873.58
5	7251.51	4797.56		275075.52
6	7127.21	4921.86		270153.66
7	6999.63	5049.39		265104.27
8	6868.65	5180.22		259924.05
9	6734.63	5314.44		254609.61
10	6596.93	5452.14		249157.47
11	6455.57	5593.40		243564.67
12	6310.75	5738.32		237825.75
13	6162.07	5887.00		231938.75
14	6009.53	6039.54		225899.21
15	5853.05	6196.02		219703.19
16	5692.51	6356.56		213345.63
17	5527.61	6521.25		206825.37
18	5358.35	6690.22		200135.15
19	5185.30	6863.57		193271.55
20	5007.57	7041.40		186230.18
21	4825.22	7223.85		179006.33
22	4638.05	7411.02		171595.31
23	4446.03	7503.04		163992.27
24	4249.04	7600.03		156192.24
25	4046.94	8002.13		148190.11

PAGE 1

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NO.	PAYMENT TO INTEREST	PAYMENT TO PRINCIPAL	TOTAL PAYMENT	BALANCE DUE
26	3839.51	8209.46		139980.55
27	3525.90	8422.17		131555.48
28	3405.68	8640.39		122915.09
29	3284.81	8864.26		114053.03
30	2955.13	9093.94		104959.89
31	2719.51	9329.56		95530.33
32	2477.78	9571.29		86059.04
33	2229.79	9819.28		76239.76
34	1975.37	10073.70		66160.06
35	1714.36	10334.71		55831.35
36	1446.59	10602.48		45228.67
37	1171.88	10877.19		34351.68
38	890.05	11159.02		23192.66
39	600.92	11448.15		11744.21
40	304.50	11744.77		-0.26

PAGE 2

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EXHIBIT B

ASSURANCE OF COMPLIANCE WITH THE  
DEPARTMENT OF DEFENSE DIRECTIVE UNDER  
TITLE VI OF THE CIVIL RIGHTS ACT OF 1964

City of Lufkin (hereinafter called "Applicant-Recipient")  
HEREBY AGREES THAT it will comply with title VI of the Civil Rights  
Act of 1964 (P. L. 88-352) and all requirements imposed by or  
pursuant to the Directive of the Department of Defense (32 CFR Part  
300, issued as Department of Defense Directive 5500.11, December 28,  
1964) issued pursuant to that title, to the end that, in accordance  
with title VI of that Act and the Directive, no person in the  
United States shall, on the ground of race, color, or national origin  
be excluded from participation in, be denied the benefits of, or be  
otherwise subjected to discrimination under any program or activity  
for which the Applicant-Recipient receives Federal financial  
assistance from the U. S. Army Corps of Engineers and HEREBY GIVES  
ASSURANCE THAT it will immediately take any measures necessary to  
effectuate this agreement.

If any real property or structure thereon is provided or improved  
with the aid of Federal financial assistance extended to the Applicant-  
Recipient by this U. S. Army Corps of Engineers, assurance shall  
obligate the Applicant-Recipient, or in the case of any transfer of  
such property, any transferee, for the period during which the real  
property or structure is used for a purpose for which the Federal  
financial assistance is extended or for another purpose involving  
the provision of similar services or benefits. If any personal  
property is so provided, this assurance shall obligate the Applicant-  
Recipient for the period during which it retains ownership or possession  
of the property. In all other cases, this assurance shall obligate the  
Applicant-Recipient for the period during which the Federal financial  
assistance is extended to it by the U. S. Army Corps of Engineers.

THIS ASSURANCE is given in consideration of and for the purpose  
of obtaining any and all Federal grants, loans, contracts, property,  
discounts or other Federal financial assistance extended after the  
date hereof to the Applicant-Recipient by the Department, including  
installment payments after such date on account of arrangements for  
Federal financial assistance which were approved before such date.

The Applicant-Recipient recognizes and agrees that such Federal assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant-Recipient, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign this assurance on behalf of the Applicant-Recipient.

CITY OF LUFKIN

Dated January 7, 1969

By Eure Nisbet  
Mayor

\_\_\_\_\_  
\_\_\_\_\_  
(Mailing Address)

RESOLUTION

WHEREAS, the City of Lufkin has been negotiating for a contract between the United States of America and the City of Lufkin, Texas, for a water storage space in Sam Rayburn Reservoir; and,

WHEREAS, the District Engineer of the Department of the Army, Fort Worth District, Corps of Engineers, has submitted to the City of Lufkin a contract for water storage space in Sam Rayburn Reservoir, said contract being identified as Contract DACW63-69-C-0007; and,

WHEREAS, the above referred to contract has been duly received and considered by the City Commission of the City of Lufkin, Texas;

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COMMISSION OF THE CITY OF LUFKIN, TEXAS, that the said contract for water storage space in Sam Rayburn Reservoir between the United States of America and the City of Lufkin, Texas, identified as Contract DACW63-69-C-0007, be executed by the City of Lufkin, Texas, and the Mayor be authorized and directed to execute the same on behalf of the City of Lufkin, Texas.

Secret  
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**EXHIBIT D**

**STANDING INSTRUCTIONS TO LAKE MANAGER**

**SAM RAYBURN DAM AND RESERVOIR**

**EXHIBIT D**  
**STANDING INSTRUCTIONS TO LAKE MANAGER**  
**SAM RAYBURN DAM AND RESERVOIR**

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**STANDING INSTRUCTIONS TO LAKE MANAGER  
SAM RAYBURN DAM AND RESERVOIR**

**I. GENERAL**

**1. Instructions.** Detailed instructions to the project personnel at Sam Rayburn Dam and Reservoir are presented below.

a. Regulation. The Fort Worth District Water Management Office will normally issue instructions for the storage and discharge of water. In the event communications with the Fort Worth District Water Management Office are disrupted, the Lake Manager will direct regulation in accordance with the Emergency Regulation guidance provided in Section II of this exhibit.

b. Data Reporting. The Water Management Office is staffed from 0700 hours to 1600 hours daily, and 0700 hours to 1100 hours on weekends and holidays (except Christmas Day). During these hours reservoir regulators may be reached via telephone at 817-886-1551, via e-mail at [ceswf-od-1@usace.army.mil](mailto:ceswf-od-1@usace.army.mil), or (as a backup) via FAX at 817-886-6472. Outside of these hours the Water Management Office Duty Regulator may be reached via mobile telephone at 817-791-0973, or, as a backup, via the above e-mail address.

(1). Daily Report. Each day lake and hydrometeorological data will be submitted to the Fort Worth District Water Management Office between 0800 and 0830 hours. The primary means of submission will be the Internet at <http://www.swf-wc.usace.army.mil>. The secondary means of submission will be via telephone, and FAX may be used as a backup. The following data should be included in the daily report.

(a). Weather. For the 24-hour period preceding 0800 hours each day, report cumulative precipitation and evaporation values, in inches, and the maximum and minimum experienced temperature readings.

(b). Gate Settings. Gate number of each open gate, with the height of opening in feet as of 0800 hours on the date of report.

(c). Spillway Discharge. In the event discharge occurs over the uncontrolled spillway, report the respective dates and times discharge begins and ends.

(2). Reporting Severe Weather. During normal project duty hours, including weekends as applicable, severe weather will be reported as it develops, to include information and data that may be requested by the Water Management Office. Severe weather conditions outside of normal project duty hours will be reported when and as requested by the Water Management Office.

(3). Reporting Gate Operations. Upon completion of any change in gate settings, details of the gate operations will be reported to the Water Management Office via telephone, e-mail, or FAX (as backup). The report shall include the gate settings prior to change, the date and time of beginning of change, the date and time of completion of change, and the gate settings upon completion of change.

c. Reporting Unusual Events. Events or conditions not normally encountered in the routine operation of the dam and lake that might endanger the integrity of the dam or necessitate temporary or permanent revision of the operating procedures shall be promptly reported to the Operations Division and the Water Management Office. Settlement, movement, or cracking of the earth embankment or abutments, unusual change in seepage rates or development of new seepage areas, landslides, rockslides, displacement of riprap, or indication of an impending movement should be reported to the Dam Safety Program Manager in the Geotechnical Office. Any changes to the outlet works or spillway including structural settlement or movement, cracking, or vibrations, mechanical malfunction or failure shall be reported immediately to the Water Management Office and the Dam Safety Coordinator. Reference the Sam Rayburn Dam **Flood Emergency Plan** should an event occur indicating any degree of jeopardy to the safety of the dam or to the safety of the public. The stilling basin and protected/armored downstream areas must be visually monitored closely during all high releases. Outside of normal duty hours one of the persons listed on the Fort Worth District Notification List for Sam Rayburn Reservoir will be notified, and the Duty Regulator of the Water Management Office will be notified via mobile phone 817-791-0973.

d. Warnings. It is the responsibility of the Lake Manager to maintain a list in current status of residents, and/or property, which would be endangered or inconvenienced by large and/or prolonged releases, and to give adequate warning of such impending releases. Notification will be made by whatever means are available, in accordance with current Fort Worth District emergency notifications protocol. In every case, before an increase in release rate is made, a warning horn shall be sounded and the area immediately below the stilling basin visually checked for person(s) in a dangerous area.

e. Gate Changes. Gate changes will normally be directed by the Water Management Office. In the event communications with the Fort Worth District Office are disrupted, the Lake Manager will direct gate changes. During flood periods, gate changes may be required as often as every half hour. Only under unusual circumstances will gate changes be required more frequently than every half hour. Examples of such unusual circumstances include unexpectedly high rates of change in inflow to the reservoir, or a required response to a dam safety issue. The gates will be operated in a manner prescribed by the manufacturer. A complete log of all gate operations will be kept for each gate.

## **II. REGULATION PROCEDURES**

**1. Normal Regulation.** Normally, instructions for storage and release of water for conservation and flood control purposes will be issued by the Water Management Office in accordance with the

plan of regulation prescribed in Chapter 7 of this water control manual.

**2. Emergency Regulation.** In the event of disruption of communications with the Fort Worth District Water Management Office, the Lake Manager will, on their own initiative, direct operation of the reservoir in accordance with the rules outlined below:

a. Make conservation releases in accordance with the current request by the BRA as last related by the Water Management Office prior to loss of communications.

b. Take immediate steps to re-establish communication with the Fort Worth District Water Management Office.

c. Until communications are restored, regulate the reservoir in accordance with Chapter 7, Sam Rayburn Dam Reservoir Regulation Schedule.

**3. Temporary Deviations.** During the course of normal or emergency regulation of the reservoir, the Lake Manager may temporarily deviate from the current release rates in the event an immediate short-term departure is deemed necessary to protect the safety of the dam, or to avoid serious hazards to life. As soon as practicable, the Fort Worth District Water Management Office will be informed via telephone, e-mail, or FAX, as to the nature of the emergency and the subsequent response. If the deviation is conducted in the interest of dam safety, the Dam Safety Coordinator will also be notified as soon as practicable. Such actions shall be confirmed in writing, as soon as practicable, to the Fort Worth District Water Management Office and the Southwest Division Water Management Office, and shall include justification for the action.

**EXHIBIT E**

**HYDROPOWER OPERATING RULE CURVES**

**SAM RAYBURN DAM AND RESERVOIR**

SWDED-WR (13 Feb 81) 1st Ind  
SUBJECT: Sam Rayburn Reservoir Operating Rule Curves

26372  
Garland/bn/7-23E  
2 Mar 81  
CHS 3 Mar  
SULLIVAN ED-WR

DA, Southwestern Division, Corps of Engineers, 1114 Commerce Street,  
Dallas, Texas 75242

18 MARCH 1981

COOMES ED-WR

TO: District Engineer, Fort Worth, ATTN: SWFED-HL

1. Reference:

a. Disposition Form, SWDED-XR, 23 June 1978, Subject: Sam Rayburn \*  
Onboard Review of Chapter 7 of Water Control Manual.

b. Seventh Ind, SWDED-XR, 3 July 1978, Subject: Regulation - Sam  
Rayburn Reservoir, Angelina River, Texas.

c. Letter, SWFED-HL, 27 October 1980, Subject: Status of Water Control  
Manuals (Report Control Symbol DAEN-CWE-16).

2. The Sam Rayburn Reservoir operating rule curves are approved subject to  
the following comments. As stated in paragraph 8 of basic letter, the rule  
curves should be incorporated into the Sam Rayburn Reservoir Regulation  
Manual along with requirements of references 1a and 1b. The regulation  
manual for Sam Rayburn Reservoir should be submitted for approval as scheduled  
in reference 1c.

FOR THE DIVISION ENGINEER:

wd all incl

S. H. Aiken, P.E.  
Acting Chief, Engineering Division

AIKEN ED

3/3



DEPARTMENT OF THE ARMY  
FORT WORTH DISTRICT, CORPS OF ENGINEERS  
P. O. BOX 17300  
FORT WORTH, TEXAS 76102

REPLY TO  
ATTENTION OF:

SWFED-HL

13 February 1981

SUBJECT: Sam Rayburn Reservoir Operating Rule Curves

Division Engineer, Southwestern  
ATTN: SWDED-WR

1. Reference is made to ltr SWFED-HL dated 15 July 1980, subject: Sam Rayburn Reservoir - Request for Approval of Interim Plan of Regulation and 1st Indorsement thereto dated 23 July 1980.
2. On 10 February 1981, a meeting was held in Fort Worth to discuss operating rule curves for Sam Rayburn Reservoir. Representatives of the Southwestern Division and Fort Worth District Corps of Engineers, Southwestern Power Administration, Lower Neches Valley Authority, Gulf States Utilities Company and Sam Rayburn Dam Electric Cooperative, Incorporated, were in attendance.
3. Inclosed is rule curve which was discussed at the meeting. It was the consensus of all attendees to recommend the adoption of these curves for a one-year trial period.
4. The curves are guidelines for conservation pool operation only. Zones within flood control pool are unchanged. In zone one of the conservation pool the power factor allowance for Sam Rayburn is 20 percent. The discharge below Town Bluff Dam is for municipal and irrigation needs plus 1700 c.f.s. to prevent salt water intrusion. Should flooding occur below Sam Rayburn due to local inflows, power generation will be curtailed as necessary until such local flooding has ceased. For those months in which the lake elevation at the beginning of the month is in zone two, a minimum of 75 hours of power generation will be declared. Water supply and salt water intrusion prevention flow needs below Town Bluff Dam will be met as in zone one. In zones three and four, a minimum of 75 hours of power per month will be generated from 15 April to 15 October. There will be no power requirements in other months. Below Town Bluff Dam, water supply needs will be met while Sam Rayburn Reservoir is in zone three. There will be a 30-day period of operation without adjustment after Sam Rayburn Reservoir recedes into zone three to determine if the water surface will rise back to zone two. At the end of 30 days, if the pool elevation is still in zone three, FWD will advise LNVA to commence installation of their temporary salt water barriers. At the end of 60 days in zone three, no more water will be released from Sam Rayburn Reservoir to prevent salt

SWFED-HL

13 February 1981

SUBJECT: Sam Rayburn Reservoir Operating Rule Curves

water intrusion. Emergency power generation requests will be handled as requests for deviation as expeditiously as possible in zones three and four. There are no specific operating requirements for releases from Sam Rayburn Reservoir in zone four. Shortages will be declared if local flows below Town Bluff Dam are not sufficient to meet water supply needs.

5. Declarations of power generation each month will be established by the level of Sam Rayburn Reservoir at the time of the monthly meeting between representatives of the Corps of Engineers and the Southwestern Power Administration. If the lake drops to a lower zone (e.g. to zone three from zone two during the following month, power generation will not be reduced as a result of the lower level. Should the lake rise to the next higher level during the month, the power requirement for the higher level may be used for the remainder of the month.

6. In any zone of the conservation pool power may be generated on a volume basis over a seven-day period, if regulation capability of Town Bluff Dam is such that the LNVA needs can be met.

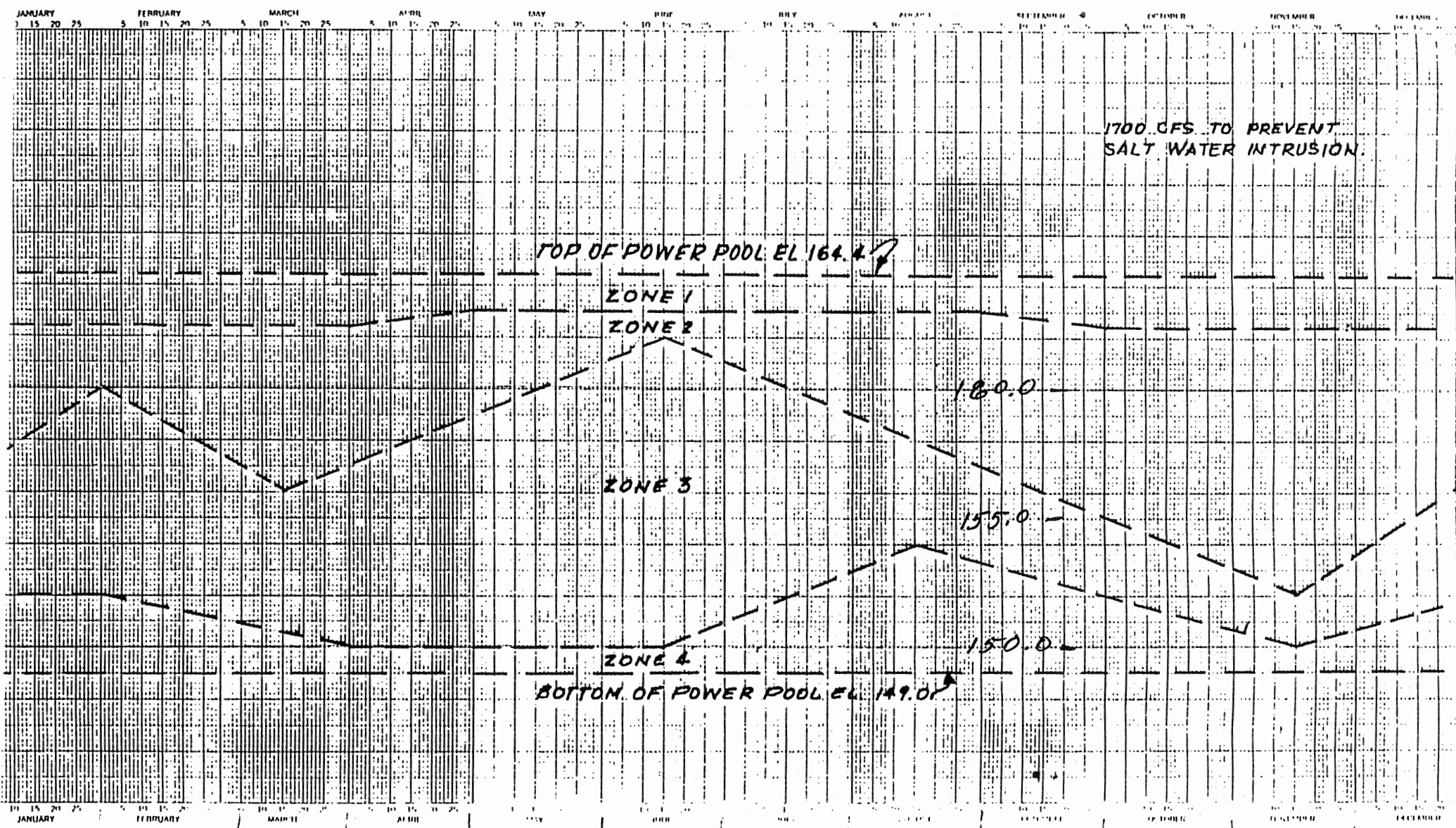
7. Operation of the buffer zones in the flood control pool at Sam Rayburn Reservoir is not changed. Regulation of the flood control pool remains as approved previously. Inclosure 2 is a copy of the approved Water Control Schedule.

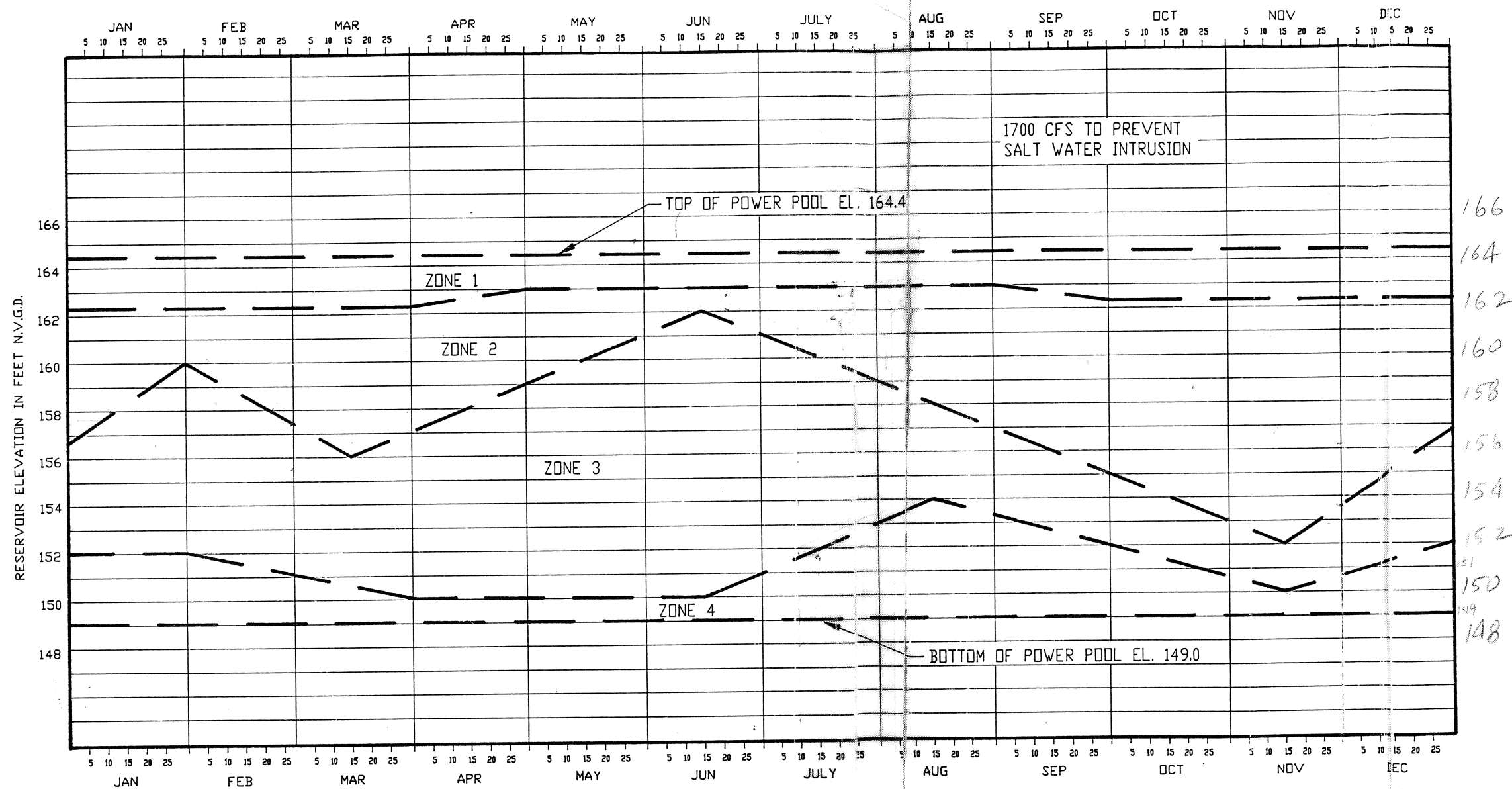
8. Request approval for immediate implementation of inclosed rule curve. If approved the rule curve will be incorporated into the Sam Rayburn Reservoir regulation manual.

FOR THE DISTRICT ENGINEER:

2 Incl  
as

S. FUJIWARA  
Chief, Engineering Division





RECOMMENDED PLAN (FEB 1981)  
SAM RAYBURN RESERVOIR  
OPERATING RULE CURVES.

ANGELINA RIVER BASIN, TEXAS  
SAM RAYBURN LAKE  
NECHES RIVER, TEXAS

SCALE AS SHOWN

U.S. ARMY ENGINEER DISTRICT, FORT WORTH 1988

ACJC E '83  
FILE: BRWVCLFS.DWG

PLATE

**EXHIBIT F**

**GUIDELINES FOR FLEXIBLE SCHEDULING OF HYDROPOWER GENERATION**

**SAM RAYBURN DAM AND RESERVOIR**

DATE: 28 October 2015

REF: Sam Rayburn Dam and Reservoir, Neches River Basin, Texas

SUBJ: Guidance for Flexible Scheduling of Hydropower Generation

BY: Travis Stanford, USACE-SWF-EC-HL

Flexible scheduling of hydropower generation at Sam Rayburn Dam will be implemented at midnight on Sunday, 1 November 2015. By 1100 hours Central Time on Friday, 30 October 2015, the Fort Worth District Water Management Office will issue notification of the effective weekly allotment of unit-hours of generation.

**Definitions:**

Generation Day – A generation day begins at midnight (hour ending 0100 the following day) and ends 24 hours later. Schedules of daily generation amounts provided to USACE will be made on the basis of a generation day so defined.

Generation Week – A generation week begins at midnight on Sunday (hour ending 0100 on Monday) and ends at midnight on the following Sunday. Allotments of generation volume, in terms of unit-hours of generation per week, will be made on the basis of a generation week so defined.

**Guidance:**

The generation schedule for any given generation week will be structured in accordance with the guidelines presented in the following table titled “Sam Rayburn Dam – Guidelines for Flexible Scheduling of Hydropower Generation”. These guidelines were developed jointly by USACE, SWPA, SWPA customers (or their representatives), and the SWPA customers’ scheduling agent. Testing of these guidelines is intended to continue for as long as is needed to adequately evaluate their performance under a wide range of hydropower and water supply demands occurring under a variety of hydrologic conditions. In the interest of improvement, the guidelines remain subject to change upon agreement of the stakeholders. Stakeholders will periodically evaluate the performance of these guidelines in light of operational experience and will consider modifications in the interest of improved performance.

## Sam Rayburn Dam – Guidelines for Flexible Scheduling of Hydropower Generation

Parameter	Guidance
<b>A.</b> Weekly Unit-Hours Allotment	Defined by the 1981 Operating Rule Curve Agreement
<b>B.</b> Minimum Unit Run Time [hrs]	2 (~380 dsf)
<b>C.</b> Minimum Unit-Hours per Day, If Scheduled [unit-hrs]	2 (~380 dsf)
<b>D.</b> Maximum Number of Generation Periods per Day	2
<b>E.</b> Minimum Time between Generation Periods	2 hours if unit is shutdown. 10 minutes if unit is disconnected from grid but remains at speed in a no-load status.
<b>F.</b> Maximum Unit-Hours per Day [unit-hrs]	18 (~3400 dsf)
<b>G.</b> Limits on Zero Generation Days	<p><u>Minimum Unit-Hrs per 3 Consecutive Day Period:</u></p> <p>Zone 1: 8 (~1500 dsf)</p> <p>Zone 2: 3 (~570 dsf)</p> <p>Zone 3: 3 (~570 dsf) [15 Apr - 15 Oct]</p> <p>Zone 4: 3 (~570 dsf) [15 Apr – 15 Oct]</p>
<b>H.</b> Minimum Days of Unit Run per Generation/Allotment Week	Dictated by the “Limits on Zero Generation Days” Parameter
<b>I.</b> Communication Protocols	<p>a) The USACE Fort Worth District Water Management Office will issue notification of a change in the weekly allotment of unit-hours of generation by 1100 hours Central Time on Friday. At a minimum the notification will be sent to the SWPA customers’ scheduling agent (currently NRG, MISO Real Time Desk); SWPA; the Sam Rayburn Powerhouse Superintendent; Sam Rayburn Powerhouse Operators; and the B.A Steinhagen Lake Manager. The weekly allotment prescribed in a notification will remain effective until such time as a new notification is issued. That is, if no notification is issued by 1100 hours Central Time on a given Friday, it will be assumed there is no change in the currently effective weekly allotment of unit-hours of generation. (see example e-mail format on next page)</p> <p>b) The SWPA customers’ scheduling agent (currently NRG) will provide written notification of the next day’s generation schedule by 1600 hours Eastern Standard Time. At a minimum, the notification will be sent to the USACE Fort Worth District Water Management Office; the USACE Fort Worth District Sam Rayburn Powerhouse Superintendent; USACE Fort Worth District Sam Rayburn Powerhouse Operators; and SWPA.</p>

Below is an example of the e-mail format for USACE written notification of a change in the weekly allotment of unit-hours of generation at Sam Rayburn Dam. **NOTE: Structure and content of text in the “Subject:” line is critical. Subject line info will be automatically read by an SWPA software program.**

---

**TO:** MISO Real Time Desk <[misorealtimedesk@nrgenergy.com](mailto:misorealtimedesk@nrgenergy.com)>; SWPA Resources <[resources@swpa.gov](mailto:resources@swpa.gov)>; CESWF-OD-L, OD-L SWF<[ceswf-od-l@usace.army.mil](mailto:ceswf-od-l@usace.army.mil)>; Massey, Dennis R SWF; Carter, Frank C SWF; Tucker, Jeremy A SWF; Nikodem, John M SWF; Martin, Joseph H SWF; Webb, Thomas R SWF; Boyett, Floyd E SWF; james.striedel@gdsassociates.com

*Cc: Optional*

**Subject:** Sam Rayburn Weekly Generation Allotment: 35 Unit-Hours Beginning 2 Nov 2015

All,

Please see subject line for Sam Rayburn weekly generation allotment. Feel free to contact the Water Management Office at 817-886-1551 with any questions.

Sincerely,  
*Sender Name*

*Sender Signature Block*

**EXHIBIT G**

**CONTRACT BETWEEN THE SOUTHWESTERN DIVISION OF THE CORPS OF  
ENGINEERS AND THE SOUTHWESTERN POWER ADMINISTRATION**

**OPERATING ARRANGEMENT**

---

CONTRACT NO. DE-GM75-80SW00058

BETWEEN  
UNITED STATES OF AMERICA  
AND

CORPS OF ENGINEERS, SOUTHWESTERN DIVISION  
DALLAS, TEXAS

Purpose of Contract: Memorandum of Understanding

Date: 7/23/80

This MEMORANDUM OF UNDERSTANDING is entered into by and between the United States Department of Energy, Southwestern Power Administration (hereinafter called "the Administrator"), and the United States Department of the Army, Corps of Engineers (hereinafter called "the Corps"),

WITNESSETH:

WHEREAS certain statutes provide that various projects constructed in the States of Arkansas, Missouri, Oklahoma, Kansas, Texas, and Louisiana, by the Department of the Army shall be operated and maintained under the direction and supervision of the Corps of Engineers and

WHEREAS the projects set forth in Exhibit A of this memorandum ("Projects") have been or are being constructed and, as shown on Exhibit A, the Division Engineer of either the Missouri River, Lower Mississippi Valley, or Southwestern Division (hereinafter called "the Division Engineer"), is responsible for the operation and maintenance of said Projects; and

WHEREAS the Division Engineer, Southwestern Division, has been delegated authority by the Director of Civil Works to negotiate and sign this memorandum as the representative of the Corps of Engineers; and

WHEREAS the Administrator recognizes the Corps' responsibility to operate the projects to serve all authorized functions including power; and

WHEREAS the Administrator is authorized by Section 5 of PL 534, 78th Congress dated December 22, 1944, to dispose of the electric energy generated from said Projects, surplus to the energy required for their operation and maintenance and to recover the cost of producing and transmitting this energy, including the amortization of capital investment allocated to power over a reasonable period of years; and

WHEREAS the Corps recognizes the Administrator's responsibility for marketing and transmission of the power generated at the projects; and

WHEREAS the Administrator coordinates and schedules the hydroelectric generation at the Projects that constitute the Southwestern Federal Power System; and

WHEREAS the Corps and the Administrator desire to meet the above recited obligations and desire that certain procedures be implemented to maintain an effective working relationship between the staff elements of the Corps and of the Administrator.

NOW, THEREFORE, the parties hereto mutually agree as follows:

1. Term of Memorandum. This memorandum shall be effective commencing on the date of execution and shall remain in effect until terminated upon 90 days prior written notice by either party.

2. Availability of Hydroelectric Generation.

(a) The Division Engineer, during the term of this memorandum, shall make available to the Administrator all of the hydroelectric generation available at the Projects listed in Exhibit A (attached hereto and hereby made a part of this memorandum), in excess of the amounts reserved for use by the projects in accordance with schedules provided by the Administrator and mutually agreed upon by the Administrator and the Division Engineer. The parties hereto agreed to supersede said Exhibit A with a new Exhibit A whenever it becomes necessary to do so as a result of any changes occurring with respect to an existing Project or Projects, or the addition of a new project or projects.

(b) Subject to temporary interruption or reduction in the availability of hydroelectric generation which, in the opinion of the Division Engineer, is necessary for the purpose of maintenance, replacement, installation of equipment, or investigation and inspection, and subject to emergencies, or other extraordinary conditions, the Corps shall operate the Projects so as to schedule and to make available hydroelectric generation as requested by the Administrator, provided that, in the opinion of the Division Engineer, compliance with such request in the operation of the Projects:

(1) Would not require the safe limits of the generating, transforming and switching facilities, and appurtenant equipment of said Projects to be exceeded, or otherwise cause damage to the same;

(2) Would not conflict with the statutory requirements for the operation of said Projects with regard to authorized purposes such as flood control, navigation, irrigation, water supply, and recreation, etc;

(3) Would avoid, insofar as practicable, harmful effects on the environment, including established fish and wildlife resources and recreation;

(4) Would not infringe upon the vested property rights of third parties;

(5) Would not be inconsiderate of the effect on any major downstream construction or maintenance activities being undertaken by public or private entities.

(c) The use by the Corps of hydroelectric generation and the outages contemplated by subsection (b) of this section, shall be scheduled in advance, so far as is practicable, to the end that there will be a minimum

of interference with the availability of hydroelectric generation to the Administrator in accordance with subsection (a) of this section.

3. Emergency. It is recognized that the Administrator has obligations to its customers, the Southwest Power Pool, and the regional power industry to maintain its reliability and prevent power failures and brownouts. In the event that conditions arise which require power and energy in excess of the amount which the Division Engineer and Administrator have mutually agreed to be available from hydro sources, and in excess of that normally available from thermal sources, the Administrator will act to acquire needed power and energy from other sources. If this is not sufficient, the Administrator, after advising the Division Engineer, may declare a power emergency. The Division Engineer's concurrent declaration of operating limits will be based on relaxation of the five limitations contained in the preceding subsection 2(b) to the maximum extent that the emergency justifies and considering any unusual situations that may exist at that time.

4. Detailed Operating Arrangements. The Division Engineer, responsible for particular projects as shown on Exhibit A, and the Administrator will establish mutually satisfactory detailed operating arrangements to be followed in the coordination of their respective responsibilities. Such detailed operating arrangements will be prepared as needed to insure effective coordination between operations for power generation, other authorized project purposes, and protection of the environment. Such detailed operating arrangements when approved by the appropriate Division Engineer and Administrator, will be attached to this Memorandum of Understanding under Exhibit B (attached hereto and hereby made a part of this memorandum) and shall be subject to amendment with the prior written approval of the appropriate Division Engineer and Administrator.

5. License for Lines and Facilities. During the term of this Memorandum the Division Engineer will permit use by the Administrator of land under jurisdiction of the Corps in connection with the operation of the Projects necessary for the location of electric power transmission lines, control and communications lines and cables, substations, switching stations, radio stations, and appurtenances constructed or found necessary by the Administrator for construction in connection with the marketing of electric power and energy produced at said Projects. Before commencement of any construction on lands under the jurisdiction of the Corps, the Administrator will submit to the Division Engineer copies of his layout, plans, and designs, and construction activities will not be started until the Division Engineer has furnished a permit or letter to the Administrator approving the construction and the location thereof. The Administrator will provide any environmental impact statement required for proposed construction.

6. Cooperation. The Division Engineer and the Administrator will make available to each other all the information necessary for the Administrator and the Division Engineer to meet their responsibilities

pursuant to law. The timely interchange of certain data and information will be necessary to insure efficient operation for all purposes. Accordingly, such interchange will be made promptly as pertinent data and information become available. Any equipment shall be installed in such a way that there will be no adverse effect on the existing equipment of the other party. The specific information interchanged between the Administrator and the Division Engineer shall include, but not be limited to, the following:

(a) The Division Engineer will furnish data on power resources available at the Projects and data which have a bearing on loading of the plants and limitations of operation.

(b) The Administrator will furnish data on estimated Federal system load requirements, and other pertinent information as are needed, to permit the Division Engineer to carry out his responsibilities for multiple-purpose operation at the Projects.

(c) The Division Engineer and the Administrator will discuss plans for adding or changing power projects, transmission facilities, and control and communication facilities in the preliminary planning phases to ensure effective coordination.

(d) The Division Engineer will furnish the Administrator with Reservoir Regulation Manuals for information and comment prior to final approval.

(e) The Administrator will furnish the Division Engineer power sales contracts for information. In addition, those contracts providing for the sale of power generation from Projects not integrated with the SWPA System, will be furnished to the Division Engineer for comment prior to final approval.

(f) The Division Engineer will furnish the Administrator summarized financial statements and operating reports with respect to construction and operation of the Projects. The financial statements will include costs as incurred under the Corps' GAO approved accounting system. The Administrator will furnish the Division Engineer like statements and reports with respect to the marketing of and accounting for revenues from power and energy made available to it from the Projects. Such statements and reports for each Project will be furnished promptly after the close of each governmental fiscal year following commencement of generation and for such other periods during each year and in such form as may be mutually agreed upon from time to time.

IN WHTNESS WHEREOF, the parties hereto have executed this Memorandum  
as of *23 July* 1980.

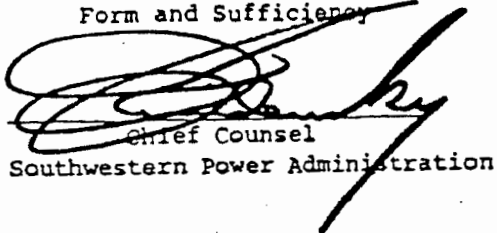
UNITED STATES OF AMERICA

Department of Energy

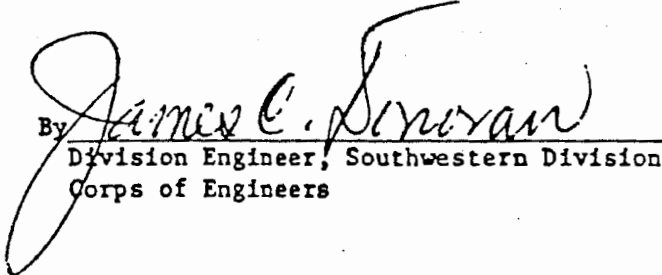


By \_\_\_\_\_  
Administrator  
Southwestern Power Administration

Approved as to Legal  
Form and Sufficiency

  
Chief Counsel  
Southwestern Power Administration

Department of the Army

By   
Division Engineer, Southwestern Division  
Corps of Engineers

Projects of the Corps

(Completed and Under Construction)

Projects for which the Division Engineer, Southwestern Division is responsible:

Beaver Lake	Keystone Lake
Broken Bow Lake	Norfolk Lake
Bull Shoals Lake	Ozark Lake
Dardanelle	Sam Rayburn Dam and Reservoir
Denison Dam - Lake Texoma	Table Rock Lake
Eufaula Lake	Tenkiller Ferry Lake
Ft. Gibson Lake	Webbers Falls Lake
Greers Ferry Lake	Whitney Lake
Robert S. Kerr Lake	

Projects for which the Division Engineer, Missouri River Division is responsible:

Stockton Lake  
Harry S. Truman Dam and Reservoir

Projects for which the Division Engineer, Lower Mississippi Valley Division is responsible:

Clarence Cannon Dam and Reservoir  
Blakely Mountain Dam - Lake Ouachita  
DeGray Lake  
Narrows Dam - Lake Greeson

EXHIBIT A



DEPARTMENT OF THE ARMY  
SOUTHWESTERN DIVISION, CORPS OF ENGINEERS  
1114 COMMERCE STREET  
DALLAS, TEXAS 75242-0218

REPLY TO  
ATTENTION OF:

Water Management Branch  
Engineering Division

Mr. Ronald H. Wilkerson  
Administrator  
Southwestern Power Administration  
Post Office Box 1619  
Tulsa, Oklahoma 74101

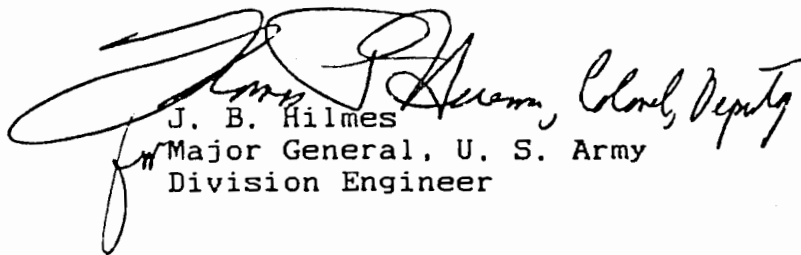
Dear Mr. Wilkerson:

In your letter transmitted to me on 23 October 1986, you referred to the meeting between our staffs of 22 October 1986. As expressed by my staff in that meeting, there is a safety hazard created downstream during rapid hydropower generation changes and the safety of the people in the downstream areas must be considered during start up of the hydropower units. Therefore, Table 5, title "Response time to change in generation" defining these limitations cannot be deferred as requested by your staff.

I do understand that there is a meeting next week among you, your customer, and the Little Rock District to discuss these issues as they pertain to Bull Shoals and Table Rock projects. However, I must reemphasize from a safety standpoint that those criteria and responsibilities contained in the Draft Operating Arrangement are considered SWD operating policies and will be used until these differences are resolved.

I have included a copy of the Draft Operating Arrangement dated 20 October 1986 for your reference. I am also looking forward to the formal signing of this document in the near future.

Sincerely,

  
J. B. Hilmes  
Major General, U. S. Army  
Division Engineer

Enclosure

Copies Furnished:

Commander, Little Rock District  
Commander, Tulsa District  
Commander, Fort Worth District

*Doing  
Review & comment  
NIE*

20 OCT 86

DRAFT

EXHIBIT "B" OF

CONTRACT NO. DE-GMIS-80 SW 00058

OPERATING ARRANGEMENT

BETWEEN THE SOUTHWESTERN DIVISION  
OF THE CORPS OF ENGINEERS AND THE  
SOUTHWESTERN POWER ADMINISTRATION

OPERATING ARRANGEMENTTABLE OF CONTENTS

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4. Procedures	B 2
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b. Operation	B 2
(1) General	B 2
(2) Flood Control Operations	B 3
(3) Conservation Operation	B 3
(4) Special Operations	B 4
(5) Individual Project Regulation and System Hydropower Operation	B 6
(6) Generation Scheduling	B 7
(7) Generating Equipment Maintenance Schedule	B 7
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c. Reporting	B 7

TABLES

<u>No.</u>	<u>Title</u>	<u>Page</u>
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2	Water Release Requirements for Instream Flow Needs	B 10
3	Desirable Water Release Requirements for Instream Flow Needs	B 11
4	Maximum Drawdown Rates in Conservation Pool	B 12
5	Response Time to Change in Generation	B 13
6	Water Control Manuals	B 14
7	Projects with Plant Efficiency Curves	B 15

OPERATING ARRANGEMENT  
(Reservoir Regulation and Power Scheduling)

1. Authority. This Arrangement states the principles and procedures relating to reservoir regulation and power scheduling of Corps of Engineers Hydroelectric Projects within the Southwestern Division (SWD) and the Southwestern Power Administration (SWPA). This Arrangement was developed in compliance with Paragraph 4 of the Memorandum of Understanding (MOU) dated 23 July 1980 and the authority therein.
2. Revision or Termination. This Operating Arrangement shall be effective commencing on the date of execution and shall remain in effect until terminated upon 90 days prior written notice by either party. It is provided further, that this Operating Arrangement may be amended with the mutual written consent of both parties.
3. Obligations. SWD and SWPA agree on the following obligations:
  - a. Obligations of SWPA:
    - (1) The marketing and transmission of surplus (in excess of project requirements) power.
    - (2) The preparation of monthly estimates of generation requirements for each SWD project.
    - (3) The scheduling of power plants to meet system requirements.
    - (4) To contract for the sale of power generated at SWD projects.
  - b. Obligations of SWD:
    - (1) The regulation of SWD projects for authorized purposes and in accordance with Presidential directives.
    - (2) The daily operation and maintenance of electric generation and switchyard facilities at each SWD power plant.
    - (3) The planning of hourly, daily and monthly regulations of SWD projects.
    - (4) The preservation of project integrity.
  - c. SWD and SWPA agree to consult on load and resource requirements.
  - d. SWD and SWPA agree to undertake improvements in their respective computer facilities.

#### 4. Procedures.

##### a. Power Allocations and Monthly Meetings.

(1) A monthly hydropower meeting will be held by SWPA on or before the last Thursday of each month to develop a 30-day operational plan, including allocations for the next month, and to review current operations, planned outages, transmission limitations, reservoir conditions (current and projected), and other items of mutual concern. The meeting may be conducted by telephone conference, providing each party approves.

(2) SWD will furnish SWPA recommended monthly available energy along with maximum and minimum energy quantities for their projects for the following month. Recommended monthly hydropower energies will consider the individual project rule curve, system guide curve, projected reservoir condition, and other beneficial reservoir uses. This information will be provided formally within four (4) working days prior to the monthly hydropower meeting.

(3) SWPA will furnish SWD its anticipated energy needs for the following month from SWD projects. Monthly hydropower needs will consider load requirements, the condition of the interconnected reservoir system, system guide curve, projected reservoir conditions, available capacity, inflow trends and the ability to obtain energy at a reasonable cost from other sources. This data will be available for two (2) days before the monthly hydropower meeting.

(4) Prior to each month's operations, an agreement between SWPA and SWD as to the proposed generation (hydropower allocation) to be accomplished at each SWD project will be obtained. A written confirmation of that agreement will be provided to SWD by SWPA. In the event that an agreement cannot be obtained at the monthly meeting, negotiations between the Administrator and Division Commander will commence.

##### b. Operation.

###### (1) General.

(a) SWPA will schedule the monthly hydropower production in accordance with the monthly agreement. However, in the event of special conditions or unforeseen events, SWPA may schedule hydropower production differently than specified in the monthly agreement, provided that these changes are arranged with the responsible SWD District Office prior to scheduling.

(b) Operation of SWD projects for hydropower operations within approved regulations will be handled between SWPA and the appropriate SWD District Office. Only in cases of disagreement concerning operations, will SWD become involved in the day-to-day operations described herein.

(c) Energy generation will commence or be adjusted when the dispatcher makes a request to the power plant operator. The power plant operator will verify that the request is within the limits agreed to between the two agencies and that it does not violate any special instructions issued by the District office. If these conditions are satisfied, the operator will commence generation to the requested limits as rapidly as conditions and equipment will permit. If the request exceeds the limits or violates the conditions previously established, the power plant operator will advise the dispatcher as to what generation is available from the power plant. It is the intent that, to the extent possible, dispatchers and power plant operators relay all problems to the respective control offices.

(d) Daily (prior to 10.00 a.m.), SWD District Offices will provide SWPA a 4-day forecast of inflow, pool elevations and any limiting constraints for each project.

(2) Flood Control Operations.

(a) During flood control operations, SWD District Office will furnish to SWPA a weekly statement of flood control objectives for the next seven days relative to individual pool regulations and planned release volumes. The release schedule will be furnished by phone until adequate computer interconnections are available.

(b) SWPA will plan its weekly generation schedule compatible with stated flood control release schedules for the week.

(c) SWD District Offices will make a daily declaration to SWPA of energy available or required releases. The minimum hydropower releases are listed in Table 1. Only under flood conditions as defined in paragraph 4(b)(4)(e) herein may generation be limited to less than shown in Table 1.

(d) SWD District Offices will provide SWPA, when possible, 48-hour notice of a change in operation that will affect power production.

(e) SWPA will reschedule generation between projects and/or obtain non-hydropower to meet its needs as expeditiously as possible to effect any reductions in project releases required by SWD District Offices for flood control needs.

(3) Conservation Operation.

(a) Each day prior to 3.30 p.m., SWPA will furnish the SWD District Offices updated hourly generation schedules for each project for the remainder of the current day and for the following day. Weekend and holiday generation schedules will be furnished by 3.30 p.m., on the last working day prior to the weekend or holiday and will also include the schedule for the next working day.

(b) SWPA will be responsible for daily hydropower operations to meet the needs of their customers and downstream release requirements shown in Table 2. Table 3 shows desirable downstream release requirements to be accomplished providing hydrologic conditions are favorable. Favorable hydrologic conditions are included in Table 3.

(c) SWPA will furnish SWD a weekly statement of their generation plans and objectives relative to pool manipulations, balancing operations, thermal purchases and other details which will provide an understanding of scheduling and generation patterns and the effects to be expected at each project. The weekly statement will be provided, if possible, by 2:00 p.m., on the preceding Friday and will include an estimate of daily release volumes from each project. This will be by telephone until such time as adequate computer interconnections are available.

(d) Release schedules by SWPA and the districts will consider project and system guide curves, pool zone criteria, drawdown limits, current and projected pool conditions, downstream needs, and the needs of other authorized uses of the project.

(e) Table 4 shows maximum drawdown rates within the conservation pool for applicable Corps projects.

#### (4) Special Operations.

(a) General. Normally, special operations will be coordinated by SWD Districts and documented in the minutes of the monthly hydropower meeting. Those special operations which have significant impacts on SWPA will be coordinated by SWD. If an emergency does not exist, SWD will consult with SWPA on alternatives and the impacts of these alternatives on the economics and reliability of the federal hydropower system. SWD will notify SWPA of the special operating limits which are necessary for the operation of its projects. Notification will be provided as soon as each special operating limit is determined. Written or teletype confirmation of each special operation limit will be transmitted by SWD to SWPA. Such notifications and confirmations will include the nature of the limit, the firmness of the limit, its probable duration, and the reason for the limit.

(b) Short Term Power Emergency. It is recognized that certain situations which adversely affect system reliability may occur. Such circumstances demand a rapid response to prevent deterioration of the system reliability. The necessary response may involve a deviation from previously agreed to schedules. These situations (short term emergencies) typically involve overloaded facilities and/or low voltage and may arise slowly, as when due to high power demands, or suddenly, as when due to the loss of a line, station, or generator on the SWPA or a neighboring system. When possible, the response deemed necessary by the SWPA dispatcher will be coordinated prior to scheduling with the appropriate SWD District Office.

When the required response time does not permit prior coordination the power plant operator will follow the direction of the SWPA dispatcher within limits specified in Table 5 and the safe operating limits of the generating, transforming and switching equipment, and the necessary coordination will begin as soon as practical. Table 5 lists the minimum time required for each project to respond to a generation change under normal and emergency conditions.

(c) Declared Power Emergency. It is recognized that SWPA has obligations to its customers, the Southwest Power Pool, and the regional power industry to maintain its reliability and prevent power failures and brownouts. In the event that conditions arise which require power and energy in excess of the amount which the Division Commander and Administrator have mutually agreed to be available from hydro sources, and in excess of that normally available from thermal sources, the Administrator will act to acquire needed power and energy from other sources. If this is not sufficient, the Administrator, after advising the Division Commander, may declare a power emergency. The Division Commander's concurrent declaration of operating limits will be based on relaxation of the five limitations listed in this paragraph to the maximum extent that the emergency justifies and considering any unusual situations that may exist at that time.

- (i) Would not require the safe limits of the generating, transforming and switching facilities, and appurtenant equipment of said projects to be exceeded or otherwise cause damage to the same.
- (ii) Would not conflict with the statutory requirements for the operation of said projects with regard to authorized purposes such as flood control, navigation, irrigation, water supply, and recreation, etc,
- (iii) Would avoid, insofar as practicable, harmful effects on the environment, including established fish and wildlife resources and recreation.
- (iv) Would not infringe upon the vested property rights of third parties.
- (v) Would not be inconsiderate of the effect on any major downstream construction or maintenance activities by public or private entities.

(d) Short Term Emergency. Short term emergencies requiring a reduction in releases such as for drowning, imminent loss of life or property, emergency maintenance or to preserve the

integrity of the project may be coordinated directly between SWD powerhouse personnel and SWPA dispatcher. Information documenting the emergency and the actions taken shall be forwarded to SWPA at the earliest possible time.

(e) Flood Constraints. SWPA recognizes that the SWD has the responsibility to minimize flooding to the extent possible by the regulation of Federal projects. Hydropower generation will be constrained to the extent possible during flood periods to prevent reservoir releases from adding to downstream flood damages. Normally, the constraints on power generation at SWD projects during flood periods will not be less than the minimum hydropower releases as shown on Table 1. However, conditions may occur where it is desirable for reservoir releases to be reduced below the Table 1 values to prevent or reduce downstream flooding. In this event, the SWD district office will notify SWPA of the restriction and its estimated duration. SWPA, if possible, will take action to reschedule generation such that the restriction can be accomplished. If this proposed restriction of power generation results in a determination by SWPA that a significant economic loss to the Federal Government or to SWPA customers would result, SWPA shall report that impact to the SWD district. Upon receipt of the SWPA finding of significant economic impact, the district shall increase the permissible release to the Table 1 value or request SWD to formally establish the constraint with documentation to SWPA describing the need, duration, and impacts of the constraint. If under such constraints as established by SWD, SWPA determines there is not enough power and energy available to maintain electric service to consumers in the marketing area, the Division Commander, based on the information provided by the respective SWD district offices and SWPA, will declare sufficient energy available by project to meet minimum needs.

(5) Individual Project Regulation and System Hydropower Operation  
To enhance the working relationship between SWD and SWPA and to form a basis for general concurrence on how the individual projects and the power system will be operated, the following will be undertaken:

(a) SWD will provide Water Control Manuals to SWPA for information and comment before final adoption. Table 6 is a list of applicable projects.

(b) SWD will provide operating guide curves and pool zone criteria for each of the SWD hydroelectric projects within the SWPA marketing area. Subsequent changes of and addition to operating guide curves will be transmitted by letter from the Division Commander to SWPA. The SWPA will comment by letter.

(c) The parties will undertake cooperative effort to establish a system guide curve that will reflect SWPA and SWD needs, including defining the periods that supplemental power may be purchased to offset the power demands.

(d) SWD will provide any update of plant efficiency curves (included in this agreement by reference) for maximizing power performance at individual projects as shown in Table 7.

(e) The Administrator will furnish SWD power sales contract for information. In addition, those contracts providing for the sale of power generation from Projects listed by name in the contracts will be furnished to the Division Commander for comment prior to final approval.

(6) Generation Scheduling. Request for actual generation at a power plant will be given to the power plant operator by the SWPA dispatcher or dispatcher designated in writing by SWPA. To the maximum extent possible, these directions will conform with the generation guidelines agreed to by the appropriate representatives of SWPA and the SWD.

(7) Generating Equipment Maintenance Schedule. The planned outage schedule will be prepared by the SWD in January each year and will be furnished to SWPA by February 1. The SWD will make every effort to avoid scheduling outages during power system peak load periods (Jun 15 - Sep 15 and Dec 15 - Mar 15). SWPA requests for schedule changes shall be submitted to SWD in writing within 30 days after receipt of the schedule. SWD will accommodate the requests to the maximum extent practicable within available resources, including manpower resources. SWPA requests for rescheduling during the course of the year due to unanticipated load requirements or water conditions, shall be transmitted to the SWD by letter. SWD will furnish a timely response. Changes to the schedule initiated by SWD during the course of the year will be coordinated with SWPA. A revised schedule will be prepared and distributed if any significant changes are made during the year. The SWD will give SWPA as much advance notice as possible in the event of unplanned or forced outages.

(8) Switching Activities. All switching at SWD power plants which may affect the high-voltage transmission system or the availability of a unit will be coordinated with each party. Detailed procedures governing clearance and hold orders will be developed and included as a part of the Arrangement.

c. Reporting. The following summary of reporting requirements is not intended to include all aspects of data and information exchange needed between the SWPA and SWD elements.

(1) Daily observed hydrologic data, forecasts, flood control release requirements and schedules will be supplied by telephone between SWPA and SWD District Offices. Summary confirmations will be supplied on the computer data file program to the extent possible.

(2) Weekly plans and schedules will be exchanged by SWPA and SWD District Offices by telephone until adequate computer interconnections are available. At that time, these will be furnished through the interconnected facilities.

(3) Notifications of constraints, emergencies or revisions will be furnished by telephone with computer data file confirmation. All elements will be included in the notification for coordinated approvals and actions. Follow-up teletypes or letters may be required for official documentation.

(4) Special needs or operations will be furnished by telephone with follow-up teletype or letter between SWPA and SWD with copies to appropriate SWD District Office. When possible these may be covered in monthly hydropower meetings and documented in the meeting minutes without additional correspondence.

(5) Monthly hydropower meeting minutes (including pre-meeting summaries, agenda, needs, recommendations and follow-up allocations) will be furnished by teletype or letter to all elements.

(6) Record of actual hydropower generated during the previous month will be provided for each project by SWPA by mail until adequate computer connections are available.

(7) Records of hourly generation and water releases for each power plant will be furnished to SWPA.

TABLE 1  
 MINIMUM HYDROPOWER RELEASES  
 DURING FLOOD CONDITIONS

<u>Reservoir</u>	<u>Allowable Daily Release</u>	
	<u>Volume (DSF)</u>	<u>Energy (MWH) (1)</u>
Beaver	950	332
Broken Bow	850	290
Bull Shoals	3,750	1,352
Denison	2,300	429
Eufaula	2,150	358
Fort Gibson	1,800	197
Greers Ferry	1,200	404
Keystone	1,500	216
Norfork	1,300	410
Sam Rayburn	1,150	161
Table Rock	2,550	943
Tenkiller Ferry	600	160
Whitney	500	86

(1) Energy values represent the energy produced by the daily release volume when pool elevation is at top of power pool.

TABLE 2  
WATER RELEASE REQUIREMENTS  
FOR INTSTREAM FLOW NEEDS

Project	Period of Time in Effect	Forecast Air Temperature ( Degrees Fahrenheit )							
		90 or Below		91 - 95		96 - 104		105 and above	
		Generation (MWH)	Discharge (DSF)	Generation (MWH)	Discharge (DSF)	Generation (MWH)	Discharge (DSF)	Generation (MWH)	Discharge (DSF)
Beaver 1/	May 1 - Oct 15	29	85	43	125	56	165	68	200
Table Rock	May 1 - Dec 1	34	100	48	140	60	175	68	200
Bull Shoals	May 1 - Oct 15	80	250	120	375	160	500	240	750
Norfork	May 1 - Oct 15	40	145	60	218	80	290	100	360
Greers Ferry 2/	May 1 - Oct 15	35	115	45	150	54	175	69	225
Keystone	Jan - Dec	Minimum release is 140 MWH, 1,000 DSF three times/week. Example: Monday, Wednesday, and Friday; Tuesday, Thursday, and Saturday.							
Broken Bow	Jan - Dec	Maintain 100 CFS from re-regulation structure, require minimum of 250 MWH, 750 DSF twice a week (separate by 3 days).							

1/ If feasible, minimum one hour morning and afternoon.

2/ Increase required release by 50 percent on one day of a 3-day period.

TABLE 3

DESIRABLE  
WATER RELEASE REQUIREMENTS  
FOR INSTREAM FLOW NEEDS

PROJECT	PERIOD OF TIME IN EFFECT	WATER RELEASE REQUIREMENTS	FAVORABLE HYDROLOGIC CONDITIONS
Dardanelle	Jan - Dec	Maximum 50-hour down time (minimum generation is 1,750 MWH 1/ per week, or inflow, whichever is less). Use at least 25 percent weekly total on Monday and Friday when minimum weekly generation scheduled.	Not restricted.
Denison	Jan - Dec	Generate at least one hour with one unit every fourth day, or as needed to replenish oxygen content of water in the tailrace and stilling basin.	Above elevation 612.0
Eufaula	Jan - Dec	Generate at least one hour with one unit every fourth day, or as needed to replenish oxygen content of water in the tailrace and stilling basin.	Not restricted.
Tenkiller Ferry	Oct 16 - May 31 Jun 1 - Oct 15	One Hour 10 MW Morning and Afternoon. One Hour 10 MW Morning and Afternoon.	Not restricted.
Bull Shoals	May 1 - Oct 15	The minimum combined operation at Bull Shoals and Norfork shall not be less than a 3-day summation of 6,000 DSF (approximately 2,000 MWH). This applies for all air temperature conditions at or above 85 .	Above elevation 649.0
Norfork	May 1 - Oct 12	Same as above.	Above elevation 545.0

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TABLE 4

MAXIMUM DRAWDOWN  
RATES IN CONSERVATION POOL

<u>Project</u>	Maximum Drawdown Per Week (ft)	Maximum Drawdown In Any Consecutive 4-Week Period (ft)
Beaver	2.0	6.0
Norfolk	1.5	5.0
Greers Ferry	1.0	4.0
Table Rock	1.5	4.5
Bull Shoals	1.5	4.5
Keystone	1.0	3.0
Tenkiller Ferry	1.5	4.5
Eufaula	1.0	3.0
Denison	1.0	3.0
Broken Bow	2.0	6.0
Sam Rayburn	1.0	2.0
Whitney	1.0	3.0

TABLE 5  
RESPONSE TIME TO CHANGE IN GENERATION

<u>PROJECT</u>	<u>TIME</u>	
	<u>NORMAL</u>	<u>EMERGENCY</u>
<u>FORT WORTH DISTRICT</u>		
Sam Rayburn	20 Minutes	5 Minutes
Whitney	20 Minutes	5 Minutes
<u>LITTLE ROCK DISTRICT</u>		
Beaver	10 Minutes	5 Minutes
Bull Shoals	10 Minutes <u>1/</u>	5 Minutes
Table Rock	10 Minutes <u>2/</u>	5 Minutes
Norfork	10 Minutes	5 Minutes
Greers Ferry	10 Minutes	5 Minutes
Dardanelle	10 Minutes	5 Minutes
Ozark	10 Minutes	5 Minutes
<u>TULSA DISTRICT</u>		
Broken Bow	20 Minutes	5 Minutes
Denison	20 Minutes	5 Minutes
Eufaula	20 Minutes	5 Minutes
Fort Gibson	20 Minutes	5 Minutes
Keystone	20 Minutes	5 Minutes
Robert S. Kerr	20 Minutes <u>3/</u>	5 Minutes
Tenkiller Ferry	20 Minutes	5 Minutes
Webbers Falls	20 Minutes	5 Minutes

Notes:

General. Indicated Emergency Start Up and Loading times assume the powerplant control room operator is starting and loading only the local units. If the operator is starting and loading remote units, response times could be as much as twice as long for starting and loading the local units. Exact Emergency Start Up and Loading times for remote plants will depend greatly upon how many units, both local and remote, the control room operator is attempting to start and load.

1/ During normal operations, the initial start up and final shutdown should not exceed 100 megawatts per hour. Additional changes should not exceed 100 megawatts per 30 minutes.

2/ During normal operations, the initial start up and final shutdown should not exceed 115 megawatts per hour.

3/ First two units may start simultaneously. A lag of 1/2 hour between third and fourth units or a lag of one hour if third and fourth are started simultaneously.

TABLE 6

WATER CONTROL MANUALS

<u>TITLE</u>	<u>DATE</u>
Lake Regulation Manual, Broken Bow Lake	Oct 1973
Water Control Manual, Lake Texoma	May 1975
Reservoir Regulation Manual for Eufaula Reservoir	Sep 1962
Reservoir Regulation Manual for Pensacola, Markham Ferry and Fort Gibson Reservoirs	Sep 1964
Reservoir Regulation Manual for Keystone Reservoir	Nov 1963
Reservoir Regulation Manual, Robert S. Kerr Lock and Dam and Reservoir	Apr 1971
Lake Regulation Manual, Tenkiller Ferry Lake	Jul 1976
Reservoir Regulation Manual, Webbers Falls Lock and Dam	May 1972
Sam Rayburn	Jan 1982
Whitney	Apr 1975
Reservoir Regulation Manual for Greers Ferry Reservoir	Mar 1963 Revised Nov 1966
Reservoir Regulation Manual for Beaver, Table Rock, Bull Shoals and Norfolk Reservoirs	Mar 1963 Revised Oct 1966
Regulation Manual for Ozark Lake and Pool No. 13	Oct 1974
Regulation Manual for Pool No. 9 and Lake Dardanelle	Feb 1976
Master Water Control Manual, Arkansas River	Jul 1980

TABLE 7

PROJECTS WITH PLANT EFFICIENCY CURVES

Beaver  
Broken Bow  
Bull Shoals (1)  
Dardanelle  
Denison  
Eufaula  
Fort Gibson  
Greers Ferry  
Keystone  
Norfolk (1)  
Ozark  
Sam Rayburn  
Table Rock  
Tenkiller Ferry (1)  
Webbers Falls  
Whitney

(1) Curves developed before units were rewound

IN WITNESS WHEREOF, the parties have executed this Memorandum as of \_\_\_\_\_, 1986.

UNITED STATES OF AMERICA  
Department of Energy

By \_\_\_\_\_  
Administrator  
Southwestern Power Administratio

Approved as to Legal  
Form and Sufficiency

\_\_\_\_\_  
Chief Counsel  
Southwestern Power Administration

UNITED STATES OF AMERICA  
Department of the Army

By \_\_\_\_\_  
Division Commander  
Southwestern Division  
Corps of Engineers

Approved as to Legal  
Form and Sufficiency

\_\_\_\_\_  
Division Counsel  
Southwestern Division  
Corps of Engineers

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**EXHIBIT H**

**CONTRACT BETWEEN THE TEXAS COMMISSION ON ENVIRONMENTAL  
QUALITY AND THE LOWER NECHES VALLEY AUTHORITY**

**AMENDMENT TO A CERTIFICATION OF ADJUDICATION**

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

RECEIVED

JUL 22 2014

Lower Neches Valley Authority



JUL 15 2014

STATE COMMISSION ON ENVIRONMENTAL QUALITY  
BRIDGET C. BOLES  
TEXAS TRUSTED WATER ENVIRONMENTAL STATEMENT

AMENDMENT TO A  
CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 06-4411K

TYPE: 50.145

Owners:	Lower Neches Valley Authority	Address:	P.O. Box 5117 Beaumont, Texas 77726
Filed:	May 9, 2014	Granted:	July 10, 2014
Purpose:	Agricultural, Industrial, Municipal, and Mining	Counties:	Jefferson, Orange, Hardin, Tyler, Liberty, Chambers, Jasper, Sabine, San Augustine, Angelina, and Nacogdoches
Watercourses:	Pine Island Bayou and Angelina River, tributaries of the Neches River, and the Neches River	Watershed:	Neches River Basin and Neches-Trinity Coastal Basin

WHEREAS, the Lower Neches Valley Authority (LNVA), Applicant, owns a portion of Certificate of Adjudication No. 06-4411 (Certificate) which authorizes the Applicant to maintain two impoundments (Lake Sam Rayburn on the Angelina River and B.A. Steinhagen Lake on the Neches River); to divert and use not to exceed 381,876 acre-feet of water per year from several points on Pine Island Bayou, tributary of the Neches River, and the Neches River, and 792,000 acre-feet of water per year from the perimeter of Lake Sam Rayburn and a point on B.A. Steinhagen Lake, Neches River Basin for agricultural, industrial, mining, and municipal purposes within the Applicant's service area in Jefferson, Orange, Hardin, Tyler, Liberty, Chambers, Jasper, Sabine, San Augustine, Angelina, and Nacogdoches Counties; and

WHEREAS, the Certificate contains a bed and banks authorization, multiple diversion rates, priority dates, and multiple special conditions apply; and

WHEREAS, the Applicant requests a correction to Certificate of Adjudication No. 06-4411J to include the boundary of the place of use for the authorized water, being LNVA's service area which was inadvertently omitted; and

WHEREAS, pursuant to 30 Texas Administrative Code §50.145, the Executive Director, on his own motion or at the request of a permittee, may make a

nonsubstantive correction to a permit without formal amendment or public notice procedures to correct a clerical error and to describe more accurately the boundary of the place of use; and

WHEREAS, the Office of General Counsel has approved this application; and

WHEREAS, the Texas Commission on Environmental Quality finds that jurisdiction over the application is established; and

WHEREAS, no requests for a contested case hearing were received for this application; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Commission on Environmental Quality in issuing this amendment;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 06-4411, designated Certificate of Adjudication No. 06-4411K is issued to the Lower Neches Valley Authority, subject to the following terms and conditions:

1. USE

In lieu of paragraph 1.USE of Certificate of Adjudication No. 06-4411I authorizing the Owner to use not to exceed 1,173,876 acre-feet of water for agricultural, industrial, municipal, and mining purposes, the Owner is now authorized to divert from Pine Island Bayou, the Neches River, Lake Sam Rayburn, and B.A. Steinhagen Lake and use:

A. 1,153,876 acre-feet for agricultural, industrial, and municipal purposes; and

B. 20,000 acre-feet for agricultural, industrial, municipal, and mining purposes

within LNVA's service area in Jefferson, Orange, Hardin, Tyler, Liberty, Chambers, Jasper, Sabine, San Augustine, Angelina, and Nacogdoches Counties within the Neches River Basin and the Neches-Trinity Coastal Basin.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate No. 06-4411, as amended, except as specifically amended herein.

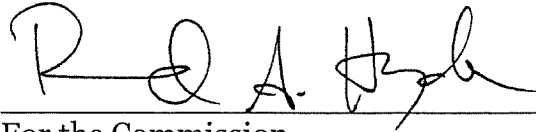
This amendment is issued subject to all superior and senior water rights in the Neches River Basin.

Owner agrees to be bound by the terms, conditions, and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the amendment which are not specifically granted

by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Commission on Environmental Quality and to the right of continuing supervision of State water resources exercised by the Commission.

A handwritten signature in black ink, appearing to read "R. Q. A. Hyle", written over a horizontal line.

For the Commission

Date Issued: **July 10, 2014**



# TEXAS COMMISSION ON ENVIRONMENTAL QUALITY



THE STATE OF TEXAS  
COUNTY OF TRAVIS

I hereby certify that this is a true and correct copy of a Texas Commission on Environmental Quality document, which is filed in the permanent records of the Commission. Given under my hand and the seal of office on

RECEIVED

JAN 22 2014

Lower Neches Valley Authority

## AMENDMENT TO A CERTIFICATE OF ADJUDICATION

*Bridget C. Bohac* JAN 16 2014  
Bridget C. Bohac, Chief Clerk  
Texas Commission on Environmental Quality

CERTIFICATE NO. 06-4411J

TYPE: 11.122

Owners: Lower Neches Valley Authority Address: P.O. Box 5117  
Beaumont, Texas 77726

Filed: October 25, 2012 Granted: January 13, 2014

Purpose: Agricultural, Industrial, Municipal, and Mining  
Counties: Jefferson, Orange, Hardin, Tyler, Liberty, Chambers, Jasper, Sabine, San Augustine, Angelina, and Nacogdoches

Watercourses: Pine Island Bayou, the Neches River, and the Angelina River, tributary of the Neches River  
Watershed: Neches River Basin and Neches-Trinity Coastal Basin

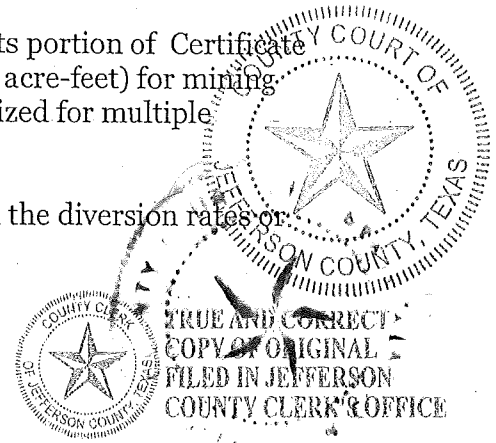
WHEREAS, the Lower Neches Valley Authority (LNVA), Applicant, owns a portion of Certificate of Adjudication (Certificate) No. 06-4411 which authorizes the Applicant to maintain two impoundments (Lake Sam Rayburn and B.A. Steinhagen Lake) and to divert and use no more than 381,876 acre-feet of water per year from several points on Pine Island Bayou and the Neches River, and 792,000 acre-feet of water per year from the perimeter of lake Sam Rayburn and a point on B.A. Steinhagen Lake, Neches River Basin for agricultural, industrial, mining, and municipal purposes within the Applicant's service area in Jefferson, Orange, Hardin, Tyler, Liberty, Chambers, Jasper, Sabine, San Augustine, Angelina, and Nacogdoches Counties; and

WHEREAS, the Certificate contains a bed and banks authorization, multiple diversion rates, priority dates, and special conditions apply; and

WHEREAS, the Applicant seeks authorization to amend its portion of Certificate No. 06-4411 to quantify the amount of water used (up to 20,000 acre-feet) for mining purposes out of the 1,173,876 acre-feet of water currently authorized for multiple purposes of use by using nominating tiers; and

WHEREAS, the Applicant is not requesting an increase in the diversion rates or the diversion amounts; and

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01/27/2014 09:08 AM Total Pages: 4 Fee: 34.00  
Debbie Newman, County Clerk - Jasper County, Texas



WHEREAS, the Texas Commission on Environmental Quality finds that jurisdiction over the application is established; and

WHEREAS, no requests for a contested case hearing were received for this application; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Commission on Environmental Quality in issuing this amendment; and

WHEREAS, the Executive Director recommends a Special Condition be included in the amendment that includes tier designation for the purpose of administering the Water Use Fee for the previous fiscal year;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 06-4411, designated Certificate of Adjudication No. 06-4411J is issued to the Lower Neches Valley Authority, subject to the following terms and conditions:

1. USE

In lieu of paragraph 1. USE of Certificate of Adjudication No. 4411I authorizing the Owner to use not to exceed 1,173,876 acre-feet of water for agricultural, industrial, municipal, and mining purposes, Owner is now authorized to use:

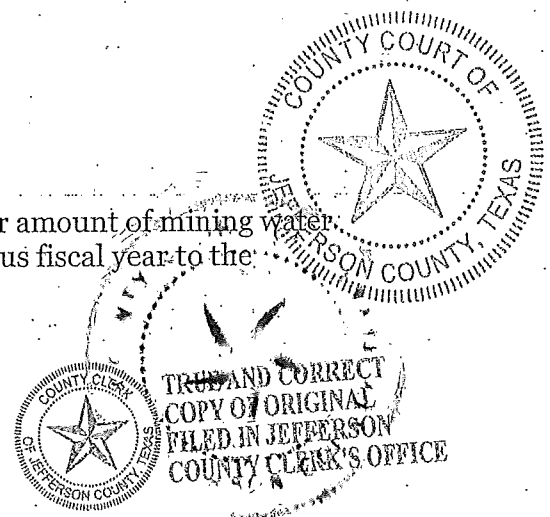
- A. 1,153,876 acre-feet for agricultural, industrial, and municipal purposes
- B. 20,000 acre-feet for agricultural, industrial, municipal, and mining purposes

2. SPECIAL CONDITION

- A. For Water Use Fee purposes, Owner shall annually designate one of the following nominating tiers based upon the Owner's annual contractual obligations for mining use:

<u>Level</u>	<u>Maximum Annual Mining Use Quantity</u>
Level 1	0 acre-feet
Level 2	up to 500 acre-feet
Level 3	up to 2,000 acre-feet
Level 4	up to 8,000 acre-feet
Level 5	up to 20,000 acre-feet

- B. Owner shall annually report the designated tier amount of mining water based on contractual obligations for the previous fiscal year to the Executive Director by August 31.



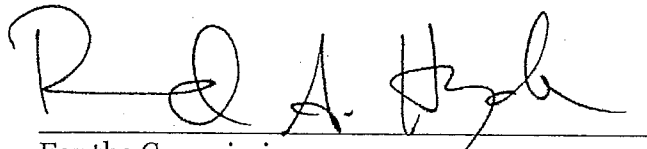
This amendment is issued subject to all terms, conditions and provisions contained in Certificate No. 06-4411, as amended, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Neches River Basin.

Owner agrees to be bound by the terms, conditions, and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Commission on Environmental Quality and to the right of continuing supervision of State water resources exercised by the Commission.

  
For the Commission

Date Issued: **January 13, 2014**

*Return to:*

**KEVIN GOMEZ  
7850 EASTEX FWY  
BEAUMONT TX 77708**

**FILED AND RECORDED  
OFFICIAL PUBLIC RECORDS**

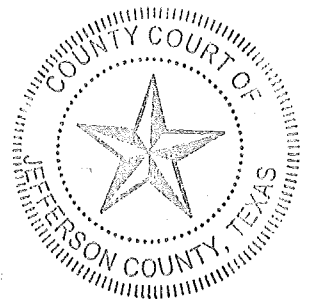
*Carolyn L. Guidry*

Carolyn L. Guidry, County Clerk  
Jefferson County, Texas

January 23, 2014 10:46:26 AM

FEE: \$34.00

2014002473



**I CERTIFY THIS IS A TRUE COPY  
Witness my Hand and Seal of Office**

**JAN 23 2014  
CAROLYN L. GUIDRY, COUNTY CLERK  
JEFFERSON COUNTY, TEXAS**

**BY *Annalisa Villasana Sherry* DEPUTY  
ANNALISA VILLASANA-SHERRY**

## FILED AND RECORDED

Instrument Number: 253893 B: OPR V: 989 P: 360

Filing and Recording Date: 01/27/2014 09:08:14 AM Pages: 4 Recording Fee: \$34.00

I hereby certify that this instrument was FILED on the date and time stamped heron and RECORDED in the PUBLIC RECORD of Jasper County, Texas.



*Debbie Newman*

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Debbie Newman, County Clerk  
Jasper County, Texas

ANY PROVISION CONTAINED IN ANY DOCUMENT WHICH RESTRICTS THE SALE, RENTAL, OR USE OF THE REAL PROPERTY DESCRIBED THEREIN BECAUSE OF RACE OR COLOR IS INVALID UNDER FEDERAL LAW AND IS UNENFORCEABLE.

# TEXAS COMMISSION ON ENVIRONMENTAL QUALITY



THE STATE OF TEXAS  
COUNTY OF TRAVIS

I hereby certify that this is a true and correct copy of a Texas Commission on Environmental Quality document, which is filed in the permanent records of the Commission. Given under my hand and the seal of office on

*LaDonna Castanuela* JUL 23 2010

LaDonna Castanuela, Chief Clerk  
Texas Commission on Environmental Quality

## AMENDMENT TO A CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 06-4411F

TYPE: 11.122

Owner:	Lower Neches Valley Authority	Address:	P.O. Box 5117 Beaumont, TX 77726-5117
Filed:	January 3, 2008	Granted:	<b>JUL 20 2010</b>
Purpose:	Agricultural, Industrial, and Municipal	County:	Jasper, Sabine, San Augustine, Angelina, Nacogdoches, Tyler, Hardin, Jefferson, Orange, Liberty, and Chambers
Watercourses:	Pine Island Bayou, Neches River, and the Angelina River, tributary of the Neches River	Watershed:	Neches River Basin

WHEREAS, Certificate of Adjudication No. 06-4411 authorizes the Lower Neches Valley Authority (LNVA), part owner, to impound water in two reservoirs (owned by the United States and operated by the U.S. Army Corps of Engineers) being Lake Sam Rayburn, located on the Angelina River in Jasper, Sabine, San Augustine, Angelina, and Nacogdoches Counties, and B.A. Steinhagen Lake, located on the Neches River in Tyler and Jasper Counties; and

WHEREAS, the Certificate also authorizes LNVA to divert and use not to exceed 381,876 acre-feet of water per year from Pine Island Bayou and the Neches River and 792,000 acre-feet of water per year from Lake Sam Rayburn and B.A. Steinhagen Lake at various rates for agricultural (irrigation), municipal, and industrial purposes within LNVA's service area in Jefferson, Orange, Hardin, Tyler, Liberty, Chambers, and Jasper Counties; and

WHEREAS, the Certificate contains various priority dates and special conditions; and

WHEREAS, Special Condition 5.C. states: "Excepting municipal purposes, all of owner's right to divert and use public water, under the priority date of November 12, 1963, is subordinate to any present or future domestic and/or municipal water needs or requirements"; and

WHEREAS, Special Condition 5.D states: "Owner's rights, under the priority date of November 12, 1963, authorized by this certificate of adjudication, shall be subordinate to any rights hereafter granted

by the Commission for storage and/or use of waters in and above the proposed Ponta Dam on the Angelina River and the proposed Weches Dam on the Neches River”; and

WHEREAS, Applicant seeks to amend Certificate of Adjudication No. 06-4411 to modify Special Conditions 5.C. and 5.D. to limit subordination of this water right to existing water rights in the Neches River Basin and to read as follows:

Special Condition 5.C. Excepting municipal purposes, all of owner's right to divert and use public water, under the priority date of November 12, 1963, is subordinate to any existing municipal water rights granted by the Commission with a priority date between November 13, 1963 and December 19, 2007.

Special Condition 5.D. Owner's rights, under the priority date of November 12, 1963, authorized by this certificate of adjudication, shall be subordinate to all existing rights granted by the Commission with a priority date between November 13, 1963 and December 19, 2007 for storage and/or use of waters in and above the proposed Ponta Dam on the Angelina River and the proposed Weches Dam on the Neches River; and

WHEREAS, the Texas Commission on Environmental Quality finds that jurisdiction over the application is established; and

WHEREAS, the Executive Director recommends modification of the Applicant’s proposed Special Conditions to reflect the filing date of the application; and

WHEREAS, the applicant and protestants reached a settlement agreement and agreed to further modify Special Conditions 5.C. and 5.D as follows:

- 5.C. Excepting municipal purposes, all of owner’s right to divert and use public water under the priority date of November 12, 1963 is subordinate to any existing municipal water rights granted by the Commission with a priority date between November 13, 1963 and January 3, 2008.
- 5.D. Owner’s rights, under the priority date November 12, 1963, authorized by this certificate of adjudication, shall be subordinate to:
  - 1. All existing rights granted by the Commission with a priority date between November 13, 1963 and January 3, 2008 to impound, divert, and/or use waters in and above the proposed Ponta Dam on the Angelina River;
  - 2. All existing rights and any rights hereafter granted by the Commission to impound, divert, and/or use waters at or above the Weches Dam site on the Neches River herein defined as Latitude 31.569553°N, Longitude 95.150500°W on the Neches River;

3. Any rights hereafter granted by the Commission to impound, divert, and/or use waters on Mud Creek above Mud Creek's confluence with the Angelina River;
4. All existing rights and any rights hereafter granted by the Commission to impound, divert, and/or use the waters of Naconiche Creek and/or any of its tributaries upstream of the point at which Highway 59 crosses Naconiche Creek herein defined as Latitude 31.766667°N, Longitude 94.566111°W on Naconiche Creek, if, but only if, all use and any reuse of such waters remains entirely within the Neches River Basin and all return flows associated with such use and reuse remain entirely in the Neches River Basin;
5. The City of Nacogdoches's existing water right under both Certificate of Adjudication 06-4864, with priority dates of January 5, 1970 and June 27, 1977, issued February 19, 1987, and Certificate of Adjudication 06-4864A, issued June 17, 1988, and up to a total of thirty-four thousand, four hundred and sixteen (34,416) acre-feet annually of water rights hereafter granted by the Commission to the City of Nacogdoches, if, but only if, all use and any reuse of such water remains entirely within the Neches River Basin and all return flows associated with such use remains entirely in the Neches River Basin, and provided that the quantity of such continued subordination shall be reduced by the amount of surface water that the City of Nacogdoches hereafter obtains by contract from sources within the Neches River Basin; and

WHEREAS, nine requests for a contested case hearing were received and were subsequently withdrawn; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Commission on Environmental Quality in issuing this amendment;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 06-4411, designated Certificate of Adjudication No. 06-4411F, is issued to the Lower Neches River Authority, subject to the following terms and conditions:

1. CONSERVATION

Owner shall implement water conservation plans that provide for the utilization of those practices, techniques, and technologies that reduce or maintain the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water, or prevent the pollution of water, so that a water supply is made available for future or alternative uses. Such plans shall include a requirement that in every wholesale water contract entered into, on or after the effective date of this amendment, including any contract extension or renewal, that each successive wholesale customer develop and implement conservation measures. If the customer intends to resell the water, then the contract for resale of the water must have

water conservation requirements so that each successive wholesale customer in the resale of the water be required to implement water conservation measures.

2. SPECIAL CONDITIONS

In lieu of Special Conditions 5.C. and 5.D., Special Condition 5.C. now reads:

5.C. Excepting municipal purposes, all of owner's right to divert and use public water under the priority date of November 12, 1963 is subordinate to any existing municipal water rights granted by the Commission with a priority date between November 13, 1963 and January 3, 2008.

Special Condition 5.D now reads:

5.D. Owner's rights, under the priority date November 12, 1963, authorized by this certificate of adjudication, shall be subordinate to:

1. All existing rights granted by the Commission with a priority date between November 13, 1963 and January 3, 2008 to impound, divert, and/or use waters in and above the proposed Ponta Dam on the Angelina River.
2. All existing rights and any rights hereafter granted by the Commission to impound, divert, and/or use waters at or above the Weches Dam site on the Neches River herein defined as Latitude 31.569553°N, Longitude 95.150500°W on the Neches River.
3. Any rights hereafter granted by the Commission to impound, divert, and/or use waters on Mud Creek above Mud Creek's confluence with the Angelina River.
4. All existing rights and any rights hereafter granted by the Commission to impound, divert, and/or use the waters of Naconiche Creek and/or any of its tributaries upstream of the point at which Highway 59 crosses Naconiche Creek herein defined as Latitude 31.766667°N, Longitude 94.566111°W on Naconiche Creek, if, but only if, all use and any reuse of such waters remains entirely within the Neches River Basin and all return flows associated with such use and reuse remain entirely in the Neches River Basin.
5. The City of Nacogdoches's existing water right under both Certificate of Adjudication 06-4864, with priority dates of January 5, 1970 and June 27, 1977, issued February 19, 1987, and Certificate of Adjudication 06-4864A, issued June 17, 1988, and up to a total of thirty-four thousand, four hundred and sixteen (34,416) acre-feet annually of water rights hereafter granted by the Commission to the City of Nacogdoches, if, but only if, all use and any reuse of such water remains entirely within the Neches River Basin and all return flows associated with such use remains entirely in the Neches River Basin, and provided that the quantity of such continued subordination shall be reduced by the amount of surface water that the City of Nacogdoches hereafter obtains by

contract from sources within the Neches River Basin.

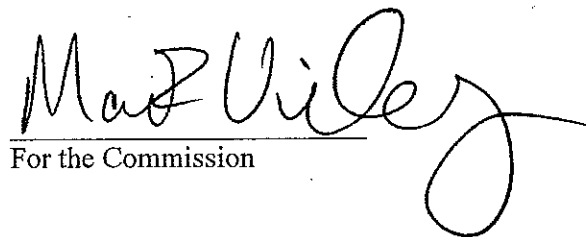
This amendment is issued subject to all terms, conditions and provisions contained in Certificate of Adjudication No. 06-4411, as amended, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Neches River Basin.

Certificate owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Commission on Environmental Quality and to the right of continuing supervision of state water resources exercised by the Commission.

  
For the Commission

Date Issued: **JUL 20 2010**

## TEXAS COMMISSION ON ENVIRONMENTAL QUALITY



COUNTY OF TRAVIS

I hereby certify that this is a true and correct copy of a  
Texas Commission on Environmental Quality document,  
which is filed in the permanent records of the Commission.  
Given under my hand and the seal of office on

JUL 08 2004

*Ladonna Casteruela*  
Ladonna Casteruela, Chief Clerk  
Texas Commission on Environmental Quality

AMENDMENT TO A  
CERTIFICATE OF ADJUDICATION

APPLICATION NO. 06-4411D

CERTIFICATE NO. 06-4411D

TYPE §11.122

Permittee:	Lower Neches Valley Authority	Address:	P.O. Box 5117 Beaumont, TX 77726-5117
Filed:	March 19, 2004	Granted:	<b>JUN 18 2004</b>
Purpose:	Agriculture, Industrial, and Municipal	Counties:	Jasper, Sabine, San Augustine, Angelina, and Nacogdoches
Watercourse:	Angelina River, tributary of the Neches River	Watershed:	Neches River Basin

WHEREAS, Certificate of Adjudication 06-4411 authorizes the Lower Neches Valley Authority (LNVA), part owner, to impound water in two reservoirs (owned by the USA and operated by the US Corps of Engineers) being Lake Sam Rayburn located on the Angelina River in Jasper, Sabine, San Augustine, Angelina, and Nacogdoches Counties and B.A. Steinhagen Lake located on the Neches River in Tyler and Jasper Counties; and

WHEREAS, the Certificate also authorizes LNVA to divert and use 381,876 acre-feet of water from Pine Island Bayou and the Neches River and 792,000 acre-feet of water from Lake Sam Rayburn and B.A. Steinhagen Lake for agricultural (irrigation), municipal, and industrial purposes within LNVA's service area in Jefferson, Orange, Hardin, Tyler, Liberty, Chambers, and Jasper Counties; and

WHEREAS, the Certificate authorizes LNVA to divert from the following points:

- A. a point on Lake Sam Rayburn at an unspecified rate,
- B. a point on B.A. Steinhagen Lake at a maximum rate of not to exceed 2,000 cfs (900,000 gpm),

- C. a point on the Neches River in Jasper County at a maximum rate of not to exceed 86 cfs (38,700 gpm),
- D. a point on the Neches River in Hardin County at an unspecified rate,
- E. a point on Pine Island Bayou in the Wesley Dyches Grant at a maximum rate of not to exceed 980 cfs (440,000 gpm), and
- F. a point on Pine Island Bayou in the Thomas Spear Grant at a maximum rate of not to exceed 936 cfs (420,000 gpm); and

WHEREAS, the Certificate contains various priority dates and special conditions; and

WHEREAS, the applicant seeks an amendment to Certificate of Adjudication No. 06-4411 to add authorization to divert anywhere along the perimeter of Lake Sam Rayburn; and

WHEREAS, the City of Lufkin, part owner of this certificate, and has agreed in writing to this application; and

WHEREAS, the Texas Commission on Environmental Quality finds that jurisdiction over the application is established; and

WHEREAS, no one protested the granting of this application; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Commission on Environmental Quality in issuing this amendment;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 06-4411, designated as Certificate of Adjudication No. 06-4411D, is issued to the Lower Neches Valley Authority subject to the following terms and conditions:

1. DIVERSION

In addition to the previous authorizations, LNVA is authorized to divert the authorized 792,000 acre-feet of water from any point on the perimeter of Lake Sam Rayburn.

2. CONSERVATION

Owner shall implement a conservation plan that provides for the utilization of water conservation practices, techniques and technologies that reduce or maintain the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water,

or prevent the pollution of water, so that a water supply is made available for future or alternative uses. Such plans shall include a requirement that in every wholesale water contract entered into, on or after the effective date of this amendment, including any contract extension or renewal, that each successive wholesale customer develop and implement conservation measures. If the customer intends to resell the water, then the contract for resale of the water must have water conservation requirements so that each successive wholesale customer in the resale of the water be required to implement water conservation measures.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate of Adjudication No. 06-4411 except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Neches River Basin.

Owner agrees to be bound by the terms, conditions, and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

This amendment is issued subject to the Rules of the Texas Commission on Environmental Quality and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS COMMISSION ON  
ENVIRONMENTAL QUALITY



For the Commission

Date issued: JUN 18 2004

041899

FILED FOR RECORD  
AT 8:55 O'CLOCK A.M.

AUG 27 2004

Janice McDaniel  
Clerk, County Court, Sabine County  
TX  
Deputy Clerk

2/18/04  
AFTER RECORDING RETURN TO:  
LOWER NECHES VALLEY AUTHORITY  
P.O. BOX 5117  
BEAUMONT, TX 77726-5117

THE STATE OF TEXAS  
COUNTY OF SABINE  
I HEREBY CERTIFY THAT THIS INSTRUMENT WAS FILED AND TIMED  
STAMPED HEREON BY ME AND WAS ONLY RECORDED IN THE VOLUME  
AND PAGE OF THE NAMED RECORDS OF SABINE COUNTY TEXAS AS  
STAMPED HEREON BY ME

RECORDED 8-27-04  
VOL 214 PAGE 312



OFFICIAL PUBLIC RECORDS  
JANICE MCDANIEL, COUNTY CLERK  
SABINE COUNTY, TEXAS  
Deputy Clerk

VOL 0214 PAGE 313

3  
H-16

01-2915

VOL. 699 PAGE 541

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION



COUNTY OF TRAVIS
I hereby certify that this is a true and correct copy of a Texas Natural Resource Conservation Commission document, which is filed in the permanent records of the Commission.
Given under my hand and the seal of office on

AUG 17 2001

Signature of L. Donna Castañuela and date stamp JUL 30 2001

L. Donna Castañuela, Chief Clerk
Texas Natural Resource Conservation Commission

AMENDMENT TO CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 06-4411C Type: Section 11.122
Owner: Lower Neches Valley Authority Address: P.O. Box 5117 Beaumont, TX 77726
Filed: April 26, 2001 Granted: JUL 23 2001
Purpose: Irrigation, Municipal Industrial Counties: Jefferson, Orange, Hardin Tyler, Liberty, Chambers, and Jasper
Watercourse: Neches River and Pine Island Bayou, tributary of the Neches River Watershed: Neches River Basin

WHEREAS, Certificate of Adjudication No. 06-4411 was issued to Lower Neches Valley Authority on August 8, 1986 and authorizes owner to store water in two existing reservoirs which are owned by the United States and operated by the U.S. Corps of Engineers, being Lake Sam Rayburn located on the Angelina River in Jasper, Sabine, San Augustine, Angelina, and Nacogdoches Counties and B.A. Steinhagen Lake (Dam "B") located on the Neches River in Tyler and Jasper Counties; and

WHEREAS, the amount of water stored in the aforesaid reservoirs is equivalent to a release from B.A. Steinhagen Lake, and the total amount of water released must not exceed 820,000 acre-feet per annum at a rate not to exceed 2,000 cfs (897,000 gpm) for owner's authorized uses; and

WHEREAS, Certificate of Adjudication No. 06-4411 further authorizes owner to divert and use not to exceed 381,876 acre-feet of water from Pine Island Bayou and the Neches River for municipal, industrial, and irrigation purposes, and 820,000 acre-feet per annum from Sam Rayburn and B.A. Steinhagen Lakes for municipal, industrial, and irrigation purposes; and

WHEREAS, Certification of Adjudication No. 06-4411 authorizes owner to divert water at the following location and rates:

- a. Lake Sam Rayburn - unspecified rate,
b. B.A. Steinhagen Lake - maximum rate of 2,000 cfs (900,000 gpm),
c. A point on the Neches River in Jasper County - maximum rate of 86 cfs (38,700 gpm),

- d. A point on the Neches River in Hardin County - unspecified rate, and
- e. Two authorized points on Pine Island Bayou in Jefferson County - maximum rate of 633 cfs (284,850 gpm) in the Wesley Dyches Grant and a maximum rate of 633 cfs (284,850 gpm) in the Thomas Spear Grant; and

WHEREAS, an amendment to the Certificate of Adjudication, No. 06-4411A, was issued on June 10, 1987 and authorizes an increase in the maximum diversion rates at two points on Pine Island Bayou to 980 cfs (440,000 gpm) in the Dyches Grant and 936 cfs (420,000 gpm) in the Spear Grant, to change 60,000 acre-feet of water per annum authorized for industrial use to municipal use, and to reword certain provisions of the certificate; and

WHEREAS, an amendment to the Certificate of Adjudication, No. 06-4411B, was issued August 9, 1991 and authorizes the owner to install two temporary saltwater barriers and impound, from time to time, not to exceed 1,115 acre-feet of water between elevations 0.0 feet mean sea level and 5.0 feet mean sea level in barrier No. 1, and not to exceed 529 acre-feet of water between elevations 0.0 feet mean sea level and 3.0 feet mean sea level in barrier No. 2; and

WHEREAS, Certificate of Adjudication No. 06-4411 also included multiple special conditions; and

WHEREAS, owner applied to amend Certificate of Adjudication No. 06-4411, as amended, to authorize use of the total amount of water authorized, 1,201,876 acre-feet per annum, for any of the uses authorized within any areas that are served by the Lower Neches Valley Authority in both the Neches River and Neches-Trinity Coastal Basins, and to return the water diverted but not consumed to a stream in the vicinity of where the water was used within the service area; and

WHEREAS, the Texas Natural Resource Conservation Commission finds that jurisdiction over the application is established; and

WHEREAS, the Executive Director has determined that the water used but not consumed shall be returned to the Neches River Basin or the Neches-Trinity Coastal Basin; and

WHEREAS, in order to facilitate the maintenance of the Commission's water availability models for the Neches-Trinity Coastal Basin, staff recommends that the permit contain a special condition requiring owner to notify the Commission of any new return flow discharge resulting from the use of water authorized by this certificate greater than 1,000,000 gallons per day; and

WHEREAS, no person protested the granting of the proposed amendment to Certificate of Adjudication No. 06-4411, as amended.

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Natural Resource Conservation Commission in issuing this amendment; and

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 06-4411, as amended, designated as Certificate of Adjudication 06-4411C, is issued to the Lower Neches Valley Authority, subject to the following terms and conditions:

2. USE

In lieu of the previously authorized uses, Lower Neches Valley Authority may use the total amount of water authorized, 1,201,876 acre-feet per annum, for any of the uses authorized within any areas that are or may be served by the LNVA in the Neches River Basin and Neches-Trinity Coastal Basin. The water authorized herein shall be diverted as follows:

- a. From Pine Island Bayou and the Neches River - 381,876 acre-feet of water per annum, and
- b. From Lakes Sam Rayburn and B.A. Steinhagen - 820,000 acre-feet of water per annum.

5. SPECIAL CONDITION

- R. In lieu of Special Condition 5 F. of the original certificate issued August 8, 1986, Lower Neches Valley Authority shall return all water diverted but not consumed to the Neches River Basin or to the Neches-Trinity Coastal Basin.
- S. Lower Neches Valley Authority shall notify the Commission of any new continuous municipal or industrial return flow discharges over 1,000,000 (one million) gallons of water per day, resulting from water authorized for use by this certificate, upstream of the tidal zone where said discharge began subsequent to the granting of this amendment.

6. CONSERVATION

Owners shall implement water conservation plans that provide for the utilization of those practices, techniques, and technologies that reduce or maintain the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water, or prevent the pollution of water, so that a water supply is made available for future or alternative uses.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate of Adjudication No. 06-4411, as amended, including the priority dates established therein, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Neches River Basin.

Certificate owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Natural Resource Conservation Commission and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS NATURAL RESOURCE  
CONSERVATION COMMISSION



For the Commission

Date Issued: JUL 23 2001

ROBERT HARRIS  
Deputy GEN. Manager  
P.O. Box 5117  
Beaumont, TX 77726

The Public

to  
P.O. Box Neches Valley  
Authority

699  
544  
01-2915



*WHEREAS, applicant has requested an amendment to Certificate No. 06-4411, as amended, to install from time to time, two temporary saltwater barriers, i.e., one on the Neches River and one on Pine Island Bayou, tributary of the Neches River to protect freshwater intake facilities from saltwater moving upstream to authorized diversion points during periods of low flow; and*

*WHEREAS, the Texas Water Commission finds that jurisdiction over the application is established; and*

*WHEREAS, no person protested the granting of this application; and*

*WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Water Commission in issuing this amendment; and*

*NOW, THEREFORE, this amendment to Certificate No. 06-4411, as amended, is issued to Lower Neches Valley Authority, subject to the following terms and conditions:*

**1. IMPOUNDMENTS**

- C. Certificate owner is authorized to construct a saltwater barrier (No. 1) on the Neches River and may impound from time to time not to exceed 1115 acre-feet of water between elevations 0.0 feet mean sea level and 5.0 feet mean sea level. The barrier area will be adjacent to the Martin Palmer Survey, Abstract No. 19, Orange County, Texas. The barrier will be in the vicinity of Latitude 29.860° N, Longitude 94.998° W and also being N 74° W, 6205 feet from the southeast corner of the Amasa Rand Survey, Abstract No. 498, Orange County, approximately 8.5 miles north of Beaumont, Jefferson County, Texas.*
- D. Certificate owner is authorized to construct a saltwater barrier (No. 2) on Pine Island Bayou, Jefferson and Hardin Counties, and may impound from time to time not to exceed 529 acre-feet of water between elevations 0.0 feet mean sea level and 3.0 feet mean sea level. The barrier area is adjacent to the Thomas Spear Survey, Abstract No. 50, Jefferson County, Texas. The barrier will be in the vicinity of an area N 35° E, 4691 feet from the northwest corner of the Harvey P. Savery Survey, Abstract No. 47, Jefferson County, approximately 6.5 miles north-northwest of Beaumont, Jefferson County, Texas.*

## 5. SPECIAL CONDITIONS

- M. Certificate owner shall document downstream salinity conditions prior to installation of the saltwater barriers and may install the barriers when the encroaching saltwater wedge is at a point one mile downstream of the confluence of the Neches River and Pine Island Bayou.
- N. Certificate owner shall notify the Texas Water Commission and Texas Parks and Wildlife Department prior to the installation and/or after the breaching of the saltwater barriers.
- O. Certificate owner shall provide reports to the Texas Water Commission and Texas Parks and Wildlife Department for the seven-day period prior to the installation of the structures. These reports should include salinity surveys and reservoir stage and outflow conditions for Steinhagen Reservoir and Sam Rayburn Reservoir.
- P. Certificate owner shall consult with Texas Parks and Wildlife Department concerning the installation of fish passes in the saltwater barriers and will implement such installation as deemed necessary.
- Q. This amendment shall expire and become null and void on December 31, 2001 unless prior to such date certificate owner applies for an extension hereof and such application is subsequently granted for an additional term or in perpetuity. The priority date of this amendment and any extensions hereof shall be February 6, 1991.

*This amendment is issued subject to all terms, conditions and provisions contained in Certificate No. 06-4411, as amended, except as specifically amended herein.*

*This amendment is issued subject to all superior and senior water rights in the Neches River Basin.*

*Certificate owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.*

*All other matters requested in the application which are not specifically granted by this amendment are denied.*

Certificate owner shall use those practices, techniques and technologies that will reduce the loss or waste of water and improve the efficiency and use of water so that only so much water as can be beneficially used will be diverted.

This amendment is issued subject to the Rules of the Texas Water Commission and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS WATER COMMISSION

*[Signature]* for  
John Hall, Chairman

DATE ISSUED: AUG 09 1991

ATTEST:

*[Signature]*  
Gloria A. Vasquez, Chief Clerk

FILED FOR RECORD

1991 AUG 26 PM 2:23

MOLLY THERIOT  
COUNTY CLERK  
ORANGE COUNTY, TEXAS

*[Signature]* DEPUTY STATE OF TEXAS

COUNTY OF ORANGE

I hereby certify that this instrument was filed on the date and time stamped hereon by me and was duly recorded in the Official Public Records of Real Property of Orange County, Texas, on

AUG 26 1991

A.T. Hebert Jr.  
Lower Neches Valley authority  
P.O. Box 3464  
Beaumont, Tx. 77704  
q.



*[Signature]*  
COUNTY CLERK, Orange County, Texas

AMENDMENT TO  
CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 06-4411A

TYPE: AMENDMENT

Name: Lower Neches Valley  
Authority

Address: P.O. Drawer 3464  
Beaumont, Texas 77704

Filed: February 10, 1987

Granted: May 5, 1987

Purpose: Municipal, Industrial  
and Irrigation

Counties: Angelina, San Augustine,  
Jasper, Tyler, Sabine,  
Nacogdoches, Hardin,  
Jefferson, Liberty and  
Chambers

Watercourse: Angelina River and  
Pine Island Bayou,  
tributaries of the  
Neches River and the  
Neches River

Watershed: Neches River Basin and  
Neches-Trinity Coastal  
Basin

WHEREAS, Certificate of Adjudication No. 06-4411 was issued to Lower Neches Valley Authority on August 8, 1986, and authorized the certificate owner to divert and use water from Pine Island Bayou and the Neches River and, in accordance with a 1956 contract with the United States of America, to use water from Lake Sam Rayburn located in Jasper, Sabine, San Augustine, Angelina and Nacogdoches Counties on the Angelina River and B.A. Steinhagen Lake (Dam "B") located in Tyler and Jasper Counties on the Neches River; and

WHEREAS, applicant has requested an amendment to Certificate No. 06-4411 to increase the maximum diversion rates at two points on Pine Island Bayou, to change 60,000 acre-feet of the water authorized for industrial use per year to municipal use, and to reword certain provisions of the certificate; and

WHEREAS, the Texas Water Commission finds that jurisdiction over the application is established; and

WHEREAS, no person protested the granting of this application; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Water Commission in issuing this amendment.

NOW, THEREFORE, this amendment to Certificate No. 06-4411 is issued to Lower Neches Valley Authority, subject to the following provisions:

1. IMPOUNDMENT

Paragraph 1.B. of the certificate is amended to read as follows:

Owner is authorized to store water in an existing dam and reservoir (B.A. Steinhagen Lake or Dam B) on the Neches River which is owned by the United States of America and operated by the U.S. Corps of Engineers. The amount of water to be stored is equivalent to a release of not to exceed 2000 cfs for owner's authorized uses and the total amount of water released for owner's use must not exceed 820,000 acre-feet. The dam is located in the Peter B. Pry Grant, Abstract 31, Jasper County and the James Perkins Grant, Abstract 29, Tyler County, Texas.

2. USE

Paragraph 2 of the certificate is amended to read as follows:

- A. Certificate owner is authorized to divert and use not to exceed 114,202 acre-feet of water per annum for municipal purposes. The water authorized herein shall be diverted from the following sources and in the amounts indicated:
- (1) Pine Island Bayou & the Neches River 4202 acre-feet
  - (2) Lake Sam Rayburn & B.A. Steinhagen Lake 110,000 acre-feet
- B. Certificate owner is authorized to divert and use not to exceed 651,314 acre-feet of water per annum for industrial purposes. The water authorized herein shall be diverted from the following sources and in the amounts indicated:
- (1) Pine Island Bayou & the Neches River 51,314 acre-feet
  - (2) Lake Sam Rayburn & B.A. Steinhagen Lake 600,000 acre-feet
- C. Certificate owner is authorized to divert and use not to exceed 436,360 acre-feet of water per annum for the irrigation of 85,000 acres of land. The water authorized herein shall be diverted from the following sources and in the amounts indicated:
- (1) Pine Island Bayou & the Neches River 326,360 acre-feet
  - (2) Lake Sam Rayburn & B.A. Steinhagen Lake 110,000 acre-feet

D. Certificate owner is authorized to store, divert and use water pursuant to Certificate of Adjudication No. 06-4411, as amended, in that portion of the Neches-Trinity Coastal Basin within the owner's boundaries and in the Neches River Basin within or without the boundaries of such owner as provided in Article 8280-103 Vernon's Annotated Texas Statutes.

3. DIVERSION

In lieu of the diversion rate of 633 cfs (284,850 gpm) included in Paragraph 3.E. of the certificate, owner is authorized to divert water at a maximum rate of 980 cfs (440,000 gpm) at the described diversion point on Pine Island Bayou.

In lieu of the diversion rate of 633 cfs (284,850 gpm) included in Paragraph 3.F. of the certificate, owner is authorized to divert water at a maximum rate of 936 cfs (420,000 gpm) at the described diversion point on Pine Island Bayou.

4. PRIORITY

Paragraph 4.D. of the certificate is amended to read as follows:

The time priority of owner's right is November 12, 1963 for the diversion and use of the remaining 110,000 acre-feet of water per annum for municipal purposes; the remaining 600,000 acre-feet of water per annum for industrial purposes; the remaining 110,000 acre-feet of water for irrigation purposes and all of the 86 cfs (38,700 gpm) of the diversion rate at the diversion point in the Benjamin Richardson Survey.

Paragraph 4.E. is hereby added to the certificate as follows:

The time priority of owner's right is February 10, 1987 for the additional 347 cfs (155,150 gpm) of the diversion rate at the point described in Paragraph 3.E. of the certificate and for the additional 303 cfs (135,150 gpm) of the diversion rate at the point described in Paragraph 3.F. of the certificate.

5. SPECIAL CONDITIONS

Paragraph 5.E. of the certificate is amended to read as follows:

Certificate owner shall secure, on a monthly basis, data as to the water released from B.A. Steinhagen Reservoir (Dam B). Such data may be obtained from the U.S. Army Corps of Engineers or other approved means. Owner shall measure within 5% accuracy the amount of water diverted and used at the other authorized points of diversion.

Paragraph 5.G. of the certificate is amended to read as follows:

Certificate owner shall secure, on a monthly basis, a report of the amount of water released for each authorized purpose from B.A. Steinhagen Reservoir (Dam B) for owner's use. Said report may be obtained from the United States Army Corps of Engineers or other approved means. Owner shall also measure the amount of water diverted from Pine Island Bayou and the Neches River for each authorized purpose and shall report annually on forms provided by the Commission.

Paragraph 5.H. of the certificate is amended to read as follows:

Certificate owner shall, upon request from the Commission, obtain for B.A. Steinhagen Reservoir from the Corps of Engineers, or by other approved means, and provide to the Commission, daily reports of reservoir levels, daily releases of water through the dam, and daily inflows into the reservoir. Owner shall also, upon Commission's request, obtain from the U.S. Geological Survey, or by other approved means, and provide sedimentation data within the reservoir and chemical quality data of the stored water.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate No. 06-4411, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Neches River Basin and the Neches-Trinity Coastal Basin.

Certificate owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Water Commission and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS WATER COMMISSION

*Paul Hopkins*  
 \_\_\_\_\_  
 Paul Hopkins, Chairman

*Ralph Roming*  
 \_\_\_\_\_  
 Ralph Roming, Commissioner

*John O. Houchins*  
 \_\_\_\_\_  
 John O. Houchins, Commissioner

H-28

DATE ISSUED:

June 10, 1987

ATTEST:

*Mary Ann Hefner*  
 \_\_\_\_\_  
 Mary Ann Hefner, Chief Clerk

101 90 0100

FILED FOR RECORD  
*Lita Lamm*  
COUNTY CLERK  
JEFFERSON COUNTY, TEXAS

JUN 29 11 08 AM '87

Return to:  
A.T. Hebert Jr  
Lower Neches Valley Authority  
P. O. Drawer 2465  
Beaumont, TX 77704

STATE OF Texas COUNTY OF JEFFERSON

I hereby certify that this instrument was filed on  
the date and time stamped hereon by me and was duly  
recorded in the Official Public Records of Real Property  
of Jefferson County, Texas, on

JUN 29 1987



*Lita Lamm*  
County Clerk, Jefferson County, Texas

06/29/87 RCD 87 16331 \$ 11.00

#17839  
CERTIFICATE OF ADJUDICATION

CERTIFICATE OF ADJUDICATION: 06-4411

Map Vol 9 Pg 51  
OWNER: Lower Neches Valley  
Authority  
P.O. Drawer 3464  
Beaumont, Texas 77704

COUNTIES: Jefferson, Hardin, Jasper,  
Tyler, Liberty and Chambers

PRIORITY DATES: August 12, 1913,  
November 8, 1913,  
December 31, 1924,  
and November 12,  
1963

WATERCOURSE: Angelina River and  
Pine Island Bayou  
tributaries to the  
Neches River and the  
Neches River

BASIN: Neches River

WHEREAS, by final decree of the 344th Judicial District Court of Chambers County, in Cause No. 344-10864, In Re: The Adjudication of Water Rights in the Lower Neches and Angelina Rivers Segment of the Neches River Basin and the Eastern Portion of the Neches-Trinity Coastal Basin, dated October 30, 1985, a right was recognized under Certified Filing 4, Certified Filing 134, Permit 823, Permit 826 and Permit 2124 authorizing the Lower Neches Valley Authority to appropriate waters of the State of Texas set forth below;

WHEREAS, the Lower Neches Valley Authority on August 24, 1956, entered into a contract with the United States of America for conservation storage in Sam Rayburn Reservoir and B. A. Steinhagen Reservoir;

NOW, THEREFORE, this certificate of adjudication to appropriate waters of the State of Texas in the Neches-Trinity Coastal Basin is issued to the Lower Neches Valley Authority, subject to the following terms and conditions:

## 1. IMPOUNDMENT

- A. Owner is authorized to store water in an existing dam and reservoir (Lake Sam Rayburn) on the Angelina River which is owned by the United States of America and operated by the U.S. Corps of Engineers. The minimum amount of water to be stored above elevation 149 feet mean sea level is at least sufficient to generate power equivalent to 42,200 kilowatts for a minimum period of 75 hours per month for each of the six monthly periods from mid-April through mid-October of each year. The dam is located in the Thomas McGalin Grant, Abstract 26 and the Marion Smith Survey 38, Abstract 939, Jasper County, Texas.
- B. Owner is authorized to store water in an existing dam and reservoir (B.A. Steinhagen Lake or Dam B) on the Neches River which is owned by the United States of America and operated by the U.S. Corps of Engineers. The amount of water to be stored is equivalent to a release of not to exceed 2000 cfs for owner's authorized uses and the total amount of water released must not exceed 820,000 acre-feet. The dam is located in the Peter B. Pry Grant, Abstract 31, Jasper County and the James Perkins Grant, Abstract 29, Tyler County, Texas.

## 2. USE

- A. Owner is authorized to divert and use not to exceed 54,202 acre-feet of water per annum for municipal purposes within the service area of the Lower Neches Valley Authority. The water authorized herein shall be diverted from the following sources and in the amounts indicated:
- (1) Pine Island Bayou & the Neches River....4,202 acre-feet
- (2) Lake Sam Rayburn &  
B.A. Steinhagen Lake.....50,000 acre-feet

- B. Owner is authorized to divert and use not to exceed 711,314 acre-feet of water per annum for industrial purposes within the service area of the Lower Neches Valley Authority. The water authorized herein shall be diverted from the following sources and in the amounts indicated:

- (1) Pine Island Bayou & the Neches River...51,314 acre-feet
- (2) Lake Sam Rayburn &  
B.A. Steinhagen Lake.....660,000 acre-feet

- C. Owner is authorized to divert and use not to exceed 436,360 acre-feet of water per annum for the irrigation of 85,000 acres of land within the service area of the Lower Neches Valley Authority in Chambers, Liberty and Jefferson Counties, Texas. The water authorized herein shall be diverted from the following sources and in the amounts indicated:

- (1) Pine Island Bayou & the Neches River...326,360 acre-feet
- (2) Lake Sam Rayburn &  
B.A. Steinhagen Lake.....110,000 acre-feet

### 3. DIVERSION

#### Locations and rates:

- A. At the outlet works of the hydro-electric generating facilities at Sam Rayburn Dam located in the Thomas McGalin Grant, Abstract 26, Jasper County, Texas, at an unspecified maximum rate of diversion.
- B. At the outlet structure of B.A. Steinhagen Dam (Dam B) located in the James Perkins Grant, Abstract 29, Tyler County, Texas, at a maximum rate of not to exceed 2000 cfs (900,000 gpm).
- C. At a point on the Neches River in the Benjamin Richardson Survey, Abstract 413, Jasper County, Texas at a maximum rate of not to exceed 86.00 cfs (38,700 gpm).
- D. At a point on the Neches River in the A.W. Smith Grant, Abstract 47, Hardin County, Texas at an unspecified maximum rate of diversion.
- E. At a point on Pine Island Bayou in the Wesley Dyches Grant, Abstract 17, Jefferson County, Texas at a maximum rate of not to exceed 633.00 cfs (284,850 gpm).
- F. At a point on Pine Island Bayou in the Thomas Spear Grant, Abstract 50, Jefferson County, Texas at a maximum rate of not to exceed 633.00 cfs (284,850 gpm).

### 4. PRIORITY

- A. The time priority of owner's right is August 12, 1913, for the diversion and use of 107,108 acre-feet of water for irrigation purposes at a maximum rate of 450 cfs (202,500 gpm) at the diversion point located in the said Wesley Dyches Grant.
- B. The time priority of owner's right is November 8, 1913, for the diversion and use of an additional 219,252 acre-feet of water for irrigation purposes at a maximum rate of 588 cfs (264,600 gpm) at the diversion point located in the said Thomas Spear Grant.
- C. The time priority of owner's right is December 31, 1924, for the diversion and use of 4,202 acre-feet of water per annum for municipal purposes; 51,314 acre-feet of water per annum for industrial purposes; an additional 30 cfs (13,500 gpm) at the diversion point in the Wesley Dyches Grant and an additional 45 cfs (20,250 gpm) at the diversion point in the Thomas Spear G

## Certificate of Adjudication 06-4411

- D. The time priority of owner's right is November 12, 1963, for the diversion and use of the remaining 50,000 acre-feet of water per annum for municipal purposes; the remaining 660,000 acre-feet of water per annum for industrial purposes; the remaining 110,000 acre-feet of water for irrigation purposes and all of the 86.00 cfs (38,700 gpm) of the diversion rate at the diversion point in the Benjamin Richardson Survey.
5. SPECIAL CONDITIONS
- A. Owner's right to request release of, transport, divert, and use the water authorized for irrigation of the lands described herein shall not be construed as an exclusive license or right of the owner to supply water to said lands for irrigation or other beneficial uses.
- B. Owner must not claim any water imported into either the Angelina or Neches Rivers Basin by virtue of any rights authorized by this certificate of adjudication.
- C. Excepting municipal purposes, all of owner's right to divert and use public water, under the priority date of November 12, 1963, is subordinate to any present or future domestic and/or municipal water needs or requirements.
- D. Owner's rights, under the priority date of November 12, 1963, authorized by this certificate of adjudication, shall be subordinate to any rights hereafter granted by the Commission for storage and/or use of waters in and above the proposed Ponta Dam on the Angelina River and the proposed Weches Dam on the Neches River.
- E. Owner shall install and maintain automatic water metering instruments at the point of releases at Dam "B" and at the points of diversion authorized herein, which will record within five percent (5%) of accuracy, the water released, diverted and used.
- F. Owner shall return all water diverted but not consumed to the Neches River or to Taylor Bayou in Jefferson County, Texas.
- G. Owner shall keep a record, on a monthly basis, of the amount of water released from B. A. Steinhagen Reservoir (Dam "B") and diverted from the Neches River and Pine Island Bayou for each purpose authorized herein and shall report annually on forms provided by the Commission.
- H. Owner shall, upon request from the Commission, provide daily reservoir levels, daily releases of water through the dam, and daily inflows into the reservoir. Owner shall also provide sedimentation data within the reservoir and chemical quality data of the stored water.
- I. Owner shall file copies of all water supply contracts entered into with persons who receive water from any authorized diversion point.
- J. Owners shall make no diversions of water from the diversion points, downstream of the dam, under the priority date of November 12, 1963, except to the extent that water for such diversions is released from B. A. Steinhagen Reservoir (Dam "B").
- K. Owner is authorized to use the bed and banks of the Neches River, the Lakeview Canal and Pine Island Bayou below B. A. Steinhagen Dam (Dam "B"), to convey and deliver water to be appropriated here under to downstream diversion points.
- L. Owner shall order releases to be made by the Corps of Engineers from B. A. Steinhagen reservoir at any time so long as

such releases when combined with local runoff below Dam B will not cause flooding.

The locations of pertinent features related to this certificate are shown on Pages 8, 19, 22, and 24 of the Lower Neches and Angelina Rivers Segments Certificates of Adjudication Maps, copies of which are located in the office of the Texas Water Commission, Austin, Texas and the offices of the County Clerk of Jefferson, Hardin, Jasper, Tyler, Liberty and Chambers Counties.

This certificate of adjudication is issued subject to senior and superior water rights in the Neches River Basin.

This certificate of adjudication is issued subject to the Rules of the Texas Water Commission and its continuing right of supervision of State water resources consistent with the public policy of the State as set forth in the Texas Water Code.

TEXAS WATER COMMISSION

*Paul Hopkins*  
Paul Hopkins, Chairman

DATE ISSUED:

AUG 8 1986

ATTEST:

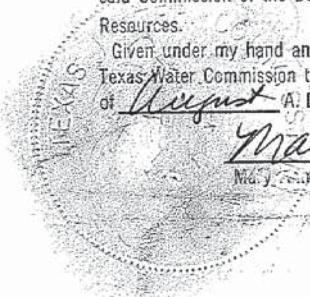
*Mary Ann Hefner*  
Mary Ann Hefner, Chief Clerk

STATE OF TEXAS  
COUNTY OF TRAVIS

I, Mary Ann Hefner, Chief Clerk of the Texas Water Commission, do hereby certify that *the foregoing* is a true and correct copy of an instrument on file in permanent records of said Commission of the Department of Water Resources.

Given under my hand and the seal of the Texas Water Commission this the *8th* day of *August* A. D., 19*86*.

*Mary Ann Hefner*  
Mary Ann Hefner, Chief Clerk



FILED FOR RECORD

1986 DEC 30 AM 11: 01

*Wanda Barker*  
COUNTY CLERK  
LIBERTY COUNTY, TEXAS

STATE OF TEXAS  
COUNTY OF LIBERTY  
I, WANDA BARKER, hereby certify that this instrument as FILED in file number sequence on the date and at the time stamped hereon by me, and was duly RECORDED in the volume and page of the OFFICIAL PUBLIC RECORDS of Liberty County, Texas, as stamped hereon by me on

DEC 31 1986

*Wanda Barker*  
COUNTY CLERK  
LIBERTY COUNTY, TEXAS



**EXHIBIT I**

**CONTRACT BETWEEN THE LOWER NECHES VALLEY AUTHORITY AND  
THE CITY OF LUFKIN**

**INTERLOCAL WATER USE AGREEMENT AND  
WATER DISTRIBUTION AGREEMENT**

Our Mission . . . To meet the needs of the Citizens

**Keith N. Wright, P.E.**  
*City Manager*  
City of Lufkin



300 East Shepherd  
P.O. Drawer 190  
Lufkin, Texas 75902-0190  
(936) 633-0211  
Fax: (936) 633-0381  
email: [kwright@cityoflufkin.com](mailto:kwright@cityoflufkin.com)

**RECEIVED**

**AUG 07 2017**

**Lower Neches Valley Authority**

August 2, 2017

Mr. Scott Hall, P.E.  
General Manager  
Lower Neches Valley Authority  
P. O. Box 5117  
Beaumont, Texas 77726-5117

Re: Interlocal Water Use and Distribution Agreement

Dear Mr. Hall:

Based on your previous requests, it is the City's opinion that the January 18, 2011 Water Use and Distribution Agreement that expired on January 18, 2016 was extended for five years per Item 5 of the agreement. The new expiration date of the agreement is January 18, 2021 unless otherwise renewed for an additional 5 years upon mutual agreement.

We appreciate your support and efforts. Let me know if you need any additional information.

Respectfully,

A handwritten signature in black ink that reads "Keith N. Wright". The signature is written in a cursive style.

Keith N. Wright, P.E.  
**City Manager**  
*City of Lufkin*

May 2011

**INTERLOCAL WATER USE AGREEMENT  
AND WATER DISTRIBUTION AGREEMENT**

This agreement, the agreement effective <sup>or January</sup> ~~December~~ 18, 2010<sup>1</sup>, by and between the City of Lufkin, a home rule city of the State of Texas ("Lufkin", "City") and the Lower Neches Valley Authority, a conservation and reclamation district and a political subdivision and body politic of the State of Texas ("Authority", "LNVA") (collectively Lufkin and LNVA are referred to as the Parties).

WHEREAS the City of Lufkin owns certain Texas state water rights and U.S. Army Corps of Engineers storage rights in the Sam Rayburn Reservoir in the amount of 28,000 acre foot, and

WHEREAS to maintain these federal rights the City must pay certain sums to the United States Government for its storage rights and for upkeep and maintenance of Sam Rayburn Dam, and

WHEREAS with the purchase of the Abitibi groundwater and surface water assets, Lufkin is in no present need to develop its Rayburn water supply for several decades, and

WHEREAS the City is currently has enough water from other sources, not to use these rights, and

WHEREAS the City and the Authority have worked together previously on water matters, and

WHEREAS the LNVA would like to make use of the City's State of Texas water rights and their US Corps of Engineers storage rights for the LNVA's use; and to assist the City of these storage costs and maintenance expenses, and

WHEREAS this agreement constitutes an interlocal agreement pursuant to Section 13b(c) of Article 8280-103 Vernon's Texas Civil Statute that will improve the quality or quantity of services essential for the development of viable communities and economic growth including the services relating to rural water

development and will contribute to the health and development of the community and private enterprise, and

WHEREAS the LNVA desires to expand its economic development program with the City in order to strengthen the economic base and further economic development of the State, and

WHEREAS LNVA is in the process of renewing its contract with the US Army Corps of Engineers (Corps) and, until that process is complete, is limited in its reservoir withdrawals, and

WHEREAS the Authority has established an economic development program pursuant to Article 8280-103 Vernon's Texas Civil Statute to serve that area surrounding Rayburn Reservoir, and

WHEREAS the Authority and the City would like to work together and share the use of these rights for a period of time, to help assist the City of those storage costs and upkeep and maintenance fees charged by the Corps, and bring water to areas presently needing this water from the perimeter of Lake Sam Rayburn.

NOW THEREFORE for and in consideration of the agreements of Parties set forth below and for other good and valuable consideration, the receipt of which is hereby acknowledged, the LNVA and the City of Lufkin agree as follows:

1. The recitals of this agreement including the terms of such recitals are hereby approved and incorporated in this agreement:
2. The LNVA and the City agree to share the use of the water rights noted above, as set forth herein, to bring water to areas presently needing water from the perimeter or within the watershed of Lake Sam Rayburn.
3. In furtherance thereof, the City agrees that the LNVA may market and manage the sale of its water rights to provide water to areas from the perimeter or within the watershed of Lake Sam Rayburn. This shall be an exclusive agreement.

4. Lufkin will retain its contract with the United States of America in good standing during the term of the assignment and maintain that contract in good standing. The City will notify the Corps of Engineers of this agreement.
5. The term of the Agreement is for an initial period of 5 years with optional 5 year renewal periods, at the discretion of the Parties.
6. Compensation to Lufkin during the initial term will be twenty-five (25%) percent of the Gross Revenue that the LNVA and Lufkin generate with the sale of the City's water payable quarterly as received by the LNVA.
7. With each payment of compensation required herein, the LNVA agrees to furnish to the City a statement that provides the total amount of water marketed at what price to customers during the compensation period covered by the payment.
8. In addition, the LNVA agrees to provide an annual report to the City of all water marketed including the terms of such water contracts.
9. During the Term of the Agreement, it will be Lufkin's duty to maintain its water rights and storage contract. It will be the LNVA's duty and responsibility to market the water, arrange for its delivery and collect the money due on the sale of the water.
10. *Insurance.* LNVA will name the City of Lufkin as an additional insured on its liability insurance policy. LNVA will require all Purchasers to have liability insurance in the amount of five million dollars (\$5,000,000) and name the LNVA and City of Lufkin as additional insured and have the Purchasers policies to be primary. LNVA will require all Purchasers to hold the LNVA and City of Lufkin harmless and to indemnify them for any consequences of their use of the water.
11. *Assignment of Agreement.* Neither Party may assign or transfer this Agreement in whole or in part by contract or by operation of law to any person or entity without the prior written consent of the other Party. A Contract for Sale of Water shall not be deemed a transfer and an assignment. Any purported assignment in contravention of this section shall be null and void. The consent of either Party to any assignment, or

any other assignment permitted hereunder, shall not constitute consent to further assignment. This Agreement shall be binding on the Parties and their respective permitted successors and assigns.

12. *Notices.* Except as otherwise specified in this Agreement, all notices, requests, approvals, and consents and other communications required or permitted under this Agreement shall be in writing and shall be deemed given the third day after being sent by (1) first class U.S. Mail, registered or certified, return receipt requested, postage pre-paid or (2) U.S. Express Mail, Federal Express, or other similar overnight bonded delivery services to the other at the address set forth below:

In the case of Lufkin:           City of Lufkin  
  P.O. Drawer 190  
  Lufkin, Texas 75902  
  Attn. City Managers

In the case of LNVA:           Lower Neches Valley Authority  
  7850 Eastex Freeway  
  Beaumont, Texas 77708-2815  
  P.O. Box 5117  
  Beaumont, Texas 77726-5117  
  Attention: General Manager

13. *Counterparts.* This Agreement shall be executed in any number of counterparts, all of which taken together shall constitute one single agreement between the Parties.

14. *Relationships.* The Parties intend to create a Governmental Interlocal Agreement relationship and nothing contained in this Agreement shall be construed to make either LNVA or Lufkin partners, joint ventures, principals, agents, or employees of the other. No officer, director, employee, agent, affiliate, or contractor retained by LNVA to perform work hereunder shall be deemed to be an employee, agent, or contractor of Lufkin. Neither Party shall have any right, power, or authority, express or implied, except as specifically allowed under the provisions of this Agreement, to bind the other. Except as set forth in this Agreement, LNVA alone shall be responsible for determining the

method, details, and means of performing its duties and obligations under this Agreement. Nothing contained herein shall be interpreted as a sale of any water right by or to any Party

15. *Consents, Approvals, and Requests.* Except as specifically set forth in this Agreement, all consents, approvals, acceptances, or similar actions to be given by either Party under this Agreement shall not be unreasonably withheld or delayed and each Party shall make only reasonable requests to the other Party under this Agreement.
16. *Severability.* If any provision of this Agreement (other than a term or provision relating to a substantial part of any payment obligation) is held by a court of competent jurisdiction to be contrary to law, then the remaining provisions of this Agreement shall remain in full force and effect.
17. *No Waiver.* No Governmental immunity or defense is waived by either Party to this Agreement. Nothing contained herein shall be construed as a consent to be sued.
18. *Entire Agreement.* This Agreement represents the entire agreement between the Parties with respect to its subject matter, and there are no other representations, understandings, or agreements between the Parties relative to such subject matter.
19. *Amendments.* No amendment to, or change, waiver or discharge of, any provision of this Agreement shall be valid unless in writing and signed by an authorized representative of the Party against which such amendment, change, waiver, or discharge is sought to be enforced.
20. *Third Party Beneficiaries.* Each Party intends that his Agreement shall not benefit, or create any right or cause of action in or on behalf of, any person or entity other than Lufkin and LNVA and their respective Permitted Assigns.
21. *Governing Law.* THIS AGREEMENT AND THE RIGHTS AND OBLIGATIONS OF THE PARTIES HEREUNDER SHALL BE CONSTRUED IN ACCORDANCE WITH AND BE GOVERNED BY THE LAWS OF THE STATE OF TEXAS. NEITHER THE LNVA NOR THE CITY WAIVES ANY IMMUNITY OR GOVERNMENTAL DEFENSE OR GIVES CONSENT TO BE SUED.

IN WITNESS WHEREOF, City of Lufkin and Lower Neches Valley Authority have each caused this Agreement to be signed and delivered by its duly authorized representative.

CITY OF LUFKIN

By: Paul F. Parker  
City Manager

Date: 12-22-10

LOWER NECHES VALLEY  
AUTHORITY

By: J. D. Webb  
President, Board of Directors

Date: 01-18-11

**EXHIBIT J**

**LOWER NECHES VALLEY AUTHORITY**

**DROUGHT CONTINGENCY PLAN**

# **LOWER NECHES VALLEY AUTHORITY**

## **DROUGHT CONTINGENCY PLAN**



***REVISED FEBRUARY 2017***

***this plan supersedes all previous revisions***

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# **DROUGHT CONTINGENCY PLAN**

## **1.0 Declaration of Policy, Purpose, and Intent**

The Lower Neches Valley Authority (“LNVA” or the “Authority”), has long recognized the importance of being prepared to address any water shortage conditions in the Neches and Trinity river basins as it may affect many industrial, municipal, and agricultural customers. This Drought Contingency Plan is reviewed and updated regularly, on intervals of not more than five (5) years, to ensure it contains current and pertinent information along with maintaining compliance with the Texas Administrative Code Title 30, Part 1, Chapter 288, Subchapter B.

In order to conserve the available water supply and/or to protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, safety, and welfare and minimize the adverse impacts of water supply shortages and other water supply emergency conditions, the Lower Neches Valley Authority adopts the following Drought Contingency Plan (the “Plan”). The Plan will identify drought response measures for the Neches and Trinity river basins, based on pool elevations at Sam Rayburn Reservoir and Lake Livingston, respectively.

Furthermore, the rate adjustments specified herein are not penalties, but shall be for the purposes of encouraging conservation of existing water supplies and the development of new water supplies.

## **2.0 Public Involvement**

Opportunity for the public and wholesale water customers to provide input into the preparation of the Plan was provided by means of publishing written notice of a public meeting to discuss the draft Plan and subsequently holding discussion regarding the draft Plan during a regularly scheduled open meeting of the LNVA Board of Directors.

## **3.0 Wholesale Water Customer Notification**

The LNVA will periodically provide wholesale water customers with information about the Plan, including information about the conditions under which each stage of the Plan is to be

initiated or terminated and the drought response measure to be implemented in each stage. This information will be provided by means of distributing copies of the approved Plan to the LNVA customers by mail as well as posting it on the LNVA's website.

#### **4.0 Coordination with Regional Water Planning Group**

The water service area of the LNVA is located within the Senate Bill One water planning areas Region I and Region H. Upon LNVA Board approval of this Plan, a copy of the Plan will be provided to those Regional Water Planning Groups to ensure consistency with the approved regional water plan(s).

#### **5.0 Authorization**

The General Manger of the LNVA, or his/her designee, is hereby authorized and directed to implement the applicable provisions of this Plan upon determination that such implementation is necessary to protect public health, safety, and welfare. The General Manager, or his/her designee, shall have the authority to initiate or terminate water shortage or other water supply emergency response measures as described in this Plan.

The Drought Contingency Plan adopted by the LNVA will have a significant impact on the availability of water to the LNVA customers during periods of protracted low flows. The various "trigger" conditions, demand measures, contingency management, and operation measures are outlined in this Plan.

#### **6.0 Application**

The provisions of the Plan shall apply to all customers utilizing water provided by the LNVA as identified in the three regions outlined in Section 7. Every wholesale water contract, including contract extensions, entered into or renewed by LNVA after the adoption of this plan is subject to the terms of the Authority's current Drought Contingency Plan, and in the case of water shortage resulting from drought, the water to be distributed shall be divided in accordance with Texas Water Code, §11.039 (See Section 9 of this Plan).

## **7.0 Definition of Service Area**

Three (3) service areas; LNVA, Devers North, and Devers South are identified in maps enclosed as Appendices A thru D. The LNVA service area (Appendix B) is comprised of canals supplied with water solely from the Neches river basin. The Devers North service area (Appendix C) is comprised of canals supplied with water solely from the Trinity river basin. The Devers South service area (Appendix D) is comprised of canals that may be supplied with water from both the Neches or Trinity river basins.

## **8.0 Trigger Conditions, Demand Management Measures, Operational Procedures, and Goals**

The triggering criteria described below are based on water contracts, demands placed on the various components of the water supply system, drought of record determinations for the reservoir(s), and any requirements placed on LNVA by the owners of the reservoir(s) in which LNVA holds water rights.

The General Manager, or his/her designee, shall monitor water supply conditions on a monthly basis and shall determine when conditions warrant initiation or termination of each stage of the Plan. Customer notification of the initiation or termination of drought response stages will be made by mail and/or telephone. The news media will also be informed.

### **8.1 LNVA Service Area**

Under the operating guidelines established by the U.S. Army Corps of Engineers for Sam Rayburn Reservoir, the conservation storage space is divided into four (4) zones which vary throughout the year on a seasonal basis. The Corps of Engineers regulates releases from the reservoir for flood control, hydropower generation, and water supply. Releases greater than that required for water supply are considered to be available as long as the water surface remains within the flood pool or upper zones of the conservation pool. When the water surface elevation in the reservoir drops into the lower zones of the conservation pool, the Corps of Engineers restricts releases to the greater of water supply requirements or minimum contractual hydropower generation releases, potentially impacting customers within the LNVA and Devers South portions of the canal system.

The LNVA has established trigger conditions for these areas based on the water surface elevation in Sam Rayburn Reservoir. The trigger conditions are described along with the actions taken and goals of the response measures for each water shortage stage as follows:

#### Stage I – Mild Water Shortage Condition

Requirements for Initiation: The LNVA will recognize a mild water shortage condition is in progress when the water surface elevation in Sam Rayburn Reservoir falls below 153.0 MSL for a continuous period of five (5) days. With Sam Rayburn water surface at elevation 153.0 MSL, the remaining water in the conservation pool is sufficient to sustain LNVA’s water use demands for approximately one year without significant rainfall in the basin.

Goal: Achieve a 90 percent reduction from non-essential water use and a 10 percent reduction in total water use.

#### Measures:

- (a) LNVA will inform its customers by mail and/or telephone. The news media will also be informed of the seriousness of the water supply situation. Drought and water supply status reports will be issued to customers and the news media on a regular basis. If necessary during the progress of a mild water shortage condition, the Authority management may call emergency meetings with its customers to discuss major operational changes and conservation strategies.
- (b) As the situation dictates, the LNVA may reduce water delivery. Any curtailment of wholesale water contracts for the purpose of human consumption will be made on a pro-rata basis in accordance with state regulation (See Section 9).
- (c) The LNVA will request its municipal customers evaluate the need for mandatory water use restrictions. These restrictions may include prohibited outdoor water use and implementation of applicable conservation measures to minimize indoor uses until the water shortage condition is terminated.
- (d) The LNVA will request its industrial customers minimize process water use to the extent feasible and encourage basic water conservation practices among employees.

- (e) LNVA personnel will monitor irrigation field levees, laterals, drains and other water delivery facilities to prevent wasting of water. Gates furnishing water to a field where water is being wasted may be closed and locked if no attempt has been made to stop the loss within 12 hours of notification, or if the loss has not been stopped within 24 hours.

Requirements for Termination: The LNVA will recognize that a mild water shortage condition has ended when the water surface elevation in Sam Rayburn Reservoir is above 153.0 MSL for fifteen (15) consecutive days. The LNVA will notify its customers and the media of the termination of Stage I in the same manner as the notification of initiation of Stage I.

## **Stage II – Moderate Water Shortage**

Requirements for Initiation: The LNVA will recognize that a moderate water shortage condition is in progress when the water surface elevation in Sam Rayburn Reservoir falls below 151.5 MSL for a continuous period of five (5) days. At a water surface at elevation of 151.5 MSL, sufficient water remains in the Sam Rayburn Reservoir water conservation pool to sustain LNVA's water use demands for approximately six months without significant rainfall in the basin.

Goal: Eliminate all non-essential water use to the maximum extent possible and achieve a 20 percent reduction in total water use.

### Measures:

- (a) LNVA will inform its customers by mail and/or telephone. The news media will also be informed of the seriousness of the water supply situation. Drought and water supply status reports will be issued to customers and the news media on a regular basis. If necessary during the progress of a moderate water shortage condition, the Authority management may call emergency meetings with its customers to discuss major operational changes and conservation strategies.

- (b) As the situation dictates, the LNVA may reduce water delivery. Any curtailment of wholesale water contracts for the purpose of human consumption will be made on a pro-rata basis in accordance with state regulation (See Section 9).
- (c) The LNVA will request its municipal customers initiate mandatory water use restrictions. These restrictions may include prohibited outdoor water use and implementation of applicable conservation measures to minimize indoor uses until the water shortage condition improves to mild or better condition. The LNVA will notify the TCEQ executive director within five (5) business days of the implementation of any mandatory provisions under the Plan.
- (d) The LNVA will request its industrial customers minimize process water use to the extent feasible and encourage basic water conservation practices among employees.
- (e) LNVA personnel will monitor any irrigation field levees, laterals, drains and other water delivery facilities to prevent wasting of water. As an interruptible supply, the availability of irrigation water may be curtailed. Gates furnishing water to a field where water is being wasted will be closed and locked and the irrigation customer will be notified that no additional water will be supplied until losses are stopped and any other wasteful practice have been corrected.
- (f) The LNVA will no longer allow keep up streams to be supplied for irrigation customers, and field top-offs will be utilized.
- (g) The LNVA will not approve new water sales contracts for low priority customers, such as small water sales, or issue new permits for irrigation and temporary construction permits.

Requirements for Termination: The LNVA will recognize that a moderate water shortage condition has ended when the water surface elevation in Sam Rayburn Reservoir is above 151.5 MSL for fifteen (15) consecutive days. The LNVA will notify its customers and the media of the termination of Stage II in the same manner as the notification of initiation of Stage II.

### **Stage III – Severe Water Shortage Condition**

Requirements for Initiation: The LNVA will recognize that a severe water shortage condition is in progress when the water surface elevation in Sam Rayburn Reservoir falls below 149.00 MSL

for a continuous period of five (5) days. Once the water surface elevation in Sam Rayburn Reservoir falls to 149.00 MSL, the water remaining in the conservation pool at Lake BA Steinhagen will only be sufficient to sustain LNVA's water use demands for approximately three months without significant rainfall in the basin. The LNVA will determine availability of irrigation and any other uncontracted water supplies by March 1st each year. An emergency water supply may be made available from the inactive pool of Sam Rayburn Reservoir upon approval of the US Army Corps of Engineers.

Goal: Eliminate all non-essential water use to the maximum extent possible and achieve a 30 percent reduction in total water use.

Measures:

- (a) LNVA will inform its customers by mail and/or telephone. The news media will also be informed of the seriousness of the water supply situation. Drought and water supply status reports will be issued to customers and the news media on a regular basis. If necessary during the progress of a severe water shortage condition, the Authority management may call emergency meetings with its customers to discuss major operational changes and conservation strategies.
- (b) As the situation dictates, the LNVA may reduce water delivery. Any curtailment of wholesale water contracts for municipal and industrial use will be made on a pro-rata basis in accordance with state regulation (See Section 9).
- (c) The LNVA will direct its municipal customers to institute mandatory water use restrictions. These restrictions may include prohibited outdoor water use and implementation of applicable conservation measures to minimize indoor uses until the water shortage condition improves to moderate or better condition. The LNVA will notify the TCEQ executive director within five (5) business days of the implementation of any mandatory provisions under the Plan.
- (d) The LNVA will direct its industrial customers minimize process water use to the extent feasible and encourage basic water conservation practices among employees.

- (e) **All interconnects delivering water from the Neches basin to the Devers South (described in Appendix D) will be closed.**
- (f) **ALL INTERRUPTIBLE WATER SUPPLIES, INCLUDING IRRIGATION AND UNCONTRACTED SUPPLIES WILL BE EVALUATED TO DETERMINE AVAILABILITY ON MARCH 1<sup>ST</sup> EVERY YEAR. NO STORED WATER WILL BE RELEASED FROM THE SAM RAYBURN RESERVOIR TO PROVIDE WATER FOR INTERRUPTIBLE SERVICES.**

Requirements for Termination: The LNVA will recognize that a severe water shortage condition has ended when the water surface elevation in Sam Rayburn Reservoir is above 149.00 MSL for fifteen (15) consecutive days. The LNVA will notify its customers and the media of the termination of Stage III in the same manner as the notification of initiation of Stage III. When flood inflows raise reservoir levels above more than one trigger level, multiple stages can be terminated concurrently.

#### **Stage IV - Emergency Water Shortage Condition**

Requirements for Initiation: The LNVA will recognize that an Emergency Water Shortage Condition is in progress upon the failure of a major component of the water supply including the pumps or canals in the LNVA's distribution system, or the contamination of the canals or source water supply which substantially curtails LNVA's ability to supply water to its customers.

Goal: Achieve maximum water use reductions to sustain essential supply for public health, safety, and welfare for the maximum period during the period of the emergency conditions.

#### Measures:

- (a) LNVA will inform its customers by mail and/or telephone. Depending on the extent of the service area affected, the news media may also be informed of the seriousness of the water supply situation.
- (b) Emergency contingency measures similar to those for various water shortage conditions as previously described may be implemented, as appropriate.

- (c) LNVA will notify its affected customers of the situation and make operational changes as needed until the emergency is resolved.
- (d) The General Manager shall act as quickly as possible to:
  - (1) Assess the severity of the problem and identify the actions needed and time required to solve the problem.
  - (2) Inform the utility director or other responsible official of each wholesale water customer by telephone or in person and suggest actions, as appropriate, to mitigate impacts and alleviate problems.
  - (3) If appropriate, notify city, county, and/or state emergency response officials for assistance.
  - (4) Undertake necessary actions, including repairs and/or clean-up as needed.
- (e) Once the initiating events for the Emergency Water Shortage Condition have been mitigated, the General Manager shall prepare a post-event assessment report on the incident and critique of emergency response procedures and actions.

Requirements for Termination: The LNVA will recognize that an emergency water shortage condition has ended when all the conditions identified as triggering events and the impacts thereof have ceased. The LNVA will notify its customers and the media of the termination of the Emergency Water Storage Condition in the same manner as the notification of initiation of the Emergency Water Storage Condition.

## **8.2 Devers North Service Area**

Under the operating guidelines established by the Trinity River Authority (TRA), the conservation storage space in Lake Livingston is divided into three zones which vary through the year on a seasonal basis. TRA currently owns 30% of the water rights for Lake Livingston and the Wallisville Projects described in Certificate of Adjudication No. 08-4248. The TRA regulates releases from the reservoir for wholesale raw water supply which includes municipal, irrigation, and industrial customers.

The LNVA owns rights to 30,000 acre-feet of water per year from the Trinity River. The water pulled from the river is delivered throughout the Devers North and Devers South systems for agricultural use.

The LNVA has established trigger conditions based on the water surface elevation in Lake Livingston as described in the TRA Water Conservation Plan. The trigger conditions are described, along with the actions taken and goals of the response measures for each water shortage stage, as follows:

### **Stage I – Mild Water Shortage Condition**

Requirements for Initiation: The LNVA will recognize that a mild water shortage condition is in progress in the Trinity River basin when the water surface elevation in Lake Livingston falls below 126.50 MSL as measured by the USGS gage at the spillway of the dam. At a water surface elevation of 126.50 MSL, 80% of the normal conservation storage remains.

Goal: Achieve a 90 percent reduction from non-essential water use.

Measures:

- (a) LNVA will inform its customers by mail and/or telephone. The news media will also be informed of the seriousness of the water supply situation. Drought and water supply status reports will be issued to customers and the news media on a regular basis. If necessary during the progress of a mild water shortage condition, the Authority management may call emergency meetings with its customers to discuss major operational changes and conservation strategies.
- (b) The LNVA will request its customers evaluate the need for mandatory water use restrictions.
- (c) LNVA personnel will monitor irrigation field levees, laterals, drains and other water delivery facilities to prevent wasting of water. Gates furnishing water to a field where water is being wasted may be closed and locked if no attempt has been made to stop the loss within 12 hours of notification, or if the loss has not been stopped within 24 hours.

Requirements for Termination: The LNVA will recognize that a severe water shortage condition has ended when the water surface elevation in Lake Livingston is above 126.50 MSL for 15

consecutive days. The LNVA will notify its customers and the media of the termination of Stage I in the same manner as the notification of initiation of Stage I.

## **Stage II – Moderate Water Shortage**

Requirements for Initiation: The LNVA will recognize that a moderate water shortage condition is in progress when the water surface elevation in Lake Livingston falls below 124.00 MSL as measured by the USGS gage at the spillway of the dam. At a water surface elevation of 124.00 MSL, 70% of the normal conservation storage remains.

Goal: Eliminate all non-essential water use to the maximum extent possible and achieve a 15 percent reduction in total water use.

### Measures:

- (a) LNVA will inform its customers by mail and/or telephone. The news media will also be informed of the seriousness of the water supply situation. Drought and water supply status reports will be issued to customers and the news media on a regular basis. If necessary during the progress of a moderate water shortage condition, the Authority management may call emergency meetings with its customers to discuss major operational changes and conservation strategies.
- (b) As the situation dictates, the LNVA may reduce water delivery. Any curtailment of wholesale water contracts will be made on a pro-rata basis in accordance with state regulation (See Section 9).
- (c) The LNVA will request its customers initiate mandatory water use restrictions. The LNVA will notify the TCEQ executive director within five (5) business days of the implementation of any mandatory provisions under the Plan.
- (d) LNVA personnel will monitor any irrigation field levees, laterals, drains and other water delivery facilities to prevent wasting of water. As an interruptible supply, the availability of irrigation water may be curtailed. Gates furnishing water to a field where water is being wasted will be closed and locked and the irrigation customer will be notified that

no additional water will be supplied until losses are stopped and any other wasteful practice have been corrected.

- (e) The LNVA will no longer allow keep up streams to be supplied for irrigation customers, and field top-offs will be utilized.
- (f) The LNVA will not approve new water sales contracts for low priority customers such as small water sales, or issue new permits for irrigation, and temporary construction permits.

Requirements for Termination: The LNVA will recognize that a moderate water shortage condition has ended when the water surface elevation in Lake Livingston is above 124.00 MSL for 15 consecutive days. The LNVA will notify its customers and the media of the termination of Stage II in the same manner as the notification of initiation of Stage II.

### **Stage III – Severe Water Shortage Condition**

Requirements for Initiation: The LNVA will recognize that a severe water shortage condition is in progress when the water surface elevation in Lake Livingston falls below 121.40 MSL as measured by the USGS gage at the spillway of the dam. At a water surface elevation of 121.40, 60% of the normal conservation storage remains. The LNVA will determine availability of irrigation and any other uncontracted water supplies by March 1st each year.

Goal: Eliminate all non-essential water use to the maximum extent possible and achieve a 25 percent reduction in total water use.

#### Measures:

- (a) LNVA will inform its customers by mail and/or telephone. The news media will also be informed of the seriousness of the water supply situation. Drought and water supply status reports will be issued to customers and the news media on a regular basis. If necessary during the progress of a severe water shortage condition, the Authority management may call emergency meetings with its customers to discuss major operational changes and conservation strategies.

- (b) As the situation dictates, the LNVA may reduce water delivery. Any curtailment of water contracts will be made on a pro-rata basis in accordance with state regulation (See Section 9).
- (c) **LNVA WILL TERMINATE THE WATER SUPPLY TO LOW PRIORITY CUSTOMERS SUCH AS SMALL WATER SALES, AND DENY ISSUANCE OF TEMPORARY CONSTRUCTION PERMITS. ALL INTERRUPTIBLE WATER SUPPLIES, INCLUDING IRRIGATION AND UNCONTRACTED SUPPLIES WILL BE EVALUATED TO DETERMINE AVAILABILITY BY MARCH 1<sup>ST</sup> EVERY YEAR.**
- (d) **Stage III of the plan may be rescinded when the Lake Livingston is at or above 121.40 feet MSL for a period of 15 consecutive days. Upon termination of Stage III, Stage II becomes operative. LNVA will notify its customers and the media of termination of Stage III in the same manner as the notification of initiation of Stage I of the Plan. When flood inflows raise reservoir levels above more than one trigger level, multiple stages can be terminated concurrently.**

#### **Stage IV - Emergency Water Shortage Condition**

Requirements for Initiation: The LNVA will recognize that an Emergency Water Shortage Condition is in progress upon the failure of a major component of the water supply including the pumps or canals in the LNVA's distribution system, or the contamination of the canals or source water supply which substantially curtails LNVA's ability to supply water to its customers.

Goal: Achieve maximum water use reductions to sustain essential supply for public health, safety, and welfare for the maximum period during the period of the emergency conditions.

Measures:

- (a) LNVA will inform its customers by mail and/or telephone. Depending on the extent of the service area affected, the news media may also be informed of the seriousness of the water supply situation.
- (b) Emergency contingency measures similar to those for various water shortage conditions as previously described may be implemented, as appropriate.
- (c) LNVA will notify its affected customers of the situation and make operational changes as needed until the emergency is resolved.
- (d) The General Manager shall act as quickly as possible to:
  - a Assess the severity of the problem and identify the actions needed and time required to solve the problem.
  - b Inform the utility director or other responsible official of each wholesale water customer by telephone or in person and suggest actions, as appropriate, to mitigate impacts and alleviate problems.
  - c If appropriate, notify city, county, and/or state emergency response officials for assistance.
  - d Undertake necessary actions, including repairs and/or clean-up as needed.
- (e) Once the initiating events for the Emergency Water Shortage Condition have been mitigated, the General Manager shall prepare a post-event assessment report on the incident and critique of emergency response procedures and actions.

Requirements for Termination: The LNVA will recognize that an emergency water shortage condition has ended when all the conditions identified as triggering events and the impacts thereof have ceased. The LNVA will notify its customers and the media of the termination of Emergency Water Storage Condition in the same manner as the notification of initiation of Emergency Water Storage Condition.

### **8.3 Devers South Service Area**

In the event the entire Devers Canal System, North and South, has less than 10,000 acres of water delivery contracts executed in a given year, only the trigger conditions and corresponding water shortage stages from the TRA Water Conservation Plan apply as described in Section 9 (Devers North Service Area). If more than 10,000 acres of water supply contracts

are executed in a given year, both TRA and LNVA trigger conditions and corresponding water shortage stages may apply as described in Section 9 (Devers North Service Area) and Section 8 (LNVA Service Area).

## **9.0 Pro-Rata Water Allocation**

In the event that the trigger criteria specified in Section 8 of the Plan for Stage I or higher have been met, the General Manger is hereby authorized to initiate allocation of water supplies. This allocation shall be performed in accordance with the State regulation in effect and in force at the time of the shortage. The regulation currently in effect is the Texas Water Code Section 11.039 shown below, which distributes water among all customers on a pro-rata basis.

### *§ 11.039. DISTRIBUTION OF WATER DURING SHORTAGE.*

- (a) If a shortage of water in a water supply not covered by a water conservation plan prepared in compliance with Texas Natural Resource Conservation Commission or Texas Water Development Board rules results from drought, accident, or other cause, the water to be distributed shall be divided among all customers pro rata, according to the amount each may be entitled to, so that preference is given to no one and everyone suffers alike.*
- (b) If a shortage of water in a water supply covered by a water conservation plan prepared in compliance with Texas Natural Resource Conservation Commission or Texas Water Development Board rules results from drought, accident, or other cause, the person, association of persons, or corporation owning or controlling the water shall divide the water to be distributed among all customers pro rata, according to:
  - (1) the amount of water to which each customer may be entitled; or*
  - (2) the amount of water to which each customer may be entitled, less the amount of water the customer would have saved if the customer had operated its water system in compliance with the water conservation plan.**
- (c) Nothing in Subsection (a) or (b) precludes the person, association of persons, or corporation owning or controlling the water from supplying water to a person who has a prior vested right to the water under the laws of this state.*

*Amended by Acts 1977, 65th Leg., p. 2207, ch. 870, § 1, eff. Sept. 1, 1977; Acts 2001, 77th Leg., ch. 1126, § 1, eff. June 15, 2001.*

## **10.0 Enforcement**

During periods of water shortage as defined above, the following rate adjustments shall apply:

- (a) For all water taken during a Stage 1 – Mild Water Shortage Condition the applicable water rate shall be increased by 25%
- (b) For all water taken during a Stage II – Moderate Water Shortage Condition the applicable water rate shall be increased by 50%
- (c) For all water taken during a Stage III – Severe Water Shortage Condition or Stage V – Emergency Water Shortage Condition the applicable rate shall be increased by 100%
- (d) During times of pro-rata allocation, as prescribed by the General Manager, contracted water volumes shall be reduced to the pro-rata allotment and all water diverted in excess of the adjusted contract volume shall be charged at the uncontracted rate with the corresponding rate adjustment. For contracted municipal and industrial customers without a specified contract volume, pro-rata allocations shall be determined based on monthly average diversion for the previous calendar year.
- (e) All interruptible water supplies, including irrigation and uncontracted supplies will be restricted to any excess flows available in the Neches River and rate adjustments as defined above shall apply.
- (f) Failure to comply with these mandatory provisions may result in temporary suspension of service.

### **11.0 Variances**

The General Manager, or his/her designee, may, in writing, grant a temporary variance to the pro-rata allocation policies provided by this Plan if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the public health, welfare, or safety and if one or more of the following conditions is met:

- (a) Compliance with this Plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the Plan is in effect.
- (b) Alternative methods can be implemented which will achieve the same level of reduction in water use.

Persons requesting an exception from the provisions of this Plan shall file a petition for variance with the General Manager. All petitions for variances shall include the following:

- (a) Name and address of the petitioner(s).
- (b) Detailed statement with supporting data and information as to how the pro-rata allocation of water under the policies and procedures established in the Plan adversely affects the petitioner or what damage or harm will occur to the petitioner or others if petitioner complies with this Ordinance.
- (c) Description of the relief requested.
- (d) Period of time for which the variance is sought.
- (e) Alternative measures the petitioner is taking or proposes to take to meet the intent of this Plan and the compliance data.
- (f) Other pertinent information.

Variations granted by the General Manager shall be subject to the following conditions, unless waived or modified by the General Manager or his designee.

- (a) Variations granted shall include a timetable for compliance.
- (b) Variations granted shall expire when the water shortage condition under which the petitioner made a request for variance has terminated.
- (c) Variations granted may be terminated with a 14 day notice by the Authority if, upon notification, grantee fails to take immediate measures to meet specified requirements of the variance.

No variance shall be granted with regards to the rate adjustment schedule as defined in Section 10 - Enforcement.

No variance shall be retroactive or otherwise justify any violation of this Plan occurring prior to the issuance of the variance.

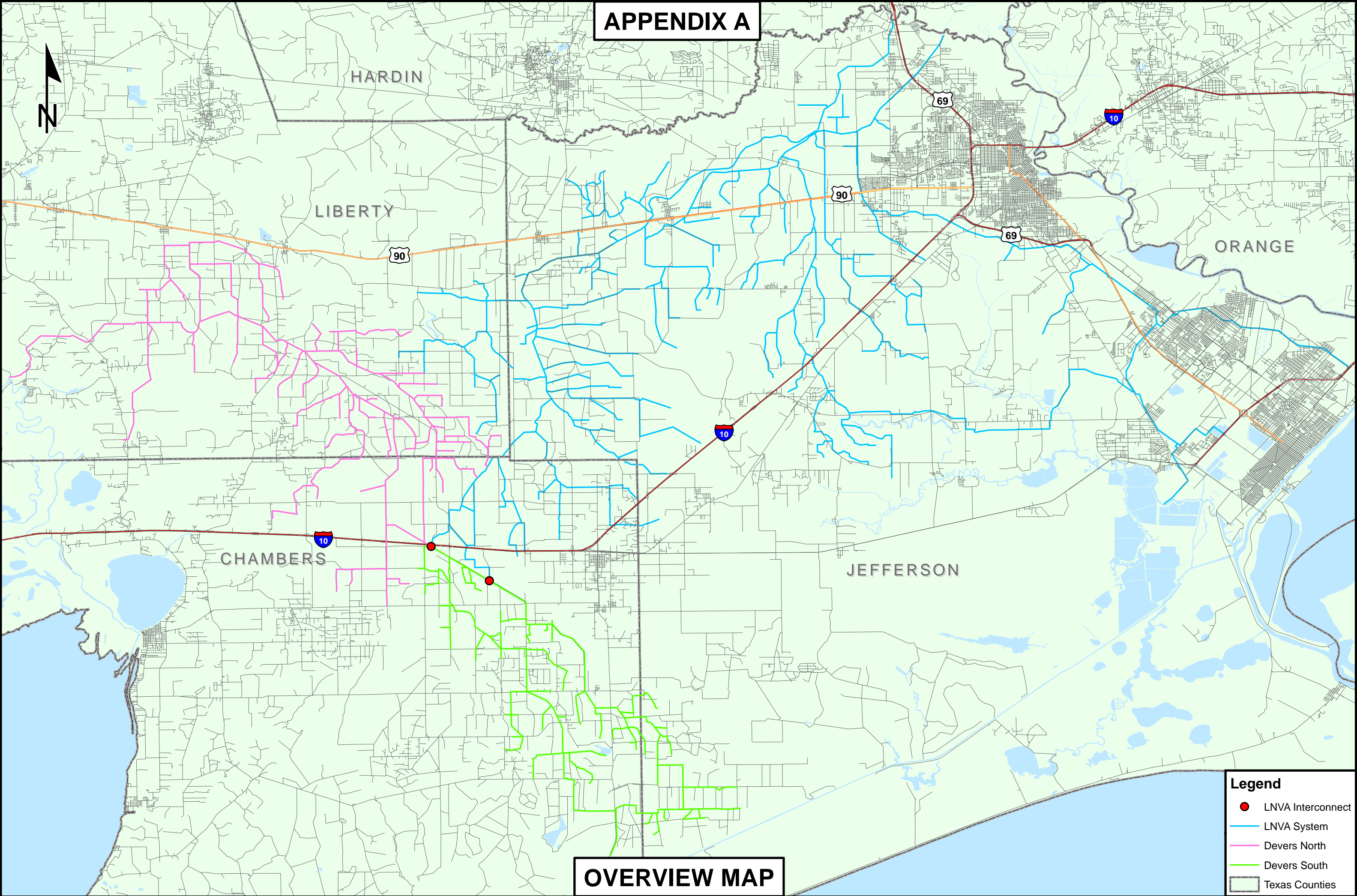
## **12.0 Severability**

It is hereby declared to be the intention of the LNVA Board of Directors that the sections, paragraphs, sentences, clauses, and phrases of this Plan are severable and, if any phrase, clause, sentence, paragraph, or section of this Plan shall be declared unconstitutional by the valid judgment or decree of any court of competent jurisdiction, such unconstitutionality shall not affect any of the remaining paragraphs, sentences, clauses, and phrases and sections of this Plan, since the same would not have been enacted by the LNVA Board of Directors without the incorporation into this Plan of any such unconstitutional phrase, clause, sentence, paragraph, or section.

# **APPENDIX A**

## **OVERALL REGION SERVICE AREA MAP**

# APPENDIX A



# OVERVIEW MAP

**Legend**

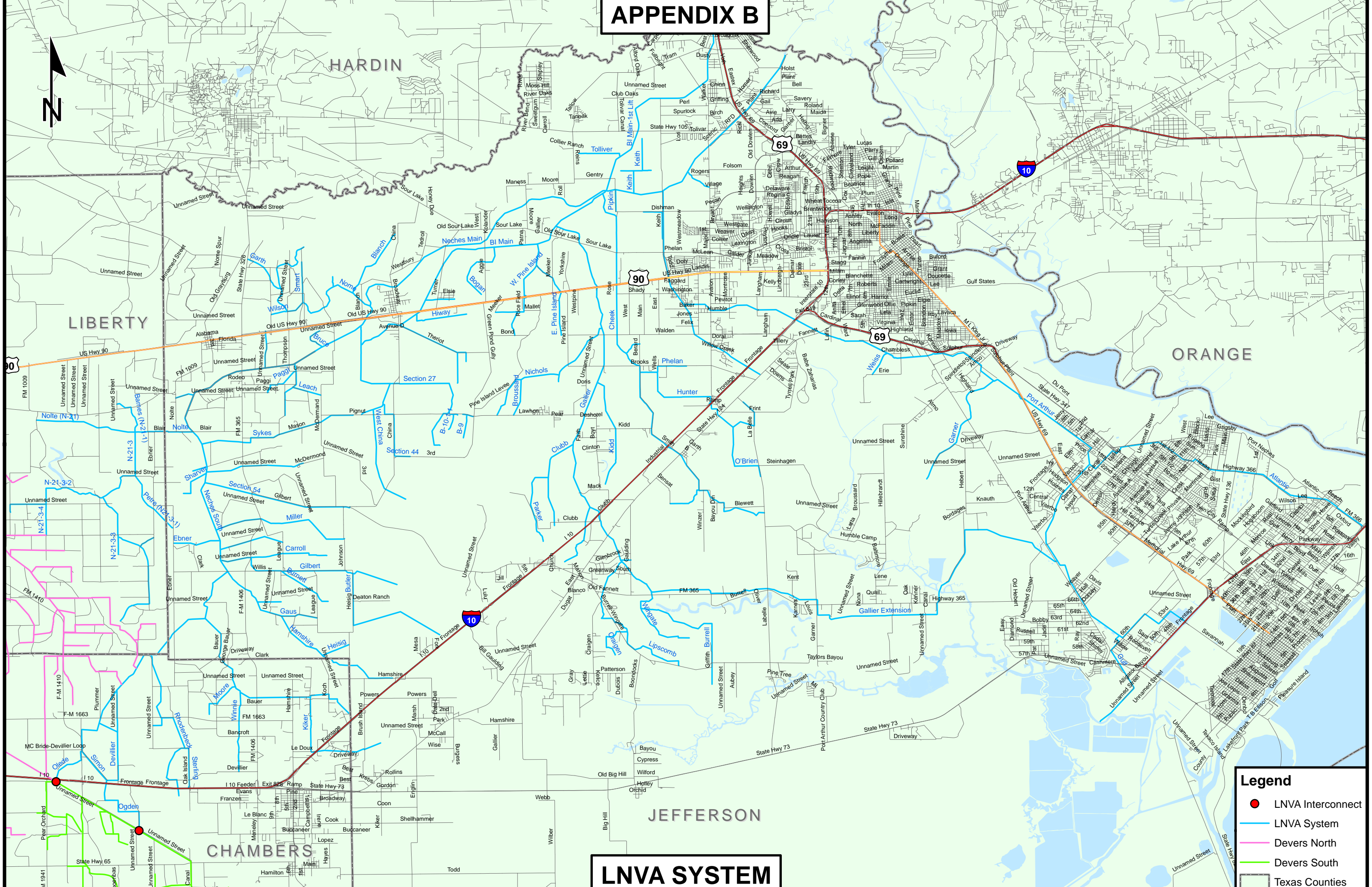
- LNVA Interconnect
- LNVA System
- Devers North
- Devers South
- ▭ Texas Counties

# **APPENDIX B**

## **LNVA**

### **SERVICE AREA MAP**

# APPENDIX B

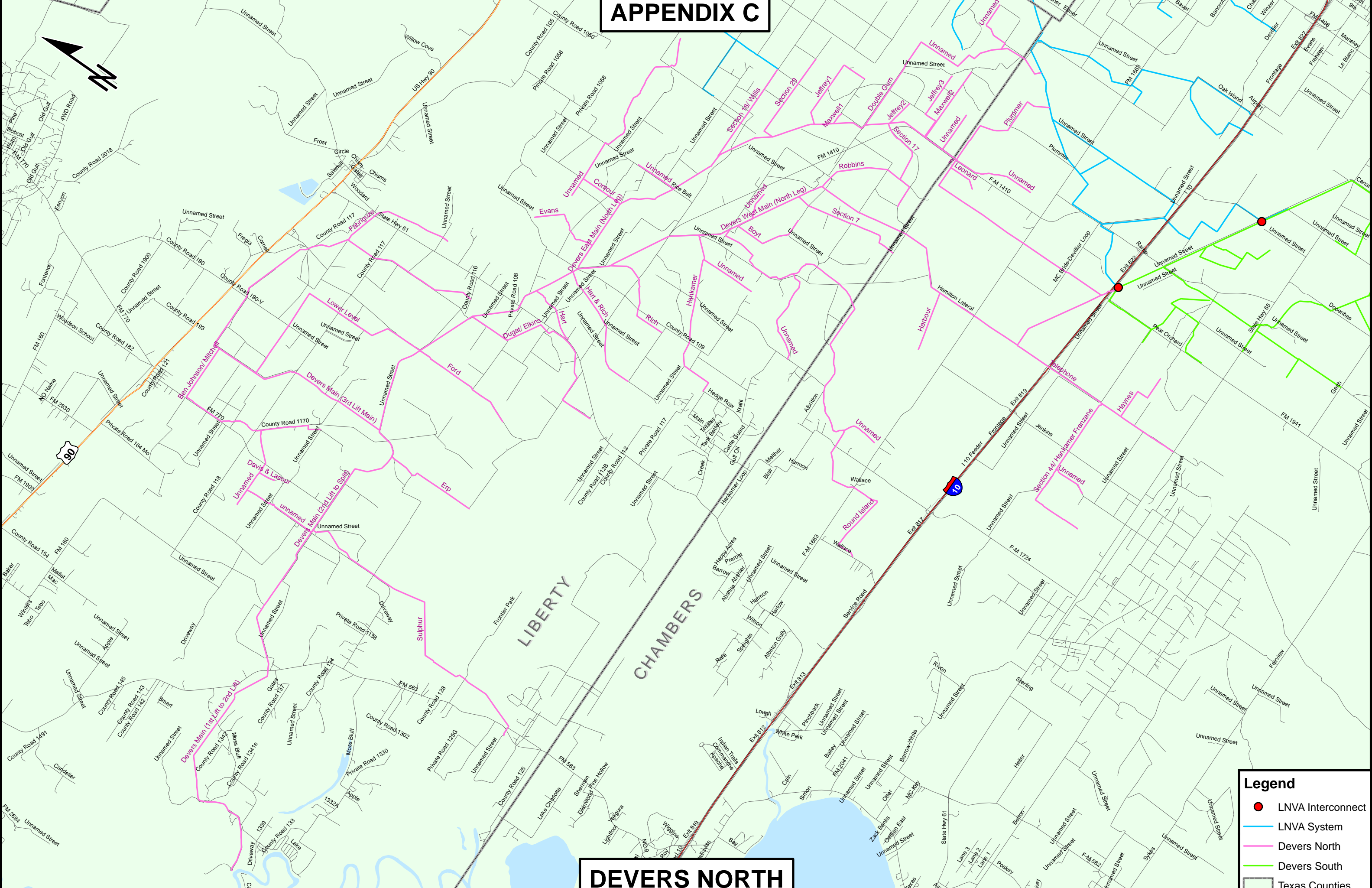


# LNVA SYSTEM

# **APPENDIX C**

## **DEVERS NORTH SERVICE AREA MAP**

# APPENDIX C



# DEVERS NORTH

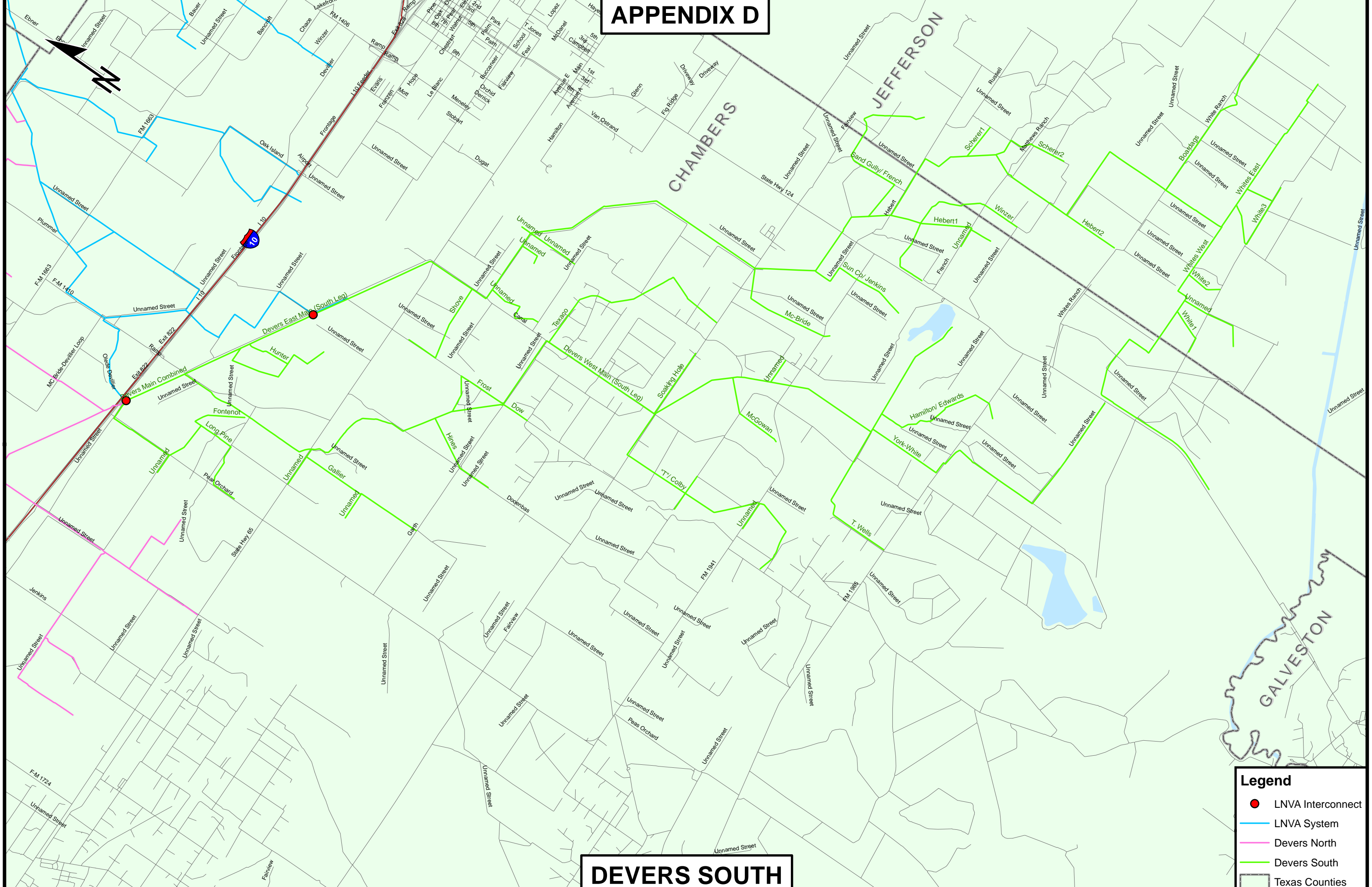
**Legend**

- LNVA Interconnect
- LNVA System
- Devers North
- Devers South
- Texas Counties

# **APPENDIX D**

## **DEVERS SOUTH SERVICE AREA MAP**

# APPENDIX D



**Legend**

- LNVA Interconnect
- LNVA System
- Devers North
- Devers South
- Texas Counties

# DEVERS SOUTH

**EXHIBIT K**

**URS-FNI-HZ TEAM**

**QUALITY MANAGEMENT SYSTEM (QMS) FORMS**

**EXHIBIT K**

**URS-FNI-HZ TEAM**

**QUALITY MANAGEMENT SYSTEM (QMS) FORMS**

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Quality - It's Good Business



QMS Form 3-6 (MM)  
Rev. 2013 QMS  
Date: 28 Feb 2013

IE QMS - Americas

Independent Technical Review

Project Name	Update Water Control Manual for Sam Rayburn Dam	Client	USACE Fort Worth District
Project Location	Jasper County, Texas	PM	Jinwei Qiu, PE
Project Number	25336792	PIC	Juan Vargas, PE

*(This section is to be completed by the Project Manager or the PM's Designee.)*

Assigned Reviewer: Anand Prakash, PE      Comments Required by: February 26, 2016  
 Work Product Originator: Jinwei Qiu, Preston Kutney, and Rifat Alam  
 Work Product to be Reviewed: Sam Rayburn Dam Water Control Manual Chapters 4 to 6  
 Review Scope: Review for correctness, completeness and technical accuracy  
 Specific Instructions: Enter specific instructions for the work product

Submitted by: *Jinwei Qiu*      02/24/2016  
 Project Manager Signature      Date

*(This Section is to be completed by the Reviewer.)*

Select:  
 A.  Reviewer has no comments.  
 or  
 B.  Comments have been provided on:  
      Marked directly on work product  
      Comment and Disposition Form 3-5  
      Other, Specify: Click to enter text

*Anand Prakash*      4/22/2015  
 Reviewer Signature      Date

*(This section is to be completed by the Reviewer after verification of comment incorporation, if box B is checked off above.)*

Select:  
 C.  Verification of comment incorporation has been performed by Reviewer. There are no outstanding issues.  
 or  
 D.  Verification of comment incorporation has been performed by Reviewer. Unresolved issues have been submitted to the Project Manager or Designee for resolution.  
 and  
 E.  Reviewer asserts that the work product ITR is complete.

*Anand Prakash*      6/29/2017  
 Reviewer Signature      Date

APPROVAL and DISTRIBUTION

ITR is complete.

*Jinwei Qiu*      06/29/2017  
 Project Manager or Designee Signature      Date

Distribution:

Project Central File - Quality File Folder

Other - Specify: Click to enter text



IE QMS - Americas

Detail Check

Project Name	Update Water Control Manual for Sam Rayburn Dam	Client	USACE Fort Worth District
Project Location	Jasper County, Texas	PM	Jinwei Qiu, PE
Project Number	25336792	PIC	Juan Vargas, PE

Identifying Information

(This section is to be completed by the Project Manager or the PM's Designee.)

Assigned Checker: Janis Murphy, PE  
Comments Required by: September 27, 2016  
Work Product Originator: Jinwei Qiu, Rifat Alam and Dawit Zeweldi  
Work Product to be Checked: Sam Rayburn Dam Water Control Manual Chapters 8 to 9  
 This Detail Check is a check for correctness, completeness and technical accuracy.  
 This Detail Check is only a technical edit for format, spelling, grammar, pagination and readability.  
Specific Instructions: Enter specific instructions for the work product.

Submitted by: Jinwei Qiu 09/23/2016  
Project Manager Signature Date

Comments

(This Section is to be completed by the Checker.)

Select:  
A.  Checker has no comments.  
or  
B.  Comments have been provided on:  
 Marked directly on work product  
 Comment and Disposition Form 3-5  
 Other; Specify: Click here to enter text.

Janis C. Murphy 9/24/16  
Checker Signature Date

Verification

(This section is to be completed by the Checker after verification of comment incorporation, if box B is checked off above.)

Select:  
C.  Verification of comment incorporation has been performed by Checker. There are no outstanding issues.  
or  
D.  Verification of comment incorporation has been performed by Checker. Unresolved issues have been submitted to the Project Manager or Designee for final resolution.  
and  
E.  Checker asserts that the work product review is complete.

Janis C. Murphy 7/1/17  
Checker Signature Date

### APPROVAL and DISTRIBUTION

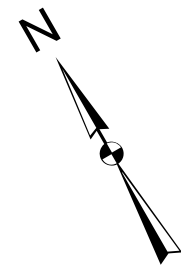
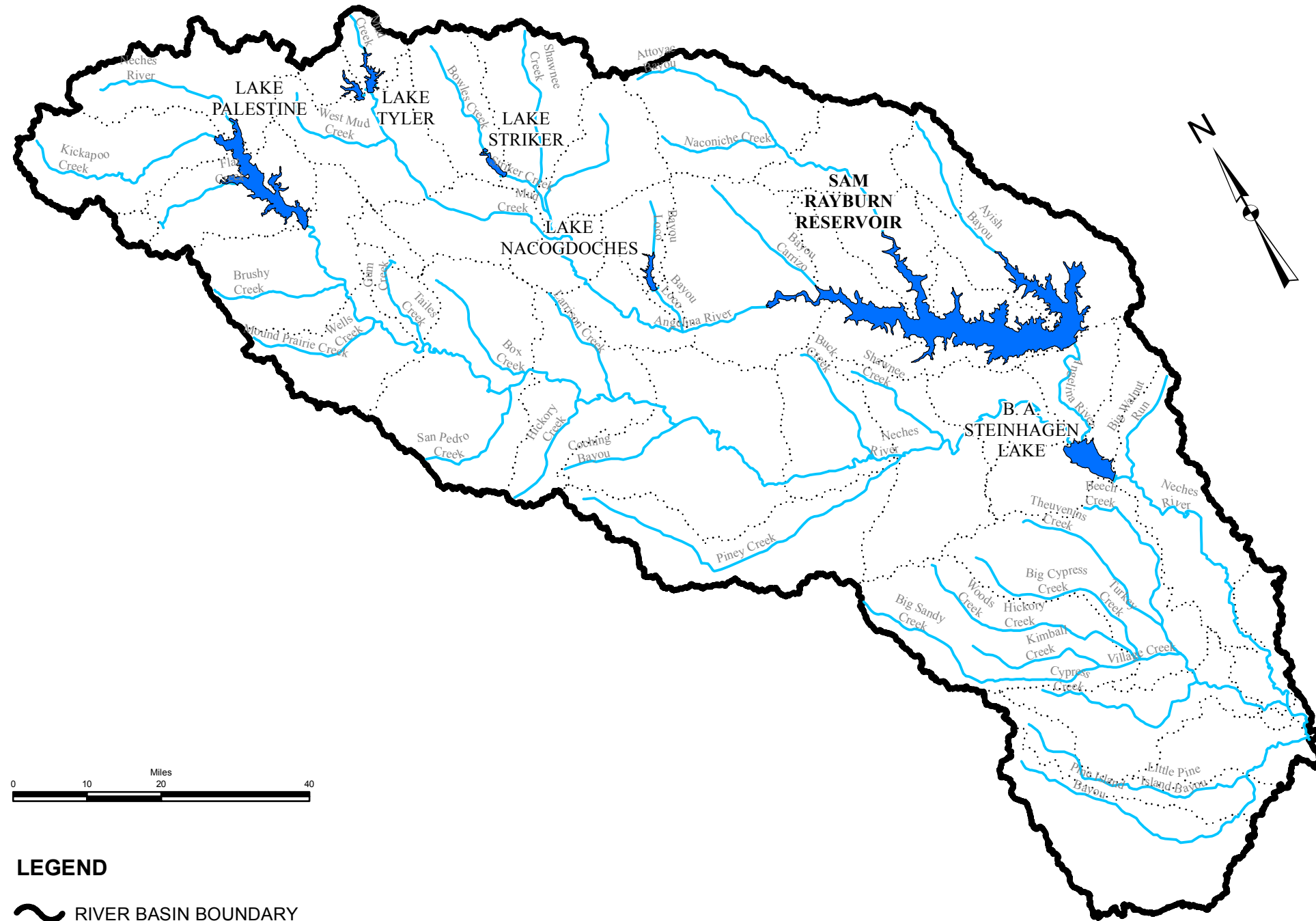
Detail Check is complete.

Jinwei Qiu 07/01/2017  
Project Manager or Designee Signature Date





#### Distribution:

Project Central File – Quality File Folder  
Other – Specify: Enter names here.





**LEGEND**

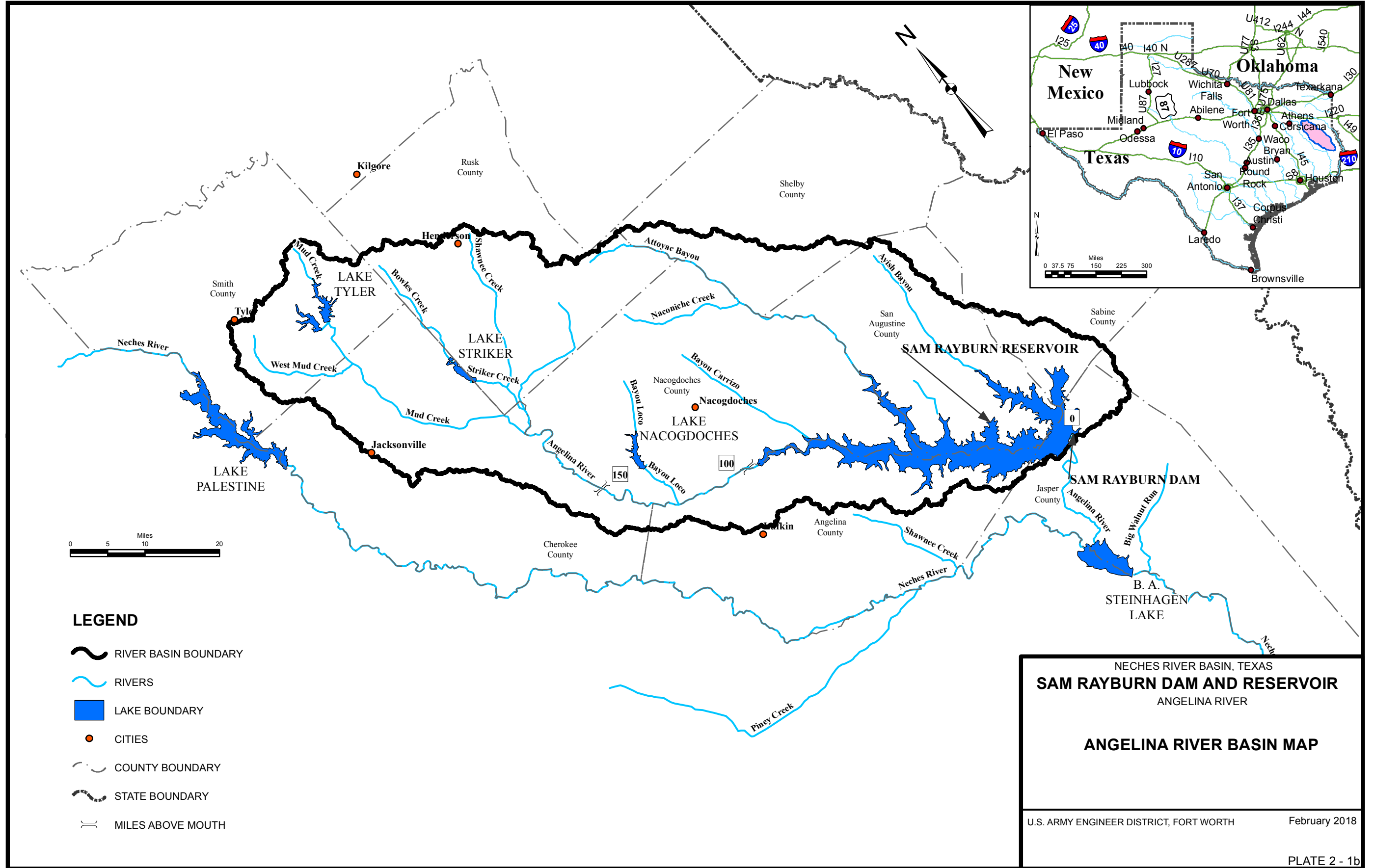
-  RIVER BASIN BOUNDARY
-  RIVER SUBBASIN BOUNDARY
-  RIVERS
-  LAKE BOUNDARY



NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

**WATERSHED MAP**  
**NECHES RIVER BASIN**

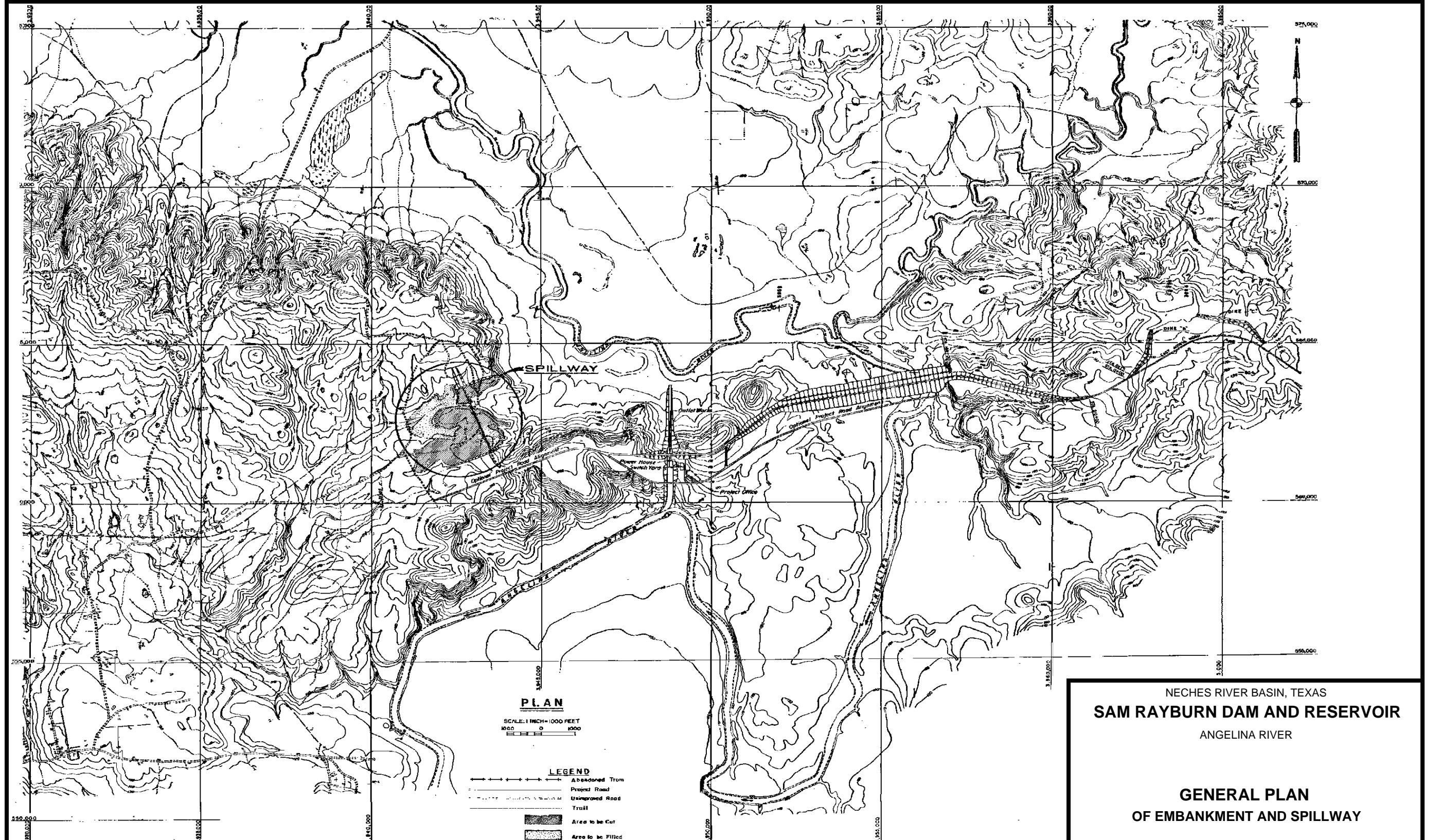
U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



- LEGEND**
- RIVER BASIN BOUNDARY
  - RIVERS
  - LAKE BOUNDARY
  - CITIES
  - COUNTY BOUNDARY
  - STATE BOUNDARY
  - MILES ABOVE MOUTH

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

**ANGELINA RIVER BASIN MAP**



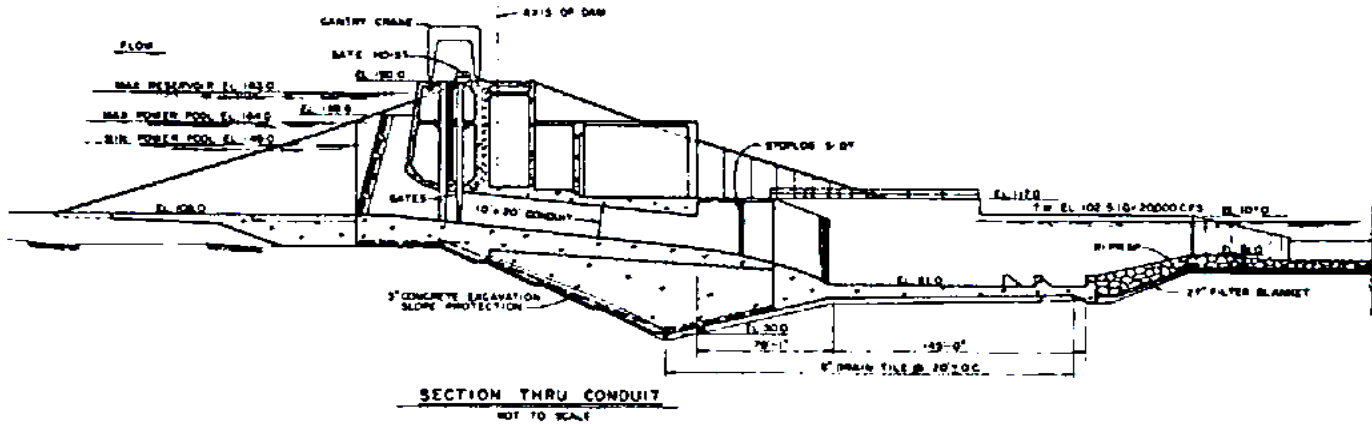
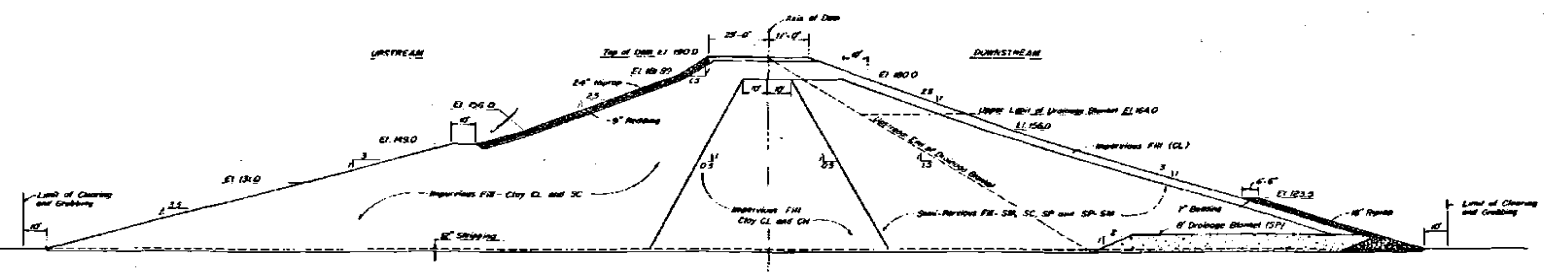
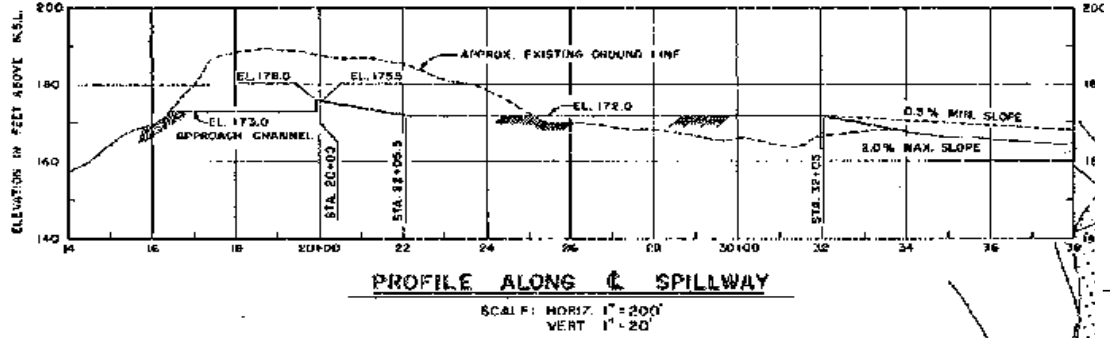
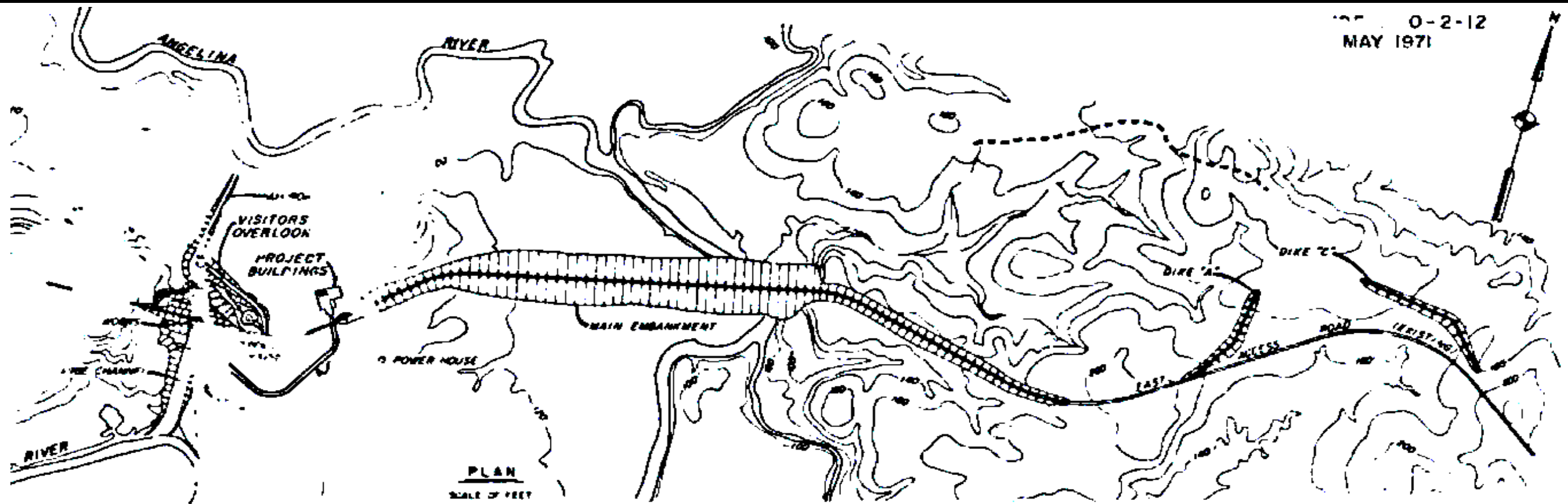
ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 IS: NGVD29 + 0.0 FEET = NAVD88 FOR SAM RAYBURN DAM AND RESERVOIR.

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

**GENERAL PLAN  
 OF EMBANKMENT AND SPILLWAY**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

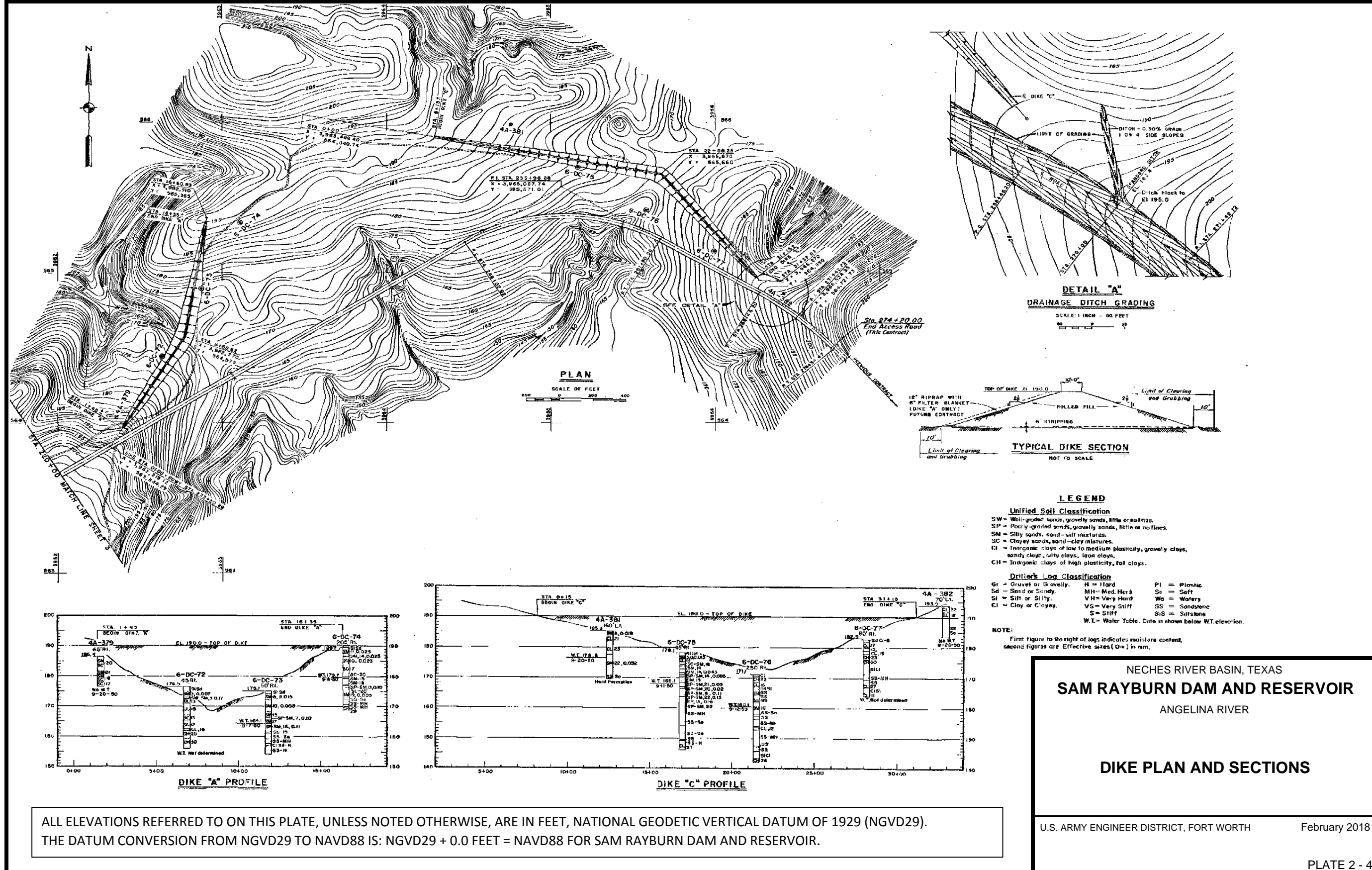
0-2-12  
MAY 1971



NOTE: ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 IS: NGVD29 + 0.0 FEET = NAVD88 FOR SAM RAYBURN DAM AND RESERVOIR.

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER  
**EMBANKMENT PLAN AND SECTIONS**

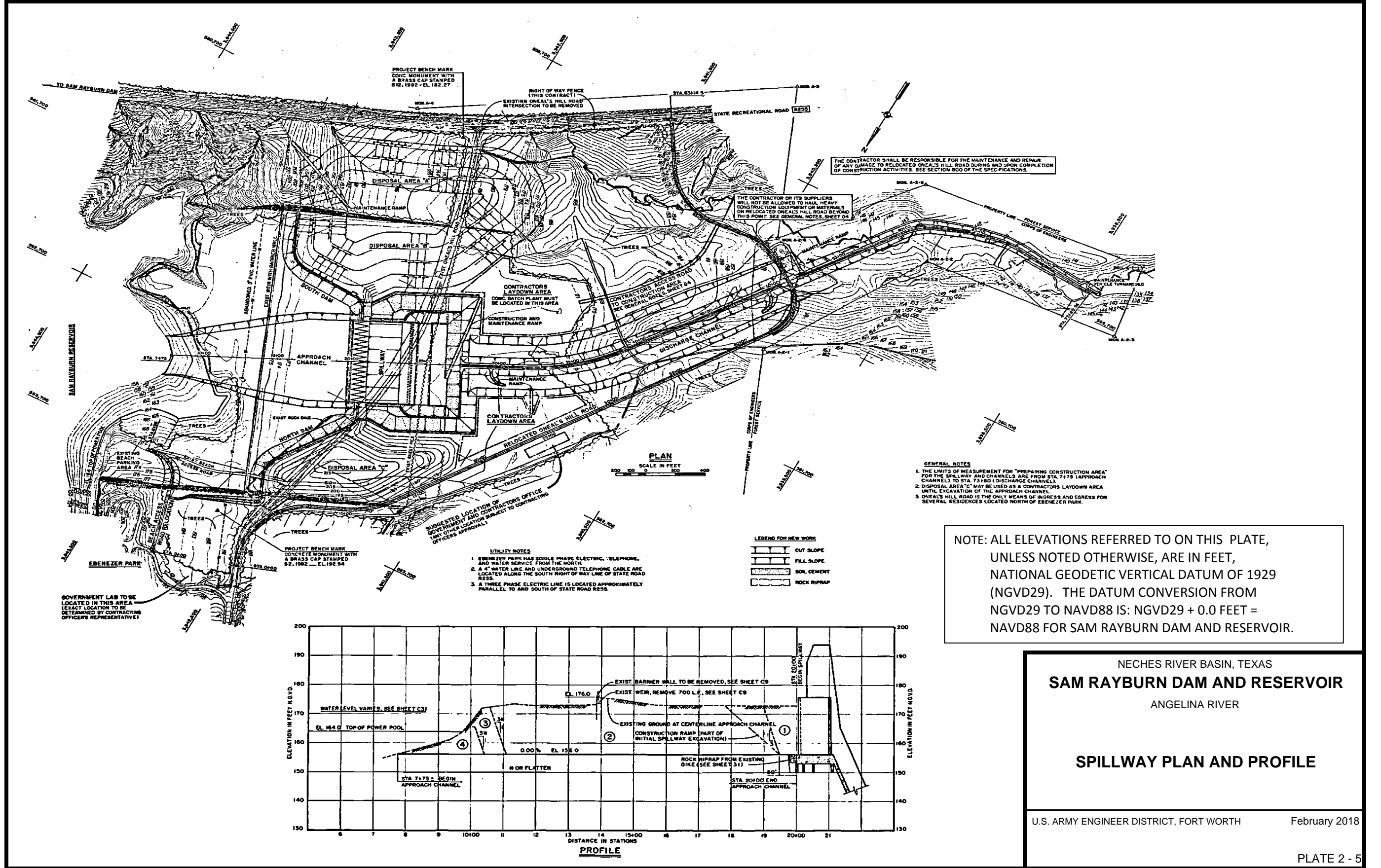
U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

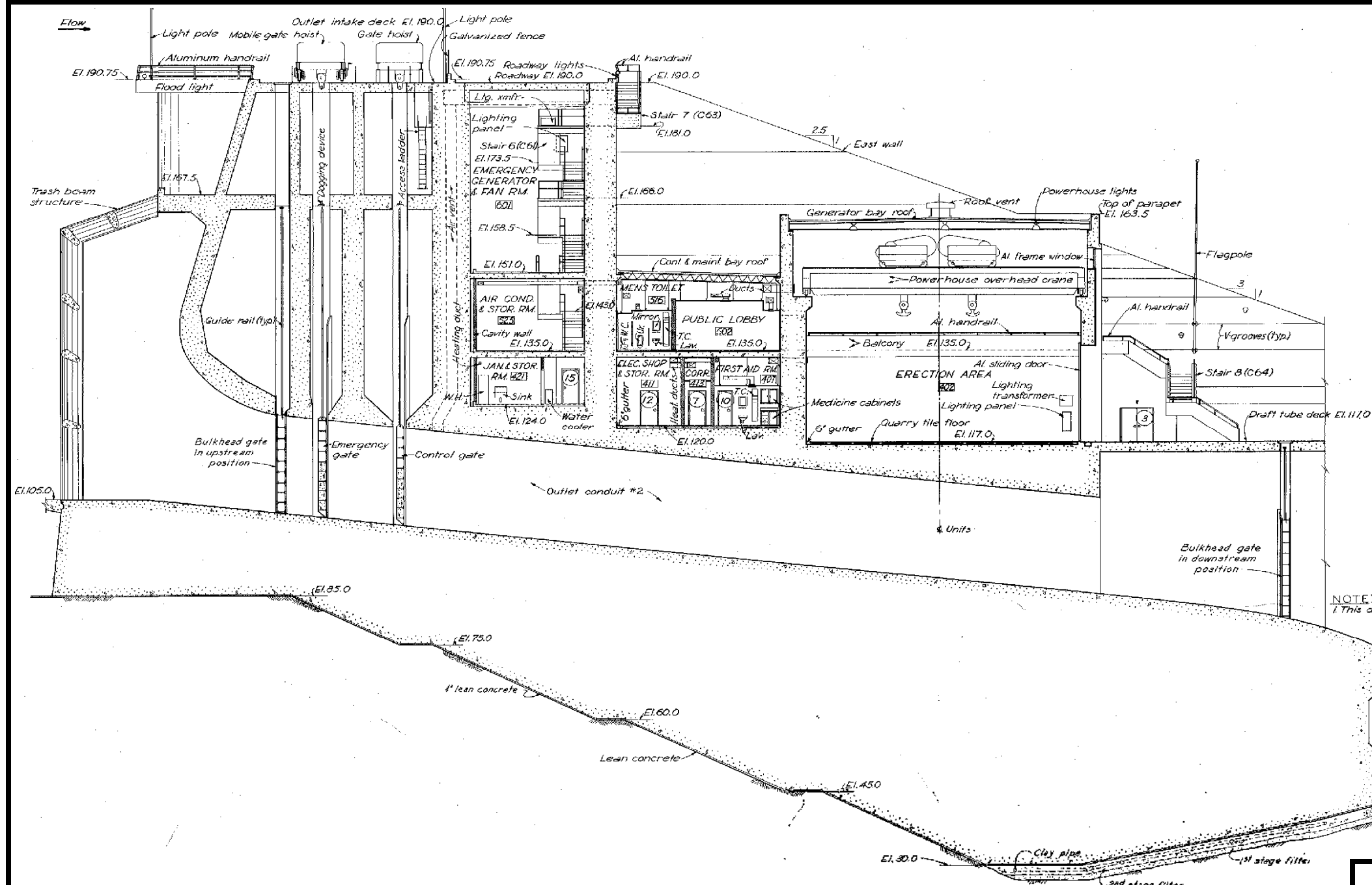


ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 IS: NGVD29 + 0.0 FEET = NAVD88 FOR SAM RAYBURN DAM AND RESERVOIR.

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER  
**DIKE PLAN AND SECTIONS**

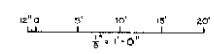
U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018





SECTION A-A  
SCALE: 1/4" = 1'-0"

NOTE:  
1. This drawing is presented for general information only.



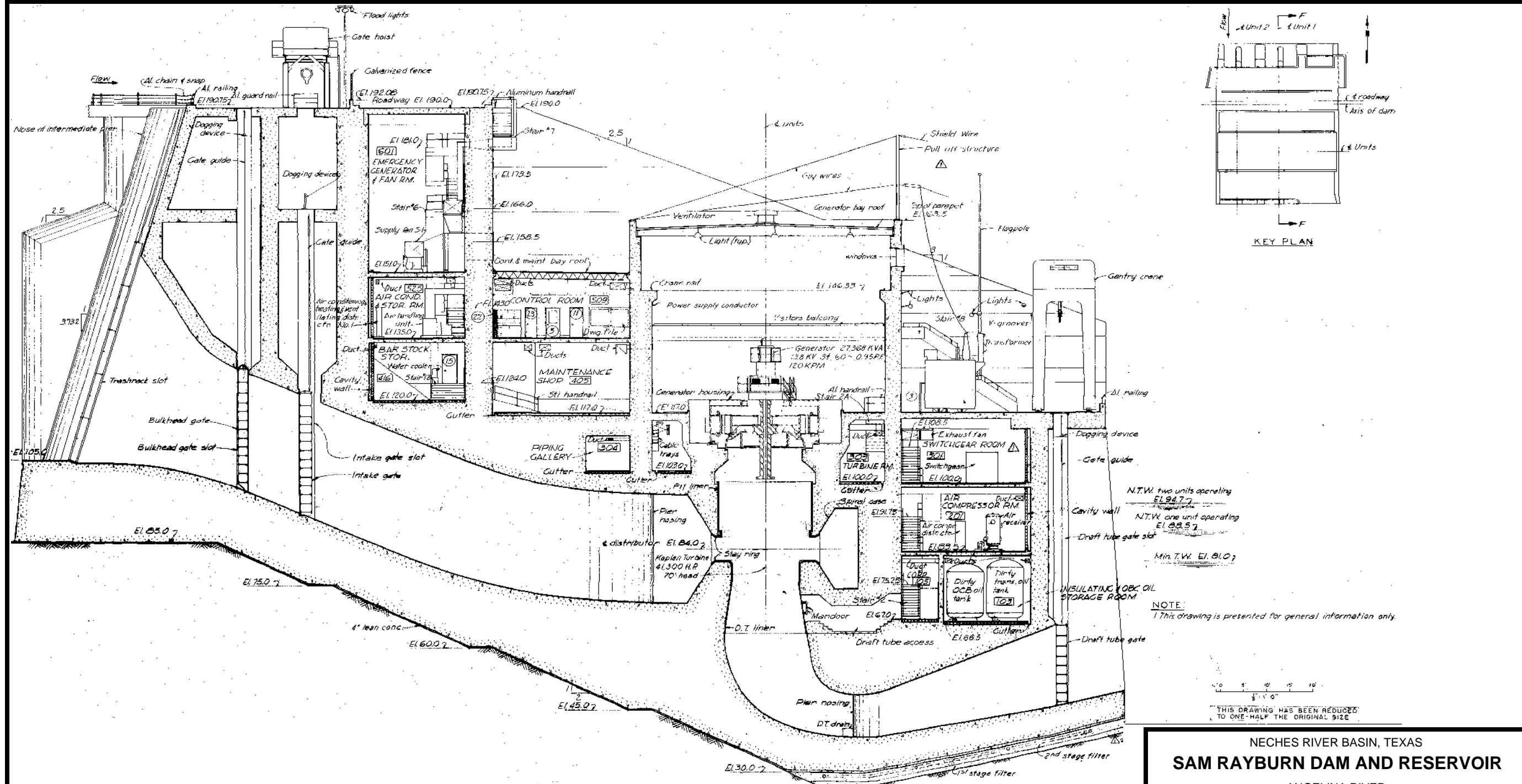
THIS DRAWING HAS BEEN REDUCED TO ONE-HALF THE ORIGINAL SIZE

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER

**OUTLET WORKS SECTION**

ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 IS: NGVD29 + 0.0 FEET = NAVD88 FOR SAM RAYBURN DAM AND RESERVOIR.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



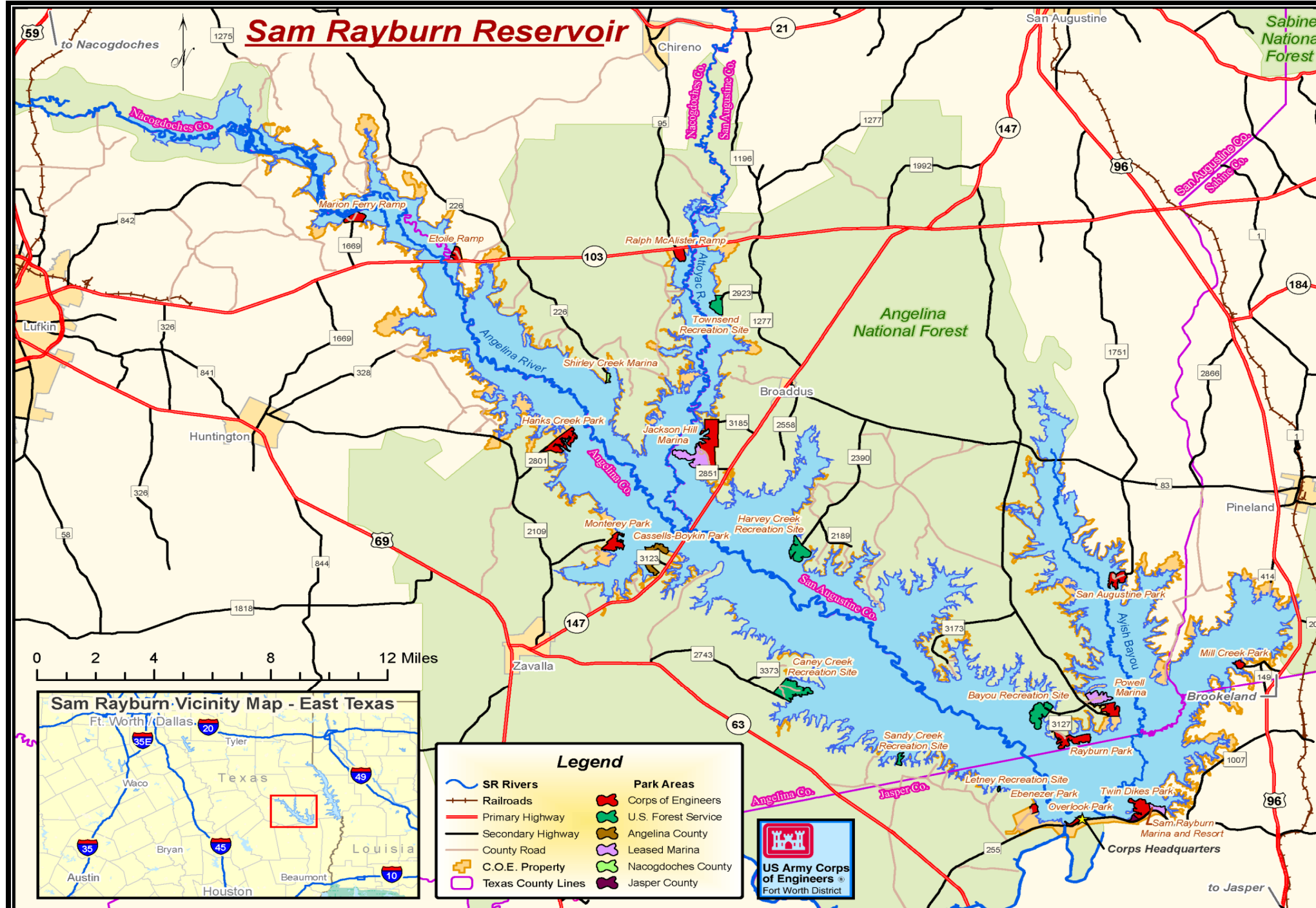
SECTION F-F  
SCALE: 1/8" = 1'-0"

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

**POWER INTAKE SECTION**

ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 IS: NGVD29 + 0.0 FEET = NAVD88 FOR SAM RAYBURN DAM AND RESERVOIR.

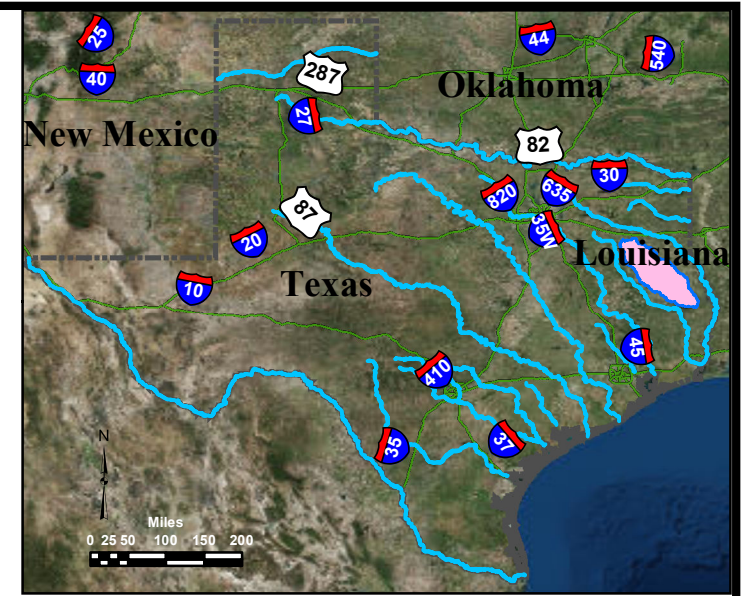
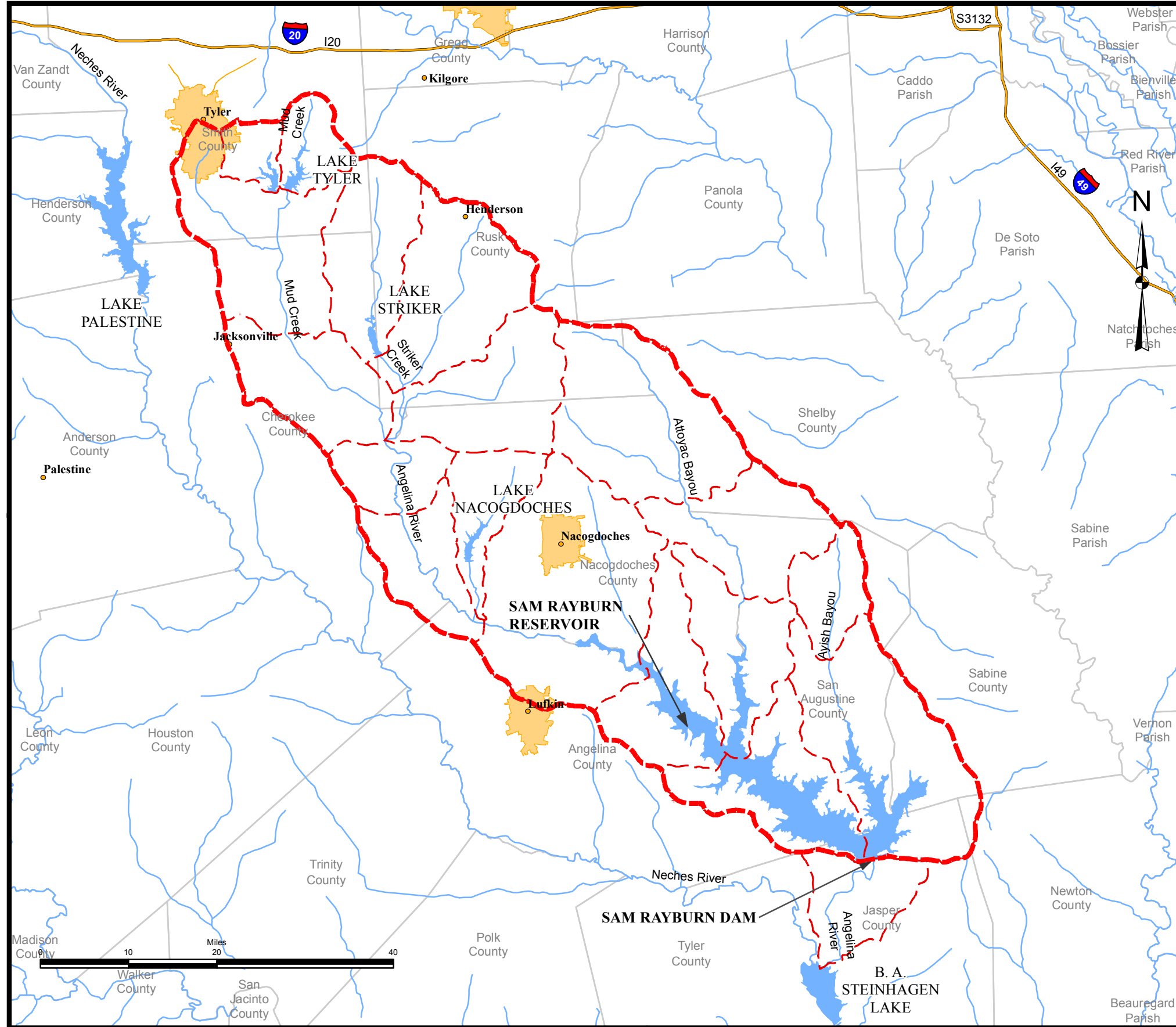
U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018










- |                       |                              |                                |
|-----------------------|------------------------------|--------------------------------|
| 1. Ebenezer Park      | 7. Monterey Park             | 13. Sam Rayburn Marina Resort* |
| 2. Twin Dikes Park    | 8. Marion Ferry Park         | 14. Powell Park Marina*        |
| 3. Mill Creek Park    | 9. Etoile Park               | 15. Jackson Hill Marina*       |
| 4. San Augustine Park | 10. Ralph McAlister Park     | 16. Shirley Creek Marina*      |
| 5. Rayburn Park       | 11. Umphrey Family Pavilion* |                                |
| 6. Hanks Creek Park   | 12. Cassells-Boykin Park*    |                                |

Note: \* Indicates parks leased and operated by state or county government or private individuals.

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER  
**PUBLIC USE AREAS**



**LEGEND**

-  RIVER BASIN BOUNDARY
-  SUB BASIN BOUNDARY
-  RIVERS
-  LAKE BOUNDARY
-  CITIES
-  INTERSTATE
-  METRO AREAS

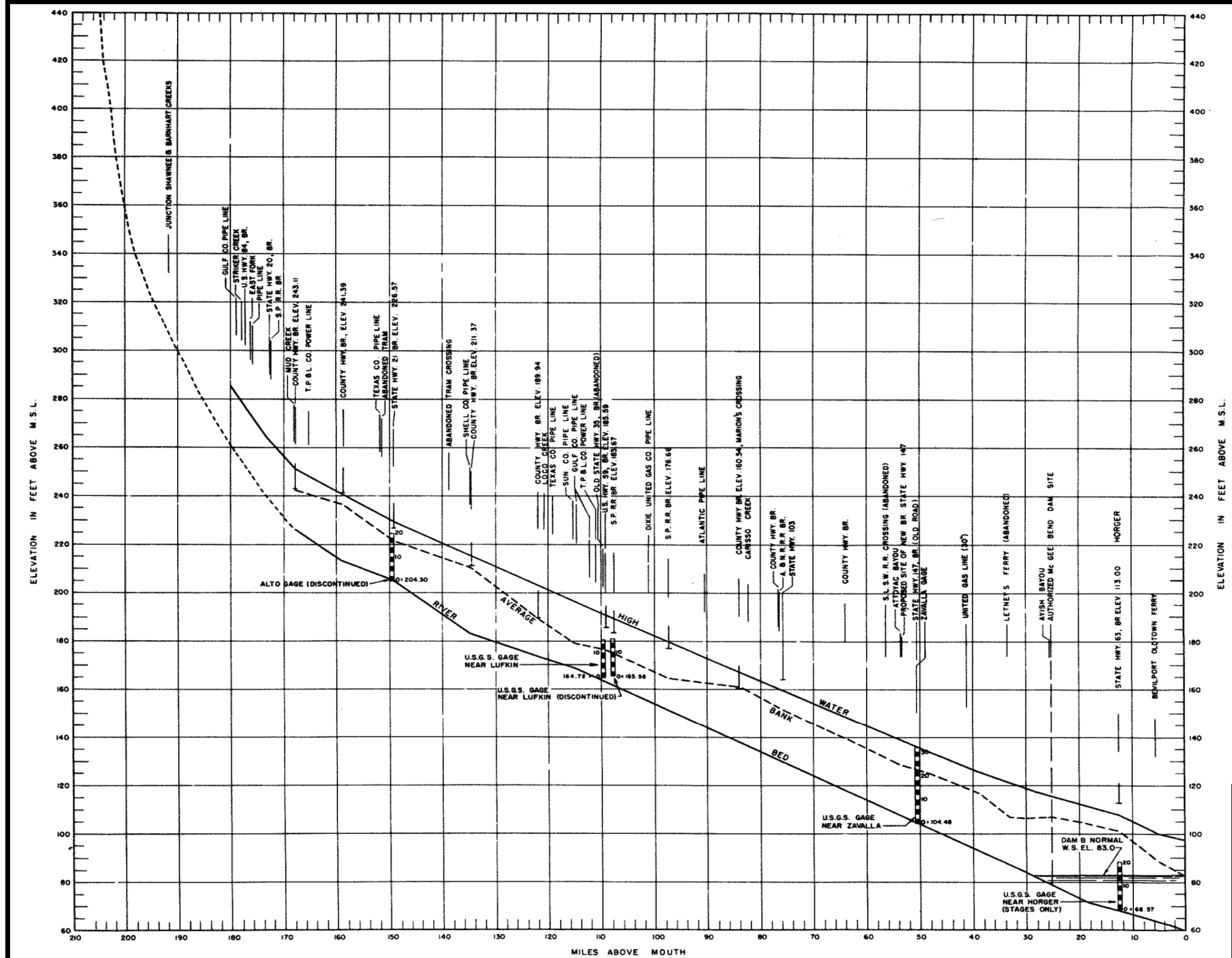
NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

**LOCAL WATERSHED MAP**

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U.S. ARMY ENGINEER DISTRICT, FORT WORTH      February 2018

PLATE 4 - 1

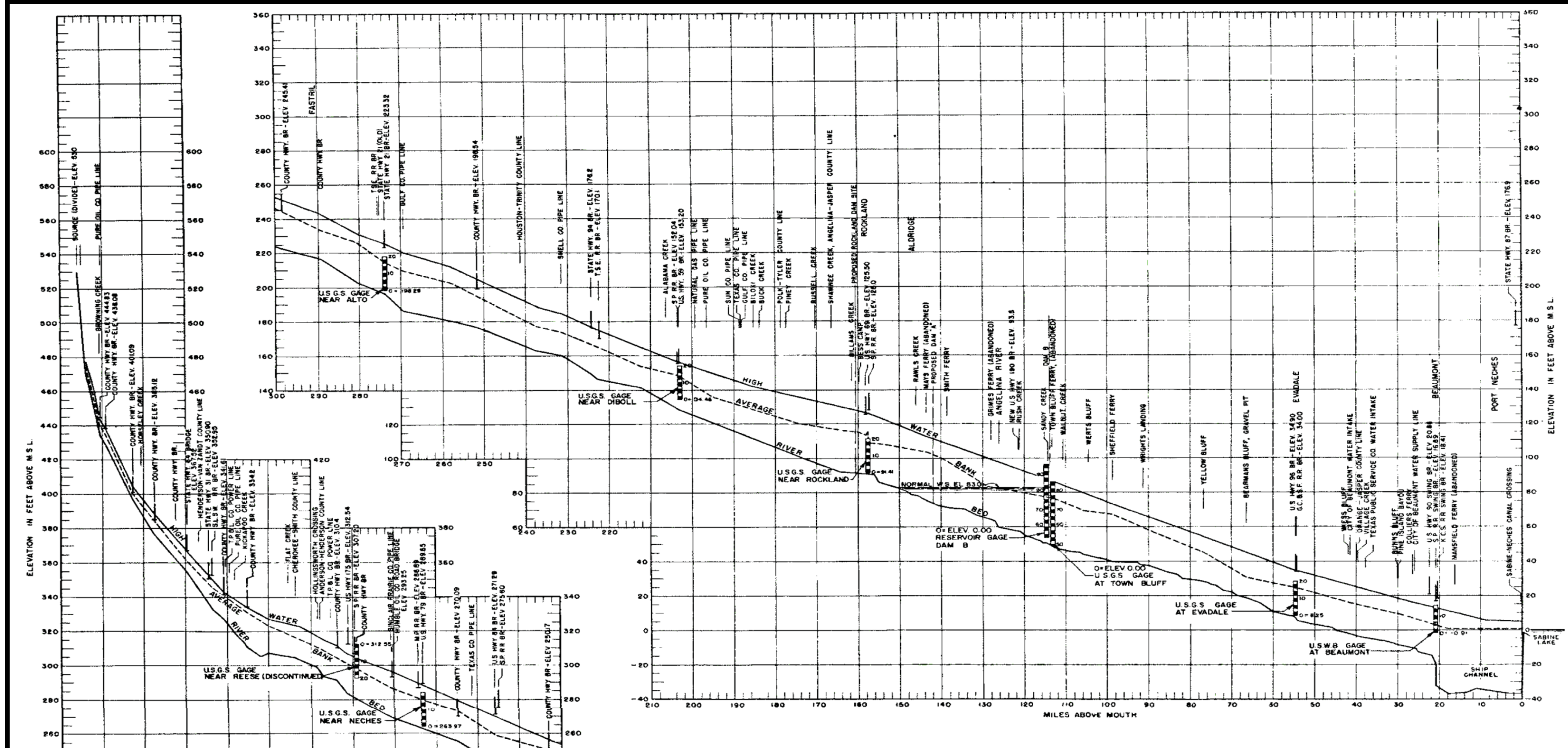


NOTE: FROM 1939 SURVEY REPORT.

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

**ANGELINA RIVER PROFILE**

ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 IS: NGVD29 + 0.0 FEET = NAVD88 FOR SAM RAYBURN DAM AND RESERVOIR.



NOTE: FROM 1939 SURVEY REPORT.

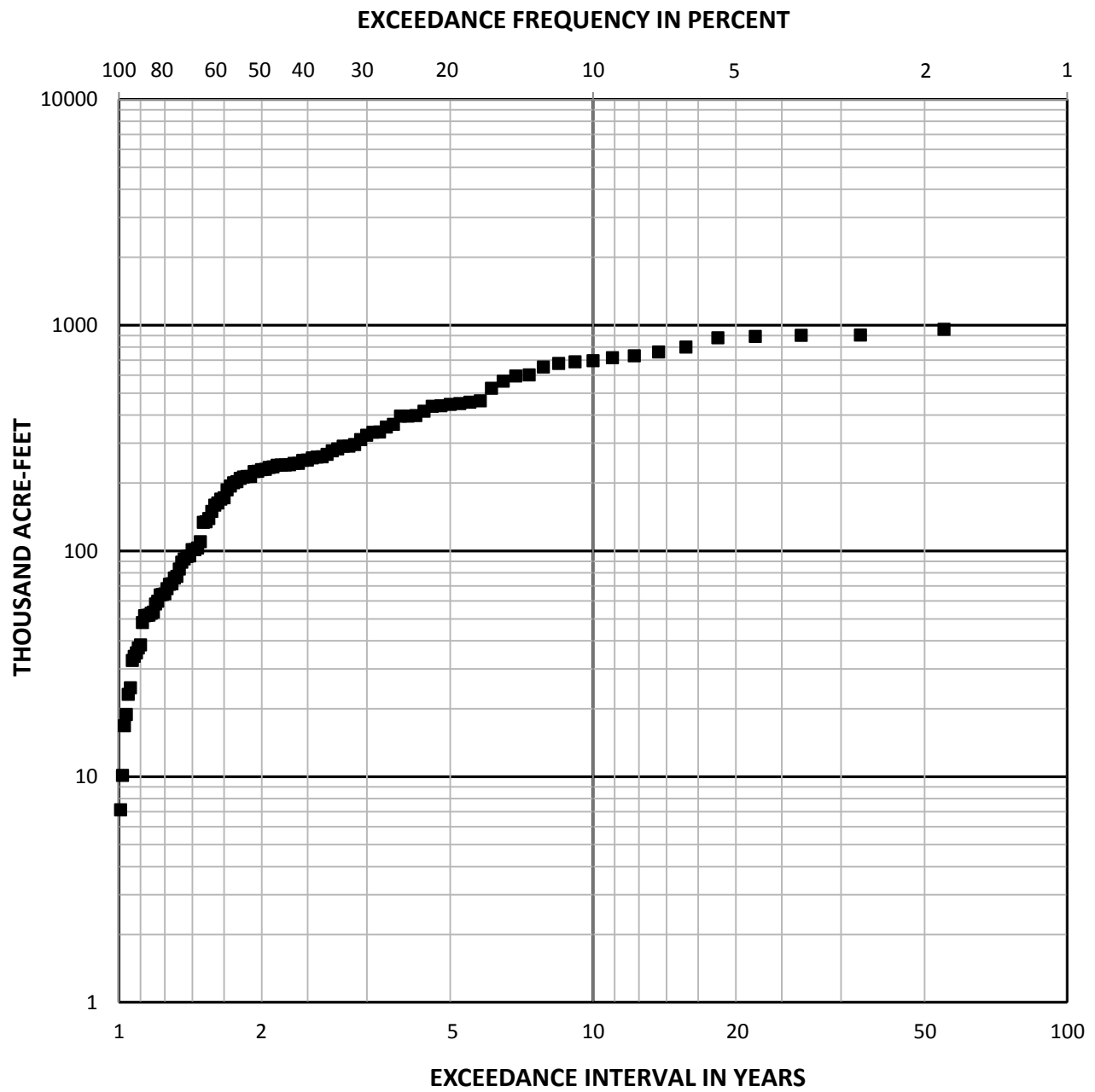
ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 IS: NGVD29 + 0.0 FEET = NAVD88 FOR SAM RAYBURN DAM AND RESERVOIR.

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

**NECHES RIVER PROFILES**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH

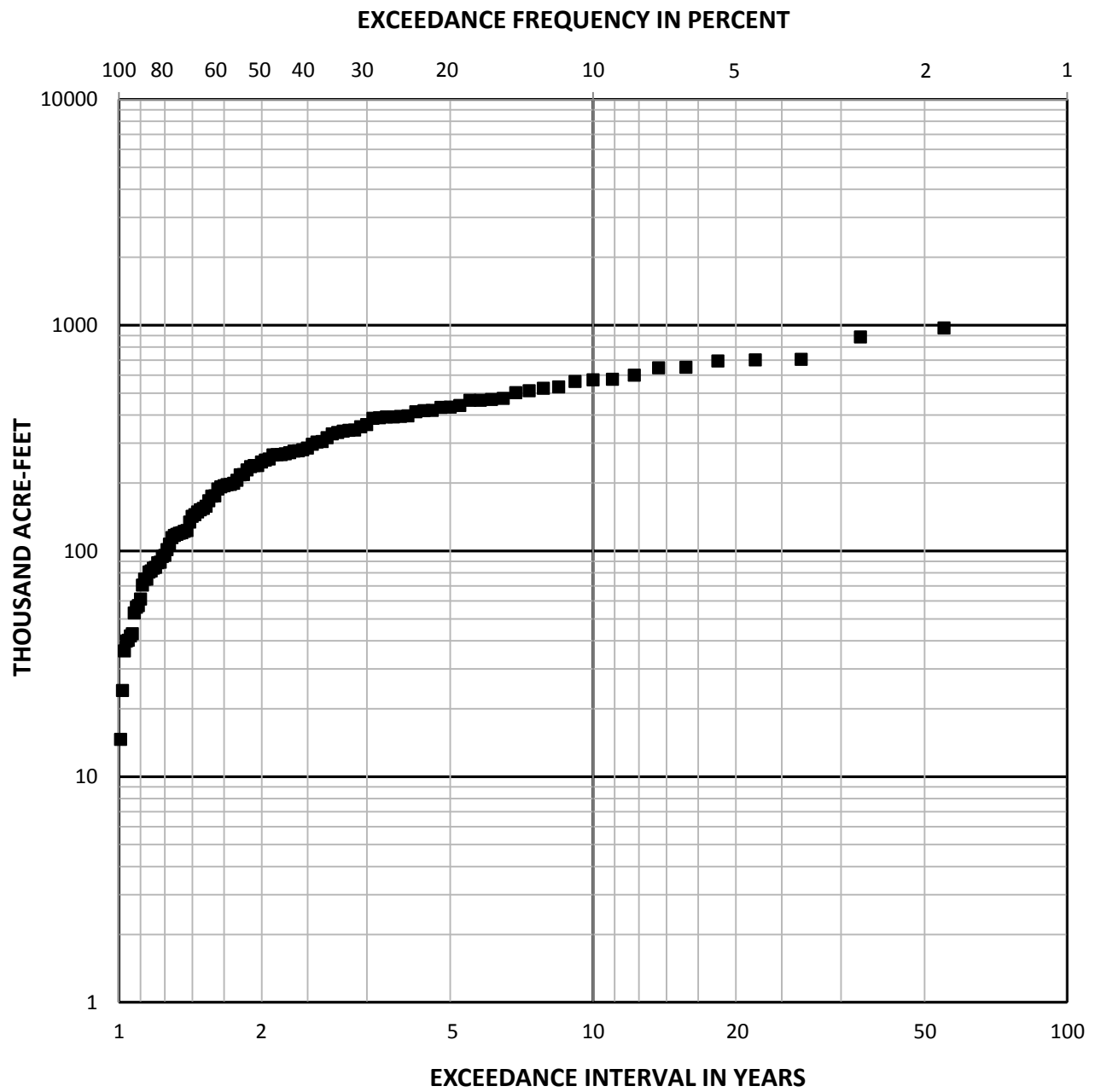
February 2018



NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER

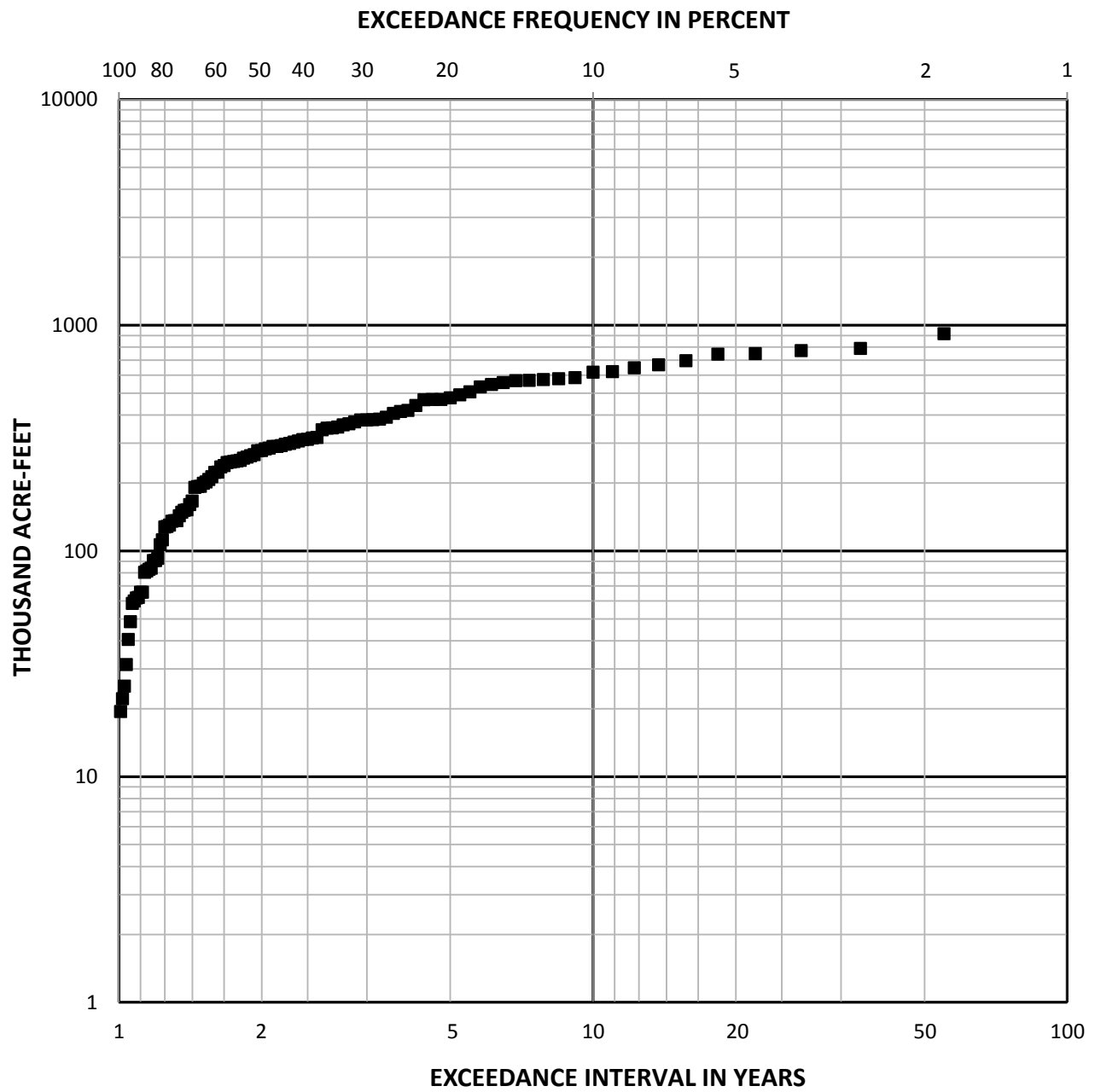
**JANUARY INFLOW FREQUENCY**  
**1908-2016**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER  
  
**FEBRUARY INFLOW FREQUENCY**  
**1908-2016**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



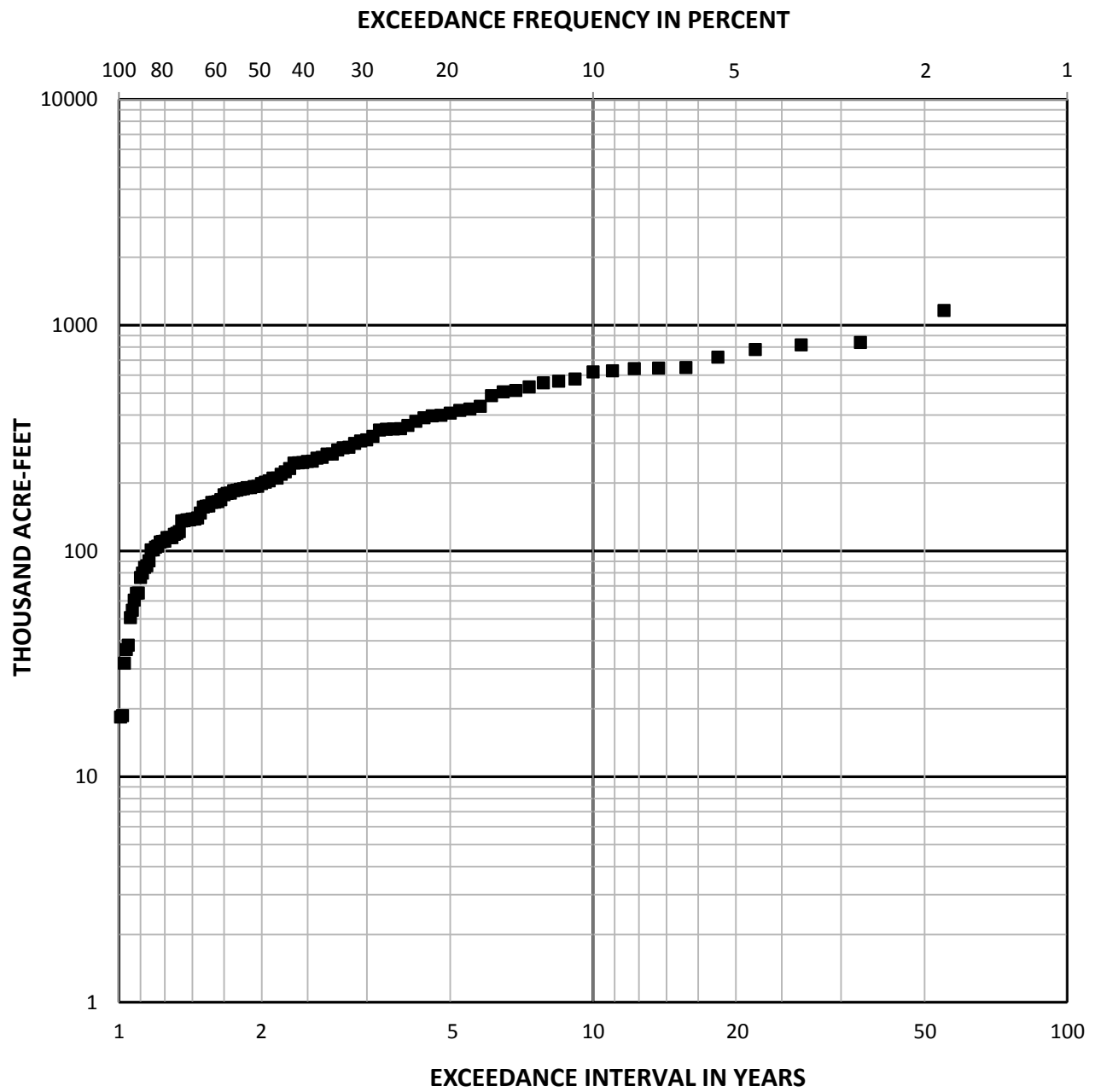
NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER

**MARCH INFLOW FREQUENCY**  
**1908-2016**

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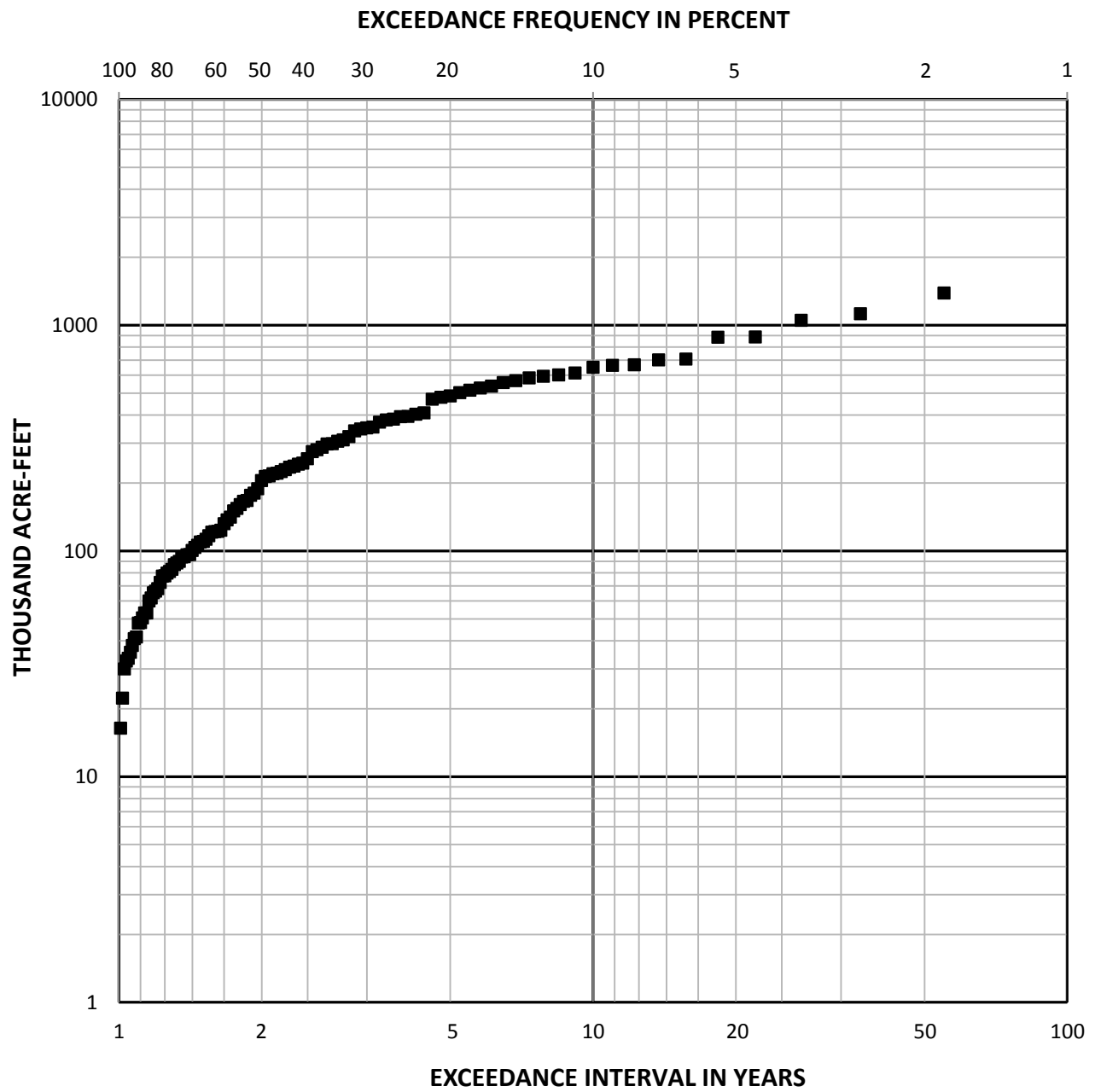
U.S. ARMY ENGINEER DISTRICT, FORT WORTH    February 2018

PLATE 4 - 6



NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER  
  
**APRIL INFLOW FREQUENCY**  
**1908-2016**

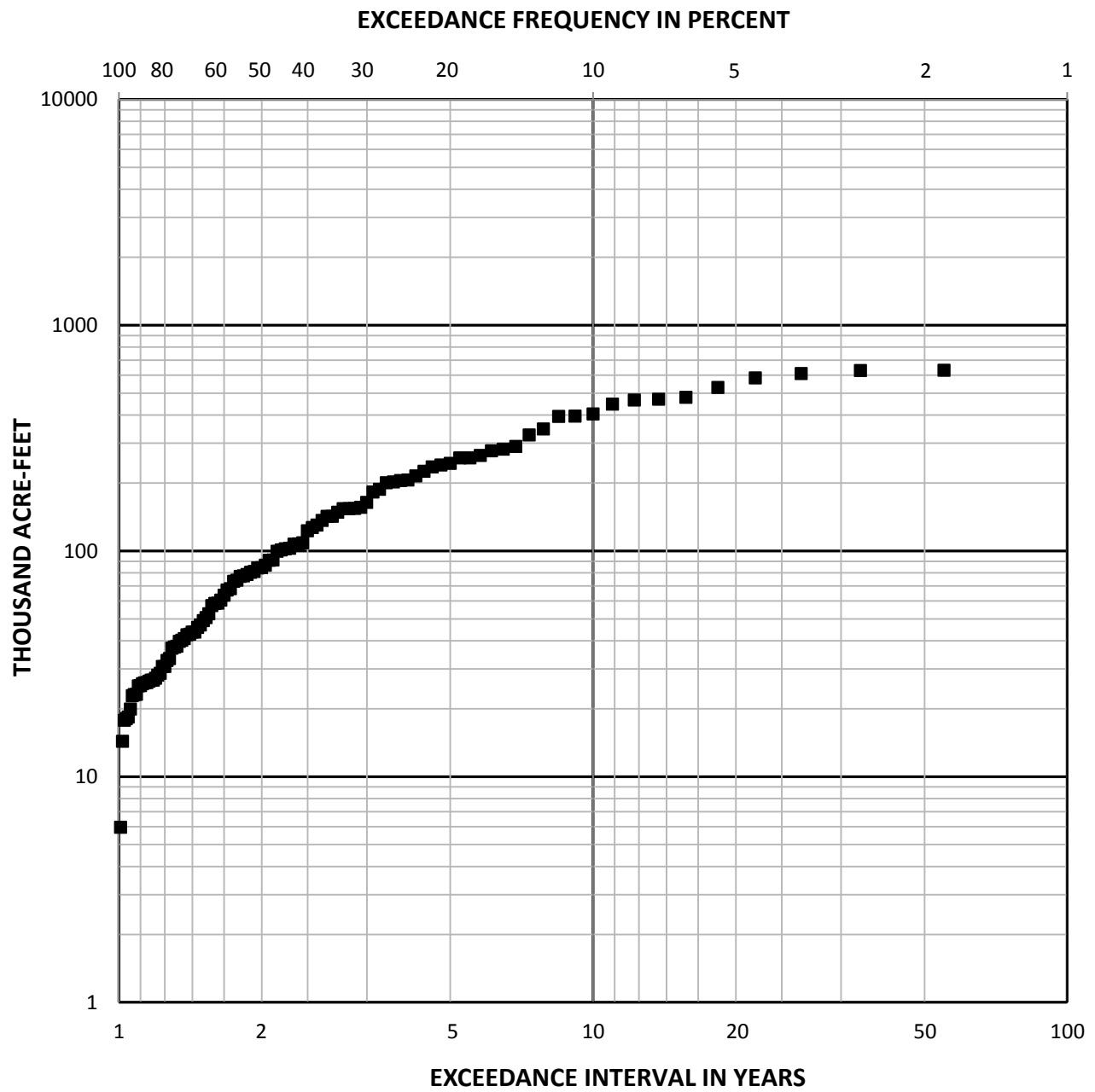
U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER

**MAY INFLOW FREQUENCY**  
**1908-2016**

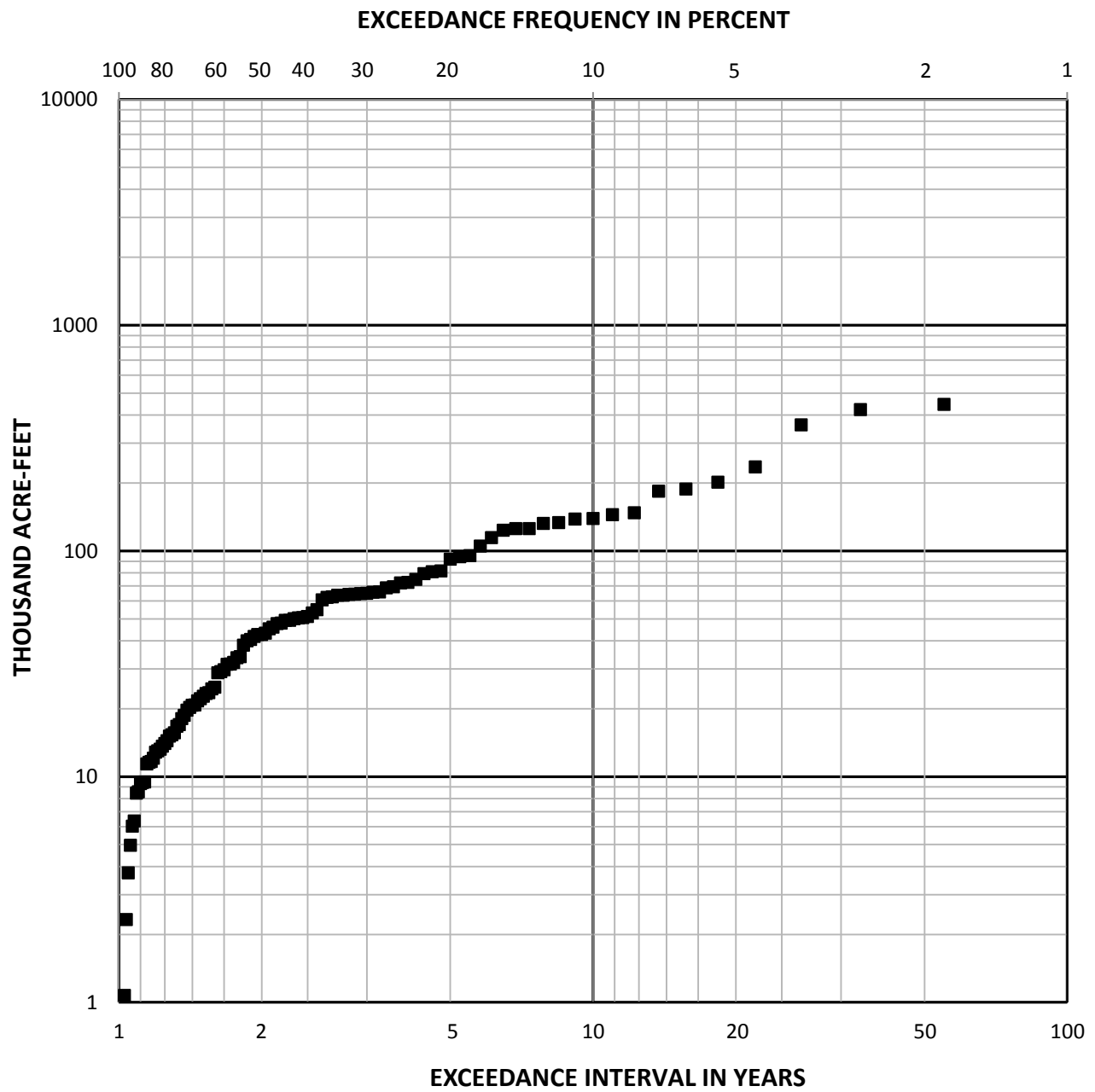
U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER

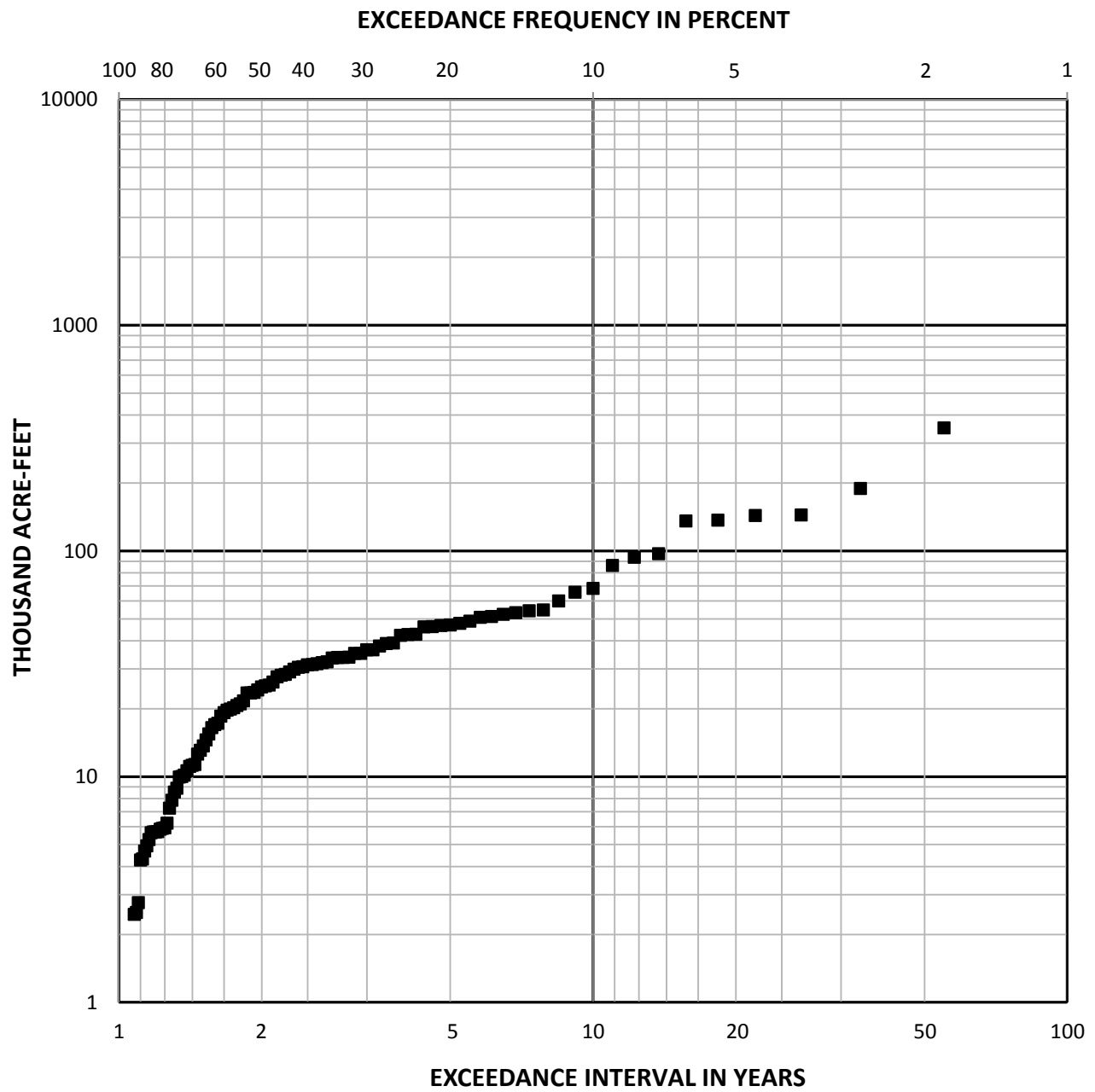
**JUNE INFLOW FREQUENCY**  
**1908-2016**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER  
  
**JULY INFLOW FREQUENCY**  
**1908-2016**

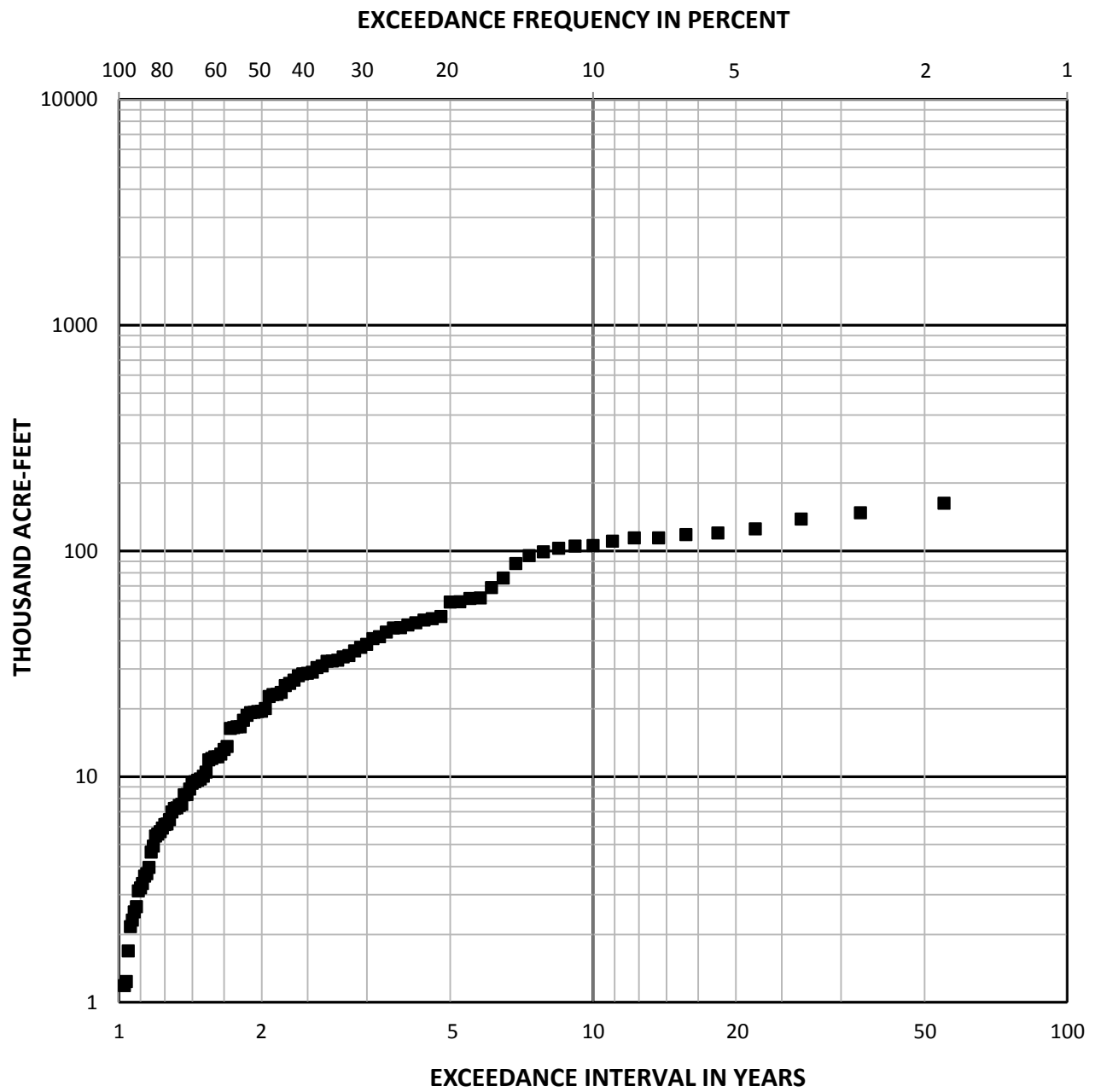
U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

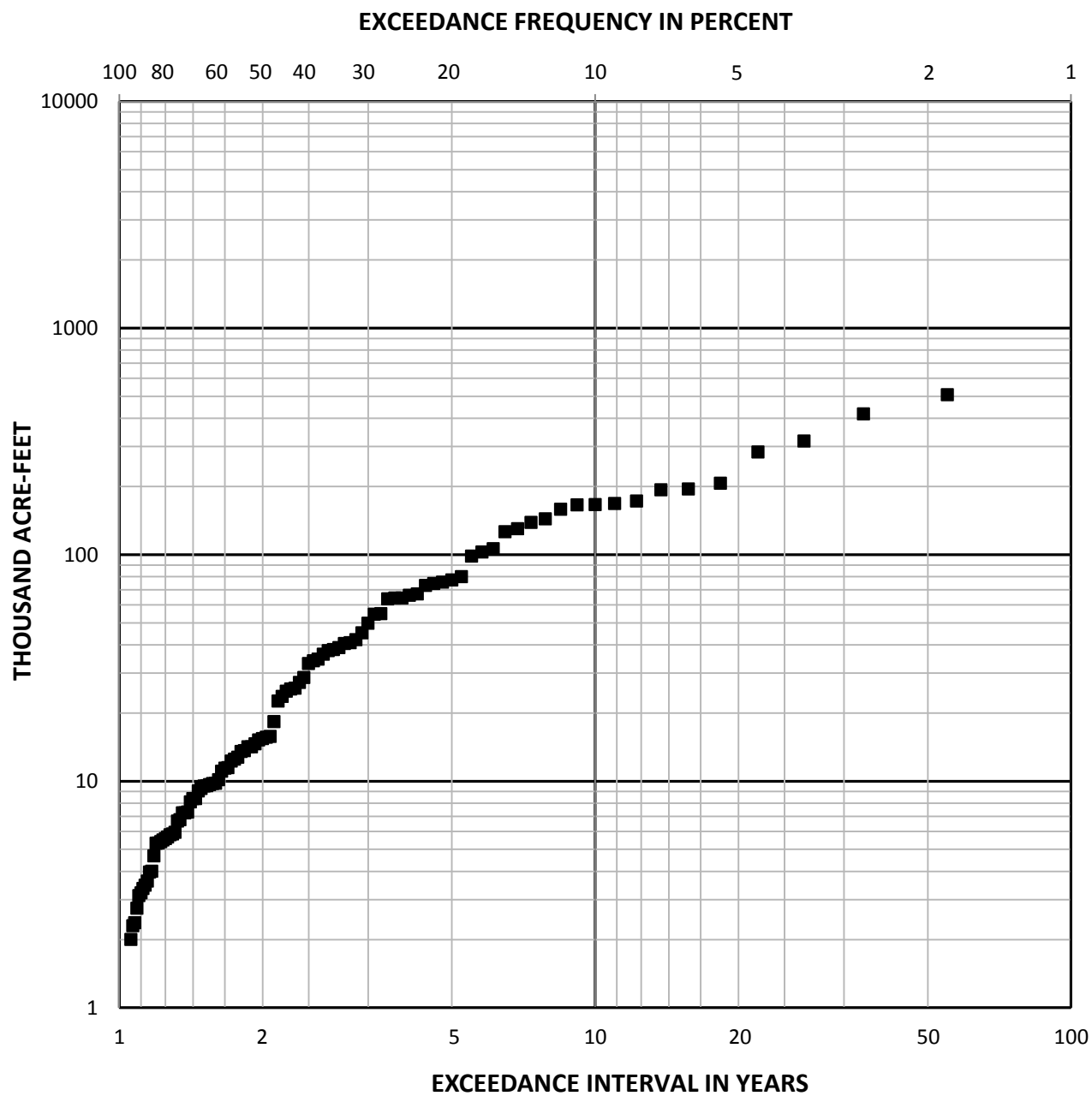
**AUGUST INFLOW FREQUENCY**  
**1908-2016**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH      February 2018



NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER  
**SEPTEMBER INFLOW FREQUENCY**  
**1908-2016**

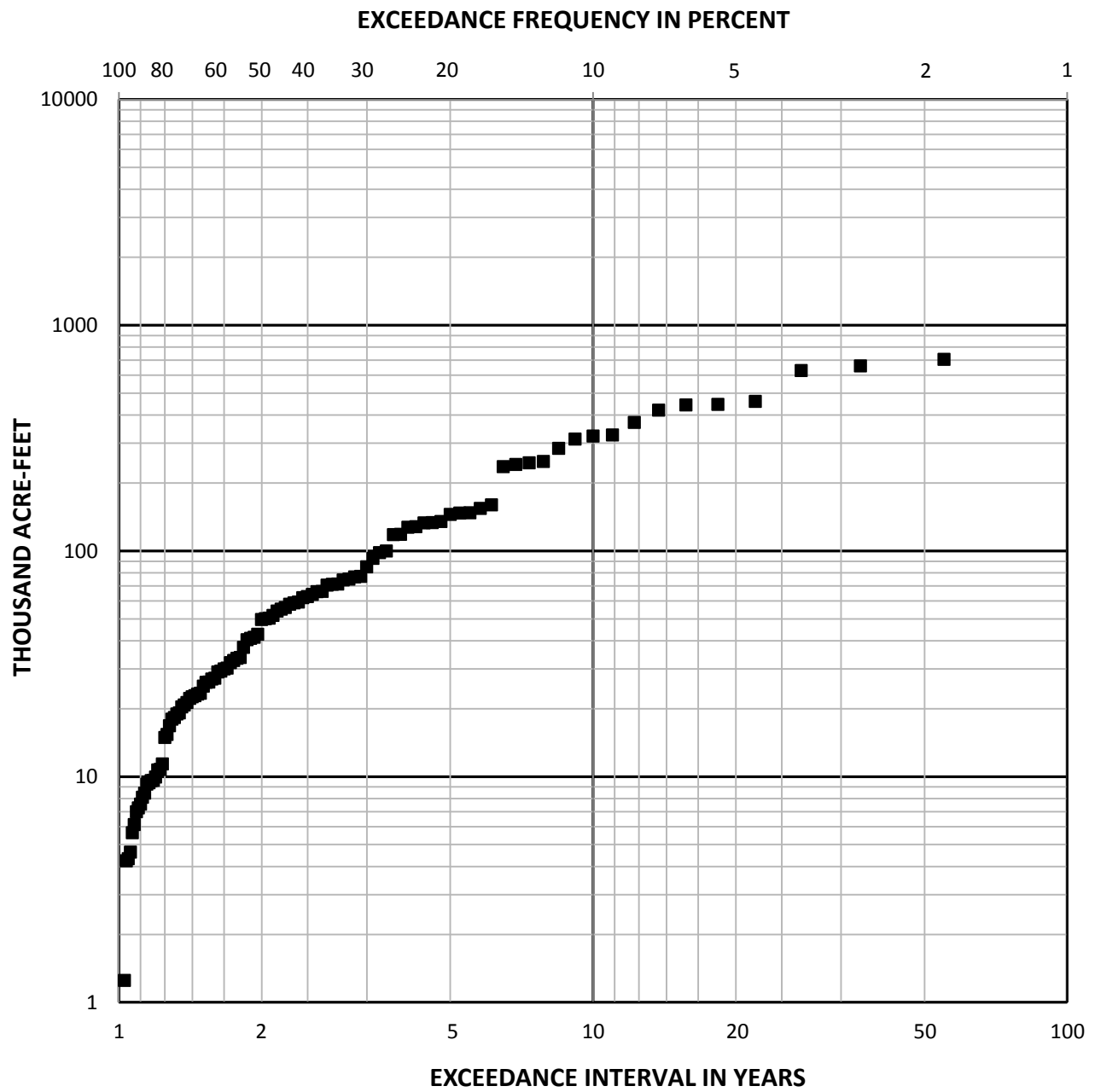
U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

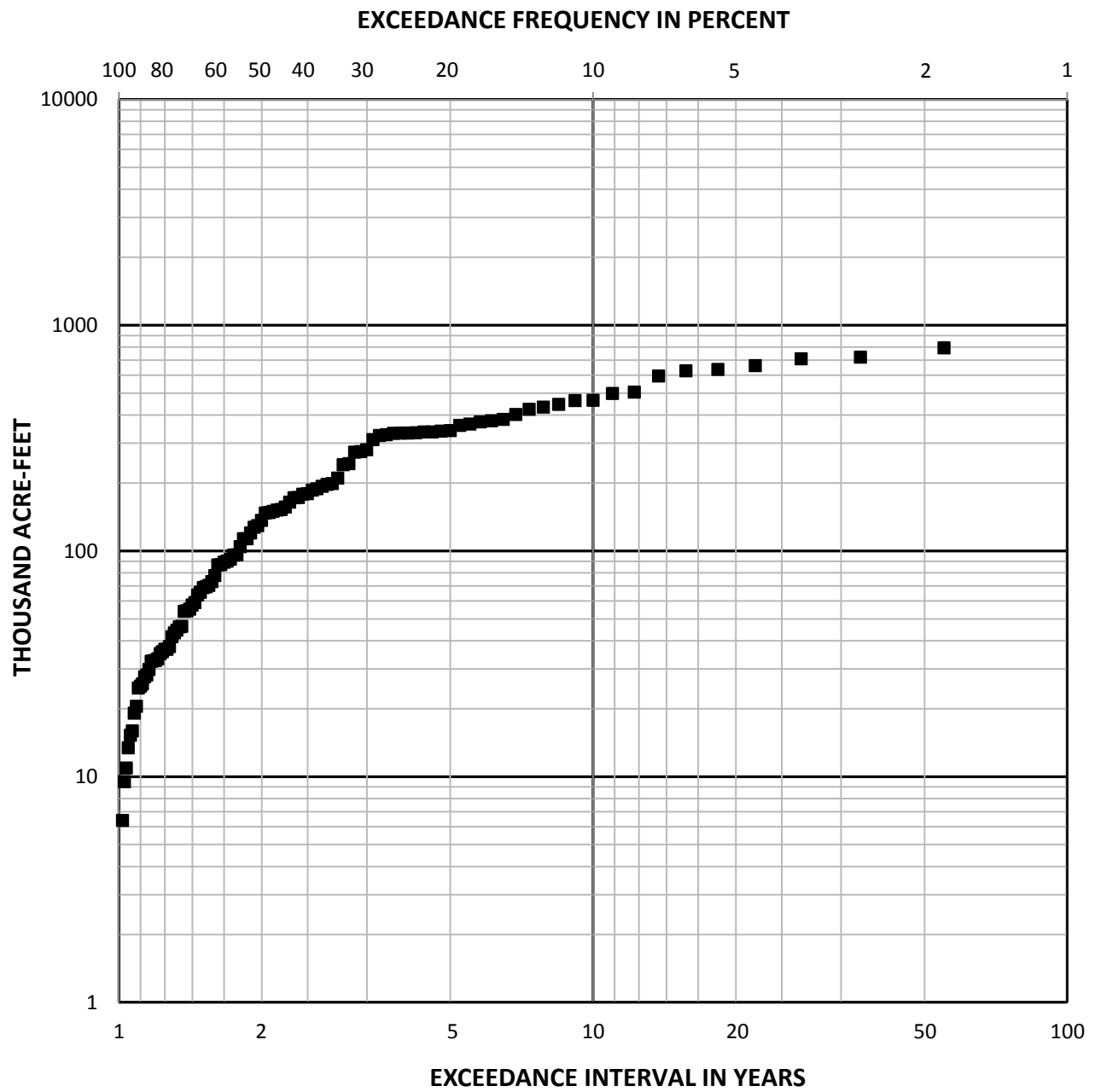
**OCTOBER INFLOW FREQUENCY**  
**1908-2016**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



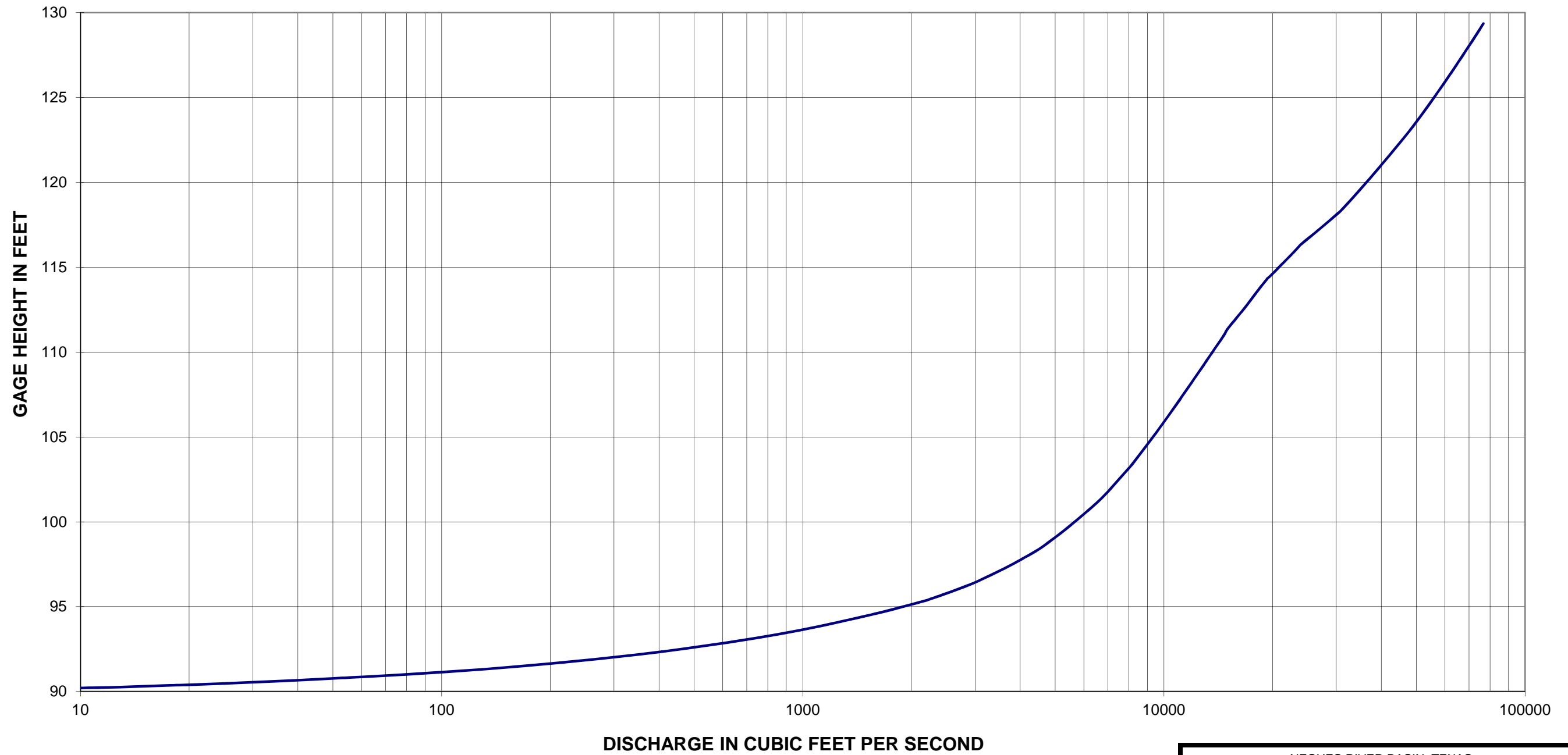
NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER  
  
**NOVEMBER INFLOW FREQUENCY**  
**1908-2016**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH      February 2018



NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER  
  
**DECEMBER INFLOW FREQUENCY**  
**1908-2016**

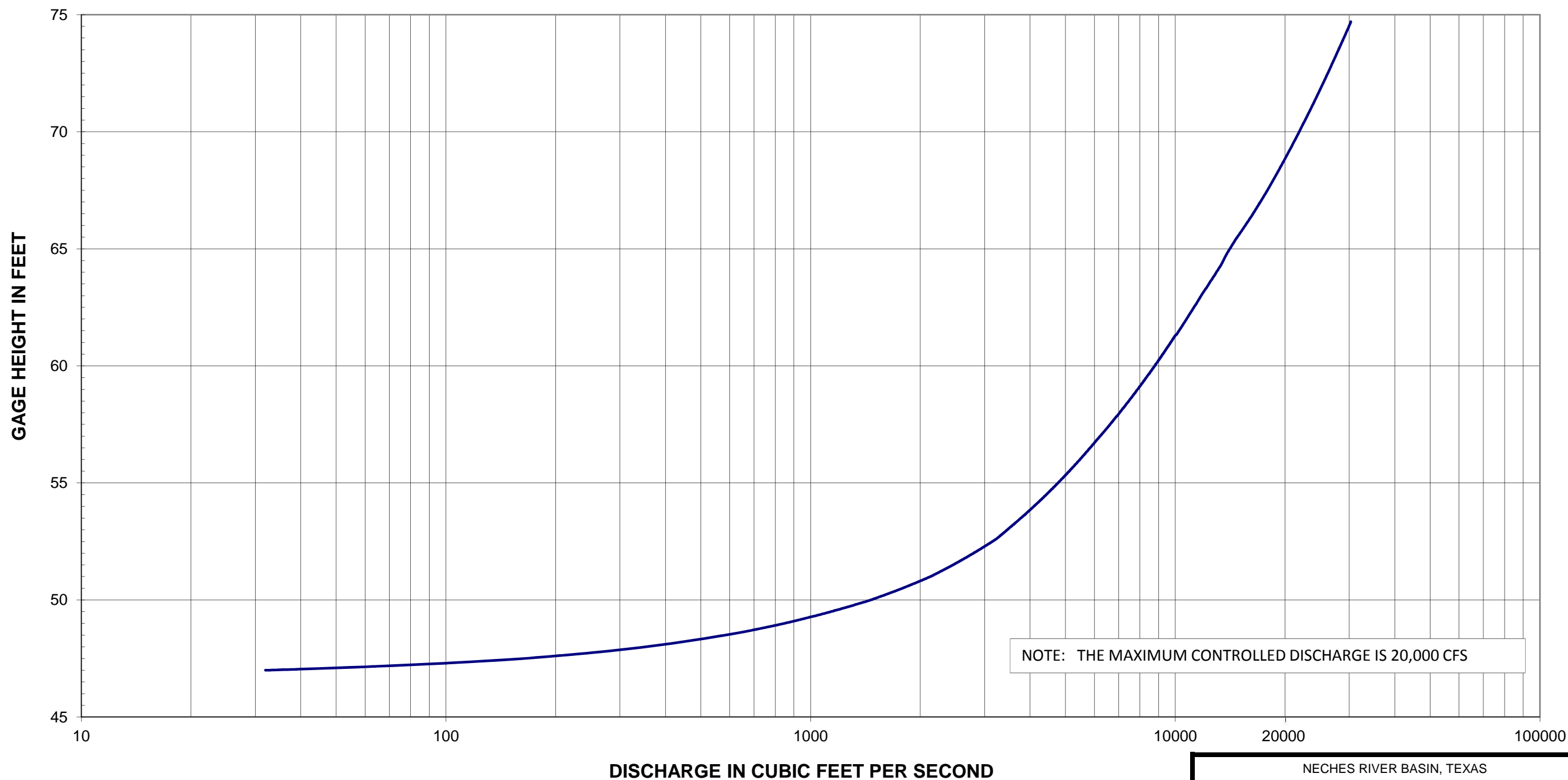
U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



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NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER  
  
**RATING CURVE**  
**NECHES RIVER NEAR ROCKLAND**  
**USGS GAGE NO. 08033500**

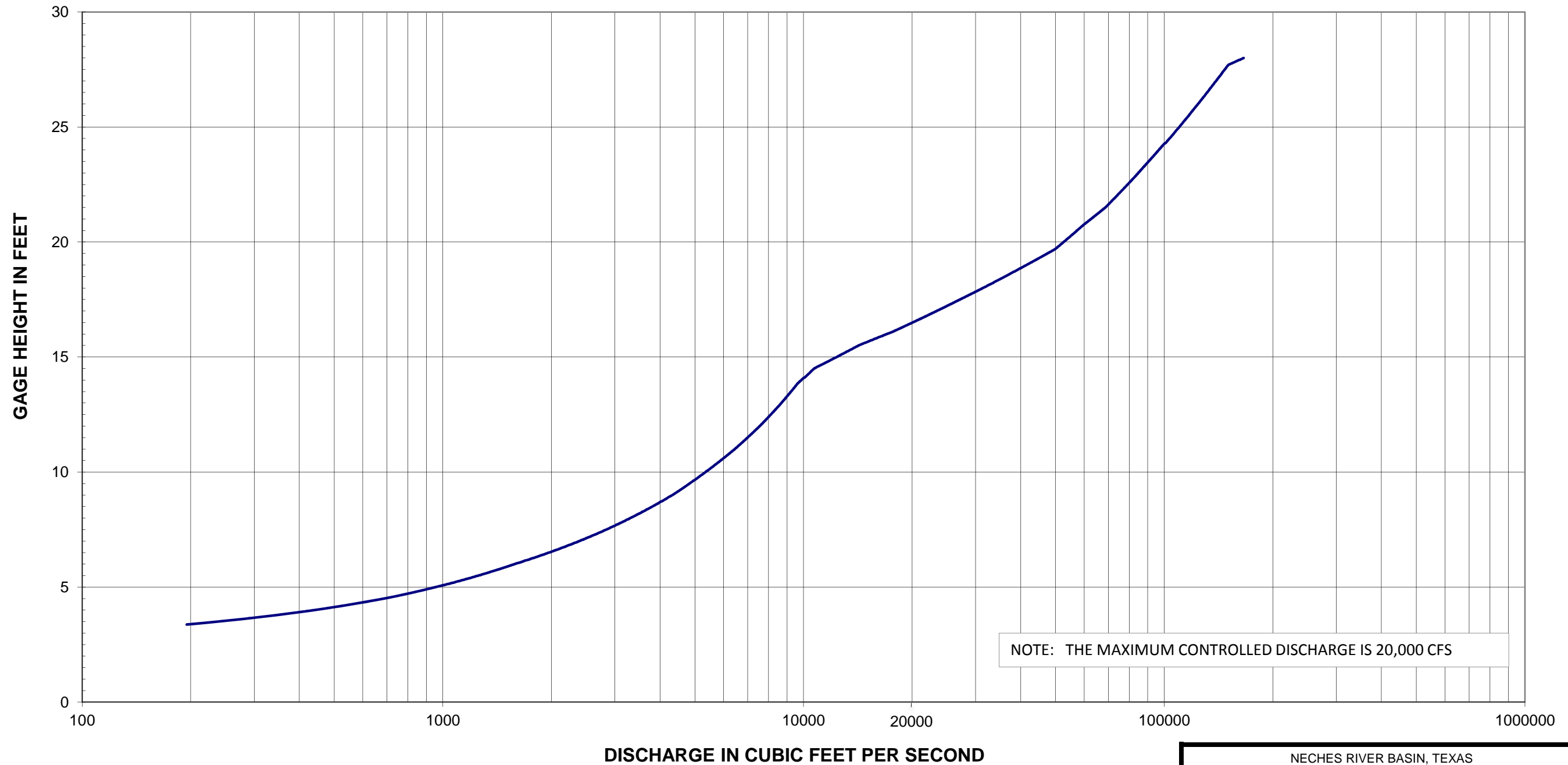
U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



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NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER  
**RATING CURVE**  
**NECHES RIVER NEAR TOWN BLUFF**  
**USGS GAGE NO. 08040600**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

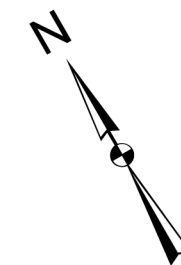
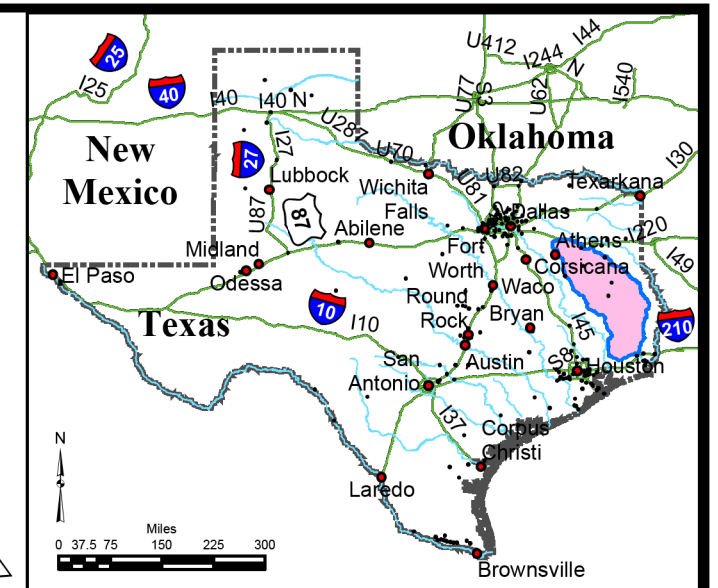
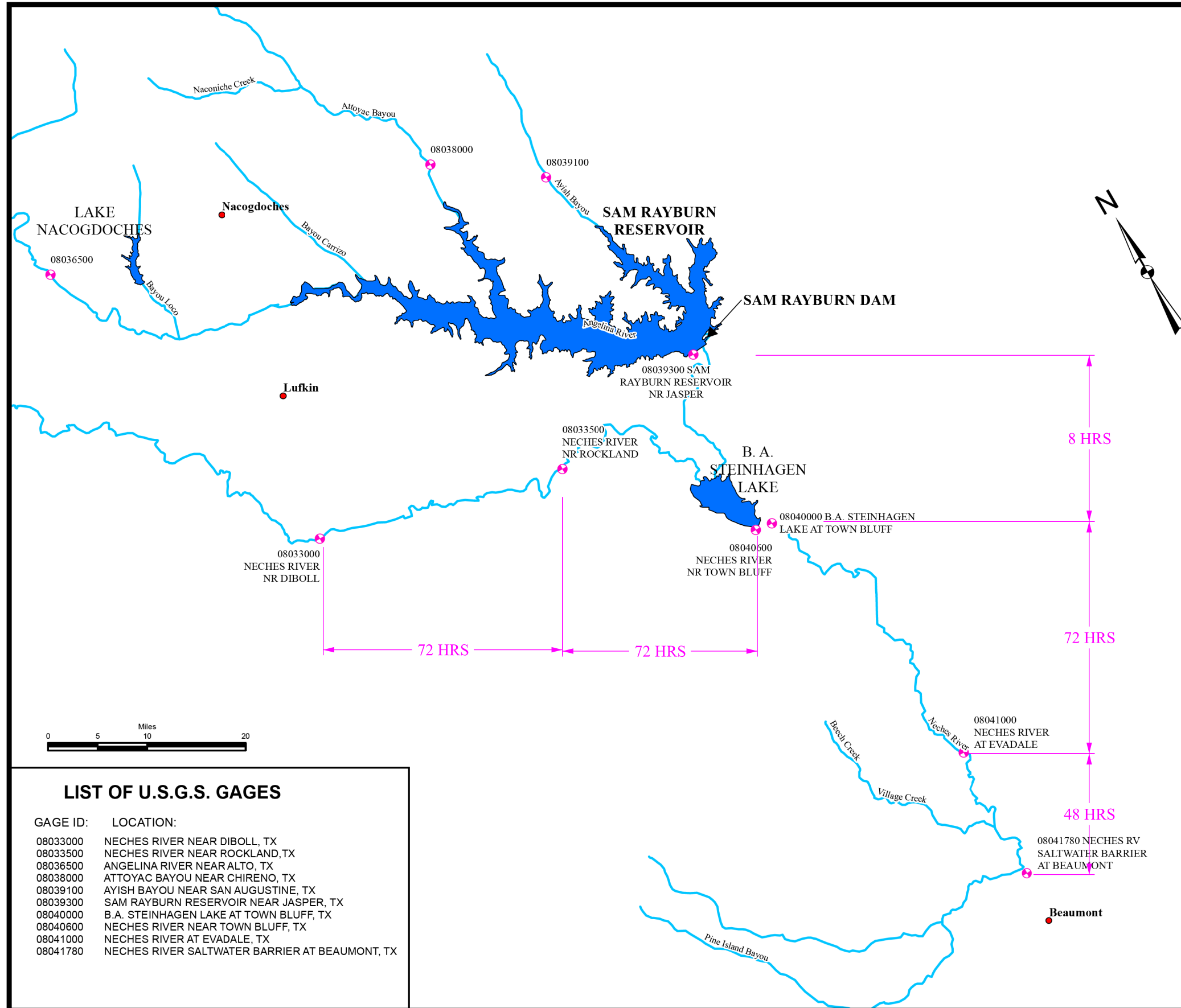


NOTE: THE MAXIMUM CONTROLLED DISCHARGE IS 20,000 CFS

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NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER  
**RATING CURVE**  
**NECHES RIVER AT EVADALE**  
**USGS GAGE NO. 08041000**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



**LEGEND**

- USGS GAGES
- LAKE BOUNDARY
- ~ RIVERS
- CITIES

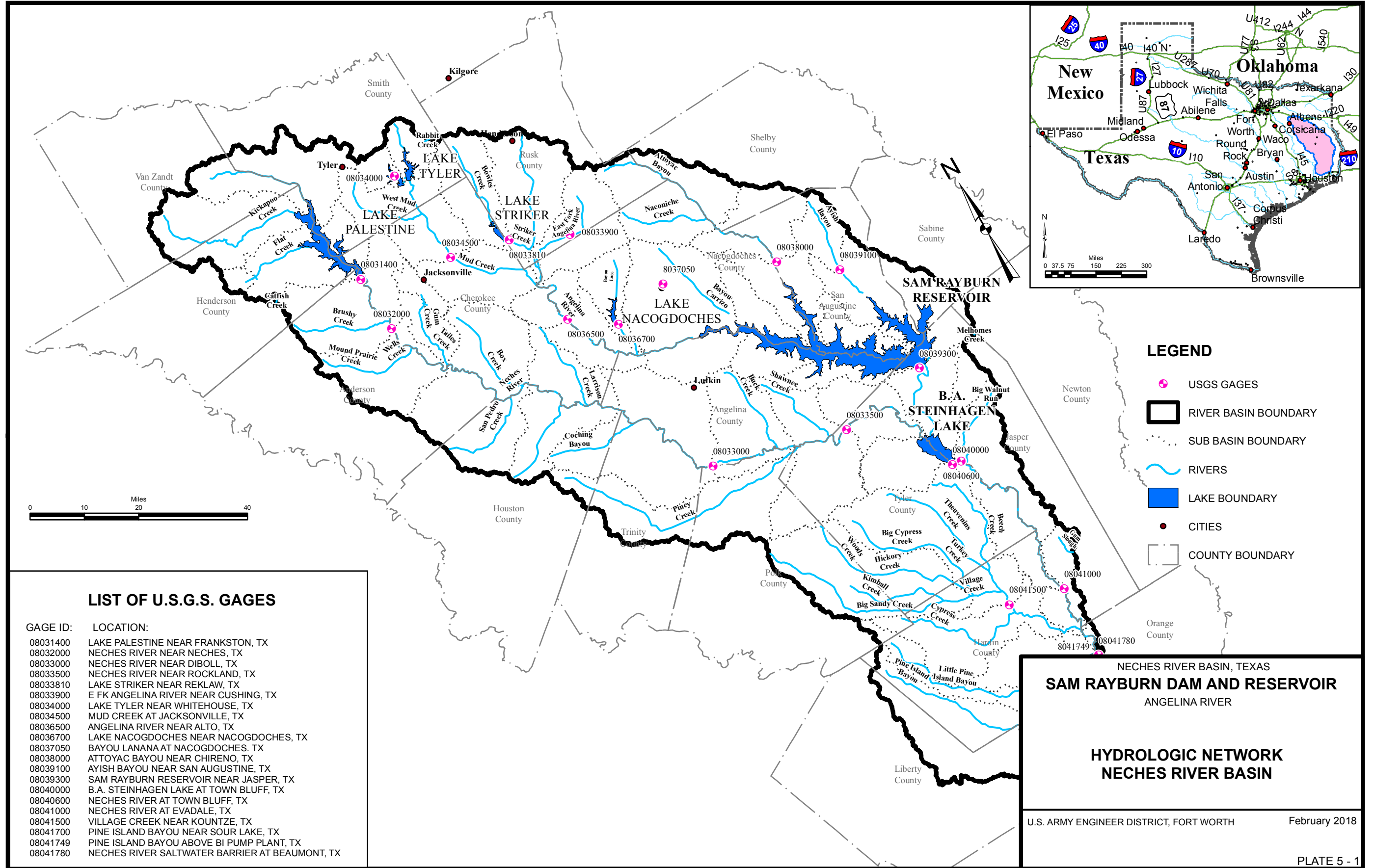


**LIST OF U.S.G.S. GAGES**

GAGE ID:	LOCATION:
08033000	NECHES RIVER NEAR DIBOLL, TX
08033500	NECHES RIVER NEAR ROCKLAND, TX
08036500	ANGELINA RIVER NEAR ALTO, TX
08038000	ATTOYAC BAYOU NEAR CHIRENO, TX
08039100	AYISH BAYOU NEAR SAN AUGUSTINE, TX
08039300	SAM RAYBURN RESERVOIR NEAR JASPER, TX
08040000	B.A. STEINHAGEN LAKE AT TOWN BLUFF, TX
08040600	NECHES RIVER NEAR TOWN BLUFF, TX
08041000	NECHES RIVER AT EVADALE, TX
08041780	NECHES RIVER SALTWATER BARRIER AT BEAUMONT, TX

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

**TRAVEL TIMES FROM  
 SAM RAYBURN DAM TO THE  
 NECHES RIVER AT BEAUMONT GAGE**



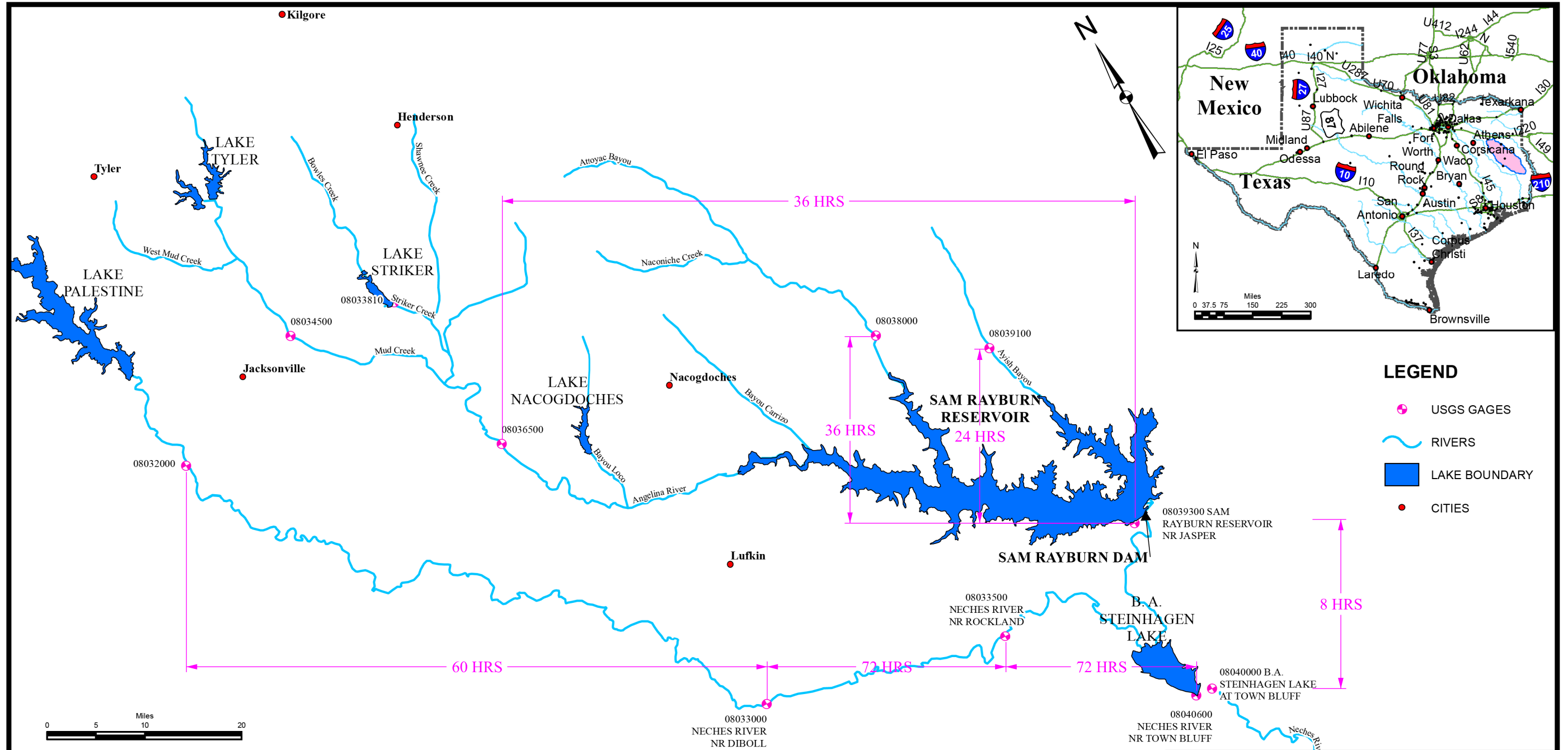
**LIST OF U.S.G.S. GAGES**

GAGE ID:	LOCATION:
08031400	LAKE PALESTINE NEAR FRANKSTON, TX
08032000	NECHES RIVER NEAR NECHES, TX
08033000	NECHES RIVER NEAR DIBOLL, TX
08033500	NECHES RIVER NEAR ROCKLAND, TX
08033810	LAKE STRIKER NEAR REKLAW, TX
08033900	E FK ANGELINA RIVER NEAR CUSHING, TX
08034000	LAKE TYLER NEAR WHITEHOUSE, TX
08034500	MUD CREEK AT JACKSONVILLE, TX
08036500	ANGELINA RIVER NEAR ALTO, TX
08036700	LAKE NACOGDOCHES NEAR NACOGDOCHES, TX
08037050	BAYOU LANANA AT NACOGDOCHES, TX
08038000	ATTOYAC BAYOU NEAR CHIRENO, TX
08039100	AYISH BAYOU NEAR SAN AUGUSTINE, TX
08039300	SAM RAYBURN RESERVOIR NEAR JASPER, TX
08040000	B.A. STEINHAGEN LAKE AT TOWN BLUFF, TX
08040600	NECHES RIVER AT TOWN BLUFF, TX
08041000	NECHES RIVER AT EVADALE, TX
08041500	VILLAGE CREEK NEAR KOUNTZE, TX
08041700	PINE ISLAND BAYOU NEAR SOUR LAKE, TX
08041749	PINE ISLAND BAYOU ABOVE BI PUMP PLANT, TX
08041780	NECHES RIVER SALTWATER BARRIER AT BEAUMONT, TX

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

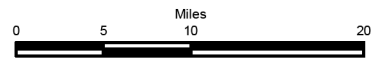
**HYDROLOGIC NETWORK**  
**NECHES RIVER BASIN**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



**LEGEND**

- + USGS GAGES
- ~ RIVERS
- LAKE BOUNDARY
- CITIES

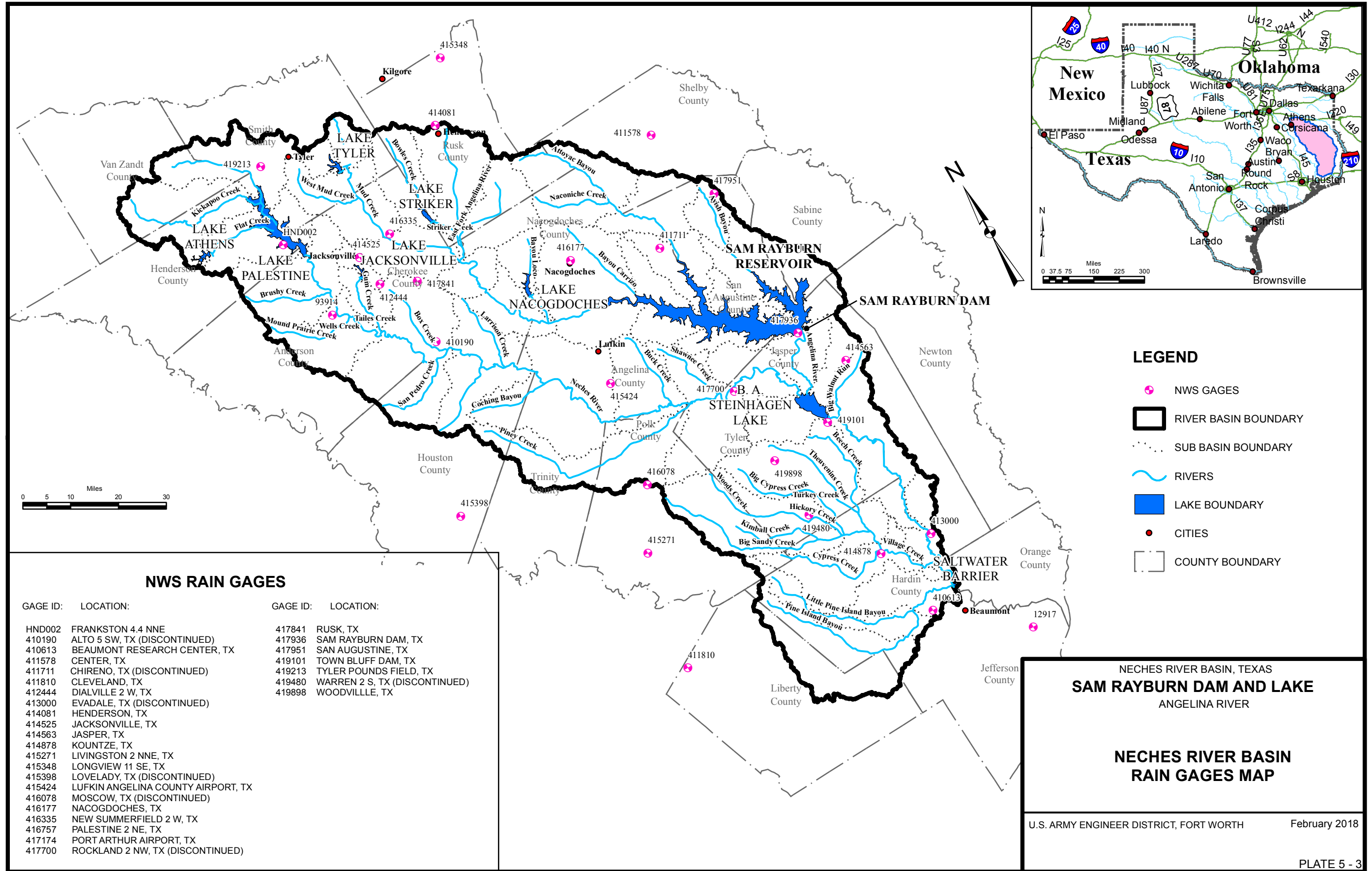


**LIST OF U.S.G.S. GAGES**

GAGE ID:	LOCATION:
08032000	NECHES RIVER NEAR NECHES, TX
08033000	NECHES RIVER NEAR DIBOLL, TX
08033500	NECHES RIVER NEAR ROCKLAND, TX
08033810	LAKE STRIKER NEAR REKLAW, TX
08034500	MUD CREEK AT JACKSONVILLE, TX
08036500	ANGELINA RIVER NEAR ALTO, TX
08038000	ATTOYAC BAYOU NEAR CHIRENO, TX
08039100	AYISH BAYOU NEAR SAN AUGUSTINE, TX
08039300	SAM RAYBURN RESERVOIR NR JASPER, TX
08040000	B.A. STEINHAGEN LAKE AT TOWN BLUFF, TX
08040600	NECHES RIVER AT TOWN BLUFF, TX

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

**TRAVEL TIMES FROM THE ALTO GAGE  
 TO SAM RAYBURN DAM**



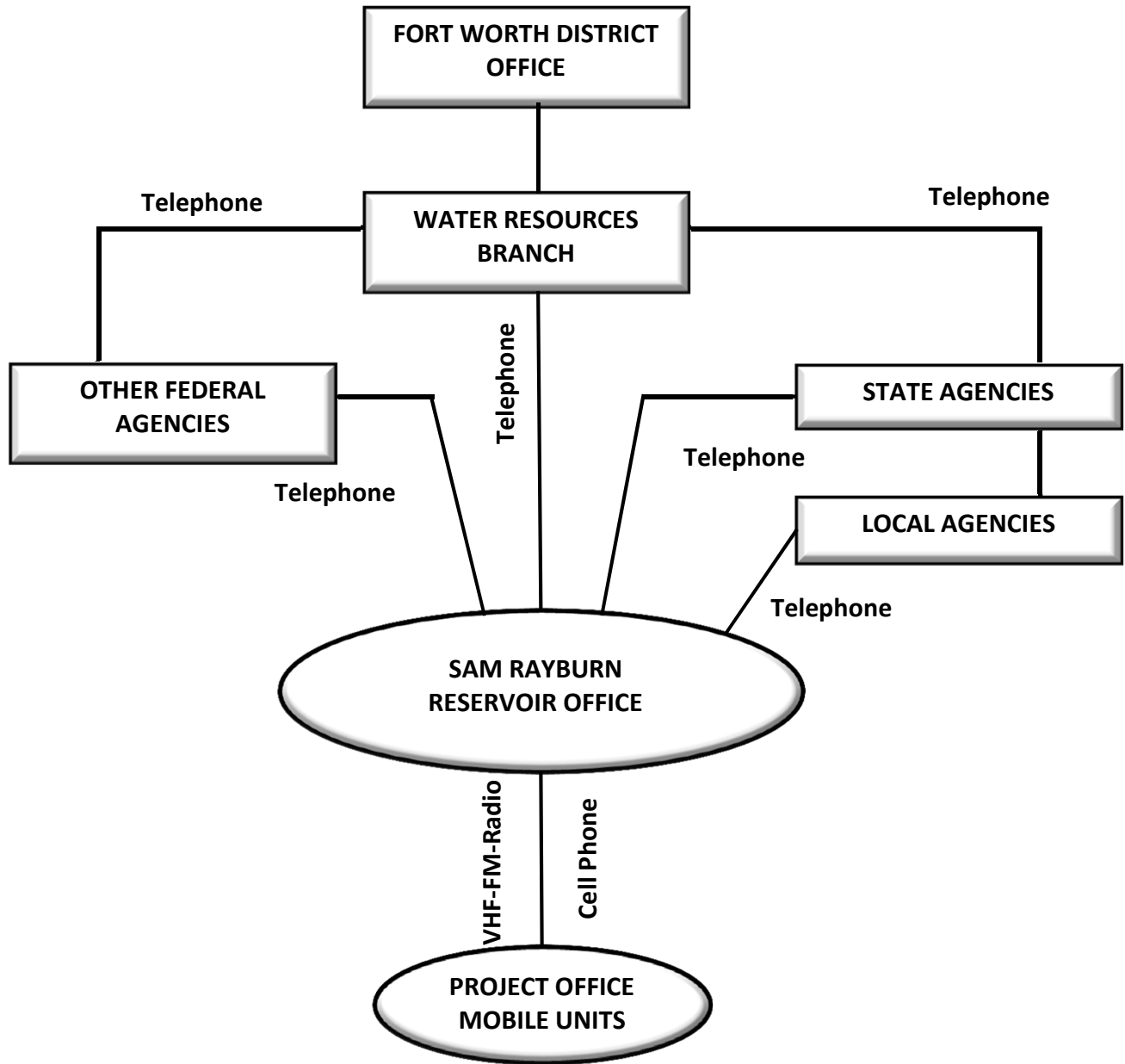
**NWS RAIN GAGES**

GAGE ID:	LOCATION:	GAGE ID:	LOCATION:
HND002	FRANKSTON 4.4 NNE	417841	RUSK, TX
410190	ALTO 5 SW, TX (DISCONTINUED)	417936	SAM RAYBURN DAM, TX
410613	BEAUMONT RESEARCH CENTER, TX	417951	SAN AUGUSTINE, TX
411578	CENTER, TX	419101	TOWN BLUFF DAM, TX
411711	CHIRENO, TX (DISCONTINUED)	419213	TYLER POUNDS FIELD, TX
411810	CLEVELAND, TX	419480	WARREN 2 S, TX (DISCONTINUED)
412444	DIALVILLE 2 W, TX	419898	WOODVILLE, TX
413000	EVADALE, TX (DISCONTINUED)		
414081	HENDERSON, TX		
414525	JACKSONVILLE, TX		
414563	JASPER, TX		
414878	KOUNTZE, TX		
415271	LIVINGSTON 2 NNE, TX		
415348	LONGVIEW 11 SE, TX		
415398	LOVELADY, TX (DISCONTINUED)		
415424	LUFKIN ANGELINA COUNTY AIRPORT, TX		
416078	MOSCOW, TX (DISCONTINUED)		
416177	NACOGDOCHES, TX		
416335	NEW SUMMERFIELD 2 W, TX		
416757	PALESTINE 2 NE, TX		
417174	PORT ARTHUR AIRPORT, TX		
417700	ROCKLAND 2 NW, TX (DISCONTINUED)		

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND LAKE**  
 ANGELINA RIVER

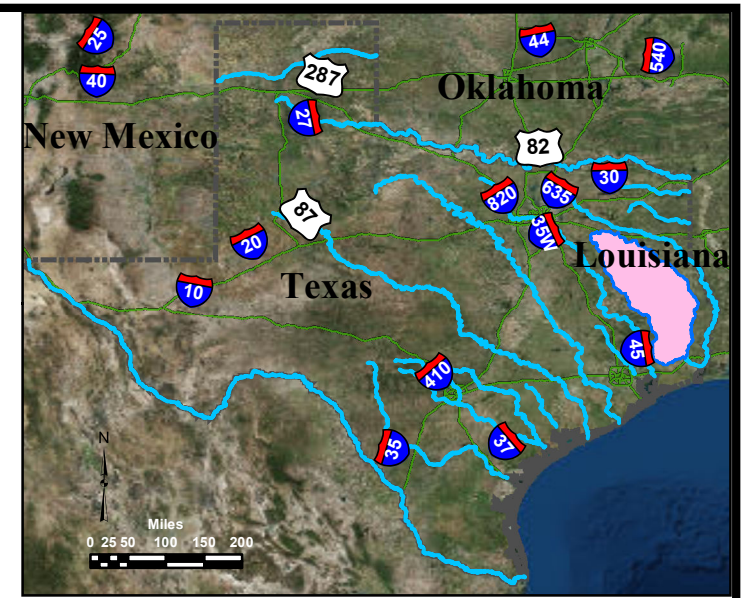
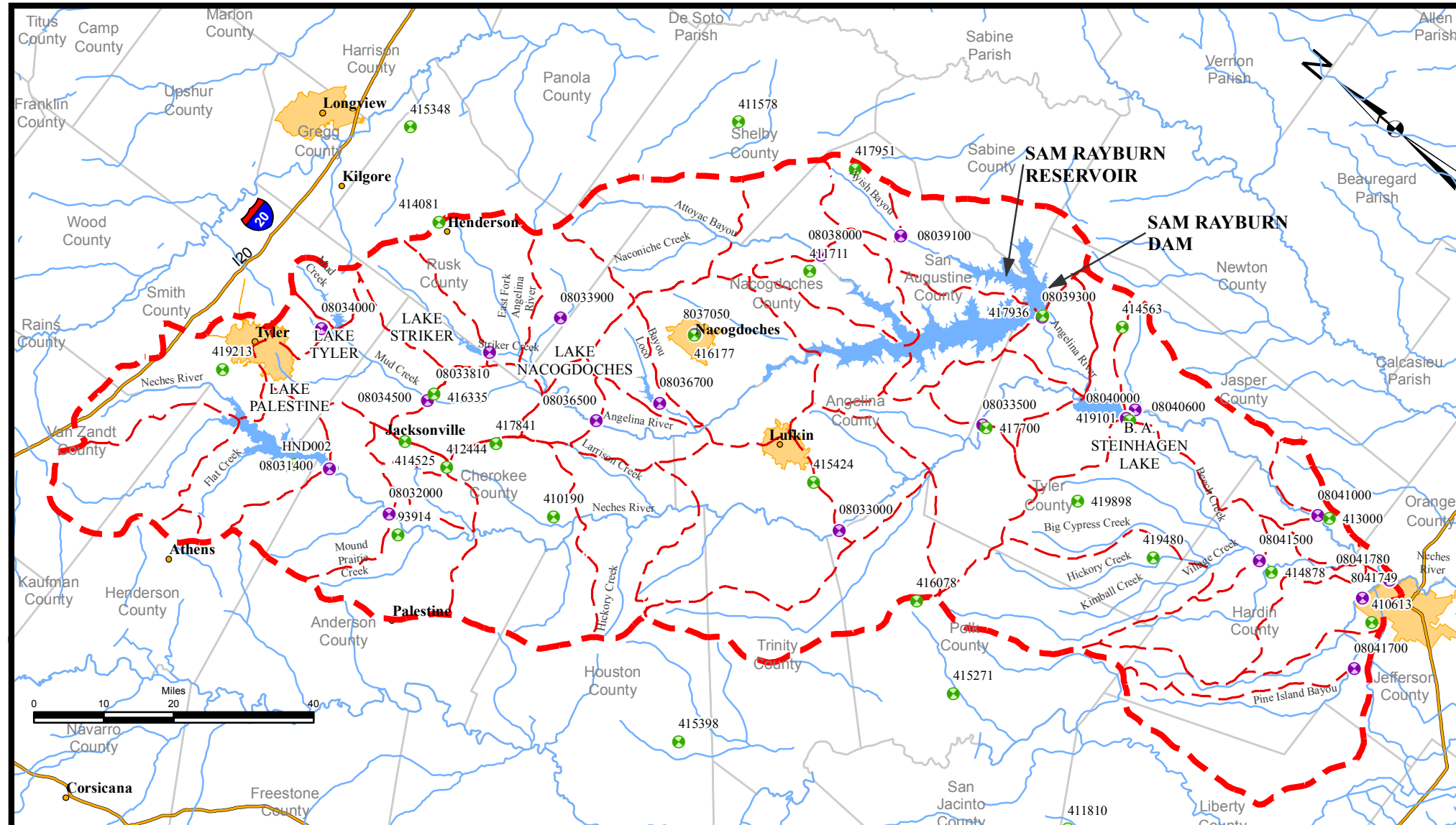
**NECHES RIVER BASIN  
 RAIN GAGES MAP**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER

**LINES OF COMMUNICATION**



**LEGEND**

- RIVER BASIN BOUNDARY
- SUB BASIN BOUNDARY
- RIVERS
- LAKE BOUNDARY
- + NWS GAGES
- + USGS GAGES
- CITIES
- INTERSTATE
- METRO AREAS

**NWS RAIN GAGES**

GAGE ID:	LOCATION:	GAGE ID:	LOCATION:
HND002	FRANKSTON 4.4 NNE	417841	RUSK, TX
410190	ALTO 5 SW, TX (DISCONTINUED)	417936	SAM RAYBURN DAM, TX
410613	BEAUMONT RESEARCH CENTER, TX	417951	SAN AUGUSTINE, TX
411578	CENTER, TX	419101	TOWN BLUFF DAM, TX
411711	CHIRENO, TX (DISCONTINUED)	419213	TYLER POUNDS FIELD, TX
411810	CLEVELAND, TX	419480	WARREN 2 S, TX (DISCONTINUED)
412444	DIALVILLE 2 W, TX	419898	WOODVILLE, TX
413000	EVADALE, TX (DISCONTINUED)		
414081	HENDERSON, TX		
414525	JACKSONVILLE, TX		
414563	JASPER, TX		
414878	KOUNTZE, TX		
415271	LIVINGSTON 2 NNE, TX		
415348	LONGVIEW 11 SE, TX		
415398	LOVELADY, TX (DISCONTINUED)		
415424	LUFKIN ANGELINA COUNTY AIRPORT, TX		
416078	MOSCOW, TX (DISCONTINUED)		
416177	NACOGDOCHES, TX		
416335	NEW SUMMERFIELD 2 W, TX		
416757	PALESTINE 2 NE, TX		
417174	PORT ARTHUR AIRPORT, TX		
417700	ROCKLAND 2 NW, TX (DISCONTINUED)		

**U.S.G.S. GAGES**

GAGE ID:	LOCATION:
08031400	LAKE PALESTINE NEAR FRANKSTON, TX
08032000	NECHES RIVER NEAR NECHES, TX
08033000	NECHES RIVER NEAR DIBOLL, TX
08033500	NECHES RIVER NEAR ROCKLAND, TX
08033810	LAKE STRIKER NEAR REKLAW, TX
08033900	E FK ANGELINA RIVER NEAR CUSHING, TX
08034000	LAKE TYLER NEAR WHITEHOUSE, TX
08034500	MUD CREEK AT JACKSONVILLE, TX
08036500	ANGELINA RIVER NEAR ALTO, TX
08036700	LAKE NACOGDOCHES NEAR NACOGDOCHES, TX
08037050	BAYOU LANANA AT NACOGDOCHES, TX
08038000	ATTOYAC BAYOU NEAR CHIRENO, TX
08039100	AYISH BAYOU NEAR SAN AUGUSTINE, TX
08039300	SAM RAYBURN RESERVOIR NEAR JASPER, TX
08040000	B.A. STEINHAGEN LAKE AT TOWN BLUFF, TX
08040600	NECHES RIVER AT TOWN BLUFF, TX
08041000	NECHES RIVER AT EVADALE, TX
08041500	VILLAGE CREEK NEAR KOUNTZE, TX
08041700	PINE ISLAND BAYOU NEAR SOUR LAKE, TX
08041749	PINE ISLAND BAYOU ABOVE BI PUMP PLANT, TX
08041780	NECHES RIVER SALTWATER BARRIER AT BEAUMONT, TX

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER

**REAL TIME WATER CONTROL  
BASE MAP**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

**SAM RAYBURN DAM AND RESERVOIR  
NORMAL SCHEDULE FOR LAKE REGULATION**

<u>REGULATION</u>	<u>LAKE CONDITION</u>	<u>LAKE ELEVATION</u>	<u>OPERATION</u> (also see NOTES section on this sheet)
A. Conservation	Rising, standing, or falling	I. At or below 164.4	See Plates 7-10 and 7-11 for guidance typically sufficient for normal operations. See Exhibits E and F for background and additional detail.
B. Flood Control	Rising, standing, or falling	I. 164.4 to 165.0	Subject to downstream controls, release not less than 4,200 dsf per day. This release volume is approximately equivalent to that produced by 24 unit-hours of 25MW output hydropower generation.
		II. 165.0 to 165.5	Subject to downstream controls, release not less than 8,400 dsf per day. This release volume is approximately equivalent to that produced by 48 unit-hours of 25MW output hydropower generation.
		III. 165.5 to 173.0 and not forecast to exceed 173.0	Subject to downstream controls, make releases at rates not to exceed 20,000 cfs.
		IV. Exceeding or forecast to exceed 173.0	Operate in accordance with the guidance shown on Plate 7-9, Inflow vs. Outflow.

**NOTES:**

1. The maximum allowable rate of controlled release from Sam Rayburn Reservoir is 20,000 cfs.
2. Downstream Controls. Releases from the storage space below 173.0 should not normally contribute to flows on the Neches River at Evadale in excess of 20,000 cfs. An exception to this rule may be warranted when the pool is forecast to rise into surcharge (above 173.0) and pre-emptive releases resulting in the exceedance of this 20,000 cfs control at Evadale may be expected to ultimately minimize peak river stages on the lower Neches River.
3. Release requirements will normally be met via hydropower generation insofar as its capacity for discharge can meet the required rate of release.
4. A minimum hydropower release of 1,150 dsf (about 6 unit-hours of generation at 25MW output) per day will normally be maintained during flood conditions (even when such release contributes to flows on the Neches River at Evadale in excess of 20,000 cfs), but may be reduced in the interest of reducing downstream flood damages. Refer to Contract No. DE-GM75-80SW0058 in Exhibit G for the protocol for reducing the minimum hydropower release to less than 1,150 dsf during time of flood.

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND LAKE**  
ANGELINA RIVER

**NORMAL REGULATION PLAN  
FOR CONSERVATION AND  
FLOOD CONTROL OPERATIONS**

U.S. ENGINEER DISTRICT, FORT WORTH

February 2018

PLATE 7-1

**SAM RAYBURN DAM AND RESERVOIR  
EMERGENCY SCHEDULE FOR LAKE REGULATION**

**INSTRUCTIONS TO RESERVOIR MANAGER FOR USE WHEN COMMUNICATIONS WITH DISTRICT OFFICE FAIL**

<u>REGULATION</u>	<u>LAKE CONDITION</u>	<u>LAKE ELEVATION</u>	<u>OPERATION (also see NOTES section on this sheet)</u>						
A. Conservation	Rising, standing, or falling	I. At or below 164.4	<p>1) If hydropower generation is in progress, reduce the rate of generation discharge to 1,150 cfs (prime power requirement) as soon as either of the following conditions occur:</p> <p>a) One or more inches of rain is experienced at or below the dam in six hours or less.</p> <p>b) Six hours of time elapses after losing communications.</p> <p>If possible, notify the authorized power dispatcher of any reductions in hydropower generation. Power generation may be further reduced or curtailed at the request of the authorized power dispatcher, but do not increase the power generation rate of release above 1,150 cfs.</p> <p>2) If hydropower generation is not in progress, do not initiate hydropower generation.</p>						
B. Flood Control	Rising, standing, or falling	I. 164.4 to 173.0	<p>1) If gated releases are in progress, close the gates using the normal rate of closure as soon as either of the following conditions occur:</p> <p>a) One or more inches of rain is experienced at or below the dam in six hours or less.</p> <p>b) Six hours of time elapses after losing communications.</p> <p>2) If hydropower generation is in progress, reduce the rate of generation discharge to 1,150 cfs (prime power requirement) as soon as either of the following conditions occur:</p> <p>a) One or more inches of rain is experienced at or below the dam in six hours or less.</p> <p>b) Six hours of time elapses after losing communications.</p> <p>If possible, notify the authorized power dispatcher of any reductions in hydropower generation. Power generation may be further reduced or curtailed at the request of the authorized power dispatcher, but do not increase the power generation rate of release above 1,150 cfs.</p> <p>3) If hydropower generation is not in progress, do not initiate hydropower generation.</p>						
	Rising, standing, or falling	II. Above 173.0 to 176.0	<p>1) If gated releases are in progress, continue releases as long as they exceed the following minimum releases using the combination of hydropower generation and gates:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">173.0 - 173.5 = 3,000 cfs</td> <td style="width: 50%;">174.5 - 175.0 = 10,000 cfs</td> </tr> <tr> <td>173.5 - 174.0 = 6,000 cfs</td> <td>175.0 - 176.0 = 22,600 cfs (Flood gates fully open)</td> </tr> <tr> <td>174.0 - 174.5 = 8,000 cfs</td> <td></td> </tr> </table>	173.0 - 173.5 = 3,000 cfs	174.5 - 175.0 = 10,000 cfs	173.5 - 174.0 = 6,000 cfs	175.0 - 176.0 = 22,600 cfs (Flood gates fully open)	174.0 - 174.5 = 8,000 cfs	
173.0 - 173.5 = 3,000 cfs	174.5 - 175.0 = 10,000 cfs								
173.5 - 174.0 = 6,000 cfs	175.0 - 176.0 = 22,600 cfs (Flood gates fully open)								
174.0 - 174.5 = 8,000 cfs									
	Rising, standing, or falling	III. Above 176.0 to 177.5	If the pool rises above spillway crest elevation 176.0, adjust the total combined project release as needed using the both hydropower generation and gates, and insofar as possible, to not exceed 22,600 cfs.						
	Rising, standing, or falling	IV. Above 177.5	Close all flood gates and hydropower generation.						

Notes:

1. Flood Gate Operation: Gate opening and closing operations should be accomplished as symmetrically as practicable with allowable difference in gate opening height between the two gates not to exceed one foot. For continuous operation the gates will normally be set at any desired 0.5-foot increment of opening height up to 10 feet (half open), after which the next opening step is directly to full open in one continuous operation - first one gate, followed immediately by the other. Closure from full open to half open should be accomplished analogously in reverse order.

NECHES RIVER BASIN, TEXAS

**SAM RAYBURN DAM AND LAKE**

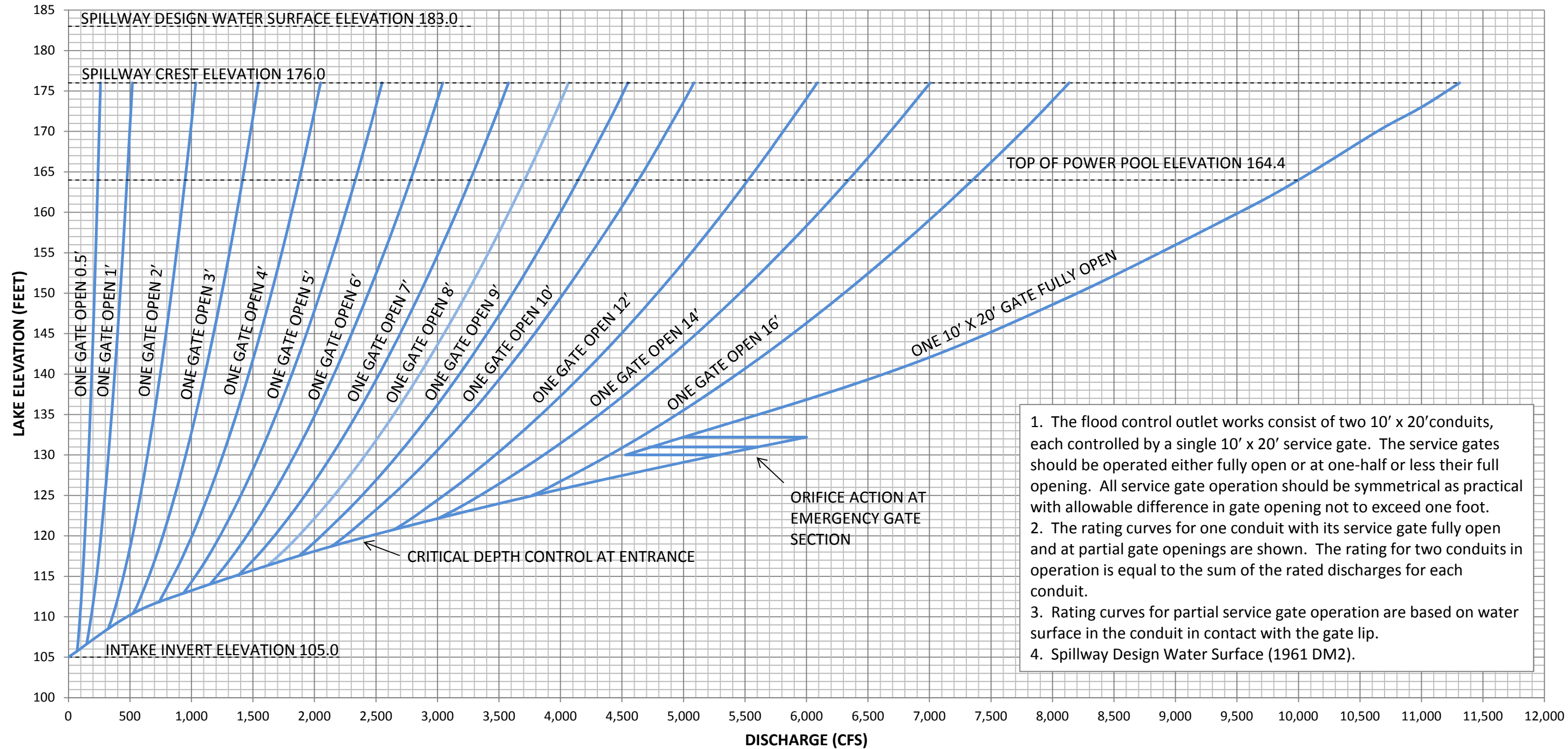
ANGELINA RIVER

**EMERGENCY REGULATION PLAN  
FOR CONSERVATION AND  
FLOOD CONTROL OPERATIONS**

U.S. ENGINEER DISTRICT, FORT WORTH

February 2018

PLATE 7-2



1. The flood control outlet works consist of two 10' x 20' conduits, each controlled by a single 10' x 20' service gate. The service gates should be operated either fully open or at one-half or less their full opening. All service gate operation should be symmetrical as practical with allowable difference in gate opening not to exceed one foot.
2. The rating curves for one conduit with its service gate fully open and at partial gate openings are shown. The rating for two conduits in operation is equal to the sum of the rated discharges for each conduit.
3. Rating curves for partial service gate operation are based on water surface in the conduit in contact with the gate lip.
4. Spillway Design Water Surface (1961 DM2).

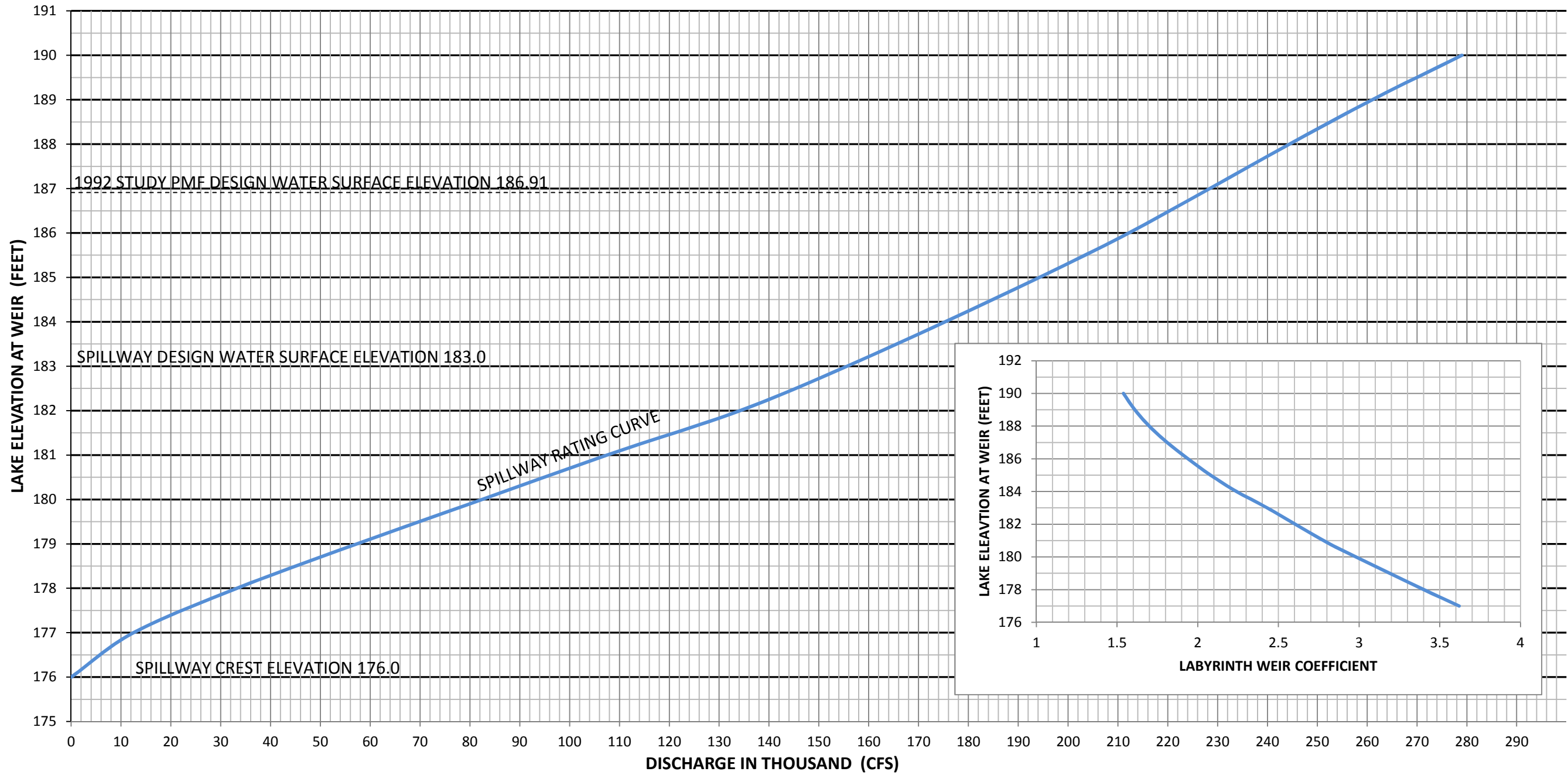
ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 FOR SAM RAYBURN DAM AND LAKE IS: NGVD29 + 0.0 FEET = NAVD88

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND LAKE**  
 ANGELINA RIVER

**OUTLET WORKS  
 CONDUIT RATING CURVES  
 TWO 10-FOOT x 20-FOOT CONDUITS**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

PLATE 7 - 3



SPILLWAY IS A CONCRETE LABYRINTH WEIR. THE SPILLWAY CONSISTS OF 16 CYCLES, 40- FEET PER CYCLE, 20 FEET HIGH. EACH CYCLE IS 200 FEET IN LENGTH ALONG ITS CREST FOR A TOTAL CREST LENGTH OF 3,200 FEET. THE NET OPENING (STRAIGHTLINE DISTANCE) IS 640 FEET FROM ABUTMENT TO ABUTMENT. THE PMF WATER SURFACE ELEVATION IS 186.91 ACCORDING TO THE 1992 STUDY .

ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 FOR SAM RAYBURN DAM AND LAKE IS: NGVD29 + 0.0 FEET = NAVD88

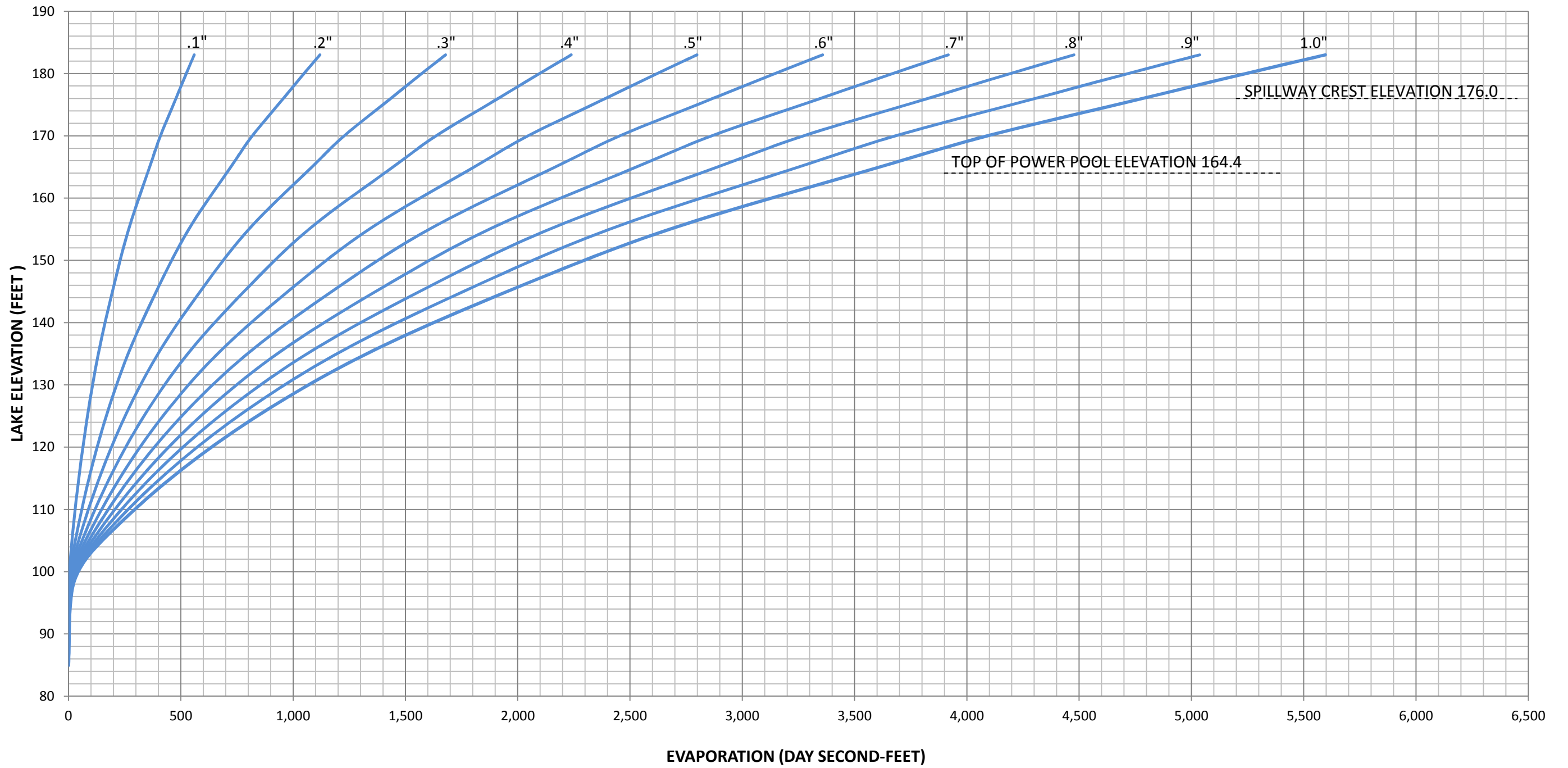
NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND LAKE**  
 ANGELINA RIVER

**SPILLWAY RATING CURVE**

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U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

PLATE 7 - 4



ONE DAY SECOND-FEET IS EQUAL TO 1.9835 ACRE-FEET.  
 MONTHLY AVERAGE PAN COEFFICIENT = 0.74 FROM TEXAS WATER DEVELOPMENT BOARD.  
 THE CURVES REPRESENT PAN EVAPORATION AMOUNTS FROM 0.1-INCH TO 1.0-INCH.

ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 FOR SAM RAYBURN DAM AND LAKE IS:  
 NGVD29 + 0.0 FEET = NAVD88

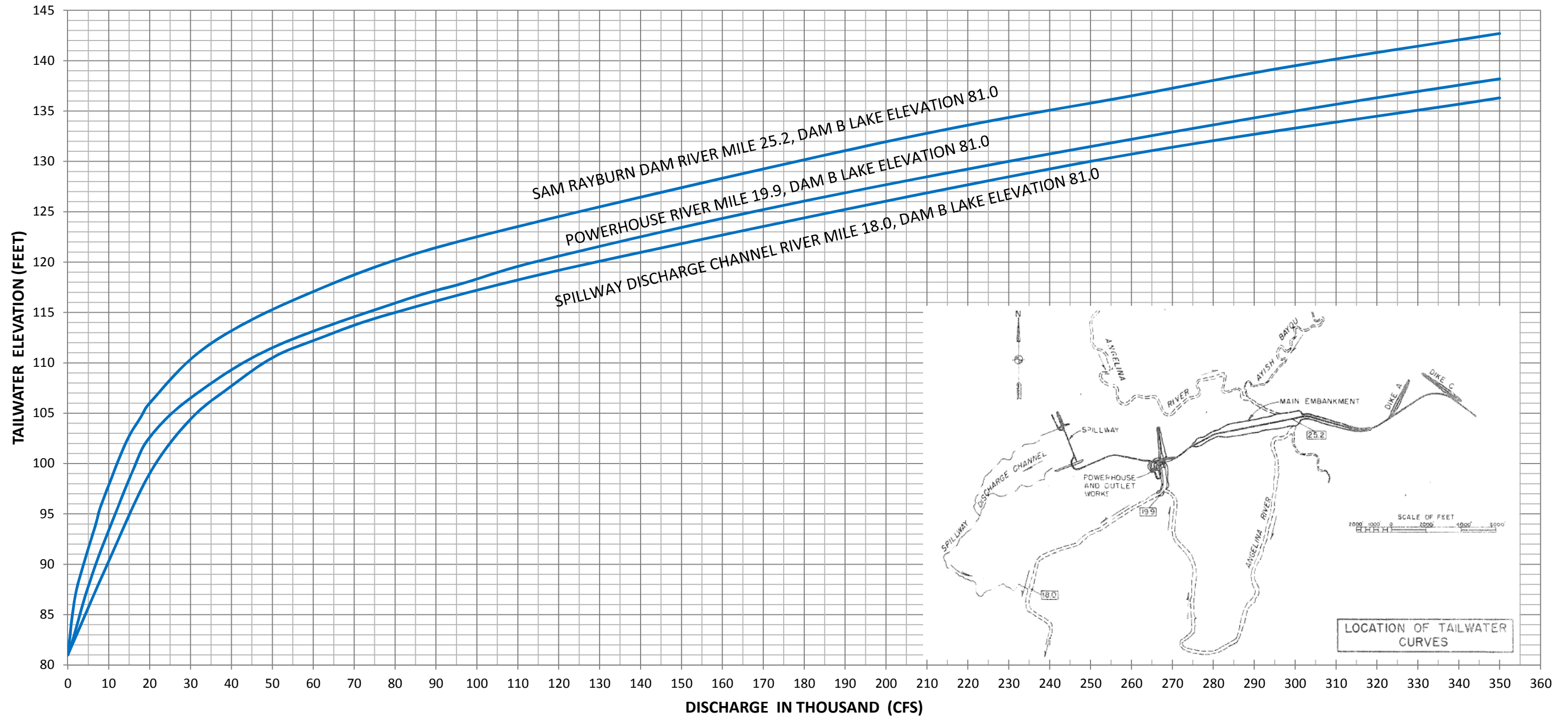
NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND LAKE**  
 ANGELINA RIVER

**LAKE EVAPORATION CURVES**

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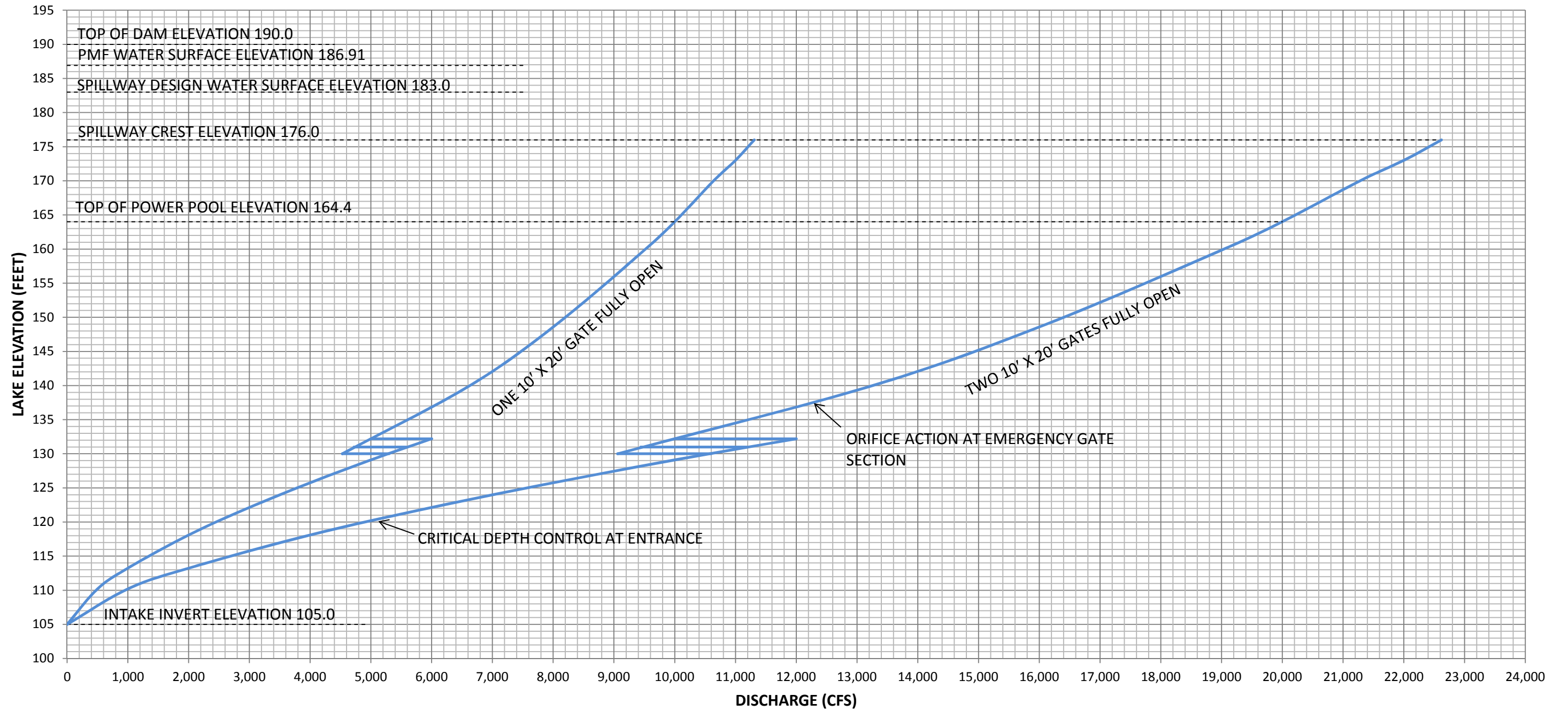
U.S. ARMY ENGINEER DISTRICT, FORT WORTH      February 2018

PLATE 7 - 5



ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 FOR SAM RAYBURN DAM AND LAKE IS: NGVD29 + 0.0 FEET = NAVD88

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND LAKE**  
 ANGELINA RIVER  
**TAILWATER RATING CURVES**



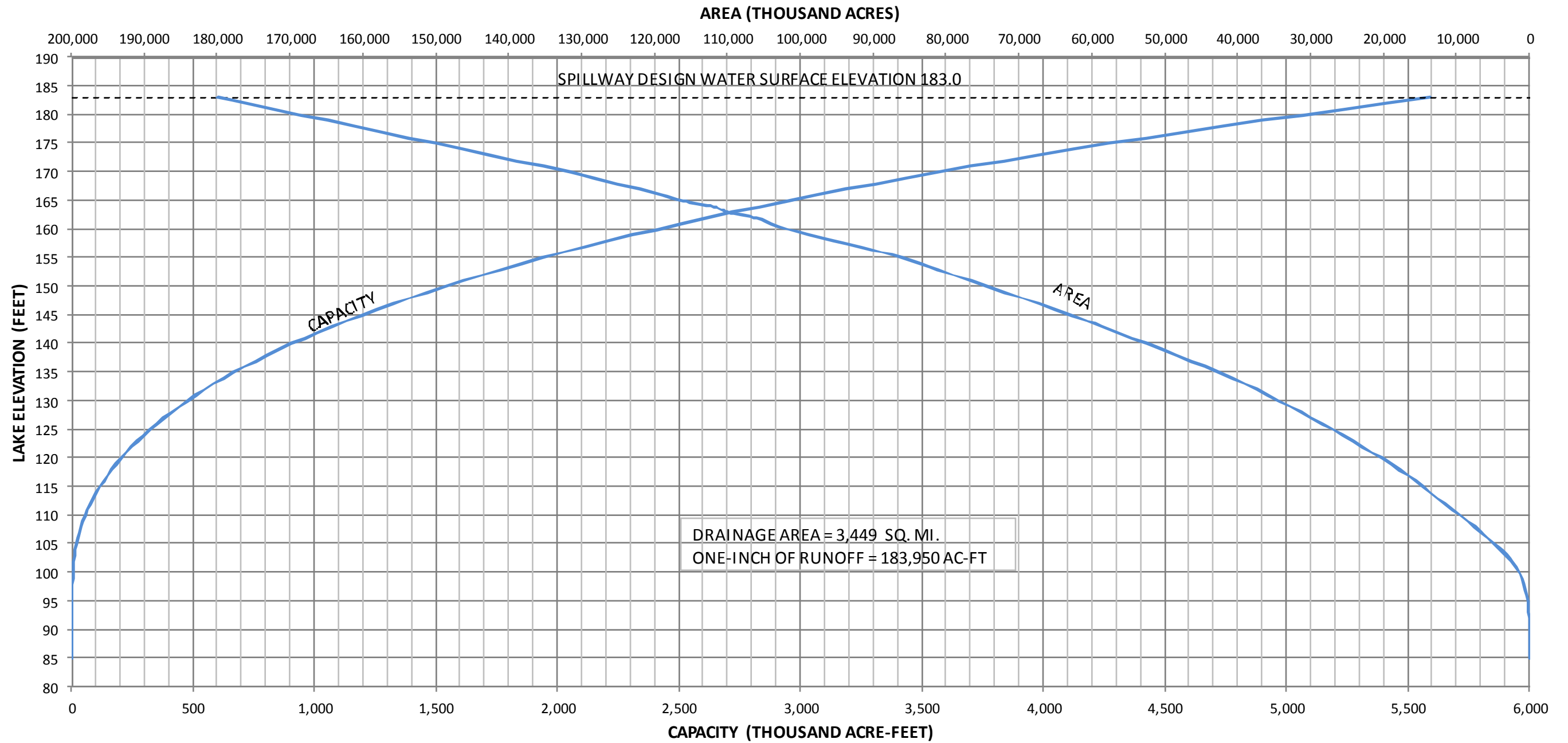
THE FLOOD CONTROL OUTLET WORKS CONSIST OF TWO 10' X 20' CONDUITS EACH CONTROLLED BY A SINGLE 10' X 20' GATE.

ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 FOR SAM RAYBURN DAM AND LAKE IS: NGVD29 + 0.0 FEET = NAVD88

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND LAKE**  
 ANGELINA RIVER

**OUTLET WORKS**  
**CONDUIT RATING CURVES**  
**TWO 10-FOOT x 20-FOOT CONDUITS**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



SAM RAYBURN LAKE VOLUMETRIC SURVEY PERFORMED BY THE TEXAS WATER DEVELOPMENT BOARD IN APRIL 2004.

ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 FOR SAM RAYBURN DAM AND LAKE IS: NGVD29 + 0.0 FEET = NAVD88

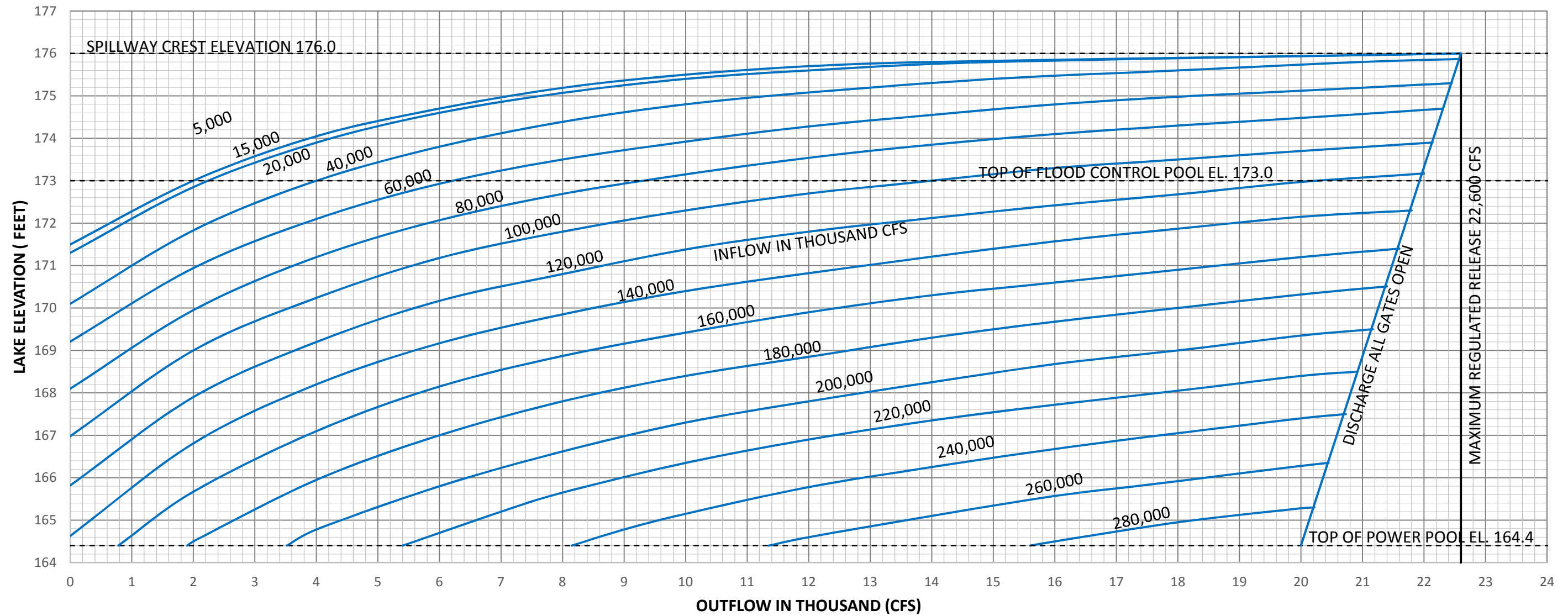
NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND LAKE**  
 ANGELINA RIVER

**AREA AND CAPACITY CURVES**

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U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

PLATE 7 - 8



**OPERATING INSTRUCTIONS**

1. The maximum allowable rate of controlled release from Sam Rayburn Reservoir is 20,000 cfs.
2. Every two hours, determine the release indicated by these curves based on the current pool elevation and the average reservoir inflow for the preceding two hours. Adjust the project release to the larger of the release indicated by these curves or the maximum release allowed subject to downstream controls, but not to exceed 20,000 cfs prior to spillway overtopping.
3. If the pool peaks at or below spillway crest elevation 176.0, maintain the maximum release attained until the pool recedes to 173.0 or a higher rate of release is allowed based on downstream control criteria.
4. If the pool rises above spillway crest elevation 176.0, adjust the project release as needed, and insofar as possible, to not exceed 22,600 cfs. The gates should reach full closure at such time that spillway flows equal 22,600 cfs.
5. When the pool goes into recession and the project release recedes to less than 20,000 cfs, make adjustments as required to maintain a 20,000 cfs project release until the pool recedes below 173.0. When inflow to the reservoir recedes to the point releases may be made subject to downstream controls without the pool rising above 173.0, refer to the Normal Regulation Plan for Flood Control Operators.

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN RESERVOIR**  
 ANGELINA RIVER

**RESERVOIR REGULATION SCHEDULE  
 INFLOW VS OUTFLOW**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH

February 2018

### Sam Rayburn Dam – Guidelines for Flexible Scheduling of Hydropower Generation

Parameter	Guidance
<b>A.</b> Weekly Unit-Hours Allotment	Defined by the 1981 Operating Rule Curve Agreement
<b>B.</b> Minimum Unit Run Time [hrs]	2 (~380 dsf)
<b>C.</b> Minimum Unit-Hours per Day, If Scheduled [unit-hrs]	2 (~380 dsf)
<b>D.</b> Maximum Number of Generation Periods per Day	2
<b>E.</b> Minimum Time between Generation Periods	2 hours if unit is shutdown. 10 minutes if unit is disconnected from grid but remains at speed in a no-load status.
<b>F.</b> Maximum Unit-Hours per Day [unit-hrs]	18 (~3400 dsf)
<b>G.</b> Limits on Zero Generation Days	<u>Minimum Unit-Hrs per 3 Consecutive Day Period:</u> Zone 1: 8 (~1500 dsf) Zone 2: 3 (~570 dsf) Zone 3: 3 (~570 dsf) [15 Apr - 15 Oct] Zone 4: 3 (~570 dsf) [15 Apr – 15 Oct]
<b>H.</b> Minimum Days of Unit Run per Generation/Allotment Week	Dictated by the “Limits on Zero Generation Days” Parameter
<b>I.</b> Communication Protocols	a) The USACE Fort Worth District Water Management Office will issue notification of a change in the weekly allotment of unit-hours of generation by 1100 hours Central Time on Friday. At a minimum the notification will be sent to the SWPA customers’ scheduling agent (currently NRG, MISO Real Time Desk); SWPA; the Sam Rayburn Powerhouse Superintendent; Sam Rayburn Powerhouse Operators; and the B.A Steinhagen Lake Manager. The weekly allotment prescribed in a notification will remain effective until such time as a new notification is issued. That is, if no notification is issued by 1100 hours Central Time on a given Friday, it will be assumed there is no change in the currently effective weekly allotment of unit-hours of generation. (see example e-mail format on next page)  b) The SWPA customers’ scheduling agent (currently NRG) will provide written notification of the next day’s generation schedule by 1600 hours Eastern Standard Time. At a minimum, the notification will be sent to the USACE Fort Worth District Water Management Office; the USACE Fort Worth District Sam Rayburn Powerhouse Superintendent; USACE Fort Worth District Sam Rayburn Powerhouse Operators; and SWPA.

NECHES RIVER BASIN, TEXAS

**SAM RAYBURN DAM AND LAKE**

ANGELINA RIVER

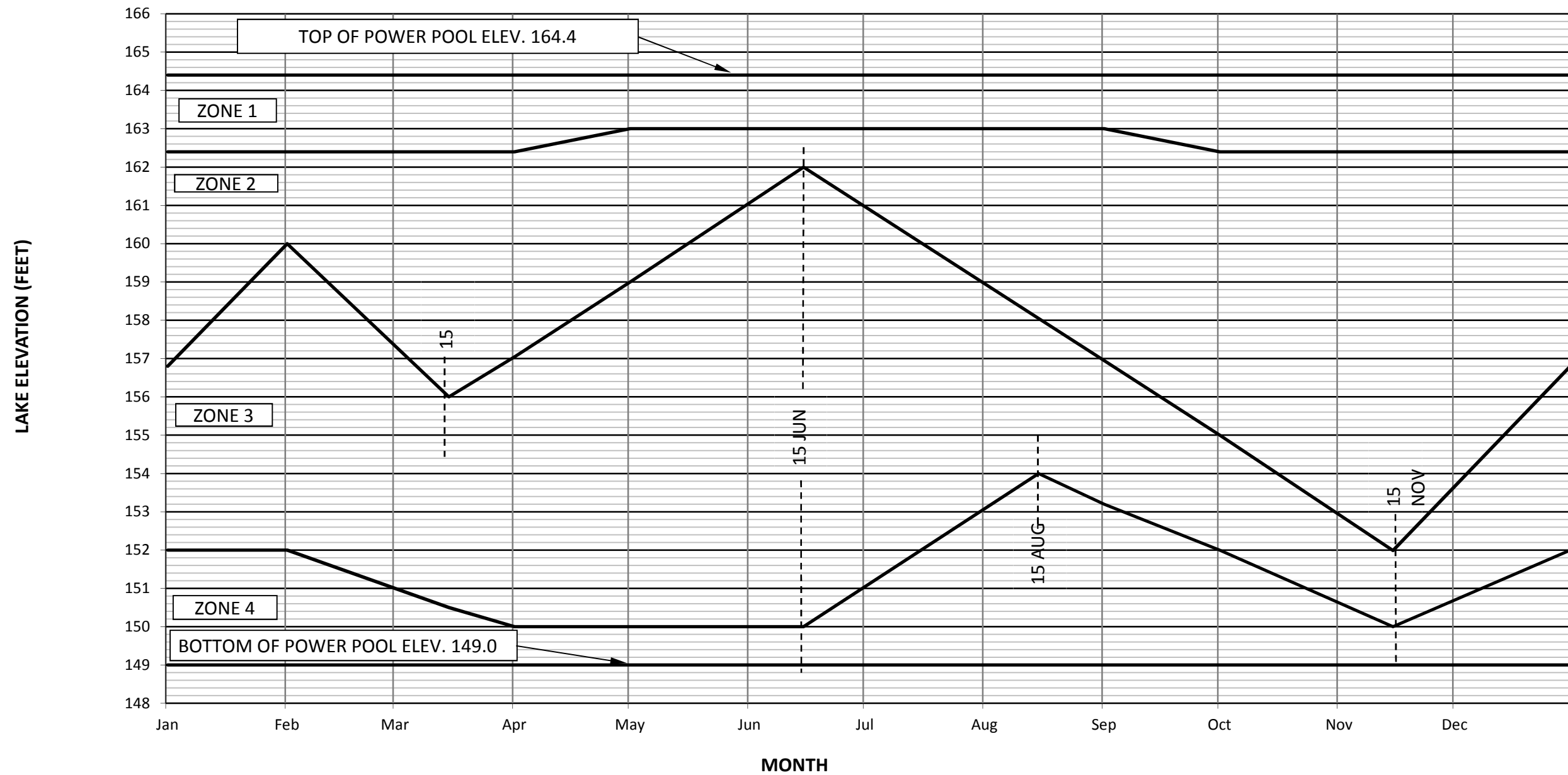
**GUIDELINES FOR FLEXIBLE SCHEDULING  
OF HYDROPOWER GENERATION**

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U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

PLATE 7 - 10

### Sam Rayburn Reservoir 1981 Rule Curves for Hydropower Operations



<u>Zone</u>	<u>Period</u>	<u>Hydropower Allotment</u> [unit - hours / mon]	<u>Hydropower Allotment</u> [**unit - hours / wk]
1	1 Jan - 31 Dec	300	70
2	1 Jan - 31 Dec	150	35
3	*15 Apr - 15 Oct	150	35
4	*15 Apr - 15 Oct	150	35

\*No designated hydropower allotment outside this period.

\*\*Derived from the monthly allotment.

NOTE: See Appendix X for details of 1981 Sam Rayburn Reservoir Operating Rule Curves agreement.

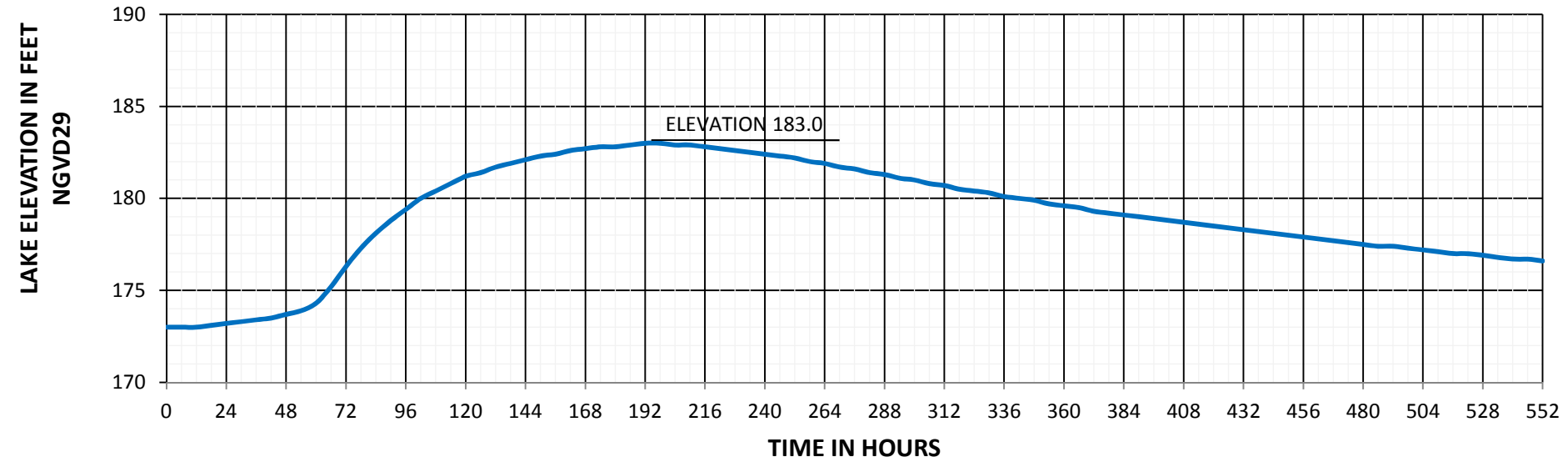
NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND LAKE**  
ANGELINA RIVER

**1981 RULE CURVES FOR  
HYDROPOWER GENERATION**

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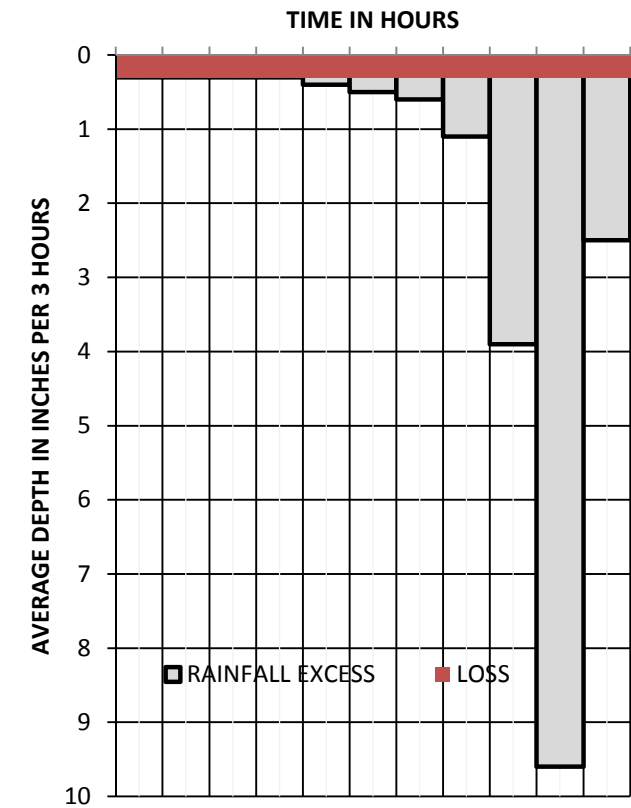
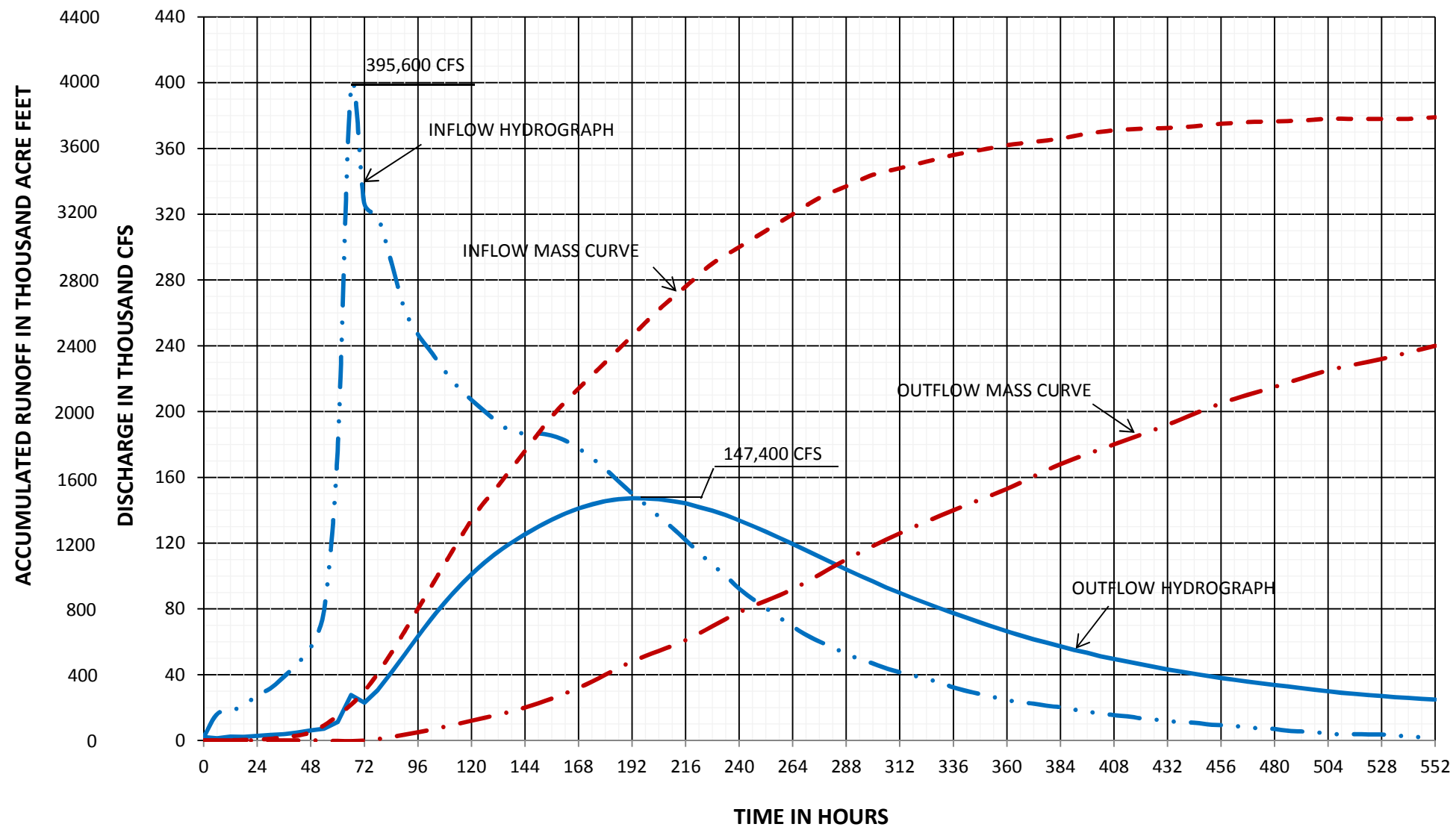
U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

PLATE 7 - 11



**HYETOGRAPH (INCHES)**

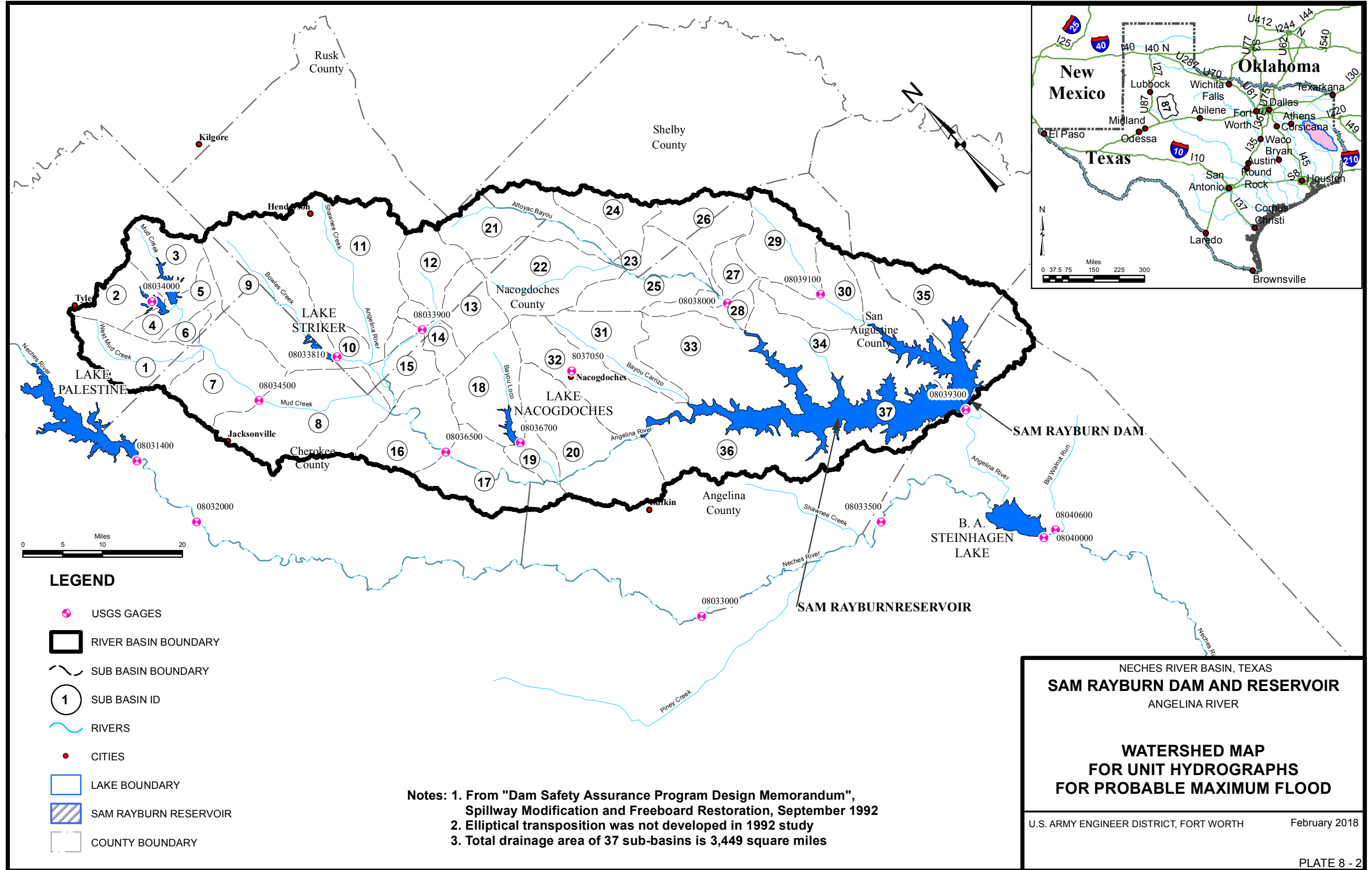
RAINFALL TOTAL	23.70
LOSS TOTAL	3.15
RAINFALL - EXCESS TOTAL	20.55
INFILTRATION INDEX ((F.A.V.G.) (IN/HR))	0.05



NOTE: DATA OBTAINED FROM "DESIGN MEMORANDUM NO. 2, SPILLWAY" DATED AUGUST 1961.

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

**SPILLWAY DESIGN FLOOD**  
**ORIGINAL 2200-FOOT SPILLWAY**

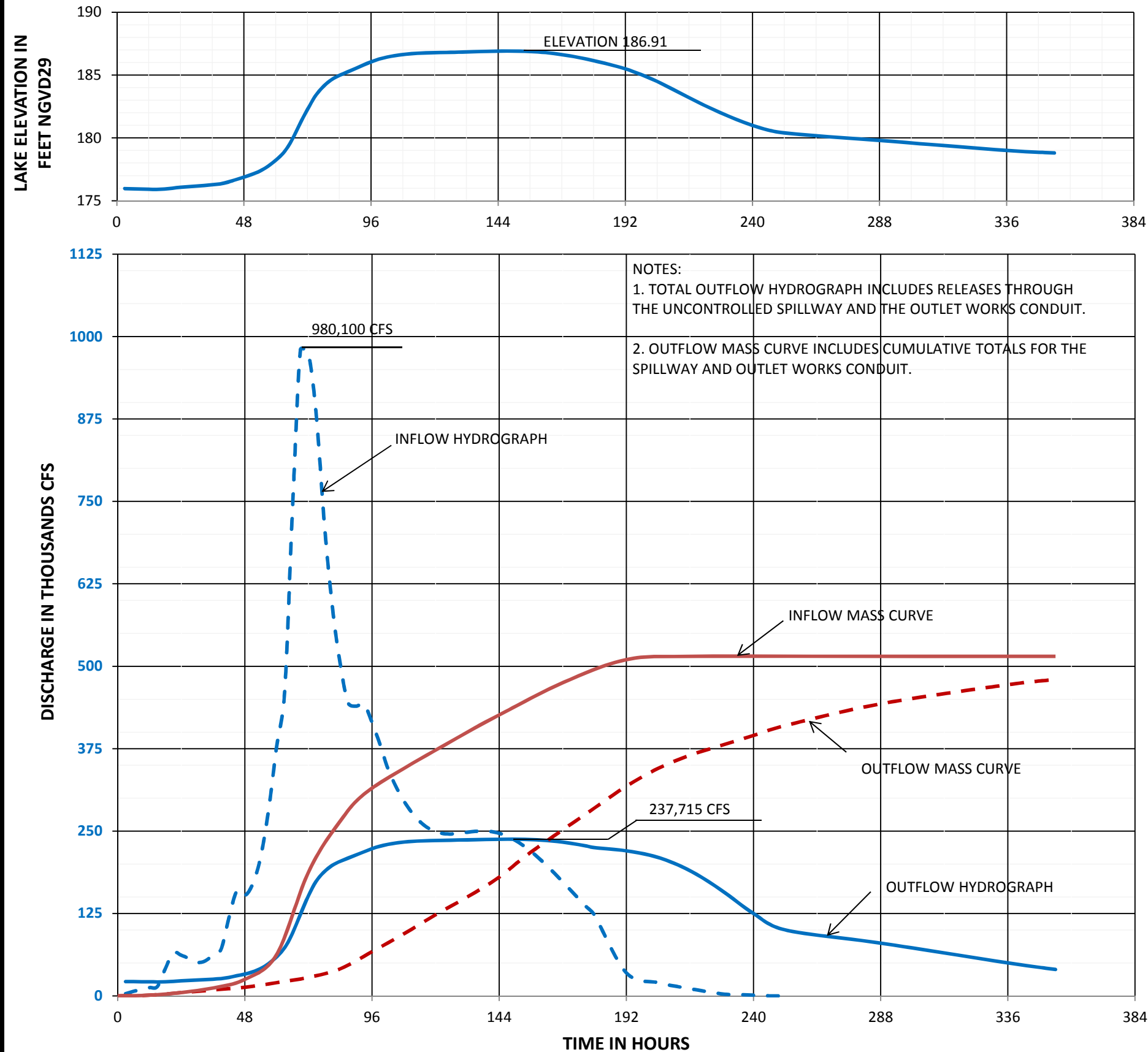


**LEGEND**

- USGS GAGES
- RIVER BASIN BOUNDARY
- SUB BASIN BOUNDARY
- SUB BASIN ID
- RIVERS
- CITIES
- LAKE BOUNDARY
- SAM RAYBURN RESERVOIR
- COUNTY BOUNDARY

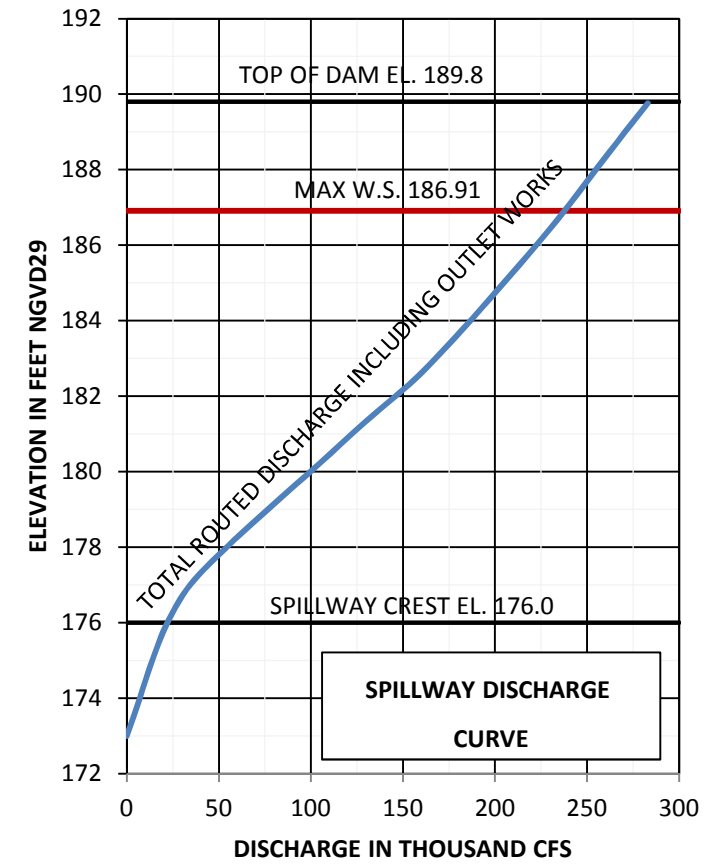
**Notes:** 1. From "Dam Safety Assurance Program Design Memorandum", Spillway Modification and Freeboard Restoration, September 1992  
 2. Elliptical transposition was not developed in 1992 study  
 3. Total drainage area of 37 sub-basins is 3,449 square miles

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018



**HYETOGRPH (INCHES)**

RAINFALL	27.67
LOSS	4.74
RAINFALL - EXCESS	22.93
INITIAL LOSS	0.60
INFILTRATION INDEX (F. A. V. G) (IN/HR)	0.05



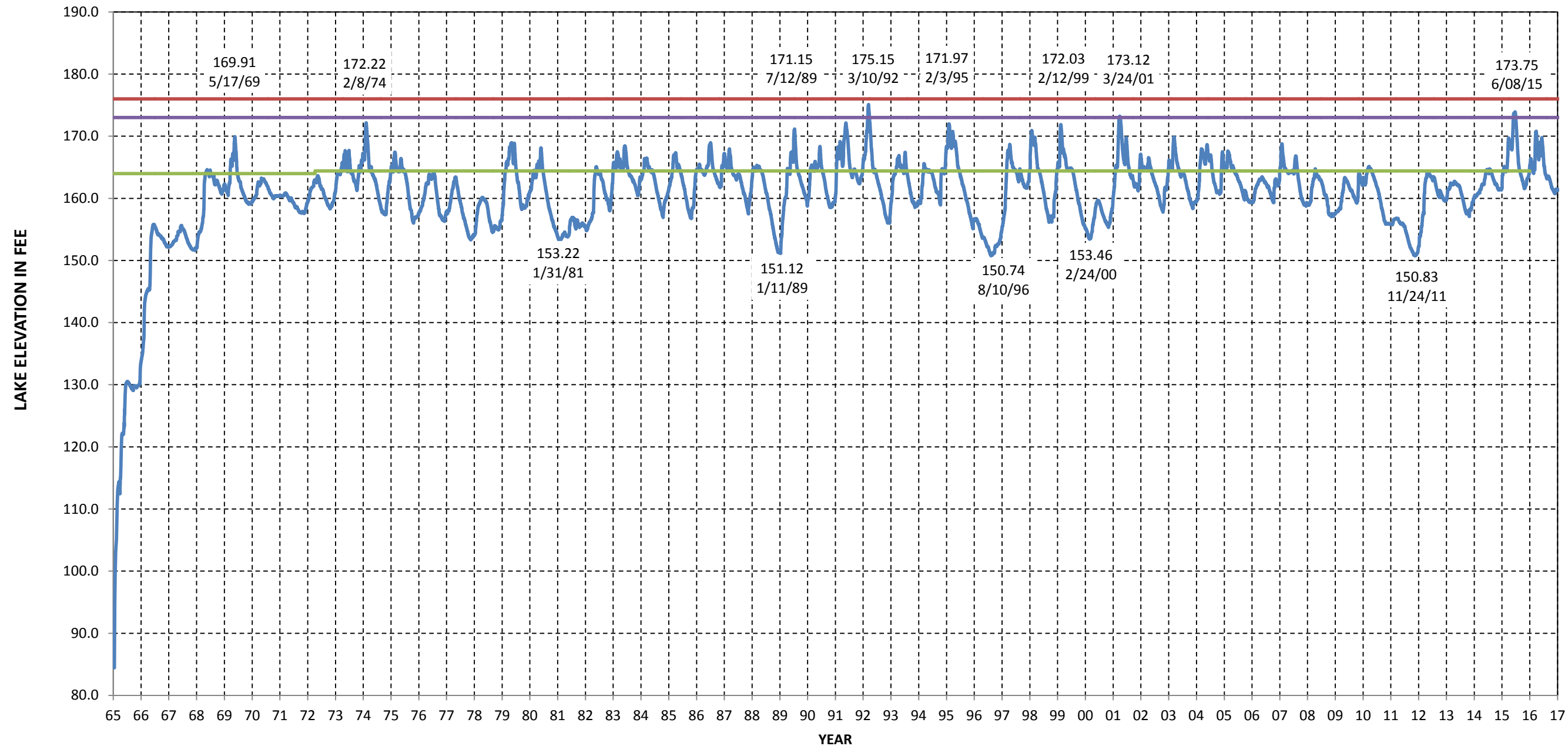
NOTES: DATA IS OBTAINED FROM SAM RAYBURN DAM AND RESERVOIR SPILLWAY MODIFICATION AND FREEBOARD RESTORATION STUDY, SEPTEMBER 1992.

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

**PROBABLE MAXIMUM FLOOD  
 INFLOW-OUTFLOW HYDROGRAPHS  
 LABYRINTH SPILLWAY**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

PLATE 8 - 3



- LAKE ELEVATION
- SPILLWAY CREST ELEVATION 176.0
- TOP OF FLOOD CONTROL POOL 173.0
- TOP OF CONSERVATION POOL ELEVATION 164.4

DELIBERATE IMPOUNDMENT BEGAN: 03/29/1965

RECORD POOL ELEVATION AND DATE: 175.15 NGVD29, 03/10/1992

THE CONSERVATION POOL WAS OFFICIALLY RAISED FROM ELEVATION 164.0 TO 164.4 FEET NGVD29 ON 07 APR 1972

NECHES RIVER BASIN, TEXAS

**SAM RAYBURN DAM AND RESERVOIR**

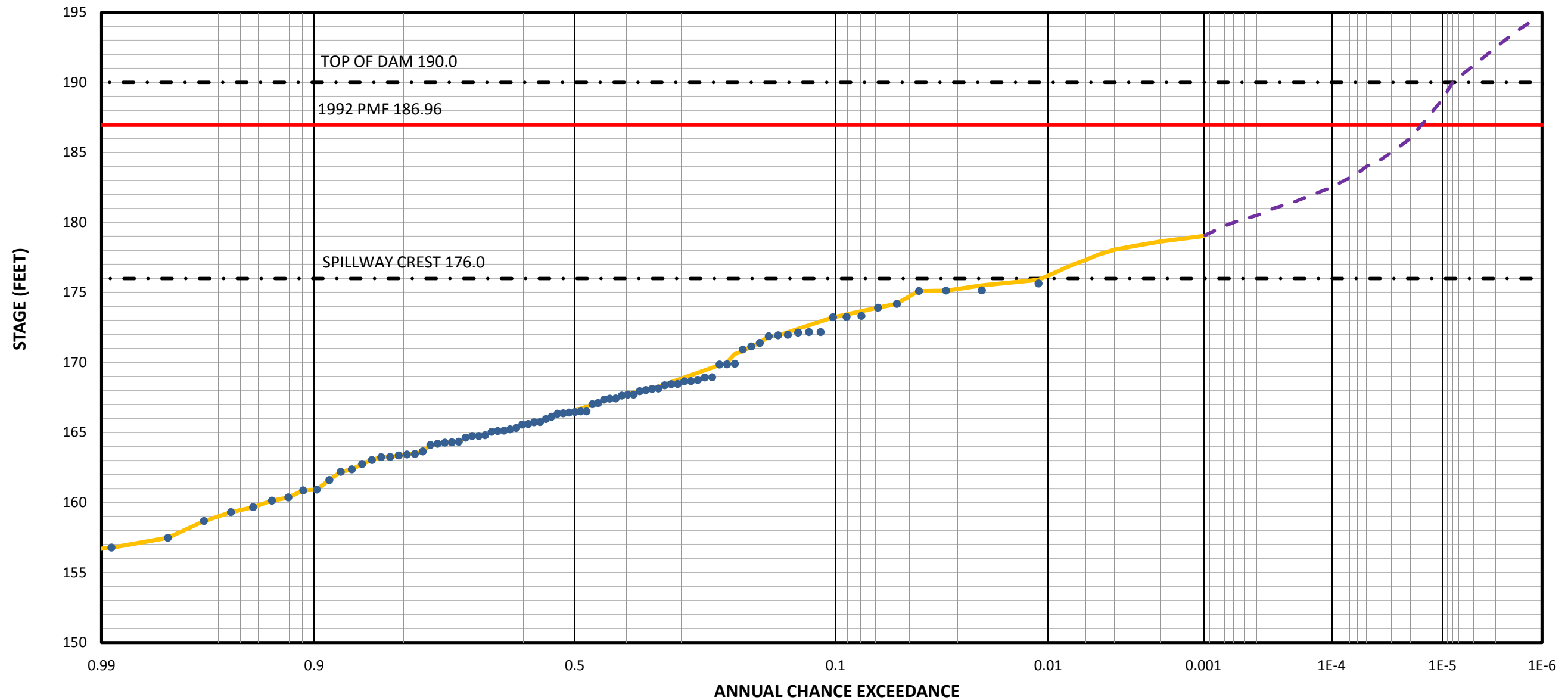
ANGELINA RIVER

**PERIOD OF RECORD LAKE LEVEL**

ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 IS: NGVD29 + 0.0 FEET = NAVD88 FOR SAM RAYBURN DAM AND RESERVOIR.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

### SAM RAYBURN DAM STAGE FREQUENCY



CREST / SPILLWAY     
  1992 PMF     
  EVENTS     
  BEST ESTIMATE     
  PA BEST ESTIMATE

ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 IS: NGVD29 + 0.0 FEET = NAVD88 FOR SAM RAYBURN DAM AND RESERVOIR.

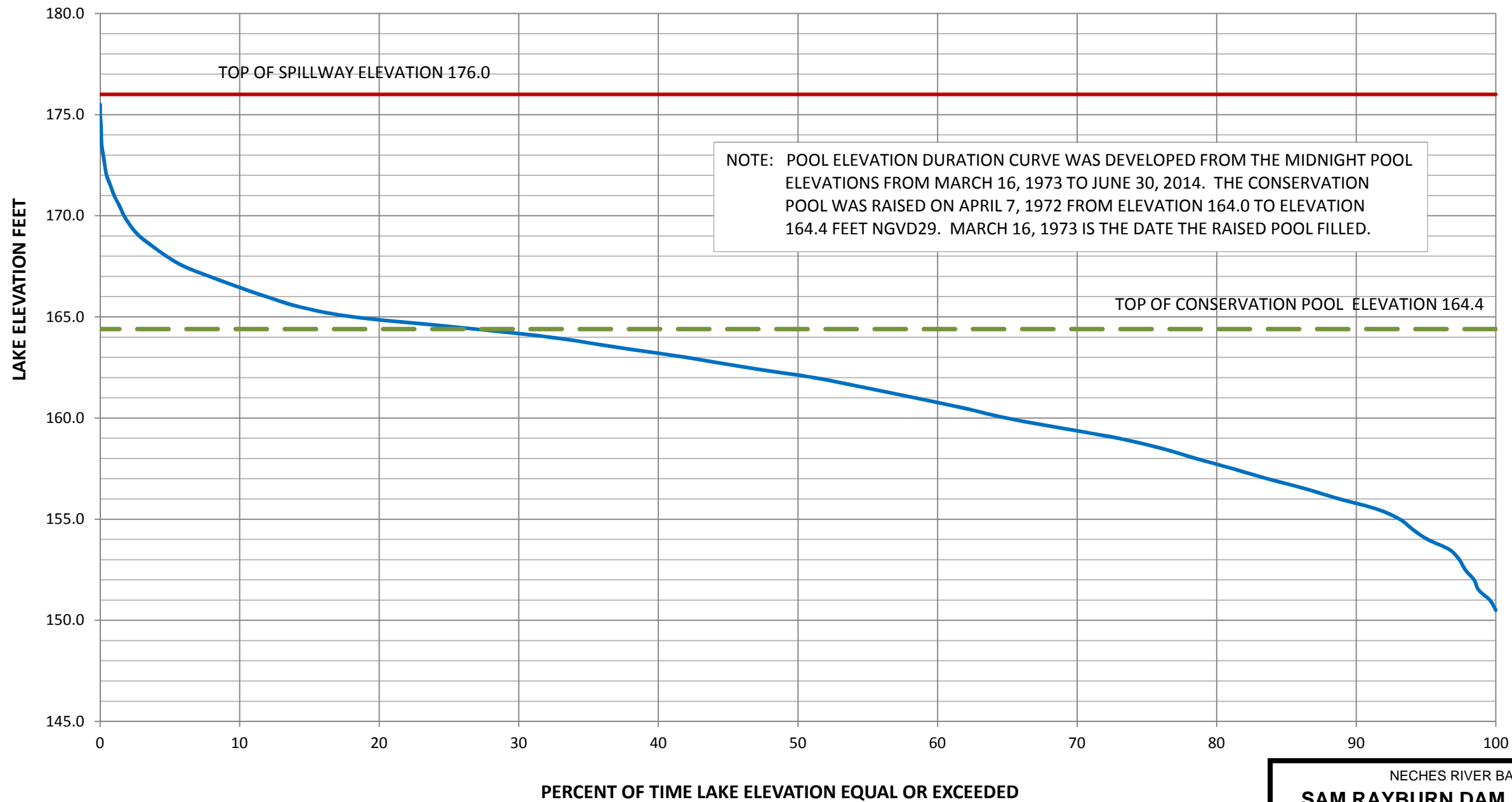
NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
 ANGELINA RIVER

ANNUAL PEAK  
 ELEVATION FREQUENCY

U.S. ARMY ENGINEER DISTRICT, FORT WORTH      February 2018

PLATE 8 - 5

### SAM RAYBURN RESERVOIR



ALL ELEVATIONS REFERRED TO ON THIS PLATE, UNLESS NOTED OTHERWISE, ARE IN FEET, NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29). THE DATUM CONVERSION FROM NGVD29 TO NAVD88 IS: NGVD29 + 0.0 FEET = NAVD88 FOR SAM RAYBURN DAM AND RESERVOIR.

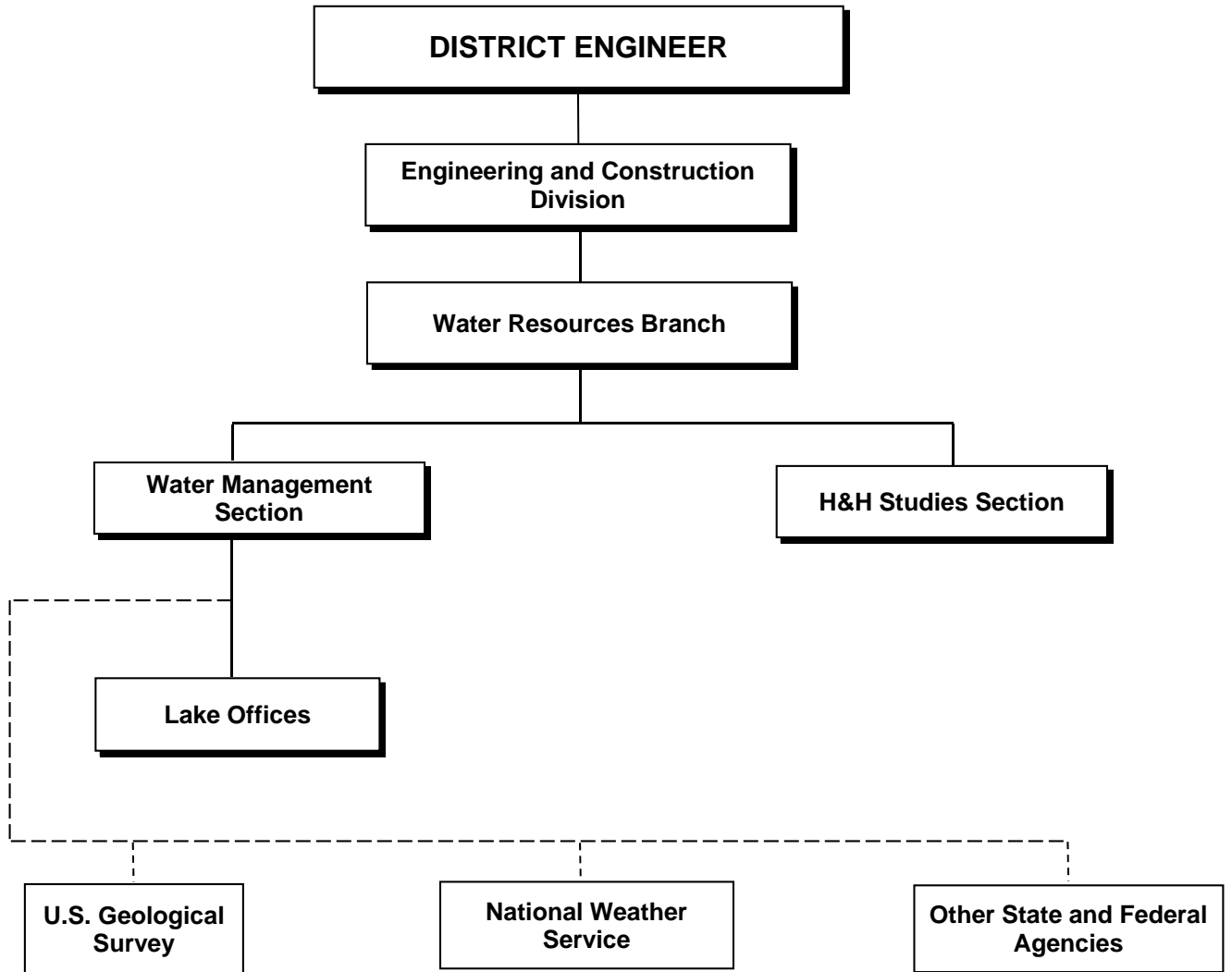
NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER

**LAKE ELEVATION DURATION**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

PLATE 8 - 6

**FORT WORTH DISTRICT  
ORGANIZATION FOR LAKE REGULATION**



——— LINES OF COMMAND AUTHORITY  
- - - - LINES OF DIRECT COMMUNICATION

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER  
**ORGANIZATION FOR  
FLOOD CONTROL REGULATION**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

FORT WORTH DISTRICT CORPS OF ENGINEERS  
RESERVOIR REPORT FOR WEDNESDAY 24SEP2014

RESERVOIR	ELEVATION 0800 FT-NGVD	TOP CONS POOL	MEAN INFLOW DSF	MEAN TURBINE DSF	DAILY PUMP MGD	RELEASES OTHER DSF	RAIN INCHES	EVAP	0800 RELEASE CFS	POOL OCCUPIED %	A-F
<b>RED RIVER BASIN</b>											
Cooper	429.18	440.0	-100	--	108.819	4	0.00	.16	4	39 C	102657
Wright Patm	225.62	225.2	45	--	42.279	112	0.00	.13	112	0 F	10999
Bob Sandlin	335.12	337.5	-183	--	--	0	--	--	0	89 C	180254
Lake O Pine	228.61	229.1	-133	--	--	53	0.00	--	53	97 C	241863
Caddo	167.69	168.5	-256	--	--	0	0.00	--	0	84 C	107779
<b>NECHES RIVER BASIN</b>											
Sam Rayburn	162.67	164.4	-1520	2229	--	0	0.00	.13	0	87 P	1218321
B.A. Steinh	82.52	83.0	2468	2000	--	0	0.00	.21	1990	93 C	61739
<b>TRINITY RIVER BASIN</b>											
Bridgeport	812.63	836.0	-42	--	--	0	0.00	--	0	38 C	138542
Eagle Mount	639.13	649.0	17	--	50.300	131	0.00	--	131	59 C	107378
Lake Worth	590.46	594.0	111	--	55.100	0	0.00	--	0	70 C	25731
Benbrook	686.18	694.0	2	--	2.786	4	0.00	.25	13	64 C	45628
Joe Pool	520.55	522.0	-5	--	6.250	5	0.00	.20	5	93 C	132233
Mountain Ck	457.02	457.0	-21	--	--	0	--	--	0	-- S	54
Ray Roberts	625.66	632.5	117	--	11.949	65	--	--	65	77 C	608520
Lewisville	515.54	522.0	160	0	49.358	341	0.00	--	341	72 C	403002
Grapevine	523.72	535.0	-14	--	--	34	0.00	.31	35	56 C	82022
Lavon	479.52	492.0	-6	--	279.844	0	0.00	.24	0	48 C	193614
Ray Hubbard	425.82	435.5	-99	--	82.500	54	0.00	--	54	61 C	297358
Cedar Creek	316.77	322.0	-17	--	90.350	0	0.00	--	0	76 C	508579
Navarro Mil	423.09	424.5	11	--	8.200	0	0.00	.26	0	87 C	43401
Bardwell	419.30	421.0	-19	--	5.631	0	0.00	.16	0	89 C	40929
Richland Cr	305.76	315.0	278	--	189.940	0	0.00	--	5	68 C	747569
<b>BRAZOS RIVER BASIN</b>											
Possum King	983.77	999.0	153	--	--	35	0.00	.30	35	61 C	315171
Granbury	684.68	692.7	26	--	52.410	17	0.00	.27	2	61 C	77483
Whitney	523.41	533.0	-614	8	--	25	0.00	.26	25	22 P	51206
Aquilla	536.10	537.5	-15	--	--	1	--	--	1	87 C	27082
Waco	459.63	462.0	-45	--	38.613	10	0.00	.28	10	90 C	162100
Proctor	1149.75	1162.0	11	--	2.044	4	0.00	.32	4	24 C	11825
Belton	582.85	594.0	-13	--	39.151	50	--	--	39	68 C	259463
Stillhouse	610.16	622.0	-8	--	32.090	1	0.00	.21	1	71 C	158311
Georgetown	775.16	791.0	-5	--	30.314	0	0.00	.20	0	54 C	19728
Granger	504.33	504.0	43	--	4.350	0	0.00	.23	0	1 F	1366
Somerville	237.38	238.0	-72	--	3.375	1	0.00	.22	1	95 C	140964
Limestone	361.43	363.0	-137	--	--	6	0.00	.22	6	91 C	189047
<b>COLORADO RIVER BASIN</b>											
Twin Buttes	1894.35	1940.2	-1	--	--	0	0.00	--	0	5 C	7929
O.C. Fisher	1853.82	1908.0	-2	--	0.000	0	0.00	.24	0	3 D	1110
O.H. Ivie	1510.92	1551.5	--	--	--	--	--	--	--	17 C	92871
Hords Creek	1885.17	1900.0	1	--	0.000	1	0.00	.28	1	23 C	1577
Buchanan	986.65	1020.5	--	--	--	--	--	--	--	31 C	264522
Marshall Fo	625.06	681.0	136	0	--	0	0.00	.15	0	34 C	373892
<b>GUADALUPE RIVER BASIN</b>											
Canyon	898.20	909.0	-25	0	--	64	0.00	.20	64	78 C	293795

Pumpage below dam (MGD): Grapevine 7.348, and Belton 16.432.  
Total outflow includes this and pumpage tabulated.  
Preliminary data--Inflow not adjusted for wind effect, etc.

- D = Sediment Pool
- C = Conservation Pool
- P = Power Pool
- F = Flood Pool
- S = Surcharge Pool
- nr = Not reported today

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER  
  
**DAILY REPORT**

Sam Rayburn  
Monthly Report  
SEP2013

DAY:	ELEVATIONS		STORAGE:	EVAP:	PUMP:	RELEASES		ADJ.:	RAIN
:	0800	: 2400	: 2400	:	:	TURBINE:	OTHER	INFLOW:	:
:	FEET-NGVD		A-F	DSF:	DSF:	DSF	DSF	DSF	INCH
1	158.33	158.35	2236619	1082	0.0	1685	0	0	0.00
2	158.28	158.28	2229803	1080	0.0	1676	0	0	0.00
3	158.22	158.25	2226886	539	0.0	1667	0	0	0.00
4	158.18	158.21	2223001	969	0.0	1679	0	0	0.00
5	158.15	158.16	2218151	537	0.0	990	0	0	0.00
6	158.09	158.12	2214277	1074	0.0	996	0	0	0.00
7	158.07	158.09	2211374	894	0.0	997	0	0	0.00
8	158.04	158.05	2207508	750	0.0	1005	0	0	0.00
9	157.99	158.00	2202682	606	0.0	998	0	0	0.00
10	157.93	157.95	2197864	961	0.0	974	0	0	0.00
11	157.92	157.92	2194016	924	0.0	1008	0	0	0.00
12	157.87	157.88	2191133	603	0.0	1008	0	0	0.00
13	157.85	157.83	2186336	1064	0.0	1008	0	0	0.00
14	157.73	157.77	2180590	531	0.0	1008	0	0	0.00
15	157.74	157.76	2179634	1060	0.0	1002	0	0	0.00
16	157.71	157.72	2175812	706	0.0	1002	0	218	0.05
17	157.66	157.67	2171042	529	0.0	1003	0	73	0.00
18	157.61	157.63	2167232	633	0.0	1004	0	83	0.00
19	157.56	157.57	2161528	1195	0.0	1005	0	76	0.00
20	157.51	157.52	2156783	596	0.0	1005	0	191	0.65
21	157.94	157.90	2193054	352	0.0	1003	0	16674	2.50
22	157.85	157.87	2190173	532	0.0	1000	0	80	0.00
23	157.79	157.81	2183462	531	0.0	1000	0	52	0.00
24	157.77	157.77	2180590	1061	0.0	1000	0	60	0.00
25	157.71	157.74	2176767	530	0.0	1010	0	0	0.00
26	157.67	157.69	2172948	705	0.0	1002	0	0	0.00
27	157.64	157.65	2169136	740	0.0	1002	0	0	0.00
28	157.59	157.59	2163428	668	0.0	1003	0	0	0.00
29	157.57	157.56	2160578	561	0.0	1005	0	130	0.05
30	157.87	157.84	2187294	1093	0.0	1001	0	12587	1.36
MONTHLY TOTAL (DSF)			23121	0	32747.	0.	30227.	4.61	
		(A-F)	-82872 45860	0	64952	0	59953		

NECHES RIVER BASIN, TEXAS  
**SAM RAYBURN DAM AND RESERVOIR**  
ANGELINA RIVER

**MONTHLY RESERVOIR REPORT**

U.S. ARMY ENGINEER DISTRICT, FORT WORTH February 2018

**TABLE 4-8**

**All Recorded Major Floods in the Neches River Watershed, 1884-2015**

**Table 4-8 All Recorded Major Floods In The Neches River Watershed, 1884-2015**

Date	Angelina River near Alto (1908-2015)		Attoyac Bayou near Chireno (1902-2015)		Neches River near Rockland (1884-2015)	
	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)
1884	—	—	—	—	34.90	62,000
1902	—	—	29.90	50,000	—	—
1904, May 9	—	—	—	—	14.50	7,750
1905, May 18	—	—	—	—	25.00	24,600
1906, Jan 11	—	—	—	—	15.50	8,450
1907, May 12	—	—	—	—	23.30	17,200
1907, Nov 23	—	—	—	—	26.10	30,400
1908, May	22.00	—	—	—	—	—
1909, Jun 4	—	—	—	—	8.70	3,920
1910, Feb 11	—	—	—	—	13.80	7,260
1911, May 2	—	—	—	—	18.80	10,800
1914, May 17	—	—	—	—	23.20	16,900
1915, May	—	—	25.00	28,000	24.80	23,600
1915, Aug	—	—	—	—	21.40	13,300
1916, May 6	—	—	—	—	25.20	25,600
1917, Feb 17	—	—	—	—	6.50	2,620
1918, May 6	—	—	—	—	6.40	2,570
1919, Jul 1	—	—	—	—	23.20	16,900
1920, Jan 27	—	—	—	—	27.10	35,800
1921, Apr 16	—	—	—	—	22.40	14,700
1922, Apr 2	—	—	—	—	28.90	45,200
1923, Apr 15	—	—	—	—	27.40	37,500
1924, Jun 2-3	—	—	18.88	8,260	22.10	14,200
1925, Jan 12-19	—	—	13.48	920	6.30	2,520
1926, Apr 16	—	—	—	—	22.70	15,100
1927, Apr 21	—	—	—	—	22.00	14,100
1928, Mar 18	—	—	—	—	9.60	4,290
1929, Jun 1	—	—	—	—	26.80	34,200

**Table 4-8 All Recorded Major Floods In The Neches River Watershed, 1884-2015 (Continued)**

Date	Angelina River near Alto (1908-2015)		Attoyac Bayou near Chireno (1902-2015)		Neches River near Rockland (1884-2015)	
	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)
1930, May 30	—	—	—	—	18.50	10,500
1931, Jan 12	—	—	—	—	14.70	7,800
1932, Feb	21.50	—	—	—	26.70	33,600
1933, Mar	—	—	25.20	28,900	16.40	8,990
1934, Mar 7	—	—	—	—	20.80	12,400
1935, May 22	—	—	—	—	28.90	39,700
1936, Jul 5	—	—	—	—	19.70	11,400
1937, Jan 24	—	—	—	—	13.70	7,190
1938, Apr 12	—	—	—	—	22.82	15,900
1939, Mar 1	—	—	—	—	17.26	9,820
1939, Dec 25-29	—	—	19.74	9,870	17.30	9,670
1940, Nov 24-30	—	—	25.97	31,900	25.50	25,900
1941, Nov 1	—	—	24.62	26,600	25.10	25,200
1943, Jan 5- Feb 6	14.18	1,930	12.37	814	9.34	4,580
1944, May 2-6	—	—	22.53	17,400	31.84	49,800
1945, Apr 3-11	—	—	20.12	9,310	28.37	37,500
1946, Feb 10-13	—	—	20.26	9,930	26.56	32,300
1947, Mar 13	—	—	—	—	22.92	17,700
1947, Apr 10	—	—	18.96	6,750	—	—
1948, Feb 12-16	—	—	17.53	3,530	15.34	8,520
1949, Mar 26-28	—	—	17.08	2,910	18.58	11,500
1950, Jun 1-6	—	—	19.43	8,100	24.66	23,500
1951, Mar 29-31	—	—	16.20	1,990	8.86	4,420
1952, Apr 26	—	—	15.63	1,680	—	—
1952, May 27	—	—	—	—	13.78	8,120
1953, Mar 12	—	—	22.63	18,700	—	—
1953, May 20	—	—	—	—	27.70	34,400

**Table 4-8 All Recorded Major Floods In The Neches River Watershed, 1884-2015 (Continued)**

Date	Angelina River near Alto (1908-2015)		Attoyac Bayou near Chireno (1902-2015)		Neches River near Rockland (1884-2015)	
	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)
1954, May 14-19	—	—	13.51	885	9.60	5,340
1955, Apr 15	—	—	—	—	19.52	12,700
1956, Apr 8	—	—	17.29	3,110	6.02	3,220
1957, May 2-4	—	—	21.34	14,300	25.34	29,700
1957, Nov 26	—	—	—	—	21.84	16,000
1958, Sep 22	—	—	21.40	14,500	—	—
1959, Apr 18- 20	—	—	16.77	2,370	17.62	11,000
1959, May 6	20.13	19,800	—	—	—	—
1960, Feb 27- Mar 7	18.14	5,080	16.85	3,040	14.70	8,790
1960, Dec 12	19.97	18,200	—	—	—	—
1961, Jan 10-16	—	—	20.94	11,500	23.07	18,800
1961, Dec 11	—	—	19.58	7,200	—	—
1962, Jan 30	18.39	8,300	—	—	—	—
1962, May 5	—	—	—	—	20.26	13,600
1962, Dec 29	—	—	—	—	8.88	4,880
1963, Feb 24	9.20	1,030	—	—	—	—
1963, Apr 11	—	—	15.32	1,560	—	—
1964, Mar 19	7.80	810	—	—	—	—
1964, Apr 5	—	—	14.84	1,380	—	—
1964, May 2	—	—	—	—	15.35	9,280
1965, Apr 2-3	18.17	7,100	18.06	4,480	—	—
1965, Jun 1	—	—	—	—	12.96	7,600
1966, Apr 27- May 7	21.51	30,600	19.62	8,700	25.60	26,800
1967, May 2- Jun 6	—	—	—	—	8.82	4,880
1967, Jun 6	9.69	1,120	15.79	1,790	—	—
1968, Apr 4-12	—	—	19.32	7,800	23.55	20,200
1968, May 16	18.02	6,500	—	—	—	—
1969, Mar 19-21	19.16	12,400	19.90	9,600	—	—

**Table 4-8 All Recorded Major Floods In The Neches River Watershed, 1884-2015 (Continued)**

Date	Angelina River near Alto (1908-2015)		Attoyac Bayou near Chireno (1902-2015)		Neches River near Rockland (1884-2015)	
	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)
1969, May 10	—	—	—	—	27.64	34,000
1970, Mar 6	—	—	14.53	1,350	—	—
1970, Apr 23-May 2	15.84	3,140	—	—	10.32	5,920
1970, Oct 28	—	—	—	—	2.70	1,240
1971, May 16-18	15.35	2,870	11.21	791	—	—
1972, Jan 10	16.13	3,360	—	—	—	—
1972, Mar 21	—	—	—	—	11.20	6,380
1972, May 2	—	—	12.21	864	—	—
1973, Mar 26	—	—	18.90	6,600	—	—
1973, Apr 29	18.27	7,650	—	—	—	—
1973, Jun 17	—	—	—	—	28.00	33,600
1974, Jan 25-29	18.95	11,200	20.67	12,000	25.35	27,700
1975, Feb 2-6	19.06	11,800	19.82	8,930	—	—
1975, May 11	—	—	—	—	19.27	12,100
1976, May 13	—	—	—	—	18.81	9,340
1976, Jun 25	17.69	5,430	—	—	—	—
1976, Jul 9	—	—	14.43	1,300	—	—
1977, Feb 16-18	17.84	4,920	15.92	1,870	—	—
1977, Apr 23	—	—	—	—	16.10	7,320
1978, Jan 24- Feb 18	—	—	—	—	12.00	4,800
1978, Feb 18	8.91	1,030	—	—	—	—
1978, Sep 16	—	—	18.24	4,930	—	—
1979, Apr 24	—	—	—	—	27.42	24,400
1979, Jun 3-4	18.63	9,350	23.42	21,500	—	—
1980, Apr 13-16	18.75	9,970	23.82	22,900	—	—
1980, May 20	—	—	—	—	25.80	19,400
1981, Jun 7-12	13.94	2,380	—	—	17.00	7,900
1981, Sep 2	—	—	23.88	23,100	—	—

**Table 4-8 All Recorded Major Floods In The Neches River Watershed, 1884-2015 (Continued)**

Date	Angelina River near Alto (1908-2015)		Attoyac Bayou near Chireno (1902-2015)		Neches River near Rockland (1884-2015)	
	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)
1982, April 21-26	18.37	8,090	20.72	11,800	22.18	12,400
1983, Feb 9	18.49	8,180	—	—	—	—
1983, May 23-24	—	—	20.59	11,500	24.56	16,300
1983, Dec 12	—	—	19.75	9,030	—	—
1984, Feb 15- Mar 10	—	—	—	—	16.35	7,480
1984, Mar 10	17.87	6,110	—	—	—	—
1984, Oct 26	—	—	17.63	3,630	—	—
1985, Feb 16	14.86	2,730	—	—	—	—
1985, Mar 3	—	—	—	—	19.10	10,000
1985, Nov 29	18.01	6,570	—	—	—	—
1986, Jun 10-12	—	—	23.13	19,600	24.42	16,200
1986, Nov 27-28	—	—	18.38	5,280	23.96	15,400
1987, Mar 3	18.18	7,250	—	—	—	—
1987, Nov 19	—	—	16.94	2,660	14.03	6,380
1987, Dec 31	19.14	12,200	—	—	—	—
1989, Mar 31	23.20	42,500	—	—	—	—
1989, May 19	—	—	19.30	7,930	—	—
1989, Jul 2	—	—	—	—	33.20	42,000
1990, May 15	19.45	14,000	—	—	—	—
1990, Jun 2-5	—	—	19.18	6,760	28.59	25,900
1991, Jan 11-20	—	—	21.53	14,400	27.73	23,000
1991, Apr 17	19.10	11,800	—	—	—	—
1991, Dec 25	19.12	11,900	—	—	—	—
1992, Mar 6-7	—	—	19.49	8,200	29.00	27,300
1993, Jun 23-29	21.26	27,700	18.02	4,410	27.11	21,700
1994, Feb 25-26	18.50	8,580	16.85	2,580	—	—
1994, Mar 10	—	—	—	—	21.01	12,000
1994, Oct 18-20	—	—	23.41	21,500	33.29	42,300

**Table 4-8 All Recorded Major Floods In The Neches River Watershed, 1884-2015 (Continued)**

Date	Angelina River near Alto (1908-2015)		Attoyac Bayou near Chireno (1902-2015)		Neches River near Rockland (1884-2015)	
	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)
1994, Dec 19	19.18	12,300	—	—	—	—
1995, Dec 21	—	—	—	—	14.63	6,380
1996, Sep 30	9.74	1,210	—	—	—	—
1997, Mar 2-15	18.38	8,040	—	—	23.12	14,500
1997, Aug 10	—	—	24.84	26,800	—	—
1998, Jan 8-11	18.31	7,740	20.75	11,900	27.17	21,800
1998, Nov 26	—	—	—	—	29.12	27,800
1999, Jan 30- Feb 1	20.53	25,100	26.01	31,700	—	—
2000, Apr 14	—	—	17.14	3,270	—	—
2000, May 10-11	16.71	3,950	—	—	11.14	4,680
2001, Mar 3-5	19.63	16,300	20.32	10,700	—	—
2001, Jun 13	—	—	—	—	29.25	28,200
2001, Dec 17-19	18.93	10,800	—	—	23.61	15,400
2002, Apr 10	—	—	19.83	9,300	—	—
2003, Feb 22-27	19.66	15,500	20.09	10,100	25.78	18,600
2004, Feb 16	—	—	—	—	23.42	14,800
2004, May 3-4	19.52	14,500	19.34	8,050	—	—
2004, Nov 25-27	18.29	7,940	19.98	9,830	28.33	25,100
2006, Feb 2	—	—	14.07	1,330	—	—
2006, Mar 26	12.00	1,840	—	—	—	—
2006, Jul 27	—	—	—	—	12.89	5,770
2007, Jan 15-19	—	—	18.59	6,280	26.86	21,100
2007, Jul 9	21.55	30,000	—	—	—	—
2008, Feb 23	—	—	—	—	21.56	13,500
2008, Mar 15-31	15.28	3,300	17.87	4,090	—	—
2009, Mar 31	15.59	3,230	—	—	18.50	10,800
2009, Apr 22-29	—	—	16.31	2,130	—	—
2009, Oct 30- Nov 3	—	—	23.17	20,700	23.74	16,000

**Table 4-8 All Recorded Major Floods In The Neches River Watershed, 1884-2015 (Continued)**

Date	Angelina River near Alto (1908-2015)		Attoyac Bayou near Chireno (1902-2015)		Neches River near Rockland (1884-2015)	
	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)
2010, Mar 14	14.56	2,860	—	—	—	—
2011, Jan 18-21	5.81	628	8.84	990	—	—
2011, May 21	—	—	—	—	7.61	2,640
2012, Mar 12-26	14.74	2,810	18.32	4,320	25.53	18,600
2013, Jan 16	—	—	16.50	2,020	—	—
2013, Feb 17	23.74	2,380	—	—	—	—
2013, Jun 7	—	—	—	—	8.70	3,470
2013, Oct 31- Nov 3	—	—	15.91	2,040	14.78	7,990
2014, May 18	27.36	5,260	—	—	—	—
2015, Mar 13-Jun 1	29.63	14,700	—	—	—	—
2015, May 28- Jun 1	—	—	19.90	8,290	29.39	28,700

**Table 4-8 All Recorded Major Floods In The Neches River Watershed, 1884-2015 (Continued)**

Date	Neches River near Town Bluff (1884-2015)		Neches River at Evadale (1884-2015)	
	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)
1884, May	86.80	120,000	26.20	125,000
1905, May 23	—	—	23.60	35,400
1906, Jan 13	—	—	21.10	16,300
1915, Aug	—	—	24.50	102,000
1921, Apr 27	—	—	17.10	26,800
1922, Apr 6	—	—	21.80	71,500
1923, Apr 19	—	—	21.50	68,500
1924, Jun 4	—	—	19.00	40,600
1925, Jan 21	—	—	13.94	9,750
1926, Apr 10	—	—	17.66	30,800
1927, Mar 18	—	—	17.34	27,800
1928, Apr 15	—	—	14.50	11,800
1929, Jun 1	—	—	22.20	83,800
1930, Feb 14	—	—	16.15	20,600
1931, Jan 18	—	—	15.76	17,900
1932, Feb 29	—	—	21.45	73,400
1933, Mar 14	—	—	16.07	19,900
1934, Feb 11	—	—	16.70	24,800
1935, May 27	—	—	20.60	64,100
1935, Dec 14	—	—	16.30	21,900
1937, Jan 28	—	—	15.42	19,300
1938, Apr 18	—	—	18.32	39,200
1939, Mar 6	—	—	16.08	21,400
1940, Feb 21	—	—	16.38	22,600
1940, Nov 23- Dec 5	—	—	20.78	59,600
1941, Nov 10	—	—	19.50	47,100
1943, Jan 16	—	—	13.10	9,500

**Table 4-8 All Recorded Major Floods In The Neches River Watershed, 1884-2015 (Continued)**

Date	Neches River near Town Bluff (1884-2015)		Neches River at Evadale (1884-2015)	
	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)
1944, May 3-11	—	—	23.58	92,100
1945, Apr 2-15	—	—	19.89	53,000
1946, Feb 18	—	—	20.30	57,000
1947, Jan 25	—	—	17.88	34,600
1948, Feb 24	—	—	16.10	22,800
1949, Apr 4-11	—	—	16.28	24,400
1950, Jun 11	—	—	19.26	46,600
1951, Mar 28- Apr 4	69.17	14,900	14.53	15,400
1952, May 25-29	73.00	21,400	15.55	19,500
1953, May 17-24	82.85	90,900	22.53	80,300
1954, May 7-14	66.50	12,800	13.19	10,900
1955, Apr 13-17	73.22	21,000	16.10	23,200
1956, Feb 10-13	65.55	12,200	13.18	10,900
1957, May 1-10	80.04	62,000	20.55	55,300
1957, Nov 28- Dec 2	77.14	35,700	18.41	35,600
1959, Apr 22- May 3	74.79	26,200	16.98	28,600
1960, Feb 29- Mar 3	71.14	21,100	16.05	20,500
1961, Jan 18-20	77.14	35,700	18.63	40,400
1962, May 1-11	73.52	23,300	16.75	23,900
1962, Dec 31	67.29	14,500	—	—
1963, Jan 3	—	—	14.35	14,200
1964, Apr 24	71.77	23,900	—	—
1964, May 2	—	—	17.21	21,300
1965, Apr 1-3	62.35	9,900	13.72	8,660
1966, Feb 10-14	74.11	27,200	18.12	27,300
1967, Apr 16-17	59.35	7,210	12.95	7,500
1968, May 12	70.47	20,200	—	—

**Table 4-8 All Recorded Major Floods In The Neches River Watershed, 1884-2015 (Continued)**

Date	Neches River near Town Bluff (1884-2015)		Neches River at Evadale (1884-2015)	
	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)
1968, Jun 2	—	—	17.19	21,300
1969, May 7-16	75.52	30,500	18.56	31,300
1970, May 4-5	63.13	10,900	14.63	11,700
1970, Oct 28-30	56.59	5,070	11.72	5,890
1972, Mar 23-25	64.06	12,000	14.58	11,400
1973, Jun 6-23	75.85	31,600	18.58	31,100
1974, Jan 20- Feb 1	72.94	24,900	18.12	27,500
1975, Jan 27-Feb 4	—	—	16.74	19,800
1975, Mar 5	69.14	18,800	—	—
1976, May 8-13	64.91	14,000	15.69	14,300
1977, May 6-10	64.61	13,200	15.60	14,800
1978, Jan 26-28	60.60	8,900	14.39	10,000
1979, Apr 3-22	69.76	20,600	18.03	27,600
1980, May 26-29	67.77	17,600	16.40	17,900
1981, Jun 8-11	65.67	14,900	16.03	16,100
1982, May 20-23	69.32	19,800	16.63	19,000
1982, Dec 30	—	—	17.60	24,600
1983, May 22	70.74	21,900	—	—
1984, Feb 12-16	73.50	26,500	17.85	26,300
1985, Mar 2-6	63.35	13,000	15.63	14,600
1986, Jun 9-12	65.64	15,600	16.71	19,400
1986, Nov 26-28	72.43	25,300	18.02	27,500
1987, Dec 8	63.77	13,500	—	—
1988, Apr 8	—	—	15.28	13,300
1989, Jul 2-6	78.49	49,200	20.79	47,900
1990, Mar 30- Apr 2	71.06	23,900	17.44	22,100
1991, Jan 25	69.33	20,800	—	—

**Table 4-8 All Recorded Major Floods In The Neches River Watershed, 1884-2015 (Continued)**

Date	Neches River near Town Bluff (1884-2015)		Neches River at Evadale (1884-2015)	
	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)
1991, May 31	—	—	17.40	24,500
1992, Mar 9-12	75.73	34,000	19.33	37,500
1993, Apr 4-7	67.76	18,500	17.31	22,800
1994, Mar 14-15	66.69	17,900	16.51	18,400
1994, Oct 23-25	76.17	35,400	19.33	41,400
1995, Dec 21	—	—	15.21	14,000
1996, Sept 28	67.27	19,800	—	—
1997, Mar 13-15	67.38	19,900	16.96	22,500
1998, Jan 8-11	71.46	26,200	17.76	26,900
1998, Nov 22	—	—	17.89	28,300
1999, Mar 14	73.45	29,600	—	—
2000, May 5-6	58.99	9,460	12.02	7,180
2001, Mar 19	—	—	17.95	31,700
2001, Jun 17	73.16	29,100	—	—
2001, Dec 14-17	66.61	20,300	17.18	27,000
2002, Nov 5-7	68.38	23,100	17.59	29,600
2004, Feb 15	—	—	16.93	22,100
2004, May 1-19	66.64	20,300	—	—
2004, Nov 30- Dec 3	69.77	25,600	17.4	24,700
2006, Apr 30	60.19	11,500	—	—
2006, May 1	—	—	12.37	7,260
2006, Oct 20-21	72.27	26,900	19.46	33,800
2008, Feb 24-26	64.21	15,200	15.49	13,800
2009, Apr 22	—	—	16.06	17,400
2009, May 4	66.42	18,400	—	—
2009, Nov 10	—	—	16.16	18,000

**Table 4-8 All Recorded Major Floods In The Neches River Watershed, 1884-2015 (Continued)**

Date	Neches River near Town Bluff (1884-2015)		Neches River at Evadale (1884-2015)	
	Gage Height (ft)	Peak Discharge (cfs)	Gage Height (ft)	Peak Discharge (cfs)
2009, Dec 25	65.38	18,300	—	—
2011, Feb 1-3	53.19	3,300	7.96	3,360
2012, Mar 21-23	67.64	19,500	17.31	25,700
2013, Jan 10- Feb 10	58.84	9,110	—	—
2013, May 12	—	—	10.96	6,400
2013, Nov 1-4	70.89	23,300	16.87	22,500
2015, May 28- Jun 1	73.50	28,000	18.58	31,200

**TABLE 4-9**

**Sam Rayburn Dam and Reservoir Monthly and Annual Inflow Volumes in Acre-feet**

TABLE 4-9

## Sam Rayburn Dam and Reservoir Monthly and Annual Inflow Volumes in Acre-Feet

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1908	295756	574882	353339	306818	701160	206036	29131	18488	38545	33001	25156	32688	2,615,000
1909	51572	74916	81410	50570	66301	99515	16961	5706	2161	11051	4235	41576	505,974
1910	64075	268600	201888	286162	219450	153612	28788	7236	4912	3125	1250	10900	1,249,998
1911	7128	14623	65550	388003	392651	23040	63992	33696	13602	9506	23162	381825	1,416,778
1912	414896	114515	466185	626099	350006	67890	49167	30616	16600	9266	6979	35741	2,187,960
1913	34034	134135	467919	279269	88173	43613	45179	25421	95236	143713	42666	401640	1,800,998
1914	133667	74913	251609	346559	613341	281996	32065	36453	26766	14614	59347	198430	2,069,760
1915	224186	265950	247271	180238	485749	33306	45933	663262	50002	24952	71321	113205	2,405,375
1916	260814	166600	90423	119493	706605	148206	54808	31603	19193	15402	29291	57562	1,700,000
1917	48074	81476	40506	64947	53075	42484	24446	16994	9765	8088	7555	32590	430,000
1918	16777	24023	22135	54595	77524	18065	9456	11216	8805	8360	58862	70176	379,994
1919	234972	266466	193135	165235	214566	234972	361560	42566	23056	193135	445254	280019	2,654,936
1920	694692	463514	267009	139670	79654	58374	15635	59969	46927	15636	64149	164151	2,069,380
1921	336255	199099	303076	648187	514349	90810	444674	23460	13167	6662	8099	24662	2,612,500
1922	75810	228165	584225	1279145	1048670	155575	41720	20965	6440	3360	30205	25690	3,499,970
1923	101170	391158	566706	1159656	407752	58590	18641	4676	43623	33992	76665	791965	3,654,594
1924	436626	386004	621206	298475	280543	465099	20244	4267	3709	5791	4623	13411	2,539,998
1925	71111	39766	31323	18372	16392	5966	2324	802	1236	102696	629156	95626	1,014,770
1926	229401	83674	343181	532205	256013	142214	91757	45965	12576	9043	22579	151392	1,920,000
1927	239478	191914	406007	374146	204806	80234	81443	16451	3211	14163	11370	29757	1,652,980
1928	52900	56200	213000	193000	65200	102000	33600	19700	3620	5310	23400	86700	854,630
1929	186000	217000	290000	136000	593000	583000	64600	9960	9340	3470	92600	120000	2,304,970
1930	395000	433000	250000	105000	176000	142000	13000	5260	6960	67000	57900	311000	1,962,120
1931	335000	303000	312000	164000	237000	25300	13200	11300	5560	2750	22200	333000	1,764,310
1932	1010000	1120000	695000	204000	98900	25200	15100	10600	7260	5670	7260	65600	3,255,490
1933	212000	305000	414000	347000	242000	107000	201000	144000	32400	12500	10700	33200	2,060,800
1934	395000	419000	646000	424000	121000	26400	9410	4930	3960	5570	33360	210100	2,298,730
1935	252300	187500	199300	185800	1123000	257700	50030	15440	12230	9540	65930	324400	2,683,170
1936	94290	95370	90590	36510	77300	37010	125300	25220	7220	5940	8430	58890	662,070
1937	461900	271800	260000	209900	40760	25760	8550	5640	7520	18310	21290	136300	1,467,730
1938	277500	205400	246000	720700	165500	49080	39960	39090	8300	5500	20320	28150	1,805,500
1939	233900	394000	299000	100800	68030	63540	9300	5840	3110	3970	9370	196900	1,387,760
1940	193500	501900	127400	198700	180300	153900	50520	33530	45560	9650	326200	1162000	2,983,160
1941	651800	354400	573700	209600	353500	325500	132300	42670	41570	126100	704600	340500	3,856,240
1942	260300	196300	285000	406600	297200	214300	74740	136700	87770	25690	37340	46000	2,067,940
1943	163000	94370	82790	64860	38070	26750	16690	8530	5700	8380	17970	27630	554,740
1944	243800	341400	419100	398400	1547000	404300	23300	13060	45490	12740	49600	326500	3,824,690
1945	879200	531800	475800	816800	220600	77410	187800	68070	19470	165700	84990	178200	3,705,840
1946	688100	885500	569100	345700	371100	393800	94020	33690	59400	45110	369900	331300	4,186,720
1947	729900	276400	238500	321100	305600	200400	38200	13660	10470	11460	49960	149600	2,345,250
1948	138900	464300	310800	268100	150100	45760	18070	5900	6120	5400	32650	44520	1,490,620
1949	202400	284700	349700	310100	154000	81060	33920	28140	17750	172200	99770	275200	2,008,940
1950	759700	650200	372800	137100	469700	628700	72510	24200	27940	22560	27290	37610	3,230,310
1951	77020	106900	160300	218090	86740	26760	12060	11100	19410	11410	10760	46260	786,810
1952	51730	144600	277900	268400	229000	74000	14000	5920	2510	2370	9590	36640	1,116,660
1953	68010	157700	578300	158100	1386000	126800	63470	31220	19230	7240	16770	77600	2,690,440
1954	101300	89020	60000	60510	188100	39690	6360	2500	1690	3620	27050	34970	614,810
1955	63720	174900	128300	249500	121800	91020	19700	35070	9490	9770	6130	15910	925,310
1956	24750	117000	61760	118300	224300	17770	4960	2760	2650	2000	4330	6390	586,970
1957	10120	41950	80190	245700	886000	264600	50460	19200	12220	194400	658700	358700	2,822,240
1958	353032	266320	192336	114426	478163	83940	49160	20651	298792	283805	62601	63696	2,266,922
1959	58058	194001	142735	287611	309735	100926	64243	46115	16331	28618	66122	171520	1,486,015
1960	267747	255139	383363	110144	81062	50576	42547	23601	23551	54796	127667	708442	2,128,635
1961	717363	395495	532045	437006	112426	73164	133457	29094	98987	37635	55096	504607	3,126,375
1962	282378	296792	206726	135479	394066	84118	40477	27657	28690	23637	29966	70	1,550,056
1963	94848	84487	106362	100902	29966	23111	13610	8885	7446	6760	9254	20447	506,078
1964	38289	42856	151061	177230	100307	27239	6019	6221	4627	5329	5640	15213	580,031
1965	23156	119504	135766	188497	131766	136457	11548	17203	34298	2301	22826	147594	970,915
1966	134452	417265	83708	190457	555564	78450	24837	52328	32725	40443	18258	43325	1,671,811
1967	37162	70491	58403	121753	109347	107213	23522	7860	5451	7295	9620	54198	612,315
1968	213310	88506	222617	778647	383397	277521	144426	37829	138260	36337	118215	372194	2,811,259
1969	159162	333856	769309	619824	650681	102585	20678	4314	8327	15755	40364	91868	2,816,722
1970	102946	118370	296323	164283	166917	22834	15295	10138	22627	75538	26235	36581	1,058,086
1971	35274	53030	48547	31779	93761	19922	20731	30468	18645	25507	29052	178883	585,600
1972	228837	121894	166163	103626	94092	28681	42563	33790	33852	42059	132785	243167	1,271,511
1973	455385	235997	490945	554475	234617	478401	138994	46651	125022	316726	284100	626687	3,988,000
1974	900930	317024	191042	168460	116650	28118	22090	31295	104767	106086	443191	423221	2,852,873
1975	363546	701030	257048	245312	501374	201993	80664	28328	3356	49734	74344	68737	2,575,464
1976	109680	141927	248388	157559	297792	224896	235412	23433	16598	13529	40873	185431	1,695,518
1977	171622	247107	282950	244338	72524	30682	21644	53242	9630	4673	50323	55083	1,243,816

**TABLE 4-9 (CONTINUED)**

**Sam Rayburn Dam and Reservoir Monthly and Annual Inflow Volumes in Acre-Feet**

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1978	251669	238784	111824	85954	60010	30754	3741	19916	102535	7244	51717	156295	1,120,442
1979	601624	562014	545756	576978	379956	528789	65609	54200	113899	64312	147439	240714	3,881,290
1980	310814	362689	317466	487180	567572	37732	1071	0	5913	950	9937	19057	2,120,381
1981	32684	61174	92674	38188	110069	240123	63620	5677	162365	74459	70500	25138	976,671
1982	71468	123074	148252	641486	346669	108609	60603	9995	0	63808	154155	660829	2,388,949
1983	243733	599179	379632	137028	536011	243628	68467	93493	49323	5845	74995	335839	2,767,173
1984	209282	413056	439844	114422	123267	52651	11655	24900	16451	206568	159523	172233	1,943,852
1985	213451	391529	350317	138248	160371	18335	43125	12569	51096	166009	312771	463664	2,321,485
1986	92083	238500	62168	109525	287218	609629	69324	54643	61783	65992	459036	433374	2,543,277
1987	239564	440320	379741	79632	105693	153427	64729	31983	59318	4001	241295	297502	2,176,206
1988	324579	151888	292177	156105	22231	14329	65730	35070	2309	15197	19156	86505	1,185,276
1989	397545	388195	306143	506247	525899	630972	422424	50763	28504	27277	20723	69308	3,374,000
1990	444970	431958	276948	248384	601017	394836	31480	14513	23131	40816	127152	146910	2,782,114
1991	956112	525034	315876	837443	663074	258151	104773	188602	119936	38830	134959	462289	4,605,080
1992	564452	970802	667331	223533	136897	77036	31418	29905	19999	13632	76931	338741	3,150,677
1993	448566	174514	618488	396240	320051	446461	147392	0	1184	79767	61950	129144	2,823,755
1994	149496	467871	380652	192428	213158	86214	29698	86093	75822	670901	146951	634829	3,134,113
1995	799081	277374	741951	563179	402091	67027	72022	42258	32456	3209	18916	152384	3,171,947
1996	64500	40124	25160	76110	32450	43662	11359	65534	110325	54543	70988	193200	787,955
1997	240170	692661	747088	512850	274615	130009	62523	349967	40764	77159	117798	364625	3,610,231
1998	903953	472675	390329	114303	35474	26027	8440	36389	117816	138448	419284	498208	3,161,346
1999	889900	511801	361364	258972	121716	187160	95076	0	30418	34500	0	53857	2,544,764
2000	18835	36046	129999	231501	340038	122444	14414	5691	11869	9741	245169	331940	1,497,684
2001	594702	338445	1201441	179752	96250	629901	62063	38844	114083	129899	98041	720271	4,203,693
2002	240742	196877	235339	418439	52973	46943	53099	32180	25297	158254	322343	594472	2,376,958
2003	290740	571667	468282	184697	47775	182038	114298	26224	61399	12243	133394	95890	2,188,649
2004	257784	705240	505540	187178	583810	289572	125477	48828	47910	167908	791977	445087	4,156,312
2005	290730	645816	365634	201101	61787	42683	51156	20193	147513	0	14882	32404	1,873,898
2006	89053	252485	152084	138117	82880	32673	79122	21620	10043	417620	56071	273251	1,605,018
2007	676582	217296	136062	90164	141015	163676	472979	135425	12020	14158	41437	104296	2,205,110
2008	53471	329693	290021	257006	103394	57196	12800	97005	0	10134	54106	88948	1,353,774
2009	59832	80443	222824	359345	95853	26055	47896	51105	29009	507609	235816	332339	2,048,126
2010	169476	342150	264030	84370	33372	40170	47614	0	25817	0	33714	9497	1,050,210
2011	51865	57236	19424	18621	48124	40868	849	0	6159	0	15344	113044	371,534
2012	200211	280090	555981	190426	41471	37482	123142	2448	105492	64184	0	73021	1,673,948
2013	224671	154124	65563	110019	50415	60489	202	0	68796	98372	145047	188254	1,165,952
2014	82970	101218	135229	146791	244847	204568	183815	47697	30937	38097	31920	89950	1,338,039
2015	524362	148606	787699	644651	883191	469205	138256	46922	35961	72973	248896	336431	4,337,153
2016	439528	120242	916595	342876	667309	346071	22689	143163	37302	0	26148	127172	3,189,095
<b>TOTAL</b>	<b>30,645,956</b>	<b>31,078,982</b>	<b>34,039,196</b>	<b>30,151,510</b>	<b>31,498,698</b>	<b>16,404,525</b>	<b>7,210,119</b>	<b>4,375,629</b>	<b>4,008,388</b>	<b>6,378,113</b>	<b>11,565,301</b>	<b>22,333,656</b>	
<b>AVG</b>	<b>281,156</b>	<b>285,128</b>	<b>312,286</b>	<b>276,619</b>	<b>288,979</b>	<b>150,500</b>	<b>66,148</b>	<b>40,143</b>	<b>36,774</b>	<b>58,515</b>	<b>106,104</b>	<b>204,896</b>	<b>2,107,248</b>

NOTES: 1. Data for period from January 1908 through March 1965 was retrieved from "Reservoir Regulation, Sam Rayburn Reservoir, Neches River Basin, May 1971".  
2. Data for period from April 1965 through December 2016 was obtained from the USACE hydrologic data.

**TABLE 7-4**

**Tabulated Area and Capacity Curves**

**TABLE 7-4**  
**Tabulated Area and Capacity Values**

**SAM RAYBURN RESERVOIR - ELEVATION vs. AREA**

AREA (IN THOUSAND ACRES)										
ELEV	0	1	2	3	4	5	6	7	8	9
80	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.006	0.014	0.029
90	0.049	0.074	0.107	0.148	0.201	0.284	0.394	0.561	0.772	1.033
100	1.397	1.871	2.495	3.205	3.967	4.836	5.741	6.663	7.582	8.586
110	9.628	10.635	11.720	12.756	13.705	14.653	15.618	16.670	17.835	19.063
120	20.357	21.650	22.932	24.298	25.702	27.048	28.488	30.015	31.450	32.904
130	34.407	35.945	37.506	39.131	40.874	42.692	44.532	46.447	48.398	50.348
140	52.395	54.468	56.525	58.618	60.612	62.703	64.881	67.103	69.389	71.739
150	74.008	76.283	78.526	80.698	82.870	85.279	87.923	93.015	96.446	99.401
160	101.724	103.481	104.745	105.844	106.887	107.910	108.930	109.955	110.987	112.026
170	113.072	114.126	139.010	142.710	146.410	150.110	153.810	157.510	161.210	164.920
180	168.630	172.350	176.070	180.000						
ELEV	0	1	2	3	4	5	6	7	8	9
ELEVATIONS IN FEET-NGVD										

**SAM RAYBURN RESERVOIR - ELEVATION vs. CAPACITY**

CAPACITY (IN THOUSAND ACRE-FEET)

ELEV	0	1	2	3	4	5	6	7	8	9
80	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.015	0.036
90	0.076	0.137	0.228	0.355	0.530	0.772	1.111	1.588	2.255	3.158
100	4.372	6.006	8.190	11.040	14.626	19.027	24.316	30.518	37.640	45.724
110	54.831	64.962	76.140	88.378	101.608	115.788	130.923	147.067	164.320	182.768
120	202.478	223.482	245.773	269.388	294.388	320.763	348.531	377.782	408.515	440.692
130	474.348	509.524	546.249	584.568	624.570	666.353	709.965	755.454	802.877	852.250
140	903.622	957.053	1012.550	1070.121	1129.736	1191.394	1255.186	1321.178	1389.424	1459.988
150	1532.861	1608.006	1685.411	1765.023	1846.807	1930.882	2017.482	2107.952	2202.682	2300.606
160	2401.168	2503.770	2607.884	2713.178	2819.544	2926.942	3035.362	3144.804	3255.276	3366.782
170	3479.331	3592.930	3719.498	3860.358	4004.918	4153.178	4305.138	4460.798	4620.158	4783.223
180	4949.998	5120.488	5294.698	5472.733						
ELEV	0	1	2	3	4	5	6	7	8	9
ELEVATIONS IN FEET-NGVD										

**TABLE 7-4**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
80.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
81.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
81.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
81.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
81.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
81.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
81.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
81.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
81.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
81.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
81.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
82.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
82.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
82.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
82.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
82.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
82.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
82.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
82.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
82.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
82.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
84.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
85.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
85.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
85.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
85.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
85.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
85.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
85.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
85.7	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
85.8	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
85.9	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
86.0	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
86.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
86.2	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
86.3	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
86.4	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
86.5	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
86.6	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
86.7	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.004
86.8	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
86.9	0.004	0.004	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
87.0	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.006	0.006
87.1	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
87.2	0.006	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
87.3	0.007	0.007	0.007	0.007	0.008	0.008	0.008	0.008	0.008	0.008
87.4	0.008	0.008	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.009
87.5	0.009	0.009	0.009	0.009	0.009	0.010	0.010	0.010	0.010	0.010
87.6	0.010	0.010	0.010	0.010	0.010	0.011	0.011	0.011	0.011	0.011
87.7	0.011	0.011	0.011	0.012	0.012	0.012	0.012	0.012	0.012	0.012
87.8	0.012	0.012	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.014
87.9	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.015	0.015	0.015
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
88.0	0.015	0.015	0.015	0.015	0.016	0.016	0.016	0.016	0.016	0.016
88.1	0.016	0.017	0.017	0.017	0.017	0.017	0.017	0.018	0.018	0.018
88.2	0.018	0.018	0.018	0.019	0.019	0.019	0.019	0.019	0.020	0.020
88.3	0.020	0.020	0.020	0.020	0.021	0.021	0.021	0.021	0.021	0.022
88.4	0.022	0.022	0.022	0.022	0.023	0.023	0.023	0.023	0.023	0.024
88.5	0.024	0.024	0.024	0.025	0.025	0.025	0.025	0.025	0.026	0.026
88.6	0.026	0.026	0.027	0.027	0.027	0.027	0.028	0.028	0.028	0.028
88.7	0.028	0.029	0.029	0.029	0.029	0.030	0.030	0.030	0.030	0.031
88.8	0.031	0.031	0.032	0.032	0.032	0.032	0.033	0.033	0.033	0.033
88.9	0.034	0.034	0.034	0.035	0.035	0.035	0.035	0.036	0.036	0.036
89.0	0.036	0.037	0.037	0.037	0.038	0.038	0.038	0.039	0.039	0.039
89.1	0.040	0.040	0.040	0.040	0.041	0.041	0.041	0.042	0.042	0.042
89.2	0.043	0.043	0.043	0.044	0.044	0.044	0.045	0.045	0.045	0.046
89.3	0.046	0.046	0.047	0.047	0.048	0.048	0.048	0.049	0.049	0.049
89.4	0.050	0.050	0.050	0.051	0.051	0.052	0.052	0.052	0.053	0.053
89.5	0.053	0.054	0.054	0.055	0.055	0.055	0.056	0.056	0.057	0.057
89.6	0.057	0.058	0.058	0.059	0.059	0.060	0.060	0.060	0.061	0.061
89.7	0.062	0.062	0.063	0.063	0.063	0.064	0.064	0.065	0.065	0.066
89.8	0.066	0.067	0.067	0.067	0.068	0.068	0.069	0.069	0.070	0.070
89.9	0.071	0.071	0.072	0.072	0.073	0.073	0.074	0.074	0.075	0.075
90.0	0.075	0.076	0.076	0.077	0.077	0.078	0.078	0.079	0.079	0.080
90.1	0.081	0.081	0.082	0.082	0.083	0.083	0.084	0.084	0.085	0.085
90.2	0.086	0.086	0.087	0.087	0.088	0.089	0.089	0.090	0.090	0.091
90.3	0.091	0.092	0.092	0.093	0.094	0.094	0.095	0.095	0.096	0.097
90.4	0.097	0.098	0.098	0.099	0.099	0.100	0.101	0.101	0.102	0.103
90.5	0.103	0.104	0.104	0.105	0.106	0.106	0.107	0.107	0.108	0.109
90.6	0.109	0.110	0.111	0.111	0.112	0.113	0.113	0.114	0.115	0.115
90.7	0.116	0.117	0.117	0.118	0.119	0.119	0.120	0.121	0.121	0.122
90.8	0.123	0.123	0.124	0.125	0.125	0.126	0.127	0.128	0.128	0.129
90.9	0.130	0.130	0.131	0.132	0.133	0.133	0.134	0.135	0.136	0.136
91.0	0.137	0.138	0.138	0.139	0.140	0.141	0.141	0.142	0.143	0.144
91.1	0.145	0.145	0.146	0.147	0.148	0.148	0.149	0.150	0.151	0.152
91.2	0.152	0.153	0.154	0.155	0.156	0.157	0.157	0.158	0.159	0.160
91.3	0.161	0.162	0.162	0.163	0.164	0.165	0.166	0.167	0.168	0.168
91.4	0.169	0.170	0.171	0.172	0.173	0.174	0.175	0.175	0.176	0.177
91.5	0.178	0.179	0.180	0.181	0.182	0.183	0.184	0.185	0.185	0.186
91.6	0.187	0.188	0.189	0.190	0.191	0.192	0.193	0.194	0.195	0.196
91.7	0.197	0.198	0.199	0.200	0.201	0.202	0.203	0.204	0.205	0.206
91.8	0.207	0.208	0.209	0.210	0.211	0.212	0.213	0.214	0.215	0.216
91.9	0.217	0.218	0.219	0.220	0.221	0.222	0.223	0.224	0.225	0.226
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
92.0	0.228	0.229	0.230	0.231	0.232	0.233	0.234	0.235	0.236	0.237
92.1	0.238	0.240	0.241	0.242	0.243	0.244	0.245	0.246	0.247	0.249
92.2	0.250	0.251	0.252	0.253	0.254	0.256	0.257	0.258	0.259	0.260
92.3	0.261	0.263	0.264	0.265	0.266	0.267	0.269	0.270	0.271	0.272
92.4	0.274	0.275	0.276	0.277	0.279	0.280	0.281	0.282	0.284	0.285
92.5	0.286	0.287	0.289	0.290	0.291	0.293	0.294	0.295	0.296	0.298
92.6	0.299	0.300	0.302	0.303	0.304	0.306	0.307	0.308	0.310	0.311
92.7	0.312	0.314	0.315	0.317	0.318	0.319	0.321	0.322	0.323	0.325
92.8	0.326	0.328	0.329	0.330	0.332	0.333	0.335	0.336	0.338	0.339
92.9	0.340	0.342	0.343	0.345	0.346	0.348	0.349	0.351	0.352	0.354
93.0	0.355	0.356	0.358	0.359	0.361	0.362	0.364	0.365	0.367	0.369
93.1	0.370	0.372	0.373	0.375	0.376	0.378	0.379	0.381	0.382	0.384
93.2	0.386	0.387	0.389	0.390	0.392	0.394	0.395	0.397	0.399	0.400
93.3	0.402	0.403	0.405	0.407	0.408	0.410	0.412	0.413	0.415	0.417
93.4	0.418	0.420	0.422	0.424	0.425	0.427	0.429	0.430	0.432	0.434
93.5	0.436	0.437	0.439	0.441	0.443	0.444	0.446	0.448	0.450	0.452
93.6	0.453	0.455	0.457	0.459	0.461	0.462	0.464	0.466	0.468	0.470
93.7	0.472	0.473	0.475	0.477	0.479	0.481	0.483	0.485	0.487	0.488
93.8	0.490	0.492	0.494	0.496	0.498	0.500	0.502	0.504	0.506	0.508
93.9	0.510	0.512	0.514	0.516	0.518	0.520	0.522	0.523	0.525	0.527
94.0	0.530	0.532	0.534	0.536	0.538	0.540	0.542	0.544	0.546	0.548
94.1	0.550	0.552	0.554	0.556	0.558	0.561	0.563	0.565	0.567	0.569
94.2	0.571	0.574	0.576	0.578	0.580	0.582	0.585	0.587	0.589	0.591
94.3	0.594	0.596	0.598	0.600	0.603	0.605	0.607	0.610	0.612	0.614
94.4	0.617	0.619	0.621	0.624	0.626	0.628	0.631	0.633	0.636	0.638
94.5	0.640	0.643	0.645	0.648	0.650	0.653	0.655	0.658	0.660	0.663
94.6	0.665	0.668	0.670	0.673	0.675	0.678	0.680	0.683	0.685	0.688
94.7	0.691	0.693	0.696	0.698	0.701	0.704	0.706	0.709	0.712	0.714
94.8	0.717	0.720	0.722	0.725	0.728	0.730	0.733	0.736	0.739	0.741
94.9	0.744	0.747	0.750	0.752	0.755	0.758	0.761	0.764	0.766	0.769
95.0	0.772	0.775	0.778	0.781	0.783	0.786	0.789	0.792	0.795	0.798
95.1	0.801	0.804	0.807	0.810	0.813	0.816	0.819	0.822	0.825	0.828
95.2	0.831	0.834	0.837	0.840	0.843	0.846	0.850	0.853	0.856	0.859
95.3	0.862	0.865	0.869	0.872	0.875	0.878	0.881	0.885	0.888	0.891
95.4	0.894	0.898	0.901	0.904	0.908	0.911	0.914	0.918	0.921	0.924
95.5	0.928	0.931	0.935	0.938	0.941	0.945	0.948	0.952	0.955	0.959
95.6	0.962	0.966	0.969	0.973	0.976	0.980	0.983	0.987	0.991	0.994
95.7	0.998	1.001	1.005	1.009	1.012	1.016	1.020	1.023	1.027	1.031
95.8	1.034	1.038	1.042	1.046	1.049	1.053	1.057	1.061	1.065	1.068
95.9	1.072	1.076	1.080	1.084	1.088	1.091	1.095	1.099	1.103	1.107
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
96.0	1.111	1.115	1.119	1.123	1.127	1.131	1.135	1.139	1.143	1.147
96.1	1.151	1.155	1.159	1.164	1.168	1.172	1.176	1.180	1.185	1.189
96.2	1.193	1.197	1.202	1.206	1.210	1.215	1.219	1.223	1.228	1.232
96.3	1.237	1.241	1.246	1.250	1.255	1.259	1.264	1.268	1.273	1.277
96.4	1.282	1.287	1.291	1.296	1.301	1.305	1.310	1.315	1.319	1.324
96.5	1.329	1.334	1.338	1.343	1.348	1.353	1.358	1.363	1.368	1.373
96.6	1.377	1.382	1.387	1.392	1.397	1.402	1.407	1.412	1.418	1.423
96.7	1.428	1.433	1.438	1.443	1.448	1.453	1.459	1.464	1.469	1.474
96.8	1.480	1.485	1.490	1.496	1.501	1.506	1.512	1.517	1.522	1.528
96.9	1.533	1.539	1.544	1.550	1.555	1.561	1.566	1.572	1.577	1.583
97.0	1.589	1.594	1.600	1.605	1.611	1.617	1.623	1.628	1.634	1.640
97.1	1.646	1.651	1.657	1.663	1.669	1.675	1.681	1.687	1.693	1.699
97.2	1.705	1.711	1.717	1.723	1.729	1.735	1.741	1.748	1.754	1.760
97.3	1.766	1.773	1.779	1.785	1.791	1.798	1.804	1.811	1.817	1.823
97.4	1.830	1.836	1.843	1.849	1.856	1.862	1.869	1.875	1.882	1.889
97.5	1.895	1.902	1.909	1.915	1.922	1.929	1.936	1.943	1.949	1.956
97.6	1.963	1.970	1.977	1.984	1.991	1.998	2.005	2.012	2.019	2.026
97.7	2.033	2.040	2.047	2.054	2.061	2.069	2.076	2.083	2.090	2.098
97.8	2.105	2.112	2.119	2.127	2.134	2.142	2.149	2.156	2.164	2.171
97.9	2.179	2.186	2.194	2.201	2.209	2.217	2.224	2.232	2.240	2.247
98.0	2.255	2.263	2.270	2.278	2.286	2.294	2.302	2.310	2.318	2.326
98.1	2.334	2.341	2.350	2.358	2.366	2.374	2.382	2.390	2.398	2.406
98.2	2.415	2.423	2.431	2.439	2.448	2.456	2.465	2.473	2.481	2.490
98.3	2.498	2.507	2.515	2.524	2.533	2.541	2.550	2.559	2.567	2.576
98.4	2.585	2.593	2.602	2.611	2.620	2.629	2.638	2.647	2.656	2.665
98.5	2.674	2.683	2.692	2.701	2.710	2.719	2.728	2.737	2.747	2.756
98.6	2.765	2.774	2.784	2.793	2.803	2.812	2.821	2.831	2.840	2.850
98.7	2.859	2.869	2.878	2.888	2.898	2.907	2.917	2.927	2.937	2.946
98.8	2.956	2.966	2.976	2.986	2.996	3.005	3.015	3.025	3.035	3.045
98.9	3.056	3.066	3.076	3.086	3.096	3.106	3.116	3.127	3.137	3.147
99.0	3.158	3.168	3.178	3.189	3.199	3.210	3.220	3.231	3.241	3.252
99.1	3.263	3.273	3.284	3.295	3.306	3.317	3.327	3.338	3.349	3.360
99.2	3.371	3.382	3.394	3.405	3.416	3.427	3.438	3.450	3.461	3.472
99.3	3.484	3.495	3.507	3.518	3.530	3.541	3.553	3.565	3.576	3.588
99.4	3.600	3.612	3.623	3.635	3.647	3.659	3.671	3.683	3.695	3.707
99.5	3.719	3.732	3.744	3.756	3.768	3.781	3.793	3.805	3.818	3.830
99.6	3.843	3.855	3.868	3.881	3.893	3.906	3.919	3.931	3.944	3.957
99.7	3.970	3.983	3.996	4.009	4.022	4.035	4.048	4.061	4.074	4.087
99.8	4.100	4.114	4.127	4.140	4.154	4.167	4.180	4.194	4.207	4.221
99.9	4.235	4.248	4.262	4.276	4.289	4.303	4.317	4.331	4.345	4.359
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
100.0	4.372	4.386	4.401	4.415	4.429	4.443	4.457	4.471	4.486	4.500
100.1	4.515	4.529	4.544	4.558	4.573	4.587	4.602	4.617	4.632	4.646
100.2	4.661	4.676	4.691	4.706	4.721	4.737	4.752	4.767	4.782	4.798
100.3	4.813	4.828	4.844	4.859	4.875	4.890	4.906	4.922	4.938	4.953
100.4	4.969	4.985	5.001	5.017	5.033	5.049	5.065	5.081	5.098	5.114
100.5	5.130	5.147	5.163	5.179	5.196	5.213	5.229	5.246	5.262	5.279
100.6	5.296	5.313	5.330	5.347	5.364	5.381	5.398	5.415	5.432	5.449
100.7	5.467	5.484	5.501	5.519	5.536	5.554	5.571	5.589	5.606	5.624
100.8	5.642	5.660	5.677	5.695	5.713	5.731	5.749	5.767	5.785	5.804
100.9	5.822	5.840	5.858	5.877	5.895	5.914	5.932	5.951	5.969	5.988
101.0	6.006	6.025	6.044	6.063	6.082	6.101	6.120	6.139	6.158	6.177
101.1	6.197	6.216	6.236	6.255	6.275	6.294	6.314	6.334	6.353	6.373
101.2	6.393	6.413	6.433	6.453	6.474	6.494	6.514	6.534	6.555	6.575
101.3	6.596	6.616	6.637	6.658	6.679	6.700	6.720	6.741	6.763	6.784
101.4	6.805	6.826	6.847	6.869	6.890	6.912	6.933	6.955	6.976	6.998
101.5	7.020	7.042	7.064	7.086	7.108	7.130	7.152	7.174	7.197	7.219
101.6	7.241	7.264	7.286	7.309	7.332	7.354	7.377	7.400	7.423	7.446
101.7	7.469	7.492	7.515	7.539	7.562	7.585	7.609	7.632	7.656	7.679
101.8	7.703	7.727	7.751	7.774	7.798	7.822	7.846	7.870	7.895	7.919
101.9	7.943	7.967	7.992	8.016	8.041	8.066	8.090	8.115	8.140	8.165
102.0	8.189	8.214	8.240	8.265	8.290	8.315	8.340	8.366	8.391	8.417
102.1	8.443	8.468	8.494	8.520	8.546	8.572	8.598	8.624	8.650	8.676
102.2	8.703	8.729	8.756	8.782	8.809	8.835	8.862	8.889	8.916	8.943
102.3	8.970	8.997	9.024	9.052	9.079	9.106	9.134	9.161	9.189	9.217
102.4	9.244	9.272	9.300	9.328	9.356	9.384	9.412	9.441	9.469	9.497
102.5	9.526	9.554	9.583	9.612	9.640	9.669	9.698	9.727	9.756	9.785
102.6	9.814	9.844	9.873	9.902	9.932	9.961	9.991	10.021	10.050	10.080
102.7	10.110	10.140	10.170	10.200	10.230	10.260	10.291	10.321	10.352	10.382
102.8	10.413	10.443	10.474	10.505	10.536	10.567	10.598	10.629	10.660	10.691
102.9	10.723	10.754	10.785	10.817	10.848	10.880	10.912	10.944	10.976	11.007
103.0	11.040	11.072	11.104	11.136	11.168	11.201	11.233	11.266	11.298	11.331
103.1	11.364	11.397	11.430	11.463	11.496	11.529	11.562	11.595	11.629	11.662
103.2	11.696	11.729	11.763	11.797	11.831	11.865	11.899	11.933	11.967	12.001
103.3	12.035	12.070	12.104	12.139	12.173	12.208	12.243	12.278	12.312	12.347
103.4	12.382	12.418	12.453	12.488	12.523	12.559	12.594	12.630	12.666	12.701
103.5	12.737	12.773	12.809	12.845	12.881	12.918	12.954	12.990	13.027	13.063
103.6	13.100	13.136	13.173	13.210	13.247	13.284	13.321	13.358	13.395	13.432
103.7	13.470	13.507	13.545	13.582	13.620	13.658	13.695	13.733	13.771	13.809
103.8	13.847	13.886	13.924	13.962	14.001	14.039	14.078	14.116	14.155	14.194
103.9	14.233	14.272	14.311	14.350	14.389	14.428	14.467	14.507	14.546	14.586
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
104.0	14.625	14.665	14.705	14.745	14.785	14.825	14.865	14.905	14.946	14.986
104.1	15.027	15.067	15.108	15.149	15.189	15.230	15.271	15.312	15.354	15.395
104.2	15.436	15.478	15.519	15.561	15.603	15.644	15.686	15.728	15.770	15.812
104.3	15.855	15.897	15.939	15.982	16.025	16.067	16.110	16.153	16.196	16.239
104.4	16.282	16.325	16.368	16.412	16.455	16.499	16.542	16.586	16.630	16.674
104.5	16.718	16.762	16.806	16.850	16.894	16.939	16.983	17.028	17.073	17.117
104.6	17.162	17.207	17.252	17.297	17.342	17.388	17.433	17.478	17.524	17.570
104.7	17.615	17.661	17.707	17.753	17.799	17.845	17.891	17.938	17.984	18.031
104.8	18.077	18.124	18.171	18.217	18.264	18.311	18.358	18.406	18.453	18.500
104.9	18.548	18.595	18.643	18.691	18.738	18.786	18.834	18.882	18.930	18.979
105.0	19.027	19.075	19.124	19.172	19.221	19.270	19.319	19.368	19.417	19.466
105.1	19.515	19.564	19.614	19.663	19.713	19.763	19.812	19.862	19.912	19.962
105.2	20.012	20.063	20.113	20.163	20.214	20.264	20.315	20.366	20.417	20.467
105.3	20.519	20.570	20.621	20.672	20.724	20.775	20.827	20.878	20.930	20.982
105.4	21.034	21.086	21.138	21.190	21.242	21.295	21.347	21.400	21.453	21.505
105.5	21.558	21.611	21.664	21.717	21.770	21.824	21.877	21.931	21.984	22.038
105.6	22.091	22.145	22.199	22.253	22.307	22.362	22.416	22.470	22.525	22.579
105.7	22.634	22.689	22.743	22.798	22.853	22.909	22.964	23.019	23.074	23.130
105.8	23.185	23.241	23.297	23.353	23.409	23.465	23.521	23.577	23.633	23.689
105.9	23.746	23.802	23.859	23.916	23.973	24.030	24.087	24.144	24.201	24.258
106.0	24.316	24.373	24.431	24.488	24.546	24.604	24.662	24.720	24.778	24.836
106.1	24.894	24.953	25.011	25.070	25.128	25.187	25.246	25.305	25.364	25.423
106.2	25.482	25.541	25.601	25.660	25.720	25.780	25.839	25.899	25.959	26.019
106.3	26.079	26.140	26.200	26.260	26.321	26.381	26.442	26.503	26.564	26.625
106.4	26.686	26.747	26.808	26.869	26.931	26.992	27.054	27.116	27.177	27.239
106.5	27.301	27.363	27.425	27.488	27.550	27.612	27.675	27.738	27.800	27.863
106.6	27.926	27.989	28.052	28.115	28.179	28.242	28.305	28.369	28.433	28.496
106.7	28.560	28.624	28.688	28.752	28.816	28.881	28.945	29.009	29.074	29.139
106.8	29.203	29.268	29.333	29.398	29.463	29.528	29.594	29.659	29.725	29.790
106.9	29.856	29.922	29.987	30.053	30.119	30.185	30.252	30.318	30.384	30.451
107.0	30.517	30.584	30.651	30.718	30.785	30.852	30.919	30.986	31.053	31.121
107.1	31.188	31.256	31.324	31.391	31.459	31.527	31.595	31.663	31.732	31.800
107.2	31.868	31.937	32.006	32.074	32.143	32.212	32.281	32.350	32.419	32.488
107.3	32.558	32.627	32.697	32.766	32.836	32.906	32.976	33.046	33.116	33.186
107.4	33.256	33.327	33.397	33.468	33.538	33.609	33.680	33.751	33.822	33.893
107.5	33.964	34.035	34.107	34.178	34.250	34.321	34.393	34.465	34.537	34.609
107.6	34.681	34.753	34.825	34.898	34.970	35.043	35.115	35.188	35.261	35.334
107.7	35.407	35.480	35.553	35.626	35.700	35.773	35.847	35.920	35.994	36.068
107.8	36.142	36.216	36.290	36.364	36.439	36.513	36.588	36.662	36.737	36.812
107.9	36.886	36.961	37.036	37.112	37.187	37.262	37.337	37.413	37.489	37.564
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
108.0	37.640	37.716	37.792	37.868	37.944	38.020	38.097	38.173	38.250	38.326
108.1	38.403	38.480	38.557	38.634	38.711	38.789	38.866	38.943	39.021	39.099
108.2	39.176	39.254	39.332	39.410	39.489	39.567	39.645	39.724	39.802	39.881
108.3	39.960	40.039	40.118	40.197	40.276	40.355	40.435	40.514	40.594	40.673
108.4	40.753	40.833	40.913	40.993	41.073	41.154	41.234	41.314	41.395	41.476
108.5	41.556	41.637	41.718	41.799	41.881	41.962	42.043	42.125	42.206	42.288
108.6	42.370	42.452	42.534	42.616	42.698	42.780	42.863	42.945	43.028	43.111
108.7	43.193	43.276	43.359	43.442	43.526	43.609	43.692	43.776	43.859	43.943
108.8	44.027	44.111	44.195	44.279	44.363	44.447	44.532	44.616	44.701	44.786
108.9	44.870	44.955	45.040	45.125	45.211	45.296	45.381	45.467	45.552	45.638
109.0	45.724	45.810	45.896	45.982	46.068	46.155	46.241	46.328	46.414	46.501
109.1	46.588	46.675	46.762	46.849	46.936	47.024	47.111	47.199	47.286	47.374
109.2	47.462	47.550	47.638	47.726	47.815	47.903	47.992	48.080	48.169	48.258
109.3	48.347	48.436	48.525	48.614	48.703	48.793	48.882	48.972	49.062	49.152
109.4	49.242	49.332	49.422	49.512	49.603	49.693	49.784	49.875	49.965	50.056
109.5	50.147	50.238	50.330	50.421	50.512	50.604	50.696	50.787	50.879	50.971
109.6	51.063	51.155	51.248	51.340	51.432	51.525	51.618	51.710	51.803	51.896
109.7	51.989	52.083	52.176	52.269	52.363	52.457	52.550	52.644	52.738	52.832
109.8	52.926	53.020	53.115	53.209	53.304	53.399	53.493	53.588	53.683	53.778
109.9	53.873	53.969	54.064	54.160	54.255	54.351	54.447	54.543	54.639	54.735
110.0	54.831	54.927	55.024	55.120	55.217	55.314	55.410	55.507	55.604	55.702
110.1	55.799	55.896	55.994	56.091	56.189	56.287	56.384	56.482	56.580	56.678
110.2	56.777	56.875	56.974	57.072	57.171	57.269	57.368	57.467	57.566	57.665
110.3	57.765	57.864	57.964	58.063	58.163	58.262	58.362	58.462	58.562	58.662
110.4	58.763	58.863	58.964	59.064	59.165	59.266	59.366	59.467	59.568	59.670
110.5	59.771	59.872	59.974	60.075	60.177	60.279	60.381	60.483	60.585	60.687
110.6	60.789	60.891	60.994	61.096	61.199	61.302	61.405	61.508	61.611	61.714
110.7	61.817	61.921	62.024	62.128	62.231	62.335	62.439	62.543	62.647	62.751
110.8	62.856	62.960	63.065	63.169	63.274	63.379	63.483	63.588	63.694	63.799
110.9	63.904	64.009	64.115	64.221	64.326	64.432	64.538	64.644	64.750	64.856
111.0	64.963	65.069	65.175	65.282	65.389	65.496	65.603	65.710	65.817	65.924
111.1	66.031	66.139	66.247	66.354	66.462	66.570	66.678	66.786	66.894	67.003
111.2	67.111	67.220	67.328	67.437	67.546	67.655	67.764	67.873	67.983	68.092
111.3	68.202	68.311	68.421	68.531	68.641	68.751	68.861	68.972	69.082	69.193
111.4	69.303	69.414	69.525	69.636	69.747	69.858	69.969	70.081	70.192	70.304
111.5	70.416	70.527	70.639	70.751	70.864	70.976	71.088	71.201	71.313	71.426
111.6	71.539	71.652	71.765	71.878	71.991	72.104	72.218	72.331	72.445	72.559
111.7	72.673	72.787	72.901	73.015	73.129	73.244	73.358	73.473	73.588	73.703
111.8	73.818	73.933	74.048	74.163	74.279	74.394	74.510	74.626	74.741	74.857
111.9	74.973	75.090	75.206	75.322	75.439	75.555	75.672	75.789	75.906	76.023
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
112.0	76.140	76.257	76.375	76.492	76.610	76.727	76.845	76.963	77.081	77.199
112.1	77.317	77.435	77.554	77.672	77.791	77.910	78.028	78.147	78.266	78.385
112.2	78.505	78.624	78.743	78.863	78.983	79.102	79.222	79.342	79.462	79.582
112.3	79.703	79.823	79.943	80.064	80.185	80.305	80.426	80.547	80.668	80.790
112.4	80.911	81.032	81.154	81.275	81.397	81.519	81.641	81.763	81.885	82.007
112.5	82.130	82.252	82.374	82.497	82.620	82.743	82.866	82.989	83.112	83.235
112.6	83.358	83.482	83.606	83.729	83.853	83.977	84.101	84.225	84.349	84.473
112.7	84.598	84.722	84.847	84.972	85.096	85.221	85.346	85.472	85.597	85.722
112.8	85.848	85.973	86.099	86.224	86.350	86.476	86.602	86.728	86.855	86.981
112.9	87.108	87.234	87.361	87.488	87.615	87.741	87.869	87.996	88.123	88.250
113.0	88.378	88.506	88.633	88.761	88.889	89.017	89.145	89.273	89.402	89.530
113.1	89.658	89.787	89.916	90.044	90.173	90.302	90.431	90.560	90.689	90.819
113.2	90.948	91.078	91.207	91.337	91.467	91.597	91.727	91.857	91.987	92.117
113.3	92.248	92.378	92.509	92.639	92.770	92.901	93.032	93.163	93.294	93.425
113.4	93.556	93.688	93.819	93.951	94.082	94.214	94.346	94.478	94.610	94.742
113.5	94.875	95.007	95.139	95.272	95.405	95.537	95.670	95.803	95.936	96.069
113.6	96.202	96.336	96.469	96.603	96.736	96.870	97.004	97.138	97.271	97.406
113.7	97.540	97.674	97.808	97.943	98.077	98.212	98.347	98.481	98.616	98.751
113.8	98.886	99.022	99.157	99.292	99.428	99.563	99.699	99.835	99.971	100.107
113.9	100.243	100.379	100.515	100.651	100.788	100.924	101.061	101.198	101.335	101.471
114.0	101.608	101.746	101.883	102.020	102.157	102.295	102.433	102.570	102.708	102.846
114.1	102.984	103.122	103.260	103.398	103.536	103.675	103.813	103.952	104.091	104.230
114.2	104.368	104.507	104.647	104.786	104.925	105.064	105.204	105.343	105.483	105.623
114.3	105.763	105.903	106.043	106.183	106.323	106.463	106.604	106.744	106.885	107.026
114.4	107.166	107.307	107.448	107.589	107.730	107.872	108.013	108.155	108.296	108.438
114.5	108.579	108.721	108.863	109.005	109.147	109.290	109.432	109.574	109.717	109.859
114.6	110.002	110.145	110.288	110.431	110.574	110.717	110.860	111.004	111.147	111.291
114.7	111.434	111.578	111.722	111.866	112.010	112.154	112.298	112.442	112.587	112.731
114.8	112.876	113.021	113.165	113.310	113.455	113.600	113.745	113.891	114.036	114.181
114.9	114.327	114.473	114.618	114.764	114.910	115.056	115.202	115.348	115.495	115.641
115.0	115.787	115.934	116.081	116.228	116.374	116.521	116.668	116.816	116.963	117.110
115.1	117.258	117.405	117.553	117.701	117.848	117.996	118.144	118.292	118.441	118.589
115.2	118.737	118.886	119.035	119.183	119.332	119.481	119.630	119.779	119.928	120.077
115.3	120.227	120.376	120.526	120.676	120.825	120.975	121.125	121.275	121.425	121.576
115.4	121.726	121.876	122.027	122.177	122.328	122.479	122.630	122.781	122.932	123.083
115.5	123.235	123.386	123.538	123.689	123.841	123.993	124.144	124.296	124.449	124.601
115.6	124.753	124.905	125.058	125.210	125.363	125.516	125.669	125.822	125.975	126.128
115.7	126.281	126.434	126.588	126.741	126.895	127.049	127.202	127.356	127.510	127.664
115.8	127.819	127.973	128.127	128.282	128.436	128.591	128.746	128.901	129.056	129.211
115.9	129.366	129.521	129.677	129.832	129.988	130.143	130.299	130.455	130.611	130.767
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
116.0	130.923	131.079	131.236	131.392	131.549	131.705	131.862	132.019	132.176	132.333
116.1	132.490	132.647	132.805	132.962	133.120	133.278	133.435	133.593	133.751	133.909
116.2	134.068	134.226	134.384	134.543	134.702	134.860	135.019	135.178	135.337	135.496
116.3	135.656	135.815	135.975	136.134	136.294	136.454	136.614	136.774	136.934	137.094
116.4	137.254	137.415	137.575	137.736	137.897	138.058	138.219	138.380	138.541	138.702
116.5	138.863	139.025	139.187	139.348	139.510	139.672	139.834	139.996	140.158	140.321
116.6	140.483	140.646	140.808	140.971	141.134	141.297	141.460	141.623	141.786	141.950
116.7	142.113	142.277	142.441	142.604	142.768	142.932	143.096	143.261	143.425	143.589
116.8	143.754	143.919	144.083	144.248	144.413	144.578	144.743	144.909	145.074	145.240
116.9	145.405	145.571	145.737	145.903	146.069	146.235	146.401	146.567	146.734	146.900
117.0	147.067	147.234	147.401	147.568	147.735	147.902	148.069	148.237	148.404	148.572
117.1	148.740	148.908	149.076	149.244	149.412	149.581	149.749	149.918	150.086	150.255
117.2	150.424	150.593	150.763	150.932	151.101	151.271	151.441	151.610	151.780	151.950
117.3	152.120	152.291	152.461	152.632	152.802	152.973	153.144	153.315	153.486	153.657
117.4	153.828	154.000	154.171	154.343	154.515	154.686	154.858	155.031	155.203	155.375
117.5	155.548	155.720	155.893	156.066	156.239	156.412	156.585	156.758	156.932	157.105
117.6	157.279	157.452	157.626	157.800	157.974	158.149	158.323	158.497	158.672	158.847
117.7	159.021	159.196	159.371	159.546	159.722	159.897	160.073	160.248	160.424	160.600
117.8	160.776	160.952	161.128	161.304	161.481	161.657	161.834	162.011	162.188	162.365
117.9	162.542	162.719	162.896	163.074	163.251	163.429	163.607	163.785	163.963	164.141
118.0	164.320	164.498	164.676	164.855	165.034	165.213	165.392	165.571	165.750	165.930
118.1	166.109	166.289	166.469	166.648	166.828	167.009	167.189	167.369	167.550	167.730
118.2	167.911	168.092	168.273	168.454	168.635	168.817	168.998	169.180	169.361	169.543
118.3	169.725	169.907	170.090	170.272	170.454	170.637	170.820	171.003	171.185	171.369
118.4	171.552	171.735	171.919	172.102	172.286	172.470	172.654	172.838	173.022	173.206
118.5	173.391	173.575	173.760	173.945	174.129	174.314	174.500	174.685	174.870	175.056
118.6	175.242	175.427	175.613	175.799	175.985	176.172	176.358	176.545	176.731	176.918
118.7	177.105	177.292	177.479	177.666	177.854	178.041	178.229	178.416	178.604	178.792
118.8	178.980	179.169	179.357	179.546	179.734	179.923	180.112	180.301	180.490	180.679
118.9	180.868	181.058	181.247	181.437	181.627	181.817	182.007	182.197	182.387	182.578
119.0	182.768	182.959	183.150	183.341	183.532	183.723	183.915	184.106	184.298	184.489
119.1	184.681	184.873	185.065	185.258	185.450	185.643	185.835	186.028	186.221	186.414
119.2	186.607	186.800	186.994	187.187	187.381	187.575	187.769	187.963	188.157	188.351
119.3	188.546	188.740	188.935	189.130	189.325	189.520	189.715	189.910	190.106	190.301
119.4	190.497	190.693	190.889	191.085	191.281	191.478	191.674	191.871	192.068	192.265
119.5	192.462	192.659	192.856	193.054	193.251	193.449	193.647	193.845	194.043	194.241
119.6	194.439	194.638	194.836	195.035	195.234	195.433	195.632	195.831	196.031	196.230
119.7	196.430	196.629	196.829	197.029	197.229	197.430	197.630	197.831	198.031	198.232
119.8	198.433	198.634	198.835	199.036	199.238	199.439	199.641	199.843	200.045	200.247
119.9	200.449	200.652	200.854	201.057	201.259	201.462	201.665	201.868	202.072	202.275
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
120.0	202.479	202.682	202.886	203.090	203.294	203.498	203.702	203.907	204.111	204.316
120.1	204.521	204.726	204.931	205.136	205.341	205.547	205.752	205.958	206.164	206.370
120.2	206.576	206.782	206.988	207.195	207.401	207.608	207.815	208.022	208.229	208.436
120.3	208.644	208.851	209.059	209.267	209.475	209.683	209.891	210.099	210.308	210.516
120.4	210.725	210.934	211.142	211.352	211.561	211.770	211.980	212.189	212.399	212.609
120.5	212.819	213.029	213.239	213.449	213.660	213.870	214.081	214.292	214.503	214.714
120.6	214.925	215.137	215.348	215.560	215.772	215.984	216.196	216.408	216.620	216.833
120.7	217.045	217.258	217.471	217.684	217.897	218.110	218.323	218.537	218.750	218.964
120.8	219.178	219.392	219.606	219.820	220.035	220.249	220.464	220.678	220.893	221.108
120.9	221.323	221.539	221.754	221.970	222.185	222.401	222.617	222.833	223.049	223.266
121.0	223.482	223.699	223.915	224.132	224.349	224.566	224.783	225.001	225.218	225.436
121.1	225.653	225.871	226.089	226.307	226.526	226.744	226.962	227.181	227.400	227.619
121.2	227.838	228.057	228.276	228.495	228.715	228.935	229.154	229.374	229.594	229.814
121.3	230.035	230.255	230.476	230.696	230.917	231.138	231.359	231.580	231.802	232.023
121.4	232.245	232.466	232.688	232.910	233.132	233.354	233.577	233.799	234.022	234.244
121.5	234.467	234.690	234.913	235.137	235.360	235.583	235.807	236.031	236.255	236.479
121.6	236.703	236.927	237.151	237.376	237.601	237.825	238.050	238.275	238.500	238.726
121.7	238.951	239.177	239.402	239.628	239.854	240.080	240.306	240.533	240.759	240.986
121.8	241.212	241.439	241.666	241.893	242.120	242.348	242.575	242.803	243.030	243.258
121.9	243.486	243.714	243.943	244.171	244.399	244.628	244.857	245.086	245.315	245.544
122.0	245.773	246.002	246.232	246.462	246.691	246.921	247.151	247.382	247.612	247.842
122.1	248.073	248.304	248.535	248.766	248.997	249.228	249.460	249.691	249.923	250.155
122.2	250.387	250.619	250.851	251.083	251.316	251.549	251.781	252.014	252.247	252.481
122.3	252.714	252.948	253.181	253.415	253.649	253.883	254.117	254.351	254.586	254.820
122.4	255.055	255.290	255.525	255.760	255.995	256.231	256.466	256.702	256.938	257.174
122.5	257.410	257.646	257.882	258.119	258.355	258.592	258.829	259.066	259.303	259.541
122.6	259.778	260.016	260.253	260.491	260.729	260.967	261.206	261.444	261.683	261.921
122.7	262.160	262.399	262.638	262.877	263.117	263.356	263.596	263.836	264.076	264.316
122.8	264.556	264.796	265.036	265.277	265.518	265.759	266.000	266.241	266.482	266.723
122.9	266.965	267.207	267.449	267.690	267.933	268.175	268.417	268.660	268.902	269.145
123.0	269.388	269.631	269.874	270.118	270.361	270.605	270.848	271.092	271.336	271.581
123.1	271.825	272.069	272.314	272.559	272.803	273.048	273.294	273.539	273.784	274.030
123.2	274.276	274.522	274.768	275.014	275.260	275.506	275.753	276.000	276.246	276.493
123.3	276.741	276.988	277.235	277.483	277.730	277.978	278.226	278.474	278.723	278.971
123.4	279.220	279.468	279.717	279.966	280.215	280.464	280.714	280.963	281.213	281.463
123.5	281.712	281.963	282.213	282.463	282.714	282.964	283.215	283.466	283.717	283.968
123.6	284.220	284.471	284.723	284.974	285.226	285.478	285.730	285.983	286.235	286.488
123.7	286.741	286.993	287.246	287.500	287.753	288.006	288.260	288.514	288.768	289.022
123.8	289.276	289.530	289.784	290.039	290.294	290.548	290.803	291.059	291.314	291.569
123.9	291.825	292.081	292.336	292.592	292.848	293.105	293.361	293.618	293.874	294.131
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
124.0	294.388	294.645	294.902	295.160	295.417	295.675	295.933	296.190	296.448	296.707
124.1	296.965	297.223	297.482	297.741	297.999	298.258	298.518	298.777	299.036	299.296
124.2	299.555	299.815	300.075	300.335	300.595	300.856	301.116	301.377	301.637	301.898
124.3	302.159	302.420	302.682	302.943	303.204	303.466	303.728	303.990	304.252	304.514
124.4	304.776	305.039	305.302	305.564	305.827	306.090	306.353	306.617	306.880	307.144
124.5	307.407	307.671	307.935	308.199	308.463	308.728	308.992	309.257	309.522	309.786
124.6	310.051	310.317	310.582	310.847	311.113	311.379	311.644	311.910	312.177	312.443
124.7	312.709	312.976	313.242	313.509	313.776	314.043	314.310	314.578	314.845	315.113
124.8	315.380	315.648	315.916	316.184	316.453	316.721	316.989	317.258	317.527	317.796
124.9	318.065	318.334	318.603	318.873	319.143	319.412	319.682	319.952	320.222	320.493
125.0	320.763	321.034	321.304	321.575	321.846	322.117	322.388	322.660	322.931	323.203
125.1	323.475	323.747	324.019	324.291	324.564	324.836	325.109	325.382	325.655	325.928
125.2	326.201	326.475	326.748	327.022	327.296	327.570	327.844	328.118	328.393	328.667
125.3	328.942	329.217	329.492	329.767	330.043	330.318	330.594	330.869	331.145	331.421
125.4	331.697	331.974	332.250	332.527	332.803	333.080	333.357	333.635	333.912	334.189
125.5	334.467	334.745	335.023	335.301	335.579	335.857	336.136	336.414	336.693	336.972
125.6	337.251	337.530	337.810	338.089	338.369	338.648	338.928	339.208	339.489	339.769
125.7	340.049	340.330	340.611	340.892	341.173	341.454	341.735	342.017	342.298	342.580
125.8	342.862	343.144	343.426	343.709	343.991	344.274	344.557	344.840	345.123	345.406
125.9	345.689	345.973	346.257	346.540	346.824	347.108	347.393	347.677	347.961	348.246
126.0	348.531	348.816	349.101	349.386	349.672	349.957	350.243	350.529	350.815	351.101
126.1	351.387	351.674	351.961	352.247	352.534	352.821	353.109	353.396	353.684	353.971
126.2	354.259	354.547	354.835	355.124	355.412	355.701	355.990	356.278	356.568	356.857
126.3	357.146	357.436	357.725	358.015	358.305	358.595	358.886	359.176	359.467	359.757
126.4	360.048	360.339	360.631	360.922	361.214	361.505	361.797	362.089	362.381	362.673
126.5	362.966	363.258	363.551	363.844	364.137	364.430	364.724	365.017	365.311	365.605
126.6	365.899	366.193	366.487	366.781	367.076	367.371	367.666	367.961	368.256	368.551
126.7	368.847	369.142	369.438	369.734	370.030	370.326	370.623	370.919	371.216	371.513
126.8	371.810	372.107	372.405	372.702	373.000	373.297	373.595	373.893	374.192	374.490
126.9	374.789	375.087	375.386	375.685	375.984	376.284	376.583	376.883	377.182	377.482
127.0	377.783	378.083	378.383	378.684	378.984	379.285	379.586	379.887	380.188	380.490
127.1	380.791	381.093	381.395	381.697	381.999	382.301	382.603	382.906	383.208	383.511
127.2	383.814	384.117	384.421	384.724	385.027	385.331	385.635	385.939	386.243	386.547
127.3	386.852	387.156	387.461	387.766	388.071	388.376	388.681	388.986	389.292	389.597
127.4	389.903	390.209	390.515	390.822	391.128	391.435	391.741	392.048	392.355	392.662
127.5	392.969	393.277	393.584	393.892	394.200	394.508	394.816	395.124	395.433	395.741
127.6	396.050	396.359	396.668	396.977	397.286	397.595	397.905	398.215	398.524	398.834
127.7	399.145	399.455	399.765	400.076	400.387	400.697	401.008	401.319	401.631	401.942
127.8	402.254	402.565	402.877	403.189	403.501	403.814	404.126	404.439	404.751	405.064
127.9	405.377	405.690	406.004	406.317	406.631	406.944	407.258	407.572	407.886	408.201
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
128.0	408.515	408.830	409.144	409.459	409.774	410.089	410.405	410.720	411.036	411.351
128.1	411.667	411.983	412.299	412.616	412.932	413.249	413.566	413.883	414.200	414.517
128.2	414.834	415.152	415.469	415.787	416.105	416.423	416.741	417.060	417.378	417.697
128.3	418.015	418.334	418.653	418.973	419.292	419.612	419.931	420.251	420.571	420.891
128.4	421.211	421.532	421.852	422.173	422.494	422.815	423.136	423.457	423.779	424.100
128.5	424.422	424.744	425.066	425.388	425.710	426.032	426.355	426.678	427.001	427.324
128.6	427.647	427.970	428.293	428.617	428.941	429.265	429.589	429.913	430.237	430.562
128.7	430.886	431.211	431.536	431.861	432.186	432.511	432.837	433.163	433.488	433.814
128.8	434.140	434.466	434.793	435.119	435.446	435.773	436.100	436.427	436.754	437.081
128.9	437.409	437.737	438.064	438.392	438.720	439.049	439.377	439.706	440.034	440.363
129.0	440.692	441.021	441.350	441.680	442.009	442.339	442.669	442.999	443.329	443.659
129.1	443.990	444.321	444.651	444.982	445.313	445.645	445.976	446.307	446.639	446.971
129.2	447.303	447.635	447.967	448.300	448.632	448.965	449.298	449.631	449.964	450.297
129.3	450.631	450.964	451.298	451.632	451.966	452.300	452.635	452.969	453.304	453.639
129.4	453.974	454.309	454.644	454.980	455.315	455.651	455.987	456.323	456.659	456.995
129.5	457.332	457.668	458.005	458.342	458.679	459.017	459.354	459.691	460.029	460.367
129.6	460.705	461.043	461.381	461.720	462.058	462.397	462.736	463.075	463.414	463.754
129.7	464.093	464.433	464.772	465.112	465.452	465.793	466.133	466.474	466.814	467.155
129.8	467.496	467.837	468.179	468.520	468.862	469.203	469.545	469.887	470.229	470.572
129.9	470.914	471.257	471.600	471.943	472.286	472.629	472.972	473.316	473.660	474.004
130.0	474.348	474.692	475.036	475.380	475.725	476.070	476.415	476.760	477.105	477.450
130.1	477.796	478.142	478.487	478.833	479.180	479.526	479.872	480.219	480.566	480.913
130.2	481.260	481.607	481.954	482.302	482.649	482.997	483.345	483.693	484.042	484.390
130.3	484.739	485.088	485.436	485.786	486.135	486.484	486.834	487.183	487.533	487.883
130.4	488.233	488.584	488.934	489.285	489.635	489.986	490.337	490.689	491.040	491.392
130.5	491.743	492.095	492.447	492.799	493.151	493.504	493.857	494.209	494.562	494.915
130.6	495.269	495.622	495.975	496.329	496.683	497.037	497.391	497.745	498.100	498.454
130.7	498.809	499.164	499.519	499.874	500.230	500.585	500.941	501.297	501.653	502.009
130.8	502.365	502.722	503.078	503.435	503.792	504.149	504.506	504.864	505.221	505.579
130.9	505.937	506.295	506.653	507.011	507.370	507.728	508.087	508.446	508.805	509.164
131.0	509.523	509.883	510.243	510.603	510.963	511.323	511.683	512.043	512.404	512.765
131.1	513.126	513.487	513.848	514.210	514.571	514.933	515.295	515.657	516.019	516.381
131.2	516.744	517.106	517.469	517.832	518.195	518.559	518.922	519.286	519.649	520.013
131.3	520.377	520.741	521.106	521.470	521.835	522.200	522.565	522.930	523.295	523.661
131.4	524.026	524.392	524.758	525.124	525.490	525.857	526.223	526.590	526.957	527.324
131.5	527.691	528.058	528.426	528.794	529.161	529.529	529.897	530.266	530.634	531.003
131.6	531.372	531.740	532.109	532.479	532.848	533.218	533.587	533.957	534.327	534.697
131.7	535.067	535.438	535.808	536.179	536.550	536.921	537.292	537.664	538.035	538.407
131.8	538.779	539.151	539.523	539.896	540.268	540.641	541.013	541.386	541.760	542.133
131.9	542.506	542.880	543.253	543.627	544.001	544.376	544.750	545.125	545.499	545.874
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
132.0	546.249	546.624	546.999	547.375	547.751	548.126	548.502	548.878	549.255	549.631
132.1	550.008	550.385	550.761	551.138	551.516	551.893	552.271	552.648	553.026	553.404
132.2	553.783	554.161	554.540	554.918	555.297	555.676	556.055	556.435	556.814	557.194
132.3	557.574	557.954	558.334	558.714	559.095	559.476	559.856	560.237	560.619	561.000
132.4	561.381	561.763	562.145	562.527	562.909	563.291	563.674	564.056	564.439	564.822
132.5	565.205	565.588	565.972	566.355	566.739	567.123	567.507	567.891	568.276	568.660
132.6	569.045	569.430	569.815	570.200	570.586	570.971	571.357	571.743	572.129	572.515
132.7	572.901	573.288	573.674	574.061	574.448	574.836	575.223	575.610	575.998	576.386
132.8	576.774	577.162	577.550	577.939	578.327	578.716	579.105	579.494	579.883	580.273
132.9	580.662	581.052	581.442	581.832	582.223	582.613	583.004	583.394	583.785	584.176
133.0	584.568	584.959	585.350	585.742	586.134	586.526	586.919	587.311	587.704	588.096
133.1	588.489	588.882	589.276	589.669	590.063	590.457	590.851	591.245	591.639	592.034
133.2	592.429	592.823	593.219	593.614	594.009	594.405	594.800	595.196	595.593	595.989
133.3	596.385	596.782	597.179	597.576	597.973	598.370	598.768	599.165	599.563	599.961
133.4	600.359	600.758	601.156	601.555	601.954	602.353	602.752	603.152	603.551	603.951
133.5	604.351	604.751	605.151	605.552	605.952	606.353	606.754	607.155	607.557	607.958
133.6	608.360	608.762	609.164	609.566	609.968	610.371	610.774	611.177	611.580	611.983
133.7	612.386	612.790	613.194	613.597	614.002	614.406	614.810	615.215	615.620	616.025
133.8	616.430	616.835	617.241	617.647	618.052	618.458	618.865	619.271	619.678	620.084
133.9	620.491	620.898	621.306	621.713	622.121	622.528	622.936	623.345	623.753	624.161
134.0	624.570	624.979	625.388	625.797	626.206	626.616	627.026	627.436	627.846	628.256
134.1	628.667	629.077	629.488	629.899	630.310	630.722	631.133	631.545	631.957	632.369
134.2	632.781	633.194	633.606	634.019	634.432	634.845	635.259	635.672	636.086	636.500
134.3	636.914	637.328	637.743	638.157	638.572	638.987	639.402	639.818	640.233	640.649
134.4	641.065	641.481	641.897	642.314	642.731	643.147	643.564	643.982	644.399	644.817
134.5	645.234	645.652	646.070	646.489	646.907	647.326	647.745	648.164	648.583	649.002
134.6	649.422	649.841	650.261	650.681	651.102	651.522	651.943	652.364	652.785	653.206
134.7	653.627	654.049	654.471	654.892	655.315	655.737	656.159	656.582	657.005	657.428
134.8	657.851	658.274	658.698	659.122	659.545	659.970	660.394	660.818	661.243	661.668
134.9	662.093	662.518	662.943	663.369	663.795	664.221	664.647	665.073	665.500	665.926
135.0	666.353	666.780	667.207	667.635	668.062	668.490	668.918	669.346	669.774	670.203
135.1	670.631	671.060	671.489	671.919	672.348	672.778	673.207	673.637	674.067	674.498
135.2	674.928	675.359	675.790	676.221	676.652	677.083	677.515	677.947	678.379	678.811
135.3	679.243	679.676	680.109	680.542	680.975	681.408	681.841	682.275	682.709	683.143
135.4	683.577	684.011	684.446	684.881	685.316	685.751	686.186	686.621	687.057	687.493
135.5	687.929	688.365	688.802	689.238	689.675	690.112	690.549	690.986	691.424	691.862
135.6	692.299	692.737	693.176	693.614	694.053	694.492	694.930	695.370	695.809	696.248
135.7	696.688	697.128	697.568	698.008	698.449	698.890	699.330	699.771	700.213	700.654
135.8	701.095	701.537	701.979	702.421	702.863	703.306	703.748	704.191	704.634	705.078
135.9	705.521	705.965	706.408	706.852	707.296	707.741	708.185	708.630	709.075	709.520
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
136.0	709.965	710.410	710.856	711.302	711.748	712.194	712.640	713.087	713.534	713.981
136.1	714.428	714.875	715.323	715.770	716.218	716.666	717.115	717.563	718.012	718.461
136.2	718.910	719.359	719.808	720.258	720.708	721.158	721.608	722.058	722.509	722.960
136.3	723.411	723.862	724.313	724.765	725.217	725.669	726.121	726.573	727.025	727.478
136.4	727.931	728.384	728.837	729.291	729.744	730.198	730.652	731.107	731.561	732.016
136.5	732.470	732.925	733.381	733.836	734.292	734.747	735.203	735.659	736.116	736.572
136.6	737.029	737.486	737.943	738.400	738.858	739.315	739.773	740.231	740.690	741.148
136.7	741.607	742.065	742.524	742.984	743.443	743.903	744.362	744.822	745.282	745.743
136.8	746.203	746.664	747.125	747.586	748.047	748.509	748.971	749.433	749.895	750.357
136.9	750.819	751.282	751.745	752.208	752.671	753.135	753.598	754.062	754.526	754.990
137.0	755.455	755.919	756.384	756.849	757.314	757.779	758.245	758.711	759.177	759.643
137.1	760.109	760.576	761.042	761.509	761.976	762.443	762.911	763.379	763.847	764.315
137.2	764.783	765.251	765.720	766.189	766.658	767.127	767.597	768.066	768.536	769.006
137.3	769.476	769.947	770.417	770.888	771.359	771.830	772.302	772.773	773.245	773.717
137.4	774.189	774.662	775.134	775.607	776.080	776.553	777.026	777.500	777.974	778.448
137.5	778.922	779.396	779.871	780.345	780.820	781.295	781.771	782.246	782.722	783.198
137.6	783.674	784.150	784.627	785.103	785.580	786.057	786.534	787.012	787.490	787.967
137.7	788.445	788.924	789.402	789.881	790.359	790.838	791.318	791.797	792.277	792.756
137.8	793.236	793.717	794.197	794.677	795.158	795.639	796.120	796.602	797.083	797.565
137.9	798.047	798.529	799.011	799.494	799.977	800.459	800.943	801.426	801.909	802.393
138.0	802.877	803.361	803.845	804.330	804.815	805.299	805.784	806.270	806.755	807.241
138.1	807.727	808.213	808.699	809.185	809.672	810.159	810.646	811.133	811.620	812.108
138.2	812.596	813.084	813.572	814.060	814.549	815.037	815.526	816.016	816.505	816.994
138.3	817.484	817.974	818.464	818.955	819.445	819.936	820.427	820.918	821.409	821.901
138.4	822.392	822.884	823.376	823.868	824.361	824.854	825.346	825.839	826.333	826.826
138.5	827.320	827.814	828.308	828.802	829.296	829.791	830.286	830.781	831.276	831.771
138.6	832.267	832.763	833.259	833.755	834.251	834.748	835.244	835.741	836.238	836.736
138.7	837.233	837.731	838.229	838.727	839.225	839.724	840.223	840.721	841.221	841.720
138.8	842.219	842.719	843.219	843.719	844.219	844.720	845.220	845.721	846.222	846.724
138.9	847.225	847.727	848.228	848.730	849.233	849.735	850.238	850.740	851.243	851.747
139.0	852.250	852.754	853.257	853.761	854.266	854.770	855.275	855.779	856.284	856.790
139.1	857.295	857.801	858.307	858.813	859.319	859.825	860.332	860.839	861.346	861.853
139.2	862.361	862.868	863.376	863.884	864.393	864.901	865.410	865.919	866.428	866.937
139.3	867.446	867.956	868.466	868.976	869.487	869.997	870.508	871.019	871.530	872.041
139.4	872.553	873.065	873.577	874.089	874.601	875.114	875.627	876.140	876.653	877.166
139.5	877.680	878.194	878.708	879.222	879.736	880.251	880.766	881.281	881.796	882.312
139.6	882.827	883.343	883.859	884.375	884.892	885.409	885.925	886.443	886.960	887.477
139.7	887.995	888.513	889.031	889.549	890.068	890.587	891.106	891.625	892.144	892.664
139.8	893.183	893.703	894.224	894.744	895.265	895.785	896.306	896.827	897.349	897.870
139.9	898.392	898.914	899.436	899.959	900.481	901.004	901.527	902.051	902.574	903.098
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
140.0	903.622	904.146	904.670	905.194	905.719	906.244	906.769	907.294	907.820	908.345
140.1	908.871	909.398	909.924	910.450	910.977	911.504	912.031	912.559	913.086	913.614
140.2	914.142	914.670	915.199	915.727	916.256	916.785	917.314	917.844	918.373	918.903
140.3	919.433	919.964	920.494	921.025	921.556	922.087	922.618	923.150	923.681	924.213
140.4	924.745	925.278	925.810	926.343	926.876	927.409	927.943	928.476	929.010	929.544
140.5	930.078	930.613	931.147	931.682	932.217	932.752	933.288	933.823	934.359	934.895
140.6	935.432	935.968	936.505	937.042	937.579	938.116	938.654	939.191	939.729	940.268
140.7	940.806	941.344	941.883	942.422	942.961	943.501	944.040	944.580	945.120	945.660
140.8	946.201	946.742	947.282	947.823	948.365	948.906	949.448	949.990	950.532	951.074
140.9	951.617	952.159	952.702	953.245	953.789	954.332	954.876	955.420	955.964	956.508
141.0	957.053	957.598	958.143	958.688	959.233	959.779	960.325	960.871	961.417	961.963
141.1	962.510	963.057	963.604	964.151	964.699	965.246	965.794	966.342	966.891	967.439
141.2	967.988	968.537	969.086	969.635	970.185	970.734	971.284	971.834	972.385	972.935
141.3	973.486	974.037	974.588	975.139	975.691	976.243	976.795	977.347	977.899	978.452
141.4	979.005	979.558	980.111	980.664	981.218	981.772	982.326	982.880	983.435	983.989
141.5	984.544	985.099	985.654	986.210	986.766	987.321	987.878	988.434	988.990	989.547
141.6	990.104	990.661	991.219	991.776	992.334	992.892	993.450	994.008	994.567	995.126
141.7	995.685	996.244	996.803	997.363	997.922	998.482	999.043	999.603	1000.164	1000.725
141.8	1001.286	1001.847	1002.408	1002.970	1003.532	1004.094	1004.656	1005.219	1005.781	1006.344
141.9	1006.907	1007.471	1008.034	1008.598	1009.162	1009.726	1010.290	1010.855	1011.419	1011.984
142.0	1012.549	1013.115	1013.680	1014.246	1014.812	1015.378	1015.945	1016.511	1017.078	1017.645
142.1	1018.212	1018.780	1019.348	1019.915	1020.484	1021.052	1021.620	1022.189	1022.758	1023.327
142.2	1023.896	1024.466	1025.036	1025.606	1026.176	1026.746	1027.317	1027.888	1028.459	1029.030
142.3	1029.601	1030.173	1030.745	1031.317	1031.889	1032.461	1033.034	1033.607	1034.180	1034.753
142.4	1035.327	1035.901	1036.475	1037.049	1037.623	1038.198	1038.772	1039.347	1039.923	1040.498
142.5	1041.074	1041.649	1042.225	1042.802	1043.378	1043.955	1044.532	1045.109	1045.686	1046.264
142.6	1046.841	1047.419	1047.997	1048.576	1049.154	1049.733	1050.312	1050.891	1051.470	1052.050
142.7	1052.630	1053.210	1053.790	1054.370	1054.951	1055.532	1056.113	1056.694	1057.276	1057.857
142.8	1058.439	1059.021	1059.604	1060.186	1060.769	1061.352	1061.935	1062.518	1063.102	1063.686
142.9	1064.270	1064.854	1065.438	1066.023	1066.608	1067.193	1067.778	1068.363	1068.949	1069.535
143.0	1070.121	1070.707	1071.294	1071.880	1072.467	1073.054	1073.642	1074.229	1074.817	1075.405
143.1	1075.993	1076.581	1077.170	1077.758	1078.347	1078.936	1079.525	1080.115	1080.704	1081.294
143.2	1081.885	1082.475	1083.065	1083.656	1084.247	1084.838	1085.429	1086.021	1086.612	1087.204
143.3	1087.796	1088.388	1088.981	1089.573	1090.166	1090.759	1091.353	1091.946	1092.540	1093.134
143.4	1093.728	1094.322	1094.916	1095.511	1096.106	1096.701	1097.296	1097.892	1098.487	1099.083
143.5	1099.679	1100.276	1100.872	1101.469	1102.065	1102.662	1103.260	1103.857	1104.455	1105.053
143.6	1105.651	1106.249	1106.847	1107.446	1108.045	1108.644	1109.243	1109.843	1110.442	1111.042
143.7	1111.642	1112.242	1112.843	1113.443	1114.044	1114.645	1115.246	1115.848	1116.450	1117.051
143.8	1117.653	1118.256	1118.858	1119.461	1120.064	1120.667	1121.270	1121.873	1122.477	1123.081
143.9	1123.685	1124.289	1124.893	1125.498	1126.103	1126.708	1127.313	1127.918	1128.524	1129.130
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET										
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
144.0	1129.736	1130.342	1130.949	1131.555	1132.162	1132.769	1133.376	1133.984	1134.592	1135.199
144.1	1135.808	1136.416	1137.025	1137.633	1138.242	1138.851	1139.461	1140.070	1140.680	1141.290
144.2	1141.900	1142.511	1143.121	1143.732	1144.343	1144.954	1145.566	1146.177	1146.789	1147.401
144.3	1148.014	1148.626	1149.239	1149.852	1150.465	1151.078	1151.692	1152.306	1152.920	1153.534
144.4	1154.148	1154.763	1155.377	1155.993	1156.608	1157.223	1157.839	1158.455	1159.071	1159.687
144.5	1160.303	1160.920	1161.537	1162.154	1162.771	1163.389	1164.007	1164.625	1165.243	1165.861
144.6	1166.479	1167.098	1167.717	1168.337	1168.956	1169.575	1170.195	1170.815	1171.436	1172.056
144.7	1172.677	1173.297	1173.919	1174.540	1175.161	1175.783	1176.405	1177.027	1177.649	1178.272
144.8	1178.895	1179.518	1180.141	1180.764	1181.388	1182.011	1182.635	1183.260	1183.884	1184.509
144.9	1185.134	1185.759	1186.384	1187.009	1187.635	1188.261	1188.887	1189.513	1190.140	1190.766
145.0	1191.394	1192.021	1192.648	1193.276	1193.903	1194.531	1195.160	1195.788	1196.417	1197.046
145.1	1197.675	1198.304	1198.933	1199.563	1200.193	1200.823	1201.454	1202.084	1202.715	1203.346
145.2	1203.978	1204.609	1205.241	1205.873	1206.505	1207.137	1207.770	1208.403	1209.036	1209.669
145.3	1210.302	1210.936	1211.570	1212.204	1212.838	1213.473	1214.108	1214.743	1215.378	1216.013
145.4	1216.649	1217.285	1217.921	1218.557	1219.194	1219.830	1220.467	1221.104	1221.742	1222.379
145.5	1223.017	1223.655	1224.293	1224.932	1225.571	1226.209	1226.849	1227.488	1228.127	1228.767
145.6	1229.407	1230.047	1230.688	1231.329	1231.969	1232.610	1233.252	1233.893	1234.535	1235.177
145.7	1235.819	1236.462	1237.104	1237.747	1238.390	1239.033	1239.677	1240.321	1240.964	1241.609
145.8	1242.253	1242.897	1243.542	1244.187	1244.832	1245.478	1246.124	1246.769	1247.415	1248.062
145.9	1248.708	1249.355	1250.002	1250.649	1251.297	1251.944	1252.592	1253.240	1253.888	1254.537
146.0	1255.186	1255.834	1256.484	1257.133	1257.782	1258.432	1259.082	1259.733	1260.383	1261.034
146.1	1261.685	1262.336	1262.987	1263.639	1264.291	1264.943	1265.595	1266.247	1266.900	1267.553
146.2	1268.206	1268.859	1269.513	1270.167	1270.821	1271.475	1272.130	1272.784	1273.439	1274.094
146.3	1274.750	1275.405	1276.061	1276.717	1277.374	1278.030	1278.687	1279.344	1280.001	1280.658
146.4	1281.316	1281.974	1282.631	1283.290	1283.948	1284.607	1285.266	1285.925	1286.584	1287.244
146.5	1287.904	1288.564	1289.224	1289.885	1290.545	1291.206	1291.867	1292.529	1293.190	1293.852
146.6	1294.514	1295.176	1295.839	1296.501	1297.164	1297.828	1298.491	1299.155	1299.818	1300.482
146.7	1301.147	1301.811	1302.476	1303.141	1303.806	1304.471	1305.137	1305.802	1306.469	1307.135
146.8	1307.801	1308.468	1309.135	1309.802	1310.469	1311.137	1311.805	1312.473	1313.141	1313.810
146.9	1314.478	1315.147	1315.816	1316.486	1317.155	1317.825	1318.495	1319.165	1319.836	1320.506
147.0	1321.177	1321.849	1322.520	1323.192	1323.864	1324.536	1325.208	1325.880	1326.553	1327.226
147.1	1327.899	1328.573	1329.246	1329.920	1330.594	1331.269	1331.943	1332.618	1333.293	1333.968
147.2	1334.644	1335.319	1335.995	1336.672	1337.348	1338.025	1338.702	1339.379	1340.056	1340.734
147.3	1341.411	1342.089	1342.767	1343.446	1344.125	1344.803	1345.483	1346.162	1346.842	1347.521
147.4	1348.202	1348.882	1349.562	1350.243	1350.924	1351.605	1352.287	1352.968	1353.650	1354.332
147.5	1355.015	1355.697	1356.380	1357.063	1357.746	1358.430	1359.114	1359.797	1360.482	1361.166
147.6	1361.851	1362.536	1363.221	1363.906	1364.592	1365.277	1365.963	1366.650	1367.336	1368.023
147.7	1368.710	1369.397	1370.084	1370.772	1371.460	1372.148	1372.836	1373.525	1374.213	1374.902
147.8	1375.591	1376.281	1376.970	1377.660	1378.350	1379.041	1379.731	1380.422	1381.113	1381.804
147.9	1382.496	1383.188	1383.880	1384.572	1385.264	1385.957	1386.650	1387.343	1388.036	1388.730
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
148.0	1389.423	1390.118	1390.812	1391.506	1392.201	1392.896	1393.591	1394.286	1394.982	1395.678
148.1	1396.374	1397.071	1397.767	1398.464	1399.161	1399.858	1400.556	1401.254	1401.952	1402.650
148.2	1403.348	1404.047	1404.746	1405.445	1406.145	1406.844	1407.544	1408.244	1408.944	1409.645
148.3	1410.346	1411.047	1411.748	1412.450	1413.152	1413.854	1414.556	1415.258	1415.961	1416.664
148.4	1417.367	1418.071	1418.774	1419.478	1420.182	1420.886	1421.591	1422.296	1423.001	1423.706
148.5	1424.412	1425.118	1425.823	1426.530	1427.236	1427.943	1428.650	1429.357	1430.064	1430.772
148.6	1431.480	1432.188	1432.896	1433.605	1434.314	1435.023	1435.732	1436.442	1437.151	1437.861
148.7	1438.572	1439.282	1439.993	1440.704	1441.415	1442.126	1442.838	1443.550	1444.262	1444.974
148.8	1445.687	1446.400	1447.113	1447.826	1448.539	1449.253	1449.967	1450.681	1451.396	1452.110
148.9	1452.825	1453.541	1454.256	1454.972	1455.687	1456.403	1457.120	1457.836	1458.553	1459.270
149.0	1459.988	1460.705	1461.423	1462.141	1462.859	1463.577	1464.296	1465.015	1465.734	1466.453
149.1	1467.173	1467.892	1468.613	1469.333	1470.053	1470.774	1471.495	1472.216	1472.937	1473.659
149.2	1474.381	1475.103	1475.825	1476.547	1477.270	1477.993	1478.716	1479.440	1480.163	1480.887
149.3	1481.611	1482.336	1483.060	1483.785	1484.510	1485.235	1485.961	1486.686	1487.412	1488.138
149.4	1488.865	1489.591	1490.318	1491.045	1491.772	1492.500	1493.228	1493.955	1494.684	1495.412
149.5	1496.141	1496.870	1497.599	1498.328	1499.057	1499.787	1500.517	1501.247	1501.978	1502.708
149.6	1503.439	1504.170	1504.902	1505.633	1506.365	1507.097	1507.829	1508.562	1509.295	1510.027
149.7	1510.761	1511.494	1512.228	1512.962	1513.696	1514.430	1515.164	1515.899	1516.634	1517.369
149.8	1518.105	1518.840	1519.576	1520.312	1521.049	1521.785	1522.522	1523.259	1523.996	1524.734
149.9	1525.472	1526.209	1526.948	1527.686	1528.425	1529.163	1529.902	1530.642	1531.381	1532.121
150.0	1532.861	1533.601	1534.342	1535.082	1535.823	1536.564	1537.306	1538.047	1538.789	1539.531
150.1	1540.273	1541.016	1541.758	1542.501	1543.244	1543.988	1544.731	1545.475	1546.219	1546.964
150.2	1547.708	1548.453	1549.198	1549.943	1550.688	1551.434	1552.180	1552.926	1553.672	1554.419
150.3	1555.166	1555.913	1556.660	1557.407	1558.155	1558.903	1559.651	1560.400	1561.148	1561.897
150.4	1562.646	1563.396	1564.145	1564.895	1565.645	1566.395	1567.145	1567.896	1568.647	1569.398
150.5	1570.149	1570.901	1571.653	1572.405	1573.157	1573.910	1574.662	1575.415	1576.168	1576.922
150.6	1577.675	1578.429	1579.183	1579.938	1580.692	1581.447	1582.202	1582.957	1583.712	1584.468
150.7	1585.224	1585.980	1586.736	1587.493	1588.250	1589.007	1589.764	1590.521	1591.279	1592.037
150.8	1592.795	1593.554	1594.312	1595.071	1595.830	1596.590	1597.349	1598.109	1598.869	1599.629
150.9	1600.390	1601.150	1601.911	1602.672	1603.434	1604.195	1604.957	1605.719	1606.481	1607.244
151.0	1608.006	1608.770	1609.533	1610.296	1611.060	1611.823	1612.588	1613.352	1614.116	1614.881
151.1	1615.646	1616.411	1617.177	1617.942	1618.708	1619.474	1620.240	1621.007	1621.774	1622.541
151.2	1623.308	1624.075	1624.843	1625.611	1626.379	1627.147	1627.916	1628.685	1629.454	1630.223
151.3	1630.992	1631.762	1632.532	1633.302	1634.072	1634.843	1635.614	1636.385	1637.156	1637.927
151.4	1638.699	1639.471	1640.243	1641.016	1641.788	1642.561	1643.334	1644.107	1644.881	1645.654
151.5	1646.428	1647.203	1647.977	1648.751	1649.526	1650.301	1651.077	1651.852	1652.628	1653.404
151.6	1654.180	1654.956	1655.733	1656.510	1657.287	1658.064	1658.842	1659.620	1660.397	1661.176
151.7	1661.954	1662.733	1663.512	1664.291	1665.070	1665.849	1666.629	1667.409	1668.189	1668.970
151.8	1669.751	1670.531	1671.313	1672.094	1672.875	1673.657	1674.439	1675.222	1676.004	1676.787
151.9	1677.570	1678.353	1679.136	1679.920	1680.703	1681.488	1682.272	1683.056	1683.841	1684.626
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
152.0	1685.411	1686.196	1686.982	1687.768	1688.554	1689.340	1690.126	1690.913	1691.700	1692.487
152.1	1693.275	1694.062	1694.850	1695.638	1696.426	1697.214	1698.003	1698.792	1699.581	1700.370
152.2	1701.160	1701.949	1702.739	1703.529	1704.320	1705.110	1705.901	1706.692	1707.483	1708.275
152.3	1709.067	1709.858	1710.651	1711.443	1712.235	1713.028	1713.821	1714.614	1715.408	1716.201
152.4	1716.995	1717.789	1718.583	1719.378	1720.173	1720.968	1721.763	1722.558	1723.354	1724.150
152.5	1724.946	1725.742	1726.538	1727.335	1728.132	1728.929	1729.726	1730.524	1731.321	1732.119
152.6	1732.917	1733.716	1734.515	1735.313	1736.113	1736.912	1737.711	1738.511	1739.311	1740.111
152.7	1740.911	1741.712	1742.513	1743.314	1744.115	1744.916	1745.718	1746.520	1747.322	1748.124
152.8	1748.927	1749.729	1750.532	1751.336	1752.139	1752.943	1753.746	1754.551	1755.355	1756.159
152.9	1756.964	1757.769	1758.574	1759.379	1760.185	1760.991	1761.797	1762.603	1763.409	1764.216
153.0	1765.023	1765.830	1766.637	1767.445	1768.253	1769.061	1769.869	1770.677	1771.486	1772.295
153.1	1773.104	1773.913	1774.722	1775.532	1776.342	1777.152	1777.963	1778.773	1779.584	1780.395
153.2	1781.206	1782.017	1782.829	1783.641	1784.453	1785.265	1786.078	1786.891	1787.704	1788.517
153.3	1789.330	1790.144	1790.958	1791.772	1792.586	1793.400	1794.215	1795.030	1795.845	1796.660
153.4	1797.476	1798.292	1799.108	1799.924	1800.740	1801.557	1802.374	1803.191	1804.008	1804.826
153.5	1805.644	1806.461	1807.280	1808.098	1808.917	1809.735	1810.554	1811.374	1812.193	1813.013
153.6	1813.833	1814.653	1815.473	1816.294	1817.115	1817.936	1818.757	1819.578	1820.400	1821.222
153.7	1822.044	1822.866	1823.688	1824.511	1825.334	1826.157	1826.981	1827.804	1828.628	1829.452
153.8	1830.276	1831.101	1831.926	1832.750	1833.575	1834.401	1835.226	1836.052	1836.878	1837.704
153.9	1838.531	1839.358	1840.184	1841.011	1841.839	1842.666	1843.494	1844.322	1845.150	1845.978
154.1	1855.106	1855.937	1856.769	1857.600	1858.432	1859.265	1860.097	1860.930	1861.763	1862.596
154.2	1863.429	1864.263	1865.097	1865.931	1866.765	1867.600	1868.435	1869.270	1870.105	1870.941
154.3	1871.776	1872.613	1873.449	1874.285	1875.122	1875.959	1876.796	1877.634	1878.472	1879.309
154.4	1880.148	1880.986	1881.825	1882.664	1883.503	1884.342	1885.182	1886.022	1886.862	1887.703
154.5	1888.543	1889.384	1890.225	1891.066	1891.908	1892.750	1893.592	1894.434	1895.277	1896.120
154.6	1896.963	1897.806	1898.649	1899.493	1900.337	1901.181	1902.026	1902.871	1903.715	1904.561
154.7	1905.406	1906.252	1907.098	1907.944	1908.790	1909.637	1910.484	1911.331	1912.178	1913.026
154.8	1913.874	1914.722	1915.570	1916.419	1917.268	1918.117	1918.966	1919.816	1920.665	1921.515
154.9	1922.366	1923.216	1924.067	1924.918	1925.769	1926.620	1927.472	1928.324	1929.176	1930.029
155.0	1930.881	1931.734	1932.588	1933.441	1934.295	1935.149	1936.003	1936.858	1937.712	1938.567
155.1	1939.423	1940.278	1941.134	1941.990	1942.847	1943.703	1944.560	1945.417	1946.275	1947.132
155.2	1947.990	1948.848	1949.707	1950.566	1951.425	1952.284	1953.143	1954.003	1954.863	1955.724
155.3	1956.584	1957.445	1958.306	1959.167	1960.029	1960.891	1961.753	1962.616	1963.478	1964.341
155.4	1965.205	1966.068	1966.932	1967.796	1968.660	1969.525	1970.390	1971.255	1972.120	1972.986
155.5	1973.851	1974.718	1975.584	1976.451	1977.318	1978.185	1979.052	1979.920	1980.788	1981.656
155.6	1982.525	1983.394	1984.263	1985.132	1986.001	1986.871	1987.741	1988.612	1989.483	1990.353
155.7	1991.224	1992.096	1992.968	1993.840	1994.712	1995.584	1996.457	1997.330	1998.203	1999.077
155.8	1999.951	2000.825	2001.699	2002.574	2003.449	2004.324	2005.199	2006.075	2006.951	2007.827
155.9	2008.703	2009.580	2010.457	2011.334	2012.212	2013.090	2013.968	2014.846	2015.724	2016.603
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
156.0	2017.483	2018.362	2019.242	2020.123	2021.004	2021.885	2022.767	2023.650	2024.533	2025.416
156.1	2026.300	2027.185	2028.070	2028.955	2029.842	2030.728	2031.615	2032.503	2033.391	2034.280
156.2	2035.169	2036.059	2036.949	2037.839	2038.731	2039.622	2040.515	2041.407	2042.301	2043.194
156.3	2044.089	2044.983	2045.879	2046.774	2047.671	2048.567	2049.465	2050.363	2051.261	2052.160
156.4	2053.059	2053.959	2054.859	2055.760	2056.662	2057.563	2058.466	2059.369	2060.272	2061.176
156.5	2062.081	2062.985	2063.891	2064.797	2065.703	2066.610	2067.518	2068.426	2069.334	2070.243
156.6	2071.153	2072.063	2072.973	2073.885	2074.796	2075.708	2076.621	2077.534	2078.447	2079.362
156.7	2080.276	2081.191	2082.107	2083.023	2083.940	2084.857	2085.774	2086.693	2087.611	2088.531
156.8	2089.450	2090.371	2091.291	2092.212	2093.134	2094.056	2094.979	2095.903	2096.826	2097.750
156.9	2098.676	2099.601	2100.527	2101.453	2102.380	2103.307	2104.235	2105.163	2106.092	2107.021
157.0	2107.951	2108.882	2109.812	2110.743	2111.675	2112.606	2113.539	2114.471	2115.404	2116.337
157.1	2117.270	2118.204	2119.138	2120.073	2121.007	2121.942	2122.878	2123.814	2124.750	2125.686
157.2	2126.623	2127.560	2128.498	2129.436	2130.374	2131.312	2132.251	2133.190	2134.130	2135.070
157.3	2136.010	2136.951	2137.892	2138.833	2139.775	2140.717	2141.659	2142.602	2143.545	2144.488
157.4	2145.432	2146.376	2147.321	2148.265	2149.210	2150.156	2151.102	2152.048	2152.994	2153.941
157.5	2154.888	2155.835	2156.783	2157.731	2158.680	2159.629	2160.578	2161.528	2162.477	2163.427
157.6	2164.378	2165.329	2166.280	2167.232	2168.184	2169.136	2170.089	2171.042	2171.995	2172.948
157.7	2173.903	2174.857	2175.812	2176.767	2177.722	2178.678	2179.634	2180.590	2181.547	2182.504
157.8	2183.461	2184.419	2185.377	2186.336	2187.294	2188.254	2189.213	2190.173	2191.133	2192.094
157.9	2193.054	2194.016	2194.977	2195.939	2196.901	2197.864	2198.827	2199.790	2200.754	2201.718
158.0	2202.682	2203.646	2204.612	2205.577	2206.542	2207.508	2208.474	2209.440	2210.407	2211.374
158.1	2212.341	2213.309	2214.277	2215.245	2216.213	2217.182	2218.151	2219.121	2220.090	2221.060
158.2	2222.030	2223.001	2223.972	2224.943	2225.914	2226.886	2227.858	2228.830	2229.803	2230.775
158.3	2231.749	2232.722	2233.696	2234.670	2235.645	2236.619	2237.594	2238.569	2239.545	2240.521
158.4	2241.497	2242.473	2243.450	2244.427	2245.404	2246.382	2247.360	2248.338	2249.316	2250.295
158.5	2251.274	2252.254	2253.233	2254.213	2255.194	2256.174	2257.155	2258.136	2259.118	2260.100
158.6	2261.082	2262.064	2263.046	2264.029	2265.012	2265.996	2266.980	2267.964	2268.948	2269.933
158.7	2270.918	2271.904	2272.889	2273.875	2274.861	2275.847	2276.834	2277.822	2278.809	2279.796
158.8	2280.784	2281.772	2282.761	2283.750	2284.739	2285.729	2286.718	2287.708	2288.698	2289.689
158.9	2290.680	2291.671	2292.663	2293.655	2294.647	2295.639	2296.632	2297.625	2298.618	2299.612
159.0	2300.605	2301.600	2302.594	2303.588	2304.583	2305.579	2306.574	2307.569	2308.565	2309.561
159.1	2310.557	2311.554	2312.550	2313.547	2314.544	2315.542	2316.540	2317.537	2318.535	2319.533
159.2	2320.532	2321.531	2322.530	2323.529	2324.529	2325.528	2326.528	2327.529	2328.529	2329.530
159.3	2330.530	2331.531	2332.533	2333.534	2334.536	2335.538	2336.541	2337.543	2338.545	2339.549
159.4	2340.552	2341.555	2342.559	2343.563	2344.567	2345.571	2346.576	2347.581	2348.585	2349.591
159.5	2350.596	2351.602	2352.608	2353.614	2354.621	2355.627	2356.634	2357.642	2358.649	2359.656
159.6	2360.664	2361.672	2362.680	2363.689	2364.698	2365.707	2366.716	2367.726	2368.735	2369.745
159.7	2370.755	2371.766	2372.776	2373.787	2374.798	2375.810	2376.821	2377.833	2378.845	2379.857
159.8	2380.869	2381.882	2382.895	2383.908	2384.922	2385.936	2386.949	2387.963	2388.978	2389.992
159.9	2391.007	2392.022	2393.038	2394.053	2395.069	2396.085	2397.101	2398.117	2399.134	2400.151
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
160.0	2401.168	2402.185	2403.203	2404.220	2405.238	2406.257	2407.274	2408.293	2409.312	2410.330
160.1	2411.349	2412.368	2413.387	2414.407	2415.427	2416.446	2417.466	2418.487	2419.507	2420.527
160.2	2421.548	2422.569	2423.590	2424.611	2425.632	2426.654	2427.676	2428.698	2429.719	2430.742
160.3	2431.764	2432.787	2433.810	2434.833	2435.856	2436.879	2437.903	2438.926	2439.950	2440.974
160.4	2441.998	2443.022	2444.047	2445.072	2446.096	2447.122	2448.147	2449.172	2450.198	2451.224
160.5	2452.250	2453.276	2454.302	2455.329	2456.355	2457.382	2458.409	2459.436	2460.463	2461.491
160.6	2462.519	2463.546	2464.574	2465.603	2466.631	2467.660	2468.688	2469.718	2470.747	2471.776
160.7	2472.805	2473.835	2474.865	2475.895	2476.925	2477.955	2478.986	2480.016	2481.047	2482.078
160.8	2483.110	2484.141	2485.172	2486.204	2487.236	2488.268	2489.300	2490.333	2491.365	2492.398
160.9	2493.431	2494.464	2495.498	2496.531	2497.565	2498.598	2499.633	2500.667	2501.701	2502.736
161.0	2503.771	2504.805	2505.840	2506.875	2507.911	2508.946	2509.982	2511.017	2512.053	2513.089
161.1	2514.125	2515.161	2516.197	2517.234	2518.270	2519.307	2520.344	2521.381	2522.417	2523.455
161.2	2524.492	2525.530	2526.567	2527.604	2528.642	2529.680	2530.718	2531.757	2532.795	2533.833
161.3	2534.872	2535.910	2536.949	2537.988	2539.027	2540.066	2541.105	2542.145	2543.185	2544.224
161.4	2545.264	2546.304	2547.344	2548.384	2549.425	2550.465	2551.506	2552.546	2553.587	2554.628
161.5	2555.669	2556.710	2557.751	2558.793	2559.834	2560.876	2561.918	2562.960	2564.002	2565.044
161.6	2566.086	2567.129	2568.172	2569.214	2570.257	2571.300	2572.343	2573.386	2574.430	2575.473
161.7	2576.517	2577.561	2578.604	2579.648	2580.692	2581.737	2582.781	2583.825	2584.870	2585.915
161.8	2586.960	2588.005	2589.050	2590.095	2591.140	2592.186	2593.231	2594.277	2595.323	2596.369
161.9	2597.415	2598.461	2599.508	2600.554	2601.601	2602.648	2603.695	2604.742	2605.789	2606.836
162.0	2607.884	2608.931	2609.979	2611.026	2612.074	2613.122	2614.170	2615.218	2616.267	2617.315
162.1	2618.364	2619.412	2620.461	2621.510	2622.559	2623.607	2624.657	2625.706	2626.756	2627.805
162.2	2628.854	2629.904	2630.954	2632.004	2633.054	2634.104	2635.154	2636.205	2637.255	2638.306
162.3	2639.356	2640.407	2641.458	2642.509	2643.560	2644.612	2645.663	2646.714	2647.766	2648.817
162.4	2649.869	2650.921	2651.973	2653.025	2654.078	2655.130	2656.183	2657.235	2658.288	2659.341
162.5	2660.393	2661.446	2662.500	2663.553	2664.606	2665.659	2666.713	2667.767	2668.821	2669.874
162.6	2670.928	2671.982	2673.037	2674.091	2675.145	2676.200	2677.254	2678.309	2679.364	2680.419
162.7	2681.474	2682.530	2683.585	2684.640	2685.696	2686.751	2687.807	2688.863	2689.919	2690.975
162.8	2692.031	2693.087	2694.144	2695.200	2696.257	2697.314	2698.371	2699.427	2700.485	2701.542
162.9	2702.599	2703.656	2704.714	2705.771	2706.829	2707.887	2708.945	2710.003	2711.061	2712.119
163.0	2713.178	2714.237	2715.295	2716.354	2717.413	2718.471	2719.531	2720.590	2721.649	2722.708
163.1	2723.768	2724.827	2725.887	2726.947	2728.007	2729.066	2730.126	2731.187	2732.247	2733.307
163.2	2734.368	2735.428	2736.489	2737.550	2738.611	2739.671	2740.733	2741.794	2742.855	2743.917
163.3	2744.978	2746.040	2747.102	2748.163	2749.225	2750.287	2751.350	2752.412	2753.474	2754.537
163.4	2755.599	2756.662	2757.725	2758.787	2759.850	2760.914	2761.977	2763.040	2764.103	2765.167
163.5	2766.230	2767.294	2768.358	2769.422	2770.486	2771.550	2772.614	2773.678	2774.743	2775.808
163.6	2776.872	2777.937	2779.002	2780.067	2781.132	2782.197	2783.262	2784.327	2785.393	2786.458
163.7	2787.524	2788.590	2789.656	2790.722	2791.788	2792.854	2793.920	2794.987	2796.053	2797.120
163.8	2798.187	2799.254	2800.321	2801.388	2802.455	2803.522	2804.590	2805.657	2806.725	2807.792
163.9	2808.860	2809.928	2810.996	2812.064	2813.132	2814.200	2815.269	2816.337	2817.406	2818.475
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
164.0	2819.543	2820.613	2821.681	2822.750	2823.820	2824.889	2825.958	2827.028	2828.098	2829.167
164.1	2830.237	2831.307	2832.377	2833.448	2834.518	2835.588	2836.658	2837.729	2838.800	2839.871
164.2	2840.941	2842.012	2843.083	2844.155	2845.226	2846.297	2847.369	2848.440	2849.512	2850.584
164.3	2851.656	2852.728	2853.800	2854.872	2855.944	2857.017	2858.089	2859.162	2860.235	2861.307
164.4	2862.380	2863.453	2864.526	2865.600	2866.673	2867.746	2868.820	2869.893	2870.967	2872.041
164.5	2873.115	2874.189	2875.263	2876.337	2877.412	2878.486	2879.561	2880.635	2881.710	2882.785
164.6	2883.860	2884.935	2886.010	2887.085	2888.161	2889.236	2890.312	2891.387	2892.463	2893.539
164.7	2894.615	2895.691	2896.767	2897.844	2898.920	2899.997	2901.073	2902.150	2903.227	2904.303
164.8	2905.381	2906.458	2907.535	2908.612	2909.689	2910.767	2911.844	2912.922	2914.000	2915.078
164.9	2916.156	2917.234	2918.312	2919.391	2920.469	2921.548	2922.626	2923.705	2924.784	2925.863
165.0	2926.942	2928.021	2929.101	2930.180	2931.259	2932.339	2933.418	2934.498	2935.578	2936.658
165.1	2937.738	2938.818	2939.898	2940.979	2942.060	2943.140	2944.221	2945.302	2946.382	2947.463
165.2	2948.544	2949.625	2950.707	2951.788	2952.870	2953.951	2955.033	2956.115	2957.197	2958.279
165.3	2959.361	2960.443	2961.525	2962.608	2963.690	2964.773	2965.856	2966.938	2968.021	2969.104
165.4	2970.188	2971.271	2972.354	2973.438	2974.521	2975.605	2976.688	2977.772	2978.856	2979.940
165.5	2981.024	2982.109	2983.193	2984.278	2985.362	2986.447	2987.531	2988.616	2989.701	2990.787
165.6	2991.872	2992.957	2994.042	2995.128	2996.213	2997.299	2998.385	2999.470	3000.556	3001.643
165.7	3002.729	3003.815	3004.902	3005.988	3007.075	3008.161	3009.248	3010.335	3011.422	3012.509
165.8	3013.596	3014.684	3015.771	3016.858	3017.946	3019.034	3020.122	3021.210	3022.298	3023.386
165.9	3024.474	3025.562	3026.651	3027.739	3028.828	3029.917	3031.006	3032.094	3033.184	3034.273
166.0	3035.362	3036.451	3037.541	3038.630	3039.720	3040.810	3041.900	3042.990	3044.080	3045.170
166.1	3046.260	3047.351	3048.441	3049.531	3050.622	3051.713	3052.804	3053.895	3054.986	3056.077
166.2	3057.168	3058.260	3059.352	3060.443	3061.535	3062.626	3063.719	3064.811	3065.903	3066.995
166.3	3068.087	3069.179	3070.272	3071.365	3072.458	3073.550	3074.643	3075.736	3076.830	3077.923
166.4	3079.016	3080.110	3081.203	3082.297	3083.390	3084.484	3085.578	3086.672	3087.767	3088.861
166.5	3089.955	3091.050	3092.144	3093.239	3094.333	3095.428	3096.523	3097.618	3098.714	3099.809
166.6	3100.905	3102.000	3103.095	3104.191	3105.287	3106.383	3107.479	3108.575	3109.671	3110.768
166.7	3111.864	3112.960	3114.057	3115.154	3116.251	3117.348	3118.445	3119.542	3120.639	3121.737
166.8	3122.834	3123.931	3125.029	3126.127	3127.225	3128.323	3129.421	3130.519	3131.617	3132.716
166.9	3133.814	3134.913	3136.011	3137.110	3138.209	3139.308	3140.407	3141.506	3142.605	3143.705
167.0	3144.804	3145.904	3147.004	3148.104	3149.204	3150.303	3151.404	3152.504	3153.604	3154.705
167.1	3155.805	3156.906	3158.007	3159.107	3160.208	3161.309	3162.410	3163.512	3164.613	3165.715
167.2	3166.816	3167.918	3169.020	3170.122	3171.223	3172.325	3173.428	3174.530	3175.632	3176.735
167.3	3177.837	3178.940	3180.043	3181.146	3182.249	3183.352	3184.455	3185.559	3186.662	3187.765
167.4	3188.869	3189.973	3191.076	3192.180	3193.284	3194.389	3195.493	3196.597	3197.702	3198.806
167.5	3199.911	3201.016	3202.121	3203.226	3204.331	3205.436	3206.541	3207.646	3208.752	3209.857
167.6	3210.963	3212.069	3213.175	3214.281	3215.387	3216.493	3217.600	3218.706	3219.812	3220.919
167.7	3222.026	3223.133	3224.240	3225.346	3226.454	3227.561	3228.668	3229.776	3230.883	3231.991
167.8	3233.099	3234.207	3235.314	3236.423	3237.531	3238.639	3239.748	3240.856	3241.965	3243.073
167.9	3244.182	3245.291	3246.400	3247.509	3248.618	3249.728	3250.837	3251.946	3253.056	3254.166
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
168.0	3255.275	3256.385	3257.496	3258.605	3259.716	3260.826	3261.937	3263.047	3264.158	3265.269
168.1	3266.379	3267.490	3268.602	3269.712	3270.824	3271.935	3273.047	3274.158	3275.270	3276.382
168.2	3277.494	3278.606	3279.718	3280.830	3281.942	3283.055	3284.167	3285.280	3286.393	3287.506
168.3	3288.618	3289.731	3290.844	3291.958	3293.071	3294.185	3295.298	3296.412	3297.525	3298.639
168.4	3299.753	3300.867	3301.982	3303.096	3304.210	3305.325	3306.439	3307.554	3308.669	3309.784
168.5	3310.899	3312.014	3313.129	3314.244	3315.360	3316.476	3317.591	3318.707	3319.823	3320.939
168.6	3322.055	3323.171	3324.287	3325.404	3326.520	3327.636	3328.753	3329.870	3330.987	3332.104
168.7	3333.221	3334.338	3335.456	3336.573	3337.690	3338.808	3339.926	3341.043	3342.162	3343.280
168.8	3344.397	3345.516	3346.634	3347.752	3348.871	3349.990	3351.108	3352.227	3353.346	3354.465
168.9	3355.584	3356.704	3357.823	3358.943	3360.062	3361.182	3362.302	3363.421	3364.542	3365.662
169.0	3366.782	3367.902	3369.023	3370.143	3371.264	3372.385	3373.506	3374.626	3375.748	3376.868
169.1	3377.990	3379.111	3380.233	3381.354	3382.476	3383.598	3384.719	3385.842	3386.964	3388.086
169.2	3389.208	3390.331	3391.453	3392.576	3393.698	3394.821	3395.944	3397.067	3398.190	3399.313
169.3	3400.437	3401.560	3402.684	3403.808	3404.931	3406.055	3407.179	3408.303	3409.427	3410.552
169.4	3411.676	3412.801	3413.925	3415.050	3416.175	3417.300	3418.425	3419.550	3420.675	3421.800
169.5	3422.926	3424.051	3425.177	3426.303	3427.428	3428.554	3429.680	3430.807	3431.933	3433.059
169.6	3434.186	3435.312	3436.439	3437.566	3438.693	3439.820	3440.947	3442.074	3443.201	3444.329
169.7	3445.457	3446.584	3447.712	3448.840	3449.968	3451.096	3452.224	3453.352	3454.480	3455.609
169.8	3456.738	3457.866	3458.995	3460.124	3461.253	3462.382	3463.511	3464.640	3465.770	3466.899
169.9	3468.029	3469.159	3470.289	3471.418	3472.549	3473.679	3474.809	3475.939	3477.070	3478.200
170.0	3479.331	3480.462	3481.593	3482.724	3483.855	3484.986	3486.117	3487.249	3488.380	3489.512
170.1	3490.644	3491.775	3492.907	3494.039	3495.171	3496.304	3497.436	3498.569	3499.701	3500.834
170.2	3501.967	3503.099	3504.232	3505.365	3506.499	3507.632	3508.765	3509.899	3511.032	3512.166
170.3	3513.300	3514.434	3515.568	3516.702	3517.836	3518.971	3520.105	3521.240	3522.375	3523.509
170.4	3524.644	3525.779	3526.914	3528.050	3529.185	3530.320	3531.456	3532.591	3533.727	3534.863
170.5	3535.999	3537.135	3538.271	3539.407	3540.543	3541.680	3542.816	3543.953	3545.090	3546.227
170.6	3547.364	3548.501	3549.638	3550.775	3551.913	3553.051	3554.188	3555.326	3556.463	3557.602
170.7	3558.740	3559.878	3561.016	3562.154	3563.293	3564.431	3565.570	3566.709	3567.848	3568.987
170.8	3570.126	3571.265	3572.404	3573.544	3574.683	3575.823	3576.962	3578.103	3579.242	3580.383
170.9	3581.522	3582.663	3583.803	3584.944	3586.084	3587.225	3588.366	3589.507	3590.647	3591.789
171.0	3592.930	3594.073	3595.218	3596.365	3597.515	3598.667	3599.822	3600.980	3602.140	3603.302
171.1	3604.467	3605.635	3606.804	3607.977	3609.152	3610.329	3611.509	3612.691	3613.876	3615.063
171.2	3616.253	3617.445	3618.640	3619.837	3621.037	3622.239	3623.444	3624.651	3625.861	3627.073
171.3	3628.288	3629.505	3630.725	3631.947	3633.171	3634.398	3635.628	3636.860	3638.094	3639.332
171.4	3640.571	3641.813	3643.058	3644.305	3645.554	3646.806	3648.061	3649.318	3650.577	3651.839
171.5	3653.104	3654.371	3655.640	3656.912	3658.186	3659.463	3660.742	3662.024	3663.309	3664.595
171.6	3665.885	3667.177	3668.471	3669.768	3671.067	3672.368	3673.673	3674.979	3676.289	3677.601
171.7	3678.915	3680.231	3681.551	3682.872	3684.197	3685.523	3686.852	3688.184	3689.518	3690.854
171.8	3692.194	3693.535	3694.879	3696.226	3697.575	3698.927	3700.281	3701.637	3702.996	3704.357
171.9	3705.721	3707.088	3708.457	3709.828	3711.202	3712.579	3713.958	3715.339	3716.723	3718.109
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET

ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
172.0	3719.498	3720.888	3722.279	3723.670	3725.061	3726.453	3727.845	3729.238	3730.631	3732.024
172.1	3733.417	3734.812	3736.206	3737.601	3738.996	3740.391	3741.787	3743.183	3744.580	3745.977
172.2	3747.374	3748.772	3750.170	3751.568	3752.967	3754.366	3755.766	3757.166	3758.566	3759.967
172.3	3761.367	3762.769	3764.171	3765.573	3766.975	3768.378	3769.781	3771.185	3772.589	3773.993
172.4	3775.398	3776.803	3778.208	3779.614	3781.021	3782.427	3783.834	3785.241	3786.649	3788.057
172.5	3789.466	3790.874	3792.283	3793.693	3795.103	3796.513	3797.924	3799.335	3800.746	3802.158
172.6	3803.570	3804.982	3806.395	3807.809	3809.222	3810.636	3812.051	3813.465	3814.880	3816.296
172.7	3817.711	3819.128	3820.544	3821.961	3823.378	3824.796	3826.214	3827.633	3829.051	3830.470
172.8	3831.890	3833.310	3834.730	3836.151	3837.572	3838.993	3840.415	3841.837	3843.259	3844.682
172.9	3846.105	3847.529	3848.953	3850.377	3851.802	3853.227	3854.653	3856.078	3857.504	3858.931
173.0	3860.358	3861.785	3863.213	3864.641	3866.069	3867.498	3868.927	3870.357	3871.787	3873.217
173.1	3874.647	3876.079	3877.510	3878.941	3880.374	3881.806	3883.239	3884.672	3886.106	3887.540
173.2	3888.974	3890.409	3891.844	3893.279	3894.715	3896.151	3897.588	3899.024	3900.462	3901.899
173.3	3903.337	3904.776	3906.215	3907.654	3909.093	3910.533	3911.973	3913.414	3914.855	3916.296
173.4	3917.738	3919.180	3920.623	3922.065	3923.509	3924.952	3926.396	3927.840	3929.285	3930.730
173.5	3932.176	3933.621	3935.067	3936.514	3937.961	3939.408	3940.856	3942.304	3943.752	3945.201
173.6	3946.650	3948.100	3949.549	3951.000	3952.450	3953.901	3955.353	3956.804	3958.256	3959.709
173.7	3961.162	3962.615	3964.068	3965.522	3966.977	3968.431	3969.886	3971.342	3972.797	3974.253
173.8	3975.710	3977.167	3978.624	3980.082	3981.540	3982.998	3984.457	3985.916	3987.375	3988.835
173.9	3990.295	3991.756	3993.217	3994.678	3996.140	3997.602	3999.064	4000.527	4001.990	4003.454
174.0	4004.918	4006.382	4007.847	4009.312	4010.777	4012.243	4013.709	4015.176	4016.643	4018.110
174.1	4019.577	4021.045	4022.514	4023.982	4025.452	4026.921	4028.391	4029.861	4031.332	4032.803
174.2	4034.274	4035.746	4037.218	4038.690	4040.163	4041.636	4043.110	4044.583	4046.058	4047.532
174.3	4049.008	4050.483	4051.959	4053.435	4054.911	4056.388	4057.865	4059.343	4060.821	4062.299
174.4	4063.778	4065.257	4066.737	4068.216	4069.697	4071.177	4072.658	4074.139	4075.621	4077.103
174.5	4078.585	4080.068	4081.552	4083.035	4084.519	4086.003	4087.488	4088.973	4090.458	4091.944
174.6	4093.430	4094.917	4096.403	4097.891	4099.378	4100.866	4102.354	4103.843	4105.332	4106.822
174.7	4108.312	4109.802	4111.292	4112.783	4114.274	4115.766	4117.258	4118.750	4120.243	4121.736
174.8	4123.230	4124.724	4126.218	4127.713	4129.208	4130.703	4132.199	4133.695	4135.191	4136.688
174.9	4138.186	4139.683	4141.181	4142.679	4144.178	4145.677	4147.176	4148.676	4150.176	4151.677
175.0	4153.178	4154.679	4156.181	4157.683	4159.185	4160.688	4162.191	4163.695	4165.199	4166.703
175.1	4168.208	4169.712	4171.218	4172.724	4174.230	4175.736	4177.243	4178.750	4180.258	4181.766
175.2	4183.274	4184.783	4186.292	4187.801	4189.311	4190.821	4192.332	4193.842	4195.354	4196.866
175.3	4198.377	4199.890	4201.402	4202.916	4204.429	4205.943	4207.458	4208.972	4210.487	4212.002
175.4	4213.518	4215.034	4216.550	4218.067	4219.584	4221.102	4222.620	4224.139	4225.657	4227.176
175.5	4228.695	4230.215	4231.735	4233.256	4234.777	4236.298	4237.819	4239.341	4240.864	4242.387
175.6	4243.910	4245.434	4246.958	4248.481	4250.006	4251.531	4253.057	4254.582	4256.108	4257.634
175.7	4259.162	4260.688	4262.216	4263.744	4265.272	4266.801	4268.330	4269.859	4271.390	4272.919
175.8	4274.450	4275.981	4277.512	4279.043	4280.576	4282.108	4283.641	4285.174	4286.708	4288.241
175.9	4289.775	4291.310	4292.845	4294.380	4295.916	4297.452	4298.988	4300.525	4302.062	4303.600
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET										
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
176.0	4305.138	4306.676	4308.215	4309.754	4311.293	4312.833	4314.374	4315.914	4317.455	4318.996
176.1	4320.538	4322.080	4323.622	4325.165	4326.708	4328.251	4329.795	4331.339	4332.883	4334.429
176.2	4335.974	4337.520	4339.065	4340.612	4342.159	4343.706	4345.253	4346.801	4348.350	4349.898
176.3	4351.447	4352.997	4354.546	4356.097	4357.647	4359.198	4360.750	4362.301	4363.853	4365.405
176.4	4366.958	4368.511	4370.064	4371.619	4373.172	4374.727	4376.282	4377.837	4379.393	4380.949
176.5	4382.505	4384.062	4385.620	4387.177	4388.735	4390.293	4391.852	4393.411	4394.970	4396.530
176.6	4398.090	4399.650	4401.211	4402.772	4404.334	4405.896	4407.458	4409.021	4410.584	4412.147
176.7	4413.711	4415.275	4416.840	4418.405	4419.971	4421.536	4423.102	4424.668	4426.235	4427.803
176.8	4429.370	4430.938	4432.506	4434.075	4435.644	4437.213	4438.783	4440.353	4441.923	4443.494
176.9	4445.065	4446.637	4448.209	4449.782	4451.354	4452.927	4454.500	4456.075	4457.648	4459.223
177.0	4460.798	4462.374	4463.949	4465.525	4467.102	4468.678	4470.255	4471.833	4473.411	4474.989
177.1	4476.567	4478.146	4479.726	4481.306	4482.886	4484.466	4486.047	4487.628	4489.209	4490.792
177.2	4492.374	4493.957	4495.540	4497.123	4498.707	4500.291	4501.875	4503.460	4505.046	4506.631
177.3	4508.217	4509.804	4511.391	4512.978	4514.565	4516.153	4517.742	4519.330	4520.919	4522.508
177.4	4524.098	4525.688	4527.278	4528.870	4530.460	4532.052	4533.644	4535.236	4536.829	4538.422
177.5	4540.016	4541.609	4543.204	4544.798	4546.393	4547.988	4549.583	4551.180	4552.776	4554.373
177.6	4555.970	4557.567	4559.166	4560.764	4562.362	4563.961	4565.561	4567.160	4568.760	4570.360
177.7	4571.961	4573.562	4575.164	4576.766	4578.369	4579.971	4581.574	4583.178	4584.782	4586.386
177.8	4587.990	4589.595	4591.200	4592.806	4594.412	4596.018	4597.625	4599.232	4600.839	4602.447
177.9	4604.056	4605.664	4607.273	4608.882	4610.492	4612.102	4613.712	4615.324	4616.935	4618.546
178.0	4620.158	4621.771	4623.383	4624.996	4626.609	4628.223	4629.837	4631.452	4633.066	4634.682
178.1	4636.297	4637.914	4639.530	4641.146	4642.764	4644.381	4645.999	4647.618	4649.236	4650.855
178.2	4652.474	4654.094	4655.714	4657.334	4658.956	4660.577	4662.198	4663.820	4665.442	4667.065
178.3	4668.688	4670.312	4671.935	4673.560	4675.184	4676.809	4678.434	4680.060	4681.686	4683.312
178.4	4684.939	4686.566	4688.193	4689.821	4691.450	4693.078	4694.707	4696.336	4697.966	4699.597
178.5	4701.227	4702.857	4704.489	4706.121	4707.752	4709.384	4711.018	4712.650	4714.284	4715.917
178.6	4717.552	4719.187	4720.821	4722.457	4724.092	4725.728	4727.364	4729.001	4730.639	4732.276
178.7	4733.914	4735.552	4737.191	4738.830	4740.469	4742.109	4743.749	4745.390	4747.030	4748.671
178.8	4750.313	4751.955	4753.598	4755.240	4756.883	4758.526	4760.170	4761.814	4763.459	4765.104
178.9	4766.750	4768.395	4770.041	4771.688	4773.334	4774.981	4776.629	4778.277	4779.925	4781.574
179.0	4783.223	4784.873	4786.522	4788.172	4789.823	4791.474	4793.125	4794.776	4796.429	4798.081
179.1	4799.733	4801.387	4803.040	4804.694	4806.348	4808.002	4809.658	4811.313	4812.968	4814.625
179.2	4816.281	4817.938	4819.595	4821.252	4822.911	4824.569	4826.228	4827.887	4829.546	4831.206
179.3	4832.866	4834.526	4836.188	4837.849	4839.510	4841.172	4842.834	4844.498	4846.161	4847.824
179.4	4849.488	4851.152	4852.816	4854.481	4856.147	4857.812	4859.479	4861.145	4862.812	4864.479
179.5	4866.146	4867.814	4869.483	4871.151	4872.820	4874.490	4876.160	4877.830	4879.500	4881.171
179.6	4882.843	4884.515	4886.187	4887.859	4889.532	4891.205	4892.878	4894.552	4896.227	4897.901
179.7	4899.576	4901.251	4902.927	4904.603	4906.279	4907.957	4909.633	4911.311	4912.989	4914.667
179.8	4916.346	4918.025	4919.705	4921.384	4923.064	4924.745	4926.426	4928.107	4929.789	4931.471
179.9	4933.153	4934.836	4936.520	4938.203	4939.887	4941.571	4943.255	4944.940	4946.626	4948.312
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09

**TABLE 7-4 (Continued)**

**SAM RAYBURN RESERVOIR - ELEVATION CAPACITY TABLE**

ELEVATIONS IN FEET-NGVD, CAPACITIES IN THOUSAND ACRE-FEET										
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
180.0	4949.998	4951.685	4953.372	4955.059	4956.746	4958.434	4960.123	4961.811	4963.500	4965.190
180.1	4966.879	4968.570	4970.261	4971.952	4973.643	4975.334	4977.026	4978.719	4980.412	4982.105
180.2	4983.798	4985.493	4987.187	4988.881	4990.577	4992.272	4993.967	4995.664	4997.360	4999.057
180.3	5000.754	5002.452	5004.150	5005.849	5007.547	5009.247	5010.946	5012.646	5014.346	5016.046
180.4	5017.748	5019.449	5021.150	5022.853	5024.556	5026.258	5027.961	5029.665	5031.369	5033.074
180.5	5034.778	5036.483	5038.188	5039.895	5041.601	5043.307	5045.014	5046.722	5048.429	5050.137
180.6	5051.846	5053.555	5055.264	5056.973	5058.683	5060.394	5062.104	5063.815	5065.526	5067.238
180.7	5068.951	5070.663	5072.376	5074.089	5075.803	5077.517	5079.231	5080.946	5082.661	5084.376
180.8	5086.092	5087.809	5089.525	5091.242	5092.959	5094.678	5096.396	5098.114	5099.833	5101.552
180.9	5103.271	5104.992	5106.712	5108.433	5110.153	5111.875	5113.597	5115.319	5117.042	5118.765
181.0	5120.488	5122.211	5123.936	5125.660	5127.385	5129.110	5130.835	5132.562	5134.288	5136.015
181.1	5137.742	5139.469	5141.197	5142.925	5144.653	5146.382	5148.111	5149.841	5151.571	5153.301
181.2	5155.033	5156.764	5158.495	5160.227	5161.959	5163.692	5165.424	5167.158	5168.892	5170.626
181.3	5172.360	5174.095	5175.831	5177.566	5179.302	5181.039	5182.775	5184.512	5186.250	5187.987
181.4	5189.726	5191.464	5193.203	5194.942	5196.682	5198.422	5200.163	5201.903	5203.645	5205.386
181.5	5207.128	5208.870	5210.613	5212.356	5214.100	5215.843	5217.587	5219.332	5221.077	5222.822
181.6	5224.567	5226.313	5228.060	5229.807	5231.554	5233.301	5235.049	5236.797	5238.546	5240.295
181.7	5242.044	5243.794	5245.544	5247.294	5249.045	5250.796	5252.548	5254.300	5256.053	5257.805
181.8	5259.559	5261.312	5263.065	5264.820	5266.575	5268.330	5270.084	5271.840	5273.597	5275.353
181.9	5277.109	5278.867	5280.624	5282.382	5284.141	5285.899	5287.658	5289.417	5291.177	5292.938
182.0	5294.698	5296.459	5298.220	5299.982	5301.744	5303.506	5305.270	5307.033	5308.796	5310.560
182.1	5312.325	5314.089	5315.854	5317.621	5319.387	5321.152	5322.919	5324.687	5326.455	5328.222
182.2	5329.991	5331.759	5333.528	5335.298	5337.068	5338.838	5340.609	5342.380	5344.151	5345.923
182.3	5347.696	5349.468	5351.242	5353.015	5354.789	5356.563	5358.338	5360.113	5361.889	5363.664
182.4	5365.440	5367.217	5368.994	5370.771	5372.549	5374.328	5376.106	5377.885	5379.665	5381.444
182.5	5383.224	5385.005	5386.786	5388.567	5390.349	5392.131	5393.914	5395.696	5397.479	5399.264
182.6	5401.047	5402.832	5404.617	5406.402	5408.188	5409.974	5411.760	5413.547	5415.334	5417.122
182.7	5418.910	5420.698	5422.487	5424.276	5426.066	5427.855	5429.646	5431.437	5433.228	5435.020
182.8	5436.812	5438.604	5440.396	5442.189	5443.983	5445.777	5447.571	5449.366	5451.161	5452.957
182.9	5454.752	5456.549	5458.346	5460.143	5461.940	5463.738	5465.536	5467.334	5469.133	5470.933
ELEV	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09